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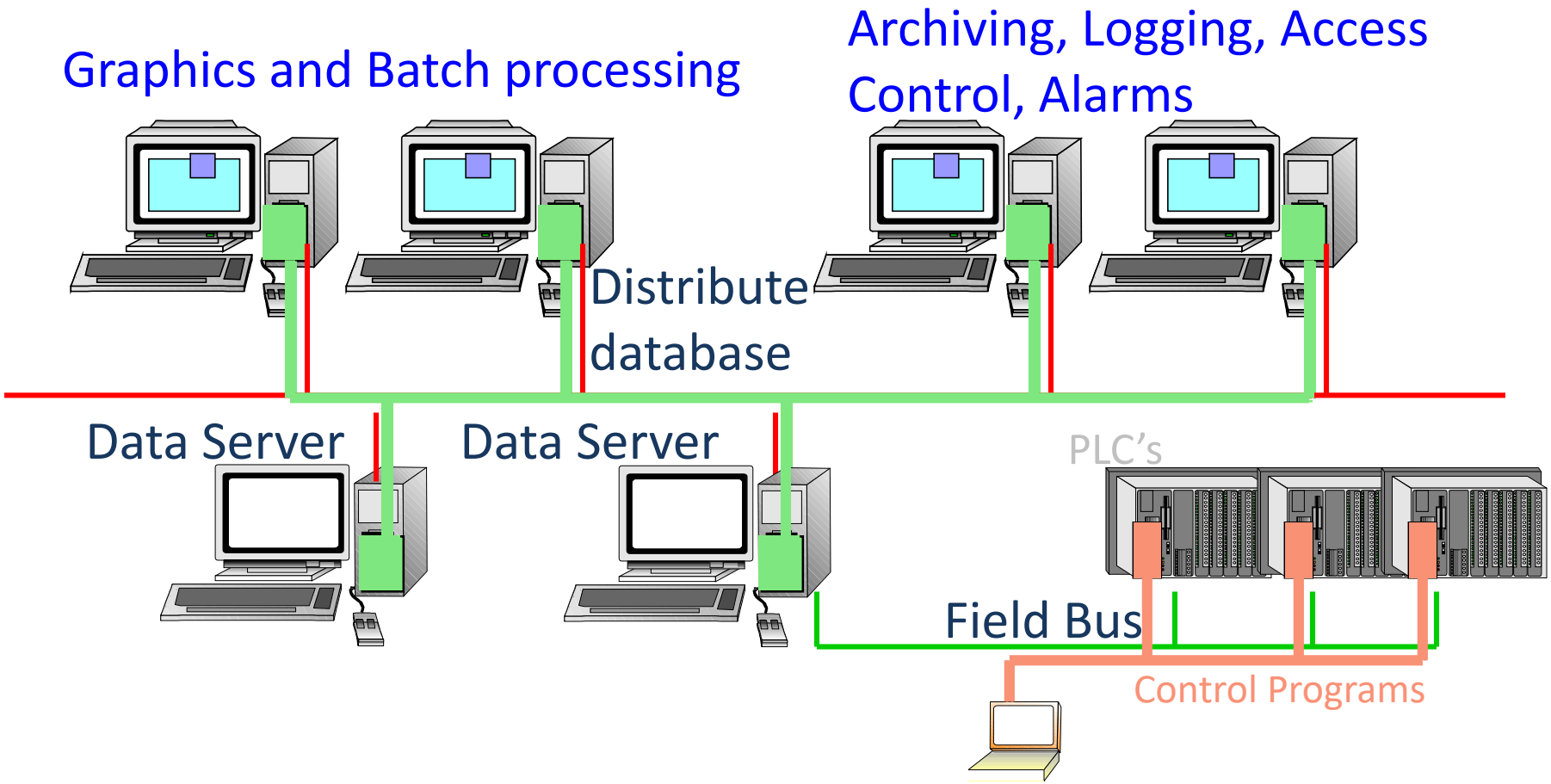
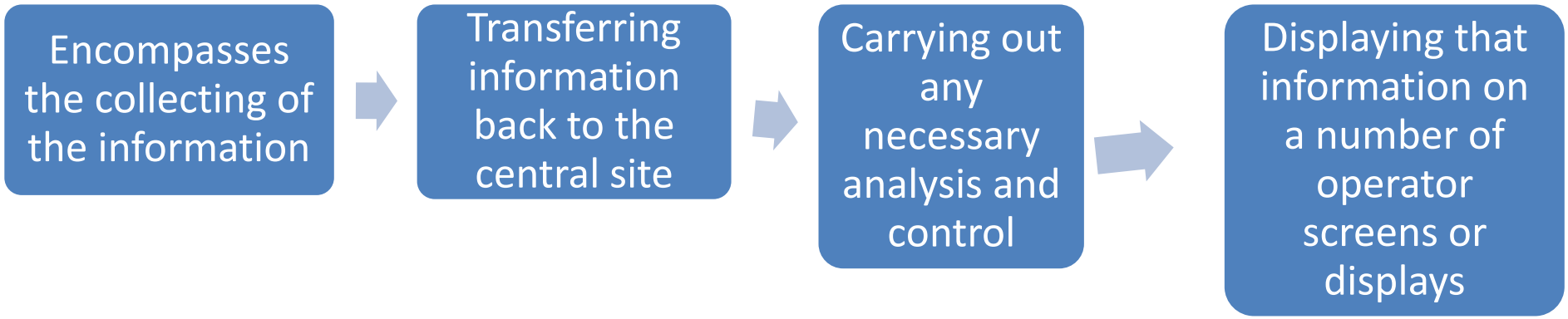
INTRODUCTION

