Substation Engineering
Substation Automation Basics (Part 2 of 3)

Milav Dabgar

Substation Automation Basics (Part 2 of 3)

- Course: Substation Engineering (DI04009011)
- Unit 5: Substation Automation System (SAS)
- Focus: SAS Architecture & IEDs

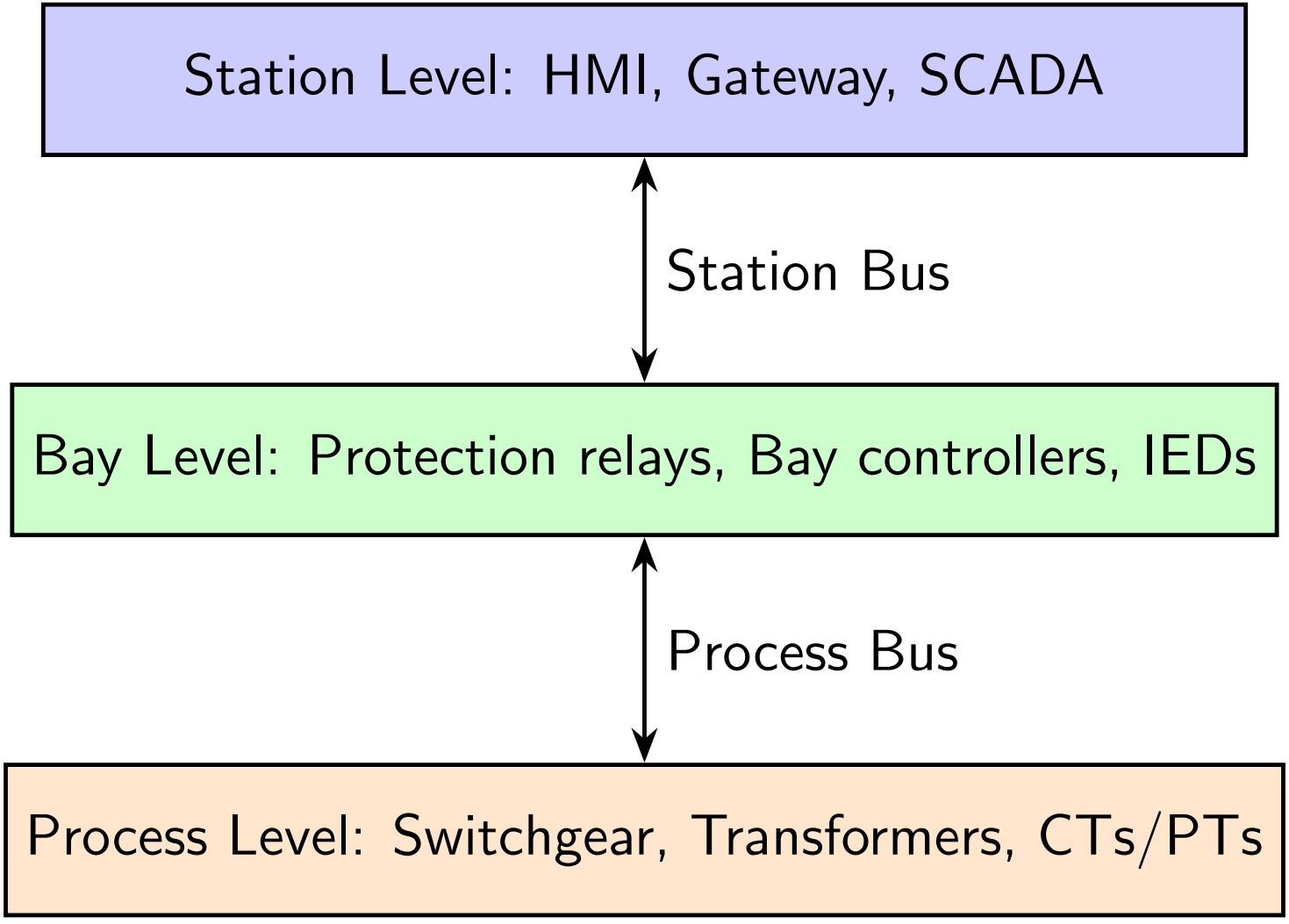
Agenda

- Review of SAS Concepts
- The Three-Level Architecture of SAS
- Station Level Functions
- Bay Level Functions
- Process Level Functions
- Introduction to Intelligent Electronic Devices (IEDs)
- Key Functions of IEDs
- Integration of IEDs in the Substation

Recap: What is a Substation Automation System?

- Integration of protection, control, and monitoring functions.
- Replaces traditional hardwired control panels with digital networks.
- Enhances reliability, reduces outage times, and enables remote management.

Hierarchical Architecture of SAS



The Station Level

- Highest level within the substation.
- Houses the Substation HMI (Human Machine Interface).
- Contains engineering and maintenance workstations.
- Acts as a gateway for communication with remote control centers (SCADA).

