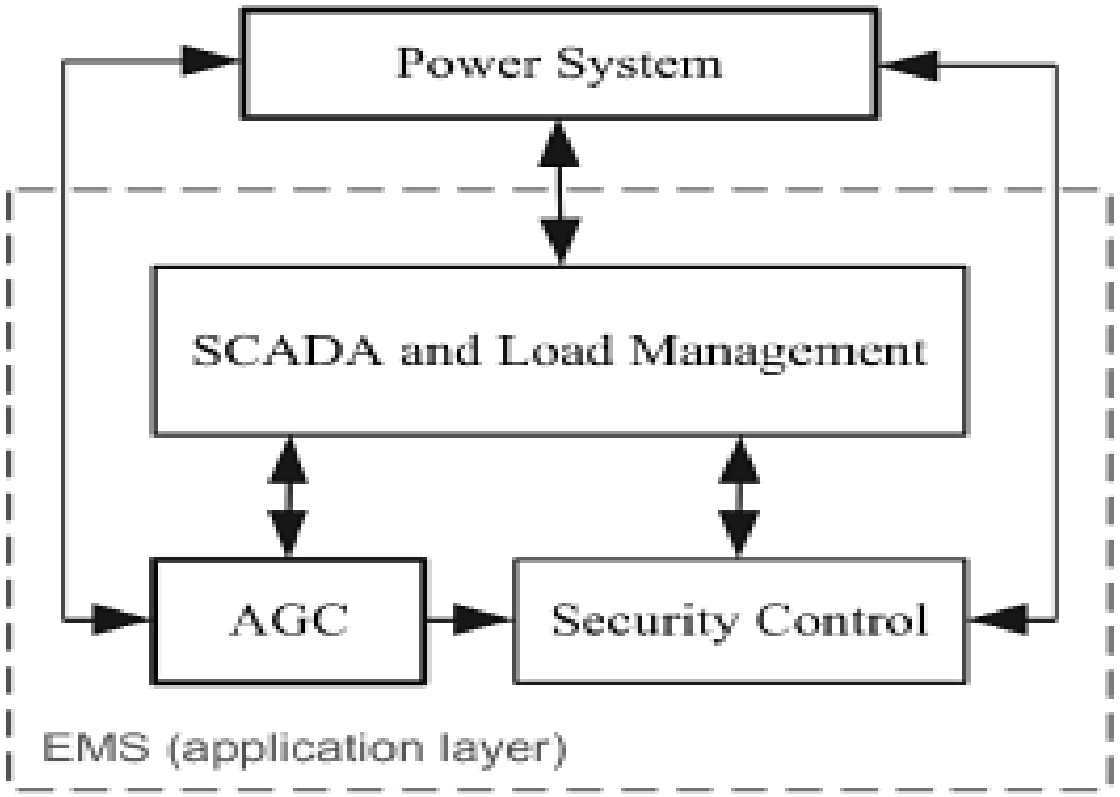
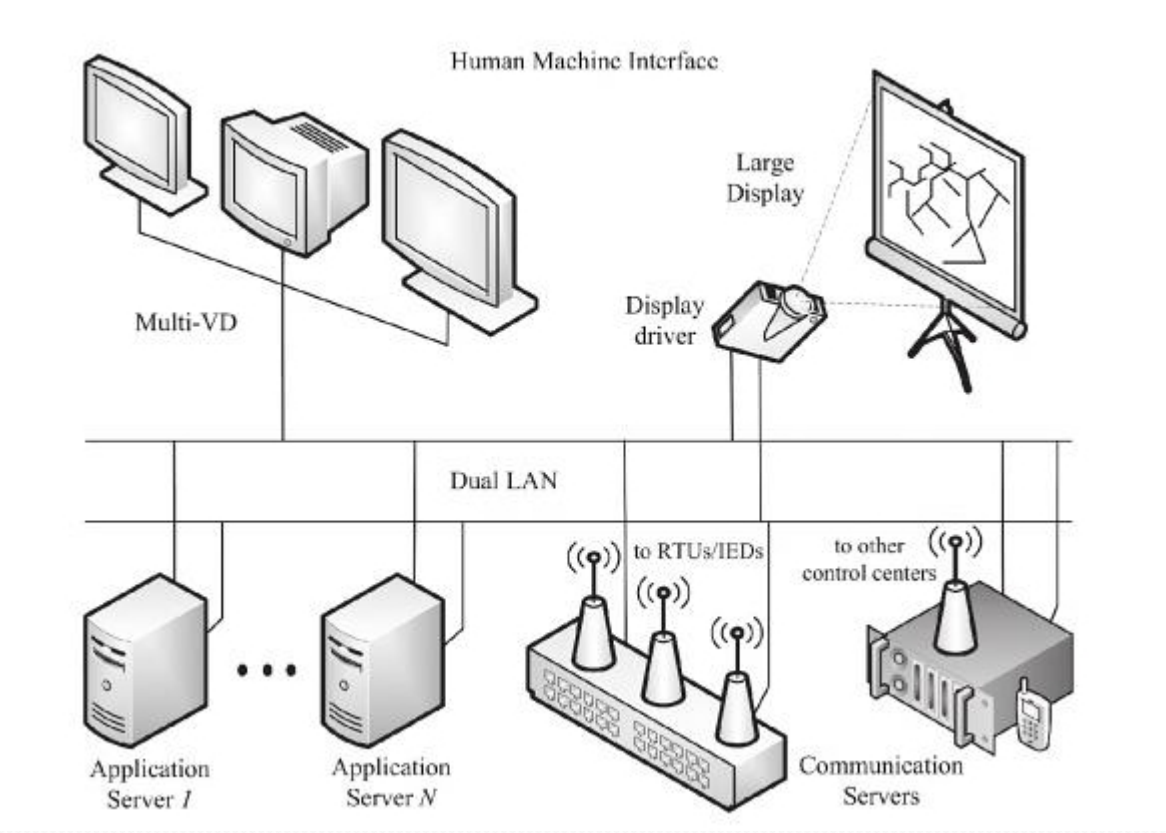
SECTION A

