Migrating from OPC Classic to OPC-UA

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OPC Classic at CERN

Process Supervision

WINCC OA SYSTEM

Siemens WinCC OA provides an HMI and SCADA layer

Process Management

OPC Servers are generally here in the Process Management Layer controlling devices

WINCC OA DRIVER (OPC CLIENT)

DEVICE TYPE A OPC SERVER | DEVICE TYPE B OPC SERVER | DEVICE TYPE C OPC SERVER

Devices are controlled via OPC Servers, each device type has a dedicated OPC Server. 3rd party device vendors usually provide an OPC Server for their device

Field Management

Communications between the OPC Server and the devices is vendor specific

The OPC Classic family
OPC-DA
OPC-HDA
OPC-XML
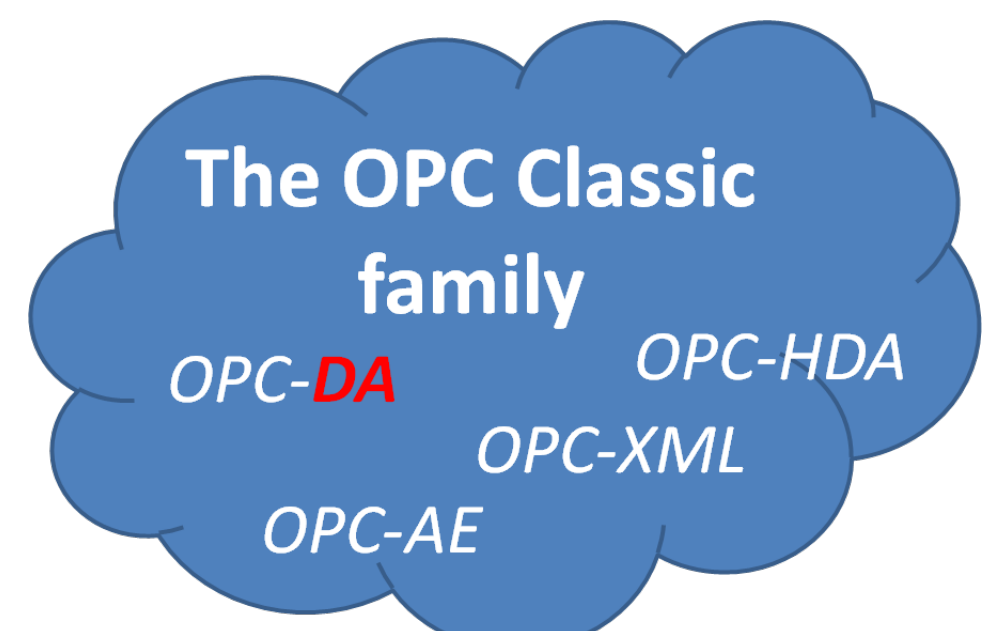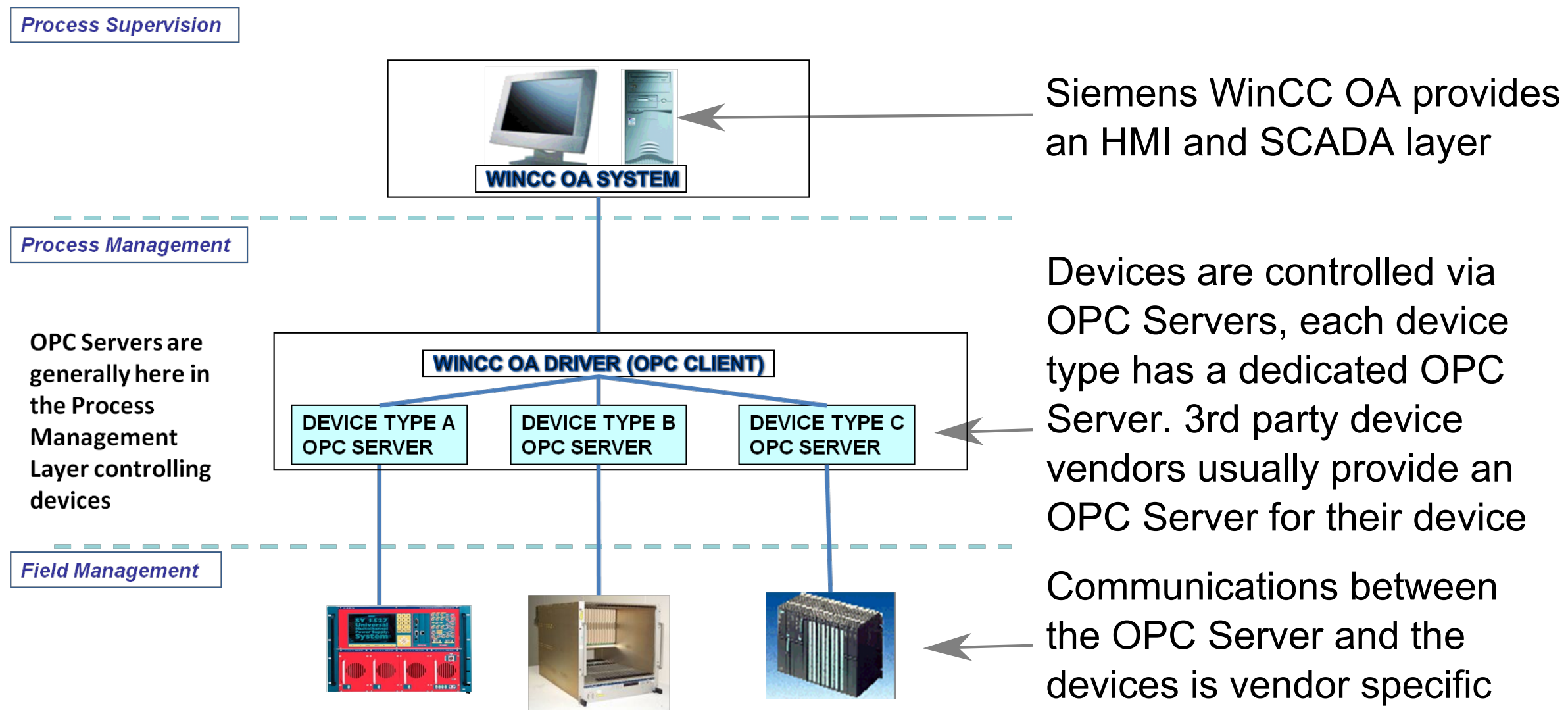OPC-AE

