Requirements and Methods for Reducing Fault Clearing Times in Smart Grids

Dr. Alexander Apostolov, Benton Vandiver III

OMICRON electronics Corp USA

Smart Grid Definition

- Energy Independence and Security Act (2007):
- *It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid:*

Smart Grid Definition

- Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
- Dynamic optimization of grid operations and resources, with full cyber-security.
- Deployment and integration of distributed resources and generation, including renewable resources.

Questions

- What are we doing?
- Why are we doing it?
- How are we going to do it?

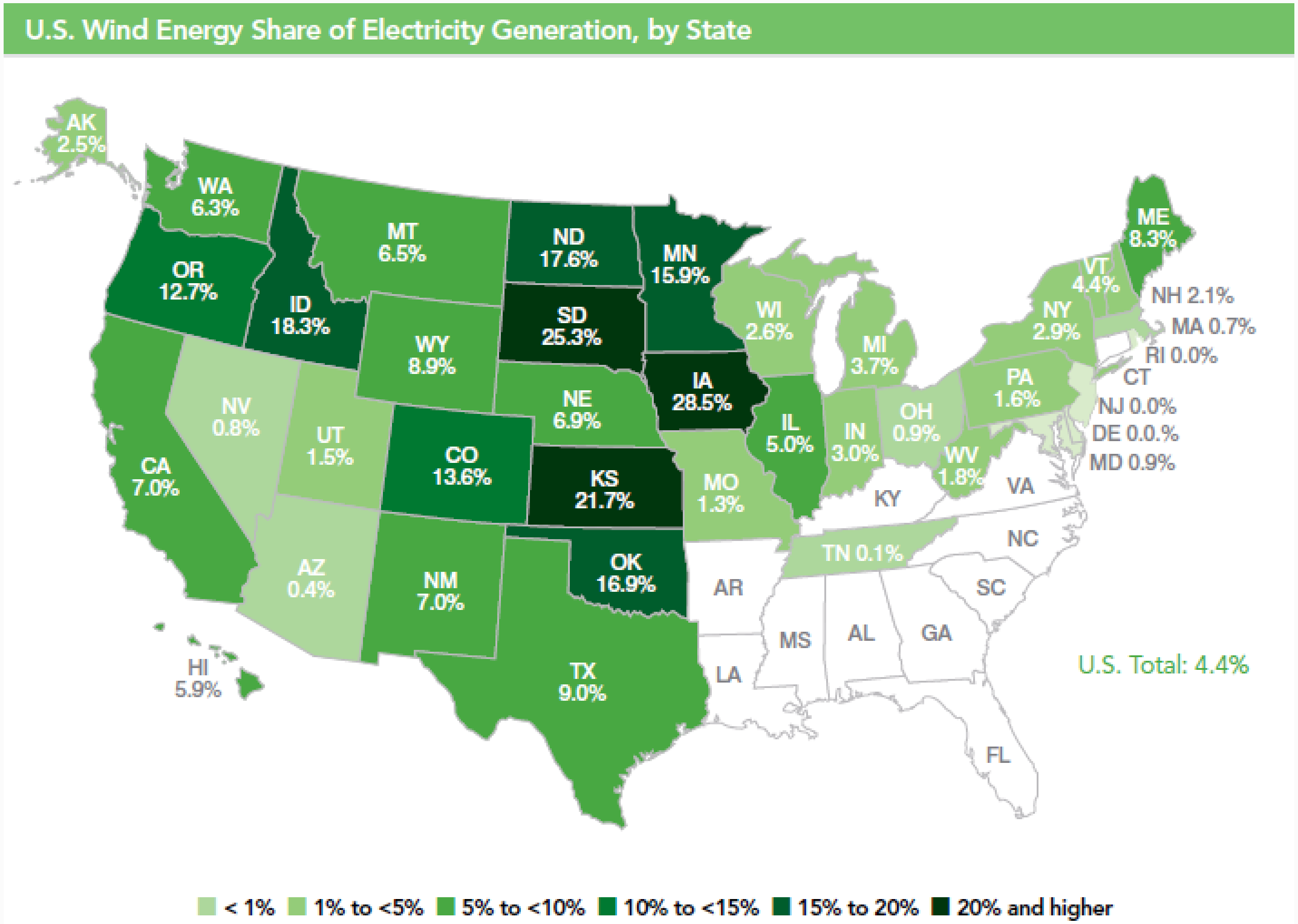
What are we doing?

- We are trying to reduce the fault clearing time
- Faults at the transmission level
- Faults at the distribution level

Why are we doing it?

- Increased percentage of wind generation in many countries and in the United States
- Requirements to maintain the reliability of the system during and after short circuit faults

