

Paper 218

**Open Software Architecture for Process
Simulation: the current status of the
CAPE-OPEN standard**

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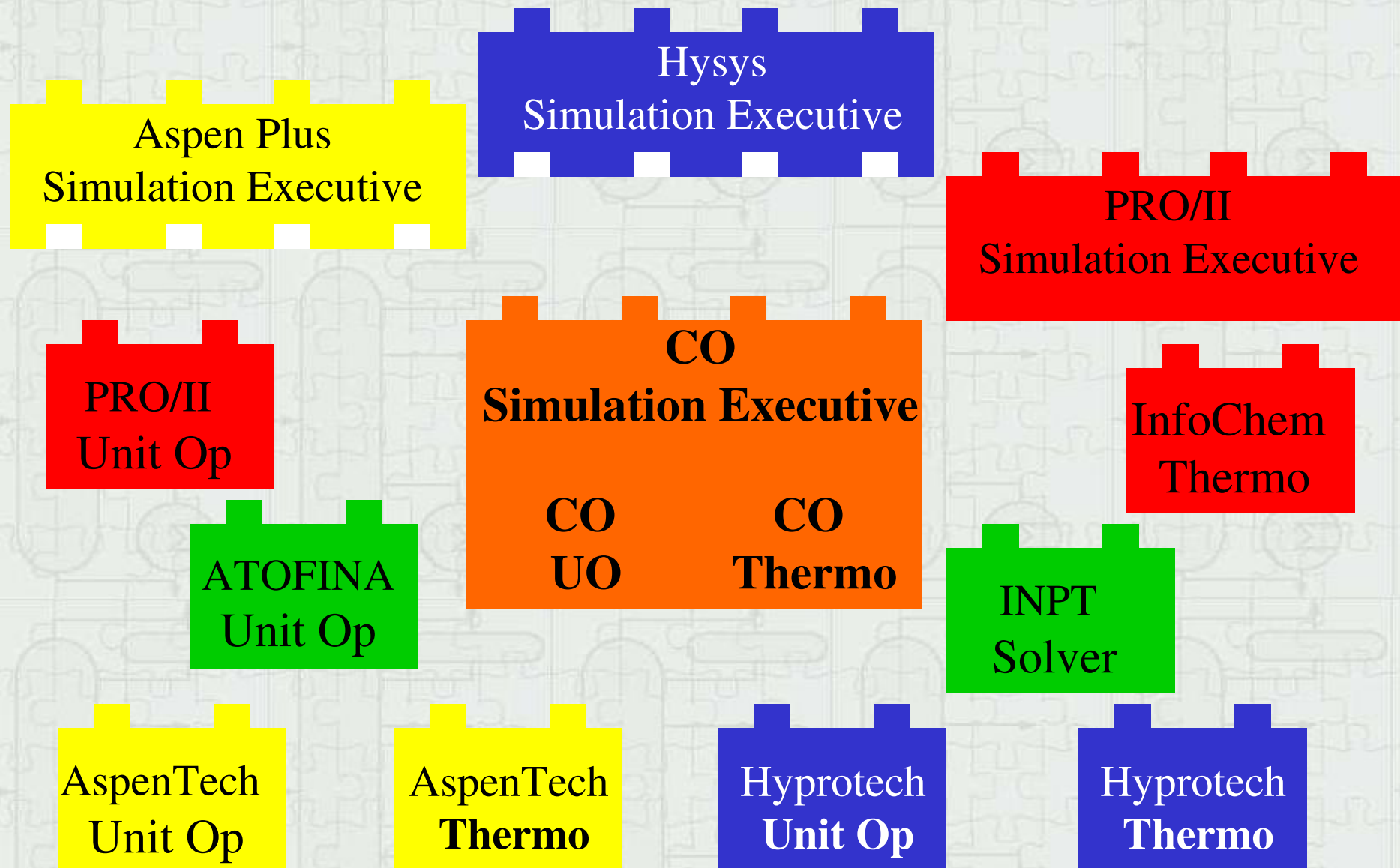
Overview

- **Introduction**
- **CAPE-OPEN Laboratories Network**
- **CAPE-OPEN Technology**
- **Delivering software components**
- **Conclusion**





Introduction

- **Process simulators: limited interoperability, reuse of third-party models or developments**
- **CAPE-OPEN is a standardisation process for achieving true plug and play of process industry simulation software components**
- **Relies on proven information technology:**
 - ⇒ **Unified Modelling Language (UML)**
 - ⇒ **Object-oriented approach**
 - ⇒ **Distributed component architecture**
 - ⇒ **COM and CORBA middleware**

CAPE-OPEN supports all combinations of components



CAPE-OPEN Projects

N°	Nom de la tâche	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	OO-CAPE	■								
2	OS-CAPE		■							
3	CAPE-OPEN 			■	■	■				
4	Global CAPE-OPEN  					■	■	■	■	
5	CO-LaN							■	■	■
6	GCO-Support 							■	■	

