DESIGN OF SCADA SYSTEM FOR Engineering Applications

Dr. Sasidharan Sreedharan
www.sasidharan.webs.com
Contents

• Transducers
• Data Acquisition System
• PC Connectivity
• Controllers
• Extension to LAN/WAN
• Conclusion
SCADA Hierarchy

5
- Planning, Statistics, Finances

4
- Production planning, orders, purchase

3
- Workflow, order tracking, resources

2
- Supervisory

1
- Group control
- Unit control
- Field
- Sensors & actors

0
- Primary technology

SCADA = Supervisory Control And Data Acquisition

administration

enterprise

(manufacturing) execution
Transducers

• Transducer
  – a device that converts a **primary form of energy** into a corresponding signal with a different energy form
    • Primary Energy Forms: mechanical, thermal, electromagnetic, optical, chemical, etc.
  – take form of a **sensor or an actuator**

• Sensor (e.g., thermometer)
  – a device that detects/measures a signal or stimulus
  – acquires information from the “real world”

• Actuator (e.g., heater)
  – a device that generates a signal or stimulus
Sensor Systems

We are typically interested in **electronic sensor**

- convert desired parameter into **electrically measurable signal**

• General Electronic Sensor

  - primary transducer: changes “**real world**” parameter into electrical signal
  - secondary transducer: converts **electrical signal** into **analog or digital values**

• Typical Electronic Sensor System
Electronic Sensor Systems

- Components vary with application
  - digital sensor within an instrument
    - microcontroller
      - signal timing
      - data storage
  - analog sensor analyzed by a PC
  - multiple sensors displayed over internet
Primary Transducers

• Conventional Transducers
  
  *large, but generally reliable, based on older technology*
  
  – thermocouple: temperature difference
  – compass (magnetic): direction

• Microelectronic Sensors
  
  *millimeter sized, highly sensitive, less robust*
  
  – photodiode/phototransistor: photon energy (light)
    • infrared detectors, proximity/intrusion alarms
  – piezoresisitve pressure sensor: air/fluid pressure
  – micro accelerometers: vibration, velocity (car crash)
  – chemical sensors: O₂, CO₂, Cl, Nitrates (explosives)
  – DNA arrays: match DNA sequences
Pressure Transducer

A pressure transducer measures the pressure of a fluid or gas.

Blood Pressure Monitoring System

Differential Pressure Transducer

http://www.rdpe.com/
Load Cell

A load cell measures load or force

Example Primary Transducers

- **Light Sensor**
  - *photoconductor*
    - light $\rightarrow$ $\Delta R$
  - *photodiode*
    - light $\rightarrow$ $\Delta I$

- **membrane pressure sensor**
  - *resistive (pressure $\rightarrow$ $\Delta R$)*
  - *capacitive (pressure $\rightarrow$ $\Delta C$)*
Displacement Measurements

• Measurements of size, shape, and position utilize displacement sensors

• Examples
  – diameter of part under stress (direct)
  – movement of a microphone diaphragm to quantify liquid movement through the heart (indirect)

• Primary Transducer Types
  – Resistive Sensors (Potentiometers & Strain Gages)
  – Inductive Sensors
  – Capacitive Sensors
  – Piezoelectric Sensors

• Secondary Transducers
  – Wheatstone Bridge
  – Amplifiers
Displacement Transducer

http://www.rdpe.com/
Temperature Sensor Options

- **Resistance Temperature Detectors (RTDs)**
  - Platinum, Nickel, Copper metals are typically used
  - positive temperature coefficients

- **Thermistors (“thermally sensitive resistor”)**
  - formed from semiconductor materials, not metals
    - often composite of a ceramic and a metallic oxide (Mn, Co, Cu or Fe)
  - typically have negative temperature coefficients

- **Thermocouples**
  - based on the Seebeck effect: dissimilar metals at diff. temps. → signal

\[
R_T = R_0 \left[ 1 + \alpha_1 T + \alpha_2 T^2 + \cdots + \alpha_n T^n \right] = R_0 \left[ 1 + \alpha_1 T \right]
\]

\[
R_T = R_0 \exp \left[ B \left( \frac{1}{T} - \frac{1}{T_0} \right) \right]
\]
Temperature Transducer

http://www.thermometricscorp.com
Example MEMS Transducers

• MEMS = micro-electro-mechanical system
  – miniature transducers created using IC fabrication processes

