ascolab.
automation systems communication laboratory

> **Consulting**

> **Services**

Unified Automation

> **Products**

> **Toolkits**

Overview OPC UA

Industrial Communication

- Secure by Design
- Reliable
- Scalable
- Interoperable
- Vendor-independent
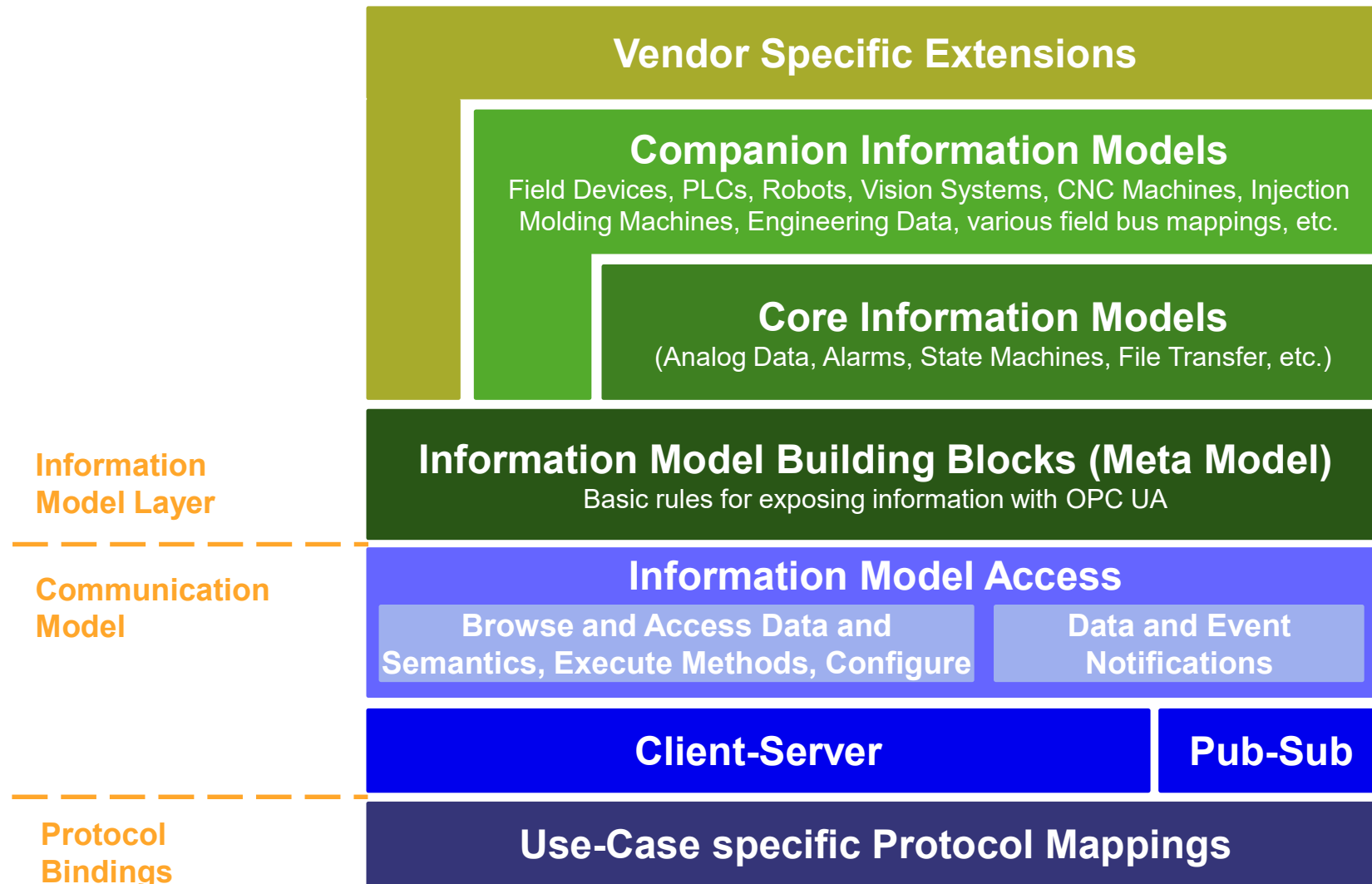
Information Modelling

