



High Availability in EtherNet/IP Systems using Parallel Redundancy Protocol (PRP)

Technical Track

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Introduction

High Availability

PRP Solution
And Applications

Installation

Initialization

Operation

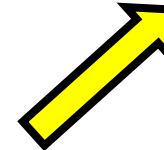
Failure Recovery

High Availability

$$\text{Availability} = \text{MTTF} / (\text{MTTF} + \text{MTTR})$$

Mean-Time-To-Fail (MTTF)

Mean-Time-To-Repair (MTTR)



High Availability



Availability, %	Downtime per Year	Downtime per Month	Downtime per Week
99.9999% ("six nines")	31.5 seconds	2.59 seconds	0.605 seconds
99.999% ("five nines")	5.26 minutes	25.9 seconds	6.05 seconds
99.99% ("four nines")	52.56 minutes	4.32 minutes	1.01 minutes
99.95%	4.38 hours	21.56 minutes	5.04 minutes
99.9% ("three nines")	8.76 hours	43.2 minutes	10.1 minutes
99.8%	17.52 hours	86.23 minutes	20.16 minutes
99.5%	1.83 days	3.60 hours	50.4 minutes
99% ("two nines")	3.65 days	7.20 hours	1.68 hours
90% ("one nines")	36.5 days	72 hours	16.8 hours

High Availability

$$\text{Availability} = \text{MTTF} / (\text{MTTF} + \text{MTTR})$$

Mean-Time-To-Fail (MTTF)

Mean-Time-To-Repair (MTTR)

High
Availability



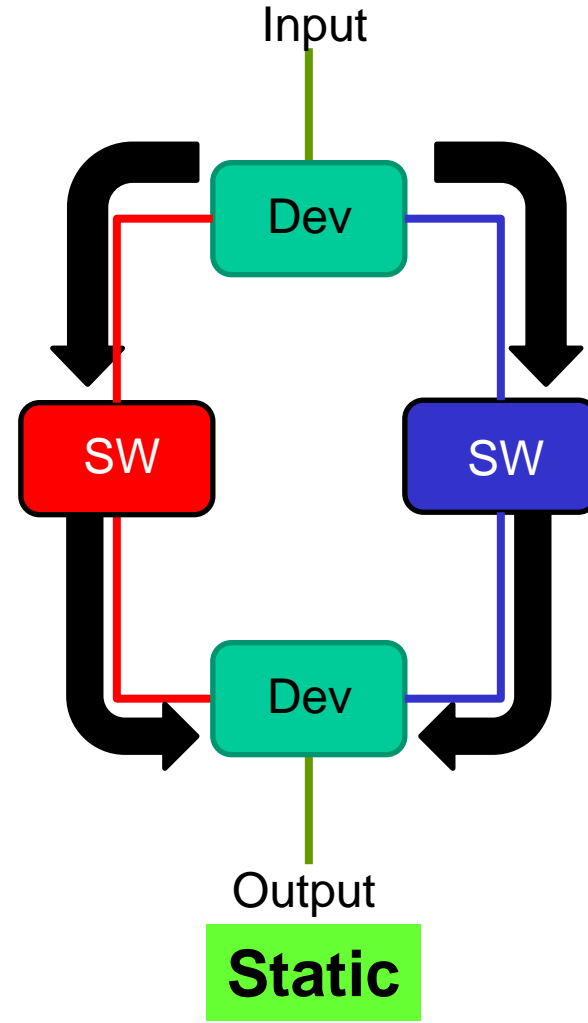
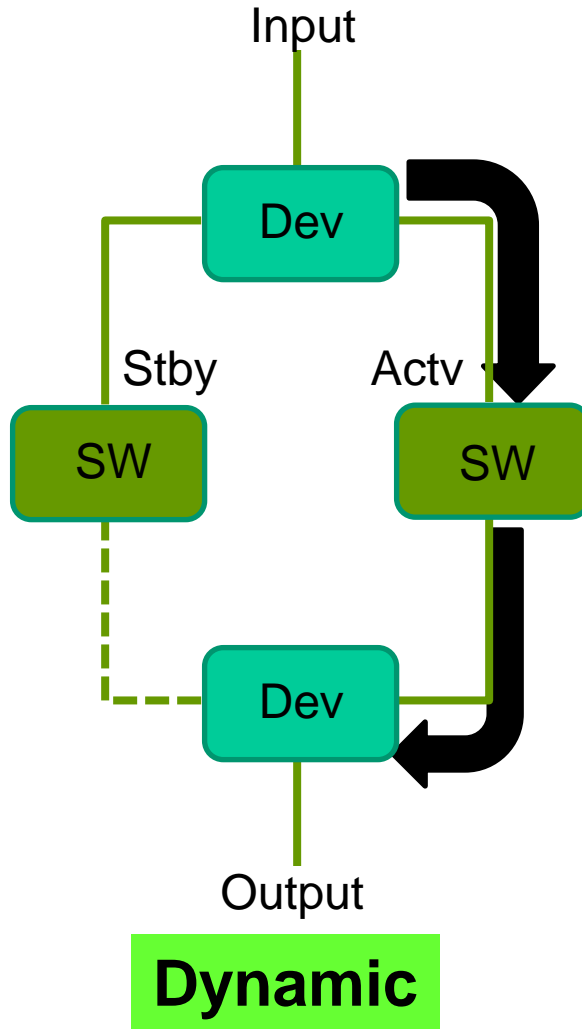
Availability, %	Downtime per Year	Downtime per Month	Downtime per Week
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Impossible to create networks that never fail

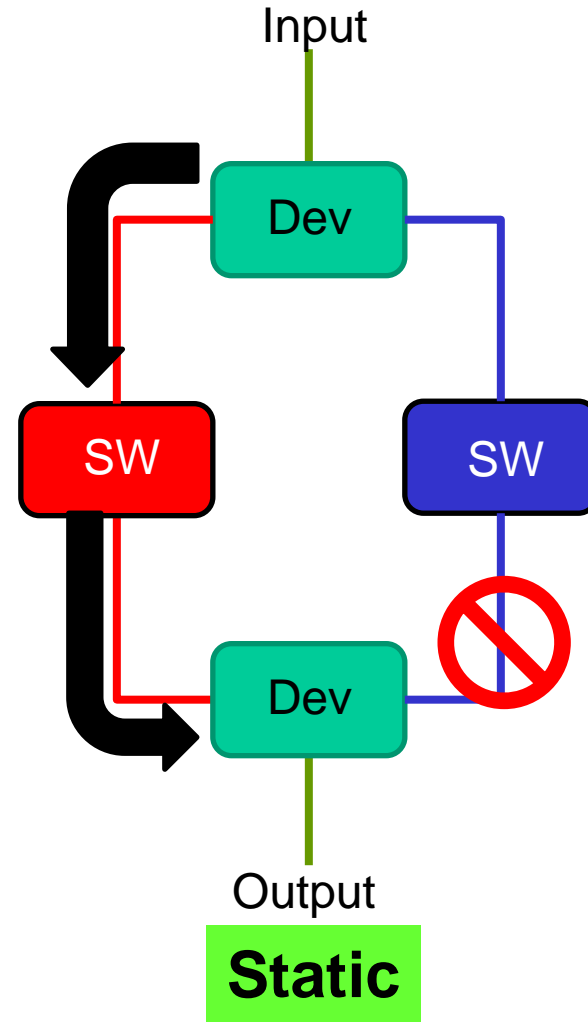
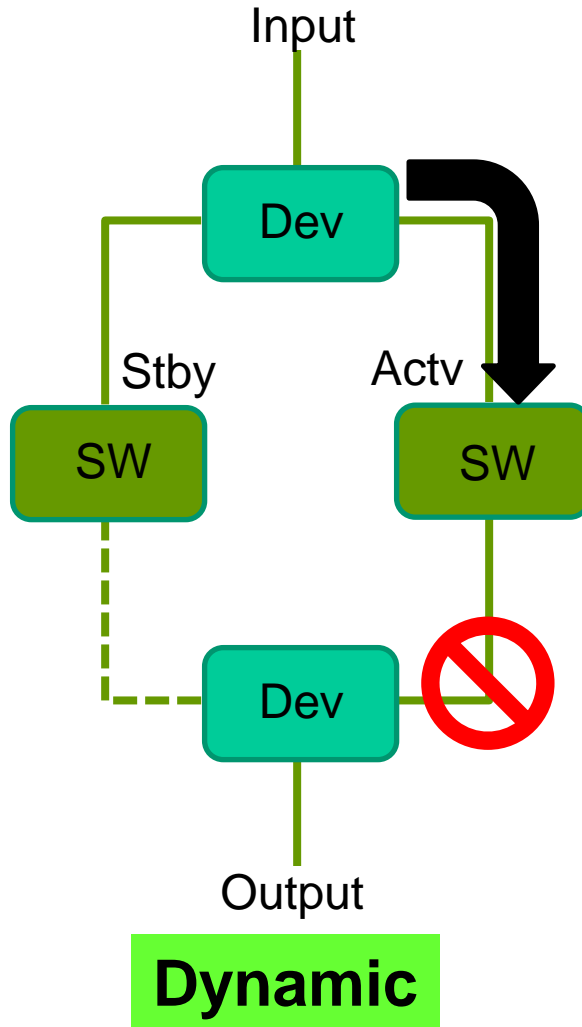
Key to High Availability is reduced recovery time

