

Process simulation as a domain- specific OPC UA information model

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Presentation outline

- Classic OPC
- OPC Unified Architecture
- Soft-sensor based on OPC UA
- OPC UA as a challenge to CAPE-OPEN ?



Where we are

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Protocols & interfaces

- 4-20 mA
- SMART
- HART
- Ethernet
- Sattbus
- Modbus
- Profibus / Fieldbus
- EDAS
- CIP
- CIM-IO
- IEC 870-5-101/104
- http / https
- ODBC
- WCF
- **Classic OPC**

Classic OPC

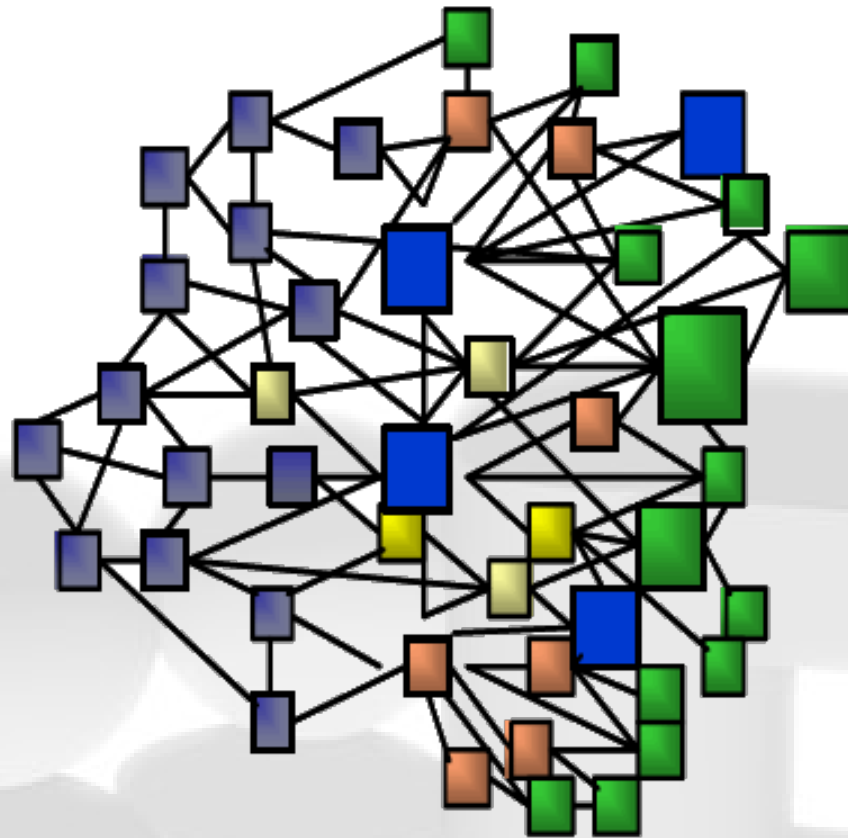
- Classic OPC is a set of de-facto standards

<http://www.opcfoundation.org>



- For interfacing between process automation (SCADA, PLC, DCS) and the rest of IT
- Time span: 1996 – 2005
- Based on COM technology (Microsoft, 1993)

Resulting industrial IT architecture



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OPC UA (Unified Architecture)

- OPC UA (Unified Architecture) is a single de-facto standard, evolution of Classic OPC

<http://www.opcfoundation.org>



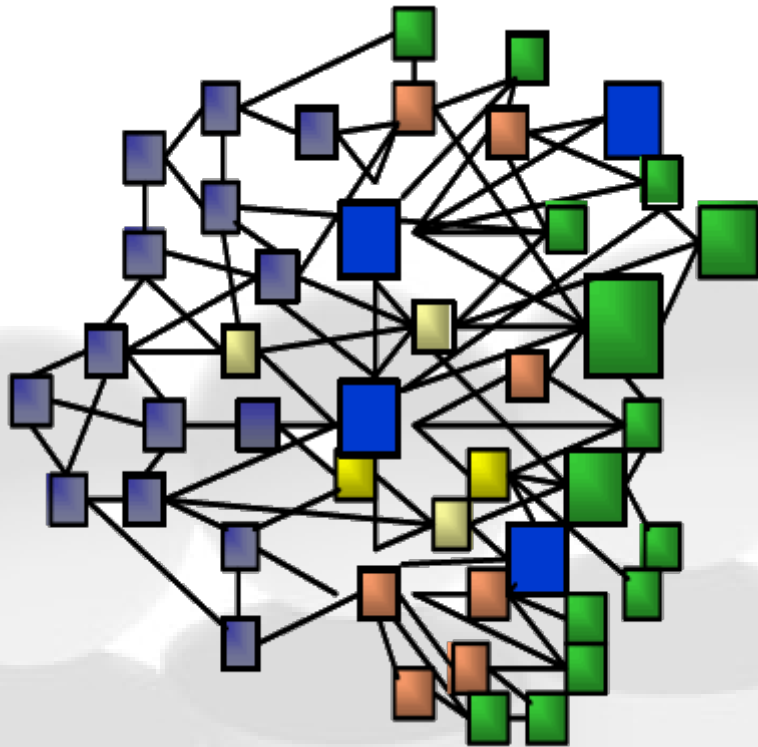
- Time span: 2006 - ...
 - Based on SOA
 - Platform-independent (non-Microsoft specific)
 - Object-oriented
 - Semantic: domain-specific information models