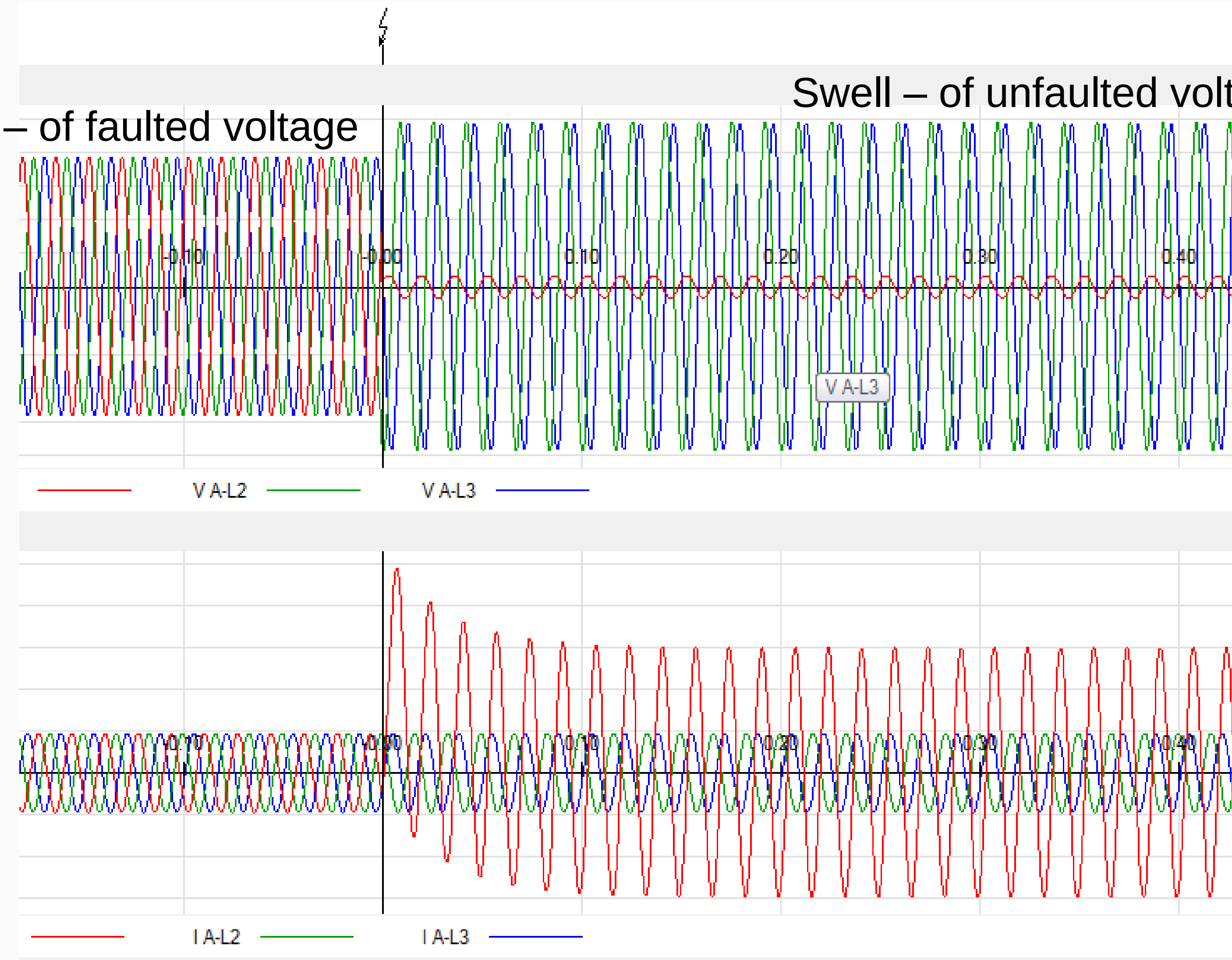
Increasing Penetration of DERs



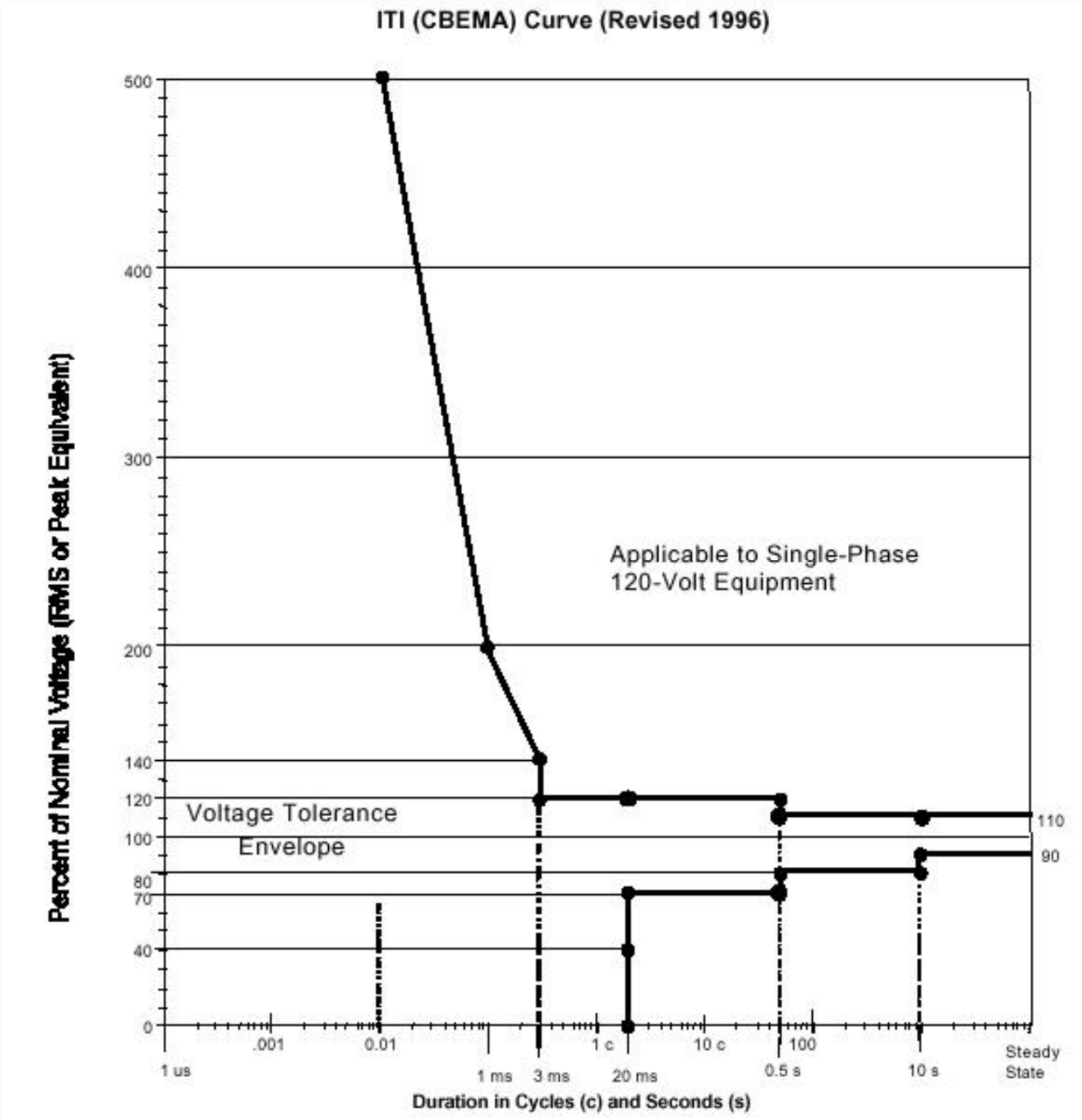
Effect of Short Circuit Fault

Swell – of unfaulted voltages

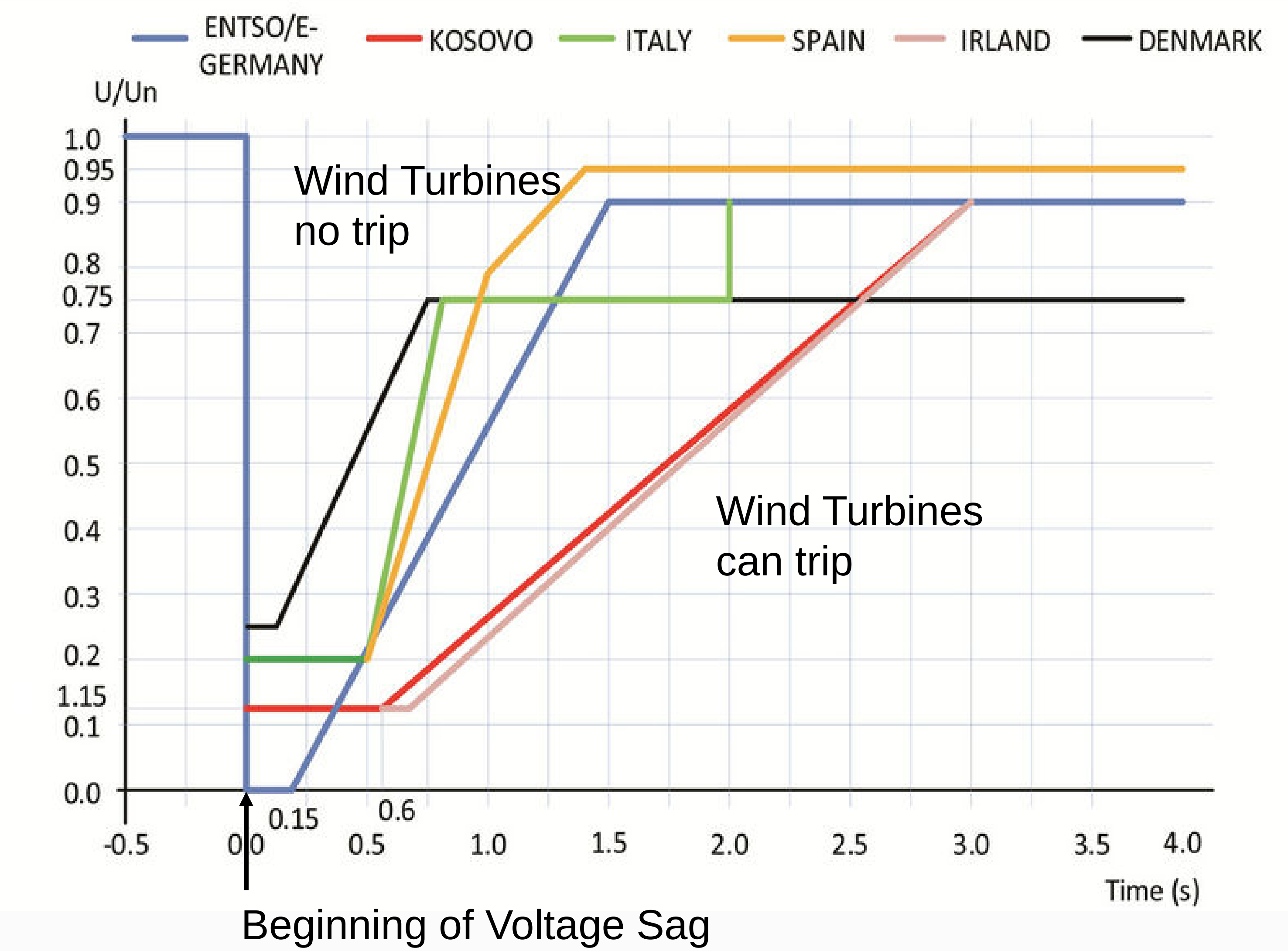
Sag – of faulted voltage



Power Quality Definitions



