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SAARC ENERGY CENTRE
Energy for Peace & Prosperity

Industrial Communication Protocol II: OPC UA

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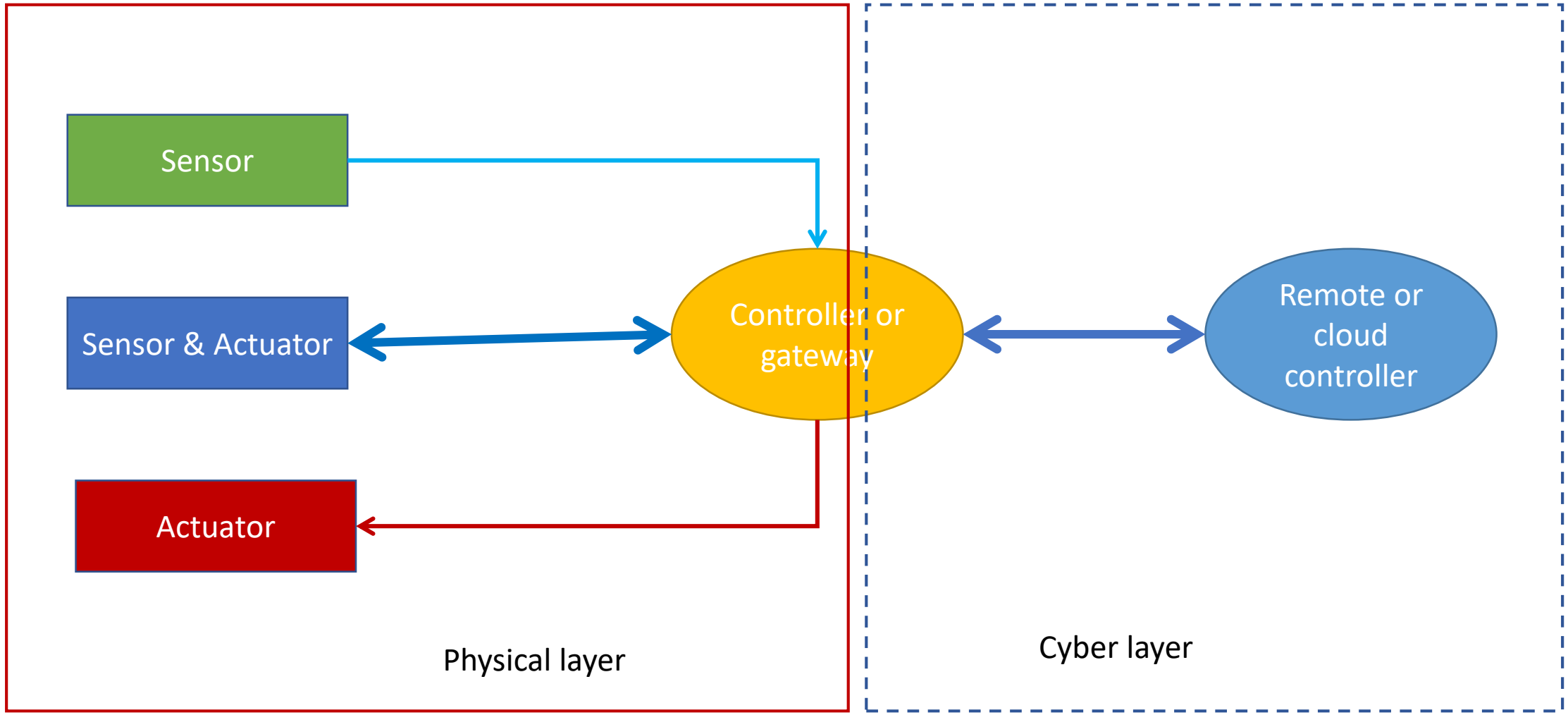
Profile

- Researcher
  - Motor system energy efficiency
  - Appliance energy efficiency standards and labels
  - Cooling efficiency
  - Industrial IoT standardization
- **Programmer**
  - Embedded device and system
  - IoT cloud OPC UA server
  - Web application
  - Web crawling
- Coordinator
  - International cooperation
  - Technology transfer

