



Inter-Substation Communication leveraging IEC 61850 for wide area substation communications

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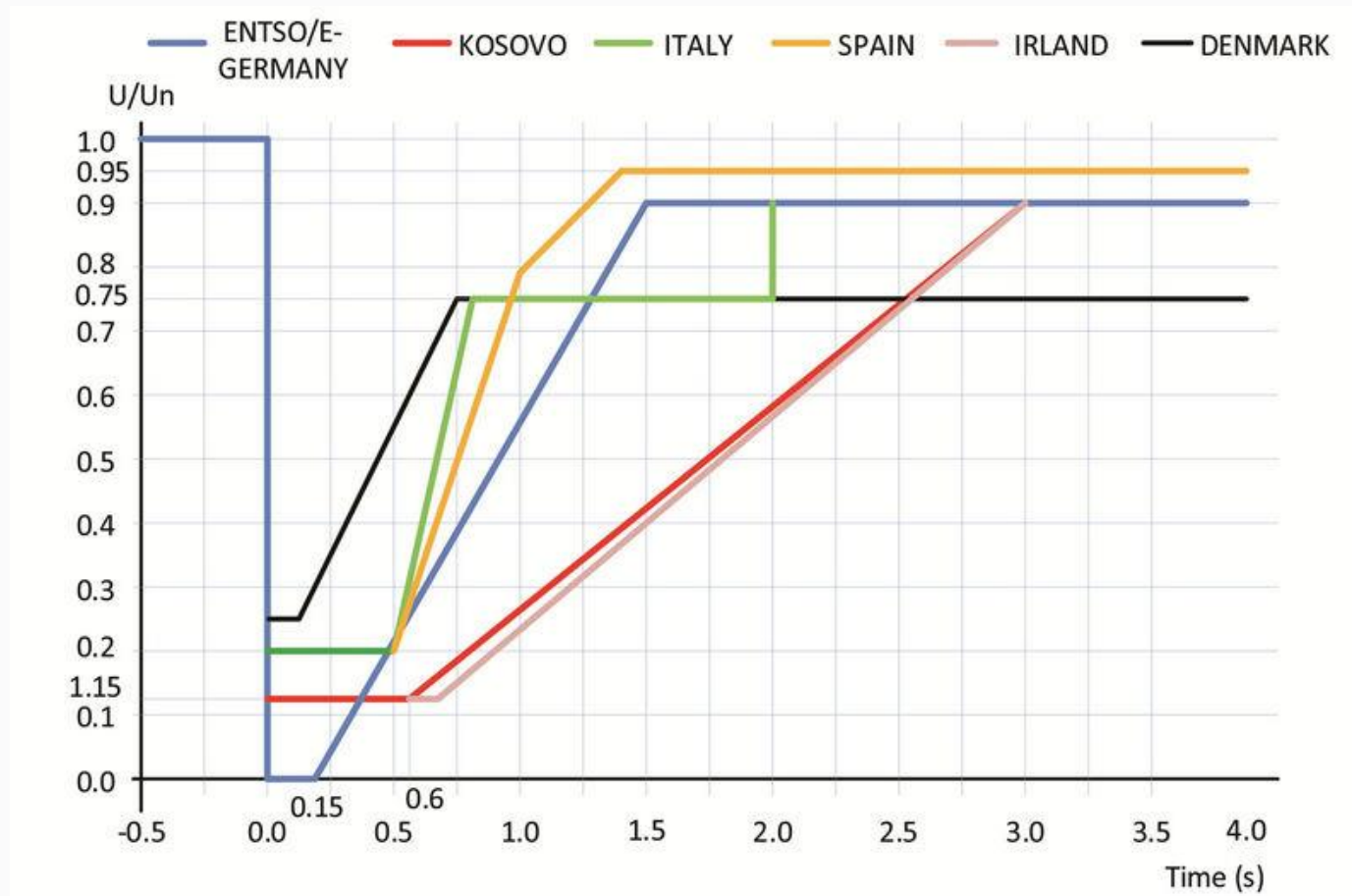
Questions

- What are we doing?
- Why are we doing it?
- How are we doing it?

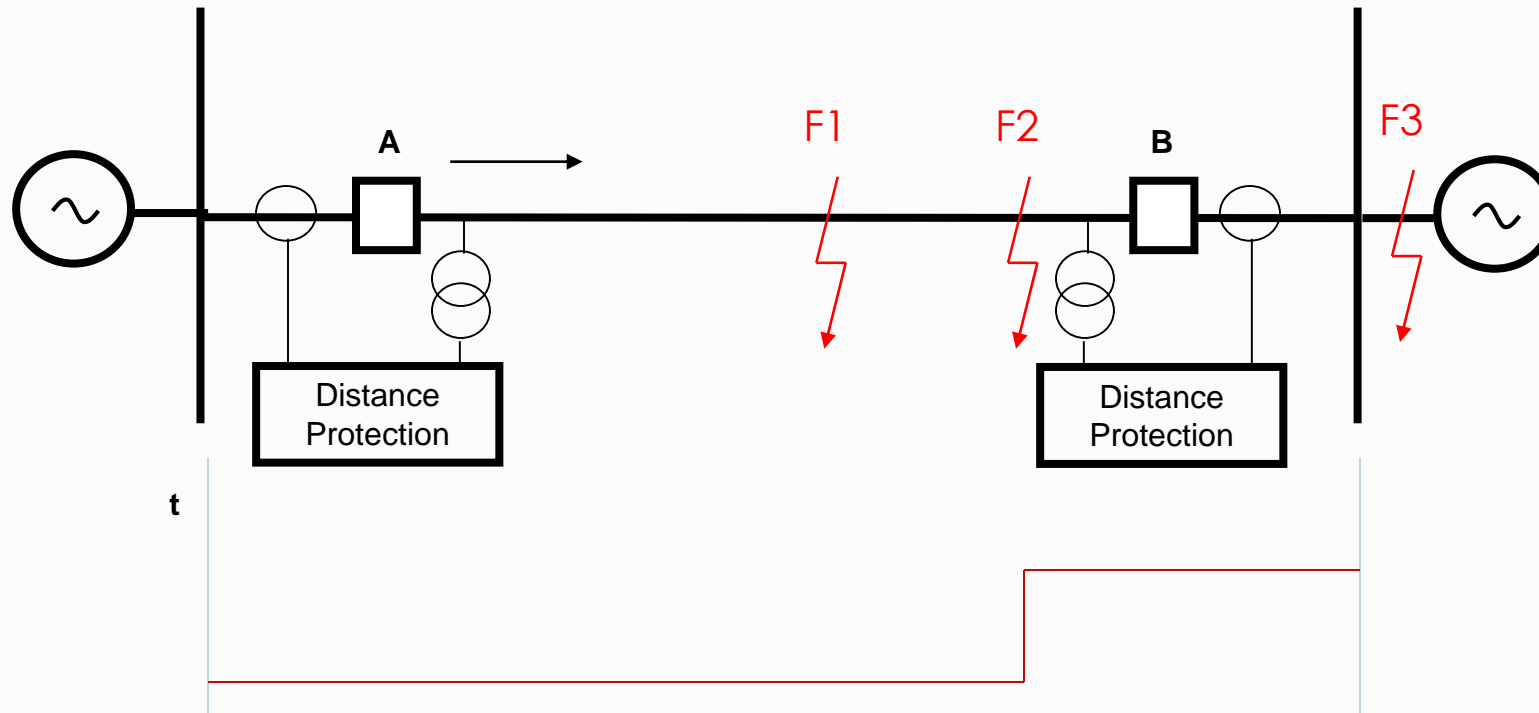
What are we doing?