Supervisory Control And Data Acquisition

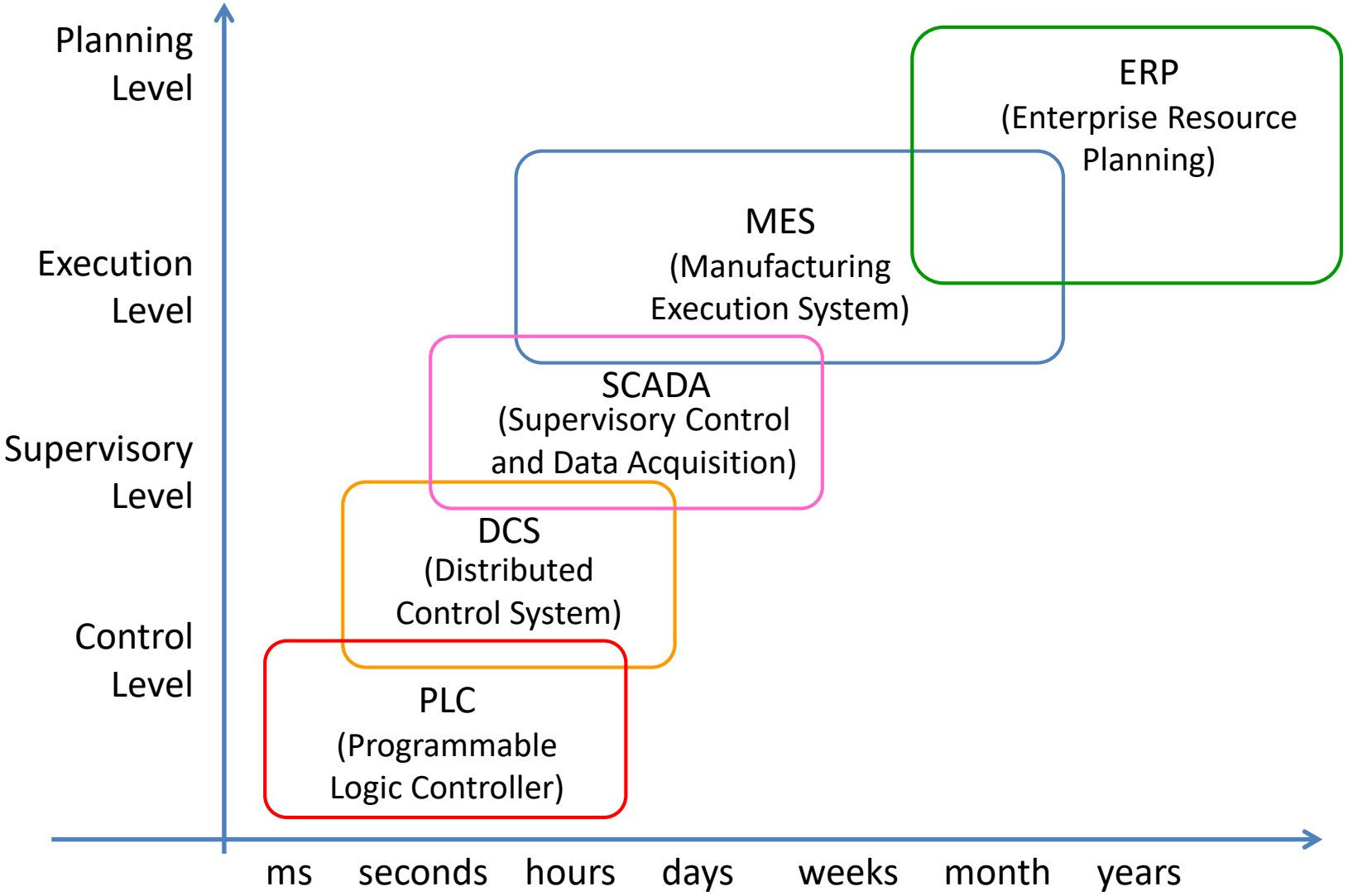


INTRODUCTION

- Telemetry data + data acquisition = SCADA
- SCADA:



RESPONSE TIME AND HIERARCHICAL LEVEL



INTRODUCTION

ADVANTAGES OF SCADA	DISADVANTAGES OF SCADA
• Can record and store a very large amount of data. • Data can be displayed according to the users require. • Thousands of sensors over a wide area can be connected to the system. • The operator can incorporate real data simulations into the system. • Many types of data can be collected from the RTUs. • The data can be from everywhere.	• The system is more complicated than the sensor to panel type. • Different operating skills are required, such as system analysts and programmer. • A lot of wire to handle. • The operator can only see as far as the PLC.

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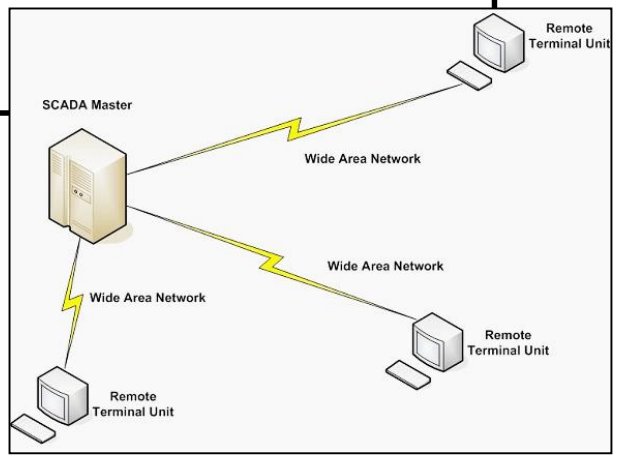
2. SCADA SYSTEMS AND THEIR IMPLEMENTATIONS

3. PROGRAMMING FOR SCADA/ HMI SYSTEMS
4. INSTRUMENTATION AND SMART INSTRUMENTATIONS SYSTEMS
5. DATA ACQUISITION
6. COMMUNICATION PROTOCOLS, EARTHING AND EARTH LOOPS
7. DESIGN OF A DATA ACQUSITION
8. FAULT-FINDING AND PROBLEM ANALYSIS

SCADA SYSTEMS AND THEIR IMPLEMENTATIONS

1st GENERATION: MONOLITHIC

- Done by mainframe system
- Network didn't exist
- Redundant since a back-up mainframe system was connected at the bus level and used in the event of the failure of the mainstream system.



SCADA SYSTEMS AND THEIR IMPLEMENTATIONS

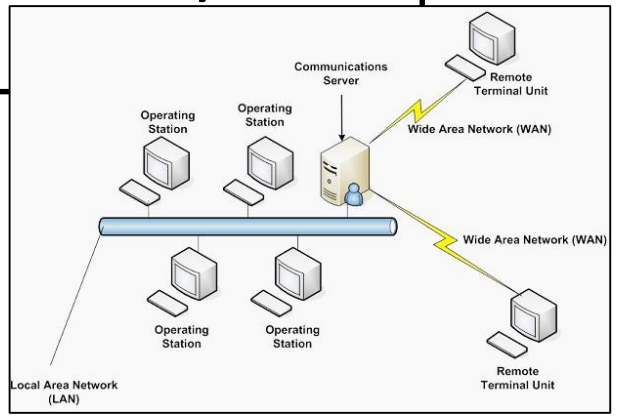
2nd GENERATION: DISTRIBUTED

HOW?

