Communications, protocols and information modeling: The fundamentals of IoT, IIOT, M2M, industrie 4.0

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NEW · ONLINE NOW & IN STORES SOON

CONNECTED COFFEE

NESPRESSO PRODIGIO ESPRESSO MACHINE *with* MILK FROTHER »

The newest Nespresso machine is also the smartest, thanks to smartphone compatibility.

GET CONNECTED

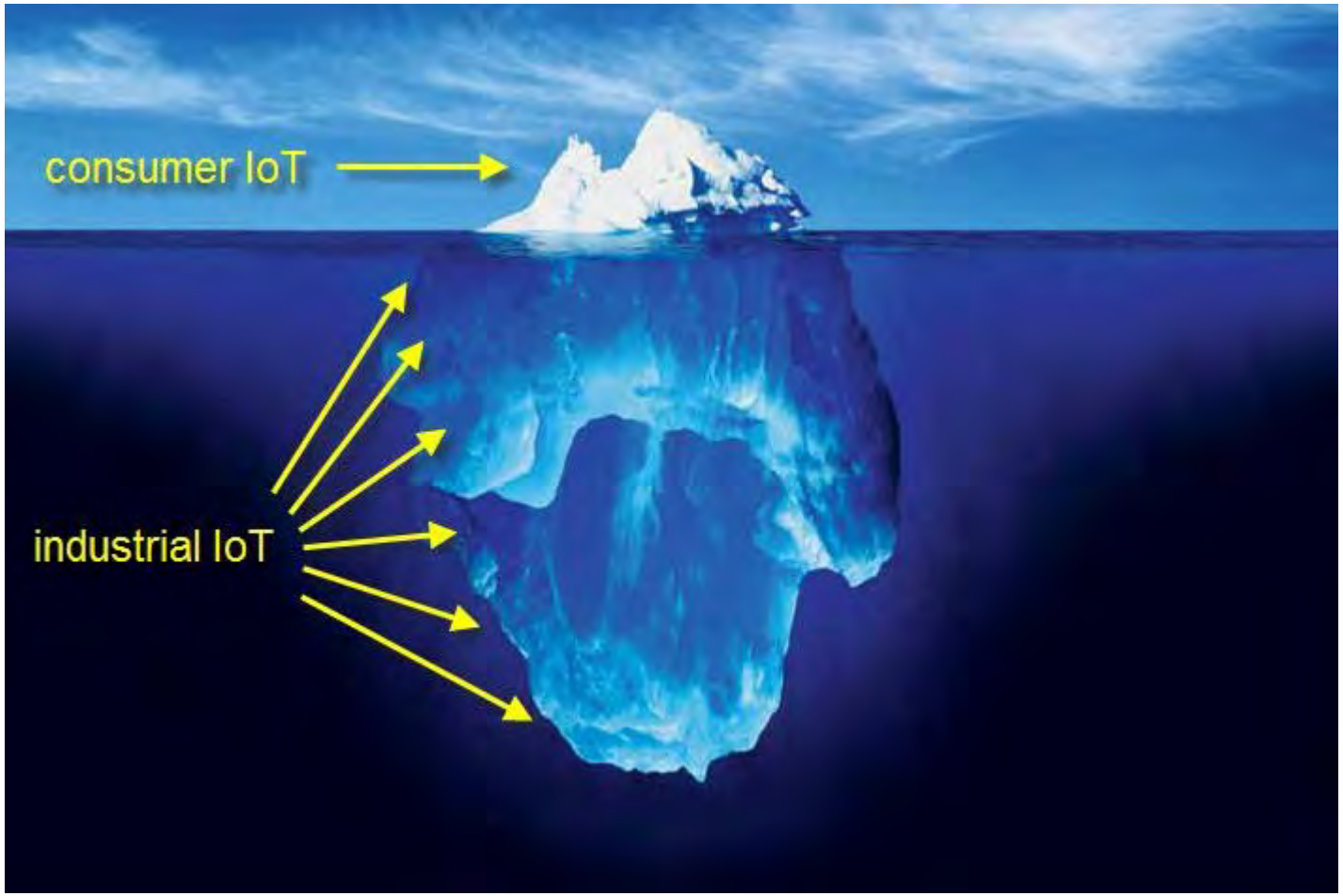
Smartphone connectivity and alerts for water, capsule stock and descaling keep you in-the-know on your machine's status.

The Connected World of Data (IOT)

- The racket, has gyroscopes, accelerometers and a piezoelectric sensor in the handle. These sensors pick up a variety of data, including where the ball hits the strings, how much power goes into a shot and how much spin a player puts on a ball.

The value of IIoT ……

Honeywell



Often expressed in mind-boggling numbers

OPC Foundation

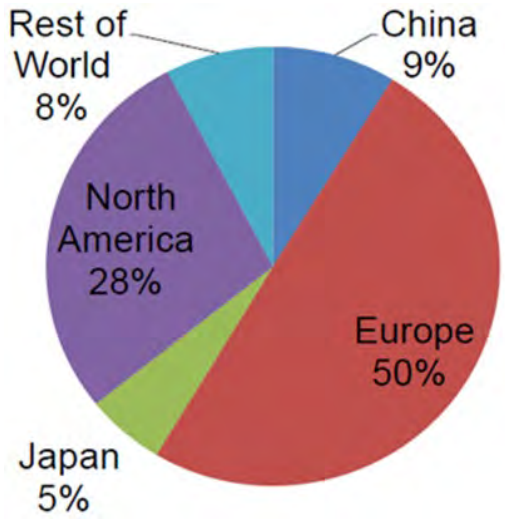
- Broad Vision
  Secure, reliable, multi-vendor, multi-platform, multi-domain information interoperability from sensor to enterprise

- International Scope
  - Non profit organization (founded 1995)
  - Companies from Automation & IT
  - Standard: OPC UA is IEC62541

- Deliverables
  - Open Specification
  - Tools: certification tools
  - Compliance Labs

- NOTE: Professional OPC UA Toolkits are the ecosystem

OPC Members



OPC Board

- Microsoft, SAP, Siemens, Beckhoff, Honeywell, Yokogawa, and others
- New members coming soon

The Industrial Interoperability Standard

OPC UA: The industrial framework enabling secured, standardized data and interfaces

Interoperability

Independent:
Vendor, Platform, Market and OS

Discoverable Service Oriented Architecture (SOA) independent of the transport method

Run by a Non-Profit (OPC Foundation)

60M install base and exponential growth

Scalability: From Sensor to Cloud

Data Modelling

Rich data modeling (preserves data context)

Vendors can extend the data model of each product (Companion Specification)

