

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

Getting your SAN to perform at its best

**CISCO** Live !

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Solutions Engineer, @spaulose

Session ID: BRKDCN-3641

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Welcome to Melbourne!



# Businesses are interconnected

An aerial photograph of a busy city intersection, likely in Hong Kong, showing significant traffic congestion. A large white bus is stuck in the middle of the intersection, surrounded by other vehicles including red taxis and a green van. Pedestrians with umbrellas are visible on the sidewalks, suggesting it might be raining. The intersection features yellow grid markings and crosswalks. The text "Traffic congestion results in productivity loss" is overlaid on the bottom half of the image.

**Traffic congestion results in productivity loss**



**Storage fabric is key to smooth operations of your digital city**

# Agenda

- 01 Common architectures
- 02 Understanding and detecting SAN congestion
- 03 Preventing and predicting SAN congestion
- 04 Summary

# Cisco MDS Switch Hardware

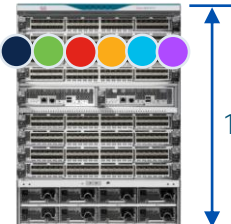
## SAN directors

16/32/64G



26RU

MDS 9718  
768 ports



14RU

MDS 9710  
384 ports



9RU

MDS 9706  
192 ports



## 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

## Fabric switches

32G



MDS 9132T



MDS 9148T



MDS 9396T

64G



MDS 9124V



MDS 9148V



MDS 9396V

FCIP



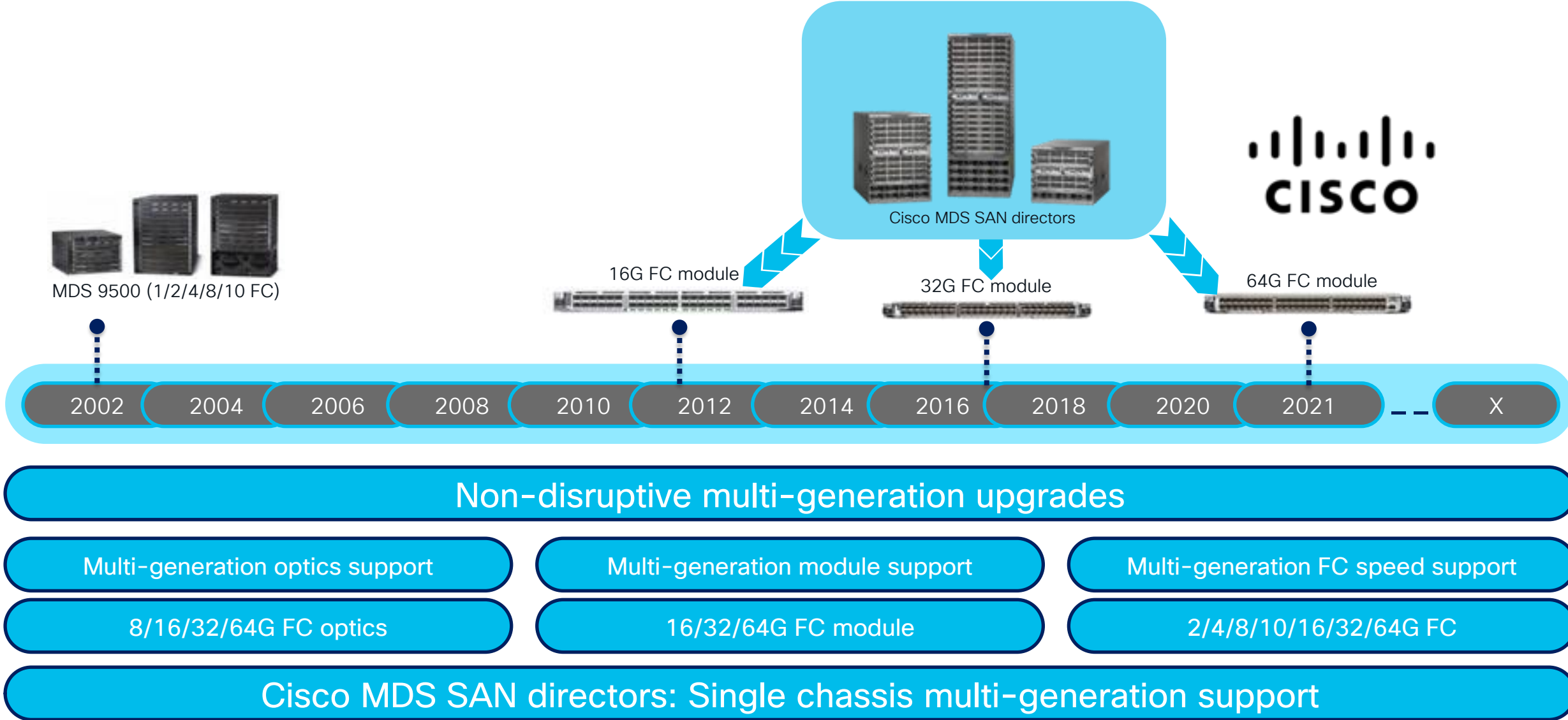
MDS 9220i



MDS 9250i

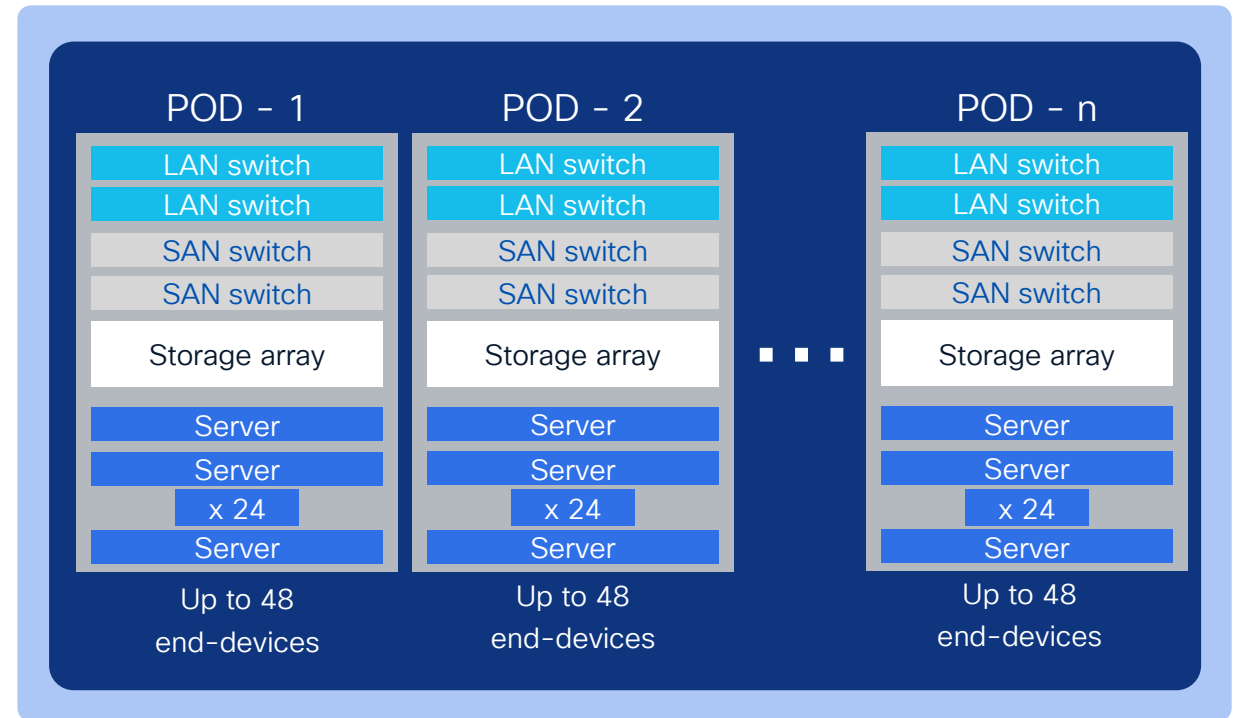
- 8/16/32/64G FC
- 4/8/16/32G FC
- 2/4/8/10/16G FC
- SAN Analytics
- FCIP
- FICON

# Cisco MDS Switch Hardware



# Common Architectures

# POD Fabric



## Benefits

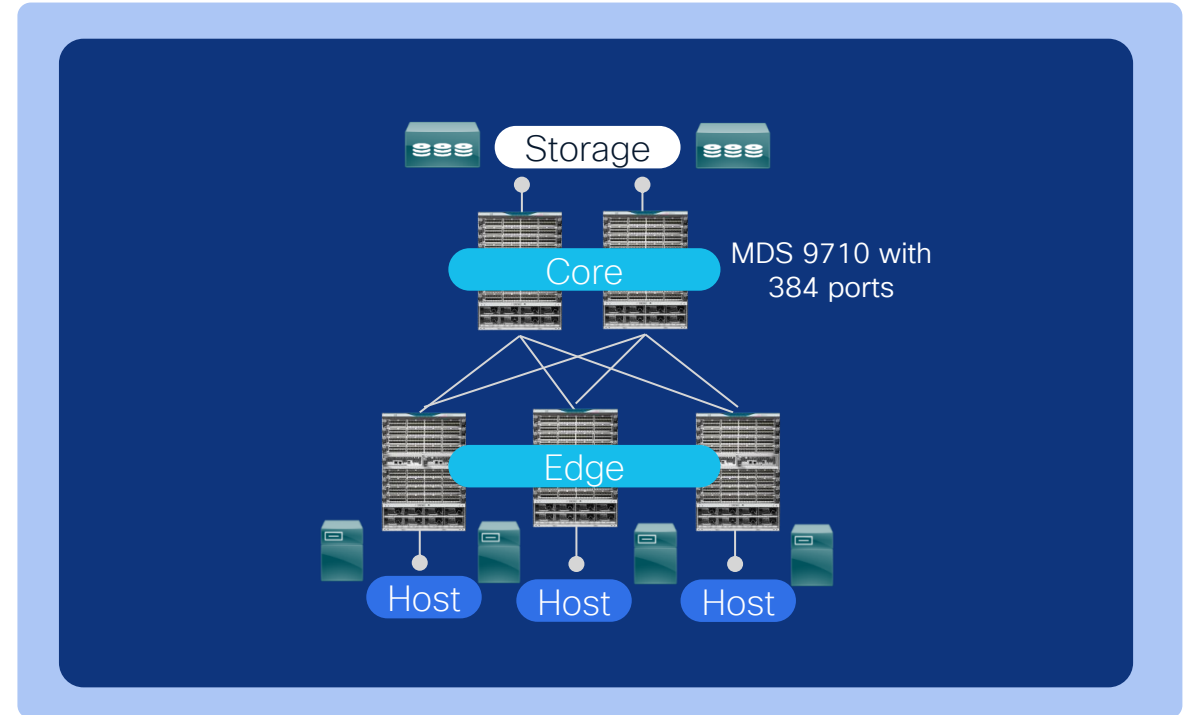
Best at containing SAN congestion / slow drain within the rack