- The processing was distributed across multiple stations (connected via LAN) and shared information in real time.

NETWORK PROTOCOL?

- Mostly proprietary, led to significant security problems

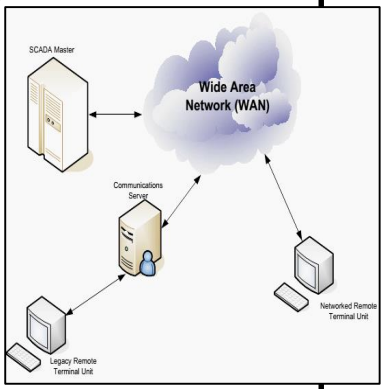


SCADA SYSTEMS AND THEIR IMPLEMENTATIONS

3rd GENERATION: NETWORKED

SYSTEM?

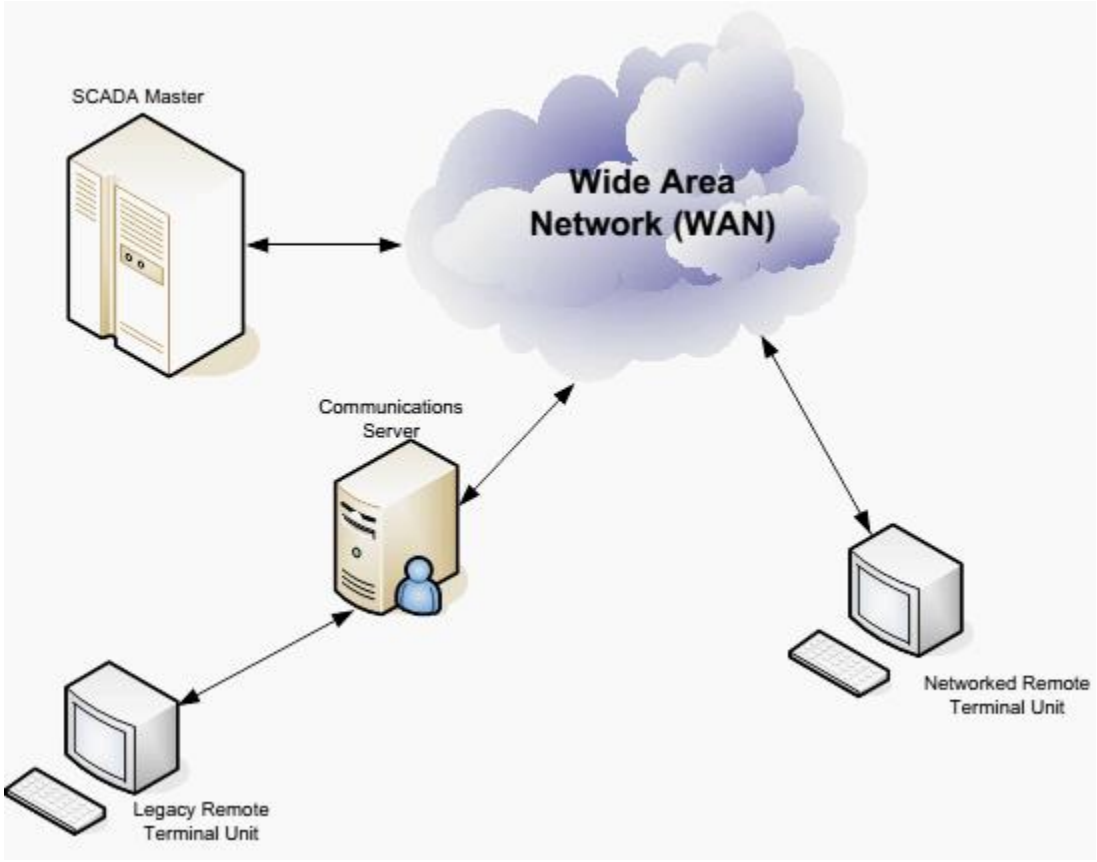
- Use open system architecture rather than a vendor controlled proprietary environment.
- WAN protocols is used for communication between master station & communication equipment.
- Vulnerable to remote cyber attacks



ADVANTAGE?

- Easier to connect to the third party
- Standard security improvements are applicable

