

AFDX™

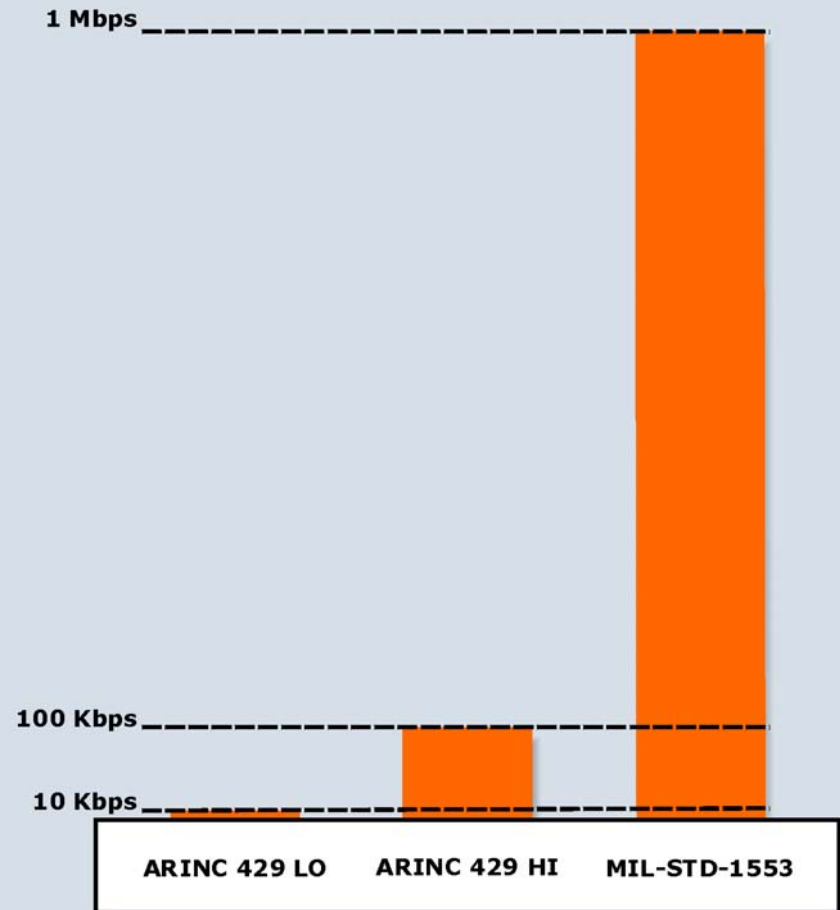
***Avionics Full Duplex Switched
Ethernet Network***

