



Network Best Practices for Artificial Intelligence Data Centre

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Solutions Engineer
America's Cloud & AI Infrastructure
BRKDCN-2921



Webex App

Questions?

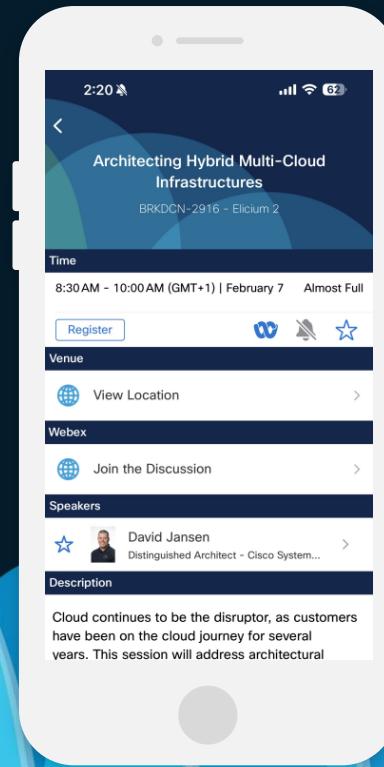
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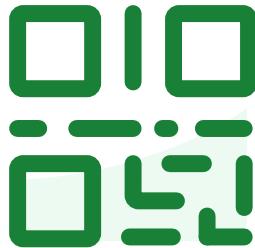
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About Me



- Based In Ontario Canada
- @Cisco 4.5 years
- Background in M&E Engineering

The background of the slide features a large, stylized graphic composed of overlapping semi-circles in shades of green, teal, and blue, creating a wave-like pattern.

Agenda

- Why AI is important today and, in the future
- Network For AI Cluster
- Traffic Load-balancing
- Automation and Visibility
- The Blueprint For Today

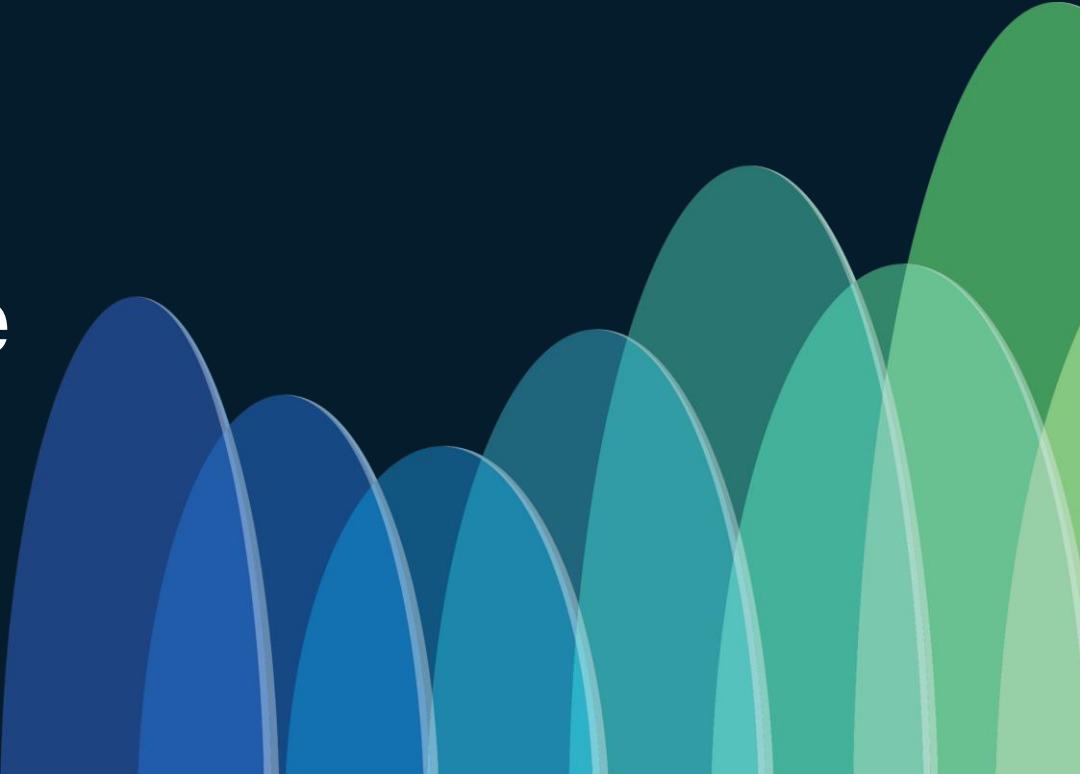
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What do you think about AI

- ① Start presenting to display the poll results on this slide.

Why AI is important today and, in the future



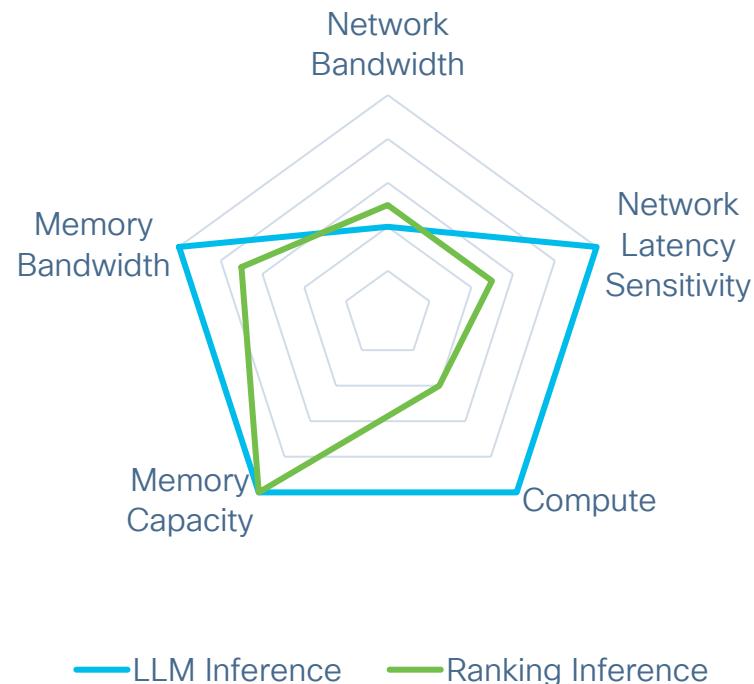
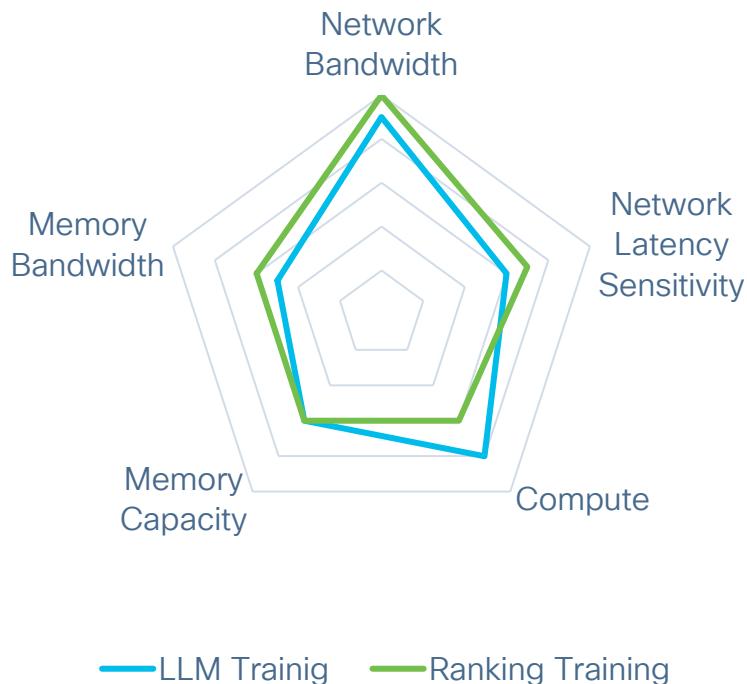
AI/ML can help many industries

Healthcare	Financial Services	Public Sector	Media and Entertainment	Manufacturing	Retail
Medical Risk Prediction	High Frequency Trading Analysis	Intelligent Public Transport	Content Generation	Visual Inspection	Personalized Recommendation
Early diagnostics	Quant Research	Security Log Analytics	Natural Language Processing	Anomaly Detection	Demand Forecasting
Medical Research	Fraud and Risk Analytics	Disaster Recovery Assistance	Content Classification	Asset Management	Visual Search

AI cluster types and interaction with network

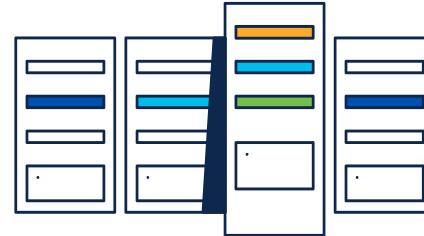
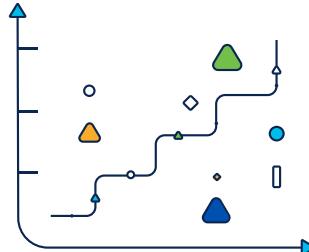
	Distributed Training	Production Inference
Node to Node Bandwidth	High	Low
Key Metric	Training time of a model	High Availability and Latency
Operational Mode	Model training is offline	Usually online, requires real time response
Infrastructure requirement	Large network with many GPU/CPU hosts	Smaller network with mid size of CPU/GPU hosts

Training vs Inference



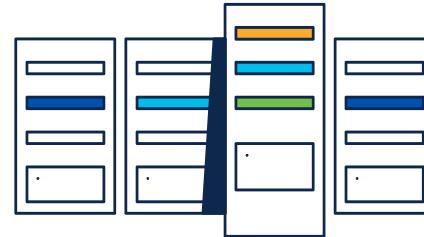
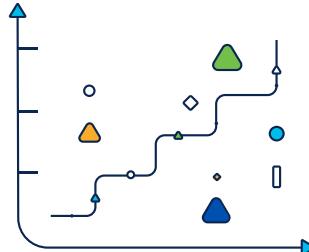
Large-scale distributed training

- Key Challenge of Training Cluster
 - Model Doubles every 2 months
 - Bigger model, higher accuracy
 - Most common single training runs on 512 GPUs
- Cluster Key Components
 - Compute Nodes
 - Network
 - Distributed File System/Storage
 - Job Scheduling and Orchestration
 - Software Framework for AI model



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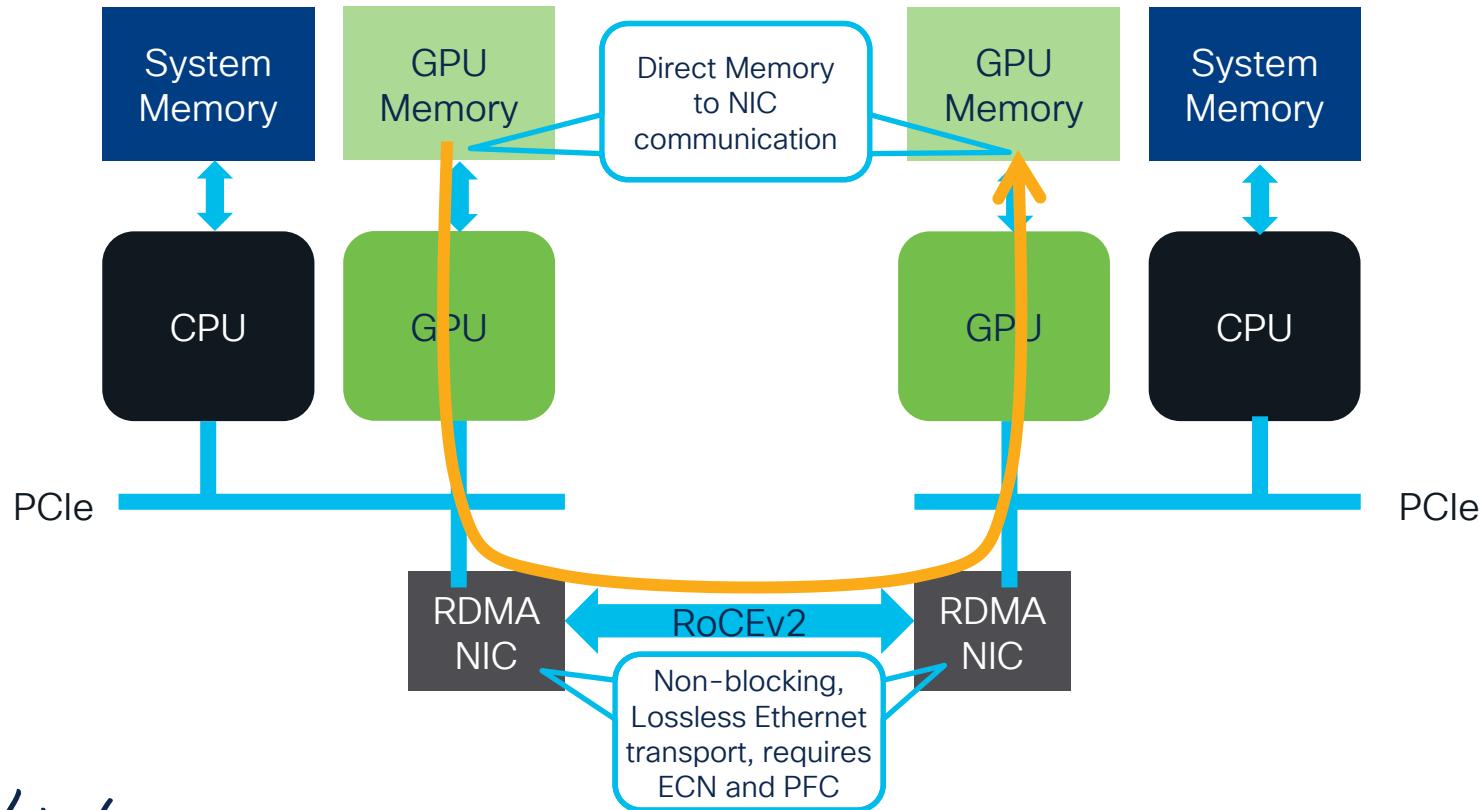


Audience Q&A

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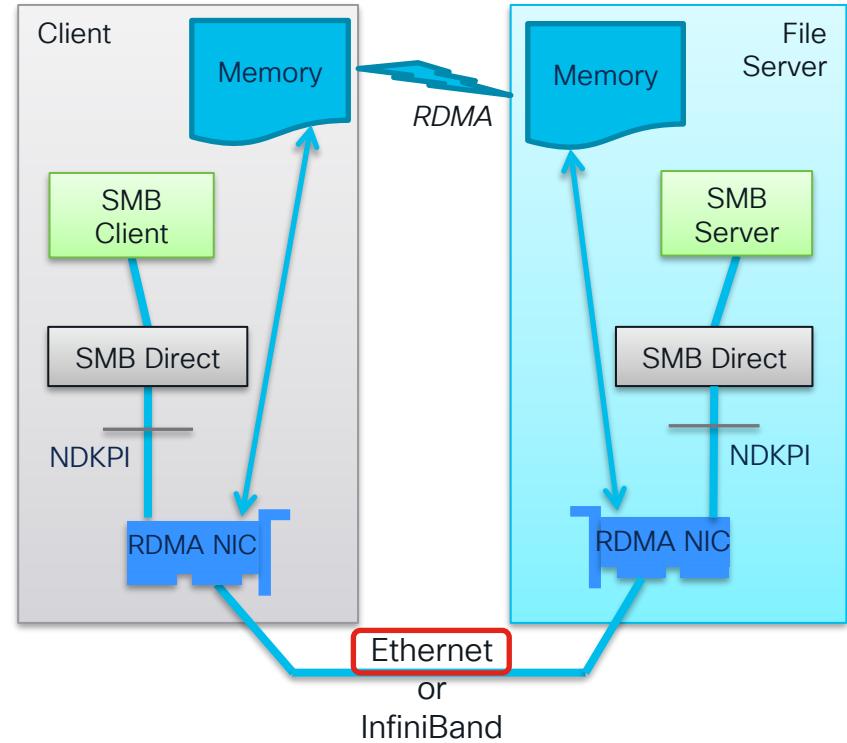
Network For AI Cluster

RoCEv2 – benefits and requirements



RDMA – remote data memory access

- Allows application software to communicate directly with the hardware (RDMA NIC)
- Bypasses OS stack
- RDMA delivers, low latency, high throughput, zero copy capabilities
- RDMA Hardware Technologies
 - RoCE: RDMA over Converged Ethernet
 - iWARP: RDMA over TCP/IP
 - Infiniband



RoCEv2 – basics

- Extension of RoCE protocol that involves a simple modification of the RoCE packet format
- Carry IP header and UDP header that serves as a stateless encapsulation layer for RDMA transport over IP



Source: https://en.wikipedia.org/wiki/RDMA_over_Converged_Ethernet



RoCEv2

- Uses well-known UDP Destination Port (dport) value 4791
- UDP Source Port (sport) serves as opaque flow identifier that can be used by networking infrastructure for packet forwarding optimizations (e.g., ECMP)
- Supports both IPv4 and IPv6
- Makes use of ECN field in IPv4/6 header for signaling of congestion

RoCEv2 End-To-End lossless behavior

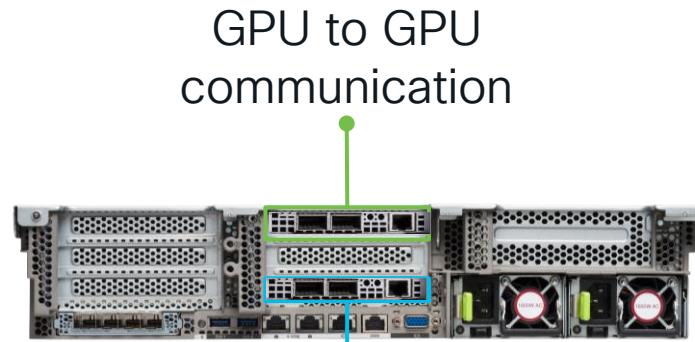
- Requires PFC to be enabled for RoCEv2 transport
- Traffic priority to be preserved between Layer 2 and Layer 3 network
 - Packet/Flow identification follows standard practices of IP/Ethernet networks (i.e., DSCP/802.1Q)
- ECN marking (WRED or consider AFD)
- Configure ETS
 - 802.1Qaz ETS

The screenshot shows a page from the InfiniBand Architecture Volume 1 - General Specifications. The page title is "InfiniBand™ Architecture VOLUME 1 - GENERAL SPECIFICATIONS". The header for the section is "RoCEv2 (IP Routable RoCE)". The date is "September 2, 2014". The section title is "A17.9 RoCEv2 NETWORK CONSIDERATIONS". Sub-section title is "A17.9.1 LOSSLESS NETWORK". A callout box contains the text: "As with RoCE, the underlying networks for RoCEv2 should be configured as lossless. In this context, lossless doesn't mean that packets are abso-". The page number is 1.

Networks – Why do I need them?



UCS C240 M7 Rack Server
Up to 2 GPUs



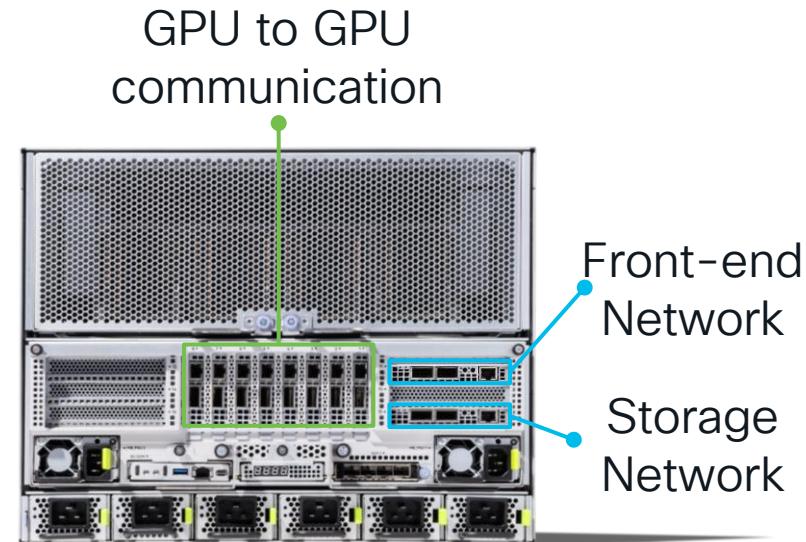
GPU to GPU
communication

Front-end and
Storage Network

Networks – Why do I need them?