PICTURE OF 3rd GENERATION SCADA



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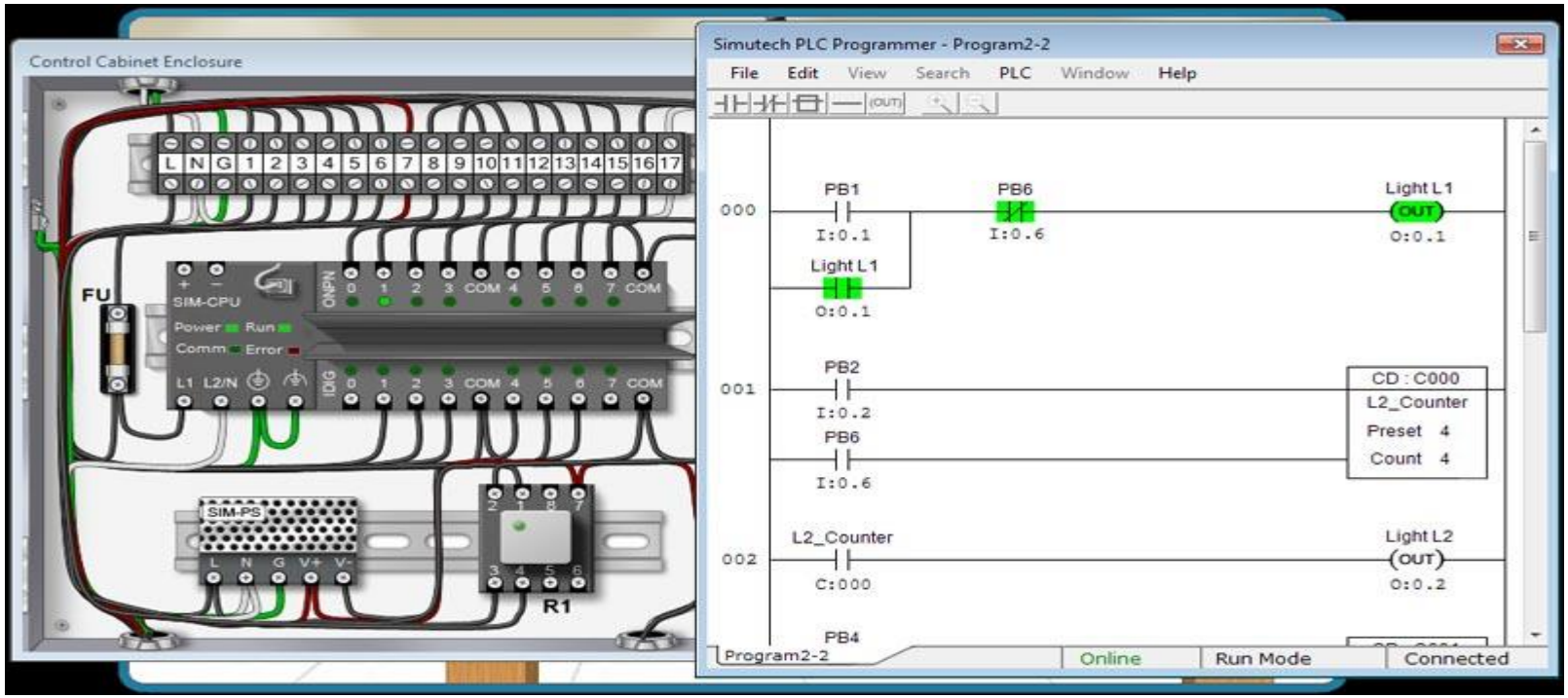
PROGRAMMING FOR SCADA/ HMI SYSTEM

- Two ladder logic: vertical line (supply power) drawn at each side of the diagram with the line of logic drawn in horizontal lines.



PROGRAMMING FOR SCADA/ HMI SYSTEM

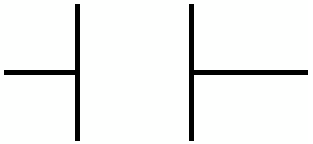
- **Basic rule of ladder logic:**
  - Two vertical lines supplying the power are drawn at each sides of diagram with the lines of logic drawn in horizontal lines.
  - Read the ladder diagram from left to right and top to bottom.
  - Electrical devices are normally indicated in their normal de-energized condition.
  - Contacts related with coils, timers, counters and other instructions have same numbering as their control device.
  - Devices that show a start operation for certain time normally wired in parallel.

PROGRAMMING FOR SCADA/ HMI SYSTEM

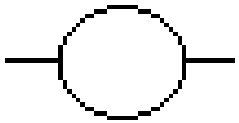
- **Different ladder-logic instruction:**
  - Standard relay logic type
  - Diagnostic
  - Miscellaneous (sub routines etc)
  - Timer and counters
  - Arithmetic
  - Logical
  - Move
  - Comparison
  - File manipulation
  - Sequencer instructions
  - Specialized analog (PID)
  - Communication instructions

REPLACING RELAY BY PLC

First step- We have to translate all of the items we're using into symbols the PLC understands



A contact symbol



A coil symbol

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INSTRUMENATION AND SMART INSTRUMENTATION SYSTEM

- Instrumentation
  - Branch of engineering deals with measurement and control.
- Instrument
  - Device that measures @ manipulates variables such as flow, temperature, level or pressure.
- Control instruments
  - Able to change a field parameter, and provide remote or automated control capabilities. *E.g: Solenoids, valves, circuit breakers, and relays.*

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DATA ACQUISITION

WHAT?

Sampling of the real world to generate data that can be manipulated by computer

ABBREVIATIONS

DAQ @ DAS

EXPLANATION

Include appropriate sensors that convert any measurement parameter to an electrical signal

STEPS

Acquired data: Displayed→ analyzed→ store on computer

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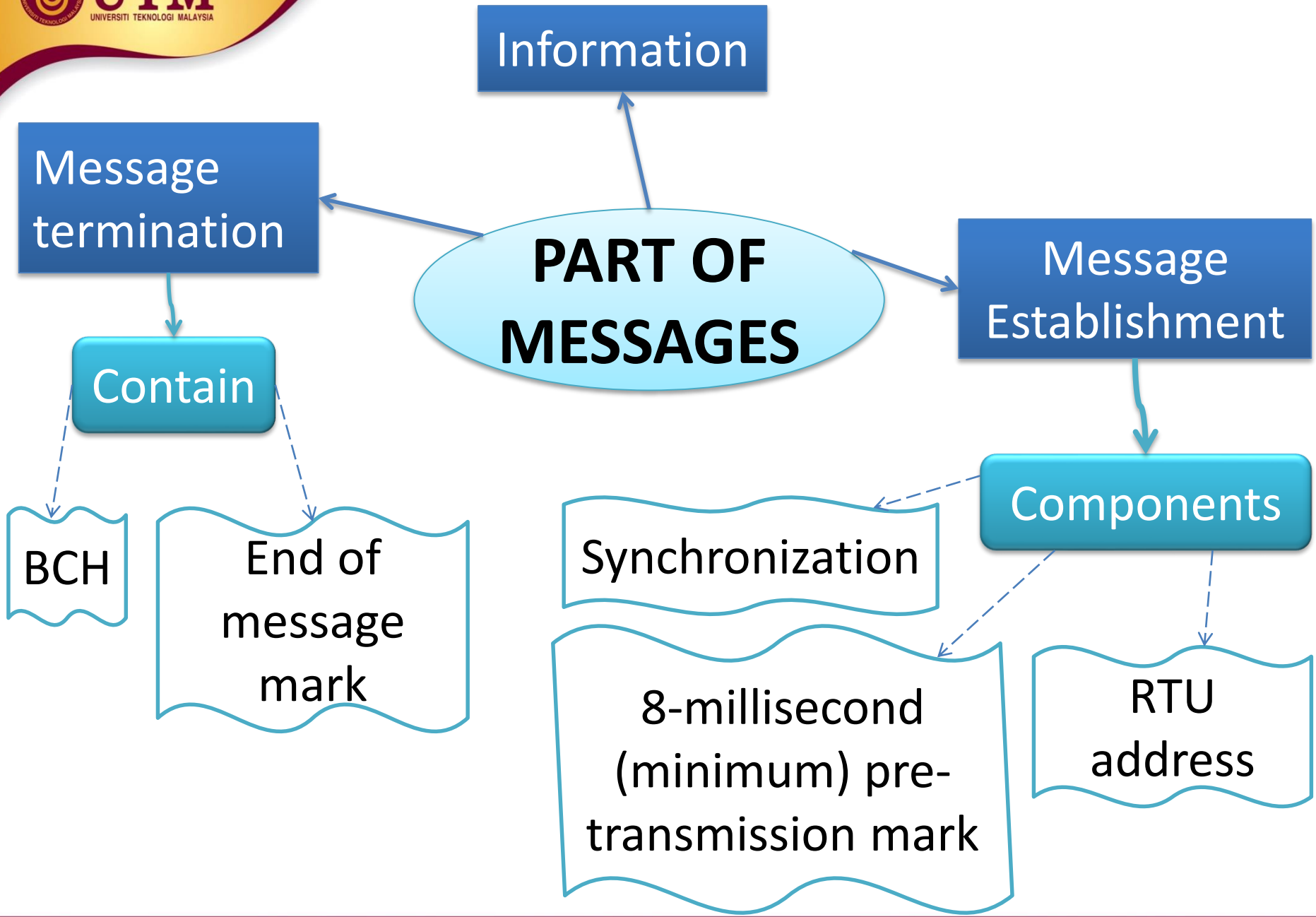
COMMUNICATION PROTOCOLS