Ride-Through Capability

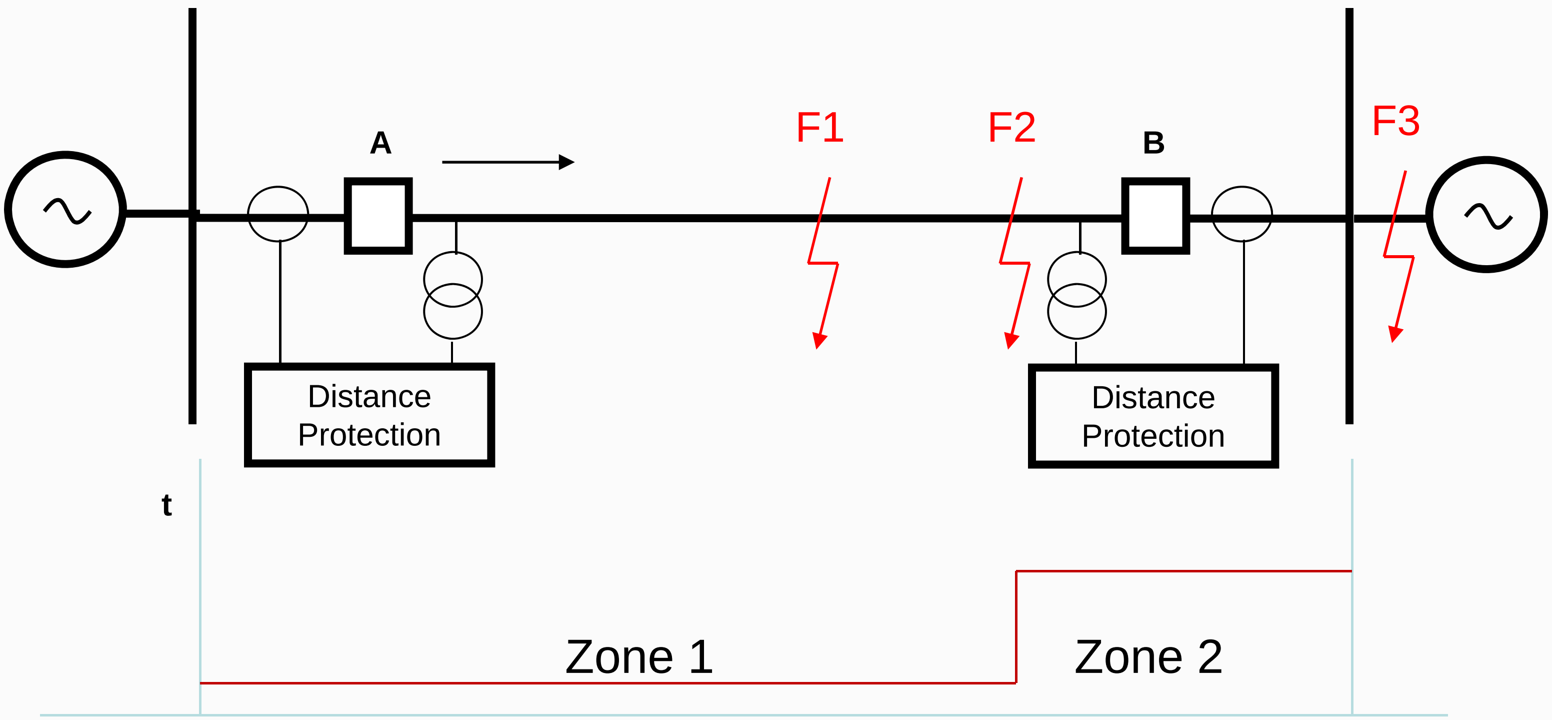


How are we doing it?

- Zone 2 fault clearing times may result in voltage sags that may result in the tripping of a large number of wind generators
- Requirements for communications based accelerated protection schemes