- Object-oriented
- Extensible
- Real-time related data
  - Timestamps
  - Quality (e.g. communication lost)
- Base for Companion Specifications
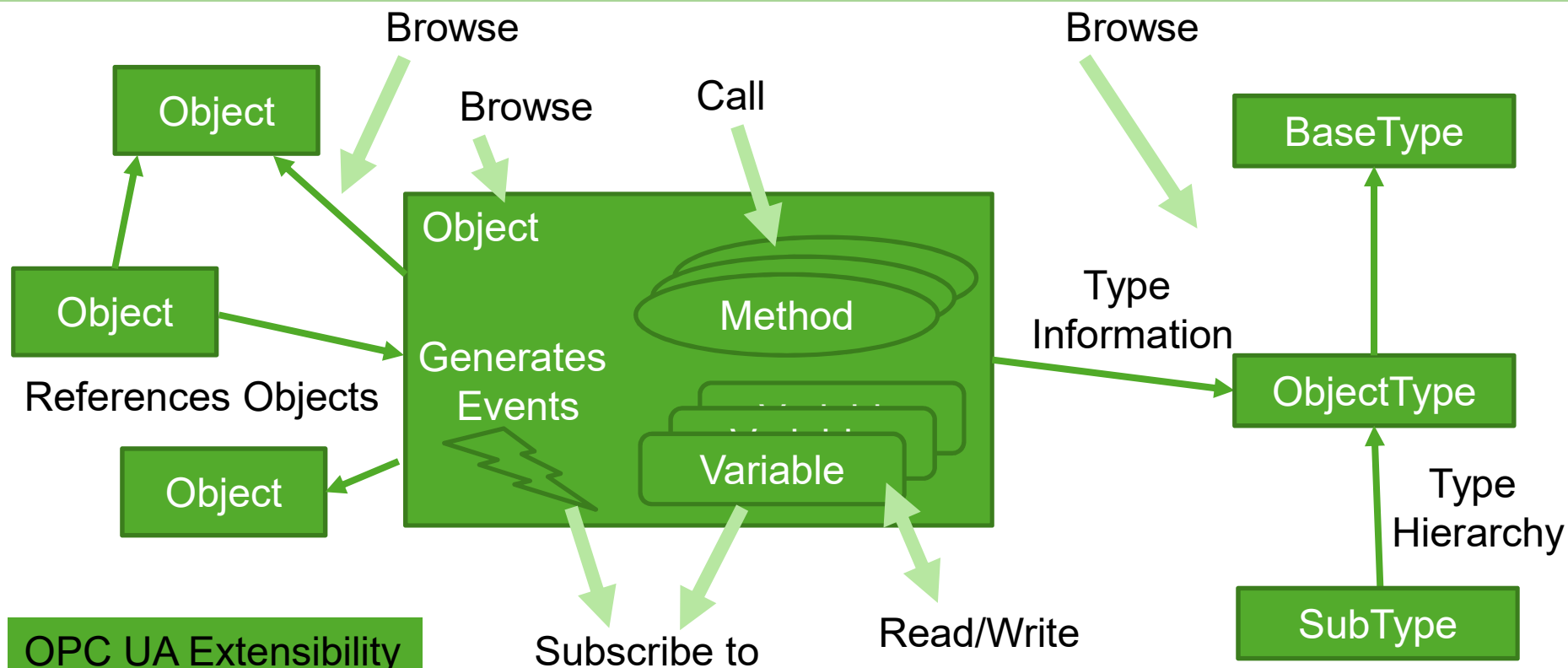
Functionality

- Finding OPC UA Applications
- Connecting Applications
- Authentication and Authorization
- Discovering content (Browsing)
  - Instances and Type Information
- Reading and Writing Data
- Notification on Data Changes
- Notification on Events
- Alarm and Condition handling
- Accessing History of Data
- Accessing History of Events

Unified Automation

OPC Unified Architecture – The Big Picture

Vendor Specific Extensions

Companion Information Models
Field Devices, PLCs, Robots, Vision Systems, CNC Machines, Injection Molding Machines, Engineering Data, various field bus mappings, etc.

Core Information Models
(Analog Data, Alarms, State Machines, File Transfer, etc.)

Information Model Layer

Information Model Building Blocks (Meta Model)
Basic rules for exposing information with OPC UA

Communication Model

Information Model Access

| Browse and Access Data and Semantics, Execute Methods, Configure | Data and Event Notifications |

Client-Server | **Pub-Sub**

Protocol Bindings

Use-Case specific Protocol Mappings

OPC UA Information Modelling (in a Nutshell)

Browse

Browse

Browse

Call

Object

BaseType

Object

Object

Method

Type Information

ObjectType

References Objects

Generates Events

Object

Variable

Type Hierarchy

SubType

Subscribe to

Read/Write

OPC UA Extensibility

ObjectType	Structure (Variables and Methods) and Semantic of Objects
VariableType	Structure (Sub-Variables and DataType) and Semantic of Variables
DataType	Structure and Semantic of DataTypes
ReferenceType	Semantic of References, ReferenceType Hierarchy
EventTypes	Structure (Event Fields) and Semantic of Events

