

the Transmission Research Section of IRCTR (International Research Center for Telecommunications - Transmission and Radar) and also Program Director of the Center for Wireless Personal Communications (CEWPC). Since June 1999, he has been with Aalborg University, Denmark as Co-director of Center for PersonKommunikation (CPK) and holds the Chair of Wireless Information and Multimedia Communications. He was involved in the European ACTS project FRAMES (Future Radio Wideband Multiple Access System) as a DUT Project Leader. He is Project leader of several international industrial funded projects. He has published over 300 technical papers, authored and co-authored three books "*CDMA for Wireless Personal Communications*," "*Universal Wireless Personal Communications*," and "*Wideband CDMA for Third Generation Mobile Communications*" published by Artech House, Boston. His current research interest lies in wireless networks, packet communications, multiple access protocols, adaptive equalizers, spread-spectrum CDMA systems, and multimedia communications.

He has served as a member of advisory and program committees of several IEEE international conferences. He has also presented keynote speeches, invited papers, and tutorials on WPMC at various universities, technical institutions, and IEEE conferences. He was the Organizer and Interim Chairman of the IEEE Vehicular Technology/Communications Society Joint Chapter, Benelux Section. He is now the Elected Chairman of the joint chapter. He is also founder of the IEEE Symposium on Communications and Vehicular Technology (SCVT) in the Benelux and he was the Symposium Chairman of SCVT'93.

He is the Co-ordinating Editor and Editor-in-chief of the Kluwer international journal on *Wireless Personal Communications* and also a member of the editorial board of other international journals, including the IEEE Communications Magazine and the IEE Electronics Communication Engineering Journal. He was the Technical Program Chairman of the PIMRC'94 International Symposium held in The Hague, The Netherlands, during September 19-23, 1994, and also of the Third Communication Theory Mini-Conference in conjunction with the GLOBECOM'94 held in San Francisco, CA, November 27-30, 1994. He was the Conference Chairman of IEEE Vehicular Technology Conference, VTC'99 (Fall), Amsterdam, The Netherlands held on September 19-22, 1999 and also the steering committee chairman of The Second International Symposium on Wireless Personal Multimedia Communications (WPMC), Amsterdam, The Netherlands held on September 21-23, 1999.

He is listed in the US Who's Who in the World. He is a fellow of the IEE, a fellow of the Institution of Electronics & Telecommunication engineers, a senior member of IEEE and a member of NERG (The Netherlands Electronics and Radio Society).

Index

- Additive white Gaussian noise (AWGN), 63, 69
- Advanced Communication Technologies and Services (ACTS), 3, 8, 233
- Air interface multiple access, 3
- Algorithm, 38, 239, 240, 247
- AM-PM conversion, 127
- Analog-to-digital conversion, 48
- ANDEFT, 23
- Antennas, 9, 10
- Anti-jamming, 159
- Asynchronous Transfer Mode (ATM), 1, 7, 12, 13, 14, 15, 229, 235, 237, 238, 239
 - adaptation layer, 14
 - network layer, 14
- Auto-covariance matrix, 98
- Automatic repeat request (ARQ), 243–245
- Available bit rate (ABR), 3, 4
- Averaging CDMA, 161
- Avoidance CDMA, 161
- AWACS, 3, 4

- Backoff, 125
- BAHAMA, 3
- Bandwidth, 47
- Battery, 9, 10
- Bessel function, 99
- Binary codes, 54
- B-ISDN, 7, 9, 12
- Bit error ratio (BER), 33, 66, 67
- Bit rate, 47
- Block codes, 54
- Block interleaver, 59
- BPSK, 6, 40, 62, 244
- Butterfly, 41, 145, 146

- CDMA era, 157
- CDMA, 25, 155–176

- Cell loss ratio (CLR), 243–245
- Channel
 - characterization, 2
 - coding, 220
 - estimate, 98
 - estimator, 96
 - model, 180–182
 - models, 16
- Clipping, 123–126
- Code sequence, 163–165, 170
- Coded modulation, 62–70
- Coding, 53–70
- Coherence time, 19, 20
- Coherent detection, 95–107
- Complementary code, 87
- Concatenated codes, 61
- Constant bit rate (CBR), 3
- Constellation, 41, 60, 57, 60, 62, 63, 66
- Convolutional codes, 55
- Convolutional interleaver, 59
- CORDIC algorithm, 50
- Correlation peak, 81, 86
- Correlation, 81
- Crest factor, 119
- Cross-covariance matrix, 98
- CSMA/CA, 6
- Cyclic extension, 39–42
- Cyclic prefix, 80, 81

