Electrical Network Automation and Communication Systems

CHAPTER 9
Communications in power system automation

استاد : سرکار خانم دکتر مروج
تهیه کننده :محمدرضا صفویه

9.1 Overview

- Data communications is the core of a *power system automation system*

- Without communications the whole system will collapse

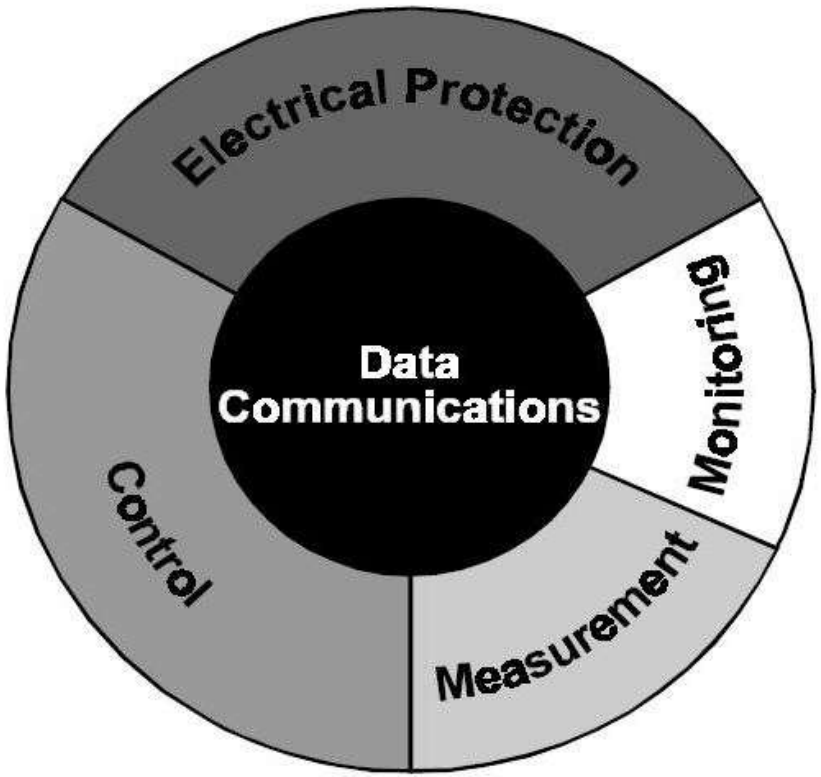


Figure 9.1
Power system automation

9.2 Configuration

- The typical power system automation configuration is illustrated in Figure 9.2.