- **Protocols:** controls the message format common to all devices on a network
- **Common protocols** used in radio communications and telemetry symmetry→ **HDLC, MPT1317, Modbus protocols**
- Transmission of information between master and RTUs→ using time division mutiplexing techniques (requires use of serial digital messages
- **Efficiency=**Information bits transmitted+Total bits transmitted
- **Security,** ability to detect errors (caused by noise)in the original information transmitted.
- **Flexibility**: allows different amounts and types of information to be transmitted upon command by the master region

TYPES OF COMMUNICATION PROTOCOLS

TYPE OF MESSAGES	EXPLANATION
Message Establishment	Provide **signals**→ synchronize the receiver and transmitter.
Information	Provided **data in a coded form** → allow receiver to decode the information and property utilize it.
Message termination	Provided **message security checks** and a means of denoting the end of the messages. Security check: logical operations on the data, results in predefined number of check bits transmitted with the message.


Information
PART OF MESSAGES
Message termination
Contain
BCH
End of message mark
Message Establishment
Components
Synchronization
8-millisecond (minimum) pre-transmission mark
RTU address

Common reference point for all signal situated at zero potential

EARTHING AND GROUNDING REQUIREMENTS

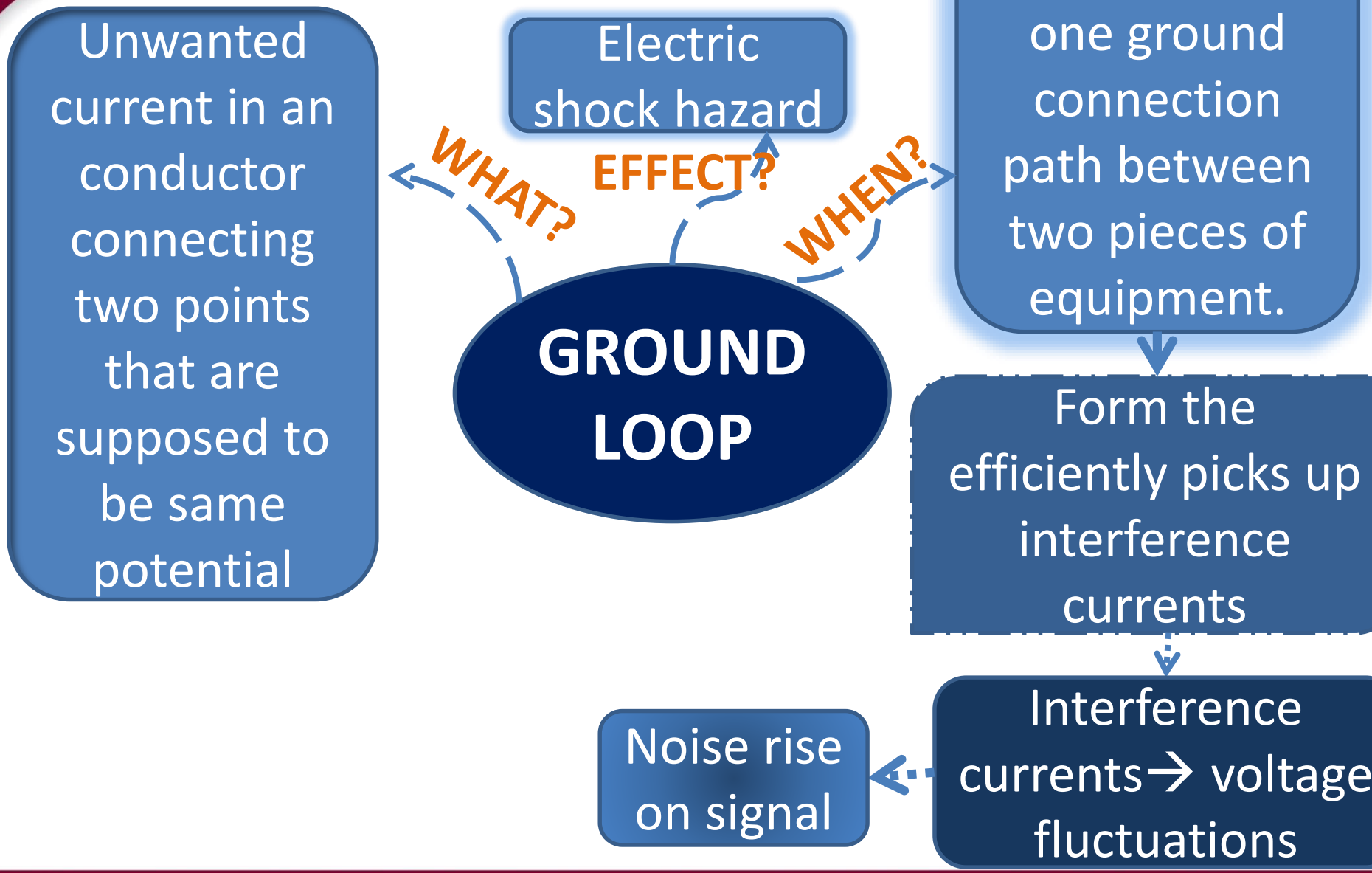
Requirements when setting up effective earthing system