Availability is increased by introducing Redundancy

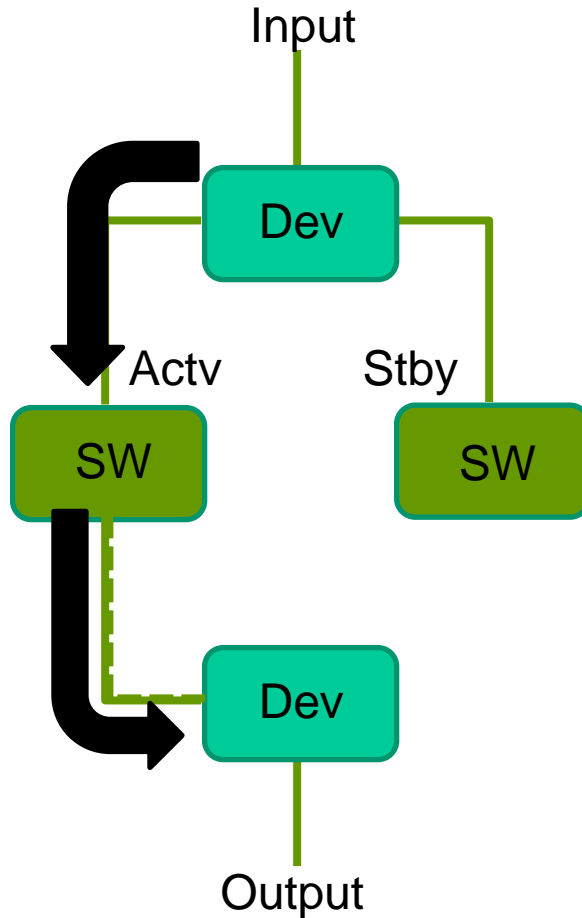
Network Redundancy



Network Redundancy



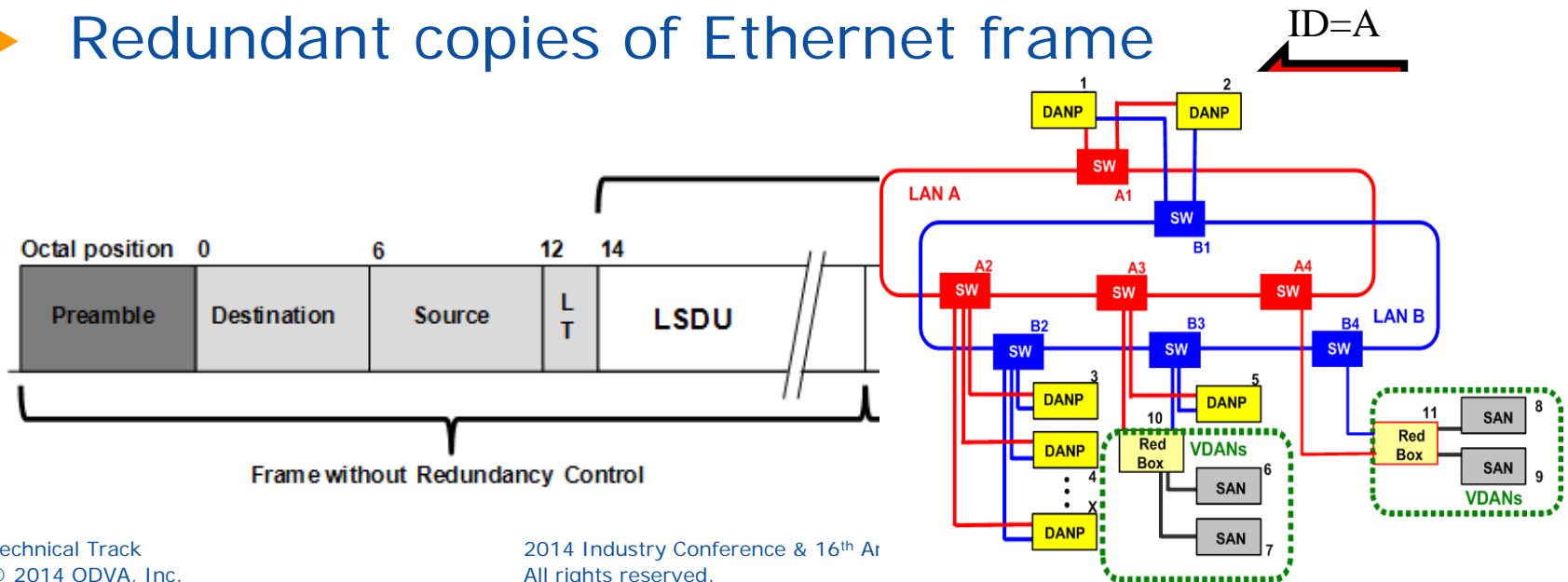
Network Redundancy



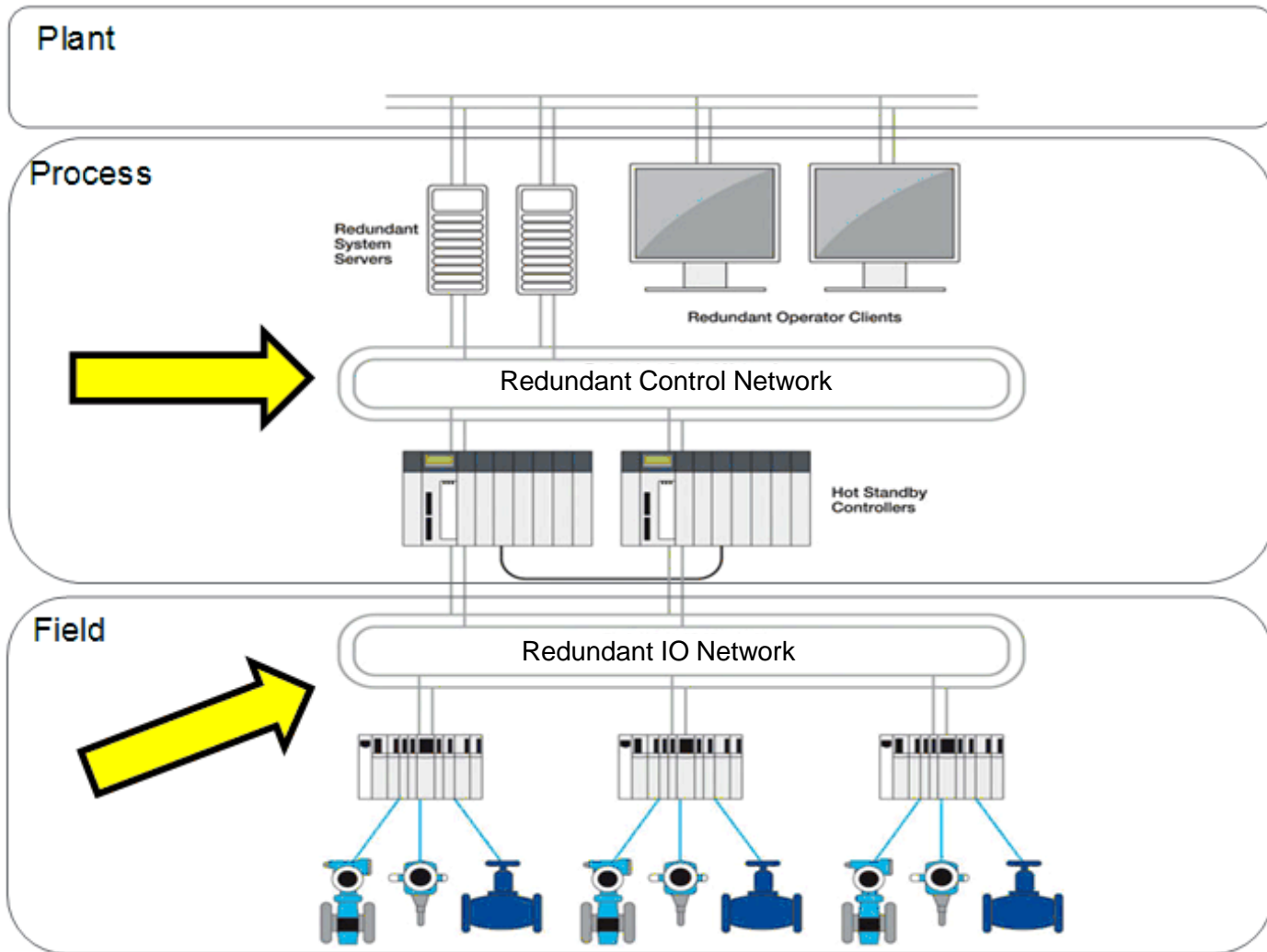
Dynamic

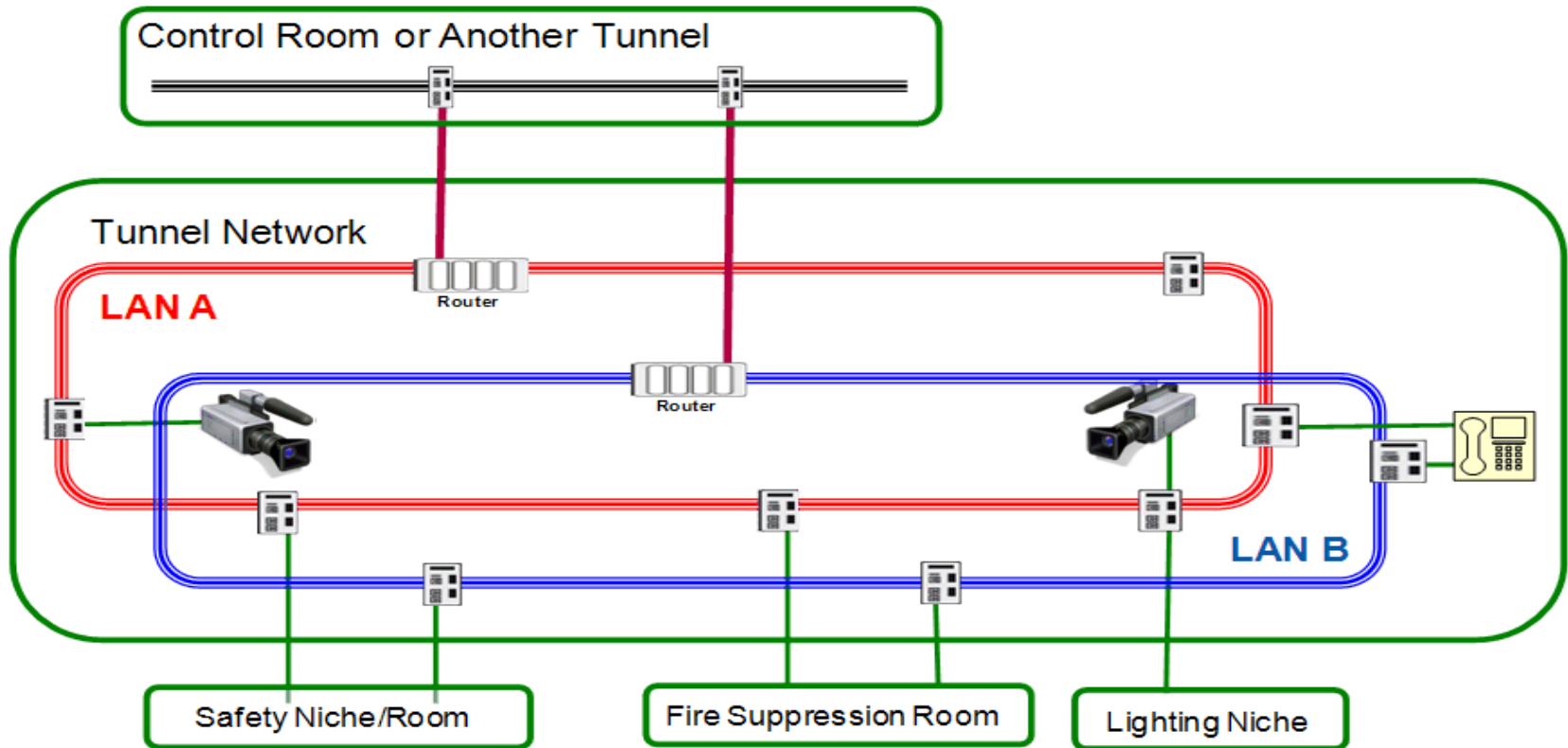
Static Network Redundancy Solution:

- ▶ Defined in IEC 62439-3 Ed 2.0-2012-07, Clause 4
- ▶ 100% Network Availability
- ▶ 0mS Recovery Time
- ▶ Redundant Independent Networks (LAN A/B)
- ▶ Redundant copies of Ethernet frame

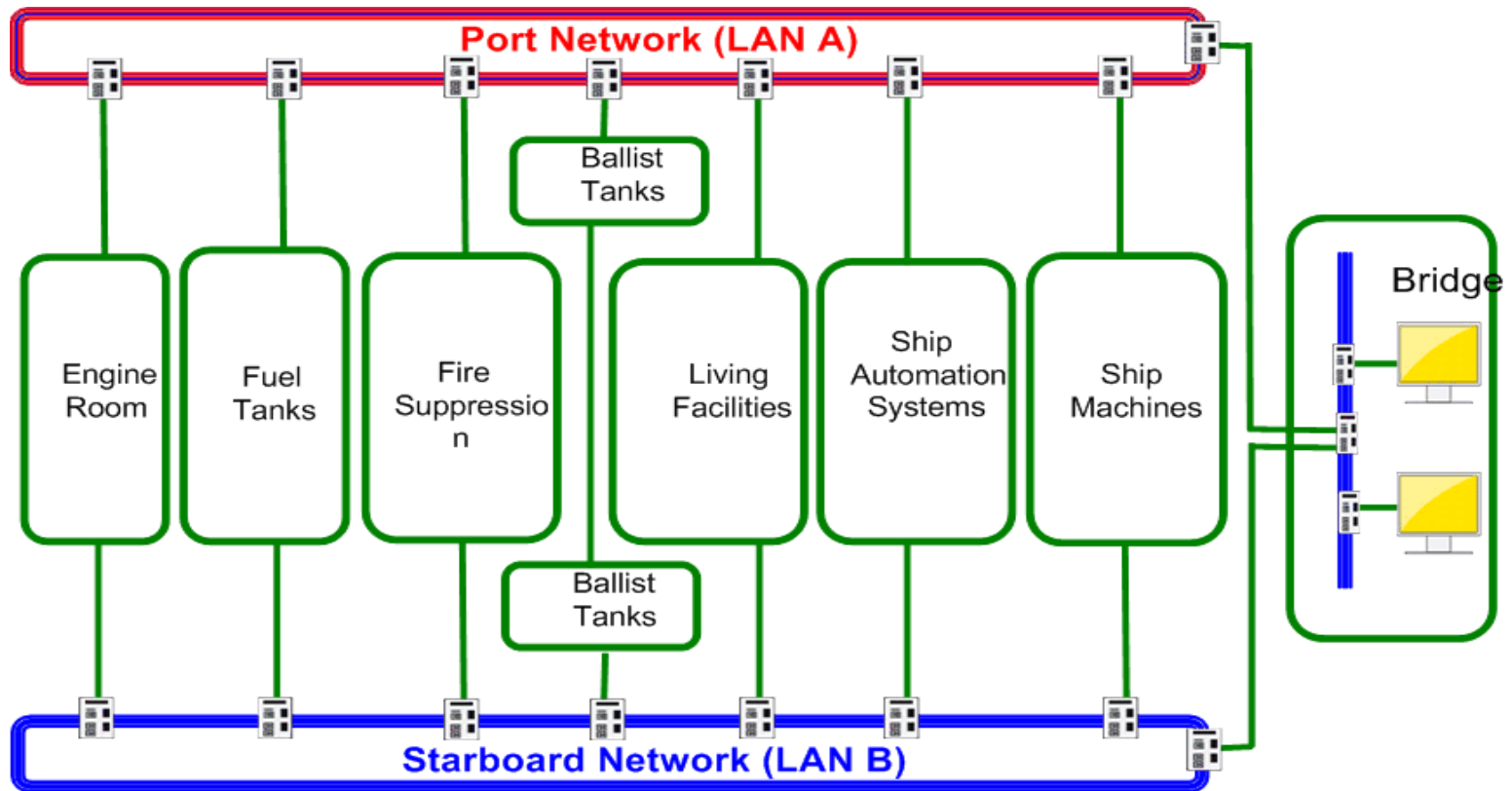


Plant Network





American Bureau of Shipping
requires network redundancy



Introduction

High Availability

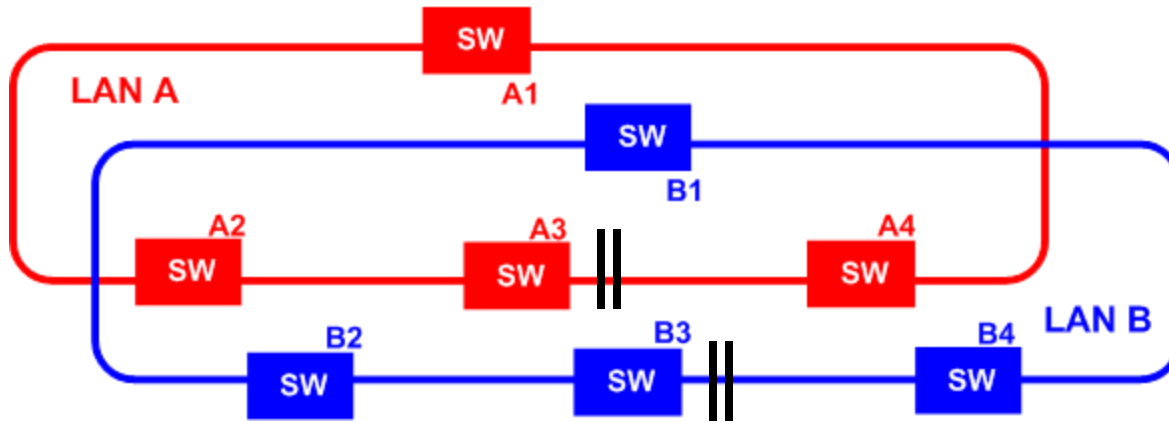
PRP Solution
And Applications

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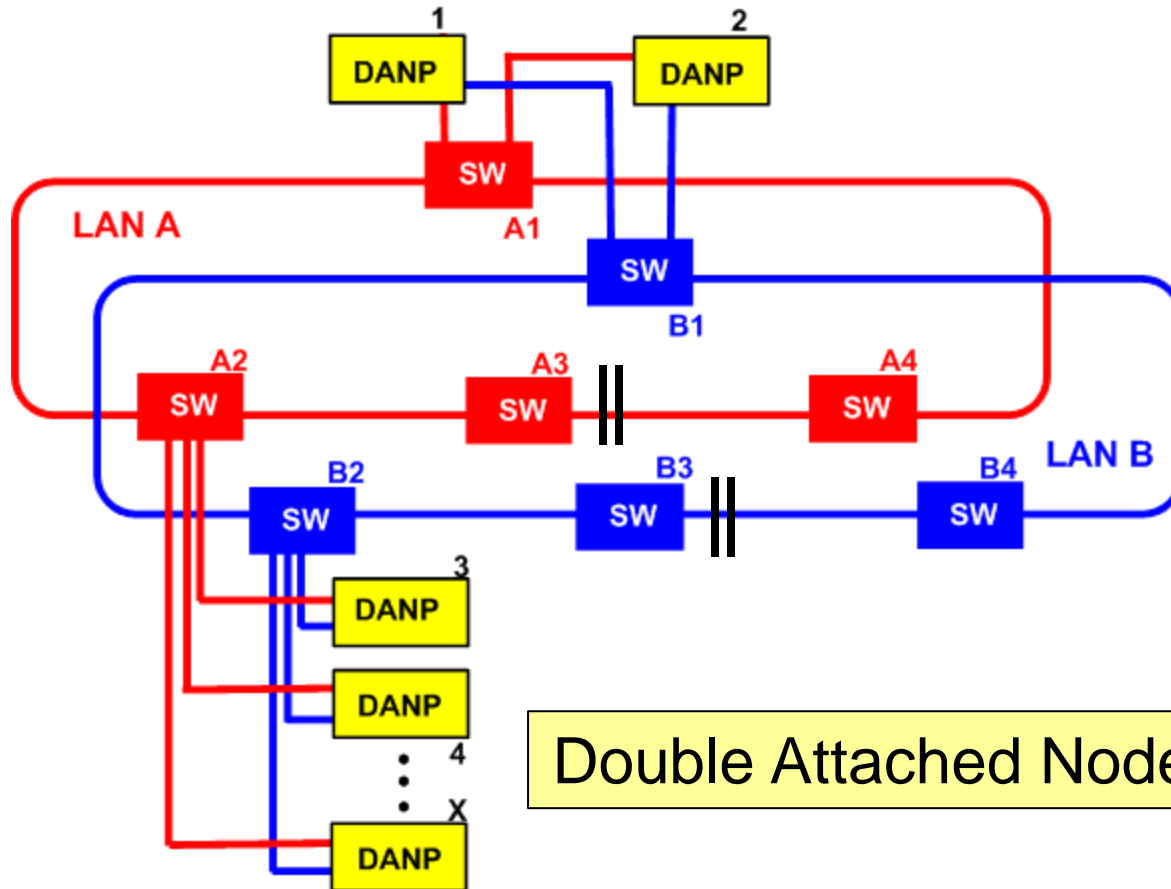
Failure Recovery



Static Redundancy
Network Symmetry and Resiliency
Rapid Spanning Tree Protocol (RSTP)

