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Communication Principles and IEC 61850
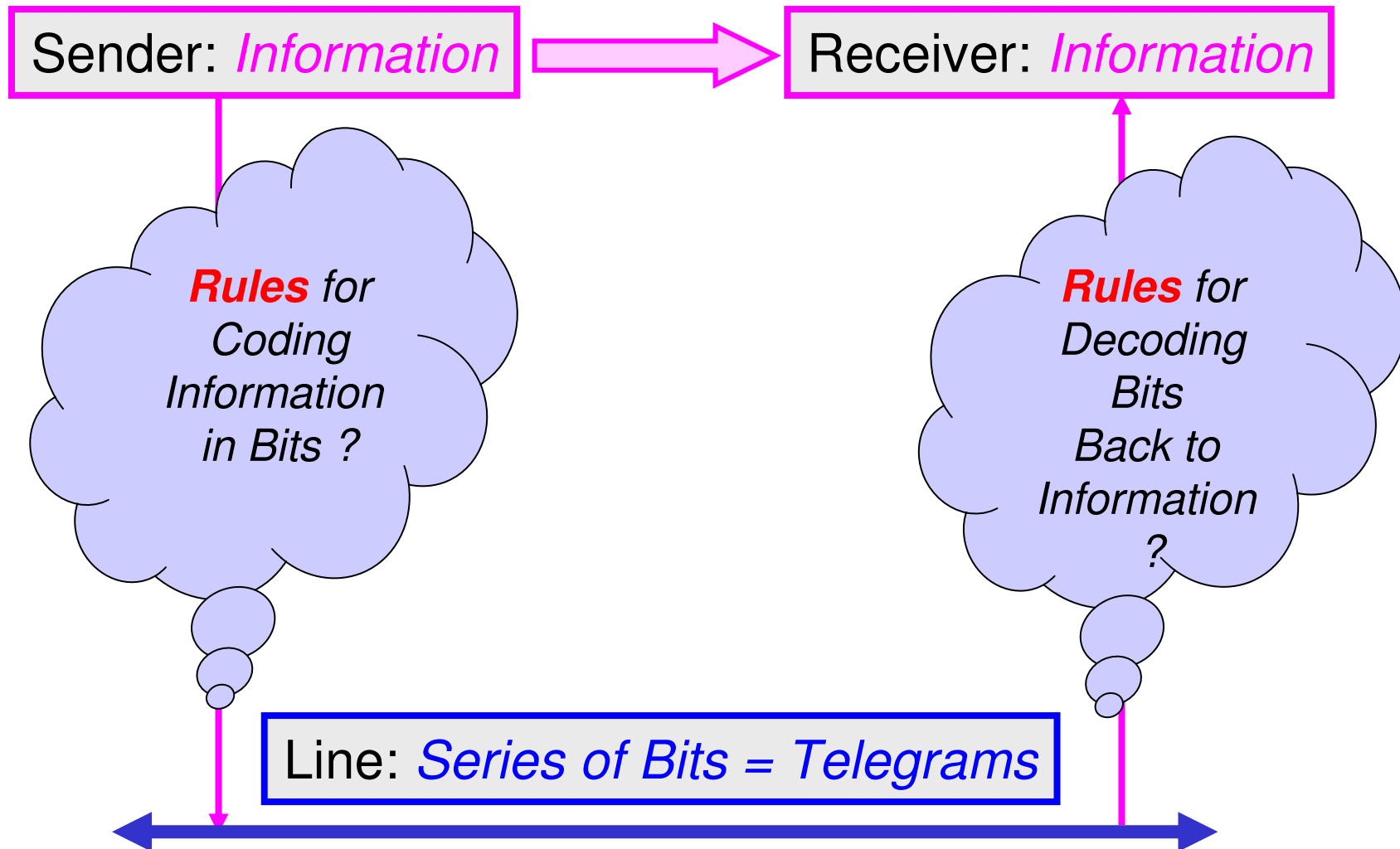
