07/26/2011)

07/27/2011 68 ORDER granting 64 Motion for Extension of Time to Answer. Deft True Context Mobile Solutions Corporation's time to answer or otherwise respond to pltf's Complaint is extended to 8-31-2011. Signed by Judge Leonard Davis on 07/27/11. cc:attys 7-27-11 (mll,) (Entered: 07/27/2011)

07/27/2011 69 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Xora, Inc.(Price, Adam) (Entered: 07/27/2011)

07/28/2011 70 Agilis ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Agilis Systems, LLC.(Nolte, Nelson) (Entered: 07/28/2011)

07/28/2011 71 Realtime Results ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Realtime Results, LLC.(Nolte, Nelson) (Entered: 07/28/2011)

07/28/2011 72 NOTICE of Attorney Appearance by Gregory Loren Maag on behalf of Invensys Systems, Inc. (Maag, Gregory) (Entered: 07/28/2011)

07/28/2011 73 ***FILED IN ERROR. SHOULD BE REFILED AS AN APPLICTION FOR EXTENSION OF TIME TO ANSWER*** Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, by Invensys Systems, Inc.. (Attachments: # 1 Text of Proposed Order Granting Motion)(Warden, Thomas) Modified on 7/29/2011 (mll,). (Entered: 07/28/2011)

07/28/2011 74 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re The DataMAX Software Group Inc.(Pogorzelski, Henry) (Entered: 07/28/2011)

07/28/2011 75 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, by Cengea Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Lee, Joseph) (Entered: 07/28/2011)

07/29/2011 Defendant's Unopposed First Application for Extension of Time to Answer Complaint 60 is granted pursuant to Local Rule CV-12 for Spira Data Corp. to 8/22/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 ***FILED IN ERROR. Document # 73 Unopposed Motion. PLEASE IGNORE. TO BE REFILED AS UNOPPOSED APPLICATION FOR EXTENSION OF TIME.*** (mjc,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 61 is granted pursuant to Local Rule CV-12 for Data Systems International, Inc. to 8/31/2011. 20 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed First Application for Extension of Time to Answer Complaint 63 is granted pursuant to Local Rule CV-12 for Millenium Information Technology, Inc. to 8/19/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 66 is granted pursuant to Local Rule CV-12 for Ventyx Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 67 is granted pursuant to Local Rule CV-12 for Environmental Systems Research Institute, Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 69 is granted pursuant to Local Rule CV-12 for Xora, Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 74 is granted pursuant to Local Rule CV-12 for The DataMAX Software Group Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 07/29/2011)

07/29/2011 76 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, (Refiled Pursuant to Clerk's Entry on Docket No. 73) by Invensys Systems, Inc.. (Attachments: # 1 Text of Proposed Order Granting Motion)(Warden, Thomas) (Entered: 07/29/2011)

07/29/2011 77 ORDER granting 75 Motion for Extension of Time to Answer. Deft Cengea Solutions Inc's time to answer or otherwise respond to pltf's Complaint is extended to 8-31-2011. Signed by Judge Leonard Davis on 07/29/11. cc:attys 7-29-11 (mll,) (Entered: 07/29/2011)

07/29/2011 78 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Zerion Software, Inc..(Ragland, William) (Entered: 07/29/2011)

08/01/2011 79 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Air2Web Inc..(Thompson, Larry) (Entered: 08/01/2011)

08/01/2011 80 NOTICE of Attorney Appearance by Eric Hugh Findlay on behalf of Survey Analytics LLC

(Findlay, Eric) (Entered: 08/01/2011)

08/01/2011 81 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, or Otherwise Respond by Survey Analytics LLC. (Attachments: # 1 Text of Proposed Order)(Craft, Roger) (Entered: 08/01/2011)

08/01/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 78 is granted pursuant to Local Rule CV-12 for Zerion Software, Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 08/01/2011)

08/01/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 79 is granted pursuant to Local Rule CV-12 for Air2Web Inc. to 8/16/2011. 15 Days Granted for Deadline Extension. (Filed by pltf on behalf of deft.)(mll,) (Entered: 08/01/2011)

08/02/2011 82 ORDER granting 76 Motion for Extension of Time to Answer. Defendant Invensys Systems, Inc. is granted a 30-day extension of time to 8-31-2011 to answer or otherwise respond to Plaintiffs Complaint. Signed by Judge Leonard Davis on 08/02/11. cc:attys 8-02-11 (mll,) (Entered: 08/02/2011)

08/02/2011 83 ORDER granting 81 Motion for Extension of Time to Answer. Deft Survey Analytics LLC shall have to 8-31-2011 to move, answer, or otherwise respond to Plaintiffs Complaint. Signed by Judge Leonard Davis on 08/02/11. cc:attys 8-02-11 (mll,) (Entered: 08/02/2011)

08/03/2011 84 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Spring Wireless USA, Inc..(Campbell, Christopher) (Entered: 08/03/2011)

08/03/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 84 is granted pursuant to Local Rule CV-12 for Spring Wireless USA, Inc. to 8/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 08/03/2011)

08/09/2011 85 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re BizSpeed, Inc..(Cornelius, William) (Entered: 08/09/2011)

08/09/2011 86 APPLICATION to Appear Pro Hac Vice by Attorney Mark S Carlson for Survey Analytics LLC. (mll,) (Entered: 08/10/2011)

08/10/2011 Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 85 is granted pursuant to Local Rule CV-12 for BizSpeed, Inc. to 9/6/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 08/10/2011)

08/17/2011 87 Syclo, LLC's ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Syclo, L.L.C..(McSwane, Douglas) (Entered: 08/17/2011)

08/18/2011 88 ANSWER to 70 Answer to Complaint, Counterclaim of Agilis Systems by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 08/18/2011)

08/18/2011 89 ANSWER to 71 Answer to Complaint, Counterclaim of Realtime Results by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 08/18/2011)

08/18/2011 90 ANSWER to 87 Answer to Complaint, Counterclaim of Syclo, LLC by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 08/18/2011)

08/19/2011 91 NOTICE of Attorney Appearance by Darryl M Woo on behalf of Environmental Systems Research Institute, Inc. (Woo, Darryl) (Entered: 08/19/2011)

08/22/2011 92 MOTION to Dismiss by Spira Data Corp.. (Attachments: # 1 Text of Proposed Order, # 2 Exhibit A)(Lawson, Carroll) (Entered: 08/22/2011)

08/24/2011 93 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint re Antenna Software, Inc..(Perque, Chris) (Entered: 08/24/2011)

08/25/2011 94 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, for Defendant Air2Web, Inc. by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 08/25/2011)

08/26/2011 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint 93 is granted pursuant to Local Rule CV-12 for Antenna Software, Inc. to 9/12/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 08/26/2011)

08/29/2011 95 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint re Zerion Software, Inc..(Ragland, William) (Entered: 08/29/2011)

08/29/2011 96 ORDER granting 94 Motion for Extension of Time to Answer. DefendantAir2Web Inc.s deadline to answer or otherwise respond to the Complaint is extended to 9-15-2011. Signed by Judge Leonard Davis on 08/29/11. cc:attys 8-29-11 (mll,) (Entered: 08/29/2011)

08/29/2011 97 RESPONSE in Opposition re 92 MOTION to Dismiss of Spira Data Corp. filed by MacroSolve, Inc.. (Attachments: # 1 Exhibit 1 [Spira Website], # 2 Text of Proposed Order)(Antonelli, Matthew) (Entered: 08/29/2011)

08/30/2011 98 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, by The DataMAX Software Group Inc.. (Attachments: # 1 Text of Proposed Order Proposed Order)(Pogorzelski, Henry) (Entered: 08/30/2011)

08/30/2011 99 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint re Data Systems International, Inc..(Marriott, Michelle) (Entered: 08/30/2011)

08/30/2011 100 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint re Spring Wireless USA, Inc..(Campbell, Christopher) (Entered: 08/30/2011)

08/30/2011 101 MOTION to Dismiss by TrueContext Mobile Solutions Corporation. (Attachments: # 1 Heartfield Declaration, # 2 Exhibit A, # 3 Proposed Order)(Heartfield, J) (Entered: 08/30/2011)

08/30/2011 102 Defendant Xora, Inc.'s ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Xora, Inc..(Price, Adam) (Entered: 08/30/2011)

08/30/2011 103 Unopposed MOTION for Extension of Time to File Answer Complaint by Cengea Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Lee, Joseph) (Entered: 08/30/2011)

08/31/2011 104 ORDER granting 98 Motion for Extension of Time to Answer. Defendant The DataMAX Software Group Inc. shall have until 9-30-2011 to answer, move or otherwise respond to plaintiffs Original Complaint. Signed by Judge Leonard Davis on 08/31/11. cc:attys 8-31-11 (mll,) (Entered: 08/31/2011)

08/31/2011 105 ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Ventyx Inc.. (Auvil, Steven) (Entered: 08/31/2011)

08/31/2011 106 ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Environmental Systems Research Institute, Inc..(Woo, Darryl) (Entered: 08/31/2011)

08/31/2011 107 ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by Invensys Systems, Inc..(Warden, Thomas) (Entered: 08/31/2011)

08/31/2011 108 CORPORATE DISCLOSURE STATEMENT filed by Invensys Systems, Inc. identifying Corporate Parent Siebe, Inc., Other Affiliate Invensys PLC, Other Affiliate Invensys Group Holdings Ltd., Other Affiliate Invensys, Inc., Other Affiliate Invensys Group Ltd. for Invensys Systems, Inc.. (Warden, Thomas) (Entered: 08/31/2011)

08/31/2011 109 ANSWER to 1 Complaint,, Affirmative Defenses, COUNTERCLAIM against MacroSolve, Inc. by Survey Analytics LLC.(Craft, Roger) (Entered: 08/31/2011)

08/31/2011 110 CORPORATE DISCLOSURE STATEMENT filed by Xora, Inc. (Price, Adam) (Entered: 08/31/2011)

08/31/2011 111 ANSWER to 106 Answer to Complaint, Counterclaim of ESRI by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 08/31/2011)

08/31/2011 112 ANSWER to 107 Answer to Complaint, Counterclaim of Invensys by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 08/31/2011)

08/31/2011 113 ANSWER to 109 Answer to Complaint, Counterclaim of Survey Analytics by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 08/31/2011)

08/31/2011 114 ANSWER to 105 Answer to Complaint, Counterclaim of Ventyx by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 08/31/2011)

08/31/2011 115 ANSWER to 102 Answer to Complaint, Counterclaim of Xora by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 08/31/2011)

09/01/2011 116 RESPONSE in Opposition re 101 MOTION to Dismiss of TrueContext filed by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 09/01/2011)

09/01/2011 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint 95 is granted pursuant to Local Rule CV-12 for Zerion Software, Inc. to 9/30/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/01/2011)

09/01/2011 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint 99 is granted pursuant to Local Rule CV-12 for Data Systems International, Inc. to 9/29/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/01/2011)

09/01/2011 Defendant's Unopposed Third Application for Extension of Time to Answer Complaint 100 is granted pursuant to Local Rule CV-12 for Spring Wireless USA, Inc. to 10/1/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/01/2011)

09/01/2011 117 CORPORATE DISCLOSURE STATEMENT filed by Syclo, L.L.C. identifying Corporate Parent None for Syclo, L.L.C.. (McSwane, Douglas) (Entered: 09/01/2011)

09/01/2011 118 NOTICE of Settlement as to Cengea Solutions, Inc. by MacroSolve, Inc. (Thompson, Larry) (Entered: 09/01/2011)

09/02/2011 119 CORPORATE DISCLOSURE STATEMENT filed by Agilis Systems, LLC identifying Corporate Parent Gilead Group, LLC. for Agilis Systems, LLC. (Nolte, Nelson) (Entered: 09/02/2011)

09/02/2011 120 CORPORATE DISCLOSURE STATEMENT filed by Realtime Results, LLC identifying Corporate Parent Gilead Group, LLC. for Realtime Results, LLC. (Nolte, Nelson) (Entered: 09/02/2011)

09/02/2011 121 CORPORATE DISCLOSURE STATEMENT filed by Ventyx Inc. identifying Corporate Parent Abb Inc. for Ventyx Inc.. (Auvil, Steven) (Entered: 09/02/2011)

09/02/2011 122 Unopposed MOTION for Extension of Time to File Answer UNOPPOSED THIRD MOTION FOR EXTENSION OF TIME TO ANSWER OR OTHERWISE RESPOND TO COMPLAINT by BizSpeed, Inc.. (Attachments: # 1 Text of Proposed Order)(Cornelius, William) (Entered: 09/02/2011)

09/06/2011 123 CORPORATE DISCLOSURE STATEMENT filed by Environmental Systems Research Institute, Inc. (Woo, Darryl) (Entered: 09/06/2011)

09/06/2011 124 ORDER granting 122 Motion for Extension of Time to Answer. Defendant Bizspeed, Inc. shall have to 10-06-2011 to answer or otherwise respond to Plaintiff's Complaint. Signed by Judge Leonard Davis on 09/06/11. cc:attys 9-07-11 (mll,) (Entered: 09/07/2011)

09/07/2011 125 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint re Antenna Software, Inc..(Perque, Chris) (Entered: 09/07/2011)

09/09/2011 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint 125 is granted pursuant to Local Rule CV-12 for Antenna Software, Inc. to 9/26/2011. 14 Days Granted for Deadline Extension.(mll,) (Entered: 09/09/2011)

09/09/2011 126 REPLY to Response to Motion re 92 MOTION to Dismiss filed by Spira Data Corp.. (Attachments: # 1 Exhibit B, # 2 Exhibit C, # 3 Exhibit D)(Johnson, Timothy) (Entered: 09/09/2011)

09/12/2011 127 REPLY to Response to Motion re 101 MOTION to Dismiss filed by TrueContext Mobile Solutions Corporation. (Attachments: # 1 Exhibit B, # 2 Exhibit C, # 3 Exhibit D) (Heartfield, J) (Entered: 09/12/2011)

09/13/2011 128 CORPORATE DISCLOSURE STATEMENT filed by TrueContext Mobile Solutions Corporation identifying Corporate Parent None for TrueContext Mobile Solutions Corporation. (Heartfield, J) (Entered: 09/13/2011)

09/14/2011 129 SUR-REPLY to Reply to Response to Motion re 92 MOTION to Dismiss of Spira Data filed by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 09/14/2011)

09/14/2011 130 SUR-REPLY to Reply to Response to Motion re 101 MOTION to Dismiss of TrueContext filed by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 09/14/2011)

09/19/2011 131 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint re Antenna Software, Inc..(Perque, Chris) (Entered: 09/19/2011)

09/19/2011 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint 131 is granted pursuant to Local Rule CV-12 for Antenna Software, Inc. to 10/26/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/19/2011)

09/22/2011 132 NOTICE by MacroSolve, Inc. of Dismissal of Cengea Solutions, Inc. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 09/22/2011)

09/28/2011 133 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, for Defendant Air2Web, Inc. by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 09/28/2011)

09/28/2011 134 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint re Data Systems International, Inc..(Marriott, Michelle) (Entered: 09/28/2011)

09/28/2011 135 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint re Zerion Software, Inc..(Ragland, William) (Entered: 09/28/2011)

09/29/2011 136 ORDER granting 132 Notice of Dismissal filed by MacroSolve, Inc. All claims by MacroSolve against Cengea in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and cost. Signed by Judge Leonard Davis on 09/29/11. cc:attys 9-29-11(mll,) (Entered: 09/29/2011)

09/29/2011 137 ORDER granting 133 Motion for Extension of Time to Answer. DefendantAir2Web Inc.s deadline to answer or otherwise respond to the Complaint is extended to 10-17-2011. Signed by Judge Leonard Davis on 09/29/11. cc:attys 9-29-11 (mll,) (Entered: 09/29/2011)

09/30/2011 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint 134 is granted pursuant to Local Rule CV-12 for Data Systems International, Inc. to

10/28/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/30/2011)

09/30/2011 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint 135 is granted pursuant to Local Rule CV-12 for Zerion Software, Inc. to 10/31/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 09/30/2011)

09/30/2011 138 ***DOCUMENT FILED IN ERROR. PLEASE DISREGARD.*** Defendant The DataMAX Software Group, Inc. ANSWER to 1 Complaint,, of Plaintiff MacroSolve by The DataMAX Software Group Inc..(Collins, Michael) Modified on 10/3/2011 (mjc,). (Entered: 09/30/2011)

09/30/2011 139 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint re Spring Wireless USA, Inc..(Campbell, Christopher) (Entered: 09/30/2011)

10/03/2011 Defendant's Unopposed Fourth Application for Extension of Time to Answer Complaint 139 is granted pursuant to Local Rule CV-12 for Spring Wireless USA, Inc. to 10/28/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 10/03/2011)

10/03/2011 140 ***DOCUMENT FILED IN ERROR. PLEASE DISREGARD.*** Defendant The DataMAX Software Group, Inc. ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by The DataMAX Software Group Inc..(Collins, Michael) Modified on 10/3/2011 (mjc,). (Entered: 10/03/2011)

10/03/2011 ***FILED IN ERROR. Document # 138 Answer. PLEASE IGNORE. DOCUMENT TO BE REFILED TO ENTER COUNTERCLAIM INTO SYSTEM.*** (mjc,) (Entered: 10/03/2011)

10/03/2011 141 Unopposed MOTION for Extension of Time to File Answer Fourth Motion for Extension of Time to Answer or Otherwise Respond to Complaint by BizSpeed, Inc.. (Attachments: # 1 Text of Proposed Order)(Cornelius, William) (Entered: 10/03/2011)

10/03/2011 ***FILED IN ERROR. Document # 140 Answer and Counterclaim. PLEASE IGNORE. CORRECTED DOCUMENT TO BE FILED.***(mjc,) (Entered: 10/03/2011)

10/03/2011 142 Defendant The DataMAX Software Group, Inc. ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by The DataMAX Software Group Inc.. (Collins, Michael) (Entered: 10/03/2011)

10/03/2011 143 ANSWER to 142 Answer to Complaint, Counterclaim of DataMAX Software by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 10/03/2011)

10/06/2011 144 ORDER granting 141 Motion for Extension of Time to Answer. Defendant Bizspeed, Inc. shall have to 11-07-2011 to answer or otherwise respond to Plaintiff's Complaint. Signed by Judge Leonard Davis on 10/06/11. cc:attys 10-06-11 (mll,) (Entered: 10/06/2011)

10/07/2011 145 ORDER granting 103 Motion for Extension of Time to Answer. Signed by Judge Leonard Davis on 10/07/11. cc:attys 10-07-11 (mll,) (Entered: 10/07/2011)

10/12/2011 146 CORPORATE DISCLOSURE STATEMENT filed by The DataMAX Software Group Inc. (Collins, Michael) (Entered: 10/12/2011)

10/14/2011 147 NOTICE of Settlement as to Syclo, LLC by MacroSolve, Inc. (Antonelli, Matthew) (Entered: 10/14/2011)

10/19/2011 148 Joint MOTION to Dismiss as to Syclo LLC by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 10/19/2011)

10/24/2011 149 ***VACATED AND REPLACED BY 156 ORDER*** ORDER granting 148 Motion to Dismiss. All claims and counterclaims made by MacroSolve and Syclo against each other in this action are dismissed without prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 10/20/11. cc:attys 10-24-11 (mll,) Modified on 11/1/2011 (mll,). (Entered: 10/24/2011)

10/25/2011 150 Defendant's Unopposed Sixth Application for Extension of Time to Answer Complaint re Antenna Software, Inc..(Perque, Chris) (Entered: 10/25/2011)

10/25/2011 151 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint re Zerion Software, Inc..(Ragland, William) (Entered: 10/25/2011)

10/26/2011 Defendant's Unopposed Sixth Application for Extension of Time to Answer Complaint 150 is granted pursuant to Local Rule CV-12 for Antenna Software, Inc. to 11/9/2011. 14 Days Granted for Deadline Extension.(mll,) (Entered: 10/26/2011)

10/26/2011 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint 151 is granted pursuant to Local Rule CV-12 for Zerion Software, Inc. to 11/18/2011. 18 Days Granted for Deadline Extension.(mll,) (Entered: 10/26/2011)

10/26/2011 152 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint re Data Systems International, Inc..(Marriott, Michelle) (Entered: 10/26/2011)

10/27/2011 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint 152 is granted pursuant to Local Rule CV-12 for Data Systems International, Inc. to

11/18/2011. 21 Days Granted for Deadline Extension.(mll,) (Entered: 10/27/2011)

10/27/2011 153 Unopposed MOTION to Vacate 149 Order on Motion to Dismiss, And To Enter New Order Dismissing Syclo LLC With Prejudice by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 10/27/2011)

10/28/2011 154 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint re Spring Wireless USA, Inc..(Campbell, Christopher) (Entered: 10/28/2011)

10/31/2011 Defendant's Unopposed Fifth Application for Extension of Time to Answer Complaint 154 is granted pursuant to Local Rule CV-12 for Spring Wireless USA, Inc. to 11/14/2011. 14 Days Granted for Deadline Extension.(mll,) (Entered: 10/31/2011)

10/31/2011 155 Unopposed MOTION for Extension of Time to File Answer Unopposed Fifth Motion for Extension of Time to File Answer or Otherwise Respond to Complaint by BizSpeed, Inc.. (Attachments: # 1 Text of Proposed Order)(Cornelius, William) (Entered: 10/31/2011)

10/31/2011 156 ORDER granting 153 Motion to Vacate 149 Order on Motion to Dismiss. All claims and counterclaims made by MacroSolve and Syclo against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 10/31/11. cc:attys 11-01-11 (mll,) (Entered: 11/01/2011)

11/01/2011 157 ORDER granting 155 Motion for Extension of Time to Answer. Defendant Bizspeed, Inc. shall have to 11-21-2011 to answer or otherwise respond to Plaintiff's Complaint. Signed by Judge Leonard Davis on 11/01/11. cc:attys 11-01-11 (mll,) (Entered: 11/01/2011)

11/02/2011 158 Unopposed MOTION to Withdraw FROM RECIEVING CM/ECF NOTIFICATIONS by Syclo, L.L.C.. (Attachments: # 1 Text of Proposed Order)(McSwane, Douglas) (Entered: 11/02/2011)

11/03/2011 159 ORDER granting 158 Motion to Withdraw from Receiving Electronic Notification. Electronic notices sent in this case to Douglas R. McSwane, Jr. shall terminate effective the date of this order. Signed by Judge Leonard Davis on 11/03/11. cc:attys 11-04-11 (mll,) (Entered: 11/04/2011)

11/09/2011 160 Defendant Antenna Software, Inc.'s ANSWER to 1 Complaint,, Affirmative Defenses, COUNTERCLAIM against MacroSolve, Inc. by Antenna Software, Inc..(Perque, Chris) (Entered: 11/09/2011)

11/09/2011 161 CORPORATE DISCLOSURE STATEMENT filed by Antenna Software, Inc. (Perque, Chris) (Entered: 11/09/2011)

11/09/2011 162 ANSWER to 160 Answer to Complaint, Counterclaim of Antenna Software, Inc. by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 11/09/2011)

11/14/2011 163 ANSWER to 1 Complaint,, and, COUNTERCLAIM against MacroSolve, Inc. by Spring Wireless USA, Inc..(Campbell, Christopher) (Entered: 11/14/2011)

11/15/2011 164 ANSWER to 163 Answer to Complaint, Counterclaim of Spring Wireless USA, Inc. by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 11/15/2011)

11/18/2011 165 Defendant's Unopposed Sixth Application for Extension of Time to Answer Complaint re Data Systems International, Inc..(Marriott, Michelle) (Entered: 11/18/2011)

11/18/2011 166 DEFENDANT ZERION SOFTWARE, INC.'S ANSWER to 1 Complaint,, and, COUNTERCLAIM against MacroSolve, Inc. by Zerion Software, Inc..(Ragland, William) (Entered: 11/18/2011)

11/18/2011 167 CORPORATE DISCLOSURE STATEMENT filed by Zerion Software, Inc. (Ragland, William) (Entered: 11/18/2011)

11/18/2011 168 Unopposed MOTION for Extension of Time to File Answer UNOPPOSED SIXTH MOTION FOR EXTENSION OF TIME TO ANSWER OR OTHERWISE RESPOND TO COMPLAINT by BizSpeed, Inc.. (Attachments: # 1 Text of Proposed Order)(Cornelius, William) (Entered: 11/18/2011)

11/18/2011 169 ANSWER to 166 Answer to Complaint, Counterclaim of Zerion Software by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 11/18/2011)

11/21/2011 Defendant's Unopposed Sixth Application for Extension of Time to Answer Complaint 165 is granted pursuant to Local Rule CV-12 for Data Systems International, Inc. to 11/23/2011. 5 Days Granted for Deadline Extension.(mll,) (Entered: 11/21/2011)

11/21/2011 170 ORDER granting 168 Motion for Extension of Time to Answer. Defendant Bizspeed, Inc. shall have up to 11-23-2011 to answer or otherwise respond to Plaintiff's Complaint. Signed by Judge Leonard Davis on 11/21/11. cc:attys 11-21-11 (mll,) (Entered: 11/21/2011)

11/22/2011 171 ORDER that no further extensions of time to answer will be granted absent a showing

of good cause. Signed by Judge Leonard Davis on 11/22/11. cc:attys 11-22-11(mll,) (Entered: 11/22/2011)

11/22/2011 172 ANSWER to 1 Complaint,, by Air2Web Inc..(Schoenthaler, Peter) (Entered: 11/22/2011)

11/22/2011 173 CORPORATE DISCLOSURE STATEMENT filed by Air2Web Inc. identifying Corporate Parent Velti Plc for Air2Web Inc.. (Schoenthaler, Peter) (Entered: 11/22/2011)

11/22/2011 174 MOTION for Extenson of Time to Answer Complaint by Air2Web Inc..(Schoenthaler, Peter) Modified on 11/28/2011 (mll,). (Entered: 11/22/2011)

11/23/2011 175 ANSWER to 1 Complaint,, and, COUNTERCLAIM against MacroSolve, Inc. by BizSpeed, Inc..(Cornelius, William) (Entered: 11/23/2011)

11/23/2011 176 CORPORATE DISCLOSURE STATEMENT filed by BizSpeed, Inc. (Cornelius, William) (Entered: 11/23/2011)

11/23/2011 177 ANSWER to 175 Answer to Complaint, Counterclaim of Bizspeed by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 11/23/2011)

11/23/2011 178 Joint MOTION to Dismiss Data Systems International, Inc. by Data Systems International, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order) (Thompson, Larry) (Entered: 11/23/2011)

11/28/2011 179 ORDER granting 178 Motion to Dismiss. All claims made by MacroSolve against DSI in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 11/28/11. cc:attys 11-28-11 (mll,) (Entered: 11/28/2011)

12/01/2011 180 Request by MacroSolve, Inc. for Clerk's Entry of Default against General Data Company, Inc.. (Attachments: # 1 Proposed Clerk's Entry of Default, # 2 Thompson Decl ISO Request for Clerk's EOD -- General Data, # 3 Ex 1 [Return of Service Executed as to General Data], # 4 Ex 2 [Cert of Service for General Data], # 5 Ex 3 [General Data About Us and Location Webpage], # 6 Ex 4 [Emails between P Wenzel and M Antonelli re Default of General Data])(Thompson, Larry) (Entered: 12/01/2011)

12/01/2011 181 Request by MacroSolve, Inc. for Clerk's Entry of Default against Millenium Information Technology, Inc.. (Attachments: # 1 Proposed Clerk's Entry of Default, # 2 Thompson Decl ISO Request for Clerk's EOD -- MIT, # 3 Ex 1 [Return of Service Executed as to MiT], # 4 Ex 2 [Cert of Service for Mit])(Thompson, Larry) (Entered: 12/01/2011)

12/01/2011 182 NOTICE by MacroSolve, Inc. re 57 Order, of Readiness for Scheduling Conference (Thompson, Larry) (Entered: 12/01/2011)

12/05/2011 183 Clerk's ENTRY OF DEFAULT as to General Data Company, Inc. (mll,) (Entered: 12/05/2011)

12/05/2011 184 Clerk's ENTRY OF DEFAULT as to Millenium Information Technology, Inc. (mll,) (Entered: 12/05/2011)

12/06/2011 185 NOTICE of Attorney Appearance by Kris Yue Teng on behalf of MacroSolve, Inc. (Teng, Kris) (Entered: 12/06/2011)

12/19/2011 186 NOTICE of Change of Address by Mark S Carlson (Carlson, Mark) (Entered: 12/19/2011)

12/21/2011 187 ORDER granting 174 Motion for Extension of Time to Answer. Signed by Judge Leonard Davis on 12/21/11. cc:attys 12-21-11 (mll,) (Entered: 12/21/2011)

12/30/2011 188 Joint MOTION to Dismiss Survey Analytics LLC With Prejudice by MacroSolve, Inc., Survey Analytics LLC. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 12/30/2011)

01/03/2012 189 Joint MOTION to Dismiss Zerion Software, Inc. by MacroSolve, Inc., Zerion Software, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 01/03/2012)

01/03/2012 190 ORDER granting 188 Motion to Dismiss. All claims and counterclaims made byMacroSolve and Survey Analytics against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 01/03/12. cc:attys 1-03-12 (mll,) (Entered: 01/03/2012)

01/04/2012 191 ORDER granting 189 Motion to Dismiss. All claims and counterclaims made by MacroSolve and Zerion against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 01/04/12. cc:attys 1-05-12 (mll,) (Entered: 01/05/2012)

01/12/2012 192 NOTICE of Attorney Appearance by Jennifer Parker Ainsworth on behalf of Antenna Software, Inc. (Ainsworth, Jennifer) (Entered: 01/12/2012)

01/13/2012 193 APPLICATION to Appear Pro Hac Vice by Attorney Nolan M Goldberg for Antenna

Software, Inc. (mll,) (Entered: 01/13/2012)

01/18/2012 194 NOTICE by Zerion Software, Inc. re 191 Order on Motion to Dismiss, Notice of Request for Termination of Electronic Notices In This Action (Ragland, William) (Entered: 01/18/2012)

03/14/2012 195 NOTICE of Attorney Appearance by Stephen R Smith on behalf of Spring Wireless USA, Inc. (Smith, Stephen) (Entered: 03/14/2012)

03/16/2012 196 ORDER granting in part and denying in part 92 Motion to Dismiss; granting in part and denying in part 101 Motion to Dismiss. Defendants motions to dismiss are DENIED; Defendants alternative motions to quash service are GRANTED. MacroSolve is ORDERED to file proof that service of process has been properly effected upon Spira Data and TrueContext within 90 days from issuance of this order. MacroSolves failure to comply with this order may result in dismissal of the claims against Defendants. Signed by Judge Leonard Davis on 03/16/12. cc:attys 3-19-12 (mll,) (Entered: 03/19/2012)

03/28/2012 197 NOTICE of Settlement as to Antenna Software, Inc. by MacroSolve, Inc. (Thompson, Larry) (Entered: 03/28/2012)

03/30/2012 198 Joint MOTION to Dismiss Antenna Software, Inc. by Antenna Software, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 03/30/2012)

04/04/2012 199 ORDER granting 198 Motion to Dismiss. All claims and counterclaims made by MacroSolve and Antenna against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 04/04/12. cc:attys 4-04-12 (mll,) (Entered: 04/04/2012)

04/17/2012 200 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, or Otherwise Respond, by TrueContext Mobile Solutions Corporation. (Attachments: # 1 Proposed Order)(Heartfield, J) (Entered: 04/17/2012)

04/23/2012 201 ORDER granting 200 Motion for Extension of Time to Answer. Deft TrueContext Mobile Solutions Corporation's time to answer or otherwise respond to pltf's Complaint is extended to 6-04-2012. Signed by Judge Leonard Davis on 04/23/12. cc:attys 4-23-12 (mll,) (Entered: 04/23/2012)

05/01/2012 202 Return of Service Executed as to Spira Data Corp. on 4/12/2012, by International Service through the Hague Convention process (Canada). (mll,) (Entered: 05/01/2012)

05/01/2012 203 NOTICE by Antenna Software, Inc. of Request for Termination of CM/ECF Notification (Perque, Chris) (Entered: 05/01/2012)

05/03/2012 204 ANSWER to 1 Complaint,, by Spira Data Corp..(Lawson, Carroll) (Entered: 05/03/2012)

05/23/2012 205 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint,, or Otherwise Respond, by TrueContext Mobile Solutions Corporation. (Attachments: # 1 Proposed Order)(Heartfield, J) (Entered: 05/23/2012)

05/25/2012 206 ORDER denying 205 Motion for Extension of Time to Answer re 205 Unopposed MOTION for Extension of Time to File Answer re 1 Complaint, or Otherwise Respond. Signed by Judge Leonard Davis on 5/24/12. (mjc,) (Entered: 05/25/2012)

05/25/2012 207 APPLICATION (APPROVED) to Appear Pro Hac Vice by Attorney Edward S Jarmolowicz for Invensys Systems, Inc. (pkb,) (Entered: 05/25/2012)

06/01/2012 208 ANSWER to 1 Complaint,,, COUNTERCLAIM against MacroSolve, Inc. by TrueContext Mobile Solutions Corporation.(Heartfield, J) (Entered: 06/01/2012)

06/05/2012 209 International Return of Service Executed as to TrueContext Mobile Solutions Corporation on 4/12/2012, served through the Hague Convention process requirements. (mll,) (Entered: 06/05/2012)

06/07/2012 210 NOTICE by MacroSolve, Inc. NOTICE OF READINESS FOR SCHEDULING CONFERENCE (Thompson, Larry) (Entered: 06/07/2012)

06/12/2012 211 NOTICE of Attorney Appearance by Robert D Spendlove on behalf of Spring Wireless USA, Inc. (Spendlove, Robert) (Entered: 06/12/2012)

06/13/2012 212 ORDER setting Status Conference for 8/6/2012 01:30 PM before Judge Leonard Davis. Signed by Judge Leonard Davis on 06/13/12. cc:attys 6-14-12(mll,) (Entered: 06/14/2012)

06/14/2012 213 NOTICE by Survey Analytics LLC of Request for Termination of Electronic Notices (Findlay, Eric) (Entered: 06/14/2012)

06/15/2012 214 NOTICE by MacroSolve, Inc. re 196 Order on Motion to Dismiss,,,,, Notice of Compliance with Order (Teng, Kris) (Entered: 06/15/2012)

07/18/2012 215 NOTICE of Attorney Appearance by Michael E Jones on behalf of Ventyx Inc. (Jones, Michael) (Entered: 07/18/2012)

07/18/2012 216 NOTICE of Attorney Appearance by Allen Franklin Gardner on behalf of Ventyx Inc. (Gardner, Allen) (Entered: 07/18/2012)

07/18/2012 217 NOTICE by Environmental Systems Research Institute, Inc. of Appearance by Elizabeth J. White (White, Elizabeth) (Entered: 07/18/2012)

07/18/2012 218 NOTICE of Attorney Appearance by Michael J Sacksteder on behalf of Environmental Systems Research Institute, Inc. (Sacksteder, Michael) (Entered: 07/18/2012)

07/23/2012 219 NOTICE of Attorney Appearance by Jennifer Parker Ainsworth on behalf of Agilis Systems, LLC, Realtime Results, LLC (Ainsworth, Jennifer) (Entered: 07/23/2012)

07/30/2012 220 NOTICE of Attorney Appearance by Lance Lee on behalf of Invensys Systems, Inc. (Lee, Lance) (Entered: 07/30/2012)

08/03/2012 221 NOTICE of Attorney Appearance by Daymon Jeffrey Rambin on behalf of MacroSolve, Inc. (Rambin, Daymon) (Entered: 08/03/2012)

08/03/2012 222 NOTICE of Attorney Appearance by Elizabeth L DeRieux on behalf of MacroSolve, Inc. (DeRieux, Elizabeth) (Entered: 08/03/2012)

08/03/2012 223 NOTICE of Attorney Appearance by Sidney Calvin Capshaw, III on behalf of MacroSolve, Inc. (Capshaw, Sidney) (Entered: 08/03/2012)

08/06/2012 224 NOTICE of Attorney Appearance by Andy Tindel on behalf of Spira Data Corp. (Tindel, Andy) (Entered: 08/06/2012)

08/06/2012 225 Minute Entry for proceedings held before Judge Leonard Davis: Status Conference held on 8/6/2012. (Court Reporter Shea Sloan.) (Attachments: # 1 Attorney Sign-In Sheet) (rlf) (Entered: 08/07/2012)

08/08/2012 226 ANSWER to 208 Answer to Complaint, Counterclaim of TrueContext by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 08/08/2012)

08/08/2012 227 ORDER REFERRING CASE to Magistrate Judge John D. Love to conduct pretrial proceedings. Signed by Judge Leonard Davis on 08/08/12. cc:attys 8-09-12(mll,) (Entered: 08/09/2012)

08/09/2012 228 ORDER setting Scheduling/Status Conference for 9/7/2012 09:30 AM before Magistrate Judge John D. Love. Signed by Magistrate Judge John D. Love on 08/09/12. cc:attys 8-10-12(mll,) (Entered: 08/10/2012)

08/10/2012 229 Joint MOTION to Stay Deadlines As To Invensys by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 08/10/2012)

08/10/2012 230 Unopposed MOTION to Withdraw as Attorney by Invensys Systems, Inc.. (Attachments: # 1 Text of Proposed Order)(Maag, Gregory) (Additional attachment(s) added on 8/13/2012: # 2 Text of Proposed Order) (gsg,). (Entered: 08/10/2012)

08/13/2012 231 ORDER granting 229 Motion to Stay. All deadlines with respect to Invensys and Macrosolve are stayed for 30 days. The parties are ORDERED to submit closing documents no later than 9-14-2012. Signed by Magistrate Judge John D. Love on 08/13/12. cc:attys 8-13-12 (mll,) (Entered: 08/13/2012)

08/13/2012 232 ORDER granting 230 Motion to Withdraw as Attorney. Attorney Gregory Loren Maag and Thomas Loyd Warden terminated. Signed by Magistrate Judge John D. Love on 08/13/12. cc:attys 8-13-12 (mll,) (Entered: 08/13/2012)

08/15/2012 233 Joint MOTION to Dismiss by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 08/15/2012)

08/17/2012 234 ORDER granting 233 Motion to Dismiss Invensys Systems, Inc. Each party shall bear its own costs. Signed by Judge Leonard Davis on 8/17/12. (mjc,) (Entered: 08/17/2012)

09/04/2012 235 NOTICE of Attorney Appearance by Ravi R Ranganath on behalf of Environmental Systems Research Institute, Inc. (Ranganath, Ravi) (Entered: 09/04/2012)

09/05/2012 236 Joint MOTION for Entry of Docket Control, Discovery, Protective & ESI Orders and Appointment of Mediator by MacroSolve, Inc.. (Attachments: # 1 Exhibit 1 [DCO], # 2 Exhibit 2 [DO], # 3 Exhibit 3 [PO], # 4 Exhibit 4 [ESI Order])(Antonelli, Matthew) (Entered: 09/05/2012)

09/06/2012 237 NOTICE by Air2Web Inc. re 236 Joint MOTION for Entry of Docket Control, Discovery, Protective & ESI Orders and Appointment of Mediator Adoption of and Joinder in (Schoenthaler, Peter) (Entered: 09/06/2012)

09/06/2012 NOTICE that the status conference set for Friday, September 7, 2012 at 9:30 a.m. has been CANCELLED. (srg) (Entered: 09/06/2012)

09/07/2012 238 PROTECTIVE ORDER. Signed by Magistrate Judge John D. Love on 09/07/12. cc:attys 9-07-12(mll,) (Entered: 09/07/2012)

09/07/2012 239 DISCOVERY ORDER. Signed by Magistrate Judge John D. Love on 09/07/12. cc:attys 9-07-12(mll,) (Entered: 09/07/2012)

09/07/2012 240 ORDER REGARDING E-DISCOVERY. Signed by Magistrate Judge John D. Love on 09/07/12. cc:attys 9-07-12(mll,) (Entered: 09/07/2012)

09/07/2012 241 DOCKET CONTROL ORDER. Jury Selection set for 6/2/2014 09:00AM before Judge Leonard Davis. Jury Trial set for 6/9/2014 09:00 AM before Judge Leonard Davis. Markman Hearing set for 2/14/2013 09:00 AM before Magistrate Judge John D. Love. Pretrial Conference set for 5/22/2014 09:00 AM before Magistrate Judge John D. Love. Signed by Magistrate Judge John D. Love on 09/07/12. cc:attys 9-07-12(mll,) (Entered: 09/07/2012)

09/07/2012 242 ORDER REFERRING CASE to Mediator. James Knowles added as Mediator. Signed by Magistrate Judge John D. Love on 09/07/12. cc:attys 9-07-12(mll,) (Entered: 09/07/2012)

09/19/2012 243 NOTICE by The DataMAX Software Group Inc. Defendant's Notice of Service of Initial Disclosures (Collins, Michael) (Entered: 09/19/2012)

09/19/2012 244 NOTICE by Spring Wireless USA, Inc. of Service of Initial Disclosures (Spendlove, Robert) (Entered: 09/19/2012)

09/19/2012 245 NOTICE by Ventyx Inc. of service of Initial Disclosures (Auvil, Steven) (Entered: 09/19/2012)

09/19/2012 246 NOTICE by Spira Data Corp. of Service of Initial Disclosures (Lawson, Carroll) (Entered: 09/19/2012)

09/19/2012 247 NOTICE by Agilis Systems, LLC of Service of Initial Disclosures (Nolte, Nelson) (Entered: 09/19/2012)

09/19/2012 248 NOTICE by Realtime Results, LLC of Service of Initial Disclosures (Nolte, Nelson) (Entered: 09/19/2012)

09/19/2012 249 NOTICE by Air2Web Inc. Filing of Initial Disclosures (Schoenthaler, Peter) (Entered: 09/19/2012)

09/19/2012 250 Joint MOTION for Extension of Time to Serve Initial Disclosures Pursuant to the Court's Discovery Order by Environmental Systems Research Institute, Inc.. (Attachments: # 1 Text of Proposed Order Granting Joint Motion for Extension of Time to Serve Initial Disclosures)(White, Elizabeth) (Entered: 09/19/2012)

09/20/2012 251 NOTICE of Discovery Disclosure by BizSpeed, Inc. NOTICE OF INITIAL DISCLOSURES (Cornelius, William) (Entered: 09/20/2012)

09/20/2012 252 ORDER granting 250 Motion for Extension of Time. ESRIs deadline to serve its initial disclosures pursuant to the Court's Discovery Order is extended to 9-26-2012. Signed by Magistrate Judge John D. Love on 09/20/12. cc:attys 9-20-12 (mll,) (Entered: 09/20/2012)

09/25/2012 253 NOTICE of Attorney Appearance by Califf Teal Cooper on behalf of MacroSolve, Inc. (Cooper, Califf) (Entered: 09/25/2012)

09/25/2012 254 Joint MOTION to Dismiss TRUECONTEXT WITHOUT PREJUDICE by MacroSolve, Inc., TrueContext Mobile Solutions Corporation. (Attachments: # 1 Text of Proposed Order) (Thompson, Larry) (Entered: 09/25/2012)

09/25/2012 255 Unopposed MOTION to Remove Attorneys from Receiving CM/ECF Notifications by Invensys Systems, Inc.. (Attachments: # 1 Text of Proposed Order)(Kjelland, Kurt) (Entered: 09/25/2012)

09/26/2012 256 ORDER granting 255 Motion to terminate electronic notices. Signed by Magistrate Judge John D. Love on 9/26/2012. (gsg) (Entered: 09/26/2012)

09/27/2012 257 NOTICE of Attorney Appearance - Pro Hac Vice by Carl L Sollee on behalf of BizSpeed, Inc.. Filing fee $ 100, receipt number 0540-3802440. (Sollee, Carl) (Additional attachment(s) added on 9/28/2012: # 1 SEALED Attachment) (pkb,). (Entered: 09/27/2012)

09/27/2012 258 ORDER granting 254 Motion to Dismiss. The claims brought by MacroSolve against deft TrueContext Mobile Solutions Corporation are hereby DISMISSED WITHOUT PREJUDICE. MacroSolve and TrueContext shall each bear their own costs and attorneys fees. Signed by Judge Leonard Davis on 09/27/12. cc:attys 9-28-12 (mll,) (Entered: 09/28/2012)

09/28/2012 259 ORDER consolidating this civil action with causes 6:11cv490, 6:11cv686, 6:12cv44, 6:12cv45, 6:12cv46, 6:12cv47, 6:12cv74, 6:12cv92, 6:12cv194 for pretrial issues

only, with the exception of venue. The earliest filed civil action 6:11cv287 shall serve as the Lead Case for consolidated issues. The individual cases will remain active for venue motions and trial. All motions, other than venue motions, shall be filed in the consolidated lead case. Parties shall submit a single Docket Control, Discovery, ESI, and Protective Order, and each of the respective orders shall be filed in the Lead Case. Signed by Magistrate Judge John D. Love on 09/28/12. cc:attys 9-28-12(mll,) (Entered: 09/28/2012)

09/28/2012 Consolidated Defendants added: Citigroup Inc (6:11cv490); Avis Rent A Car System LLC (6:11cv686); Facebook Inc (6:12cv44); Hyatt Corporation (6:12cv45); Newegg (6:12cv46); Walmart Stores Inc (6:12cv47); GEICO Insurance Agency Inc, GEICO Casualty Company, Government Employees Insurance Company (6:12cv74); Inter-Continental Hotels Corporation, Six Continents Hotels Inc (6:12cv92); MovieTickets.com Inc (6:12cv194). (mll,) (Entered: 09/28/2012)

09/28/2012 260 NOTICE of Attorney Appearance by Mark G Davis on behalf of MovieTickets.com, Inc. (Davis, Mark) (Entered: 09/28/2012)

09/28/2012 261 NOTICE of Attorney Appearance by Anne Marie Cappella on behalf of MovieTickets.com, Inc. (Cappella, Anne) (Entered: 09/28/2012)

10/01/2012 262 Joint MOTION to Dismiss Environmental Systems Research Institute, Inc. WITHOUT PREJUDICE by Environmental Systems Research Institute, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/01/2012)

10/01/2012 263 NOTICE of Attorney Appearance - Pro Hac Vice by James William Lucey on behalf of Xora, Inc.. Filing fee $ 100, receipt number 0540-3808421. (Lucey, James) (Entered: 10/01/2012)

10/01/2012 264 NOTICE of Attorney Appearance by Erik Joseph Osterrieder on behalf of Spira Data Corp. (Osterrieder, Erik) (Entered: 10/01/2012)

10/01/2012 265 MOTION for Order Limiting Geico To A Reasonable Number Of Invalidity Theories by MacroSolve, Inc.. (Attachments: # 1 Exhibit 1 [Geico ICs], # 2 Exhibit 2 [Prior Art Index], # 3 Exhibit 3 [Mosaid], # 4 Exhibit 4 [9/26/12 Spivey Email], # 5 Text of Proposed Order)(Antonelli, Matthew) (Entered: 10/01/2012)

10/02/2012 266 Joint MOTION to Stay Deadlines with Respect to MacroSolve and Hyatt Only by Hyatt Corporation, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/02/2012)

10/02/2012 267 ORDER granting 266 Motion to Stay. All deadlines with respect to Hyatt and Macrosolve are stayed for 30 days. Parties are further ORDERED to submit closing documents no later than 11-01-2012. Signed by Magistrate Judge John D. Love on 10/02/12. cc:attys 10-02-12 (mll,) (Entered: 10/02/2012)

10/02/2012 268 NOTICE by The DataMAX Software Group Inc. 's Notice of Disclosure of Source Code (Collins, Michael) (Entered: 10/02/2012)

10/03/2012 269 NOTICE of Change of Address by Michael Charles Smith (Smith, Michael) (Entered: 10/03/2012)

10/03/2012 270 ORDER granting 262 Motion to Dismiss. All claims and counterclaims between pltf and deft Environmental Systems Research Institute Inc are DISMISSED without prejudice. Parties shall bear their own costs and attys fees. Signed by Judge Leonard Davis on 10/02/12. cc:attys 10-03-12 (mll,) (Entered: 10/03/2012)

10/04/2012 271 Joint MOTION for Extension of Time to Complete Discovery re Production of Documents Pursuant to the Court's Discovery Order by Spring Wireless USA, Inc.. (Attachments: # 1 Text of Proposed Order)(Spendlove, Robert) (Additional attachment(s) added on 10/5/2012: # 2 Corrected Proposed Order) (gsg,). (Entered: 10/04/2012)

10/04/2012 272 Joint MOTION for Extension of Time to Complete Discovery re Production of Documents Pursuant to the Court's Discovery Order by Air2Web Inc.. (Attachments: # 1 Text of Proposed Order Proposed Order)(Schoenthaler, Peter) (Entered: 10/04/2012)

10/04/2012 273 Consent MOTION for Extension of Time to Complete Discovery To Produce Documents Pursuant to The Court's Discovery Order by Agilis Systems, LLC. (Attachments: # 1 Text of Proposed Order)(Nolte, Nelson) (Additional attachment(s) added on 10/5/2012: # 2 Corrected Proposed Order) (gsg,). (Entered: 10/04/2012)

10/04/2012 274 Joint MOTION for Extension of Time to Complete Discovery to October 18, 2012 by BizSpeed, Inc.. (Attachments: # 1 Text of Proposed Order)(Sollee, Carl) (Entered: 10/04/2012)

10/04/2012 275 MOTION for Order Limiting MovieTickets' Invalidity Theories by MacroSolve, Inc.. (Attachments: # 1 Invalidity Contentions, # 2 Prior Art Index, # 3 Claim Charts, # 4 Mosaid, # 5 Text of Proposed Order)(Cooper, Califf) (Entered: 10/04/2012)

10/04/2012 276 NOTICE by The DataMAX Software Group Inc. 's Notice of Service of Additional

Disclosures (Collins, Michael) (Entered: 10/04/2012)

10/04/2012 277 NOTICE by MacroSolve, Inc. 's Notice of Service of Additional Disclosures (Cooper, Califf) (Entered: 10/04/2012)

10/05/2012 278 Joint MOTION to Dismiss Inter-Continental Hotels Corporation and Six Continents Hotels, Inc. WITH PREJUDICE by Inter-Continental Hotels Corporation, MacroSolve, Inc., Six Continents Hotels, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/05/2012)

10/05/2012 279 ORDER granting 271 Joint Motion for Extension of Time to Complete Discovery. Spring Wireless's deadline to produce documents pursuant to paragraph 2.B of the Court's Discovery Order dated September 7, 2012 as Docket No. 239 shall be extended by two weeks up to and including October 18, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/5/12. (mjm,) (Entered: 10/05/2012)

10/05/2012 280 ORDER granting 272 Joint Motion for Extension of Time to Complete Discovery. AirWeb's deadline to produce documents pursuant to paragraph 2.B of the Court's Discovery Order dated September 7, 2012 as Docket No. 239 shall be extended by two weeks up to and including October 18, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/5/12. (mjm,) (Entered: 10/05/2012)

10/05/2012 281 ORDER granting 273 Motion for Extension of Time to Complete Discovery. Agilis and RealTime's deadline to produce documents pursuant to paragraph 2.B of the Court's Discovery Order dated September 7, 2012 as Docket No. 239 shall be extended by two weeks up to and including October 18, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/5/12. (mjm,) (Entered: 10/05/2012)

10/05/2012 282 ORDER granting 274 Joint Motion for Extension of Time to Complete Discovery. BizSpeed's deadline to produce documents pursuant to paragraph 2.B of the Court's Discovery Order dated September 7, 2012 as Docket No. 239 shall be extended to October 18, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/5/12. (mjm,) (Entered: 10/05/2012)

10/05/2012 283 Unopposed MOTION to Withdraw as Attorney Victor de Gyarfas by Wal-Mart Stores, Inc.. (Attachments: # 1 Text of Proposed Order)(Smith, Michael) (Entered: 10/05/2012)

10/05/2012 284 Consent MOTION for Extension of Time to File Consented Joint Motion for Extension of Time re: the Court's Mediation Deadline for Agilis, RealTime, Air2Web and Xora by Agilis Systems, LLC, Realtime Results, LLC. (Attachments: # 1 Text of Proposed Order) (Nolte, Nelson) (Entered: 10/05/2012)

10/08/2012 285 Unopposed MOTION for Extension of Time to File Response/Reply to GEICO's Motion to Transfer Venue (Dkt. No. 45 of of pre-consolidated action 6:12-cv-74) by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/08/2012)

10/09/2012 286 NOTICE by Environmental Systems Research Institute, Inc. of Request for Termination of Electronic Notices (White, Elizabeth) (Entered: 10/09/2012)

10/09/2012 287 ORDER granting 285 Unopposed Motion of MacroSolve, Inc. for Extension of Time to File Response to the Motion to Transfer (Dft. No. 45 of pre-consolidated action 6:12cv74) filed by Geico Insurance Agency, Inc., Geico Casualty Company, and Governmental Employees Insurance Company from October 8, 2012 to November 9, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/9/12. (mjm,) (Entered: 10/09/2012)

10/09/2012 288 ORDER granting defendants' Agilis, Realtime, Air2Web and Xora's 284 Joint Motion for Extension of Time to Extend the mediation deadline from October 19, 2012 until November 7, 2012. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 10/9/12. (mjm,) (Entered: 10/09/2012)

10/09/2012 289 ORDER granting 283 Motion to Withdraw as Attorney. Attorney Victor DeGyarfas terminated. Signed by Magistrate Judge John D. Love on 10/09/12. cc:attys 10-10-12 (mll,) (Entered: 10/10/2012)

10/11/2012 290 Joint MOTION to Dismiss Hyatt Corp. With Prejudice by Hyatt Corporation, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/11/2012)

10/11/2012 291 Joint MOTION for Extension of Time to File --- Consented Joint Motion for Extension of Time for Mediation Deadline by Wal-Mart Stores, Inc.. (Chapman, Laura) (Additional attachment(s) added on 10/15/2012: # 1 Text of Proposed Order) (gsg,). (Entered: 10/11/2012)

10/12/2012 292 Joint MOTION to Dismiss Spira Data Corp. Without Prejudice by MacroSolve, Inc., Spira Data Corp.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered:

10/12/2012)

10/12/2012 293 Unopposed MOTION to Stay Certain Deadlines with Wal-Mart Stores, Inc. by Wal-Mart Stores, Inc.. (Attachments: # 1 Text of Proposed Order)(Chapman, Laura) (Entered: 10/12/2012)

10/12/2012 294 NOTICE by Avis Rent A Car System, LLC, Facebook, Inc., Newegg, Wal-Mart Stores, Inc. Joint Opposition to Plaintiff's Motion for Order Limiting Defendants' Invalidity Theories (Attachments: # 1 Exhibit A, # 2 Exhibit B, # 3 Exhibit C, # 4 Exhibit D, # 5 Exhibit E, # 6 Text of Proposed Order)(Mead, Lowell) (Entered: 10/12/2012)

10/15/2012 295 NOTICE by Agilis Systems, LLC, Realtime Results, LLC re 294 Notice (Other), Notice (Other) Of Concurrence Regarding Certain Defendants' Joint Opposition to Plaintiff's Motion for Order Limiting Defendants' Invalidity Theories (Nolte, Nelson) (Entered: 10/15/2012)

10/15/2012 296 ORDER granting 278 Motion to Dismiss. All claims and counterclaims made between pltf and defts Inter-Continental Hotels Corporation and Six Continents Hotels, Inc. in this action are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 10/15/12. cc:attys 10-15-12 (mll,) (Entered: 10/15/2012)

10/15/2012 297 ORDER granting 290 Motion to Dismiss. All claims and counterclaims between Plaintiff MacroSolve, Inc. and Defendant Hyatt Corporation are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 10/15/12. cc:attys 10-15-12 (mll,) (Entered: 10/15/2012)

10/15/2012 298 ORDER granting 293 Motion to Stay Deadlines. All deadlines are stayed up to and including November 16, 2012, and closing documents are to be submitted no later than November 16, 2012. Signed by Magistrate Judge John D. Love on 10/15/2012. (gsg) (Entered: 10/16/2012)

10/16/2012 299 NOTICE by Inter-Continental Hotels Corporation, Six Continents Hotels, Inc. of Request for Termination of Electronic Notices (Murphy, George) (Entered: 10/16/2012)

10/16/2012 300 NOTICE by Hyatt Corporation of Request for Termination of Electronic Notices (Hanasz, Joseph) (Entered: 10/16/2012)

10/16/2012 301 RESPONSE in Opposition re 275 MOTION for Order Limiting MovieTickets' Invalidity Theories filed by MovieTickets.com, Inc.. (Attachments: # 1 Exhibit 1, # 2 Exhibit 2, # 3 Text of Proposed Order)(Crum, Isaac) (Entered: 10/16/2012)

10/16/2012 303 ORDER granting 292 Motion to Dismiss. All claims and counterclaims between pltf and deft Spira Data Corp are dismissed without prejudice. Each party shall bear their own costs and attys fees. Signed by Judge Leonard Davis on 10/16/12. cc:attys 10-17-12 (mll,) (Entered: 10/17/2012)

10/17/2012 302 REPORT of Mediation by James Knowles. Mediation result: Resolutions reached with BizSpeed and DataMAX(Knowles, James) (Entered: 10/17/2012)

10/17/2012 304 Joint MOTION to Stay Deadlines with Respect to MacroSolve and Ventyx by MacroSolve, Inc., Ventyx Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/17/2012)

10/18/2012 305 NOTICE by Spira Data Corp. Request to Terminate Electronic Service (Osterrieder, Erik) (Entered: 10/18/2012)

10/18/2012 306 Joint MOTION to Stay All Deadlines With Respect to Spring Wireless USA, Inc. by Spring Wireless USA, Inc.. (Attachments: # 1 Text of Proposed Order)(Spendlove, Robert) (Entered: 10/18/2012)

10/18/2012 307 RESPONSE in Opposition re 265 MOTION for Order Limiting Geico To A Reasonable Number Of Invalidity Theories filed by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company. (Attachments: # 1 Exhibit A, # 2 Exhibit B, # 3 Exhibit C, # 4 Exhibit D, # 5 Exhibit E, # 6 Exhibit F, # 7 Text of Proposed Order)(Spivey, Jonathan) (Entered: 10/18/2012)

10/18/2012 308 ORDER granting 304 Motion to Stay Deadlines as to deft Ventyx Inc. All deadlines are stayed to 11-19-2012. Parties are ORDERED to submit closing documents no later than 11-19-2012. Signed by Magistrate Judge John D. Love on 10/18/12. cc:attys 10-18-12 (mll,) (Entered: 10/18/2012)

10/19/2012 309 ORDER granting 306 Motion to Stay as to deft Spring Wireless USA Inc. All deadlines are stayed to 11-19-2012. Parties are ORDERED to submit closing documents no later than 11-19-2012. Signed by Magistrate Judge John D. Love on 10/19/12. cc:attys 10-19-12 (mll,) (Entered: 10/19/2012)

10/19/2012 310 Joint MOTION to Stay All Deadlines With Respect to MovieTickets.com, Inc. by MovieTickets.com, Inc.. (Attachments: # 1 Text of Proposed Order)(Crum, Isaac) (Entered: 10/19/2012)

10/19/2012 311 Joint MOTION to Dismiss BizSpeed, Inc. Without Prejudice by BizSpeed, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/19/2012)

10/22/2012 312 NOTICE by Spira Data Corp. of Request for Termination of Electronic Notice (Tindel, Andy) (Entered: 10/22/2012)

10/22/2012 313 ORDER granting 310 Motion to Stay all Deadlines with Respect to Movietickets.com, Inc. All deadlines are stayed until 11/19/2012. Parties are ordered to submit closing documents by that time. Signed by Magistrate Judge John D. Love on 10/22/12. (mjc,) (Entered: 10/22/2012)

10/22/2012 314 NOTICE by MacroSolve, Inc. re 294 Notice (Other), Notice (Other) Reply in Support of Motion for Order Limiting Defendants' Invalidity Theories (Cooper, Califf) (Entered: 10/22/2012)

10/23/2012 315 Joint MOTION to Stay All Deadlines With Respect to Defendant Facebook, Inc. by Facebook, Inc.. (Attachments: # 1 Text of Proposed Order)(Keefe, Heidi) (Entered: 10/23/2012)

10/23/2012 316 ORDER granting 311 Motion to Dismiss. All claims and counterclaims between pltf and deft BizSpeed Inc are hereby DISMISSED without prejudice. Each party shall bear their own costs and attys' fees. Signed by Judge Leonard Davis on 10/23/12. cc:attys 10-24-12 (mll,) (Entered: 10/24/2012)

10/24/2012 317 ***DEFICIENT FILING. DISREGARD.*** Joint MOTION to Stay Deadlines with Respect to MacroSolve and Realtime Results LLC by MacroSolve, Inc., Realtime Results, LLC. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) Modified on 10/26/2012 (gsg). (Entered: 10/24/2012)

10/24/2012 318 ***DEFICIENT FILING. DISREGARD.*** Joint MOTION to Stay Deadlines with Respect to MacroSolve and Agilis Systems by Agilis Systems, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) Modified on 10/26/2012 (gsg). (Entered: 10/24/2012)

10/24/2012 319 Joint MOTION to Dismiss Wal-Mart Stores, Inc. With Prejudice by MacroSolve, Inc., Wal-Mart Stores, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/24/2012)

10/26/2012 NOTICE of Deficiency regarding the joint motions, entries 317 and 318, submitted. No certificates of conference. Correction should be made by 1 business day. (gsg) (Entered: 10/26/2012)

10/29/2012 320 Joint MOTION to Stay Deadlines with Respect to MacroSolve and Agilis Systems by Agilis Systems, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order) (Cooper, Califf) (Entered: 10/29/2012)

10/29/2012 321 Joint MOTION to Stay Deadlines with Respect to MacroSolve and Realtime Results LLC by MacroSolve, Inc., Realtime Results, LLC. (Attachments: # 1 Text of Proposed Order) (Cooper, Califf) (Entered: 10/29/2012)

10/29/2012 322 Joint MOTION to Dismiss Agilis Systems, LLC With Prejudice by Agilis Systems, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/29/2012)

10/29/2012 323 Joint MOTION to Dismiss Realtime Results, LLC With Prejudice by MacroSolve, Inc., Realtime Results, LLC. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/29/2012)

10/29/2012 324 REPLY to Response to Motion re 265 MOTION for Order Limiting Geico To A Reasonable Number Of Invalidity Theories filed by MacroSolve, Inc.. (Cooper, Califf) (Entered: 10/29/2012)

10/29/2012 325 Joint MOTION for Extension of Time to File /Joint Motion to Extend Deadlines by Air2Web Inc., Avis Rent A Car System, LLC, Citigroup Inc, GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, MacroSolve, Inc., Newegg, Xora, Inc.. (Attachments: # 1 Text of Proposed Order) (Spivey, Jonathan) (Entered: 10/29/2012)

10/29/2012 326 ORDER granting 315 Motion to Stay Deadlines with Respect to Facebook, Inc. due to settlement. All deadlines are stayed through 11/21/2012. Parties are ordered to submit closing documents by 11/21/2012. Signed by Magistrate Judge John D. Love on 10/29/12. (mjc,) (Entered: 10/29/2012)

10/30/2012 327 ***FILED IN ERROR. SEE ENTRY 329 FOR CORRECTED FILING.*** Consent MOTION for Extension of Time to File Consented Joint Motion for Extension of Time re: the Court's Mediation Deadline for Newegg, Inc. and Avis Rent A Car System, LLC by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) Modified on 10/30/2012 (gsg). (Entered: 10/30/2012)

10/30/2012 328 Joint MOTION to Dismiss Ventyx, Inc. With Prejudice by MacroSolve, Inc., Ventyx Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/30/2012)

10/30/2012 329 Consent MOTION to Stay Consented Joint Motion for Extension of Time re: the Court's Mediation Deadline for Newegg, Inc. and Avis Rent A Car System, LLC by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 10/30/2012)

10/30/2012 330 ORDER granting 325 Motion for Extension of Time. Signed by Magistrate Judge John D. Love on 10/30/12. cc:attys 10-30-12 (mll,) (Entered: 10/30/2012)

10/31/2012 331 ORDER granting 329 Motion to Stay. Plaintiffs deadline for mediation as to Defendants Newegg, Inc. and Avis Rent A Car System, LLC is extended to 12-12-2012. Signed by Magistrate Judge John D. Love on 10/31/12. cc:attys 10-31-12 (mll,) (Entered: 10/31/2012)

10/31/2012 332 ORDER granting 319 Motion to Dismiss. All claims and counterclaims between Plaintiff and Defendant Walmart Stores Inc are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 10/31/12. cc:attys 10-31-12 (mll,) (Entered: 10/31/2012)

10/31/2012 333 ORDER denying as moot 320 Motion to Stay; granting 322 Motion to Dismiss. All claims and counterclaims between Plaintiff MacroSolve and Defendant Agilis Systems LLC are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 10/31/12. cc:attys 10-31-12 (mll,) (Entered: 10/31/2012)

10/31/2012 334 ORDER denying as moot 321 Motion to Stay; granting 323 Motion to Dismiss. All claims and counterclaims between Plaintiff MacroSolve and Defendant Realtime Results LLC are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 10/31/12. cc:attys 10-31-12 (mll,) (Entered: 10/31/2012)

11/01/2012 335 Joint MOTION to Dismiss Air2Web, Inc. Without Prejudice by Air2Web Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/01/2012)

11/01/2012 336 ORDER denying as moot 291 Motion for Extension of Time. Signed by Magistrate Judge John D. Love on 11/01/12. cc:attys 11-01-12 (mll,) (Entered: 11/01/2012)

11/01/2012 337 ORDER granting 328 Motion to Dismiss. All claims and counterclaims between Plaintiff and defendant Ventyx Inc in this action are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 11/01/12. cc:attys 11-01-12 (mll,) (Entered: 11/01/2012)

11/02/2012 338 ORDER granting 335 Motion to Dismiss. All claims between pltf and defendant Air2Web Inc in this action are hereby DISMISSED WITHOUT PREJUDICE. Parties shall bear their own costs and attorneys fees. Signed by Judge Leonard Davis on 11/02/12. cc:attys 11-02-12 (mll,) (Entered: 11/02/2012)

11/14/2012 339 Joint MOTION to Dismiss Facebook, Inc. With Prejudice by Facebook, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/14/2012)

11/14/2012 340 Joint MOTION to Dismiss Spring Wireless USA, Inc. With Prejudice by MacroSolve, Inc., Spring Wireless USA, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/14/2012)

11/15/2012 341 Joint MOTION to Stay All Deadlines With Respect to The DataMAX Software Group, Inc. by MacroSolve, Inc., The DataMAX Software Group Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/15/2012)

11/15/2012 342 ORDER granting 339 Motion to Dismiss. All claims between pltf and deft Facebook Inc are DISMISSED with prejudice. Each party shall bear its own attys' fees and costs. Signed by Judge Leonard Davis on 11/15/12. cc:attys 11-16-12 (mll,) (Entered: 11/16/2012)

11/15/2012 343 ORDER granting 340 Motion to Dismiss. All claims and counterclaims made by MacroSolve and Spring Wireless against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 11/15/12. cc:attys 11-16-12 (mll,) (Entered: 11/16/2012)

11/16/2012 344 ORDER FOR CLOSING DOCUMENTS. Signed by Magistrate Judge John D. Love on 11/16/2012. (gsg) (Entered: 11/19/2012)

11/19/2012 345 Joint MOTION TO EXTEND STAY OF DEADLINES WITH RESPECT TO MOVIETICKETS.COM, INC. re 313 Order on Motion to Stay, by MovieTickets.com, Inc.. (Attachments: # 1 Text of Proposed Order)(Crum, Isaac) (Entered: 11/19/2012)

11/20/2012 346 ORDER granting 345 Motion to extend stay of all deadlines with respect to MovieTickets.com, Inc. Signed by Magistrate Judge John D. Love on 11/20/12. cc:attys 11-20-12 (mll,) (Entered: 11/20/2012)

11/20/2012 347 NOTICE by Avis Rent A Car System, LLC, Citigroup Inc, GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, MacroSolve, Inc., Newegg Joint Motion for Entry of Discovery, Docket Control, ESI & Protective Orders (Attachments: # 1 Exhibit Discovery Order, # 2 Exhibit Docket Control Order, # 3 Exhibit ESI Order, # 4 Exhibit Protective Order)(Cooper, Califf) (Entered: 11/20/2012)

11/21/2012 348 NOTICE by Ventyx Inc. Request For Termination of Notices (Gardner, Allen) (Entered: 11/21/2012)

11/21/2012 349 DISCOVERY ORDER. Signed by Magistrate Judge John D. Love on 11/21/12. cc:attys 11-21-12(mll,) (Entered: 11/21/2012)

11/21/2012 350 ORDER REGARDING E-DISCOVERY. Signed by Magistrate Judge John D. Love on 11/21/12. cc:attys 11-21-12(mll,) (Entered: 11/21/2012)

11/21/2012 351 PROTECTIVE ORDER. Signed by Magistrate Judge John D. Love on 11/21/12. cc:attys 11-21-12(mll,) (Entered: 11/21/2012)

11/21/2012 352 DOCKET CONTROL ORDER. First Mediation Completion due by 12/12/2012; Second Mediation to be compledted by 3-18-2014. Jury Selection set for 6/2/2014 09:00AM before Judge Leonard Davis. Jury Trial set for 6/9/2014 09:00 AM before Judge Leonard Davis. Markman Hearing set for 2/14/2013 09:00 AM before Magistrate Judge John D. Love. Pretrial Conference set for 5/22/2014 09:00 AM before Magistrate Judge John D. Love. Signed by Magistrate Judge John D. Love on 11/21/12. cc:attys 11-21-12(mll,) (Entered: 11/21/2012)

11/27/2012 353 Joint MOTION to Dismiss The DataMAX Software Group Inc. With Prejudice by MacroSolve, Inc., The DataMAX Software Group Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/27/2012)

11/28/2012 354 ORDER granting 353 Motion to Dismiss. All claims and counterclaims made by MacroSolve and The DataMAX Sofware Group Inc against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Leonard Davis on 11/28/12. cc:attys 11-28-12 (mll,) (Entered: 11/28/2012)

11/28/2012 355 NOTICE by Avis Rent A Car System, LLC, Citigroup Inc, GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, MacroSolve, Inc., Newegg of Patent Local Rule 4-3 Joint Claim Construction Statement (Attachments: # 1 Exhibit Intrinsic and Extrinsic Evidence)(Cooper, Califf) (Entered: 11/28/2012)

11/29/2012 356 Joint MOTION to Dismiss MovieTickets.com, Inc. With Prejudice by MacroSolve, Inc., MovieTickets.com, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 11/29/2012)

11/30/2012 357 ORDER granting 356 Motion to Dismiss. All claims and counterclaims made by MacroSolve and MovieTickets against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 11/30/12. cc:attys 11-30-12 (mll,) (Entered: 11/30/2012)

