Levels of Digital System Construction

Operation & Maintenance of Commercial Product

Implementing Commercial Product

Commercial Product Development

Plant Operations

System Engineering

Design Engineering

System Integrator

Product Architecture Engineer

I&C Maintenance Engineering

Module Design Engineer

Plant Specific Construction

Manufactured Construction

Root Cause(s) Analysis may require this level of knowledge

Knowledge of this level may be needed for critical or precision requirements.

GRID

Plant

Plant System

Feedwater Control
Turbine Control
Radiation Monitoring
HPCI/RCIC

Application-Specific Configuration

Equip Layout Network Comm	Plant Sys Logic Displays/Cntrls

Dip-Switch Settings / System Parameters

System Platforms

Engineering/Operator Stations
Primary Logic Processor
Remote I/O Station
Communication Topology
Communication Routers

Modules

Analog/Digital Input Cards
Analog/Digital Output Cards
I/O Station Processor Cards
Main Logic Processor Cards
Network Interface Cards

Module Internals

Circuit Boards: etching layout Backplane Power Supply	Cntrl Executive Watchdog Logic Timing Diagnostics Communication

Components

Resistors Flash Memory CPU/ADC/DAC	Compilers OS Kernel Math Library

Ethernet Switches/Firewalls
COTS Software/Hardware

Component Fabrication

Silicon Wafers	Micro-code

Product Development

Module Design Engineer

- Common HW / SW functional subsystems?
- System shared resources?
- Inter-module communication requirements?
- What form factor to use?
- Multiplex I/O channels?
- What level of diagnostics do we need?
- What are the system power sources?
- What are EMI/RFI requirements?
- Have I created antennas or transmitters?
- What type of watchdog circuit should be used?
- Should we mask interrupts during critical processing?
- Which components meet the accuracy, speed, reliability, and cost criteria?
- Do we use an OS kernel or write an executive?
- Does the material being used react to any chemicals that might be found in my primary customer base operations?

Product Architecture Engineer

- What functions do our customers use right now?
- What types of application languages do our customers want?
- What is the lowest and highest I/O count used?
- Windows 2000 or XP for the Engineering Station?
- Can we make it easy for the customer with simple needs, but provide enough freedom for tuning critical applications?
- What card-types will our system need to have?
- What media should I support (e.g. fiber optic)?
- Where will configuration data reside (e.g., EPROM, Workstation)?
- What are the physical constraints (e.g., density limitations, accuracy limitations, speed)?

Application Development

System Integrator

- Do we have this system expertise in house?
- Do we need system expertise, or will the client provide sufficient detail?
- Are we dealing with liability we don't want?
- What is the I/O count?
- What failure modes should we consider?
- What is the total power consumption?
- Network Security?
- Which modules are required? Optional?
- What Comm protocols are supported?
- What are the scan rates?
- EMI/RFI generation and susceptibility?
- Number of system inputs and outputs available?
- Types of functions provided?
- What does the watchdog monitor? Is it enough?
- What are the heat, humidity, power limits and requirements?
- What is the diagnostic coverage?

Design Engineer

- What are the plant system requirements?
- What plant system hazards do I need to consider?
- Does the proposed architecture use redundant signals?
- Is the spare capacity where I need it?
- How do we configure network links?
- What sensors generate inputs? What output signals are generated?
- What are the random and systematic uncertainties?
- Application size limitations?
- What types/ranges of input signals accepted?
- What types/ranges of output signals provided?
- Are there module configuration switches?
- Is runtime diagnostic information provided to application?

Operation & Maintenance

Maintenance

- Can we swap boards during operations?
- Can maintenance functions adversely impact operations?
- What should we monitor?
- What is the functional organization of the modules?
- How does data flow through the system?
- Is there any critical timing?
- Are there runtime module diagnostics?
- Is there a separate I/O processor?
- Does it control trouble / alert / alarm contacts?
- Module configuration switches?
- Internal / external clocks?
- Redundant components?
- Do other modules access memory on module?
- (Board level repair)
- How do I program EPROMs?
- What are the input loading / output driving specifications (e.g., gate input pins)?

System Engineering

- How do I monitor plant system performance?
- How can the control system adversely impact plant system behavior?
- What tuning parameters are available on-line?
- What parameters must be controlled?
- Who can access system parameters/logic/logs?
- What can/should I monitor during operation?
- What are the major internal interfaces?
- What types of external interfaces are available?
- Are there functions or options we should avoid?
- Are there failure modes we need to consider?
- How do modules communicate? How do I tell if the communication is working?
- How do I know if the control functions are working?
- Is there a watchdog timer?
- Does timeout cause power-up reset?
- Single A/D or D/A converter per channel or multiple channels?
- What are the failure modes for each component?

Operations

- How do I operate the system?
- How do I know when the digital system is not operating correctly?
- What indications are in the control room?
- What action should be taken for system health alarms?
- Which ones indicate system operability?

Config Cntrl

- What documentation must be controlled?
- How do we ensure that documentation is complete and reflects as-installed system?
- Do we control hardware by board/firmware rev?
- What software do we control? Application logic, OS, 3rd party software, firmware?
- How do we document and control system and application settings and parameters?
- What types of media do we need to control?
- Do we control backups?
- Can system engineers use uncontrolled backups to reload system?
- Does the supplier document & capture revision levels of all development tools?
- Do we have all software licenses? Do any expire?

Color Key Legend

Construction Level	Domain Knowledge
Plant Specific	Core
Commercial	Secondary
Components	Tertiary

Copyright 2007 Process Design Consultants, Inc
P.O. Box 8308, Duck NC 27949 252-261-5676

Drawing #: TR-G-0010

Title: Levels of Digital System Construction

Date: 4/22/07

Rev 2