RECENT INNOVATIONS IN CONTROL SYSTEMS TECHNOLOGIES FOR AGILE PROJECT EXECUTION

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Process Control and Safety Systems
Yokogawa Italy
Scenario

• Products and Projects
  – Product developments according to technological improvements and marketing strategies
  – Project execution according to best engineering practices

• Not enough any more:
  – Technological developments to favorite efficient/flexible project execution and minimize risk
## Project development key drivers

<table>
<thead>
<tr>
<th>Key Driver</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement drives scoping</td>
<td>Lowest Cost</td>
</tr>
<tr>
<td>Mitigate Project Risks</td>
<td>Within budget</td>
</tr>
<tr>
<td>Manage Changes Flexibly</td>
<td>Anytime</td>
</tr>
<tr>
<td>Improve Engineering Quality</td>
<td>Flawless</td>
</tr>
<tr>
<td>Reduce Delivery Schedule</td>
<td>up to 30%</td>
</tr>
<tr>
<td>Increase Lifecycle Value</td>
<td>Built-in</td>
</tr>
<tr>
<td>Local and Global standards</td>
<td>Compliance</td>
</tr>
</tbody>
</table>

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### Challenges
- Reduce unnecessary work
- Minimize customization
- Validate software without HW FAT
- Prevent design recycle and HW/SW rework
- Minimize unnecessary HW
- Eliminate / minimize physical, data & schedule dependencies
- Simplify 3rd party package I/F configuration
- Accommodate change easily & less impact
- Less effort in Alarm management & Cyber Security
- Reduce effort of Documentation
- Challenge traditional approaches

### Approaches
#### Smart Engineering
- Re-usable Applications
- Secure Remote Testing
- Smart JB designs
- Virtualization

#### Delivery Excellence
- Consistent Risk Mitigation
- Knowledge Management
- LEAN execution
- Basic Design Toolkit

#### ICSS Technology
- Networking
- Modularity/Standards based Design
- Independent (parallel) phases
- Flexible Binding at site
- Built-in Management of Change

### Generic Benefits
- Predictable and modular Engineering
- Optimized Engineering and Space Utilization
- Minimize Travel (Reviews, Testing, Validation)
- Optimized project execution
- No Engineering Surprises
- Validated & proven Integration
- Early Plant Startup
- Easy Modification
- Reduced Footprint
Increase efficiency and Reducing cost in all projects

Agile Project EXecution

ICSS technology
Smart Engineering
Delivery Excellence
Cloud Enabled Delivery
Project & Lifecycle Value Delivery
Plant Automation Security Suite
Value Toolkit
Lifecycle Dynamic Simulator
Field Digital Integration Services

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AGILE PROJECT EXECUTION

Benefits: Removing waste and Reducing cost

What is our approach
APEX, Removing waste and Reducing cost in all Projects

Our Approach

- Next Generation Platform
- Delivery Excellence
- Smart Engineering

Customer Benefits

- Removing Waste and Minimize Customization
- Flexible Binding and Late Changes
- Lowest Cost, Consistent Quality

ICSS technology

CONVERGENCE

Smart Engineering

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APEX Smart Engineering

Customer Benefits

• Predictable Engineering, No Engineering Surprises
• Optimize Space Utilization (Power, Weight, Cooling)
• Minimize Travel (Reviews, Testing, Validation)
• SEPARATING LOGICAL FROM PHYSICAL

Our Approach

• Module (class) based engineering
• Re-usable Applications
• Standard Panels
• Global PC, preconf. switches
• Virtual (remote) test
APEX – Technology

Customer Benefits

• Early Plant Startup
• Easy Modification
• Reduced Footprint

Our Approach

• Network-IO
• System Independent Loop Check (without FCS CPU)
• Flexible Binding at site
• Built-in Management of Change

I/O Backplane

Universal I/O Module
• 16 Channels IO
• Signal: AI/AO/DI/DO
• Software Configurable
• HART 7 Support
• Full Redundancy

Signal Conditioner (Optional)
• Wide range of I/O
• Pulse, Relay, DO, etc.