11/30/2012 358 NOTICE by Spring Wireless USA, Inc. Request for Termination of Electronic Notices (Campbell, Christopher) (Entered: 11/30/2012)

12/03/2012 359 Joint MOTION to Stay All Deadlines With Respect to Xora, Inc. by MacroSolve, Inc., Xora, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 12/03/2012)

12/04/2012 360 ORDER denying 275 Motion for Order Limiting Movietickets Invalidity Theories. Because defendant Movietickets.com, Inc. was dismissed from the action on November 30, 2012, MacroSolve's Motion is DENIED as MOOT. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 12/4/12. (mjm,) (Entered: 12/04/2012)

12/04/2012 361 NOTICE by MovieTickets.com, Inc. Request for Termination of Notices (Crum, Isaac) (Entered: 12/04/2012)

12/04/2012 362 ORDER denying 341 Motion to Stay all Deadlines with Respect to the Data. On November 28, 2012, defendant The DataMAX, Inc. was dismissed. Accordingly, the parties' motion is DENIED as MOOT. This is a text only order and no document is attached. Signed by Magistrate Judge John D. Love on 12/4/12. (mjm,) (Entered: 12/04/2012)

12/04/2012 363 ORDER granting 359 Motion to Stay. All deadlines are stayed up to and including 1-03-2013, as to pltf and deft Xora Inc. The parties are ORDERED to submit closing documents no later than 1-03-2013. Signed by Magistrate Judge John D. Love on 12/04/12. cc:attys 12-04-12 (mll,) (Entered: 12/04/2012)

12/04/2012 364 NOTICE by Avis Rent A Car System, LLC, Citigroup Inc, GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, MacroSolve, Inc., Newegg Joint Submission Regarding Potential Technical Advisors (Cooper, Califf) (Entered: 12/04/2012)

12/06/2012 365 NOTICE by Wal-Mart Stores, Inc. Request for Termination of Electronic Notices (Chapman, Laura) (Entered: 12/06/2012)

12/10/2012 366 Joint MOTION to Dismiss Xora, Inc. With Prejudice by MacroSolve, Inc., Xora, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 12/10/2012)

12/12/2012 367 Unopposed MOTION Extend Mediation Deadline by Citigroup Inc. (Attachments: # 1 Text of Proposed Order)(Sacksteder, Michael) (Entered: 12/12/2012)

12/12/2012 368 ORDER OF DISMISSAL OF XORA, Inc. Signed by Judge Leonard Davis on 12/12/2012. (gsg) (Entered: 12/13/2012)

12/13/2012 369 ORDER granting 367 Motion to Extend Mediation Deadline. Signed by Magistrate Judge John D. Love on 12/13/2012. (gsg) (Entered: 12/13/2012)

12/19/2012 370 MOTION to Amend/Correct Docket Control Order by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 12/19/2012)

12/28/2012 371 Joint MOTION to Stay All Deadlines With Respect to Avis Rent A Car System, LLC by Avis Rent A Car System, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 12/28/2012)

01/02/2013 372 ORDER granting 371 Motion to Stay. All deadlines are stayed to 1-31-2013. Parties shall submit closing documents no later than 1-31-2013. Signed by Magistrate Judge John D. Love on 01/02/13. cc:attys 1-02-13 (mll,) (Entered: 01/02/2013)

01/03/2013 373 RESPONSE in Opposition re 370 MOTION to Amend/Correct Docket Control Order filed by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, Newegg. (Attachments: # 1 Exhibit A, # 2 Exhibit B, # 3 Text of Proposed Order)(Spivey, Jonathan) (Entered: 01/03/2013)

01/03/2013 374 NOTICE by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, Newegg Defendants' Technology Tutorial (Attachments: # 1 Exhibit A (Tutorial))(Clark, Bryan) (Entered: 01/03/2013)

01/03/2013 375 NOTICE by MacroSolve, Inc. of MacroSolve's Technical Tutorial (Cooper, Califf) (Entered: 01/03/2013)

01/03/2013 376 NOTICE by Facebook, Inc. re 342 Order on Motion to Dismiss Facebook's Request for Termination of Electronic Notices (Mead, Lowell) (Entered: 01/03/2013)

01/04/2013 377 CLAIM CONSTRUCTION BRIEF filed by MacroSolve, Inc.. (Attachments: # 1 Exhibit 816 Patent, # 2 Exhibit Microsoft Computer Dictionary, # 3 Exhibit File History Excerpts, # 4 Exhibit Dictionary of Computing, # 5 Exhibit Defendants' P.R. 4-2 Disclosure) (Cooper, Califf) (Entered: 01/04/2013)

01/07/2013 378 REPLY to Response to Motion re 370 MOTION to Amend/Correct Docket Control Order filed by MacroSolve, Inc.. (Cooper, Califf) (Entered: 01/07/2013)

01/09/2013 379 NOTICE by Data Systems International, Inc. of Request for Termination of Case CM/ECF Notifications (Attachments: # 1 Text of Proposed Order)(Guastello, Christine) (Entered: 01/09/2013)

01/14/2013 380 ORDER granting 370 Motion to Amend/Correct Docket Control Order. The Markman hearing in this matter shall be rescheduled for 9-26-2013 at 9:00 a.m., to be conducted in conjunction with Civil Action No. 6:12cv385. Signed by Magistrate Judge John D. Love on 01/14/13. cc:attys 1-15-13 (mll,) (Entered: 01/15/2013)

01/14/2013 Markman Hearing reset for 9/26/2013 09:00 AM before Magistrate Judge John D. Love. (mll,) (Entered: 01/15/2013)

01/15/2013 381 Order reassigning this case to United States District Judge Michael H. Schneider per General Order 13-3. Please see Appendix D: Addendum Regarding Cases Assigned to Judge Schneider. Judge Leonard Davis no longer assigned to the case. (tlh,) (Entered: 01/15/2013)

01/18/2013 382 Emergency MOTION to Amend/Correct 352 Order, Set Scheduling Order Deadlines, Set Hearings,,, by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, Newegg. (Attachments: # 1 Text of Proposed Order) (Spivey, Jonathan) (Entered: 01/18/2013)

01/18/2013 383 RESPONSE in Opposition re 382 Emergency MOTION to Amend/Correct 352 Order, Set Scheduling Order Deadlines, Set Hearings,,,Emergency MOTION to Amend/Correct 352 Order, Set Scheduling Order Deadlines, Set Hearings,,, filed by MacroSolve, Inc.. (Attachments: # 1 Exhibit Exhibit 1 - December 18, 2012 Email, # 2 Text of Proposed Order)(Cooper, Califf) (Entered: 01/18/2013)

01/22/2013	384	REPLY to Response to Motion re 382 Emergency MOTION to Amend/Correct 352 Order, Set Scheduling Order Deadlines, Set Hearings,,,Emergency MOTION to Amend/Correct 352 Order, Set Scheduling Order Deadlines, Set Hearings,,, filed by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, Newegg. (Spivey, Jonathan) (Entered: 01/22/2013)
01/23/2013	385	ORDER granting 382 Motion to Amend/Correct. parties are directed to resubmit a Docket Control Order no later than February 1, 2013. Signed by Magistrate Judge John D. Love on 1/23/2013. (gsg) (Entered: 01/23/2013)
01/31/2013	386	Joint MOTION to Amend/Correct the Docket Control Order by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company, MacroSolve, Inc., Newegg. (Attachments: # 1 Exhibit Docket Control Order)(Cooper, Califf) (Entered: 01/31/2013)
01/31/2013	387	MOTION for Extension of Time to File /Consolidated Joint Motion for Extension of Deadline to Submit Closing Documents by Avis Rent A Car System, LLC. (Attachments: # 1 Text of Proposed Order)(Warshawsky, Kimberly) (Entered: 01/31/2013)
02/01/2013	388	ORDER granting 387 Motion for Extension of Time. The request to extend the deadline to submit closing documents as to Avis Rent A Car System, LLC until February 8, 2013 is GRANTED. No further extensions will be granted. Signed by Magistrate Judge John D. Love on 2/1/2013. (gsg) (Entered: 02/01/2013)
02/01/2013	389	Joint MOTION to Dismiss Avis Rent A Car System, LLC WITH PREJUDICE by Avis Rent A Car System, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order) (Cooper, Califf) (Entered: 02/01/2013)
02/05/2013	390	SCHEDULING ORDER: Final Pretrial Conference set for 5/22/2014 09:00 AM in Ctrm 207 (Tyler) before Magistrate Judge John D. Love. Amended Pleadings due by 7/18/2013. Jury instructions due by 3/28/2014. Jury Selection set for 6/2/2014 09:00 AM in Ctrm 102 (Tyler) before Judge Michael H. Schneider. Jury trial is set for 9:00 a.m. 6/9/2014. Mediation Completion due by 3/18/2014. Markman Hearing set for 9/26/2013 09:00 AM in Ctrm 207 (Tyler) before Magistrate Judge John D. Love. Proposed Pretrial Order due by 3/28/2014. Signed by Magistrate Judge John D. Love on 2/5/13. (mjc,) (Entered: 02/05/2013)
02/05/2013		Set Deadlines/Hearings: Jury Trial set for 6/9/2014 09:00 AM in Ctrm 102 (Tyler) before Judge Michael H. Schneider. (mjc,) (Entered: 02/05/2013)
02/06/2013	391	ORDER granting 389 Motion to Dismiss. All claims and counterclaims made by MacroSolve and Avis against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Michael H. Schneider on 02/06/13. cc:attys 2-06-13 (mll,) (Entered: 02/06/2013)
02/20/2013	392	NOTICE by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company of Intent to Issue Subpoena (Attachments: # 1 Exhibit Exhibit A)(Spivey, Jonathan) (Entered: 02/20/2013)
04/04/2013	393	NOTICE by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company /Notice of Request for Ex Parte Reexamination (Attachments: # 1 Exhibit A)(Spivey, Jonathan) (Entered: 04/04/2013)
04/10/2013	394	Joint MOTION to Dismiss Citigroup Inc. With Prejudice by Citigroup Inc, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Cooper, Califf) (Entered: 04/10/2013)
04/15/2013	395	ORDER granting 394 Motion to Dismiss. All claims and counterclaims made by MacroSolve and CitiGroup against each other in this action are dismissed with prejudice. Each party shall bear its own attorneys' fees and costs. Signed by Judge Michael H. Schneider on 04/15/13. (mll,) (Entered: 04/15/2013)
04/16/2013	396	Opposed MOTION For Leave to Supplement Their Invalidity Contentions by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company. (Attachments: # 1 Text of Proposed Order)(Spivey, Jonathan) (Entered: 04/16/2013)
04/17/2013	397	MOTION to Stay Pending Reexamination by GEICO Casualty Company, GEICO Insurance Agency Inc, Government Employees Insurance Company. (Attachments: # 1 Exhibit A, # 2 Exhibit B, # 3 Text of Proposed Order)(Spivey, Jonathan) (Entered: 04/17/2013)

Events

since last

full update

US District Court Civil Docket

U.S. District - Texas Eastern
(Tyler)

6:11cv194

Macrosolve, Inc. v. Canvas Solutions, Inc. et al

Date Filed:	**04/18/2011**	Class Code:	**CLOSED**
Assigned To:	**Judge Leonard Davis**	Closed:	**Yes**
Referred To:		Statute:	**35:271**
Nature of suit:	**Patent (830)**	Jury Demand:	**Both**
Cause:	**Patent Infringement**	Demand Amount:	**$0**
Lead Docket:	**None**	NOS Description:	**Patent**
Other Docket:	**6:12cv00044** **6:12cv00047** **1:12cv00050** **6:12cv00046** **6:12cv00045** **6:12cv00194** **6:12cv00074** **6:12cv00076** **6:12cv00092**		
Jurisdiction:	**Federal Question**		

Litigants	Attorneys
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Date	#	Proceeding Text	Source
04/18/2011	1	COMPLAINT against Canvas Solutions, Inc., GeoAge, Inc., Kony Solutions, Inc., Pogo Corporation, SWD Interactive LLC, Widget Press, Inc. (Filing fee $ 350 receipt number 0540-2993986.), filed by MacroSolve, Inc.. (Attachments: # 1 Exhibit A [816 Patent], # 2 Civil Cover Sheet)(Antonelli, Matthew) (Additional attachment(s) added on 4/25/2011: # 3 Exhibit A Searchable) (mjc,). (Entered: 04/18/2011)	
04/18/2011		Judge Leonard Davis added. (mll,) (Entered: 04/20/2011)	
04/19/2011	2	NOTICE of Attorney Appearance by Larry Dean Thompson, Jr on behalf of MacroSolve, Inc. (Thompson, Larry) (Entered: 04/19/2011)	
04/19/2011	3	Notice of Filing of Copyright Form (AO 121). AO 121 mailed to the Register of Copyrights. (Antonelli, Matthew) (Entered: 04/19/2011)	
04/19/2011	4	CORPORATE DISCLOSURE STATEMENT filed by MacroSolve, Inc. (Antonelli, Matthew) (Entered: 04/19/2011)	

04/19/2011	5	NOTICE by MacroSolve, Inc. Notice of Related Case (Antonelli, Matthew) (Entered: 04/19/2011)
04/20/2011	6	E-GOV SEALED SUMMONS Issued as to Canvas Solutions, Inc., GeoAge, Inc., Kony Solutions, Inc., Pogo Corporation, SWD Interactive LLC, Widget Press, Inc. (Attachments: # 1 Summons (es), # 2 Summons(es), # 3 Summons(es), # 4 Summons(es), # 5 Summons(es))(kls,) (Entered: 04/20/2011)
04/20/2011	7	NOTICE of Attorney Appearance by Zachariah Harrington on behalf of MacroSolve, Inc. (Harrington, Zachariah) (Entered: 04/20/2011)
05/02/2011	8	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Widget Press, Inc..(Cornelius, William) (Entered: 05/02/2011)
05/03/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 8 is granted pursuant to Local Rule CV-12 for Widget Press, Inc. to 6/16/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 05/03/2011)
05/03/2011	9	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re SWD Interactive LLC.(Coleman, Debra) (Entered: 05/03/2011)
05/04/2011	10	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Kony Solutions, Inc.(Sacksteder, Michael) (Entered: 05/04/2011)
05/06/2011	11	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Canvas Solutions, Inc..(Guaragna, John) (Entered: 05/06/2011)
05/10/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 9 is granted pursuant to Local Rule CV-12 for SWD Interactive LLC to 6/15/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 05/10/2011)
05/10/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 10 is granted pursuant to Local Rule CV-12 for Kony Solutions, Inc. to 6/10/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 05/10/2011)
05/10/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 11 is granted pursuant to Local Rule CV-12 for Canvas Solutions, Inc. to 6/10/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 05/10/2011)
05/10/2011	12	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re GeoAge, Inc..(Maloney, Collin) (Entered: 05/10/2011)
05/11/2011	13	Return of Service Executed as to Widget Press, Inc. on 4/20/2011, by personal service. (mll,) (Entered: 05/12/2011)
05/11/2011	14	Return of Service Executed as to Pogo Corporation on 4/20/2011, by personal service; answer due: 5/11/2011. (mll,) (Entered: 05/12/2011)
05/11/2011	15	Return of Service Executed as to Kony Solutions, Inc. on 4/20/2011, by personal service. (mll,) (Entered: 05/12/2011)
05/11/2011	16	Return of Service Executed as to GeoAge, Inc. on 4/20/2011, by personal service; answer due: 5/11/2011. (mll,) (Entered: 05/12/2011)
05/11/2011	17	Return of Service Executed as to Canvas Solutions, Inc. on 4/20/2011, by personal service. (mll,) (Entered: 05/12/2011)
05/13/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 12 is granted pursuant to Local Rule CV-12 for GeoAge, Inc. to 6/10/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 05/13/2011)
05/18/2011	18	Return of Service Executed as to SWD Interactive LLC on 4/25/2011, by cert mail. (mll,) (Entered: 05/18/2011)
05/20/2011	19	NOTICE of Application for Extension of Time to Answer Complaint by Pogo Corporation (pro se). (mll,) (Entered: 05/24/2011)
05/24/2011		Defendant's Unopposed First Application for Extension of Time to Answer Complaint 19 is granted pursuant to Local Rule CV-12 for Pogo Corporation to 6/23/2011. 30 Days Granted for Deadline Extension. (filed by deft pro se)(mll,) (Entered: 05/24/2011)
06/07/2011	20	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re SWD Interactive LLC. (Coleman, Debra) (Entered: 06/07/2011)
06/08/2011	21	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Kony Solutions, Inc..(Sacksteder, Michael) (Entered: 06/08/2011)
06/09/2011	22	Unopposed MOTION for Extension of Time to File Answer re 1 Complaint, or Otherwise Respond by Canvas Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Guaragna, John) (Entered: 06/09/2011)
06/09/2011	23	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re GeoAge, Inc..(Maloney, Collin) (Entered: 06/09/2011)

06/10/2011		Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 20 is granted pursuant to Local Rule CV-12 for SWD Interactive LLC to 6/30/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 06/10/2011)
06/10/2011		Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 21 is granted pursuant to Local Rule CV-12 for Kony Solutions, Inc. to 6/24/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 06/10/2011)
06/10/2011		Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 23 is granted pursuant to Local Rule CV-12 for GeoAge, Inc. to 6/27/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 06/10/2011)
06/10/2011	24	ORDER granting 22 Motion for Extension of Time to Answer. Deft Canvas Solutions Inc shall have to 7-15-2011 to answer, plead or otherwise respond to pltf's Complaint. Signed by Judge Leonard Davis on 06/10/11. cc:attys 6-10-11 (mll,) (Entered: 06/10/2011)
06/14/2011	25	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Widget Press, Inc..(Cornelius, William) (Entered: 06/14/2011)
06/17/2011		Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 25 is granted pursuant to Local Rule CV-12 for Widget Press, Inc. to 7/15/2011. 29 Days Granted for Deadline Extension.(mll,) (Entered: 06/17/2011)
06/23/2011	26	NOTICE of Voluntary Dismissal by MacroSolve, Inc. (Antonelli, Matthew) (Additional attachment (s) added on 6/29/2011: # 1 Text of Proposed Order) (mll,). (Entered: 06/23/2011)
06/23/2011	27	MOTION for Extension of Time to File Answer to Complaint by Pogo Corporation. (mll,) (Entered: 06/23/2011)
06/23/2011	28	MOTION for Leave to File Electronically as pro se by Andrew Farrell for Pogo Corporation. (mll,) (Entered: 06/23/2011)
06/23/2011	29	MOTION to Change Venue to the Middle District of Florida, Orlando Division by Pogo Corporation. (mll,) (Entered: 06/23/2011)
06/23/2011	30	Unopposed MOTION for Extension of Time to File Answer re 1 Complaint, by Kony Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Sacksteder, Michael) (Entered: 06/23/2011)
06/24/2011	31	NOTICE of Voluntary Dismissal by MacroSolve, Inc. (Antonelli, Matthew) (Additional attachment (s) added on 6/29/2011: # 1 Text of Proposed Order) (mll,). (Entered: 06/24/2011)
06/24/2011	32	ORDER granting 30 Motion for Extension of Time to Answer. Kony Solutions Inc shall have to 7-08-2011 to move, answer, or otherwise respond to pltf's Complaint. Signed by Judge Leonard Davis on 06/24/11. cc:attys 6-27-11 (mll,) (Entered: 06/27/2011)
06/29/2011	33	Unopposed MOTION for Extension of Time to File Answer re 1 Complaint, by SWD Interactive LLC. (Attachments: # 1 Text of Proposed Order)(Coleman, Debra) (Entered: 06/29/2011)
06/30/2011	34	ORDER granting 33 Motion for Extension of Time to Answer. The deadline for SWD Interactive LLC to answer or otherwise respond to the Original Complaint is extended to 7-14-2011. Signed by Judge Leonard Davis on 06/30/11. cc:attys 6-30-11 (mll,) (Entered: 06/30/2011)
06/30/2011	35	ORDER granting 26 Notice of Voluntary Dismissal filed by MacroSolve, Inc. All claims in this action by pltf against deft Pogo Corporation are dismissed without prejudice. Defendant Pogo's Motions 27 , 28 , and 29 are DENIED as moot. Signed by Judge Leonard Davis on 06/30/11. cc:attys 6-30-11(mll,) (Entered: 06/30/2011)
06/30/2011	36	ORDER granting 31 Notice of Voluntary Dismissal filed by MacroSolve, Inc. Pltf's claim against deft GeoAge Inc is dismissed without prejudice. Signed by Judge Leonard Davis on 06/30/11. cc:attys 6-30-11(mll,) (Entered: 06/30/2011)
07/05/2011	37	NOTICE of Voluntary Dismissal by MacroSolve, Inc. (Attachments: # 1 Text of Proposed Order) (Antonelli, Matthew) (Entered: 07/05/2011)
07/06/2011	38	ORDER granting 37 Notice of Voluntary Dismissal filed by MacroSolve, Inc. Pltf's claim against deft Widget Press Inc is dismissed without prejudice. Signed by Judge Leonard Davis on 07/06/11. cc:attys 7-07-11(mll,) (Entered: 07/07/2011)
07/08/2011	39	Kony Solutions, Inc.'s ANSWER to 1 Complaint, and Affirmative Defenses to Complaint for Patent Infringement, COUNTERCLAIM against MacroSolve, Inc. by Kony Solutions, Inc..(Sacksteder, Michael) (Entered: 07/08/2011)
07/08/2011	40	CORPORATE DISCLOSURE STATEMENT filed by Kony Solutions, Inc. (Sacksteder, Michael) (Entered: 07/08/2011)
07/11/2011	41	NOTICE by GeoAge, Inc. Of Request to Terminate Electronic Notification of Filings (Maloney, Collin) (Entered: 07/11/2011)
07/11/2011	42	ORDER that plaintiff file a notice that the case is ready for scheduling conference when all of the defendants have either answered or filed a motion to transfer or dismiss. The notice shall be filed within five days of the last remaining defendant's answer or motion. Signed by Judge Leonard Davis on 07/11/11. cc:attys 7-12-11(mll,) (Entered: 07/12/2011)

07/13/2011	43	Unopposed MOTION for Extension of Time to File Answer re 1 Complaint, (Second) by SWD Interactive LLC. (Attachments: # 1 Text of Proposed Order)(Coleman, Debra) (Entered: 07/13/2011)
07/14/2011	44	ORDER granting 43 Motion for Extension of Time to Answer. The deadline for SWD Interactive LLC to answer or otherwise respond to the Original Complaint is extended to 7-28-2011. Signed by Judge Leonard Davis on 07/14/11. cc:attys 7-14-11 (mll,) (Entered: 07/14/2011)
07/15/2011	45	ANSWER to 1 Complaint, by Canvas Solutions, Inc..(Guaragna, John) (Entered: 07/15/2011)
07/15/2011	46	CORPORATE DISCLOSURE STATEMENT filed by Canvas Solutions, Inc. (Guaragna, John) (Entered: 07/15/2011)
07/18/2011	47	ANSWER to 39 Answer to Complaint, Counterclaim of Kony Solutions, Inc. by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 07/18/2011)
07/20/2011	48	NOTICE by MacroSolve, Inc. of dismissal without prejudice as to SWD Interactive LLC (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 07/20/2011)
07/24/2011	49	NOTICE by MacroSolve, Inc. re 42 Order, NOTICE OF READINESS FOR SCHEDULING CONFERENCE (Thompson, Larry) (Entered: 07/24/2011)
08/08/2011	50	ORDER setting Status Conference for 9/6/2011 01:30 PM before Judge Leonard Davis. Signed by Judge Leonard Davis on 08/08/11. cc:attys 8-09-11(mll,) (Entered: 08/09/2011)
08/11/2011	51	ORDER granting 48 Notice of Dismissal filed by MacroSolve, Inc. MacroSolves claim against SWD Interactive LLC is dismissed without prejudice. Signed by Judge Leonard Davis on 08/11/11. cc:attys 8-12-11(mll,) (Entered: 08/12/2011)
08/31/2011	52	NOTICE of Attorney Appearance by Jeffrey Lance Johnson on behalf of Canvas Solutions, Inc. (Johnson, Jeffrey) (Entered: 08/31/2011)
09/01/2011	53	Unopposed MOTION to Stay Deadlines Following Settlement and Notice of Settlement by Kony Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Sacksteder, Michael) (Entered: 09/01/2011)
09/02/2011	54	Unopposed MOTION to Stay Deadlines by Canvas Solutions, Inc.. (Attachments: # 1 Text of Proposed Order)(Guaragna, John) (Entered: 09/02/2011)
09/02/2011	55	ORDER granting 53 Motion to Stay. All deadlines between Plaintiff Macrosolve, Inc. and Defendant Kony Solutions, Inc. are hereby stayed 14 days. Signed by Judge Leonard Davis on 09/02/11. cc:attys 9-02-11 (mll,) (Entered: 09/02/2011)
09/02/2011		NOTICE OF CANCELLATION OF HEARING. Status Conference set 09/06/2011 @ 1:30 pm before Judge Davis has been cancelled. (rlf,) (Entered: 09/02/2011)
09/06/2011	56	ORDER granting 54 Motion to Stay; deadlines are STAYED as to deft Canvas Solutions Inc for 30 days, to 10-03-2011. Signed by Judge Leonard Davis on 09/06/11. cc:attys 9-07-11 (mll,) (Entered: 09/07/2011)
09/16/2011	57	NOTICE of Settlement as to Kony Solutions, Inc. by MacroSolve, Inc. (Thompson, Larry) (Entered: 09/16/2011)
09/20/2011	58	Joint MOTION to Dismiss Kony Solutions, Inc. With Prejudice by Kony Solutions, Inc., MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 09/20/2011)
09/21/2011	59	ORDER granting 58 Motion to Dismiss. All claims and counterclaims in this action between pltf and deft Kony Solutions Inc are dismissed with prejudice, with each party to bear their own costs, expenses, and attorney's fees. Signed by Judge Leonard Davis on 09/21/11. cc:attys 9-21-11 (mll,) (Entered: 09/21/2011)
09/28/2011	60	NOTICE of Settlement as to Canvas Solutions, Inc. by MacroSolve, Inc. (Thompson, Larry) (Entered: 09/28/2011)
09/30/2011	61	Joint MOTION to Dismiss Canvas Solutions, Inc. by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 09/30/2011)
10/03/2011	62	ORDER granting 61 Motion to Dismiss. All claims made by MacroSolve against Canvas in this action are dismissed with prejudice. Each party shall bear its own attorneys fees and costs. Signed by Judge Leonard Davis on 10/03/11. cc:attys 10-03-11 (mll,) (Entered: 10/03/2011)

US District Court Civil Docket

U.S. District - Texas Eastern
(Tyler)

6:11cv101

Macrosolve, Inc v. Brazos Technology Corporation et al

Date Filed:	03/04/2011	Class Code:	CLOSED
Assigned To:	Magistrate Judge John D Love	Closed:	Yes
Referred To:		Statute:	35:271
Nature of suit:	Patent (830)	Jury Demand:	Both
Cause:	Patent Infringement	Demand Amount:	$0
Lead Docket:	None	NOS Description:	Patent
Other Docket:	6:12-cv-00384-LED 6:12-cv-00385-LED 6:12-cv-00387-LED 6:12-cv-00389-LED 6:12-cv-00416-LED 6:12-cv-00417 6:12-cv-00418-LED		
Jurisdiction:	Federal Question		

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Date	#	Proceeding Text	Source
03/04/2011	1	COMPLAINT For Patent Infringement against Blue Shoe Mobile Solutions, LLC, Brazos Technology Corporation, Formstack, LLC, On The Spot Systems, Inc. (Filing fee $ 350 receipt number 0540-2917884.), filed by MacroSolve, Inc.. (Attachments: # 1 Civil Cover Sheet, # 2 Ex A [816 Patent])(Antonelli, Matthew) (Additional attachment(s) added on 4/25/2011: # 3 Exhibit A Searchable) (mjc,). (Entered: 03/04/2011)	
03/04/2011	2	NOTICE of Attorney Appearance by Larry Dean Thompson, Jr on behalf of MacroSolve, Inc. (Thompson, Larry) (Entered: 03/04/2011)	
03/04/2011	3	CORPORATE DISCLOSURE STATEMENT filed by MacroSolve, Inc. (Thompson, Larry) (Entered: 03/04/2011)	
03/04/2011	4	Notice of Filing of Patent/Trademark Form (AO 120). AO 120 mailed to the Director of the U.S. Patent and Trademark Office. (Thompson, Larry) (Entered: 03/04/2011)	
03/04/2011	--	Judge Leonard Davis added. (mll,) (Entered: 03/04/2011)	
03/04/2011	5	NOTICE of Attorney Appearance by Zachariah Harrington on behalf of MacroSolve, Inc. (Harrington, Zachariah) (Entered: 03/04/2011)	
03/07/2011	6	E-GOV SEALED SUMMONS Issued as to Blue Shoe Mobile Solutions, LLC, Brazos Technology Corporation, Formstack, LLC, On The Spot Systems, Inc., and emailed to pltf for service. (mll,) (Entered: 03/07/2011)	
03/08/2011	7	NOTICE of Attorney Appearance by Andrew W. Spangler on behalf of MacroSolve, Inc. (Spangler, Andrew) (Entered: 03/08/2011)	
03/15/2011	8	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Brazos Technology Corporation.(Bobo, Matthew) (Entered: 03/15/2011)	
03/15/2011	9	Return of Service Executed as to On The Spot Systems, Inc. on 3/7/2011, by personal service on the Texas Secretary of State; answer due: 3/28/2011. (mll,) (Entered: 03/17/2011)	
03/15/2011	10	Return of Service Executed as to Blue Shoe Mobile Solutions, LLC on 3/7/2011, by personal service on Texas Secretary of State; answer due: 3/28/2011. (mll,) (Entered: 03/17/2011)	
03/15/2011	11	Return of Service Executed as to Formstack, LLC on 3/7/2011, by personal service on Texas Secretary of State; answer due: 3/28/2011. (mll,) (Entered: 03/17/2011)	
03/21/2011	--	Defendant's Unopposed First Application for Extension of Time to Answer Complaint 8 is granted pursuant to Local Rule CV-12 for Brazos Technology Corporation to 4/7/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 03/21/2011)	
03/25/2011	12	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Blue Shoe Mobile Solutions, LLC.(Maloney, Collin) (Entered: 03/25/2011)	
03/25/2011	13	NOTICE of Attorney Appearance by Collin Michael Maloney on behalf of Blue Shoe Mobile Solutions, LLC (Maloney, Collin) (Entered: 03/25/2011)	
03/25/2011	14	NOTICE of Attorney Appearance by Otis W Carroll, Jr on behalf of Blue Shoe Mobile Solutions, LLC (Carroll, Otis) (Entered: 03/25/2011)	
03/25/2011	15	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re On The Spot Systems, Inc..(Lyons, Crystal) (Entered: 03/25/2011)	
03/28/2011	--	Defendant's Unopposed First Application for Extension of Time to Answer Complaint 12 is granted pursuant to Local Rule CV-12 for Blue Shoe Mobile Solutions, LLC to 4/27/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 03/28/2011)	
03/28/2011	--	Defendant's Unopposed First Application for Extension of Time to Answer Complaint 15 is granted pursuant to Local Rule CV-12 for On The Spot Systems, Inc. to 5/2/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 03/28/2011)	
03/29/2011	16	Defendant's Unopposed First Application for Extension of Time to Answer Complaint re Formstack, LLC.(Jones, Michael) (Entered: 03/29/2011)	

04/01/2011	17	NOTICE of Attorney Appearance by Dave Ross Gunter on behalf of Brazos Technology Corporation (Gunter, Dave) (Entered: 04/01/2011)
04/01/2011	18	NOTICE of Attorney Appearance by Jonathan T Suder on behalf of Brazos Technology Corporation (Suder, Jonathan) (Entered: 04/01/2011)
04/01/2011	--	Defendant's Unopposed First Application for Extension of Time to Answer Complaint 16 is granted pursuant to Local Rule CV-12 for Formstack, LLC to 5/1/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 04/01/2011)
04/01/2011	20	ORDER that plaintiff file a notice that the case is ready for scheduling conference when all of the defendants have either answered or filed a motion to transfer or dismiss. The notice shall be filed within five days of the last remaining defendant's answer or motion. Signed by Judge Leonard Davis on 04/01/11. cc:attys 4-04-11(mll,) (Entered: 04/04/2011)
04/04/2011	19	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Brazos Technology Corporation.(Suder, Jonathan) (Entered: 04/04/2011)
04/06/2011	--	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 19 is granted pursuant to Local Rule CV-12 for Brazos Technology Corporation to 5/9/2011. 30 Days Granted for Deadline Extension.(mll,) (Entered: 04/06/2011)
04/25/2011	21	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Blue Shoe Mobile Solutions, LLC.(Maloney, Collin) (Entered: 04/25/2011)
04/25/2011	22	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re On The Spot Systems, Inc..(Lyons, Crystal) (Entered: 04/25/2011)
04/26/2011	--	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 21 is granted pursuant to Local Rule CV-12 for Blue Shoe Mobile Solutions, LLC to 5/12/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 04/26/2011)
04/26/2011	--	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 22 is granted pursuant to Local Rule CV-12 for On The Spot Systems, Inc. to 5/17/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 04/26/2011)
04/27/2011	23	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint re Formstack, LLC.(Jones, Michael) (Entered: 04/27/2011)
04/29/2011	--	Defendant's Unopposed Second Application for Extension of Time to Answer Complaint 23 is granted pursuant to Local Rule CV-12 for Formstack, LLC to 5/17/2011. 15 Days Granted for Deadline Extension.(mll,) (Entered: 04/29/2011)
05/06/2011	24	Third MOTION for Extension of Time to File Answer Complaint by On The Spot Systems, Inc.. (Attachments: # 1 Text of Proposed Order)(Lyons, Crystal) (Entered: 05/06/2011)
05/09/2011	25	Defendant Brazos Technology Corporation's ANSWER to 1 Complaint, by Brazos Technology Corporation.(Suder, Jonathan) (Entered: 05/09/2011)
05/09/2011	26	CORPORATE DISCLOSURE STATEMENT filed by Brazos Technology Corporation (Suder, Jonathan) (Entered: 05/09/2011)
05/09/2011	27	ORDER granting 24 Motion for Extension of Time to Answer re 24 Third MOTION for Extension of Time to File Answer Complaint . On The Spot Systems' answer is due by 6/17/2011. Signed by Judge Leonard Davis on 5/9/11. (mjc,) (Entered: 05/09/2011)
05/09/2011	--	Set/Reset Deadlines: On The Spot Systems, Inc. answer due 6/17/2011. (mjc,) (Entered: 05/09/2011)
05/11/2011	28	ANSWER to 1 Complaint, by Blue Shoe Mobile Solutions, LLC.(Maloney, Collin) (Entered: 05/11/2011)
05/12/2011	29	APPLICATION to Appear Pro Hac Vice by Attorney Christopher E Gatewood for Blue Shoe Mobile Solutions, LLC. (mll,) (Entered: 05/12/2011)
05/17/2011	30	ANSWER to 1 Complaint, and , COUNTERCLAIM against MacroSolve, Inc. by Formstack, LLC. (Jones, Michael) (Entered: 05/17/2011)
05/17/2011	31	CORPORATE DISCLOSURE STATEMENT filed by Formstack, LLC identifying Corporate Parent None for Formstack, LLC. (Jones, Michael) (Entered: 05/17/2011)
05/18/2011	32	APPLICATION to Appear Pro Hac Vice by Attorney Clifford C Dougherty, III for Formstack, LLC (mll,) (Entered: 05/19/2011)
05/18/2011	33	APPLICATION to Appear Pro Hac Vice by Attorney Amy D White for Formstack, LLC (mll,) (Entered: 05/19/2011)
06/09/2011	34	Fourth MOTION for Extension of Time to File Answer Complaint by On The Spot Systems, Inc.. (Attachments: # 1 Text of Proposed Order)(Lyons, Crystal) (Entered: 06/09/2011)
06/09/2011	35	ANSWER to 30 Answer to Complaint, Counterclaim of Formstack by MacroSolve, Inc..(Antonelli, Matthew) (Entered: 06/09/2011)

06/10/2011	36	ORDER granting 34 Motion for Extension of Time to Answer. Deft On the Spot Systems Inc shall respond or otherwise answer pltf's Complaint by 7-18-2011. Signed by Judge Leonard Davis on 06/10/11. cc:attys 6-10-11 (mll,) (Entered: 06/10/2011)
06/10/2011	37	Unopposed MOTION to Withdraw as Attorney by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Spangler, Andrew) (Entered: 06/10/2011)
06/14/2011	38	ORDER granting 37 Motion to Withdraw as Attorney. Attorney Andrew W. Spangler terminated. Signed by Judge Leonard Davis on 6/14/11. (mjc,) (Entered: 06/14/2011)
06/16/2011	39	NOTICE of Attorney Appearance by Allen Franklin Gardner on behalf of Formstack, LLC (Gardner, Allen) (Entered: 06/16/2011)
07/18/2011	40	NOTICE of Voluntary Dismissal by MacroSolve, Inc. (Attachments: # 1 Text of Proposed Order) (Antonelli, Matthew) (Entered: 07/18/2011)
07/19/2011	41	ORDER re 40 Notice of Voluntary Dismissal filed by MacroSolve, Inc. dismissing with prejudice On The Spot Systems, Inc. Each party shall bear their own costs and attorney's fees. Signed by Judge Leonard Davis on 7/19/11. (mjc,) (Entered: 07/19/2011)
07/24/2011	42	NOTICE by MacroSolve, Inc. re 20 Order, NOTICE OF READINESS FOR SCHEDULING CONFERENCE (Thompson, Larry) (Entered: 07/24/2011)
08/08/2011	43	ORDER setting Status Conference for 9/6/2011 01:30 PM before Judge Leonard Davis. Signed by Judge Leonard Davis on 08/08/11. cc:attys 8-09-11(mll,) (Entered: 08/09/2011)
08/09/2011	44	NOTICE of Settlement AS TO BLUE SHOE MOBILE SOLUTIONS, LLC by MacroSolve, Inc. (Thompson, Larry) (Entered: 08/09/2011)
08/15/2011	45	Joint MOTION to Dismiss Blue Shoe Mobile Solutions, LLC by Blue Shoe Mobile Solutions, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 08/15/2011)
08/17/2011	46	ORDER granting 45 Motion to Dismiss with prejudice all claims and counterclaims asserted by Plaintiff MacroSolve, Inc. and Defendant Blue Shoe Mobile Solutions, LLC. Signed by Judge Leonard Davis on 8/16/11. (mjc,) (Entered: 08/17/2011)
08/30/2011	47	MOTION to Change Venue to the United States District Court for the Southern District of Texas by Brazos Technology Corporation. (Attachments: # 1 Exhibit 1, # 2 Exhibit 2, # 3 Text of Proposed Order)(Gunter, Dave) (Entered: 08/30/2011)
09/06/2011	48	Minute Entry for proceedings held before Judge Leonard Davis: Status Conference held on 9/6/2011. (Court Reporter Shea Sloan.) (Attachments: # 1 Attorney Sign-in Sheet) (sms,) (Entered: 09/06/2011)
09/08/2011	49	Unopposed MOTION for Extension of Time to Complete Discovery to Comply With Patent Rules 3-1 & 3-2 by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 09/08/2011)
09/08/2011	50	CONSENT to Proceed Before US Magistrate Judge by Brazos Technology Corporation, Formstack, LLC, MacroSolve, Inc.. Case reassigned to Magistrate Judge John D. Love. (mll,) (Entered: 09/08/2011)
09/08/2011	51	ORDER assigning case to Judge John D Love by consent of the parties for all further proceedings and entry of judgment. Signed by Judge Leonard Davis on 09/08/11. cc:attys 9-08-11(mll,) (Entered: 09/08/2011)
09/09/2011	52	ORDER granting 49 Unopposed Motion for Extension of Time to Complete Discovery. The deadline to comply with Patent Local Rules 3-1 and 3-2 is extended from 9/12/11 to 9/26/11. Signed by Magistrate Judge John D. Love on 9/9/11. (leh,) (Entered: 09/12/2011)
09/09/2011	53	ORDER that the Court dates listed on this Order be incorporated into the proposed Docket Control Order which is due by 9-23-2011. Signed by Magistrate Judge John D. Love on 09/09/11. cc:attys 9-12-11(mll,) (Entered: 09/12/2011)
09/19/2011	54	Unopposed MOTION for Extension of Time to File Response/Reply as to 47 MOTION to Change Venue to the United States District Court for the Southern District of Texas , Unopposed MOTION for Discovery Relating to Venue by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order) (Antonelli, Matthew) (Entered: 09/19/2011)
09/20/2011	55	ORDER granting 54 Motion for Extension of Time; granting 54 Motion for Discovery. Signed by Magistrate Judge John D. Love on 09/20/11. cc:attys 9-20-11 (mll,) (Entered: 09/20/2011)
09/23/2011	56	Unopposed MOTION for Entry Of Agreed Docket Control Order and Agreed Discovery Order by MacroSolve, Inc.. (Attachments: # 1 Exhibit 1 [DCO], # 2 Exhibit 2 [Discovery Order])(Antonelli, Matthew) (Entered: 09/23/2011)
10/11/2011	57	DISCOVERY ORDER. Signed by Magistrate Judge John D. Love on 10/11/11. (leh,) (Entered: 10/11/2011)
10/12/2011	58	DOCKET CONTROL ORDER. Markman Hearing set for 10/11/2012 at 9:00 AM in Ctrm 207 (Tyler) before Magistrate Judge John D. Love. Jury Selection set for 5/6/2013 9:00 AM, with Jury Trial

		set for 5/13/2013 at 9:00 AM. Signed by Magistrate Judge John D. Love on 10/11/11. (leh,) (Entered: 10/12/2011)
10/12/2011	59	NOTICE by Blue Shoe Mobile Solutions, LLC Of Request for Termination of Electronic Notices (Carroll, Otis) (Entered: 10/12/2011)
10/25/2011	60	NOTICE of Designation of Mediator, Hon. Robert Faulkner (Ret.), filed by MacroSolve, Inc.. (Antonelli, Matthew) (Entered: 10/25/2011)
10/26/2011	61	MEDIATION ORDER. Robert Faulkner added as Mediator. Mediation to be conducted (1st round) no later than 6/22/2012. Signed by Magistrate Judge John D. Love on 10/26/11. (leh,) (Entered: 10/26/2011)
11/11/2011	62	NOTICE of Settlement with Brazos Technology Corporation by MacroSolve, Inc. (Antonelli, Matthew) (Entered: 11/11/2011)
11/21/2011	63	NOTICE of Discovery Disclosure by Formstack, LLC regarding Initial Disclosures (Jones, Michael) (Entered: 11/21/2011)
11/22/2011	64	NOTICE of Discovery Disclosure by MacroSolve, Inc. re Initial Disclosures (Thompson, Larry) (Entered: 11/22/2011)
11/29/2011	65	Joint MOTION to Dismiss Brazos Technology Corporation by MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Antonelli, Matthew) (Entered: 11/29/2011)
11/30/2011	66	ORDER OF DISMISSAL of Brazos Technology Corporation. Order granting 65 Joint Motion to Dismiss. All claims and counterclaims made by MacroSolve and Brazos against each other in this action are dismissed with prejudice. The Court will retain jurisdiction over the parties for settlement purposes. Each party to bear their own attorneys' fees and costs. Signed by Magistrate Judge John D. Love on 11/30/11. (leh,) (Entered: 11/30/2011)
11/30/2011	67	ORDER denying 47 Brazos Technology Corporation's Motion to Change Venue to the US District Court for the Southern District of Texas as MOOT, pursuant to the order dismissing Brazos from this action. Signed by Magistrate Judge John D. Love on 11/30/11. (leh,) (Entered: 11/30/2011)
12/08/2011	68	Unopposed MOTION FOR EXTENSION OF THE DECEMBER 16, 2011 DEADLINES re 58 Order, Set Scheduling Order Deadlines, Set Deadlines/Hearings,,, by Formstack, LLC. (Attachments: # 1 Text of Proposed Order)(Jones, Michael) (Entered: 12/08/2011)
12/09/2011	69	ORDER granting Defendant Formstack LLC's 68 Unopposed Motion for Extension of the December 16, 2011 Deadlines. The deadline is extended to 1/6/2012 Signed by Magistrate Judge John D. Love on 12/9/11. (leh,) (Entered: 12/09/2011)
12/20/2011	70	Joint MOTION to Dismiss Formstack, LLC With Prejudice by Formstack, LLC, MacroSolve, Inc.. (Attachments: # 1 Text of Proposed Order)(Thompson, Larry) (Entered: 12/20/2011)
12/21/2011	71	ORDER OF DISMISSAL with prejudice. Order granting 70 Motion to Dismiss. All claims and counterclaims made by Macrosolve Inc and Formstack LLC against each other in this action are dismissed with prejudice. Each party to bear their own attorneys' fees and costs. Signed by Magistrate Judge John D. Love on 12/21/11. (leh,) (Entered: 12/21/2011)
05/30/2012	72	FINAL JUDGMENT entererd pursuant to the Order granting the Parties' Joint Motion to Dismiss. It is ordered that the parties take nothing and that all pending motions are denied as moot. All costs are to be borne by the party that incurred them. All claims, counterclaims, and third party claims in this suit are dismissed in their entirety. Signed by Magistrate Judge John D. Love on 5/30/2012. (leh,) (Entered: 05/30/2012)

REEXAM CONTROL NUMBER	FILING OR 371 (c) DATE	PATENT NUMBER
90/012,829	04/03/2013	7822816

CONFIRMATION NO. 6993

NDQ SPECIAL REEXAM GROUP
1000 LOUISIANA STREET
FIFTY-THIRD FLOOR
HOUSTON, TX 77002

REEXAMINATION REQUEST NOTICE

OC000000060391234

Date Mailed: 04/11/2013

NOTICE OF REEXAMINATION REQUEST FILING DATE

(Third Party Requester)

Requester is hereby notified that the filing date of the request for reexamination is 04/03/2013, the date that the filing requirements of 37 CFR § 1.510 were received.

A decision on the request for reexamination will be mailed within three months from the filing date of the request for reexamination. (See 37 CFR 1.515(a)).

A copy of the Notice is being sent to the person identified by the requester as the patent owner. Further patent owner correspondence will be the latest attorney or agent of record in the patent file. (See 37 CFR 1.33). Any paper filed should include a reference to the present request for reexamination (by Reexamination Control Number).

cc: Patent Owner
22206
FELLERS SNIDER BLANKENSHIP
BAILEY & TIPPENS
THE KENNEDY BUILDING
321 SOUTH BOSTON SUITE 800
TULSA, OK 74103-3318

/sdstevenson/

Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900

REEXAM CONTROL NUMBER	FILING OR 371 (c) DATE	PATENT NUMBER
90/012,829	04/03/2013	7822816

CONFIRMATION NO. 6993

REEXAM ASSIGNMENT NOTICE

22206
FELLERS SNIDER BLANKENSHIP
BAILEY & TIPPENS
THE KENNEDY BUILDING
321 SOUTH BOSTON SUITE 800
TULSA, OK 74103-3318

OC000000060391235

Date Mailed: 04/11/2013

NOTICE OF ASSIGNMENT OF REEXAMINATION REQUEST

The above-identified request for reexamination has been assigned to Art Unit 3992. All future correspondence to the proceeding should be identified by the control number listed above and directed to the assigned Art Unit.

A copy of this Notice is being sent to the latest attorney or agent of record in the patent file or to all owners of record. (See 37 CFR 1.33(c)). If the addressee is not, or does not represent, the current owner, he or she is required to forward all communications regarding this proceeding to the current owner(s). An attorney or agent receiving this communication who does not represent the current owner(s) may wish to seek to withdraw pursuant to 37 CFR 1.36 in order to avoid receiving future communications. If the address of the current owner(s) is unknown, this communication should be returned within the request to withdraw pursuant to Section 1.36.

NOTICE OF USPTO EX PARTE REEXAMINATION PATENT OWNER STATEMENT WAIVER PROGRAM

The USPTO has implemented a pilot program where, after a reexamination proceeding has been granted a filing date and before the examiner begins his or her review, the patent owner may orally waive the right to file a patent owner's statement. See *"Pilot Program for Waiver of Patent Owner's Statement in Ex Parte Reexamination Proceedings,"* 75 FR 47269 (August 5, 2010). One goal of the pilot program is to reduce the pendency of reexamination proceedings and improve the efficiency of the reexamination process.

Ordinarily when ex parte reexamination is ordered, the USPTO must wait until after the receipt of the patent owner's statement and the third party requester's reply, or after the expiration of the time period for filing the statement and reply (a period that can be as long as 5 to 6 months), before mailing a first determination of patentability. The USPTO's first determination of patentability is usually a first Office action on the merits or a Notice of Intent to Issue Reexamination Certificate (NIRC).

Under the pilot program, the patent owner's oral waiver allows the USPTO to act on the first determination of patentability immediately after determining that reexamination will be ordered, and in a suitable case issue the reexamination order and the first determination of patentability (which could be a NIRC if the claims under reexamination are confirmed) at the same time.

Benefits to the Patent Owner for participating in this pilot program include reduction in pendency.

To participate in this pilot program, Patent Owners may contact the USPTO's Central Reexamination Unit (CRU) at 571-272-7705. The USPTO will make the oral waiver of record in the reexamination file in an interview summary and a copy will be mailed to the patent owner and any third party requester.

cc: Third Party Requester(if any)
NDQ SPECIAL REEXAM GROUP
1000 LOUISIANA STREET
FIFTY-THIRD FLOOR
HOUSTON, TX 77002

/sdstevenson/

Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900

Patent Assignment Abstract of Title

Total Assignments: 1

Application #: 10643516 **Filing Dt:** 08/19/2003 **Patent #:** 7822816 **Issue Dt:** 10/26/2010
PCT #: NONE **Publication #:** US20040034684 **Pub Dt:** 02/19/2004
Inventor: J. David Payne
Title: SYSTEM AND METHOD FOR DATA MANAGEMENT

Assignment: 1

Reel/Frame: 014418 / 0844 **Received:** 08/27/2003 **Recorded:** 08/19/2003 **Mailed:** 03/16/2004 **Pages:** 3
Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).
Assignor: PAYNE, J. DAVID **Exec Dt:** 08/07/2003
Assignee: MACROSOLVE, INC.
5800 EAST SKELLY DRIVE
TULSA, OKLAHOMA 74135
Correspondent: FELLERS, SNIDER, BLANKENSHIP ET AL.
SCOTT R. ZINGERMAN
321 SOUTH BOSTON, SUITE 800
TULSA, OK 74103-3318

Search Results as of: 04/11/2013 09:48 AM

If you have any comments or questions concerning the data displayed, contact PRD / Assignments at 571-272-3350. v.2.2.2
Web interface last modified: Dec 18, 2012

PTO/SB/57 (02-13)
Approved for use through 07/31/2015. OMB 0651-0064
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also referred to as FORM PTO-1465)

REQUEST FOR *EX PARTE* REEXAMINATION TRANSMITTAL FORM

Address to:
Mail Stop *Ex Parte* Reexam
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Attorney Docket No.: 20351.RX816

Date: April 3, 2013

1. [✔] This is a request for *ex parte* reexamination pursuant to 37 CFR 1.510 of patent number 7,822,816 issued October 26, 2010. The request is made by:
   [ ] patent owner. [✔] third party requester.
2. [✔] The name and address of the person requesting reexamination is:
   Novak Druce Connolly Bove + Quigg LLP
   1000 Louisiana, Fifty-Third Floor
   Houston, Texas 77002
3. Requester claims [ ] small entity (37 CFR 1.27) or [ ] micro entity status (37 CFR 1.29).
4. [ ] a. A check in the amount of $_____ is enclosed to cover the reexamination fee, 37 CFR 1.20(c)(1);
   [ ] b. The Director is hereby authorized to charge the fee as set forth in 37 CFR 1.20(c)(1) to Deposit Account No. _____;
   [ ] c. Payment by credit card. Form PTO-2038 is attached; **or**
   [✔] d. Payment made via EFS-Web.
5. [✔] Any refund should be made by ___ check or [✔] credit to Deposit Account No. 141437. 37 CFR 1.26(c). If payment is made by credit card, refund must be to credit card account.
6. [✔] A copy of the patent to be reexamined having a double column format on one side of a separate paper is enclosed. 37 CFR 1.510(b)(4).
7. [ ] CD-ROM or CD-R in duplicate, Computer Program (Appendix) or large table
   [ ] Landscape Table on CD
8. [ ] Nucleotide and/or Amino Acid Sequence Submission
   If applicable, items a. – c. are required.
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
      i. [ ] CD-ROM (2 copies) or CD-R (2 copies); **or**
      ii. [ ] paper
   c. [ ] Statements verifying identity of above copies
9. [ ] A copy of any disclaimer, certificate of correction or reexamination certificate issued in the patent is included.
10. [✔] Reexamination of claim(s) 1-14 is requested.
11. [✔] A copy of every patent or printed publication relied upon is submitted herewith including a listing thereof on Form PTO/SB/08, PTO-1449, or equivalent.
12. [✔] An English language translation of all necessary and pertinent non-English language patents and/or printed publications is included.

13. ☐ The attached detailed request includes at least the following items:

a. A statement identifying each substantial new question of patentability based on prior patents and printed publications. 37 CFR 1.510(b)(1).

b. An identification of every claim for which reexamination is requested, and a detailed explanation of the pertinency and manner of applying the cited art to every claim for which reexamination is requested. 37 CFR 1.510(b)(2).

14. ☐ A proposed amendment is included (only where the patent owner is the requester). 37 CFR 1.510(e).

15. ☑ a. It is certified that a copy of this request (if filed by other than the patent owner) has been served in its entirety on the patent owner as provided in 37 CFR 1.33(c).

The name and address of the party served and the date of service are:

Fellers Snider Blankenship, Bailey & Tippens

The Kennedy Building, 321 South Boston Suite 800, Tulsa, OK 74103-3318

Date of Service: April 3, 2013; **or**

☐ b. A duplicate copy is enclosed since service on patent owner was not possible. An explanation of the efforts made to serve patent owner **is attached**. See MPEP § 2220.

16. Correspondence Address: Direct all communication about the reexamination to:

☑ The address associated with Customer Number: 13992

OR

☐ Firm or Individual Name

Address

City	State	Zip
Country		
Telephone	Email	

17. ☑ The patent is currently the subject of the following concurrent proceeding(s):

☐ a. Copending reissue Application No.

☐ b. Copending reexamination Control No.

☐ c. Copending Interference No.

☑ d. Copending litigation styled:

Macrosolve, Inc. v. GEICO Insurance Agency Case No. 6:12-cv-74

U.S. District Court for the Eastern District of Texas

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

/Jay J. Guiliano/ — Authorized Signature

April 3, 2013 — Date

Jay J. Guiliano — Typed/Printed Name

41,810 — Registration No.

☐ For Patent Owner Requester

☑ For Third Party Requester

PA-B

US006477373B1

(12) **United States Patent**
Rappaport et al.

(10) **Patent No.: US 6,477,373 B1**
(45) **Date of Patent: Nov. 5, 2002**

(54) **METHOD AND APPARATUS TO MAINTAIN CONNECTIVITY FOR MOBILE TERMINALS IN WIRELESS AND CELLULAR COMMUNICATIONS SYSTEMS**

(75) Inventors: **Stephen S. Rappaport**, Stony Brook, NY (US); **Yunsang Park**, Germantown, MD (US)

(73) Assignee: **Research Foundation of State University of New York**, Stony Brook, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/636,043**

(22) Filed: **Aug. 10, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/148,151, filed on Aug. 10, 1999.

(51) **Int. Cl.**[7] **H04Q 7/20**

(52) **U.S. Cl.** **455/436**; 455/450; 455/452; 455/510

(58) **Field of Search** 455/436, 435, 455/423, 450, 452, 509, 510, 512, 67.1

(56) **References Cited**

U.S. PATENT DOCUMENTS

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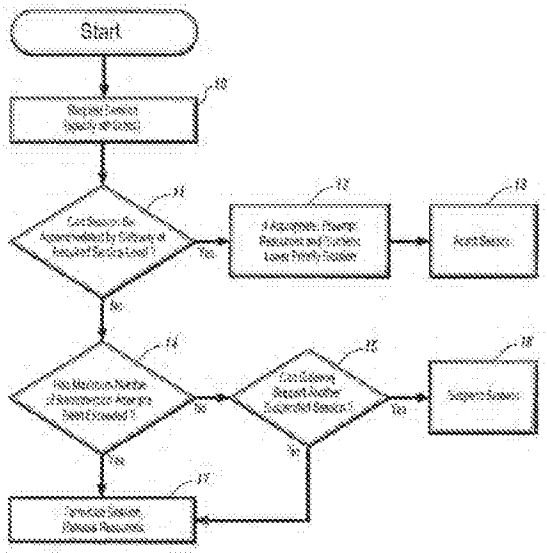
(57) **ABSTRACT**

The present invention is directed to a system and method that allows mobile platforms each supporting any of a variety of call types, and each having differing mobility characteristics, to maintain connectivity to a backbone network in spite of unreliable radio links that occasionally fail. It accomplishes this by using automatic and user-transparent reconnection attempts for appropriate call sessions when an interruption of the link occurs. The network may be supporting a variety of different call types simultaneously. Access to network connectivity resources can be provided according to call session priority based on (for example, call session type, platform mobility, hand-off status, and user class (fee-for-service)) criteria. The technology allows support of suspended sessions and uses repeated reconnection attempts with priority access to network resources. It also provides for hand-offs of suspended sessions to neighboring gateways as mobile terminals move throughout the service area. In a network that uses this technology, for example, voice calls (typical of time-sensitive stream traffic) may preempt resources of time-insensitive data calls causing suspended sessions that do not result in session failures. Priority access for hand-offs of active sessions with respect to new call sessions can be accommodated. Mobile users that have some autonomy or who are perhaps exchanging time-insensitive data with a remote site can continue to function essentially undisturbed by link failures since the connectivity and reconnection procedures are managed by the network in a manner that is transparent to the end users. Mobile computing sessions and delay-insensitive data communications, for example, will be able to continue, largely unaware of link failures.

25 Claims, 10 Drawing Sheets



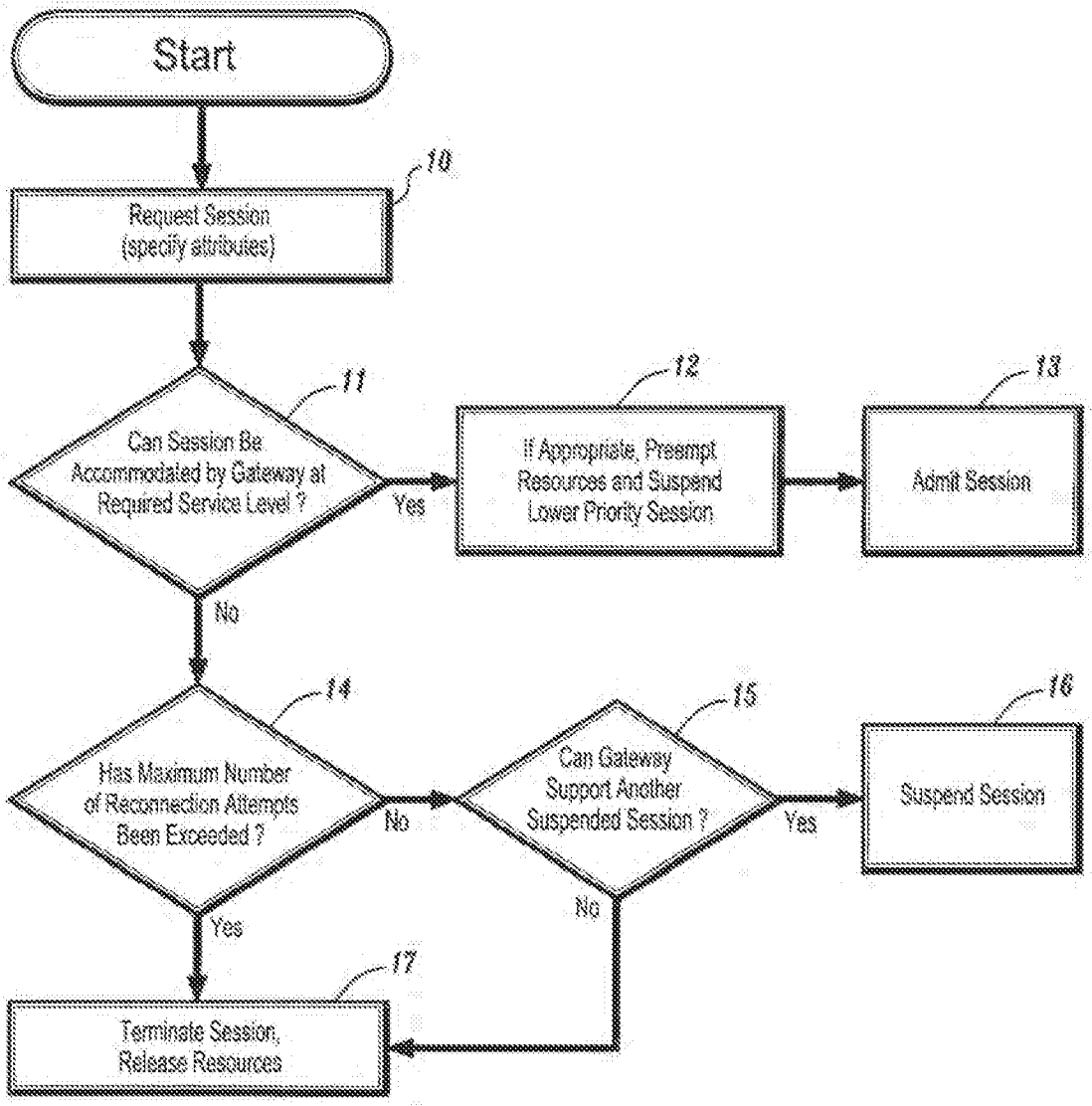

Start
10
Request Session
(specify attributes)
11
Can Session Be
Accommodated by Gateway at
Required Service Level ?
Yes
12
If Appropriate, Preempt
Resources and Suspend
Lower Priority Session
13
Admit Session
No
14
Has Maximum Number
of Reconnection Attempts
Been Exceeded ?
No
15
Can Gateway
Support Another
Suspended Session ?
Yes
16
Suspend Session
No
Yes
17
Terminate Session,
Release Resources

FIG. 1

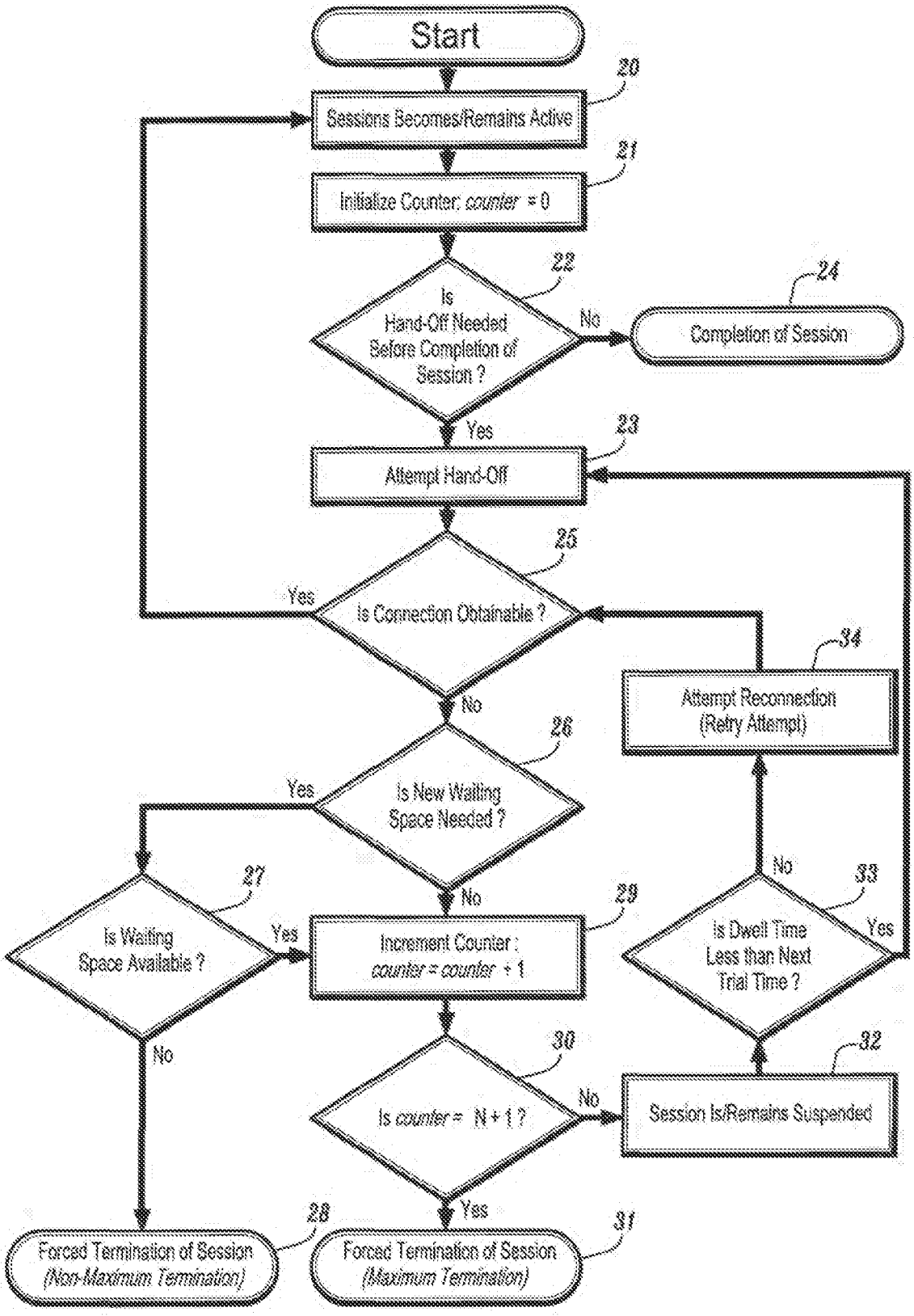
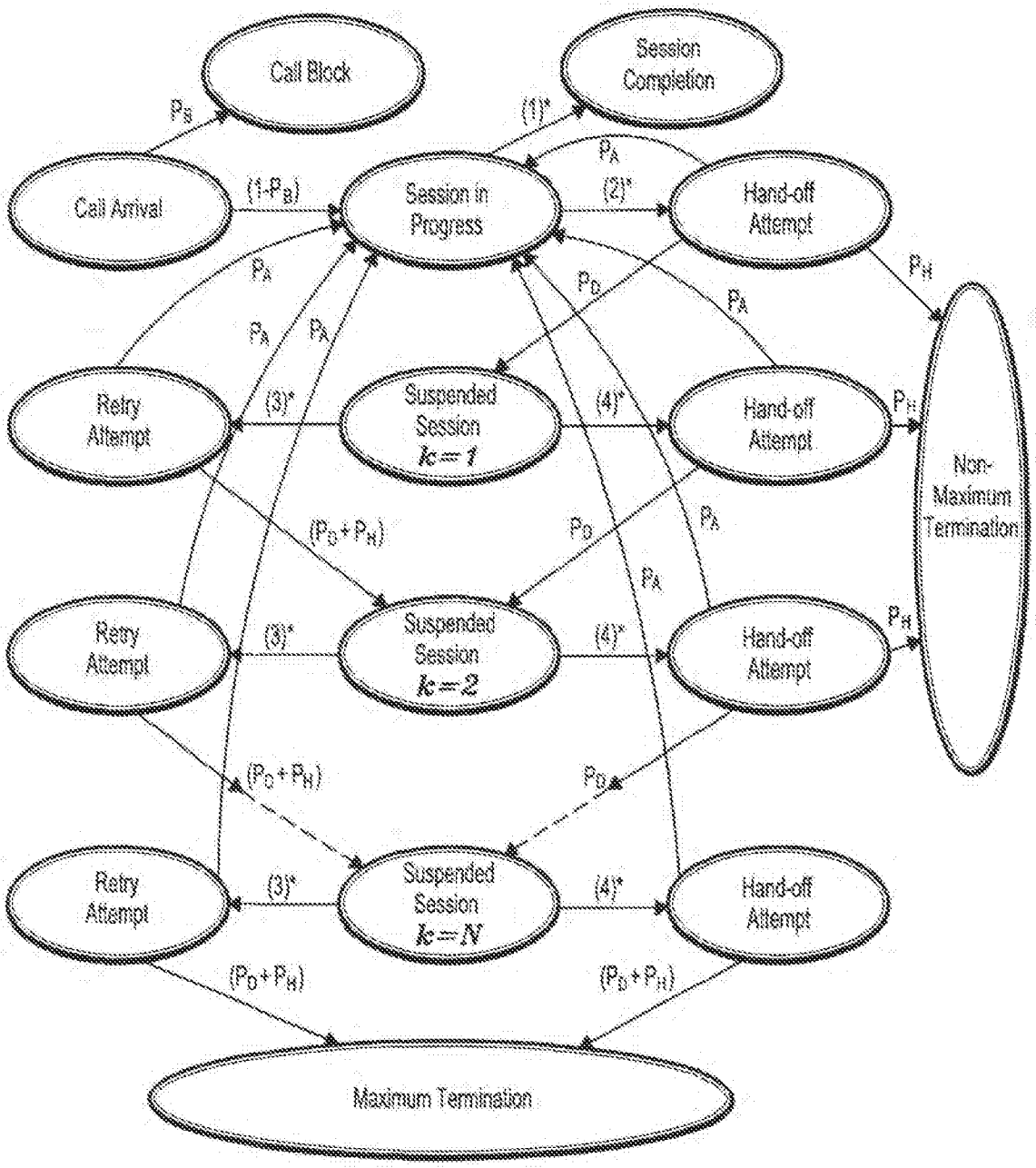

Start
20
Sessions Becomes/Remains Active
21
Initialize Counter: counter = 0
22
Is Hand-Off Needed Before Completion of Session ?
No
24
Completion of Session
Yes
23
Attempt Hand-Off
25
Is Connection Obtainable ?
Yes
No
34
Attempt Reconnection (Retry Attempt)
26
Is New Waiting Space Needed ?
Yes
No
27
Is Waiting Space Available ?
Yes
No
29
Increment Counter : counter = counter + 1
33
Is Dwell Time Less than Next Trial Time ?
No
Yes
30
Is counter = N + 1 ?
No
32
Session Is/Remains Suspended
Yes
28
Forced Termination of Session (Non-Maximum Termination)
31
Forced Termination of Session (Maximum Termination)

FIG. 2



Flow chart of events in the lifetime of a session: $(1)^* = \frac{\mu(g)}{\mu_D(g) + \mu(g)}$,

$(2)^* = \frac{\mu_D(g)}{\mu_D(g) + \mu(g)}$, $(3)^* = \frac{\mu_r(k,g)}{\mu_D(g) + \mu_r(k,g)}$, and $(4)^* = \frac{\mu_D(g)}{\mu_D(g) + \mu_r(k,g)}$

FIG. 3

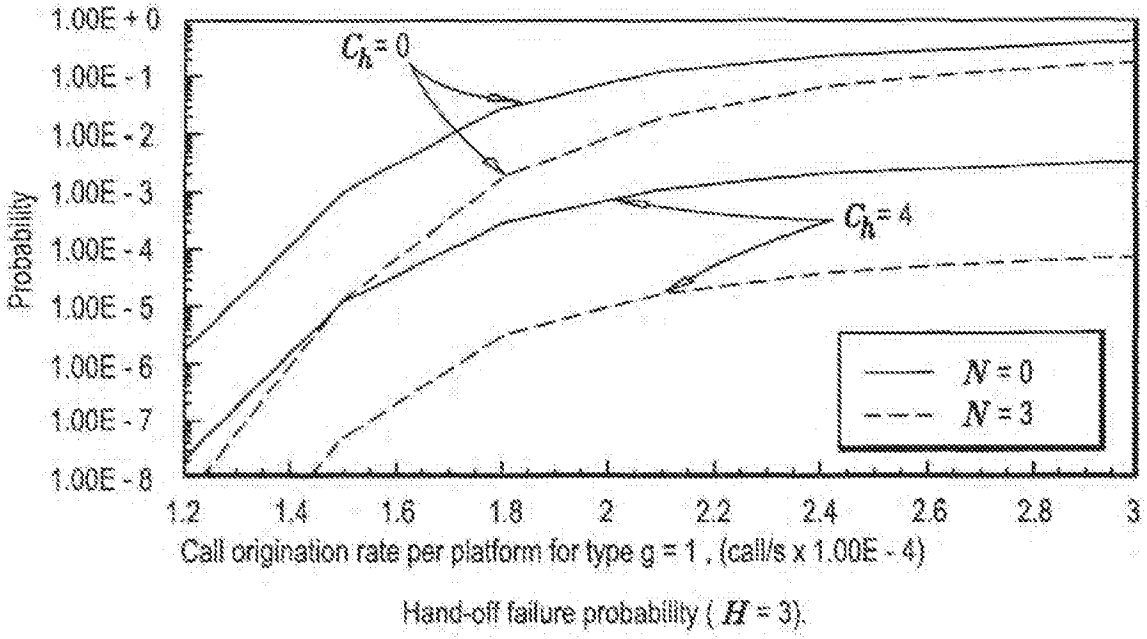

1.00E + 0
1.00E - 1
1.00E - 2
1.00E - 3
1.00E - 4
1.00E - 5
1.00E - 6
1.00E - 7
1.00E - 8
Probability
$C_h = 0$
$C_h = 4$
$N = 0$
$N = 3$
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
Call origination rate per platform for type g = 1 , (call/s x 1.00E - 4)
Hand-off failure probability (H = 3).

