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(54) METHODS AND SYSTEMS FOR SENDING PACKETS THROUGH A PLURALITY OF TUNNELS

(71) Applicant: **Pismo Labs Technology Limited**, Kowloon (HK)

(72) Inventors: **Patrick Ho Wai SUNG**, Kowloon (HK); **Kam Chiu NG**, New Territories (HK); **Wan Chun LEUNG**, New Territories (HK)

(73) Assignee: **Pismo Labs Technology Limited**, Kowloon (HK)

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(52) **U.S. Cl.**

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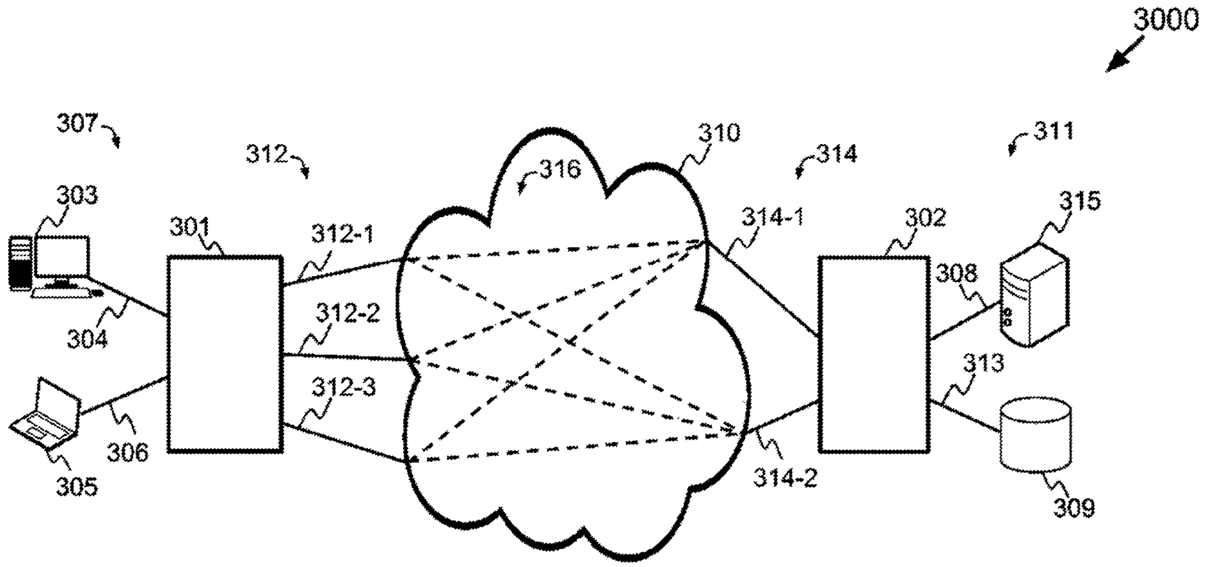
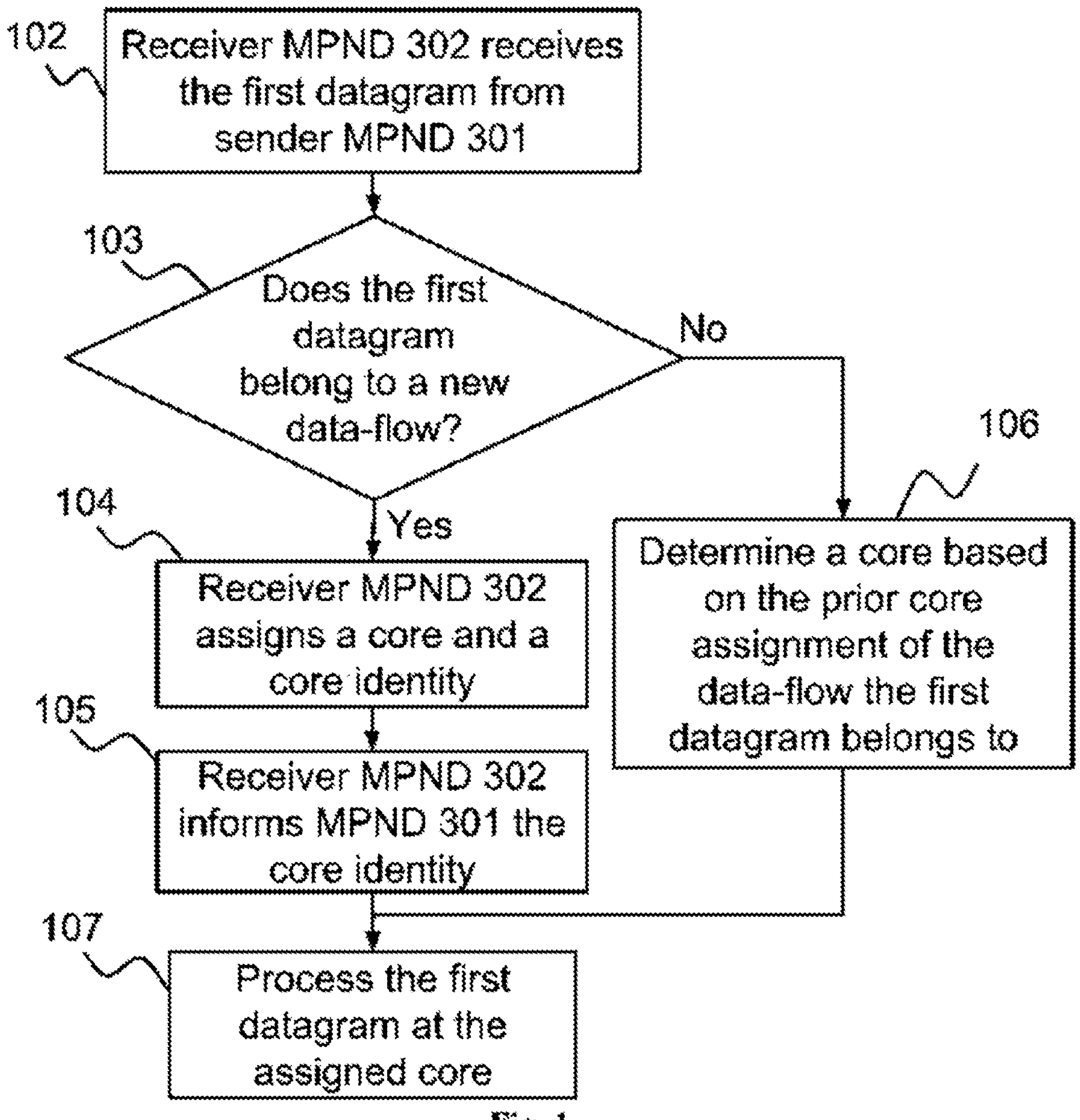
(57) **ABSTRACT**

Described in example embodiments herein are methods and systems for implementing sending packets from a first network node to a second network node. Packets belonging to the same session may be sent through the same or different tunnels. The second network node processes packets belonging to the same session using the same core. In accordance with an example embodiment, the first network node informs the second network code the core to process the packets. Optionally, selection of core at the second network node is assisted by a core identity created by the first network based on the session. The core identity may be stored in the header or payload of the packets. In an example embodiment, the second network determines the core for processing packet belonging to the same session.




102
Receiver MPND 302 receives the first datagram from sender MPND 301
103
Does the first datagram belong to a new data-flow?
No
Yes
104
Receiver MPND 302 assigns a core and a core identity
105
Receiver MPND 302 informs MPND 301 the core identity
106
Determine a core based on the prior core assignment of the data-flow the first datagram belongs to
107
Process the first datagram at the assigned core
Fig. 1

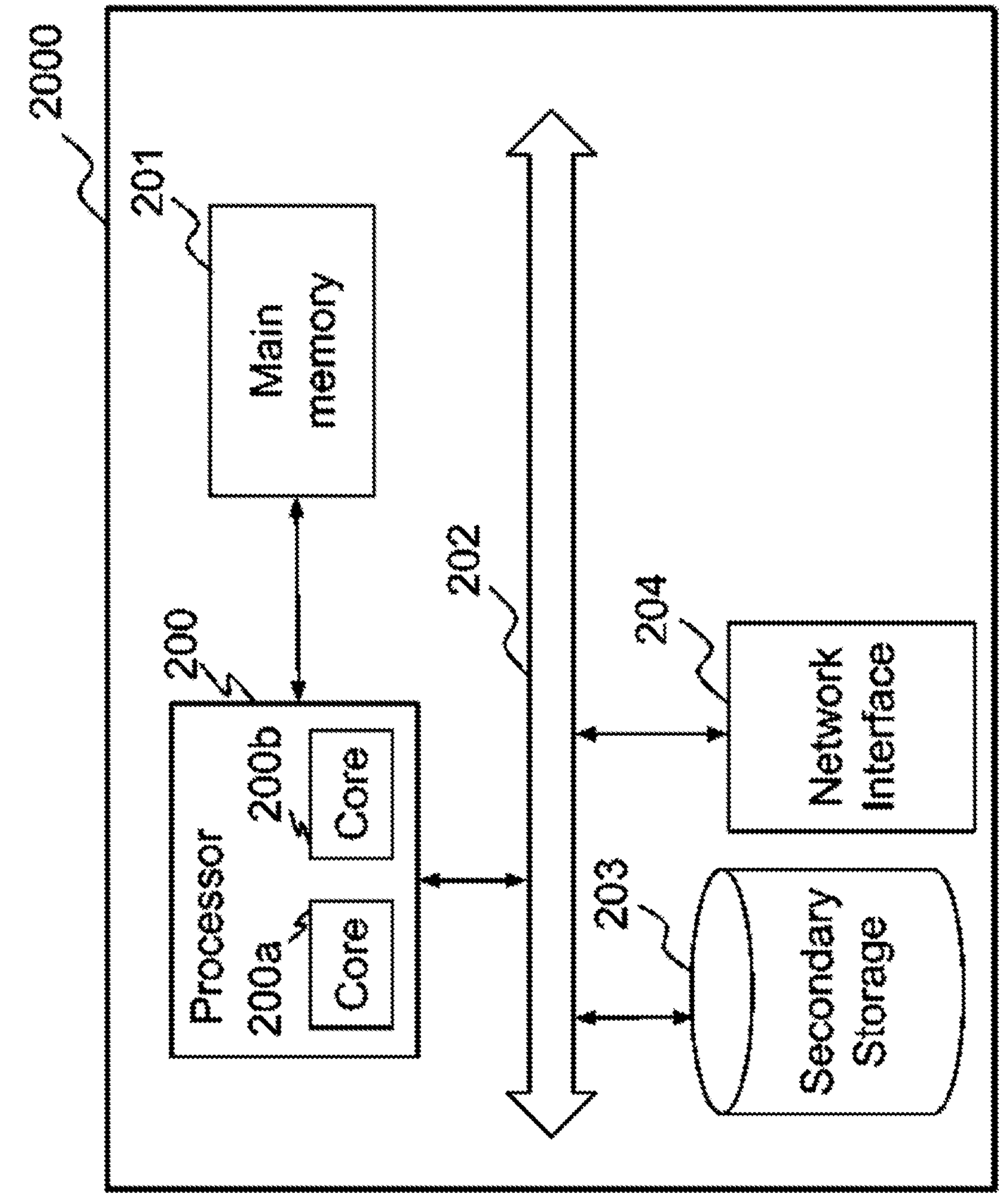

2000
201
Main memory
200
Processor
200a
Core
200b
Core
202
204
Network Interface
203
Secondary Storage

