Secure & Reliable Communication of Information Using OPC UA

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Presenter

- **PAUL HUNKAR**
  - President DS Interoperability - Independent Consultant
  - Extensive OPC Knowledge
    - Editor for multiple parts of OPC UA Standard
    - Chairman for OPC UA ISA-95 Working Group
    - Active in multiple collaboration efforts (MDIS, DS-TAS, MTConnect...)
    - OPC Technical Advisory Council Member
  - Over 30 years experience in the Automation Industry
    - Historians, Advanced Controls, New Technology, Operator Consoles

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Overview

Three Major sections

⇢ OPC Classic & OPC UA

⇢ Security

⇢ Information vs Data

Summary

Overview

- Summary OPC
- Show small device (demo) – remote connection via phone
- Overview of security / reliability
- (show GDS? Or show security?)
- Overview of information models
- Groups – details
- Vendors (Yokogawa)
- Calculation engine (show app)
- PLC Open – show embedded device again

Consumer Electronics

- **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.**

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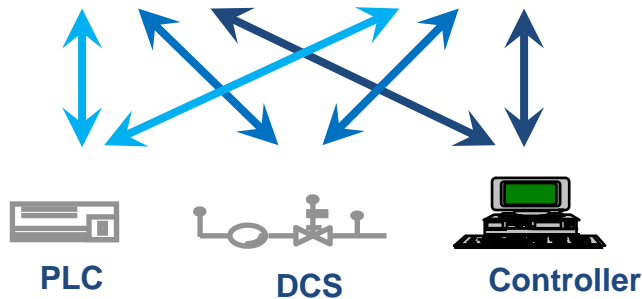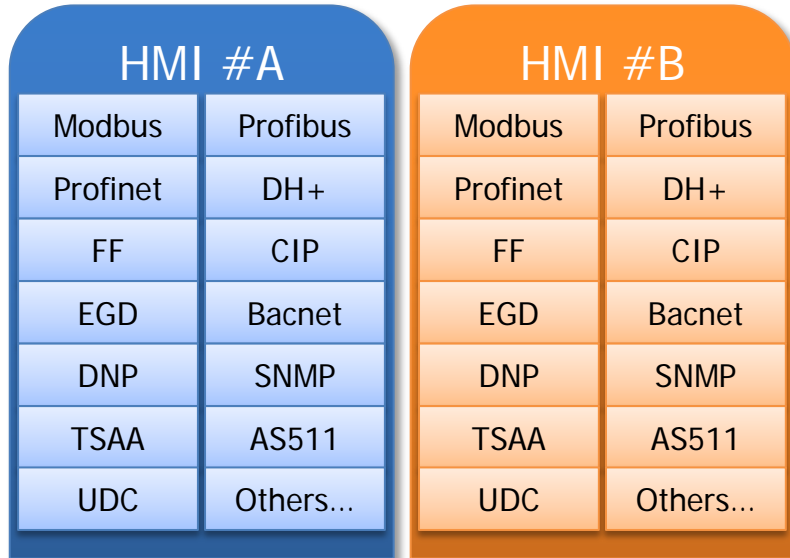Sept. 9-11, 2014 Houston, TX

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Business value proposition

- Total Cost Of Ownership
- Multiple Vendors
- Multiple Products
- Expectations Of Multivendor Interoperability
- Information Integration
- Plug-and-play Not Plug And Pray
- Systems Thinking
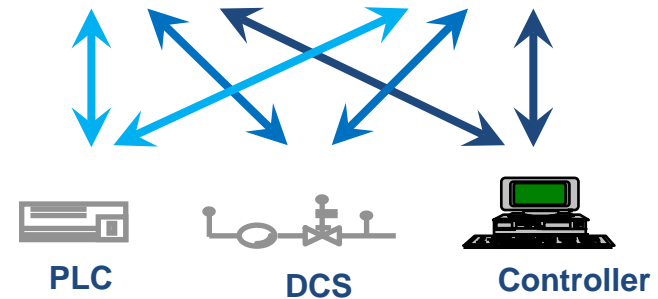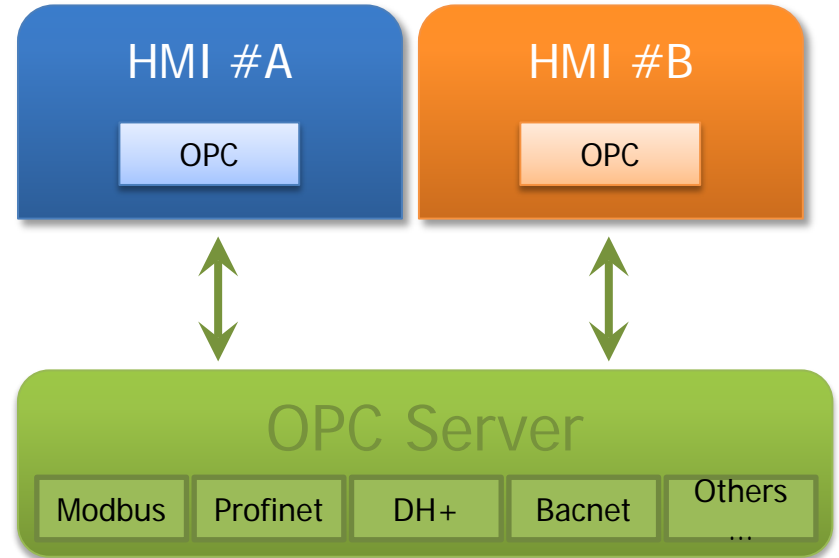- Consumer-electronics Driving Expectations