Users

IFP
TotalFinaElf
BP
Bayer AG
Dow
BASF AG
DuPont
Norsk Hydro

ICI
Shell
Air Products
UOP
Air Liquide
Mitsubishi
JGC

Suppliers

Honeywell
AEA
Aspentech
SimSci
QuantiSci
RSI

ProSim SA
Infochem
PSEnterprise
BELSIM SA
Dechema e.V.
Protesoft

Academics

INPT
RWTH.LPT
RWTH.I5
Imperial Coll.
NTNU
Univ. Virginia
DTU
UPC
TITech
Kyoto Univ.
CMU
UMass
MIT

Overview

- **Introduction**
- **CAPE-OPEN Laboratories Network**
 - **A not for profit organization driven by industrial end-users**
- **CAPE-OPEN Technology**
- **Delivering software components**
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CO-LaN missions

CAPE-OPEN Laboratories Network

1. User priorities for CO standards:

- ⇒ work with software vendors to clarify user priorities for process modelling software component/environment interoperability
- ⇒ promote communication and cooperation among CAPE software vendors to insure that the CO standards actually translate into commercially valuable interoperability

2. Dissemination and exploitation:

- ⇒ distribute CO information and technology internationally
 - Web portal: www.colan.org

CO-LaN missions

CAPE-OPEN Laboratories Network

3. CAPE-OPEN specifications life cycling management:

⇒ **organise the maintenance, evolution, and expansion of the specifications**

4. Software component testing:

⇒ **manage the process as well as the testing steps**

- **deliver testing software**
- **publicize compliant components**

5. Training facilitation:

⇒ **ensure training modules are developed and available**

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CAPE-OPEN Technology

➤ Business interfaces

- These interfaces are domain-specific interfaces for the CAPE application domain. They define interfaces to CO components involved in a CO process simulation application.

➤ CAPE-OPEN Simulator Executives (COSE) Interfaces

- They are interfaces for CO simulator executives. Within this category, services of general use are defined such as diagnostics and material systems in order to be called by any CO component.

➤ Common interfaces

- Specifications for handling services that may be required by any Business and COSE interfaces. They support basic functions and are always independent of Business and COSE Interfaces.

➤ Implementation specifications

- COM
- CORBA

The BIG PICTURE: releases

0.9 (CAPE-OPEN)

0.93 (GCO 2001)

1.0 (GCO 2002)

