



# Network Best Practices for Artificial Intelligence Data Centre

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

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# Webex App

## Questions?

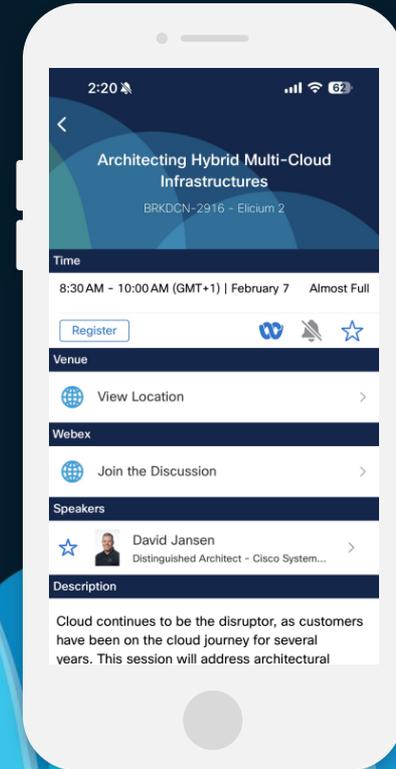
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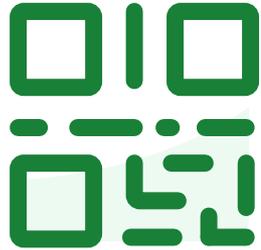
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# About Me



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

# 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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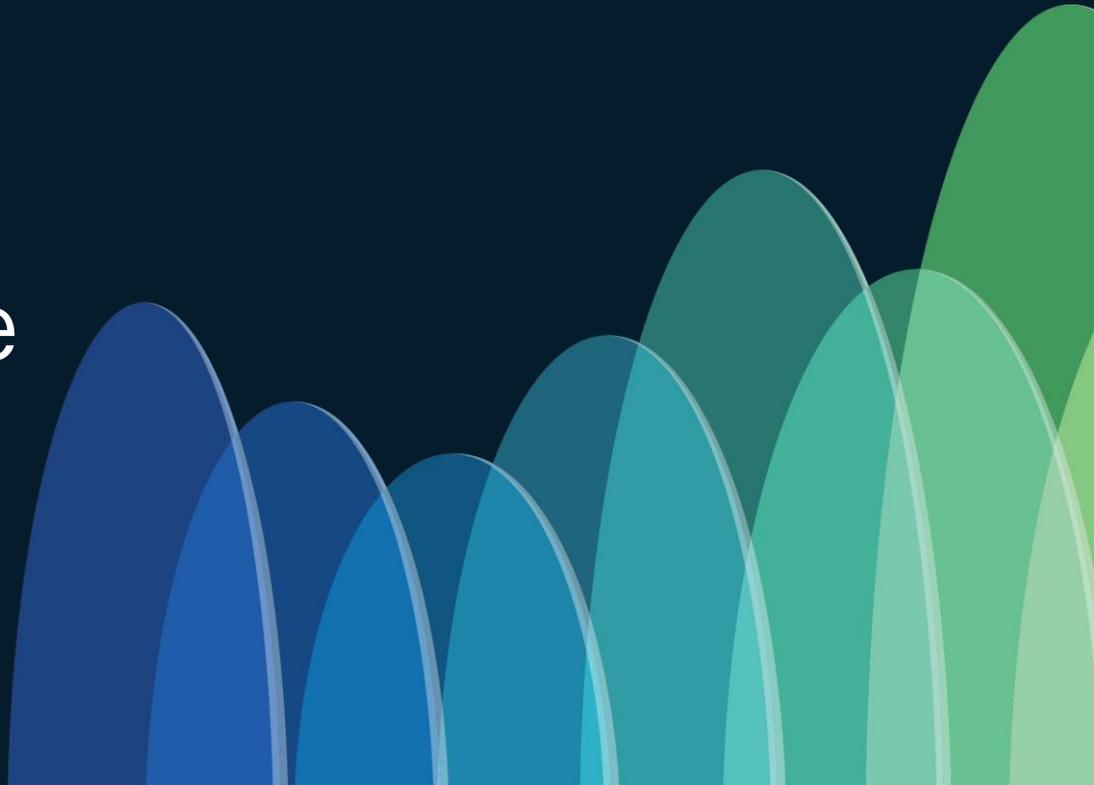
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# What do you think about AI

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# Why AI is important today and, in the future



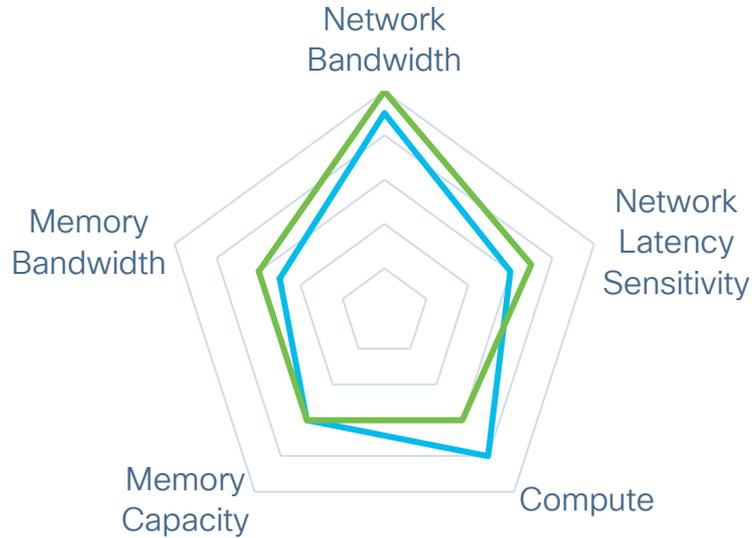
# AI/ML can help many industries

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

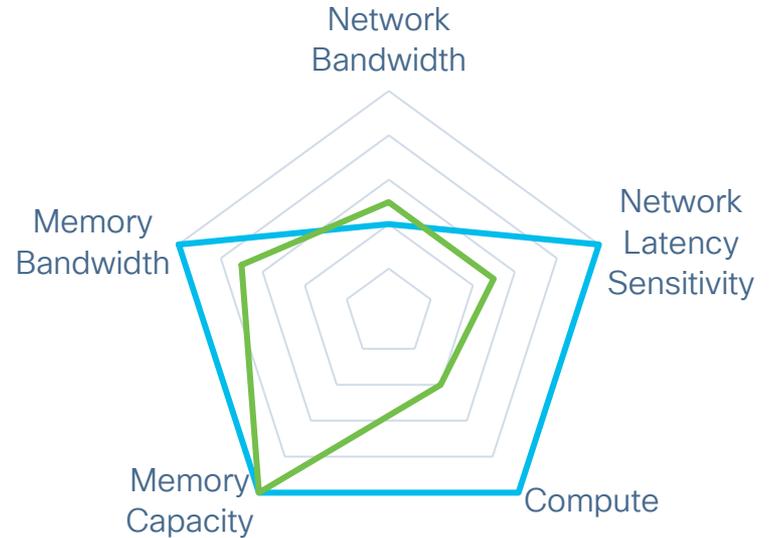
# AI cluster types and interaction with network

	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



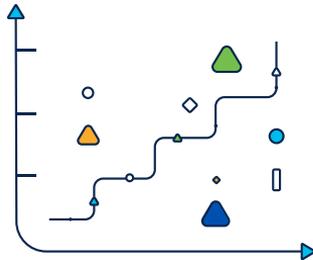
— LLM Trainig — Ranking Training



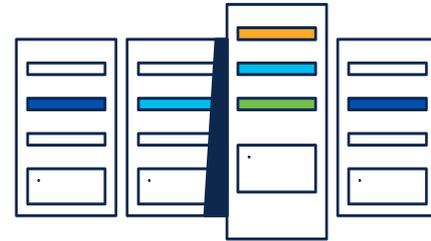
— LLM Inference — Ranking Inference

# 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

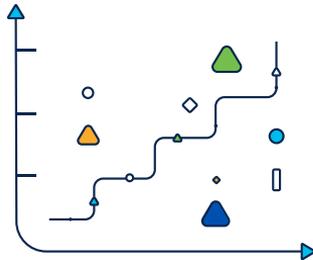


- Cluster Key Components
  - Compute Nodes
  - Network
  - Distributed File System/Storage
  - Job Scheduling and Orchestration
  - Software Framework for AI model

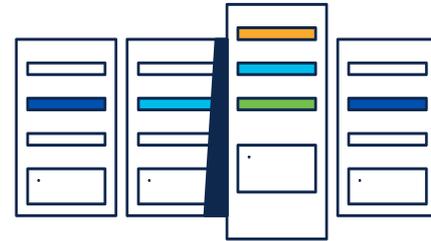


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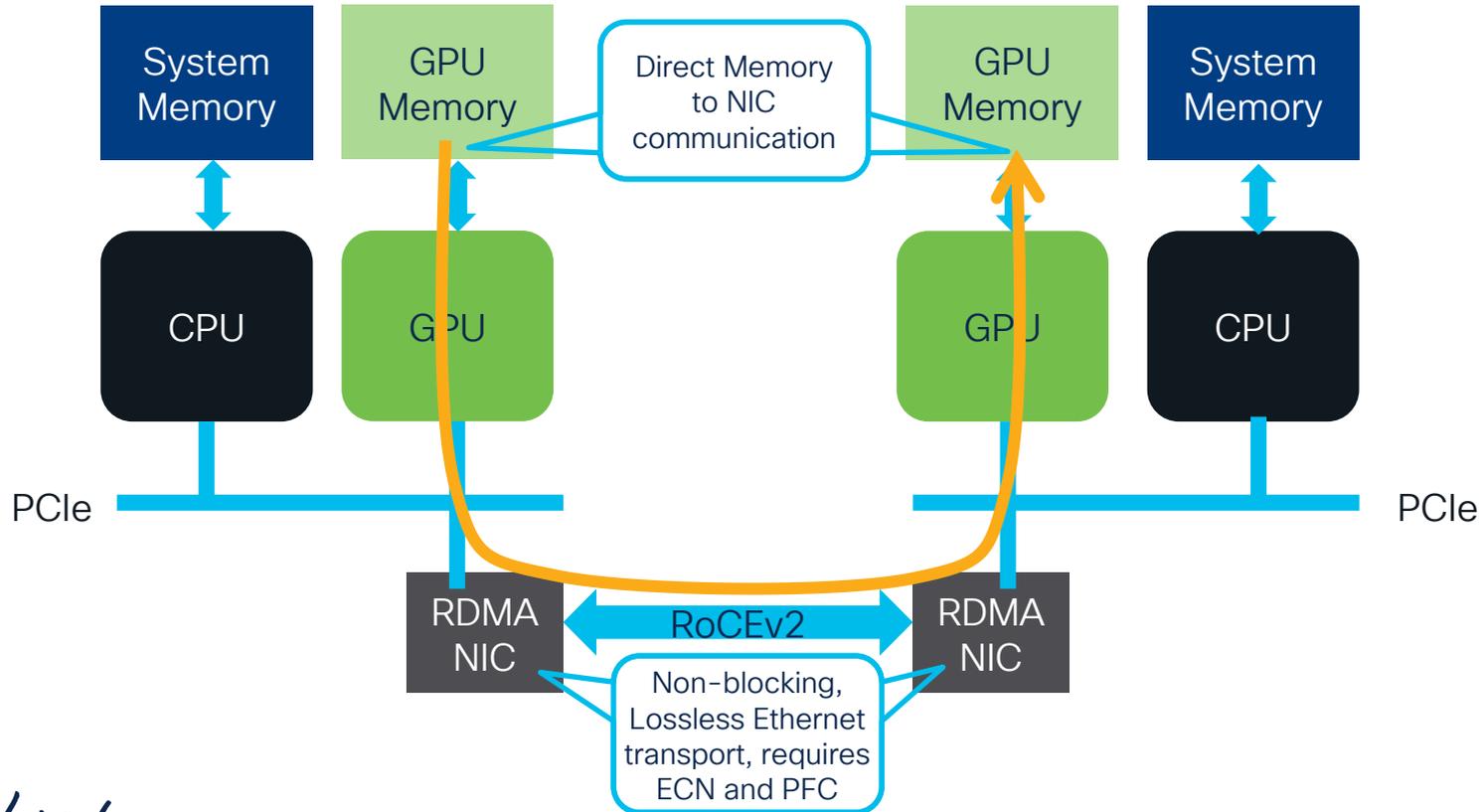
# Audience Q&A

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# Network For AI Cluster

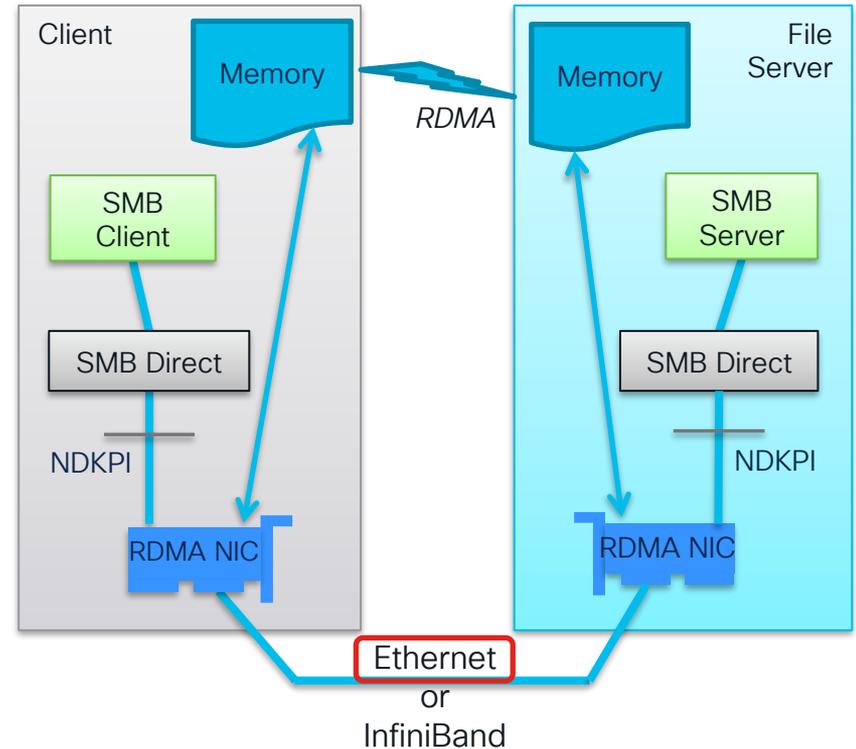


# RoCEv2 – benefits and requirements



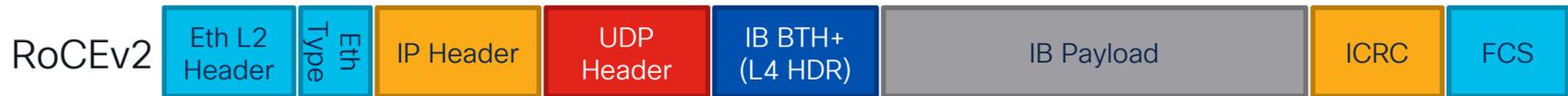
# RDMA – remote data memory access

- 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](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

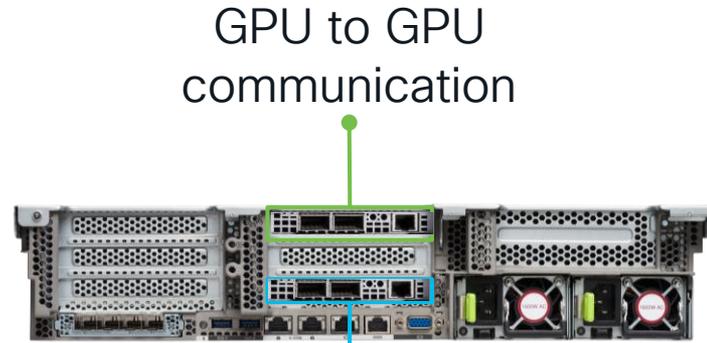
- Requires PFC to be enabled for RoCEv2 transport
- Traffic priority to be preserved between Layer 2 and Layer 3 network
  - Packet/Flow identification follows standard practices of IP/Ethernet networks (i.e., DSCP/802.1Q)
- ECN marking (WRED or consider AFD)
- Configure ETS
  - 802.1Qaz ETS

InfiniBand™ Architecture	RoCEv2 (IP Routable RoCE)	September 2, 2014
VOLUME 1 - GENERAL SPECIFICATIONS		
<b>A17.9 RoCEv2 NETWORK CONSIDERATIONS</b>		1
<b>A17.9.1 LOSSLESS NETWORK</b>		2
	As with RoCE, the underlying networks for RoCEv2 should be configured as lossless. In this context, lossless doesn't mean that packets are abso-	3
		4

# Networks – Why do I need them?



UCS C240 M7 Rack Server  
Up to 2 GPUs



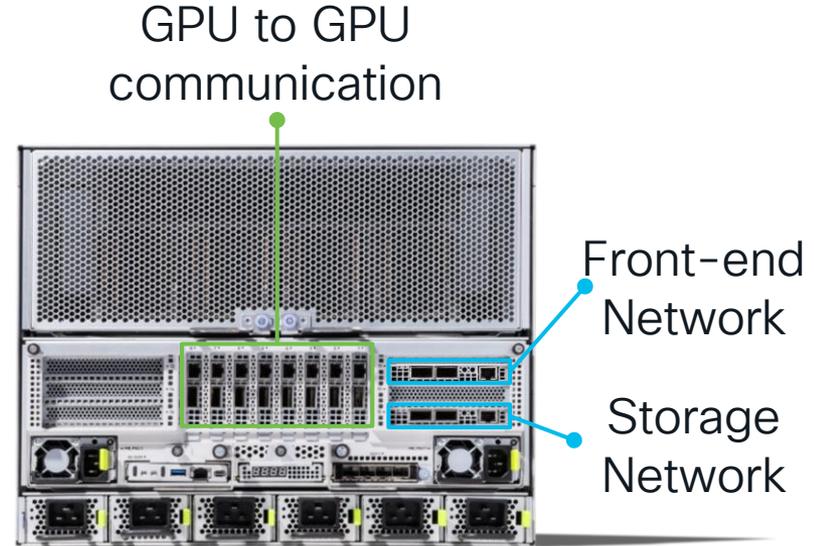
GPU to GPU  
communication

Front-end and  
Storage Network

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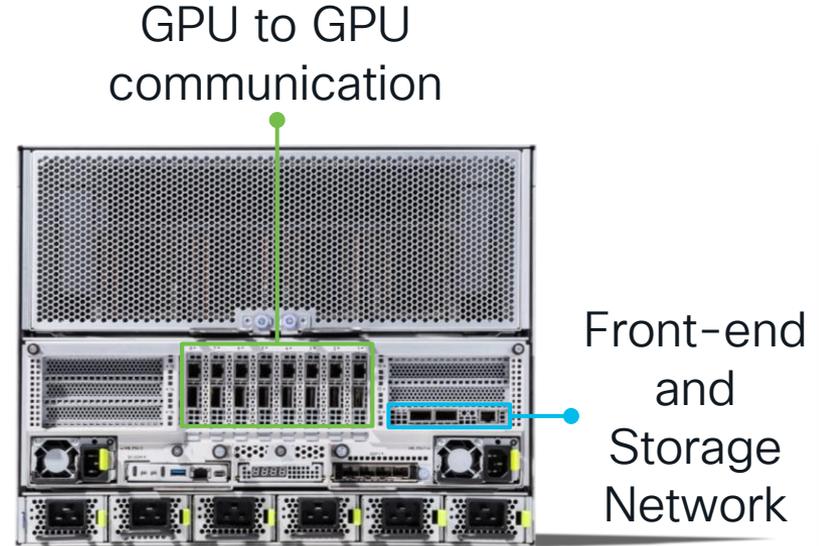
UCS C885A M8 Rack Server  
8 GPUs