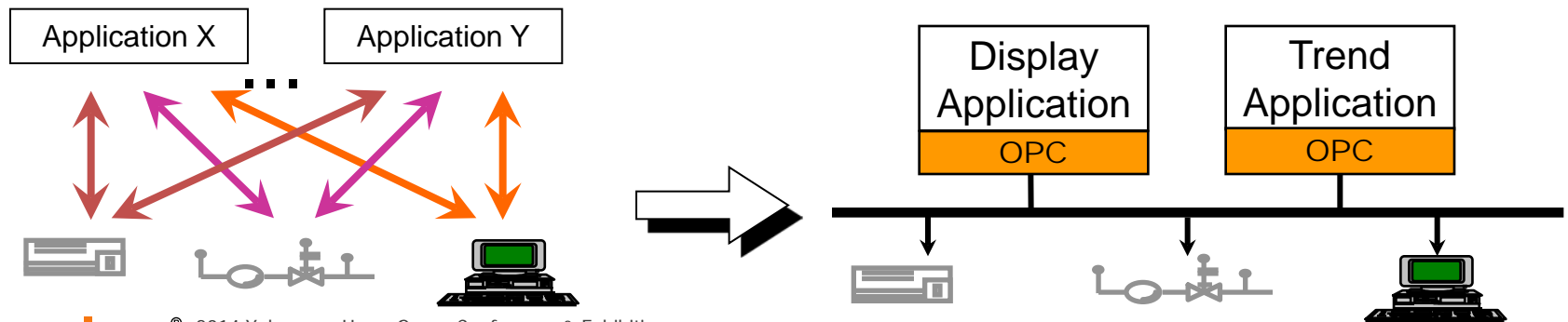YOKOGAWA

History: The "original problem"

- **Before OPC**

HMI #A	
Modbus	Profibus
Profinet	DH+
FF	CIP
EGD	Bacnet
DNP	SNMP
TSAA	AS511
UDC	Others...

HMI #B	
Modbus	Profibus
Profinet	DH+
FF	CIP
EGD	Bacnet
DNP	SNMP
TSAA	AS511
UDC	Others...

PLC   DCS   Controller

- **With OPC**

HMI #A
OPC

HMI #B
OPC

OPC Server				
Modbus	Profinet	DH+	Bacnet	Others...

PLC   DCS   Controller

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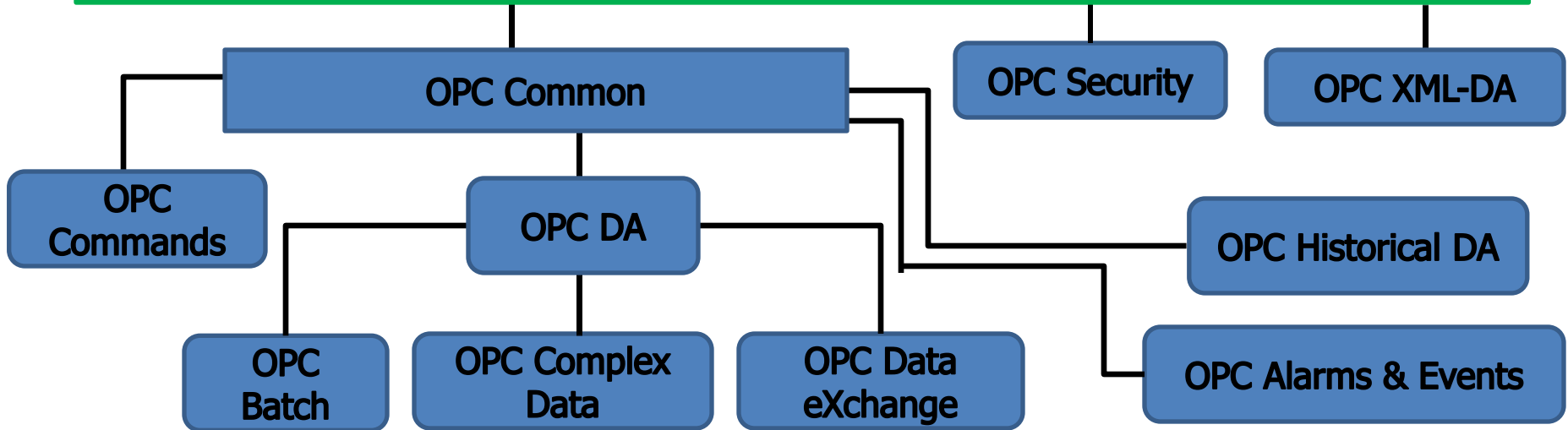
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OPC – De Facto Standard Industrial Automation

- OPC Foundation has more then 470+ members
- 27,000+ products use OPC
- Millions of installations of OPC worldwide
- Most of the deployments use what is now called OPC Classic which is a DCOM based protocol created in the 1990's.
- OPC eliminated the point-to-point communication problems the industry experienced
  - This reduced cost for end users and system suppliers
  - Eliminated problems with individual drivers being updated

History: Technology evolved...

OPC Overview

- OPC Common
  - OPC Commands
  - OPC DA
    - OPC Batch
    - OPC Complex Data
    - OPC Data eXchange
  - OPC Historical DA
  - OPC Alarms & Events
- OPC Security
- OPC XML-DA

- **More capabilities needed in DA - OPC Data Access 1.0, 2.05a, 3.0**
- **Need to store real-time values - OPC Historical Data Access**
- **Need to standardize Alarm Notifications - OPC Alarms & Conditions**
- **Need to standardize Data Acquisition via internet - OPC XML-DA**
- **Need to allow PLC-to-PLC communications - OPC Data eXchange**
- **Need to secure access to servers/tags - OPC Security**
- **Need to standardize batch-process operations - OPC Batch**
- **Need to standardize a simple PLC program - OPC Commands**

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Features Provided By OPC Classic

Features

- Discover OPC Servers on the network/PC
- View the tags available in the server
- Tags could be grouped into a hierarchy
- Read one or more tags
- Write to one or more tags
- Subscribe to tags and receive value-change notifications
- Easily identify good/bad data

Benefits

- Clients can be completely agnostic to the underlying PLC, protocol, and addressing scheme
- Easy configuration possible by simply pointing + clicking
- Reading and writing to tags is much easier than memorizing a PLC address
- Optimized traffic on the wire thanks to a highly-efficient subscription model.
  - Adding more clients does not necessarily add more overhead.

