High Availability in EtherNet/IP Systems using Frame Replication and Elimination for Reliability (FRER) As defined in the TSN Standard IEEE 802.1CB-2017

George A. Ditzel III
Schneider Electric

October 10, 2018

Availability = MTTF / (MTTF+MTTR)

Mean-Time-To-Fail (MTTF)

Mean-Time-To-Repair (MTTR)

High Availability

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

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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

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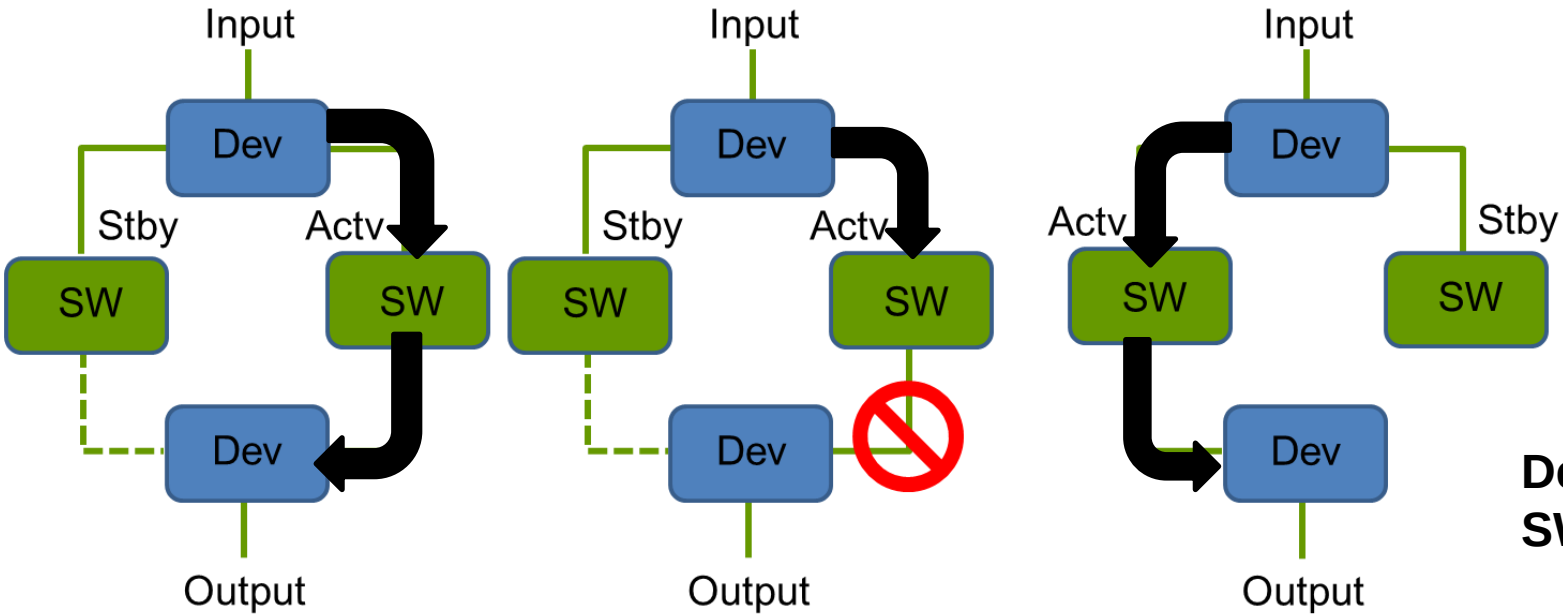
Dynamic Network Redundancy



Normal Operation

Failure

Recovery

Dev = Device
SW = Ethernet Switch

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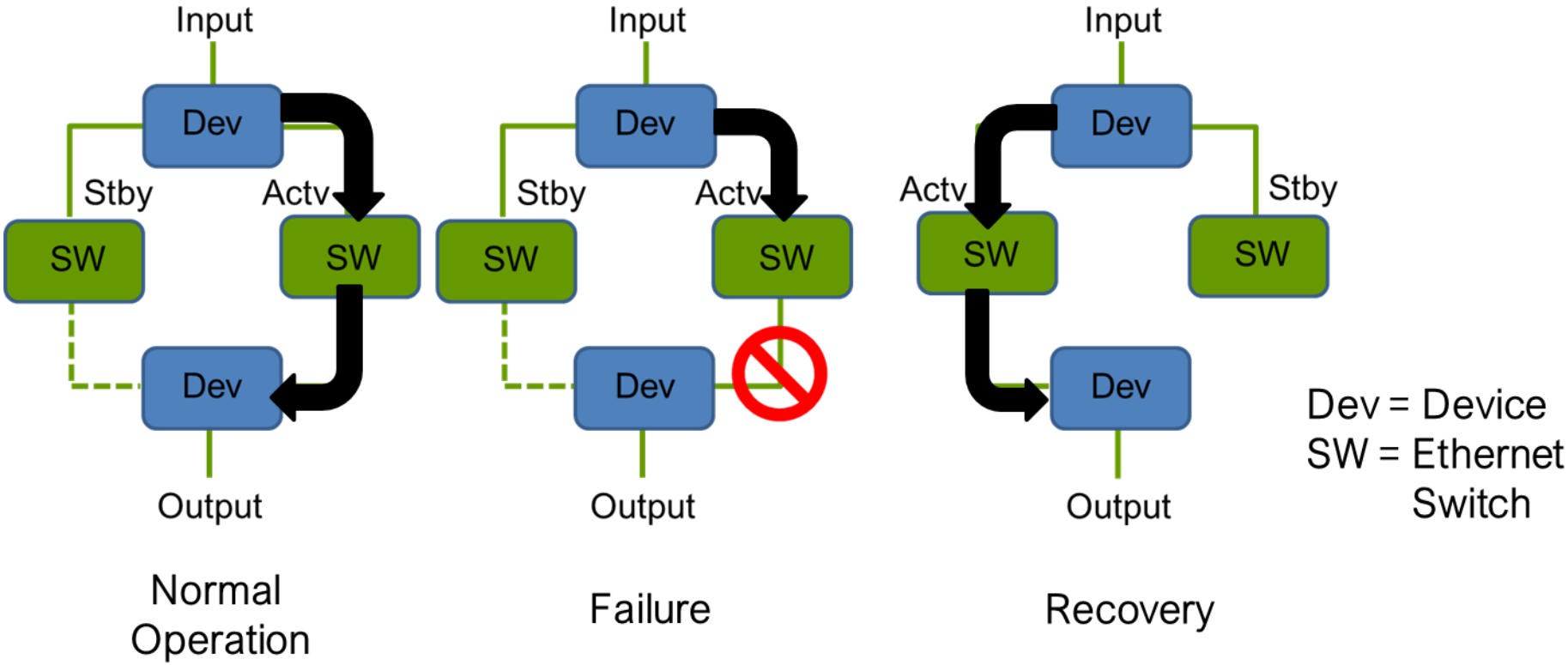
Dynamic Network Redundancy