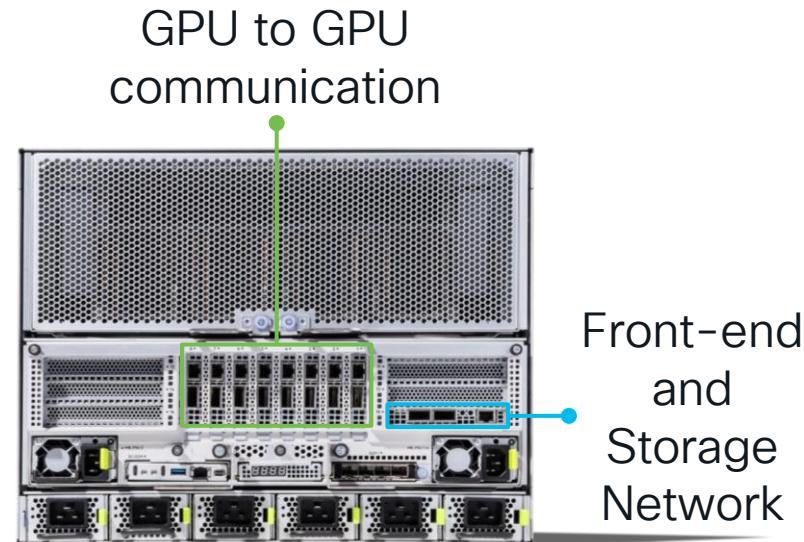
UCS C885A M8 Rack Server
8 GPUs



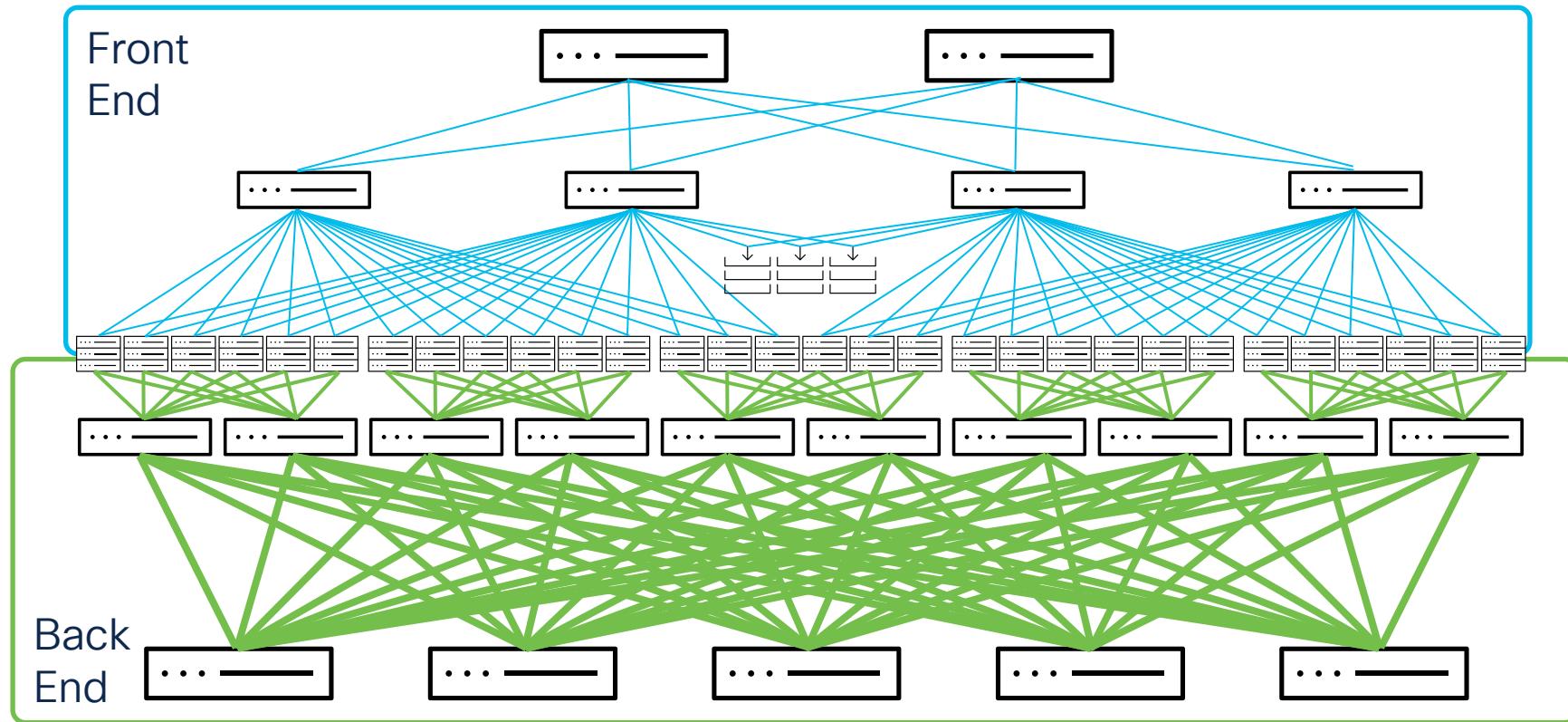
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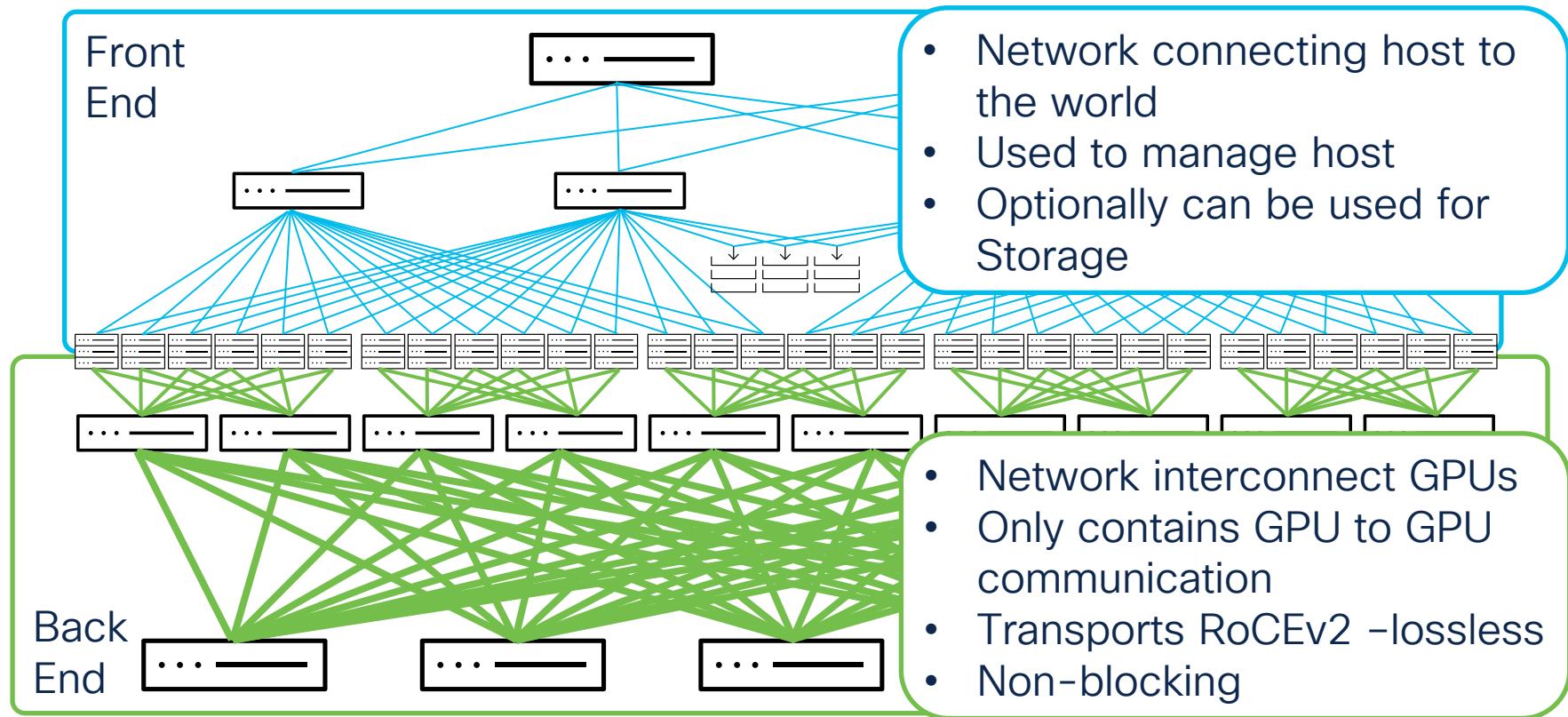
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Non-blocking network



Non-blocking network



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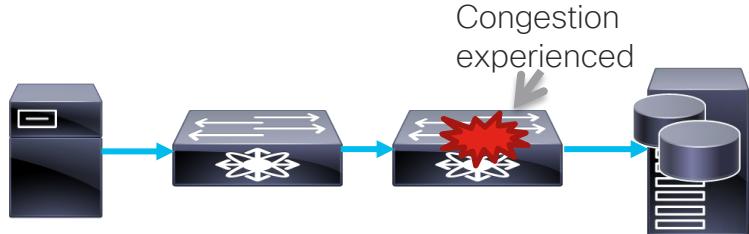


Audience Q&A

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Explicit Congestion Notification (ECN)

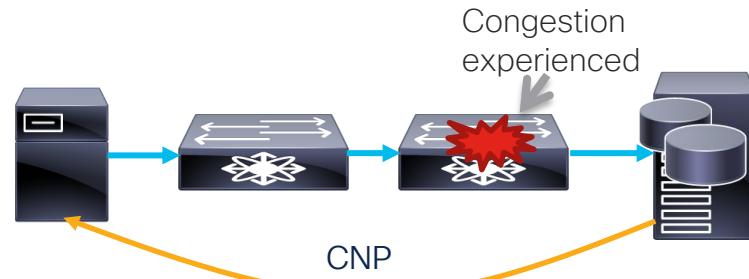
- IP Explicit Congestion Notification (ECN) is used for congestion notification.
- ECN enables end-to-end congestion notification between two endpoints on IP network
- ECN uses 2 LSB of Type of Service field in IP header



ECN	ECN Behavior
00	Non ECN Capable
10	ECN Capable Transport (0)
01	ECN Capable Transport (1)
11	Congestion Encountered

Explicit Congestion Notification (ECN)

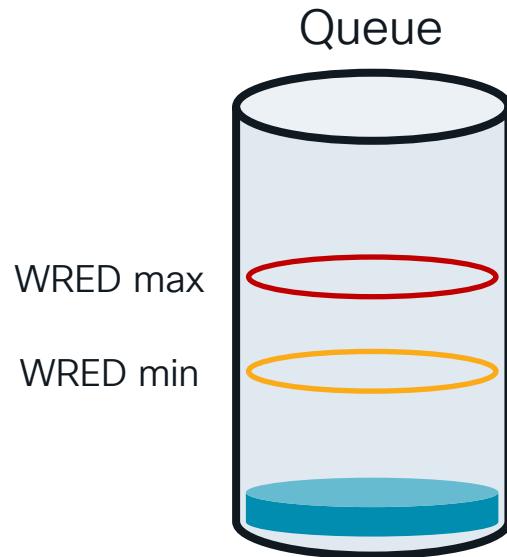
- IP Explicit Congestion Notification (ECN) is used for congestion notification.
- ECN enables end-to-end congestion notification between two endpoints on IP network
- ECN uses 2 LSB of Type of Service field in IP header
- In case of congestion, ECN gets transmitting device to reduce transmission rate using Congestion Notification Packet (CNP) without pausing traffic.



ECN	ECN Behavior
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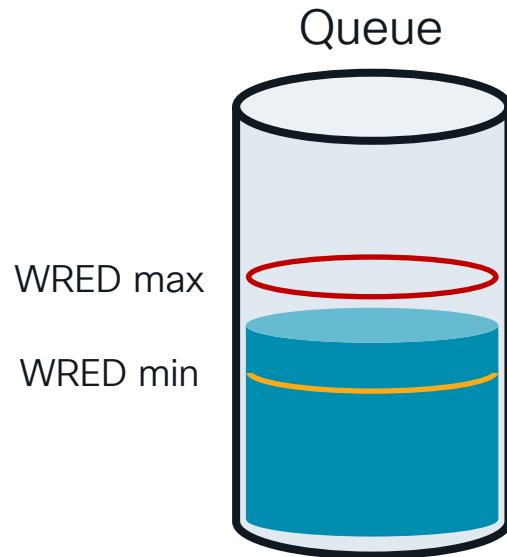
How does WRED ECN work?

- WRED (Weighted Random Early Detection) is used to signalize severity of congestion
- ECN is not marked when buffer usage is below WRED min threshold



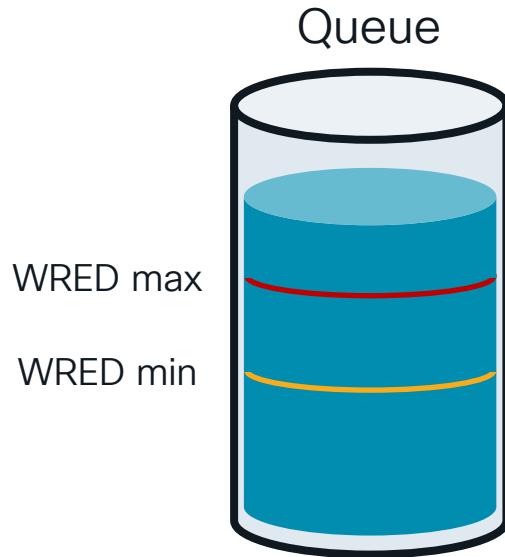
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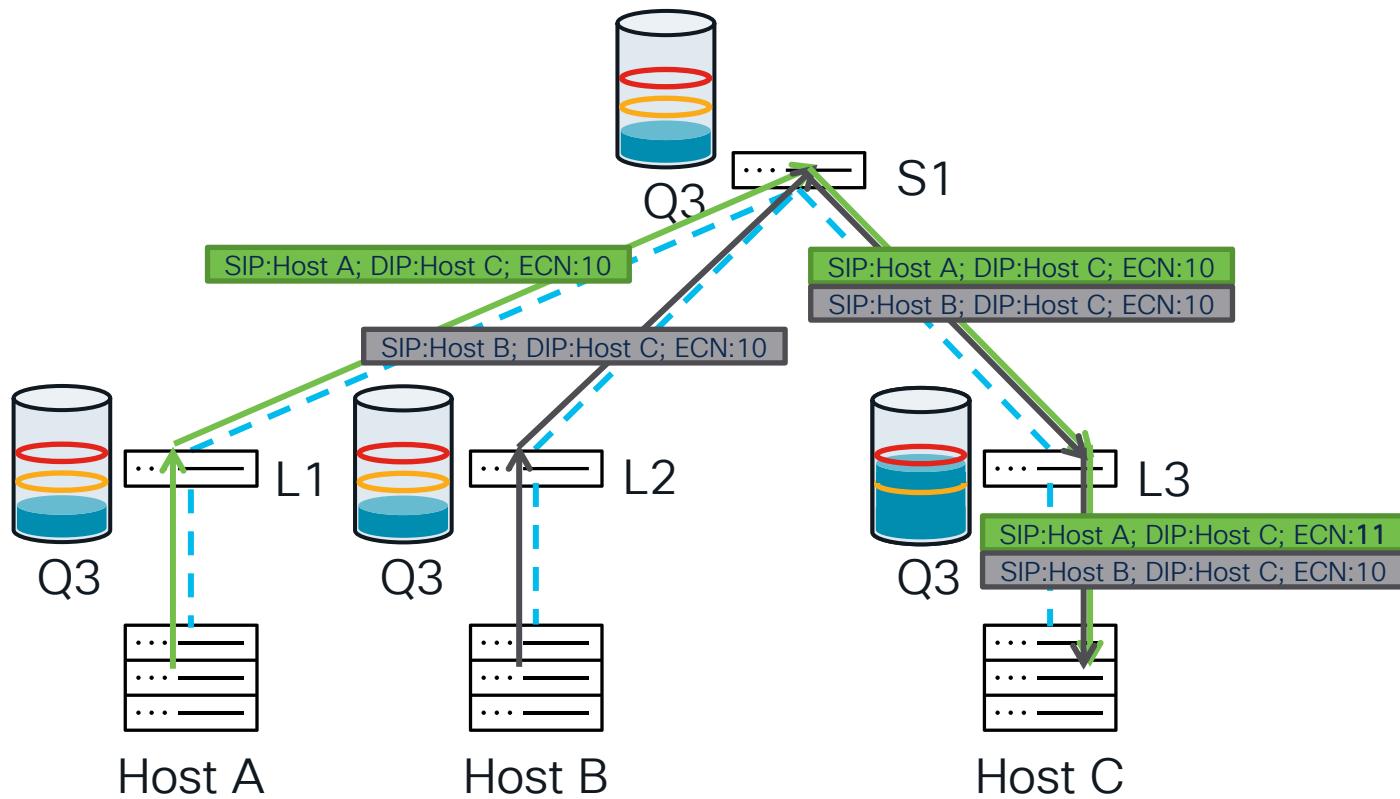


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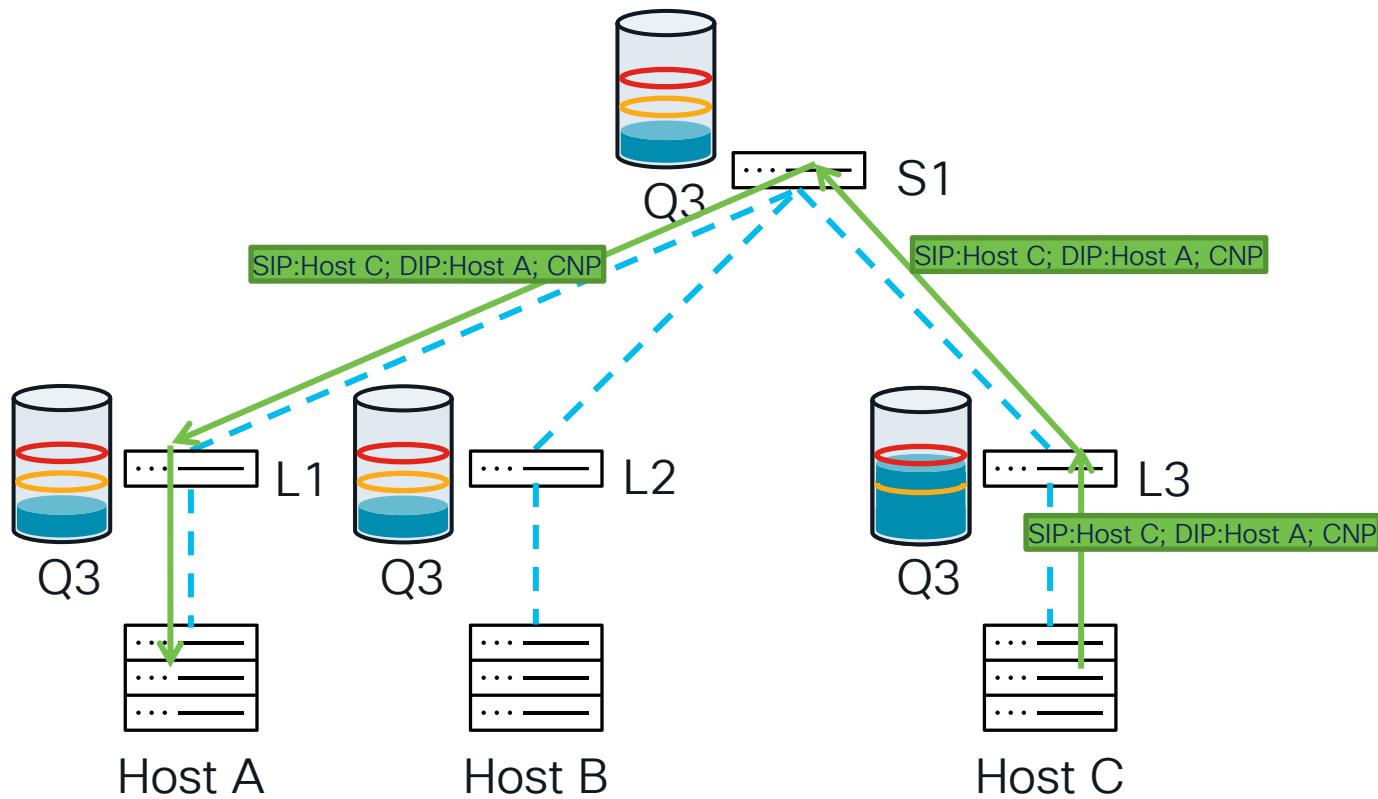
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- When buffer usage is minimal threshold, Congestion Encountered will be marked on N number of randomly selected packets (probability parameter)
- After buffer usage crosses MAX threshold, every ECN capable packet will be marked with Congestion Encountered



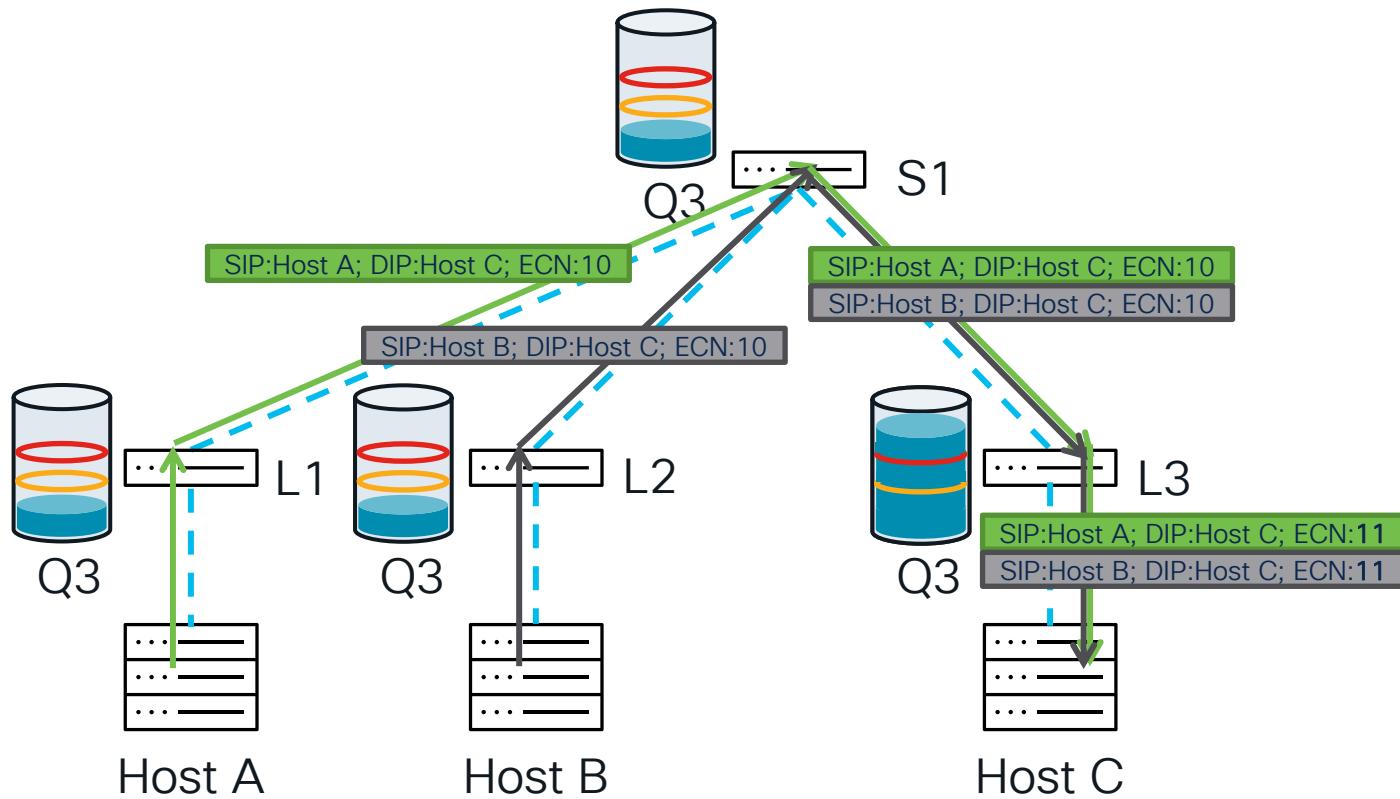
Explicit Congestion Notification – End to End



