
# Wide Area GOOSE and its Applications to System Integrity Protection Schemes

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# Questions

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

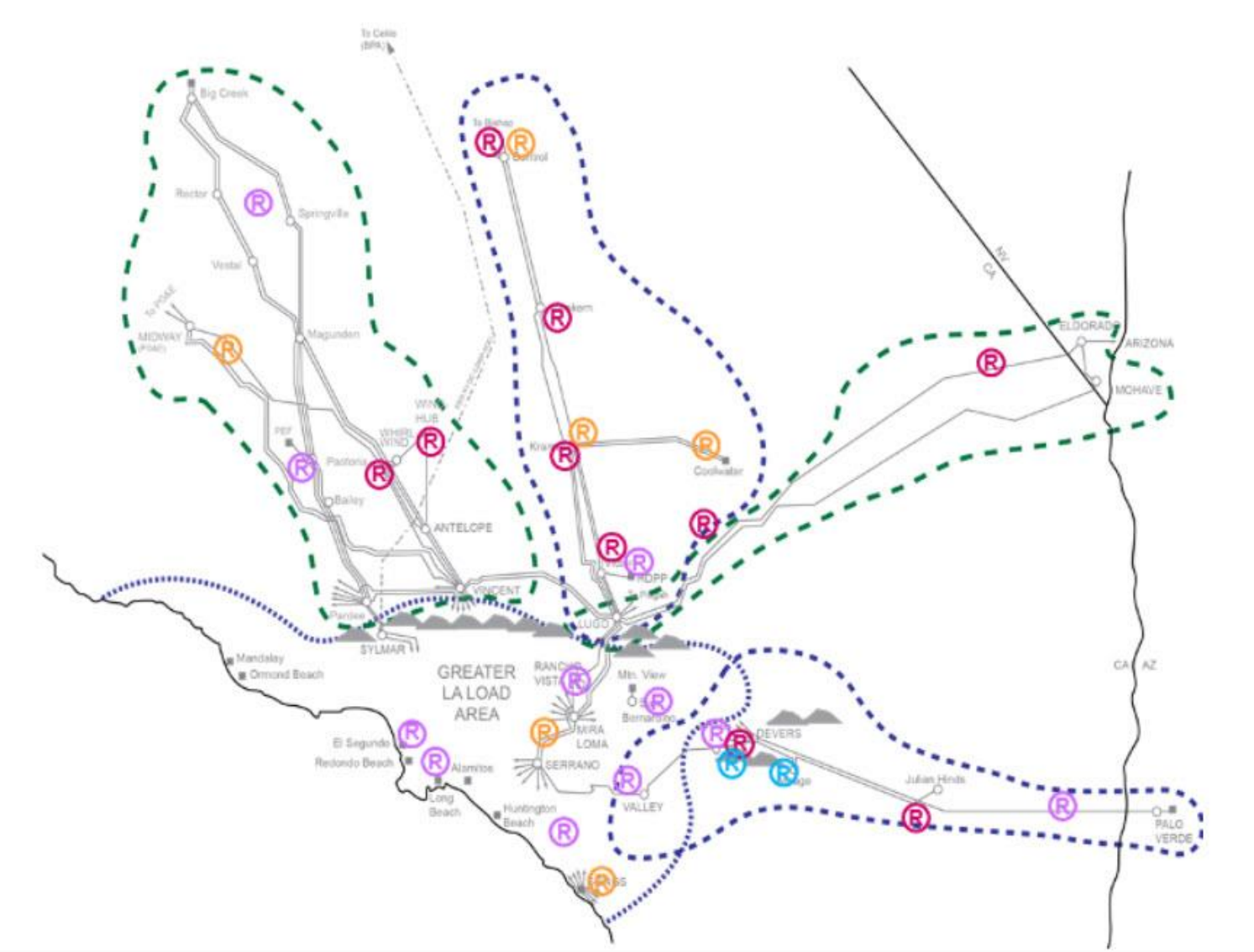
# What are we doing?

- Support distributed System Integrity Protection Schemes (SIPS)

# Why are we doing it?

- To maintain electric power system stability during wide area disturbances

# RAS example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Mtn. View
MIRA
LOMA
SERRANO
VALLEY
DEVERS
El Segundo
Redondo Beach
Alamitos
Long
Beach
Huntington
Beach
Codiwater
ELDORADO
ARIZONA
MOHAVE
Julian Hinds
PALO
VERDE
CA
AZ

# How are we doing it?

- Using IEC 61850 GOOSE messages
- Based on good understanding of SIPS
- Based on good understanding of the principles of GOOSE within and outside of the substation
- Based on good understanding of the communications technology
- Based on good understanding of cyber security challenges and solutions