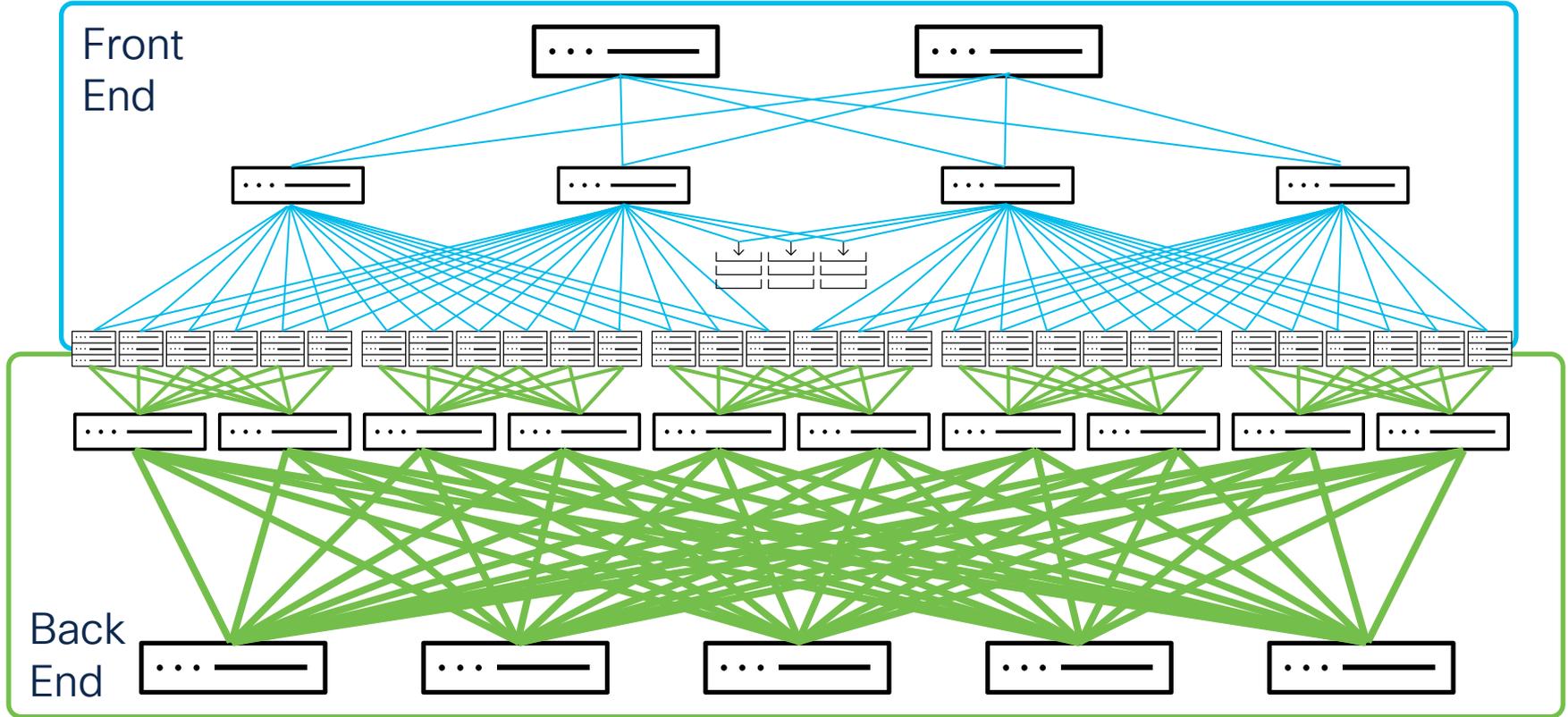
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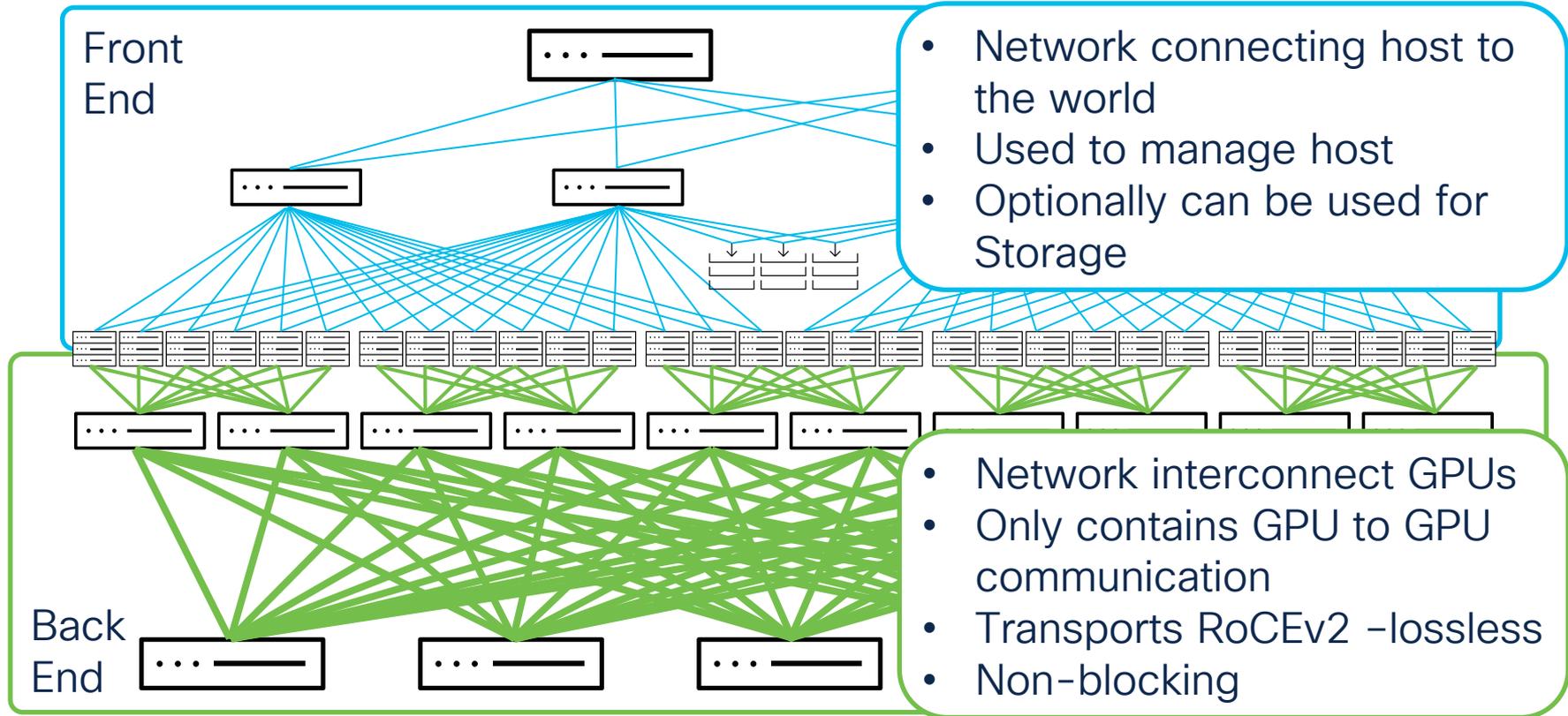
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# Non-blocking network



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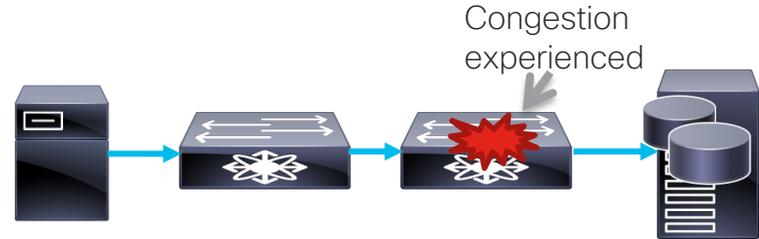


# Audience Q&A

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# Explicit Congestion Notification (ECN)

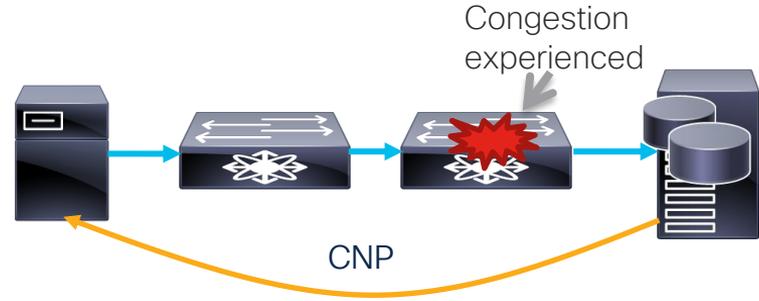
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- ECN enables end-to-end congestion notification between two endpoints on IP network
- ECN uses 2 LSB of Type of Service field in IP header



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

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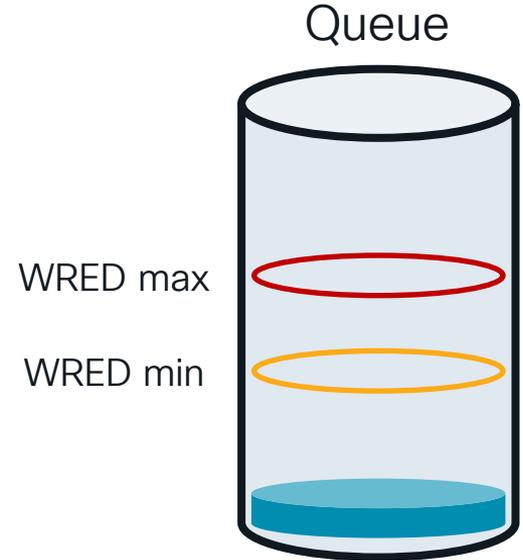
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- ECN enables end-to-end congestion notification between two endpoints on IP network
- ECN uses 2 LSB of Type of Service field in IP header
- In case of congestion, ECN gets transmitting device to reduce transmission rate using Congestion Notification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



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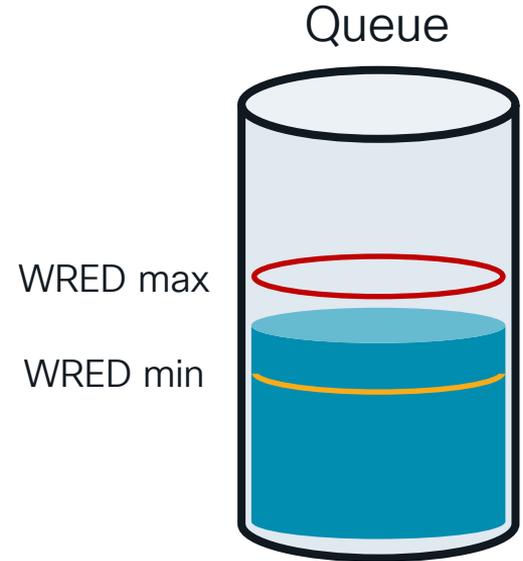
# How does WRED ECN work?

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



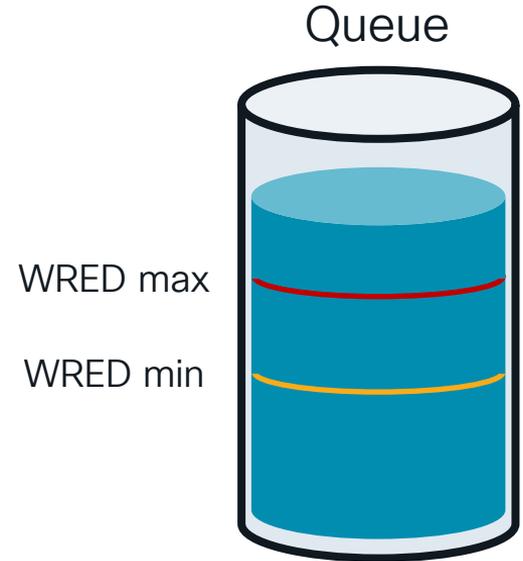
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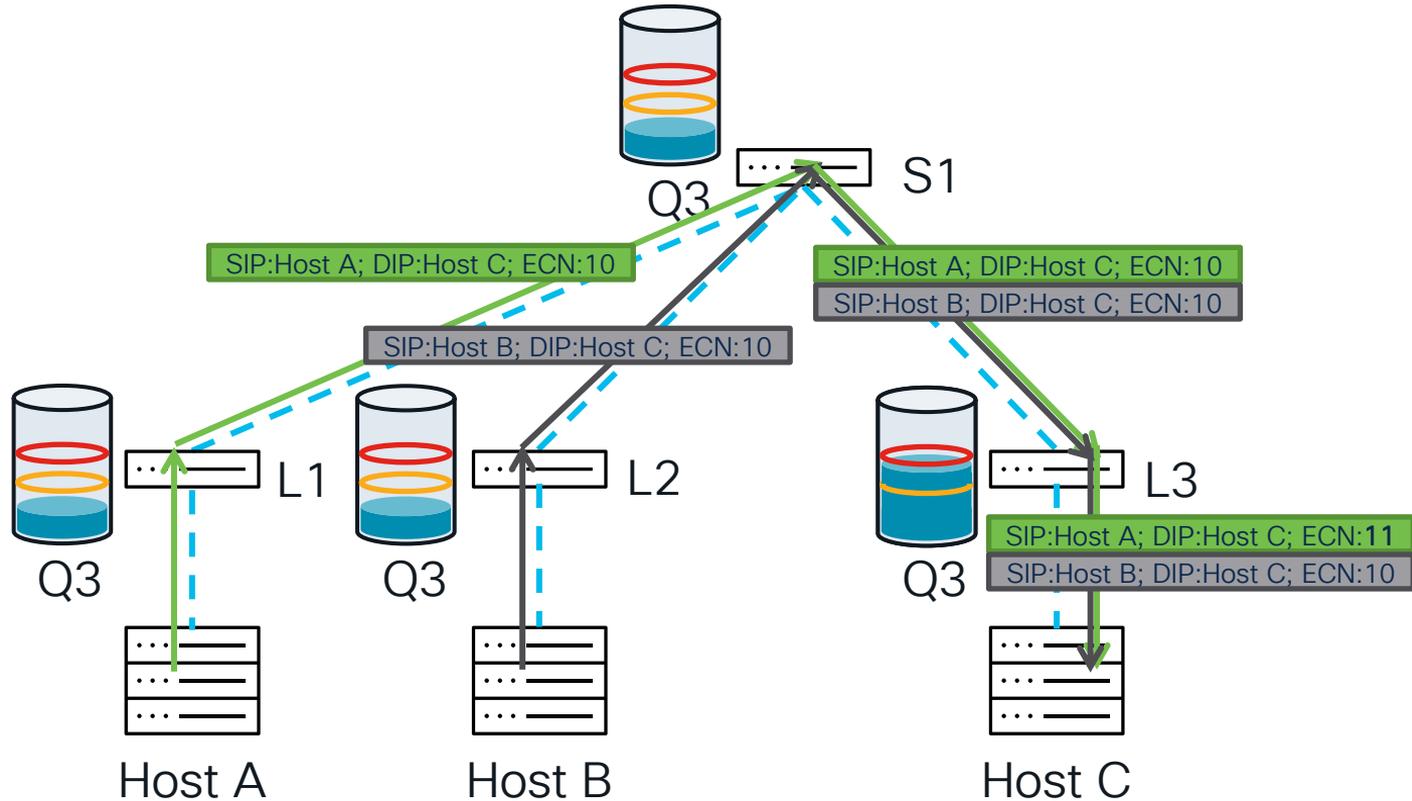


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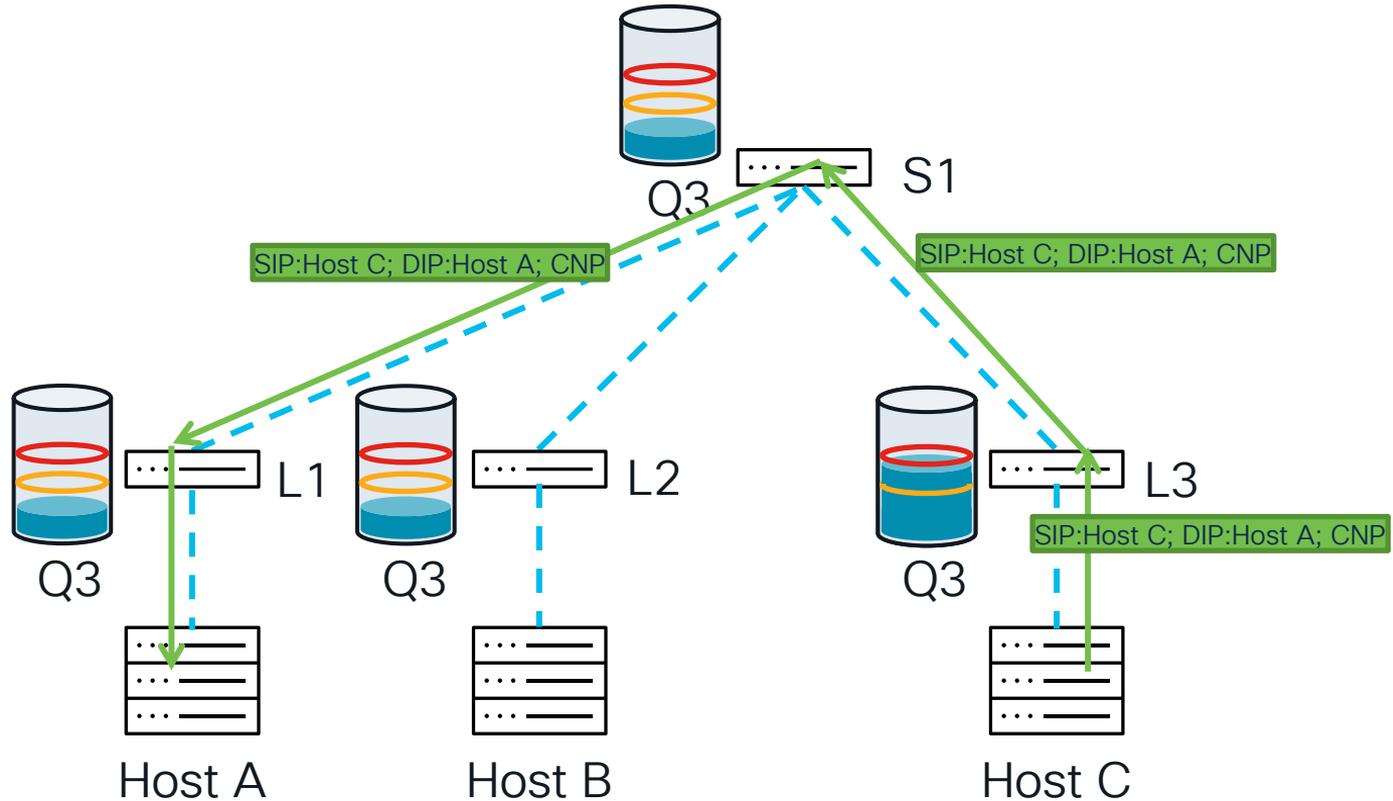
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- After buffer usage crosses MAX threshold, every ECN capable packet will be marked with Congestion Encountered



