Advanced Control Technology in Process Industry

Kuliah Umum
Universitas Komputer Indonesia
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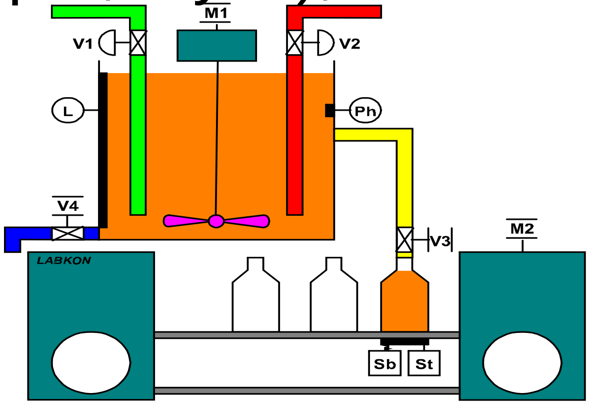
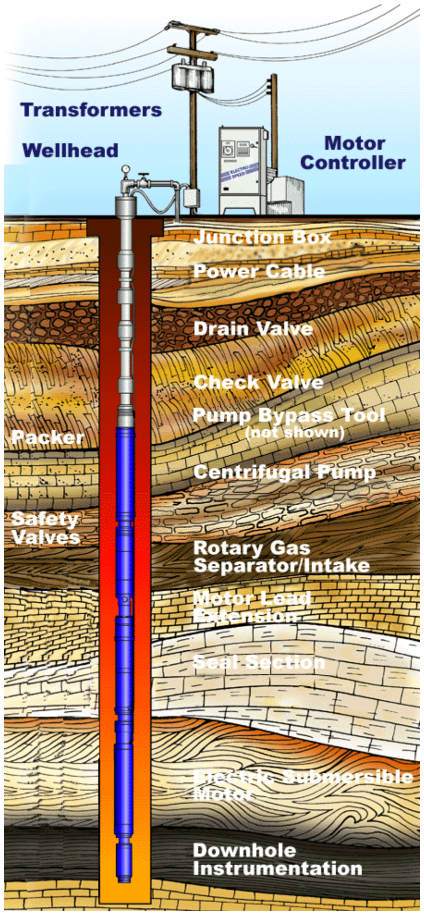
What is in your mind?

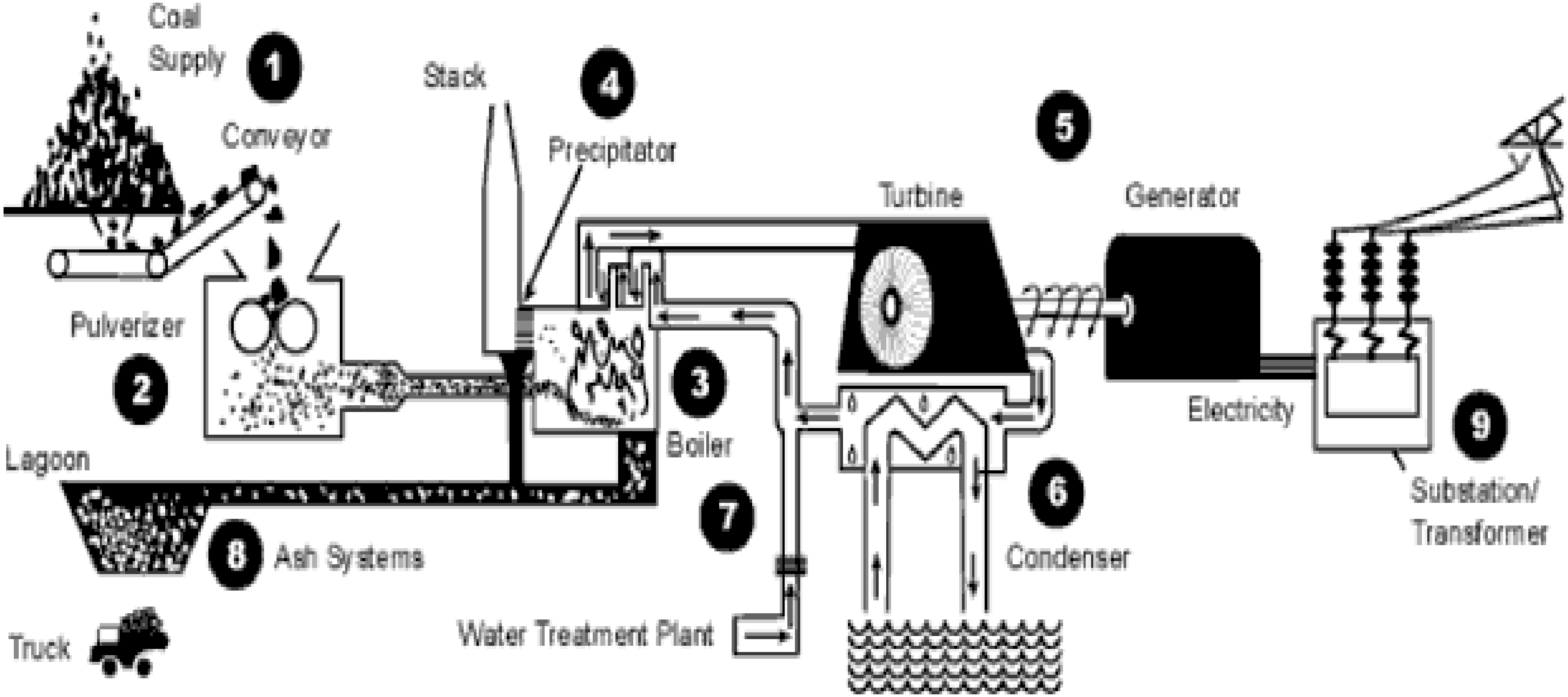
Processes

- Oil drilling (Chevron Pacific Indonesia, Conoco Phillips, CNOOC, PERTAMINA, etc.)
- Refinery and Gas Distributions (Pertamina, Badak LNG, PGN, etc.)
- Chemical processes (Fertilizer plant, Cement, Steel, etc.)
- Process: Continuous, Batch Processes (Polymer, pulp & paper, rayon), etc.



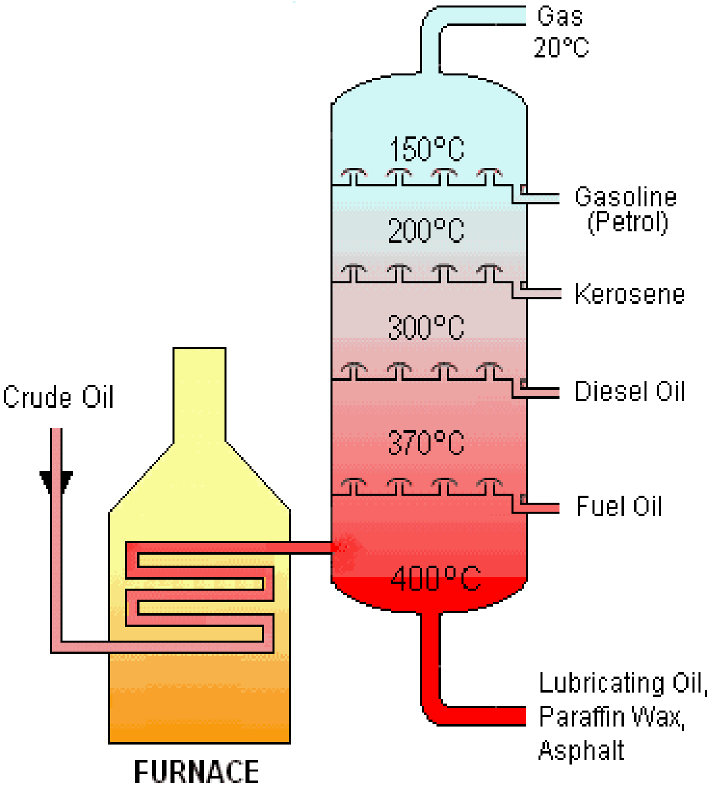


Process Example: Power Generation



- How is the electricity produced?
- What is the indicator of the plant operation?
- Key variables: Steam flow (F), Boiler level (L), Furnace Temperature (T), Coal quality (C), etc

Process Example: Refinery Plant



- How does the plant work?
- Is the plant controllable?
- Control variables: Temperature, Pressure, Flow, Fluid Level, etc

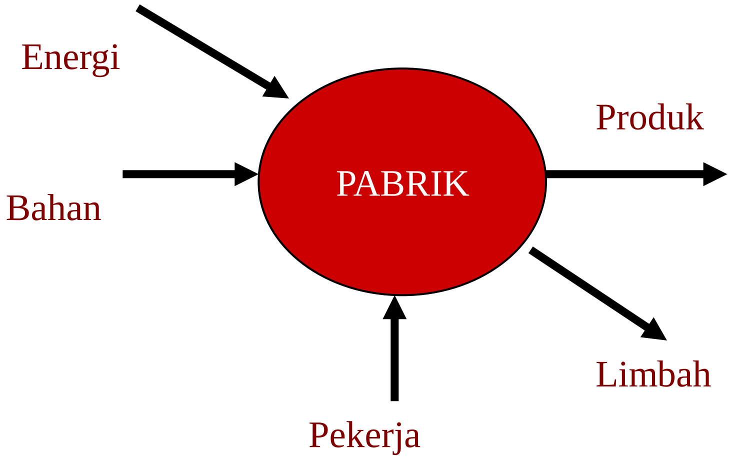
Basic Concept of Process Control

BAHASAN

- Mengapa perlu sistem kontrol?
- Konsep Dasar Sistem Kontrol
  - Plant & Controller
  - Process Variable (PV)
  - Set Point (SV)
  - Manipulated Variable (MV)
- Pengontrol
  - Kontrol Manual (Open Loop)
  - Kontrol ON-OFF (Close Loop)
  - PID Controller

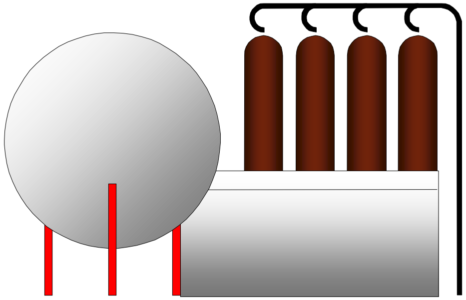
TUJUAN PABRIK

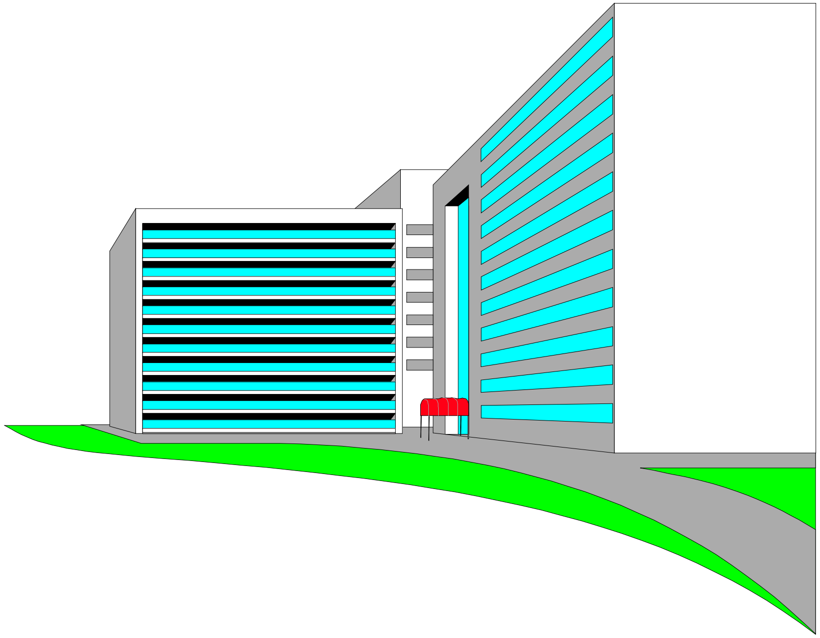
- Menghasilkan keuntungan
  - Memaksimalkan produk
    - Kualitas
    - Kuantitas
  - Meminimumkan ongkos
    - Bahan mentah, energi
    - Penanganan limbah
    - Jumlah pekerja
    - Jam kerja
- Tetap menjaga keselamatan & kelestarian
  - Manusia
  - Pabrik
  - Lingkungan



CONTOH SEDERHANA

- Suatu pabrik harus memasok air hangat untuk sebuah apartemen berkapasitas 200 kamar

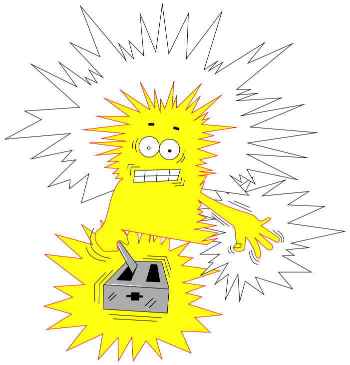




KRITERIA KESELAMATAN

- Utamakan Keselamatan
  - Keuntungan tinggi akan sia-sia bila tidak selamat
  - Celaka akan memakan balik keuntungan

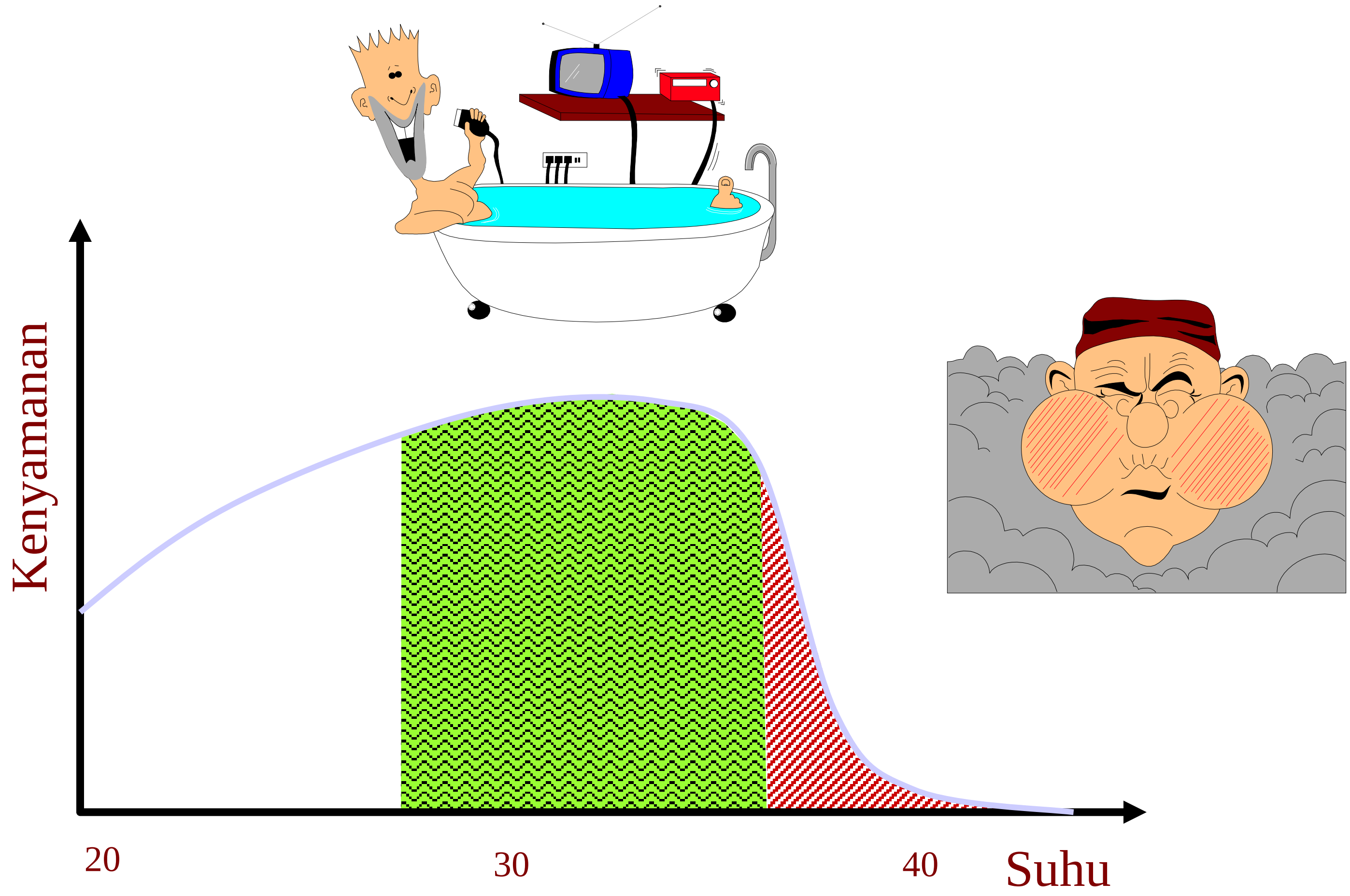
- Contoh pabrik air hangat
  - Pemanas listrik: praktis, bahaya tersengat
  - Pemanas gas: murah, tidak praktis
  - Pemanas matahari: ramah lingkungan, murah, tidak andal



KRITERIA KUALITAS

- Kualitas adalah ukuran bagus tidaknya suatu produk sesuai dengan peruntukannya, dan juga konsistensi dalam menjaga mutu tersebut.
  - Tepat : cocok dipakai, bisa dijual dengan harga tinggi
  - Kurang atau lebih: harga jatuh, bahkan bisa berbahaya
- Pada kasus air panas, kualitas yang diharapkan pemakai misalnya :
  - Suhu sekitar 30 – 35 ^{O} Celcius
  - Bening, tidak ada kotoran
  - Tidak berbau, tidak berasa
  - Tidak beracun, bersih dari kuman, dll

