METHODS AND APPARATUS RELATED TO A FLEXIBLE DATA CENTER SECURITY ARCHITECTURE

Application number: 20150163171
Abstract: In one embodiment, edge devices can be configured to be coupled to a multi-stage switch fabric and peripheral processing devices. The edge devices and the multi-stage switch fabric can collectively define a single logical entity. A first edge device from the edge devices can be configured to be coupled to a first peripheral processing device from the peripheral processing devices. The second edge device from the edge devices can be configured to be coupled to a second peripheral processing device from the peripheral processing devices. The first edge device can be configured such that virtual resources including a first virtual resource can be defined at the first peripheral processing device. A network management module coupled to the edge devices and configured to provision the virtual resources such that the first virtual resource can be migrated from the first peripheral processing device to the second peripheral processing device.

Type: Application
Filed: February 13, 2015
Issued: June 11, 2015
Assignee: Juniper Networks, Inc.
Inventors: Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

METHODS AND APPARATUS FOR CENTRALIZED VIRTUAL SWITCH FABRIC CONTROL

Application number: 20150131670
Abstract: In some embodiments, an apparatus comprises a processing module, disposed within a first switch fabric element, configured to detect a second switch fabric element having a routing module when the second switch fabric element is operatively coupled to the first switch fabric element. The processing module is configured to define a virtual processing module configured to be operatively coupled to the second switch fabric element. The virtual processing module is configured to receive a request from the second switch fabric element for forwarding information and the virtual processing module is configured to send the forwarding information to the routing module.

Type: Application
Filed: January 23, 2015
METHODS AND APPARATUS FOR CONFIGURING A VIRTUAL NETWORK SWITCH

Application number: 20150092605

Abstract: In one embodiment, a method includes sending a configuration signal to a virtual network switch module within a control plane of a communications network. The configuration signal is configured to define a first network rule at the virtual network switch module. The method also includes configuring a packet forwarding module such that the packet forwarding module implements a second network rule, and receiving status information from the virtual network switch module and status information from the packet forwarding module. The status information is received via the control plane.

Type: Application

Filed: December 10, 2014

Issued: April 2, 2015

Assignee: JUNIPER NETWORKS, INC.

Inventors: Gunes Aybay, Pradeep Sindhu, Anjan Venkatramani

Methods and apparatus related to a flexible data center security architecture

Patent number: 8958432

Abstract: In one embodiment, edge devices can be configured to be coupled to a multi-stage switch fabric and peripheral processing devices. The edge devices and the multi-stage switch fabric can collectively define a single logical entity. A first edge device from the edge devices can be configured to be coupled to a first peripheral processing device from the peripheral processing devices. The second edge device from the edge devices can be configured to be coupled to a second peripheral processing device from the peripheral processing devices. The first edge device can be configured such that virtual resources including a first virtual resource can be defined at the first peripheral processing device. A network management module coupled to the edge devices and configured to provision the virtual resources such that the first virtual resource can be migrated from the first peripheral processing device to the second peripheral processing device.
Methods and apparatus for centralized virtual switch fabric control
Patent number: 8942245
Abstract: In some embodiments, an apparatus comprises a processing module, disposed within a first switch fabric element, configured to detect a second switch fabric element having a routing module when the second switch fabric element is operatively coupled to the first switch fabric element. The processing module is configured to define a virtual processing module configured to be operatively coupled to the second switch fabric element. The virtual processing module is configured to receive a request from the second switch fabric element for forwarding information and the virtual processing module is configured to send the forwarding information to the routing module.

Methods and apparatus for configuring a virtual network switch
Patent number: 8937862
Abstract: In one embodiment, a method includes sending a configuration signal to a virtual network switch module within a control plane of a communications network. The configuration signal is configured to define a first network rule at the virtual network switch module. The method also includes configuring a packet forwarding module such that the packet forwarding module implements a second network rule, and receiving status information from the virtual network switch module and status information from the packet forwarding module. The status information is received via the control plane.
SCALABLE SECURITY SERVICES FOR MULTICAST IN A ROUTER HAVING INTEGRATED ZONE-BASED FIREWALL

Application number: 20140237541

Abstract: A multicast-capable firewall allows firewall security policies to be applied to multicast traffic. The multicast-capable firewall may be integrated within a routing device, thus allowing a single device to provide both routing functionality, including multicast support, as well as firewall services. The routing device provides a user interface by which a user specifies one or more zones to be recognized by the integrated firewall when applying stateful firewall services to multicast packets. The user interface supports a syntax that allows the user to define subsets of the plurality of interfaces associated with the zones, and define a single multicast policy to be applied to multicast sessions associated with a multicast group. The multicast policy identifies common services to be applied pre-replication, and exceptions specifying additional services to be applied post-replication to copies of the multicast packets for the one or more zones.