Table of content

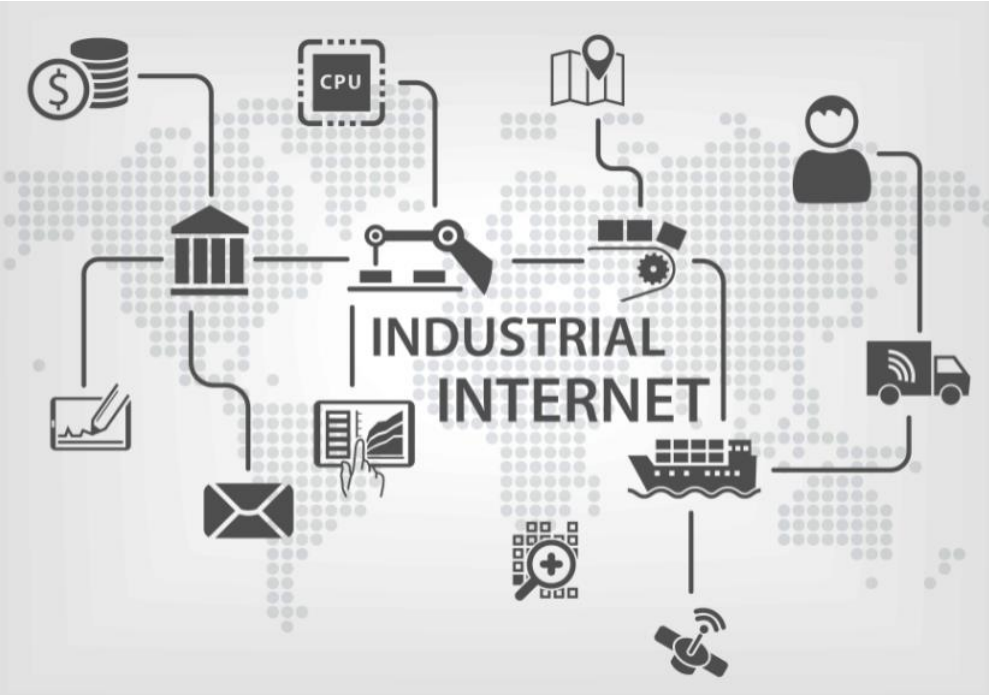
How machines or systems to “talk” with each other or “talk” to cloud?



What is IIoT?

IIoT refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management.

- from Wikipedia



IIoT needs common understanding language – communication protocol

▪ BSAP	▪ CC-Link	▪ CIP	▪ CAN
▪ CANopen	▪ ControlNet	▪ DeviceNet	▪ DF-1
▪ DirectNET	▪ EtherCAT	▪ Ethernet Global Data (EGD)	▪ Ethernet Powerlink
▪ EtherNet/IP	▪ FINS	▪ FOUNDATION fieldbus	▪ GE SRTP
▪ HART Protocol	▪ Honeywell SDS	▪ HostLink	▪ INTERBUS
▪ MECHATROLINK	▪ MelsecNet	▪ Modbus	▪ Optomux
▪ PieP	▪ Profibus	▪ PROFINET IO	▪ SERCOS interface
▪ SERCOS III	▪ Sinec H1	▪ SynqNet	▪ TTEthernet
▪ RAPIEnet			
▪ OPC DA	▪ OPC HDA	▪ OPC UA	▪ MTConnect
▪ 1-Wire	▪ BACnet	▪ C-Bus	▪ DALI
▪ DSI	▪ KNX	▪ LonTalk	▪ Modbus
▪ oBIX	▪ VSCP	▪ X10	▪ xAP
▪ ZigBee			
▪ IEC 60870-5	▪ DNP3	▪ IEC 60870-6	▪ IEC 61850
▪ IEC 62351	▪ Modbus	▪ Profibus	
▪ ANSI C12.18	▪ IEC 61107	▪ DLMS/IEC 62056	▪ M-Bus
▪ Modbus	▪ ZigBee Smart Energy 2.0		
▪ CAN	▪ FMS	▪ FlexRay	▪ IEBus

What is OPC UA?

- OPC UA originated from OPC (Ole Process Control) from 1995
  - OPC DA
  - OPC HDA
  - OPC Alerts & Event
- OPC UA is Open Platform Communication Unified Architecture, a new generation of OPC standards
- Supported by international companies
  - Microsoft
  - ABB
  - Siemens
  - ……

OPC UA features

- An IEC international standard – IEC 62541
- Client - server communication model
- Focus on communicating with industrial equipment and systems for data collection and control
- Open - freely available and implementable under GPL 2.0 license
- Cross-platform - not tied to one operating system or programming language (Windows, Linux, Android, etc)
- Service-oriented architecture (SOA)
- Inherent complexity - in September 2020, the specification consisted of 3151 pages in 15 documents
- High security functionality for authentication, authorization, integrity and confidentiality
- Integral information model for specific industries, such as oil, gas, buildings