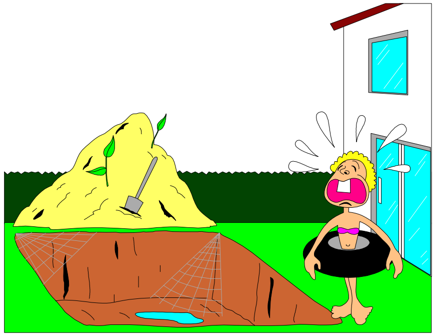
MENGEJAR KUALITAS

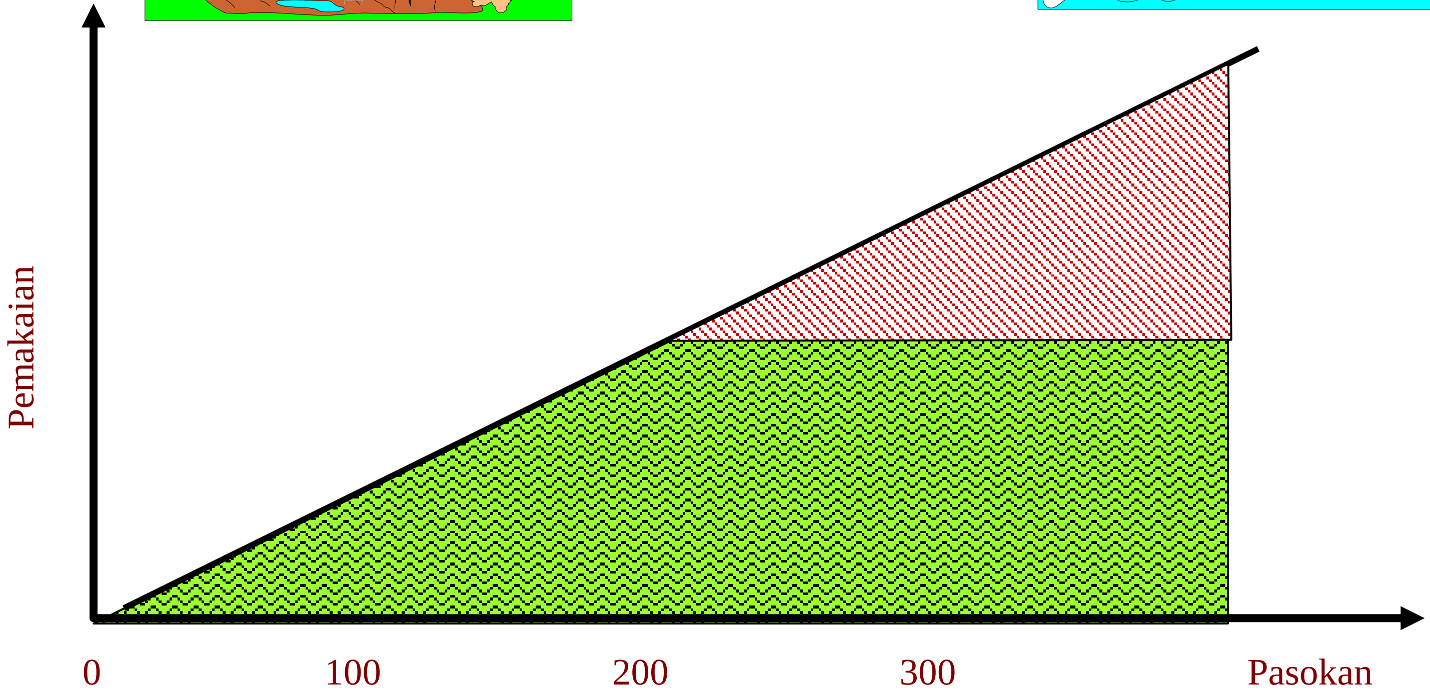


KRITERIA KUANTITAS

- Kuantitas adalah ukuran banyak / jumlah produk, dimana kuantitas harus disesuikan dengan kebutuhan.
  - Kurang, maka kesempatan meraih untung akan hilang
  - Berlebih, akan jadi sisa yang dijual murah bahkan terbuang percuma
- Dalam kasus pabrik air hangat:
  - Memasok 200 kamar

MENGEJAR KUANTITAS



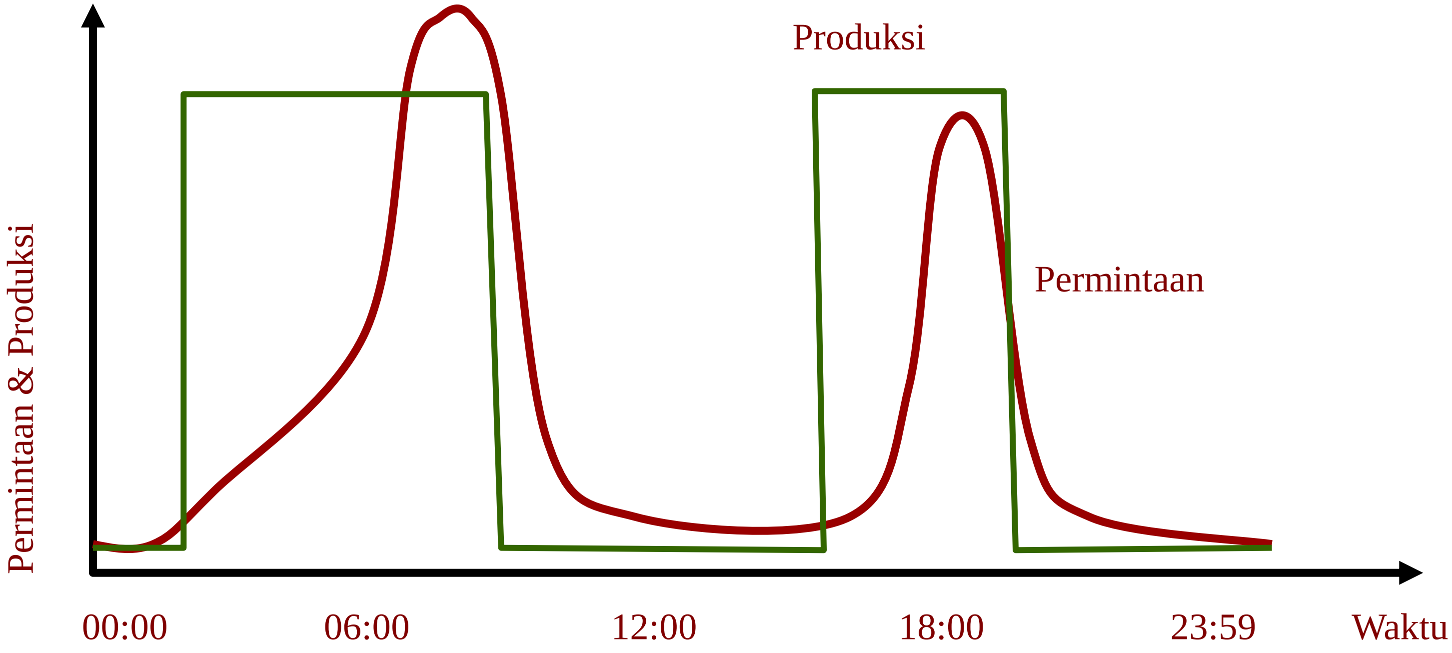


BEBAN PRODUKSI

- Beban produksi adalah titik operasi pabrik untuk menghasilkan kuantitas dan kualitas produk tertentu secara konsisten
- Beban operasi biasanya tetap, namun mungkin saja berubah akibat :
  - Permintaan pasar
  - Ketersediaan bahan baku, energi
  - Ada pemeliharaan pabrik
- Penjadwalan diperlukan bila pabrik sering mengubah kondisi operasi
  - Reguler / antisipatif
  - Mendadak / reaktif

PENJADWALAN

- Contoh pada plant air:
  - Permintaan naik di pagi hari dan sore hari



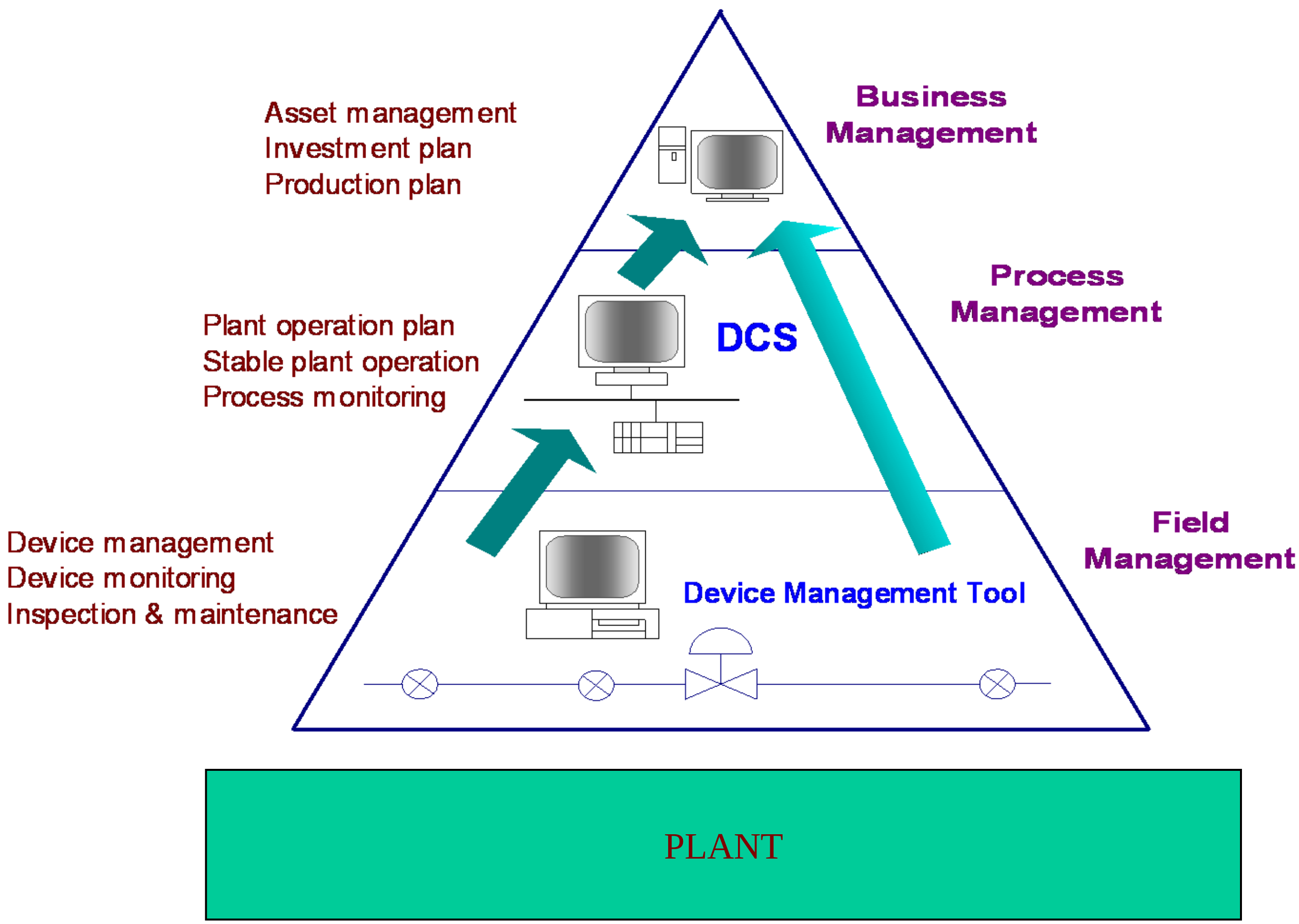
OPTIMASI

- Optimasi adalah mengatur operasi pabrik agar menghasilkan keuntungan sebanyak mungkin dalam batasan yang ada
- Objektif (tujuan)
  - Memperoleh keuntungan sebanyak mungkin
- Parameter yang diatur
  - Beban produksi (titik operasi yang menghasilkan produk dengan kualitas dan kuantitas tertentu)
  - Penjadwalan
- Batasan :
  - Keamanan
  - Kapasitas produksi terpasang
  - Ketersediaan waktu, biaya, bahan, energi, dan orang
  - Regulasi

PERAN INSTRUMENTASI & KONTROL

- Instrumentasi Industri (industrial instrumentation)
  - Peralatan pengukuran dan pengendalian yang digunakan pada proses produksi di Industri
- Kontrol Proses (process control)
  - Suatu metoda untuk mengontrol besaran-besaran fisika maupun kimia pada suatu proses
- Mengontrol (to control)
  - Mempertahankan nilai beberapa besaran pada nilai acuan atau referensi (set-point)

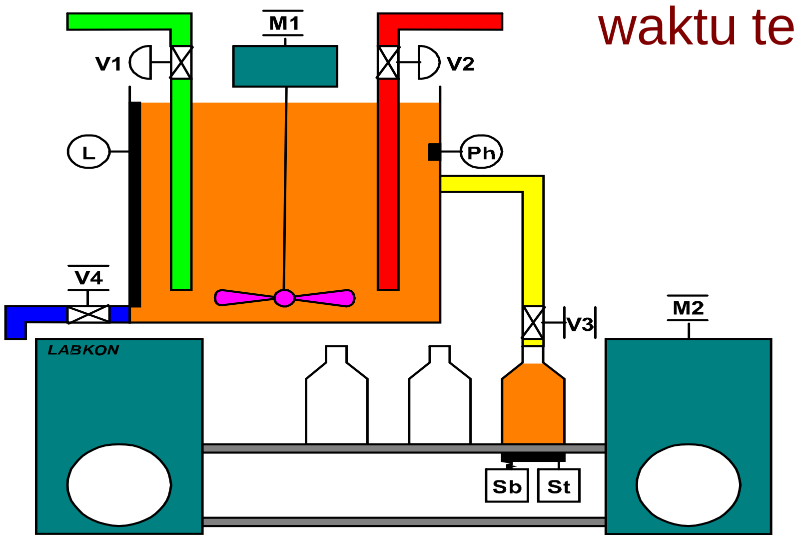
HIERARKI SISTEM KONTROL PROSES



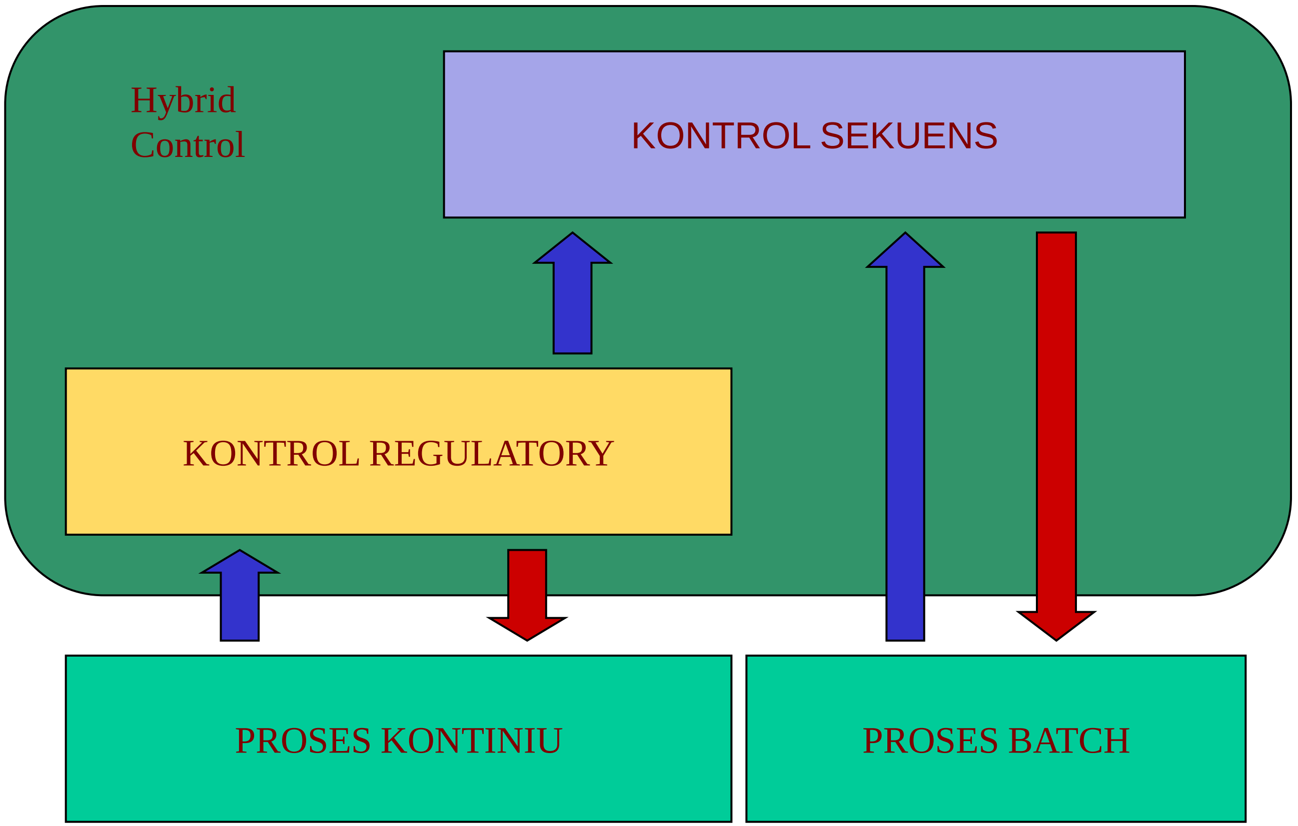
JENIS-JENIS PROSES

❑ Proses Kontinu
- Umpan diberikan terus-menerus
- Pengolahan berlangsung terus-menerus
- Produk dihasilkan terus-menerus

❑ Proses Batch
- Umpan diberikan dalam waktu tertentu
- Pengolahan berdasarkan penjadwalan waktu
- Produk dihasilkan pada waktu tertentu

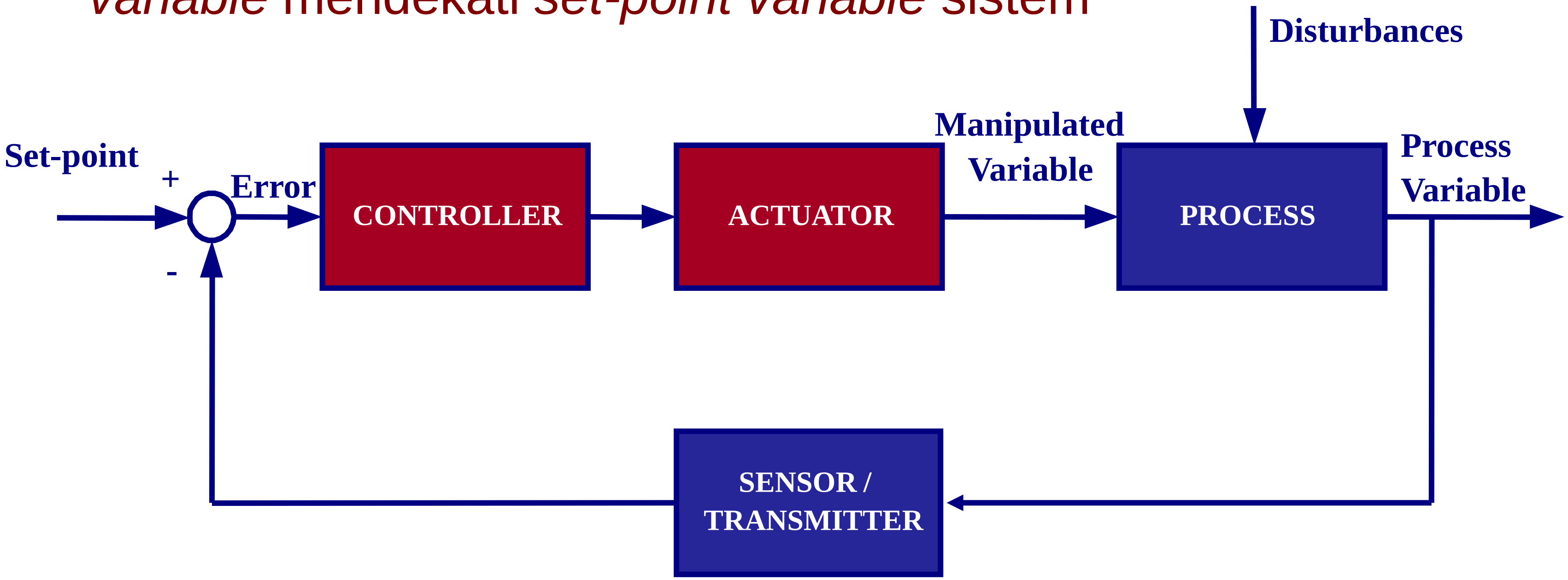


JENIS-JENIS PENGONTROLAN



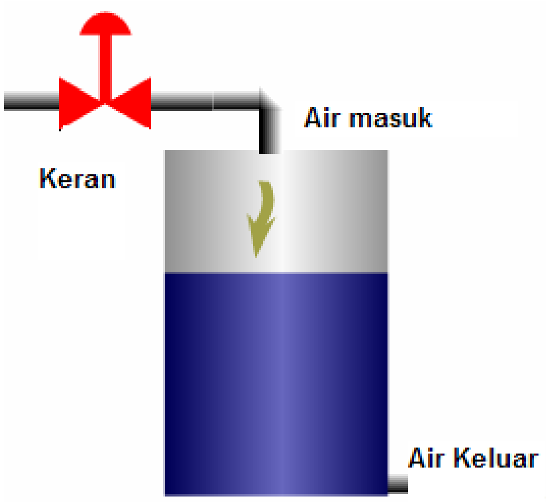
KONTROL REGULATOR

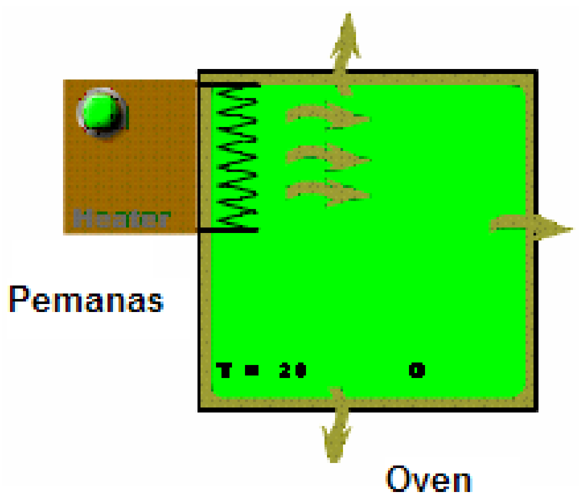
- Kontrol regulator dipasang pada proses kontinyu dengan tujuan utama adalah menjaga kondisi pabrik pada titik operasi tertentu
- Biasanya berupa kontrol umpan balik dimana pengontrol membandingkan *process variable* dengan *set-point variable* kemudian mengatur *manipulated variable* sehingga *process variable* mendekati *set-point variable* sistem