FIG. 4

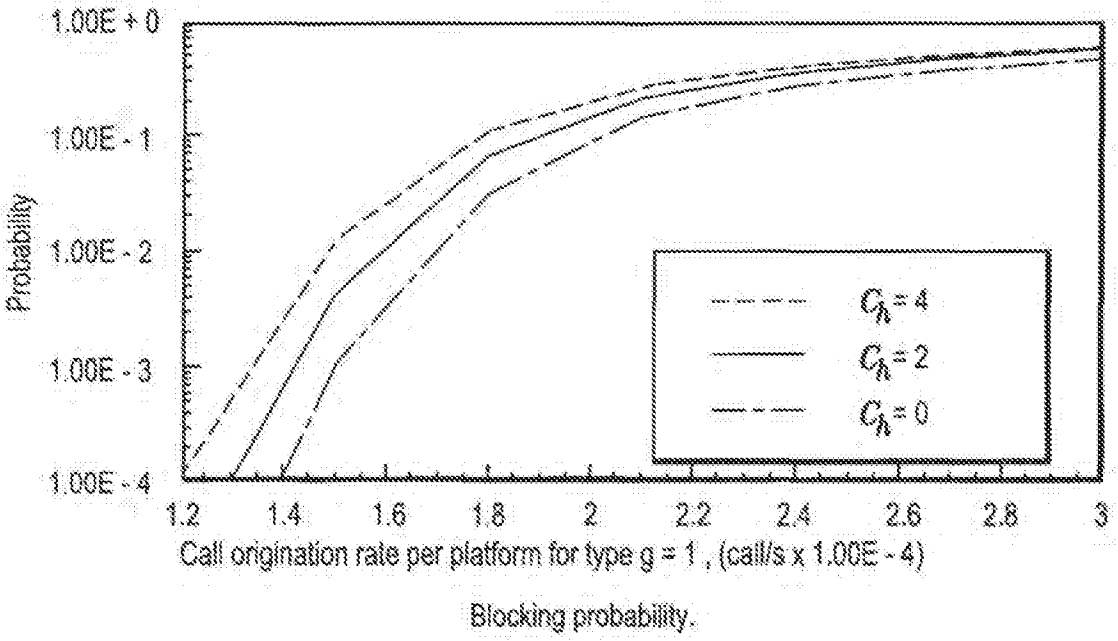
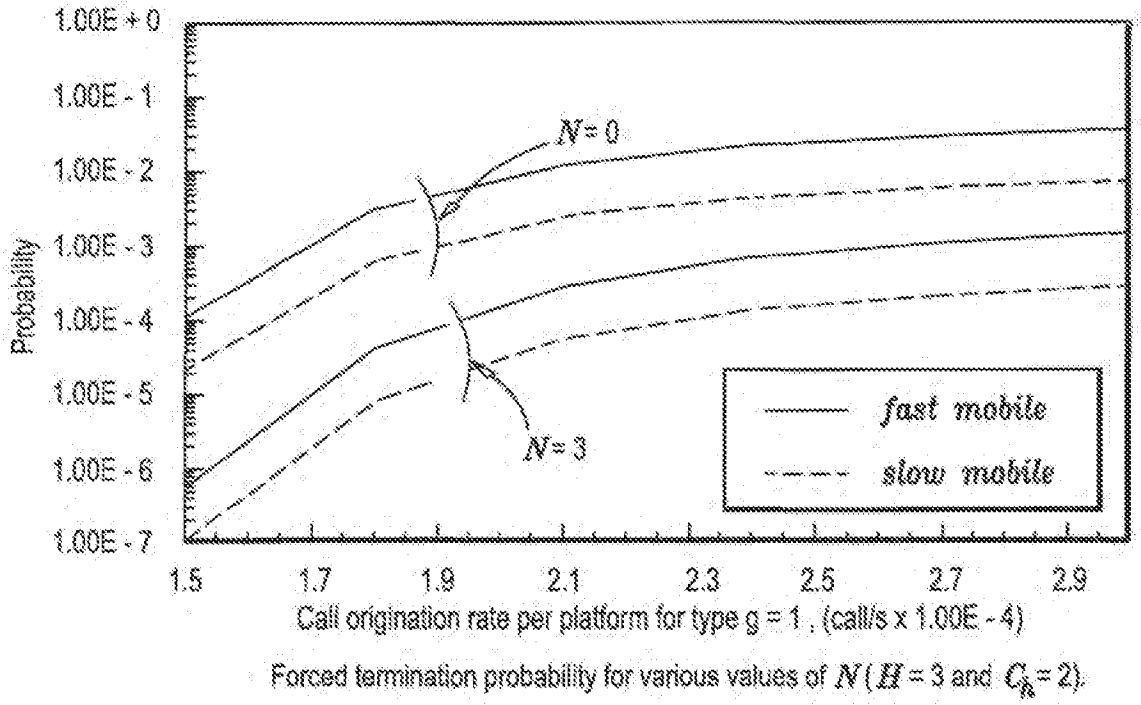
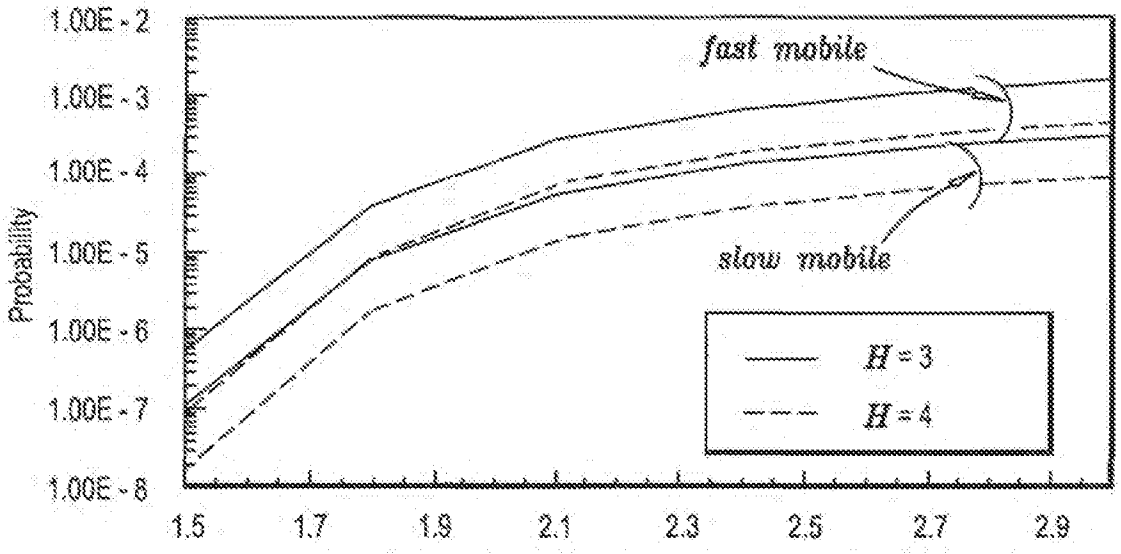

1.00E + 0
1.00E - 1
1.00E - 2
1.00E - 3
1.00E - 4
Probability
$C_h = 4$
$C_h = 2$
$C_h = 0$
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
Call origination rate per platform for type g = 1 , (call/s x 1.00E - 4)
Blocking probability.

FIG. 5



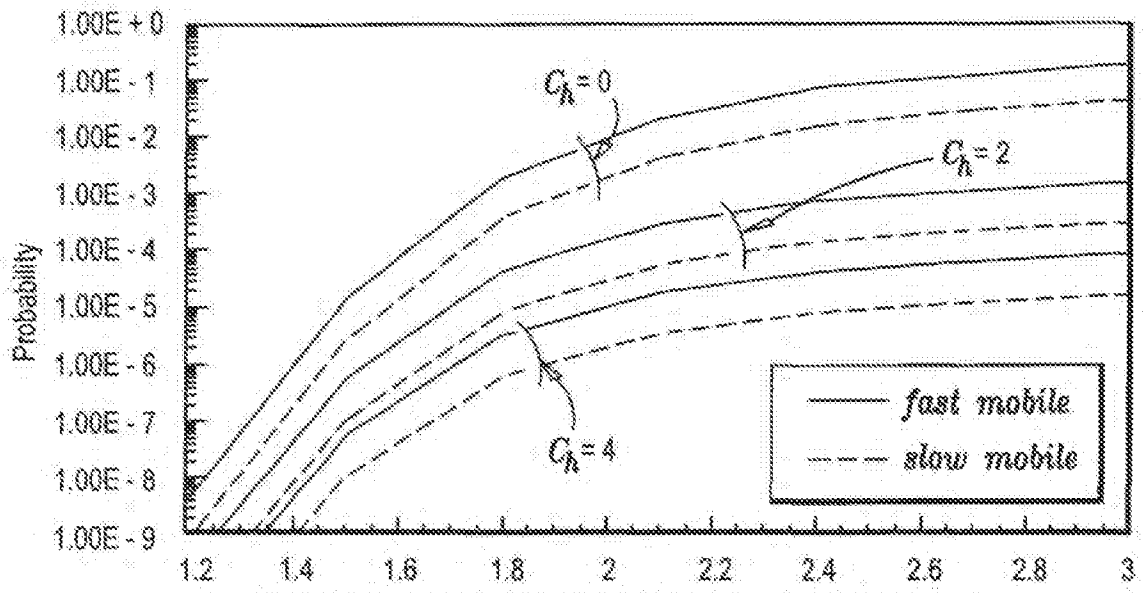
Forced termination probability for various values of N (H = 3 and C_h = 2).

FIG. 6



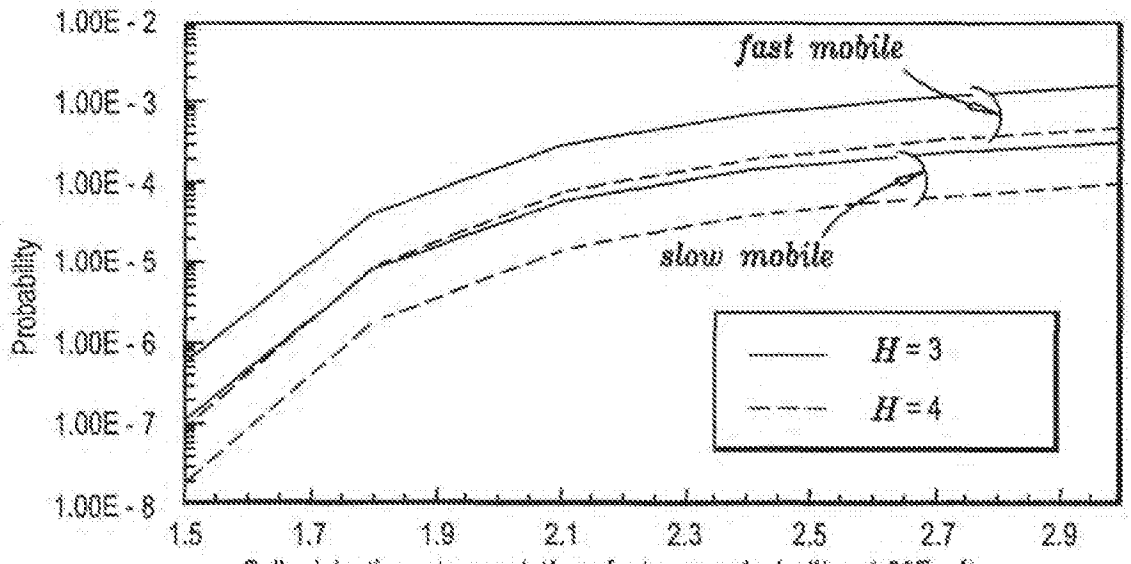
Forced termination probability for various values of H (N = 3 and C_h = 2).

FIG. 7



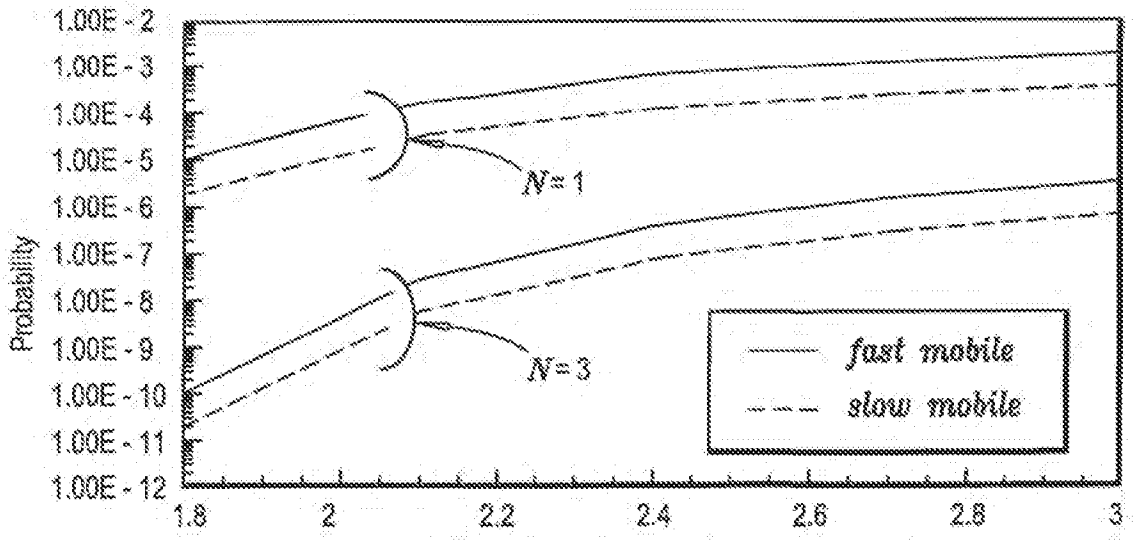
Forced termination probability for various values of C_h ($H = 3$, $N = 3$).

FIG. 8



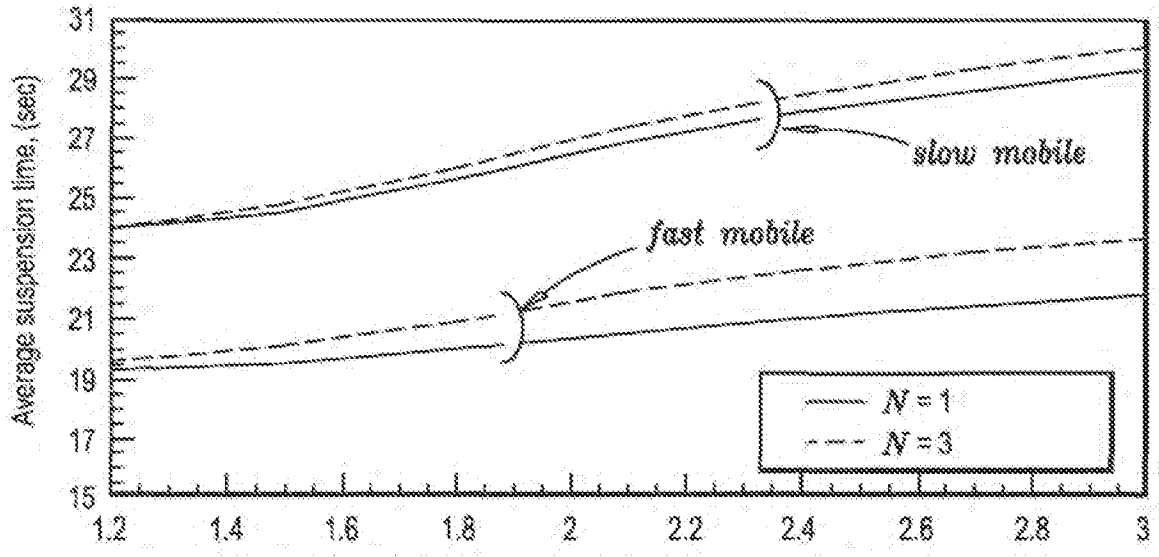
Non-maximum termination probability for various values of H ($N = 3$ and $C_h = 2$).

FIG. 9



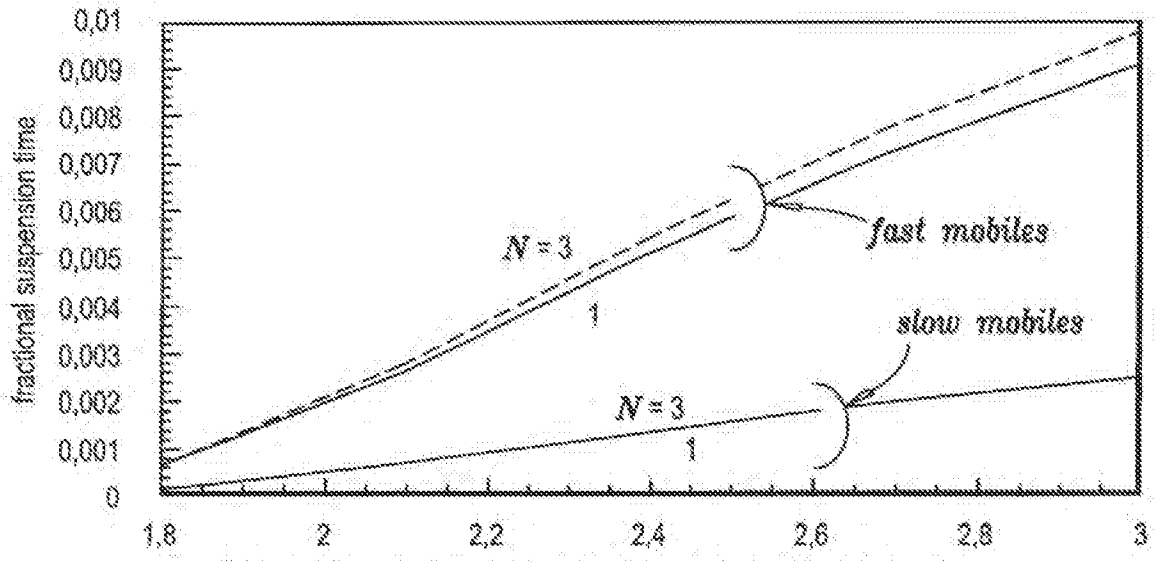
Maximum termination probability for various values of N (H = 3 and C_h = 2).

FIG. 10



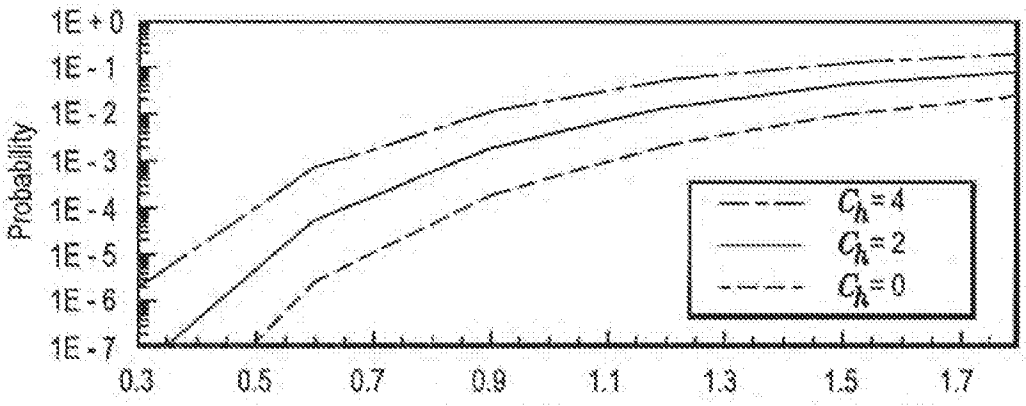
Average time per suspension (H = 3 and C_h = 2).

FIG. 11



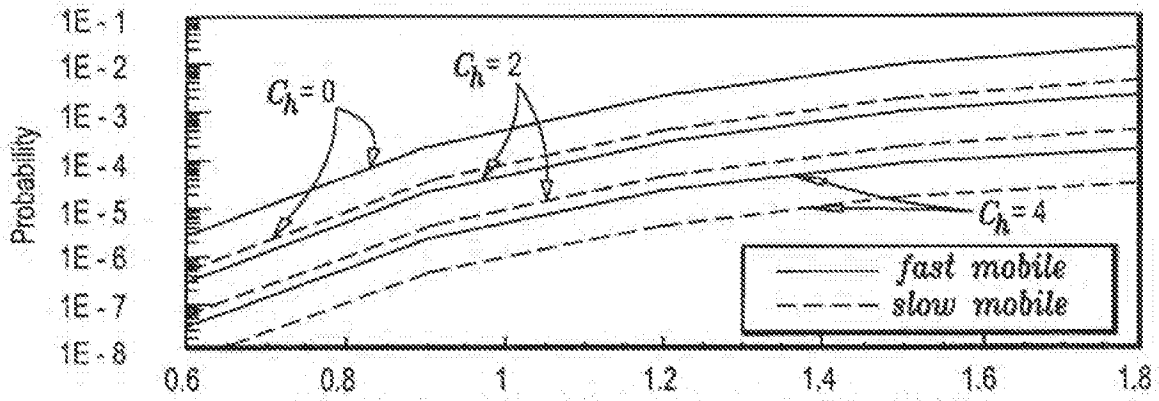
Fractional suspension time ($H = 3$ and $C_h = 2$).

FIG. 12



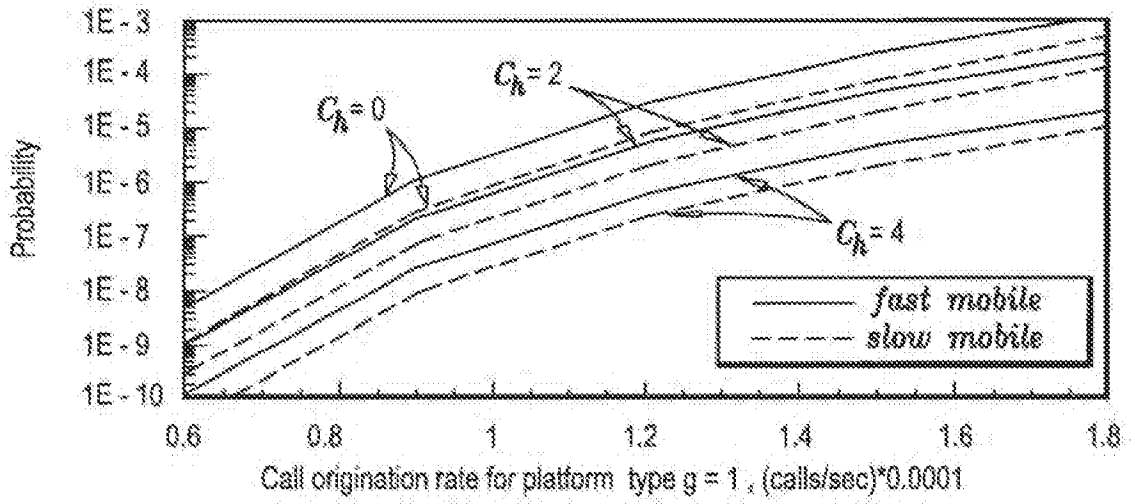
Blocking probability of voice type sessions: $C = 15$, $\upsilon(1,0) = \upsilon(2,0) = 300$.

FIG. 13



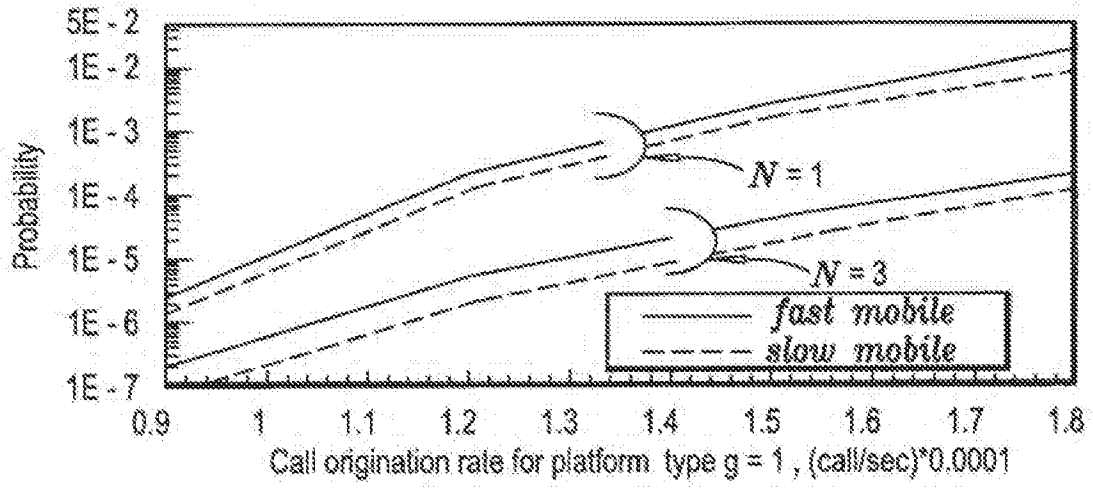
Forced termination probability of voice type sessions: C = 15 , v (1,0)= v (2,0)=300.

FIG. 14



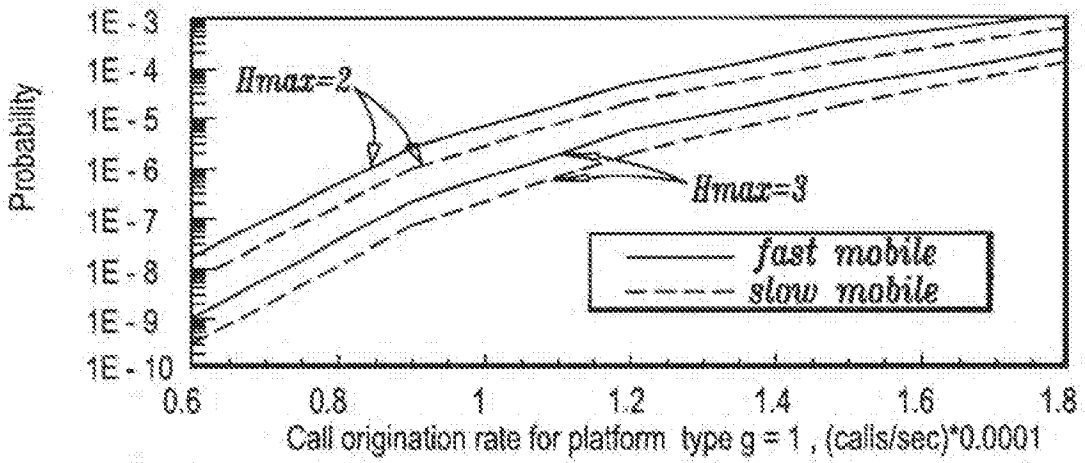
Forced termination probability of data type sessions with various C_h: C= 15 , v(1,0)= v(2,0)=300, N = 3, H = 3 .

FIG. 15



Forced termination probability of data type sessions with various N: C= 15 , $\upsilon(1,0)$= $\upsilon(2,0)$=300, C_h= 2, H = 3.

FIG. 16



Forced termination probability of data type sessions with various H: C= 15 , $\upsilon(1,0)$= $\upsilon(2,0)$=300, C_h= 2, N = 3.

FIG. 17

METHOD AND APPARATUS TO MAINTAIN CONNECTIVITY FOR MOBILE TERMINALS IN WIRELESS AND CELLULAR COMMUNICATIONS SYSTEMS

REFERENCE TO RELATED APPLICATION

This application is based on a provisional application, U.S. Ser. No. 60/148,151, filed on Aug. 10, 1999.

GOVERNMENT LICENSE RIGHTS

The present invention was developed in part by the Department of Naval Research under Grant No. N00014-15530 and the United States National Science Foundation under Grant No. NCR 94-15530. The United States Government has certain rights to the invention.

BACKGROUND

1. Technical Field

The present invention relates generally to a mobile communication systems and, in particular, to a system and method for controlling admission to a mobile communications system that provides reliable connectivity and maintains mobile user connectivity between mobile platforms and the communication network by automatically and transparently attempting to reconnect disrupted links.

2. Description of Related Art

Visions of the future allude to unprecedented availability of conveniences and services based on pervasive communication and computer technologies. The full realization of these ambitions requires ubiquitous, reliable communications for moving and stationary users on demand. At the core of these services is the reliable communication of voice, data, image, video, multi-media and control messages on networks that are designed to support a wide range of call types as well as users having different mobility characteristics. Significant trends in this regard are underway in essentially every industrialized country and increasingly, a vast communications infrastructure is becoming available which can grow to realize these aspirations.

As noted above, to provide services to mobile users comparable to those obtainable by fixed users via wireline facilities, appropriate attention must be paid to the peculiarities of mobile communications. Modern communications networks that support mobile platforms (pedestrians, vehicles, planes, trains, buses, etc.) often use many wireless gateways connected to a more or less fixed (backbone) network. The gateways, which are sometimes referred to as "cells" "base stations" or "access points," allow tetherless links to nearby mobile platforms. Users within the coverage area of a gateway are said to be in the cell of that gateway. It is to be understood that the term "cell" is used herein in a broad generic sense and can mean gateway, sector, zone, macro-cell, micro-cell, etc. In wireless mobile environments, propagation conditions are often harsh due to multipath and fading, bandwidth is a severe constraint, while mobility support and call management add additional complexity. Furthermore, the network must support disparate call types whose distinct needs must be accommodated. Disparate call types may have different measures of quality and generally require different amounts and types of communications resources for acceptable service. Various resource types that may be needed for mobile communications include, for example, radio bandwidth (channels), buffer space at the gateways and in the backbone network, antenna beam steering system components (including tracking and steering processors at the gateways), call supervising processors at the gateways and in the backbone network, transmitted signal power at the gateways and at the mobile stations, access to control channels, and computational capability in various network components.

With conventional and future wireless and cellular systems that implement various call types (thereby requiring various resource types), appropriate attention must be paid to the peculiarities of mobile communications. In these environments, propagation conditions are often harsh due to multipath and fading, bandwidth is a severe constraint, while mobility support and call management add additional complexity. In addition, since tetherless or radio links to mobile platforms are of variable quality and change with time, they often fail. Accordingly, a lower layer admission control protocol and system that is capable of ameliorating the effects of such failures by maintaining a connection from an active mobile user to the network for the benefit of higher layer protocols is highly desirable.

SUMMARY OF THE INVENTION

The present invention is directed to a system and method for controlling admission to a mobile communications system, which allows mobile platforms each supporting any of a variety of call types, and each having differing mobility characteristics, to maintain connectivity to a backbone network in spite of unreliable radio links that occasionally fail. The present invention employs an admission protocol that provides automatic and user-transparent reconnection attempts for appropriate call sessions when an interruption of the link occurs. Further, a network that employs an admission protocol of the present invention may support a variety of different call types simultaneously, wherein access to network connectivity resources can be provided according to call session priority based on (for example, call session type, platform mobility, hand-off status, and user class (fee-for-service)) criteria. The admission control protocol provides support of suspended sessions and uses repeated reconnection attempts with priority access to network resources, and provides for hand-offs of suspended sessions to neighboring gateways as mobile terminals move throughout the service area.

In a network that employs an admission control protocol according to the present invention, voice calls, for example (or other time-sensitive stream traffic) may preempt resources of time-insensitive data calls, which result in suspended sessions that do not result in session failures. Priority access for hand-offs of active sessions with respect to new call sessions can also be accommodated. Mobile users that have some autonomy or who are perhaps exchanging time-insensitive data with a remote site can continue to function essentially undisturbed by link failures since the connectivity and reconnection procedures are managed by the network in a manner that is transparent to the end users. Mobile computing sessions and delay-insensitive data communications, for example, will be able to continue, largely unaware of link failures.

Since the present invention can be applied to admission control of sessions that are supported at each gateway, it is not necessary that a session that is admitted to a cell have dedicated access to resources. Thus, because some users may emit/receive data in bursts, other users who have been admitted to a cell can share the resources. This allows efficient resource use through rapid access and relinquishment of dedicated resources managed by the media access communications layer.

These and other aspects, features and advantages of the present invention will be described or become apparent from the following detailed description of preferred embodiments, which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a flow diagram of a method for controlling admission to a communications network according to one aspect of the present invention;

FIG. **2** is a flow diagram of a method for reconnecting to a communications network according to one aspect of the present invention;

FIG. **3** is a flow diagram illustrating events in the lifetime of a session according to one aspect of the present invention;

FIG. **4** is a graphical diagram illustrating experimental results of a hand-off failure probability as a function of new call origination rate;

FIG. **5** is a graphical diagram illustrating experimental results of a blocking probability as a function of new call origination rate;

FIG. **6** is a graphical diagram illustrating experimental results of the dependence of forced termination probability on the number of allowable reconnection attempts as a function of new call origination rate;

FIG. **7** is a graphical diagram illustrating experimental results of the dependence of forced termination probability on the maximum number of supported suspended sessions as a function of new call origination rate;

FIG. **8** is a graphical diagram illustrating experimental results of forced termination probability for various values of out-of priority as a function of new call origination rate;

FIG. **9** is a graphical diagram illustrating experimental results of the dependence of non-maximum termination probability on the maximum number of supported suspended sessions as a function of new call origination rate;

FIG. **10** is a graphical diagram illustrating experimental results of the dependence of maximum termination probability on the maximum number of reconnection attempts as a function of new call origination rate;

FIG. **11** is a graphical diagram illustrating experimental results of the dependence of average time per suspension as a function of new call origination rate;

FIG. **12** is a graphical diagram illustrating experimental results of the dependence of fractional suspension time on the number of allowable reconnection attempts as a function of new call origination rate;

FIG. **13** is a graphical diagram illustrating experimental results of the dependence of blocking probability of a voice session on the number of reserved channels as a function of new call origination rate;

FIG. **14** is a graphical diagram illustrating experimental results of the dependence of forced termination probability of a voice session on the number of reserved channels as a function of new call origination rate;

FIG. **15** is a graphical diagram illustrating experimental results of the dependence of forced termination probability of a data session on the number of reserved channels as a function of new call origination rate;

FIG. **16** is a graphical diagram illustrating experimental results of the dependence of forced termination probability of a data session on the number of maximum allowable reconnection attempts as a function of new call origination rate; and

FIG. **17** is a graphical diagram illustrating experimental results of the dependence of forced termination probability of a data session on the number of maximum supportable suspended sessions as a function of new call origination rate.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In general, the present invention is directed to a system and method for controlling admission of session requests and maintaining connectivity of mobile platforms to a communications network. The present invention is particularly advantageous for implementation with, e.g., cellular communication systems that seamlessly support services for a wide range of user needs, including voice, data, video and multi-media. Indeed, although is envisioned that mobile users will substantially engage in computer processing in an off-line mode, such users will occasionally connect to a network in order to exchange data and/or files in various modalities. With increasing demand for a variety of wireless services, technologies that can potentially support increasingly smart mobile terminals and an array of services such as multi-media, voice, and mobile computing are of interest. ATM/B-ISDN offers an approach with flexible bandwidth allocation, high speed, and quality of service (QoS) selection. In addition, ATM can be used in the wireless context (WATM). Furthermore, rerouting of packets in the fixed network to accommodate ATM type communications with mobile users can be implemented as in known in the art. Moreover, multiple links from a mobile user to network base stations may be employed for the purpose of accommodating users with different bandwidth needs.

In adapting these (and other) technologies that were initially conceived in the context of wireline services, appropriate attention must be paid to the peculiarities of mobile communications. In these environments, propagation conditions are often harsh due to multipath and fading, bandwidth is a severe constraint, while mobility support and call management add additional complexity. In addition, since tetherless or radio links to mobile platforms are of variable quality and change with time, they often fail. To ameliorate and combat the effects of such failures, the present invention employs a connection-oriented approach wherein reliable connectivity is provided between mobile platforms and the backbone network in spite of such link failures. An admission control procedure and a lower layer protocol is employed that attempts to maintain a connection from an active mobile user to the network for the benefit of higher layer protocols, which assume that the physical link is intact. A lower layer admission control protocol according to one aspect of the present invention provides connectivity through transparent reconnection attempts, which are invoked when the link fails. It should be especially noted that just because a connection is established between a mobile user and the network, this does not necessarily imply that specific resources are dedicated exclusively to an individual mobile user and the session. The only implication is that a session for which such a connection has been established (i.e., an admitted session) can use it, perhaps in a packet-oriented mode, as well as share network resources with other users who also have "connections." Rapid assignment of rights to use specific resources is then managed by a media access protocol that interacts with admitted sessions. This allows efficient resource use by users whose communication needs are bursty, and at the same time allows the network to accommodate a wide range of different session types.

In circuit-switched cellular communication systems that are currently deployed for real-time voice, a radio link

failure between a mobile user and a base causes the call to be terminated and cleared from the system. In contrast, mobile users that are engaged in mobile computing (or other forms of data transmission) may have the capability to operate semi-autonomously since data communications with the network are packetized and not necessarily streamed. So with appropriate network design, a temporary disconnection from the network may be transparent to the user. Thus, by implementing the techniques described herein, short term radio link disconnections, which are frequent in mobile communications, need not result in failed sessions, discarded information and wasted use of resources. The current invention concerns maintaining connectivity for sessions that have gained admission to network resources. It is applicable to both circuit switched and packet switched systems.

The issue of how to maintain connectivity of a mobile user to the network can be very important for implementation of new mobile wireless services. The present invention provides a system and method that attempts to maintain mobile user connectivity to the network by automatically and transparently attempting to reconnect disrupted links to mobile data users. For this purpose, we consider session-oriented communications and develop a tractable analytical model for traffic performance based on multi-dimensional birth-death processes (as described in detail below). The approach allows consideration of various platform types, such as pedestrians, automobiles, and buses, which may have very different mobility characteristics and performance characteristics, such as blocking, forced session termination, carried traffic, the average time per suspension, and the average number of suspensions per session are computed based on the model.

With a session-oriented approach, a communication session is initiated, during which the user has access to network resources, although this access may be shared with others. Owing to the hostile mobile environment and user mobility, the user's connection to the network during a session may be severed. A session, which may interrupted because of, e.g., failure of a hand-off attempt, is treated as a suspended session. Since the mobile user can act semi-autonomously, such disconnections can be transparent. That is, the mobile user can continue to function in an off-line mode while the system will begin transparent automatic reconnection attempts to reestablish a link to the network. Only after a fixed (given) number of such attempts to reconnect have failed, is the session deemed to have failed. Disconnection of a radio link does not cause the session to be cleared from the system until all reconnection efforts fail. Reconnection attempts for suspended sessions will be initiated while the mobile user application (operating at a higher protocol layer) continues.

It is to be understood that the systems and methods described herein may be implemented in various forms of hardware, software, firmware, special purpose processors, or a combination thereof. In particular, the present invention is preferably implemented as an application comprising program instructions that are tangibly embodied on a program storage device (e.g., magnetic floppy disk, RAM, ROM, Flash memory etc.) and executable by any device or machine comprising suitable architecture. It is to be further understood that, because some of the process steps depicted in the accompanying Figures are preferably implemented in software, the actual connections between such steps may differ depending upon the manner in which the present invention is programmed. Given the teachings herein, one of ordinary skill in the related art will be able to contemplate these and similar implementations or configurations of the present invention.

Referring now to FIG. 1, a high level flow diagram illustrates a method for controlling admission to a mobile communications network according to one aspect of the present invention. Initially, a mobile platform seeking access to network resources (i.e., admission) will transmit a session request to an appropriate gateway specifying attributes associated with the required service level of the mobile platform (step 10). It is to be understood that a session request provided by a mobile terminal may comprise any one of the following: (1) a request for a new session; (2) a request for a hand-off of an active session; (3) a request for a retry attempt; or (4) a request for a hand-off attempt of a suspended session. In accordance with the present invention, it is possible that a mobile platform with a suspended session on board leaves its current cell. Thus, reconnection attempts described herein comprise at least two types of reconnection attempts—retry attempts and hand-off attempts of suspended sessions. Retry attempts are those session requests that are sent to the same gateway that supported the session in the mobile user's last interaction with the backbone network. Nominally, these attempts are for (renewed) access to resources at the gateway that is currently providing service (i.e., control channels) for the suspended session. On the other hand, hand-off attempts of suspended sessions are made when the mobile platform moves out of the cell, or signal propagation changes occur, so that the mobile favors an alternative gateway for service. When a mobile platform with a suspended session (or active session) on board leaves the current cell, a request for a hand-off attempt is initiated to the appropriate gateway.

As demonstrated in further detail below, the criteria used for admitting new sessions (e.g., voice sessions, data sessions) or hand-off of either active or suspended sessions at a gateway may depend on any number of attributes that are specified in connection with the session request (step 10) including, but not limited to, the session type (data session, voice session), platform mobility, whether the session is a fee-for-service priority class, requested service quality and/or data rate, whether the requested session is a new session or a suspended session (retry attempt), whether the requested session is a hand-off attempt of an active session or suspended session, and/or the estimated resources needed to accommodate the session. By way of example, in a network that implements an admission control protocol according to the present invention, voice sessions (or other time-sensitive stream traffic), for example, may preempt resources of time-insensitive data calls causing suspended sessions that do not result in session failures. Priority access for hand-offs of active sessions with respect to new sessions can be accommodated. Mobile users that have some autonomy or who are perhaps exchanging time-insensitive data with a remote site can continue to function essentially undisturbed by link failures since the connectivity and reconnection procedures are managed by the network in a manner that is transparent to the end users. So link interruptions can be transparent to some users. High priority call sessions (such as hand-offs of active voice or delay sensitive sessions) may result in preemption of resources from some lower priority sessions. These lower priority sessions may be suspended. Thus, the support of suspended sessions is transparent to these high priority users.

Moreover, in a preferred embodiment of the current invention, when the physical connection between a mobile terminal and the network fails, the session is suspended and the mobile terminal will attempt to reconnect by successive

reconnection requests made at random time intervals. A maximum number of reconnection attempts, N, is allowed for each suspended session. If a reconnection has not been secured after this maximum is reached, the session is considered to have failed and the call will be cleared from the system and all system resources used by the session are released. As explained below in greater detail with reference to FIG. 2, the number of reconnection attempts for suspended sessions is counted and updated in a counter that resides in the mobile terminal. In another embodiment of the present invention, upon the suspension of a session, a timer is also set in the supporting network. If communication is not resumed before the expiration of the timer the network resources reserved for the session will be released for use by other call sessions.

To support suspended sessions and reconnection attempts, the system preferably allocates a suitable number of control channels for signaling. Access to control channels is one of the resources needed to support a session. Since the control channels also use wireless resources (notably bandwidth, buffer space), a maximum number of suspended sessions that the system will allow in each cell (at each gateway), denoted H, is preferably designated. It is to be understood that the number H can differ from cell-to-cell (gateway-to-gateway).

Referring again to FIG. 1, after a session request (step **10**), a determination is made as to whether the requested session can be accommodated by the gateway at the requested service level (step **20**). In a preferred embodiment of the present invention, this determination is based on, e.g., the maximum number of simultaneous connections (i.e., active sessions), denoted herein as C, that can be supported by the gateway (i.e., each cell or gateway can support a maximum of C connections), as well as priorities (as indicated above) that are designated to particular session types. For example, preferably, a cut-off priority is provided for hand-offs and reconnection attempts, wherein C_k connections (of the maximum number of allowable connections C) in each cell are reserved for hand-off attempts (from mobile platforms entering a cell) and for reconnection attempts from suspended sessions (retry attempts) in the cell. In addition, since voice sessions are especially susceptible to hand-off failures, a cut-off priority is preferably utilized to reserve some resources for a voice session.

Based on the above, in general, when a request for a new session (voice, data) is received (in step **10**), a connection will be established for the new session (affirmative result in step **11**) if there are fewer than C-C_k active sessions in the cell. As described above, time-sensitive sessions may be afforded priority. For instance, preferably, voice sessions are given preemptive priority over data sessions for using channel resources. Since voice sessions must be transmitted or received on a real time basis, reconnection attempts for voice sessions are preferably not allowed. When a voice session arrives and finds all channels C occupied, an active data session (if any are present) is preferably suspended (step **12**) (or possibly terminated) to accommodate it. More specifically, when a voice session arrives in a cell in which all channels are occupied and fewer than H sessions are in suspension, and, at least, one active session is of data type, an arriving voice session will obtain a connection (step **13**) but an active data session will be suspended (step **12**). The choice of which data session to be suspended or be terminated is assumed to be random. If there are no active data sessions that can be preempted to service the incoming voice session, the voice arrival will not be accommodated. That is, it will be blocked if it is a new call, or terminated if it is a hand-off.

When a session request for a hand-off attempt (of an active session or suspended session) is received (in step **10**), a connection will be established (affirmative determination in step **11**) and the session will be granted admission (step **13**) if there are less than C active sessions in the cell. On the other hand, if there are C active sessions in the cell, the session requesting the hand-off will not be accommodated (negative result in step **11**). However, an active session attempting the hand-off to the target cell will be suspended (step **16**) if such active session fails to obtain a connection (negative result in step **11**) and the gateway can support a suspended session (i.e., there are less than H suspended sessions in the target cell) (affirmative determination in step **15**). On the other hand, the active session will be terminated (step **17**) if there are C active sessions (negative result in step **11**) and H suspended sessions in the target cell (negative result in step **15**).

Likewise, a suspended session attempting a hand-off to the target cell will remain suspended (step **16**) if such suspended session fails to obtain a connection (negative result in step **11**), the number of reconnection attempts by the suspended session has not been exceeded (negative determination in step **14**), and the gateway can support a suspended session (i.e., there are less than H suspended sessions in the target cell) (affirmative determination in step **15**). On the other hand, the suspended session requesting a hand-off will be terminated (step **17**) if there are C active sessions (negative result in step **11**) and either the suspended session has exceeded the maximum number of reconnection attempts N (affirmative determination in step **14**) or there are H suspended sessions in the target cell (negative result in step **15**).

A detailed discussion of a reconnection process and reconnection counting process according to one aspect of the present invention will now be described with reference to FIG. 2. As indicated above, reconnection attempts comprise retry attempts and hand-off attempts of suspended sessions. Retry attempts are those session requests that are sent to the same gateway that supported the session in the mobile user's last interaction with the backbone network. Nominally, these attempts are for (renewed) access to resources at the gateway that is currently providing service (i.e., control channels) for the suspended session. On the other hand, hand-off attempts of suspended sessions are made when the mobile platform moves out of the cell, or signal propagation changes occur, so that the mobile favors an alternative gateway for service. As described in detail below, when the physical connection between a mobile terminal and the network fails (e.g., unsuccessful handoff), the session may be suspended and the mobile terminal will attempt to reconnect by successive reconnection requests that are made at random time intervals (referred to as "trial times" as described in detail below). A maximum number of reconnection attempts N are allowed for each suspended session. If a reconnection has not been secure after this maximum is reached, the session is considered to have failed and the session will be cleared from the system and all system resources used by the session are released. The number of reconnection attempts for suspended sessions is counted and updated in a counter in the mobile terminal.

Referring now to FIG. 2, initially, it is assumed that a session is either activated (e.g., a new session or a suspended session that is admitted) or remains active (e.g., due to a successful handoff) in a given cell (step **20**). When the session becomes/remains active, the reconnection attempt counter of the mobile platform is set to 0 (step **21**). It is to be understood that even though a session has experienced

suspension, the counter will be reset to 0 if a suspended session is activated. A session may experience many suspension experiences during its lifetime before it is successfully completed.

If a handoff is needed before the completion of an active session (affirmative result in step **22**) (e.g., when the mobile platform moves out of the cell, or signal propagation changes occurs, so that the mobile terminal favors an alternative gateway for service), the mobile terminal will request a hand-off (step **24**). On the other hand, if a hand-off is not necessary before the completion of an active session (negative result in step **22**), the session will be successfully completed (step **24**) and the system resources are cleared.

Upon a hand-off attempt (step **23**), a determination is made as to whether a connection in the target gateway is currently available for the active session (step **25**). If the target gateway has less that C active sessions, the arriving hand-off call can successful obtain a connection (affirmative result in step **25**) and the session will remain active in the target cell (return to step **20**). On the other hand, an active session that fails to gain access to a connection will lose its wireless link. In conventional cellular systems, the session would be cleared from the system. In accordance with the present invention, however, if an active session loses it wireless link (i.e., is disconnected), the session may either be suspended and reconnection attempts will be initiated, or the session is terminated, depending on the circumstances.

More specifically, when a mobile terminal with an active session (or suspended session) moves to a target cell that has insufficient resource available to accommodate the attributes of the session such that a connection is not available (e.g., the target cell has C active sessions) (negative determination in step **25**), a determination is made as to whether new waiting space is needed (step **26**). In particular, a determination is made (in step **26**) as to whether the session in question is the result of an unsuccessful hand-off attempt, which would require the cell to support an additional suspended session (no retry attempt of a suspended session would require new waiting space since the suspended session already occupies one of the H spaces allowed for suspended sessions in each cell). Therefore, if it is determined that new waiting space is needed (affirmative determination in step **26**) (e.g., because of an unsuccessful hand-off (i.e., non admitted) of an active or suspended session), a determination is then made as to whether the cell has waiting space available (step **27**). If the cell has H suspended sessions (a negative determination in step **27**), the session will be terminated. In other words, if in a target cell, there are insufficient resources available to accommodate a hand-off of a session having the attributes of a suspended or active session, and the total number of suspended sessions in the target cell is H, the session will not be admitted in the target cell (at the target gateway). So, even if a suspended or active session has not exhausted the allowable number of reconnection attempts N, the session will be forced into termination if it fails its hand-off attempt because the system already has H suspended sessions in the target cell. This forced termination is what is referred to herein as a non-maximum termination.

On the other hand, if new waiting space is not required (negative determination in step **26**) (due to an unsuccessful retry attempt) or waiting space is available for a session (active or suspended) of an unsuccessful hand-off (affirmative determination in step **27**), the reconnection counter of the mobile terminal will be incremented by one (step **29**). In other words, if in a target cell, there are insufficient resources available to accommodate the session but there are fewer than H suspended sessions, the hand-off will be supported as a suspended session at the target gateway and the reconnection efforts will continue. A modification of the backbone network route between the remote user and the new serving gateway will be made so that communications can resume if a reconnection succeeds at this gateway. (Some resources at the previous gateway may be released). Moreover, if a retry attempt in the cell is unsuccessful (i.e., a suspended session supported by the cell fails reconnection attempt with the cell), the reconnection efforts will continue. In the target cell, additional reconnection attempts (e.g., retry attempts) may be made and the counter will be incremented for each unsuccessful attempt.

After the reconnection counter of the mobile terminal is incremented (step **29**), a determination is made as to whether the number of reconnection attempts has exceeded the maximum number allowed N (step **30**). If the suspended session has exceeded the number of allowed reconnection attempts (affirmative determination in step **30**), the session will be terminated (step **31**). In other words, when a mobile platform with an active or suspended session moves to a target cell that has no channels available (failed hand-off), the session will be/remain suspended in the target cell (if there are fewer than H suspended sessions already in the target cell) and the mobile's reconnection attempt counter will be incremented. In the target cell, additional reconnection attempts may be made. The reconnection counter of the mobile will be incremented for each unsuccessful attempt. It may happen that the supporting platform moves to yet another cell. At that time, a hand-off attempt of the suspended session will be made to the new target cell. This hand-off attempt will count as an attempted reconnection in the target cell (i.e., a hand-off attempt generated by a suspended session is counted as one reconnection attempt in the sense that the reconnection counter will be incremented and, as such, the last attempt before termination can be either a retry attempt or a hand-off attempt). On the other hand, if the hand-off attempt succeeds in getting a channel, the session will be continued and the reconnection counter will be set to 0. If there are no channels available and there are H suspended sessions in the new target cell, the session will be terminated. For non-terminated sessions, the process will continue in this way as long as there has not been N consecutive failed reconnection (hand-off or retry) attempts. When this limit is reached the session will be forced to terminate. The forced termination of an N-suspended session due to the maximum number of allowable reconnection attempts being met is referred to herein as a maximum termination. The mobile terminal may confirm this termination to the network via the control channel. It is to be appreciated that a timeout in the network can also be used as a backstop.

Referring back to FIG. **2**, if the maximum number of reconnection attempts has not been met (negative determination in step **30**), the session will remain suspended (if it was already suspended) or become suspended (if it was an active session) (step **32**). After each failed reconnection attempt, a random time is generated for the next retry attempt epoch, which is referred to herein as the next trail time (or, simply, the retry attempt time). Furthermore, a dwell time is determined, which is a random variable defined as the duration of time that a two-way link of satisfactory quality can be maintained between a platform and its current base, for whatever reason. The dwell time of platform in a cell depends on many factors including; mobility, signal power, propagation conditions, fading, etc. For purposes the present discussion, it is assumed that the dwell time is

simply a random hand-off epoch (although, as explained below, the dwell time is used as a component in constructing a model of the present invention). If a hand-off epoch arises before current retry attempt epoch (i.e., the dwell time is less than the next trail time) (affirmative determination in step **33**), a hand-off attempt of a suspended session will occur (step **23**). On the other hand, if the current retry attempt epoch arises before a hand-off epoch (i.e., the dwell time is not less than the next trail time) (negative determination in step **33**), a retry attempt will occur (step **34**). In either reconnection attempt case, if the attempt fails, the reconnection counter of the mobile terminal will be incremented by one. IF the attempt succeeds, the session becomes active (affirmative result in step **25**, return to step **20**) and the counter is reset to 0 (step **21**). Again, as described in detail above, this process will continue until one of the following events occur: (1) the session is successfully completed (step **24**); (2) the session is forced to terminate due to the lack of waiting space in the target cell when a hand-off attempt is made (step **28**); or (3) there are N successive failed reconnection attempts (step **31**).

Advantageously, the present invention allows mobile platforms each supporting any of a variety of call types, and each having differing mobility characteristics, to maintain connectivity to a backbone network in spite of unreliable radio links that occasionally fail. It is applicable to circuit switched and packet switched networks, and provides for management of disparate call types as well as call handoffs. The scheme is applicable to admission control of sessions that are supported at each gateway. It is not necessary that a session that is admitted at a gateway have dedicated exclusive access to resources. Thus, because some sessions may emit/receive data in bursts, other sessions that have been admitted to a cell can share the resources. This allows efficient resource use through rapid access and relinquishment of dedicated resources managed by the media access communications layer. This invention affords many advantages over prior art systems. For instance, the present invention:

1. provides reliable connectivity of mobile users to a backbone network in spite of unreliable links;
2. provides full support of mobile platforms having different mobility characteristics;
3. provides support of disparate call session types;
4. allows single or multiple reconnection attempts for appropriate suspended sessions;
5. provides support of retry attempts for suspended sessions;
6. provides support of hand-offs for suspended sessions;
7. considers multiple resources and mobility in session admission, hand-off and reconnection criteria;
8. provides prioritized admission, hand-off and reconnection criteria based on session attributes;
9. is applicable to circuit switched or packet switched mobile networks;
10. allows reconnection attempts that are transparent to end users; and
11. is applicable to wireless communication systems employing any of the primary air interface technologies, including, but not limited to, FDMA, TDMA, CDMA and hybrids.

MODEL DESCRIPTION

To evaluate the performance of the scheme described above, we extended the analytical framework that we have been developing in recent years (see, e.g., S. S. Rappaport, "The Multiple-Call Hand-off Problem in High-Capacity Cellular Communication System," IEEE Trans. Vehic. Technol., August 1991, vol. VT-40, no.3, pp. 546–557; S. S. Rappaport, "Blocking Hand-off and Traffic Performance for Cellular Communication System with Mixed Platforms," IEE (British) Proceedings, Part I, Communications, Speech and Vision, October 1993, vol. 40, no. 5, pp. 389–401; D. Hong and S. S. Rappaport, "Traffic Model and Performance Analysis for Cellular Mobile Radio Telephone Systems with Prioritized and Non-Prioritized Hand-off Procedures," IEEE Trans. Vehic. Technol., August 1986, vol. VT-35, no. 3, pp. 77–92; Y. Park and S. S. Rappaport, "Cellular Communication Systems with Voice and Background Data," pp. 33–42 in 'Mobile Multimedia Communications,' D. J. Goodman and D. Raychaudhuri, eds., Plenum Press, New York, 1997; and C. Purzynski and S. S. Rappaport, "Prioritized Resource Assignment for Mobile Cellular Communication Systems with Mixed Services and Platform Types," IEEE Trans. On Vehicular Technology, August 1996, vol. 45, No.3, pp. 443–458.). The analytical framework decouples a cell from other cells and iteratively determines the average hand-off arrival rate to a cell. Moreover, the hand-off arrival process to a cell is taken as a Poisson point process. These assumptions, which are now used by almost all researchers who do work in this area, also have intuitive appeal, because it is not likely that channels in ALL neighboring cells are either heavily occupied or lightly occupied at the same time. So, if a cell has multiple neighbors, the arrival rate to a cell (which is proportional to the sum of the departure rates from its neighbors) would tend to remain constant about its mean value.

The underlying approach, which uses multidimensional birth-death processes, allows numerical computation of relevant state probabilities and traffic performance measures. The framework we developed obviates the need for dealing with overall system states and allows consideration of the much fewer cell states by invoking a conservation rule that relates mean hand-off and departure rates. While the number of cell states can still be formidable for certain parameter choices, it is quite manageable for many practical configurations of current interest, especially because the cell state transition matrix is sparse. Moreover, we used Gauss-Seidel iteration as part of our solution algorithm. This allows one to deal with only one state balance equation at a time. As the number of channels per cell increases, the number of states increases rapidly, and the approach is not scalable. However, a method to extrapolate results for much larger systems may be employed.

To accommodate the essential features of the present problem, it was necessary to define new state variables to account for suspended sessions and their status (number of reconnection attempts made)—and to reformulate the state balance equations. At the same time we wanted to include consideration of mixed platform types that have different mobility characteristics as well as provide a model that considers priority for hand-off sessions. Additional new performance measures that are meaningful in the present context are introduced and formulated. We had little difficulty in performing the calculations on a current desktop workstation. After developing a suitable state description for the current problem, the global state balance equations for the system are formulated and solved for the state probabilities. These are used to compute important traffic performance measures for the proposed system.

In a model description according to an embodiment of the present invention, a large geographical area is considered containing many spatial zones that are defined by the (satisfactory electromagnetic signal) coverage of specific network gateways (base stations). These spatial zones are

referred to herein as cells but it is to be understood that this term is used in a generic sense. The spatial zones can be sectors of a cell, microcells, macrocells, satellite beams, etc. Large numbers of mobile platforms of several types move about in the region. The platform types differ primarily in the mobility characteristics and each platform can support at most one connection at any given time. The maximum number of simultaneous connections that each base station can support is C.

We use the concept of dwell time to characterize platform mobility. This is a random variable defined as the duration of time that a two-way link of satisfactory quality can be maintained between a platform and its current base, for whatever reason. The dwell time of platform in a cell depends on many factors including: mobility, signal power, propagation conditions, fading, etc. Although other generalizations are possible, here we take the probability density function (p.d.f.) of dwell time to be a negative exponential distribution (with a parameter depending on mobility of the platform type). Similarly, the unencumbered session duration and the k-trial time were taken to be n.e.d. random variables (with parameters depending on intended session duration and the value of k, respectively).

In the following we let g be an index that defines the platform type and mobility. Consider a suspended session that has already failed k−1 reconnection attempts. The next reconnection attempt is called the "k-reconnection attempt" where 1≦k≦N. It is important to emphasize that there are two driving processes that generate reconnection attempts. One is the retry process, which consists of successive statistically independent realizations of a random variable, $T_r(k, g)$, to generate epochs for retry attempt times for a suspended session. The other is the hand-off departure process—because hand-off attempts always try to establish a link and therefore count as reconnection attempts. The random variable gives the time from the previous reconnection event (either hand-off or retry) to the next anticipated retry attempt. The random variable, $T_r(k,g)$, can in general depend on k. Thus, the minimum rate of reconnection attempts depends on the number of attempts that have already been made. Of course, if the supporting platform leaves its current cell before the anticipated retry epoch, a hand-off attempt (to establish a link) will be made at that time and the value of k will be adjusted. If the session is in a suspended state after this attempt, a new random variable (for a retry epoch) will be generated. The random variable, $T_r(k,g)$, generated after the k−1 retry attempt, which represents the maximum time to the next anticipated retry attempt is called the "k-trial time". A suspended session that has not reestablished a link after k−1 reconnection trials and is waiting for the next (k^{th}) reconnection attempt, is called a "k-suspended session".

Assume that the system comprises G types of platforms, indexed by {g=1,2,3, . . . , G}. The call origination rate from a non-communicating g-type platform is denoted A(g). We define $\alpha(g)=A(g)/A(1)$. The number of non-communicating g-type platforms in any cell is denoted $\nu(g,0)$. Therefore, the total call origination rate for g-type platforms in a cell is $A_n(g)=A(g)\cdot\nu(g,0)$. It is assumed that the number of non-communicating communicating platforms is much larger than the maximum available connections in a cell so that the call generation rate does not depend on the number of sessions in progress (this is called an infinite population model).

Generally the bandwidth and other resources needed for connection of a call may depend on call type. A model that considers resource use based on call (connection) type may be used. However, we preferably focus on the issue of maintaining connectivity, and it is thus assumed that each active connection requires the same resources. Each cell or gateway can support a maximum of C connections. There are no quotas for specific mobility platform type. Cut-off priority for hand-offs and reconnection attempts is included in the present discussion. Thus, C_h connections in each cell are reserved for hand-off attempts (from platforms entering a cell) and for reconnection attempts from suspended sessions in the cell. A connection will be established for a new call only if there are fewer than $C-C_h$ active sessions in the cell. Hand-off attempts will fail to get a connection if there are C active sessions in the cell. An active session (attempting a hand-off to a target cell) will be suspended if it fails to get a connection but there are less than H suspended sessions in the target cell. It will be terminated if there are C active sessions and H suspended sessions in the target cell.

The platform is considered to "leave" the cell at the expiration of its current (random) dwell time. A communicating platform that leaves a cell generates a hand-off arrival to some other cell. Here the dwell time in a cell for g-type platform is taken as a n.e.d. random variable, $T_d(g)$, having a mean $\bar{T}_d(g)=1/\mu_d(g)$. The k-trial time of a suspended session on g-type platform is a n.e.d. random variable, $T_r(g)$, having a mean $\bar{T}_r(k,g)=1/\mu_r(k,g)$, where 1≦k≦N, and $\mu_r(k,g)$ (k=1, . . . , N; g=1, . . . G), is the parameter that determines the reconnection attempt rate for a k-suspended session on a g-type platform.

State Description

Consider a single cell. We define the cell state by a sequence of non-negative integers. When a maximum of N reconnection attempts are permitted for a suspended session, the state of the cell can be written as G n-ruples as follows

$$\begin{array}{cccccc} s_1 & u_{1,1} & u_{1,2} & u_{1,3} & \cdots & v_{1,N} \\ s_2 & v_{2,1} & v_{2,2} & v_{2,3} & \cdots & v_{2,N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ s_S & u_{G,1} & v_{G,2} & v_{G,3} & \cdots & v_{G,N} \end{array}$$

where u_g {g=1,2,3, . . . , G} is the number of active sessions on g-type platforms and $v_{g,k}$ {g=1,2, . . . , G;k=1,2, . . . , N} is the number of k-suspended sessions on g-type platforms. For convenience we order the states using an index s=0,1, . . . , S_{max}. Thereafter, u_g and $v_{g,k}$ can be written explicitly dependent on the state. That is $u_g=u(s,g)$ and $v_{g,k}=v(s,g,k)$.

When the cell is in state s_i the following characteristics can be determined. The number of active sessions is

$$n(s,g)=\sum_{g=1}^{G} u(s,g). \tag{1}$$

The number of suspended sessions on g-type platforms is

$$v(s,g)=\sum_{k=1}^{N} v(s,g,k). \tag{2}$$

The total number of suspended sessions in cell, regardless of platform type, is

$$u(s)=\sum_{g=1}^{G} u(s,g) \quad (3)$$

The number of sessions either active or suspended on g-type platforms in the cell is

$$n(s,g)=u(s,g)+v(s,g) \quad (4)$$

The total number of sessions in progress that are either active or suspended is

$$n(s)=u(s)+v(s) \quad (5)$$

There are constraints on permissible cell states. These include the total number of active sessions in a cell must be less than or equal to maximum supportable connections, $u(s)\leq C$; and the total number of suspended sessions in a cell must be less than or equal to the maximum number of suspended sessions allowed in a cell, $v(s)\leq H$

Driving Processes

There are five major driving processes for this problem. We preferably use Markovian assumptions for driving processes to allow solution within the multidimensional birth-death process framework. Each process is listed below:

- {n}: generation of new calls
- {c}: completion of calls
- {h}: hand-off arrival of calls
  - $\{h_0\}$: active session hand-off arrivals
  - $\{h_1\}$: 1-suspended session hand-off arrivals
  - . . .
  - $\{h_N\}$: N-suspended session hand-off arrivals
- {d}: hand-off departure of calls
  - $\{d_0\}$: active session hand-off departures
  - $\{d_1\}$: 1-suspended session hand-off departures
  - . . .
  - $\{d_N\}$: N-suspended session hand-off departures
- {r}: retry attempts

The dimension of the new call generation process, $\{n\}_1$ is G, since there are G different types of mobility platforms. Similarly, the dimensions of the hand-off arrival and departure processes, {h} and {d}, are Gx(N+1), since N-times of reconnection attempts are permitted for a suspended session besides of existence of active sessions. The dimension of the retry attempt process {r} is GxN, since N types of suspended sessions can arise from G different types of platforms.

Generation of New Calls

A transition into state s, due to a new call arrival on a g-type platform when the cell is in state x_m, will cause the state variable $u(x_m,g)$ to be increased by 1. Because of cut-off priority, C_k connections are held for arrivals of hand-off attempts (of active or suspended sessions) and for retry attempts of suspended sessions. Thus a permissible state x_m is a predecessor state of s for a new call arrives on g-type platform, if $u(x_m)<C-C_k$ and the state variables are related by

$$u(x_m,g)=u(s,g)-1$$

$$v(x_m,f)=v(s,f) \quad (6)$$

The corresponding transition flow is given by

$$\gamma_n(x_m,s)=\lambda_n(g) \quad (7)$$

in which $\lambda_n(g)$, is the new call arrival rate per cell from platforms of type g.

Completion of Calls

A transition into state s, due to successful completion of a session on a g-type platform when the cell is in state x_m, will cause the state variable $u(x_m,g)$ to be decreased by 1. Thus a permissible state x_m is a predecessor state of s for call completion on a g-type platform if the state are related by

$$u(x_m,g)=u(s,g)+1$$

$$v(x_m,f)=v(s,f) \quad (8)$$

The unencumbered session duration on a g-type platform is a n.e.d. random variable, T(g), having a mean $\bar{T}(g)=1/\mu(g)$. Then the transition flow into state s from x_m due to a session completion is given by

$$\gamma_c(x_m,s)=u(g)\mu(x_m,g) \quad (9)$$

Hand-Off Arrival of Calls

Active session Hand-Off Arrivals

When a cell has less than C active sessions, arriving hand-off calls can obtain a connection. Thus a permissible state x_{hh} is a predecessor state of s for an active session hand-off arrival on a g-type platform when $u(x_{hh})<C$ and the state variables are related by

$$u(x_{hh},g)=u(s,g)-1$$

$$v(x_{hh},f)=v(s,f) \quad (10)$$

When an active session needs a hand-off, it will become a 1-suspended session if the target cell has C active sessions but the total number of suspended sessions in that cell is less than H. A transition into state s, due to an hand-off arrival of active session on a g-type type platform when the cell is in state x_{hh} (in which the cell has C active sessions but the total number of suspended sessions in that cell is less than H), will cause the state variable $v(x_{hh},g,1)$ to increase by 1. Thus a permissible state x_{hh} is a predecessor state of s for hand-off arrival of active session on a g-type platforms when $u(x_{hh})=C$ and $v(x_{hh})<H$ if the state variables are related by

$$u(x_{hh},g)=u(s,g)$$

$$v(x_{hh},1)=v(s,g,1)-1$$

$$v(x_{hh},f)=v(s,g,f)_{g\neq 1} \quad (11)$$

We let A_g be the average rate at which hand-off arrivals of active session impinge on the cell and F_g denote the fraction of hand-off arrival of active session that are from g-type platforms. Initially we guess A_g and F_g, but these values are determined by the dynamics of process. We will subsequently determine these values using an iterative approach. The corresponding transition flow for active session hand-off attempts is given by

$$\gamma_{hh}(x_{hh},s)=A_g F_g \quad (12)$$

Hand-Off Arrivals of Suspended Sessions

If the target cell has less than maximum number of simultaneously supportable connections, C_r when a k-suspended session hand-off attempt arrives, $(1\leq k\leq N)$, the session will be accommodated and will become an active session in the target cell. Thus a permissible state x_{hk} is a predecessor state of s for hand-off arrivals of k-suspended sessions on g-type platform when $u(x_{hk})<C_r$ if the state variables are related by

$$u(x_{ns,g})=u(s,g)+1$$

$$v(x_{ns,g},k)=v(s,g,k) \quad (13)$$

where $1 \leqq k \leqq N$.