Examples:
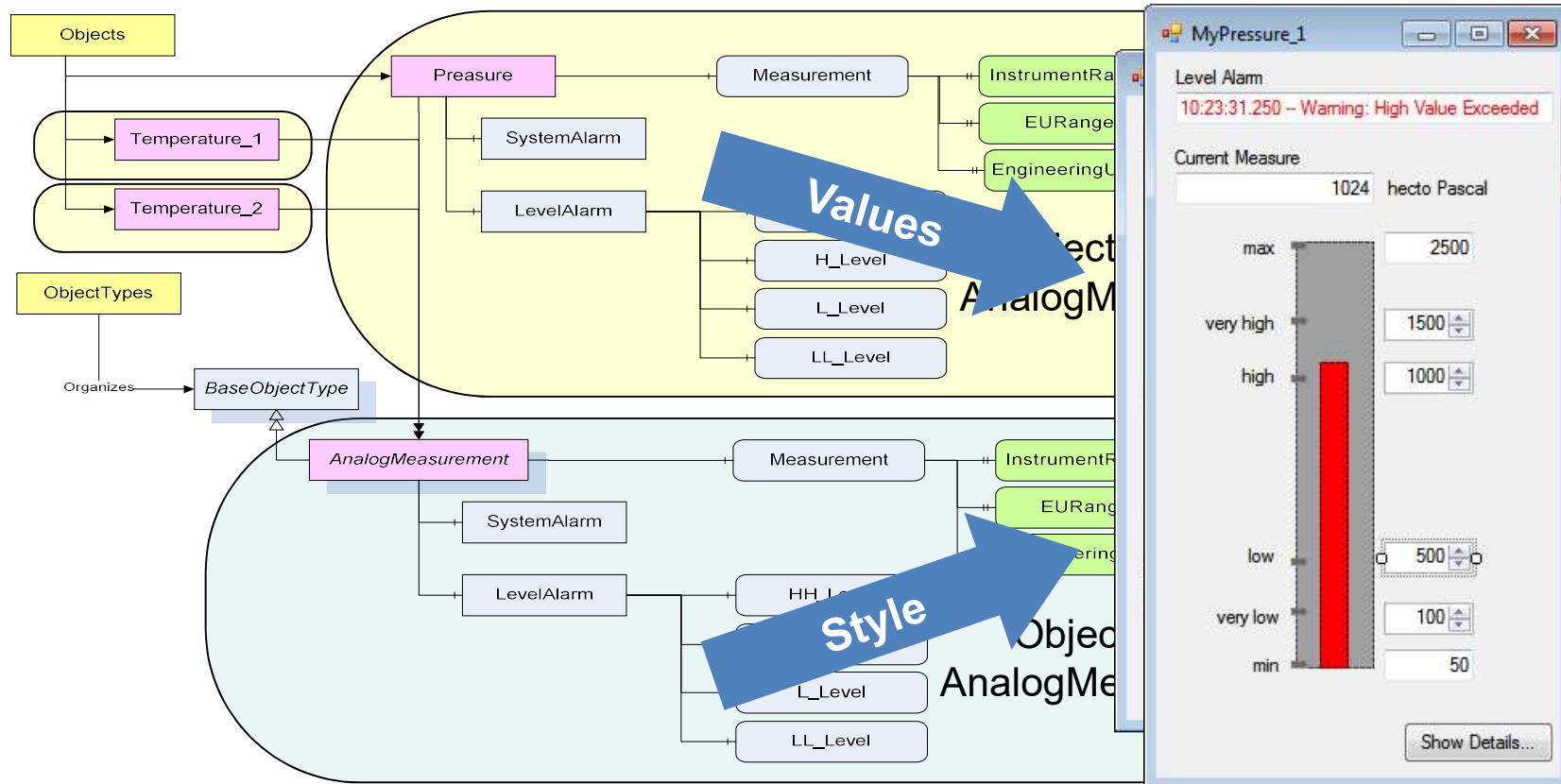- File Transfer
- State Machines

ObjectType (Class)

