



**Comparison/Contrast of TSN
Frame Replication and Elimination for Reliability (FRER)
And
IEC 62439-3 PRP and HSR**

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March 4, 2020

- High Availability and Redundancy
- Sample Target Network
- PRP/HSR Solution vs FRER Solution
 - Cost
 - Performance
- Conclusion

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

Availability = MTTF / (MTTF+MTTR)

Mean-Time-To-Fail (MTTF)

Mean-Time-To-Repair (MTTR)

High Availability

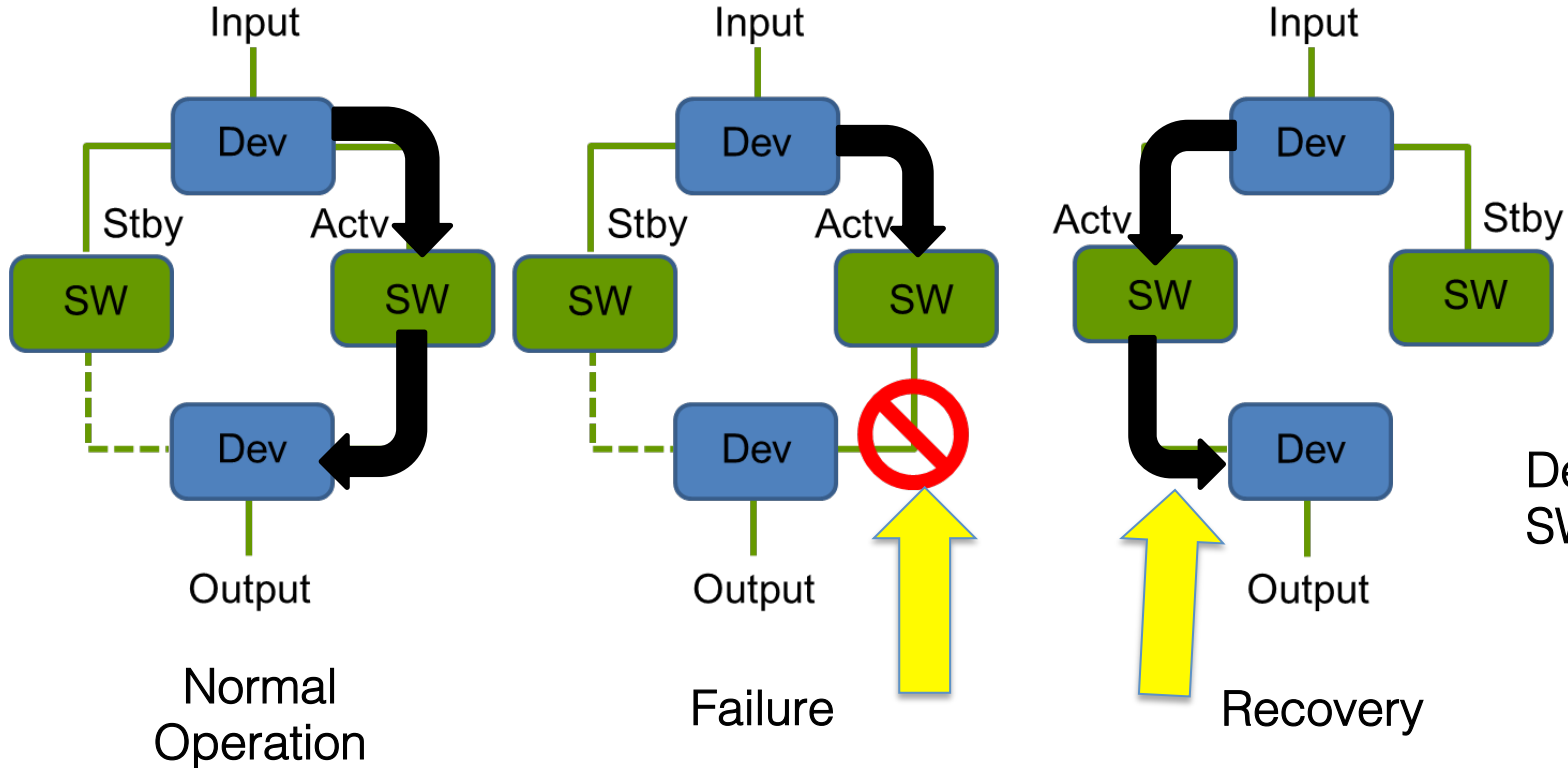


High Availability



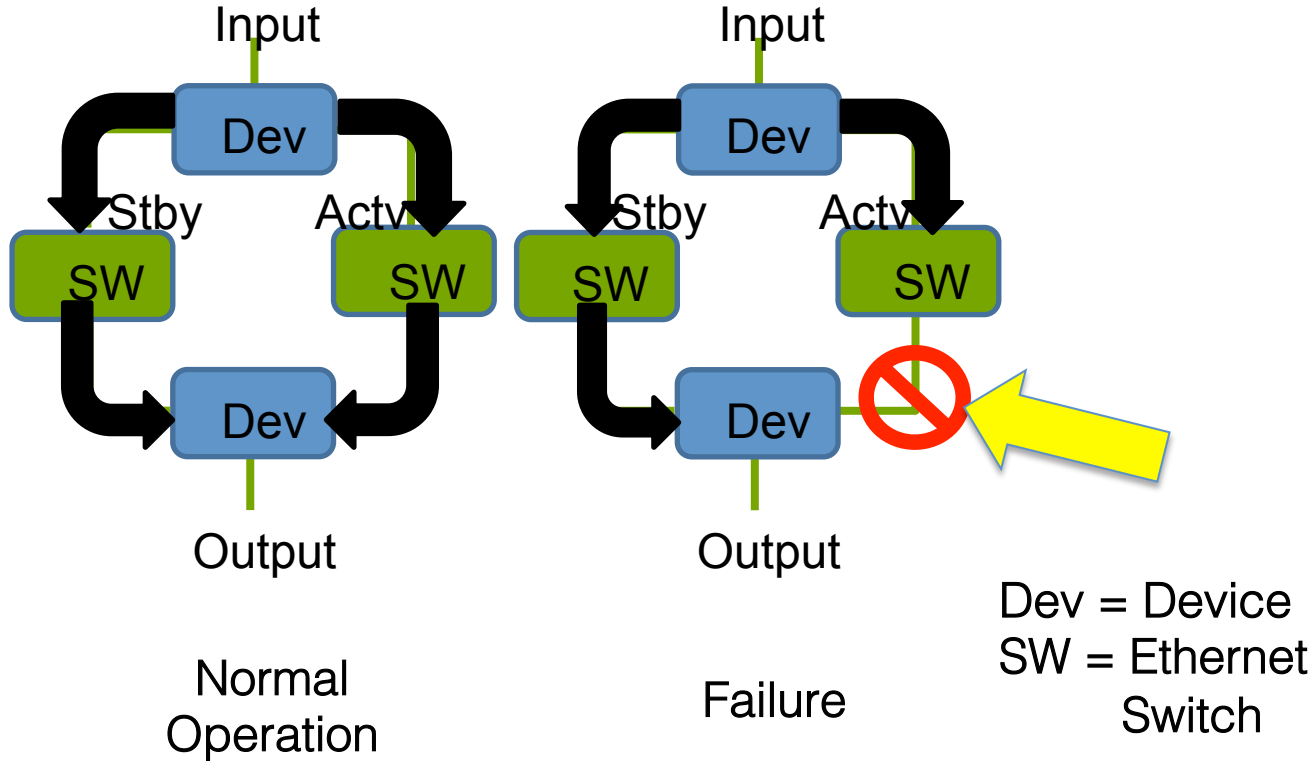
Availability, %	Downtime per Year	Downtime per Month	Downtime per Week
99.9999% ("six nines")	31.5 seconds	2.59 seconds	0.605 seconds
99.999% ("five nines")	5.26 minutes	25.9 seconds	6.05 seconds
<p>Impossible to create networks that never fail; Key to High Availability is reduced recovery time Availability is increased by introducing Redundancy</p>			
99.9%	1.05 days	8.00 hours	80.4 minutes
99% ("two nines")	3.65 days	7.20 hours	1.68 hours
90% ("one nines")	36.5 days	72 hours	16.8 hours

