OPC Foundation
OPC UA Enabling the Internet of Things

Thomas J. Burke

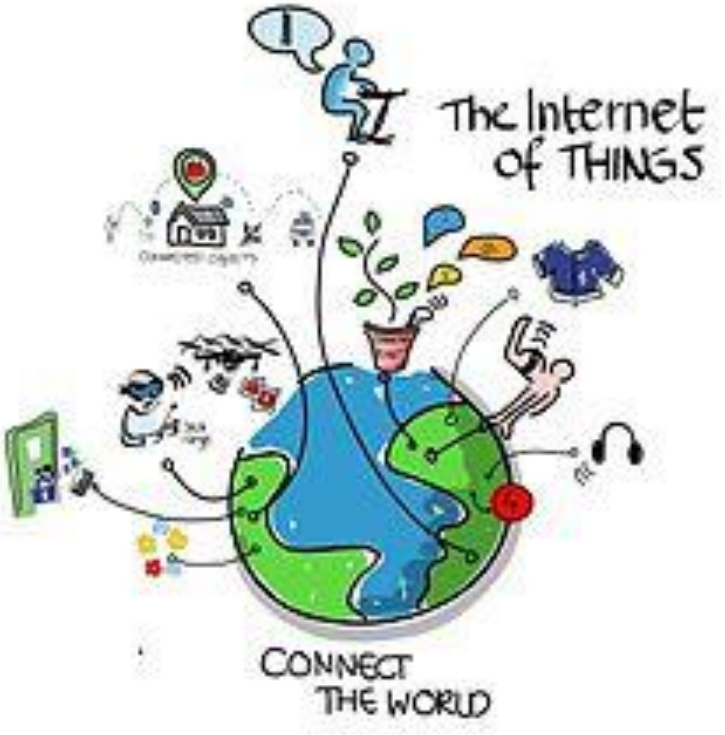
OPC Foundation President & Executive Director

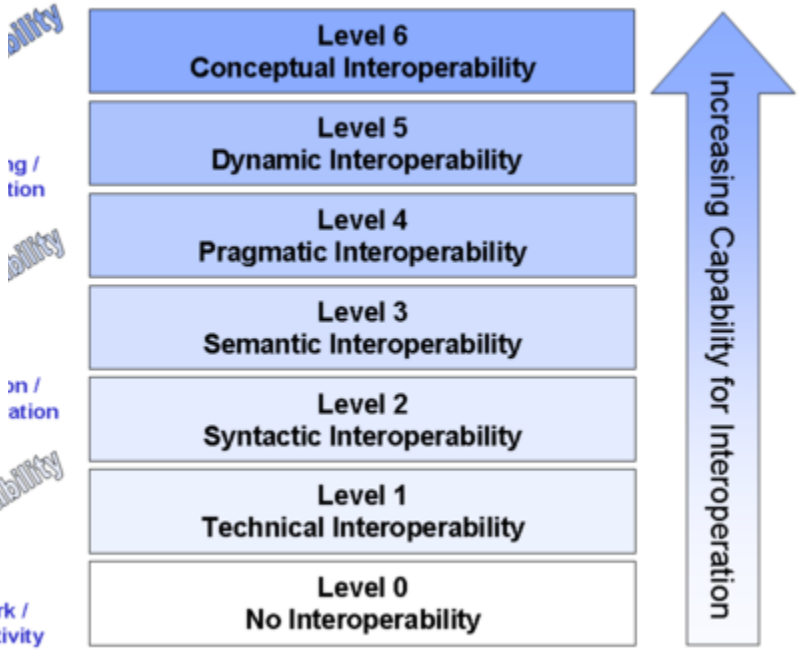
Beginning Thoughts

- The OPC Foundation started in 1995 to develop a standard to address solving the device driver problem for industrial automation. Provide a standard interface between the software that has the intimate knowledge of communicating to the underlying devices, and first-tier visualization applications.

- Architecture of technology was focused on leveraging Microsoft technology as an integral part of the architecture.

Innovation & Interoperability





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Consumer Electronics -> Industrial Automation

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IoT - Definition

What is the Internet of Things?

"Connected world solutions combine sensors and technologies to enable objects and infrastructure to interact with monitoring, analytics and control systems over Internet-style networks."

Source: Forrester

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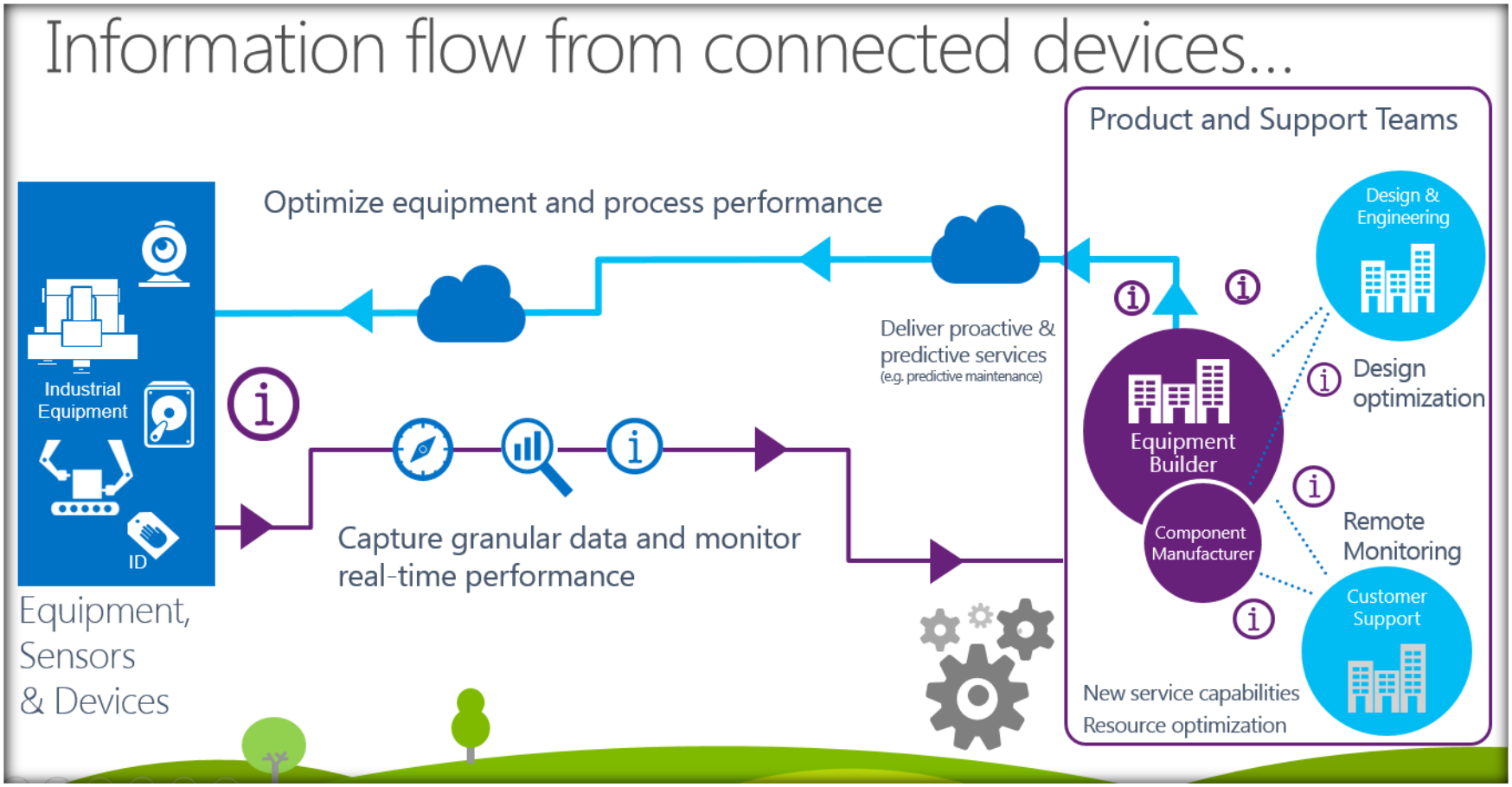
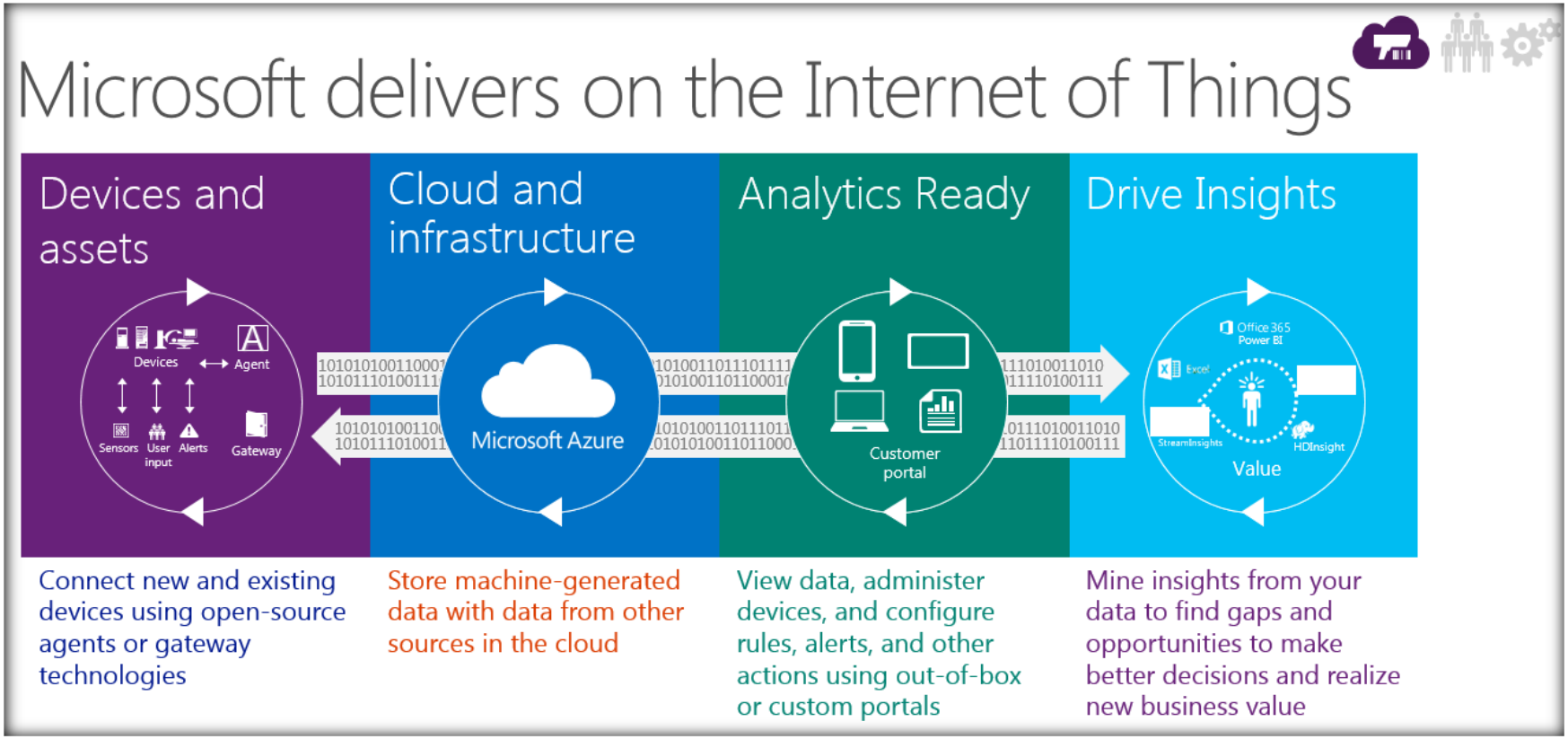
IoT - Definition



IoT - Definition



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Industrie 4.0 – Definition

Industrie 4.0

- everyone is talking about it: politicians, organisations…
- in all journals are innumerable articles

→ **Do you know what**

Industrie 4.0 means?

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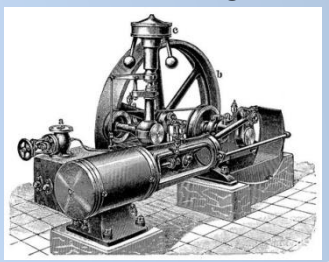
Industrie 4.0:
4 stages of the Industrial Revolution

Drivers
Quality of life
Engineering Sciences

1st

steam engine



GB

1782

Power generation
Mechanical automation

Mobility

2nd

conveyor belt

US

1913

Industrialization

µelectronics

3rd

Computer, NC,PLC

US/EU

1954

Electronic Automation

ICT

4th

Cyber Physical Systems

EU

2015

Smart Automation

Source: Acatech, Final report of the Industrie 4.0 Working Group, April 2013

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Industrie 4.0: Individualized products require a factory floor managing itself

- Consumers expect
  - Order — Products which they can individually modify
Quantity „1“ manufacturing
  - Monitor — Status of production
  - Cost — Same for individualized products compared to high series
  - Delivery — Quick, not after 6-8 weeks

- The production line has to be extremely flexible and located nearby

  → bring home product lines

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Industrie 4.0: Why?

Support of the mechanical and plant engineering to strengthen their competitiveness.

What should be achieved?