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Benefits From OPC Adoption

Vendors were no longer required to maintain extensive device protocol libraries

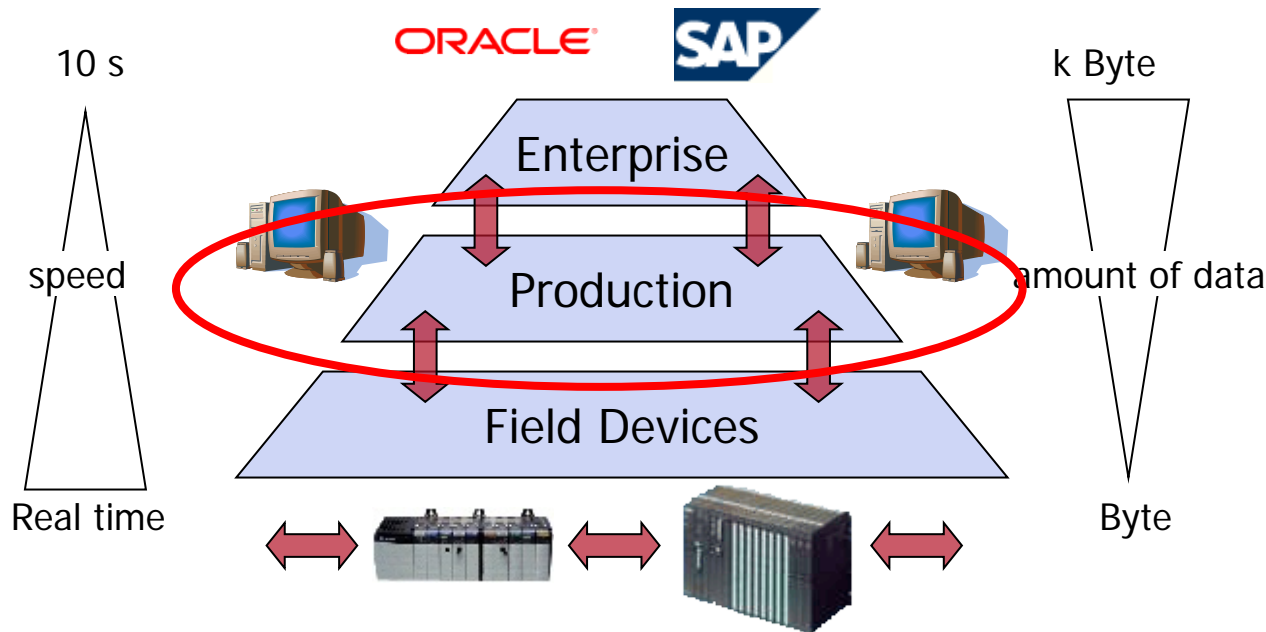High-quality and affordable device-drivers (Servers) emerged

More specialized Clients emerged

Developer toolkits emerged for rapid development of custom applications that could also integrate with the OPC infrastructure

End-users could mix-and-match numerous vendor products to achieve the best overall solution

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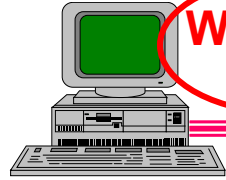
Use cases OPC was designed for

- OPC Classic was designed as standard API for HMI / SCADA systems to access process data provided by different protocol drivers

- OPC A&E and HDA were designed as standard API to access alarm and history data managed by SCADA systems
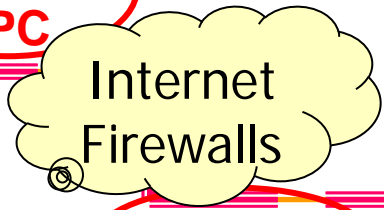

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10 s

k Byte

Enterprise

speed

Production

amount of data

Field Devices

Real time

Byte

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OPC Classic – Limits

MES and/or HMI Application (OPC Client)
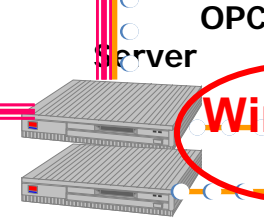
Windows PC

Internet Firewalls

DCOM

HMI Application (OPC Client)

OPC Server

Windows PC

**Certification?
Interoperability Test?
Configuration?
Security Setup?**

PLC
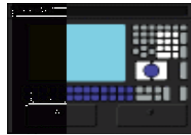
Embedded HMI

No Standard

?

PLC

PLC

Tunnel Alternate OS
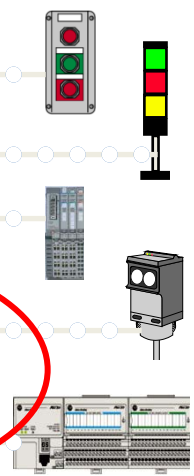
- - - - Proprietary Protocol
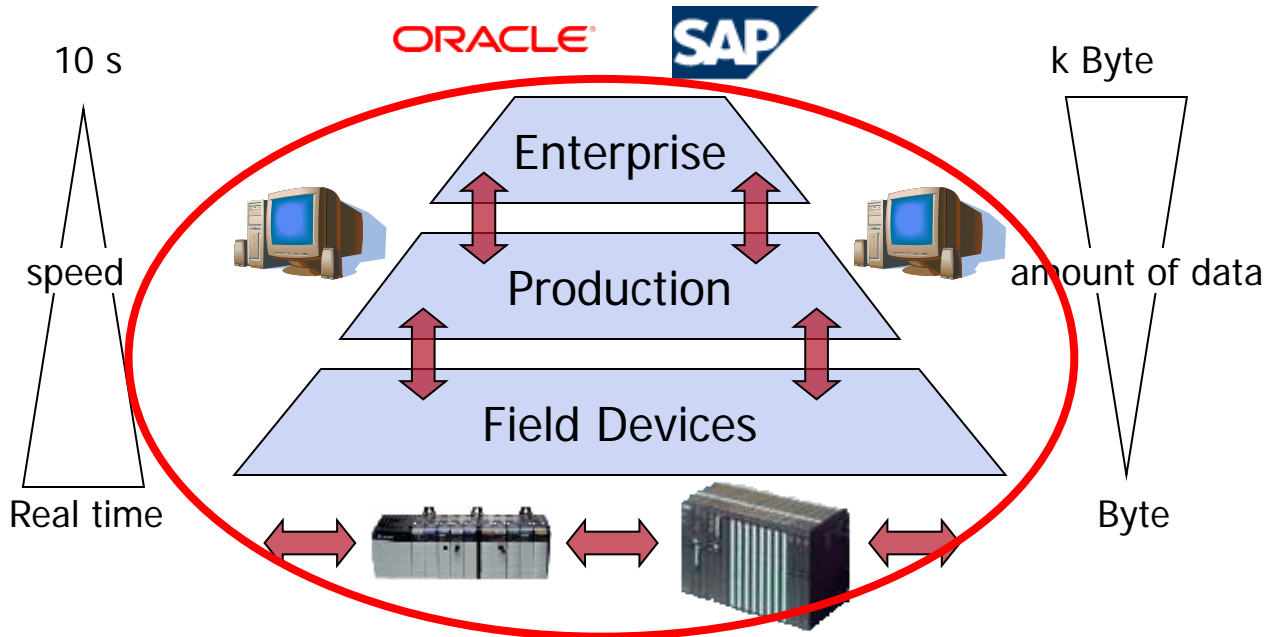
══════ OPC Data Access

