From LAN to WAN – assessing the communication network for protection, automation, and control

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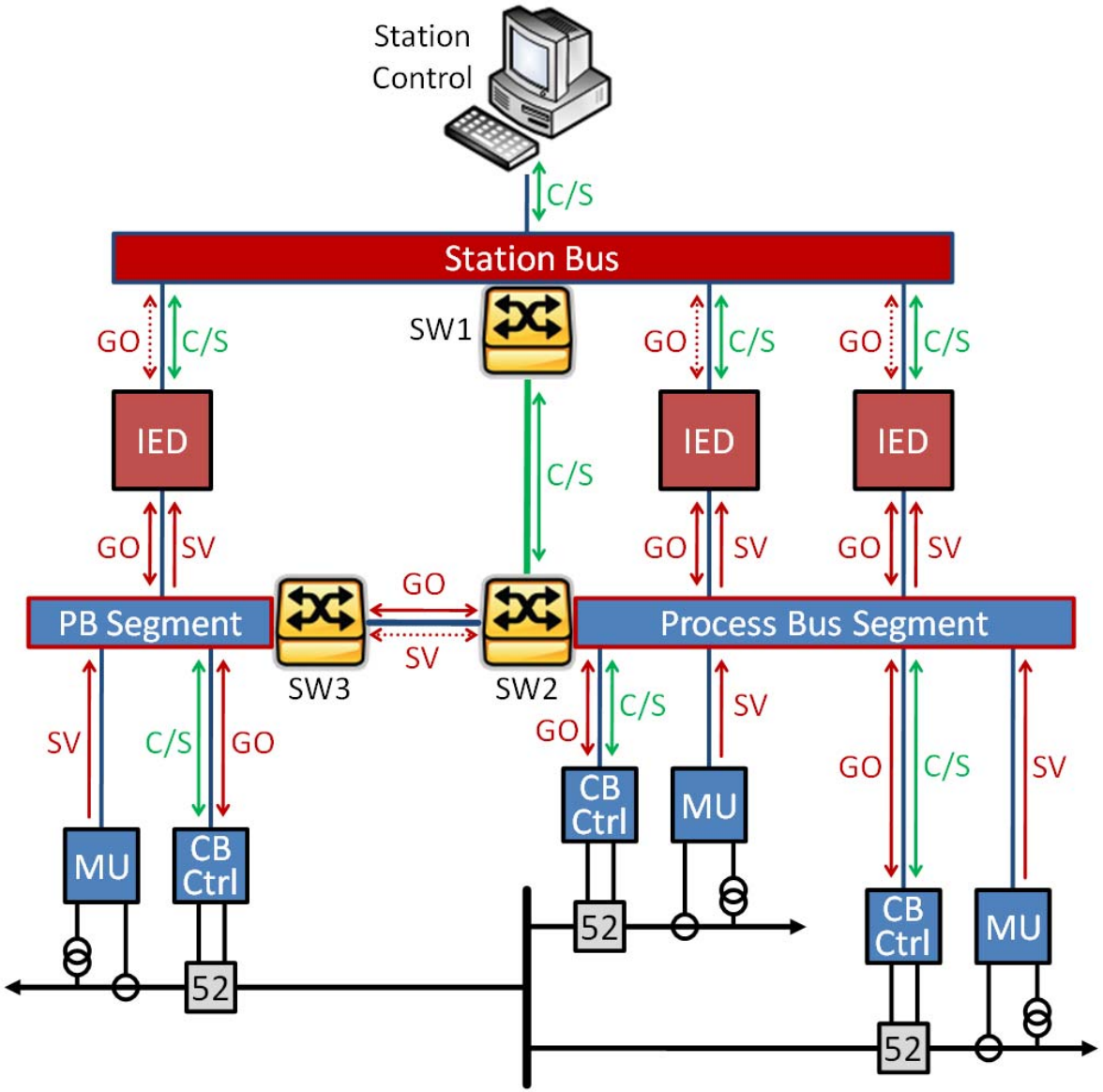
pacworld
PROTECTION, AUTOMATION & CONTROL WORLD CONFERENCE