Type: Application

Systems and methods for implementing virtual switch planes in a physical switch fabric

Patent number: 8811391

Abstract: A switching device includes multiple interfaces and a switch fabric. The switch fabric includes switch integrated circuits arranged in a number of stages. Multiple virtual switch planes may be implemented in the switch fabric. Data traffic received at the interfaces is selectively assigned to different ones of the virtual switch planes.

Type: Grant
Assignee: Juniper Networks, Inc.
Inventors: Philippe Lacroute, Matthew A. Tucker, John D. Weisbloom, Anjan Venkatramani, Jayabharat Boddu, Stefan Dyckerhoff

System architecture for a scalable and distributed multi-stage switch fabric
Patent number: 8804710
Abstract: In some embodiments, an apparatus includes a first housing, a second housing and at least one cable. The first housing includes a first interface card of a switch fabric. The second housing includes a second interface card of the switch fabric and a third interface card of the switch fabric. The second interface card of the switch fabric is operatively and physically coupled to the third interface card of the switch fabric via a midplane. The second interface card defines a plane that is nonparallel to the a plane defined by the third interface card and a plane defined by the midplane. The plane defined by the third interface card is nonparallel to the plane defined by the second interface card and the plane defined by the midplane. The cable is configured to operatively couple the first interface card to the second interface card.

Type: Grant
Filed: December 29, 2008
Issued: August 12, 2014
Assignee: Juniper Networks, Inc.
Inventors: Gunes Aybay, Jaya Bandyopadhyay, Jean-Marc Frailong, Pradeep Sindhu, Philip A. Thomas, Anjan Venkatramani

Methods and apparatus related to a modular switch architecture
Patent number: 8804711
Abstract: In some embodiments, an apparatus includes a first housing, a second housing and at least one cable. The first housing includes a first interface card of a switch fabric. The second housing includes a second interface card of the switch fabric and a third interface card of the switch fabric. The second interface card of the switch fabric is operatively and physically coupled to the third interface card of the switch fabric via a midplane. The second interface card defines a plane that is nonparallel to the a plane defined by the third interface card and a plane defined by the midplane. The plane defined by the third interface card is nonparallel to the plane defined by the second interface card and the plane defined by the midplane. The cable is configured to operatively couple the first interface card to the second interface card.
and the plane defined by the midplane. The cable is configured to operatively couple the first interface card to the second interface card.

**Virtual machine mobility in data centers**

**Patent number:** 8775625  
**Abstract:** A data center management device determines that a virtual machine should be moved from a first physical system to a second physical system. The data center management device instructs a first service appliance at the first physical system to perform state synchronization with a second service appliance at the second physical system in order to continue providing the services offered prior to the move. The data center management device instructs the virtual machine to be instantiated at the second physical system.

**Methods and apparatus related to flow control within a data center switch fabric**

**Patent number:** 8755396  
**Abstract:** In one embodiment, an apparatus includes a switch core that has a multi-stage switch fabric physically distributed among a set of chassis. The multi-stage switch fabric has a set of input buffers and a set of output ports. The switch core can be configured to be coupled to a set of edge devices. The apparatus can also include a controller implemented in hardware without software during operation and with software during configuration and monitoring. The controller can be coupled to the set of input buffers and the set of output ports. The controller can be configured to send a flow control signal to an input buffer from
the set of input buffers when congestion at an output port from the set of output ports is predicted and before congestion in the switch core occurs.

**Methods and apparatus related to any-to-any connectivity within a data center**

*Patent number:* 8730954

*Abstract:* In one embodiment, an apparatus includes a switch core that defines a single logical entity and has a multi-stage switch fabric physically distributed across a plurality of chassis. The multi-stage switch fabric has a plurality of ingress ports and a plurality of egress ports. The switch core is configured to be coupled to a plurality of peripheral processing devices via the plurality of ingress ports and the plurality of egress ports. The switch core is also configured to provide non-blocking connectivity at line rate between a first peripheral processing device disposed with a first chassis and a second peripheral processing device disposed within a second chassis.

**Scalable security services for multicast in a router having integrated zone-based firewall**

*Patent number:* 8713627

*Abstract:* A multicast-capable firewall allows firewall security policies to be applied to multicast traffic. The multicast-capable firewall may be integrated within a routing device, thus allowing a single device to provide both routing functionality, including multicast support, as well as firewall services. The routing device provides a user interface by which a user specifies one or more zones to
be recognized by the integrated firewall when applying stateful firewall services to multicast packets. The user interface supports a syntax that allows the user to define subsets of the plurality of interfaces associated with the zones, and define a single multicast policy to be applied to multicast sessions associated with a multicast group. The multicast policy identifies common services to be applied pre-replication, and exceptions specifying additional services to be applied post-replication to copies of the multicast packets for the one or more zones.

