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**Yung et al.**

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(54) **HEURISTIC BEHAVIOR PATTERN  
MATCHING OF DATA FLOWS IN ENHANCED  
NETWORK TRAFFIC CLASSIFICATION**

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(52) **U.S. Cl.** ..... **370/253; 370/235; 370/252;**  
**709/224**

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**370/224, 229, 230, 231, 236.1, 238, 235,**  
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See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

4,914,650	A	4/1990	Sriram	
5,828,846	A	10/1998	Kirby	
6,003,077	A	12/1999	Bawden	
6,023,456	A	2/2000	Chapman	
6,038,216	A *	3/2000	Packer	370/231
6,046,980	A *	4/2000	Packer	370/230
6,122,670	A *	9/2000	Bennett et al.	709/236
6,144,636	A *	11/2000	Aimoto et al.	370/229
6,219,050	B1	4/2001	Schaffer	
6,285,660	B1	9/2001	Ronen	
6,363,056	B1	3/2002	Beigi	
6,397,359	B1	5/2002	Chandra	
6,584,467	B1	6/2003	Haught	
6,591,299	B2 *	7/2003	Riddle et al.	709/224
6,625,648	B1	9/2003	Schwaller	
6,628,938	B1	9/2003	Rachabathuni	

6,681,232	B1	1/2004	Sistanizadeh	
6,690,918	B2	2/2004	Evans	
6,701,359	B1	3/2004	Calabrez	
6,738,352	B1	5/2004	Yamada	
6,798,763	B1	9/2004	Kimura	
6,894,972	B1	5/2005	Phaal	
7,010,611	B1 *	3/2006	Wiryaman et al.	709/232
7,120,931	B1	10/2006	Cheriton	
7,154,416	B1	12/2006	Savage	
7,155,502	B1	12/2006	Galloway	
7,193,968	B1	3/2007	Kapoor	
7,215,637	B1	5/2007	Ferguson	
7,224,679	B2	5/2007	Solomon	

(Continued)

**OTHER PUBLICATIONS**

Pazos, C.M. et al., "Flow Control and Bandwidth Management in  
Next Generation Internets" IEEE, Jun. 22, 1998, pp. 123-132.\*

(Continued)

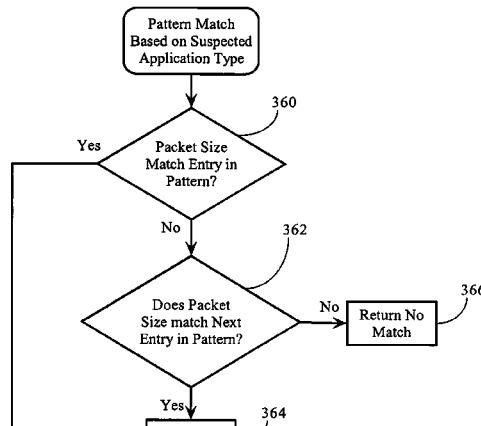
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(57) **ABSTRACT**

Methods, apparatuses and systems facilitating enhanced clas-  
sification of network traffic that extends beyond analysis of  
explicitly presented packet attributes and holistically ana-  
lyzes data flows, and in some implementations, related data  
flows against known application behavior patterns to classify  
the data flows. Implementations of the present invention  
facilitate the classification of encrypted or compressed net-  
work traffic, or where the higher layer information in the data  
flows are formatted according to a non-public or proprietary  
protocol.

**31 Claims, 11 Drawing Sheets**



U.S. PATENT DOCUMENTS

7,292,531 B1 11/2007 Hill  
7,296,288 B1 11/2007 Hill  
7,324,447 B1 1/2008 Morford  
7,385,924 B1 6/2008 Riddle  
7,554,983 B1 6/2009 Muppala  
2002/0122427 A1 9/2002 Kamentsky  
2002/0143901 A1 10/2002 Lupo  
2003/0035385 A1 2/2003 Walsh  
2003/0112764 A1 6/2003 Gaspard  
2003/0185210 A1 10/2003 McCormack

2004/0125815 A1 7/2004 Shimazu  
2006/0045014 A1 3/2006 Charzinski

OTHER PUBLICATIONS

Ye, Guanhua et al., "Using explicit congestion notification in stream control transmisson provided in networks", IEEE, May 19-22, 2003, pp. 704-709.\*

Yung, U.S. Appl. No. 10/917,952, entitled: Examination of connection handshake to enhance classification of encrypted network traffic, Aug. 2004.