SCADA IN ELECTRIC UTILITIES:

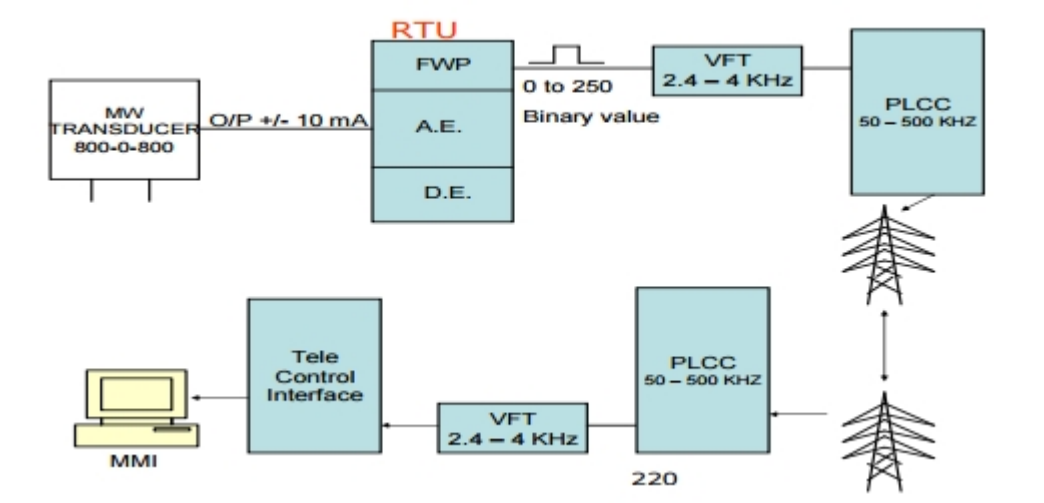
Application layer of modern ems



Typical SCADA structure



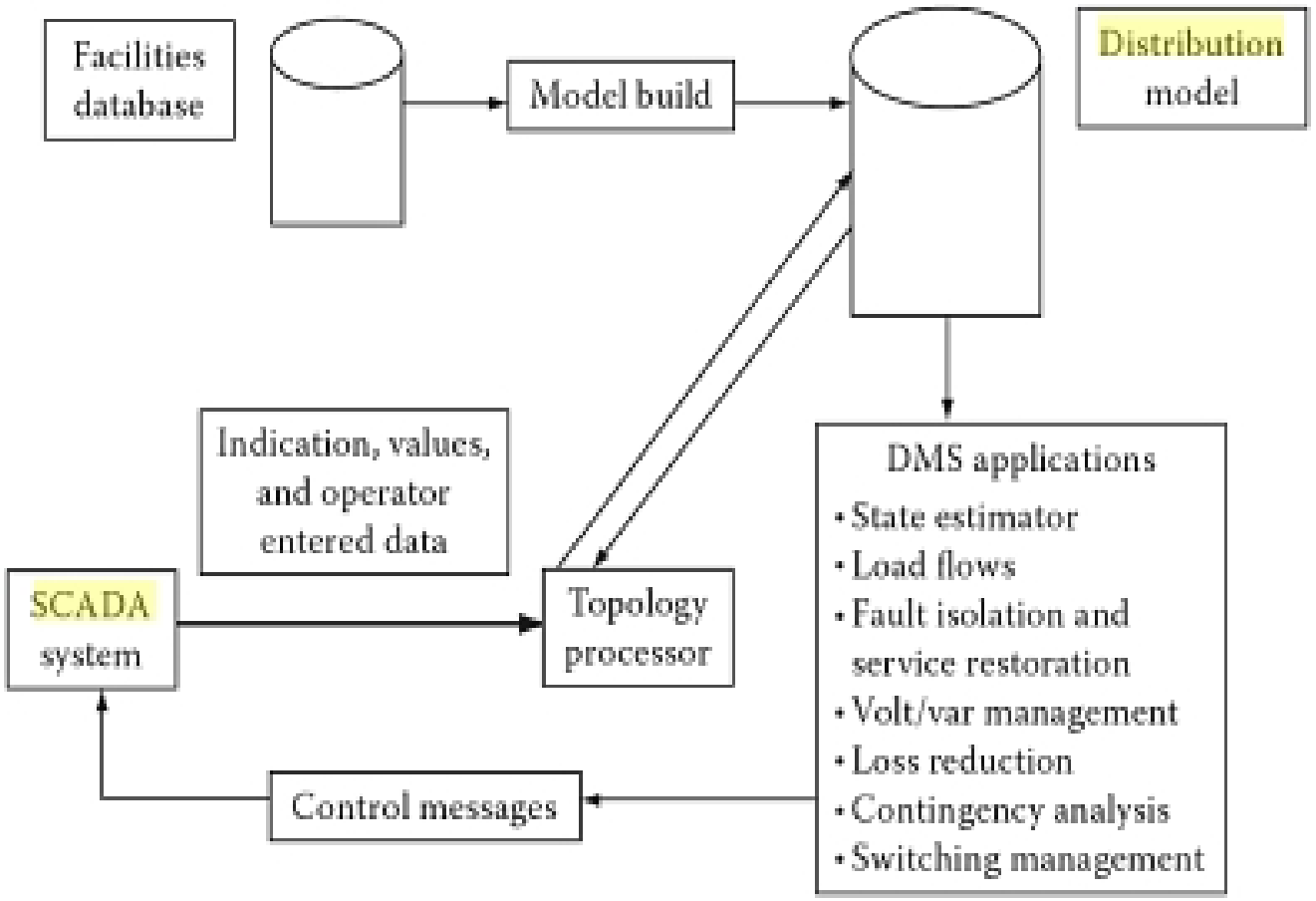
Single line diagram used in SCADA in Generation



SCADA IN Generation

- Power system automation is the act of automatically controlling the power system via automated processes within computers and intelligent I&C devices.
- It consists of three Major processes, namely, data acquisition, power system supervision and power Systems control all working in a coordinated automatic fashion.
- Data acquisition refers to collecting data in the form of measured analog current or voltages values or the Open or closed status of contact points. Power system supervision is carried out by Operators and maintenance engineers through this acquired data either at a remote site Represented by computer displays and graphically wall displays or locally, at the Device site, in the form of front-panel displays and laptop computers.
- Control refers to sending command messages to a device to operate the I&C (A collection of devices that monitor, control and protect the system is referred as instrumentation and control (I&C) system) and power system devices.