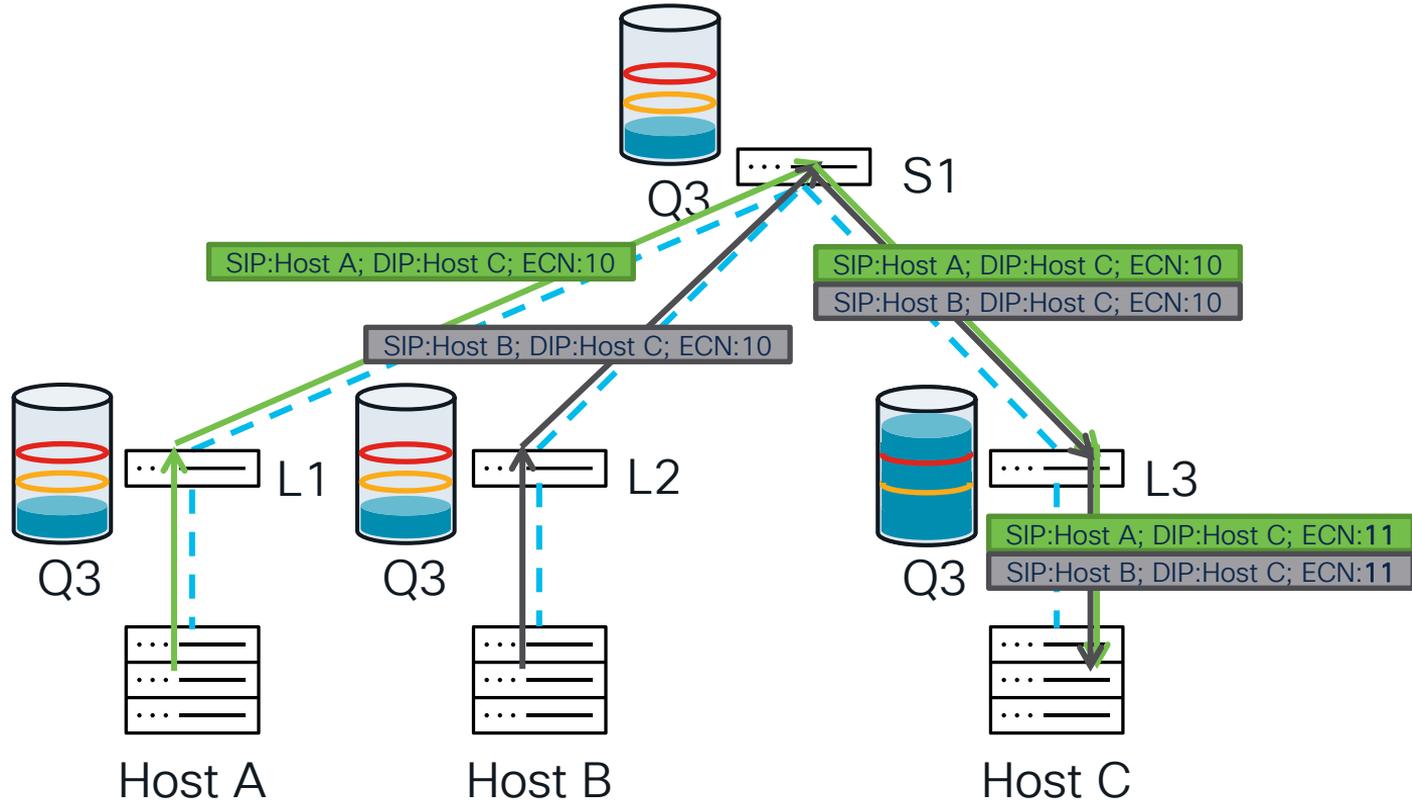
# Explicit Congestion Notification – End to End



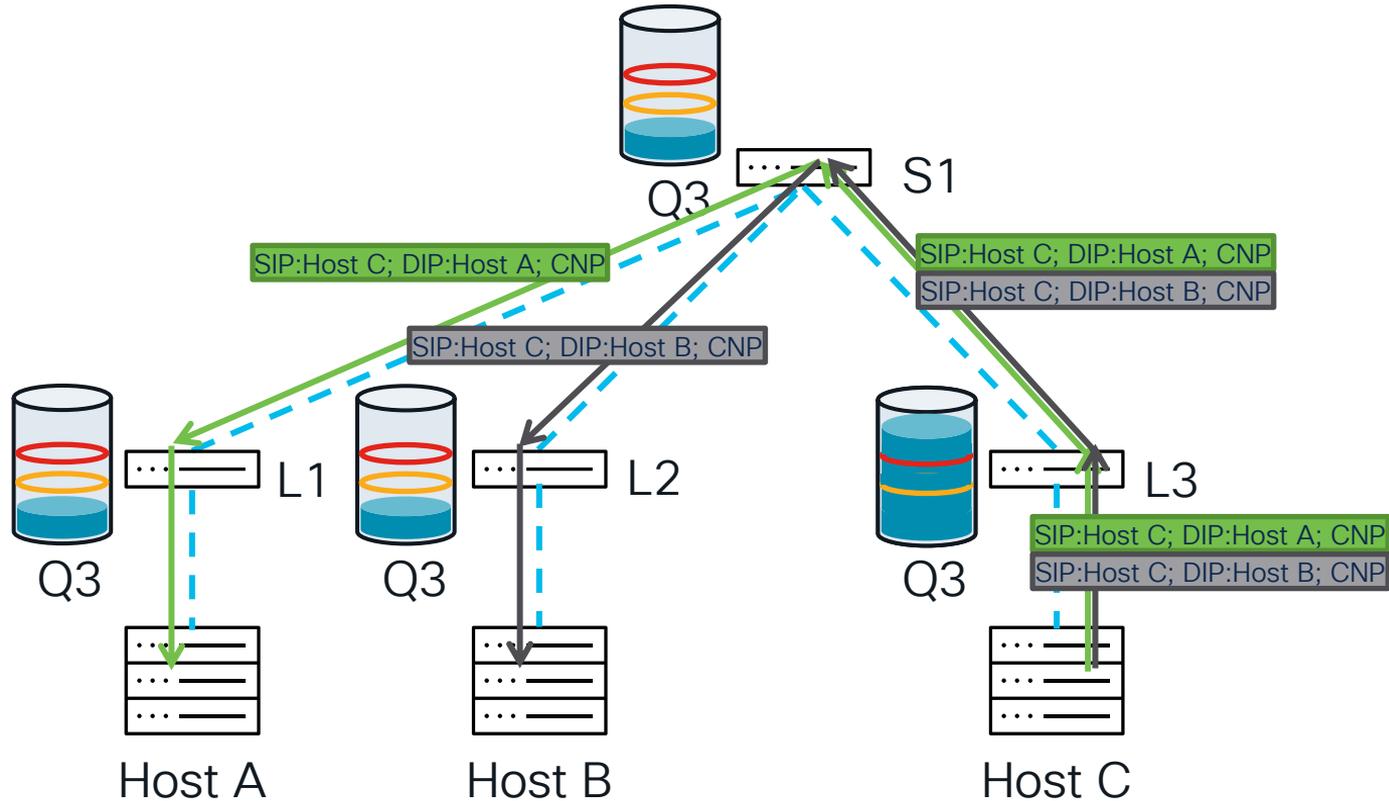
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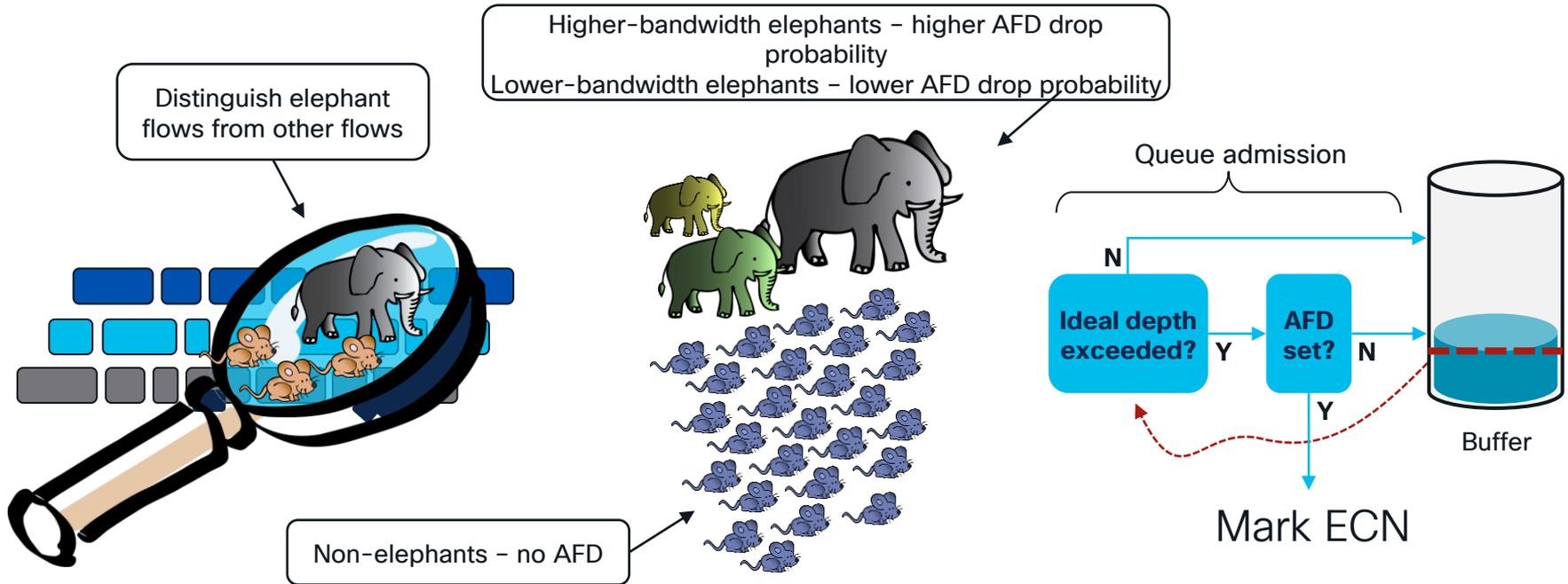


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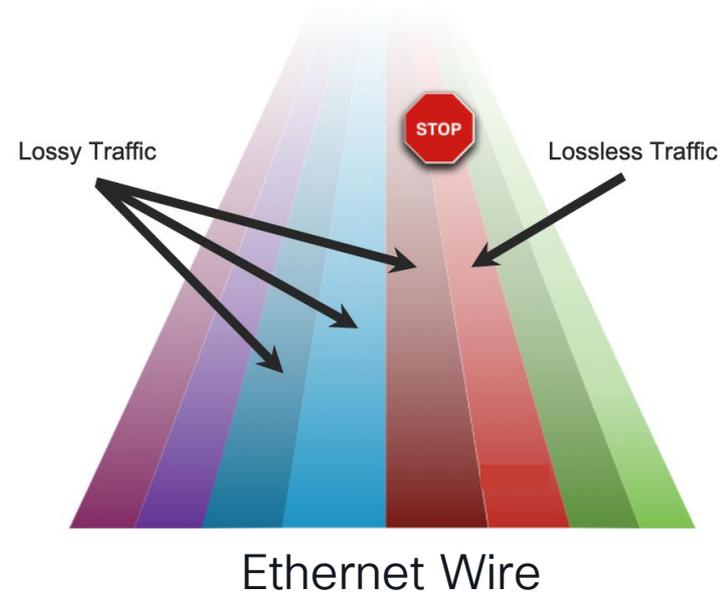
# Approximate Fair Drop (AFD)

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



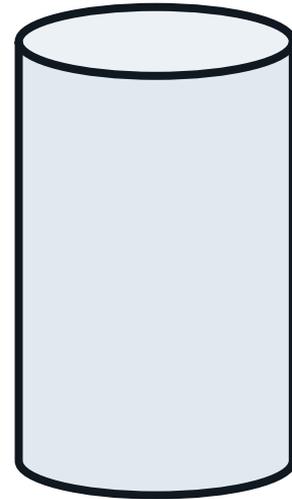
# Priority Flow Control

- 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



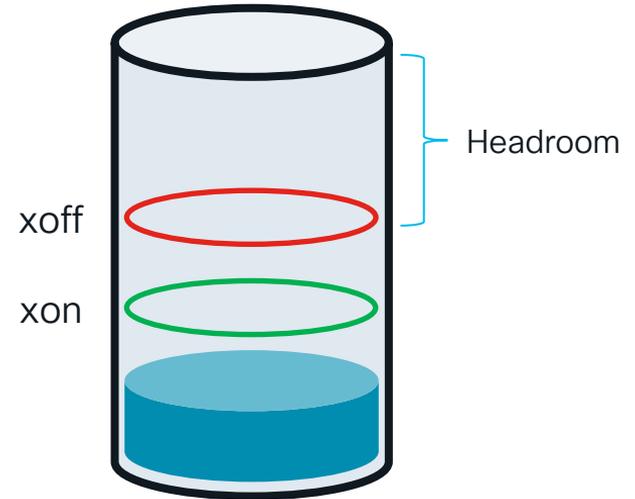
# PFC – How pause frames are sent

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



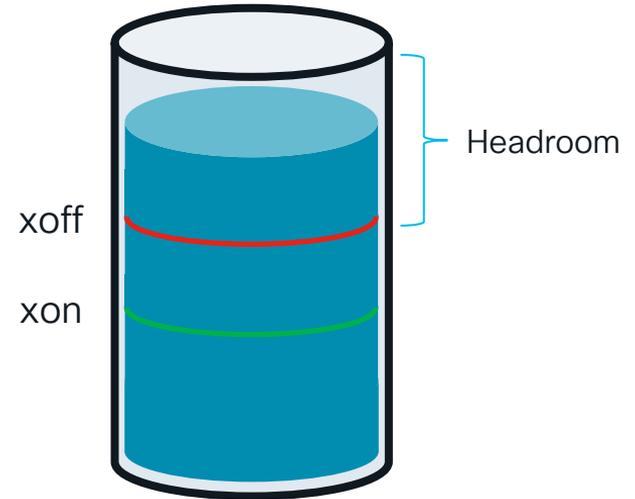
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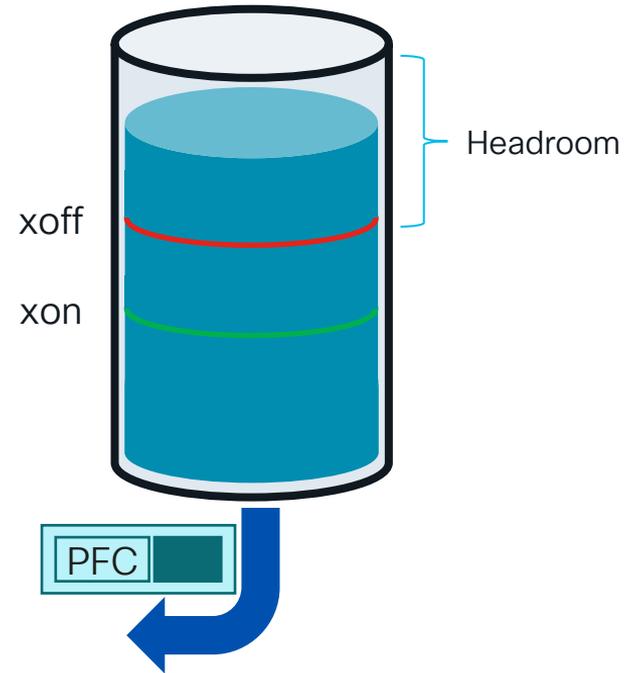
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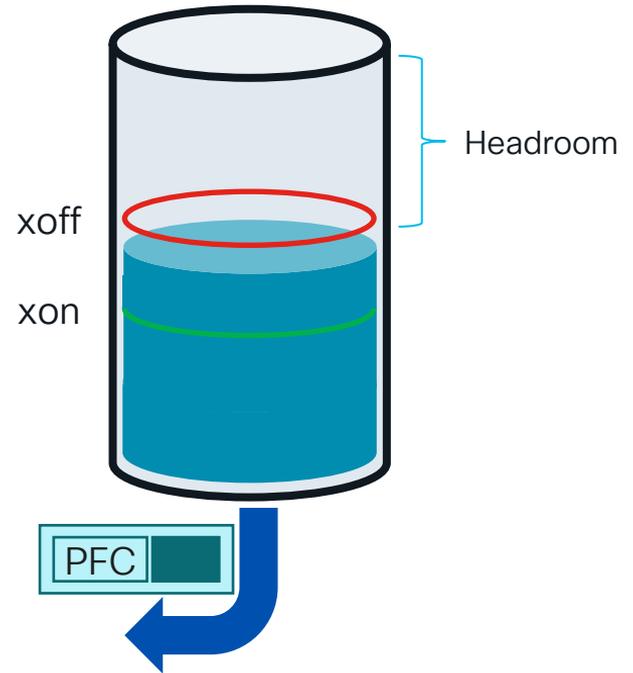
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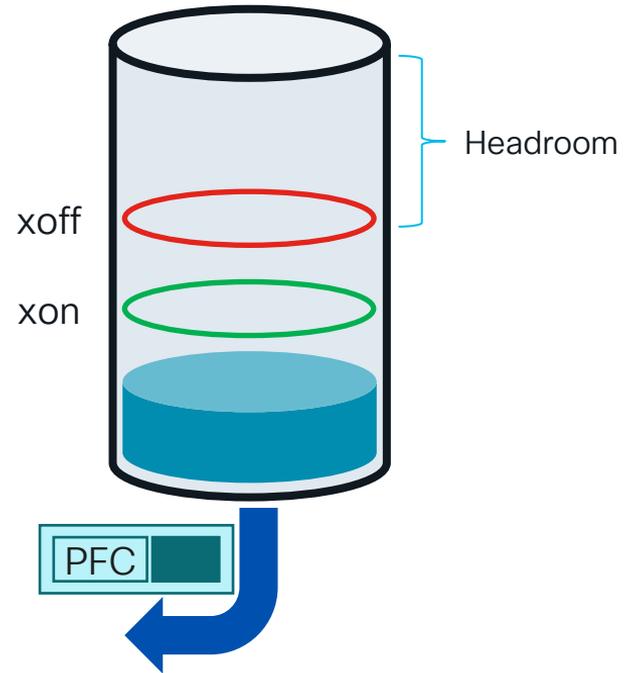
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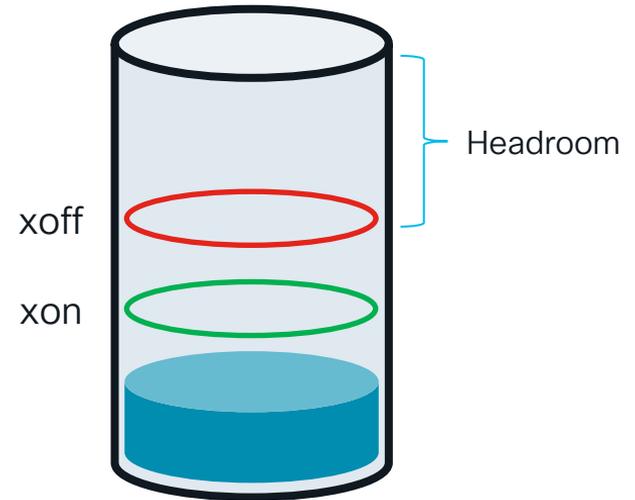
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- While draining the queue, and utilization is below *xon* threshold system will stop sending PFC frames