SOA (Service Oriented Architecture)

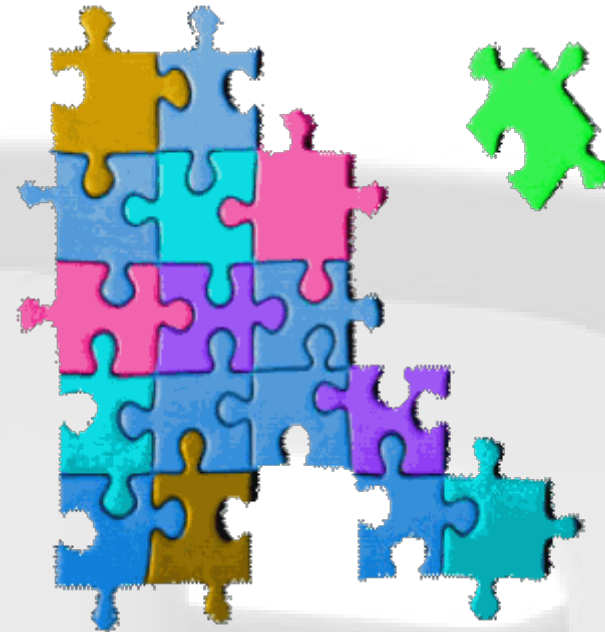
business
process

service

interoperable
software module