- flexible order processing
- efficient resource management
- connected, reliable production
- 100% traceability and quality ensurance
- self-optimizing manufacturing and production
- consistent engineering

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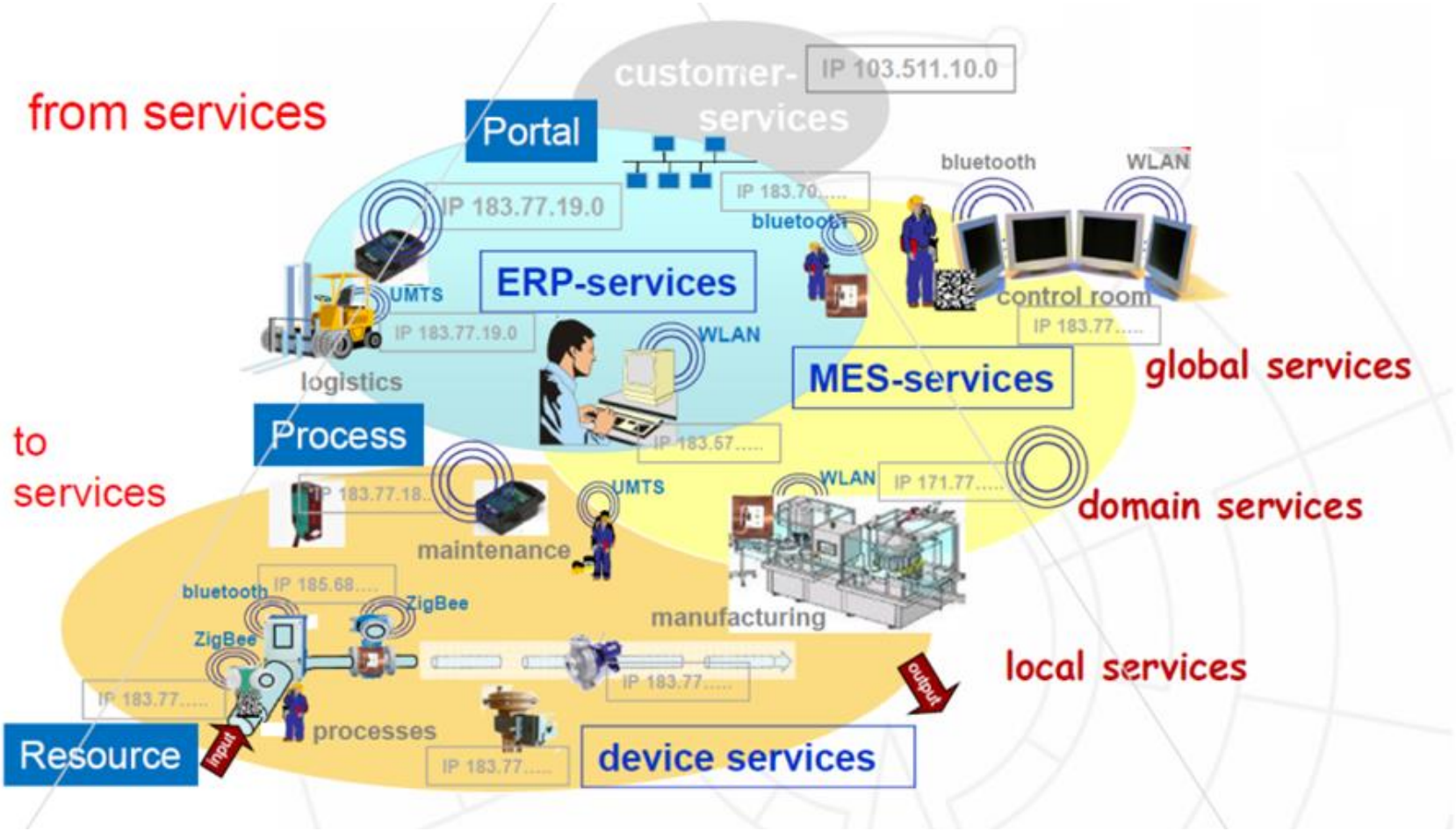
New: OPC-UA integrated into devices allow „From service to service“

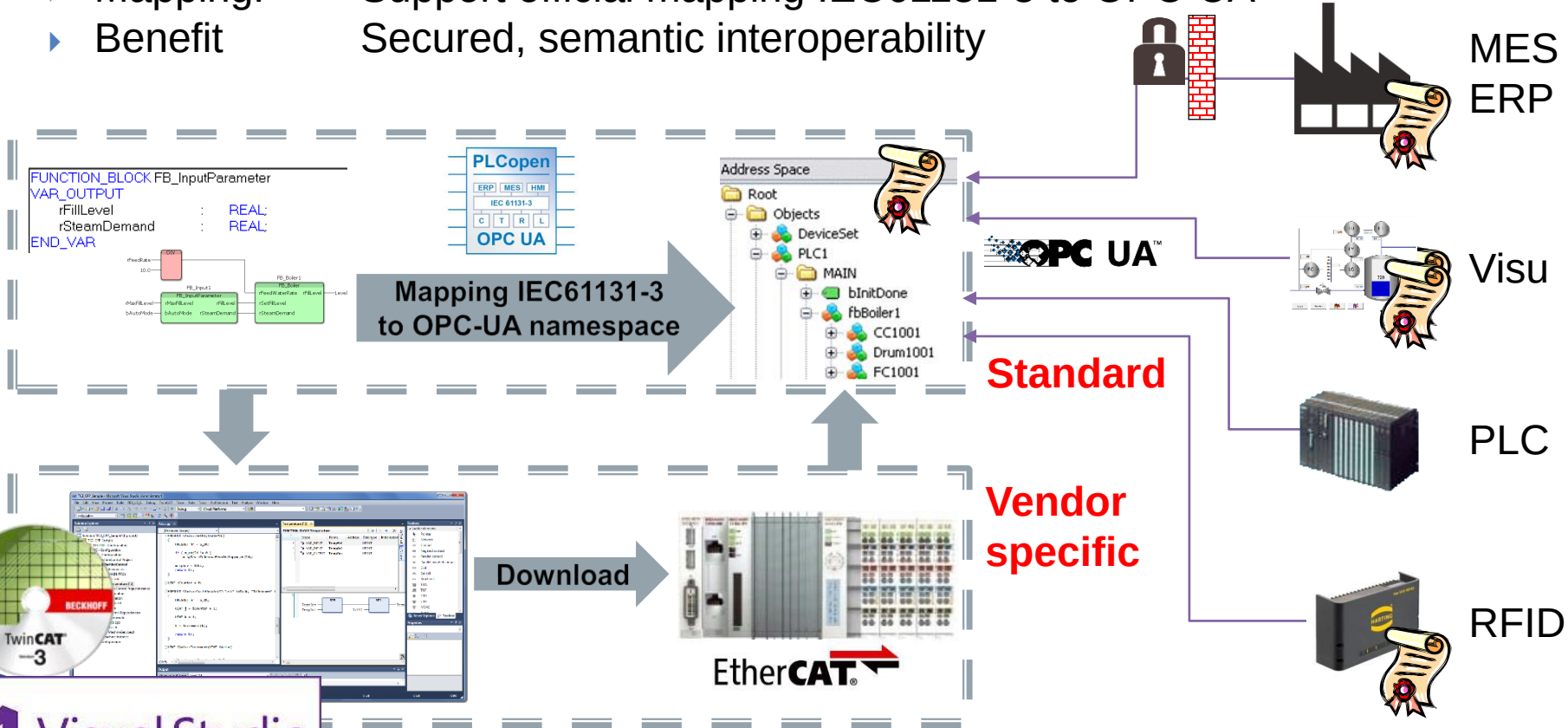


Source: Prof. Zühlke, DFKI

Into Controller: Informationmodell

- Connection >**to the controller** <

- Integrated: PLC and OPC-UA in embedded device
- Mapping: Support official mapping IEC61131-3 to OPC-UA
- Benefit Secured, semantic interoperability



Visual Studio Microsoft Partner

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Use Case | MES to PLC

Success Story

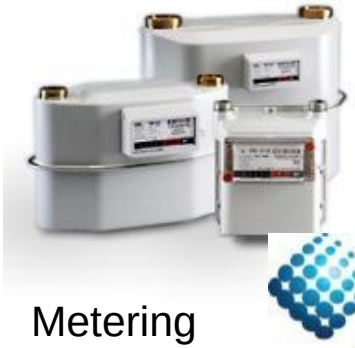
- From shop floor (Beckhoff) controller to top floor (SAP)
- OPC-UA: Direct connection from MS into controller

Benefit

- Quick: due to OPC-UA done in 20min
- easy to use for PLC and MES team
- standardized interface layer
- fast connection, include security out of the box

Elster

- 7,000 employees,
  38 major locations
- 200 million installations in
  the last 10 years



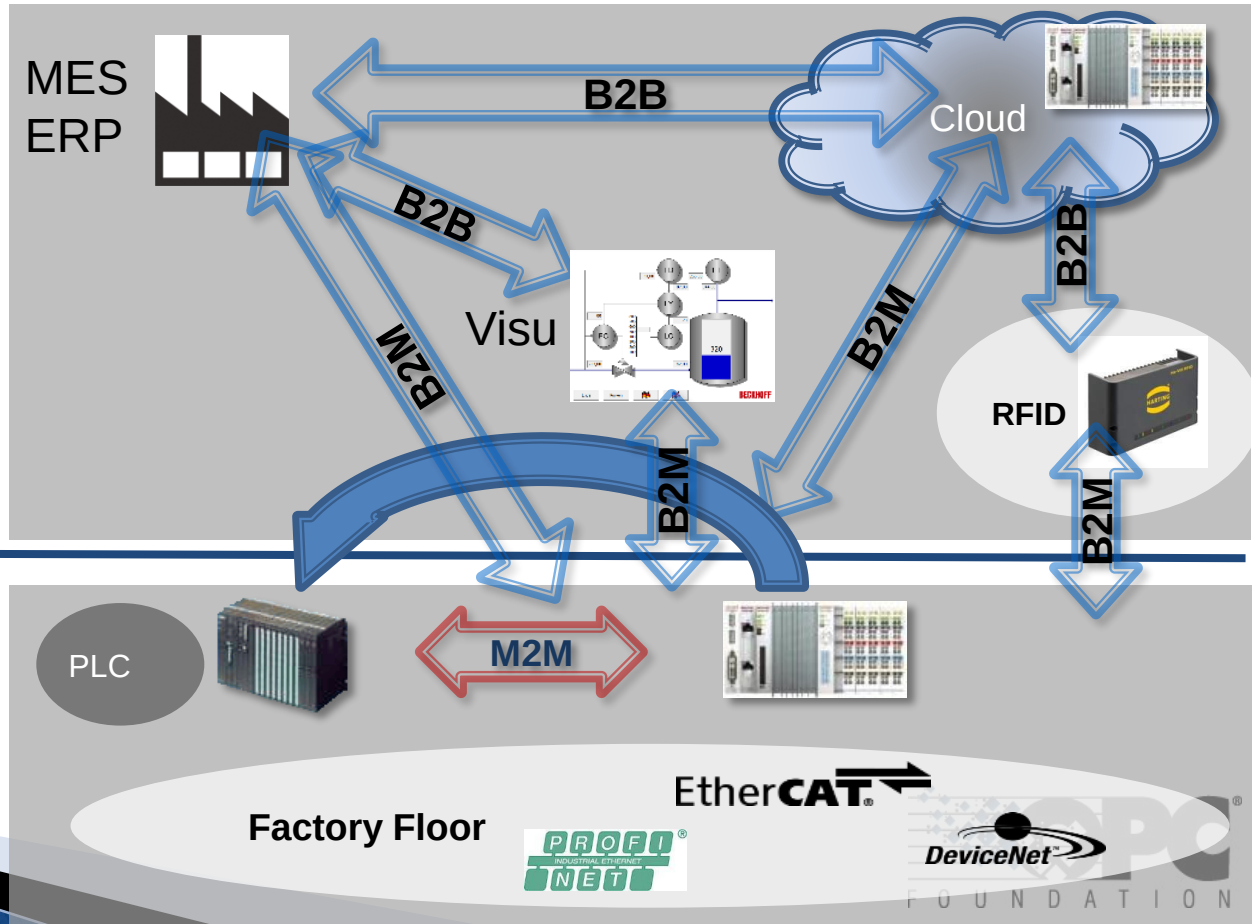
Metering
Gas, Water, Electricity

elster
Vital Connections

Different understanding of IT and IA3: Real-time Categories of communication

Services are running in IT or Automation teal time context – so 3 transitions:

B2B: Business to business (ms to minutes e.g. MES to ERP, to cloud)
B2M: Business to machine (ms to minutes e.g. from MES into controller)
M2M: machine to machine (µs to ms, e.g. robot to robot)

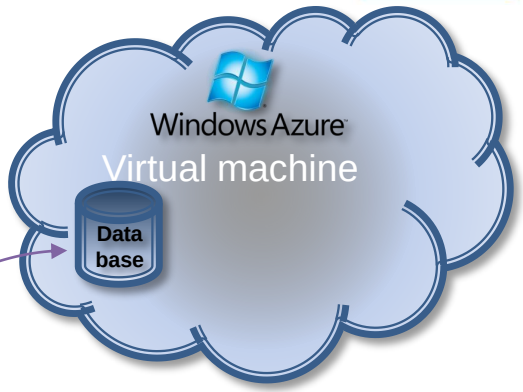


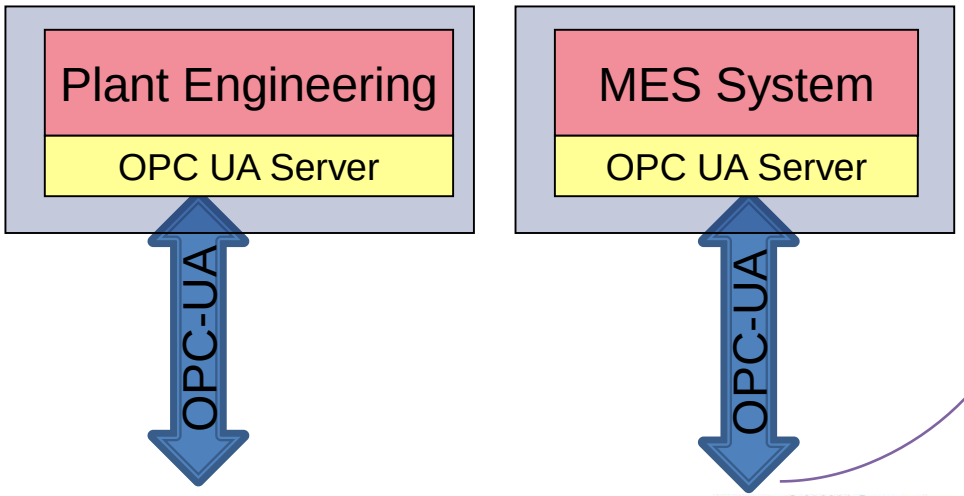
From Controller: PLCopen FB

PLCopen
ERP MES HMI
IEC 61131-3
C T R L
OPC UA

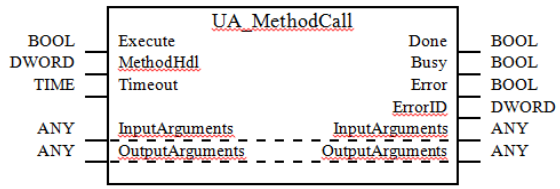
Released April-2014

Connection >**from the controller** <
Controller initiating communication

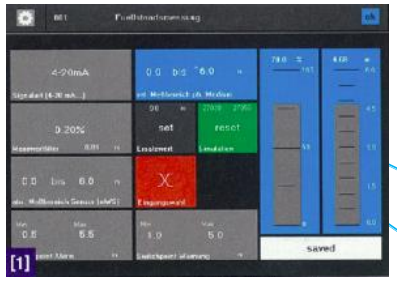




- **Vertical & Horizontal**
- **Fieldbus independent**
- **It's fast – but not a fieldbus**



