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Borgstahl et al.

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[54] **CAPABILITY ADDRESSABLE NETWORK AND METHOD THEREFOR**

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[73] Assignee: **Motorola, Inc.**, Schaumburg, Ill.

[21] Appl. No.: **08/729,207**

[22] Filed: **Oct. 15, 1996**

[51] **Int. Cl.**[7] **H04J 3/00**

[52] **U.S. Cl.** **370/401**; 370/260; 370/338

[58] **Field of Search** 370/260, 261, 370/262, 310, 329, 338, 341, 348, 349, 401

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,572,528	11/1996	Shuen	370/338
5,680,392	10/1997	Semaan	370/261
5,758,079	5/1998	Ludwig et al.	370/261

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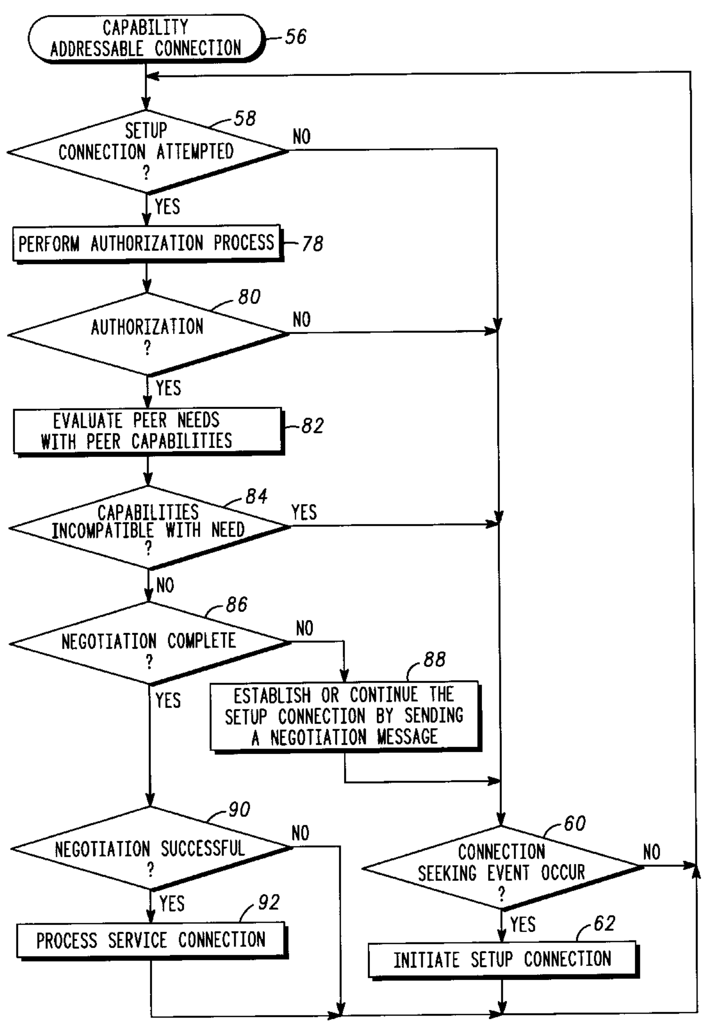
Assistant Examiner—Shick Hom
Attorney, Agent, or Firm—Gregory John Gorrie; Robert D. Atkins

[57] **ABSTRACT**

A wireless, peer-to-peer, capability addressable network (**22**) is disclosed. The network (**22**) accommodates any number of peers (**20**). Network connections are formed based upon proximity between peers (**20**) and upon a needs and capabilities evaluation (**82**). Networks (**22**) support three classifications of service capabilities: service requesting, service providing, and service relaying. Wireless communications occur at a sufficiently low power to form a detection zone (**28**) of less than five meters for many peers (**20**).

