cisco Live!

Let's go

The bridge to possible

Manage, Operate, and Optimise High-Performance Storage Area Networks

Getting your SAN to perform at its best

Roman Vitasek
Technical Solutions Architect

BRKDCN-3641

Cisco Webex App

Questions?

Use Cisco Webex App to chat
with the speaker after the session

How

1. Find this session in the Cisco Live Mobile App
2. Click “Join the Discussion”
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4. Enter messages/questions in the Webex space

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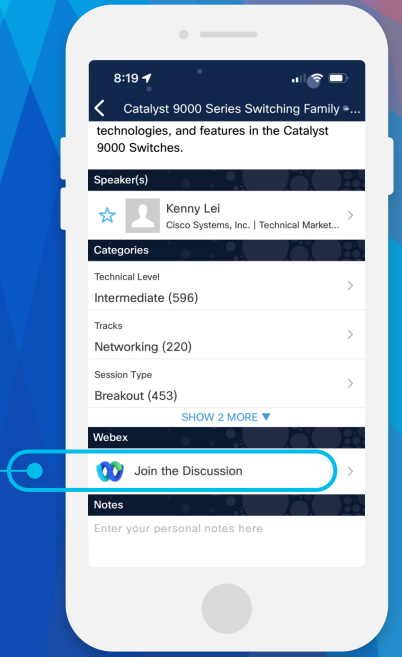

https://ciscolive.ciscoevents.com/ciscolivebot/#BRKDCN-3641

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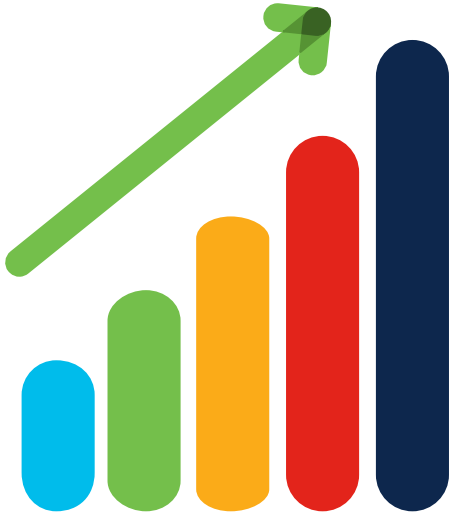
Exponential Data Growth



2020
64.2 Zettabytes

2025
180 Zettabytes

1 Yottabyte

by 2030

https://insightsndata.com/the-exponential-growth-of-data-understanding-the-implications-and-preparing-for-the-future-ee07c380e98d

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Agenda

- Overview
- Common Architectures
- Understanding and Detecting SAN Congestion
- Preventing and Predicting SAN Congestion
- Summary

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Cisco MDS 9000 Switch Hardware

SAN Directors

16/32/64G

MDS 9718

768 ports

MDS 9710

384 ports

MDS 9706

192 ports

All Certified NVMe/FC Switching and analytics

Fabric Switches

32G

MDS 9132T

MDS 9148T

MDS 9396T

64G

MDS 9124V

NEW

MDS 9148V

MDS 9396V

Modules

64G

48 x 64G FC

32G

48 x 32G FC

FCIP

24 x 16G FC, 8 x 1/10 GE & 2 x 40 GE

FCIP

MDS 9220i

MDS 9250i

8/16/32/64G FC · 4/8/16/32G FC · 2/4/8/10/16G FC · SAN Analytics · FCIP · FICON

Line-rate, non-blocking, non-oversubscribed, since 2013

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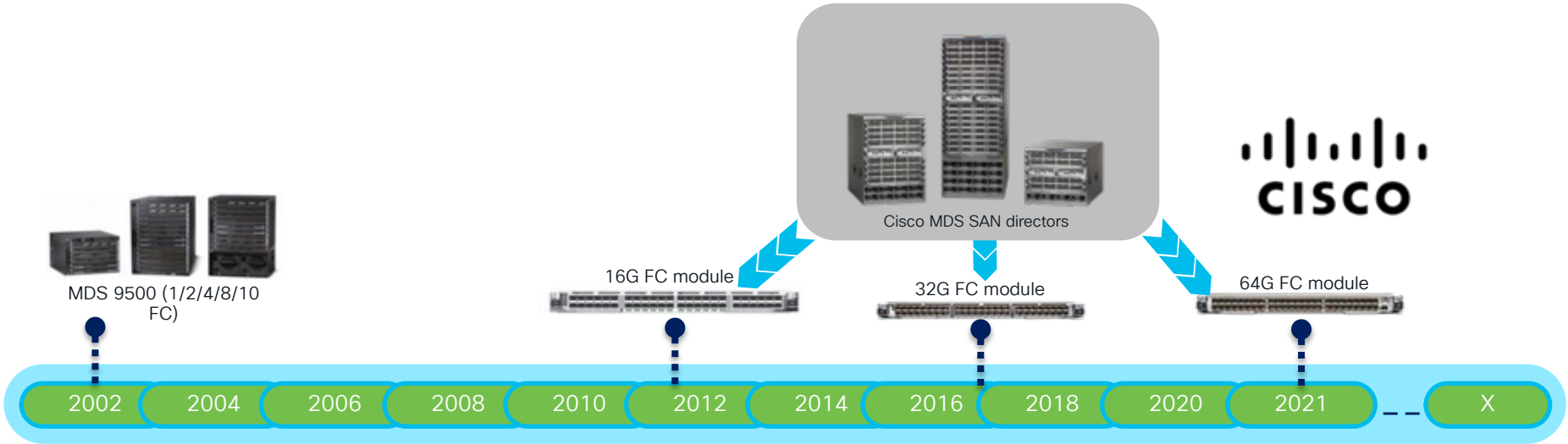
Unique Investment Protection



Non-disruptive multi-generation upgrades

Multi-generation optics support	Multi-generation module support	Multi-generation FC speed support
8/16/32/64G FC optics	16/32/64G FC module	2/4/8/10/16/32/64G FC

Cisco MDS SAN directors: Single chassis multi-generation support

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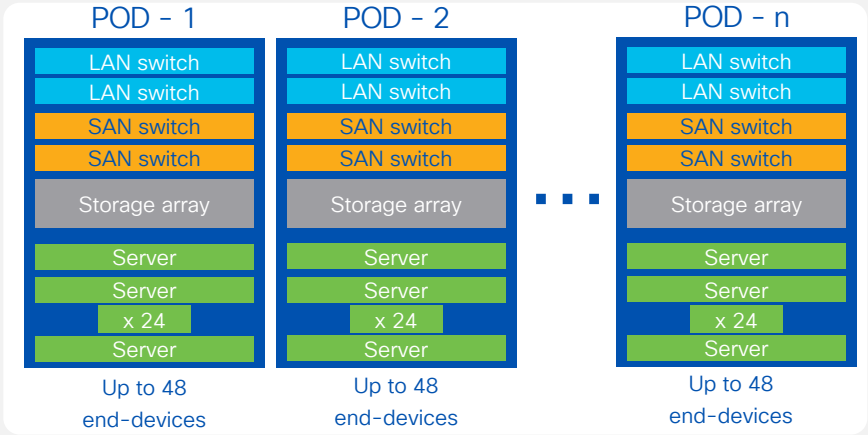
Pod Architecture



Benefits

- Best at containing SAN congestion / slow drain within the rack
- No effect on other racks while one rack is under maintenance

Challenges

- Requires a different data center operational model

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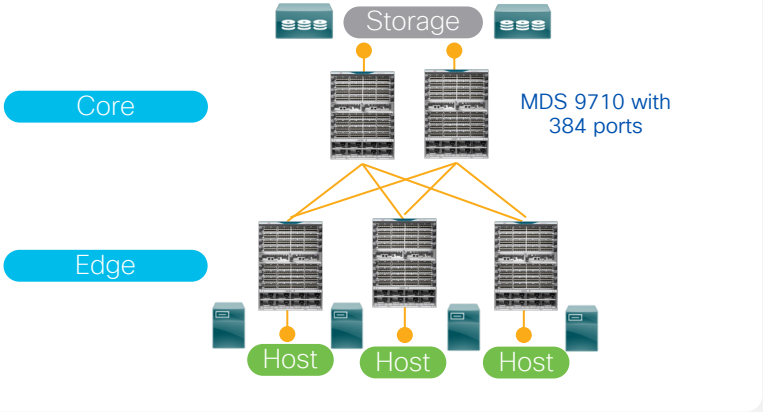
Edge-Core Design