OPC UA Open resources

- Official organization: OPC Foundation https://opcfoundation.org/
- Free documents: standards and specifications are free
- Lots of free resources for all platforms and languages:
  - OPC UA .Net Standard (C#)
  - Open 62541 (C)
  - S2OPC project (C)
  - Node-opcua (Javascript)
  - Python-opcua (Python)
  - ……

OPC UA Standard – IEC 62541

- **Part 1: Overview and Concepts**
- **Part 2: Security Model**
- **Part 3: Address Space Model**
- **Part 4: Services**
- **Part 5: Information Model**
- **Part 6: Mappings**
- Part 7: Profiles
- Part 8: Data Access
- Part 9: Alarms and Conditions
- Part 10: Programs
- Part 11: Historical Access
- Part 12: Discovery and global services
- Part 13: Aggregates
- Part 14: PubSub

OPC UA Standard – IEC 62541 documents

- OPC 10000-14 - UA Specification Part 14 - PubSub 1.04.pdf
- OPC 10000-15 - UA Specification Part 15 - Safety 1.04.pdf
- OPC 10000-17 - UA Specification Part 17 - Alias Names 1.04.pdf
- OPC 10000-200 - UA Specification Part 200 - Industrial Automation 1.00.0.pdf
- OPC UA Part 1 - Overview and Concepts 1.03 Specification.pdf
- OPC UA Part 2 - Security Model 1.03 Specification.pdf
- OPC UA Part 3 - Address Space Model 1.03 Specification.pdf
- OPC UA Part 4 - Services 1.03 Specification.pdf
- OPC UA Part 5 - Information Model 1.03 Specification.pdf
- OPC UA Part 6 - Mappings 1.03 Specification.pdf
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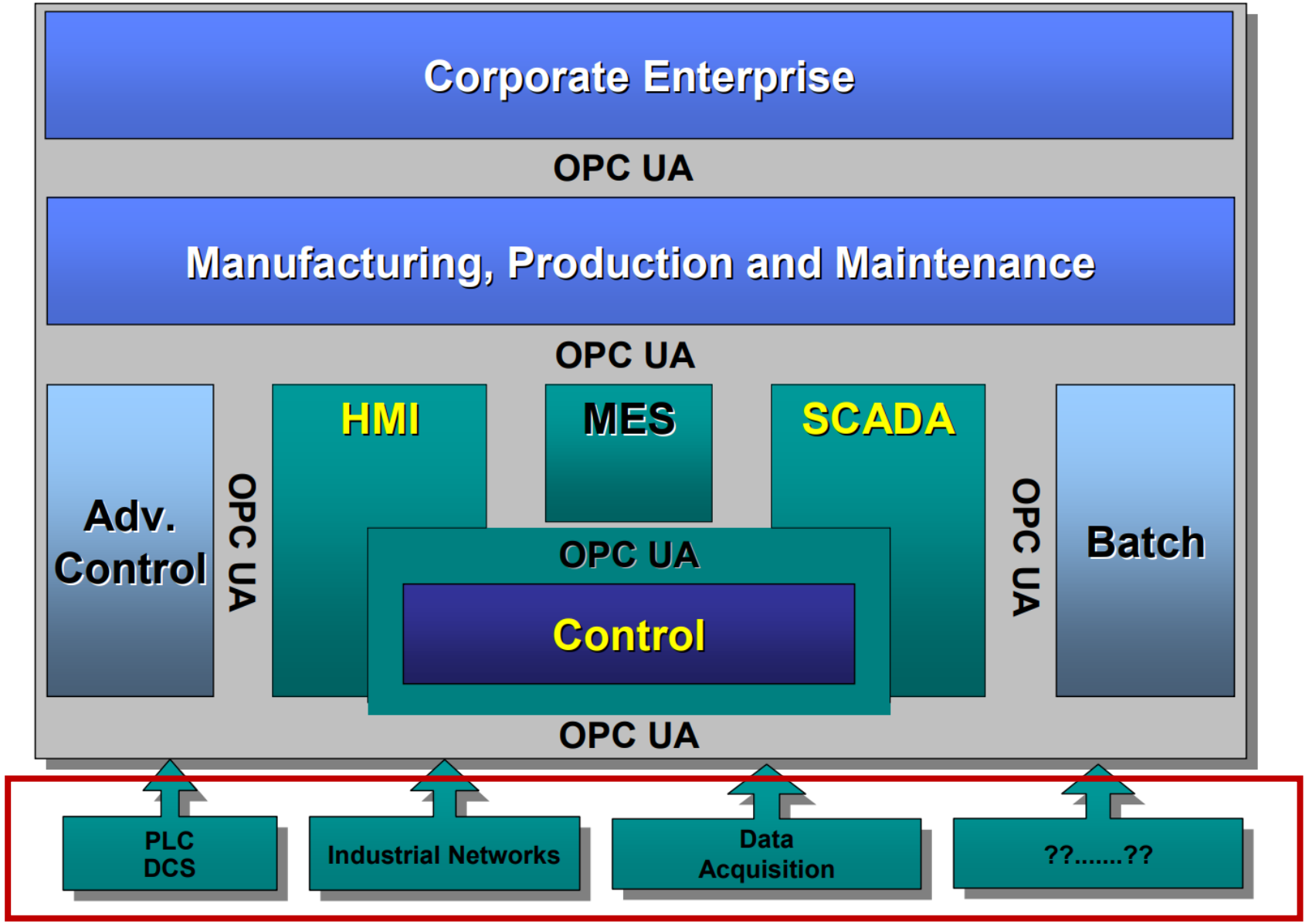
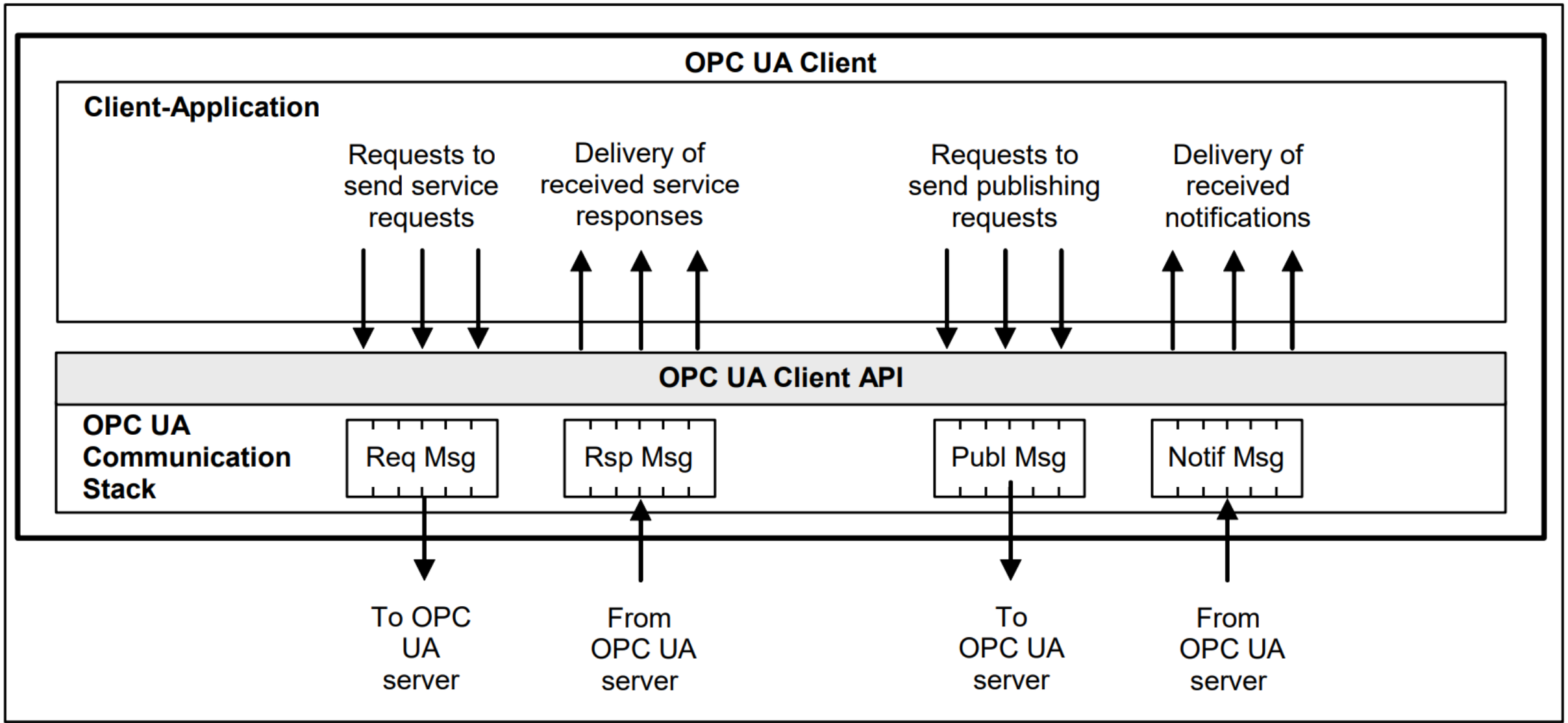
- OPC UA Part 8 - DataAccess 1.03 Specification.pdf
- OPC UA Part 9 - Alarms and Conditions 1.03 Specification.pdf
- OPC UA Part 10 - Programs 1.03 Specification.pdf
- OPC UA Part 11 - Historical Access 1.03 Specification.pdf
- OPC UA Part 12 - Discovery 1.03 Specification.pdf
- OPC UA Part 13 - Aggregates 1.03 Specification.pdf

