US007697492B2

(12) **United States Patent**
Petite

(10) **Patent No.: US 7,697,492 B2**
(45) **Date of Patent: *Apr. 13, 2010**

(54) **SYSTEMS AND METHODS FOR MONITORING AND CONTROLLING REMOTE DEVICES**

(75) Inventor: **Thomas David Petite**, Douglasville, GA (US)

(73) Assignee: **Sipco, LLC**, Atlanta, GA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 975 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/159,768**

(22) Filed: **Jun. 23, 2005**

(65) **Prior Publication Data**

US 2005/0243867 A1 Nov. 3, 2005

Related U.S. Application Data

(63) Continuation of application No. 09/812,044, filed on Mar. 19, 2001, now Pat. No. 6,914,893, which is a continuation-in-part of application No. 09/704,150, filed on Nov. 1, 2000, now Pat. No. 6,891,838, and a continuation-in-part of application No. 09/439,059, filed on Nov. 12, 1999, now Pat. No. 6,437,692, and a continuation-in-part of application No. 09/412,895, filed on Oct. 5, 1999, now Pat. No. 6,218,953, and a continuation-in-part of application No. 09/271,517, filed on Mar. 18, 1999, now abandoned, and a continuation-in-part of application No. 09/172,554, filed on Oct. 14, 1998, now Pat. No. 6,028,522, and a continuation-in-part of application No. 09/102,178, filed on Jun. 22, 1998, now Pat. No. 6,430,268.

(60) Provisional application No. 60/224,043, filed on Aug. 9, 2000.

(51) **Int. Cl.**
H04W 4/00 (2009.01)

(52) **U.S. Cl.** **370/338**; 370/401; 340/870.02

(58) **Field of Classification Search** .... None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,665,475 A 5/1972 Gram

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0718954 6/1996

(Continued)

OTHER PUBLICATIONS

Khan, Robert E., "The Organization of Computer Resources into a Packet Radio Network," IEEE Transactions on Communications, Jan. 1977, vol. Com-25 No. 1, pp. 169-178.
Westcott, Jill A., "Issues in Distributed Routing for Mobile Packet Radio Network," IEEE 1982, pp. 233-238.
Brownrigg, E.B. et al.; A Packet Radio Network for Library Automation; IEEE (1987); pp. 456-462.
Brownrigg, E.B. et al.; A Packet Radio Networks; Architectures, Protocols, Technologies and Applications (1987), (introduction pp. ix-xviii); pp. 3-274.

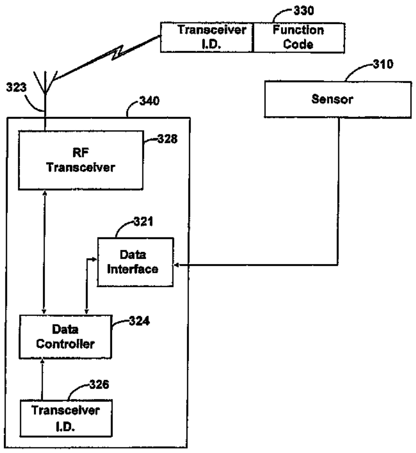
(Continued)

Primary Examiner—Phirin Sam
(74) *Attorney, Agent, or Firm*—Troutman Sanders LLP; James H. Yancey, Jr.; Filip A. Kowalewski

(57) **ABSTRACT**

Systems and methods for monitoring and controlling remote devices are provided. In an embodiment, a system can comprise one or more remotely controlled sensors and actuators. The remote sensors/actuators can interface with uniquely identified remote transceivers that transmit and/or receive data. The embodiment can also comprise a plurality of transceivers each having a unique address, and a controller adapted to communicate with at least one of the transceivers in a preformatted message. A sensor can be associated with at least one transceiver to detect a condition and output a data signal to the transceiver, and an actuator can be associated with a transceiver to receive a control signal and activate a device. Other embodiments are also claimed and described.

25 Claims, 9 Drawing Sheets



U.S. PATENT DOCUMENTS

3,705,385	A	12/1972	Batz
3,723,876	A	3/1973	Seaborn, Jr.
3,742,142	A	6/1973	Martin
3,848,231	A	11/1974	Wooten
3,892,948	A	7/1975	Constable
3,906,460	A	9/1975	Halpern
3,914,692	A	10/1975	Seaborn, Jr.
3,922,492	A	11/1975	Lumsden
3,925,763	A	12/1975	Wadwhani et al.
4,025,315	A	5/1977	Mazelli
4,056,684	A	11/1977	Lindstrom
4,058,672	A	11/1977	Crager et al.
4,083,003	A	4/1978	Haemmig
4,120,452	A	10/1978	Kimura et al.
4,124,839	A	11/1978	Cohen
4,135,181	A	1/1979	Bogacki et al.
4,204,195	A	5/1980	Bogacki
4,213,119	A	7/1980	Ward et al.
4,277,837	A	7/1981	Stuckert
4,278,975	A	7/1981	Kimura et al.
4,322,842	A *	3/1982	Martinez 370/204
4,354,181	A	10/1982	Spletzer
4,396,910	A	8/1983	Enemark et al.
4,396,915	A	8/1983	Farnsworth et al.
4,417,450	A	11/1983	Morgan, Jr. et al.
4,436,957	A	3/1984	Mazza
4,446,454	A	5/1984	Pyle
4,446,458	A	5/1984	Cook
4,454,414	A	6/1984	Benton
4,468,656	A	8/1984	Clifford et al.
4,488,152	A	12/1984	Arnason et al.
4,495,496	A	1/1985	Miller, III
4,551,719	A	11/1985	Carlin et al.
4,611,198	A	9/1986	Levinson et al.
4,621,263	A	11/1986	Takenaka et al.
4,630,035	A	12/1986	Stahl et al.
4,631,357	A	12/1986	Grunig
4,670,739	A	6/1987	Kelly, Jr.
4,692,761	A	9/1987	Robinton
4,707,852	A	11/1987	Jahr et al.
4,731,810	A	3/1988	Watkins
4,742,296	A	5/1988	Petr et al.
4,757,185	A	7/1988	Onishi
4,788,721	A	11/1988	Krishnan et al.
4,800,543	A	1/1989	Lyndon-James et al.
4,825,457	A	4/1989	Lebowitz
4,829,561	A	5/1989	Matheny
4,849,815	A	7/1989	Streck
4,851,654	A	7/1989	Nitta
4,856,046	A	8/1989	Steck et al.
4,857,912	A	8/1989	Everett, Jr. et al.
4,875,231	A	10/1989	Hara et al.
4,884,123	A	11/1989	Morris et al.
4,897,644	A	1/1990	Hirano
4,906,828	A	3/1990	Halpern
4,908,769	A	3/1990	Vaughan et al.
4,918,690	A	4/1990	Markkula, Jr. et al.
4,918,995	A	4/1990	Pearman et al.
4,928,299	A	5/1990	Tansky et al.
4,939,726	A	7/1990	Flammer et al.
4,940,976	A	7/1990	Gastouniotis et al.
4,949,077	A	8/1990	Mbuthia
4,952,928	A	8/1990	Carroll et al.
4,962,496	A	10/1990	Vercellotti et al.
4,967,366	A	10/1990	Kaehler
4,968,970	A	11/1990	LaPorte
4,968,978	A	11/1990	Stolarczyk
4,972,504	A	11/1990	Daniel, Jr. et al.
4,973,957	A	11/1990	Shimizu et al.
4,973,970	A	11/1990	Reeser
4,977,612	A	12/1990	Wilson
4,980,907	A	12/1990	Raith et al.
4,989,230	A	1/1991	Gillig et al.
4,991,008	A	2/1991	Nama
4,993,059	A	2/1991	Smith et al.
4,998,095	A	3/1991	Shields
4,999,607	A	3/1991	Evans
5,007,052	A	4/1991	Flammer
5,032,833	A	7/1991	Laporte
5,038,372	A	8/1991	Elms et al.
5,055,851	A	10/1991	Sheffer
5,057,814	A	10/1991	Onan et al.
5,061,997	A	10/1991	Rea et al.
5,079,768	A	1/1992	Flammer
5,086,391	A	2/1992	Chambers
5,091,713	A	2/1992	Horne et al.
5,111,199	A	5/1992	Tomoda et al.
5,113,183	A	5/1992	Mizuno et al.
5,113,184	A	5/1992	Katayama
5,115,224	A	5/1992	Kostusiak et al.
5,115,433	A	5/1992	Baran et al.
5,124,624	A	6/1992	de Vries et al.
5,128,855	A	7/1992	Hilber et al.
5,130,519	A	7/1992	Bush et al.
5,130,987	A	7/1992	Flammer
5,131,038	A	7/1992	Puhl et al.
5,134,650	A	7/1992	Blackmon
5,136,285	A	8/1992	Okuyama
5,155,481	A	10/1992	Brennan, Jr. et al.
5,159,317	A	10/1992	Brav
5,162,776	A	11/1992	Bushnell et al.
5,177,342	A	1/1993	Adams
5,189,287	A	2/1993	Parienti
5,191,192	A	3/1993	Takahira et al.
5,191,326	A	3/1993	Montgomery
5,193,111	A	3/1993	Matty et al.
5,195,018	A	3/1993	Kwon et al.
5,197,095	A	3/1993	Bonnet et al.
5,200,735	A	4/1993	Hines
5,204,670	A	4/1993	Stinton
5,212,645	A	5/1993	Wildes et al.
5,216,502	A	6/1993	Katz
5,221,838	A	6/1993	Gutman et al.
5,223,844	A	6/1993	Mansell et al.
5,231,658	A	7/1993	Eftechiou
5,235,630	A	8/1993	Moody et al.
5,239,294	A	8/1993	Flanders et al.
5,239,575	A	8/1993	White et al.
5,241,410	A	8/1993	Streck et al.
5,243,338	A	9/1993	Brennan, Jr. et al.
5,245,633	A	9/1993	Schwartz et al.
5,251,205	A	10/1993	Callon et al.
5,252,967	A	10/1993	Brennan et al.
5,253,167	A	10/1993	Yoshida et al.
5,265,150	A	11/1993	Helmkamp et al.
5,265,162	A	11/1993	Bush et al.
5,266,782	A	11/1993	Alanara et al.
5,272,747	A	12/1993	Meads
5,282,204	A	1/1994	Shpancer et al.
5,282,250	A	1/1994	Dent et al.
5,289,165	A	2/1994	Belin
5,291,516	A	3/1994	Dixon et al.
5,295,154	A	3/1994	Meier et al.
5,305,370	A	4/1994	Kearns et al.
5,309,501	A	5/1994	Kozik et al.
5,315,645	A	5/1994	Matheny
5,317,309	A	5/1994	Vercellotti et al.
5,319,364	A	6/1994	Waraksa et al.
5,319,698	A	6/1994	Glidwell et al.
5,319,711	A	6/1994	Servi
5,323,384	A	6/1994	Norwood et al.
5,325,429	A	6/1994	Kurgan
5,329,394	A	7/1994	Calvani et al.
5,331,318	A	7/1994	Montgomery