***Presented by
Kevin Christian***

Ballard Technology |||||

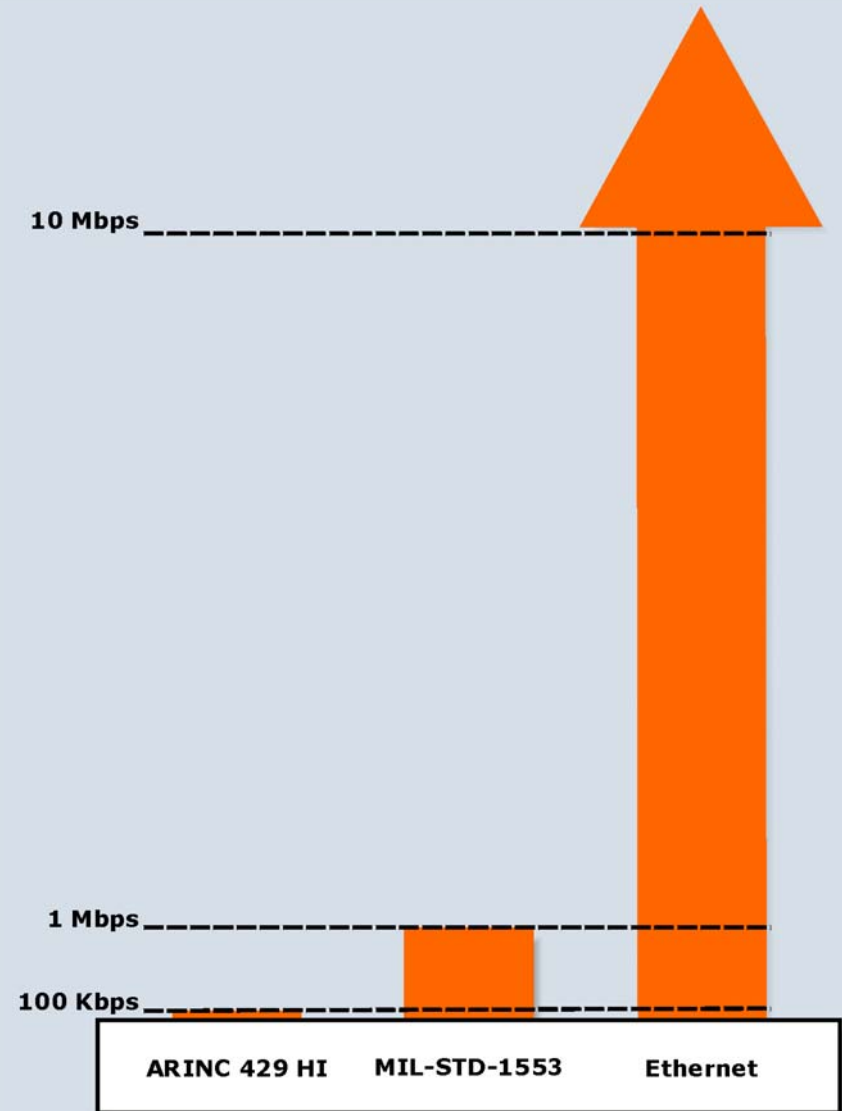
Background

- Current avionics databuses developed in 1970s
- Speeds of 10 Kbps to 1 or 2 Mbps
- Higher speeds needed



Why not use Ethernet?

- Speeds of ≥ 10 Mbps
- Readily available low cost parts
- Well established software protocols



Avionics databus requirements

- Deterministic
 - Bounded latency, i.e., fresh data
- Reliability
 - Redundancy
- Light weight



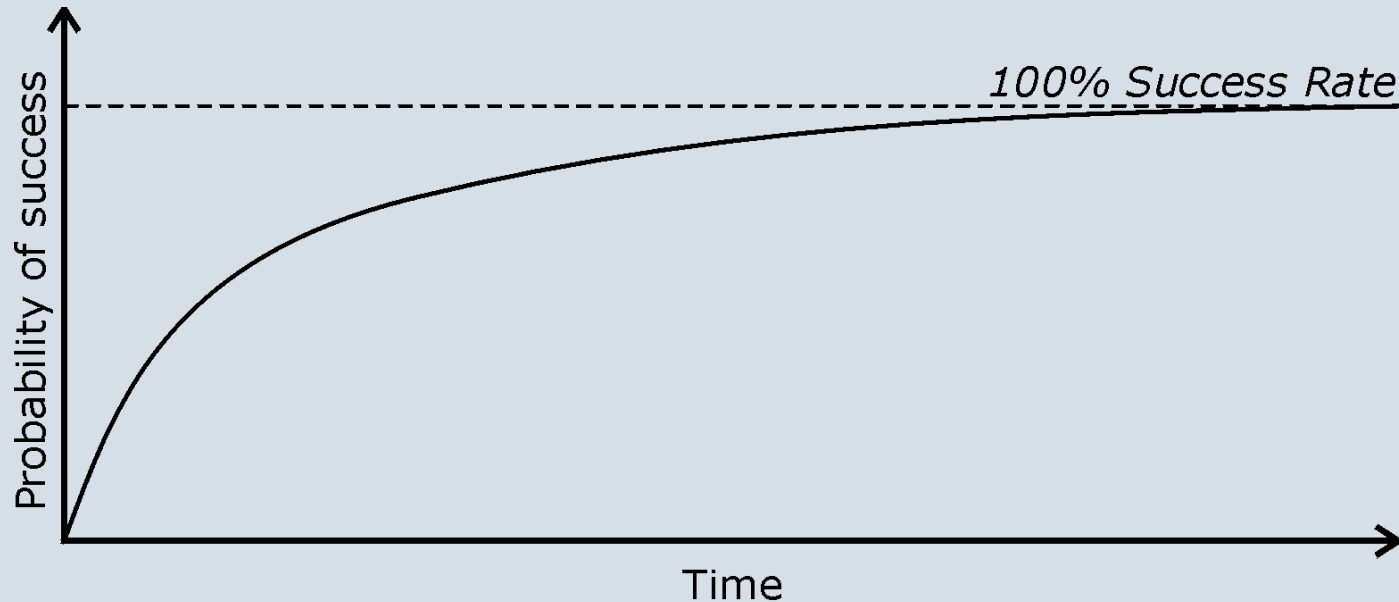
Ethernet

- Probabilistic
- Non-redundant
- Switched star topology
- High bandwidth
- Growth capability
- Scalable



