

Open Distributed Automation and Control with IEC 61499

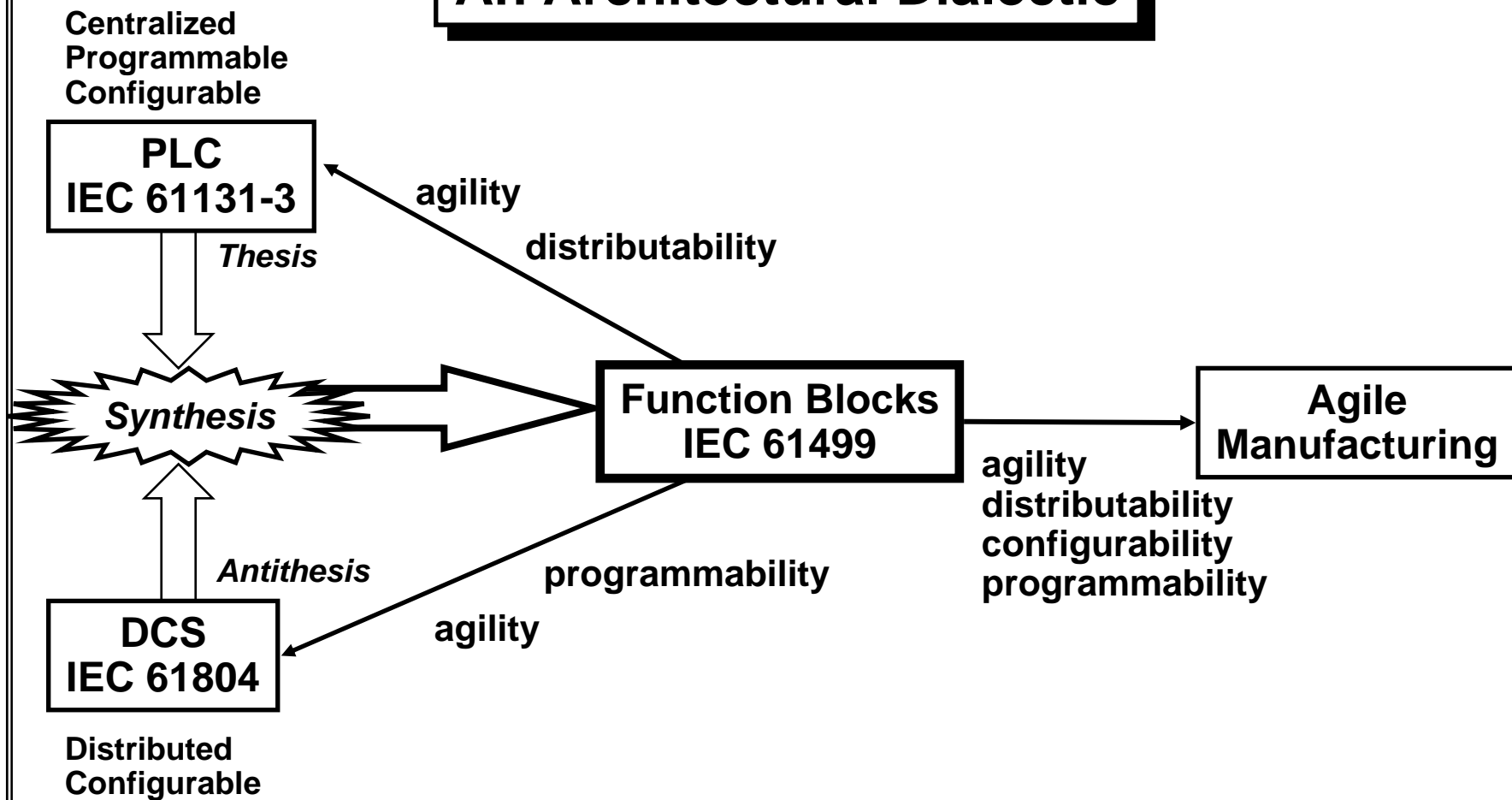
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Open Distributed Automation and Control with IEC 61499

- **Background**
- Architecture
- Object Models
- Software Tool Requirements
- Status and Future

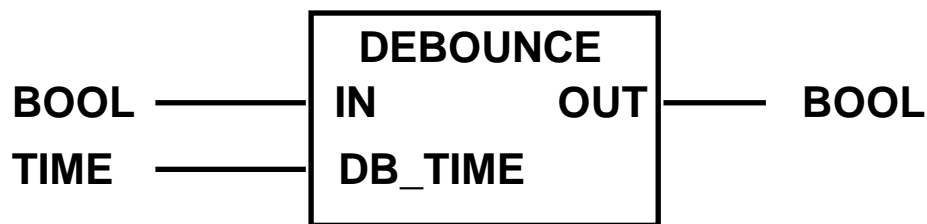
Distributed Automation: An Architectural Dialectic



IEC 61131-3: Modern (1993) Software Engineering for Automation and Control

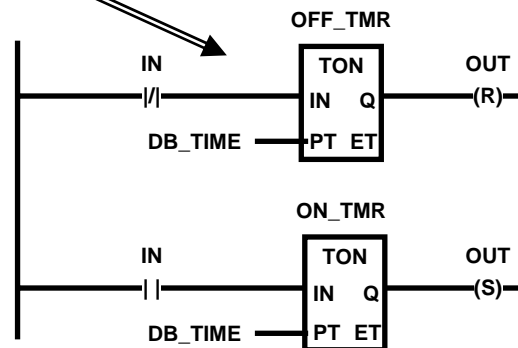
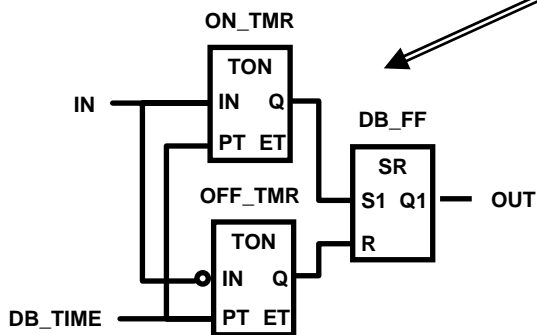
- **Encapsulation/Reuse Mechanisms**
 - Function Blocks, Functions, Data Types, Programs
- **Application-adapted Languages**
 - Ladder Diagram (LD) for logic control (“power flow”)
 - Function Block Diagram (FBD) for regulatory control (“data flow”)
 - Sequential Function Chart (SFC) for state-machine control
 - Structured Text (ST) for information processing
 - Instruction List (IL) for assembly-level programming
- **A Mature, Internationally Adopted Standard**
 - First edition: 1993
 - Second edition: 2001