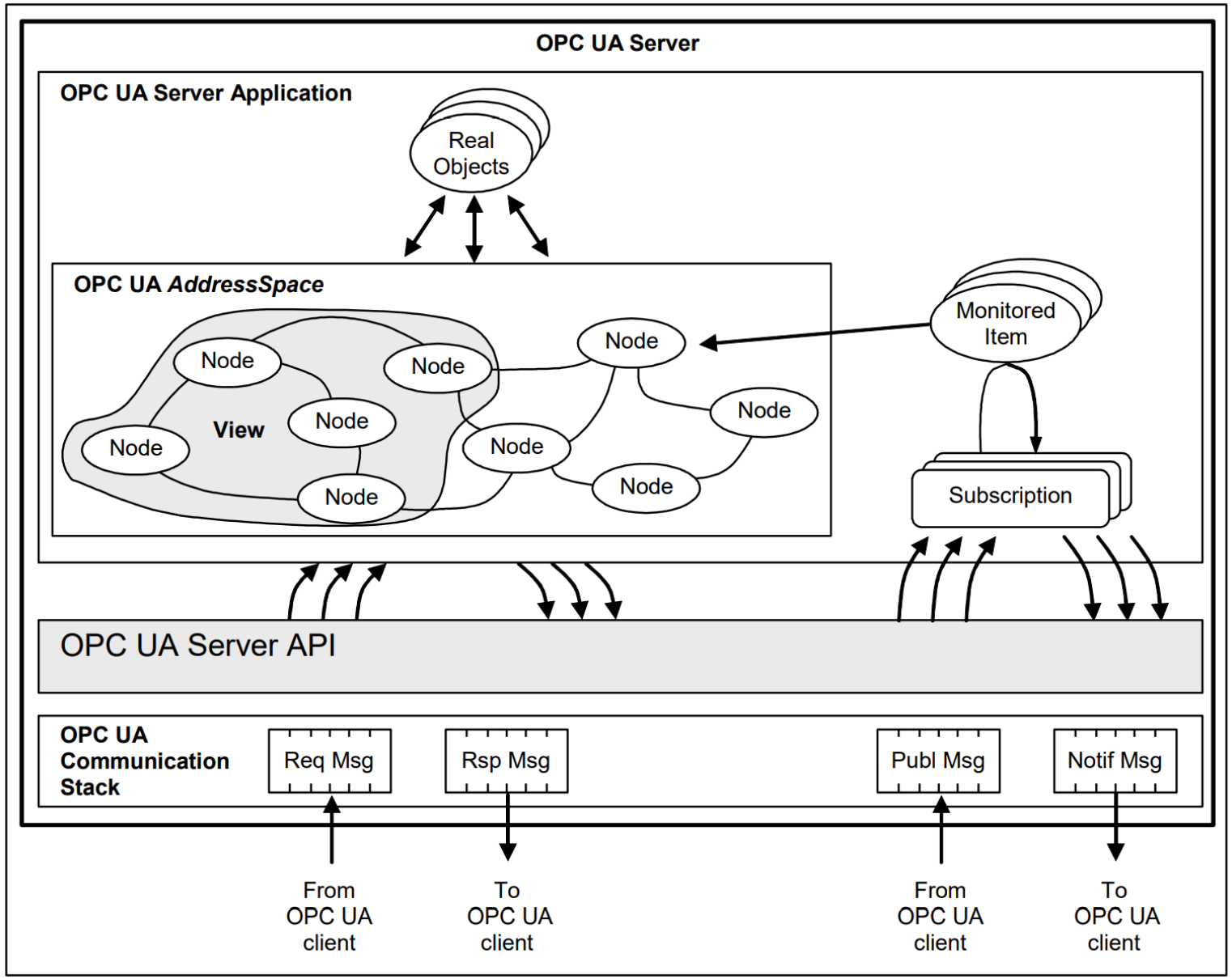
OPC UA Target applications



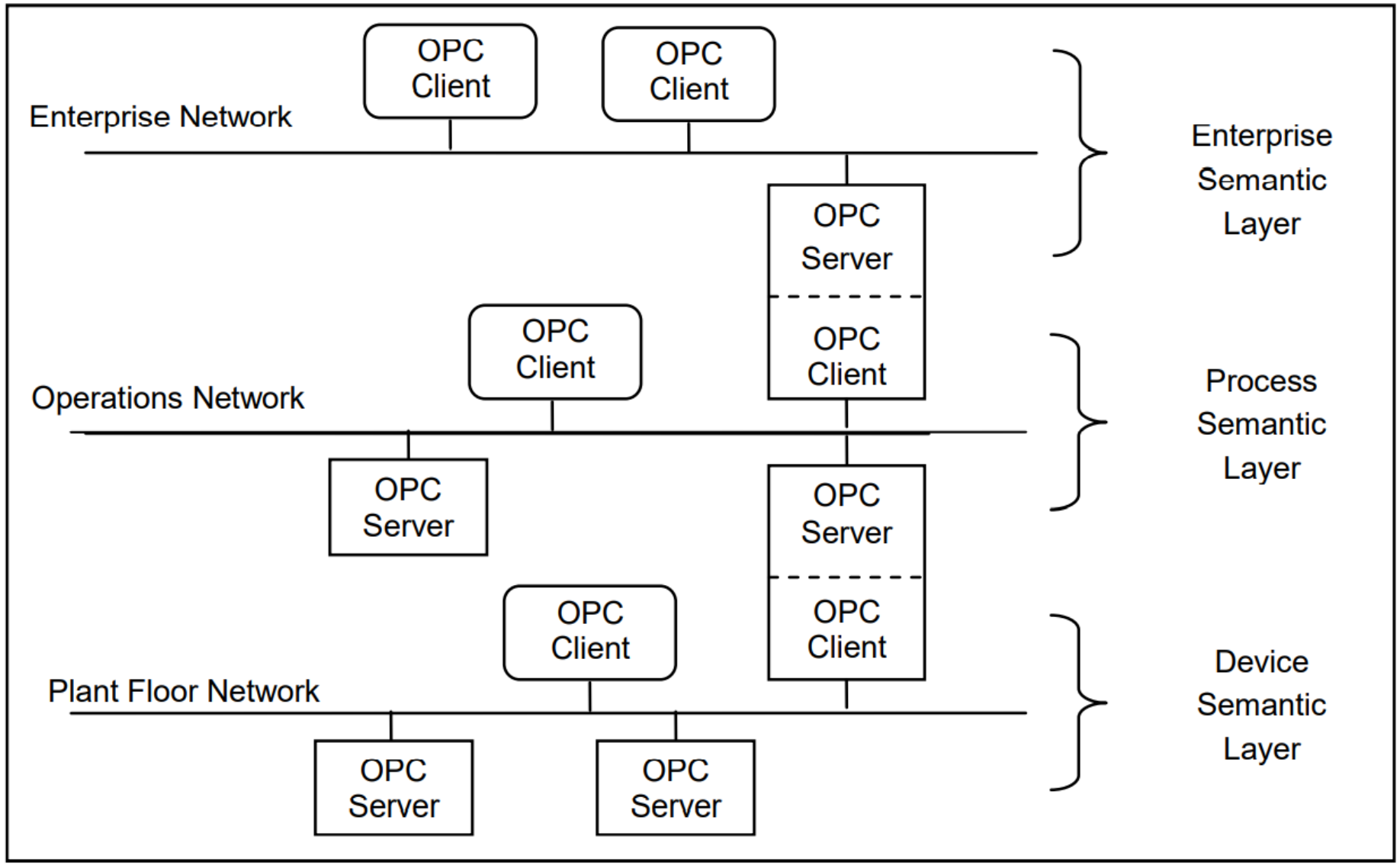
OPC UA Client architecture



OPC Server architecture



OPC UA – chained server



Case 1: Smart pump demonstrator

Smart sensors and meters

VFD

Flow

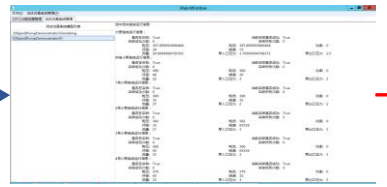
Pressure

Power

Modbus

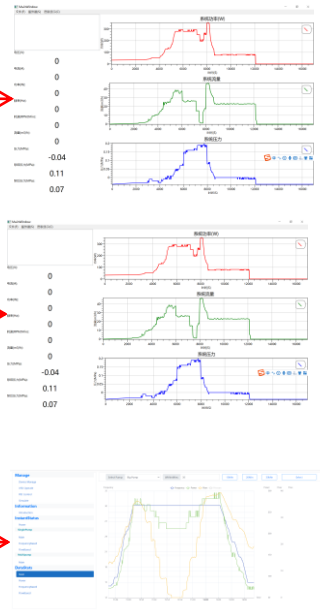
Data gateway

Cloud OPC Server



OPC UA Protocol

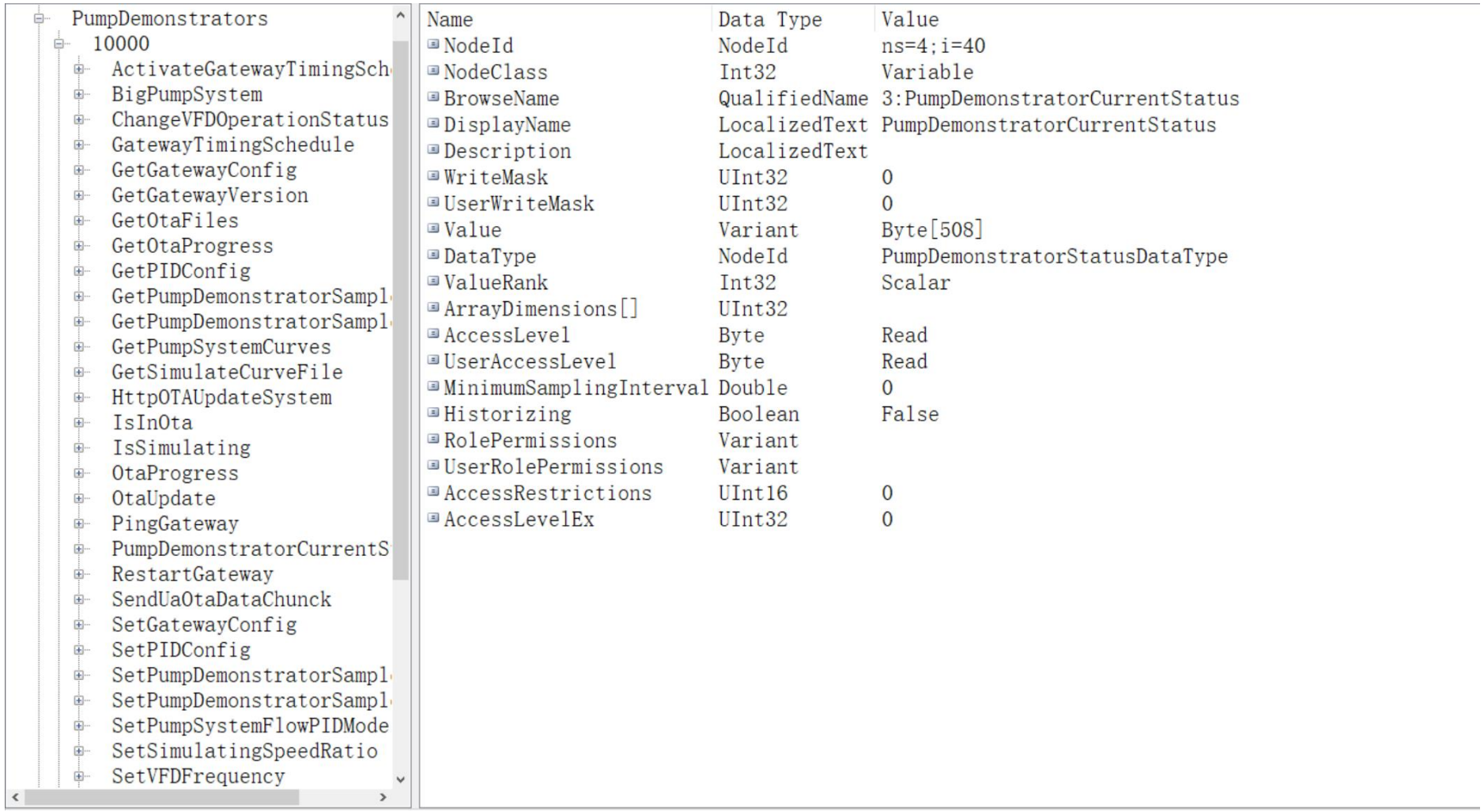