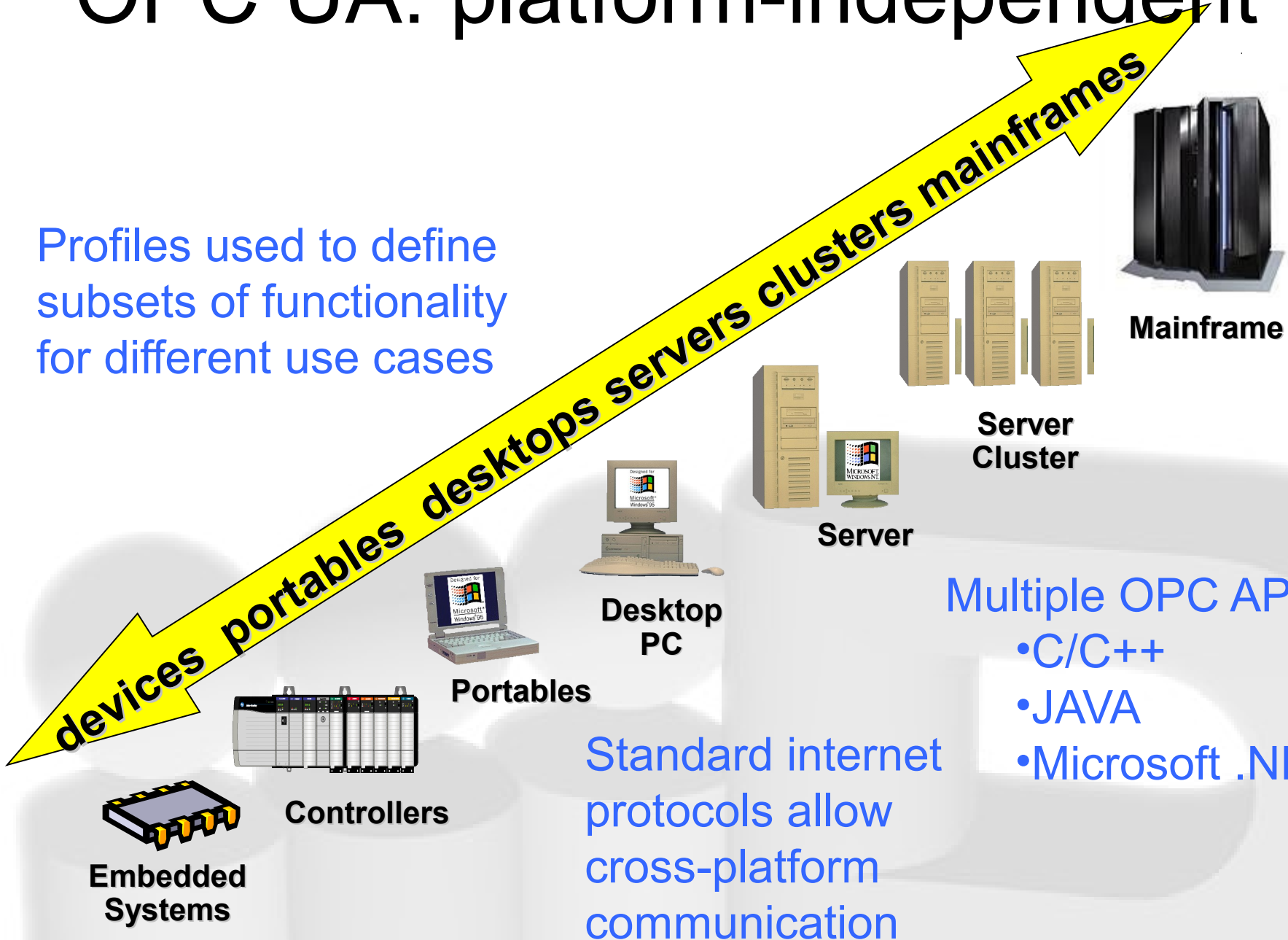
before SOA



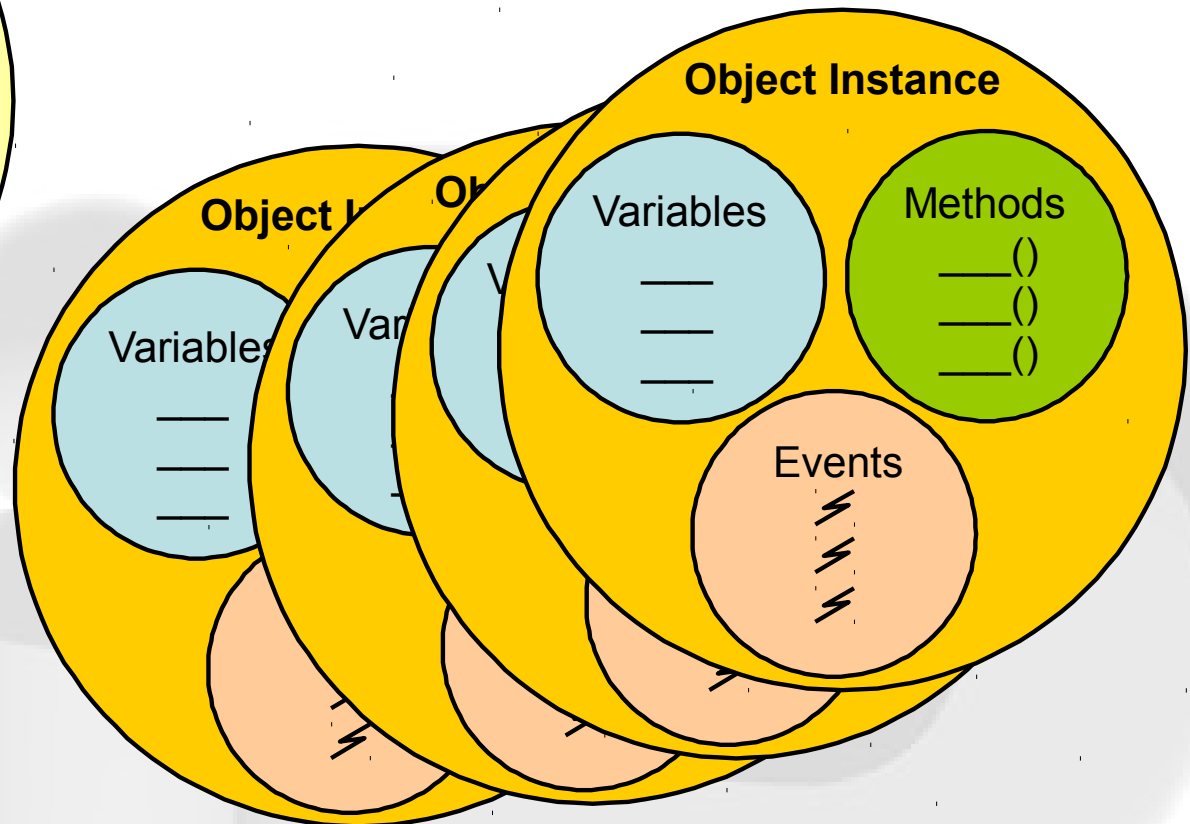
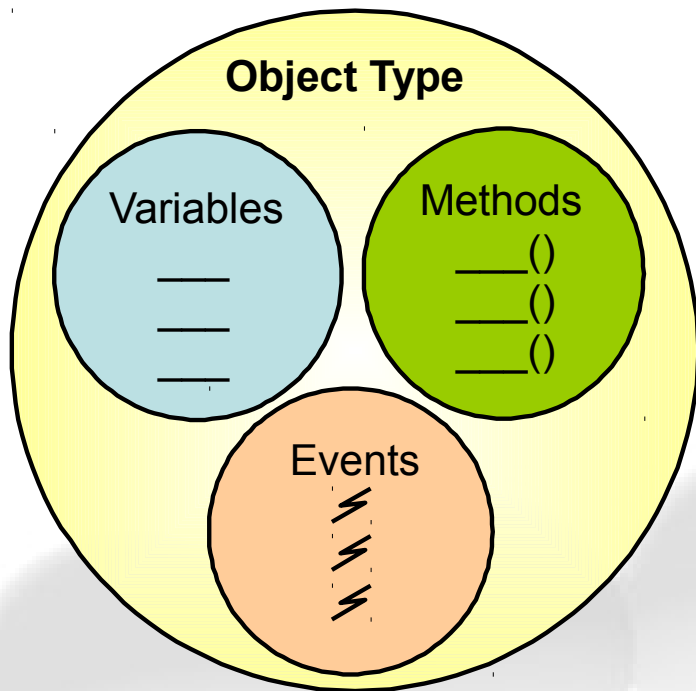
after SOA