5,334,974	A		8/1994	Simms et al.	
5,335,265	A		8/1994	Cooper et al.	
5,343,493	A		8/1994	Karimullah	
5,345,231	A		9/1994	Koo et al.	
5,345,595	A		9/1994	Johnson et al.	
5,347,263	A		9/1994	Carroll et al.	
5,354,974	A		10/1994	Eisenberg	
5,355,278	A		10/1994	Hosoi et al.	
5,355,513	A		10/1994	Clarke et al.	
5,365,217	A		11/1994	Toner	
5,371,736	A		12/1994	Evan	
5,382,778	A		1/1995	Takahira et al.	
5,383,134	A		1/1995	Wrzesinski	
5,390,206	A		2/1995	Rein	
5,406,619	A		4/1995	Akhteruzzman et al.	
5,412,192	A		5/1995	Hoss	
5,412,760	A		5/1995	Peitz	
5,416,475	A		5/1995	Tolbert et al.	
5,416,725	A		5/1995	Pacheco et al.	
5,418,812	A		5/1995	Reyes et al.	
5,420,910	A		5/1995	Rudokas et al.	
5,424,708	A		6/1995	Ballestry et al.	
5,432,507	A		7/1995	Mussino et al.	
5,438,329	A		8/1995	Gastouniotis et al.	
5,439,414	A		8/1995	Jacob	
5,440,545	A		8/1995	Buchholz et al.	
5,442,553	A		8/1995	Parrillo	
5,445,287	A		8/1995	Center et al.	
5,445,347	A		8/1995	Ng	
5,451,929	A		9/1995	Adelman et al.	
5,451,938	A		9/1995	Brennan, Jr.	
5,452,344	A		9/1995	Larson	
5,454,024	A		9/1995	Lebowitz	
5,465,401	A		11/1995	Thompson	
5,467,074	A		11/1995	Pedtke	
5,467,082	A		11/1995	Sanderson	
5,467,345	A		11/1995	Cutler, Jr. et al.	
5,468,948	A		11/1995	Koenck et al.	
5,471,201	A		11/1995	Cerami et al.	
5,473,322	A		12/1995	Carney	
5,475,689	A		12/1995	Kay et al.	
5,481,259	A		1/1996	Bane	
5,481,532	A		1/1996	Hassan et al.	
5,484,997	A		1/1996	Haynes	
5,488,608	A		1/1996	Flammer, III	
5,493,273	A		2/1996	Smurlo et al.	
5,493,287	A		2/1996	Bane	
5,502,726	A		3/1996	Fischer	
5,506,837	A		4/1996	Sollner et al.	
5,509,073	A		4/1996	Monnin	
5,513,244	A		4/1996	Joao et al.	
5,515,419	A		5/1996	Sheffer	
5,517,188	A		5/1996	Caroll et al.	
5,522,089	A		5/1996	Kikinis et al.	
5,528,215	A		6/1996	Siu et al.	
5,539,825	A		7/1996	Akiyama et al.	
5,541,938	A		7/1996	Di Zenzo et al.	
5,542,100	A		7/1996	Hatakeyama	
5,544,036	A		8/1996	Brown, Jr. et al.	
5,544,784	A		8/1996	Malaspina	
5,548,632	A		8/1996	Walsh et al.	
5,550,358	A		8/1996	Tait et al.	
5,550,359	A		8/1996	Bennett	
5,550,535	A		8/1996	Park	
5,553,094	A		9/1996	Johnson et al.	
5,555,258	A		9/1996	Snelling et al.	
5,555,286	A		9/1996	Tendler	
5,562,537	A		10/1996	Zver et al.	
5,565,857	A		10/1996	Lee	
5,568,535	A		10/1996	Sheffer et al.	
5,570,084	A		10/1996	Ritter et al.	
5,572,438	A		11/1996	Ehlers et al.	
5,573,181	A		11/1996	Ahmed	
5,574,111	A		11/1996	Brichta et al.	
5,583,850	A		12/1996	Snodgrass et al.	
5,587,705	A		12/1996	Morris	
5,589,878	A		12/1996	Cortjens et al.	
5,590,038	A		12/1996	Pitroda	
5,590,179	A		12/1996	Shincovich et al.	
5,592,491	A		1/1997	Dinkins	
5,594,431	A		1/1997	Sheppard et al.	
5,596,719	A		1/1997	Ramakrishnan et al.	
5,602,843	A		2/1997	Gray	
5,604,414	A		2/1997	Milligan et al.	
5,604,869	A		2/1997	Mincher et al.	
5,606,361	A		2/1997	Davidsohn et al.	
5,608,786	A		3/1997	Gordon	
5,613,620	A		3/1997	Center et al.	
5,615,277	A		3/1997	Hoffman	
5,619,192	A		4/1997	Ayala	
5,625,410	A		4/1997	Washino et al.	
5,628,050	A		5/1997	McGraw et al.	
5,629,687	A		5/1997	Sutton et al.	
5,629,875	A		5/1997	Adair, Jr.	
5,630,209	A		5/1997	Wizgall et al.	
5,631,554	A		5/1997	Briese et al.	
5,636,216	A		6/1997	Fox et al.	
5,640,002	A		6/1997	Ruppert et al.	
5,644,294	A		7/1997	Ness	
5,655,219	A		8/1997	Jusa et al.	
5,657,389	A		8/1997	Houvener	
5,659,300	A		8/1997	Dresselhuys et al.	
5,659,303	A		8/1997	Adair, Jr.	
5,668,876	A		9/1997	Falk et al.	
5,673,252	A		9/1997	Johnson et al.	
5,673,304	A		9/1997	Connor et al.	
5,673,305	A		9/1997	Ross	
5,682,139	A		10/1997	Pradeep et al.	
5,682,476	A		10/1997	Tapperson et al.	
5,689,229	A		11/1997	Chaco et al.	
5,699,328	A		12/1997	Ishizaki et al.	
5,701,002	A		12/1997	Oishi et al.	
5,702,059	A		12/1997	Chu et al.	
5,704,046	A		12/1997	Hogan	
5,704,517	A		1/1998	Lancaster, Jr.	
5,706,191	A		1/1998	Bassett et al.	
5,706,976	A		1/1998	Purkey	
5,708,223	A		1/1998	Wyss	
5,708,655	A		1/1998	Toth et al.	
5,712,619	A		1/1998	Simkin	
5,712,980	A		1/1998	Beeler et al.	
5,714,931	A		2/1998	Petite et al.	
5,717,718	A		2/1998	Roswell et al.	
5,719,564	A	*	2/1998	Sears	340/870.02
5,726,634	A		3/1998	Hess et al.	
5,726,984	A		3/1998	Kubler et al.	
5,732,074	A		3/1998	Spaur et al.	
5,732,078	A		3/1998	Arango	
5,736,965	A		4/1998	Mosebrook et al.	
5,740,232	A		4/1998	Pailles et al.	
5,742,509	A		4/1998	Goldberg et al.	
5,745,849	A		4/1998	Britton	
5,748,104	A		5/1998	Argyroudis et al.	
5,748,619	A		5/1998	Meier	
5,754,111	A		5/1998	Garcia	
5,754,227	A		5/1998	Fukuoka	
5,757,783	A		5/1998	Eng et al.	
5,757,788	A		5/1998	Tatsumi et al.	
5,761,083	A		6/1998	Brown, Jr. et al.	
5,764,742	A		6/1998	Howard et al.	
5,767,791	A		6/1998	Stoop et al.	
5,771,274	A		6/1998	Harris	
5,774,052	A		6/1998	Hamm et al.	
5,781,143	A		7/1998	Rossin	
5,790,644	A		8/1998	Kikinis	
5,790,662	A		8/1998	Valerij et al.	

5,790,938	A		8/1998	Talarmo	
5,796,727	A		8/1998	Harrison et al.	
5,798,964	A		8/1998	Shimizu et al.	
5,801,643	A		9/1998	Williams et al.	
5,815,505	A		9/1998	Mills	
5,818,822	A		10/1998	Thomas et al.	
5,822,273	A		10/1998	Bary et al.	
5,822,544	A		10/1998	Chaco et al.	
5,825,772	A		10/1998	Dobbins et al.	
5,826,195	A		10/1998	Westerlage et al.	
5,828,044	A		10/1998	Jun et al.	
5,832,057	A		11/1998	Furman	
5,838,223	A		11/1998	Gallant et al.	
5,838,237	A		11/1998	Revell et al.	
5,838,812	A		11/1998	Pare, Jr. et al.	
5,841,118	A		11/1998	East et al.	
5,841,764	A		11/1998	Roderique et al.	
5,842,976	A		12/1998	Williamson	
5,844,808	A		12/1998	Konsmo et al.	
5,845,230	A		12/1998	Lamberson	
5,852,658	A		12/1998	Knight et al.	
5,854,994	A		12/1998	Canada et al.	
5,862,201	A		1/1999	Sands	
5,864,772	A		1/1999	Alvarado et al.	
5,873,043	A		2/1999	Comer	
5,874,903	A	*	2/1999	Shuey et al.	340/870.02
5,880,677	A		3/1999	Lestician	
5,883,886	A	*	3/1999	Eaton et al.	370/314
5,884,184	A		3/1999	Sheffer	
5,884,271	A		3/1999	Pitroda	
5,886,333	A		3/1999	Miyake	
5,889,468	A		3/1999	Banga	
5,892,690	A		4/1999	Boatman et al.	
5,892,758	A		4/1999	Argyroudis	
5,892,924	A		4/1999	Lyon et al.	
5,896,097	A		4/1999	Cardozo	
5,897,607	A		4/1999	Jenney et al.	
5,898,369	A		4/1999	Godwin	
5,905,438	A		5/1999	Weiss et al.	
5,907,291	A		5/1999	Chen et al.	
5,907,491	A		5/1999	Canada et al.	
5,907,540	A		5/1999	Hayashi	
5,907,807	A		5/1999	Chavez, Jr. et al.	
5,914,672	A		6/1999	Glorioso et al.	
5,914,673	A		6/1999	Jennings et al.	
5,917,405	A		6/1999	Joao	
5,917,629	A		6/1999	Hortensius et al.	
5,923,269	A	*	7/1999	Shuey et al.	340/870.02
5,926,103	A		7/1999	Petite	
5,926,529	A		7/1999	Hache et al.	
5,926,531	A		7/1999	Petite	
5,933,073	A		8/1999	Shuey	
5,941,363	A		8/1999	Partyka et al.	
5,941,955	A		8/1999	Wilby et al.	
5,948,040	A		9/1999	DeLorme et al.	
5,949,779	A		9/1999	Mostafa et al.	
5,949,799	A		9/1999	Grivna et al.	
5,953,319	A		9/1999	Dutta et al.	
5,953,371	A		9/1999	Roswell et al.	
5,955,718	A		9/1999	Levasseur et al.	
5,960,074	A		9/1999	Clark	
5,963,146	A		10/1999	Johnson et al.	
5,963,452	A		10/1999	Etoh et al.	
5,963,650	A		10/1999	Simionescu et al.	
5,966,658	A		10/1999	Kennedy, III et al.	
5,969,608	A		10/1999	Sojdehei et al.	
5,973,756	A		10/1999	Erlin	
5,974,236	A		10/1999	Sherman	
5,978,364	A		11/1999	Melnik	
5,978,371	A		11/1999	Mason, Jr. et al.	
5,986,574	A		11/1999	Colton	
5,987,421	A		11/1999	Chuang	
5,991,625	A		11/1999	Vanderpool	
5,991,639	A		11/1999	Rautiola et al.	
5,994,892	A		11/1999	Turino et al.	
5,995,592	A		11/1999	Shirai et al.	
5,995,593	A		11/1999	Cho	
5,997,170	A		12/1999	Brodbeck	
5,999,094	A		12/1999	Nilssen	
6,005,759	A		12/1999	Hart et al.	
6,005,963	A		12/1999	Bolle et al.	
6,021,664	A		2/2000	Granato et al.	
6,023,223	A		2/2000	Baxter, Jr.	
6,026,095	A		2/2000	Sherer et al.	
6,028,522	A		2/2000	Petite	
6,028,857	A		2/2000	Poor	
6,031,455	A		2/2000	Grube et al.	
6,032,197	A		2/2000	Birdwell et al.	
6,035,213	A		3/2000	Tokuda et al.	
6,035,266	A		3/2000	Williams et al.	
6,036,086	A		3/2000	Sizer, II et al.	
6,038,491	A		3/2000	McGarry et al.	
6,044,062	A		3/2000	Brownrigg et al.	
6,054,920	A		4/2000	Smith et al.	
6,060,994	A		5/2000	Chen	
6,061,604	A		5/2000	Russ et al.	
6,064,318	A		5/2000	Kirchner, III et al.	
6,067,017	A		5/2000	Stewart et al.	
6,067,030	A		5/2000	Burnett et al.	
6,069,886	A		5/2000	Ayerst et al.	
6,073,169	A		6/2000	Shuey et al.	
6,073,266	A		6/2000	Ahmed et al.	
6,073,840	A		6/2000	Marion	
6,075,451	A		6/2000	Lebowitz et al.	
6,078,251	A		6/2000	Landt et al.	
6,087,957	A		7/2000	Gray	
6,088,659	A		7/2000	Kelley et al.	
6,094,622	A		7/2000	Hubbard et al.	
6,100,817	A		8/2000	Mason, Jr. et al.	
6,101,427	A		8/2000	Yang	
6,101,445	A		8/2000	Alvarado et al.	
6,108,614	A	*	8/2000	Lincoln et al.	702/183
6,112,983	A		9/2000	D'Anniballe et al.	
6,115,580	A		9/2000	Chuprun et al.	
6,119,076	A		9/2000	Williams et al.	
6,121,593	A		9/2000	Mansbery et al.	
6,121,885	A		9/2000	Masone et al.	
6,124,806	A	*	9/2000	Cunningham et al. ..	340/870.02
6,127,917	A		10/2000	Tuttle	
6,128,551	A		10/2000	Davis et al.	
6,130,622	A		10/2000	Hussey et al.	
6,133,850	A		10/2000	Moore	
6,137,423	A		10/2000	Glorioso et al.	
6,140,975	A		10/2000	Cohen	
6,141,347	A		10/2000	Shaughnessy et al.	
6,150,936	A		11/2000	Addy	
6,150,955	A		11/2000	Tracy et al.	
6,157,464	A		12/2000	Bloomfield et al.	
6,157,824	A		12/2000	Bailey	
6,163,276	A		12/2000	Irving et al.	
6,172,616	B1		1/2001	Johnson et al.	
6,174,205	B1		1/2001	Madsen et al.	
6,175,922	B1		1/2001	Wang	
6,177,883	B1		1/2001	Jennetti et al.	
6,181,255	B1		1/2001	Crimmins et al.	
6,181,284	B1		1/2001	Madsen et al.	
6,181,981	B1		1/2001	Varga et al.	
6,188,354	B1		2/2001	Soliman et al.	
6,192,390	B1		2/2001	Berger et al.	
6,198,390	B1		3/2001	Schlager et al.	
6,199,068	B1		3/2001	Carpenter	
6,208,266	B1		3/2001	Lyons et al.	
6,215,404	B1		4/2001	Morales	
6,218,953	B1		4/2001	Petite	
6,218,958	B1		4/2001	Eichstaedt	
6,218,983	B1		4/2001	Kerry et al.	