Dedicated buses & traffic segregation

- Station Bus
  - Client / Server communication
  - GOOSE
- Process Bus
  - Sampled Values
  - GOOSE
  - Client / Server communication

Fully digital PAC system

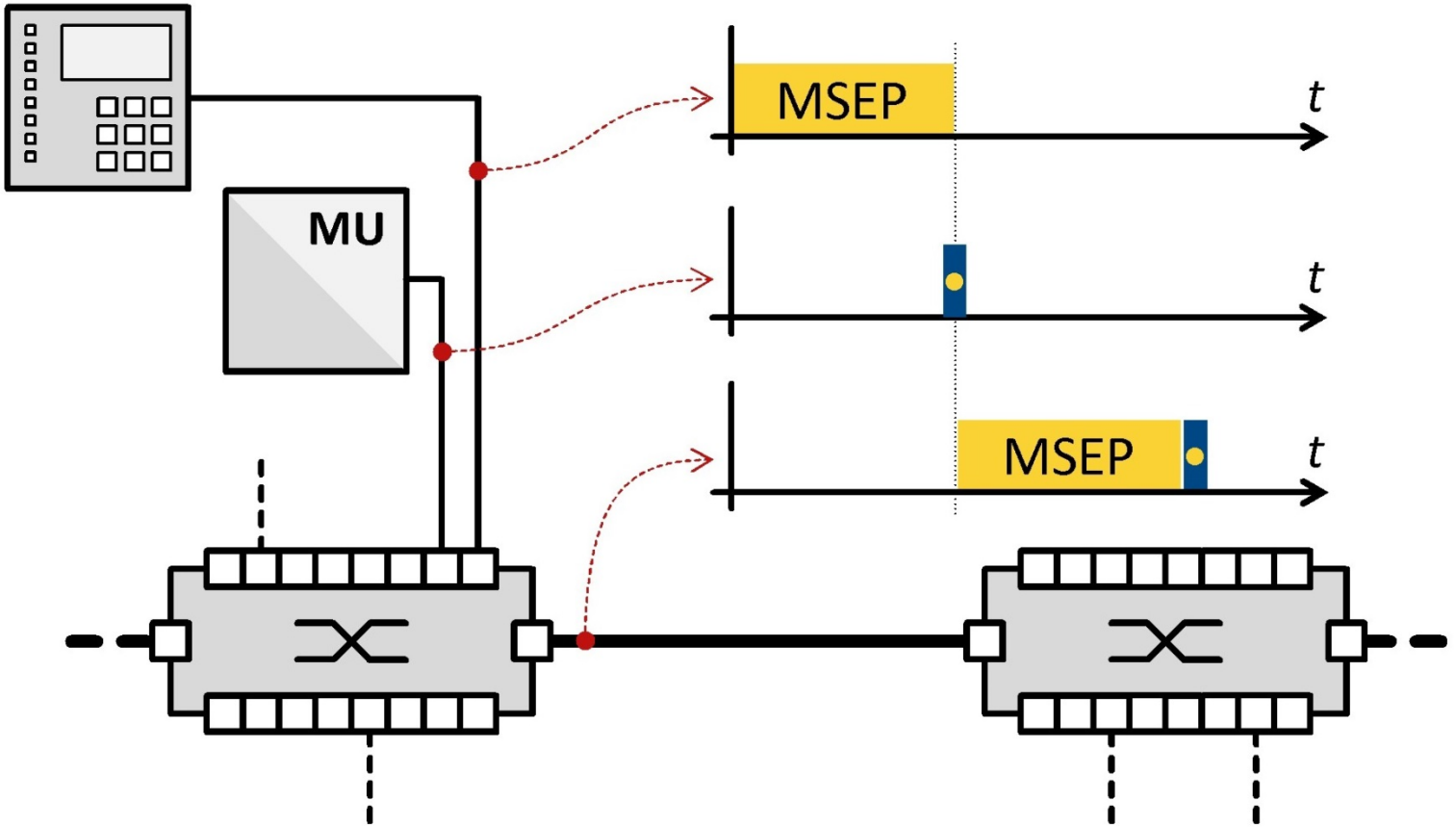


Performance in IEC 61850-5

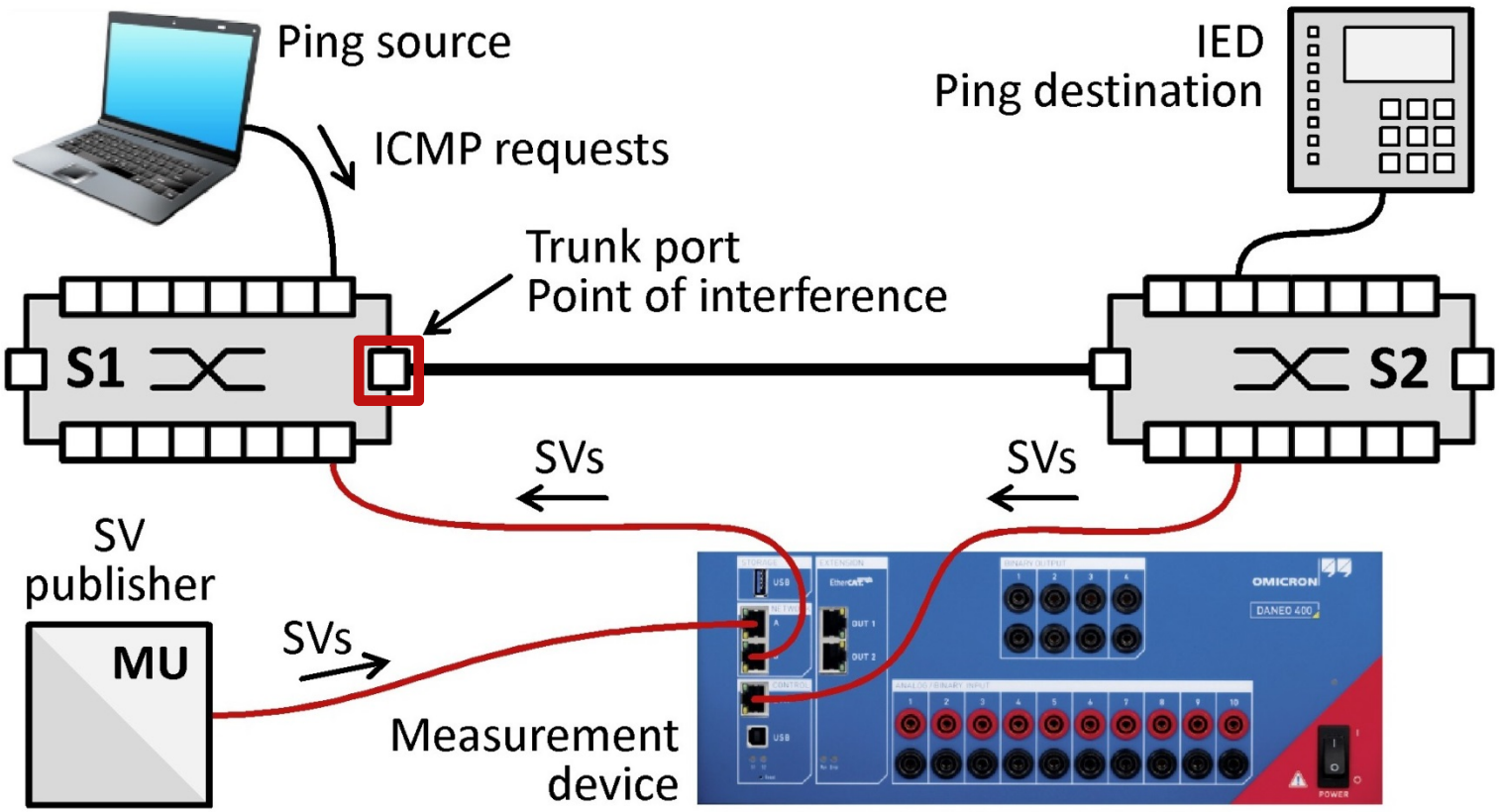
Transfer time class	Transfer time [ms]	Application examples: Transfer of
TT0	>1 000	Files, events, log contents
TT1	1 000	Events, alarms
TT2	500	Operator commands
TT3	100	Slow automatic interactions
TT4	20	Fast automatic interactions
TT5	10	Releases, status changes
TT6	3	Trips, blockings

