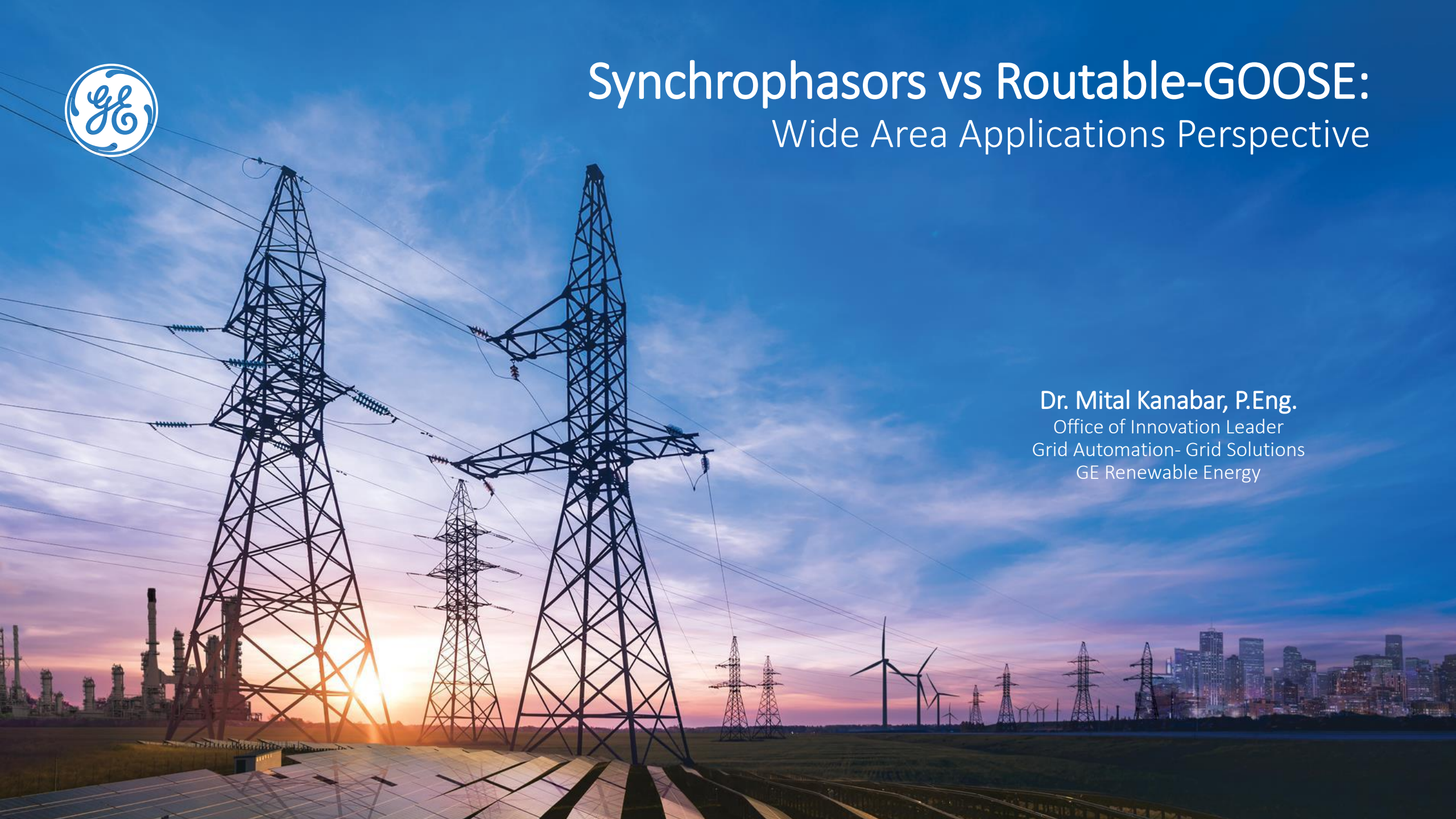

Synchrophasors vs Routable-GOOSE:
Wide Area Applications Perspective

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Outline

Introduction to Routable mechanism of the GOOSE

Synchrophasor vs R-GOOSE mechanisms

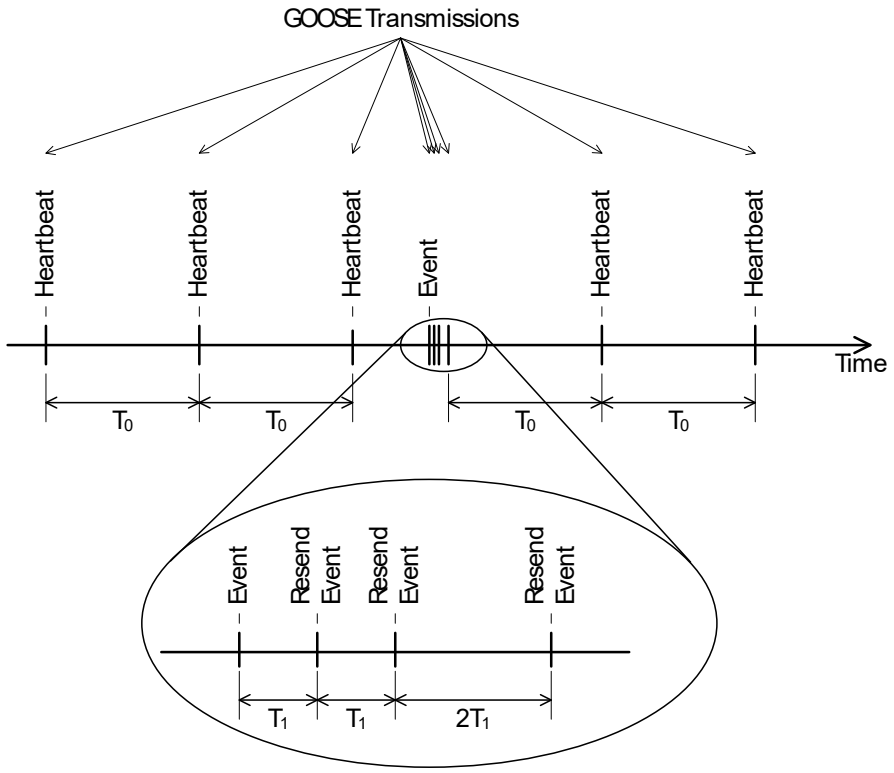
Synchrophasor vs R-GOOSE – a comparative example