No effect on other racks while one rack is under maintenance

## Challenges

Requires a different data center operational model

# Edge-Core Design



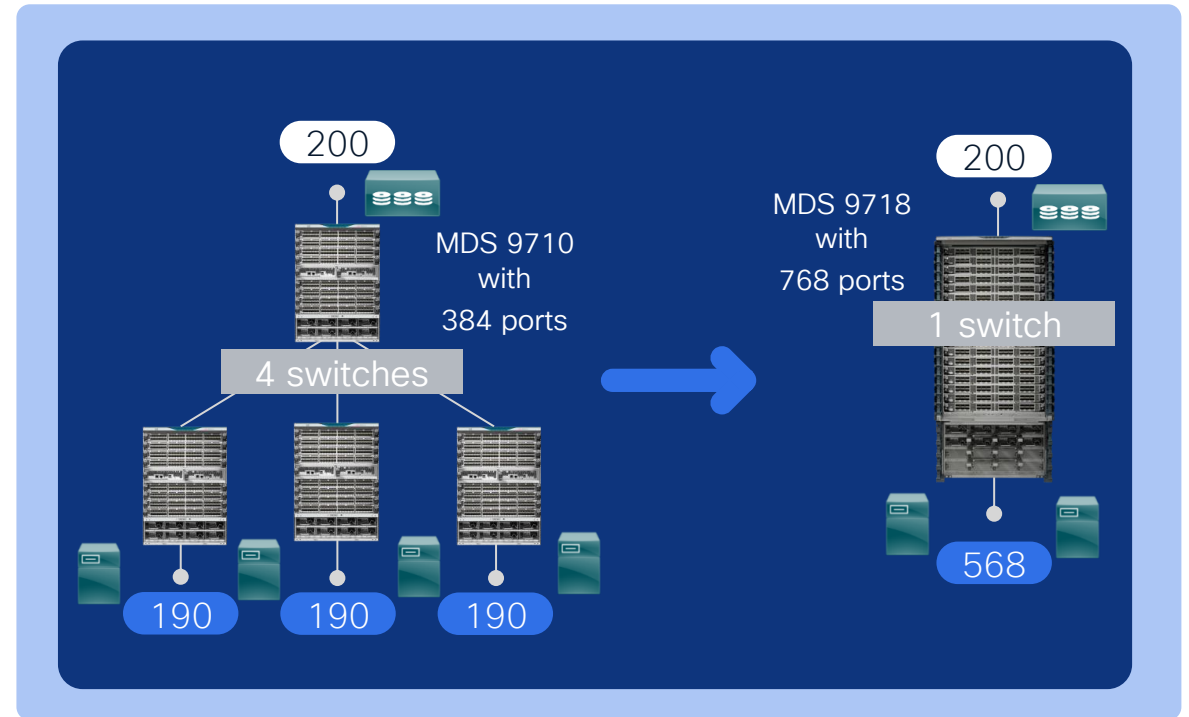
## Benefits

Most Deployed. Tried and Tested

## Challenges

Prone to congestion and slow drain

# Edge-Core Design



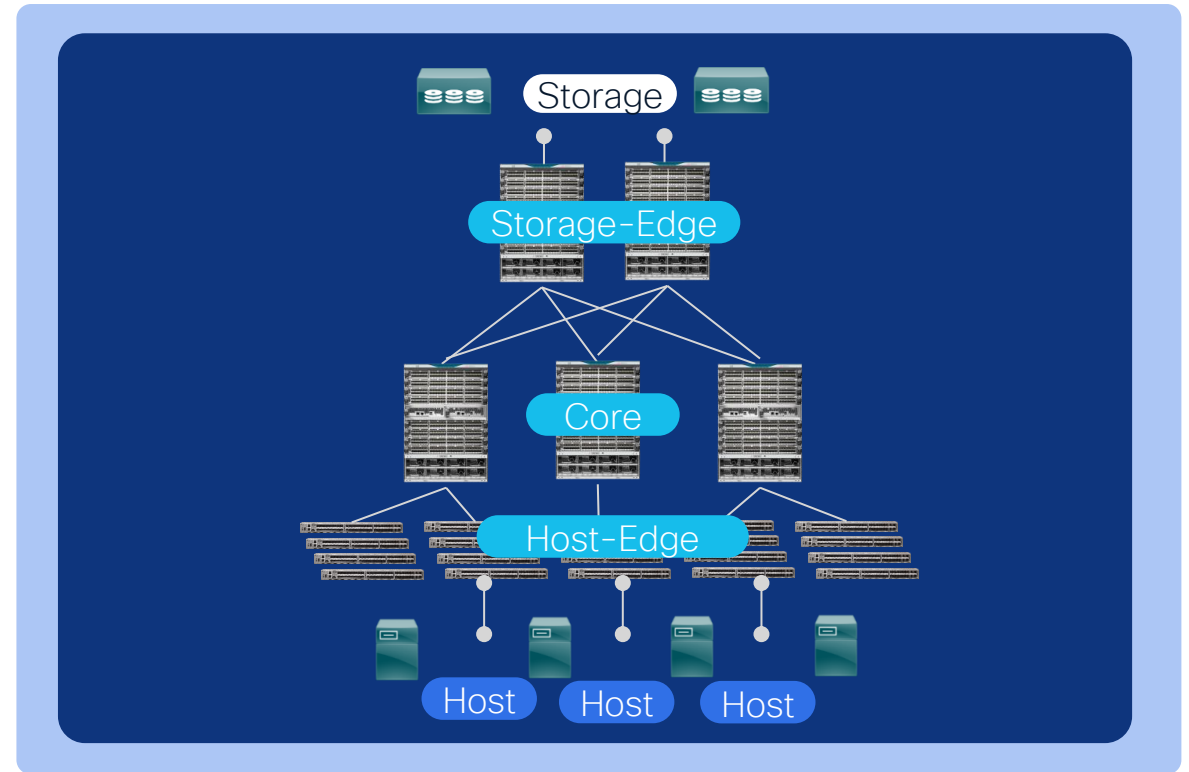
## Benefits

- Less operational overhead
- Reduced Congestion/Slow drain

## Challenges

- Cable length and scaling beyond 768 devices

# Large Scale Edge-Core Design



## Benefits

Easy to Scale and Investment protection

Reduced Congestion/Slow drain

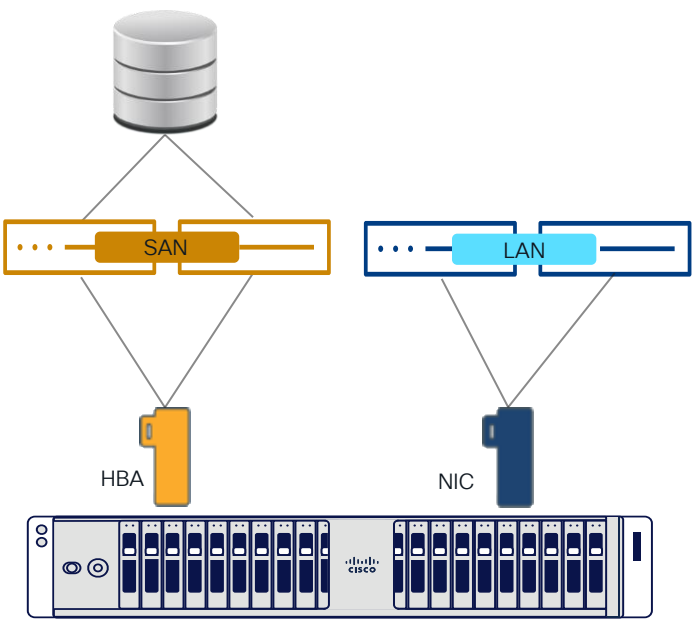
## Challenges

Prone to Congestion/Slow drain

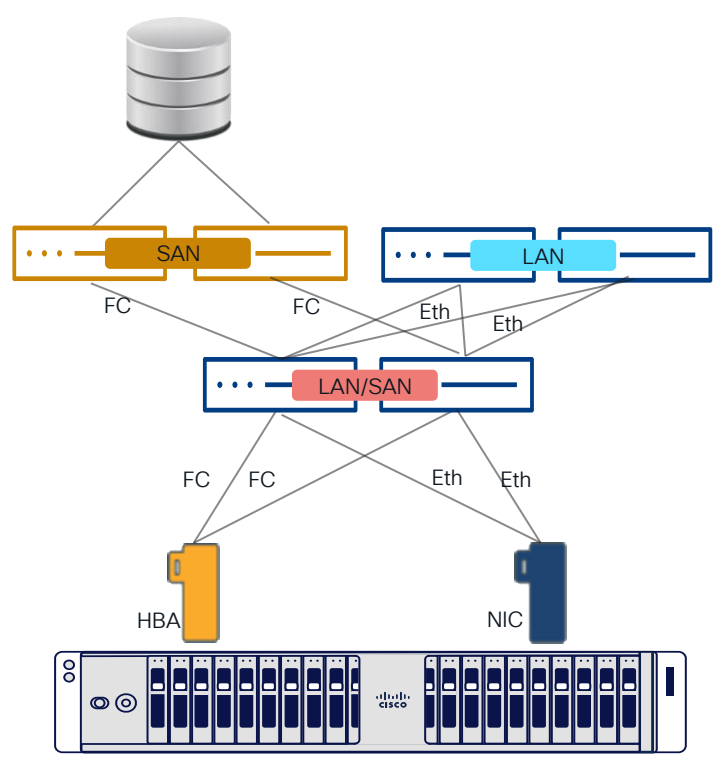
Strict operational control

# Typical LAN and SAN Designs

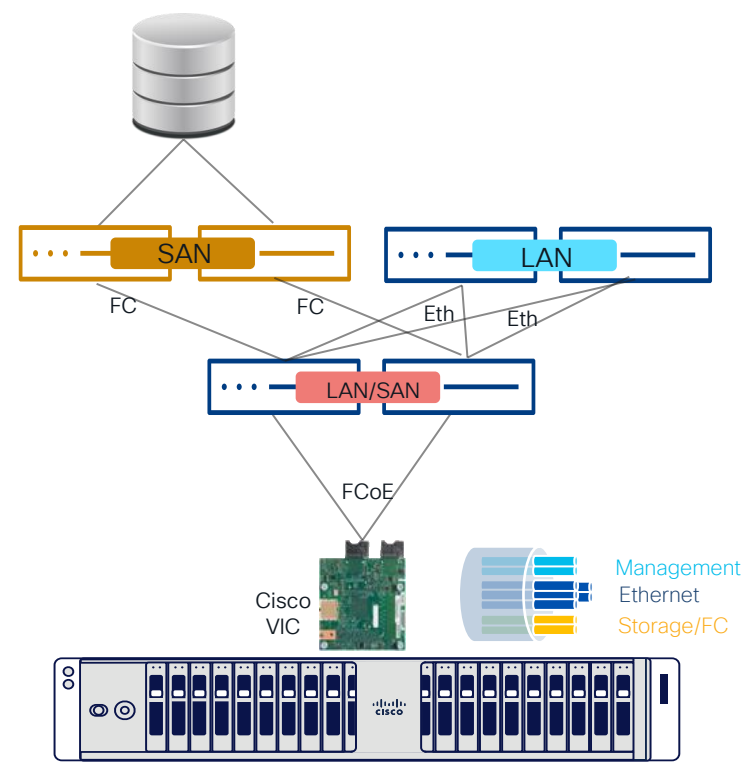
LAN and SAN separation



Convergence at ToR switch



Converged at ToR switches and host

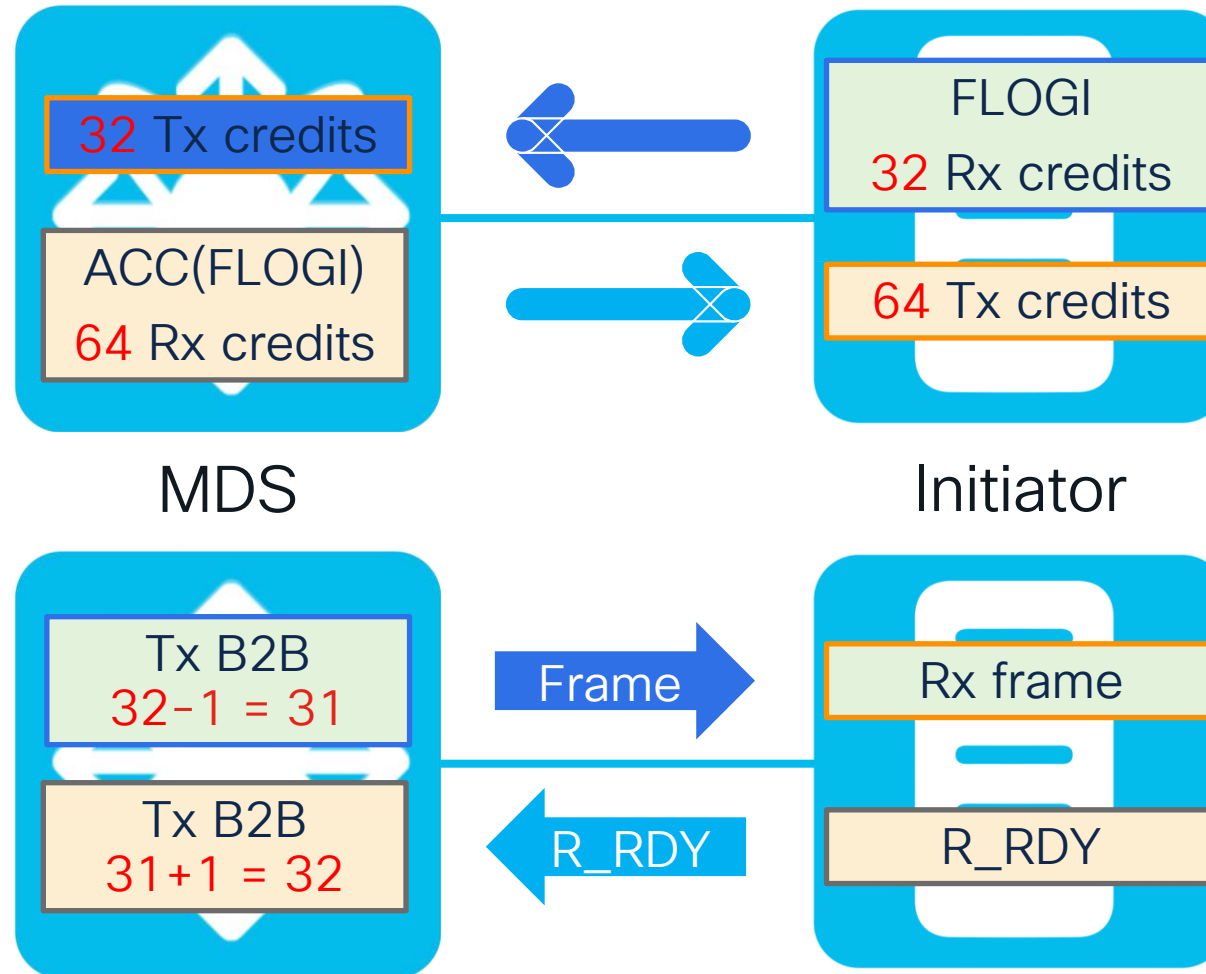


