Aalto University
School of Chemical
Technology

OPC & OPC UA

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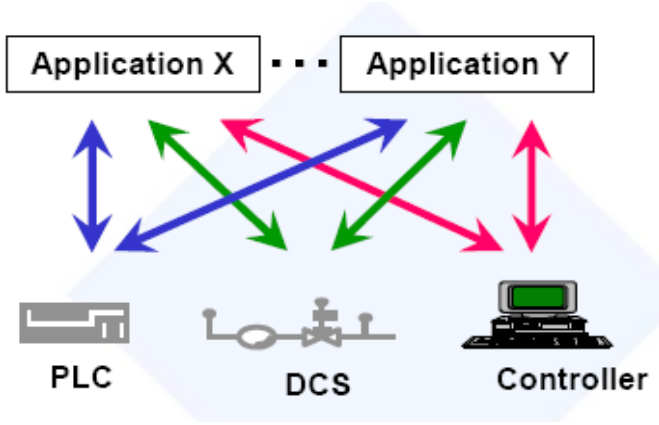
OPC FOUNDATION

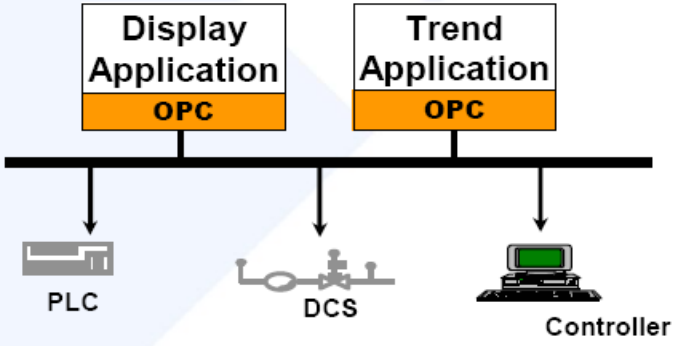
Outline

- Introduction
- OPC
- OPC UA
- Conclusions
- ABB System & OPC?

What is OPC?

- Solution to moving information from control equipment to HMI and SCADA applications
- Problem:
  - Many different vendors
  - Custom made solutions
  - Proprietary technologies
  - Point-to-point integration
  - Limited real-time information

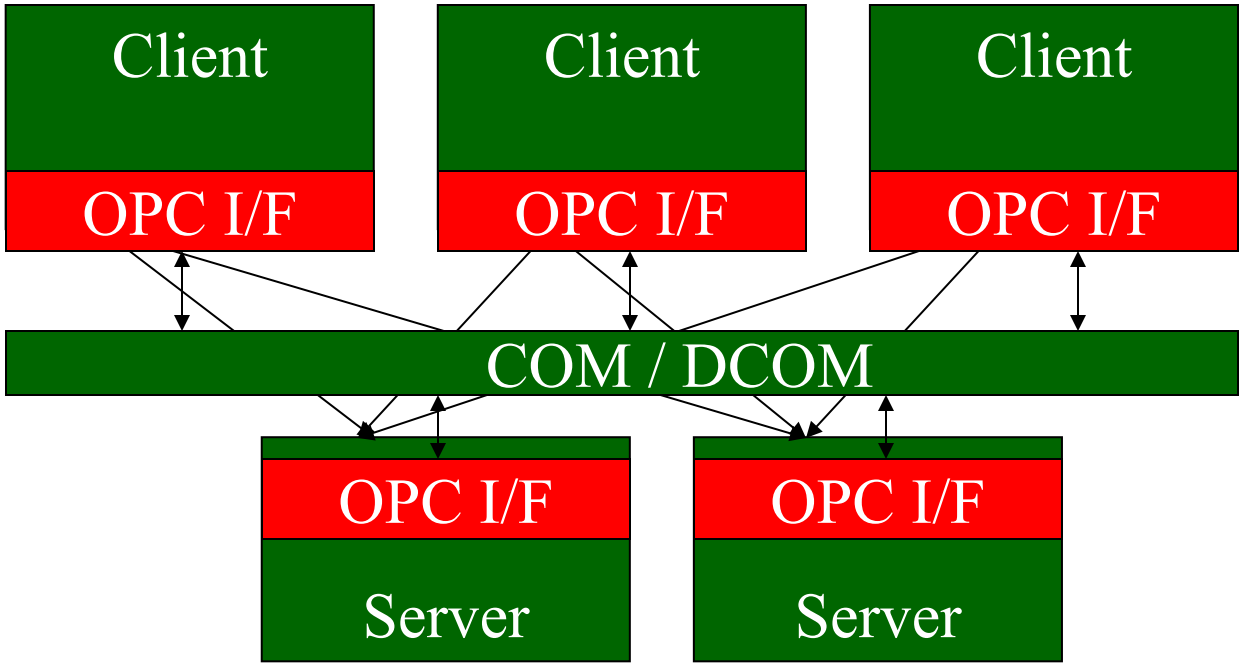




[OPC Foundation, DevCon 2006]

What is OPC?

OPC vs Old "Spaghetti" Model



OPC Foundation

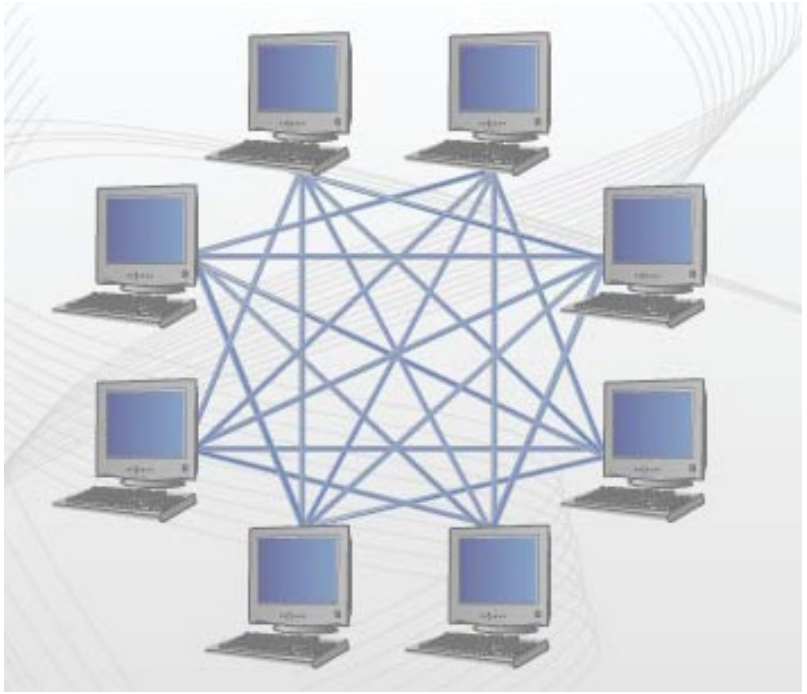
- OPC “Open connectivity via open standards.”
  - OLE for Process Control
    - Object Linking and Embedding
- Non-profit organization dedicated to ensuring interoperability in automation by creating and maintaining open specifications
- 400+ member companies
  - Including all the major players on the automation field.
- 100+ end-user members
- Collaborating with other standardization organizations

History of the OPC

- 1995 OPC Foundation task Force
  - Fisher-Rosemount, Rockwell software, Opto 22, Intellution, Intuitive technology
- 1996 OPC Foundation releases first specification
- 1997 OPC Foundation Europe
- 1998 OPC Data Access specification 2.0
- 1999 OPC Alarm & Events specification
- 2000 OPC XML & OPC DX announced
- 2002 OPC XML-DA specification 1.0
- 2004 OPC Unified Architecture Kick-Off

OPC Foundation

- Devices are tested
  - OPC Self tests
  - OPC Interoperability sessions
  - OPC Foundation-sanctioned test labs.