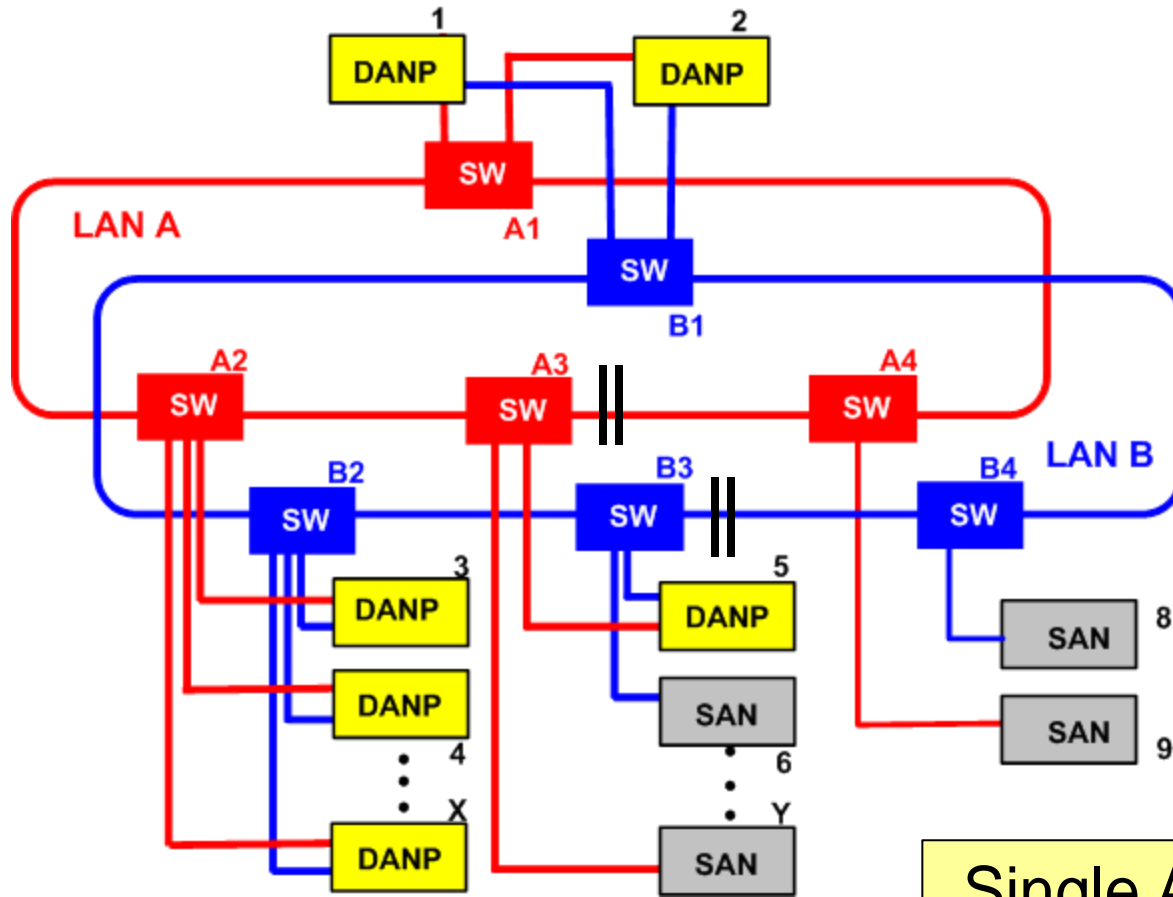
Forward Frames > 1522 bytes

Installation



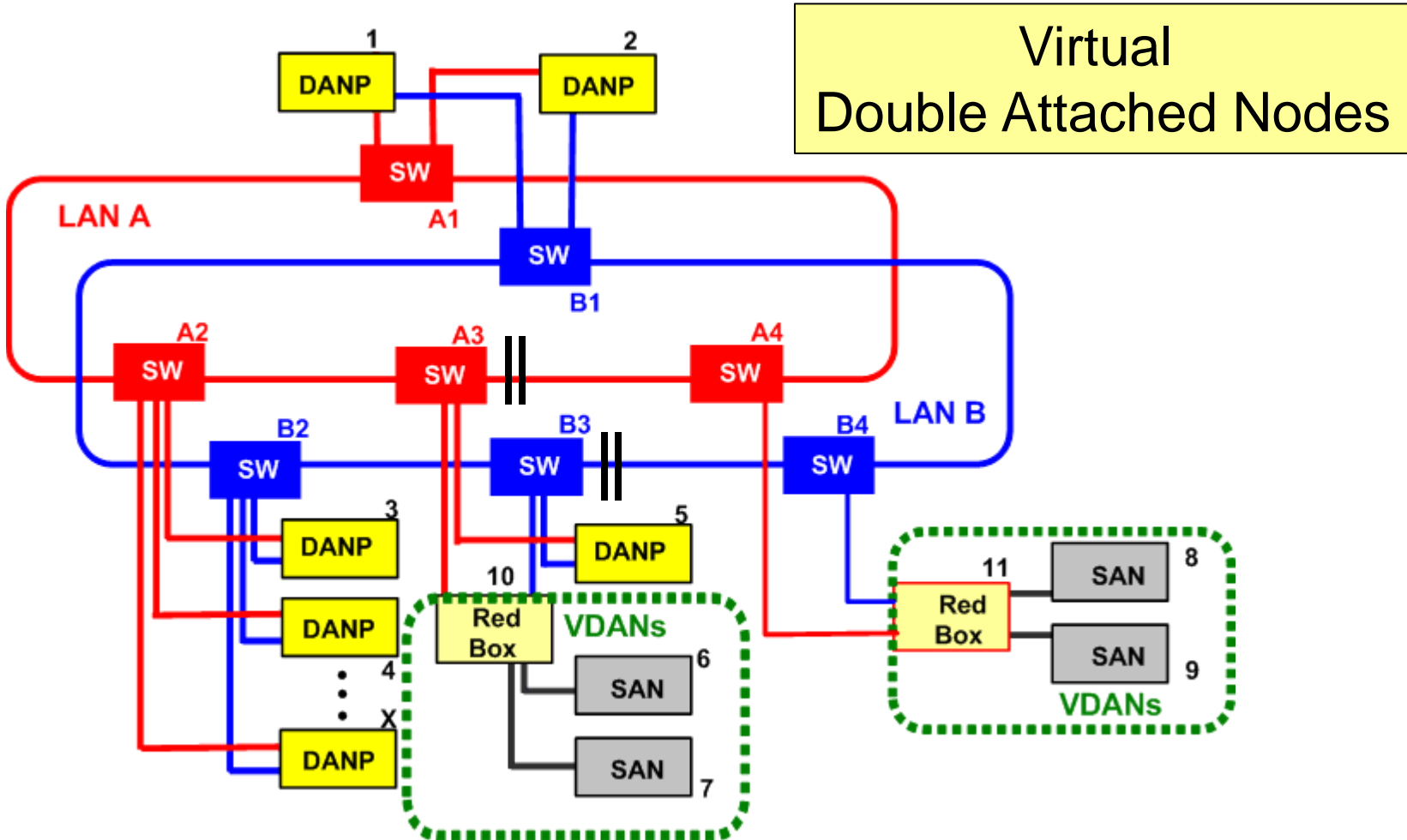
Double Attached Nodes with PRP

Installation



Single Attached Nodes

EtherNet/IP - Install VDANS



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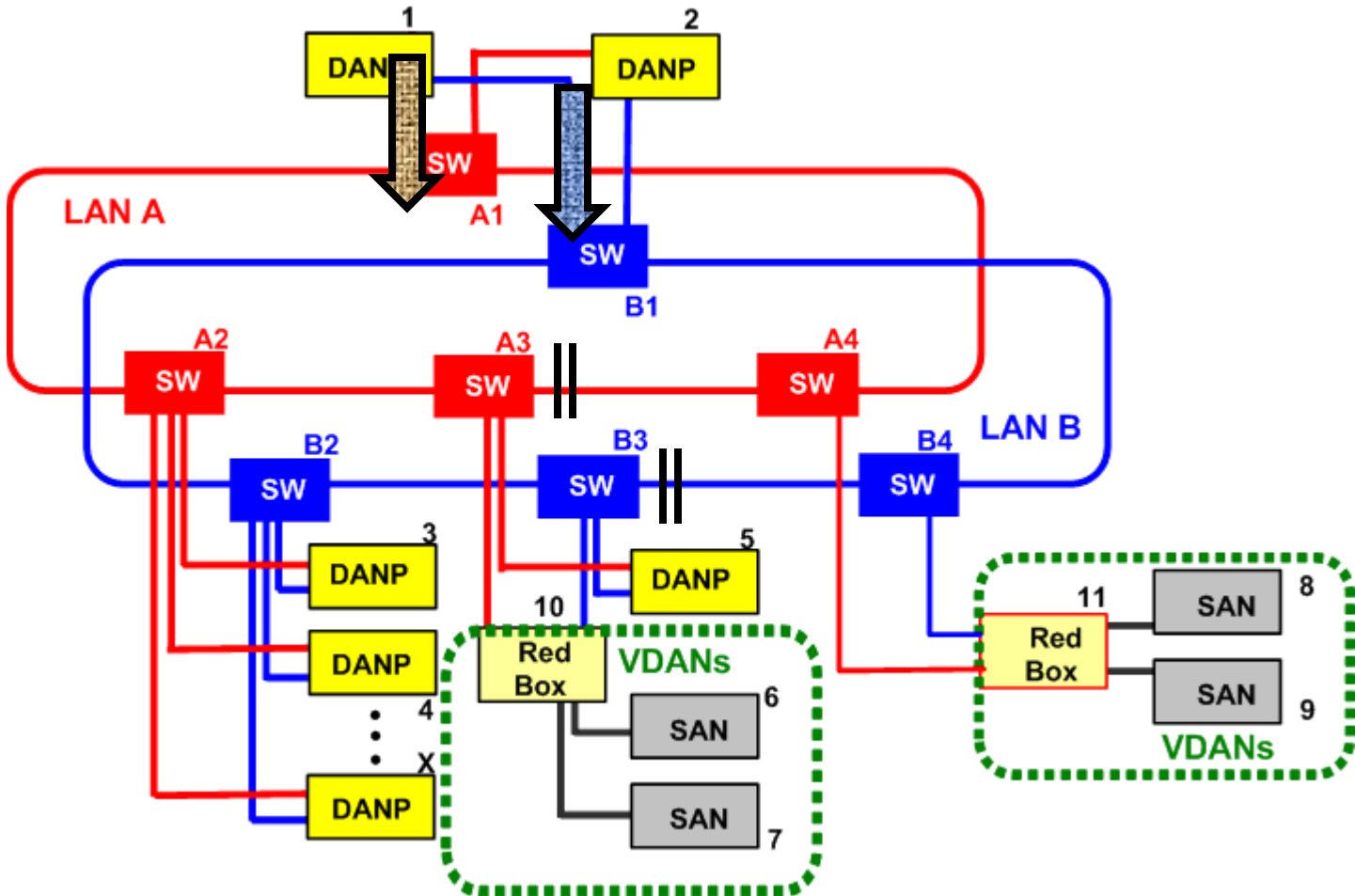
Installation