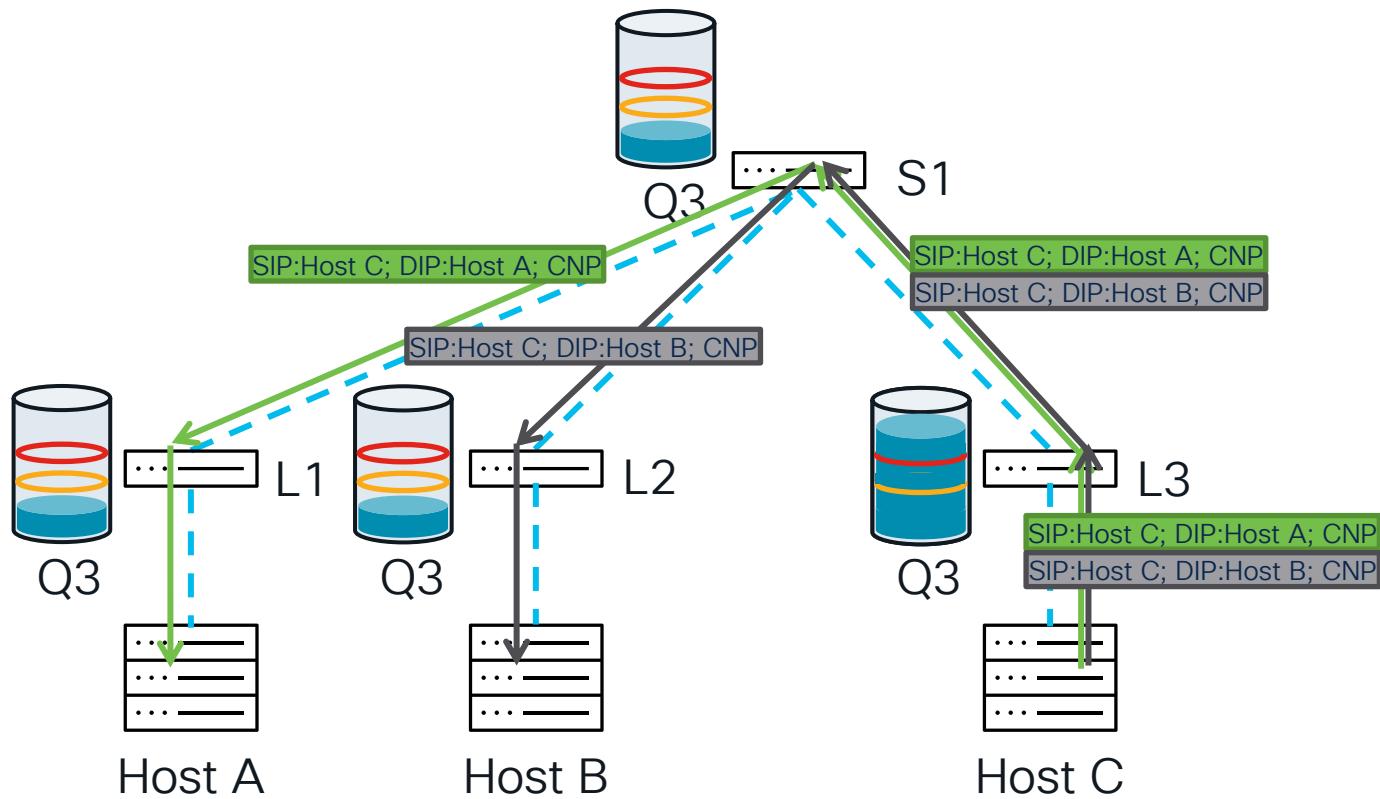
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Explicit Congestion Notification – End to End



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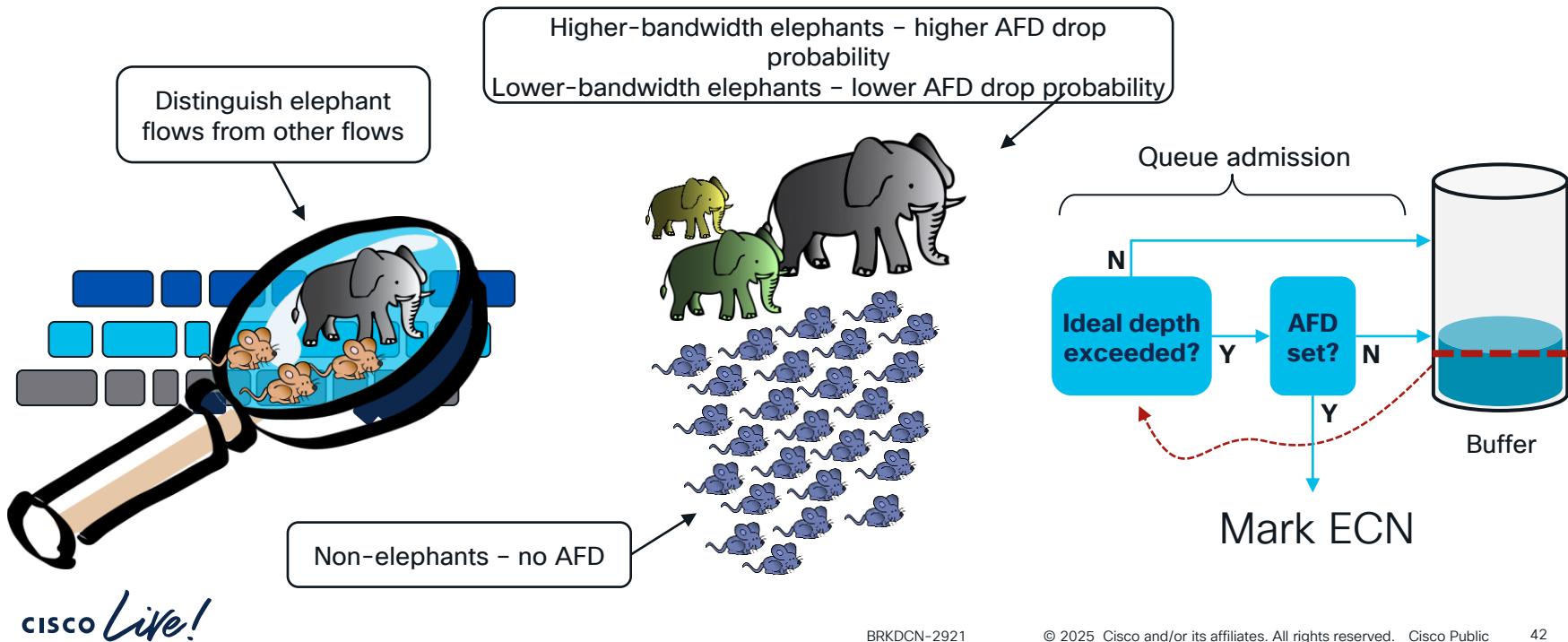


Audience Q&A

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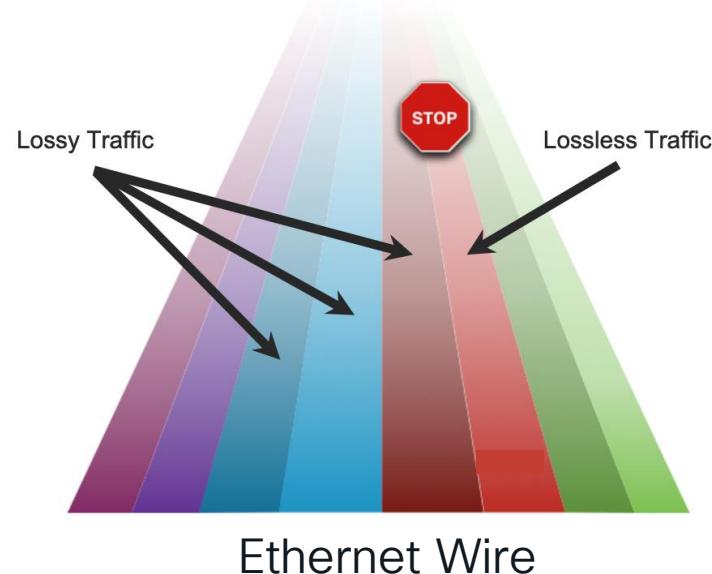
Approximate Fair Drop (AFD)

Maintain throughput while minimizing buffer consumption by elephant flows – **keep buffer state as close to the ideal as possible**



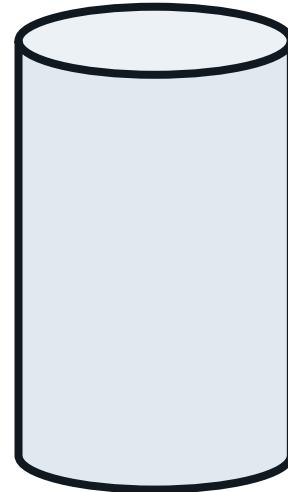
Priority Flow Control

- Flow Control Mechanism – 802.1Qbb
- A.k.a "Lossless Ethernet"
- PFC enables Flow Control on a Per-Priority basis
- PFC is also called Per-Priority-Pause
- Therefore, we have the ability to have lossless and lossy priorities at the same time on the same wire
- Allows traffic to operate over a lossless priority independent of other priorities
- Other traffic assigned to other priority will continue to transmit and rely on upper layer protocols for retransmission



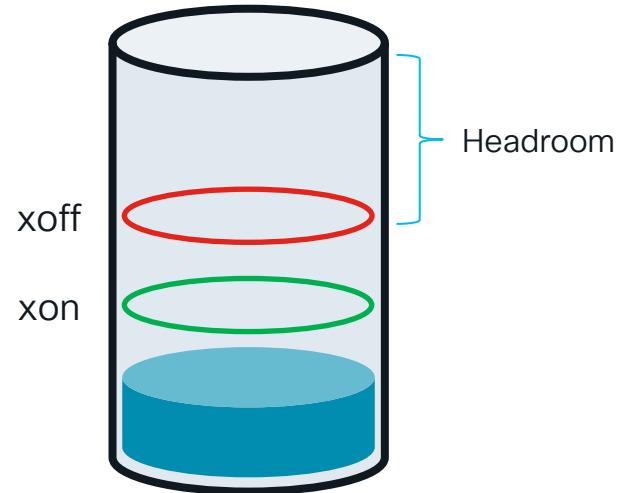
PFC – How pause frames are sent

- PFC sets thresholds in no-drop queue
- Headroom is present to accommodate “in flight” packets



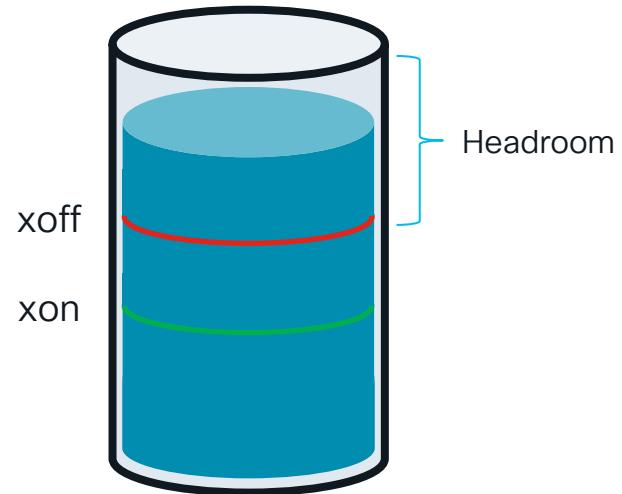
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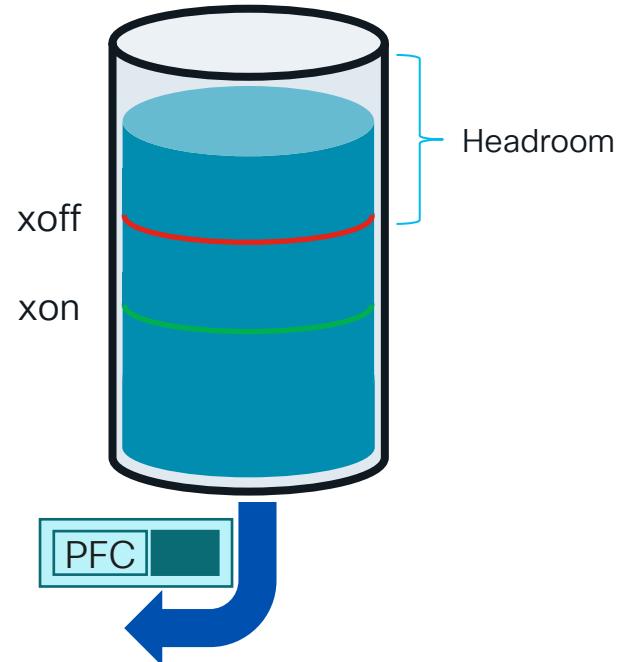
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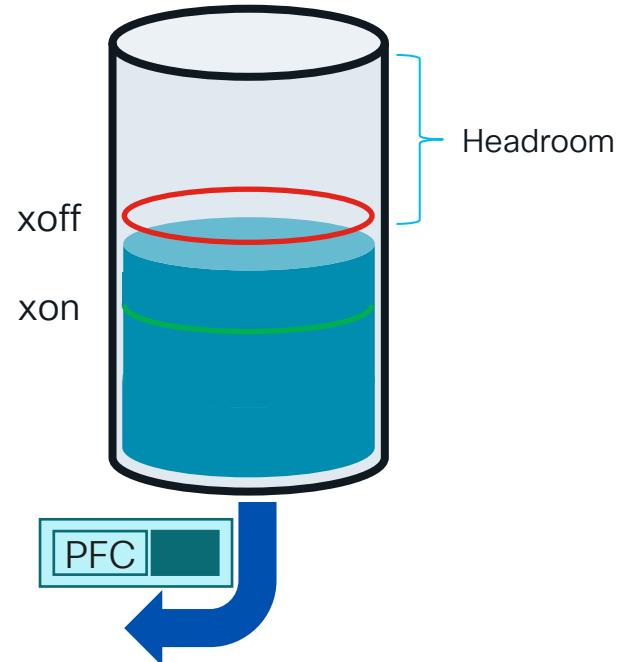
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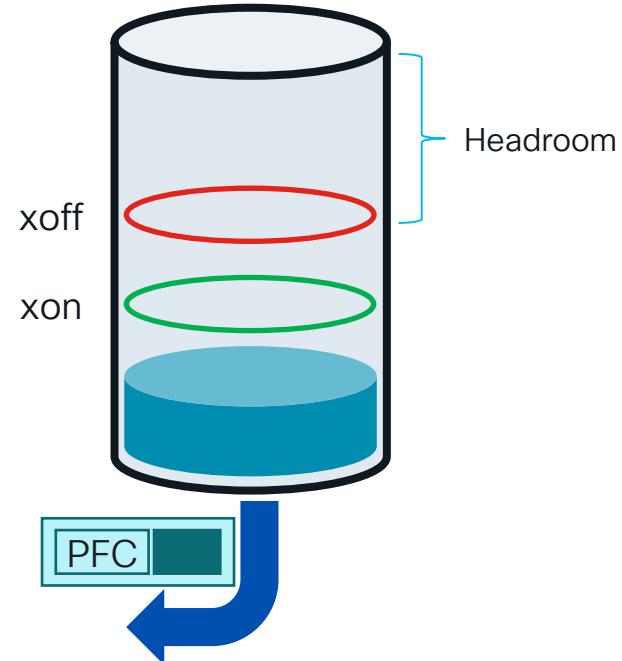
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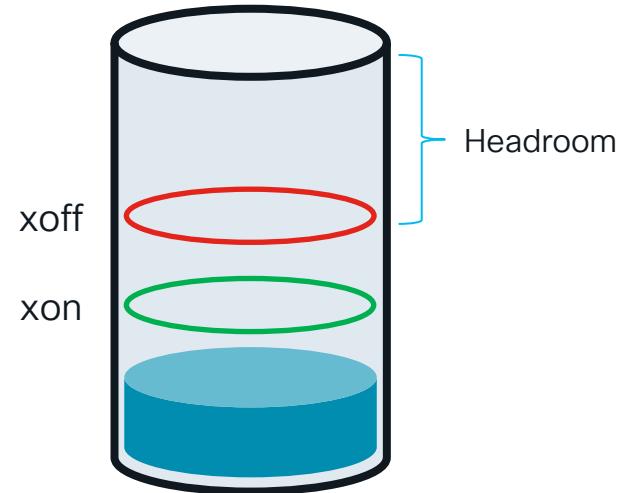
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- While draining the queue, and utilization is below *xon* threshold system will stop sending PFC frames

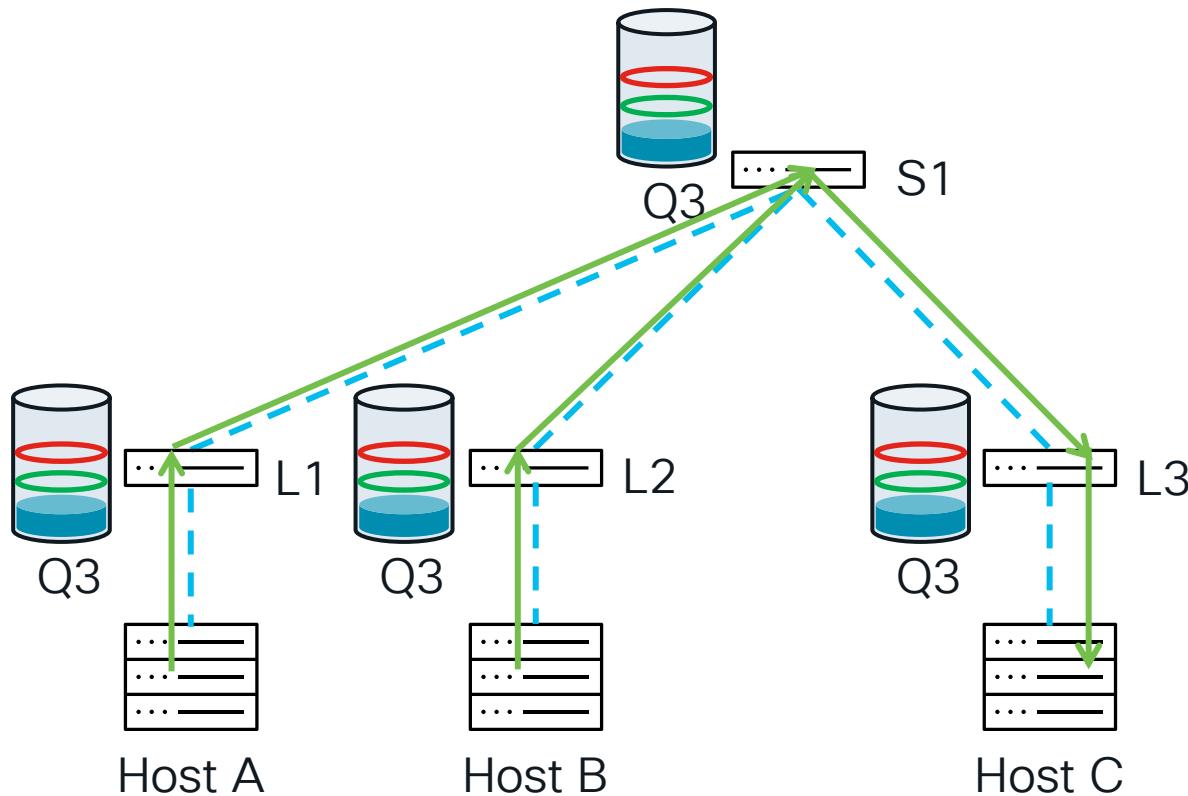


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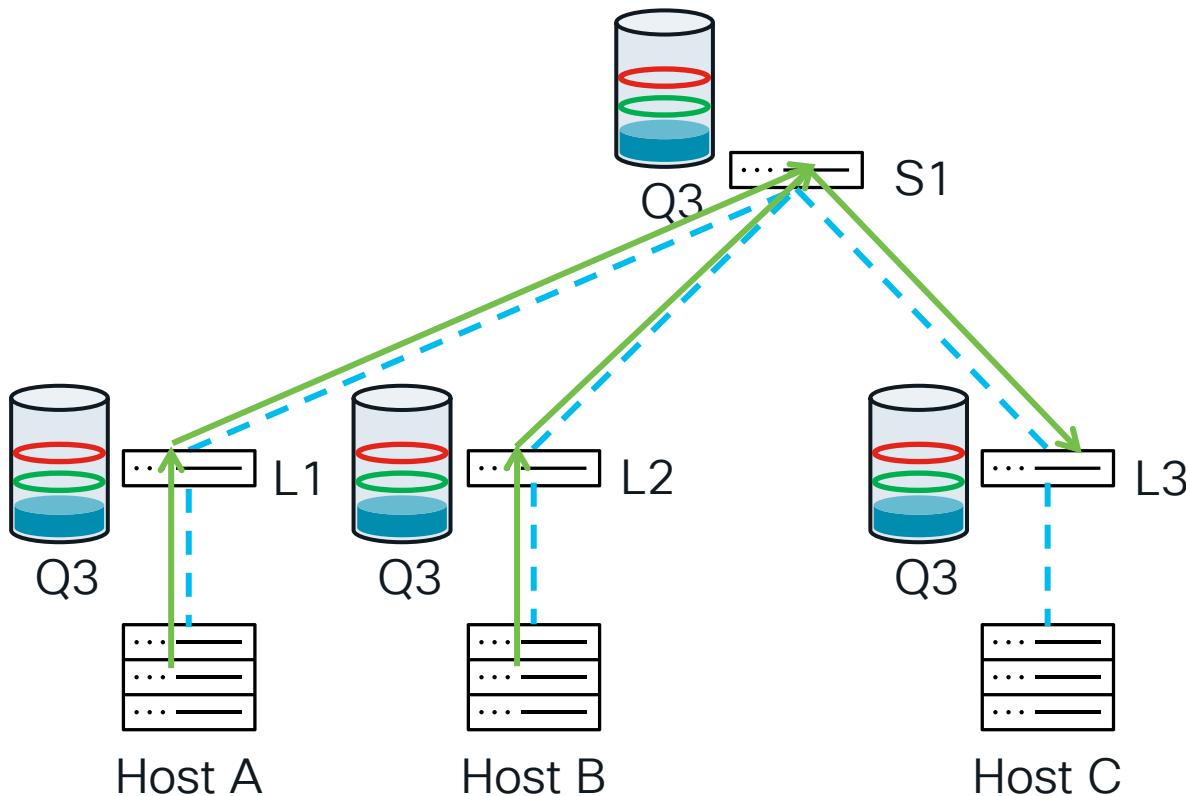
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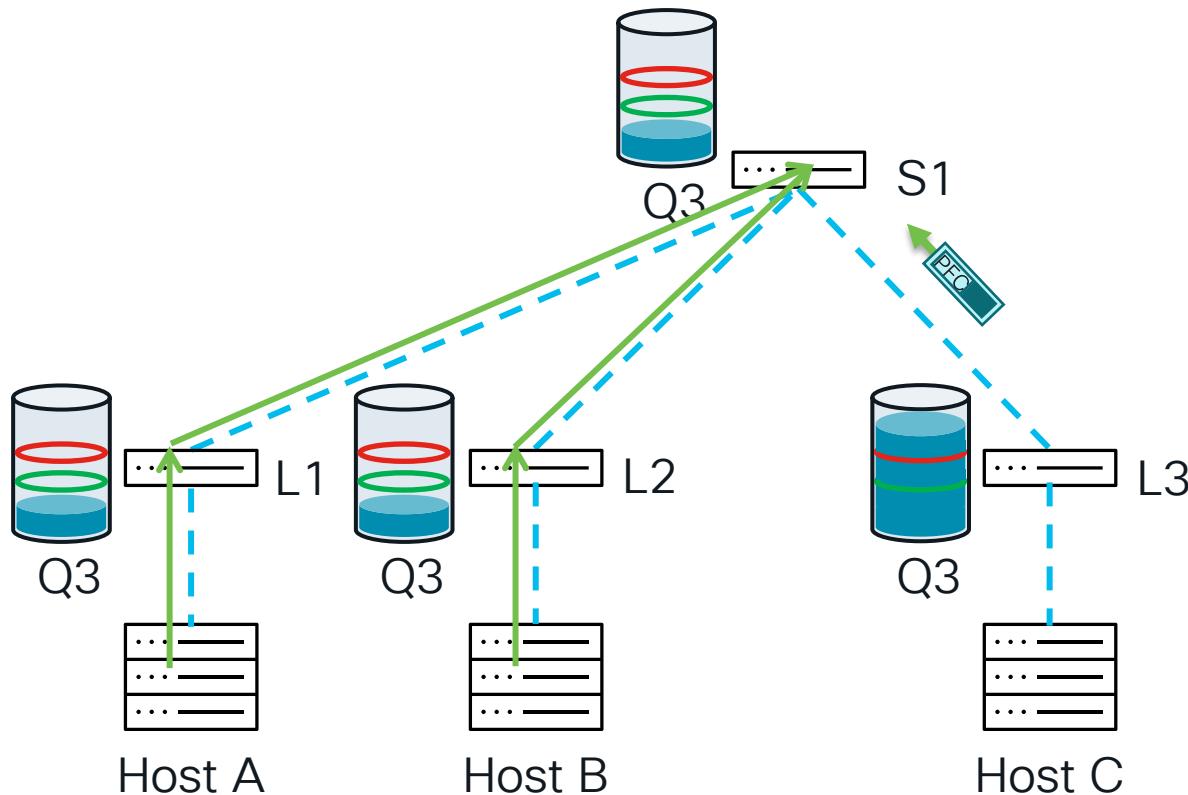
PFC hop by hop