Fig. 2

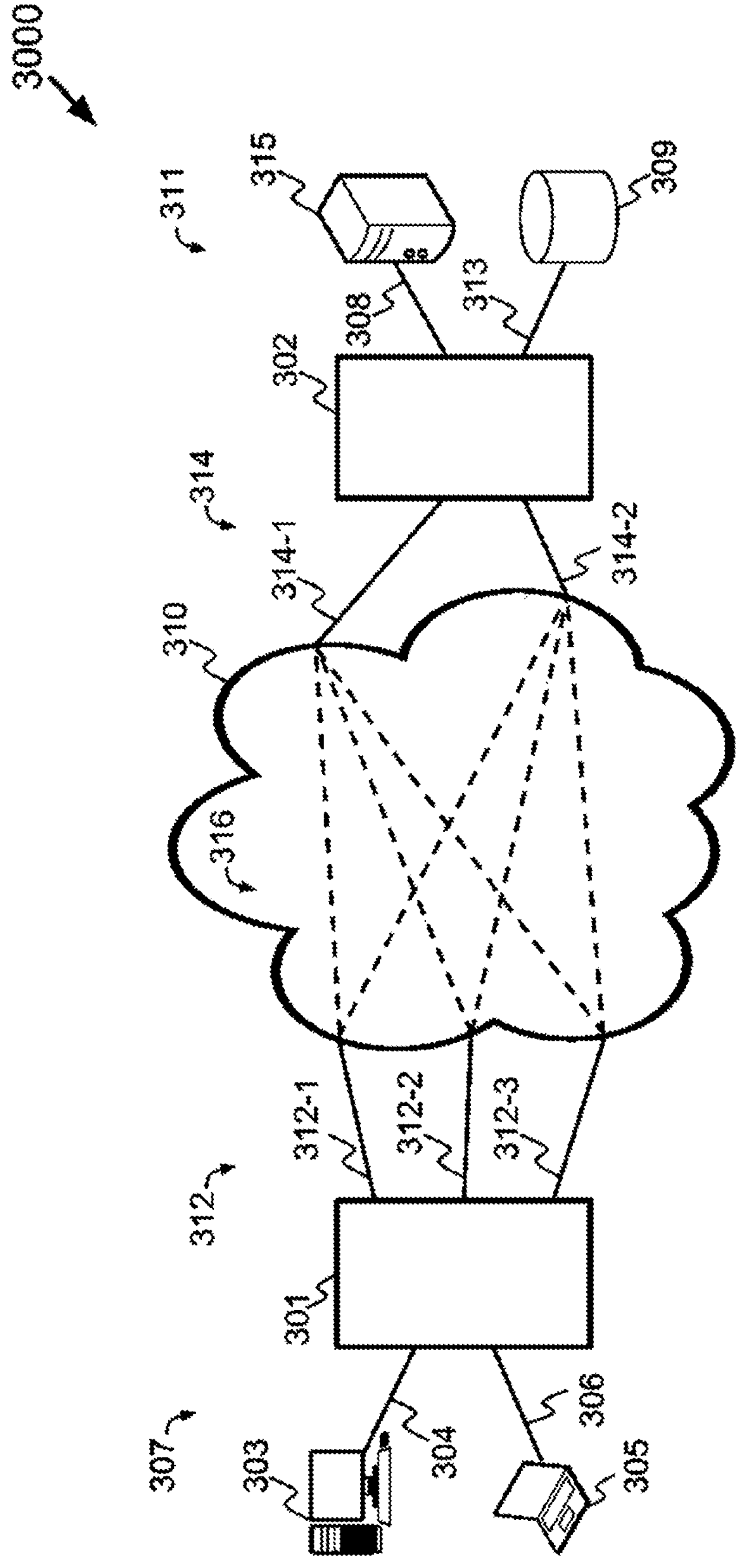

3000
311
315
309
308
313
302
314
314-1
314-2
310
316
312
312-1
312-2
312-3
301
307
303
304
306
305

Fig. 3

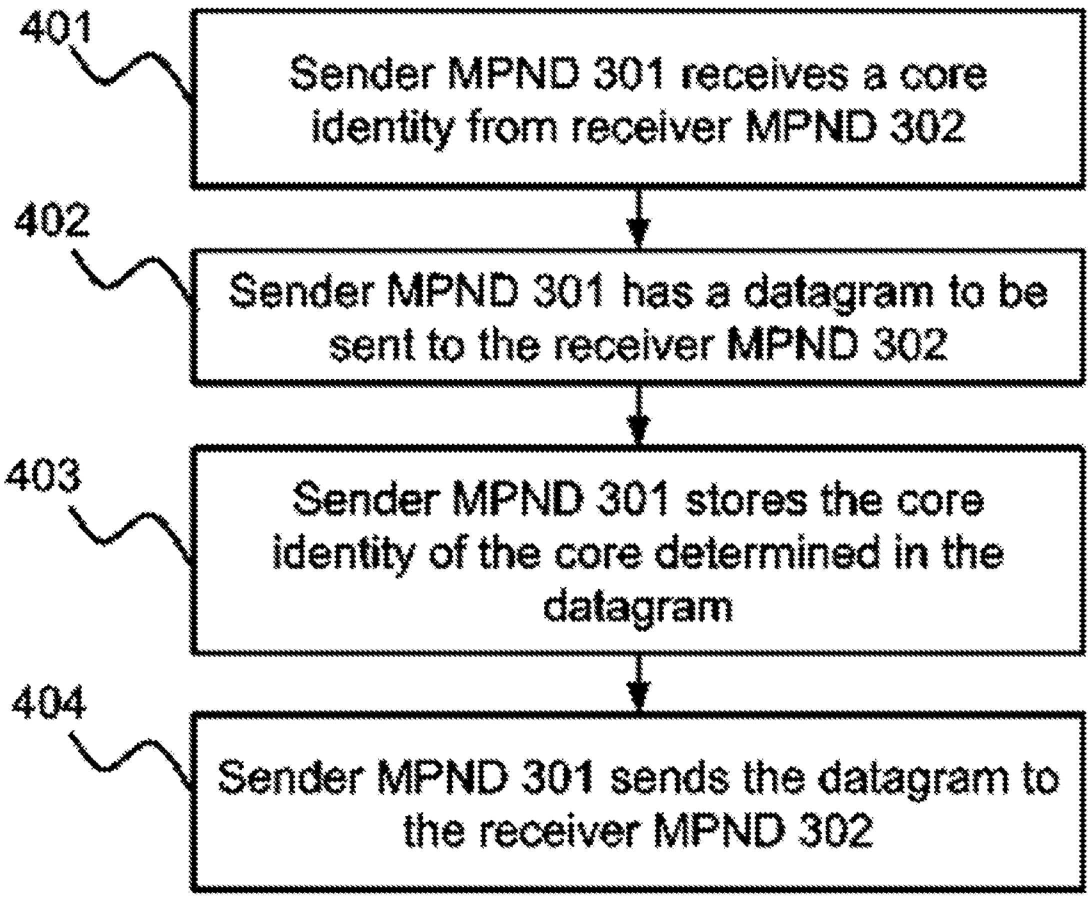

401
Sender MPND 301 receives a core identity from receiver MPND 302
402
Sender MPND 301 has a datagram to be sent to the receiver MPND 302
403
Sender MPND 301 stores the core identity of the core determined in the datagram
404
Sender MPND 301 sends the datagram to the receiver MPND 302

Fig. 4

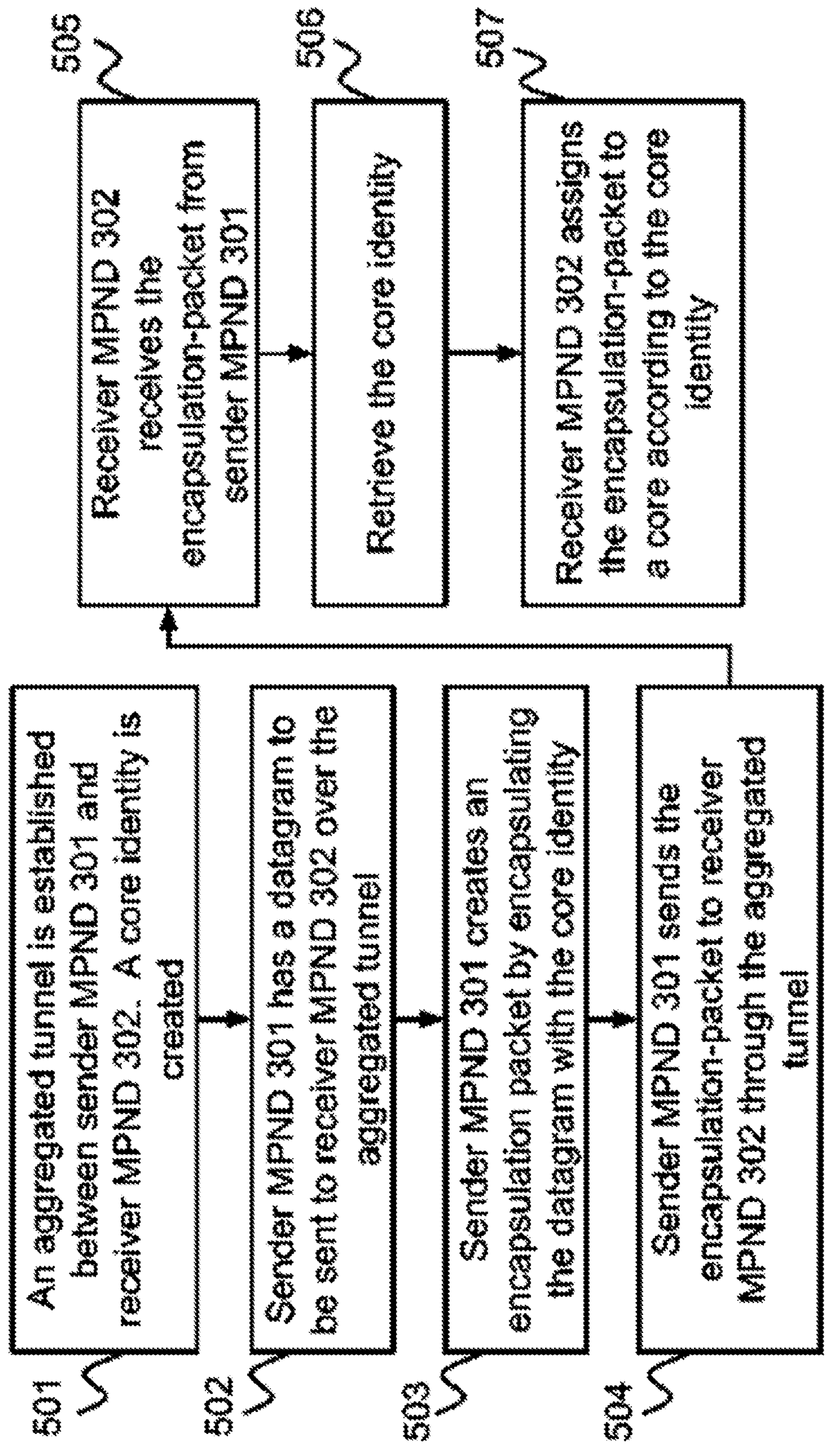

501
An aggregated tunnel is established between sender MPND 301 and receiver MPND 302. A core identity is created
502
Sender MPND 301 has a datagram to be sent to receiver MPND 302 over the aggregated tunnel
503
Sender MPND 301 creates an encapsulation packet by encapsulating the datagram with the core identity
504
Sender MPND 301 sends the encapsulation-packet to receiver MPND 302 through the aggregated tunnel
505
Receiver MPND 302 receives the encapsulation-packet from sender MPND 301
506
Retrieve the core identity
507
Receiver MPND 302 assigns the encapsulation-packet to a core according to the core identity