Performance class	Requirement description	Transfer time		Typical for Interface (IF [a])
		Class	ms	
P1	The total transmission time shall be below the order of a quarter of a cycle (5 ms for 50 Hz, 4 ms for 60 Hz).	**TT6**	≤ 3	3,5,8
P2	The total transmission time shall be in the order of half a cycle (10 ms for 50 Hz, 8 ms for 60 Hz).	**TT5**	≤ 10	2,3,11
[a] Interfaces according to Figure 2.				

Ethernet packet interference



Measuring the effects



Influence of interfering traffic

Ping (ICMP) traffic to interfere with Sampled Values

Packet size	Packet duration @ 100Mbit/s	Packet frequency	Probability for interference
500 bytes (4000 bits)	40 µs	1000 s^{-1}	4 %
1538 bytes (12304 bits)	123 µs	885 s^{-1}	10.9 %

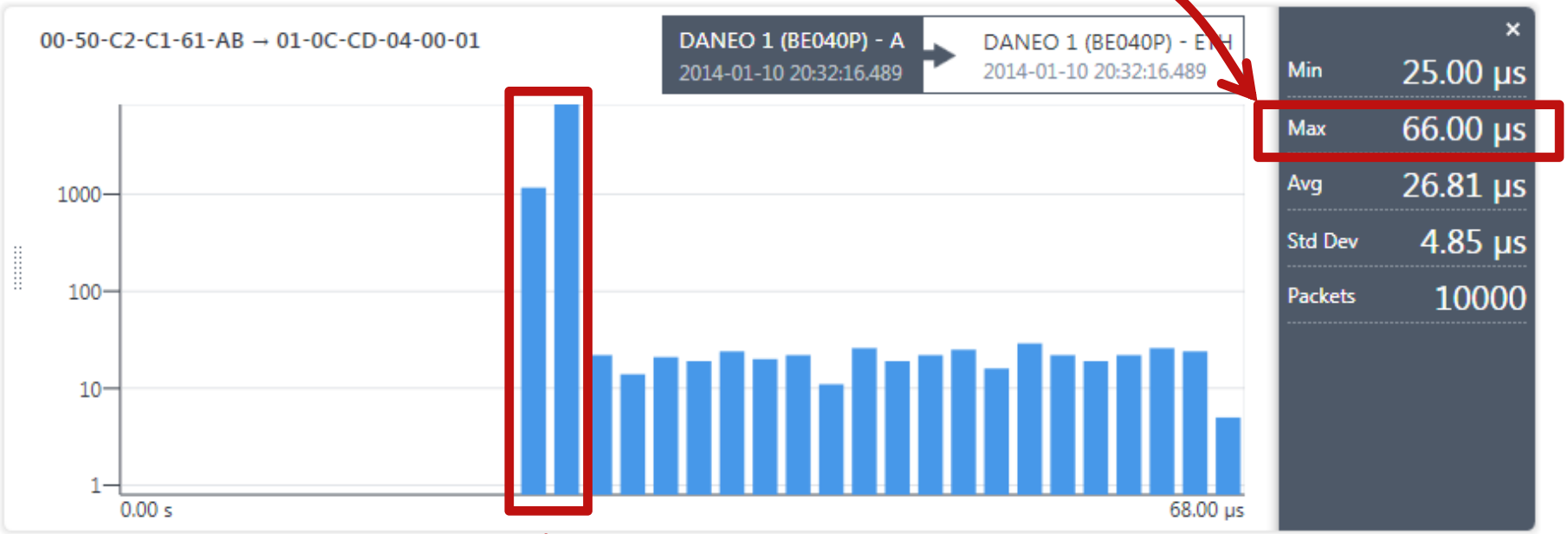
Occupied bandwidth ≡ probability for interference