OPC advantages (Iwanitz, Lange – 2005)

Hardware manufacturer	The product can be used by all OPC-compatible systems in the market and is not limited to an individual system for which a corresponding solution (i.e. specific drivers) must be developed. Due to the existence of standardized interfaces and the interoperability related to them, there is no need to become familiar with the specific requirements of other systems. The Time-to-Market for new device generations is significantly reduced as only one OPC server has to be updated, not a large number of drivers or DDE servers. The effort needed for support is also reduced as only one product has to be supported.
Software manufacturer	The product can be used with all devices and communication protocols on the market that make available an OPC interface. The manufacturer no longer has to develop corresponding solutions (specific drivers). Due to the existence of standardized interfaces and the interoperability related to them, there is no need to become familiar with the specifications of other devices and communication protocols. The time needed for support is considerably reduced as many products to be supported (product specific drivers up to now) no longer exist.

OPC advantages (Iwanitz, Lange – 2005)

System integrator	Flexibility in the choice of product is considerably increased, as is, consequently, the number of projects that can be processed. The time needed for integration and training is considerably reduced, as OPC provides a standardized interface which remains the same for all products.
End user	OPC provides additional flexibility (distribution of components, use of new technologies, choice between products, etc.) during the design of the overall system as products of various manufacturers can be combined. The increasing variety of products available on the market should, in the future, lead to a noticeable reduction of costs with increasing quality and user comfort. By relying on an acceptable standard in this sector, investments will be better protected.

Outline

- Introduction
- OPC
  - DA
  - HDA
- OPC UA
- Conclusions
- ABB system & OPC

OPC

- OPC is a published industrial standard
  - OPC Foundation defined Microsoft DCOM based interface standards
- De facto standard for moving information from different control systems and fieldbuses.
- **Server – Client** structure

- Based on Microsoft COM/DCOM
  - Security based on DCOM => No applicable security
  - Reliability based on DCOM => Unreliable
- Address space model is a tree
  - Groups and nodes
  - Independent of HDA and A&E address spaces

OPC

- Many standards exist
  - Data Access
  - Alarms & Events
  - Historical Data Access
  - Complex Data
  - Batch
  - Data eXchange
  - XML Data Access
  - Commands
  - Security
- Standards have different releases even.
  - E.g. OPC DA r1 / r2 / r3

OPC DA

- Data Access
- Provides standardized access to real time data
  - ”User” can ask for most recent values
- Communication between all devices and applications is consistent
  - Custom & Automation interfaces
  - Supports only Read & Write commands
- Available for every major process control system

OPC DA

- Secures scalability
- Provides access to single-value data items called ”Points”
- One device may have many points
  - E.g. Flow controller
    - Setpoint: FIC101.SP
    - Process value: FIC101.PV
    - …
  - Each point treated as separate point

OPC DA

- Each point consists of:
  - Value
  - Quality
  - Timestamp
    - If a device timestamp available, OPC server passes it on
    - If not – OPC Server adds own timestamp
    - (Server can also overrun it's timestamp if needed.)

OPC HDA

- Historical Data Access
- Used to retrieve historical data for analysis from process historians
  - Typically from database
- Any OPC HDA client application can access **archived** data via OPC HDA
  - Historical trends
  - Reports
  - Spreadsheets
  - …

OPC HDA

- Typical questions for a HDA
  - What were the values for FIC101.PV over the last week?
  - What was the average daily flow for past month in FIC101.PV?
  - How many changes where there in FIC101.SP per day on average over the past year?
  - What was the total monthly flow for each month in the past year for FIC101.PV?
- OPC HDA vs. ODBC/SQL?
  - OPC HDA: Process data
  - ODBC/SQL: Business/relational data
  - Complements each other

OPC other

- OPC A&E (Alarms and Events)
  - Used to exchange and acknowledge process alarms and events
- OPC DX (Data eXchange)
  - Defines how OPC Servers exchanges data with other OPC servers
- OPC XML (eXtensible Markup Language)
  - Encapsulates process control data, making it available across all operating systems

OPC XML DA

- Published 12.7.2003
- Text based (XML)
- No problems with firewalls
- Operating system independent
- Slow for process automation