# Understanding and Detecting SAN Congestion

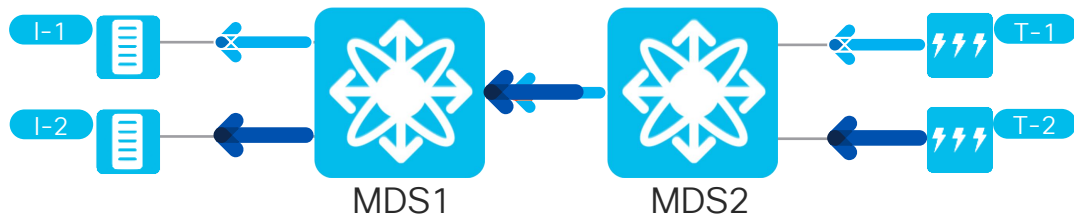
Troubleshooting SAN  
congestion is like  
searching for a  
needle in a haystack



# Fiber Channel Flow Control



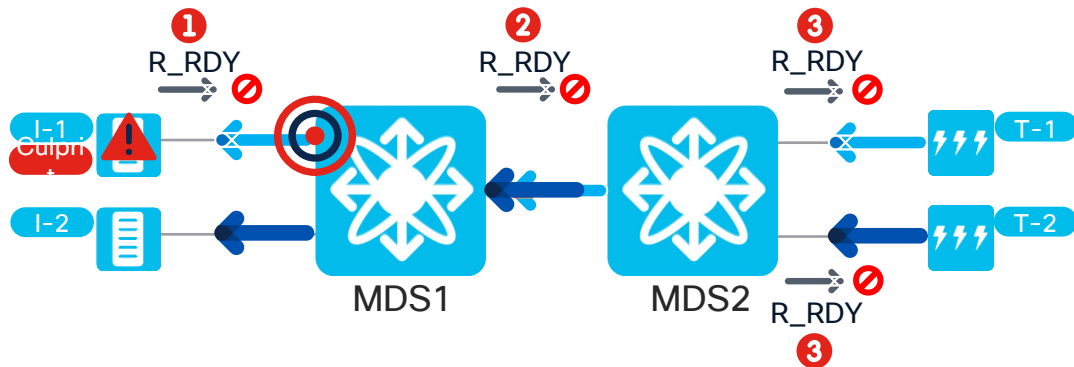
# Common causes of SAN congestion



# Common causes of SAN congestion

## Slow Drain

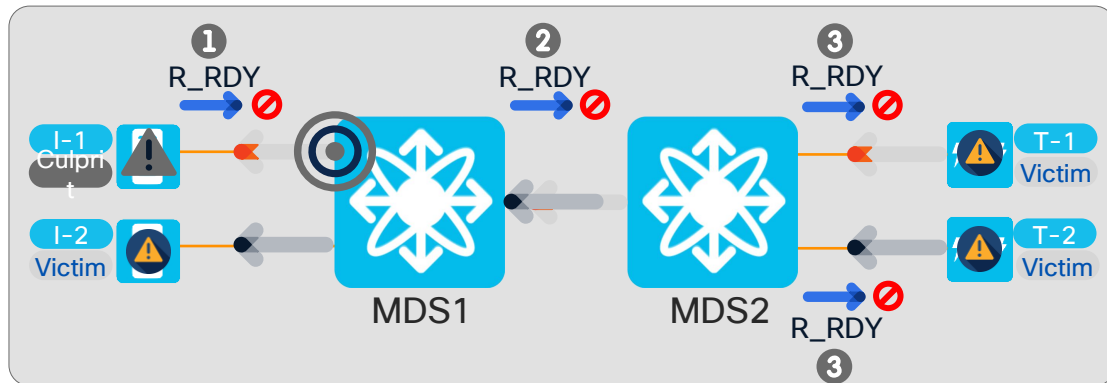
Tx B2B credit starvation



# Common causes of SAN congestion

## Slow Drain

Tx B2B credit starvation

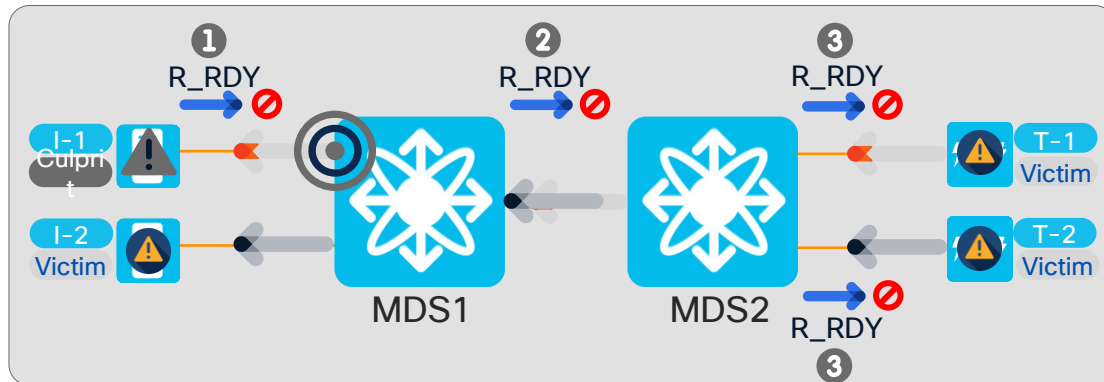


Frames are not dropped in FC fabric. Rather, they consume switch buffers causing a fabric-wide congestion.

# Common causes of SAN congestion

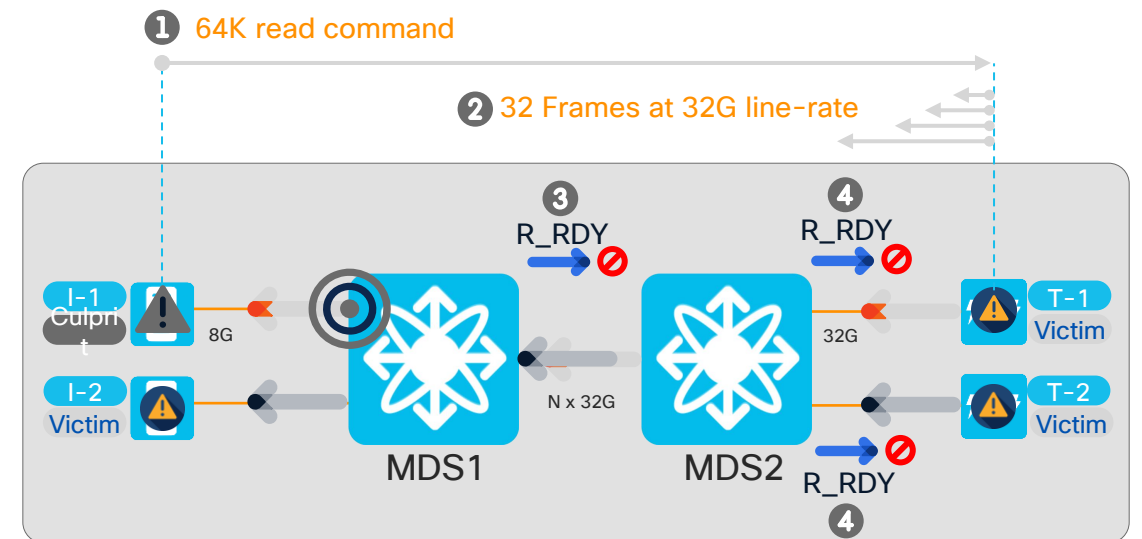
## Slow Drain

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.

# Congestion Detection

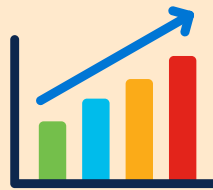
- Most problems start when a port hits 0 Tx/Rx B2B credits
- Increment Tx/Rx “B2B Transitions to Zero” counter
- Additional counters to provide further context:



TxWait  
2.5µs



Slowport-monitor  
1-500ms



Tx-datarate  
%



Timeout-drops  
500ms



Credit-Loss-Recovery  
1s / 1.5s

# Preventing and Predicting SAN Congestion

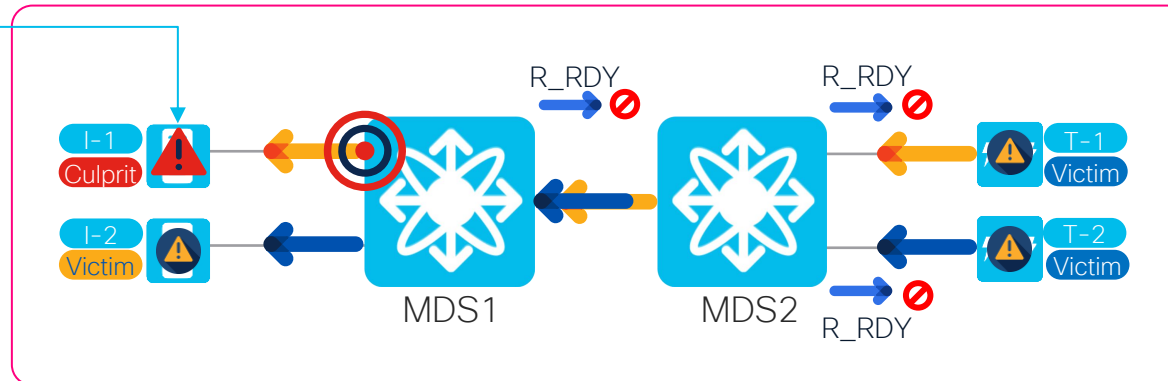
# The Root Cause of SAN Congestion

## 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.**



# The Solution

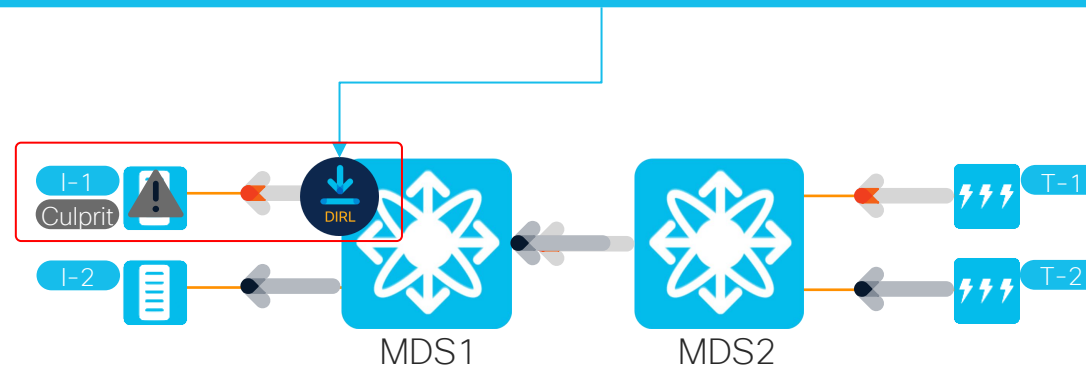
## Cisco Dynamic Ingress Rate Limiting



**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



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

# The Solution – 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 NXOS  
8.5.1+.



## Affordable

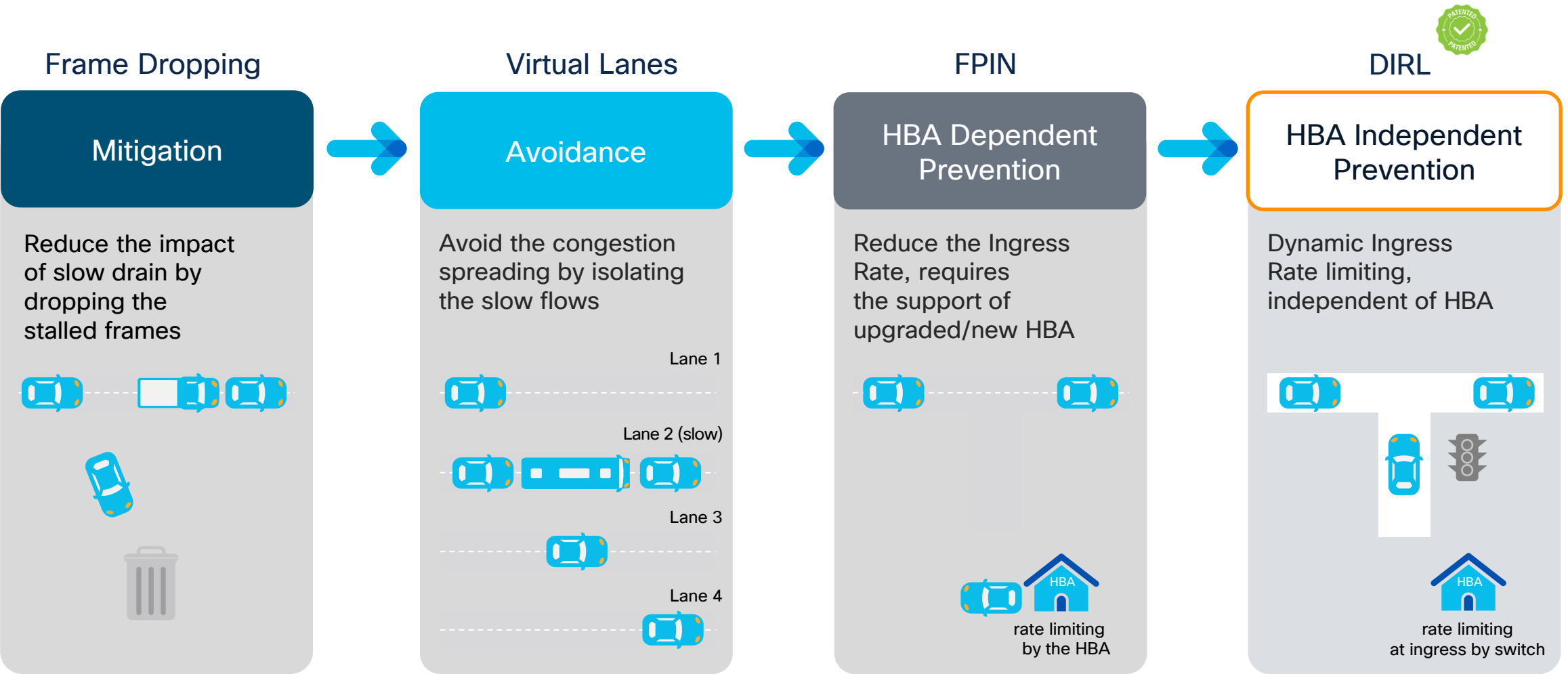
No additional license  
needed.



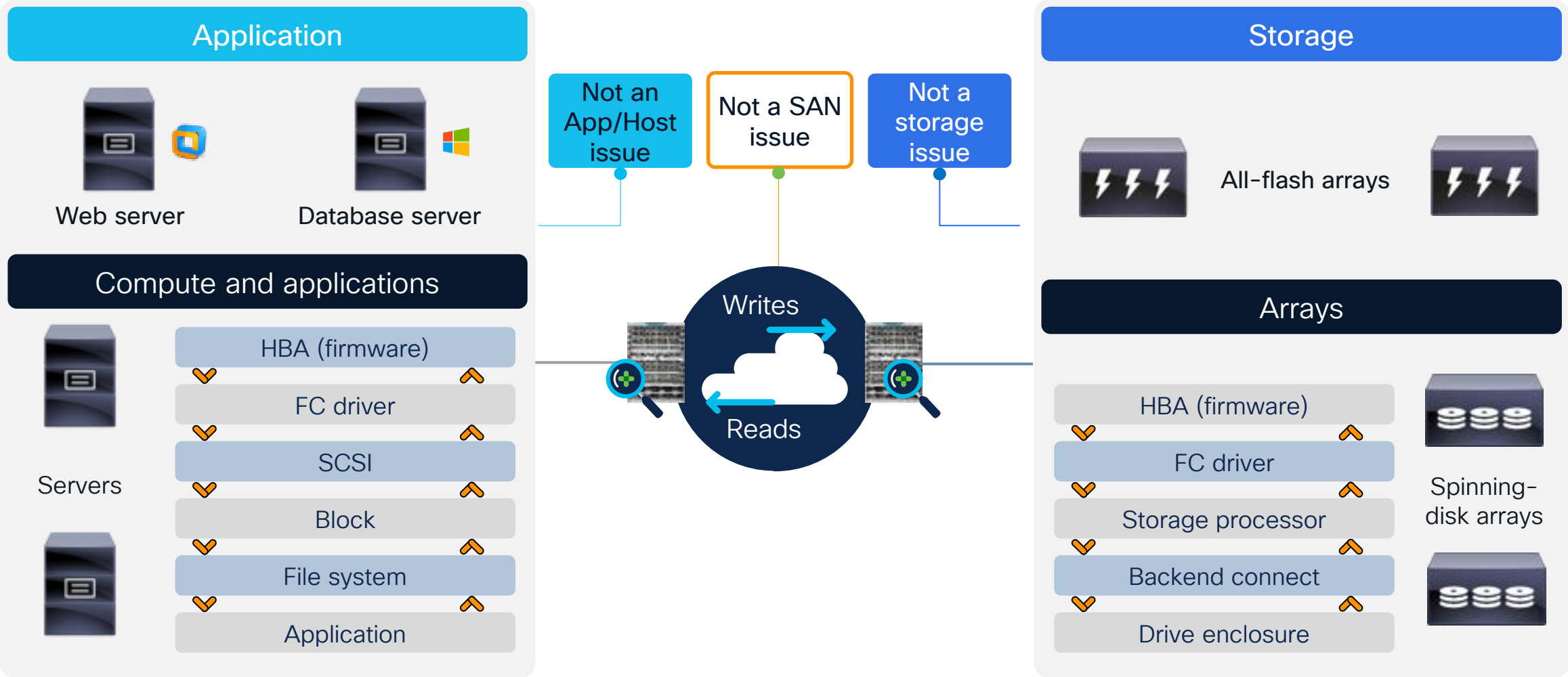
## Topology Independent

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

# SAN Congestion Management Innovation

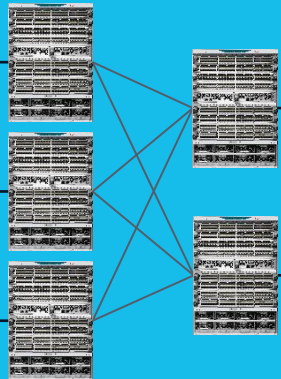


# Where is the problem?



# Cisco Nexus Dashboard SAN Analytics

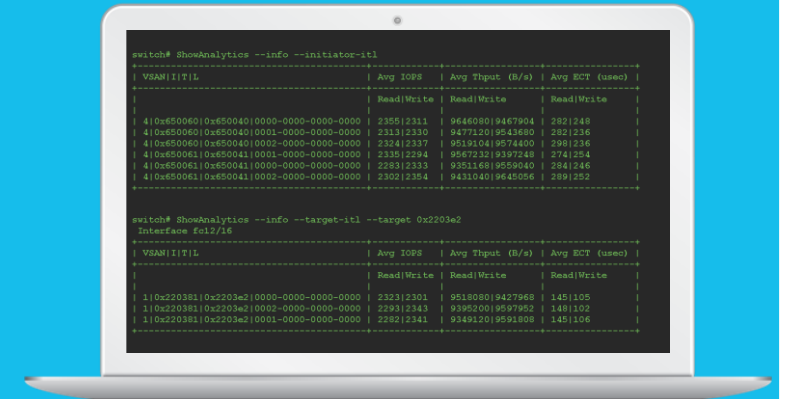
## Scale for always-on visibility



MDS 9700

### SAN Analytics

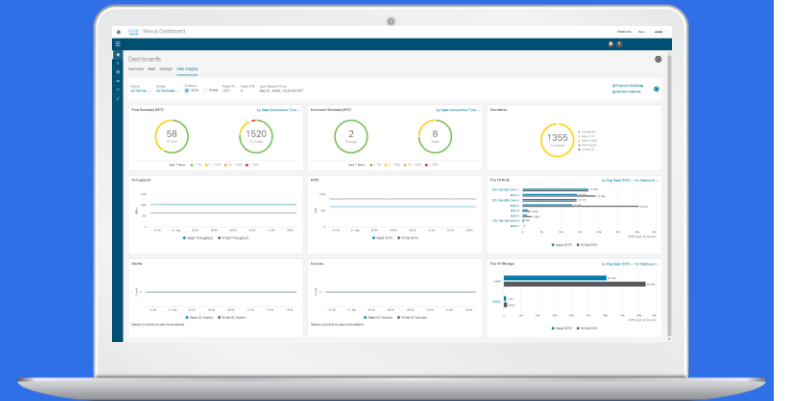
- 100K flows monitored per MDS 9700
- Real-time (microsecond) visibility into any flow using on-switch CLI
- 30-second export interval to NDFC