• Microaccelerometer
  – cantilever beam
  – suspended mass

• Rotation
  – gyroscope

• Pressure

Diaphragm (Upper electrode)

Lower electrode

5-10mm
Passive Sensor Readout Circuit

- **Photodiode Circuits**
  - [Diagram]
  - Voltage divider
  - One element varies

- **Thermistor Half-Bridge**
  - Voltage divider
  - One element varies

- **Wheatstone Bridge**
  - $R_3$ = resistive sensor
  - $R_4$ is matched to nominal value of $R_3$
  - If $R_1 = R_2$, $V_{out}$-nominal = 0
  - $V_{out}$ varies as $R_3$ changes

\[
V_{out} = V_{CC} \left( \frac{R_3}{R_2 + R_3} - \frac{R_4}{R_1 + R_4} \right)
\]
Operational Amplifiers (OPAMPS)

• Properties
  – open-loop gain: ideally infinite: practical values 20k-200k
    • high open-loop gain $\Rightarrow$ virtual short between + and - inputs
  – input impedance: ideally infinite: CMOS opamps are close to ideal
  – output impedance: ideally zero: practical values 20-100$\Omega$
  – zero output offset: ideally zero: practical value <1mV
  – gain-bandwidth product (GB): practical values ~MHz
    • frequency where open-loop gain drops to 1 V/V

• Commercial OPAMPS provide many different properties
  – low noise
  – low input current
  – low power
  – high bandwidth
  – low/high supply voltage
  – special purpose: comparator, instrumentation amplifier
Basic OPAMP Configuration

• Voltage Comparator
  – digitize input

• Voltage Follower
  – buffer

• Non-Inverting Amp

• Inverting Amp
More OPAMP Configurations

- Summing Amp
- Differential Amp
- Integrating Amp
- Differentiating Amp
Converting Configuration

• Current-to-Voltage

\[ V_{out} = -I_{in}R \]

• Voltage-to-Current

\[ I_L = \frac{V_{in}}{R} \]
Instrumentation Amplifier

- Robust **differential gain** amplifier

- Input stage
  - high input impedance
    - buffers gain stage
  - no common mode gain
  - can have differential gain

- Gain stage
  - differential gain, low input impedance

- Overall amplifier
  - amplifies only the differential component
    - high common mode rejection ratio
  - high input impedance suitable for biopotential electrodes with high output impedance

\[ G_d = \frac{2R_2 + R_1}{R_1} \left( \frac{R_4}{R_3} \right) \]
Signal Conditioning Devices

Provides amplification for a wide selection of transducer types. Multiple channel conditioning with or without digital display or RS232.

http://www.rdpe.com
Connecting Sensors to Microcontrollers

• Analog
  – many microcontrollers have a **built-in A/D**
    • 8-bit to 12-bit common
    • many have multi-channel A/D inputs

• Digital
  – serial I/O
    • use serial I/O port, store in memory to analyze
    • **synchronous (with clock)**
      – must match byte format, stop/start bits, parity check, etc.
    • **asynchronous (no clock)**: more common for comm. than data
      – must match baud rate and bit width, transmission protocol, etc.
  – frequency encoded
    • use timing port, measure pulse width or pulse frequency
Connecting Smart Sensors to PC/Network

• “Smart sensor” = sensor with built-in signal processing & communication
  – e.g., combining a sensor and a microcontroller

• Data Acquisition Cards (DAQ)
  – PC card with analog and digital I/O
  – interface through Lab VIEW/MATLAB or user-generated code

• Communication Links Common for Sensors
  – asynchronous serial comm.
    • universal asynchronous receive and transmit (UART)
      – 1 receive line + 1 transmit line. nodes must match baud rate & protocol
    • RS232 Serial Port on PCs uses UART format (but at +/- 12V)
      – can buy a chip to convert from UART to RS232
  – synchronous serial comm.
    • serial peripheral interface (SPI)
      – 1 clock + 1 bidirectional data + 1 chip select/enable
  – I²C = Inter Integrated Circuit bus
    • designed by Philips for comm. inside TVs, used in several commercial sensor systems