- Data rate, 6, 8
- Decision feedback equalizer, 50
- DECT, 9
- Deep fades, 59
- Delay spread, 16–19, 33, 39, 43
- Delay, 39

- DFT, 22
- Differential amplitude and phase shift keying (DAPSK), 115

- Differential detection, 106–116
 Differential techniques, 48, 95, 106–116.
 Digital Audio Broadcasting (DAB), 23, 104, 233–235
 Digital filter, 45
 Digital Video Broadcasting (DVB), 104, 235–237
 Direct sequence (DS) CDMA, 160, 162–165, 182–184, 194
 Doppler shift, 19
 Doppler spread, 19, 33
 DS/FH CDMA, 161
 DS/TH CDMA, 161
 Dynamic channel allocation (DCA), 222, 229–232
 Effective guard time, 44
 Effective isotropic radiated power, 246
 Equal gain combining, 187
 Equalizer, 50
 Error floor, 67, 69, 70
 ETSI BRAN, 4, 5, 25, 229
 Fading channel, 68
 FDD, 4
 FFT, 22, 40, 47, 48
 FH/TH CDMA, 161
 Filtering, 45
 Forward-error correction coding, 33, 54–58
 Frame structure, 243
 FRAMES, 156
 Frequency division multiple access (FDMA), 213
 Frequency error standard deviation, 85
 Frequency hopping (FH) CDMA, 160, 165–168
 Frequency hopping OFDMA, 213–228
 Frequency
 modulation (FM), 158
 offset, 73, 77, 78
 synchronization, 221
 synchronization, 73, 75, 78
 Gaussian Minimum Shift Keying (GMSK), 49
 Global information village, 1, 2
 Gold codes, 197
 GSM, 7, 8, 9
 Guard time, 39–42
 Hamming distance, 54
 Hamming window, 124
 Handover, 173
 HDTV, 7, 23
 Health hazards, 2
 HIPERLAN, 5, 6, 7, 8, 241–251
 Hybrid
 CDMA, 160
 contention CDMA, 160
 contentionless CDMA, 160
 OFDM/CDMA, 160
 Ideal OFDM spectrum, 128
 IDFT, 36–39
 IEEE 802.11, 4, 5, 6, 7, 9, 25, 241–251
 IFFT, 33, 36–39, 43, 44, 47, 48
 Information bandwidth, 158
 In-phase component, 88
 Intercarrier interference (ICI), 39, 40, 44, 45, 46, 73
 Interference rejection, 159
 Interfrequency handover, 175
 Interleaving, 59
 Internet protocol (IP), 1
 Internet, 1
 Interpolation matrix, 98
 Intersymbol interference (ISI), 44, 45, 46, 73
 Irreducible packet error ratio, 70
 ISDN, 9
 ISM, 6
 Kaiser window, 124
 KATHRYN, 23
 KINEPLEX, 23
 Linear minimum mean square error (LMMSE), 176
 Lorentzian spectrum, 74
 Low probability of interception (LPI), 159
 Magic WAND, 3, 4, 25, 233–241
 Matched filter, 86
 Matrix inversion, 98
 Maximal ratio combining (MRC), 187
 Maximum delay spread, 18, 19
 Maximum likelihood decoding, 145–147
 MC-CDMA receiver, 188
 MC-CDMA transmitter, 188
 MEDIAN, 3, 4
 Medium access control (MAC), 242–252
 Minimum mean square error combining (MMSEC), 187
 MMAC, 4, 5, 241–251
 Mobile broadband systems (MBS), 5, 6, 12, 13, 14

- Mobile multimedia, 1
- Mobile telephony, 1
- Multi carrier (MC)-CDMA, 27, 160, 179–209, 215
- Multipath channel models, 16
- Multipath propagation, 15–20
- Multitone (MT)-CDMA, 160
- Multiuser detection (MUD), 175
- Multi-user detection, 155

- Narrowband CDMA, 157
- Network interface unit, 14, 15
- Non-binary codes, 54
- Non-ideal power amplifier, 127
- Normalized delay spread, 66, 68, 69
- Normalized Euclidean distance, 61, 69
- Normalized guard time, 67, 68
- Nyquist sampling, 96