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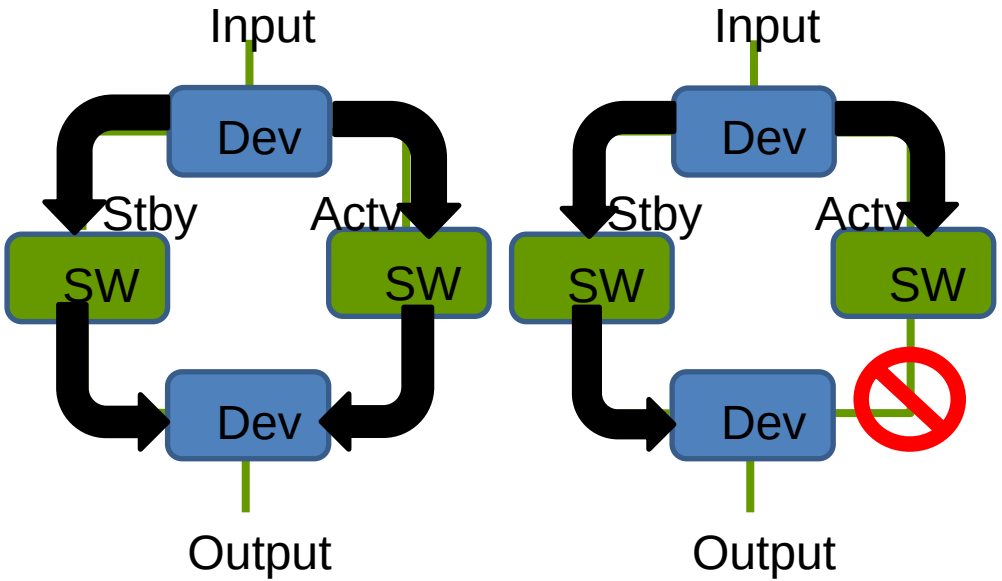
Static Network Redundancy



Normal Operation

Failure

Dev = Device
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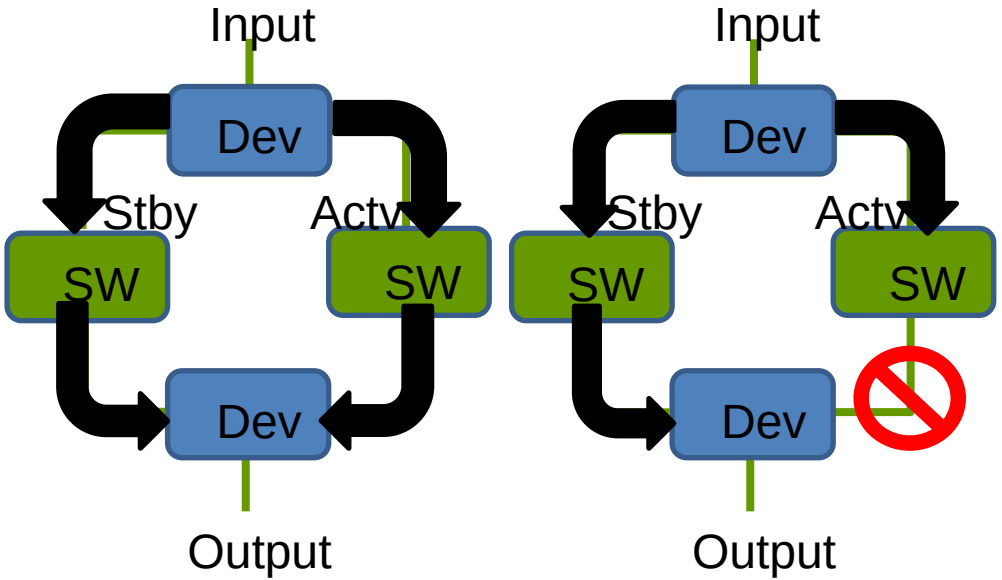
Static Network Redundancy