Benefits

- Most deployed option
- Tried and tested

Challenges

- Prone to congestion and slow drain

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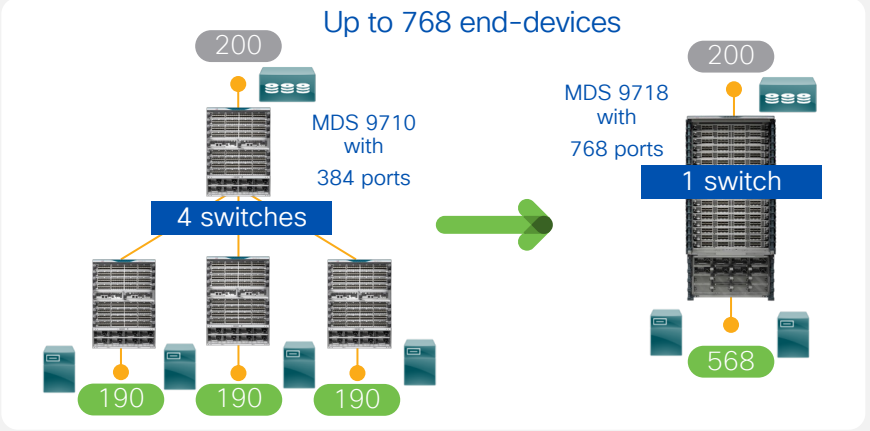
Consolidated Fabric



Benefits

- Fewer switches
- Less operational overhead
- Reduced congestion / slow drain

Challenges

- Watch out for cable length
- Scaling beyond 768 devices

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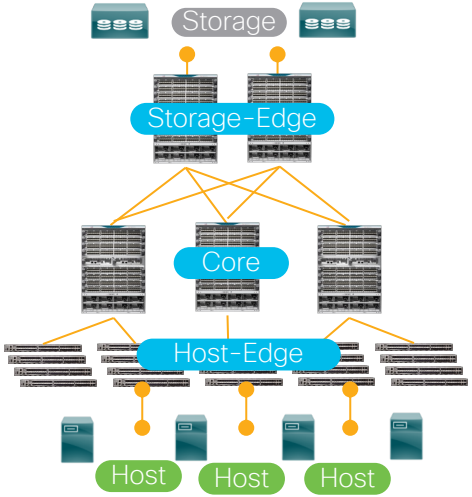
Large Scale Edge-Core-Edge Design



Benefits

- Best at scaling up an existing fabric
- Long term investment protection (20 years)

Challenges

- Prone to congestion and slow drain
- Requires strict processes around operation control

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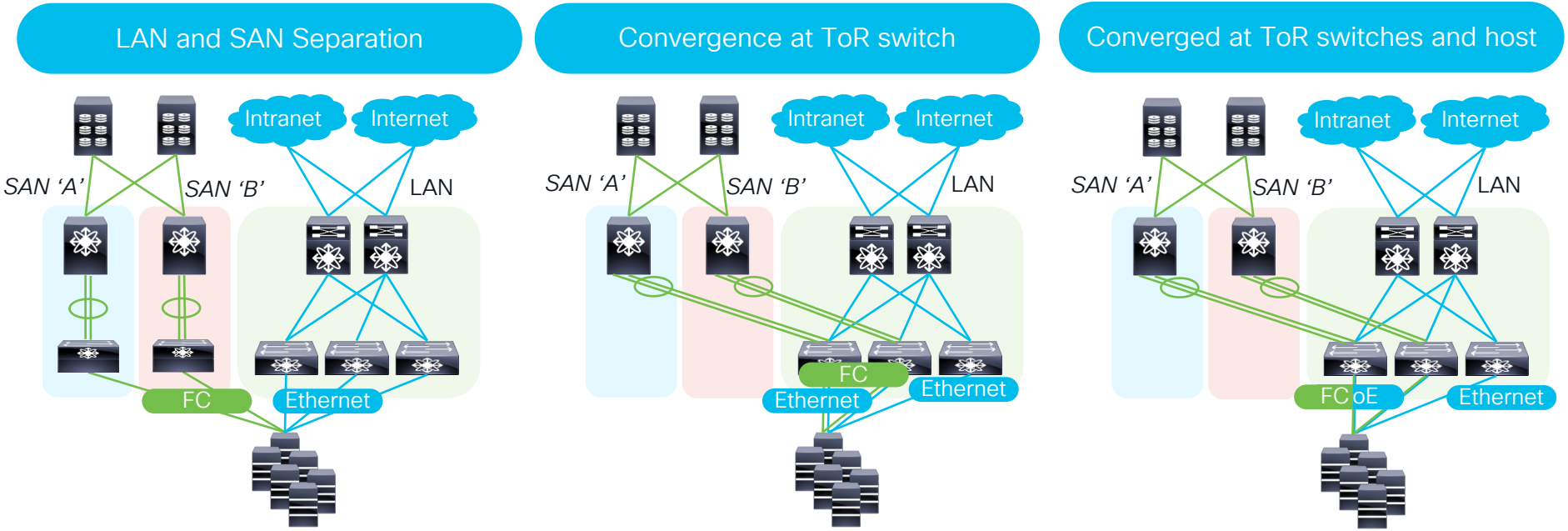
Typical LAN and SAN Designs



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Troubleshooting SAN congestion is like searching for a needle in a haystack

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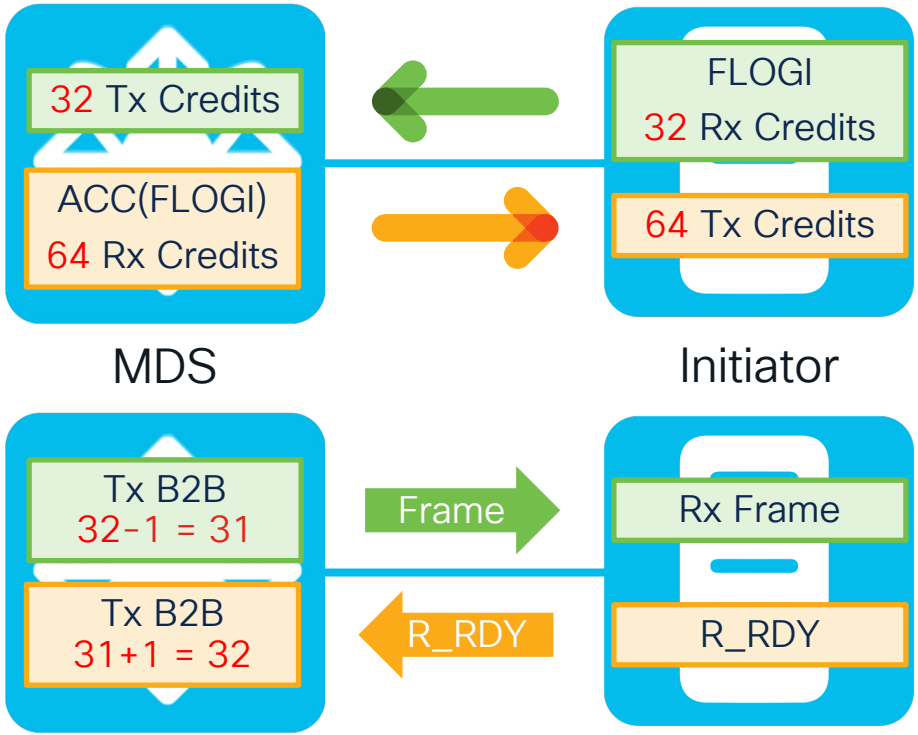
Fibre Channel Flow Control



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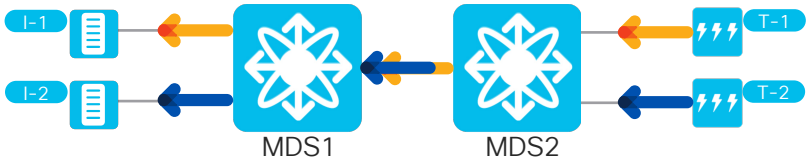
Common Causes of SAN Congestion