Function Blocks: Object-Oriented Encapsulation and Reuse in IEC 61131-3

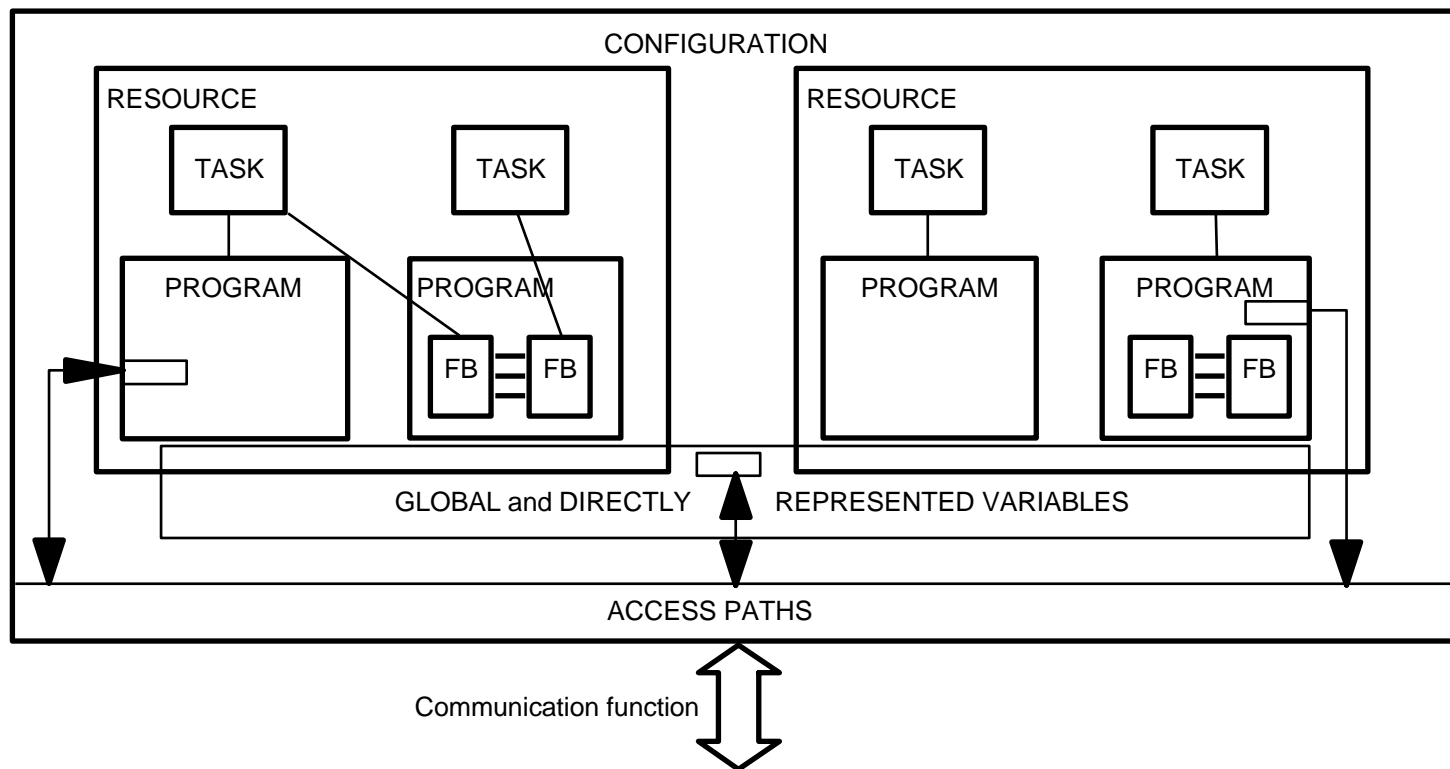


External Interface Specification

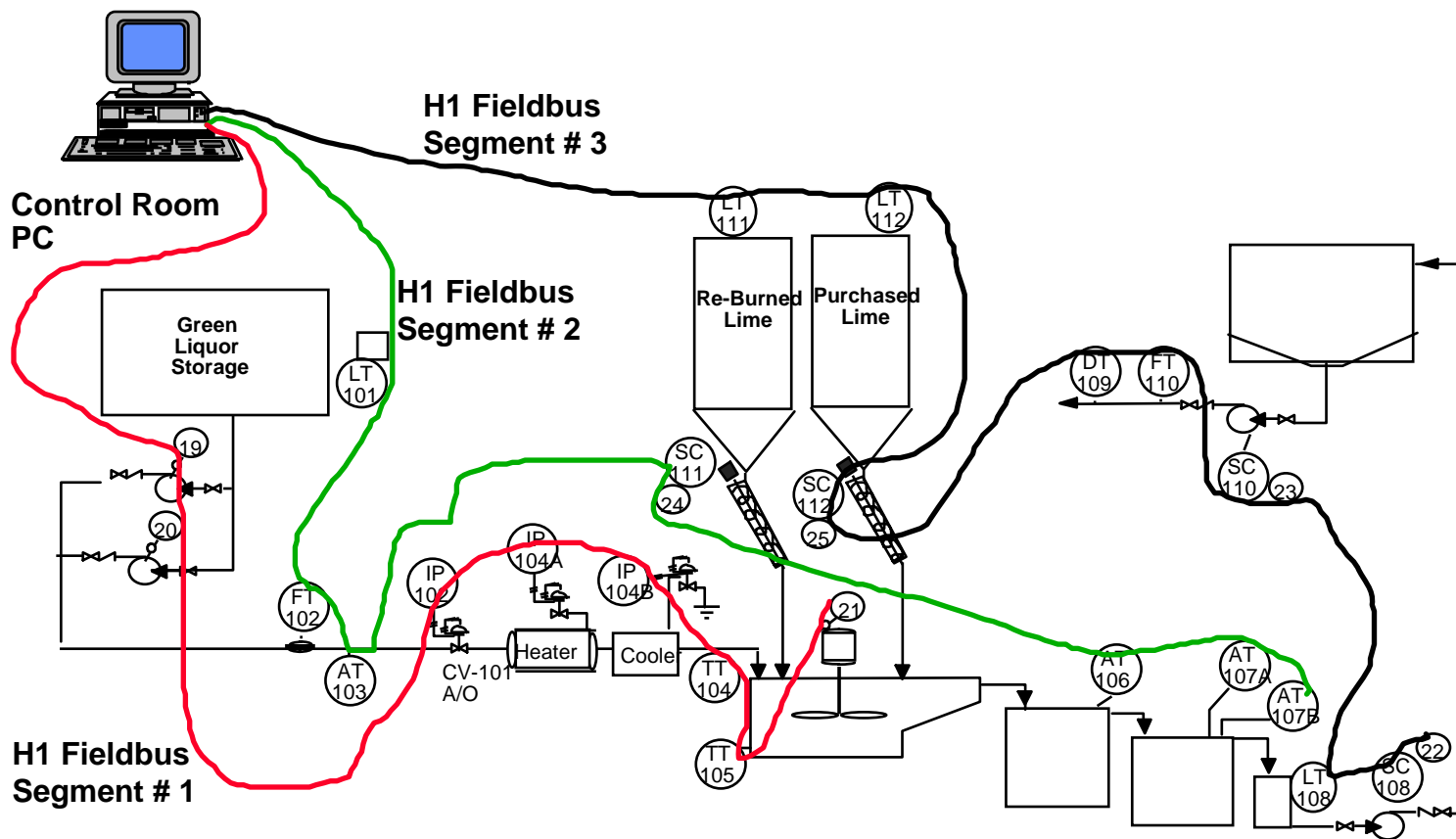
Control Algorithm Specification



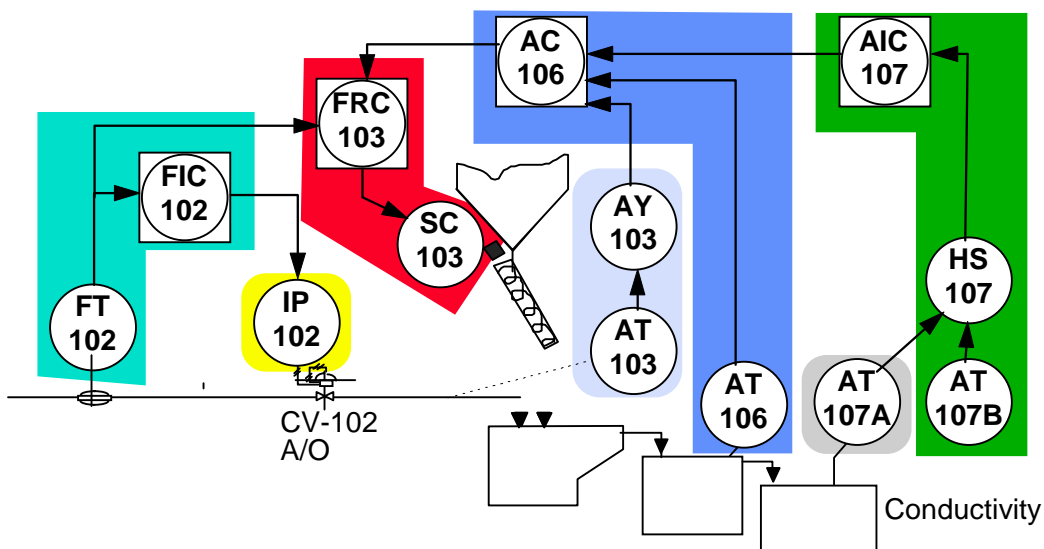