Dynamic Network Redundancy

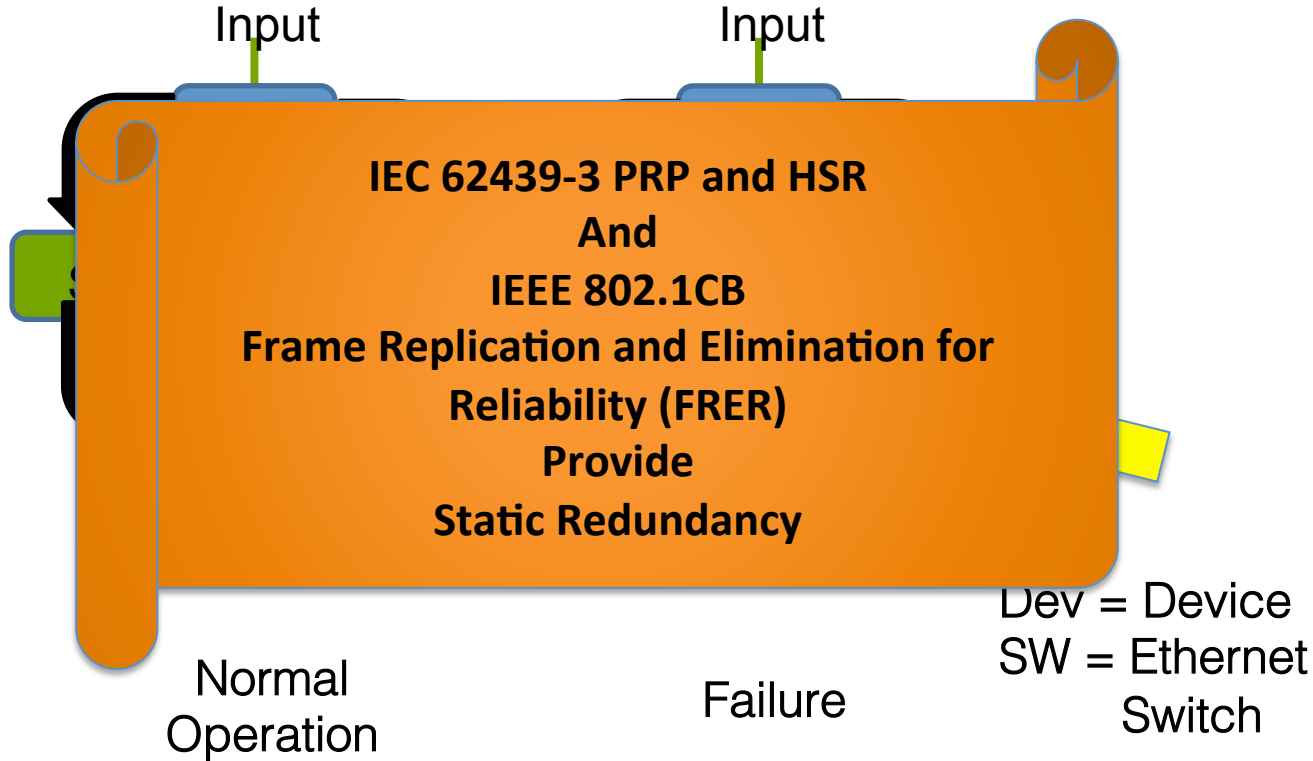


Dev = Device
 SW = Ethernet
 Switch

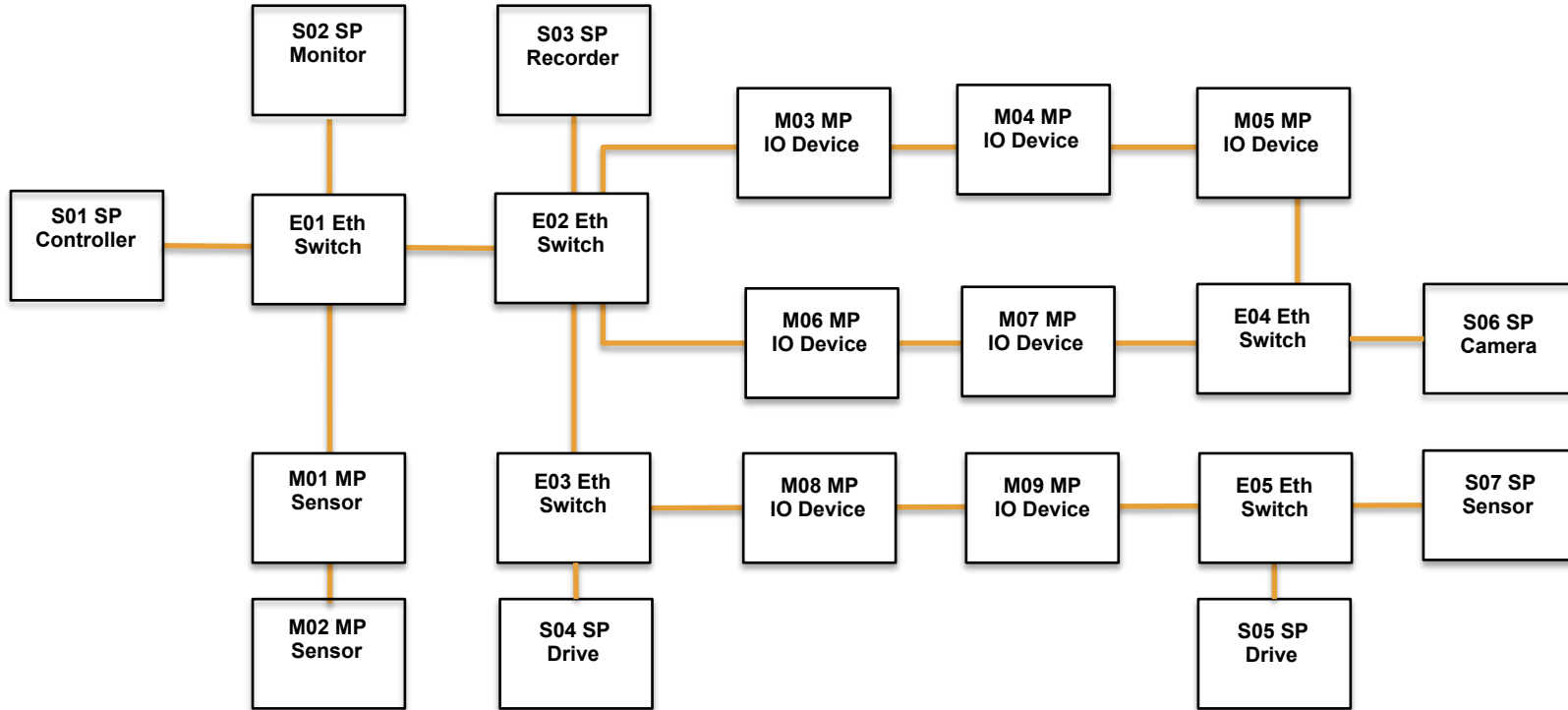
Static Network Redundancy



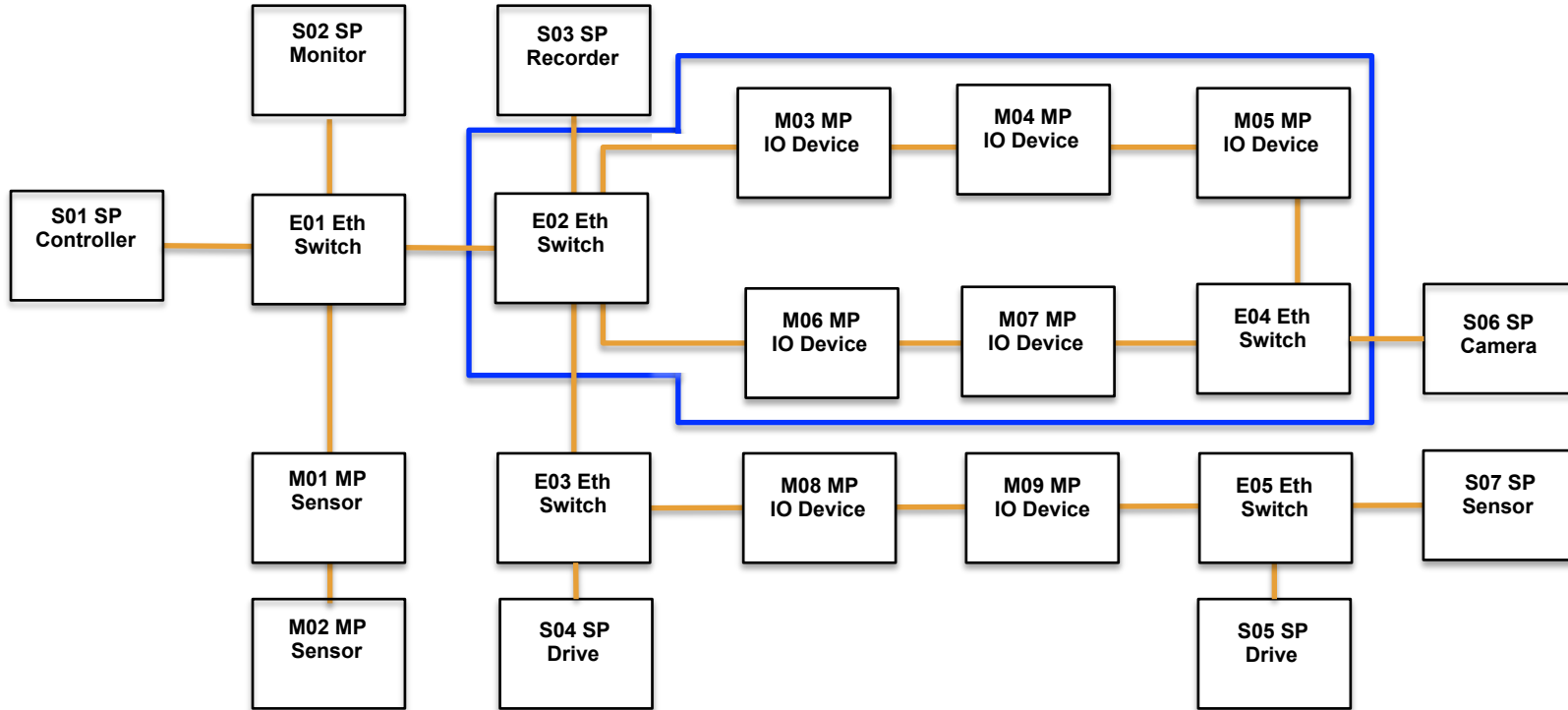
Static Network Redundancy



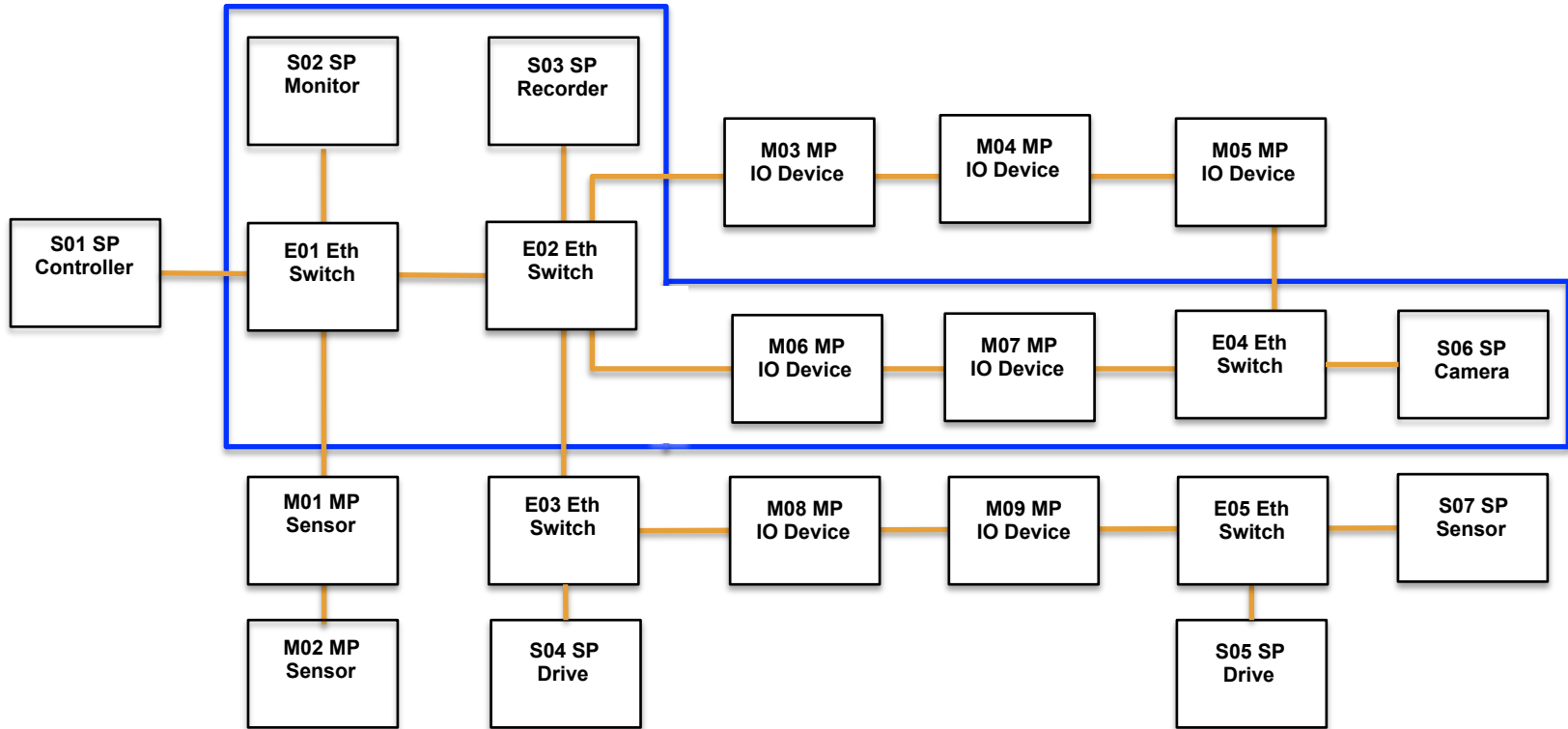
Sample Target Network



Sample Target Network

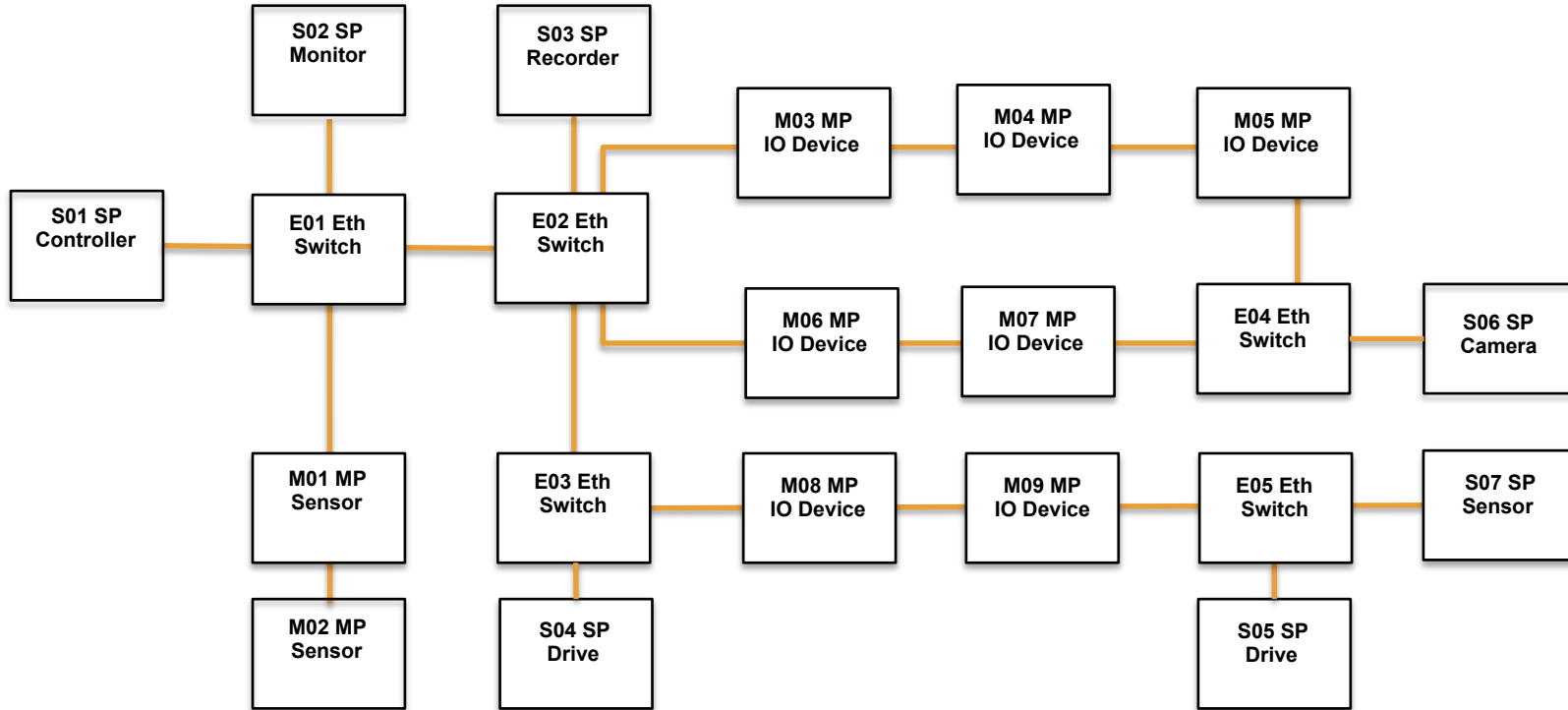