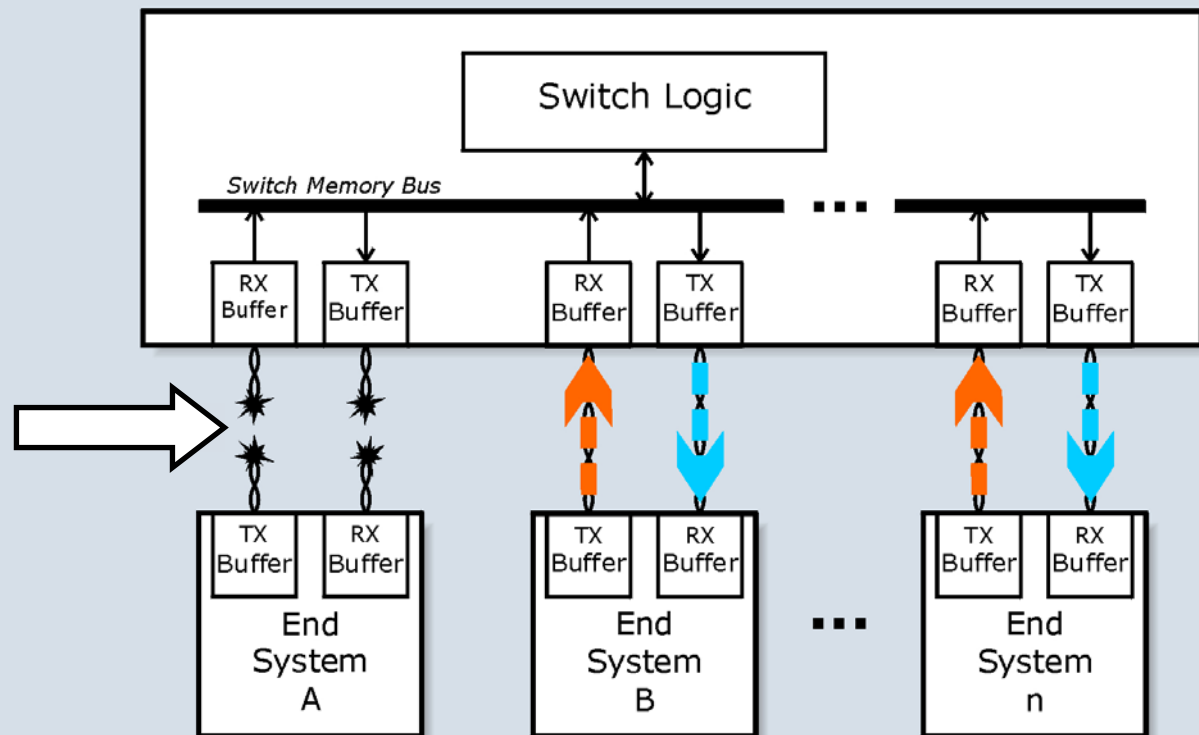
Ethernet is probabilistic:

- Unbounded latency
- Terminals compete for bandwidth
- Random and unlimited transmissions



Ethernet is non-redundant:

- Faulty line may disconnect a terminal or a switch



What is AFDX?

- Avionics Full Duplex Switched Ethernet
- ARINC 664 Aircraft Data Network, Part 7
- Flight-worthy Ethernet