> **AnalogMeasurement is example for combining the Core Information Models Data Access (Part 8) and Alarms and Conditions (Part 9)**
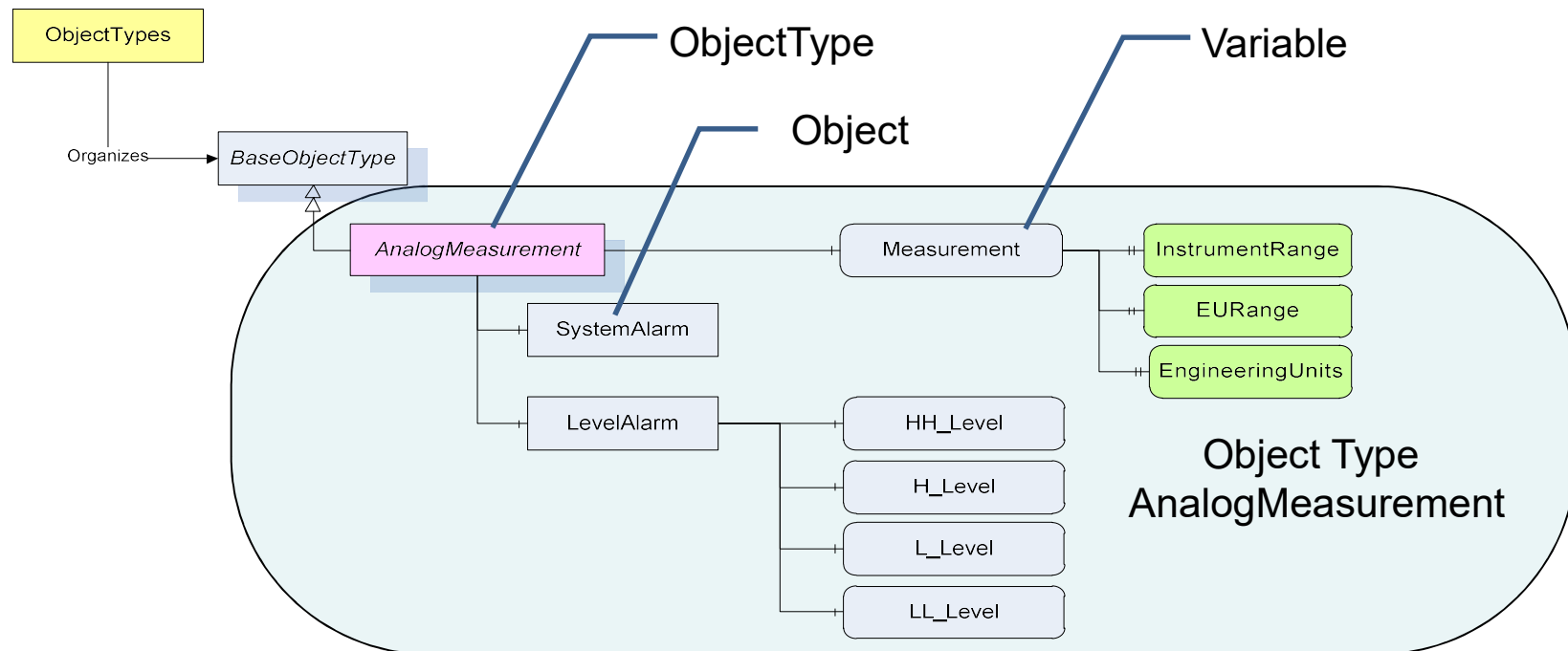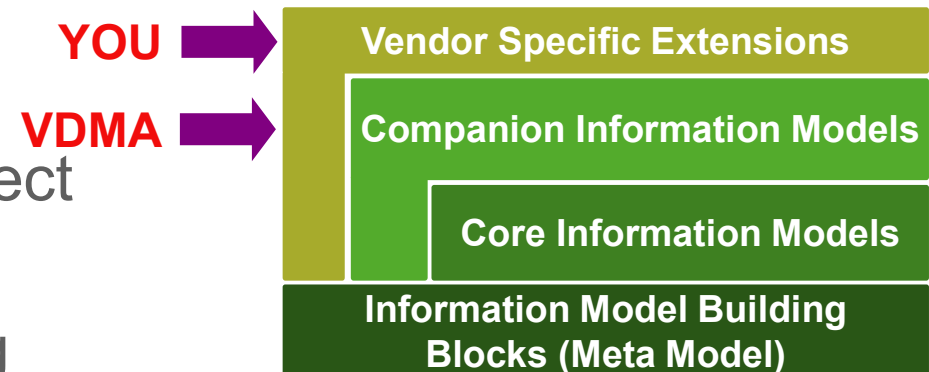
ObjectType and Instances (Objects)