OPC UA: platform-independent

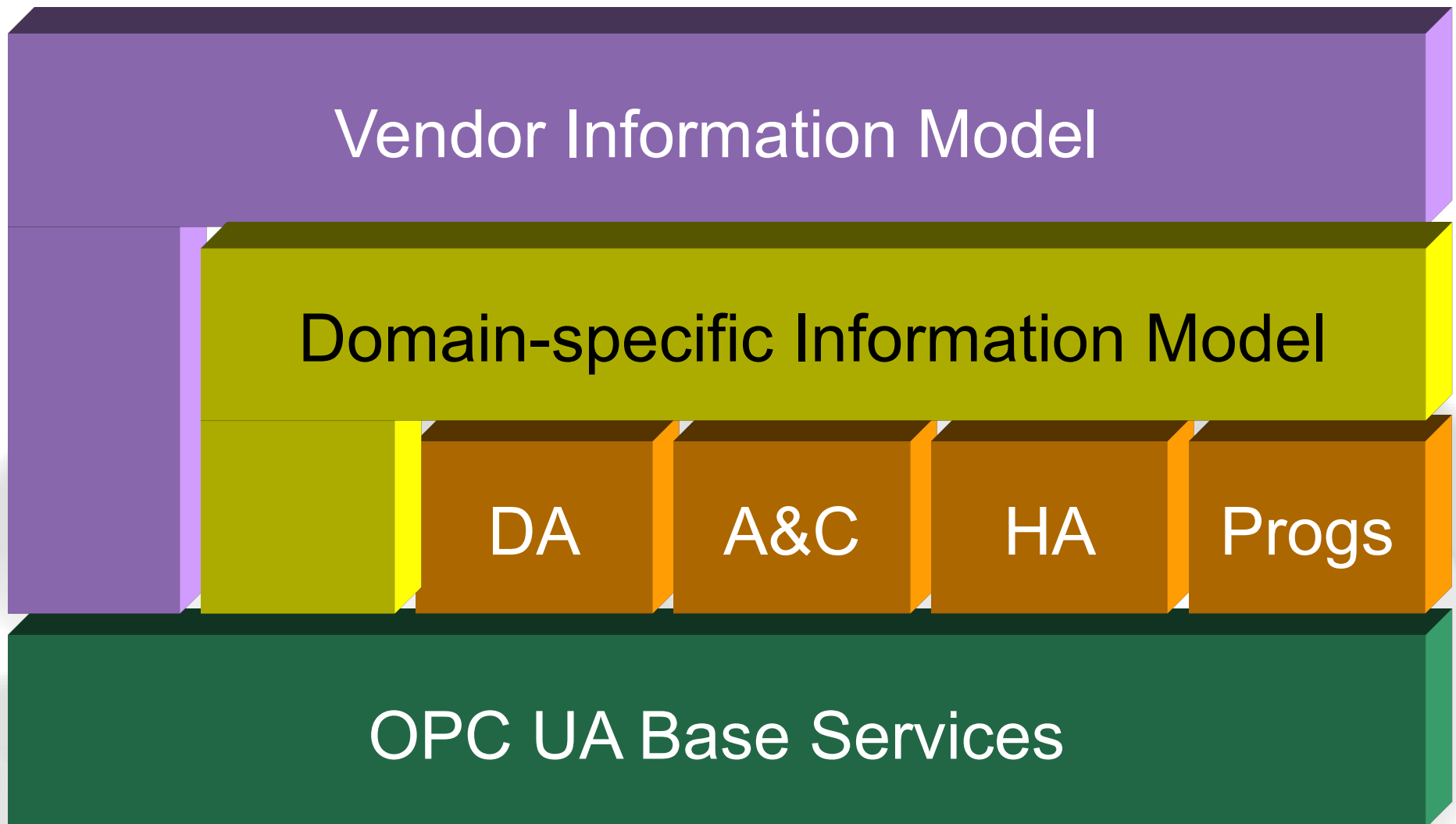
Profiles used to define subsets of functionality for different use cases