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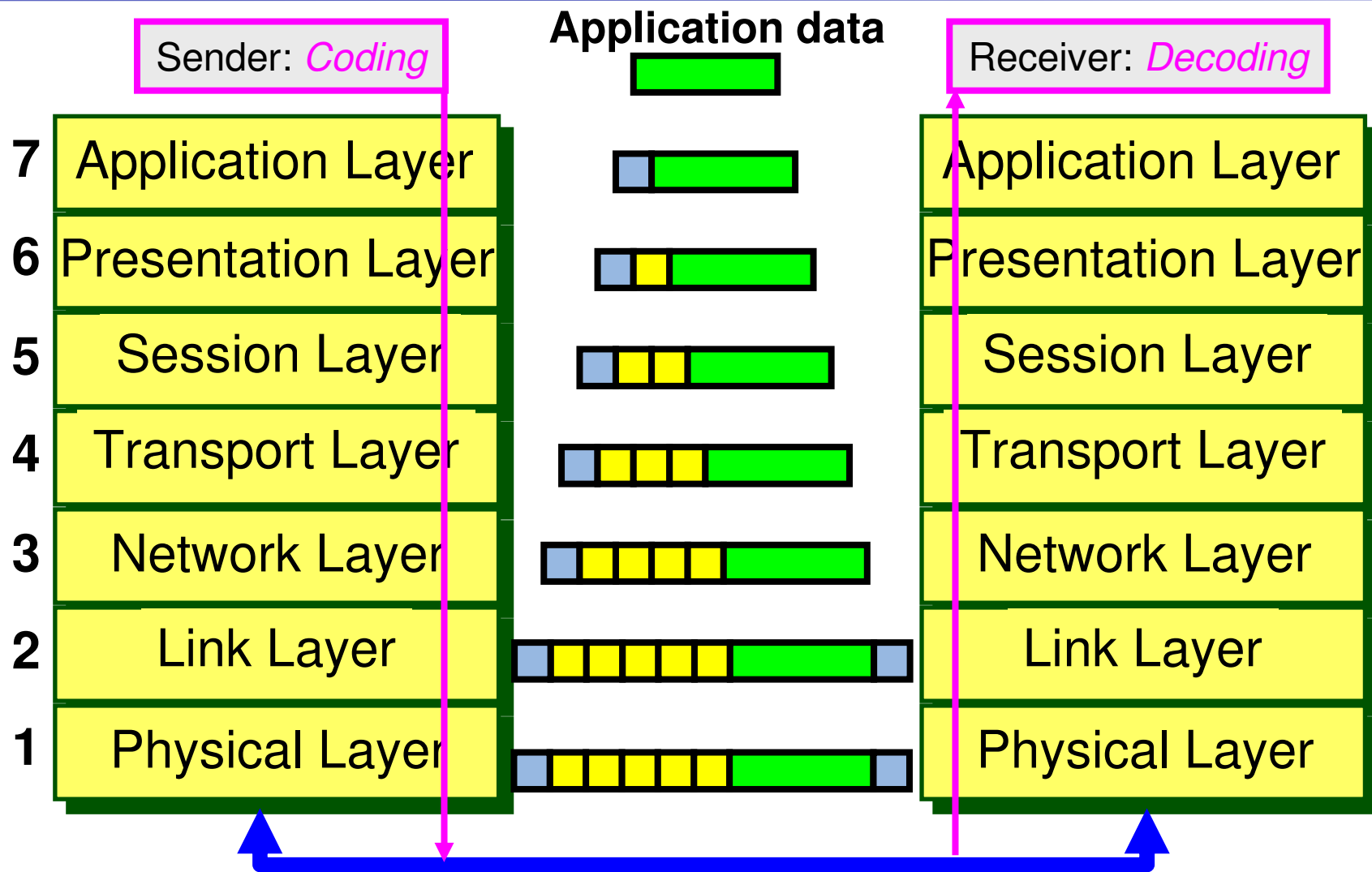# IEC 61850
The Communication Principles