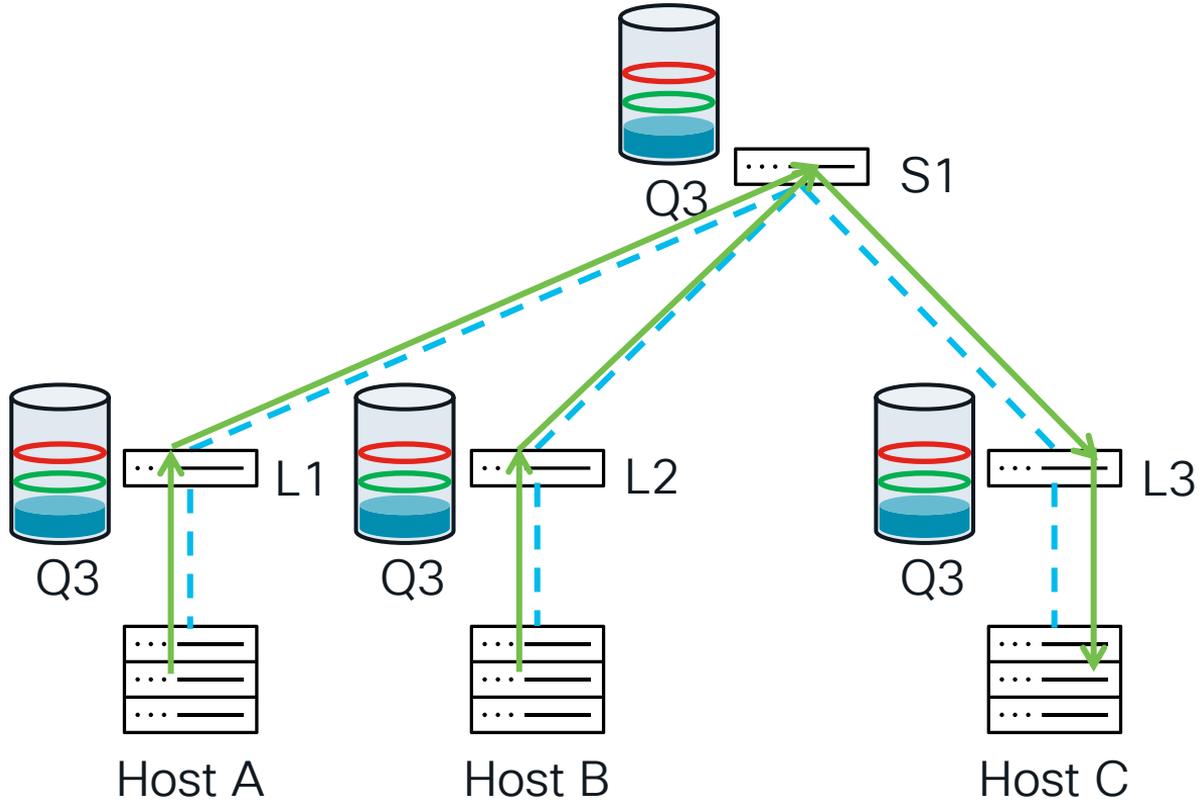


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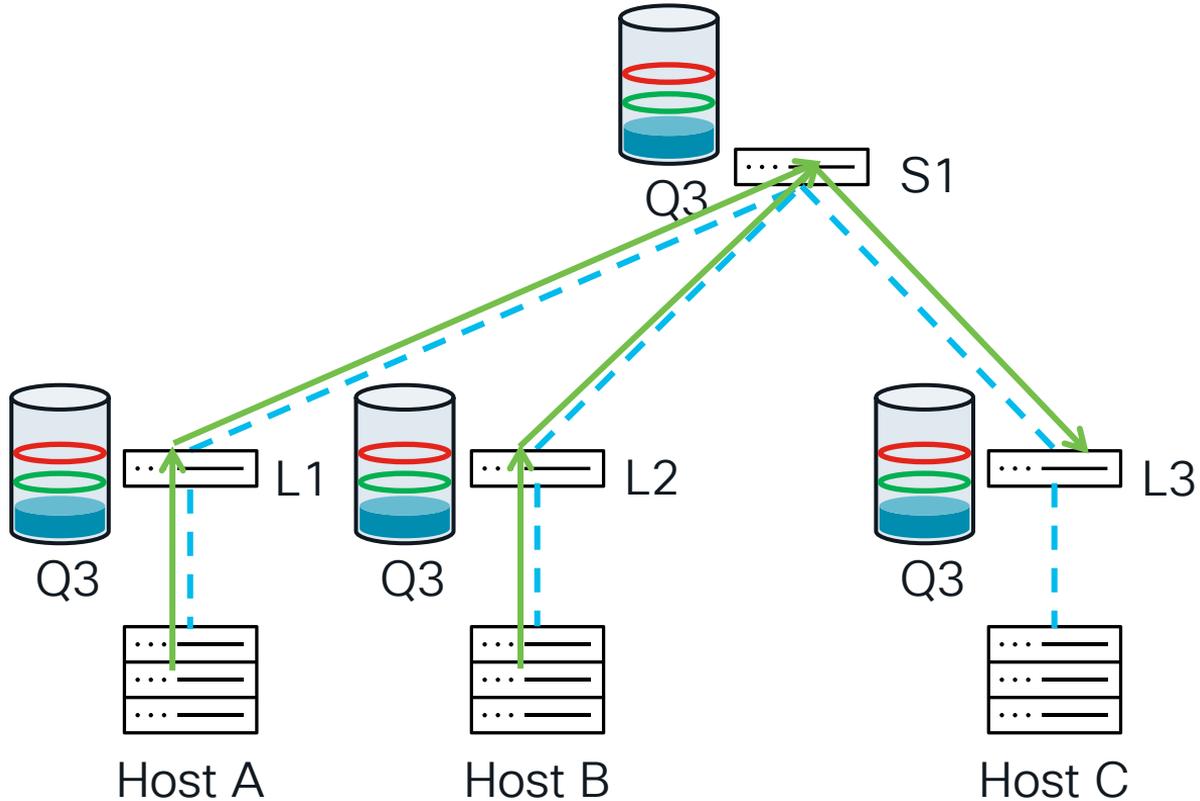
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# PFC hop by hop

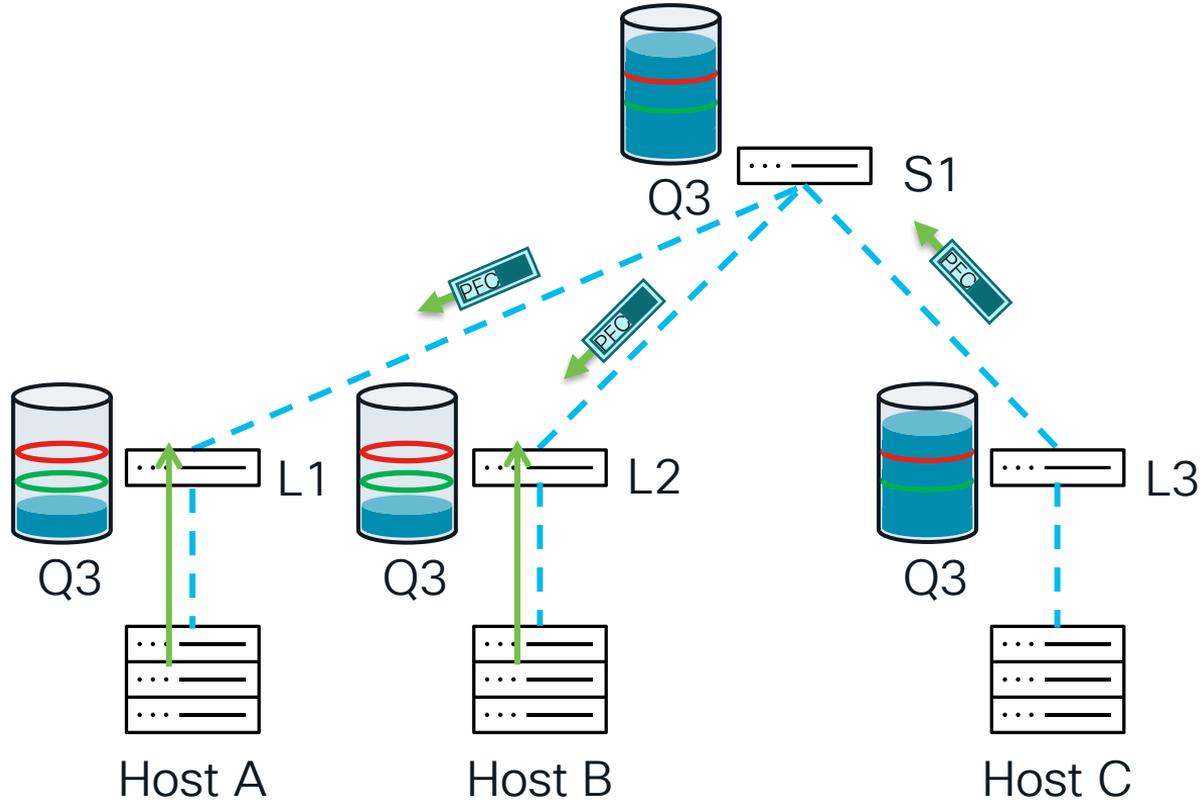


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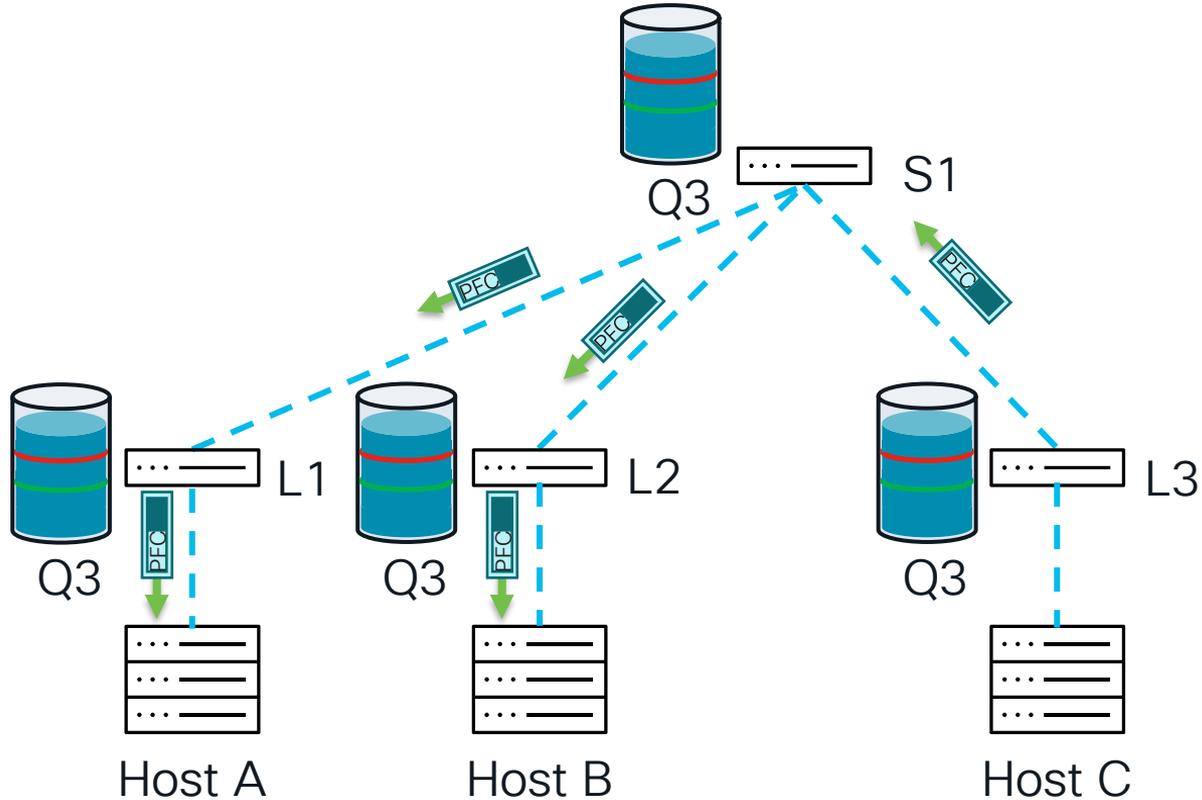




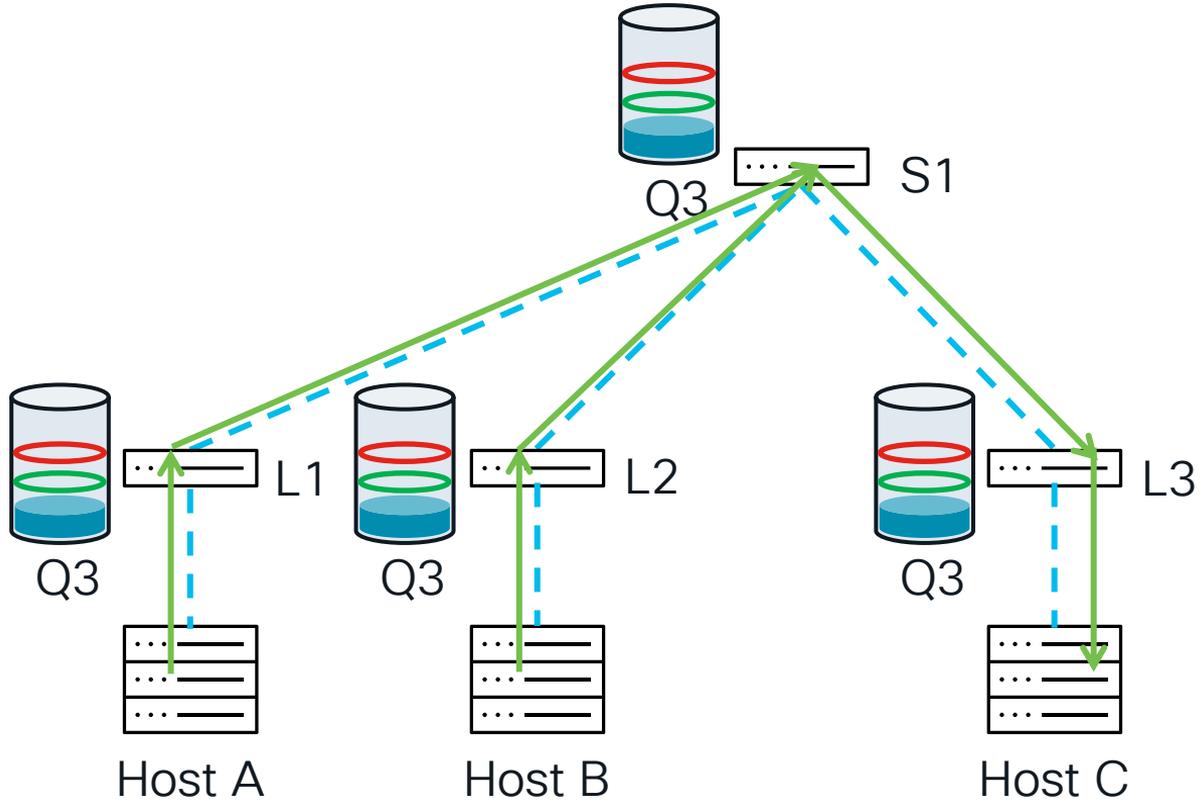
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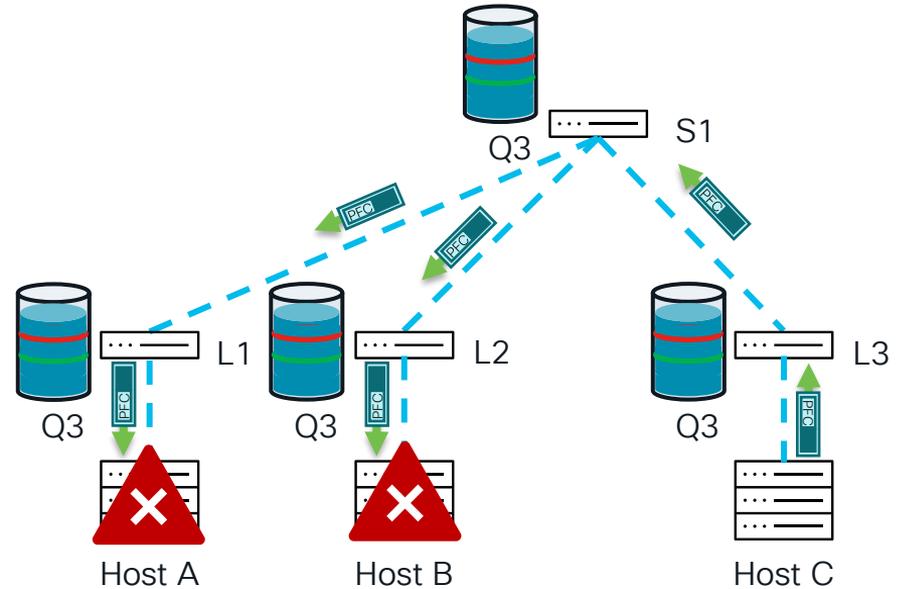


# PFC hop by hop



# PFC storm

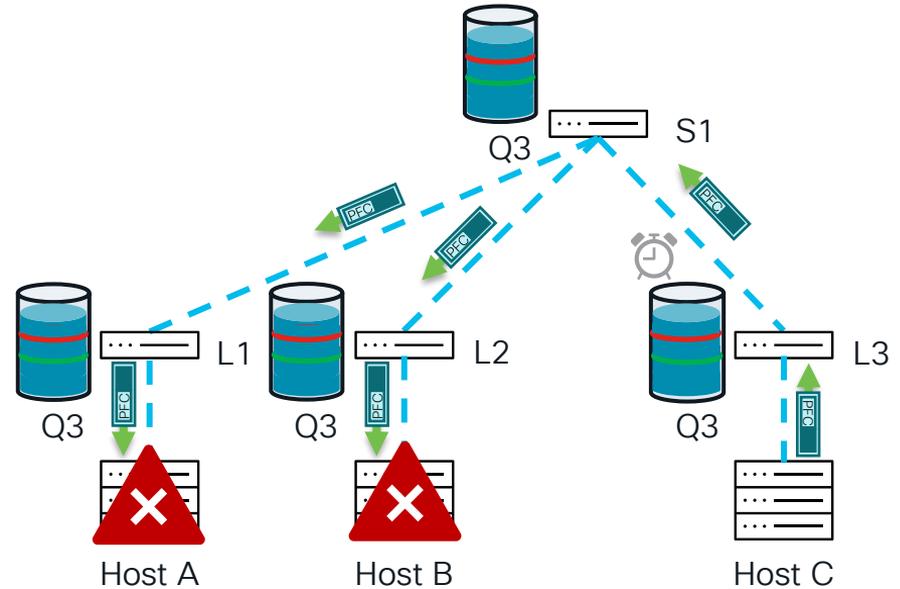
- In occasion of NIC or network malfunction, PFC storm can be triggered to send continues PFC frames in the network
- Network will propagat those frame to all senders
- PFC storm will stop traffic coming from sender
- PFC watchdog can drain the queue



[https://www.microsoft.com/en-us/research/wp-content/uploads/2016/11/rdma\\_sigcomm2016.pdf](https://www.microsoft.com/en-us/research/wp-content/uploads/2016/11/rdma_sigcomm2016.pdf)

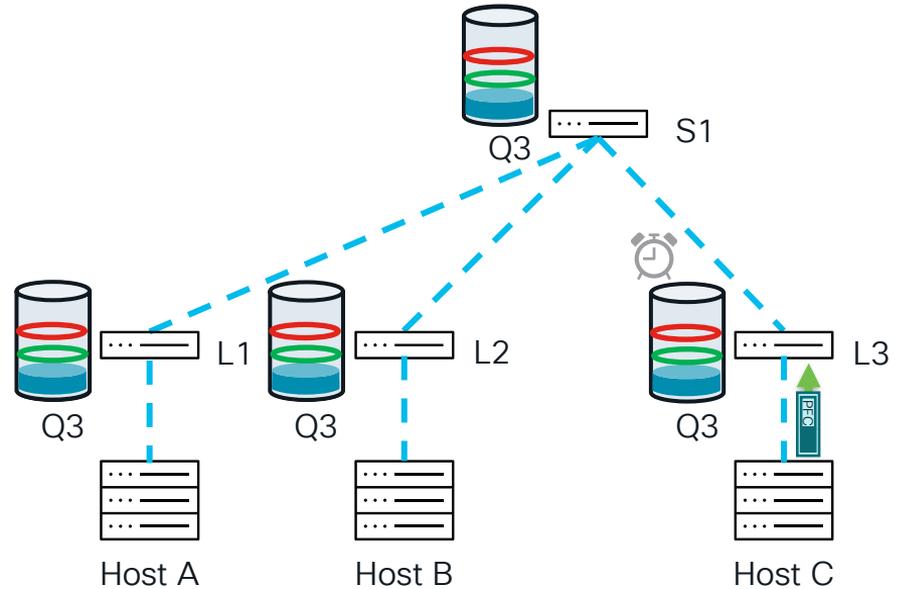
# PFC watchdog

- 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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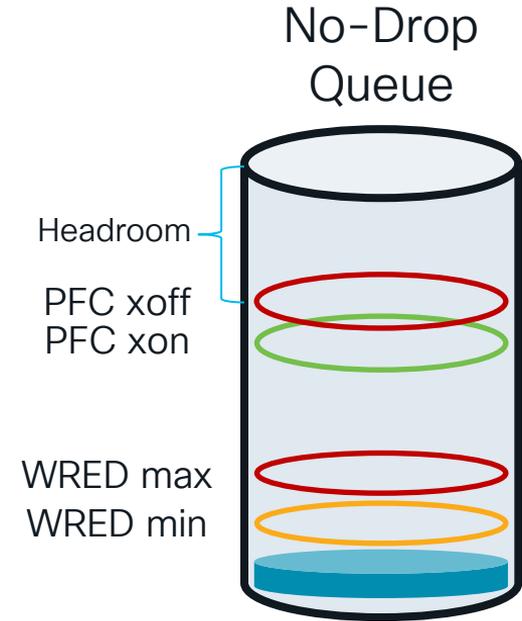
# Audience Q&A

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# RoCEv2: PFC and ECN together

How does it work?