Termination Block
No need for Marshalling Cabinets!
## N-IO for Hazardous Applications

<table>
<thead>
<tr>
<th>Non-IS</th>
<th>IS base plate</th>
<th>H-System</th>
<th>IS base plate</th>
<th>4500 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-IO</td>
<td>IS base plate</td>
<td>H-System</td>
<td>IS base plate</td>
<td>4500 series</td>
</tr>
</tbody>
</table>

### Yokogawa

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APEX Delivery Excellence

Customer Benefits

- Minimize Waste
- Robust time management
- Validated & Optimized Integration

Our Approach

- Consistent Risk Mitigation
- Functional Safety Management
- LEAN execution based on 3R
- Basic Design Toolkit

LEAN: reduce waste through innovation
3R: Right people, Right location, Right timing
Shorter project execution

**Solution platform**
*that exceeds the capabilities of conventional production control systems*

Conventional Execution

- Design
- Configuration
- Application & HW FAT
- Ship & Install
- Field wiring
- Site Activity (incl. Loop check)

Agile Project EXecution

- Design
- Configuration
- Application AFAT
- Site Activity

**Increasing quality and Reduce waste**

- The class module effect
- N-I0 Solution effects
- FieldMate Validator effects

**HFAT: Hardware FAT**
**AFAT: Application FAT**

Possible Early Startup

Reducing risks of handover slippage
Tolerate delays in project execution

Solution platform that exceeds the capabilities of conventional production control systems

Conventional Execution

Agile Project EXecution

Later Start

Increasing quality and Reduce waste

The class module effect

N-IO Solution effects

FieldMate Validator effects

HFAT: Hardware FAT
AFAT: Application FAT
Tangible APEX Benefits
APEX and how we deliver DIFFERENTIATING value

**APEX:** Competitive Project Execution model applicable to all projects

**Next Generation Platform:**
- **ADSuite:** Automation Design Suite Master Database
- **Network-IO:** Universal I/O and signal conditioner
- **Validator:** FieldMate Validator N-IO loop commissioning software
- **Integration:** DCS-ESD, DCS-subsystems

**Agile Project Execution**

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CENTUM VP R6 ADSuite
New Engineering Environment Benefits
ADSuite: Large Project and Operational benefit

Global repository & Module Engineering

Flexible Binding

Automation Design Master Database

Automatic Document Generation

Management of Change

Bulk Engineering also on site

Repository Server

Master Class module

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Modular Application Logic

- PIC001
  - PID
- PT001
- PCV001
- XY001
- SEQ
- XI001

Global Application Repository

Module Libraries

- MACToolkit
  - O&G process
  - System Integration
  - Alarm suppression
- Power
  - CCPP process
  - VGB
- Fertilizer
  - Ammonia
  - Urea
- Sub-sea
- Batch
- Batch
- Sub-sea
- Batch
- Others
ADSuite + N-IO = Flexible Binding

Flexible Binding

Modular Application Logic

- PIC001
- PID
- SEQ

HIS (OWS)/ENG

Project Database

Vnet/IP

ADSuite Automation Design Master Database

ADSuite N-IO Software Configuration Table

- PT001
- PCV001
- XY001
- XI001

faceplate

PT001

PCV001

XY001

XI001

AO: PCV001

DO: XY001

AI: PT001

AO: PT001

NIO1 Ch. 1

DI: XI001

NIO1 Ch. 4

Ch.1

Ch.2

Ch.3

Ch.4

NIU

NIO

N-ESB Bus

FCU (CPU)

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ADSuite + N-IO = Flexible Binding before FAT until SAT

- Modular Application Logic
  - PIC001 (PID)
  - SEQ

- Application FAT using Test system

- FAT

- WIRING CHECK
  - ADSuite
    - Automation Design Master Database
  - N-IO Software Configuration Table
    - NIO1 Ch.1
    - AI: PT001
    - NIO1 Ch.2
    - DO: PCV001
    - NIO1 Ch.3
    - AO: PCV001
    - NIO1 Ch.4
    - DI: XI001

- Early Wiring check using Validator
- Integrated loop-check after HMI is power-up

- SAT

- Co-innovating tomorrow™
SILC: System Independent Loop Commissioning

**Factory work without I/O**
- Application coding by using labels
- Application FAT

**Site work without HMI and Controller**
- Install and wiring
- Devices parameter setting
- Loop check

**Controller**

**HMI**

**Concurrent work**

**STEP 1**
- App Device parameter setting & loop check

**STEP 2**
- Get I/O Tags & information

**STEP 3**
- Generate reports automatically

**STEP 4**
- Return fixed I/O information

**AD Suite Master Database**

**STEP 1-4 shows SILC workflow.**
Avoiding Project Delays

Reduce delays and be assured of starting production on schedule

Application validation during FAT

Designed & constructed on site

Virtual I/O wiring

Last minute software marshaling

Smart Configurable IO
Integration
Various Field Digital Communication Protocols

- **ALP121** PROFIBUS-DP Module
- **ALF111** FOUNDATION fieldbus Module
- **HART I/O Module**
- **A2EN402/404** N-ESB Bus Coupler Module
- **ALE111** Ethernet Communication Module
Operate and monitor your sub-systems in CENTUM, like CENTUM.