Initialization

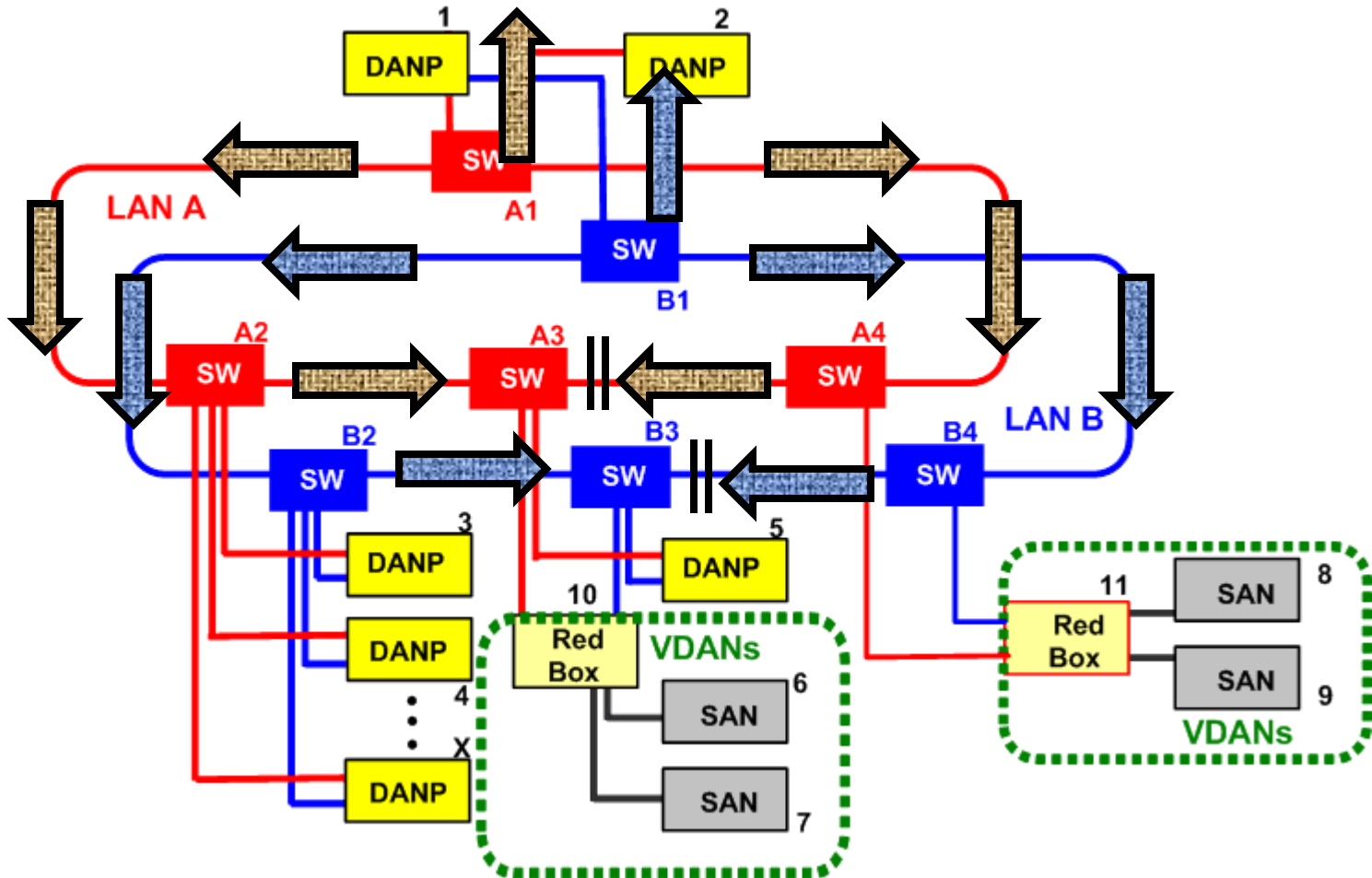
Operation

Failure Recovery

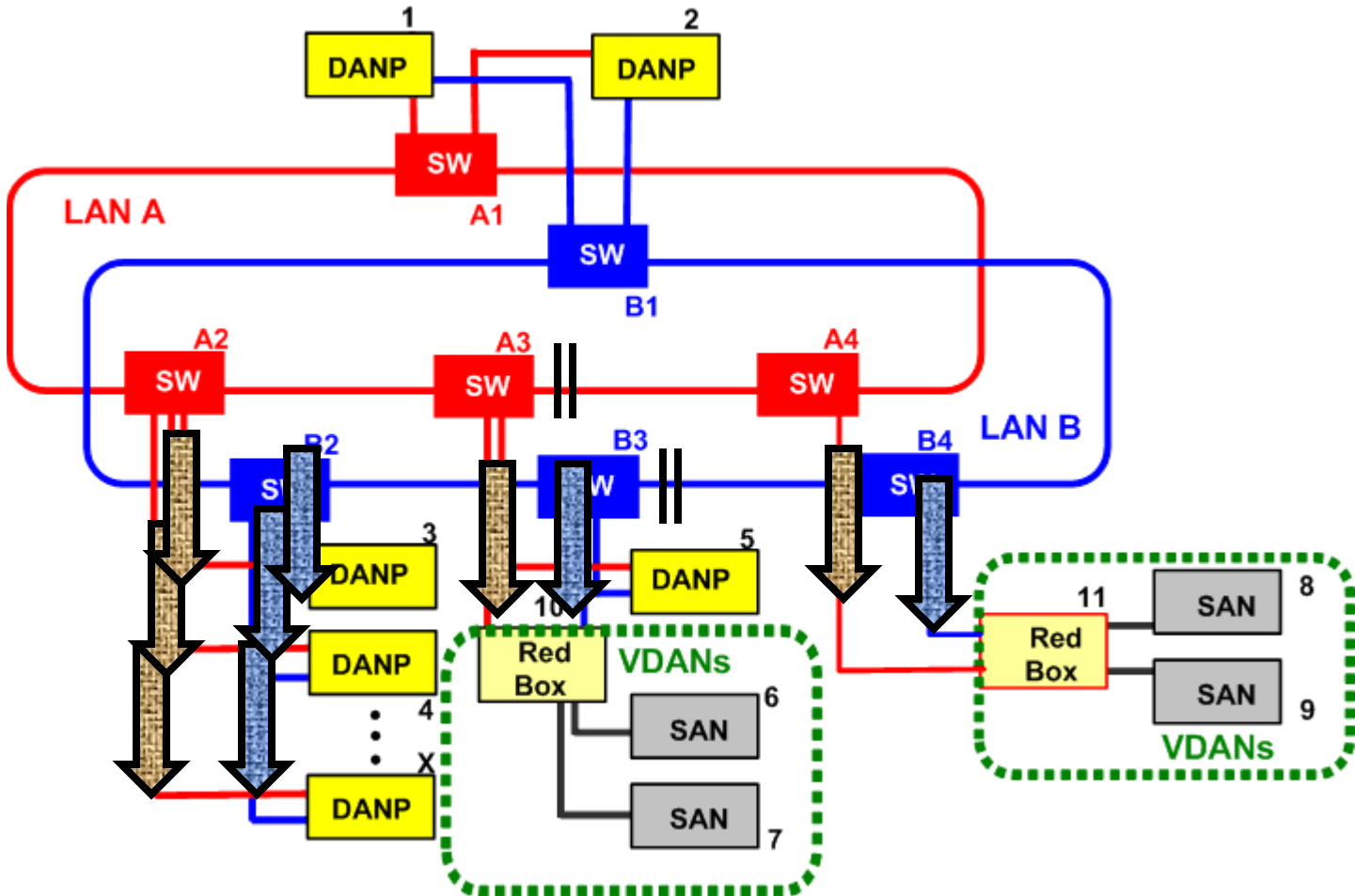
Initialization



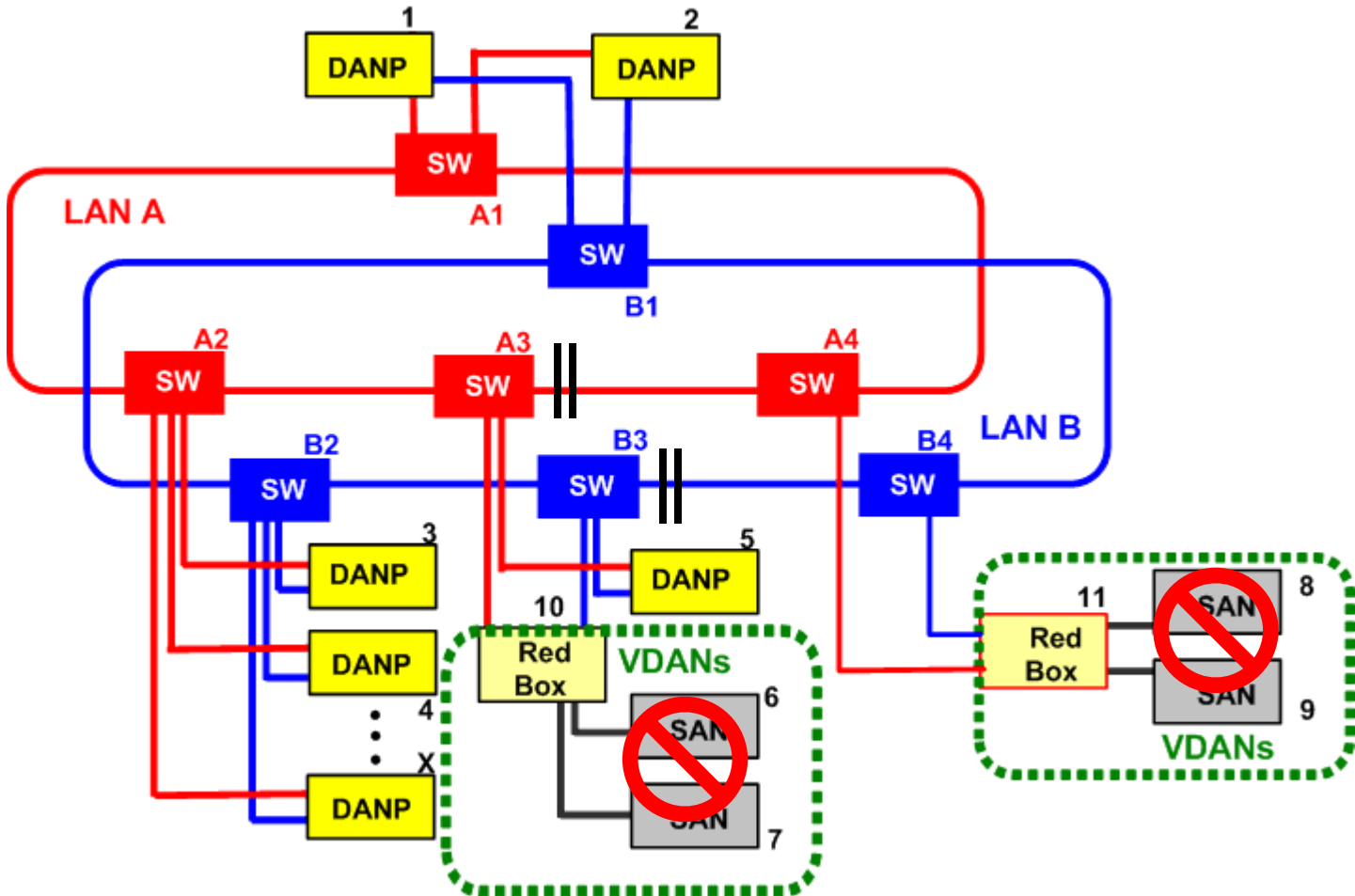
Initialization



Initialization



Filtered from VDANS



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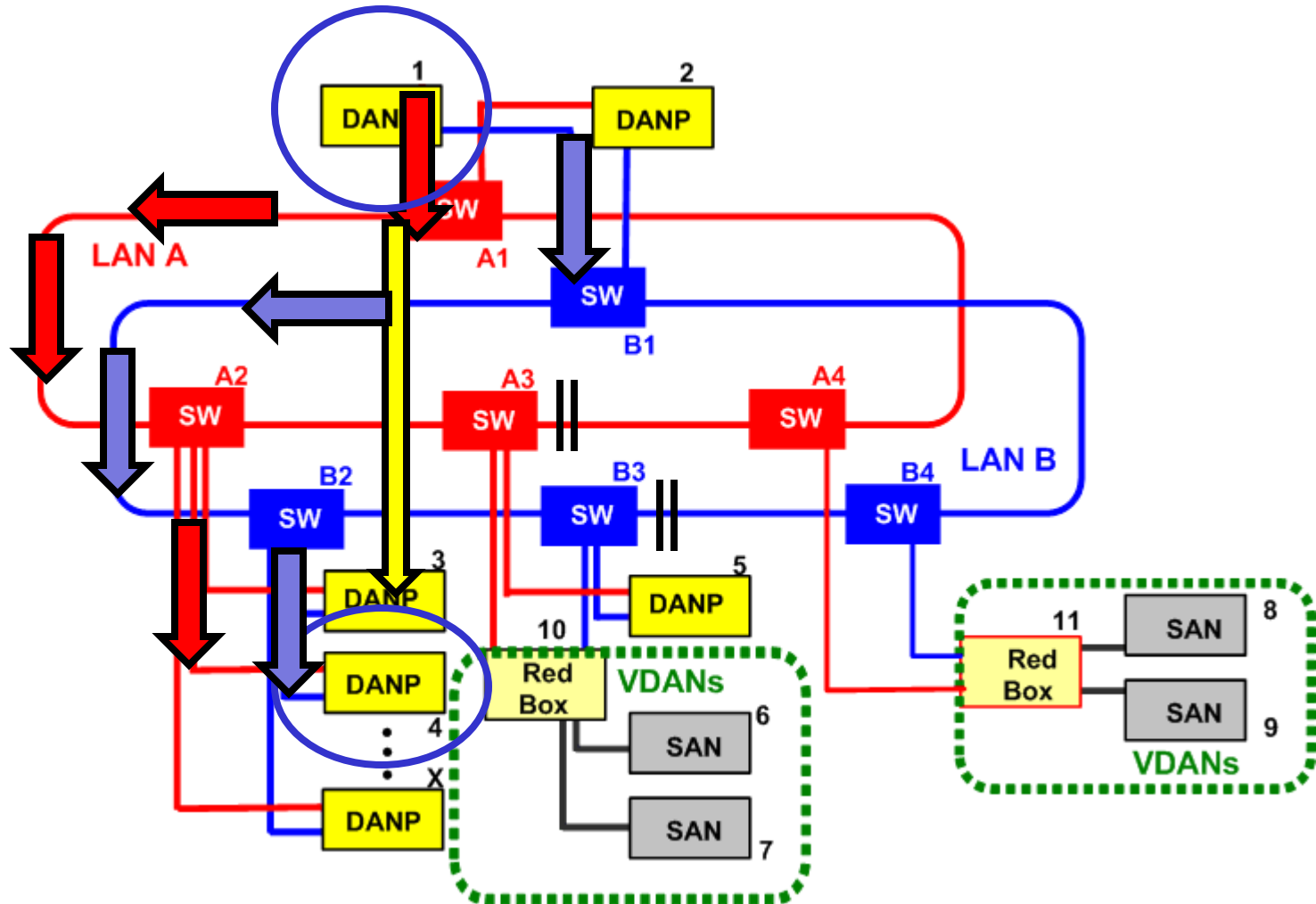
Installation