\* cited by examiner

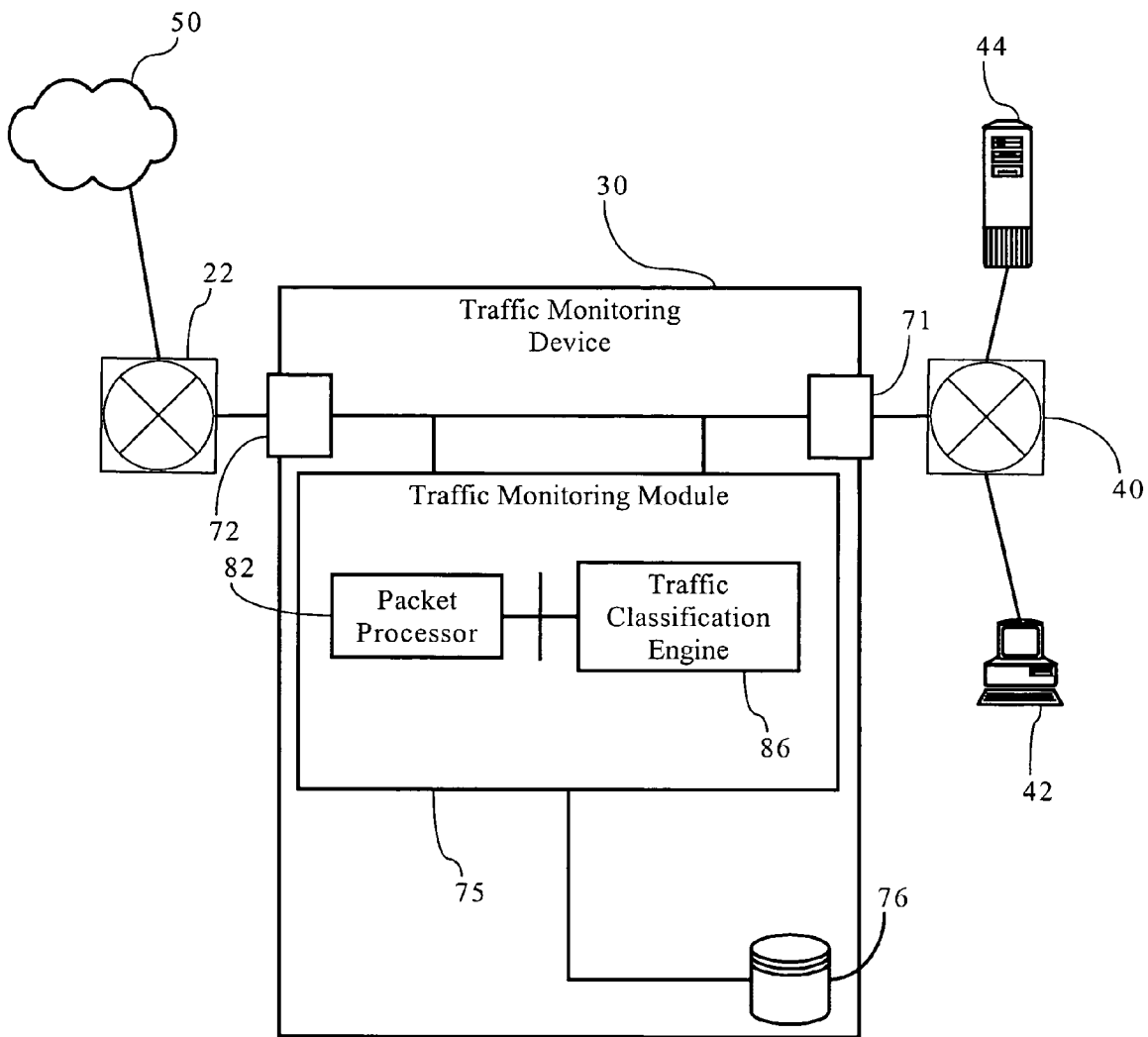


Fig. 1

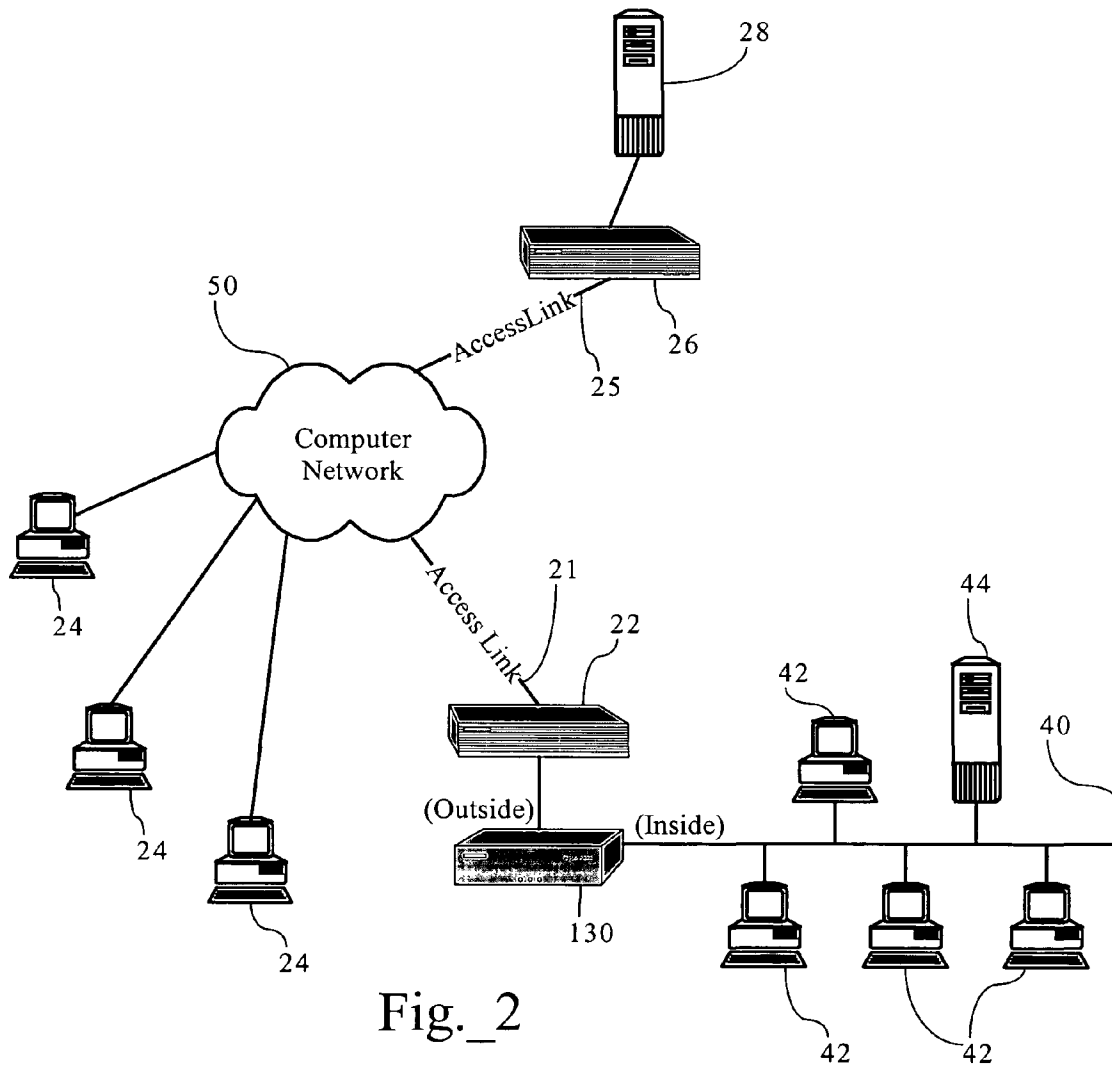


