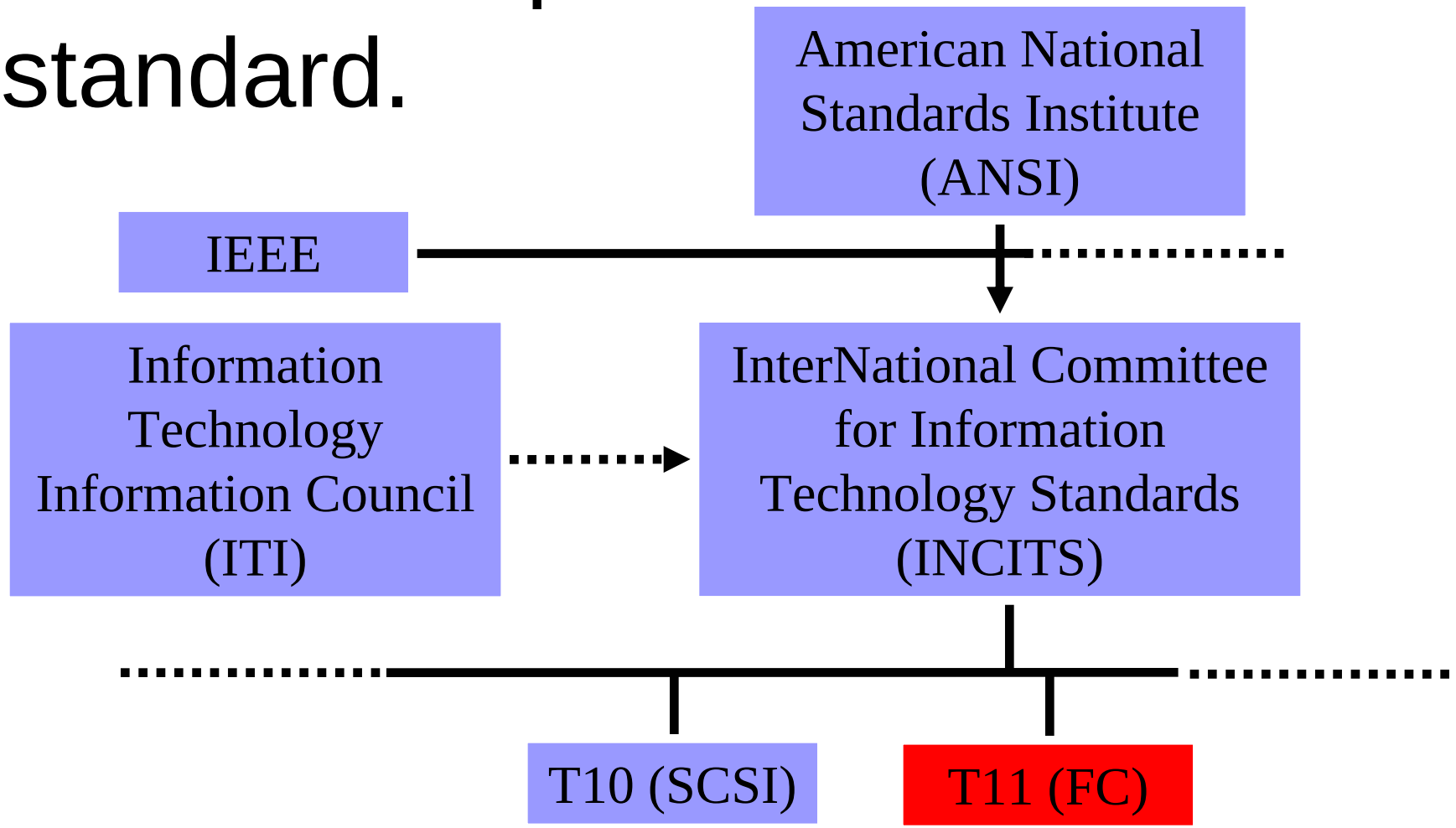
Fibre Channel Testing For Avionics Applications

Overview

- A Brief Introduction to Fibre Channel
  - Fibre Channel Basics
  - Characteristics of a Real-Time Network
- An Overview of a Fibre Channel Avionics Network
  - Topology Use
  - Fault Tolerant Designs
- Some Popular Avionics Protocols
  - 1553
  - ASM
  - RDMA
- Testing Challenges
- Testing Strategies

A Brief Introduction To Fibre Channel

What is Fibre Channel?
It is an accepted international standard.

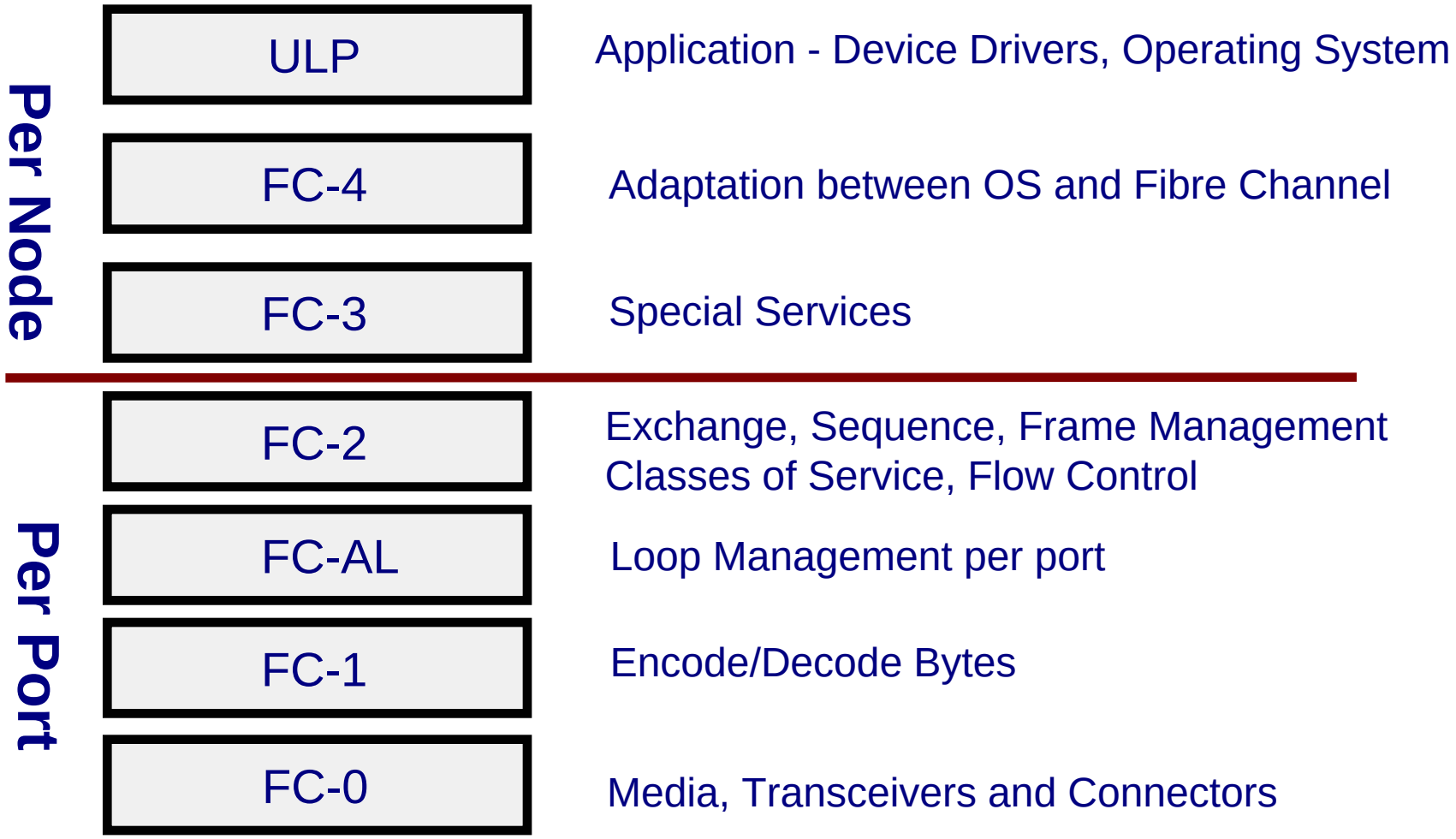


What is Fibre Channel?