- Minimize the effects of impedance coupling between different circuits
- Ensure earth loops are not created

Types

- Safety or power earth
- Low level signal earth
- High level signal earth
- Building earth

EARTH LOOP


Unwanted current in an conductor connecting two points that are supposed to be same potential
WHAT?
Electric shock hazard
EFFECT?
WHEN?
More than one ground connection path between two pieces of equipment.
GROUND LOOP
Form the efficiently picks up interference currents
Interference currents→ voltage fluctuations
Noise rise on signal

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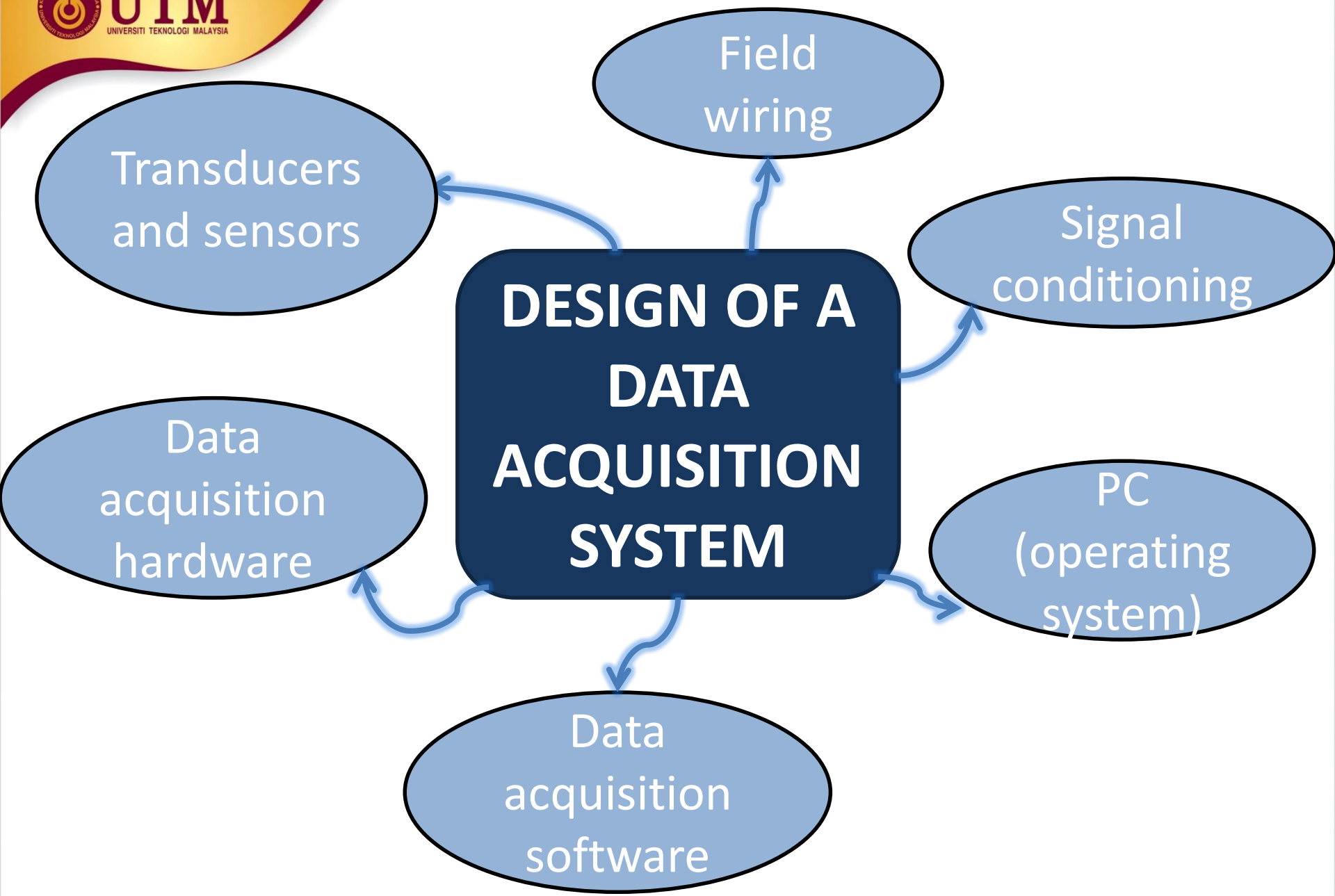
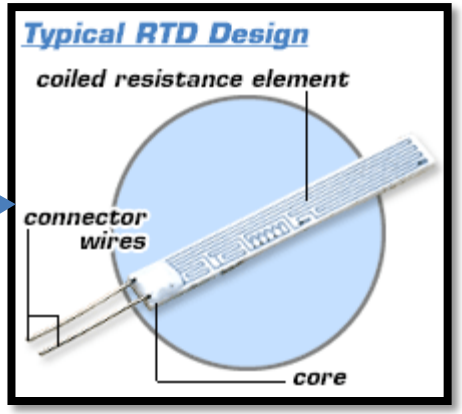

Field wiring
Transducers and sensors
Signal conditioning
DESIGN OF A DATA ACQUISITION SYSTEM
Data acquisition hardware
PC (operating system)
Data acquisition software