Maps domain specific protocols, e.g. BACNet | MTConnect | Weihenstephan…

Maps domain specific information e.g. Robotics, Machine Vision, …

Security

Secure by Design

Based on **open security standards**

Authentication | Encryption

Evolves with Security Industry standards

Scalable security

OPC UA in the world

IIC

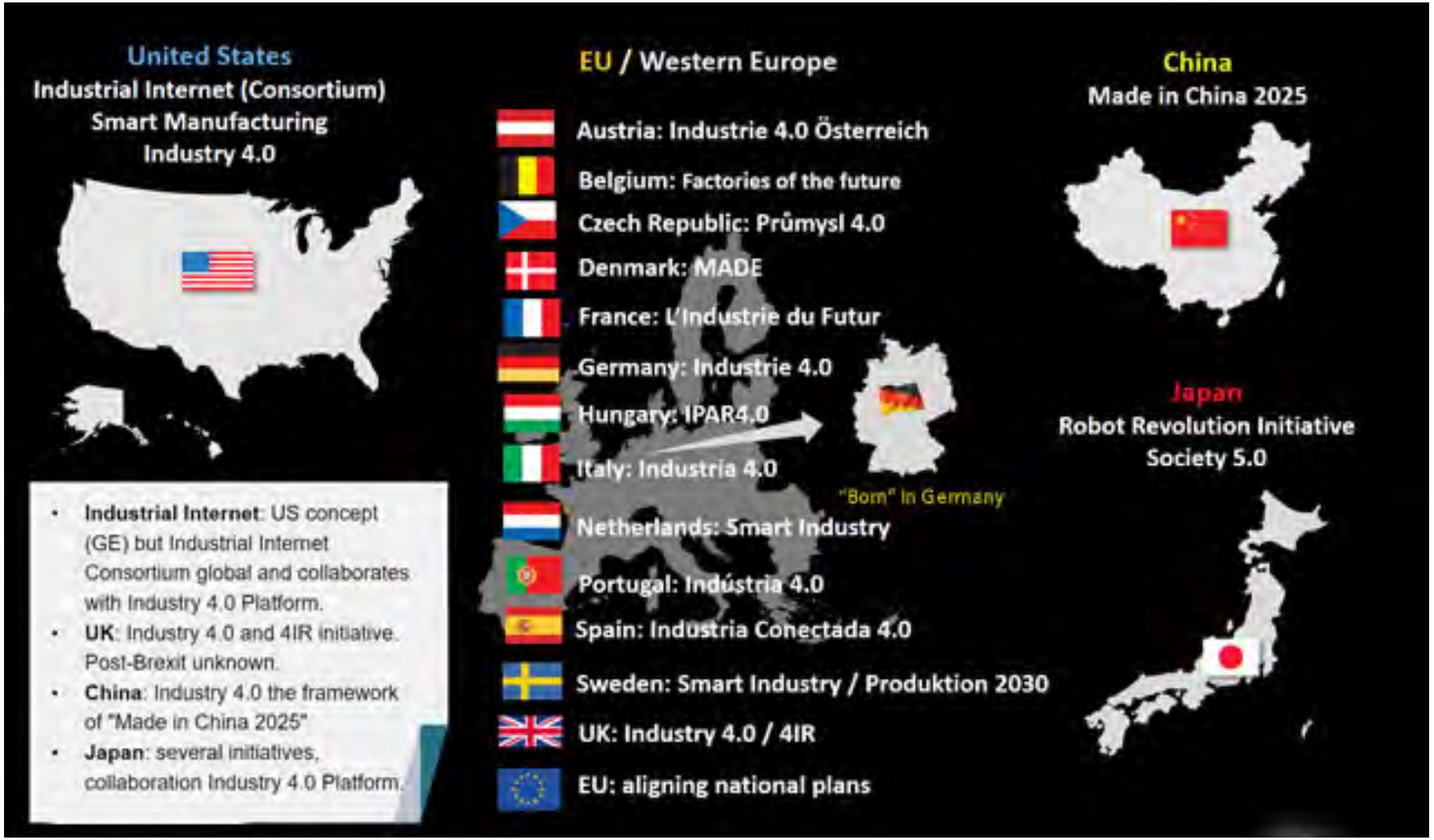
Industrie4.0

Made in China2025

Japan IVI

Korea MII3.0

Upcoming Global OPC UA Initiatives



Industrial Internet Consortium OPC UA Testbeds

Example testbeds with integrated OPC UA:

1. SMART MANUFACTURING CONNECTIVITY FOR BROWN-FIELD SENSORS

2. TIME SENSITIVE NETWORKING (TSN) TESTBED

3. SMART FACTORY WEB TESTBED

https://www.iiconsortium.org/pdf/IIC_PUB_G5_V1.0_PB_20170228.pdf

Industrie 4.0 Requires OPC UA

Industrie 4.0 Full
Target: standards, norms and research, > 5 years

Definition of full Industrie 4.0 properties incl. strategic outlook

Industrie 4.0 Ready
Target: manufacturers, < 5 years

What are the minimum properties that products must have in order to participate in the Industrie 4.0 network?

Industrie 4.0 Basic
Target: customers, today

Which products are currently well prepared for Industrie 4.0?

Industrie 4.0 communication	Transfer of product data and data files for interpretation or simulation, for example; product data in standardised form The product can be addressed via the network, supplies and accepts data, Plug & Produce via Industrie 4.0-compliant services	T	M	Manufacturer makes data that is relevant for the customer available/accessible online with the aid of identification, e.g. PDF via http(s)
		I	M	Product addressable online via TCP/UDP&IP with at least the information model from OPC-UA
Industrie 4.0 services and conditions	Definition still open (service system) General interface for loadable services and messages regarding statuses Essential basic services that an Industrie 4.0 product must support and provide	T	O	Description of the device interface available digitally
			O	Information such as statuses, error messages, warnings, etc. available via OPC-UA information model in accordance with an industry standard

EVERY I4.0 IMPLEMENTATION LEVEL OFFICIALLY REQUIRES OPC UA

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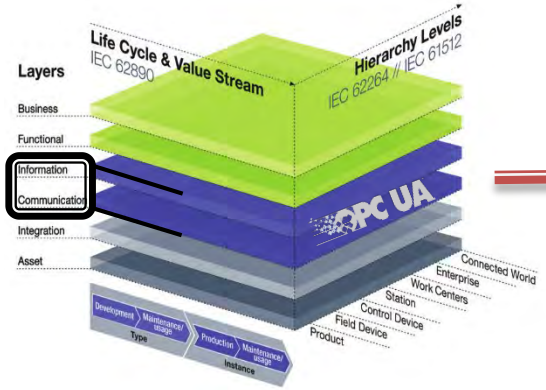
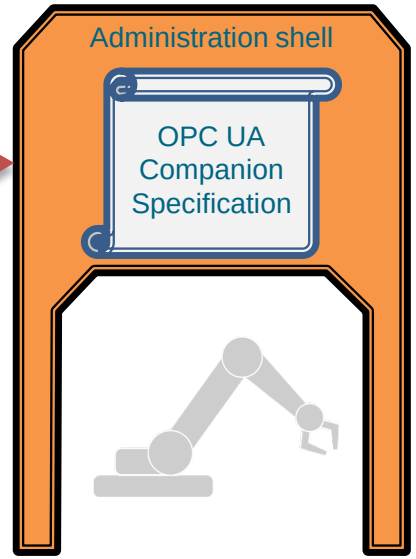
Robotics Uses OPC UA to Implement Industrie 4.0





OPC Architecture: In Depth

Specific Models

Use case specific models

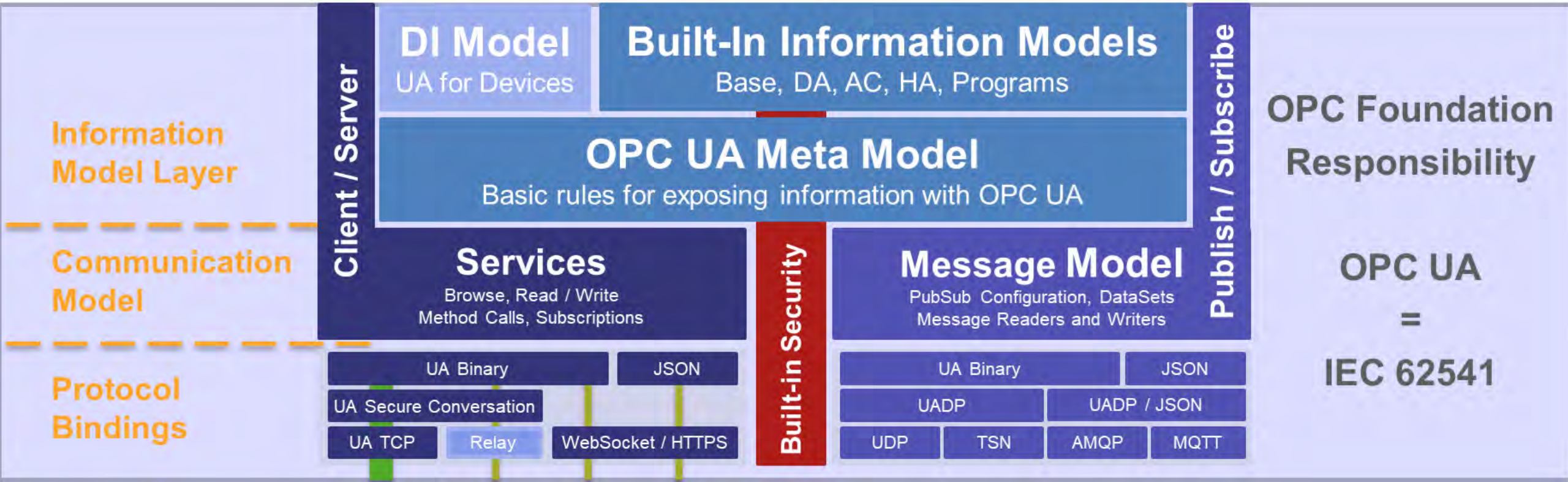
Industry specific models

Device / machine specific models

Companion Information Models

PLCopen, ADI, FDI, FDT, BACnet, MDIS, ISA95, AutomationML, MTConnect, AutoID, VDW, EUROMAP, Robotics, Vision Systems, IEC 61850/61400, Sercos, Powerlink, PROFInet, …