6,219,409	B1	4/2001	Smith et al.	
6,229,439	B1	5/2001	Tice	
6,233,327	B1	5/2001	Petite	
6,234,111	B1	5/2001	Ulman et al.	
6,236,332	B1	5/2001	Conkright et al.	
6,243,010	B1	6/2001	Addy et al.	
6,246,677	B1	6/2001	Nap et al.	
6,246,886	B1	6/2001	Olivia	
6,249,516	B1	6/2001	Brownrigg et al.	
6,259,369	B1	7/2001	Monico	
6,275,707	B1	8/2001	Reed et al.	
6,286,756	B1	9/2001	Stinson et al.	
6,288,634	B1	9/2001	Weiss et al.	
6,288,641	B1	9/2001	Carsais	
6,295,291	B1	9/2001	Larkins	
6,301,514	B1	10/2001	Canada et al.	
6,304,556	B1	10/2001	Haas	
6,305,602	B1	10/2001	Grabowski et al.	
6,308,111	B1	10/2001	Koga	
6,311,167	B1	10/2001	Davis et al.	
6,314,169	B1	11/2001	Schelberg, Jr. et al.	
6,317,029	B1	11/2001	Fleeter	
6,334,117	B1	12/2001	Covert et al.	
6,351,223	B1	2/2002	DeWeerd et al.	
6,356,205	B1	3/2002	Salvo et al.	
6,357,034	B1	3/2002	Muller et al.	
6,362,745	B1	3/2002	Davis	
6,363,057	B1	3/2002	Ardalan et al.	
6,366,217	B1	4/2002	Cunningham et al.	
6,366,622	B1	4/2002	Brown et al.	
6,369,769	B1	4/2002	Nap et al.	
6,370,489	B1	4/2002	Williams et al.	
6,373,399	B1	4/2002	Johnson et al.	
6,380,851	B1	4/2002	Gilbert et al.	
6,384,722	B1	5/2002	Williams	
6,393,341	B1	5/2002	Lawrence et al.	
6,393,381	B1	5/2002	Williams et al.	
6,393,382	B1	5/2002	Williams et al.	
6,396,839	B1	5/2002	Ardalan et al.	
6,400,819	B1	6/2002	Nakano et al.	
6,401,081	B1	6/2002	Montgomery et al.	
6,405,018	B1	6/2002	Reudink et al.	
6,411,889	B1	6/2002	Mizunuma et al.	
6,415,245	B2	7/2002	Williams et al.	
6,421,354	B1	7/2002	Godlewski	
6,421,731	B1	7/2002	Ciotti, Jr. et al.	
6,422,464	B1	7/2002	Terranova	
6,424,270	B1	7/2002	Ali	
6,424,931	B1	7/2002	Sigmar et al.	
6,430,268	B1	8/2002	Petite	
6,431,439	B1	8/2002	Suer et al.	
6,437,692	B1	8/2002	Petite et al.	
6,438,575	B1	8/2002	Khan et al.	
6,445,291	B2	9/2002	Addy et al.	
6,456,960	B1	9/2002	Williams et al.	
6,457,038	B1	9/2002	Defosse	
6,462,644	B1	10/2002	Howell et al.	
6,462,672	B1	10/2002	Besson	
6,477,558	B1	11/2002	Irving et al.	
6,483,290	B1	11/2002	Hemminger et al.	
6,484,939	B1	11/2002	Blaeuer	
6,489,884	B1	12/2002	Lamberson et al.	
6,491,828	B1	12/2002	Sivavec et al.	
6,492,910	B1	12/2002	Ragle et al.	
6,504,357	B1	1/2003	Hemminger et al.	
6,507,794	B1	1/2003	Hubbard et al.	
6,509,722	B2	1/2003	Lopata	
6,519,568	B1	2/2003	Harvey et al.	
6,538,577	B1	3/2003	Ehrke et al.	
6,542,076	B1	4/2003	Joao	
6,542,077	B2	4/2003	Joao	
6,543,690	B2	4/2003	Leydier et al.	
6,560,223	B1	5/2003	Egan et al.	
6,574,603	B1	6/2003	Dickson et al.	
6,584,080	B1	6/2003	Ganz et al.	
6,600,726	B1	7/2003	Nevo et al.	
6,608,551	B1	8/2003	Anderson et al.	
6,618,578	B1	9/2003	Petite	
6,618,709	B1	9/2003	Sneeringer	
6,628,764	B1	9/2003	Petite	
6,628,965	B1	9/2003	LaRosa et al.	
6,653,945	B2	11/2003	Johnson et al.	
6,654,357	B1	11/2003	Wiedeman	
6,671,586	B2	12/2003	Davis et al.	
6,674,403	B2	1/2004	Gray et al.	
6,678,255	B1	1/2004	Kuriyan	
6,678,285	B1	1/2004	Garg	
6,731,201	B1	5/2004	Bailey et al.	
6,735,630	B1	5/2004	Gelvin et al.	
6,747,557	B1	6/2004	Petite et al.	
6,771,981	B1	8/2004	Zalewski et al.	
6,804,532	B1	10/2004	Moon et al.	
6,816,088	B1	11/2004	Knoska et al.	
6,888,876	B1	5/2005	Mason, Jr. et al.	
6,891,838	B1	5/2005	Petite	
6,914,533	B2	7/2005	Petite	
6,914,893	B2	7/2005	Petite	
6,959,550	B2	11/2005	Freeman et al.	
7,027,416	B1	4/2006	Kriz	
7,054,271	B2	5/2006	Brownrigg et al.	
7,227,927	B1 *	6/2007	Benedyk et al.	379/9.05
2001/0002210	A1	5/2001	Petite	
2001/0003479	A1	6/2001	Fujiwara	
2001/0021646	A1	9/2001	Antonucci et al.	
2001/0024163	A1	9/2001	Petite	
2001/0034223	A1	10/2001	Rieser et al.	
2001/0038343	A1	11/2001	Meyer et al.	
2002/0002444	A1	1/2002	Williams et al.	
2002/0013679	A1	1/2002	Petite	
2002/1112323		1/2002	Petite	
2002/0019725	A1	2/2002	Petite	
2002/0027504	A1	3/2002	Petite et al.	
2002/0031101	A1	3/2002	Petite	
2002/0032746	A1	3/2002	Lazaridis	
2002/0061031	A1	5/2002	Sugar et al.	
2002/0072348	A1	6/2002	Wheeler et al.	
2002/0089428	A1	7/2002	Walden et al.	
2002/0095399	A1	7/2002	Devine et al.	
2002/0098858	A1	7/2002	Struhsaker	
2002/0109607	A1	8/2002	Cumeralto et al.	
2002/0136233	A1	9/2002	Chen et al.	
2002/0158774	A1	10/2002	Johnson et al.	
2002/0163442	A1	11/2002	Fischer	
2002/0169643	A1	11/2002	Petite	
2002/0193144	A1	12/2002	Belski et al.	
2003/0001754	A1	1/2003	Johnson et al.	
2003/0023146	A1	1/2003	Shusterman	
2003/0028632	A1	2/2003	Davis	
2003/0030926	A1	2/2003	Aguren et al.	
2003/0034900	A1	2/2003	Han	
2003/0035438	A1	2/2003	Larsson	
2003/0036822	A1	2/2003	Davis et al.	
2003/0046377	A1	3/2003	Daum et al.	
2003/0058818	A1	3/2003	Wilkes et al.	
2003/0069002	A1	4/2003	Hunter et al.	
2003/0073406	A1	4/2003	Benjamin et al.	
2003/0078029	A1	4/2003	Petite	
2003/0093484	A1	5/2003	Petite	
2003/0133473	A1	7/2003	Manis et al.	
2003/0169710	A1	9/2003	Fan et al.	
2003/0185204	A1	10/2003	Murdock	
2003/0210638	A1	11/2003	Yoo	
2004/0047324	A1	3/2004	Diener	
2004/0053639	A1	3/2004	Petite	
2004/0131125	A1	7/2004	Sanderford, Jr. et al.	
2004/0133917	A1	7/2004	Schilling	

2004/0183687	A1	9/2004	Petite
2004/0228330	A1	11/2004	Kubler et al.
2005/0190055	A1	9/2005	Petite
2005/0195768	A1	9/2005	Petite
2005/0195775	A1	9/2005	Petite
2005/0201397	A1	9/2005	Petite
2006/0098576	A1	5/2006	Brownrigg et al.
2008/0186898	A1	7/2008	Petite
2009/0006617	A1	1/2009	Petite
2009/0068947	A1	12/2009	Petite

FOREIGN PATENT DOCUMENTS

EP	07144		2/1998
EP	1096454		5/2001
FR	2817110		5/2002
GB	2229302		9/1990
GB	2247761		3/1992
GB	2262683		6/1993
GB	2297663		8/1996
GB	2310779		9/1997
GB	2326002		12/1998
GB	2336272		10/1999
GB	2352004		1/2001
GB	2352590		1/2001
JP	60261288		12/1985
JP	01255100		10/1989
JP	11353573		12/1999
JP	200113590		4/2000
JP	2001063425		3/2001
JP	2001088401		4/2001
JP	2001309069		11/2001
JP	2001319284		11/2001
JP	2001357483		12/2001
JP	2002007672		1/2002
JP	2002007826		1/2002
JP	2002085354		3/2002
JP	2002171354		6/2002
KR	2001025431		4/2001
WO	WO 90/13197		11/1990
WO	9524177		9/1995
WO	WO 98/00056		1/1998
WO	WO98/10393	A1	3/1998
WO	WO 98/37528		8/1998
WO	WO 99/13426		3/1999
WO	0023956		4/2000
WO	WO00/36812	A1	6/2000
WO	WO 01/15114		3/2001
WO	WO 01/24109		4/2001
WO	WO 02/08725		1/2002
WO	WO 02/08866		1/2002
WO	WO 02/052521		7/2002
WO	WO 03/007264		1/2003
WO	WO 03/021877		3/2003
WO	04/002014		12/2003

OTHER PUBLICATIONS

Brownrigg, E.B. et al.; Distributions, Networks, and Networking: Options for Dissemination; Workshop on Electronic Texts Session III (http://palimpsest.standford.edu/byorg/Ic/etextw/sess3.html 1992): pp. 1-10.

Brownrigg, E.B. et al.; User Provided Access to the Internet; (http://web.simmons.edu/~chen/nit/NIT'92/033-bro.htm 2005) pp. 1-6.

Wey, Jyhi-Kong et al.; Clone Terminator: An Authentication Service for Advanced Mobile Phone System; IEEE (1995); pp. 175-179.

Davis, A.B. et al.; Knowledge-Based Management of Cellular Clone Fraud; IEEE (1992); pp. 230-234.

Johnson, David B.; Routing in Ad Hoc Networks of Mobile Hosts; IEEE (1995); pp. 158-163.

Jubin, John and Tornow, Janet D., "The Darpa Packet Radio Network Protocols,"Proceedings of the IEEE, vol. 75, No. 1, Jan. 1987, pp. 21-32.

Kleinrock, Leonard and Kamoun, Farouk, "Hierarchical Routing for Large Networks," North-Holland Publishing Company, Computer Networks 1, 1997, pp. 155-174.

Perkins, C.E. et al.; Highly Dynamic Destination-Sequenced Distance-Vector Routing (DSDV) for Mobile Computers; SIGCOMM 94-9/94 London England UK (1994); pp. 234-244.

Wu, J.; Distributed System Design; CRC Press (1999); pp. 177-180 and 204.

Khan, Robert E., Gronemeyer, Steven A. Burchfiel, Jerry, and Kunzelman, Ronald C., "Advances in Packet Radio Technology" IEEE Nov. 1978, vol. 66, No. 11, pp. 1468-149.

Westcott, Jil et al., "A Distributed Routing Design For A Broadcoast Environment", IEEE 1982, pp. 10.4.0-10.4.5.

Khan, Robert E. et al., "Advances in Packet Radio Technology", IEEE Nov. 1978, vol. 66, No. 11, pp. 1468-1496.

Frankel, Michael S., "Packet Radios Provide Link for Distributed, Survivable C3 in Post-Attack Scenarios", MSN Jun. 1983.

Lauer, Greg et al., "Survivable Protocols for Large Scale Packet Radio Networks", IEEE 1984, pp. 15.1-1 to 15.1-4.

Gower, Neil et al., "Congestion Control Using Pacing in a Packet Radio Network", IEEE 1982, pp. 23.1-1 to 23.1-6.

MacGregor, William et al., "Multiple Control Stations in Packet Radio Networks", IEEE 1982, pp. 10.3-1 to 10.3-5.

Shacham, Nachum et al., "Future Directions in Packet Radio Technology", IEEE 1985, pp. 93-98.

Jubin, John, "Current Packet Radio Network Protocols", IEEE 1985, pp. 86-92.

Westcott, Jill A., Issues in Distributed Routing for Mobile Packet Radio Network, IEEE 1982, pp. 233 238.

Lynch, Clifford A. et al., Packet Radio Networks, "Architectures, Protocols, Technologies and Applications,", 1987.

Brownrigg, Edwin, "User Provided Access to the Internet,", Open Access Solutions, http://web.simmons.edu/chen/nit/NIT'92/033-bro.htm, Jun. 8, 2005-Jun. 9, 2005.

K. Bult, et al.; "Low Power Systems for Wireless Microsensors;" UCLA Electrical Engineering Department, Los Angeles, CA and Rockwell Science Center, Thousand Oaks, CA; pp. 25-29.

David B. Johnson and David A. Maltz, Dynamic Source Routing in Ad Hoc Wireless Networks; Computer Science Department; Carnegie Mellon University; a chapter in Mobile Computing; Feb. 29, 1996; pp. 1-18.

David A. Maltz et al.; Experiences Designing and Building a Multi-Hop Wireless Ad Hoc Network Testbed; School of Computer Science, Carnegie Mellon University; Mar. 5, 1999; pp. 1-20.

"Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications;" IEEE Std 802.11-1997; published Jun. 26, 1997 by the IEEE; pp. 1-459.

John Jubin and Janet D. Tornow; "The DARPA Packet Radio Network Protocols;" Proceedings of the IEEE; vol. 75, No. 1, Jan. 1987; pp. 64-79.

Chane Lee Fullmer; "Collision Avoidance Techniques for Packet-Radio Networks" thesis; University of California at Santa Cruz, CA; Jun. 1998; pp. 1-172.

Babak Daneshrad, et al.; 1997 Project Summary "Mobile Versatile Radios (MoVeR);" University of California, Los Angeles; pp. 1-4.

Rajeev Jain, et al.; 1997 Project Summary "Held Untethered Nodes;" University of California, Los Angeles; pp. 1-5.

Randy H. Katz and Eric A. Brewer; 1997 Project Summary "Towards a Wireless Overlay Internetworking Architecture;" University of California, Berkeley; pp. 1-8, including slide show presentation at http://daedalus.cs.berkeley.edu/talks/retreat.6.96/Overview.pdf.

J.J. Garcia-Luna-Aceves, et al.; "Wireless Internet Gateways (Wings);" IEEE, 1997; pp. 1271-1276.

Randy H. Katz, et al.; "The Bay Area Research Wireless Access Network (BARWAN);" Electrical Engineering and Computer Science Department, University of California, Berkeley, CA; IEEE, 1996; pp. 15-20, including slide show presentation at http://daedalus.cs.berkeley.edu/talks/retreat.6.97/BARWAN.S97.ppt.

USPTO's Decision dated Nov. 28, 2008 Denying Ex Parte Reexamination of USPN 7,103,511 in U.S. Appl. No. 90/010,315.

USPTO's Decision dated Jun. 22, 2009 Granting Ex Parte Reexamination of USPN 7,103,511 in U.S. Appl. No. 90/010,509.

USPTO's Decision dated Jun. 22, 2009 Granting Ex Parte Reexamination of USPN 7,103,511 in U.S. Appl. No. 90/010,505.
USPTO's Decision dated Jun. 22, 2009 Granting Ex Parte Reexamination of USPN 7,103,511 in U.S. Appl. No. 90/010,507.
USPTO's Decision dated Jun. 22, 2009 Granting Ex Parte Reexamination of USPN 7,103,511 in U.S. Appl. No. 90/010,508.
USPTO's Decision dated Jul. 21, 2009 Granting Ex Parte Reexamination of USPN 6,891,838 in U.S. Appl. No. 90/010,512.
USPTO's Decision dated Jul. 21, 2009 Granting Ex Parte Reexamination of USPN 6,891,838 in U.S. Appl. No. 90/010,510.
USPTO's Decision dated Jul. 21, 2009 Granting Ex Parte Reexamination of USPN 6,891,838 in U.S. Appl. No. 90/010,511.
USPTO's Decision dated Nov. 13, 2008 Granting Ex Parte Reexamination of USPN 6,891,838 in U.S. Appl. No. 90/010,301.