Station Level: Key Components

Component	Primary Function	Location
HMI Server	Data visualization and local control	Station Control Room
Gateway	Protocol conversion to communicate with NCC	Station Control Room
Time Server (GPS)	Precise time synchronization for all devices	Station Control Room

The Bay Level

- Intermediate level directly controlling individual substation bays (e.g., line bay, transformer bay).
- Operates independently of the Station Level (distributed intelligence).
- Consists primarily of Intelligent Electronic Devices (IEDs) acting as bay controllers and protection relays.
- Ensures bay-level interlocking.

The Process Level

- The physical primary equipment in the switchyard.
- Includes Circuit Breakers, Disconnectors, Transformers.
- Includes primary sensors like Current Transformers (CTs) and Potential Transformers (PTs).
- In modern SAS, it includes Merging Units (MUs) that digitize analog signals.

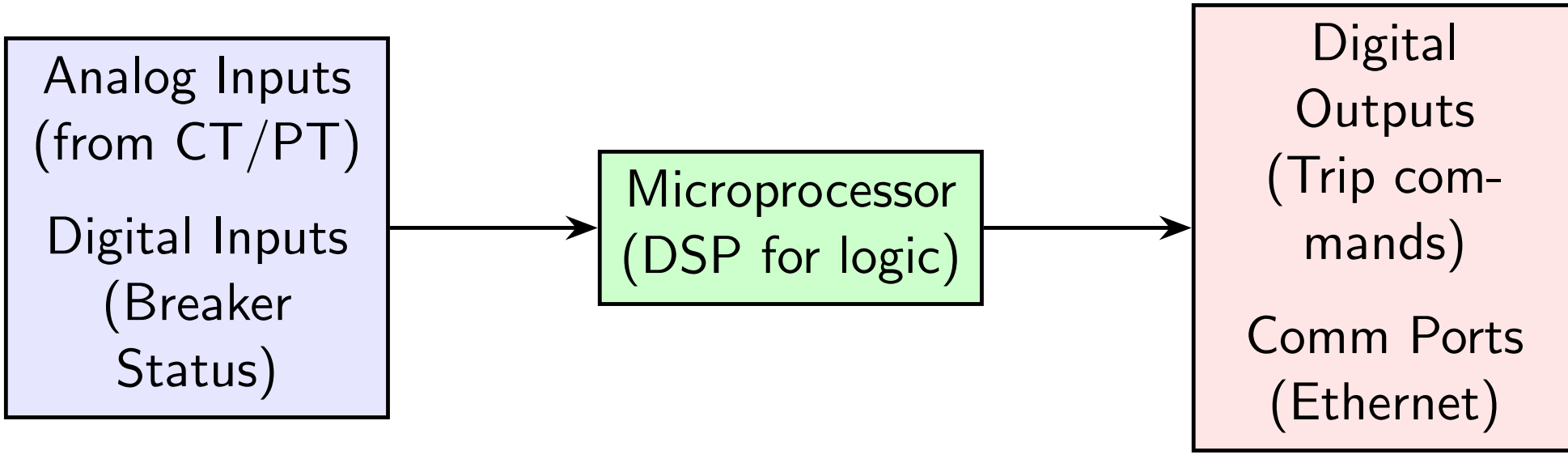
Intelligent Electronic Devices (IEDs)

- Microprocessor-based controllers of power system equipment.
- Receive data from sensors and power equipment.
- Issue control commands (e.g., trip circuit breakers) based on programmed logic.
- Replace discrete protection relays, meters, and controllers.

Core Functions of an IED

Function	Description
Protection	Detects faults and isolates them instantly.
Control	Opens/closes breakers and switches locally or remotely.
Monitoring	Measures voltage, current, power, and equipment health.
Communication	Transmits data to the Station Level and other IEDs.

IED Architecture



Benefits of IED Integration

- Reduced Wiring: Fiber optic cables replace hundreds of copper wires.
- Self-Monitoring: IEDs can detect their own internal failures.
- Event Analysis: High-resolution oscillography helps diagnose fault causes.
- Flexibility: Logic can be updated via software rather than rewiring panels.

Interlocking Logic in IEDs

- Prevents unsafe operations (e.g., opening a disconnector under load).
- Traditional: Hardwired through auxiliary contacts.
- Modern SAS: Implemented via software logic inside the Bay Control Unit (IED).
- Allows complex, fail-safe interlocking schemes.

Summary

- SAS architecture is divided into Station, Bay, and Process levels.
- Station level handles global control and external communication.
- Bay level operates specific equipment via IEDs.
- Process level includes the primary high-voltage equipment.
- IEDs consolidate protection, control, and monitoring into smart digital units.

Next Lecture Preview

- How do these IEDs talk to each other?
- Introduction to Communication Protocols.
- The IEC 61850 Standard.
- SCADA integration in substations.