DISTRIBUTION SYSTEM WITH SCADA INTERFACE



SCADA IN POWER DISTRIBUTION

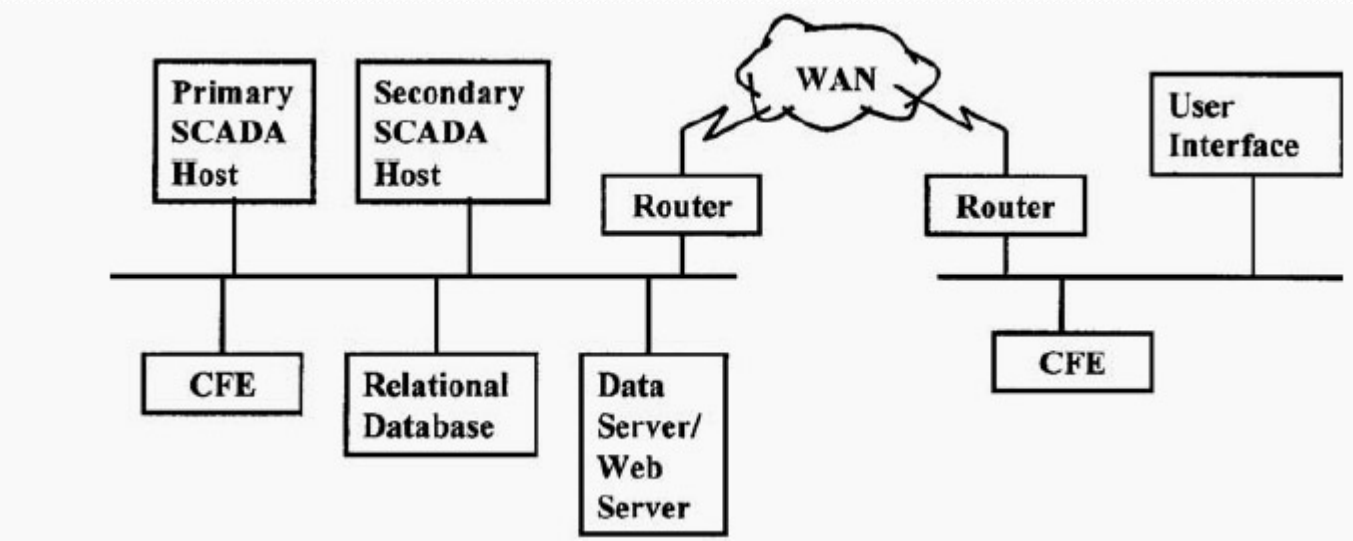
Supervisory Control And Data Acquisition (SCADA) system is the heart of ***Distribution Management System (DMS) architecture***.

- Evaluate existing systems and develop strategies to make improvements, replace aged or problematic systems, or meet new business objectives
- Pre-screen possible bidders and prepare requests for information (RFIs)
- Develop procurement specifications and a complete request for proposal (RFP) including terms and conditions
- Participate in vendor evaluations and scoring

SCADA IN POWER DISTRIBUTION

- Seek technical and business clarifications with vendors and contribute to or lead contract negotiations
- Provide hands-on system configuration and integration services (e.g., databases, displays, application integration, and intelligent electronic device (IED) integration)
- Support functional and performance factory acceptance testing (FAT) and point-to-point checkout
- Create site acceptance test (SAT) procedures and assist in performing SAT
- Create, organize, and deliver custom SCADA training
- Assist with substation automation applications
- Assist with energy management system (EMS) applications
- Assist with distribution management system (DMS) applications

SCADA IN POWER GRID



DESCRIPTION OF SCADA IN POWER GRID

- ***At a high level, the elements of a distribution automation system can be divided into three main areas:***

- A **SCADA system** should have all of the infrastructure elements to support the multifaceted nature of distribution automation and the higher level applications of a DMS. A Distribution SCADA system's primary function is in support of distribution operations telemetry, alarming, event recording, and remote control of field equipment.
- A modern SCADA system should support the engineering budgeting and planning functions by providing access to power system data without having to have possession of an operational workstation

Main elements of SCADA system

- Host equipment
- **Communication infrastructure** (*network and serial communications*)
- Field devices (*in sufficient quantity to support operations and telemetry requirements of a DMS platform*)

- Host servers (*redundant servers with backup/failover capability*).
- **Communication front-end nodes** (*network based*).
- Full graphics user interfaces.
- Relational database server (*for archival of historical power system values) and data server/Web server (for access to near real time values and events*).