Type: Grant
Filed: April 29, 2009
Issued: April 29, 2014
Assignee: Juniper Networks, Inc.
Inventors: Kannan Varadhan, Jean-Marc Frailong, Anjan Venkatramani

METHODS AND APPARATUS FOR PROVIDING SERVICES IN DISTRIBUTED SWITCH

Application number: 20140003433

Abstract: In some embodiments, a non-transitory processor-readable medium stores code representing instructions to be executed by a processor. The code causes the processor to receive, from a source peripheral processing device, a portion of a data packet having a destination address associated with a destination peripheral processing device. The code causes the processor to identify, based on the destination address, a service to be performed on the portion of the data packet. The code causes the processor to select, based on the service, an identifier of a service module associated with the service. The code further causes the processor to send the portion of the data packet to the service module via a distributed switch fabric such that the service module performs the service on the portion of the data packet and sends the portion of the data packet to the destination peripheral processing device via the distributed switch fabric.

Type: Application
Filed: June 29, 2012
Issued: January 2, 2014
Assignee: Juniper Networks, Inc.
Inventors: Krishna Narayanaswamy, Jean-Marc Frailong, Anjan Venkatramani, Srinivasan Jagannadhan
METHODS AND APPARATUS FOR PROVIDING SERVICES IN DISTRIBUTED SWITCH

Application number: 20140006549
Abstract: In some embodiments, a non-transitory processor-readable medium stores code representing instructions to be executed by a processor. The code causes the processor to receive, at an edge device, a first data unit having a characteristic. The code causes the processor to identify, at a first time, an identifier of a service module associated with the characteristic in response to each entry from a set of entries within a flow table not being associated with the characteristic. The code causes the processor to define an entry in the flow table associated with the characteristic and the identifier of the service module. The code causes the processor to send the first data unit to the service module. The code causes the processor to receive, at the edge device, a second data unit having the characteristic, and send the second data unit to the service module based on the entry.

Type: Application
Filed: June 29, 2012
Issued: January 2, 2014
Assignee: Juniper Networks, Inc.
Inventors: Krishna Narayanaswamy, Jean-Marc Frailong, Anjan Venkatramani, Srinivasan Jagannadhan

METHODS AND APPARATUS FOR CONFIGURING A VIRTUAL NETWORK SWITCH

Application number: 20130315060
Abstract: In one embodiment, a method includes sending a configuration signal to a virtual network switch module within a control plane of a communications network. The configuration signal is configured to define a first network rule at the virtual network switch module. The method also includes configuring a packet forwarding module such that the packet forwarding module implements a second network rule, and receiving status information from the virtual network switch module and status information from the packet forwarding module. The status information is received via the control plane.

Type: Application
Filed: May 13, 2013
Issued: November 28, 2013
Convenient, flexible, and efficient management of memory space and bandwidth

Abstract: A device may receive a request to read data from or write data to a memory that includes a number of memory banks. The request may include an address. The device may perform a mapping operation on the address to map the address from a first address space to a second address space, identify one of the memory banks based on the address in the second address space, and send the request to the identified memory bank.

Methods and apparatus for configuring a virtual network switch

Abstract: In one embodiment, a method includes sending a configuration signal to a virtual network switch module within a control plane of a communications network. The configuration signal is configured to define a first network rule at the virtual network switch module. The method also includes configuring a packet forwarding module such that the packet forwarding module implements a second network rule, and receiving status information from the virtual network switch module and status information from the packet forwarding module. The status information is received via the control plane.

METHODS AND APPARATUS FOR A CONVERGED WIRED/WIRELESS ENTERPRISE NETWORK ARCHITECTURE
Application number: 20130083724
Abstract: In some embodiments, an apparatus comprises a core network node and a control module within an enterprise network architecture. The core network node is configured to be operatively coupled to a set of wired network nodes and a set of wireless network nodes. The core network node is configured to receive a first tunneled packet associated with a first session from a wired network node from the set of wired network nodes. The core network node is configured to also receive a second tunneled packet associated with a second session from a wireless network node from the set of wireless network nodes through intervening wired network nodes from the set of wired network nodes. The control module is operatively coupled to the core network node. The control module is configured to manage the first session and the second session.