20 Claims, 5 Drawing Sheets



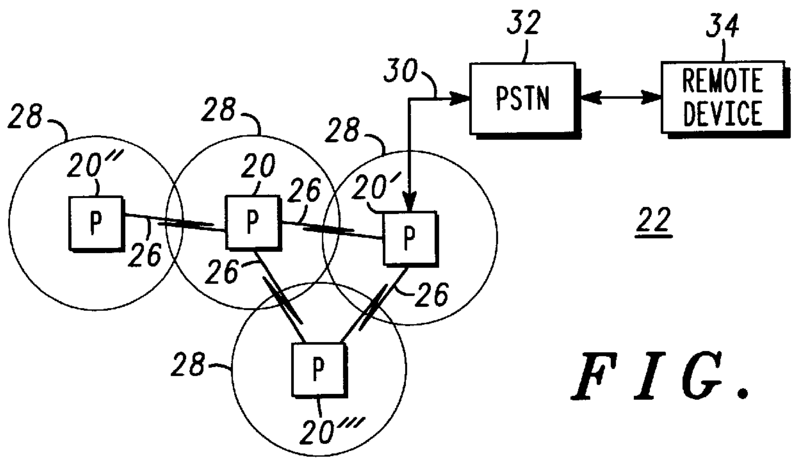

32
34
30
PSTN
REMOTE DEVICE
28
28
28
20″
20
26
20′
P
P
P
26
26
26
22
28
P
20‴

FIG. 1

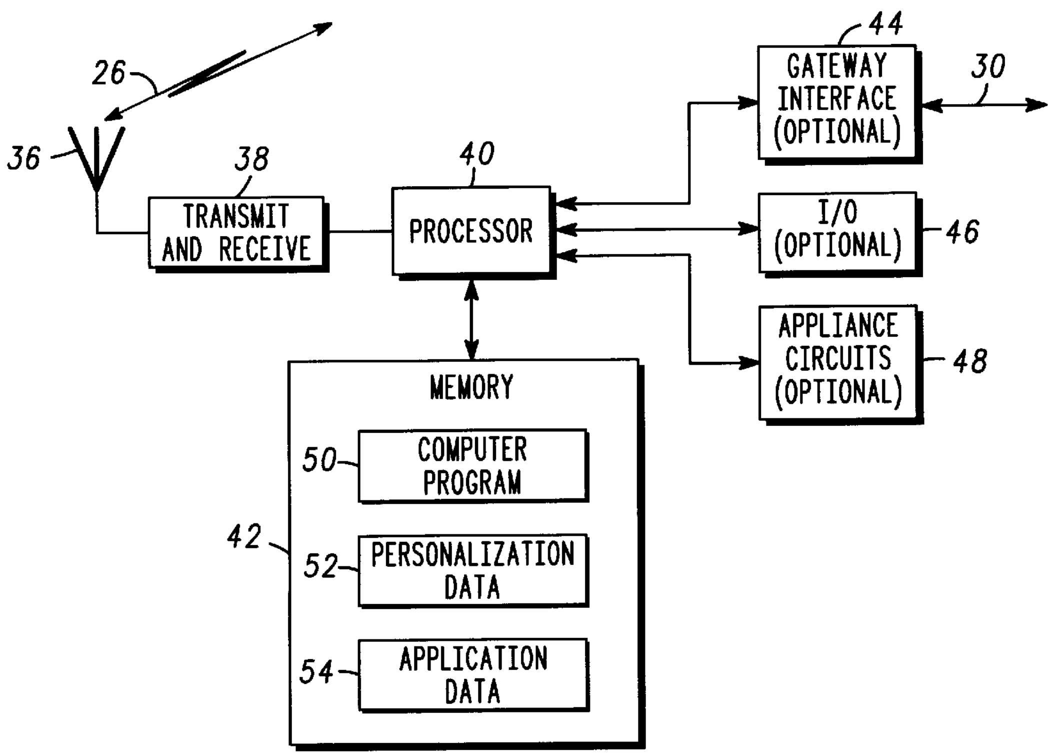

44
26
GATEWAY INTERFACE (OPTIONAL)
30
36
38
40
TRANSMIT AND RECEIVE
PROCESSOR
I/O (OPTIONAL)
46
APPLIANCE CIRCUITS (OPTIONAL)
48
MEMORY
50
COMPUTER PROGRAM
42
52
PERSONALIZATION DATA
54
APPLICATION DATA