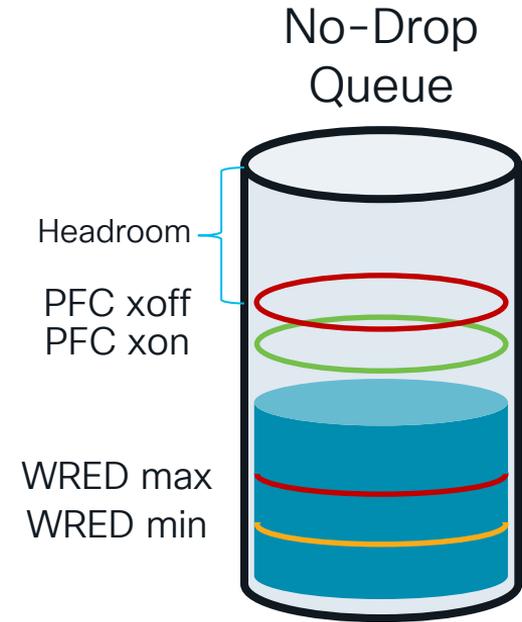
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  - Signalize early for congestion, give enough time for end points to react
- PFC threshold are set higher than ECN
  - In case oversubscription buffers can be filled quickly without giving time to ECN to react
  - PFC will react and mitigate congestion



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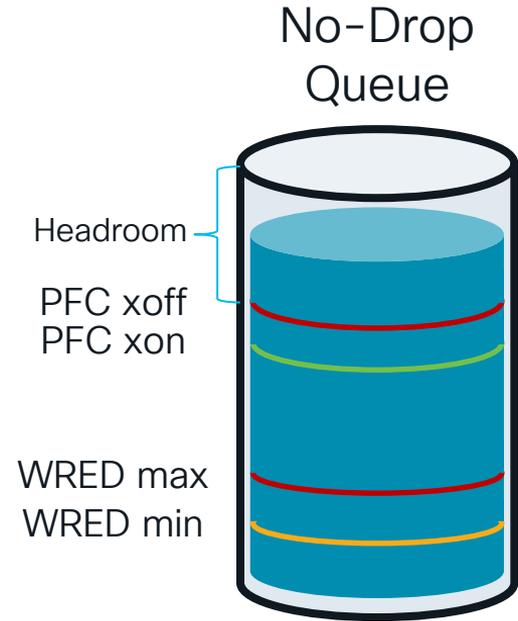
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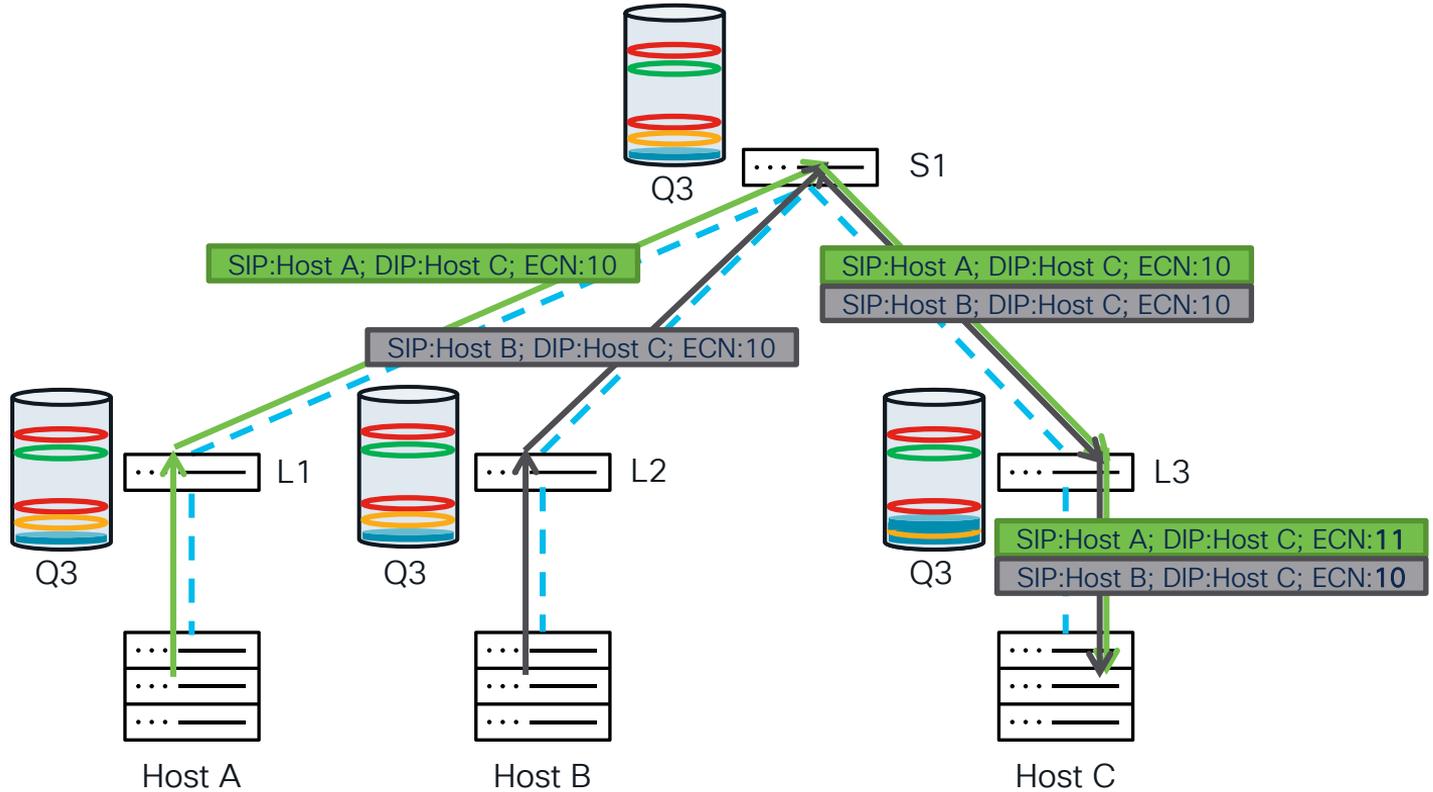
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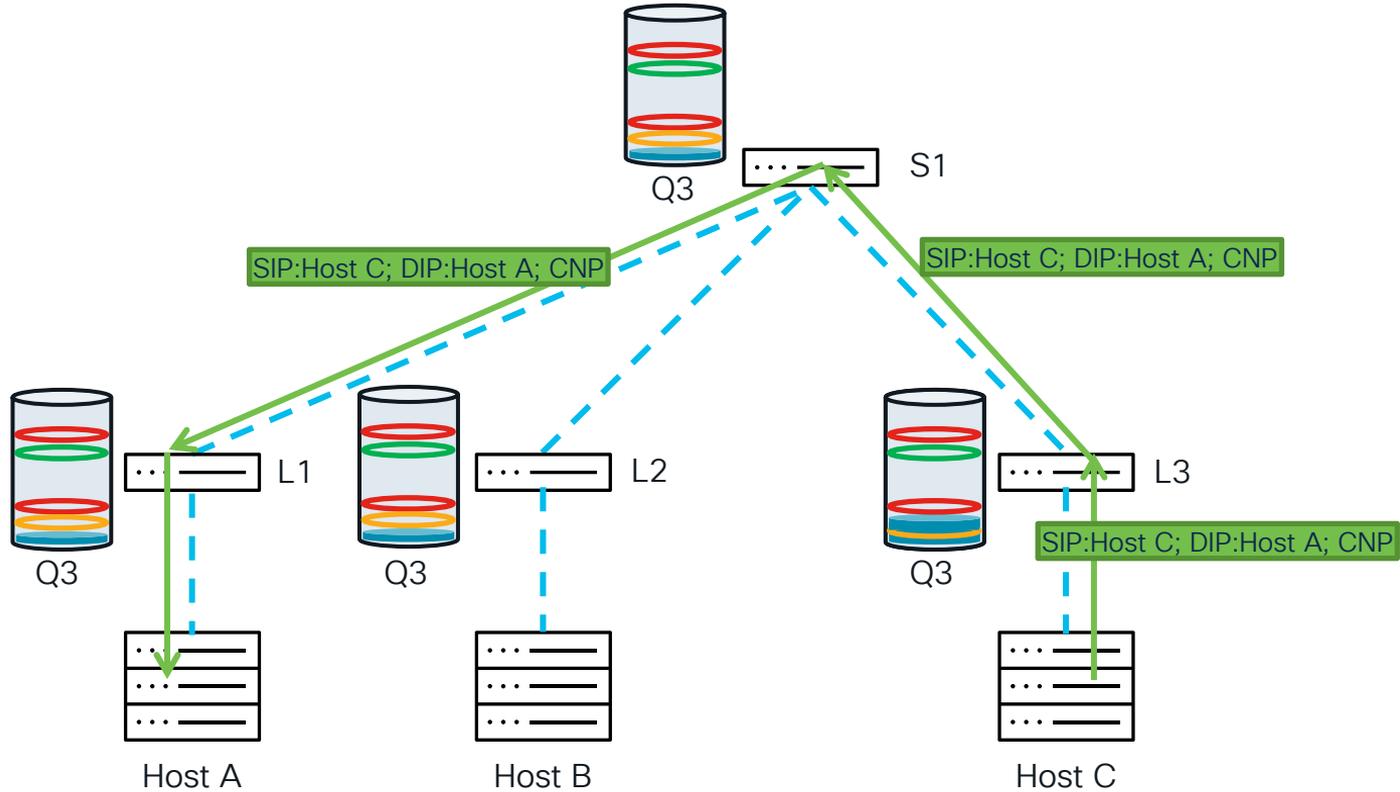
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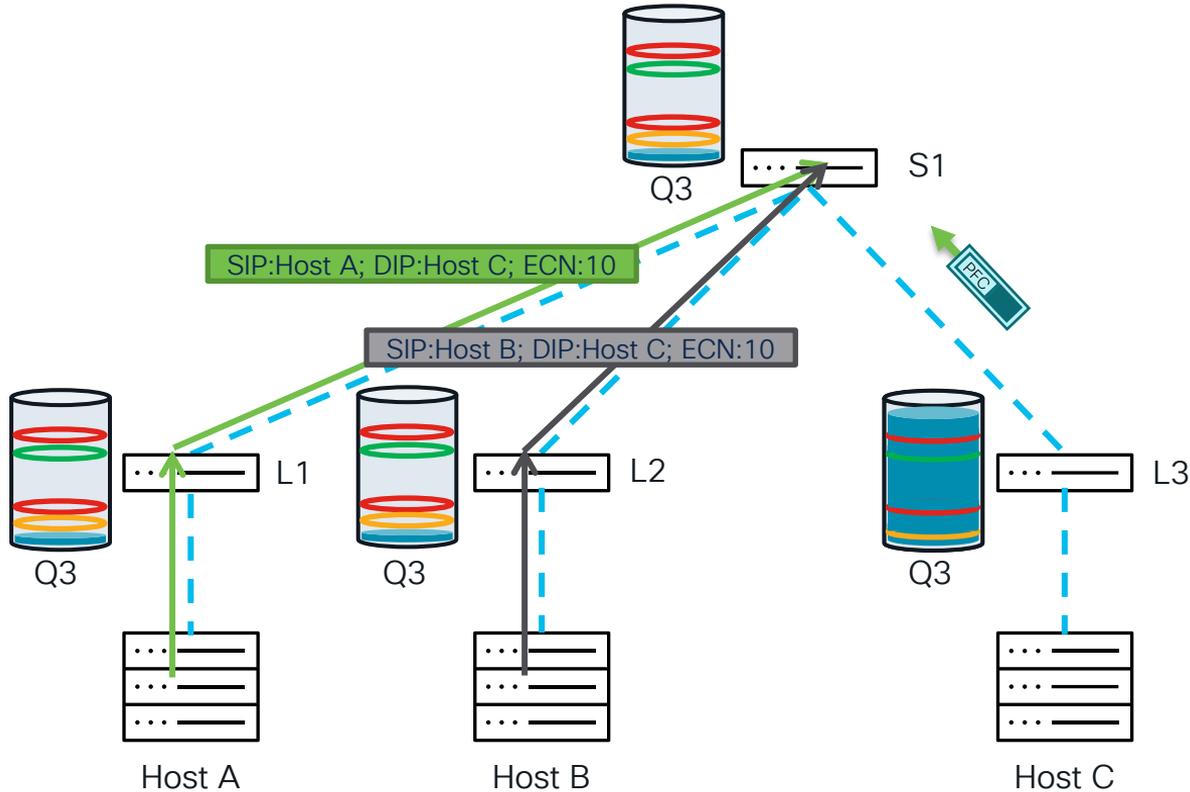
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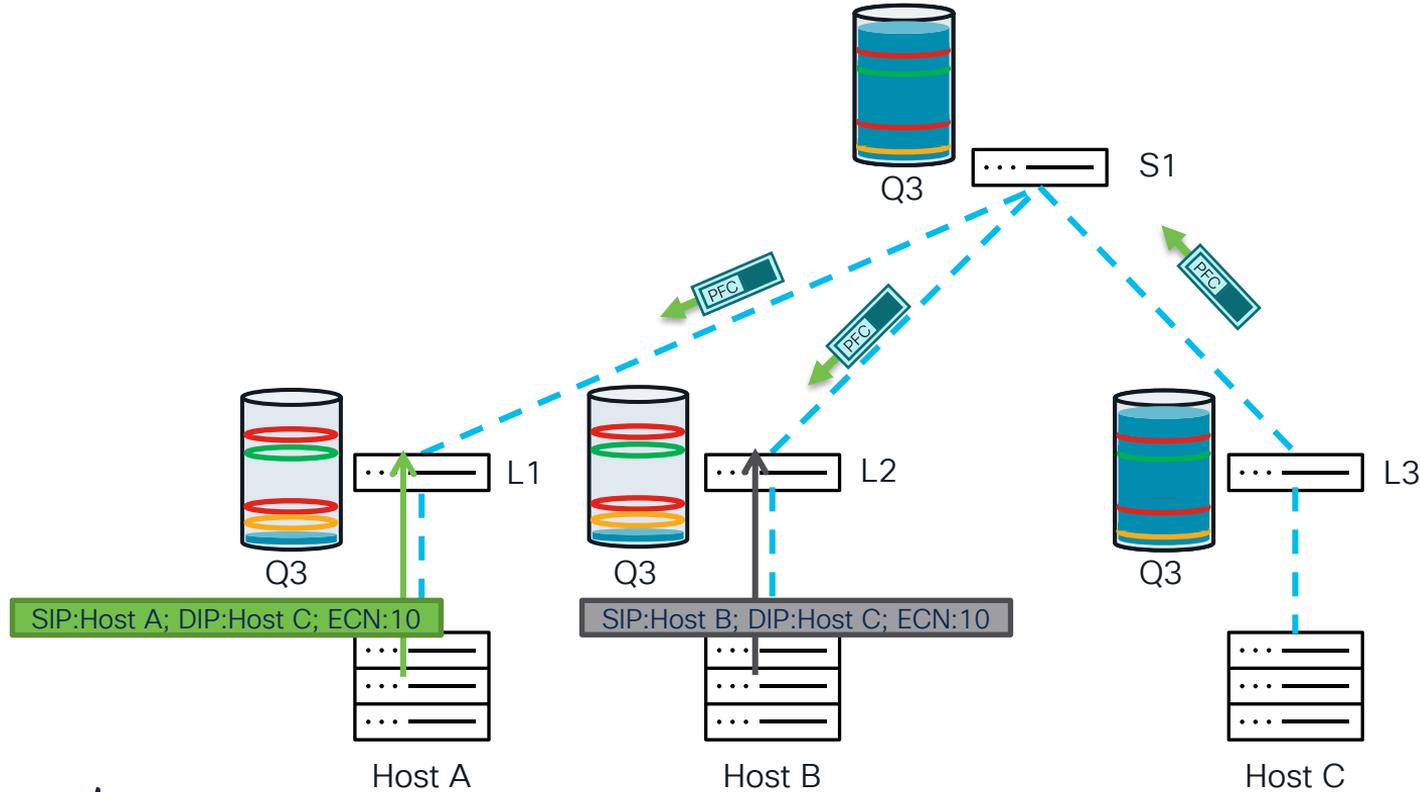
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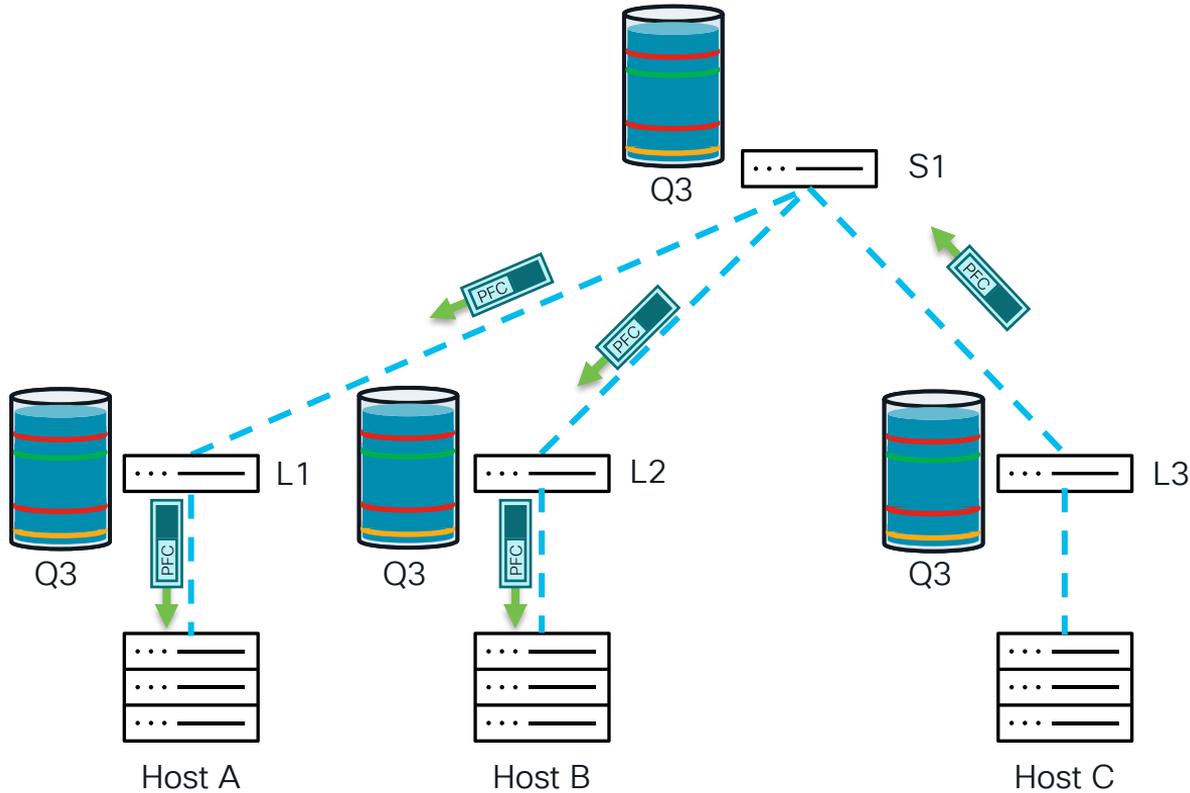
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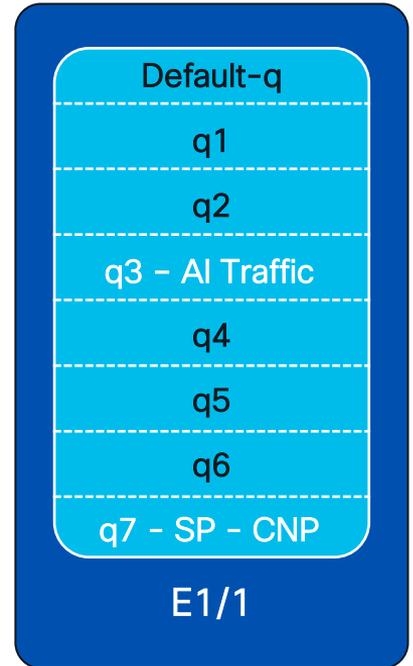