Graphical, dynamical clients



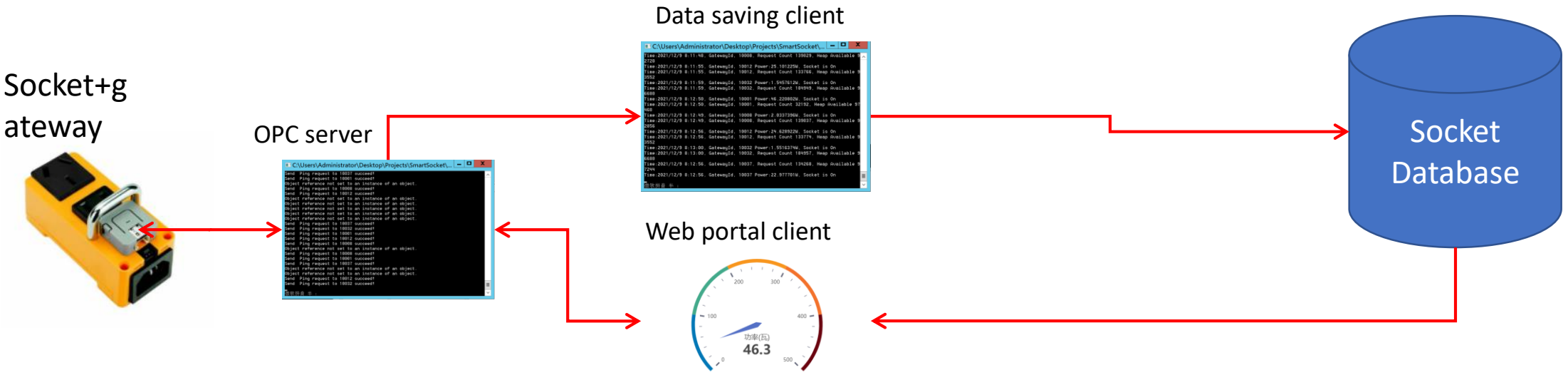
Case 1: modelling

Equipment	Number of devices	Comments
VFD	5	ABB ACS310 series, 1 bigger VFD and 4 smaller ones
Motor	5	China Southern Pump, 1 motor with 1.5 kW and 4 small motors with 0.5 kW
Pump	5	China Southern Pump, 1 big pump 1.5 kW and 4 small pumps with 0.5 kW
Flow meter 1	2	Asmik smart electromagnetic integrated flowmeter for big pump system and main output pipe of small pump systems