* cited by examiner

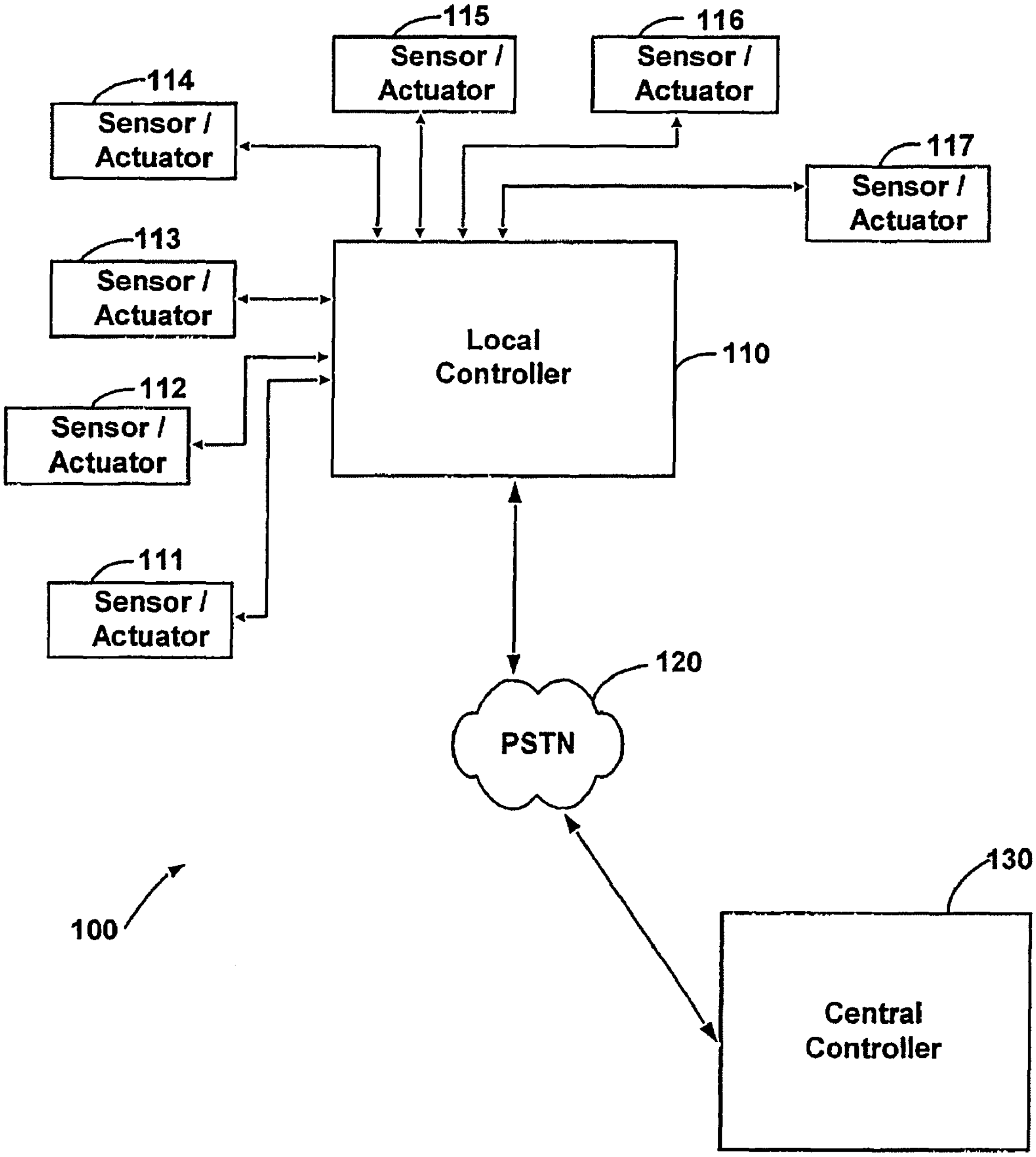


FIG. 1
(PRIOR ART)

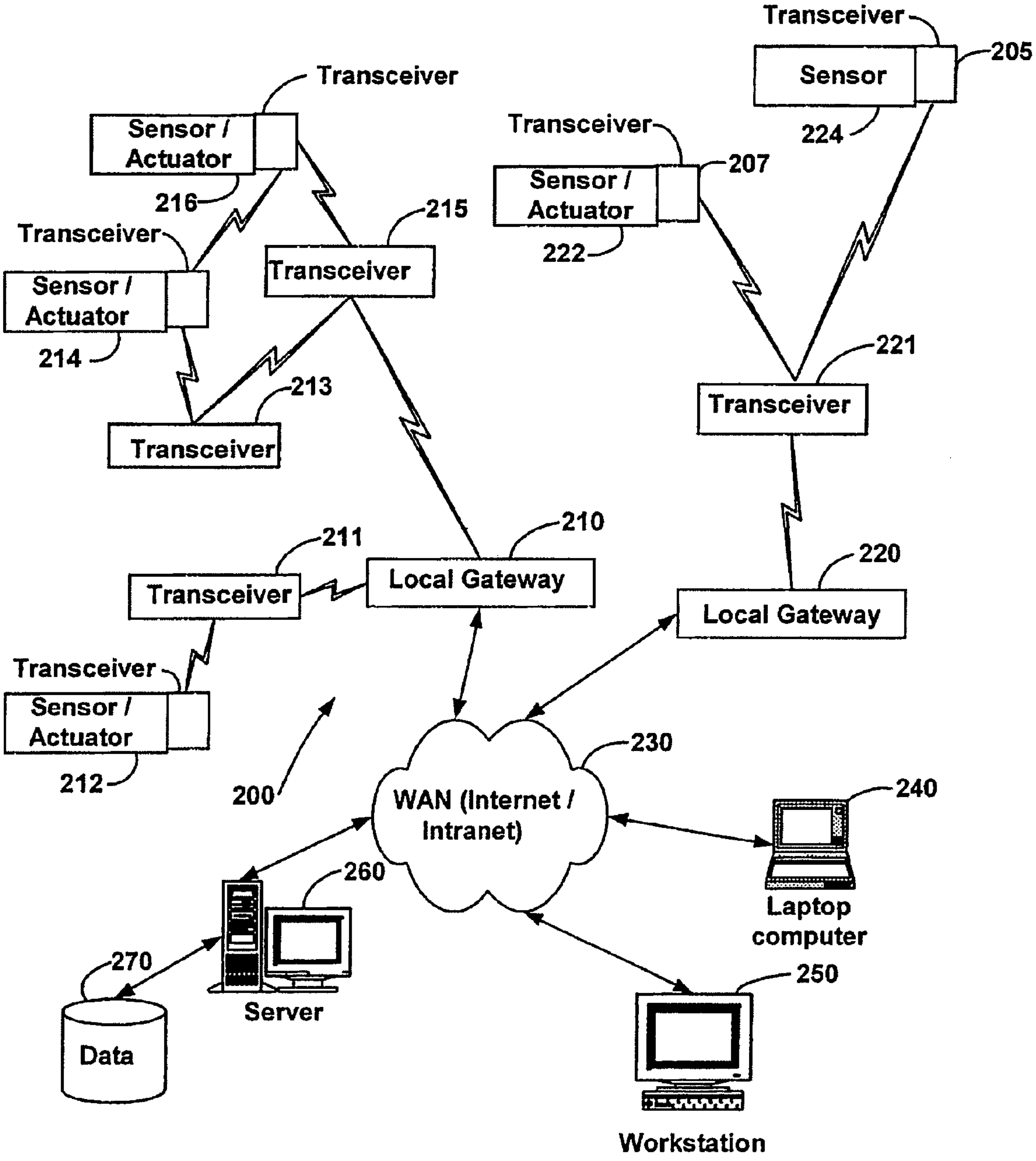

Transceiver
205
Sensor
224
Transceiver
207
Sensor / Actuator
222
Transceiver
Sensor / Actuator
216
Transceiver
215
Transceiver
Sensor / Actuator
214
213
Transceiver
221
Transceiver
211
Transceiver
210
Local Gateway
220
Local Gateway
Transceiver
Sensor / Actuator
212
200
230
WAN (Internet / Intranet)
240
Laptop computer
260
270
Server
Data
250
Workstation

FIG. 2

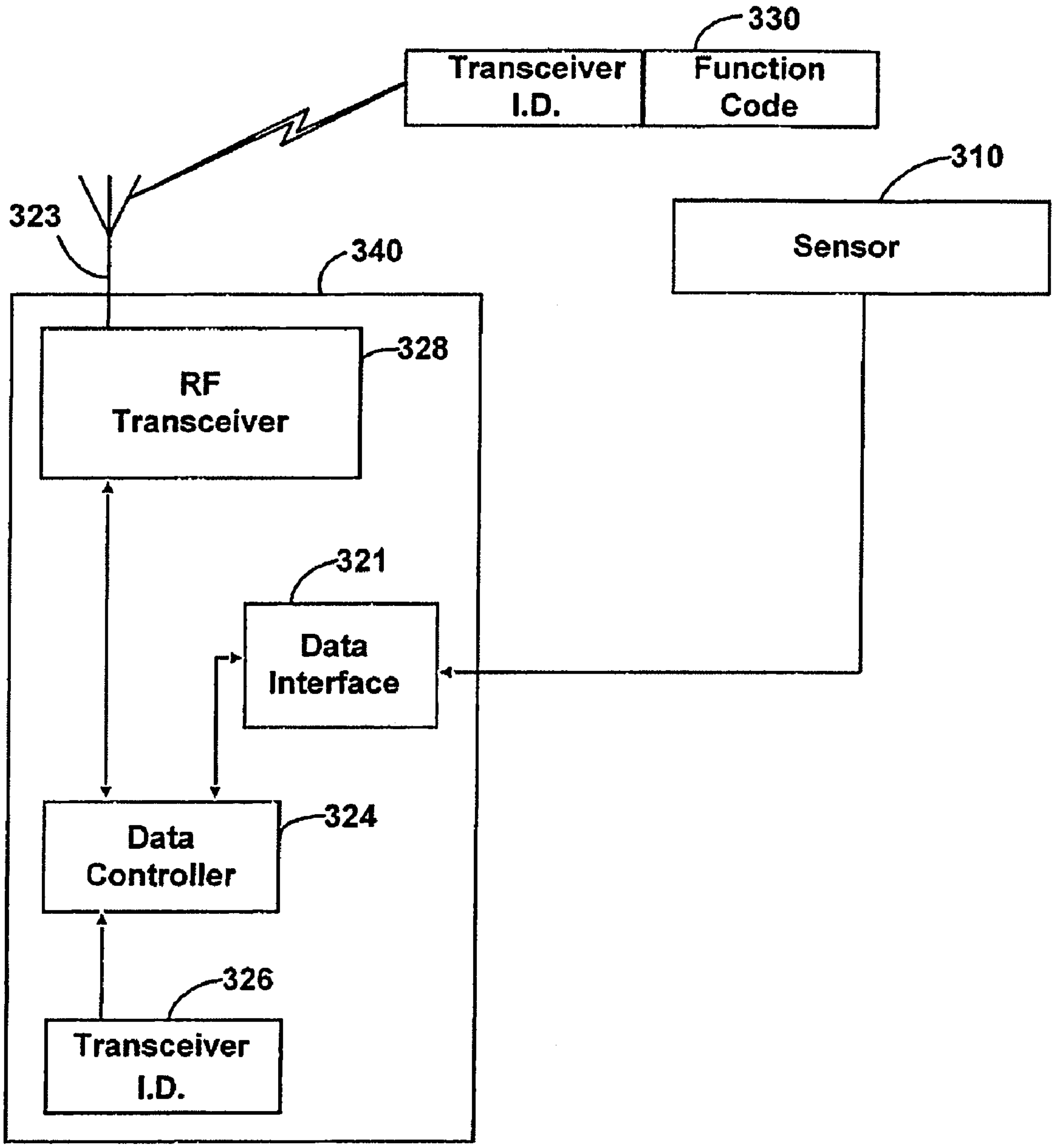

330
Transceiver I.D.
Function Code
310
Sensor
323
340
RF Transceiver
328
321
Data Interface
Data Controller
324
326
Transceiver I.D.

FIG. 3

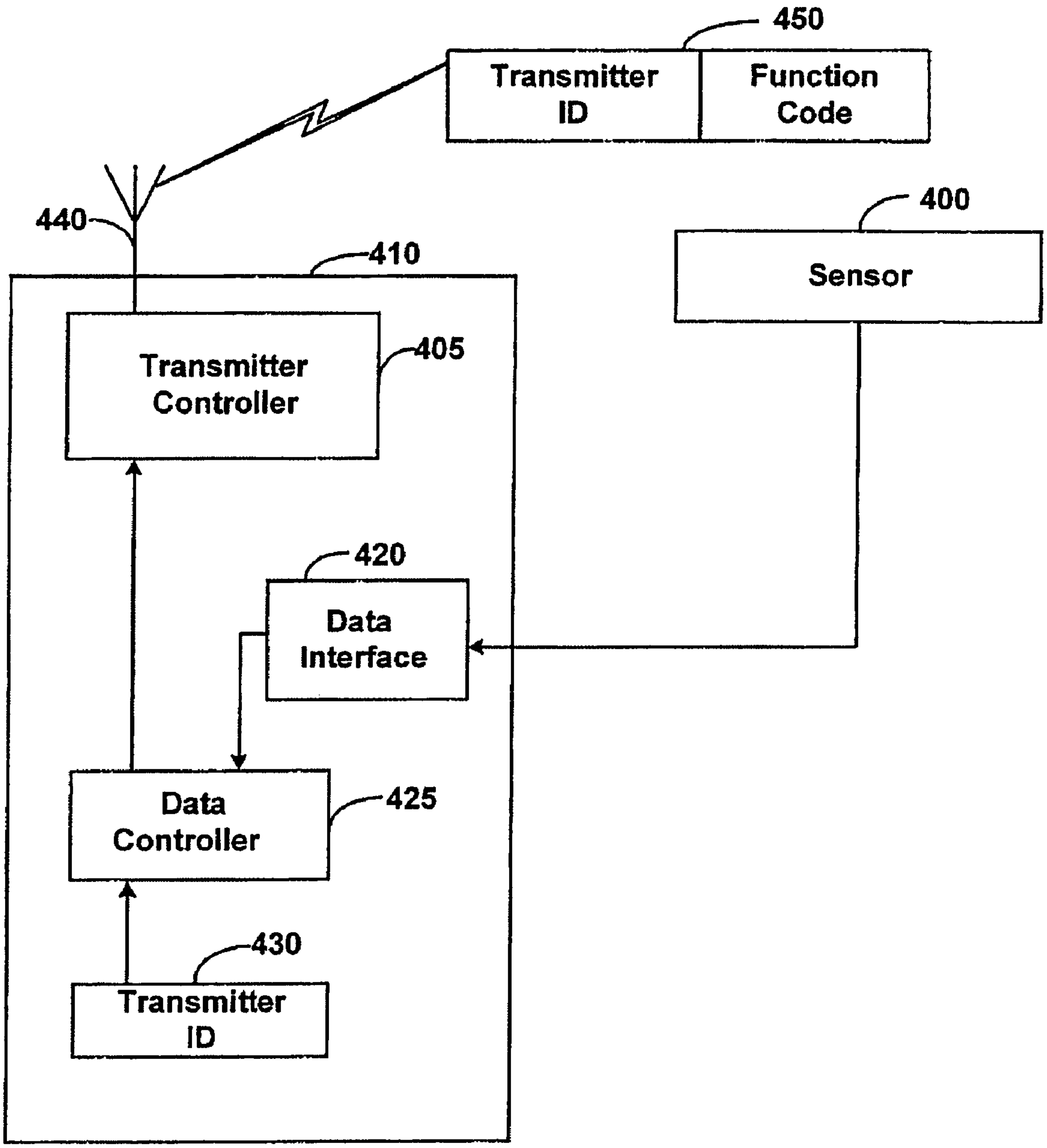

450
Transmitter ID
Function Code
440
400
Sensor
410
Transmitter Controller
405
420
Data Interface
Data Controller
425
430
Transmitter ID

