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Wood et al.(10) **Pub. No.: US 2017/0126547 A1**(43) **Pub. Date: May 4, 2017**(54) **DATA PATH SWITCHING****Publication Classification**(71) Applicant: **CradlePoint, Inc.**, Boise, ID (US)(72) Inventors: **Steven Wood**, Boise, ID (US); **Patrick Sewall**, Boise, ID (US); **David A. Johnson**, Boise, ID (US)(51) **Int. Cl.****H04L 12/725** (2006.01)**H04L 12/751** (2006.01)**H04L 12/46** (2006.01)**H04L 12/721** (2006.01)(52) **U.S. Cl.**CPC **H04L 45/304** (2013.01); **H04L 45/12**(2013.01); **H04L 45/02** (2013.01); **H04L 12/46**

(2013.01)

(21) Appl. No.: **15/408,967**(22) Filed: **Jan. 18, 2017****Related U.S. Application Data**

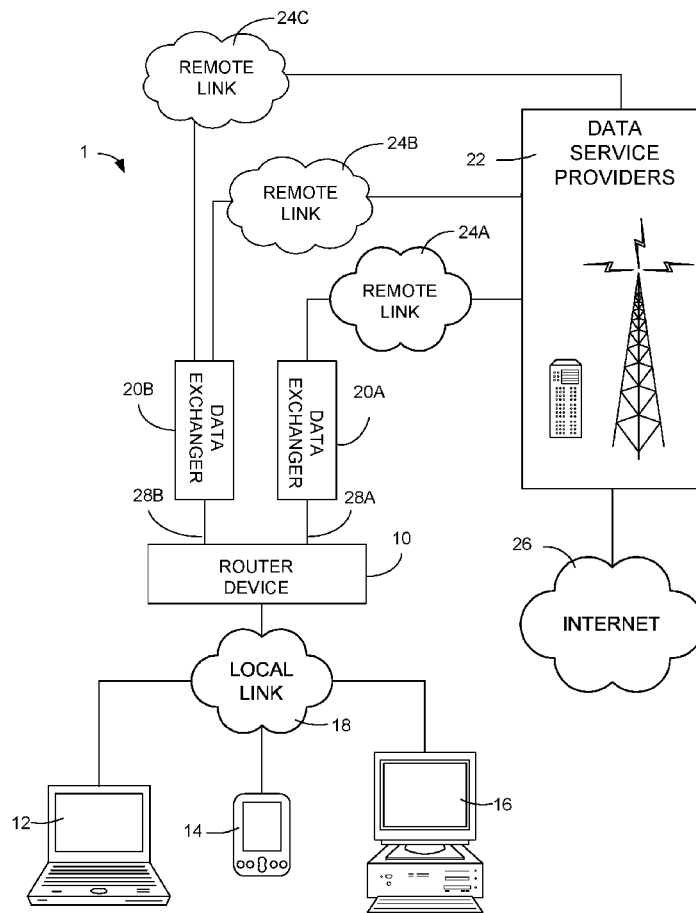
(63) Continuation of application No. 12/350,460, filed on Jan. 8, 2009, now Pat. No. 9,584,406, which is a continuation-in-part of application No. 10/936,124, filed on Sep. 8, 2004, now Pat. No. 7,764,784.

(60) Provisional application No. 61/019,875, filed on Jan. 9, 2008, provisional application No. 61/019,876, filed on Jan. 9, 2008.

(57)

ABSTRACT

A method for selecting a data path includes identifying a plurality of available data paths between a router device and a wide area network. Path selection data is obtained. The path selection rules are processed with the obtained path selection data. For each of a plurality of data communications to be routed, one of the plurality of available data paths is selected according to the processing of the path selection rules. Each of the plurality of data communications is routed between a local area network and the wide area network via a data exchanger and a remote link that follows the data path selected for that data communication