Normal Operation

Failure

Dev = Device
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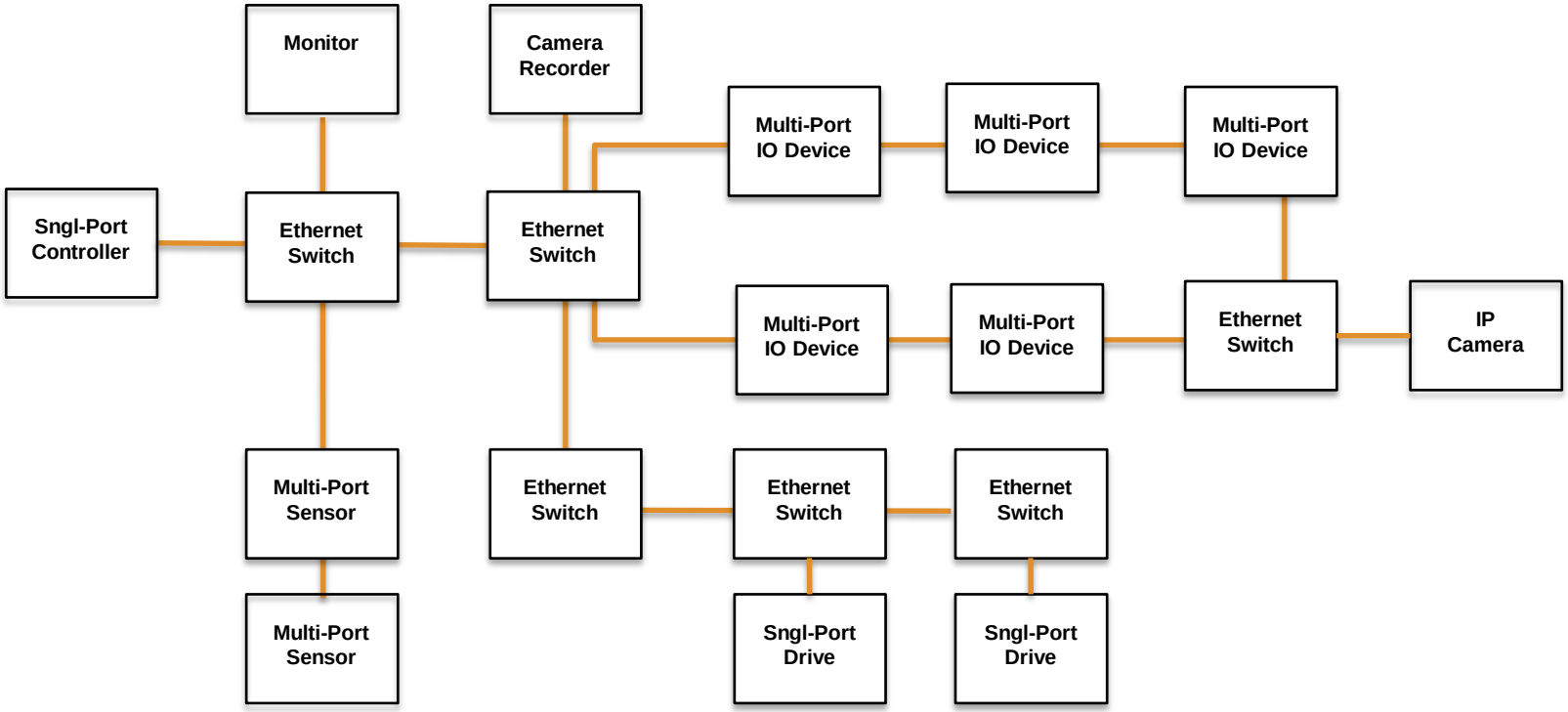
Example EtherNet/IP System



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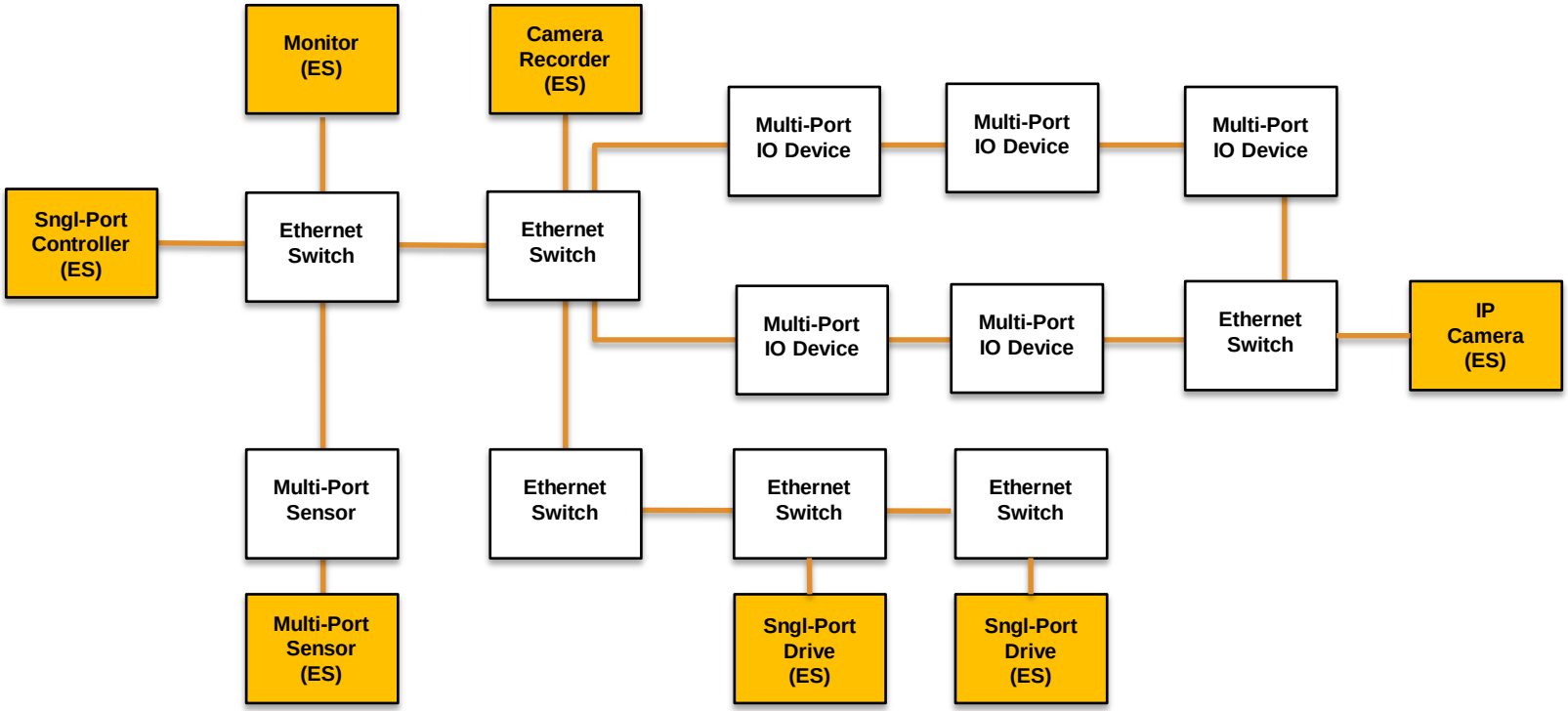
FRER Components: End Systems (ES)