> **Programming against Types – Defined on Type and applied on Instances**

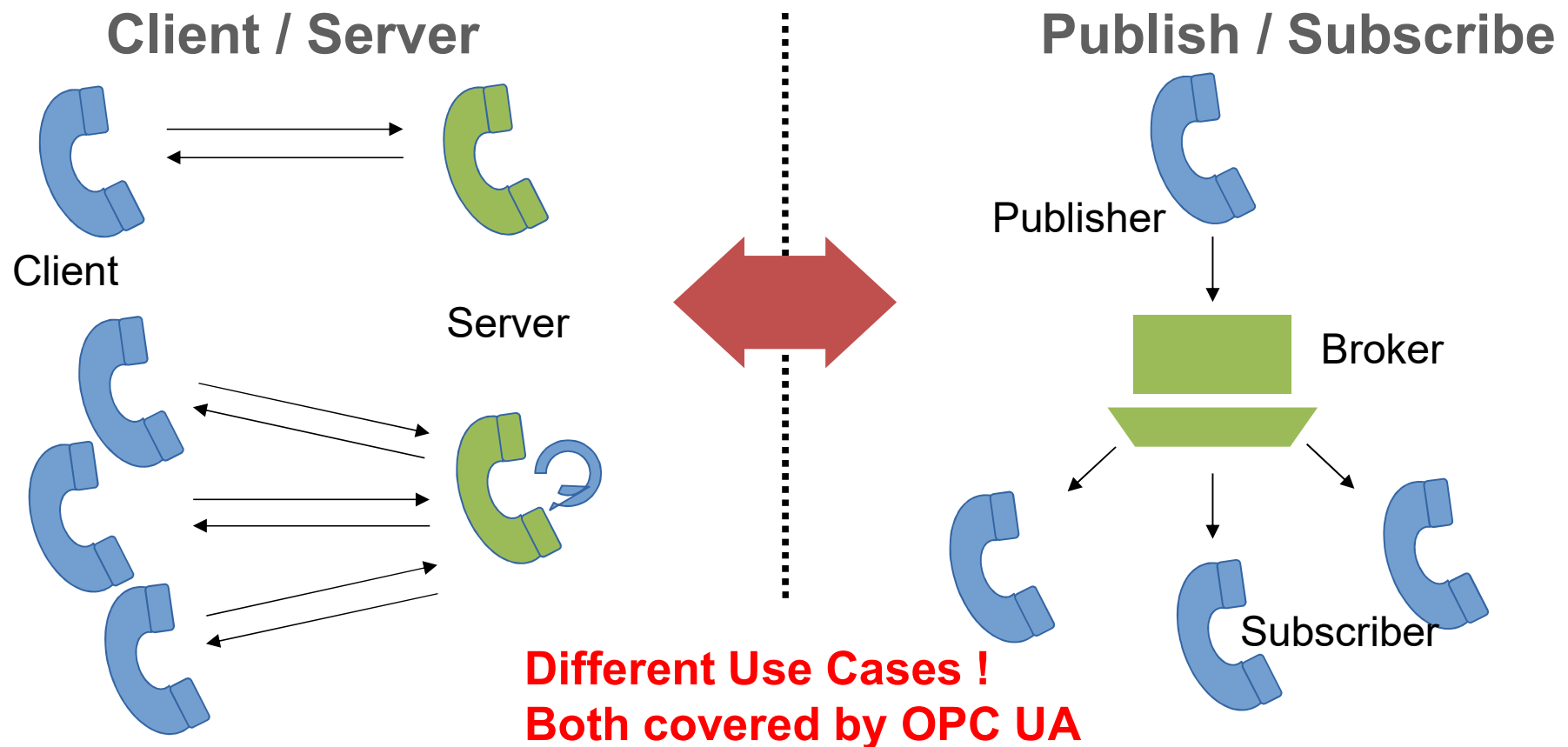**Unified Automation**

Companion Information Models

OPC Foundation collaborates with organizations and domain experts

- **OPC UA defines HOW**
- **Domain experts define WHAT**
  - Robotics, Vision Systems, Injection Molding
- **Organizations define WHAT**
  - PLCopen, FDI, FDT
  - BACnet, MDIS, ISA95
  - AutomationML, MTConnect
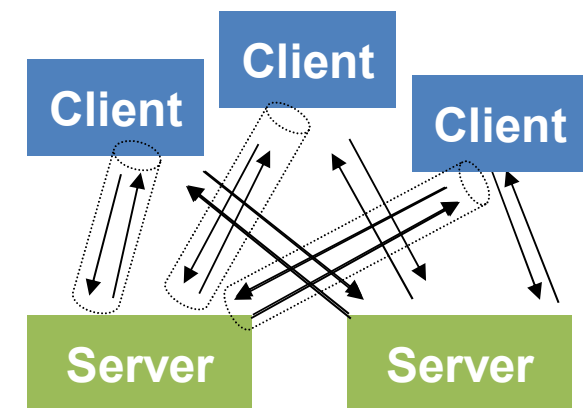 - IEC 61850/61400
  - VDMA, and more coming
- **YOU define WHAT**

YOU ➡ **Vendor Specific Extensions**

VDMA ➡ **Companion Information Models**

Core Information Models

Information Model Building Blocks (Meta Model)

Communication Models in OPC UA

> Analogy: Phone Call vs. Webinar

Client / Server

Client

Server

Publish / Subscribe

Publisher

Broker

Subscriber

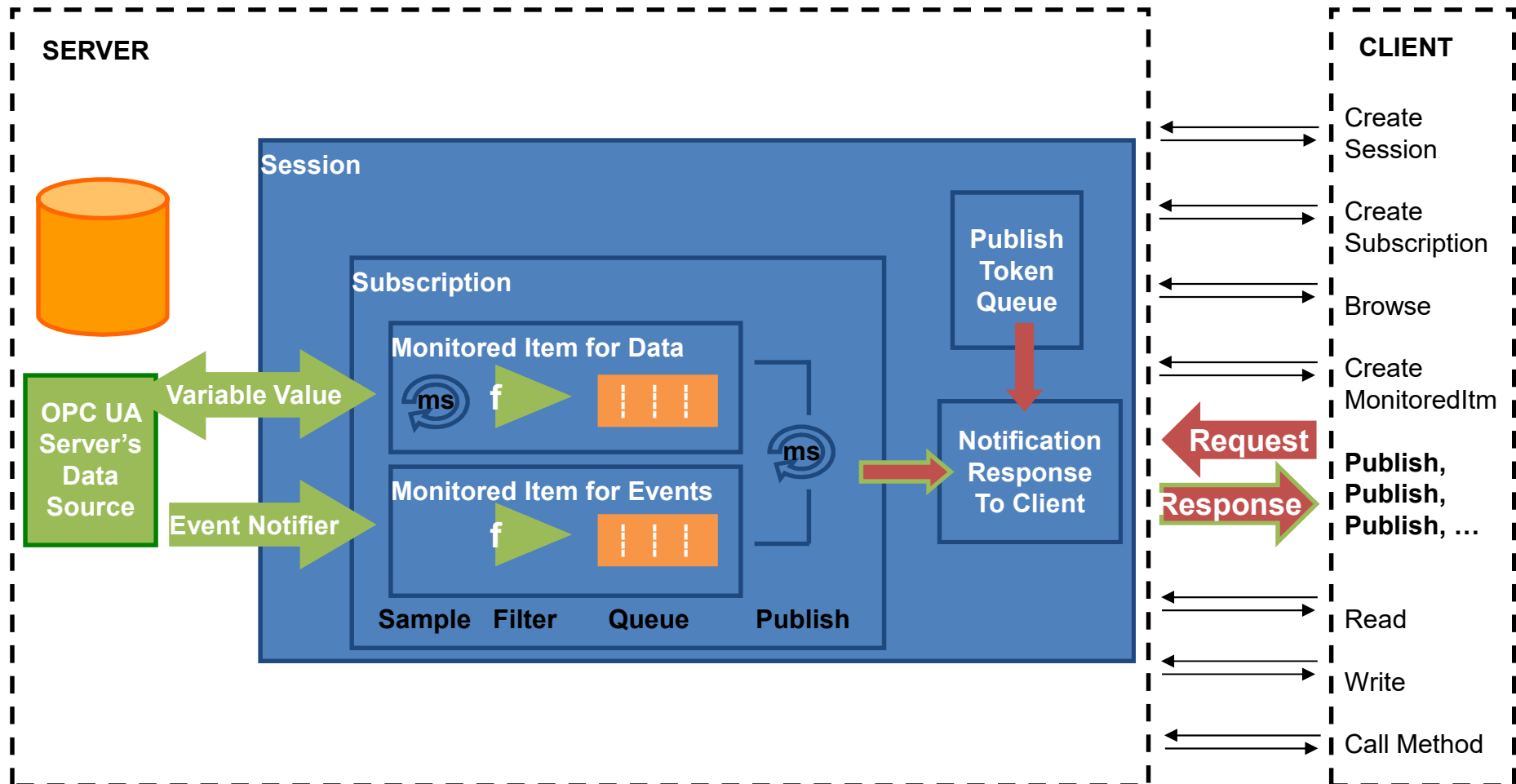**Different Use Cases !**
Both covered by OPC UA