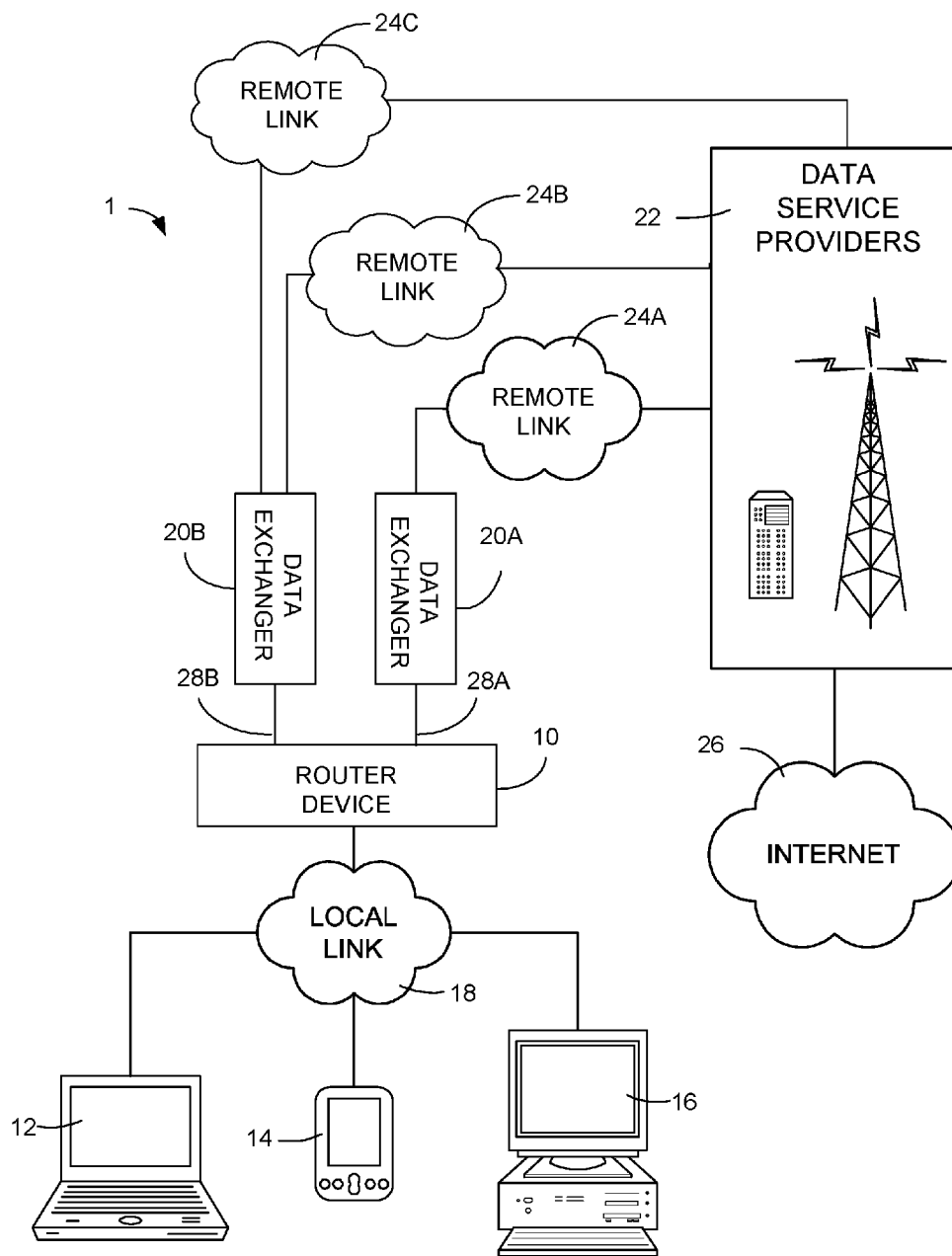


FIG. 1

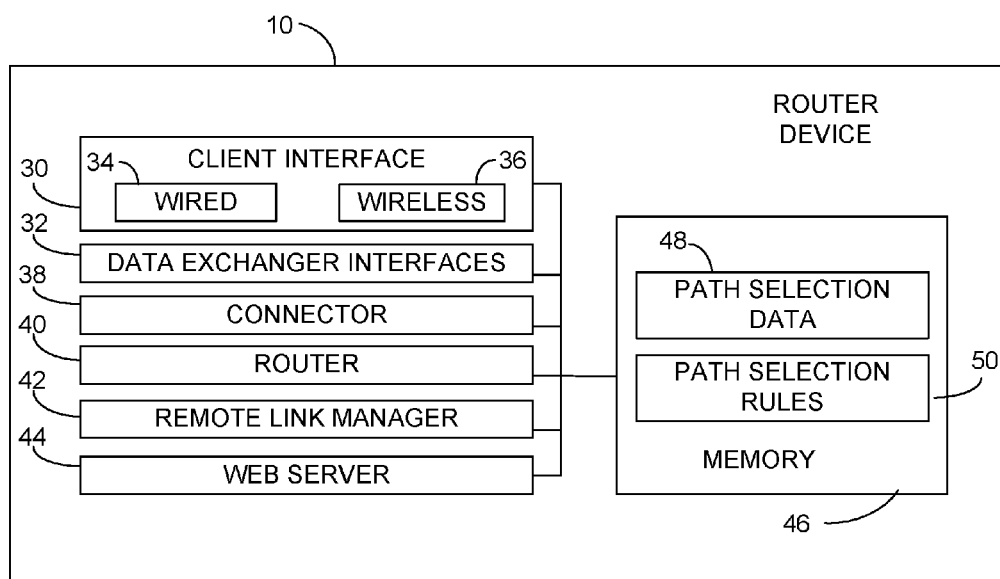


FIG. 2

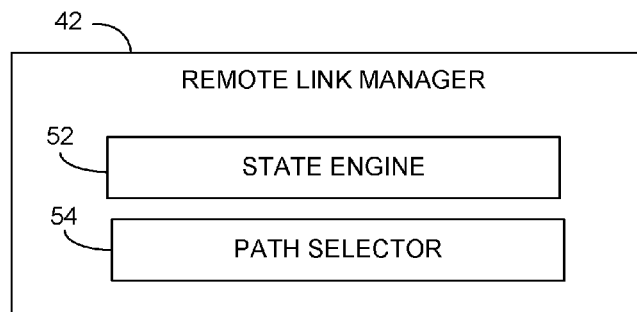


FIG. 3

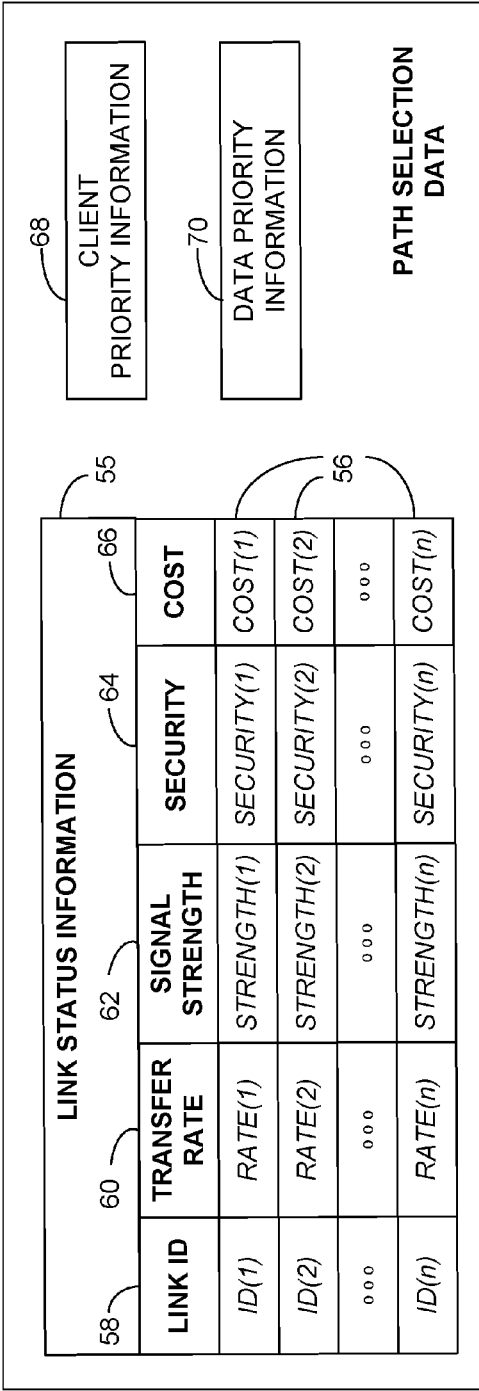


FIG. 4

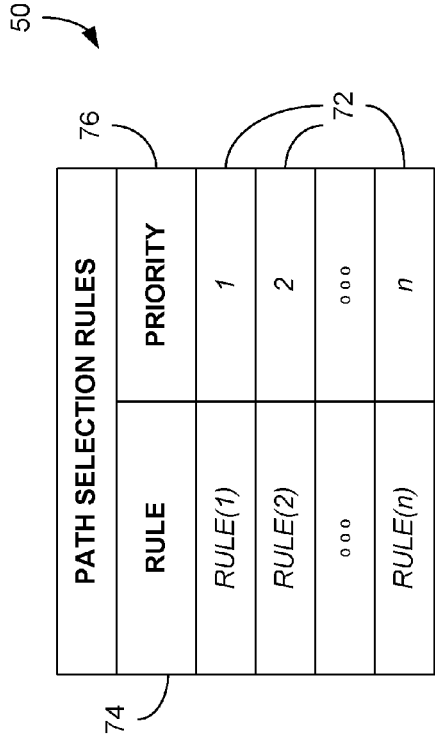


FIG. 5

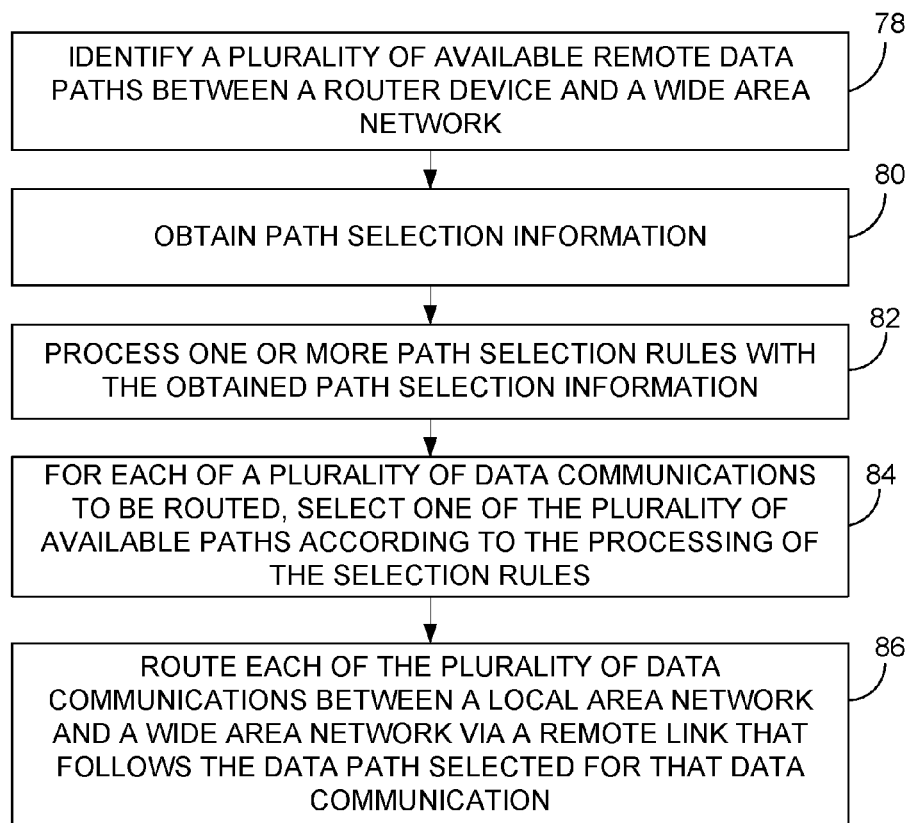


FIG. 6

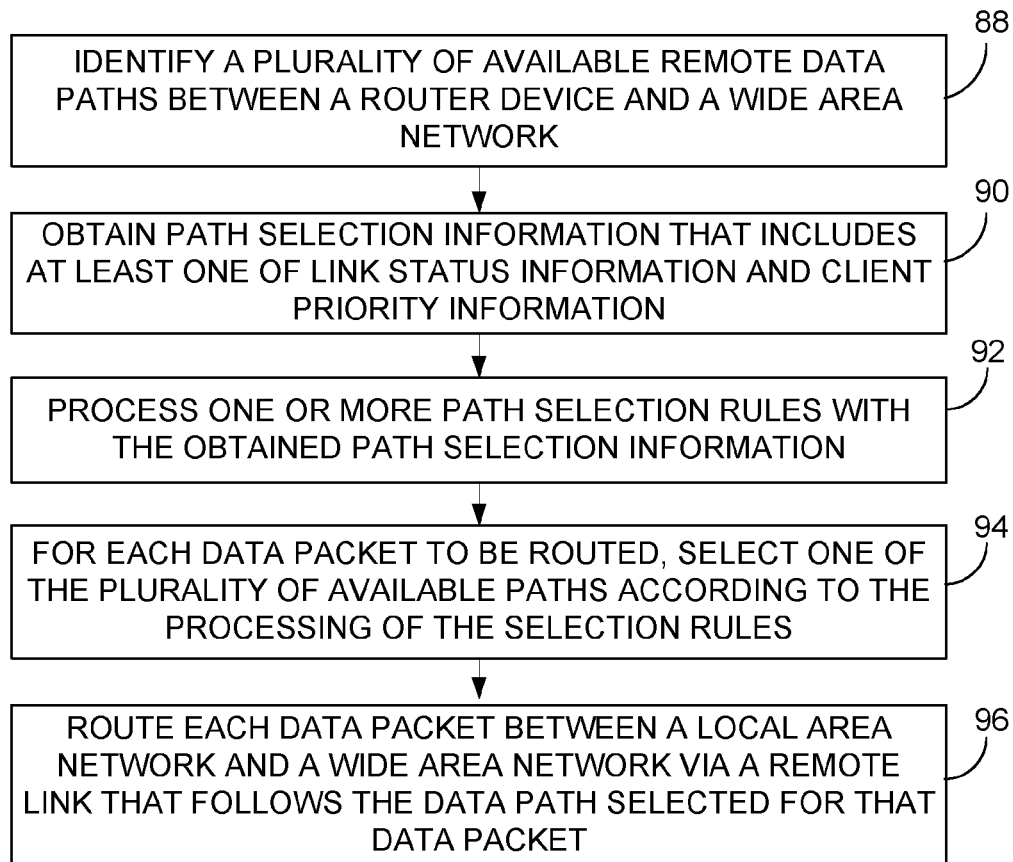


FIG. 7

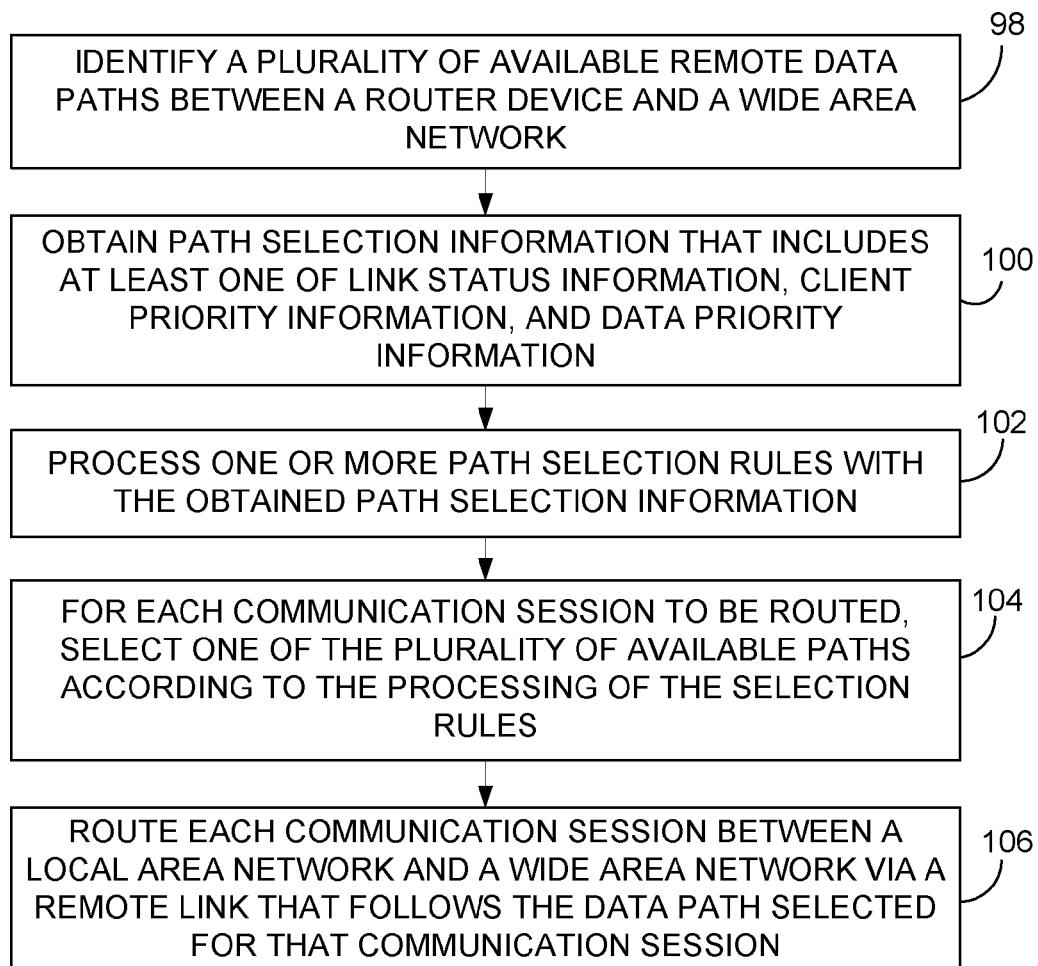


FIG. 8

DATA PATH SWITCHING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation application of U.S. patent application Ser. No. 12/350,460 filed Jan. 8, 2009 and entitled “Data Path Switching,” which is a continuation in part of U.S. patent application Ser. No. 10/936,124 filed Sep. 8, 2004 and entitled “Device Cradle,” which issued as U.S. Pat. No. 7,764,784, and claims the priority of provisional applications 61/019,875 entitled “Packet Based QoS Through Multiple Simultaneous WAN Connections” filed Jan. 9, 2008 and 61/019,876 entitled “Session Based QoS Through Multiple Simultaneous WAN Connections” filed Jan. 9, 2008, the disclosures of which are hereby incorporated by reference in their entireties.

BACKGROUND

[0002] Routers allow client devices in a local area network (LAN) to access a wide area network (WAN). Often, a router connects to the WAN via a data exchanger such as a data enabled cellular device, a DSL modem, or a cable modem. A given router may be equipped to simultaneously connect to multiple data exchangers. Each data exchanger is equipped to establish a data link with one or more service providers over which the router device can route data communications. Thus, at any given point a router device may be presented with multiple available data paths for accessing a WAN. The router device, unfortunately, is not capable of dynamically switching data paths for data communications being routed between one or more clients on a local area network and one or more servers on a wide area network.

DESCRIPTION OF THE DRAWINGS

[0003] FIG. 1 illustrates an exemplary environment in which embodiments of the present invention can be implemented.

[0004] FIGS. 2-5 are block diagrams showing physical and logical components of a Router according to an embodiment of the present invention.

[0005] FIGS. 6-8 are exemplary flow diagrams illustrating steps taken in performance of various embodiments of the present invention.

DETAILED DESCRIPTION

[0006] INTRODUCTION: Various embodiments described below operate to automatically select a data path for routing data communications between a router device and a wide area network (WAN) such as the internet. A given router device may be presented with multiple available paths for establishing data links with a various service providers. That router device can automatically select one of those available paths based on objective criteria such as data transfer costs and speeds and client priority. In particular, various embodiments described herein operate to route each data packet or each communication session via a data path selected for that packet or session.