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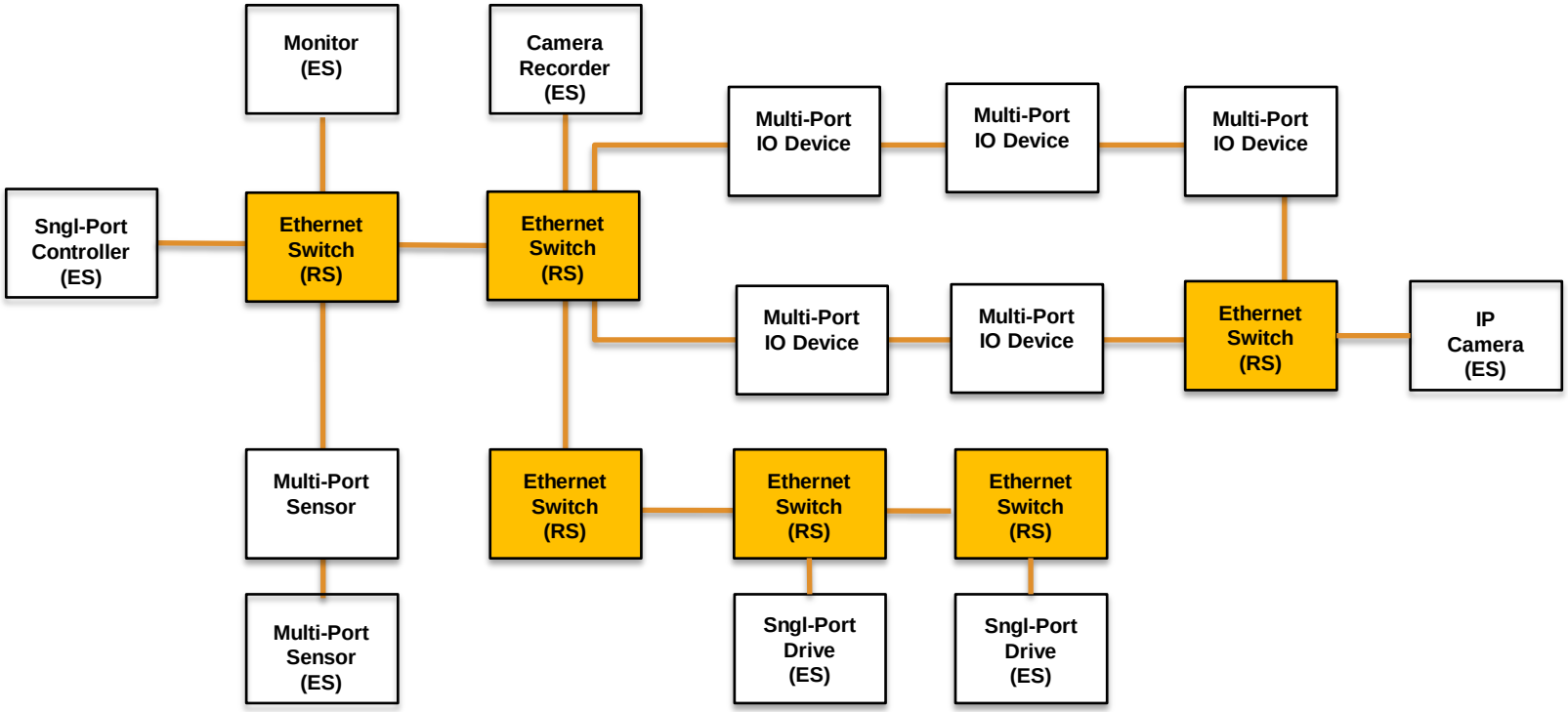
FRER Components: Relay Systems (RS)



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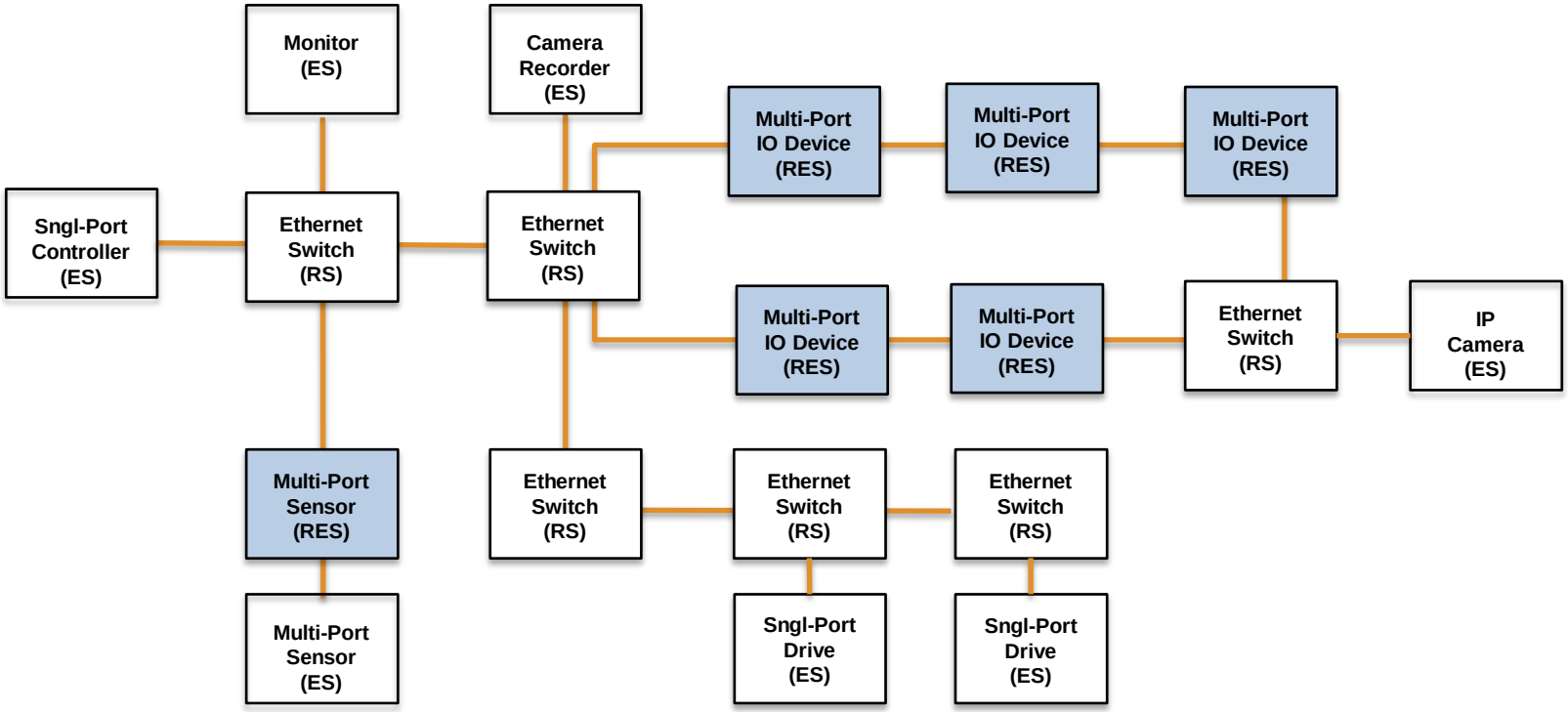
Relay-End Systems (RES)