Sample Target Network – Converged Video



Cost

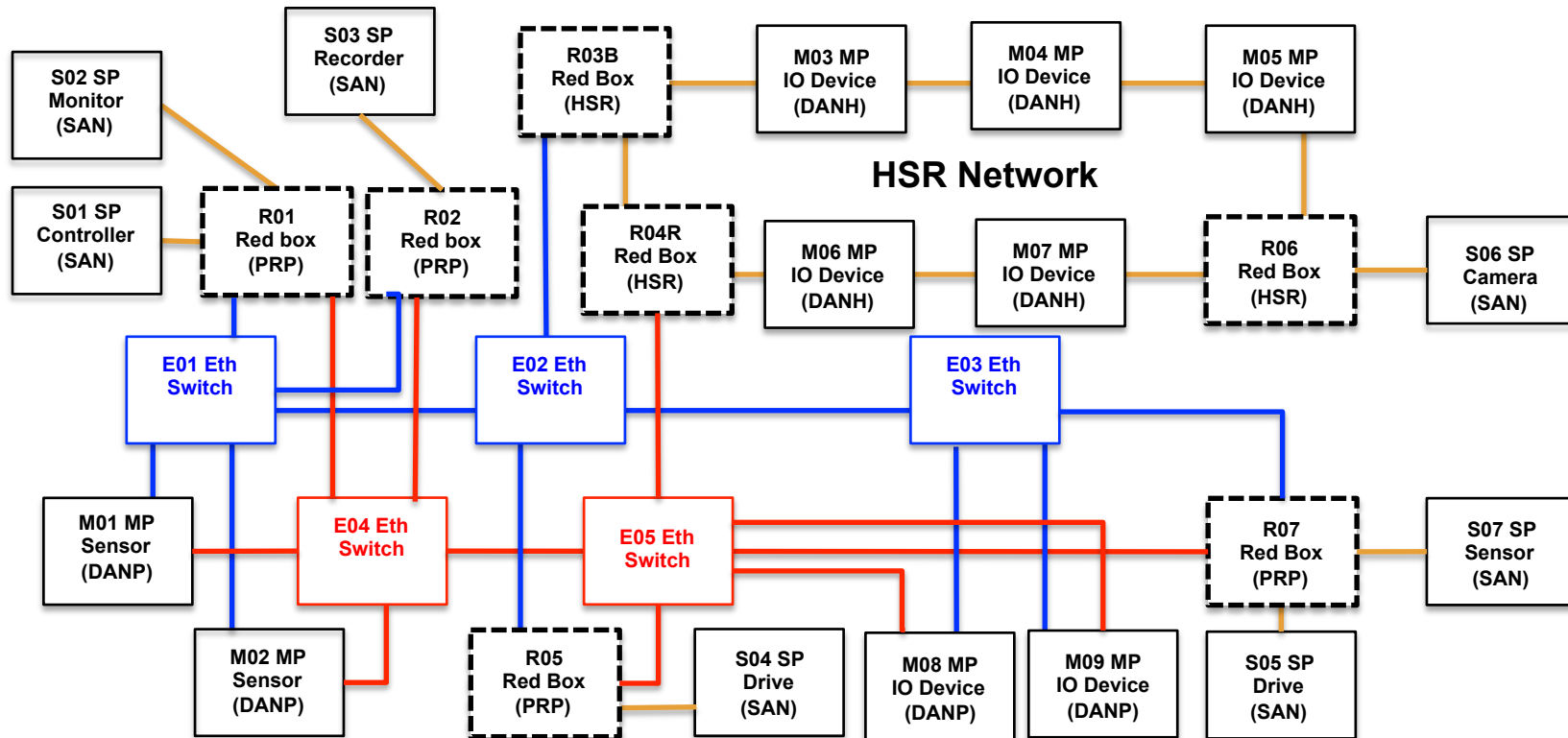
Sample Target Network



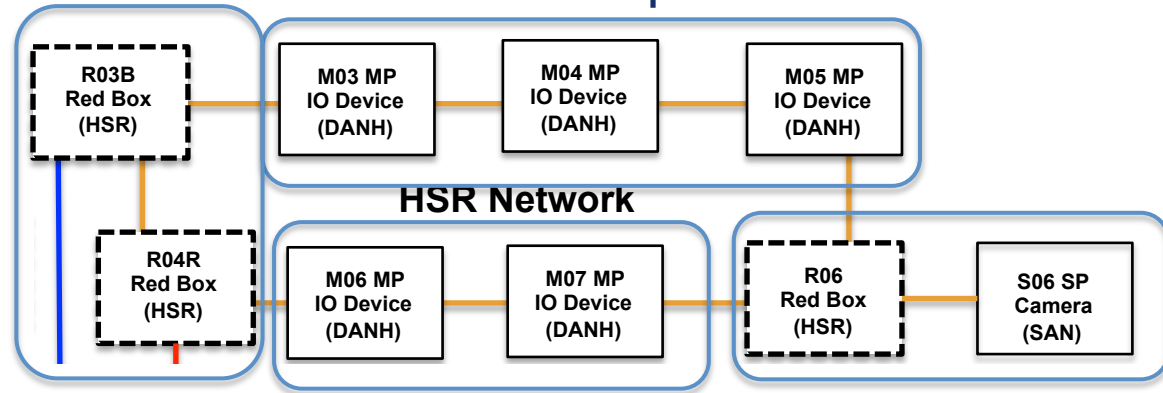
Sample Target Network- Cost

Single port Devices [Sx]	7	x	500	=	3500
Multiport Devices [Mx]	9	x	1000	=	9000
Ethernet Switches [Ex]	5	x	1000	=	5000
Cable	21	x	50	=	1050
Total				=	18550