- Substation-to-substation communications for protection, automation and control
- Horizontal communications for applications such as accelerated transmission line protection schemes
- Vertical communications for applications such as System Integrity Protection Schemes

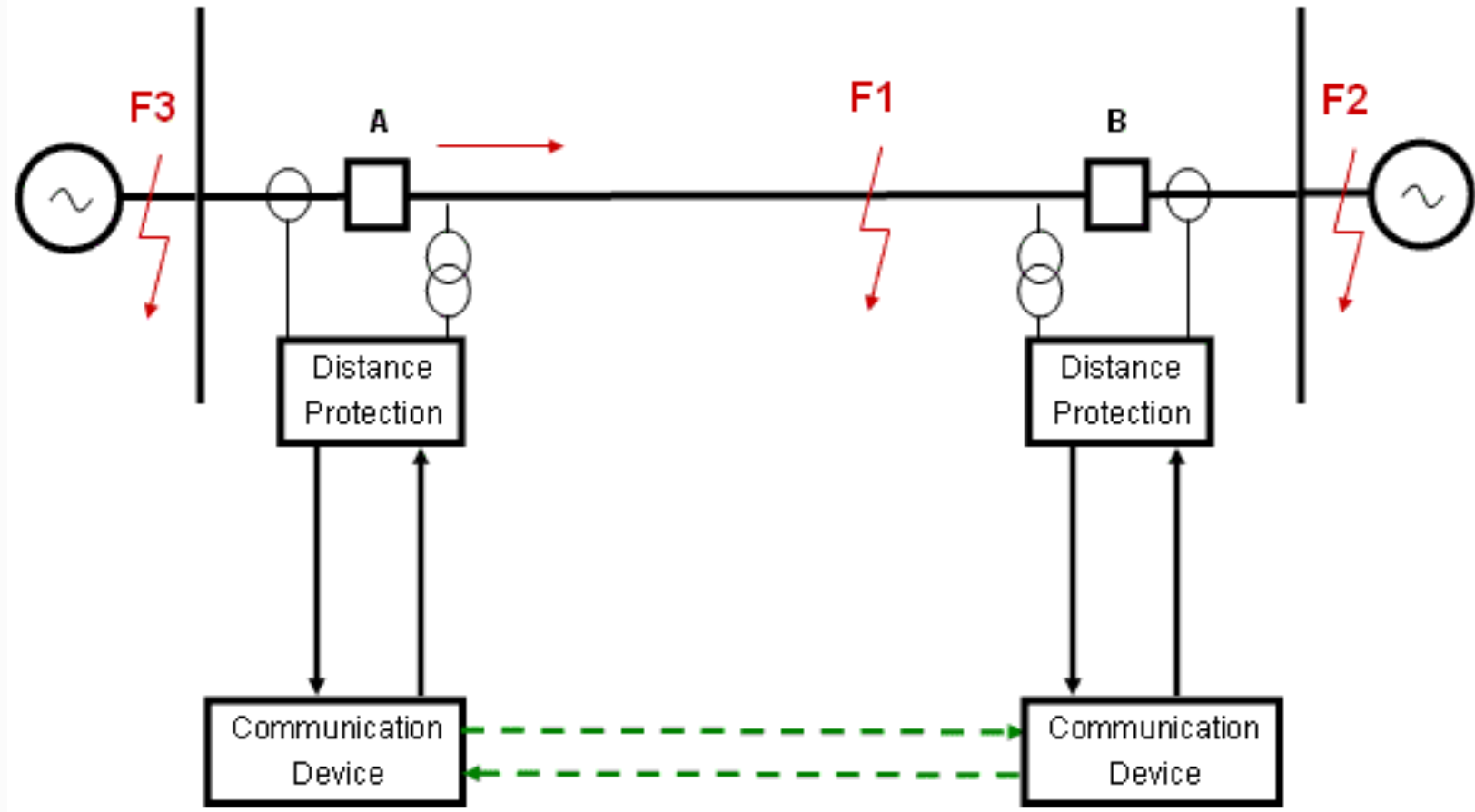
Ride-Through Capability



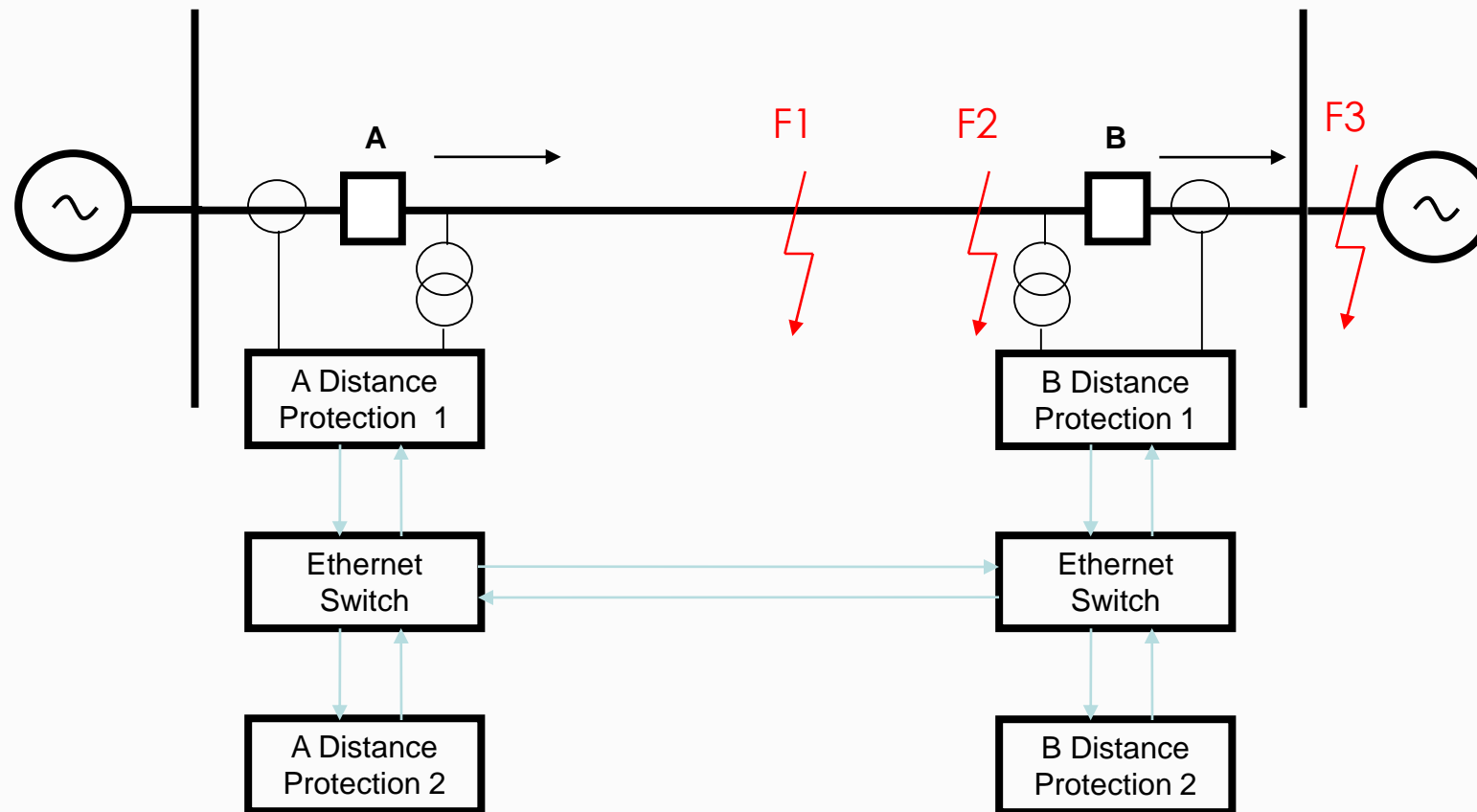
Transmission Line Protection



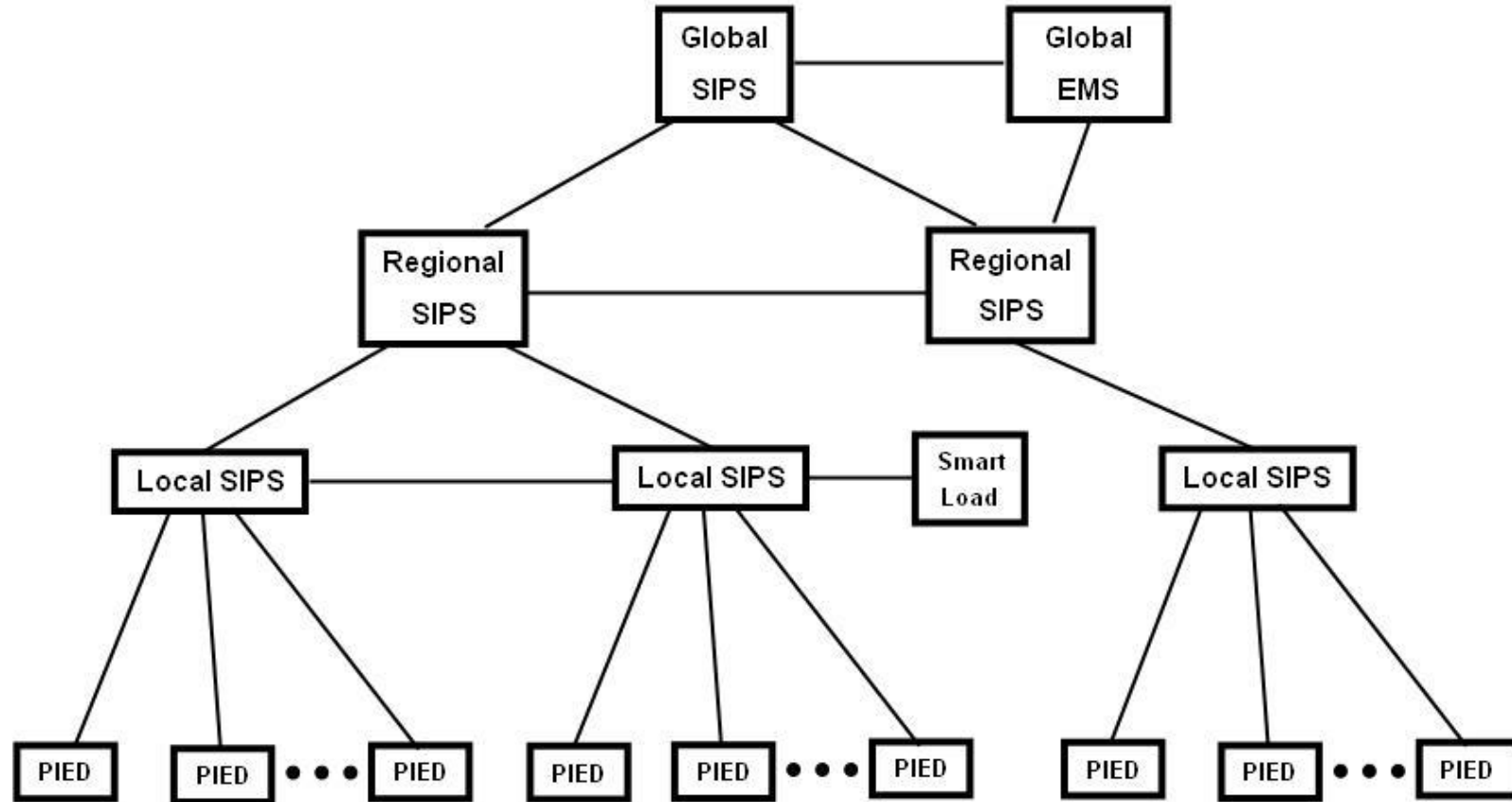
Accelerated Scheme



IEC 61850 Based Accelerated Line Protection



SIPS Hierarchy



SIPS Functionality

- SIPS can be considered as systems that have three main types of functional elements:
 - System monitoring elements
 - Protection elements
 - Execution elements

Why are we doing it?