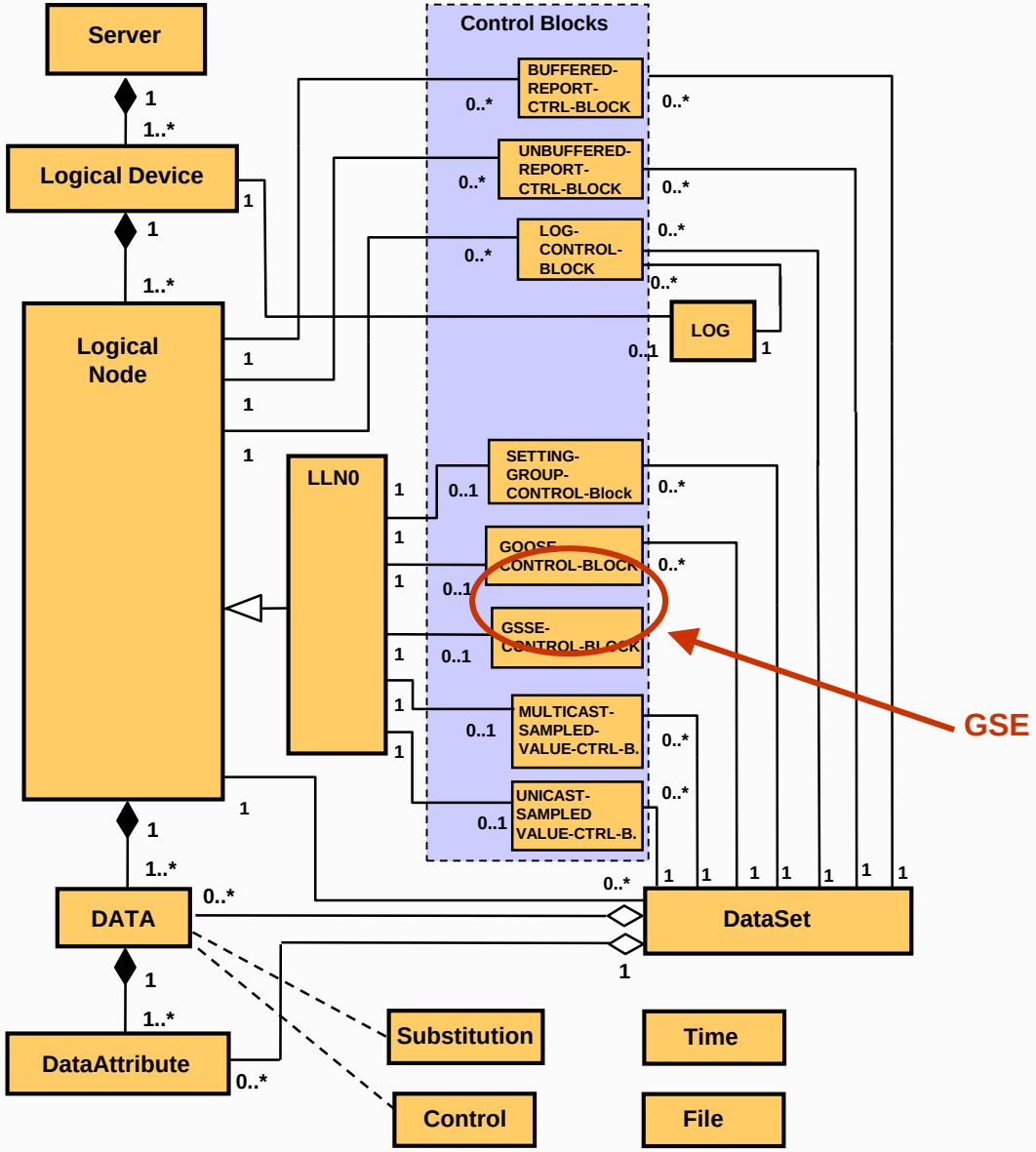
# GOOSE in IEC 61850

- GOOSE messages are one of the key differentiators of IEC 61850
- Client – Server communications are not suitable for protection applications
- Peer-to-Peer communications can meet the protection performance requirements
- Successful implementation of GOOSE based protection systems requires not only good understanding of the basics, but also planning and motivation

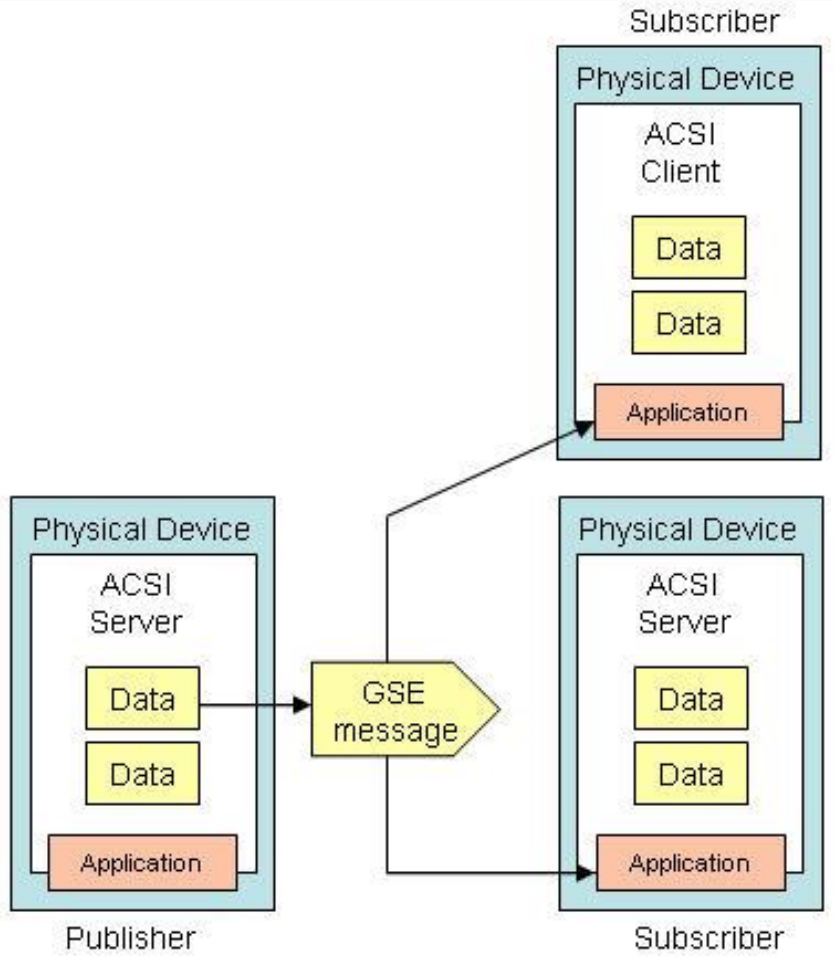
# GOOSE History: Chicago, May 1998

- Kay Clinard
  George Schimmel
  Herb Falk
  John Tengdin
  Mark Simon
  Charlie Sufanna
  Alex Apostolov
  Jim Whatley (remotely)