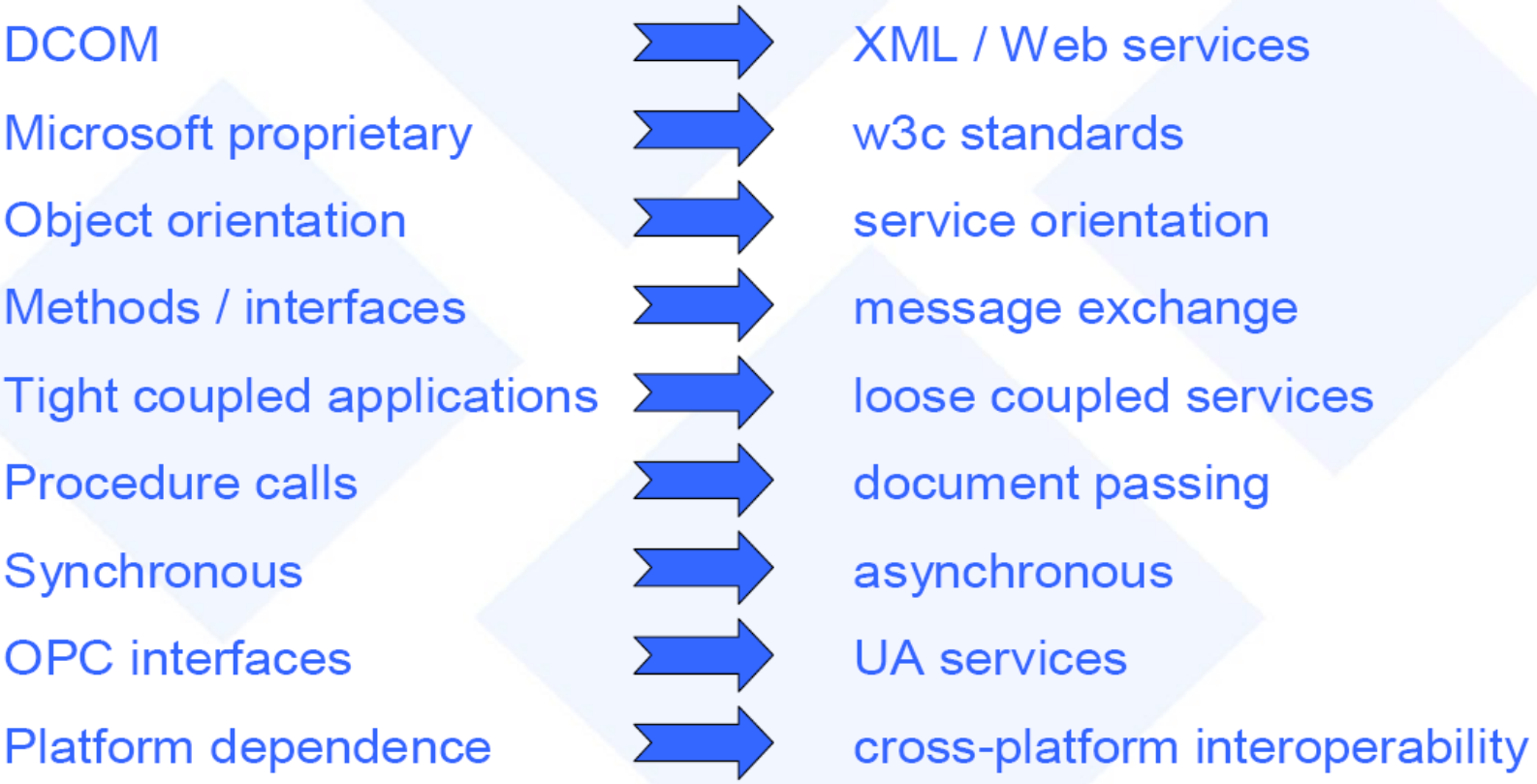
Outline

- Introduction
- OPC
- OPC UA
  - From OPC to OPC UA – The paradigm change
  - OPC Unified Architecture
  - The new things
  - Details
  - Success possibilities / Risks
  - Situation autumn 2009
- Conclusions

OPC UA - Why new standard?

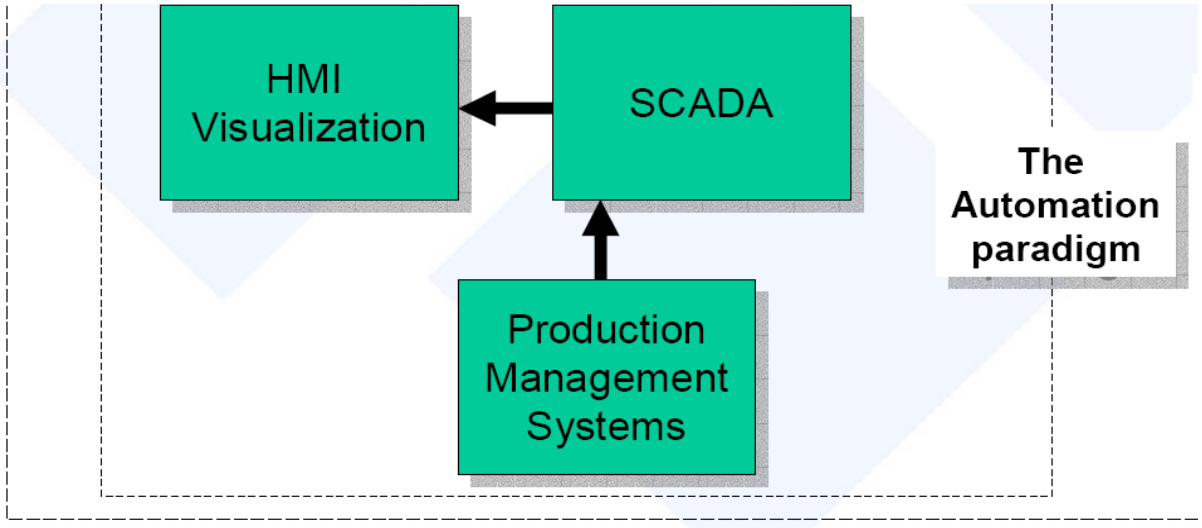
- Complex configuration and maintenance
- Vulnerability to system and network failures
- Lack of security
- DCOM retires
- SOA and .NET
- Integration of DA, HDA, A&E
- New application areas: MES, ERP, embedded

From OPC DA to OPC UA



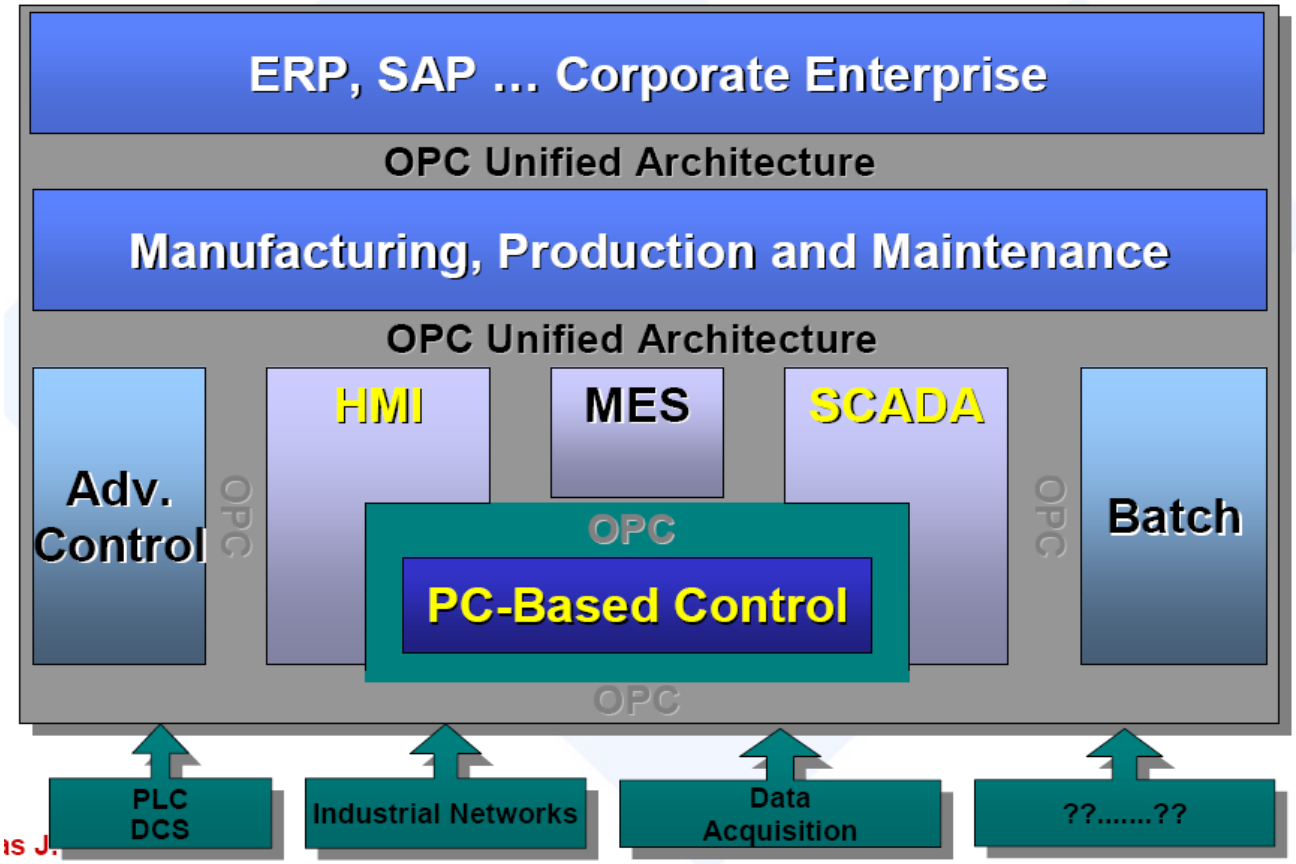
[OPC Foundation, DevCon 2006]