Suppose that a target cell has no available channel resources for connection of an arriving hand-off call, but the total number of suspended sessions in that cell is less than maximum number of supportable suspended sessions, H. Then a hand-off attempt will fail and a k-suspended session becomes a (k+1)-suspended session in the target cell unless the mobile's counter indicate k=N. Thus a permissible state x_{ns} is a predecessor state of s for hand-off arrival of k-suspended session on a g-type platform when $u(x_{ns})<C$ and $v(x_{ns})<H$, if the state variable are related by

$$u(x_{ns,g})=u(s,g)$$

$$v(x_{ns,g},k+1)=v(s,g,k+1)-1$$

$$v(x_{ns,g},j)=v(s,g,j),(k+1) \quad (14)$$

where $1 \leqq k \leqq N$.

It should be remembered that when the counter of the terminal indicates N+1, then the terminal has attempted the maximum allowable number of reconnection attempts. This call will be forced into termination. So, a failure of hand-off attempt when the counter of the terminal is N causes a call to be forced into termination. This type of termination (a call is terminated with k=N) is called maximum termination and is described in detail below in the section, PERFORMANCE MEASURES.

Let $A_g(k)$ be the average rate at which hand-off arrivals of k-suspended session on a g-type platform impinge on the cell, $F_{sg}(k)$ denote the fraction of hand-off arrival of k-suspended sessions that are from g-type platform. Initially we guess $A_g(k)$ and $F_{sg}(k)$ but using an iterative method, we will subsequently determine the values required by the dynamics of the process. Then the corresponding transition flow is given by

$$\gamma_{ns}(s,x_{ns})=A_g(k)F_{sg}(k) \quad (15)$$

where $1 \leqq k \leqq N$.

Departure of Hand-Off Calls

Hand-Off Departures of Active Sessions

A transition into state s, due to a hand-off departure of active session on a g-type platform when the cell is in state x_{dg}, will cause the state variables $u(x_{dg},g)$ to be decreased by 1. Thus a permissible state x_{dg} is a predecessor state of s for a hand-off departure of active session on a g-type platforms, if the state variables are related by

$$u(x_{dg,g})=u(s,g)+1$$

$$v(x_{dg,j})=v(s,g,j) \quad (16)$$

The corresponding transition flow is given by

$$\Gamma_{dg}(s,x_{dg})=\mu_g(g)u(x_{dg,g}) \quad (17)$$

Hand-Off Departures of k-Suspended Sessions

A transition into state s, due to a hand-off departure of k-suspended session on a g-type platform when the cell is state x_{dg}, will cause the state variable $v(x_{dg},g,k)$ to be decreased by 1. Thus a permissible state x_{dg} is a predecessor state of s for a hand-off departures of k-suspended session on g-type platforms, if the state variables are related by

$$u(x_{dg,g})=u(s,g)$$

$$v(x_{dg,g},k)=v(s,g,k)+1$$

$$v(x_{dg,j})=v(s,g,j),j\neq k \quad (18)$$

where $1 \leqq k \leqq N$.

The corresponding transition flow is given by

$$\gamma_{dg}(s,x_{dg})=v_g(g)v(x_{dg,g},k) \quad (19)$$

where $1 \leqq k \leqq N$.

Retry Attempts

If the cell has less than the maximum number of active sessions in progress when a terminal attempts a reconnection trial (either hand-off or retry) for a k-suspended session, the reconnection attempt will succeed and the session will become active. Thus, a transition into state s, due to a retry attempt for a k-suspended session on a g-type platform, when $u(x_r)<C$ and the cell is state x_r, will cause the state variable $u(x_r,g)$ increased by 1 and $v(x_r,g,k)$ to be decreased by 1. So, a permissible state x_r is a predecessor state of s for a retry attempt of k-suspended session on a g-type platform, if $u(x_r)<C$ and the state variables are related by

$$u(x_{r,g})=u(s,g)-1$$

$$v(x_{r,g},k)=v(s,g,k)+1$$

$$v(x_r,g,j)=v(s,g,j),j\neq k \quad (20)$$

where $1 \leqq k \leqq N$.

If the system is supporting C active sessions when the terminal makes a retry attempt for a k-suspended session, the retry attempt will fail. When the counter of terminal indicates less than the N, the terminal will wait for the next reconnection attempt. When a cell is in state x_r, a failure of a retry attempt for a k-suspended session on a g-type platform will occur when the mobile's counter indicates less than the maximum allowable reconnection attempts (k<N), will cause the state variable $v(x_r,g,k)$ to be decreased by 1 and $v(x_r,g,k+1)$ to be increased by 1. Thus a permissible state x_r is a predecessor state of s for the failure of a k-repeated trial (k<N) on a g-type platform when $u(x_r)=C$ and $v(x_r)<H$, if the state variables are related by

$$u(x_{r,g})=u(s,g)$$

$$v(x_{r,g},k)=v(s,g,k)+1$$

$$v(x_{r,g},k+1)=v(s,g,k+1)-1$$

$$v(x_{r,g},j)=v(s,g,j),j\neq k,k+1 \quad (21)$$

where $1 \leqq k \leqq N$.

When the counter of the terminal indicates N+1, then the terminal has been attempted maximum allowable reconnection attempts. This call will be forced into termination. So, the failure of a reconnection attempt when the counter of the terminal is N causes a call to be forced into termination. This type of termination (a call is terminated with k=N) is called maximum termination and described in detail in the section, PERFORMANCE MEASURES. Thus a permissible state x_r is a predecessor state of s for the failure of a N-reconnection attempt on a g-type platform when $u(x_r)=C$ and $v(x_r)<H$, if the state variables are related by

$$u(x_{r,g})=u(s,g)$$

$$v(x_{r,g},N)=v(s,g,N)+1$$

$$v(x_{r,g},j)=v(s,g,j),j\neq N \quad (22)$$

The corresponding transition flow is given by

$$\gamma_s(s,x,k)=\mu_s(k,g)\cdot\delta_{s,g,k} \quad (23)$$

Flow Balance Equations

From the above equations, the total transition flow into state s from any permissible predecessor state x can be written as

$$q(s,s)=\gamma_s(s,s)+\gamma_s(s,s)+\gamma_s(s,s)+\gamma_s(s,s)+\gamma_s(s,s) \quad (24)$$

where

$$\gamma_s(s,s)=\gamma_{s,0}(s,s)+\gamma_{s,1}(s,s)+\ldots+\gamma_{s,N}(s,s), \quad (25)$$

$$\gamma_s(s,s)=\gamma_{s,0}(s,s)+\gamma_{s,1}(s,s)+\ldots+\gamma_{s,N}(s,s), \quad (26)$$

$$\gamma_s(s,s)=\gamma_{s,0}(s,s)+\gamma_{s,1}(s,s,2)+\ldots+\gamma_{s,N}(s,s,N), \quad (27)$$

s≠x, and flow into a state has been taken as a positive quantity.

The total flow out of state s is denoted, q(s,s) and is given by

$$q(s,s)=-\sum_{\substack{x=0\\ x\neq s}}^{S_{max}} q(s,x) \quad (28)$$

The statistical equilibrium state probabilities can be found by solving the flow balance equations. This is a set of Smax+1 simultaneous equations.

$$\sum_{j=0}^{S_{max}} q(i,j)\cdot p(j)=0, \quad i=0,1,\ldots,S_{max}-1 \quad (29)$$

$$\sum_{j=0}^{S_{max}} p(j)=1, \quad (30)$$

in which, for i≠j, q(i,j) is the net transition flow into state i from state j, and q(i,i) is the total transition flow out of state i.

Hand-Off Arrival Parameters

The average hand-off arrival rate of active session, Λ_a, the average hand-off arrival rate of k-suspended session, $\Lambda_s(k)$, where $1\leqq k\leqq N$, the fraction of hand-off arrivals of active session that are g-type platform, F_g, and the fraction of hand-off arrivals of k-suspended sessions that are g-type platform, $F_g(k)$, where $1\leqq k\leqq N$, can be determined from the dynamics of the process itself. An iterative method can be used. The average hand-off departure rate of active sessions on g-type platforms can be expressed as

$$\delta_a(g)=\sum_{s=0}^{S_{max}} \mu_a(g)\cdot n(s,g)\cdot p(s), \quad (31)$$

Thereafter, the overall average hand-off departure rate of active sessions can be written as

$$\delta_a=\sum_{g=1}^{G}\delta_a(g) \quad (32)$$

The average hand-off departure rates of k-suspended sessions on g-type platform can be expressed as

$$\delta_s(g,k)=\sum_{s=0}^{S_{max}} \mu_s(g)\cdot n(s,g,k)\cdot p(s) \quad (33)$$

Also, the overall average hand-off departure rates of k-suspended sessions can be written as

$$\delta_s(k)=\sum_{g=1}^{G}\delta_s(g,k), \quad (34)$$

From these equations, we find that the fraction of hand-off departures of active sessions that are on g-type platforms is

$$F_g=\delta_a(g)/\delta_a, \quad (35)$$

and, the fraction of hand-off departures of k-suspended sessions on g-type mobility platform is

$$F_s(k)=\delta_s(g,k)/\delta_s(k) \quad (36)$$

Since the maximum allowable reconnection attempts is N, there are N average hand-off departure rates and fractions, each corresponding to a value of k. Any hand-off departure of an active session of a g-type platform a cell corresponding to a hand-off arrival of active session of a g-type platform to another cell. Also, a hand-off departure of a k-suspended session of a g-type platform from a cell, corresponds a hand-off arrival of a k-suspended session of a g-type platform to another cell. Therefore, for a homogeneous system in statistical equilibrium, the hand-off arrival and departure rates per cell must be equal and the component hand-off arrival rates of k-suspended sessions and hand-off departure rates of k-suspended sessions, where $1\leqq k\leqq N$, must also equal one another. That is we must have

$$F_g=F'_g$$

$$F_{s,g}(k)=F'_{s,g}(k)$$

$$\Lambda_a=\delta_a$$

$$\Lambda_s(k)=\delta_s(k) \quad (37)$$

where $1\leqq k\leqq N$.

Performance Measures

When the statistical equilibrium state probabilities and transition flow are found, the required performance measures can be calculated.

Carried Traffic

An important performance measure from a system point of view is the carried traffic. For given resources, larger carried traffic implies more efficient use and more revenue for the service provider. The carried traffic for g-type platform, $A_c(g)$, is

$$A_c(g)=\sum_{s=0}^{S_{max}} n(s,g)\cdot p(s), \quad (38)$$

The total carried traffic, A_c, is

$$A_c=\sum_{g=1}^{G} A_c(g), \quad (39)$$

Average Number of k-Suspended Sessions

The average number of k-suspended sessions on g-type platforms, $A_s(k,g)$, is

$$A_s(k,g) = \sum_{n=k}^{N_{max}} n(c,g,k)\cdot p(n). \quad (40)$$

The average number of k-suspended sessions regardless of platform type, $A_s(k)$, is

$$A_s(k) = \sum_{g=1}^{G} A_s(k,g). \quad (41)$$

Then, the average number of suspended sessions, A_{ss}, is

$$A_{ss} = \sum_{k=1}^{N} A_s(k). \quad (42)$$

Blocking Probability

The blocking probability, P_B, is the average fraction of new call arrivals that fail to acquire a connection. Blocking events occurs when the cell is in one of state of following disjoint subsets of states

$$L_B = \{(n,n_s) | n \geq C - CR_s\}. \quad (43)$$

Blocking probability is expressed as

$$P_B = \sum_{n \in L_B} p(n). \quad (44)$$

Hand-Off Failure Probability

The hand-off failure probability, P_{HF}, is the average fraction of hand-off attempts that are denied in the target cell because the system in target cell supports maximum supportable connections and maximum supportable suspended sessions. A session, either active or suspended, that is denied in the target cell due to the lack of system capacity will be forced into termination and cleared from system database. We define following disjoint set of states, in which hand-off attempts will fail

$$L_{HF} = \{(n,n_s) | n = C \vee (n = nH)\}. \quad (45)$$

Then, the hand-off failure probability is expressed as

$$P_{HF} = \sum_{n \in L_{HF}} p(n). \quad (46)$$

The hand-off attempt rate to a cell depends directly on the states of its neighboring cells (those from which it receives hand-offs), and not on the state of the target cell. So if we average over the states of the neighbors and recall that we are considering a homogeneous layout (in which all cells have the same parameters) equation (46) results.

Forced Termination Probability

The forced termination probability, $P_{FT}(g)$, is defined as the probability that a call on a g-type platform that is not blocked is forced into termination due to hand-off failure during its lifetime. The terminated call will be cleared from system. There are two possible scenarios in which a call is forcibly terminated due to a hand-off attempt failure during its lifetime. Firstly, a call, whether active or suspended, attempts its hand-off to a cell in which the system already supports the maximum number of connections and the maximum number of suspended sessions. In this case, a call will be forcibly terminated even if it hasn't finished its maximum allowable number of reconnection attempts. A premature termination of a session, either an active or suspended, which has not finished ,its maximum allowable reconnection attempts is called a non-maximum termination. Secondly, a suspended session is forcibly terminated if it reaches the maximum allowable number of reconnection attempts. It should be recalled that a suspended session will attempt its hand-off when it moves to another cell even though the radio link between mobile unit and base was disconnected. A hand-off attempt generated by a suspended session is counted as one reconnection attempt in the sense that the reconnection counter will be incremented. Therefore, the last attempt before termination can be either a retry attempt or a hand-off attempt. The termination of an N-suspended session due to the maximum number of allowable reconnection attempts being met is called a maximum termination.

For the purpose of calculating forced termination probability, we define the following disjoint set of states.

$$L_{HF} = \{(n,n_s) | n = C \vee (n = nH)\} \quad (47)$$

$$L_{nm} = \{(n,n_s) | n = C\}. \quad (48)$$

When the cell is one of states in L_{HF}, the cell already supports the maximum number of active sessions but the number of suspended sessions in the cell is less than the maximum supportable suspended sessions. If a call, either active or suspended call, arrives due to a hand-off attempt when a cell is one of these states, it will stay as a suspended session unless the reconnection counter indicates maximum allowable reconnection attempts, (N+1). When the counter of call indicate (N+1), a call will be forced into termination.

When the cell is one of the states L_{nm} the system supports fewer connections than the limit. Therefore, an arriving hand-off, either active or suspended call, and retry attempt will succeed in gaining access to network resources. The corresponding probabilities are

$$P_{nm} = \sum_{n \in L_{nm}} p(n) \quad (49)$$

$$P_{HF} = \sum_{n \in L_{HF}} p(n). \quad (50)$$

It is to be understood that only the failure of a hand-off attempt could cause a non-maximum termination. No retry attempt can result in a non-maximum termination since the suspended session already occupies one of the H spaces allowed for suspended sessions in each cell. Succinctly, a retry attempt cannot cause a forced termination unless it is the last allowable attempt for that session and it fails to reconnect.

FIG. 3 is a flow graph depicting events in the lifetime of a call. As illustrated, some suspended or active sessions will be forced to terminate because of the failure of their hand-off attempts or retry attempts. The probability that an active session on a g-type platform attempts a hand-off as an upcoming event before its session completion can be written as

$$\frac{\mu_h(g)}{\mu(g)+\mu_h(g)}$$

And, the probability that an active session on a g-type platform successfully completes its session before a trial of hand-off attempt can be written as

$$\frac{\mu(g)}{\mu(g)+\mu_h(g)}$$

The probability that an active session becomes a 1-suspended session due the lack of system capacity in target cell is P_B. For suspended sessions, there are two possible upcoming events, hand-off or retry attempt. When the dwell time of a suspended session is less than the next trial time, the session will attempt hand-off. Otherwise, the session will attempt retry. The probability that a k-suspended session on a g-type platform attempts hand-off as a next upcoming event can be written as

$$\frac{\mu_h(g)}{\mu_r(k,g)+\mu_h(g)}$$

Also, the probability that a k-suspended session on a g-type platform attempts retry as the next upcoming event can be written as

$$\frac{\mu_r(k,g)}{\mu_r(k,g)+\mu_h(g)}$$

A hand-off event of a suspended session, it can result in resumption of an active session, a forced termination, or continued suspension (with an incremented reconnection attempt counter). These events occur with respective P_A,P_{FB} and P_{FF}.

A retry attempt generated by a suspended session, can result in: 1) the suspended session becoming active (with probability of P_A); 2) the continued suspension with incremented reconnection counter if the maximum number of allowed reconnection attempts has not been reached (with probability $P_{FB}+P_{FF}$).

There are two possible scenarios in which a k-suspended session becomes a (k+1)-suspended session. One is to attempt hand-off and be continued suspension. The other is to generate a reconnection attempt and be continued in suspension. Therefore, the probability, $\theta_k(g)$, that a k-suspended session on a g-type platform becomes a (k+1)-suspended session through either a retry or a hand-off attempt can be written as

$$\theta_k(g)=\frac{\mu_r(k,g)\cdot(P_{FB}+P_{FF})}{\mu_r(k,g)+\mu_h(g)}+\frac{\mu_h(g)\cdot P_B}{\mu_r(k,g)+\mu_h(g)} \tag{51}$$

$$=\frac{\mu_r(k,g)\cdot(P_{FB}+P_{FF})+\mu_h(g)\cdot P_B}{\mu_r(k,g)+\mu_h(g)} \tag{52}$$

where $1\leqq k<N$.

Even though a call has experienced suspension, the counter will be reset to zero if a suspended call is activated. A call may have suspension experiences during its lifetime before it is successfully completed. The suspension and reconnection process is initiated after an active call fails a hand-off attempt. Therefore, the probability that an active call has a hand-off attempt as an upcoming event and acquire connection through either successful hand-off or retry attempt should be calculated for measuring the system performance. The probability, $\eta(g)$, that an active call on a g-type platform, will remain active is the sum of the probabilities of the following events: 1) it succeeds on the upcoming hand-off attempt, 2) fails on the upcoming event and (therefore) is suspended but it succeeds in its 1-retry attempt or next hand-off attempt, 3) becomes a suspended session and fails its 1-retry attempt but succeeds its 2-retry attempt or next hand-off attempt, and so on. Therefore, the probability can be written as

$$\eta(g)=\frac{\mu_h(g)\cdot P_A}{\mu(g)+\mu_h(g)}+\frac{\mu_h(g)\cdot P_B\cdot P_A}{\mu(g)+\mu_h(g)}+ \tag{53}$$

$$\frac{\mu_h(g)\cdot P_B\cdot P_A\cdot\theta_1(g)}{\mu(g)+\mu_h(g)}+\frac{\mu_h(g)\cdot P_B\cdot P_A\cdot\theta_1(g)\cdot\theta_2(g)}{\mu(g)+\mu_h(g)}+\ldots+$$

$$\frac{\mu_h(g)\cdot P_B\cdot P_A\cdot\theta_1(g)\cdot\theta_2(g)\cdots\theta_{N-1}(g)}{\mu(g)+\mu_h(g)}$$

$$=\frac{\mu_h(g)\cdot P_A}{\mu(g)+\mu_h(g)}\left(1+P_B\left(1+\sum_{k=1}^{N-1}\prod_{m=1}^{k}\theta_m(g)\right)\right) \tag{54}$$

where $1\leqq k\leqq N$.

Non-Maximum Termination Probability

In previous discussion, we defined premature termination of a session, either an active or suspended, as on which has not finished its maximum allowable number of reconnection attempts, as a non-maximum termination. Therefore, if the counter of a terminal does not indicate (N+1) when a session is forced into termination, the event is called non-maximum termination. The non-maximum termination probability, P_{NT} (g), is defined as the probability that a call on a g-type platform, either active or suspended, that is forced into termination during its lifetime due to a failure of a hand-off attempt even though it has not finished its maximum allowable number of reconnection attempts. This probability is the sum of the probabilities that a session is forced into termination when it is a 1-suspended session, 2-suspended session, . . . , up to an N−1 suspended session. The probability, $\psi_0(g)$, that a call on a g-type platform is forcibly terminated due to a failure of hand-off during its lifetime can be written as

$$\psi_0(g)=\frac{\mu_h(g)\cdot P_B}{\mu_0(g)+\mu(g)}+\frac{\mu_h(g)\cdot P_B\cdot\eta(g)}{\mu_0(g)+\mu(g)}+\frac{\mu_h(g)\cdot P_B\cdot\eta(g)^2}{\mu_0(g)+\mu(g)}+\ldots \tag{55}$$

$$=\frac{\mu_h(g)\cdot P_B\cdot\sum_{n=0}^{\infty}\eta(g)^n}{\mu_0(g)+\mu(g)} \tag{56}$$

In the same fashion, the probability that a call on a g-type platform is forcibly terminated while it is a k-suspended session, where 0<k<N, due to a failure of hand-off during its lifetime, $\psi_k(g)$, can be written as

$$\psi_k(g)=\frac{\mu_h(g)\cdot P_B\cdot\sum_{n=0}^{\infty}\eta(g)^n}{\mu_0(g)+\mu(g)}\cdot\left(\frac{\mu_r(g)\cdot P_B}{\mu_0(g)+\mu_r(k,g)}\right)\prod_{m=1}^{k-1}\theta_m(g) \tag{57}$$

Then, the overall non-maximum termination probability, $P_{nxf}(g)$, can be written as

$$P_{nxf}(g) = \theta_{nx}(g) + \theta_{nx}(g) + \cdots + \theta_{N-1}(g) \quad (58)$$

$$= \frac{\mu_h(g) \cdot P_{hf} \cdot \sum_{j=0}^{N} \eta(g,j)}{\mu_h(g) + \mu(g)} \left(1 + \frac{\mu_h(g) \cdot P_{hf}}{\mu_h(g) + \mu_c(k,g)} \sum_{k=1}^{N-1} \prod_{m=1}^{k} \theta_m(g)\right) \quad (59)$$

$$= \frac{\mu_h(g) \cdot P_{hf}}{\mu_h(g) + \mu(g)} \cdot \frac{1}{1 - \eta(g)} \left(1 + \frac{\mu_h(g) \cdot P_{hf}}{\mu_h(g) + \mu_c(k,g)} \sum_{k=1}^{N-1} \prod_{m=1}^{k} \theta_m(g)\right) \quad (60)$$

Probability of Maximum Termination

The probability of maximum termination, $P_{mxf}(g)$, is defined as the probability that a call on a g-type platform that is forced to terminate during its lifetime because the maximum allowable number of reconnection attempts have been reached. The last attempt of maximum termination can be either a hand-off or retry. The probability of maximum termination, $P_{mxf}(g)$, can be written as

$$P_{mxf}(g) = \frac{\mu_h(g) \cdot (P_{hf} + P_{rf}) \cdot P_{hf} \cdot \prod_{m=1}^{N-1} \theta_m(g)}{(\mu(g) + \mu_h(g) \cdot (1 - \eta(g))} \quad (61)$$

The forced termination probability, $P_{ff}(g)$, is defined as the probability that a call on a g-type platform that is not blocked is forced into termination due to hand-off failure or failure of reconnection attempts during its lifetime. It can be written as

$$P_{ff}(g) = P_{nxf}(g) + P_{mxf}(g) \quad (62)$$

Average Time Per Suspension

A call may experience a suspension or some suspensions during its lifetime. When a call becomes a suspended session, the terminal on that call will start its reconnection process. This reconnection effort can succeed or fail. The average time per suspension on a g-type platform, W(g), is the expected time that reconnection process will carry on. Therefore, it is the average time frame from the point that an active session becomes a suspended session to the point that a suspended session becomes an active session or be forced into termination.

To calculate the average time per suspension, determine the average rate of suspension and the number of calls in suspension from the state probabilities. Little's law will then be applied to find the average amount of time in suspension.

The average rate of call suspension for a g-type platform, H(g), is given by

$$H(g) = \sum_{n=0}^{N} \mu_h(n) \cdot (\lambda_h \cdot P_{hf}) \quad (63)$$

$$= P_{hf} \cdot \lambda_h \cdot P_b \quad (64)$$

And we can determine the average number of suspended calls on g-type platform, $A_s(g)$, from equation (40) as follows

$$A_s(g) = \sum_{k=1}^{N} A_{sk}(k, g) \quad (65)$$

Thereafter, we can find the average time per suspension of a g-type call, W(g). Using Little's law, this is

$$W(g) = A_s(g)/H(g). \quad (66)$$

Average Number of Suspensions Per Session

The average number of suspensions per session on g-type platform, S(g), is the expected number of suspensions for a call on g-type platform during its lifetime. Firstly, we will determined the average rate of accommodating calls on g-type platform, E(g). Since some part of calls will be blocked due to lack of system capacity, the average rate of accommodating calls on g-type platform, E(g), can be expressed as

$$E(g) = \lambda_n(g) \cdot (1 - P_b) \quad (67)$$

And, then the average number of suspensions per session on g-type platform, S(g), can be written as

$$S(g) = H(g)/E(g). \quad (68)$$

Average Times Per Session

Average Time in Suspension Per Session

The average time in suspension per session on g-type platform, $M_s(g)$, is the expected waiting time for a call on g-type platform during its lifetime. Using Little's law, we can write this as

$$M_s(g) = S(g) \cdot W(g) = \frac{H(g)}{E(g)} \cdot \frac{A_s(g)}{H(g)} = \frac{A_s(g)}{E(g)}. \quad (69)$$

Average Total Lifetime of a Session

Let $M_t(g)$ denote the average total lifetime of a call on a g-type platform, regardless of how the call ends. Recall that a call can finish its session successfully or unsuccessfully, i.e. by call completion or forced termination). The quantity $M_t(g)$ is the expected time that a call spends in the system. Using Little's law, this can be written as

$$M_t(g) = \frac{A_n(g) + A_s(g)}{E(g)}. \quad (70)$$

Suspension Time

The fraction of a call's lifetime that it is suspended is an important performance metric. For a call on a g-type platform, this is denoted by U(g). This can be written as

$$U(g) = \frac{M_s(g)}{M_t(g)} = \frac{A_s(g)}{\lambda_n(g) + A_s(g)} \quad (71)$$

EXPERIMENTAL RESULTS

Numerical results were generated using the approach described herein. The unencumbered session duration was set at 100s for numerical purposes. Two types of platforms were considered, low mobility and high mobility. A mean dwell time of 500s was assumed for low mobility platforms and 100s for high mobility platform. The mean k-trial time of a k-suspended session on g-type platform was chosen to be 20s for $1 \leq k \leq N$. (That is, $\bar{T}_s(k, g) = 20s$). It is to be understood that it is possible that the mean trial time of k-suspended session can be dependent on k and g, for example $\bar{T}_s(1, g) \neq \bar{T}_s(2, g)$. For convenience and computational purposes, we took k-trial time to be 20 sec., independently of k and g.

For all calculations described herein, $\alpha(g) = 1$ was assumed, so that platform types generate new calls at the same average rate. We took the number of channels in a cell

to be 25, and a total of 600 non-communicating users (300 users for slow mobiles and 300 users for fast mobiles) in each cell was assumed.

The abscissas for FIGS. **4**–**12** illustrate call demand with the assumptions stated above. In these, the abscissas are the new call origination rate per platform for platform type 1. The ratio of new call origination rates of other platform types to that of type 1 platforms were fixed by the parameters $\alpha(g)$. An abscissa value of 2.78×10^{-4} calls/s corresponds roughly to one call per hour per user and a (new) offered load of 16.5 erlangs. The figures are for cells with 25 channels.

If a maximum of three reconnection attempts is allowed for a suspended session, and (up to) four suspended sessions can be supported in a cell, these parameter choices result in 73,710 permissible states. We used a desktop Sun Ultra-2 workstation for the calculations. About forty minutes of running time was needed to determine the cell state probabilities. We performed ten calculations, with different call origination rates, to generate FIGS. **4**–**12**. So, the total time needed to calculate the performance characteristics shown in these figures was about seven hours.

When an active or suspended session requires a hand-off, the session is terminated if there are C connections in progress in the target cell and no waiting spaces are available. This probability is denoted P_{ff} and is a calculated result. FIG. **4** shows hand-off failure probability, P_{fh}, as a function of new call origination rate on type 1 platform. While many parameters affect forced termination probability, the influence of P_{fh} is very strong. There are two important parameters that can control hand-off failure probability in our system configuration. One is the number, C_h, of cut-off priority. Clearly, it is seen that if more channels are reserved for hand-off or retry attempts, a smaller hand-off failure probability is obtained. However, as we can see in FIG. **5**, with increasing C_h, new call arrivals will be more likely to fail to acquire a connection. The other important parameter is the number, N, of maximum allowable of reconnection attempts. As this parameter is increased, a session is less likely to be terminated.

FIG. **6** illustrates the dependence of the forced termination probability on the number of maximum allowable reconnection attempts, N. As we can see, increasing N results in fewer sessions being forced to terminate during their lifetimes. For an abscissa value of 2.0×10^{-4} calls/sec, forced termination probability decreases by about two orders of magnitude as N increases from 0 to 3. It is also seen in FIG. **10** that this is mainly due to a reduction in maximum termination probability. We see that increase of maximum allowable reconnection attempt, N, has a dramatic affect on reducing of maximum termination probability.

FIG. **7** shows the dependence of forced termination probability on the maximum number, H, of suspended sessions that are supported. The more calls that can be supported as suspended sessions, the less the forced termination probability. For an abscissa value of 2.0×10^{-4} calls/sec, forced termination probability decreases by about one order of magnitude as H increases from 3 to 4. It is seen in FIG. **9** that this is mainly because of reduction of non-maximum termination probability.

FIG. **8** illustrates the forcal termination probability for various value of C_h used for cut-off priority. When we increase the number of connections that are reserved for hand-off or reconnection attempts, forced termination probability is decreased; but (as we see in FIG. **4**) blocking of new calls is increased. It is also seen that calls on slow mobiles have smaller forced termination probability. That is because a call on slow mobile can finish its session with relatively fewer hand-offs during its lifetime.

FIG. **11** illustrates the dependence of average time per suspension, W(g), on call demand. The number N, of maximum allowable reconnection attempts and the platform mobility are parameters. Consider suspended sessions on fast mobiles in comparison with those on slow platforms. Since reconnection attempts are made at hand-off events, the former would generally have earlier opportunities to resume active status. Thus calls on slow mobiles have greater average waiting time per suspension than calls on fast mobiles. This is shown in the figure. For an abscissa value of 2.0×10^{-4} calls/sec, calls on slow mobiles have about 5 sec. more waiting time than calls on fast mobiles. It is seen that increasing N increases W(g). With increasing call demand this trend is clearer. This is because, with higher N, fewer calls will undergo forced termination and the queue of suspended calls will be increased.

FIG. **12** illustrates the fractional suspension time with N as a parameter. It is seen that with increasing call demand the fractional suspension time increases. This is because with increasing call demand the system is increasingly crowded, so a call is more likely to be suspended. It is also seen that calls on fast mobiles have a greater fractional suspension time than calls on slow mobiles. Consider calls on fast mobiles in comparison with those on slow mobile. Recall from FIG. **6** that increasing N reduces the forced termination probability for calls on both fast and slow platforms. Fast mobiles especially benefit from increasing N. That is, more are served to completion. However, we see from FIG. **12** that these calls will spend more of their lifetime in suspension. Thus, both the likelihood of successful completion and the fraction of time spent in suspension increase with increasing N. The effect is more pronounced for calls on fast mobiles.

In summary, in the above-described embodiment, to support mobile computing (and other semi-autonomous mobile-user) applications in a cellular communication system, a scheme was described which provides automated attempts to maintain network connectivity for users. In the case of a link failure, this allows a user to continue in a temporary off-line mode while awaiting an active network connection in the background. The multi-dimensional birth-death process framework was used to compute theoretical traffic performance characteristics for the scheme. The model considers mixed platform mobilities, hand-off issues and priority, as well as reconnection attempts. Traffic performance depends on traffic demand and mix, the amount of priority given for hand-off calls and the limit on the number of allowable reconnection attempts. For example parameters, the probability of forced termination of a session during its lifetime can be reduced by two orders of magnitude using only a maximum of three retry attempts. Increasing the number of suspended sessions that can be supported at a base can significantly reduce the forced termination probability. About one order of magnitude decrease is achievable as H increases from 3 to 4. Also, increasing the number of channels reserved for hand-off attempts (C_h) can reduce the forced termination probability. About one order of magnitude improvement is achieved as C_h increases from 0 to 2. However, C_h should be chosen carefully, since increasing C_h results in more new calls being blocked. By allowing more reconnection attempts for suspended sessions, the average suspension time increases slightly. Approximately 1 sec. for a call on fast mobile and less than 0.5 sec. for a call on slow mobile increases is shown as N increases from 1 to 3 with very high traffic situation.

Another exemplary application of the above-described admission control protocol for systems with multiple traffic classes and mixed platform types will now be described. As indicated above, the present invention may be employed for cellular communication systems that support both voice and data sessions. During a session a mobile user has access to network resources, although this access may be shared with others. Upon the failure of a link to a mobile data user, the scheme attempts to maintain connectivity to the network through transparent reconnection attempts. The approach allows periods of independent autonomous operation by mobile data terminals. Preemptive priority is used to guarantee transparency for voice sessions. An analytically tractable model that allows consideration of mixed platform types, (such as pedestrians, vehicles, etc.), having different mobility characteristics and mixed traffic classes, (such as voice, data, etc.) is described below. This embodiment is particularly useful in the context of wide area mobile computing applications.

Because of the time insensitive nature of many data traffic types, some delay during communication is not critical. However, a lost connection which results in the termination of a session is significant, since it waste valuable wireless resources. Therefore, the question of "how to maintain connectivity of a mobile user to the network" is an important issue. As described above, a system that supports widely disparate call traffic types as well as platforms with different mobility characteristics is preferable and a session-oriented approach is used. A session is typified as either a voice session or a data session. Preemptive priority is used to guarantee transparency for voice sessions. For data sessions, the scheme attempts to maintain a connection to the network. Data calls that are preempted or disconnected during the hand-off process, are allowed a fixed number of reconnection attempts. Only after a given number of such attempts to reconnect have failed, is the data session deemed to have failed. The strategy attempts to maintain connectivity for mobile data users in a way that is transparent to them. This allows for example, mobile computing users to continue functioning autonomously (though not indefinitely) in an off-line mode.

When the physical link between a mobile terminal that has an active data session and the network fails, the data session is suspended. The mobile terminal will attempt to reconnect by successive reconnection requests made at random time intervals. These are called reconnection attempts. A maximum number, N, of reconnection attempts is allowed for each suspended session. If a reconnection has not been secured after this maximum is reached, the session is considered to have failed and is cleared from the system.

To support suspended sessions and reconnection attempts for data sessions, the system should have allocated necessary control channels for signaling. Since the control channels also need wireless resources, we assume there is a maximum number, H, of suspended sessions that the system will allow in each cell. If a platform with a suspended session on board leaves its current cell, a reconnection attempt is made to establish a link in the new cell. This hand-off attempt counts towards the limit, N. If, in the target cell, there are no available channels to accommodate the arriving data session, and if there are already H suspended sessions in the target cell, the arriving data session cannot be admitted in the target cell. So, even if a suspended session has not exhausted the allowable number of reconnection attempts, it will be forced into termination if (owing to the existence of H suspended sessions in the target cell), it fails its hand-off attempt.

Since voice sessions must be transmitted or received on a real time basis, reconnection attempts are not allowed. Instead, voice sessions have preemptive priority over data sessions for using channel resources. When a voice session arrives and finds all channels occupied, an active data session (if any are present) will be either suspended or terminated to accommodate it. The choice of which data session to be suspended or be terminated is assumed to be random. If there are no active data sessions that can be preempted to service the incoming voice session the voice arrival will not be accommodated. That is, it will be blocked if it is a new call, or terminated if it is a hand-off.

There are various reasons that cause an active data session to be suspended. For example, one reason is failure of a hand-off attempt. Specifically, if a data session attempts a hand-off when the channels in the target cell are fully occupied but, in the target cell, there are fewer than H data sessions suspended, the hand-off attempt will be fail but the session will wait for another connection opportunity as a suspended session. Another reason for suspension arises when an active data session is preempted by an arriving voice session. When a voice session arrives in a cell in which all channels are occupied and fewer than H sessions are in suspension, and, at least, one active session is of data type, an arriving voice session will obtain a connection but an active data session will be suspended.

Model Description

In the following we let g be an index that defines the platform type and mobility. Consider a suspended session that has already failed k-1 reconnection attempts. The next attempt is called the "k-reconnection attempt" where $1 \leq k \leq N$. It is important to emphasize that there are two driving processes that generate reconnection attempts. One is the retry process, which consists of successive statistically independent realizations of a random variable, $T_r(k, g)$, to generate epochs for retry attempt times for a suspended session. The other is the hand-off departure process—because hand-off attempts always try to establish a link and therefore count as reconnection attempts. The random variable, $T_r(k, g)$, gives the time from the previous reconnection event (either hand-off or retry) to the next anticipated retry attempt. The random variable, $T_r(k, g)$, can in general depend on k. Thus, the minimum rate of reconnection attempts depends on the number of attempts that have already been made. Of course, if the supporting platform leaves its current cell before the anticipated retry epoch, a hand-off attempt (to establish a link) will be made at that time and the value of k will be adjusted. If the session is in a suspended state after this attempt, a new random variable (for a retry epoch) will be generated. The random variable, $T_r(k, g)$, generated after the k-1 reconnection attempt, represents the maximum time to the next anticipated retry attempt. This is called the "k-trial time". The next reconnection attempt will be made either at this time or at the time that the supporting platform leaves the cell, whichever is the shortest. A suspended session that has not reestablished a link after k-1 reconnection trials and is waiting for the next (k^{th}) reconnection attempt, is called a "k-suspended session".

In the following description, we consider a large cellular system with many mobile platforms of several types. Each mobile can potentially generate a voice session or a data session. However, each platform can support at most one connection at any give time and each connection needs one channel (resource) to communicate. The platform types differ primarily in there mobility characteristics. The maximum number of simultaneous connections that each base station can support is C.

When a platform with either an active or suspended session moves to another cell, a hand-off is needed. We assume hand-off detection and initiation are perfect. For a voice session, a hand-off attempt will succeed to gain a connection in the target cell if there are fewer than C voice sessions in that cell. A voice session that fails to gain a connection will lose its wireless link and cleared from system. For a data session, a hand-off attempt will gain access to a connection in the target cell if there are less than C sessions, either of voice type or data type, in progress in that cell. When a hand-off of a data session fails, a session will be suspended if the reconnection counter in the terminal indicates less than N and no more than H suspended sessions are in the same cell.

Platform mobility is characterized using the concept of dwell time—a random variable which is defined as the duration of time that a two-way communication link of satisfactory quality can be maintained between a platform and its current base, for whatever reason. The amount of time that a session must use a channel for satisfying communication is modeled using the concept of unencumbered session duration. The unencumbered session duration is a random variable, which is the amount of time that the call would spend in service if there were no suspensions or forced termination. Similarly, the k-trial time is a random variable. A k-suspended session will execute a retry attempt after the epoch of the k-trial time unless it moves to another cell. If a k-suspended session moves to another cell before the epoch of the k-trial time, a hand-off attempt will be made.

Example Problem Statement

The system supports G types of mobile platforms, indexed by {g=1, 2, 3 . . . G} having different mobility characteristics. Potentially, a non-communicating platform generate two types of sessions, voice and data, however, no more than one session can be supported by a platform at any given time. The voice session origination rate from a non-communicating g-type platform is denoted $A_v(g)$. We define $\alpha(g)=A_v(g)/A_v(1)$. Similarly the data session generation rate from a non-communicating g-type platform is denoted $A_d(g)$ and we define $\beta(g)=A_d(g)/A_d(g)$. The number of non-communicating g-type platforms in any cell is denoted by $v(g,0)$. Therefore, the total voice session generation rate for g-type platforms in any cell can be denoted $A_{vv}(g)=A_v(g)\times v(g,0)$ and the total data session generation rate for g-type platforms in a cell can be denoted $A_{vd}(g)=A_d(g)\times v(g,0)$. An infinite population model is assumed.

A model that considers resource use based on connection type is employed. Here, it is assumed that each active connection, either for a data session or a voice session, requires the same amount of resources. Each cell or gateway can support a maximum of C connections. There are no quotas for either specific mobility platform types or specific session types. We consider cut-off priority for hand-off arrivals (either voice or data sessions) and for reconnection attempts of suspended data sessions. Thus, C_h connections in each cell are reserved for hand-off attempts (for either voice sessions or data sessions) and for reconnection attempts of suspended data sessions in the cell. A connection will be established for a new voice session only if there are less than $C-C_h$ active voice sessions in the cell. For an arriving data session, a connection will be made if there are fewer than C sessions, either of voice type or data type, in the cell. A hand-off attempt of a voice session will fail if there are C voice sessions in the cell.

A voice session that fails in a hand-off attempt will be terminated and cleared from the system. A hand-off attempt of a data type session will fail if there are C active sessions, either of voice type or data type, in the cell. A data session that fails in a hand-off attempt will be suspended if there are fewer than H suspended sessions the cell, and the session has not exceeded the maximum allowable number (N) of reconnection attempts. A platform is considered to "leave" the cell at the expiration of its current (random) dwell time. A communicating platform that leaves a cell generates a hand-off arrival to some other cell. The dwell time in a cell for a g-type platform is a ned random variable, $T_c(g)$, having a mean $\bar{T}_c(g)=1/\mu_c(g)$. More general dwell time distributions can be treated, at the cost of increased dimensionality of the state space. The unencumbered voice session duration on a g-type platform is a ned random variable, $T_v(g)$, having a mean $\bar{T}_v(g)=1/\mu_v(g)$. The unencumbered data session duration on a g-type platform is a ned random variable, $T_d(g)$, having a mean $\bar{T}_d(g)=1/\mu_d(g)$. The k-trial time of a suspended session on g-type platform is ned random variable, $T_r(g)$, having a mean $\bar{T}_r(k,g)=1/\mu_r(k,g)$, where $1\leq k\leq N$, and $\mu_r(k,g)$ (k=1, 2, . . . , N;g=1, . . . , G) is the parameter that determines the reconnection attempt rate for a k-suspended session on a g-type platform.

State Description

Considering a single cell, we define the cell state by a sequence of non-negative integers. When a maximum of N reconnection attempts are permitted for a suspended data session, the state of the cell can be written as G n-tuples as follows

$$\begin{array}{ccccccc} v_1 & w_1 & r_{1,1} & r_{1,2} & r_{1,3} & \cdots & r_{1,N} \\ v_2 & w_2 & r_{2,1} & r_{2,2} & r_{2,3} & \cdots & r_{2,N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ v_G & w_G & r_{G,1} & r_{G,2} & r_{G,3} & \cdots & r_{G,N} \end{array} \quad (71)$$

where v_g {g=1,2 . . . G} is the number of active voice sessions on g-type platforms, w_g {g=1,2, . . . , G} is the number of active data sessions on g-type platforms, and $r_{g,k}$ {g=1,2, . . . , G; k=1,2, . . . , N} is the number of k-suspended sessions on g-type platforms. For convenience, we order the states using an index s=0,1 . . . s_{max}.

Thereafter, V_g, w_g, and $r_{g,k}$ can be written explicitly dependent on the state. That is

$$v_g=v(s,g), w_g=w(s,g),$$

and

$$r_{g,k}=r(s,g,k).$$

When the cell is in state s, the following characteristics can be determined. The number of voice sessions is

$$v(s)=\sum_{g=1}^{G} v(s,g) \quad (72)$$

The number of active data sessions is

$$w(s)=\sum_{g=1}^{G} w(s,g) \quad (73)$$

The number of suspended sessions, regardless of platform type, is

$$r(s)=\sum_{g=1}^{G}\sum_{k=1}^{K}\rho(s,g,k). \tag{74}$$

And, the total number of sessions in progress in a cell is

$$f(s)=c(s)+r(s). \tag{75}$$

There are constraints on permissible cell states. These includes the total number of active sessions in a cell must be fewer than or equal to maximum supportable connections, $f(s)\leq C$; and the total number of suspended sessions in a cell must be fewer than or equal to the maximum number of suspended sessions allowed in a cell, $r(s)\leq R$.

There are nine driving processes. These are: (1) generation of voice sessions (2) generation of data sessions (3) completion of voice sessions (4) completion of data sessions (5) hand-off arrival of voice sessions (6) hand-off arrivals of data session (either active or suspended) (7) hand-off departure of voice sessions (8) hand-off departure of data sessions (either active or suspended) (9) retry attempts. To allow solution within the multidimensional birth-death process framework, Markovian assumptions are used as in known in the art.

Flow Balance Equations and Hand-Off Arrival Parameters

The total transition flow into state s from any permissible predecessor state x is denoted as q(x,s). Then, the total flow out of state s is denoted q(s, s) and is given by

$$q(s,s)=-\sum_{\substack{x=1\\ x\neq s}}^{S_{max}+1} q(s,x). \tag{76}$$

The statistical equilibrium solution for the state probabilities can be found using the flow balance equations. This is a set of $S_{max}+1$ simultaneous equations for the unknown state probabilities,

$$\sum_{j=0}^{S_{max}+1} q(i,j)\pi(j)=0,\quad i=0,1,\ldots,S_{max}+1 \tag{77}$$

$$\sum_{j=0}^{S_{max}+1}\pi(j)=1. \tag{78}$$

in which, for, $i\neq j$, q (i, j) is the net transition flow into state i from state j, and q(i, i) is the total transition flow out of state i.

Hand-off parameters can be determined from the dynamics of the process itself. An iterative method can be used. The average hand-off departure rate of voice sessions on g-type platforms, $\Delta_{vv}(g)$, can be expressed as

$$\Delta_{vv}(g)=\sum_{s=0}^{S_{max}}\mu_v(g)\cdot v(s,g)\cdot p(s). \tag{79}$$

Thereafter, the overall average hand-off departure rate of voice sessions, Δ_{vv}, can be written as

$$\Delta_{vv}=\sum_{g=1}^{G}\Delta_{vv}(g). \tag{80}$$

The average hand-off departure rate of active data sessions on g-type platforms, $\Delta_{dv}(g)$, can be expressed as

$$\Delta_{dv}(g)=\sum_{s=0}^{S_{max}}\mu_d(g)\cdot v(s,g)\cdot p(s) \tag{81}$$

Thereafter, the overall hand-off departure rate of active data sessions, $\Delta_{dv,a}$, can be written as

$$\Delta_{dv}=\sum_{g=1}^{G}\Delta_{dv}(g). \tag{82}$$

The average hand-off departure rates of k-suspended sessions on g-type platforms, $\Delta_r(g, k)$, can be expressed as

$$\Delta_r(g,k)=\sum_{s=0}^{S_{max}}\mu_{rd}(g)\cdot v(s,g,k)\cdot p(s). \tag{83}$$

Also, the overall average hand-off departure rates of k-suspended sessions, $\Delta_r(k)$, can be written as

$$\Delta_r(k)=\sum_{g=1}^{G}\Delta_r(g,k). \tag{84}$$

From these equations, we find that the fraction of hand-off departures of voice sessions that are on g-type platforms, F_{vg}, is

$$F_{vg}=\Delta_{vv}(g)/\Delta_{vv} \tag{85}$$

the fraction of hand-off departures of active data sessions that are on g-type platform, F_{dvg}, is

$$F_{dvg}=\Delta_{dv}(g)/\Delta_{dv} \tag{86}$$

and, the fraction of hand-off departures of k-suspended sessions on g-type platforms, $F_{rg}(k)$, is

$$F_{rg}(k)=\Delta_r(g,k)/\Delta_r(k). \tag{87}$$

For a homogeneous system in statistical equilibrium the hand-off arrival and departure rates per cell must be equal. We must have

$$F_{vg}=F_{vdg}, F_{vg}=F_{rdg}, F_{rg}(k)=F_{rg}(l), \Delta_{vv}=\Delta_{dv}, \Delta_{dv}=\Delta_{rv}$$

and

$$\Delta_r(k)=\Delta_r(l).$$

where $1\leq k\leq N$.

PERFORMANCE MEASURES

Carried Traffic and Average Number of k-Suspended Sessions

An important performance measure from a system point of view is the carried traffic. Since the traffic of data sessions is transparent to user of voice session, the carried traffic of voice sessions is same regardless of the amount of data

sessions in the system. The carried traffic of voice sessions for g-type platforms, $A_{v,v}(g)$, is

$$A_{v,v}(g) = \sum_{s=0}^{s=\infty} n(s, g) \cdot p(s). \quad (88)$$

Clearly, the traffic of data sessions strongly depends on the traffic of voice sessions in the system. The carried traffic of data sessions for g-type platform, $A_{v,d}(g)$, is

$$A_{v,d}(g) = \sum_{s=0}^{s=\infty} n(s, g) \cdot p(s). \quad (89)$$

The average number of k-suspended sessions for g-type platforms, $A_{v,s}(g, k)$, is

$$A_{v,s}(g, k) = \sum_{s=0}^{s=\infty} r(s, g, k) \cdot p(s). \quad (90)$$

Blocking Probability

The blocking probability for voice sessions is the average fraction of newly generated voice sessions that are denied access to a channel. Since there are no quotas for specific type of mobility platform, the blocking probability is the same for all types of platforms. Blocking of newly generated voice sessions occurs when the cell is in one of the states in $L_{bv,v}$ for which the number of active voice sessions is $C-C_v$ or more, i.e., $L_{bv,v}=\{s:v(s)\geq C-C_v\}$. And, the blocking probability of voice session, $P_{bv,v}$ is expressed as

$$P_{bv,v} = \sum_{s \in L_{bv,v}} p(s). \quad (91)$$

The blocking probability for data sessions is the average fraction of newly generated data sessions that are denied access to a channel. A newly generated data session will be blocked if it finds all channels are occupied (by either by voice or data sessions). Blocking of newly generated data sessions occurs when the cell is in one of the states in the set, $L_{bd,v}$ where $L_{bd,v}=\{s:b(s)=C\}$. So, the blocking probability, $P_{bd,v}$ for a data session is given by

$$P_{bd,v} = \sum_{s \in L_{bd,v}} p(s). \quad (92)$$

Hand-Off Failure Probability

The hand-off failure probability of voice sessions, $P_{fv,v}$ is the average fraction of voice-session hand-off attempts that are denied admission in the target cell because all channels are already occupied by voice sessions in the cell. A voice-session hand-off failure occurs when the cell is in a state belonging to $L_{fv,v}$ where $L_{fv,v}=\{s:v(s)=C\}$. So, the hand-off failure probability of voice sessions is given by

$$P_{fv,v} = \sum_{s \in L_{fv,v}} p(s). \quad (93)$$

The hand-off failure probability of a data session, $P_{fd,v}$, is the average fraction of hand-off attempts for data sessions that are denied admission in the target cell because all channels are occupied and H suspended sessions are in the cell. A data session, either active or suspended, that is denied admission in the target cell due to the lack of resources will be forced into termination and cleared from the system. A data-session hand-off attempt will fail if it occurs when the system is in one of the states belonging to the set $L_{fd,v}=\{s:v(s)=C, r(s)=H\}$. So, the hand-off failure probability of data sessions is given by

$$P_{fd,v} = \sum_{s \in L_{fd,v}} p(s). \quad (94)$$

Forced Termination Probability

A voice session that fails in a hand-off will be forced into termination. The forced termination probability of voice sessions on g-type platform, $P_{ft,v}(g)$, is defined as the probability that a g-type voice session that is not blocked is interrupted due to hand-off failure during its lifetime. It can be shown that the forced termination probability of a voice type session is given by

$$P_{ft,v}(g) = \frac{\mu_h(g) \times P_{fv}}{\mu_c(g) + \mu_h(g) \times P_{fv}}. \quad (95)$$

The forced termination probability of a data session on a g-type platform, $P_{ft,d}(g)$, is defined as the probability that a data session that is not blocked is forced into termination during its lifetime.

DISCUSSION OF RESULTS

Numerical results were generated using the approach described above. For FIGS. **13–17**, a mean unencumbered voice-session duration of 108s was assumed and a mean unencumbered data-session duration of 20s was assumed. Two platform types, low mobility and high mobility, were considered. A mean dwell time of 500s was assumed for a low mobility platform and 100s was assumed for a high mobility platform. A homogeneous system was assumed. The mean k-trial time of a g-type k-suspended session was chosen to be 10s for $1 \leq k \leq N$. The abscissas for FIGS. **13–17** reflect call demands with the assumptions stated above. In these, the abscissa is the new voice session origination rate for platform type 1 (denoted $\lambda_{v,v}(1)$). The ratio of new voice session generation rates from other platform types to that of type 1 platforms were held fixed with parameters $\alpha(g)$. Also, the new data session generation rate for platform type g is determined with respect to new voice session origination rate using parameters, $\beta(g)$. For all calculations, $\alpha(g)=\beta(g)=1$ is assumed.

FIGS. **13–14** illustrate voice traffic performances. Since the traffic of data sessions is transparent to users of voice session, the traffic performance of voice sessions with data traffic is identical to that without data traffic. FIG. **13** illustrates the blocking probability of voice session. As the number of reserved channels, C_v, is increased, obviously more newly generated voice session can not be accommodated.

FIG. **14** illustrates the forced termination probability of voice session. As the number C_v increase, fewer voice sessions are forced into termination with the cost of blocking of more newly generated voice sessions. Clearly, voice sessions on fast mobile platforms have higher forced termination probability than that on slow mobile platform. This is because voice sessions on fast mobile platforms are most likely to experience more hand-offs during lifetime of a session.

FIG. 15 shows the forced termination probability of data sessions for various values of C_h used for cut-off priority. When we increase C_h, clearly, forced termination probability of data sessions decreased. It is also seen that data sessions on slow mobile have smaller forced termination probability. This is because a data session on slow mobile can finish its session with relatively fewer hand-offs during its lifetime. FIG. 16 illustrates the dependence of forced termination probability of data sessions on the number of maximum allowable reconnection attempts, N. As we can see, increasing N results in fewer data sessions being forced to terminate during their lifetime. FIG. 17 illustrates the dependence of forced termination probability of data sessions on the number of maximum supportable suspended sessions, H. With increasing H, clearly, the less the forced termination probability of data session is expected.

In summary, with rapidly growing interest in the area of multimedia and mobile computing, the issue of how to accommodate diverse traffic types in wireless network may be solved using the admission control protocols described herein in which each type of media is managed with different strategy according to the characteristics. For time-insensitive data sessions, the system allows users to continue in a temporary off-line mode while awaiting an active network connection in the background. For time-sensitive voice session, the system gives preemptive priority over data traffic so that the transparency of data traffic is guaranteed to voice users.

Although illustrative embodiments have been described herein with reference to the accompanying drawings, it is to be understood that the present system and method is not limited to those precise embodiments, and that various other changes and modifications may be affected therein by one skilled in the art without departing from the scope or spirit of the invention. It is to be understood that all such changes and modifications are intended to be included within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A method for controlling admission to a communications network, comprising the steps of:

activating a session between a wireless terminal and the communications network;

suspending the session if a communication link between the wireless terminal and communications network fails;

automatically attempting to maintain connectivity between the wireless terminal and the communications network through transparent reconnection attempts; and

reactivating the suspended session if reconnection is effected, wherein the step of automatically attempting to maintain connectivity comprises requesting a hand-off of the suspended session to an alternative gateway,

wherein the method further comprises the step of allocating a predetermined maximum number of suspended session H that may be maintained by a gateway in the communications network, and wherein the step of suspending the session comprises the steps of:

attempting a hand-off of the active session to the gateway; and

if the hand-off fails, suspending the session if there are less than H suspended sessions in the gateway.

2. The method of claim 1, wherein the step of activating a session comprises the steps of:

receiving a session request of a session seeking admission to the communications network, wherein the session request comprises at least one attribute corresponding to a service level of the session;

determining if the session can be accommodated at the requested service level; and

admitting the session, if the session can be accommodated.

3. The method of claim 2, wherein the at least one attribute comprises session type, mobile platform mobility, priority class and a combination thereof.

4. The method of claim 2, wherein the step of determining if the session can be accommodated comprises the steps of:

determining a priority level of the session request and the amount of available resources in the communications network; and

preempting system resources and suspending an active session having a priority that is lower than the priority of the session request, if necessary, to accommodate the session request.

5. The method of claim 1, wherein the step of activating a session comprises reactivating a suspended session.

6. The method of claim 1, further comprising the step of terminating the session if there are H suspended sessions in the gateway.

7. The method of claim 1, further comprising the step of allocating a predetermined maximum number of allowable reconnection attempts N of a suspended session.

8. The method of claim 7, wherein the step of automatically attempting to maintain connectivity comprises the steps of:

performing a reconnection attempt to reactivate the suspended session;

counting the number of reconnection attempts; and

terminating the session, if the number of reconnection attempts exceeds N.

9. The method of claim 8, wherein the step of counting is performed by a counter in the wireless terminal.

10. The method of claim 9, wherein the counter is initialized when the suspended session is reactivated.

11. The method of claim 8, further comprising the step of computing a random time for a next reconnection attempt, after each failed reconnection attempt.

12. The method of claim 8, wherein the step of performing a reconnection attempt to reactivate the suspended session, comprises the step of attempting a hand-off of the suspended session to a target gateway, wherein the hand-off attempt to the target gateway is counted as a reconnection attempt.

13. A program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform method steps for controlling admission to a communications network, the method comprising the steps of:

activating a session between a wireless terminal and the communications network;

suspending the session if a communication link between the wireless terminal and communications network fails;

automatically attempting to maintain connectivity between the wireless terminal and the communications network through transparent reconnection attempts; and

reactivating the suspended session if reconnection is effected, wherein the step of automatically attempting to maintain connectivity comprises requesting a hand-off of the suspended session to an alternative gateway,

wherein the program storage device further comprises instructions for performing the step of allocating a

predetermined maximum number of suspended session H that may be maintained by a gateway in the communications network, and wherein the instructions for performing the step of suspending the session comprise instructions for performing the steps of:

attempting a hand-off of the active session to the gateway; and

if the hand-off fails, suspending the session if there are less than H suspended sessions in the gateway.

14. The program storage device of claim 13, wherein the instructions for performing the step of activating a session comprise instructions for performing the steps of:

receiving a session request of a session seeking admission to the communications network, wherein the session request comprises at least one attribute corresponding to a service level of the session;

determining if the session can be accommodated at the requested service level; and

admitting the session, if the session can be accommodated.

15. The program storage device of claim 14, wherein the at least one attribute comprises session type, mobile platform mobility, priority class and a combination thereof.

16. The program storage device of claim 13, wherein the instructions for performing the step of determining if the session can be accommodated comprise instructions for performing the steps of:

determining a priority level of the session request and the amount of available resources in the communications network; and

preempting system resources and suspending an active session having a priority that is lower than the priority of the session request, if necessary, to accommodate the session request.

17. The program storage device of claim 13, wherein the instructions for performing the step of activating a session comprise instructions for reactivating a suspended session.

18. The program storage device of claim 13, further comprising instructions for performing the step of terminating the session if there are H suspended sessions in the gateway.

19. The program storage device of claim 13, further comprising instructions for performing the step of allocating a predetermined maximum number of allowable reconnection attempts N of a suspended session.

20. The program storage device of claim 19, wherein the instructions for performing the step of automatically attempting to maintain connectivity comprise instructions for performing the steps of:

performing a reconnection attempt to reactivate the suspended session;

counting the number of reconnection attempts; and

terminating the session, if the number of reconnection attempts exceeds N.

21. The program storage device of claim 20 further comprising instructions for performing the step of computing a random time for a next reconnection attempt, after each failed reconnection attempt.

22. The program storage device of claim 20, wherein the instructions for performing the step of performing a reconnection attempt to reactivate the suspended session comprise instructions for performing the step of attempting a hand-off of the suspended session to a target gateway, wherein the hand-off attempt to the target gateway is counted as a reconnection attempt.

23. A communications system, comprising;

a wireless terminal; and

a gateway comprising a system for controlling admission to the communications network, wherein the system comprises a lower communication layer adapted to maintain a connection of an active session between the wireless terminal and communications network through automatic and transparent reconnection attempts when a communication link between the wireless terminal and communications system fails, wherein the system for controlling admission comprises:

means for activating a session between the wireless terminal and the communications network;

means for suspending the session if a communication link between the wireless terminal and communications network fails;

means for automatically attempting to maintain connectivity between the wireless terminal and the communications network through transparent reconnection attempts, wherein the means for automatically attempting to maintain connectivity comprises means for requesting a hand-off of the suspended session to an alternative gateway; and

means for reactivating the suspended session if reconnection is effected,

wherein the system further comprises means for allocating a predetermined maximum number of suspended session H that may be maintained by a gateway in the communications network, and wherein the means for suspending the session comprises means for attempting a hand-off of the active session to the gateway; and if the hand-off fails, suspending the session if there are less than H suspended sessions in the gateway.

24. The communications system of claim 23, wherein the communications systems comprises one of a packet-switched network and a circuit-switched network.

25. The system of claim 23, wherein the wireless terminal comprises a mobile terminal or a fixed terminal.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

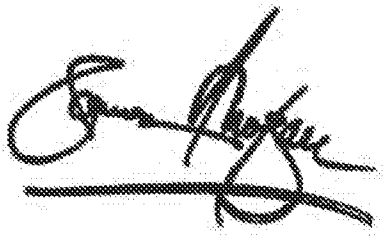
PATENT NO. : 6,477,373 B1
DATED : November 5, 2002
INVENTOR(S) : Rappaport et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 1,
Lines 13 and 14, "Grant No. N00014-15530" should read
-- Grant No. N00014-9511217 --

Signed and Sealed this

Third Day of June, 2003



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(54) A method and architecture for an interactive two-way data communication network

(57) A two-way data communication device such as a data ready cellular telephone, a two-way pager, or a telephone communicates via a two-way data communication network with a server computer on a computer network that has an interface to the two-way data communication network, i.e, is coupled to the two-way data communication network. For example, the computer network can be a corporate wide area network, a corporate local area network, the Internet, or any combination of computer networks. The two-way data communication device utilizes a client module to transmit message including a resource selector chosen by the user to a server on a server computer on the computer network. The server processes the message and transmits a response over the two-way data communication network to the client module. The client module interprets the response and presents the response to the user via a structured user interface. Alternatively, the user transmits a request that directs the server to transmit the response to the request to another location or to another user.

EP 0 779 759 A2

Description

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BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to data communications, and in particular to two-way data communication devices including a cellular telephone, a two-way pager, and a telephone that permit a user to interface with and interact with a server on a computer network.

Description of Related Art

For at least the last five years, the wireless communication industry has tried to merge computing with wireless communications. This industry wide effort has held the promise of bringing software intelligence to telecommunication devices including mobile wireless communications devices such as cellular telephones and two-way pagers as well as standard telephones.

After years of research and development, and hundreds of millions of dollars' investment by some of the largest companies in the field such as Motorola, AT&T, Sony, Matsushita, Phillips and IBM, the results have been nothing but disappointing. Typically, the intelligent communication devices resulting from these efforts include both the hardware necessary for a computer module and the hardware for a wireless communications module. Examples of such products are Simon from IBM and Bell South, MagicLink from Sony, and Envoy from Motorola.

Fundamental design and cost problems arising directly from the approach taken by the designers of these intelligent communication devices have limited widespread market acceptance of these devices. The combination of a wireless communication module with a computing module leads to a device that is too bulky, too expensive, and too inflexible to address the market requirements.

The combination of the two modules is too large and too heavy to fit in a user's pocket. Pocket size is a key requirement of the mobile communication market which remains unmet by these devices

In addition, the cost of these devices is close to the sum of the cost of the computer module and of the communications module, which is around a one thousand dollar end-user price. Market research indicates that the market for intelligent wireless communications devices is at prices around $300. Even with a 20% compound cost decline, it would take five years for the combination units to meet today's customers' price requirements. It is therefore unlikely that devices designed by combining a computer and a wireless module, no matter how miniaturized and cost reduced, can satisfy the cost requirement of the market during this decade.

To succeed in the market place, intelligent wireless communication devices must be able to support a wide variety of applications specific to each market segment. Typically, these applications must be added to the device by the end-user after purchase. Thus, the device must provide a method for loading the initial application and for subsequent updating of the application.

The price sensitivity for intelligent communication devices and the size limitations means that an intelligent communication device cannot support the amount of core memory (RAM), a hard disk or non-erasable memory, or a traditional floppy disk drive, commonly found on computers. These limitations close the traditional routes for delivering new applications or updates to intelligent communications devices.

As a result, the current crop of intelligent communication devices run only the few applications which were burned into their ROMs at the factory or which are contained in a ROM card plugged into a slot designed for this purpose. This scheme lacks the flexibility needed to run the thousands of applications required to address the fragmented requirements of the market and provides no simple method for updating the applications after the device has been sold.

Two other communication oriented attempts at bringing intelligence to telephones are Short Messaging Service (SMS) and Analog Display Service Interface (ADSI). SMS specifies how messages are delivered to and from a cellular telephone and how the cellular telephone should store the messages. SMS also defines some simple processing which the cellular telephone can perform on the message, such as calling a telephone number embedded in the message.

SMS's architecture is similar to that of paging networks with the difference that devices implementing the SMS architecture operate over the control channel of the cellular telephone network. SMS is deployed primarily in Europe over the GSM network.

SMS messages are not delivered in real time. The time delays can range from 30 seconds up to 10 minutes, which makes SMS unsuitable for real time applications. The main purpose of SMS is the delivery of messages. SMS does not

specify an application protocol or cellular telephone application module which further restricts its usefulness in running applications on cellular telephones. After a few years of deployment in Europe, SMS implementations have been limited to notification services such as two-way paging and voice mail notification.

SMS as a medium is unsuited to building applications which allows the retrieval, manipulation, and storage of information. This is the reason why the industry giants have not turned to SMS in their quest to add intelligence to cellular telephones, but have consistently attempted to combine a computer module with a wireless communications module.

ADSI was designed as an extension to Interactive Voice Response Systems. ADSI allows a smart telephone with a small screen to display prompts to assist users in choosing among various options. By using visual prompts instead of cumbersome voice prompts, ADSI is thought to make the use of interactive voice services easier and faster.

ADSI allows data to be sent from the service provider to the telephone in the form of screens. ADSI also allows the telephone to respond through touch tone signaling with a special coding to describe the full alphanumeric character set. With ADSI, a telephone is primarily a passive device. Services send text screens to the telephone, and the telephone sends back short strings indicating the choices the user made from the text screen.

ADSI makes no provisions for performance of processing in the telephone. As a result, ADSI generates a high traffic load on the telephone network since each user input is sent back to the service for processing. This makes ADSI unsuitable for wireless networks where bandwidth is at a premium and "air efficiency" is one of the most sought after qualities. The lack of processing capability in the telephone and the high bandwidth requirements of ADSI have prevented it from being considered by the industry for implementing intelligent wireless devices.

Up to now, intelligent communication devices have combined a computing module with a wireless communications module. However, to gain widespread acceptance, a two-way data communication device with processing capability and the ability to run a wide variety of differing user applications is needed. In addition, such a device should be comparable in size, cost, and weight to a cellular telephone.

SUMMARY OF THE INVENTION

According to the principles of this invention, the prior art limitations of combining a computer module with a wireless communication module have been overcome. In particular, a two-way data communication device of this invention, such as a cellular telephone, two-way pager, or telephone includes a client module that communicates with a server computer over a two-way data communication network. The principles of this invention can be used with a wide variety of two-way data communication networks. For example, two-way data communication networks for cellular telephones that may be used include a cellular digital packet data network as well as TDMA, CDMA, and GSM circuit switched data networks; and the AMPS analog cellular network with a modem. Similarly, for two-way pagers, two-way data communication networks include PACT, the new AT&T endorsed two way paging standard, or other priority two-way paging networks with data transport capability. The two-way data communication network for a telephone is the public switched telephone network.

Using the two-way communication device that includes the client module, a user can provide information to the server computer, retrieve information from the server computer, provide data to an application on the server computer which uses the data and provides information to the two-way communication device, or sends the information to another location. The functionality provided to the user of the two-way communication device is limited only by the applications available on a server computer that is accessible to the user over the two-way data communication network.

This invention allows for the first time two-way communications devices such as cellular telephones, two-way pagers, and telephones to become open application platforms which in turn empowers software developers to deliver value-added applications and services to any two-way communication device that incorporates the principles of this invention. This is a radical shift from the current situation where telephones and two-way pagers are closed, proprietary systems. Consequently, an even playing field is created for the market to invent new uses for two-way communication devices and for two-way communication networks. Any entity from corporations to individuals can make new applications available to the installed base of two-way data communication devices that include this invention without physical modification or addition to the two-way communication device. Years after purchase, a two-way communication device incorporating this invention will run all the applications which were developed since its purchase.

Further, all these applications are available without the end user having to add anything or make any modification to the two-way communication device. Also, the applications are independent of the two-way data communication network. The applications do not depend on any feature of the two-way data communication network. Thus, the applications are unaffected by a change in the two-way data communication network.

Also, the applications on the server computer are independent of the two-way data communication device with which the server computer is interacting. An application on the server computer can communicate with any two-way data communication device that includes the client module of this invention and a network interface module to transmit data over, and receive data from the two-way data communication network. These two features mean that an investment in developing an application is insulated from either advances in two-way data communication devices, or advances in two-way data communication network technology.

As indicated above, the two-way data communication device of this invention utilizes a client module to transmit a message including a resource locator selected by the user over the two-way data communication network to a server on a server computer on the computer network. For example, the computer network can be a corporate wide area network, a corporate local area network, the Internet, or any combination of computer networks.

The server processes the message, i.e, executes the application addressed by the resource locator and transmits a response over the two-way data communication network to the two-way data communication device, which stores the response in a memory. The client module interprets the response and generates a user interface using information in the response. In one embodiment, the user interface includes at least one user data input option that is associated with a resource locator. In another embodiment, the user interface is a display.

The resource locator associated with the at least one user data input option can address any one of a wide variety of objects. In one embodiment, the resource locator associated with the at least one user data input option addresses an object on the server computer that transmitted the response. In another embodiment, the resource locator addresses an object on another server computer coupled to the two-way data communication network. In yet another embodiment the resource locator addresses an object stored in the two-way communication device.