  • several different sensor comm. protocols for different applications
Programmable Transducer

Programmable transducer of d.c. current and voltage with RS-485 interface, analog and relays output
Transducer Signal Conditioning Systems

Transducer Signal Conditioning Using 2B31

- TRANSDUCERS (SENSORS):
  - Pressure
  - Temperature
  - Strain
  - Force
  - Torque

- DIFFERENTIAL OUTPUT
  - mV/V
  - mV/mA

- INSTRUMENT AMPLIFIER
- BUFFER
- LOW PASS (2Hz) FILTER

- REGULATED EXCITATION

- ADJUSTABLE BRIDGE EXCITATION

- VOLT./CURRENT SET

- OUTPUT: 0 TO 10V

- INDICATOR CONTROLLER
- RECORDER
- DATA ACQUISITION SYSTEM

2B30J and 2B31J Analog Devices BIOSs

27
Parallel Port PC Interface Circuit
Transducer PC Interface
Transducer PC Interface Module

PC Interface

Wireless Interface Devices

Wireless Interface Mechanism

Diagram showing the flow of power from an AC wall transformer and battery/energy harvest, through regulators, battery backup control, microcontroller, ZigBee transceiver, and to a wireless network server and internet server, ultimately connected to a cell phone.
Microprocessors

80C552 Microprocessor Development Board and interfacing devices
Programmable Logic Controllers (PLC)

1. Programmable, showed the ability in terms of memory for storing programs that have been created that could easily be altered functionality or usefulness.

2. Logic, showed the ability to process input arithmetic and logic (ALU), ie comparing operation, add, multiply, divide, subtract, negation, AND, OR, and others.

3. Controller, showing the ability to control and regulate the process so as to produce the desired output.
Microcontrollers

PIC Serial Communication

PIC USB Interface
RS 232 Interface with Max 232A

Pin 16 +5V and Pin 15 Gnd.
Intelligent Electronic Devices

GE Sub Station Control Module
IED Gate Way Controller
TI's Smart Power and Energy Evaluation Board

Power Analytics, Quality Monitoring, Circuit Breakers, Power protection, Substation automation controller, Intelligent electronic devices
Data Loggers

- Industrial grade enclosure
- 2 Slots for analog or digital input or output cards
- Ethernet interface
- CANbus for expansion modules
- Screw terminal connections
- Up to 16 GB of local memory
- USB Master interface for USB stick memory
- Two PROFIBUS interfaces
- Four serial interfaces
- Signal conditioning within device
- Universal inputs and outputs
- Extended functions / software channels

Delphin Technology Latest Data Logger
INTRODUCTION

TagTemp is a compact water proof temperature data logger. Housed in an IP67 enclosure, TagTemp can be installed in harsh environments in different applications. It can be easily programmed and set via a handy infrared IR-LINK 3 interface connected to a USB port under Windows software or with a Palm compatible PDA, IrDA interface under Palm OS. LogChart II software allows for logger configuration, recorded data retrieval, plotting, historical analysis and exports data to spreadsheets.

Powered by an inexpensive lithium coin cell, it can operate continuously for more than one year. Its high resolution (14 bit ADC) and data memory capacity (16k loggings) makes it the ideal product for accurate monitoring of temperature for long periods or fast sampling.

TYPICAL APPLICATIONS

- Transportation of foods that require refrigeration, allowing tracking of the travel conditions throughout the entire course;
- Transportation of goods in ships during long travels;
- Monitoring of laboratories, recording the ambient temperature;
- Monitoring of computer rooms with easy access to registered information;
- Transportation of medicine or vaccines
- Monitoring of temperature in blood centers;
- Transportation of transplanted organs, testifying ideal temperature conditions;
- Monitoring the complete process of pasteurization of food and beverages.

CONFIGURATION AND DATA DOWNLOAD

Configuring and downloading data with Palm OS compatible devices by means of the Infrared interface is easy and convenient. The data can be transferred to a PC through the HotSync synchronizer.