OPC UA object oriented: types and instances



OPC UA: architecture



OPC UA: semantic

Domain-specific information models for:

- 1.device information
 - 2.analyser devices
 - 3.plant operation and maintenance
 - 4.batch control
 - 5.PLC programming
- **process simulation capabilities ?**

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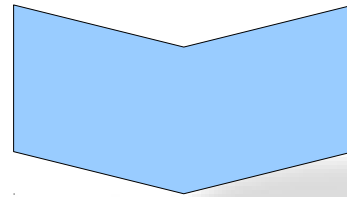
Soft sensors

Soft-sensors = replace real sensors with virtual, calculated results

- Model-driven - first principle models
- Data-driven - based on raw data manipulation
 - Principle Component Analysis (PCA)
 - Partial Least Squares (PLS)
 - Artificial Neural Networks (ANN).

The soft-sensor of the example

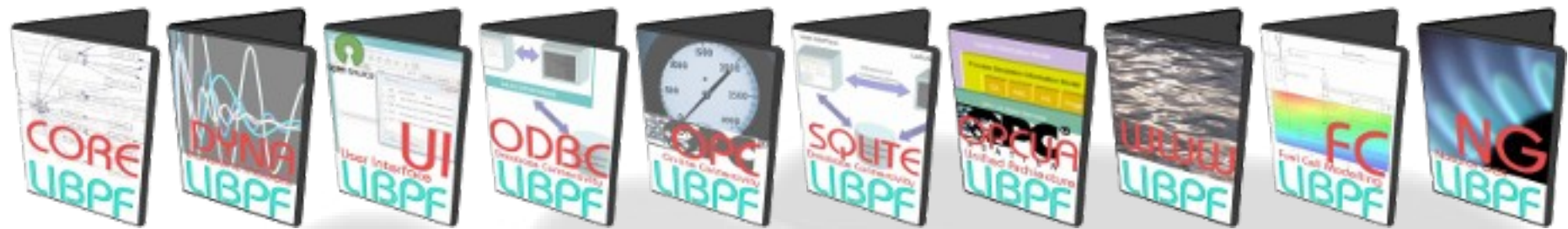
- Gas-chromatograph measures the composition of a material stream composed of short-chain hydrocarbons



- Soft-sensor computes:
 - Lower / higher heating value and Wobbe-Index;
 - LEL / UEL (lower and upper explosive limits) and LOC (limiting oxygen content);
 - Density, dew- and bubble-point with an equation of state specific for Natural Gas (GERG-2004)