Flow meter 2	2	Asmik smart electromagnetic split flowmeter for small pump system #1 and #3
Pressure meter	10	Asmik smart pressure meter for all pump systems installed before and after the pump

Case 1: OPC address space modelling



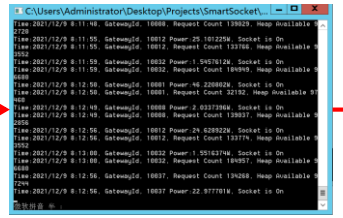
Case 2: smart socket



Case 3: smart home

Database

Data saving client



Socket+g
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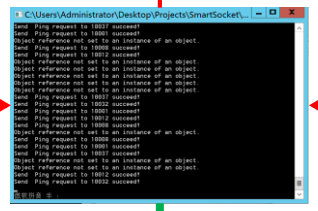
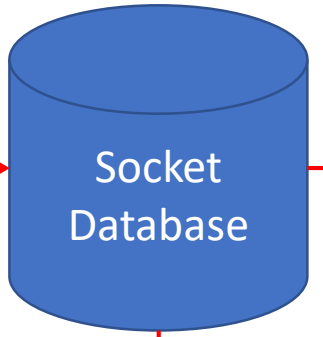
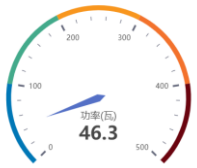
OPC server





Web portal client

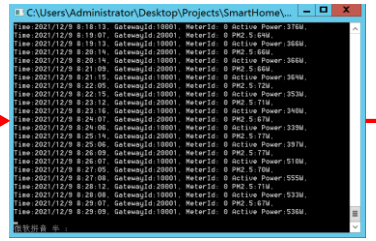


Air sensor

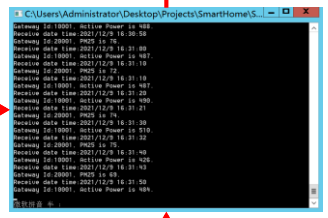
Gateway

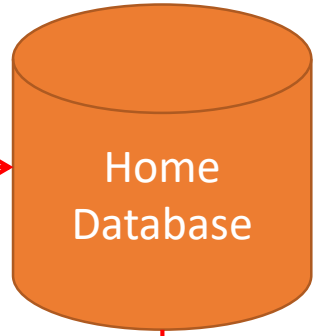
Database

Data saving client



OPC server





Power meter

Gateway RS485
supported

Web portal client

Thank You !

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