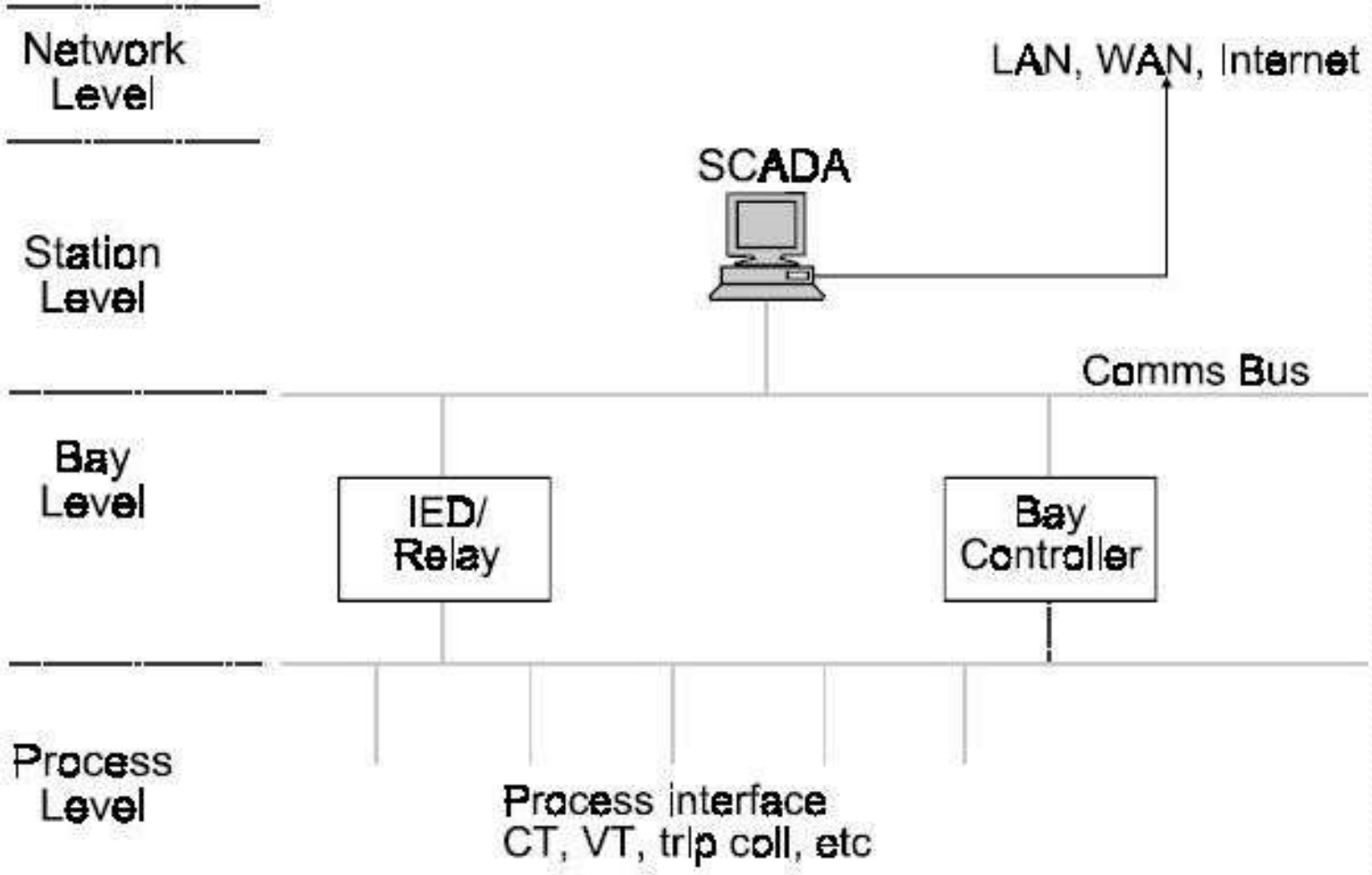


Figure 9.2
Typical power system automation structure

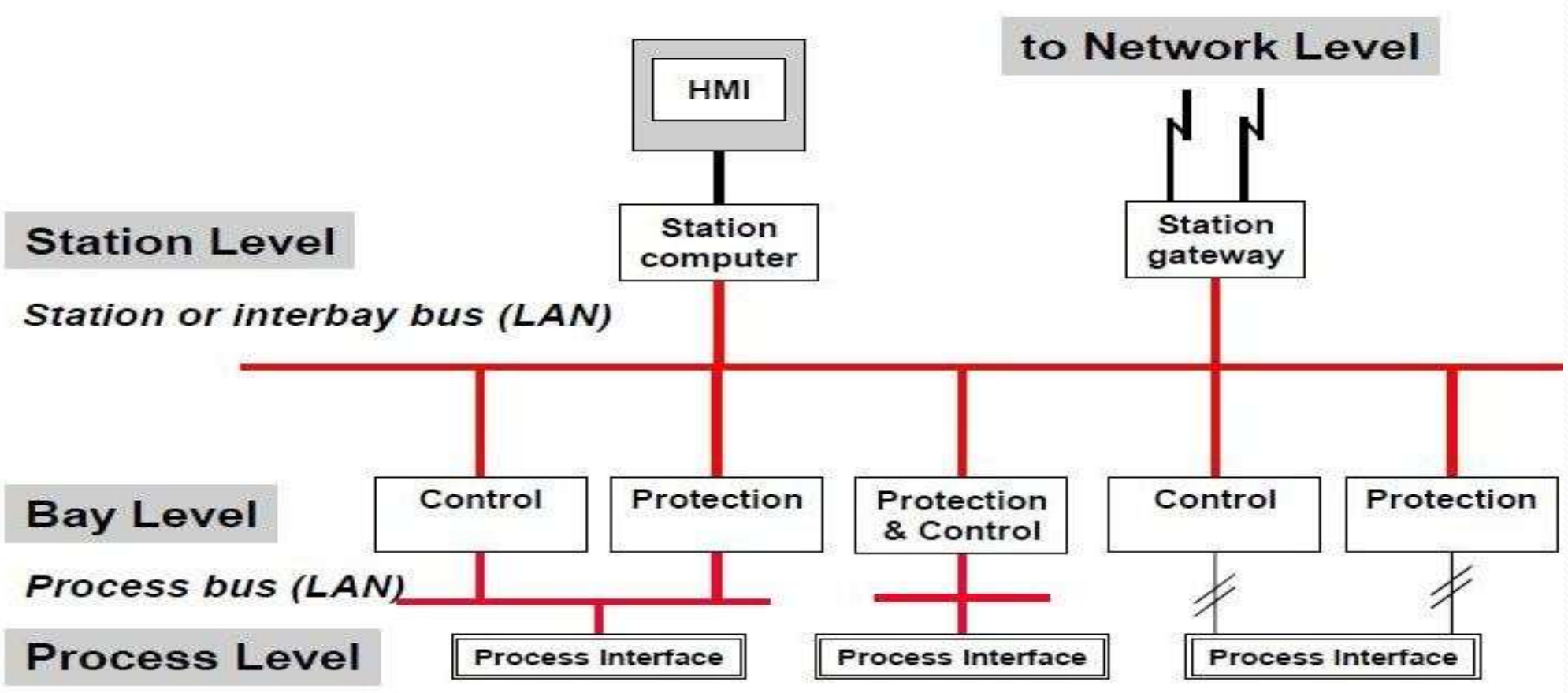
- The process level consists of the equipment providing information to the bay level
- The bay level consists of four main application processes