Use Case | Machine to Machine



SCADA

Requests for process values and state changes

qualitiy problems in freshwater ①

water works 1

pumping plant 1

② Requests for process values and state changes

closed user group

② please overtake filling of elevated reservoir

level reached ①

stop pumping ②

③ due to problems at group1 supplier of freshwater has changed to group 2

elevated reservoir

water works 2

pumping plant 2

Challenge:

500 devices

pumps

waterboilers

1400 km2

Use Case | Machine to Machine

Effects saving costs

- Transmission of complex data structures -> there‘s no configuration of every single datapoint required
- Replacement of a proprietary solution by a combined OPC UA client/server Standardization of data communication reduces interfaces, just OPC UA client and server
- A physical interruption of the connection does not lead to a loss of information -> automatically buffered in the OPC UA server for a time and can be retrieved as soon as the connection has been restored
- Using safety mechanisms authentication, signing and encryption integrated in OPC UA in addition to a closed mobile radio group to ensure the integrity of the confidential data

- **solution provided us with a saving on the initial licensing costs of more than 90 % per device**

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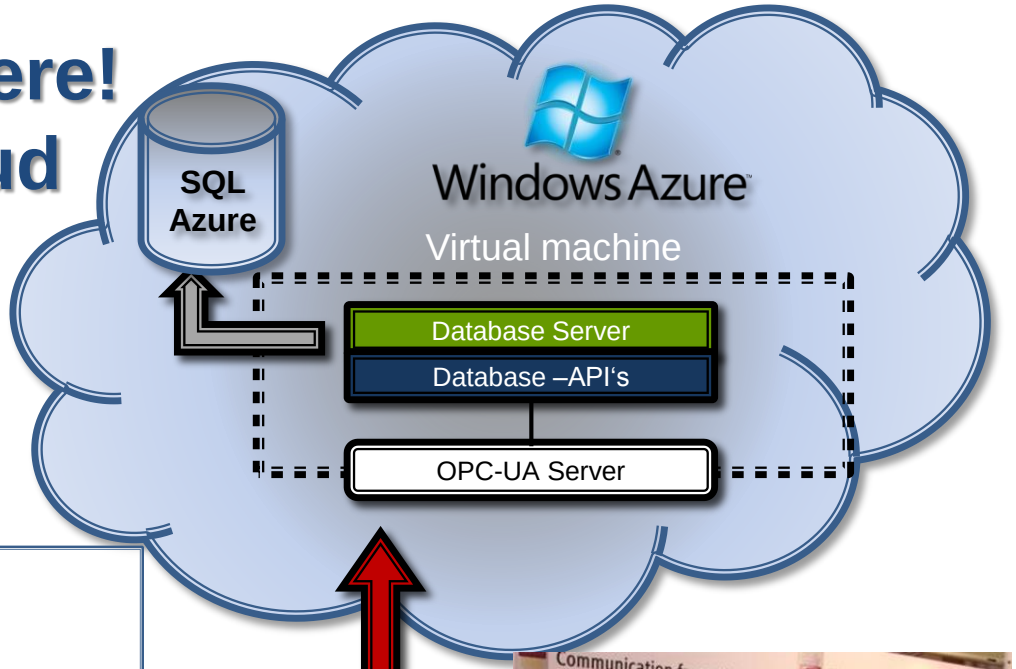
Where is the cloud? Here! From controller to cloud



Runtime: PLCopen Function Blocks for OPC-UA method call

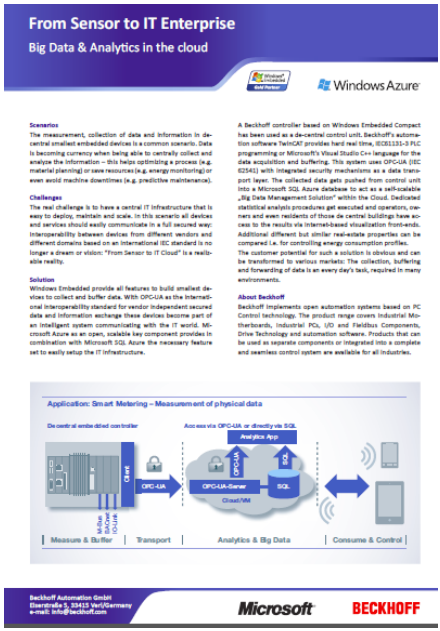
```
fb_OpcUaOpen(
        bExecute := TRUE,
        sUrl := 'opc.tcp://ew2013.cloudapp.net:4840',
        tTimeout := T#15s,
        hSession => hSessionHandle);
...
fb_OpcUaMethodCall(
        bExecute := TRUE,
        sParam := 'INSERT INTO table VALUES(ID, Time, Val)',
        tTimeout := T#15s,
        hSession := hSessionHandle,
        hMethod := hMethodHandle);
```

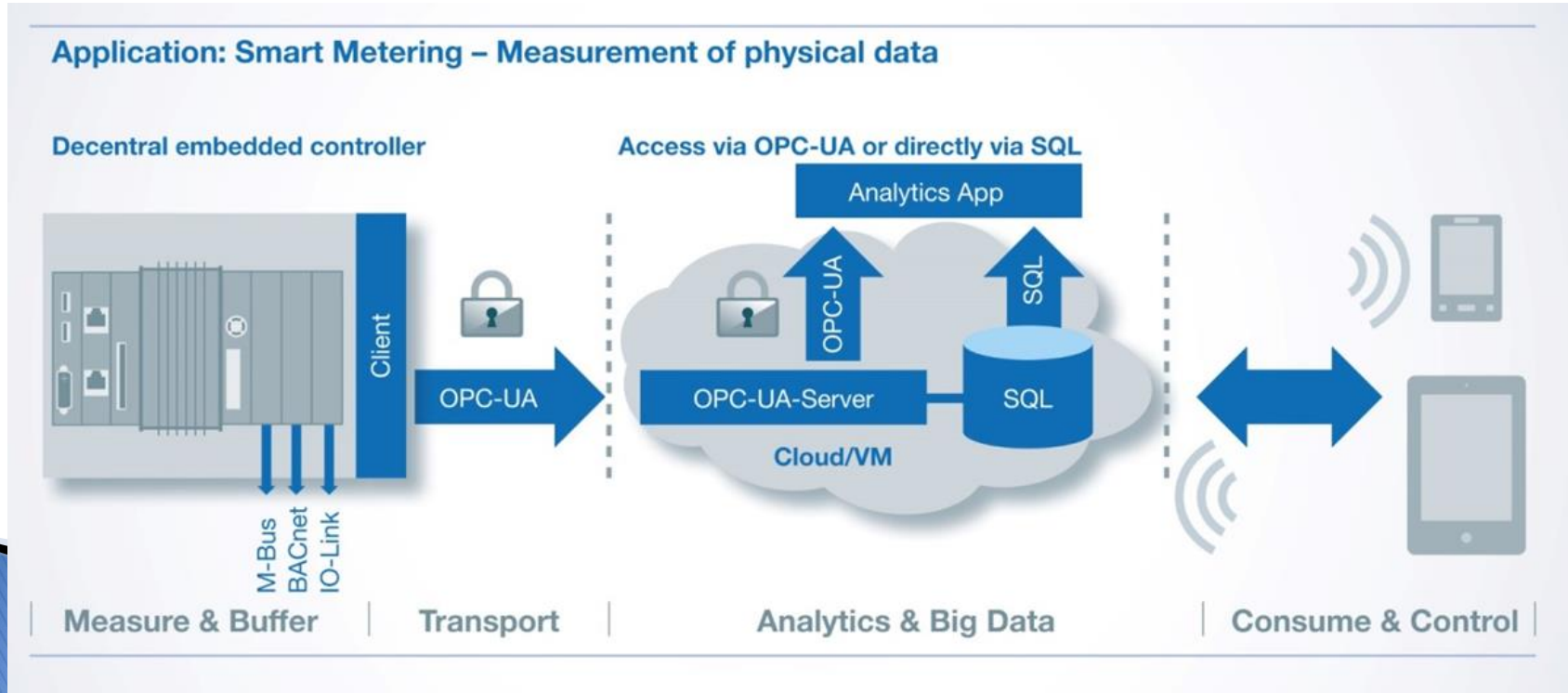
Use Case | Smart metering

Decentral measurement (optional local buffering of data),
pushing into central databases for analytics
and deploying results

- Smart metering project in Germany
- London Underground: measure vibration data

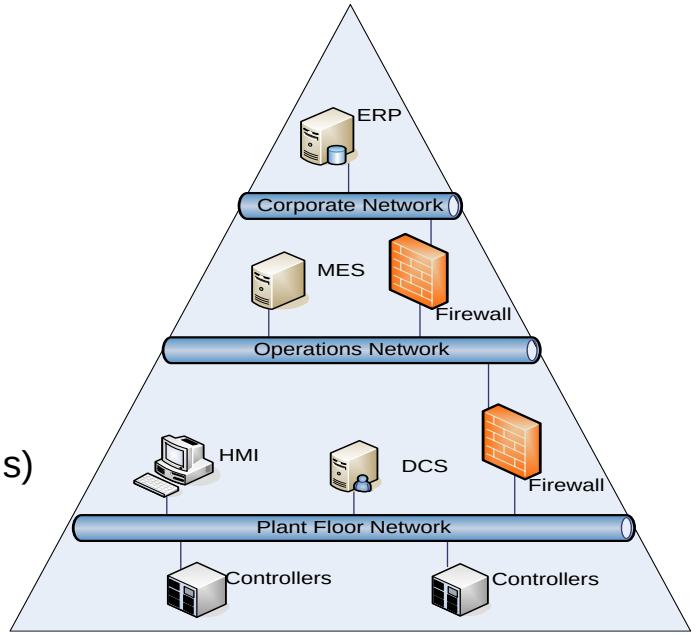
- Wish: better connection to cloud (like relay)



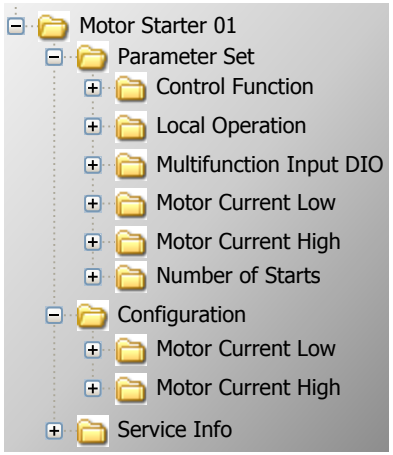


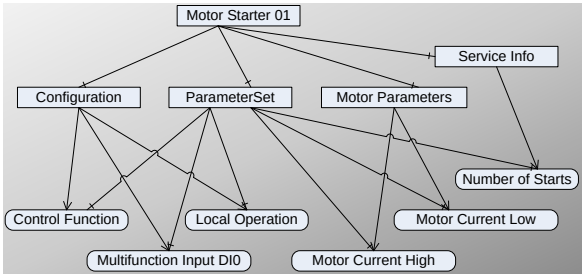
IoT or Industrie 4.0
OPC-UA is the enabler

- **Communication infrastructure**
  - Secure, interoperable, reliable, performant, scalable
  - Platform-independent (OS, language, vendor)
  - Technology:
    - Service-oriented
    - Provide technology independend from services
  - Small set of easy to use services
    - 37 operations
    - Grown up in Automation market - (e.g. time stamp, status) but neutral for other vertical markets



- **Information modelling**
  - Rich, objectoriented and extensible typmodel
  - Typmodel in adress space
  - Full mashed network
  - Scalable:
    Support simple and complex models
  - Standardized Informationmodels based on OPC UA
    - PLCopen, BACnet, MTConnect…





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OPC Foundation: Who We Are

Community:	• The OPC Foundation is the world's leading community for interoperability solutions based on OPC specifications that deliver universal connectivity.
Collaboration:	• The mission of this community is to advance the development, adoption and certification of OPC based products through global collaborations.
Compliance:	• The Foundation is the official source for the OPC Certification Program, ensuring that OPC products plug-and-play in real-world application.

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OPC Foundation Business Update

Suppliers preach guaranteed interoperability is achievable via their close knit club.

Standards organizations preach adoption of the specifications from their organization, and how membership in their organization facilitates certification and guaranteed interoperability.

What is the real answer?

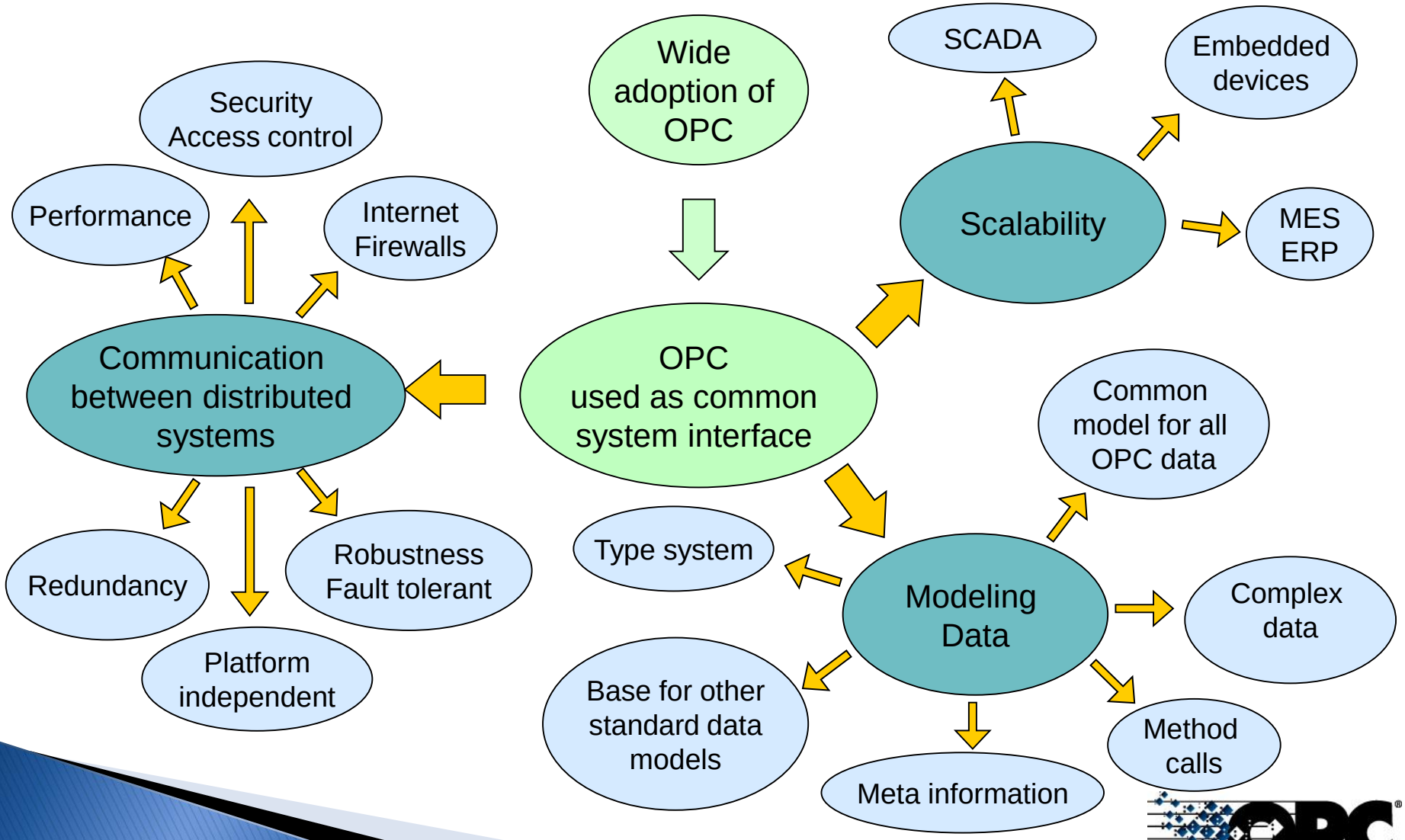
OPC Foundation Business Update

Consumer-electronics are driving the way of future with respect to setting the stage for the engineers of today and tomorrow and expectations in industrial automation.