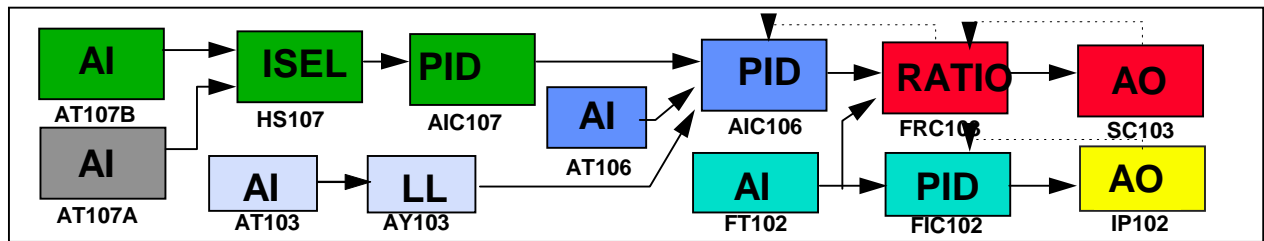
Centralized System Configuration in IEC 61131-3



Distributed Configuration in Fieldbus Systems (Physical View)



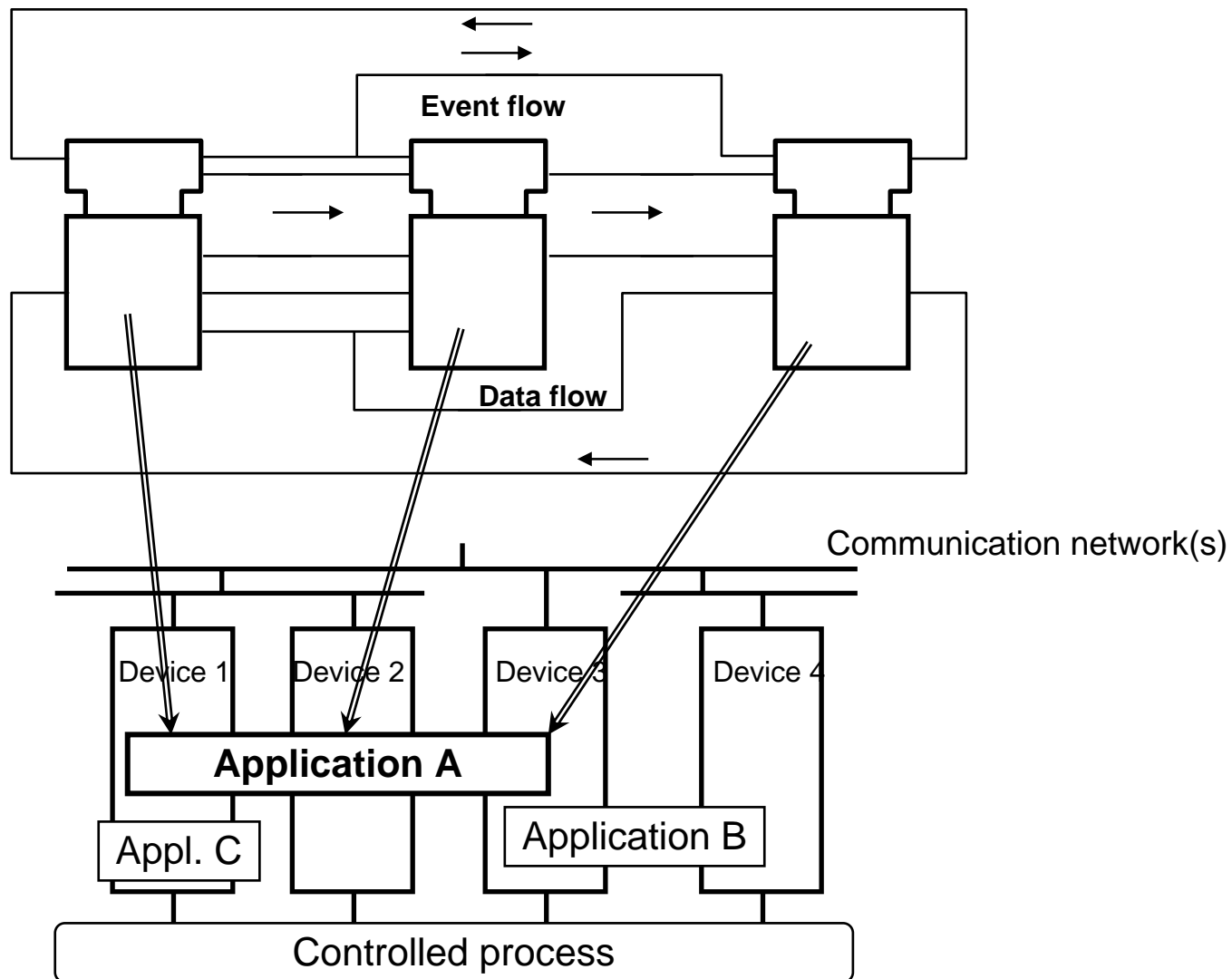
Distributed Configuration in Fieldbus Systems (Logical View)