- There are requirements for improving the quality, reliability and efficiency of PAC systems
- Quality: the standard of something as measured against other things of a similar kind.
- Reliability: the ability of an apparatus or system to consistently perform its intended function without degradation or failure.
- Efficiency: the extent to which a resource is used in order to effectively achieve an objective.

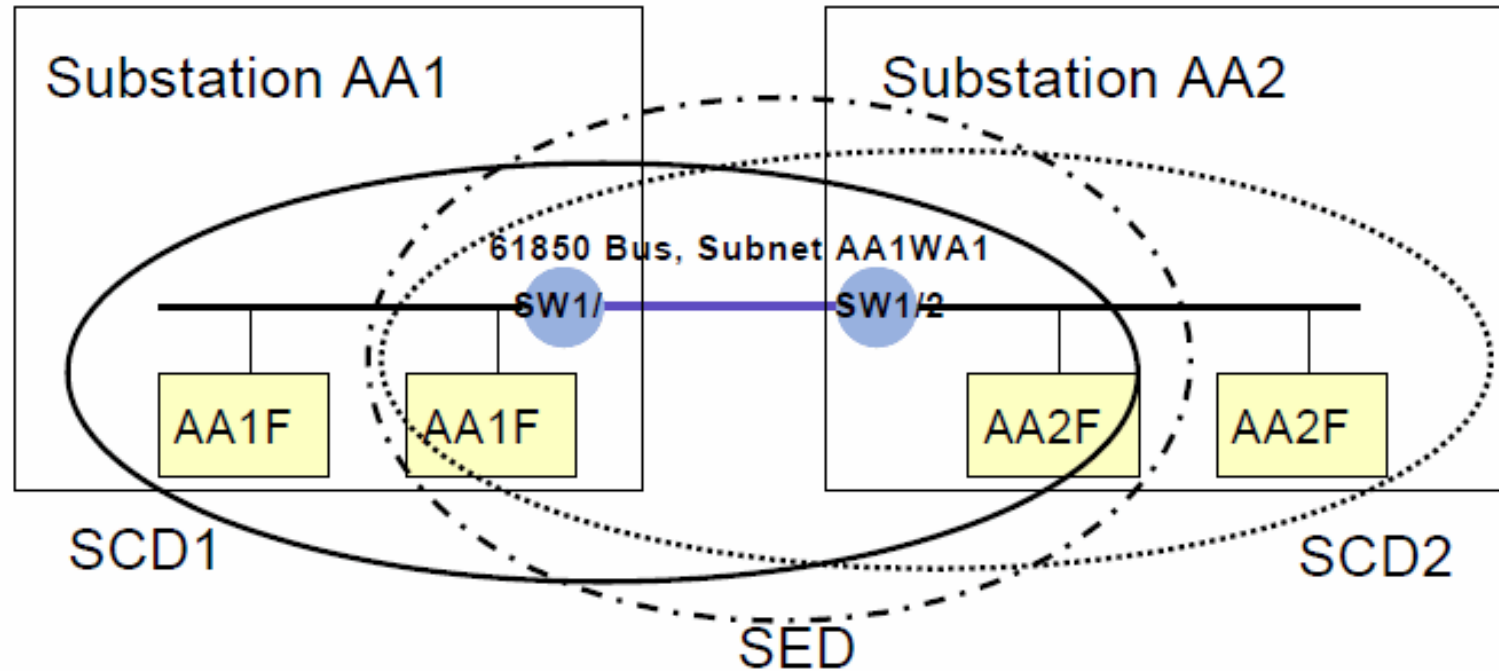
Why are we doing it?

- Conventional client-server protocols such as IEC60870-5-101, IEC60870-5-104 and DNP 3.0 are connection oriented and do not meet the performance requirements for many PAC applications
- They do not support high-speed peer-to-peer communications
- The detailed semantical object model in IEC 61850 is not available in other protocols

Why are we doing it?