Engineers expect that they can purchase and use products from multiple vendors and a work out-of-the-box courtesy of consumer-electronics.

Suppliers in industrial automation encourage you to buy only products from them and their preferred compatible vendors.

Requirements for OPC UA



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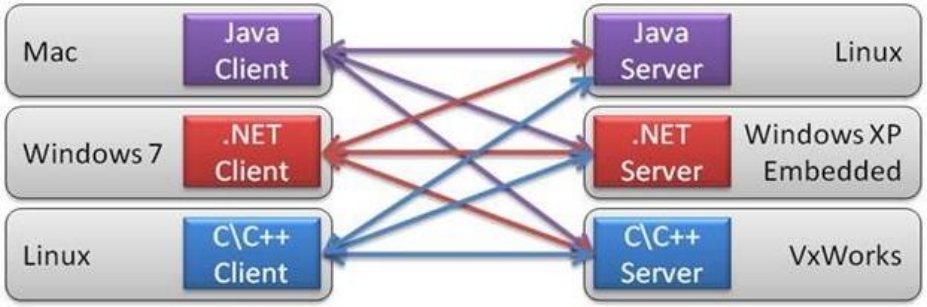
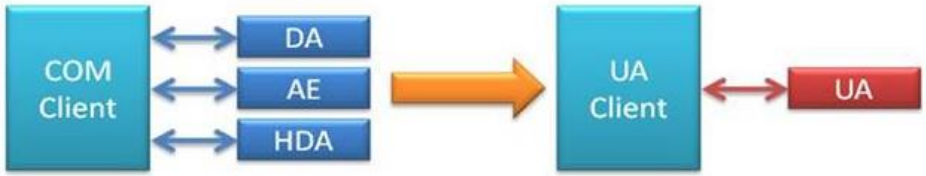
Key Features and Benefits

Cross Platform

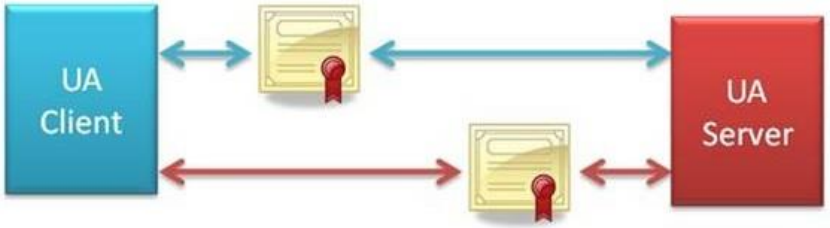


Unified Access



Internet and Firewall friendly

Standard Security Model



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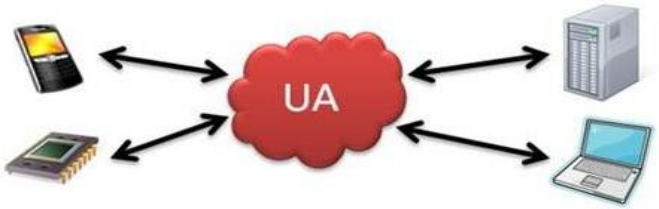
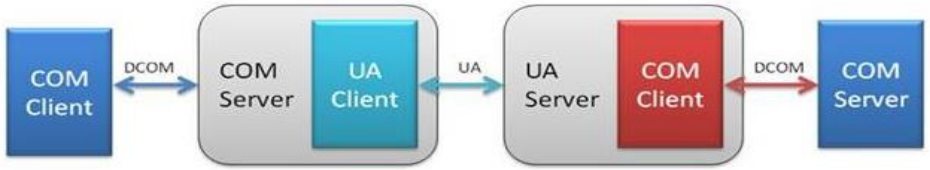
Key Features and Benefits

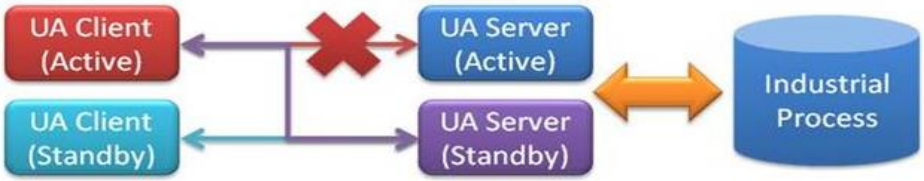
Single Solution from Embedded to Enterprise



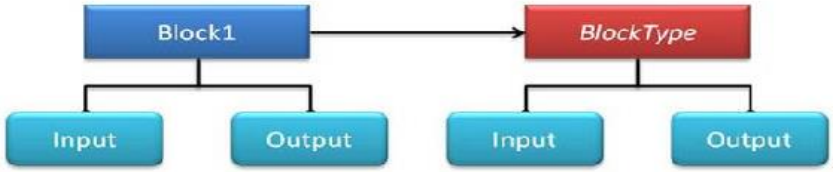
Builds on existing investments in OPC COM



Reliability by design



Flexible object-oriented information model



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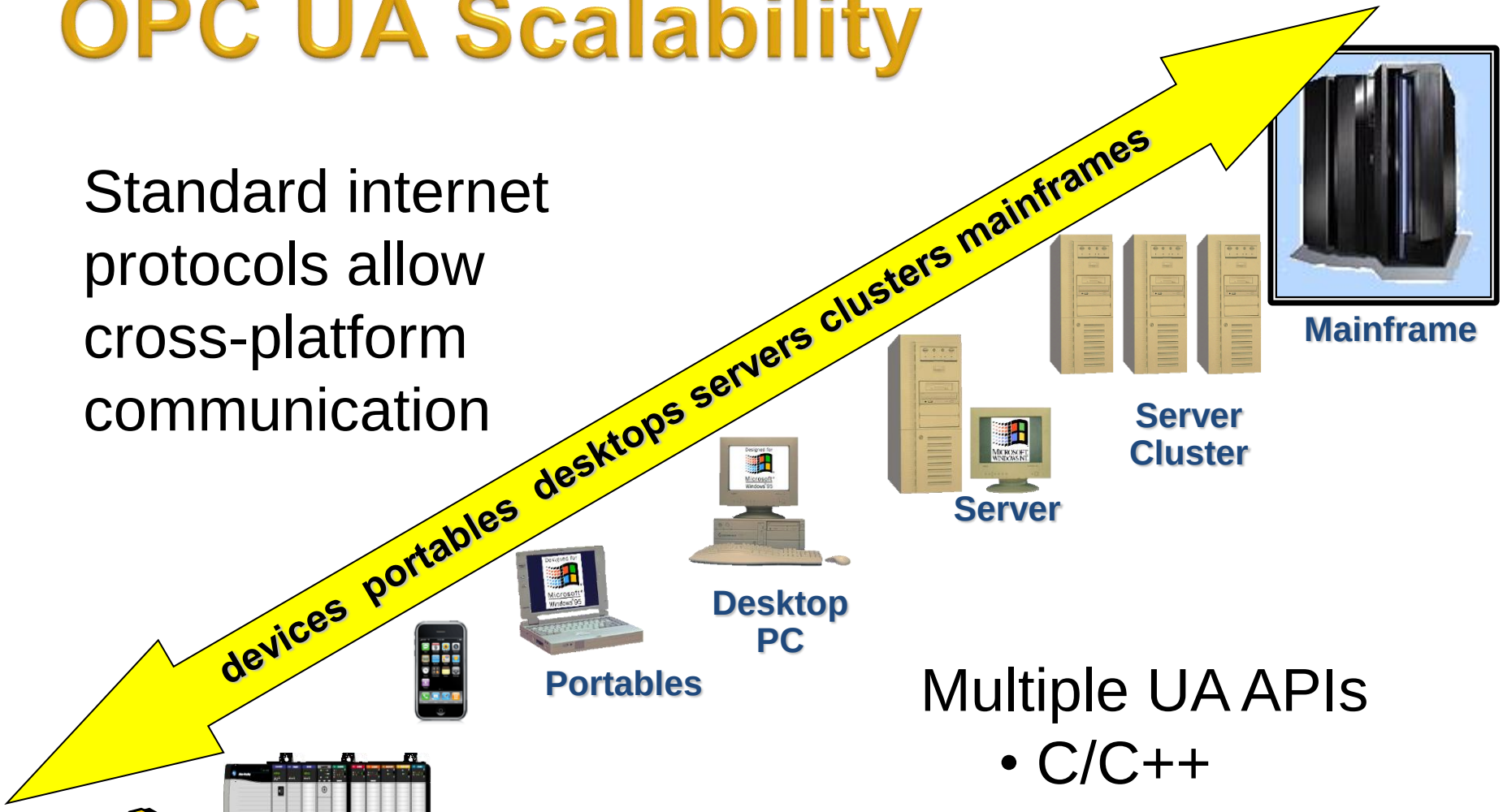
OPC UA Scalability

Standard internet protocols allow cross-platform communication



Multiple UA APIs

- C/C++
- JAVA
- Microsoft .NET

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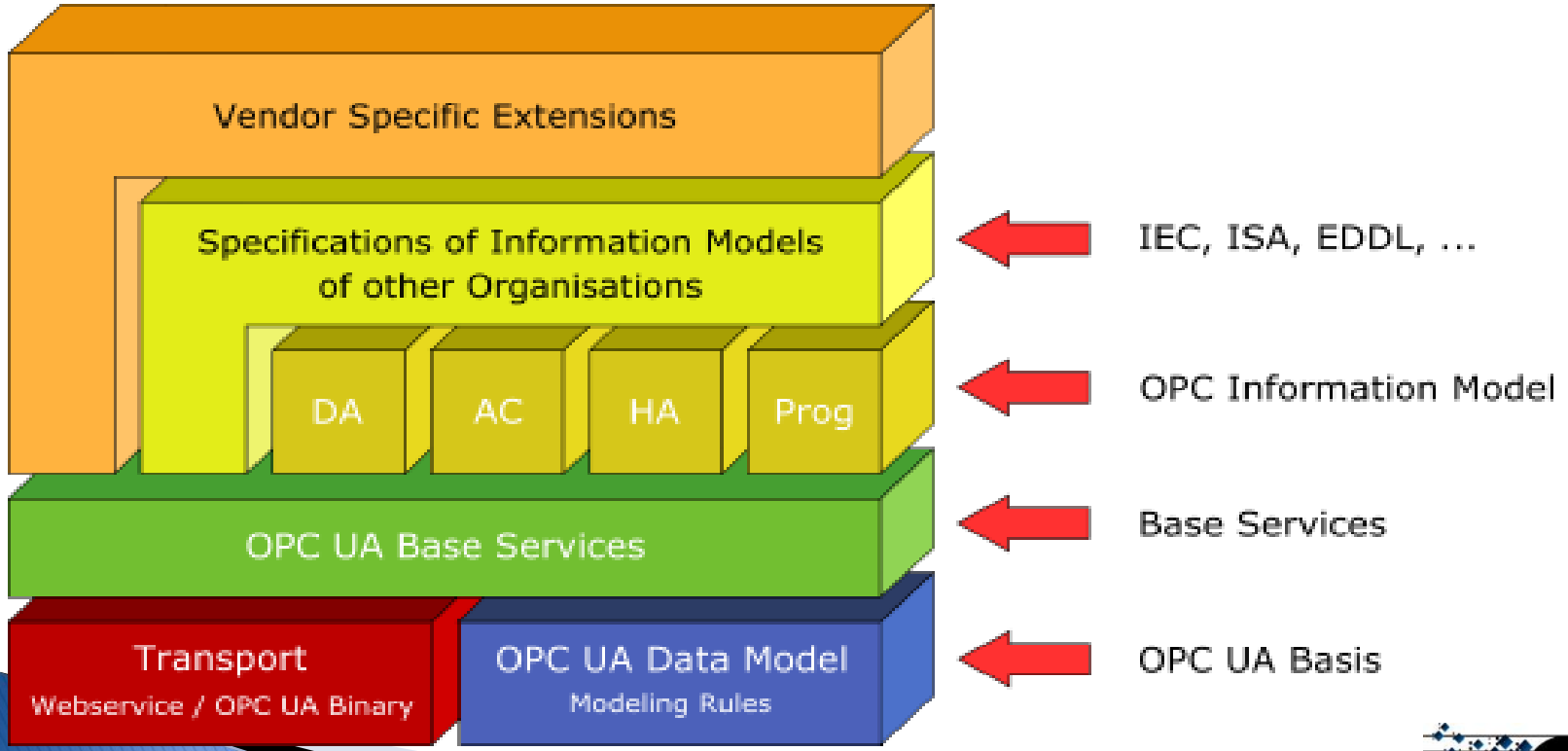
OPC UA Information Modeling