PROCESS / PLANT

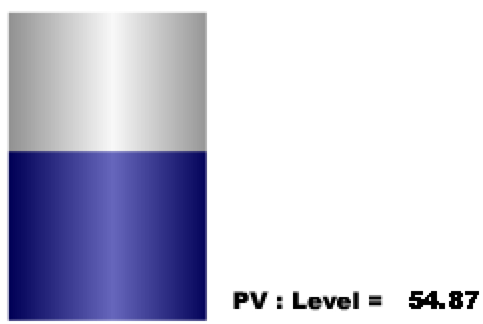
- Plant, atau proses, adalah sistem fisis yang diinginkan untuk beroperasi sesuai kondisi tertentu
- Contoh: plant tangki air yang harus menampung air dengan volume tertentu
- Contoh: oven yang harus dihangatkan hingga suhu tertentu



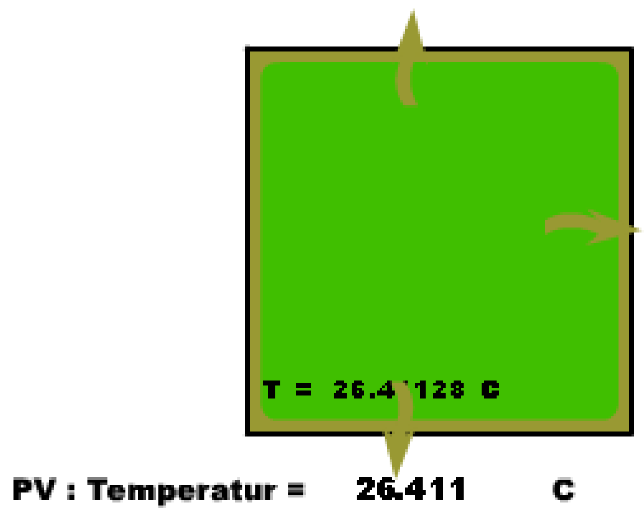


PROCESS VARIABLE (PV)

- Setiap plant memiliki satu atau beberapa process variable (PV) yang ingin diamati dan dijaga
- Process Variable dipengaruhi kondisi internal dan eksternal plant



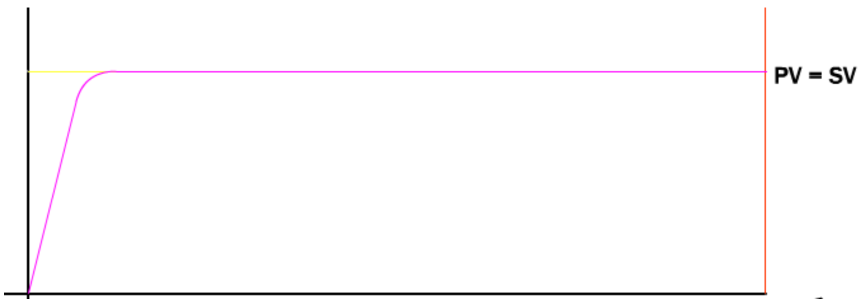
Contoh Plant : Tangki



Contoh Plant : Oven

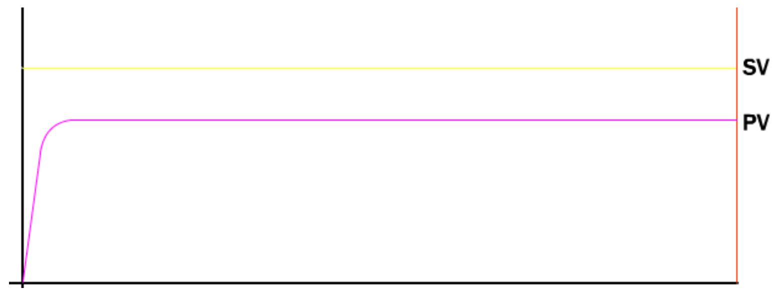
SET POINT VARIABLES (SV)

Harga dimana PV ingin dijaga stabil

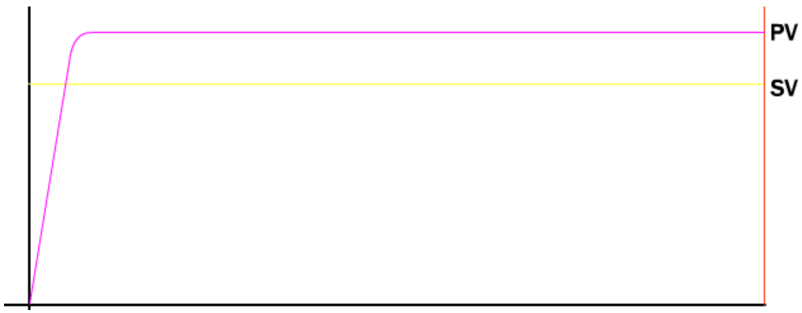


Plant mencapai kondisi stabil, PV = SV

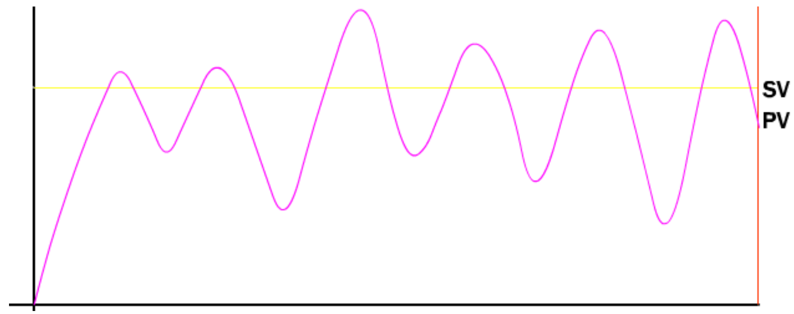
Kondisi yang diinginkan



Plant mencapai kondisi stabil, PV < SV



Plant mencapai kondisi stabil, PV > SV

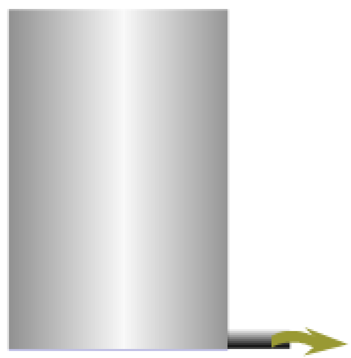


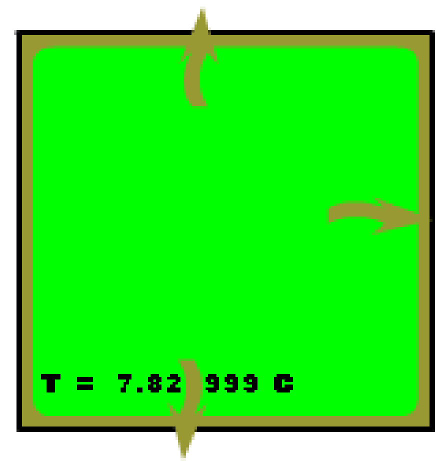
Plant tidak mencapai kondisi stabil

DISTURBANCE

Gangguan yang mengakibatkan PV berubah

Air yang keluar dari tangki dapat disebut sebagai gangguan karena menyebabkan sistem tidak dapat mencapai set point

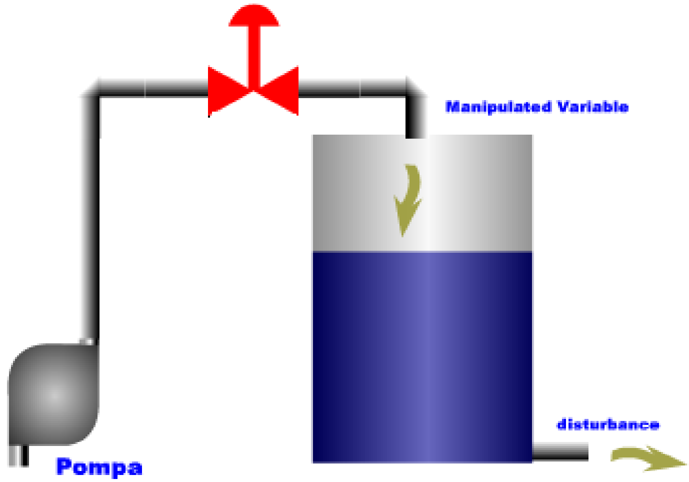




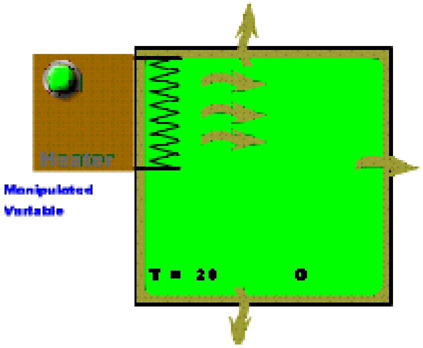
Kalor yang merambat keluar dari oven dapat disebut sebagai gangguan karena menyebabkan sistem tidak dapat mencapai set point

MANIPULATED VARIABLE (MV)

- Sinyal yang akan mengubah umpan (bahan / energi, dll) ke proses sehingga PV akan terpengaruh



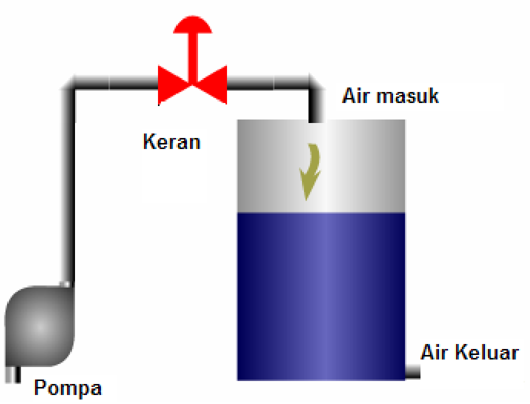
Untuk mengkompensasi gangguan pada sistem tangki, dipasang pompa untuk mengalirkan air ke tangki.



Pada sistem oven digunakan heater untuk mengkompensasi kalor yang keluar dari oven.

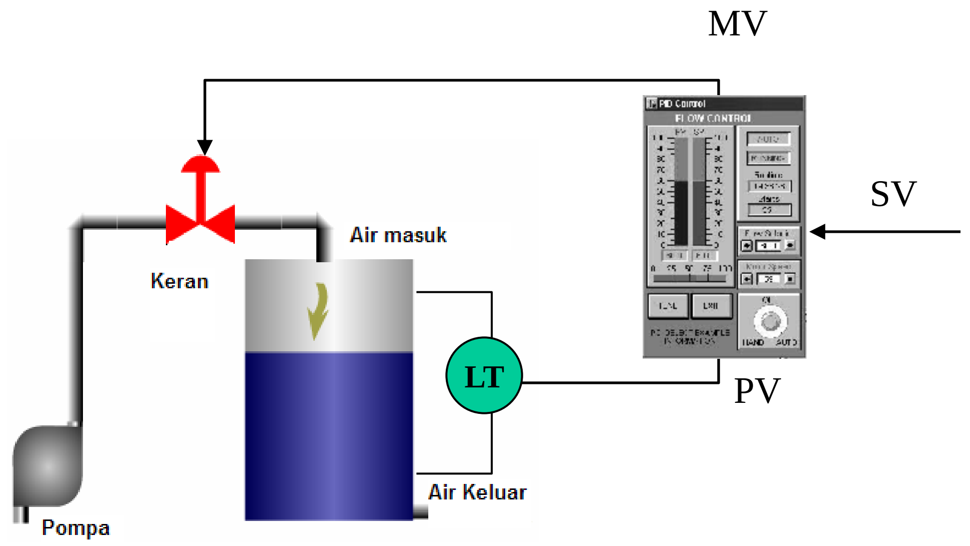
SISTEM KONTROL MANUAL

- Manusia, dengan intuisi dan akal sehat, mampu mengubah-ubah MV sehingga plant beroperasi dengan baik.
- Keterbatasan manusiawi:
  - Kecepatan reaksi
  - Banyaknya indera dan tangan
  - Bosan dan Lelah



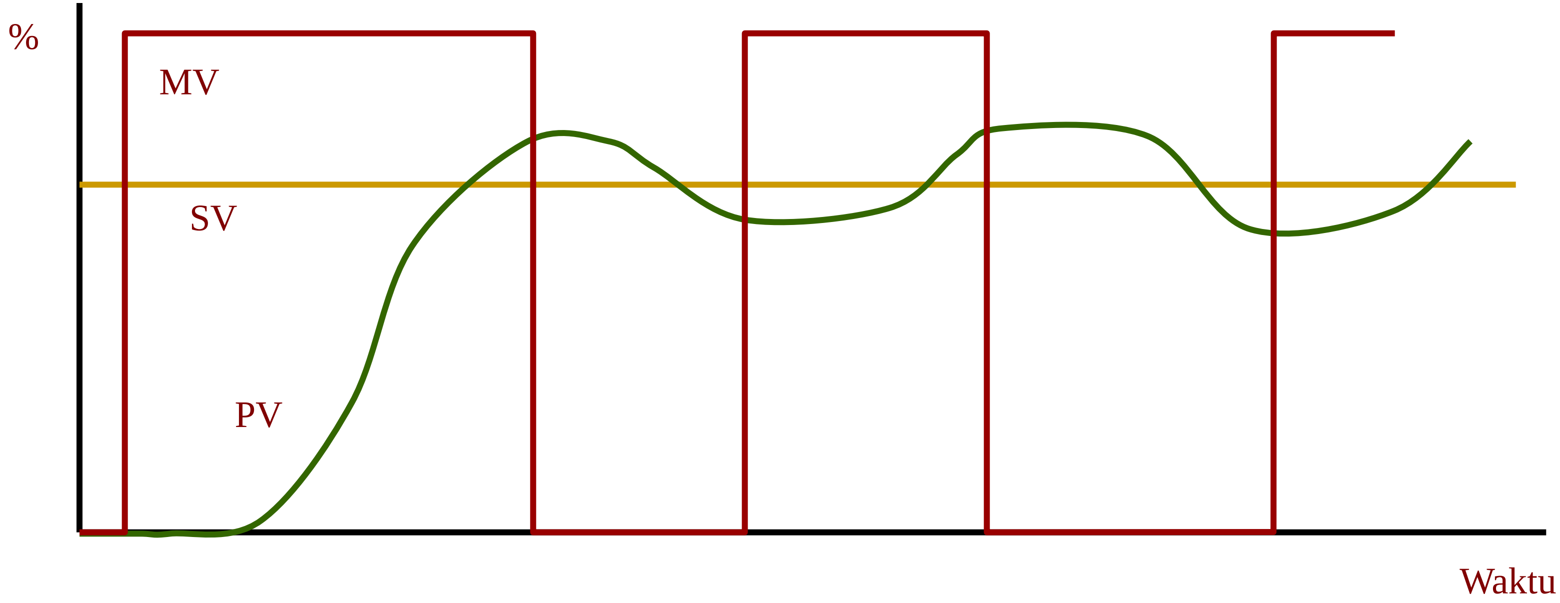
SISTEM KONTROL OTOMATIS

- Piranti yang mampu mengubah-ubah MV secara ilmiah, dengan cara membandingkan PV dan SV lalu menghitung MV berdasarkan hukum dan parameter tertentu