  1-protection

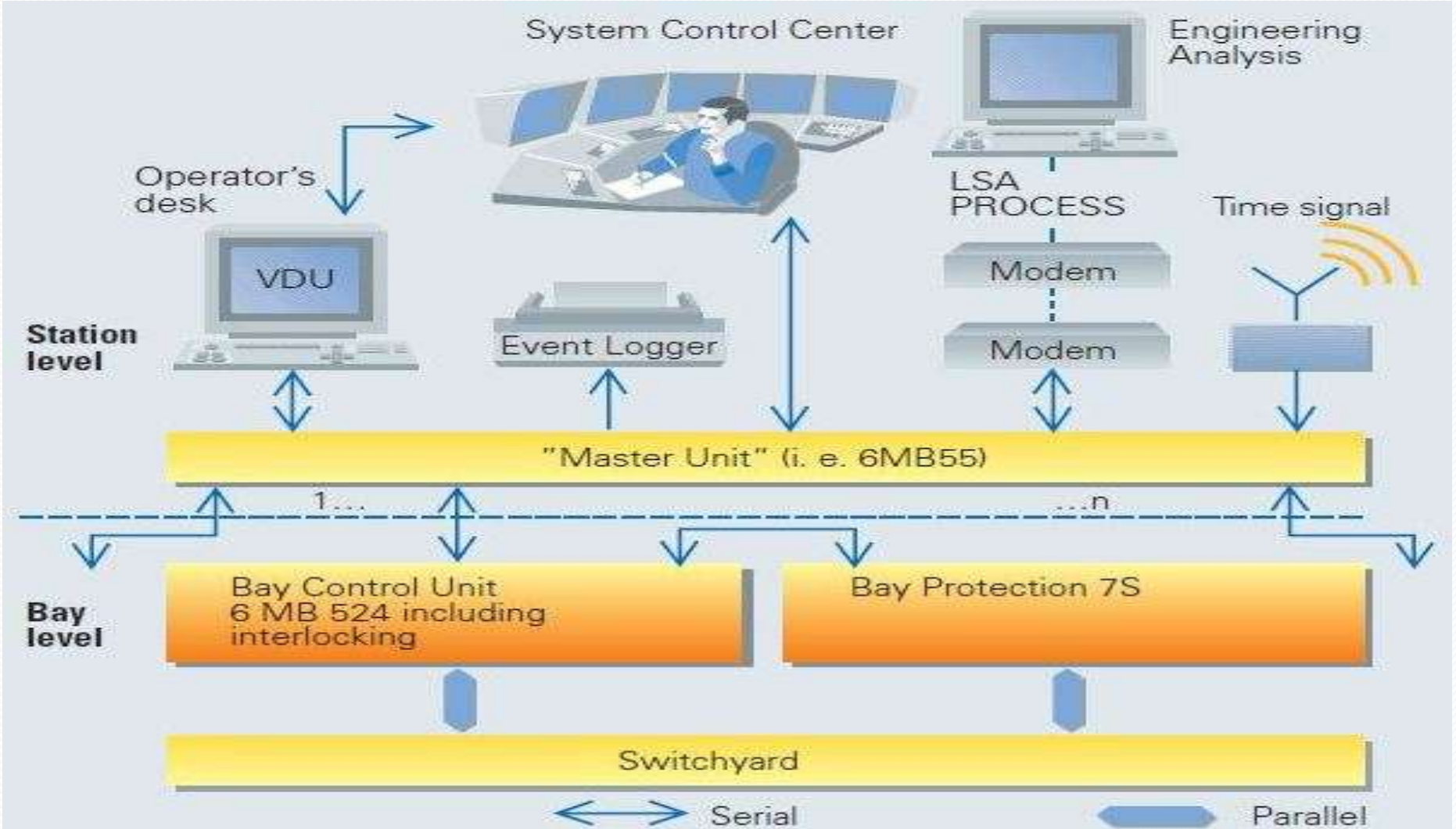
  2-control

  3- measurement/metering

  4-monitoring



- The station level consists of the station SCADA (optional) and possibly a gateway or communications processor.
- The network level may consist of a central SCADA, to which each substation is connected, and/or a LAN, MAN, WAN or the Internet.



9.3 Communication requirements

Performance	Low	Medium	High
Speed/Data throughput	<10 kbps	>10 kbps < 1 Mbps	>1 Mbps
Response time	>1 s	<1 s >10 ms	< 0 ms
Time Synchronization	1 s	1 ms ± 0.1 ms	1 µs ± 0.5 µs
Avalanche Handling	No data through-put required during avalanche	Some data through-put required	All data through-put required
Data Integrity	Some errors allowed	Limited errors allowed	No errors allowed
Link Availability	All data can wait until link available	Some data can wait for a limited time	No data can wait
Data Priority	Can be sent after all other data	To be sent after high priority data; can wait for request	To be sent immediately; cannot wait for request

Table 9.1
Communication requirements

9.3.1 Protection

- Electrical protection has always functioned independently on the bay level.
- Protection needs to be fast, reliable and secure.

-electromechanical relays : one relay dedicated for one function.

-Digital relays and multi-function relays :

more than one protection function in one device.

-IEDs: protection functions together with control functions, measurement, monitoring and communications.

Digital relays and multi-function relays

- more than one protection function in one device.

IED :

- protection functions together with control functions, measurement, monitoring and communications.