Future releases

Simulation context

COSE Services

Other Services

External Interaction Session

Planning & Scheduling

Operations & Control

SMST

Numeric

Hybrid Solvers

PEDR

Optimisation MILP, MINLP

PDAE Solvers

Solvers LAE, NLAE, DAE

Hybrid Units

Unit Operations

Unit Operations

Business interfaces

Physical Properties

Electrolytes

Reactions

Petroleum Fractions

Polymers

Thermodynamic and Physical Properties

Physical Properties Data Bases

Common Interfaces

Parameters Collections

Persistence

Error Handling

Identification

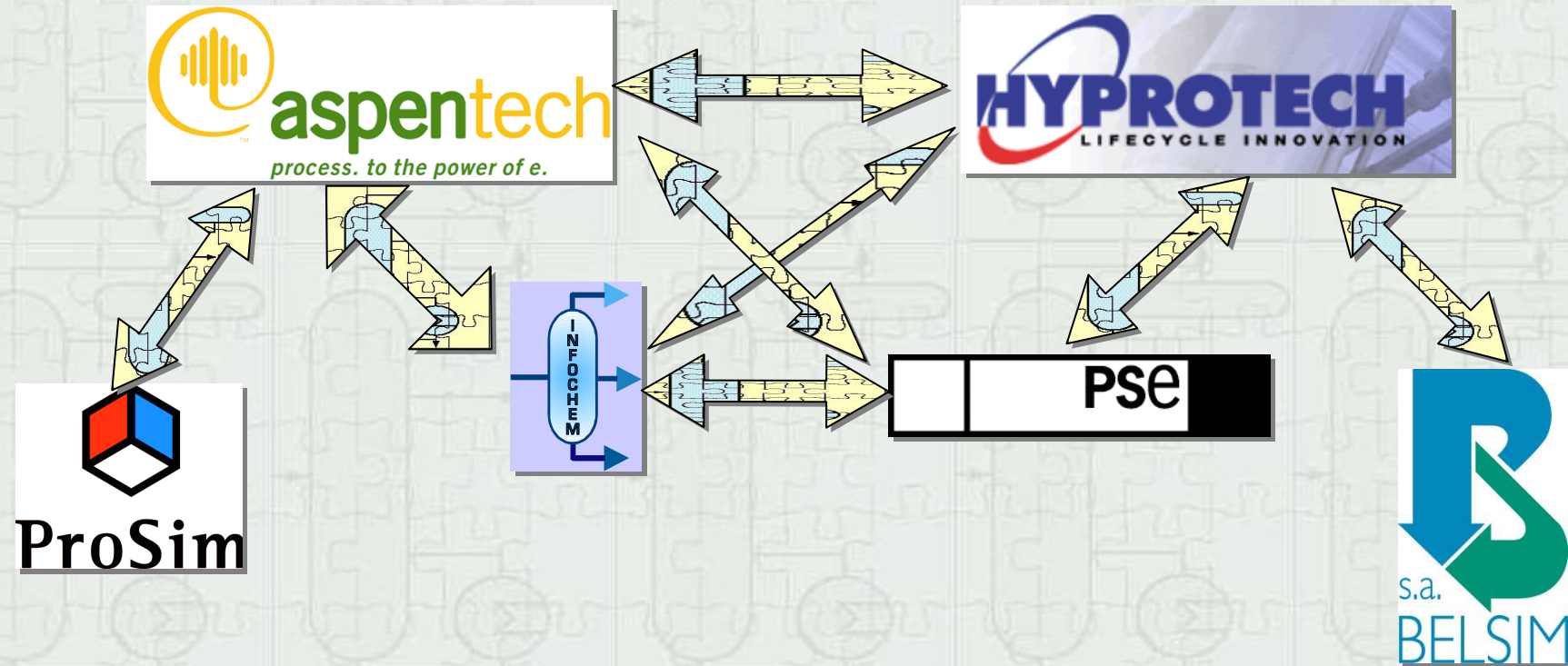
Known Objects Utilities

Types and undefined values

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 - ⇒ **Major suppliers are proposing CO compliant tools**
- **Conclusion**

Delivering interoperable software components



- Many combinations tested (not all)
- As well with some operating companies legacy software
- Almost no performance degradation in best case

Supplier	Software	Interfaces	Technology
AspenTech www.aspentech.com	Aspen Plus 11.1	Thermodynamic and physical properties socket Unit operations socket	COM
AspenTech	Aspen Properties 11.1	Thermodynamic and physical properties plug	COM
Hyprotech www.hyprotech.com	HYSYS.Plant 2.4	Thermodynamic and physical properties socket Unit operations socket	COM
Hyprotech	Distil	Thermodynamic and physical properties socket	COM
Hyprotech	COMThermo 1.1	Thermodynamic and physical properties plug	COM
Process Systems Enterprise (PSE) www.psenderprise.com	gPROMS	Thermodynamic and physical properties socket gO:CAPE-OPEN Unit plug	COM (COM/CORBA bridge)
Process Systems Enterprise (PSE)		Numerical solvers sockets (linear algebraic, nonlinear algebraic, differential-algebraic; mixed integer nonlinear programming)	CORBA
Process Systems Enterprise (PSE)		Equation Set Object plug	CORBA
Belsim www.belsim.com	VALI III	Thermodynamic and physical properties socket	COM
Prosim S.A. www.prosim.net	ATOM	Thermodynamic and physical properties plug	COM
Prosim S.A.	Odysseo	Dynamic flash unit plug	COM
Infochem www.infochemuk.com	Multiflash 3.1	Thermodynamic and physical properties plug	COM
RSI www.rsi-France.com	INDISS	Thermodynamic and physical properties plug and socket Unit Operation plug and socket	COM COM

IFP www.ifp.fr	SPIP	Thermodynamic and physical properties plug	COM
IFP	FIBER	Unit Operation plug	COM
INP Toulouse-LGC-CNRS www.inp-toulouse.fr/lgc	Numerical Services Provider and Continuous Model Builder	Numerical Solvers plug and socket	CORBA
INP Toulouse-LGC-CNRS	M&S	Unit plug	COM
INP Toulouse-LGC-CNRS	Flowsheet Server	Sequential Modular Specific Tools plug	CORBA
DECHEMA www.dechema.de	DETERM	Physical Properties Data Bank Plug	COM
RWTH.LPT www.lfpt.rwth-aachen.de		Numerical solvers plug	CORBA
RWTH.I5 www-i5.informatik.rwth-aachen.de	COM-CORBA Bridge Java Unit Skeleton Java Material Object Skeleton	Bridge Unit Operation plug Material Object and Material Template	COM, CORBA CORBA CORBA
CO-LaN www.colan.org	Tester Suite (1)	Thermodynamic and physical properties plug and socket Unit Operation plug and socket	COM, CORBA through bridging
CO-LaN	Tester Suite (1)	MINLP socket & plug PPDB socket SMST socket & plug	COM
NORSK HYDRO www.hydro.com		Heating Tank Unit Operation Fluent Wrap Unit Operation CASE test socket	CORBA
UPC www.upc.es/eq/	MOPEDR MOPP	PEDR Prototype Planning and Scheduling Package	CORBA CORBA

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Conclusion

- **Significant results obtained**
- **Commercial implementations available**
- **Proven technology**
- **Major benefits already from Unit and Thermo**

Benefits from CAPE-OPEN standard

➤ Benefits for suppliers

- ⇒ Increased usage of CAPE tools
- ⇒ Reduced development costs

➤ Benefits for users

- ⇒ Develop once, run everywhere
- ⇒ Access to best-in-class solutions

➤ Benefits for academics

- ⇒ Improved dissemination of research results
- ⇒ Better adaptation to industrial needs

Use the CAPE-OPEN standard for your benefit !

Thank you for your attention

**Questions
and
comments
welcome !**