Initialization

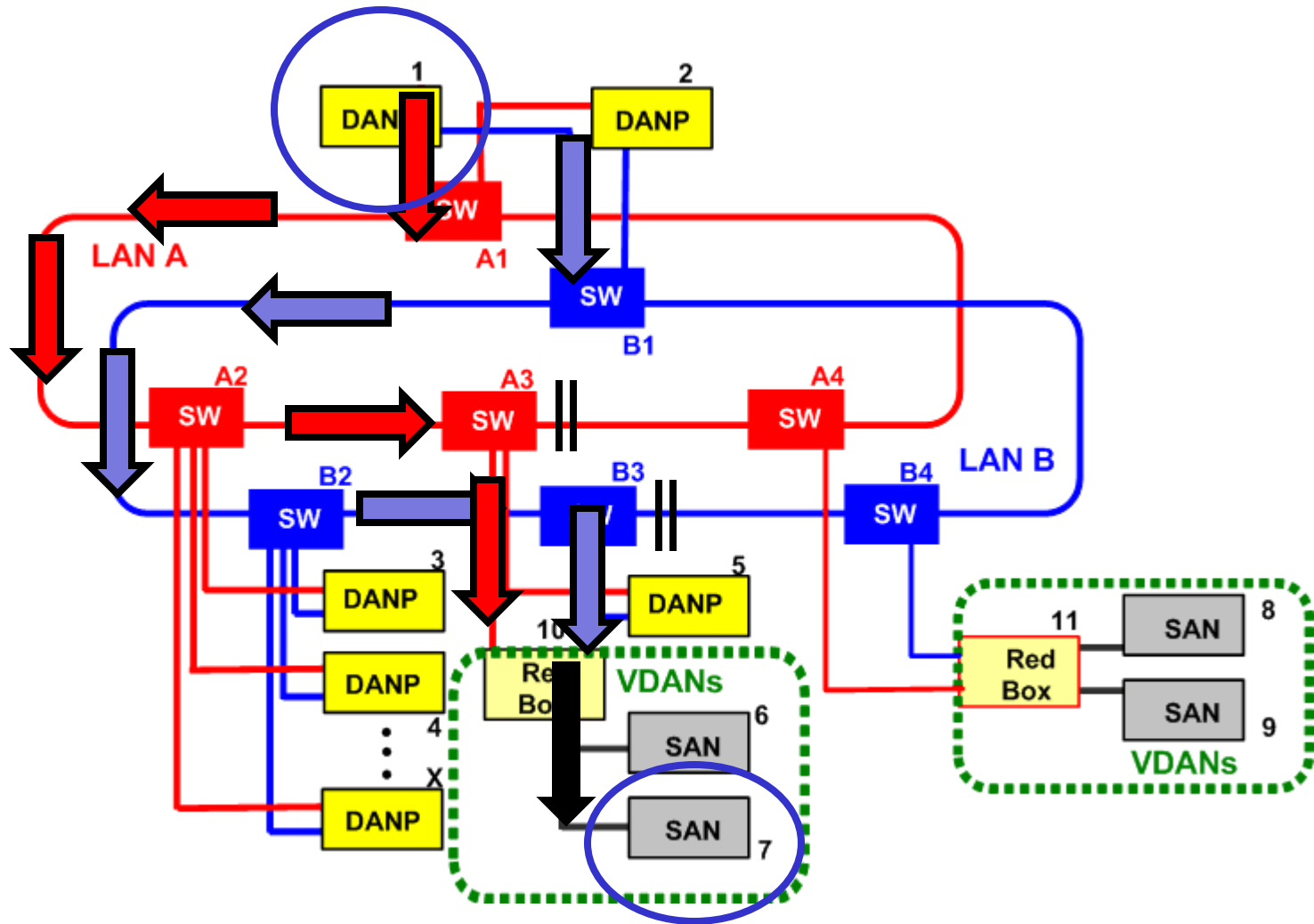
Operation

Failure Recovery

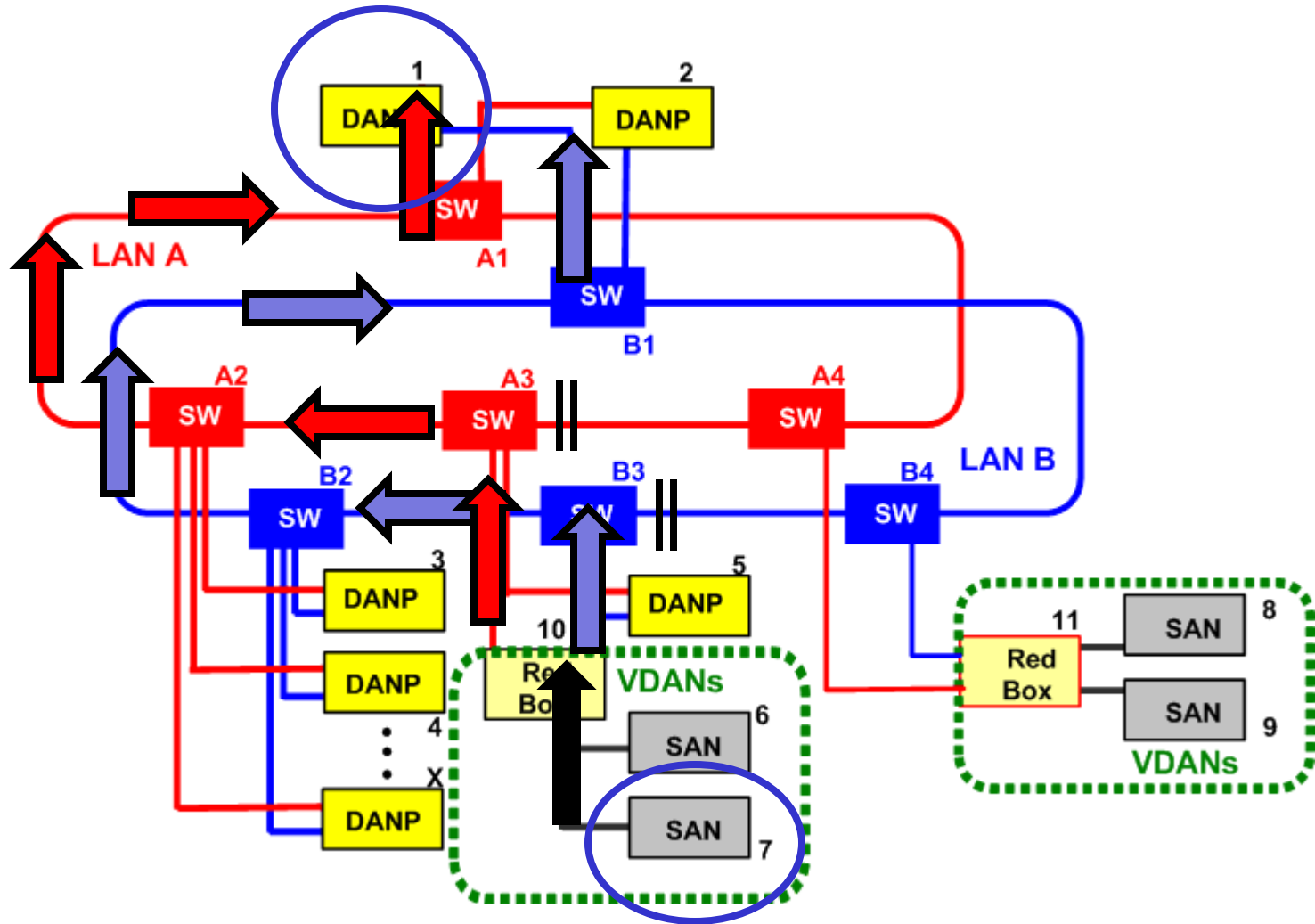
DANP to DANP



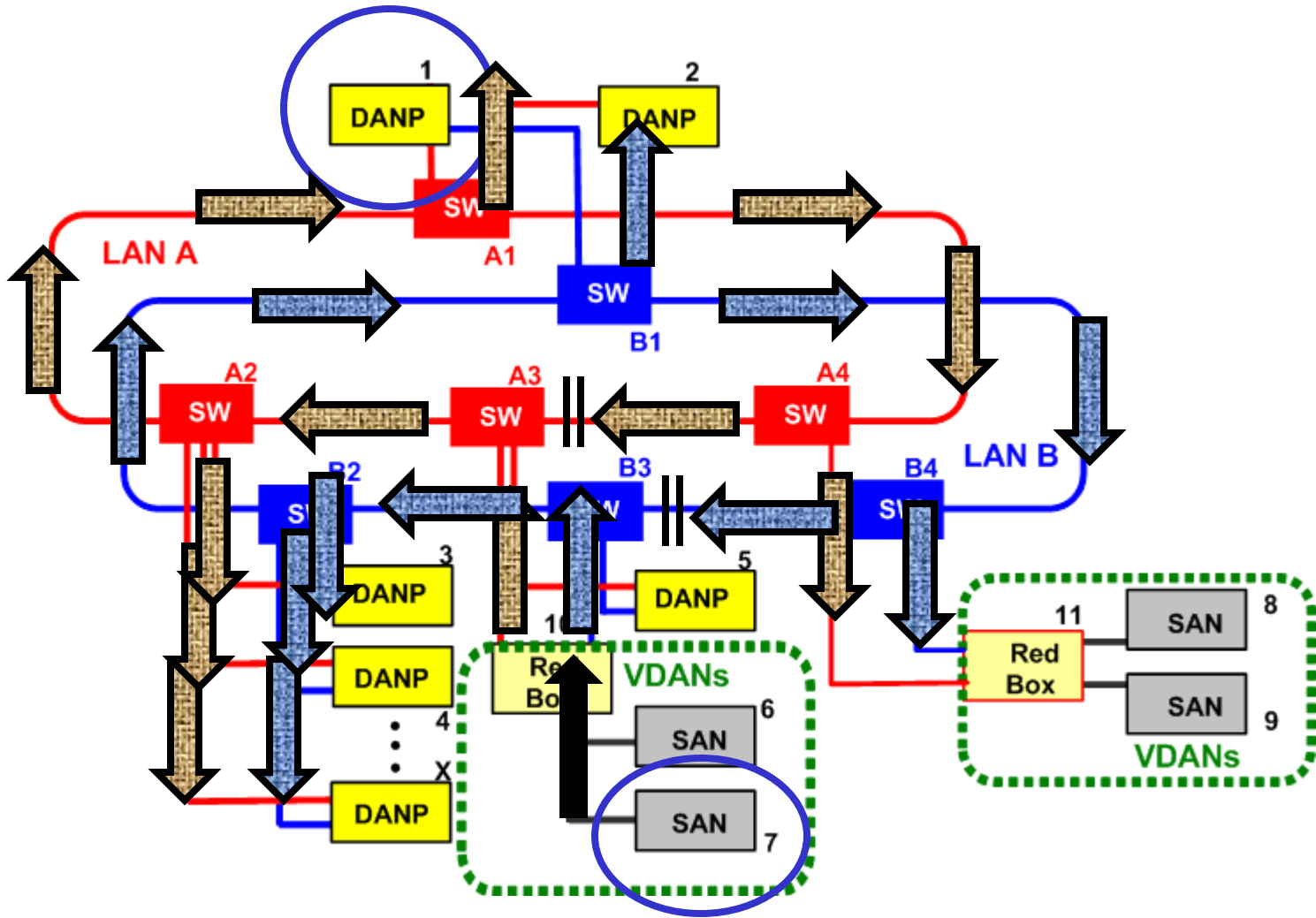
DANP to VDAN



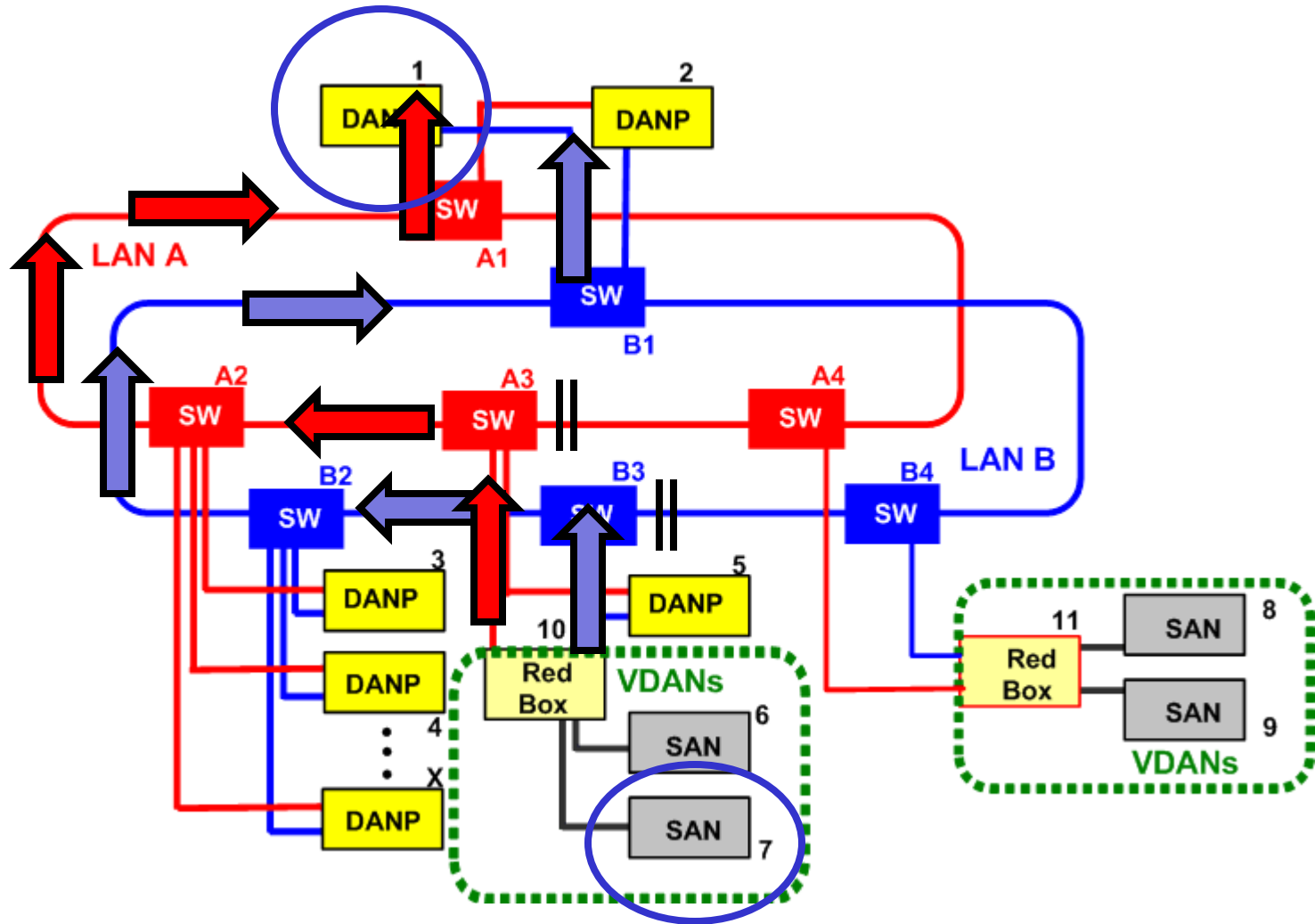
VDAN to DANP



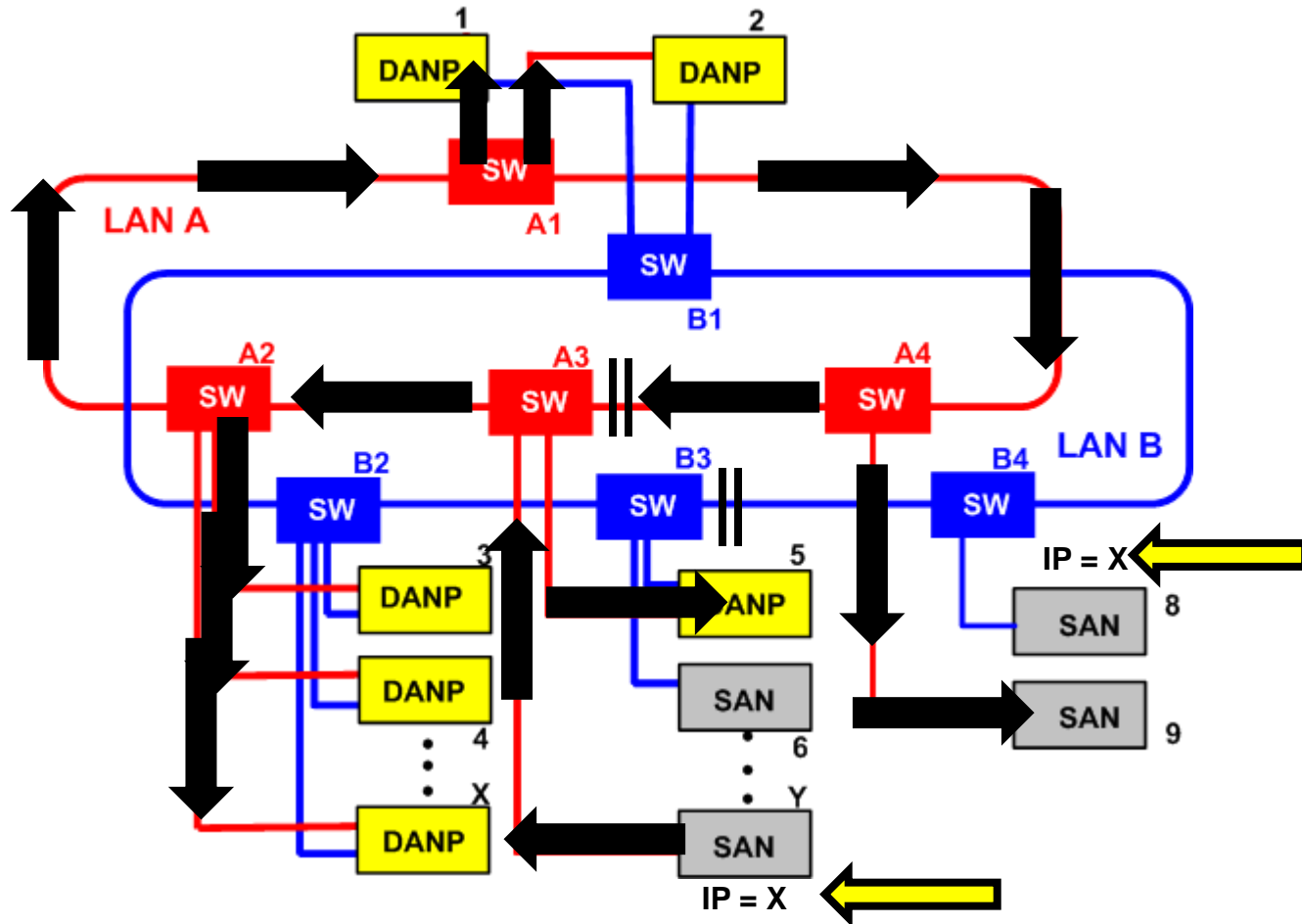