ON-OFF CONTROLLER

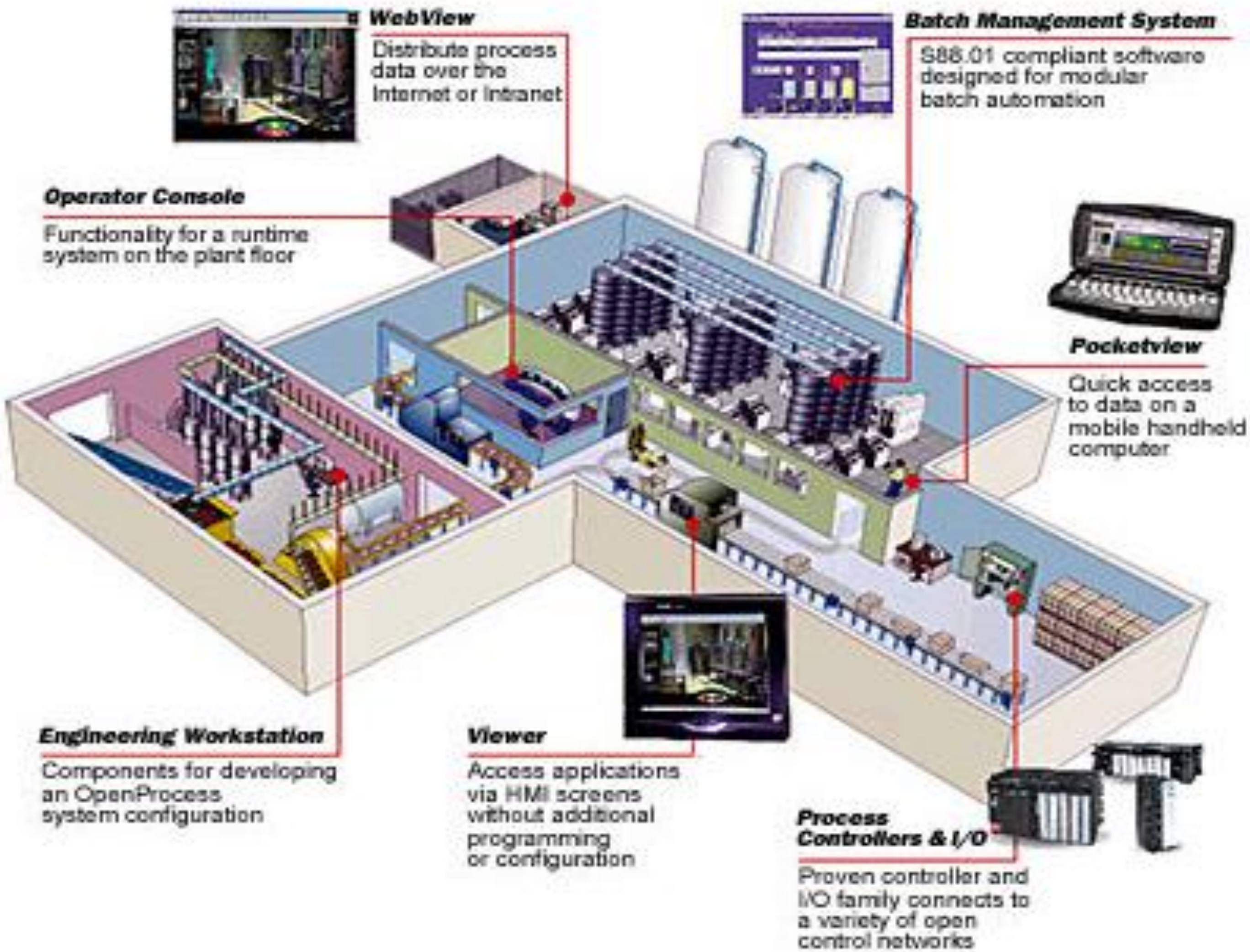
- Salah satu tipe pengontrol dengan logika sederhana untuk menentukan MV
  - Saat OFF, jika PV < SV - Band maka MV jadi ON
  - Saat ON, jika PV > SV + Band maka MV jadi OFF
- Dengan demikian PV akan berosilasi disekitar SV



Technology Trend in Process Industry

- Distributed Control Systems (DCS)
- Supervisory Control and Data Acquisition (SCADA) System
- Programmable Logic Controller (PLC)
- Conventional Control Algorithms (On-Off Controller, PID Controller)
- Advanced Control Algorithms: Cascade Control, Override Control, Model Predictive Control, etc

General Component of Automation System



Types of Industrial Control Systems

- Distributed Control Systems (DCS)
- Programmable Logic Controller (PLC)
- Hybrid Control
- SCADA Systems

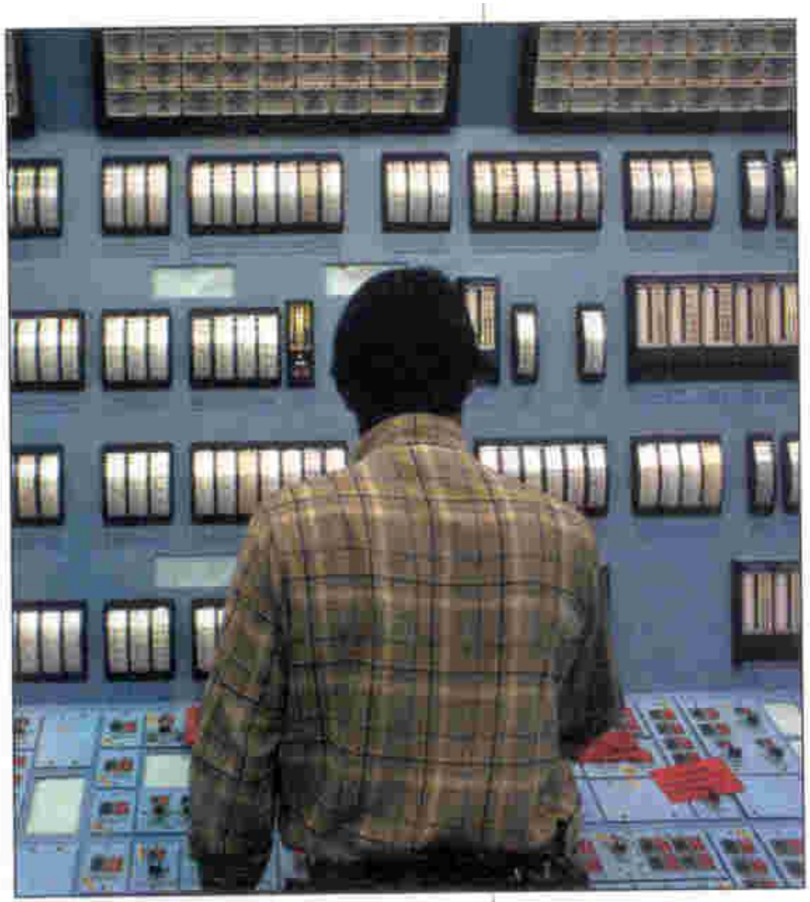
Distributed Control Systems (DCS)

TANTANGAN PABRIK BESAR

- **Lokasi Luas**
  - Bagaimana menyambung sensor di plant ke pengontrol ?
  - Bagaimana menyambung pengontrol ke aktuator ?
- **Multi Unit**
  - Bagaimana mengkoordinasi, atau sebaliknya mengurangi, ketergantungan antar unit ?
  - Bagaimana menjaga kecepatan respon tiap unit ?
- **Kompleksitas Proses**
  - Bagaimana menentukan loop (pasangan PV/SV/ MV) yang tepat ?
  - Bagaimana memasang banyak loop kontrol dengan efisien ?
  - Bagaimana mengolah data yang banyak ?
- **Human Friendly**
  - Bagaimana agar tidak lelah mengoperasikan pabrik yang besar ?
  - Bagaimana agar tampak sederhana ?

Conventional Instrument Panel

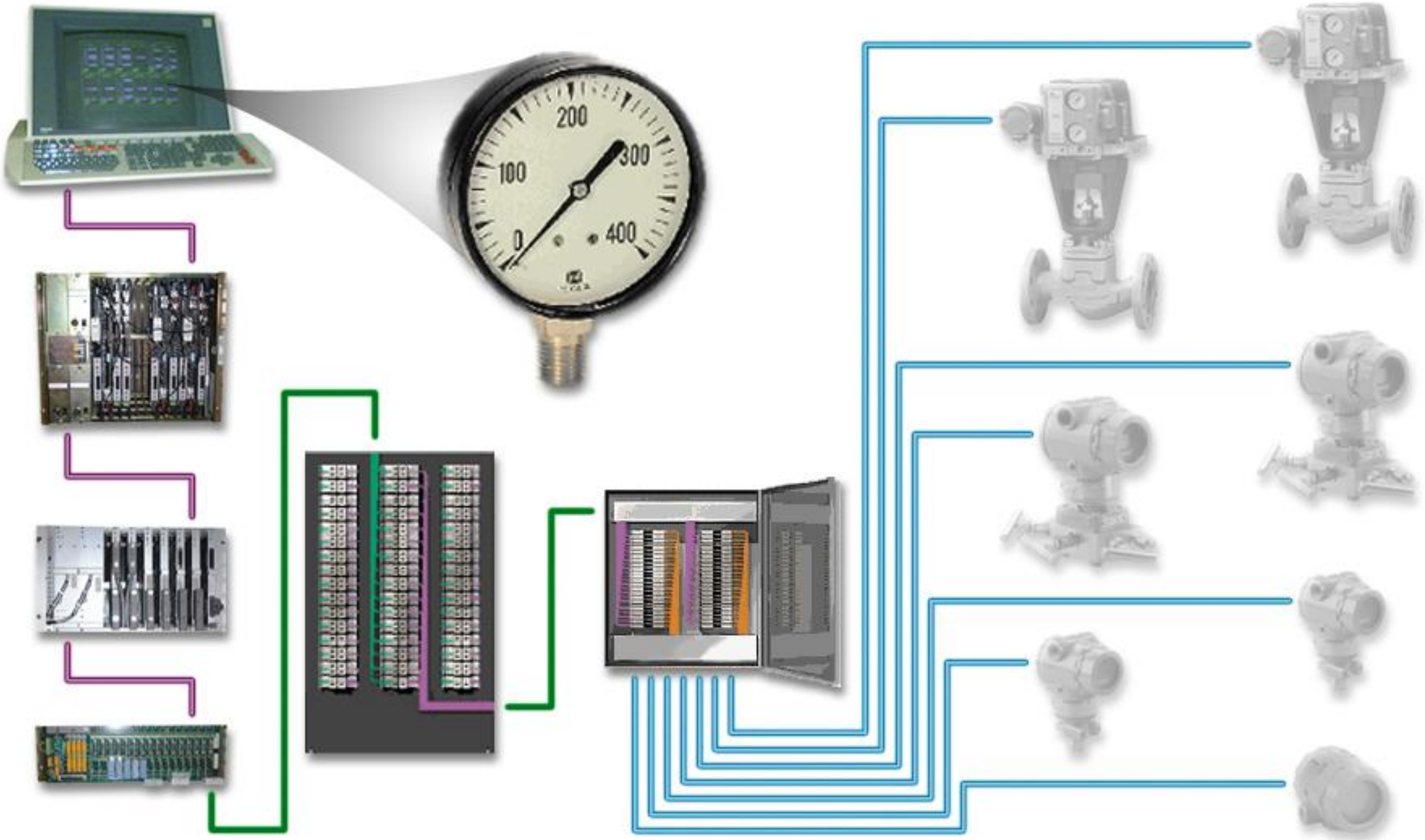
- The days of clip board, chart recorders and single loop controllers
- Someone had a good idea in 1975…



Distributed Control System DCS

- 1975…
- Let's Squeeze and Network
  - 20-30 controllers into a card
  - a few cards into a box
  - a few boxes into a network
  - Consoles workstations replace panel displays, chart recorders etc etc
- DCS is born!!!

DCS: A Proprietary Architecture - To the I/O



Why Distributed Our Control ?

Ease of implementation

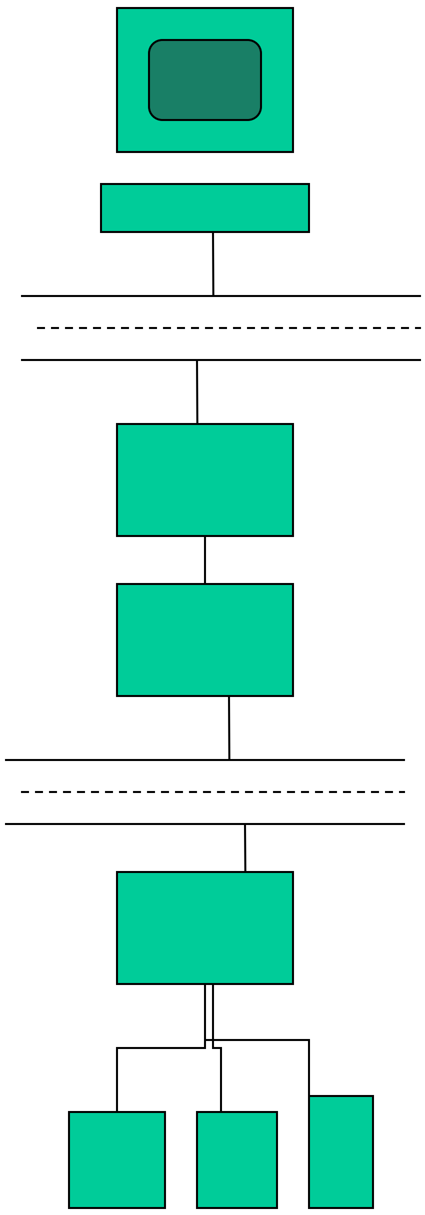
- Hardware
  - Many modules alike
  - Cable connected versus hardwiring
- Software
  - No programming but library of configuration modules "*cut and paste*"
  - Fewer mistakes
- Understanding
  - Fewer hardware types to buy, learn and repair
  - Fewer mistakes

Basic DCS Functions

- Control loops
- Execute special programmed logic
- Monitor inputs
- Alarm the plant operations
- Trend, log, and report data

DCS Architecture

- User Interface
- Plant-Wide Data Highway
- Communication Modules
- Controller Modules
- Local I/O Bus
- I/O Modules
- Process Instruments

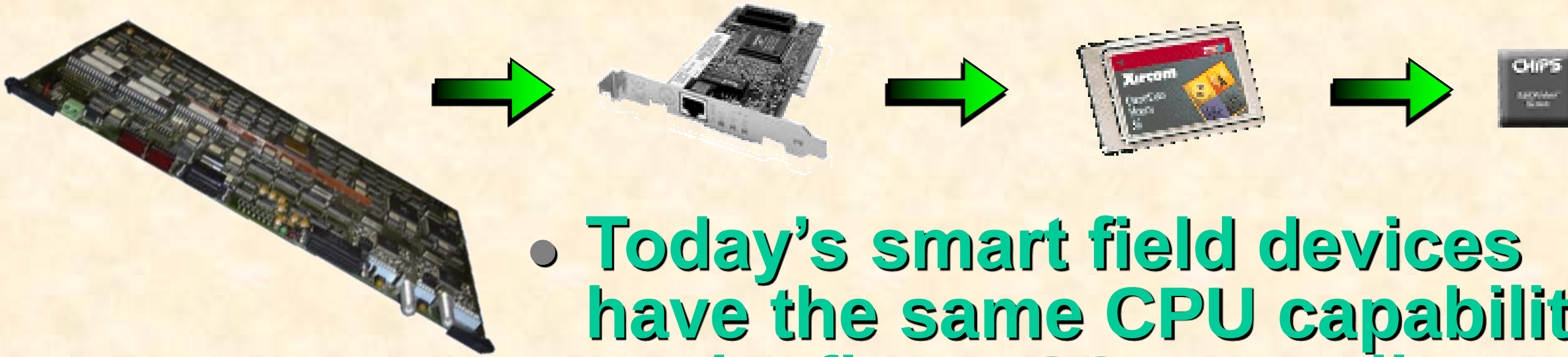


I/O Modules

- Main interface between DCS and process
- Convert information to digital form
- Signal filtering

Technology Changes Facilitated the Improvement in Automation

Miniaturization – CPU Capacity



- Today's smart field devices have the same CPU capability as the first DCS controller!

Technology Standards

1-5 V → 4-20 mA → WE'VE GOT HART ABILITY → DELIVERING THE WORLD'S FIELDBUS

- Increased demands for functionality drive new technology standards

DCS Components

- Operator station
  - Collects data relating to the process operation
  - Displaying and manipulating the process data
- Control station
  - Containts control function
- Communication system
  - Exchanges data between the operator station, control station and other stations

DCS Interfaces

- Human – machine Interface
- Engineering Interface
- Interface to other systems
- Process Interface

Human-Machine Interface

- Interface between the DCS and the operator
- Central monitoring of the plants
- Gives up-to-date plant information to the operator using graphical user interface
- Translates operator instruction into the machine
- It permits the operator to perform
  - operations
  - maintenance and troubleshooting
  - development

Engineering Interface

- Interface between the DCS and the engineers
- It permits system build-up and software maintenance in the DCS
- Engineering development station

Interface to Other System

- Supervisory computer interface
  - Connects the DCS to a supervisory computer
  - Transmits control data and receives supervisory operation commands and optimal setting
- Control sub-system interface
  - Connects the DCS to other types of instruments
    - Programmable Logic Control (PLC)
    - Composition analyzer to integrate plant operation
    - etc

Process Interface

- Interface between the DCS and the plant (field instruments)
- The control station receive measurement signals from sensors and perform control calculation in accordance with the deviations from the set-point values
- Output signals are sent to the final control elements to performs compensatory actions

Goals of DCS Use

Improving plant control system

- Production
  - Optimizing the production schedule
  - Optimizing the equipment assignments
- Consistency product
- Efficiency
  - Energy and material saving
- Safety
- Cost
  - Plant-wide optimization
  - Optimization of personnel utilization

DCS Issues

- Problems of open standard
- Impact of fieldbus
- Configuration made easy
- Significance to batching functions
- Challenge of advanced control method

Why Distributed Our Control ?

Operator Productivity

- Easy to see change
- More information to make good decisions
- Improved ability to respond to any upset
- Consistent actions by all operators
- Fewer upset

Why Distributed Our Control ?

- Flexibility
  - Hardware modules
  - Software modules

Plant Efficiency

- Sophisticated control
  - Analog and discrete on same module
  - Comprehensive interlocks easily implemented
- Extensive information
  - Available to suggest improvements
- Optimization
  - Local
  - Plant wide

Why Distributed Our Control ?

Maintenance of Records

- ❑ Process history
  - ▪ Plant operations
  - ▪ System change and growth
  - ▪ Various configurations
- ❑ Suggest improvements
  - ▪ Trend of process
  - ▪ Analysis (X-Y, XbarR, etc)
  - ▪ Relational database manager (RDBM)

Why Distributed Our Control ?

Reliability

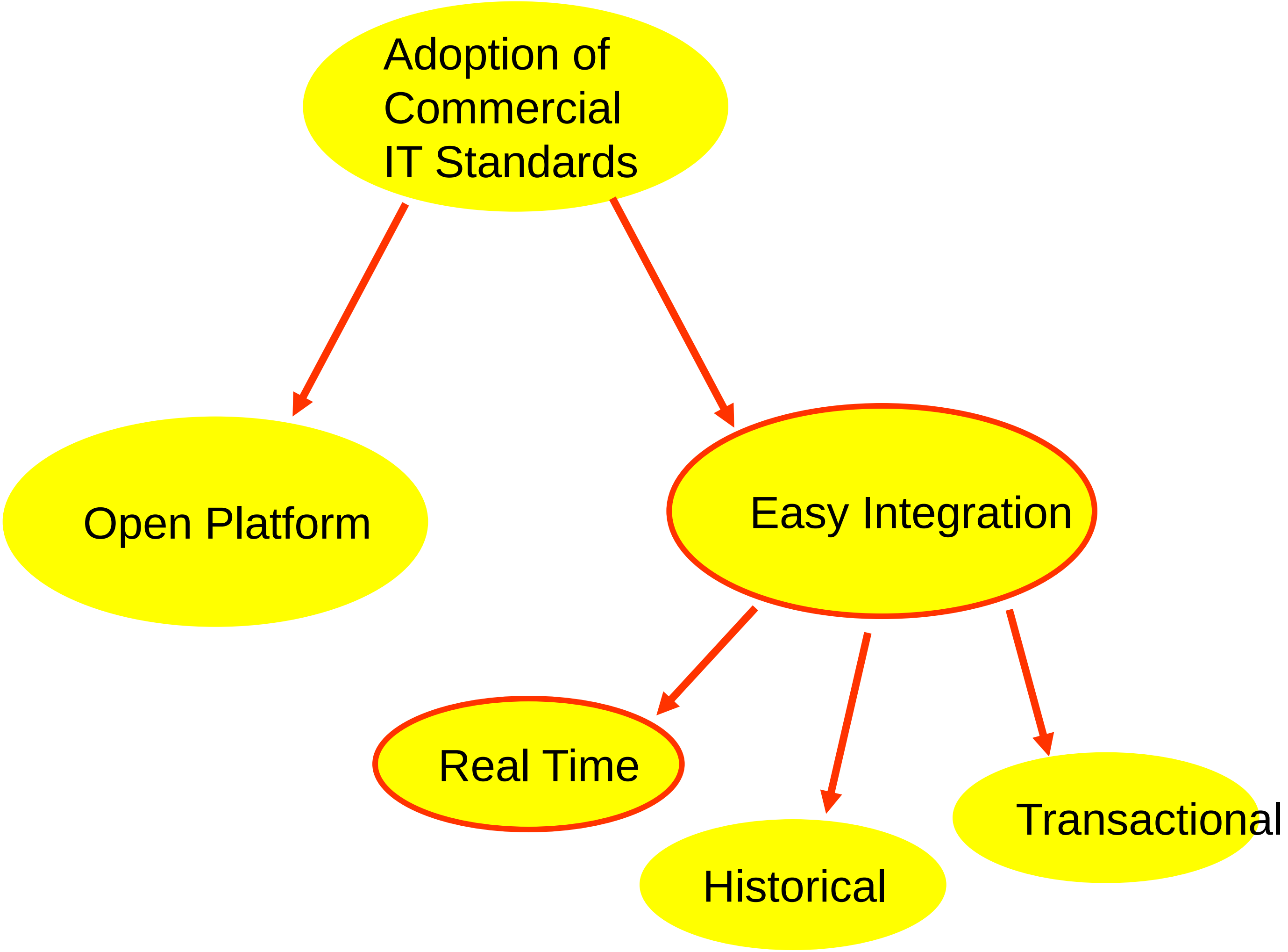
- ❑ Distributed risk
- ❑ Redundant paths
- ❑ Graceful degradation
- ❑ Fast detection of any system failure
- ❑ Easier to replace parts
- ❑ Longer life time

Why Distributed Our Control ?