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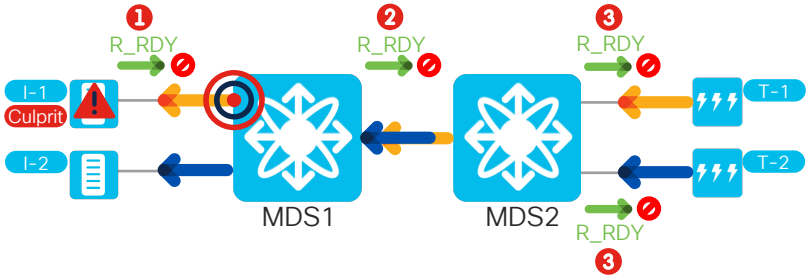
Common Causes of SAN Congestion

Slow Drain

Tx B2B credit starvation



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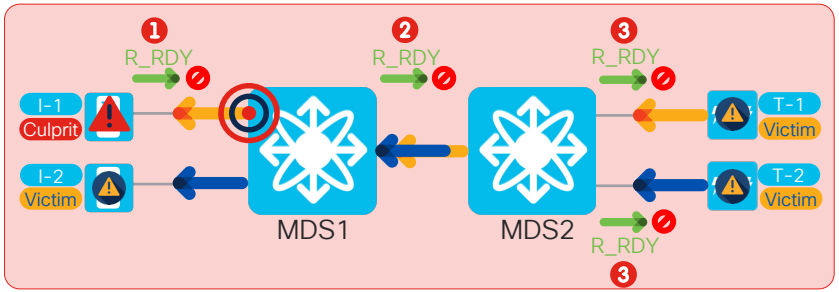
Common Causes of SAN Congestion

Slow Drain

Tx B2B credit starvation



Frames are not dropped in FC fabric. Rather, they consume switch buffers causing a fabric-wide congestion.

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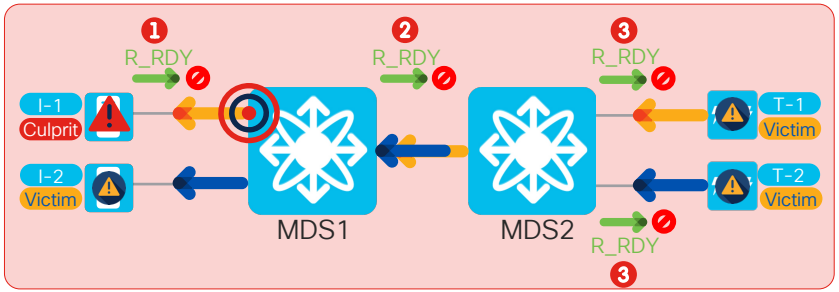
Common Causes of SAN Congestion

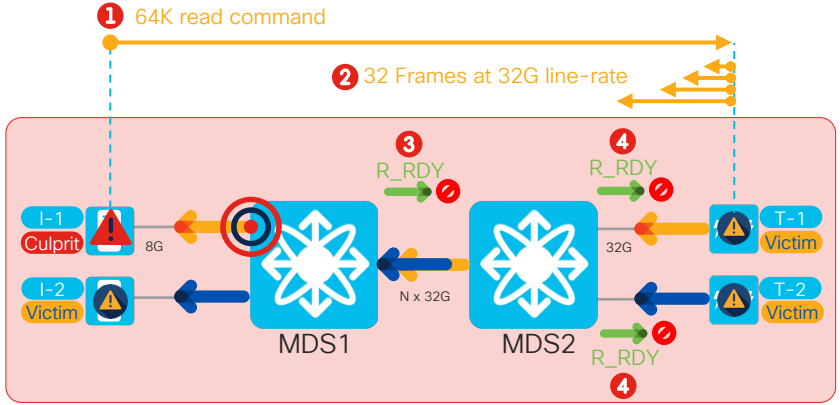
Slow Drain

Tx B2B credit starvation



Overutilisation

Receive data rate on ISL port is faster than the host port speed



Frames are not dropped in FC fabric. Rather, they consume switch buffers causing a fabric-wide congestion.

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Congestion Detection

- Most problems start when a port hits 0 Tx/Rx B2B credits
- Increment Tx/Rx “B2B Transitions to Zero” counter
- Additional counters to provide further context:

TxWait
2.5µs

Slowport-monitor
1-500ms

Tx-datarate
%

Timeout-drops
500ms

Credit-Loss-Recovery
1s / 1.5s

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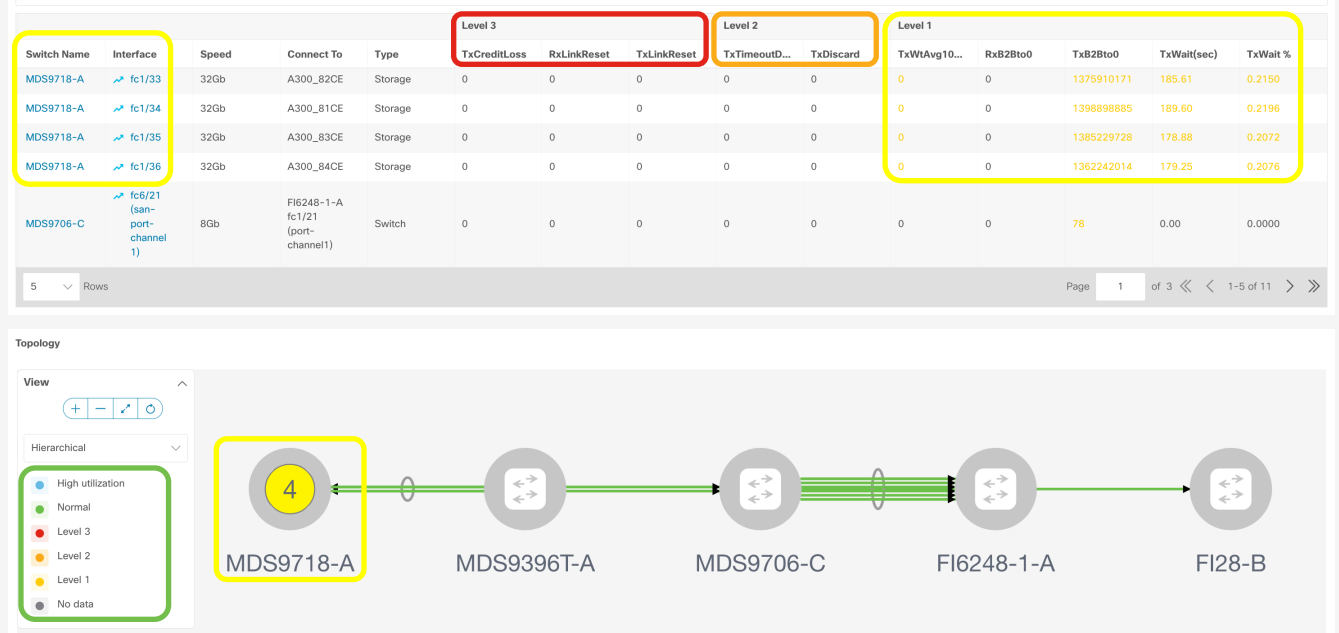
NDFC Congestion Analysis

- NDFC provides online congestion analysis, and displays list of devices with potential slow drain issues:



					Level 3			Level 2		Level 1				
Switch Name	Interface	Speed	Connect To	Type	TxCreditLoss	RxLinkReset	TxLinkReset	TxTimeoutD...	TxDiscard	TxWtAvg10...	RxB2Bto0	TxB2Bto0	TxWait(sec)	TxWait %
MDS9718-A	fc1/33	32Gb	A300_82CE	Storage	0	0	0	0	0	0	0	1375910171	185.61	0.2150
MDS9718-A	fc1/34	32Gb	A300_81CE	Storage	0	0	0	0	0	0	0	1398898885	189.60	0.2196
MDS9718-A	fc1/35	32Gb	A300_83CE	Storage	0	0	0	0	0	0	0	1385229728	178.88	0.2072
MDS9718-A	fc1/36	32Gb	A300_84CE	Storage	0	0	0	0	0	0	0	1362242014	179.25	0.2076
MDS9706-C	fc6/21 (san-port-channel 1)	8Gb	FI6248-1-A fc1/21 (port-channel1)	Switch	0	0	0	0	0	0	0	78	0.00	0.0000

