Argument in favour of IEC 61499: System level design of automation systems
Examples from SmartGrid, Logistics and Manufacturing

Valeriy Vyatkin, University of Auckland
http://www.ece.auckland.ac.nz/~vyatkin/
and
Antonio Valentini, o3neida
University of Auckland, New Zealand

Enabler: powerful networked embedded controllers

Enabler: Open Source Tool for function block programming
Software Architecture for Distributed Networking Control Systems

Agent-based & Holonic Control

Distributed systems

Model-based engineering

Control engineering legacy
Key benefits of IEC 61499

• System-level design of distributed intelligence for complex systems
  – IEC 61499 provides two-stage design flow:
    1. Hardware-independent functionality – good for testing
    2. Deployed distributed code

• Event connections provide for most natural semantics of connecting plant and model

• Many other useful things: strong data encapsulation, state-machine programming, etc.
SmartGrid and IEC 61850
IEC 61499: Distributed Intelligence Simulation and Deployment

IEC 61850: Interoperability and Communication
IEC 61850: object-oriented substation model with Logical Nodes

Voltage 11 kV

IEC 61850 Logical Node Model

Logical Device

PROCESS LEVEL

BAY LEVEL
Making IEC 61850 Executable

logic + LN = iLN

Intelligence + Database = Intelligent Logical Node

FREEDM Green Hub Architecture

SmartGrid Intelligence Engineering:
- How to design and validate distributed intelligence?
- Where and how to deploy it?
intelligent Logical Nodes of IEC 61850 for FREEDM

- Intelligent agents at the device level
- Implemented using new industrial standards
  - IEC 61850 – Object-oriented model for substation automation
  - IEC 61499 – Function blocks architecture for distributed automation
Co-simulation Environment for Distributed Intelligence

Distributed Intelligence Simulation

Zone1
IFM 1

Zone2
IFM 2

Zone3
IFM 3

Sampled Values
Current
Operate

PDIF LN
Overcurrent –
PIOC LN

Zero Zone
Protection

IFM 1

IFM 2

IFM 3

CB1

CB2

OR

OR

OR

UDP

UDP

Trip
Deploy on Utility-embraced Industrial Devices

IEC 61499 – Major Enabler of Holistic Design
Example:
IEC 61499 control of a future shoe manufacturing line in Italy

Slide courtesy of A. Brusaferri – ITIA-CNR, Italy
Airport Baggage Handling Systems

Distributed FB Testbed with 50+ Nodes

Network traffic and response time have been measured using PRTG Traffic Analyzer.

Network traffic for 3 selected control nodes

Event transmission delays between two control nodes
Now, if you have a network of 4 control devices it is enough just to tell which function block will reside in which device. *The IEC 61499 tool will do the rest!*
Holistic Design of Large Control Systems

Airport Baggage Handling

Smart Power Distribution

Manufacturing Plants

Will be built from smart components (like this conveyor)

Executable Specification in Function Blocks

Generation Software

FB Tools

View & Simulate

Real-time Control
IEC 61499 Day at SPS/IPC/Drives

23rd of November 2011, Nuremberg, Germany
9:30 – 16:00, open doors policy
Organizer: Prof Valeriy Vyatkin, University of Auckland, New Zealand
Sponsors: ISaGRAF and NxtControl

Program:
1. Workshop “Industrial experiences of IEC 61499 application”;
2. Lunch-time presentations by leading researchers;
3. Hands-on trainings on ISaGRAF and NxtControl tools;

The workshop will reflect industrial experiences, in particular of Tessmar (Austria), ITIA-CNR (Italy), Glidepath (New Zealand), PROFACTOR (Austria), Visual Components Oy (Finland), Turomas Group (Spain) and Energex (Australia) in applying IEC 61499 technology provided by software tools of ISaGRAF(Canada), 4DIAC(Austria) and NxtControl (Austria) and using off-the-shelf hardware of Advantech, Beck, Beckhoff, FESTO, SIEMENS, Wago and other suppliers.

Admission: Free for SPS/IPC/Drives visitors and exhibitors
To register contact: iec61499day@gmail.com
More information on IEC 61499

Second Edition of the Book

- Fully revised and extended
- Based on the second edition of the standard (2011)
- Reflects latest developments
- New chapters
  - In particular, discussing commercial tools and ISaGRAF and NxtStudio, and commercial hardware platforms
- Examples and tutorials reworked
- Expected by the end of October, 2011

More information on IEC 61499

New State of the Art Review

V. Vyatkin,
“IEC 61499 as Enabler of Distributed and Intelligent Automation: State of the Art Review”
IEEE Transactions on Industrial Informatics, 2011, in print

Download preview from my site.
http://www.ece.auckland.ac.nz/~vyatkin/
Thank you!