OPC Classic is actually a family of specifications release by the OPC Foundation. One of OPC-UA's goals is to unify a new specification under a single standard.

Currently, all of CERN's OPC deployments are OPC Classic. In fact the vast majority of OPC implementations are OPC-DA (Data Access). Types of devices monitored and controlled at CERN using OPC include:
- CAEN, Wiener and ISEG power supplies powering electronics and detector tubes.
- VME crates controlling specialist peripheral devices.
- ELMBs (a proprietary I/O module for controlling front end equipment).
- Siemens and Schneider PLCs for process automation.
- LabVIEW programs interacting with various hardware.

OPC-UA highlights

OPC Classic requires Microsoft's COM/DCOM for information transmission and inter-application security whereas OPC-UA has a built in specification for transmission and security based on modern, **cross platform** standards. OPC-UA applications are not limited to the Windows platform.

Following on from the point above, OPC-UA servers can be written for **embedded** platforms. The full OPC-UA specification is chunked into profiles, vendors could provide devices with embedded profile servers built in.

OPC Classic delegates security to COM/DCOM. OPC-UA has **comprehensive security** built-in, based on Public Key Infrastructure for secure client/server communications. Additionally the specification provides a means for providing user ID for authentication, authorisation and auditing.

OPC-UA includes an extensive vocabulary for modeling devices and processes. OPC-UA servers can handle **type templates** from which identical instances can be produced. Additional OPC-UA address space enhancements include events, methods and views .

OPC-UA provides a **choice of message formats, transport mechanisms and security options**. UABinary is a compact encoding means designed for efficient use of bandwidth. XML encoding is for generic XML enabled clients. OPC.TCP transport is fast and efficient, HTTP is ubiquitously available.

Message Format
UA Binary
XML

Transport
OPC.TCP
SOAP/HTTP(S)
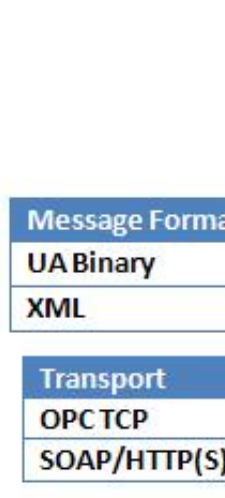
Advantages for CERN

Microsoft have de-emphasized COM/DCOM for inter process communication. The future of COM/DCOM is uncertain.