Fibre Channel is a communication protocol between host processors and secondary storage elements.

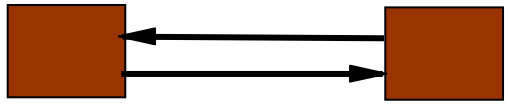
- Fibre Channel has been designed by combining the best characteristics of I/O subsystems and networks.
- Fibre Channel has been designed to be a universal carrier of data protocols.

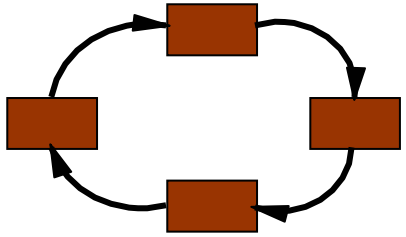
Architectural Levels – Simple Node

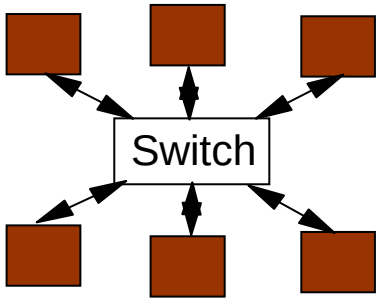


Fibre Channel Basics; Topology Terms

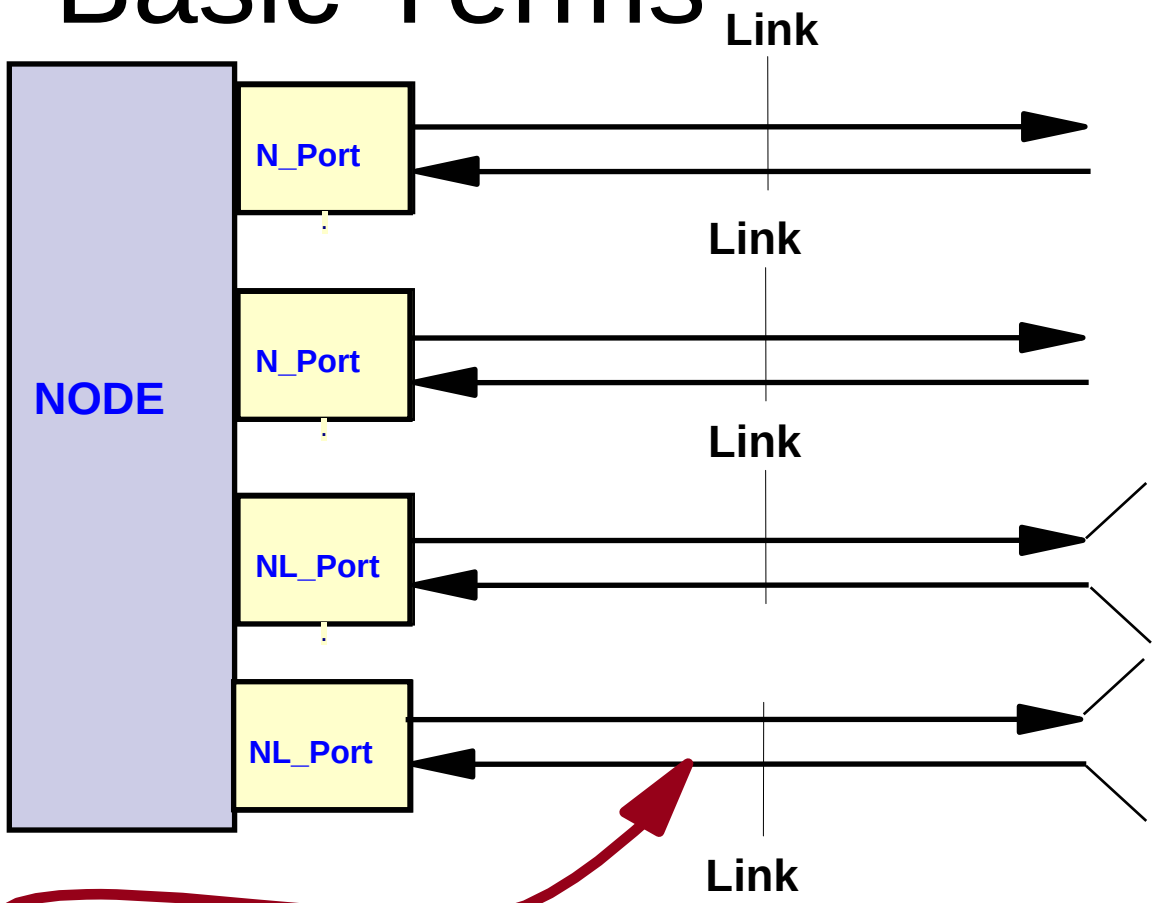
- Point-to-Point
  - Exactly two N_Ports connected together
  - No Switch (routing function) present
- Arbitrated Loop topology
  - Low cost attachment of 1-126 ports
  - Two NL_Ports is a practical minimum
  - Switch (routing function) distributed into each NL_Port
  - Can use Loop and Switch topologies together
- Switch topology
  - Up to 14 million ports connected together
  - 2 million reserved for special functions
  - Generic centralized switch (routing) environment
  - Well-Known Services usually required