GENERAL FEATURES

- Enclosure: IP67, flame retardant, ABS+PC
- Dimensions: 47 x 30 x 12 mm
- Temperature measurement accuracy: ±0.5 °C
- Reading resolution: 14 bits or 16,384 levels
- Memory capacity: 16,000 loggings
- Reading intervals: from 1 second to 1 hour
- Loggings can be programmed to start immediately, on exit by the device’s button, by date/time or by programmed setpoint or through a PDA
- Loggings can be programmed to stop at full memory, at some specified number of samples or never (circular memory)
- Internal button to command alarm/stop logging
- Configuration and data retrieval software for Windows 98, XP, 2000 and PalmOS
- Non contact IR communication up to 2 feet, 30° angle
- Operating temperature: -20 °C to +70 °C
- Internal replaceable lithium coin cell (2032 type)
- Estimated battery life: 1 year with one weekly download and 6 minutes measuring interval. Battery life depends heavily on data retrieval frequency
- Accepts up to 40 identification characters for user application
- LED indication of functioning mode and alarm
Remote Terminal Units

Promosys  USD $ 180 / pc
Net Guardian 832A SNMP Remote Terminal Unit

832A mediates 32 discrete alarms, 32 ping alarms, and 8 analog alarms to SNMP traps, and supports multiple SNMP managers at multiple IP addresses.
MATLAB Data Acquisition Toolbox

• Data Acquisition toolbox provides functions for connecting MATLAB to Data Acquisition Hardware

• Data Acquisition toolbox provides a complete set of tools for analog i/p, analog o/p and digital I/o from variety of PC compatible data Acquisition hardware

• The toolbox configure data acquisition hardware and read data into MATLAB and Simulink for immediate analysis and send out data

• Data Acquisition toolbox is used to write and read data from **USB-6008 DAQ device from National Instruments**.
USB – 6008 DAQ Device

NI USB – 6008 is a simple and low-cost multifunction I/o device from NI

The device has following specifications

• 8 Analog i/p’s (12 bits, 10kS/s)
• Compatible with Lab View, Lab windows and Measurement Studio for
  visual studio.NET

NI DAQmx Driver Software

NI DAQmx Driver

• NI provides a native .NET API for NI – DAQmx
• This is available as a part of the NI - DAQmx driver and does not require a measurement Studio
Simulink

- Simulink is developed by the MathWorks is a commercial tool for modeling, Simulating and analyzing dynamic systems
- Its primary interface is a graphical block diagramming tool and a customizable set of block libraries
- It offers tight integration with the rest of the MATLAB environment and can either drive MATLAB or be scripted from it
- Simulink is widely used in control theory and digital signal.
Data Acquisition System

• The purpose of Data Acquisition is to measure an electrical or physical phenomenon such as Voltage, Current, temperature, pressure and sound

• PC-based Data uses a combination of modular hardware application Software and a computer to take measurements

• Data Acquisition is a process of acquiring signals from real world phenomena
  
  Digitizing the signals analyzing presenting and saving the data

• The DAQ systems has following parts
  
  • Physical inputs/output signals
  
  • DAQ device/hardware
  
  • Driver Software
  
  • Application Software
PC-BASED DATA ACQUISITION

INPUT/OUTPUT SIGNALS

ANALOG

DIGITAL

COUNTER/TIMER

SENSORS

HARDWARE

DATA ACQUISITION HARDWARE

SOFTWARE

APPLICATION AND DRIVER SOFTWARE
**Physical input/output signal**

- A physical input/output signal is typically a voltage or current signal

  **DAQ Device/Hardware**

- DAQ hardware acts as the interface between the computer and the outside world

- It primarily functions as a device that digitizes incoming analog signals so that the computer can interpret them

- A DAQ device (Data Acquisition Hardware) usually has these functions
  - Analog i/p
  - Analog o/p
  - Digital I/o
  - Counter/Timer
• Different DAQ devices such as
  • “Desktop DAQ devices” where we need to plug a PCI DAQ board into the computer. The Software is running on the computer
  • “Portable DAQ devices” for connection to USB port Wi-Fi connections etc. The Software is running on Computer
  • “Distributed DAQ devices” Where the software is developed on the computer and then downloaded to the distributed DAQ device
**Driver Software**

- Driver Software is the layer of software for easily communicating with the hardware.
- It forms the Middle Layer between the Application software and the hardware.
- Driver Software also prevents a programmer from having to register level programming or complicated commands in order to access the hardware functions.
- Driver Software from NI: NI-DAQmx.