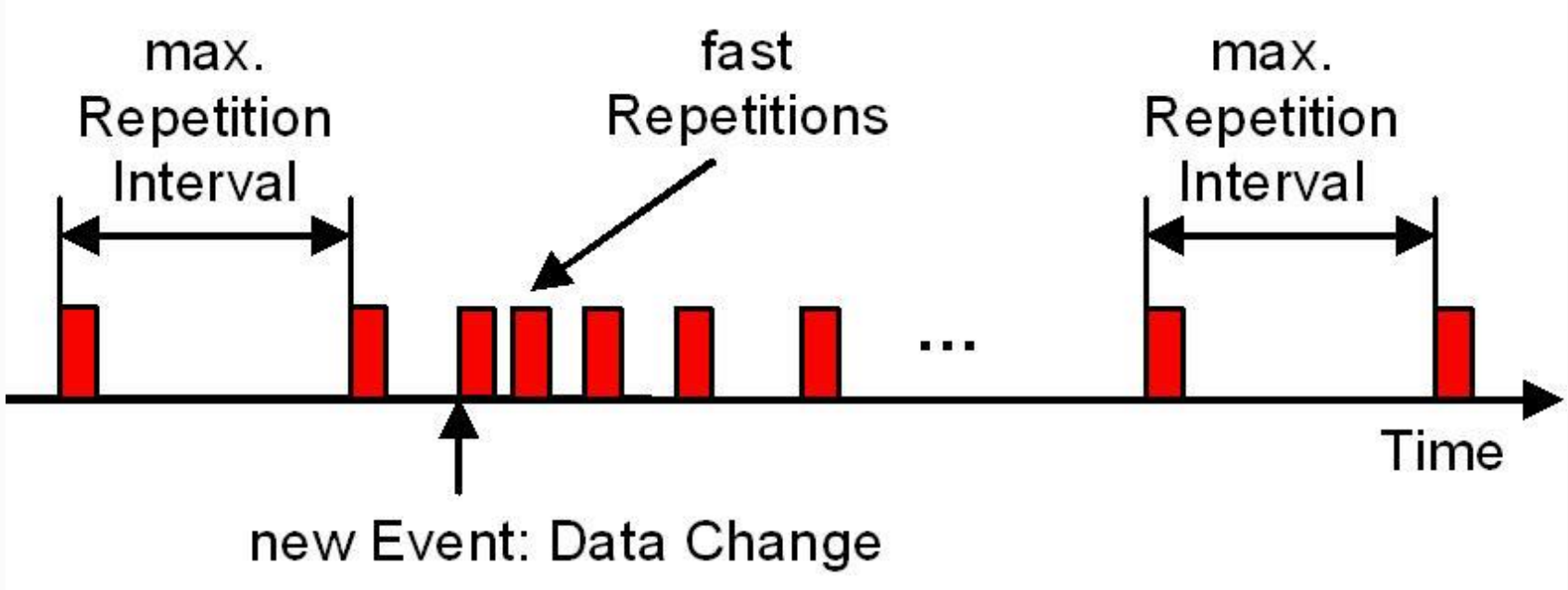
# IEC 61850 Services



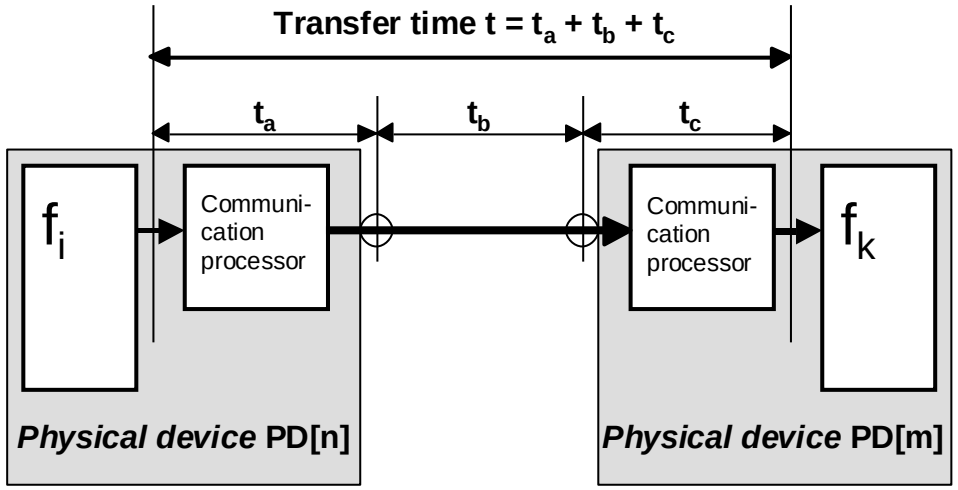
# IEC 61850 Services



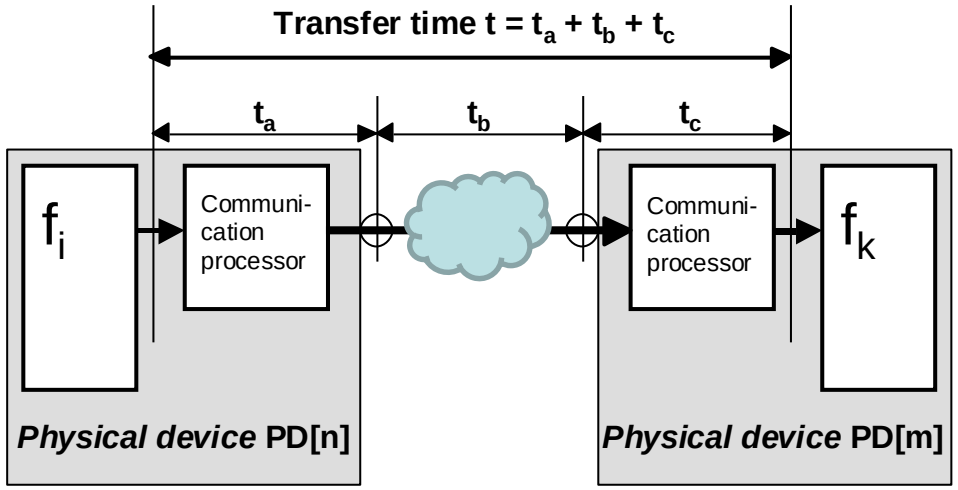
# GSE Messages:



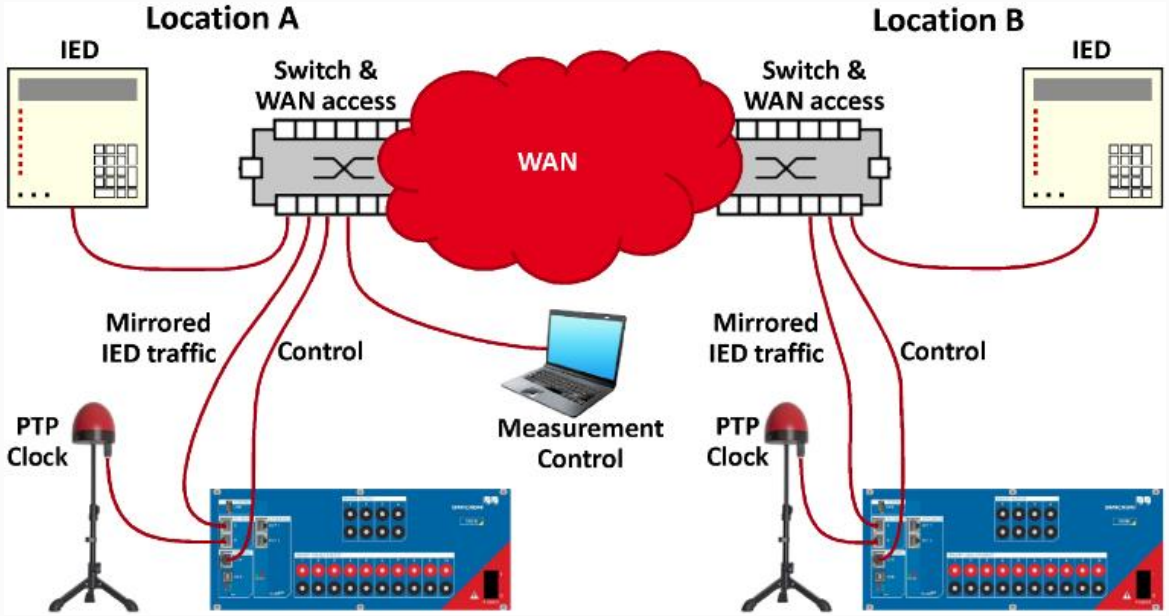
# GOOSE Performance



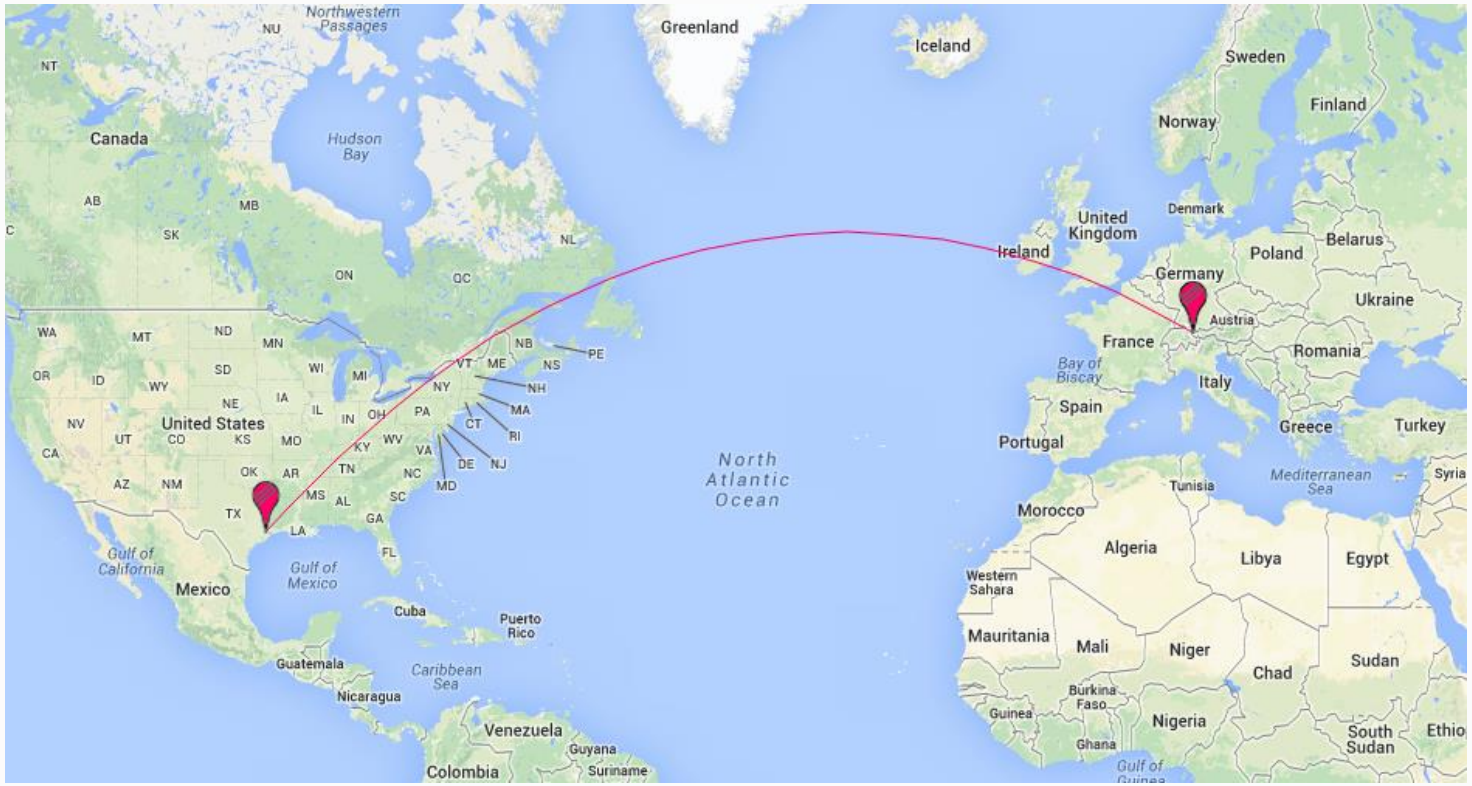
# GOOSE WAN Performance



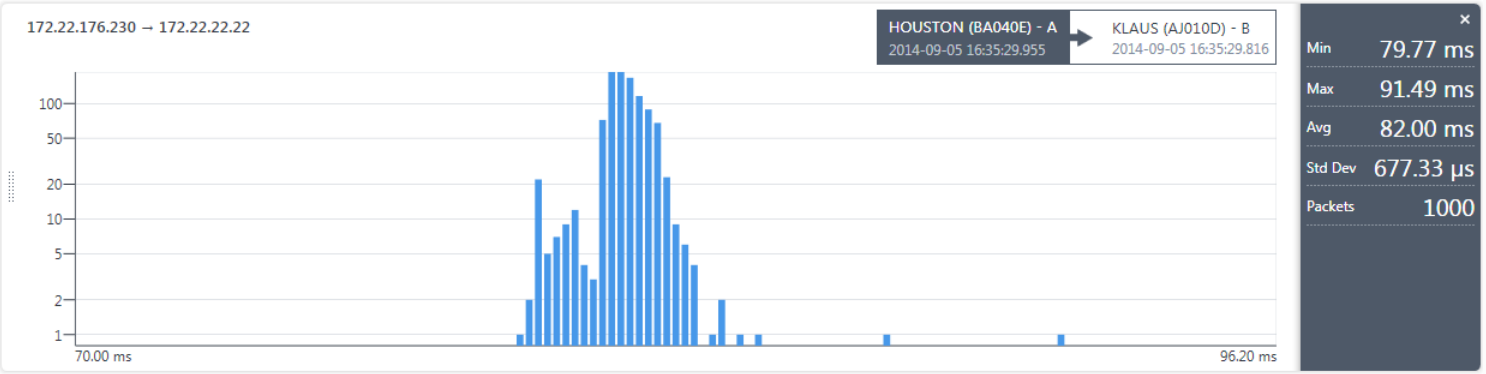
# Propagation time measurement

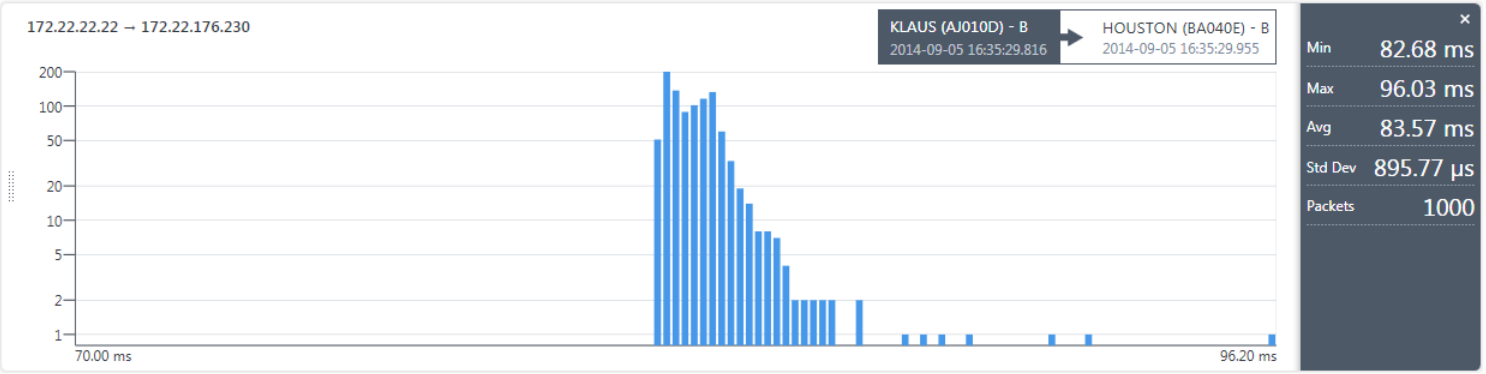


# Transatlantic latency

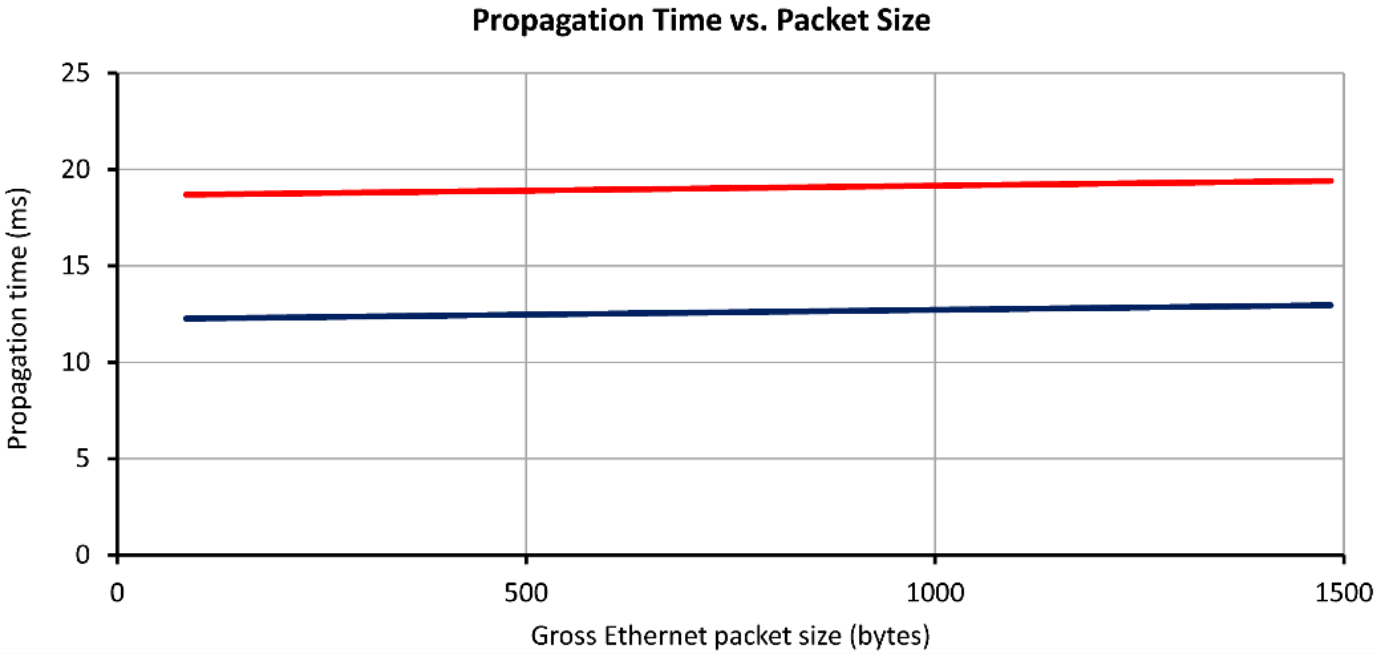


# Propagation delay Texas - Austria



# Two way propagation delay Germany - Austria



# GOOSE Control Block

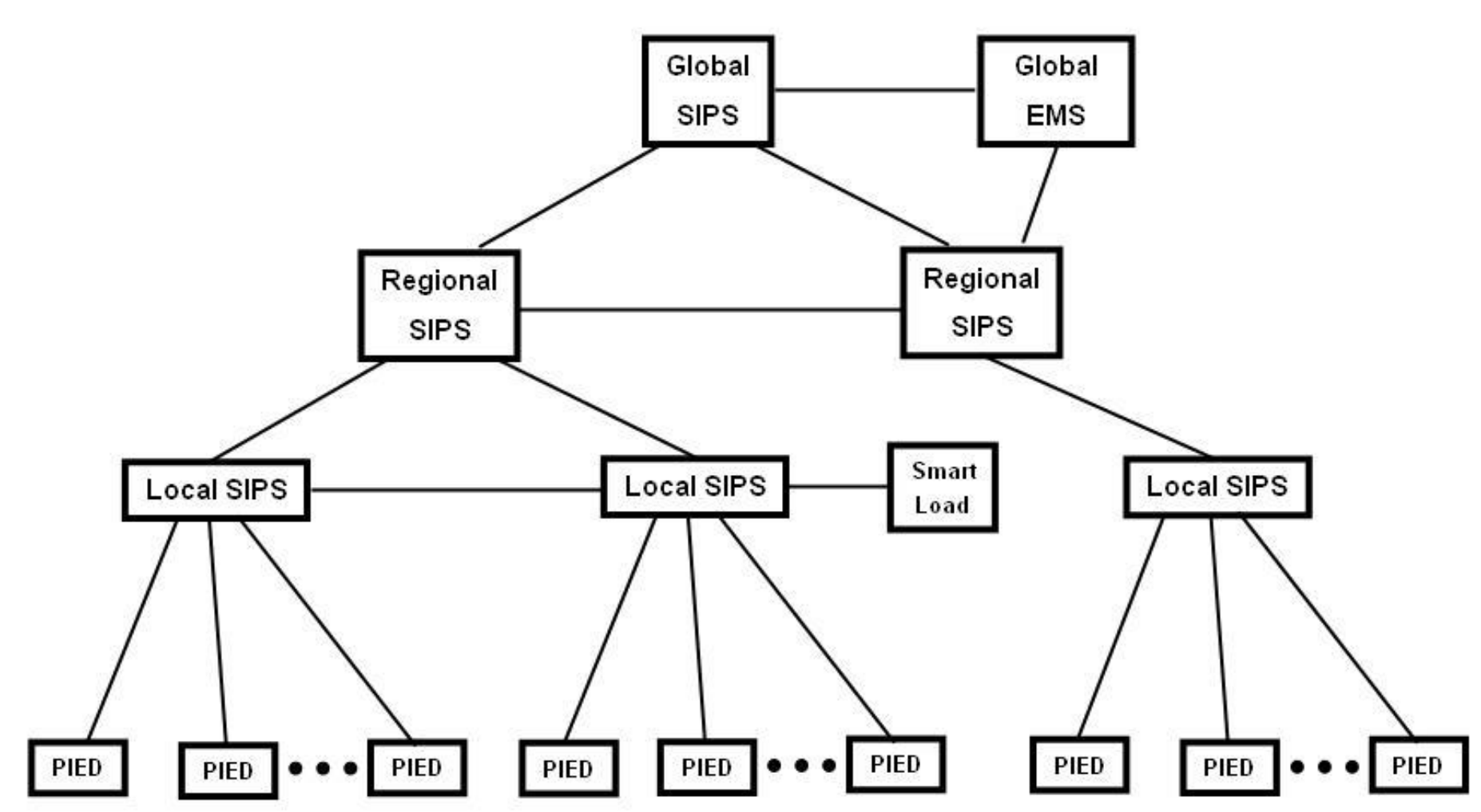
| Attribute name | Attribute type | r/w | m | Value/value range/explanation |
|---|---|---|---|---|
| **GoEna** | Boolean | rw | m | |
| **GoID** | Visible-string | r | m | |
| **DatSet** | Visible-string | r | m | |
| **ConfRev** | Unsigned | r | m | |
| **NdsCom** | Boolean | r | m | |
| **DstAddress** | PHYCOMADDR* | r | m | |
| **MinTime** | Unsigned | r | o | |
| **MaxTime** | Unsigned | r | o | |
| **FixedOffs** | Boolean | r | o | |
| **SecurityEnable**** | ENUMERATED | r | o | None, DigitalSignature, DigitalSignatureandEdgeAuthentication |