R-GOOSE based wide area application – a case study

Cyber security & Performance considerations

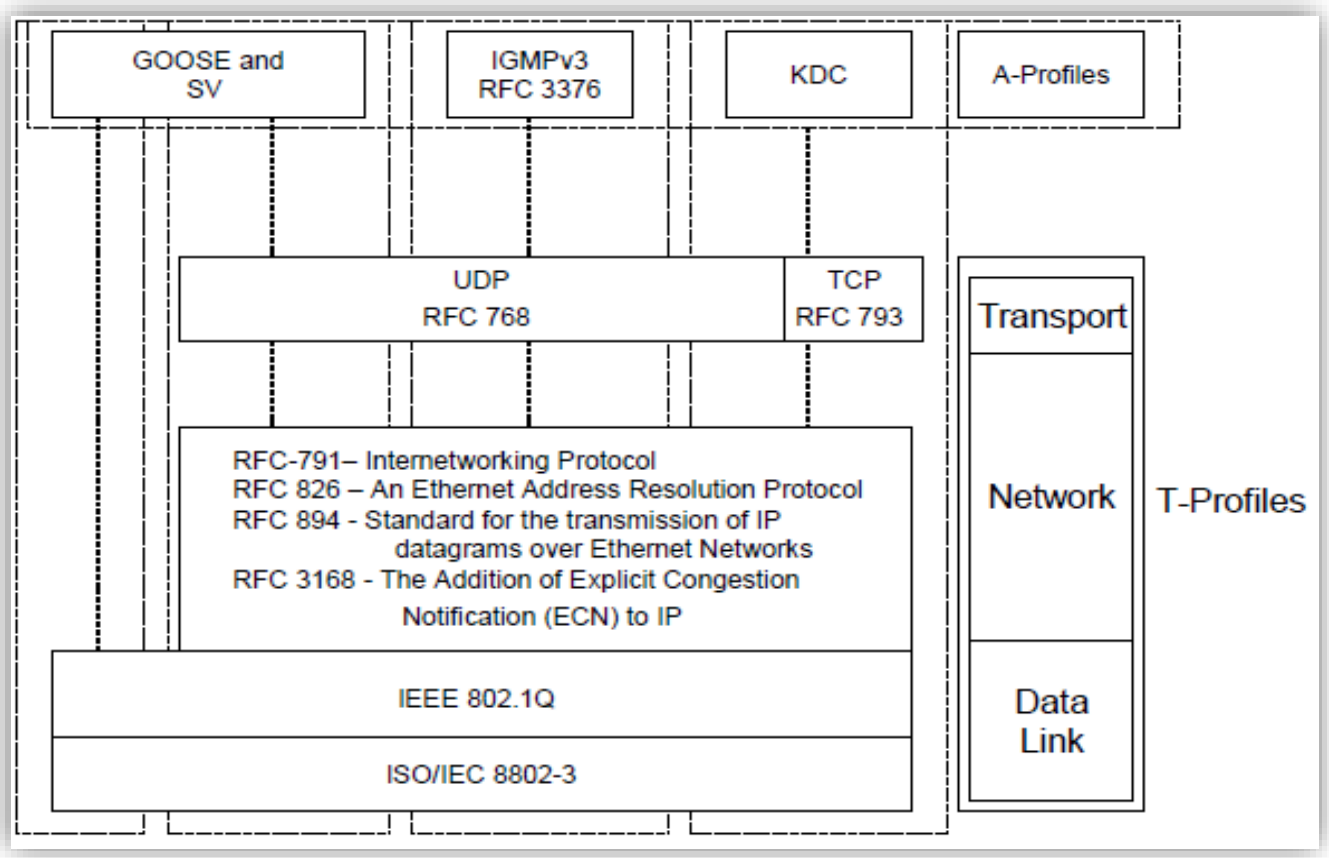
Lessons learned & summary

Introduction to Routable-GOOSE



T_0 - TxGOOSE UPDATE TIME setting value

T_1 - TxGOOSE1 RETRANS TIME setting value



R-GOOSE messages are routed over layer-3 routers with UDP/IP headers; multicast over IP networks using IGMPv3 protocol