[0007] ENVIRONMENT: FIG. 1 illustrates exemplary environment 1 in which various embodiments of the present invention may be implemented. Environment 1 includes router device 10 and clients 12, 14, and 16 and local link 18. Clients 12, 14, and 16 represent generally any computing

devices capable of communicating with router device 10. Router device 10, discussed in more detail later, represents generally a device capable of connecting to clients 12, 14, and 16 and performing one or more tasks as guided by a connected client.

[0008] Local link 18 interconnects router device 10 and clients 12, 14, 16. Local link 18 represents generally a cable, wireless, or remote link via a telecommunication link, an infrared link, a radio frequency link, or any other connector or system that provides electronic communication between devices 10, 12, 14, and 16. The path followed by link 18 between devices 10, 12, 14, and 16 in the schematic view of FIG. 1 represents the logical communication path between these devices, not necessarily the physical path between the devices. Devices 10, 12, 14, and 16 can be connected at any point and the appropriate communication path established logically between the devices.

[0009] Environment 1 also includes data exchangers 20A, 20B and service providers 22. Each data exchanger 20A, 20B represents generally any combination of hardware and programming that can be utilized by router device 10 to connect to a wide area network (WAN) such as the internet. A given data exchanger 20A, 20B may, for example, take the form of a data capable cellular device such as a cell phone or card adapter, a DSL modem, a cable modem, or even a dial-up modem.

[0010] Service providers 22 represent generally infrastructure configured to provide internet related data services to subscribers such as an owner of data exchangers 20A, 20B. For example, where a given data exchanger 20A, 20B is a data enabled cellular telephone or card adapter, a corresponding service providers 22 may be a cellular telephone service provider capable of providing voice and data services to subscribers allowing access to internet 26. Where a given data exchanger 22A, 22B is a DSL or cable modem, a corresponding service providers 22 may include a more traditional internet service provider (ISP) providing data access to internet 26.