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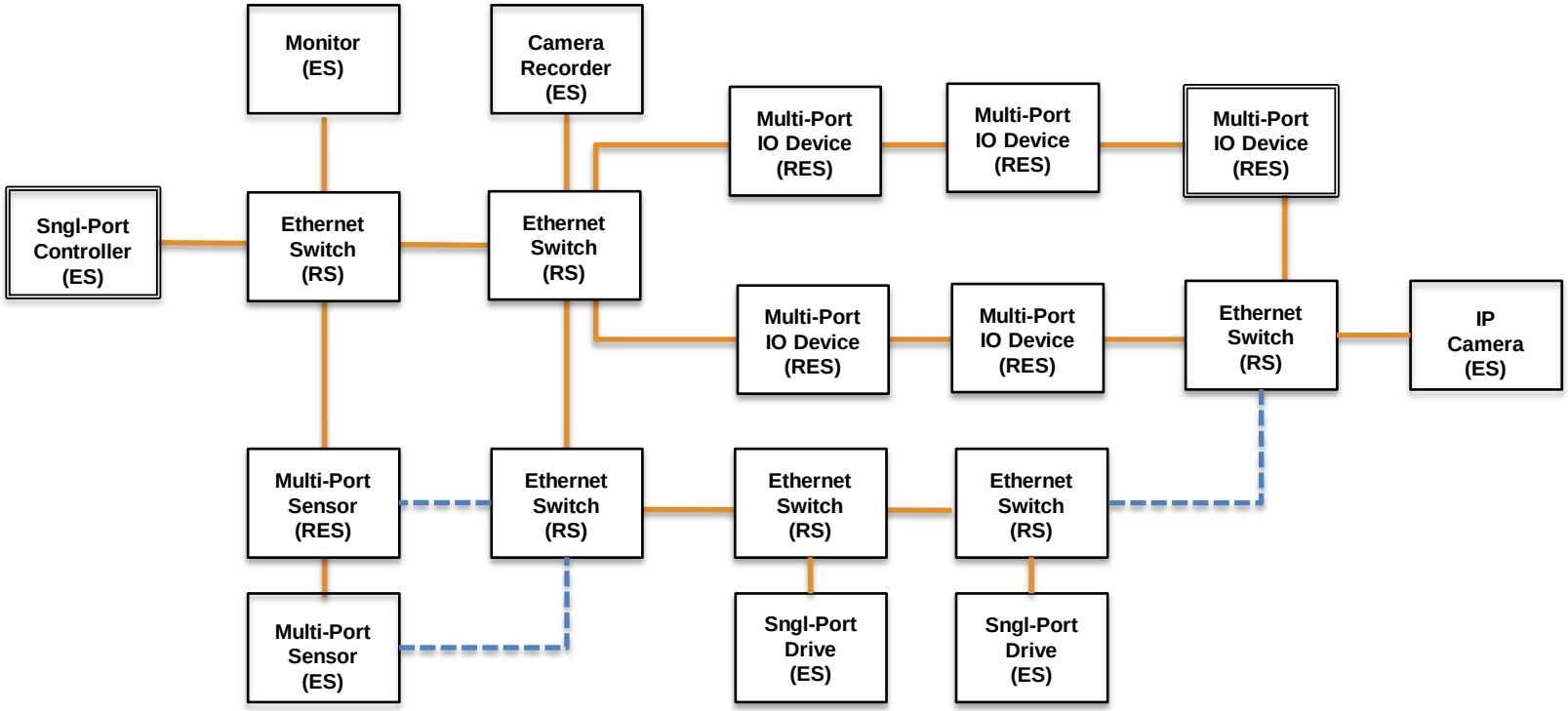
FRER Components and Network Interconnect



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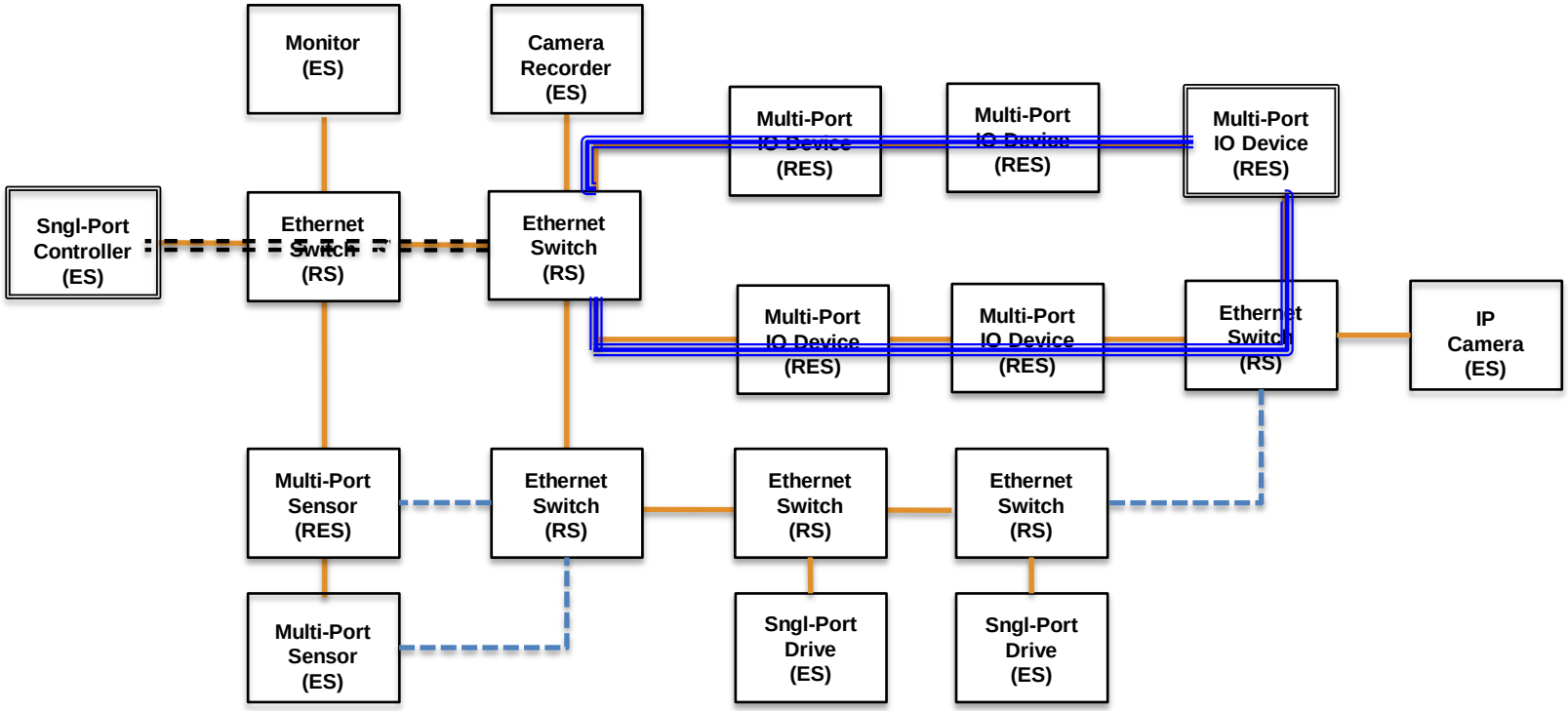
FRER and Ring Network – Single Talkers/Listeners