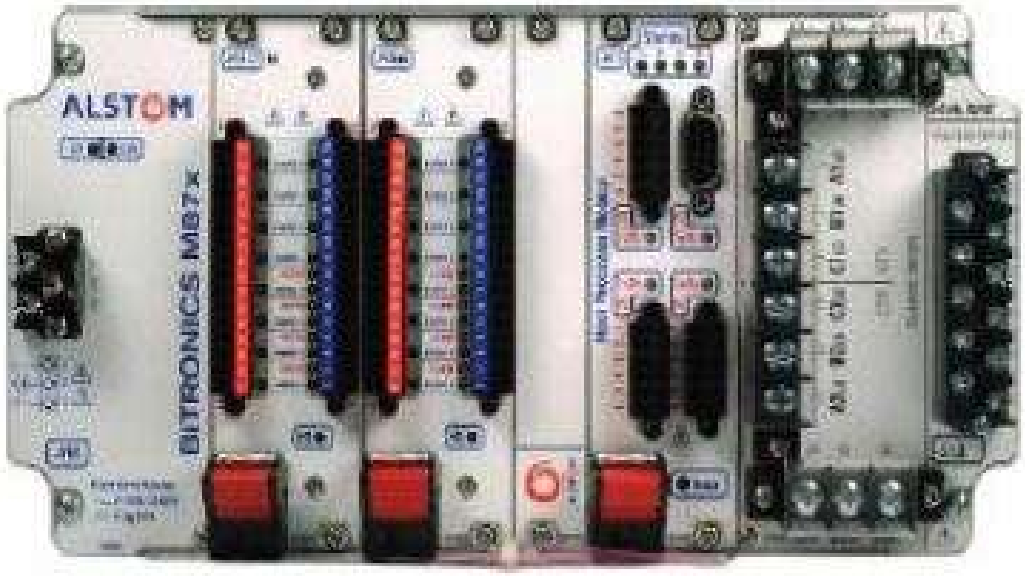


Figure 9. Alstom BiTRONICS M872 measuring and recording IED

Figure 8. MiCOM Alstom Px40 protection IED

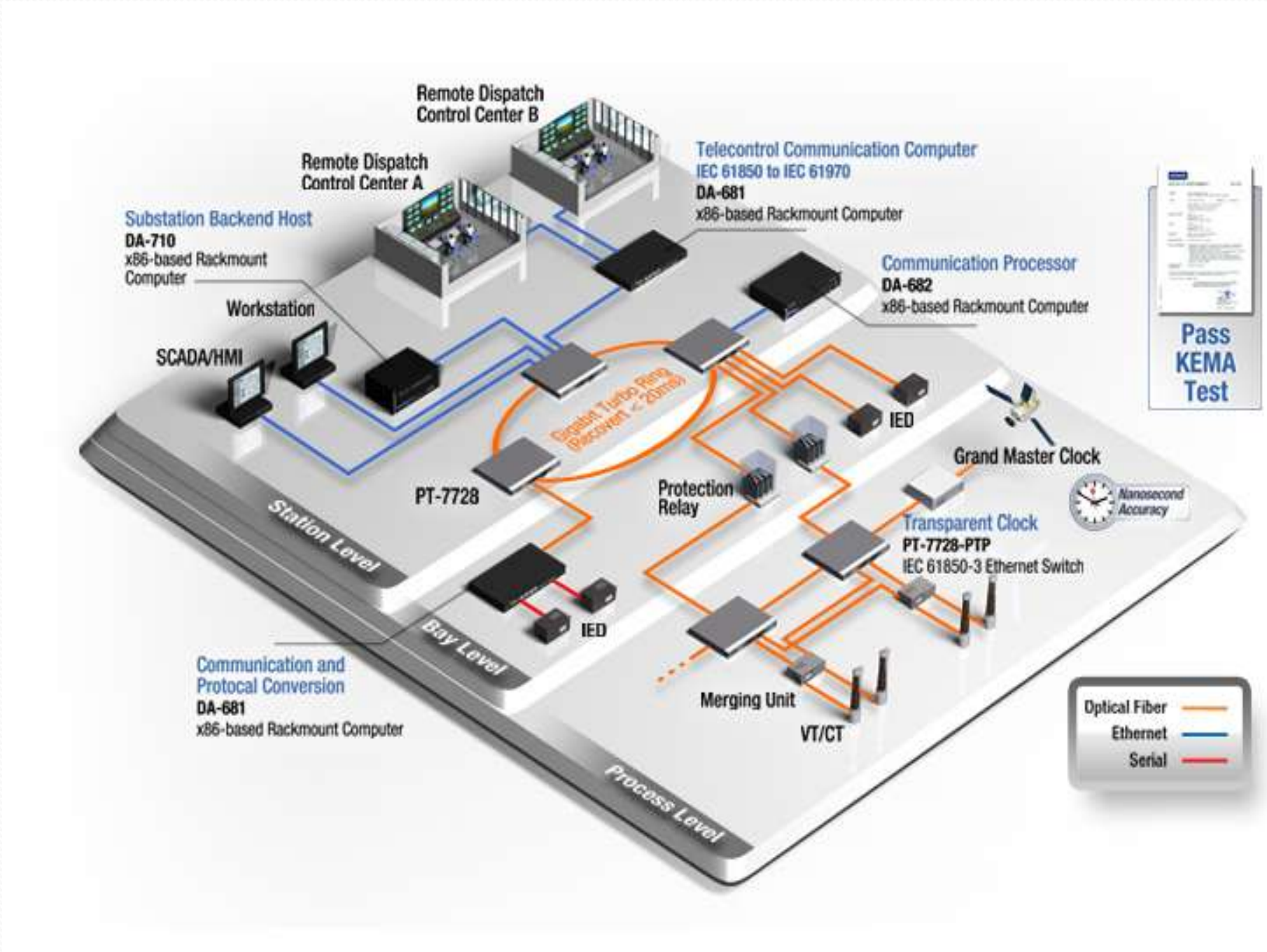
A. Lower Level (Protection)

- The field information to the protection application is provided by the instrument transformers and other electrical transducers.