General Information and
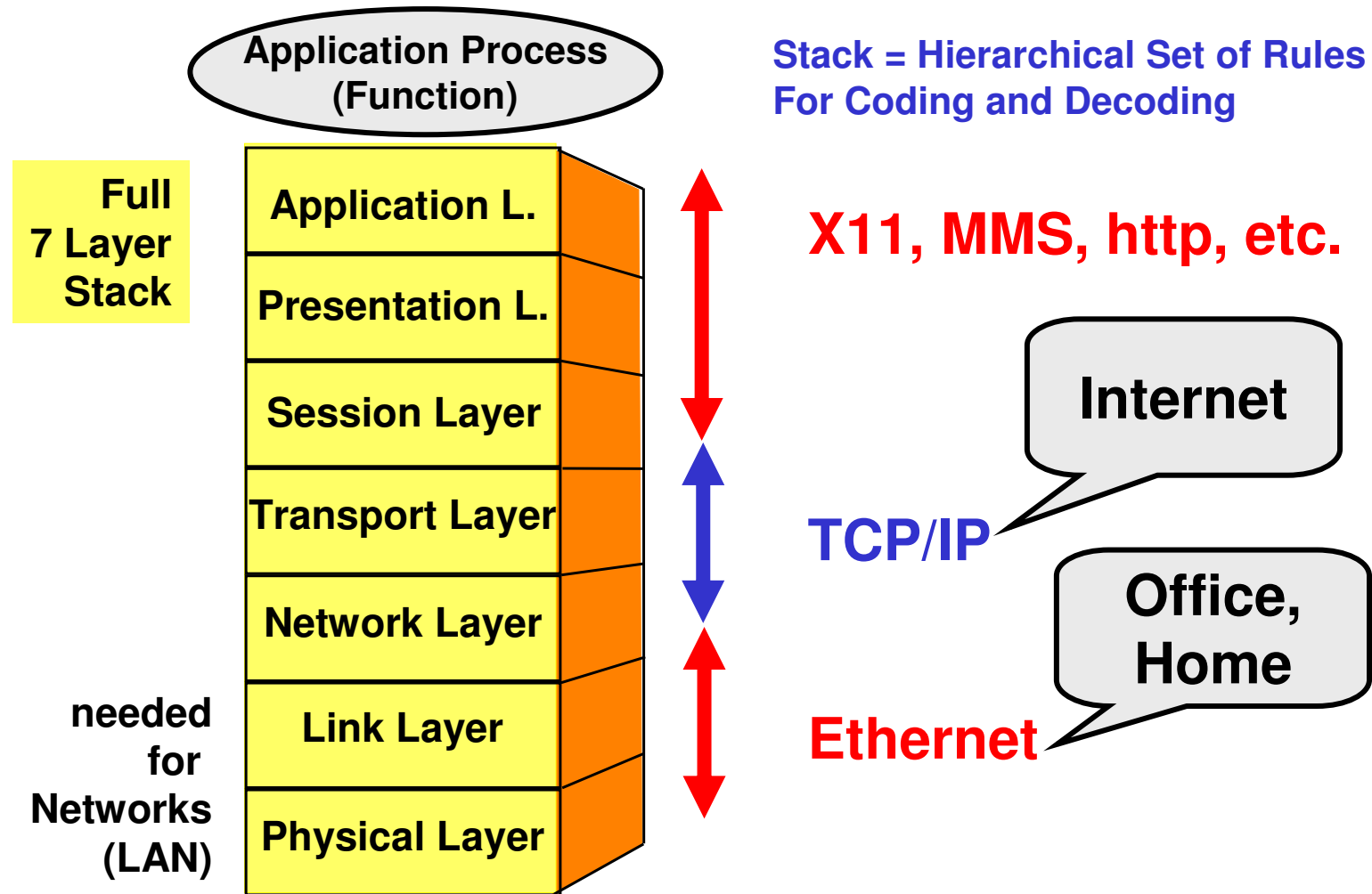**references to IEC 61850-7-2 and IEC 61850-8-1 and 9-2**