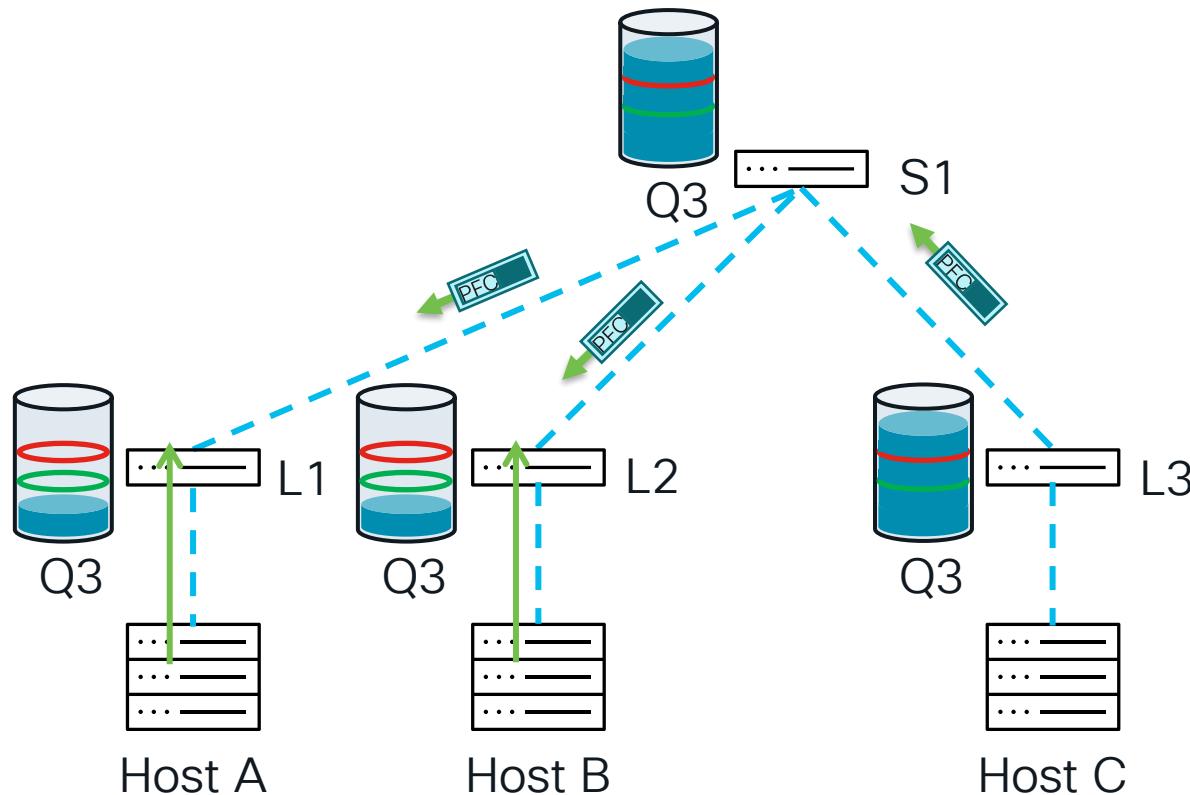
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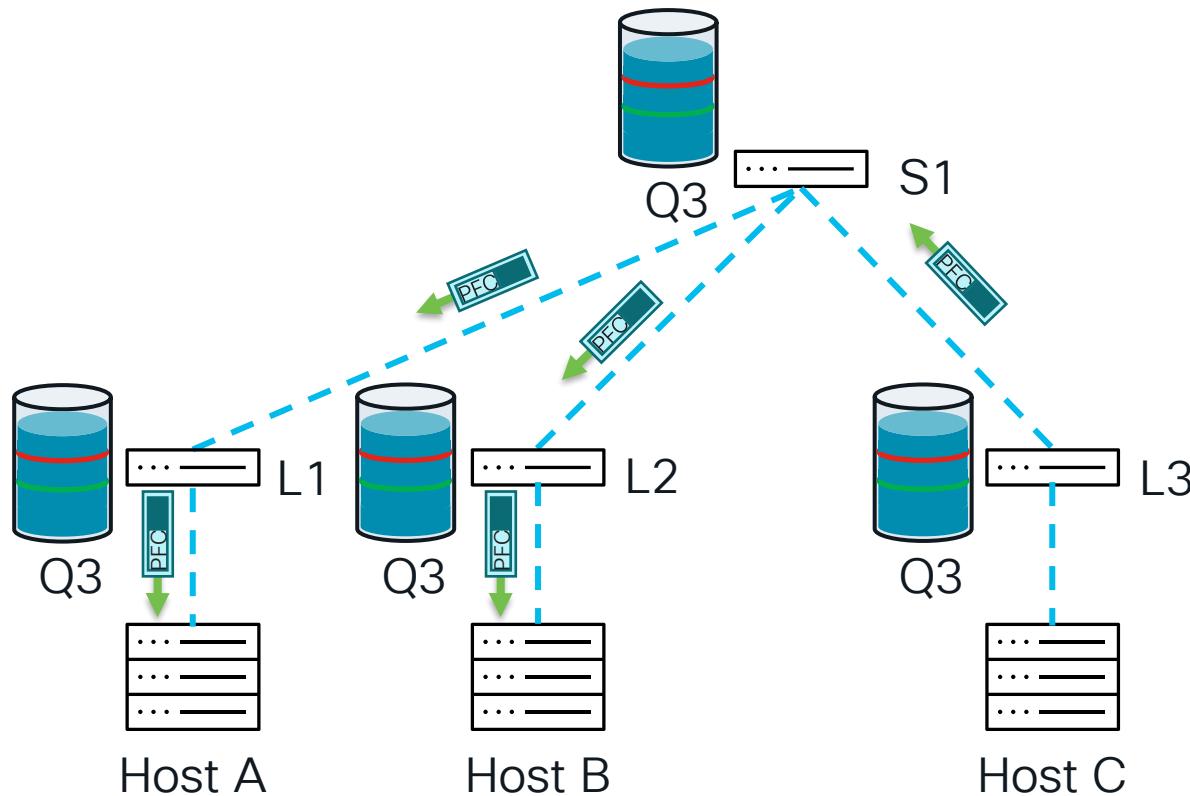
PFC hop by hop



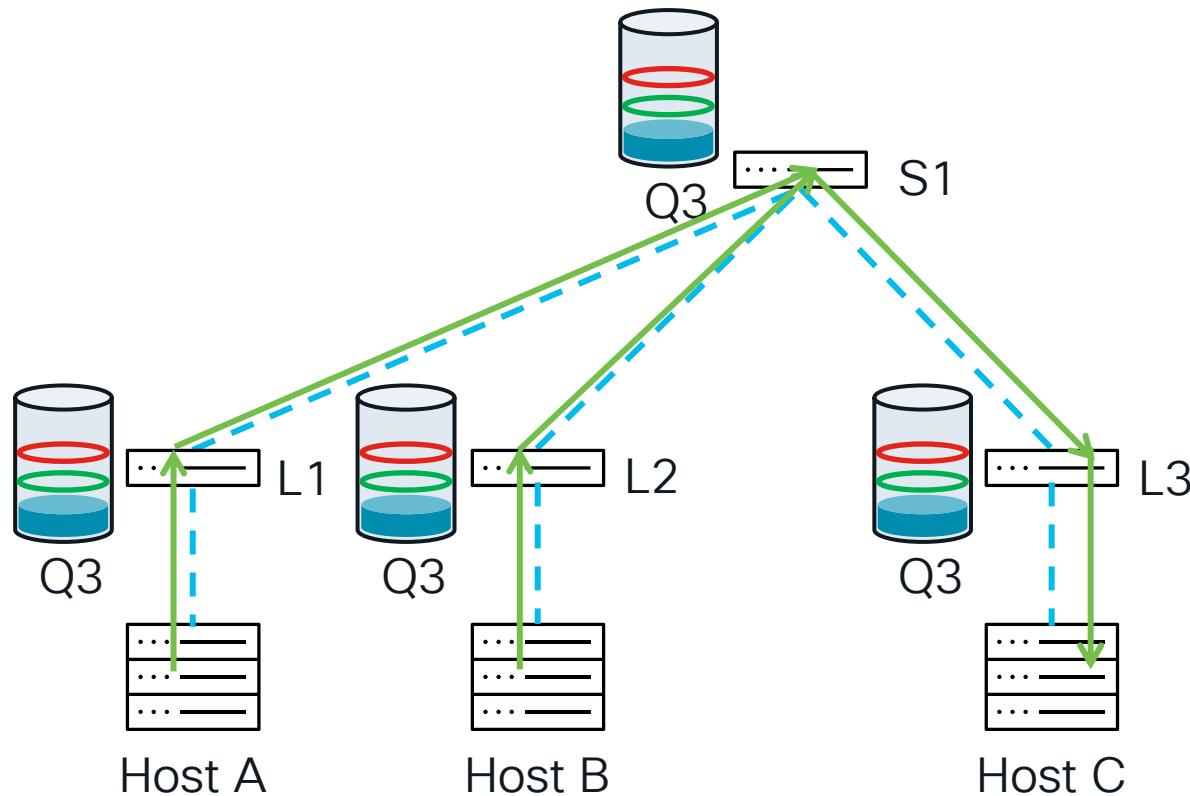
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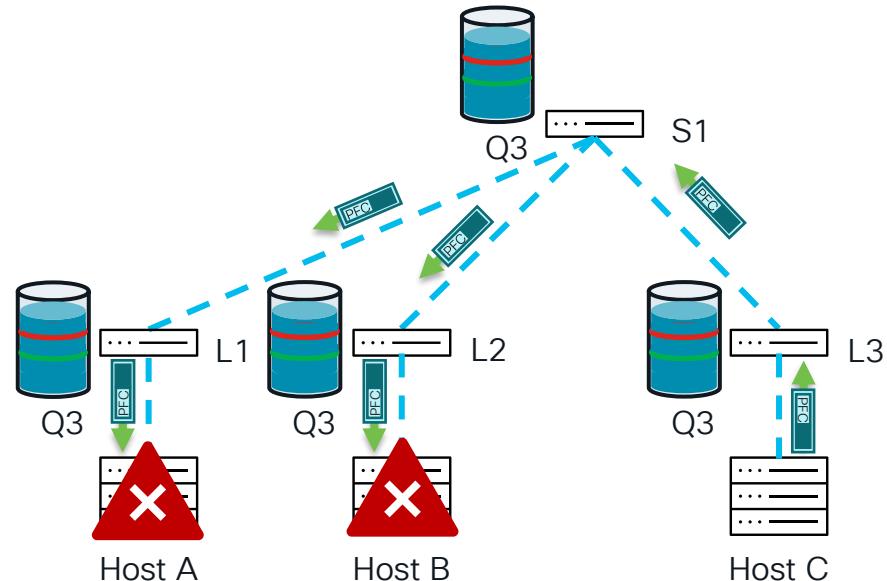


PFC hop by hop



PFC storm

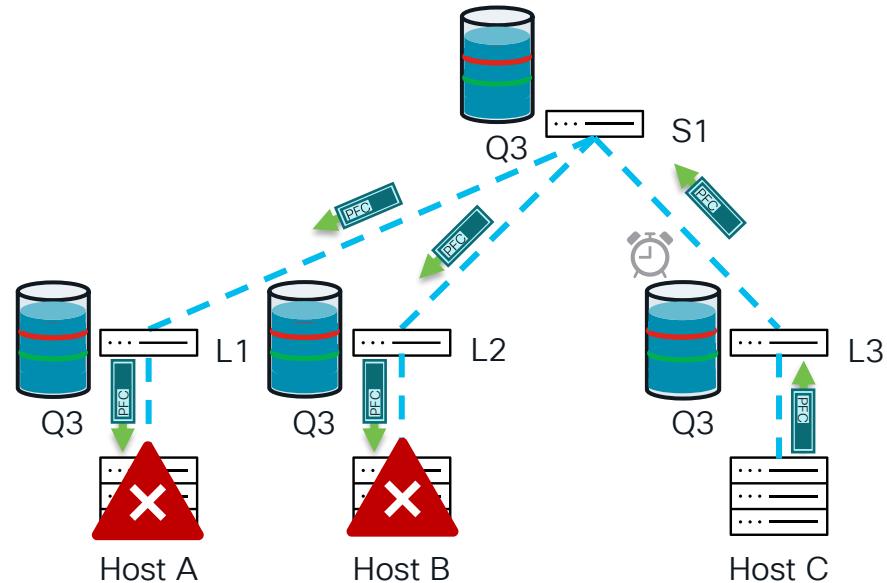
- In occasion of NIC or network malfunction, PFC storm can be triggered to send continuous PFC frames in the network
- Network will propagate those frame to all senders
- PFC storm will stop traffic coming from sender
- PFC watchdog can drain the queue



https://www.microsoft.com/en-us/research/wp-content/uploads/2016/11/rdma_sigcomm2016.pdf

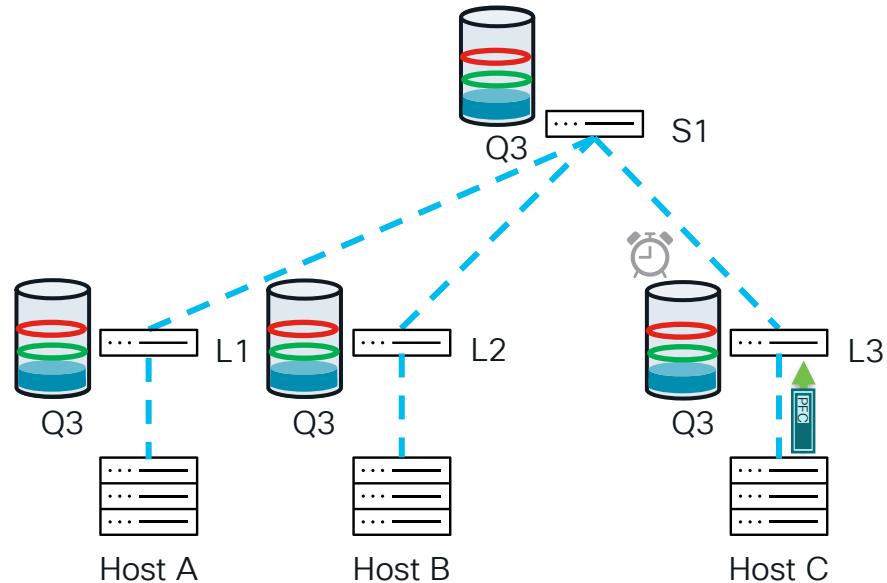
PFC watchdog

- PFC watchdog sets a timeout, if a packet exceeds time out, all packets from a queue will be cleared
- The watchdog prevents PFC frames propagating to sender and blocking it
- PFC Watchdog is supported on Cisco Nexus 9000 switches



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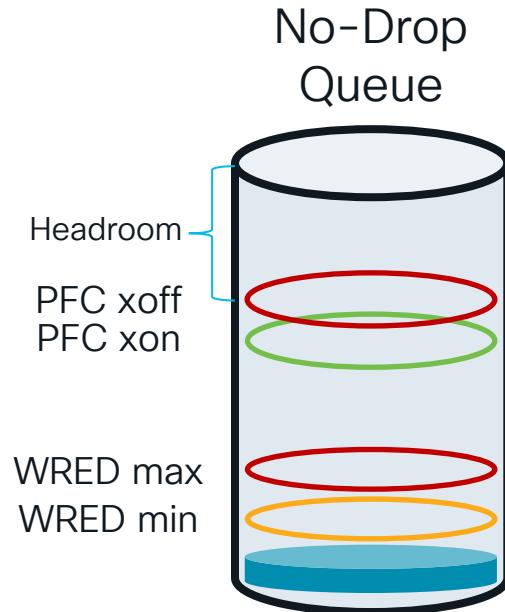
Audience Q&A

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RoCEv2: PFC and ECN together

How does it work?

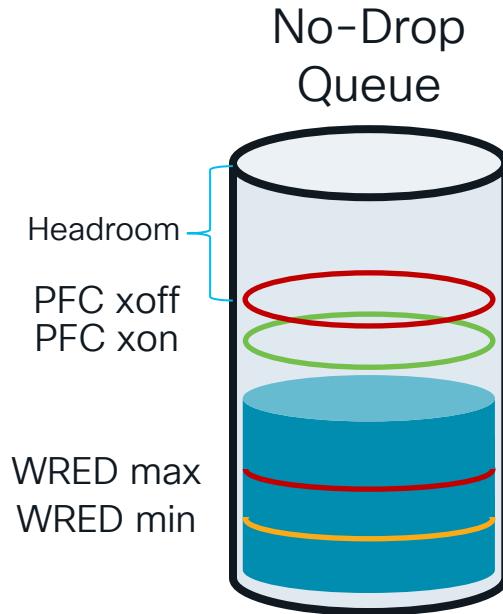
- WRED threshold are set low in no-drop queue
 - Signalize early for congestion, give enough time for end points to react
- PFC threshold are set higher than ECN
 - In case oversubscription buffers can be filled quickly without giving time to ECN to react
 - PFC will react and mitigate congestion