FIG. 4

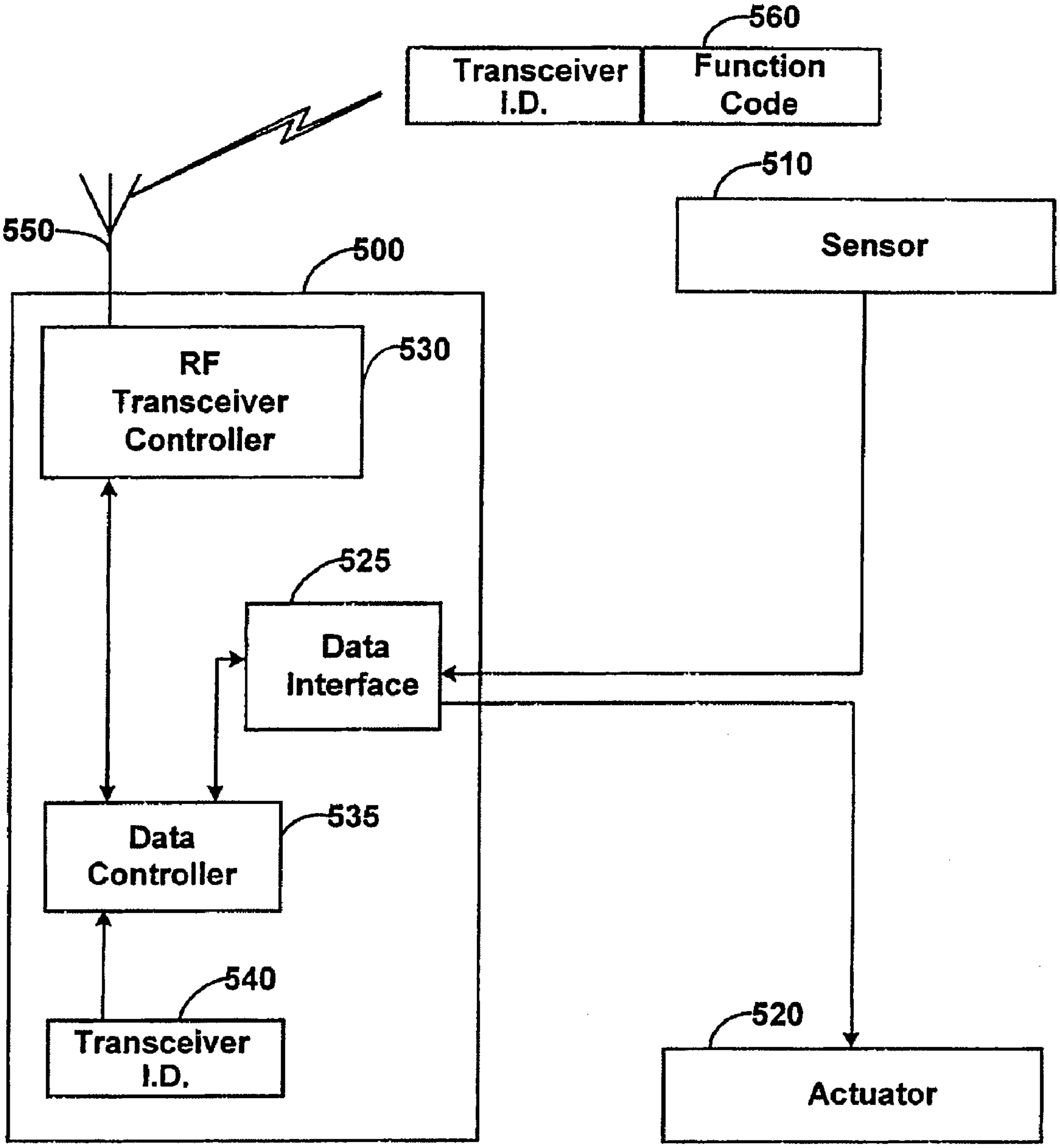

560
Transceiver I.D.
Function Code
510
Sensor
550
500
RF Transceiver Controller
530
525
Data Interface
535
Data Controller
540
Transceiver I.D.
520
Actuator

FIG. 5

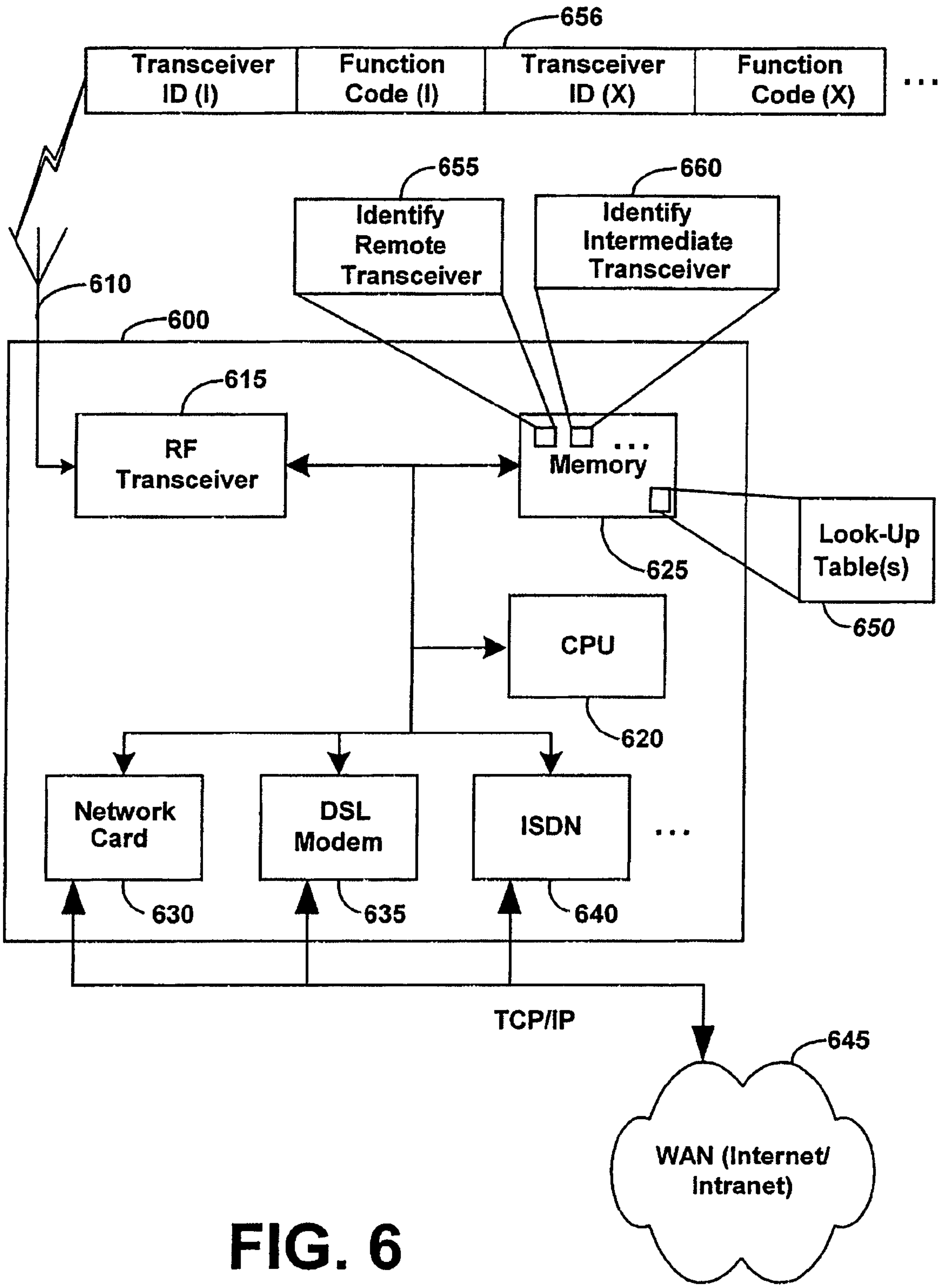

656
Transceiver ID (I)
Function Code (I)
Transceiver ID (X)
Function Code (X)
...
655
Identify Remote Transceiver
660
Identify Intermediate Transceiver
610
600
615
RF Transceiver
...
Memory
625
Look-Up Table(s)
650
CPU
620
Network Card
630
DSL Modem
635
ISDN
640
...
TCP/IP
645
WAN (Internet/ Intranet)

FIG. 6

FIG. 7 Message Structure

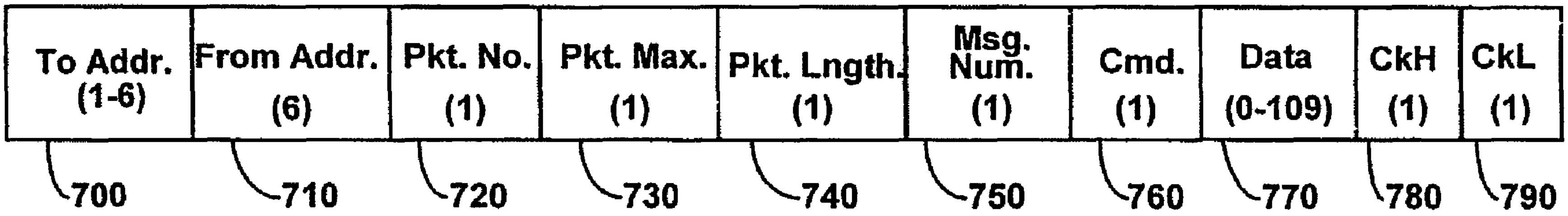
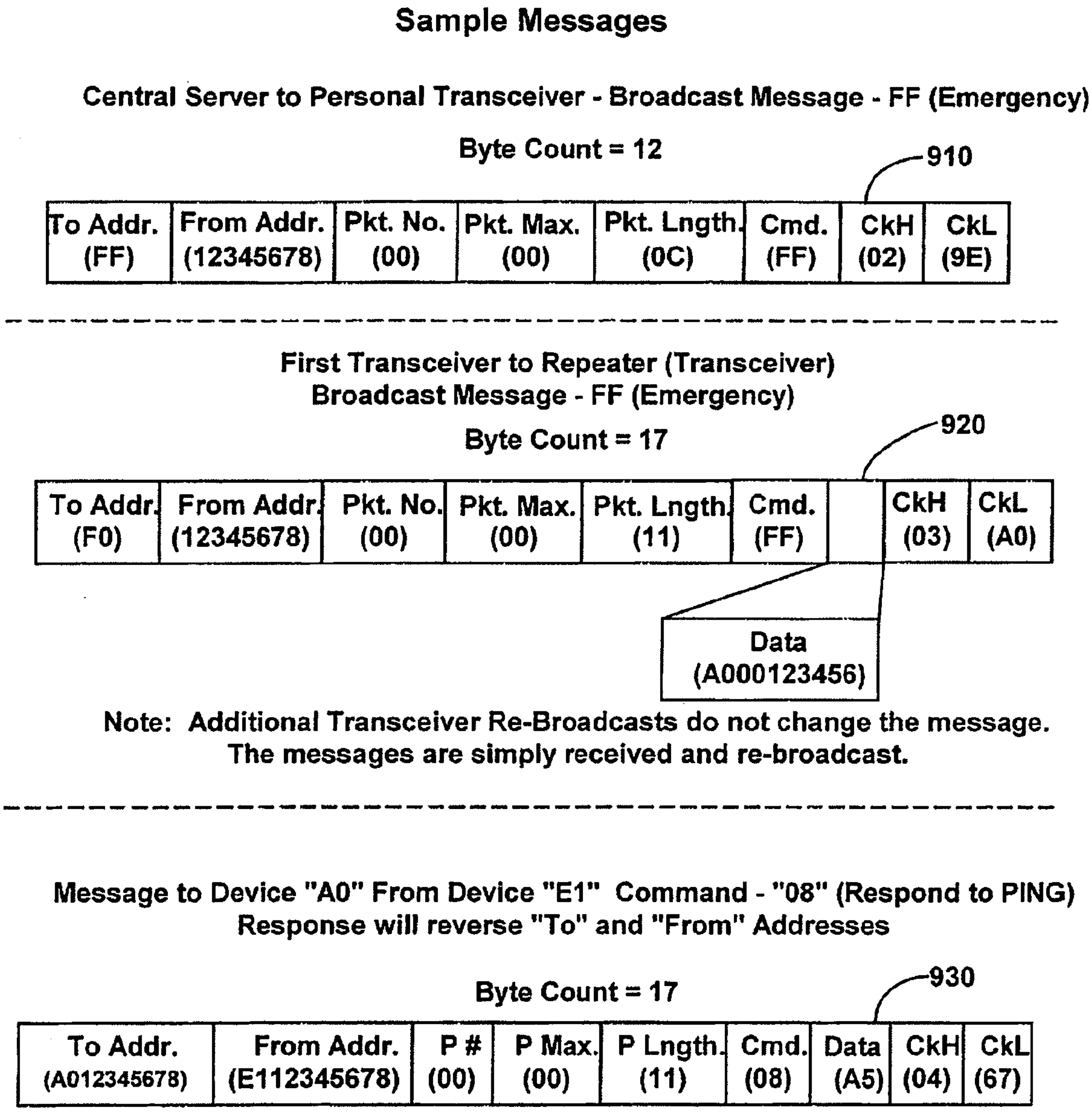


FIG. 8

"To Address"	Byte Assignment:
MSB - Byte 1 Device Type	FF-F0 (16) - Broadcast All Devices (1 Byte Address) EF-1F (224) - Device Type Base (2 to 6 Byte Address) 0F-00 (16) - Personal Transceiver Identification (6 Byte Address)
Byte 2 Mfg./Owner ID	FF-F0 (16) - Broadcast all Devices (Byte 1 Type) (2 Byte Broadcast Address) EF-00 (240) - Mfg./Owner Code Identification Number
Byte 3 Mfg./Owner Extension ID	FF-F0 (16) - Broadcast all Devices (Byte 1 & Byte 2 Type) (3 Byte Broadcast Address) EF-00 (240) - Device Type/Mfg./Owner Code ID Number
Byte 4	FF-F0 (16) - Broadcast all Devices (Byte 1 & Byte 2 Type) (4 Byte Broadcast Address) EF-00 (240) - ID Number
Byte 5	(FF-00) 256 - Identification Number
Byte 6	(FF-00) 256 - Identification Number



Sample Messages

Central Server to Personal Transceiver - Broadcast Message - FF (Emergency)

Byte Count = 12

To Addr.	From Addr.	Pkt. No.	Pkt. Max.	Pkt. Lngth.	Cmd.	CkH	CkL
(FF)	(12345678)	(00)	(00)	(0C)	(FF)	(02)	(9E)

First Transceiver to Repeater (Transceiver)
Broadcast Message - FF (Emergency)

Byte Count = 17

To Addr.	From Addr.	Pkt. No.	Pkt. Max.	Pkt. Lngth.	Cmd.	Data	CkH	CkL
(F0)	(12345678)	(00)	(00)	(11)	(FF)	(A000123456)	(03)	(A0)

Note: Additional Transceiver Re-Broadcasts do not change the message.
The messages are simply received and re-broadcast.

