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# SAN Overview: How Fibre Channel Hosts & Targets Really Communicate

**Live Webcast**

**September 23, 2021**

**10:00 am PT / 1:00 pm ET**

# Today's Presenters

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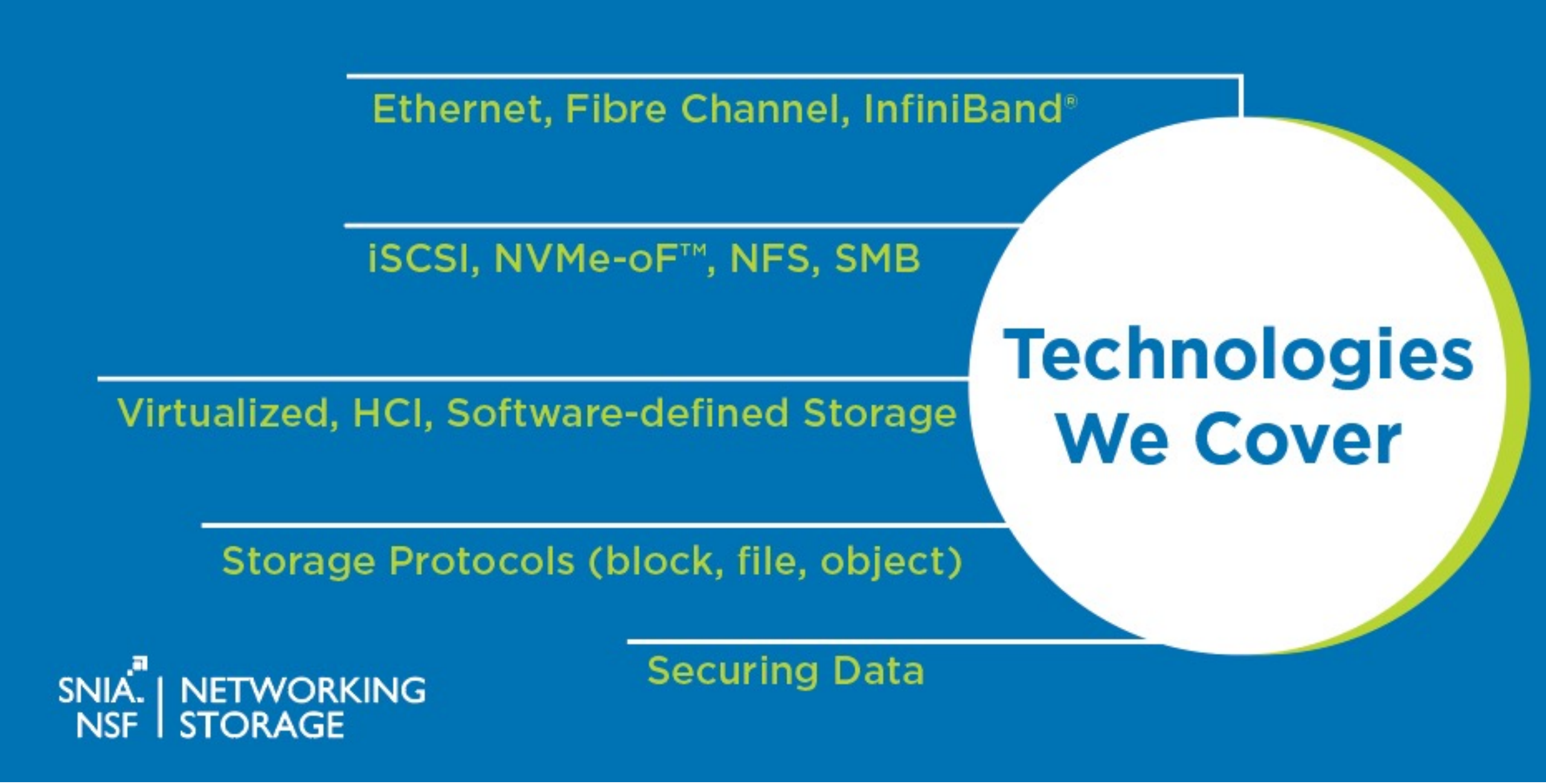

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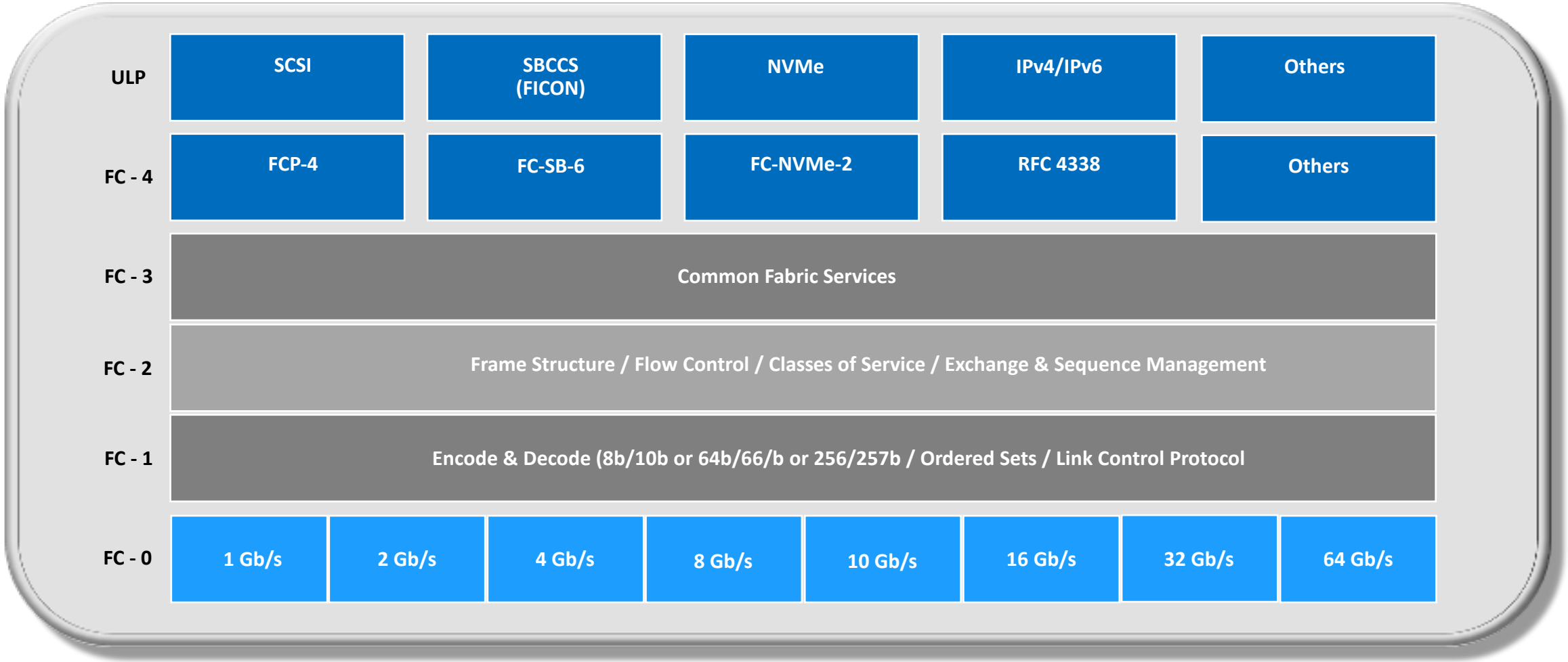
# Agenda