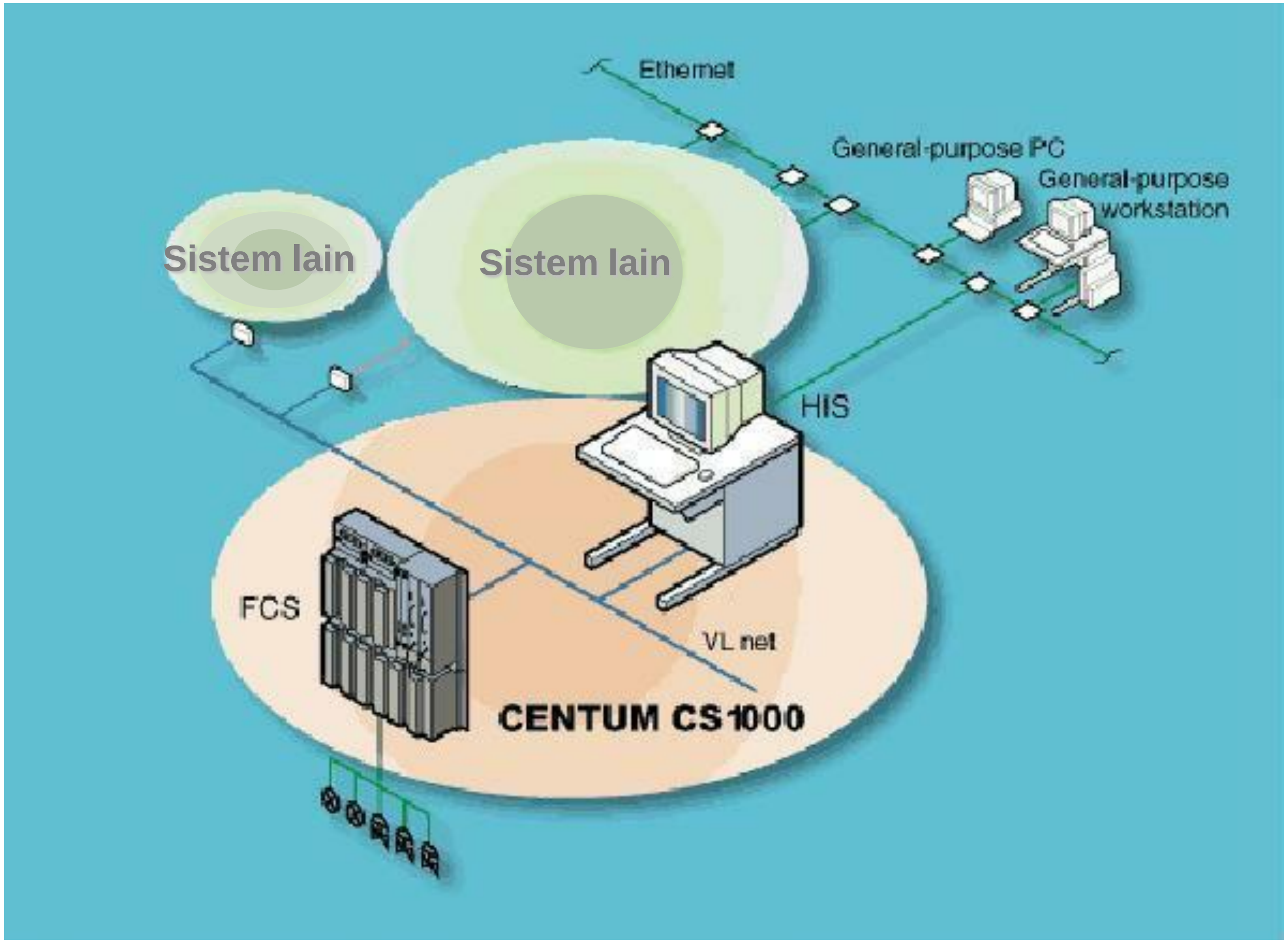
Easy Expansion & Change

- ❑ Capability and Capacity
- ❑ No reprogramming
  - Existing system will accept new additions
- ❑ Modules all alike
  - Add only what is needed
  - Nothing to buy ahead of time
- ❑ No need to know the future
  - Nature of changes
  - Amount of changes
  - Timing of changes……or even if they will occur

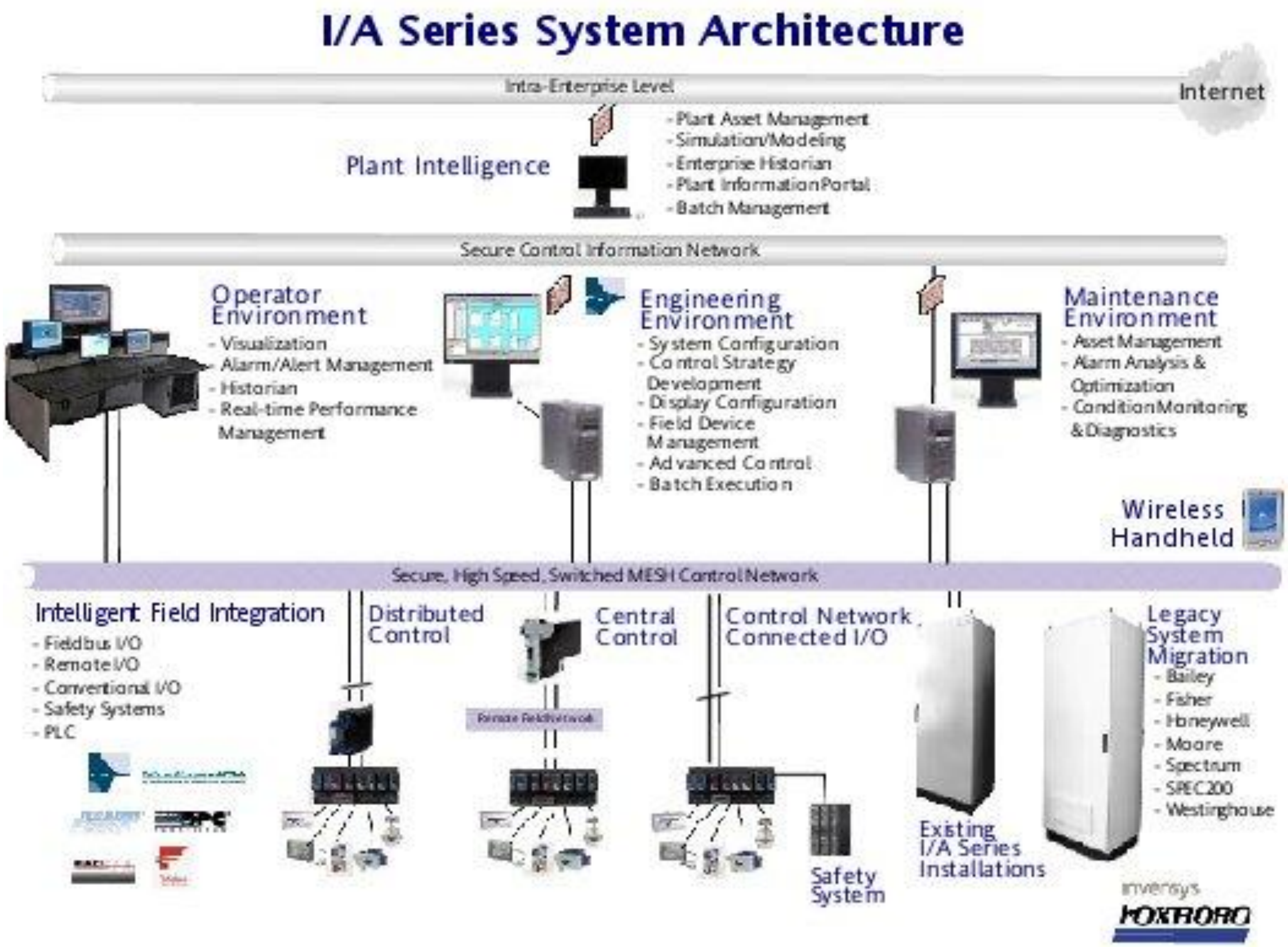
Key Technological Trends



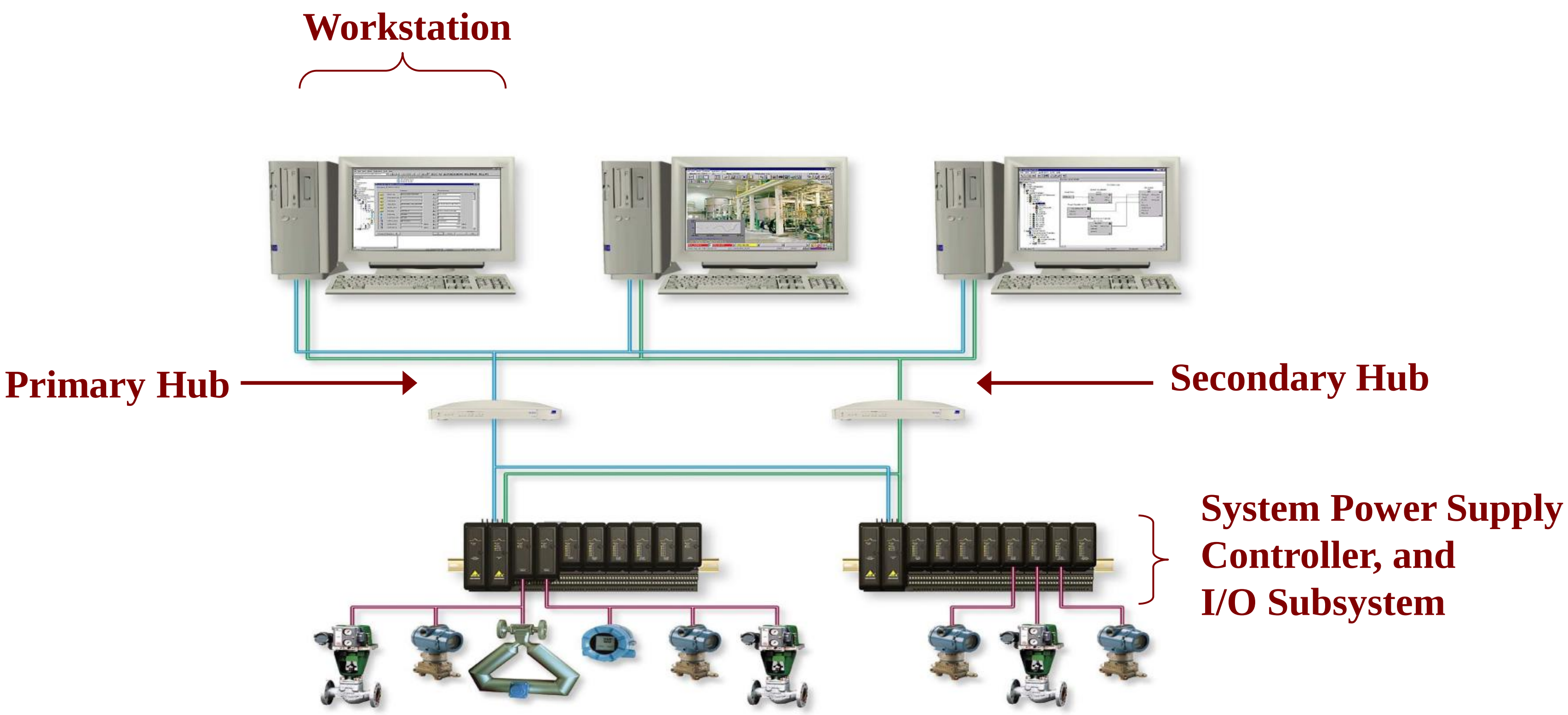
YOKOGAWA CS1000 ARCHITECTURE



FOXBORO IA SERIES ARCHITECTURE



ARSITEKTUR SISTEM DCS ROSEMOUNT

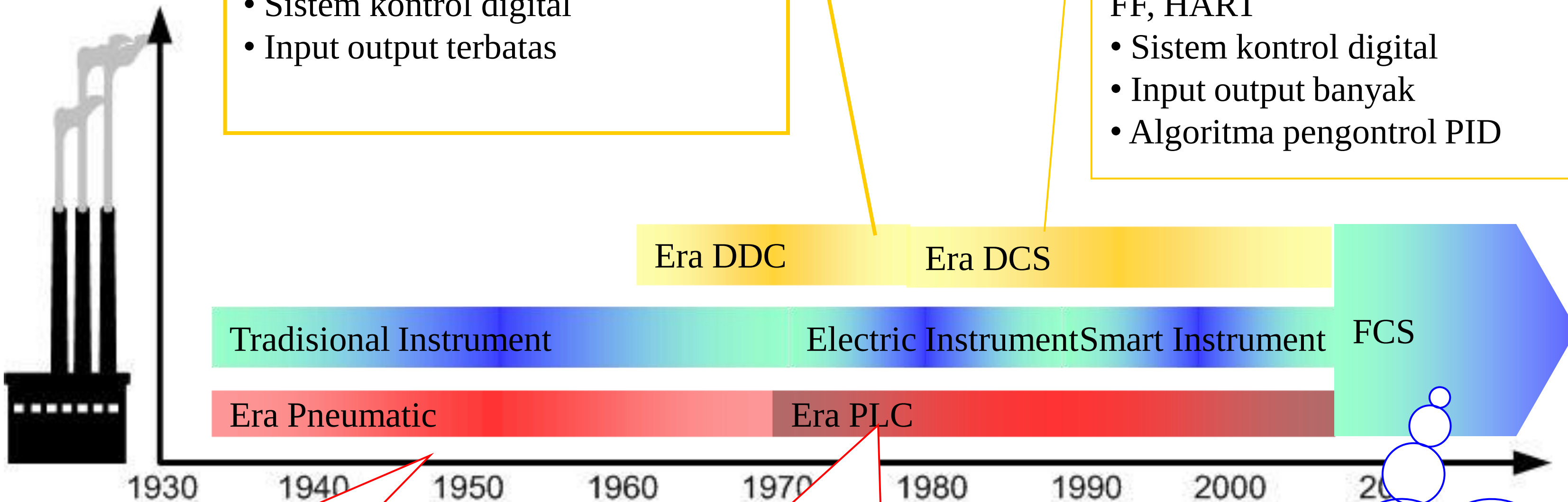


Programmable Logic Controller (PLC)

Sejarah Singkat Sistem Kontrol Industri

- Proses kontinyu
- Sederhana
- Sinyal elektrik analog 4-20 mA
- Sistem kontrol digital
- Input output terbatas

- Proses kontinyu
- Lebih kompleks
- Sinyal elektrik analog 4-20 mA, FF, HART
- Sistem kontrol digital
- Input output banyak
- Algoritma pengontrol PID



- Proses Diskrit
- Sederhana
- Sinyal pneumatic 3-15 psi
- Sistem kontrol penumatik-mekanik
-Input/output terbatas

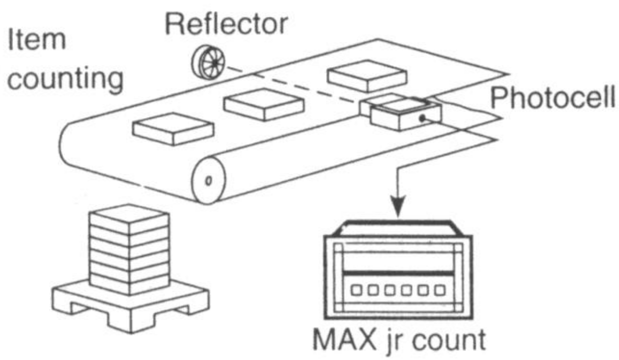
•Menggantikan relay
•Sinyal elektrik 4-20mA
•Sistem kontrol digital
•Input/output banyak
•Sistem kontrol yang lebih kompleks seperti PID

•Sinyal digital
•FF network
•Direct download

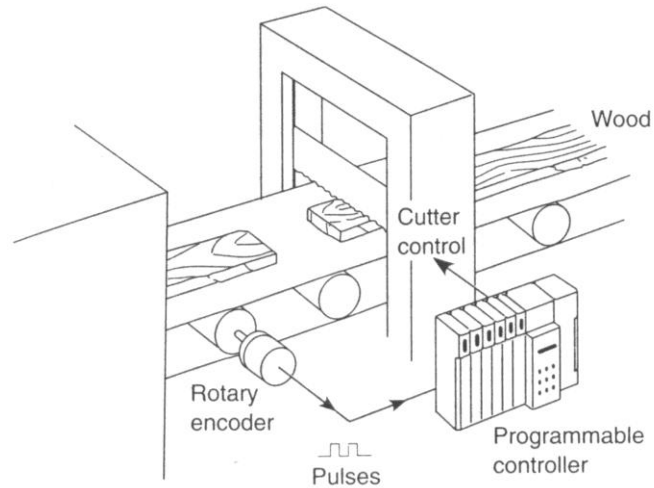
Perkembangan PLC

- Dengan majunya perkembangan elekronika semikonduktor telah membawa revolusi teknologi PLC
- Pengunaan PLC dimulai sekitar tahun 70an dan dipakai pada industri manufakur
- Keuntungan dari PLC:
  - **Efektifitas biaya dalam mengontrol sistem kompleks**
  - **Fleksibel dalam mengkonfigurasi**
  - **Kemampuan komputasi untuk kontrol canggih**
  - **Kemudahan dalam troubleshooting mengurangi downtime.**
  - **Komponen yang mudah didapatkan dapat beroperasi tahunan**