[0011] Remote links 24A, 24B, 24C are each a data link that interconnects a given data exchanger 20A, 20B and service provider 22. Each remote link 24A, 24B, 24C represents generally any combination of a cable, wireless, or remote connection via a telecommunication link, an infrared link, a radio frequency link, or any other connectors or systems that provides electronic communication between data exchanger 20 and service providers 22.

[0012] In the embodiment illustrated in environment 1, device links 28A, 28B interconnect router device 10 and data exchangers 20A, 20B. Each device link 28A, 28B represents generally any combination of a cable, wireless, or remote connection via a telecommunication link, an infrared link, a radio frequency link, or any other connector or system that provides electronic communication between devices 10 and 20. As examples, device link 28 may incorporate a physical USB cable or radio waves carrying communications of any one of a number of protocols such as Bluetooth.

[0013] It is noted that one or both data exchangers 20A, 20B may be fully integrated into router device 10 or may be cards, dongles, or the like that plug into router device 10. Thus one or both device links 28A, 28B may include internal connections within router device 10. While FIG. 1 illustrates the existence of two data exchangers 20A, 20B, router device 10 may be configured to utilize any number of data exchangers.

[0014] ROUTER DEVICE: FIG. 2 is a block diagram illustrating physical and logical components of router device 10. In this example, router device 10 represents generally any combination of hardware and programming capable routing network communications between clients on the local network and between the clients and a wide area network such as the internet via a selected one of a plurality of data exchangers. In the example of FIG. 3 router device 10 includes client interface 30 and data exchanger interfaces 32. Client interface 30 represents generally any combination of hardware and program instructions capable of supplying a communication interface between router device 10 and clients 12, 14, and 16 shown in FIG. 1. Data exchanger interfaces 32 each represent any combination of hardware and programming enabling data to be communicated between router device 10 and a data exchanger such as data exchanger 20A or 20B in FIG. 1.

[0015] Client interface 30 is shown to include wired interface 34 and wireless interface 36. Wired interface 34 represents generally any interface through which communications can pass between router device 10 and clients 12, 14, and 16 via one or more physical wires. Wired interface 34 may include one or more serial or parallel ports including but not limited to USB and FireWire ports. Wireless interface 36 represents generally any interface through which information can be exchanged between router device 10 and clients 12, 14, and 16 via a wireless protocol such as ultrawideband (UWB), Bluetooth, or 802.11.