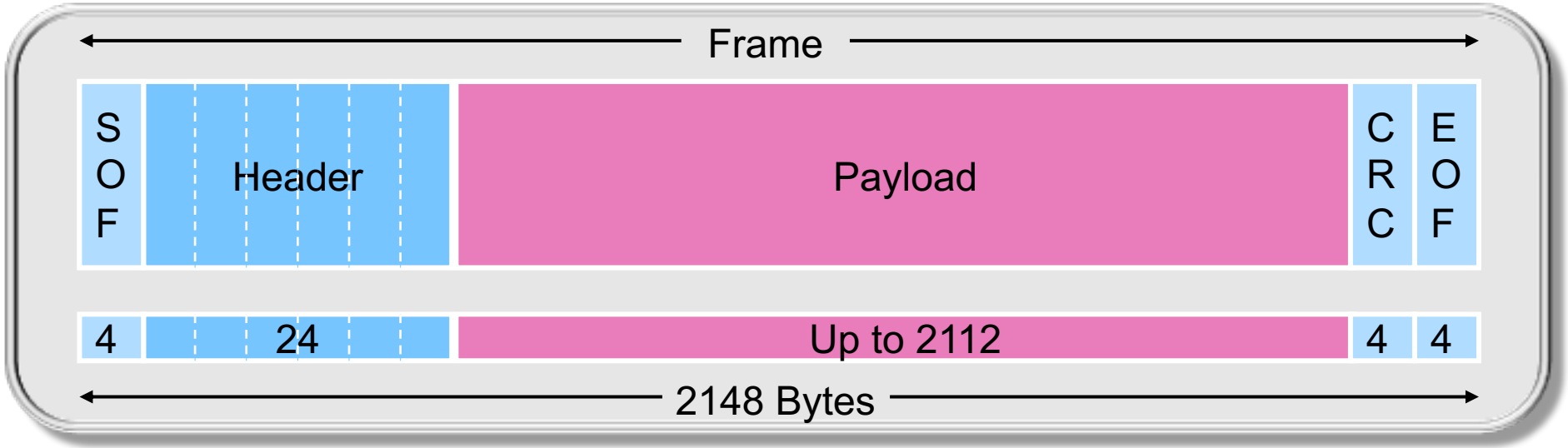
- Fibre Channel Stack
- Fibre Channel Link Initialization
- Fibre Channel Port Types
- Fibre Channel Flow Control
- Host/Target Logins
- Host/Target IO

# The Fibre Channel Stack

# Fibre Channel Structure



# Fibre Channel Frame Format

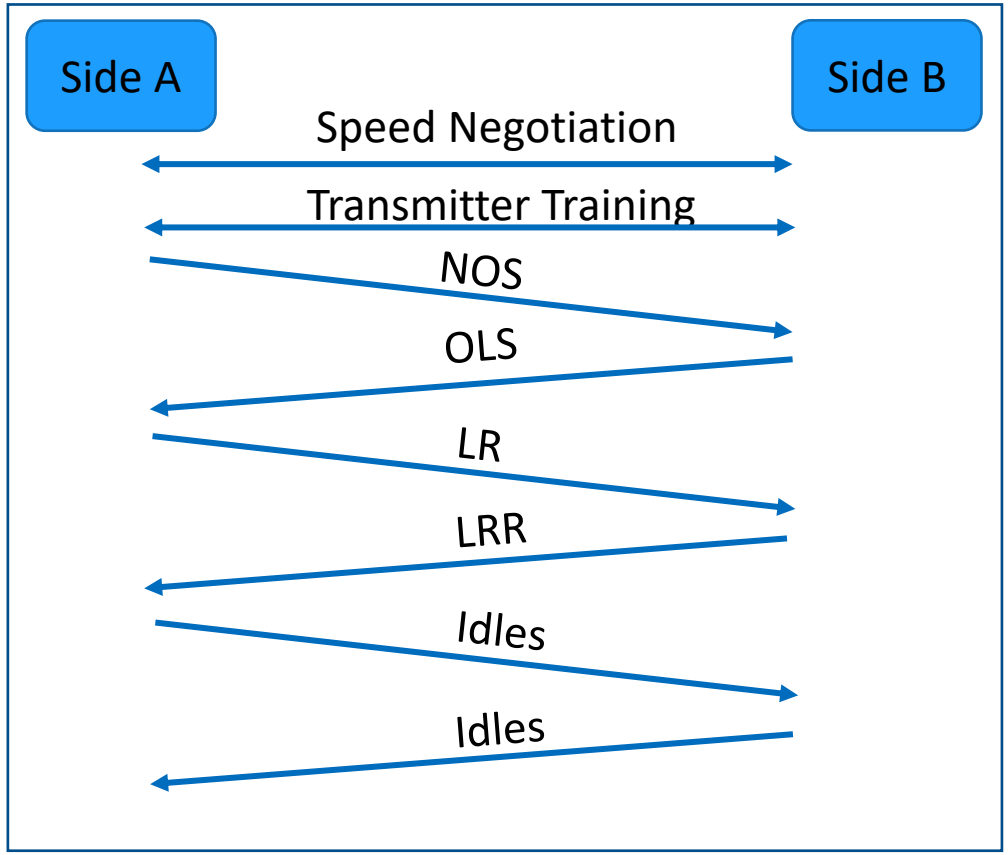



| | Word | Bits 31-24 | Bits 23-16 | Bits 15-8 | Bits 7-0 |
|---|---|---|---|---|---|
| HEADER | 0 | R_CTL | D_ID | | |
| | 1 | CS_CTL | S_ID | | |
| | 2 | TYPE | F_CTL | | |
| | 3 | SEQ_ID | DF_CTL | SEQ_CNT | |
| | 4 | OX_ID | | RX_ID | |
| | 5 | Parameters | | | |
| Payload | 6 to 534 | Payload | | | |

