



# 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



# 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

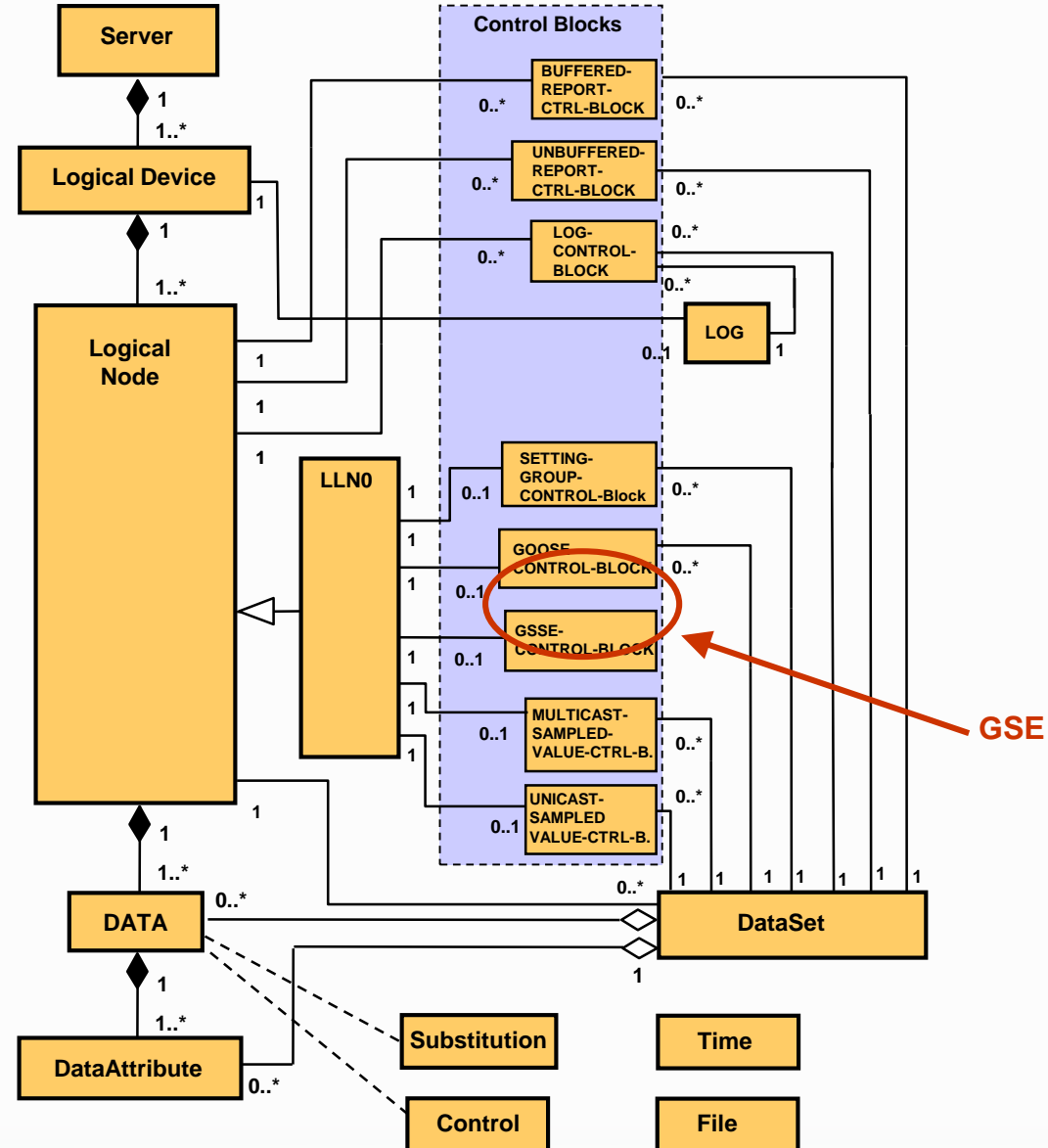
- GOOSE messages are one of the key differentiators of IEC 61850
- Client – Server communications are not suitable for protection applications
- Peer-to-Peer communications can meet the protection performance requirements
- Successful implementation of GOOSE based protection systems requires not only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

# GOOSE History: Chicago, May 1998

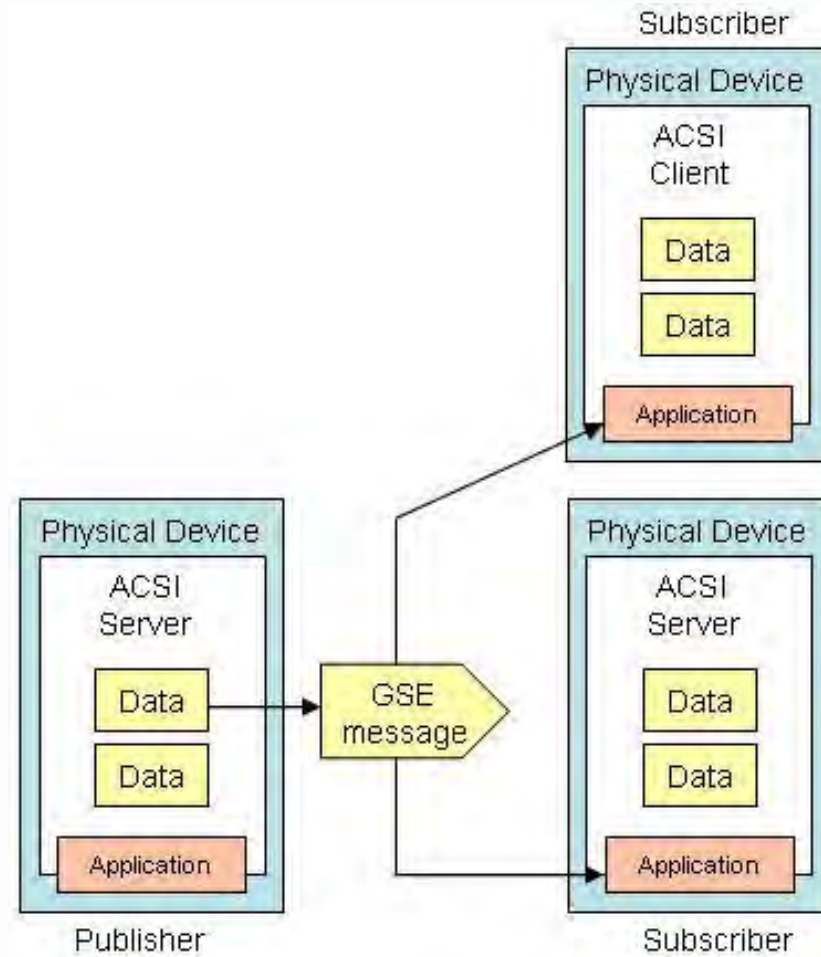
- Kay Clinard  
George Schimmel  
Herb Falk  
John Tengdin  
Mark Simon  
Charlie Sufanna  
Alex Apostolov  
Jim Whatley (remotely)