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Requirements for OPC UA
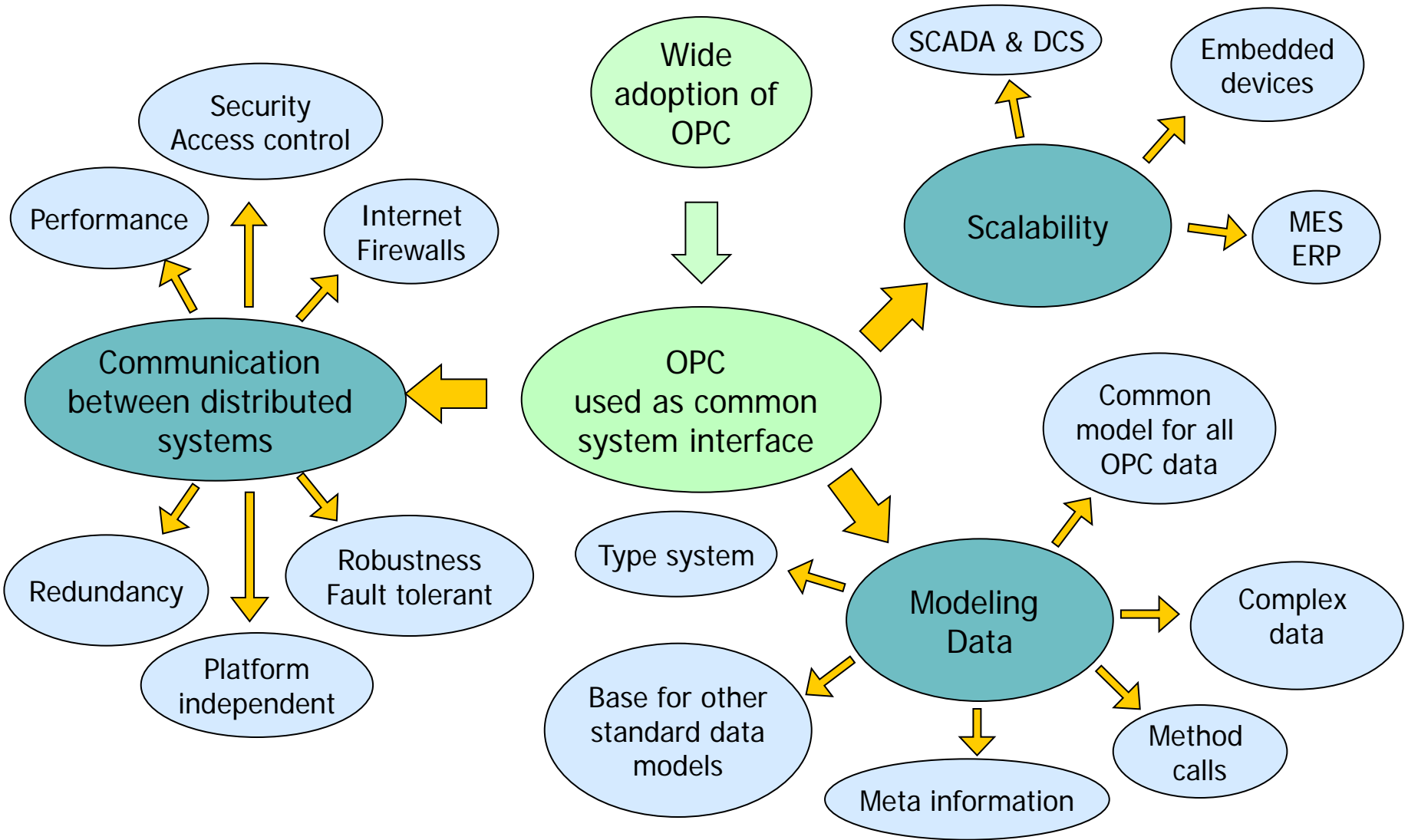
Use cases OPC UA was designed for

OPC UA was design to include:

- Embedded devices direct to higher levels
- Communication between embedded devices
- Remote sensors
- Direct Integration at the enterprise level

Unified Data

- ## Existing OPC Classic DCOM interfaces:
  - Each passes a specific type of data
  - No relationship of data between interfaces
  - Relating data is done by the client