Basic Terms



Each N_Port is attached to a **link**

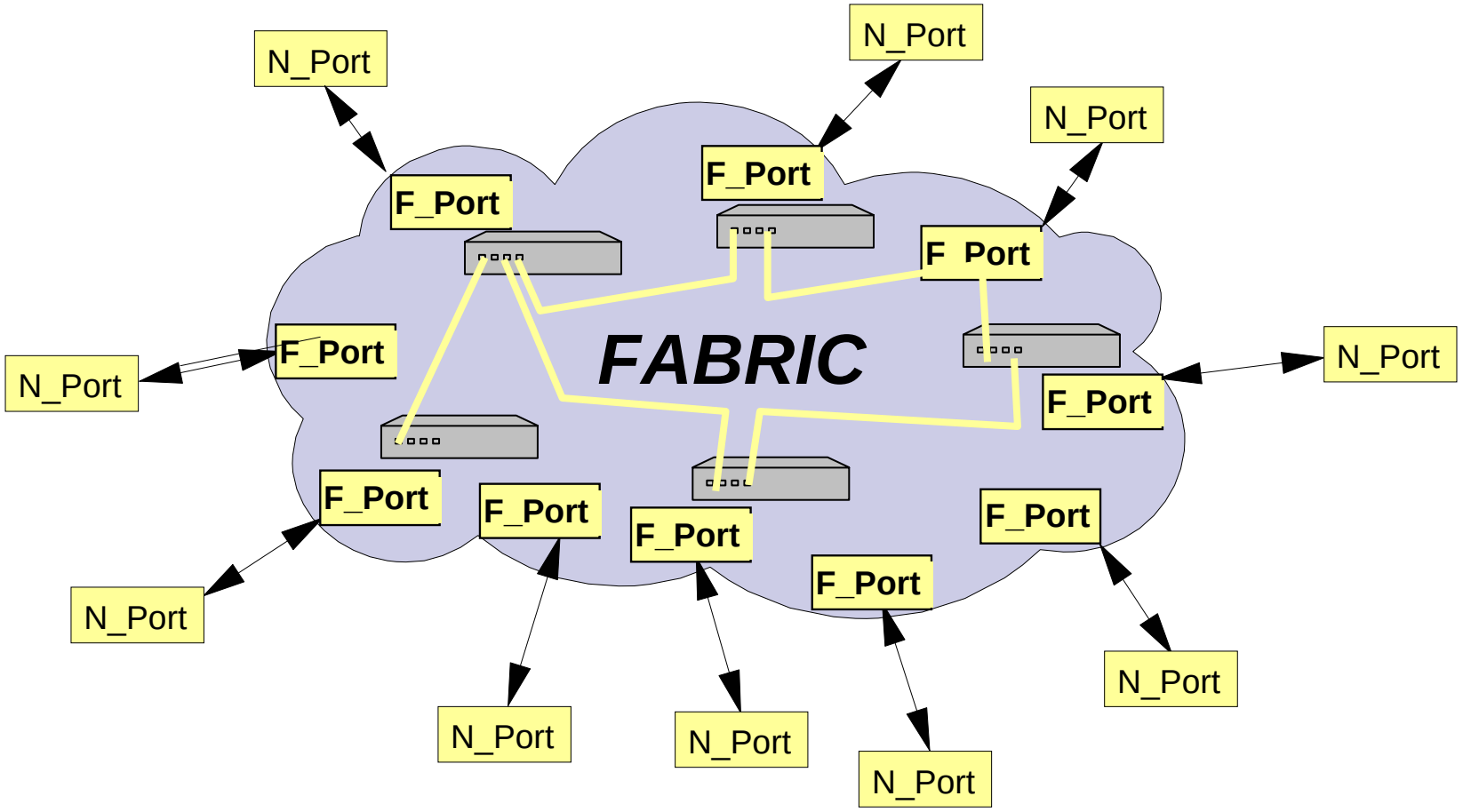
A link has **two fibers** with transmission in opposite directions

A fibre is a **copper or optical strand**

A Node attached to an arbitrated loop has at least one **NL_Port** (Node Port with additional Loop functions)

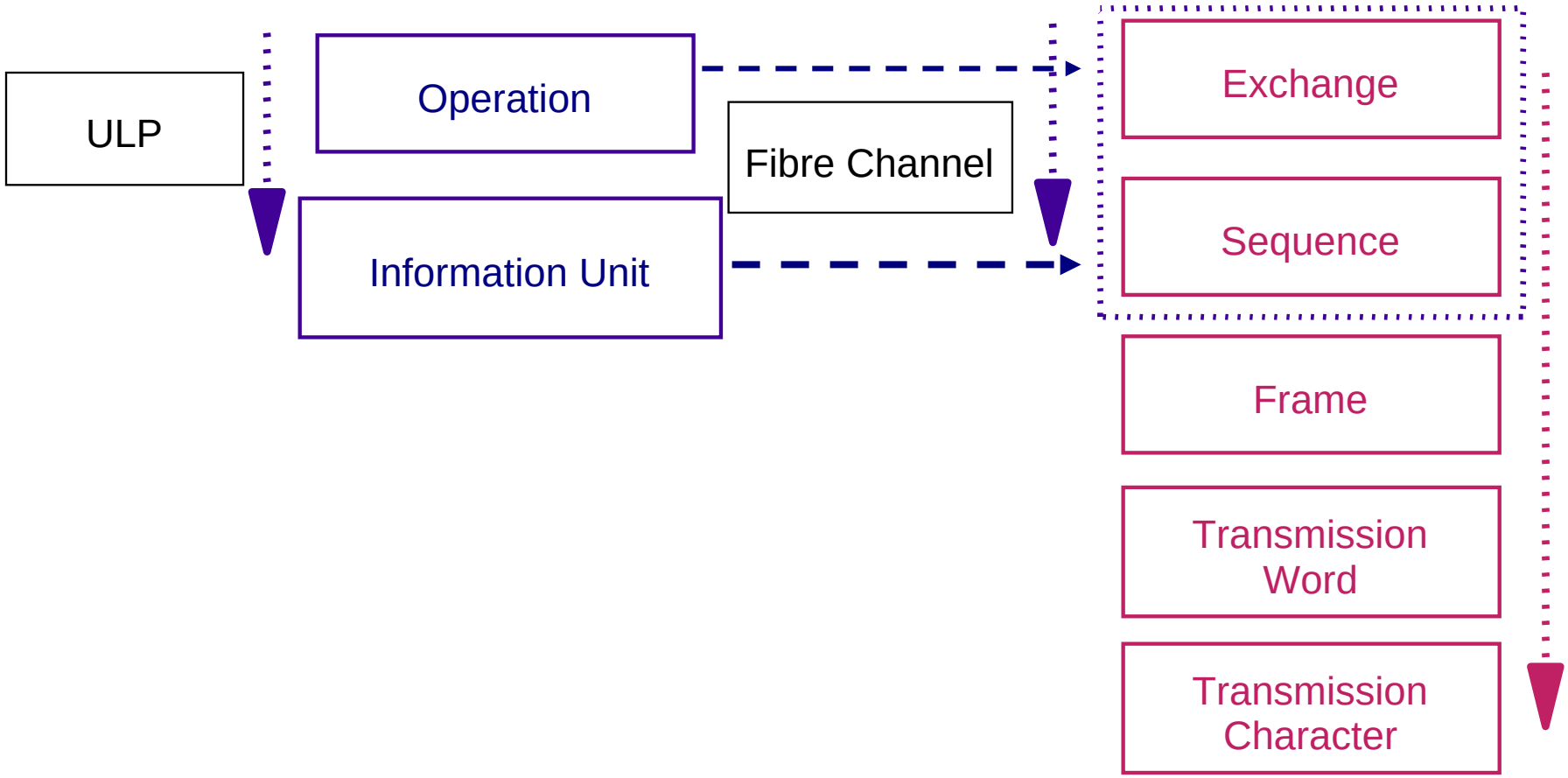
The fibers in the link are logically, if not physically split to form a loop.

Topology Examples



Each link from an N_Port is attached to an **F_Port**

Data Organization Hierarchy



Classes of Service

- Class of Service - Style of information transfer
  - Connection-Oriented (e.g., phone system)
  - Connectionless (e.g., mail system)
- There are two user classes of services commonly used in Avionics Fibre Channel
  - Class 2
    - Acknowledged Packet-Switched Service
    - Buffer-to-Buffer and End-to-End Flow Control
  - Class 3
    - Unacknowledged (Datagram) Packet-Switched Service
    - Buffer-to-Buffer flow control

Where Can I Get more Fibre Channel Information?