Client/Server Communication

> **Services – Protocol Independent**
>   ◦ Client-friendly, abstract API to access information in the Server
>   ◦ Small number of generic Services

> **Request/Response (SOA)**
>   ◦ Connection/session context required (peer-to-peer)
>   ◦ Reliable transport, acknowledgement of every message
>   ◦ Long polling for "DataChange", keep alive
>   ◦ „Private" subscription for each client
>   ◦ Higher resource consumption when many connections (>500)
>   ◦ Use Case: asynchronous communication of huge amount of flexible data

> **Protocol Mappings**
>   ◦ Mandatory: UA-TCP (Binary Encoding, UA Secure Conversation, TCP based Protocol)
>   ◦ Optional: HTTPS or Web Sockets

ERP/MES, SCADA/HMI, IT/Cloud Communication!

Unified Automation

Publish Services – Notify on Change

SERVER

CLIENT

Session

Subscription

OPC UA Server's Data Source

Variable Value

Monitored Item for Data

ms   f

Event Notifier

Monitored Item for Events

f

ms

Sample   Filter   Queue   Publish

Publish Token Queue

Notification Response To Client

Create Session

Create Subscription

Browse

Create MonitoredItm

Request

Response

Publish, Publish, Publish, …

Read

Write

Call Method

Publish/Subscribe Communication

- ▸ Extension to Client/Server
  - ◦ Optimized „public" Subscription
  - ◦ Only subset of Client/Server functionality
  - ◦ Configuration via Client/Server
- ▸ UDP based Pub/Sub
  - ◦ Connection-less, broadcast-style communication, unidirectional
  - ◦ Fire and forget transportation (no ack)
  - ◦ "Public" subscription, same data for all clients
  - ◦ Low resource consumption many subscribers (>1000) consume same data
  - ◦ Cyclic publish of "all" data (deterministic via TSN)
  - ◦ **Use Case: synchronous communication small amount of fixed data**

**Field Level Communication !**

Cloud Communication !
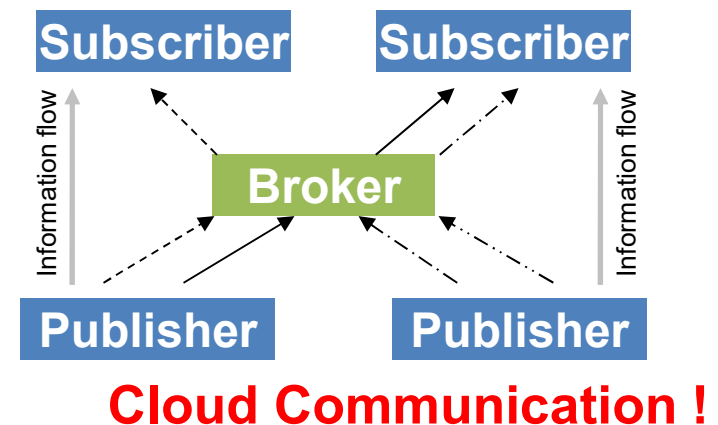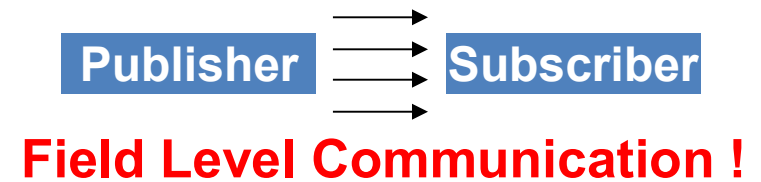
Publishing in Publish/Subscribe