From OPC DA to OPC UA



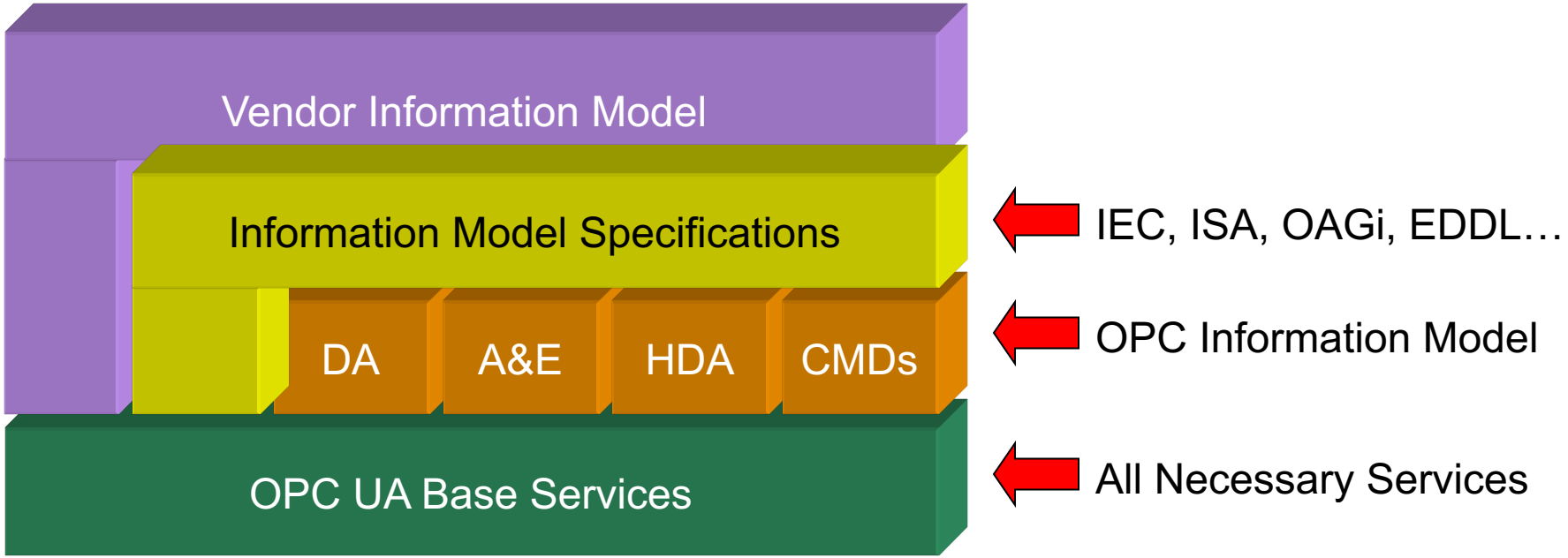
[OPC Foundation, DevCon 2006]

From OPC DA to OPC UA



[OPC Foundation, DevCon 2006]

Specification layers



[OPC foundation, Jim Luth, OPC Day 2006]

OPC UA architecture base

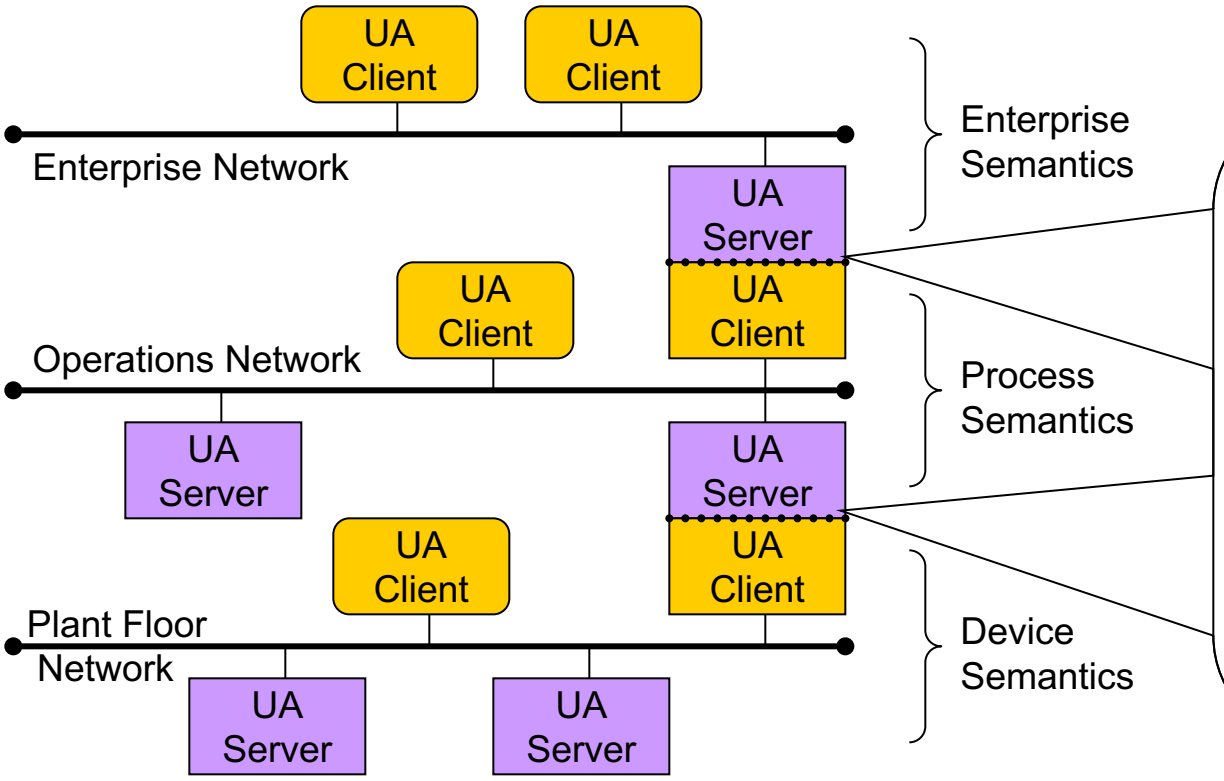
- Architecture
  - Integration of DA, A&E, Commands, Complex types and Object types
- Designed for federation
  - Abstract data/information from the plant floor, through information models, up to enterprise systems
- Information modeling
  - Development and deployment of standard information models to address industry domain specifics
- Complex data
  - OPC standard & Domain & Vendor specific
- Security
- Enterprise integration
- Robustness & Reliability
  - Sequence numbers, keep-alive messages, resynchronizing, redundancy
- Programs
- Companion standards
  - Industry groups define what OPC unified Architecture Transports