# ECN and PFC make DCQCN



# 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 be 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
<snip>
```

Enable PFC\*

\*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
```

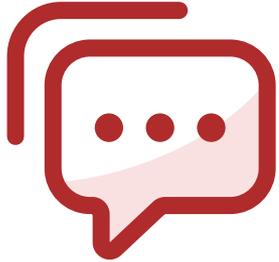
```
priority-flow-control mode on
```

```
priority-flow-control watch-dog-interval on
```

Enable PFC  
per interface

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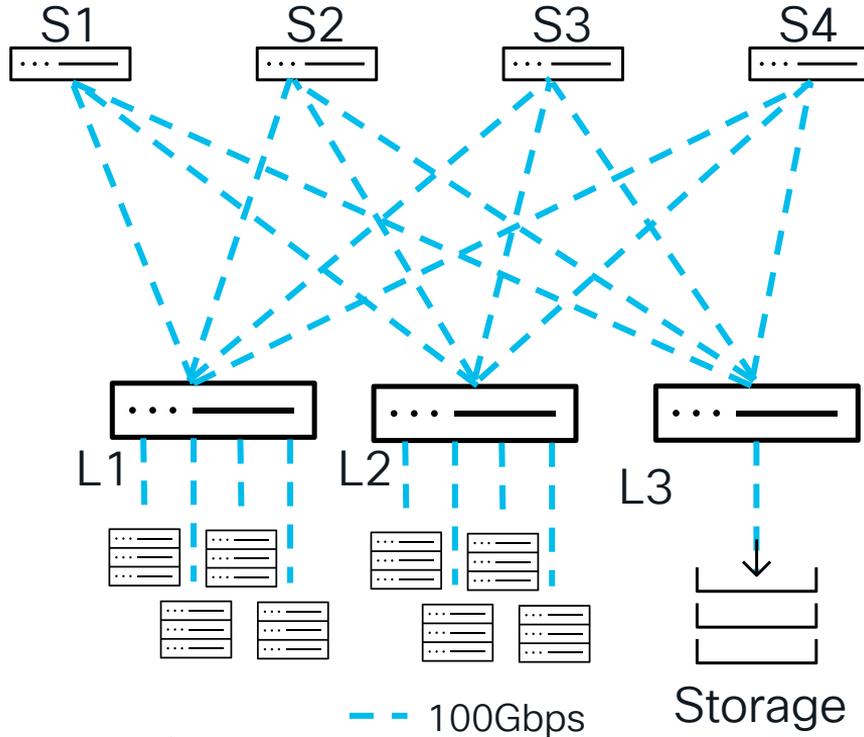


# Audience Q&A

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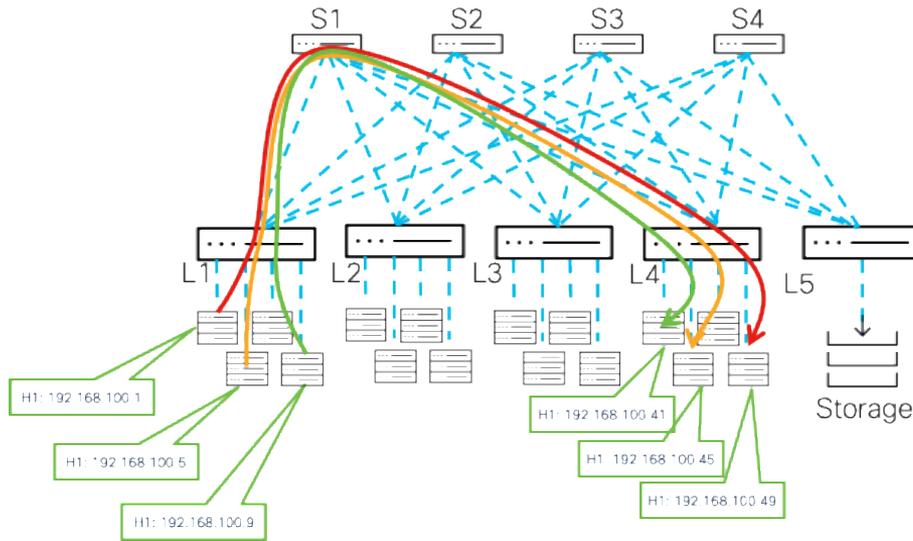
# Traffic Load-balancing

# 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

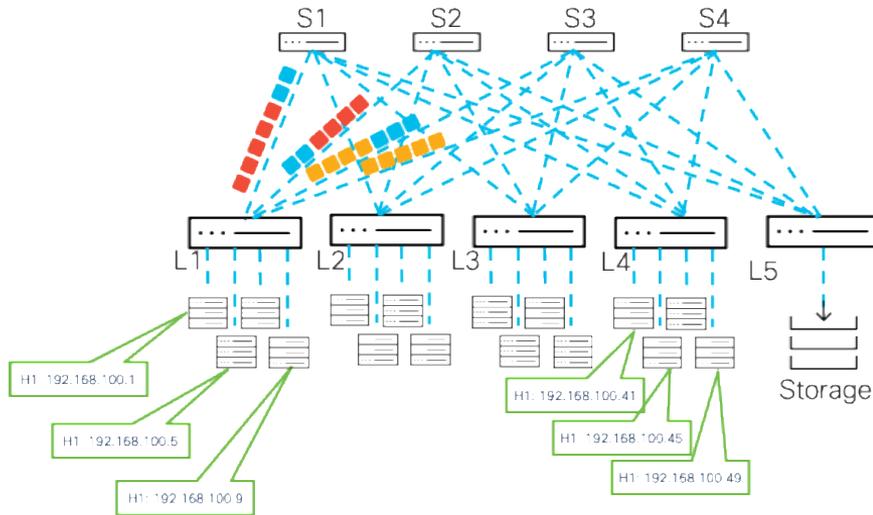
- UDF offset of Nexus 9000 switches starts from first byte of IP header
- Destination Q Pair is 33 bytes from beginning of IP field (IP (20B) + UDP (8B) + IB (5B)) or 6<sup>th</sup> byte in InfiniBand header

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	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 interface	0030	ff	ff	00	09	03	00	14	72	81	f5	e	
> Ethernet II, Src: MellanoxTech_c4:7c:ab (b8:ce:f6:c4:7c:ab), Dst: Cisco_23:d3:95	0040	64	3d	50	c3	60	3d	db	77	94	3d	05	e
> 802.1Q Virtual LAN, PRI: 0, DEI: 0, ID: 103	0050	1b	3d	fd	f2	da	3c	c7	a1	87	3d	78	e
> Internet Protocol Version 4, Src: 172.16.103.11, Dst: 172.16.112.11	0060	a2	3c	4f	94	47	3d	00	24	f4	3a	bc	e
> User Datagram Protocol, Src Port: 49152, Dst Port: 4791	0070	8c	3d	89	08	16	3d	9d	c4	a0	3c	b5	e
> InfiniBand	0080	57	3d	a3	14	9d	3d	39	76	85	3d	a5	e
Base Transport Header	0090	a2	3d	43	f0	96	3d	a9	a5	96	3d	f2	e
Opcode: Reliable Connection (RC) - RDMA READ response Middle (14)	00a0	0c	3b	45	49	11	3d	61	df	82	3d	6b	7
0... .. = Solicited Event: False	00b0	1a	3d	b5	8e	38	3d	25	33	ed	3c	bd	7
.1. .... = MigReq: True	00c0	57	3d	6d	44	55	3d	80	12	da	3a	90	3
..0 .. = Pad Count: 0	00d0	ad	3c	5d	92	34	3d	2b	2a	22	3c	fd	3
.... 0000 = Header Version: 0	00e0	31	3d	60	ca	70	3d	1f	68	6d	3d	6d	3
Partition Key: 65535	00f0	10	3d	65	e8	aa	3c	e4	4f	75	3d	4b	e
Reserved: 00	0100	81	3d	5c	15	a5	3d	b8	1e	82	3d	22	3
Destination Queue Pair: 0x000903	0110	0f	3d	88	9e	1a	3d	65	97	7f	3c	29	e
0... .. = Acknowledge Request: False	0120	8d	3d	a7	8c	41	3d	58	48	ff	3c	07	3
.000 0000 = Reserved (7 bits): 0	0130	17	3d	5b	72	64	3c	d5	b7	d7	3a	71	3
Packet Sequence Number: 1340033	0140	a1	3d	d9	f9	45	3d	eb	6a	1c	3c	03	3
Invariant CRC: 0xb5baee4d	0150	06	3d	73	c4	60	3d	b1	8d	a3	3d	50	4
> Data (1024 bytes)	0160	7a	3c	a0	6e	e6	3b	a0	16	6d	3c	b9	4
	0170	28	3d	ec	b9	5e	3d	eb	f6	28	3c	a3	e
	0180	13	3d	4b	93	86	3d	85	28	c4	3c	6b	e
	0190	53	3a	53	c9	f4	3c	6c	fa	51	3d	64	2
	01a0	91	3d	f4	44	69	3d	f2	8e	90	3d	0b	1
	01b0	5f	3d	91	cb	97	3d	43	51	ba	3c	e5	e

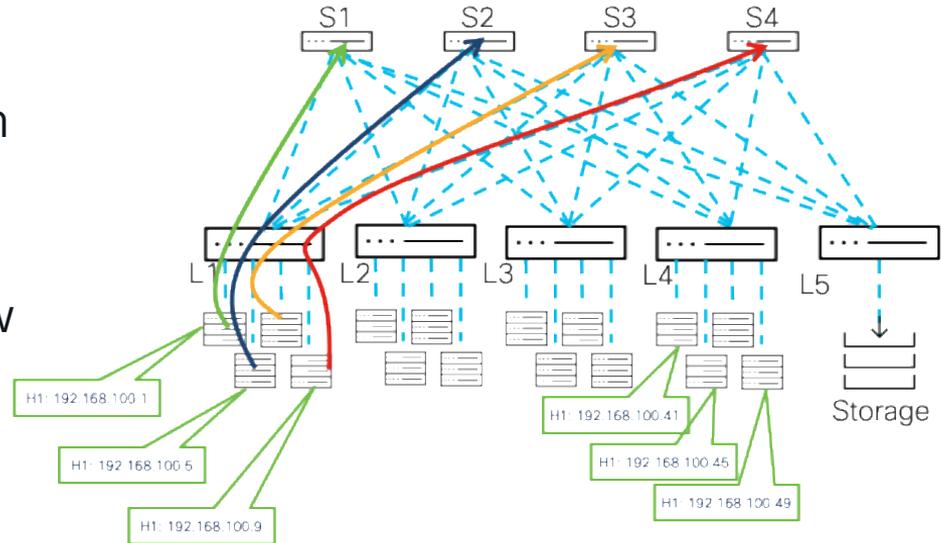
# Dynamic Load Balancing – Flowlet Mode



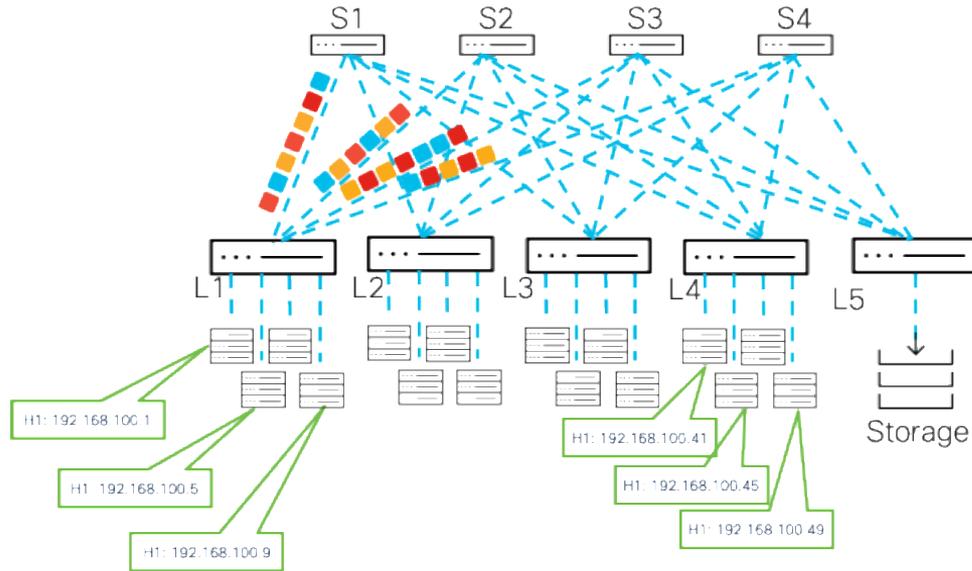
- Flowlets maintain the link, or dynamically change the link
- Least utilized link is chosen, for new flow, or at time flows are moved to different link
- Ageing time is used avoid out of order packets, it should be  $2 \times \text{RTT}$
- All workloads are balanced fairly and if flows are bursty they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

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# 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	<input checked="" type="checkbox"/>	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	Enable MACsec in the fabric
	AI_Fabric_QOS_25G	Cisco Type 7 Encrypted Octet String

# Nexus Dashboard Fabric Controller

Edit interface(s)

? — ✕

Additional CLI for the interface

Enable Interface\*  Uncheck to disable the interface

Enable Netflow  Netflow is supported only if it is enabled on fabric

Netflow Monitor  Provide the Layer 3 Monitor Name

Netflow Sampler  Netflow sampler name, applicable to N7K only

Enable priority flow control  Enable priority flow control

Enable QoS Configuration  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

Custom QoS Policy  Custom QoS Policy must be defined previously

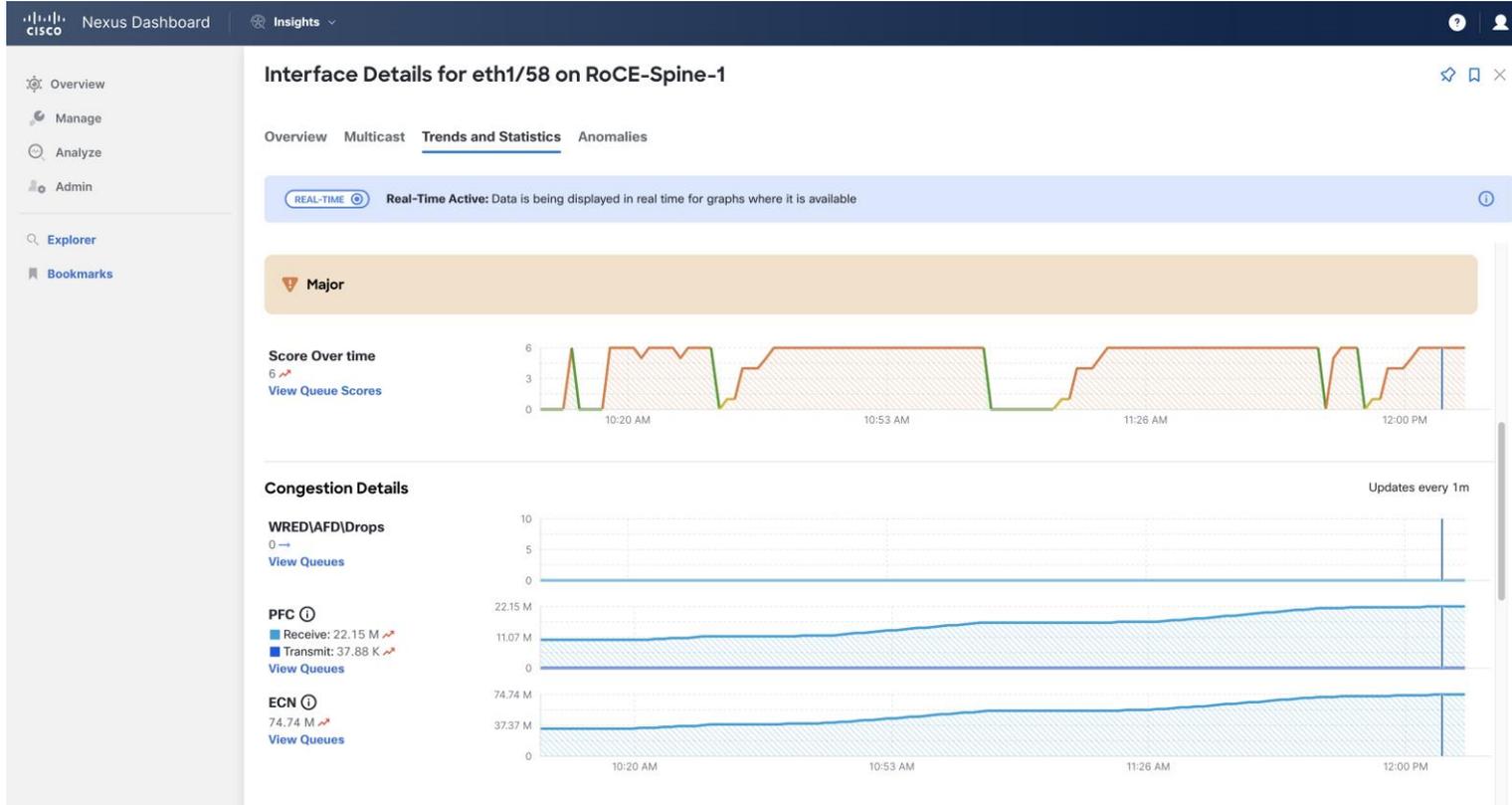
Custom Queuing Policy  Queuing Policy must be defined previously

# 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 data to collector
- Leveraged by Nexus Dashboard Insights



# Nexus Dashboard Insights – Congestion visibility



# Nexus Dashboard Insights – Congestion visibility

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

Overview Multicast **Trends and Statistics** Anomalies

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

### Microbursts

Microbursts by

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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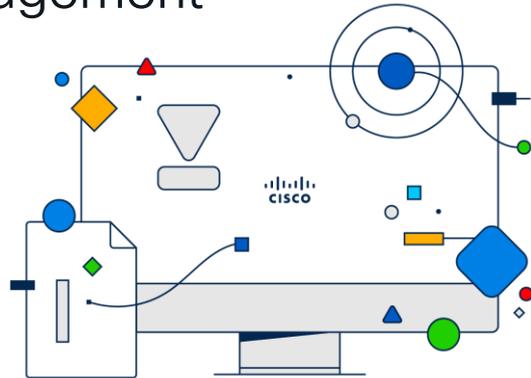
# Blueprint of Today

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# 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