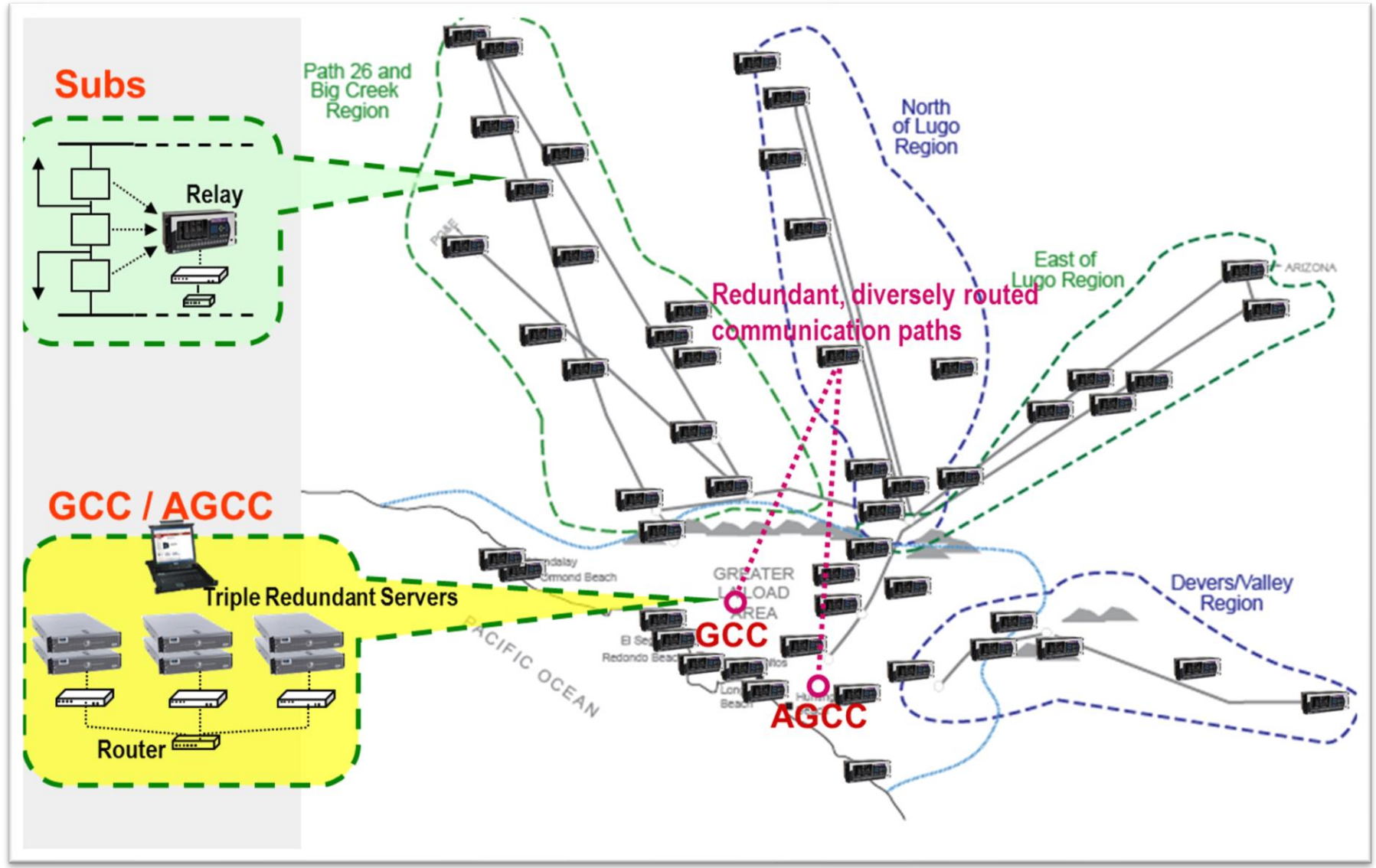
Synchrophasor and R-GOOSE

Parameters	Synchrophasors	R-GOOSE
Publications	IEEE C37.118.1/.2	IEC 61850
Communication	Client/Server (IP Unicast)	Publisher/Subscriber (IP Multicast)
Data transmission	specified rate, 1Hz to 120/240 Hz	Event-driven (1-2 Hz for no event; retransmission for events)
Data items	Synchrophasors, Freq Analog, Digital	Analog and Digital (status)
Security	Not inherently	Key Distribution Center (KDC)
Priority	Regular (due to high data rate)	Higher (Event driven)
Networks	Regular IP/Layer-3 Router	IP/Layer-3 Router with IGMPv3 (firewall to support as well)
Configuration	CFG frames (CFG-1, 2)	ICD, IID, CID files

