Communication Systems in Power Systems

Introduction

- Communications is the enabling technology for Power System
- No single communication technology as being best suited for all power system needs
- Requirements must consider type, source, amount, frequency, and delivery requirements of data/voice transmitted

Communication Needs of Power Systems

- Reliability
- Cost effectiveness
- Capacity to handle data rates
- Adequate to meet response requirements
- Ability to reach identified areas of power system
- Ease of operation and maintenance
- Security (of data and of control actions)

Communication Reliability

Reliable communication with respect to:

- Exposure to severe environment
- Electromagnetic Interference (EMI)
- Transient EMI (lightning, faults)
- Outage of transmission lines
- Power outages
- Radio paths obstructed or attenuated (by buildings or foliage)

Cost Effectiveness

- Communication system costs are significant
- High cost of communication system may become an impediment
  - Evaluate both first cost and lifetime operation and maintenance costs
  - Look for best trade-off between total costs and overall performance

Capacity to handle data rates

- Perform data rate audit of present and upcoming schemes
  - Analyze each function
  - Determine bit rate required to perform the function
- Consider worst case scenarios
- Each communications system has a bandwidth limit
- There should be at least enough bandwidth along each path to meet data requirements
- A good margin allows for future growth and increased system flexibility

Ability to meet response requirements

- Response requirements (measured in sec.) are distinct from data rate requirements (measured in kb/s or Mb/s), and must be met independently.

- Different functions have vastly different requirements for the delivery of the information; for example:

Function	*Delivery requirements*
Open or close feeder switches	1-2 seconds
Acquire substation status data	2-5 seconds
Acquire feeder measurements	5-10 seconds
Acquire meter data	15 min. – 24 hours and up

Ability to Reach Areas of Power System

- Difficult Terrain
- Communications that rely on the power line may have difficulty
  - During outage of line
  - Extreme weather conditions
- Terminal equipment in outage areas may require backup power for long durations

Ease of Operation and Maintenance

- A communications system is a complex combination of transmitters, receivers, and data links
- Manpower not trained and not familiar with communications equipment
- Use standardized components and communication protocols

Security of data and control actions

- Power System communication Data and Voice have critical importance
- Substations are an element of the country's critical infrastructure
  - Are you sure that you are in complete control?
- Maintaining the security of communications between the control center and field devices is one of the most urgent problems facing today's control environment.
- Data Encryption and Decryption