Fig. 2

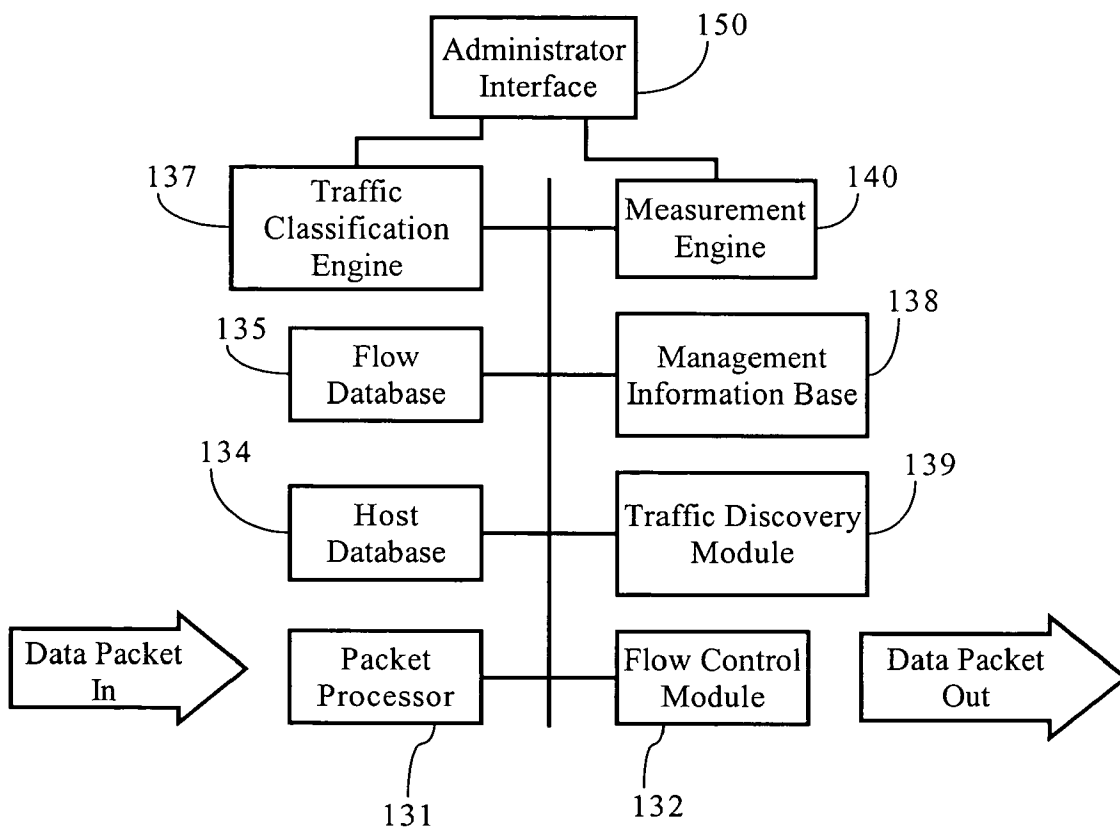


Fig. 3

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