RoCEv2: PFC and ECN together

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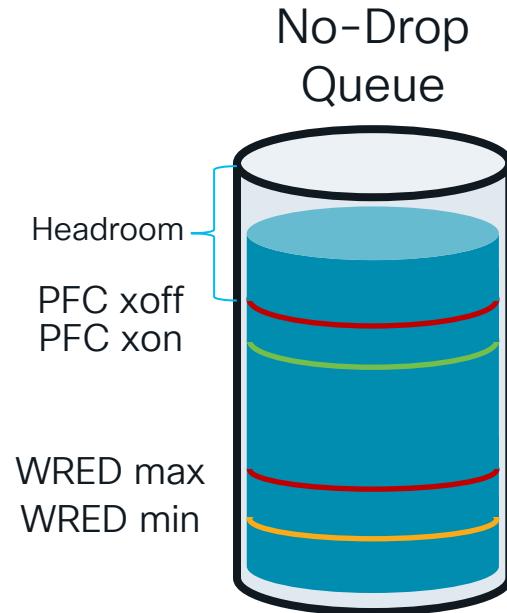
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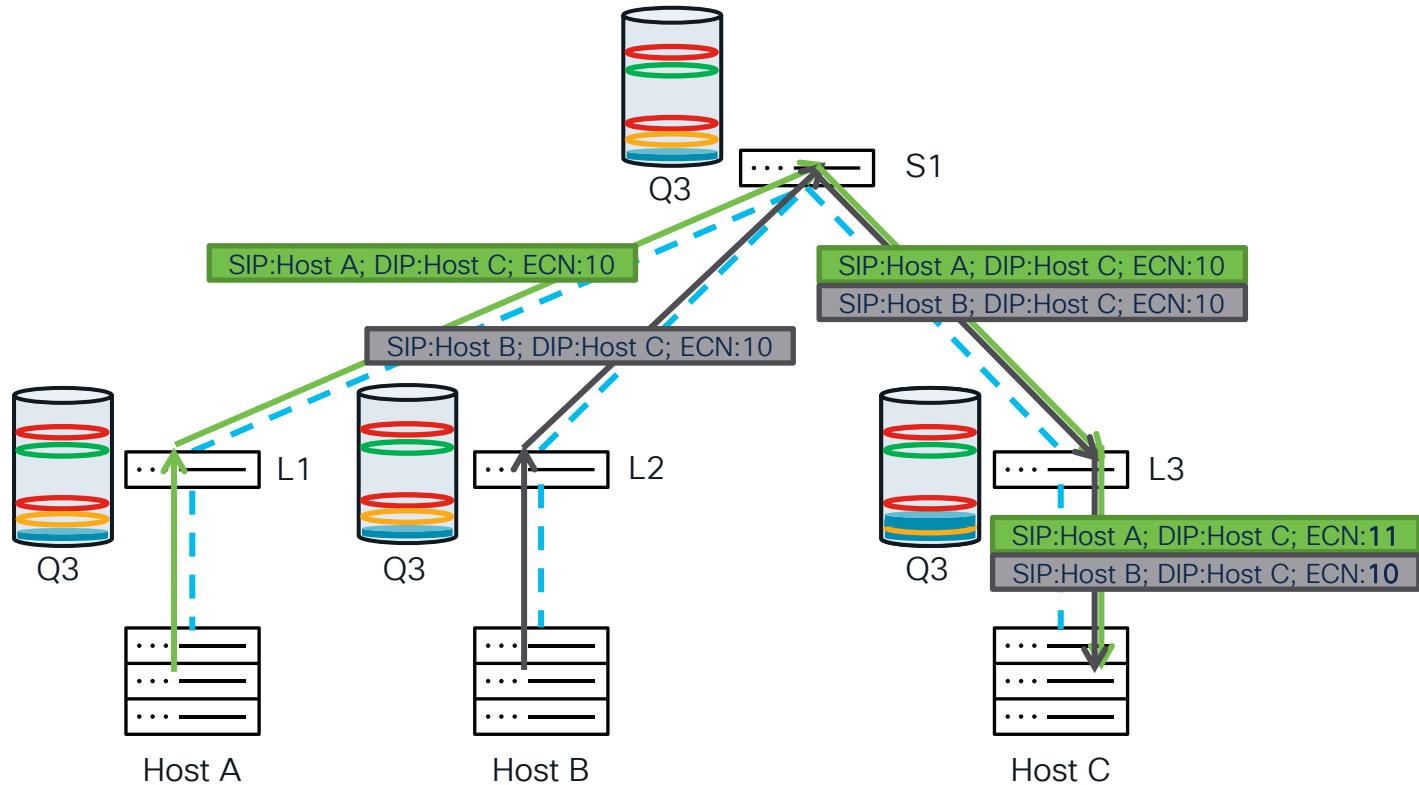
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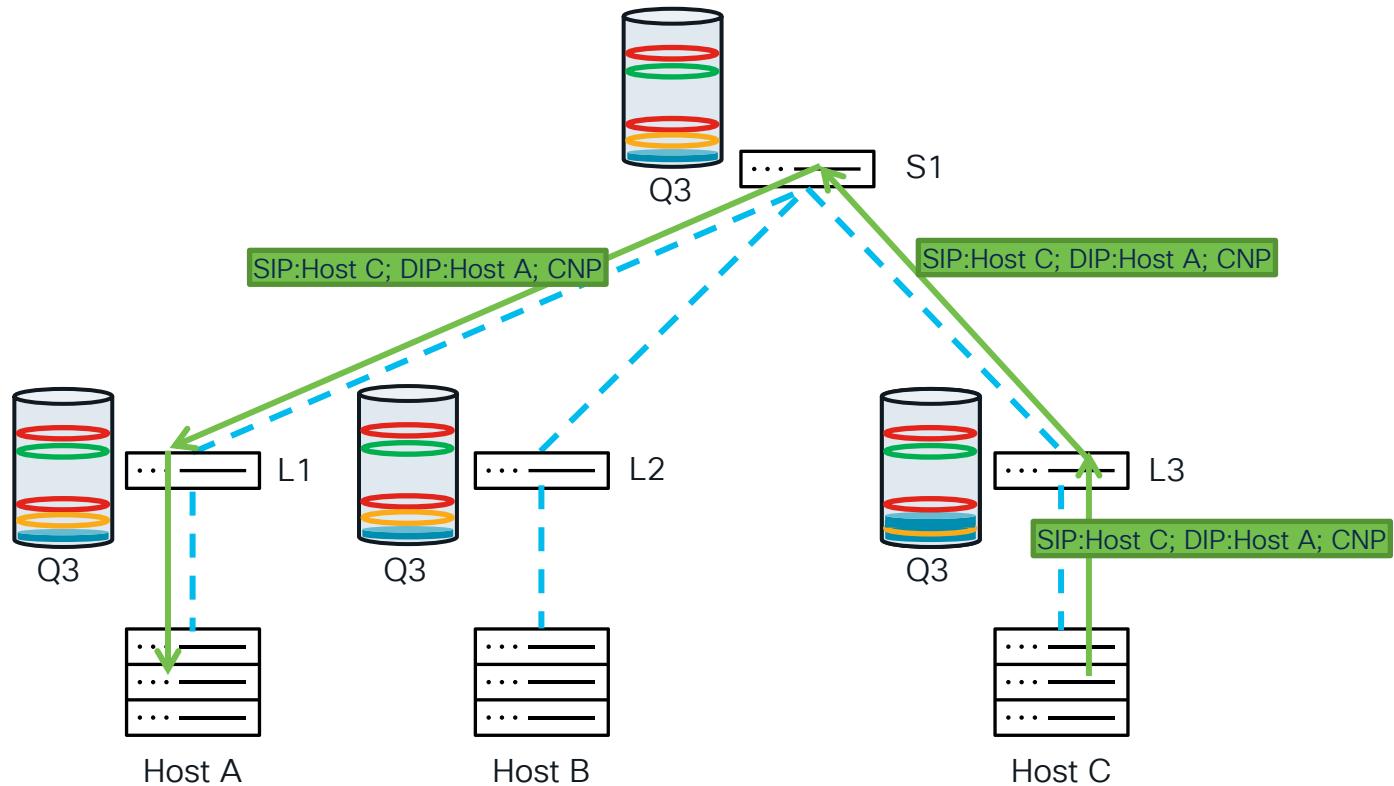
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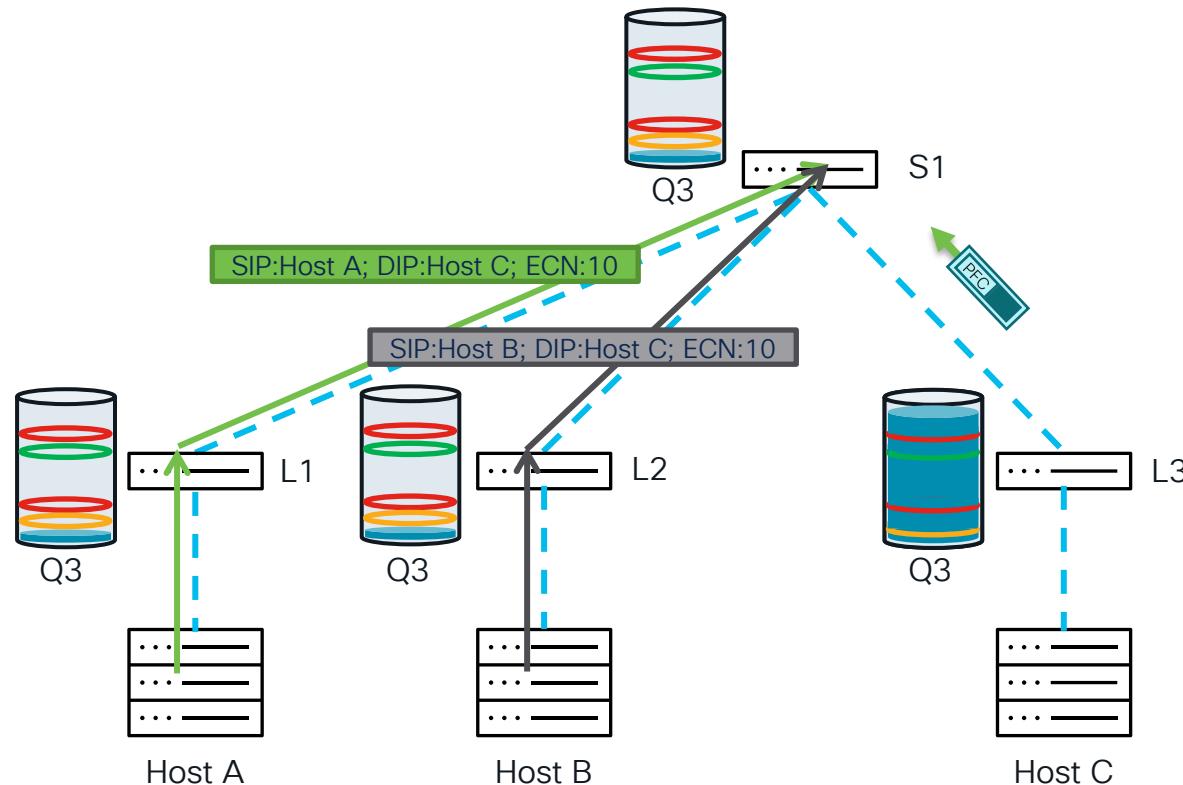
ECN and PFC make DCQCN



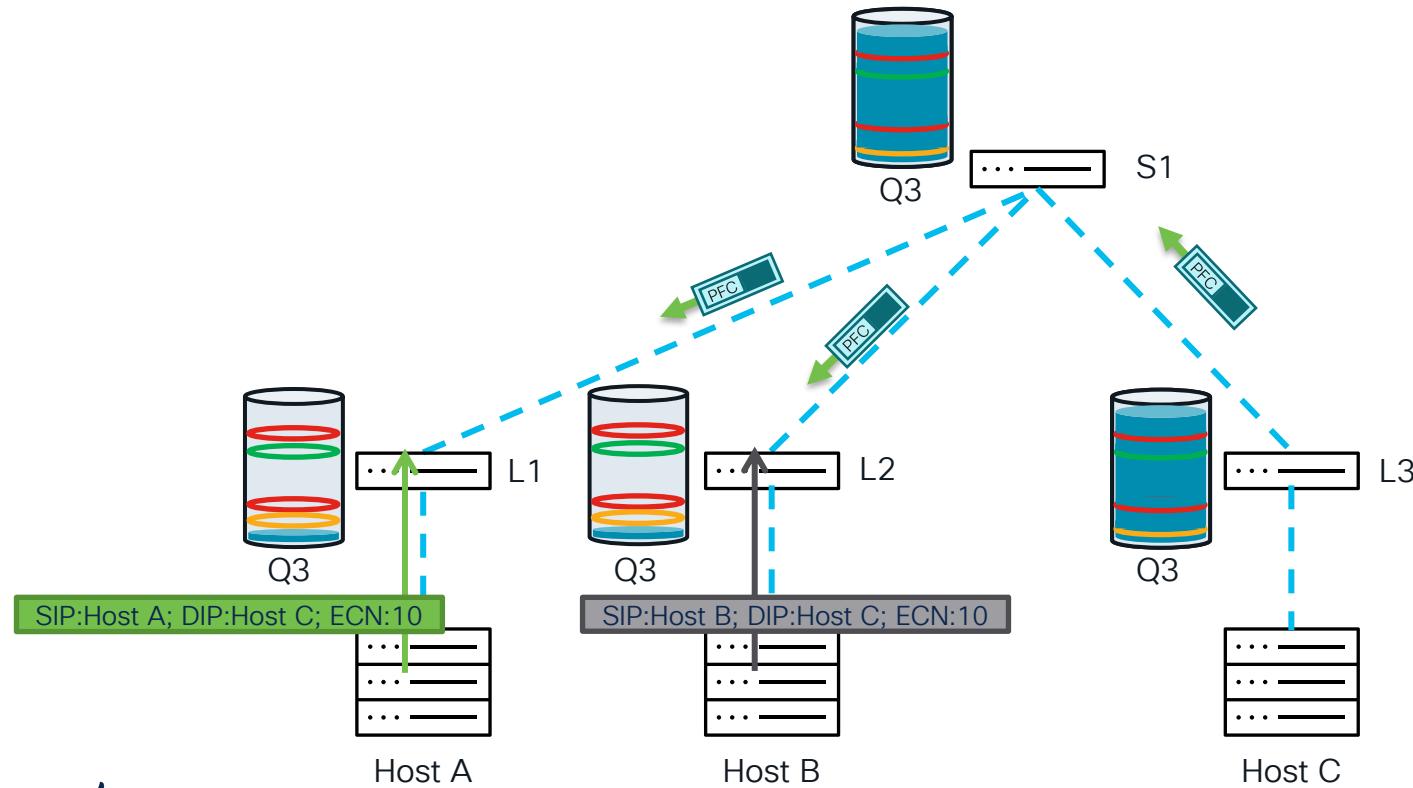
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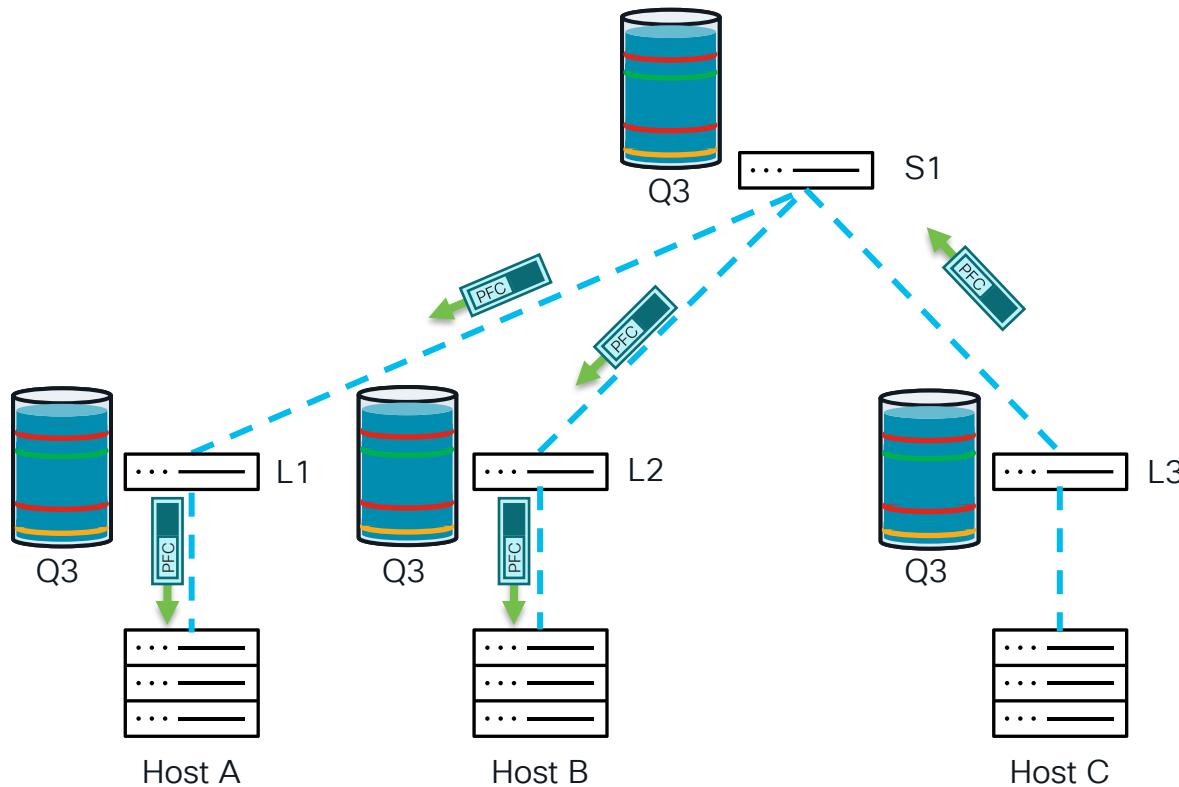
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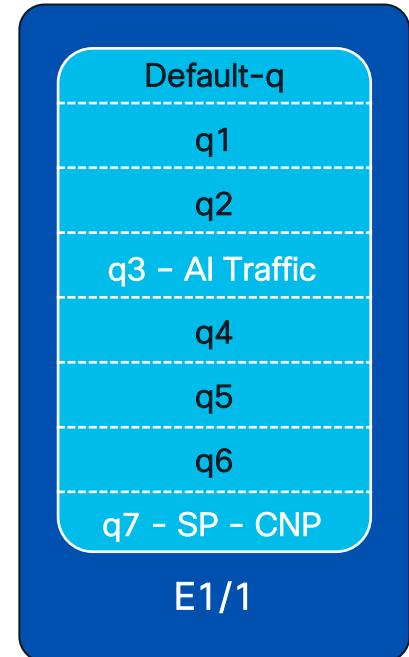


ECN and PFC make DCQCN



Quality of service

- Required separate queue for RoCEv2 traffic
 - Distinguished from other traffic in the port
 - Provide dedicated scheduling resources, to reduce latency
 - No contention for buffer resources with other traffic
 - RoCEv2 is not part of strict priority queue, high volume of it might affect control plane
- RoCEv2 traffic requires ECN, PFC on the queue, while other traffic does not
- CNP traffic is part of strict priority queue, to deliver congestion signaling in time



Quality of service - Configuration

```
class-map type qos match-all class-roce  
  match dscp 24  
class-map type qos match-all class-cnp  
  match dscp 48  
  
policy-map type qos QOS_classification_policy  
  class class-roce  
    set qos-group 3  
  class class-cnp  
    set qos-group 7  
  class class-default  
    set qos-group 0
```

Classification
for RoCE

Classification
for CNP

Quality of service - Configuration

```
policy-map type queuing custom-8q-out-policy
  class type queuing c-out-8q-q7
    priority level 1
```

```
<snip>
```

```
  class type queuing c-out-8q-q3
    bandwidth remaining percent 99
    random-detect minimum-threshold 150 kbytes maximum-threshold 3000 kbytes drop-probability 7
  weight 0 ecn
```

```
<snip>
```

```
  class type queuing c-out-8q-q-default
    bandwidth remaining percent 1
```

WRED min

WRED max

WRED random
marked packets

```
policy-map type network-qos custom-8q-nq-policy
```

```
<snip>
```

```
  class type network-qos c-8q-nq3
    mtu 9216
    pause pfc-cos 3
```

Enable PFC*

```
<snip>
```

*PFC default thresholds

Quality of service- Configuration

```
system qos  
  service-policy type network-qos custom-8q-nq-policy  
  service-policy type queuing output custom-8q-out-policy
```

Enable WRED ECN

```
interface Ethernet1/1  
  service-policy type qos input QOS_classification_policy  
  priority-flow-control mode on  
  priority-flow-control watch-dog-interval on
```

Enable PFC
per interface

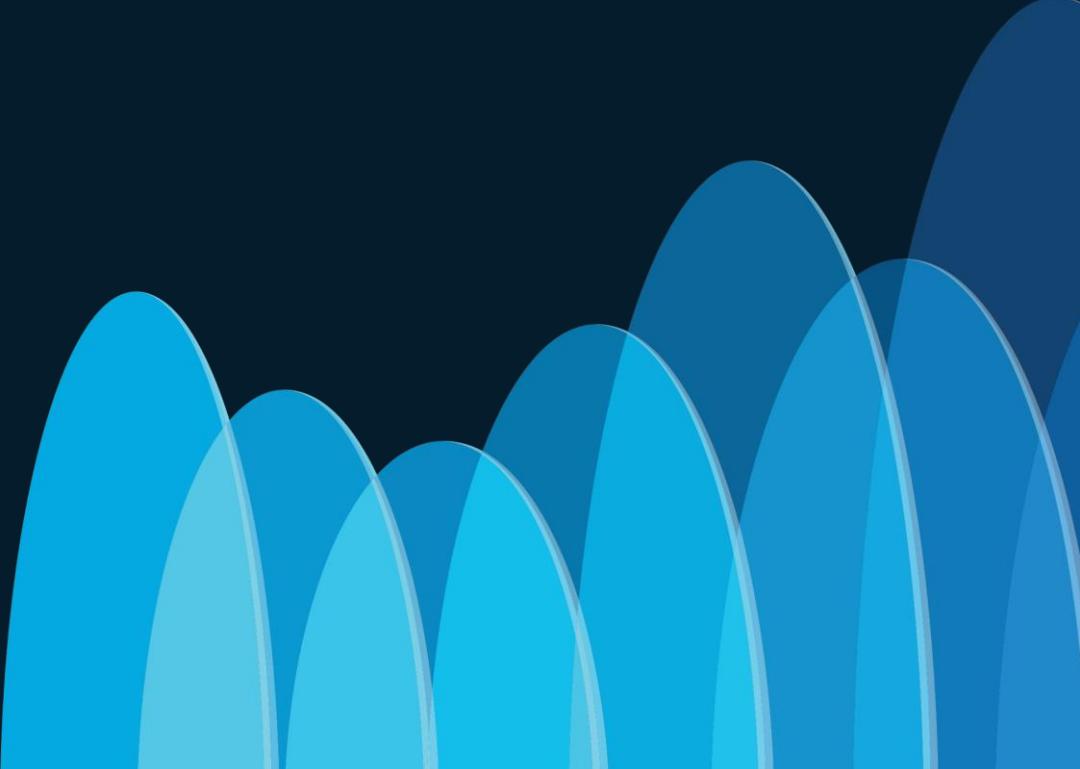
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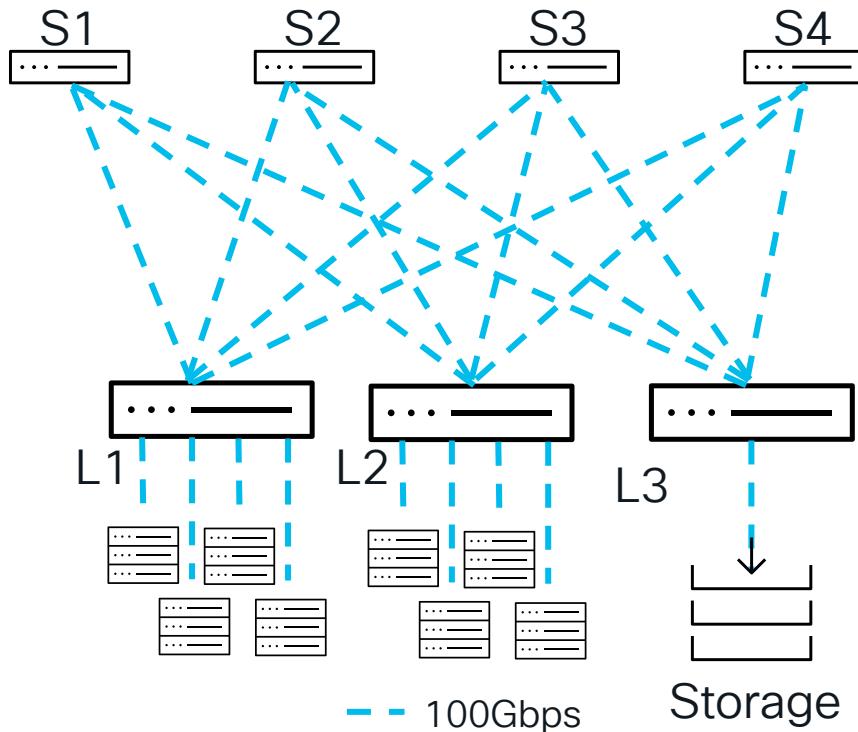
Audience Q&A

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Traffic Load-balancing

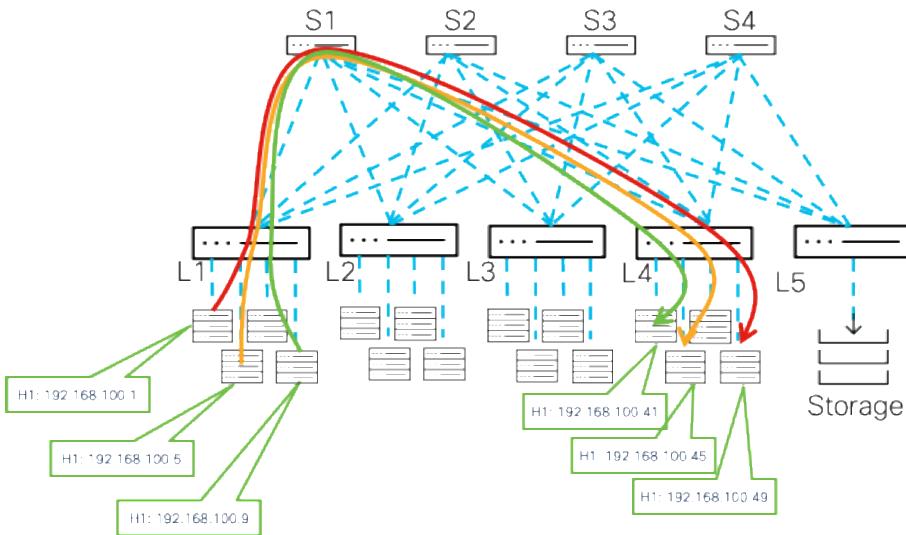
A series of overlapping, semi-transparent blue bell-shaped curves of varying heights, creating a sense of depth and data flow across the right side of the slide.

Non-blocking Network



- Non-Blocking Network, allow host to talk to other hosts at full bandwidth
- Leaf: Same bandwidth to the host as to the spine
- Reduces need for congestion management to increase performance

Traffic polarization on the uplinks – Problem



- Traffic does not provide enough entropy to ECMP
- Traffic is polarized to a spine S1 only
- Traffic polarization can affect application performance, triggering congestion management (PFC and ECN).