Some Detector Control System administrators have selected Linux as their preferred OS. OPC Classic applications bound to Windows could be replaced with equivalent OPC-UA applications running on Linux.

Power supplies provided with built in OPC-UA servers would simplify DCS architecture, removing the need for machines to host OPC servers.

DCOM security can be laborious to configure, and sensitive to operating system upgrades and patches. OPC-UA's x509 certificate based security can leverage the existing CERN Certificate Authority infrastructure.

Firewall settings for HTTP and OPC.TCP transports are simple.

Well modeled high voltage channels, for example. with methods for turning channels on and off gives an intuitive representation of the underlying device, minimizing user misinterpretation.

In monitor and control environments where processing power and bandwidth are a major concern. Messages can be packaged in UABinary and transported over OPC.TCP.
Enterprise data publication environments, where supporting a wide client base is important, may opt for SOAP/XML encoding transported over HTTP.

OPC-UA Stacks

The OPC foundation provide reference stacks for the OPC-UA specification to profit making organisations in return for a fee. Stacks are available in .Net, Java and C/C++.

The primary goal of the stacks is interoperability in terms of message formats, transmission modes and security measures. Currently all stacks support UA Binary encoding and OPC.TCP transmission but only the .Net stack supports XML encoding and HTTP based transmission.
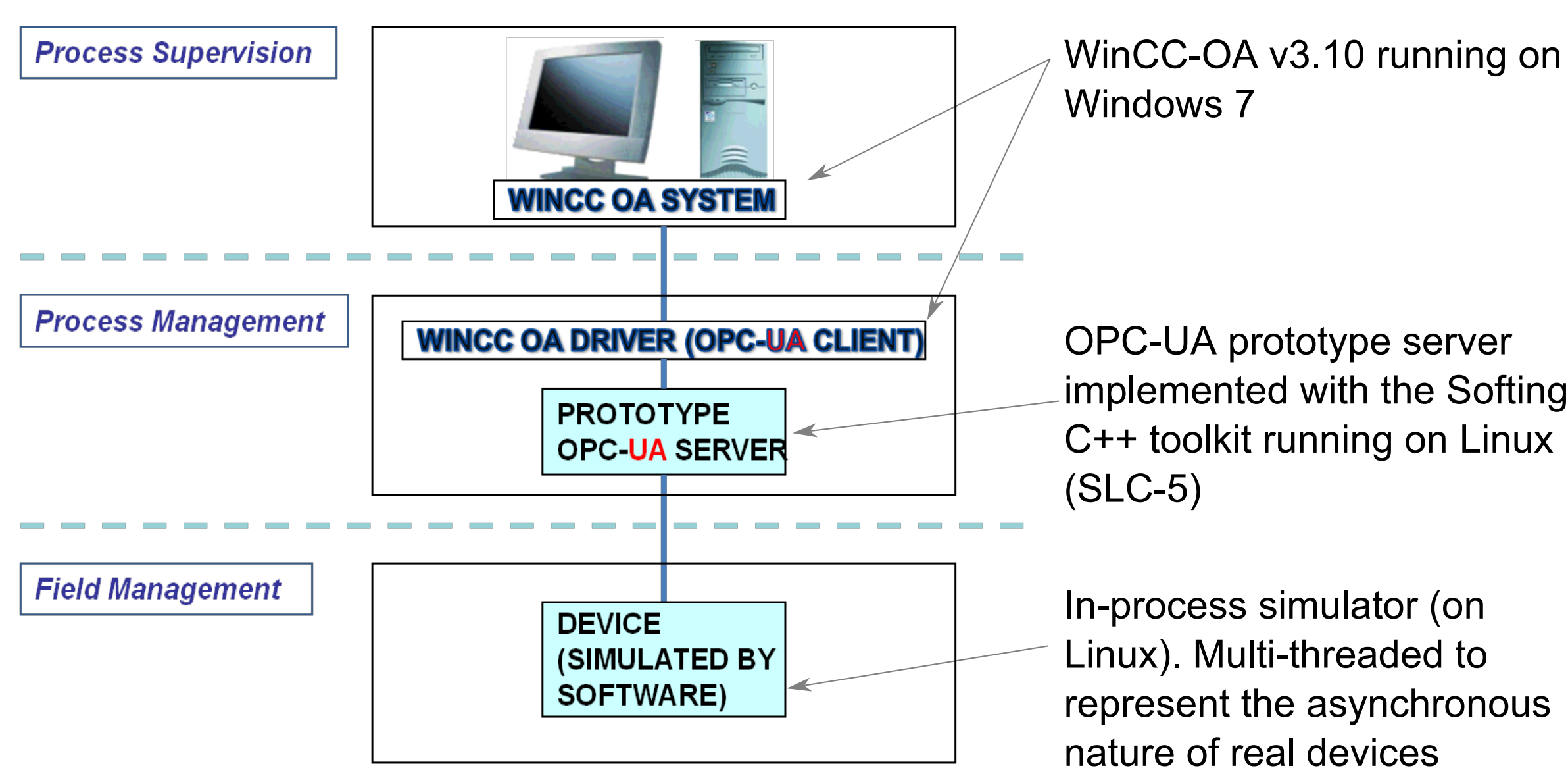
Microsoft .NET
Java