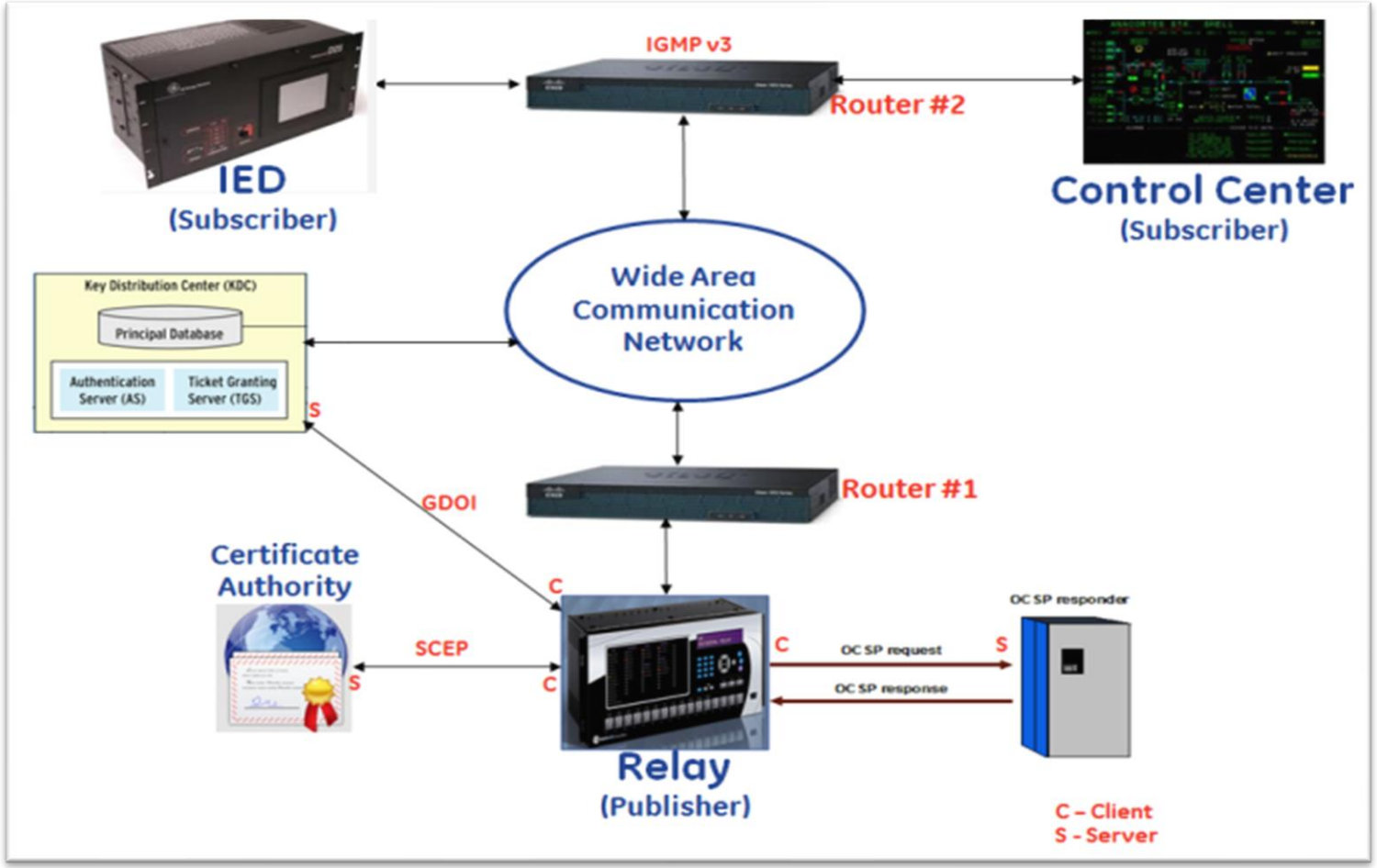
Synchrophasor vs R-GOOSE

Parameters	Synchrophasors	R-GOOSE
Frame size	100 Byte	100 Byte
Data rate	30 frames/sec	5 frames/sec (worst case-1 event per second per device)
Number of devices transmitting	100 devices	100 devices
Byte Per Second over network	100*30*100=300000 Bytes/sec	100*5*100=50000 Bytes/sec (worst case)
Bandwidth requirements	300000*8=2.4Mbps	50000*8=0.4Mbps (worst case)
Number of locations/devices data received	1	Many (IP multicast)
Storage requirements per Year	300000 *3600*8760= 9.4 Tera Bytes	50000*3600*8760= 1.6 Tera Bytes (worst case)
Typical performance requirements	100 milliseconds to few seconds	<10 ms

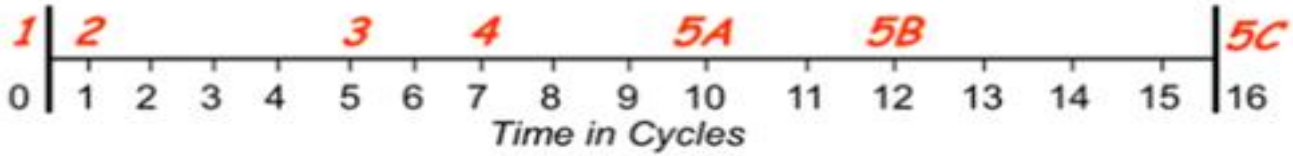
R-GOOSE based Remedial Action Scheme – a case study



Cyber security considerations



Performance considerations



	Time	Operational Events
Step 1	@ 0 Cycle	3 Phase Fault on the Bus
Step 2	@ 1 Cycle	Relay Processing time for trip signal to CBs
Step 3	@ 5 Cycles	Open CBs for line/transformer out
Step 4	@ 7 Cycles	RAS Logic Processing for trip signal to CBs to trip generators
Step 5A	@ 10 Cycles	Open CBs associated with 12 generators (I Batch Mitigation)