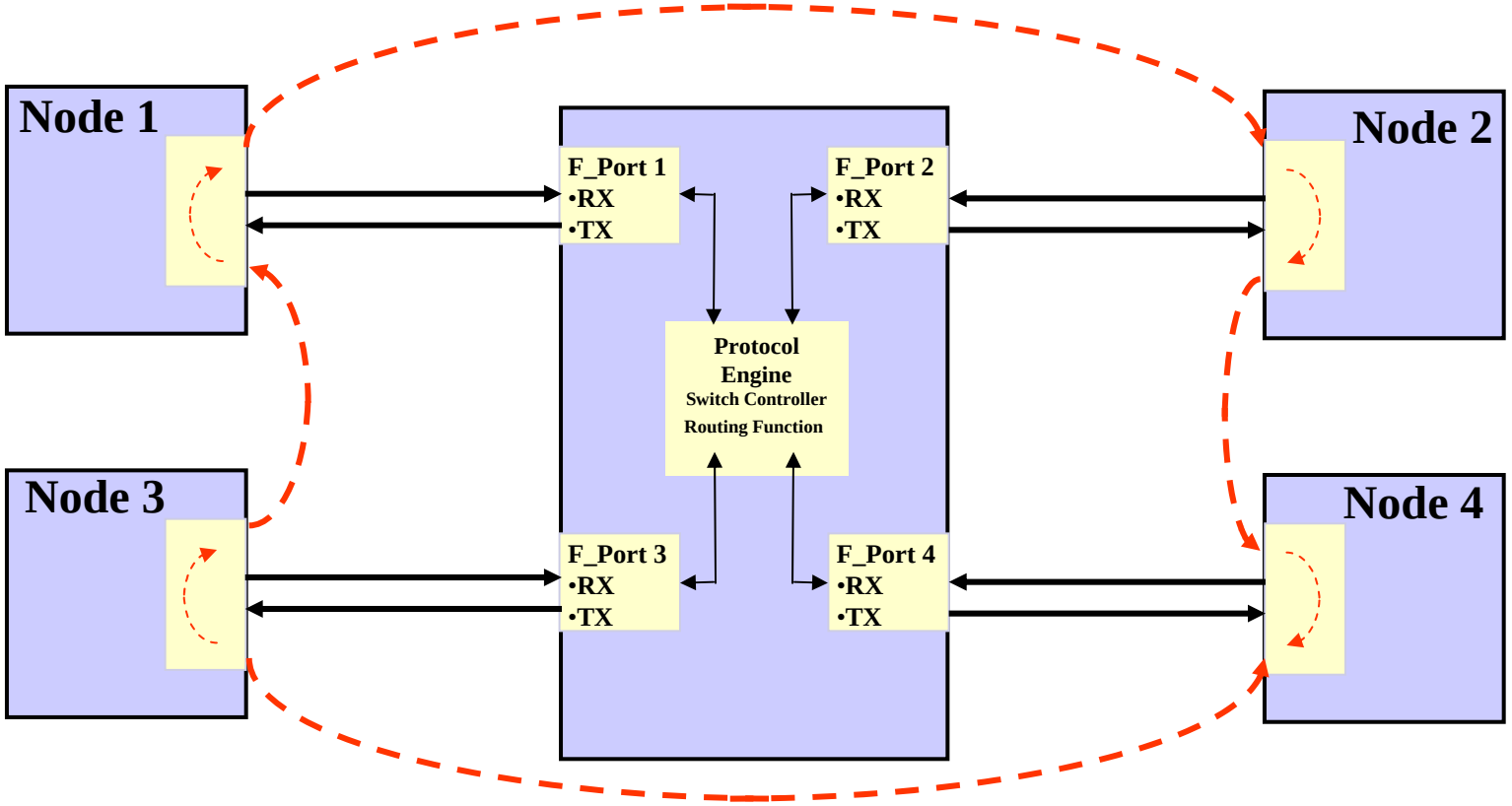
Where to get the Standard's Documents

- Completed Standards
  - Techstreet
    1327 Jones Dr.
    Ann Arbor, MI 48105 USA
    Phone: (734) 302-7801
    Fax: (734) 302-7811
    E-mail: service@techstreet.com
- T11 Web Site at www.t11.org
  - May get drafts in PDF format, many of which are completed
- Your Internal Corporate Library

An Overview of a Fibre Channel Avionics Network

Topology Development

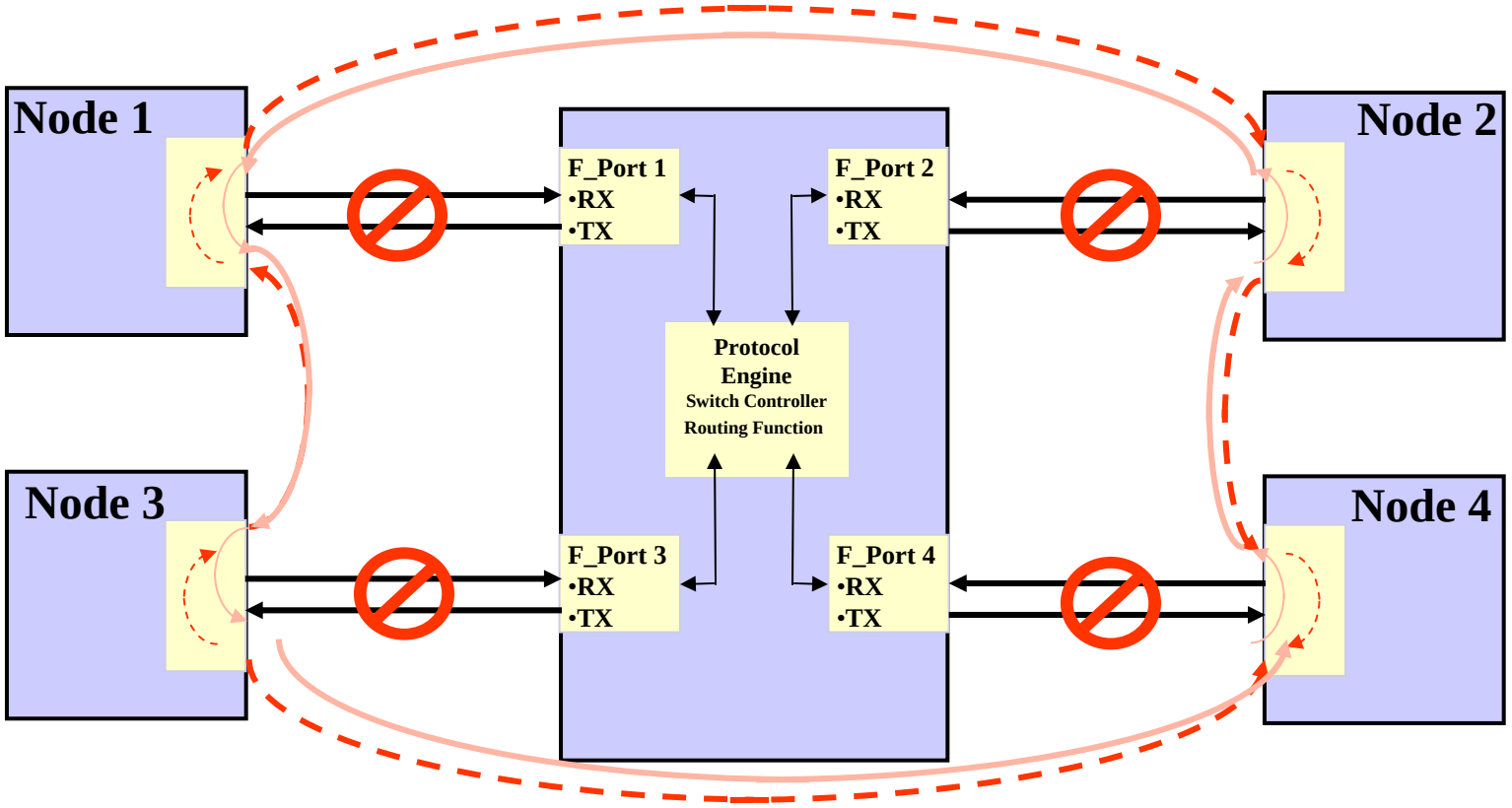
Switched And/Or Arbitrated Loop Topologies