Pemasangan PLC



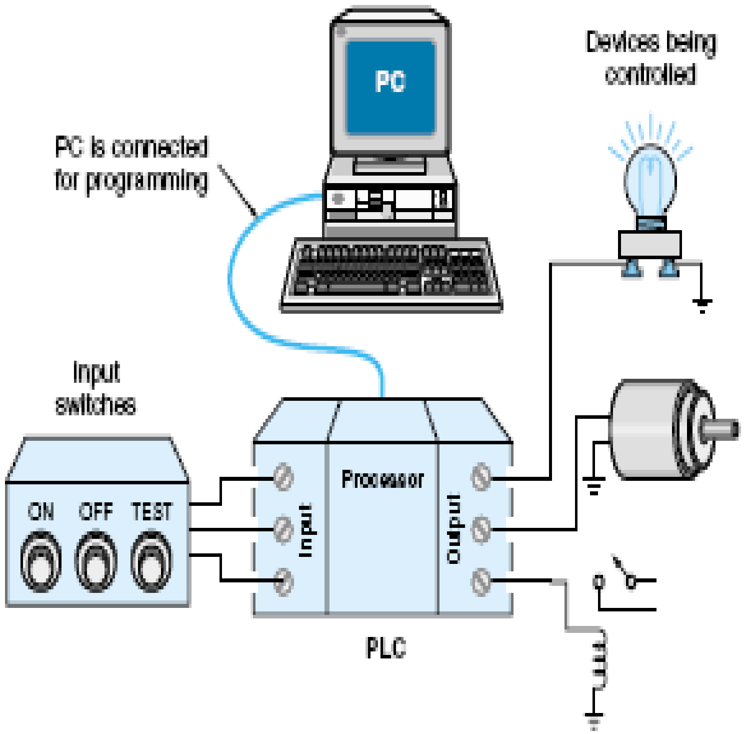
Mechanical Counter

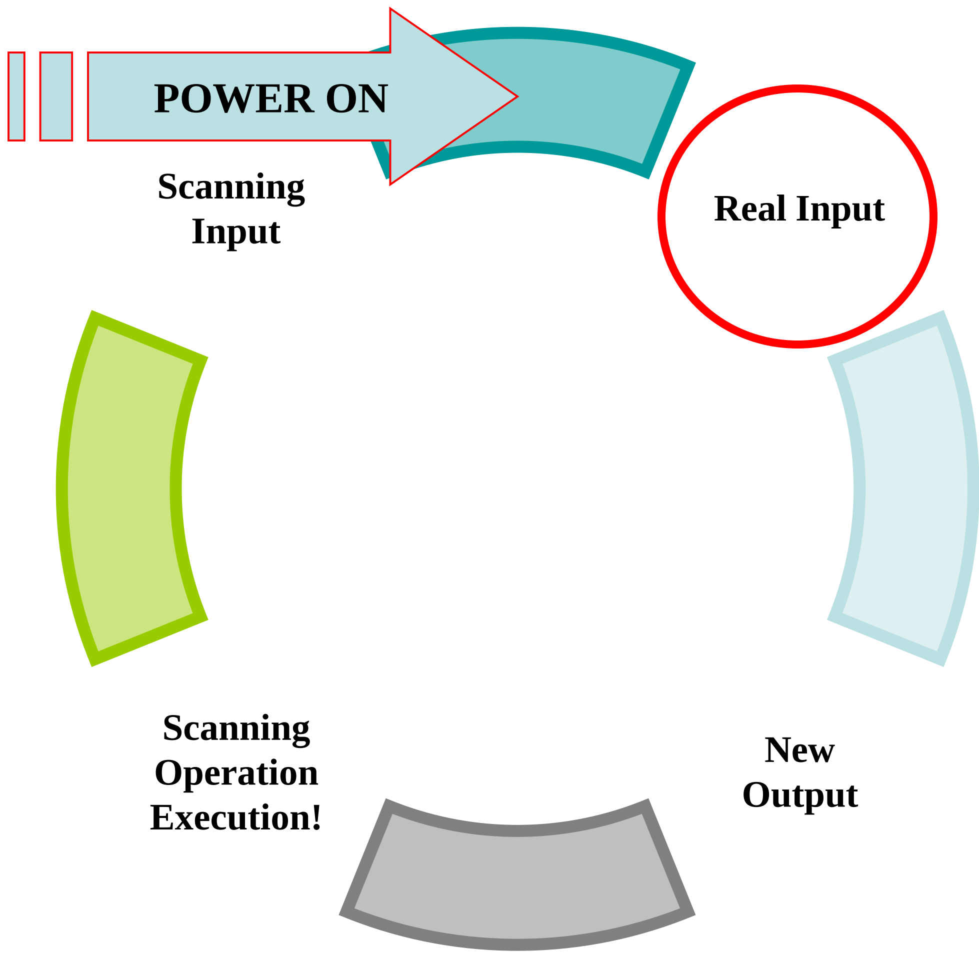


PLC as Counter & Controller

Struktur PLC tidak hanya menampilkan pekerjaan relay, tetapi juga menampilkan aplikasi-aplikasi lain seperti counter, perhitungan, perbandingan dan pemrosesan sinyal analog.

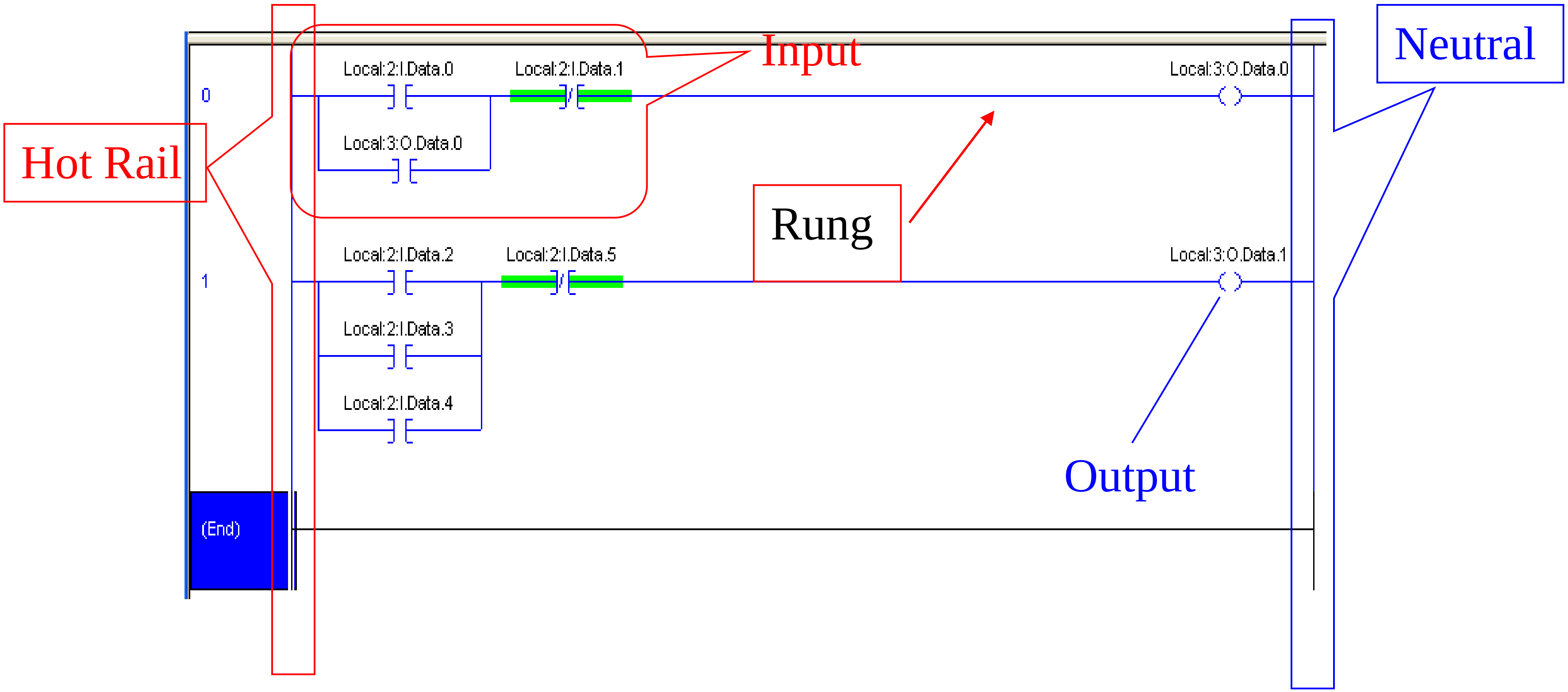
Sistem Kerja PLC



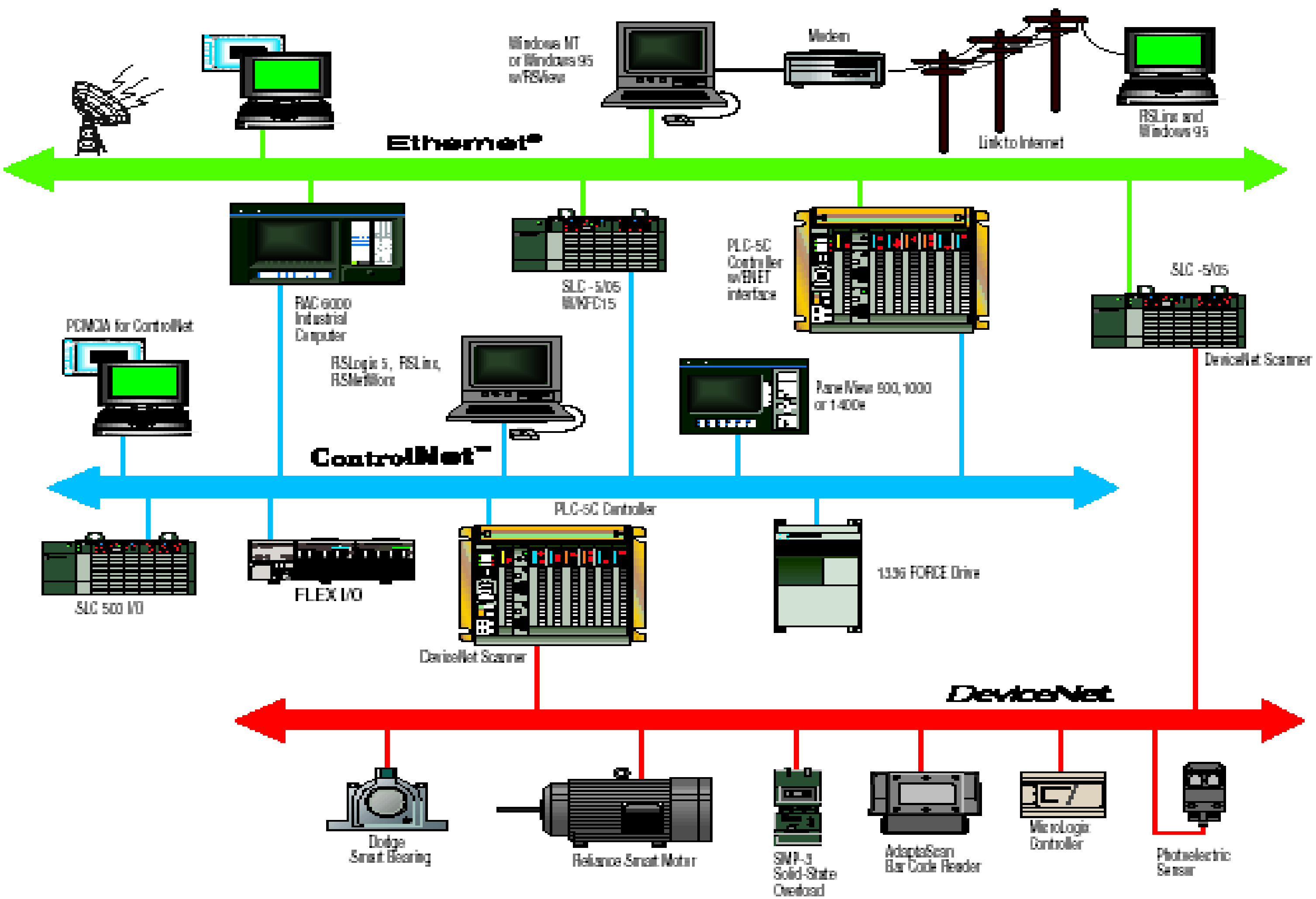


Cara Kerja Program PLC

- PLC diprogram dengan teknik berdasarkan logika skema pengkabelan relay
- Daya listrik ada di sebelah kiri, garis vertikal, hot rail.
- Di sebelah kanan disebut neutral rail.



PLC Saat Ini


Windows NT
or Windows 95
w/RSView
Modem
Link to Internet
RSLinx and
Windows 95
Ethernet®
PLC-5C
Controller
w/ENET
interface
SLC -5/05
W/KFC15
SLC -5/05
RAC 6000
Industrial
Computer
PCMCIA for ControlNet
RSLogix 5, RSLinx,
RSNetWorx
PanelView 900, 1000
or 1400e
DeviceNet Scanner
ControlNet™
PLC-5C Controller
SLC 500 I/O
FLEX I/O
1336 FORCE Drive
DeviceNet Scanner
DeviceNet
Dodge
Smart Bearing
Reliance Smart Motor
SMP-3
Solid-State
Overload
AdaptaScan
Bar Code Reader
MicroLogix
Controller
Photoelectric
Sensor

Keuntungan PLC dalam Otomatisasi

- Waktu implementasi proyek lebih cepat
- Mudah dalam modifikasi
- Kalkulasi biaya proyek lebih akurat
- Memerlukan waktu training lebih pendek
- Perubahan desain lebih mudah (dengan software)
- Aplikasi kendali yang luas
- Perawatan mudah
- Reliabilitas tinggi
- Relatif tahan terhadap kondisi lingkungan yang buruk

SCADA Systems

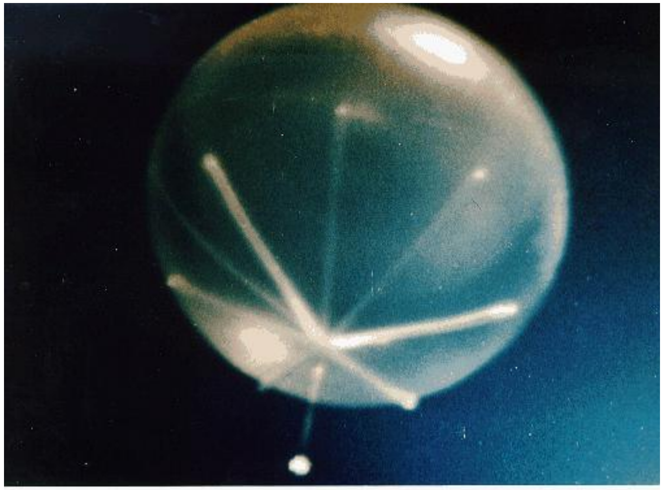
SCADA Terminology

- SCADA is an acronym for ***Supervisory Control and Data Acquisition***
- *Data Acquisition* :
  Gathers information from widely distributed processes
- *Supervisory Control* :
  Calculate and give limited control instructions to distant process facilities

Terms & Terminology

- Field Instrumentation
- Data Acquisition
- Control Loop
- Supervisory Control
- Remote Terminal Unit (RTU)
- Master Terminal Unit (MTU)
- SCADA Server
- Communications Equipment

Historical Background (1)

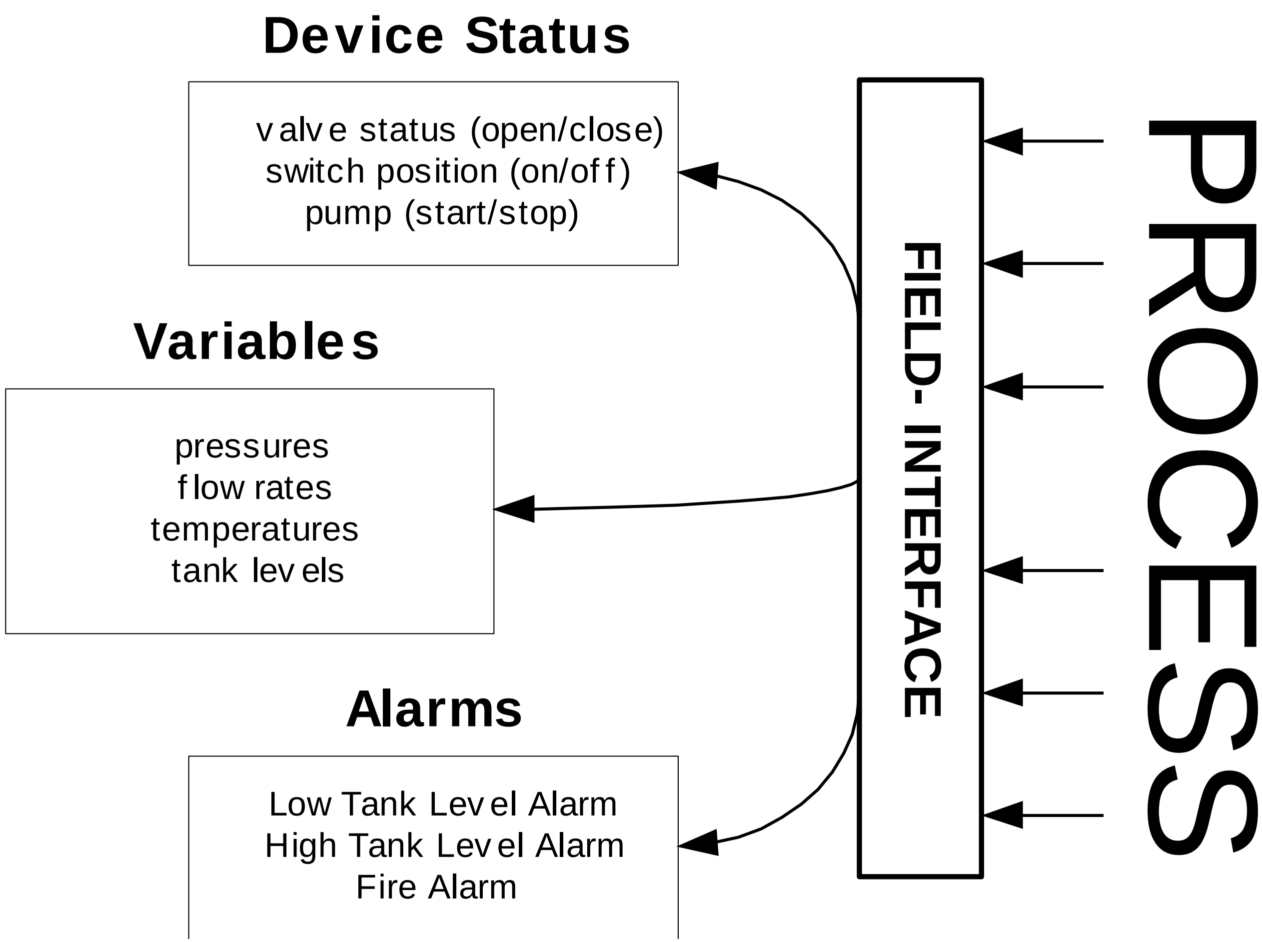


- 1960s:
  - *Radio Telemetry :* weather monitoring using unmanned balloon/rocket
  - *Hardwired Remote Monitoring :* oil & gas and processing industries
- 1970s :
  - *Two-way radio telemetry*
  - *Mini-computer*
  - *Distributed Process Control System (DCS)*
  - *Programmable Logic Controller (PLC)*