Developed with partner organizations



OPC Foundation strategy:

- Rules for OPC UA CS developed together with partners
- Predefined process for joint OPC UA CS
- Templates to ensure standardized format and potential certifications
- Compliance
- Intellectual Property
- Working Processes

Markets https://opcfoundation.org/markets-collaboration/

- **Automation**
- **Building Automation**
- **Energy**
- **Engineering**
- **Measurement**
- **Oil & Gas**
- **Transportation**

VDMA represents the breadth of the manufacturing industry

VDMA has more than 3200 member companies

- Agricultural Machinery
- Air Conditioning and Ventilation
- Air Pollution Control
- Air-handling Technology
- Building Control and Management
- Cleaning Systems
- Compressors, Compressed Air and Vacuum Technology
- Construction Equipment and Building Material Machines
- Drying Technology
- Electrical Automation
- Electronics, Micro and Nano Technologies
- Engine Systems for Power and Heat Generation
- Engines and Systems
- Fire Fighting Equipment
- Fluid Power
- Food Processing Machinery and Packaging Machinery
- Foundry Machinery
- Gas Welding
- Hydro Power
- Integrated Assembly Solutions
- Large Industrial Plant Manufacturing
- Lifts and Escalators
- Machine Tools and Manufacturing Systems
- Machine Vision
- Materials Handling and Intralogistics
- Measuring and Testing Technology
- Metallurgical Plants and Rolling Mills
- Metallurgy
- Micro Technologies
- Mining
- Plastics and Rubber Machinery
- Power Systems
- Power Transmission Engineering
- Precision Tools
- Printing and Paper Technology
- Process Plant and Equipment
- Productronic
- Pumps + Systems
- Refrigeration and Heat Pump Technology
- Robotics
- Robotic + Automation
- Security Systems
- Software and Digitization
- Surface Treatment Technology
- Textile Care, Fabric and Leather Technology
- Textile Machinery
- Thermal Turbines and Power Plants
- Thermo Process Technology
- Valves
- Waste Treatment and Recycling
- Wind Energy
- Woodworking Machinery

OPC UA CS Release (Candidate)

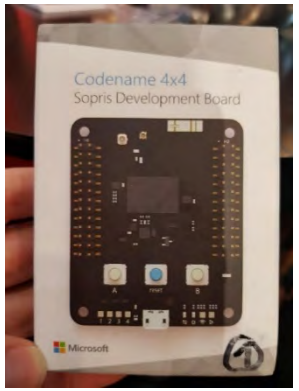
OPC UA CS under development

Awareness existent

Growing into new markets

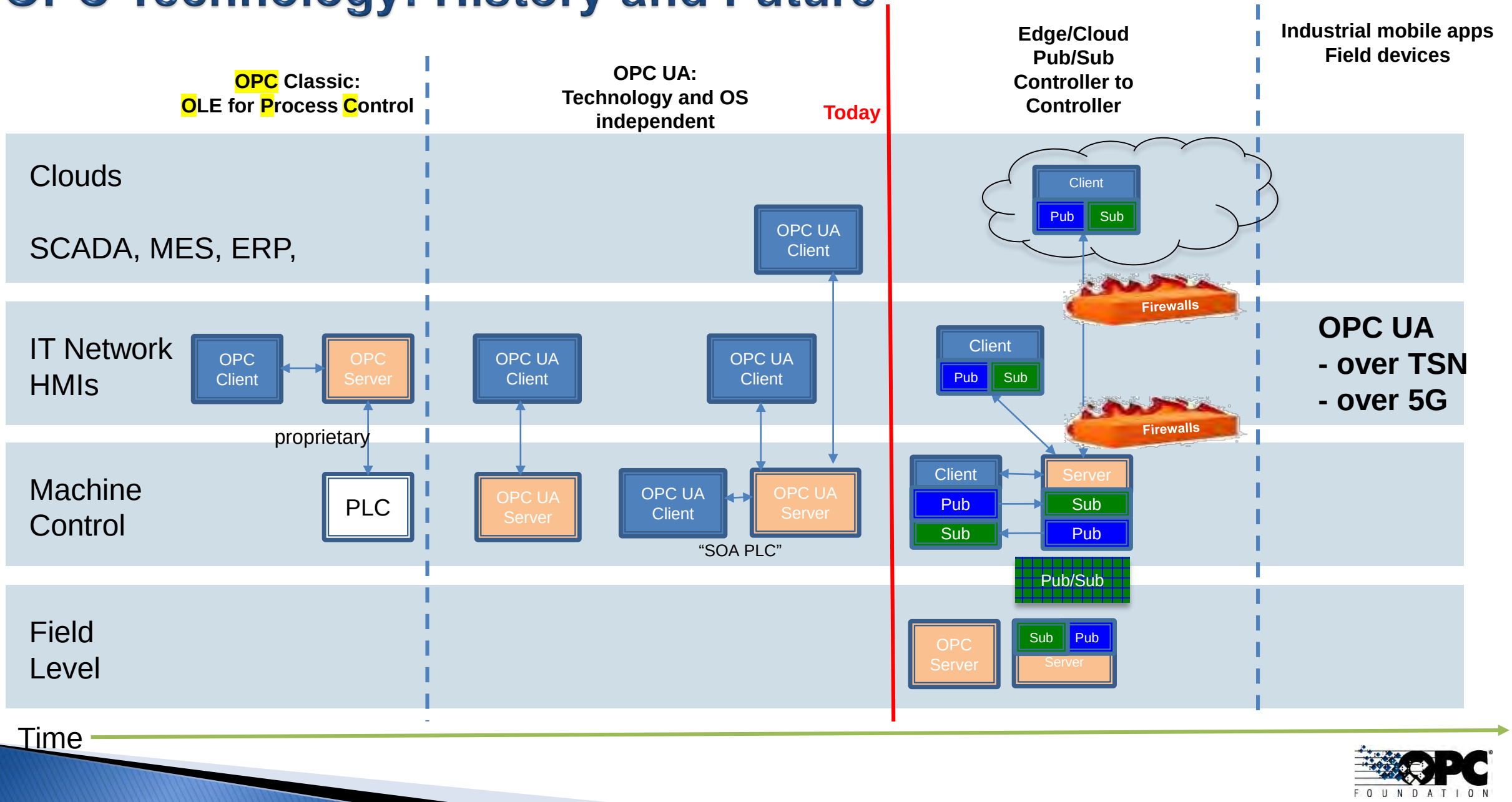
- 2016: Commercial product OPC UA in chip

- 2018: OPC UA in Microsoft IoT chip
  Azure Sphere: IoT chip for secured connection
  https://www.microsoft.com/en-us/azure-sphere/



- 2018: Industrial kitchen equipment
  HKI association modelled 13 devices

OPC Technology: History and Future



OPC UA: Security analyzed by BSI

Who: **Federal Office for Information Security (German Government BSI)**

Why: **Because of relevance of OPC UA for German Industry**

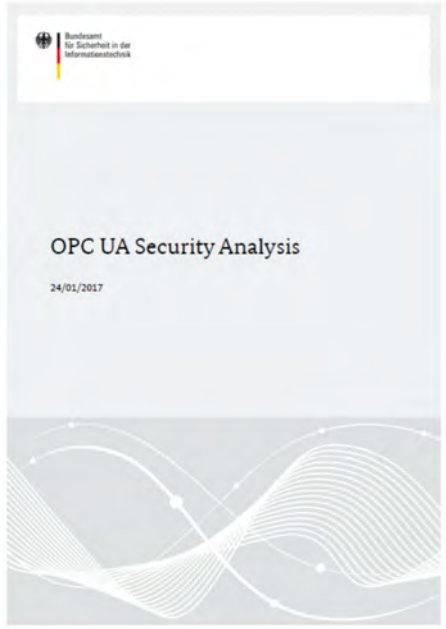
What: **Security Evaluation of OPC-UA – finalized March 2016**