- Modeling Data – Providing Information
- Transport Data – Platform Independent



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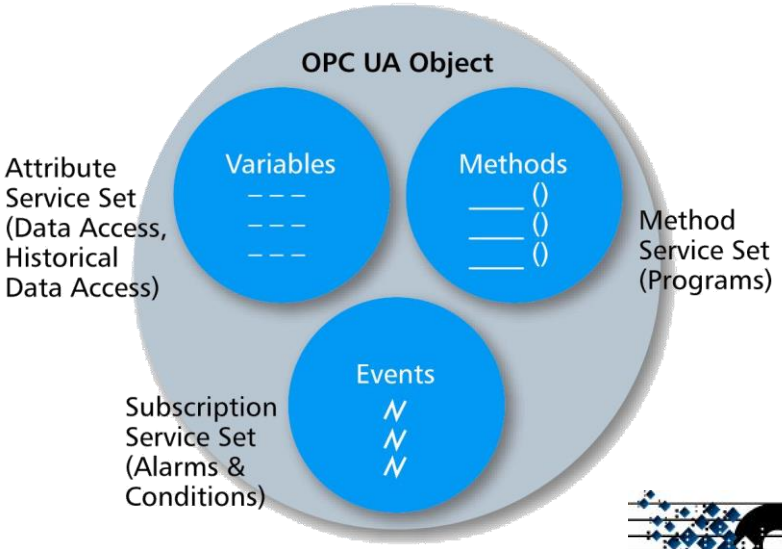
Unified Data Model

- Unification ➔ Simplification
- Classic OPC defines different address space models for process data, alarms and historical data
- Reduced system integration costs by providing a common architecture for accessing information



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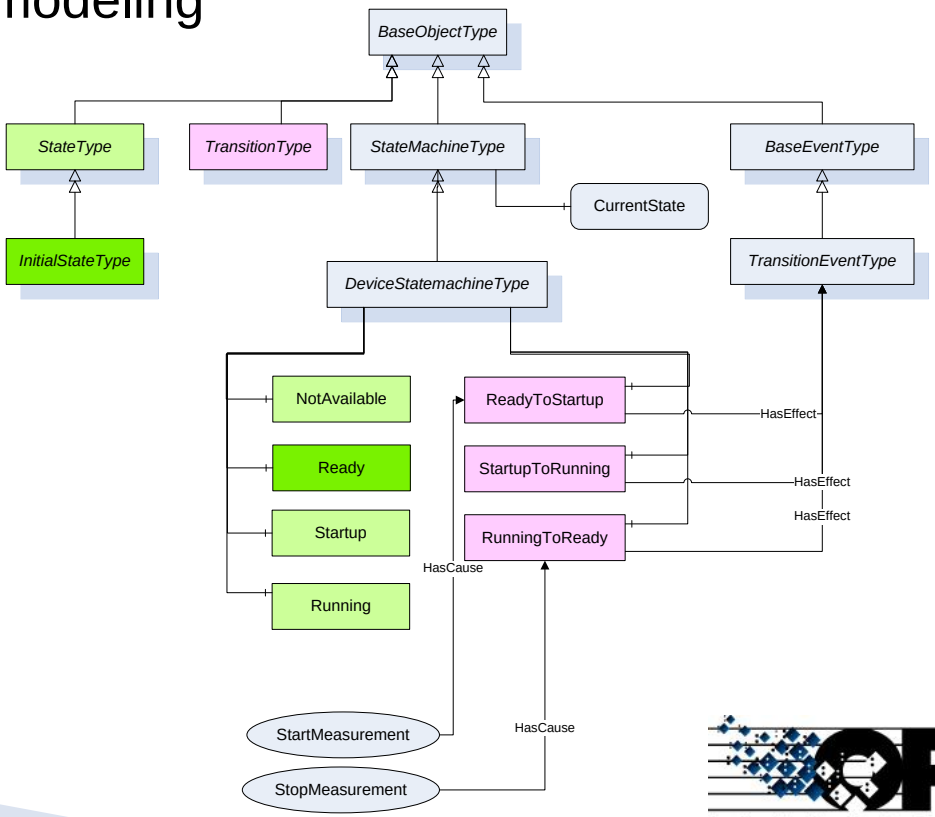
Complex Data, Modeling

- OPC products can now represent complex systems with OPC UA's rich Information Model
- OPC UA provides data and meta data
- UA Information model defines modeling elements and modeling rules
  - Complex data types
  - Methods

    State machines
  - Inheritance



OPC Foundation Collaborations

- OpenO&M
- ADI
- PLCOpen / MES
- ISA-95
- FDI
- FDT
- MTConnect
- ODVA/Sercos
- BACnet (Europe)
- PRODML
- MDIS
- DSATS
- AutomationML
- SLC

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Collaboration in Building Automation

- Collaboration with BACnet Interest Group Europe (BIG-EU)
- Integration of Industrial and Building Automation
- Mapping of BACnet and OPC Unified Architecture
- First mapping specification planned for July 2013

BACnet working group started on October 01, 2012

- Collaboration with ONFIV (Video) in discussion
- OPC is used but lack of standardization in this area

Physical Security Systems

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Collaboration in Energy

- OPC UA evaluation is in progress and supported by OPC Foundation
- MCS-DCS Interface Standardization (MDIS)
  - Standard for drilling
- Smart Grid Interoperability Panel (SGIP)
  - Selection of standards used for Smart Grid in North America
  - Review by Cyber Security Working Group (CSWG)

OPC UA evaluated for use in different standards

- WG 10 – Communications & associated data models in power systems (IEC 61850)
- WG 13 – Energy management system application program interface
- OPC UA Experts involved in these working groups

IEC TC 57 Power Systems

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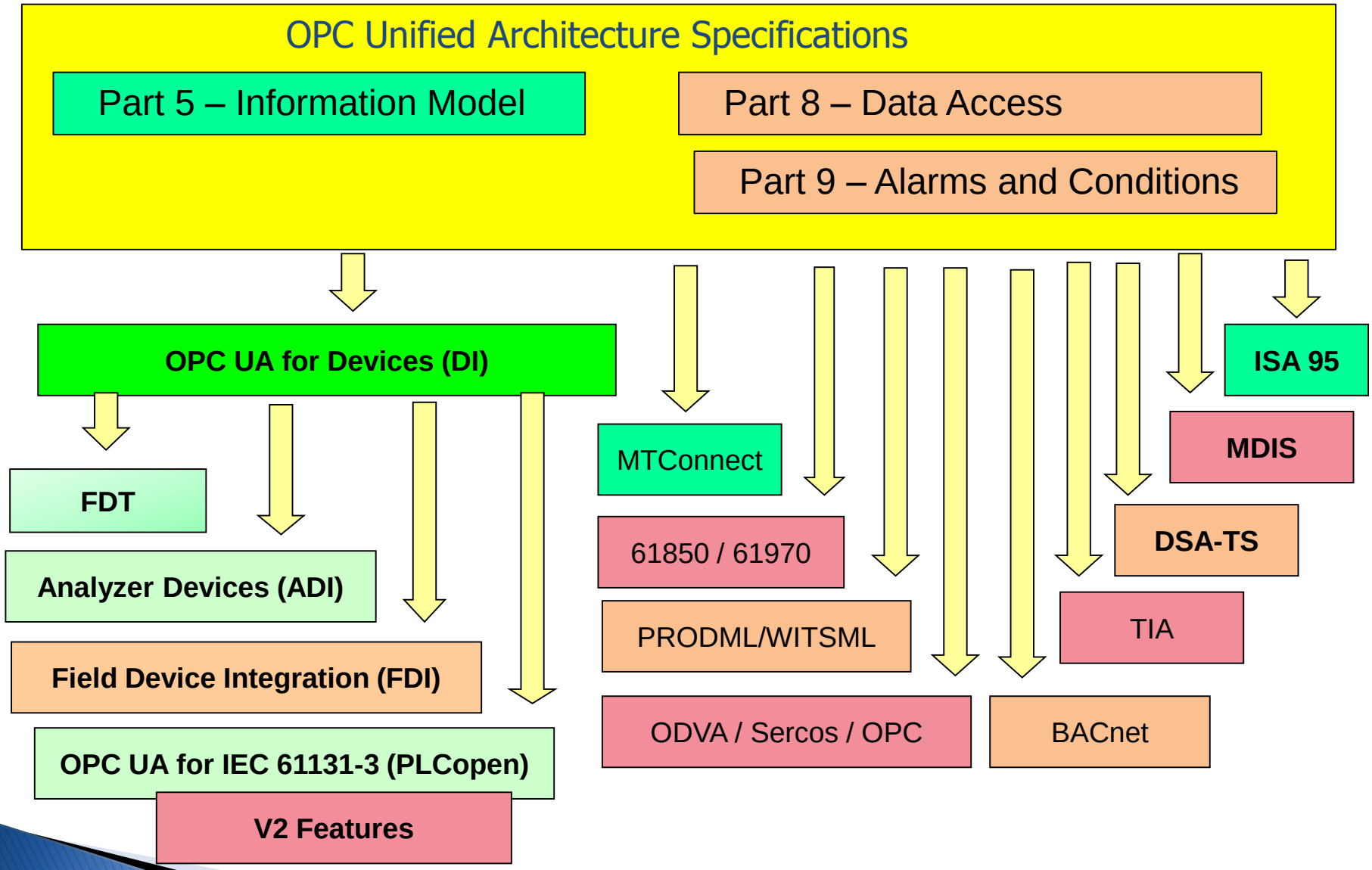
Companion Specifications

- MTConnect Completed
- ISA S95 Completed
- MDIS Under Development
- PLCOpen Released
- BACnet In Progress

Industrial Automation Collaboration



MDIS

OIL & Gas Platforms

- Topside controls
- Subsea controls
- Multiple vendors
- Integration is key challenge

Operating Companies - Want standard communication interface between:

- Subsea gateway,
- MCS (Master Control Station)
- DCS (Distributed Control System)

MDIS - **M**CS-**D**CS **I**nterface **S**tandardization

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MDIS Members

The current members are:

- ABB,
- Aker Solutions,
- BP,
- Chevron,
- ConocoPhillips,
- Dril-Quip,
- Emerson,
- ENGlobal,
- ExxonMobil,
- FMC,
- GE Oil and Gas,
- Honeywell,
- Invensys,
- Wood Group Kenny,
- Kongsberg,
- OneSubsea,
- Petrobras,
- Prediktor,
- Proserv,
- Rockwell Automation,
- Shell,
- Siemens,
- Statoil,
- Total,
- W-Industries,
- Woodside,
- Yokogawa

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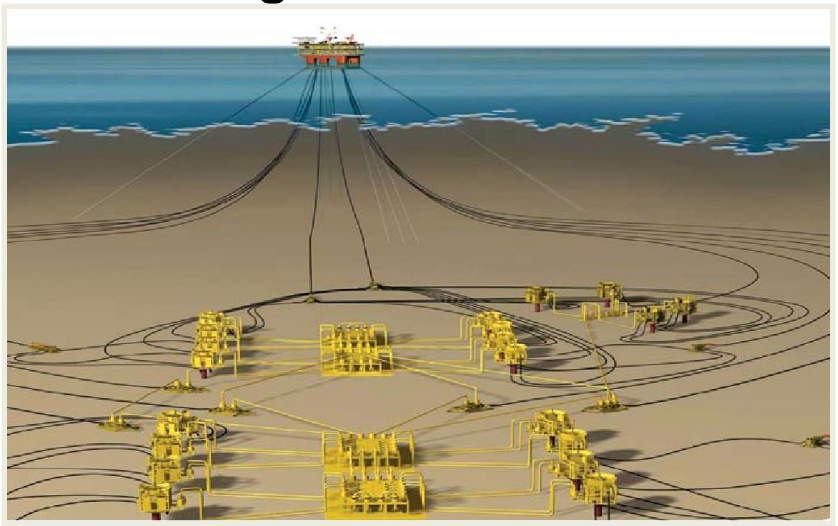
MDIS – Standardize?

What are the goals?

- Cost Savings in engineering
- Cost Savings in system test and integration

What is being standardized?