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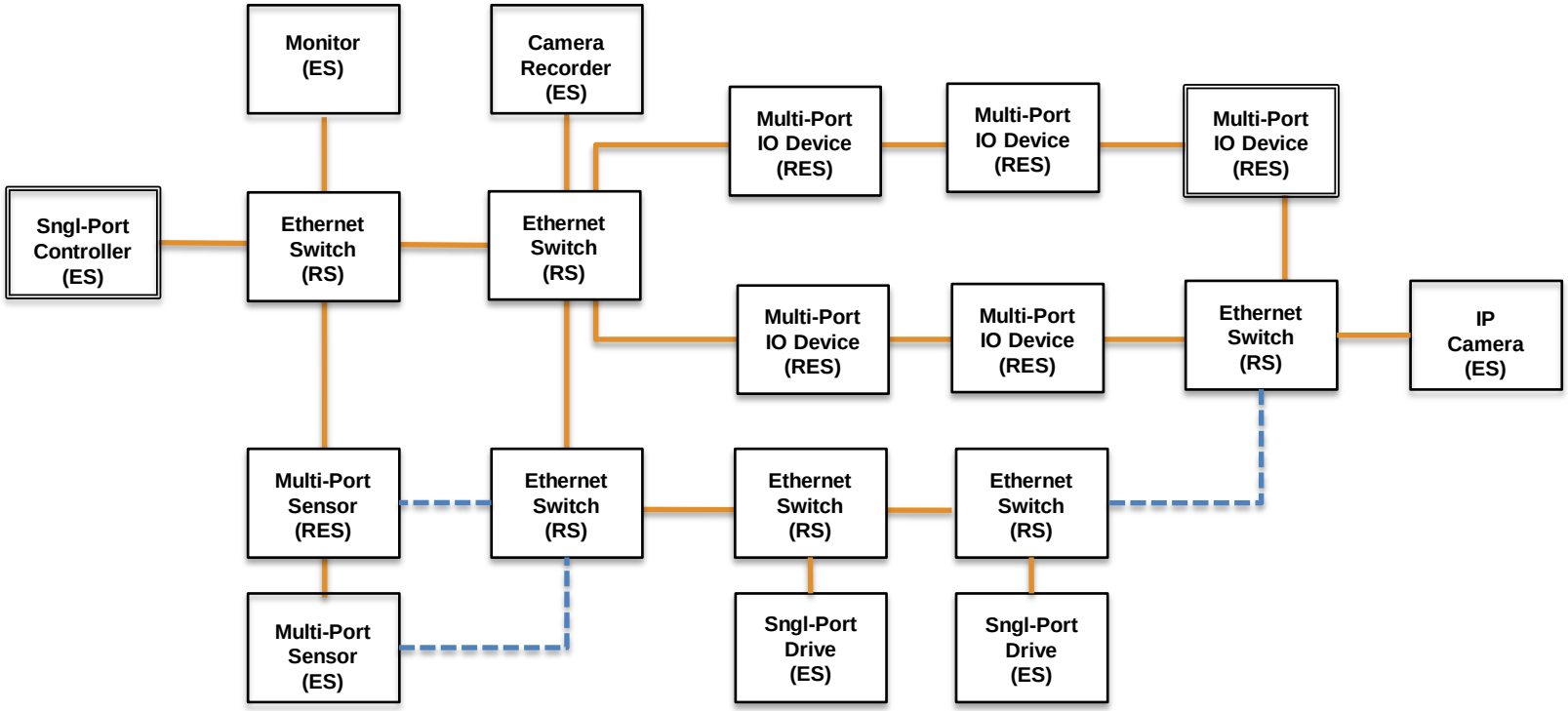
FRER and Mesh Network