Basic Concepts of IEC 61499

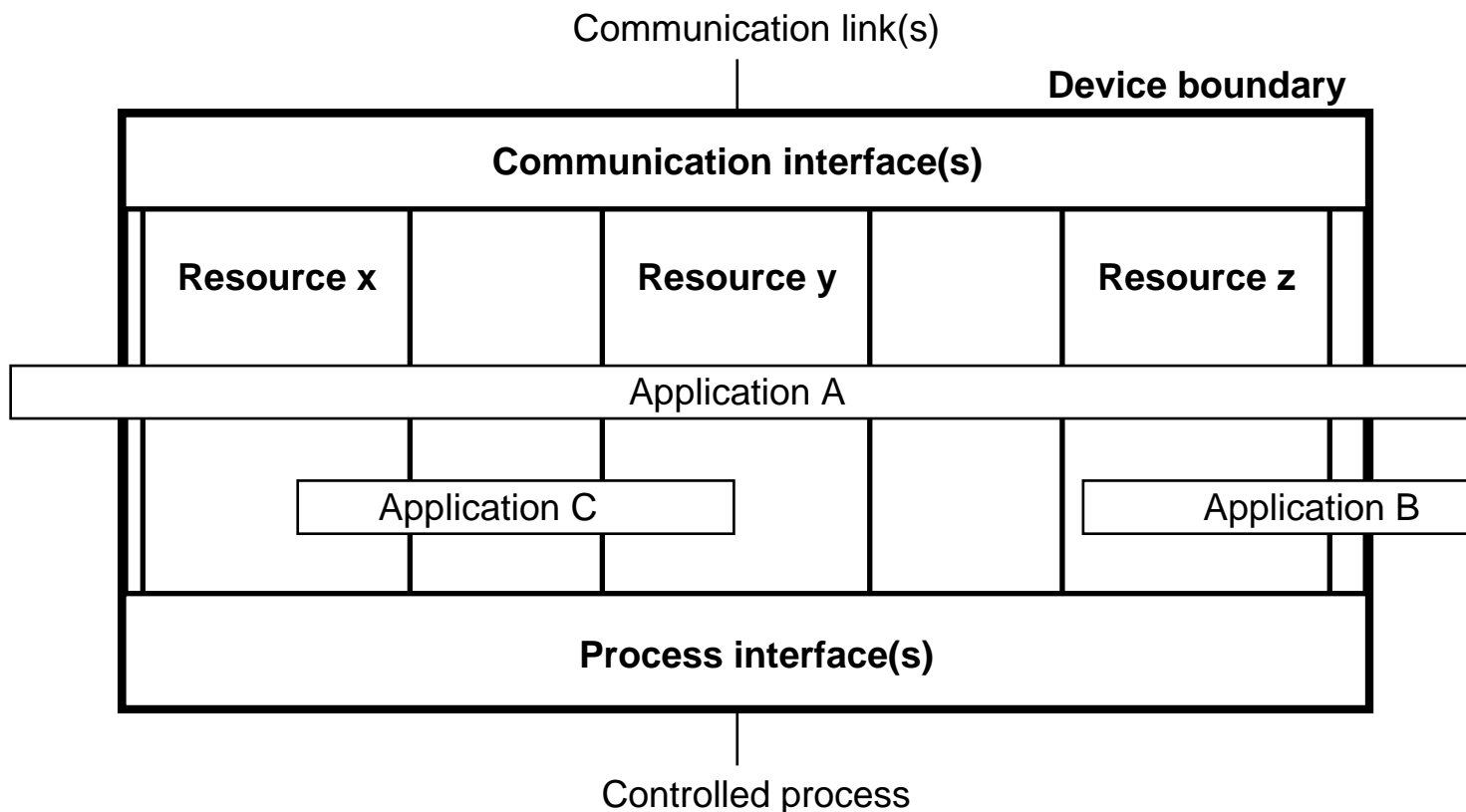
- **Distributed applications**
- **Object-oriented software encapsulation and reuse**
- **Event and data interfaces**
- **Event-driven state machines**
- **Service interfaces**
- **Management services**
- **Software portability**