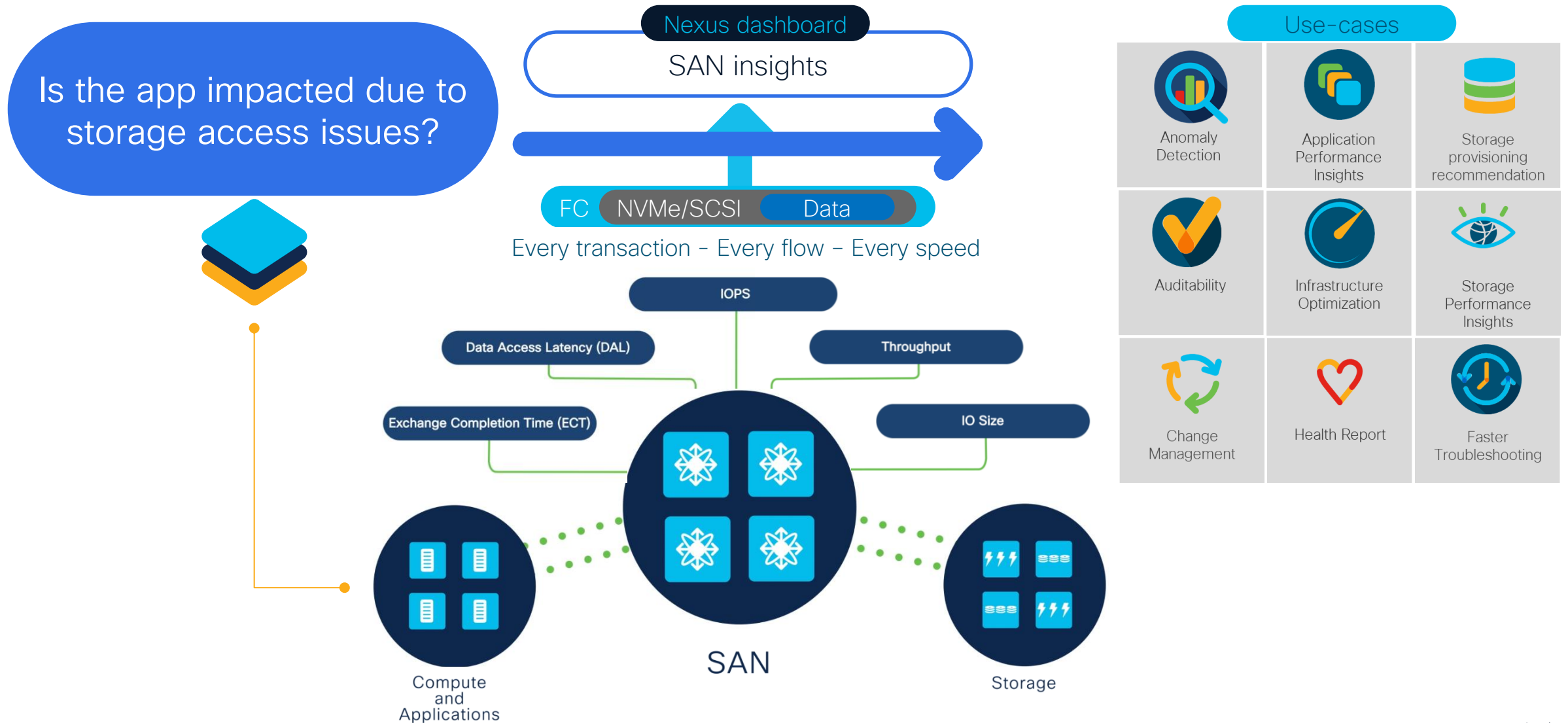
Nexus Dashboard  
SAN Insights

### Nexus Dashboard for SAN insights

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

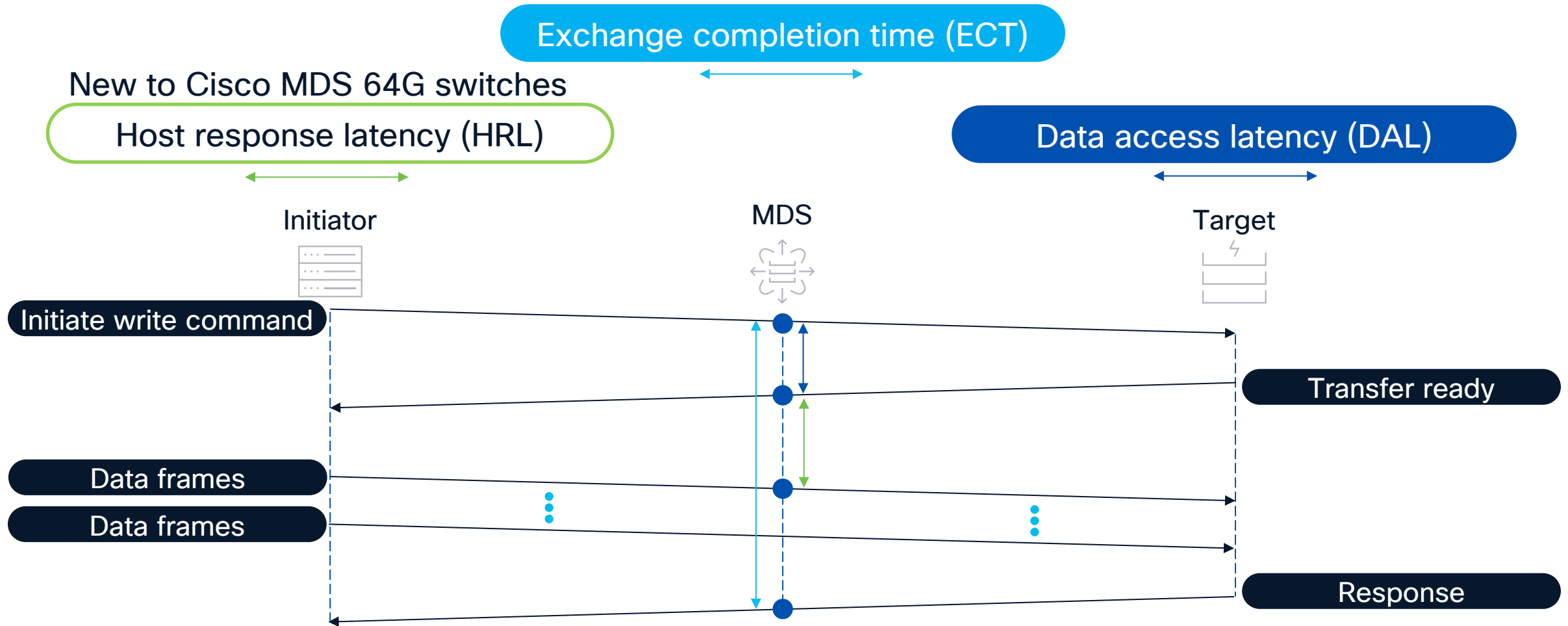


# NVMe and SCSI I/O visibility using SAN Analytics



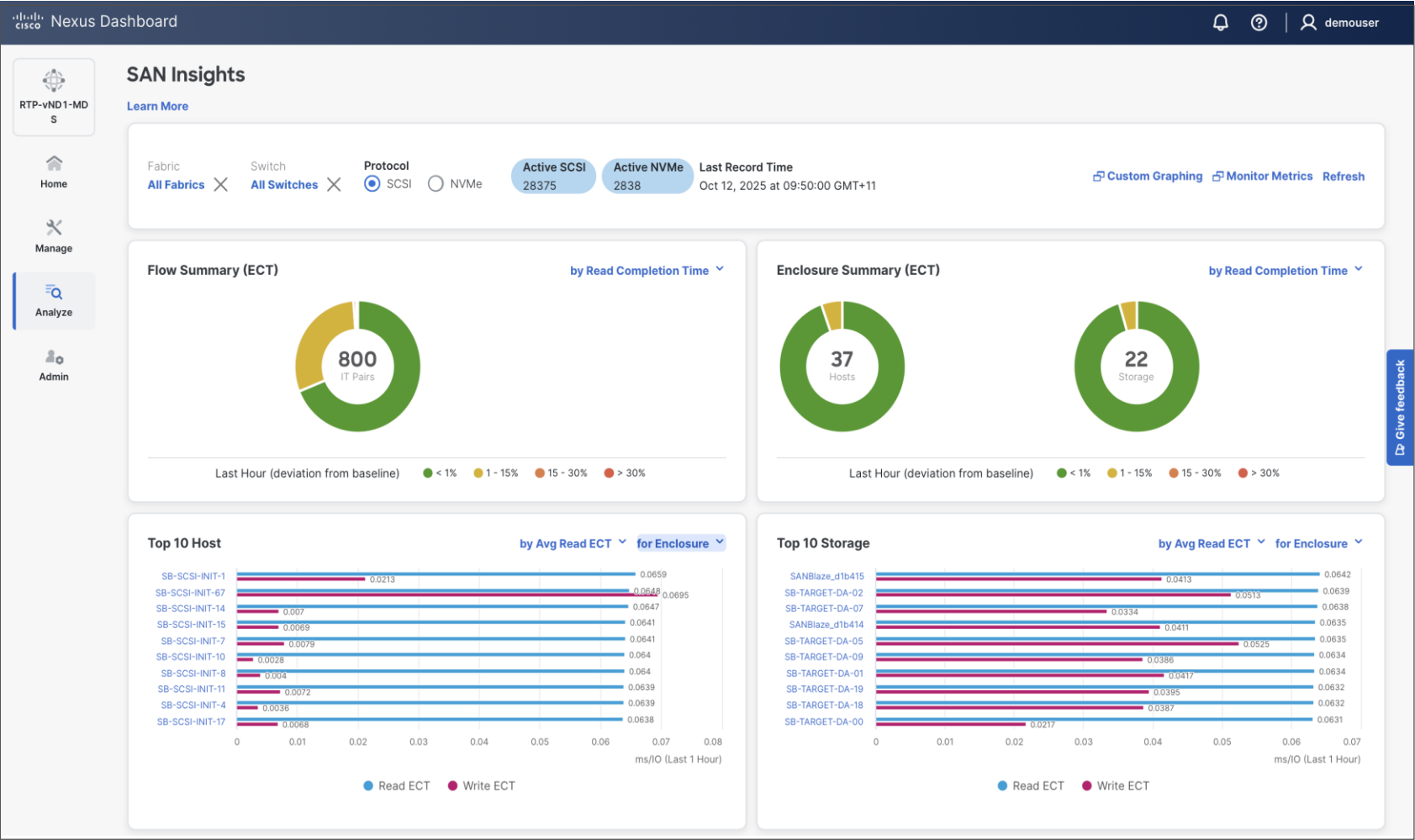
# Cisco SAN Analytics flow metrics

## Write I/O operation



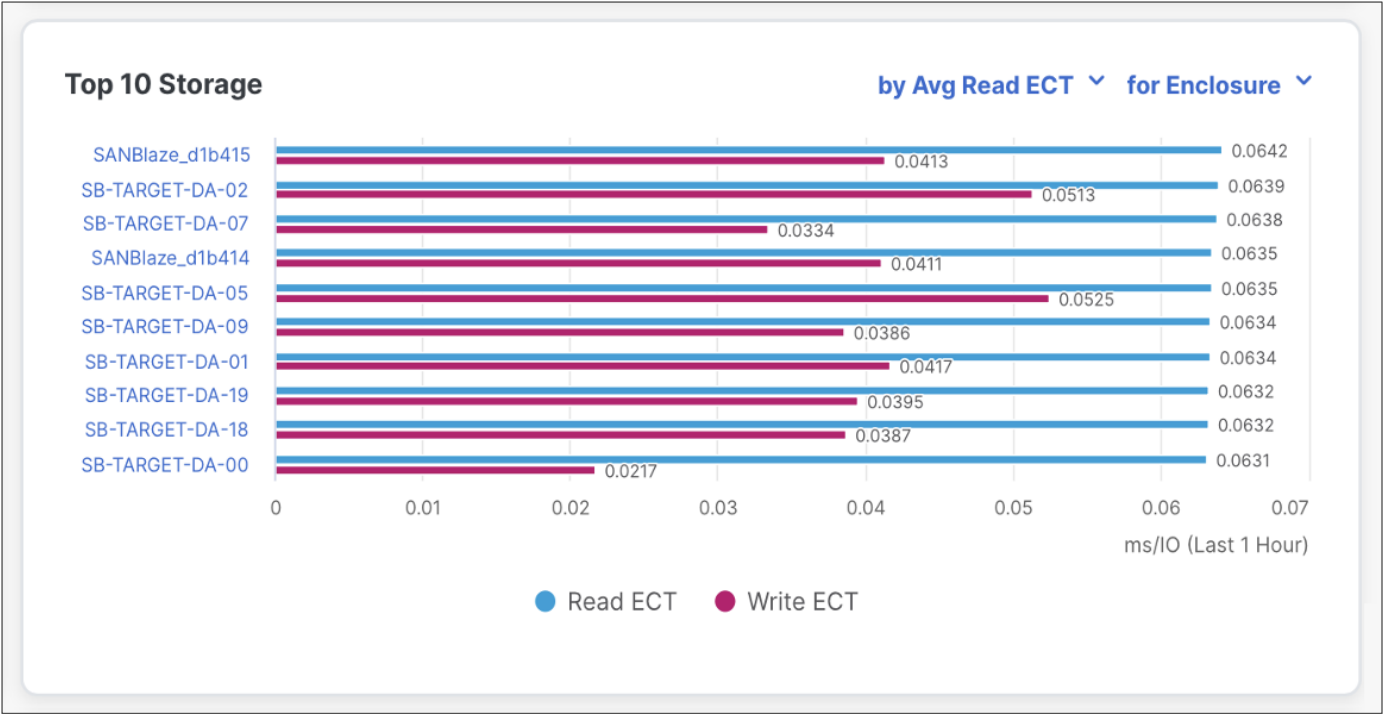
# Cisco Nexus Dashboard SAN Insights

## Dashboard View



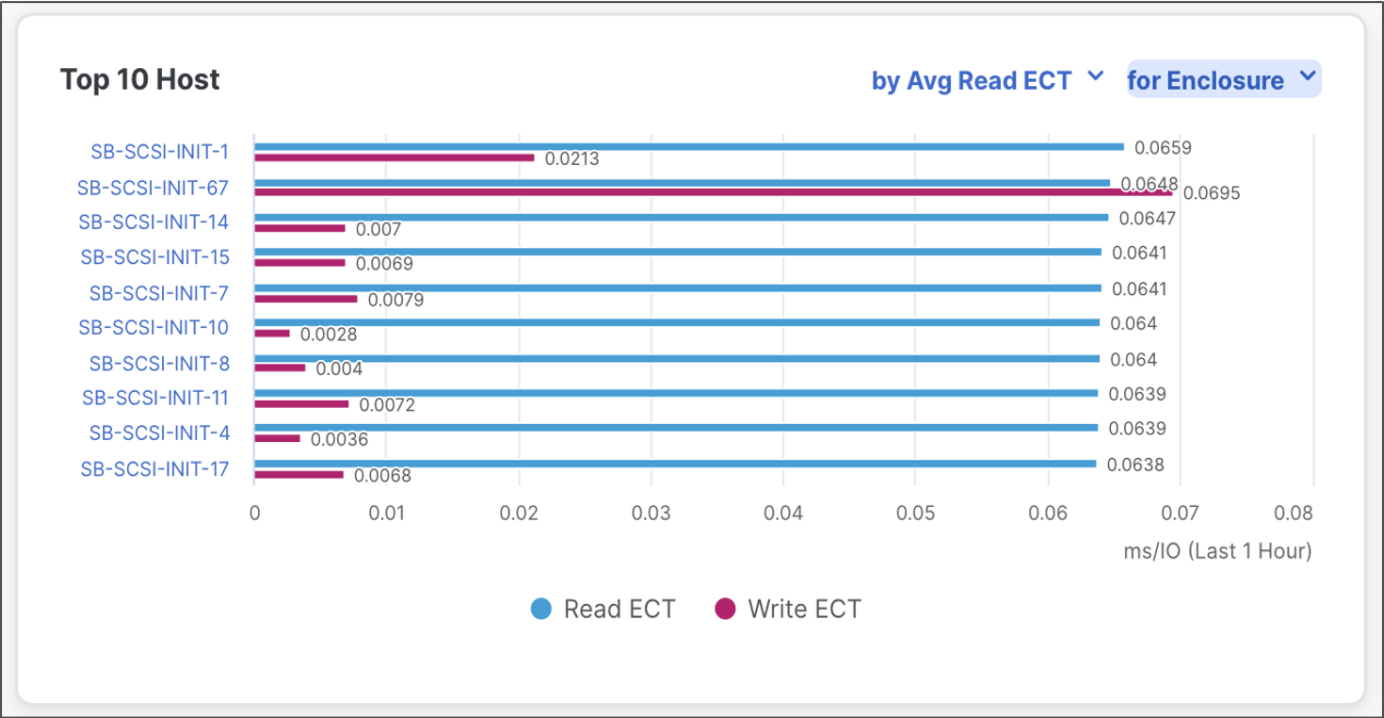