- SCADA has proven its value in operation during inclement weather conditions, service restoration, and daily operations, the dependency on SCADA has created a requirement for ***highly available and high performance systems***. Redundant server hardware operating in a "*live*" backup/failover mode is required to meet the high availability criteria.

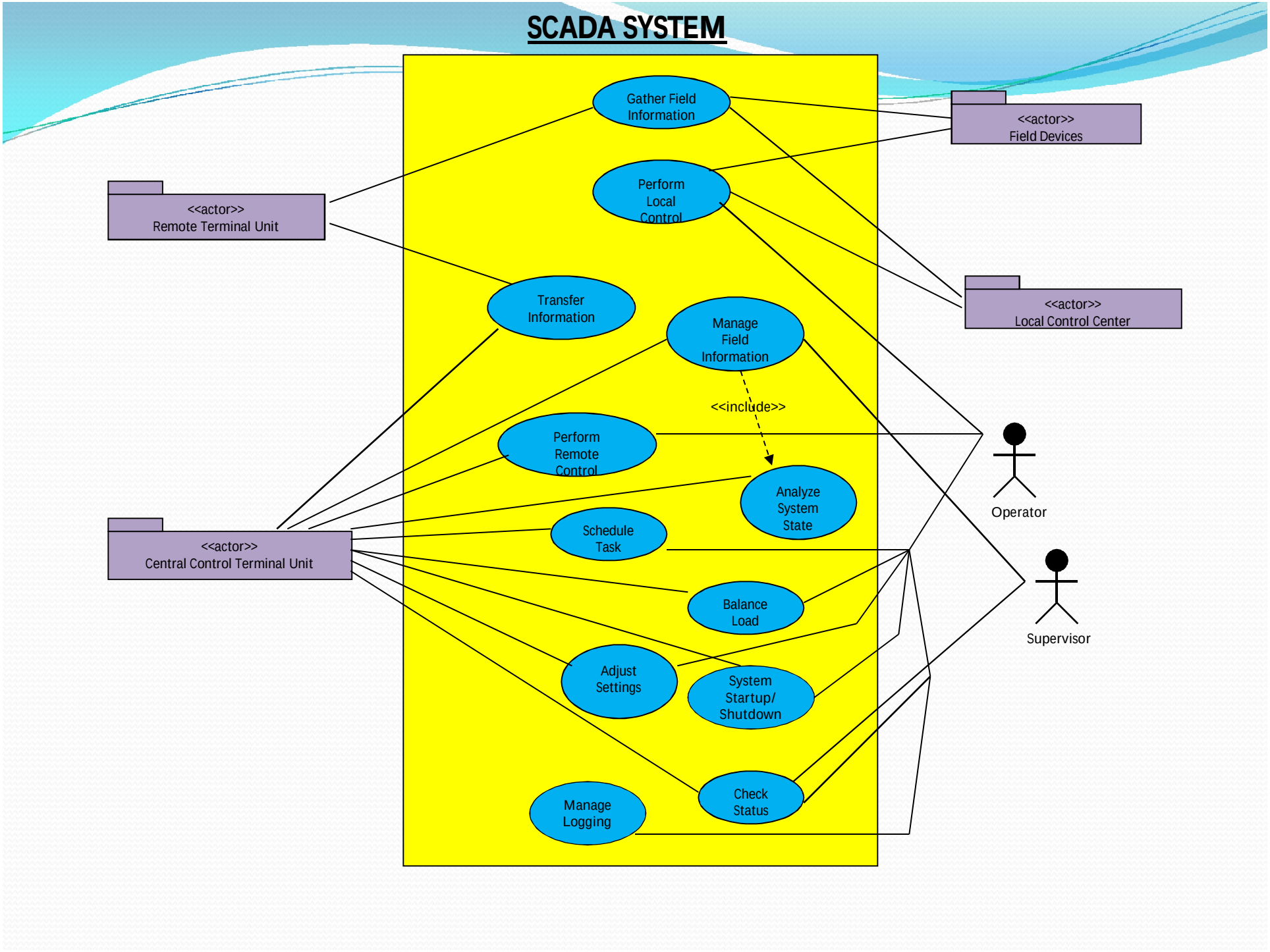
USE CASE DIAGRAM FOR SCADA SYSTEM

- Description: The goal is to supervise, control, monitor and acquire data for critical infrastructure systems, operate from remote end and ensure security and safety
- Actors:
  - Field Devices
  - Local Control Center (LCC)
  - Remote Telemetry Units (RTU)
  - Master / Central Control Terminal Unit (MTU)
  - Operator
  - Supervisor