5 Rows Page 1 of 3 1-5 of 11

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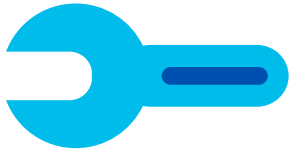
SAN Congestion Management

Reactive | Proactive | Predictive



Detecting SAN Congestion
(TxWait, RxWait, Tx-datarate)

Preventing SAN Congestion
(Dynamic Ingress Rate Limiting)

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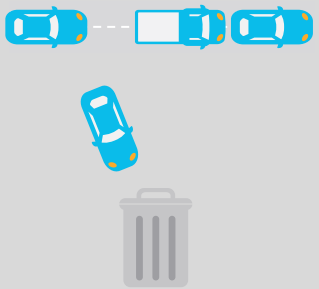
SAN Congestion Management Innovations

Frame Dropping

Mitigation

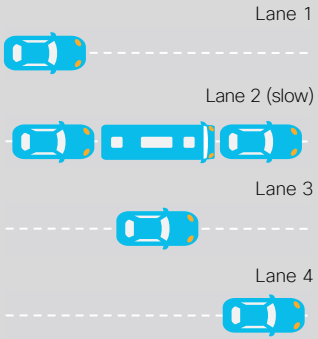
Reduce the impact of slow drain by dropping the stalled frames



Virtual Lanes

Avoidance

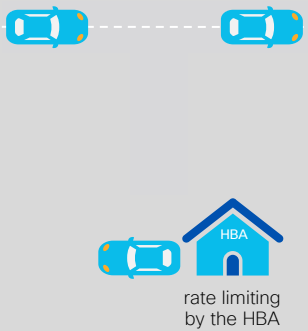
Avoid the congestion spreading by isolating the slow flows



FPIN

HBA Dependent Prevention

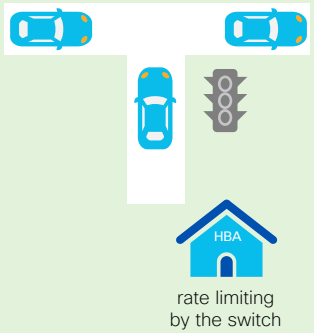
Reduce the Ingress Rate, requires the support of HBA



DIRL

HBA Independent Prevention

Dynamic Ingress Rate Limiting, independent of HBA



Prevent SAN Congestion with MDS DIRL – Cisco Exclusive capability/patent

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Common Causes of SAN Congestion

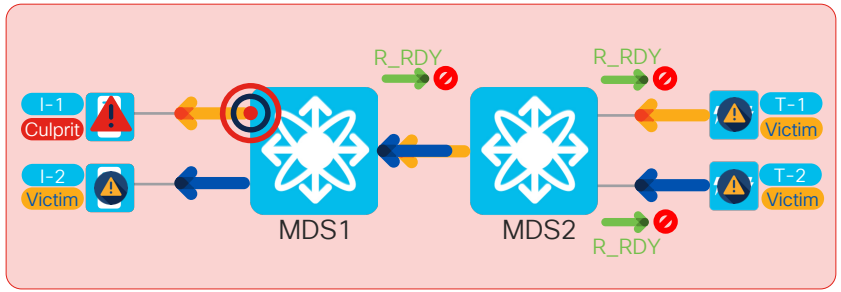
Slow Drain

Overutilisation

Different Detection
On the switch port connected to the culprit device

Similar Effects
On fabric and victim devices

Same Root Cause
The culprit device is receiving more than it can ingest



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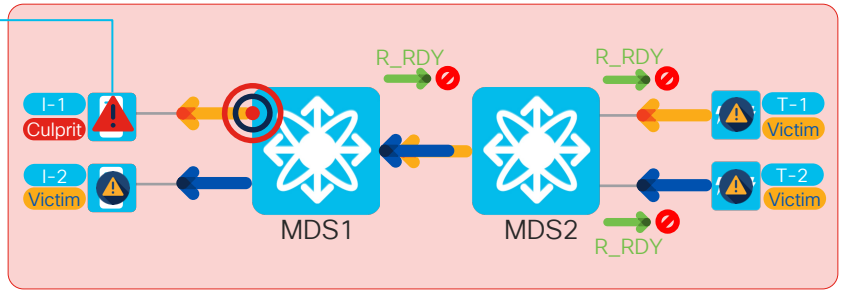
The Root Cause of SAN Congestion

The Root Cause

I-1 is receiving more than it can ingest

Why is I-1 receiving more than it can ingest?

...because I-1 is asking for it.



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The Solution

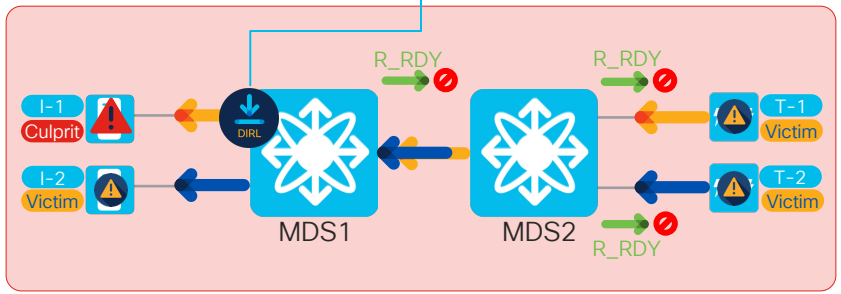
Cisco Dynamic Ingress Rate Limiting

DIRL

I-1 is asking for more than it can ingest

DIRL limits I-1's asking rate to reduce its receiving rate

DIRL dynamically changes I-1's asking rate to adapt to its traffic profile



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The Solution

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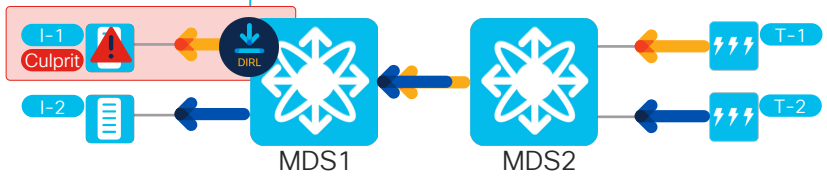

DIRL prevents SAN Congestion due to Slow-Drain and Overutilisation.

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Cisco Dynamic Ingress Rate Limiting

End-device Independent
No need to upgrade end-devices.

Adaptive
Dynamically adjusts to the traffic profile of the host.

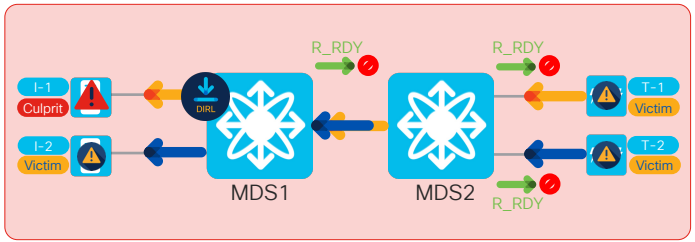
No Side Effects
Rate limits congested hosts only.

Easy Adoption
Software-only upgrade.

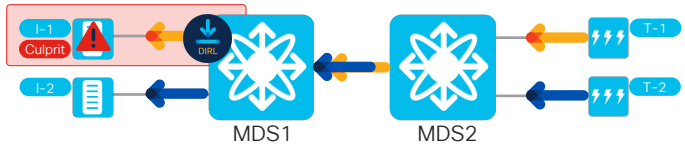
Affordable
No additional license needed.

Topology Independent
Edge-core, edge-core-edge, or collapsed core topologies.