# IEC 61850 Services



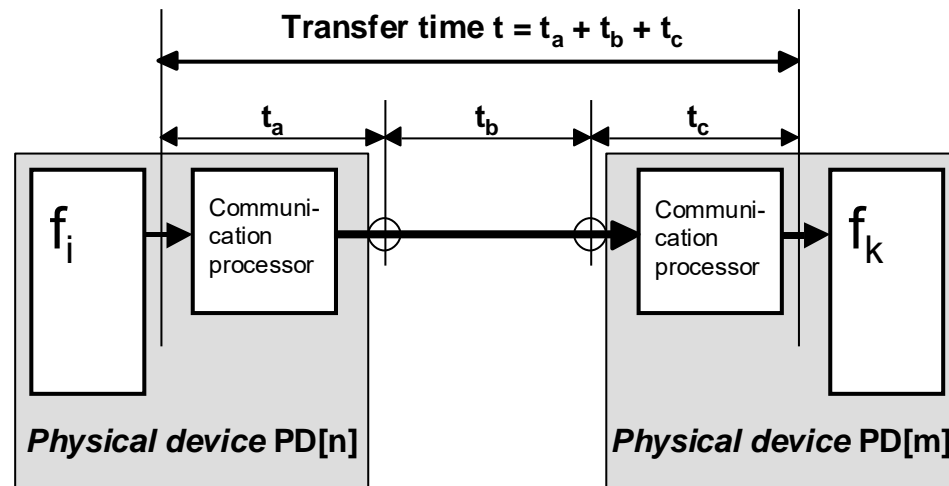
# IEC 61850 Services



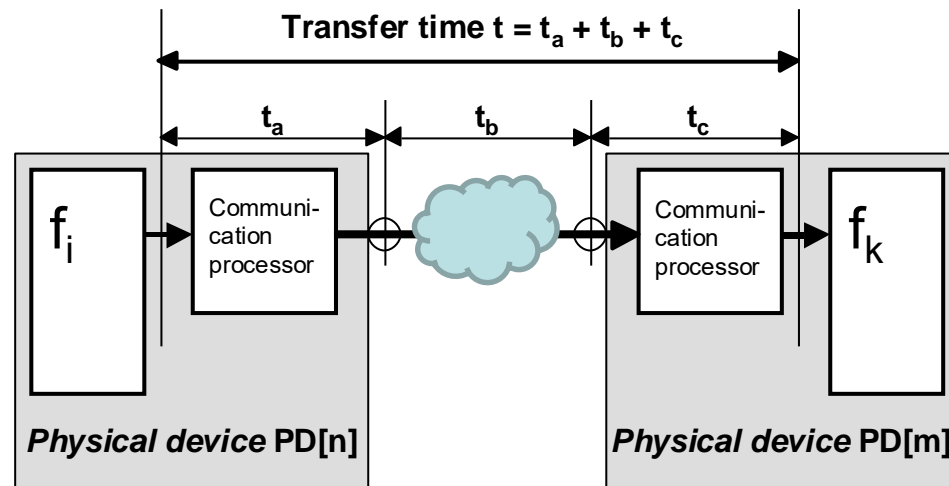
# GSE Messages:



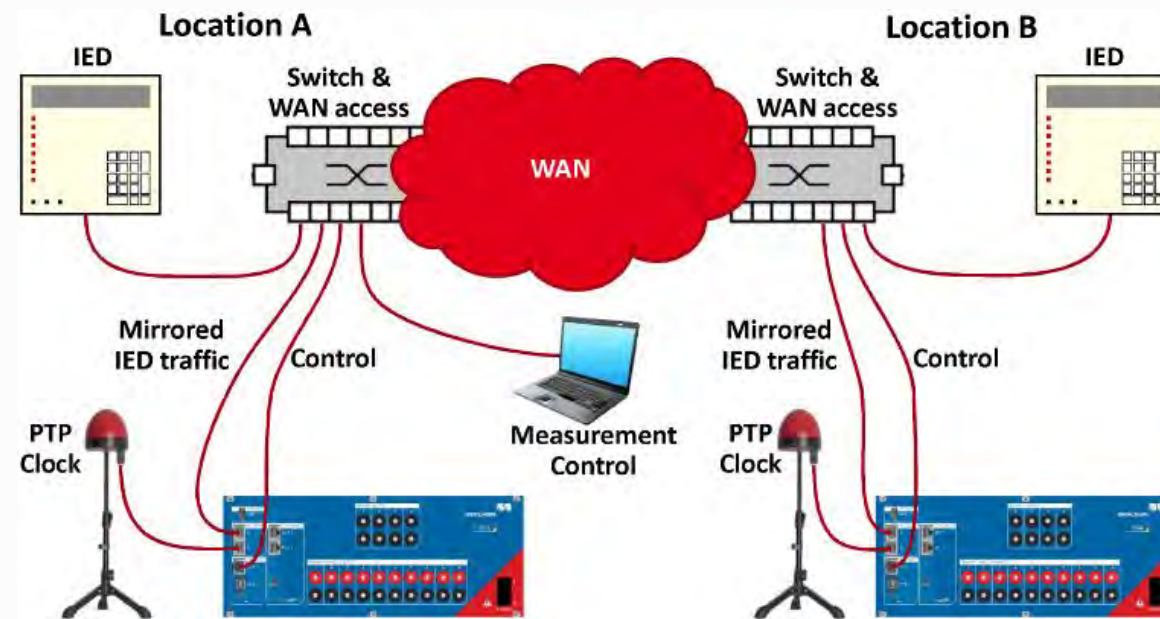
# GOOSE Performance



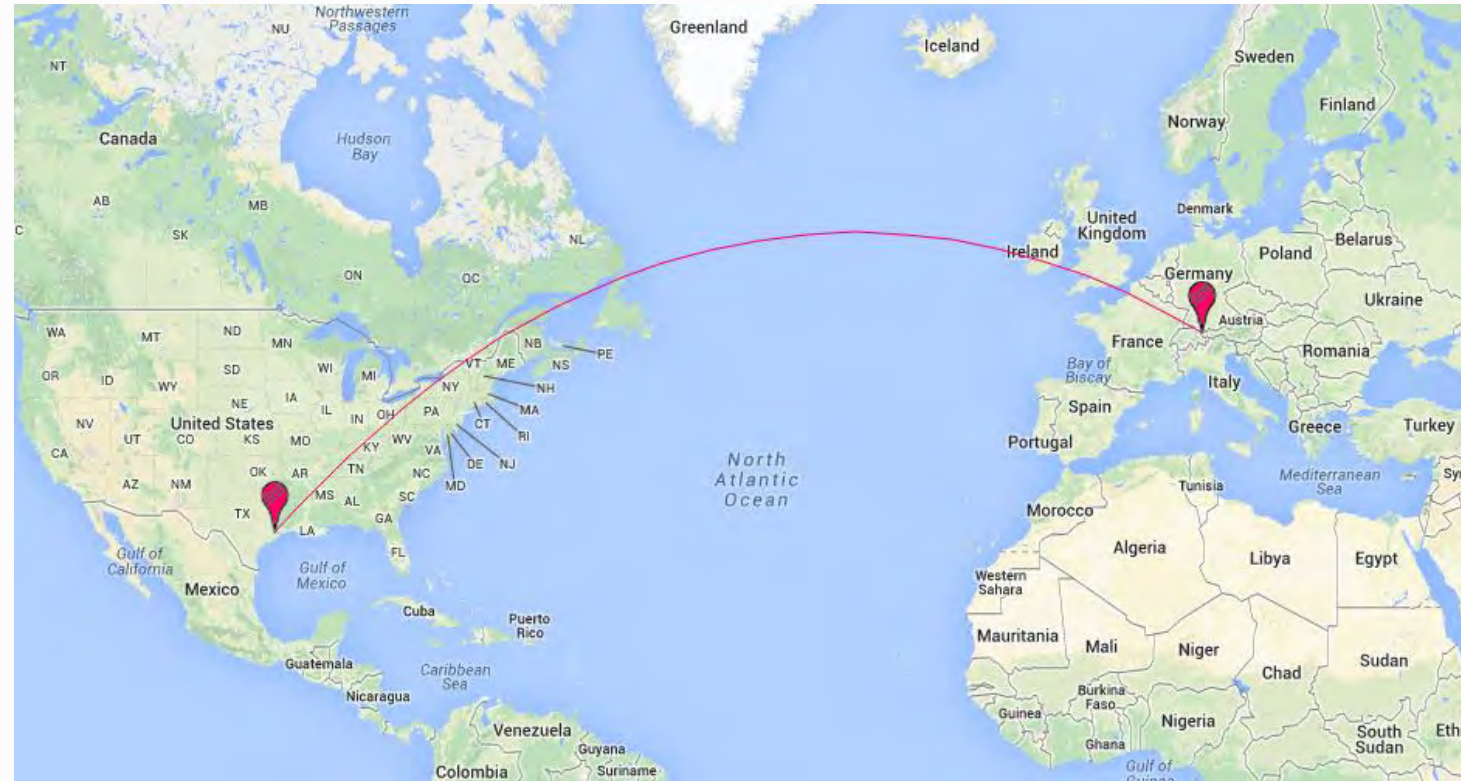
# GOOSE WAN Performance



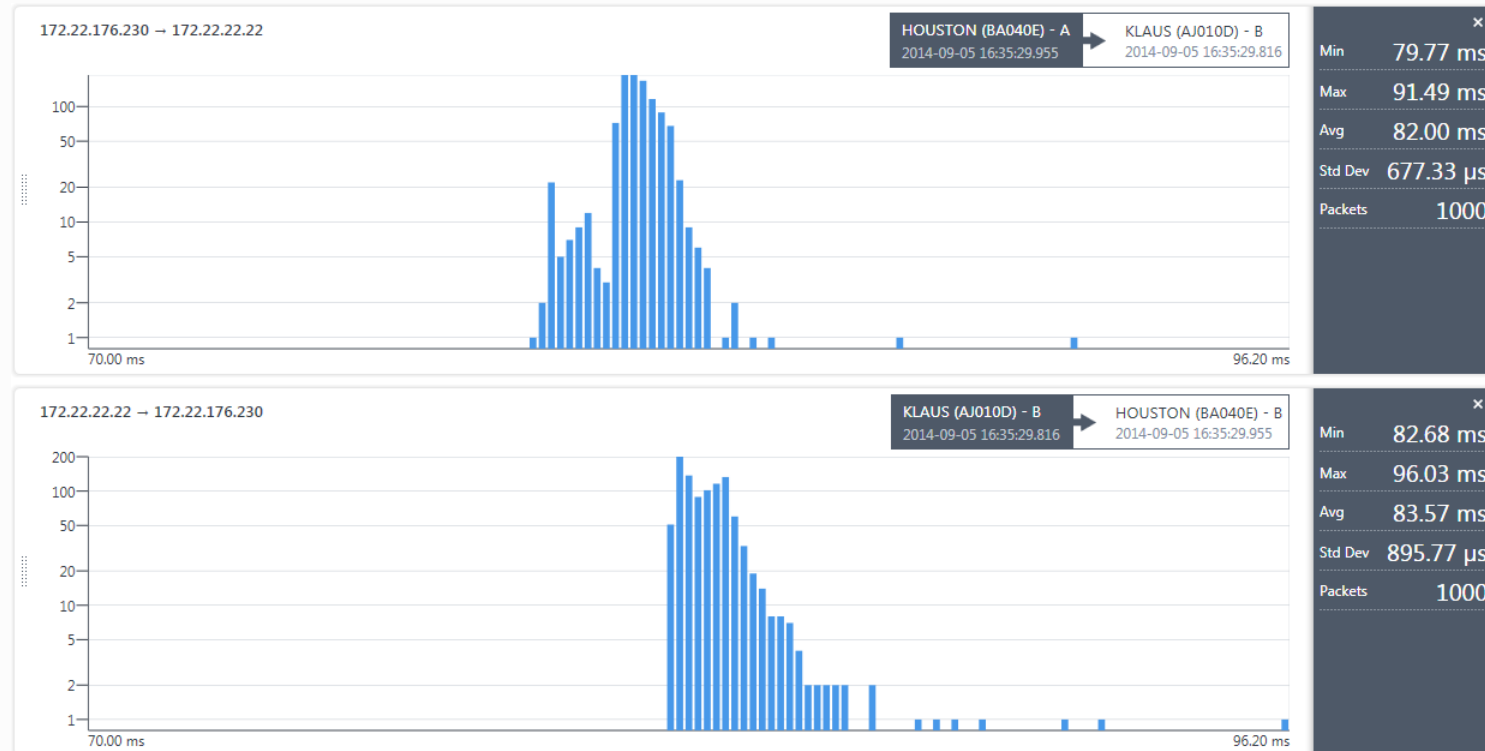
# Propagation time measurement



# Transatlantic latency

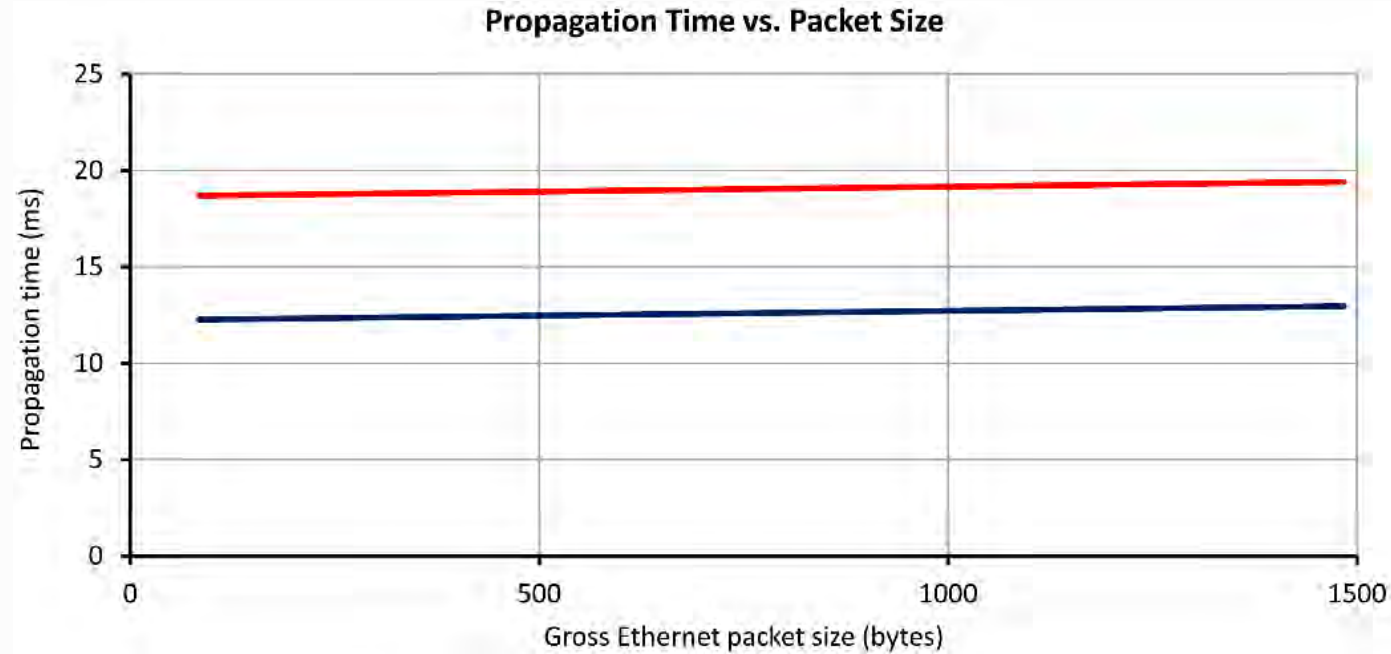