Fig. 5

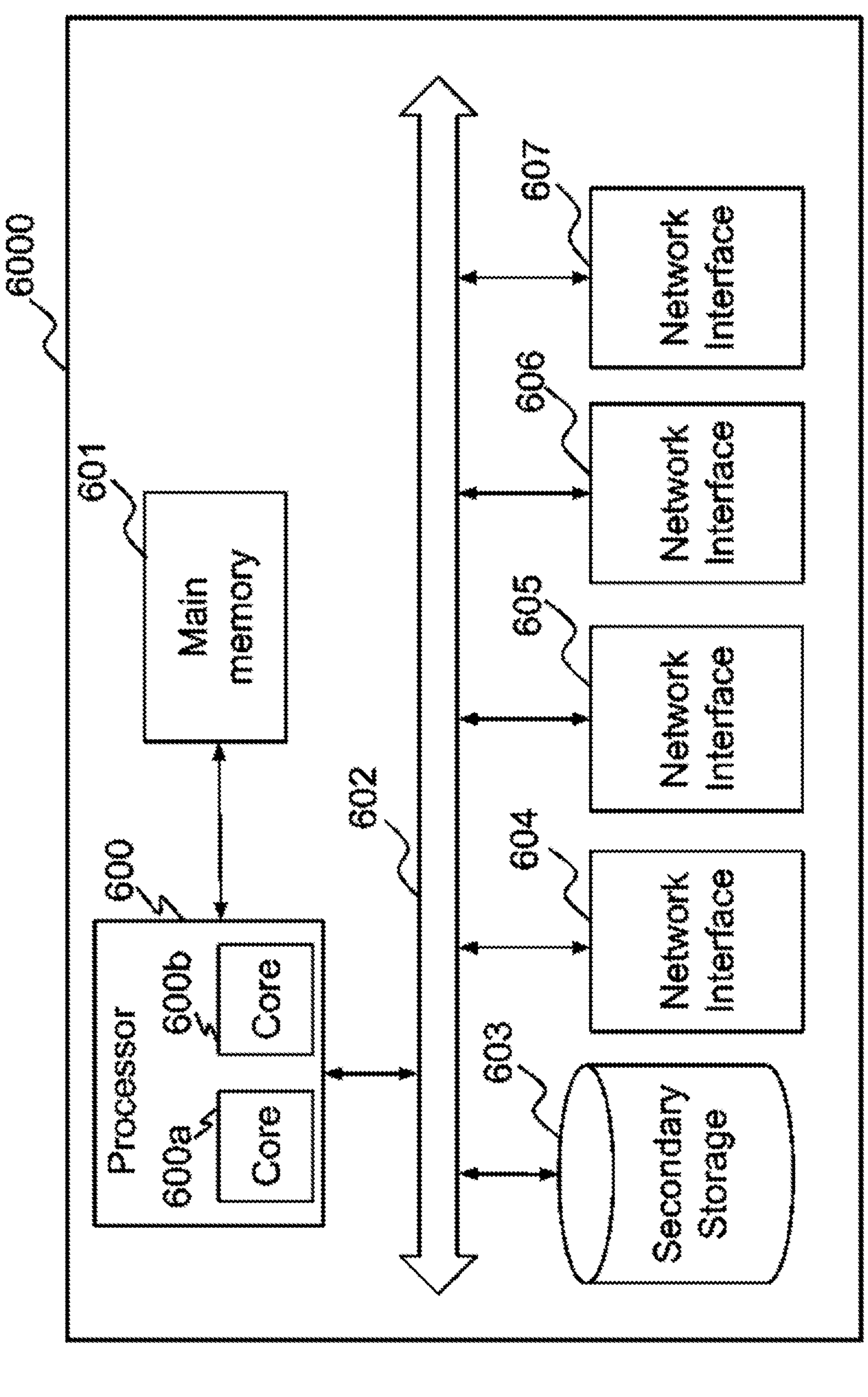

6000
601
Main memory
600
Processor
600a
Core
600b
Core
602
603
Secondary Storage
604
Network Interface
605
Network Interface
606
Network Interface
607
Network Interface

Fig. 6

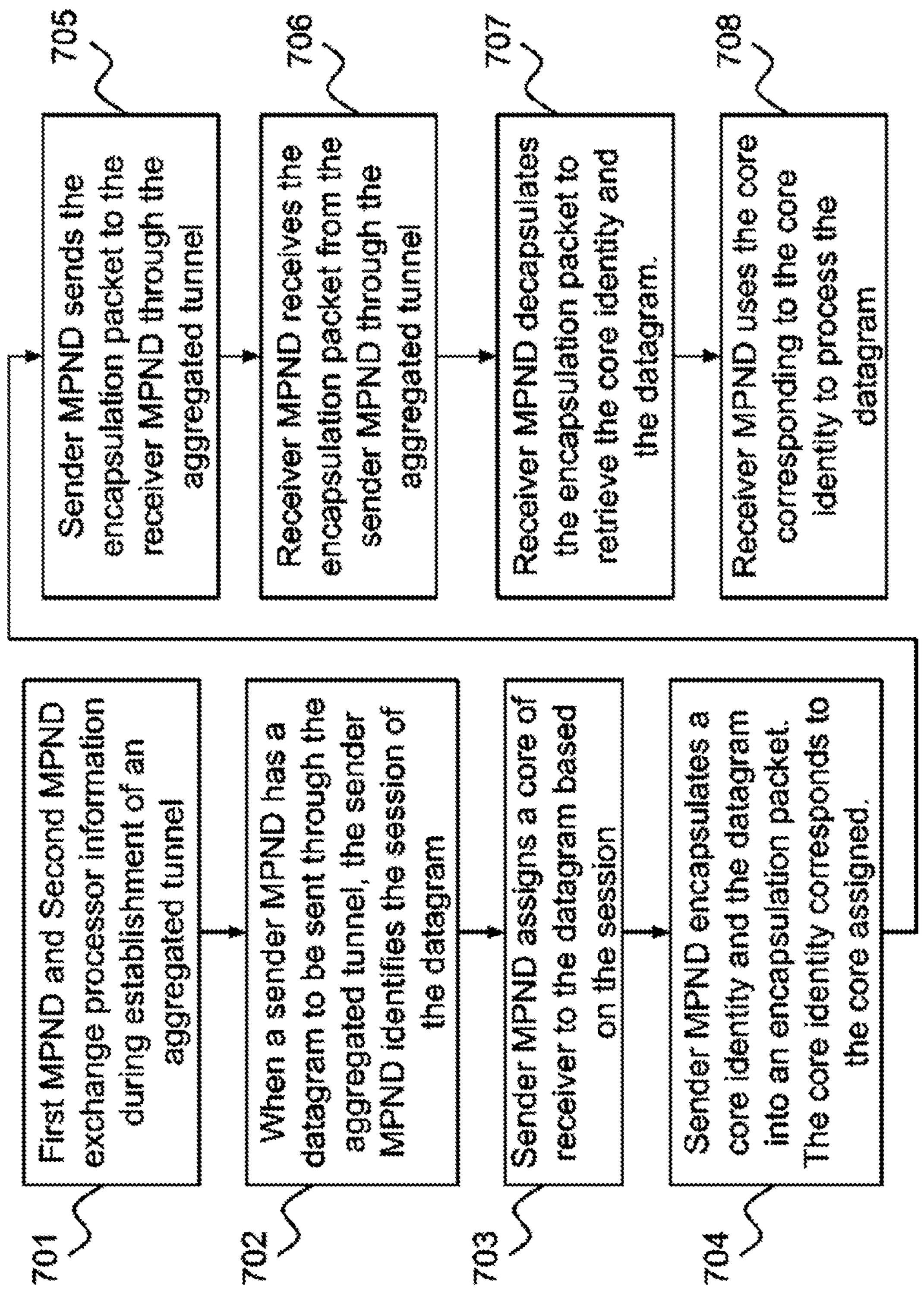

701
First MPND and Second MPND exchange processor information during establishment of an aggregated tunnel
702
When a sender MPND has a datagram to be sent through the aggregated tunnel, the sender MPND identifies the session of the datagram
703
Sender MPND assigns a core of receiver to the datagram based on the session
704
Sender MPND encapsulates a core identity and the datagram into an encapsulation packet. The core identity corresponds to the core assigned.
705
Sender MPND sends the encapsulation packet to the receiver MPND through the aggregated tunnel
706
Receiver MPND receives the encapsulation packet from the sender MPND through the aggregated tunnel
707
Receiver MPND decapsulates the encapsulation packet to retrieve the core identity and the datagram.
708
Receiver MPND uses the core corresponding to the core identity to process the datagram