Without Cisco DIRL



With Cisco DIRL



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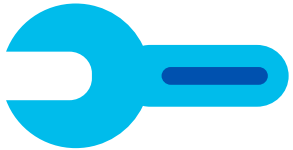
SAN Congestion Management

Reactive → Proactive → Predictive



Detecting SAN Congestion
(TxWait, RxWait, Tx-datarate)

Preventing SAN Congestion
(Dynamic Ingress Rate Limiting)

Predicting SAN Congestion
(SAN Analytics and Insights)

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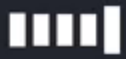
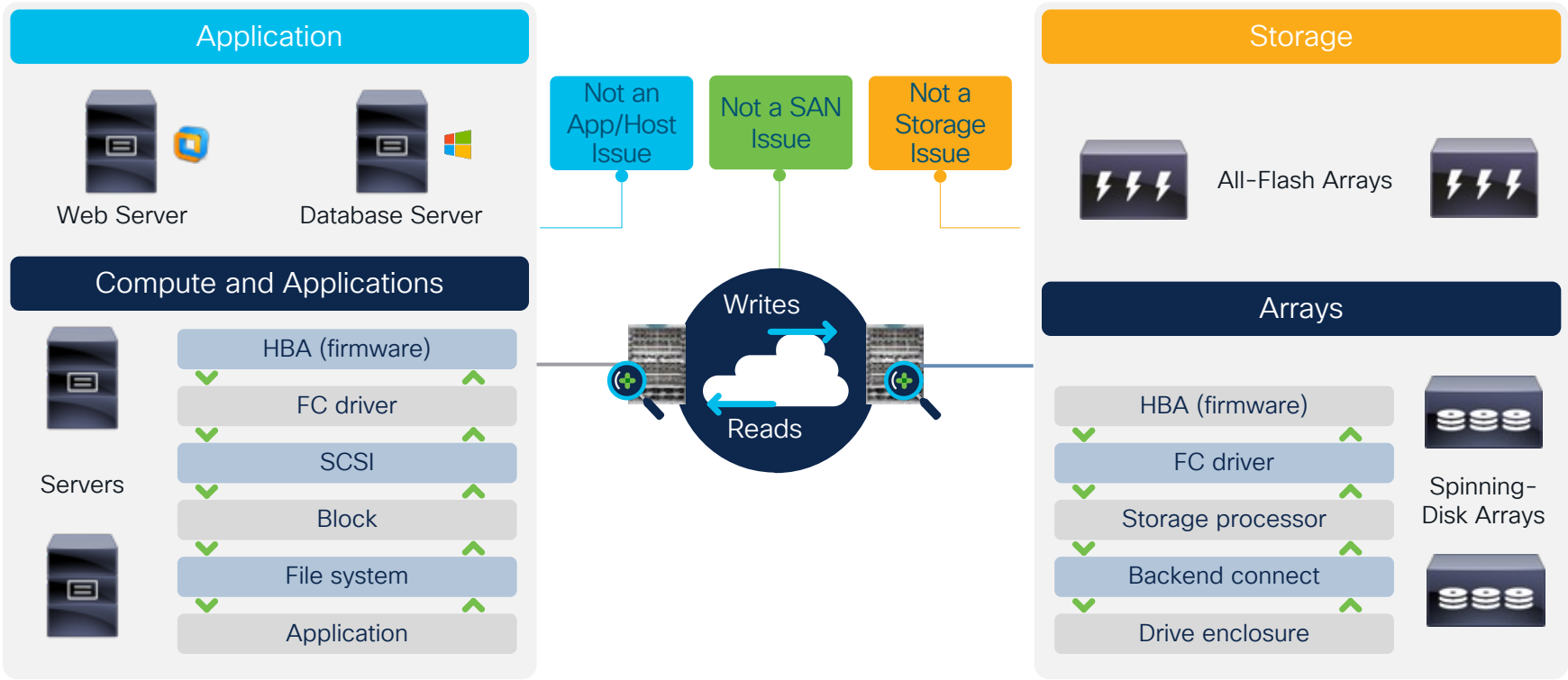


Where is the Problem?



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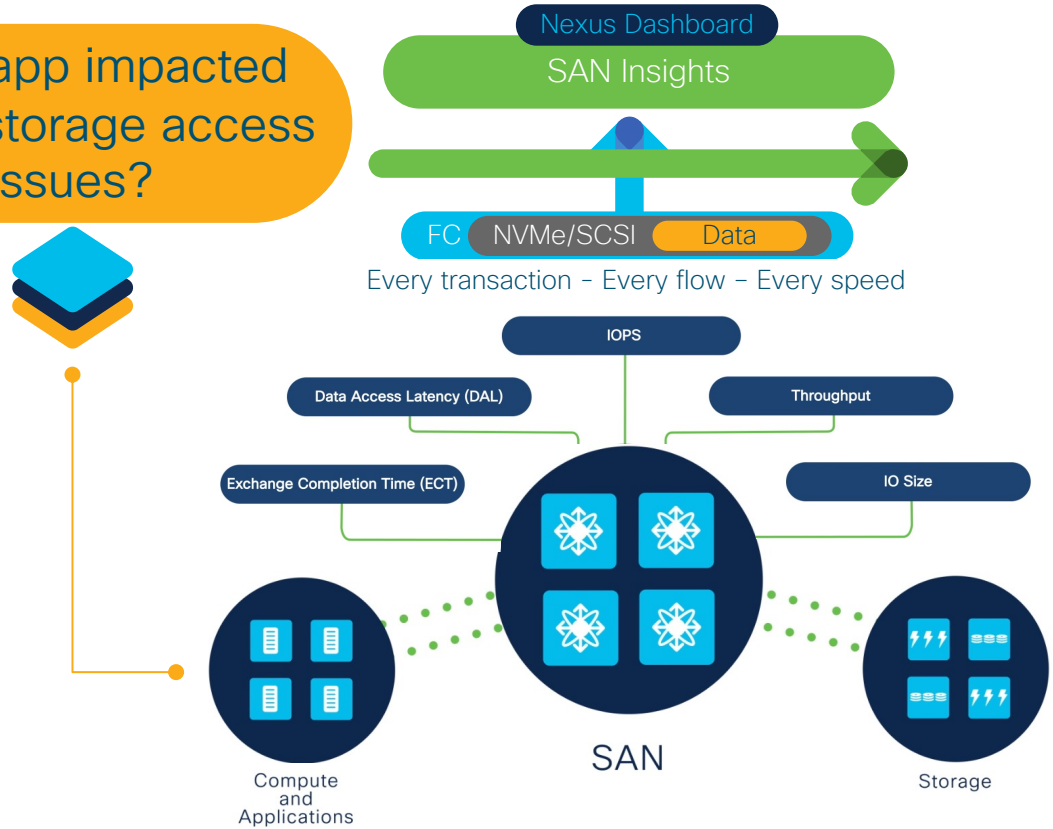
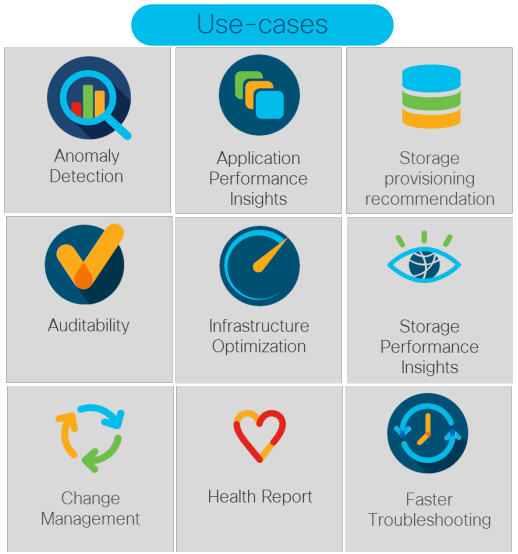
NVMe and SCSI I/O Visibility Using SAN Analytics

Is the app impacted due to storage access issues?