Only Sampled Values – no interferences

Baseline for following measurements: 26µs

500 bytes packets interfering

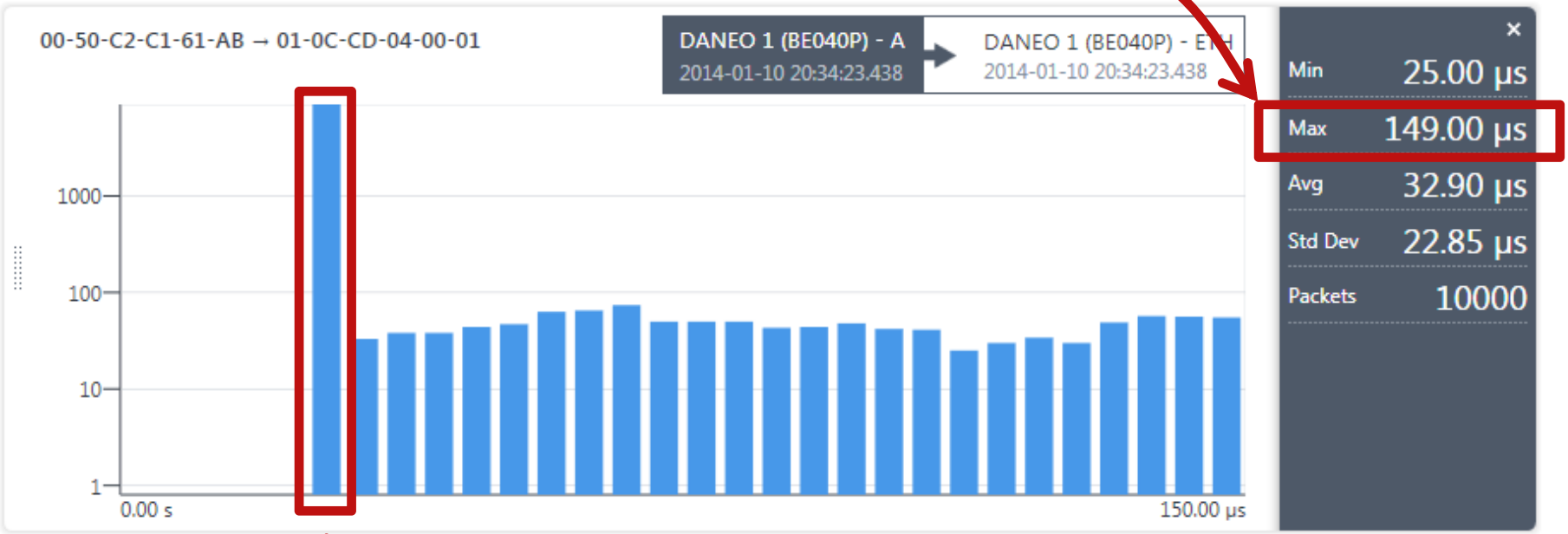
40µs + 26µs



9592 = 96%

1538 bytes packets interfering

123µs + 26µs

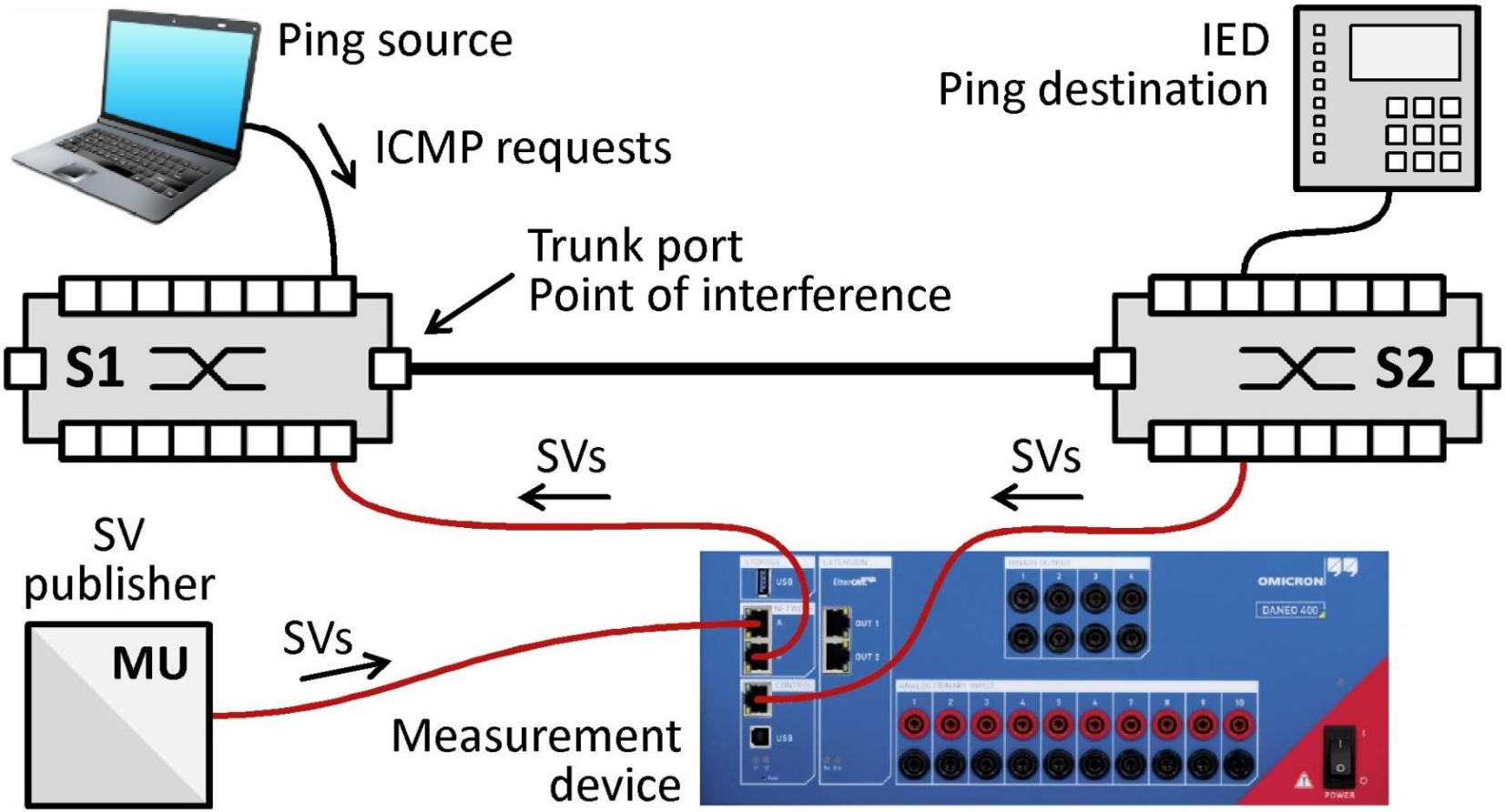


8894 = 89%

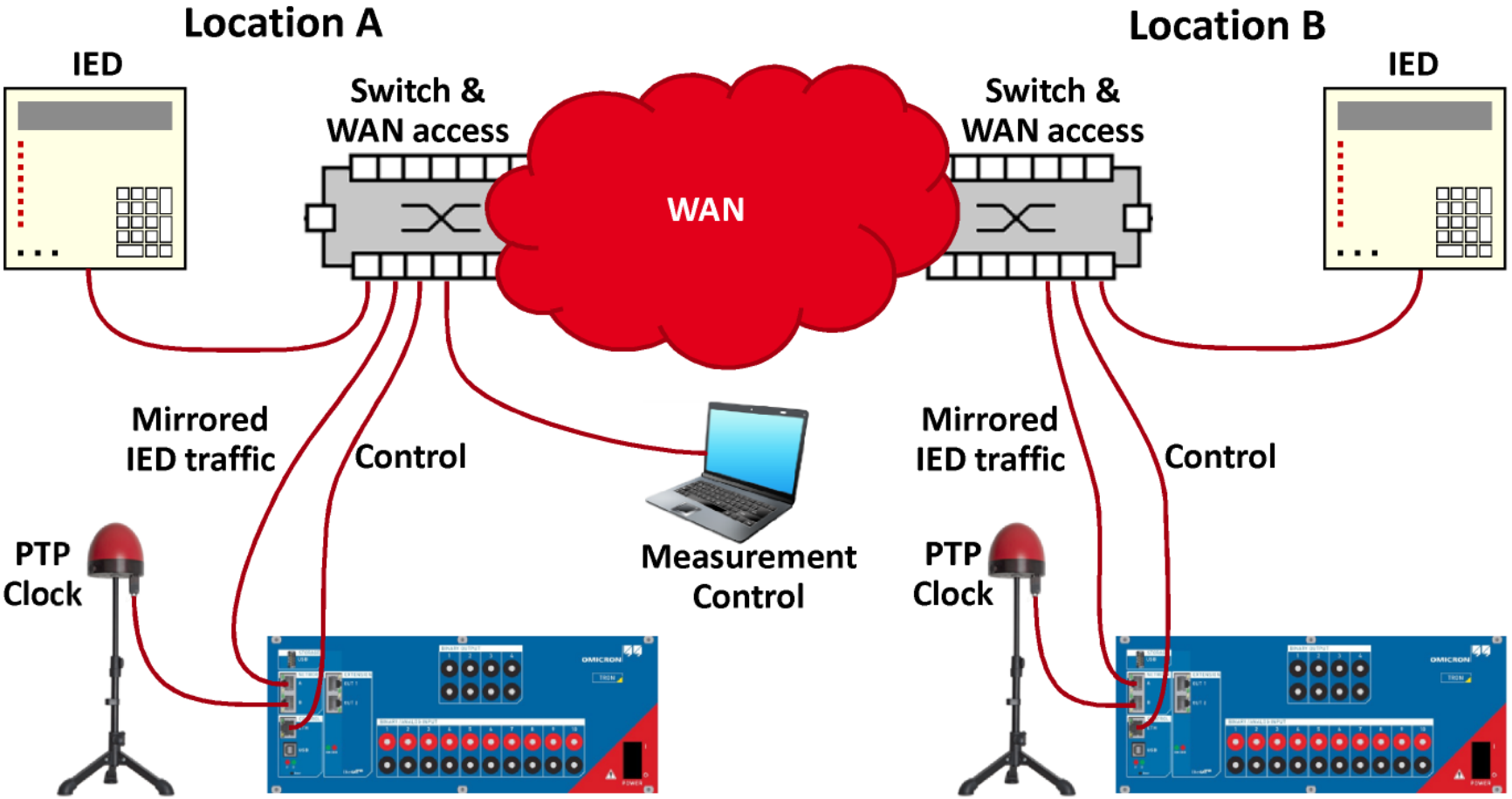
Theoretical examination vs. measurements

- Perfect match
- Measurements reveal the expected effects
- Measurement method is viable
- Measurements reveal timing behavior in power utility communication networks

Local area network – simplified setup



Wide area scenario



Verifying designs of power utility communication networks

- Design criteria
  - Throughput
  - Timing performance
- Theoretical examination
  - Delivers expected timing behavior
- Measurement
  - Verifies delivery of design criteria

Thank you for your attention !

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