**Application Software**

- Application Software adds analysis and presentation capabilities to the driver software.
  
  The software applications does the tasks as:
  
  - Real Time Monitoring
  - Data analysis
  - Data logging
  - Control Algorithms
  - Human Machine interface (HMI)

- In order to create a DAQ application we need a programming development tool such as Visual Studio/C#, Lab View etc.
MAX – Measurement and Automation Explorer

• Measurements and Automation Explorer (MAX) provides access to the National Instruments devices
• With MAX we can
  • Configure our NI hardware and software
  • Create and edit channels, tasks, interfaces, scales, and virtual Instruments
  • Execute system diagnostics
  • View devices and instruments connected to the system
  • Update the NI software
**DAQ in MATLAB**

- It is used to create DAQ applications with or without Measurement Studio in both situation NI – DAQmx driver library is needed
  
  **NI – DAQmx**

- NI provides a native .NET API for NI – DAQmx. This is available as a part of the NI – DAQmx driver and does not require Measurement Studio

- Data Acquisition Programming with DAQmx involves the following steps
  
  - Start the task
  - Perform a read operation
  - Perform a write operation to DAQ
  - Stop and clear the task

- Data Acquisition is a text – based programming is similar to Lab View
  
  NI – DAQmx  programming its function calls is same as NI – DAQmxVIs
DAQ Application

Introduction

• Data Acquisition Toolbox in MATLAB create a simple Data Acquisition application
• A simple DAQ applications should follow these steps
  • Initialization
  • Read/Write
  • Clean Up
• Initialization

Creating a device object

In Initialization we need to specify what kind of device we are using. We can analog input()
And analog output() function in data acquisition toolbox

Example

ai = analog input (‘nidaq’, ‘Dev1’);
and:
ao = analog output (‘nidaq’, Dev1’);
• The data Acquisition Toolbox supports DAQ devices from different vendors. In order to use a Device from NI we need to set “nidaq” as the adapter name. DevX is the default name created by the system.

• Adding channels
  Example: ai0 = addchannel(ai, 0);

• Read/Write
  Example: a0_value = 3.5;
  putsample(a0, a0_value)
  ai_value = getsample(ai)

• Cleanup
  delete(a1)
Sample Code

% Write and Read to a NI USB-6008 DAQ device

clear
clc

% Initialization-----------------------

% Analog Input:
ai = analoginput('nidaq', 'Dev1');

% Analog Output:

ao = analogoutput('nidaq', 'Dev1');

% Adding Channels------------------

% Analog Input - Channel 0

ai0 = addchannel(ai, 0);
ao0 = addchannel(ao, 0);
% Write Data------------------------------------------
ao_value = 3.5;
putsample(ao, ao_value)
% Read Data------------------------------------------
ai_value = getsample(ai)
% Cleaning Up----------------------------------------
delete(ai)
delete(ao)
DAQ in Simulink

- Simulink has built - in blocks for data acquisition, but depending on the version of MATLAB/Simulink they might not work properly with USB-6008 DAQ device. In that case we can call MATLAB function from Simulink.

Simulink/Data Acquisition Toolbox (R2007a) is used.
# Generic visualization packages