When the user selects the at least one user data input option, the client module interprets the selection and if required, appends any input data to the resource allocator associated with the at least one user data input option. The client module transmits a message including the resource locator with any appended input data to the server computer. Alternatively, the resource locator with any appended data can be addressed to another server computer, or can address an object stored in the two-way communication device. If the resource locator addresses an object on a server computer, the client module provides the message to the network interface module which in turn transmits the message over the two-way data communication network.

Thus, in this embodiment, the message originally transmitted to the two-way data communication device included all the information necessary for the client module to generate the user interface, to associate the user selection and any data entered with a particular resource locator, and to transmit the appropriate resource locator in a subsequent message. The client module includes an interpreter that processed the information in the message. Since the message included all the information needed by the client module, the server computer that transmitted the message retained no state information concerning the message. Consequently, the server computer is defined as a stateless server computer.

An important aspect of this invention is that the message includes all information necessary for the client module to generate the user interface and a particular user interface can be independent from other user interfaces. Unlike prior art systems that gave the user a predetermined menu from which to select items, or limited the user to an E-mail like format, according to the principles of this invention, the user interfaces and possible interactions available to the user are determined only by the applications that developers make available. The possible interactions and user interfaces for one application can be totally different and independent from the possible interactions and user interfaces of another application. Thus, a cellular telephone, two-way pager, and a telephone all truly become an open platform.

These features of the invention are a significant departure from prior art systems. Typically, in the prior art, use of a particular application on a particular platform required that the application be compatible with the operating system on that platform. Further, each time a new version of the application was released, the user was required to take steps to update the application on the user's platform. Further, if the user of the platform did not modify the operating system as new versions of the operating system were released, at some point in time, the platform would no longer be capable of processing a new version of an application that required a current version of the operating system.

This invention eliminates these problems. As explained above, the client module in the two-way data communication device functions an interpreter. The application on the server computer provides all information necessary for the interpreter to generate a user interface on the two-way data communication device, and in response to user selections or data input using the user interface, to route messages to an appropriate server, i.e, either the server that sent the original information or another server.

Thus, the client module only interprets this information and interacts appropriately with the hardware of the two-way data communication device. Consequently, to update an application requires only changes on the server computer and not changes in each two-way data communication device that communicates with that server computer. This invention eliminates the usual requirement for distribution of application software, and application software updates to the end user of the two-way data communication device.

In one embodiment, a two-way data communication system for communication between a server computer and a two-way data communication device selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, includes a two-way data communication network, a server computer coupled to the two-way data communication network, and a two-way data communication device coupled to the two-way data communication network. The server computer includes a two-way data communication interface module coupled to the two-way data communication network, and a server coupled to the two-way data communication interface module. The server receives a message including a resource locator from the two-way data communication network. The resource locator includes an address of the server computer and of an application on that server computer. The server processes the message using the

resource locator. In this embodiment, the server transmits a response to the message over the two-way data communication network.

The two-way data communication device, selected from the group consisting of a cellular telephone, a two-way pager, and a telephone, includes a network interface module coupled to the two-way data communication network, and a client module coupled to the network interface module. The client module transmitted the message including the resource locator to the server over the two-way data communication network. The client module also processes the response to the message from the server. The response includes information for a user interaction over the two-way data communication network.

The client module of this invention is lightweight, and thus requires only lightweight resources in a two-way data communication device. Consequently, the client module can use existing resources in such a device and therefore does not add to the cost of the two-way data communication device.

In one embodiment, the interpreter within the client module includes a plurality of managers including a user interface manager coupled to a display of the two-way data communication device where the user interface manager handles interactions with the display. The user interface manager also is coupled to a keypad of the two-way data communication device and handle interactions with the keypad. Herein, a keypad can be a telephone keypad, the keys found on a two-way pager, or other data input interface of a two-way communication device.

In one embodiment, the response generated by the server computer includes a plurality of resource locators and at least one of the plurality of resource locators includes an address to another server coupled to the communication network.

According to the principles of this invention, a method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer includes:

```
        generating a message by a client module in
    response to data entered by the user of a two-way
    data communication device coupled to a two-way
    data communication network,
            wherein the client module executes on a
        microcontroller of the two-way data
        communication device; and
            the message includes a resource locator;
                transmitting the message over the
            two-way data communication network to a
            server computer wherein the server
            computer is identified by the resource
            locator;
        executing an application on the server
    computer identified by the resource locator to
    generate a response to the message; and
        transmitting the response to a location
    identified by the application.
```

As indicated above the location can be the two-way communication device, another server computer, or some other device coupled to the server computer.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates one embodiment of the airnet network of this invention that includes the two-way data communication devices of this invention.

Figures 2A to 2H are illustrations of a series of screen displays of the two-way data communication device of this invention that illustrate one application of the principles of this invention.

Figures 3A to 3F are illustrations of a series of screen displays of the two-way data communication device of this invention that illustrate a second application of the principles of this invention.

Figures 4A to 4I are illustrations of a series of screen displays of the two-way data communication device of this invention that illustrate yet another application of the principles of this invention.

Figure 5 illustrates another embodiment of the airnet network of this invention that includes the two-way data communication devices of this invention and an airnet network translator.

Figure 6 is a block diagram of a mobile wireless communication device that includes the client and support modules of this invention.

Figure 7 is a more detailed diagram of the mobile wireless communication device and a server computer within the airnet network architecture of this invention.

Figures 8A to 8D are a process flow diagram showing the process performed by the client in the mobile wireless communication device and the server on the server computer of Figure 7.

Figure 9 is a diagram of a mobile wireless communication device of this invention that includes a novel predictive text entry system that is a part of this invention.

Figures 10A to 10T are one embodiment of a letter frequency table.

Figure 11 is a process flow diagram for one embodiment of a data entry process that includes the novel predictive data entry process of this invention.

Figure 12 is a more detailed diagram of the mobile wireless communication device and the airnet network translator within the airnet network architecture of the another embodiment of this is invention.

Figure 13 is a process flow diagram showing the various processes performed by the airnet network translator of Figure 12.

Figure 14 is a diagram illustrating the various module managers included in one embodiment of the client module of this invention.

Herein, objects with the same reference numeral are the same object. Also, the first number of a reference numeral indicates the Figure where the object first appeared.

DETAILED DESCRIPTION

According to the principles of this invention, a novel airnet network 150, i.e., a two-way data communication network, interconnects any one, any combination, or all of two-way data communication devices 100, 101, or 102, that each include this invention, with a wide variety of computer networks 120, 130, and 140, for example. As explained more completely below, each two-way data communication device 100, 101, and 102 can be configured to transmit data to and receive data from any desired combination of computers on computer networks 120, 130, and 140. Airnet network 150 is the two-way data communication path from the two-way data communication device to the particular computer that is accessed by the user of that two-way data communication device.

Each wireless communication device 100 that includes this invention can communicate over airnet network 150 with any server computer 121, 131, and 141 on airnet network 150 that includes at least one application that communicates and interacts with the processes of this invention that are included within device 100. Thus, device 100 can access information on the computer network and provide information to the computer network. Similarly, a two-way pager 101, and a telephone 102 with a modem 103, that each include this invention, can communicate over airnet network 150 with any of server computers 121, 131, and 141 that includes at least one application that communicates and interacts with the processes of this invention that are included within devices 101 and 102.

As explained more completely below, an application on a server computer can be accessed by any two-way data communication device that can communicate with that server computer. The application is independent of the particular type of two-way data communication device that is used to access the application and independent of the particular two-way data communication network used. This means that a user can access an application from anywhere so long as the user has a two-way data communication device that can communicate with the server computer.

In one embodiment, a process on wireless communication device 100 is configured as a client process and the applications on server computers 121, 131 and 141 on airnet network 150, that communicate with the client process, are server processes. This architecture allows some of the processing burden to be moved away from cellular telephone 100, across airnet network 150, to a server module on any computer on airnet network 150.

Specifically, a wireless communication device 100 e.g., a cellular telephone, with a telephone like keypad, communicates via a data capable cellular telephone network 110, e.g., a cellular digital packet data telephone network, with an application on a server computer on a computer network that has an interface to data capable cellular telephone network 110. For example, the computer network can be a corporate wide area network 120, a corporate local area network 130, or perhaps the internet 140.

Similarly, a two-way pager 101 communicates via a two-way pager network 111 with an application on a server

computer on a computer network that has an interface to two-way pager network 111. Again, for example, the computer network can be a corporate wide area network 120, a corporate local area network 130, or perhaps the Internet 140. Finally, a telephone 102 communicates via a modem 103 and public switched telephone network 112 with an application on a server computer on a computer network that has an interface to public switched telephone network 112. As with the other two-way data communication devices, the computer network can be, for example, a corporate wide area network 120, a corporate local area network 130, or perhaps the Internet 140.

In each of two-way data communication devices 100, 101, and 102, the client process is stored as a client module in the device and the execution of the client module on a microcontroller in the device is sometimes referred to as the client process. The client process performs important processing functions locally. This allows the communication between the client process, hereinafter sometimes referred to as simply client, and the server process, hereinafter sometimes referred to as server, to be minimized and the server computing requirements to grow slowly as the number of clients, i.e., users, grows.

The client module is small, e.g., under 64 KByte, and requires only low processing power congruent with the memory chips and built-in microcontrollers in two-way data communication devices such as cellular telephone 100, two-way pager 101, and telephone 102. Thus, unlike the prior art attempts at an intelligent telephone, the cost, size, and battery life of either cellular telephones, two-way pagers, or telephones that incorporate this invention are not adversely affected.

While client/server architectures have been used extensively in computer networks, a client/server architecture implemented using two-way communication data devices such as cellular telephone 100, two-way pager 101, or telephone 102 yields new and unexpected results. This invention allows for the first time a wide variety of two-way data communication devices including but not limited to cellular telephones, two-way pagers, and telephones to become open application platforms which in turn empowers software developers to deliver value added applications and services to any two-way data communication device which incorporates the principles of this invention.

This is a radical shift from the current situation where cellular telephones, two-way pagers, and telephones are closed, proprietary systems. Consequently, an even playing field is created for the market to invent new uses for cellular telephones and data capable cellular networks, for two-way pagers and two-way pager networks, and for telephones on the public switched network.

Any entity from corporations to individuals can make new applications available to the installed base of data ready cellular telephones, two-way pagers, and telephones, that include this invention without physical modification or addition to the devices. Years after purchase, a two-way data communication device with this invention can run all the applications which were developed since its purchase. Further, all these applications are available without the user having to add anything or make any modification to the two-way data communication device. These features of the invention are a significant departure from prior art systems. Typically, in the prior art, use of a particular application on a particular platform required that the application be compatible with the operating system on that platform. Further, each time a new version of the application was released, the user was required to take steps to update the application on the user's platform. Further, if the user of the platform did not modify the operating system as new versions of the operating system were released, at some point in time, the platform would no longer be capable of processing a new version of an application that required a current version of the operating system.

Also, small devices, such as cellular telephones or pagers, usually do not have card slots, floppy or hard disk drives, or other means commonly found on computers to add or update applications. This limitation has led prior art attempts at intelligent communication devices to design closed systems with fixed functionality. Such devices can neither adapt nor be adapted to the fast changing requirements of the market place and so have not met with market success.

This invention eliminates these problems. The client process in the two-way data communication device functions an interpreter. The application on the server computer provides all information necessary for the interpreter to generate a user interface on the two-way data communication device, and in response to user selections or data input using the user interface, to route messages to an appropriate server, i.e, either the server that sent the original information or another server.

Thus, the client process only interprets this information and interacts appropriately with the hardware of the two-way data communication device. Consequently, to update an application requires only changes on the server computer and not changes in each two-way data communication device that communicates with that server computer. This invention eliminates the usual requirement for distribution of application software, and application software updates to the end user of the two-way data communication device.

For example, if initially, two-way pager 101 receives a response to a message from an application on server computer 121 on corporate wide area network 120, the interpreter in two-way pager 101 generates a user interface on display screen 106 using information in the message. As described more completely below, options presented in the user interface can allow the user to access information, or provide information to any one, any combination of, or all of networks 120, 130, and 140.

Specifically, in the response to the message from two-way pager 101, the application initially accessed on server computer 121 included resource locators for applications on each of networks 120, 130, 140, typically common gateway

interface programs, accessible to the user of pager 101 as well as information required to generate the user interface. Consequently, when the user makes a particular selection or enters data, the interpreter accesses the appropriate resource locator and appends any necessary data to the resource locator. The client transmits a message including the resource locator to the appropriate server.

As shown by this example, the applications on networks 120, 130, 140 send to the two-way data communication device all information necessary to generate a user interface, and to process all user input. Consequently, only an application must be changed to update the information provided to the two-way data communication device.

In addition, since all the information needed by the client to generate a user interface and all information necessary for the client process to respond to any input data is included in the message, the computer server does not retain any state information concerning the information transmitted to the client process. Consequently, the computer server is stateless.

Each two-way data communication device 100, 101, and 102 that utilizes airnet network 150, includes a data communication capability, a display screen, preferably a multi-line display screen, and storage capability for the processes of this invention in an on-board memory, and for the message being processed. Nearly every data capable cellular telephone, e.g., a telephone that utilizes a cellular digital packet data network, includes excess on-board memory capacity and a multi-line display screen. These hardware resources are often available, but unused in a data capable cellular telephone because of the indivisibility of memory chip packages. The inclusion of the processes of this invention in such cellular telephones therefore has very little effect on the cost, size, and power consumption of the cellular telephone. Similarly, the inclusion of the processes of this invention in two-way pagers and telephones, that include a microcontroller and memory, has very little affect on the cost, size, and power consumption of these devices.

Thus, unlike prior art approaches that attempted to combine a computer module and a wireless communication module in a single package, this embodiment of the invention preferably utilizes the memory and processing power that currently exists in the cellular telephone 100, two-way pager 101, telephone 102 or other wireless or landline two-way data communication devices. This approach limits the cost of the resulting device and overcomes many of the problems of the prior art devices, e.g., the size and weight of the two-way data communication device is not changed, and, as explained above, updating user applications is removed from cellular telephone 100, two-way pager 101, and telephone 102.

In particular, unlike devices produced by previous industry attempts at combining computing modules and a wireless cellular module, two-way data communication devices which incorporate this invention are size and cost competitive with voice-only telephones and can, for the first time, satisfy the market cost and size requirements for an intelligent cellular telephone, for example.

The incremental cost of supporting interactive applications on cellular telephone 100, two-way pager 101, and telephone 102 is reduced to at most a slightly larger screen that is required to display the application to the user. This is a fraction of the cost of adding a complete computer module to a cellular telephone, for example.

The incremental power consumption required to support this invention is also very small, as the incremental memory and screen required are small consumers of power compared to the cellular radio itself. Intelligent two-way data communication devices built according to the principles of this invention are not expected to have a significantly lower battery life than standard cellular telephones, or two-way pagers, for example.

The configuration and processes of the client process in two-way data communication devices 100, 101, and 102 are similar when the differences in the devices and the two-way data communication network over which the devices communicate are considered. Consequently, in the following description, the operation of data-ready cellular telephone 100 is considered. The same or similar operations can be performed on two-way data communication devices 101, and 102. The main difference is that some device dependent features within the client module must be changed to accommodate the particular hardware used in the two-way communication device. However, the client module architecture described more completely below limits the number of changes that must be made.

As indicated above, in response to user actions, wireless communication device 100 transmits a message, typically a data request, to a server computer 121 on computer network 120 and receives a response to the message. Alternatively, the user action can result in directions to server computer 121 on computer network 120 to transmit the response to the message to another location or to another user. Also, wireless communication device 100 can receive a message from any one of the computers coupled to airnet network 150.

An important aspect of this invention is that the client module interpreter in wireless communication device 100 generates a user interface by which the user can both initiate and receive messages from a variety of applications. The interactions take place in real-time and are not limited by the client module interpreter. The uses of wireless communication device 100 are limited only by the availability of applications on server computers.

The applications available are determined by application developers. Prior to considering one implementation of the invention in further detail, several illustrative examples of applications that can be implemented according to the principles of this invention are described. These applications are illustrative only and are not intended to limit the invention to the particular applications and features described.

In one use, the user configures cellular telephone 100 to access server computer 121 on XYZ corporate wide area

network 120. In response to the access by the user, server computer 121 transmits a card deck to cellular telephone 100 over data capable cellular telephone network 110. As explained more completely below, a card deck includes one or more cards, and each card is interpreted by the client module to generate a user interface screen.

In the embodiment illustrated in Figure 2A, the initial card deck transmitted to cellular telephone 100 includes an introductory display card and a choice card. Figure 2A is an example of introductory screen display 200 that is generated on display screen 105 by the client process in cellular telephone 100 by interpreting the display card. As used herein, a display screen is the physical display apparatus in a two-way communication device. A screen display is the image presented on the display screen.

In this embodiment, display screen 105 is a pixel display that displays graphics. In another embodiment, display screen 105 displays only text and so the graphics would not appear on display screen 105. Screen display 200, and other screen displays described more completely below, include a horizontal arrow, i.e., a multi-card deck indicator, to communicate to the user that the current deck includes another card. The inclusion of screen indicators, such as the multi-card deck indicator, to communicate with the user is optional. The functionality of this invention is independent of such screen indicators.

When the user presses a predetermined key, or key sequence, the client process in cellular telephone 100 interprets the next card in the card deck, i.e., the choice card, and in turn generates a menu 201 (Fig. 2B) of items that can be accessed by the user. In this embodiment, each of the menu items is available on server computer 121 to the user who, in this example, is a representative of XYZ corporation visiting ABC Designs.

As explained more completely below, each of the menu items is associated with a resource locator that includes an address of the particular object associated with that menu item, typically an address to a common gateway interface program on server computer 121. In general, a resource locator includes an address and may include appended data. The address can be to a local object within the two-way data communication device or to a remote object on a server computer. As is known to those skilled in the art, the common gateway interface is an Internet standard that is used to dynamically generate information, e.g., cards. In view of this disclosure, other techniques to generate dynamic cards could be used.

Initially, the highlighting of the first line of menu 201 is not present. When a key on the keypad of cellular telephone 100 is pressed, the menu item corresponding to that key is highlighted on screen 105. Thus, menu 201 shows the first item highlighted to indicate that the one key was pressed by the user. However, highlighting a selected item is a feature that is specific to this example, and in general is not required to implement the invention. Other methods can be used to indicate the user's choice on display screen 105 such as an arrow pointing at the choice, if such an indication is desired.

After the one key is pressed, the user presses a predetermined key, e.g., an enter key, to verify the selection. Alternatively, in another embodiment, the verification of the selection is not required. In both embodiments, the resource locator for the selection is transmitted to server computer 121 by the client process in cellular telephone 100 over data capable cellular telephone network 110. In response to the selection, server computer 121 processes the message containing the selection, and in this embodiment, transmits another card deck to cellular telephone 100.

The client process in cellular telephone 100 interprets the first card in the deck received from server computer 121, which is a choice card, and generates a screen display 202, that includes a second menu as illustrated in Fig. 2C, on display screen 105. Initially, none of the items in the second menu are highlighted.

Notice that screen display 202 includes a header, that describes the selection made by the user on screen display 201, in addition to the second menu of choices available to the user. A multi-display screen card indicator 203, e.g., in this embodiment, a hand icon with a finger pointing down, shows that the screen associated with the current choice card includes additional items that are not shown on display screen 105. Herein, a screen can be larger than the number of lines available on display screen 105 and so the user must scroll the screen display to view the complete screen.

Thus, to view the additional items, the user presses a first screen scroll key, e.g., a next key, on cellular telephone 100. In this embodiment, when the first screen scroll key is pressed, each line of the display is rolled up one line. The resulting display has an icon with a finger pointing up (not shown) if the menu requires only two screen displays. If the menu requires more than two screen displays, the second screen display of the menu would have two icons, one with a finger pointing up, and another with a finger pointing down. To scroll between the various lines in the second menu, the user uses the first screen scroll key, and a second screen scroll key.

If the user displays the last line of a card, e.g., the last line in the second menu, and presses the first screen scroll key nothing happens. In this embodiment, the user must make a choice before the next card is available.

Screen display 202 also includes representations of two soft keys, a home key 204, and an info key 205. In this example, these soft keys are defined only for the card used to generate screen display 202. When the user presses a predetermined key sequence, the home key is highlighted to indicate the selection. In this embodiment, when the home key is selected, the user is returned to screen display 200. In another embodiment, the user could be returned, for example, to a home screen display that is displayed each time the user activates cellular telephone 100 for use on airnet network 150.

The home key is associated with a pointer, that in one embodiment is a resource locator, and the card addressed

by the pointer is displayed by the client process when the home key is selected by the user. Specifically, if the pointer is to a card in the current deck, the client process simply displays that card. If the pointer is to other than a card in the current deck, the client process in cellular telephone 100 retrieves the deck containing the card at the location identified by the pointer. The location could be, for example, either a memory in cellular telephone 100, or a memory in computer 121.

Similarly, when the user presses another predetermined key sequence, the info key is highlighted to indicate the selection. In this embodiment, when the info key is selected, a help screen is displayed for the user that describes the possible selections. The particular contents of the help screen are determined by the provider of the service. Specifically, a pointer is associated with the info key and when the info key is depressed by the user, the information stored at the location identified by the pointer is retrieved and interpreted by the client process in cellular telephone 100.

Returning to the menu in Figure 2C, since the user wants to determine the status of an order, the user pushes the two key on the keypad of cellular telephone 100. In response to the key press, the second choice in the menu is highlighted as shown in Figure 2C. In response to verification of the key press, e.g., the user presses a predetermined key sequence, cellular telephone 100 transmits a check open order request to computer 121, i.e. the client process transmits a message that includes a resource locator associated with the menu item selected by pressing the two key.

In response to the check open order request, computer 121 transmits yet another card deck to cellular telephone 100. The client process in cellular telephone 100 interprets this deck, that is an entry card, and in turn generates a purchase order number entry screen display 206 (Fig. 2D) on display screen 105. Notice that screen display 206 has a previous soft key 207 and a fax soft key 208. Again, each of these soft keys has an associated pointer and the information stored at the location identified by the pointer is retrieved and interpreted by the client process when the user selects the soft key.

In this example, the user does not select a soft key, but rather the user enters the purchase order number as shown in Figure 2E using the keypad of cellular telephone 100. The user enters only the various numbers. The client process formats the number and inserts the dashes as shown in Figure 2E.

After the purchase order is entered, the user presses a predetermined key sequence to indicate to the client process that entry of the purchase order number is complete. Notice that the user is entering data and not simply selecting a menu item. The user is utilizing cellular telephone 100 as if cellular telephone 100 was a computer connected to network 120, but, as explained more completely below, cellular telephone 100 is similar to a standard digital data capable cellular telephone that communicates over data capable cellular telephone network 110. Specifically, cellular telephone 100 is not a combination of a computer module and a wireless communication module as in prior art attempts to create an intelligent telephone.

In addition, the user enters data using only the standard cellular telephone keypad. Thus, cellular telephone 100 eliminates the need for a computer keyboard or for a sophisticated touch screen that recognizes motion of a pointing object. This is important to maintaining the size, weight, and power requirements of cellular telephone 100 similar to those of a voice-only cellular telephone. In one embodiment, to facilitate data entry, as explained more completely below, cellular telephone 100 includes a text prediction process that reduces the number of key strokes required to enter text data. In this embodiment, the text prediction process is turned on or off for each entry card.

In response to entry of the purchase order number, the client process transmits a request to server computer 121 for the particular purchase order. Specifically, the client process appends the entered data to a resource locator and transmits a message containing the resource locator to server computer 121. Server computer 121, in response to the message, retrieves the appropriate purchase order and transmits the purchase order as a card deck to the client process in cellular telephone 100 over airnet network 150.

The client process interprets the card deck and generates a screen display 209 (Fig. 2F). Initially, fax key 208 is not highlighted in screen display 209.

Notice that screen display 209 includes multi-display screen card indicator 203 to show the user that the purchase order screen contains more information that can be displayed at one time on display screen 105.

After the user reviews the purchase order, the user presses the key sequence for fax key 208 and in response, fax key 208 is highlighted as illustrated in Figure 2F.

In response to selection of fax key 208, the client process retrieves the card deck at the location identified by the pointer associated with fax key 208. If the location is on server computer 121, the client process transmits a message including a resource locator to server computer 121 and in response to the message, server computer 121 transmits back yet another card deck. If the location is on a server computer other than server computer 121, the client process transmits a message including a resource locator to that server computer and in response to the message, that server computer transmits back yet another card deck. If the location identified by the pointer is within cellular telephone 100, the client process simply retrieves the deck. In either case, fax form 210 (Fig. 2G), that is an entry card, is displayed on display screen 105 by cellular telephone 100. This example demonstrates the information accessed by the client process can be located in any number of locations. The resource locator associated with the fax key identifies the appropriate location.

When fax form 210 is displayed, the user enters the facsimile machine telephone number at ABC Designs, as

shown in Figure 2H, using the cellular telephone keypad. In this embodiment, the telephone number is automatically formatted by the client process. After the telephone number is entered, the client process appends the telephone number to a resource locator and transmits the information to server computer 121.

When server computer 121 receives the information, server computer 121 executes a common gateway interface application (CGI) pointed to by the resource locator. The CGI application grabs the necessary information and transmits the information via e-mail to a fax gateway. The fax gateway, upon receipt of the e-mail, converts the information to a fax and sends the information to the specified telephone number. Thus, cellular telephone 100 requires neither a printer connection nor a print driver, but yet can print using the facsimile machine at ABC Designs.

As illustrated in this example, cellular telephone 100 transmitted a request for a particular purchase order, and scheduled transmission of data responsive to the request to a local machine capable of printing the data. Thus, the processes of this invention, as described more completely below, in cellular telephone 100 in combination with data capable cellular telephone network 110 and server computer 121 permit cellular telephone 100 to effectively utilize an application on server computer 121 on network 120 even though cellular telephone 100 utilizes only a microcontroller found in telephone 100 and does not required a separate computer module as in the prior art.

In addition, the client process using the information transmitted from server computer 121, i.e. the cards, generates a wide-variety of user interfaces as illustrated in Figures 2A to 2H. The particular configuration of the various user interfaces is defined by the cards transmitted in a card deck. Consequently, the user interface is not fixed to one particular format such as an E-mail type format, but rather the format is variable and can be redefined by each card that is interpreted by the client process. Also, in general, the user interface for one application on a server computer is independent from the user interface for another application on that server computer.

Specifically, the application accessed on server computer 121 generates the card deck and so in turn defines each of the various user interfaces. Each user interface permits the user to identify a particular selection. Each particular selection could result in generation of a different user interface with different selections. Thus, the user interfaces are limited only by the applications accessible to the two-way data communication device.

As shown below, a wide variety of applications can be provided on a server computer. Despite the robustness of the client module in interpreting a wide variety of application, typically, the client process is lightweight and thus requires only lightweight resources, e.g., 60 Kbytes of read-only memory (ROM) for the client module, 10 Kbytes of random access memory (RAM), and less than one million instructions per second (MIPS) of processing power. Since the client process needs only these lightweight resources in a two-way data communication device, the client can use existing resources in such a device and therefore does not add to the cost of the two-way data communication device such as data capable cellular telephone 100.

In another embodiment, the user can configure cellular telephone 100 to access server computer 131 on corporate local area network 130. In response to the access by the user, computer 131 transmits a home card (not shown) to cellular telephone 100 which in turn generates a home screen display on display screen 105.

When the user selects personal information on the home screen display or on a subsequent screen display associated with the home card, a message including a resource locator for a personal information deck is transmitted from cellular telephone 100 to computer 131. In response to the message, computer 131 transmits a card deck that includes a display card and a choice card to cellular telephone 100. In these examples, the card deck is described as including one of three cards, a display card, a choice card, and an entry card. However, these examples are illustrative only, and are not intended to limit the invention to those particular embodiments of cards. In view of this disclosure, those skilled in the art will be able to form combinations of these types of cards and define other types of cards, if such cards are appropriate for the particular application.

The client process in cellular telephone 100 interprets the display card that includes image and text data and generates screen display 300 on display screen 105 (Fig. 3A). Screen display 300 includes a home key 301, and an info key 302. When the user selects home key 301, the user is returned to the home screen. Info key 302 functions in a manner similar to that described above for info key 205.

When the user presses a predetermined key, the client process interprets the choice card and a second screen display 304 (Fig. 3B) is driven on display screen 105. Screen display 304 is a menu of the personal information that is stored on server computer 131 for use by the user of cellular telephone 100. Multi-display screen card indicator 203, e.g., the hand with a finger pointing down, illustrates to the user that the list has additional items that appear on the next screen display. Screen display 304 also indicates the number of E-mail messages, faxes, and voice messages waiting for the user.

The user scrolls the screen display line by line until screen display 305 is on display screen 105. Initially, the fourth item in the menu is not highlighted. In this example, the user presses the four key on the keypad of cellular telephone 100 to view the user's schedule. In response to the key press, the client module in cellular telephone 100 transmits a message, including a resource locator associated with the menu item selected by pressing the four key, to server computer 131 using data capable cellular telephone network 110 and corporate local area network 130.

In response to the message, server computer 131 executes the application identified in the resource locator. Upon completion of the execution, server computer 131 transmits, over corporate local area network 130 and data capable

cellular telephone network 110 to cellular telephone 100, a card deck that includes a choice card that describes the user's schedule for that day.

In this embodiment, when server computer 131 completes the transmission, server computer 131 has completed the response to the message and has transmitted all necessary information to cellular telephone 100. Therefore, server computer 131 does not retain any state information concerning the transmitted information and so is referred to as a stateless server computer 131. In this embodiment, the client process can only request a card deck. However, as demonstrated herein, card decks and the two-way interactive data communication system of this invention provide the user with a new level of capability.

When cellular telephone 100 receives the card deck, the client process in cellular telephone 100 interprets the choice card and drives screen display 306 (Fig. 3D) on display screen 105. Initially, the first item in the menu of screen display 306 is not highlighted. When the user depresses the one key on the keypad of cellular telephone 100, cellular telephone 100 highlights the first item in the menu. Cellular telephone 100 generates screen display 308 (Fig. 3E) upon the user subsequently depressing a predetermined key. Screen display 306 includes a schedule key 309, that when selected returns the user to screen display 306 (Fig. 3D). Screen display 308 also includes a more detailed description of the 10:00 a.m. meeting.

While screen display 308 is active, if the user depresses a predetermined key, the user is presented with the options in screen display 310 (Fig. 3F). Initially, item two in screen display 310 is not highlighted.

In this example, the user depresses key two on the keypad of cellular telephone 100 and so cellular telephone 100 sends a message including a resource locator to server computer 131 to send an E-mail message to Bill Smith confirming the meeting at 10:00 a.m. When server computer 131 executes the application addressed by the resource locator, an E-mail message is sent.

In another example, the user of cellular telephone 100 connects to internet service provider computer 141 on internet 140 using data capable cellular telephone network 110. Upon connection of cellular telephone 100, service provider 141 transmits to cellular telephone 100 a card deck to generate Figures 4A to 4C.

The client process in cellular telephone 100 interprets the first card in the card deck from computer 141 and generates screen display 400 (Fig. 4A). When the user presses a predetermined key, cellular telephone 100 displays screen display 401 (Fig. 4B). Screen display 401 provides the user with a series of choices that group services alphabetically.

When the user depresses the seven key on the keypad of cellular telephone 100, cellular telephone 100 displays a list of the services that have letters P, R, or S as the first letter in the service name. In this embodiment, screen displays 401 and 402 are a single card, e.g., a single screen. Each of the various services associated with a key has an index and when a particular choice is made by the user, the choice defines an index. The client process then displays all of the services with the index that corresponds to the index defined by the user's choice.

In screen display 402, the user is given a series of choices of services that are available to the user under tab seven. Initially, item three in screen display 402 is not highlighted. In this example, the user depresses the three key on the keypad of cellular telephone 100 to select the stock quotes and item three in screen display 402 is highlighted.

In response to this selection, cellular telephone 100 transmits a request for a stock quote, i.e, a message including a resource locator, over cellular telephone network 100 and internet 140 to service provider 141. In response to the request, service provider computer 141 executes the application addressed by the resource locator. The application retrieves a card deck that, in turn is transmitted to cellular telephone 100. The card deck includes a display card and an entry card.

Upon receiving the card deck, the client process in cellular telephone 100 interprets the display card and generates screen display 403 (Fig. 4D). When the user depresses a predetermined key, entry screen display 406 (Fig. 4E) is generated on display screen 105 of cellular telephone 100.

Initially, the box with letters SUNW in screen display 406 is empty. The letters SUNW are entered in the box by the user to indicate the ticker symbol of the stock for which the user wants information. After the user has entered the stock ticker symbol, the user presses the predetermined key to indicate that the entry is complete.

In response to the entry by the user, the client module appends the stock ticker symbol to the resource locator and transmits the resource locator to service provider computer 141 which, in turn, executes an application addressed by the resource locator to retrieve the latest stock market information for the stock ticker symbol. Service provider 141 uses the retrieved information to generate a card deck that contains the information and then transmits the card deck to cellular telephone 100.

The client process in cellular telephone 100 interprets the first card in the deck and generates screen display 409 (Fig. 4F). For convenience, the Figures 4F to 4I are grouped together and separated by a dotted line. However, at any given time, in this embodiment, display screen 105 can display any four adjacent lines and so the grouping of lines in Figures 4F to 4I is for convenience only to demonstrate the level of information that can be retrieved and displayed by the client process. The use of a four line display screen is illustrative only. The client process of this invention can work with any size display screen, even a one line display screen. However, a multi-line display screen is preferred.

In the Figures discussed above, the display screen is a pixel display and so can display images. In another embod-

iment, the display screen only displays text and is smaller in size. For such an embodiment, the various entries are abbreviated and only text is displayed, but the general operation is identical to that just described. Also, the various computer networks can be interlinked so that a user with access to one computer network can obtain information on another computer network. Moreover, the embodiments described above are merely illustrative. One important aspect of this invention is that cellular telephone 100 can interact with any type of server application that is configured to communicate with and interact with the client process in cellular telephone 100. Thus, the user is no longer limited to only a few services offered by a telephone network provider.

In Figure 1, the cellular telephone user must address, i.e., connect to, each computer of interest to access the different services. Consequently, each computer requires the information necessary to communicate with cellular telephone 100. In another embodiment, not illustrated, cellular telephone 100 contacts a single central computer over data capable cellular telephone network 110. This computer is connected to each of the other networks illustrated in Figure 1. Consequently, the user of cellular telephone 100 sends a message including a resource locator to the central computer, the central computer processes the message and retrieves the information addressed by the resource locator from the appropriate network shown in Figure 1. After the requested information is retrieved, the central computer generates a card deck and transmits the card deck to cellular telephone 100. In this embodiment, only one computer must be configured to communicate with cellular telephone 100. However, that same computer must be configured to communicate with all other computer networks that are of interest to the user of cellular telephone 100.

Hence, according to the principles of this invention, the client process on a two-way data communication device can initiate an interaction with a particular server computer. The server computer transmits (i) information to the client process to generate a user interface, and (ii) a resource locator for each possible selection by the user from the user interface. The resource locators can address applications on the server computer, applications on over server computers, or an application on the server computer that in turn accesses other server computers. Consequently, the user of a two-way data communication device is limited only by the applications provided on the server computers.

Further, the user can be provided new and/or updated capabilities by modifying the applications on the server computers. There is no requirement that the client process be changed for a new or updated application. The client process must only interpret the information received from an application and transmit a message for additional information. These operations are unaffected by a new or updated application. Consequently, as noted above, this invention does not require distribution of application updates or new applications to the end user of the two-way data communication device.

Figure 5 is an illustration of another embodiment of airnet network 150. In this embodiment, the messages from a two-way data communication device, e.g., devices 100, 101, and 102 are directed to an airnet network translator 500. Airnet network translator 500 and a particular two-way data communication device, e.g., any one of devices 100, 101, and 102 communicate using the protocol for point-to-point communication on the particular network linking airnet network translator 500 and that two-way data communication device. For example, if data capable cellular telephone network 110 is a cellular digital packet data network, either the transmission control protocol (TCP) or the user datagram protocol (UDP) can be used.

Airnet network translator 500 transfers data between the two-way data communication device and the selected computer network after translator 500 validates the communication path, as explained more completely below, and encrypts the message transferred to the computer network if necessary. In addition, airnet network translator 500 collects transaction and billing information concerning the communication between the two-way data communication device and the designated computer network. Specifically, airnet network translator 500 provides access control for paying services and a logging mechanism for billing. Airnet network translator 500 can also provide a directory service to users.

Figure 6 is a block diagram of a typical GSM digital cellular telephone. Each of the hardware components in cellular telephone 600 is known to those skilled in the art and so the hardware components are not described in detail herein. The compiled and linked processes of this invention are stored in ROM 601 as a client module 602 and support modules 603. Upon activation of a predetermined key sequence utilizing the keypad, physical layer processor 610, that is sometimes referred to herein as a microcontroller, initiates a client process using client module 602 in ROM 601.

In this embodiment, client module 602 includes a plurality of manager modules, as explained more completely below. The particular manager modules utilized is determined by the characteristics of the particular cellular telephone 100 in which client module 602 is implemented. Client module 602 must include manager modules to interface with modules that control the particular hardware in cellular telephone 100, a manager module to interface with the particular cellular telephone network protocol used by cellular telephone 100, and a manager module to interpret the card decks received. Therefore, the particular manager modules described herein are only illustrative of the principles of this invention and are not intended to limit the invention to the specific modules described more completely below.

In this embodiment, the client process controls the operations of a plurality of cellular telephone dependent support processes that are stored in ROM 601 such as a display module, a keypad module, and a network and terminal control module, that were referred to above collectively as support modules 603. The combination of the client process, display process, keypad process, and network and terminal control process are considered foreground tasks by the microker-

nel in cellular telephone 600. Also, herein module and process are used interchangeably, but those skilled in the art will appreciate that the module is the computer software as stored in a memory, preferably, a ROM, of cellular telephone 600 and the corresponding process is the execution of the module by the microcontroller in cellular telephone 600. Again, note that this invention does not require a separate processor and instead can utilize the processing power that already exists in cellular telephone 600, because as described above, the client process of this invention is so light-weight.

The user interface for cellular telephone 600 determines the version of the user interface manager module that is stored in ROM 601. In one embodiment, the parameters used to define the user interface level are the display resolution, the pixel access of the display, and the support of soft keys. One definition of the user interface levels is given in Table 1.

TABLE 1

USER INTERFACE LEVEL DEFINITIONS	
Level 1	Text only; 1 or more lines; 12 to 15 characters per line; and no soft keys.
Level 2	Text only; 4 or more lines; 20 to 25 characters per line; and soft keys.
Level 3	Pixel access; 150 by 75 pixels or larger; and soft keys.

The user interface manager module presents data to the display module which in turn drives display screen 605; and captures data entered by the user on display screen 605. In response to this information, the client process prepares a message for transmission by a network manager module.

To more completely explain the operations performed over airnet network 150, Figure 7 is a block diagram that illustrates the various components in one embodiment of this invention of cellular telephone 700. Those skilled in the art will appreciate that cellular telephone 700 includes circuitry and software similar to that illustrated in cellular telephone 600 for voice and data operations supported by cellular telephone 700 in addition to the modules for operation on airnet network 750. Similarly, server computer 743 includes other software and hardware that is known to those skilled in the art and so is not illustrated in Figure 7 for clarity.

In this embodiment, client module 702 in digital cellular telephone 700, that is executing on the microcontroller of telephone 700, communicates with server computer 743 over cellular digital packet data (CDPD) network 710. Cellular digital packet data network 710 is used to illustrate one embodiment of this invention on one two-way data communication network. The principles of this invention can be used with a wide variety of two-way data communication networks. For example other two-way data communication networks for cellular telephones that may be used include TDMA, CDMA, and GSM circuit switched data networks; and the AMPS analog cellular network with a modem. Similarly, for two-way pagers, two-way data communication networks include PACT, or other priority two-way paging networks with data transport capability.

Prior to considering the operation of this configuration of airnet network 750 in more detail, another aspect of this invention is required. Specifically, a technique is required for conveying instructions from digital cellular telephone 700 to a server application on server computer 743, and conversely.

A telephone interaction description language (PIDL) is defined for use by service developers. A terminal interaction language (TIL) is a distillation of the telephone interaction description language and describes the same interaction to digital cellular telephone 700 as the telephone interaction description language describes to computer 743.

With the exceptions described more completely below, a process in the terminal interaction language is a compressed version of the same process written in the telephone interaction description language. The terminal interaction language allows easy parsing on the two-way data communication device, which in turn makes the client smaller than a client for the telephone interaction description language that is readable by humans, but is not optimized for parsing by a machine.

The compression from the telephone interaction description language to the terminal interaction description language is done typically at run time because some cards are computed cards and so cannot be precompiled. A wide variety of techniques can be used to convert the telephone interaction description language to terminal interaction language. The important aspect is that, if bandwidth across the cellular telephone network is limited, a compressed form of the telephone interaction description language is used.

Preferably, each data type is compressed to facilitate optimal transfer over the two-way data communication network. For example, the verbs in the telephone interaction description language are compressed using a binary tokenization. Graphics are compressed using run length limited compression and text is compressed using any one of the well-known techniques for text compression. While compression of the telephone interaction description language is not required to implement this invention, compression makes the invention more efficient by utilizing the bandwidth of

the network more effectively.

Instructions in the telephone interaction description language and in the terminal interaction language are grouped into a deck and a card. Each deck includes one or more cards. A card includes the information, i.e., a set of telephone interaction description language, required to generate a screen. As indicated above, a screen can be larger than the number of lines in a display screen. Other equivalent terms for a card include a page and an atomic interaction. Thus, a card deck is simply a group of screens. The number of cards in a card deck is selected to facilitate efficient use of the resources in the two-way data communication device and in the airnet network.

For simplicity, in this embodiment, each card is a single operation. Herein, an operation is defined as a related set of actions such that the user does not encounter an unanticipated delay in moving from one action to the next, i.e, the user does not have to wait for client module 702 to retrieve another card deck from computer 743. Also, a deck may include definitions of soft keys that stay in force while the deck is active, i.e, being executed by the cellular telephone microcontroller.

Computer 743 may contain stored static telephone interaction description language decks. Computer 743 also generates telephone interaction description language decks in response to data from, or choices made by, the user of cellular telephone 700.

In the embodiment shown in Figure 7, computer 743 converts a telephone interaction description language deck to a terminal interaction language deck, that in turn is transmitted to cellular telephone 700. The terminal interaction language is designed so that decks can be stored unaltered in memory 716 of cellular telephone 700 and referenced directly with little or no parsing. While telephone interaction description language decks on computer 743 may contain references to images, a terminal interaction language deck contains the images at the end of the deck. Thus, if a particular two-way data communication device does not support display of images, the images are easily stripped from the terminal interaction language deck before the deck is transmitted to that particular two-way data communication device.

As indicated above, each interaction with the user of cellular telephone 700 is described by a deck or a series of decks. Logically, the user retrieves a terminal interaction language deck stored in a memory 716 of cellular telephone 700 after receipt from computer 743 over CDPD network 710. The user reviews the information displayed by cards in the deck and makes choices and/or enters requested information and then requests another deck, as described above with respect to Figures 2A to 2H, for example.

When the user receives a deck, the first card of information is displayed on display screen 705. Typically, as shown above, the first card is text, an image, or a combination of an image and text. After the user has reviewed the first card, the user hits a NEXT key to view the next card in the deck. Similarly, a user can return to a previous card in the deck by using a PREV key. Thus, using the NEXT and PREV keys, the user can navigate back and forth through the deck. Within a card, the user uses a scroll key or keys to move the portion of the card displayed up and down. This description of a particular method used to navigate through a deck and within a card is not intended to limit the invention to this particular method. In view of this disclosure, those skilled in the art will be able to use a wide variety of ways to navigate through a deck and within a card.

Cards, in this embodiment, are one of three types, a display card, a choice card, and an entry card. Independent of the type of card, the card can contain text and images. In addition, the invention is not limited to these three particular types of cards. The definition of the three particular types of cards is used to facilitate a description of the invention and to assist the developer's in organizing applications.

A display card gives information to the user to read. The display content can include any one of, or any combination of text, an image, and a soft key. The soft key is in effect only while the display card is active.

A choice card displays a list of choices for the user. The choices are automatically presented in a format specified on the choice card. See Appendix I, which is a part of the present disclosure and is incorporated herein by reference in its entirety. As explained above, the user makes a choice by depressing the key corresponding to the choice.

An entry card is used to obtain input data from the user. An entry card displays one or more entry lines. Typically, each entry line includes a display followed by an entry line. The entry line, in this embodiment, can be for either numeric or text data.

In this embodiment, choice and entry cards prevent the user from moving to the next card until the user has entered the requested information. When the user reaches the last card in a deck and hits the NEXT key, a request for a new deck is initiated. The deck requested is determined by either the deck that the user has completed, or by the choices made by the user. Also, when the deck is completed, the choices and/or data entered by the user typically are transmitted along with the request for the new deck to computer 743.

Appendix I is one embodiment of a syntax for the telephone interaction description language and the terminal interaction language of this invention. In one embodiment, the telephone interaction description language is described using a subset of the standard generalized markup language. Only a subset of the standard generalized markup language is utilized so that telephone interaction description language parsers also can be written easily using simple tools like lex and yacc.

Returning to operation over airnet network 750, cellular telephone 700 includes a display module 712, a keyboard module 711, a client module 702, and a UDP interface module 714. In this embodiment, module 702 is stored in a non-

volatile memory (not shown) of telephone 700 and is executed by the microcontroller (not shown) in telephone 700. Modules 711, 712, and 714 operate under the control of client module 702.

Client module 702 includes instructions that direct the microcontroller in cellular telephone 700 to perform the operations described more completely below with respect to Figures 8A to 8D. The operations include sending uniform resource locator (URL) requests to HyperText Transfer Protocol (HTTP) server 749, parsing and displaying a TIL deck or decks returned by HTTP server 749, and generating new URLs based on the user's key presses. For a description of HTTP server software and platforms that can run the HTTP server software, see, for example, Ian S. Graham, The HTML Sourcebook, John Wiley & Sons, Inc., New York, Chapt. 8, (1995), which is incorporated herein by reference.

User datagram protocol (UDP) interface module 714 couples CDPD network 710 to client module 702, and allows client module 702 to communicate using UDP over CDPD network 710. The user datagram protocol is well known to those skilled in the art and is documented extensively. UDP interface module 714 supports transmission of simple stand-alone messages between the connection partners.

Display module 712 is a display driver that couples client module 702 to display screen 705 and so allows client module 702 to specify the information presented on display screen 705. The user interface manager module within client module 702 converts the display information in a card to instructions for display module 704 which in turn provides signals that drive the hardware that controls the operation of display screen 705. For example, if the TIL deck includes an image, the user interface manager module determines whether the active card calls for display of the image. If the active card directs the user interface manager module to display the image, the user interface manager module passes the image in memory 716 to display module 712, which in turn displays the image on display screen 705.

Keyboard module 705 couples keypad 715 to client module 702, and stores data representing keys pressed by the user on physical keypad 715 in memory 716. Keyboard module 705 notifies client module 702 when the user has pressed a key.

When client module 702 is notified of a key press, the user interface manager module within client module 702 passes information about the key press to display module 712 that in turn displays the appropriate character on display screen 705, if an entry card is active. If the user interface manager module determines that a choice card is active, and the key press corresponds to one of the choices, the user interface manager module sends instructions to display module 712 that result in the choice being identified for the user, e.g., highlighted as described above.

In addition to HTTP server 749, host computer 743 includes a UDP interface module 748, CGI programs 761 stored in a memory 755 of host computer 743, and TIL decks 760 stored in memory 755.

HTTP server 749 uses UDP interface module 748 to send data to and receive data from CDPD network 710. TIL decks 760 are TIL decks that can be accessed by HTTP server 749. Static files containing PIDL decks are converted to TIL decks only once on HTTP server 749. CGI programs 761 are common gateway interface programs that produce PIDL decks that are used by HTTP server 749 to produce TIL decks that in turn are transmitted via UDP interface modules 748 and 714 and cellular telephone network 710 to client module 702. In this embodiment, the services available over airnet network 750 are applications accessible by HTTP server 749 on Internet 140 for which a service developer has written a PIDL deck, or a CGI script that in turn generates a PIDL deck, and is stored on computer 743.

The architecture in Figure 7 demonstrates some important aspects of this invention. First, the applications, the PIDL decks and CGI scripts in this embodiment, are independent of the particular two-way data communication network. For HTTP server 749 to communicate over a different two-way data communication network that does not support UDP, only UDP interface module 748 must be changed. The applications are unaffected by such a change.

Second, the applications on HTTP server 749 are independent of the two-way data communication device with which HTTP server 749 is interacting. An application on HTTP server 749 can communicate with any two-way data communication device that includes the appropriate client and a module to transmit and receive data over the two-way data communication network. These two facts mean that an investment in developing an application is insulated from either advances in two-way data communication devices, or advances in two-way data communication network technology.

Figures 8A to 8D are a process flow diagram for one embodiment of this invention. Initially, when the user initiates communication over airnet network 750, client module 702 initializes a work space in memory 716 of cellular telephone 700 and then, in get home URL process 801, stores a URL in the work space. According to the principles of this invention, in one embodiment, each cellular telephone that utilizes the airnet network has a home URL stored in a non-volatile memory that is used to retrieve a home card deck for the cellular telephone. In another embodiment, the cellular telephone obtains the home URL from server 749. Thus, in get home URL process 801, client module 702 obtains the home URL. Herein, a URL is an example of a specific embodiment of a resource locator.

For example, in get home URL process 801, client module 702 obtains a home URL, such as

http://www.libris.com/airnet/home.cgi

and stores the home URL in the work space. The portion of the home URL, http://www.libris.com, identifies a particular HTTP server, i.e, server 749, on the world-wide web. The portion of the URL, /airnet/home.cgi, specifies a particular common gateway interface program within CGI programs 761. The use of a URL pointing to a server on the world-wide web is illustrative only is not intended to limit the invention to applications on the world-wide web. In general, cellular

telephone 700 obtains an identifier, i.e, a resource locator, of a home application on a home server that is executed by the server when the cellular telephone initially becomes active on airnet network 750, and stores the resource locator in the work space.

Next in create HTTP request process 802, client module 702 converts the URL in the work space to a HTTP request. For example, for the above URL, create HTTP request process 802 generates a method field, such as

GET /airnet/home.cgi HTTP/1.0

The GET method is part of HTTP. Thus, the format for the GET method is known to those skilled in the art. Also, this particular form of the method is used because a specific server connection is established by cellular telephone 700 and so identification of the server is unnecessary. Nevertheless, briefly, this command instructs server 749 to execute application home.cgi and execution of application home.cgi in turn results in generation of a home deck and a subsequent transmission of the home deck to cellular telephone 700. HTTP/1.0 specifies the HTTP version used by client module 702 in cellular telephone 700.

In addition to the method field, client module 702 in process 802 could also generate appropriate HTTP request fields to pass information to server 749 about the capabilities of client module 702. The request fields can include information such as lists of the MIME content-types acceptable to the client; lists of data encoding types acceptable to the client; user authentication and encryption scheme information for the server; the length in bytes of the message being sent to the server; and the Internet mail address of the user accessing the server. This list of information is illustrative only and is not intended to limit the invention to the particular request fields described herein. Any request field defined by HTTP can be utilized by client module 702. However, in this embodiment, the defaults are utilized and so no HTTP request fields are generated.

Typical HTTP methods that can be generated in HTTP request process 802 are a GET method for requesting either a TIL deck from server 749, or execution of a common gateway interface program on server 749; and a GET method request to a common gateway interface program with data, e.g., a query string appended to the URL. In either case, a URL is transmitted to server 749 within the particular message. After create HTTP request process 802 is complete, client process transfers to transmit request process 804.

However, if the transmission control protocol is used instead of UDP, client module 702 would access a TCP module in establish server connection process 803 that replaced UDP module 714. Since, in this embodiment, UDP is used, establish connection process 803 is enclosed by a dashed line in Figure 8A to indicate that this process is unnecessary when using UDP.

In establish server connection process 803, a virtual connection would be made over CDPD network 710 between TCP interface module 714 and a TCP interface module in HTTP server 749 so that data could be transmitted between cellular telephone 700 and computer 743 using TCP, e.g., buffers to support data exchange are defined. The establishment of a TCP connection is well-known and so is not described further.

In Figure 8A, a dashed line connects establish server connection process 803 with establish client connection process 860, that is also dashed, that is performed by HTTP server 749. This indicates that both client module 702 and server 749 are required to complete process 803.

When the TCP virtual connection is established, client module 702 transfers processing from establish server connection process 803 to transmit request process 804. Similarly, server 749 transfers to request received check 861, in which server 749 waits until a request is received. Establish client connection process 860 is not needed for UDP and so HTTP server 749 initiates processing in request received check process 861. Process 860 is enclosed within a dashed line box to indicate that the process is used only for TCP.

In transmit request process 804, the HTTP request is sent from the work area in telephone 700 to HTTP server 749. Again, a dashed line connects process 804 of client module 702 to request received check 861 that is performed by HTTP server 749 to indicate that the check is dependent upon information from client module 702. When the transmission of the request is complete, client module 702 transfers to response received check 806.

Upon receipt and storage of the HTTP request, request received check 861 transfers to service request process 862 in which HTTP server 749 initiates service of the received request. In service request process 862, if the HTTP request only seeks transfer of a static deck, HTTP server 749 retrieves the requested static deck from TIL decks 760. Conversely, if the request requires server 749 to obtain data from the Internet or to append data to a particular file, server 749 launches the common gateway interface application addressed in the request, and passes the data in the HTTP request to this application for further processing.

For example, if the user of cellular telephone 700 requested a fax as in Figure 2F, the HTTP request identifies a common gateway interface application in CGI programs 761 that accepts as input data the telephone number and grabs the information to be faxed. The CGI application generates an e-mail transmission to the fax gateway. Similarly, for a stock quote, server 749, in response to the HTTP request, launches a common gateway interface application that sends out a stock query over Internet 140 to a stock quote service provider using the ticker tape symbol passed as input data by server 749 to the common gateway interface application. When the response to the stock query is received, the common gateway interface application builds a PIDL deck that includes the data in the response to the stock query.

Upon completion of servicing the request, HTTP server 749 converts the PIDL deck to a TIL deck and returns the

TIL deck to client module 702 using UDP in transfer response process 863, that is connected by a dotted line to response received check 806 in client module 702. As the TIL deck is transferred, client module 702 stores the deck in memory 716.

After the TIL deck is transferred, HTTP server 749 closes the process for responding to the message from cellular telephone 700. All the information needed by client module 702 to generate a user interface on display screen 705 and for responding to any selection or data entry presented in the user interface is included in the TIL deck. Consequently, client module 702 only has to interpret the TIL deck and interpret the user input to transmit the next message to HTTP server 749. The state for the HTTP server is defined in the next message. Consequently, HTTP server 749 is stateless because HTTP server 749 does not retain state information concerning a response to a message after the message is transmitted.

However, in another embodiment (not shown), a server could retain state information concerning each interaction with a client module. For example, if the server transmitted a choice card to the client module, the server would retain state information indicating that a choice was pending from the client module. In this embodiment, when the user makes a choice, e.g., depresses key two to indicate choice two, the choice is transmitted to the server which in turn accesses the URL associated with choice two. If this URL addresses another application, the server executes that application. Thus, in this embodiment, the server retains state information concerning each interaction with a client module. In view of this disclosure, those skilled in the art can implement the principles of this invention utilizing a server that retains state information when such a client/server combination is advantageous.

Returning to the present embodiment, when the TIL deck is received, client module 702 leaves response received check process 806 and transfers to process first card 808. However, if TCP is used instead of UDP, client module 702 upon leaving check 806 would close the virtual TCP connection in transmission completed process 807. Upon closing the virtual TCP connection, processing would transfer to process first card 808. Again, transmission complete process 807 is enclosed within a dashed line box to indicate that process 807 is used only with TCP.

In process first card 808, client module 702 parses the TIL deck and interprets the first card. Processing transfers from process first card 808 to generate display process 809.

In generate display process 809, client module 702 passes the data to be displayed in the first card to display module 712. Display module 712, in response to the data, drives the text and images in the data on display screen 705. Generate display process 809 transfers processing to key press check 820 through node 813. In Figures 8A to 8D, any circular node with the same alphanumeric character and reference numeral is the same node. The circular nodes are used to establish connections between the various processes in the method of Figures 8A to 8D without cluttering the figures with a number of connection lines.

Client module 702 waits in key press check 820 for the user to press a key on keypad 715 of cellular telephone 700. In this embodiment, cellular telephone 700 is assumed to have the capability to support two soft keys, a scroll-up key, a scroll-down key, a previous key, a next key, and keys zero to 9 that are configured in the standard telephone keypad configuration. In view of the following disclosure, if one or more of these keys are not present, one of skill in the art can alter the method for the particular configuration of the cellular telephone keypad, or other two-way data communication device keypad. For example, if the cellular telephone included a home key, the key press processing described more completely below would include a check that detected when the home key was pressed and would in turn transfer to get home URL process 801.

Briefly, the processes in Figures 8B to 8C, identify the key pressed by the user, identify the action required, and then transfer to a process that implements the action required. Specifically, when a key on the keypad is pressed, keypad module 711 stores an identifier for the key in work memory 716 and notifies client module 702 of the key press. Upon receipt of the notification from keypad module 711, client module 702 reads the storage location in work memory 716 to determine the key pressed and transfers processing from key press check 820 to scroll key check 821.

In scroll key check 821, client module 702 determines whether the user pressed either of the scroll keys. If a scroll key was pressed, processing transfers to adjust display process 822 and otherwise to display card check 823.

In adjust display process 822, client module 702 determines which of the scroll-up or scroll-down keys was pressed. Client module 702 then sends information to display module 712 so that the current display is either scrolled-up one line or scrolled- down one line. If the scroll key would move the display beyond a boundary of the current card, the scroll key press is ignored in adjust display process 822.

In response to the information from client module 702, display module 712 adjusts the screen display on display screen 705. Client module 702 transfers processing from adjust display process 822 to key press check 820 through node 813.

If a scroll key was not pressed, processing is passed through scroll key check 821 to display card check 823. Client module 702 takes action that depends on the particular type of card that is currently being displayed on display screen 705. If the current card is a display card, client module 702 passes through display card check 823 to soft key check 828, and otherwise transfers to choice card check 824.

Assuming for the moment that the current card is not a display card, choice card check 824 determines whether the current card is a choice card. If the current card is a choice card, client module 702 passes through choice card check

824 to choice key check 826, and otherwise transfers to data key check 826.

Assuming for the moment that the current card is neither a display card nor a choice card, the current card must be an entry card, because in this embodiment only three card types are defined. Thus, client module 702 does not check for an entry card. Rather, data key check 826 determines whether a valid data key was pressed. In this embodiment, the data keys are keys zero to nine on the key pad, and the # key. In other embodiments, other combinations of keys could be defined as data keys. If the pressed key was one of the data keys, data key check 826 transfers to process data entry 827 and otherwise transfers to soft key check 828.

In process data entry 827, client module 702 knows whether the predictive text entry process is turned-on, because one of the parameters on the entry card specifies whether to use the predictive text entry process, as described in Appendix I, which is incorporated herein by reference in its entirety.

If the predictive text entry process is not turned-on, client module 702 in process data entry 827 enters the pressed key value in a text entry buffer in work memory 716 at the appropriate location. Also, client module 702 sends information to display module 712 so the value of the pressed key is displayed in the appropriate location on display screen 705 by display module 712.

If the predictive text entry process is turned-on, client module 702 uses the novel predictive text entry process in process data entry 827, as described more completely below with respect to Figures 9, 10A to 10T, and 11, to determine the letter to select from the set of letters associated with the pressed key. After the predictive text entry process determines the appropriate letter, a value representing the letter is stored at the appropriate location in the text buffer in work memory 716. Also, client module 702 sends information to display module 712 so that the letter is displayed in the appropriate location on display screen 705. Upon completion of process data entry 827, client module 702 transfers processing through node 813 to key press check 820.

The previous description assumed that the current card was an entry card, but if the current card is a choice card, choice card check 824 transferred to choice key check 826. In generate display process 804 for the choice card, each of the choices are labeled according to information on the choice card and some or all of the choices are displayed on display screen 705. Thus, choice key check 826 determines whether the pressed key corresponds to one of the choices. If the pressed key is one of the choices, client module 702, in one embodiment, sends information to display module 712 to indicate the selected choice. Client module 702 also transfers from choice key check 826 through node 831 to store identifier process 850 (Fig. 8D), that is described more completely below. Conversely, if the pressed key is not one of the choices, choice key check 826 transfers to soft key check 828.

Soft keys can be specified both for a deck as a whole and per card, i.e., a physical key on the keypad is specified as a soft key as described more completely in Appendix I. Each soft key specification includes an identifier that defines the action to be taken when the soft key is pressed.

When a soft key is specified for a deck, the soft key remains in effect for the entire deck. However, when a soft key is specified for a card, the card soft key specification temporarily overrides the corresponding deck soft key specification, i.e., the deck soft key specification for the same physical key as the card soft key specification, while the card is visible, i.e., displayed on display screen 705. This override is done independently for the two soft keys. Thus, soft key check 828 transfers processing to first soft key check 829 if the key pressed is one of the two possible physical soft keys. Conversely, soft key check 828 transfers processing to next key check 840 (Fig. 8C), if neither of the two possible physical soft keys is pressed by the user.

In first soft key check 829, client module 702 determines whether the pressed key corresponds to the first soft key. If the pressed key is the first soft key, check 829 passes the active identifier for the first soft key to store identifier process 850 through node 831. Conversely, if the pressed key is not the first soft key, processing transfers from check 829 to second soft key check 830.

If the pressed key is the second soft key, check 830 passes the active identifier for the second soft key to store identifier process 850 through node 831. Conversely, if the pressed key is not the second soft key, e.g., a physical key that can be defined as a soft key was pressed but neither the current deck nor the current card defines a soft key for that physical key, processing transfers from check 830 to key press check 820 through node 813.

When pressing transfers to next key check 840, client module 702 determines whether the pressed key was the next key. If the next key was pressed, processing transfers to display card check 841 and otherwise to previous key check 846.

If a display card is the current card, the next key is used to move to another card in a deck, or alternatively to another deck. Thus, display card check 841 transfers processing to last card check 842 when a display card is the current card, and otherwise to entry card check 843.

Last card check 842 determines whether the current card is the last card in the deck. If the current display card is not the last card in the deck, last card check 842 transfers processing to read next card process 845, which in turn reads the next card in the deck and transfers through node 812 to generate display process 809.

If the current display card is the last card in the deck, the deck includes an identifier that specifies the location to transfer to from the last card. This identifier can be a URL to another deck, to a common gateway interface program, or an address for a card within the current deck, for example. Thus, last card check 842 transfers through node 831 to

store identifier process 850 when the current display card is the last card in the deck.

If the current card is not a display card but is an entry card, display card check 841 transfers to entry card check 843. In this embodiment, the next key is the predetermined key used to indicate that all the data for an entry on an entry card has been entered. Thus, if the current card is an entry card, entry card check 843 transfers processing to store data process 844.

Store data process 844 stores the data entered in at an appropriate location in memory that is specified in the current entry card. Typically, the data is combined as an argument with a URL and stored. Upon completion, store data process 844 transfers through node 810 to create HTTP request process 802 (Fig. 8A).

When the next key is pressed, if the current card is neither a display card nor an entry card, the current card is a choice card. However, as indicated above, in this embodiment client module 702 requires that the user make a choice and does not allow use of the next key. Consequently, if the current card is not an entry card, entry card check 843 transfers processing through node 813 to key press check 820.

The previous discussion assumed that the next key was pressed and so next key check 840 transferred processing to display card check 841. However, if the next key was not pressed, next key check 840 transfers processing to previous key check 846. If the previous key was pressed, check 846 transfers to first card check 847 and otherwise returns processing to key press check 820.

First card check 847 determines whether the current card is the first card of a deck. If the current card is not the first card, processing transfers from first card check 847 to read previous card 849, which in turn reads the previous card and transfers to generate display process 809 through node 813. Conversely, if the current card is the first card, processing transfers to home deck check 848.

If the current card is the first card in the home deck, there is not a previous card and so home deck check transfers processing to key press check 820 through node 813 and so the previous key press is ignored. If the current deck is not the home deck, home deck check 848 retrieves the identifier for the previous deck and transfers through node 831 to store identifier process 850.

Store identifier process 850 is reached through node 831 from several different points. The operations in store identifier process 850 are the same irrespective of the particular process that transfers to process 850. In each instance, an identifier is passed to store identifier process 850 and process 850 saves the identifier in working memory 716. The identifier can be, for example, a pointer to another location in the current card, an address of another card in the current deck, a URL to a deck stored in working memory 716, a URL to a TIL deck in TIL decks 760 on computer 743, or perhaps, a URL to a common gateway interface program in CGI programs 761 on computer 743. Thus, process 800 checks the stored identifier to determine the action required.

Specifically, in identifier to current deck check 851, client module 702 determines whether the identifier is to a card in the current deck. If the identifier points to the current deck, check 851 transfers processing to retrieve data process 852 and otherwise to URL to local deck check 853.

In retrieve data process 852, client module 702 retrieves the information stored at the location indicated by the identifier from working memory 716 and processes the information. Retrieve data process 852 transfers through node 812 to generate display 809 (Fig. 8A) that was described above.

URL to local deck check 853 determines whether the identifier is a URL to a deck that is stored in working memory 716, e.g., cached. If the deck is stored locally, check 853 transfers to retrieve local deck 854 which in turn moves the local deck into the storage location for the current deck. Retrieve local deck 854 transfers processing through node 811 to process first card 808 (Fig. 8A), that was described above.

If the identifier is neither to a location in the current deck, nor to a local deck, the identifier is a URL to an object on computer 743. Thus, in this case, check 853 returns processing to create HTTP request 802 through node 810.

Process 800 continues so long as the user continues to enter and process the information provided. In this embodiment, process 800 is terminated, for example, either by the user powering-off cellular telephone 700, selecting a choice or entry card that discontinues operations of client module 702, or remaining inactive for a time longer than a time-out period so that client module 702 shuts itself down.

To further illustrate the operations in process 800, consider the following example which is returned to client module 702 as a TIL deck in response to a HTTP request generated by process 802. For readability, Table 2 presents the deck in PIDL. In this example, all of the choices are for applications on the same server. However, in another embodiment, each URL could address any desired combination of servers.

TABLE 2

EXAMPLE OF PIDL CHOICE DECK

```
(PIDL)
(CHOICE)
(CE URL=http://www.libris.com/airnet/nnn/News
(CE URL=http://www.libris.com/airnet/www/Weather
(CE URL=http://www.libris.com/airnet/sss/Sports
(/CHOICE)
(/PIDL)
```

In process first card 808, client module 702 interprets the information in Table 2 and transfers to generate display process 809. In generate display process 809, client module 702 sends information to display module 712 so that the user is presented with a list of three choices on display screen 705, i.e, a user interface for the choice card is generated:

1. News
2. Weather
3. Sports

Generate display process 809 (Fig. 8A) transfers to key press check 820 (Fig. 8B). When the user presses the two key on keypad 715, key press check 820 transfers through check 821 to display card check 823.

Since the current card is a choice card, check 823 transfers processing to choice card check 824, which in turn transfers to choice key check 826. Since the two key was pressed and that key is a choice key, check 826 transfers processing to store identifier process 850 (Fig. 8D). In process 850, client module 702 stores the URL corresponding to two, i.e,

URL=http://www.libris.com/airnet/www

in working memory 716.

Since this URL is to an object on computer 743, processing transfers through checks 851 and 853 to create HTTP request process 802, which in turn generates the request. When the HTTP request is transmitted to server 749, as described above with respect to process 804, server 749 in service request process 862 retrieves deck www from TIL decks 760. An example of the deck is given in Table 3. Again for readability, the deck in present herein in PIDL.

TABLE 3

EXAMPLE OF A SECOND PIDL CHOICE DECK

```
(PIDL)
(CHOICE)
(CE URL=http://www.libris.com/airnet/www-1/World
(CE URL=http://www.libris.com/airnet/www-2/National
(CE URL=http://www.libris.com/airnet/www-3/State
(CE URL=http://www.libris.com/airnet/www-4/Local
(/CHOICE)
(/PIDL)
```

The deck in Table 3 is transmitted to cellular telephone 700 and stored in memory 716, as described above with respect to process 806. The choice card is processed in process 808 and displayed in process 809. As a result of process 809, the user is presented with a list of choices:

1. World

2. National
3. State
4. Local.

When the user makes another selection, the same sequence of processes as described above for the first choice card is executed by client module 702, and another URL is stored that points to a program on server 749 that retrieves the desired weather information and generates a deck with that information. This deck is transferred to cellular telephone 700 and displayed.

As described above, if the current card is an entry card and a key is pressed, client process 702 reaches data key press check 826 (Fig. 8B). If the pressed key is a valid data key, check 826 transfers to process data entry 827.

In one embodiment, process data entry 827 uses a novel predictive text entry process for text entry. Recall that on a typical telephone keypad, the keys are labeled with both a number and two or three letters. For example, the two key is also labeled abc. This leads to some ambiguity when using the telephone keypad to enter text. Is the user attempting to enter an **a**, **b**, or **c** when the two key is pressed?

In one prior art method, two keystrokes were required to enter each letter of text. The first keystroke identified the first key and the second key stroke identified the specific letter desired on the first key. For example, to enter the letter **s**, the user would first press the seven key that is labeled with letters **p**, **r**, and **s**. Next, the user would press the three key to select the letter **s**. While this method may work well for short sequences that consist of only three or four letters, the method does not work well for English text. For example, if the user has already entered **th** and then presses the three key that is labeled with letters **d**, **e**, and **f**, almost always the desired next letter is the letter **e**. Therefore, making the user press the two key is an extra and unnecessary step.

Client module 702 of this invention utilizes a novel predictive text entry process to reduce the number of key strokes required to enter text using a telephone keypad, or any similar keypad. Using this process, in most cases a single key stroke suffices to enter a single letter.

While this embodiment of the invention is described in terms of a telephone keypad, the principles of the invention are not limited to only a telephone keypad. In general, the process described more completely below, can be extended to any keypad where a single key is used to enter two or more letters. Further, the process is not limited to only letters, but rather is applicable to any keypad where a single key is used to represent two or more characters. In view of the following disclosure, those skilled in the art can use the principles of the predictive text entry process in a wide variety of applications.

The system for predictive text entry includes a predictive text entry module 901 that in this embodiment is included in client module 702, keyboard module 711, and a letter frequency table 902 that is loaded into memory 716, when client module 702 is activated. Predictive text entry module 901 is used in process data entry 827 when specified by the current entry card. Predictive text entry module 901 performs routine buffer management processes, that are known to one of skill in the art and so are not described further to avoid detracting from the process.