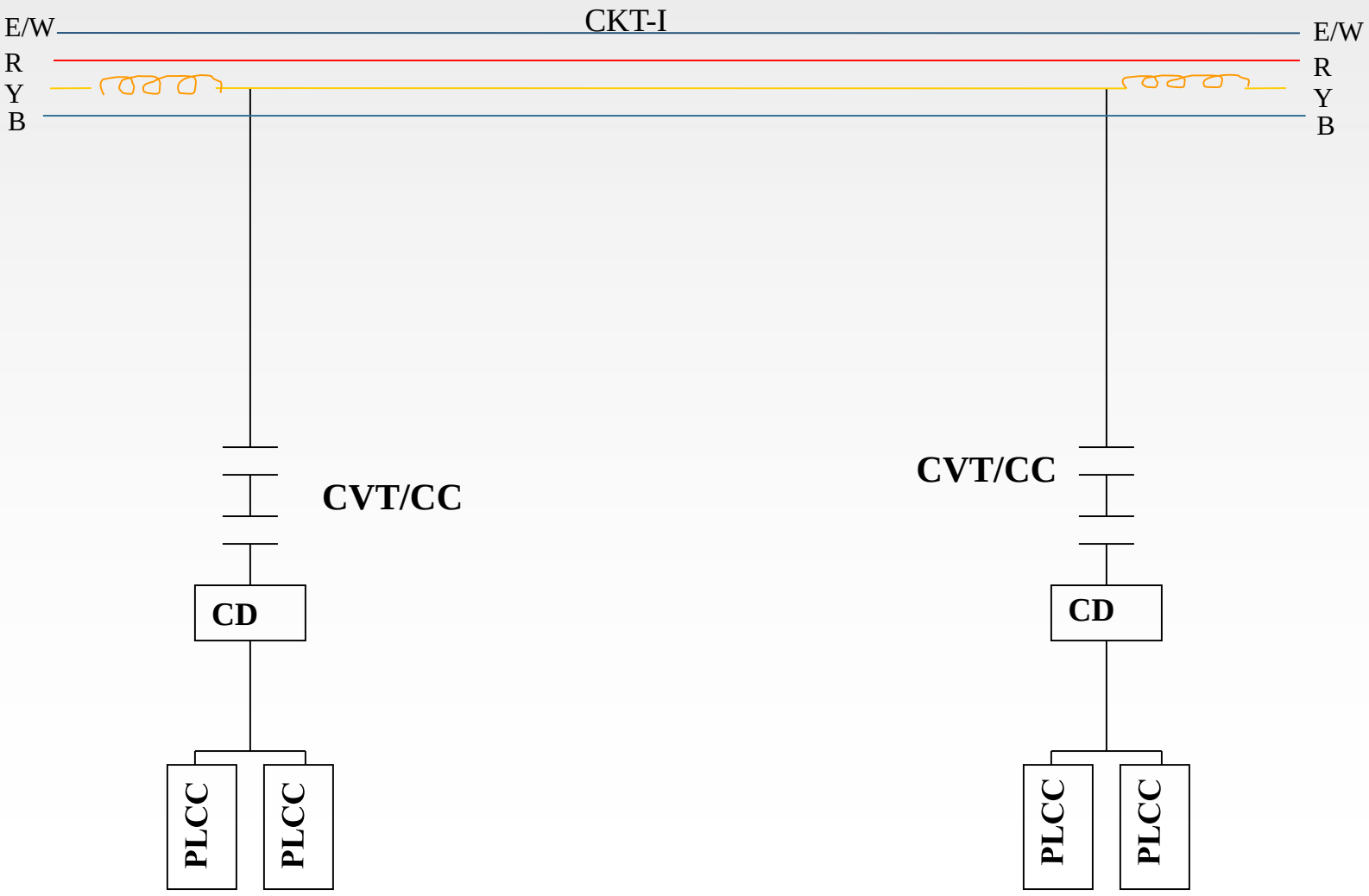
Communication Technologies

Wired	Wireless
Power Line Carrier Communication(PLCC)	Microwave
Dedicated Leased Line	VSAT
Optic Fiber	Mobile Networks

Power Line Carrier Communication(PLCC)

- Power Lines used for point to point communication
- Terminal equipment used to send/receive data/voice
- Works on audio band width 20 Hz to 20 KHz
- Carrier 30 KHz to 500 KHz

Typical PLCC Arrangement for Line to Phase Ground Coupling



Coupling Types in PLCC System

- Line Trap, Coupling Device (CD) & Capacitive Coupling (CC)/Capacitive Voltage Transformer (CVT) known as Coupling Equipment
- CD consists of Surge Arrester, Drain coil, Matching transformer, Earth switch
- Functions of Coupling Equipment
  - Inject carrier signal to EHV line without loss
  - Decouple carrier equipment from EHV line

PLCC Uses

- Voice communication
- Tele-control
- Tele-protection
- SCADA data from RTU

- PLCC Pros
  - Easy availability
  - Cost effective
  - Ease of operation & maintenance

PLCC Cons

- Limited bandwidth(4 KHz)
- Data speeds up to only 1200 Bauds possible
- Prone to Noise and Interference
- Effect of weather conditions-frost, high pollution, etc
- Depends on physical connectivity of power lines
- Needs government approval for carrier freq selection
- Not suitable for today's needs of automation like SAS, remote control etc.