- Analysis of specification
- Analysis of Reference Implementation

Result: **Available on BSI web**

Commented version on OPC web www.opcfoundation.org/security

Bundesamt für Sicherheit in der Informationstechnik



See also video from BSI „Results Security Analysis“

OPC Youtube Channel

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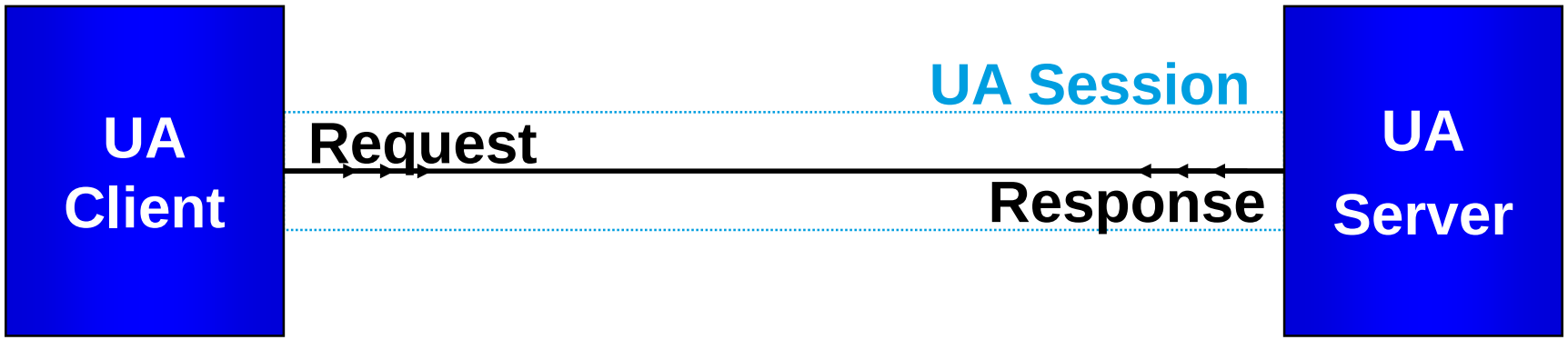
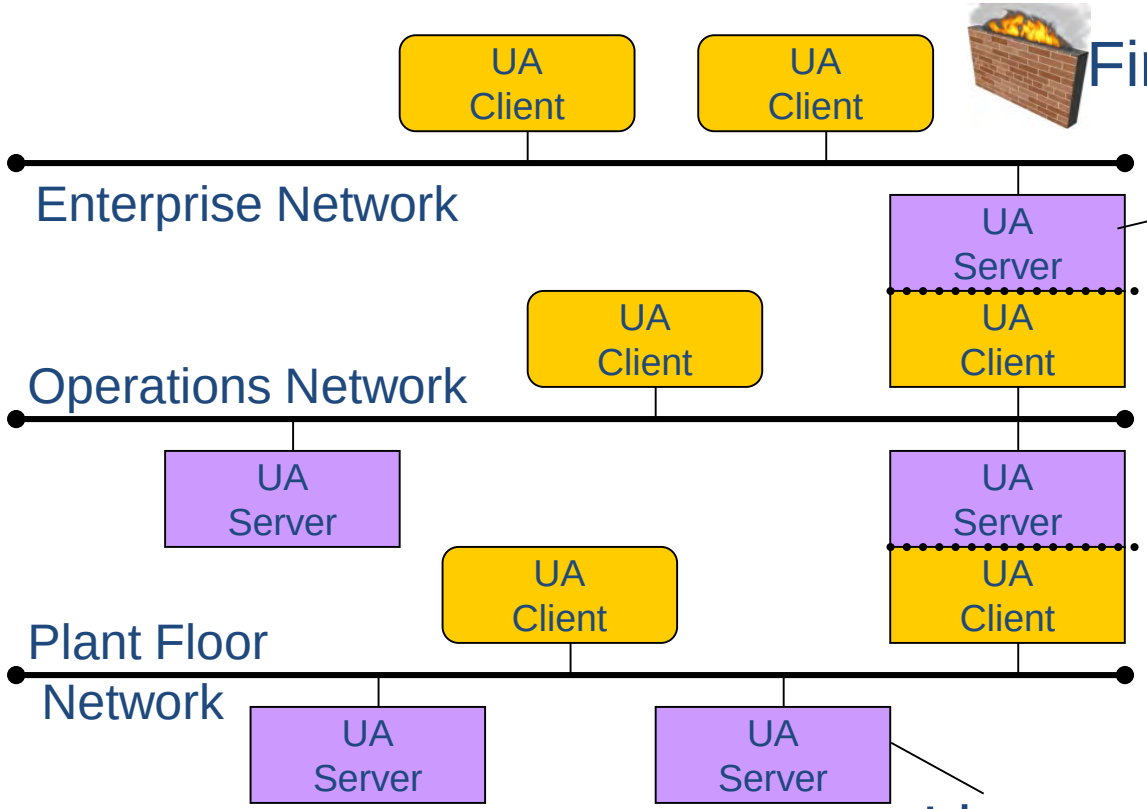
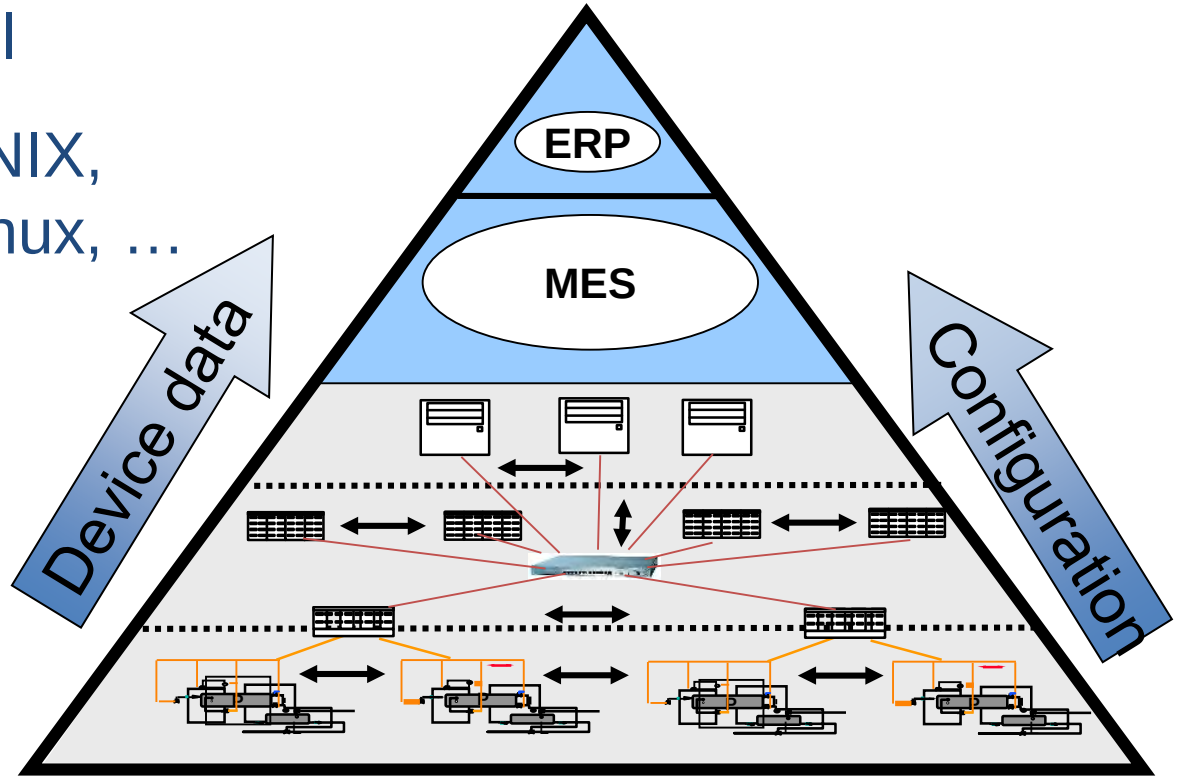
Communication Reliability