# Cisco Nexus Dashboard SAN Insights

## Dashboard View



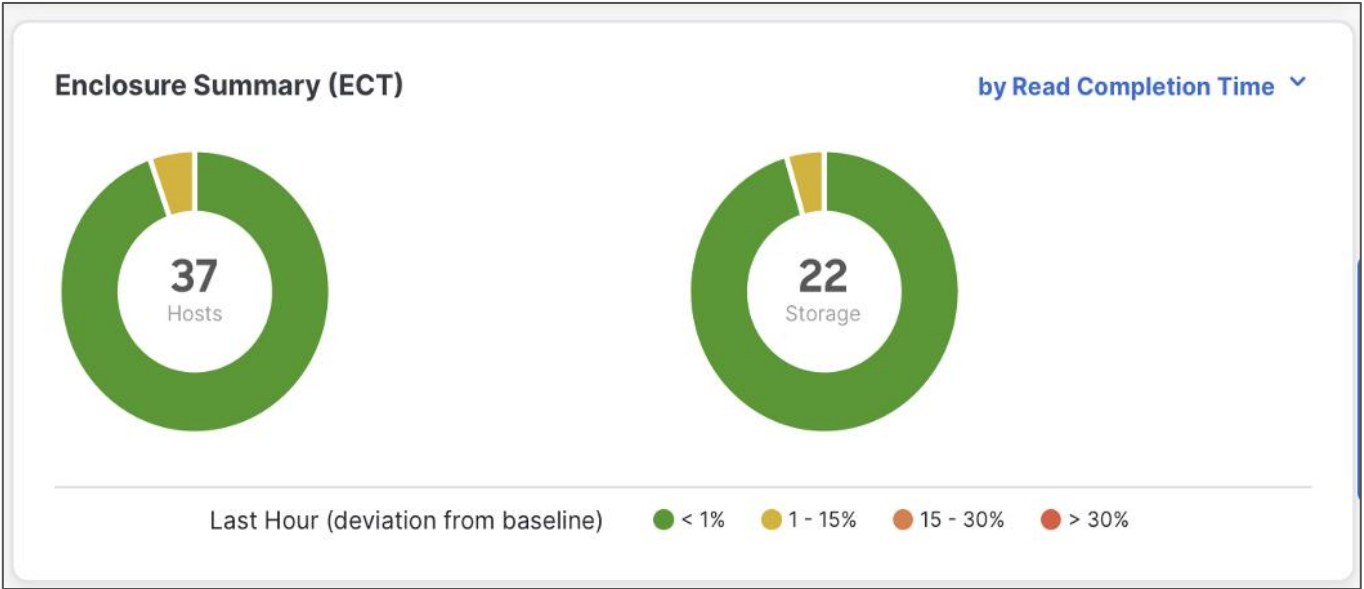
# Cisco Nexus Dashboard SAN Insights

## Dashboard View



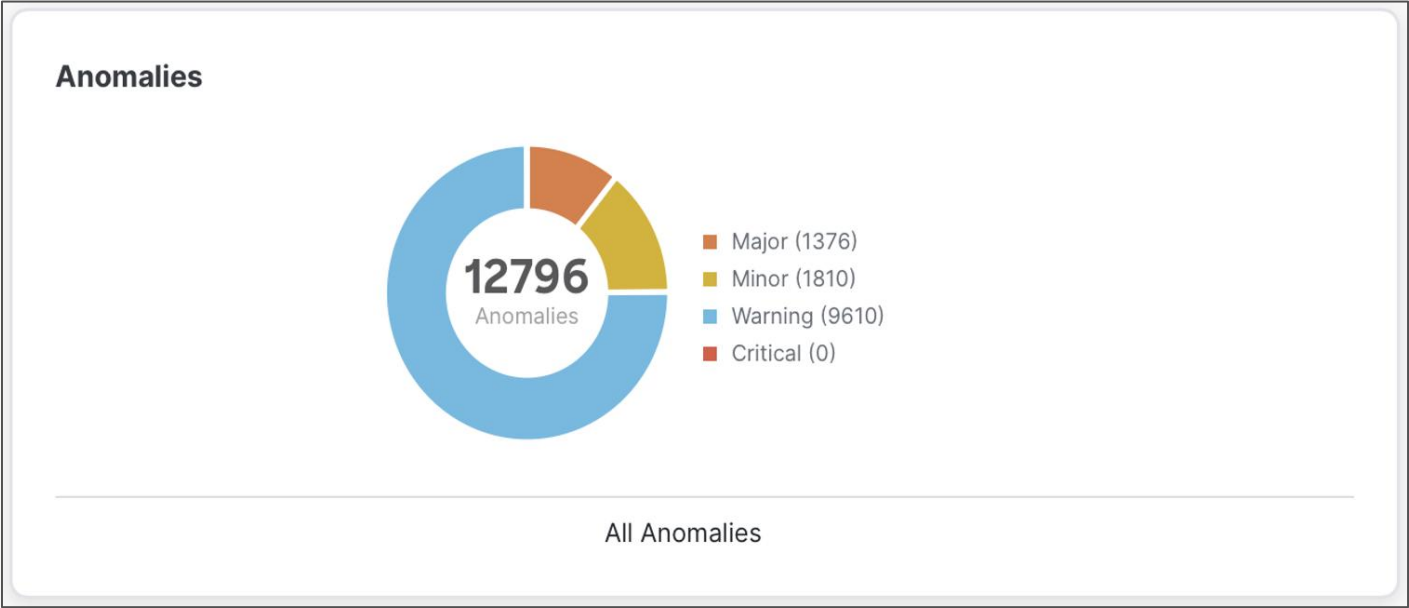
# Cisco Nexus Dashboard SAN Insights

## Dashboard View

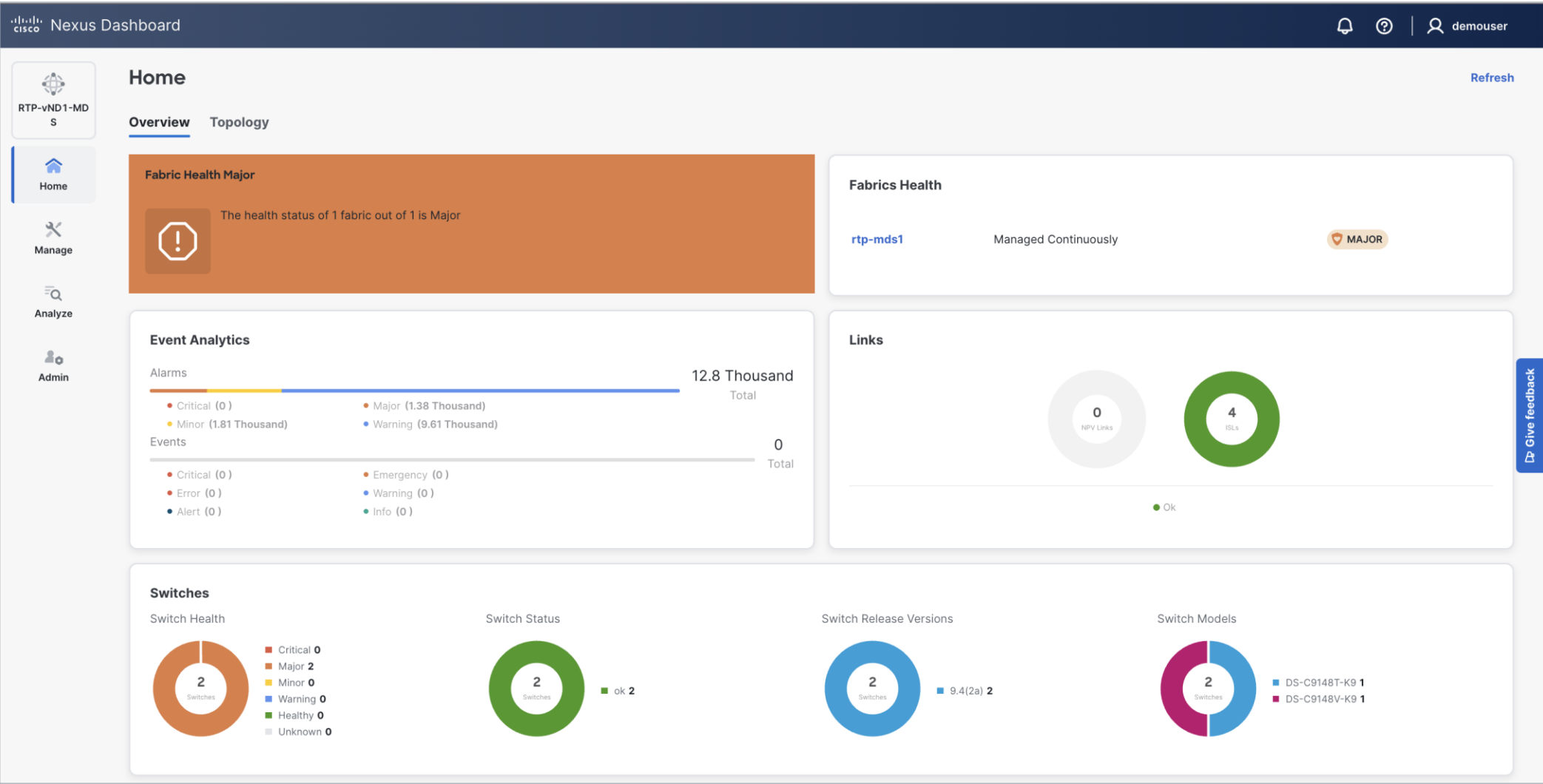


# Cisco Nexus Dashboard SAN Insights

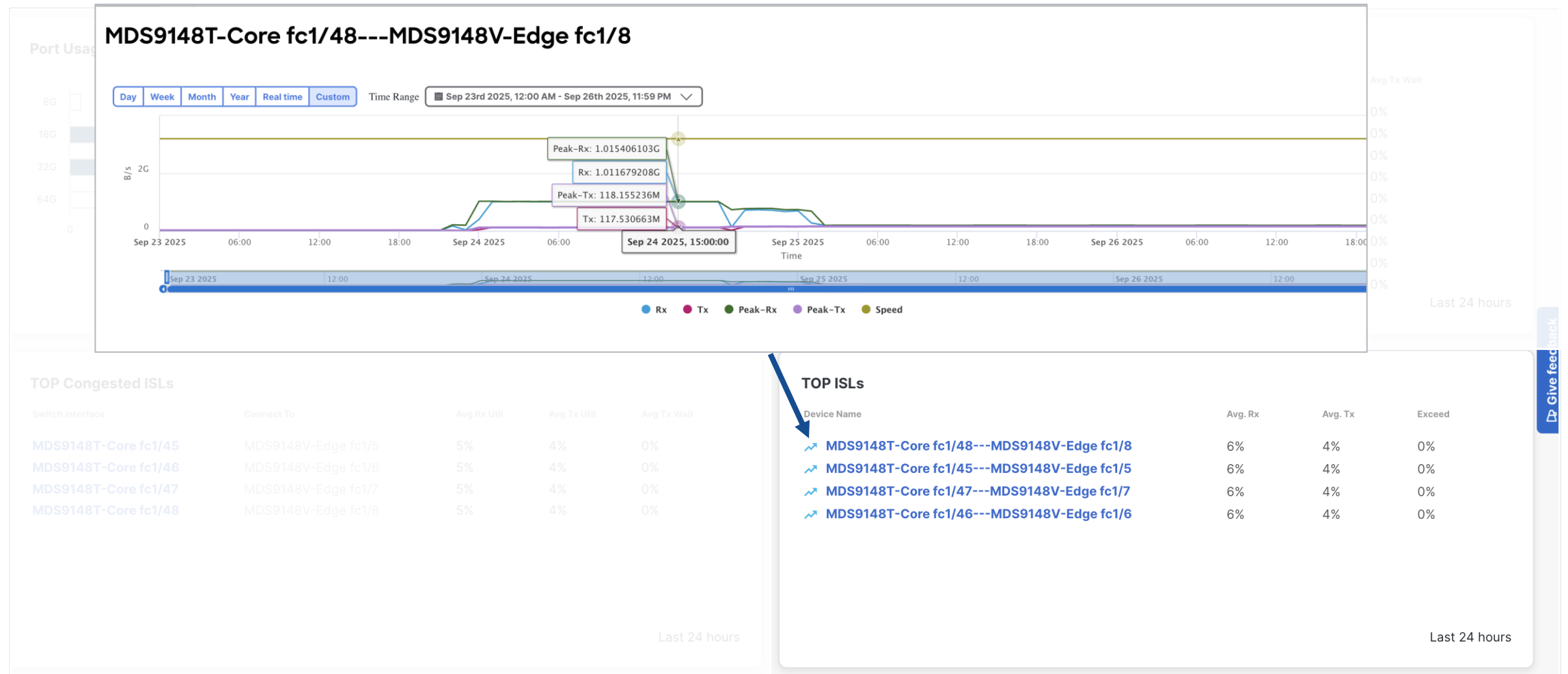
## Dashboard View



# Nexus Dashboard for SAN Controller – Dashboard



## Monitor ISL performance



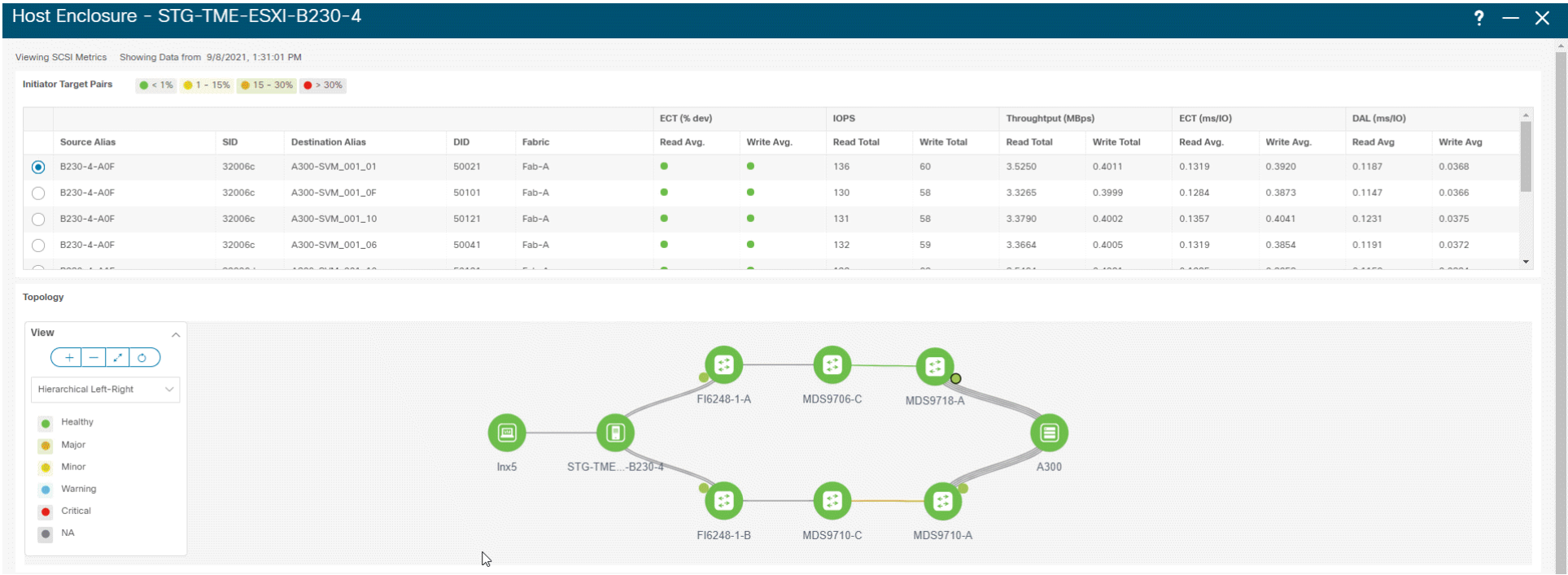