FIG. 2

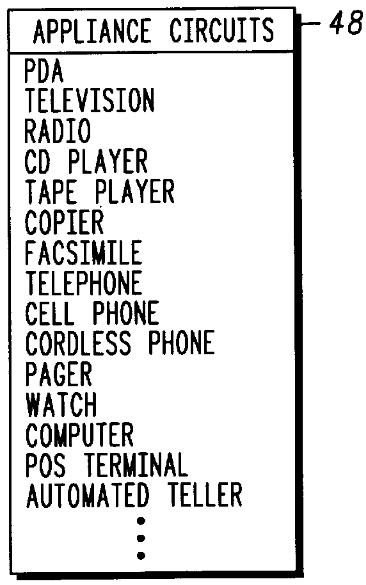


FIG. 3

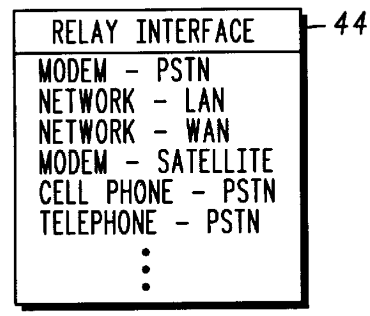


FIG. 4

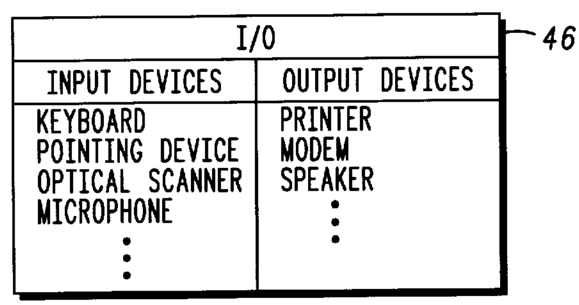


FIG. 5

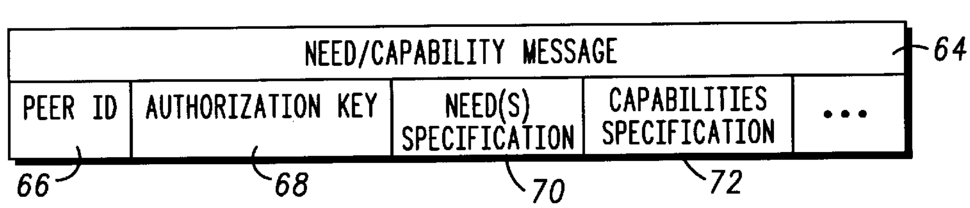


FIG. 7

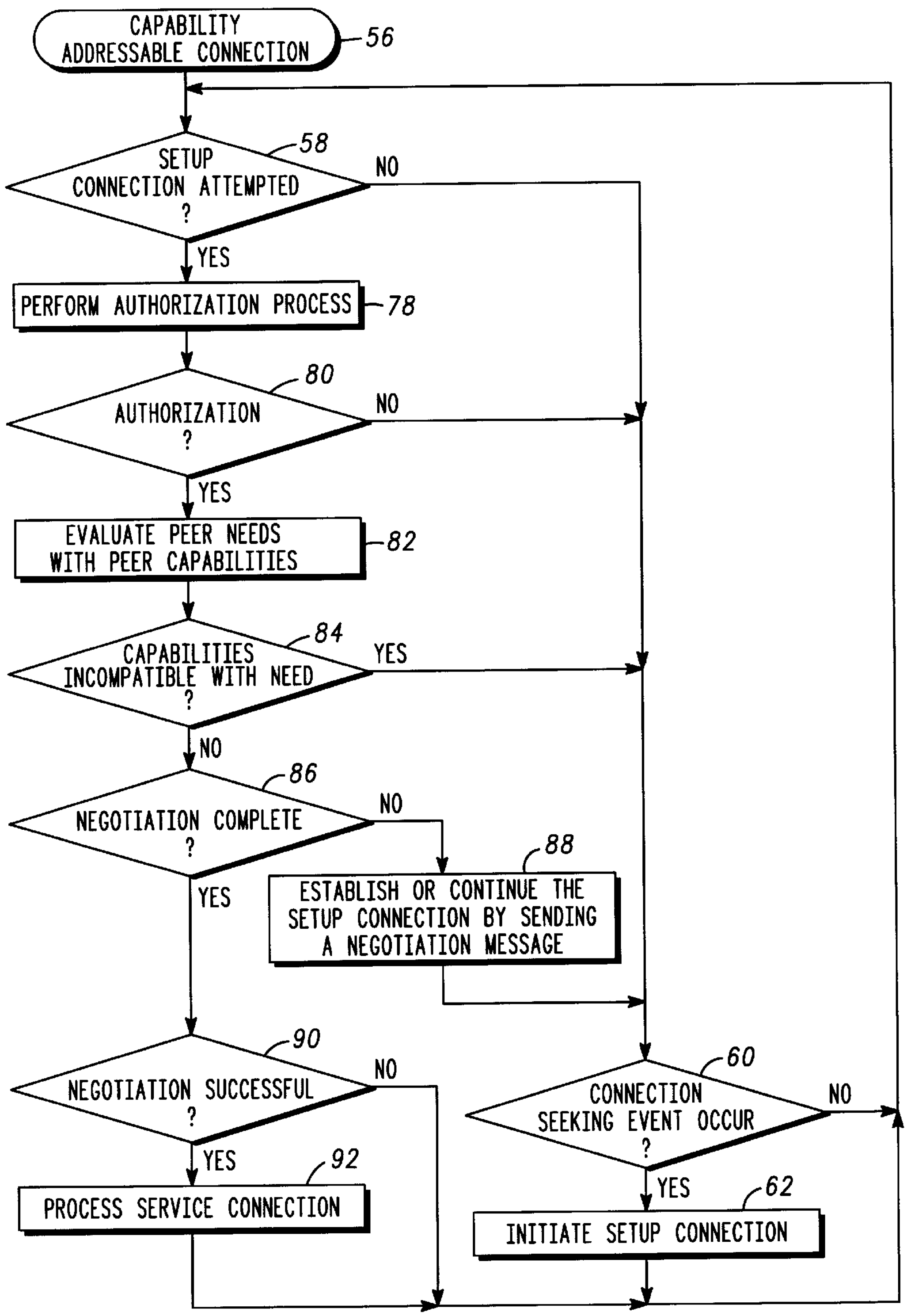

CAPABILITY ADDRESSABLE CONNECTION
56
SETUP CONNECTION ATTEMPTED ?
58
NO
YES
PERFORM AUTHORIZATION PROCESS
78
AUTHORIZATION ?
80
NO
YES
EVALUATE PEER NEEDS WITH PEER CAPABILITIES
82
CAPABILITIES INCOMPATIBLE WITH NEED ?
84
YES
NO
NEGOTIATION COMPLETE ?
86
NO
88
ESTABLISH OR CONTINUE THE SETUP CONNECTION BY SENDING A NEGOTIATION MESSAGE
YES
NEGOTIATION SUCCESSFUL ?
90
NO
YES
92
PROCESS SERVICE CONNECTION
CONNECTION SEEKING EVENT OCCUR ?
60
NO
YES
62
INITIATE SETUP CONNECTION

FIG. 6

74

NEED TABLE	
CODE	MEANING
—	APPLIANCE PERSONALIZATION (E.G., OWNERS NAME)
—	HARD COPY (E.G., PRINT)
—	VISUAL IMAGE (E.G., DISPLAY)
—	AUDIO (E.G., HIGH FIDELITY)
—	GATEWAY (E.G., INTERNET)
—	FINANCIAL TRANSACTIONS (E.G., POS, POINT OF SALE)
—	LOCK/UNLOCK (E.G., SECURITY ENABLE/DISABLE)
⋮	⋮

FIG. 8

76

CAPABILITY TABLE	
CODE	MEANING
—	APPLIANCE PERSONALIZATION (E.G., OWNERS NAME)
—	HARD COPY (E.G., PRINT)
—	MULTIMEDIA (E.G., REAL TIME VIDEO)
—	VOICE (E.G., SPEECH)
—	AUDIO (E.G., HIGH FIDELITY)
—	GATEWAY (E.G., INTERNET)
—	FINANCIAL TRANSACTIONS (E.G., POS, POINT OF SALE)
—	LOCK/UNLOCK (E.G., SECURITY ENABLE/DISABLE)
⋮	⋮