- Standard Interface
- Standard Information Mode
- Architectures



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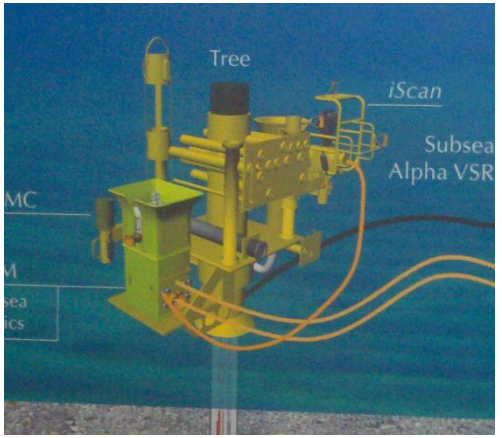
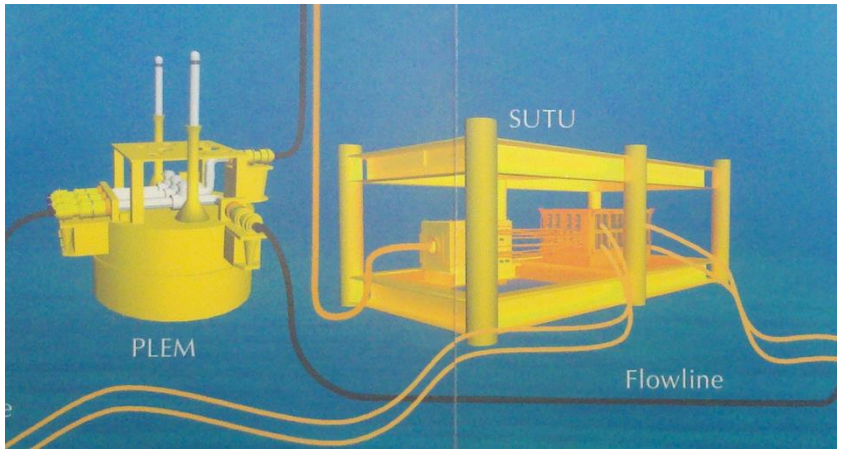
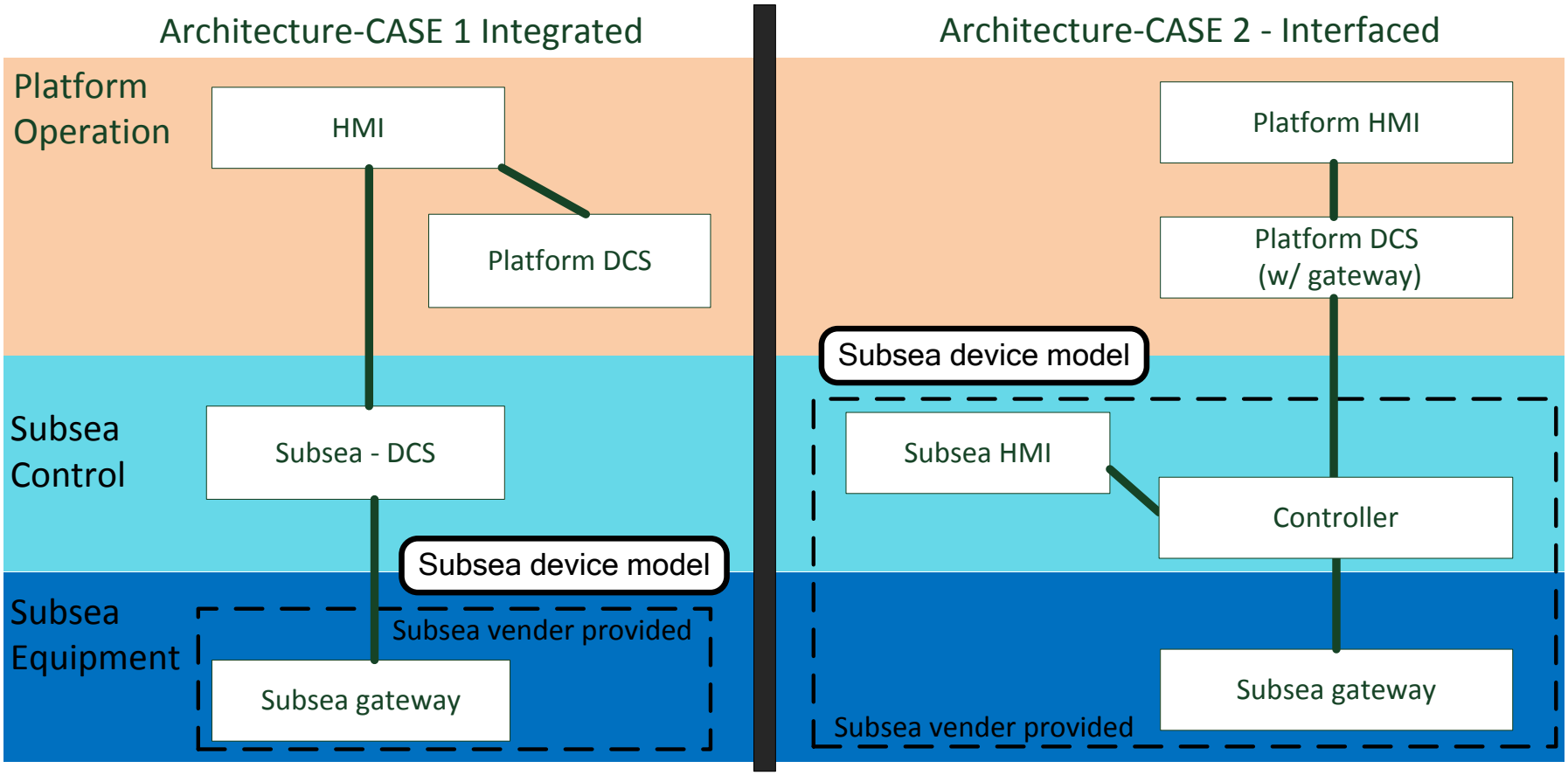
MDIS - Standardization

- Interface
  - What communication protocol (OPC UA)
    - Redundancy
    - Robustness
    - Security
- Information Model
  - Valve
  - Choke
  - Instrument
  - Discrete
  - CIMV
  - DHPT
  - MPFM
  - EPU
  - SEM
  - Motor
  - Manifold





MDIS - Architecture



Certified Products

Vendors with Certified Products

Questions?

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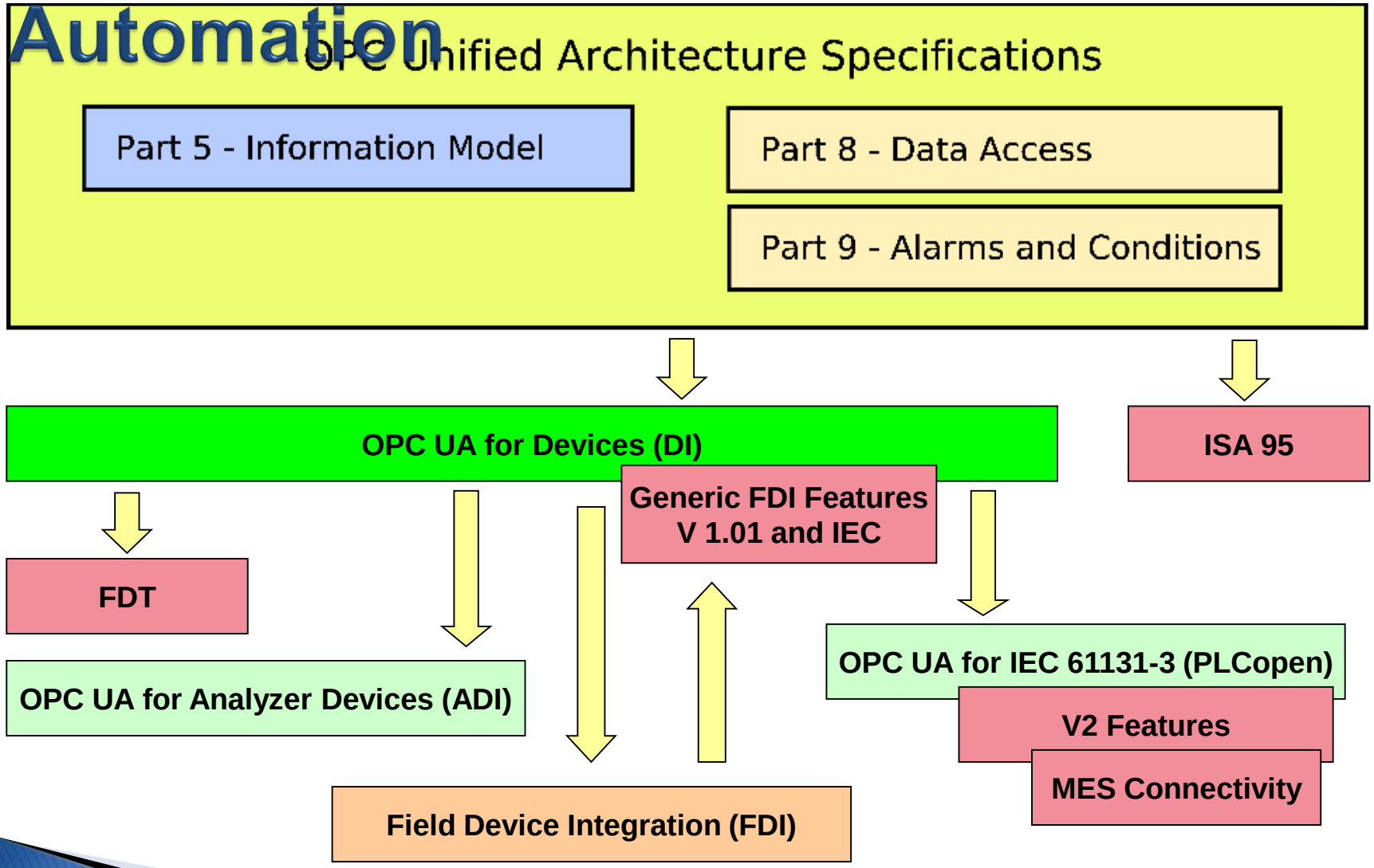
- Thomas.Burke@opcfoundation.org

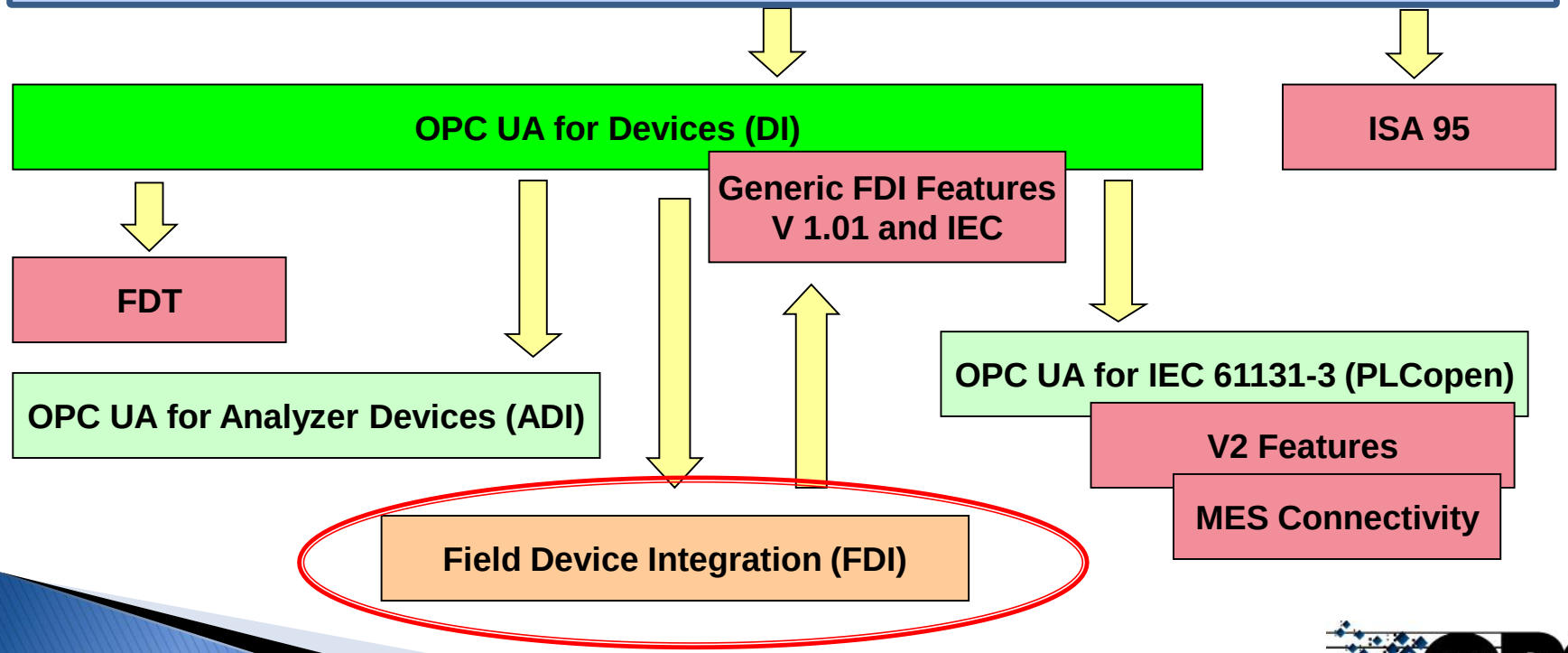
Collaboration in Industrial Automation



Collaboration in Industrial

Field Device Integration (FDI)

- FDI company founded in September 2011 by FF, OPCF, HF, PNO
- Tool development ongoing
- Process of IEC specification release ongoing