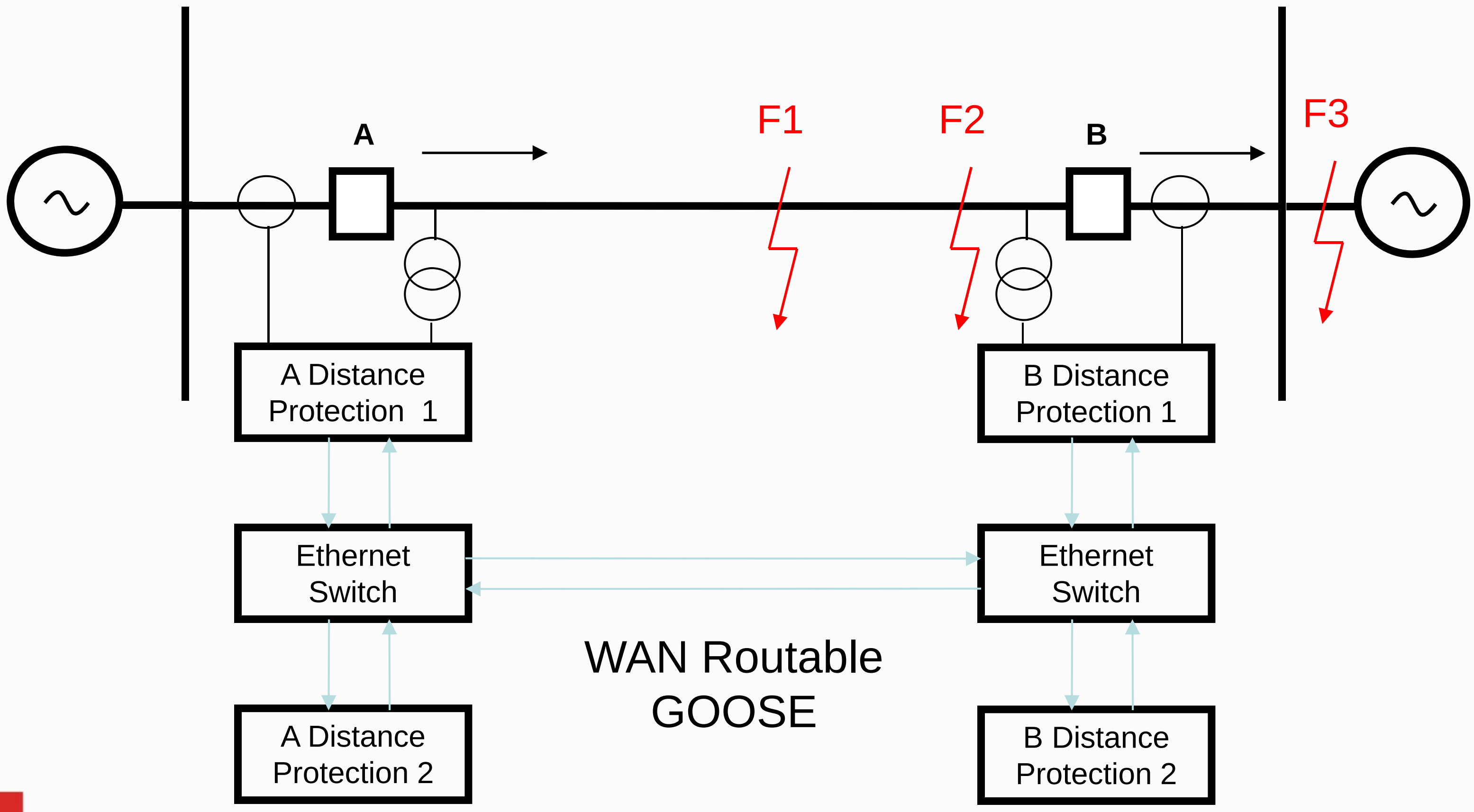
Transmission Line Protection

Typical zone step distance scheme

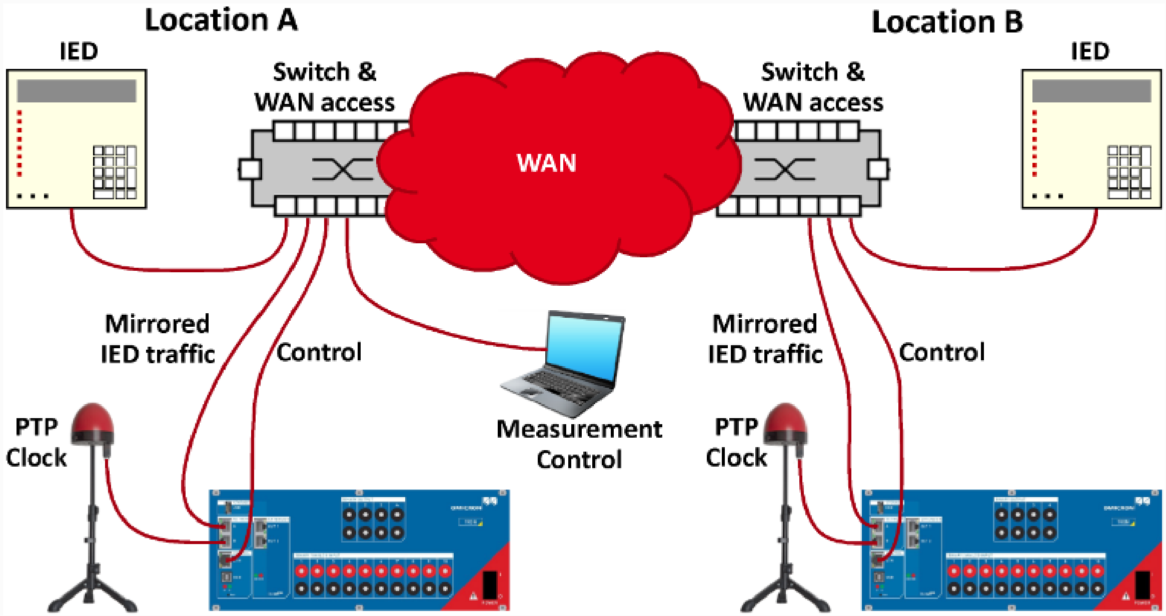


IEC 61850 Based Accelerated Scheme

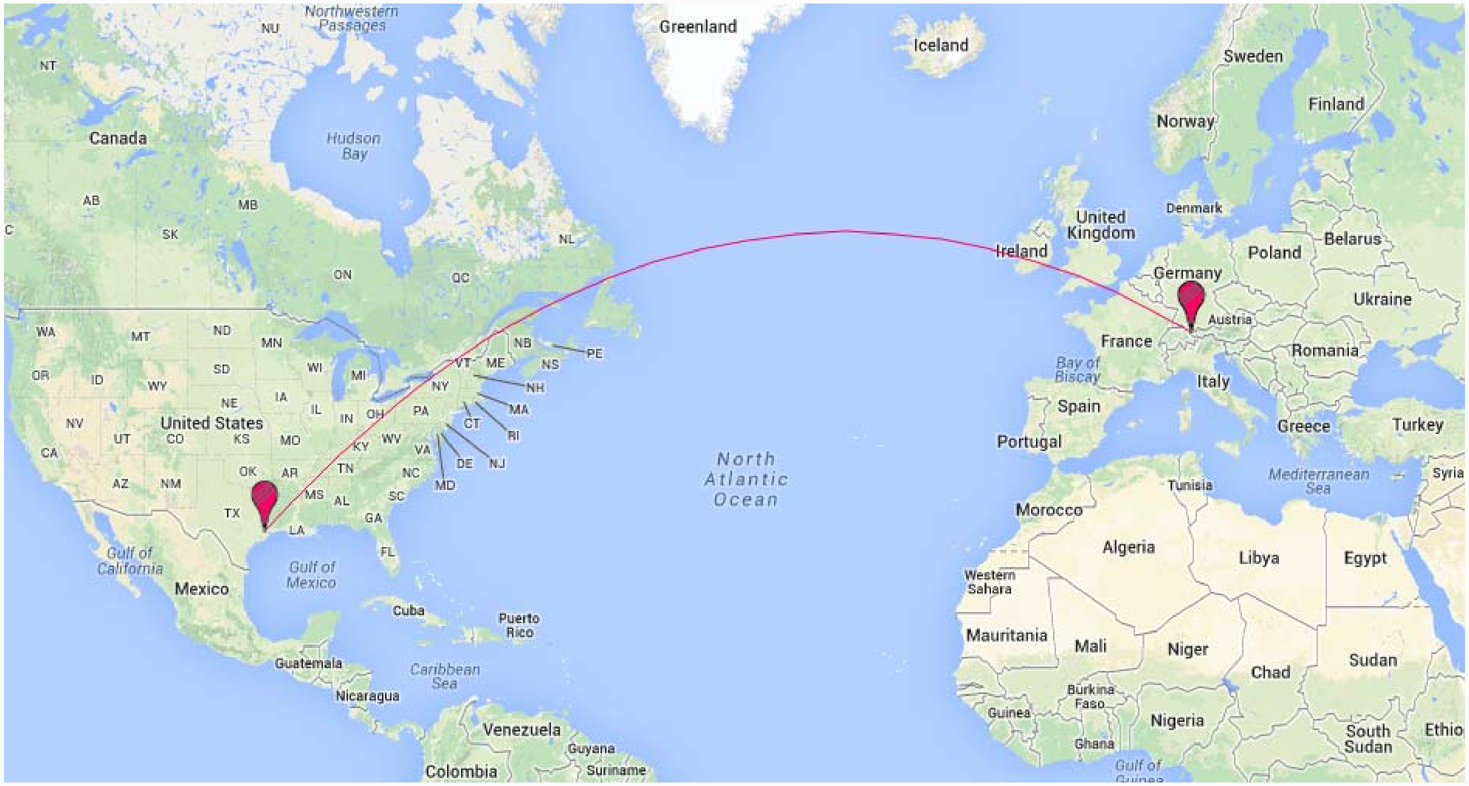
Choices are: direct, transfer trip, permissive, or blocking
Add a directional element for Directional Comparison Permissive or Blocking