FIG. 9

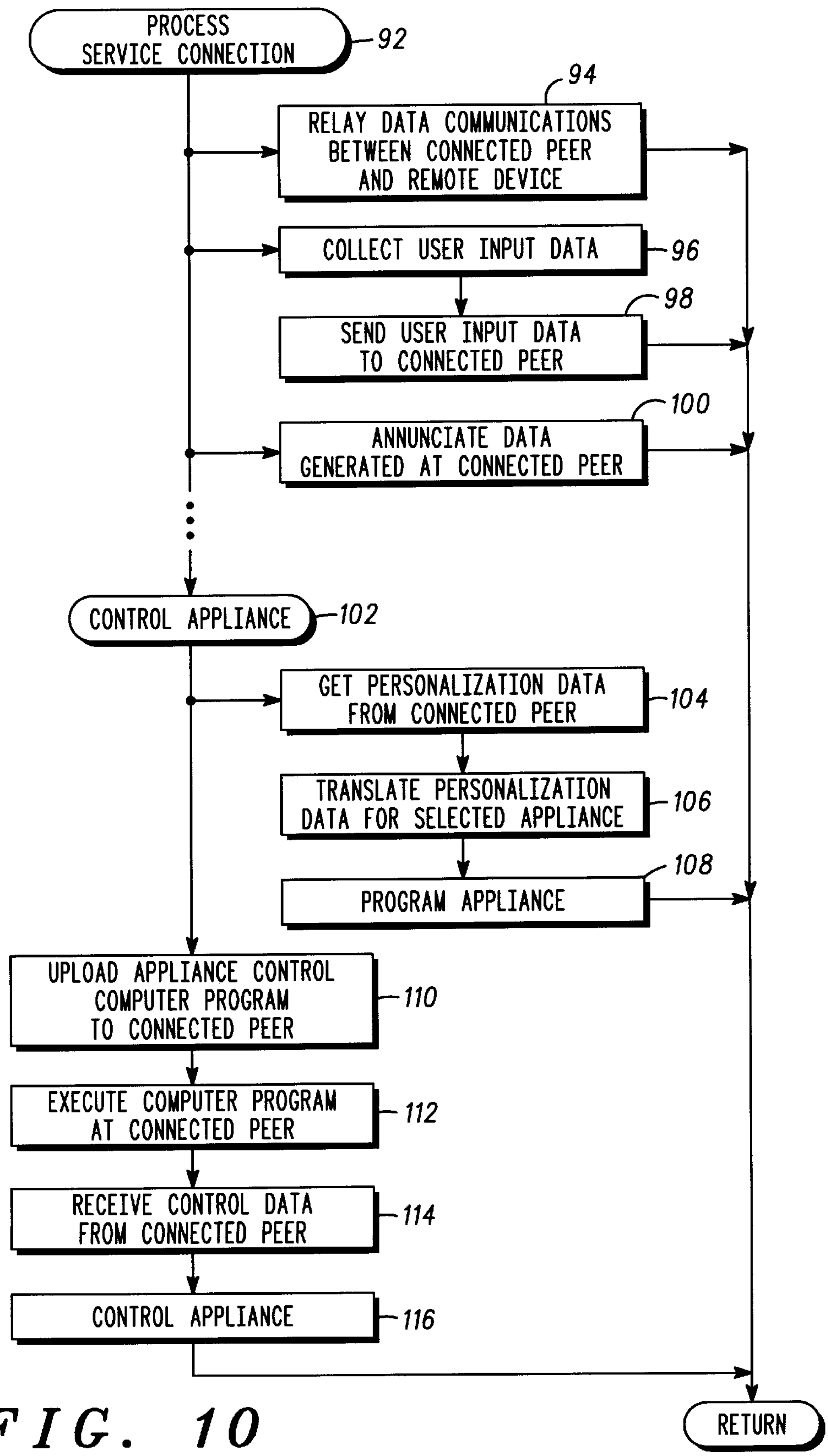

PROCESS SERVICE CONNECTION
92
94
RELAY DATA COMMUNICATIONS BETWEEN CONNECTED PEER AND REMOTE DEVICE
COLLECT USER INPUT DATA
96
98
SEND USER INPUT DATA TO CONNECTED PEER
100
ANNUNCIATE DATA GENERATED AT CONNECTED PEER
CONTROL APPLIANCE
102
GET PERSONALIZATION DATA FROM CONNECTED PEER
104
TRANSLATE PERSONALIZATION DATA FOR SELECTED APPLIANCE
106
108
PROGRAM APPLIANCE
UPLOAD APPLIANCE CONTROL COMPUTER PROGRAM TO CONNECTED PEER
110
EXECUTE COMPUTER PROGRAM AT CONNECTED PEER
112
RECEIVE CONTROL DATA FROM CONNECTED PEER
114
CONTROL APPLIANCE
116
RETURN

FIG. 10

CAPABILITY ADDRESSABLE NETWORK AND METHOD THEREFOR

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to data communication networks. More specifically, the present invention relates to a peer-to-peer network in which node addressing is dynamically configurable.

BACKGROUND OF THE INVENTION

In a typical day many people come into contact with a massive number of electronically controlled devices. Such devices range from automobiles and appliances, to home and office equipment, and to telephones and televisions to name but a few. Many of these devices are required to move from time to time, and many of these devices are even portable. These devices provide a vast and diverse assortment of services for the people coming into contact with them. However, they suffer from a common problem related to user input and output (I/O).

User I/O refers to components and processes used to communicate user-supplied data to an electronic device and to annunciate data from an electronic device so the data may be perceived by a user. Although electronic devices provide a vast and diverse assortment of services, they tend to have redundant I/O. In other words, many such devices have displays, speakers, and the like at which data may be annunciated and have buttons, switches, keypads, and other controls at which user-supplied data may be communicated to the devices. In order to keep costs low and size small, user I/O capabilities often suffer. As a result, many electronic devices encountered in everyday life, and particularly many portable devices, are cumbersome and tedious to use because communicating data from a user to the devices is difficult and because provisions are unavailable for clearly annunciating data for a user's benefit.

In theory, this user I/O problem could be ameliorated by better integrating electronic devices to ease data communications therebetween. For example, a portable telephone could receive a facsimile (fax), but typically has no capability to print the fax and typically has no capability to communicate with a printer which may be able to print the fax. Likewise, a pager may receive a call-back phone number, but typical pagers have no capability to transfer the call-back number to a telephone from which the call-back can be made. User involvement is required to address these and many other data transfer issues. While many conventional data communication or computer network architectures are known, the conventional architectures are unsuitable for the task of integrating a plurality of electronic devices which collectively provide a vast and diverse assortment of services.

Conventional computer networks require excessively complicated setup or activation procedures. Such setup and activation procedures make the jobs of forming a connection to a new network node and making changes in connectibility permission cumbersome at best. Setup and activation procedures are instituted, at least in part, to maintain control of security and to define network addresses. Typically, a system administration level of security clearance is required before access is granted to network tables that define the network addresses. Thus, in conventional networks, many network users lack sufficient security clearance to activate and obtain addresses of network nodes with which they may wish to connect on their own.

Once setup is performed, either directly by a user or by a system administrator, connections are formed when an initiating node presents the network with the address of a network node to which a connection is desired. The setup or activation requirements of conventional networks force nodes to know or obtain a priori knowledge of node addresses with which they wish to connect prior to making the connection. Excessive user attention is involved in making the connection through setup procedures and during the instant of connection to obtain addresses. This level of user involvement leads to an impractical network implementation between the everyday electronic devices with which people come into contact.

Further, conventional computer networks tend to be infrastructure intensive. The infrastructure includes wiring, servers, base stations, hubs, and other devices which are dedicated to network use but have no substantial non-network use to the computers they interconnect. The use of extensive network components is undesirable for a network implementation between everyday electronic devices because an immense expense would be involved to support such an infrastructure and because it impedes portability and movability of nodes.

The use of wiring to interconnect network nodes is a particularly offensive impediment to the use of conventional networks because wiring between diverse nodes is not suitable when some of the nodes are portable. Wireless communication links could theoretically solve the wiring problem. And, conventional wireless data communication networks are known. However, the conventional wireless networks do little more than replace wire lines with wireless communication links. An excessive amount of infrastructure and excessive user involvement in setup procedures are still required.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention may be derived by referring to the detailed description and claims when considered in connection with the Figures, wherein like reference numbers refer to similar items throughout the Figures, and:

FIG. **1** shows a layout diagram depicting exemplary relationships between various peers in a wireless peer-to-peer data communication network configured in accordance with the teaching of the present invention;

FIG. **2** shows a block diagram of hardware included in a peer;

FIG. **3** shows a list of appliance circuits which may be included in the hardware illustrated in FIG. **2**;

FIG. **4** shows a list of gateways which may be included in the hardware illustrated in FIG. **2**;

FIG. **5** shows a list of I/O devices which may be included the hardware illustrated in FIG. **2**;

FIG. **6** shows a flow chart of exemplary tasks included in a capability addressable connection process performed by a peer;

FIG. **7** shows a data format diagram of an exemplary need/capability message communicated from a peer to initiate a setup connection;

FIG. **8** shows an exemplary need table which identifies possible network service needs which might occur at a peer;

FIG. **9** shows an exemplary capability table which identifies possible network capabilities which may be provided by a peer; and

FIG. **10** shows an exemplary flow chart of a process service connection procedure performed at a peer.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a layout diagram depicting relationships between various peers (P) **20** in a capability addressable, wireless, peer-to-peer data communication network **22** configured in accordance with the teaching of the present invention. While FIG. **1** shows only a few peers **20**, virtually any computer or microprocessor controlled electronic device throughout the world may serve as a peer **20**. Accordingly, network **22** supports an unlimited number of possible connections between peers **20**.