❑ **ISO/OSI Model**

❑ **The stack of IEC 61850**

❑ **Event driven and time critical services**

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Exchange of data by serial communication

Sender: *Information* ⟹ Receiver: *Information*

Rules for
Coding
Information
in Bits ?

Rules for
Decoding
Bits
Back to
Information
?

Line: *Series of Bits = Telegrams*

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Coding/decoding acc. to the ISO/OSI model

Application data

Sender: *Coding*

Receiver: *Decoding*

7	Application Layer	Application Layer
6	Presentation Layer	Presentation Layer
5	Session Layer	Session Layer
4	Transport Layer	Transport Layer
3	Network Layer	Network Layer
2	Link Layer	Link Layer
1	Physical Layer	Physical Layer

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The 7 layers of the ISO/OSI Model

Application Process (Function)

Stack = Hierarchical Set of Rules For Coding and Decoding

Full 7 Layer Stack

Application L.	
Presentation L.	
Session Layer	
Transport Layer	
Network Layer	
Link Layer	
Physical Layer	

X11, MMS, http, etc.

Internet

TCP/IP

Office, Home

Ethernet

needed for Networks (LAN)

MMS Manufacturing Message Specification
TCP Transport Control Protocol
IP Internet Protocol
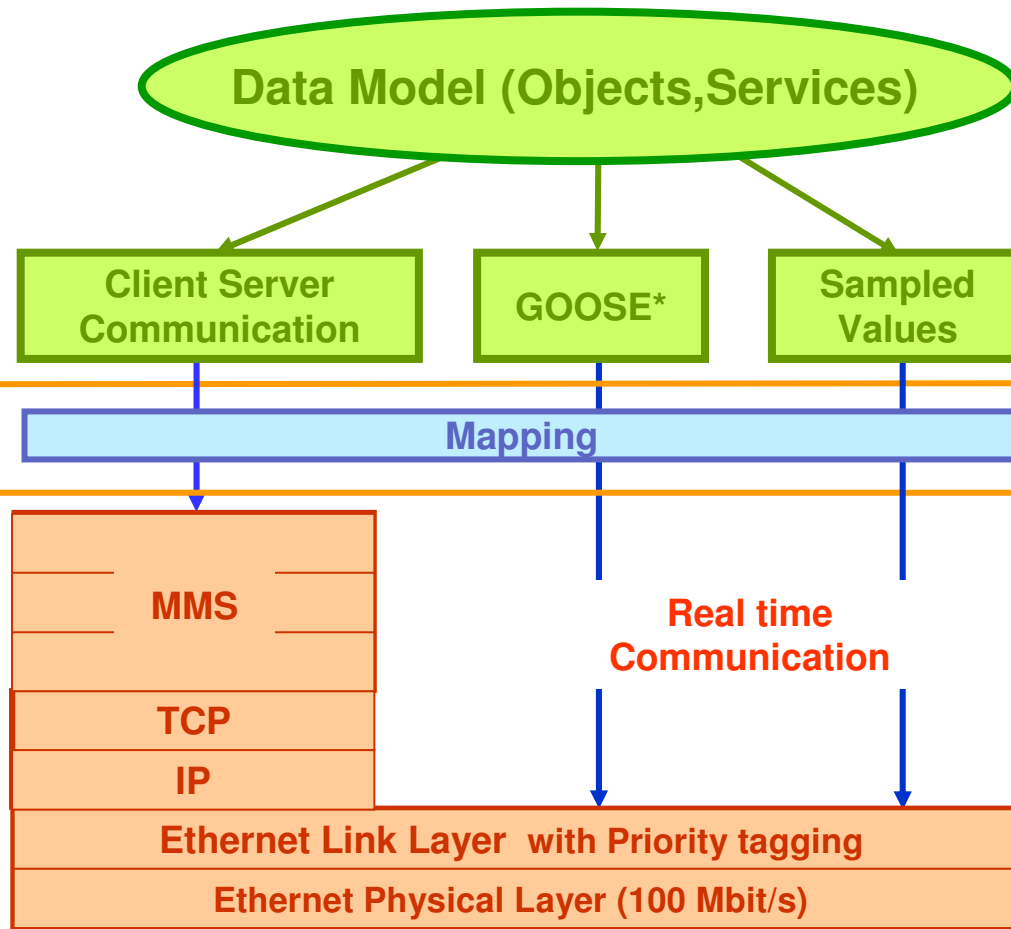
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The Stack of IEC 68150 and Model Mapping