Type: Application
Filed: October 4, 2011
Issued: April 4, 2013
Inventors: Pradeep SINDHU, Abhijit CHOU DHURY, James MURPHY, Raghavendra MAL LYA, Pranay POGDE, Phalguni NANDA, Jayabharat BODDU, Gunes AYBAY, Anjan VENKAT RAMANI

Convenient, flexible, and efficient management of memory space and bandwidth
Patent number: 8397010
Abstract: A device may receive a request to read data from or write data to a memory that includes a number of memory banks. The request may include an address. The device may perform a mapping operation on the address to map the address from a first address space to a second address space, identify one of the memory banks based on the address in the second address space, and send the request to the identified memory bank.

Type: Grant
Filed: July 27, 2007
Issued: March 12, 2013
Assignee: Juniper Networks, Inc.
Inventors: Anjan Venkatramani, Srinivas Perla, John Keen

METHODS AND APPARATUS RELATED TO A FLEXIBLE DATA CENTER SECURITY ARCHITECTURE
**Application number:** 20130003726  
**Abstract:** In one embodiment, edge devices can be configured to be coupled to a multi-stage switch fabric and peripheral processing devices. The edge devices and the multi-stage switch fabric can collectively define a single logical entity. A first edge device from the edge devices can be configured to be coupled to a first peripheral processing device from the peripheral processing devices. The second edge device from the edge devices can be configured to be coupled to a second peripheral processing device from the peripheral processing devices. The first edge device can be configured such that virtual resources including a first virtual resource can be defined at the first peripheral processing device. A network management module coupled to the edge devices and configured to provision the virtual resources such that the first virtual resource can be migrated from the first peripheral processing device to the second peripheral processing device.  
**Type:** Application  
**Filed:** September 10, 2012  
**Issued:** January 3, 2013  
**Assignee:** Juniper Networks, Inc.  
**Inventors:** Pradeep SINDHU, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

**Methods and apparatus related to a low cost data center architecture**  
**Patent number:** 8340088  
**Abstract:** In one embodiment, an apparatus can include a first edge device that can have a packet processing module. The first edge device can be configured to receive a packet. The packet processing module of the first edge device can be configured to produce cells based on the packet. A second edge device can have a packet processing module configured to reassemble the packet based on the cells. A multi-stage switch fabric can be coupled to the first edge device and the second edge device. The multi-stage switch fabric can define a single logical entity. The multi-stage switch fabric can have switch modules. Each switch module from the switch modules can have a shared memory device. The multi-stage switch fabric can be configured to switch the cells so that the cells are sent to the second edge device.  
**Type:** Grant  
**Filed:** September 11, 2009  
**Issued:** December 25, 2012
Methods and apparatus related to low latency within a data center

Patent number: 8335213

Abstract: In one embodiment, an apparatus includes a switch core that has a multi-stage switch fabric. The multi-stage switch fabric has a set of ingress ports and a set of egress ports. The switch core can be configured to be coupled to a set of edge devices via the set of ingress ports and the set of egress ports. The switch core can be configured to receive a packet from an ingress port from the set of ingress ports. The switch core can be configured to send a set of cells associated with the packet from the ingress port to an egress port from the set of egress ports without a store-and-forward delay associated with a zero-load latency for the switch core.

Type: Grant
Filed: June 30, 2009
Issued: December 18, 2012
Assignee: Juniper Networks, Inc.
Inventors: Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

Ordering write bursts to memory

Patent number: 8327057

Abstract: A device may receive requests intended for a memory that includes a number of banks, determine a number of the requests intended for each of the banks, determine an order for the requests based on the determined number of the requests intended for each of the banks, and send one of the requests to the memory based on the determined order.

Type: Grant
Filed: July 27, 2007
Issued: December 4, 2012
Assignee: Juniper Networks, Inc.
Inventors: Anjan Venkatramani, Srinivas Perla, John Keen
Systems and methods for implementing virtual switch planes in a physical switch fabric  
Patent number: 8320369  
Abstract: A switching device includes multiple interfaces and a switch fabric. The switch fabric includes switch integrated circuits arranged in a number of stages. Multiple virtual switch planes may be implemented in the switch fabric. Data traffic received at the interfaces is selectively assigned to different ones of the virtual switch planes.  
Type: Grant  
Filed: June 6, 2008  
Issued: November 27, 2012  
Assignee: Juniper Networks, Inc.  
Inventors: Philippe LaCroute, Matthew A Tucker, John D Weisbloom, Anjan Venkatramani, Jayabharat Boddu, Stefan Dyckerhoff