Propagation time measurement

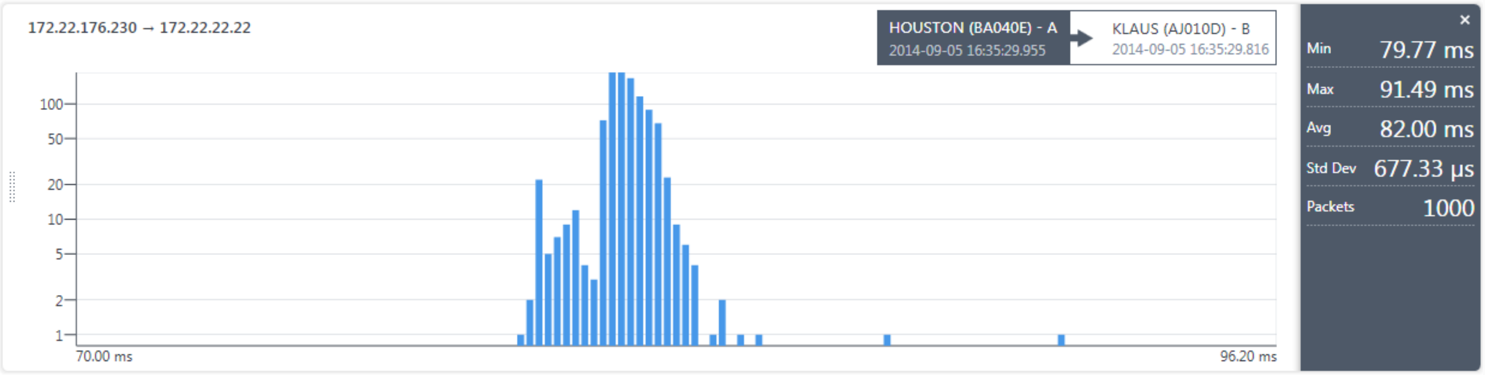


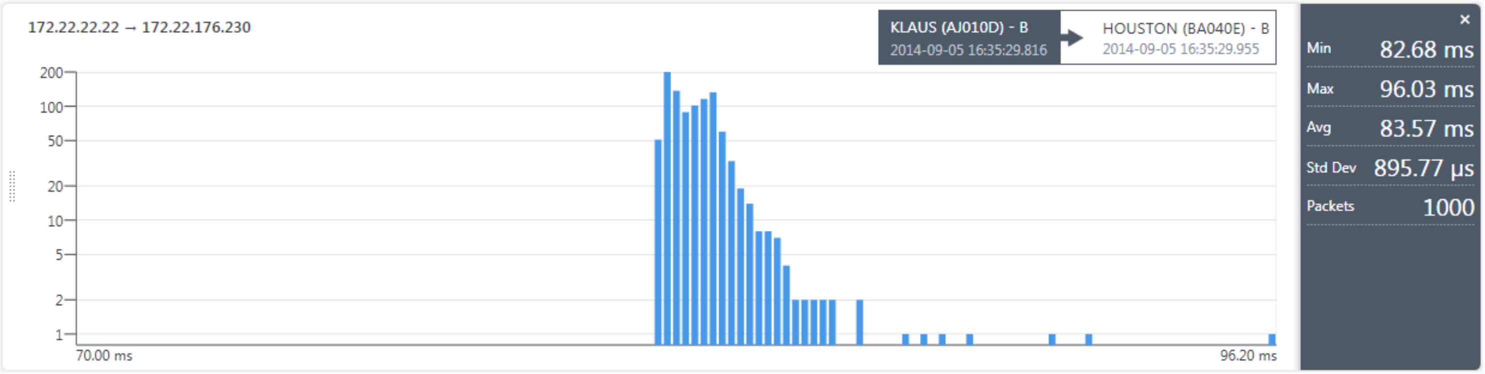
Extreme WAN Test: Transatlantic GOOSE latency