*Revisions to PHYCOMADDR can be found in clause 8.1.1.3.2
**Additional attribute to be added to the control block.

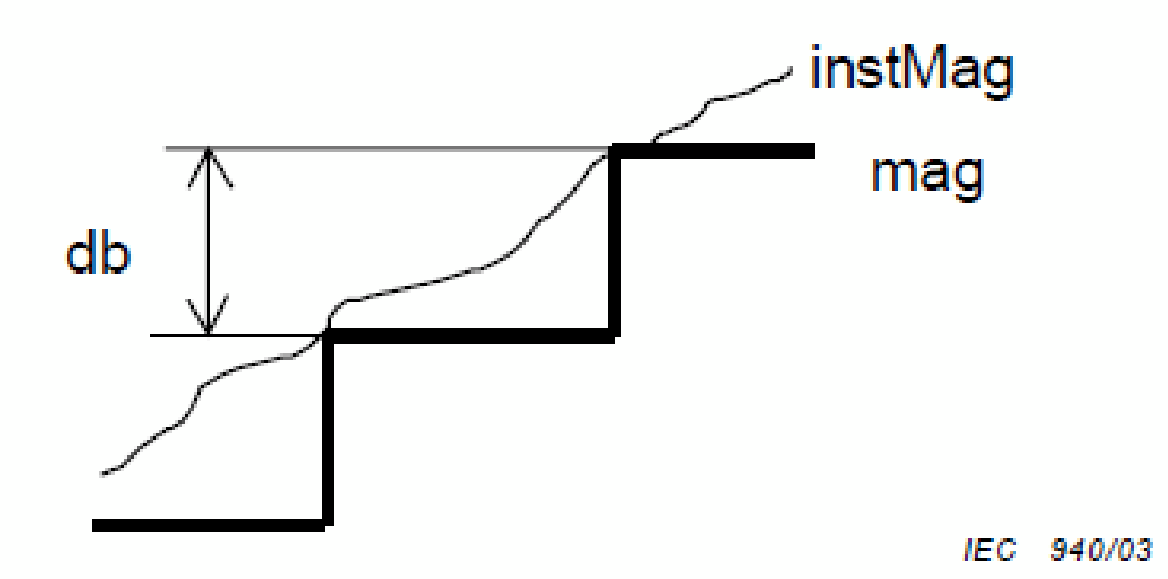
# SIPS Functionality

- SIPS can be considered as systems that have three main types of functional elements:
  - System monitoring elements
  - Protection elements
  - Execution elements
- The function of the system monitoring elements is to:
  - Detect a change in power system topology
  - Detect a change in system load
  - Detect a change in generation