<table>
<thead>
<tr>
<th>Company</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB</td>
<td>Process Portal, Operator interact</td>
</tr>
<tr>
<td>CTC Parker Automation</td>
<td>CitectSCADA (AUS, ex CI technologies,</td>
</tr>
<tr>
<td>Citect</td>
<td></td>
</tr>
<tr>
<td><a href="http://www.citect.com">www.citect.com</a>)</td>
<td></td>
</tr>
<tr>
<td>Intellution (GE Fanuc)</td>
<td>Intellution (iFix3.0) 65000 installs, M$38 turnover</td>
</tr>
<tr>
<td>Iconics</td>
<td>Genesis</td>
</tr>
<tr>
<td>National Instruments</td>
<td>LabView, Lookout</td>
</tr>
<tr>
<td><strong>Rockwell Software</strong></td>
<td><strong>RSView</strong></td>
</tr>
<tr>
<td>Siemens</td>
<td>WinCC, ProTool/Pro</td>
</tr>
<tr>
<td>Taylor</td>
<td>Process Windows</td>
</tr>
<tr>
<td>TCP</td>
<td>SmartScreen</td>
</tr>
<tr>
<td>USDATA</td>
<td>Factorylink, 25000 installs, M$28 turnover</td>
</tr>
<tr>
<td><strong>Wonderware (Invensys)</strong></td>
<td><strong>InTouch</strong>, 48000 installs, M$55 turnover</td>
</tr>
</tbody>
</table>

…XYCOM, Nematron, **Modicon PanelMate**, OIL System PI Data Historian. Ann Arbor Technology, Axeda, Eaton Cutler-Hammer, ei3, InduSoft, Opto22, ….
INTELLIGENT CONTROLLERS
Controller - Definition

A controller is a device which monitors and affects the operational conditions of a given dynamical system.
Conventional Controllers

1. **On-off Control** (on-off signaling is sufficient: thermostat control of heater)
2. **Proportional Control**: (Good alternative to on/off control.
3. **Derivative Control**
4. **Integral Control**
5. **PID Control**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Response time</th>
<th>Overshoot</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-off</td>
<td>Smallest</td>
<td>Highest</td>
<td>Large</td>
</tr>
<tr>
<td>Proportional</td>
<td>Small</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Integral</td>
<td>Decreases</td>
<td>Increases</td>
<td>Zero</td>
</tr>
<tr>
<td>Derivative</td>
<td>Increases</td>
<td>Decreases</td>
<td>Small change</td>
</tr>
</tbody>
</table>
Brain Interface

Robotic Control

Power Suite

KANAGAWA POWER SUIT
Boeing 737 cockpit control
Intelligent systems

• Intelligence: System must perform meaningful operations.

• Interprets information.

• Comprehends the relations between the phenomena or objects.

• Applies the acquired information to new conditions.
Intelligent Controllers

• Neuro
• Fuzzy
• Evolutionary – genetic
• Hybrid fuzzy neuro genetic controllers
• Particle Swarm
• Bacteria Foraging
• Ant Colony
Neural networks (NN, 1940's)

Neural networks offer a powerful method to explore, classify, and identify patterns in data.

- **Website of Matlab**
- Neuron: $y=\sum w_i x_i$
Neural networks

• Simplified model of biological nervous system; analogous to human brain with large number of neurons.
• Once trained, the network can be put to effective use in solving unknown or untrained instances of the problem.
• Can be applied to problems in pattern recognition, image processing, data compression, forecasting, optimization etc.
Fuzzy Logic

• Fuzzy logic representations founded on Fuzzy set theory try to capture the way humans represent and reason with real world knowledge in the face of uncertainty.

• Wide applications in consumer electronics.
Fuzzy Logic

• Deal with imprecise entities in automated environments (computer environments)
• Base on fuzzy set theory.
• Most applications in control and decision making

Matlab's Fuzzy Logic Toolbox

Omron’s fuzzy processor
Genetic Algorithms

• Developed in 1970 by John Holland.
• Random search which mimic some of the processes of natural evolution.
• Based on a qualifying function termed as fitness function.(fitness means figure of merit)
• Genetic operators such as reproduction, cross over, mutation etc are used.
• Used for optimization applications
Particle Swarm Optimization

- It was developed in 1995 by J. Kennedy and R. Eberhart

- PSO is a robust stochastic optimization technique based on the movement and intelligence of swarms.

- PSO applies the concept of social interaction to problem solving.

- It uses a number of agents (particle) than constitute a swarm moving around the search space looking for the best solution.
ANT COLONY ALGORITHMS

Ant Algorithms – (P.Koumoutsakos – based on notes L. Gamberdella (www.idsia.ch)}
Bacteria Foraging

- Algorithm based on how bacteria multiplies
Figure 2.3.5  Parts of a manipulator: The industrial robot manipulator has a body, arm, and wrist. Names match those of the corresponding human parts.
Figure 2.3.1 Basic components of an industrial robot
What is AIBO?