- OPC UA recovers from communication loss
- OPC UA ensures robust and reliable communication
  - Keep-alive monitoring
  - Buffering of data and acknowledgements
  - Fast recovery in case of communication errors
  - Redundancy concepts

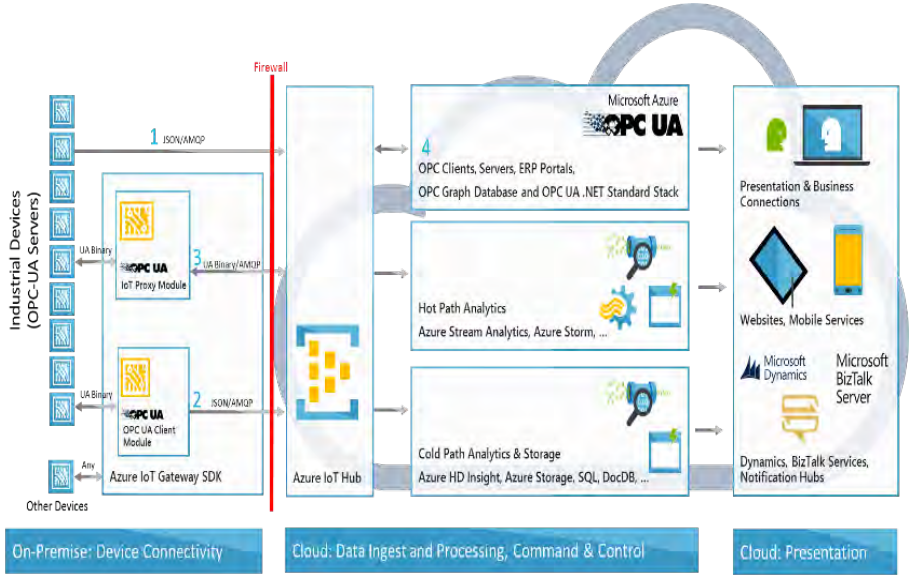


Vertical Integration





Microsoft commitment to OPC UA



Dedicated engineering team focused on adding OPC UA support to Microsoft products located in Munich, directly reporting to Azure IoT directors in Redmond

Download flyer here
https://opcfoundation.org/wp-content/uploads/2016/10/Microsoft-OPC-UA-5-Clicks-To-Digital-Factory.pdf

Brownfield integration: Gateways!

Before USB

DIN Keyboard / Centronics printer / PS2 mouse

Transition

Use adopters to connect old and new world

With USB

OPC UA Client

OPC UA

Benefit:
Consistent, compatible data model for all machines, plus security!

Market of gateways

- <$500
- Connect to PLCs or fieldbus systems
- No changes to machines required!

proprietary

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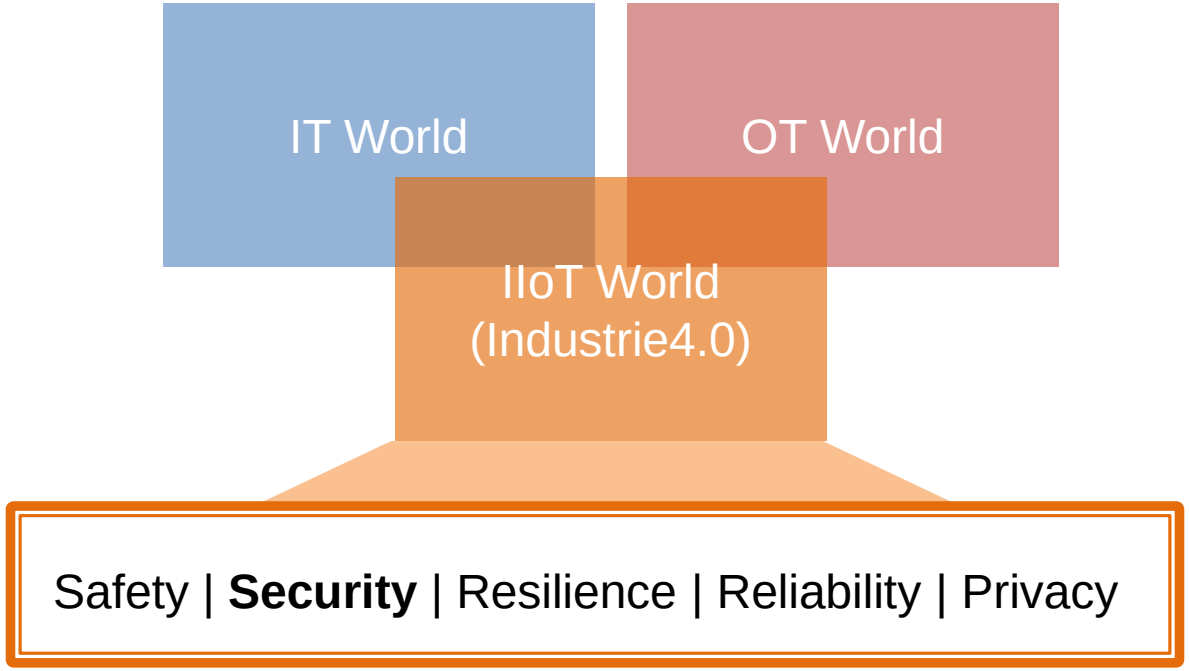
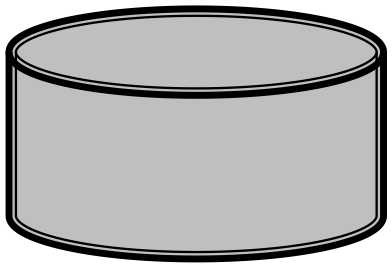
Data Security

Key Concepts

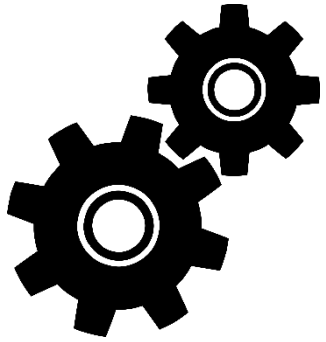
Trustworthiness: Key System Characteristics