[0016] Router device 10 also includes connector 38, router 40, remote link manager 42, and web server 44, and memory 46. Connector 38 represents generally any combination of hardware and programming configured to send signals for controlling data exchangers of various types. In the example of FIG. 1, router device 10 utilizes data exchangers 20A and 20B. Data exchangers 20A and 20B may be from different manufactures and may be designed to interact with different data service providers. Thus, connector 38 utilizes different signals for each data exchanger 20A and 20B to achieve the same result. Connector 38 is responsible sending appropriate signals to cause a selected data exchanger to perform a particular task. Such tasks can include establishing a remote link with a data service provider so that access can be made to a wide area network such as internet 26. Other tasks include sending signals to poll a data exchanger for link status information identifying a state of the remote link between the data exchanger and a wide area network.

[0017] Where the remote link between a given data exchanger and a corresponding data service provider is wireless, the link status information can identify a signal strength of the remote link and a data transfer rate of the remote link. For a data enabled cellular device, the signal strength is a function of the proximity of the data exchanger and a cell tower or other transceiver with which the data exchanger communicates. Improved signal strength can allow for improved data transfer rates.

[0018] Router 40 represents generally any combination of hardware and programming for routing network communication received through client interface 30 to be transmitted by a selected data exchanger to a wide area network such as internet 26. Router 40 is also responsible for routing inbound network communications received from a wide area network and directed via client interface 30 to a specified client 12, 14, or 16. Outbound and inbound network communications, for example can be an IP (internet Protocol) packets directed

to a target on a wide area network or to a particular network device 12, 14, or 16 on a local area network.

[0019] Remote link manager 42, discussed in more detail below with respect to FIGS. 3-5, represents generally any combination of hardware and programming capable of automatically selecting one of a plurality of available data paths over which a router 40 routes data communications to a wide area network. An available data path, as used herein, represents a possible communication path between a data exchanger and a data service provider for that data exchanger. In other words, an available data path represents an existing or possible remote link between a data exchanger and a corresponding data service provider. Remote link manager 42 is then responsible for causing router 40 to route data communications over a remote link between a given data exchanger and a corresponding data service provider where that remote link follows the selected data path. In the example of FIG. 1, router device 10 has three available data paths for routing data communications to a wide area network. Remote link 24C follows one available data path, remote link 24B follows a second, and remote link 24A follows a third.

[0020] Web server 44 represents generally any combination of hardware and programming capable of serving interfaces such as web pages to clients 12, 14, and 16. Such web pages may include web pages that when displayed by a network device allows a user to provide or otherwise select settings related to the operation of router device 10.

[0021] Memory 46 represents generally one or more computer readable mediums capable of storing data that is accessible to remote link manager 42. As shown memory 46 includes path selection data 48 and connection rules 52. Path selection data 48, described in more detail below with respect to FIG. 4, represents generally a database of objective information that can be used to determine which of a plurality of available data paths is to be used to route a data communication. As noted that data communication may be a data packet or a communication session.

[0022] Path selection rules 50, discussed in more detail below with respect to FIG. 5, represent generally a collection of data representing rules that when processed with path selection data can be used to select a data path. Data communications can then be communicated via a remote link that follows that selected data path. For example, one selection rule may indicate that the fastest available data path is to be selected. The fastest available data path can be identified by processing or examining path selection data 48. Another rule may indicate that the cheapest available data path is to be selected, while another may indicate that the most secure is to be selected. As circumstances cause path selection data to change, new data paths may be selected from time to time. As an example, the signal strength of a remote link following an initially selected data path may fall below an acceptable level as defined by a selection rule. As a result, a different available data path is selected. That newly selected data path would correspond to a remote link with a stronger signal strength.

[0023] FIG. 3 is a block diagram illustrating physical and logical components of remote link manager 42. In this example, remote link manager 44 is shown to include state engine 52 and path selector 54. State engine 52 represents generally any combination of hardware and programming configured to obtain and report path selection data. Path selector 54 represents generally any combination of hard-

ware and programming configured to identify available data paths and to process path selection rules 50 with path selection data. Path selector 54 then selects one of a plurality of available data paths according to the processing of the path selection rules. As stated above, an available data path represents an existing or possible remote link between a data exchanger and a corresponding data service provider.

[0024] As discussed below, path selection data 48 includes, among other data, link status information obtained and reported by state engine 52. The link status information identifies the status of remote links established or capable of being established between one or more data service providers and one or more data exchangers coupled to router device 10. The link status information can include data identifying past and present data transfer rates, signal strength, security capabilities, data transfer costs, and user account data.

[0025] To collect the link status information, state engine 52 is configured to utilize connector 38 to poll data exchangers coupled to router device 10 for information concerning data transfer rates and signal strengths. State engine 52 may also communicate via an established remote link with one or more data service providers to obtain user account data. Such data can include user account information regarding data transfer rates and limits. For example, a user may be entitled to transfer a certain amount of data in a billing period. Additional transfers during that period are charged at a per megabyte rate. In such an example, state engine 52 may obtain data identifying the amount of data already transferred in a given period as well as data identifying any per megabyte costs.

[0026] State engine 52 may report collected link status information directly to and at the request of path selector 54. State engine 52 may also report collected link status information by updating path selection data 48. Path selector 54 may then acquire link status information directly from state manager 52 or by parsing path selection data 48. In operation, state engine 54 and path selector 54 may perform their respective tasks on a timed schedule. Alternatively, state engine 52 may continually collect and report link status information allowing path selector 54 continually to select an available data path based on the instantaneous state of the link status information included in path selection data 48.

[0027] FIG. 4 is a block diagram depicting an exemplary implementation of path selection data 48. In this example, path selection data 48 includes link status information 55 taking the form of a database of entries 56. Each entry 56 corresponds to a data path that can be followed to establish a remote link between a data service provider and a data exchanger coupled to router device 10. Each entry 56 includes data in a number of fields 58-66. The link ID field of a given entry 56 contains data identifying a particular data path. Transfer rate field 60 of each entry 56 contains data identifying a data transfer rate or rates. The data transfer rate may be an instantaneous and/or average data transfer rate obtained and reported by state engine 52. Signal strength field 62 of each entry 56 contains data identifying a signal strength or strengths. The signal strength may be an instantaneous and/or average signal strength obtained and reported by state engine 52.

[0028] Security field 64 of each entry 56 contains data identifying security information. Such security information may identify one or more blocked ports the identity of which was obtained and reported by state engine 52. Cost field 66

of each entry 56 contains data corresponding to the cost of transferring data. For example, such data could include information for determining a per megabyte cost for transferring data. In a given implementation, there may be no additional cost for transferring up to a certain volume of data during a given period of time. Any volume over that limit may be charged at a per megabyte rate. Thus, information in cost field 66 may include a running count of the volume of data transferred in a given period, a volume limit for that period, and a per megabyte rate when that limit is exceeded.