As used herein, the term "peer-to-peer" is defined to mean having at least common portions of communications protocol and/or capability and does not refer to equivalence of physical size, functional capability, data processing capacity or transmitter/receiver range or power. Each peer or communication node **20** of communications network **22** may establish a personal area network. For example, a first and a second of nodes **20** first find or determine that each other is a compatible node. Then, as a result of self-initiated processes, first and second nodes **20** form the personal network. First and second nodes **20** must detect that they are in a particular proximity to one another and if so a communication link is established. This link may be accomplished by known RF, IR, optical or acoustic techniques, or by conduction through a living body. When a link is established, first and second nodes **20** exchange what their needs and capabilities are. When needs and capabilities are not able to be satisfied or matched, one of first and second nodes **20** may alternately route the communications link to a third communication node **20**. Put another way, a communications platform that includes at least two nodes having overlapping communications regions could also include means for exchanging needs and capabilities information between the at least two nodes for forming a communication network.

Network **22** is desirably configured in a peer-to-peer architecture so that only a minimal number of network-specific components are used and no fixed infrastructure is required. In the preferred embodiments, each peer **20** can initiate a connection with other peers **20** without servers being required to manage the connections. Moreover, peers **20** can freely move about without affecting the network structure or requiring the performance of reconfiguration, setup, or activation procedures.

Free movement of peers **20** is further supported by using wireless communication links **26** as a physical transport layer in network **22**. In the preferred embodiments, wireless communication links **26** are RF links operating in the higher regions of the microwave band so that small, lightweight, inexpensive, omni-directional antennas may be used. However, other RF frequencies, optical links, and other wireless communication links known to those skilled in the art may be used as well. The specific protocols used in implementing wireless communication links **26** are not important to the present invention. Various TDMA, FDMA, and/or CDMA techniques known to those skilled in the art may be employed. However, all peers **20** in network **22** desirably have the ability to communicate using the protocols, regardless of the capabilities and needs of the peers **20**.

FIG. **1** depicts a detection zone **28** surrounding each peer **20**. In the preferred embodiments, wireless communication links **26** for the vast majority of peers **20** are operated at a sufficiently low power so that a wireless communication range for a given peer **20** is preferably less than 5 meters, although the range may be much greater, for the typical peer **20**. The use of this degree of low power transmissions limits interference between independent connections which may share the wireless spectrum at different locations. Moreover, the use of this degree of low power transmissions is compatible with configuring a substantial portion of peers **20** as portable devices. Those skilled in the art will appreciate that hand portable electronic devices share the characteristics of being physically small, lightweight, and including a self-contained power source such as a battery. Extremely low power transmissions do not severely deplete the reserves of small batteries typically used in portable devices.

While a peer **20** may potentially connect through network **22** with a vast multitude of peers **20**, the use of low power wireless communication links **26** limits the number of potential connections at any given instant in time to those peers **20** which are physically proximate to one another. In other words, only when a first peer **20** resides in the detection zone **28** of a second peer **20** and that second peer **20** resides in the detection zone **28** of the first peer **20** can a connection through network **22** occur.

Rather than specifying a network unique address to initiate a connection, network **22** uses physical proximity along with a needs and capabilities evaluation (discussed below) to target a peer **20** with which a connection is desired. By not specifying a network unique address to initiate a connection, user involvement in making connections is reduced and network addressing becomes dynamically configurable. Such an addressing scheme is useful in exchanging data between devices a user carries and comes into contact with on a daily basis. Relaying information between peers not in direct communication is also possible. For example, peer **20''** may establish a communication link with peer **20'''** via peer **20**. In this case, peer **20** provides the relay interface between the other two peers.

Not all peers **20** are required to be portable devices. FIG. **1** shows a communication link **30**, which may or may not include a wireline link, connecting a peer **20'** to a public switched telecommunication network (PSTN) **32**. Through PSTN **32**, peer **20'** may communicate with a vast assortment of remote devices **34**, of which FIG. **1** shows only one. Peer **20'** may be powered from a public power network (not shown) so that minimizing power consumption is not a significant design issue. While FIG. **1** depicts only PSTN **32** linking a peer **20** to a remote device **34**, other local area network (LAN), wide area network (WAN) or communication links known to those skilled in the art may connect a peer **20** to remote devices **34**. Remote devices **34** may or may not themselves be peers **20**. While network **22** uses proximity as a factor in targeting peers **20** to which connections are formed, the use of routing, gateway or relaying peers **20'** permits connections to be extended over great distances through the use of other networks.

FIG. **2** shows a block diagram of hardware included in a peer **20**. Peer **20** includes an antenna **36** configured to support wireless communication link **26**. Antenna **36** couples to a transmit and receive section **38**. Transmit and receive section **38** is compatible with the protocols peers **20** use to communicate with one another. Transmit and receive section **38** couples to a processor **40**. Processor **40** couples to a memory **42**, an optional gateway **44**, communication link **30**, an optional I/O section **46**, transmit and receive unit **38** and optional appliance circuits **48**.

Processor **40** executes computer programs **50** which are stored in memory **42**. Computer programs **50** define processes performed by processor **40** and peer **20**. Memory **42** additionally stores personalization data **52** and application data **54**. Personalization data **52** characterize a user or owner of peer **20** and may change from user to user. ID codes, passwords, and PINs are examples of personalization data as are radio or TV channel presets, language preferences, and speed dial telephone numbers. Application data **54** are provided by performing peer applications, and may change from moment to moment. A facsimile, a telephone number received over a pager, data scanned in using a bar code reader, and a sound snippet received from a microphone or other audio source represent examples of application data.

In one embodiment, the present invention is realized as an integrated circuit for interactively coupling one or more communication nodes in a common network. The integrated circuit includes, in combination, a receiver for receiving input data, a transmitter for transmitting output data and a processor. The processor is coupled to the receiver and transmitter for interactively coupling a first common node to a second common node. The processor includes apparatus for activating a communications link between the first and second common nodes when the first and second common nodes are within a predetermined distance from each other and when needs and capabilities of said first and second common nodes overlap.