Data Security

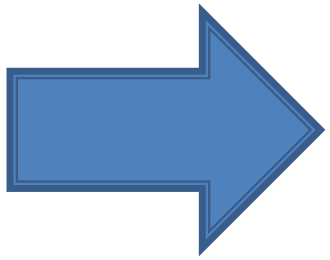


Data at Rest



Data in Process

OPC UA

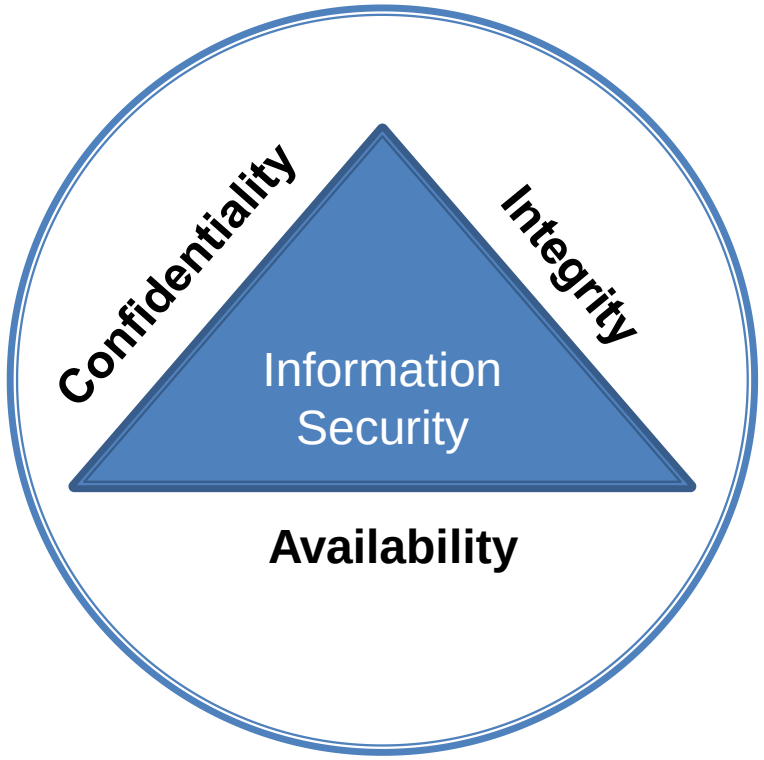


Data in Motion

Key Security Concepts

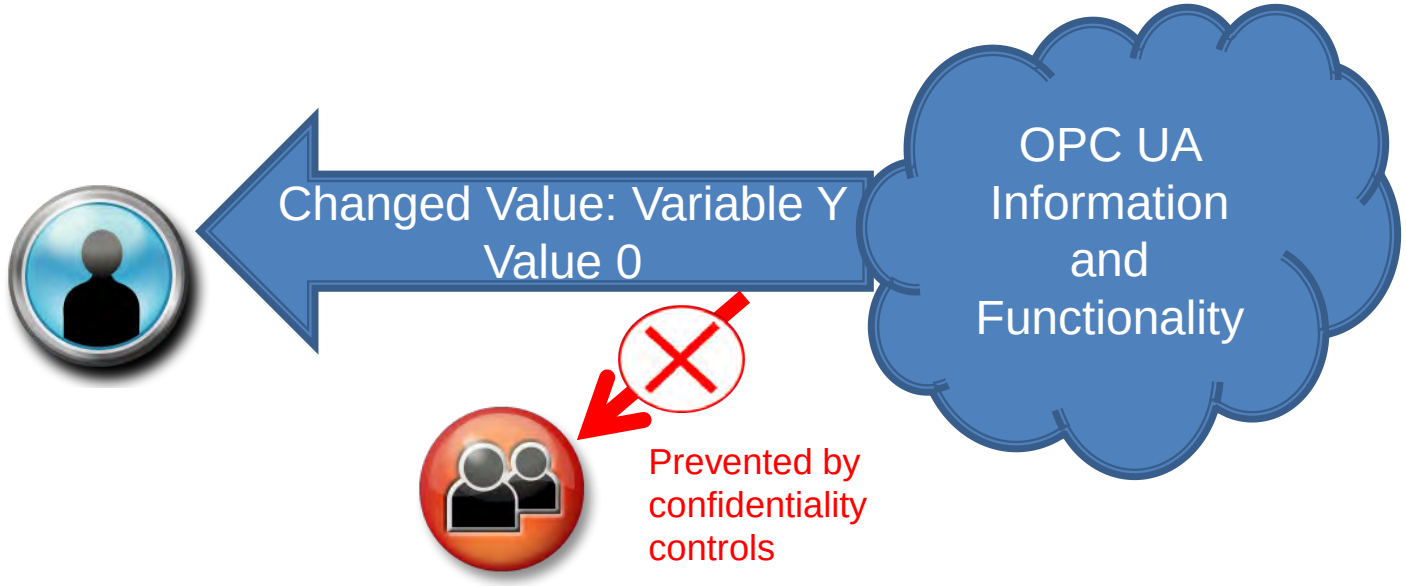
- **Trusted Information (CIA triad)**
  - Confidentiality
  - Integrity
  - Availability

- **Access Control (AAA principle)**
  - Authentication
  - Authorization
  - Accounting (Auditability)