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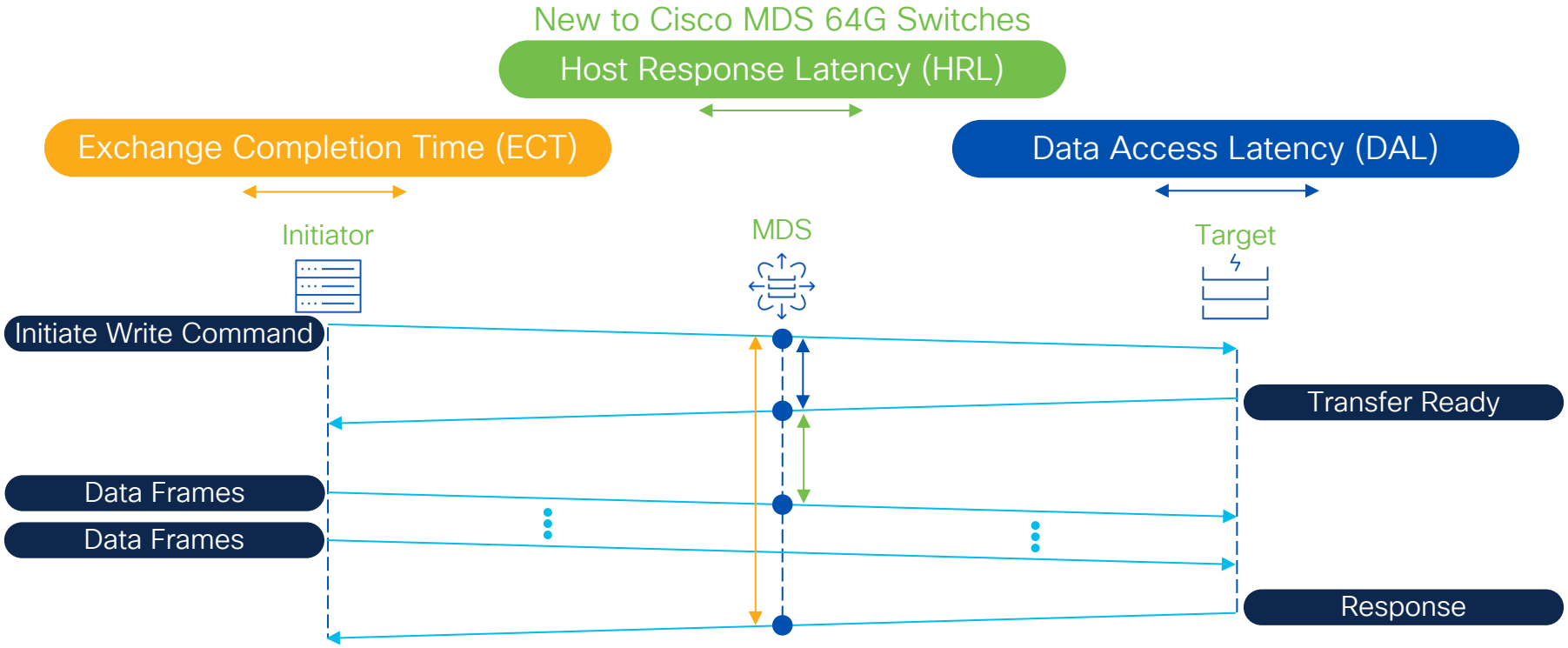
Cisco SAN Analytics Flow Metrics

Write I/O Operation



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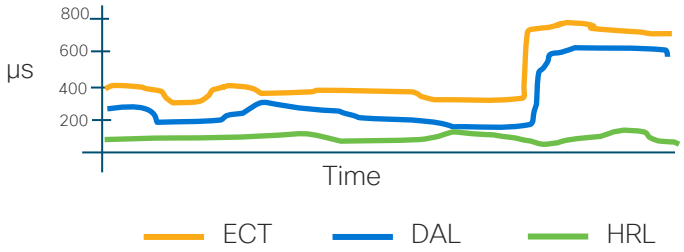
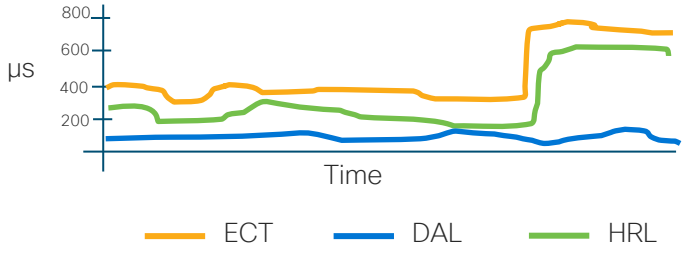
Pinpointing Storage I/O Performance Issues

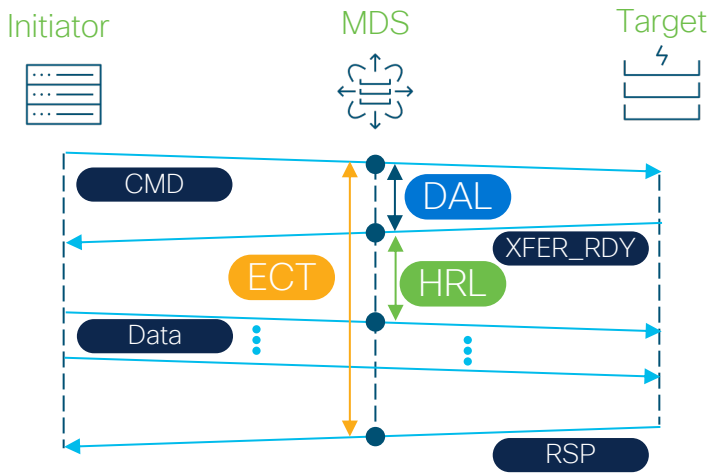
Storage performance is degraded due to delay caused by storage array



Storage performance is degraded due to delay caused by host



Write Transaction



Where is the bottleneck ?

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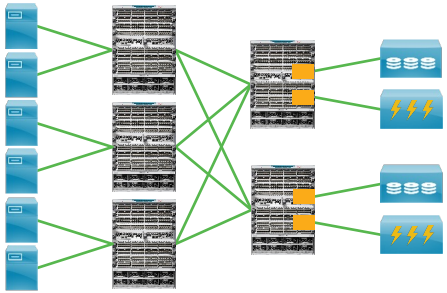
Analytics enabled port(s)

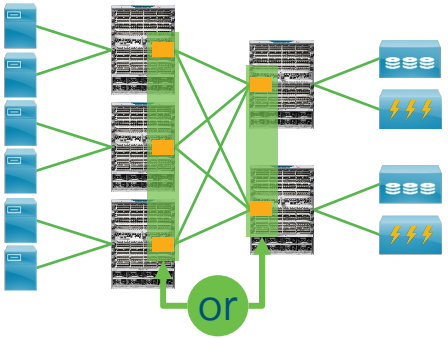
Deployment Models

Storage Ports



Closest to Storage

ISL Ports



High capacity 64G ISLs

Host Ports

Closest to Apps

- Inspection of traffic at least once in the end-to-end data path is enough
- Avoid double inspection of traffic
- Design for uniform utilisation of the NPU
- Most customers are enabling analytics on storage ports

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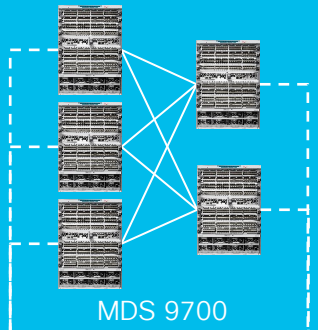
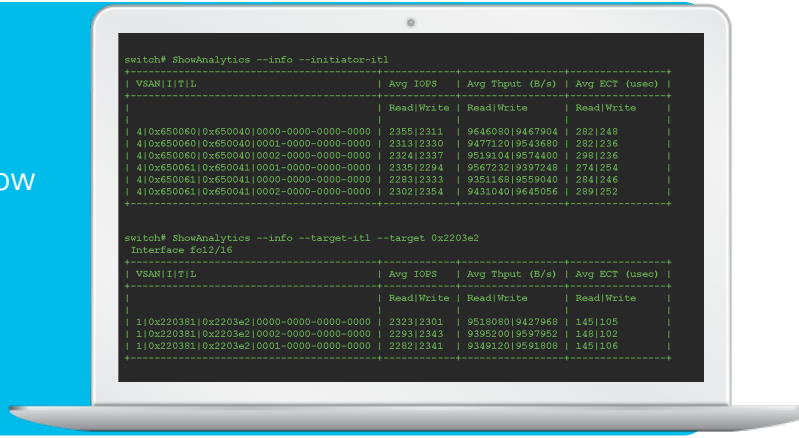
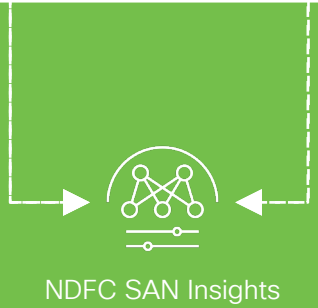
Cisco SAN Analytics Scale for Always-on Visibility