Step 5B	@ 12 Cycles	Open CBs associated with 4 generators (II Batch Mitigation)
Step 5C	@ 16 Cycles	Open CBs associated with 2 generators (III Batch Mitigation)

1 cycle = 16.7 milliseconds

Event Detection Fault Clearing:

RAS Processing:

Mitigation Generation Tripping / Load Shedding:

Lesson’s Learned & Summary

- ✓ Requirements right from planning stage
  - ✓ Cyber security & Performance
  - ✓ Redundancy & Remote testing
- ✓ Utility communication network
  - ✓ Segregate traffic of R-GOOSE and Management
  - ✓ Bandwidth requirements to meet performance
  - ✓ Firewall not blocking IGMPv3 traffic
- ✓ Implementation Agreement and technical workshops are useful for high-tech projects

- ➢ High-speed + secured R-GOOSE can be achieved for wide-area applications
  - ➢ priority tagging, VLAN, IP Class of Traffic
- ➢ Security mechanisms supported by R-GOOSE
  - ➢ Key Distribution Center
  - ➢ Consider Infrastructure to be supported
- ➢ Synchrophasors vs R-GOOSE for WAPC >> Select per application & network requirements

IEEE Standard for Phasor Data Concentrators for Power Systems

Sponsor

Power System Relaying Committee
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