AFDX vs. Ethernet

- AFDX

Deterministic

Redundant

- Switched star
- High bandwidth
- Growth
- Scalable

- Ethernet

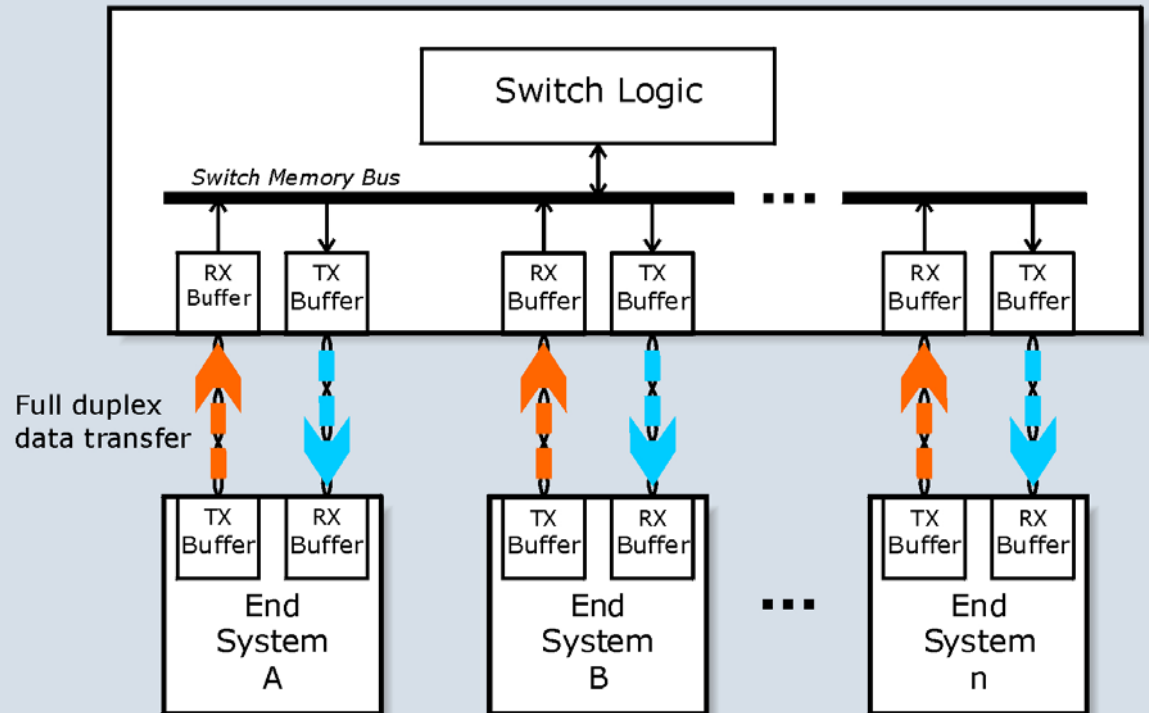
Probabilistic

Non-redundant

- Switched star
- High bandwidth
- Growth
- Scalable

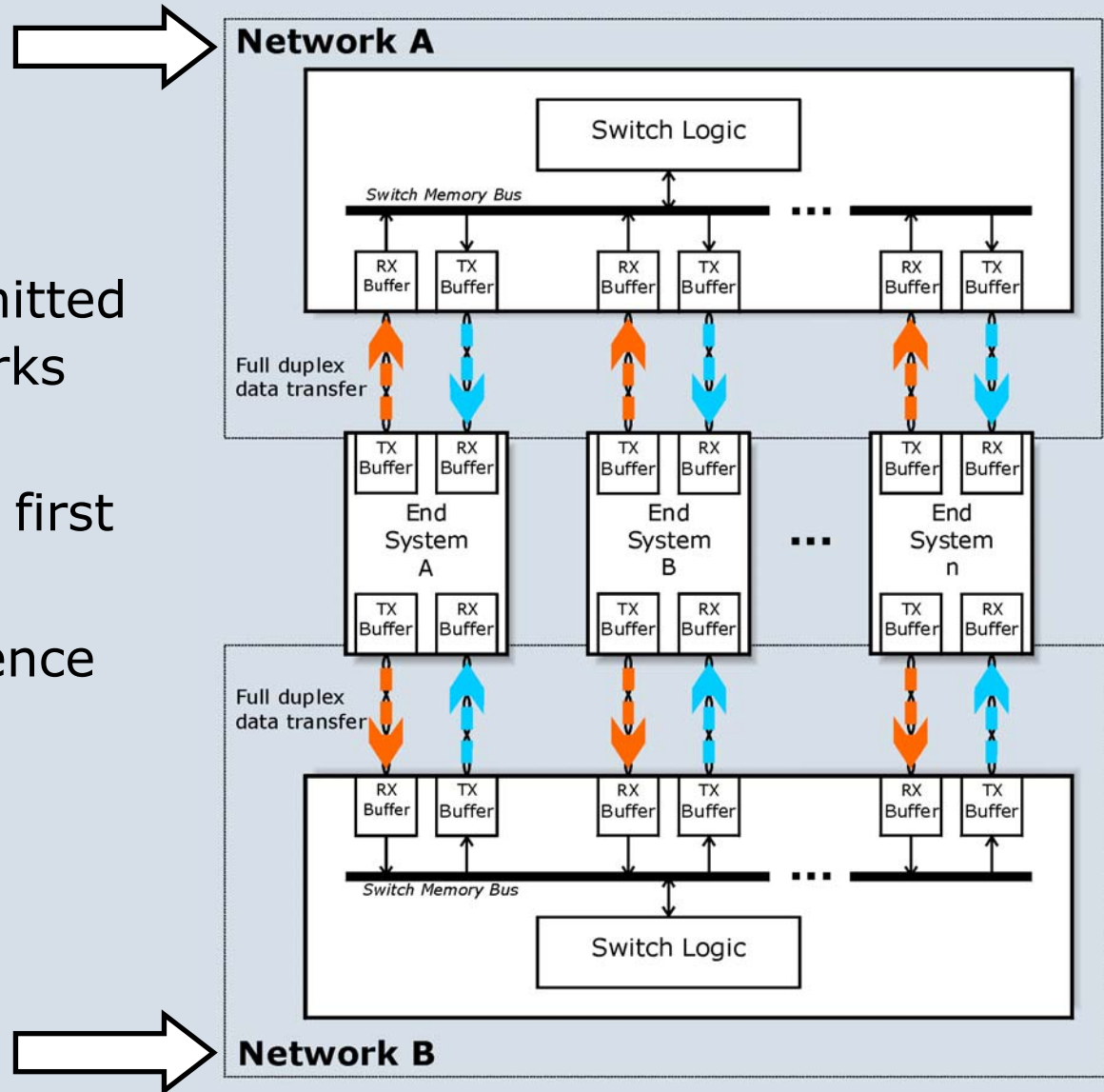
AFDX is deterministic:

- Smart, preconfigured switches
 - Full duplex
 - RX/TX message buffers
- Predefined message routing in switch
- Admissions control
 - “Budget your bandwidth”



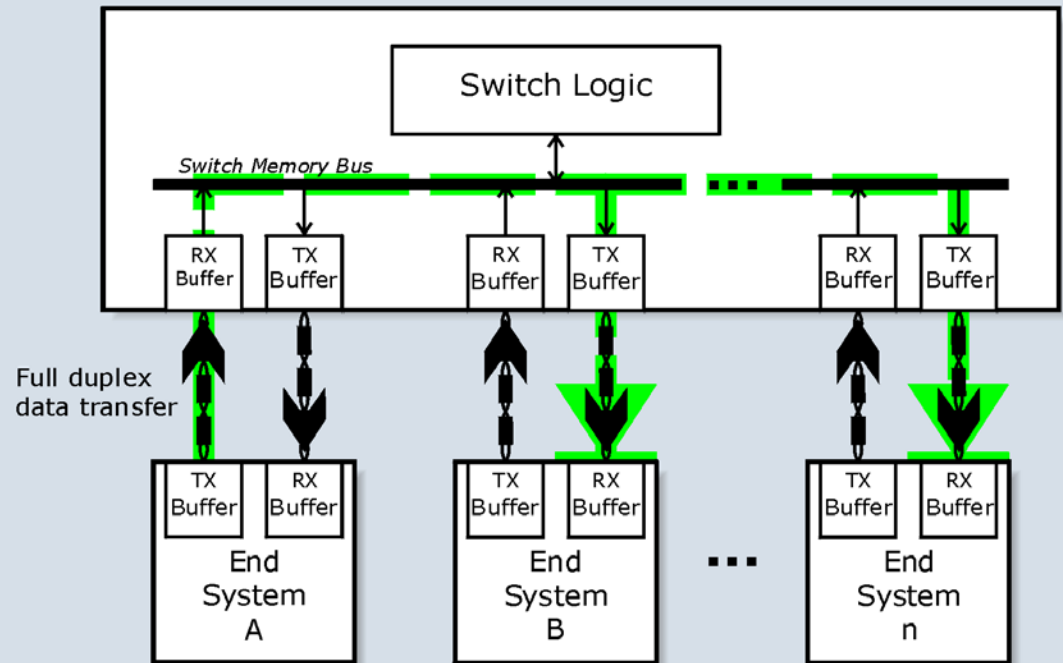
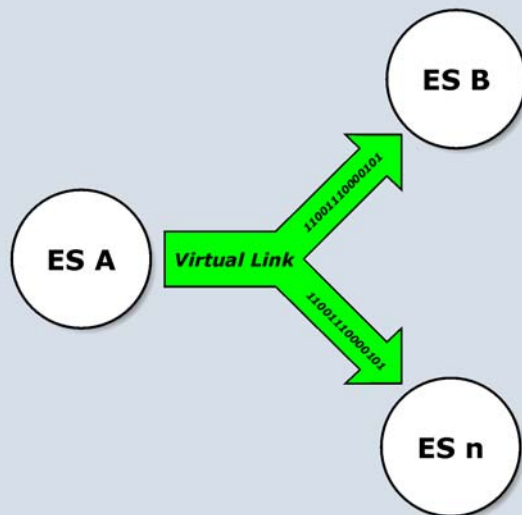
AFDX is redundant:

- Messages transmitted onto both networks (A and B)
- Receiver accepts first valid occurrence
- Embedded sequence numbers



Virtual Links

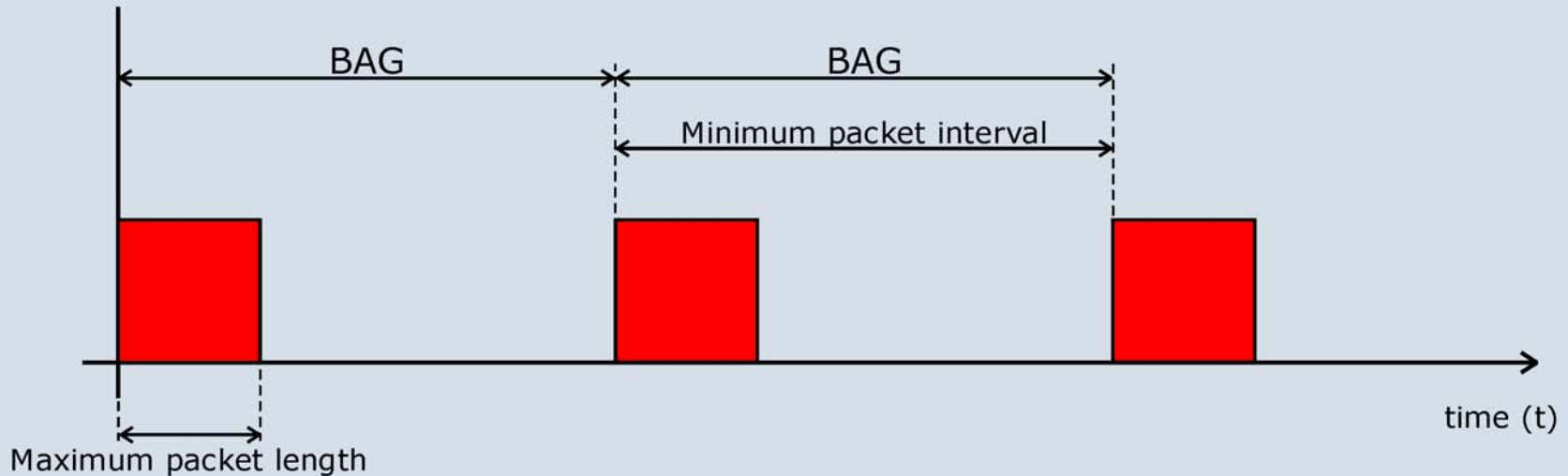
- “VL”
- MAC used for VL
- Connects end systems
 - Logical
 - Unidirectional
 - 1 source
 - ≥ 1 destinations