SAN Analytics

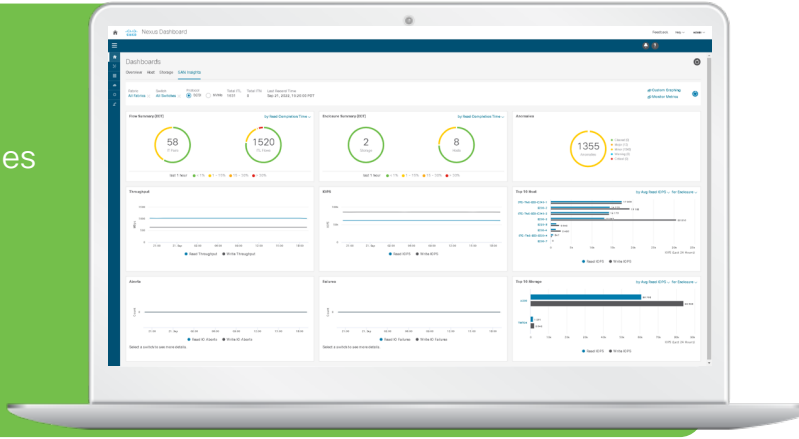
- 100K flows monitored per MDS 9700
- Real-time (microsecond) visibility into any flow using on-switch CLI
- 30-second export interval to NDFC





NDFC SAN Insights

- 1 million flows received from multiple switches
- Anomaly detection
- Automatic baseline, deviations, trending
- End-to-end correlation



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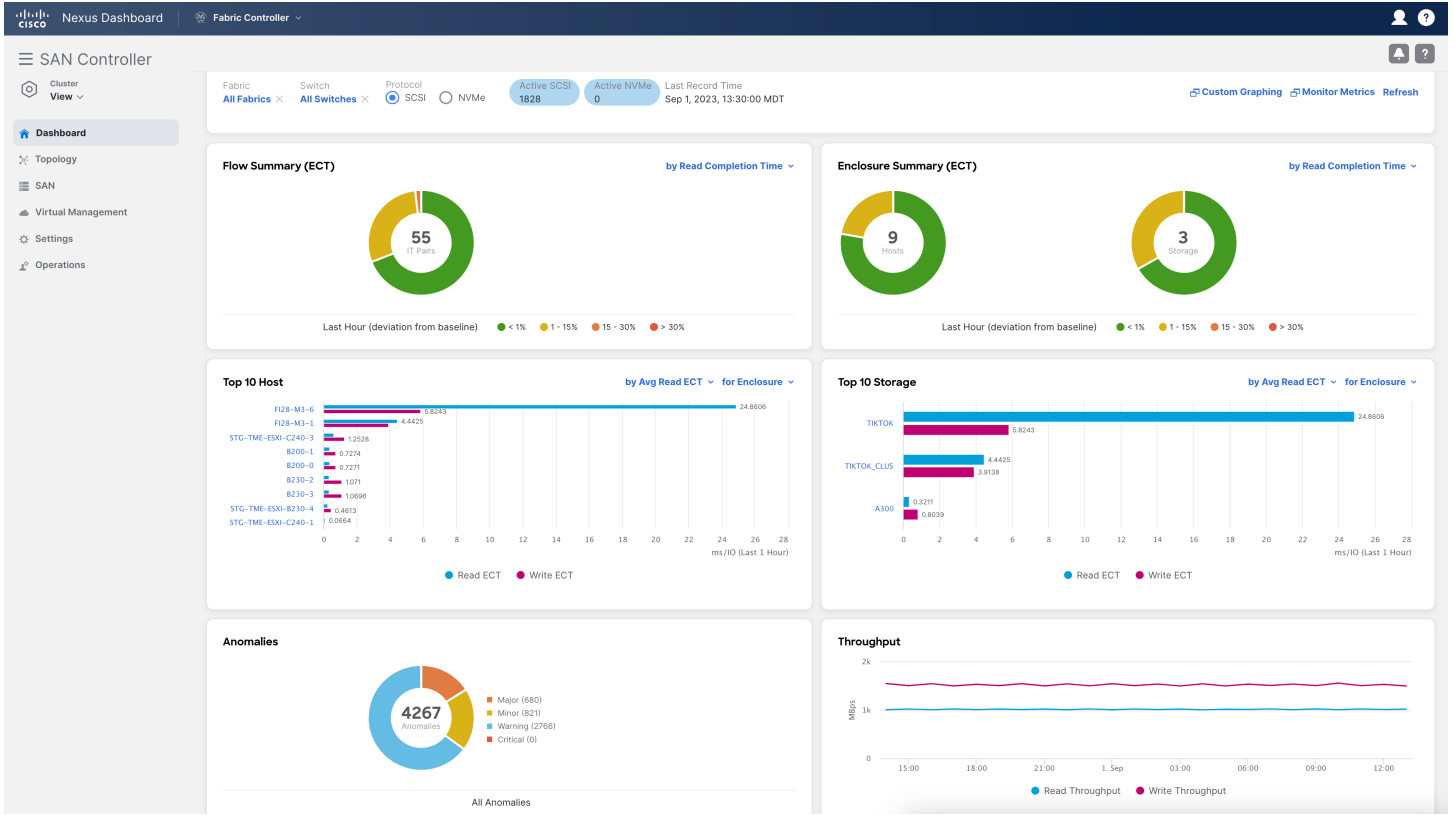
NDFC SAN Insights



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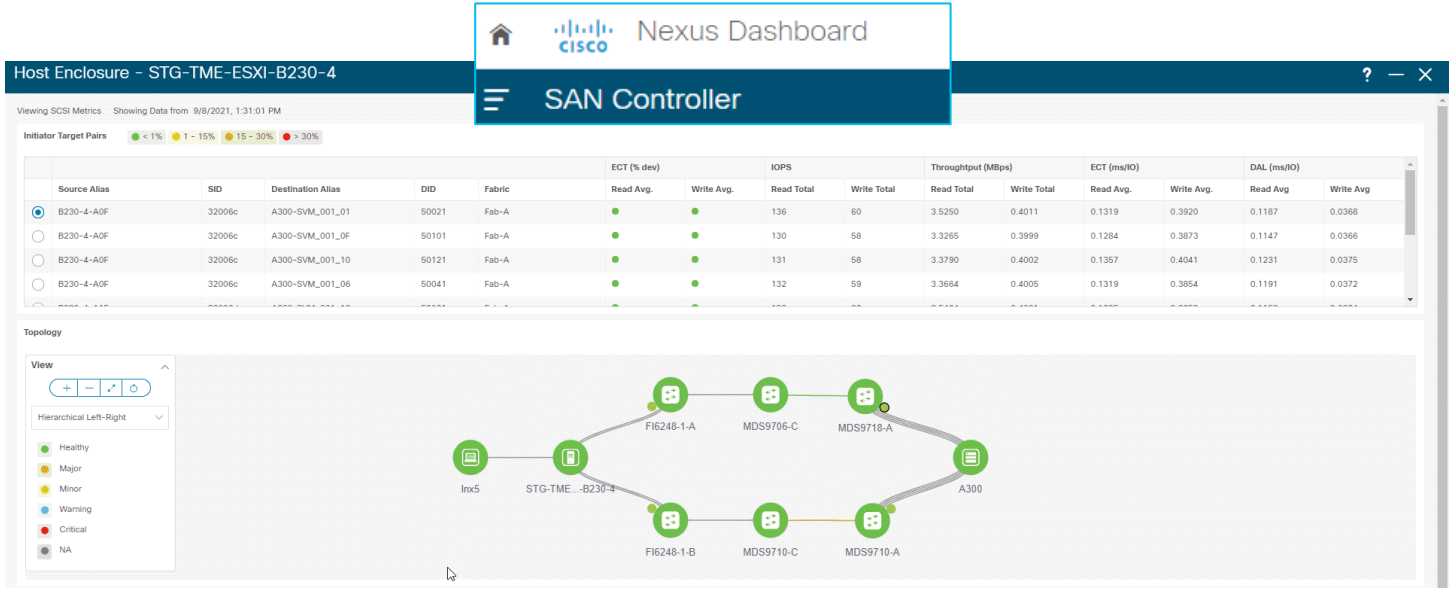
Cisco UCS and VM Traffic Visibility using NDFC



End-to-end Visualization

VM hosted on UCS servers, service profiles, vHBA/vNIC names, FI ports, etc.