Forwarding plane configuration for separation of services and forwarding in an integrated services router  
Patent number: 8300532  
Abstract: A method may include receiving a packet at an ingress line interface in a forwarding plane of a network element, the packet including header information. The method may also include conducting a flow table lookup in the forwarding plane to identify an existing flow for the packet and determining, in the forwarding plane and based on the header information, whether a predicted flow can be identified for the packet if an existing flow can not be identified. The method may further include performing a service access control list (ACL) lookup in the forwarding plane if a predicted flow can not be identified; and forwarding the packet to one of a services plane or an egress line interface in the forwarding plane based on one of the existing flow, the predicted flow, or the service ACL lookup.  
Type: Grant  
Filed: September 23, 2008  
Issued: October 30, 2012  
Assignee: Juniper Networks, Inc.  
Inventors: Anjan Venkatramani, Kannan Varadhan, Jean-Marc Frailong, Sanjay Gupta, Linda Sun, Sankar Ramamoorthi, Pradeep Sindhu, Anand S. Athreya, Chih-Wei Chao, Shuhua Ge
**Banked memory arbiter for control memory**

**Patent number:** 8285914

**Abstract:** A device includes a memory that includes a number of banks. The device receives requests for accessing the memory, determines the banks to which the requests are intended, determines one or more of the banks that are available, selects one or more of the requests to send to the memory based on the one or more of the banks that are available and have a request to be serviced, and sends the selected one or more requests to the memory.

**Type:** Grant

**Filed:** July 27, 2007

**Issued:** October 9, 2012

**Assignee:** Juniper Networks, Inc.

**Inventors:** Anjan Venkatramani, Srinivas Perla, John Keen

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**Methods and apparatus related to a flexible data center security architecture**

**Patent number:** 8265071

**Abstract:** In one embodiment, edge devices can be configured to be coupled to a multi-stage switch fabric and peripheral processing devices. The edge devices and the multi-stage switch fabric can collectively define a single logical entity. A first edge device from the edge devices can be configured to be coupled to a first peripheral processing device from the peripheral processing devices. The second edge device from the edge devices can be configured to be coupled to a second peripheral processing device from the peripheral processing devices. The first edge device can be configured such that virtual resources including a first virtual resource can be defined at the first peripheral processing device. A network management module coupled to the edge devices and configured to provision the virtual resources such that the first virtual resource can be migrated from the first peripheral processing device to the second peripheral processing device.

**Type:** Grant

**Filed:** September 11, 2009

**Issued:** September 11, 2012

**Assignee:** Juniper Networks, Inc.

**Inventors:** Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra
Mapping address bits to improve spread of banks

**Patent number:** 8225027  
**Abstract:** A device may include a group of requestors issuing requests, a memory that includes a set of memory banks, and a control block. The control block may receive a request from one of the requestors, where the request includes a first address. The control block may perform a logic operation on a high order bit and a low order bit of the first address to form a second address, identify one of the memory banks based on the second address, and send the request to the identified memory bank.

**Type:** Grant  
**Filed:** June 30, 2011  
**Issued:** July 17, 2012  
**Assignee:** Juniper Networks, Inc.  
**Inventors:** Anjan Venkatramani, Srinivas Perla, John Keen

Systems and methods for implementing end-to-end checksum

**Patent number:** 8190966  
**Abstract:** A network device includes input logic and output logic. The input logic receives multiple packets, where each of the multiple packets has a variable length, and generates a first error detection code for one of the received multiple packets. The input logic further fragments the one of the variable length packets into one or more fixed length cells, where the fragmentation produces a cell of the one or more fixed length cells that includes unused overhead bytes that fill up the cell beyond a last portion of the fragmented one of the variable length packets, and selectively inserts the first error detection code into the overhead bytes. The input logic also forwards the one or more fixed length cells towards the output logic of the network device.

**Type:** Grant  
**Filed:** September 10, 2007  
**Issued:** May 29, 2012  
**Assignee:** Juniper Networks, Inc.  
**Inventor:** Anjan Venkatramani

Methods and apparatus for provisioning at a network device in response to a virtual resource migration notification
**METHODS AND APPARATUS FOR CENTRALIZED VIRTUAL SWITCH FABRIC CONTROL**

**Abstract:** In some embodiments, an apparatus comprises a processing module, disposed within a first switch fabric element, configured to detect a second switch fabric element having a routing module when the second switch fabric element is operatively coupled to the first switch fabric element. The processing module is configured to define a virtual processing module configured to be operatively coupled to the second switch fabric element. The virtual processing module is configured to receive a request from the second switch fabric element for forwarding information and the virtual processing module is configured to send the forwarding information to the routing module.