# Nexus Dashboard for SAN Controller

Nexus Dashboard provides online **congestion analysis**, and displays list of devices with potential slow drain issues



# Nexus Dashboard for SAN Controller

Cisco UCS and VM traffic visibility using Nexus Dashboard



## End-to-end visualisation

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

## Traffic trends and seasonality

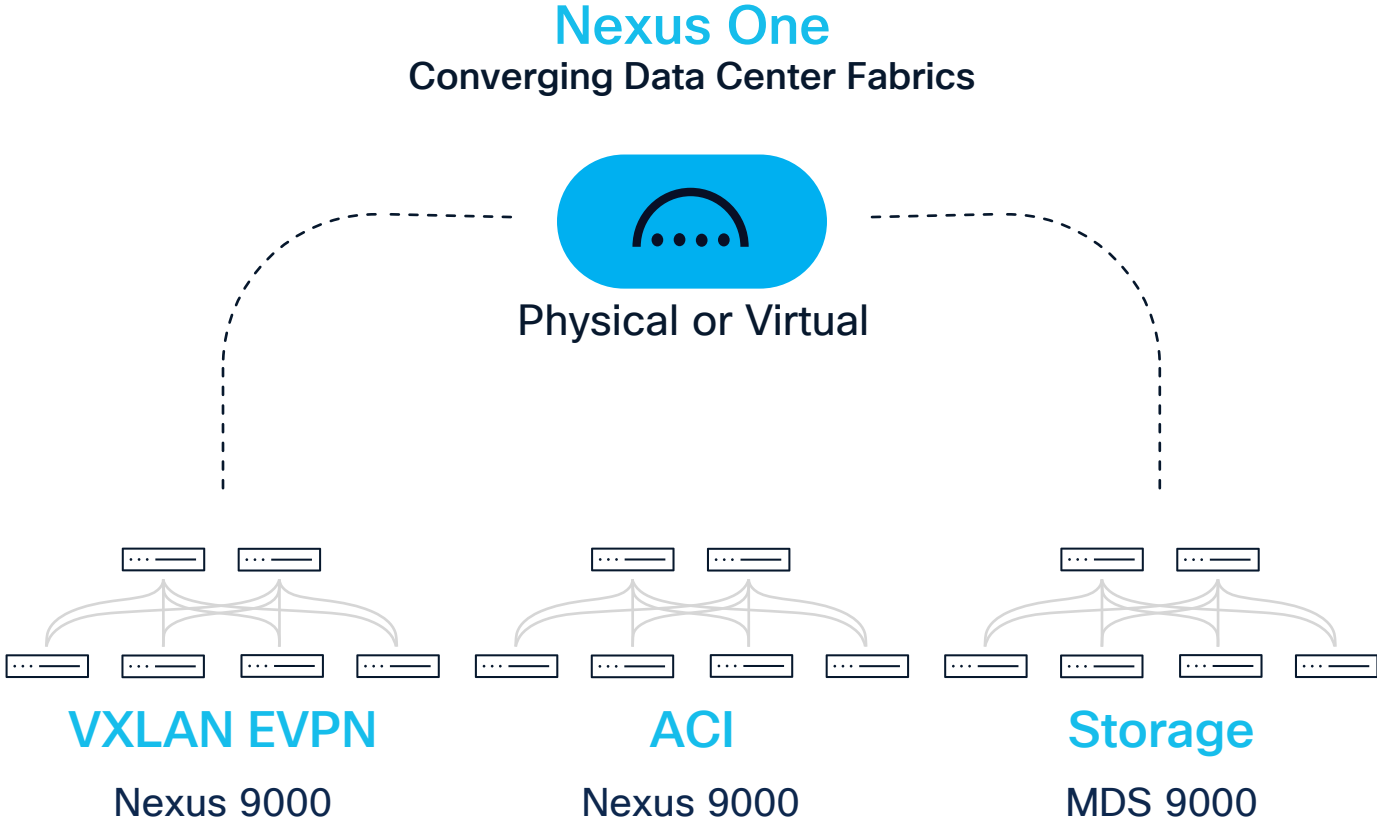
For every vNIC/vHBA and service profile

## Inventory

Server memory, CPU, serial numbers, etc.