- IEC 61850 is not just a communications protocol
- It supports a standardized engineering process based on the different System Configuration Language (SCL) files
- Substation-to-Substation communications engineering is based on System interface Exchange Description (SED) files

System interface Exchange Description (SED)

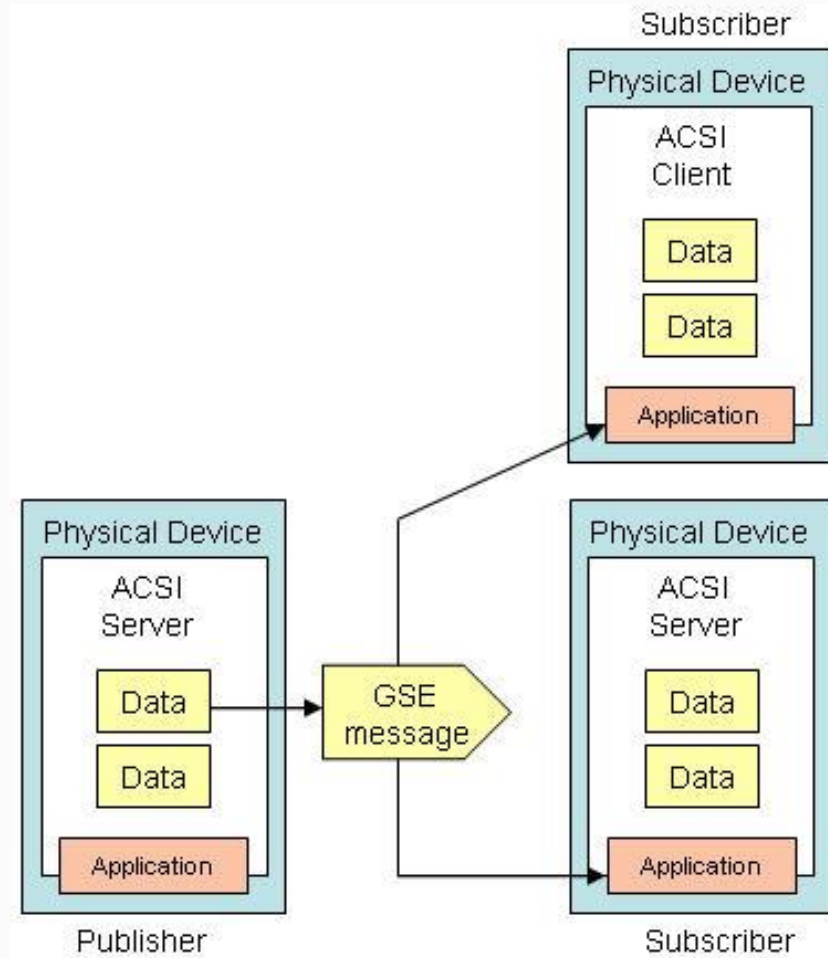


High bandwidth wide area connection 'looks like switch'

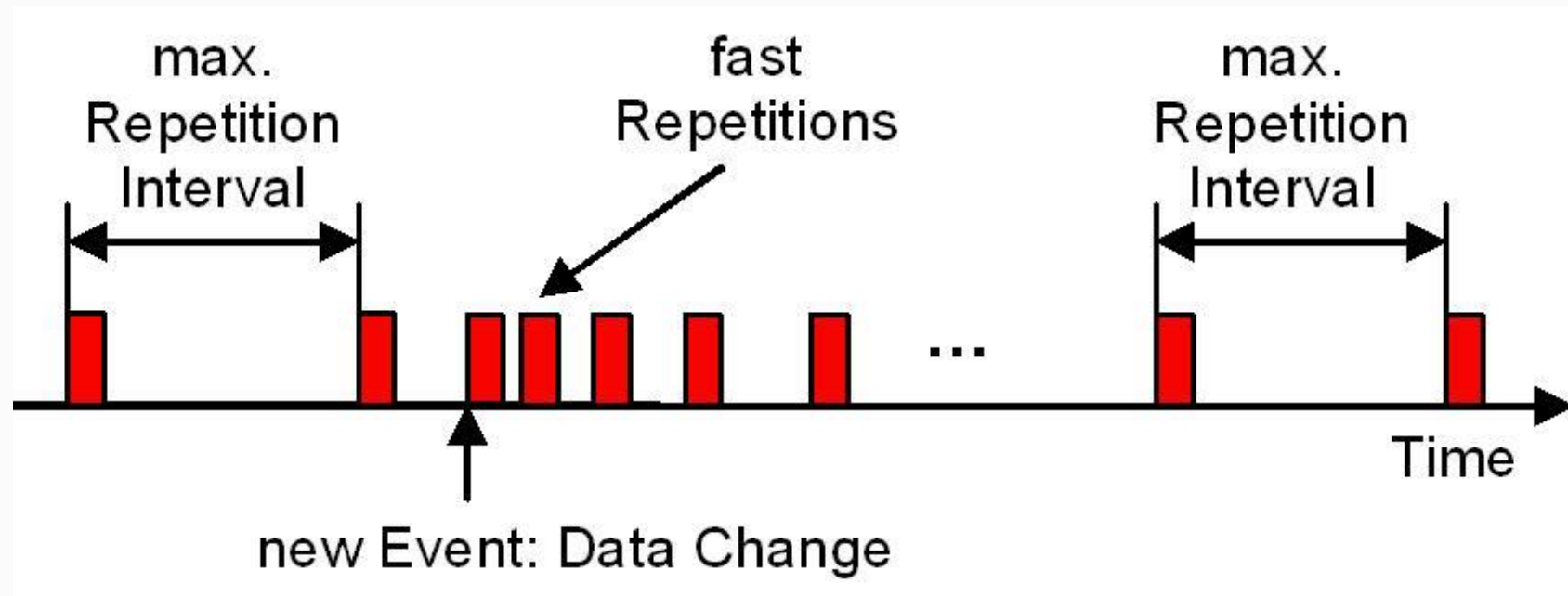
How are we doing it?

- Use of IEC 61850 GOOSE and sampled values based versus conventional hardwired interfaces
- Using GOOSE over existing communications channel
- Using GOOSE over Layer 2
- Using GOOSE over Layer 2.5
- Using R-GOOSE

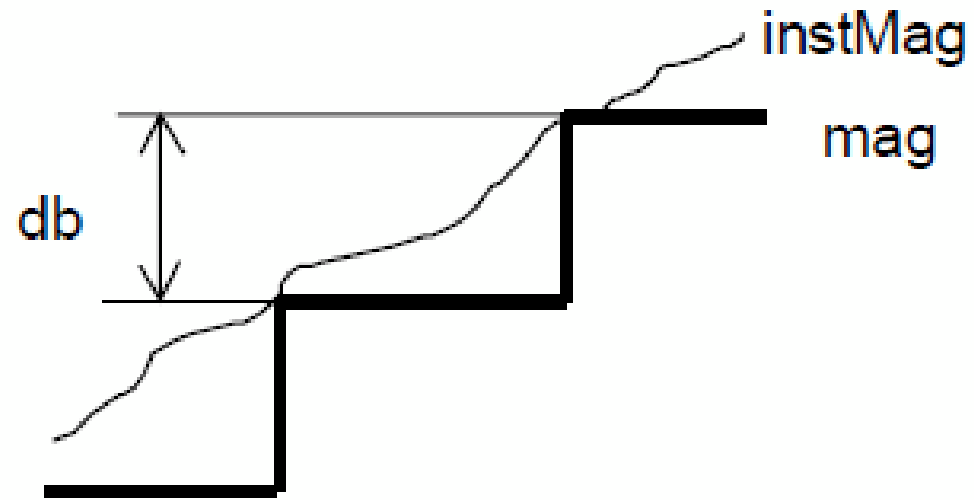
IEC 61850 Services



GSE Messages:



Analog GOOSE Applications

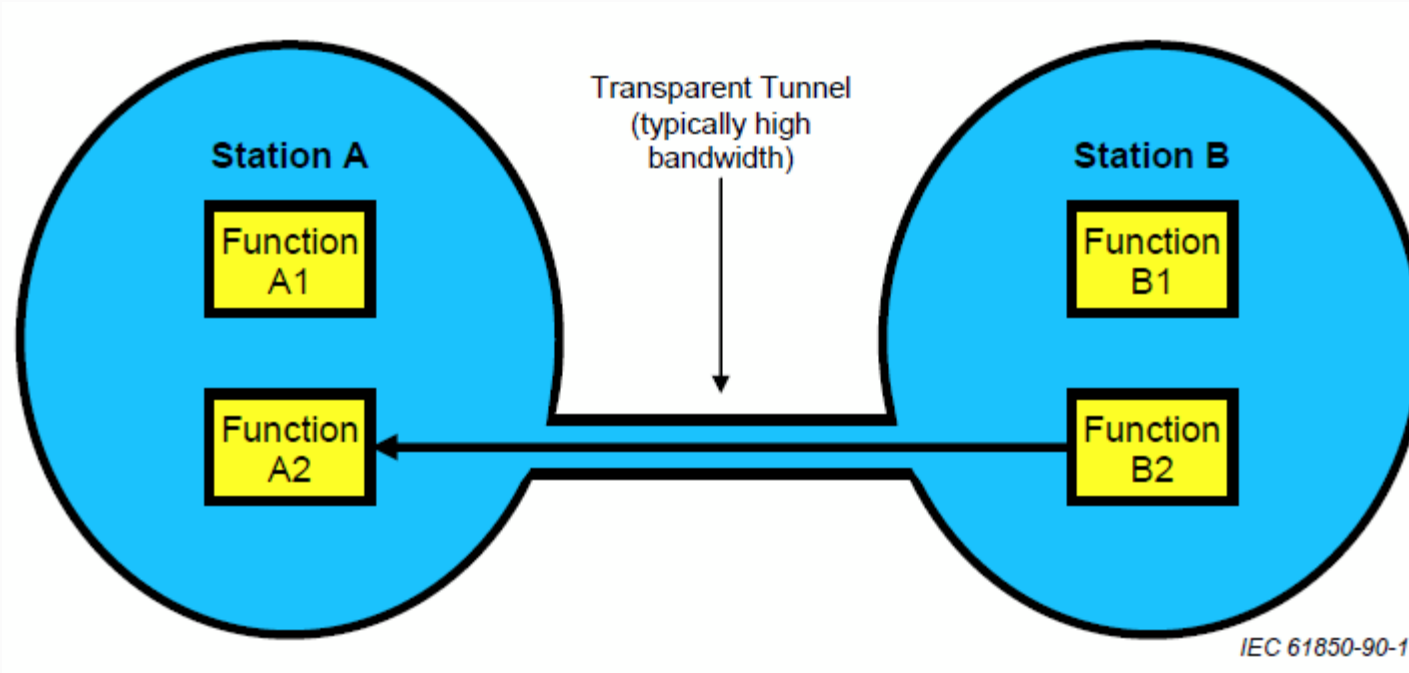


IEC 940/03

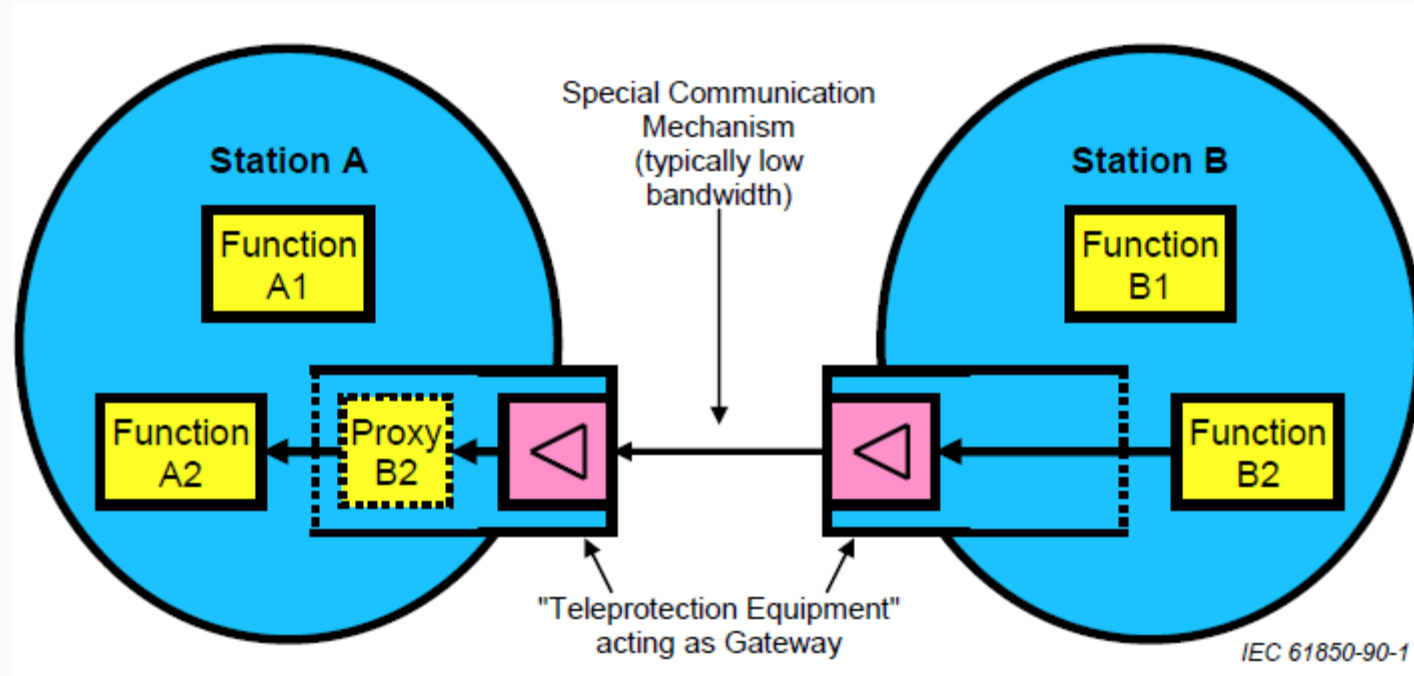
IEC 61850 Reports

- IEC 61850-90-1 – Using IEC 61850 for communication between substations
- IEC 61850-90-5 – Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118