FIG. **3** shows a non-exhaustive list of examples of appliance circuits **48** which may be included in a peer **20**. Referring to FIGS. **2** and **3**, appliance circuits **48** may be configured as any type of a wide variety of everyday, commonly encountered electronically controlled devices, fixed or portable. Thus, a peer **20** may, in addition to being a peer **20**, be a personal digital assistant (PDA), television, radio, CD player, tape player, copier, facsimile machine, telephone, cellular telephone, cordless telephone, pager, watch, computer, point of sale (POS) terminal, automated teller, or other electronic device.

FIG. **4** shows a non-exhaustive list of gateways **44** which may be included in a peer **20**. Referring to FIGS. **2** and **4**, gateways **44** may be configured as any of a wide variety of relay, routing, or protocol conversion devices known to those skilled in the art. For example, a peer **20** may, in addition to being a peer **20**, be a modem which couples peer **20** to PSTN **32** (see FIG. **1**). Other gateways **44** may couple a peer **20** to LANs or WANs. Still other gateways **44** may couple a peer **20** modem to a satellite, a peer **20** cell phone to PSTN **32**, a plain old telephone (POT) peer **20** to PSTN **32**.

FIG. **5** shows a non-exhaustive list of I/O devices **46** which may be included in a peer **20**. Referring to FIGS. **2** and **5**, I/O devices **46** may be classified into input devices and output devices. Input devices may include keyboards, pointing devices, optical scanners, microphones, and other well known input devices. Output devices may include printers, monitors, speakers, and other well known output devices. Thus, in addition to being a peer **20**, a peer **20** may be an I/O device **46**.

Those skilled in the art will appreciate that gateways **44**, I/O section **46** and appliance circuits **48** are not mutually exclusive categories. For example, many devices fall into multiple categories. For example, a computer considered as an appliance may include both an I/O section and a gateway. Likewise, a gateway may serve an I/O role.

FIG. **6** shows a flow chart of tasks included in a capability addressable connection process **56** performed by a peer **20**. Process **56** is defined by a computer program **50** stored in memory **42** of peer **20** (see FIG. **2**) in a manner well known to those skilled in the art. In the preferred embodiments, all peers **20** perform a process similar to process **56**.

Process **56** includes a query task **58** during which peer **20** determines whether a setup connection is being attempted. Generally, task **58** allows a first peer **20** to determine whether a second peer **20** is physically proximate to the first peer **20**. Task **58** causes transmit and receive section **38** (see FIG. **2**) to monitor wireless communication link **26** (see FIG. **1**) to determine whether a signal compatible with a protocol being used by network **22** (see FIG. **1**) can be received. Due to the above-described low transmission power levels used by peers **20**, when a signal is detected, the peer **20** sending the signal is located near the receiving peer **20**.

When task **58** fails to determine that a setup connection is being attempted, a query task **60** determines whether a connection-seeking event has occurred. A connection-seeking event causes a peer **20** to seek out a connection with another peer **20**. Connection-seeking events can be triggered using a periodic schedule. For example, connections may be sought out every few seconds. In this example, the schedule may call for more frequent periodic connection attempts from peers **20** which are powered from a public power network and less frequent connection attempts from peers **20** which are battery powered. Connection-seeking events can also be triggered upon the expiration of a fixed or random interval timer or upon the receipt of other external information. The other external information can include information obtained through appliance circuits **48**, gateway **44**, or I/O section **46** (see FIG. **2**) including user input.

If task **60** fails to determine that a connection-seeking event has occurred, program control loops back to task **58**. If task **60** determines that a connection-seeking event has occurred, process **56** performs a task **62**. Task **62** initiates an unsolicited setup connection. The setup connection is not addressed to any particular peer **20** of network **22**. Rather, it is broadcast from the peer **20** making the attempt and will be received by all peers **20** within the detection zone **28** (see FIG. **1**) of the broadcasting peer **20**. As discussed below, the broadcast signal need not be answered by another peer **20** even when another peer **20** is in detection zone **28**. At this point, the broadcasting peer **20** need not know if any other peer **20** can receive the broadcast signal, and the broadcasting peer **20** may or may not know any particular needs or capabilities of other peers **20** should other peers **20** be sufficiently proximate so that a connection may be formed.

Task **62** initiates a setup connection by broadcasting a need/capability message **64**, an exemplary format for which is depicted in FIG. **7**. Referring to FIG. **7**, message **64** includes an ID **66** for the peer **20** broadcasting message **64**, an authorization key **68**, a need specification **70**, a capability specification **72**, and can include other data elements. ID **66** is desirably sufficiently unique within the domain of network **22** so that it may be used in an addressed service connection, should the setup connection prove successful. Authorization key **68** includes one or more data codes which may be used by a receiving peer **20** in performing an authorization process. Needs specification **70** is a list of network needs currently experienced by the broadcasting peer **20**. Capability specification **72** is a list of network capabilities which the broadcasting peer **20** may provide to other peers **20** of network **22**.

Needs specification **70** may be determined by consulting a need table **74**, an exemplary and non-exhaustive block diagram of which is depicted in FIG. **8**. As illustrated in FIG. **8**, data codes may be associated with a variety of network service needs which a service-requesting peer **20** may experience.

One exemplary need is that of appliance personalization. In the appliance personalization need example, a PDA might need to personalize nearby appliances. To satisfy this need, personalization data **52** (see FIG. **2**) should be programmed into certain nearby appliances without user intervention. As a result, the certain appliances will always be programmed with a particular user's personalization data whenever that user is near, without requiring action on the user's part, and regardless of prior persons who may have used the appliance.

Other exemplary needs can include that of printing application data **54** (see FIG. **2**), displaying application data **54**, annunciating application data **54** at a speaker, routing connectivity to the Internet or other network resources, POS transactions, passage through secure areas or toll booths, and the like.

Capability specification **72** may be determined by consulting a capability table **76**, an exemplary and non-exhaustive block diagram of which is depicted in FIG. **9**. As illustrated in FIG. **9**, data codes may be associated with a variety of network capabilities provided by a service-providing peer **20**. For example, a service-providing peer **20** capability can be that of appliance personalization. Thus, a peer **20** may be capable of being personalized by personalization data **52** (see FIG. **2**). Other examples include capabilities of printing, displaying, annunciating over a speaker, relaying a connection through the Internet or other network or POS terminal, and unlocking a secured passageway, to name a few. In general, potential capabilities are compatible with potential needs.

Referring back to FIG. **7**, need/capability message **64** includes those codes from tables **74** and **76** (see FIGS. **8–9**) that currently apply. While a peer **20** may have more than one need or capability at a given instant, nothing requires a peer **20** to have multiple needs or capabilities. Moreover, nothing requires a peer **20** to have both a network need and a network capability. Message **64** serves as a need message if a peer need is specified regardless of whether a peer capability is specified and as a capability message if a peer capability is specified regardless of whether a peer need is specified.