Default ECMP algorithm

- By default, ECMP looks at source and destination IP and Layer 4 ports
- Hosts in AI fabric may belong to uniform subnets
- Layer 4 ports, destination port is 4791 for RoCEv2
- Entropy comes from Layer 4 Source Port

```
N9K-switch# show ip load-sharing
IPv4/IPv6 ECMP load sharing:
Universal-id (Random Seed) : 2467474893
Load-share mode : address source-destination port source-destination
Rotate: 32
```

User Defined Field (UDF) ECMP algorithm

- UDF ECMP looks at source and destination IP and User Defined Field in a packet
- User can choose what field to look at to enhance entropy
- Every RoCE conversation is identified by Destination Queue Pair, in IB header
- Destination Queue Pair is 3-byte field

```
N9K-switch# show ip load-sharing
IPv4/IPv6 ECMP load sharing:
Universal-id (Random Seed) : 908907021
Load-share mode : address source-destination udf offset 33 length 24
Rotate: 32
```

User Defined Field (UDF) – Destination Q Pair

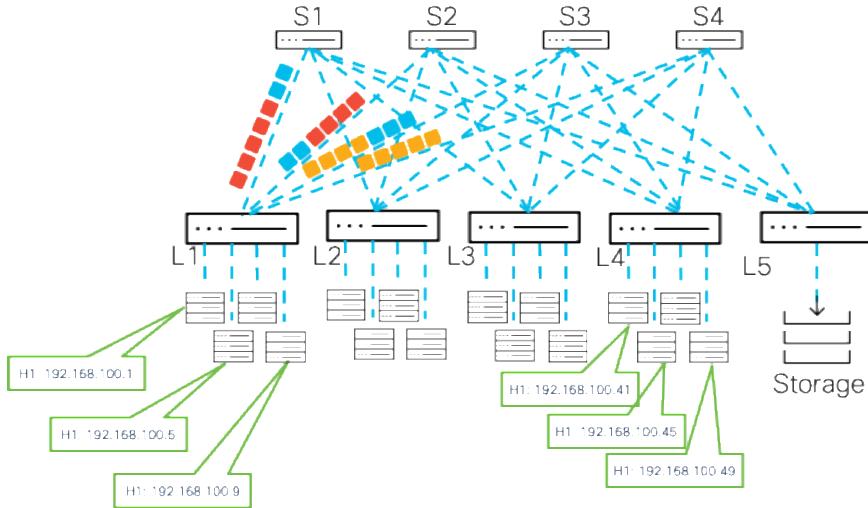
- UDF offset of Nexus 9000 switches starts from first byte of IP header
- Destination Q Pair is 33 bytes from beginning of IP field (IP (20B) + UDP (8B) + IB (5B)) or 6th byte in InfiniBand header

No.	Time	Source	Destination	Protocol	Length	Info
1	0.0000000000	172.16.103.11	172.16.101.11	RRoCE	1086	RC RDMA Read Response Middle QP=0x000a19
2	0.000020260	172.16.103.11	172.16.101.11	RRoCE	1086	RC RDMA Read Response Middle QP=0x000a19
5	0.116549167	172.16.103.11	172.16.104.11	RRoCE	78	RC RDMA Read Request QP=0x000a00
6	0.116561041	172.16.103.11	172.16.104.11	RRoCE	78	RC RDMA Read Request QP=0x000a00
7	0.122176963	172.16.103.11	172.16.112.11	RRoCE	1086	RC RDMA Read Response Middle QP=0x000903
8	0.122185013	172.16.103.11	172.16.112.11	RRoCE	1086	RC RDMA Read Response Middle QP=0x000903
9	0.236039751	172.16.103.11	172.16.101.11	RRoCE	78	RC RDMA Read Request QP=0x000a19
10	0.236050373	172.16.103.11	172.16.101.11	RRoCE	78	RC RDMA Read Request QP=0x000a19


```
> Frame 7: 1086 bytes on wire (8688 bits), 1086 bytes captured (8688 bits) on intel
> Ethernet II, Src: MellanoxTech_C417:ab (b8:ce:f6:c4:7c:ab), Dst: Cisco_23:d3:95
> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 103
> Internet Protocol Version 4, Src: 172.16.103.11, Dst: 172.16.112.11
> User Datagram Protocol, Src Port: 49152, Dst Port: 4791
> InfiniBand
  <-- Base Transport Header
    Opcode: Reliable Connection (RC) - RDMA READ response Middle (14)
    0... .... = Solicited Event: False
    .1.. .... = MigReq: True
    ..0. .... = Pad Count: 0
    .... 0000 = Header Version: 0
    Partition Key: 65535
    Reserved: 00
    Destination Queue Pair: 0x000903
    0... .... = Acknowledge Request: False
    .000 0000 = Reserved (7 bits): 0
    Packet Sequence Number: 1340033
    Invariant CRC: 0xb5bae4d
    Data (1024 bytes)
```

0030 ff ff 00 00 09 03 00 14 72 81 f5 €
0040 64 3d 58 c3 60 3d db 77 94 3d 05 €
0050 1b 3d fd f2 da 3d c7 a1 87 3d 78 €
0060 a2 3d 4f 94 47 3d 00 24 14 3a bc €
0070 8c 3d 89 88 16 3d 9d c4 a9 3c b5 €
0080 57 3d a3 14 9d 3d 39 78 85 3d a5 €
0090 a0 3d 4d 49 11 3d 61 cf 96 3d 92 €
00a0 1a 3d b5 8e 38 3d 25 33 8d 3d 60 €
00b0 57 3d 6d 44 55 3d 9d 12 d8 3a 98 €
00c0 ad 3c 5d 92 34 3d 2b 2a 22 3c fd €
00d0 31 3d 60 ca 70 3d 1f 68 6d 3d 6d €
00e0 10 3d 65 e8 aa 3c e4 4f 75 3d 4b €
0100 81 3d 5c 15 a5 3d 8b 1e 82 3d 22 €
0110 0f 3d 88 9e 1a 3d 65 97 7f 3c 29 €
0120 8d 3d a7 8c 41 3d 58 48 ff 3c 07 €
0130 17 3d 5b 72 64 3c d5 b7 d7 3a 71 €
0140 a1 3d d9 f9 45 3d eb 6a 1c 3c 03 €
0150 06 3d 73 c4 60 3d b1 8d a3 3d 50 4
0160 7a 3d a0 6e e6 3b a0 16 6d 3c b9 €
0170 28 3d ec b9 5e 3d eb f6 28 3c a3 €
0180 13 3d ab 93 86 3d 85 28 c4 3c 6b €
0190 53 3d 53 c9 f4 3c 6c fa 51 3d 64 2
01a0 91 3d f4 44 69 3d f2 8a 90 3d 0b 1
01b0 5f 3d 91 cb 97 3d 43 51 ba 3c e5 €

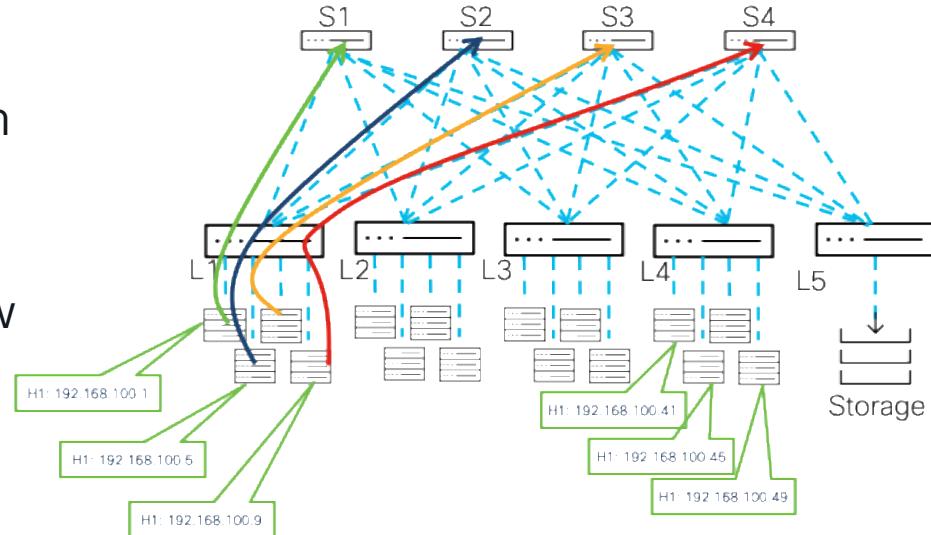
Dynamic Load Balancing – Flowlet Mode



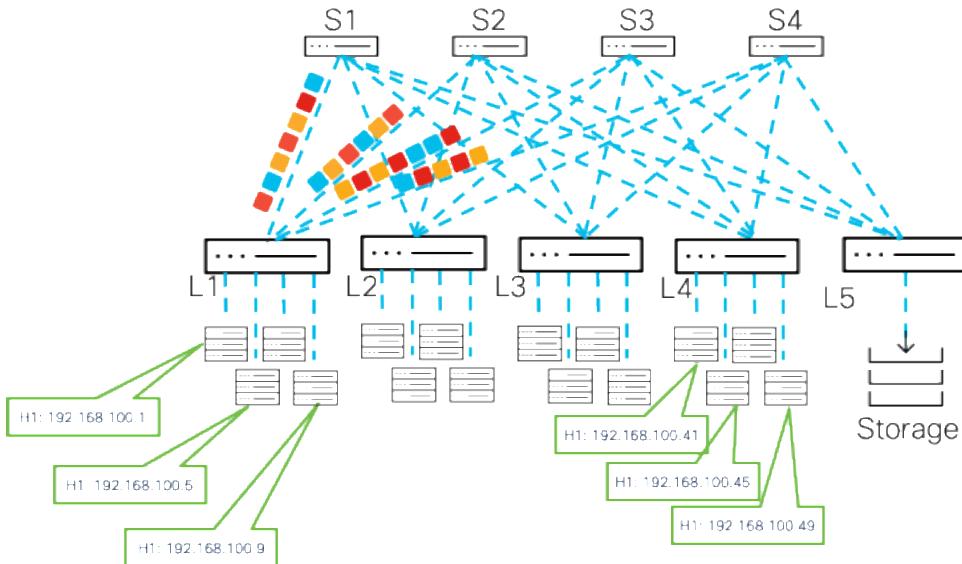
- Flowlets maintain the link, or dynamically change the link
- Least utilized link is chosen, for new flow, or at time flows are moved to different link
- Ageing time is used avoid out of order packets, it should be $2 \times \text{RTT}$
- All workloads are balanced fairly and if flows are bursty they can dynamically change path

Dynamic Load Balancing – Static Pinning

- Allows static pinning between ingress and egress ports
- Valid only for multipath destination traffic
- Steady bit rate flows, or undersubscribed network, to allow fair distribution of the traffic
- Manual configuration, or API



Dynamic Load Balancing – Per-packet Mode



- Per packet mode load balancing, allows fair distribution of traffic
- Least utilized link is chosen per packet, delivering uniform usage of the links
- As packet of same flow, will take different path, may happen that they arrive at destination endpoints out of order
- Expected in deployments with per-packet load balancing for receiver to put packet in order (host needs to do packet reordering)

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Audience Q&A

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Automation and Visibility



Nexus Dashboard Fabric Controller

Create Fabric ? — ×

N9K Cloud Scale Platform Queuing Policy
Select an Option
Queuing Policy for all 92xx, -EX, -FX, -FX2, -FX3, -GX series switches in the fabric

N9K R-Series Platform Queuing Policy
Select an Option
Queuing Policy for all R-Series switches in the fabric

Other N9K Platform Queuing Policy
Select an Option
Queuing Policy for all other switches in the fabric

Enable AI / ML QoS and Queuing Policies
 Configures QoS and Queuing Policies specific to N9K Cloud Scale switch fabric for AI / ML network loads

AI / ML QoS & Queuing Policy*
AI_Fabric_QOS_100G
Queuing Policy based on predominant fabric link speed:
400G / 100G / 25G

AI_Fabric_QOS_400G
AI_Fabric_QOS_100G
AI_Fabric_QOS_25G
Enable MACsec in the fabric
Cisco Type 7 Encrypted Octet String

Nexus Dashboard Fabric Controller

Edit interface(s)

? — ×

Edit interface(s)		Additional CLI for the interface
<p>Enable Interface*</p> <p><input checked="" type="checkbox"/> Uncheck to disable the interface</p>		
<p>Enable Netflow</p> <p><input type="checkbox"/> Netflow is supported only if it is enabled on fabric</p>		
<p>Netflow Monitor</p> <p><input type="text"/> Provide the Layer 3 Monitor Name</p>		
<p>Netflow Sampler</p> <p><input type="text"/> Netflow sampler name, applicable to N7K only</p>		
<p>Enable priority flow control</p> <p><input checked="" type="checkbox"/> Enable priority flow control</p>		
<p>Enable QoS Configuration</p> <p><input checked="" type="checkbox"/> Enable to configure a QoS Policy for this interface. If AI/ML Queuing is enabled on the fabric, will use the QOS_CLASSIFICATION policy. Enter a custom policy below to override</p>		
<p>Custom QoS Policy</p> <p><input type="text"/> Custom QoS Policy must be defined previously</p>		
<p>Custom Queuing Policy</p> <p><input type="text"/> Queuing Policy must be defined previously</p>		

Visibility – Flow table

- Collects full flow information plus metadata
 - 5-tuple flow info
 - Interface/queue info
 - Flow start/stop time
 - Packet disposition (drop indicators)
 - Burst measurement
- Export date to collector
- Leveraged by Nexus Dashboard Insights



Nexus Dashboard Insights – Congestion visibility

Interface Details for eth1/58 on RoCE-Spine-1

REAL-TIME Real-Time Active: Data is being displayed in real time for graphs where it is available

Major

Score Over time
View Queue Scores

The graph displays a score over time from 10:20 AM to 12:00 PM. The score fluctuates between 0 and 6, with several sharp peaks reaching a value of 6, indicating major issues. The area under the curve is shaded green.

Congestion Details

Updates every 1m

WRED\AFD\Drops
View Queues

The graph shows WRED\AFD\Drops from 10:20 AM to 12:00 PM. The count of drops remains consistently low, near zero, across the entire time period.

PFC
Receive: 22.15 M
Transmit: 37.88 K
View Queues

The graph displays PFC rates from 10:20 AM to 12:00 PM. The receive rate is approximately 22.15 M, and the transmit rate is approximately 37.88 K. Both rates show a slight upward trend over the period.

ECN
74.74 M
View Queues

The graph shows ECN rates from 10:20 AM to 12:00 PM. The rate is approximately 74.74 M, showing a gradual increase from 37.37 M at 10:20 AM to about 74.74 M by 12:00 PM.

Nexus Dashboard Insights – Congestion visibility

The screenshot shows the Cisco Nexus Dashboard Insights interface. The top navigation bar includes the Cisco logo, 'Nexus Dashboard', 'Insights' (selected), and user icons for help and profile.

The main content area displays 'Interface Details for eth1/58 on RoCE-Spine-1'. Below this, a navigation bar has tabs: Overview, Multicast, **Trends and Statistics**, and Anomalies. A status message indicates 'Real-Time Active: Data is being displayed in real time for graphs where it is available'.

The 'Trends and Statistics' section is titled 'Microbursts'. It shows a table of microburst data for queue-3, ordered by Start Time. The columns include Queue, Start Time, Number of Bursts, Max Duration (ns), Avg Duration (ns), Max Peak, and Avg Peak.

Queue	Start Time	Number of Bursts	Max Duration (ns)	Avg Duration (ns)	Max Peak	Avg Peak
queue-3	May 31 2024 12:05:00.000000 PM	172	2.09 ms	551.82 ns	4,554,368	2,738,949
queue-3	May 31 2024 12:00:00.000000 PM	538	1.94 ms	493.66 ns	5,137,184	2,709,682
queue-3	May 31 2024 11:55:00.000000 AM	76	550.57 ns	243.96 ns	3,174,080	2,203,202
queue-3	May 31 2024 11:50:00.000000 AM	331	3.11 ms	590.47 ns	7,363,616	2,874,888
queue-3	May 31 2024 11:45:00.000000 AM	279	8.18 ms	737.11 ns	6,466,720	2,965,094
queue-3	May 31 2024 11:40:00.000000 AM	386	2.70 ms	648.39 ns	6,902,688	2,952,173
queue-3	May 31 2024 11:35:00.000000 AM	354	3.64 ms	688.12 ns	6,847,776	2,963,263
queue-3	May 31 2024 11:30:00.000000 AM	266	3.22 ms	641.42 ns	6,009,536	2,913,820

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Audience Q&A

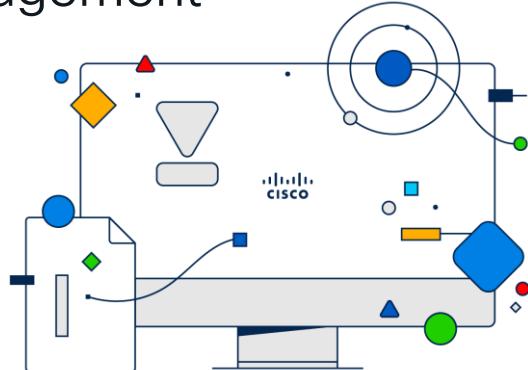
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Blueprint of Today



Choosing the right infrastructure

- Build a Clos Fabric / Spine-Leaf
- Fixed Switches
 - Lower Latency, single AISC
 - Power Efficient
- Right Congestion management
- Routed Fabric
 - Use BGP for control plane
 - Scalable design
 - Two tier design
 - Three tier design



Customer request #1

- Build Cluster of 260 GPUs
 - Use case: Inferencing for 100s of users, RAG, and fine tuning of a model
 - Cluster is built with stand alone server (e.g. Cisco UCS-C240-M7)
- Build non-blocking network, for GPU communication
- Predictable and low latency for efficient training
- Host connectivity at dual 100Gbps
- Fabric at 400Gbps for efficient load-balancing

Networks – Why do I need them?



UCS C240 M7 Rack Server
Up to 2 GPUs

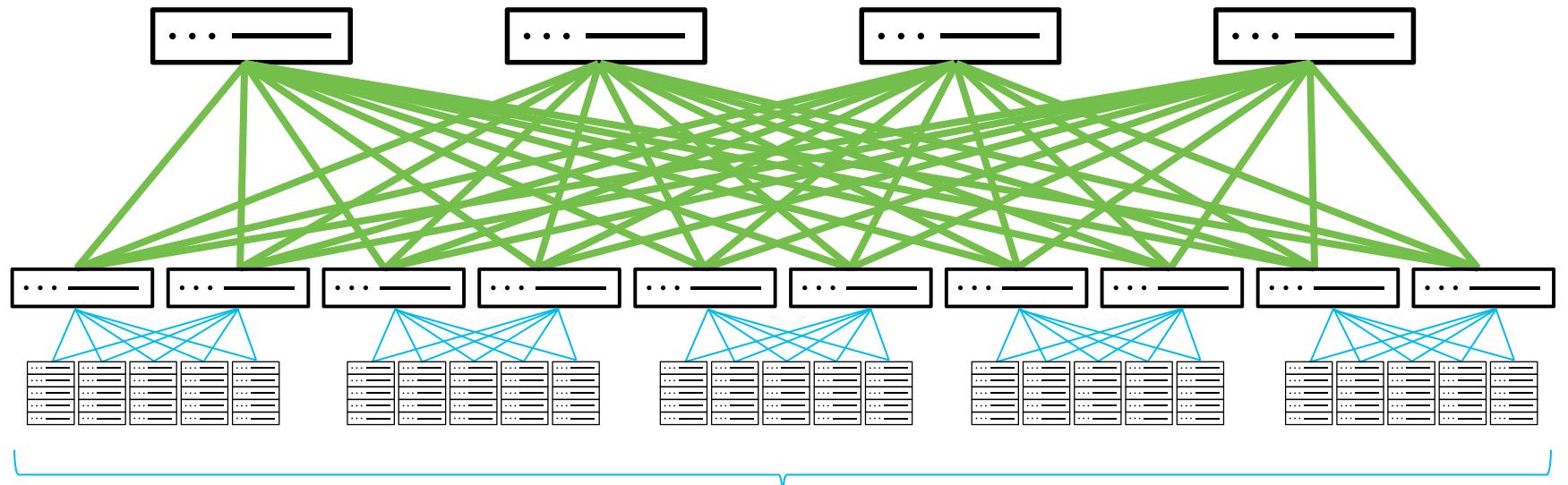
GPU to GPU, Front-end and
Storage Network



Customer request #1 - Proposal

- Standalone server can have up to 2 GPUs
 - As required is 260 GPUs, 130 Stand alone servers are needed
 - Each standalone server is equipped with dual 100G port NIC
- 260 x 100G ports required for host connectivity in leaf layer
 - 26 x 100G host interfaces per leaf switch, for 10 leaf switches
 - Aggregate into 8 x 400G uplinks per switch for Spine connectivity
- Total of 4 spines 20 x 400G ports used per Spine
- Leave room for future expansion