LIBPF: LIBrary for Process Flowsheeting

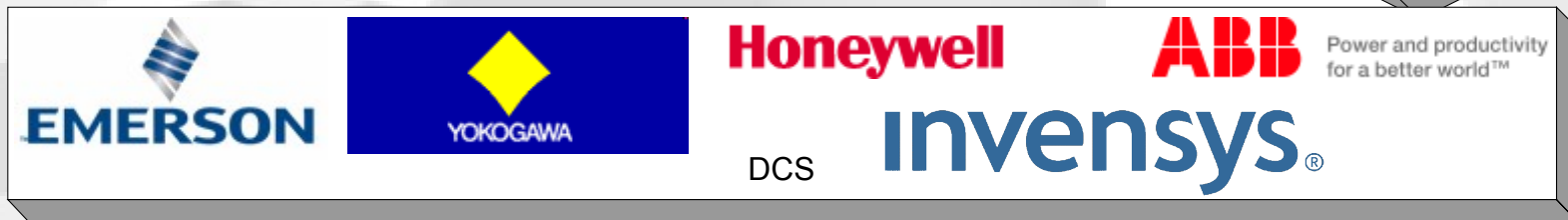
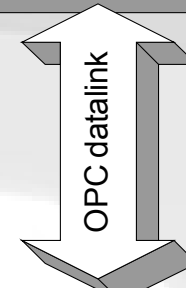
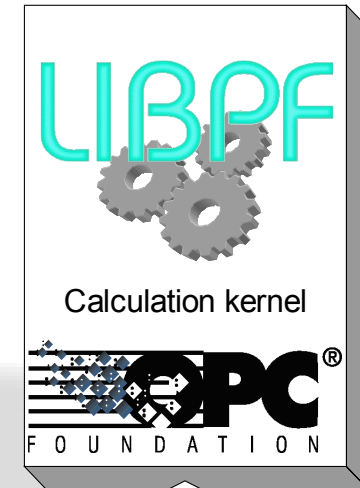
- Modular Software Development Kit (SDK) for process flowsheeting



- Object-oriented C++ library:
 - Components, physical properties, phases, streams, unit operations and flowsheets
 - Tools: solvers, input/output, object persistency, communication interfaces