The Switched Network Is The Primary Communications Path

Topology Development

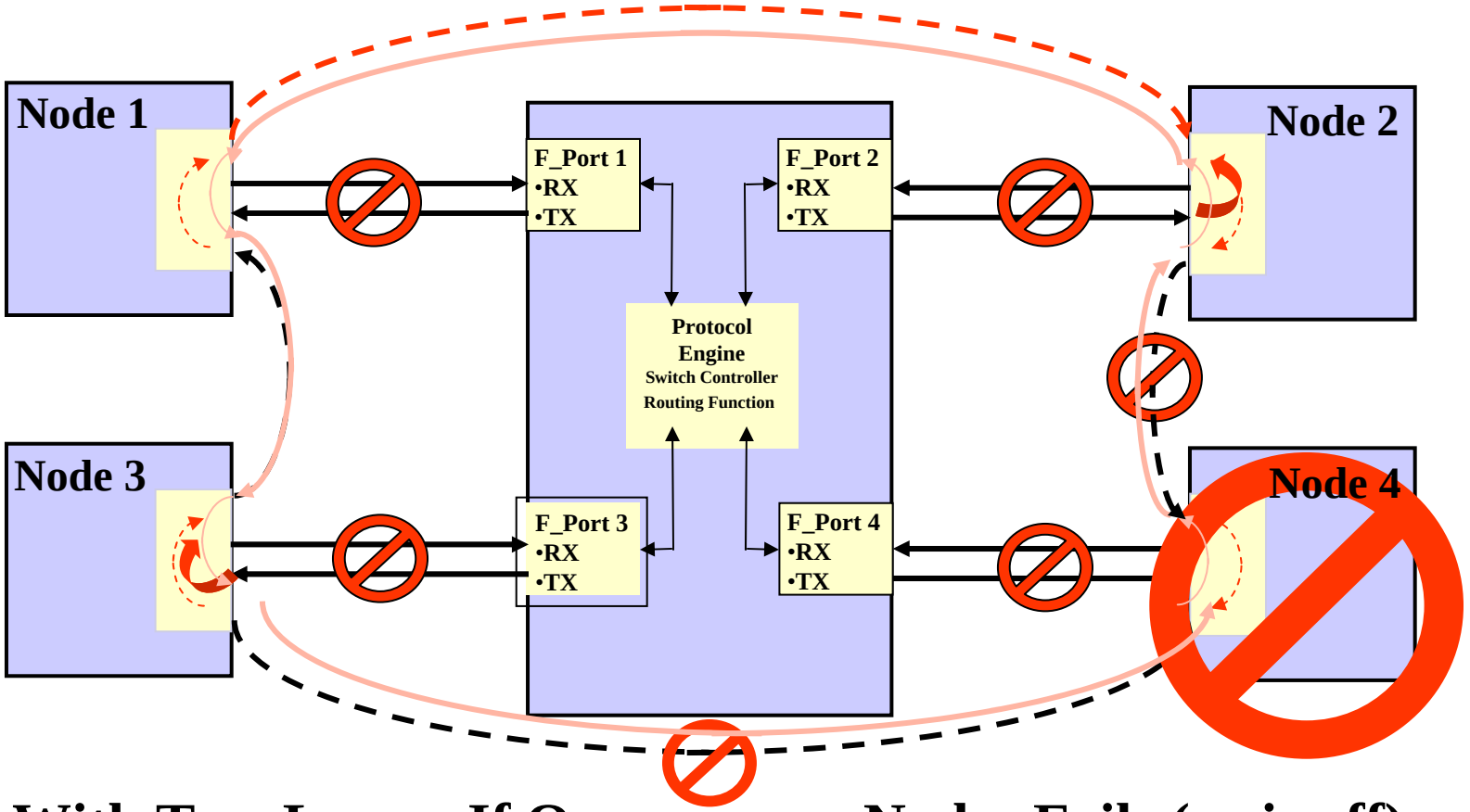
Arbitrated Loop Robustness - Or Lack Thereof



- **To Avoid A Failure, Two Loops Are Used**
  - **Loops Look Redundant When The Loops Are Operating Normally**
  - **In Reality, One Loop Carries Data, The Other Is Idle**

Topology Development

Failed Node Loop Back Operation



With Two Loops, If One or more Nodes Fails (or is off), A Loop Can Still Be Maintained with a Loopback circuit

Some Popular Avionics Protocols

Avionics Protocols

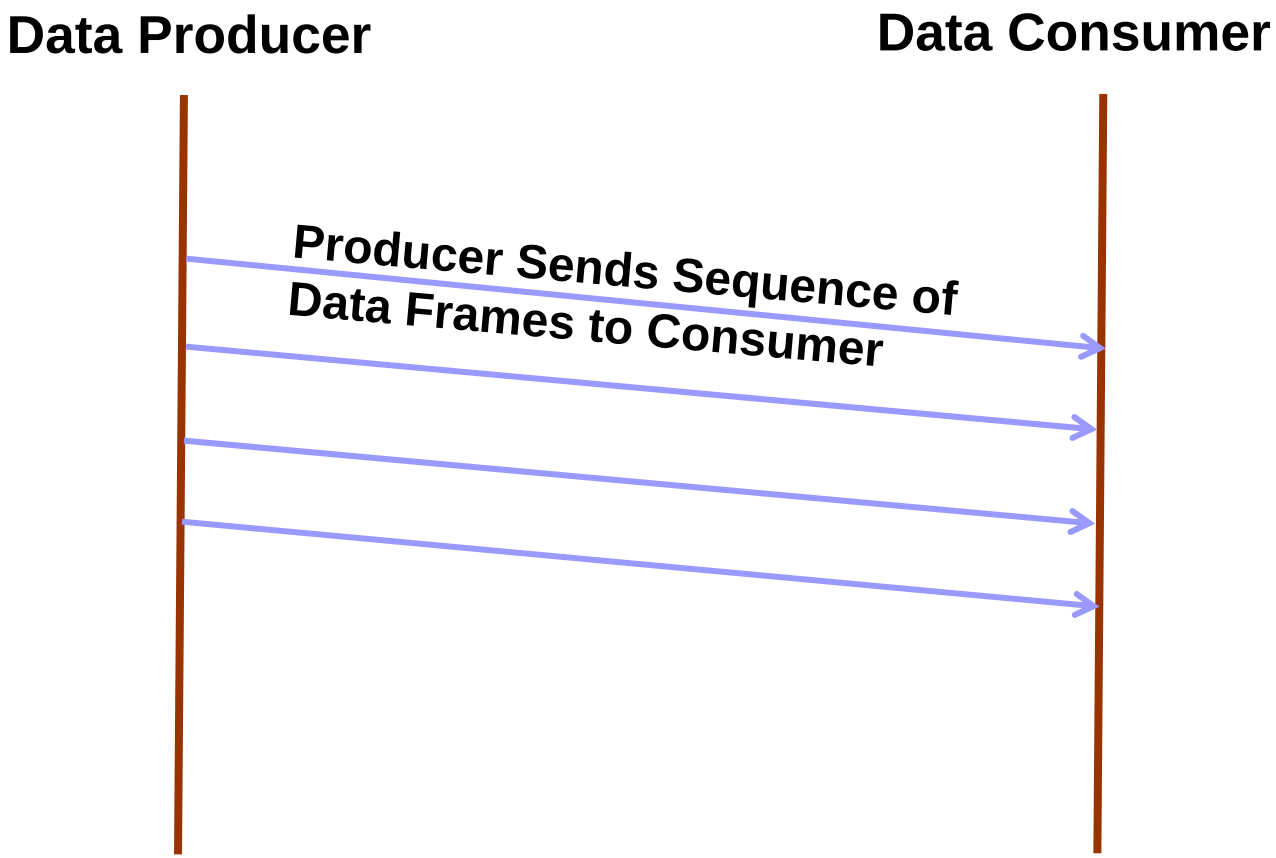
Remember Fibre Channel separates the command set from the means of the transport