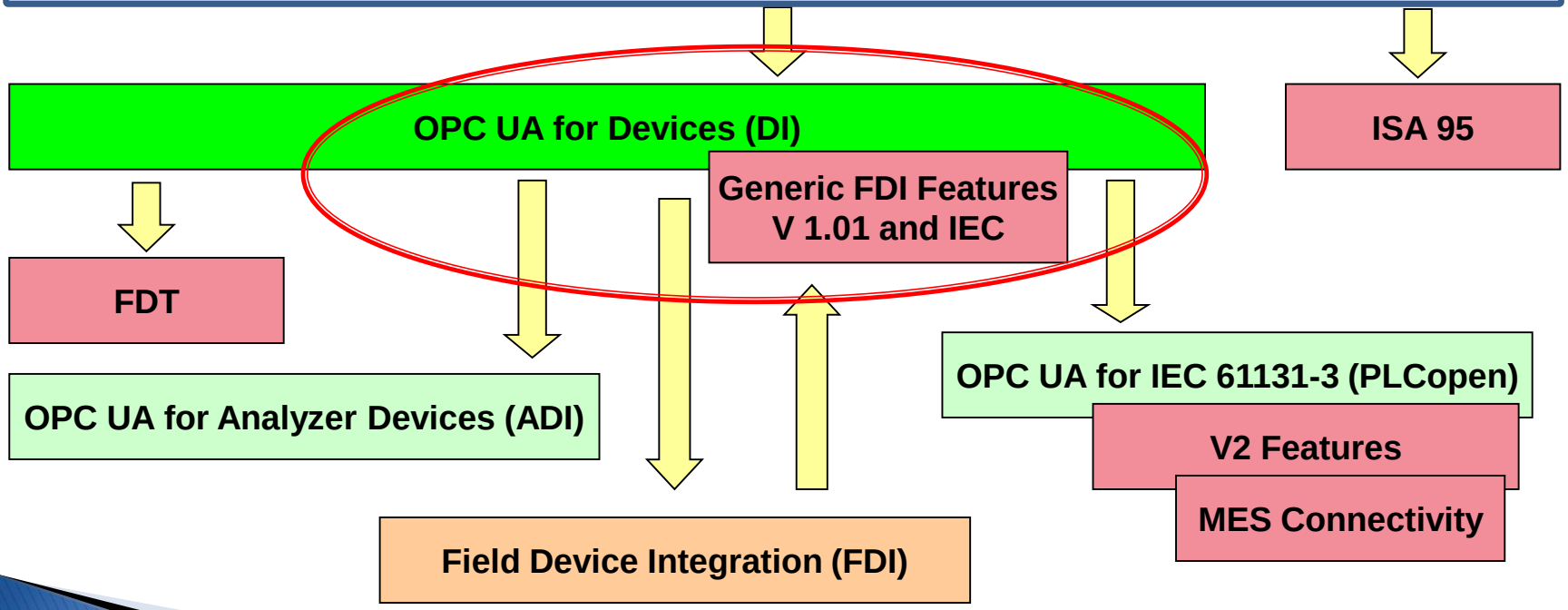


OPC FOUNDATION

Collaboration in Industrial

OPC UA for Devices

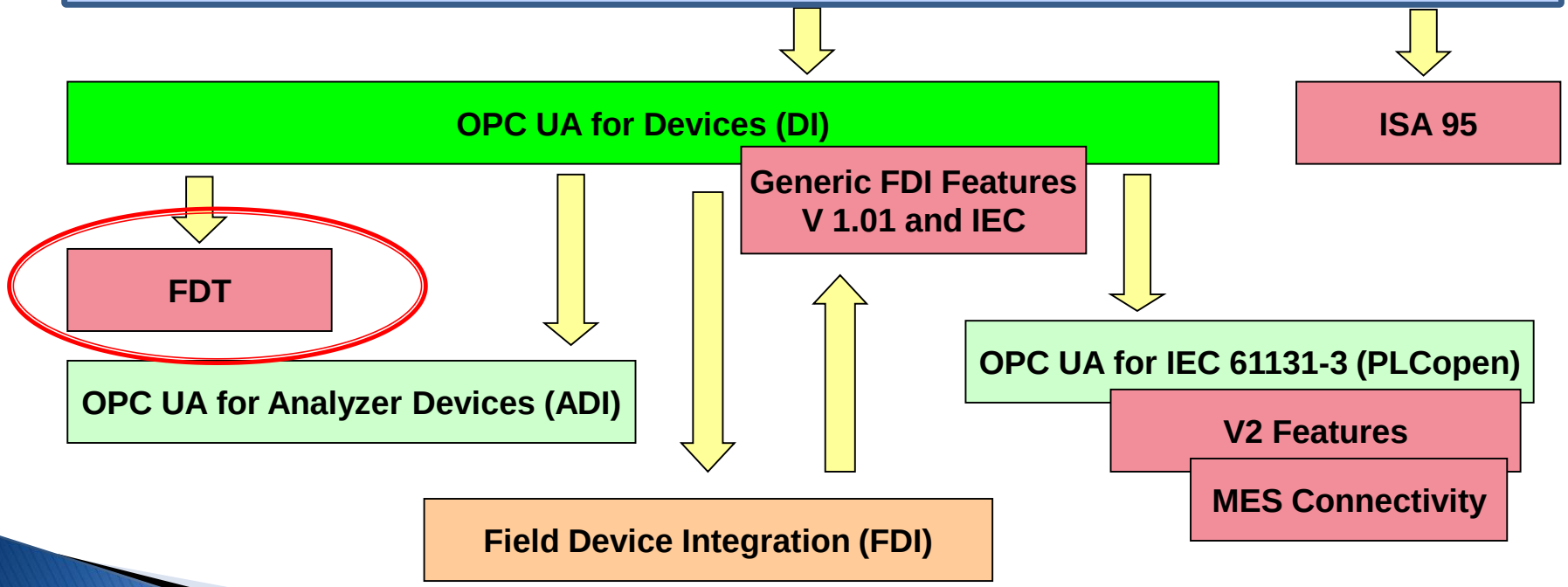
- V1.01 work started April 2012
- Goal: Move generic FDI feature to OPC DI
  - Locking, Edit Mode, GUI elements
- Prepare for IEC standardization
- Release planned for September 2012



Collaboration in Industrial

OPC UA for FDT

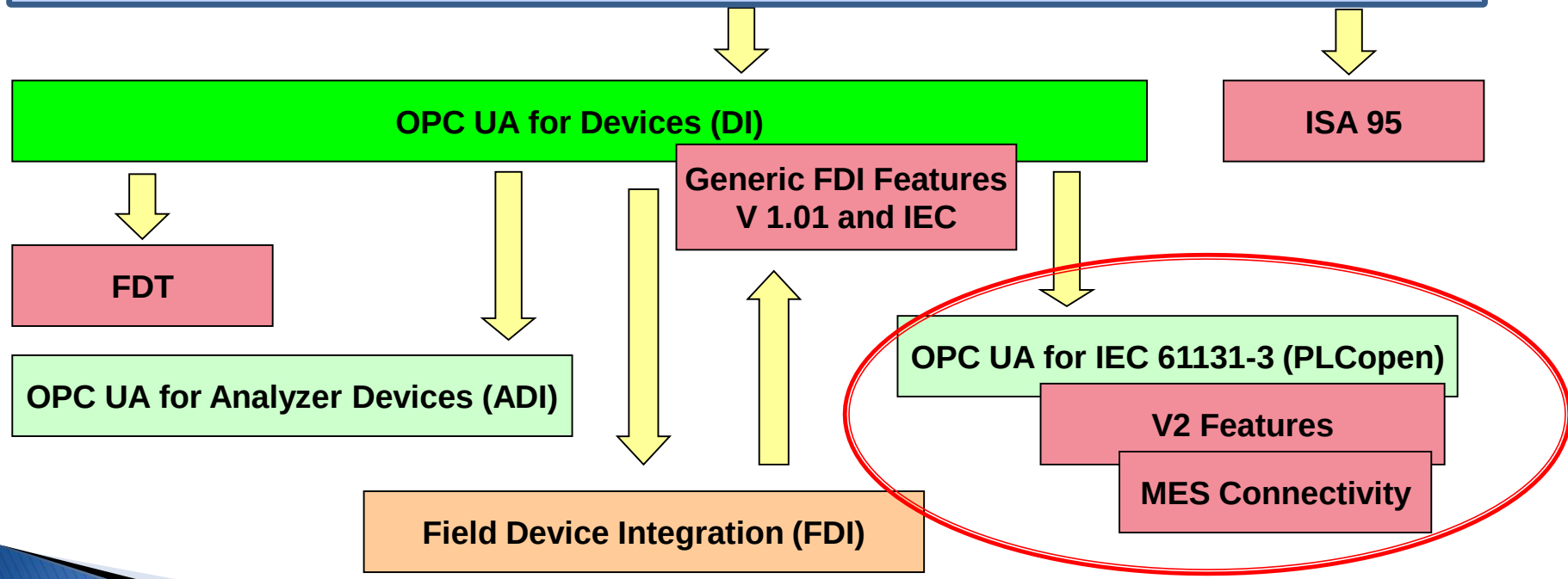
- Working group started in July 2011
- Mapping of FDT 2.0 to OPC UA
- FDT 2.0 released



Collaboration in Industrial

OPC UA for IEC 61131-3 (PLCopen)

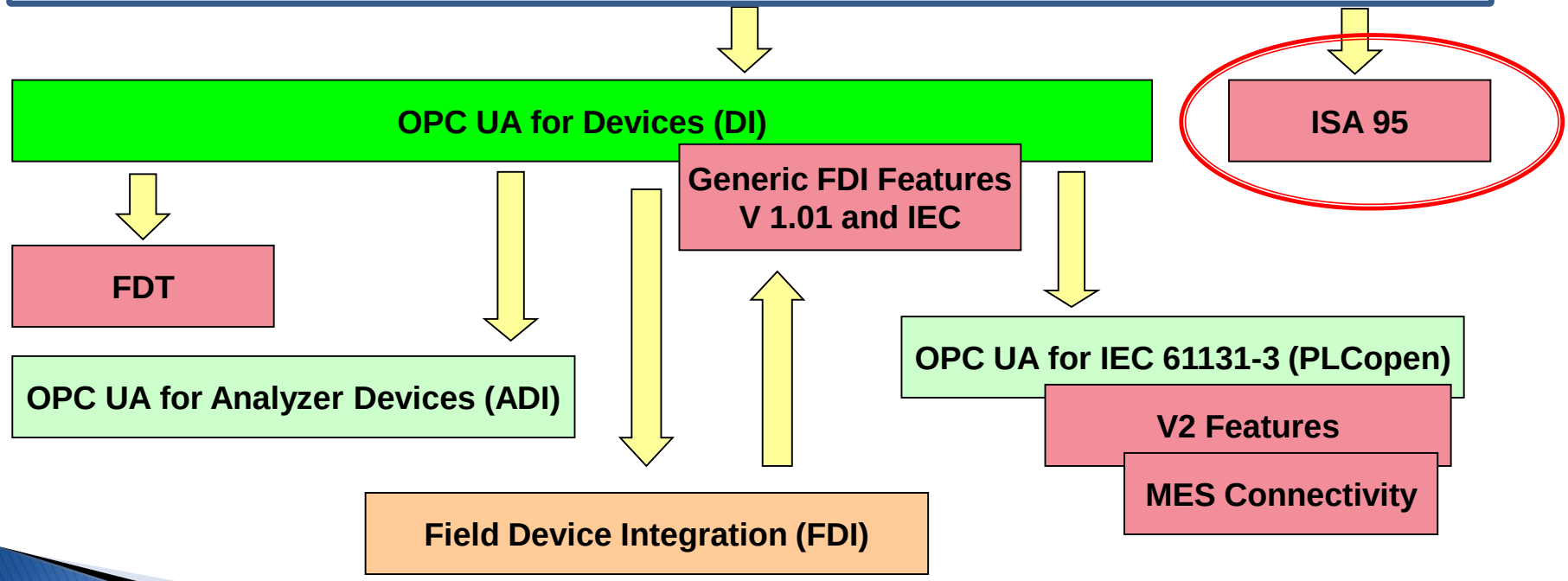
- V2.0 work started January 2011
  - PLC to PLC communication, OPC UA client function blocks
  - OPC UA Alarms & Condtions, Methods, Historical Access in a PLC
- MES Connectivity working group started November 2011
  - Define use cases for MES connectivity to machines and PLCs
  - Describe solutions for use cases with OPC UA



Collaboration in Industrial

OPC UA for ISA 95

- Working group started January 2012
- MES integration based on OPC UA and ISA 95
- Use Cases have been defined
- Object model development started
- Planned implementations before the end of 2012



OPC FOUNDATION

Collaboration in Building Automation

- Collaboration with BACnet Interest Group Europe (BIG-EU)
- Integration of Industrial and Building Automation
- Mapping of BACnet and OPC Unified Architecture
- First mapping specification planned for July 2013

BACnet working group started on October 01, 2012

- Collaboration with ONFIV (Video) in discussion
- OPC is used but lack of standardization in this area

Physical Security Systems

OPC FOUNDATION

Collaboration in Energy

- OPC UA evaluation is in progress and supported by OPC Foundation
- MCS-DCS Interface Standardization (MDIS)
  - Standard for drilling
- Smart Grid Interoperability Panel (SGIP)
  - Selection of standards used for Smart Grid in North America
  - Review by Cyber Security Working Group (CSWG)

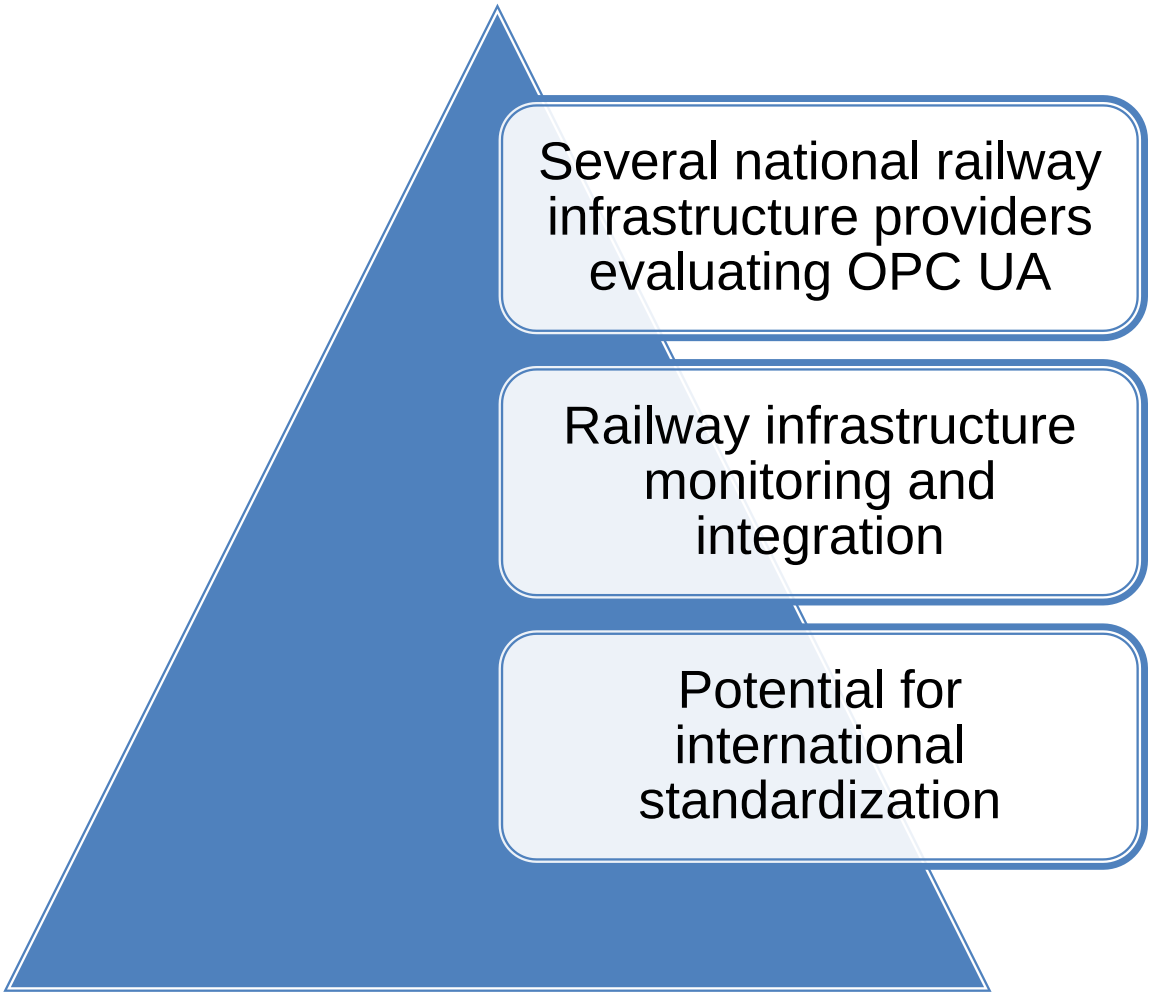
OPC UA evaluated for use in different standards

- WG 10 – Communications & associated data models in power systems (IEC 61850)
- WG 13 – Energy management system application program interface
- OPC UA Experts involved in these working groups