Referring back to FIG. **6**, after task **62** broadcasts message **64** (see FIG. **7**), program control loops back to task **58**.

When task **58** eventually detects that a setup connection is being attempted by receiving a message **64**, a task **78** performs an authorization process. Task **78** uses authorization key **68** (see FIG. **7**) from message **64** to determine if the peer **20** attempting to setup a connection is authorized to connect to the receiving peer **20**. Task **78** allows an owner of a peer **20** to restrict access to the owned peer **20** through network **22**. The authorization process of task **78** may be used, for example, to restrict personalization capabilities of an appliance to a small family group. Alternatively, a peer **20** having a POS capability may perform an extensive authorization process before permitting a transaction to take place. A peer **20** having a need may also qualify the receipt of provided services depending upon the authorization process provided by task **78**.

After task **78**, a query task **80** determines whether the authorization process **78** authorized the attempted setup connection. If authorization is denied, program control loops back to task **60**. The receiving peer **20** need not reply or otherwise acknowledge the attempted setup connection.

If authorization is accepted, a task **82** evaluates peer needs with peer capabilities. In other words, task **82** causes the message-receiving peer to compare its available capabilities (if any) to any needs listed in a received unsolicited need/capability message **64** (see FIG. **7**) and to compare its available needs (if any) to any capabilities listed in the message **64**. After task **82**, a query task **84** acts upon the result of the evaluation of task **82**. If no internal capabilities match needs indicated in an unsolicited message **64**, and if no internal needs match capabilities indicated in an unsolicited message **64**, then neither peer **20** can be of service to the other. Program control loops back to task **60**, and the receiving peer **20** need not reply or otherwise acknowledge the attempted setup connection.

At this point, the vast multitude of potential connections which a peer **20** may make within network **22** has been greatly reduced in scope without the use of network-unique addressing. The low power transmission scheme excludes most peers **20** in network **22** from being connectable at a current instant because most peers **20** will not be proximate one another. Of the few peers **20** which may be within each other's detection zones **28** (see FIG. **1**), the scope of potential connections has been further limited through the authorization process of task **78** and needs and capabilities evaluation of task **82**. Additional exclusions on the remaining potential connections are performed through a negotiation process carried on between a service-requesting peer **20** and a service-providing peer **20**.

When task **84** determines that capabilities and needs appear to be compatible, a query task **86** determines whether this negotiation process is complete. If the negotiation process is not complete, a task **88** establishes or otherwise continues the setup connection in furtherance of the negotiation process by sending an addressed negotiation message (not shown) to the peer **20** whose peer ID **66** (see FIG. **7**) was included in a just-received needs/capabilities message **64**. The negotiation message can have a form similar to that of needs/capabilities message **64**, but be specifically addressed to the other peer **20**.

After task **88**, program control loops back to task **60**. Subsequent negotiation messages may, but need not, be received. If such subsequent negotiation messages indicate that both peers **20** to the prospective connection have completed negotiation, a query task **90** determines whether the negotiation was successful. If the negotiation was not successful, program control loops back to task **58**, and no service connection will result. However, if the negotiation was successful, a process service connection procedure **92** is performed. During procedure **92**, a one-to-one, addressed connection is established between peers **20** to perform network services. Upon completion of the service connection, program flow loops back to task **58**.

While nothing prevents capability addressable connection process **56** from relying upon user intervention during the setup connection process, user intervention is not required. Whether user intervention is required or not should depend upon the security, a priori knowledge and other considerations connected with the nature of the peers **20** involved. For example, peers **20** involved in financial transactions can benefit upon user intervention to ensure security. However, personalization of user-owned appliances and many other connection scenarios need not rely on user intervention.

FIG. **10** shows a flow chart of process service connection procedure **92**. Procedure **92** illustrates a collection of tasks which can be performed at a service-providing peer **20** in support of a service connection. Not all peers **20** need to be able to perform all the tasks depicted in FIG. **10**. Likewise, many peers **20** may include other tasks which suit the nature of those particular peers **20**.

Procedure **92** performs a task **94** to provide a network relay, router, or gateway capability for a service-receiving peer **20** of network **22** through an established service connection. During task **94**, a service-providing peer **20** relays data communications between the connected peer **20** and a remote device **34** (see FIG. **1**). After task **94**, program flow returns to process **56** (see FIG. **6**). Task **94** may be used to extend the service connection to the Internet or other network.

Procedure **92** performs tasks **96** and **98** to provide a user input capability for a service-receiving peer **20** of network **22** through an established service connection. During task **96**, the service-providing peer **20** collects user input from its I/O section **46** (see FIG. **2**). During task **98**, the service-providing peer **20** sends the collected user input data to the connected service-receiving peer **20**. After task **98**, program flow returns. Tasks **96** and **98** may be used to control or program appliances from a PDA or other device which may have enhanced user input capabilities.

Procedure **92** performs a task **100** to provide a user output capability for a service-receiving peer **20** of network **22** through an established service connection. During task **100**, the service-providing peer **20** receives data generated from the service-receiving peer **20** over the service connection and annunciates the data at an output device in its I/O section **46** (see FIG. **2**). The data may be annunciated in an audibly or visibly perceivable format or in any other format perceivable by human senses. After task **100**, program flow returns. Task **100** may be used to annunciate data collected in a portable peer **20** at a non-portable annunciating device. Alternatively, task **100** may be used to annunciate data generated by a stationary appliance with limited I/O capability at a portable annunciating device.

Procedure **92** performs a control appliance process **102** to support the controlling of appliances. Tasks **104**, **106**, and **108** of process **102** are performed to program an appliance peer **20** with personalization data **52** (see FIG. **2**). During task **104**, a service-providing peer **20** gets personalization data **52** from the connected, service-receiving peer **20** using the service connection. Next, task **106** translates the network compatible personalization data **52** into a format suitable for the specific appliance to be programmed with personalization data **52**. Those skilled in the art will appreciate that not all personalization data **52** available in a service-receiving peer **20** need to be applicable to all appliances. Thus, task **106** can use as much of personalization data **52** as applies to the specific appliance. After task **106**, task **108** causes the appliance to be programmed with the translated personalization data **52**. After task **108**, program flow returns.