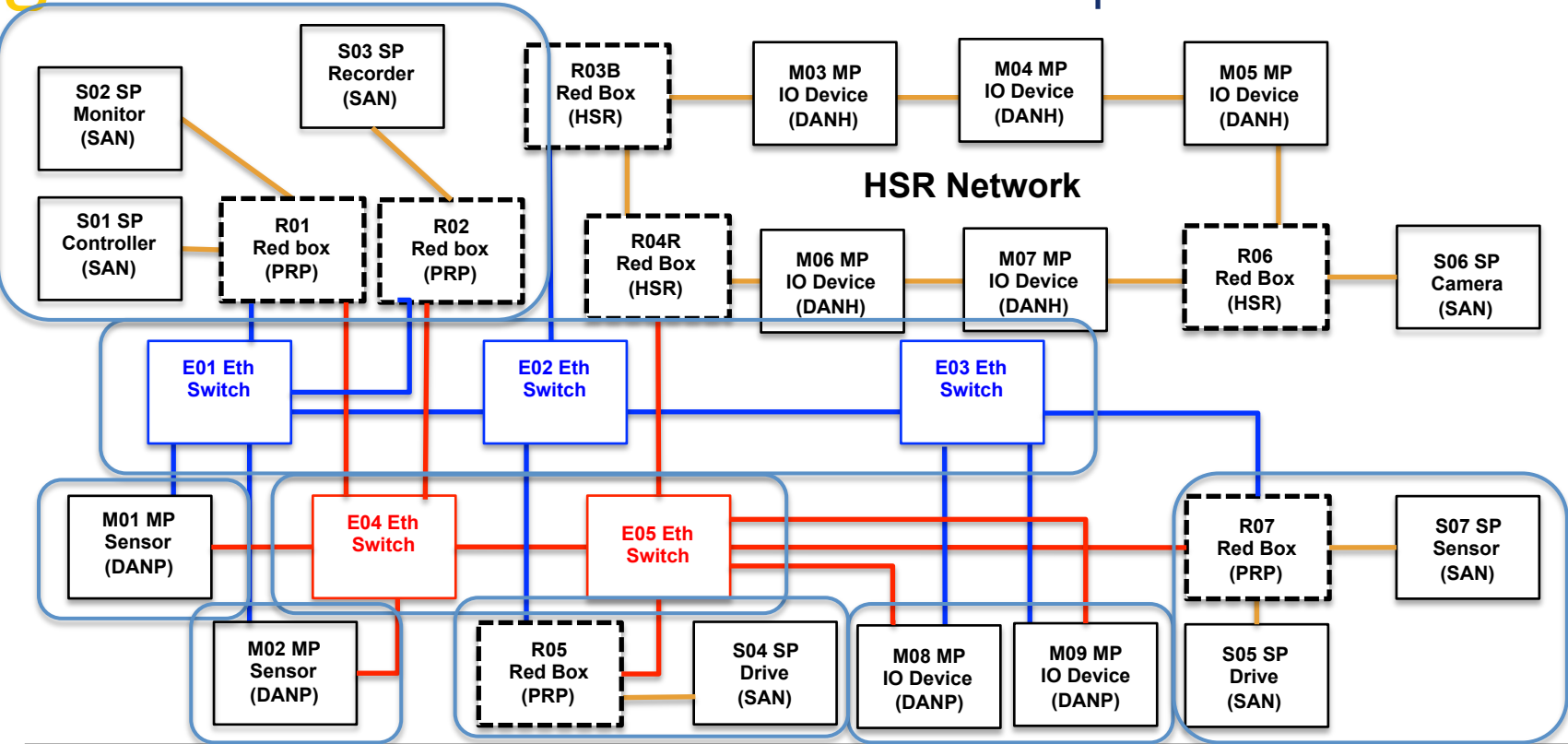
Sample IEC 62439 Network



Sample IEC 62439 Network



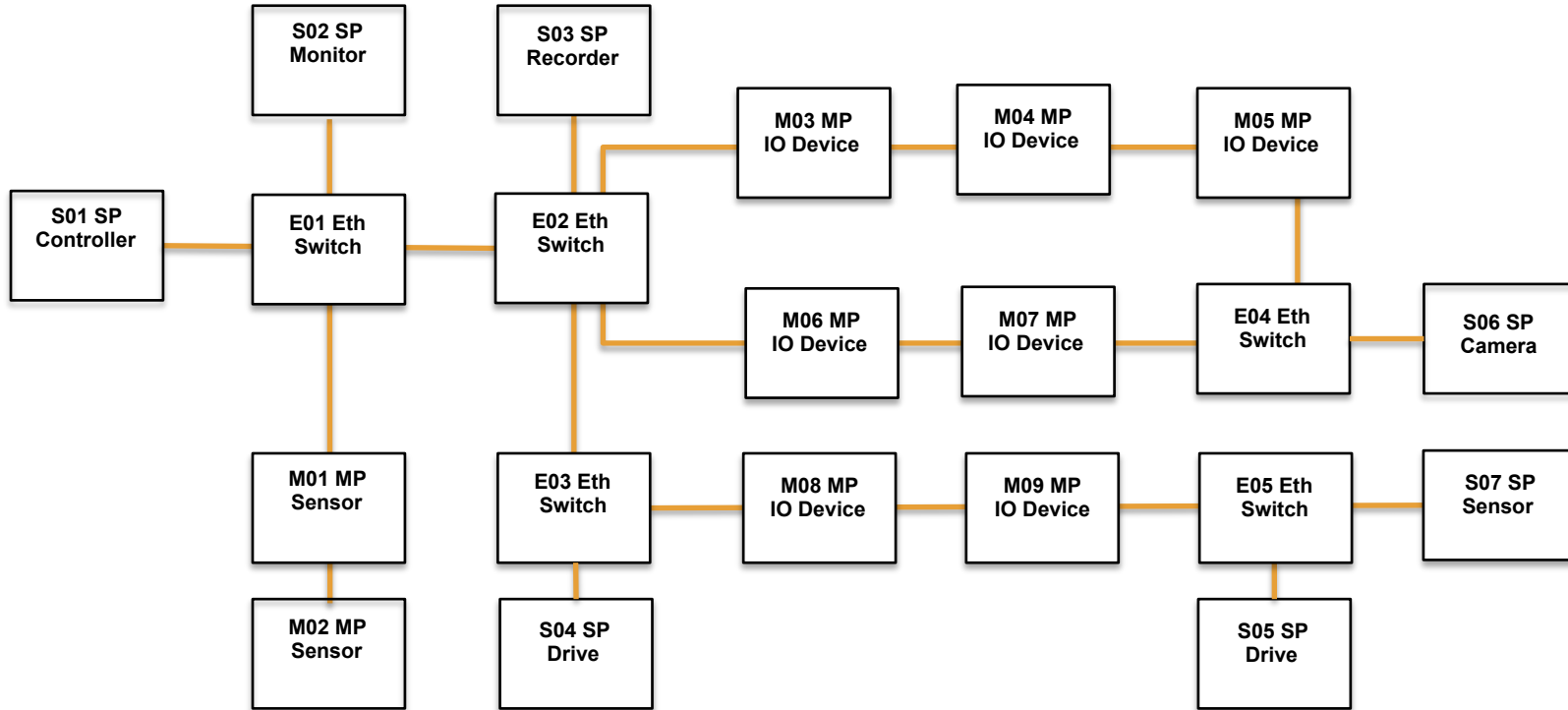
Sample IEC 62439 Network



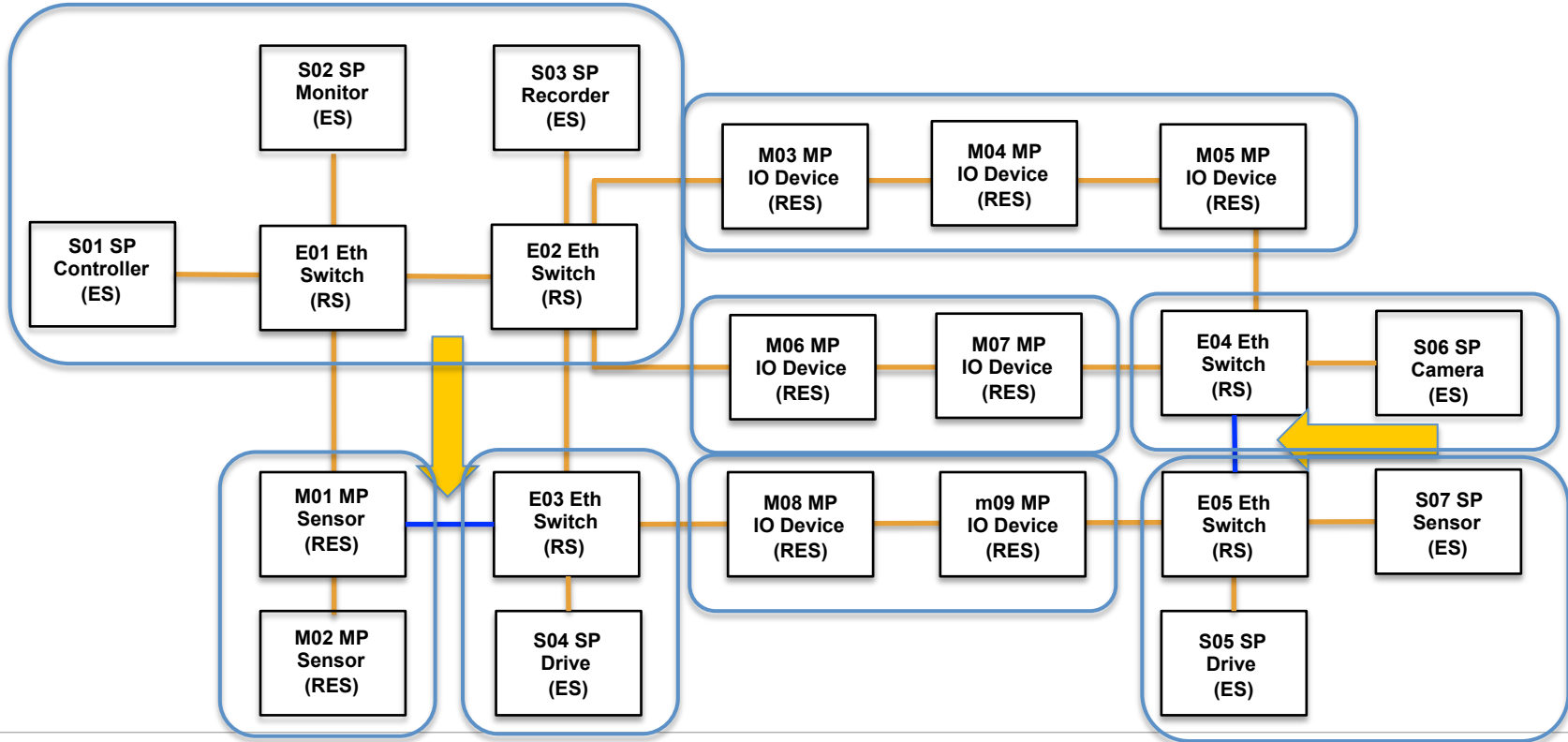
Sample Target Network- Cost

Add PRP/HSR				=	100
Single port Devices [Sx]	7	x	500	=	3500
Multiport Devices+PRP/HSR [Mx]	9	x	1100	=	9900
Ethernet Switches [Ex]	5	x	1000	=	5000
Red Boxes [Rx]	7	x	1100	=	7700
Cable	26	x	50	=	1300
Total				=	27400