# Link Initialization

# Link Initialization

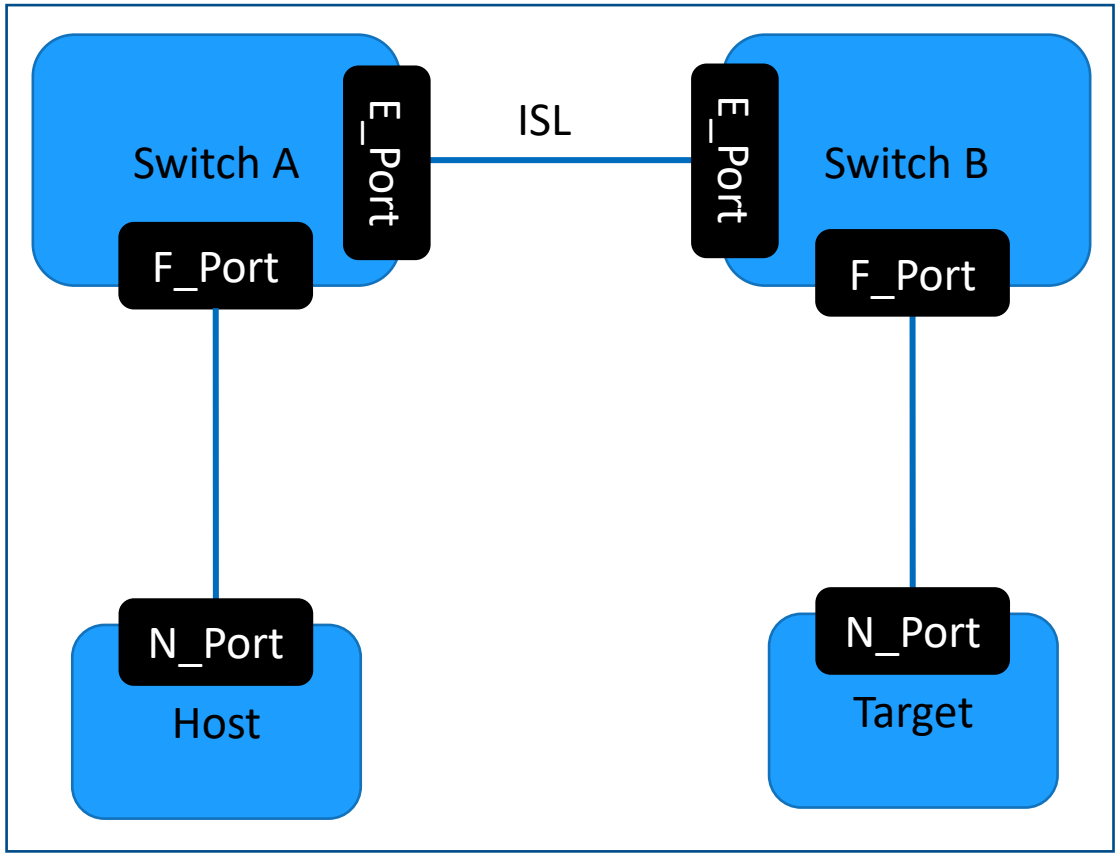
- Fibre Channel links initialize via a 6 (or 7 step) process:
  - Speed Negotiation
  - Transmitter Training – Forward Error Correction(FEC)
  - Not Operational Sequence(NOS)
  - OffLine Sequence(OLS)
  - Link Reset(LR)
  - Link Reset Response(LRR)
  - IDLE



# Port Types

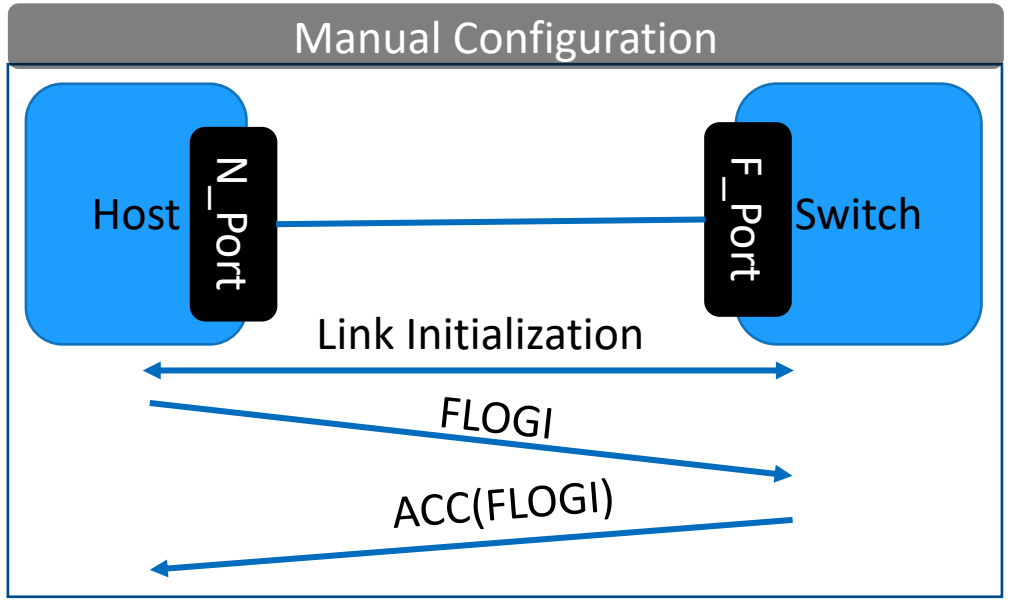
# Port Types

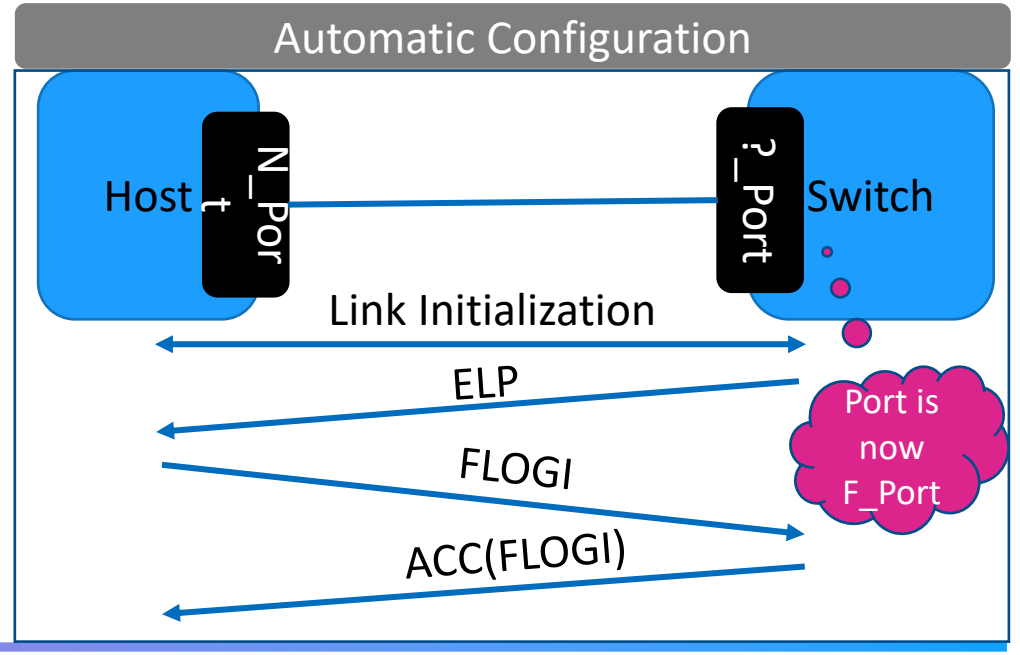
- N_Port – Node Port
  - End device(HBA) port
  - Host or Target
- F_Port – Fabric Port
  - Switch port connecting to N_Port
- E_Port – Expansion Port
  - Switch port connecting another switch
  - Inter Switch Link(ISL)



# Port Type Determination

- Host / Target port types are always N_Port
- Switch port types can be manually configured or automatically determined
- Manual
  - Switch port waits for FLOGI
  - N_Port transmits Fabric Login(FLOGI)
- Automatic
  - Switch port transmits ELP
  - Switch port waits for ELP or FLOGI



# Well Known Services

# Fibre Channel Addressing

- Fibre Channel uses 3 byte layer 3 addresses called N_Port IDs or FCIDs
  - Analogous to IP address
- The first byte of the FCID is the Domain ID of the switch
  - Analogous to IP Subnet
- There are a small number of Well Known Addresses(WKA) to send traffic to predefined services
  - 0xFFFFFE – Fabric Login Server – Destination of FLOGI
  - 0xFFFFFD – Fabric Controller – Destination of ELP
  - 0xFFFFFC – Fibre Channel Name Server(FCNS) – Destination of queries
  - 0xFFFFFA – Fibre Channel Management Server