Tasks **110**, **112**, **114**, and **116** of process **102** are performed to allow a user to easily control an appliance. These tasks can be performed on a PDA, for example, which has a display and user input capability exceeding the user I/O capabilities typically found on appliances. In this case, an appliance is a service-receiving peer **20** while the PDA is a service-providing peer **20**. During task **110**, the service-receiving peer **20** uploads an appliance control computer program to the connected service-providing peer using the service connection. Next, during task **112** the service-providing peer **20** executes the just-uploaded computer program. Task **112** causes the service-providing peer **20** to become specifically configured to provide a desirable user interface for the specific appliance being controlled. Next, during task **114** control data are received at the service-receiving peer **20** over the service connection. The control data originated from user input is supplied through the control computer program being executed on the service-providing peer **20**. After task **114**, task **116** controls the subject appliance in accordance with the control data received in task **114**. After task **116**, program flow returns.

In summary, the present invention provides an improved capability addressable network and corresponding method. This network is suitable for interconnecting a plurality of everyday electronic devices, including movable and portable devices that provide a vast and diverse assortment of services. A priori activation and setup procedures are not required in this network because no network specific equipment requires network addresses in order to make connections. Although device addresses are not needed to establish connections, device names must be known by connected peers before meaningful communication can be established and information exchanged. In this context, a device or peer name is simply a unique identifier that allows one device or peer **20** to be uniquely distinguished from any other device or peer **20**. Consequently, a minimal amount of user involvement is needed to make connections to peers, and peers may make connections to new peers as a routine matter. Network node addressing is dynamically configurable because network connections are formed based upon proximity and upon a needs and capabilities evaluation rather than on unique network-wide address encoding.

Although the preferred embodiments of the invention have been illustrated and described in detail, it will be readily apparent to those skilled in the art that various modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claims.

What is claimed is:

1. In a capability addressable peer-to-peer data communication network, a method of establishing network connectivity comprising the steps of:

initiating a setup connection between first and second peers of said network by transmitting an unsolicited message containing an identification of said first peer to said second peer;

authorizing said second peer to establish said setup connection with said first peer based on said identification of said first peer:

exchanging needs and capabilities between said first and second peers after establishing said setup connection; and

selectively processing an addressed service connection in response to said exchange of needs and capabilities.

2. The method as claimed in claim **1**, wherein said addressed service connection occurs when said needs of said first peer match said capabilities of said second peer.

3. The method as claimed in claim **1**, wherein said addressed service connection occurs when said needs of said second peer match said capabilities of said first peer.

4. The method as claimed in claim **1**, further comprising the steps of:

providing a network capability available through said second peer to said first peer using said service connection; and

said network capability includes relaying, at said second peer, data communications between said first peer and a device in data communication with said second peer.

5. The method as claimed in claim **1**, further comprising the steps of:

providing a network capability available through said second peer to said first peer using said service connection; and

said network capability includes collecting user input data at said second peer and communicating said user input data to said a first peer.

6. The method as claimed in claim **1**, further comprising the step of providing a network capability available through said second peer to said first peer using said service connection, wherein said network capability includes annunciating, at said second peer, user output data generated at said first peer.

7. The method as claimed in claim **1**, further comprising the step of providing a network capability available through said second peer to said first peer using said service connection, wherein said network capability includes controlling an appliance through said second peer in response to control data generated at said first peer.

8. The method as claimed in claim **7**, further comprising the steps of:

uploading a computer program from said second peer to said first peer, said computer program defining a process for controlling said appliance; and

executing said computer program at said first peer to generate said control data.

9. The method as claimed in claim **7**, further comprising the steps of:

storing personalizing data at said first peer; and

programming said appliance with said personalizing data.

10. A method of operating a capability addressable peer-to-peer data communication network comprising the steps of:

a) broadcasting an unsolicited beacon message from a first peer node;

b) identifying said second peer node as being authorized to establish communications with said first peer node when said first peer node receives a response message from said second peer node;

c) establishing a setup connection between said first peer node and said second peer node;

d) receiving information by first peer node describing a network capability provided by said second peer node; and

e) forming a service connection between said first peer node and said second peer node when said capability information indicates a capability compatible with a need of said first peer node.

11. A method as claimed in claim **10**, further including the step of routing the service connection by the second peer node to a third peer node to fulfill said need of said first peer node, if said second peer node is unable to fulfill said need of said first peer node.

12. A method of operating a capability addressable peer-to-peer data communication network comprising the steps of:

a) detecting, at a first one of a service-requesting peer and a service-providing peer, physical proximity of a second one of said service-requesting and service-providing peers;

b) determining whether a need for a service connection exists at one of said service-requesting and service-providing peers;

c) establishing, if said determining step identifies said need, a setup wireless connection between said service-requesting and service-providing peers;

d) communicating authorization information describing said service-requesting peer to said service-providing peer;

e) forming a wireless service connection between said service-requesting and service-providing peers when said service-requesting peer is authorized through an identification code;

f) communicating capability information describing said service-providing peer to said service-requesting peer;

g) forming said wireless service connection between said service-requesting and service-providing peers when said service-providing peer is determined to have a capability compatible with said need determined in step b); and

h) providing said capability using said service connection.

13. A method as claimed in claim **12**, wherein said providing step comprises the step of relaying, at said service-providing peer, data communications between said service-requesting peer and a device in data communication with said service-providing peer.

14. A method as claimed in claim **12**, wherein said providing step comprises the steps of:

collecting user input data at a first one of said service-providing and service-requesting peers; and

communicating said user input data to said a second one of said service-providing and service-requesting peers.

15. A method as claimed in claim **12**, wherein said providing step comprises the steps of:

generating user output data at a first one of said service-providing and service-requesting peers; and

annunciating said user output data to said a second one of said service-providing and service-requesting peers.

16. A method as claimed in claim **12**, wherein said providing step comprises the steps of:

generating appliance control data at a first one of said service-providing and service-requesting peers; and controlling an appliance in accordance with said control data at a second one of said service-providing and service-requesting peers.

17. An apparatus for interactively coupling one appliance to another appliance, comprising:

a receiver for receiving input data;

a transmitter for transmitting output data; and

a processor coupled to said transmitter for broadcasting an unsolicited message from said one appliance that includes an identity of said one appliance, and wherein said processor receives through said receiver a response message.

18. The apparatus as claimed in claim **17**, wherein a setup connection between said one appliance and said another appliance is formed over a wireless communication link.

19. The apparatus as claimed in claim **18**, wherein said setup connection occurs when said one appliance and said another appliance are within a wireless communication range of less of than 400 meters.

20. The apparatus as claimed in claim **17**, wherein said processor further includes a memory for storing a list of needs and capabilities of said one appliance that is compared with another list received through said receiver from said another appliance.

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