- OPC UA specific selection of events or life data to be included in messages

- Messaging protocol specific encoding and transport
- Different protocols can be supported e.g. AMQP, MQTT
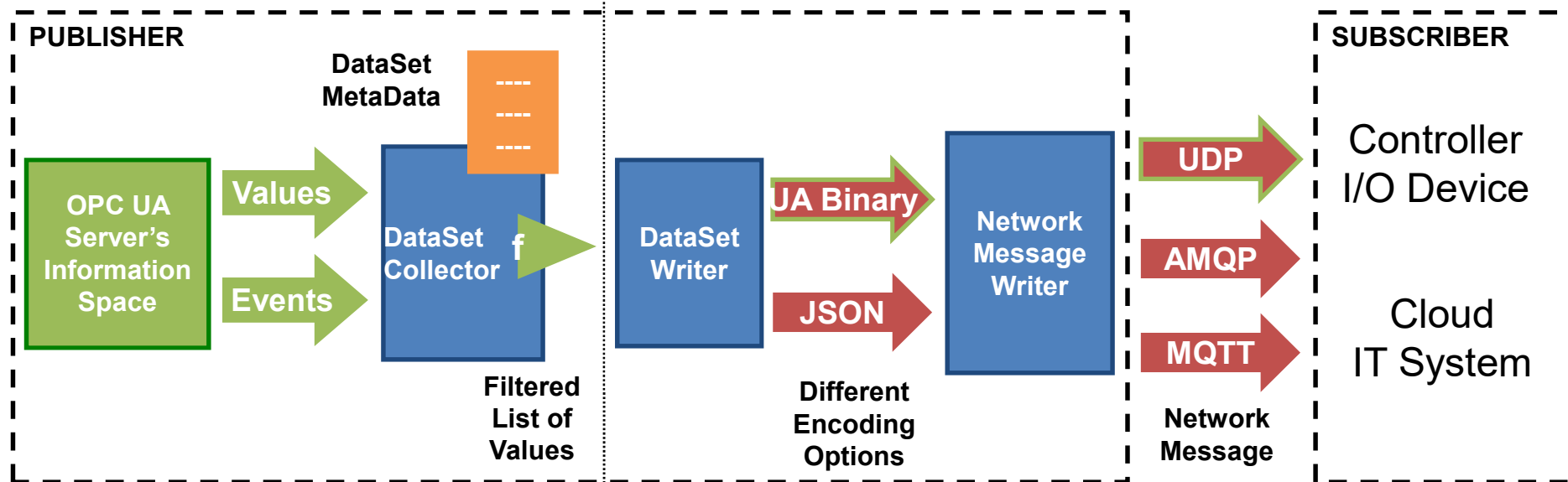
- Released Profiles
  - UDP UADP
  - MQTT UADP
  - MQTT JSON