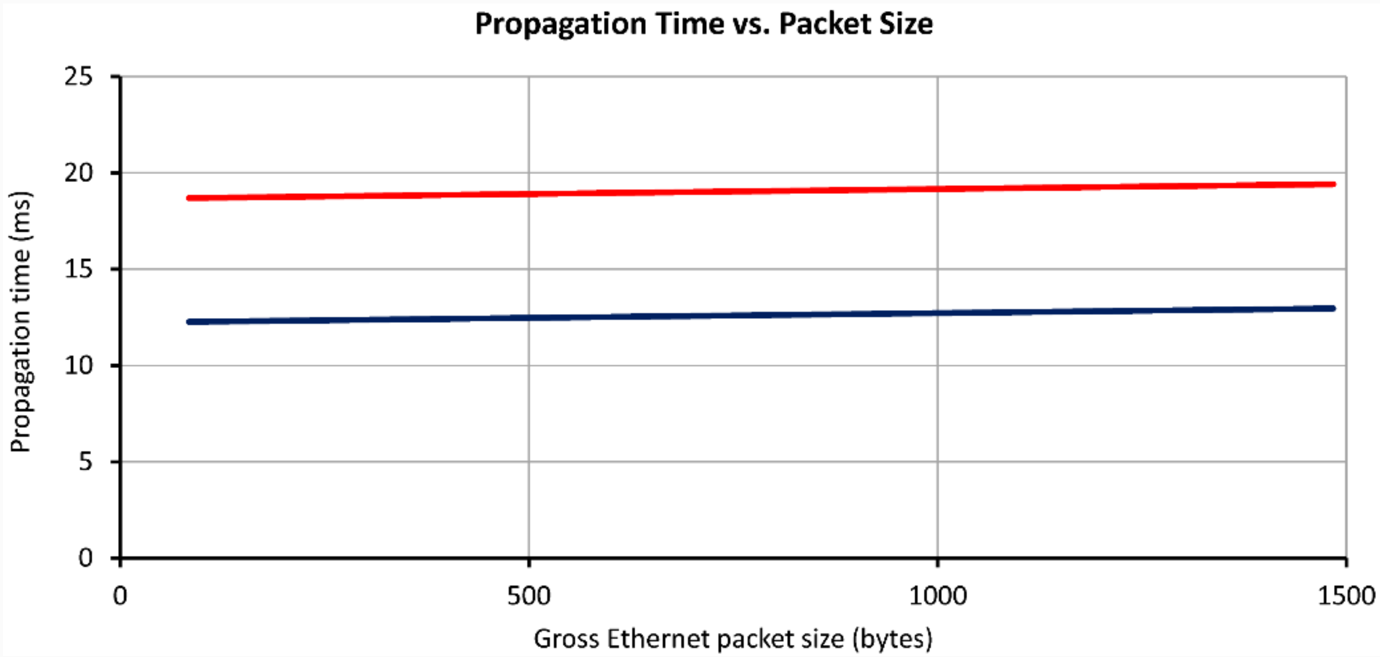
Propagation delay Texas - Austria

80 to 96mS one-way times, 82-84mS average



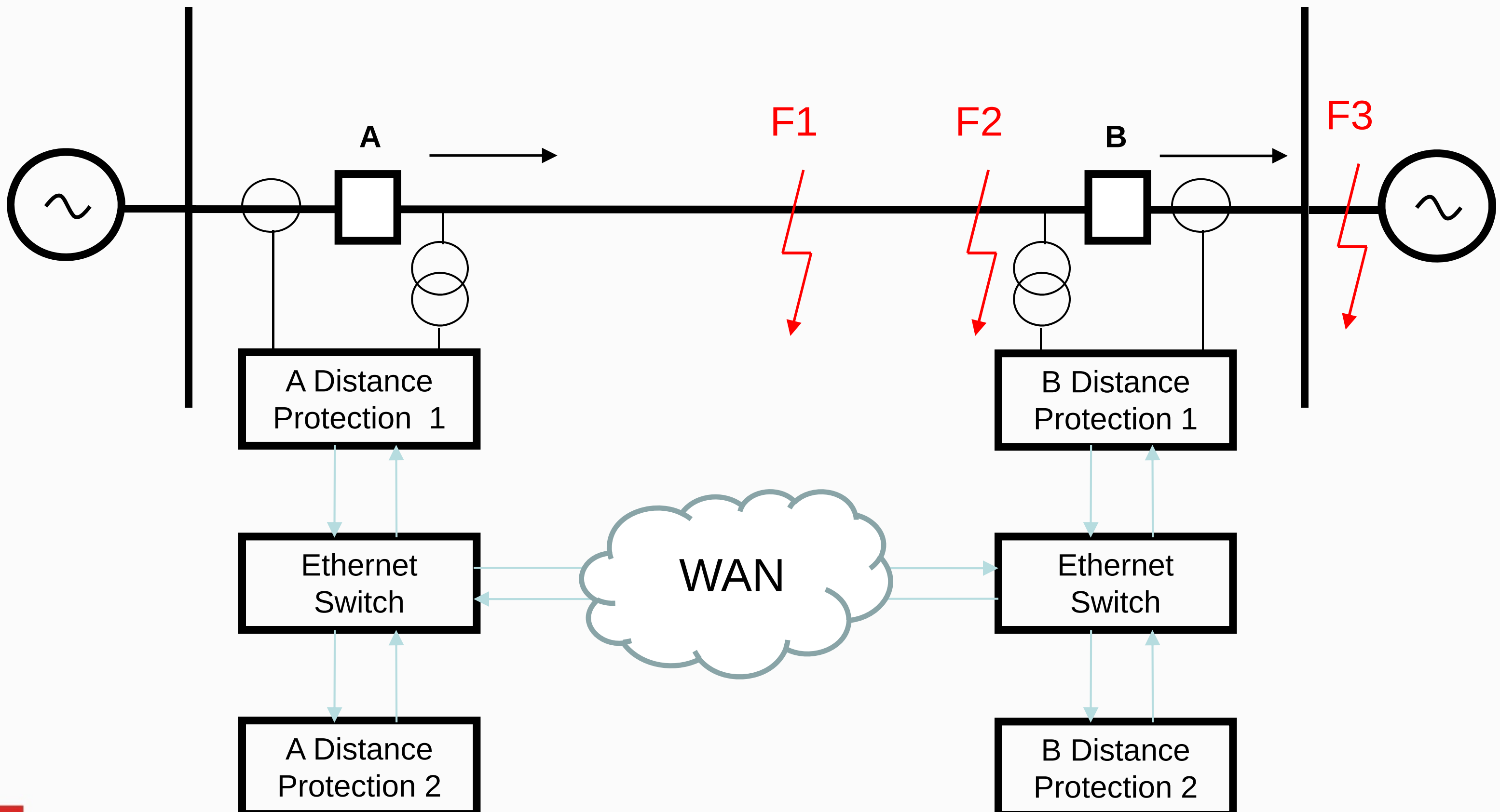


Two way propagation delay Germany - Austria

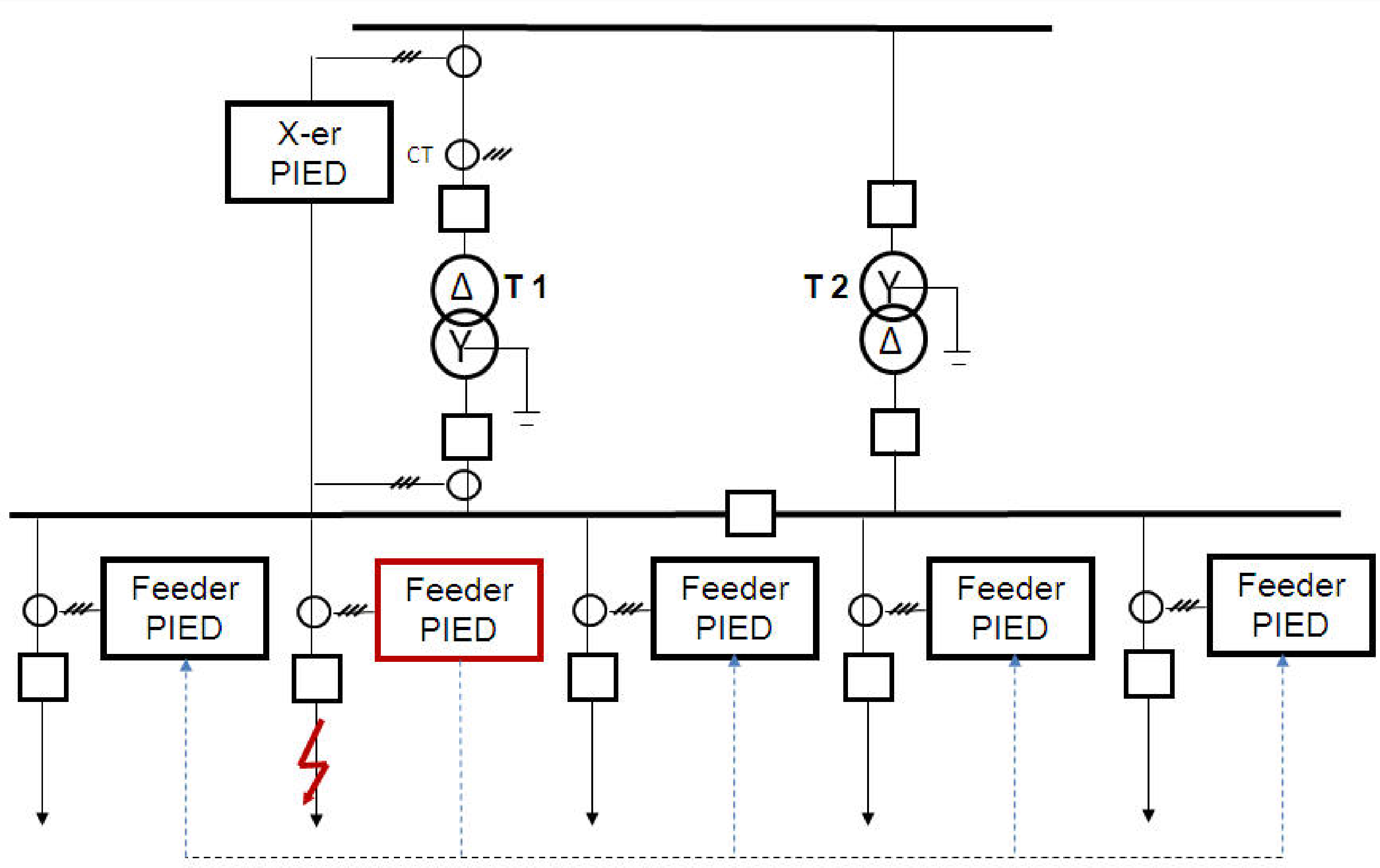


IEC 61850 Based Accelerated Scheme

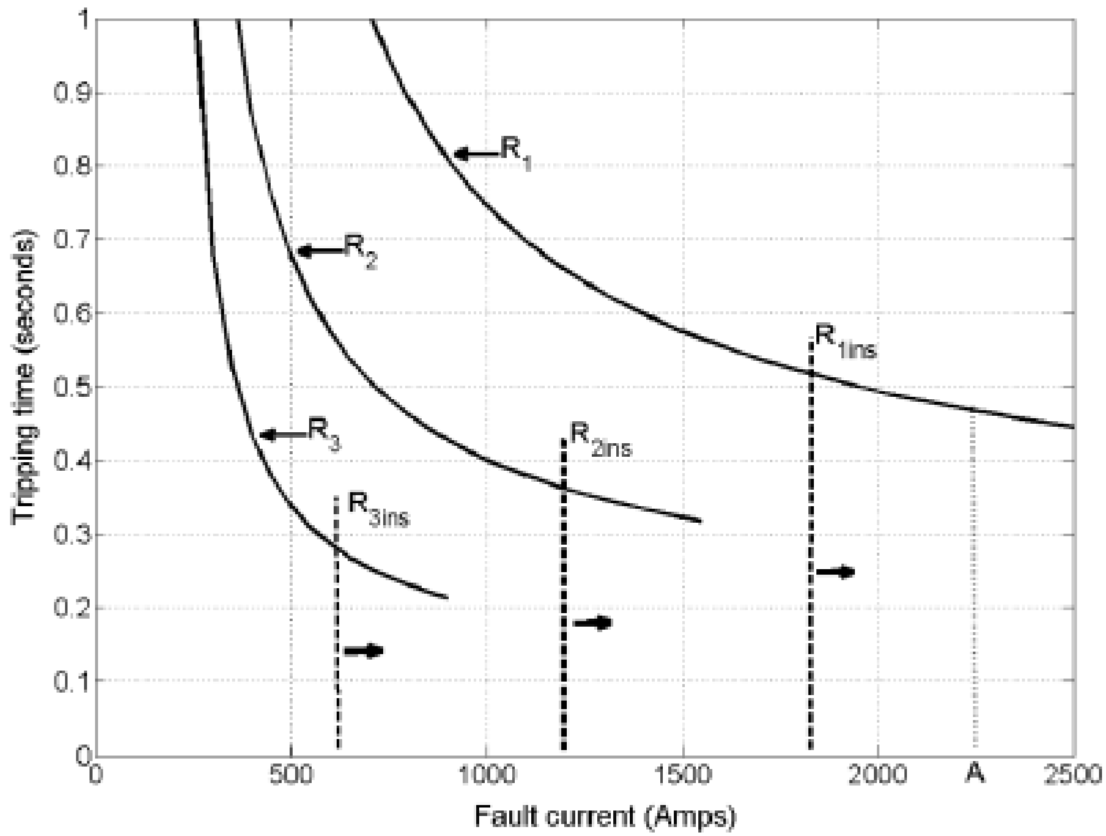
Using Routable GOOSE can reduce Z2 times by 80%