- ## Unified Architecture (UA) interfaces:
  - Single set of Services
  - Information models relate data
    - Example:
      For one tag like TI-101, the current process value, alarm messages, and historical values can be obtained in one request to the server.
    - In OPC Classic the client program would need to make three requests to three different servers
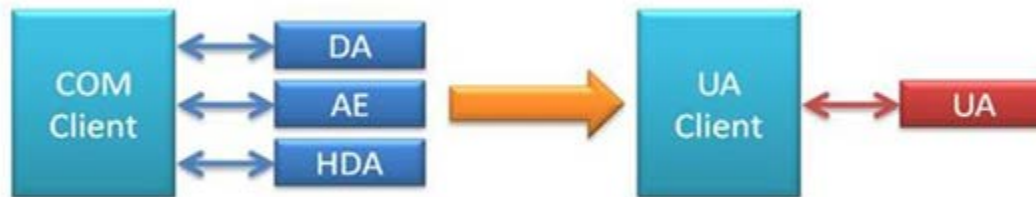
OPC Classic   OPC Unified Architecture

Unified Data: Information Models

- OPC UA modeling language allows custom information models

- Extensible & built on the standard base services

- Many other organization have built information models on top of it

OPC UA

Information Models Collaborations

FDT

FDI

DI

PLCOpen

ADI

SmartGrid 61850, ...

BACnet

MES: ISA-95

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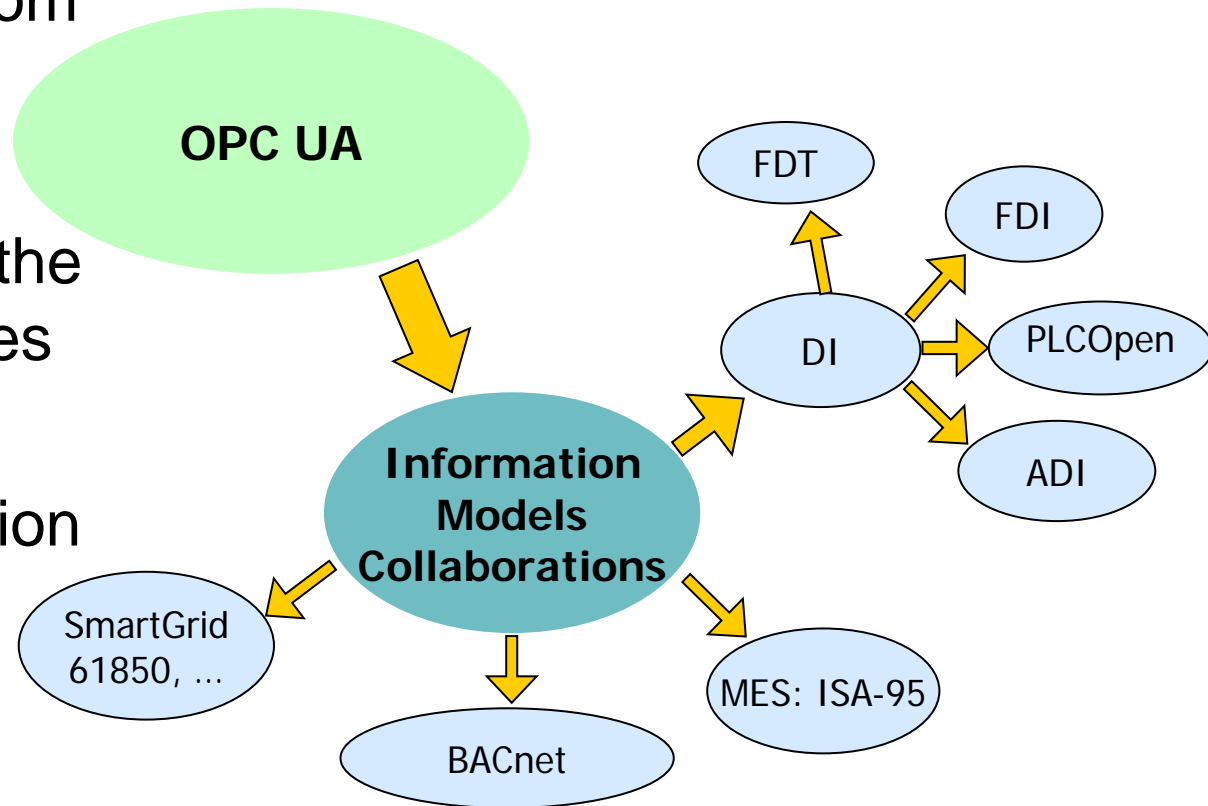
Development Environment Independence

- No Microsoft, or other IT supplier, technology required
  - Operating system independent
  - Programming language independent
- Clients and servers are running on:
  - Windows 7 and 8, Linux,
    VxWorks, Embedded OS's, ...
- UA clients and servers have been written in different programming languages:
  - C# (.Net), C++, C, Java, ...
- Benefit to end users:
  - More options for client and servers to run in the environment of your choosing
  - Longer lived technology since it is not tied to any one product family

Cross Platform
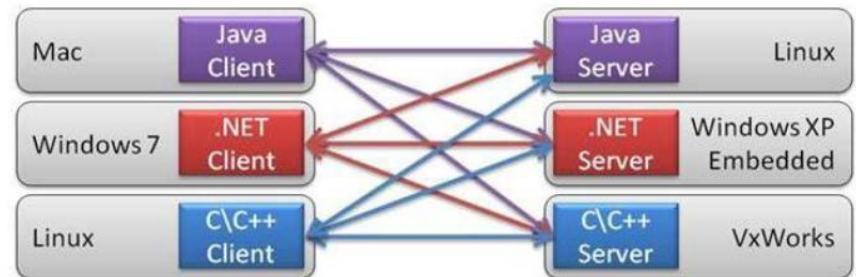
OPC UA: Available Platforms

CE

Microchip

Tablet

OPC UA

Desktop PC

Enterprise Servers

Smartphone

PLC/Controller

Laptop

Protocol Independence

- Transport protocol and application data layers are separated
- Different transports can be used with no change to the data configuration
- Transport choices
  - Web Services
    - Uses IT standards such as WS Security and WS Secure Conversation
  - UA Native Binary
    - Optimized for high speed data transfer
- Choices an integral part of the OPC UA specifications