■ *Model according to state-of-the-art SA technology*

- SA specific data model evolves slowly
- Communication technology changes quickly
- Splitting of SA specific data model from communication technology

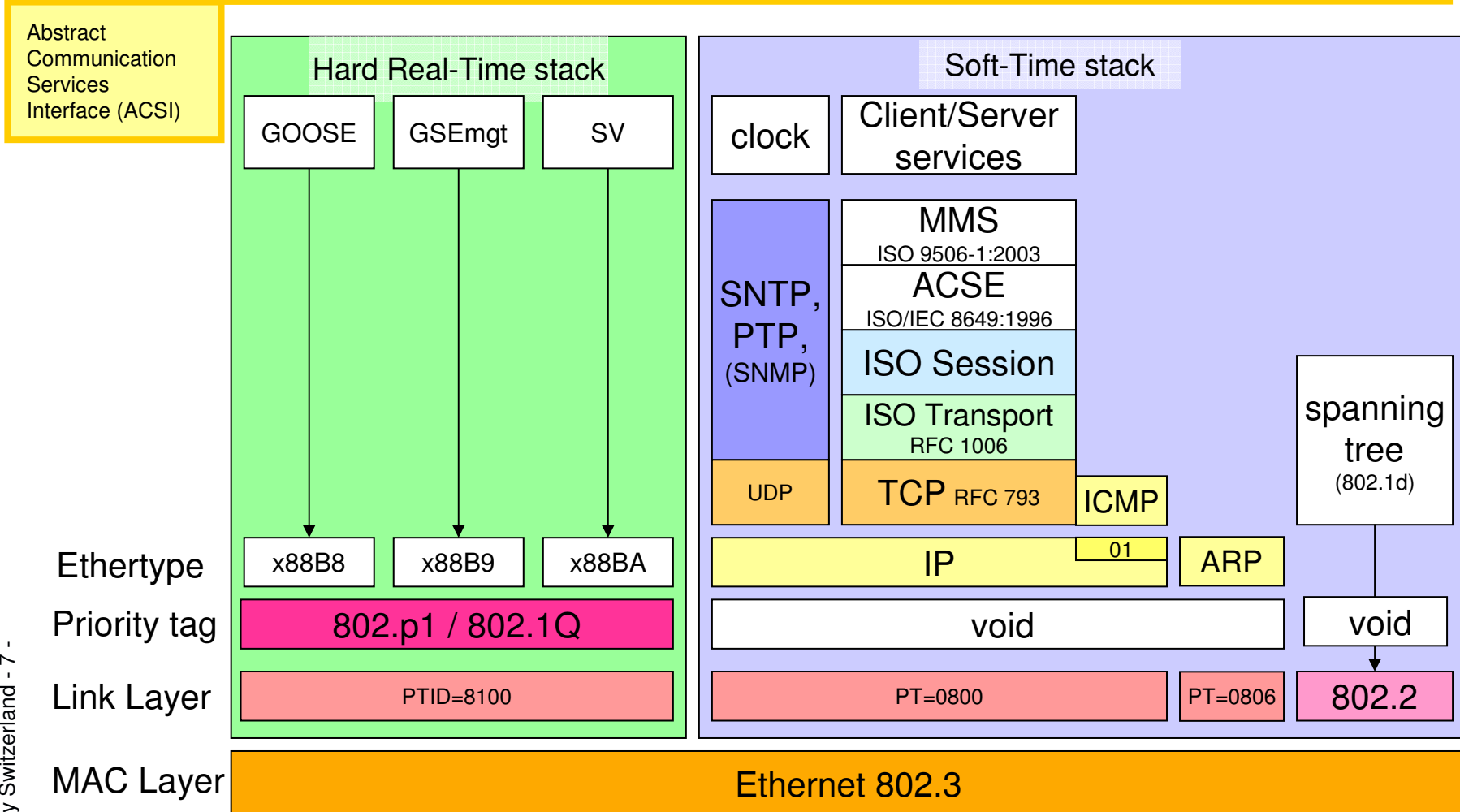Abstract Communication Services Interface (ACSI)