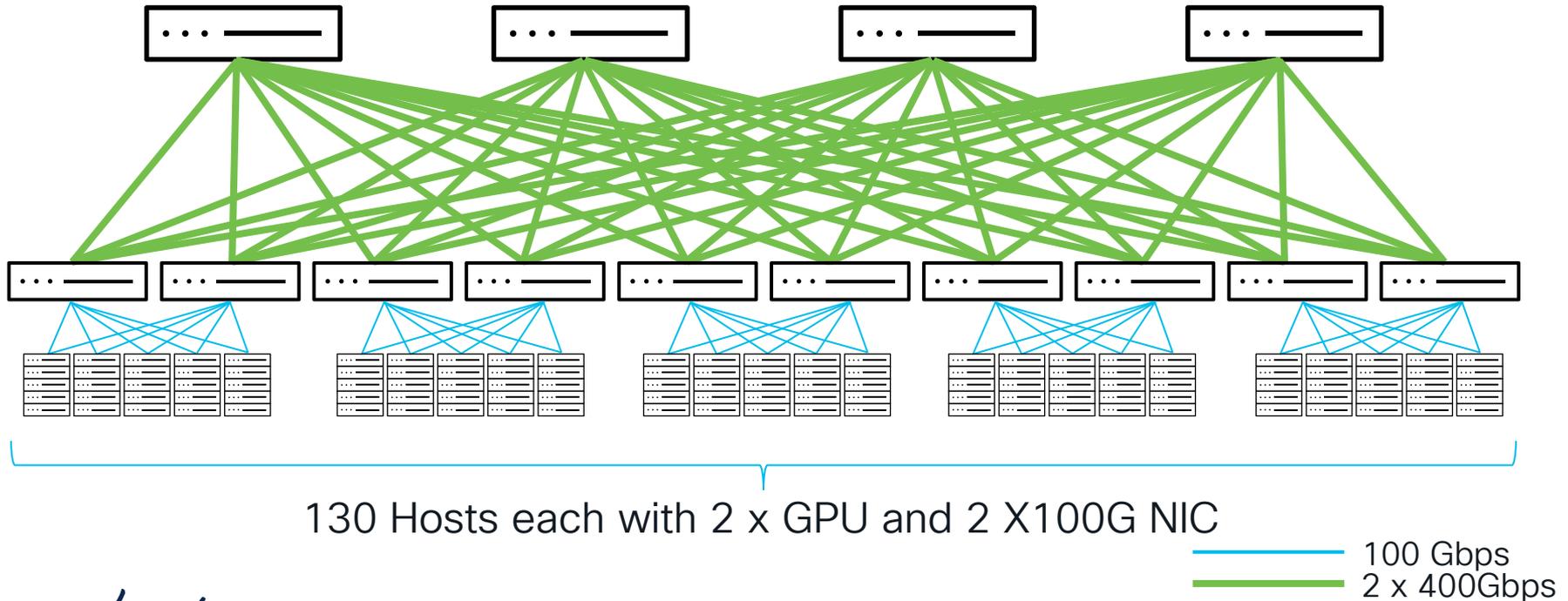
GPU to GPU, Front-end and  
Storage Network



# Customer request #1 - Proposal

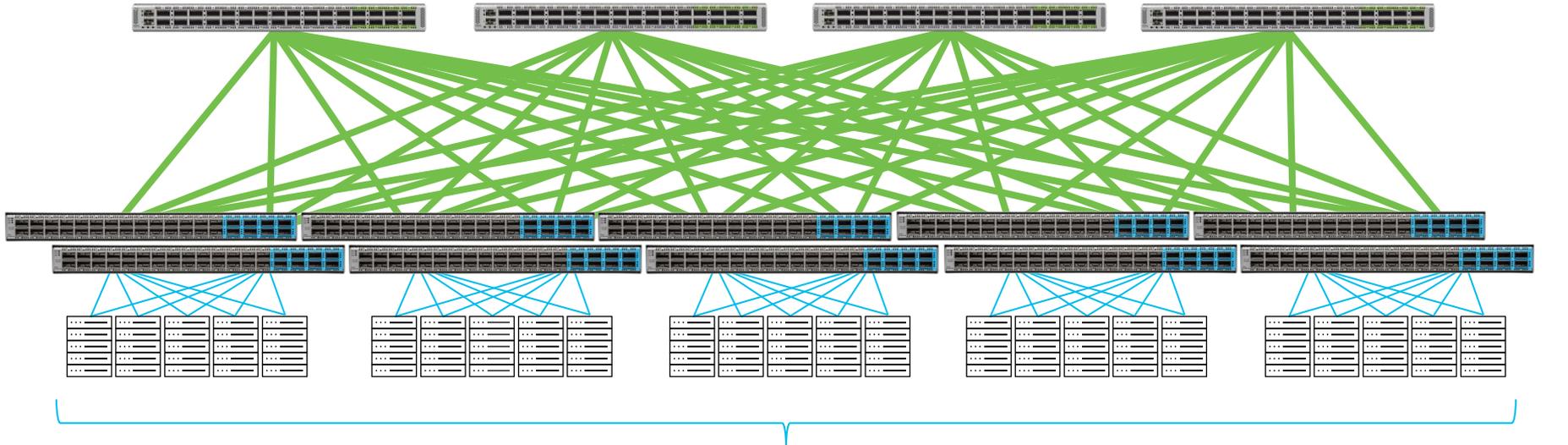
- Standalone server can have up to 2 GPUs
  - As required is 260 GPUs, 130 Stand alone servers are needed
  - Each standalone server is equipped with dual 100G port NIC
- 260 x 100G ports required for host connectivity in leaf layer
  - 26 x 100G host interfaces per leaf switch, for 10 leaf switches
  - 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

# Customer request #1 - Design



130 Hosts each with 2 x GPU and 2 X100G NIC

N9K-C93600CD-GX



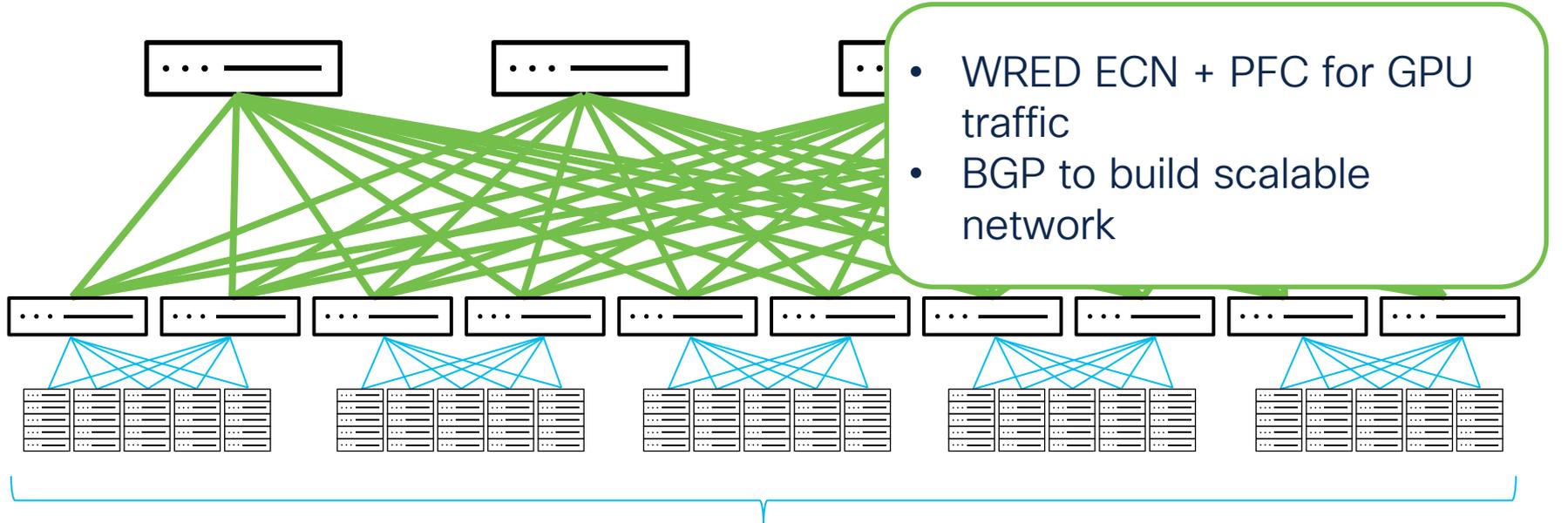
N9K-C9332D-GX2B



— 100 Gbps  
— 2 x 400Gbps

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# Customer request #1 - Design



130 Hosts each with 2 x GPU and 2 X100G NIC

— 100 Gbps  
— 2 x 400Gbps

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# Audience Q&A

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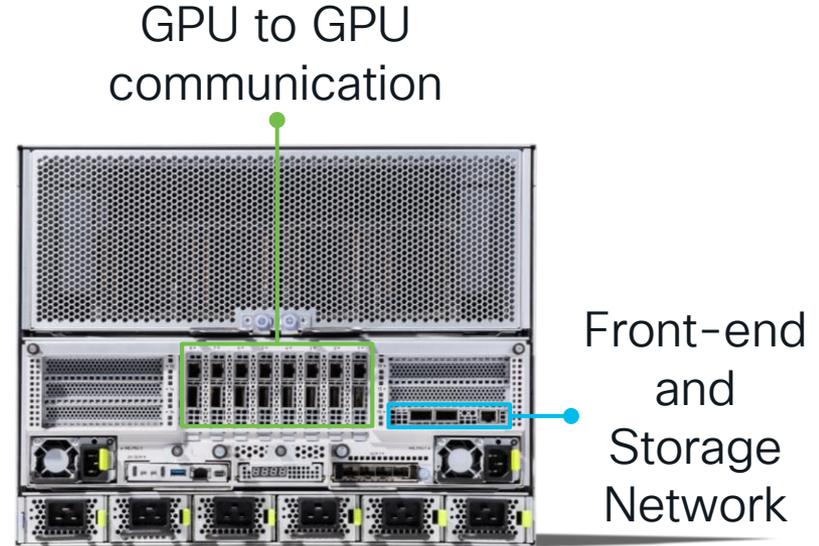
# Customer request #2

- 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



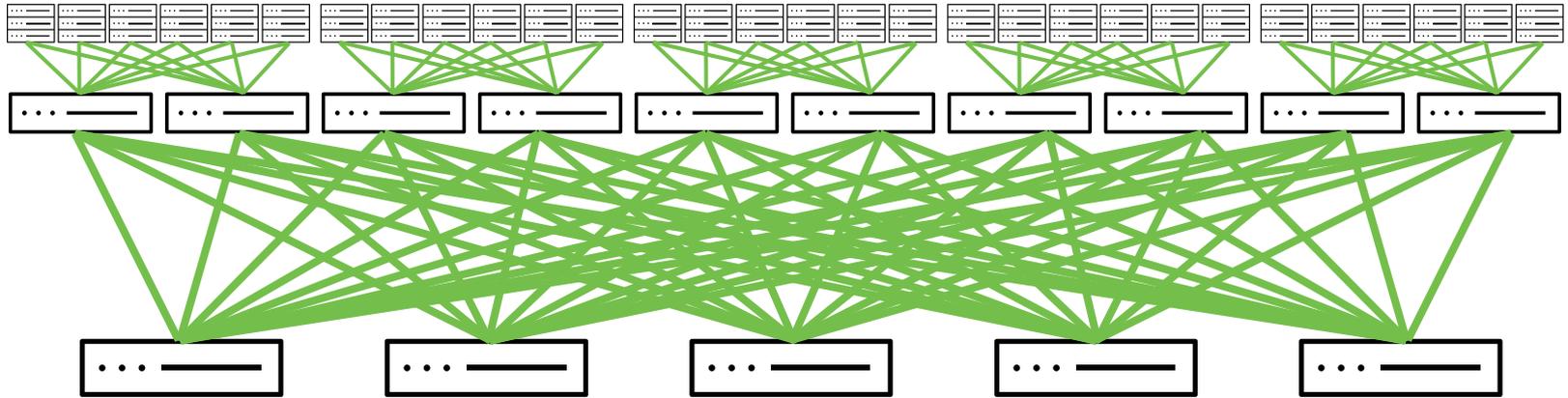
# Customer request #2 – Proposal for Back-End

- 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

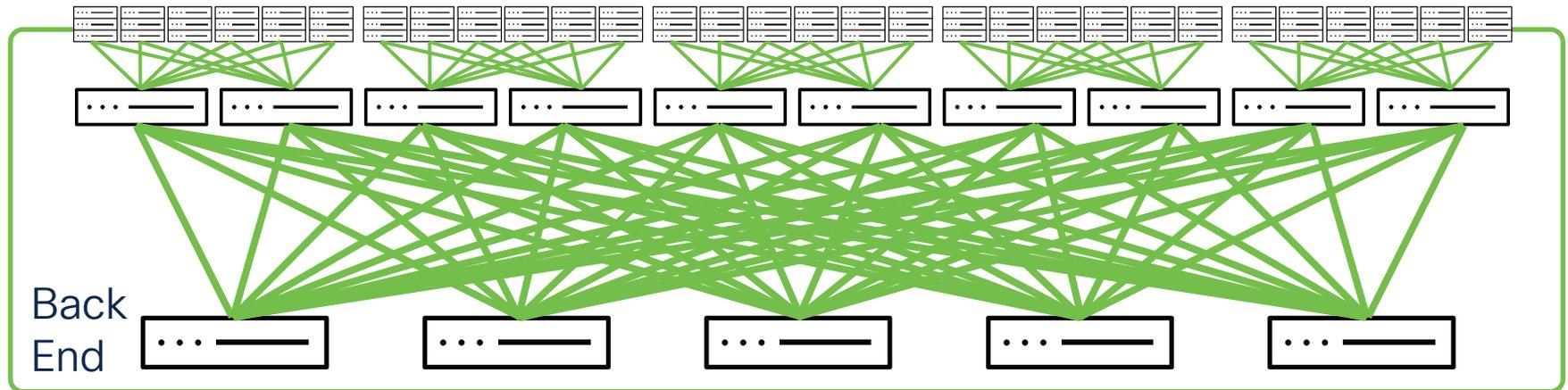
# Front-End and Back-End Cluster Network



# Back-End Cluster Network



# Back-End Cluster Network



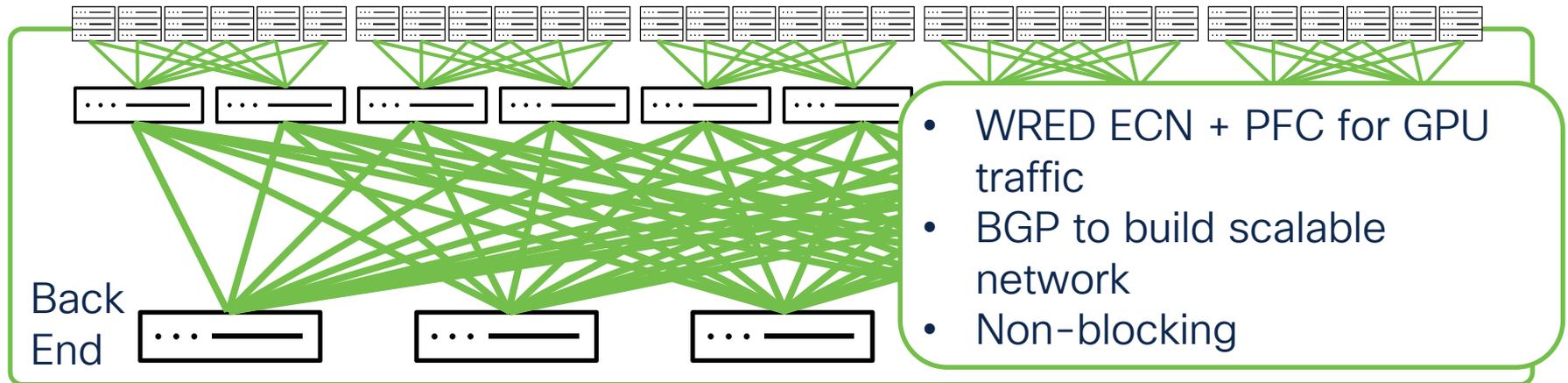
Back  
End

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— 4 x 400 Gbps

— 6 x 400Gbps

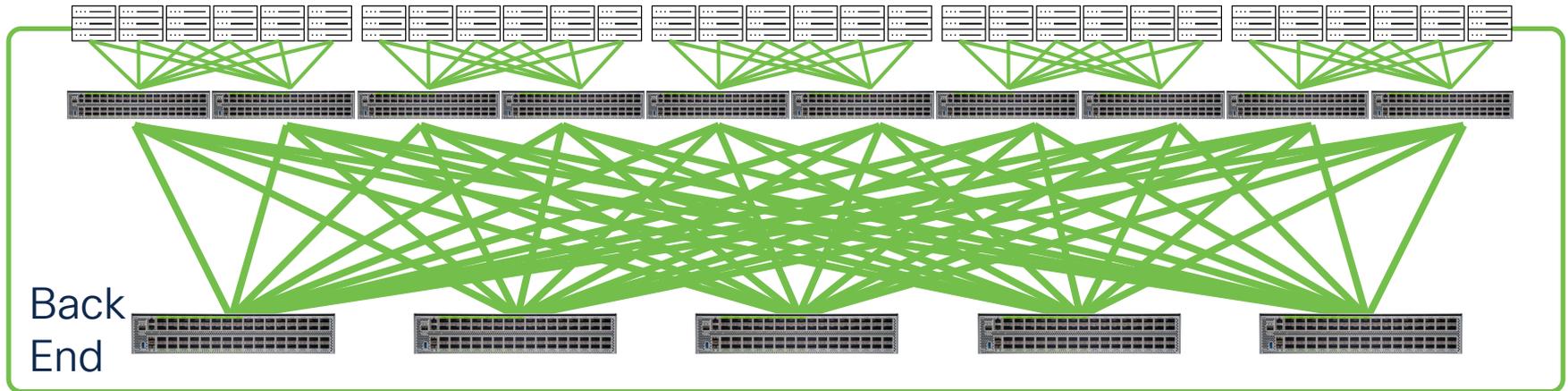
# Back-End Cluster Network



# Back-End Cluster Network



N9K-C9364D-GX2A



Back  
End

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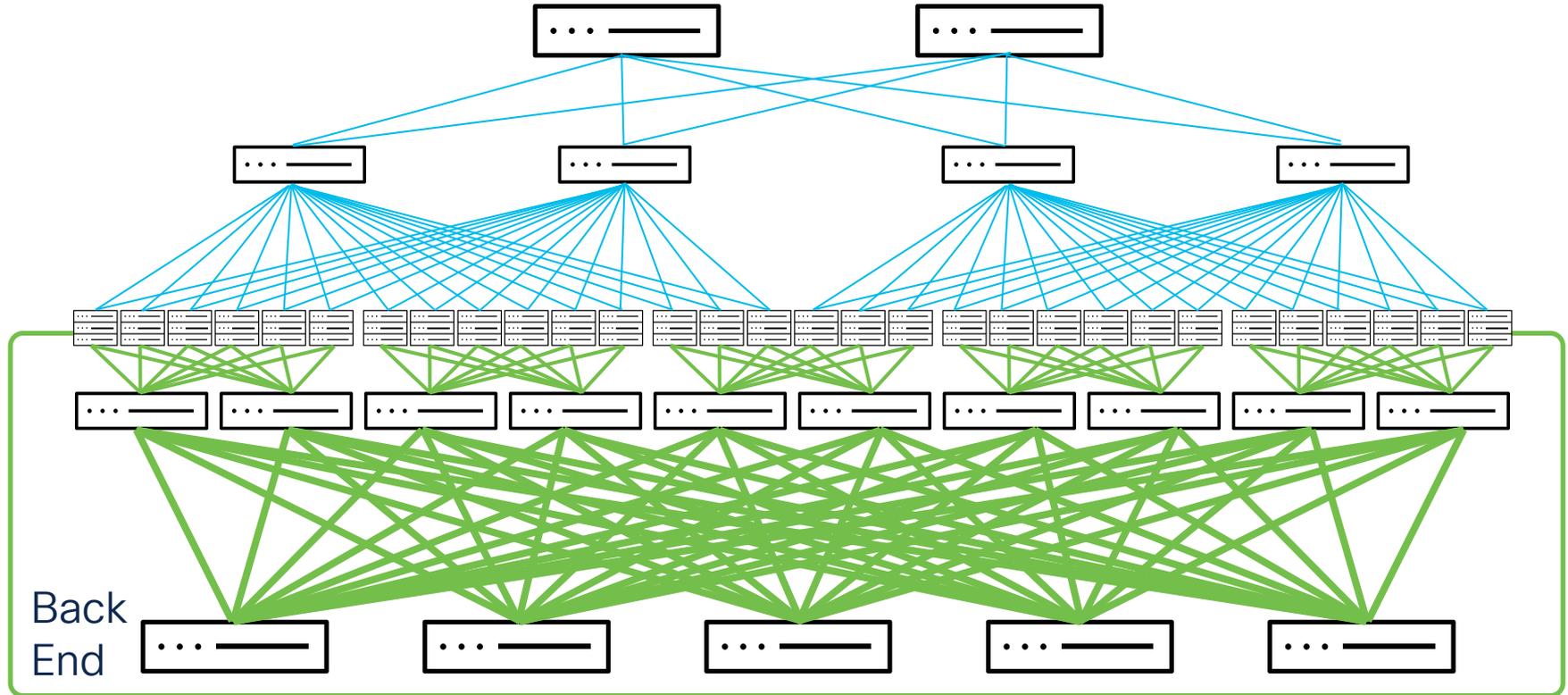
— 4 x 400 Gbps