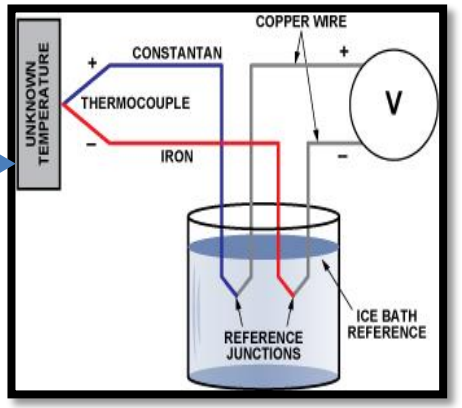
TRANSDUCERS AND SENSORS

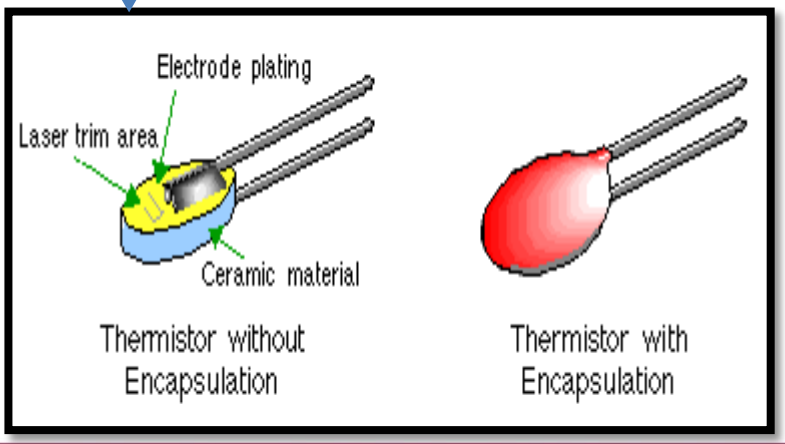
WHAT?

Provide actual interface between the real world and data acquisition system by converting the physical phenomenon into electrical signals

EXAMPLE

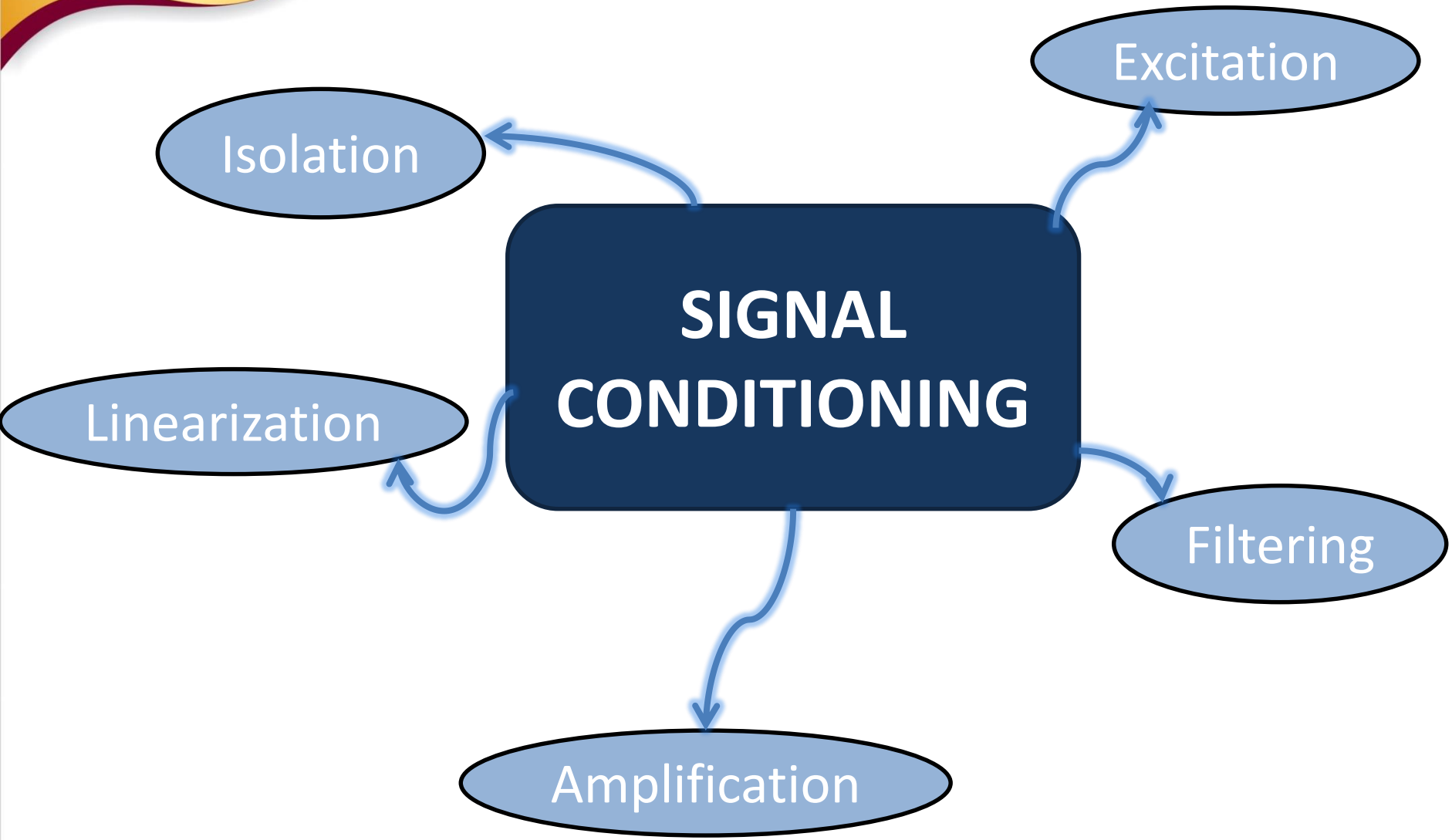






FIELD WIRING AND COMMUNICATIONS CABLING

- Field wiring- physical connection from the transducers and sensors to signal conditioning hardware and/or data acquisition hardware.
- Physical link (RS-232 and RS-485) communication interfaces: known as communications cabling.