Message to Device "A0" From Device "E1" Command - "08" (Respond to PING)
Response will reverse "To" and "From" Addresses

Byte Count = 17

To Addr.	From Addr.	P #	P Max.	P Lngth.	Cmd.	Data	CkH	CkL
(A012345678)	(E112345678)	(00)	(00)	(11)	(08)	(A5)	(04)	(67)

FIG. 9

SYSTEMS AND METHODS FOR MONITORING AND CONTROLLING REMOTE DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 09/812,044, filed Mar. 19, 2001, and entitled "System and Method for Monitoring and Controlling Remote Devices", now U.S. Pat. No. 6,914,893. U.S. patent application Ser. No. 09/812,044 is a continuation-in-part of: U.S. patent application Ser. No. 09/704,150, filed Nov. 1, 2000, and entitled "System and Method for Monitoring and Controlling Residential Devices", now U.S. Pat. No. 6,891,838; U.S. patent application Ser. No. 09/271,517, filed Mar. 18, 1999, and entitled, "System For Monitoring Conditions in a Residential Living Community", now abandoned; U.S. patent application Ser. No. 09/439,059, filed Nov. 12, 1999, and entitled, "System and Method for Monitoring and Controlling Remote Devices", now U.S. Pat. No. 6,437,692; U.S. patent application Ser. No. 09/102,178, filed Jun. 22, 1998, and entitled, "Multi-Function General Purpose Transceiver", now U.S. Pat. No. 6,430,268; U.S. patent application Ser. No. 09/172,554, filed Oct. 14, 1998, and entitled, "System for Monitoring the Light Level Around an ATM", now U.S. Pat. No. 6,028,522; and U.S. patent application Ser. No. 09/412,895, filed Oct. 5, 1999, and entitled, "System and Method for Monitoring the Light Level Around an ATM", now 6,218,953. U.S. patent application Ser. No. 09/812,044 also claims the benefit of U.S. Provisional Application Ser. No. 60/224,043, filed Aug. 9, 2000, and entitled "SOS OEA Packet Message Protocol (RF)". Each of the above-identified applications are hereby incorporated by reference in their entireties as if fully set forth below.

TECHNICAL FIELD

The present invention generally relates to remotely operated systems, and more particularly to a system for monitoring, controlling and, reporting on remote systems utilizing radio frequency (RF) transmissions.

BACKGROUND

There are a variety of systems for monitoring and controlling manufacturing processes, inventory systems, and emergency control systems. Most automatic systems use remote sensors and controllers to monitor and automatically respond to system parameters to reach desired results. A number of control systems utilize computers to process sensor outputs, model system responses, and control actuators that implement process corrections within the system. For example, the electric power generation and metallurgical processing industries successfully control production processes by utilizing computer control systems.

Many environmental and safety systems require real-time monitoring. Heating, ventilation, and air-conditioning systems (HVAC), fire reporting and suppression systems, alarm systems, and access control systems utilize real-time monitoring, and often require immediate feedback and control.

A problem with expanding the use of control system technology is the cost of the sensor/actuator infrastructure required to monitor and control such systems. The typical approach to implementing control system technology includes installing a local network of hard sensor(s)/actuator(s) and a local controller. There are expenses associated with developing and installing the appropriate sensor(s)/actuator(s) and connecting functional sensor(s)/actuator(s) with the local controller. Another prohibitive cost of control systems is the installation and operational expenses associated with the local controller.

FIG. **1** sets forth a block diagram illustrating certain fundamental components of a prior art control system **100**. The prior art control system **100** includes a plurality of sensor/actuators **111**, **112**, **113**, **114**, **115**, **116**, and **117** electrically and physically coupled to a local controller **110**. Local controller **110** provides power, formats and applies data signals from each of the sensors to predetermined process control functions, and returns control signals as appropriate to the actuators. Often, prior art control systems are further integrated via the public switched telephone network (PSTN) **120** to a central controller **130**. Central controller **130** can also serve as a technician monitoring station and/or forward alarm conditions via PSTN **120** to appropriate officials.

Prior art control systems similar to that of FIG. **1** require the development and installation of an application-specific local system controller. In addition, each local system requires the direct coupling of electrical conductors to each sensor and actuator to the local system controller. Such prior art control systems are typically augmented with a central controller **130** that may be networked to the local controller **110** via PSTN **120**. As a result, prior art control systems often are susceptible to a single point of failure if the local controller **110** goes out of service. Also, appropriately wiring an existing industrial plant can be dangerous and expensive.

BRIEF SUMMARY OF THE INVENTION

The embodiments of present invention are directed to a system and method of monitoring and controlling remote devices. More specifically, the present system is directed to a system for monitoring and controlling remote devices by transmitting data between the remote systems and a gateway interface via a packet message protocol system.

A preferred embodiment can comprise one or more remote sensors to be read and one or more actuators to be remotely controlled. The remote sensor(s)/actuator(s) can interface with unique remote transceivers that transmit and/or receive data. If necessary in individual applications, signal repeaters may relay information between the transceiver(s) and the gateway interface. Communication links between the remote transceivers and the gateway interface are preferably wireless, but may also be implemented with a mixture of wireless and wired communication links.

To successfully communicate between the transceiver(s) and the gateway interface, a preferred embodiment of the present invention can receive a plurality of RF signal transmissions containing a packet protocol via a preferred embodiment of data structures that include sender and receiver identifiers, a description of the packet itself, a message number, commands, data, and an error detector. The data structure can be integrated with alternate data communication protocols for use with many other communication systems and networks. Also, a preferred embodiment of the present invention can be integrated into an existing control system using networked wireless transceivers. Distinct control signals from the pre-existing system can be mapped into the packet protocol enabling integration into a pre-existing control system easily and inexpensively.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a prior art control system.

FIG. **2** is a block diagram illustrating a monitoring/control system in accordance with a preferred embodiment of the present invention.

FIG. **3** is a block diagram illustrating a transceiver in accordance with a preferred embodiment of the present invention.

FIG. **4** is a block diagram illustrating a transmitter in accordance with a preferred embodiment of the present invention.

FIG. **5** is a block diagram illustrating a transceiver in accordance with a preferred embodiment of the present invention integrated with a sensor and an actuator.

FIG. **6** is a block diagram illustrating a local gateway in accordance with a preferred embodiment the present invention.

FIG. **7** is a table illustrating the message protocol in accordance with a preferred embodiment of the present invention.

FIG. **8** is a table illustrating various "to" addresses in accordance with a preferred embodiment of the present invention.

FIG. **9** illustrates three sample messages using a message protocol system in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. **2** sets forth a block diagram illustrating a preferred embodiment of a control system **200** in accordance with the present invention. The control system **200** can consist of one or more transceivers. An exemplary transceiver **205** can be integrated with a sensor **224** to form a first combination. A second transceiver **207** can be integrated with an actuator **222** to form a second combination. The transceivers **205**, **207** are preferably wireless RF transceivers that are small and transmit a low-power-RF signal. As a result, in some applications, the transmission range of a given transceiver **205**, **207** may be limited. As will be appreciated from the description that follows, this limited transmission range of the transceivers **205**, **207** can be a desirable characteristic of the control system **200**. Although the transceivers **205**, **207** are depicted without user interfaces such as a keypad (not shown), the transceivers **205**, **207** may be configured with user selectable buttons or an alphanumeric keypad (not shown). Often, the transceivers **205**, **207** can be electrically interfaced with a sensor/actuator **222** such as a smoke detector, a thermostat, or a security system, where external buttons are not needed.

One or more specific types of RF transceivers can be used with the various embodiments of the present invention. For example, one RF transceiver that may be used is the TR1000, manufactured by RF Monolithics, Inc. The TR1000 hybrid transceiver is well suited for short range, wireless data applications where robust operation, small size, low power consumption, and low-cost are desired. All critical RF functions may be performed within a single hybrid semi-conductor chip, simplifying circuit design and accelerating the design-in process. The receiver section of the TR1000 is sensitive and stable. A wide dynamic range log detector, in combination with digital automatic gain control (AGC) provides robust performance in the presence of channel noise or interference. Two stages of surface acoustic wave (SAW) filtering provide excellent receiver out-of-band rejection. The TR100 includes provisions for both on-off keyed (OOK) and amplitude-shift key (ASK) modulation. The TR100 employs SAW filtering to suppress output harmonics, for compliance with FCC and other regulations.

Additional details of the TR1000 transceiver need not be described herein, because the present invention is not limited by the particular choice of transceiver. Indeed, numerous RF transceivers may be implemented in accordance with the teachings of the present invention. Such other transceivers may include other 900 MHz transceivers, as well as transceivers at other frequencies. In addition, infrared, ultrasonic, and other types of wireless transceivers may be employed. Further details of the TR1000 transceiver may be obtained through data sheets, application notes, design guides (e.g., the "ASH Transceiver Designers Guide"), and other publications.

The control system **200** can also include a plurality of stand-alone transceivers **211**, **213**, **215**, and **221**. Each of the stand-alone transceivers **211**, **213**, **215**, and **221**, and each of the integrated transceivers **212**, **214**, **216**, **222**, and **224** can receive an incoming RF transmission and transmit an outgoing signal. This outgoing signal may be a low-power-RF transmission signal, a high-power-RF transmission signal, or may be electric signals transmitted over a conductive wire, a fiber optic cable, or other transmission media. It will be appreciated by those skilled in the art that the integrated transceivers **212**, **214**, **216**, **222**, and **224** can be replaced by RF transmitters for applications that require continuous data collection only.

The local gateways **210** and **220** can receive remote data transmissions from one or more of the stand-alone transceivers **211**, **213**, **215**, and **221**, or one or more of the integrated transceivers **212**, **214**, **216**, **222**, and **224**. The local gateways **210** and **220** can analyze the transmissions received, convert the transmissions into TCP/IP format, and further communicate the remote data signal transmissions via the WAN **230**. The local gateways **210** and **220** may communicate information, service requests, and/or control signals to the remote integrated transceivers **212**, **214**, **216**, **222**, and **224**, from the server **260**, the laptop computer **240**, and/or the workstation **250** across the WAN **230**. The server **260** can be further networked with the database server **270** to record client specific data. Further information regarding the integration of embodiments of the present invention into the WAN **230** can be found in U.S. Pat. No. 6,891,838 application entitled, "System and Method for Monitoring and Controlling Residential Devices."

It will be appreciated by those skilled in the art that if an integrated transceiver (either of **212**, **214**, **216**, **222**, and **224**) is located sufficiently close to one of the local gateways **210** or **220** such that the integrated transceiver's outgoing signal can be received by a gateway, the outgoing signal need not be processed and repeated through one of the stand-alone transceivers **211**, **213**, **215**, or **221**.

A monitoring system constructed in accordance with the teachings of the present invention may be used in a variety of environments. In accordance with a preferred embodiment, a monitoring system **200** such as that illustrated in FIG. **2** may be employed to monitor and record utility usage by residential and industrial customers, to transfer vehicle diagnostics from an automobile via a RF transceiver integrated with the vehicle diagnostics bus to a local transceiver that further transmits the vehicle information through a local gateway onto a WAN, to monitor and control an irrigation system, or to automate a parking facility. Further information regarding these individual applications can be found in U.S. Pat. No. 6,891,838 entitled, "System and Method for Monitoring and Controlling Residential Devices."

The integrated transceivers **212**, **214**, **215**, **222**, and **224** can have substantially identical construction (particularly with regard to their internal electronics), which provides a cost-effective implementation at the system level. Alternatively, the transceivers (integrated or stand-alone) can differ as known to one of ordinary skill in the art as necessitated by individual design constraints. Furthermore, a plurality of stand alone transceivers **211**, **213**, **215**, and **221**, which may be identical, can be disposed in such a way that adequate RF coverage is provided. Preferably, the stand-alone transceivers **211**, **213**, **215**, and **221** may be dispersed sufficient that only one stand-alone transceiver will pick up a transmission from a given integrated transceiver **212**, **214**, **216**, **222**, and **224** (due in part to the low power transmission typically emitted by each transmitter).

In certain instances, however, two or more, stand-alone transceivers may pick up a single transmission. Thus, the local gateways **210** and **220** may receive multiple versions of the same data transmission from an integrated transceiver, but from different stand-alone transceivers. The local gateways **210** and **220** may utilize this information to triangulate or otherwise more particularly assess a location from which the common data transmission is originating. Due to the transmitting device identifier incorporated within the preferred protocol in the transmitted signal, duplicative transmissions (e.g., transmissions duplicated to more than one gateway or to the same gateway) may be ignored or otherwise appropriately handled.

The advantage of integrating a transceiver, as opposed to a one-way transmitter, with the sensor is the transceiver's ability to receive incoming control signals and to transmit data signals upon demand. The local gateways **210** and **220** may communicate with all system transceivers. Since the local gateways **210** and **220** can be permanently integrated with the WAN **230**, the server **260** coupled to the WAN **230** can host application specific software. Further, the data monitoring and control devices of the present invention can be movable as necessary given that they remain within signal range of a stand-alone transceiver **211**, **213**, **215**, or **221** that subsequently is within signal range of a local gateway **210**, **220** interconnected through one or more networks to server **260**. As such, small application specific transmitters compatible with control system **200** can be worn or carried. It will be appreciated that a person so equipped may be in communication with any device communicatively coupled with the WAN **230**.