— 6 x 400Gbps

# 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



Back  
End

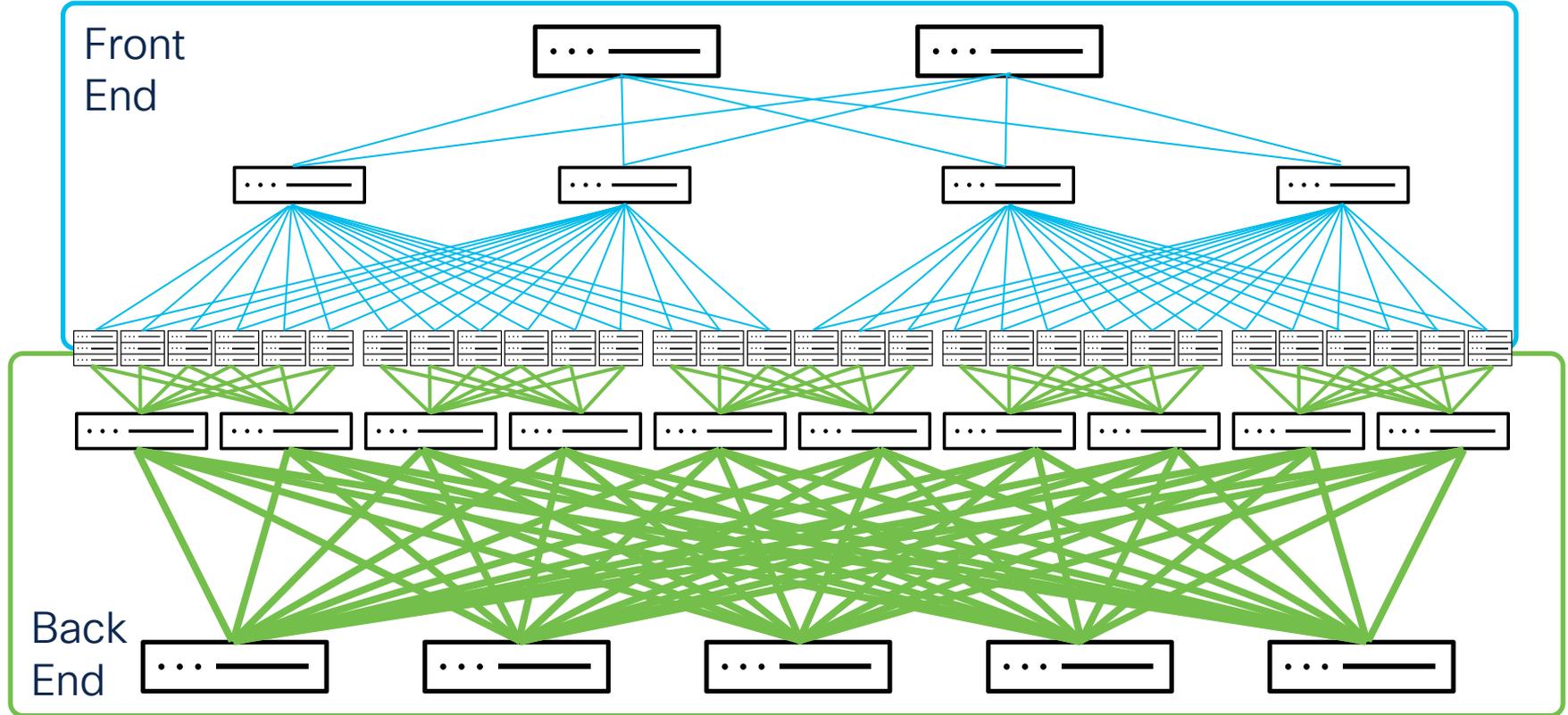
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— 100 Gbps

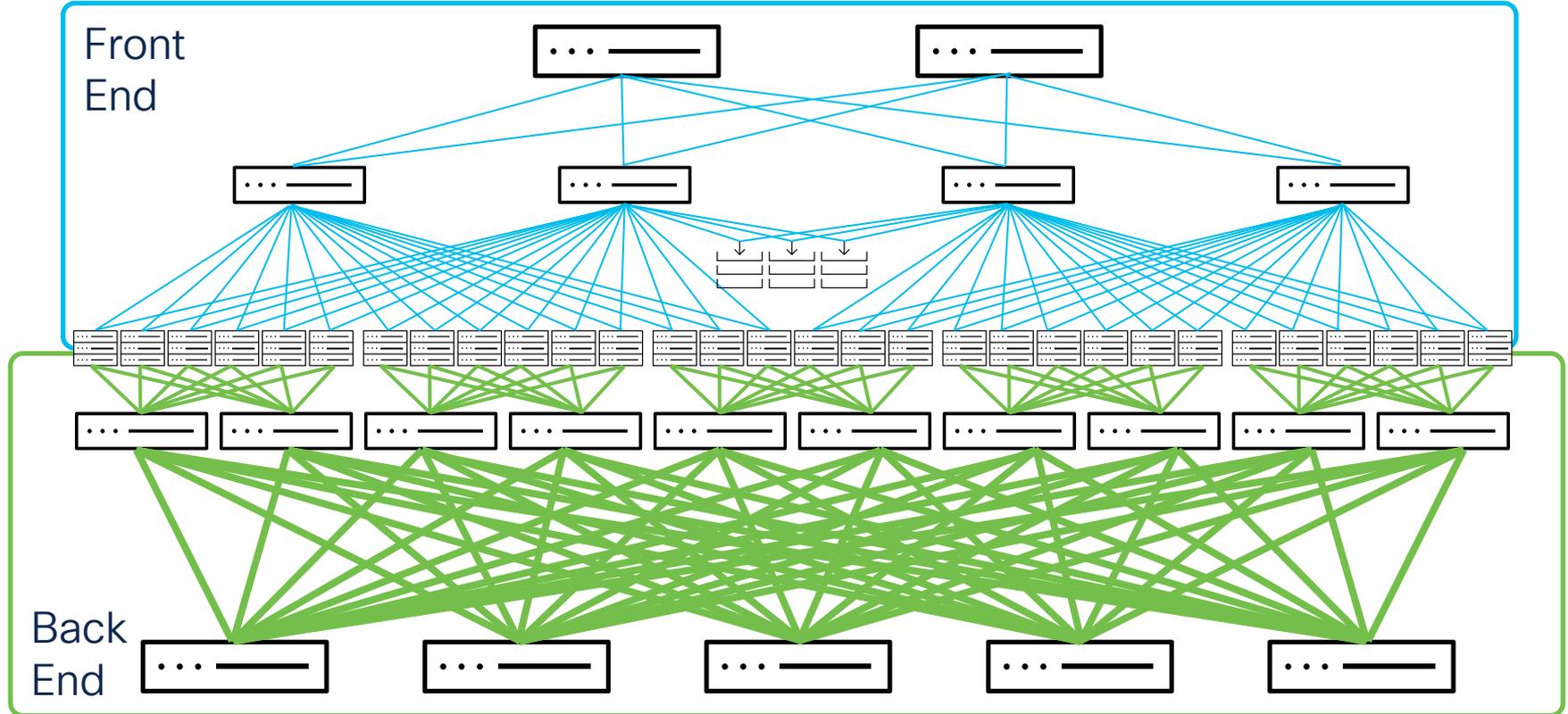
— 4 x 400 Gbps

— 6 x 400Gbps

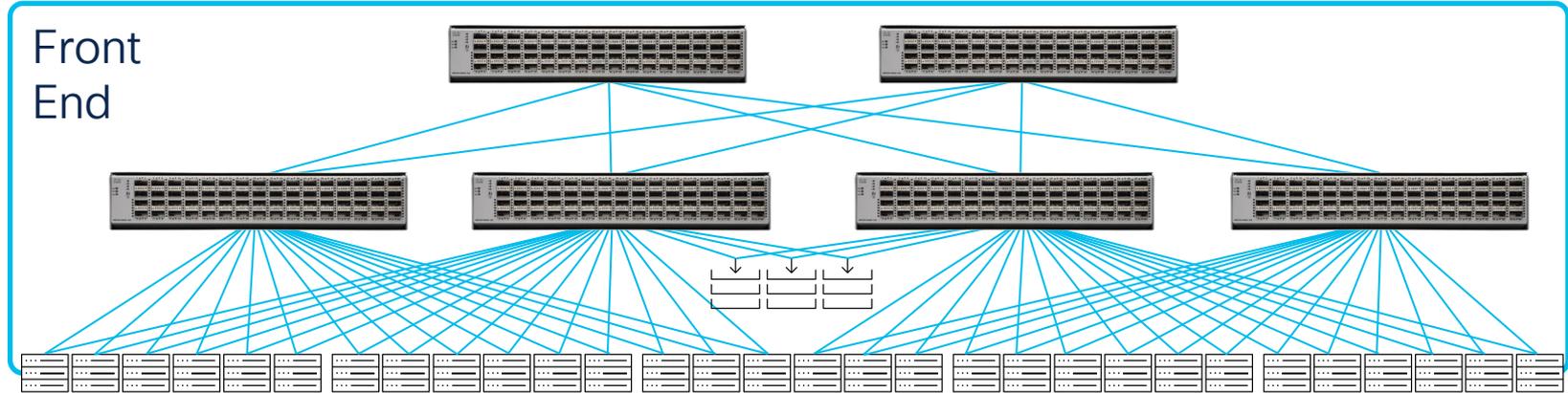
# Front-End and Back-End Cluster Network



# Front-End and Back-End Cluster Network

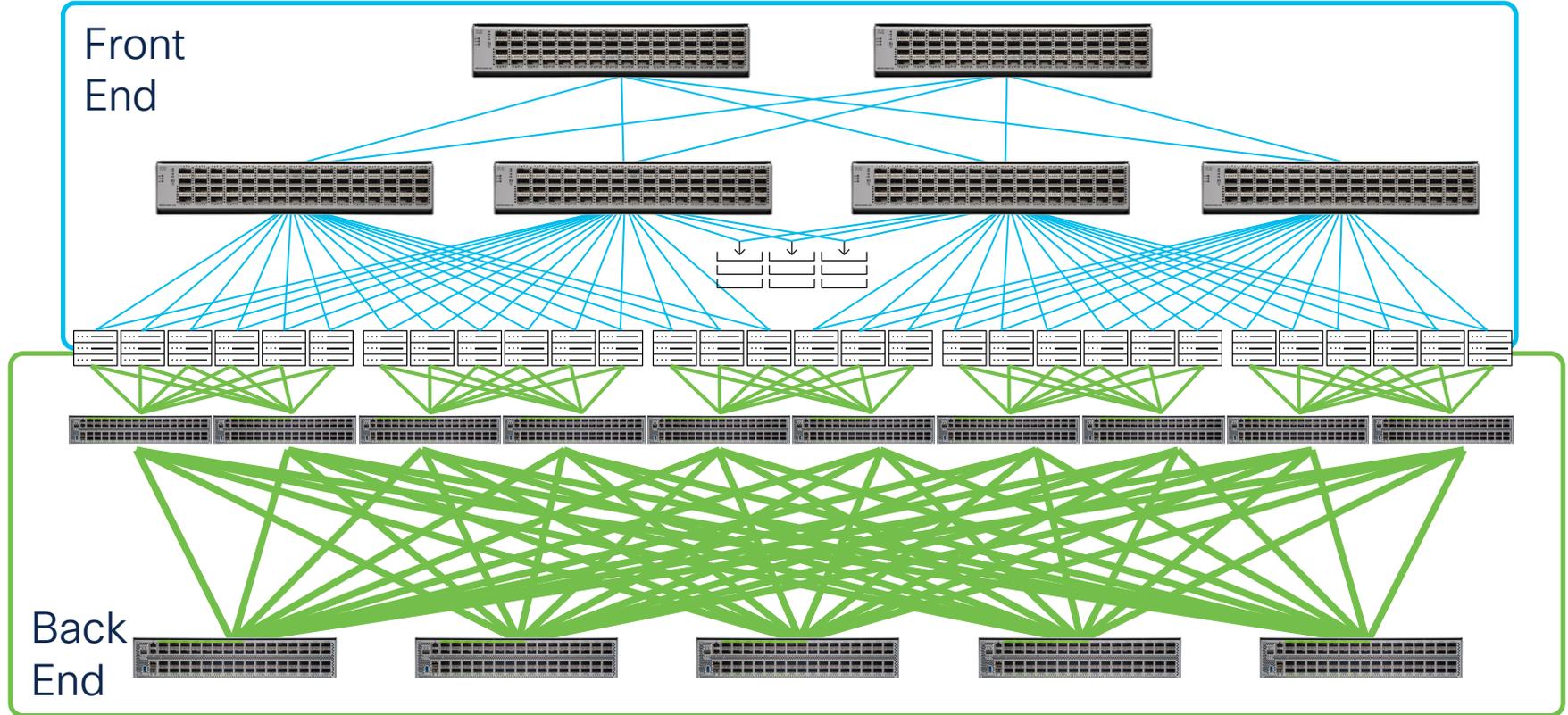


# Front-End Cluster Network

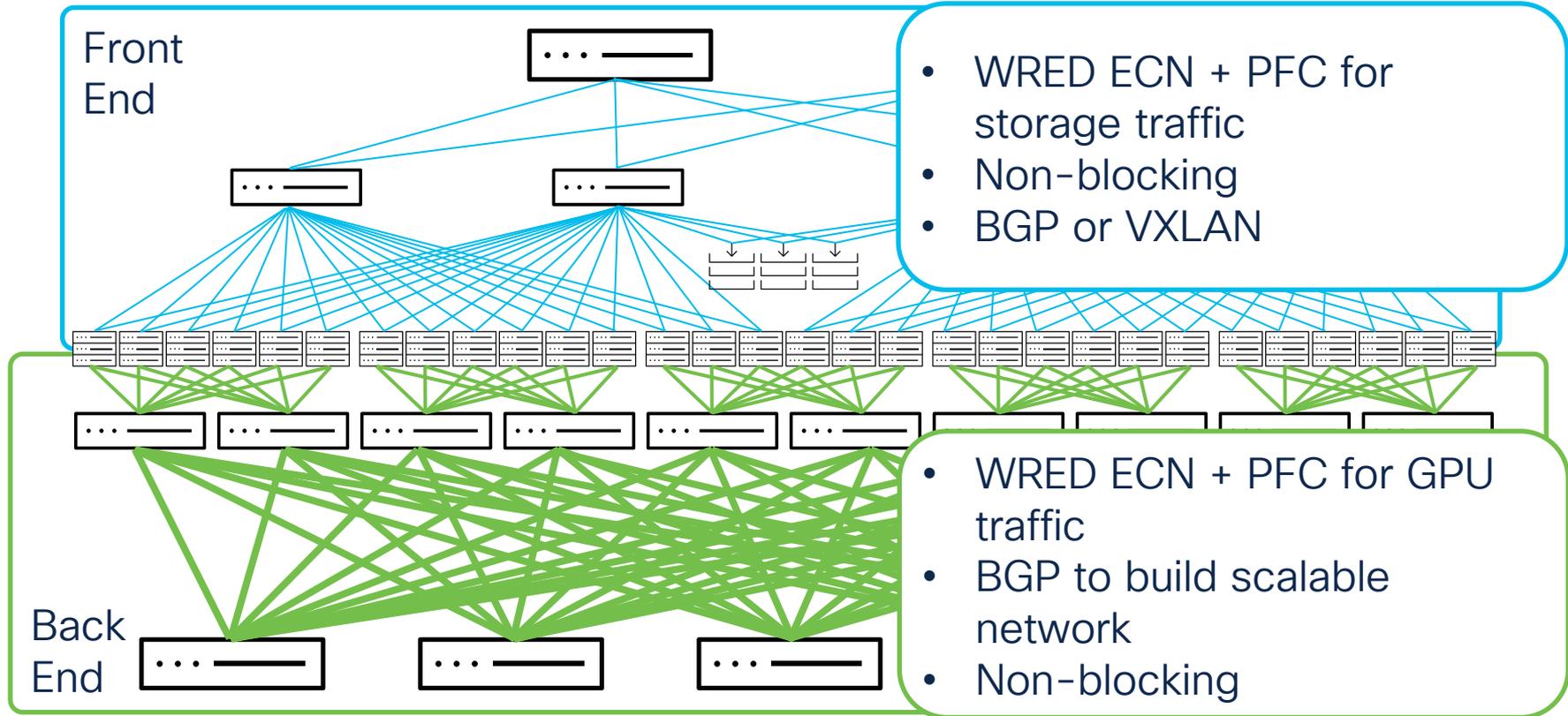


N9K-C9364C-GX

# Front-End and Back-End Cluster Network



# Front-End and Back-End Cluster Network



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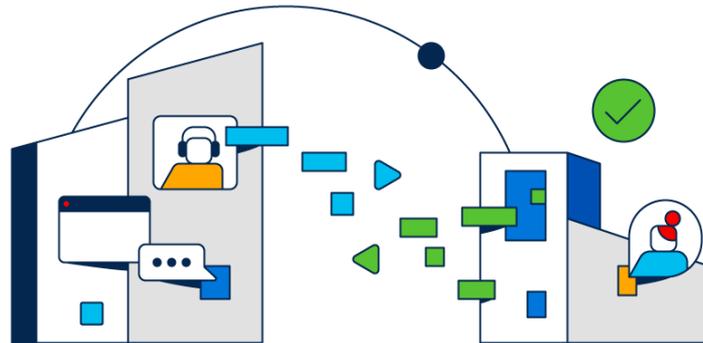
# Audience Q&A

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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



## 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 Clu...
- AI Clusters Require Lossless N... +
- How to Manage Congestion Eff... +
- How Visibility into Network Be... +
- Network Design to Accommod... +
- Conclusion
- Related Materials

Save Download Print

- 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)



# The Blueprint For Today

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allenrobel / NDFC-AIML-Fabric Public

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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

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0 forks

Report repository

Releases

No releases published

Packages

No packages published



# The Blueprint For Today



## Preferred Networks, Inc. Eliminates Overlapping Investment and Network Bottlenecks

< Back to URL

Updated: October 15, 2021

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- 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?

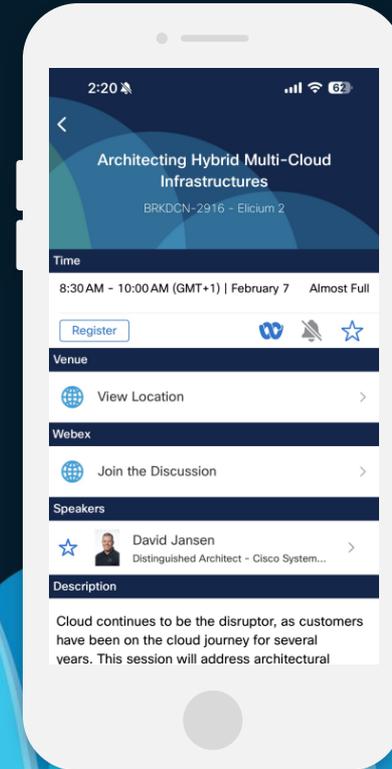
Use the Webex app to chat with the speaker after the session

## How

- 1 Find this session in the Cisco Events mobile app
- 2 Click “Join the Discussion”
- 3 Install the Webex app or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until February 28, 2025.

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# Fill Out Your Session Surveys



Participants who fill out a minimum of 4 session surveys and the overall event survey will get a unique Cisco Live t-shirt.

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



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Content Catalog

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Thank you

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A series of overlapping, vertically-oriented ovals in various shades of blue, ranging from light to dark, positioned on the right side of the image.