- Future
  - TSN UADP for deterministic real-time communication

OPC UA Communication Framework
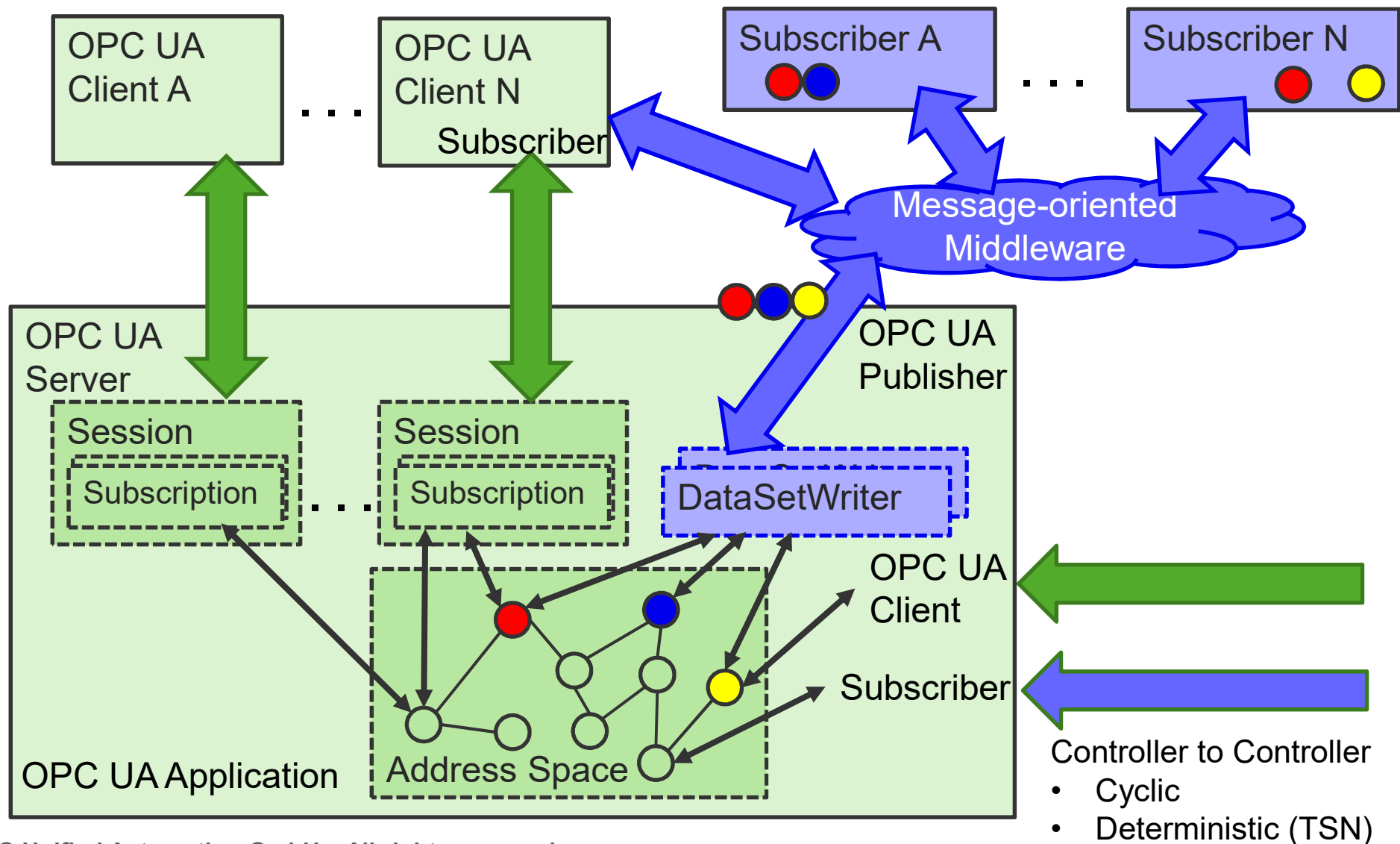
Summary

ONE – Information Model

    Object-oriented, flexible, extendable

TWO – Communication Models

    Client / Server

        - service oriented, request/response, on demand

    Publish/Subscribe – multicast, unidirectional, „cyclic"

THREE – Protocols

    Client/Server: UA-TCP – TCP-based, Binary, Port 4840

    Broker-less PubSub:

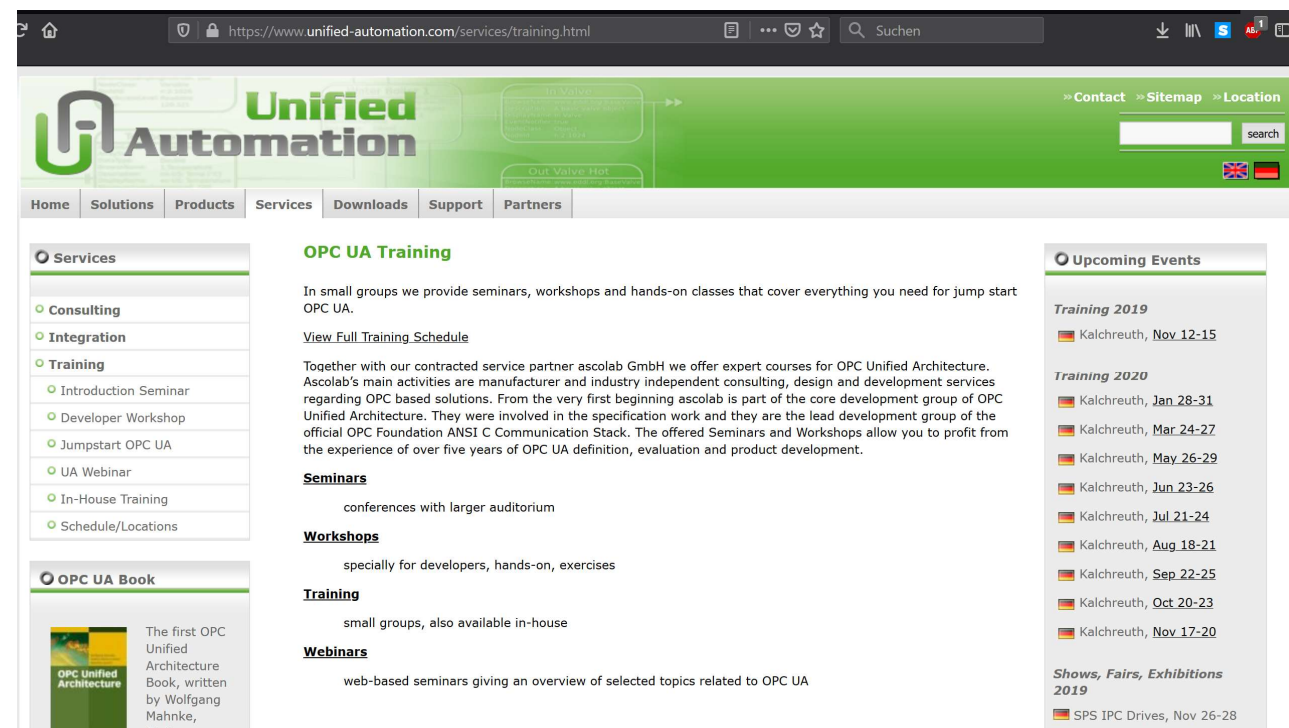   UADP – UDP based, UA Binary, TSN deterministic

    Broker-based PubSub: MQTT-based, JSON/Binary, Cloud

OPC UA Training & Seminars

> **Check out Unified Automation Website**

> **From Experts**

> **To Experts**

Questions?

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OPC Day Seminar: 13:00-17:30 Meeting room 203, 2nd floor