[OPC foundation, Jim Luth, OPC Day 2006]

The Big Things

- Widened vertical scope with new transports
  - Embedded devices (Efficiency optimized TCP / Binary)
  - Enterprise systems (Interoperability optimized WS / XML)
- Information modelling
  - Collaboration with standardization organizations ISA, MIMOSA, IEC, OAGi, EDDL, FDT, PLCOpen, MS MUG & NAMUR
  - OpenO&M
- Platform Neutrality
  - .Net (Windows)
  - ANSI C (Linux, embedded)
  - Java (Linux, Unix)
- Security & Reliability
  - Possible to use in distributed and critical applications
- Profiles
- Backwards compatible

Vertical server chaining



"Aggregating" UA Servers extract and process data from lower level "Device" UA Servers.

Data is recast using different information models appropriate for the clients at the higher level.

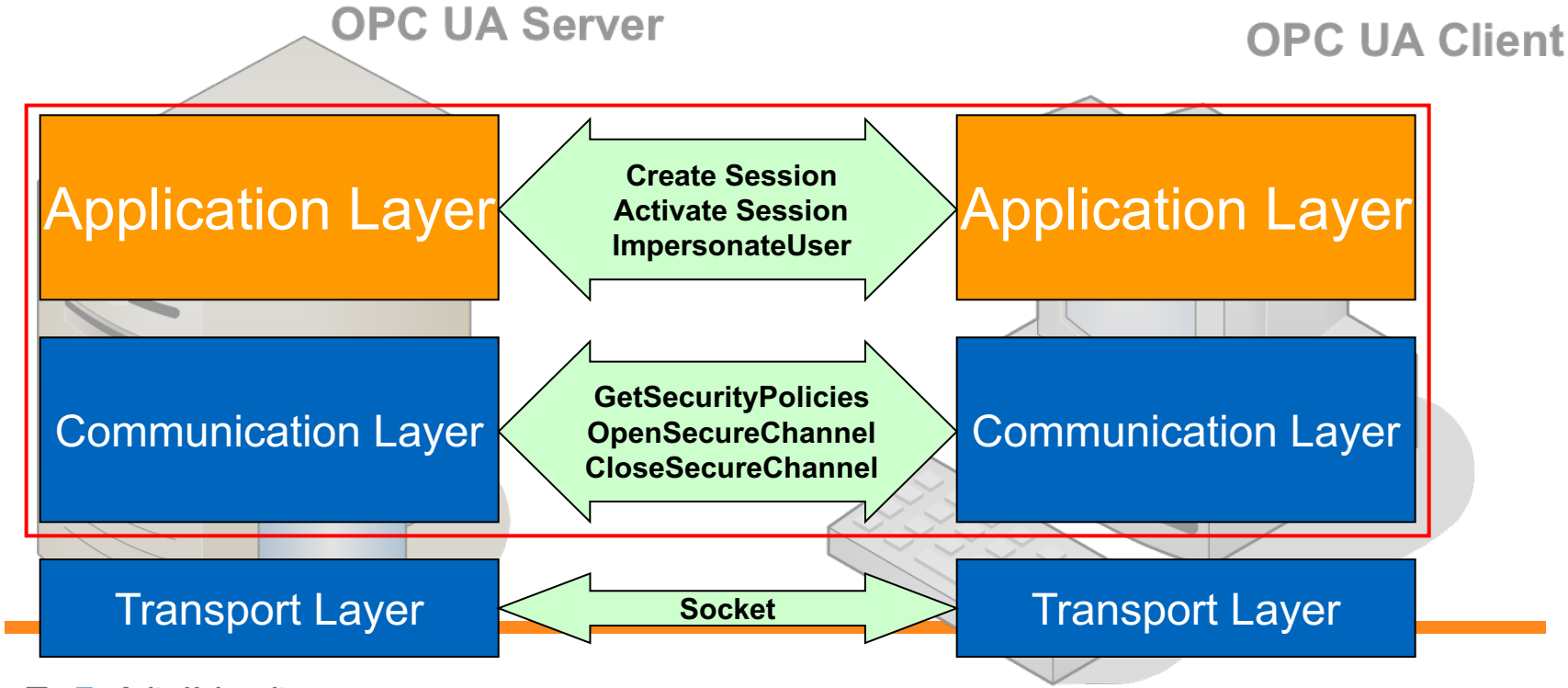
[OPC Foundation, DevCon 2006]

Transports

- Consists of encoding and message exchange
- Encodings
  - XML
  - UA Binary
- Transports
  - SOAP (Simple Object Access Protocol)
  - UA TCP
- Combinations
  - Efficiency optimized TCP / Binary
  - Interoperability optimized WS / XML

Security (optional)

- Application authentication
- User authentication
- Message integrity
- User authorization
- Confidentiality
- Auditing