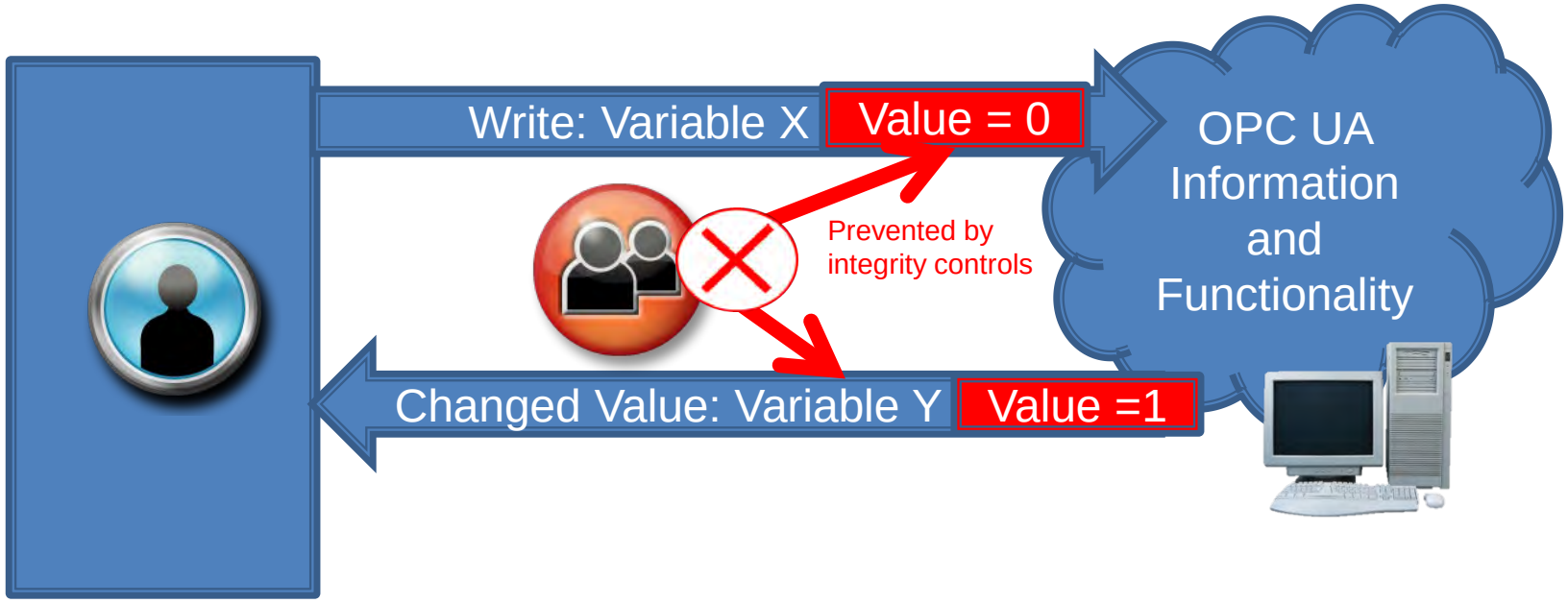
Key Security Concepts

- **Confidentiality**
  → Protecting privacy of message contents



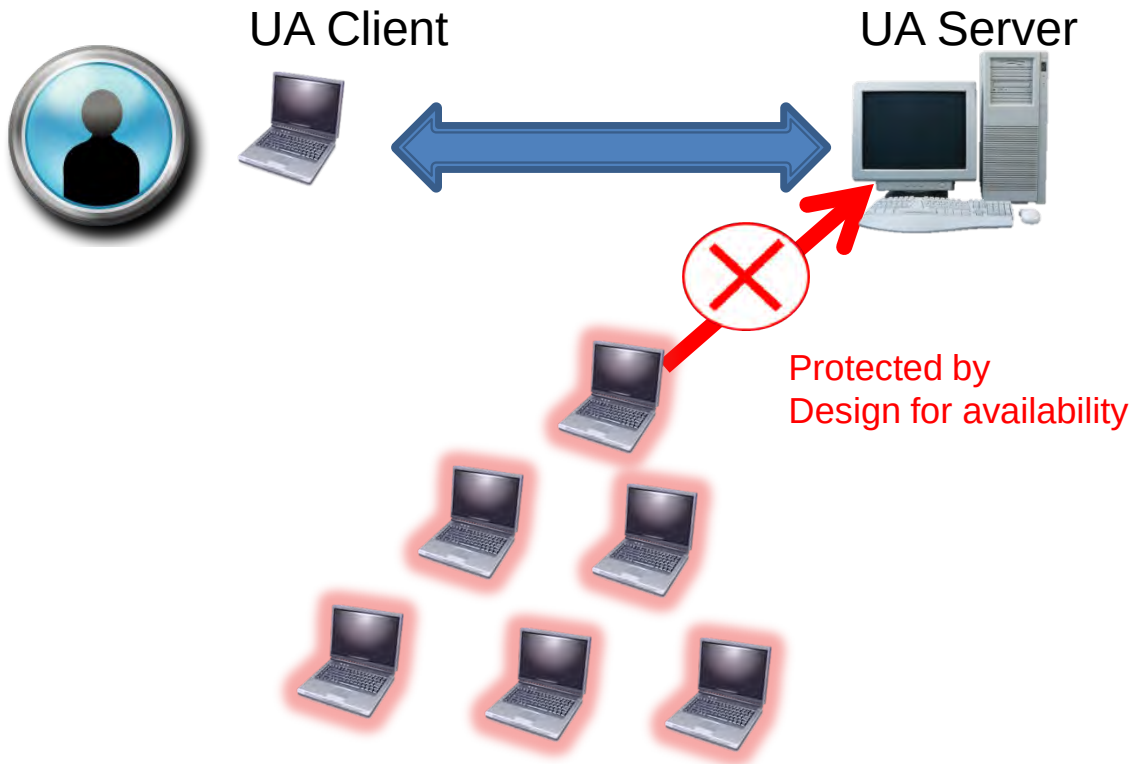
Key Security Concepts

- **Integrity**
  → Not manipulating the content of a message



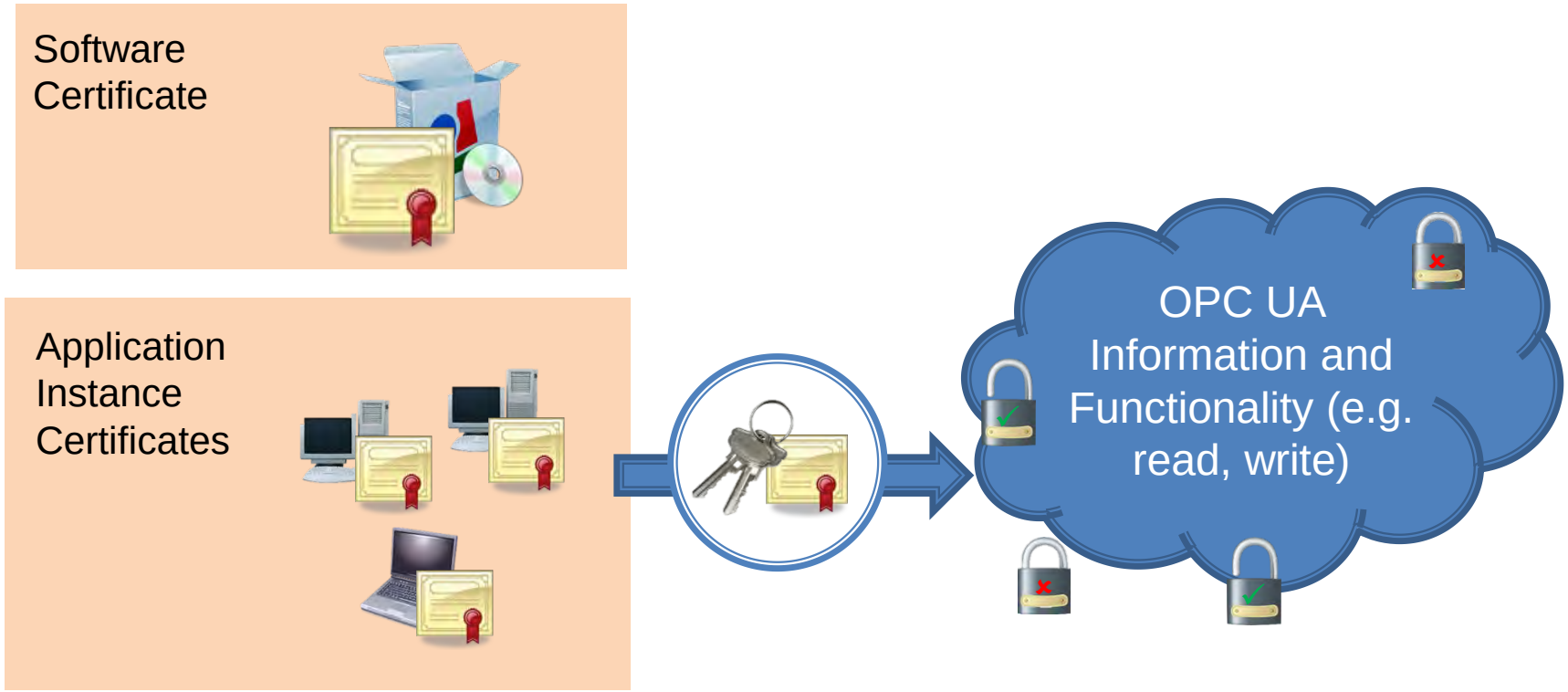
Key Security Concepts

- **Availability**
  → Resiliant to DoS threats, maximizing availability



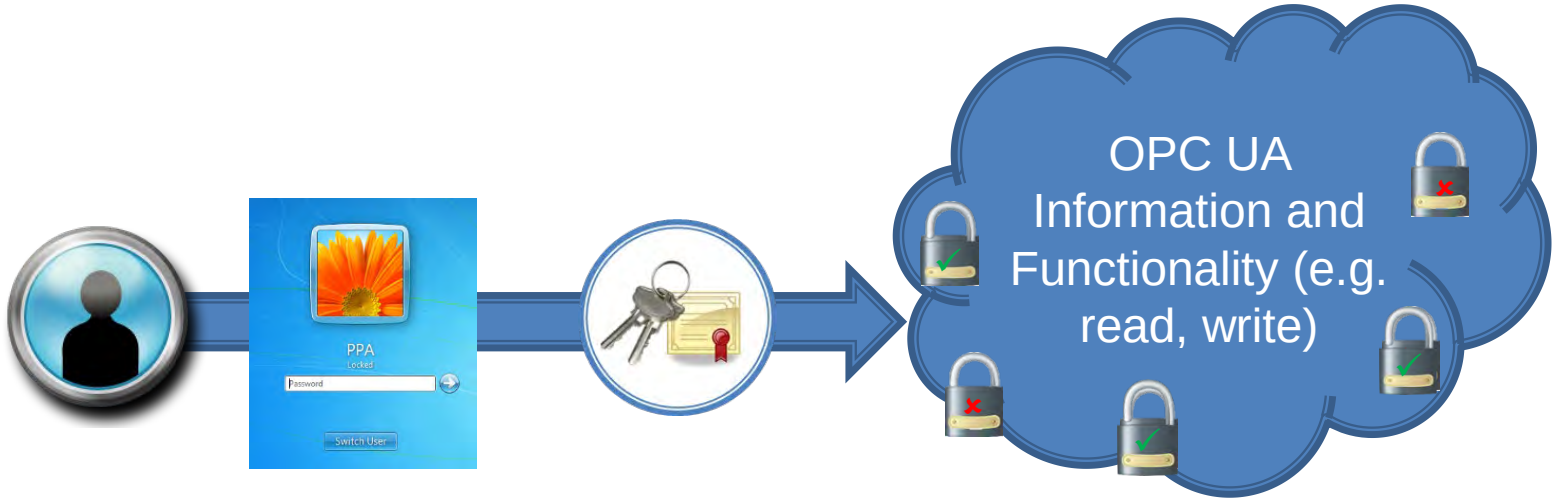
Key Security Concepts

- **Application: Authentication** and **Authorization**



Key Security Concepts

- **User: Authentication** and **Authorization**

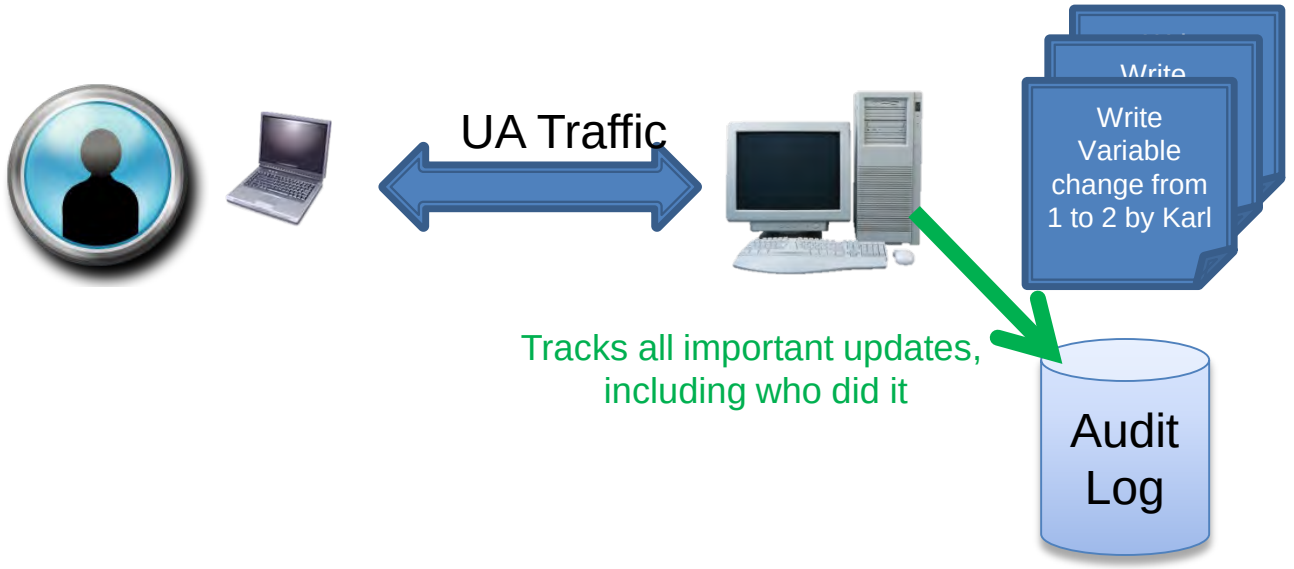


1. Authenticate User
(e.g. username and password)

2. Authorize for specific
operations and information
(e.g. writing a specific value)

Key Security Concepts

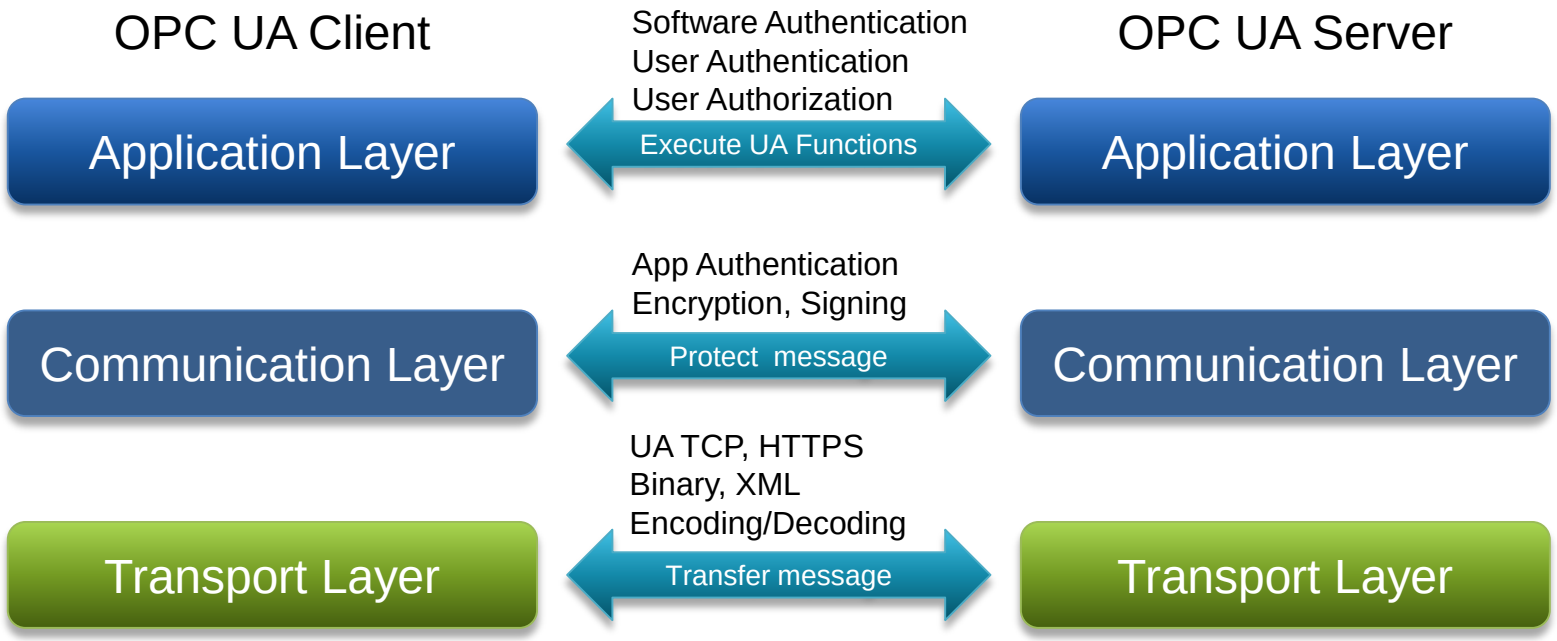
- **Auditability**
  →Tracking important interactions



OPC UA Defines Audit Parameters and to be included in audit records.

Communication Protocol

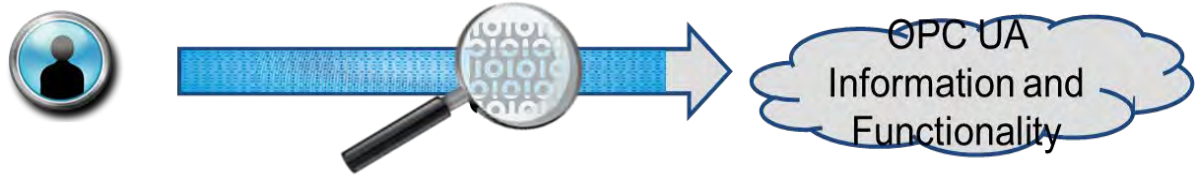
- Layered conceptual communication model



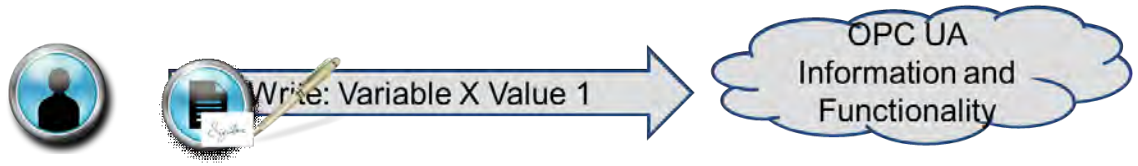
- Allow to choose appropriate abilities to meet various requirements
  - Level 3 Apps : **Internet accessibility** and **Security** (e.g. HTTP & XML, E & S)
  - Level 2 Apps : **High speed** and **Security** (e.g. UA TCP & BIN, S)
  - Level 1 Apps : **High speed** and **Small-footprint** (e.g. UA TCP & BIN)

Communication Layer Security

- **Confidentiality** → Encrypting of Messages



- **Integrity** → Signing of Messages



- **Availability** → Minimal message processing before authentication

Examples:
- Restricting message size
- No security related error codes returned

Communication & Application Layer Security

- Authentication of applications
  - Application instance certificates
  - Certificate Authority (CA)

- Authentication of users
  - Username / password, WS-Security Token or X.509 certificates,
  - Fits into existing infrastructures like Active Directory
- Authorization (Server Specific)
  - Fine-granular information in address space (Read, Write, Browse)
  - Writing of meta data, calling methods
- Auditability
  - Generating audit events for security related operations

Thank you!

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