Sample Target Network



Sample FRER Network (Partial Mesh)



Sample Target Network- Cost

Add TSN				=	100	
Single port Devices [Sx]	7	x	500	=	3500	4200
Multiport Devices +TSN [Mx]	9	x	1100	=	9900	
Ethernet Switches +TSN [Ex]	5	x	1100	=	5500	
Cable	23	x	50	=	1150	
Total				=	20050	20750

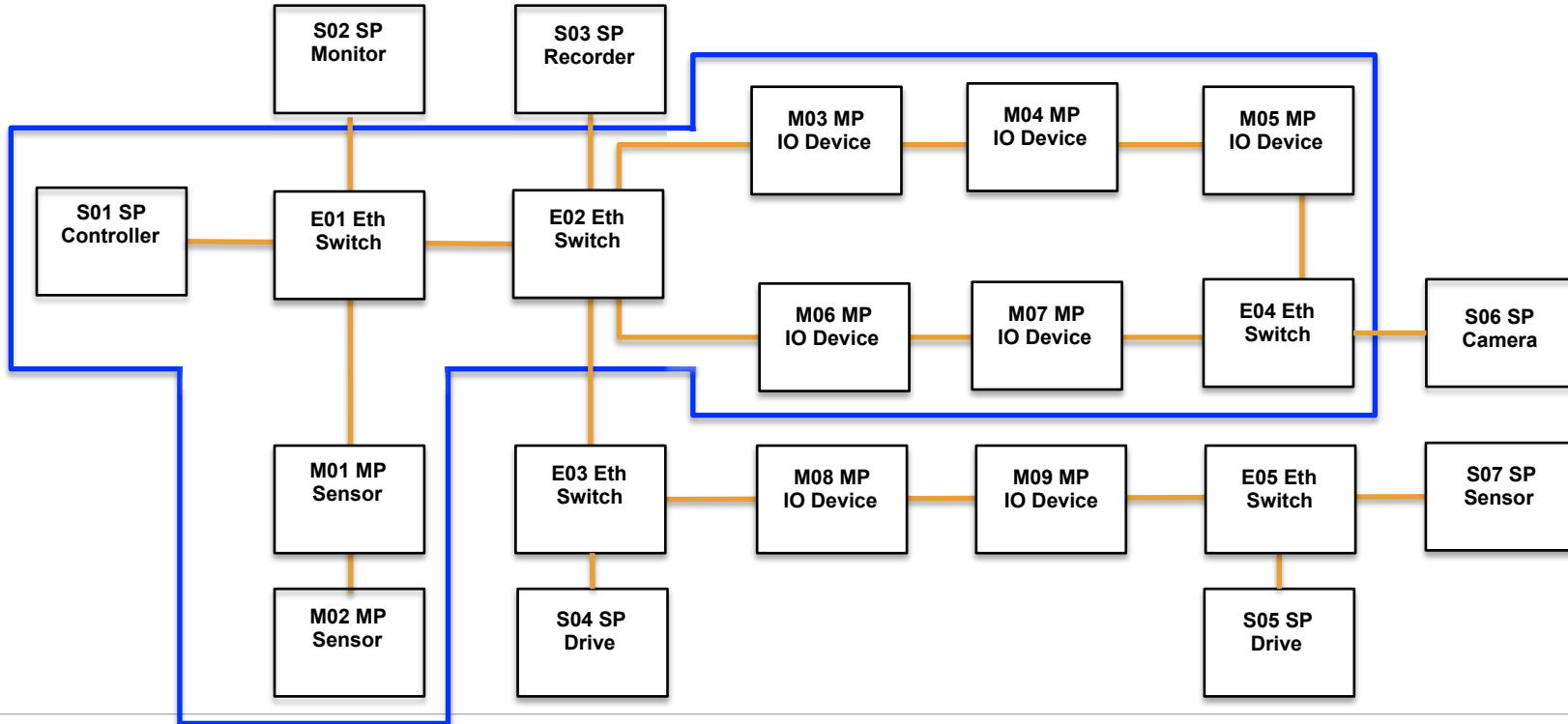
Cost Summary

		Sample	PRP/HSR	TSN	
Single port Devices [Sx]	=	3500	3500	3500	4200
Multiport Devices [Mx]	=	9000	9900	9900	
Ethernet Switches [Ex]	=	5000	5000	5500	
Red Boxes [Rx]	=		7700		
Cable	=	1050	1300	1150	
Total	=	18550	27400	20050	20750
Cost Difference	=		48%	9%	12%
[(S-T)/S]					