Red-Box as Proxy



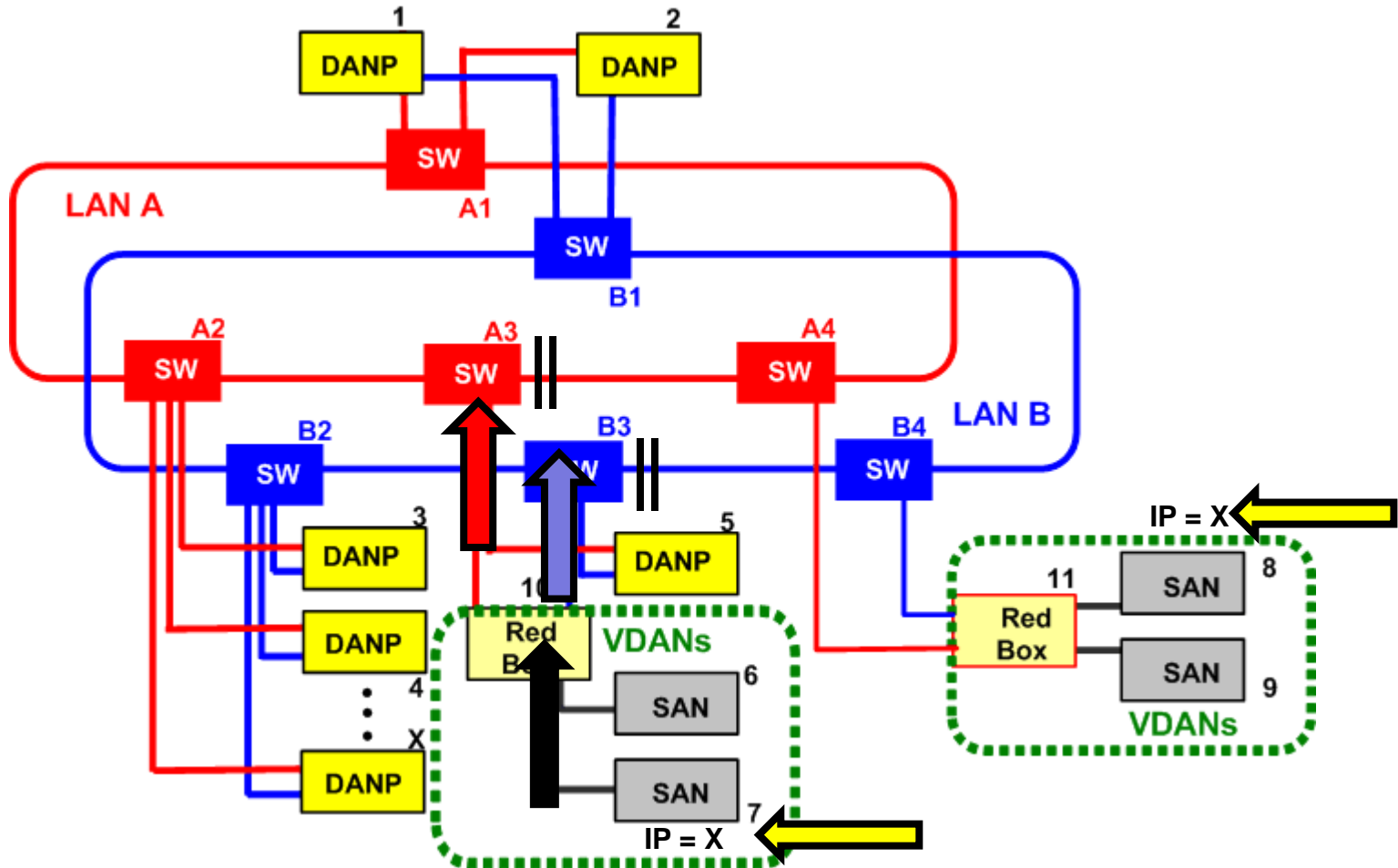
Appended Frame



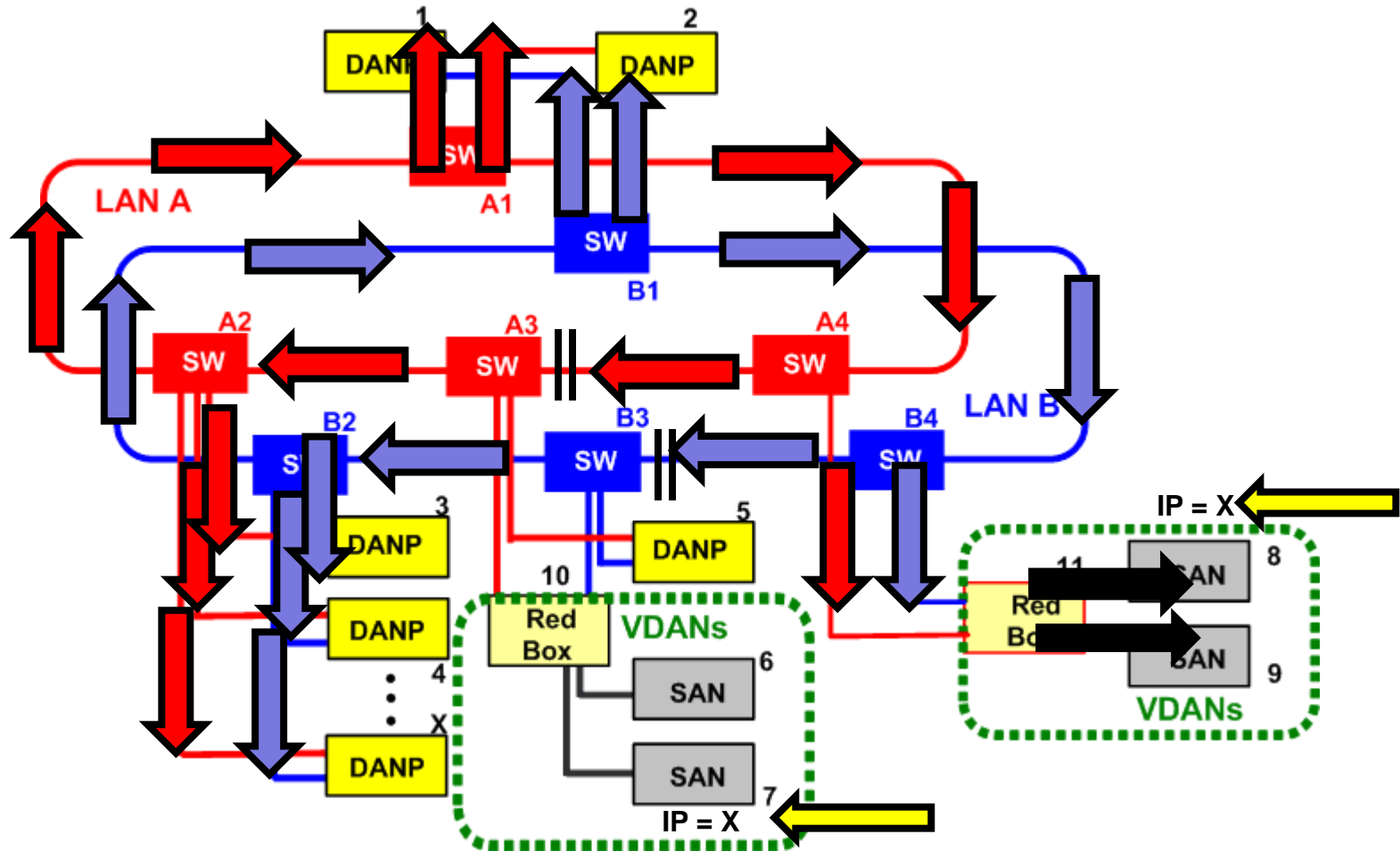
ACD - Direct SANs



ACD - VDANs



ACD - VDANs



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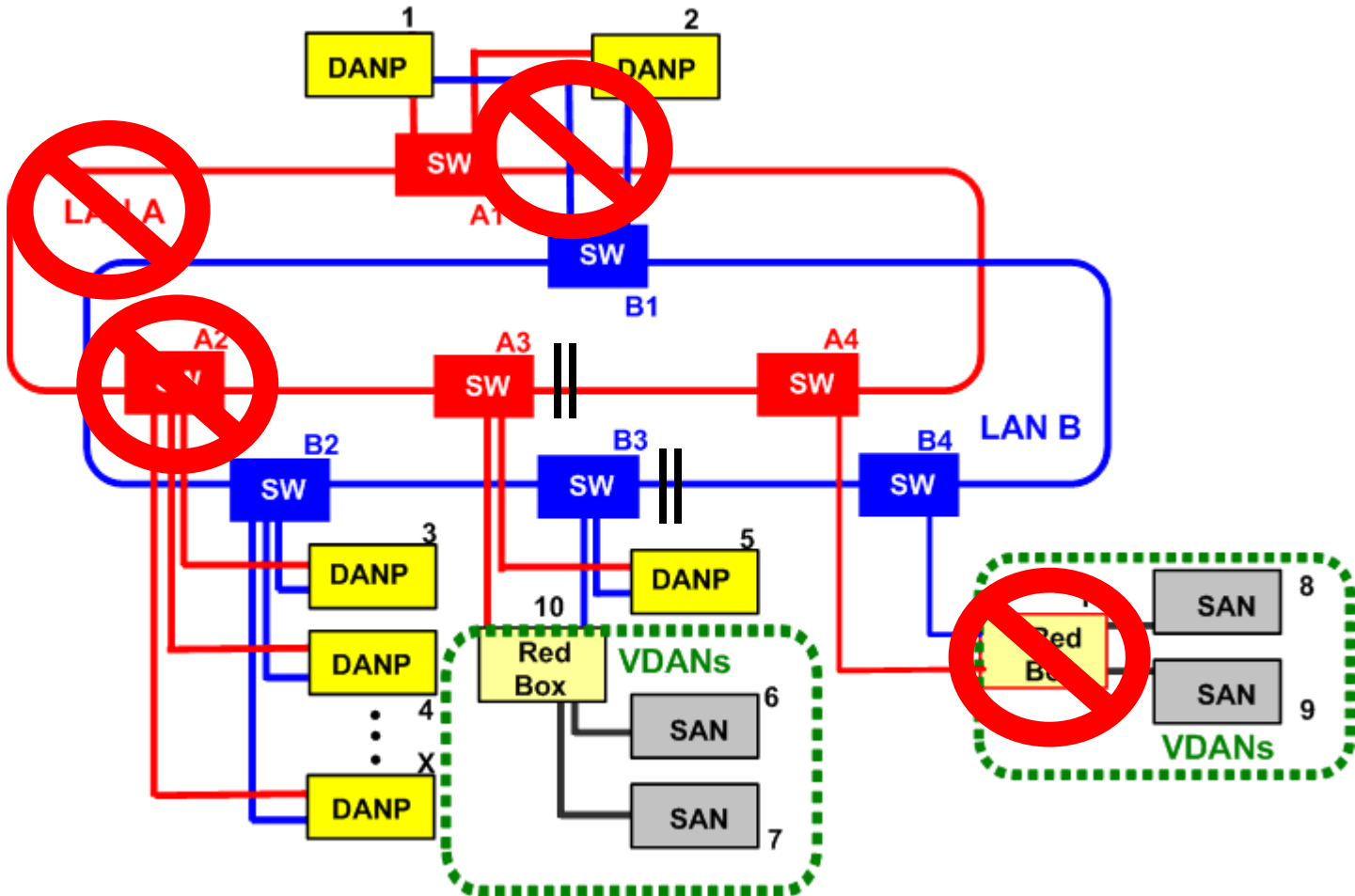
Installation