In one embodiment, the server **260** collects, formats, and stores client specific data from each of the integrated transceivers **212**, **214**, **216**, **222**, and **224** for later retrieval or access from the workstation **250** or the laptop **240**. The workstation **250** or the laptop **240** can be used to access the stored information through a Web browser. In another embodiment, the server **260** may perform the additional functions of hosting application specific control system functions and replacing the local controller by generating required control signals for appropriate distribution via the WAN **230** and the local gateways **210**, **220** to the system actuators. In another embodiment, clients may elect for proprietary reasons to host any control applications on their own WAN connected workstation. The database **270** and the server **260** may act solely as a data collection and reporting device with the client workstation **250** generating control signals for the system.

Reference is now made to FIG. **3**, which is a block diagram illustrating certain functional blocks of a transceiver **340** that may be integrated with sensor **310** in accordance with a preferred embodiment of the present invention. For example, sensor **310** in its simplest form can be a two-state device, such as a smoke alarm. Alternatively, the sensor **310** may output a continuous range of values to the data interface **321** such as a thermometer. If the signal output from the sensor **310** is an analog signal, the data interface **321** may include an analog-to-digital converter (not shown) to convert signals output to the transceiver **340**. Alternatively, a digital interface (communicating digital signals) may exist between the data interface **321** and each sensor **310**.

The sensor **310** can be communicatively coupled with the RF transceiver **340**. The RF transceiver **340** may comprise a RF transceiver controller **328**, a data interface **321**, a data controller **324**, a transceiver identifier **326**, and an antenna **328**. As shown in FIG. **3**, a data signal forwarded from the sensor **310** may be received at an input port of the data interface **321**. The data interface **321** may be configured to receive the data signal. In those situations where the data interface has received an analog data signal, the data interface **321** may be configured to convert the analog signal into a digital signal before forwarding a digital representation of the data signal to the data controller **324**.

In accordance with a preferred embodiment, each transceiver **340** may be configured with a unique transceiver identification **326** that uniquely identifies the RF transceiver **340**. The transceiver identification **326** may be programmable, and implemented an EPROM. Alternatively, the transceiver identification **326** may be set and/or configured through a series of dual inline package (DIP) switches. Additional implementations of the transceiver identification **326**, whereby the number may also be set and/or configured as desired, may be implemented.

The unique transceiver identification **326** coupled with a function code for a sensor "on" condition can be formatted by data controller **324** for transformation into the RF signal **330** by RF transmitter **328** and transmission via antenna **323**.

While the unique transceiver address can be varied, it is preferably a six-byte address. The length of the address can be varied as necessary given individual design constraints. This data packet **330** communicated from transceiver **340** will readily distinguish from similar signals generated by other transceivers in the system.

Of course, additional and/or alternative configurations may also be provided by a similarly configured transceiver. For example, a similar configuration may be provided for a transceiver that is integrated into, for example, a carbon monoxide detector, or a door position sensor. Alternatively, system parameters that vary across a range of values may be transmitted by transceiver **340** as long as data interface **321** and data controller **324** are configured to apply a specific code that is consistent with the input from sensor **310**. As long as the code was understood by the server **260** or workstation **250**, the target parameter can be monitored by the embodiments of the present invention.

Reference is now made to FIG. **4**. FIG. **4** is a block diagram illustrating a transmitter in accordance with a preferred embodiment of the present invention. The sensor **400** may be coupled to the RF transmitter **410**. The RF transmitter **410** may comprise a transmitter controller **405**, a data interface **420**, a data controller **425**, a transmitter identification **430**, and an antenna **440**. The data signal forwarded from the sensor **400** may be received at an input port of the data interface **420**. The data interface **420** may be configured to receive the data signal. In those situations where the data interface **420** has received an analog data signal, the data interface **420** may be configured to convert the analog signal into a digital signal before forwarding a digital representation of the data signal to the data controller **425**.

Each transmitter/transceiver **410** may be configured with a unique transmitter identification **430** that uniquely identifies the RF transmitter **410**. The transmitter identification number **430** may be programmable, and implemented with an EPROM. Alternatively, the transmitter identification **430** may be set and/or configured through a series of dual inline package (DIP) switches. Additional implementations of the transmitter identification **430**, whereby the identification may be set and/or configured as desired, may also be implemented.

The data controller **425** may be configured to receive both a data signal from the data interface **420** and the transmitter identification **430**. The data controller **425** may be configured to format (e.g., concatenate) both data portions into a composite information signal. The composite information signal may be forwarded to the transmitter controller **415** which can then transmit the encoded RF signal from the sensor **400** via a packet message protocol system. The transmitter controller **415** may convert information from digital electronic form into a format, frequency, and voltage level suitable for transmission from antenna **440**. The transmitter identification **430** can be set for a given transmitter **410**. When received by the application server **260** (FIG. **2**), the transmitter identification **430** may be used to access a look-up table that identifies, for example, the location, the system, and the particular parameter assigned to that particular transmitter. Additional information about the related system may also be provided within the lookup table, with particular functional codes associated with a corresponding condition or parameter, such as but not limited to, an appliance operating cycle, a power status, a temperature, a position, and other information.

FIG. **5** sets forth a block diagram of the transceiver **500** integrated with a sensor **510** and an actuator **520** in accordance with a preferred embodiment of the present invention. Here, the data interface **525** is shown with a single input from the sensor **510**. It is easy to envision a system that may include multiple sensor inputs. The RF transceiver **500** may comprise a transceiver controller **530**, a data interface **525**, a data controller **535**, a transceiver identification **540**, and an antenna **550**. The data signal forwarded from the sensor **510** may be received at an input/output port of the data interface **525**. The data interface **525** may be configured to receive the data signal and transmit a command signal. In those situations where the data interface **525** has received an analog data signal, the data interface **525** may be configured to convert the analog signal into a digital signal before forwarding a digital representation of the data signal to the data controller **525**. Similarly, when the data controller **535** forwards a digital representation of a command signal, the data interface **525** may be configured to translate the digital command signal into an analog voltage suitable to drive the actuator **520**.

In accordance with a preferred embodiment, each RF transceiver **500** may be configured with a unique transceiver identification **540** that uniquely identifies the RF transceiver **500**. The transceiver identification **540** may be set or configured as described above.

The data controller **535** may be configured to receive both a data signal from the data interface **525** and the transceiver identification number **540**. The data controller **535** may also receive one or more data signals from other RF communication devices. As previously described, the data controller **535** may be configured to format (e.g., concatenate) both data signal portions originating at the RF transceiver **500** into a composite information signal which may also include data information from other closely located RF communication devices. The composite information signal may be forwarded to a transceiver controller **530**, which may be configured to transmit the encoded RF data signals via the packet messaging system. It will be appreciated that the transceiver controller **530** may convert information from digital electronic form into a format, frequency, and voltage level suitable for transmission from the antenna **550**.

For example, a common home heating and cooling system might be integrated with an embodiment of the present invention. The home heating system may include multiple data interface inputs from multiple sensors. A home thermostat control connected with the home heating system could be integrated with a sensor that reports the position of a manually adjusted temperature control (i.e., temperature set value) and a sensor integrated with a thermister to report an ambient temperature. The condition of related parameters can be sent to the data interface **525** as well as including the condition of the system on/off switch, the climate control mode selected (i.e., heat, fan, or AC). In addition, depending upon the specific implementation, other system parameters may be provided to data interface **525** as well.

The addition of the actuator **520** to the integrated transceiver **500** permits the data interface **525** to apply signals to the manual temperature control for the temperature set point, the climate control mode switch, and the system on/off switch. This, a remote workstation **250** or a laptop **240** with WAN access (see FIG. **2**) could control a home heating system from a remote location.

Again, each of these various input sources can be routed to the data interface **525**, which provides the information to the data controller **535**. The data controller **535** may utilize a look up table to access unique function codes that are communicated in the data packet **560**, along with a transceiver identification code **540**, to the local gateway and further onto the WAN. In general, the operation of RF transceiver **500** will be similar to that described above.

The various RF communication devices illustrated and described may be configured with a number of optional power supply configurations. For example, a personal mobile transceiver may be powered by a replaceable battery. Similarly, a stand-alone RF transceiver repeater may be powered by a replaceable battery that may be supplemented and/or periodically charged via a solar panel. These power supply circuits, therefore, may differ from RF communication device to RF communication device depending upon the remote system monitored, the related actuators to be controlled, the environment, and the quality of service level required. Those skilled in the art will appreciate and understand how to meet the power requirements of the various RF communication devices. As a result, it is not necessary to further describe a power supply suitable for each RF communication device and each application in order to appreciate the concepts and teachings of the present invention.

Having illustrated and described the operation of the various combinations of RF communication devices with the various sensors **114** and sensor actuators **112** consistent with the present invention, reference is now made to FIG. **6**. FIG. **6** is a block diagram further illustrating a local gateway **600** in accordance with a preferred embodiment of the present invention. A local gateway **600** may comprise an antenna **610**, an RF transceiver **615**, a central processing unit (CPU) **620**, a memory **625**, a network card **630**, a digital subscriber line (DSL) modem **635**, and an integrated services digital network (ISDN) interface card **640**. The local gateway **600** can also include many other components not illustrated in FIG. **6**, capable of enabling a terminal control protocol Internet protocol (TCP/IP) connection to the WAN **130**.

The RF transceiver **615** may be configured to receive incoming RF signal transmissions via an antenna **610**. Each of the incoming RF signal transmissions can be consistently formatted in the convention previously described. The local gateway **600** may also be configured such that the memory **625** includes a look-up table **650** that may assist in identifying the various remote and intermediate RF communication devices used in generating and transmitting the received data transmission as illustrated in memory sectors **650** and **660** herein labeled, "Identify Remote Transceiver" and "Identify Intermediate Transceiver," respectively. Programmed or recognized codes within the memory **625** may also be provided and configured for controlling the operation of a CPU **620** to carry out the various functions that are orchestrated and/or controlled by the local gateway **600**. For example, the memory **625** may include program code for controlling the operation of the CPU **625** to evaluate an incoming data packet to determine what action needs to be taken. One or more look-up tables **650** may also be stored within the memory **625** to assist in this process. Furthermore, the memory **625** may be configured with program code to identify a remote RF transceiver **655** or identify an intermediate RF transceiver **660**. Function codes, RF transmitter and/or RF transceiver identification numbers may all be stored with associated information in the look-up tables **650**.

Thus, one look-up table **650** may be provided to associate transceiver identifications with a particular user. Another look-up table **650** may be used to associate function codes with the interpretation thereof. For example, a unique code may be associated by a look-up table **650** to identify functions such as test, temperature, smoke alarm active, or security system breach. In connection with the lookup table(s) **650**, the memory **625** may also include a plurality of code segments that are executed by the CPU **620**, which may control operation of the gateway **600**. For example, a first data packet segment **665** may be provided to access a first lookup table to determine the identity of the RF transceiver **625**, which transmitted the received message. A second code segment may be provided to access a second lookup table to determine the proximate location of the message generating RF transceiver **600**, by identifying the RF transceiver **600** that relayed the message. A third code segment may be provided to identify the content of the message transmitted. Namely, is it a fire alarm, a security alarm, an emergency request by a person, or a temperature control setting. Additional, fewer, or different code segments may be provided to carry out different functional operations and data signal transfers.

The local gateway **600** may also include one or more mechanisms to facilitate network based communication with remote computing devices. For example, the gateway **600** may include a network card **630**, which may allow the gateway **600** to communicate across a local area network to a network server, which in turn may contain a backup gateway **110** to the WAN **645**. Alternatively, the local gateway **600** may contain a DSL modem **635**, which may be configured to provide a link to a remote computing system, by way of the PSTN. In yet another alternative, the local gateway **600** may include an ISDN card **640** configured to communicate via an ISDN connection with a remote system. Other communication interfaces may be provided as well to serve as primary and or backup links to the WAN **645** or to local area networks that might serve to permit local monitoring of local gateway **600** health and data packet control.

For each of the remote devices to communicate, there needs to be a standard enabling each device to understand a message. FIG. **7** sets forth a format of a data packet protocol in accordance with a preferred embodiment of the present invention. All messages transmitted within the system consist of a "to" address **700**, a "from" address **710**, a packet number **720**, a number of packets in a transmission **730**, a packet length **740**, a message number **750**, a command number **760**, any data **770**, and a check sum error detector (CKH **780** and CKL **790**).

The "to" address **700** can indicate the intended recipient of the packet. This address can be scalable from one to six bytes based upon the size and complexity of the system. By way of example, the "to" address **700** can indicate a general message to all transceivers, to only the stand-alone transceivers, or to an individual integrated transceiver. In a six byte "to" address, the first byte indicates the transceiver type to all transceivers, to some transceivers, or a specific transceiver. The second byte can be the identification base, and bytes three through six can be used for the unique transceiver address (either stand-alone or integrated). The "to" address **700** can be scalable from one byte to six bytes depending upon the intended recipient(s).

The "from" address **710** can be a the six-byte unique transceiver address of the transceiver originating the transmission. The "from" address **710** can be the address of the controller when the controller requests data, or this can be the address of the integrated transceiver when the integrated transceiver sends a response to a request for information to the controller.

The packet number **720**, the packet maximum **730**, and the packet length **740** can be used to concatenate messages that are greater than 128 bytes. The packet maximum **730** can indicate the number of packets in the message. The packet number **720** may be used to indicate a packet sequence number for a multiple-packet message.

The message number **750** can be originally assigned by the controller. Messages originating from the controller can be assigned an even number. Responses to the controller can be the original message number plus one, rendering the responding message number odd. The controller can then increment the message number **750** by two for each new originating message. This enables the controller to coordinate the incoming responses to the appropriate command message.

The next section is the command byte **760** that requests data from the receiving device as necessary. There can be two types of commands: device specific and not device specific. Device specific commands can control a specific device such as a data request or a change in current actuator settings. A number of commands are not device specific. Such commands are for example, but not limited to, a ping, an acknowledge, a non-acknowledgement, downstream repeat, upstream repeat, read status, emergency message, and a request for general data, among others. General data may include a software version number, the number of power failures, and/or the number of resets.

The data **770** section may contain data as requested by a specific command. The requested data can be many values. By way of example, test data can be encoded in ASCII (American Standard Code for Information Interchange) or many other encoding systems. The data section of a single packet can be scalable up to 109 bytes. When the requested data exceeds 109 bytes, the integrated transceiver can divide the data into appropriate number of sections and concatenates the series of packets for one message using the packet identifiers as discussed above.

The checksum sections **780**, **790** can be used to detect errors in the transmissions. In one embodiment, any error can be detected via cyclic redundancy check sum methodology. This methodology divides the message as a large binary number by the generating polynomial (in this case, CRC-16). The remainder of this division is then sent with the message as the checksum. The receiver then calculates a checksum using the same methodology and compares the two checksums. If the checksums do not match, the packet or message will be ignored. While this error detection methodology is preferred, many other error detection systems can be used.