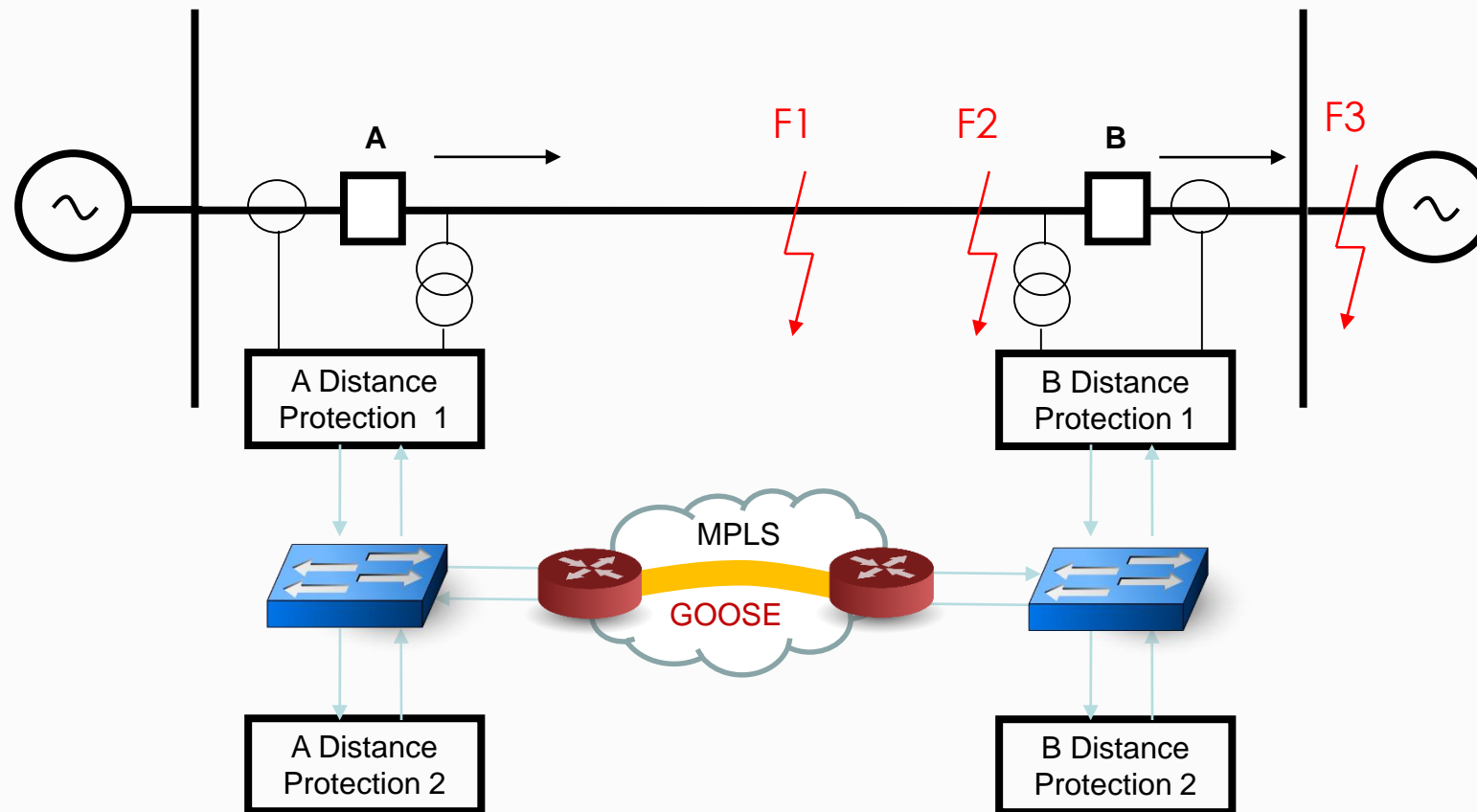
SS-SS Tunneling



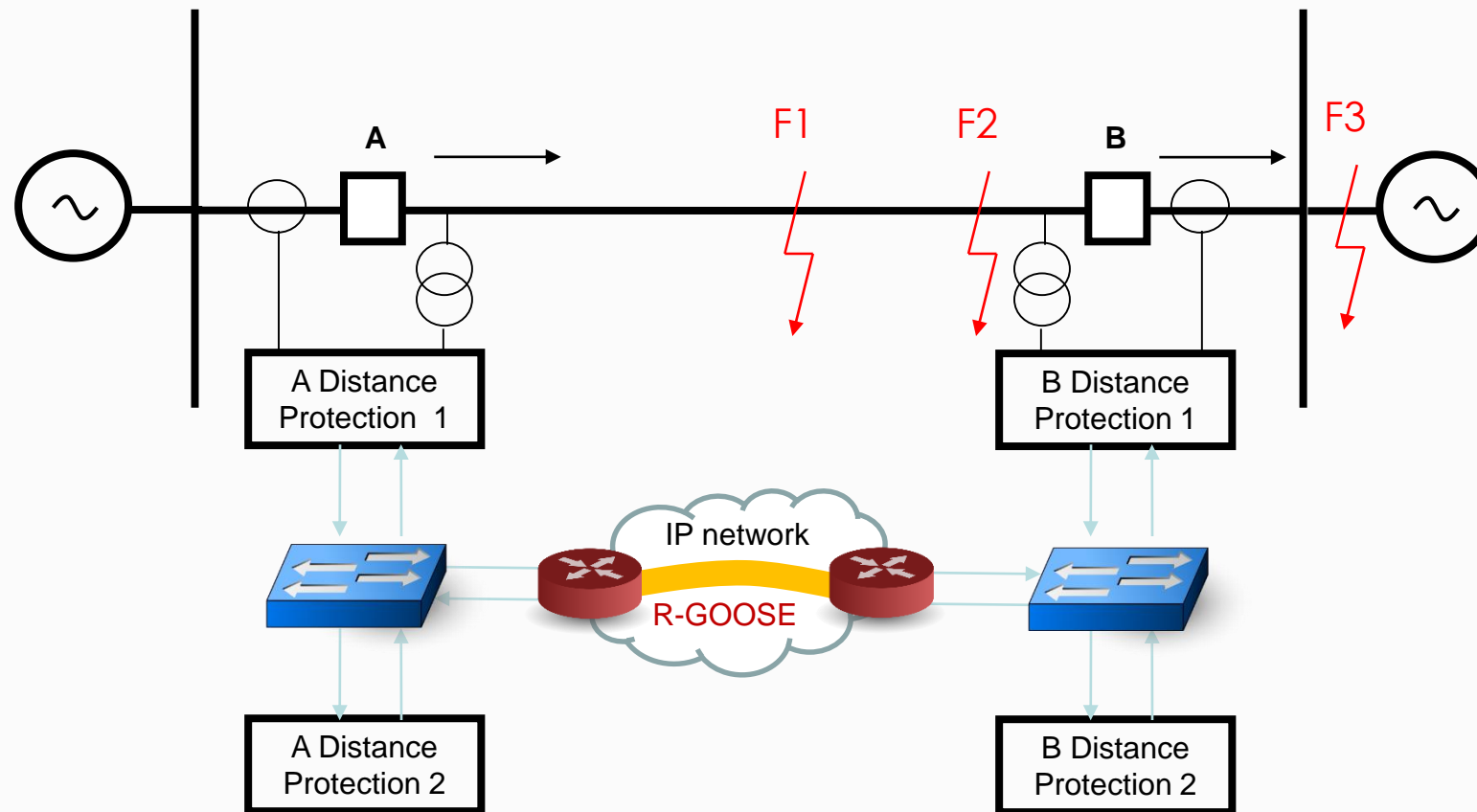
SS-SS Mechanism



IEC 61850 Based Accelerated Line Protection



IEC 61850 Based Accelerated Line Protection



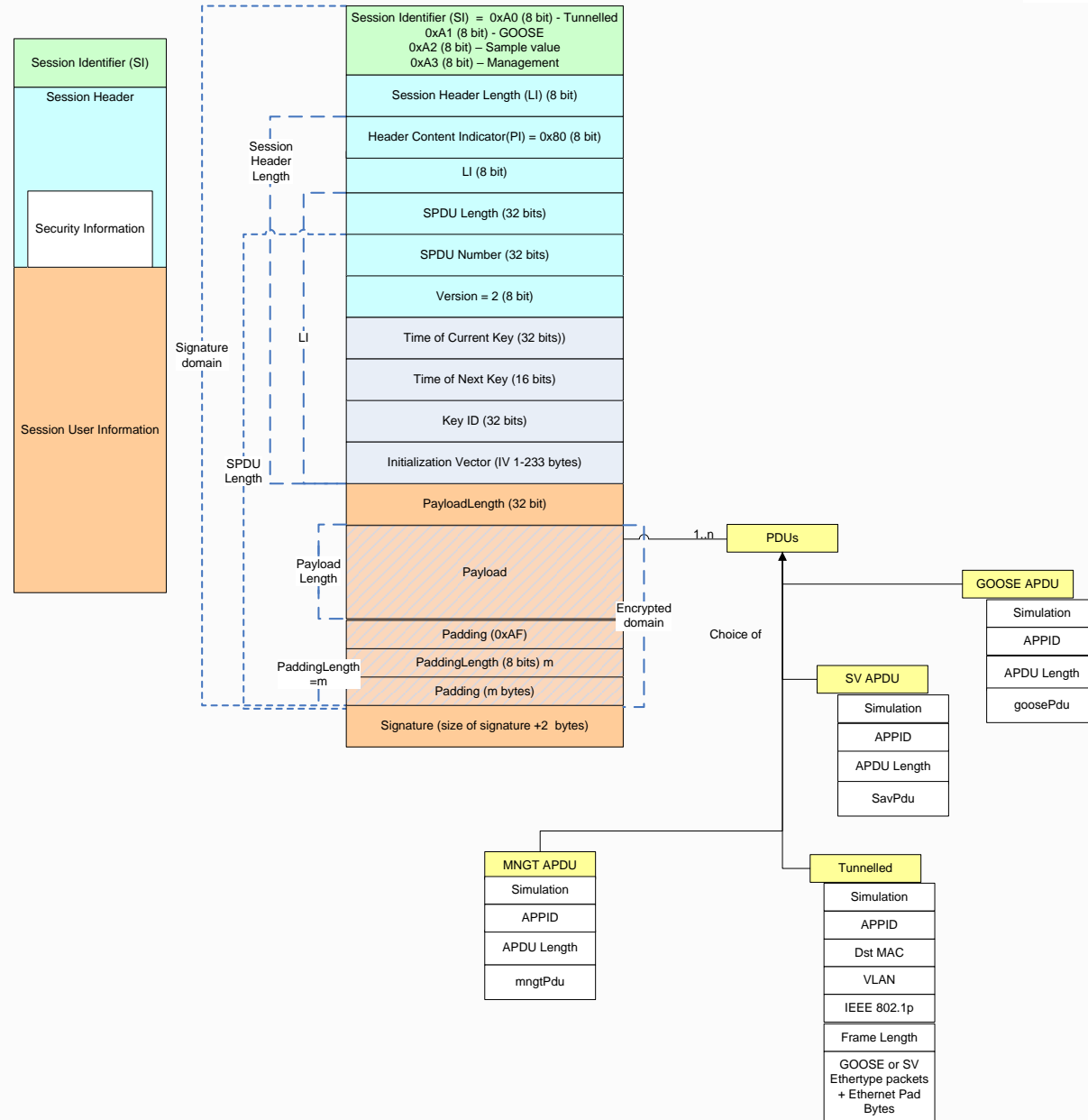
R-GOOSE Control Block

Attribute name	Attribute type	r/w	m	Value/value range/explanation
GoEna	Boolean	rw	m	
GoID	Visible-string	r	m	
DatSet	Visible-string	r	m	
ConfRev	Unsigned	r	m	
NdsCom	Boolean	r	m	
DstAddress	UDPCOMADDR*	r	m	
MinTime	Unsigned	r	o	
MaxTime	Unsigned	r	o	
FixedOffs	Boolean	r	o	
SecurityEnable**	ENUMERATED	r	o	None, Signature, SignatureAndEncryption
* The definition of UDPCOMADDR can be found in Table 5.				
** Additional attribute to be added to the control block.				

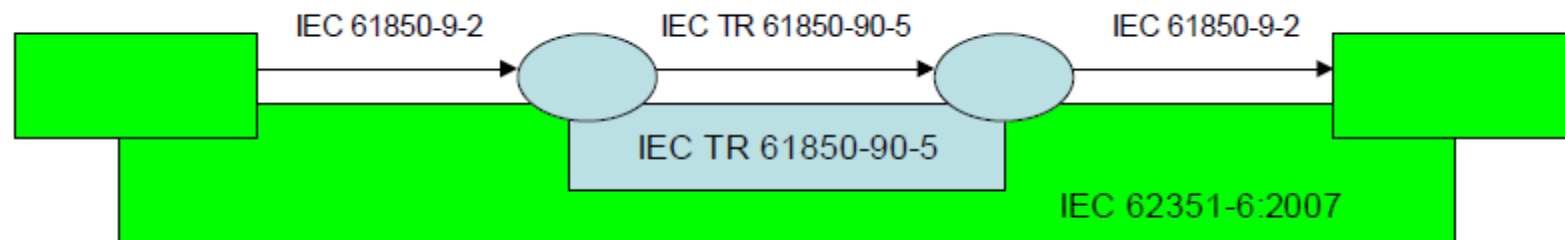
UDPCOMADDR

Attribute name	Attribute type	r/w	m	Value/value range/explanation
PRIORITY	Unsigned8	r	m	Range of values shall be limited from 0 to 7.
VID	Unsigned16	r	m	Range of values shall be limited from 0 to 4 095.
APPID	Unsigned16	r	m	As defined in Annex C in IEC 61850-8-1
TransportInUse	Unsigned8	r	o	Is an enumerated value whose values are: IPv4, IPv6, and DNS assigned
IPClassOfTraffic	Unsigned8	r	c	If TransportInUse=IPv4, the value shall represent the IPv4 TypeOfService value. If TransportInUse=IPv6, the value shall be the IPv6 Class of Traffic field.
IPv6FlowLabel	Unsigned32	r	c	If TransportInUse= IPv4, the value shall be zero (0) and shall be ignored. If the TransportInUse= IPv6, the value shall contain the 24 bits of the IPv6 Flow Label field in the least significant part of the unsigned value.
IPAddressLength	Unsigned8	r	c	If TransportInUse= IPv4, the value shall be four (4). If TransportInUse= IPv6, the value shall be sixteen (16). If TransportInUse= DNS, the value shall be the length of the DNS string, not including terminating NULL.
IPAddress	OCTET-STRING	r	c	This attribute shall be 64 octets in size. Any unused octets, based upon the IPAddressLength attribute value, shall be zero (0).