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

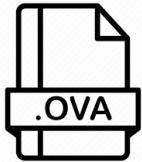
# Cisco Nexus Dashboard



# Available form factors



.iso



.ova

Virtual



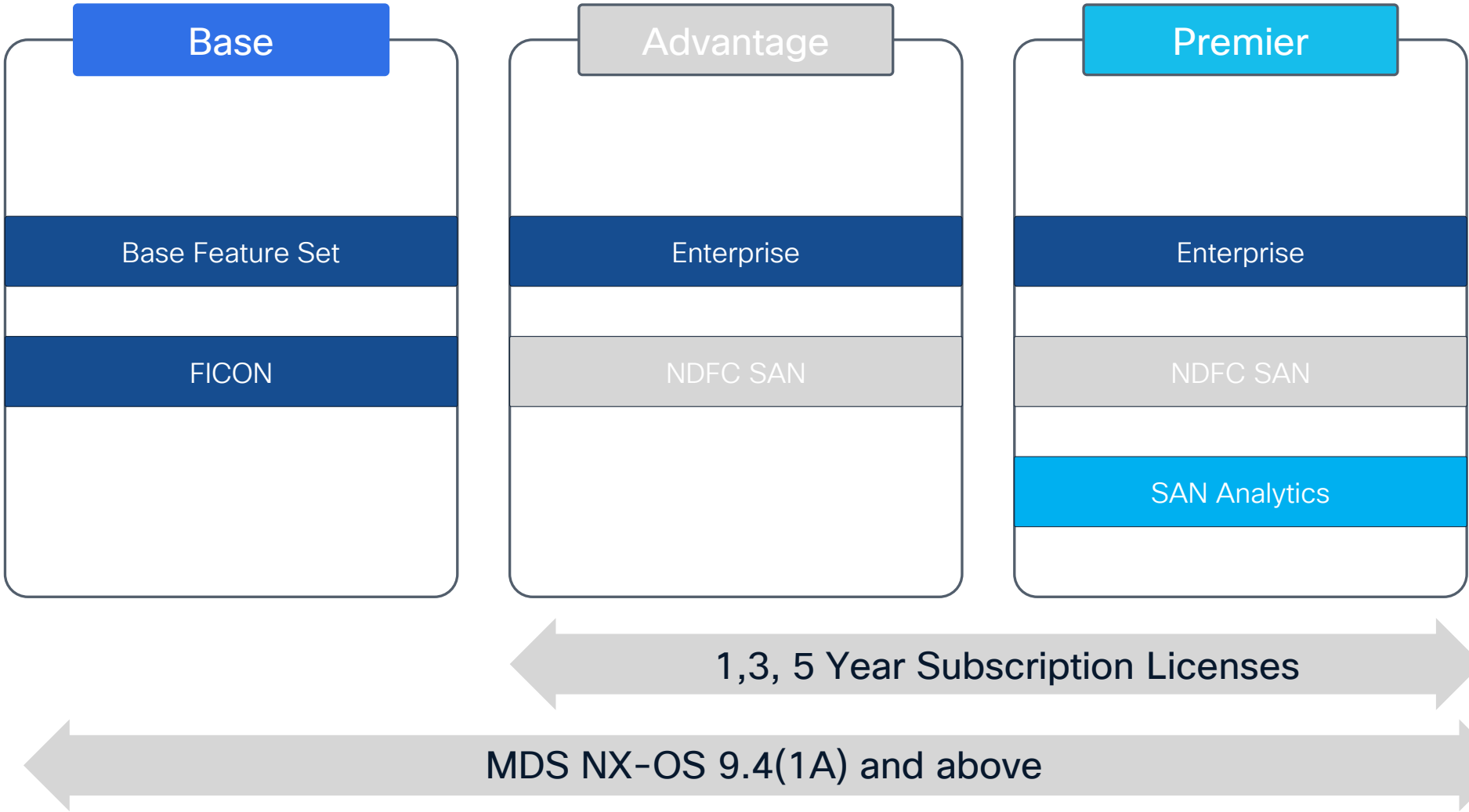
.qcow2



Amazon Machine  
Image (AMI)

AWS

# Cisco MDS Subscription License Tiers



# MDS Software Features and Licensing



Reference Slide

| Feature                                                | No License (Base) | Advantage License | Premier License |
|--------------------------------------------------------|-------------------|-------------------|-----------------|
| <b>MDS and Network Features</b>                        |                   |                   |                 |
| MDS Smart Zoning                                       | ✓                 | ✓                 | ✓               |
| MDS Congestion Isolation                               | ✓                 | ✓                 | ✓               |
| Cisco MDS Dynamic Ingress Rate Limiting (DIRL)         | ✓                 | ✓                 | ✓               |
| MDS FPIN                                               | ✓                 | ✓                 | ✓               |
| MDS SPAN                                               | ✓                 | ✓                 | ✓               |
| MDS Fport channel trunk                                | ✓                 | ✓                 | ✓               |
| MDS link-diag                                          | ✓                 | ✓                 | ✓               |
| MDS Port Monitor                                       | ✓                 | ✓                 | ✓               |
| MDS Port Tracking                                      | ✓                 | ✓                 | ✓               |
| MDS Dynamic Port VSAN Membership (DPVM)                | ✓                 | ✓                 | ✓               |
| MDS command schedule                                   | ✓                 | ✓                 | ✓               |
| <b>Management Protocols</b>                            |                   |                   |                 |
| LDAP                                                   | ✓                 | ✓                 | ✓               |
| SSH                                                    | ✓                 | ✓                 | ✓               |
| TACACS+                                                | ✓                 | ✓                 | ✓               |
| TELNET                                                 | ✓                 | ✓                 | ✓               |
| SFTP                                                   | ✓                 | ✓                 | ✓               |
| FCSP                                                   | ✓                 | ✓                 | ✓               |
| NTP                                                    | ✓                 | ✓                 | ✓               |
| NPV/NPIV                                               | ✓                 | ✓                 | ✓               |
| NXAPI                                                  | ✓                 | ✓                 | ✓               |
| HTTP Server                                            | ✓                 | ✓                 | ✓               |
| Virtual Machine Identification Server (VMIS)           | ✓                 | ✓                 | ✓               |
| Advanced traffic engineering– Quality of Service (QoS) | ✓                 | ✓                 | ✓               |
| FICON CUP                                              | ✓                 | ✓                 | ✓               |
| Fabric binding                                         | ✓                 | ✓                 | ✓               |
| FCIP encryption (9220i)                                | ✓                 | ✓                 | ✓               |

| Feature                                                | No License (Base) | Advantage License | Premier License |
|--------------------------------------------------------|-------------------|-------------------|-----------------|
| <b>Security Features</b>                               |                   |                   |                 |
| FCIP encryption (Director switches)                    |                   |                   |                 |
| VSAN-based access control                              |                   | ✓                 | ✓               |
| FC Security Protocol (FC-SP) authentication            |                   | ✓                 | ✓               |
| IKE digital certificates                               |                   | ✓                 | ✓               |
| Enhanced VSAN routing inter-VSAN routing               |                   | ✓                 | ✓               |
| IVR Network Address Translation over FC                |                   | ✓                 | ✓               |
| Zone-based traffic prioritizing                        |                   | ✓                 | ✓               |
| Zone-based FC QoS                                      |                   | ✓                 | ✓               |
| Extended BB_Credits                                    |                   | ✓                 | ✓               |
| Fibre Channel write acceleration                       |                   | ✓                 | ✓               |
| Fabric binding for Fibre Channel                       |                   | ✓                 | ✓               |
| Cisco TrustSec Fibre Channel Link Encryption           |                   | ✓                 | ✓               |
| <b>Analytics and Management Tools</b>                  |                   |                   |                 |
| NDFC graphical management tool                         |                   | ✓                 | ✓               |
| SAN Insights                                           |                   |                   | ✓               |
| SAN Analytics anomaly detection and alerting by policy |                   |                   | ✓               |
| Real-time Flow Analytics                               |                   |                   | ✓               |
| Host and Storage Views                                 |                   |                   | ✓               |
| 80+ SAN Analytics metrics                              |                   |                   | ✓               |
| SCSI and NVMe Flow Visibility                          |                   |                   | ✓               |
| <b>Integration Features</b>                            |                   |                   |                 |
| ECT / DAL / HRL                                        |                   |                   | ✓               |
| Virtana Integration                                    |                   |                   | ✓               |
| VMID Integration                                       |                   |                   | ✓               |
| On-switch and off-switch analytics data access         |                   |                   | ✓               |
| SQL-like Query Access                                  |                   |                   | ✓               |
| gRPC streaming API                                     |                   |                   | ✓               |

\* FICON functionality requires a FICON license on MDS NX-OS 8.x FICON qualified releases. On MDS NX-OS 9.x release train, 9.4(1A) onwards, FICON functionality is included in the MDS base switch software for FICON qualified releases, and it does not require a FICON license.

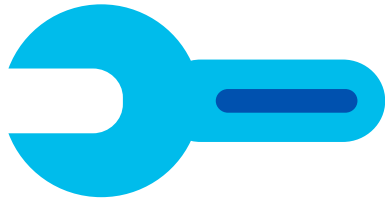
# Summary

# Summary

Reactive

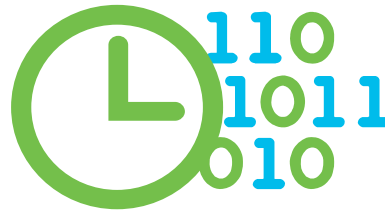
Proactive

Predictive



Detecting SAN  
congestion

(TxWait, RxWait, Tx-datarate)



Preventing SAN  
congestion

(Dynamic ingress rate limiting)



Predicting SAN  
congestion

(SAN analytics and insights)

# Further References



Reference Slide

## Whitepapers

### **Identifying SAN Congestion Victims with Cisco MDS RxWait Counter**

<https://www.cisco.com/c/en/us/td/docs/dcn/whitepapers/identifying-san-congestion-victims-with-cisco-mds-rxwait-counter.html>

### **Slow-Drain Device Detection, Troubleshooting, and Automatic Recovery**

<https://www.cisco.com/c/dam/en/us/products/collateral/storage-networking/mds-9700-series-multilayer-directors/whitepaper-c11-737315.pdf>

### **Monitoring and Alerting in SAN Fabric with Cisco MDS 9000 Series Switches and NDFC**

<https://www.cisco.com/c/en/us/td/docs/dcn/whitepapers/monitoring-and-alerting-in-san-fabric-with-mds9000-and-ndfc.html>

### **Design a Reliable and Highly Available Fibre Channel SAN**

<https://www.cisco.com/c/dam/en/us/td/docs/dcn/whitepapers/design-a-reliable-and-highly-available-fibre-channel.pdf>

## Lab

### **Explore Cisco Nexus Dashboard 4.1 for MDS 9000**

<https://dcloud2-syd.cisco.com/content/profile/explore-cisco-nexus-dashboard-41-for-mds9000>

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**Thank you**

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