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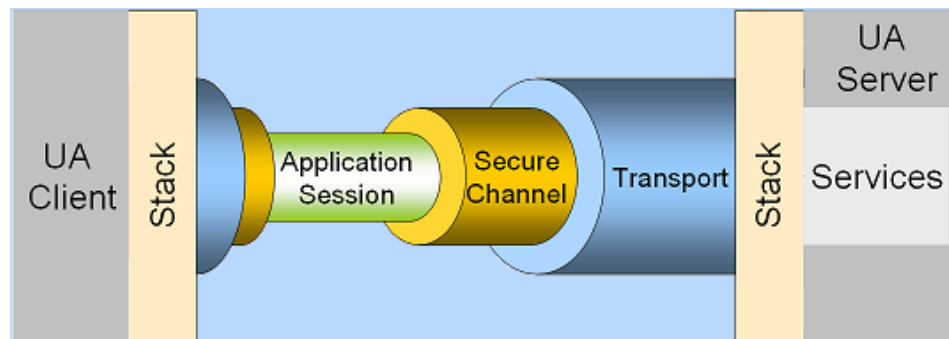
Communication Layering

Tool or Language Dependent (e.g. .NET)

API

Proxy / Stubs

.NET (WCF) Version
Portable C/C++ Version
Java Version

WSDL / SOAP or TCP / Binary Services Binding

Scalable Platform Independent Messaging Model

Abstract UA Model Specification

Business Model, Abstract Service Definition

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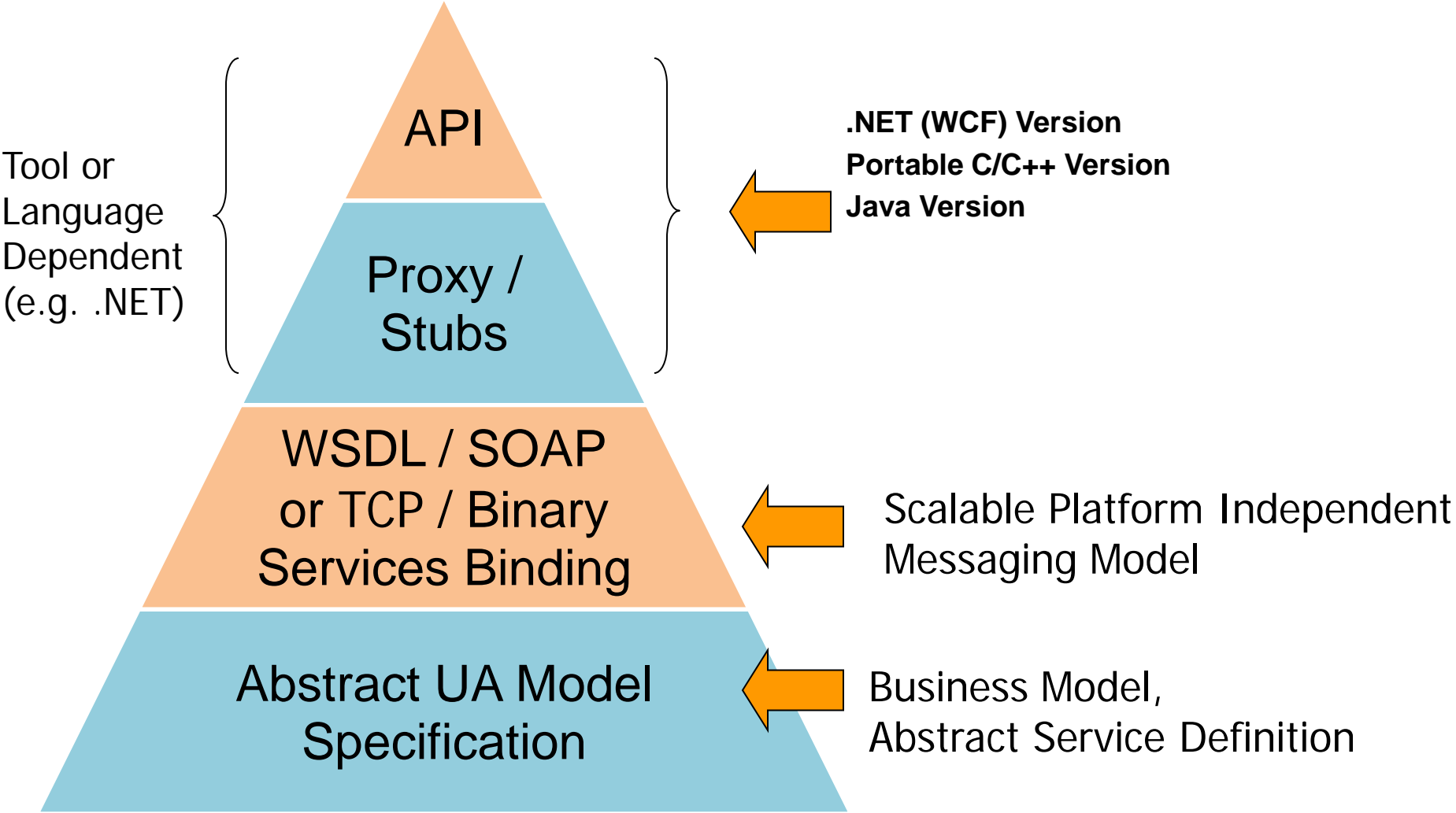
Unified Data: Specification Layering