Fiber Optic Communication

- Two types of fibre-

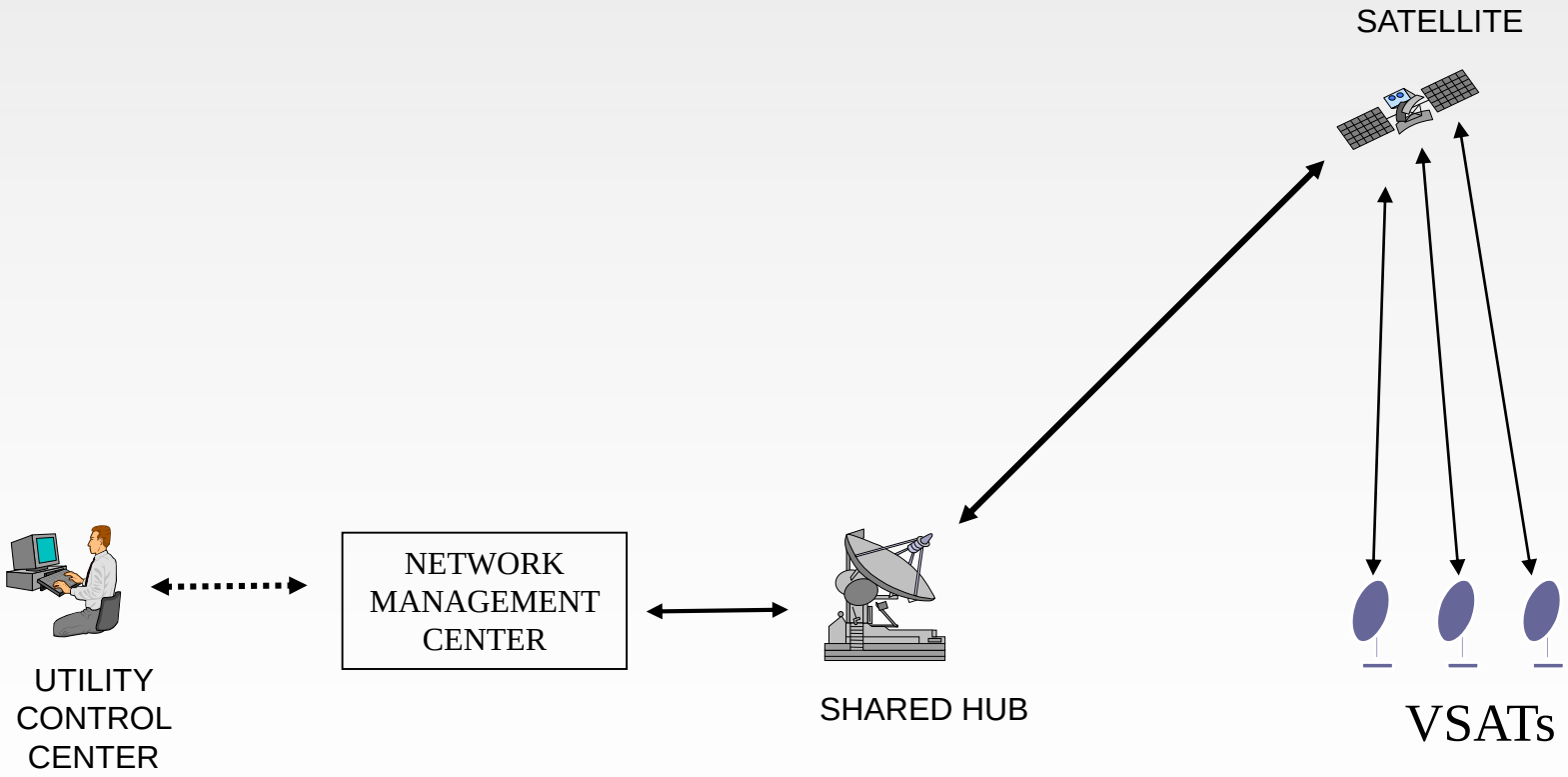
  Multi mode > 50 micron core: Upto 20 Kms

  Single mode < 10 micron core: More than 40 Kms

- Selected on the basis of distance & bandwidth needs

- Wave Division Multiplexing Used

VSAT Communication



Mobile Communication

IoT

- Cellular Networks: 2G—5G
- WLAN
- LR-WPAN
- LPWAN

Tele-Control Protocols

- IEC 60870-5-101 protocol (from RTU to Control Center communication
- IEC 60870-6-502 (ICCP) protocol (between two Control Canters)
- IEC 60870-5-103 protocol (for communication between IEDs in a Substation)
- IEC 60870-5-104 protocol
- MODBUS Protocol (MFTs)
- DNP 3.0 Protocol (Serial)---Master Station
- DNP 3.0 Protocol (TCP/IP)---Master Station
- IEC 61850 protocol (for Substation Automation)