- ASM
- RDMA
- 1553

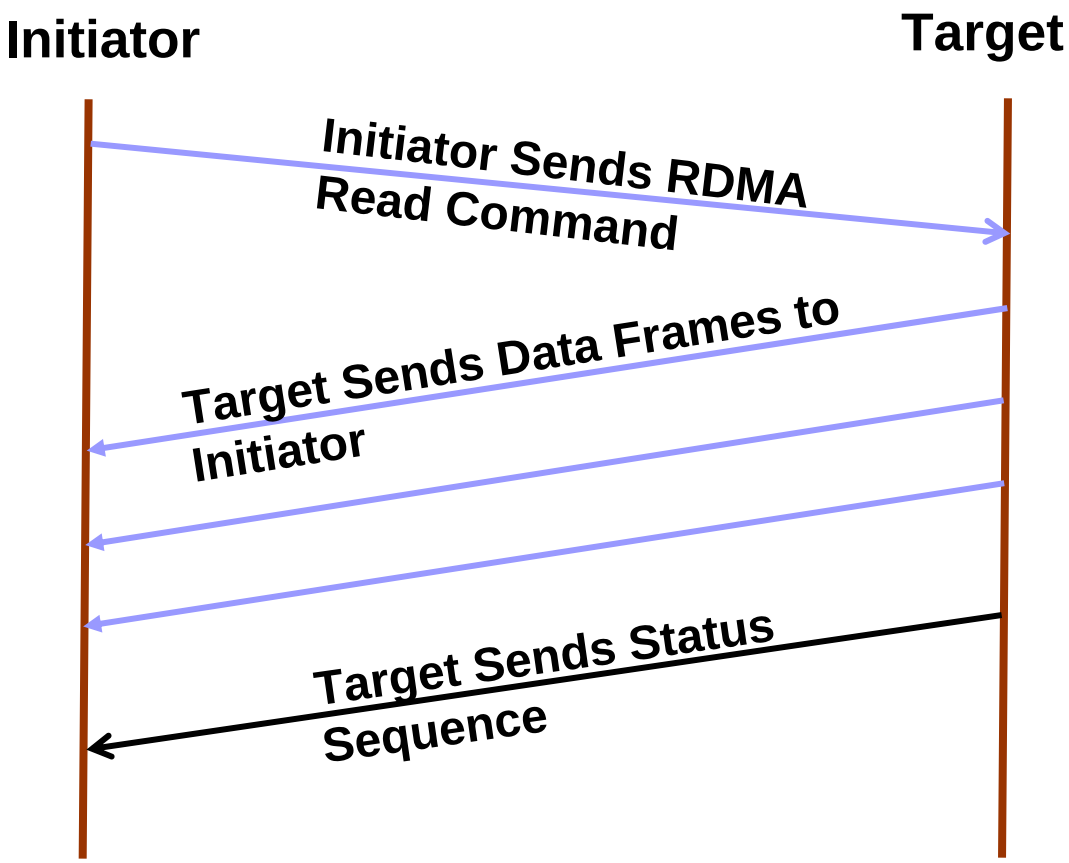
Fault tolerance and Determinism for Avionics Fibre Channel applications

- Fault tolerance and Determinism are derived from a combination of architecture, topology utilization, physical transport protocol, and application protocol