# Propagation delay Texas - Austria





# Two way propagation delay Germany - Austria



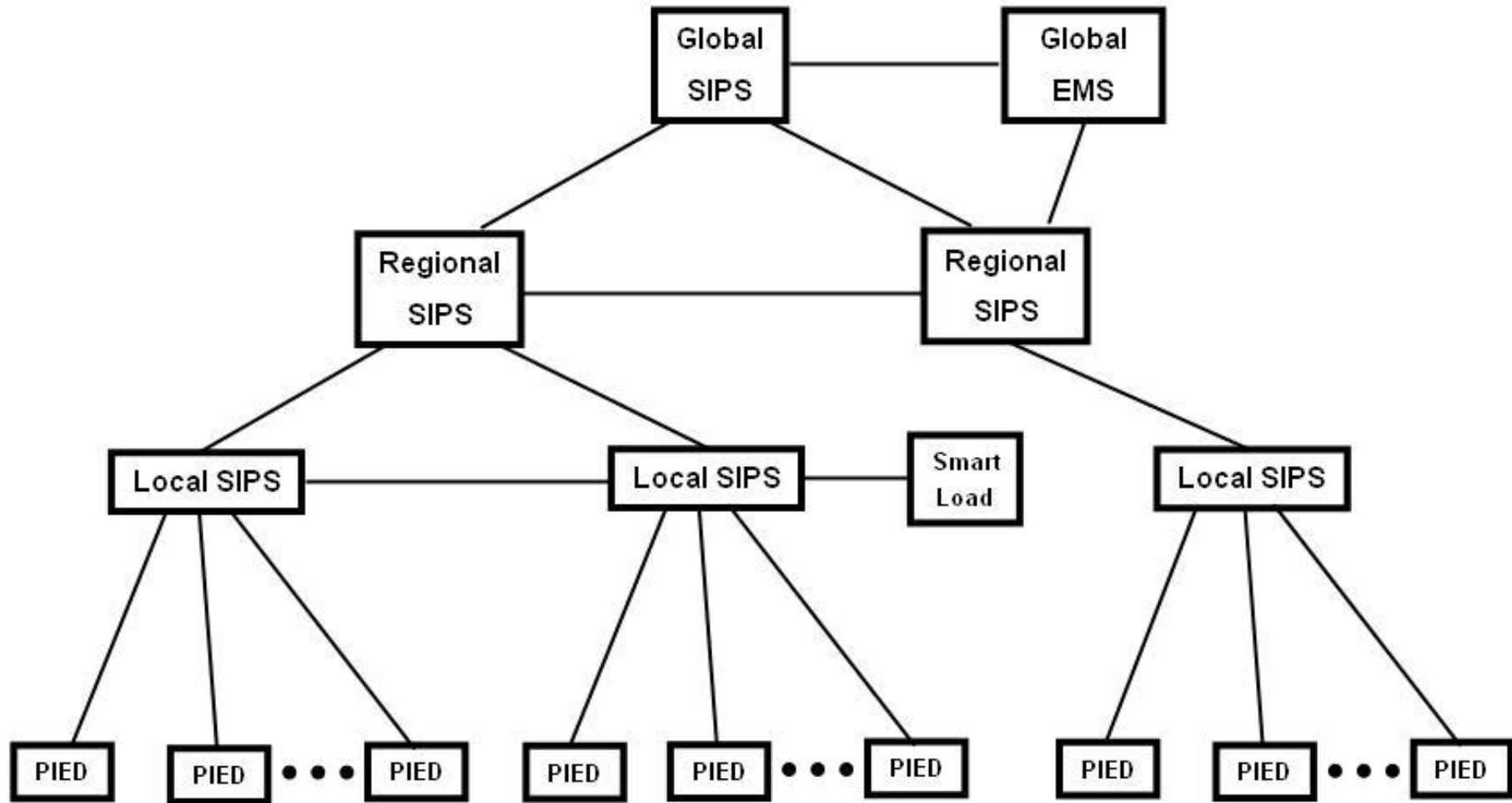
# GOOSE Control Block

| 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,<br>DigitalSignatureandEdgeAuthentication |
| *Revisions to PHYCOMADDR can be found in <a href="#">clause 8.1.1.3.2</a> |                |     |   |  |
| **Additional attribute to be added to the control block.                  |                |     |   |  |