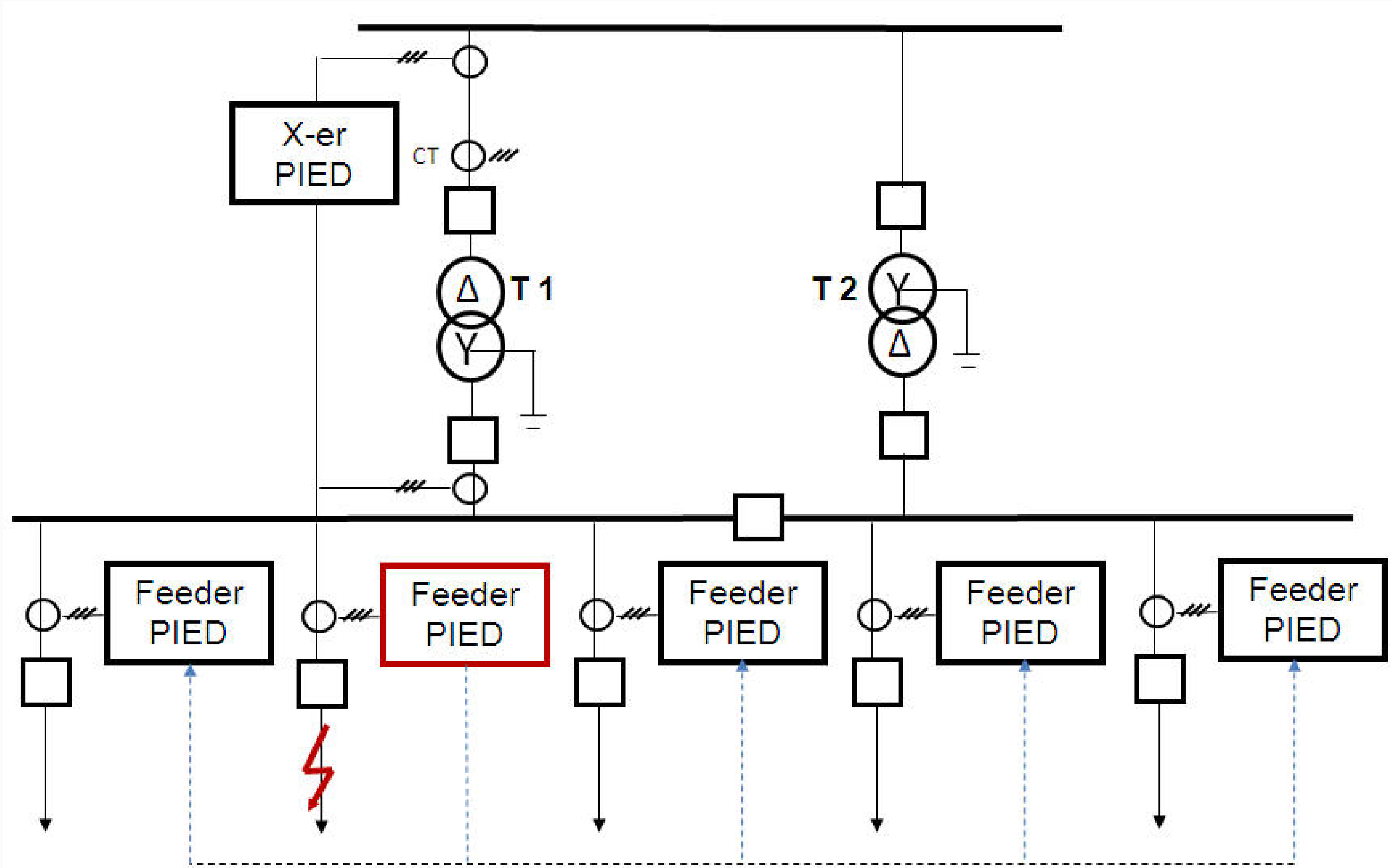
Conventional distribution protection



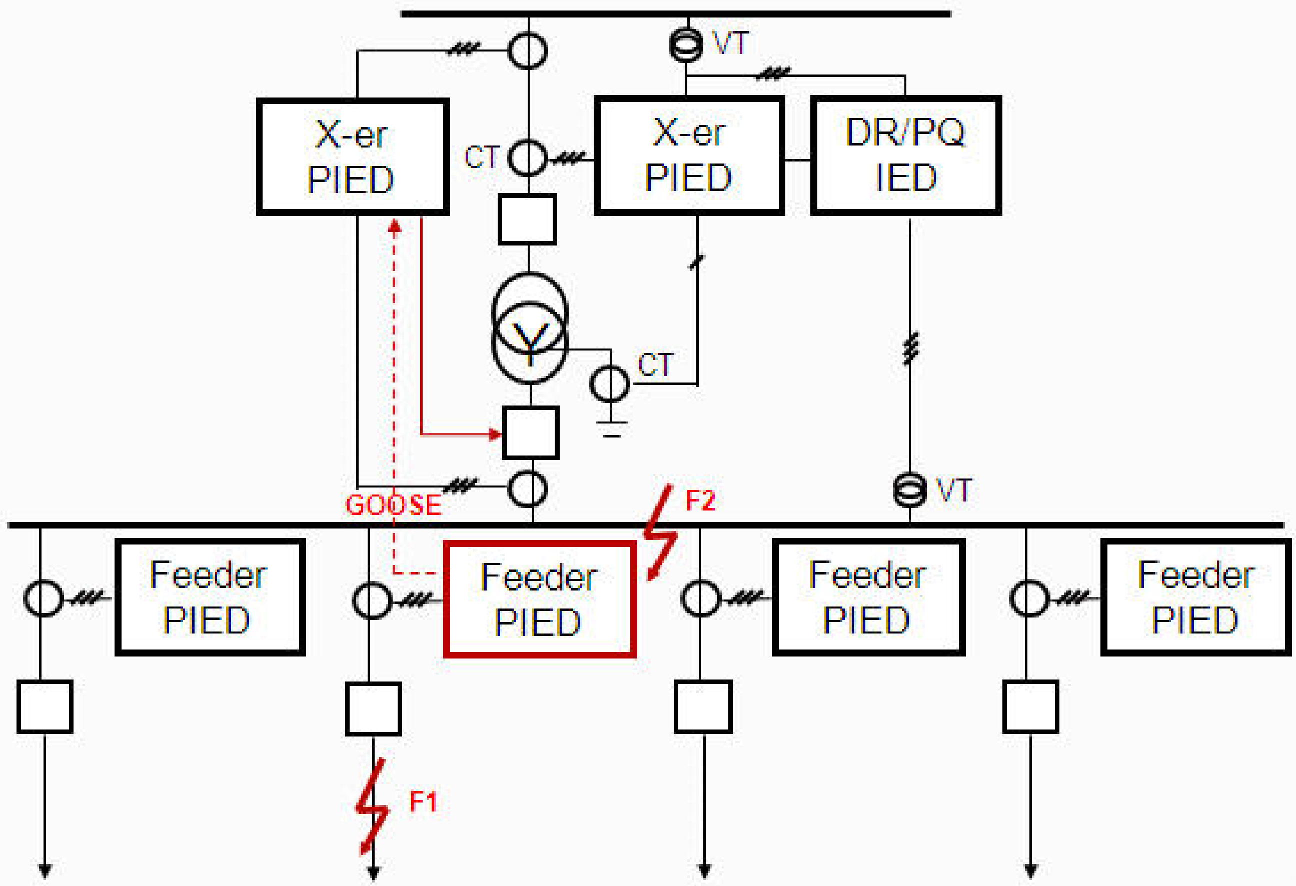
Overcurrent coordination – too slow bus fault trip