Fig. 7

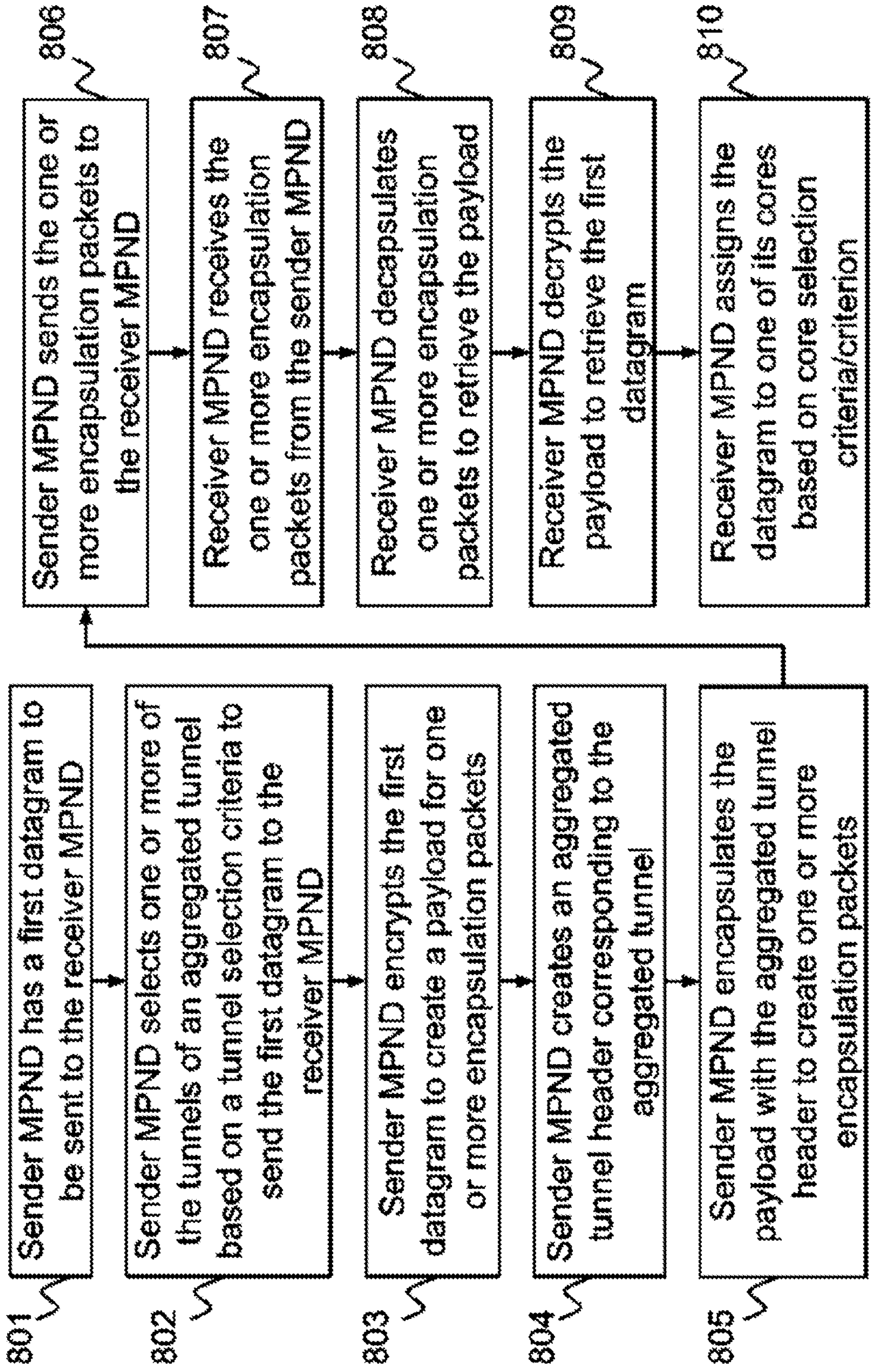

801
Sender MPND has a first datagram to be sent to the receiver MPND
802
Sender MPND selects one or more of the tunnels of an aggregated tunnel based on a tunnel selection criteria to send the first datagram to the receiver MPND
803
Sender MPND encrypts the first datagram to create a payload for one or more encapsulation packets
804
Sender MPND creates an aggregated tunnel header corresponding to the aggregated tunnel
805
Sender MPND encapsulates the payload with the aggregated tunnel header to create one or more encapsulation packets
806
Sender MPND sends the one or more encapsulation packets to the receiver MPND
807
Receiver MPND receives the one or more encapsulation packets from the sender MPND
808
Receiver MPND decapsulates one or more encapsulation packets to retrieve the payload
809
Receiver MPND decrypts the payload to retrieve the first datagram
810
Receiver MPND assigns the datagram to one of its cores based on core selection criteria/criterion

Fig. 8

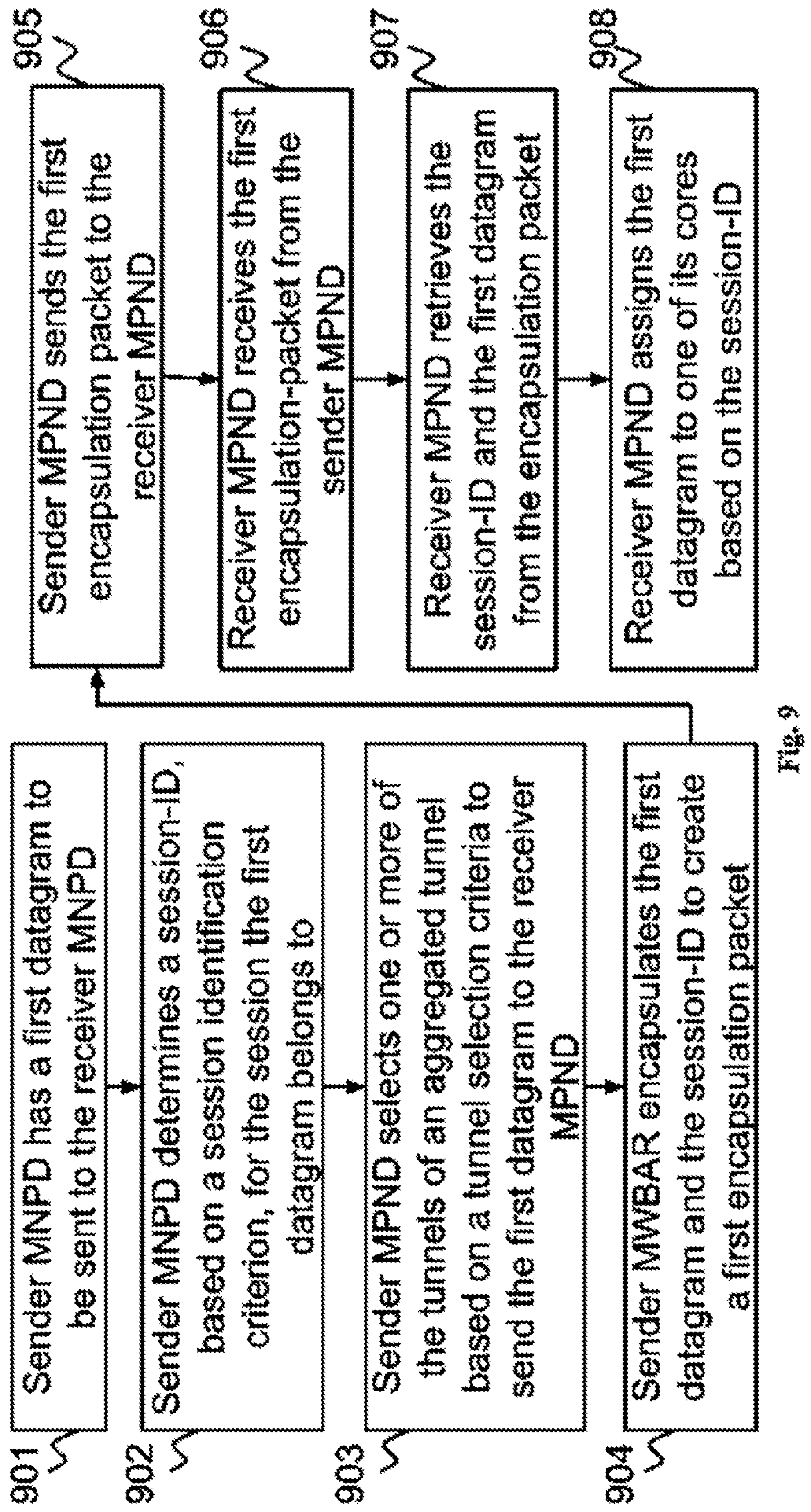

901
Sender MNPD has a first datagram to be sent to the receiver MNPD
902
Sender MNPD determines a session-ID, based on a session identification criterion, for the session the first datagram belongs to
903
Sender MPND selects one or more of the tunnels of an aggregated tunnel based on a tunnel selection criteria to send the first datagram to the receiver MPND
904
Sender MWBAR encapsulates the first datagram and the session-ID to create a first encapsulation packet
905
Sender MPND sends the first encapsulation packet to the first receiver MPND
906
Receiver MPND receives the first encapsulation-packet from the sender MPND
907
Receiver MPND retrieves the session-ID and the first datagram from the encapsulation packet
908
Receiver MPND assigns the first datagram to one of its cores based on the session-ID

Fig. 9

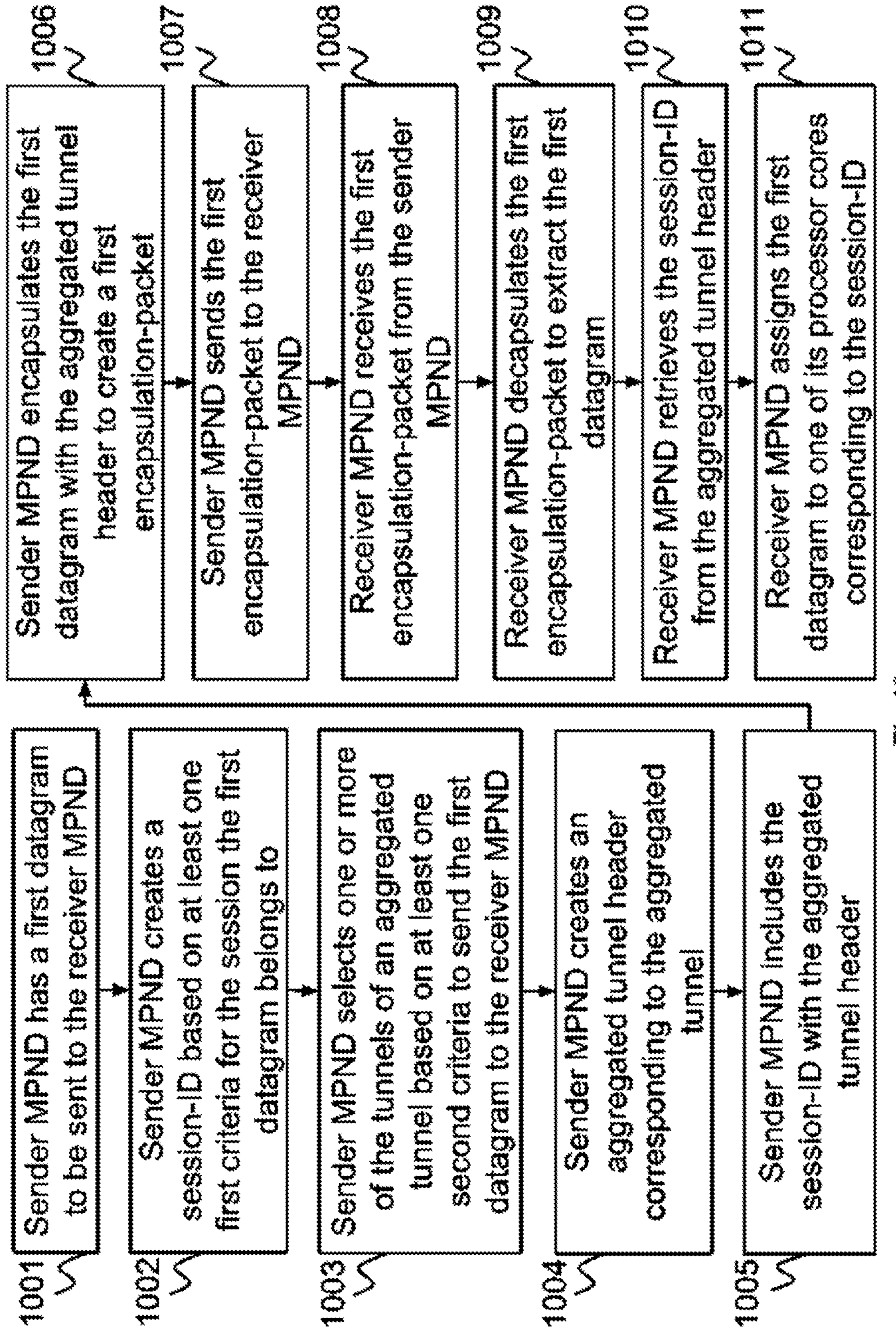

1001
Sender MPND has a first datagram to be sent to the receiver MPND
1002
Sender MPND creates a session-ID based on at least one first criteria for the session the first datagram belongs to
1003
Sender MPND selects one or more of the tunnels of an aggregated tunnel based on at least one second criteria to send the first datagram to the receiver MPND
1004
Sender MPND creates an aggregated tunnel header corresponding to the aggregated tunnel
1005
Sender MPND includes the session-ID with the aggregated tunnel header
1006
Sender MPND encapsulates the first datagram with the aggregated tunnel header to create a first encapsulation-packet
1007
Sender MPND sends the first encapsulation-packet to the receiver MPND
1008
Receiver MPND receives the first encapsulation-packet from the sender MPND
1009
Receiver MPND decapsulates the first encapsulation-packet to extract the first datagram
1010
Receiver MPND retrieves the session-ID from the aggregated tunnel header
1011
Receiver MPND assigns the first datagram to one of its processor cores corresponding to the session-ID

Fig. 10

METHODS AND SYSTEMS FOR SENDING PACKETS THROUGH A PLURALITY OF TUNNELS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This Application is a Bypass Continuation of International Application No. PCT/IB2019/052743 filed on Apr. 4, 2019, the entire disclosure of which is specifically incorporated herein by reference thereto.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate to the field of network data communications at a network device, and specifically, to select computing cores of the network device to process packets sent through a plurality of tunnels.