System Architecture for Distributed Applications



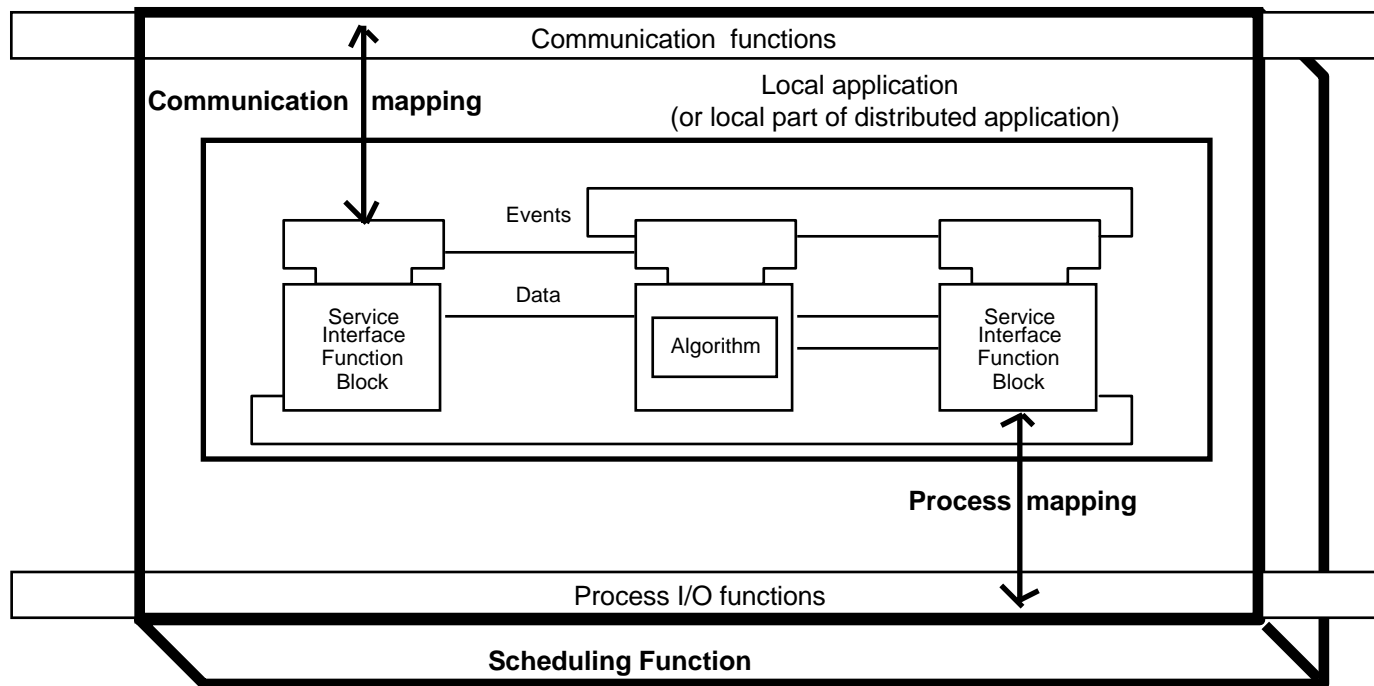
Device Architecture

- **Device = Container for Resources**
- **Device provides Communications & Process Interfaces**

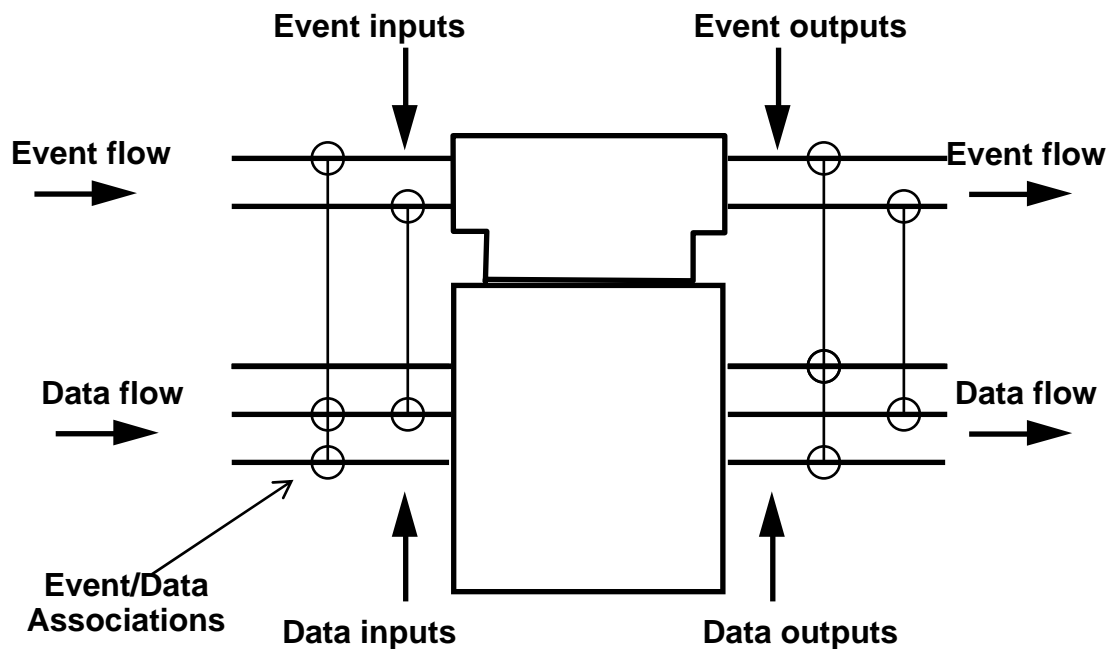


Resource Architecture

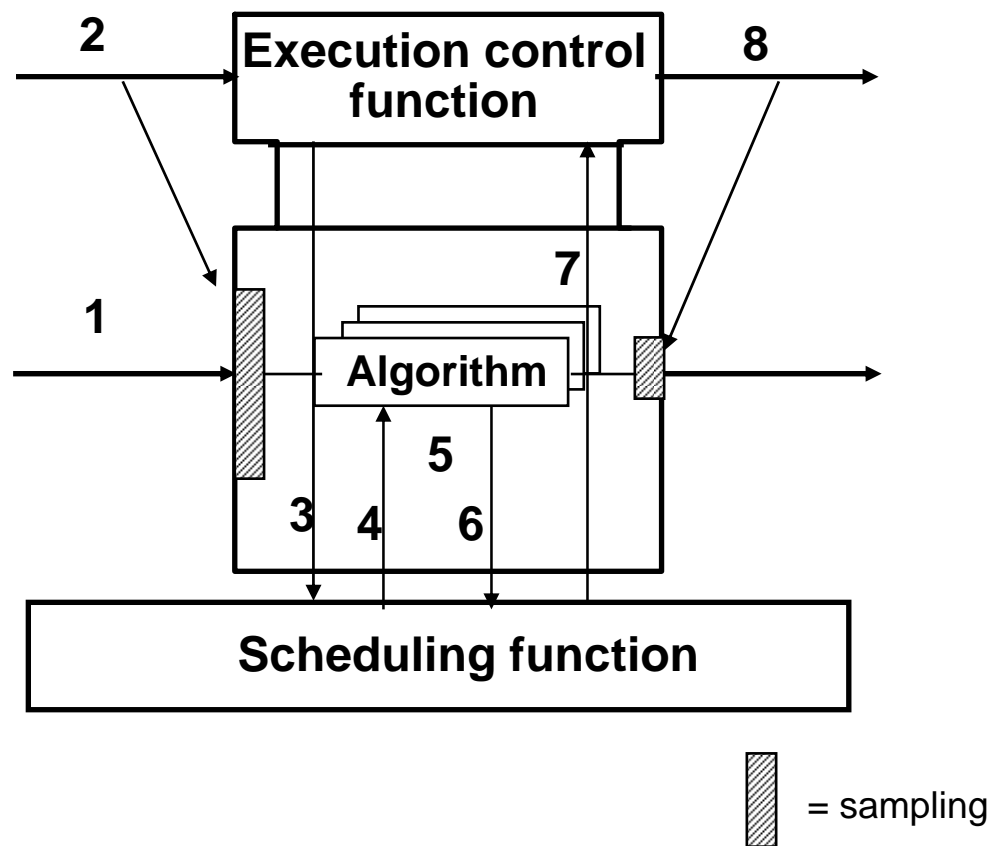
- Resource schedules & executes FB algorithms
- Resource maps Communications & Process I/O Functions to Service Interface Function Blocks