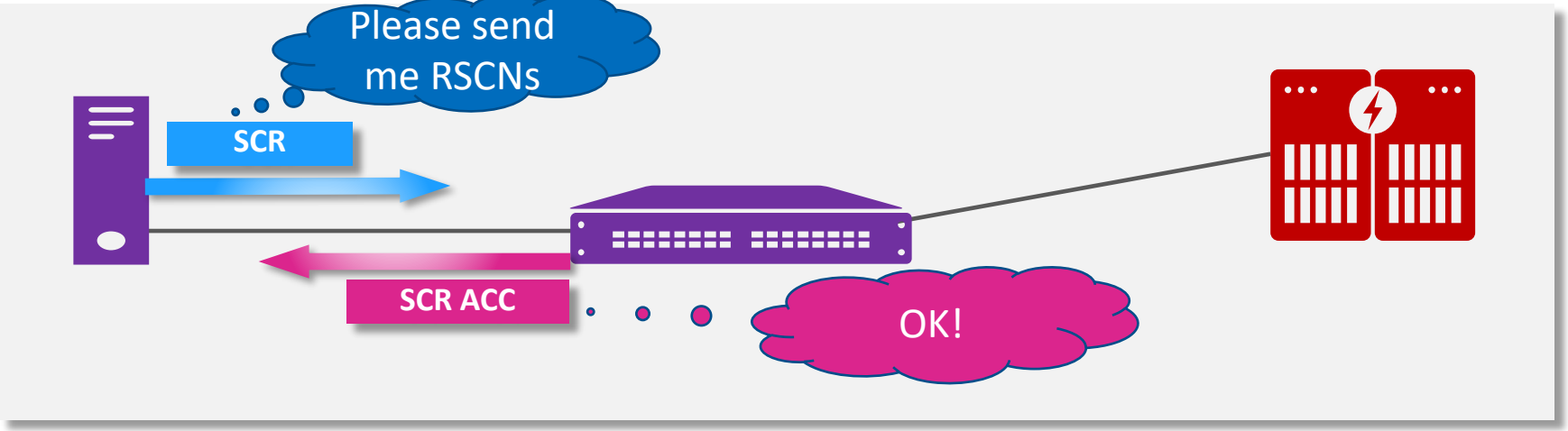
# Fabric Login(FLOGI) Processing

- A N_Port must log into the fabric to obtain an FCID
- This is a Fabric Login which occurs via the FLOGI
- Fabric Login(FLOGI) is transmitted by the N_port to the F_Port Server
- FLOGI contains various device specific parameters
- F_Port Server allocates FCID within its Domain and transmits Accept
- N_Port now has FCID and can communicate to other WKAs and end devices(if known or preconfigured)

# Fibre Channel Fabric Controller

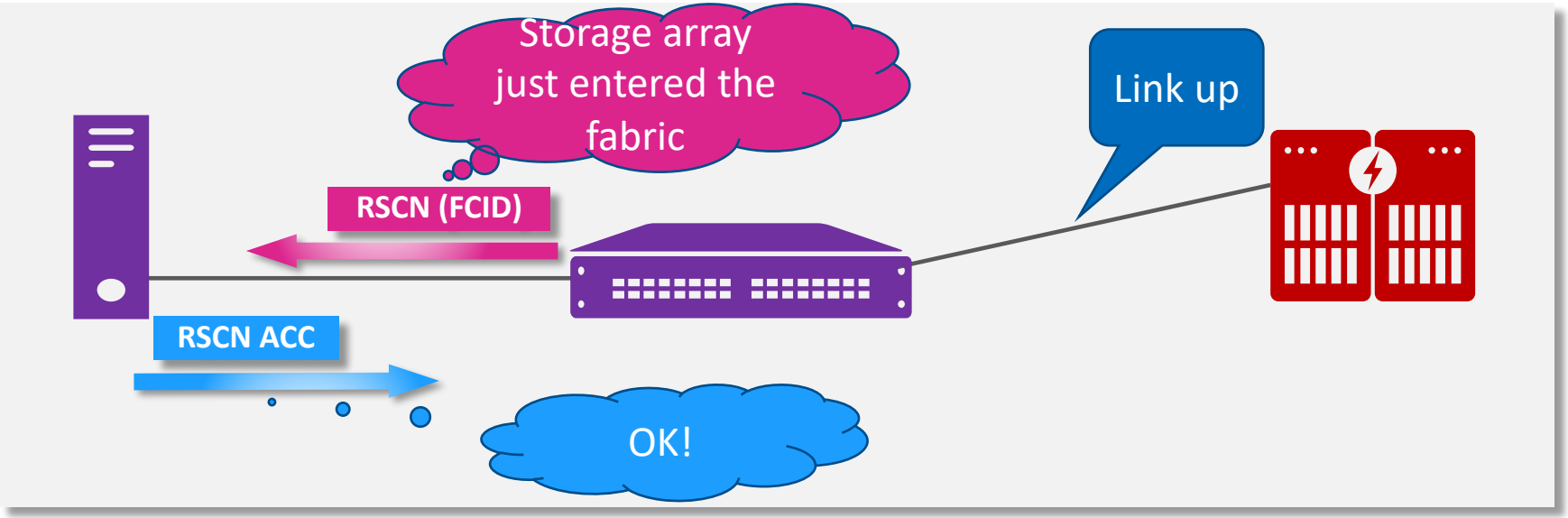
- Responsible for the Fabric operation
- Handles switch to switch (F-class) traffic
- FFFFFD
  - State Change Registration (SCR)
  - Registered State Change Notifications(RSCNs)

When devices enter and leave the fabric the switches send Registered State Change Notifications(RSCNs) to “interested” end devices