In one embodiment of this invention, this system can be implemented via an RF link at a basic rate of 4,800 bits per second (bps) with a data rate of 2,400 bps. All the data can be encoded in the Manchester format such that a high to low transition at the bit center point represents a logic zero and a low to high transition represents a logic one. Other RF formats can be used depending upon individual design constraints. For example, a quadrature phase shift encoding method could be used, enabling the control system to communicate via hexadecimal instead of binary.

While the message indicates specific byte length for each section, only the order of the specific information within the message is constant. The byte position number in individual transmissions can vary because of the scalability of the "to" address, the command byte, and the scalability of the data.

The message can further include a preface and a postscript (not shown). The preface and postscripts are not part of the message body, but rather serve to synchronize the control system and to frame each packet of the message. The packet begins with the preface and ends with a postscript. The preface can be a series of twenty-four logic ones followed by two bit times of high voltage with no transition. The first byte of the packet can then follow immediately. The postscript will be a transition of the transmit data line from a high voltage to a low voltage, if necessary. It is less desirable to not leave the transmit data line high after the message is sent.

FIG. **8** sets forth a preferred embodiment of the "to" address byte assignment in accordance with an embodiment of the present invention. As shown in FIG. **8**, the "to" address consists of six bytes. The first byte (Byte **1**) can indicate the device type. The second byte (Byte **2**) can indicate the manufacturer or the owner. The third byte (Byte **3**) can be a further indication of the manufacturer or owner. The fourth byte (Byte **4**) can either indicate that the message is for all devices, or that the message is for a particular device. If the message is for all devices, the fourth byte can be a particular code. If the message is for a particular device, the fourth, fifth, and sixth bytes (Byte **5** and Byte **6**) can be a unique identifier for the particular devices.

Having described a general message structure in accordance with an embodiment of the present invention, reference is made to FIG. **9**. FIG. **9** illustrates three sample messages. The first message **910** illustrates the broadcast of an emergency message "FF" from a central server with an address "0012345678" to a integrated transceiver with an address of "FF."

The second message **920** illustrates how the first message might be sent to a stand-alone transceiver. Emergency message "FF" from a central server with address "00123456578" can be first sent to stand-alone transceiver "FO." The second message contains additional command data "A000123456" that may be used by the system to identify further transceivers to send the signal through on the way to the destination device.

The third message **930** illustrated in FIG. **9** illustrates how the message protocol of the present invention may be used to "ping" a remote transceiver to determine transceiver health. For example, source unit "E112345678" may originate a ping request by sending command "08" to a transceiver identified as "A012345678." The response to the ping request can be as simple as reversing the "to address" and the "from address" of the command such that a healthy receiver will send a ping message back to the originating device. A system in accordance with a preferred embodiment of the present invention may be configured to expect a return ping within a specific time period. Operators of the present invention could use the delay between the ping request and the ping response to model system loads and to determine if specific system parameters might be adequately monitored and controlled with the expected feedback transmission delay of the system.

Returning to FIG. **2**, the local gateway **210** can act as a local communications master in a system, such as system **200**. With the exception of emergency messages, the local gateway **210** usually initiates communications with any remote transceivers (either stand-alone **211**, **213**, **215**, **221** or integrated **212**, **214**, **216**, **224**). The remote transceivers then respond based upon the command received in the message. In general, the local gateway **210** expects a response to all messages sent to any of the remote transceivers **211**, **212**, **213**, **214**, **215**, **216**, **221**, and **225**.

To acknowledge a message, any of the remote transceivers **211**, **212**, **213**, **214**, **215**, **216**, **221**, **224** can send one of two messages: a positive acknowledgement or a negative acknowledgement. The positive acknowledgement may have two forms. When the message is between the local gateway **210** or a stand-alone transceiver **211**, **213**, **215**, **221** and another stand-alone transceiver **211**, **213**, **215**, **221**, the acknowledgement can be a re-send the original message with no changes. The second form is for a message sent from the local gateway **210** stand-alone transceiver **211**, **213**, **215**, **221** to a integrated transceiver **212**, **214**, **216**, **224**. In this case, the positive acknowledgement can be a message containing the requested data.

Emergency messages are preferably the only messages initiated by the integrated transceivers **212**, **214**, **216**, **224**. To accommodate receiving any emergency messages, the local gateway **210** may dedicate one-half of every ten-second period to receive emergency messages. During these time periods, the local gateway **210** may not transmit messages other than acknowledgements to any emergency messages. The integrated transceivers **212**, **214**, **216**, **224** may detect the period of silence, and in response, may then transmit the emergency message.

There are typically two forms of emergency messages: from personal safety/security transceiver(s) and from permanently installed safety/security transceiver(s). In the first case of the personal transceiver, the emergency message can consist of a predetermined "to" address and an odd, random number. In response to this emergency message, the local gateway **210** can acknowledge during a silent period. The personal transceiver can then repeat the same emergency message. The local gateway **210** can then forward the emergency message on to the WAN **230** in the normal manner.

Upon receipt of the local gateway **210** acknowledgement, the personal transceiver can reset itself. If no acknowledgement is received within a predetermined time period, the personal transceiver may continue to re-transmit the original emergency message until acknowledged by the local gateway **210** for a predetermined number of re-transmissions.

In the second case, the permanently installed safety/security transceiver (**212**) may send one message to the local gateway **210** during a time out period. The emergency message can be transmitted to a predetermined address other than the emergency address for personal transceivers.

The foregoing description has illustrated certain fundamental concepts of the invention, and other additions and/or modifications may be made consistent with the inventive concepts. For example, the one-way transmitters may be adapted to continuously monitor the current status of water, gas, and other utility meters. One-way transmitters might further be used to monitor and report actual operational hours on rental equipment or any other apparatus that must be serviced or monitored on an actual run-time schedule.

The transceivers of the current invention may be adapted to monitor and apply control signals in an unlimited number of applications. For example, two-way transceivers of the current invention can be adapted for use with pay-type-publicly-located telephones, cable television set converter boxes, and a host of residential appliances and devices enabling a remote controllable home automation and security system. For example, building automation systems, fire control systems, alarm systems, industrial trash compactors, and building elevators can be monitored and controlled with devices consistent with the present invention. In addition, courier drop boxes, time clock systems, automated teller machines, self-service copy machines, and other self-service devices can be monitored and controlled as appropriate. By way of further example, a number of environment variables that require monitoring can be integrated with the system of the present invention to permit remote monitoring and control. For instance, light levels in the area adjacent to automated teller machines must meet minimum federal standards. Also, the water volume transferred by water treatment plant pumps, smokestack emissions from a coal burning power plant or a coke fueled steel plant oven can be remotely monitored.

In a geographic area appropriately networked with permanently located stand-alone transceivers consistent with the embodiments of the invention, personal transceivers can be used to monitor and control personnel access and egress from specific rooms or portions within a controlled facility. Personal transceivers can also be configured to transfer personal information to public emergency response personnel, to transfer personal billing information to vending machines, or to monitor individuals within an assisted living community.

The transceivers using the packet message protocol of the present invention may be further integrated with a voice-band transceiver. As a result, when a person presses, for example, the emergency button on a transmitter, medical personnel, staff members, or others may respond by communicating via two-way radio with the person. Each transceiver may be equipped with a microphone and a speaker enabling a person to communication information such as their present emergency situation or their specific location.

The foregoing description has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the inventions to the precise embodiments disclosed. Obvious modifications or variations are possible in light of the above teachings. For example, the transceiver can be permanently integrated into an alarm sensor or other stationary device within a system, and the control system server and/or local gateway could be configured to identify the transceiver location by the transceiver identification number alone. It will be appreciated that, in embodiments that do not utilize stand-alone transceivers, the transceivers will be configured to transmit at a high RF power level to effectively communicate with the control system local gateway.

It will be appreciated by those skilled in the art that the information transmitted and received by the wireless transceivers of the present invention may be further integrated with other data transmission protocols for transmission across telecommunications and computer networks. In addition, it should be further appreciated that telecommunications and computer networks can function as a transmission path between the networked wireless transceivers, the local gateways, and the central server.

While the various embodiments of this invention have been described in detail with particular reference to exemplary embodiments, those skilled in the art will understand that variations and modifications can be effected within the scope of the invention as defined in the appended claims. Accordingly, the scope of the various embodiments of the present invention should not be limited to the above discussed embodiments, and should only be defined by the following claims and all applicable equivalents.

I claim:

1. In a communication system to communicate command and sensed data between remote devices, the system comprising:

a receiver address comprising a scalable address of at least one remote device;

a command indicator comprising a command code;

a data value comprising a scalable message; and

a controller associated with a remote wireless device comprising a transceiver configured to send and receive wireless signals, the remote device configured to send a preformatted message comprising the receiver address, a command indicator, and the data value via the transceiver to at least one other remote device.

2. The system of claim **1**, further comprising:

a plurality of transceivers each having a unique address, the transceiver being one of the plurality of transceivers;

a plurality of controllers associated with each the controller associated with at least one of the transceivers, the controller being in communication with at least one other transceiver with a preformatted message, the preformatted message having at least one scalable field;

at least one sensor associated with at least one of the transceivers to detect a condition and output a data signal to the transceiver; and

at least one actuator associated with at least one of the transceivers to activate a device.

3. The system of claim **1**, wherein the controller sends the preformatted message via an associated transceiver, and at least one transceiver sends the preformatted response message.

4. The system of claim **1**, wherein at least one transceiver receives the preformatted message requesting sensed data, confirms the receiver address as its own unique address, receives a sensed data signal, formats the sensed data signal into scalable byte segments, determines the number of segments required to contain the sensed data signal, and generates and transmits the preformatted response message comprising at least one packet.

5. The system of claim **4**, wherein the packet further comprises:

a preface having a predetermined sequence including a first logic level and a subsequent sequence comprising at least two bytes of a second logic level; and

a postscript having a low voltage output.

6. The system of claim **1**, wherein each remote device is adapted to transmit and receive radio frequency transmissions to and from at least one other transceiver.

7. The system of claim **1**, wherein the preformatted message comprises Manchester encoding.

8. A method of communicating command and sensed data between remote wireless devices, the method comprising:

providing a receiver to receive at least one message;

wherein the message has a packet that comprises a command indicator comprising a command code, a scalable data value comprising a scalable message, and an error detector that is a redundancy check error detector; and

providing a controller to determine if at least one received message is a duplicate message and determining a location from which the duplicate message originated.

9. The method of claim **8**, further comprising providing at least one remote wireless communication device, wherein at least one of the devices comprise geographically remote transceivers adapted to transmit and receive the at least one message using radio frequency transmissions.

10. The method of claim **8**, further comprising providing at least one remote wireless communication device, wherein at least one of the devices has a unique address and the packet further comprises at least one scalable address field to contain the unique address for at least one device.

11. The method of claim **8**, further comprising providing an actuator associated with at least one of the remote devices, the actuator configured to actuate in response to the command code.

12. The method of claim **8**, further comprising sending at least one message via Manchester type encoding.

13. The method of claim **8**, further comprising determining if an error exists in a packet of the at least one message.

14. A wireless communication device for use in a communication system to communicate command and sensed data between remote wireless communication devices, the wireless communication device comprising:

a transceiver configured to send and receive wireless communications; and

a controller configured to communicate with at least one other remote wireless device via the transceiver with a preformatted message, the controller further configured to format a message comprising a receiver address comprising a scalable address of at least one remote wireless device; a command indicator comprising a command code; a data value comprising a scalable message.

15. The wireless communication device of claim **14**, further comprising at least one sensor configured to detect a condition and output a signal to the controller.

16. The wireless communication device of claim **14**, wherein the controller is further configured to determine if at least one received message is a duplicate message and determine a location from which the duplicate message originated.

17. The wireless communication device of claim **14**, further comprising at least one actuator configured to implement an action corresponding to the command code.

18. The device of claim **14**, wherein the transceiver comprises a unique transceiver address to distinguish the transceiver from other transceivers.

19. In a system for communicating commands and sensed data between remote devices comprising a communications device for communicating commands and sensed data, the communications device comprising:

a transceiver operatively configured to be in communication with at least one other of a plurality of transceivers, wherein the transceiver has a unique address, wherein the unique address identities the individual transceiver, wherein the transceiver is geographically remote from the other of the plurality of transceivers, wherein each transceiver communicates with each of the other transceivers via preformatted messages;

a controller configured to be in communication with the transceiver, the controller configured to provide preformatted messages for communication; wherein the preformatted messages comprises at least one packet, wherein the packet comprises: a receiver address comprising a scalable address of the at least one of the intended receiving transceivers; sender address comprising the unique address of the sending transceiver; a command indicator comprising a command code; at least one data value comprising a scalable message; and an error detector comprising a redundancy check error detector; and wherein the controller is configured to interact with the transceiver to send preformatted command messages.

20. The communications device of claim **19**, further comprising a sensor operatively configured to detect a condition and output a sensed data signal that corresponds to the condition to the transceiver.

21. The communications device of claim **20**, wherein the transceiver is configured to receive a preformatted command message requesting sensed data, confirms the receiver address as its own unique address, receives the sensed data signal, formats the sensed data signal into scalable byte segments, determines a number of segments required to contain the sensed data signal, and generates and transmits the preformatted response message comprising at least one packet.

22. In a system for controlling geographically diverse devices from a central location, a communications device comprising:

means for dynamically sending and receiving messages, wherein the sent messages comprise commands and the received messages comprise responses to the commands, wherein the message comprises at least one means for packeting a message;

a means for communicating information, the communicating means comprising: means for receiving messages; means for preparing responses to the received message; and means for sending the response message; wherein each communicating means has a unique identifying address;

and wherein the packeting means comprises: means for identifying intended recipients; means for identifying a sender; means for indicating a command; means for data transfer; means for indicating potential error; means for indicating a byte length of a packet; means for indicating a total number of packets in a message; means for identifying a message; means for alerting a recipient to an incoming packet; and means for indicating an end of a packet.

23. The communications device of claim **21**, wherein the means for communicating information is further configured to encode messages via Manchester encoding.

24. The communication device of claim **23**, wherein the means for indicating potential error is configured to detect if an error exists in a packet or a number of packets of at least one message.

25. A wireless communication device for use in a communication system to communicate a number of commands and sensed data between remote wireless communication devices, the wireless communication device comprising:

a transceiver configured to send and receive wireless communications; and

a controller configured to communicate with at least one other remote wireless device via the transceiver with a preformatted message, the controller further configured to reformat a message comprising a receiver address comprising a scalable address of at least one remote wireless device; a command indicator comprising a command code; a data value comprising a scalable message.

* * * * *