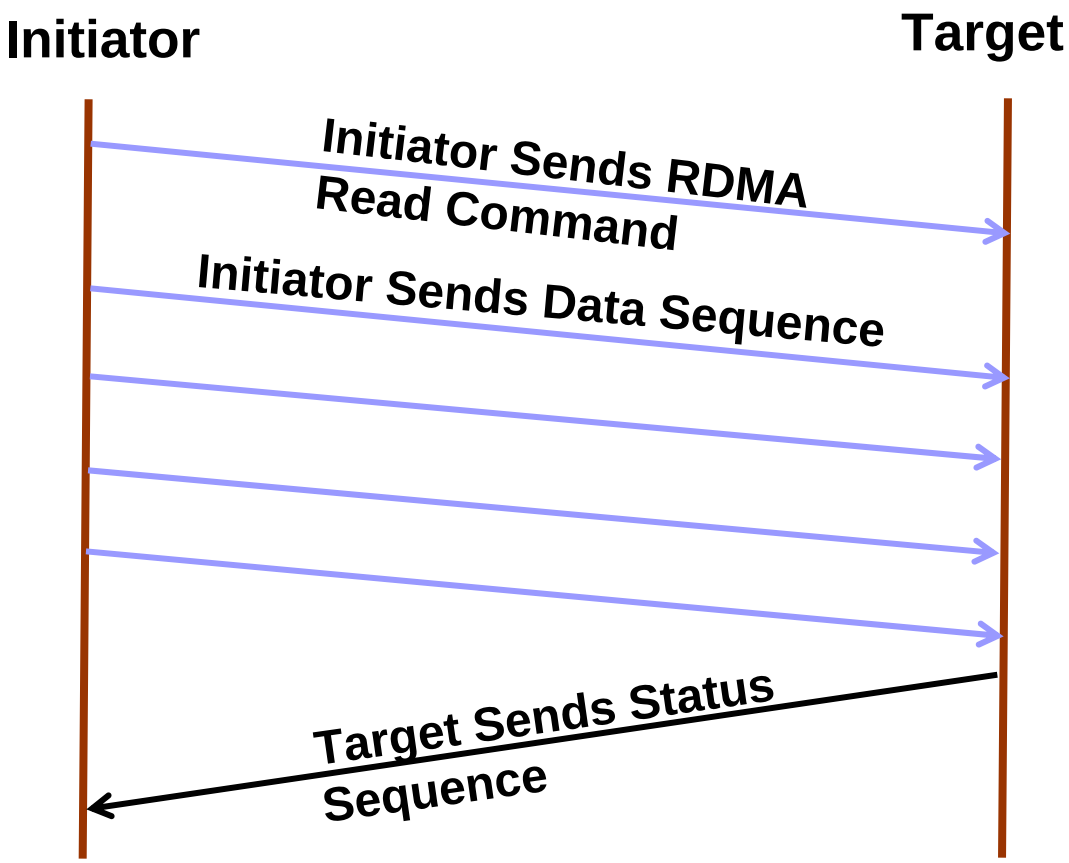
Example ASM Exchange



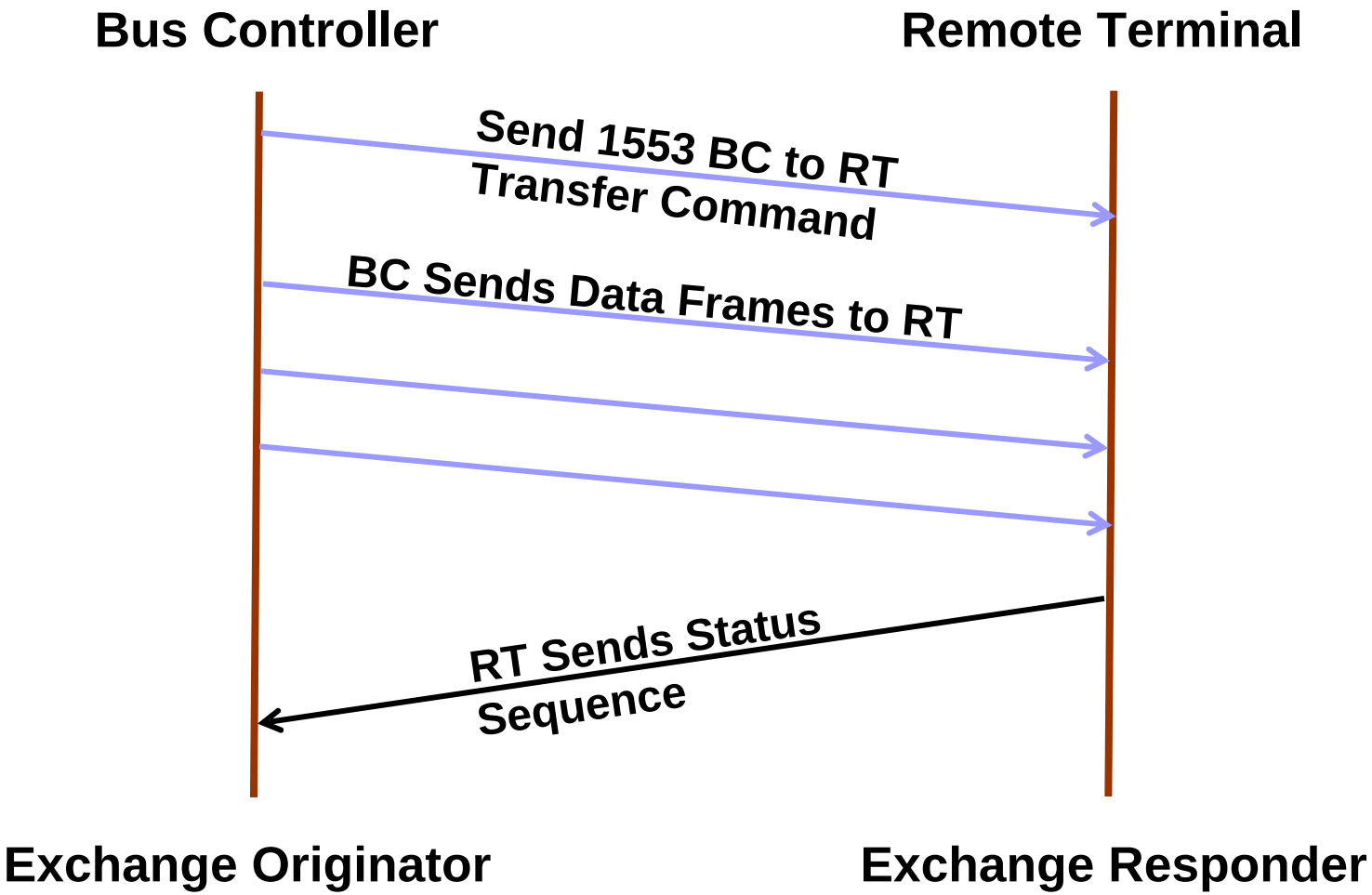
Example RDMA Read Operation



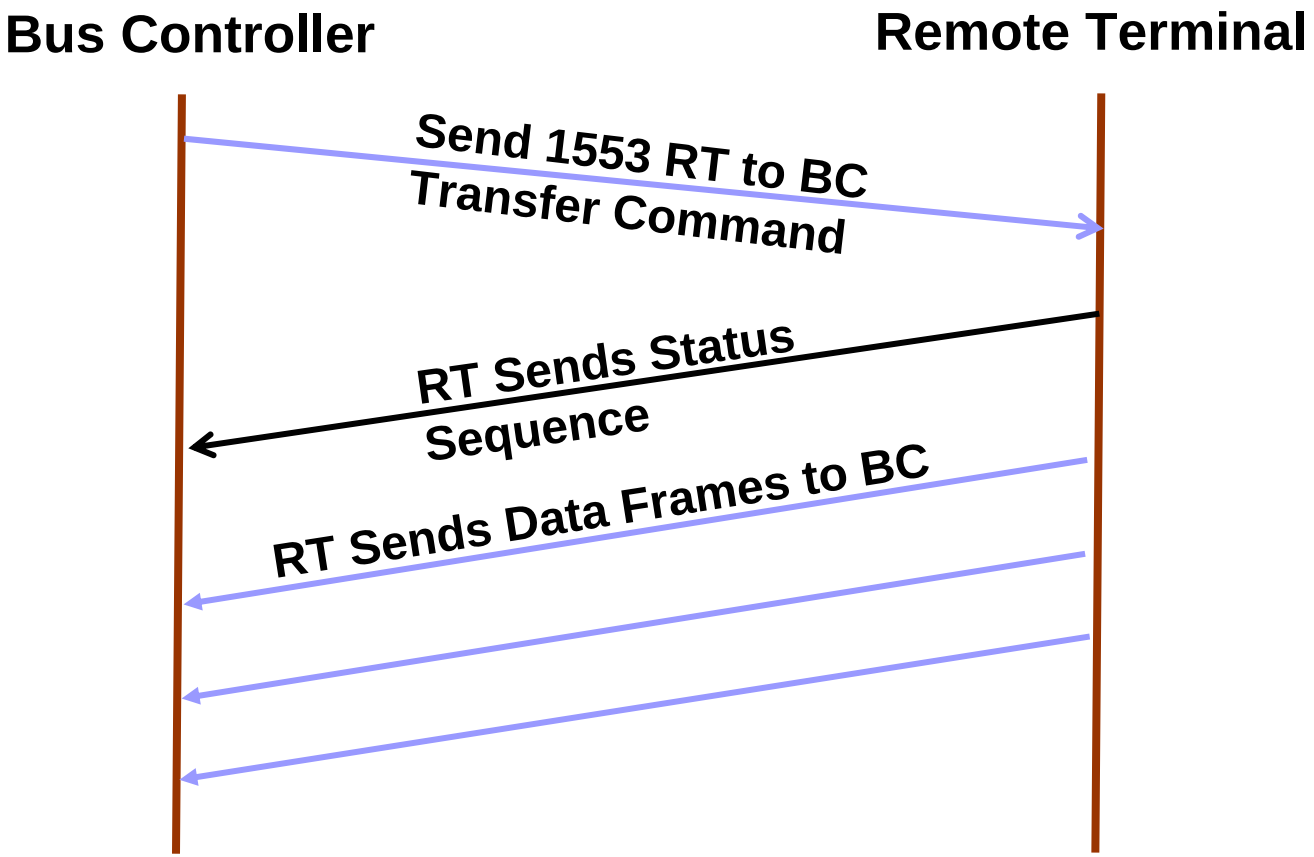
Example RDMA Write Operation



Example 1553 BC-RT Operation



Example 1553 RT-BC Operation



Testing Challenges

Testing Challenges

- The shear volume of the bandwidth
- Except for the point-to-point topology there is no single place to tap where all the traffic may be monitored
- Since the topology is not a bus there is no completely unobtrusive way to tap a link
- Fault tolerance and Determinism are derived from a combination of architecture, topology utilization, physical transport protocol, and application protocol