- Graphic
- Trend
- Tuning
- Alarms

... and more

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• Simple Architecture
  – Just add one more UGS2 with same configuration (such as Vnet/IP address) for redundant communication.
  – No extra software license is necessary for redundant configuration.
  – No FT(Fault Tolerant) Server, no extra L2 switches, no shared disk as HA cluster are necessary.
# UGS High Capacity

<table>
<thead>
<tr>
<th>Items</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Tags</td>
<td>100,000</td>
</tr>
<tr>
<td>Number of data items that can be defined (*1)</td>
<td>600,000</td>
</tr>
<tr>
<td>Number of data items for communication with controllers (*1) (*2)</td>
<td>450,000</td>
</tr>
<tr>
<td>Data Throughput (*1)</td>
<td>6,400 data/sec</td>
</tr>
<tr>
<td>Number of Alarms</td>
<td>44 alarms/sec</td>
</tr>
<tr>
<td>1 second trend points</td>
<td>2,048</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of subsystem controllers</th>
<th>Total</th>
<th>STARDOM</th>
<th>OPC DA/A&amp;E Server</th>
<th>Modbus/TCP/RTU</th>
<th>EtherNet/IP</th>
<th>IEC 61850 IED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>256</td>
<td>256</td>
<td>16</td>
<td>256</td>
<td>256</td>
<td>256</td>
</tr>
</tbody>
</table>

| Switch-over time               | 1 sec |

*1: The number of data items depends on the application conditions.

*2: The UGS accesses the controllers’ data by assigning each of the controller’s data into the data items in the UGS2’s function block(s). Among all the definable data items with no communication with controllers can be used as a data buffer for the data set by other sources such as an FCS.
“Optimal” integration with subsystems

- Sub-system communications
  - Data for HMI: OPC Client (redundant) workstation can manage up to 100,000 TAGs
  - Data for control logic: put (redundant) link module in one rack of the related CPU
  - Integrated Control+Safety system provides optimization + performance at the same time

<table>
<thead>
<tr>
<th>UGS</th>
<th>Distr. communication modules</th>
</tr>
</thead>
</table>
| Benefits | - Lower Controller CPU load  
- High throughput  
- Multiple protocols  
- A&E by OPC A&E | - Simple reliable industrial solution  
- Subsystem data directly available in DCS controller for control/logic functions |
| Drawbacks | - Unreliable IT technology  
- Subsystem data NOT directly available in DCS controller for control/logic functions | - Affecting Controller CPU load (to be distributed among the DCS controllers)  
- Not supporting A&E with timestamps |
Integration with Safety System

- Plant Asset Management
- Human Interface Station
- Engineering Station
- Plant Information management

Vnet Router

Plant Asset Management

Human Interface Station

Engineering Station

Plant Information management

Real Time Control Network Vnet/IP

Field Control Stations

3rd party system Subsystems

Unified Gateway Station

Vnet System

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Safety System Integration

- DCS and SIS are 'truly integrated'
  - SIS and DCS data are within the same window
  - SIS data can be used in the FCS
  - Sequence of Event (SOE) data from the SIS and DCS are integrated
Direct implementation from C&E diagrams

- iDefine logic editor (Cause & Effect, State transition diagram) provides the concise view of Safety Requirement Specification. You can capture and check behavior of the SIF dynamically and verify the output leading to ESD by simulator. All these can be done without programming knowledge (e.g. FBD, ladders)

**Cause & Effect & State Analysis**
Comparing with traditional programming ie. FBD or ladder, iDefine logic editor expresses SRS more closely.

**Simulator**
You can see the dynamic of the logic in the editor. This lead to early discovery of errors and correction can be taken at the earliest possible opportunity. This greatly reduce the impact and amount of rework as we approach late stage of project cycle.
User can directly implement C&E diagram which is automatically converted into FBD by just clicking ‘Graphic View’ tab.
FBD generated from C&E Module