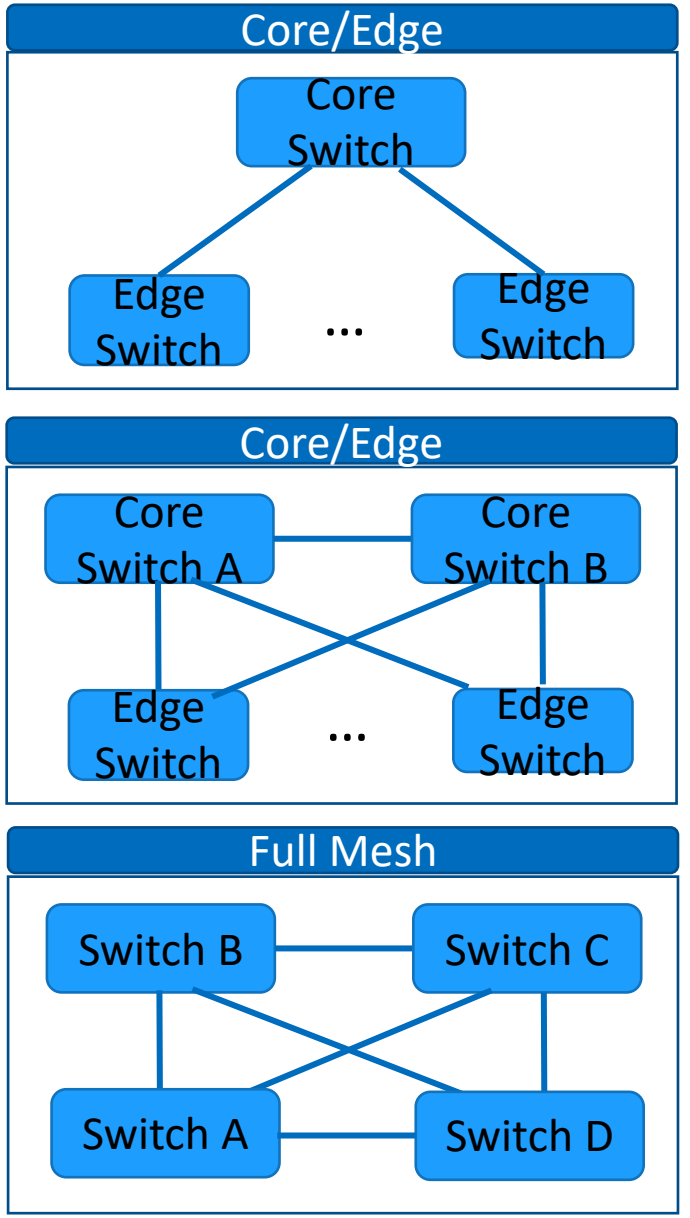
# Fibre Channel Fabric Controller

- When devices enter and leave the fabric, switches send Registered State Change Notifications(RSCNs) to “interested” end devices
- After receiving RSCNs end devices can do further FCNS queries



# Topologies

- FC allows for arbitrary topologies
- Fabric Shortest Path First(FSPF) routing protocol efficiently chooses correct path
- Allows theoretically 239 connected switches



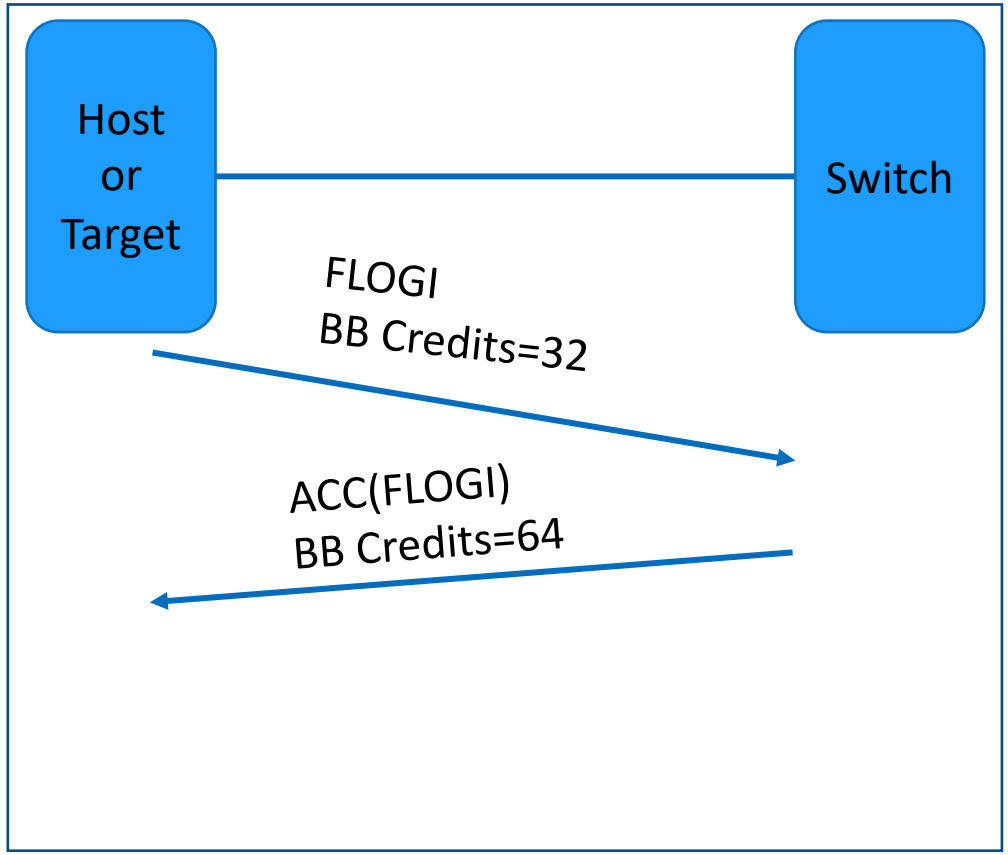
# Fibre Channel Flow Control

# Fibre Channel Flow Control

- All communication protocols implement some form of flow control
- Flow control equalizes data entering network with data exiting network
- If more data enters a network than the network can process then frame(packet) drops/data loss results
- Fibre Channel utilizes Buffer-to-Buffer flow control
- Buffer-to-Buffer flow control works by exchanging the number of receive buffers available on each side of the link
- Each side maintains knowledge of the number of available receive buffers the adjacent side of the link has
- A new frame is only transmitted when a receive buffer is available

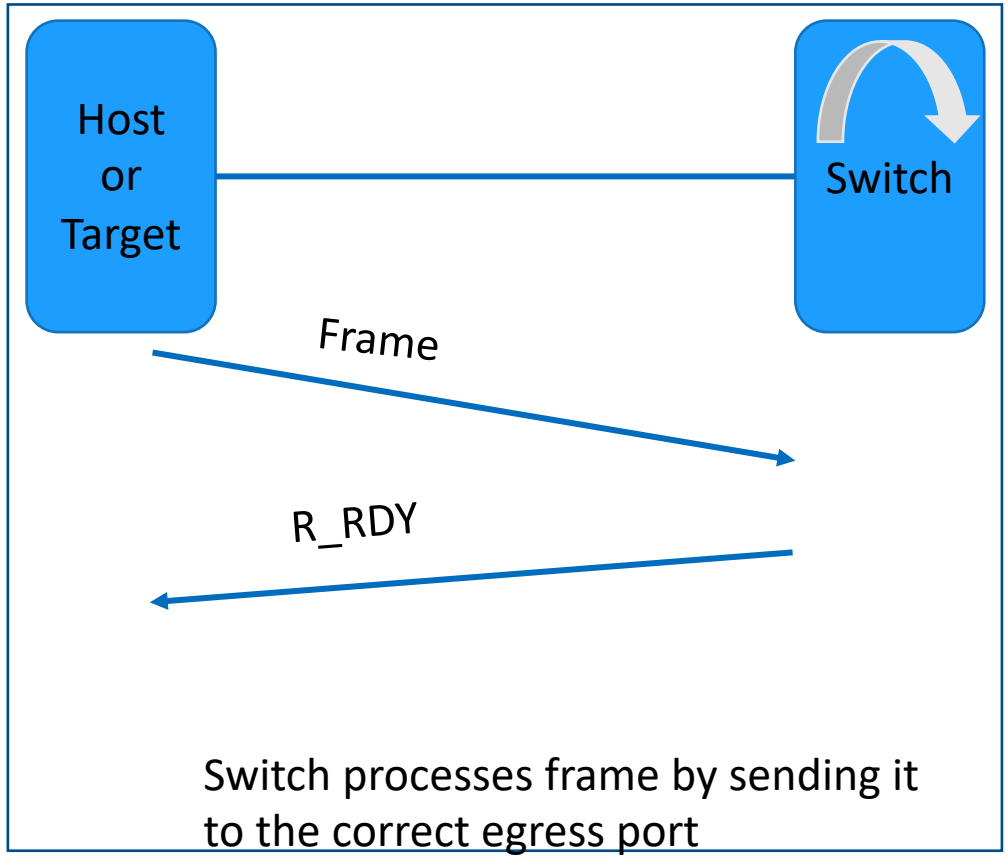
# Fibre Channel Flow Control

- Called Buffer to Buffer Credits
- Each side transmits the number of actual receive buffers it has
- Each side records the received value
- Values may be different
- No negotiation!