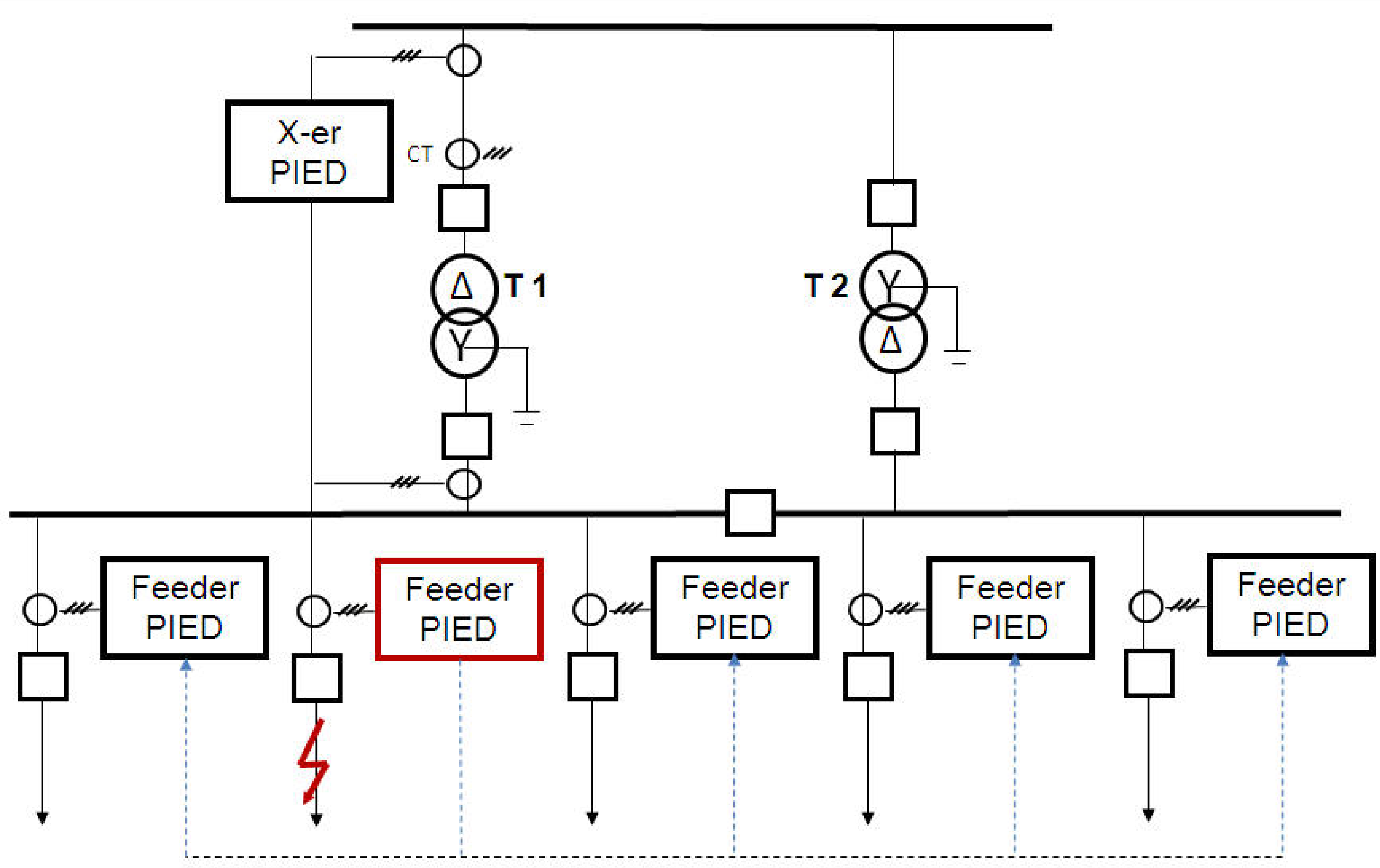
Adapting to topology changes



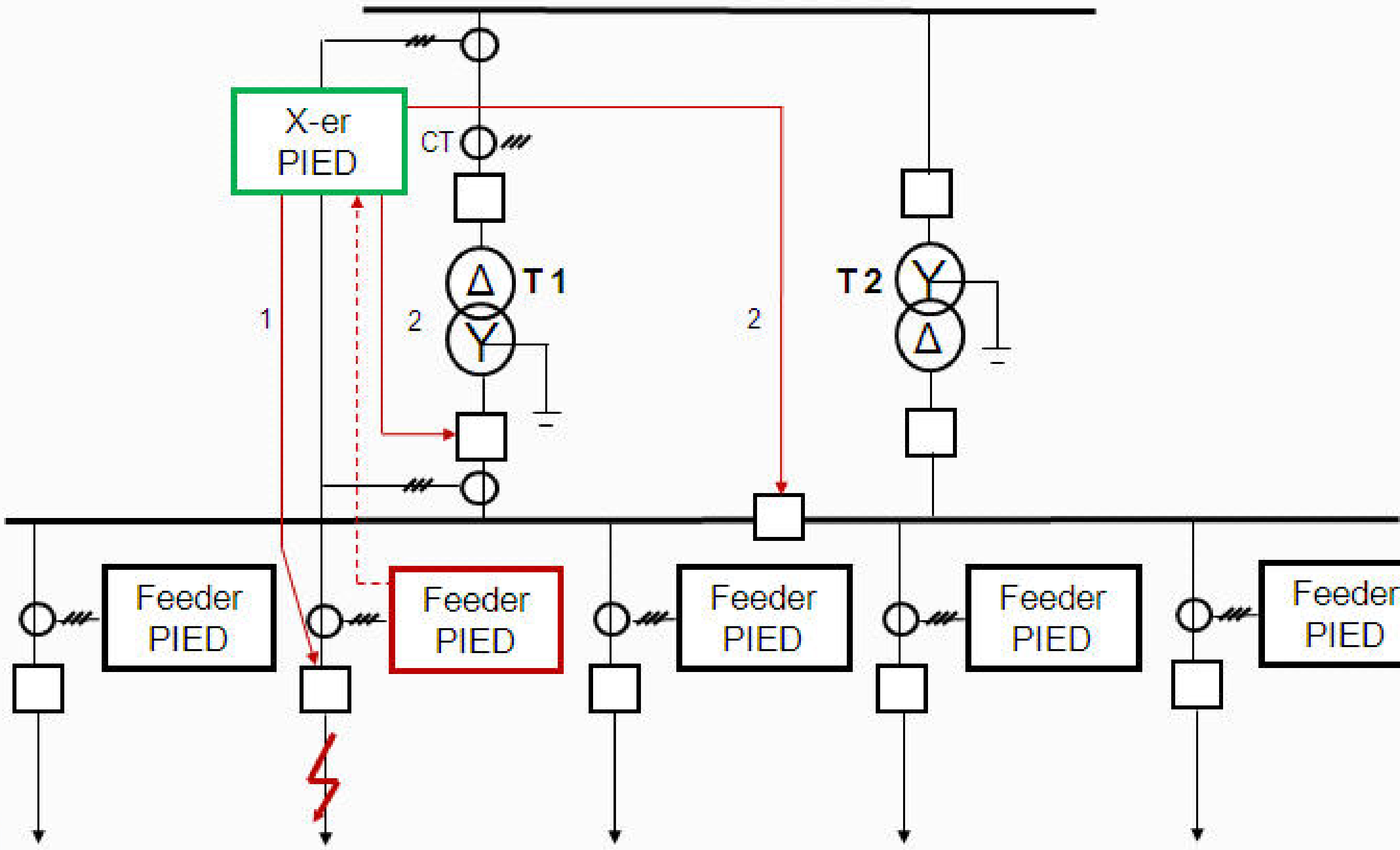
Adapting to Fault Location



Adapting to Changes in Voltage (Sympathetic Trip)



Adapting to IED Failure (Selective Backup Tripping)



Conclusions

- We need a new approach to transmission and especially distribution protection
- Communications based solutions using IEC 61850 GOOSE messages are available to meet these challenges

QUESTIONS?