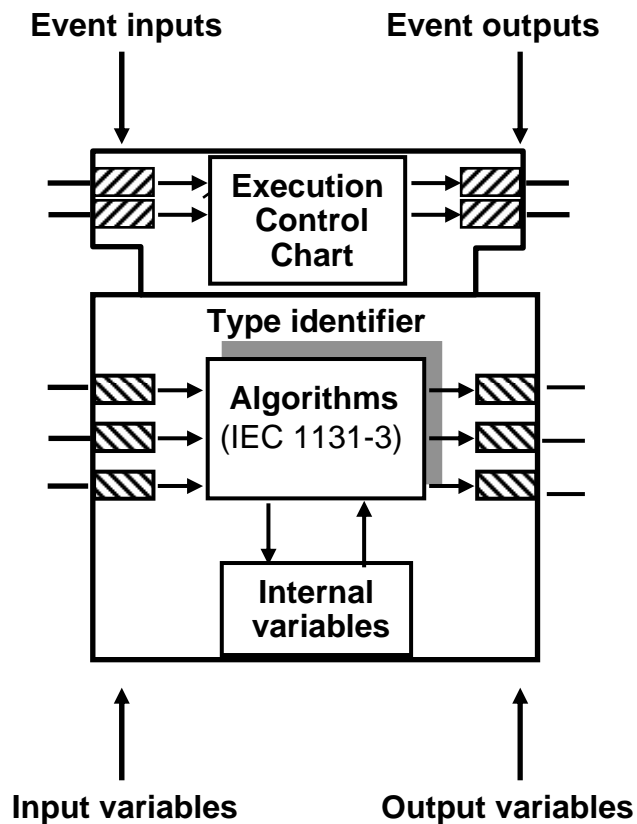
Event and Data Interfaces



Event-Driven Execution Control

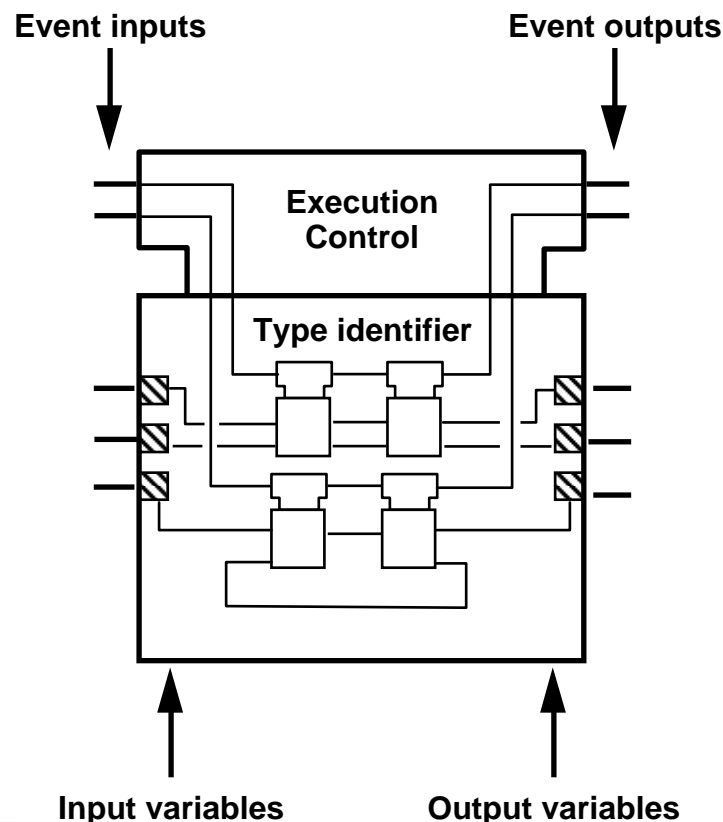


Encapsulation and Reuse: Basic Function Block Types

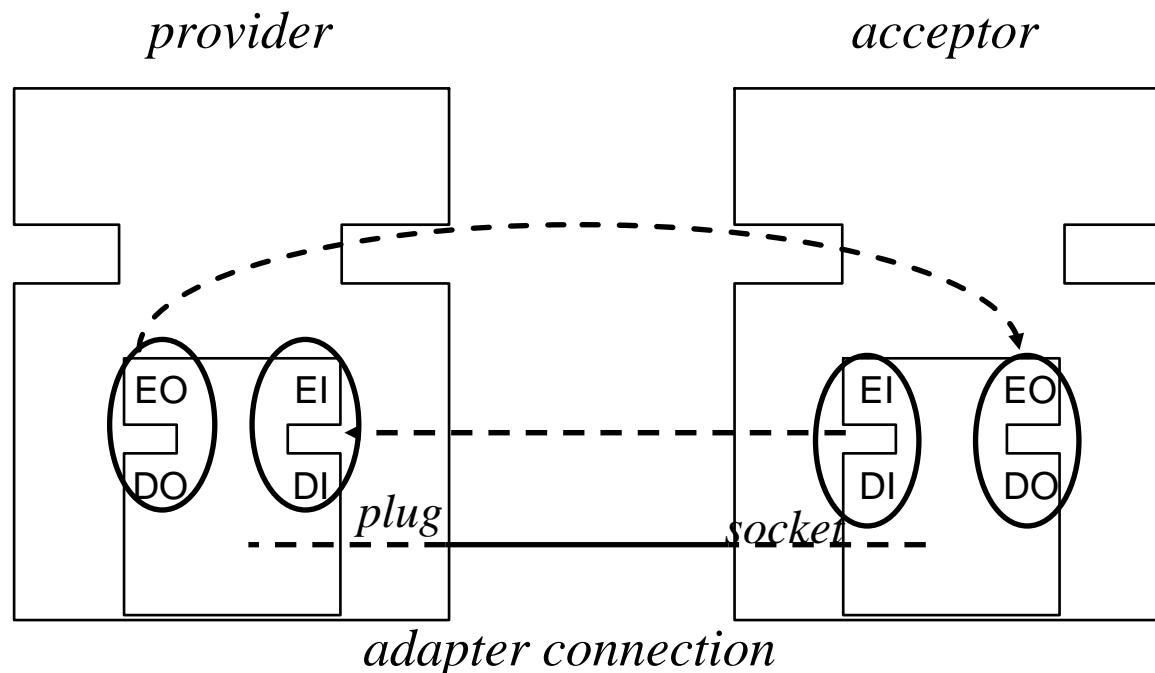


Software Encapsulation and Reuse: Composite Function Block Types

- Functional composition
- Reusable
- Atomic (not distributable)