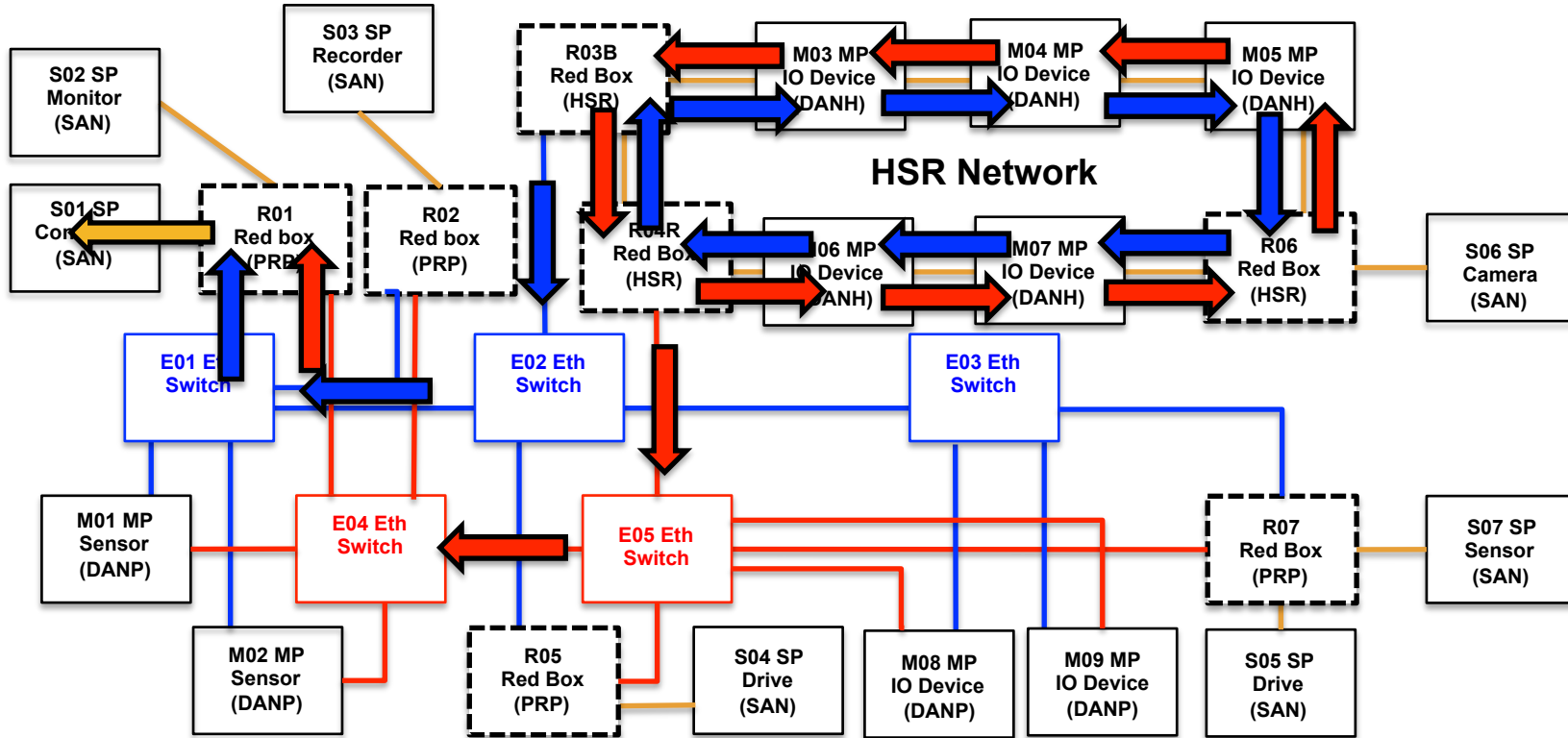


Performance and Determinism

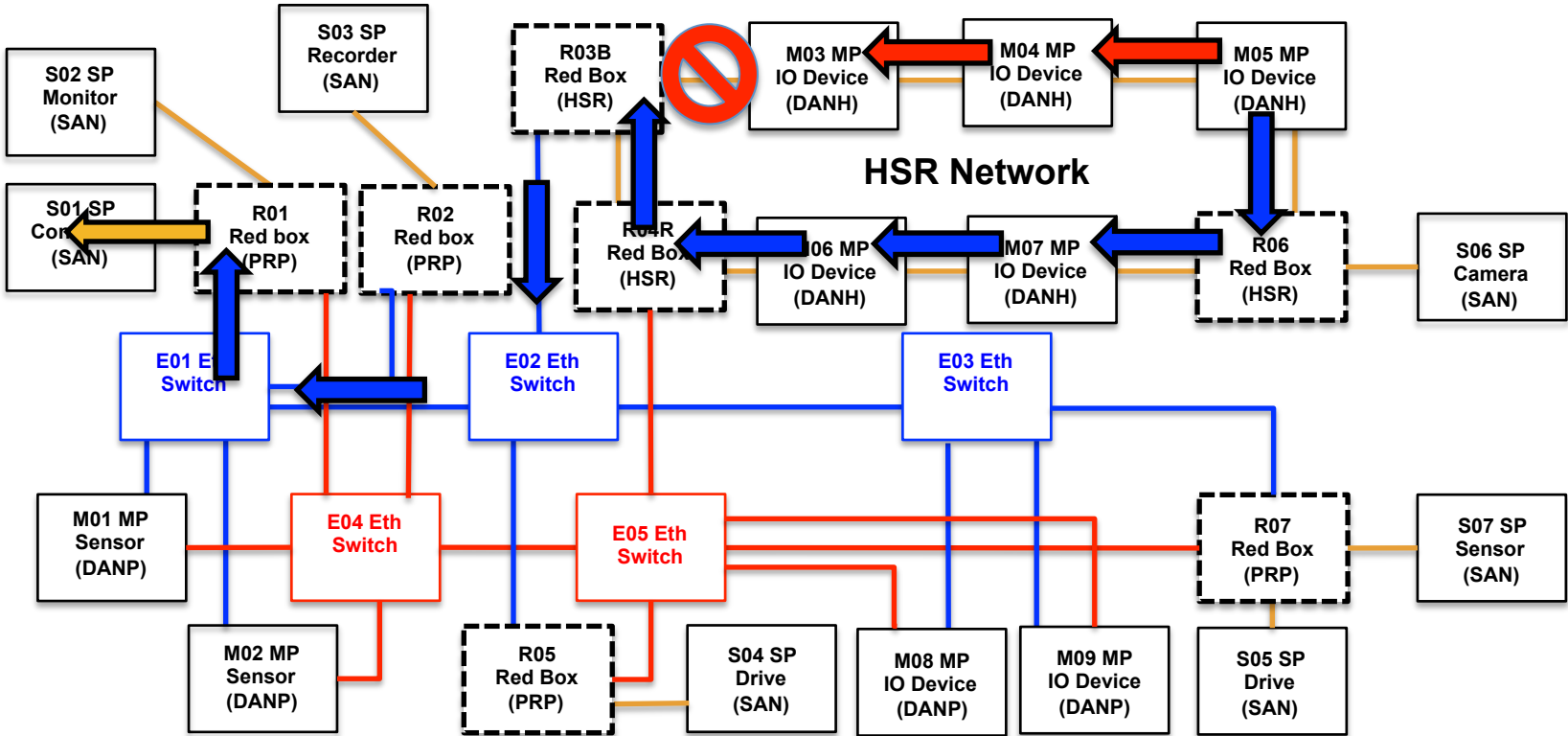
Sample Target Network



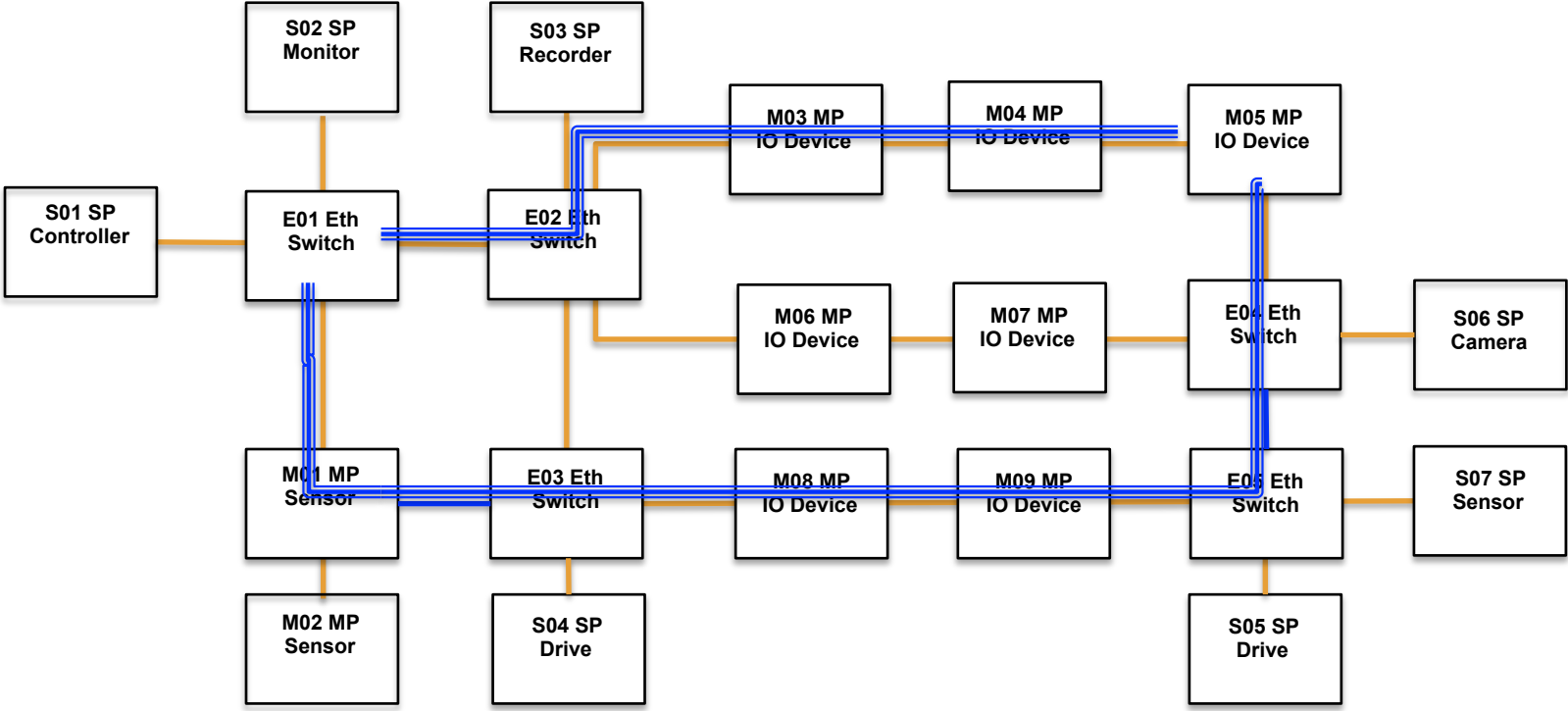
Sample IEC 62439 Network



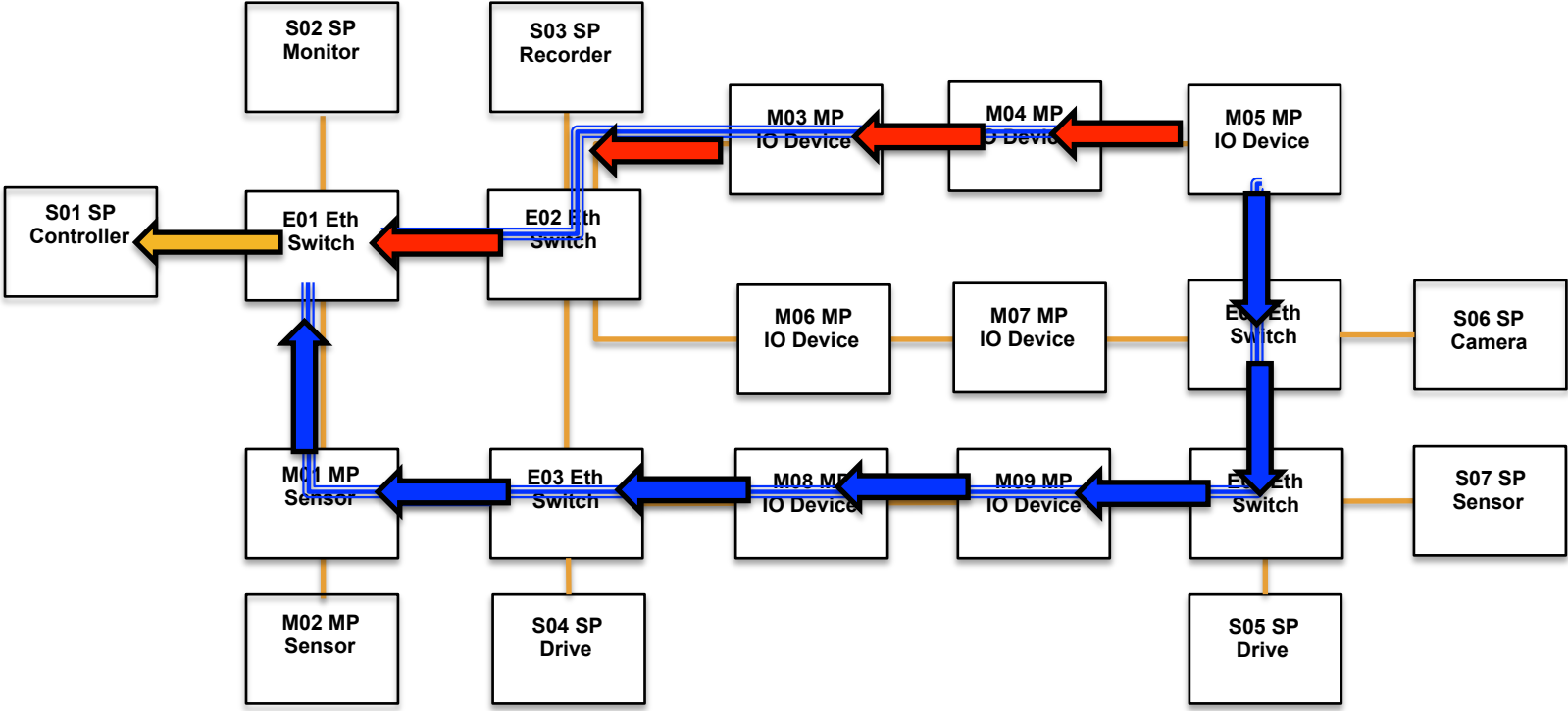