- OFDMA, 213–228
- Offset synchronization, 222
- Optimal timing, 88
- Orthogonal Frequency Division Multiplexing (OFDM), 1, 3, 5, 20, 21, 22, 23, 33–51, 115, 233, 239, 241
 - preamble, 238, 244, 249–252
 - receiver, 95
 - symbol time, 41
 - transceiver, 48, 245
- Orthogonal restoring combining, 189
- Orthogonality, 35, 40, 41, 44, 89

- Packet error ratio (PER), 68, 69
- Packet transmission, 105
- PAP ratio distribution, 121–123
- PAP reduction codes, 138–150
- Parallel interference cancellation (PIC), 175
- Peak cancellation, 119, 130
- Peak windowing, 123–126
- Peak-to-average power (PAP), 121–156
- Phase
 - error, 84
 - estimation, 83
 - noise spectral density, 75
 - noise, 73
- Phase-locked loop (PLL), 76, 77
- Pilot estimates, 98
- Pilot subcarrier, 105
- Pilots, 97, 98, 236, 248, 251
- Postguard interval, 44

- Power
 - amplifier, 127
 - control, 172
 - delay profile, 17
 - spectral density, 134, 136
- Preguard interval, 44
- Privacy, 159
- Processing gain, 158
- PSK, 33, 95
- Pulse amplitude modulation (PAM), 60
- Pulse modulation (PM), 158
- Pure CDMA, 160

- QAM, 6, 33, 34, 35, 41, 46, 48, 53, 61–62
- QPSK, 6, 56, 60, 61, 62, 230, 232, 244
- Quadrature component, 88
- Quality of service (QoS), 243–245, 247
- Quantized OFDM signal, 87

- Radio interface unit (RIU), 14, 15
- Raised cosine, 45, 89
- RAKE receiver, 155, 171
- Random frequency hopping, 224
- Rapp's model, 127
- Rayleigh fading, 66, 68
- Reed-Solomon codes, 54
- Reference cancellation function, 131
- Repetition codes, 54
- Rolloff factor, 44, 45

- Safety considerations, 10, 11
- SAMBA, 3, 4
- Scrambling, 130, 150–152
- Sensitivity, 73
- Shift registers, 55
- Sidelobes, 81
- Signal processing, 47, 245
- Signal-to-noise ratio (SNR), 33, 46, 56–58, 96, 107, 232
- Single parity check, 54
- Single-carrier modulation, 49–51
- Single-sided spectrum, 74
- Smart antenna, 3
- Soft decision, 56, 58
- Soft handover, 173
- Spreading code, 157, 158, 160
- Spread-spectrum, 156
 - modulation, 158
 - multiple access (SSMA), 158
- Standard deviation, 81
- Subcarriers, 39

- Suboptimal decoding, 147
- Successive interference cancellation (SIC), 176
- SWAN, 3
- Symbol energy-to-noise density ratio (E_b/N_0), 56, 57, 59, 61, 62, 65
- Symbol scrambling, 150–152
- Symbol structure, 91
- Symbol time, 39, 44, 230, 235
- Synchronization, 73–92

- TDD, 4, 6
- TDMA, 4
- TDMA/CDMA, 161
- Time hopping (TH) CDMA, 160–170
- Time synchronization, 221
- Timing errors, 78–80
- Timing offset, 73
- Tracking loop bandwidth, 76
- Training symbol, 81
- Transmission bandwidth, 158
- Trellis coding, 62

- UMTS, 9
- UNII, 6

- Variable bit rate (VBR), 3
- Very large scale integration (VLSI), 23
- Very-High-Speed Digital Subscriber Line (VDSL), 23
- Virtual channel identifier (VCI), 13
- Virtual path identifier (VPI), 13
- Viterbi decoding, 56
- Voltage controlled Oscillator (VCO), 76

- Walsh-Hadamard code, 197
- Walsh-Hadamard transform, 146, 147
- WATM, 3
- Wideband CDMA, 157
- Windowing, 42–46, 235, 245
- Wireless Broadband Mobile Communication Systems, 12, 13, 14, 15
- Wireless Customer Premises Network (WCPN), 2
- Wireless Local Area Network (WLAN), 1, 2, 6,
- Wireless Local Loop (WLL), 2

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.