BACKGROUND ART

[0003] A multi Wide Area Network (WAN) site-to-site VPN router is a router that supports aggregating bandwidth of a plurality of WAN connections by forming an aggregated tunnel. This type of routers is referred to as MPND router hereinafter. A MPND router may establish a plurality of aggregated tunnels with a plurality of network nodes. Selection of WAN connections for a particular aggregated tunnel may be determined based on various factors such as, but not limited to, source IP address, destination IP address, source port number, destination port number, content of application data, Quality of Service (QoS) requirement of the applications, time and date, user-ID, bandwidth, latency or hop-count of the connected links etc. individually or in any combination thereof. Commonly these MPNDs have the capability to add or remove WAN connections as needed during data transfer. Determining the WAN connections to be comprised in an aggregated tunnel may be performed by an administrator/user or by the router itself according to real-time requirements.

[0004] An MPND may be implemented with one processing-unit or a plurality of processing-units, such as multiprocessor devices. A processing-unit may have a plurality of cores. The use of a plurality of cores may provide improved performance by sharing the load of processing network datagrams or packets. MPNDs may simultaneously handle traffic received from many applications running on numerous host machines such as desktop/laptop computers, servers, smartphones, and more recently IoT devices etc. Different cores in the MPND may have different processing performance due to different factors, including processing load. Indiscriminately allocating the received datagrams or packets to the cores may result in consecutive packets of a particular data session being processed by different cores. This may then result in out out-of-order datagrams or packets progressing and lower overall throughput of the particular data session.

SUMMARY OF THE INVENTION

[0005] The present invention discloses methods and systems to improve the rate of processing of datagrams at a receiver MPND by assigning each received datagram to a determined core of the processor of the receiver MPND. The determination is made by matching each received datagram against a criterion or criteria. Datagrams that satisfy a particular criterion or a set of criteria are associated with a particular session. Datagrams belonging to the same session is assigned to the same core. This conditional assignment reduces re-ordering of datagrams which, as a result, reduces packet-drops and increases the overall data throughput rate of the receiver MPND.

[0006] In one embodiment, the receiver MPND associates a received datagram to a particular session based on values of one or more of the header fields, or the content of the payload contained in the datagram. In this embodiment, the sender MPND is not required to know the processor information comprised in the receiver MPND. The processor information of a receiver MPND may include, but not limited to, the number of cores comprised within the receiver MPND. Value or status of any parameter that is associated with the cores may also be included in the processor information. In this particular embodiment, the receiver MPND assigns the received datagrams to its cores independently from the sender MPND.

[0007] In one embodiment, the sender MPND receives the Processor information of the receiver MPND prior to sending the datagram. In this embodiment, the sender MPND determines which core the receiver MPND should assign the received datagram to. The sender MPND then sends the corresponding instruction to the receiver MPND.

[0008] In one embodiment, tunnels are used to create connection-oriented communication links between the sender MPND and the receiver MPND. The tunnels are established at the sender MPND based on a criterion. Each datagram destined for the receiver MPND is then encapsulated with the tunnel header creating a new datagram (referred to as "encapsulation packet" herein). Each encapsulation packet is then sent to the receiver MPND. After receiving each encapsulation packet, the receiver MPND determines a core to which the received encapsulation packet will be assigned to. There is no limitation on how this determination is made by the receiver MPND.

[0009] In one embodiment where tunnels are used to send datagrams from the sender MPND to the receiver MPND, the sender MPND receives the PI of the receiver MPND prior to sending the datagram. In this embodiment, the sender MPND determines which core the receiver MPND should assign the received encapsulation packet to.

[0010] In one embodiment, the sender MPND and the receiver MPND are able to send and receive datagrams using aggregated tunnels as used by MPNDs. In this embodiment encapsulation packets are created by encapsulating each datagram with the aggregated tunnel header. Each encapsulation packet is then sent to the receiver MPND. After receiving each encapsulation packet, the receiver MPND determines a core to which the received encapsulation packet will be assigned to.

[0011] In one embodiment where the sender MPND and the receiver MPND uses aggregated tunnels to transmit and receive datagrams, the sender MPND receives the processor information of the receiver MPND prior to sending the datagram. In this embodiment, the sender MPND determines which core the receiver MPND should assign the received encapsulation packet to.

[0012] The one or more criteria used to assign the received datagrams to a particular core is related to the one or more condition based on which the tunnel is formed. In one embodiment, the receiver MPND assigns inbound data units to a core with less processing load to reduce processing-delay. The term "data unit" used herein refer to any Protocol

Data Unit (PDU). For consistency, only the term "datagram" is used hereinafter to refer to such PDU. Although the present invention describes methods and systems to conditionally allocate datagrams to cores of a multicore system, one of ordinary skill in the art would appreciate that the methods and systems detailed herein can be applied to any computing system with a plurality of processors such as a single multicore processor, a plurality of single core processors, a plurality of multicore processors and the like.

DETAILED DESCRIPTIONS

[0013] The ensuing description provides preferred exemplary embodiment(s) only, and is not intended to limit the scope, applicability or configuration of the invention. Rather, the ensuing description of the preferred exemplary embodiment(s) will provide those skilled in the art with an enabling description for implementing a preferred exemplary embodiment of the invention. It is being understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the invention as set forth in the appended claims. Thus, the embodiment(s) are not to be limited to those shown, but are to be accorded the widest scope consistent with the principles and features described herein.

[0014] For purpose of clarity, details relating to technical material that is known in the technical fields related to the embodiment(s) have not been described in detail. Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits may be shown in block diagrams in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail in order to avoid obscuring the embodiments.

[0015] Also, it is noted that the embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a session diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed, but could have additional steps not included in the figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination corresponds to a return of the function to the calling function or the main function.

[0016] Embodiments, or portions thereof, may be embodied in program instructions operable upon a processing-unit for performing functions and operations as described herein. The program instructions making up the various embodiments may be stored in a non-transitory storage medium. Moreover, as disclosed herein, the term "non-transitory storage medium" may represent one or more devices for storing data, including read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), random access memory (RAM), magnetic RAM, core memory, floppy disk, flexible disk, hard disk, magnetic tape, CD-ROM, flash memory devices, a memory card and/or other machine readable mediums for storing information. The term "machine-readable medium" includes, but is not limited to portable or fixed storage devices, optical storage mediums, magnetic mediums, memory chips or cartridges, wireless channels and various other mediums capable of storing, containing or carrying instruction(s) and/or data. A machine-readable medium can be realized by virtualization, and can be a virtual machine readable medium including a virtual machine readable medium in a cloud-based instance.

[0017] The term "non-transitory computer-readable medium", "main memory", or "secondary storage", as used herein refers to any medium that participates in providing instructions to a processing-unit for execution. The computer-readable medium is just one example of a machine-readable medium, which may carry instructions for implementing any of the methods and/or techniques described herein. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical or magnetic disks. Volatile media includes dynamic memory. Transmission media includes coaxial cables, copper wire and fiber optics. Transmission media can also take the form of acoustic or light waves, such as those generated during radio-wave and infrared data communications.

[0018] A volatile storage may be used for storing temporary variables or other intermediate information during execution of instructions by processing-unit. A non-volatile storage or static storage may be used for storing static information and instructions for processing-unit, as well as various system configuration parameters.

[0019] The storage medium may include a number of software modules that may be implemented as software code to be executed by the processing-unit using any suitable computer instruction type. The software code may be stored as a series of instructions or commands, or as a program in the storage medium.

[0020] Various forms of computer readable media may be involved in carrying one or more sequences of one or more instructions to the processing-unit for execution. For example, the instructions may initially be carried on a magnetic disk from a remote computer. Alternatively, a remote computer can load the instructions into its dynamic memory and send the instructions to the system that runs the one or more sequences of one or more instructions.

[0021] A processor may be a microprocessor, a microcontroller, a digital signal processor (DSP), a central processing unit (CPU), a multiprocessor, a multi-core processor. A processor may also be an independent processor may have a plurality of processing unit called cores. A multiprocessor or a multi-core processor that share a common operating system, any combination of those devices, or any other circuitry configured to process information are also considered as a processor for this invention.

[0022] A processing-unit executes program instructions or code segments for implementing embodiments of the present invention. Furthermore, embodiments may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program instructions to perform the necessary tasks may be stored in a computer readable storage medium. A processing-unit(s) can be realized by virtualization, and can be a virtual processing-unit(s) including a virtual processing-unit in a cloud-based instance.

[0023] Embodiments of the present invention are related to the use of a computer system for implementing the techniques described herein. In an embodiment, the inventive processing-units may reside on a machine such as a computer platform. According to one embodiment of the invention, the techniques described herein are performed by a computer system in response to the processing-unit executing one or more sequences of one or more instructions contained in the volatile memory. Such instructions may be read into the volatile memory from another computer-readable medium. Execution of the sequences of instructions contained in the volatile memory causes the processing-unit to perform the process steps described herein. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement the invention. Thus, embodiments of the invention are not limited to any specific combination of hardware circuitry and software.

[0024] A code segment, such as program instructions, may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

[0025] Alternatively, hardwired circuitry may be used in place of, or in combination with, software instructions to implement processes consistent with the principles of the invention. Thus, implementations consistent with principles of the invention are not limited to any specific combination of hardware circuitry and software.

[0026] A network interface may be implemented by a standalone electronic component or may be integrated with other electronic components. A network interface may have no network connection or at least one network connection depending on the configuration. A network interface may be an Ethernet interface, a wireless communication interface, a frame relay interface, a fibre optic interface, a cable interface, a Digital Subscriber Line (DSL) interface, a token ring interface, a serial bus interface, a universal serial bus (USB) interface, Firewire interface, Peripheral Component Interconnect (PCI) interface, etc.

[0027] A network interface may connect to a wired or wireless access network. An access network may carry one or more network protocol data. A wired access network may be implemented using Ethernet, fiber optic, cable, DSL, frame relay, token ring, serial bus, USB, Firewire, PCI, or any material that can pass information. A wireless access network may be implemented using infrared, High-Speed Packet Access (HSPA), HSPA+, Long Term Evolution (LTE), WiMax, GPRS, EDGE, GSM, CDMA, WiFi, CDMA2000, WCDMA, TD-SCDMA, BLUETOOTH, WiBRO, Evolution-Data Optimized (EV-DO), Digital Enhanced Cordless Telecommunications (DECT), Digital AMPS (IS-136/TDMA), Integrated Digital Enhanced (iDEN) or any other wireless technologies.