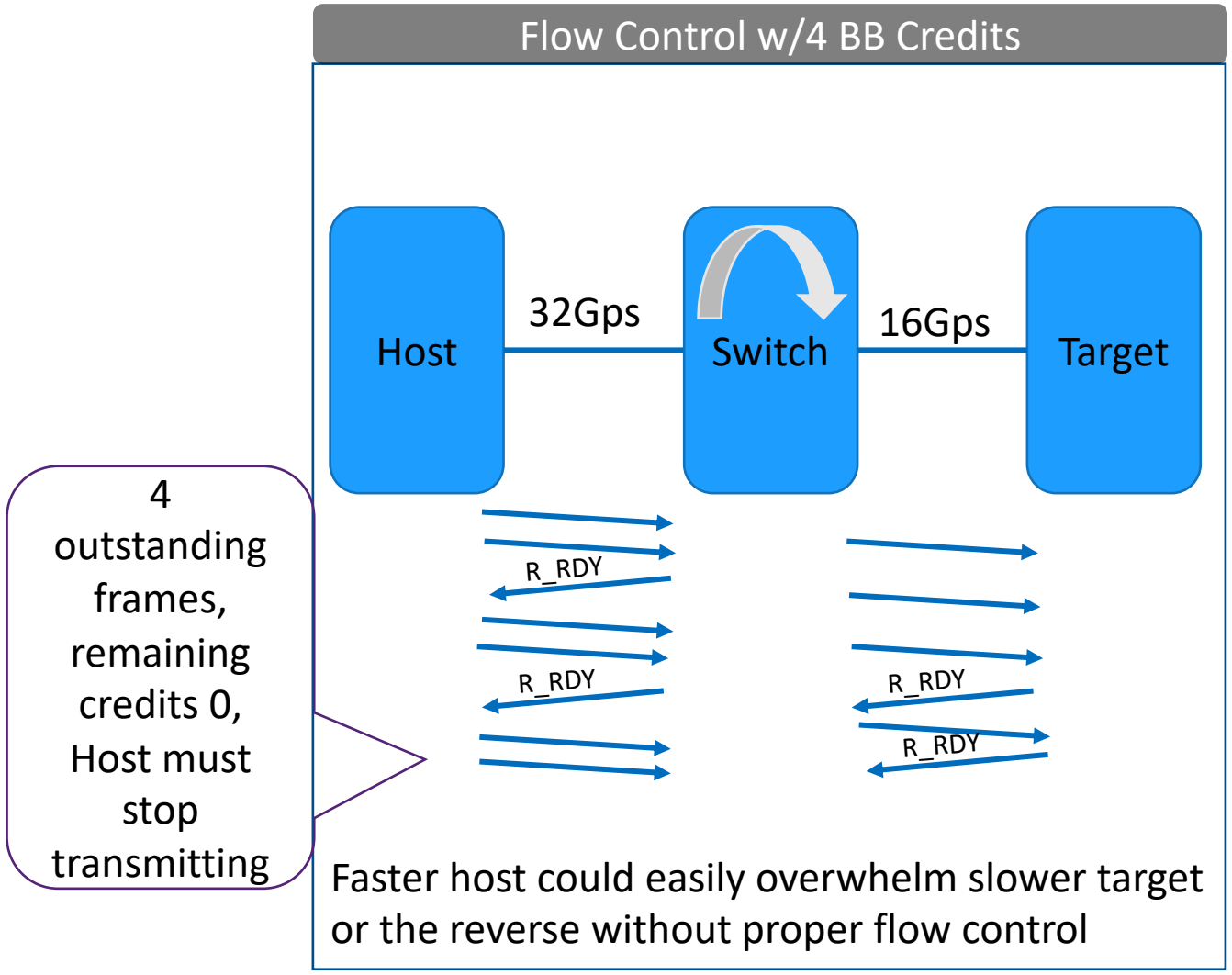
# Fibre Channel Flow Control

- R_RDY is called BB Credit
- Transmitting side transmits a frame if remaining credits is > 1
  - Remaining credits are decremented by 1
  - Frame is transmitted
  - If remaining credits is 0 then frame waits
- Receiving side receives frame and processes it.
  - Once received frame is processed and buffer location is cleared a R_RDY is transmitted back
- Transmitting side increments remaining credits by 1