**Type:** Application

**Filed:** November 22, 2010

**Issued:** May 24, 2012

**Assignee:** JUNIPER NETWORKS, INC.

**Inventors:** Gunes AYBAY, Pradeep SINDHU, Anjan VENKATRAMANI

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**VIRTUAL MACHINE MOBILITY IN DATA CENTERS**
Application number: 20110314155

Abstract: A data center management device determines that a virtual machine should be moved from a first physical system to a second physical system. The data center management device instructs a first service appliance at the first physical system to perform state synchronization with a second service appliance at the second physical system in order to continue providing the services offered prior to the move. The data center management device instructs the virtual machine to be instantiated at the second physical system.

Type: Application
Filed: June 16, 2010
Issued: December 22, 2011
Assignee: JUNIPER NETWORKS, INC.
Inventors: Krishna NARAYANASWAMY, Anjan VENKATRAMANI

Ordering refresh requests to memory
Patent number: 8078791

Abstract: A device may generate a refresh signal that identifies a beginning of a refresh interval, determine the availability of banks of a memory device, and send refresh requests to the banks during the refresh interval based on the availability of the banks.

Type: Grant
Filed: July 27, 2007
Issued: December 13, 2011
Assignee: Juniper Networks, Inc.
Inventors: Srinivas Perla, Anjan Venkatramani, John Keen

Methods and apparatus for routing between virtual resources based on a routing location policy
Patent number: 8054832

Abstract: In one embodiment, a method includes performing, at a host device on a first side of a single-hop link, packet classification associated with hairpin routing of a first data packet between a first virtual resource and a second virtual resource that are logically defined at the host device. The first virtual resource can be different than the second virtual resource. The method also includes transmitting a second data packet to a network device on a second side of the single-hop link so that packet classification associated with hairpin routing of the second data packet
packet between at least two virtual resources logically defined at the host device is performed at the network device.

**Type:** Grant  
**Filed:** December 30, 2008  
**Issued:** November 8, 2011  
**Assignee:** Juniper Networks, Inc.  
**Inventors:** Amit Shukla, Anjan Venkatramani

### MAPPING ADDRESS BITS TO IMPROVE SPREAD OF BANKS

**Application number:** 20110254590  
**Abstract:** A device may include a group of requestors issuing requests, a memory that includes a set of memory banks, and a control block. The control block may receive a request from one of the requestors, where the request includes a first address. The control block may perform a logic operation on a high order bit and a low order bit of the first address to form a second address, identify one of the memory banks based on the second address, and send the request to the identified memory bank.  
**Type:** Application  
**Filed:** June 30, 2011  
**Issued:** October 20, 2011  
**Assignee:** JUNIPER NETWORKS, INC.  
**Inventors:** Anjan VENKATRAMANI, Srinivas PERLA, John KEEN

### Mapping address bits to improve spread of banks

**Patent number:** 7996597  
**Abstract:** A device may include a group of requestors issuing requests, a memory that includes a set of memory banks, and a control block. The control block may receive a request from one of the requestors, where the request includes a first address. The control block may perform a logic operation on a high order bit and a low order bit of the first address to form a second address, identify one of the memory banks based on the second address, and send the request to the identified memory bank.  
**Type:** Grant  
**Filed:** July 27, 2007  
**Issued:** August 9, 2011  
**Assignee:** Juniper Networks, Inc.
Inventors: Anjan Venkatramani, Srinivas Perla, John Keen

**METHODS AND APPARATUS FOR CONFIGURING A VIRTUAL NETWORK SWITCH**

**Application number:** 20110103259  
**Abstract:** In one embodiment, a method includes sending a configuration signal to a virtual network switch module within a control plane of a communications network. The configuration signal is configured to define a first network rule at the virtual network switch module. The method also includes configuring a packet forwarding module such that the packet forwarding module implements a second network rule, and receiving status information from the virtual network switch module and status information from the packet forwarding module. The status information is received via the control plane.  
**Type:** Application  
**Filed:** November 4, 2009  
**Issued:** May 5, 2011  
**Inventors:** Gunes Aybay, Pradeep Sindhu, Anjan Venkatramani

**SYSTEM ARCHITECTURE FOR A SCALABLE AND DISTRIBUTED MULTI-STAGE SWITCH FABRIC**

**Application number:** 20100165983  
**Abstract:** In some embodiments, an apparatus includes a first housing, a second housing and at least one cable. The first housing includes a first interface card of a switch fabric. The second housing includes a second interface card of the switch fabric and a third interface card of the switch fabric. The second interface card of the switch fabric is operatively and physically coupled to the third interface card of the switch fabric via a midplane. The second interface card defines a plane that is nonparallel to the a plane defined by the third interface card and a plane defined by the midplane. The plane defined by the third interface card is nonparallel to the plane defined by the second interface card and the plane defined by the midplane. The cable is configured to operatively couple the first interface card to the second interface card.  
**Type:** Application  
**Filed:** December 29, 2008  
**Issued:** July 1, 2010
METHODS AND APPARATUS RELATED TO A MODULAR SWITCH ARCHITECTURE