Historical Background (2)

- 1980s :
  - *Low cost microcomputer (PC)*
  - *Satellite Communications*
  - *Cellular Telephone*
- 1990s :
  - *Local Area Network (LAN)*
  - *High Speed Communication Devices*
  - *Internet*

Data Acquisition



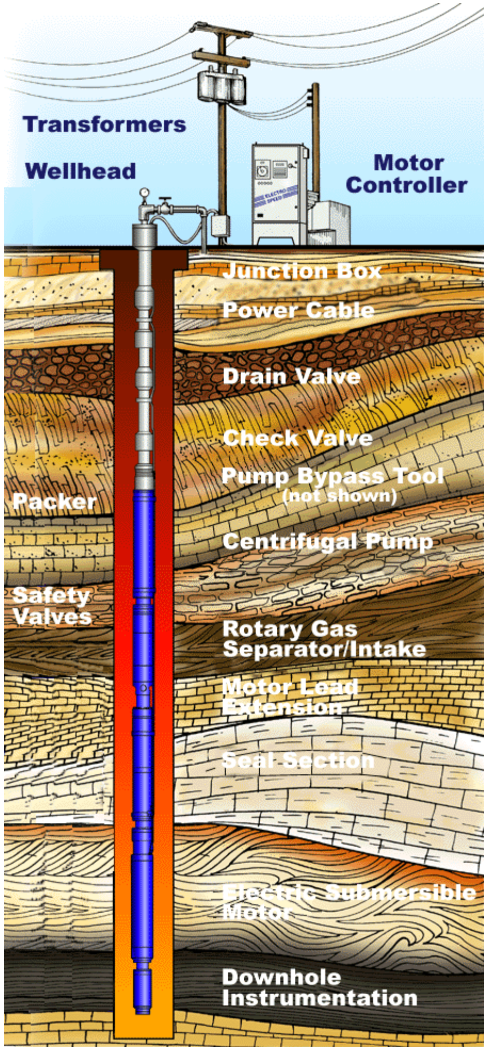
Data Acquisition on an ESP System

Load Current (A)

Line Frequency (A)

Vibration (Hz)

Current Leakage (A)



ESP Compensator Pressure (Mpa)

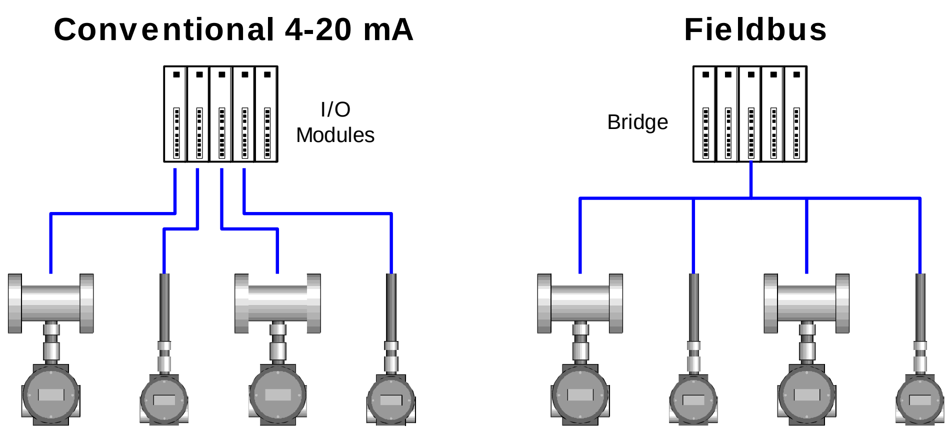
Intake Pressure

Intake Temperature (ºC)

Motor Winding Temperature (ºC)

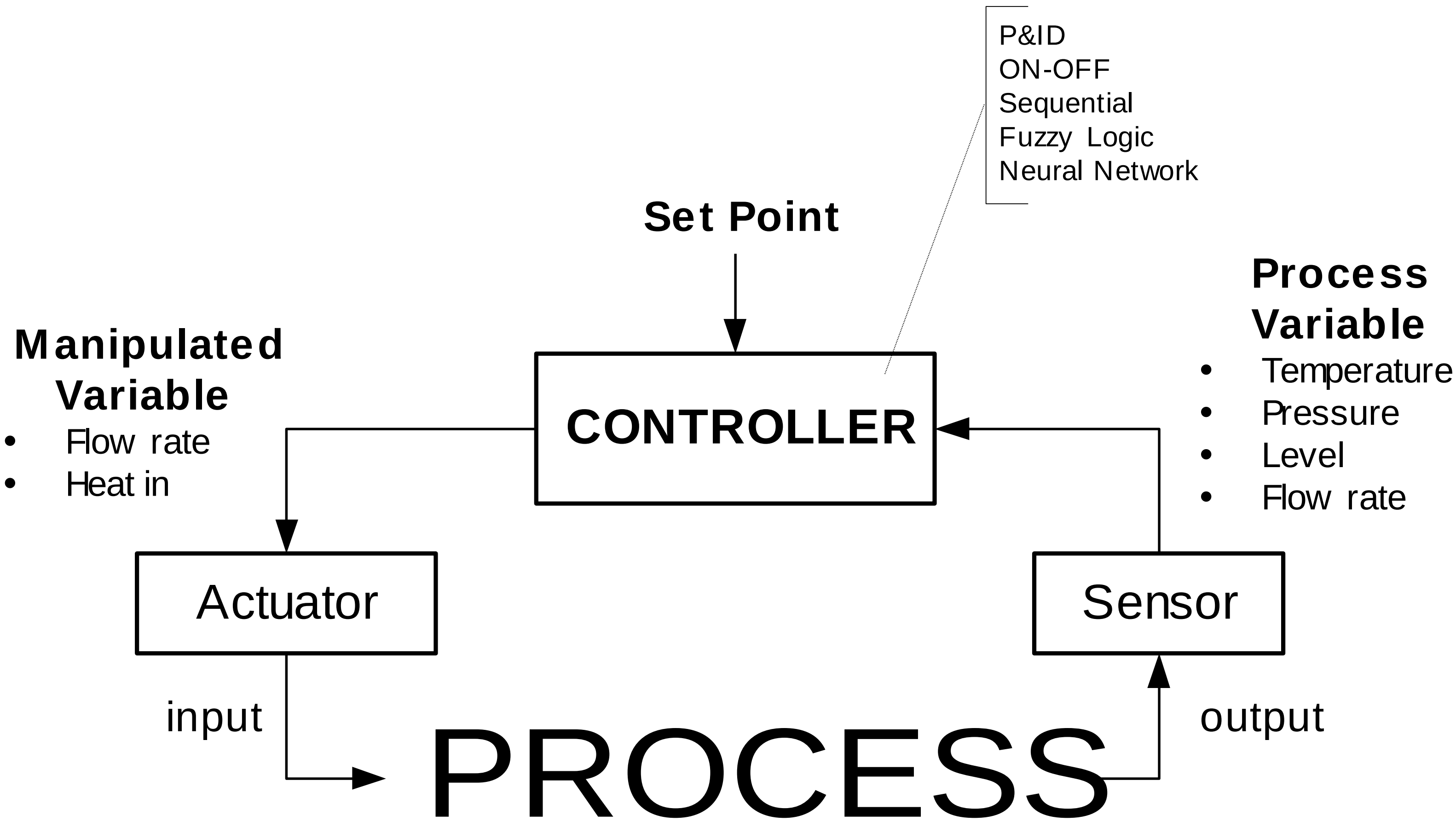
Types of Field Devices

- Conventional
  - 4-20 mA analog signal
  - Discrete status (0/1)
  - Point-to-point configuration
  - Dedicated wiring for each devices



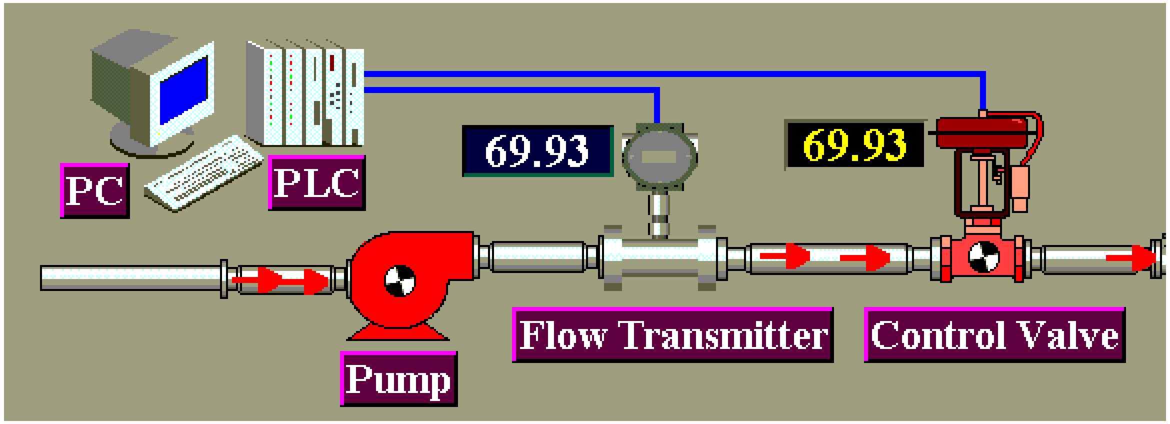
- Fieldbus based
  - Microprocessor and embedded system technology
  - Digital signal
  - Point-to-point or point-to-multipoint
  - Simplified wiring, drawings, and control engineering
  - Embedded control algorithm
  - example :
    - Foundation Fieldbus Transmitter
    - Profibus Transmitter
    - HART transmitter

Control Loop



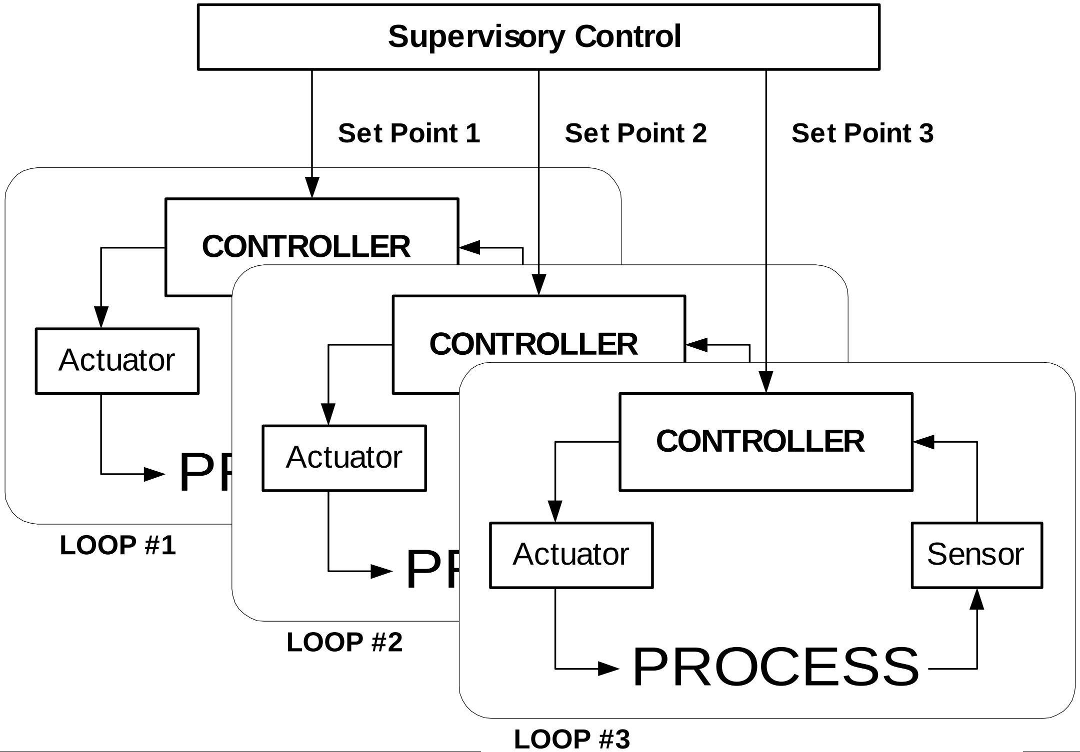
Example : Flow Control Loop

- Objective :
  - maintain flow rate at a desired value (set point)
- Control elements :
  - Sensor : Flow Transmitter
  - Controller : PLC (PID)
  - Actuator : Control Valve



Supervisory Control

- Set point management for several control loops
- Optimization to achieve "the best operating point"
- Use advanced control algorithm
  - cascade controller
  - ratio controller
  - override control
  - etc



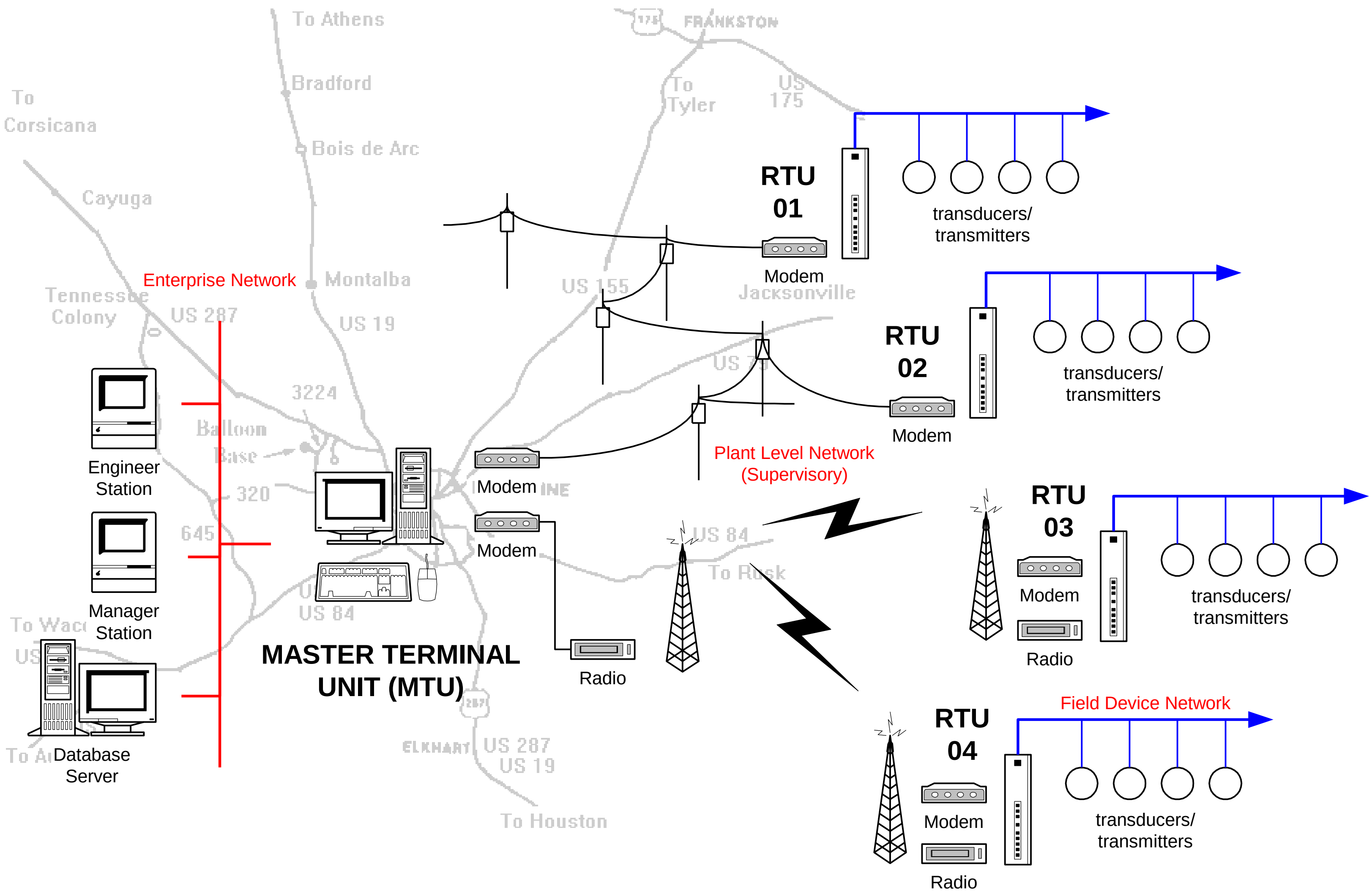
Goals to Achieve

- Technical :
  - Safety
  - Increased productivity
  - Equipment protection and maintenance
  - Operational optimization
  - Energy saving
  - Immediate access to inventories, receipts, deliveries, etc.
- Economical :
  - Plant-wide optimization
  - Optimization of personnel utilization

Applicable Processes

- Widely distributed processes; spreading over large areas
- Require frequent, regular, or immediate intervention
- High cost of routine visits to monitor facility operation
- Examples :
  - Oil and gas production facilities
  - Pipelines for gas, oil, chemical, or water
  - Electric power transmission system
  - Railroad traffic
  - Feed water purification plant
  - Building automation