OPC-UA Toolkits

As a non-profit making organisation, CERN does not have access to the OPC Foundation stacks. However, 3rd party vendors offer commercial OPC-UA toolkits - essentially software libraries - built on top of the stacks. These libraries wrap the stacks and add extra features (session life-cycle management for example). Developing an OPC-UA application using a toolkit is faster and requires less code than developing the same application based solely on the stack. In addition the vendors provide professional support and maintenance packages.
Prominent OPC-UA toolkit providers include:
- **Softing**: .Net and C++ toolkits, available on Windows and Linux.
- **Prosys OPC**: Java toolkit, for platforms running the JRE6 Java Virtual Machine
- **Unified Automation**: C/C++ toolkits, can be cross compiled for various target platforms. Java toolkit (Prosys OPC resellers).

OPC-UA for device monitoring and control

OPC-UA was evaluated as a replacement middleware technology for existing OPC Classic implementations. The common WinCC-OA/OPC/device stack was recreated as below using OPC-UA middleware (rather than OPC-Classic).

Process Supervision

WINCC OA SYSTEM

WinCC-OA v3.10 running on Windows 7

Process Management

WINCC OA DRIVER (OPC-UA CLIENT)

PROTOTYPE OPC-UA SERVER

OPC-UA prototype server implemented with the Softing C++ toolkit running on Linux (SLC-5)

Field Management

DEVICE (SIMULATED BY SOFTWARE)

In-process simulator (on Linux). Multi-threaded to represent the asynchronous nature of real devices

Cross platform monitor and control functionality works.
- WinCC OA can browse the server's address space.
- Datapoints can be mapped to server address space elements
- Datapoints can subscribe to server for changes in monitored items on device
- Datapoints can be used to write to exposed items on a device