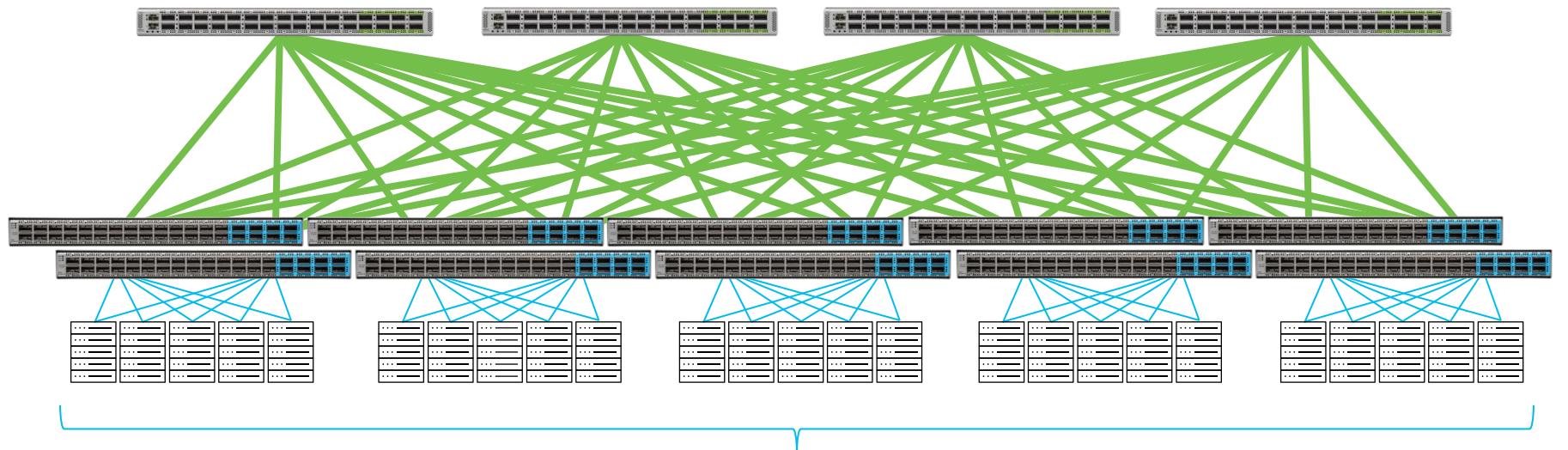
Customer request #1 - Design



130 Hosts each with 2 x GPU and 2 X100G NIC

100 Gbps
2 x 400Gbps

Customer request #1 - Design



130 Hosts each with 2 x GPU and 2 X100G NIC

N9K-C93600CD-GX

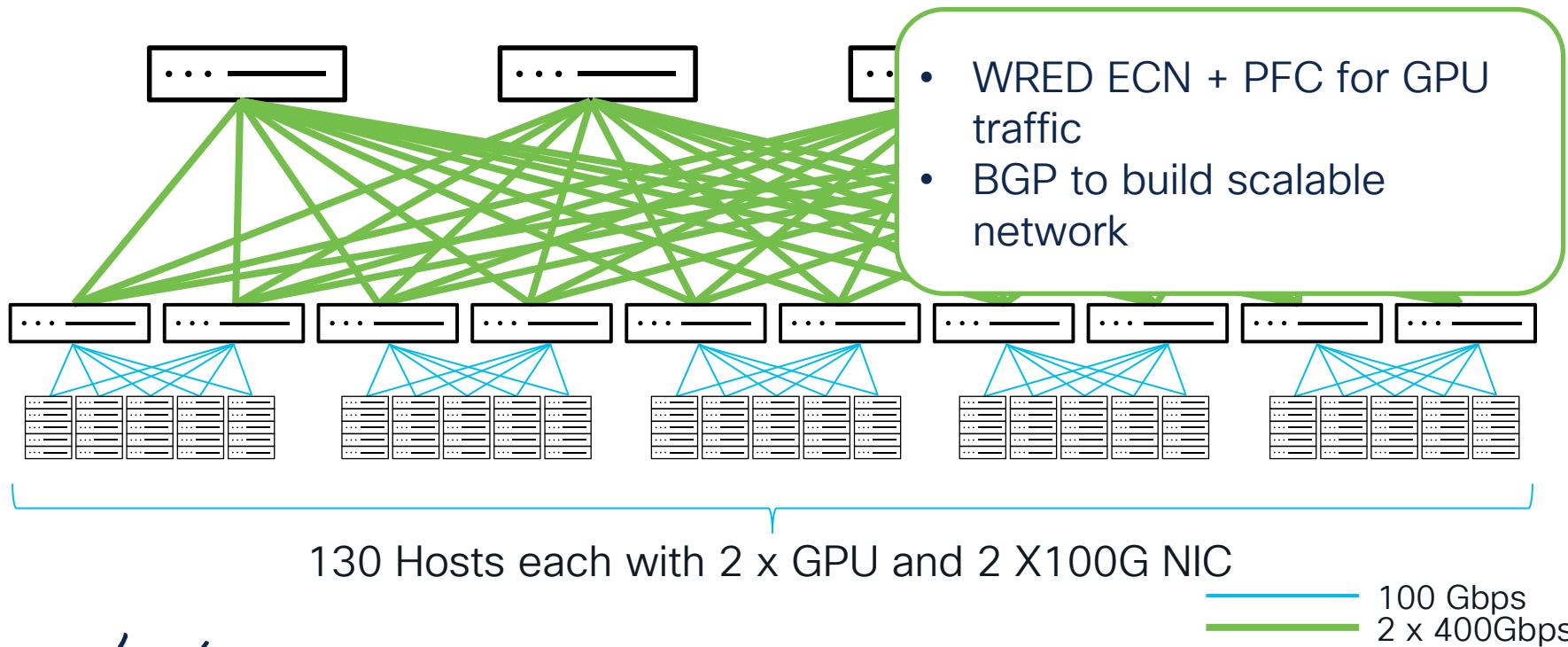


N9K-C9332D-GX2B

100 Gbps
2 x 400Gbps

CISCO Live!

Customer request #1 - Design



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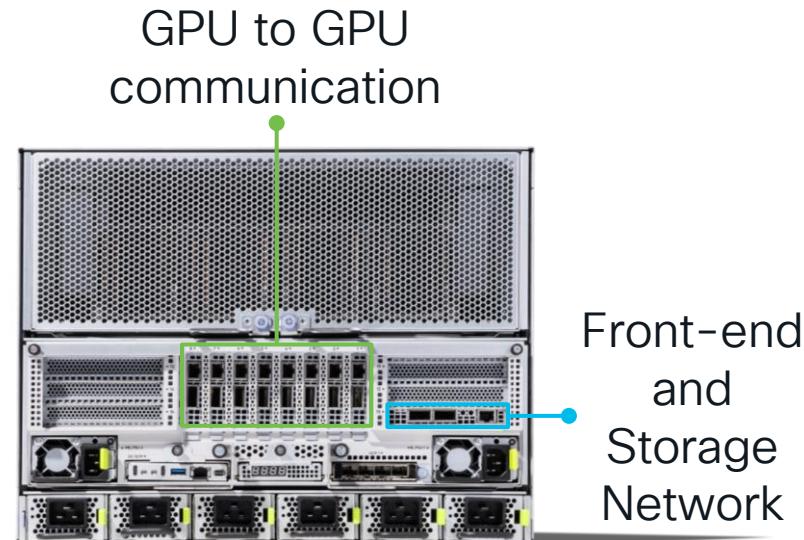
Customer request #2

- Build Powerful Cluster of 320 GPUs, for large training model use case
 - Cluster is built with powerful accelerators (e.g. 8-way GPU server)
- Build non-blocking back-end network, for GPU communication
 - Predictable and low latency for efficient training
 - Host connectivity at 8 ports of 400Gbps
 - Fabric at 400Gbps for efficient load-balancing
- Build front-end network, for server-to-server interaction, and storage connectivity
 - 2 x 100Gbps ports for connectivity, non-blocking and future expansion

Networks – Why do I need them?



UCS C885A M8 Rack Server
8 GPUs



Customer request #2 – Proposal for Back-End

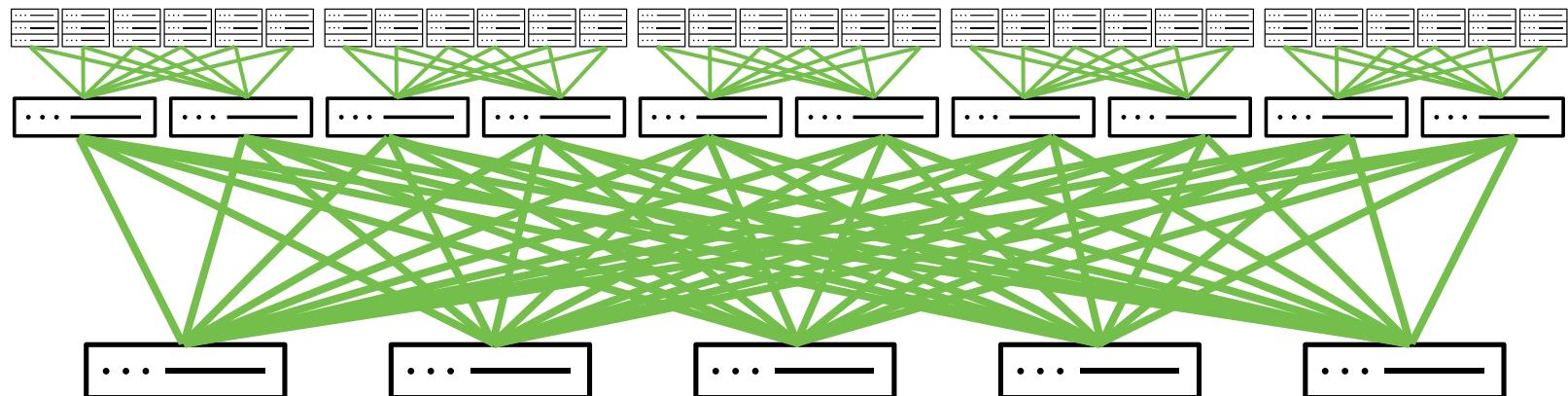
- Powerful AI training accelerator, has 8 GPUs per server
 - As required is 320 GPUs, 40 host are sufficient
 - Each host will connect with 8x 400G QSFP-DD ports
- 320 x 400G ports required for host connectivity in leaf layer
 - 32 x 400G host interfaces per leaf switch, for 10 leaf switches
 - Non-blocking network 32 x 400G uplinks per leaf for Spine connectivity
- Total of 5 spines 64 x 400G ports used per Spine

Front-End and Back-End Cluster Network

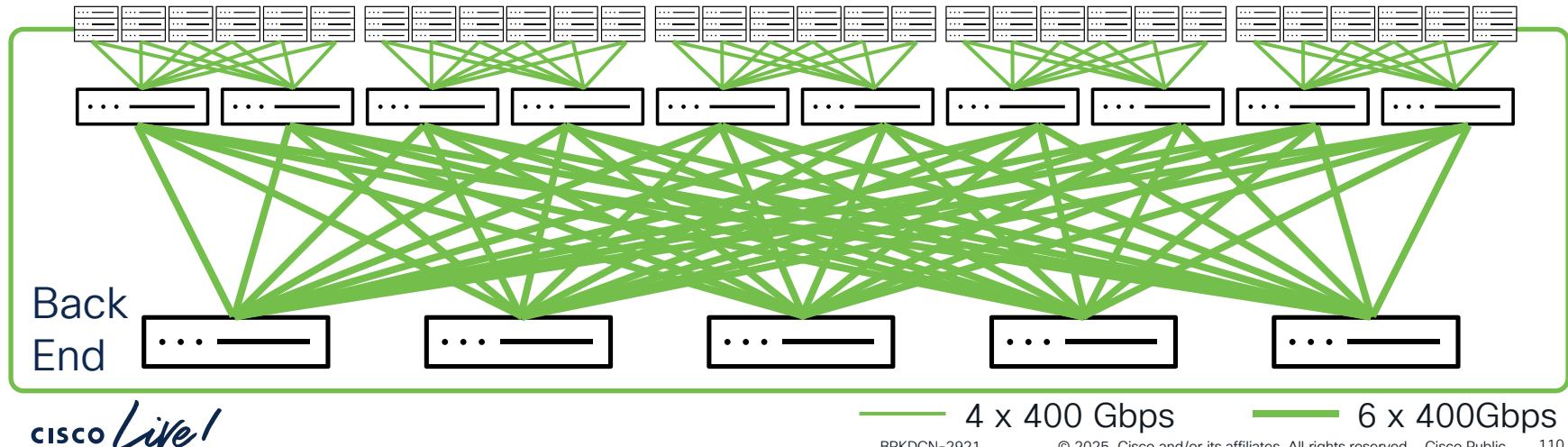


40 Hosts each with 8 x GPU

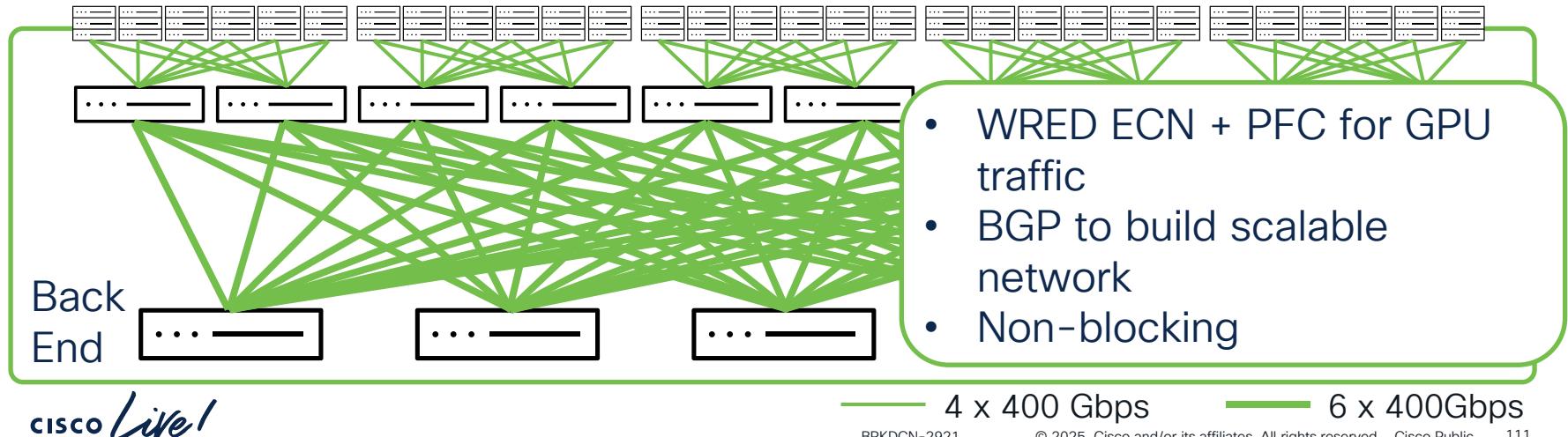
Back-End Cluster Network



Back-End Cluster Network



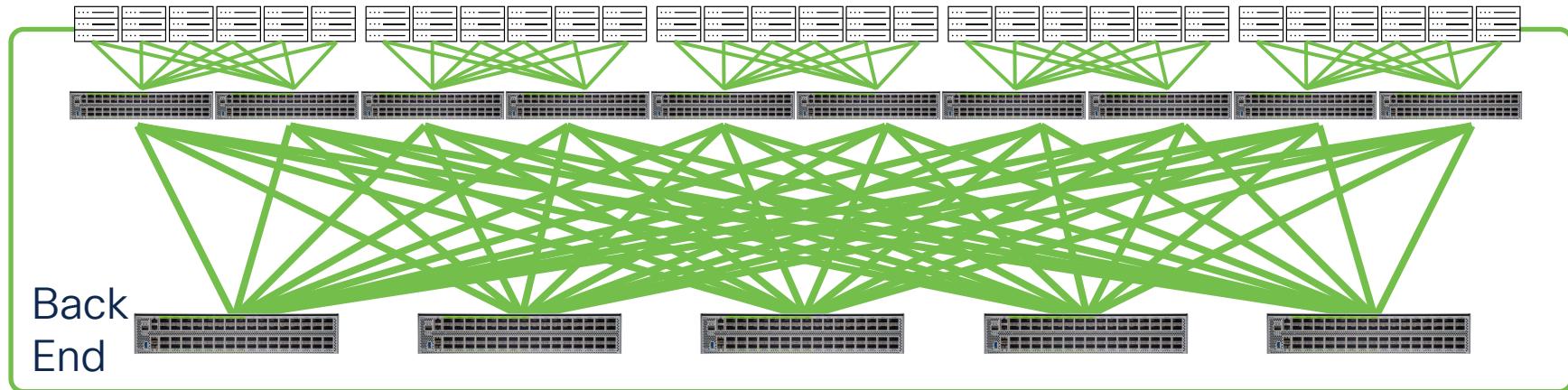
Back-End Cluster Network



Back-End Cluster Network



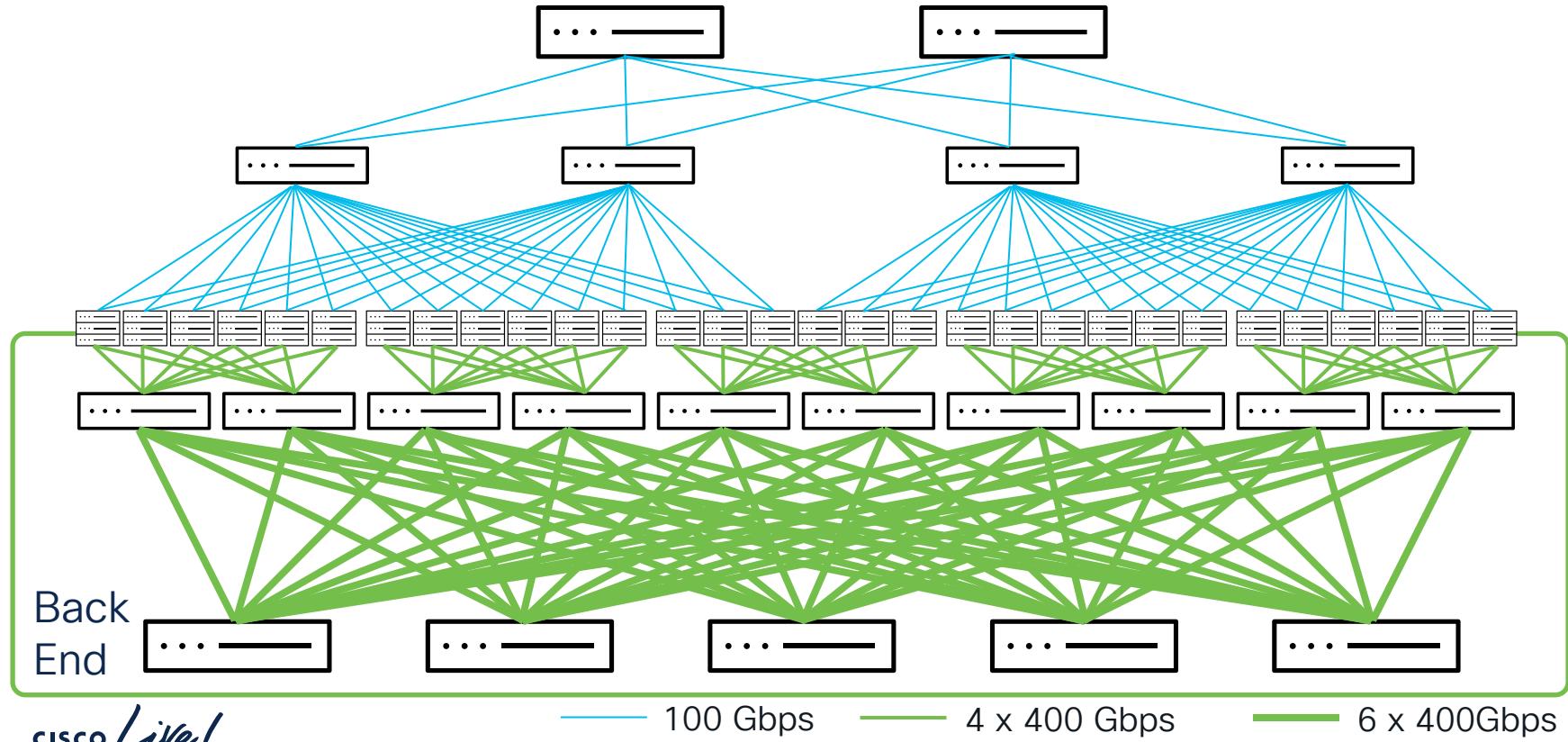
N9K-C9364D-GX2A



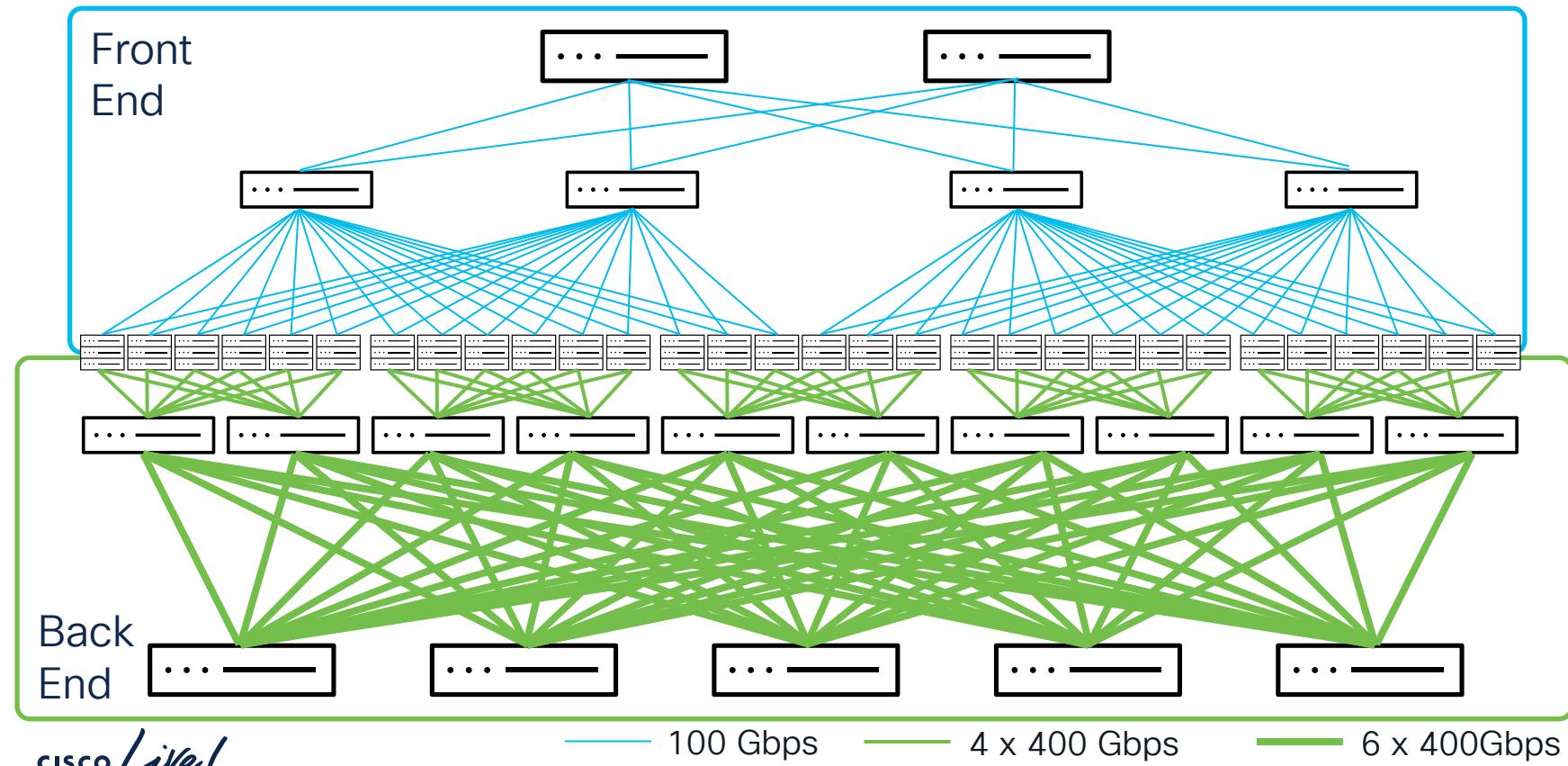
Customer request #2 – Proposal for Front-End

- Front End network for host communication, and storage
 - Each server has 2 x 100G ports
- 80 x 100G ports required for host connectivity in leaf layer
 - 20 x 100G host interfaces per leaf switch, for 4 leaf switches
 - Non-blocking network 20 x 100G uplinks per leaf for Spine connectivity
- Total of 2 spines 40 x 100G ports used per Spine
- Storage NFS network in Front End
 - 3 Storage array connected to leaf
 - RoCEv2 for storage networks