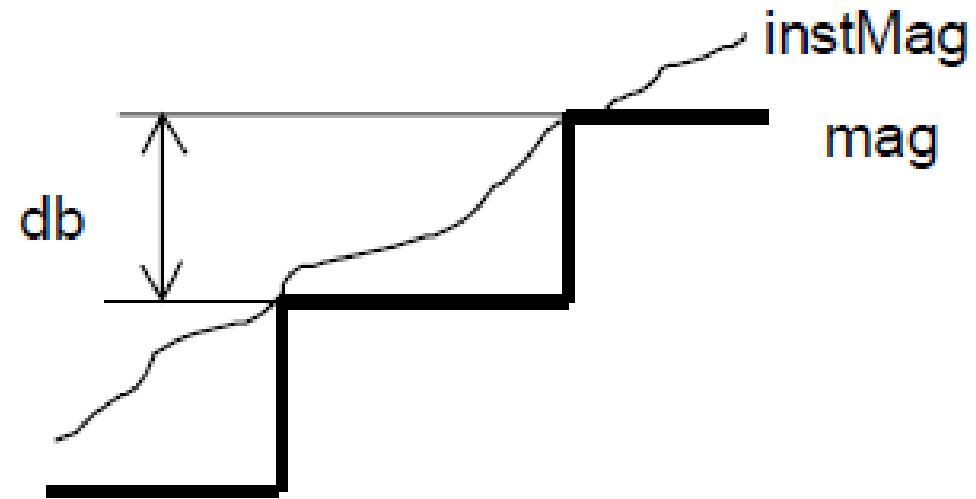
# SIPS Functionality

- 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

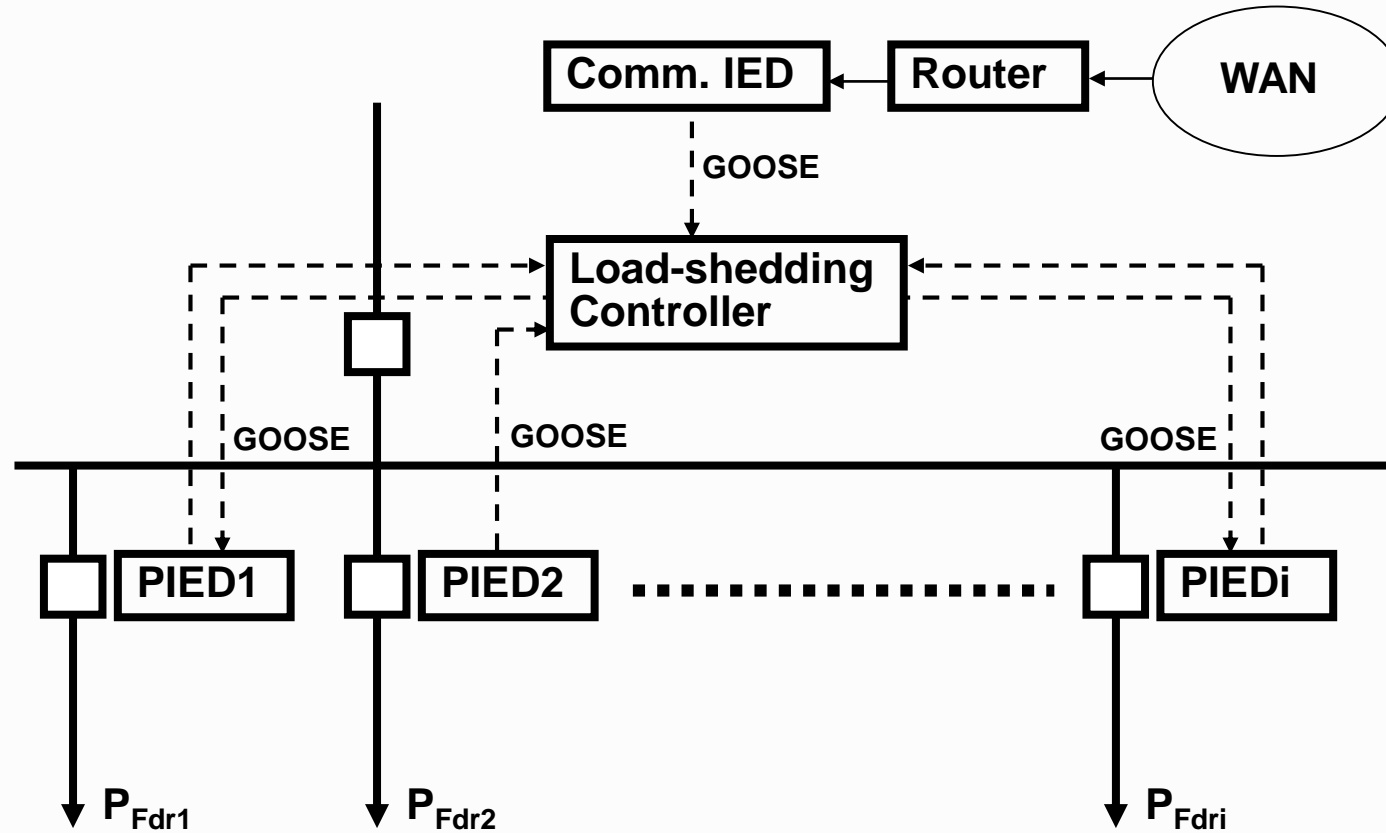