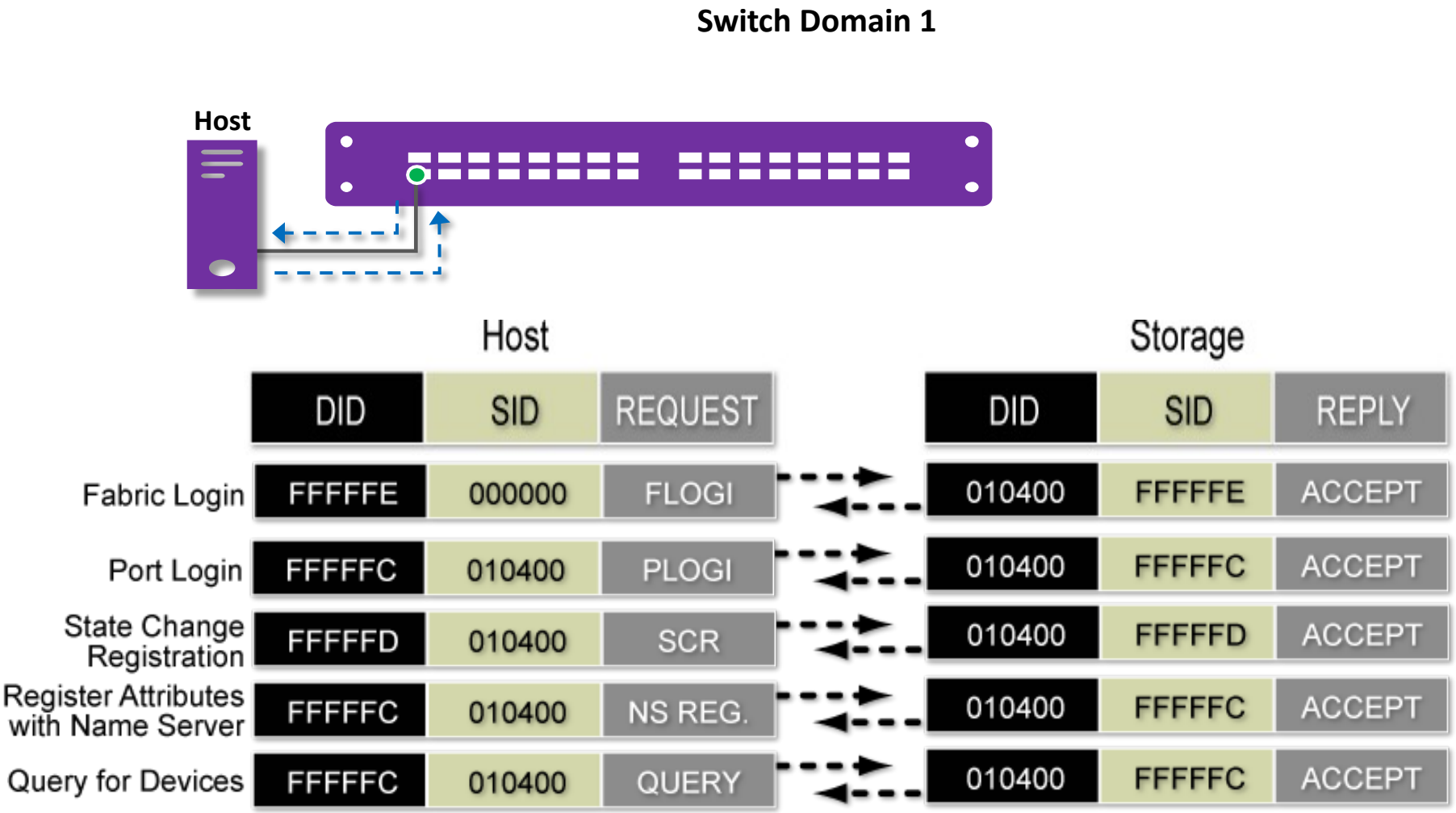
# Fibre Channel Flow Control

- A faster device could easily overwhelm a slower device
- Slowness might be because of
  - Different link speeds
  - Internal congestion
  - Device is simultaneously communicating with multiple devices
  - ISL congestion/overutilization