[0029] Path selection data 48 is also shown to include client priority information 68 and data priority information 70. Client priority information 68 represents data identifying a hierarchy among the client devices utilizing router device 10. For example, a client device having the highest priority may be entitled to route data communications along the data path supplying the greatest bandwidth. Data priority information 70 represents data identifying a hierarchy among various types of data communications. In a given example, data communications can fall into two categories—those that rely on real-time data exchanges and those that do not. Data communications for transferring files typically do not rely on real time data exchanges while data communications for video gaming and audio/video interaction do. Thus, those data communications that rely on real-time exchanges are given higher priority and provided access to data paths supplying higher bandwidths.

[0030] Path selector 54 can then parse path selection data 48 to identify link status information for an available data path as well as client priority information and data priority information. Remember, an available data path represents a remote link that has or can be established between a data service provider and a data exchanger coupled to router device 10. The link status information can include current and average data transfer rates and current and average signal strengths for each of the available data paths. The link status information can also include, for each available data path, data identifying security and cost considerations. The client priority information identifies a hierarchy among those client devices that are currently utilizing router device 10. The data priority information identifies a hierarchy among data communication types currently being routed.

[0031] It is also noted that path selector 54 may communicate directly with state engine 52 requesting the link status information. In response to the request, state engine 52, as described above, may obtain the link status information for path selector by polling data exchangers coupled to router device and/or communication with one or more data service providers via an established remote link.

[0032] FIG. 5 is a block diagram depicting an exemplary implementation of path selection rules 50 taking the form of a database of entries 72. Each entry 72 includes data in fields 74-76. Rule field 74 of each entry 72 includes data identifying a rule used by path selector 54 to select an available data path. Data in priority field 76 of each entry 72 contains information identifying a priority of the rule identified by that entry 72 with respect to the rules identified by other entries 72. For example, it may be most important that an available data path having security settings that allow the transfer of data of a particular type be selected. For example, certain available data paths might not be compatible with peer to peer file sharing. Thus, such a rule would have first priority. Assuming that the link status information found in path selection data 48 reveals more than one available data

path that can be used to transfer the data, a secondary rule may require the selection of an available data path resulting in the lowest cost for transferring the data. The lowest cost available data path to be selected. Assuming that the link status information found in path selection data 48 reveals more than one available data path that can be used to transfer the data at the lowest cost, a third level rule may require the selection of an available data path having the best signal strength or transfer rate. A fourth level rule may require that the data path providing the greatest transfer rate or bandwidth be allocated to data communications of a high priority communications type or received from a high priority client device.

[0033] Thus, path selector 54 can process path selection rules 50 with link status information, client priority information, and data priority information found in path selection data 48 to select an available data path for routing a data communication. That data communication may be a data packet or a communication session. Router 40 can then route the data communication between a local area network and a wide area network via a data exchanger and a remote link that follows the selected data path. If such a remote link is not currently established, path selector 54 can utilize connector 40 to cause a corresponding data exchanger to establish that remote link. In doing so, path selector 54 may also utilize connector 40 to close any other remote links previously being used.

[0034] In a given example, data communications determined to originate from a high priority client device or determined to be of a high priority data communication type are routed via a remote link that supplies the highest bandwidth. Those data communications may be communication sessions. Thus, a communications session that, at a given point in time, is of a highest priority data type or that is received from high priority client device is routed via the remote link that provides the highest bandwidth at that time. Data communications to be routed may also be a data packet such that a first data packet or group of packets routed from a client device can follow one data path while a subsequent data packet or packets may follow another data path as conditions change.

[0035] In other examples, factors such as cost and security considerations may be taken into account when routing data communications of any form. The path selection rules may, as indicated above, cause the selection of the data path providing the greatest bandwidth. However, when cost or security becomes a factor, those rules may dictate that a slower data path be selected.

[0036] OPERATION: The operation of embodiments of the present invention will now be described with reference to FIGS. 6-8. FIG. 6 is an exemplary flow diagram that depicts actions taken to select one of a plurality of available data paths to route each or a plurality of data communications. Starting with FIG. 6, a plurality of available data paths are identified (step 78). In the Example of FIGS. 2-5, path selector 54 may accomplish step 78 by utilizing connector 38 to communicate with the data exchangers coupled to router device 10 via data exchanger interfaces 32. In doing so, those data exchangers return information identifying the available data paths. Alternatively, path selection data 48 may include an entry 56 for a number of data paths, not all of which are available at a given point in time. For example, a particular data exchanger may be disconnected from router device 10 and later reconnected. When disconnected, a data

path supplied by that data exchanger would not be available. Thus, state engine 52 may maintain path selection data 48 so that each entry 56 includes a flag or other indicator reflecting that a given data path is an available or an unavailable data path. Path selector 54 could then parse path selection data 48 to identify the available data paths.

[0037] Path selection data is then obtained (step 80). In the example of FIGS. 2-5, path selection data is shown to include link status information, client priority information and data priority information. To implement step 80, state engine 52 may, periodically or on-demand, poll data exchangers coupled to router device 10 via data exchanger interfaces 32 for the link status information. State engine 52 may then report that information directly to path selector 54 or it may utilize that information to update path selection data 48. In the later case, path selector 54 would then parse path selection data 48 for the link status information as well as the client and data priority information.

[0038] One or more path selection rules are then processed with the obtained path selection data (step 82). For each of a plurality of data communications to be routed, one of the plurality of available data paths is selected according to the processing of the path selection rules (step 84). In the example of FIGS. 2-5, path selector 54 accesses and processes path selection rules with the path selection data obtained in step 80. For each data communication, path selector 54 then selects a particular data path based on the processing of the path selection rules. For example, the path selection rules may dictate that the security settings of a selected data path allow the transfer of data of a given type, that the cost of transfer be as low as possible, and the transfer rate be as great as possible based upon client and data priority information for a given data communication. By processing such rules with the path selection data, path selector 54 can identify and select a qualified one of the available data paths for each of the plurality of data communications.

[0039] Each of the plurality of data communications is then routed between a local area network and a wide area network via the remote link that follows the data path selected for that data communication (step 86). The flow diagram of FIG. 6 is generic with respect to the nature of the data communications to be routed. FIG. 7 presumes that each data communication is a data packet, while FIG. 8 presumes that each data communication is a communication session.

[0040] Moving to FIG. 7, a plurality of available data paths are identified (step 88). In the Example of FIGS. 2-5, path selector 54 may accomplish step 88 by utilizing connector 38 to communicate with the data exchangers coupled to router device 10 via data exchanger interfaces 32. In doing so, those data exchangers return information identifying the available data paths. Alternatively, path selection data 48 may include an entry 56 for a number of data paths, not all of which are available at a given point in time. For example, a particular data exchanger may be disconnected from router device 10 and later reconnected. When disconnected, a data path supplied by that data exchanger would not be available. Thus, state engine 52 may maintain path selection data 48 so that each entry 56 includes a flag or other indicator reflecting that a given data path is an available or an unavailable data path. Path selector 54 could then parse path selection data 48 to identify the available data paths.

[0041] Path selection data is then obtained (step 90). That path selection data includes at least one of link status information and client priority information. In the examples of FIGS. 2-5, state engine 52 may, periodically or on-demand, poll data exchangers coupled to router device 10 via data exchanger interfaces 32 for the link status information. State engine 52 may then report that information directly to path selector 54 or it may utilize that information to update path selection data 48. In the later case, path selector 54 would then parse path selection data 48 for the link status information as well as the client priority information.