# Analog GOOSE Applications

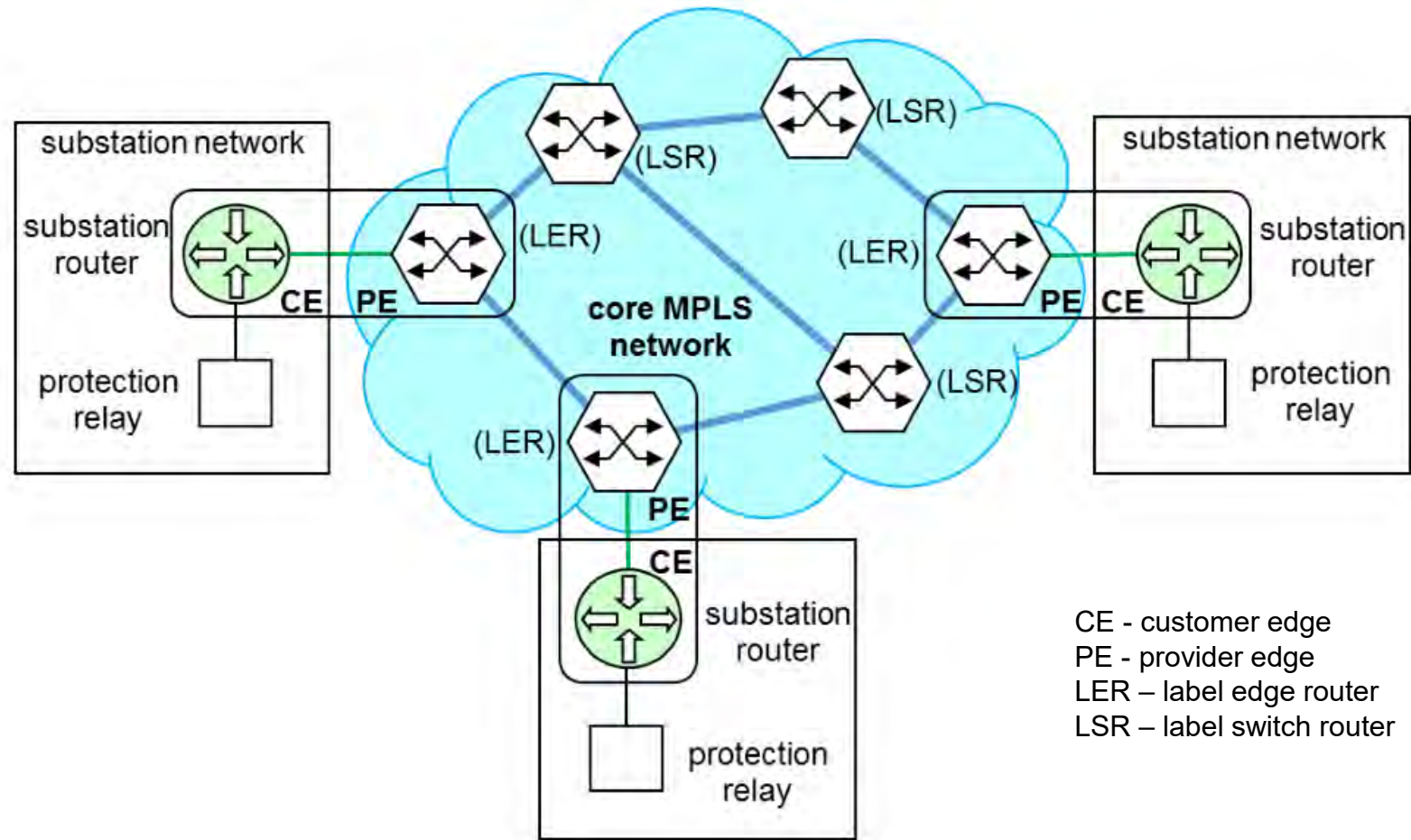


IEC 940/03

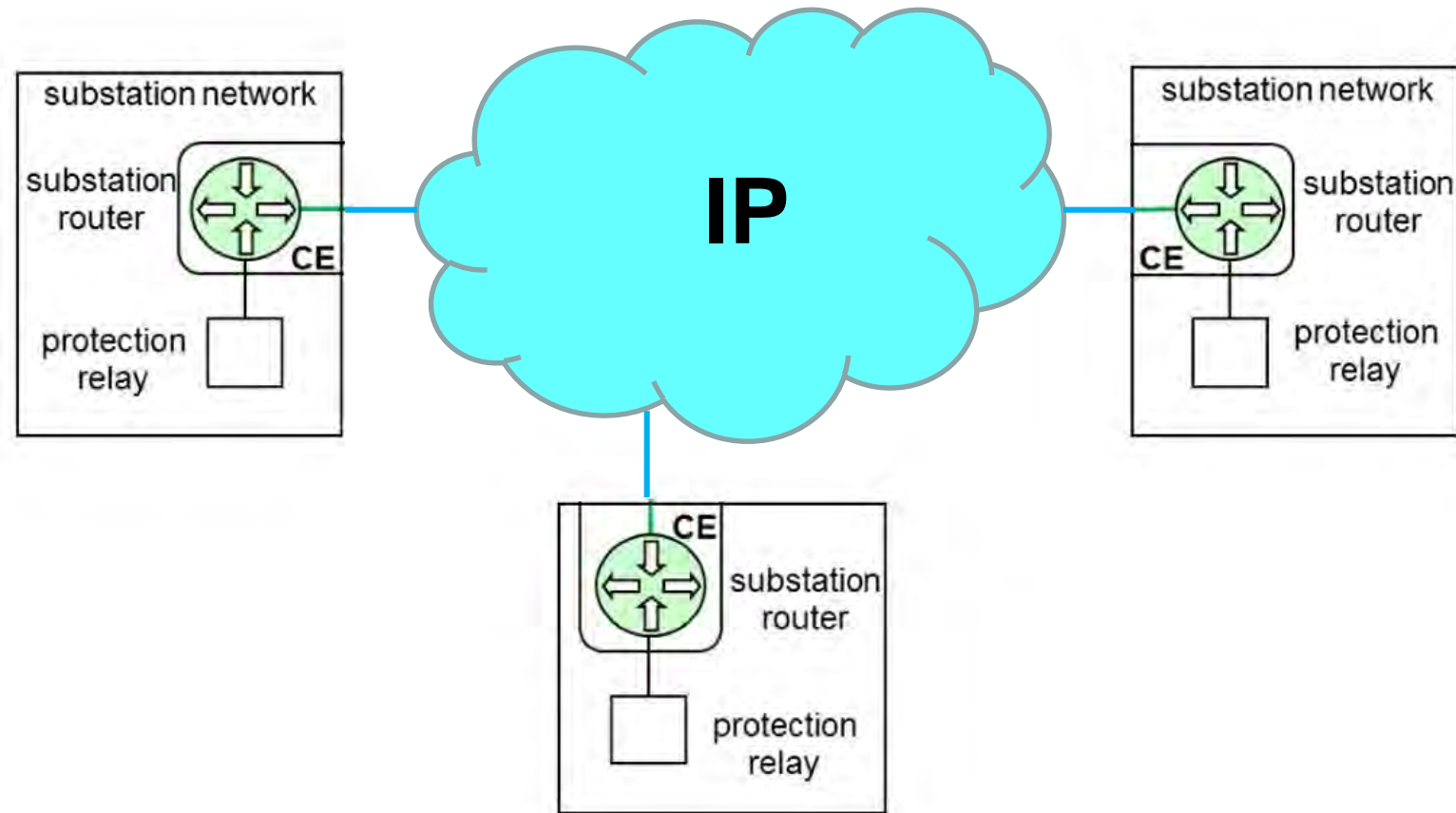
# Adaptive Load-shedding



# MPLS for Wide Area GOOSE

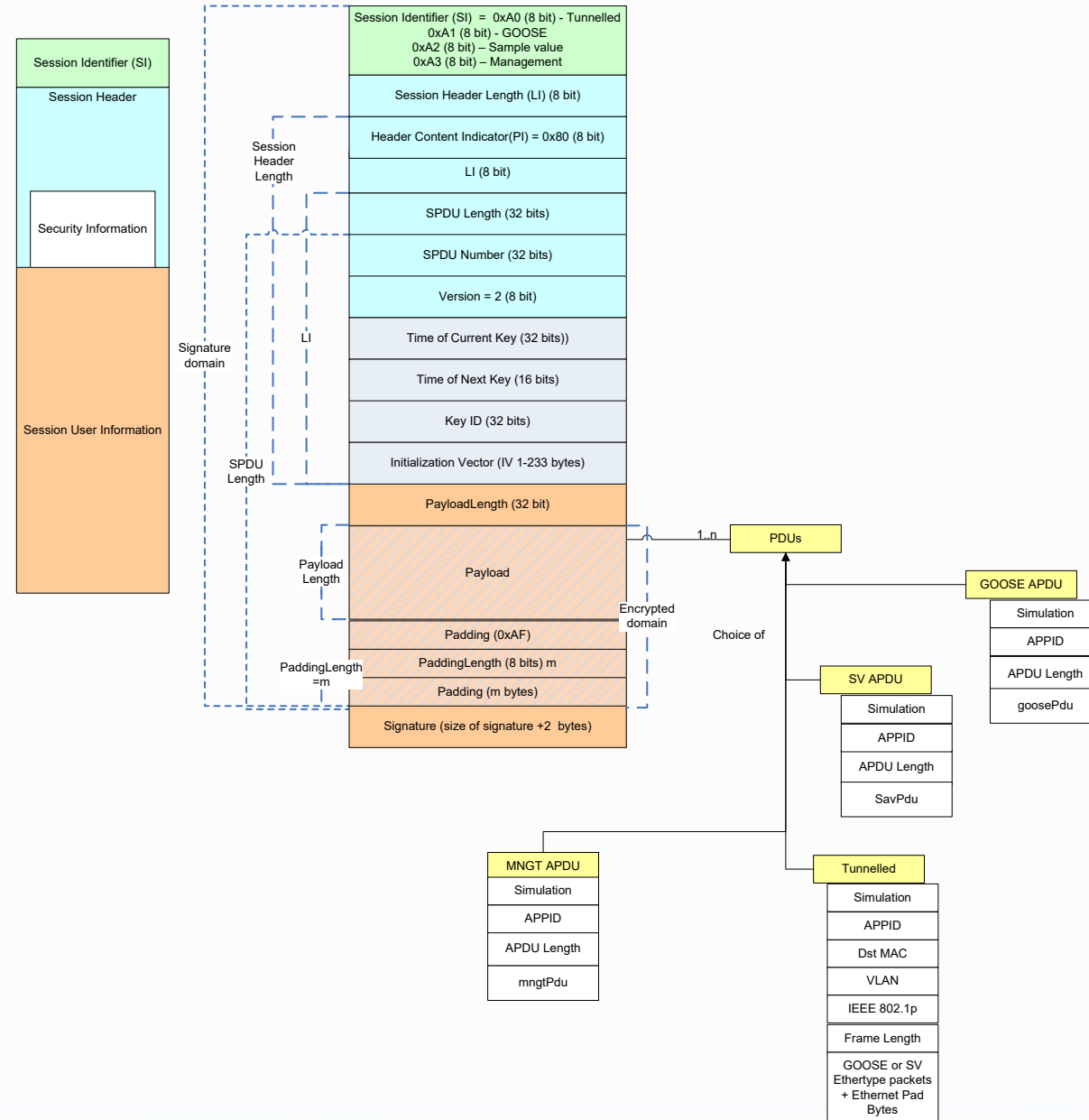