AIBO stands for "Artificial Intelligence RObot"
- it also means friend in Japanese

AIBO's (generation 1) exterior is designed by the Japanese artist Sorayama Hagime (also known from Playboy magazine)

AIBO was the first of its kind – at least commercially
AIBO before design!

Instincts:
- Exercise
- Affection
- Appetite
- Curiosity

Emotions:
- Joy (Happiness)
- Sadness
- Anger
- Surprise
- Disgust / (Discontent)
- Fear

AIBO stands for "Artificial Intelligence ROBOT"
LAN WAN Interconnection
Protocol Converters

RJ45 LAN port (10BaseT) allows communication via protocols such as **IEC 60870-5-104**.
Traditional Control
Traditional Control

- Dedicated Consoles
- Point to point communication
- No network
  - No remote access
  - No remote diagnostic
SCADA?

Supervisory Control

And

Data Acquisition

Archiving, Logging, Access Control, Alarms

Graphics and Batch processing

Distributed database

Data Server

PLC’s

Field Bus

Control Programs

Used when Application size exceeds:

20 K I/O to 450 K I/O
What, Where and Why

• What is “SCADA” and where is it used
  – Supervisory Controls And Data Acquisition
  – Application area:
    • Industrial processes: chemical, power generation and distribution, metallurgy, ...
    • Nuclear processes: reactors, nuclear waste, ...
    • Experimental physics: Tokamaks, HEP laboratories
  – Application size:
    • 20 K I/O to 450 K I/O
What do SCADA Provide?

• Flexible and open architecture
• Basic SCADA functionality
  • MMI
  • Alarm Handling and Trending
  • Access Control
  • Automation
  • Logging, Archiving, Report Generation
• Interfaces to H/W and S/W
• Interfaces to ERP- and Expert-Systems
• Development Tools
SCADA functions (1): MMI
SCADA functions

• Trending
  • Multiple trending charts
  • Charts are pre-defined or configured on-line
  • Charts contain multiple pens,
  • Zooming, scrolling, panning, ‘Hairline’
  • Real-time and historical trending

• Alarm Handling
  • Based on limit and status checking *
  • Alarms are **time stamped and logically centralised**
  • Notifications (audible, visual, Email, GSM)
  • Multiple **alarm priority levels**
SCADA functions

• Access Control
  • Users organised in groups with a set of allocated privileges
  • Large number of groups possible
  • Privileges limit write access to process parameters
  • Some allow access to graphics and functionality to be limited

• Automation
  • Actions can be initiated automatically triggered by an event *
  • Recipes
  • Sequencing and scripting possibilities

• Logging, Archiving
  Data stored in compressed and proprietary format
  Logging / Archiving either for a set number of parameters or for a set period of time
  Logging / Archiving can be frequency or event driven *
  Logging of user actions together with a user ID
  VCR facility for playback of stored data

• Report Generation
  Reports created using SQL type
  Automatic generation, printing and archiving of reports
  Use of ‘components’ for report generation
Benefits of SCADA

• Standard frame for application
• Rich functionality
• Reliability and Robustness (very large installed base, mission critical processes)
• Limited specific development
• Technical support and maintenance
Communication for SCADA Systems

• It should be stressed that communication is of primary importance for SCADA system.
• In most application, a normal telephone voice channel of about 400 to 3400 Hz bandwidth is satisfactory.
• For low speed data transmission, a narrow bandwidth, usually located above the highest voice frequency, can be used.
• In such cases, the voice band is restricted to about 400 to 2200 Hz, and the data are transmitted from 2200 to 3400 Hz.
• This type of operation is called “Speech-plus,” and it provides for both voice and data communication on a single voice channel, with a somewhat degraded voice channel.
Is SCADA the only Future? ...

New Technology: Jet Web
Each node is an individual Web Server
All nodes and all I/O hooked up to the Ethernet

... probably not, but a very attractive one.
Regards,

Dr. Sasidharan Sreedharan
YBL Systems and Solutions
(Electrical Power System Research Consultants)
www.sasidharan.webs.com