Traffic Trends and Seasonality

For every vNIC/vHBA and service profile

Inventory

Server memory, CPU, serial numbers, etc.

End-to-end visibility into I/O flows is also available in non-UCS environments

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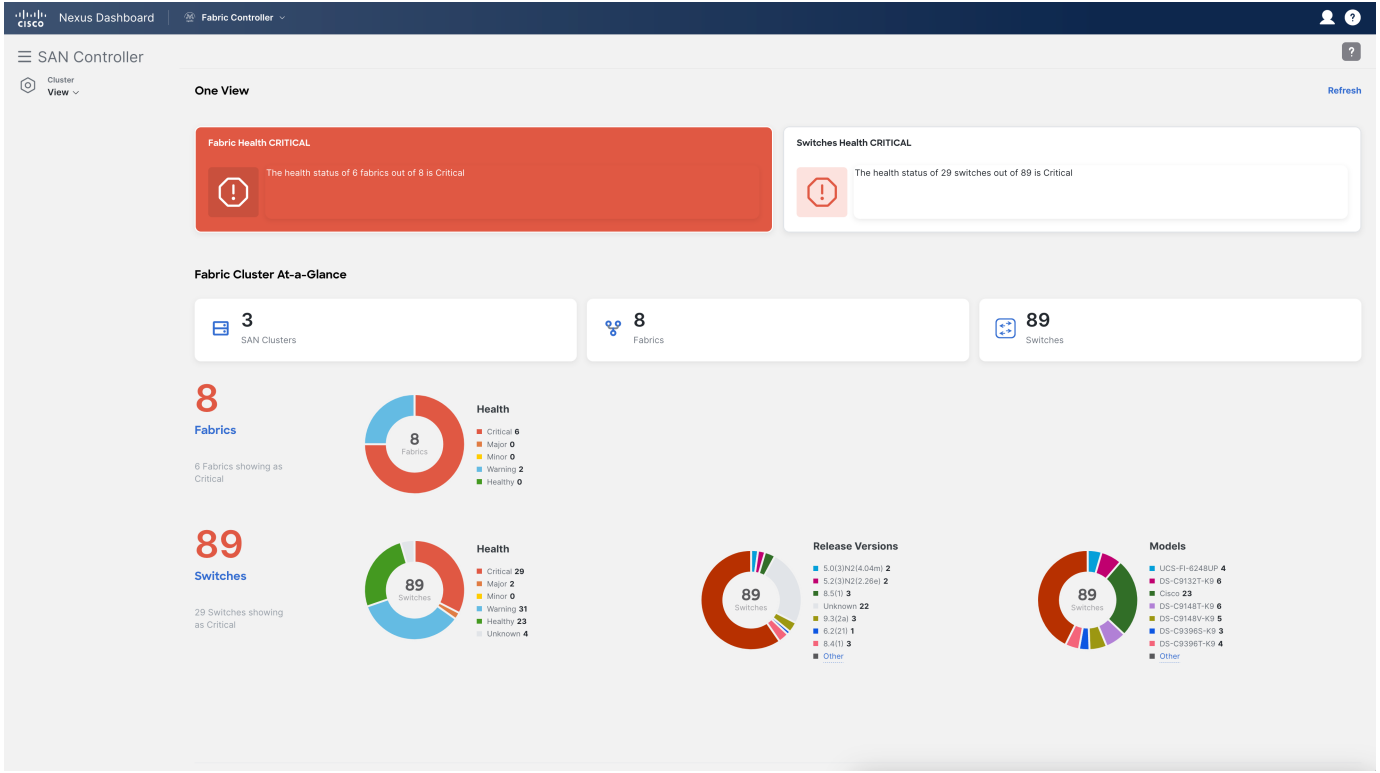
NDFC SAN One View



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Agenda

- Overview
- Common Architectures
- Understanding and Detecting SAN Congestion
- Preventing and Predicting SAN Congestion
- Summary

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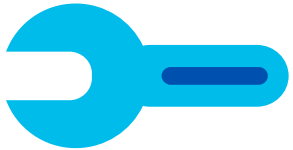
Summary

Reactive → Proactive → Predictive



Detecting SAN Congestion
(TxWait, RxWait, Tx-datarate)

Preventing SAN Congestion
(Dynamic Ingress Rate Limiting)

Predicting SAN Congestion
(SAN Analytics and Insights)

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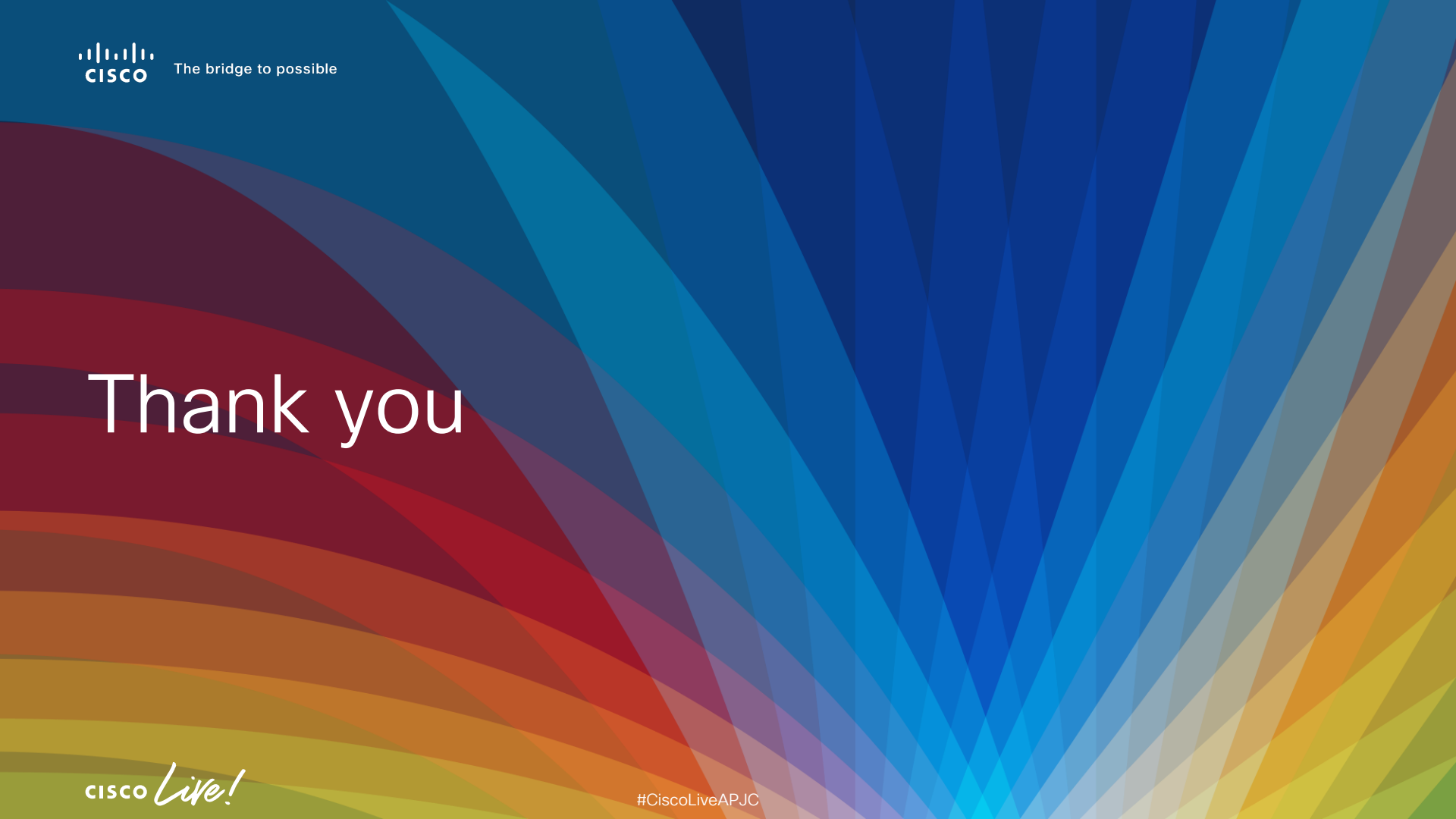
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