VL connects ES A to ES B and ES n.

Budgeting Bandwidth

- BAG = Bandwidth Allocation Gap
- Each VL has preconfigured bandwidth
 - Max packet length
 - Min packet interval
- $1 \text{ ms} \leq \text{BAG} \leq 128 \text{ ms}$



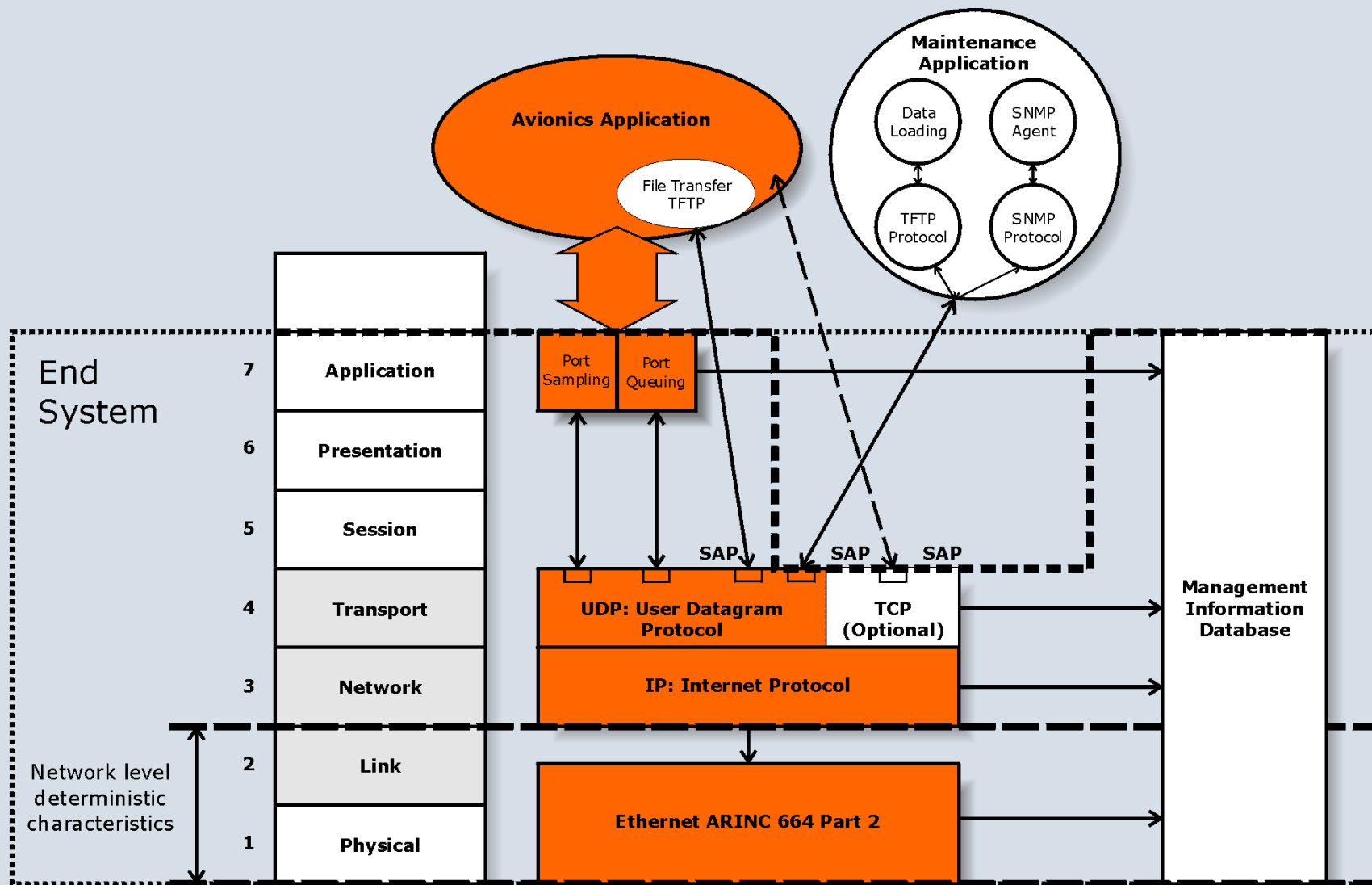
AFDX system designer

- The AFDX system designer must define:
 - Virtual links (VL)
 - Bandwidth allocation gap (BAG)
 - Ports (Sampling and Queuing)