Initialization

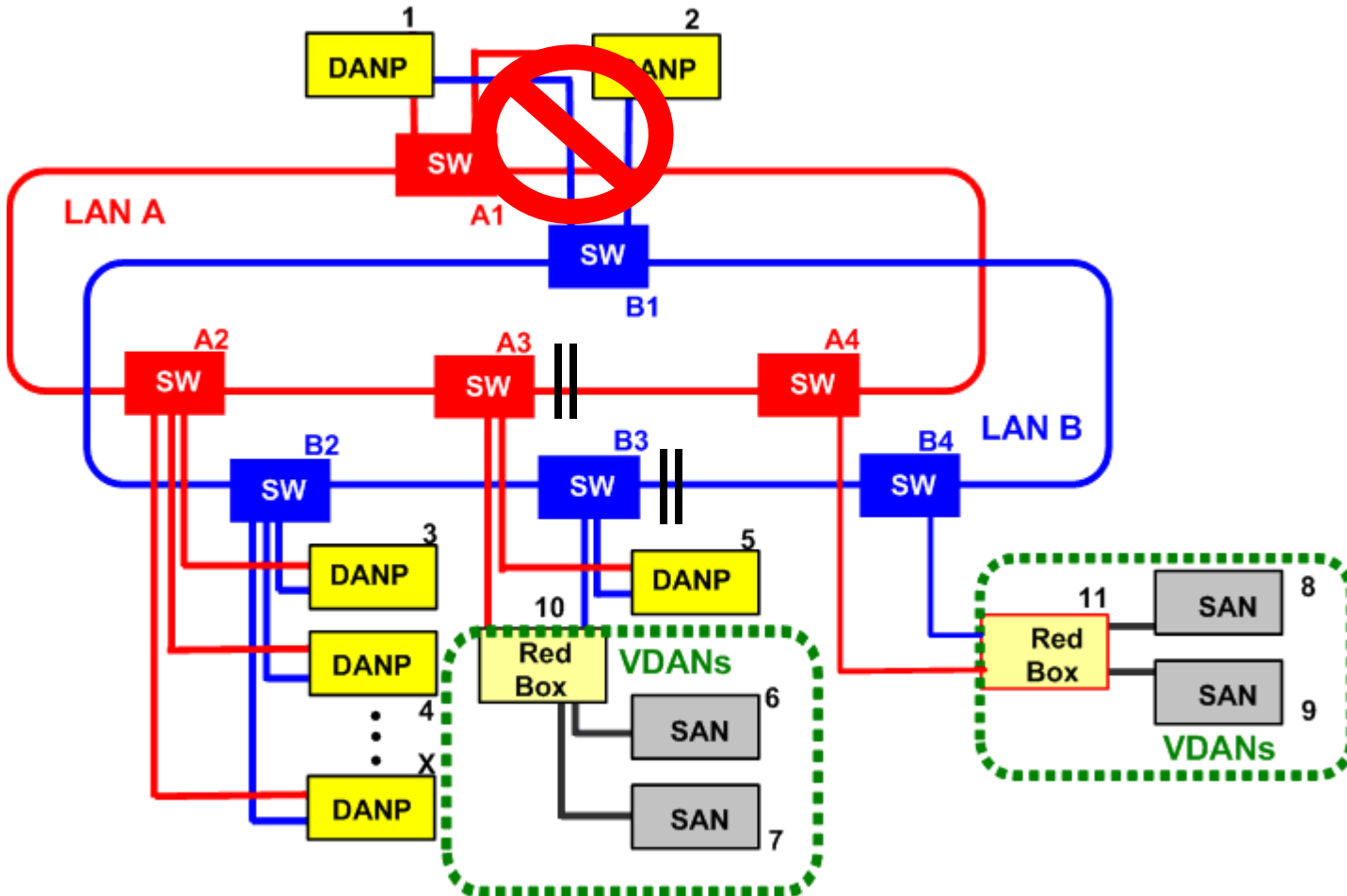
Operation

Failure Recovery

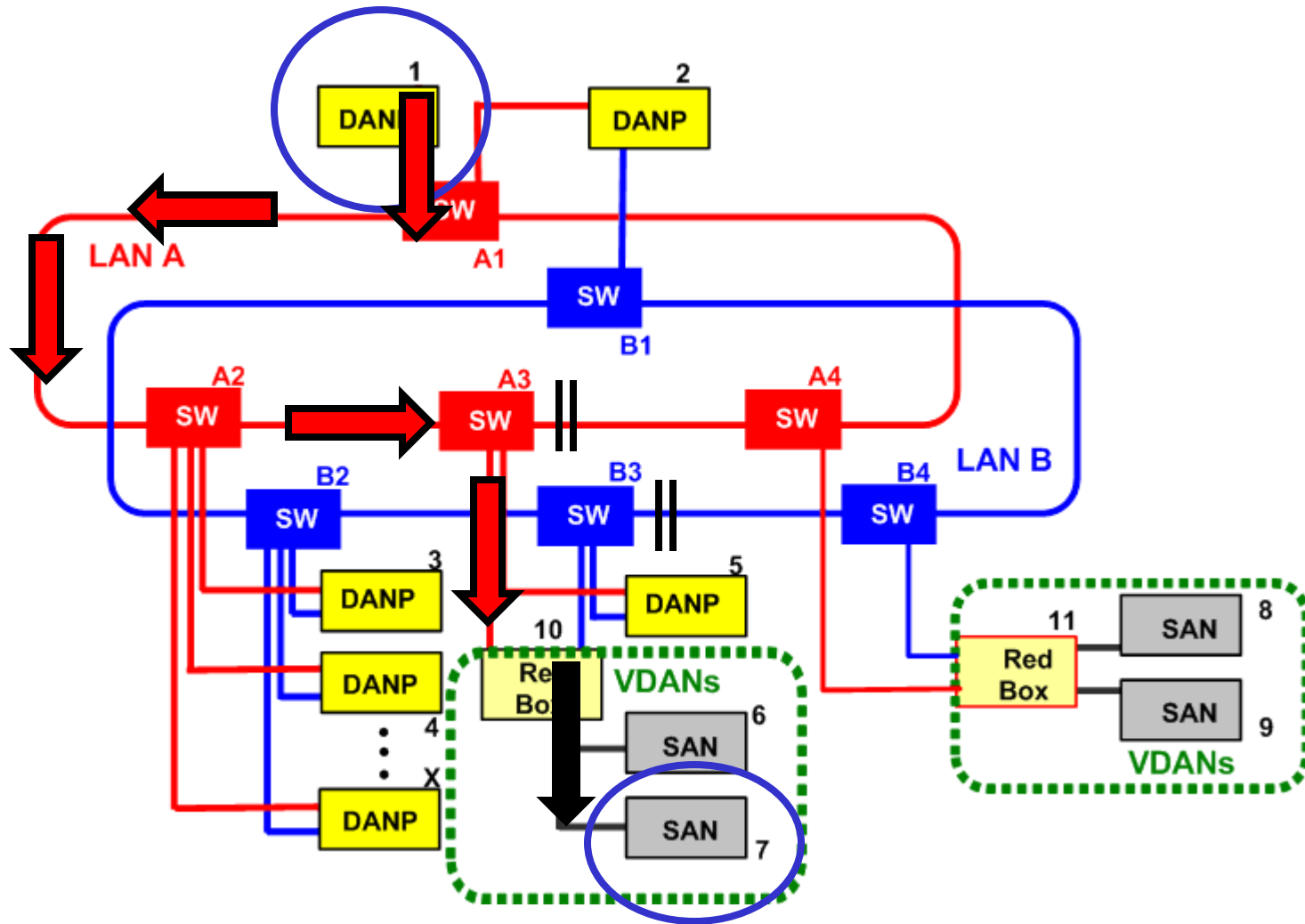
Illustrated Failures



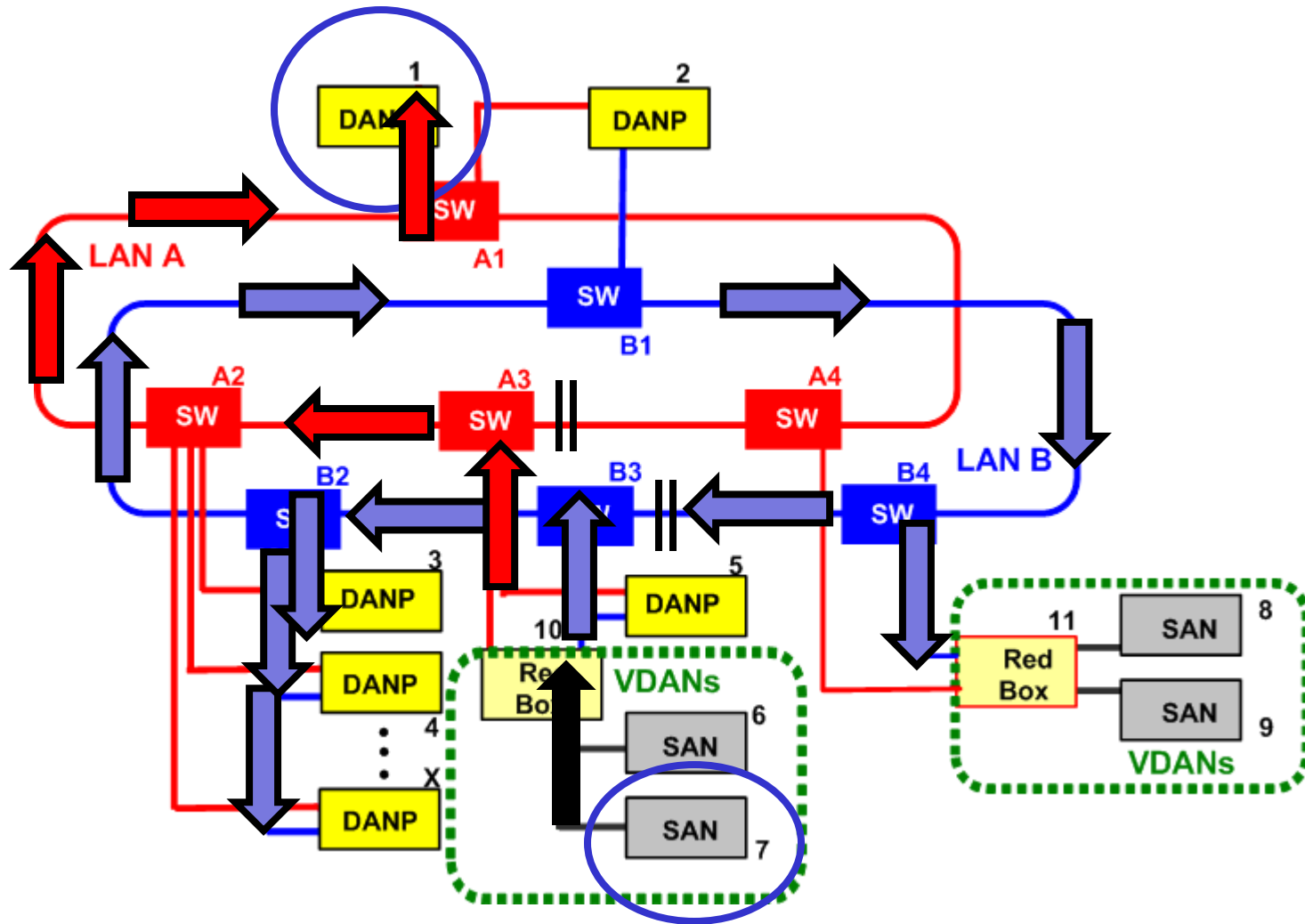
Cable Failure



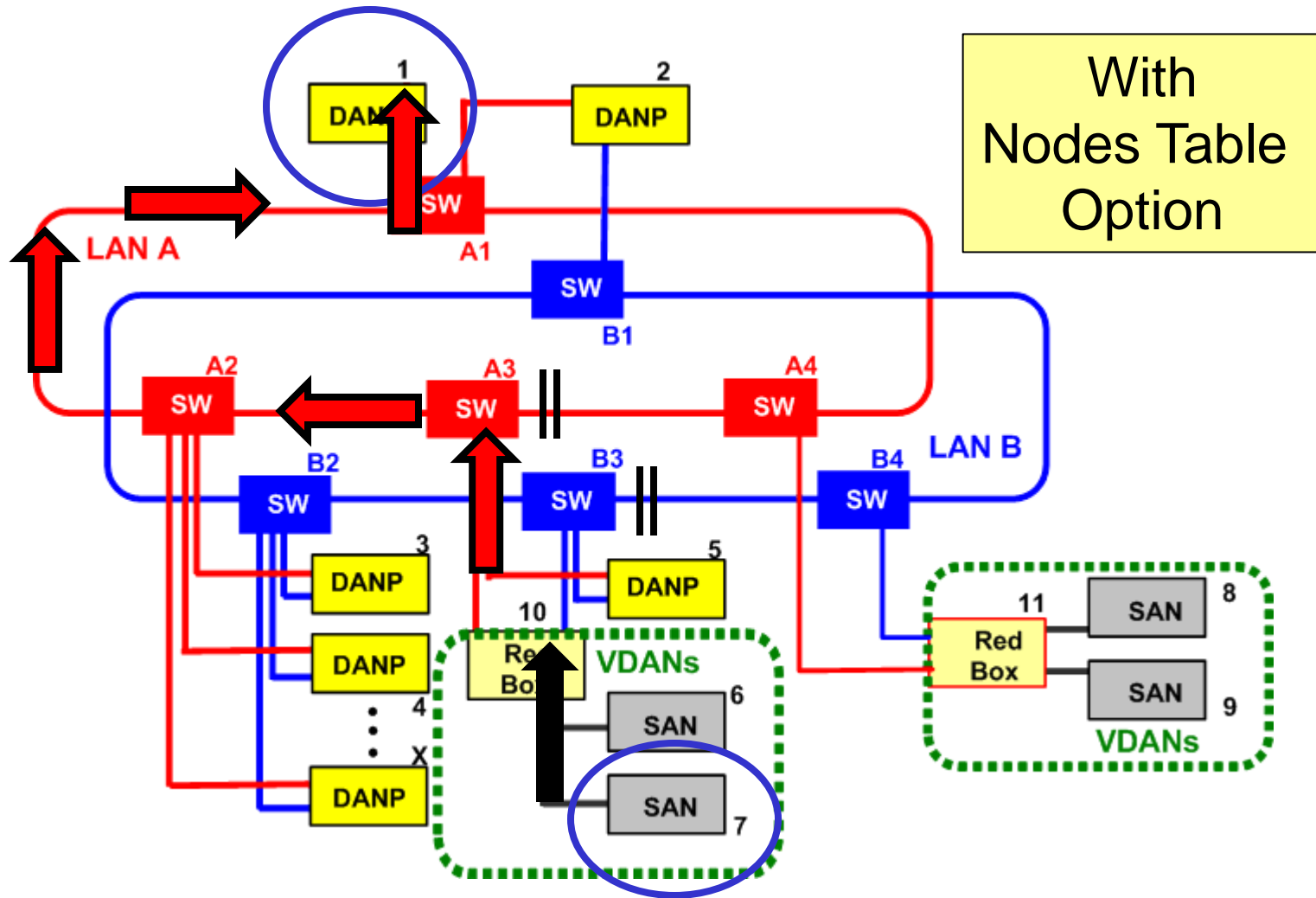
Cable Failure



Cable Failure

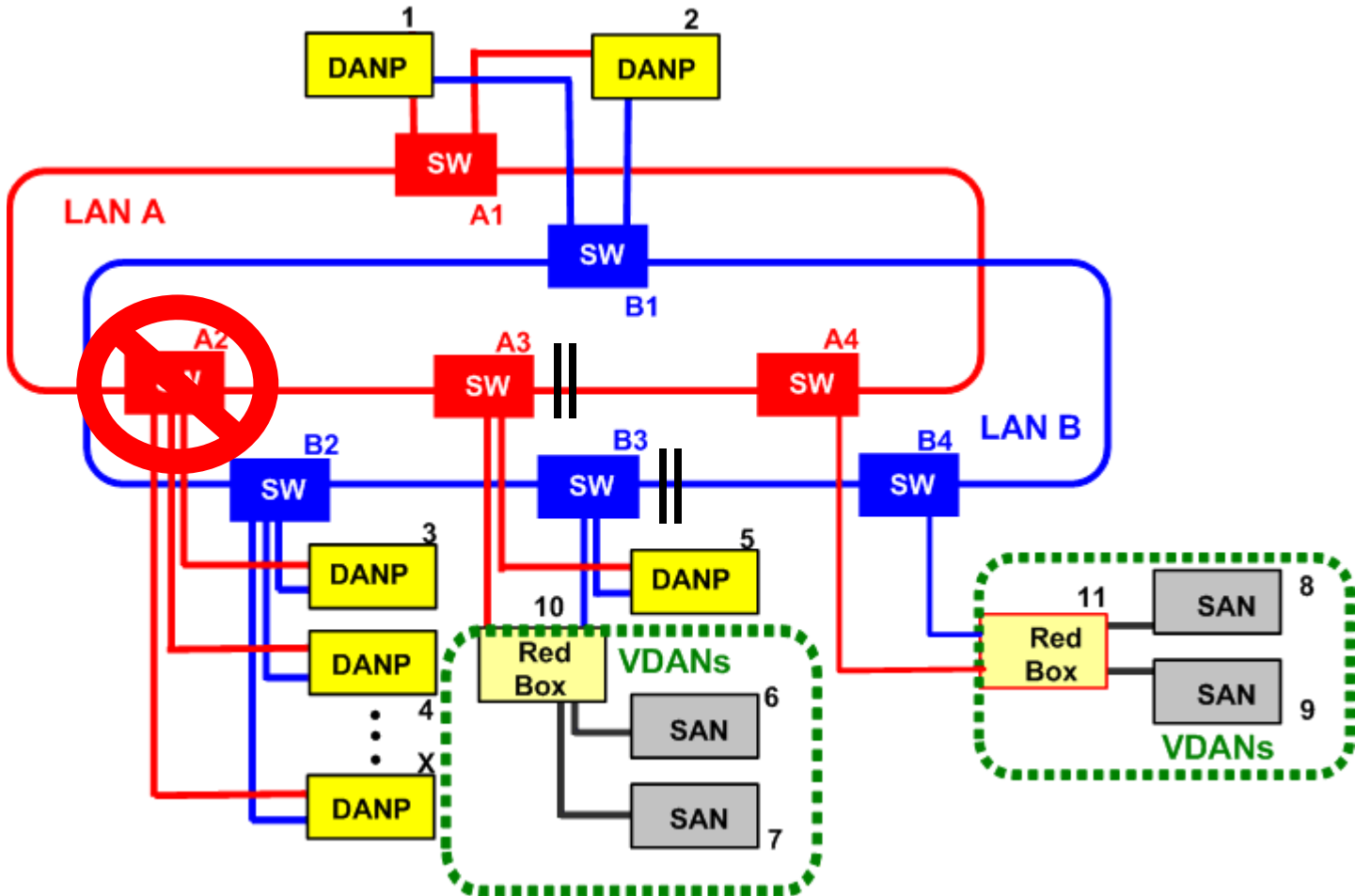


Cable Failure-SAN Transmit

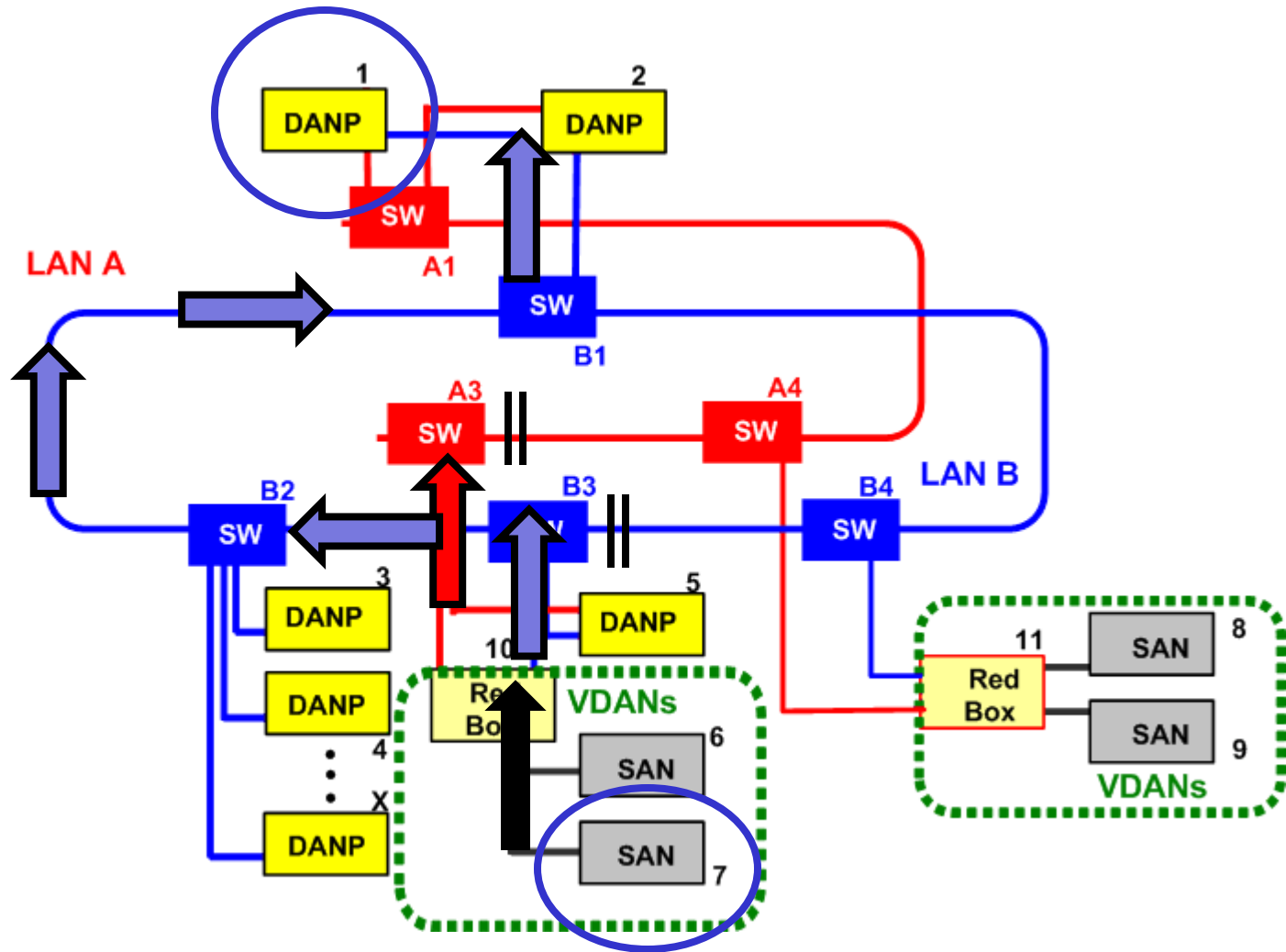


With