Testing Strategies

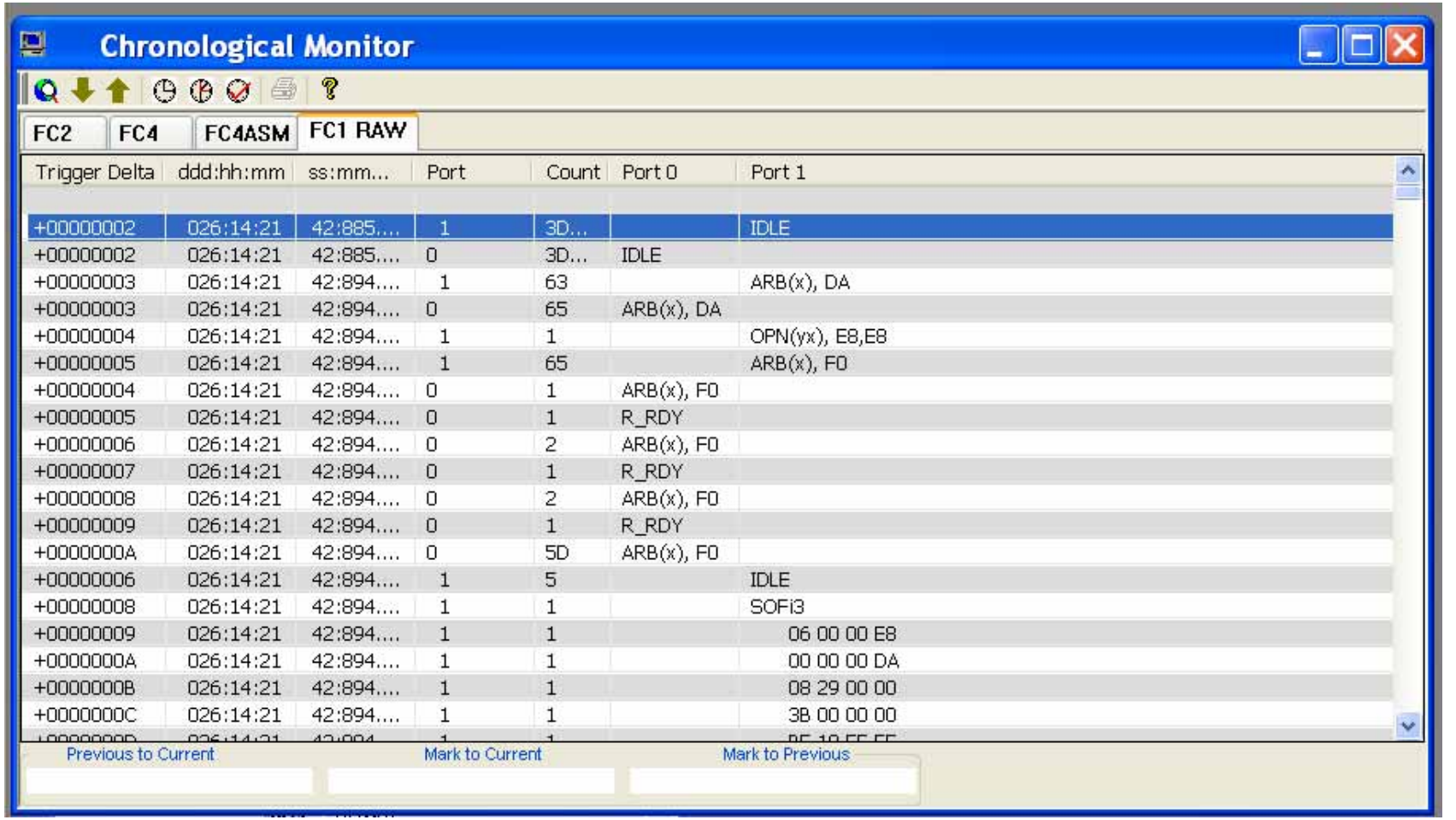
Testing Strategies

- Protocol Analyzers
- Data Generators
- Emulators

Protocol Analyzer

- Flow Control
  - Are there any delays being caused by the network?
- Determinism
  - Are Exchanges occuring in timely manner?
  - Are Sequences and frames being received in a timely manner?
- Data Integrity
  - Is the contents of frame data correct?

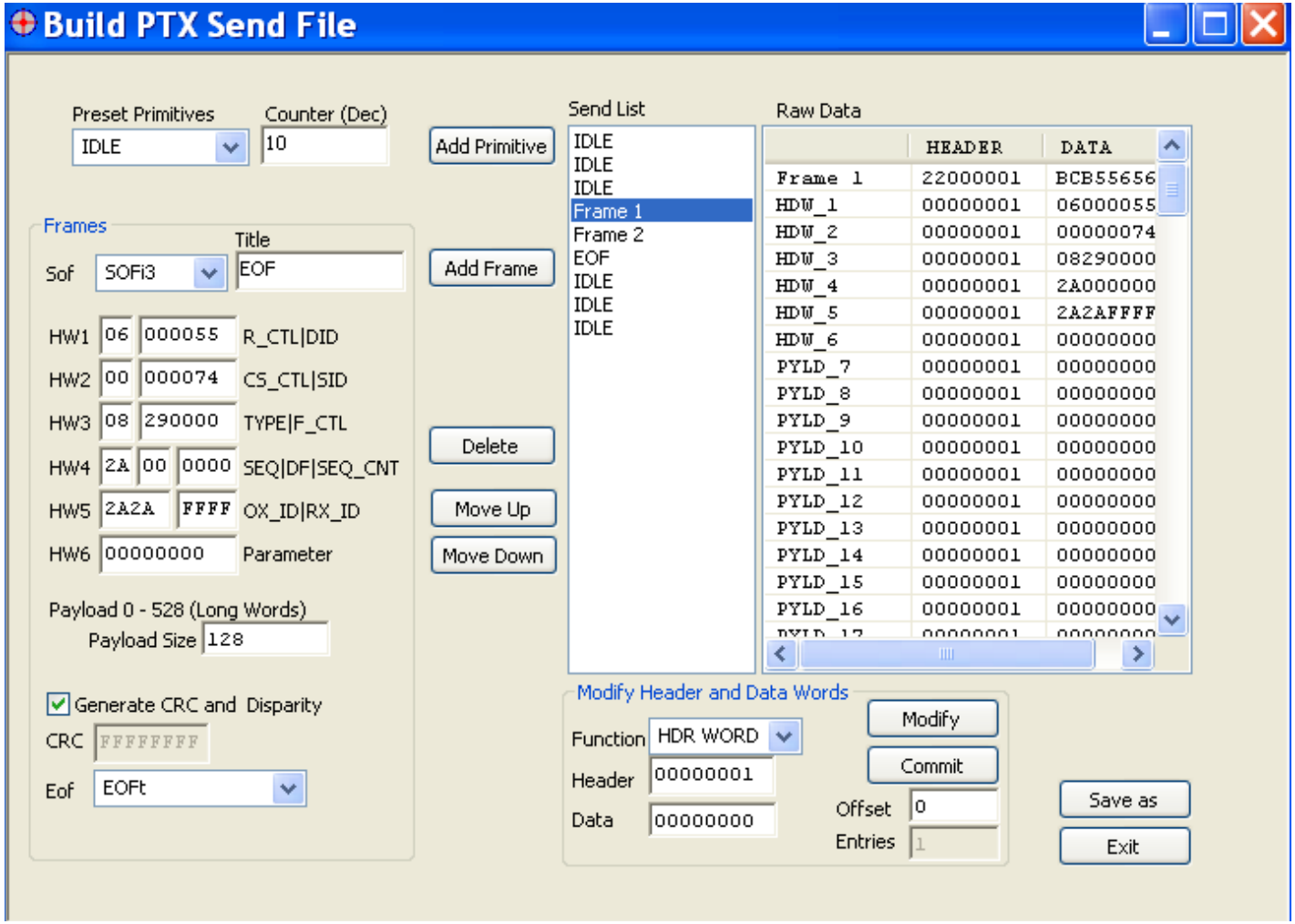
Protocol Analyzer



Data Generators

- Flow Control
  - What does it take to overwhelm network or node?
- Determinism
  - Place time tag in Frame payload and measure networks effective transmission rates
- Data Integrity
  - FC-4 Protocol errors
  - Introduce Application Data errors

Data Generators



Emulator

- Simulate device/network traffic
- Change data frames on-the-fly
  - Also known as “data corruption”

Summary

- Fault tolerance and Determinism are derived from a combination of architecture, topology utilization, physical transport protocol, and application protocol
- 3 types of Testing
  - Protocol Analyzer
  - Data Generator
  - Emulator