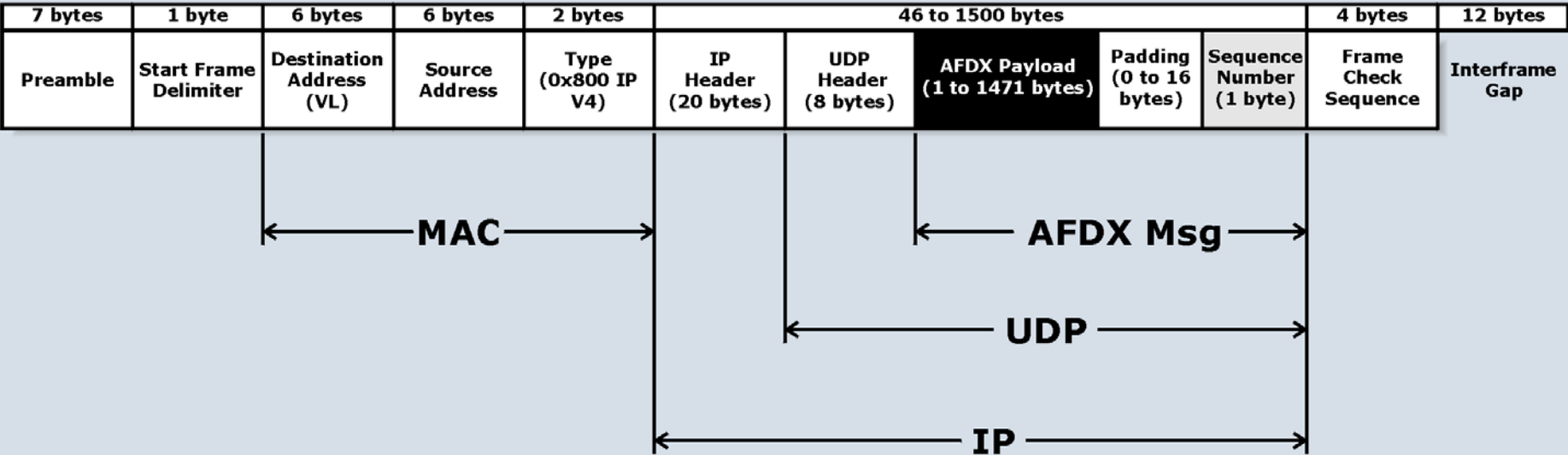
AFDX system designer



End System Communications Stack

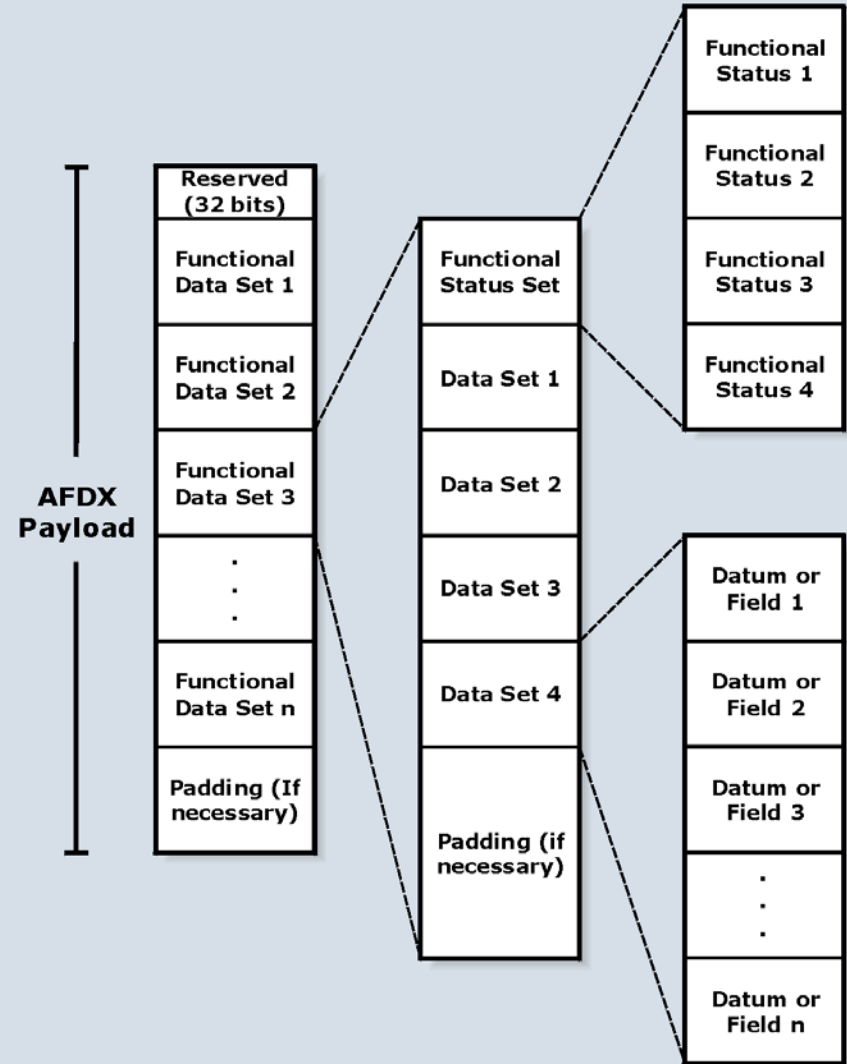


AFDX Ethernet Frame Structure

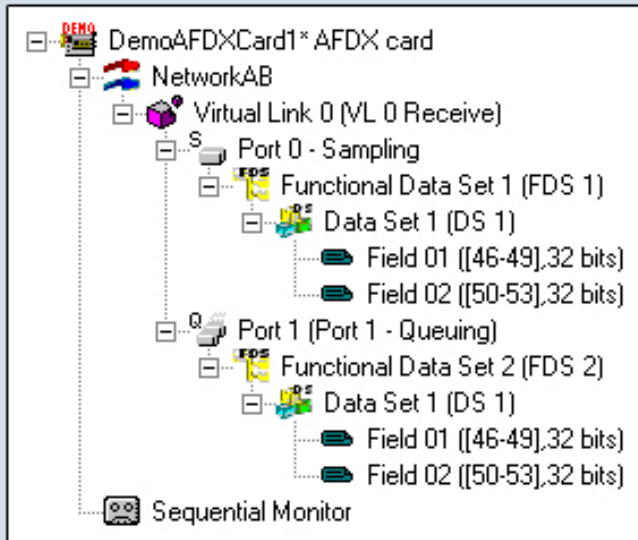


AFDX Payload

- AFDX Payload
 - Functional Data Set
 - Functional Status Set
 - Data Sets



AFDX in CoPilot



AFDXMonView2 - Monitoring AFDX #0 count=64

Record: Run Stop Pause Display: Hex Linear Display Filter: Edit Off Go To Message: Go Search: Define Back Fwd Step: Back Fwd

Frame	Time	NET	VL	RSN	Dst Port	Errors
0	5.188642 sec	A	1	110	0x0001	
1	5.328846 sec	A	1	111	0x0001	
2	5.471434 sec	A	1	112	0x0001	

Sequential Record 0
 Frame 0 (63 bytes)
 Ethernet II, Src: 00:00:00:00:00:20, Dst: 03:00:00:00:00:01
 Internet Protocol
 User Datagram Protocol
Avionics Full Duplex Switched Ethernet (VL:1 RSN:110 NET:A)

- Dst Addr: 03:00:00:00:00:01
 - Constant field: 03:00:00:00 (correct)
 - AFDX VL: 1
- Src Addr: 00:00:00:00:00:20
- IP Dst Addr: 224.224.0.1
 - Class: D
 - Constant field: 0x0E0 (correct)
 - Virtual Link Identifier: 0x0001
- IP Src Addr: 10.0.0.0
 - Class: A
 - Private IP address: 0x0A
 - Network ID: 0x00
 - Equipment ID: 0x00
 - Partition ID: 0x00
 - Network: 1 - A
 - AFDX Payload: 20 bytes
 - RSN: 110

```

00000000  03 00 00 00 00 01 00 00 00 00 00 20 08 00 45 00  .....E.
00000010  00 3F 00 00 00 00 00 00 11 CC CC 0A 00 00 00 E0 E0  ?.....
00000020  00 01 00 01 00 01 00 1D CC CC 54 68 69 73 20 69  .....This i
00000030  73 20 73 61 6D 70 6C 65 20 64 61 74 61 2E 6E  s sample data.n
  
```

AFDX in Review

- Avionics Full Duplex Switched Ethernet
- AFDX uses, but deviates from Ethernet and other specifications
- “Smart” switches
- Deterministic
- Redundant
- 100 Mbps

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