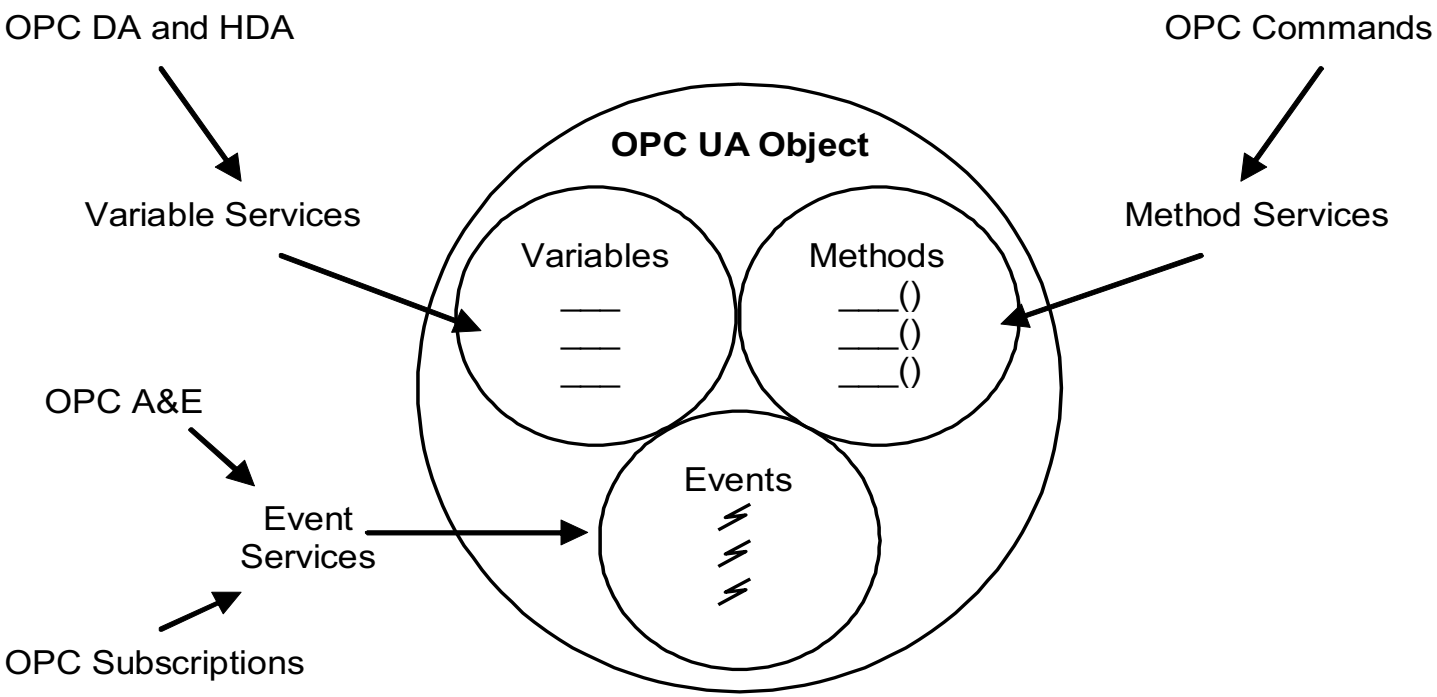


[OPC Foundation, DevCon 2006]

Reliability / Robustness

- Keep-alive messages (heartbeat)
  - Clients are able to detect failed servers and connections reliable unlike in DCOM
- Sequence numbers in messages
  - Re-sync of missed messages
- Notification mechanism decoupled from callback
  - Callback channel can be reset without loss of data
- Redundancy
  - Support for redundant servers and clients

OPC UA Object model



[OPC Foundation, DevCon 2006]

Implementation

- Easy migration
  - Wrapper for server and proxy for client
- Stack provided by the OPC for
  - ANSI C
  - .NET 3.0
  - Java 5.0
- Programmer API:s from OPC for all the platforms
  - Hides all the details from the programmer
- If the OPC client or server is not your core product you will use commercial programming kit.
- Implementing UA should be easier than implementing OPC DA

Timetable 2006

- All parts of the specification by December 2006
- First applications 2007/2008

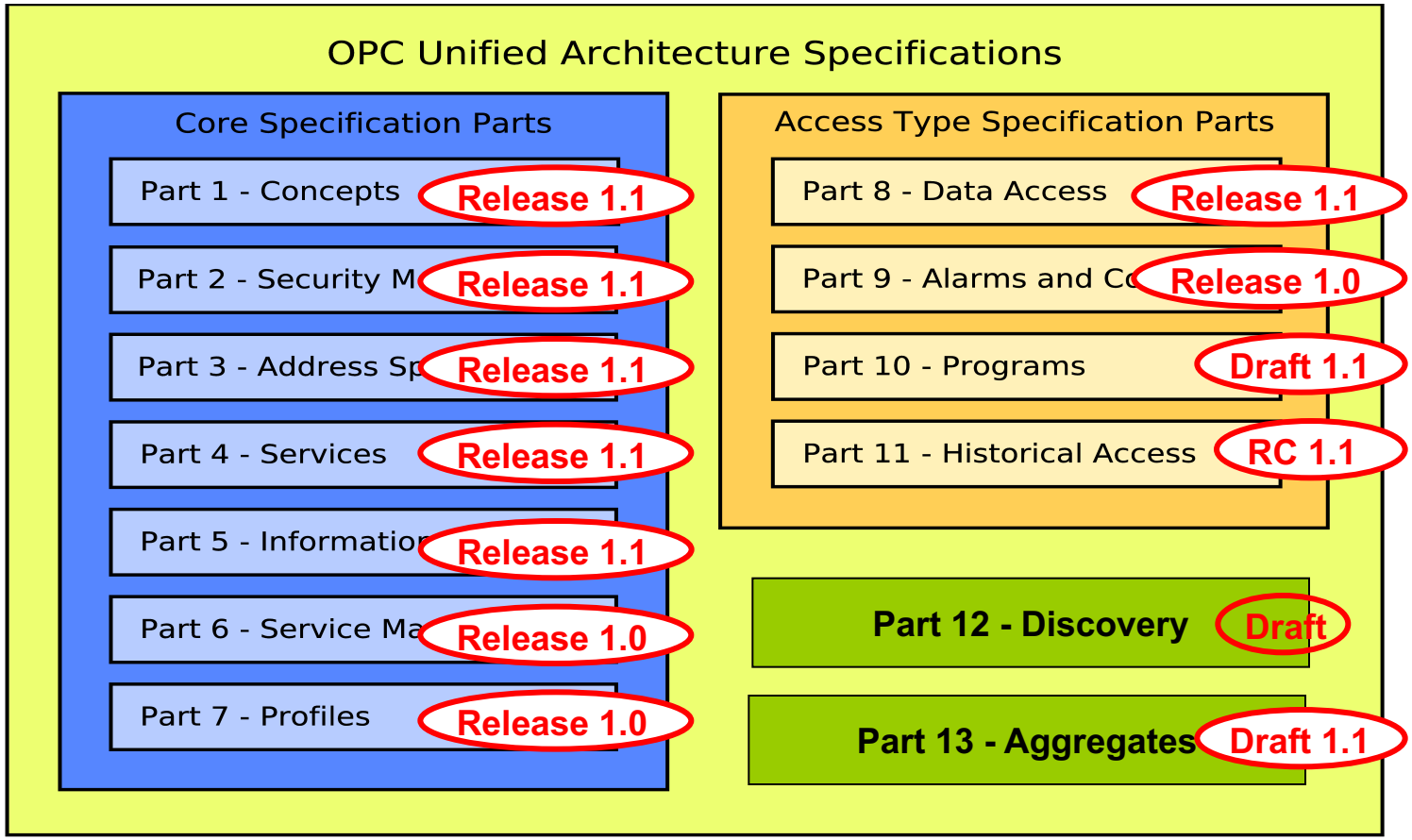
Core Feature	ANSI C/C++	JAVA	Microsoft .NET
XML/text Web Service			√
UA Binary	√	2007-12	√
UA Binary Web Service	(P)	(P)	√
UA TCP	√	2007-12	√
UA Secure Conversation	√	2007-12	√
UA API	√	2007-12	√
DA COM Wrapper			√
AE COM Wrapper			2007-12
HDA COM Wrapper			2007-12
DA COM Proxy			2007-11
AE COM Proxy			2008-03
HDA COM Proxy			2007-12
Discovery Server	√		√