Nodes Table
Option

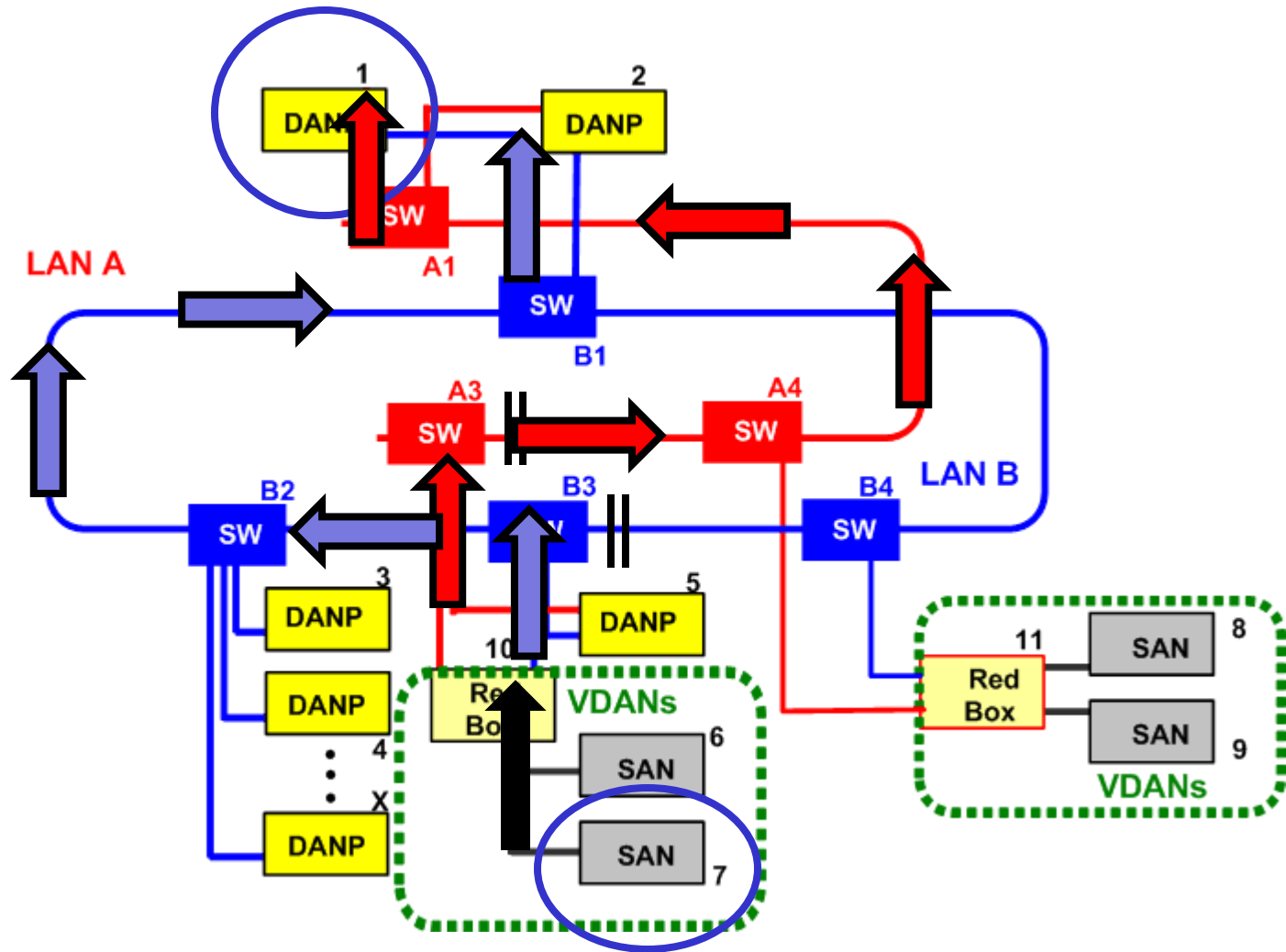
Network Device Failure



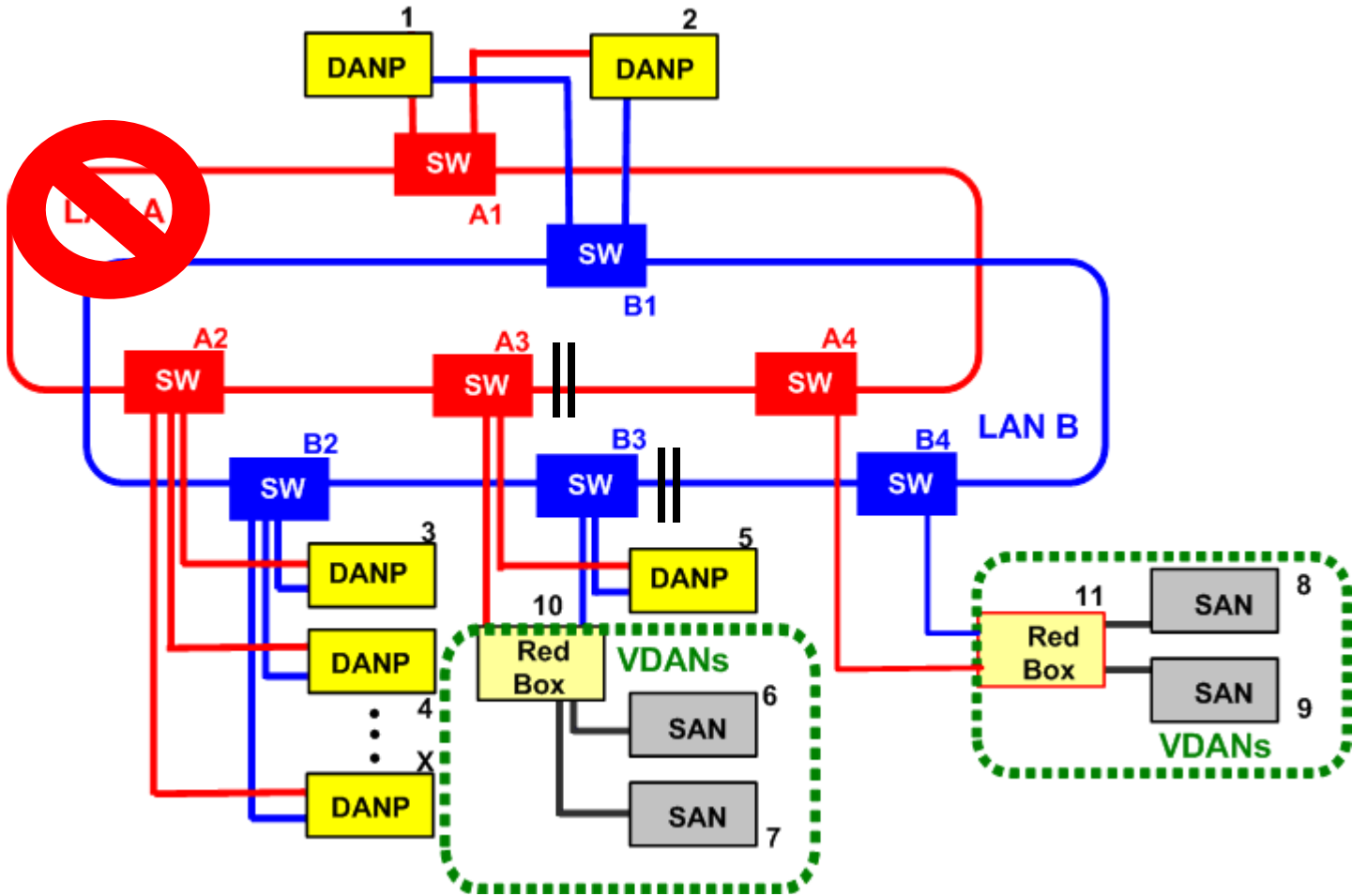
Device Failure-Before Healing



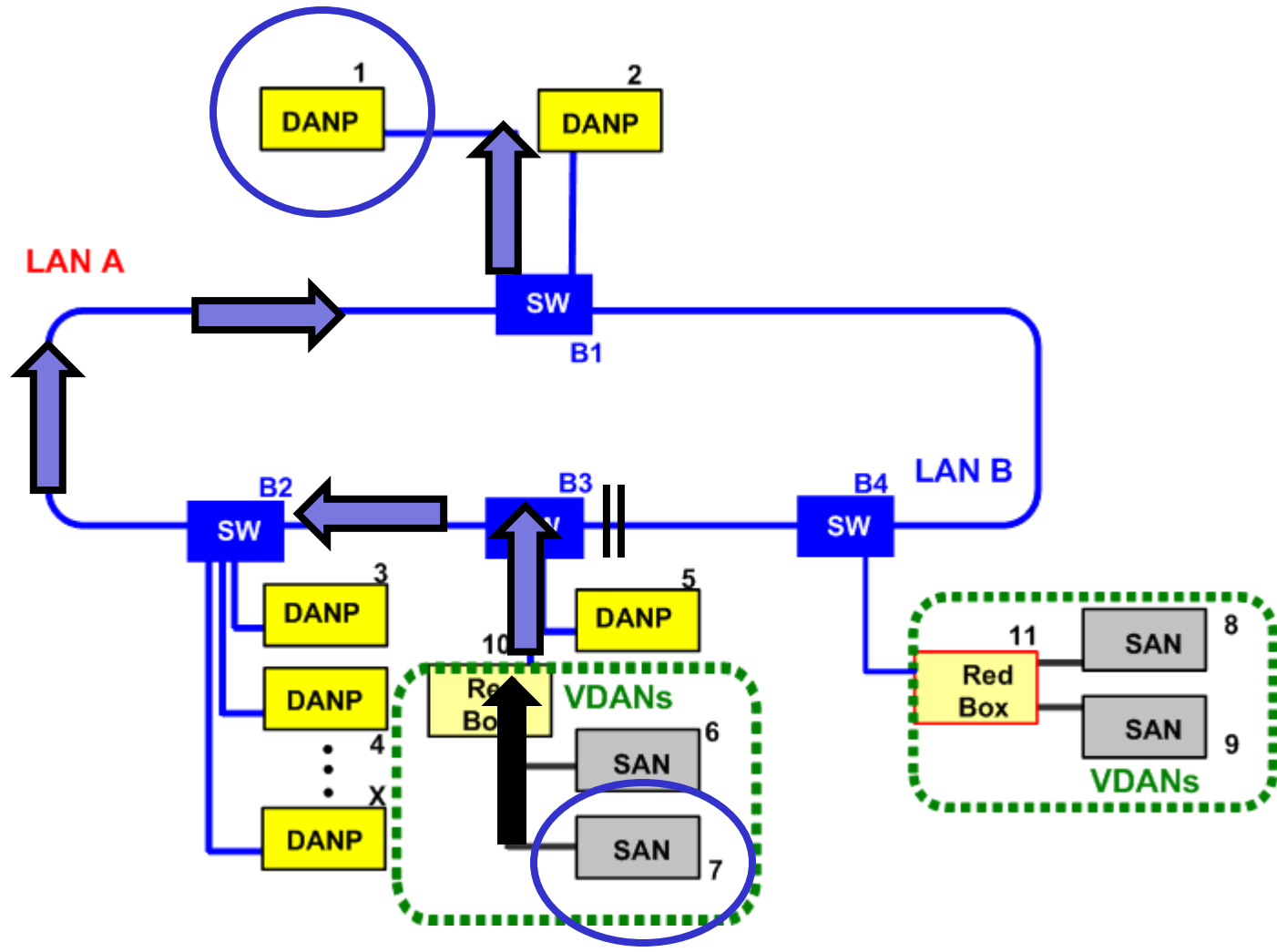
Device Failure-After Healing



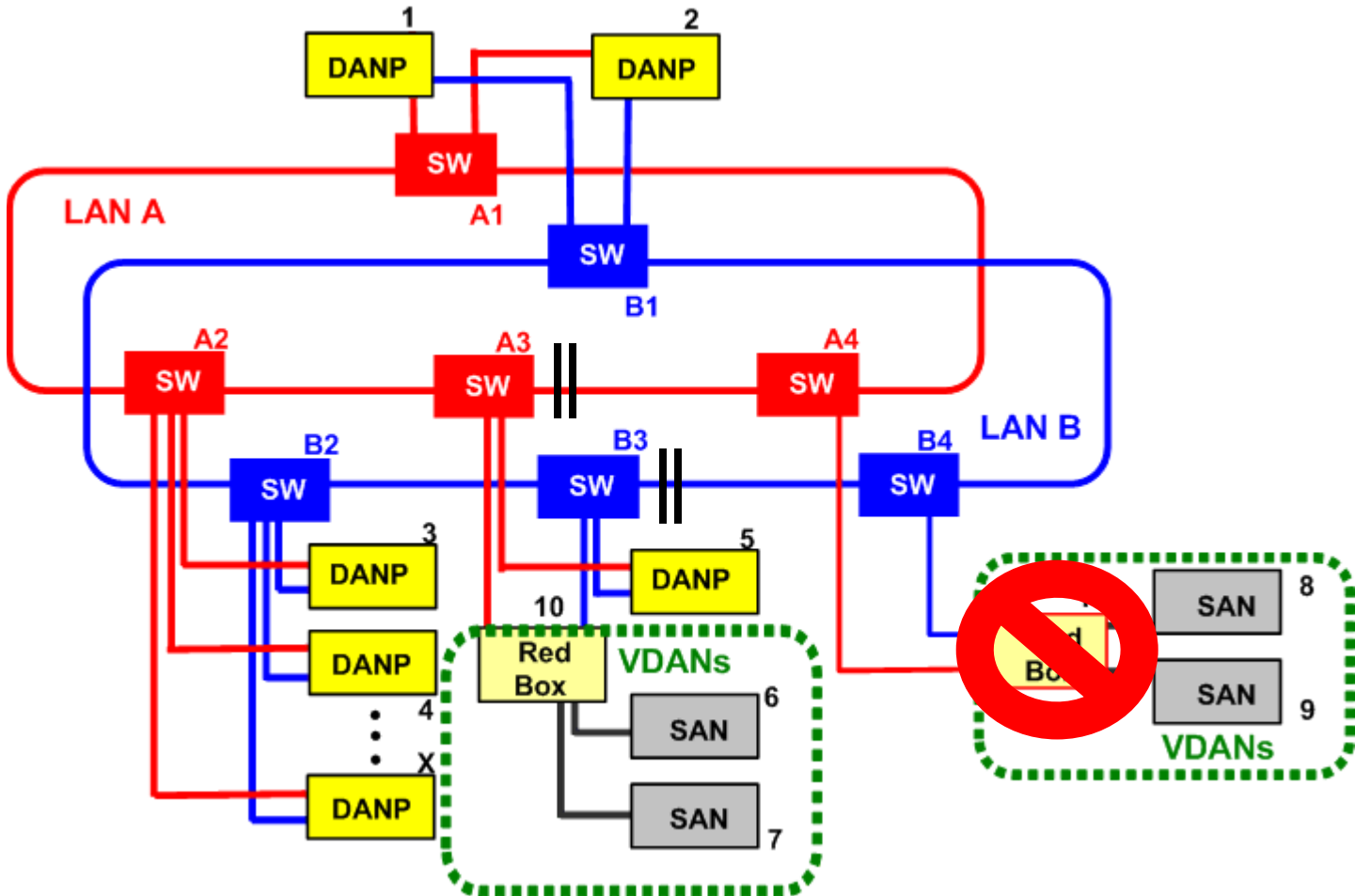
Network Failure



Network Failure-LAN B Only



Red-Box Failure





Questions?

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