 - "subapplications" are distributable



Adapter Interfaces

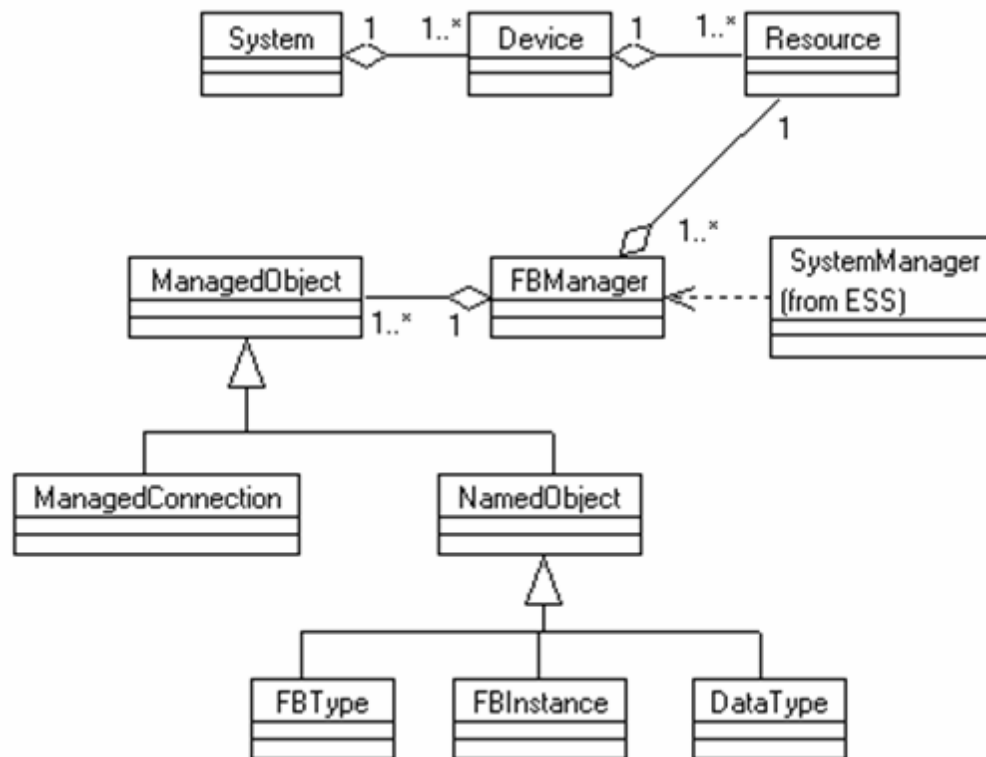


- Reduce diagram clutter
- Simplify transducer interface
- Capture patterns of interaction

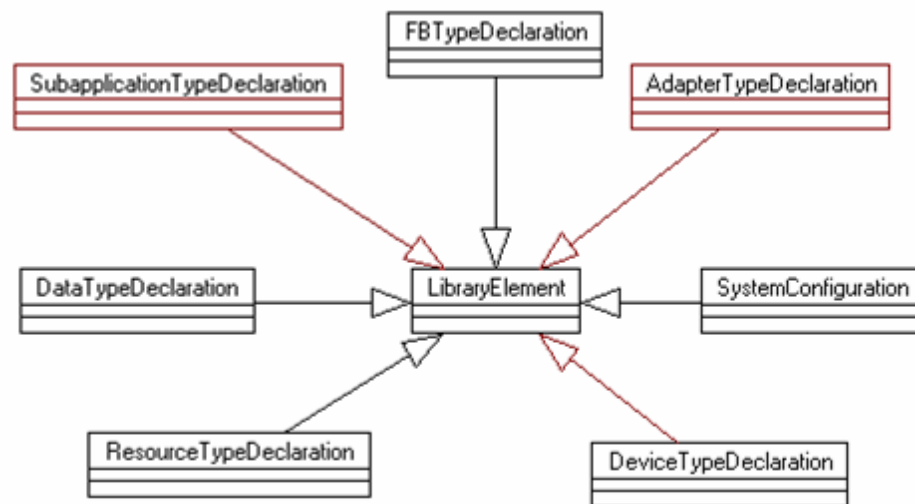
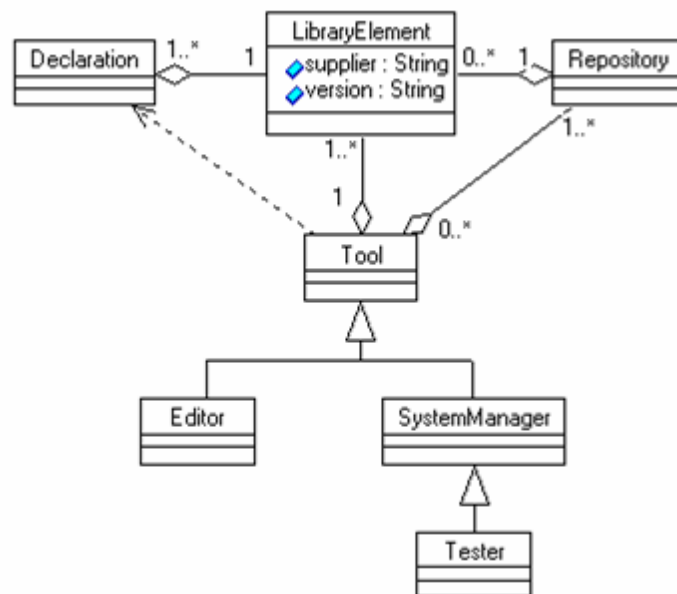
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- **Object Models**
- Software Tool Requirements
- Status and Future