**Application number:** 20100165984

**Abstract:** In some embodiments, an apparatus includes a first housing, a second housing and at least one cable. The first housing includes a first interface card of a switch fabric. The second housing includes a second interface card of the switch fabric and a third interface card of the switch fabric. The second interface card of the switch fabric is operatively and physically coupled to the third interface card of the switch fabric via a midplane. The second interface card defines a plane that is nonparallel to the a plane defined by the third interface card and a plane defined by the midplane. The plane defined by the third interface card is nonparallel to the plane defined by the second interface card and the plane defined by the midplane. The cable is configured to operatively couple the first interface card to the second interface card.

**Type:** Application

**Filed:** December 29, 2008

**Issued:** July 1, 2010

**Inventors:** Gunes Aybay, Jaya Bandyopadhyay, Jean-Marc Frailong, Pradeep Sindhu, Philip A. Thomas, Anjan Venkatramani

METHODS AND APPARATUS RELATED TO A LOW COST DATA CENTER ARCHITECTURE

**Application number:** 20100061391

**Abstract:** In one embodiment, an apparatus can include a first edge device that can have a packet processing module. The first edge device can be configured to receive a packet. The packet processing module of the first edge device can be configured to produce cells based on the packet. A second edge device can have a packet processing module configured to reassemble the packet based on the cells. A multi-stage switch fabric can be coupled to the first edge device and the second edge device. The multi-stage switch fabric can define a single logical entity. The multi-stage switch fabric can have switch modules. Each switch module from the switch modules can have a shared memory device. The multi-
stage switch fabric can be configured to switch the cells so that the cells are sent to the second edge device.

**METHODS AND APPARATUS RELATED TO LOSSLESS OPERATION WITHIN A DATA CENTER**

**Application number:** 20100061367  
**Abstract:** In one embodiment, an apparatus includes a switch core that defines a single logical entity and has a multi-stage switch fabric that has a set of stages physically distributed across a set of chassis. The set of stages collectively has a set of ingress ports and a set of egress ports. The switch core can be configured to be coupled to a set of peripheral processing devices via the set of ingress ports and the set of egress ports. The switch core can be configured to admit a set of cells associated with a packet into an ingress port from the set of ingress ports when delivery of the set of cells can be substantially guaranteed without loss through the multi-stage switch fabric.

**METHODS AND APPARATUS RELATED TO A FLEXIBLE DATA CENTER SECURITY ARCHITECTURE**

**Application number:** 20100061242  
**Abstract:** In one embodiment, edge devices can be configured to be coupled to a multi-stage switch fabric and peripheral processing devices. The edge devices and the multi-stage switch fabric can collectively define a single logical entity. A first edge device from the edge devices can be configured to be coupled to a first peripheral processing device from the peripheral processing devices. The second edge device from the edge devices can be configured to be coupled to a second peripheral processing device from the peripheral processing devices. The first
edge device can be configured such that virtual resources including a first virtual resource can be defined at the first peripheral processing device. A network management module coupled to the edge devices and configured to provision the virtual resources such that the first virtual resource can be migrated from the first peripheral processing device to the second peripheral processing device.

**Type:** Application  
**Filed:** September 11, 2009  
**Issued:** March 11, 2010  
**Inventors:** Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

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**METHODS AND APPARATUS RELATED TO VIRTUALIZATION OF DATA CENTER RESOURCES**

**Application number:** 20100061389

**Abstract:** In one embodiment, an apparatus includes a switch core that has a multi-stage switch fabric. A first set of peripheral processing devices coupled to the multi-stage switch fabric by a set of connections that have a protocol. Each peripheral processing device from the first set of peripheral processing devices is a storage node that has virtualized resources. The virtualized resources of the first set of peripheral processing devices collectively define a virtual storage resource interconnected by the switch core. A second set of peripheral processing devices coupled to the multi-stage switch fabric by a set of connections that have the protocol. Each peripheral processing device from the first set of peripheral processing devices is a compute node that has virtualized resources. The virtualized resources of the second set of peripheral processing devices collectively define a virtual compute resource interconnected by the switch core.