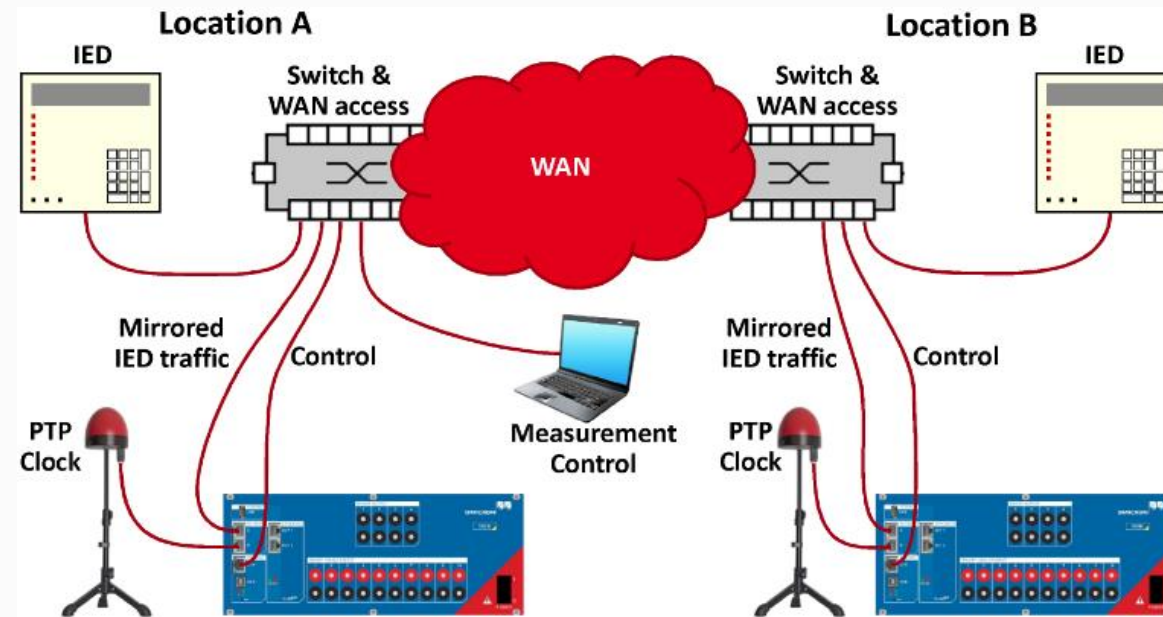
IEC 61850 90-5 Session Protocol



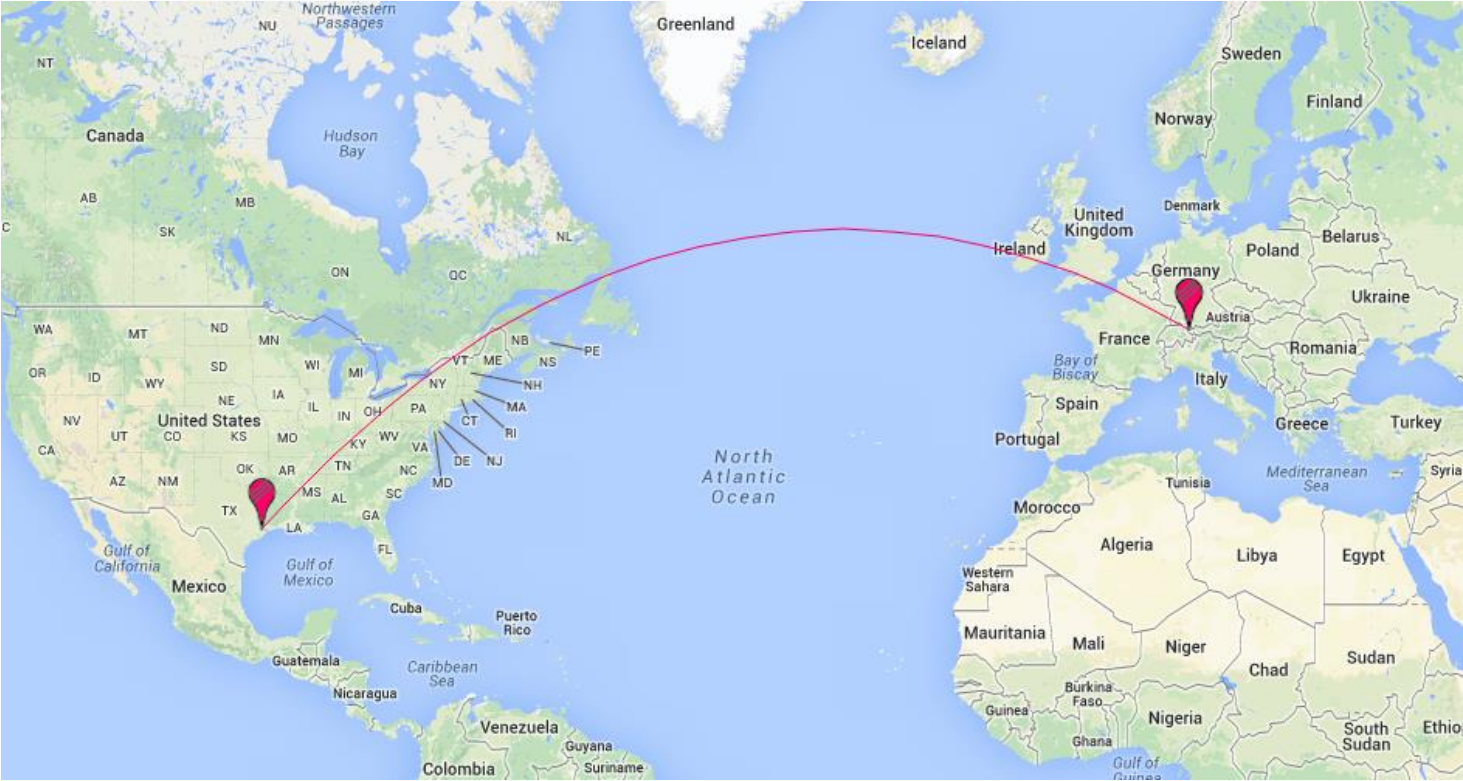
E2E Cryptographic Integrity



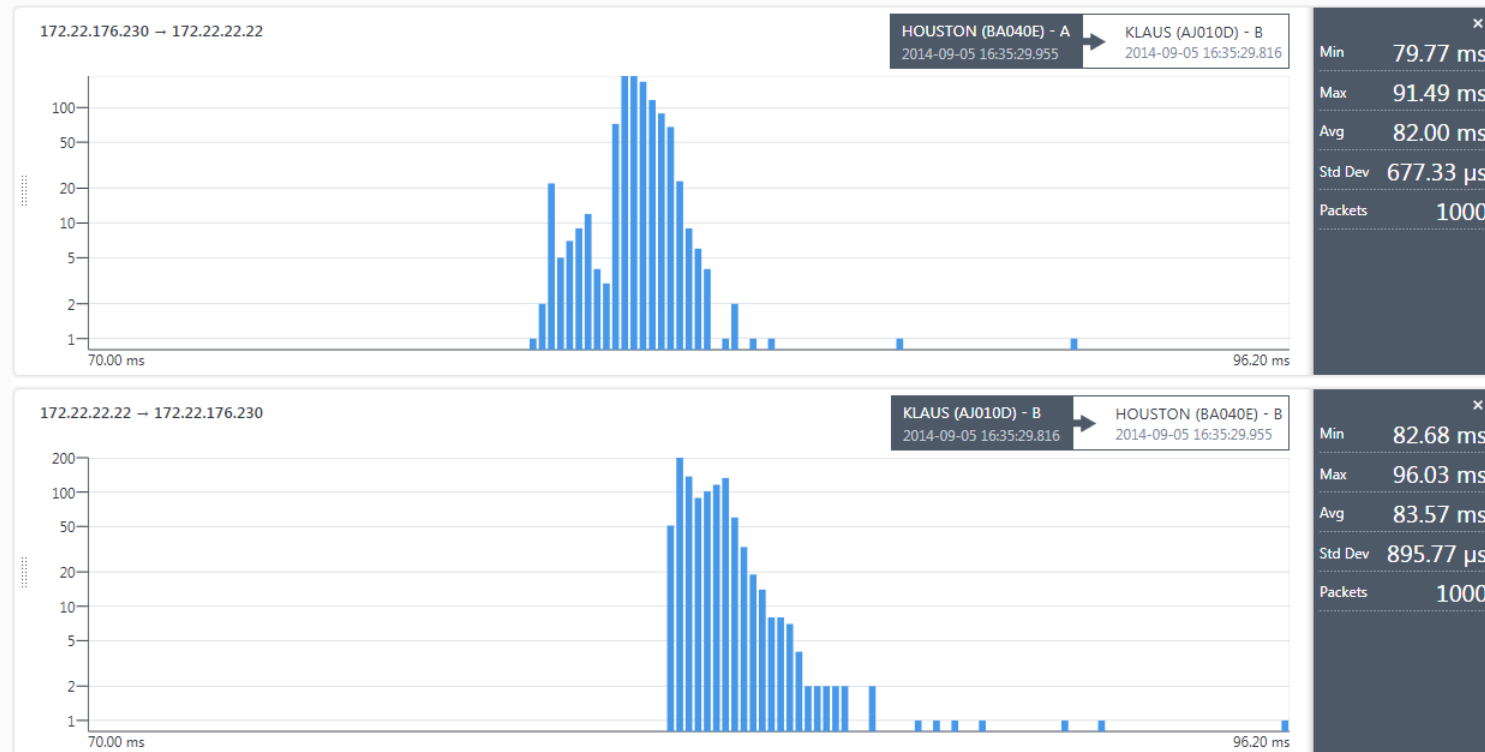
Propagation time measurement



Transatlantic GOOSE latency



One way propagation delay Texas - Austria



Two way propagation delay Germany - Austria