# Wide Area R-GOOSE





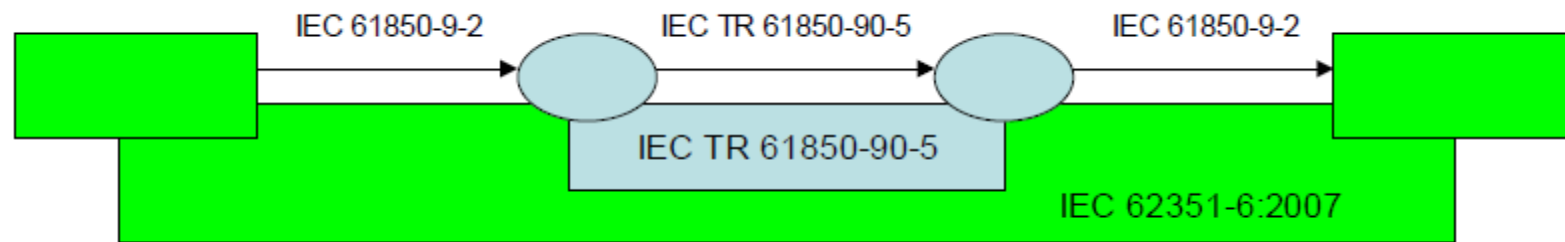
# IEC 61850 90-5 Session Protocol



# 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