SCADA System Architecture



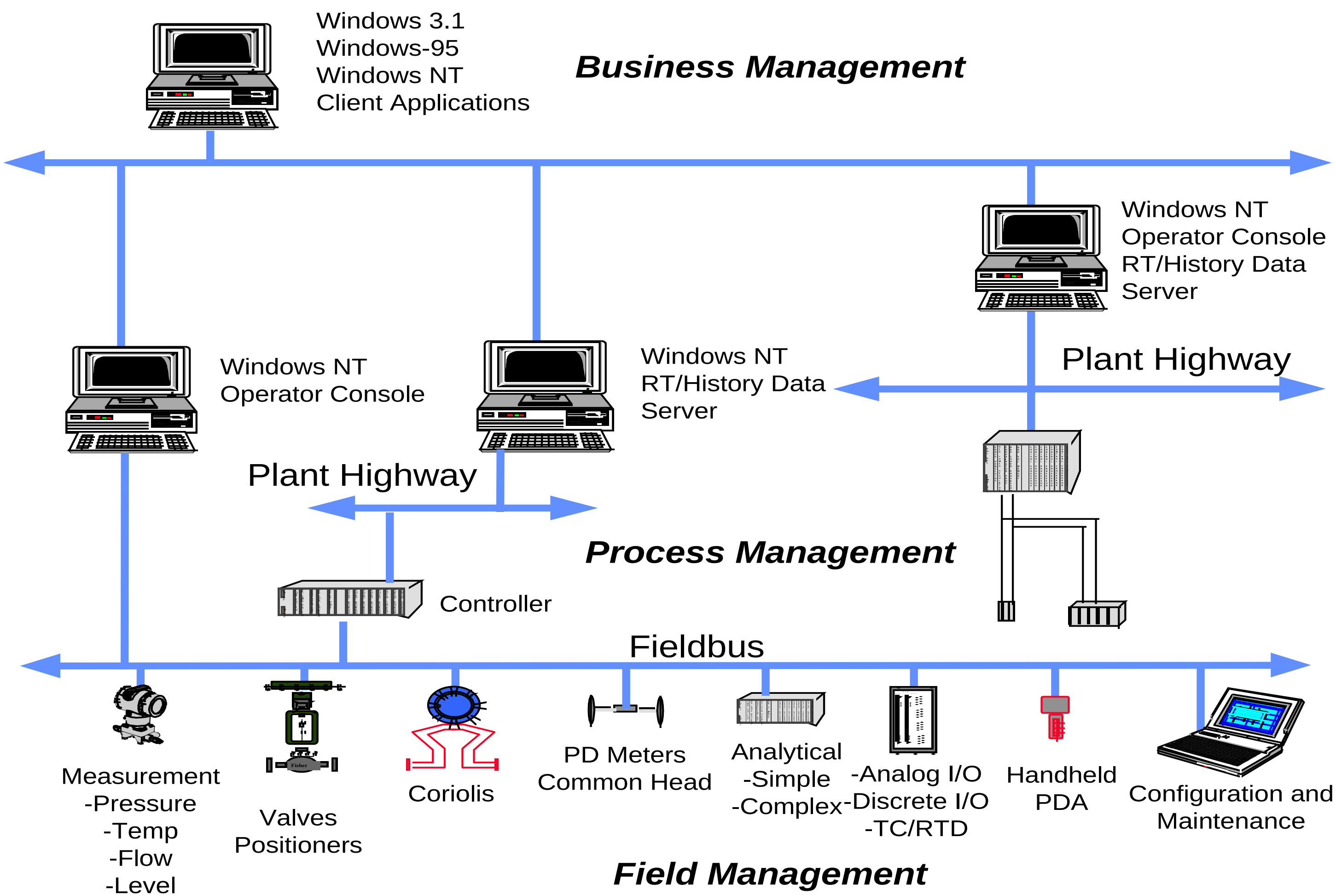
Data Communications

- One MTU can exchange data with one or more RTUs
- Data exchange within MTU and RTUs follows a pre-defined set of rules called *communication protocol*
- Data is encoded as *binary signal* (series of ones and zeros)
- This binary signal is modulated before it propagates through communication medium
- Two-way communications (half or full duplex)
- serial transmission (asynchronous/synchronous)
- Leased or non-leased line
- Guided or wireless medium :
  - radio link (UHF, VHF, microwave, satellite)
  - cable link (telephone, twisted pair, coaxial, power line carrier)
  - fiber optic
  - etc

Remote Terminal Unit (RTU)

- Placed at remote plant location
- Integrated with instrumentation and control systems (PLC or DCS)
- Functions :
  - Gathers information from the field
  - Send the information to MTU
  - Process the supervisory control instruction from MTU

Communications



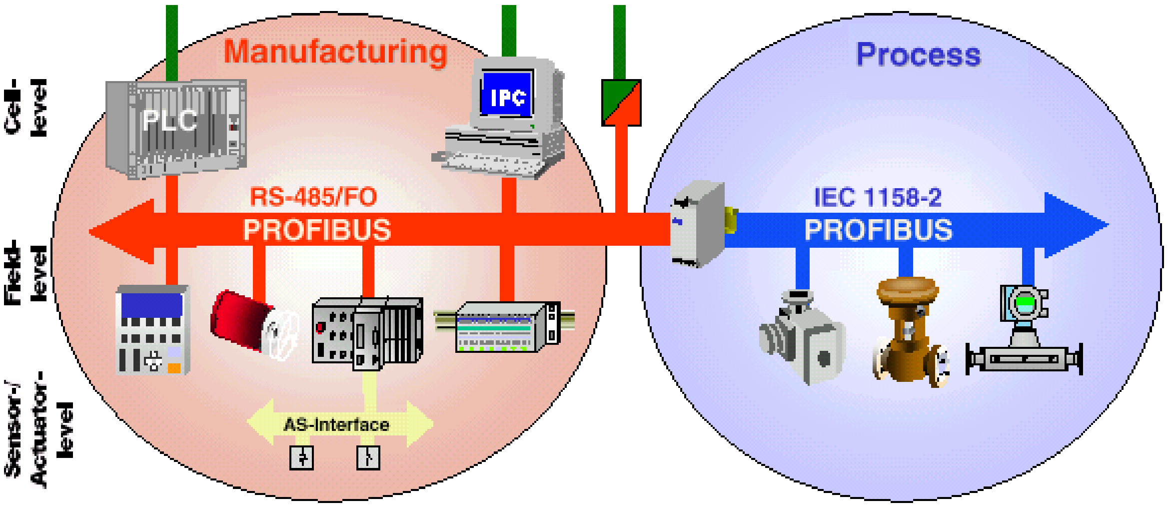
Device Network

Actuator/Sensor Level

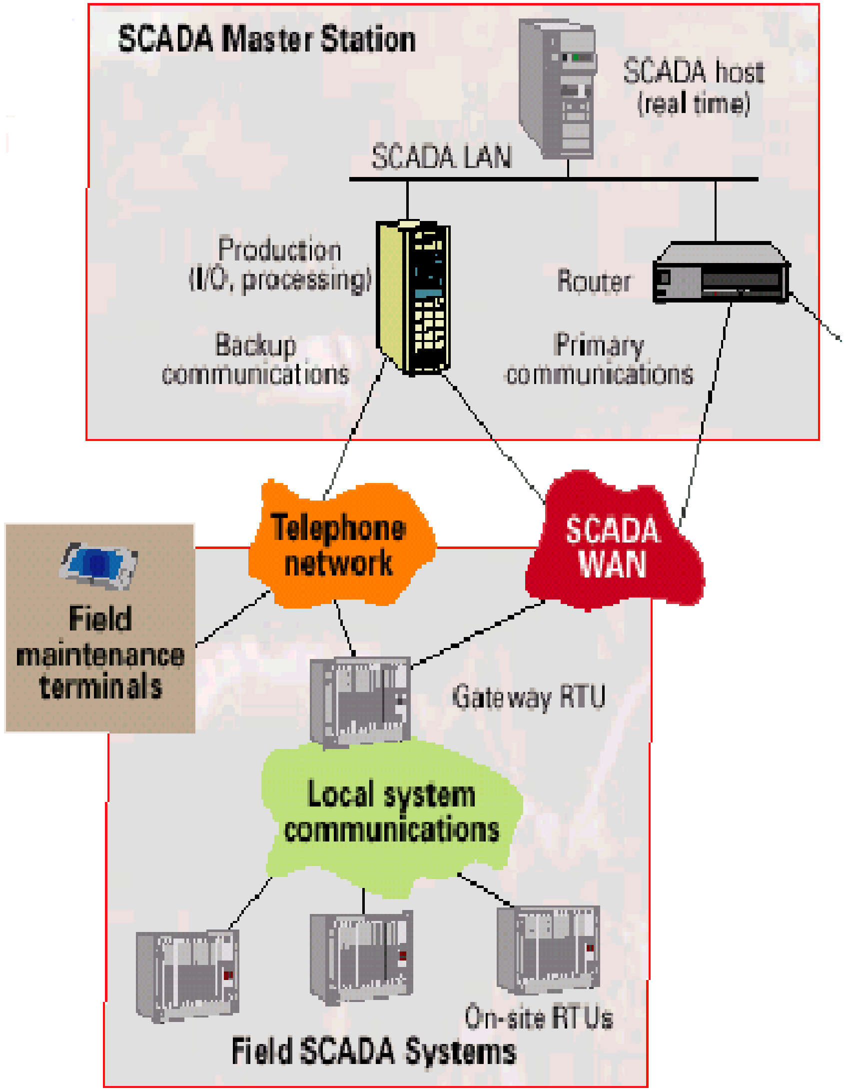
- Analog signals of the conventional sensors and actuators are transmitted via two-wire cable
- One dedicated two-wire cable is required for each sensor/actuator
- Analog-to-digital and digital-to-analog converters are required to enable interfacing and communications with other intelligent devices (programmable controllers, smart transmitter, fieldbus devices)

Field Level

- Intelligent field devices are configured in multidrop/bus topology
- Single or multi-master mode is supported
- The numbers of field devices in a field level network is limited
- Interoperability issue



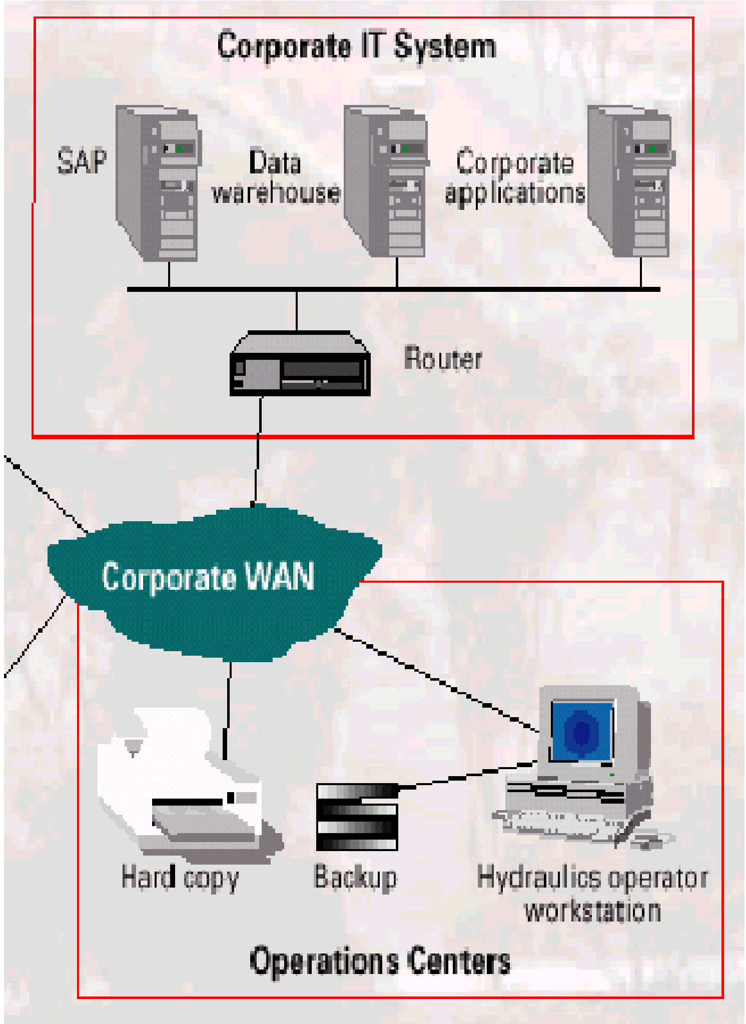
Plant Network



- RTU to Sub-MTU to MTU connection
- Medium
  - guided : cable, telephone, ISDN, optical fiber, etc.
  - wireless : broadcast radio, microwave, satellite
- Protocol
  - DH, DH+, DH-485, ControlNet
  - Modbus, ModbusPlus, ModbusTCP
  - Hostlink
  - DNP

Corporate/Enterprise Network

- Ethernet
- TCP/IP
- Corporate Applications
  - Real time asset management
  - Business support
  - Marketing & sales
  - Procurement
  - Manufacturing
  - Distribution
  - Data warehouse



Master Terminal Unit (MTU)

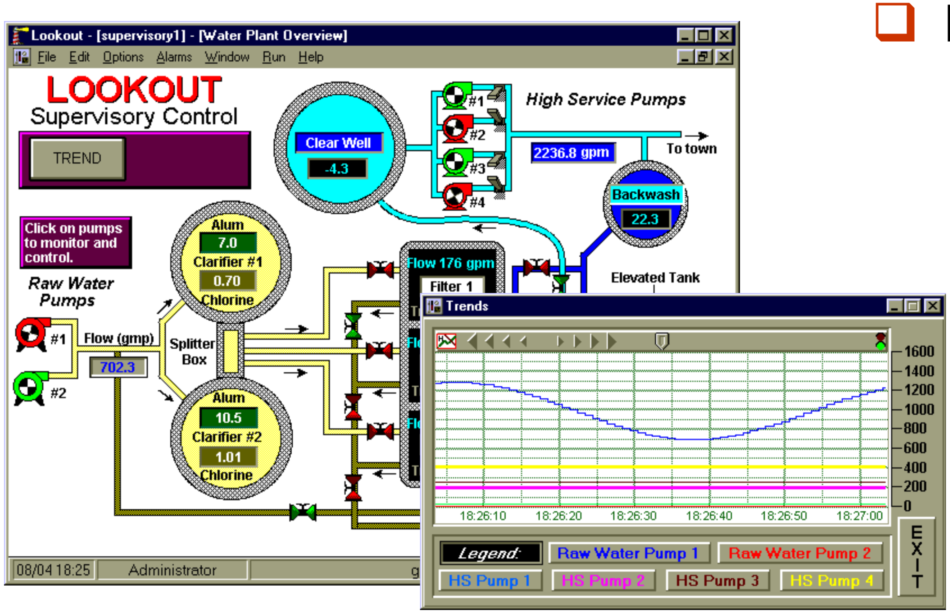
- Customized configuration for each applications
- Connected to Local Area Network (LAN)
- Equipped with auxiliary devices (data storage, console, pointing devices, etc)
- Functions :
  - Collect process information from RTUs and share the information on the LAN
  - Online operator interface (MMI)
  - Send supervisory control instruction to RTUs
  - Alarm management
  - Report generation
  - System security
  - Central data processing

Man Machine Interface (MMI)

- Provides human access to field automation system
  - Operational
  - Maintenance & troubleshooting
  - Development
- Function :
  - Communicates with field I/O from Programmable Logic Controllers (PLCs), Remote Terminal Units (RTUs), and other devices.
  - Gives up-to-date plant information to the operator using graphical user interface
  - Translates operator instruction into the machine
  - Engineering development station
  - Operator station

Man Machine Interface

- Plant information :
  - Process Variables
  - Device status
  - Alarms
  - Control Loops
  - etc

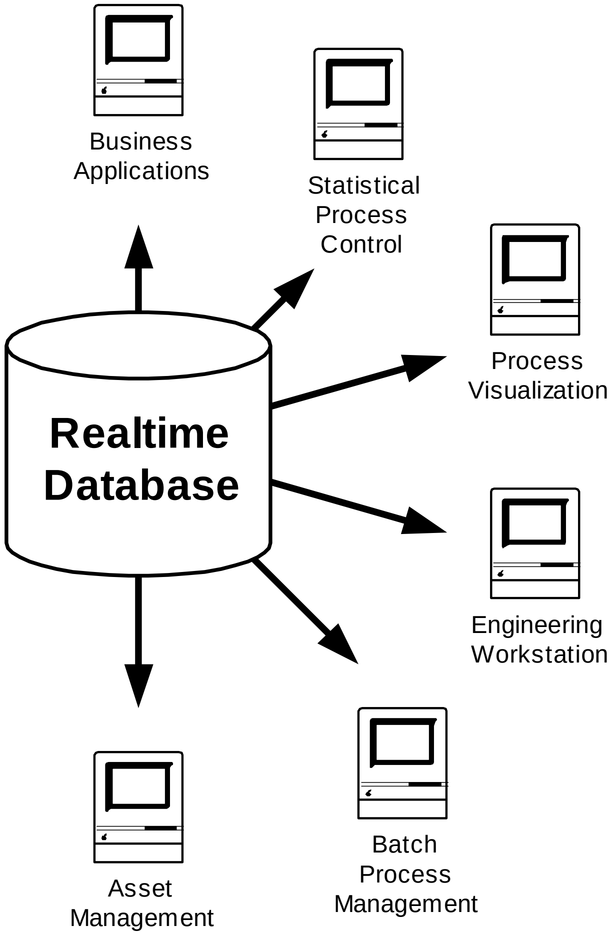


- Presentation Method :
  - Graphics Trending
  - Charts
  - Reports
  - Animation
  - etc
- Equipment :
  - Keyboard
  - Mouse or other pointing devices
  - Touchscreen or CRT
  - etc.

User Applications

- Development tools is provided by SCADA system supplier (scripting tools)
- Examples :
  - Meter gross/net computation
  - Pipeline terminal display
  - Pipeline inventory
  - Transient modeling systems
  - Dynamic leak detection
  - Pipeline simulator
  - Compressor optimization
  - Automatic well testing
  - Well revenue calculation
  - etc.

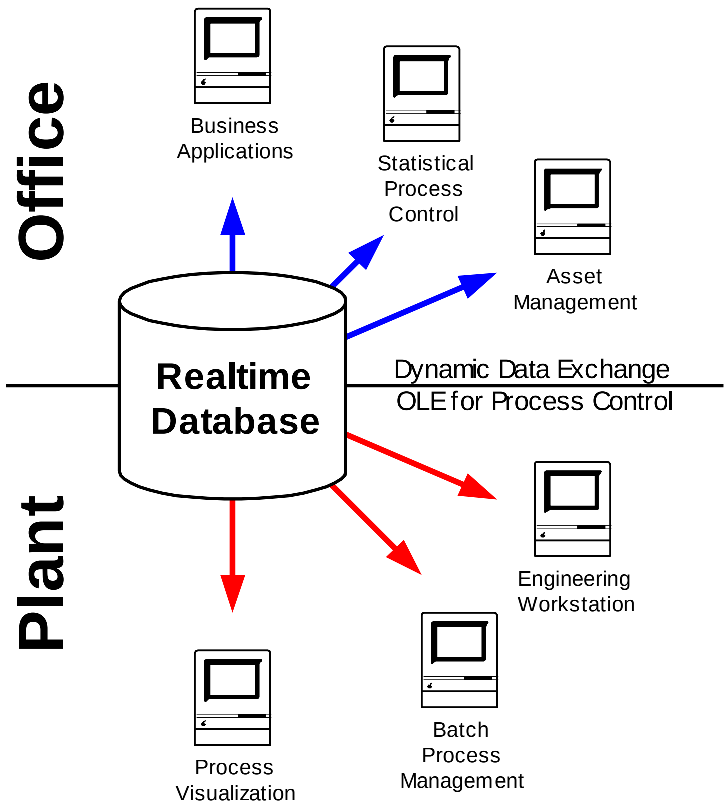
System Database



- Store historical process information for engineering, production, maintenance, and business purposes
- Features :
  - Engineering units conversion
  - Analog value filtering
  - Value limit checking
- Standardized Data Structure
  - Analog point structure
  - Status point structure
  - Accumulator point structure
  - Container points
  - User defined structure
- Each point in the database has a number of associated parameters, all of which can be referenced relative to a single tag name

Plant-Office Data Integration

- Networking has been successfully implemented from field device level up to management level.
- Data can easily be interchanged between applications in the same computer or different computers over a network.
- SCADA system can give an immediate response needed from field device to management system.
- Real-time plant information can be transferred to office application.
- Corporate information system must be designed to meet its business process.



Web-based Process Monitoring

- Internet browser as an acceptable MMI standard will minimizes operator/user training by providing a familiar operating environment
- Many visualization techniques are available (JavaScript, Java, Shockwave/Flash, etc)
- Extra development effort is not needed since SCADA supplier software usually provide integrated web-based and application specific MMI development
- Allows the users (e.g. : supervisor/manager) to monitors process operation, documents and reports either in the Intranet or Internet
- Secured network design is a must to avoid cyber risk such as hacking attempts and virus

Web Based Monitoring Example