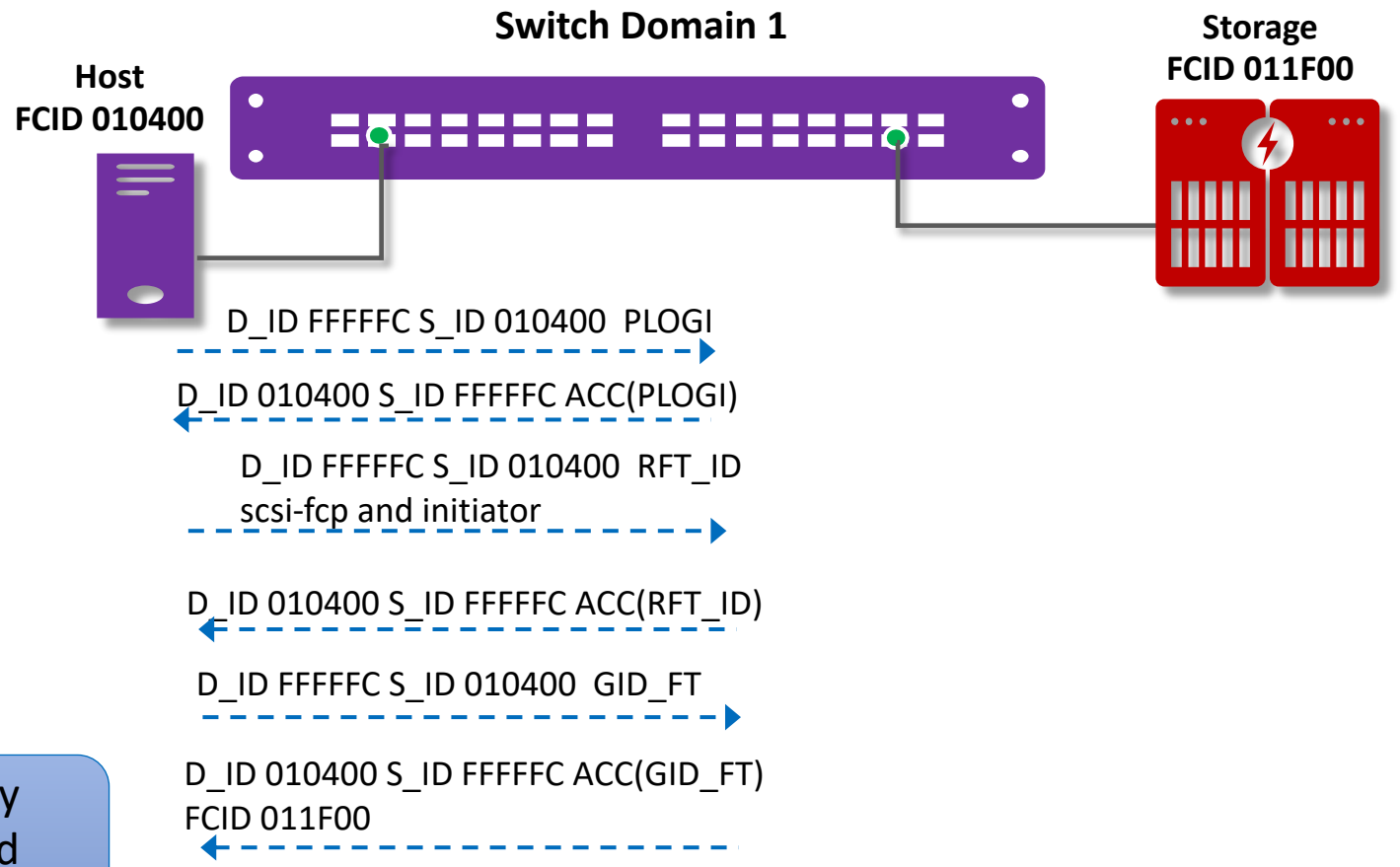
# Host/Target Logins

# Host Summary



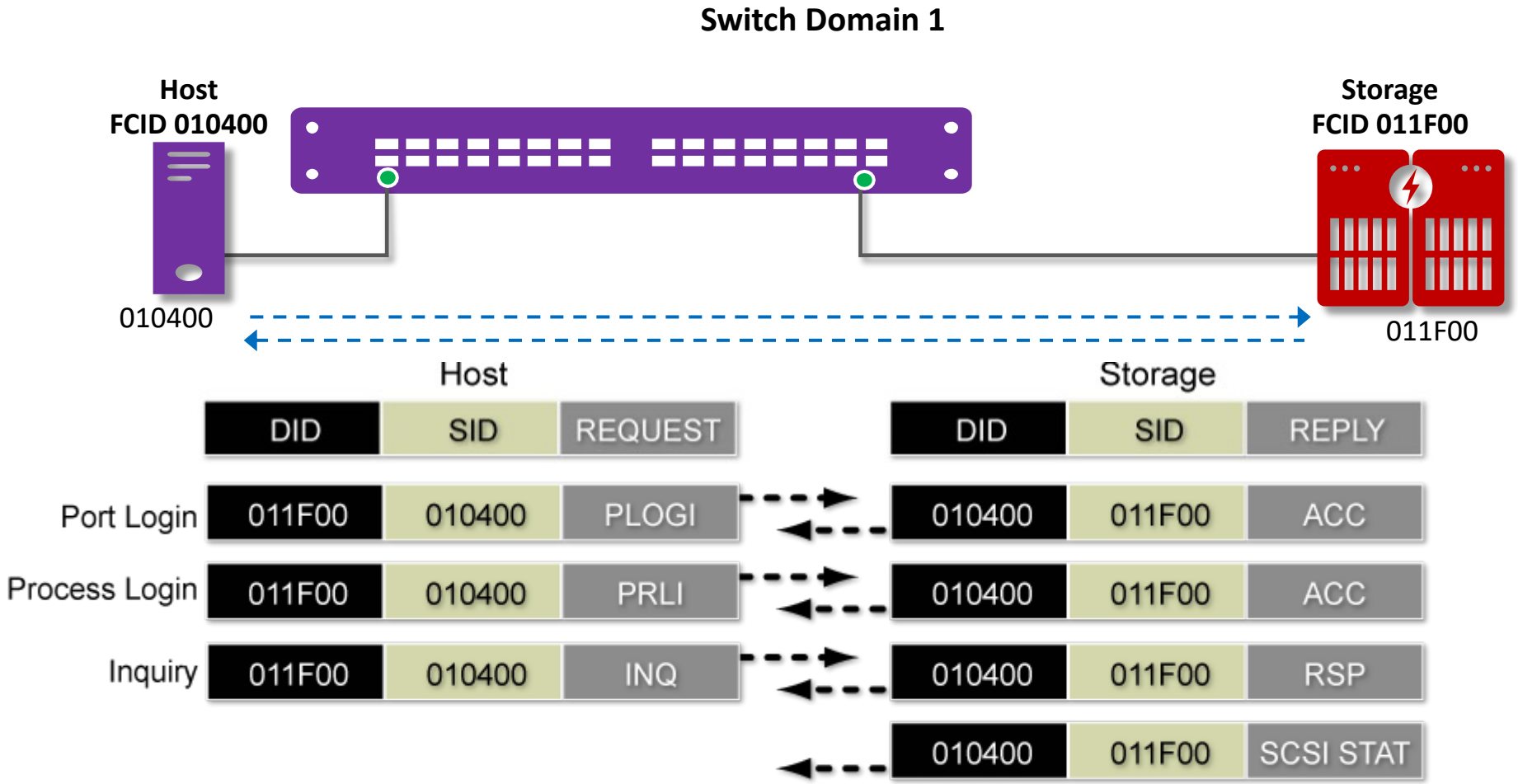
# FCNS Queries

1. Host first logs in to the FCNS using WKA 0xFFFFFC
2. Host will typically register that it supports scsi-fcp and is an initiator via RFT_ID (Register FC4 Types)
3. Host can then send in queries to determine who it is allowed to communicate with based on zoning
4. GID_FT is Get Port IDs by Feature Type
5. FCNS informs the Host that it can communicate with the FCID 011F00




Note: The above is one example. There are many different ways Hosts and Targets can register and query FCNS

# Host to Target Initialization

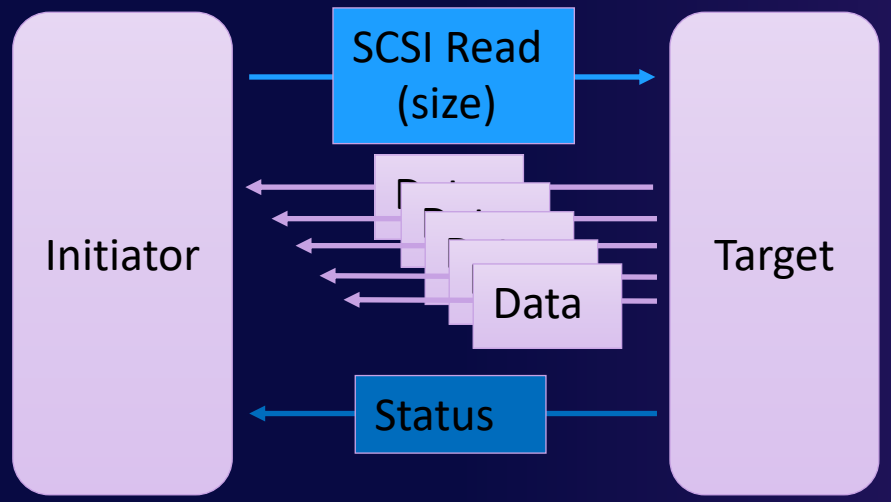


# Host/Target IO

# SCSI/NVMe Read IO Flow

A Read command requests data from the target

Initiator requests data from a block location and a size



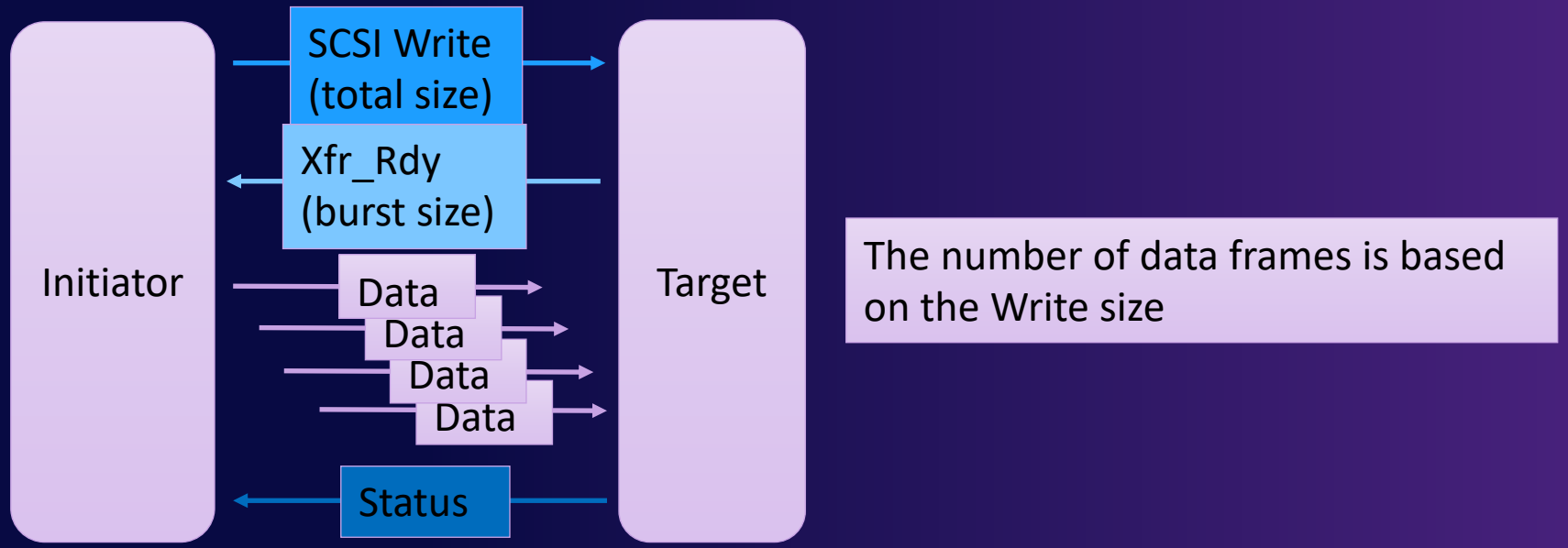

The number of data frames is based on the Read size

# SCSI/NVMe Write IO Flow

A write command sends data from the initiator to the target block location

The initiator controls the total size of the write command

The target controls the size of each burst




The number of data frames is based on the Write size

# Summary

- Fibre Channel provides transport that is:
  - Purpose built for SCSI/NVMe IO
  - High performance
  - Low latency
  - Lossless
  - Easily expanded
  - Feature rich
- Fibre Channel flow control equalizes received data with transmitted data without dropping frames
- Initiators can communicate with targets without knowing the underlying topology

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