Stack Interface

ISO/OSI – Stack
Hierarchical set of
Rules how information is coded for
transmission
According to state-of-the art
communication technology

* **G**eneric **O**bject **O**riented **S**ubstation **E**vent

Data Model (Objects,Services)

| Client Server Communication | GOOSE* | Sampled Values |

Mapping

MMS

TCP

IP

Real time Communication

Ethernet Link Layer with Priority tagging

Ethernet Physical Layer (100 Mbit/s)

Stack selection according to the state-of-the-art Communication technology

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IEC 61850 Stack: Technical Details

Abstract
Communication
Services
Interface (ACSI)

Hard Real-Time stack

| GOOSE | GSEmgt | SV |

Soft-Time stack

| clock | Client/Server services |

SNTP,
PTP,
(SNMP)

MMS
ISO 9506-1:2003

ACSE
ISO/IEC 8649:1996

ISO Session

ISO Transport
RFC 1006

| UDP | TCP RFC 793 | ICMP |

spanning tree
(802.1d)

Ethertype

| x88B8 | x88B9 | x88BA | | IP | 01 | ARP | |

Priority tag

| 802.p1 / 802.1Q | | void | | void |

Link Layer

| PTID=8100 | | PT=0800 | PT=0806 | 802.2 |

MAC Layer

Ethernet 802.3

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Time critical Services

- ❑ **Transfer of generic object oriented system events (GOOSE)**
  - ❑ Some few data like blockings, releases, position, trips, etc. have to be transmitted very fast and reliable.
  - ❑ Therefore, the transmission is time critical (highest demand 4 ms)

- ❑ **Transfer of sampled (analog) values (SV)**
  - ❑ **The samples have to be precisely synchronized depending on the demanding functions.**
  - ❑ **Therefore, the synchronization is time critical (highest demand 1 μs). If the sampling is not synchronized the samples have to be tagged with a time of the same accuracy to compare sinusoidal waves or to to calculate phasors.**
  - ❑ **In addition, the stream of samples has to be transmitted fast enough that the fast reaction time e.g. of protection in not more delayed than with hardwired connections.**

Time-critical Services using only the 2 Lowest Layers of the stack

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For comparison: Client-Server Communication

Used for non time-critical services only !

Client – Server services using all 7 layers of the ISO/OSI stack

❑ A point – point association is established and supervised and may be terminated: Associate / Release / Abort

❑ MMS: Dynamically built (server addresses, authentication)

❑ Maximum number is IED implementation dependent

❑ The mechanism is very reliable

❑ Telegrams are "acknowledged" on a low level

❑ Normally, no data are lost since telegrams with errors may be resend again

❑ Comfortable mechanism – you now it from your office and from the Internet - but time consuming, i.e. not suited for time-critical communication

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Confirmation of spontaneous messages ?

❑ The reception of a **report** may be <u>confirmed</u> and in case of losses repeated. Using the full stack and takes some time.