[OPC Foundation]

Success possibilities / Risks (2006)

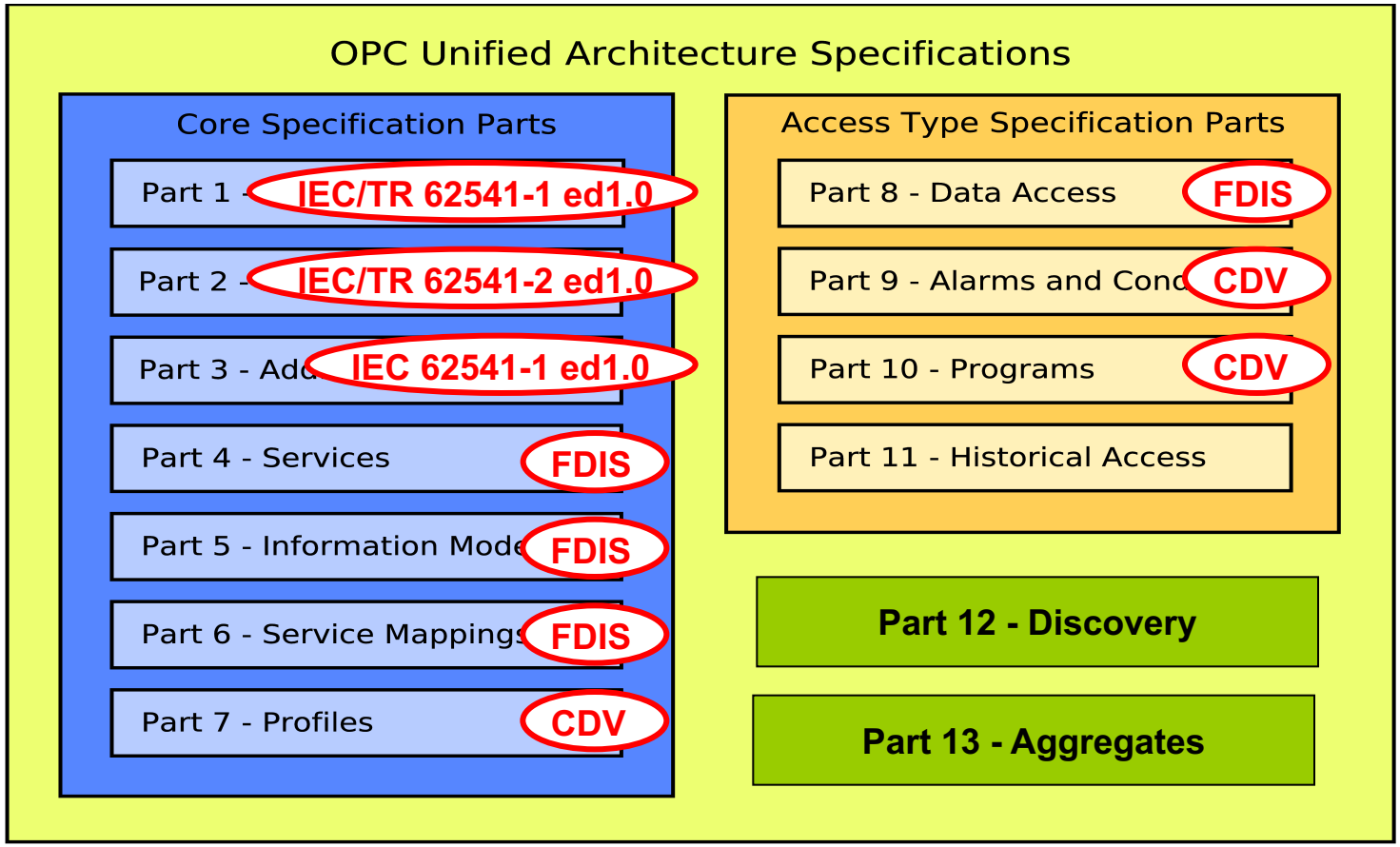
+ Clear migration path to new architecture
  - Wrappers for old client and servers
+ Stacks and API:s in addition to interface specification to ease the programming and enhance interoperability
+ Test and certification program for products
- Substantially larger and more complex specification
- Specification defines only the transportation of data, is this enough for interoperability
- Huge scope, old specifications were for one purpose only

OPC UA Situation 2010Oct



[OPC Theme day - Oct 2010, Matthias Damm]

Status IEC 62541 (OPC UA)



FDIS (Final Draft for International Standard) – voting ends 2010-10-31
CDV (Committee Draft for Voting) – Currently in review

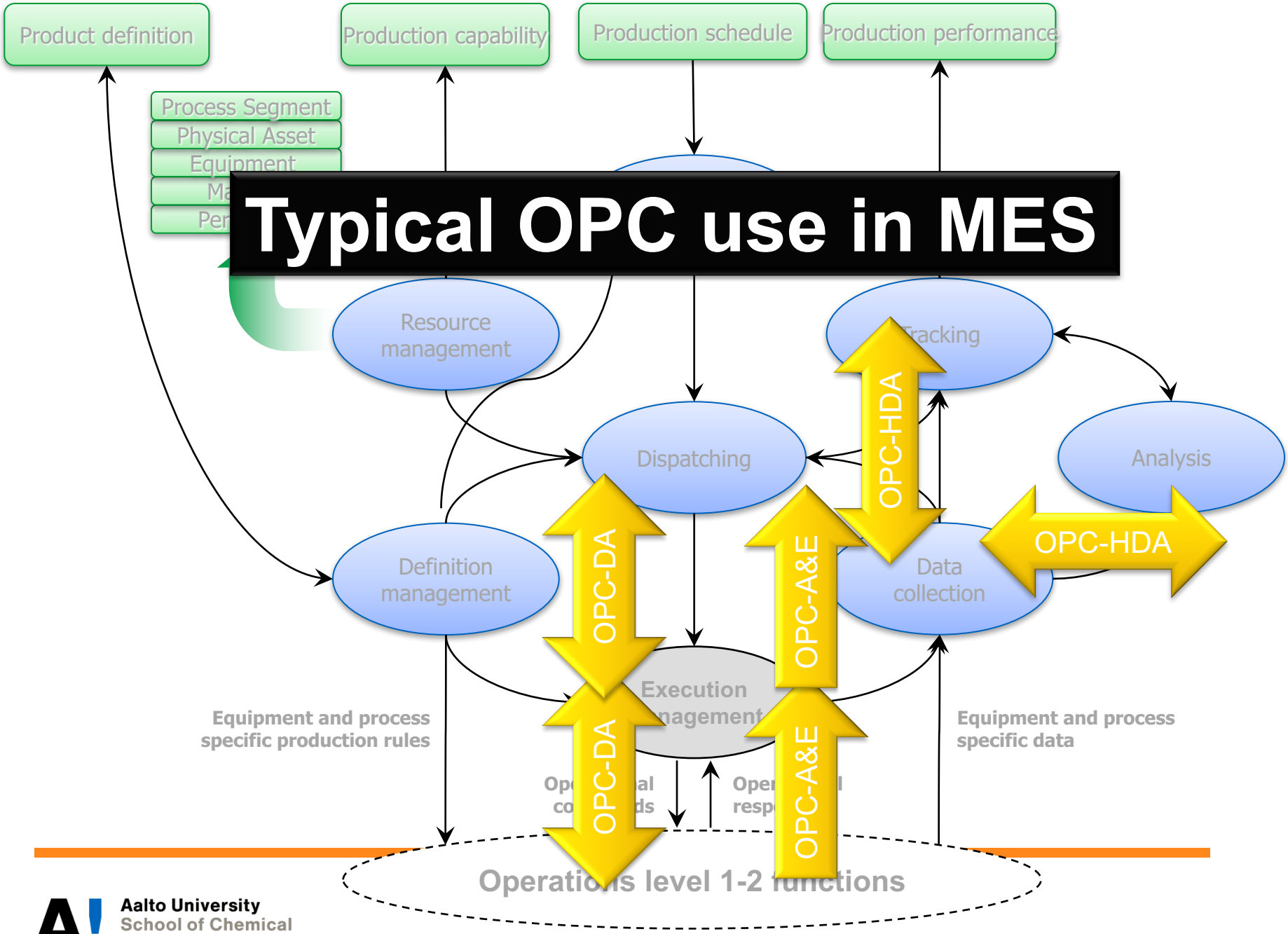
[OPC Theme day - Oct 2010, Matthias Damm]