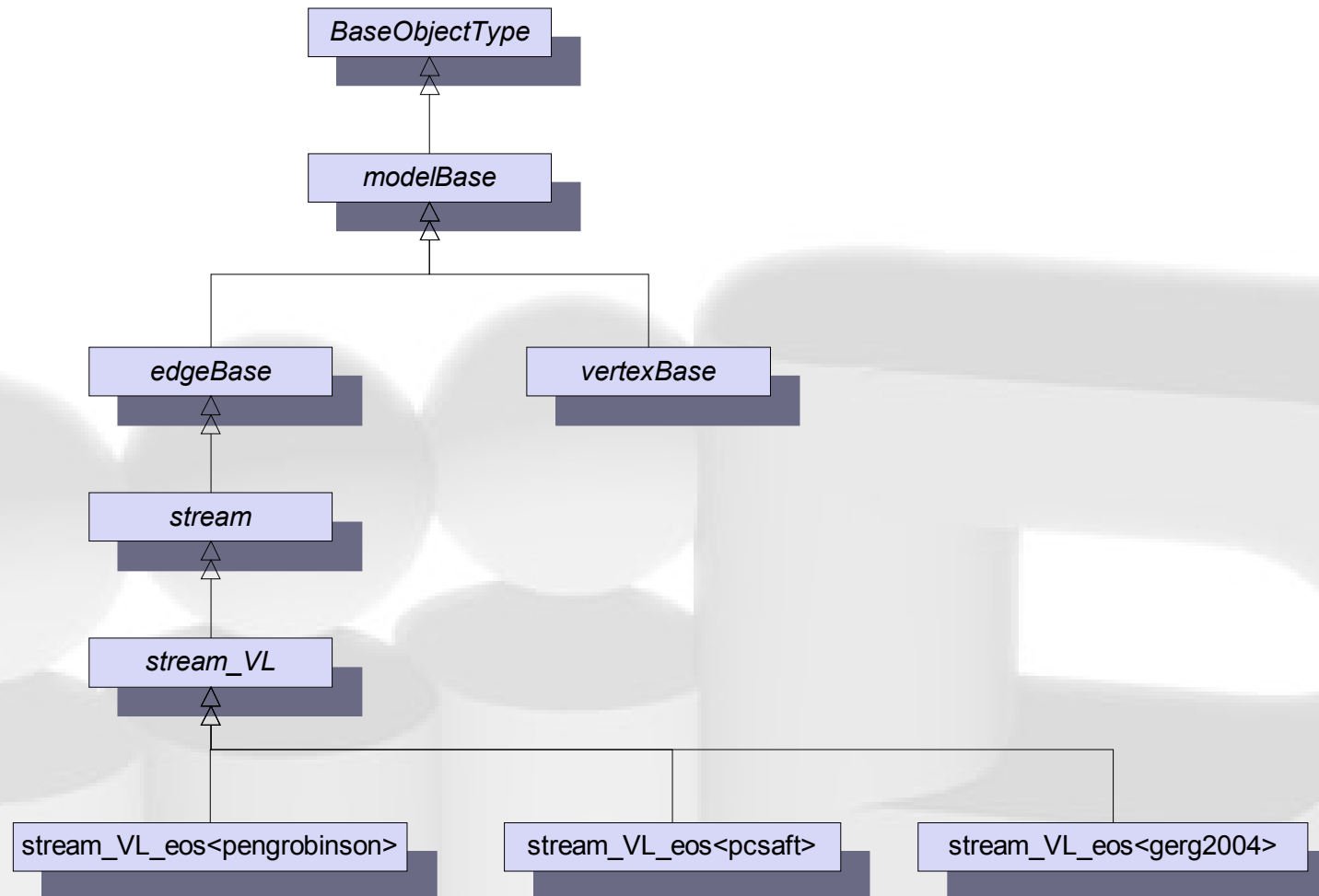
Classic OPC soft sensor

- OPC DA 2.0.4 client
- Placeholder tags have to be defined in the OPC server
- Configuration via XML file
- Start / stop as an operating system service



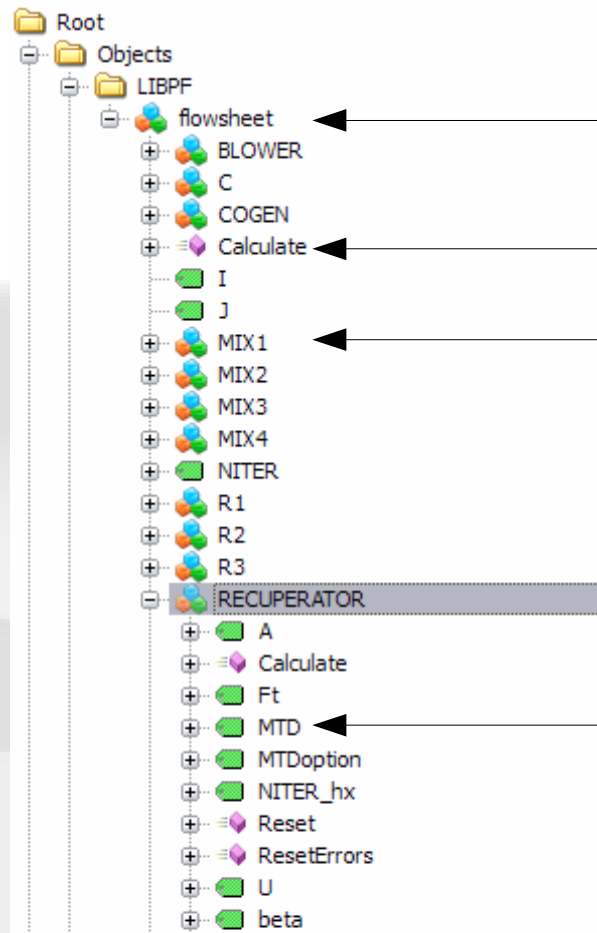
OPC UA process simulation information model

OPC UA node types from LIBPF objects



OPC UA soft sensor prototype

LIBPF objects are exposed as OPC UA nodes at runtime



Flowsheet object instance

Method can be actioned on the object

Unit operation object instance

Quantity with engineering unit object instance

OPC UA soft sensor features

- Runs on both Windows and Linux
- Could even be integrated directly into the device (gas-chromatograph, fiscal meter)
- No configuration files
- The configuration can be performed using any 3rd party OPC UA client, thanks to the discovery and browsing capabilities

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CAPE-OPEN vs. OPC UA

Item	CAPE-OPEN	OPC UA
Definition	Standards for interfacing process modelling software components developed specifically for the design and operation of chemical processes	secure and reliable cross platform framework for access to real time and historical data and events
Embedding	in-process	out-of-process
Protocol scope	Local, LAN	Local, LAN, WAN
Supported operating systems	Windows	Windows, Embedded Windows XP, QNX, Linux
Typical use	Unit operation interfacing	Flowsheet or whole-model interfacing
Typical application	Interoperability between different process simulators	On-line modeling applications

Applicability of OPC UA to CAPE

- OK to transfer 10000 variables that require an out-of-process computation of 500 ms in one batch: communication overhead < 10%
- The function call grouping should be implemented in the host (feasible for simultaneous solution algorithms):
 - Simulation executive groups calls to individual unit operation models
 - Unit operation model groups calls to physical property subroutines