Sample IEC 62439 Network



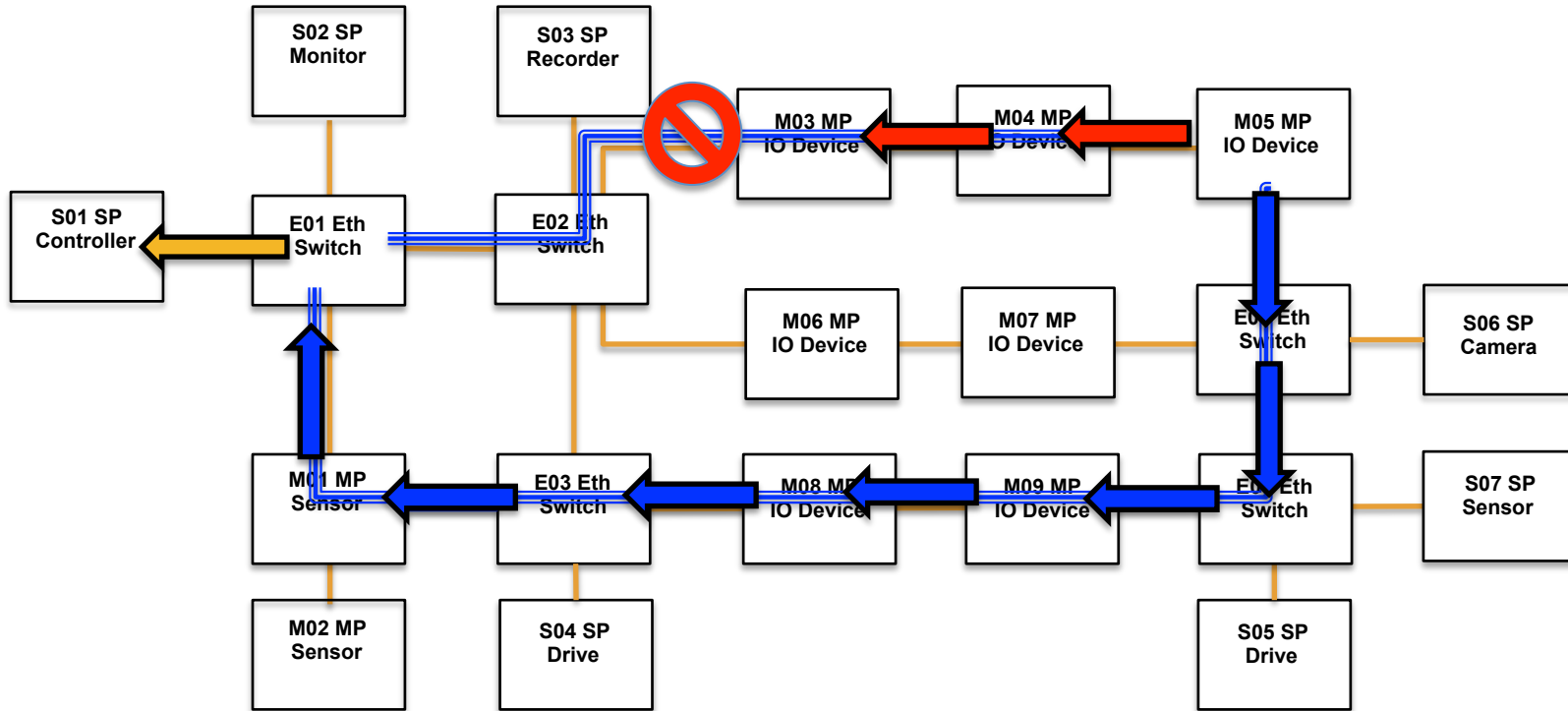
Sample FRER Network (Partial Mesh)



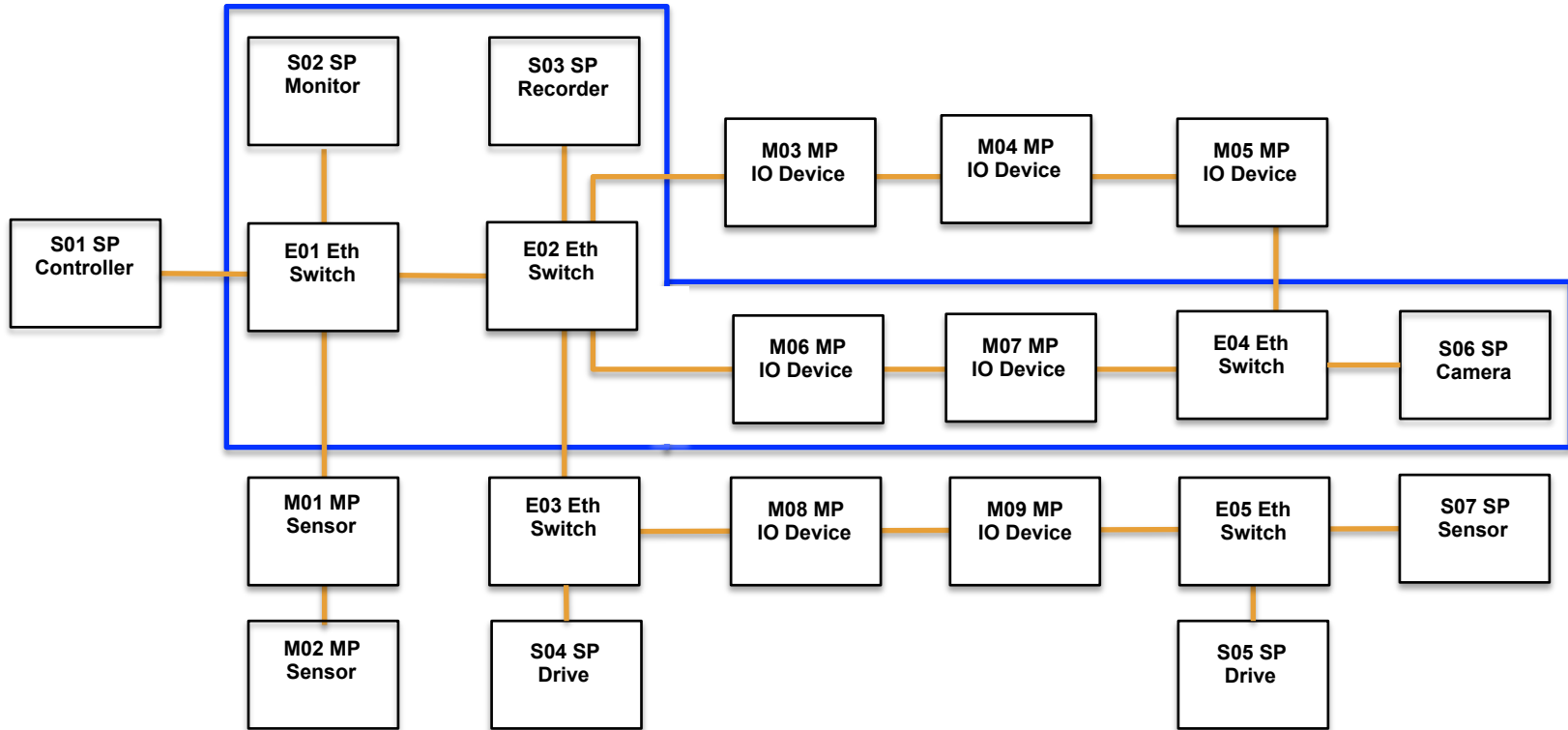
Sample FRER Network (Partial Mesh)



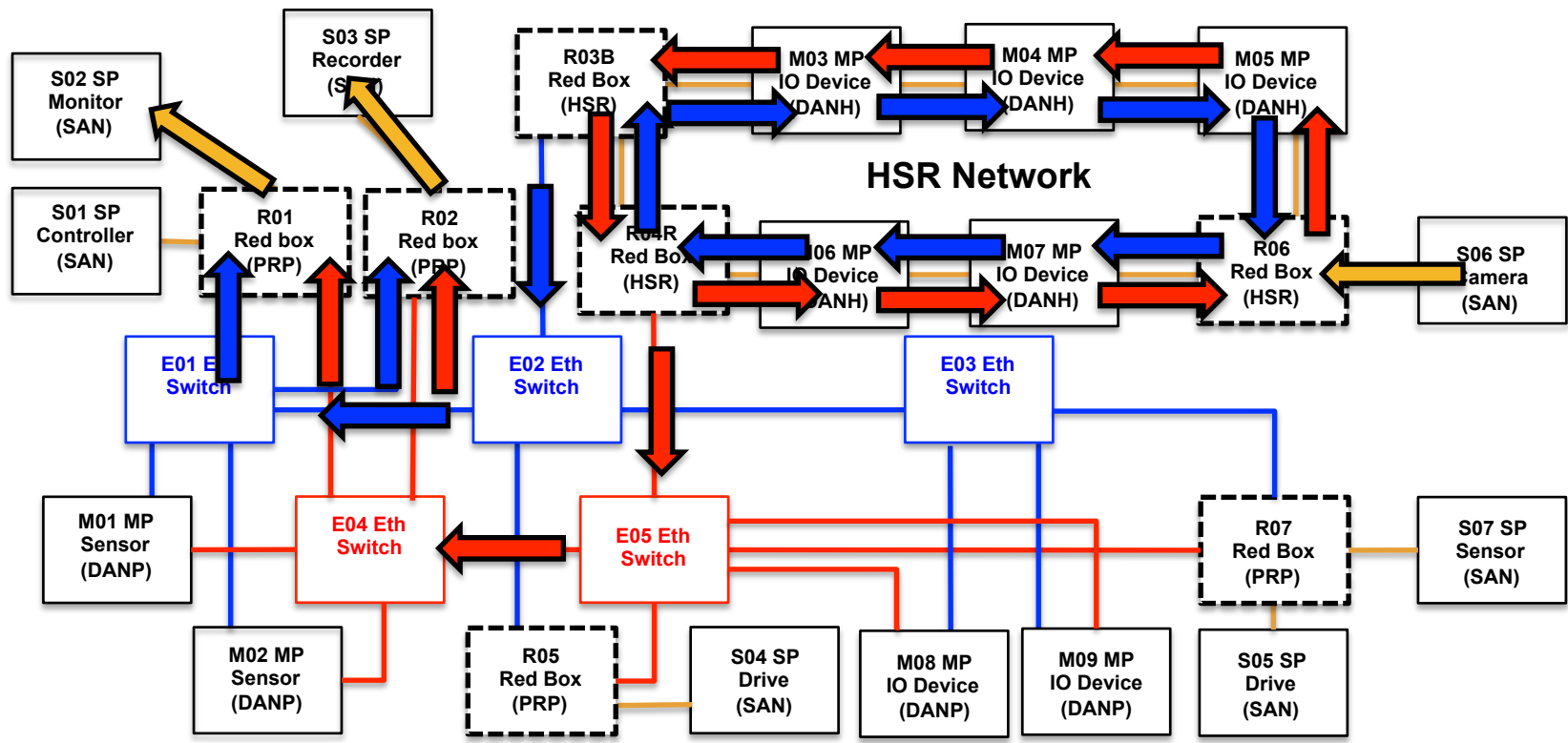
Sample FRER Network (Partial Mesh)