[0028] Embodiments, or portions thereof, may be embodied in a computer data signal, which may be in any suitable form for communication over a transmission medium such that it is readable for execution by a functional device (e.g., processing-unit) for performing the operations described herein. The computer data signal may include any binary digital electronic signal that can propagate over a transmission medium such as electronic network channels, optical fibers, air, electromagnetic media, radio frequency (RF) links, and the like, and thus the data signal may be in the form of an electrical signal, optical signal, radio frequency or other wireless communication signal, etc. The code segments may, in certain embodiments, be downloaded via computer networks such as the Internet, an intranet, LAN, MAN, WAN, the PSTN, a satellite communication system, a cable transmission system, and/or the like.

[0029] FIG. **3** illustrates a typical network topology **3000** where a plurality of MPNDs may be connected together via groups of access networks. There is no limitation to the number of MPND that can be connected together. System **3000** is adapted according to embodiments configured to transmit and receive data through aggregated multiple connections, also herein referred to as "aggregated tunnel", according to the present invention. System **3000** includes multiple sites **307** and **311**. Sites **307** and **311** each comprise at least one MPND **301** and MPND **302** respectively. Network **310** may comprise one or more of a local area network (LAN), metropolitan area network (MAN), wide area network (WAN), wireless network, the public switched telephone network (PSTN), the Internet, an intranet, an extranet, or other similar networks. Desktop computer **303** and laptop computer **305** are connected to network MPND **301** using connections **304** and **306** respectively. File server **315** and database server **309** are connected to MPND **302** using connections **308** and **313** respectively. There is no limitation that only desktop computers, laptop computers, file servers and database servers can connect to MPNDs **301** and **302**. Any electronic device with networking capability may connect to MPNDs **301** and **302**.

[0030] Access networks **312** and **314** are data connections for communicating information within network **310** between sites **307** and **311**. These number of access networks are shown only for illustration. A person skilled in the art would appreciate that any number and arrangement of access networks are possible to be adapted by MPNDs **301** and **302**. Access networks **312-1**, **312-2**, **312-3**, **314-1** and **314-2** may have similar or different network characteristics, including packet loss rate and bandwidth capabilities. Further, access networks **312** and **314** may comprise different types of network connections, such as a WiFi, fiber optics, cable, DSL, T1, 3G, 4G, 5G, satellite connections, Ethernet, ATM, and the like. It is also noted that MPNDs **301** and **302** may be thought of as both a sender or receiver, and discussions regarding the functionality of either site may be implemented on the other site. In other words, system **3000** may be implemented as a symmetrical network with bidirectional data transfer capabilities.

[0031] When establishing an aggregated connection between MPNDs **301** and **302**, such as by implementing an aggregated site-to-site VPN connection, a plurality of tunnels **316** may be created. The plurality of tunnels **316** correspond to a unique permutation of the WAN connections **312** of site **307** and the network connections **314** of site **311**. One or more of the plurality of tunnels **316** may be established through networks **310** between MPNDs **301** and **302**. There is no limitation that the plurality of tunnels **316** must be two per access networks **312** or three per access networks **314**. There is no limitation that both MPND **301** and **302**

must have a plurality of WAN ports or must connect to a plurality of WAN connections. However, at least one of MPND **301** and **302** must connect to a plurality of WAN connections through a plurality of WAN interfaces or ports.

[0032] FIG. **6** is an illustrative block diagram of a router **6000**, which has similar functionalities to MPNDs **301** and **302**, according to one of the embodiments of the present invention. Router **6000** comprises processor **600**, main memory **601**, systembus **602**, secondary storage **603**, and network interfaces **604**, **605**, **606** and **607**. Processor **600** and main memory **601** are connected to each other directly. Processor **600** is connected to secondary storage **603** and network interlaces **604**, **605**, **606** and **607** through systembus **602**. Systembus **602** can be any of several types of bus structures including a memory bus, a peripheral bus, and a local bus using any of a variety of bus architectures. Secondary storage **603** stores program instructions for execution by processor **600**. Processor **600** comprises a plurality of cores as processing units. For illustration purpose only, processor **600** has two cores, namely core **600***a* and core **600***b*. Those who are skilled in the art would appreciate that processor **600** is not limited to have only two cores, but may also have more than two cores. The scope of the invention is not restricted to router **6000** having four network interfaces, such that router **6000** is allowed to have network interfaces higher or below this number. Moreover, router **6000** is not limited to have only one processor **600**, but may also have a plurality of processors.

[0033] It shall be appreciated that the present disclosure is not limited to the architecture of system **6000**. For example, any suitable processor based device may be utilized for implementing the above teachings, including without limitation routers, personal computers, laptop computers, computer workstations, multiprocessor servers, and even mobile telephones. Moreover, certain embodiments may be implemented on application specific integrated circuits (ASICs) or very large scale integrated (VLSI) circuits. In fact, persons of ordinary skill in the art may utilize any number of suitable structures capable of executing logical operations according to the embodiments.

[0034] A access network connects a network interface of a network device such as MPND to interconnected networks, such as the Internet. The network interface can be an Ethernet interface, a 3G/4G/5G network interface, a WiMAX network interface, or any other network interface of a network device. A network interface can also be a virtual network interface of a virtual machine (VM). A access network is in form of optical fiber, Ethernet, ATM, Frame Relay, T1/E1, IPv4, IPv6, wireless technologies, Wi-Fi, WiMAX, High-Speed Packet Access technology, 3GPP Long Term Evolution (LTE) or the like.

[0035] An end-to-end connection is a connection between a source node and a destination node. An end-to-end connection may include one or more access networks and one or more intermediate nodes. In one of the embodiments of the present invention, an end-to-end connection between a source node and a destination node is a virtual private network (VPN) tunnel.

[0036] A tunnel is an end-to-end connection established between two MPNDs using their respective tunnel interfaces and one or more access networks. A tunnel is established using a tunnelling protocol that encapsulates one type of protocol data unit (PDU) into another type of protocol data unit. Examples of tunnelling protocols include, but are not limited to, Generic Routing Encapsulation (GRE) and Layer-2 Tunneling Protocol (L2TP). A tunnel creates a virtual point-to-point connection between two network nodes. Tunnels may or may not encrypt the encapsulated PDU such as an IP packet. More than one tunnel interface can be established using the same network interface of a MPNS. The two MPNDs on each end of a tunnel may be directly connected or may be connected through one or more interconnected networks.

[0037] An information packet is a PDU that contains control information, such as address information, and user data. An information packet can be a network layer PDU such as Internet Protocol (IPv4 or IPv6), a transport layer PDU such as Transmission Control Protocol (TCP) or User Datagram Protocol (UDP), or PDU of any other protocol that is capable of carrying information over a access network.

[0038] Data flow, session and data session are considered as interchangeable in the present invention. For example, a multimedia data session or session is a set of multimedia senders and receivers and the data streams flowing from senders to receivers. A multimedia conference is an example of a multimedia data session or flow.

[0039] FIG. **1** and FIG. **4** should be viewed in conjunction with network architecture diagram FIG. **3**. FIG. **1** and FIG. **4** illustrate steps performed by receiver MPND **302** and sender MPND **301** respectively according to one embodiment of the present invention. In this embodiment, receiver MPND **302** relies on a core identity in datagrams to select a core to process the received datagram. The core identity may be in the form of a string, a number, a hash, a code or any data format that is recognizable by sender MPND **301** and receiver MPND **302**. In case there is no core identity in a datagram, receiver MPND **302** will inform sender MPND **301** the core identity for future datagrams belonging to the same flow of the datagram.

[0040] At step **102**, receiver MPND **302** receives a first datagram from one of access networks **312** and **314**. At step **103**, receiver MPND **302** determines whether the first datagram belongs to a new session or a session already having one or more datagrams received.

[0041] The session is identified based on a data session identification process. The data session identification process may be based on, but not limited to core identity, source IP address, destination IP address, source port number, destination port number, connection-state, payload-content, quality of service (QoS) requirement of the applications, time and date, user-ID, bandwidth, latency or hop-count of the connected links etc. individually or in any combination thereof.

[0042] If the datagram belongs to a new session, at step **104**, receiver MPND **302** assigns a core to process datagrams of the new session. The new session comprises the first datagram and to be received datagrams of the new session. Receiver MPND **302** also creates or assigns a core identity corresponding to the assigned core.

[0043] At step **105**, receiver MPND **302** informs sender MPND **301** the identity of the core assigned. There is no limit that step **104** must be performed immediately after step **103**. For example, step **104** may be performed after step **107**. In one variance, step **104** may be performed after one or more datagrams belonging to the new session have arrived at receiver MPND **302**.

[0044] There is no limit that all datagrams belonging to a session must be sent by the same WAN interface of sender MPND **301** or must be sent through the same path, or must be received by the same network interface at receiver MPND **302**. It is preferred that all datagrams of the new session, except the first one datagram or the first few datagrams, are sent by sender MPND **301** along with the core identity

[0045] If one or more datagrams belonging to a session already have already arrived at the receiver MPND **302**, at step **106**, receiver MPND **302** then determines the core based on prior core assignment of the session the first datagram belongs to. When there is a core identity stored in the first datagram, receiver MPND **302** will assign the core corresponding to the core identity to process the first datagram.

[0046] At step **107**, receiver MPND **302** processes the datagram using the core assigned. The processed datagram will then be forwarded to the corresponding destination, such as receiver MPND **302** or a device, such as file server **315** or database server **309**, connected to MPND **302**.

[0047] FIG. **4** illustrates steps performed by sender MPND **301** and receiver MPND **302** according to one embodiment of the present invention. The embodiment illustrated by FIG. **4** may be implemented together with the embodiment illustrated by FIG. **3** in a system or be implemented independently from FIG. **3**. In this particular embodiment, sender MPND **301** has a core identity sent by receiver MPND **302** prior to sending the datagram. The core identity is to be used by the receiver MPND **302** as described in the embodiment of FIG. **1**.

[0048] For all embodiments disclosed The processor information may be sent by receiver MPND **302**, or pre-shared with sender MPND **301** by a user or administrator of the both MPND **302** and MPND **303**, or from a remote management node.

[0049] At step **401**, sender MPND **301** receives the core identity sent by receiver MPND **302** at step **105** from MPND **302** for a flow. In one variant, sender MPND **301** receives the core identity before sending the initial datagram of a new flow. In one variant, sender MPND **301** receives the core identity after sending the initial datagram or the initial few datagrams of a new flow.

[0050] At step **402**, sender MPND **301** has a datagram to be sent to the receiver MPND **302**. The datagram may be created by MPND **301** based on another datagram received from a device, such as desktop computer **303** and laptop computer **305**, connected to MPND **301**.

[0051] At step **403**, sender MPND **301** puts the core identity, which corresponds to the core determined, into the datagram.

[0052] At step **404**, sender MPND **301** sends the datagram to receiver MPND **302** through one of access networks **312**.

[0053] There is no limitation whether the core identity is encrypted or not. There is also no limitation whether the core identity is stored in the header section or payload section of a datagram. In one example, sender MPND **301** encrypts the core identity and stores it at the header section of the datagram during step **403**. Receiver MPND **302** then decrypts the encrypted core identity before assigning the first datagram to a core at step **106**. In another example, the core identity is not encrypted. It is preferred that the core identity is not encrypted and stored in the header section of the datagram in order to reduce processing load.

[0054] FIG. **5** illustrates steps performed by sender MPND **301** and receiver MPND **302** according to one embodiment of the present invention. Comparing this embodiment to the embodiment illustrated by FIG. **1** and FIG. **4**, datagrams to be sent by sender MPND **301** are encapsulated in encapsulation packets and are sent through an aggregated tunnel. FIG. **5** should be viewed in conjunction with FIG. **3**.