**Type:** Application  
**Filed:** June 30, 2009  
**Issued:** March 11, 2010  
**Inventors:** Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

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**METHODS AND APPARATUS RELATED TO LOW LATENCY WITHIN A DATA CENTER**

**Application number:** 20100061240
Abstract: In one embodiment, an apparatus includes a switch core that has a multi-stage switch fabric. The multi-stage switch fabric has a set of ingress ports and a set of egress ports. The switch core can be configured to be coupled to a set of edge devices via the set of ingress ports and the set of egress ports. The switch core can be configured to receive a packet from an ingress port from the set of ingress ports. The switch core can be configured to send a set of cells associated with the packet from the ingress port to an egress port from the set of egress ports without a store-and-forward delay associated with a zero-load latency for the switch core.

Type: Application
Filed: June 30, 2009
Issued: March 11, 2010
Inventors: Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

METHODS AND APPARATUS RELATED TO FLOW CONTROL WITHIN A DATA CENTER SWITCH FABRIC

Abstract: In one embodiment, an apparatus includes a switch core that has a multi-stage switch fabric physically distributed among a set of chassis. The multi-stage switch fabric has a set of input buffers and a set of output ports. The switch core can be configured to be coupled to a set of edge devices. The apparatus can also include a controller implemented in hardware without software during operation and with software during configuration and monitoring. The controller can be coupled to the set of input buffers and the set of output ports. The controller can be configured to send a flow control signal to an input buffer from the set of input buffers when congestion at an output port from the set of output ports is predicted and before congestion in the switch core occurs.

Type: Application
Filed: June 30, 2009
Issued: March 11, 2010
Inventors: Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

METHODS AND APPARATUS RELATED TO ANY-TO-ANY CONNECTIVITY WITHIN A DATA CENTER
Application number: 20100061394
Abstract: In one embodiment, an apparatus includes a switch core that defines a single logical entity and has a multi-stage switch fabric physically distributed across a plurality of chassis. The multi-stage switch fabric has a plurality of ingress ports and a plurality of egress ports. The switch core is configured to be coupled to a plurality of peripheral processing devices via the plurality of ingress ports and the plurality of egress ports. The switch core is also configured to provide non-blocking connectivity at line rate between a first peripheral processing device disposed with a first chassis and a second peripheral processing device disposed within a second chassis.
Type: Application
Filed: June 30, 2009
Issued: March 11, 2010
Inventors: Pradeep Sindhu, Gunes Aybay, Jean-Marc Frailong, Anjan Venkatramani, Quaizar Vohra

SCALABLE SECURITY SERVICES FOR MULTICAST IN A ROUTER HAVING INTEGRATED ZONE-BASED FIREWALL
Application number: 20100043067
Abstract: A multicast-capable firewall allows firewall security policies to be applied to multicast traffic. The multicast-capable firewall may be integrated within a routing device, thus allowing a single device to provide both routing functionality, including multicast support, as well as firewall services. The routing device provides a user interface by which a user specifies one or more zones to be recognized by the integrated firewall when applying stateful firewall services to multicast packets. The user interface supports a syntax that allows the user to define subsets of the plurality of interfaces associated with the zones, and define a single multicast policy to be applied to multicast sessions associated with a multicast group. The multicast policy identifies common services to be applied pre-replication, and exceptions specifying additional services to be applied post-replication to copies of the multicast packets for the one or more zones.
Type: Application
Filed: April 29, 2009
Issued: February 18, 2010
Assignee: Juniper Networks, Inc.
Inventors: Kannan Varadhan, Jean-Marc Frailong, Anjan Venkatramani
Systems and methods for implementing virtual switch planes in a physical switch fabric

**Patent number:** 7397794

**Abstract:** A switching device includes multiple interfaces and a switch fabric. The switch fabric includes switch integrated circuits arranged in a number of stages. Multiple virtual switch planes may be implemented in the switch fabric. Data traffic received at the interfaces is selectively assigned to different ones of the virtual switch planes.

**Type:** Grant
**Filed:** November 21, 2002
**Issued:** July 8, 2008
**Assignee:** Juniper Networks, Inc.
**Inventors:** Philippe Lacroute, Matthew A. Tucker, John D. Weisbloom, Anjan Venkatramani, Jayabharat Boddu, Stefan Dyckerhoff

Systems and methods for implementing end-to-end checksum

**Patent number:** 7284181

**Abstract:** A network device includes interface logic and processing logic. The interface logic receives data. The processing logic generates a checksum of the data and fragments the data into one or more cells. The processing logic further determines whether one of the one or more cells includes at least one of cell overhead bytes and cell pad bytes, and selectively inserts the checksum into the at least one of cell overhead bytes and pad bytes based on the determination.

**Type:** Grant
**Filed:** April 24, 2002
**Issued:** October 16, 2007
**Assignee:** Juniper Networks, Inc.
**Inventor:** Anjan Venkatramani