USE CASES

i. System Shut Down / Startup
ii. Gather Field Information
iii. Perform Local Control
iv. Transfer Field Information
v. Manage Field Information
vi. Perform Remote Control
vii. Analyze System State
viii. Schedule Task
ix. Balance Load
x. Adjust Settings
xi. Check Status

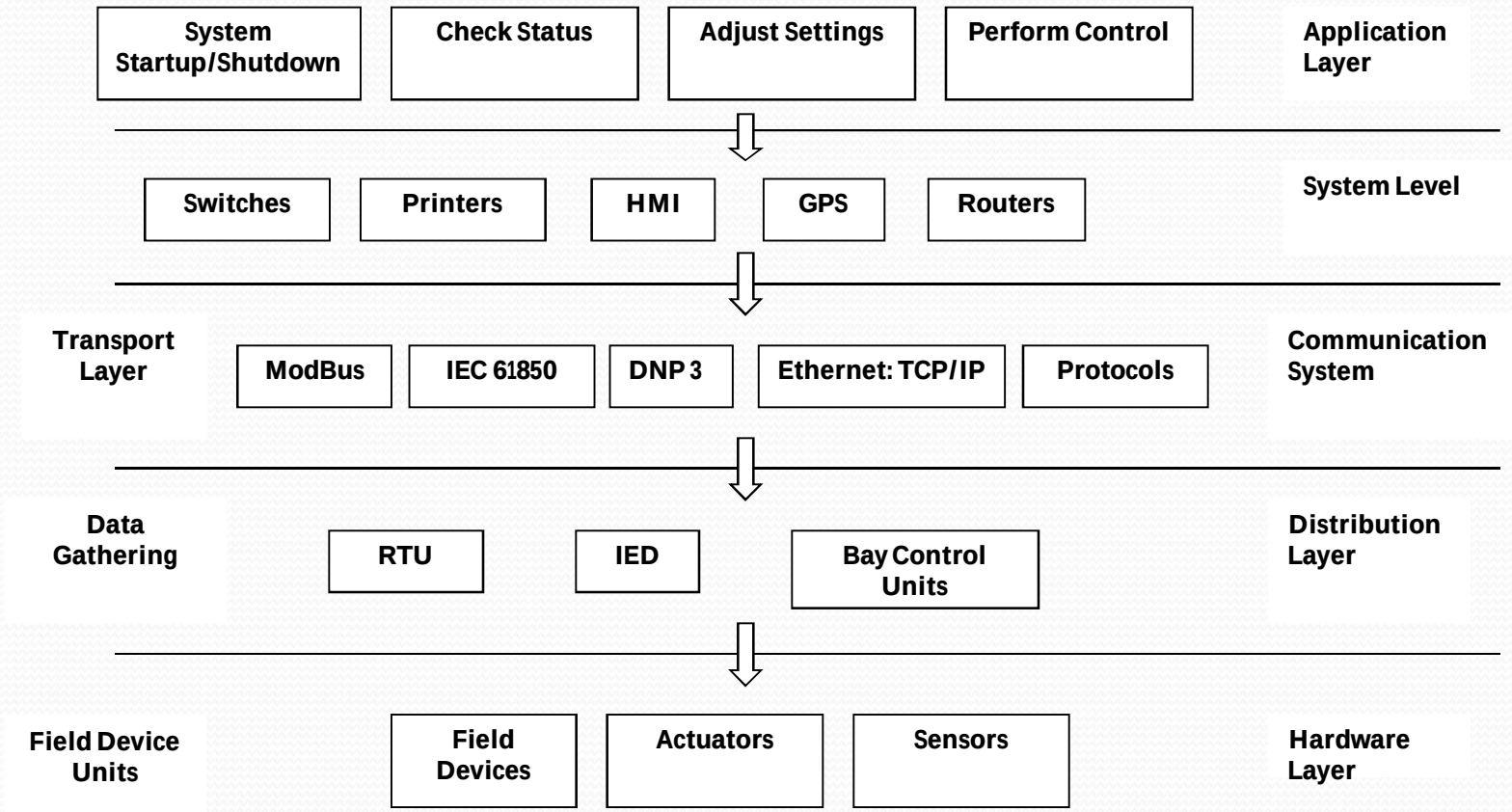
SCADA SYSTEM



PRE CONDITIONS FOR SCADA SYSTEM

- The operator is logged in.
- The system is real time system.