Vendor Specific Specification

Information Model Specifications ⬅ IEC, ISA, MIMOSA …

| DA | A&E | HDA | CMDs | ⬅ OPC Information Model

OPC UA Base Services ⬅ All Necessary Services
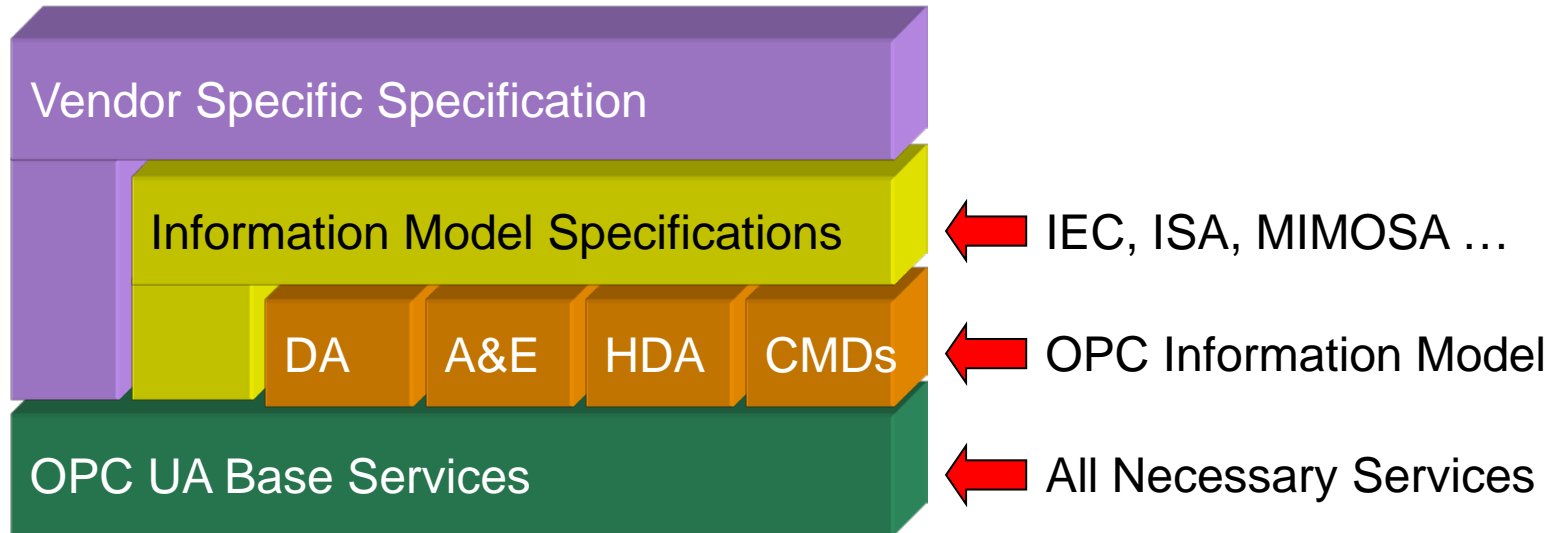
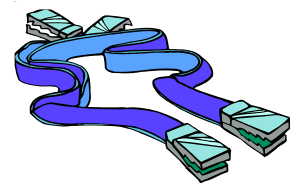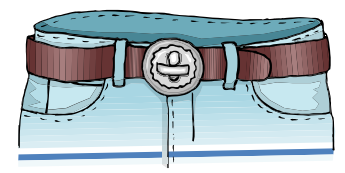- Clients written to just the base can access all data from the higher level layers

- OPC Foundation information models cover most OPC Classic functions

- Industry, company or system specific information models can be added without changing the base services

Robust

- Features added based upon years of experience with OPC Classic
- Subscription Update Features
  - Keep-alive (heartbeat) messages
    - Allows clients to detect a failed server or channel
  - Sequence Numbers in each update message
    - Allows client re-sync to obtain missed messages
- Redundancy
  - Built into the base services
  - Designed for easy (optional) redundancy of both Clients and Servers

Reliability by design

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Backward Compatible
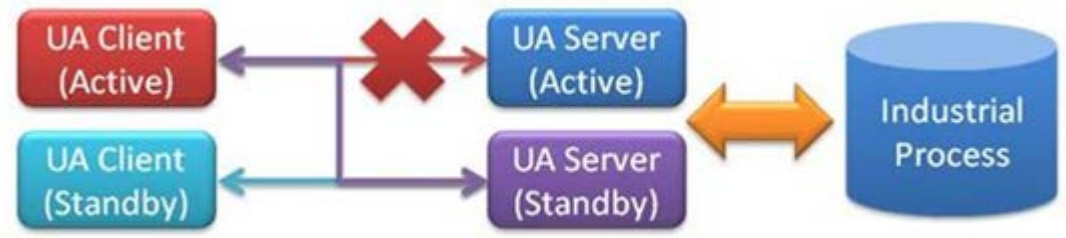
- Existing OPC Classic clients and servers can be used with OPC UA clients and servers using wrappers
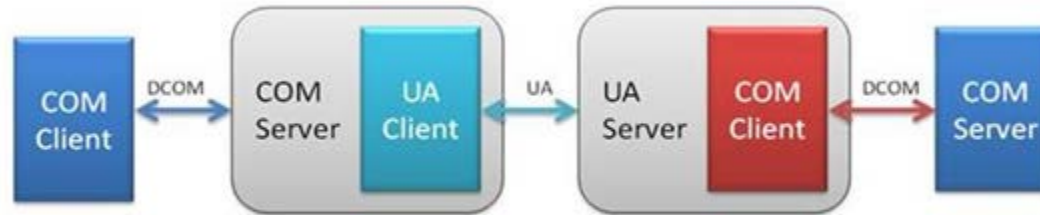
- A wrapper talks OPC Classic and OPC UA protocols

Forward Looking

- • Firewall Friendly
- • Relay and cloud based computing

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OPC UA Scalability & Profiles