[0042] One or more path selection rules are then processed with the obtained path selection data (step 92). For each of a plurality of data packets to be routed, one of the plurality of available data paths is selected according to the processing of the path selection rules (step 94). In the example of FIGS. 2-5, path selector 54 accesses and processes path selection rules with the path selection data obtained in step 80. For each data packet, path selector 54 then selects a particular data path based on the processing of the path selection rules. For example, the path selection rules may dictate that the security settings of a selected data path allow the transfer of data of a given type, that the cost of transfer be as low as possible, and the transfer rate be as great as possible based upon client priority information for a given data packet. By processing such rules with the path selection data, path selector 54 can identify and select a qualified one of the available data paths for each of the plurality of data packets.

[0043] Each of the plurality of data packets is then routed between a local area network and a wide area network via the remote link that follows the data path selected for that data packet (step 96). Thus in a particular implementation, each data packet to be routed can be routed via a remote link identified to have the greatest bandwidth at a given time. In another implementation, data packets for a high priority client device can be routed via a remote link having the highest bandwidth at a given time while data packets for a lower priority client device can be routed via another remote link having a lower bandwidth at that time.

[0044] In yet another implementation step 94 involves selecting the first data path for a first subset of the plurality of data packets to be routed and selecting the second data path for a second subset of the plurality of data packets to be routed. The ratio of a number of the data packets in the first subset compared to a number of the data packets in the second subset is determined according to the processing of the path selection rules in step 92. In step 94, the each data packet of the first subset is routed between the local area network and the wide area network via the data exchanger and a first remote link that follows the first data path. Each data packet of the second subset is routed between the local area network and the wide area network via the data exchanger and a second remote link that follows the second data path.

[0045] In another example, step 94 involves selecting a first data path for a first subset of the plurality of data packets and a second subset of the plurality of data packets as well as selecting a second data path for a third subset of the plurality of data packets and a fourth subset of the plurality of data packets. In this example, data packets in the first and third subsets originated from a first client device and data packets in the second and fourth subsets originated from the

second client device. A first ratio of a number of the data packets in the first subset compared to a number of the data packets in the second subset and a second ratio of a number of the data packets in the third subset compared to a number of the data packets in the fourth subset are determined according to the processing of the path selection rules in step 92. Each data packet of the first and second subsets is routed between the local area network and the wide area network via the data exchanger and a first remote link that follows the first data path. Each of data packet of the third and fourth subsets between the local area network and the wide area network via the data exchanger and a second remote link that follows the second data path.

[0046] FIG. 8 presumes that each data communication to be routed is a communication session. Initially, a plurality of available data paths are identified (step 98). In the Example of FIGS. 2-5, path selector 54 may accomplish step 98 by utilizing connector 38 to communicate with the data exchangers coupled to router device 10 via data exchanger interfaces 32. In doing so, those data exchangers return information identifying the available data paths. Alternatively, path selection data 48 may include an entry 56 for a number of data paths, not all of which are available at a given point in time. For example, a particular data exchanger may be disconnected from router device 10 and later reconnected. When disconnected, a data path supplied by that data exchanger would not be available. Thus, state engine 52 may maintain path selection data 48 so that each entry 56 includes a flag or other indicator reflecting that a given data path is an available or an unavailable data path. Path selector 54 could then parse path selection data 48 to identify the available data paths.

[0047] Path selection data is then obtained (step 100). That path selection data includes at least one of link status information and client priority information, and data priority information. In the examples of FIGS. 2-5, state engine 52 may, periodically or on-demand, poll data exchangers coupled to router device 10 via data exchanger interfaces 32 for the link status information. State engine 52 may then report that information directly to path selector 54 or it may utilize that information to update path selection data 48. In the later case, path selector 54 would then parse path selection data 48 for the link status information as well as the client priority information.

[0048] One or more path selection rules are then processed with the obtained path selection data (step 102). For each of a plurality of communication sessions to be routed, one of the plurality of available data paths is selected according to the processing of the path selection rules (step 104). In the example of FIGS. 2-5, path selector 54 accesses and processes path selection rules with the path selection data obtained in step 80. For each communication session, path selector 54 then selects a particular data path based on the processing of the path selection rules. For example, the path selection rules may dictate that the security settings of a selected data path allow the transfer of data of a given type, that the cost of transfer be as low as possible, and the transfer rate be as great as possible based upon client and data priority information for a given communication session. By processing such rules with the path selection data, path selector 54 can identify and select a qualified one of the available data paths for each of the plurality of communication sessions.

[0049] Each of the plurality of communication sessions is then routed between a local area network and a wide area network via the remote link that follows the data path selected for that communication session (step 106). Thus in a particular implementation, each communication session to be routed can be routed via a remote link identified to have the greatest bandwidth at a given time. In another implementation, a communication session of a high priority data communication type or for a high priority client device or can be routed via a remote link having the highest bandwidth at a given time. A communication session of a lower priority data communication type or for a lower priority client device can be routed via another remote link having a lower bandwidth at that same time.

[0050] In a particular example, the path selection data includes data priority information for data of a first type and data of a second type and link status information for a first data path and a second data path. Step 104 involves selecting, according to the processing of the path selection rules, the first data path for a first communication session of data of the first type and selecting the second data path for a second communication session of data of the second type. Step 106 involves routing the first communication session between the local area network and the wide area network via the data exchanger and a first remote link that follows the first data path and routing the second communication session between the local area network and the wide area network via the data exchanger and a second remote link that follows the second data path.

[0051] CONCLUSION: The schematic diagram of FIG. 1 illustrates an exemplary environment in which embodiments of the present invention may be implemented. Implementation, however, is not limited to this environment. The diagrams of FIGS. 2-5 show the architecture, functionality, and operation of various embodiments of the present invention. A number of the blocks are defined as programs. Each of those blocks may represent in whole or in part a module, segment, or portion of code that comprises one or more executable instructions to implement the specified logical function(s). Each block may also represent in whole or in part a circuit or a number of interconnected circuits to implement the specified logical function(s).

[0052] Also, the present invention can be embodied in any computer-readable media for use by or in connection with an instruction execution system such as a computer/processor based system or an ASIC (Application Specific Integrated Circuit) or other system that can fetch or obtain the logic from computer-readable media and execute the instructions contained therein. "Computer-readable media" can be any media that can contain, store, or maintain programs and data for use by or in connection with the instruction execution system. Computer readable media can comprise any one of many physical media such as, for example, electronic, magnetic, optical, electromagnetic, or semiconductor media. More specific examples of suitable computer-readable media include, but are not limited to, a portable magnetic computer diskette such as floppy diskettes or hard drives, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory, or a portable compact disc.

[0053] Although the flow diagrams of FIGS. 6-8 show specific orders of execution, the orders of execution may differ from that which is depicted. For example, the order of execution of two or more blocks may be scrambled relative

to the order shown. Also, two or more blocks shown in succession may be executed concurrently or with partial concurrence. All such variations are within the scope of the present invention.