LAYERS OF SCADA



LAYER PATTERN

- SCADA system being highly complex and distributed, it is important to understand SCADA in Terms of Layers for simplicity as shown in Figure above. The intent, forces, advantages for the layer patterns are the same. However here we apply this pattern on the real physical system.
- Layer 1: It is the field Units, considering the Generation, Transmission and Distribution at one place, we have all the process controls, I/Os, status, metering, measuring values, etc. It also includes local control.
- Layer 2: The field values, I/O – analog, digital, measuring and other commands, operations, are taken to RTUs, IEDs, PLCs, BCUs, and other I/O cards to communicate to higher end.

LAYER PATTERN

- Layer 3: This includes all the communication cables, protocol architecture required for higher end communication interfaced with all field signals. It is the backbone in the modern control centers, which has immensely reduced physical wiring, big marshalling and increased the reliability and more improved quality signals. Today latest protocols like IEC 61850, Modbus and other proprietary protocols are used.
- Layer 4: This includes the Control centre equipped with dynamic changing states of the system displayed on HMI, which is powerful to read values, prompt and diagnosis system change and with a click on HMI, to carry out operations.

LAYER PATTERN

- Layer 5: Connection with the outside world using Internet and various new technology related to mobile / cell phone operations.

SCADA FUNCTIONS

- Supervisory Control
- Data Acquisition
- Real Time Database
- Graphical Operator Interface
- Alarm Processing
- Data Historian/Strip Chart Trending
- Mapboard Interface

SCADA PRINCIPLES OF OPERATION

- Interface with Physical Devices
  - Remote terminal unit (RTU)
  - Intelligent electronic device (IED)
  - Programmable logic controller (PLC)
- Communications
  - Directly wired (typical for shorter distances)
  - Power line carrier (less common)
  - Microwave (very frequently used)
  - Radio (VHF, spread spectrum)
  - Fiber optic (gaining popularity)

ENERGY MANAGEMENT SYSTEM (EMS) FUNCTIONS

- Control
  - Automatic Generation Control (AGC)
  - Voltage Control
  - Interchange Transaction Scheduling
  - Load Shedding & Restoration (including special stability controls)
- Analysis
  - State Estimation/Contingency Analysis
  - Economic Dispatch
  - Short Term Load Forecasting

OPERATOR DISPLAY AND CONTROL FUNCTIONS

- Display real-time network status on geographic and schematic maps
- Control of circuit breakers and switches
- Graphical user interface -pan, zoom, decluttering
- Dynamic coloring to show real-time changes
- On-line data modification for construction and maintenance
- Optimization functions and decision making support

SCADA TRENDS

- Open Protocols
  - Open industry standard protocols are replacing vendor-specific proprietary communication protocols
- Interconnected to Other Systems
  - Connections to business and administrative networks to obtain productivity improvements and mandated open access information sharing
- Reliance on Public Information Systems
  - Increasing use of public telecommunication systems and the internet for portions of the control system

KEY TECHNOLOGY DRIVERS

- Open architectures and protocols
- Microprocessor-based field equipment
  - “smart” sensors and controls
- Convergence of operating systems
- Ubiquitous communications
  - cheaper, better, faster

MAJOR SCADA VENDORS

- Asea Brown Boveri (ABB)
- Areva (formerly ESCA)
- GE Harris
- Siemens
- Advanced Control Systems (ACS)
- Open Systems International (OSI)

SCADA PROTOCOLS

- ANSI X3.28
- BBC 7200
- CDC Types 1 and 2
- Conitel
- 2020/2000/3000
- DCP 1
- DNP 3.0
- Gedac 7020
- IBM 3707
- Landis & Gyr 8979
- Pert
- PG&E
- QEI Micro II
- Redac 70H
- Rockwell
- SES 91
- Tejas 3 and 5
- TRW 9550
- Vancomm