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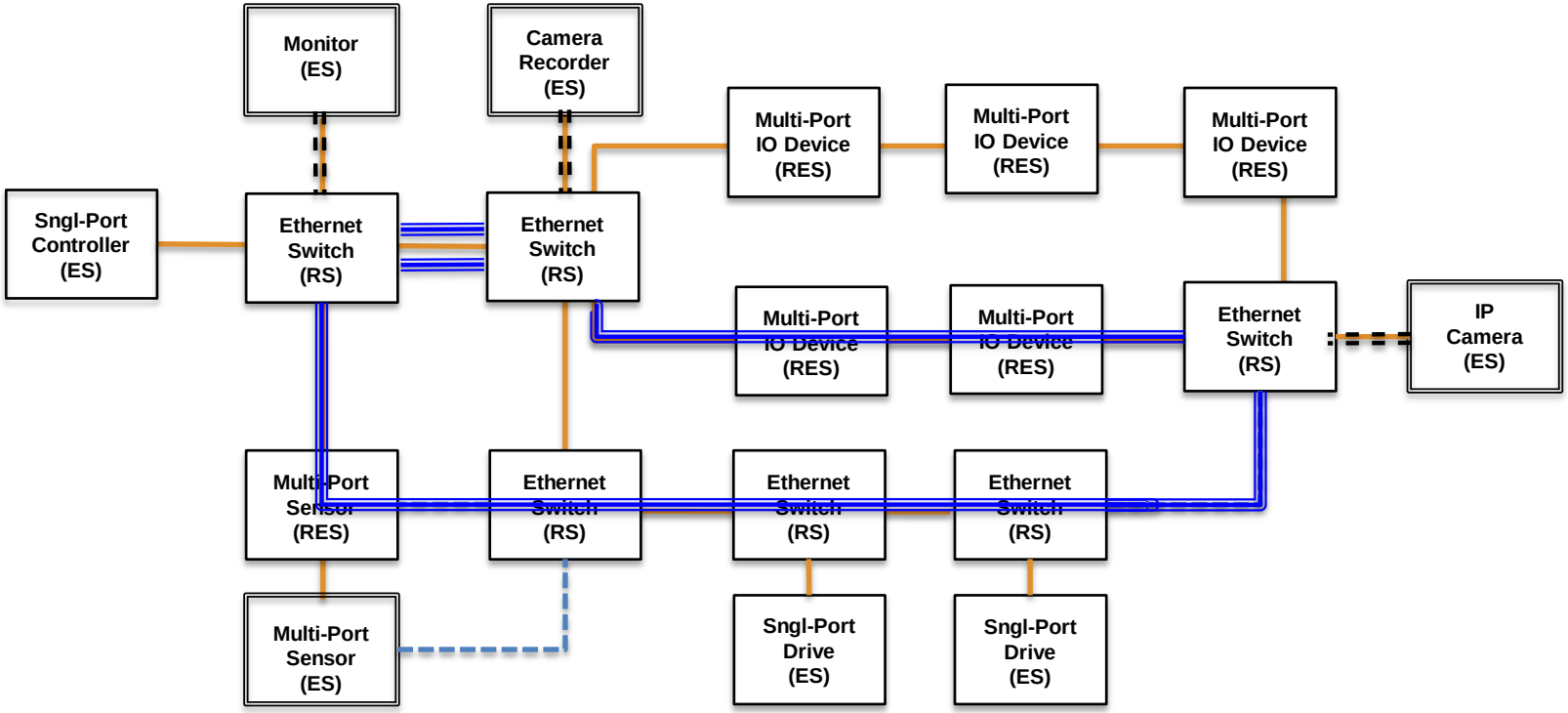
FRER and Mesh Network – Multiple Listeners



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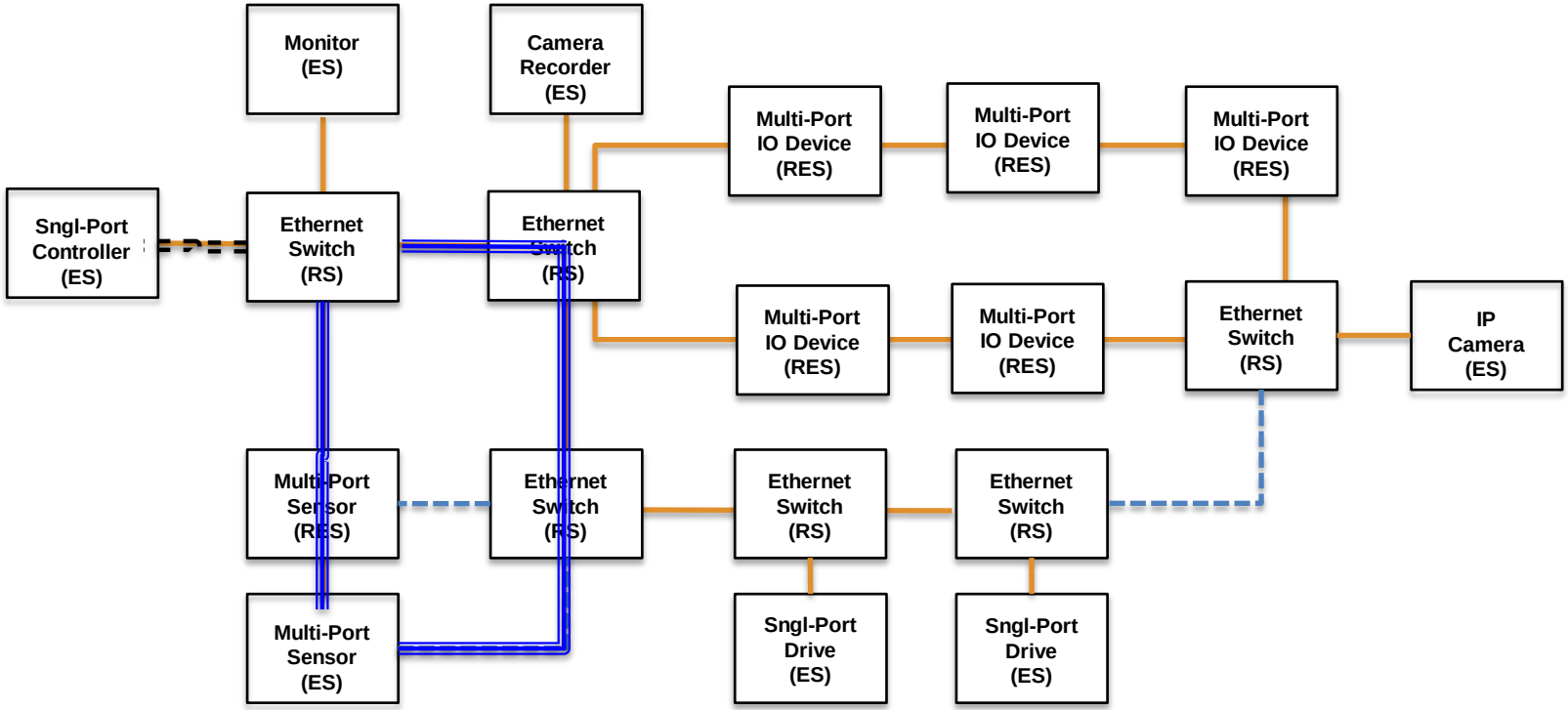
FRER and Mesh Network Single Talkers/Listeners