[0055] At step **501**, an aggregated tunnel is established between sender MPND **301** and receiver MPND **302**. The aggregated tunnel may be established using one or more of access networks **312** and one or more access networks **314** through network **310**. During the aggregated tunnel establishment stage, receiver MPND **302** sends sender MPND **301** a core identity.

[0056] At step **502**, sender MPND **301** has a datagram to be sent to receiver MPND **302**. The datagram may be received from a network node in a network connected to sender MPND **301** and designated to receiver MPND **302** or a network node in a network connected to receiver MPND **302**. At step **503**, sender MPND **301** creates an encapsulation packet by encapsulating the datagram with an aggregated tunnel header. In the aggregated tunnel header, the core identity is stored. The encapsulation packet may be an IP packet. The payload portion of the IP packet is unencrypted and holds the aggregated tunnel header and the datagram.

[0057] At step **504**, sender MPND **301** sends the encapsulation-packet to receiver MPND **302**. At step **505**, receiver MPND **302** receives the encapsulation-packet from the sender MPND **301**. At step **506**, receiver MPND **302** examines the encapsulation packet and retrieve the core identity from the aggregated tunnel header. Then MPND **302** selects one of its cores based on the core identity to process the datagram, which is retrieved from the payload portion of the encapsulation packet.

[0058] Since in this particular embodiment, MPND **301** does not encrypt the payload of the encapsulation packet, receiver MPND **302** does not need to perform any decryption at step **506** to retrieve the core identity. At step **507**, receiver MPND **302** assigns the encapsulation packet to a core corresponding to the core identity. The core will then process the encapsulation packet. Then receiver MPND **302** may send the datagram, which is in the payload of the encapsulation packet, to a corresponding receiving network node after the processing.

[0059] When more datagrams arrived at sender MPND **301** and are designated to receiver MPND **302** through the aggregated tunnel, steps **502** to **507** will repeat. Therefore core identities of tunnel headers of the encapsulation packets encapsulating the datagrams will be the same.

[0060] In one variant, during step **501**, sender MPND **301** may also send receiver MPND **302** a core identity. When receiver MPND **302** has datagrams to be sent to sender MPND **301**, receiver MPND **302** will also encapsulate the datagrams with that core identity in encapsulation packets and then send the encapsulation packets to sender MPND **301**.

[0061] In one variant, receiver MPND **302** provides the core identity to sender MPND **301** prior to the transmission of data datagrams of a particular data session (e.g. using a handshake method) from sender MPND **301** to receiver MPND **302**. In another variant, the core identity is predetermined and set by the administrator or a user. In another variant, sender MPND **301** receives or collects the core identity from a remote management node or from a data storage device. In one variant of this embodiment, only the number of total cores of the receiver node to be used to process datagrams, is shared with sender MPND **301**. In another variant, the total number of cores comprised in receiver MPND **302** is shared with sender MPND **301** and sender MPND **301** determines the number of process-cores to be used.

[0062] In one variant, step **503** and step **506** are modified. At modified step of **503**, sender MPND **301** encrypts the datagram and tunnel header and then stores both in the payload portion of an encapsulation packet. The datagram and the tunnel headers are encrypted. At modified step **506**, receiver MPND **302** first decrypts the payload of the encapsulation packet to retrieve the datagram and the tunnel header. Then the core identity could be retrieved from the tunnel header.

[0063] In one variant, the core identity is not sent by receiver MPND **302** during step **501**. Instead, a session-ID is sent by receiver MPND **302**.

[0064] In one variant, there is no core identity sent by receiver MPND **302** during step **501**. Instead, a session-ID is determined by MPND **301** and is sent to receiver MPND **302**.

[0065] In another variant, the core identity is replaced by a session-ID and the session-ID is a hash value.

[0066] There is no limitation on the format, data-type or length of a session-ID as long it is able to uniquely identify a data session. For example, a session-ID may be, without limitation, in the format of plain-text alphanumeric, binary or hexadecimal.

[0067] FIG. **7** illustrates steps performed by a sender MPND and a receiver MPND according to one embodiment of the present invention. In this embodiment, similar to the embodiment illustrated in FIG. **5**, the sender MNPD will assign a core identity for each packet to be sent to the receiver MPND. However not all encapsulation packets have the same core identity. Instead, core identity is determined mainly based on the data session of the datagram to be sent to the receiver MPND.

[0068] At step **701**, a first MPND and a second MPND exchanges processor information during establishment of an aggregated tunnel. For illustration purpose only, the first MPND is MPND **301** and the second MPND **302** is MPND **302**. Both MPND **301** and MPND **302** may be sender and receiver. The processor information includes number of cores each MPND has. For example, MPND **301** has one processing-unit and the processing-unit has four cores. MPND **301** informs MPND **302** that it has four cores. For example, MPND **301** has two processing-units and each processing-unit has eight cores. MPND **302** informs MPND **301** that it has sixteen cores. There is no limitation on representation of processor information and core information. The number of cores may be simply represented by four bits to represent one of the cores. For example, processor information may be in string, bytes or binary data.

[0069] In another example, the number of cores is represented by characters or strings. For illustration purpose only, MPND **301** may send "AA", "BB", "CC" and "DD" to MPND **302** as core identities for the four cores respectively. MPND **302** may send MPND **301** "core1", "core2", "core3", "core4", "core5", "core6", "core7", "core8", "core9", "core10", "core11", "core12", "core13", "core14", "core15", and "core16" as core identities for the four cores respectively.

[0070] Processor information may also include core selection criteria. For example, the core selection criteria is to select a core based on types of datagrams. For example, certain cores should not be used and/or certain cores are preferred to be used. The processor information may also be updated after the aggregated tunnel is established. In one example, when more cores are added or made available at a MPND, the MPND may update the other MPND about the number of cores.

[0071] At step **702**, when sender MPND receives a datagram that is designated to a receiver MPND, processing-unit of the sender MPND identifies the data session that the datagram belongs to. There are myriad methods to identify a data session, such as those disclosed in step **103** of the embodiment illustrated by FIG. **1**.

[0072] At step **703**, sender MPND assigns a core to the datagram based on the data session. If the datagram is the first datagram in the data session, sender MPND may select one of the cores from the number of cores of receiver MPND. There are many ways to select the core. There is no limitation on the selection method. For example, sender MPND selects the core randomly. In another example, sender MPND selects core uniformly that the first data session uses the first core, the second data session uses the second core, and so on. If there are four cores, the fifth data session will use the first core again. In another example, any of the cores may be selected, except one or more non-selectable cores. The non-selectable cores may only be used for certain specific datagrams, such as high priority datagrams.

[0073] If the datagram is not the first datagram of the data session, sender MPND looks up for the core that is already assigned to data session.

[0074] At step **704**, the core identity corresponding to the core assigned at step **703** and the datagram are encapsulated in one or more encapsulation packets. At step **705**, sender MPND sends the one or more encapsulation packets to receiver MPND through the aggregated tunnel, which was already established at step **701**.

[0075] The core identity may be in the form of a string, a number, a hash, a code or any data format that is recognizable by receiver MPND.

[0076] At step **706**, receiver MPND receives the one or more encapsulation packets from sender MPND from the aggregated tunnel. At step **707**, receiver MPND decapsulates the one or more encapsulation packets to extract the datagram and the core identity. At step **708**, receiver MPND processes the datagram by using the core indicated by the core identity.

[0077] When more datagrams belonging to the same data session arrive later, those datagrams will also be assigned with the same core identity, i.e., the same core of receiver MPND, already assigned to the data session.

[0078] FIG. **8** illustrates steps performed by a sender MPND and a receiver MPND according to one embodiment of the present invention. In this embodiment sender MPND does not use any information related to the processor information of receiver MPND. Sender MPND encrypts the datagrams before sending them to receiver MPND. Receiver MPND decrypts the received datagrams and then determine corresponding cores to process the datagrams.

[0079] At step **801**, sender MPND has a first datagram to be sent to receiver MPND. At step **802**, the sender MPND selects one or more of the tunnels of an aggregated tunnel (which is already established between the two MPND) based on a tunnel selection criterion to send the first datagram to receiver MPND. The tunnel selection criterion is determined as described in step **103** of FIG. **1**. At step **803**, sender MPND encrypts the first datagram to create a payload for one or more encapsulation packets. At step **804**, sender MPND creates an aggregated tunnel header corresponding to the aggregated tunnel.

[0080] At step **805**, sender MPND encapsulates the payload and the aggregated tunnel header to create one or more encapsulation-packet. If the payload is small enough to be fit inside one encapsulation packet, only one encapsulation packet is required. Otherwise more encapsulation packets will be required. At step **806**, sender MPND sends the one or more encapsulation packet to receiver MPND. At step **807**, receiver MPND receives the one or more encapsulation packets from sender MPND. At step **808**, receiver MPND decapsulates the one or more encapsulation packets to retrieve the datagram.

[0081] At step **809**, receiver MPND decrypts the second datagram to retrieve the first datagram. At step **810**, receiver MPND assigns the datagram to one of its cores based on a core selection criterion. The core selection criterion is to first identify the data session the datagram belongs to. Datagrams belonging to the same data session are processed by the same core. Secondly, if the datagram is the first datagram of a new data session, receiver MPND selects a core to process the datagram. Therefore, when a session identifier has not been received before by receiver MPND, the datagram encapsulated in the encapsulation packet with the session identifier is the first datagram of the session. There is no limitation on the method of selection. For example, the selection may be based on core availability or core loading. The core may also be selected randomly or sequentially. In another example, any of the cores may be selected, except one or more non-selectable cores. The non-selectable cores may only be used for certain specific datagrams, such as high priority datagrams.

[0082] The core selected and the session identifier are stored for later look-up.

[0083] If the first datagram belongs to a data session already identified, receiver MPND selects a core that is already selected for the data session to process the first datagram. When the session identifier was received, processing unit of receiver MPND is able to determine which data session the first datagram belongs to. The core may be looked up by using the session identifier.

[0084] FIG. **9** illustrates steps performed by a sender MPND and a receiver MPND according to one embodiment of the present invention. In this embodiment, receiver MPND does not need to decrypt the datagrams in order to select the core to process the datagrams. Instead, an unencrypted session-ID is used for that purpose. As discussed before, there is no limitation on the format, data-type or length of a session-ID as long it is able to uniquely identify a data session. Additionally, in this embodiment, the whole datagrams may be encrypted, only parts of the datagrams may be encrypted or the datagrams may not be encrypted at all. A session-ID for a datagram is used to identify a particular data session (such as, but not limited to, a TCP data session) that the particular datagram belongs to. Datagrams belonging to different data sessions are assigned with different session-IDs. Receiver MPND may directly retrieve the session-ID without decryption and select a core based on the session-ID to process the datagram.

[0085] At step **901**, sender MPND has a first datagram to be sent to receiver MPND. At step **902**, sender MPND creates a session-ID based on a data session identification process for the data session the first datagram belongs to. The data session identification process is determined as described in step **103** of FIG. **1**. At step **903**, sender MPND selects one or more of the tunnels of an aggregated tunnel based on a tunnel selection criterion to send the first datagram to the receiver MPND. There is no limitation on the tunnel selection criterion. For example, one or more tunnels may be selected according to tunnel bandwidth, tunnel latency, tariffs of using an access network that one or more tunnels used, and/or geographical location of the sender MPND.