System Management Model



Software Tool Models



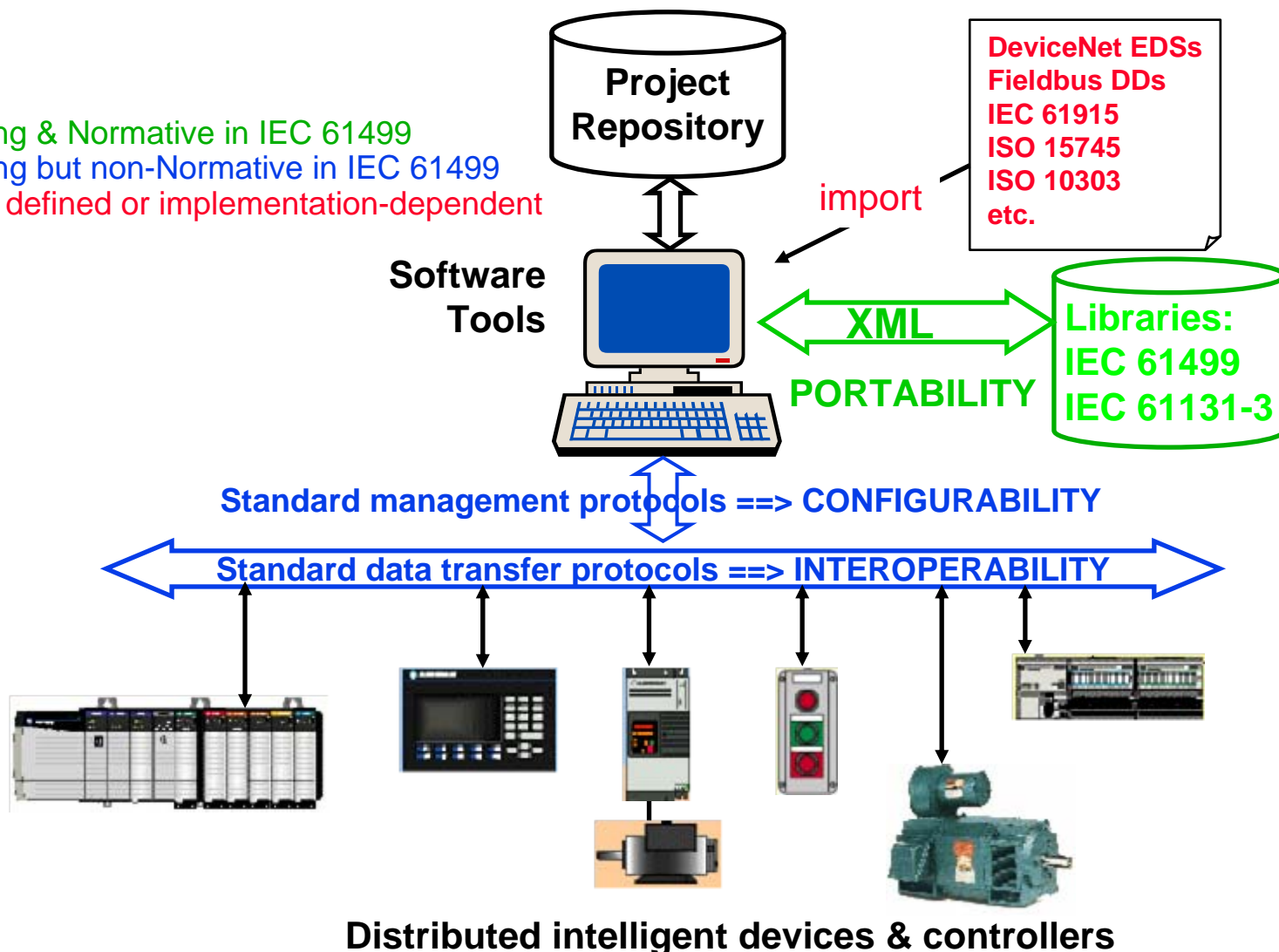
Open Distributed Systems: The IEC 61499 Vision

KEY:

Existing & Normative in IEC 61499

Existing but non-Normative in IEC 61499

To be defined or implementation-dependent



Distributed intelligent devices & controllers

Software Tool Requirements (1)

- **Information to be provided by tool supplier**
 - Applicable library element type(s)
 - Engineering task(s) supported
- **Exchange of library elements**
 - via XML per defined DTDs for:
 - » data types
 - » other library elements
- **Information to be provided by library element supplier**
 - sufficient to enable the user to fully determine functionality
 - at a minimum, event + data interfaces + service specification
 - IP protection allowed when element implementation is provided
- **Display of declarations**
 - in a form appropriate to the engineering task
- **Modification of declarations**
 - as appropriate to the engineering task

Software Tool Requirements (2)

- **Validation of declarations**
 - as required by the associated engineering task
 - examples:
 - » syntax checking
 - » semantic checking
 - » simulation and testing, individually and in combinations
- **Implementation of declarations**
 - as required by the associated engineering task
 - examples:
 - » production of executable code ("firmware")
 - » creation and interconnection of *function block instances* in *devices* and *resources*
- **System operation, testing and maintenance**
 - as required by the associated engineering task
 - examples:
 - » facilities described above
 - » configuration/operation of information interchange
 - » management services

IEC Project 61499 Status & Future

- **PASs (Publicly Available Specifications)**
 - IEC PAS 61499-1, Architecture
 - IEC PAS 61499-2, Software tool requirements
- **Ongoing Work**
 - 61499-3, Application guidelines
 - (to be proposed) 61499-4, Rules for compliance profiles
- **2-year trial use period**
 - Incorporate lessons learned from trial implementations
 - Parts 1,2 CDVs projected: 2003-10-01

First Feasibility Demonstration: Kitakyushu City, Japan, 2000-10-20

Operator Interface + Logging

High-level Service Interfaces

High-Level Control, Monitoring + Diagnostics

Control-level Service Interfaces

**Rockwell
Automation**

PROFACTOR
Research for Success

softing

Machine Control

Machine Control

Machine Control

I/O
Service
Interfaces

Machine #1



Simulation



Machine #2