OPC UA Performance

- Case Study (2009)

  http://download.intel.com/platforms/applied/indpc/OPC_Unified_Arch_CS.pdf

  – Roundtrip time for Read calls in a loop
    - 1 Client
      – 2,3 ms – 1 Variable
      – 3,0 ms – 10 Variables
      – 10 ms – 100 Variables
      – 97 ms – 1000 Variables
    - 10 Clients parallel
      – 18 ms – 1 Variable
      – 21 ms – 10 Variables
      – 76 ms – 100 Variables
      – 680 ms – 1000 Variables



Typical OPC use in MES

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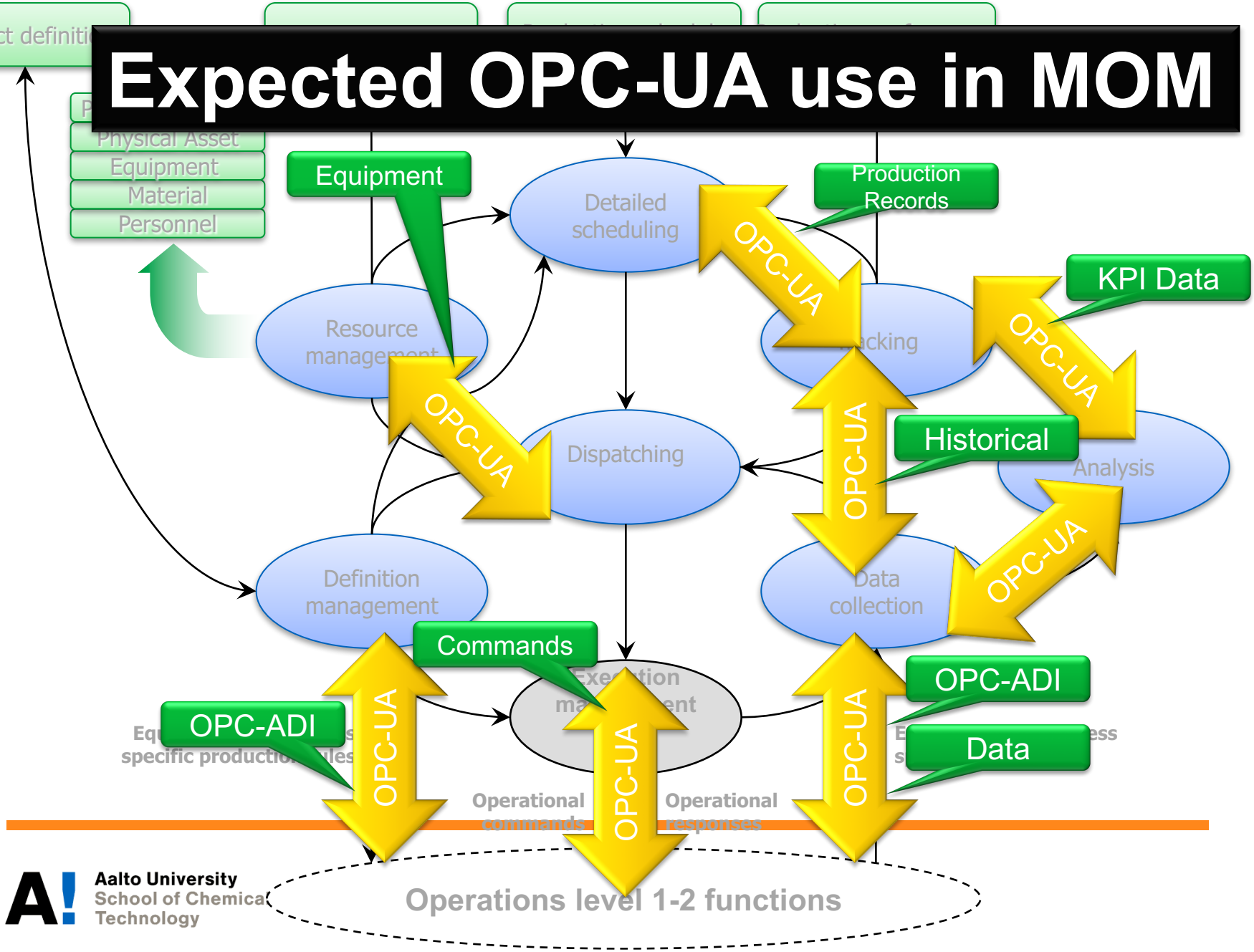
[OPC Theme day - 13 Oct 2009, Dennis Brandl]

Expected OPC-UA use in MOM



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Conclusions

- **Server – Client** structure
- OPC
  - Widely used
  - MS dependent
- OPC UA
  - New standard for information transport
  - Based on SOA and WS
  - From automation viewpoint
  - Scalable from embedded to enterprise systems
  - Collaboration with other standards
  - Huge momentum

[OPC Foundation, DevCon 2006]

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ABB & OPC

- ABB 800xA DCS system is built upon OPC
  - Communication above PLC-level is OPC based
  - The OPC server for the Connectivity server must be enabled to listen to your PLC Device.
- Connecting the OPC Server
  1. Open the OPC Server configurator
  2. Open the Data Access tab screen.
  3. In the Controller Identity field, enter the IP address of the PLC.
  4. Click Connect.
  5. Open the Alarm and Event tab screen, and repeat Step 2 and Step 3.
  6. Enable time synchronization from Settings → Time synchronization