IEC TC 57 Power Systems

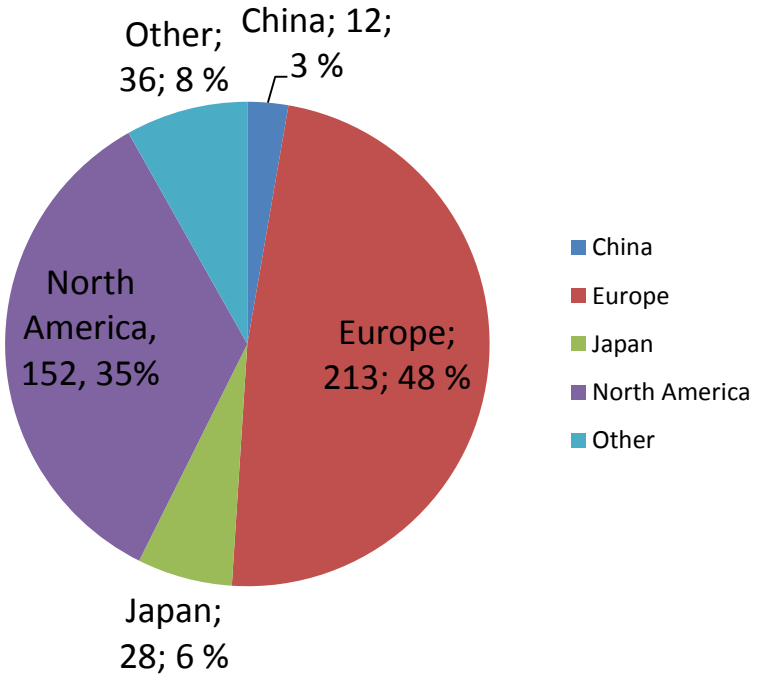
OPC FOUNDATION

Collaboration in Transportation



Important Demographics

Membership



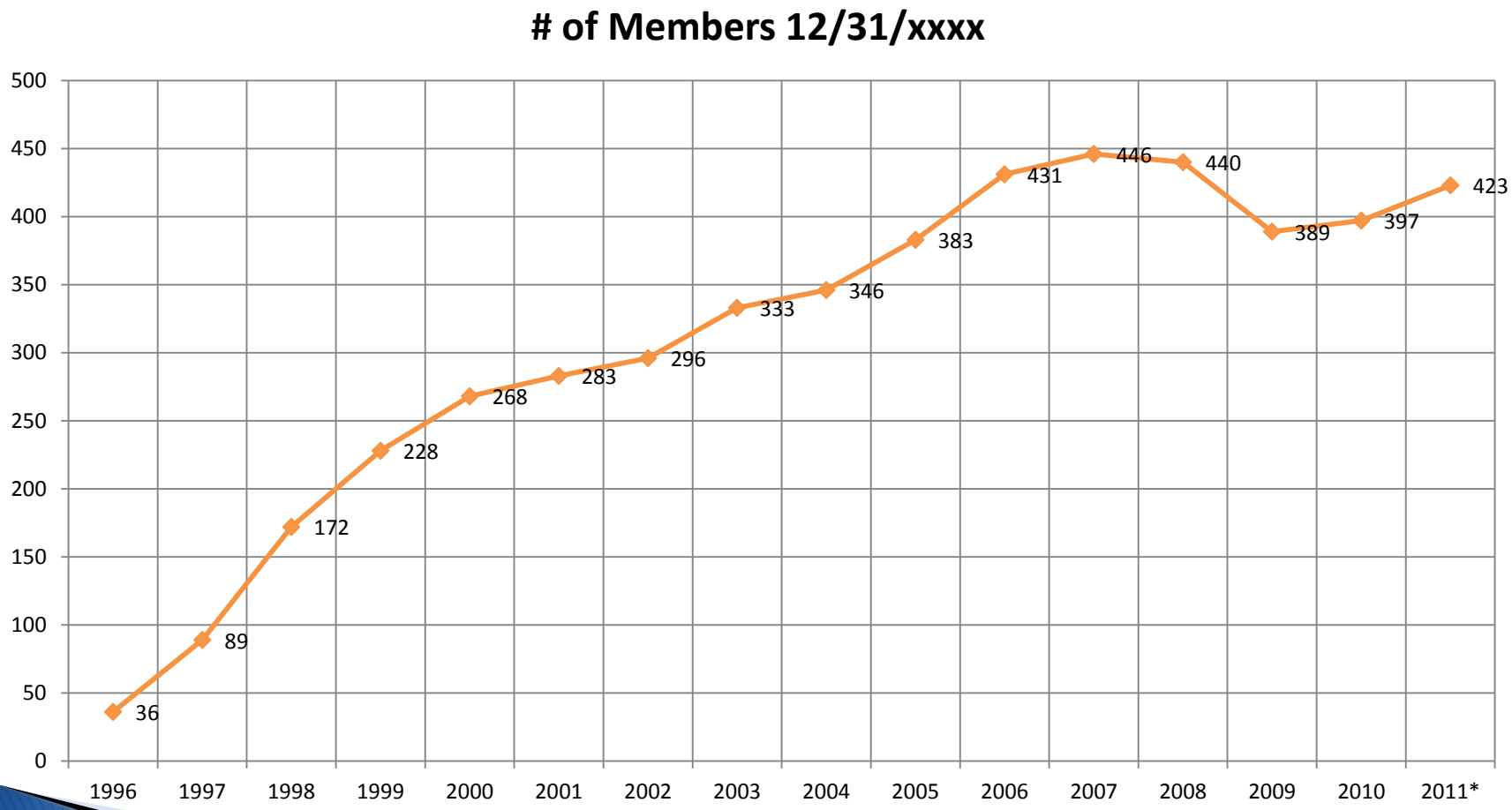
Markets

Key OPC technology markets:

- Industrial Automation
- Building Automation
- Embedded Devices
- Energy Management (Smart Grid)
- Manufacturing Enterprise Management
- Cloud-based Computing
- M2M
- And many more ….

OPC FOUNDATION

OPC Foundation Membership



OPC UA Highlights

IEC international recognition.

- 62451 released specifications.
- All core specifications released

Companion specifications under development

- Released
  - DI, ADI, PLCOpen
  - ISA 95, MTConnect
- FDI cooperation LLC

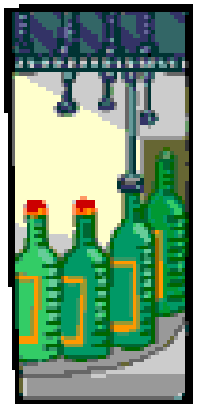
Technology adoption increasing

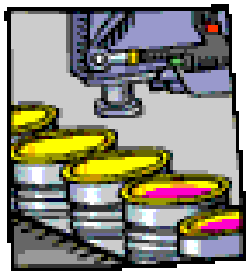
Strong certification program

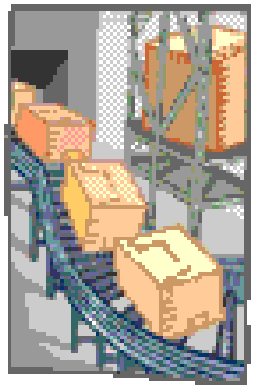
Industry recognition, end-user recognition

Why OPC ?

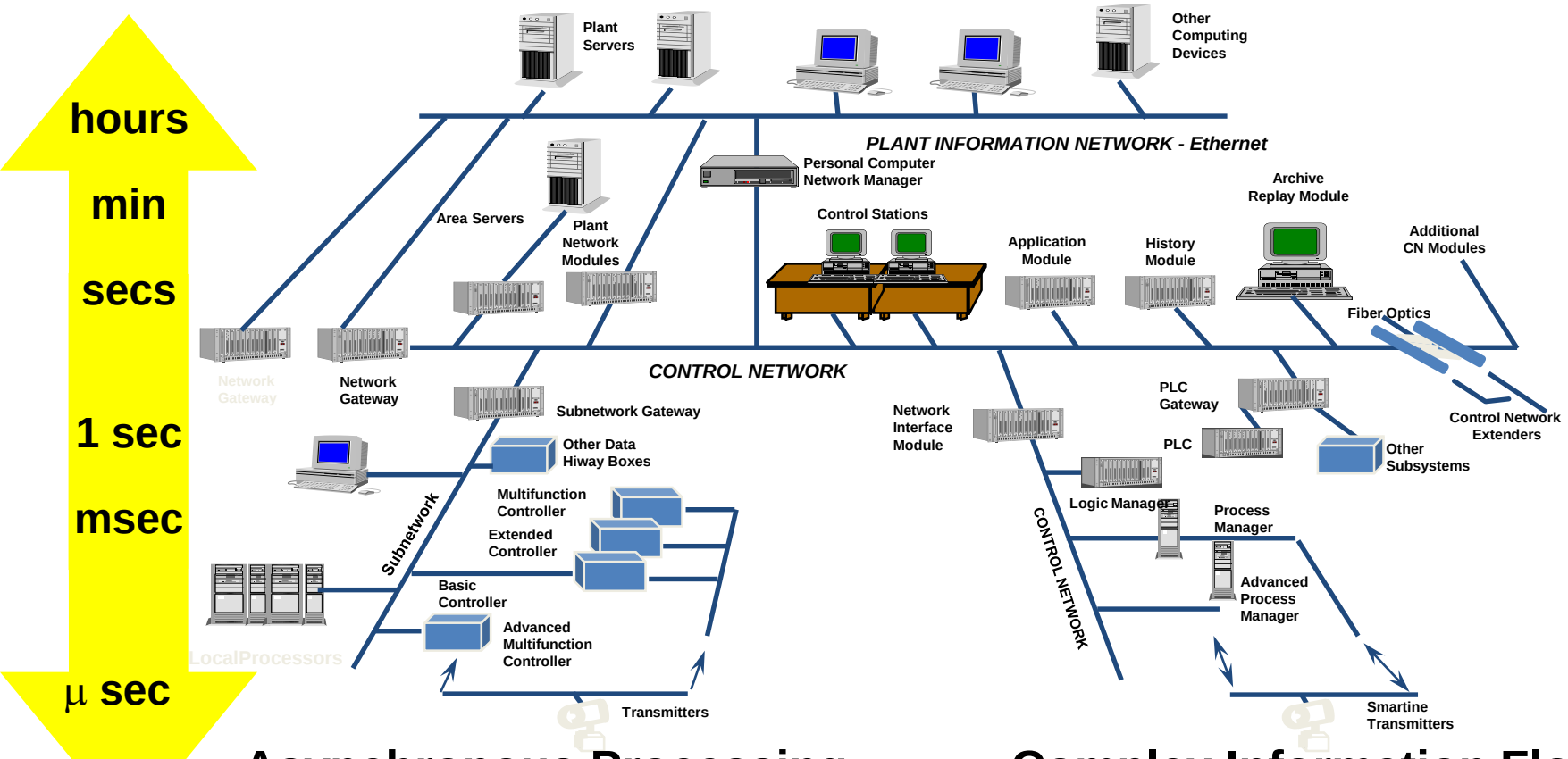
- Interoperability
- Standards : fact or fiction?
- Where did OPC come from?
- Four Core Companies
- OPC Foundation
- Write a communications driver one time
- Solve World Hunger?







The Plant : a Complex Environment with many opportunities for standards for interoperability

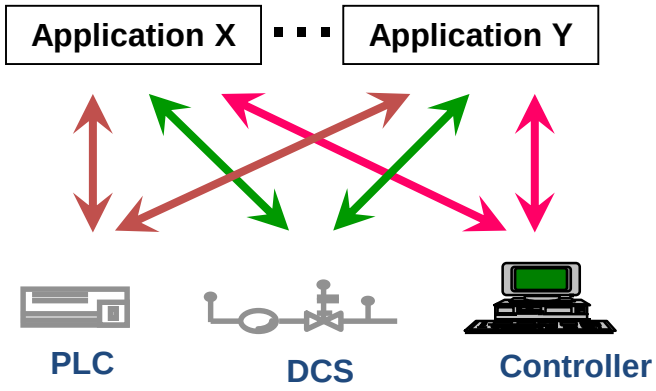


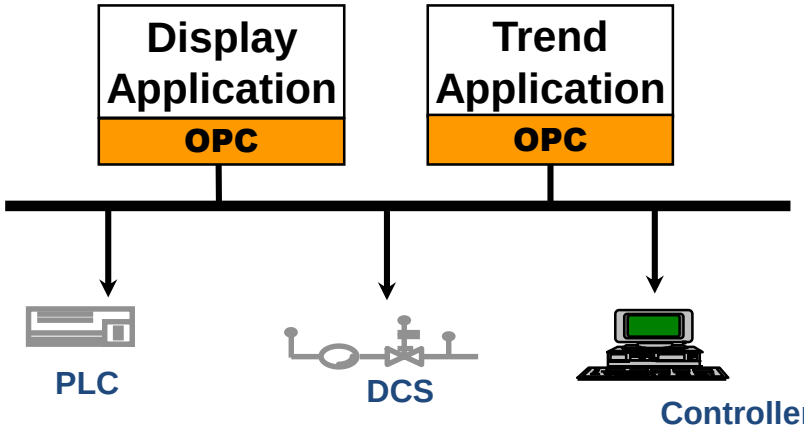
- Asynchronous Processing
- Multiple Interfaces
- Mission Critical
- How To Manage Changes?

- Complex Information Flows
- Multi-vendor
- Proprietary

OPC History

- **The Problem**
  - Many different vendors
  - Custom made solutions
  - Proprietary technologies
  - Point-to-point Integration
  - Limited “real-time” information
  - Maintenance nightmare
  - Multiple dependencies
- **Solution**
  - OPC





History of OPC Foundation

- September 1996
  - Formation of: Fisher-Rosemount, Rockwell Software, Opto 22, Intellution, and Intuitive Technology
- October 1998
  - Release of Data Access Specification 2.0
- June 1999
  - Release of Alarm & Events Specification 1.0
- 2000 / 2001
  - OPC XML and OPC DX were announced
- October 2002
  - Release of OPC XML-DA Specification 1.0
- **2004 >>> OPC UA Workgroup Kick-Off**

OPC Collaboration / Evangelism

OpenO&M	•(ISA S95, Oagis, MIMOSA, MESA (WBF), OPC)
PLCopen	
FDI Cooperation LLC,	•(FF, Hart, PNO, OPC, FDT)
MTConnect	
FDT	
S95	
Machinery Initiative (ODVA, Sercos, OPC)	
MDIS	
Smart Grid	•(OpenADR/ESI) SGIP, CSWG

SLC	• (Energistics, OPC, Geospatial, PODS, MIMOSA, PIDX, PoscCeasar)
Cloud Based Initiative (TIA)	
SPE	• (DSATS, WITSML)
CIM	
Building Automation (BACnet)	
ProdML	

Companion Specifications

MTConnect Completed

ISA S95 Completed

MDIS Under Development

PLCOpen Released

BACnet In Progress