Auto-converted FBD

Exported to excel spreadsheet

Logic can be added in auto-converted FBD

→ shown as ‘F(x)’ in C&E
### iDefine: Benefits for Customers

#### Benefit Map - Classified by Plant Lifecycle Phase

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Plant Lifecycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FEED</td>
</tr>
<tr>
<td></td>
<td>Execution</td>
</tr>
<tr>
<td></td>
<td>FAT/SAT Commissioning</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
</tr>
<tr>
<td></td>
<td>Modification</td>
</tr>
<tr>
<td>1 Concise and Structure approach to understand SIF</td>
<td>Useful for Requirement Capture</td>
</tr>
<tr>
<td>[Cause &amp; Effect, SA, Simulator]</td>
<td>Useful to Review SIF</td>
</tr>
<tr>
<td></td>
<td>Useful to Confirm SIF</td>
</tr>
<tr>
<td>2 FSM Support</td>
<td>Applicable for User Defined FSM</td>
</tr>
<tr>
<td>[FSM Support tool]</td>
<td></td>
</tr>
<tr>
<td>3 Maintain one single database for key SRS information</td>
<td>Useful for Safekeeping Design</td>
</tr>
<tr>
<td>[iDefine Database]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Useful for Safekeeping Design</td>
</tr>
<tr>
<td></td>
<td>Useful for Safekeeping Test Case</td>
</tr>
<tr>
<td>4 Simple HMI</td>
<td>Useful for Standalone Monitoring</td>
</tr>
<tr>
<td>[Simulator, HMI graphic, Test interface]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Useful to Review SIF</td>
</tr>
<tr>
<td></td>
<td>Useful to Confirm SIF</td>
</tr>
</tbody>
</table>
Summary
<table>
<thead>
<tr>
<th>WATERFALL</th>
<th>FAST TRACKING</th>
<th>AGILE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="WATERFALL Diagram" /></td>
<td><img src="image2" alt="FAST TRACKING Diagram" /></td>
<td><img src="image3" alt="AGILE Diagram" /></td>
</tr>
</tbody>
</table>

- **Scope** completely defined at the beginning;
- Customer and project team have the complete knowledge;
- Project planned from the beginning;
- A unique final deliverable;
- No interaction with the customer

- **Scope** kept partially open;
- Overlapped phases;
- Shorter cycles;
- More interaction with the customer;
- Partial deliverables.

- **Scope** kept open;
  - **Iterations** based for continuous results delivery;
  - Team integrates the customer;
  - Focus on delivering value to customer;
  - Team made up of individuals with cross-functional skills, self-organized

Source: laSalle Almere
Conclusion: APEX Value by phase

<table>
<thead>
<tr>
<th>FEED</th>
<th>Execution</th>
<th>Testing / Commissioning</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Point of</td>
<td>Optimize Total Automation</td>
<td>Flawless Start-up &amp;</td>
<td>Reduce Total Cost of</td>
</tr>
<tr>
<td>Responsibility</td>
<td>Investment</td>
<td>Commissioning</td>
<td>Ownership</td>
</tr>
<tr>
<td></td>
<td>Improve Project economics</td>
<td>Flexible binding</td>
<td></td>
</tr>
<tr>
<td>Standard Design of</td>
<td>Reduce Execution dependencies</td>
<td></td>
<td>Reduce maintenance effort</td>
</tr>
<tr>
<td>Cabinets, reduced</td>
<td>Getting ICSS off from Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rack-room space</td>
<td>critical path</td>
<td></td>
<td>Maintain latest documentation</td>
</tr>
<tr>
<td>Standard Functional</td>
<td>Optimize project execution in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of Application</td>
<td>terms of timelines and effort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Design of</td>
<td>Reduce engineering complexities</td>
<td>Ease of Bulk changes,</td>
<td></td>
</tr>
<tr>
<td>smart JB’s, optimized</td>
<td>and improved quality</td>
<td>Management of change,</td>
<td></td>
</tr>
<tr>
<td>cable routing</td>
<td>Simplify documentation</td>
<td>Auto documentation etc.</td>
<td></td>
</tr>
<tr>
<td>Reduce travel</td>
<td>Reduced footprint and cabling</td>
<td>Shorter loop checks and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>related work</td>
<td>standard commissioning procedures</td>
<td></td>
</tr>
<tr>
<td>Reduce travel</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>

APEX
Ambitious Project
Execution
- ICSS technology
- Smart Engineering
- Delivery Excellence

yi-MAC
Innovative MAC
ICSS for APEX: Overview

- N-IO, AD-Suite, FM-Validator
  - Flexible Binding
  - SILC: System Independent Loop Commissioning
  - Smart Junction Box

- AD Suite
  - Module based engineering
  - Separation between logical and physical
  - Bulk Generation
  - Auto Documentation with Module
  - Industry Library (DCS/SIS)

- Standardization
  - Standard Cabinet / Hardware Design
  - Global PC
  - Preconfigured network Switches

- Integration
  - Smart and flexible integration with subsystems (UGS)
  - Complete DCS-SIS integration (CentumVP+ProsafeRS)
  - Easy configuration from C&E diagrams (iDefine)
  - Structured Systematic Approach for FSM requirements (Yokogawa)
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Thank you