Predictive text entry module 901 stores a letter entry for each letter entered in a text buffer 903 in memory 716. In this embodiment, letters Q and Z are assigned to the one key and the zero key is used to enter a space, period, and comma, i.e., the zero key provides punctuation. However, these assignments are illustrative only, and are not intended to limit the invention to this particular embodiment.

The first letter entered is placed at the left end of the buffer and each additional letter is placed in the left most unused space in buffer 903. Thus, the last letter entered in text buffer 903 is the right most character. Letter frequency table 902, sometimes referred to as a table of predictive letter entries, is a look-up table where each entry in the look-table is addressed by three indices. The first two indices represent the two most recently entered letters in text buffer 903 and the third index represents the key that was pressed. Each predictive letter entry stored in letter frequency table 902 defines which of the letters associated with the pressed key to use given the previous two letters. For example, since **the** is a commonly occurring string, the entry in table 902 addressed by (t, h, 3) returns **e**, or more concisely the predictive letter entry **2** is returned to indicate that the second letter of the group of letters **d**, **e**, and **f** associated with the three key is the predicted letter. Of course, letter frequency table 902 could be altered to return more than a single letter.

In this embodiment, letter frequency table 902 was empirically generated using a collection of e-mail. Appendix II is a computer program listing that was used to generate letter frequency table 902 that is illustrated in Figures 10A to 10T. Briefly, the computer program implements a process that sequentially steps through the data provided and (i) for each possible single letter determines the most likely letter that follows for each key on the keypad; and (ii) for each possible combination of two letters determines the most likely letter that follows for each key on the keypad. In this embodiment, the most likely letter is the letter having the greatest frequency after the single letter. Similarly, the most likely letter is the letter having the greatest frequency after the combination of two letters. If there is a tie in the frequency, the first letter associated with a key is selected. Of course, other measures of likelihood could be used to generate the entries in table 902.

Thus, in Figures 10A to 10T, the first of the ten columns, i.e., the left most column, is the two letter sequence and

the first row, i.e., the top row is the keys on the key pad used to enter text. A combination of an entry in the first column and a key in the top row is used to select the predicted text entry. Thus, using the example of th, this two key sequence appears in the first column of Figure 10C. When the three key is pressed, the letter in the row with th as the first entry and in the column with three as the first entry, i.e., e, is retrieved. Alternatively, if the four key is pressed, letter i is retrieved from the table.

In this embodiment, table 902 is a buffer of two bit numbers. Each two bit number has a value in the range of zero to three, and the two bit number represents a predicted letter for the pressed key. Thus, for a two key labeled with letters A, B and C, a zero represents A; a one represents B; and a two represents C. In general, the number of bits used is determined by the key that represents the maximum number of characters. In this embodiment, the maximum number of characters represented by a key is three. The number of storage bits required is an integer S where S is the smallest number such that 2**S is greater than or equal to the maximum number of characters represented by a key.

In this embodiment, three indices i0, i1, and i2 are used generate a table index that in turn is used to access a particular predictive letter entry in table 902 of two bit numbers. Each letter is represented as a number, i.e., a letter entry, with letter A being zero, letter B being a one, letter C being a two, and so forth with letter Z being twenty-five. A space element is assigned a space element value of twenty-six. Thus, in this embodiment, there are twenty-seven possible characters.

Upon the initial entry to process 1100 (Fig. 11), letter indices i0, i1, and i2 were set to twenty-six in the initial processing of the entry card to indicate that the text buffer is empty. Also, as explained more completely below, as each letter of text is entered, letter indices i0 and i1 are updated and stored in memory 716.

However, in another embodiment, an initialize indices process is the first operation in predictive text entry process 1100. In this embodiment, for the first letter entered, letter indices i0 and i1 are set to twenty six; for the second letter entered, letter index i0 is set to twenty six and letter index i1 is set to the value of the letter in text buffer 903; and for all letters entered after the first two, the value associated with next to the last letter in text buffer 903 is assigned to letter index i0 and the value associated with the last letter in text buffer 903 is assigned to letter index i1.

Punctuation key check 1101 determines whether the zero key was pressed, i.e., the key selected to represent punctuation.

If the zero key was pressed, processing transfers from check 1101 to process punctuation entry 1102. Process punctuation entry 1102 sets index i2 to twenty-six, and sends the space element value to display letter process 1108. Display letter process 1108 transfers the space element value to display module 712 which in turn drives a space in the text entry on display screen 705. This completes the operation of process data entry for a zero key press and so processing returns to key press check 820.

If the zero key was not pressed, processing transfers through punctuation key check 1101 in data entry process 1100 to key one-to-nine check 1103, i.e., to a data entry key check. If the pressed key was any one of keys one to nine, check 1103 transfers to set letter index process 1104 and otherwise to rotate last entry process 1109.

In set letter index process 1104, one is subtracted from the numeric value of the pressed key and the resulting value is assigned to index i2. Set index process 1104 transfers to generate table index process 1105.

Generate table index process 1105 combines indices i0, i1 and i2 to create a table index. In this embodiment, table index TABLE_INDEX is defined as:

$$TABLE\_INDEX = (((i0 * 27) + i1) * 9) + i2$$

Upon completion of generate table index process 1105, generate text entry process 1106, retrieves the two bit value in the table at the location pointed to by table index TABLE_INDEX and converts the two bit value to a letter represented by the two bit value.

Generate text entry process 1106 transfers to update index process 1107, which in turn stores the value of letter index i1 as letter index i0; stores the value of the retrieved letter in letter index i1; and stores the predicted letter in text buffer 903. While this step assumes that letter indices i0, and i1 are stored and accessed each time in process 827, alteratively, the last two letters in text buffer 903 can be retrieved and assigned to indices i0 and i1, respectively, as described above.

Update index process 1107 transfers to display letter process 1108. Display letter process 1108 sends information to display module 712 which in turn generates the predicted letter on display screen 705.

If the pressed key is not one of keys one to nine, i.e, is not a data entry key, processing transfers from check 1103 to rotate last entry 1109. Recall that data key check 826 determined whether the pressed key was one of the zero to nine keys, or the # key. Thus, since checks 1101 and 1103 determined that keys zero to nine were not pressed, the only key press remaining is the # key, i.e., the rotate entry key, which indicates the user wants a letter different than the one entered last in text buffer 903. In rotate last entry 1109, the last character, i.e., the right most character, in text buffer 903 is replaced by the next character in the set of characters assigned to the last key pressed before the # key was pressed. Again, the use of the # key is illustrative only and is not intended to limit the invention to the use of that particular key to rotate an entry.

For example, if the last character in the text buffer 903 was a t and the # key is pressed, process 1109 changes the t to u. If the # key is pressed again, the u is changed to a v. Alternatively, if the last character in text buffer 903 was a u

and the # key is pressed, process 1109 changes the u to a v. If the last character in text buffer 903 was a v and the # key is pressed, process 1109 changes the v to a t. If index i1 is stored, as the last character in text buffer 903 is rotated, index i1 is updated.

Text entry in cellular telephone 700 in different languages or contexts can be supported by using different letter frequency tables. For example, for plumbers, the prediction table can be based on text about plumbing procedures. For Frenchmen, the prediction table can be based on French text. Also, multiple letter frequency tables could be stored in cellular telephone 700, or selectively transmitted to cellular telephone 700, and a particular letter frequency table would be selected on an entry card.

In addition, an entry in the table can be more that a single letter, and thus save even more key strokes. For example, if the text buffer contains **sche** then typing a **3** could return **dule** rather than just **d**. Further, this novel method of text entry can be utilized with other than a cellular telephone. The method is applicable to any device that has several characters assigned to a single key on a keypad.

In the above embodiment, the English alphabet and a space element were used as the character set. Thus, the number 27 used in defining the table index is just the number N of characters in the set. Similarly, the number 9 used in defining the table index is just the number M of keys in the keypad that represent two or more different characters. Hence, predictive text entry method of this invention is not limited to text and is directly applicable to any keypad where each key represents a plurality of different characters.

In the embodiment of Figures 7, 8, and 9, client module 702 and server module 749 communicate over CDPD network 710. However, this architecture is illustrative only of the principles of the invention and is not intended to limit the invention to the particular architecture described. Client module 702 and server module 749 can use a wide variety of two-way data communication links to exchange resource locators, e.g., URLs, and TIL decks. For example, the communications link could be a switched voice circuit in which the client module and server module communicate using modems. Alternatively, the communications link could be any other packet switched network, so long as there is some way for client module 702 to get requests to server module 749 and for server module 749 to send data back to client module 702. Further, a special purpose server could be used in place of HTTP server 749. For example, the principles of this invention can be used over various data transport mechanisms including circuit switched data and packet switched data. These data transport mechanisms are being defined and implemented for most of the cellular network standards including GSM, TDMA, and CDMA.

In the configuration of airnet network 750 (Fig. 7), client module 702 communicated directly with a server computer 743. In another embodiment, as illustrated in Figure 5, the two-way data communication device first communicates with an airnet network translator 500 that in turn communicates with the appropriate server. In this embodiment, the operation of two-way data communication devices 100, 101, and 102 is similar to that described above for cellular telephone 700, except the method field in the request generated in process 802 has a different form. For example, using the same information as before, the method field in this embodiment is:

GET http://www.libris.com/airnet /home.cgi?&oost=1 ANTP/1.0

The method field includes the full address of the server, the expected cost of the service, and the version of the protocol used for communicating with airnet network translator 500. The two-way data communication device transmits the HTTP request including the complete URL to airnet network translator 500.

Figure 12 is a more detailed block diagram that illustrates the structures in one embodiment of airnet network translator 500, according to the principles of this invention. In this embodiment, airnet network translator 500 is a computer running under the UNIX operating system with an interface to CDPD network 710. Such computers are well known to those skilled in the art. Thus, herein only the structures and processes that must be added to such a computer are described.

Airnet network translator 500 supports internet protocol (IP) connections over CDPD network 710 and with each computer network with which translator 500 can interact. In this embodiment, each of the modules in network translator 500 are processes that are executed by the processor in the computer. Control module 1201 is a daemon that listens for transmissions over an IP connection from CDPD network 710. When control module 1201 accepts a transmission, control module 1201 spawns an ANT request processor 1204, which in this embodiment is a process, as indicated above. While in Figure 12, only one ANT request processor 1204 is shown, there is an ANT request processor spawned for each transmission that control module 1201 accepts and the ANT request processor remains active until the communication is terminated.

Figure 13 is a process flow diagram that illustrates the operation of ANT request processor 1204. This process flow diagram considers transmissions that utilize both TCP/IP and UDP/IP. However, the processes that are specific only to TCP/IP are enclosed in dashed-line boxes. Upon being spawned for a TCP/IP, in establish connection process 1300, ANT request processor 1204 establishes a TCP connection using a TCP module in the server with the client module over CDPD network 710. After the connection is established processing transfers from process 1300 to request received check 1301.

If UDP is being used, upon being spawned ANT request processor 1204 initiates processing in request received check 1301. In check 1301, ANT request processor 1204 determines whether the request from cellular telephone 700

(Fig. 12) has been received and stored in memory 1210. Memory 1210 represents both RAM and non-volatile memory in this embodiment. When the request has been received and stored, processing transfers from check 1301 to retrieve data process 1302.

In retrieve data process 1302, ANT request processor 1204 retrieves information concerning the source of the URL, i.e., client module 702 of cellular telephone 700 from customer database 1213, and the destination specified in the URL, i.e., the designated server, from server database 1212. Both databases 1212 and 1213 are stored in memory 1210. A customer record in database 1213 includes, for example, a carrier address, e.g., an IP number, an airnet network translator account number, billing information, and server subscriptions. A server record in database 1212 includes a server IP address, name, category, and class of service. Class of service refers to the pricing of the service, e.g., basic services, premium services, or pay-per-view services. Other pricing schemes can be supported in other implementations. When the information is retrieved for the server and service specified in the URL, and for the customer, processing transfers to valid request check 1303.

In valid request check 1303, ANT request processor 1204 determines, for example, whether client module 702, i.e., the customer, is authorized to access airnet network translator 500; whether client module 702 is authorized to access the server specified in the URL; whether the specified server is available through translator 500; and whether the specified server supports the requested service. Thus, valid request check 1303, validates the client, the server, and the client/server pair. Also, since an estimated cost is included in the request, the status and credit limits on the customer's account could be checked to determine whether the estimated cost is acceptable. If all of the checks are true, processing transfers to create HTTP request process 1306. Conversely, if any one of the checks is untrue, valid request check 1303 passes information concerning the error to return error process 1304.

Return error process 1304 launches a CGI program stored in memory 1210 based on the information received and passes appropriate information to the CGI program. The CGI program builds an appropriate PIDL deck describing the error and converts the PIDL deck to a TIL deck, as described above. When the TIL deck describing the error is complete, return error process 1304 transfers processing to log transaction process 1315 that is described more completely below.

If all the checks in valid request check 1303 are true, create HTTP request 1306 converts the request in memory 1211 to a request specific to the server specified, which in this embodiment is a HTTP request. For example, for the above request, create HTTP request process 1306 generates a method field, such as

GET /airnet/home.cgi?&client=xyz&cost=1 HTTP/1.0

In this embodiment, the method field includes the same information as in the embodiment described above, and in addition, the method field includes a client identification and the estimated cost.

After create HTTP request process 1306 is complete, ANT request processor 1204 accesses TCP module 1203 in establish server connection process 1307 for TCP/IP and transfers to secure transmission check 1308 for UDP/IP. In establish connection process 1307, a connection is made between the server designated in the client request and the TCP interface module (not shown) so that data can be transmitted between airnet network translator 500 and the server. When the TCP connection to the server is established, ANT request processor 1204 transfers processing from establish server connection process 1307 to secure transmission check 1308.

In secure transmission check 1308, ANT request processor 1204 determines whether the HTTP request from the client requested a server that utilizes a protocol that supports encryption. If such a server was requested, processing transfers to negotiate process 1309 and otherwise to transmit request process 1310.

In negotiate process 1309, ANT request processor 1204 negotiates an encryption technique with the server. Upon completion of the negotiation, processing transfers from process 1309 to encryption process 1311. In encryption process 1311, the HTTP request is encrypted using the negotiated encryption technique, and then processing transfers to transmit request process 1310.

In transmit request process 1310, the HTTP request is sent from memory 1210 to the HTTP server. When the transmission is complete, ANT request processor 1204 goes to result received check 1312.

As described above, upon receipt of the request, the HTTP server services the request. Upon completion of servicing the request, the HTTP server returns either a PIDL deck or a TIL deck to airnet network translator 500. The deck is stored in memory 1210. If the server does not convert the PIDL deck to a TIL deck, the translation is done by airnet network translator 500.

When the deck is received and stored, ANT request processor 1204 transitions from check 1312 to transmission completed process 1313 for TCP/IP and to secure transmission check 1314 for UDP/IP. ANT request processor 1204 closes the TCP circuit with the server in transmission completed process 1313. Upon closing the server TCP connection, processing transfers to secure transmission check 1314.

If the server utilized encryption, the deck stored in memory 1210 is encrypted. Thus, secure transmission check 1314 transfers processing to decryption process 1316 if encryption was used and otherwise to log transaction 1315.

In decryption process 1316, the encrypted deck is decoded and stored in memory 1210. Also, after the decoding, if the deck must be converted to a TIL deck, the translation is performed. Decryption process 1316 transfer to log transaction process 1315.

In log transaction process 1315, ANT request processor 1204 writes a description of the transaction to transaction log 1211 in memory 1210. In this embodiment, each transaction record includes a customer identification, a server identification, time required for the transaction, cost of the transaction, and a completion code. In one embodiment, for security purposes, each cellular telephone is assigned to only one customer and only one account.

After the transaction is logged, processing transfers to transmit result 1317. In transmit result 1317, ANT request processor 1204 returns the deck to client 702. After the deck is transmitted, ANT request processor 1204 is terminated.

In one embodiment, if an airnet network translator is fully loaded and another transmission comes in, the translator returns the address of another airnet network translator and refuses the transmission. The cellular telephone transmits the message to the other airnet network translator. In yet another embodiment, all incoming transmissions are directed to a router. A plurality of airnet network translators are connected to the router. The router monitors the status of each translator. Each incoming transmission is routed to the least busy translator, which in turn responds to the transmission and performs the necessary operations for continuing communications with the client module.

In the above description of client module 702, module 702 interacted with components within the cellular telephone to perform the various operations specified by the user. To insulate client module 702 from the exigencies of various cellular telephones to the extent possible, a general architecture for client module 702 is described more completely below. This general architecture is designed to have specific manager modules that interact with the modules described above within the cellular telephone and to provide standard information to the remaining manager modules within client module 702. The manager modules with client module 702 form an interpreter that interprets TIL decks to generate a user interface; interprets data input by the user; and interprets the TIL decks so that the data input by the user is combined with an appropriate resource locator and either a message is sent to an appropriate server, or another local TIL deck is interpreted by client module 702. While this embodiment is for a cellular telephone, the manager modules are generic and so are applicable to any client module in a two-way data communication device.

This approach limits the modifications that must be made to client module 702 to implement the principles of this invention in a wide variety of two-way data communication devices over a wide variety of two-way data communication networks. Also, in the above embodiment, client module 702 supported communications and interactions over the cellular telephone network. However, client module 702 can also support local services on cellular telephone 700. Typical local services includes local messages, an address book, and preconfigured e-mail replies, or any combination of such services.

In this embodiment, client module 702 includes a plurality of manager modules including a navigation manager module 1401, a network manager module 1402, a TIL manager module 1403, an archive manager module 1404, a local manager module 1405, an event manager module 1406, a timer manager module 1407, a user interface manager module 1408, a memory manager module 1409, and a device dependent module 1410.

Navigation manager module 1401 handles card and deck navigation as well as managing any caches. Navigation manager module 1401 owns and manages a history list and as well as a pushed card list. In addition, navigation manager module 1401 functions as the main line of client module 702; does all event distribution; and supports local services.

For local services, like local message store, there are two basic approaches that can be used. First, local services are implemented in a CGI-like manner. Each local service has an entry point which is called with an argument list. A TIL deck is returned via the event manager. From that point on, the TIL deck is processed in the standard manner. This approach limits local services to the same constraints as remote services. A less restrictive approach is to allow the local service to field events instead of the standard event loop. The local service would construct TIL cards on-the-fly and feed them to user interface manager 1406. Note that the local service would need to cooperate with the standard event loop with regard to the history, the pushed card list, and any other state that is normally managed by the event loop. Table 4 is a listing of processes for the architecture for navigation manager module 1401.

TABLE 4

ARCHITECTURE FOR NAVIGATION MANAGER MODULE 1401

```
ProcessEvents (void);
PushLocation (void * location, Boolean forStack);
void * PopLocation (Boolean forStack);
void * CurrentLocation();
struct LOCAL_SERVICE {
     char name[50];
     FUNC HandleEvent(Event * pevent);
     FUNC StartLocalService(void);
     FUNC StopLocalService(void);
     };
static LOCAL_SERVICE localServices[]={ ... };
STATUS HandleEvent(Event * pevent);
STATUS StartLocalService();
STATUS StopLocalService();
```

Routine ProcessEvents is the main entry point for event processing in client module 702. Typical events include key presses on the keypad, choice selection for a choice card, text entry for an entry card, network events, and history events. Routine ProcessEvents can be called at any time to process an event or events. Routine ProcessEvents does not return until all events on a queue generated by event manager module 1406 are processed. If a local service is running, events are distributed to the local service before being processed by routine ProcessEvents.

The remaining routines in Table 4 are called internally to navigation manager module 1401 and by local services. Routine PushLocation pushes a location on the history list and issues a request for that location. The forStack flag indicates a stack push of local cards.

Routine *PopLocation pops a location on the history stack and issues a request for the top location of the history stack. In routine *PopLocation the forStack flag indicates that all cards since the last stack push should be popped.

Routine *CurrentLocation returns the current location the current URL being displayed.

As shown in Table 4, each local service provides a number of functions. If a local service is running, function HandleEvent, the local service's event handler, is called before any processing by navigation manager module 1401. If the event is handled by the local service, the event is not processed any further.

Function StartLocalService is the local services start function. Function StartLocalService is called before any events are distributed to the local function. Similarly, function StopLocalService is the stop function for the particular local service. Function StopLocalService is called when no more events are distributed to the local service.

Network manager module 1402 insulates the rest of client module 702 from the specific networking protocol used over the cellular telephone network. Network manager module 1402 delivers requests to the server specified in the URL via the cellular telephone network interface; segments responses from the server for lower latency; delivers responses from local services to navigation module 1401 via event module 1406; handles request/response cycle (e.g. cancellation, retry strategy) with the server over the cellular telephone network; can receive asynchronous messages from the server; performs memory management of TIL decks; performs caching of TIL decks; handles all negotiations concerning protocols and server scaling with the server; handles any encryption for information exchanged between cellular telephone 700 and the server.

In some cellular telephone, the maximum message size is fixed. However, for UDP and TCP messages, a more direct interface is used that bypasses this limitation of message passing. It is important to avoid copying network data from memory buffer to memory buffer as such copying increases the memory "high water mark" as well as decreases performance. Since different cellular telephones have different interfaces for delivering network data, network manager module 1402 manages the network data. In this way, network data is only copied from the network buffer for long-term

storage.

When a message or reply arrives, network manager module 1402 uses event manager module 1406 to report that fact. However, access to the data by other manager modules in client module 702 is through a protocol that allows storage of data in a variety of fashions on different telephones. Any transparent, short-term caching of TIL data is handled by network manager module 1402. Table 5 is one architecture for network manager module 1402.

TABLE 5

SPECIFICATION FOR NETWORK MANAGER MODULE 1402

```
typedef short TID;
void NM_Init(void);
void NM_Terminate(void);
TID NM_SendRequest (void *requestData, int length, Boolean ignoreCache);
NM_CancelRequest (TID TRANSACTIONId);
NM_DataType(TID TRANSACTIONId);
NM_GetData(TID TRANSACTIONId, void *data, int *length, Boolean *complete);
void *NM_HoldData (TID TRANSACTIONId);
NM_ReleaseData(TID TRANSACTIONId);
TID NM_StartData(int data Type, char *requestData, int length);
STATUS NM_EndData(TID TRANSACTIONId);
STATUS NM_SetDataLength (TID TRANSACTIONId, int length);
STATUS NM_GrowDataLength (TID TRANSACTIONId, int grow);
int NM_GetDataLength(TID TRANSACTIONId);
void *NM_GetDataPointer (TID TRANSACTIONId);
STATUS NM_DeliverData (TID TRANSACTIONId);
```

Network manager module 1402 identifies each network data transaction by a 16-bit transaction identification code TID. Network manager module 1402 increments transaction identification code TID by one for each new transaction. Transaction identification code TID rolls over after 0xffff.

Routine NM_Init initializes network manager module 1402 and so is called before any other calls in network manager module 1402. Routine NM_Terminate closes processing of network manager module 1402 and so is called after all other calls in network manager module 1402.

Network manager module 1402 uses routine TID NM_SendRequest as the standard process of sending a request to the server. Pointer *requestData in the call to routine TID MN_SendRequest is defined by the server protocol. Similarly, the state, e.g., the Boolean value, of variable ignoreCache is used to indicate whether any cached replies should be ignored. After sending the request, this routine returns a server transaction identification code TRANSACTIONId. A local service can also send a request to the server.

When the user instructs client module 702 to cancel a request, network manager module 1402 calls a routine NM_CancelRequest with cellular telephone transaction identification code TID and server transaction identification code TRANSACTIONId. Routine NM_CancelRequest issues a command to the server to cancel the specified request.

When data are received from the network, the data can be either a response to a request sent by routine TID MN_SendRequest, or by a local service. Thus, in response to receiving data from the server, network manager module 1402 generates an event that includes server transaction identification code TRANSACTIONId and the type of data DATAType. For replies to requests sent by routine TID MN_SendRequest, server transaction identification code TRANSACTIONId is the same as the one returned by the matching call to routine TID MN_SendRequest and data type DATAType indicates that the data is a response. For local service originated messages, server transaction ID is new, and data type DATAType depends on whether the data is an e-mail, pushed TIL, or another type.

After the network event is received by event manager module 1406, and navigation manager module 1401 distributes control of the event to network manager module 1402, network manager module 1402 users the server transaction identification code TRANSACTIONId and the remaining routines in Table 5 to process the data.

Routine NM_DataType is used to return the particular data type dataTYPE, e.g. reply, MIME, server push, etc. Routine NM_GetData sets a pointer to the data identified by server transaction identification code TRANSACTIONId, retrieves the length of the data, and determines whether all the data has been received. The interface provided by this routine allows the first part of a data stream, e.g. the first card of a TIL deck, to be processed by client module 702 before the rest of the deck is received.

Routine NM_HoldData is called before calling routine NM_GetData to hold the data and thus insure that the data remains valid during processing by client module 702. If the data is not held, the data can be deleted or moved with the internal buffers of network manager module 1402. If the data is held, routine NM_ReleaseData is called after network data has been processed to release the data.

Routines TID NM_StartData, NM_EndData, NM_SetDataLength, NM_GrowDataLength, NM_GetDataLength, NM_GetDataPointer, and NM_DeliverData are used internally by network manager module 1402, and by local services to deliver data. By allowing local services to use these routines, the same buffers can be used to store both network and locally generated data thereby reducing the amount of memory required to support client module 702.

Routine TID NM_StartData creates a new data transaction and triggers a data delivery event. Routine NM_EndData is called when all data for the given server transaction identification code TRANSACTIONId has been transmitted. Routine NM_SetDataLength sets the data segment to a given length and may cause the location of the data to change. Routine NM_GrowDataLength grows the data segment by a given length and also may cause the location of the data to change. Routine NM_GetDataLength returns the length of the data segment. Routine NM_GetDataPointer returns a pointer to the data. This routine is preferably called before writing into the data buffer. Also, this routine is preferably called whenever the data's location may have changed. Routine NM_DeliverData can be called when at least one card has been stored to reduce latency while the other cards are being generated.

TIL manager module 1403 insulates the rest of client module 702 from changes to the TIL specification. The interface provided by TIL manager module 1403 has the following characteristics: removes the need for parsing by the rest of client module 702; uses cursors to avoid generating data structures on-the-fly; does not need an entire deck to operate; and handles TIL versioning.

Each TIL deck contains a major and a minor version number. The minor version number is incremented when TIL changes in a way that does not break existing TIL manager modules. The major version number is incremented for non-compatible versions of TIL.

Each TIL deck has the same hierarchy. One embodiment of this hierarchy is presented in Table 6. In Table 6, indentation is used to represent the relationships of the various hierarchical levels.

TABLE 6

TIL DECK HIERARCHY

```
deck
    options
    softkeys
        options
    card
        options
        softkeys
            options
        formatted text
            formatted lines
        entries
            options
formatted line
```

The interface presented in Table 7 for TIL manager module 1403 is designed with the assumption that TIL is a direct tokenization of PIDL as described in Appendix I. However, the interface does not have any dependencies on that tokenization and can support other PIDL encoding techniques. Given the above assumption, the opaque pointers described below are actual pointers into the TIL deck itself. A rudimentary object typing scheme based on where in the deck the

opaque pointer points can be used to implement the generic functions described below. If this object typing is not feasible due to details of TIL encoding, the generic functions can be replaced with specific functions.

TABLE 7

ARCHITECTURE FOR TIL MANAGER MODULE 1403

```
typedef char *opaque;
typedef opaque Deck;
typedef opaque Card;
typedef opaque Text;
```

```
        typedef opaque Entry;
        typedef opaque Option;
        typedef opaque SoftKey;
        typedef opaque Object;

    /* Generic functions */
        FirstOption(Object obj, Option *o);
            /* obj is a card, softkey, entry, or deck */
        GetSoftkey(Object obj, Option *o);
            /* obj is a card or deck */
        GetText(Object obj, Option *o);
            /* obj is a card or entry */

    /* Deck functions */
        SetDeck(Deck d, int length);
             /* tells module which deck to use */
        DeckGetCard(Card *c, int num);
    -or-
        DeckGetCard(Deck d, Card *c, int num);

    /* Card functions */
        int CardType(Card c);
        CardFirstEntry(Card c, Entry *e);
        CardLookupSoftkey(Card c, int num, Softkey *s);
        CardIsLast(Card c);

    /* Option cursor functions */
        OptionNext(Option *o);
        char *OptionKey(Option o);
        char *OptionValue(Option o)

    /* Entry cursor functions */
    /* Text (and image) cursor functions */
        TextNextToken(Text *t, int *type, int *subtype,
                              int *length, char *data);
```

Archive manager module 1404 stores and retrieves long-lived information. This information includes: data related to the server's location and/or required to support server scaling; data related to encryption; TIL caching (transparent to user); TIL storage (specified by user); and message storage and retrieval (see local manager module). Archive man-

ager module 1404 should support a variety of nonvolatile memory schemes that are provided by the two-way data communication devices.

Local manager module 1405 is an interface to local device resources, such as local messages, address book entries, and preconfigured e-mail replies. Local manager module 1405 should also define an abstract interface to navigation manager module 1401 for use by archive manager module 1404.

Table 8 is an architecture for an interface within local manager module 1405 to access to an address book stored on cellular telephone 700. The name of a routine in Table 8 is descriptive of the operations performed by the routine.

TABLE 8

ARCHITECTURE FOR ADDRESS BOOK ACCESS

```
int NumAddresses();
char *AddressName(int num);
char *AddressGetEMail(int num);
     // returns e-mail address
char *AddressGetPhone(int num);
     // returns phone number
char * AddressGetFax(int num);
     // returns fax number
SetAddress(int num, char *name, char *email,
                char *phone, char *fax);
DeleteAddress(int num);
InsertAddress(int before);
```

Table 9 is an architecture for an interface within local manager module 1405 to access predetermined replies stored on cellular telephone 700. The name of a routine in Table 9 is descriptive of the operations performed by the routine.

TABLE 9

ARCHITECTURE FOR PREDETERMINED REPLY ACCESS

```
int NumReplies();
char * GetReply(int num);
DeleteReply(int num);
SetReply(int num, char *text);
InsertReply(int before);
```

Table 10 is an architecture for an interface within local manager module 1405 to access messages stored locally on cellular telephone 700. The name of a routine in Table 10 is descriptive of the operations performed by the routine.

TABLE 10

ARCHITECTURE FOR LOCALLY STORED MESSAGE ACCESS

```
int NumMessages();
void *FirstMessage();
void *NextMessage();
int MessageType(void *msg);
      // e.g. e-mail, TIL, etc.
void *MessageContent(void *msg);
void *SaveMessage(int type, void *content, int
                        contentLength);
DeleteMessage(void *msg);
```

Event manager module 1406 handles the distribution of events. In this embodiment, events include low-level events like key presses and higher level navigation and user interface events. There are typically only a small number of events at any one time. The main event loop in the two-way data communication device dependent module keeps calling EM_GetNextEvent() until no events are left in the queue. Note that processing one event can cause another event to be pushed onto the queue. The main event loop is not restarted until another event is pushed onto the queue due to a user key press or a network event.

In this embodiment, the event types include:

1) keypad events, i.e., pressing of a key;
2) choice events relating to a current choice card, e.g., the user selecting choice three;
3) text entry events relating to a current entry card, e.g., the user keying in "Hello";
4) network events, e.g., response arrived, request arrived, transaction terminated, network status; and
5) history events, e.g., pop, pop to marker.

Table 11 is an architecture for event manager module 1406. As in the other tables herein, the name of a routine in Table 11 is descriptive of the operations performed by the routine and in addition a brief description is given in the comment field.

TABLE 11

ARCHITECTURE FOR EVENT MANAGER MODULE 1406

```
struct Event {
     int  type;
     void *data;
          /* e.g. keycode, choice num, entry
               text, status code, other data */
```

```
}
EM_QueueEvent(int type, void * data);
     /* Adds event at end of queue*/
EM_GetNextEvent(Event * event);
     /*Pops next event*/
EM_PeekNextEvent(Event event);
     /*Peeks at next event*/
```

Timer manager module 1407 allows timer events to support timeouts, animation, and other time-domain features. Timeouts are delivered via event manager module 1406.

Table 12 is an architecture for timer manager module 1407. As in the other tables herein, the name of a routine in Table 12 is descriptive of the operations performed by the routine.

TABLE 12

ARCHITECTURE FOR TIMER MANAGER MODULE 1407

```
TimerInit();
int TimerSet(int milliseconds, int code, void
                    *clientData);
     /*Returns a timer identification timerId to
          be used for cancellations*/
TimerCancel(int timerId);
TimerCancelAll()
```

User interface manager module 1408 handles interactions with the keypad and the display. Each of the three types of user interfaces defined in Table 1 above requires a different version of user interface manager module 1408. For most cellular telephones, only one card at a time is used. However, some cellular telephones can display multiple cards at once and so would require a different version of user interface manager module 1408 from the version that handled display of only one card at a time.

In this embodiment, user interface manager module provides a user interface for the three types of cards display, choice, and entry; provides hooks for custom user interfaces for the address list and e-mail reply entry; only cares about the user interface aspects of cards and provides no navigation, argument, or option processing; handles all text and graphic layout including word wrapping; handles scrolling of text; operates from PIDL data structures; generates keyboard events, some of which may be generated by soft keys; and generates high-level events, e.g. next card, choice entry 3, text entry "IBM".

Table 13 is an architecture for processing cards by user interface manager module 1408. As in the other tables herein, the name of a routine in Table 13 is descriptive of the operations performed by the routine.

TABLE 13

ARCHITECTURE FOR CARD PROCESSING BY UI MANAGER MODULE 1408

```
void UI_StartCard(Card c);
     /* called to begin display and processing of
          a given card*/
void UI_EndCard(Card c);
     /*called when a card is no longer to be
          displayed*/
Boolean UI_HandleEvent(Event *pevent) ;
     /*returns true if the event is handled, false
          if not*/
```

Table 14 is an architecture for the user interface implementation by user interface manager module 1408. As in the other tables herein, the name of a routine in Table 14 is descriptive of the operations performed by the routine.

TABLE 14

ARCHITECTURE FOR UI IMPLEMENTATION BY UI MANAGER MODULE 1408

```
UI_ LayoutCard(Card c, Boolean draw, Proc
                              callback)
     /* relies on global data; needs to be able
          to:  draw as it goes; and note the
          special function of the currentLine
          (e.g. none, choice, softkey)*/
int numLines, firstVisible, lastVisible,
                                   currentLine;
char currentEntry[80];
int currentChoice;
void *currentSoftkey;
Card currentCard; and
     ... other info as needed for in-line
          scrolling
```

The callback routine is notified of the special function of each line as the line is laid out. Thus, routine UI_LayoutCard can be used to scroll to a particular choice. If the current line is too wide to display all at once, horizontal scrolling is used to display the complete line, one display width at a time.

Memory manager module 1409 is optional, and is used in two-way data communication devices that do not support dynamic memory allocation. In these devices, all memory allocation and releases must go through memory manager module 1409. Also, by allocating memory in advance via memory manager module 1409, client module 702 does not run out of memory due to some other process on the device using up memory.

In one embodiment, the airnet network translator described above was used with an Internet server to communicate with client module. The Internet server was a UNIX computer running the Mosaic HTTP server. The executable code was generated by compiling the source code on a computer running the Sun Microsystems Operating System Solaris 2.4 using Sun Microsystems compiler SunPro C and C#, and the Sun Microsystems SDK make utility. All of these products are available from Sun Microsystems of Mountain View, California.

Various embodiments of a novel interactive two-way data communication system, a two-way data communication device, an airnet network architecture, and a predictive text entry system have been described herein. These embodiments are illustrative only of the principles of the invention and are not intended to limit the invention to the specific embodiments described. In view of this disclosure, those skilled in the art will be able to use the principles of this invention in a wide variety of applications to obtain the advantages of this invention, as described above.

APPENDIX I

A DESCRIPTION OF PIDL AND TIL

The main structure of PIDL is described by an abstract syntax. This appendix describes the elements of the language and their semantics. In the syntax description of each element, an element is defined in an enhanced BNF.

a ::= b	the element a is defined as b
a ::= b ::= c	the element a is defined as b or c
b c	the element b followed by element c, the intervening space is just for clarity
a|b|c	element a or element b or element c
{a}	the element a is optional
{a}*	the element a may appear zero or more times in a row
{a}+	the element a may appear one or more times in a row
abc	the characters abc literally
ol(a)	an option list with zero or more topions of the element a, see Options below

In general, the element blank-space can optionally appear between any two other elements. To keep the diagram clear, it has been omitted except where required. Where a blank-space is illegal or treated specially, it is noted.

The PIDL ELEMENTS

```
          deck  ::= deck-header {softkey}* {card}+ deck-
                    footer
   deck-header  ::= <PIDL  ol(deck-options) >
 deck-options   ::= o-args | o-cost | o-ttl
   deck-footer  ::= </PIDL>
```

A deck consists of one or more cards. There must be at least one card. A deck may also have a number of softkeys defined that stay in force for the whole deck. See soft keys below for the syntax and full description.

```
       o-cost  ::= cost=  value
        o-ttl  ::= ttl=  integer
```

Additional arguments to be passed on the next deck request are given in o-args. See Arguments below for syntax and full description.

The cost of retrieving this page (exclusive of telephone system charges) is represented in o-cost. If no o-cost is given, the deck cost is included with the user's standard service contract.

Decks can be cached by the cellular telephone for a period of time. The o-ttl entry indicates the number of seconds that the deck can be cached from time of reception. If no o-ttl entry is given, the deck can only be cached for short periods of time, for example, to

implement a back function similar to that of most Web browsers. If the value of o-ttl is zero, the deck must not be cached.

CARD ELEMENTS

card ::= display-card | choice card | entry-card

A card is one of three types of card in this embodiment. These are described in the sections below.

card-options ::= o-name | o-next | o-prev

o-name ::= **name=** identifier

o-next ::= **next=** destination

o-prev ::= **prev=** destination

All cards can have these options. The optional o-name option gives a name to the card. If a card has a name, the card can be referred to by a destination.

The o-next and o-prev give destinations for the NEXT and PREV keys. If omitted, the defaults are the next and previous sequential card in the deck. If o-prev is omitted from the first card, the PREV key returns to the deck last visited. If o-next is omitted from the last card, the NEXT key returns to the first card of the current deck. However, this default behavior is only a fail-safe; the last card in a deck should always have either an o-next option, or be a choice card where each choice entry indicates a new destination.

DISPLAY CARD

```
display-card    ::= display-header display-content
                display-footer
display-header  ::= <DISPLAY option-list >
display-options ::= card-options
display-content ::= { softkey }* formatted text
display-footer  ::= </DISPLAY>
```

Display cards give information for the user to read. See Formatted Text below for a full description of the format of information that can be displayed. Softkeys can be described for this card only, see Softkeys below.

CHOICE CARD

```
choice-card     ::= choice-header display-content
                { entries } choice-footer
choice-header   ::= <CHOICE  ol{choice-options} >
choice-options  ::= card-options | o-method | o-key
                | o-default
o-method        ::= method= method-type
method-type     ::= number | list | alpha | group
entries         ::= { choice-entry }+
                ::= { group-entry { choice-entry }+ }+
choice-footer   ::= </CHOICE>
```

Choices let user pick one from a list. The initial display content is shown to the user, followed by the choices. Each choice can have one line of formatted text (which may be wrapped or scrolled by the phone if too long).

How the choices are displayed and chosen

is based on the o-method option. Note that this option is a hint only, and can be disregarded by the phone. The number method is the default and indicates that the choices are numbered sequentially from one and are chosen by pressing the appropriate digit on the keypad. If there are more than nine options, the phone may choose some other method of selection. The list method indicates that the list should be unnumbered and that the user should scroll through the list and hit some designated enter key to choose an entry. The alpha method is like list, only it is an indication that the text of the entries should be used to aid selection if at all possible. In this case, the entries are assumed to be alphabetically sorted. The group method is described in more detail below.

The o-key option indicates, if present, the key of an argument to be added to the argument list. See Arguments below for more information. The value of the argument comes from the choice entry; see below. The o-default option indicates the default value if the user just hit ENTER. See o-default under Entry Card below for more information.

choice-entry ::= <CE ol(entry-options) > formatted-line

entry-options ::= action-options | o-value

Each choice has text displayed to the user. If the action-options are given,

the indicated action is performed if the choice is made. If the o-value option is present, it supplies the value to the argument identified with the o-key option in the choice header. If no o-value is given, the text of the entry is used (without any formatting) as the argument value.

```
group-entry   ::= <GE ol(group-options) >
group-options ::= label= value
```

If the group method is used, the choices are divided into a number of groups. Each group is headed by a group-entry, which, via the label option, gives a short name to the group. The phone can then give the user a hierarchial interface for choosing among a large number of choices. The text of the label should be limited to eight characters and may be truncated by the phone.

ENTRY CARD

```
entry-card    ::= entry-header display-content entry-
                  footer
entry-header  ::= <ENTRY ol(entry-options) >
entry-options ::= card-options | o-format | o-key
                  | o-default
entry-footer  ::= </ENTRY>
```

Entries let the user enter a value. The display content is shown to the user, followed by an entry line. The user's entry is controlled by the format. The o-key option indicates the argument that

is being set by this entry. The value of the argument are the user's entry.

o-format ::= **format=** value { ; format-hint }

format-hint ::= value

This option specifies the format for user input entries. The string consists of format control characters and static text which is displayed in the input area. Most of the format control characters control what data is expected to be keyed in by the user. They are displayed as blanks until the user types into them.

The format codes are:

A	entry of any alphabetic character
9	entry of any numeric character
X	entry of any alphabetic or numeric character
*f	allow entry of any number of characters; the next character, f, is one of A, 9 or X and specifies what kind of characters can be entered.
\c	display the next character, c, in the entry field; allows display of the formatting characters in the entry field.

Format hints indicate what kind of value is expected. If a format hint is not understood, it is ignored. Currently defined format hints are:

text	text is expected to be text, use special input techniques; generally follows *A or *X
mail-reply	like text, but expected text is for an e-mail message or page; may affect input algorithm
address-list	entry is a list of e-mail addresses

o-default ::= **default=** value

The o-default option supplies a value that is used if the user simply hits NEXT. If no default value is given, then the user must supply a value.

FORMATTED TEXT

formatted-text ::= { { flow-image } { line-format } text-line }*

formatted-line ::= text-line

text-line ::= { text | image | text-format | alignment-format }*

Formatted text is what is shown to the user in most cards. Formatted lines are used for choice entries.

text-format ::= **<B>** | **<I>** | **<BL>**

::= **</B>** | **<I>** | **<BL>**

The format codes control Bold, Italic and Blinking. The slash versions cancel the formatting. Unlike HTML, these needn't be strictly nested and over application and over cancellation are

tolerated. Formatted-text and formatted-line elements start in plain mode (no bold, italic, or blinking).

alignment-format ::= <CENTER> | <BOLD> | <TAB>
The alignment codes specify how parts of a line are to be laid out. The text following the alignment code is either centered or right justified on the same line as the other text. The text or image following the code is considered to be all text up to the next alignment code or line break. All lines start implicitly aligned left. Note that these do not include an implicit line break so that one can have both left and right justified text on a single line. If there is too much text and not enough room on the line then, if in wrap mode, the non-fitting text is moved to the next line and aligned the same way. If in line mode, the line may end up running together with two spaces between the left, center, and right justified segments.

The tab code is used to create aligned columns. Rather than tab to specific character positions, the tab code separates the text for each column. The width of the column is determined by the maximal width of the text (or images) in each line. The extent of the columns is from the first line with tab codes through the last contiguous line with tab codes. Some lines may have fewer

tab codes than others, in which case they are assumed to have no text for the extra columns.

line-format ::= **<WRAP>** | **<LINE>**
::= **
**

Multiple lines of text are separated by the
 code. If a line is too long to fit on the screen and, if in wrap mode, the line is word wrapped onto multiple lines. If in line mode, the line is left as one line and is scrolled horizontally. Formatted-text and formatted-line elements start in wrap mode and may be changed with either the <WRAP> or <LINE> codes. These codes are an implicit line break.

IMAGES

image ::= **<IMAGE** ol(image-options) >
::= **<INLINE** ol(image-options) >
inline-data **</INLINE>**

flow-image ::= **<IMAGE** ol(flow-image-options) >
::= **<INLINE** ol(flow-image-options) >
inline-data **</INLINE>**

image-options ::= o-source

flow-image-options ::= image-options | o-flow

inline-data ::= *ASCII85 encoding of image data*

Images are treated as large words and, by default, are simply displayed as part of the text. Flow-Images have a flow option that causes them to be treated differently. The image data is stored in a separate data stream as identified

by the source option.

Inline images are treated identically, only the data is part of the current data stream. ASCII85 is a standard way of encoding binary data in printable ASCII, whereby each four bytes of data is encoded in five characters. Note that TIL only uses inline images, and uses a different encoding.

o-source ::= **src=** location
This option specifies the location of the source for images.

o-flow ::= **flow=** { **left** | **right** }
This option controls the alignment of flow-images. The option specifies that the image is flush left or flush right with the screen. Subsequent lines of text flow in the remaining right or left hand space.

SOFTKEYS

softkey ::= **<SOFTKEY** ol(softkey-options) >
softkey-options ::= o-label | o-button | action-options

Softkeys supply definitions for two buttons known as SOFT-L and SOFT-R. They do not show up in the normal text and graphics area displayed to the user, but on a separate line for soft key labels. (Note: in some implementations, where screen real estate is scarce, this label line may get used for normal text

and graphics display when there are no softkeys defined on the current card).

When the softkey is pressed, the indicated action takes place.

```
o-button  ::= button= side
   side   ::= left  | right
 o-label  ::= label=  value
```

The button option specifies which physical key the softkey applies to. The label option is the text that is displayed on screen for that key. The phone may truncate the label. It is suggested that labels be fewer than eight characters.

Softkeys can be specified both for the deck as a whole and per card. When specified for the deck (after the deck-header, but before the first card) they remain in effect for the entire deck. When specified for a card (at the beginning of the formatted-text for the card), they temporarily override any deck softkeys while the card is visible. Note that the override is done independently for the two keys (a card can override one softkey, but not the other). To override a deck softkey with no softkey (in effect, to remove a softkey for the duration of a card) use a softkey with no label and no action.

SYNTAX: OPTIONS

Many of the syntactic elements of PIDL have option lists associated with them. Options refine the operation of the elements they are part of. Unless otherwise noted, options do not nest, even when the same option is given in two nested elements. Options that are not defined for an element are ignored, even if valid for an enclosing element.

```
ol(valid-option)  ::= { blank-space valid-option }*
                      {blank-spaces }
     option-list  ::= ol(option)
          option  ::= key = value
             key  ::= identifier
           value  ::= plain-text
                  ::= " { text } "
```

An option list contains zero or more options. Each option is separated by blank-space (required!) and optionally followed by blank-space. In the syntax diagrams, option lists are shown as: ol(*valid-option*) where *valid-option* is replaced with an element that defines the possible options in this context. ol is a generic syntactic description of option-lists.

Each option is a key and a value. They may be given in any order within the list of options. The key is always an alpha-numeric name that is case insensitive. The value, if it is composed of only alphanumeric characters, may appear directly after the equals sign. Otherwise, the value

must be quoted. In quotes, blank-space is treated literally and is considered part of the value.

In the syntax diagrams, the possible values for various options are specified without quotes. However, quotes are always acceptable around an option value.

Unlike almost all other syntactic elements, blank space is **not** permitted between the key and the equals sign or between the equals sign and the value.

Many options have a more restricted set of possible values than represented by the above syntax. See the individual options for details.

```
  DESTINATIONS
destination  ::= location { ; animation }
             ::= card-loc { ; animation }
             ::= stack-operation { ; animation }

   location  ::= full-loc  | partial-loc
             | relative-loc
   full-loc  ::= : service-id / deck-path
             ::= : service-host / deck-path
partial-loc  ::= / deck-path
relative-loc  { ../ }* deck-path

   card-loc  ::= # identifier

  deck-path  ::= plain-text { / plain-text }*
 service-id  ::= % plain-text
```

```
service-host    ::= plain-text
                Destinations are used in some options to
                indicate the next, or previous deck or
                card to show.  A deck is specified
                either with a full location (service-id
                and deck-path), just a deck-path (in
                which case the service is the same as
                the current deck's service), or a
                relative deck-path.  In the later case,
                the last component of the current deck-
                path is removed, (and one additional
                component for each ../ in the relative
                deck-path), and the deck-path appended.

                A particular card can be a destination
                and is specified by a card-loc element.


stack-operation ::= + card-loc
                ::= -
                In addition to the normal history list
                of where a user has been that is kept by
                a phone, the phone also keeps a short
                stack of locations.  Using a plus sign
                form causes the current location (deck
                and card, and location in the history
                list, and animation used) to be pushed
                on the stack before going to the new
                card.  Using the minus sign form causes
                a return to the location on the top of
                the stack, and the history list to be
                pruned back to the saved point.  If no
                animation is given, the inverse
                animation is used.  The stack is popped.

     animation  ::= slideN | slideS
```

::= slideW | slideE
::= slideSW | slideNE
::= slideSE | slideNW
::= flipV
::= flipH
::= fade
::= none

The optional animation argument indicates what form of screen animation, if available, is to be used when going to the destination. The animation is remembered with the destination in the history and destination stack. If the user moves to a destination via a 'go' or 'next' operation, then the animation is performed. If the user moves to a destination via a 'prev' or 'pop' operation, the reverse animation associated with the current location is performed.

ACTIONS

Choice entries and soft keys can specify actions to be performed when the user selects the choice or softkey.

action-options ::= o-args | o-call | o-page

o-go ::= go= destination

o-call ::= call= value

The go operation indicates that the destination should be moved.

ARGUMENT PROCESSING

Each time a deck is requested, arguments may be passed along with the request.

These arguments may be used by the service end to compute a deck specific for the user rather than just return a pre-written deck.

Arguments are built-up as the user traverses the deck. Each argument is a key-value pair. While arguments superficially look like options, these two entities are quite distinct: Options are a part of PIDL and affect the operation of the phone. Arguments are information gathered by the phone and returned to the service. Neither PIDL nor the phone understands the arguments beyond their basic syntactic structure.

Arguments come from three places: Choice cards, Entry cards, and the args option. Each of these specifies a key-value pair that is added to a buffer of arguments to be sent. In the case of the args option, multiple arguments may be specified. When an argument key-value pair is added to the argument buffer, if the key is already present in the buffer, its value is replaced.

```
        o-args  ::= args=  arg-list
argument-list   ::= arg-key-value [ [ &  |  ; ]
                key-value ]*
arg-key-value   ::= arg-key = arg-value
      arg-key   ::= identifier
    arg-value   ::= plain-text
```

Note: The entire o-args element is

actually the value of an option. If it has more than one arg-key-value it will need to be in quotes. Since the ampersand (&) and semi-colon (;) are used as key-value pair separators, these characters cannot be part of argument values.

o-key
o-value ::= **key=** arg-key
::= **value=** arg-value

These options are used in choice and entry cards to specify the key and value for the arguments those cards set.

BASIC ELEMENTS

alpha ::= *any alphabetic character*
numeric ::= *any digit*
alpha-numeric ::= alpha | numeric
hex ::= numeric | *any letter A through F, either case*
blank-space ::= { space | tab | new-line }+
space ::= the space character
tab ::= the tab character
new-line ::= the carriage return character
::= the line feed character
::= the sequence carriage return, line feed

word ::= { alpha-numeric }+
identifier ::= alpha { alpha-numeric }*
integer ::= { + | - } { numeric }+

text ::= *any 7-bit ASCII character except <, >, ", or &*
::= > | < | " | &

```
                |  
                ::= any ISO-Latin-1 named entity
                ::= &# hex hex ;
                In text, runs of blank-space are treated
                as single spaces and my be used as point
                for word wrapping.
plain-text
      safe      ::= { alpha | numeric | safe }*
                ::= $ | - | _ | @ | . | & | !
                | * | ,
```

TIL ENCODING

Except where noted, TIL is identical to PIDL in structure. To translate PIDL to TIL several steps are conceptually needed (these may be done in one pass by a translator):

1. Escape characters with the high bit set.
2. Compress or remove all blank space where possible.
3. Tokenize comment elements with a single byte with the high bit set.
4. Inline images.

Fundamentally, TIL is just PIDL with certain common character sequences replaced by single bytes with the high-bit set. The first two steps above support this. Additionally, images are further compacted by including them inline in a dense format.

The tokenizing follows the encoding

given in the table below. Note that for purposes of element separation, the tokens that represent option key identifiers (with the equal sign) can be considered to include all preceding blank space. Similarly, the tokens that represent option values can be considered to include all following blank space.

<PIDL>	90	args=	C0	alpha	E0
</PIDL>	91	button=	C1	center	E1
<DISPLAY>	92	call=	C2	fade	E2
</DISPLAY>	93	cost=	C3	flipH	E3
<CHOICE>	94	default=	C4	flipV	E4
</CHOICE>	95	flow=	C5	group	E5
<ENTRY>	96	format=	C6	inline	E6
</ENTRY>	97	go=	C7	left	E7
<CE	A0	key=	C8	list	E8
<GE	A1	label=	C9	none	E9
<IMAGE	A2	method=	CA	number	EA
<INLINE	A3	name=	CB	right	EB
<SOFTKEY	A4	next=	CC	slideE	EC
<B>	B0	page=	CD	slideN	ED
</B>	B1	prev=	CE	slideNE	EE
<I>	B2	src=	CF	slideNW	EF
</I>	B3	ttl=	D0	slideS	F0
<BL>	B4	value=	D1	slideSE	F1
</BL>	B5			slideSW	F2
<CENTER>	B6			slideW	F3
<RIGHT>	B7				
<WRAP>	B8				
<LINE>	B9				
 	BA				

APPENDIX II

A COMPUTER PROGRAM TO GENERATE

A LETTER FREQUENCY TABLE

FOR USE IN THE PREDICTIVE DATA ENTRY PROCESS


```
/*   This program opens a text file selected by the
     user, generates the frequency table for that file,
     and then writes the frequency table to another
     file also selected by the user.
*/

#include <stdio.h>
#include <string.h>
#include <console.h>
#include <assert.h>


typedef unsigned char byte;
typedef byte triplet[3];
typedef byte tristorage[27][27][27];

IncrementTrigram(triplet t, tristorage trigrams)
{
   byte * pb;
   assert(t[0] < 27);
   assert(t[1] < 27);
   assert(t[2] < 27);
   pb = &trigrams[t[0]][t[1]][t[2]];
   if (*pb < 255) *pb = *pb + 1;
   return *pb;
}

StoreTrigramValue(triplet t, tristorage trigrams, byte
value)
{
```

```
  assert(t[0] < 27);
  assert(t[1] < 27);
  assert(t[2] < 27);
  trigrams[t[0]][t[1]][t[2]] = value;
}

byte FetchTrigramvalue(triplet t, tristorage trigrams)
{
  assert(t[0] < 27);
  assert(t[1] < 27);
  assert(t[2] < 27);
  return trigrams[t[0]][t[1]][t[2]];
}

byte DumpTrigram(triplet t, tristorage trigrams)
{
  byte value;
  assert(t[0] < 27);
  assert(t[1] < 27);
  assert(t[2] < 27);
  value = FetchTrigramValue(t, trigrams);
  if (value != 0)
  {
    printf("%c%c%c = ", t[0] + 'a', t[1] + 'a', t[2] +
'a');
    if (value == 255) printf("****");
    else          printf("%3d", value);
}
 return value;
 }

 int IdFromChar(short c)
 {
  c = tolower(c);
  if (c < 'a' || c > 'z') return 26;
  return c - 'a';
```

```
}

AddChar(tristorage trigrams, triplet t, byte b)
{
  byte value;
  unsigned short r;

  assert(b <= 26);
  if (b == 26) { t[0] = t[1] = t[2] = 26; return; }

  t[0] = t[1];
  t[1] = t[2];
  t[2] = b;

  value = FetchTrigramValue(t, trigrams);
  if (value == 255) return;

#if 0
  if (value > 64) {
    r = Random();
    if (value > 192 && r & 0xE000) return;
    else if (value > 128 && r & 0xC000) return;
    else if (value > 64 && r & 0x8000) return;
  }
#endif

  StoreTrigramValue(t, trigrams, value + 1);
}

DumpTrigrams(tristorage trigrams)
{
  int i, j, k;
  int x;
  triplet t;
  x = 0;
  for (i = 0; i < 26; ++i)
```

```
            for (j = 0; j < 26; ++j)
               for (k = 0; k < 26; ++k)
               {
                  byte value;
                  t[0] = i;
                  t[1] = j;
                  t[2] = k;


                  value = DumpTrigram(t, trigrams);

                  if (value == 0) continue;
                  if (++x == 6) {
                     printf("\n"); x = 0;
                  }
                  else
                     printf(" ");
               }
         }

         OSErr BuildTrigram(short refNum, tristorage trigrams)
         {
            OSErr err;
            triplet t;
            t[0] = t[1] = t[2] = 26;

            while (true)
            {
               long count = 80;
               char buf[80];
               int i;

               err = FSRead(refNum, &count, buf);
               if (count == 0) return err;
               for (i = 0; i < count; ++i) {
                  AddChar(trigrams, t, IdFromChar(buf[i]));
```

```
        }
        if (err) return err;
    }
    return 0;
}

Handle OpenTrigrams(void)
{
    OSErr err;
    OSType type;
    StandardFileReply reply
    short refNum;
    short id;
    Handle h;
    Str63   name;
    tristorage *trigrams;

    type = 'TEXT';
    StandardGetFile(nil, 1, &type, &reply);
    if (!reply.sfGood)   return nil;
    err = FSpOpenDF(&reply.sfFile, fsCurPerm, &refNum);
    if (err) return nil;

    memcpy(name, reply.sfFile.name, sizeof(name));

    h = NewHandle(sizeof(tristorage));

    HLock(h);
    trigrams = (tristorage *)(*h);
    memset(*trigrams, 0, sizeof(tristorage));

    BuildTrigram(refNum, *trigrams);
    FSClose(refNum);
    DumpTrigrams(*trigrams);
    HUnlock(h);
```

```
    type = 'rsrc';
    StandardGetFile(nil, 1, &type, &reply);
    if (!reply.sfGood) return;
    refNum = FSpOpenResFile(&reply.sfFile, fsCurPerm);
    if (refNum == -1) return;
    UseResFile(refNum);

    id = UniqueID('smrt');
    //id = 128;
    AddResource(h, 'smrt', id, name);
    UpdateResFile(refNum);
    FSClose(refNum);
    return h;
}

main()
{
    OSErr   err;
    Handle    h;

    cshow(stdout);
    TEInit();
    InitDialogs(OL);
    InitCursor();
    h = OpenTrigrams();
```

Claims

1. A two-way data communication system for communication between a computer and a two-way data communication device selected from a group consisting of a cellular telephone (105), a two-way pager (106), and a telephone (107), said two-way data communication system comprising:

   a two-way data communication network (110, 111, or 112);
   a server computer comprising:

   a two-way data communication interface module (748) coupled to said two-way data communication network; and
   a server (121, 131, or 141) coupled to said two-way data communication interface module;

   wherein said server (121, 131, or 141) receives a message including a resource locator from said two-way data communication network, and said resource locator includes an address of said server (121, 131, or 141);

said server (121, 131, or 141) processes said message using said resource locator; and
said server (121, 131, or 141) transmits a response to said message over said two-way data communication network (110, 111, or 112);

a two-way data communication device (105, 106, or 107) coupled to said two-way data communication network (110, 111, or 112) wherein said two-way data communication device (105, 106, or 107) is selected from the group consisting of a cellular telephone (105), a two-way pager (106), and a telephone (107), and further wherein said two-way data communication device (105, 106, or 107) further comprises:

a network interface module (714) coupled to said two-way data communication network; and
a client module (702) coupled to said network interface module (704);

wherein said client module transmits said message including said resource locator to said server (121, 131, or 141) over said two-way data communication network; and
said client module processes said response to said message from said server (121, 131, or 141) wherein said response includes information for user interaction over said two-way data communication network (110, 111, or 112).

2. A two-way data communication system for communication between a server computer and a cellular telephone, said two-way data communication system comprising:

a data capable cellular telephone communication network (110);
a server computer comprising:

a two-way data communication interface module (748) coupled to said data capable cellular telephone communication network (110); and
a server (121, 131, 141) coupled to said two-way data communication interface module;

wherein said server (121, 131, 141) receives a message including a resource locator from said data capable cellular telephone communication network (110), and said resource locator includes an address of said server (121, 131, or 141);
said server (121, 131, or 141) processes said message using said resource locator; and
said server (121, 131, or 141) transmits a response to said message over said data capable cellular telephone communication network;

a cellular telephone device (105) coupled to said data capable cellular telephone communication network (110) wherein said cellular telephone device (105) further comprises:

a network interface module (714) coupled to said data capable cellular telephone communication network (110); and
a client module (702) coupled to said network interface module (714);

wherein said client module transmits said message including said resource locator to said server (121, 131, or 141) over said data capable cellular telephone communication network (110); and
said client module processes said response to said message from said server (121, 131, or 141) wherein said response includes information for user interaction over said data capable cellular telephone communication network (110).

3. A two-way data communication system as in Claims 1 and 2 wherein said client module further comprises an interpreter wherein said interpreter generates a user interface using information in said response, and said user interface includes at least one user data input option associated with a resource locator.

4. A two-way data communication system as in Claim 3 wherein said resource locator associated with said at least one user data input option addresses an object on said server computer.

5. A two-way data communication system as in Claim 3 wherein said resource locator associated with said at least one user data input option addresses an object on another server computer coupled to said communication network.

6. A two-way data communication system as in Claim 3, 4 or 5 wherein said interpreter includes a plurality of managers including a user interface manager coupled to a display of said device wherein said user interface manager handles interactions with said display.

7. A two-way data communication system as in Claim 7 wherein said user interface manager is coupled to a keypad of said device and further wherein said user interface manager handles interactions with said keypad.

8. A two-way data communication system as in Claim 7 wherein said another resource locator including said address of said server (121, 131, or 141) and said input data comprises a uniform resource locator.

9. A two-way data communication system as in any preceding Claim wherein said response includes a plurality of resource locators and at least one of said plurality of resource locators includes an address to another server (121, 131, or 141) coupled to said communication network.

10. A two-way data communication system as in any preceding Claim wherein said server (121, 131, or 141) is a stateless server and upon said server (121, 131, or 141) completing transmission of said response, said server (121, 131, or 141) completes all processing of said request and retains no state information for said response.

11. A two-way data communication system as in any preceding Claim wherein upon said server (121, 131, 141) completing transmission of said response, said server (121, 131, 141) maintains state information concerning said message wherein said server (121, 131, 141) utilizes said state information concerning said message in response to another message from said device.

12. A two-way data communication system as in any preceding Claim wherein said device further comprises:

a memory (716); and
a resource locator stored in said memory.

13. A two-way data communication system as in any preceding Claim wherein said server computer further comprises:

a memory (755); and
at least one common gateway interface program (761) stored in said memory.

14. A two-way data communication system as in any preceding Claim wherein said server computer further comprises:

a memory (755); and
at least one card deck stored in said memory.

15. A two-way data communication system as in any preceding Claim wherein said device further comprises:

a keypad (715) having a plurality of keys; and
a keypad module (711) coupled to said keypad (715) and to said client module (702)

wherein upon a user pressing a key in said plurality of keys, said keyped module stores information identifying the pressed key in a buffer memory; and
said keypad module notifies said client module of said key press.

16. A two-way data communication system as in Claim 15 wherein said client module (702) further comprises a predictive data entry module (901), wherein said client module uses said predictive data entry module to process said stored information identifying the pressed key upon said client module receiving said notification of said key press.

17. A two-way data communication system as in Claim 16 wherein said predictive text entry module (901) generates a table index using at least one character in said buffer memory of said device in combination with information characterizing said key pressed by said user; and said predictive text entry module retrieves at least one predictive character entry from a table of predictive character entries stored in a memory using said table index wherein said at least one predictive character entry represents a character in a plurality of characters represented by said pressed key.

18. A two-way data communication system as in Claim 17 wherein said at least one character in said buffer memory is

included in a plurality of characters in said memory buffer and further wherein said plurality of characters are used in generating said table index.

19. A two-way data communication system as in Claim 18 wherein each character in said plurality of characters in said memory buffer is a character in a set of characters and further wherein

each character in said set of characters is represented by a unique number and said unique numbers range from 0 to (N-1) where N is a number of characters in said set.

20. A two-way data communication system as in Claim 19 wherein said plurality of keys comprises M keys where M is an integer.

21. A two-way data communication system as in any preceding Claim wherein said device further comprises:

a card deck stored in a memory of said device.

22. A two-way data communication system as in Claims 14 and 21 wherein said card deck includes a display card, or a choice card or an entry card.

23. A two-way data communication system as in any preceding Claim wherein said device further comprises:

a display (705); and
a display module (712) coupled to said display and to said client module (702) wherein said display module drives said display in response to user interface information from said client module.

24. A two-way data communication system as in any preceding Claim wherein said two-way data communication device is said cellular telephone or said two-way pager or said telephone.

25. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer comprising:

generating a message by a client module in response to data entered by said user of a two-way data communication device coupled to a two-way data communication network,

wherein said client module executes on a microcontroller of said two-way data communication device;
said message includes a resource locator; and
said two-way data communication device is selected from a group consisting of a cellular telephone, a two-way pager, and a telephone

transmitting said message over said two-way data communication network to a server computer wherein said server computer is identified by said resource locator;
executing an application on said server computer identified by said resource locator to generate a response to said message; and
transmitting said response to a location identified by said application.

26. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 25 wherein said response is transmitted to said client module.

27. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 26 further comprising:

interpreting said response by said client module and generating a user interface using information in said response wherein said interface includes at least one user data input option associated with a resource locator.

28. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 27 wherein said resource locator associated with said user data input option addresses an object on said server computer.

29. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone,

a two-way pager, and a telephone, to communicate with a server computer, as in Claim 29 wherein said resource locator associated with said user data input option addresses an object on another server computer.

30. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 29 further comprising:

interpreting a data input entry by a user of said two-way data communication device.

31. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 30 further comprising:

appending said data input entry to said resource locator associated with said data input entry option.

32. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 25 wherein said response is a card deck and further wherein said card deck includes at least one card.

33. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 25 further comprising:

storing said card deck stored in a memory of two-way communication device.

34. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 33 further comprising:

processing said stored card deck using said client module.

35. A method for using a two-way data communication device, selected from a group consisting of a cellular telephone, a two-way pager, and a telephone, to communicate with a server computer, as in Claim 34 further comprising:

generating a display on two-way data communication device for each card in said card deck.

36. A two-way data communication device having a microcontroller, wherein said two-way data communication device comprises:

a memory;
a display;
a display module coupled to said display wherein said display module drives said display;
a keypad including a plurality of keys;
a keypad module coupled to said keypad
wherein upon a user pressing a key in said plurality of keys, said keypad module stores information identifying the pressed key in said memory;
a network interface module wherein said network interface module receives data from and sends data to a two-way data communication network;
a client module coupled to said display module, said network interface module, said keypad module, and said memory;

wherein said client module executes on said microcontroller;
said client module, in response to a signal from said keypad module, processes said stored information identifying the pressed key and stores a character in a memory buffer; and
upon completion of data entry, said client module retrieves all characters in said memory buffer and generates a request including said characters to said network interface module which in turn transmits said request including said characters over said two-way data communication network.

37. A two-way data communication device as in Claim 36 further comprising:

a card deck stored in said memory.

38. A two-way data communication device as in Claim 37 wherein said card deck includes a choice card.

39. A two-way data communication device as in Claim 38 wherein upon said client module processing said choice card, said client module retrieves said stored information identifying the pressed key, and generates a request for a choice corresponding to the pressed key to said server (121, 131, 141).