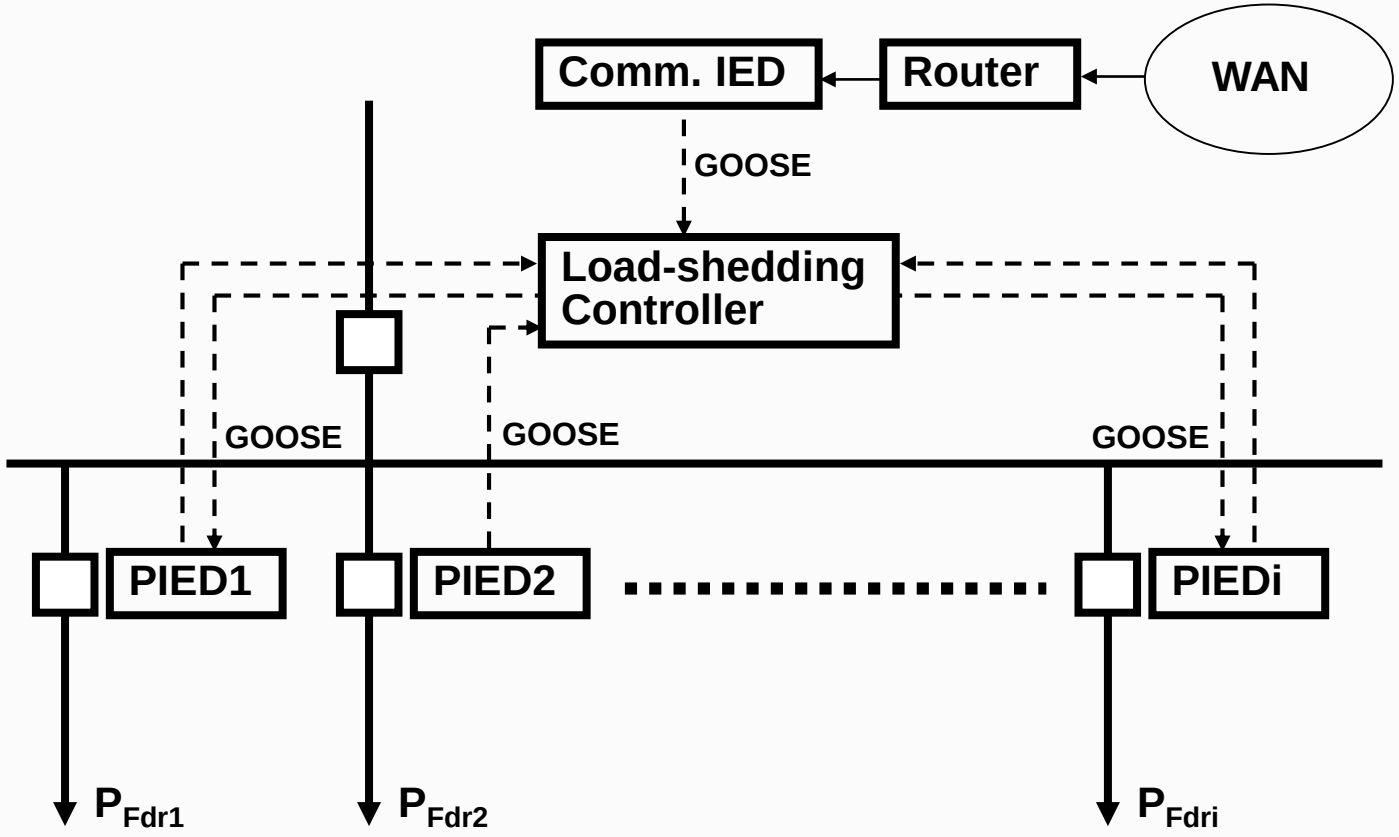
# SIPS Hierarchy



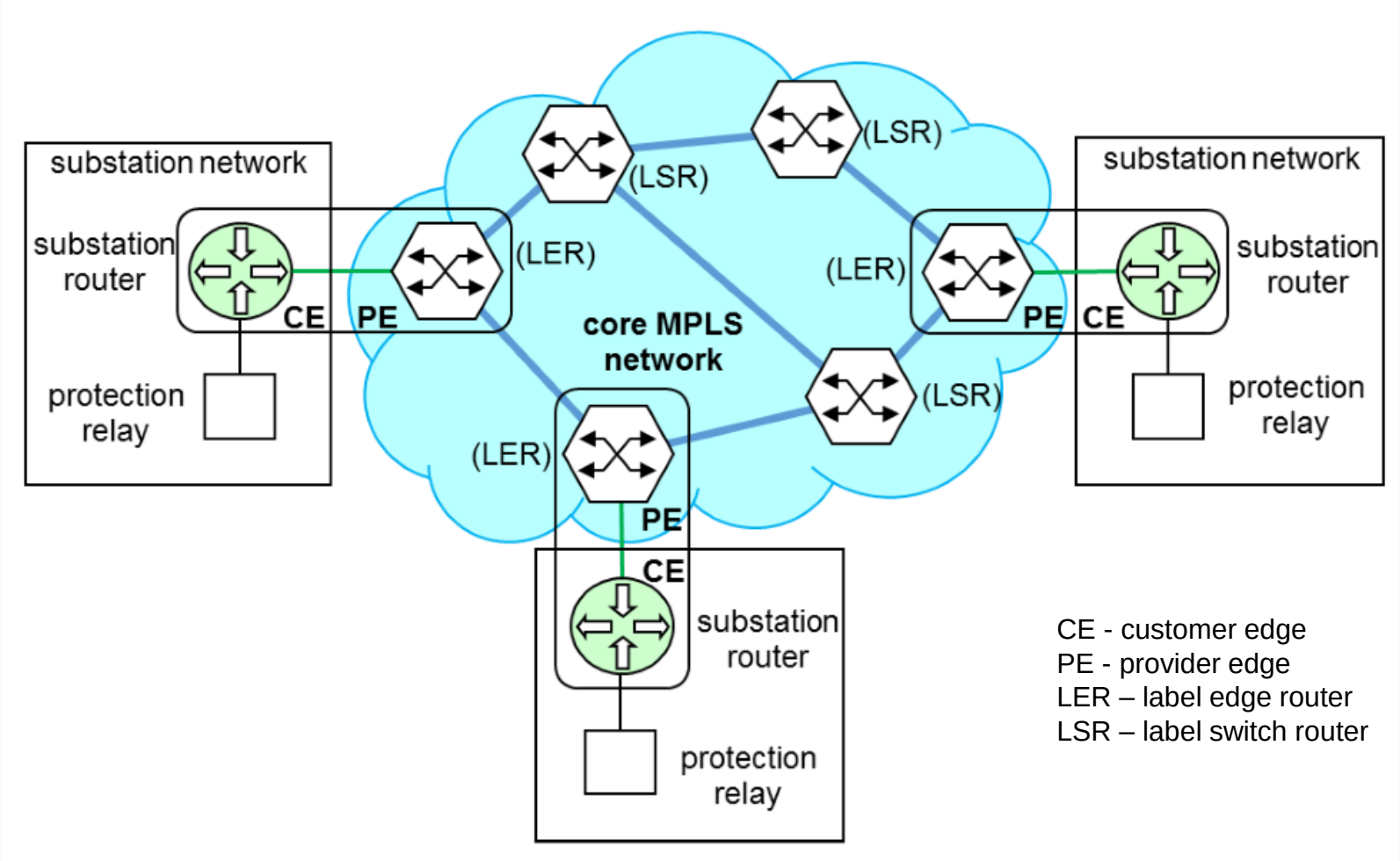
# Analog GOOSE Applications



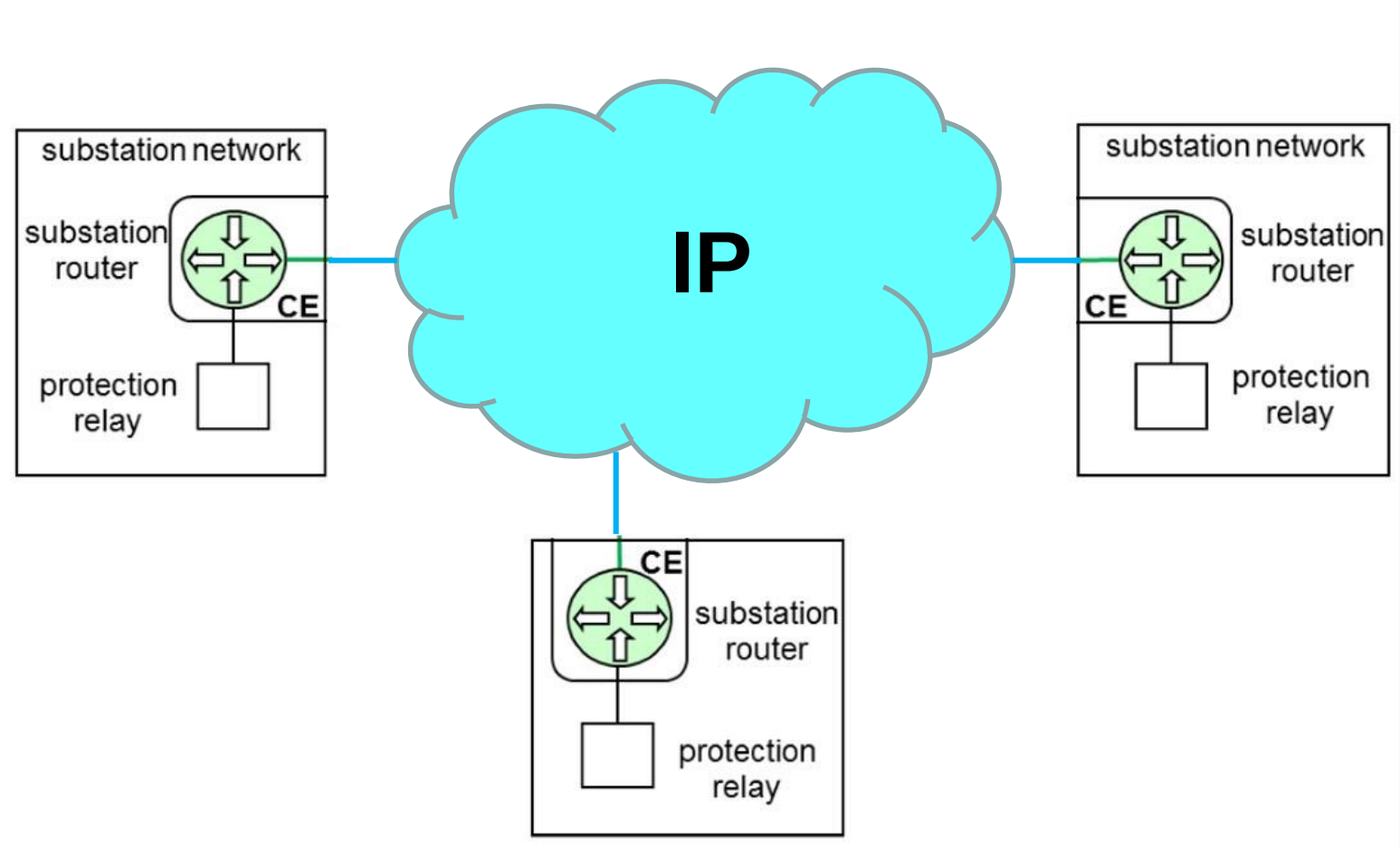
# Adaptive Load-shedding



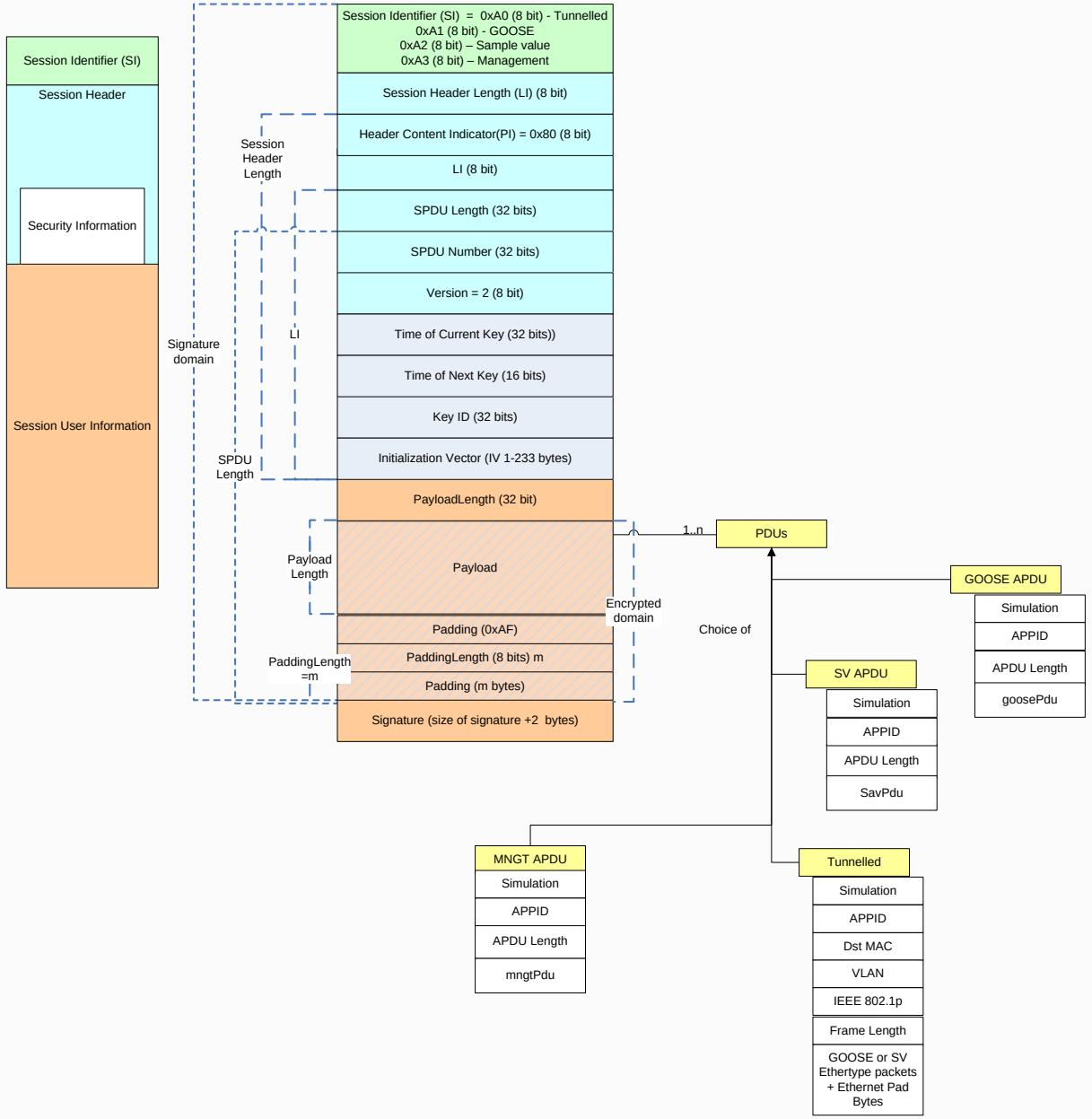
# MPLS for Wide Area GOOSE



# Wide Area R-GOOSE



# IEC 61850 90-5 Session Protocol



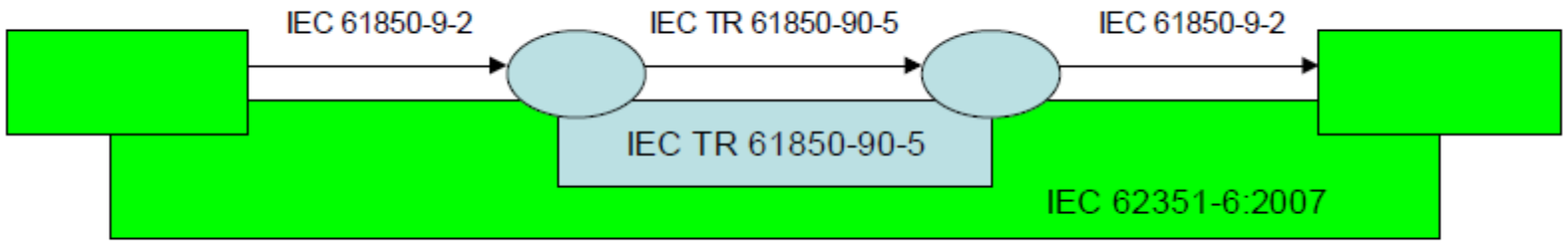
# R-GOOSE Control Block

| 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.

# E2E Cryptographic Integrity



# Conclusions

- Wide-Area-GOOSE is a new powerful tool for different SIPS related applications
- It requires good understanding of the propagation delay
- It can be implemented using 2.5 or 7 layer communications
- Cyber security has to be considered and implemented