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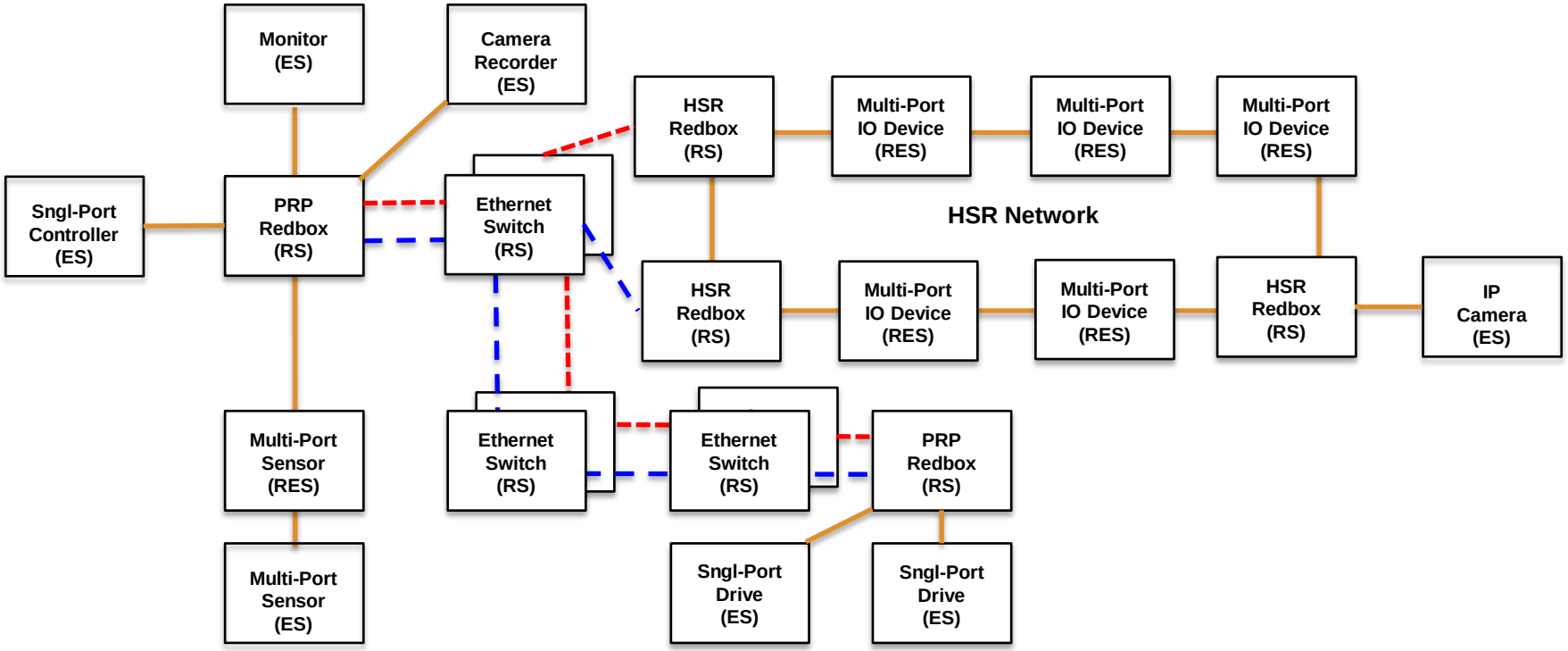
FRER and PRP/HSR Networks



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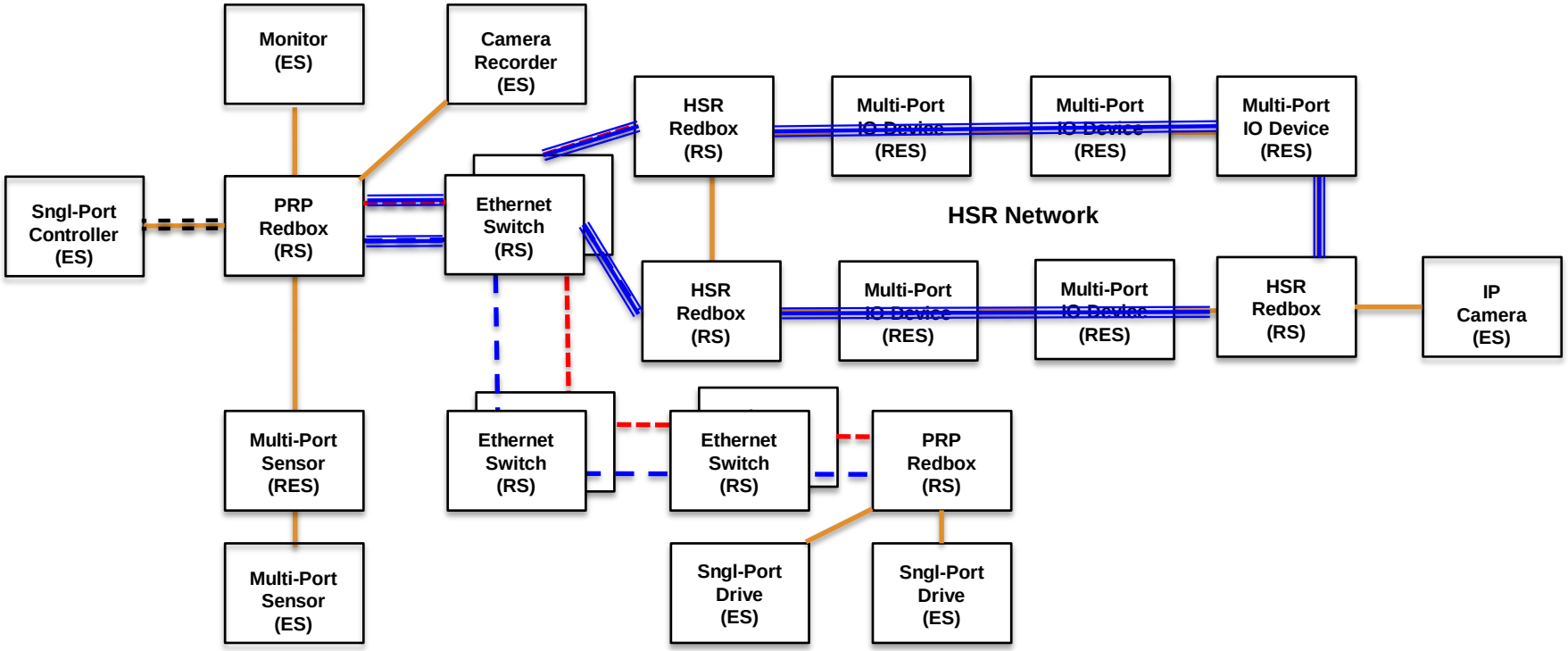
FRER and PRP/HSR Networks



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THANK YOU