[0086] At step **904**, sender MPND creates an aggregated tunnel header corresponding to the aggregated tunnel. The aggregated tunnel header comprises tunnel information, such as tunnel identification tunnel sequence number and global sequence number, and session-ID. The first datagram and aggregated tunnel header are then stored in the payload of a first encapsulation packet. There is no limitation that the session-ID must be stored in the aggregated tunnel header. For example, the session-ID may instead be stored in a section of the payload of the encapsulation packet but not in the aggregated tunnel header. Sender MPND may or may not encrypt the aggregated tunnel header.

[0087] Sender MPND also encapsulates the first datagram in the payload of the first encapsulation packet. Depending on configuration, the first datagram may or may not be encrypted by the sender MPND.

[0088] In one variant, the session-ID is stored in the header of the first encapsulation packet. In this embodiment, session-ID is not encrypted regardless if it is in the header of first encapsulation packet, in an aggregated tunnel header or in a section of the payload. This will allow receiver MPND to retrieve the session-ID without decryption at step **908**.

[0089] At step **905**, sender MPND sends the first encapsulation packet through the aggregated tunnel. As the aggregated tunnel is composed of a plurality of tunnels, the encapsulation packet is sent through a tunnel selected at step **903**. In the case that the first datagram is fragmented into a plurality of first encapsulation packets, there is no limit that all the plurality of first encapsulation packets must be sent through the same tunnel.

[0090] At step **906**, receiver MPND receives the first encapsulation packet from the sender MPND through the aggregated tunnel.

[0091] At step **907**, receiver MPND decapsulates the first encapsulation packet to retrieve the first datagram and the session-ID. If the first datagram is encrypted when being placed in the payload of the first encapsulation packet at step **904**, decryption will be performed to retrieve the first datagram. As the session-ID is not encrypted, receiver MPND is capable of retrieving the session-ID without decryption. This may allow receiver MPND to identify the session-ID quicker comparing to if the session-ID is encrypted.

[0092] At step **908**, receiver MPND assigns the first datagram to one of its cores corresponding to the session-ID.

There is no limitation on the method receiver MPND may use to select the core based on the session-ID. The selection criterion is similar to, but not identical, the core selection criterion at step **810** in the embodiment illustrated in FIG. **8**. The selected core and the session-ID may be stored for lookup. For example, the selected core and session-ID pair information is stored in a database or text file.

[0093] It is preferred to process datagrams corresponding to the same session-ID by the same core. Receiver MPND selects a core to process the datagram based on the session-ID. There is no limitation on the method of selection. For example, the selection may be based on core availability or core loading. The core may also be selected randomly or sequentially. In another example, any of the cores may be selected, except one more non-selectable cores. The non-selectable cores may only be used for certain specific datagrams, such as high priority datagrams. The selection at this step is similar to the core selection performed at step **703**.

[0094] If receiver MPND has already receive an encapsulation packet having the same session-ID, this implies that one or more datagrams of the data session corresponding to the session-ID have already been received. Receiver MPND selects a core that is already selected for the session-ID to process the first datagram. Receiver MPND may lookup for the core that is already assigned for the session-ID. For example, receiver MPND may lookup for the core, using a text file, based on the session-ID.

[0095] In one variant, session-ID is replaced by cored identity. At step **902**, sender MPND selects a core of the receiver MPND and then use the core identity, instead of a session-ID, to inform receiver MPND the core to be used to process the first datagram. Therefore, in step **904** and **907**, session-ID is replaced by the core identity. At step **908**, as the core to be used to process the first datagram is already indicated by the core identity, there is no need to store the core-ID. There is also no need to perform a core lookup based on the core identity.

[0096] When core identity is used, sender MPND should receive processor information from the receiver MPND as discussed in step **701**. Then sender MPND will select a core for datagrams belonging to the same data session. The core identity corresponding to the core is encapsulated along with the datagram.

[0097] For example, for illustration purpose only, the session identifier is represented as "A3B8F20A88C23EB" in hexadecimal format. The first-time receiver MPND receives a datagram with this session identifier, processing unit of receiver MPND assigns a core, for example, core-12, to process the datagram. From then on, whenever receiver MPND receives an encapsulation packet with session identifier "A3B8F20A88C23EB", the processing unit will use core-12 to process the datagrams in the encapsulation packets.

[0098] FIG. **10** illustrates steps performed by a sender MPND and a receiver MPND **302** according to one variant of the embodiment illustrated by FIG. **9**. Compared to the embodiment illustrated by FIG. **9**, in this particular variant the session-ID is included with the aggregated tunnel header instead of being included with the first datagram. At step **1001**, sender MPND **301** has a first datagram to be sent to receiver MPND **302**. At step **1002**, sender MPND creates a session-ID based on at least one first criterion for the data session the first datagram belongs to. The at least one first criterion is determined as described in step **103** of FIG. **1**. In one variant of this embodiment, sender MPND **301** does not create a session-ID, but rather determines a session-ID for the data session the first datagram belongs to. At step **1003**, sender MPND **301** selects one or more of the tunnels of an aggregated tunnel (which is already established between the two MPNDs) based on at least one second criterion to send the first datagram to receiver MPND **302**. The at least one second criterion may include, without restriction, the at least one first criterion. At step **1004**, sender MPND **301** creates an aggregated tunnel header corresponding to the aggregated tunnel. At step **1005**, sender MPND **301** includes the session-ID in the aggregated tunnel header. At step **1006**, sender MPND **301** encapsulates the first datagram with the aggregated tunnel header to create a first encapsulation-packet. At step **1007**, sender MPND **301** sends the first encapsulation-packet to receiver MPND **302**. At step **1008**, receiver MPND **302** receives the encapsulation-packet from sender MPND **301**. At step **1009**, receiver MPND **302** decapsulates the first encapsulation-packet to retrieve the first datagram. At step **1010**, receiver MPND **302** retrieves the session-ID from the aggregated tunnel header. At step **1011**, receiver MPND **302** assigns the first datagram to one of its cores corresponding to the session-ID as described in step **908** of FIG. **9**.

[0099] Although the embodiments described in the present invention are directed towards multi-core MPNDs, one of ordinary skill in the art would appreciate that the techniques described herein are not only applicable to multi-core MPNDs, rather any multiprocessing computing system including, but not limited to, multi-processing systems, multicore systems, manycore systems.

BRIEF DESCRIPTION OF DRAWINGS

[0100] FIG. **1** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention;

[0101] FIG. **2** illustrates a block diagram of communication device according to one of the embodiments of the present invention;

[0102] FIG. **3** illustrates a network environment according to one of the embodiments of the present invention;

[0103] FIG. **4** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention;

[0104] FIG. **5** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention;

[0105] FIG. **6** illustrates a block diagram of communication device according to one of the embodiments of the present invention;

[0106] FIG. **7** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention;

[0107] FIG. **8** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention;

[0108] FIG. **9** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention; and

[0109] FIG. **10** illustrates a flowchart of processes being performed according to one of the embodiments of the present invention.

1-40. (canceled)

41. A method for sending packets from a first network device to a second network device comprising:

at the first network device:

a. receiving a first datagram;

b. assigning a core identity, wherein the core identity corresponds to a core of the second network device;

c. encapsulating the first datagram and the core identity into a first encapsulation packet;

d. sending the first encapsulation packet to the second network device;

at the second network device:

e. receiving the first encapsulation packet;

f. retrieving the first datagram and the core identity from the first encapsulation packet; and

g. processing the first datagram using the core identified by the core identity.

42. The method of claim **41**, wherein the core identity is based on processor information provided by the second network device.

43. The method of claim **42**, wherein the processor information includes number of cores available at the second network device.

44. The method of claim **42**, wherein the processor information is provided by the second network device before the first encapsulation packet is sent.

45. The method of claim **41**, wherein the core identity is not encrypted.

46. The method of claim **41**, further comprising:

h. when the first datagram is a first in a sequence of datagrams belonging to a session, the core identity is assigned according to a selection policy and is also assigned for future datagrams of the session;

i. when the first datagram is not a first in the sequence of datagrams belonging to the session, the core identity is the same as the core identity already assigned to the session.

47. The method of claim **46**, wherein the session is identified based on the source address, source port, destination address and destination port the first datagram.

48. The method of claim **46**, wherein the datagrams belonging to the session are sent through a plurality of connections established between the first network device and the second network device; and wherein the plurality of connections is aggregated together to form an aggregated connection.

49. The method of claim **48**, further comprising: the first network device and the second network device exchange respective processor information during establishment of the aggregated connection.

50. A system for sending packets from a first network device comprising:

the first network device and a second network device; wherein the first network device is comprised of:

at least one first network interface;

at least one first processing unit; and

at least one first non-transitory computer readable storage medium for storing program instructions executable by the at least one first processing unit for and configured to cause the at least one first processing unit to perform:

a. receiving a first datagram;

b. assigning a core identity, wherein the core identity corresponds to a core of the second network device;

c. encapsulating the first datagram and the core identity into a first encapsulation packet;

d. sending the first encapsulation packet to the second network device;

wherein the second network device comprise of:

at least one second network interface;

at least one second processing unit; and

at least one second non-transitory computer readable storage medium for storing program instructions executable by the at least one second processing unit for and configured to cause the at least one second processing unit to perform:

e. receiving the first encapsulation packet;

f. retrieving the first datagram and the core identity from the first encapsulation packet;

g. processing the first datagram using the core identified by the core identity.

51. The system of claim **50**, wherein the core identity is based on processor information provided by the second network device.

52. The system of claim **51**, wherein the processor information includes number of cores available at the second network device.

53. The system of claim **51**, wherein the processor information is provided by the second network device before the first encapsulation packet is sent.

54. The system of claim **50**, wherein the core identity is not encrypted.

55. The system of claim **50**, wherein the at least one first non-transitory computer readable storage medium further stores program instructions executable by the at least one first processing unit and configured to cause the at least one first processing unit to perform the steps of:

h. when the first datagram is a first in a sequence of datagrams belonging to a session, the core identity is assigned according to a selection policy and is also assigned for future datagrams of the session;

i. when the first datagram is not a first in the sequence of datagrams belonging to the session, the core identity is the same as the core identity already assigned to the session.

56. The system of claim **55**, wherein the session is identified based on the source address, source port, destination address and destination port the first datagram.

57. The system of claim **55**, wherein the datagrams belonging to the session are sent through a plurality of connections established between the first network device and the second network device; and wherein the plurality of connections is aggregated together to form an aggregated connection.

58. The system of claim **57**, wherein the at least one first non-transitory computer readable storage medium further stores program instructions executable by the at least one first processing unit and configured to cause the at least one first processing unit and the at least one second non-transitory computer readable storage medium further stores program instructions executable by the at least one second processing unit and configured to cause the at least one second processing unit to exchange respective processor information during establishment of the aggregated connection.

59. A method for sending packets from a first network device to a second network device comprising:

at the first network device:

a. identifying session of a packet;

b. encapsulating the packet into an encapsulated packet with a core identity; wherein the core identity is based on processor information provided by the second network device and the session;

c. sending the encapsulated packet to the second network device through one connection of a plurality of connections established between the first network device and the second network device; wherein the plurality of connections is aggregated together to form an aggregated connection;

at the second network node:

d. receiving the encapsulated packet;

e. retrieving the core identity and the packet from the encapsulated packet; and

f. processing the packet at a core according to the core identity.

60. The method of claim **59**, further comprising: the second network device sends processor information to the first network node during establishment of the aggregated connection.

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