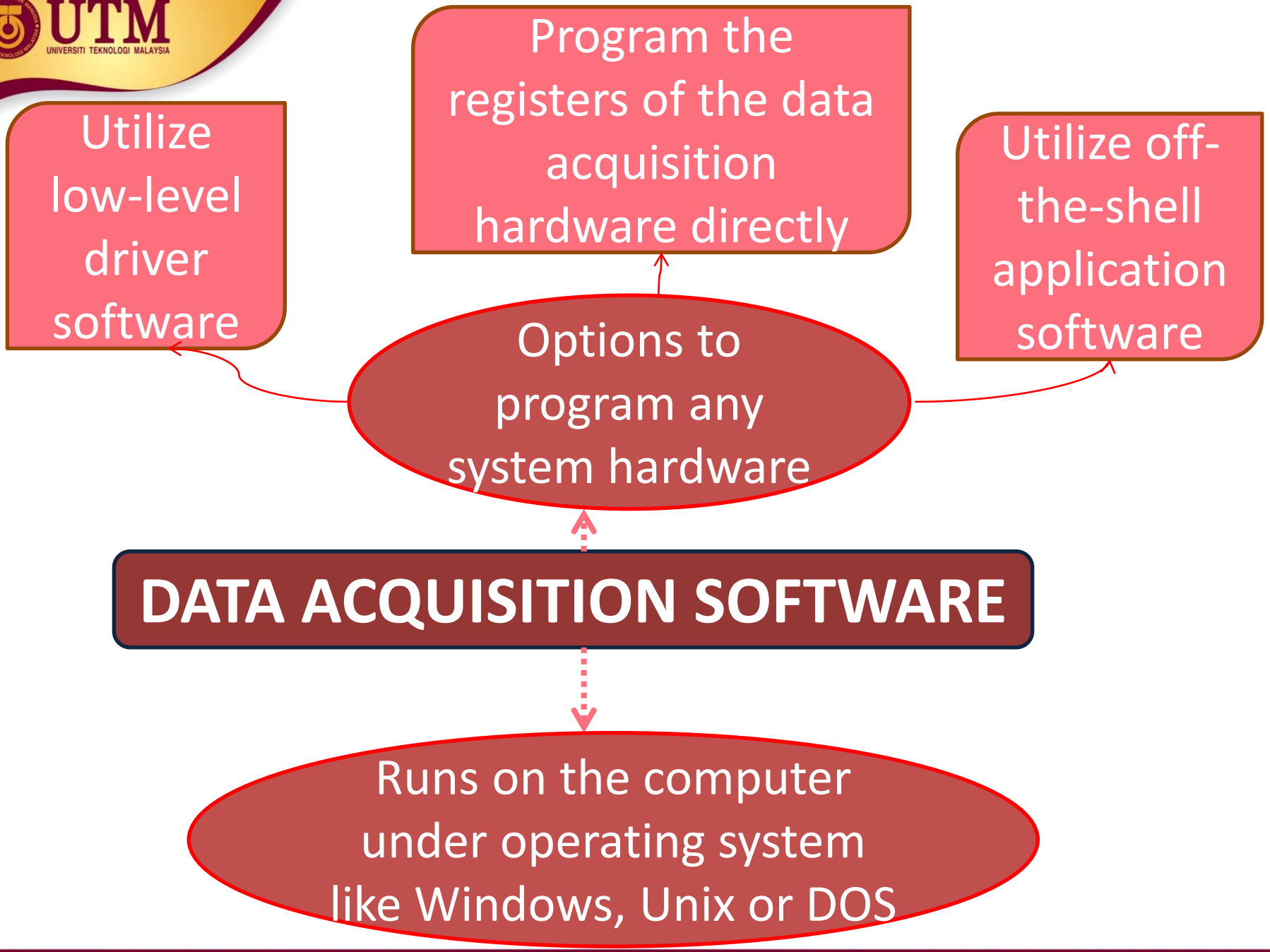

Excitation
Isolation
SIGNAL CONDITIONING
Linearization
Filtering
Amplification

DATA ACQUISITION HARDWARE

Component of a complete data acquisition and control system

FUNCTIONS

- Input, processing and conversion to digital format using DAC's
- Input, of digital signals
- Processing using DAC
- Output of digital signals


Program the registers of the data acquisition hardware directly
Utilize low-level driver software
Utilize off-the-shell application software
Options to program any system hardware
DATA ACQUISITION SOFTWARE
Runs on the computer under operating system like Windows, Unix or DOS

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FAULT FINDING AND PROBLEM ANALYSIS

Troubleshooting the whole system is compulsory during analysis process.
This includes:

- RTU and component models
- Associated component interfaced to RTU
- Radio transceivers
- Antennas and antenna feeder system
- The master station
- The central site computer facilities
- Maintenance aspects is considered at the end of the section.

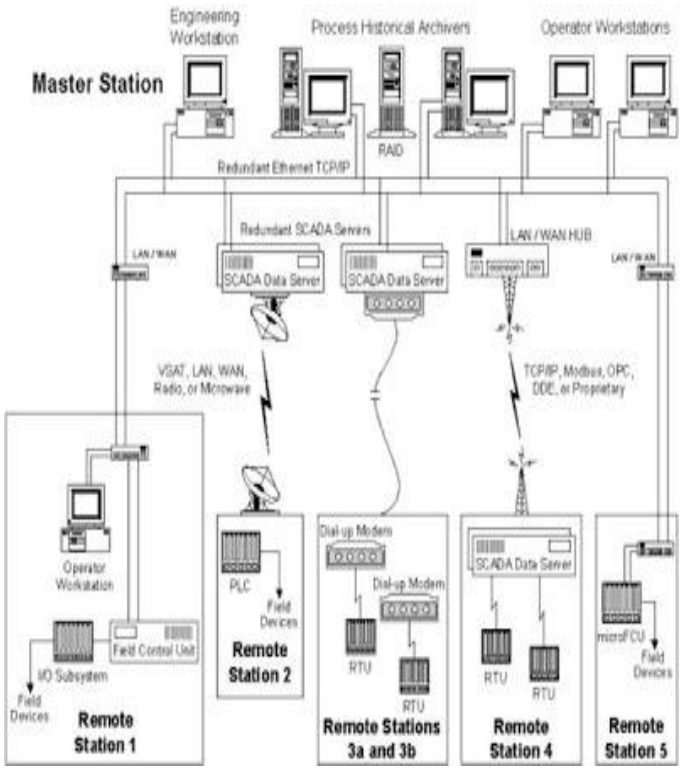

Figure 1: Overall diagram for the whole system.

TROUBLESHOOT THE RTU AND COMPONENT MODULES

- Confirm that power supply is in good condition
- Check central processing (CPU) and earthling connections
- Check the module modem
- Check for possible heating problems in the system cabinet
- Check the fuse for the module

VIDEO ON TROUBLESHOOTING PLC CIRCUITS TRAINING SOFTWARE