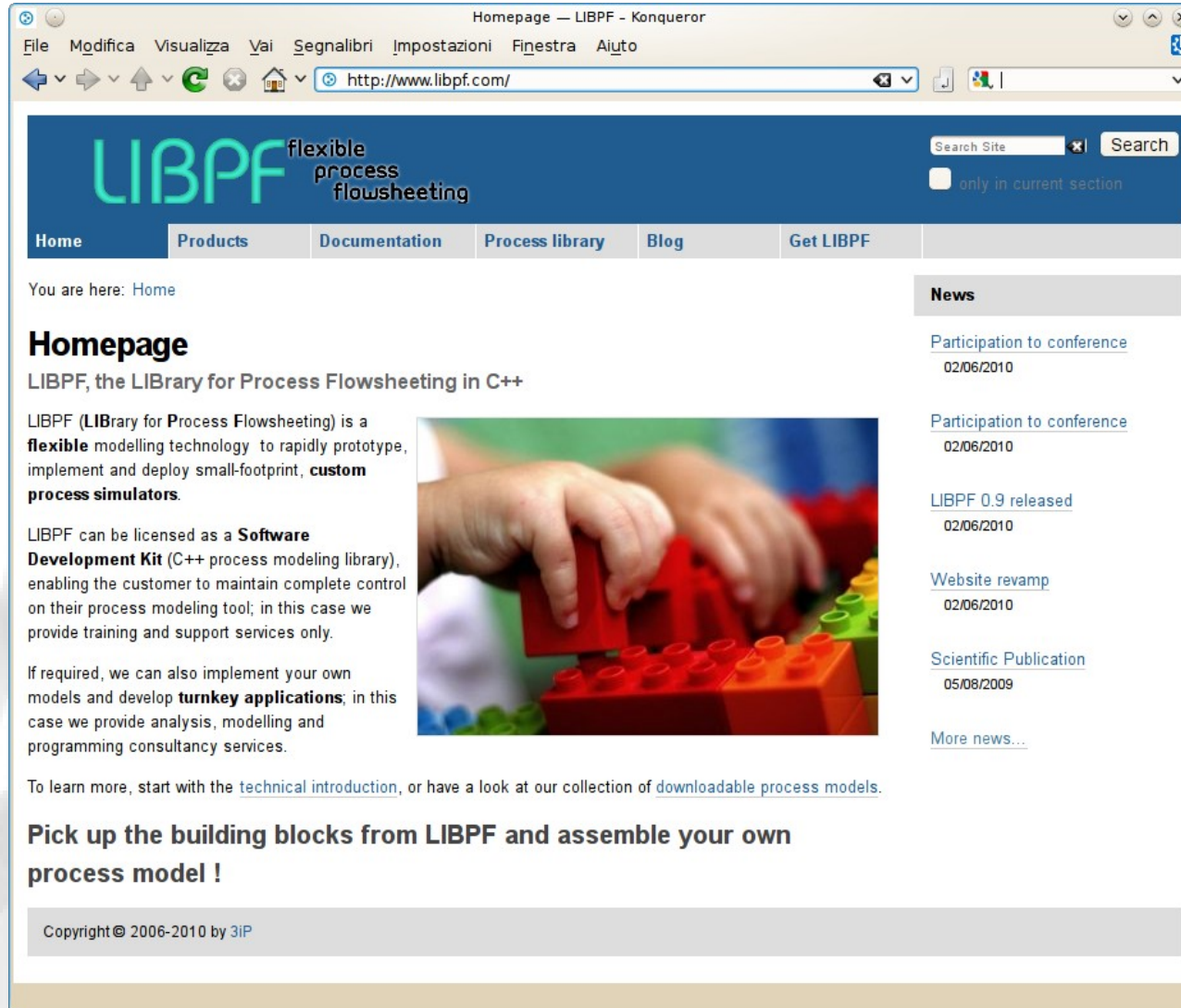
Preferred OPC UA on-line modeling applications

- Soft-sensors
- Advanced Process Control (APC)
- model predictive control (MPC)
- Plant-wide mass balance reconciliation
- Operator Training (OTS)

Future work for the community

- Agree on a domain-specific information model for process modeling on top of OPC Unified Architecture stack:
 - Process modeling objects: Components, phases, streams, unit operations
 - CAPE applications
 - On-line modeling applications

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LIBPF, the LIBrary for Process Flowsheeting in C++

LIBPF (LIBrary for Process Flowsheeting) is a **flexible** modelling technology to rapidly prototype, implement and deploy small-footprint, **custom process simulators**.

LIBPF can be licensed as a **Software Development Kit** (C++ process modeling library), enabling the customer to maintain complete control on their process modeling tool; in this case we provide training and support services only.

If required, we can also implement your own models and develop **turnkey applications**; in this case we provide analysis, modelling and programming consultancy services.



To learn more, start with the [technical introduction](#), or have a look at our collection of [downloadable process models](#).

Pick up the building blocks from LIBPF and assemble your own process model !

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