[0054] The present invention has been shown and described with reference to the foregoing exemplary embodiments. It is to be understood, however, that other forms, details and embodiments may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. A method for selecting a data path, comprising:

identifying a plurality of data paths between a router device and a wide area network, the plurality of data paths including a first data path and a second data path, the first data path having a first remote link that interconnects a first service provider and a first data exchanger, the second data path having a second remote link that interconnects a second service provider and a second data exchanger, the first data exchanger and the second data exchanger each having a device link with the router device;

obtaining path selection data for each of the plurality of data paths;

receiving a plurality of data communications to the router device from at least one client through a local link, the plurality of data communications including a first data communication and a second data communication;

processing path selection rules with the path selection data;

selecting, according to the processing of path selection rules, one of the plurality of data paths for each of the plurality of data communications on an individual basis, wherein the first data path is selected for the first data communication and the second data path is selected for the second data communication; and

routing each of the plurality of data communications between the router device and the wide area network according to the selected data path for that data communication, wherein the first data communication is routed via the first remote link that follows the first data path and the second data communication is routed via the second remote link that follows the second data path.

2. The method of claim 1, wherein the first data communication is routed via the first remote link simultaneously as the second data communication is routed via the second remote link.

3. The method of claim 1, wherein the plurality of data communications includes a first subset containing the first data communication and a second subset containing the second data communication, a ratio of a number of the data communications in the first subset compared to a number of the data communications in the second subset being determined according to the processing of the path selection rules, wherein the first data path is selected for the first subset and the second data path is selected for the second subset.

4. The method of claim 1, wherein the path selection data includes communication tier information, the first data communication having a first tier and the second data communication having a second tier, the first data path being selected for data communications having the first tier and the

second data path being selecting for data communications having the second tier according to the processing of the path selection rules.

5. The method of claim 4, wherein data communications of a first type have the first tier and data communications of a second type have the second tier, the first data communication being of the first type and the second data communication being of the second type.

6. The method of claim 1, wherein the at least one client is a plurality of clients including a first client and a second client, the path selection data including client tier information for each of the plurality of clients, data communications of the plurality of data communications received to the router device from the first client having a first tier and data communications of the plurality of data communications received to the router device from the second client having a second tier, the first data communication being received from the first client and the second data communication being received from the second client, wherein the first data path is selected for data communications having the first tier and the second data path is selected for data communications having the second tier according to the processing of the path selection rules.

7. The method of claim 1, wherein at least one of the first remote link and the second remote link is a wireless remote link and the path selection data includes a signal strength of the wireless remote link.

8. The method of claim 1, wherein the path selection data includes a security setting of each of the plurality of data paths, the security setting of the first data path being different than the security setting of the second data path.

9. A non-transitory computer readable medium having instructions thereon that when executed by a router device cause the router device to implement a method, medium having instructions for:

identifying a plurality of data paths between a router device and a wide area network, the plurality of data paths including a first data path and a second data path, the first data path having a first remote link that interconnects a first service provider and a first data exchanger, the second data path having a second remote link that interconnects a second service provider and a second data exchanger, the first data exchanger and the second data exchanger each having a device link with the router device;

obtaining path selection data for each of the plurality of data paths;

receiving a plurality of data communications to the router device from at least one client through a local link, the plurality of data communications including a first data communication and a second data communication;

processing path selection rules with the path selection data;

selecting, according to the processing of path selection rules, one of the plurality of data paths for each of the plurality of data communications on an individual basis, wherein the first data path is selected for the first data communication and the second data path is selected for the second data communication; and

routing each of the plurality of data communications between the router device and the wide area network according to the selected data path for that data communication, wherein the first data communication is routed via the first remote link that follows the first data

path and the second data communication is routed via the second remote link that follows the second data path.

10. The medium of claim 9, wherein the first data communication is routed via the first remote link simultaneously as the second data communication is routed via the second remote link.

11. The medium of claim 9, wherein the plurality of data communications includes a first subset containing the first data communication and a second subset containing the second data communication, a ratio of a number of the data communications in the first subset compared to a number of the data communications in the second subset being determined according to the processing of the path selection rules, wherein the first data path is selected for the first subset and the second data path is selected for the second subset.

12. The medium of claim 9, wherein the path selection data includes communication tier information, the first data communication having a first tier and the second data communication having a second tier, the first data path being selected for data communications having the first tier and the second data path being selecting for data communications having the second tier according to the processing of the path selection rules.

13. The medium of claim 12, wherein data communications of a first type have the first tier and data communications of a second type have the second tier, the first data communication being of the first type and the second data communication being of the second type.

14. The medium of claim 9, wherein the at least one client is a plurality of clients including a first client and a second client, the path selection data including client tier information for each of the plurality of clients, data communications of the plurality of data communications received to the router device from the first client having a first tier and data communications of the plurality of data communications received to the router device from the second client having a second tier, the first data communication being received from the first client and the second data communication being received from the second client, wherein the first data path is selected for data communications having the first tier and the second data path is selected for data communications having the second tier according to the processing of the path selection rules.

15. The medium of claim 9, wherein at least one of the first remote link and the second remote link is a wireless remote link and the path selection data includes a signal strength of the wireless remote link.

16. The medium of claim 9, wherein the path selection data includes a security setting of each of the plurality of data paths, the security setting of the first data path being different than the security setting of the second data path.

17. A router device comprising:

a router having a client interface configured to provide an interface between the router and at least one client to receive a plurality of data communications from the at least one client, the plurality of data communications including a first data communication and a second data communication;

a plurality of data exchanger interfaces configured to provide an interface between the router and a plurality of data exchangers, the plurality of data exchanger interfaces including a first data exchanger interface for

a first data exchanger and a second data exchanger interface for a second data exchanger;

a remote link manager configured to identify a plurality of data paths between the router and a wide area network, the plurality of data paths including a first data path and a second data path, the first data path having a first remote link that interconnects a first service provider and the first data exchanger, the second data path having a second remote link that interconnects a second service provider and the second data exchanger;

the remote link manager being further configured to obtain path selection data for each of the plurality of data paths, process path selection rules with the obtained path selection data, and select, according to the processing of path selection rules, one of the plurality of data paths for each of the plurality of data communications on an individual basis, wherein the first data path is selected for the first data communication and the second data path is selected for the second data communication according to the processing of path selection rules; and

the router being configured to route each of the plurality of data communications between the router device and the wide area network according to the selected data path for that data communication.

18. The router device of claim **17**, wherein the first data exchanger and the second data exchanger are embedded in the router.

19. The router device of claim **17**, wherein the path selection data includes communication tier information, data communications of a first type having a first tier and data communications of a second type have a second tier, the first data communication being of the first type and the second data communication being of the second type, the first data path being selected for data communications having the first tier and the second data path being selecting for data communications having the second tier according to the processing of the path selection rules by the remote link manager.

20. The router device of claim **17**, wherein the at least one client is a plurality of clients including a first client and a second client, the path selection data including client tier information for each of the plurality of clients, data communications of the plurality of data communications received to the router from the first client having a first tier and data communications of the plurality of data communications received to the router from the second client having a second tier, the first data path being selected for data communications having the first tier and the second data path being selected for data communications having the second tier according to the processing of the path selection rules by the remote link manager.

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