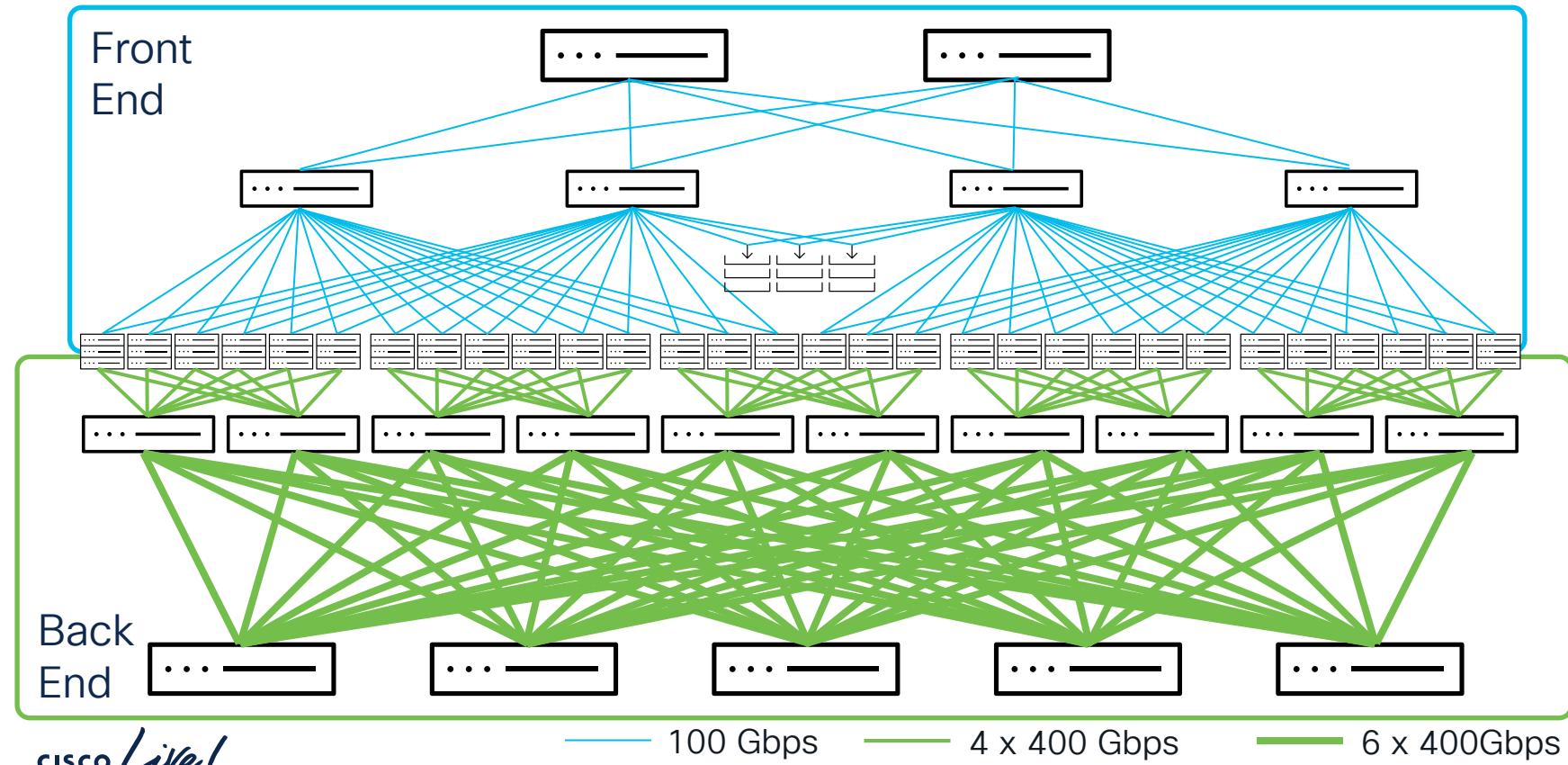
Front-End and Back-End Cluster Network



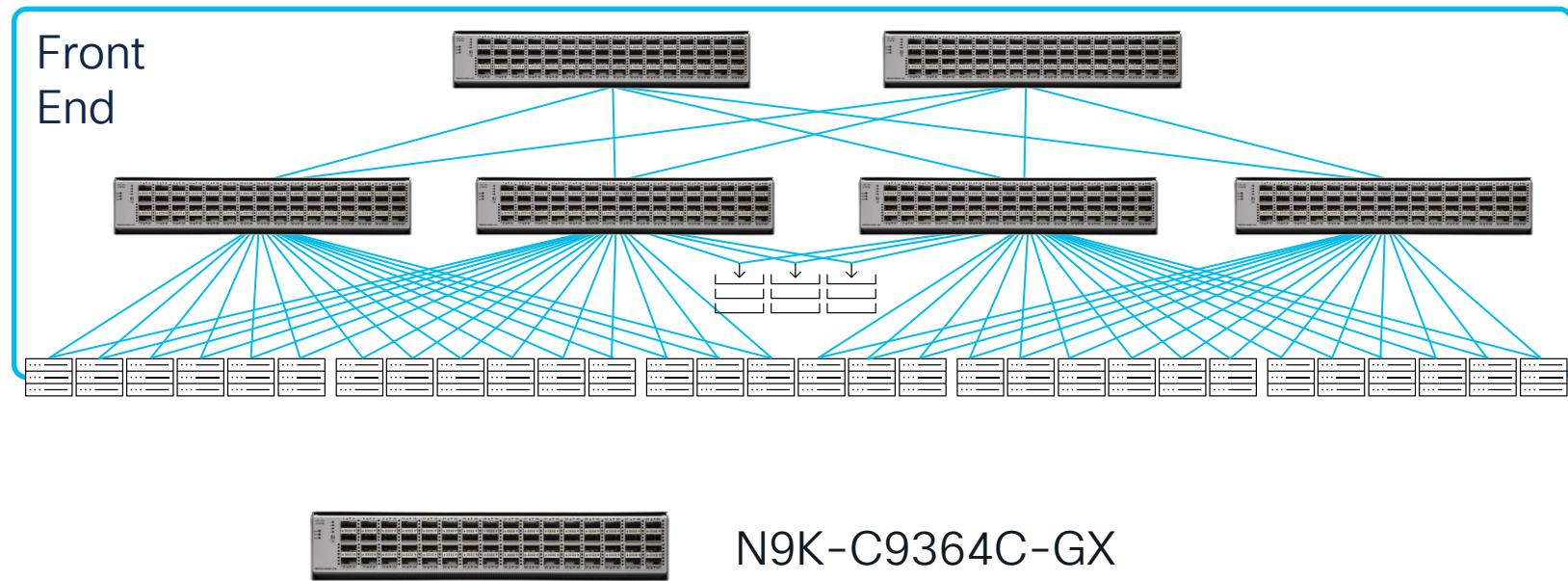
Front-End and Back-End Cluster Network



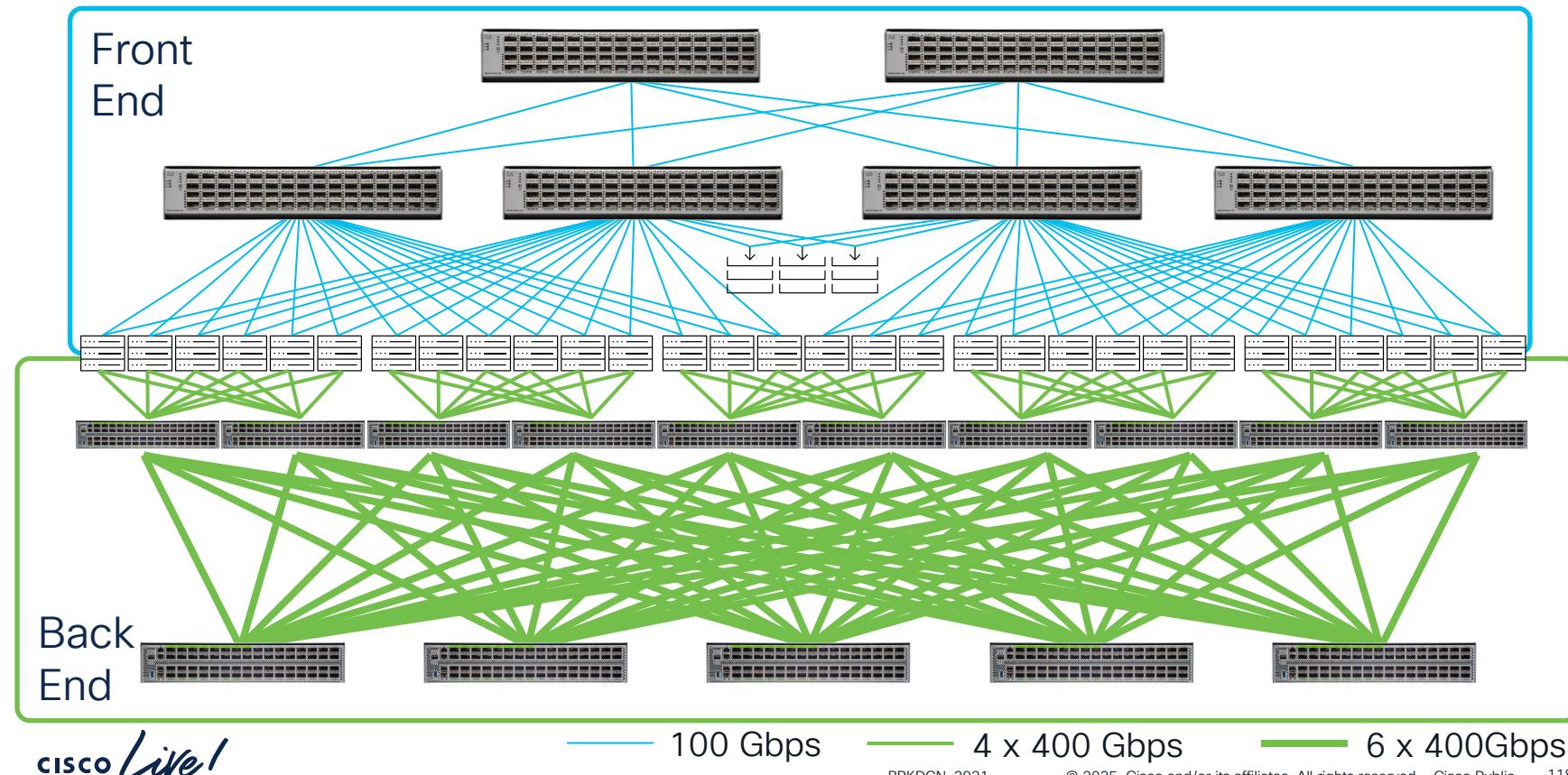
Front-End and Back-End Cluster Network



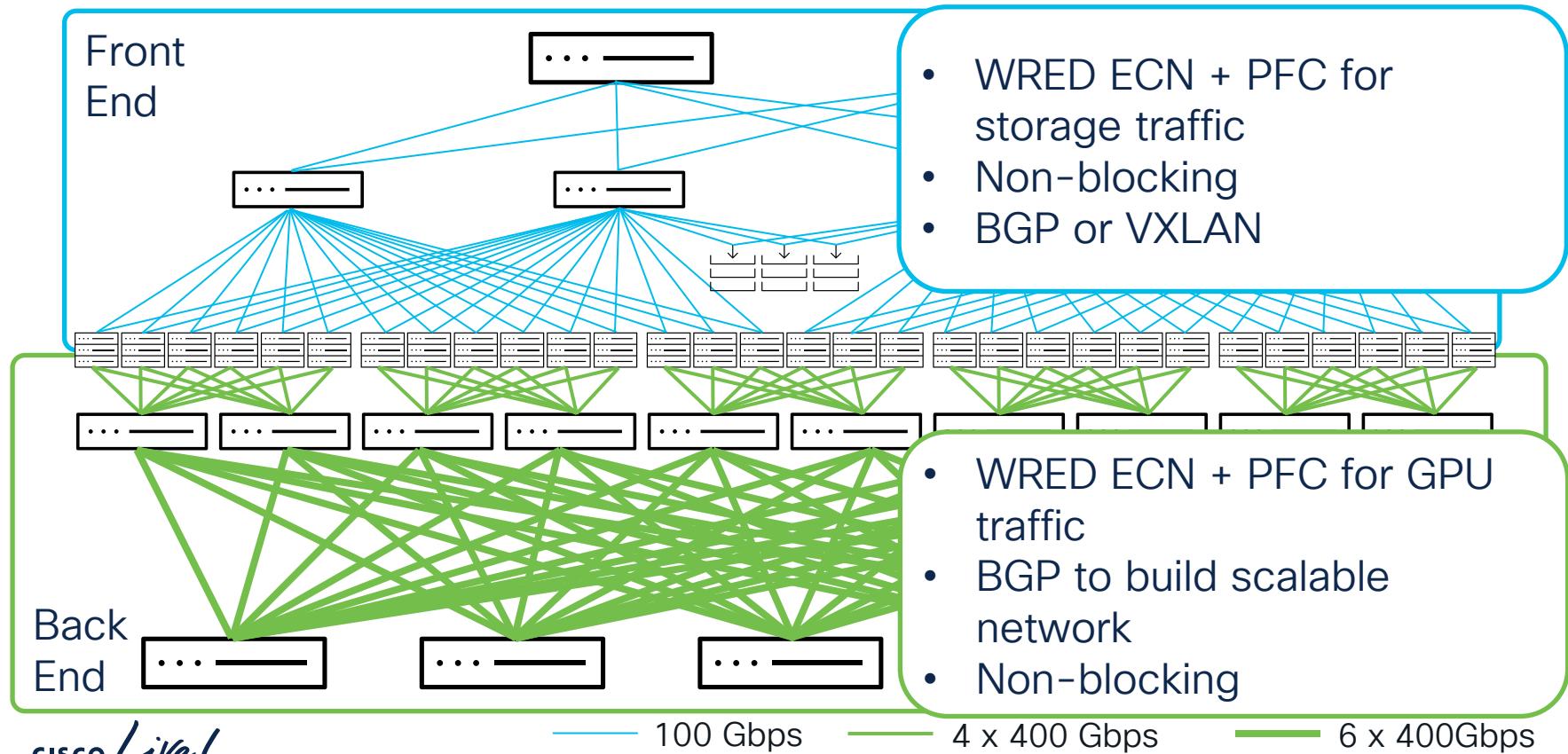
Front-End Cluster Network



Front-End and Back-End Cluster Network



Front-End and Back-End Cluster Network



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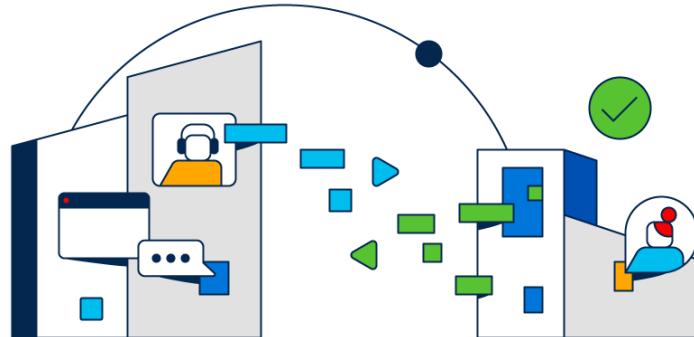
Audience Q&A

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Conclusion

Takeaways

- Robust back-end network, and flexible front-end network
- Familiar data center fabric technologies, BGP or VXLAN
- Automate network for easier bring up and operation
- Visibility in network congestion, and bottleneck to troubleshoot and optimize



The Blueprint For Today



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Cisco Data Center Networking Blueprint for AI/ML Applications

Updated: May 24, 2023

Bias-Free Language Contact Cisco

Introduction

Table of Contents

- Introduction
- RoCEv2 as Transport for AI Clusters
- AI Clusters Require Lossless Networks
- How to Manage Congestion Efficiently in AI/ML Cluster Networks
- How Visibility into Network Behavior is Critical for AI Performance
- Network Design to Accommodate AI Workloads
- Conclusion
- Related Materials

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Introduction

RoCEv2 as Transport for AI Clusters

AI Clusters Require Lossless Networks

Explicit Congestion Notification (ECN)

Priority Flow Control (PFC)

How to Manage Congestion Efficiently in AI/ML Cluster Networks

How ECN Works

How PFC Works

Using ECN and PFC Together to Build Lossless Ethernet Networks

Using Approximate Fair Drop (AFD)



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allenrobel / NDFC-AIML-Fabric Public

Code Issues Pull requests Actions Projects Security Insights

main · 1 branch · 0 tags Go to file Code ▾

allenrobel Ignore .graffle files 6101d38 47 minutes ago 10 commits

doc Update with current 'show running-config ipqos' 1 hour ago

inventory Initial commit 5 days ago

.gitignore Ignore .graffle files 47 minutes ago

AIML_Fabric.yml Template name will probably change, so let's not hardcode it 2 hours ago

AI_Cluster_QOS_template.template Adding new QOS template 2 hours ago

README.md Add topology diagram 5 days ago

ansible.cfg Initial commit 5 days ago

README.md

NDFC-AIML-Fabric

About

Ansible playbook to create an NDFC fabric which supports AI/ML workloads

Readme · 0 stars · 2 watching · 0 forks

Report repository

Releases

No releases published

Packages

No packages published



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Preferred Networks, Inc. Eliminates Overlapping Investment and Network Bottlenecks

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Updated: October 15, 2021

Bias-Free Language

Challenge

Table of Contents
Preferred Networks, Inc.

Challenge

Solution

Results and the future

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Preferred Networks, Inc. chose Cisco due to high reliability, quick response to the latest protocol, and hardware-based streaming telemetry and used Integrated Interconnect Network for deep-learning computing infrastructure into Ethernet and eliminated overlapping investment and network bottlenecks.

Executive Summary

Customer Name: Preferred Networks, Inc.
Industry: Artificial Intelligence
Location: Chiyoda-ku, Tokyo
Number of Employees: Approximately 300



Related sessions

Session ID	Session Title	Day and Time
BRKDCN-2945	IP/Ethernet Storage Networking for AI Infrastructure	Thursday, Feb 13, 1:00 PM
BRKDCN-2999	Multi-Tier Fabric-Networks Designs for the Modern Data Center	Thursday, Feb 13, 3:15 PM

Webex App

Questions?

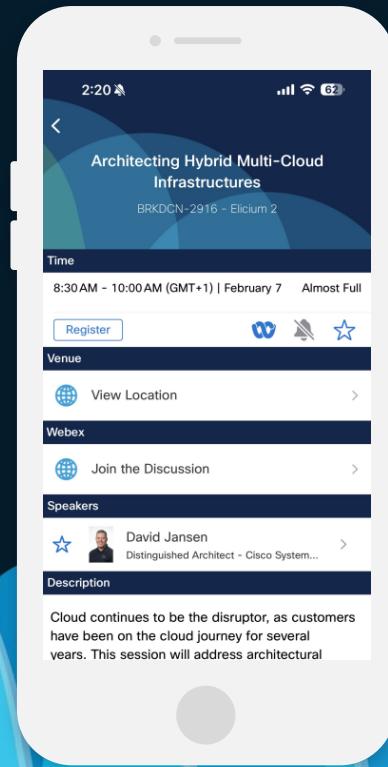
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- 2 Click “Join the Discussion”
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- 4 Enter messages/questions in the Webex space

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(from 11:30 on Thursday, while supplies last)



All surveys can be taken in the Cisco Events mobile app or by logging in to the Session Catalog and clicking the 'Participant Dashboard'



Content Catalog

A dark blue background featuring a series of overlapping, semi-transparent blue waves of varying shades, creating a sense of depth and motion.

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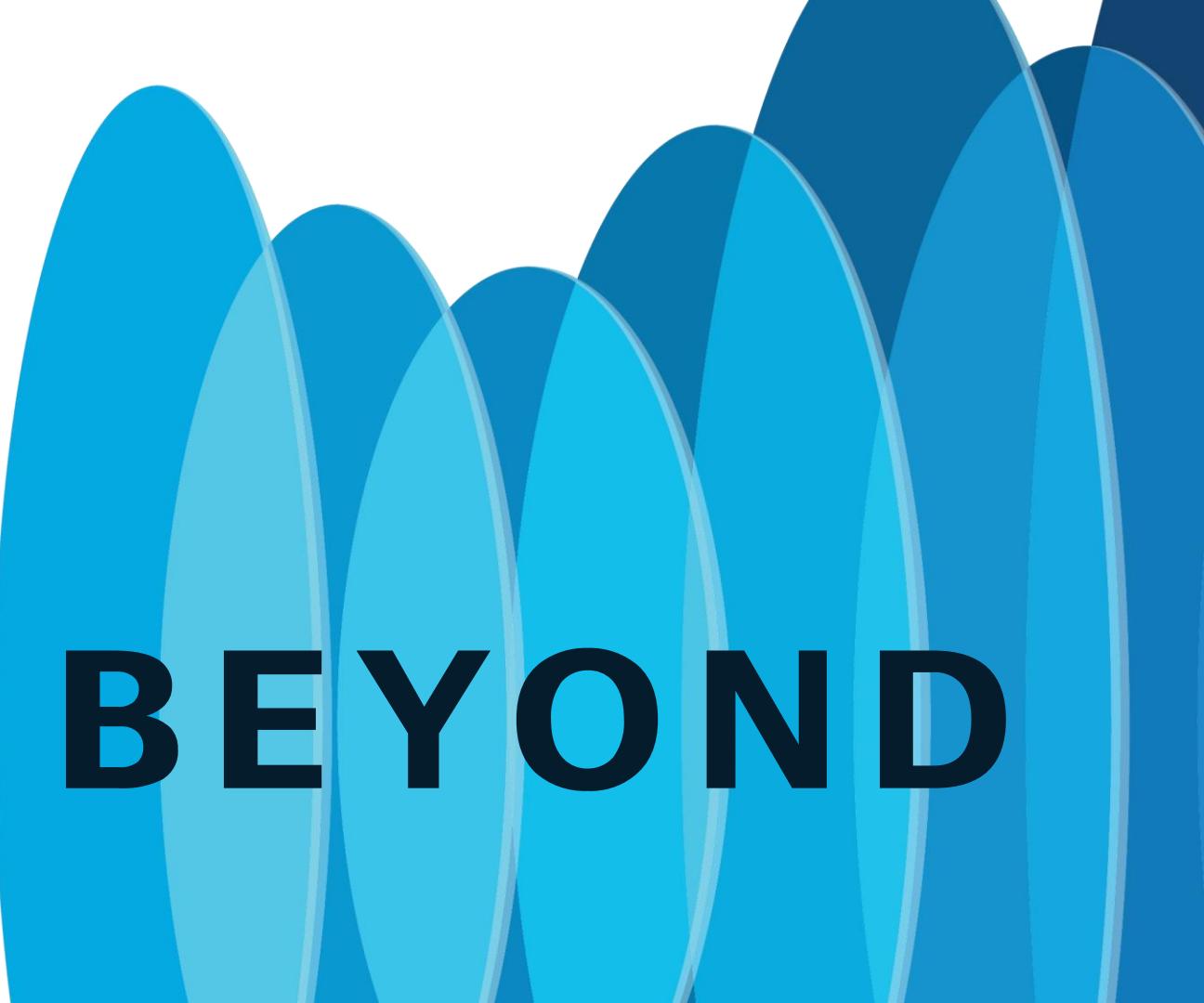
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Thank you

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