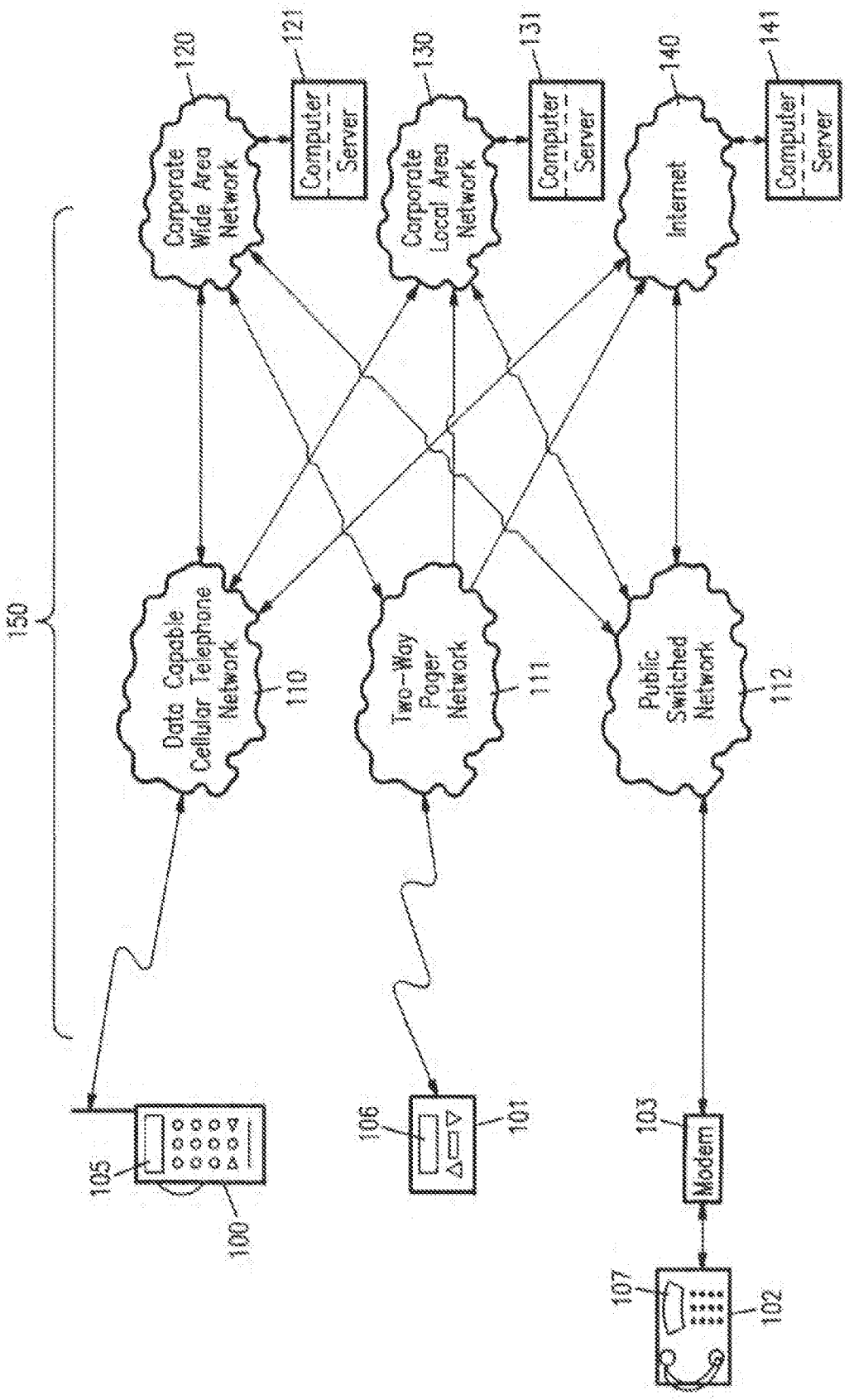

150
Corporate Wide Area Network
120
Computer Server
121
Corporate Local Area Network
130
Computer Server
131
Internet
140
Computer Server
141
Data Capable Cellular Telephone Network
110
Two-Way Pager Network
111
Public Switched Network
112
105
100
106
101
103
Modem
107
102

FIG. 1

FIG. 2A

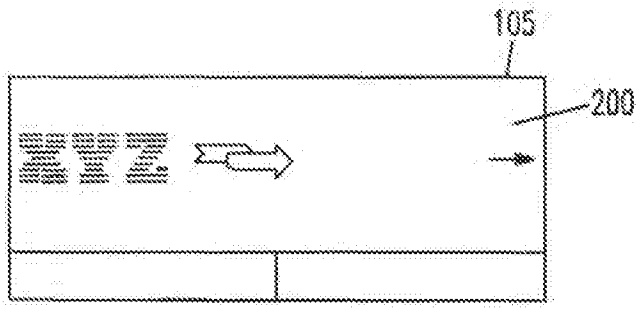


FIG. 2B

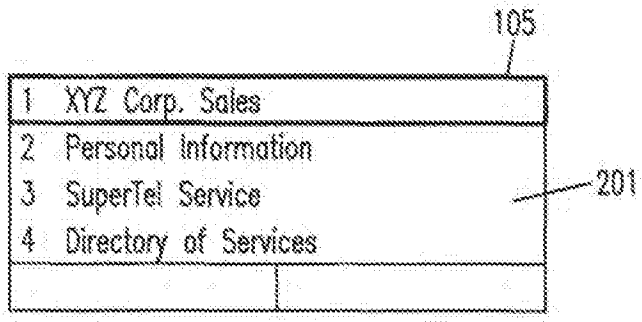


FIG. 2C

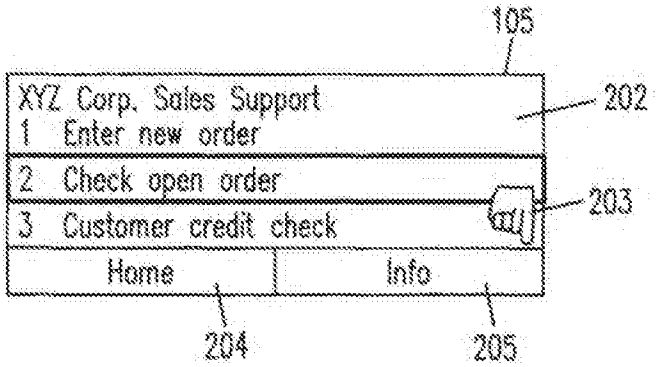


FIG. 2D

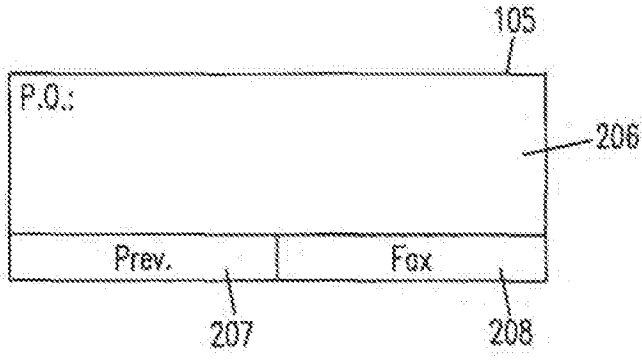


FIG. 2E

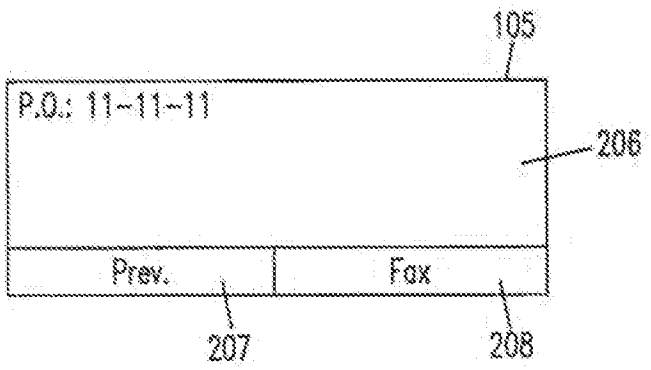


FIG. 2F

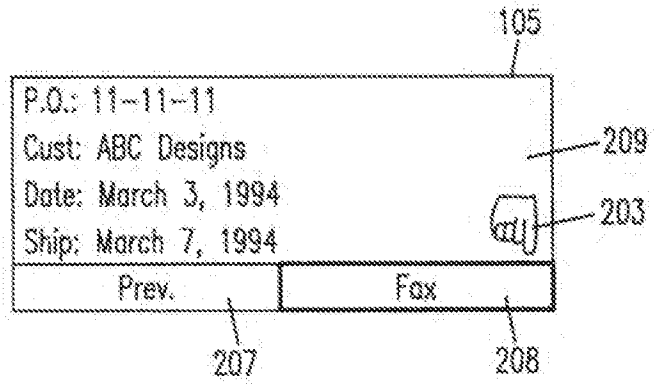


FIG. 2G

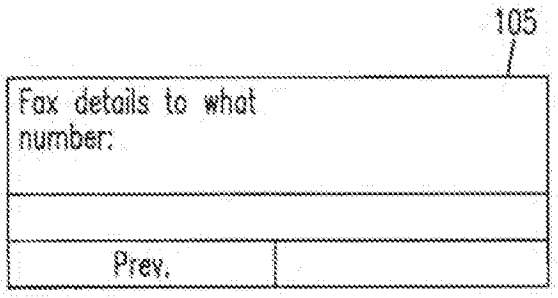
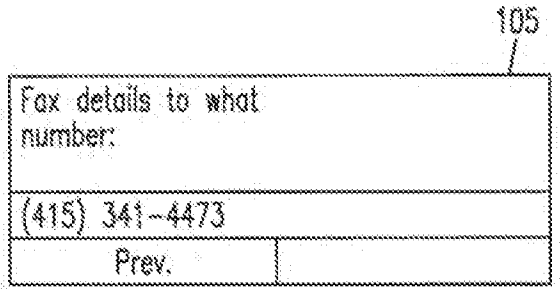


FIG. 2H



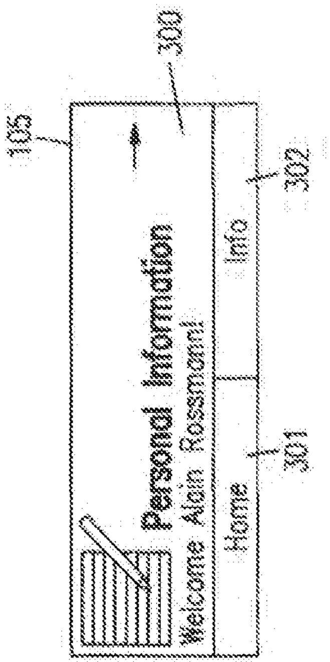


FIG. 3A

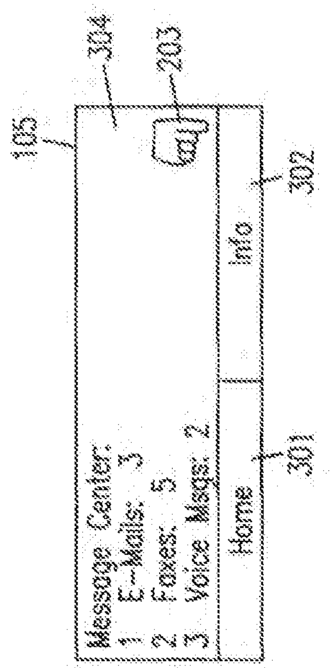


FIG. 3B

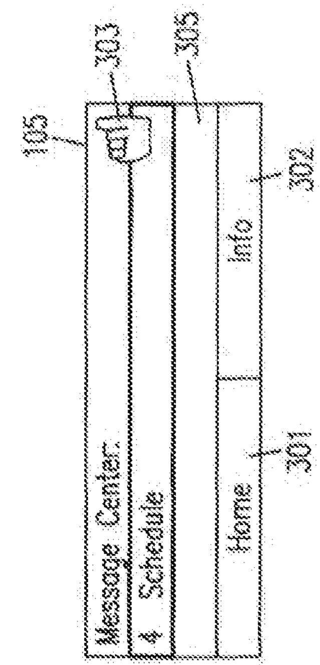


FIG. 3C

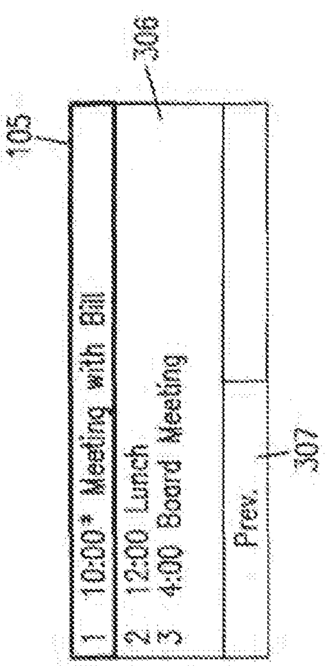


FIG. 3D

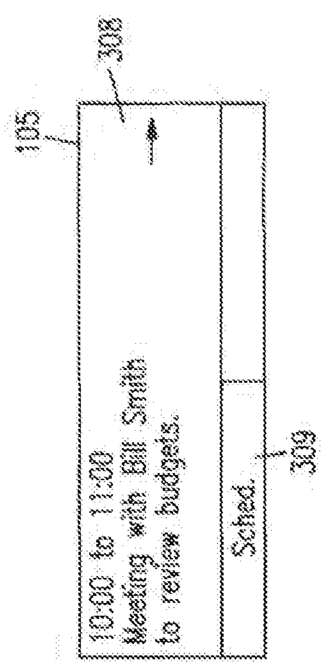


FIG. 3E

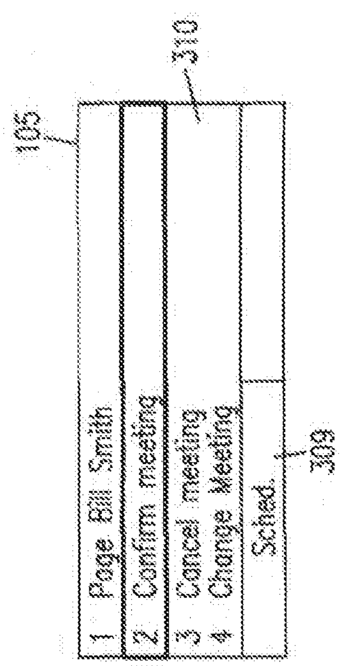


FIG. 3F

RPX-1003, p.543

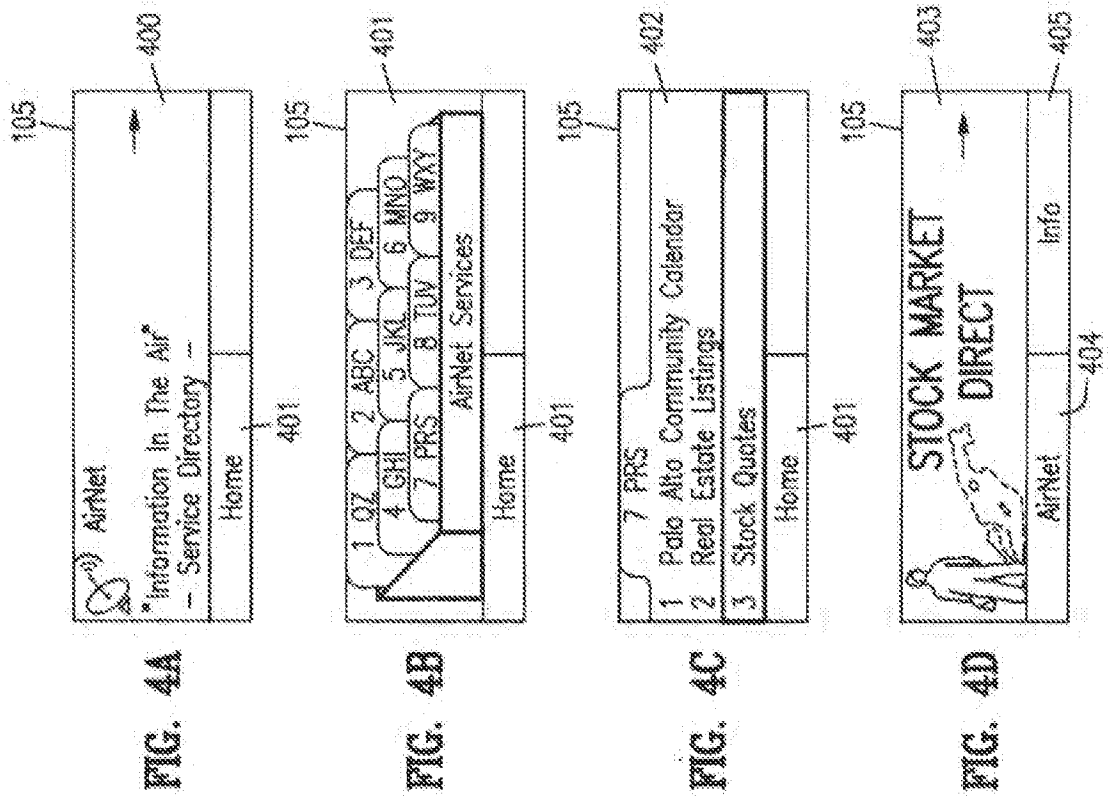


FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

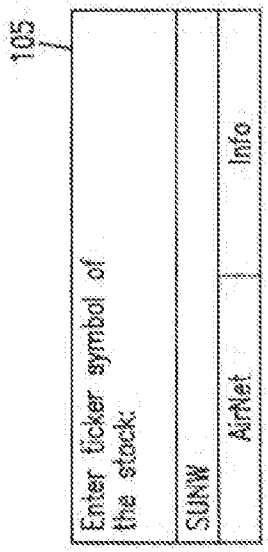


FIG. 4E

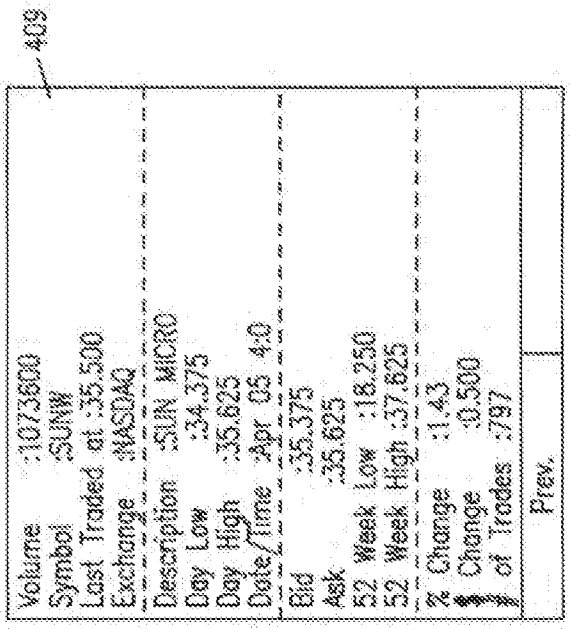


FIG. 4F

FIG. 4G

FIG. 4H

FIG. 4I

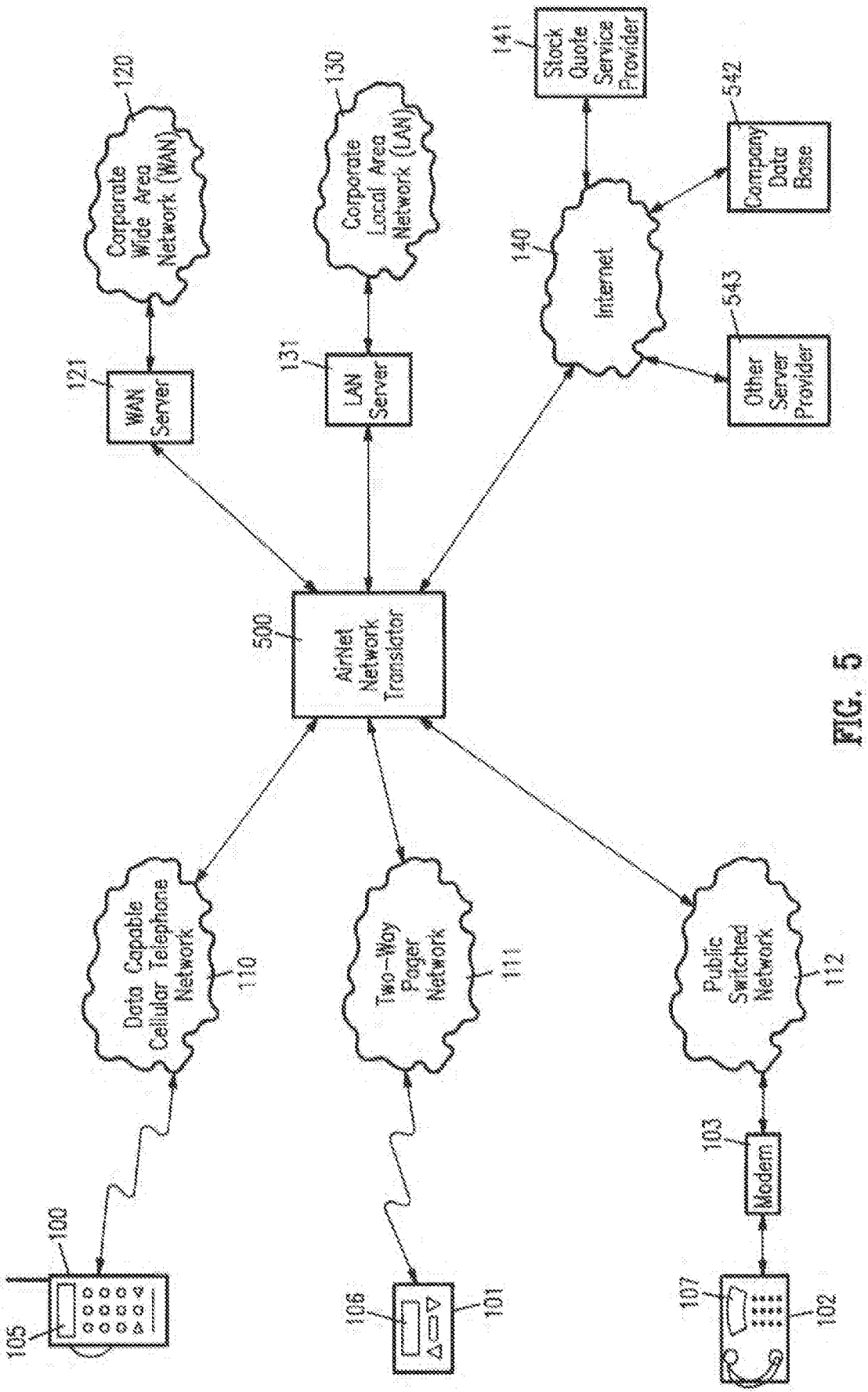


FIG. 5

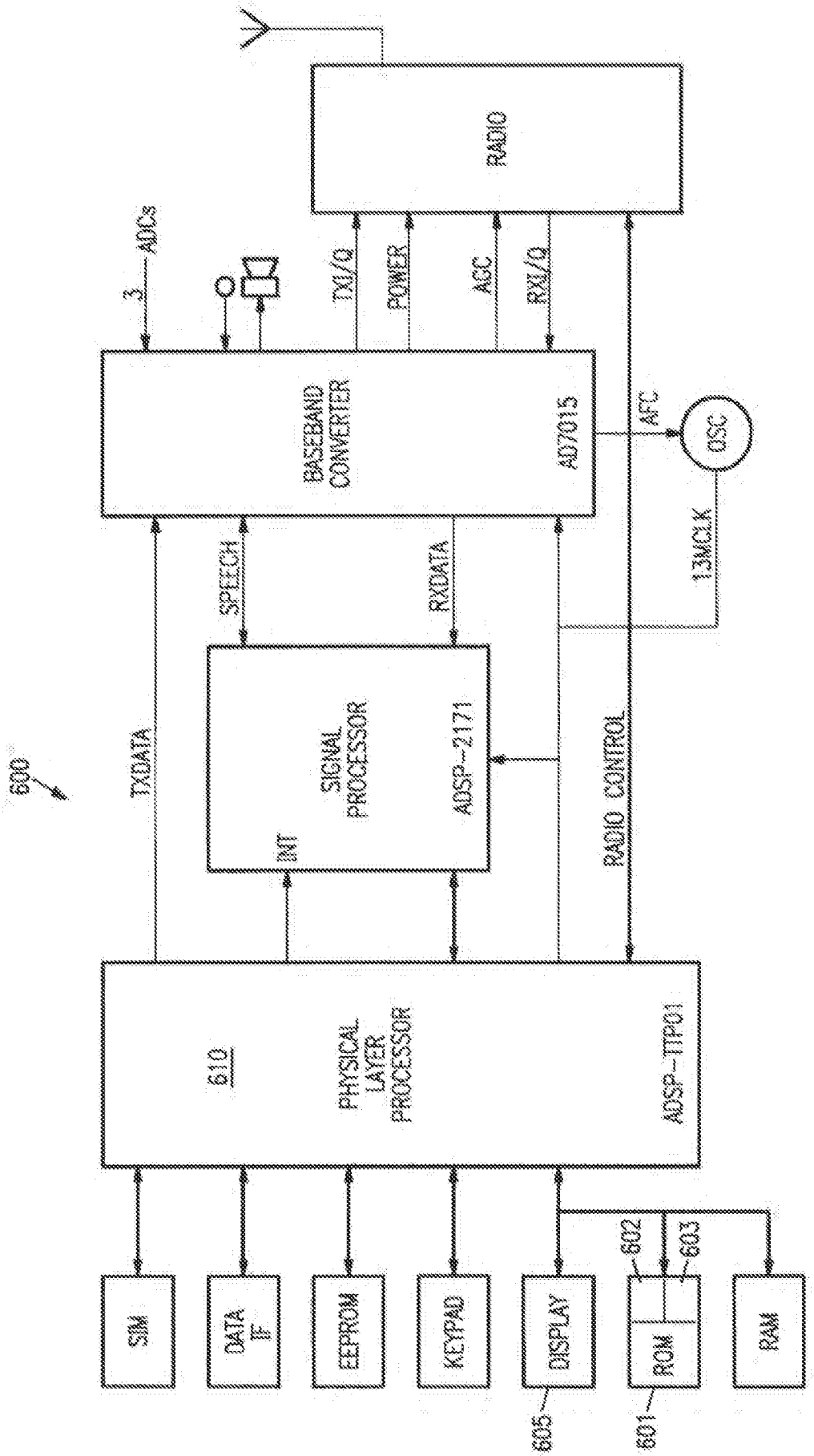


FIG. 6

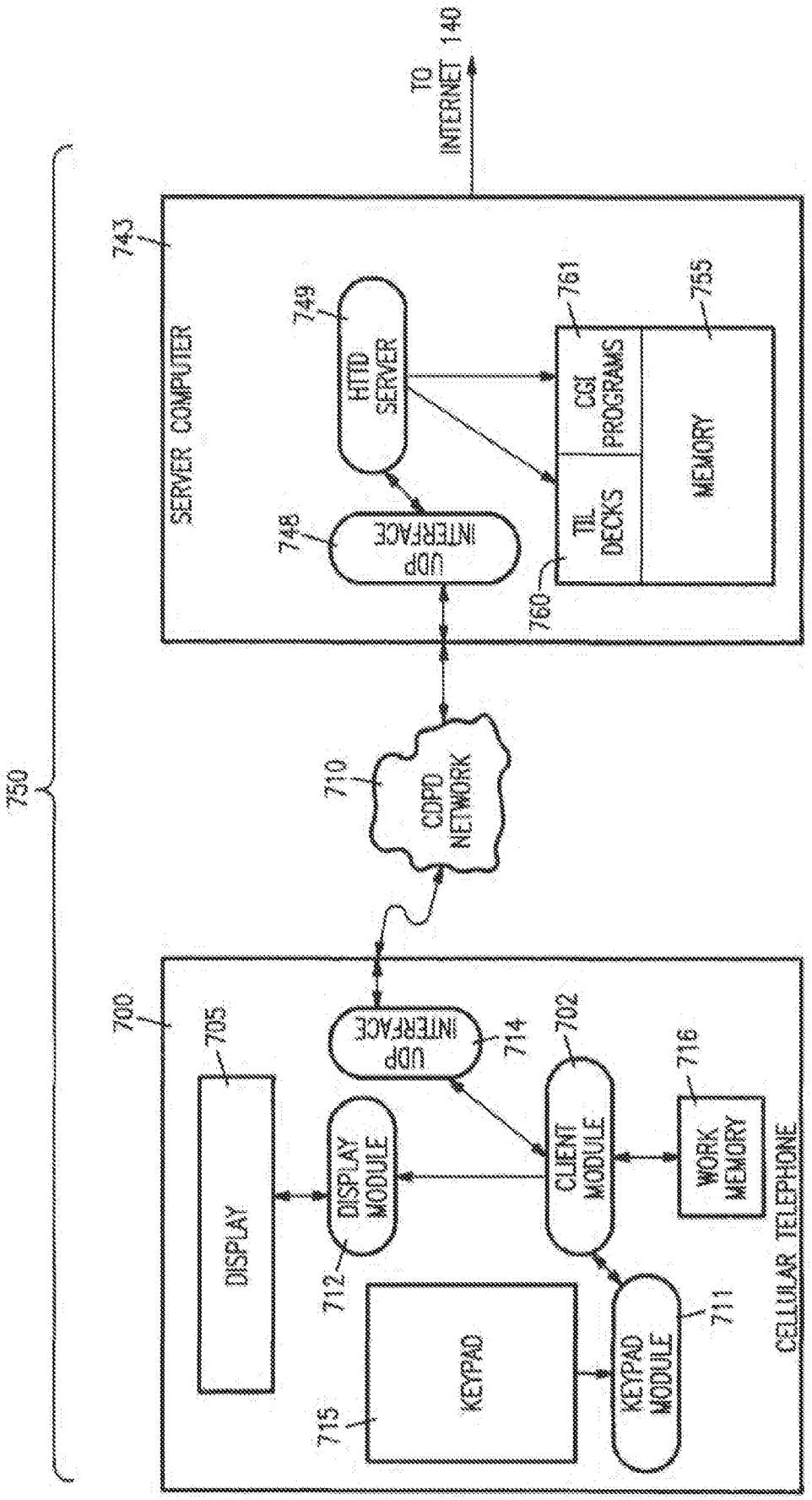


FIG. 7

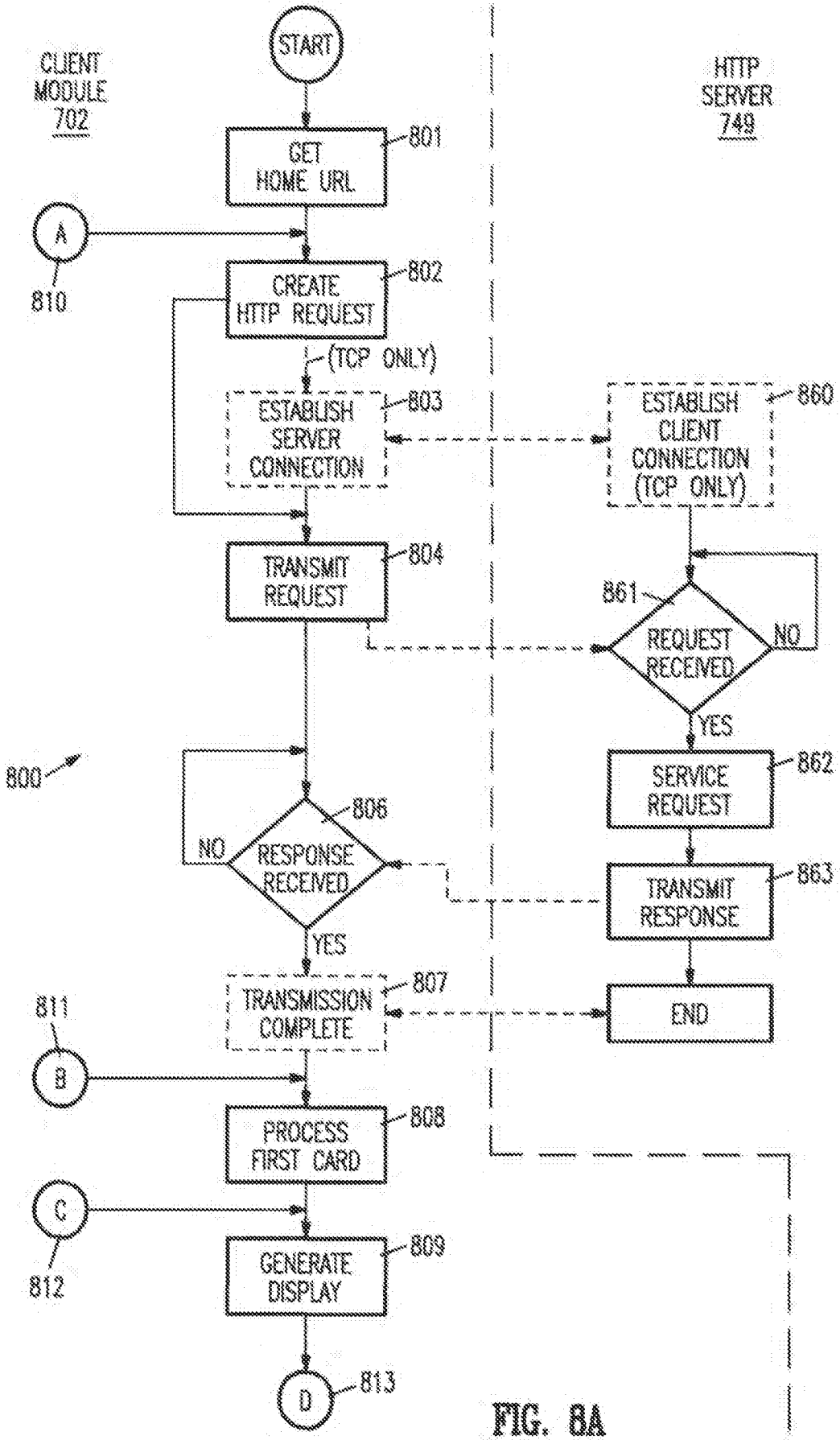


FIG. 8A

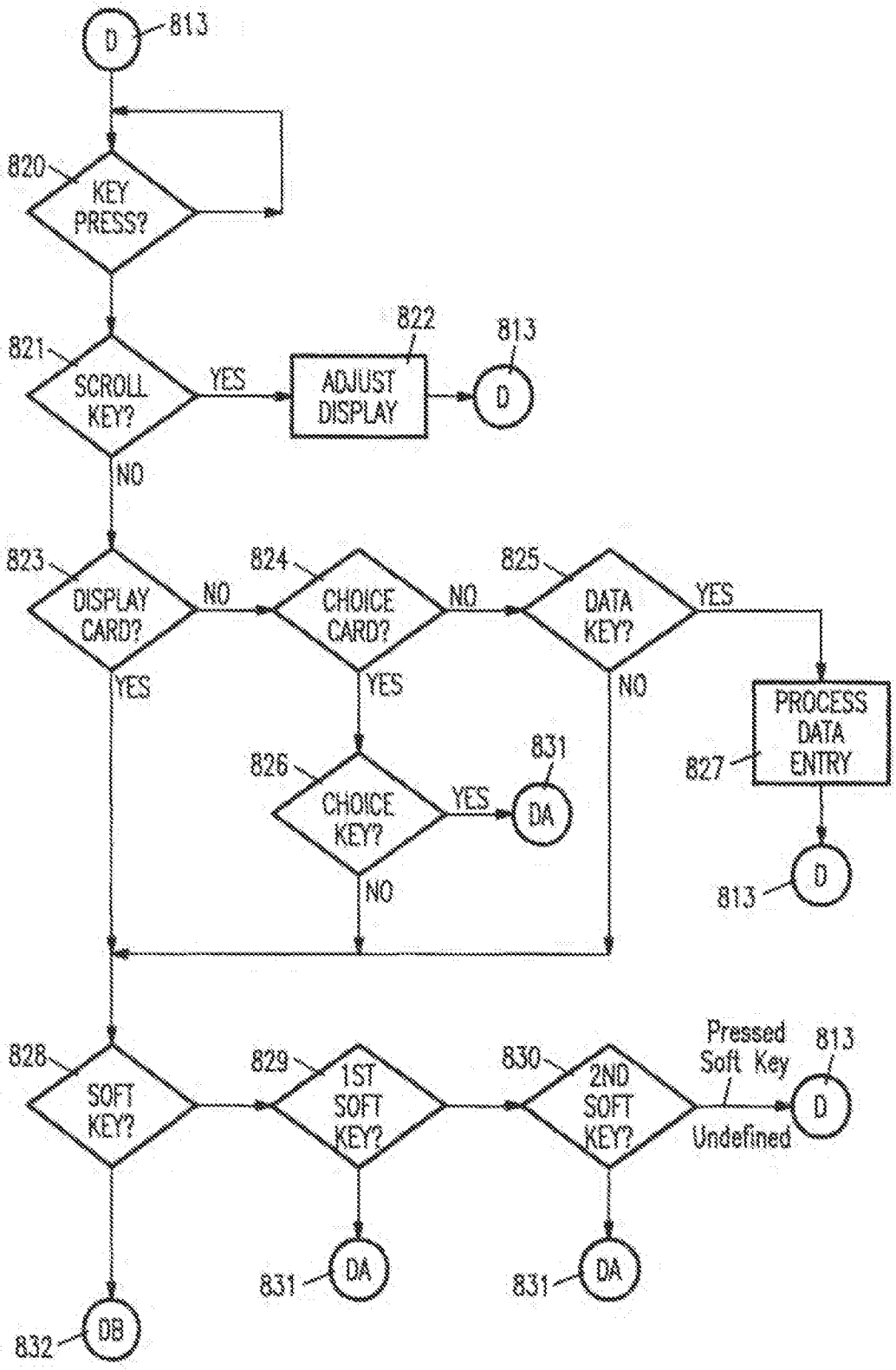

D
813
820
KEY PRESS?
821
SCROLL KEY?
YES
822
ADJUST DISPLAY
813
D
NO
823
DISPLAY CARD?
NO
824
CHOICE CARD?
NO
825
DATA KEY?
YES
YES
YES
NO
826
CHOICE KEY?
YES
831
DA
NO
827
PROCESS DATA ENTRY
813
D
828
SOFT KEY?
829
1ST SOFT KEY?
830
2ND SOFT KEY?
Pressed Soft Key
Undefined
813
D
831
DA
831
DA
832
DB

FIG. 8B

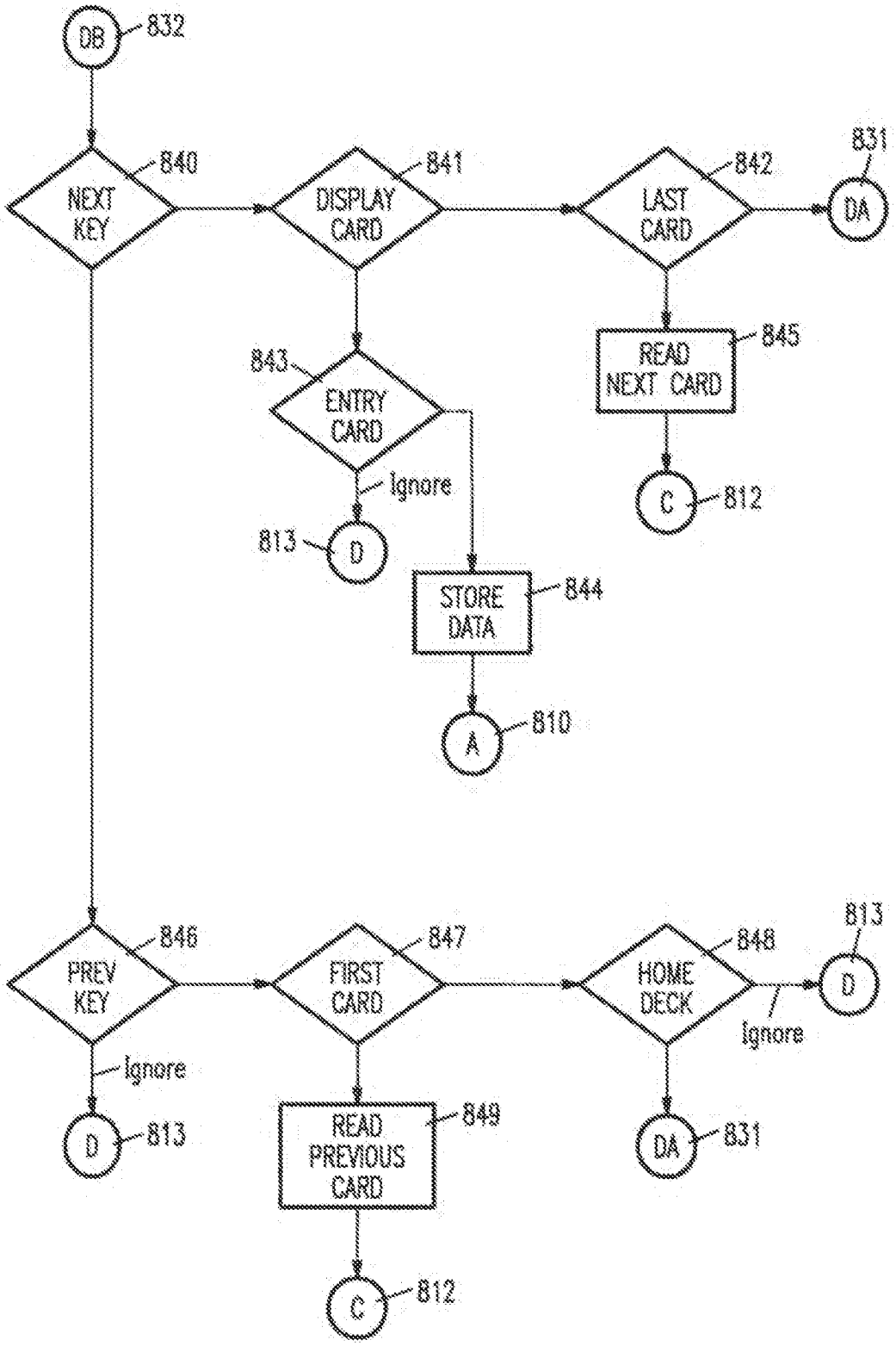


FIG. 8C

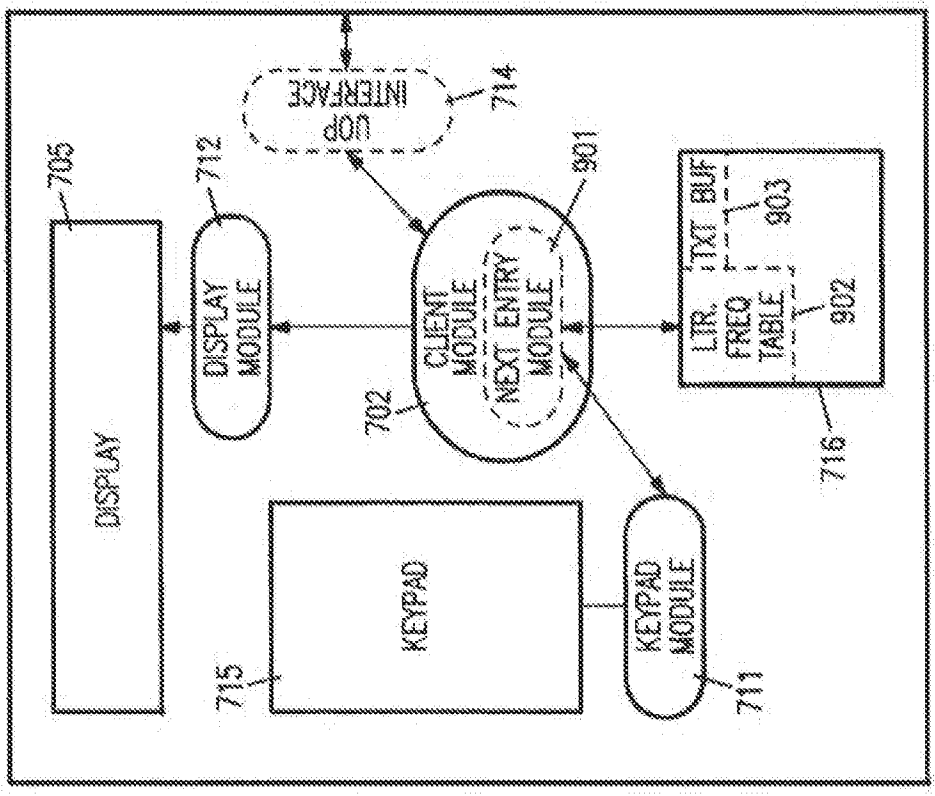


FIG. 9

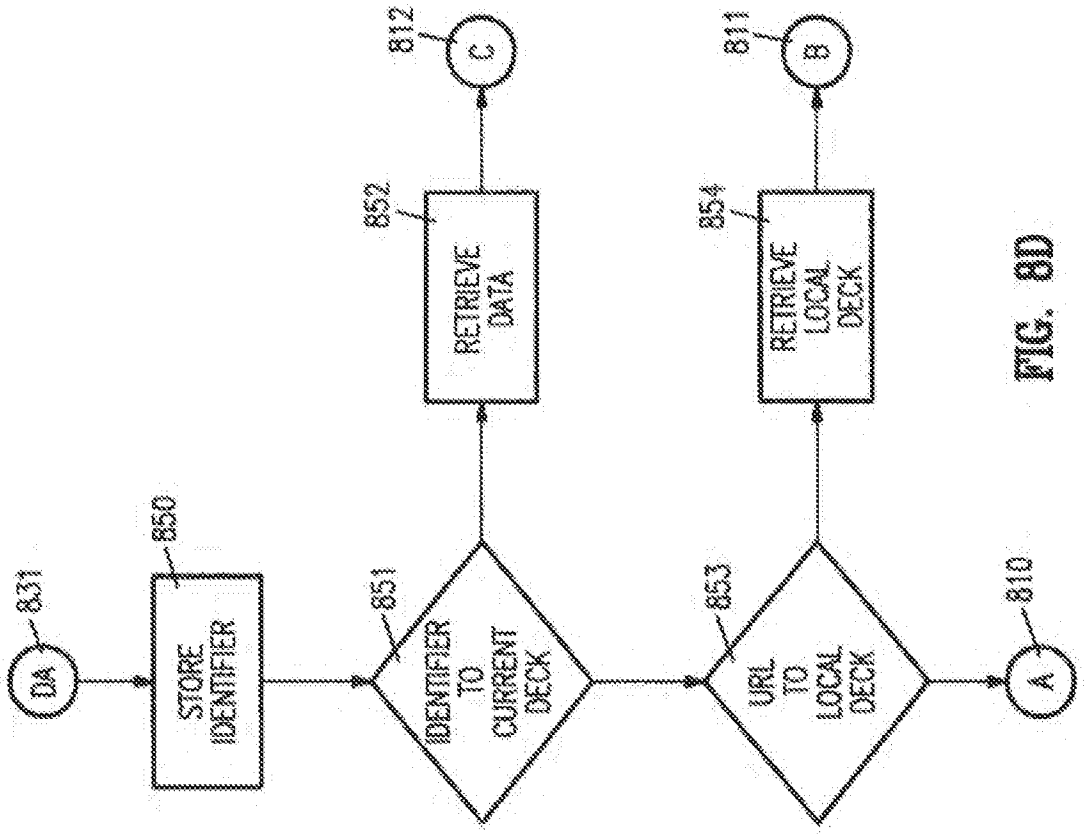


FIG. 8D

"-	-"	1	2	3	4	5	6	7	8	9
"a	a"	q	a	d	g	j	m	r	t	w
"a	b"	q	a	e	i	l	o	r	u	w
"a	c"	q	c	e	h	k	m	r	t	w
"a	d"	q	a	d	i	j	m	s	v	y
"a	e"	q	a	d	g	j	m	p	t	w
"a	f"	q	a	f	g	j	m	r	t	w
"a	g"	q	a	e	i	j	o	r	t	w
"a	h"	q	a	e	g	j	m	p	u	w
"a	i"	q	c	d	g	l	n	r	t	w
"a	j"	q	a	d	g	j	o	p	t	w
"a	k"	q	a	e	i	j	m	s	t	w
"a	l"	q	a	e	i	l	o	s	t	w
"a	m"	q	a	e	i	l	o	p	u	w
"a	n"	q	c	d	g	k	n	s	t	y
"a	o"	q	a	d	g	j	m	p	t	w
"a	p"	q	a	e	h	l	o	p	t	w
"a	q"	q	a	d	g	j	m	s	t	w
"a	r"	q	c	e	g	k	o	r	t	y
"a	s"	q	c	e	i	k	o	s	t	y
"a	t"	q	a	e	i	l	o	s	t	w
"a	u"	q	c	d	g	l	m	s	t	w
"a	v"	q	a	e	i	j	o	p	t	w
"a	w"	q	a	d	g	k	m	p	t	w
"a	x"	q	a	e	i	l	m	s	t	w
"a	y"	q	b	e	i	j	m	s	t	w
"a	z"	q	a	d	i	j	m	p	t	w
"a	"	q	a	d	g	j	m	p	t	w
"b	a"	q	c	d	g	k	n	s	t	y
"b	b"	q	a	d	i	j	m	s	t	y
"b	c"	q	a	d	g	j	o	r	t	w
"b	d"	q	a	d	g	j	m	s	t	w
"b	e"	q	c	e	g	l	n	s	t	x
"b	f"	q	a	d	g	j	m	p	t	w
"b	g"	q	a	d	g	j	m	p	t	w
"b	h"	q	a	d	g	j	m	p	t	w
"b	i"	q	c	d	g	l	n	s	t	w
"b	j"	q	a	e	g	j	m	p	t	w

FIG. 10A

"a	"a"	1	2	3	4	5	6	7	8	9
"b	k"	q	a	d	g	j	m	p	t	w
"b	l"	q	a	e	i	j	o	p	t	y
"b	m"	q	a	d	g	j	m	r	t	w
"b	n"	q	a	d	g	j	m	p	t	w
"b	o"	q	a	d	i	j	o	s	u	x
"b	p"	q	a	d	g	j	m	s	t	w
"b	q"	q	a	d	g	j	m	p	t	w
"b	r"	q	a	e	i	j	o	p	u	w
"b	s"	q	c	d	i	j	o	s	t	w
"b	t"	q	a	d	g	j	m	p	t	w
"b	u"	q	a	d	i	l	m	s	t	y
"b	v"	q	a	d	i	j	m	p	t	w
"b	w"	q	a	e	g	j	m	p	t	w
"b	x"	q	a	d	g	j	m	p	t	w
"b	y"	q	a	d	g	j	m	p	t	w
"b	z"	q	a	d	g	j	m	p	t	w
"b	"	q	a	d	g	j	m	p	t	w
"c	a"	q	b	d	g	l	n	r	t	w
"c	b"	q	a	e	g	j	m	p	t	w
"c	c"	q	a	e	i	j	o	s	t	w
"c	d"	q	a	d	g	j	m	p	t	w
"c	e"	q	a	d	i	l	n	s	t	w
"c	f"	q	a	d	i	j	m	p	t	w
"c	g"	q	a	d	i	j	m	p	t	w
"c	h"	q	a	e	i	j	o	r	t	w
"c	i"	q	a	f	i	l	n	p	t	w
"c	j"	q	a	d	g	j	m	p	t	w
"c	k"	q	b	e	i	l	m	s	t	y
"c	l"	q	a	e	i	j	o	r	u	w
"c	m"	q	c	d	g	j	m	p	t	w
"c	n"	q	a	d	g	j	m	p	t	w
"c	o"	q	a	d	g	l	m	r	u	w
"c	p"	q	a	d	g	j	m	p	t	w
"c	q"	q	a	d	g	j	m	p	t	w
"c	r"	q	a	e	i	j	o	p	u	y
"c	s"	q	a	d	i	l	o	s	t	w
"c	t"	q	a	e	i	l	o	r	u	w

FIG. 10B

"	"	1	2	3	4	5	6	7	8	9
"c	u"	q	b	e	i	l	m	s	t	w
"c	v"	q	a	d	g	j	m	p	t	w
"c	w"	q	a	d	g	j	m	p	t	w
"c	x"	q	a	d	g	j	m	p	t	w
"c	y"	q	c	d	g	j	m	p	t	w
"c	z"	q	a	d	g	j	n	p	t	w
"c	"	q	a	d	g	j	m	p	t	w
"d	a"	q	b	d	g	j	n	r	t	y
"d	b"	q	a	d	g	j	m	p	t	w
"d	c"	q	a	d	g	j	m	p	t	w
"d	d"	q	a	e	i	l	m	r	t	w
"d	e"	q	a	d	g	l	m	r	v	x
"d	f"	q	a	d	i	j	m	p	t	w
"d	g"	q	a	e	g	j	m	p	t	w
"d	h"	q	a	e	g	j	m	p	t	w
"d	i"	z	a	f	g	l	n	s	t	w
"d	j"	q	a	d	g	j	m	p	t	w
"d	k"	q	a	d	g	j	m	p	t	w
"d	l"	q	a	e	i	j	m	p	t	y
"d	m"	q	a	d	i	j	m	s	t	w
"d	n"	q	a	e	g	j	m	p	t	w
"d	o"	q	c	e	i	j	n	p	t	w
"d	p"	q	a	d	g	j	m	p	t	w
"d	q"	q	a	d	g	j	m	p	u	w
"d	r"	q	a	e	i	j	o	p	t	w
"d	s"	q	a	e	i	j	m	p	t	w
"d	t"	q	a	d	g	j	m	r	t	w
"d	u"	q	c	e	g	l	m	r	t	w
"d	v"	q	a	d	i	j	m	p	t	w
"d	w"	q	a	d	i	j	o	p	t	w
"d	x"	q	a	d	g	j	m	p	t	w
"d	y"	q	a	d	g	j	m	p	t	w
"d	z"	q	a	d	g	j	m	p	t	w
"d	"	q	a	d	g	j	m	p	t	w
"e	a"	q	c	d	g	l	n	s	t	w
"e	b"	q	c	f	g	j	m	r	t	y
"e	c"	q	a	e	h	k	o	s	t	w

FIG. 10C

"-	-"	1	2	3	4	5	6	7	8	9
"e	d"	q	b	e	i	l	n	s	u	w
"e	e"	z	a	d	i	k	n	r	t	w
"e	f"	q	a	e	i	l	o	r	t	w
"e	g"	q	a	d	i	j	o	r	u	y
"e	h"	q	a	e	i	j	m	p	t	w
"e	i"	q	a	d	g	j	n	r	v	w
"e	j"	q	a	e	g	j	m	p	t	w
"e	k"	q	a	e	i	j	m	s	t	w
"e	l"	q	a	e	i	l	o	p	v	y
"e	m"	q	a	e	i	j	o	s	u	w
"e	n"	q	c	d	g	l	o	s	t	w
"e	o"	q	a	f	g	j	n	p	u	w
"e	p"	q	a	e	h	l	o	r	t	w
"e	q"	q	a	d	g	j	m	p	u	w
"e	r"	q	a	e	i	l	n	s	v	y
"e	s"	q	c	e	i	k	n	s	t	w
"e	t"	z	c	e	i	j	m	s	t	w
"e	u"	q	a	d	g	j	m	r	t	w
"e	v"	q	a	e	i	j	o	p	t	w
"e	w"	q	a	e	h	j	o	s	t	w
"e	x"	q	a	e	i	j	m	p	t	w
"e	y"	q	a	d	g	j	o	s	t	w
"e	z"	q	a	e	g	j	m	p	t	w
"e	"	q	a	d	g	j	m	p	t	w
"f	a"	q	c	d	i	k	m	s	v	x
"f	b"	q	a	d	g	j	m	p	t	w
"f	c"	q	c	d	g	j	m	p	t	w
"f	d"	q	a	d	g	j	m	p	t	w
"f	e"	q	a	e	g	l	m	r	t	w
"f	f"	q	a	e	i	j	o	s	t	w
"f	g"	q	a	d	g	j	m	p	t	w
"f	h"	q	a	d	g	j	m	p	t	w
"f	i"	q	c	e	g	l	n	r	t	x
"f	j"	q	a	d	g	j	m	p	t	w
"f	k"	q	a	d	g	j	m	p	t	w
"f	l"	q	a	e	i	j	o	p	t	y
"f	m"	q	a	d	g	j	m	p	t	w

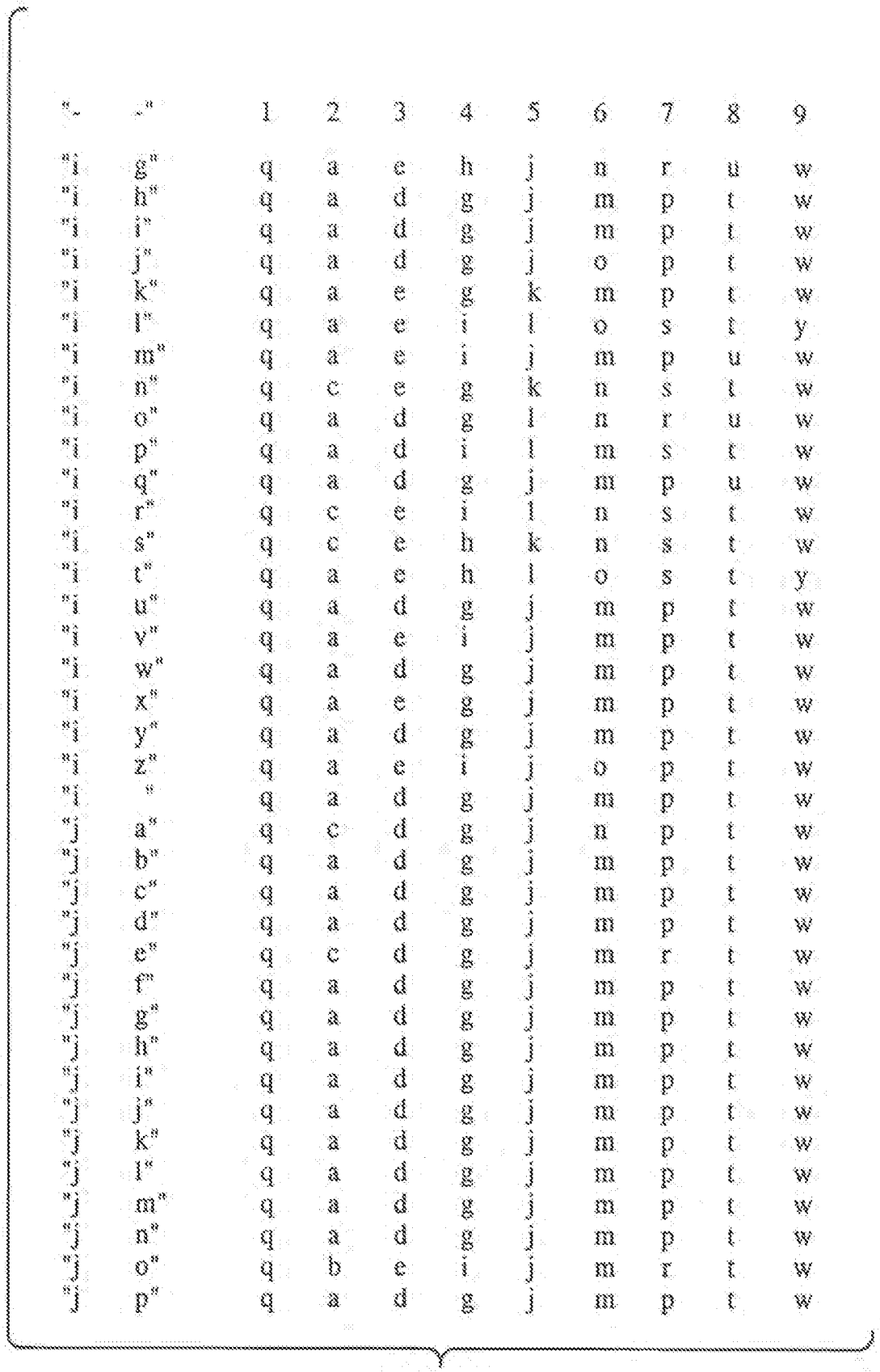
FIG. 10D

"~	~"	1	2	3	4	5	6	7	8	9
"f	n"	q	a	d	g	j	m	p	t	w
"f	o"	q	c	d	g	l	n	r	u	w
"f	p"	q	a	d	g	j	m	p	t	w
"f	q"	q	a	d	g	j	m	p	t	w
"f	r"	q	a	e	i	j	o	p	t	y
"f	s"	q	a	d	g	j	m	p	t	w
"f	t"	q	a	e	g	k	m	p	t	w
"f	u"	q	a	d	g	l	n	r	t	w
"f	v"	q	a	d	g	j	m	p	t	w
"f	w"	q	a	d	g	j	m	p	t	w
"f	x"	q	a	d	g	j	m	p	t	w
"f	y"	q	a	d	i	j	m	p	t	w
"f	z"	q	a	d	g	j	m	p	t	w
"f	"	q	a	d	g	j	m	p	t	w
"g	a"	z	a	d	i	l	n	r	t	w
"g	b"	q	a	d	g	j	m	p	t	w
"g	c"	q	a	d	g	j	m	s	t	w
"g	d"	q	a	d	g	j	o	p	t	w
"g	e"	q	a	d	g	l	n	s	t	w
"g	f"	q	a	d	g	j	m	p	u	w
"g	g"	q	a	e	g	l	m	p	t	w
"g	h"	q	a	e	g	j	o	p	t	w
"g	i"	q	c	f	g	j	n	s	v	w
"g	j"	q	a	d	g	j	m	p	t	w
"g	k"	q	a	d	g	j	m	p	t	w
"g	l"	q	a	e	i	j	o	p	t	y
"g	m"	q	a	d	g	l	m	s	t	w
"g	n"	q	a	e	i	j	o	p	t	w
"g	o"	q	a	e	i	j	o	p	t	w
"g	p"	q	a	d	g	j	m	p	t	w
"g	q"	q	a	d	g	j	m	p	t	w
"g	r"	q	a	e	g	j	o	p	t	w
"g	s"	q	a	d	g	j	m	p	t	w
"g	t"	q	a	e	h	j	o	p	t	w
"g	u"	q	a	e	i	l	m	r	t	y
"g	v"	q	a	d	g	j	m	p	t	w
"g	w"	q	a	d	g	j	m	p	t	w

FIG. 10E

"-	-"	1	2	3	4	5	6	7	8	9
"g	x"	q	a	d	g	j	m	p	t	w
"g	y"	q	a	d	g	j	m	p	t	w
"g	z"	q	a	d	g	j	m	p	t	w
"g	"	q	a	d	g	j	m	p	t	w
"h	a"	q	b	d	i	l	n	s	t	w
"h	b"	q	a	d	g	j	m	p	t	w
"h	c"	q	a	d	g	j	o	p	t	w
"h	d"	q	a	d	g	j	m	r	t	w
"h	e"	q	c	d	i	l	n	r	t	y
"h	f"	q	a	d	g	j	m	p	t	w
"h	g"	q	a	d	g	j	m	p	t	w
"h	h"	q	a	d	g	j	m	p	t	w
"h	i"	q	c	e	g	l	n	s	t	w
"h	j"	q	a	d	g	j	m	p	t	w
"h	k"	q	a	d	g	j	m	p	t	w
"h	l"	q	a	d	g	j	m	p	t	y
"h	m"	q	a	e	g	j	m	p	t	w
"h	n"	q	a	d	i	j	o	p	t	w
"h	o"	q	b	d	i	l	n	r	u	w
"h	p"	q	a	d	g	j	m	p	u	w
"h	q"	q	a	d	g	j	m	p	t	w
"h	r"	q	a	e	i	j	o	p	t	w
"h	s"	q	a	d	g	j	m	p	t	w
"h	t"	q	a	d	g	l	m	s	t	w
"h	u"	q	a	d	g	l	m	r	t	w
"h	v"	q	a	d	g	j	m	p	t	w
"h	w"	q	a	d	g	j	m	p	t	w
"h	x"	q	a	d	g	j	m	p	t	w
"h	y"	q	a	d	g	j	m	p	t	w
"h	z"	q	a	d	g	j	m	p	t	w
"h	"	q	a	d	g	j	m	p	t	w
"i	a"	q	b	d	g	l	n	r	t	w
"i	b"	q	a	e	i	l	m	r	u	w
"i	c"	q	a	e	h	k	o	r	t	y
"i	d"	q	a	e	i	l	n	p	u	w
"i	e"	q	c	d	g	l	n	r	v	w
"i	f"	q	a	f	i	j	o	p	t	y

FIG. 10F



		1	2	3	4	5	6	7	8	9
	g"	q	a	e	h	j	n	r	u	w
	h"	q	a	d	g	j	m	p	t	w
	i"	q	a	d	g	j	m	p	t	w
	j"	q	a	d	g	j	o	p	t	w
	k"	q	a	e	g	k	m	p	t	w
	l"	q	a	e	i	l	o	s	t	y
	m"	q	a	e	i	j	m	p	u	w
	n"	q	c	e	g	k	n	s	t	w
	o"	q	a	d	g	l	n	r	u	w
	p"	q	a	d	i	l	m	s	t	w
	q"	q	a	d	g	j	m	p	u	w
	r"	q	c	e	i	l	n	s	t	w
	s"	q	c	e	h	k	n	s	t	w
	t"	q	a	e	h	l	o	s	t	y
	u"	q	a	d	g	j	m	p	t	w
	v"	q	a	e	i	j	m	p	t	w
	w"	q	a	d	g	j	m	p	t	w
	x"	q	a	e	g	j	m	p	t	w
	y"	q	a	d	g	j	m	p	t	w
	z"	q	a	e	i	j	o	p	t	w
	"	q	a	d	g	j	m	p	t	w
	a"	q	c	d	g	j	n	p	t	w
	b"	q	a	d	g	j	m	p	t	w
	c"	q	a	d	g	j	m	p	t	w
	d"	q	a	d	g	j	m	p	t	w
	e"	q	c	d	g	j	m	r	t	w
	f"	q	a	d	g	j	m	p	t	w
	g"	q	a	d	g	j	m	p	t	w
	h"	q	a	d	g	j	m	p	t	w
	i"	q	a	d	g	j	m	p	t	w
	j"	q	a	d	g	j	m	p	t	w
	k"	q	a	d	g	j	m	p	t	w
	l"	q	a	d	g	j	m	p	t	w
	m"	q	a	d	g	j	m	p	t	w
	n"	q	a	d	g	j	m	p	t	w
	o"	q	b	e	i	j	m	r	t	w
	p"	q	a	d	g	j	m	p	t	w

FIG. 10G

"-	-"	1	2	3	4	5	6	7	8	9
"j	q"	q	a	d	g	j	m	p	t	w
"j	r"	q	a	d	g	j	m	p	t	w
"j	s"	q	a	d	g	j	m	p	t	w
"j	t"	q	a	d	g	j	m	p	t	w
"j	u"	q	a	d	g	l	m	s	t	w
"j	v"	q	a	d	g	j	m	p	t	w
"j	w"	q	a	d	g	j	m	p	t	w
"j	x"	q	a	d	g	j	m	p	t	w
"j	y"	q	a	d	g	j	m	p	t	w
"j	z"	q	a	d	g	j	m	p	t	w
"j	"	q	a	d	g	j	m	p	t	w
"k	a"	q	a	d	g	j	n	s	t	y
"k	b"	q	a	d	g	j	o	p	t	w
"k	c"	q	a	d	g	j	m	p	t	w
"k	d"	q	a	d	g	j	o	p	t	w
"k	e"	q	a	d	g	l	n	s	t	y
"k	f"	q	a	d	g	j	m	p	t	w
"k	g"	q	a	d	g	j	m	r	t	w
"k	h"	q	a	d	g	j	m	p	t	w
"k	i"	q	a	d	g	l	n	p	t	w
"k	j"	q	a	d	g	j	m	p	t	w
"k	k"	q	a	d	g	j	o	p	t	w
"k	l"	q	a	d	i	j	m	p	t	y
"k	m"	q	a	d	g	j	m	p	t	w
"k	n"	q	a	d	g	j	o	p	t	w
"k	o"	q	a	d	g	l	n	p	t	w
"k	p"	q	a	d	g	j	m	p	t	w
"k	q"	q	a	d	g	j	m	p	t	w
"k	r"	q	a	d	g	j	m	p	t	w
"k	s"	q	a	d	g	j	m	p	t	w
"k	t"	q	a	d	g	j	m	p	t	w
"k	u"	q	a	d	g	j	m	p	t	w
"k	v"	q	a	d	g	j	m	p	t	w
"k	w"	q	a	d	g	j	m	p	t	w
"k	x"	q	a	d	g	j	m	p	t	w
"k	y"	q	a	d	g	j	m	p	t	w
"k	z"	q	a	d	g	j	m	p	t	w

FIG. 10H

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"-	-"	1	2	3	4	5	6	7	8	9
"k	"	q	a	d	g	j	m	p	t	w
"l	a"	q	b	d	i	j	n	r	t	y
"l	b"	q	a	d	g	j	o	p	t	w
"l	c"	q	a	d	g	j	o	p	t	w
"l	d"	q	a	e	i	j	n	s	t	w
"l	e"	q	a	d	g	l	m	s	t	x
"l	f"	q	a	d	g	j	m	p	t	w
"l	g"	q	a	d	g	j	m	p	t	w
"l	h"	q	a	d	g	j	m	p	t	w
"l	i"	z	c	e	g	k	n	s	t	w
"l	j"	q	a	d	g	j	m	p	t	w
"l	k"	q	a	e	i	j	m	s	t	w
"l	l"	q	c	e	i	j	o	s	u	y
"l	m"	q	a	d	g	j	o	s	t	w
"l	n"	q	a	e	g	j	m	p	t	w
"l	o"	q	c	d	g	j	o	s	t	w
"l	p"	q	a	d	h	j	m	s	t	w
"l	q"	q	a	d	g	j	m	p	t	w
"l	r"	q	a	e	g	j	m	p	t	w
"l	s"	q	a	e	i	j	o	p	t	w
"l	t"	q	a	e	i	j	o	s	t	w
"l	u"	q	c	d	g	l	m	s	t	w
"l	v"	q	a	e	i	j	m	p	t	w
"l	w"	q	a	e	g	j	m	p	t	w
"l	x"	q	a	d	g	j	m	p	t	w
"l	y"	z	a	d	i	j	n	s	t	w
"l	z"	q	a	d	g	j	m	p	t	w
"l	"	q	a	d	g	j	m	p	t	w
"m	a"	q	c	d	i	k	n	r	t	y
"m	b"	q	a	e	i	l	m	p	t	y
"m	c"	q	c	d	i	j	o	p	t	w
"m	d"	q	a	d	g	l	m	p	t	w
"m	e"	q	a	e	g	l	n	s	t	w
"m	f"	q	a	d	g	j	o	p	t	w
"m	g"	q	a	d	g	j	m	p	t	w
"m	h"	z	a	d	g	j	m	p	t	w
"m	i"	z	c	d	g	l	n	s	t	x

FIG. 101

"-	-"	1	2	3	4	5	6	7	8	9
"m	j"	q	a	d	g	j	m	p	t	w
"m	k"	q	a	d	g	j	m	p	t	w
"m	l"	q	a	e	g	j	m	p	t	y
"m	m"	q	a	e	i	j	o	p	u	w
"m	n"	q	a	d	g	j	m	p	t	w
"m	o"	q	b	d	i	j	n	r	v	w
"m	p"	q	a	e	i	l	o	r	t	w
"m	q"	q	a	d	g	j	m	p	t	w
"m	r"	q	a	d	g	j	m	p	t	w
"m	s"	q	a	e	g	j	m	p	t	w
"m	t"	q	a	d	g	j	m	p	t	w
"m	u"	q	c	d	g	l	n	s	t	w
"m	v"	q	a	d	g	j	m	p	t	w
"m	w"	q	a	d	h	j	m	p	t	w
"m	x"	q	a	d	g	j	m	p	t	w
"m	y"	q	c	d	g	j	m	s	t	w
"m	z"	q	a	d	g	j	m	p	t	w
"m	"	q	a	d	g	j	m	p	t	w
"n	a"	q	b	d	g	l	m	r	t	w
"n	b"	q	a	d	g	j	m	p	t	w
"n	c"	q	a	e	i	l	o	r	t	y
"n	d"	q	a	e	i	l	o	s	t	y
"n	e"	q	c	e	i	l	n	s	t	w
"n	f"	q	a	e	i	j	o	s	u	w
"n	g"	q	a	e	i	l	m	s	u	w
"n	h"	q	a	d	g	j	m	p	t	w
"n	i"	z	c	e	g	l	n	s	t	x
"n	j"	q	a	d	g	j	m	p	u	w
"n	k"	q	a	e	i	j	n	s	t	w
"n	l"	q	a	e	i	j	o	p	t	y
"n	m"	q	a	e	g	j	m	p	t	w
"n	n"	q	a	e	i	j	o	p	u	y
"n	o"	q	b	d	g	l	n	r	t	w
"n	p"	q	a	d	g	j	o	p	u	w
"n	q"	q	a	d	g	j	m	p	u	w
"n	r"	q	a	d	g	j	m	p	t	w
"n	s"	q	a	e	i	l	m	p	t	w