Functionality needed varies according to system

devices portables desktops servers clusters mainframes

Mainframe

Server Cluster

Server

Desktop PC

Portables

Controllers

Embedded Systems
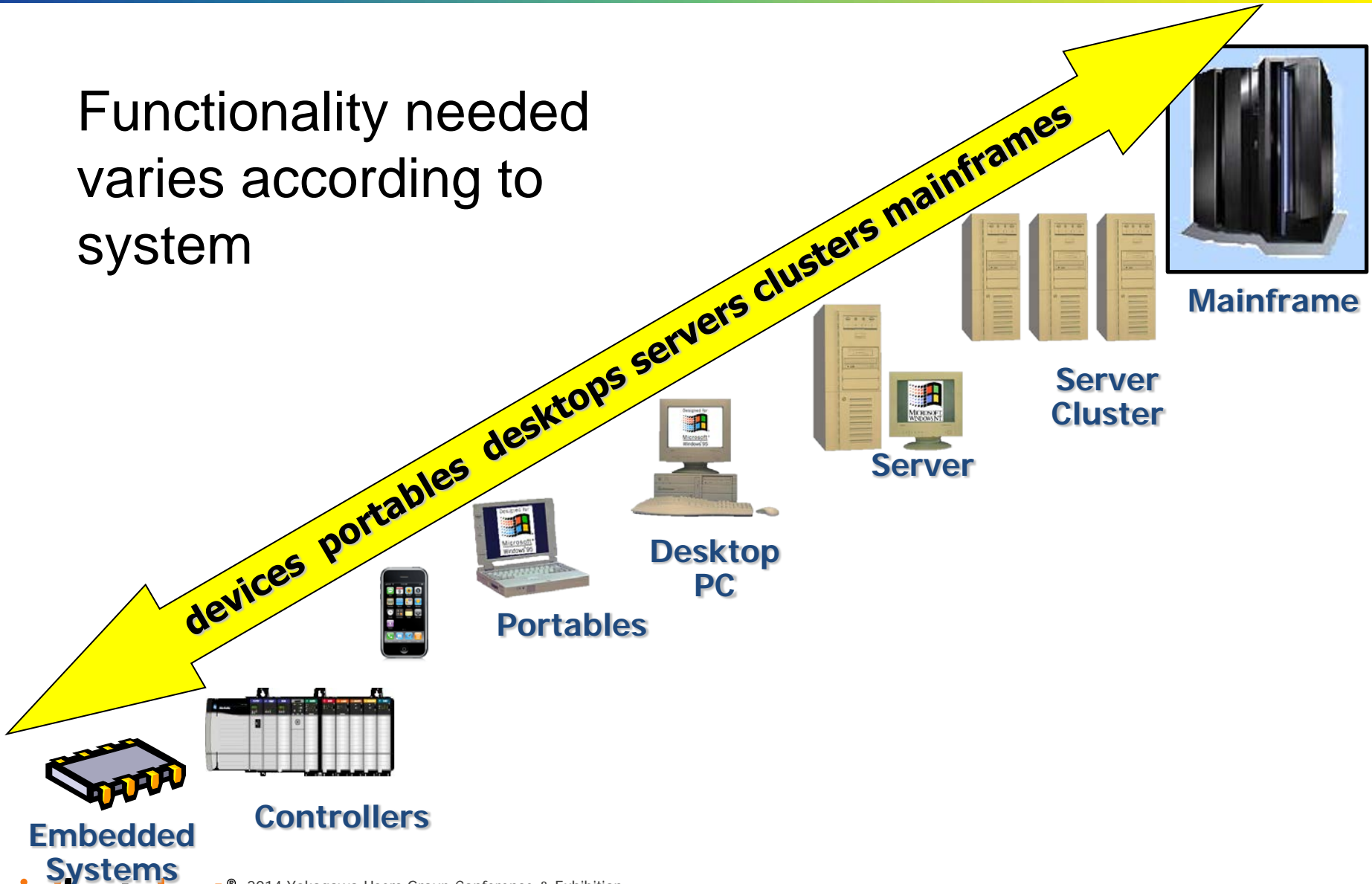
Security

- Application Security
- User Level security
- Message Security
- Audit mechanisms

All selectable by End User

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Timeline

Version 1.0

Internal Release
Modeling Language
Services
Base Model

Version 1.1

Public Release
Protocols
Built-in Models
➢Data access
➢Alarms & Conditions
➢Programs

Version 1.2

Maintenance Release
Historical Access
Compliance Updates
New features
➢HTTPs Protocol
➢File transfer

Version 1.3

Maintenance Release
Network Discovery
Central PKI
New Features
➢Durable Queues
➢Union Data Types
➢Bit Mask Data Type

2007	2008	2009	2010	2011	2012	2013	2014

Draft

Protocols
Built-in Models

Draft

Built-in Model
➢Historical Access

Draft

Network Discovery

UA Products Available

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OPC Foundation Domains

The key markets for OPC technology include

- Industrial Automation
- Building Automation
- Embedded Devices
- Energy Management (Smart Grid)
- Manufacturing Enterprise Management
- M2M
- Cloud-based Computing

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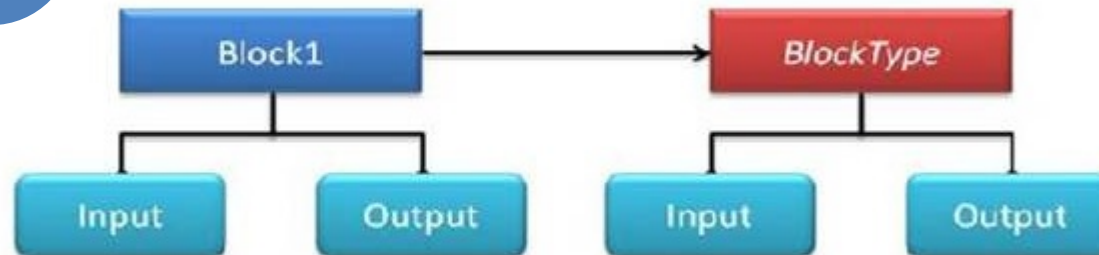The clear path to operational excellence

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OPC UA Key Features

- Unified Data
- Platform Independence
- Protocol Independence
- Robust
- Security
- Performance
- Backwards Compatible

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Demo

- Raspberry PI
  - 512 MB
  - Arm Processor
  - Unified Automation SDK
  - Full sample server
- Smartphone
  - UA expert sample client

Questions

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- Paul.Hunkar@DSInteroperability.com

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