❑ The data stream of **sampled values (SV)** is <u>not confirmed</u> but losses of some samples are handled without problems by the receiving functions, e.g. by a protection algorithm.

❑ The <u>unconfirmed</u> **GOOSE messages** may transport important time critical information like a block or a trip. Therefore, a special repetition mechanism has to guarantee a reliable transfer without losses of these data (see next page).
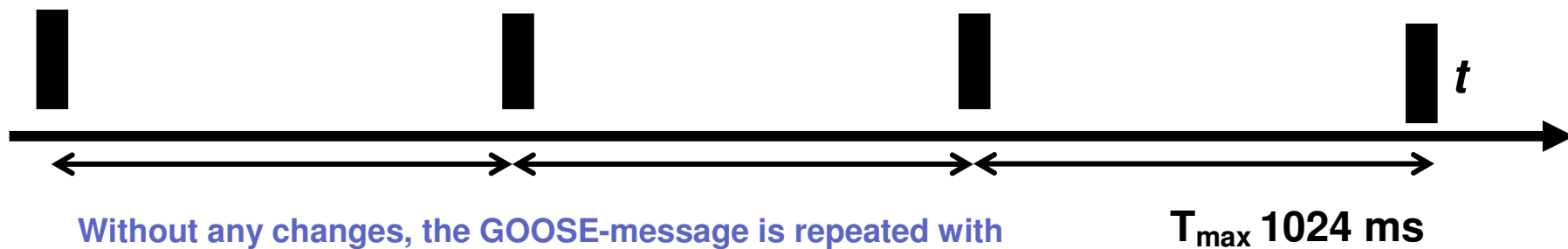
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The mechanism GOOSE messages

Change of information = event

T_{max} **1024 ms** T_{min} **2 ms** T_{max} **1024 ms**
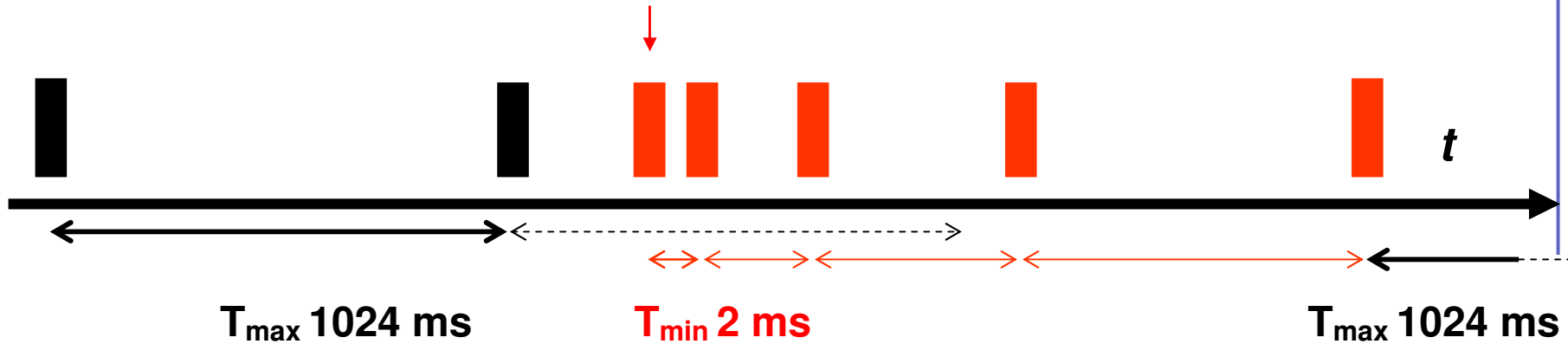
In case of a information- change, the GOOSE-message will be repeated within T_{min}.
The repetition frequency is lowered until T_{max} is reached.

T_{max} **1024 ms**

Without any changes, the GOOSE-message is repeated with T_{max} until the next event / change.

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