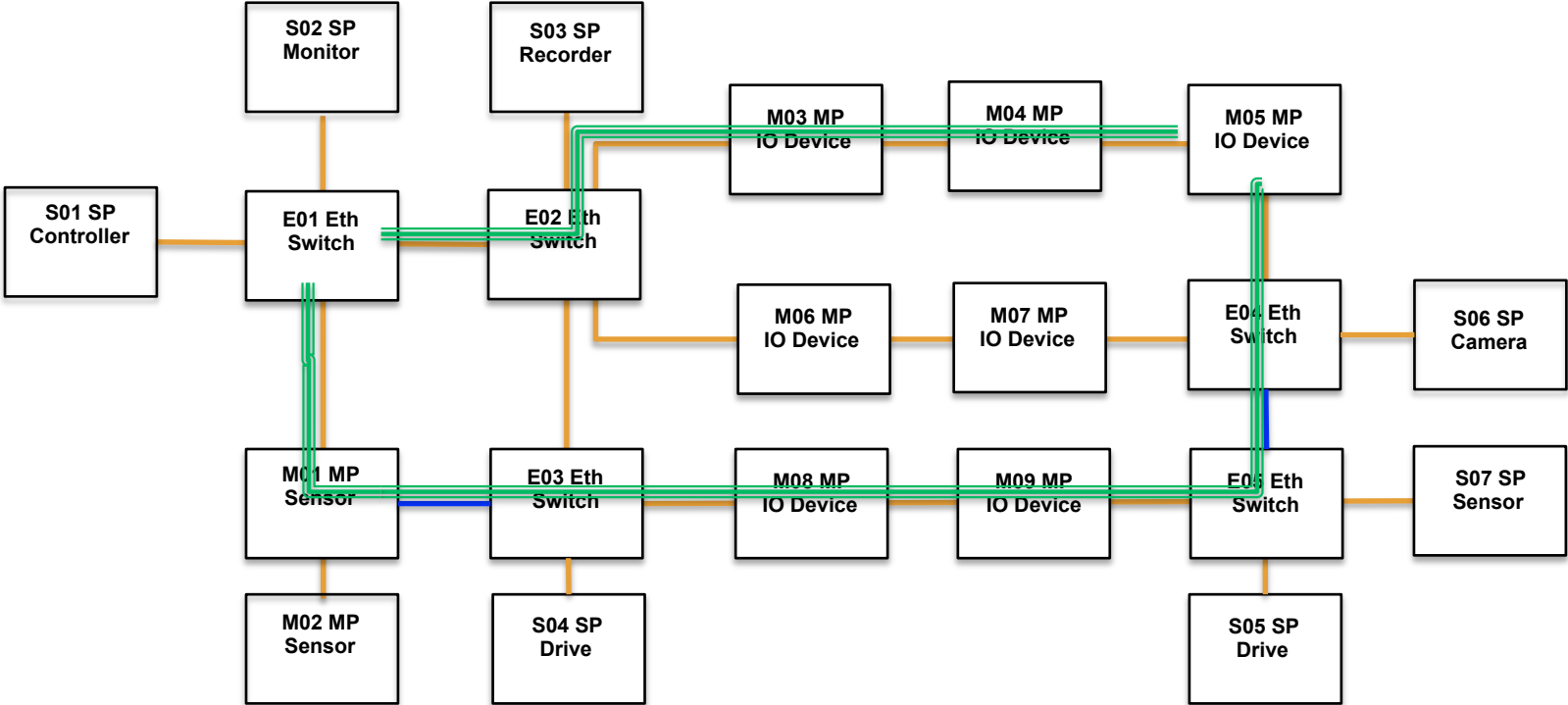
Sample Target Network



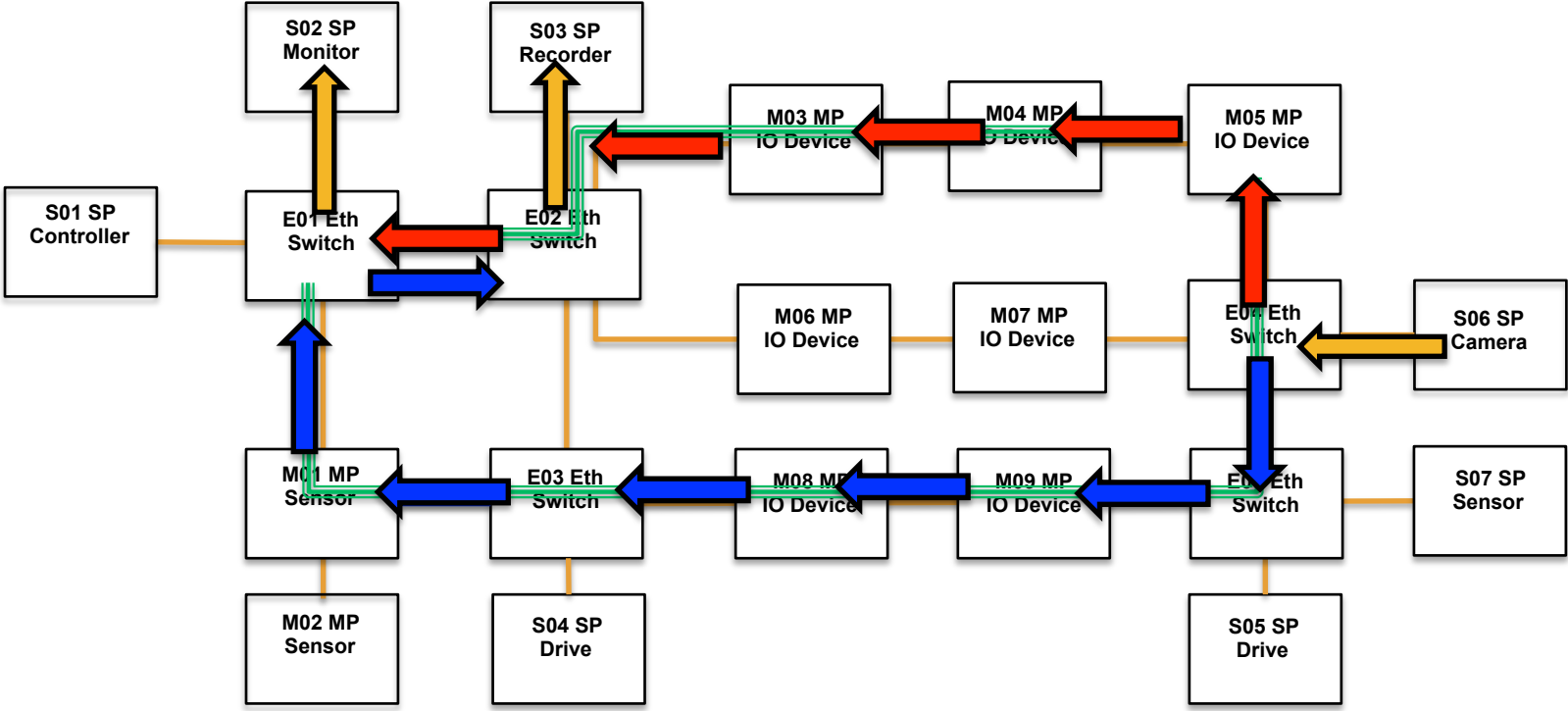
Sample IEC 62439 Network



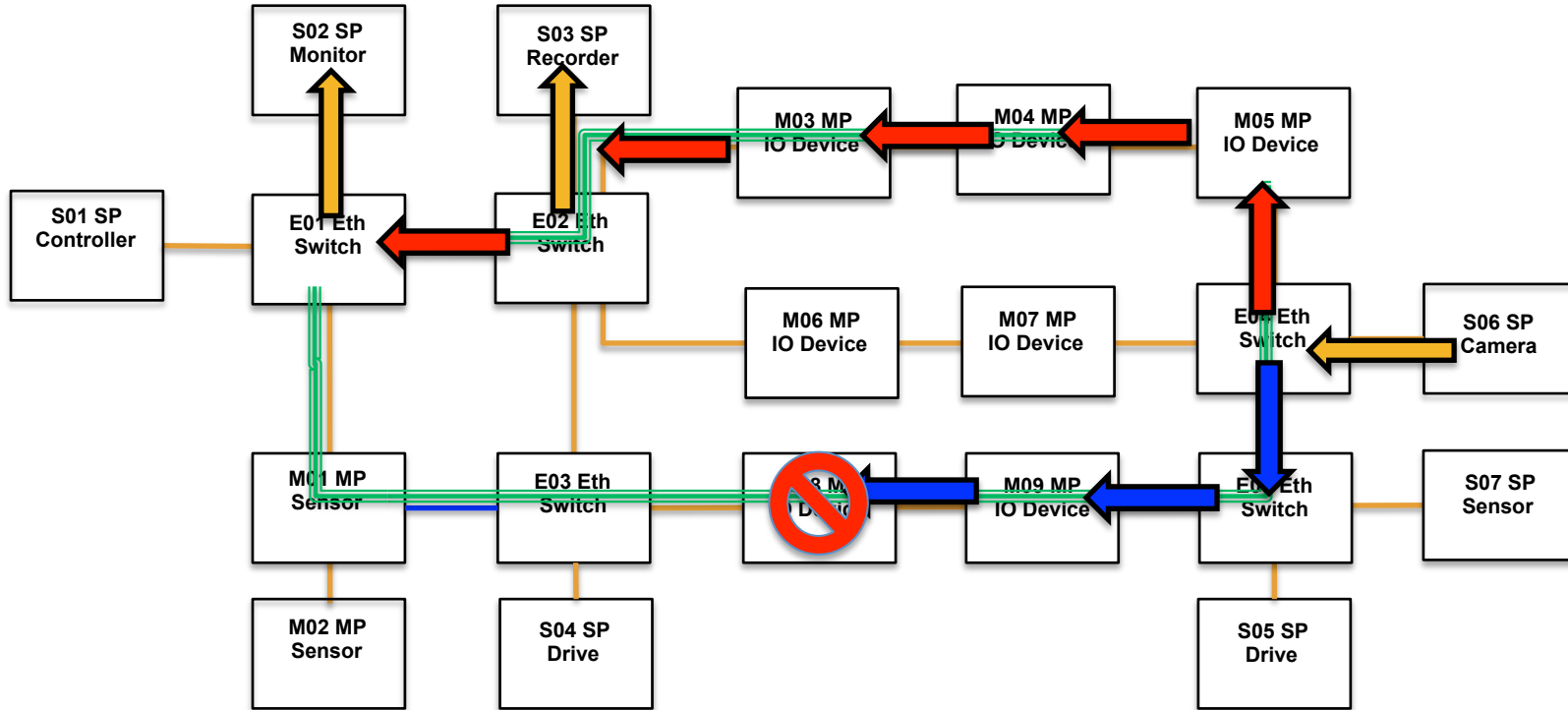
Sample FRER Network (Partial Mesh)



Sample FRER Network (Partial Mesh)



Sample FRER Network (Partial Mesh)



Conclusion

Cost

		Sample	PRP/HSR	TSN	
Total	=	18550	27400	20050	20750
Cost Difference	=		48%	9%	12%
[(S-T)/S]					

Performance

- **FRER provides higher or equal performance to PRP/HSR**

Determinism

- **Higher degree of control over the determinism of the System with control of interference traffic.**



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