Performance	Level required
Speed/data throughput	High
Response time	High
Time synchronization	High
Avalanche handling	High
Data integrity	High
Link availability	High
Data priority	High

- Very high response times are required for protection.
- Very high time synchronization is required for distance protection, synchronizing check, etc.

digital communication



Comparison between a digital communication and the conventional hardwired method bus :

-Advantages

- Huge reduction in wiring.
- Eliminating the risk of faulty wiring and/or loose connections.
- Reducing the risk of human error.
- Eliminating the risk that high electrical transients can damage equipment.
- Intelligent field information .

Comparison between a digital communication and the conventional hardwired method bus :

-Disadvantages

- More complex to configure and maintain
- Higher risk of the reliability of the protection scheme.
- Inherent time delay
- Compatible equipment required
- Higher initial cost

B. Higher level (Protection)

- This is the communication level from the protection to the station or central SCADA.

Performance	Level required
Speed/Data throughput	Low
Response time	Low
Time synchronization	High
Avalanche handling	Low
Data integrity	High
Link availability	Low
Data priority	Low

- The information required is stored in the IED and can be retrieved .
- Time synchronization is high : sequence-of-event recordings.
- Data integrity is high : no corruption of critical data, like protection settings, can be allowed.

9.3.2 Control

- Local control is executed on the lower communication level. (between the bay level and the process level)

- Remote control is dependent on the higher communications level. (between the bay level and the station/network level)

A. Lower level (Control)

- The information needed from the field for the control application is mainly limited to status of switchgear (open/close type digital inputs)

Performance	Level required
Speed/data throughput	High
Response time	High
Time synchronization	High
Avalanche handling	High
Data integrity	High
Link availability	High
Data priority	High

- All the requirements are high.
- as certain local control commands can have the same priority as a protection-initiated command.

B. Higher Level (Control)

- communication level from the control to the station or central SCADA.
- The local control and remote control applications are interdependent.
- Information sent from the bay level control AP to the SCADA :
  - status information
  - command acknowledgment
  - protection lock-out information
- Data sent from **the SCADA to the control AP** :
  - program configuration
  - specific commands

Performance	Level required
Speed/data throughput	Medium to High 1
Response time	Medium to High 1
Time synchronization	High
Avalanche handling	High
Data integrity	High
Link availability	Medium to High 1
Data priority	High

- **Speed- Response time - Link availability** :
  - Medium : Normal' data
  - High : Critical data

- **Time synchronization:**
  - High- sequence-of-event reports.

- **Avalanche handling- Data integrity- Data priority :**
  - High : All control commands and data to/from the SCADA must receive first priority in all circumstances.

9.3.3 Measurements

- **Electrical measurements :**

  - Voltages
  - currents
  - power
  - power factor
  - Harmonics
  - other analog values from transducers, e.g. transformer and motor temperatures.

A. Lower level (Measurements)

- For information and non-critical alarm.
- Raw input from the field instruments (CTs, VTs, temperature transducers)
- The same instruments may be shared with the protection.
- Data errors will be corrected within seconds.

Performance	Level required
Speed/data throughput	Low
Response time	Low
Time synchronization	Low
Avalanche handling	Low
Data integrity	Low
Link availability	Low
Data priority	Low