FIG. 10J

"	"	1	2	3	4	5	6	7	8	9
"n	r"	q	a	e	i	l	o	s	u	y
"n	s"	q	a	f	g	j	m	s	t	x
"n	v"	q	a	e	i	j	o	p	t	w
"n	w"	q	a	e	g	j	m	p	t	w
"n	x"	q	a	d	g	j	m	p	t	w
"n	y"	q	b	d	h	j	m	p	t	w
"n	z"	q	a	d	g	j	m	p	t	w
"n	"	q	a	d	g	j	m	p	t	w
"o	a"	q	b	d	g	l	m	s	t	w
"o	b"	q	a	e	i	l	o	s	t	w
"o	c"	q	a	e	h	k	o	s	u	w
"o	d"	q	a	e	i	l	o	s	u	y
"o	e"	q	a	d	g	j	m	s	t	w
"o	f"	q	a	f	g	j	m	p	t	w
"o	g"	q	a	e	i	j	o	r	t	y
"o	h"	q	a	d	g	j	n	p	t	w
"o	i"	q	c	d	g	l	n	p	t	w
"o	j"	q	a	e	g	j	m	p	t	w
"o	k"	q	a	e	i	j	m	s	t	w
"o	l"	q	b	d	i	l	o	s	u	w
"o	m"	q	a	e	i	l	m	p	t	w
"o	n"	q	a	e	g	l	n	s	t	y
"o	o"	q	a	d	g	k	n	s	t	w
"o	p"	q	a	e	h	l	m	p	t	y
"o	q"	q	a	d	g	j	m	p	t	w
"o	r"	q	a	e	g	k	m	r	t	w
"o	s"	q	c	e	i	j	o	s	t	y
"o	t"	q	a	e	h	j	o	s	t	y
"o	u"	q	c	d	g	l	n	r	t	y
"o	v"	q	a	e	i	j	m	p	t	w
"o	w"	q	a	e	i	j	n	s	t	w
"o	x"	q	a	d	i	j	m	p	t	w
"o	y"	q	a	e	g	j	m	s	t	w
"o	z"	q	a	d	g	j	m	p	t	w
"o	"	q	a	d	g	j	m	p	t	w
"p	a"	q	c	d	g	l	n	r	t	y
"p	b"	q	a	e	g	j	m	p	t	w

FIG. 10K

"-	-"	1	2	3	4	5	6	7	8	9
"p	c"	q	a	d	g	j	m	s	t	w
"p	d"	q	a	d	g	j	m	p	t	w
"p	e"	q	c	d	g	j	n	r	t	w
"p	f"	q	a	d	g	j	m	r	t	w
"p	g"	q	a	d	g	j	m	p	t	w
"p	h"	q	a	e	i	j	o	s	t	y
"p	i"	q	c	d	g	l	n	r	t	x
"p	j"	q	a	d	g	j	m	p	t	w
"p	k"	q	a	d	g	j	m	p	t	w
"p	l"	q	a	e	i	j	o	p	u	y
"p	m"	q	a	e	g	j	m	p	t	w
"p	n"	q	a	d	g	j	m	p	t	w
"p	o"	q	c	d	i	l	n	r	t	w
"p	p"	q	a	e	i	l	o	p	t	y
"p	q"	q	a	d	g	j	m	p	t	w
"p	r"	q	a	e	i	j	o	p	t	y
"p	s"	q	a	d	g	j	m	p	t	w
"p	t"	q	c	e	i	j	o	s	t	w
"p	u"	q	b	d	g	j	m	r	t	w
"p	v"	q	a	d	g	j	m	p	t	w
"p	w"	q	a	d	g	j	m	p	t	w
"p	x"	q	a	d	g	j	m	p	t	w
"p	y"	q	a	d	g	j	m	r	t	w
"p	z"	q	a	d	g	j	m	p	t	w
"p	"	q	a	d	g	j	m	p	t	w
"q	a"	q	a	d	g	j	m	p	t	w
"q	b"	q	a	d	g	j	m	p	t	w
"q	c"	q	a	d	g	j	m	p	t	w
"q	d"	q	a	d	g	j	m	p	t	w
"q	e"	q	a	d	g	j	m	p	t	w
"q	f"	q	a	d	g	j	m	p	t	w
"q	g"	q	a	d	g	j	m	p	t	w
"q	h"	q	a	d	g	j	m	p	t	w
"q	i"	q	a	d	g	j	m	p	t	w
"q	j"	q	a	d	g	j	m	p	t	w
"q	k"	q	a	d	g	j	m	p	t	w
"q	l"	q	a	d	g	j	m	p	t	w

FIG. 10L

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"-	-"	1	2	3	4	5	6	7	8	9
"q	m"	q	a	d	g	j	m	p	t	w
"q	n"	q	a	d	g	j	m	p	t	w
"q	o"	q	a	d	g	j	m	p	t	w
"q	p"	q	a	d	g	j	m	p	t	w
"q	q"	q	a	d	g	j	m	p	t	w
"q	r"	q	a	d	g	j	m	p	t	w
"q	s"	q	a	d	g	j	m	p	t	w
"q	t"	q	a	d	g	j	m	p	t	w
"q	u"	q	a	e	i	j	o	p	t	w
"q	v"	q	a	d	g	j	m	p	t	w
"q	w"	q	a	d	g	j	m	p	t	w
"q	x"	q	a	d	g	j	m	p	t	w
"q	y"	q	a	d	g	j	m	p	t	w
"q	z"	q	a	d	g	j	m	p	t	w
"q	"	q	a	d	g	j	m	p	t	w
"r	a"	q	c	d	g	l	n	p	t	w
"r	b"	q	a	d	g	j	o	p	t	w
"r	c"	q	a	e	h	l	m	p	u	w
"r	d"	q	a	e	i	j	n	s	v	w
"r	e"	q	a	e	g	l	n	s	v	w
"r	f"	q	a	e	g	j	o	p	t	w
"r	g"	q	a	e	i	j	m	s	u	w
"r	h"	q	a	e	g	j	o	p	t	w
"r	i"	z	c	e	g	l	n	p	t	w
"r	j"	q	a	d	g	j	m	p	t	w
"r	k"	q	a	e	i	l	m	s	t	y
"r	l"	q	a	d	i	j	o	p	t	y
"r	m"	q	a	e	i	j	m	s	t	w
"r	n"	q	a	e	i	j	o	s	t	w
"r	o"	q	b	d	g	l	m	p	u	w
"r	p"	q	a	d	g	j	o	r	t	w
"r	q"	q	a	d	g	j	m	p	t	w
"r	r"	q	a	e	i	j	o	p	t	y
"r	s"	q	a	e	i	j	o	p	t	w
"r	t"	z	a	e	h	j	n	s	u	w
"r	u"	q	c	e	g	l	n	s	t	w
"r	v"	q	a	e	i	j	m	p	t	w

FIG. 10M

"r	w"	q	a	d	i	j	o	p	t	w
"r	x"	q	a	d	g	j	m	p	t	w
"r	y"	q	b	d	i	j	m	p	t	w
"r	z"	q	a	d	g	j	m	p	t	w
"r	"	q	a	d	g	j	m	p	t	w
"s	a"	q	b	d	g	l	m	p	v	y
"s	b"	q	a	d	g	j	m	p	t	w
"s	c"	q	a	d	h	l	o	r	u	w
"s	d"	q	a	d	g	j	n	p	t	w
"s	e"	q	c	e	g	l	n	r	t	y
"s	f"	q	a	e	g	j	m	p	u	w
"s	g"	q	a	d	g	j	m	r	t	w
"s	h"	q	a	e	i	l	o	r	t	w
"s	i"	z	c	d	g	l	n	s	t	x
"s	j"	q	a	d	g	j	m	p	t	w
"s	k"	q	a	e	i	j	m	p	t	w
"s	l"	q	a	e	i	j	o	p	t	y
"s	m"	q	a	e	i	j	o	s	t	w
"s	n"	q	a	e	g	j	m	p	t	w
"s	o"	q	c	f	g	l	m	r	u	w
"s	p"	q	a	e	g	l	o	r	t	w
"s	q"	q	a	d	g	l	m	p	u	w
"s	r"	q	c	d	g	j	m	p	t	w
"s	s"	q	a	e	i	j	o	p	u	w
"s	t"	q	a	e	i	l	o	r	u	y
"s	u"	q	b	e	g	l	m	p	t	w
"s	v"	q	a	d	g	j	m	p	t	w
"s	w"	q	a	e	i	j	o	p	t	w
"s	x"	q	a	d	g	j	m	p	t	w
"s	y"	q	a	d	g	j	m	s	t	w
"s	z"	q	a	d	g	j	m	p	t	w
"s	"	q	a	d	g	j	m	p	t	w
"t	a"	q	c	f	i	l	n	r	t	y
"t	b"	q	a	d	g	j	m	p	t	w
"t	c"	z	a	d	h	j	o	p	t	w
"t	d"	q	a	d	g	j	m	p	t	w
"t	e"	q	c	d	g	l	m	r	u	x

FIG. 10N

"-	-"	1	2	3	4	5	6	7	8	9
"t	f"	q	a	d	i	j	o	p	t	w
"t	g"	q	a	e	g	j	o	p	t	w
"t	h"	q	a	e	i	l	o	r	u	w
"t	i"	z	c	e	g	l	o	s	v	w
"t	j"	q	a	d	g	j	m	p	t	w
"t	k"	q	a	e	g	j	m	p	t	w
"t	l"	q	a	e	i	j	m	p	t	y
"t	m"	q	a	e	g	l	o	p	t	w
"t	n"	q	a	e	g	j	m	p	t	w
"t	o"	q	c	d	g	l	m	r	u	w
"t	p"	q	c	d	g	j	m	p	u	w
"t	q"	q	a	d	g	j	m	p	t	w
"t	r"	q	a	e	i	j	o	p	u	y
"t	s"	q	c	e	i	j	o	p	u	w
"t	t"	q	a	e	i	l	o	p	t	y
"t	u"	q	a	f	i	j	n	r	t	w
"t	v"	q	a	d	g	j	m	p	t	w
"t	w"	q	a	e	i	j	o	p	t	w
"t	x"	q	a	d	g	j	m	p	t	w
"t	y"	q	a	d	g	l	m	p	t	w
"t	z"	q	a	d	g	j	m	p	t	w
"t	"	q	a	d	g	j	m	p	t	w
"u	a"	q	a	d	g	l	n	r	t	w
"u	b"	q	a	e	i	j	m	s	t	w
"u	c"	q	c	e	h	k	m	p	t	w
"u	d"	q	a	e	i	j	o	p	t	y
"u	e"	q	a	d	g	j	n	s	t	w
"u	f"	q	a	f	g	j	m	p	t	w
"u	g"	q	a	e	h	j	m	s	t	w
"u	h"	q	a	d	g	j	m	p	t	w
"u	i"	q	c	d	g	l	n	r	t	w
"u	j"	q	a	d	g	j	m	p	t	w
"u	k"	q	a	d	g	j	m	p	t	w
"u	l"	q	a	d	g	l	m	p	t	y
"u	m"	q	b	e	i	j	m	p	t	w
"u	n"	q	c	d	i	l	n	s	t	w
"u	o"	q	a	d	g	j	m	p	t	w

FIG. 100

"-	-"	1	2	3	4	5	6	7	8	9
"u	p"	q	a	d	i	l	o	p	t	y
"u	q"	q	a	d	g	j	m	p	t	w
"u	r"	q	c	e	i	l	n	s	t	y
"u	s"	q	a	e	i	l	m	s	t	y
"u	t"	q	a	e	i	l	o	s	t	w
"u	u"	q	c	d	g	j	m	p	t	w
"u	v"	q	a	d	g	j	m	p	t	w
"u	w"	q	a	d	g	j	m	p	t	w
"u	x"	q	a	d	g	j	m	p	t	w
"u	y"	q	a	e	g	j	m	s	t	w
"u	z"	q	a	d	g	j	m	p	t	w
"u	"	q	a	d	g	j	m	p	t	w
"v	a"	q	c	d	i	l	n	r	t	w
"v	b"	q	a	d	g	j	m	p	t	w
"v	c"	q	a	d	g	j	m	s	t	w
"v	d"	q	a	d	g	j	m	p	t	w
"v	e"	q	a	d	g	l	n	r	t	w
"v	f"	q	a	d	g	j	m	p	t	w
"v	g"	q	a	d	g	j	m	p	t	w
"v	h"	q	a	d	g	j	m	p	t	w
"v	i"	q	c	e	g	j	n	s	t	w
"v	j"	q	a	d	g	j	m	p	t	w
"v	k"	q	a	d	g	j	m	p	t	w
"v	l"	q	a	d	g	j	m	s	t	w
"v	m"	q	a	d	g	j	m	p	t	w
"v	n"	q	a	d	g	j	m	p	t	w
"v	o"	q	a	d	i	l	o	r	t	w
"v	p"	q	a	d	g	j	m	p	t	w
"v	q"	q	a	d	g	j	m	p	t	w
"v	r"	q	a	d	g	j	m	p	t	w
"v	s"	q	a	d	g	j	m	p	t	w
"v	t"	q	a	d	g	j	m	p	t	w
"v	u"	q	a	d	g	j	m	p	t	w
"v	v"	q	a	d	g	j	m	p	t	w
"v	w"	q	a	d	g	j	m	p	t	w
"v	x"	q	a	d	g	j	m	p	t	w
"v	y"	q	a	d	g	j	m	p	t	w

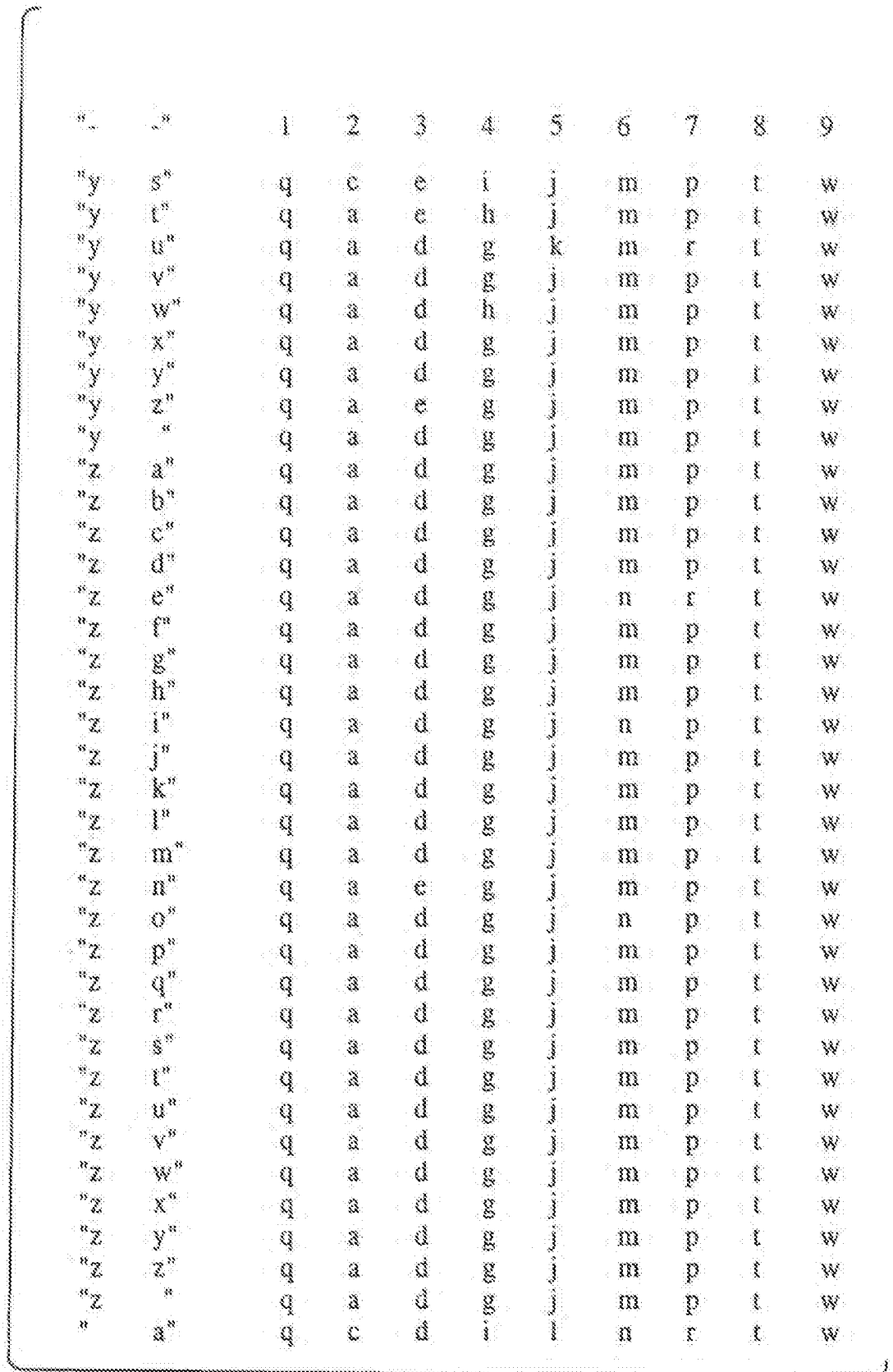
FIG. 10P

"_	`"	1	2	3	4	5	6	7	8	9
"v	z"	q	a	d	g	j	m	p	t	w
"v	"	q	a	d	g	j	m	p	t	w
"w	a"	q	b	d	i	l	n	r	v	y
"w	b"	q	a	d	g	j	m	p	t	w
"w	c"	q	a	e	g	j	m	p	t	w
"w	d"	q	a	f	g	j	m	p	t	w
"w	e"	q	b	e	i	l	n	r	v	w
"w	f"	q	a	d	g	j	m	p	t	w
"w	g"	q	a	d	g	j	m	p	t	w
"w	h"	q	a	e	i	j	o	p	t	y
"w	i"	q	c	d	g	l	n	s	t	w
"w	j"	q	a	d	g	j	m	p	t	w
"w	k"	q	a	d	g	j	m	p	t	w
"w	l"	q	a	d	g	j	m	p	t	w
"w	m"	q	a	d	g	j	m	p	t	w
"w	n"	q	a	d	g	l	m	s	t	w
"w	o"	q	a	d	g	j	n	r	u	w
"w	p"	q	a	d	h	j	m	p	t	w
"w	q"	q	a	d	g	j	m	p	t	w
"w	r"	q	a	d	i	j	o	p	t	w
"w	s"	q	a	e	g	j	m	p	t	w
"w	t"	q	a	d	g	j	m	p	t	w
"w	u"	q	a	d	g	j	m	p	t	w
"w	v"	q	a	d	g	j	m	p	t	w
"w	w"	q	a	d	g	j	m	p	t	w
"w	x"	q	a	d	g	j	m	p	t	w
"w	y"	q	a	d	g	j	m	p	t	w
"w	z"	q	a	d	g	j	m	p	t	w
"w	"	q	a	d	g	j	m	p	t	w
"x	a"	q	c	d	g	j	m	p	t	w
"x	b"	q	a	d	g	j	m	p	t	w
"x	c"	q	a	e	h	j	m	p	t	w
"x	d"	q	a	d	g	j	m	p	t	w
"x	e"	q	c	d	g	l	m	s	t	x
"x	f"	q	a	d	g	j	m	p	t	w
"x	g"	q	a	d	g	j	m	p	t	w
"x	h"	q	a	d	g	j	m	p	t	w

FIG. 10Q

"-	-"	1	2	3	4	5	6	7	8	9
"x	i"	q	c	d	g	j	n	s	t	w
"x	j"	q	a	d	g	j	m	p	t	w
"x	k"	q	a	d	g	j	m	p	t	w
"x	l"	q	a	d	i	j	m	p	t	w
"x	m"	q	a	d	g	j	m	p	t	w
"x	n"	q	a	d	g	j	m	p	t	w
"x	o"	q	a	d	g	j	m	p	t	w
"x	p"	q	a	e	i	l	o	p	t	w
"x	q"	q	a	d	g	j	m	p	t	w
"x	r"	q	a	d	g	j	m	p	t	w
"x	s"	q	a	e	i	j	m	p	t	w
"x	t"	q	a	e	g	j	m	r	u	w
"x	u"	q	a	d	g	j	m	p	t	w
"x	v"	q	a	d	g	j	m	p	t	w
"x	w"	q	a	d	g	j	m	p	t	w
"x	x"	q	a	d	g	j	m	p	t	w
"x	y"	z	a	d	g	j	m	p	t	w
"x	z"	q	a	d	g	j	m	p	t	w
"x	"	q	a	d	g	j	m	p	t	w
"y	a"	q	a	d	g	j	m	p	t	w
"y	b"	q	a	e	i	j	o	p	t	w
"y	c"	q	a	d	g	l	o	p	t	w
"y	d"	q	a	d	g	j	m	p	t	w
"y	e"	q	a	e	g	j	m	s	t	w
"y	f"	q	a	d	g	j	m	p	t	w
"y	g"	q	a	d	g	j	m	p	t	w
"y	h"	q	a	d	g	j	o	p	t	w
"y	i"	q	c	d	g	j	n	p	t	w
"y	j"	q	a	d	g	j	m	p	t	w
"y	k"	q	a	d	g	j	m	p	t	w
"y	l"	q	a	e	g	j	m	p	t	w
"y	m"	q	a	e	g	j	o	p	t	w
"y	n"	q	c	d	g	j	m	p	t	x
"y	o"	q	a	d	g	j	n	r	u	w
"y	p"	q	a	e	i	j	m	p	t	w
"y	q"	q	a	d	g	j	m	p	t	w
"y	r"	q	a	d	i	j	m	p	t	w

FIG. 10R



"-	-"	1	2	3	4	5	6	7	8	9
"y	s"	q	c	e	i	j	m	p	t	w
"y	r"	q	a	e	h	j	m	p	t	w
"y	u"	q	a	d	g	k	m	r	t	w
"y	v"	q	a	d	g	j	m	p	t	w
"y	w"	q	a	d	h	j	m	p	t	w
"y	x"	q	a	d	g	j	m	p	t	w
"y	y"	q	a	d	g	j	m	p	t	w
"y	z"	q	a	e	g	j	m	p	t	w
"y	"	q	a	d	g	j	m	p	t	w
"z	a"	q	a	d	g	j	m	p	t	w
"z	b"	q	a	d	g	j	m	p	t	w
"z	c"	q	a	d	g	j	m	p	t	w
"z	d"	q	a	d	g	j	m	p	t	w
"z	e"	q	a	d	g	j	n	r	t	w
"z	f"	q	a	d	g	j	m	p	t	w
"z	g"	q	a	d	g	j	m	p	t	w
"z	h"	q	a	d	g	j	m	p	t	w
"z	i"	q	a	d	g	j	n	p	t	w
"z	j"	q	a	d	g	j	m	p	t	w
"z	k"	q	a	d	g	j	m	p	t	w
"z	l"	q	a	d	g	j	m	p	t	w
"z	m"	q	a	d	g	j	m	p	t	w
"z	n"	q	a	e	g	j	m	p	t	w
"z	o"	q	a	d	g	j	n	p	t	w
"z	p"	q	a	d	g	j	m	p	t	w
"z	q"	q	a	d	g	j	m	p	t	w
"z	r"	q	a	d	g	j	m	p	t	w
"z	s"	q	a	d	g	j	m	p	t	w
"z	t"	q	a	d	g	j	m	p	t	w
"z	u"	q	a	d	g	j	m	p	t	w
"z	v"	q	a	d	g	j	m	p	t	w
"z	w"	q	a	d	g	j	m	p	t	w
"z	x"	q	a	d	g	j	m	p	t	w
"z	y"	q	a	d	g	j	m	p	t	w
"z	z"	q	a	d	g	j	m	p	t	w
"z	"	q	a	d	g	j	m	p	t	w
"	a"	q	c	d	i	j	n	r	t	w

FIG. 10S

"-	-"	1	2	3	4	5	6	7	8	9
"	b"	q	a	e	i	l	o	r	u	y
"	c"	q	a	e	h	l	o	r	u	y
"	d"	q	a	e	i	j	o	r	u	w
"	e"	q	a	d	i	l	n	s	v	x
"	f"	q	a	e	i	l	o	r	u	w
"	g"	q	a	e	i	l	o	r	u	w
"	h"	q	a	e	i	j	o	p	t	w
"	i"	q	c	f	g	j	n	s	t	w
"	j"	q	a	e	g	j	o	p	u	w
"	k"	q	b	e	i	j	n	p	t	w
"	l"	q	a	e	i	l	o	p	u	y
"	m"	q	a	e	i	k	o	s	u	y
"	n"	q	a	e	i	j	o	p	u	w
"	o"	z	b	f	g	k	n	r	u	w
"	p"	q	a	e	h	l	o	r	u	w
"	q"	z	a	d	g	j	m	p	u	w
"	r"	q	a	e	i	j	o	s	u	w
"	s"	q	c	e	h	l	o	p	t	y
"	t"	q	a	e	h	j	o	r	u	w
"	u"	q	a	d	i	k	n	s	t	w
"	v"	q	a	e	i	l	o	p	t	w
"	w"	q	a	e	i	j	o	r	t	w
"	x"	q	a	d	g	j	m	p	t	y
"	y"	q	a	e	i	j	o	p	u	w
"	z"	q	a	e	i	j	o	p	t	y
"	"	q	a	f	i	l	o	s	t	w

FIG. 10T

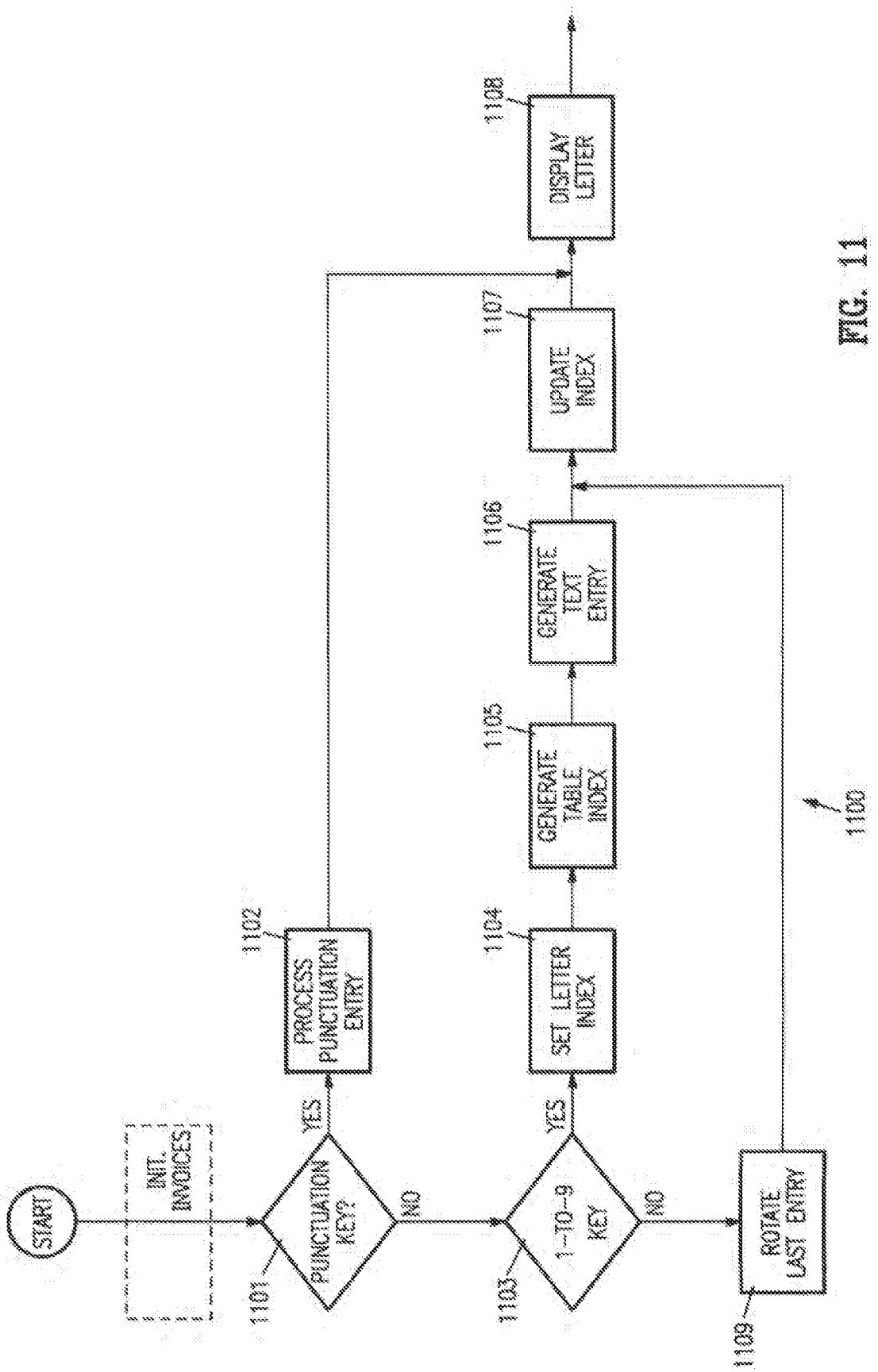


FIG. 11

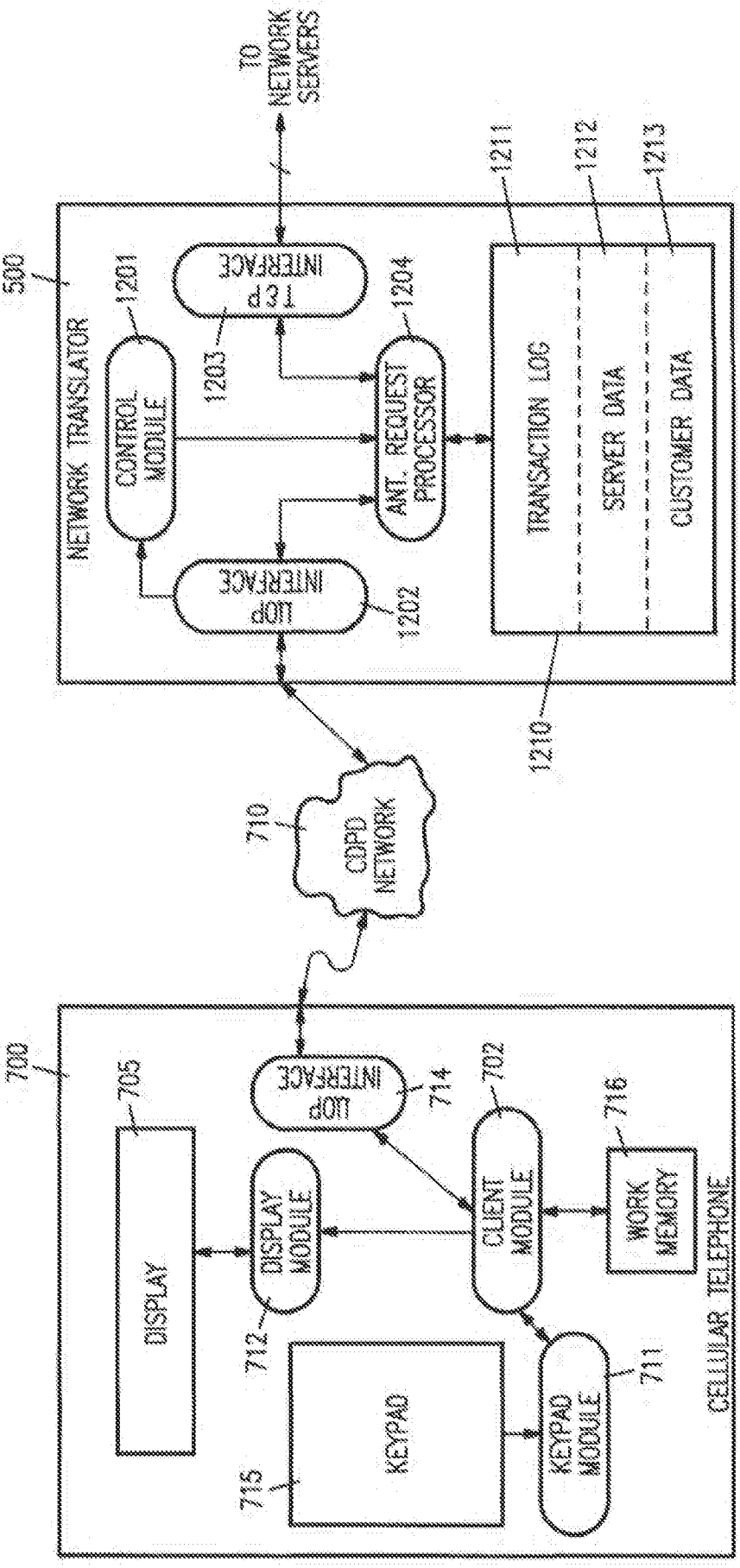


FIG. 12

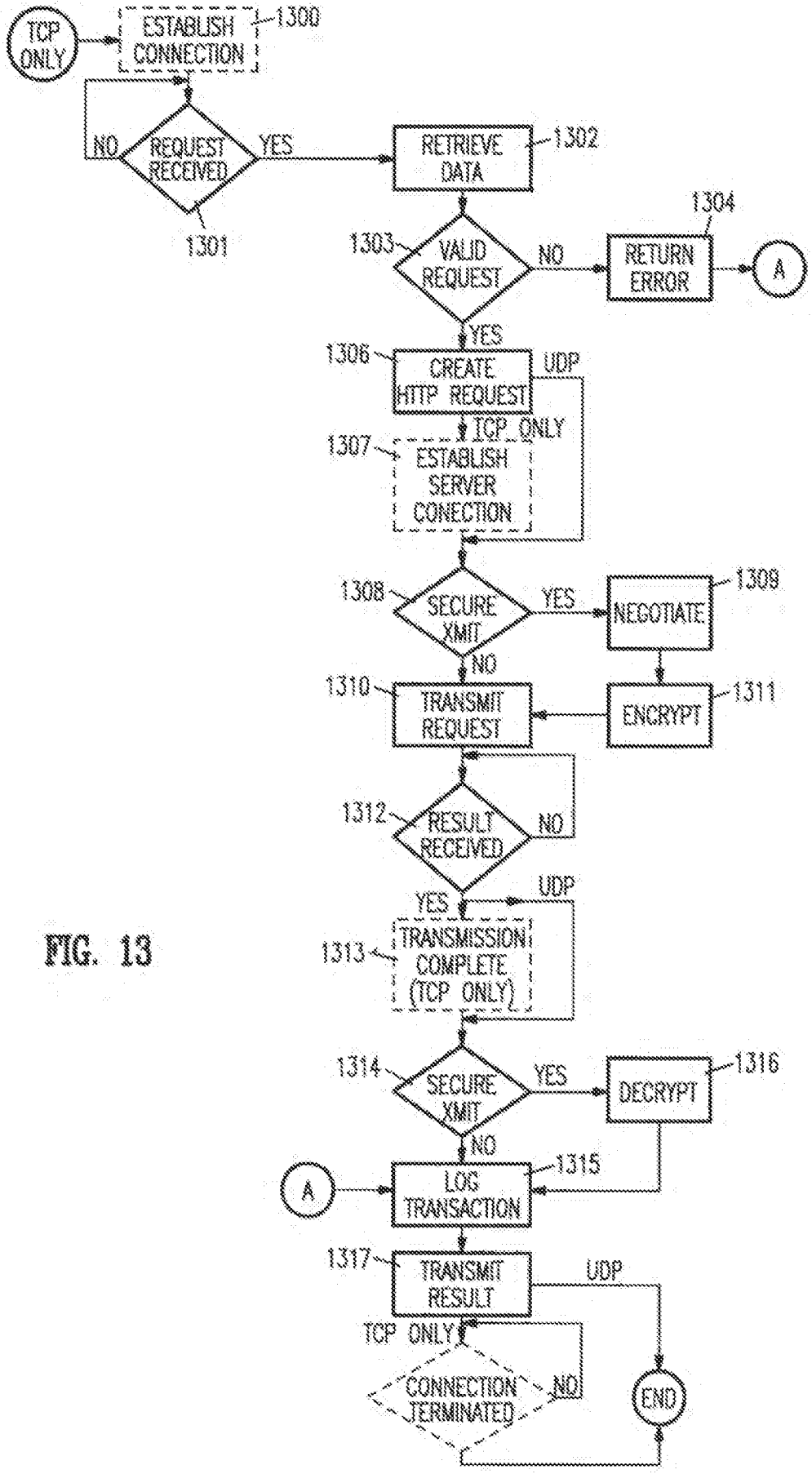


FIG. 13

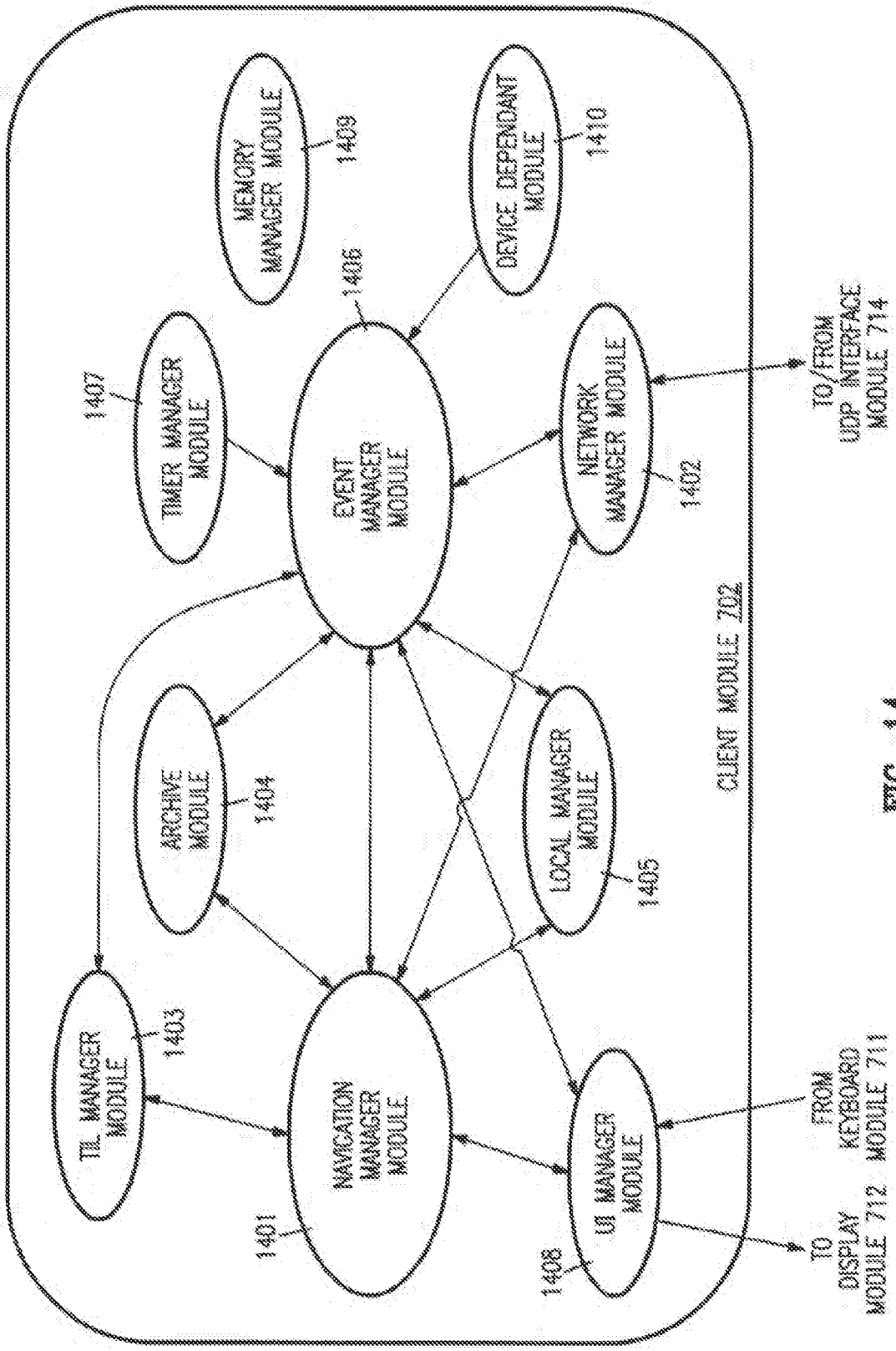


FIG. 14

PA-F

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(57) Abstract

Systems useful for analyzing data related to clinical pathways and performing actions based upon the analyses. A self-analyzing system for suggesting default clinical pathways for various procedures. A self-analyzing system for suggesting deviation from a current clinical pathway and entry into an alternative clinical pathway based upon historical information about the results of actions. Statistical analysis systems based on clinical pathways. A rating system for care providers or proposed pathways based on historical information. Systems for gathering clinical pathway information. Systems for tracking clinical pathway outcomes based on data collected post-treatment. A system for prequalification for appropriate discharge and post-discharge handling of and communication with a new class of patient, those requiring stable acute care. A questionnaire computer language and subsystem are used in various stages of the systems of the invention. Corresponding methods are also disclosed.

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HEALTH CARE DATA MANIPULATION AND ANALYSIS SYSTEM

Cross-Reference to Related Applications

This utility patent application claims the benefit of priority of U.S. Provisional Patent Application, Serial No. 60/068,825, filed December 24, 1997, U.S. Provisional Patent Application, Serial No. 60/091,552, filed July 2, 1998, and U.S. Utility Patent Application, Serial No. 09/139,423, filed August 25, 1998.

Background of the Invention

I. Field of the Invention:

The present invention provides data manipulation and analysis systems and methods associated therewith. In particular, the present invention is directed to systems useful for analyzing medical data related to clinical pathways and performing actions based upon the analyses.

II. Background of the Invention:

Escalation of medical costs has led to attempts in the past to streamline systems for providing medical care. Attempts to control such costs have heretofore been thwarted by inexact methods of gathering statistical information relevant to the medical care of interest. Certainly, rudimentary systems for tracking patient information have been developed. Moreover, patient treatment information has also been tracked and stored for further analysis. However, to date, there have not been systems for continuously tracking patient information and patient treatment information, such as clinical pathways for the patient, incorporating these into a useful form, and reacting in an automated fashion according to the recorded information. Therefore, consistent with the goal of providing cost-effective medical care, there remains a need for integrated systems capable of tracking and analyzing medical treatment information.

As an example, home health care is expected to account for an ever-increasing amount of medical care to be provided over the coming years. Therefore, cost reduction systems applicable to the home care setting are similarly highly desirable and yet are, heretofore, virtually unknown.

Similarly, there exists a need for effective data tracking and manipulation vital to providing "stable acute" care, as that term is defined and used herein. Historically, patients who had surgery would have to come to the hospital anywhere from one to three days early. After surgery, they would then spend significant time in the hospital and, in years past, these patients would actually be kept in the hospital and on bed rest for a lengthy stay. The operative patient's stay can be broken down to three phases: pre-operative, operative and post-operative. Each of these phases has changed drastically over the years.

During the pre-operative time period, patients historically came to the hospital anywhere from one to three days prior to surgery. Early arrival at the hospital usually was required for patients undergoing abdominal procedures because of the necessary to perform a bowel prep believed to be necessarily done in the hospital. This has changed because patients now can receive an equivalent bowel prep in their own home before coming to the hospital. However, although the bowel prep may be equally effective in cleaning out the intestine, the home prepared patients often become dehydrated. Yet pressures from managed care to save money have forced the medical community to ignore the fact that these patients are often dehydrated.

Additionally, even those patients not needing a bowel prep used to come in one day prior to surgery. A history and physical would be done the night before surgery and then the pre-op, including anesthesia visit and various x-rays and blood tests, would be done prior to the operation. This, too, has changed in that the history and physical is now done in the doctor's office and the pre-op, including the anesthesia visit, laboratories and x-rays, are now done a number of days prior to the operation. Again,

the pressures of managed care have reduced the prior one to three day in-hospital pre-operative period to the current practice of admission to the hospital early in the morning of surgery.

Economic pressures have recently forced movement toward minimizing any pre-operative stay. For similar reasons, it would be desirable to minimize post-operative in-hospital stays. One example of the result of this desire is the so-called "drive through mastectomy," which permits discharge from the hospital within 24-36 hours after abdominal hysterectomy or laparoscopic procedures. Unfortunately, in major abdominal procedures, there are great limitations to sending patients home early. These limitations are present for any major procedure requiring an abdominal incision (such as in gynecological oncology, radical hysterectomy, lymph node sampling or debulking, urology, radical prostatectomy, nephrectomy through abdominal approach, general surgical procedures including colectomy, small bowel resection with abdominal approach, or gastrectomy). Once there has been significant manipulation of the intestines after an abdominal incision, there are tremendous limitations to sending the patients home prior to demonstration of gastrointestinal ("GI") function, an event which can easily take four to seven days to occur.

In the operative period, there are many changes that have occurred in the past few years. For instance, the suture materials used today cause much fewer adverse reactions and are much more secure. Staple devices have increased the speed of the operative procedures as well as providing more security resulting in less problems post-operatively. For example, colectomies are now done with staple anastomoses thereby minimizing the likelihood of a leak of stool through the anastomosis is minimal. This, of course, effects the post-operative time period because fewer complications are expected and observed compared to the past. Finally, operative procedures have been significantly refined and improved, which also aids in shorter operating room ("OR") time and less post-op complications.

The post-operative period has seen many changes and improvements over the

years, including quicker ambulation of the patient, decreased bed rest, knowledge that faster discharge probably decreases likelihood of venous thrombosis and hospital acquired infections, and understanding that many post-operative situations do not necessitate long hospital stays. For example, patients who had mastectomies used to stay in the hospital for four to five days until the drain stopped yielding fluid. Presently, patients with mastectomies can go home within the first 24 hours of surgery and are taught how to take care of the drains at home. However, there are patients who have had mastectomies who have no care giver at home, yet are expected to take care of the drains, pain, any questions and any emotional discomfort without any assistance. Other improvements include decreased use of nasogastric tube after gastrointestinal procedures including small bowel resection or large bowel resection, use of patient controlled analgesia as opposed to injections which allows the patient to manage his or her pain more easily at home, development of intravenous computerized monitors which prevent against possible IV errors, use of sequential hose which are stockings which blow up on the legs in a sequential manner and significantly decrease the likelihood of thrombosis, use of H2 blockers (Histamine-2 blockers) such as PEPCID®, TAGAMET®, and ZANTAC® in the post-operative setting to significantly decrease the chance of gastric bleeding or other upper GI complications, use of home care for either the *chronically* ill post-operative patients or the generally *chronically* ill patient, and the use of improved IV antibiotics to decrease post-operative infections.

Over the past ten to fifteen years, home care has also become a viable option. However, although home care has been quite successful in the past with patients, home care has only been known for handling patients classified as chronically ill or, very recently, for handling patients who would usually come to the emergency room. For a chronically ill patient, the patient remains in the hospital for a long period of time. While it may take 24-48 hours to send the patient home, the stay at home may vary from as much as two weeks to a few months.

Hospital length of stay and other clinical pathways are ultimately the purview of the physician. However, certain guidelines exist, such as those published under the title

Milliman & Robertson Healthcare Management Guidelines by Milliman & Robertson, Inc., Actuaries & Consultants. These guidelines are gathered manually by physicians and nurses based on their collective judgment of suitable care. The gathering process is tedious and subjective. The resulting "standards" are developed not through the collection and analysis of actual data (such as would be done in preparing, for example, life insurance mortality tables), but instead are developed by committees of clinicians and others who are hired by actuarial companies and asked their subjective opinions. Therefore, these exists a need for an automated system to determine optimal treatment steps so as to improve important factors such as length of post-operative stay and recovery.

For example, the post-operative hospital stay standard for a woman after an abdominal hysterectomy is set today by such a committee. It is referred to as the "optimal" hospital stay for this procedure. If described as a 5-day post-op hospital stay, there are events during the stay that are looked for and flagged, such as a bowel movement. However, there is no data or supporting analysis that concludes that such a woman must remain in the hospital for yet another day if she has not had a bowel movement. It is simply unknown whether a bowel movement truly is a statistically significant variable or event. Rather, in prior art systems, the committee of clinicians, or others, simply make a best guess that this is a significant factor.

Because of economic pressures, it is highly desirable to provide an optimized post-operative discharge program. Additionally, it is highly desirable to provide a system capable of decreasing infection and decreasing the incidence of, for example, venous thrombosis by permitting early discharge.

The post-operative period has changed dramatically over the years from a very lengthy stay only in the hospital to using procedures that allow patients to go home sooner, such as laparoscopically assisted procedures, as well as refining various procedures so as not to require lengthy stays. Again, many of these procedures are procedures that do not require an abdominal incision and yield no problem with post-

operative bowel function. In essence, the post-operative stay has already deviated somewhat from the hospital setting to the home.

Using the example of the "drive through mastectomy", the patient has had a complex procedure which may often take up to three or more hours and has suffered a large incision. These patients are nonetheless released from the hospital because the incision is a high one which does not impair their breathing. In addition, because the patient does not have an abdominal incision, there is a low likelihood of any bowel dysfunction. However, a number of problems can still occur. First, the fairly large incision may impart a significant amount of pain for the patient, yet the patient is released with only oral medication while the patient may, in fact, require patient controlled analgesics (*e.g.*, intravenous type medications such as MORPHINE® or DEMERAL®). The patient has also had a very lengthy procedure and depending on the type of anesthesia used, may have some residual anesthesia effects, which could include nausea. The patient may require an IV antiemetic (anti-nausea agents) or intravenous fluids to aid in diminishing the nausea. Many of these patients not only have a long incision with a dressing which could leak or become infected, but they also have one or more drains in place. The patients are instructed in how to use these drains but this can be cumbersome or not entirely understood by the patient.

Moreover, once released, the physician loses track of the patient except for phone calls initiated by the patient to the physician, which may be difficult for many reasons. First, many physician phone calls during the day do not actually reach the physician but rather go to his or her staff. During the evening, the physician may not receive knowledge of the phone call whatsoever and the patient may be forced to go to the emergency room. Therefore, it would be highly desirable to have a system permitting the capability to provide home care and direct information communication to the physician and his or her staff in real time, so as to reduce the recovery period and the risk of complications.

Other patients who are rapidly discharged are post abdominal hysterectomy

patients. Often these patients have low transverse incisions which again do not yield significant problems for breathing. However, bowel dysfunction problems may still exist. Patients sometimes have difficulty taking down liquids or food for as many as three or four days. Unfortunately, these patients are sent home after post-op day one to one and a half and, at that time, with current systems, do not have any way of receiving IV fluids in the event they have nausea or difficulty taking in fluids. Additionally, if they have any significant discomfort, they are only on oral medications which may not be potent enough. Therefore, there exists a need for systems and methods for permitting expeditious and appropriate post-operative discharge, while maintaining the capability of providing an appropriate level of care to the patient while the patient continues to recover.

A third example of early discharge includes patients who have had gastrointestinal procedures. Patients with colectomies, after demonstrating the ability to take in fluids without developing abdominal distention, may be discharged from the hospital. These patients remain at risk for developing bowel dysfunction, abdominal distention, and possible major complications such as leakage from a bowel anastomosis. In present day systems, they are nevertheless sent home without any significant continued communication with the doctor or any prearranged skilled nursing care. A tremendous risk exists the patient could become ill and severely dehydrated and require a lengthy stay in the hospital upon re-admission. In some areas of the country, such discharges do not occur because physicians oppose it. There exists a need for a system able to permit such discharged patients to remain safely in the home without the attendant risks described above.

As stated previously, actuarial companies serving the health care industry today do not make recommendations to their customers (e.g., insurance companies, etc.) based upon their analysis of large collections of data as they would in other industries (e.g., life insurance), but instead use subjective, and potentially inaccurate, committees. One reason why this is true might be that actuarial companies simply have not created, nor have access to, the large amounts of data and processes needed to perform such

analysis. While others have collected health care data previously, no databases exist whereby the data is organized in such a way so as to enable meaningful analysis of the data, and no processes exist to analyze such data.

The above background describes some pre-existing mechanisms by which patients are released to the home for part of their post-operative period. Each of these mechanisms suffers from drawbacks and is, in some way, not satisfactory in comparison to the use of the present invention as a way to provide appropriate post-operative care to patients, including stable acute patients. The foregoing evidences the significant difficulties and shortcomings of known systems.

Summary of the Invention

The invention herein solves the drawbacks discussed above. The present invention is directed to data storage and manipulation system whereby clinical pathway data is collected for patients and stored in appropriate databases. The system is, preferably, a client / server based system where clients, such as actuarials, doctors, hospitals, nurses, insurance companies, and other healthcare providers can access a central repository of relevant clinical treatment information. A particularly effective aspect of the invention is that the system includes functionality for continuously reviewing the clinical pathway and treatment data for trends and, where appropriate, prompting appropriate parties of the need to change the default treatment protocols and clinical pathway or to change the particular treatment orders for a patient. While certain trends may be searched for explicitly, an important aspect of the invention is that it continuously reviews the ever-increasing data repository using automatically generated propositions in search of correlations between data elements, even unexpected correlations.

Moreover, the system provides a mechanism for rating proposed clinical pathways. For instance, a caregiver may engage the system to review a proposed pathway against the historical database and the system will provide a ranking, based on

the historical data, of the usefulness/effectiveness of the proposed approach in past cases. Moreover, in another aspect of the invention, the rating system is associated with particular care givers, such as doctors or nurses, and their historical performance can be analyzed against the general data set so as to arrive at an objective rating of the caregiver against either given or system generated criteria.

In addition, the system further comprises the functionality of providing follow-up data tracking and analysis. Previous data collection systems are hindered in that, unless there is a complication, data concerning a patient's follow-up status is rarely tracked, and even when tracked, is not tracked in sufficient detail to provide meaningful information. The follow-up data tracking portion of the present invention, however, provides a mechanism for contacting patients and generating additional, clinical pathway related data elements, wherein those elements are incorporated into the analysis for automated analysis of the effectiveness of particular clinical pathways.

For gathering the clinical pathway data, the present invention involves the use of a computerized or electronic system. In the stable acute care scenario, the computerized system is used to address the issue of sending patients home at an appropriate time in the post-operative period. The computer enables appropriate communication between the home, the nurse/caregiver seeing the patient, and the physician or the physician's assistant in the office. This type of care has been heretofore unknown. The system allows providing services to an entirely new class of care, stable acute care.

In one embodiment, the system is used to identify patients who are candidates for early (or late) post-operative discharge (and possibly stable acute care). The nurse or caregiver then sees the patient almost immediately at home and tracks the patient at home one or more times per day using the system and the information is used to create and update the clinical pathway database records for the patient. Real-time communication systems of the invention allow supervision by the physician, while not requiring the supervision to occur in a hospital setting. Assessment of the patient's

condition is performed using an questionnaire or form generated based upon the current patient's customized and changeable clinical pathway. In the stable acute care (*e.g.*, "home") setting or facility, the nurse provider can assess the patient and send information regarding the patient by using the questionnaire. The questionnaire itself will create a SOAP (Subjective, Objective, Analysis, Plan) note. The SOAP note is known to those of ordinary skill in the art as the means whereby a physician describes the patient's status and care plan.

Additionally, the system allows the physician or physician's staff to gather historical information regarding the medications, IV fluids, and other therapies provided to a patient and to determine whether or not they were given as ordered. The system also provides the capability to change the orders as needed.

One significant benefit of the invention is that the data gathered about various clinical pathways and their successfulness can be catalogued. The data can be repackaged and manipulated as needed and is believed to be of significant value in and of itself. The gathering of this data as it pertains to the heretofore nonexistent stable acute care patient class is an important advantage of the invention.

The important features of the system of the invention include the use of a computerized or electronic interface between the skilled nurse/caregiver, the patient, and the physician. In addition, the invention relies upon specialized software subsystems that allow the use of the interface, allow immediate translation from questionnaire into on-screen formats which can be read by a physician or staff, and allow prequalifying of patients during the pre-operative period for appropriate (*i.e.*, earlier or later than the average) release and stable acute care.

In prior systems, patients were only sent home when their status had reached the chronic care level. In that case, the loss of a day or two arranging home care was not considered to be a major problem because the chronic care stay at home would last anywhere from two weeks to even four weeks. However, using the present invention,

the stay at home is short and once the patient is designated to go home for stable acute care, it is important to proceed with their discharge expeditiously. This rapid process requires the use of systems of the invention which provide for prequalification of patients into the stable acute care program.

Another aspect of the invention is the use of a computerized system for identifying appropriate patients for receiving stable acute care. The system identifies patients who would usually stay in the hospital for a significant period of time because of post-op ileus (delay in bowel function). In addition, the system provides pre-operative training at the doctors office as well as informing the nurse of a patient's imminent discharge so the nurse can meet the patient soon after the discharge into the patient's home.

The communications subsystems of the invention are important to its capability of providing stable acute care and tracking clinical pathways. Point of service communication at home using either a suitable electronic or computerized device is provided by the invention. The computer can be put into communication with a data storage / server computer via any suitable means, including a modem or network adapter.

During stable acute care using the systems of the invention, daily patient visits occur. From two to four visits per day may be required and are contemplated. Daily communication includes SOAP notes, notification of whether the patient received appropriate IV medications and intravenous fluids, as well as the ability to communicate with nurses, and nurse communications with physicians for order changes. The initial orders created when the patient is sent home represent an initial or default clinical pathway anticipating potential problems and providing appropriate care orders at that time.

In addition, using the methods and systems of the present invention, the post-operative patient's stay at home may be as little as from two to five days. In order not

to lose a day or two days of potential early discharge, the patient is preferably identified and classified as an early discharge candidate prior to hospital admission.

The present invention provides systems and methods with numerous advantages. One such advantage provided by the system is the emotional advantage of sending the patient home in his or her own environment at the appropriate time, as soon as practicable under the new system. Such patients will often be more comfortable, in a psycho-social sense, and many of the difficulties that occur in the hospital regarding nursing care not being accessible are removed. A patient having a 24-hour a day caregiver directed specifically to him or her eliminates most difficulties with regard to immediate appropriate care, *i.e.*, care that does not involve skilled nursing care such as turning on IV pumps, changing an IV bag, or working with IV medicines. In addition, skilled nursing care visits vary anywhere between two and four times a day (or whatever frequency and level of care is necessary) and amount to less burden than what is required from nurses in the hospital setting.

Another aspect of the invention involves a new questionnaire format, which may be used as one way of collecting the data to be analyzed according to the present invention. This questionnaire format allows stable acute care caregivers the ability to closely track and instantly inform a patient's physician of that patient's condition. The format, as it applies to a particular patient, also provides the clinical pathway for the patient, as described *infra*. With the present invention, stable acute care providers receive updated orders about the patient on a visit by visit basis and physicians are able to track the progress of their patients instantly. The questionnaire system in conjunction with the other components of the systems of the invention allows the close communication required between home care givers and physicians in this kind of situation and solves various problems of the prior art. Statements of the language used to create each questionnaire are saved in the clinical pathway database as opposed to a simple flat file. Entire questionnaires are versioned, and may be easily modified, or recalled from earlier versions. Questions once entered may be reused in many questionnaires.

Each individual question within the questionnaire may be represented by statements in a "questionnaire language". This language is "turing complete" -- meaning that anything that can be accomplished by any general purpose programming language may be accomplished by the language that represents the questions. This allows the questions to contain data, storage, and logical information about the data within each question, and allows the attachment of significant information to each question within the questionnaire. An example would be information associated with a particular drug. Dosages, appropriate application times and such can be encoded within the question that asks if the drug is to be administered.

This method of representation was chosen to allow for complete flexibility in the representation of the clinical pathway. This structure is what allows the pathway representation to be a dynamic tree as opposed to a simple sequentially-followed set of instructions. In other words, future actions in the clinical pathway can be machine encoded directly into the questionnaire without requiring human intervention to determine the appropriate course of action during the administering of the pathway to a patient.

In one embodiment, the invention provides a system for manipulation and analysis of data related to clinical pathways, comprising a clinical pathway database for storing an initial procedure decision data element, corresponding to a decision point within the clinical pathway and at least one, preferably a plurality of, subsequent decision data elements, corresponding to available subsequent decision points within the clinical pathway, a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element, processing means, including a storage device, for performing the steps of selecting one of the at least one subsequent decision data elements, comparing the selected subsequent decision data element with the previously selected subsequent decision data elements stored in the historical clinical pathway database, and based upon predetermined correlation criteria, modifying the subsequent

decision data elements within the clinical pathway database. This will allow the changing of the physical layout of the tree. In other words, it is possible to include totally new decision points, or totally remove decision points from a clinical pathway. This differs from existing systems which simply take a fixed tree and attempt to find individualized parameters within that tree.

In addition, the present invention provides a client / server system for manipulation and analysis of data related to clinical pathways, comprising a communication network, a client workstation in communication with the communication network, wherein the client workstation comprises means for generating at least one signal corresponding to a clinical pathway decision and transmitting the at least one decision signal over the communication network, and means for receiving at least one signal corresponding to a clinical pathway modification from the communication network, and means for outputting the at least one modification signal to a signal processing means, a server on the communication network, wherein the server comprises a clinical pathway database for storing an initial procedure decision data element, corresponding to a decision point within the clinical pathway, and at least one subsequent decision data element corresponding to at least one available subsequent decision point within the clinical pathway, and a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element, and processing means, in communication with the communication network, the client workstation, and the server, for performing the steps of receiving the at least one decision signal from the communication network, based on the received decision signal, selecting one of the at least one subsequent decision data elements, comparing the selected subsequent decision data element with the previously selected subsequent decision data elements stored in the historical clinical pathway database, and based upon predetermined correlation criteria, modifying the at least one subsequent decision data elements within the clinical pathway database, then generating at least one signal corresponding to a clinical pathway modification of the subsequent decision data elements in the clinical pathway database, and transmitting the at least one clinical

pathway modification signal over the communication network to the receiving means of the client workstation.

The present invention also provides a system for manipulation and analysis of data related to clinical pathways, comprising a clinical pathway database for storing an initial procedure decision data element, corresponding to a decision point within the clinical pathway, and at least one subsequent decision data element corresponding to at least one available subsequent decision points within the clinical pathway, a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element, and processing means, including a storage device, for performing the steps of selecting one of the at least one subsequent decision data elements, comparing the selected subsequent decision data element with the previously selected subsequent decision data elements stored in the historical clinical pathway database, and based upon predetermined correlation criteria, modifying the at least one subsequent decision data element within the clinical pathway database.

In a further embodiment, the present invention provides a system for assessing utilization of medical resources based upon manipulation and analysis of statistical data related to clinical pathways, comprising a clinical pathway database for storing an initial procedure decision data element, corresponding to a decision point within the clinical pathway, and at least one subsequent decision data element corresponding to available subsequent decision points within the clinical pathway, a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element, and, for each of the previously selected subsequent decision data elements, a utilization value corresponding to the decision data element processing means, including a storage device, for performing the steps of selecting one of the at least one subsequent decision data elements, comparing the selected subsequent decision data element with the previously selected subsequent decision data elements stored in the historical clinical pathway database, and based upon predetermined correlation criteria, modifying the at

least one subsequent decision data elements within the clinical pathway database, and statistical processing means, in communication with the clinical pathway database and the historical clinical pathway database, for performing the steps of accessing the historical clinical pathway database, computing pathway utilization value based on the accessed utilization values in the database, generating at least one signal corresponding to the pathway utilization value, and outputting the at least one utilization value signal to a signal processing means.

In another embodiment, the invention provides a system for rating medical care based upon manipulation and analysis of data related to clinical pathways, comprising a clinical pathway database for storing an initial procedure decision data element, corresponding to a decision point within the clinical pathway, and at least one subsequent decision data element corresponding to available subsequent decision points within the clinical pathway, a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element, and, for each of the previously selected subsequent decision data elements, a rating value, processing means, including a storage device, for performing the steps of selecting one of the subsequent decision data elements, comparing the selected subsequent decision data element with the previously selected subsequent decision data elements stored in the historical clinical pathway database, based upon predetermined correlation criteria, modifying the subsequent decision data elements within the clinical pathway database, and statistical processing means, in communication with the clinical pathway database and the historical clinical pathway database, for performing the steps of accessing the historical clinical pathway database, computing a pathway rating value based on the accessed rating values in the historical database, generating at least one signal corresponding to the pathway rating value, and outputting the at least one rating signal to a signal processing means.

Additional advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The advantages of the invention will be realized and attained

by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

Brief Description of the Drawings

Figures 1A and 1B show flowcharts of the questionnaire system in operation from the care giver's point of view.

Figures 2A, 2B, and 2C show flowcharts of the questionnaire system in operation from the physician's point of view.

Figures 3A and 3B show flowcharts detailing the steps taken to add a patient to the system.

Figure 4 shows a block diagram of a client / server embodiment of the system of the invention.

Figure 5 shows a flowchart of a genetic algorithm analysis process, which may be used in one embodiment of the present invention.

Detailed Description of the Preferred Embodiments

The present invention may be understood more readily by reference to the following detailed description of preferred embodiments of the invention.

Before the present methods and apparatuses are disclosed and described, it is to be understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting. It must be noted that, as used in the specification and the appended claims, the singular forms "a," "an" and

"the" include plural referents unless the context clearly dictates otherwise.

Throughout this application, where publications are referenced, the disclosures of these publications in their entireties are hereby incorporated by reference into this application in order to more fully describe the state of the art to which this invention pertains.

The present invention provides a wide range of systems and processes for automating and improving upon the collection of clinical data, and the actuarial and statistical analysis of that data. In one embodiment, these systems and techniques can be applied to the health care industry, but may also have other applications as well.

In one embodiment, the present invention provides a "feedback loop" where automated actuarial analysis of an ever-growing collection of data provides ever-improving suggestions to a physician or other decision-making authority. These suggestions may take the form of recommendations of changes to continuously improve clinical pathways (as will be defined in further detail below). These suggestions can occur because the automated system of the present invention may search for statistically significant variables and correlations within the collected body of data, and the present invention may thereafter make suggestions or actually alter the existing clinical pathways based upon its analysis of the data.

As used herein "stable acute care" refers to the level of care that would, in the past, have required administration of the care in a hospital setting. Thus, stable acute care refers to care which would have been acute care in the hospital setting and which, when not in the hospital setting, is above the level of care of chronic home care.

As used herein, the term "clinical pathway" refers to a decision tree corresponding to the care of a patient. The decision tree that is the clinical pathway can have one or more nodes and each of these nodes can have one or more links to additional nodes in the tree. Each node can correspond to a care decision and can

include additional information about the care actually given. The traversal of the tree, through each decision node, to the next node in the tree represents the clinical pathway. The end effect of the clinical pathway is to document the step-by-step treatment of the patient.

I. Data Manipulation and Analysis System:

The present invention provides a system for (and corresponding methods for) manipulation and analysis of data related to clinical pathways. The system includes a clinical pathway database. In one embodiment of the present invention, clinical pathway database models a decision tree comprising various decision nodes. These nodes are stored as either text or tokenized representations of the Questionnaire Language ("QL") statements (*see infra*). The records can have the following structure:

Protocol ID
Group ID
Question ID
Version
Ordinality
Question Text

The protocol ID is the protocol being defined. Group ID identifies the grouping of the question with like questions, *i.e.*, all related questions belong to the same group, and are displayed in a single group box on the screen. Question ID is the identifier of the question itself. Version is the version of the question being asked. Ordinality is the order of the question within its group. Finally, the question text is the QL statement itself.

As each patient is added to the system, a copy of the base questionnaire for their procedure is produced and offered to the physician or system operator for change. The base questionnaire is simply a set of the clinical pathway node structures as described above. As individual questions are changed, they are versioned, *e.g.*, by incrementing a

version number. Versioning of the question can also include further information, such as date and time of the change, identity of the party making the change, original question text, etc., such that the system can provide a suitable audit trail to review all changes in any particular questionnaire.

In accordance with the present invention, the database stores an initial procedure decision data element (using the structure set forth above) corresponding to a decision point within the clinical pathway and at least one, preferably a plurality of, subsequent decision data elements, corresponding to available subsequent decision points within the clinical pathway. The system also includes a historical clinical pathway database for storing previously selected subsequent decision data elements, selected corresponding to the initial procedure decision data element. In addition, the system includes a processing means, optionally including a storage device, for various steps. While the present invention has been described in terms of particular data structures and data flow, the computational steps could be carried out by any Von Neuman machine, *i.e.*, the processing means can be any programmable digital computer, whether imbedded into a device or not or whether part of a network or not.

Also, in accordance with the present invention, the present invention provides methods for determining the quality of a clinical pathway. For instance, in one such method a default pathway is determined by, e.g., experts in the field or by the administrator of the present system. This default clinical pathway is flagged in the database as a default pathway. Using the systems described elsewhere herein, data is collected on the decisions taken and care given along the actual clinical pathway. The system further records any deviations from the default pathway by users of the system. This data is then used for the feedback systems of the present invention.

In one embodiment, the feedback system tests correlations against sets of criteria and question results. The criteria can be generated by the system administrator or user or can be generated after analyzing data in the system. For example, the system can be pre-configured to track costs, hospital stays, and long term complications. In

this configuration, for each decision point made within the clinical pathway and for each patient, the database records a particular result. In addition, the system also records the path taken through the decision tree (clinical pathway) and this path is then correlated against the result variables of interest to determine if there is any correlation. For example, the decision as to whether or not to prescreen (by asking a background question using the QL) for diabetes may alter the final cost and/or hospital duration for a particular patient. Therefore, depending upon the magnitude of these influences, a correlation can be determined to exist or not.

As noted above, a predefined preliminary set of these correlation searches may be entered manually and the system is configured to search this problem space automatically. The correlation matrix potentially includes all combinations of all questions in the questionnaire versus all recorded outcomes. Selecting and matching significant independent variables which result from this problem space is computationally NP-complete. However, one of ordinary skill in the art would recognize a number of suitable correlation algorithms useful for finding plausible solutions to this NP-complete problem space. As one example, and not intending to be bound to any particular implementation, the selection and matching of variables can be carried out using genetic programming or genetic algorithm ("GA") methods. Such algorithms can generate hypotheses upon which to test correlations. As used for the present invention, a GA will search the set of questionnaire decision points and correlate decisions against the various output variables. The system is constantly evaluating itself. As the system finds new correlating factors, they are put in place to aid in determining changes to be made to the current or default clinical pathway. In addition, as correlations are determined between clinical pathway decisions and significant outcomes (*i.e.*, outcomes of interest), changes can be made to the default pathway to optimize systematically the clinical pathway toward the desired results. These changes can be automatically made or can be presented to the physician, system administrator, or other user for approval.

In addition to GAs, there are other suitable methods for attacking the present

NP-complete problem. For instance, correlations can be viewed as patterns and the patterns then subjected to pattern matching routines. Such pattern matching is a known domain of neural networks. However, even if neural networks are used, it is preferred that the nodes and loadings still be determined by a GA. GAs can also be used in this manner to actually create analysis programs by determining an input grid for a finite state machine. Other methods for finding near optimal solutions for NP-complete problems could also be used to determine the optimal correlation matrix, such as simulated annealing. No matter the approach, one of skill in the art would recognize that the present correlation problem is combinatorily explosive is likely impossible to be attacked at all with closed form or brute-force methods.

The above-described problem is a multivariate analysis where the independent variables are the answers to questions asked during the treatment of the patient. Dependent variables are the desired outcomes. The data space is well defined, with definite sets of potential independent variables and definite sets of potential dependent variables. Difficulty exists however because the data set is so large, and which variables are significant is not known.

Traditionally this problem has gone unsolved by machine methods. The typical solution is to have domain experts determine what they believe are the significant independent variables and measure correlation to effect on desired dependent variables using standard multivariate analysis techniques. While this can lead to advances (indeed, all advances to date are done this way) there is no way to find the hidden dependencies which exist in the data sets.

Again, the selection of the possible sets of independent variables for each dependent variable is an NP complete problem, and is considered to be computationally intractable. However, while there are no definite solutions to NP complete problems, it is possible to find multiple local maxima and minima, and to progressively move towards more optimal solutions.