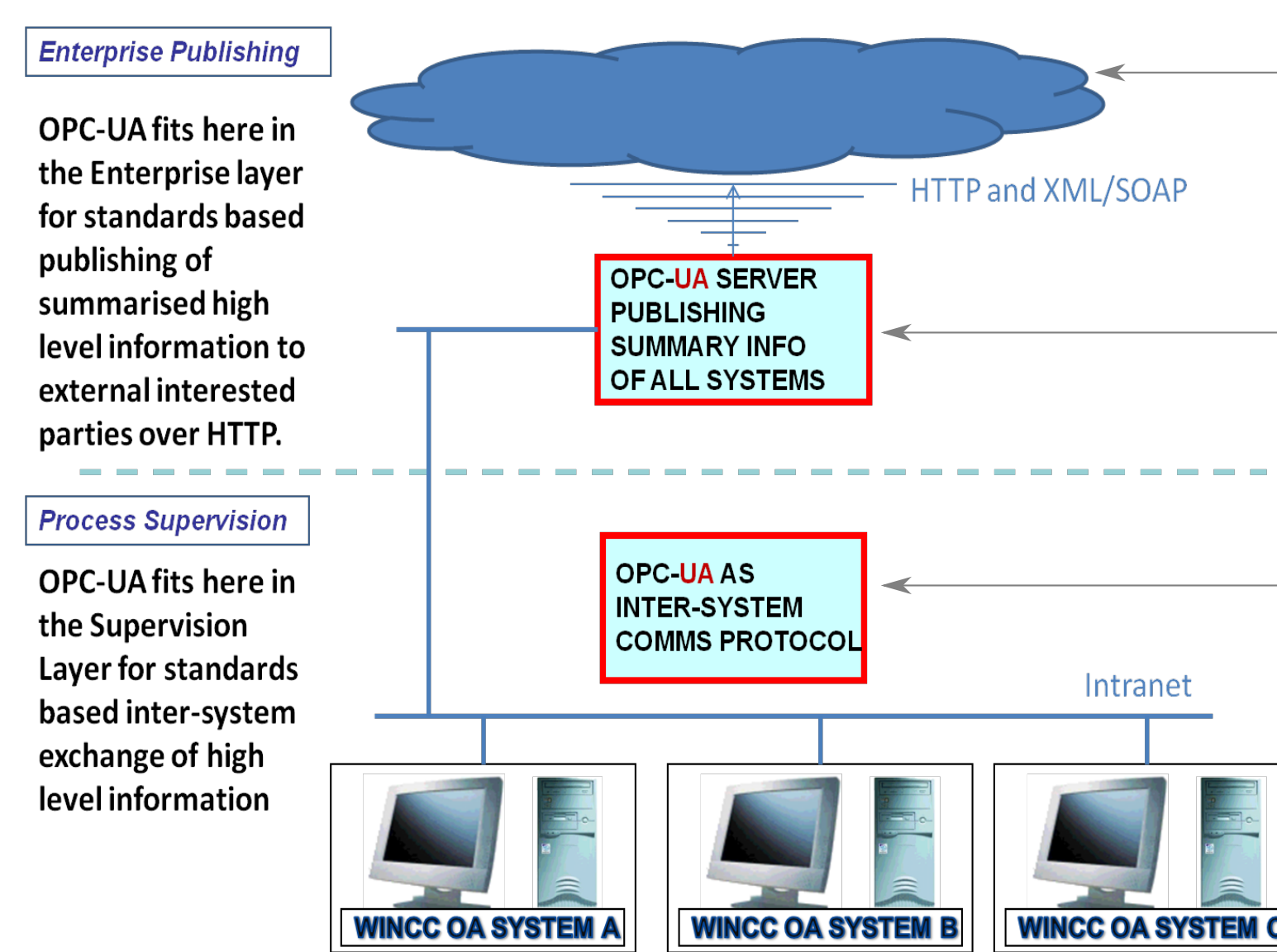**Security could not be made to work, Siemens are investigating**
- The OPC-UA client connected to untrusted OPC-UA servers, should not be possible.
- Attempts to set up signed and encrypted client/server sessions failed.

Some nice-to-have OPC-UA enhancements are not implemented yet in WinCC OA
- Address space enhancements like server side views and method calls are not available yet in WinCC OA.

OPC-UA as high level middleware

As a cross platform industry standard middleware, OPC-UA has an attractive profile for horizontal communications between peer systems. OPC-UA's XML/SOAP over HTTP capability is an attractive profile for publishing enterprise data to XML/SOAP enabled clients.

Enterprise Publishing

OPC-UA fits here in the Enterprise layer for standards based publishing of summarised high level information to external interested parties over HTTP.

HTTP and XML/SOAP

OPC-UA SERVER PUBLISHING SUMMARY INFO OF ALL SYSTEMS

Process Supervision

OPC-UA fits here in the Supervision Layer for standards based inter-system exchange of high level information

OPC-UA AS INTER-SYSTEM COMMS PROTOCOL

Intranet

WINCC OA SYSTEM A | WINCC OA SYSTEM B | WINCC OA SYSTEM C

Clients do not have to be OPC-UA specific, they need simply to be able to 'speak' HTTP and be able to parse the XML.

This type of OPC-UA implementation publishes high level system summaries over HTTP to web-service capable clients.

inter-system middleware OPC-UA implementations to exchange high level data securely and efficiently.

Inter-system middleware - missing finalised discovery service specification and implementations
- Since OPC-UA is a standard it is supported by a range of commercial off the shelf products.
- Platform agnostic - interoperable commercial libraries available with support.
- Secure client/server sessions providing message integrity and confidentiality.
- Let down by a lack of a fully specified discovery mechanism: This section of the specification is in draft and due for release soon.

Enterprise publishing - Required functionality not yet available in commercial toolkits
- Unfortunately the XML/SOAP and HTTP profile is only available in .Net toolkits, limiting the use to Windows.

Conclusion

Once issues with WinCC OA security and OPC-UA servers are resolved OPC-UA implementations will be able to provide the same level of functionality for control and monitoring as the incumbent OPC Classic implementations with the added benefit of being cross platform. OPC-UA is an attractive industrial standard for middleware for inter-systems communications and high level enterprise data publication.
The absence of some required features in commercially available toolkits means that it is not a viable option now, however, the evolution of the toolkits will be monitored and the missing features evaluated once they become available.

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