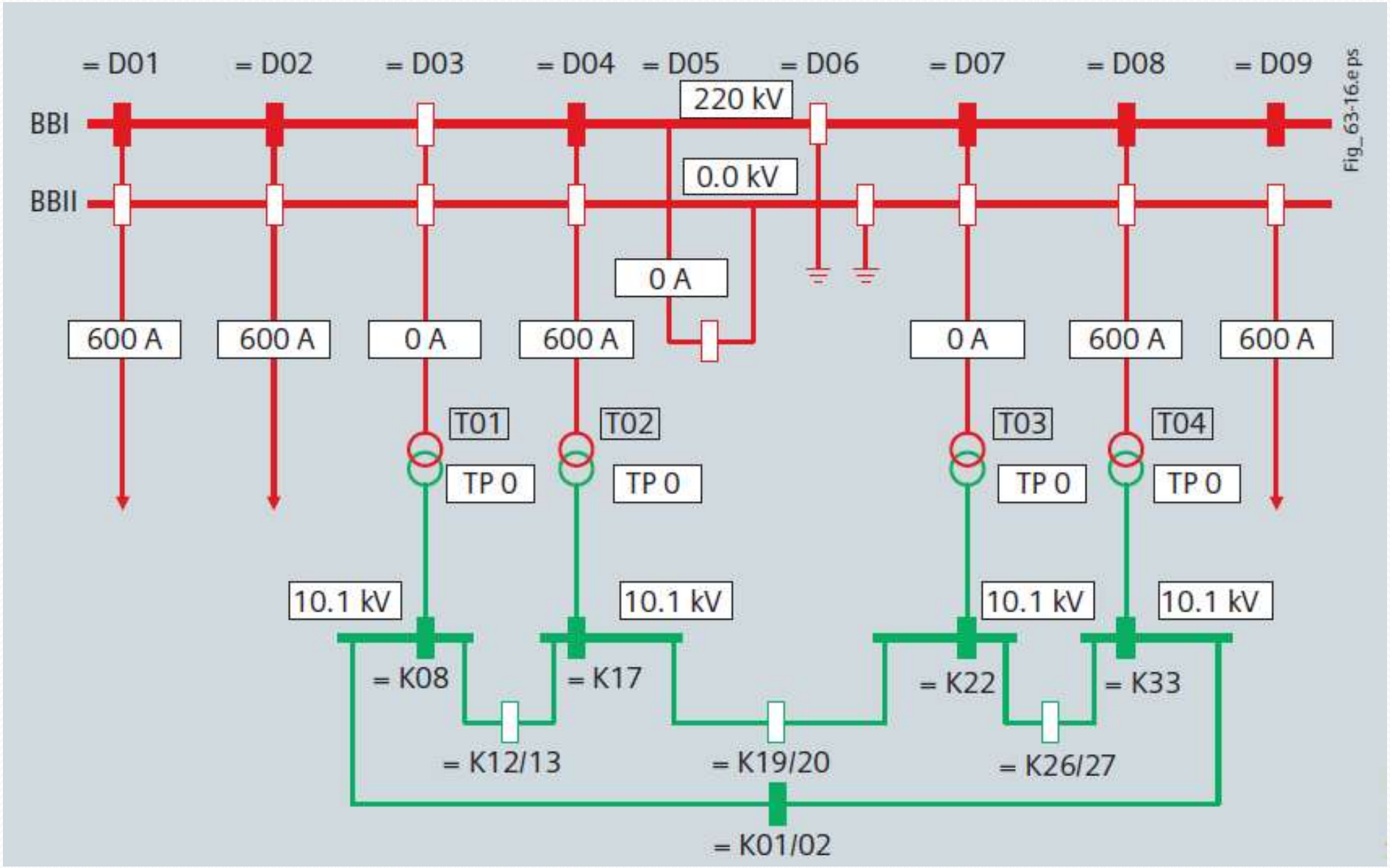
B. Higher level (Measurements)

- Measurement information will be sent through to the SCADA, by the IED.

- **IEDs** have sufficient **data storage** capacity
  - Data can be stored when the communication link to the SCADA is not available.
  - Send when the link becomes available again.

Performance	Level required
Speed/data throughput	Low
Response time	Low
Time synchronization	Low
Avalanche handling	Low
Data integrity	Low
Link availability	Low
Data priority	Low

9.3.4 Monitoring information



9.3.4 Monitoring information

- Information such as switchgear status, trip circuit status, condition monitoring, maintenance information.
- The urgency of this information is low.
- Monitoring information of high priority will be inputs directly to the control or protection applications.

A. Lower level (Monitoring)

- This is the information from the switchgear and other monitored devices to the monitoring application.

- Some of the information is assembled by the IED itself.
  - trip circuit supervision
  - trip operation counters

- Other information is digital inputs to the IED.

Performance	Level required
Speed/data throughput	Low
Response time	Low
Time synchronization	Low
Avalanche handling	Low
Data integrity	Low
Link availability	Low
Data priority	Low

B. Higher level (Monitoring)

- from the monitoring application to the SCADA

Performance	Level required
Speed/data throughput	Low
Response time	Low
Time synchronization	Low
Avalanche handling	Low
Data integrity	Low
Link availability	Low
Data priority	Low

Thank You