Introduction to CAPE-OPEN

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IFP & CO-LaN

CAPE-OPEN Vision

CAPE-OPEN COMPLIANT SOFTWARE

UNITS'Я'US®

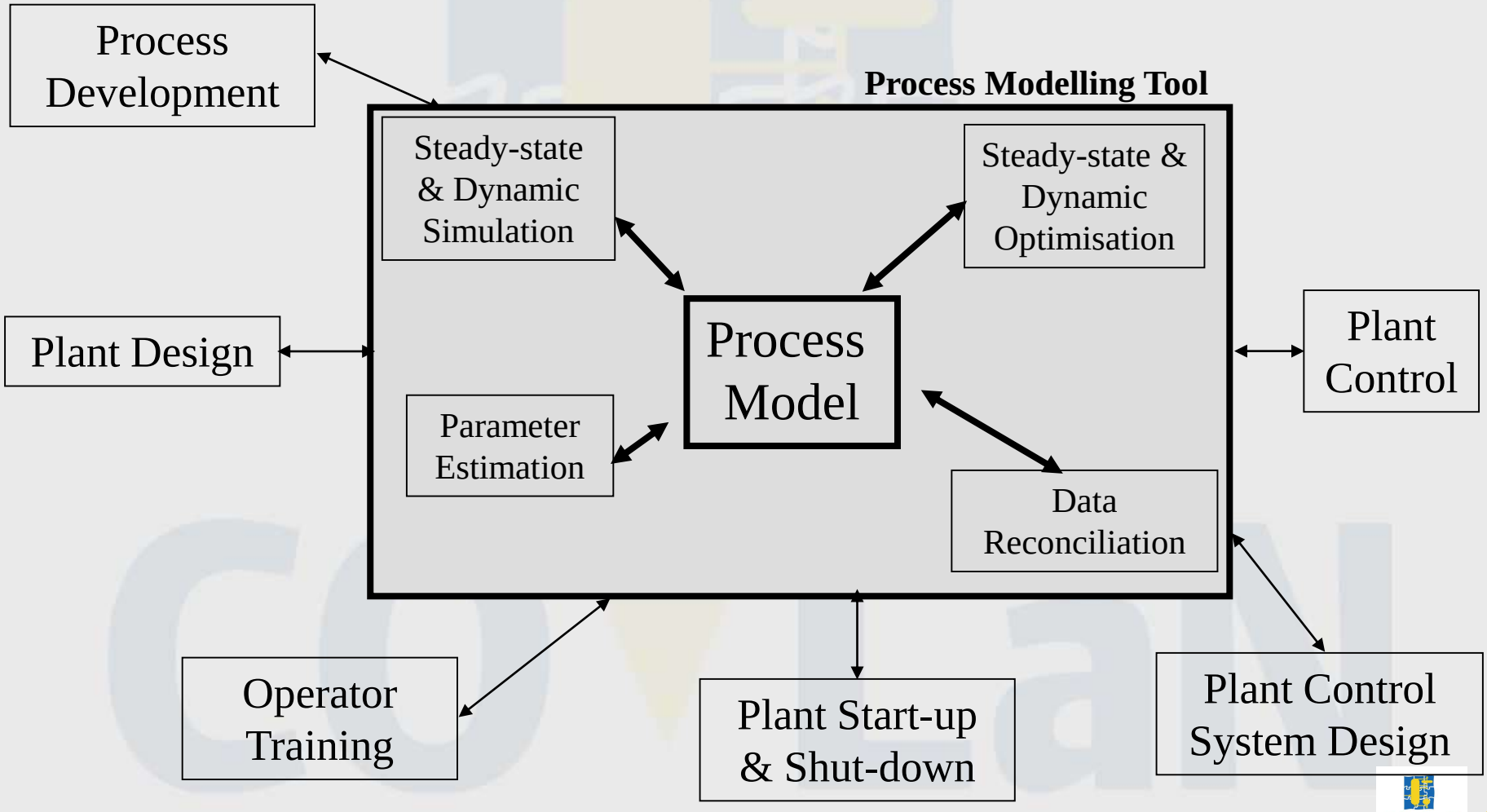
α–olefins reactor v12.3

The CAPE-OPEN Standard
What it is

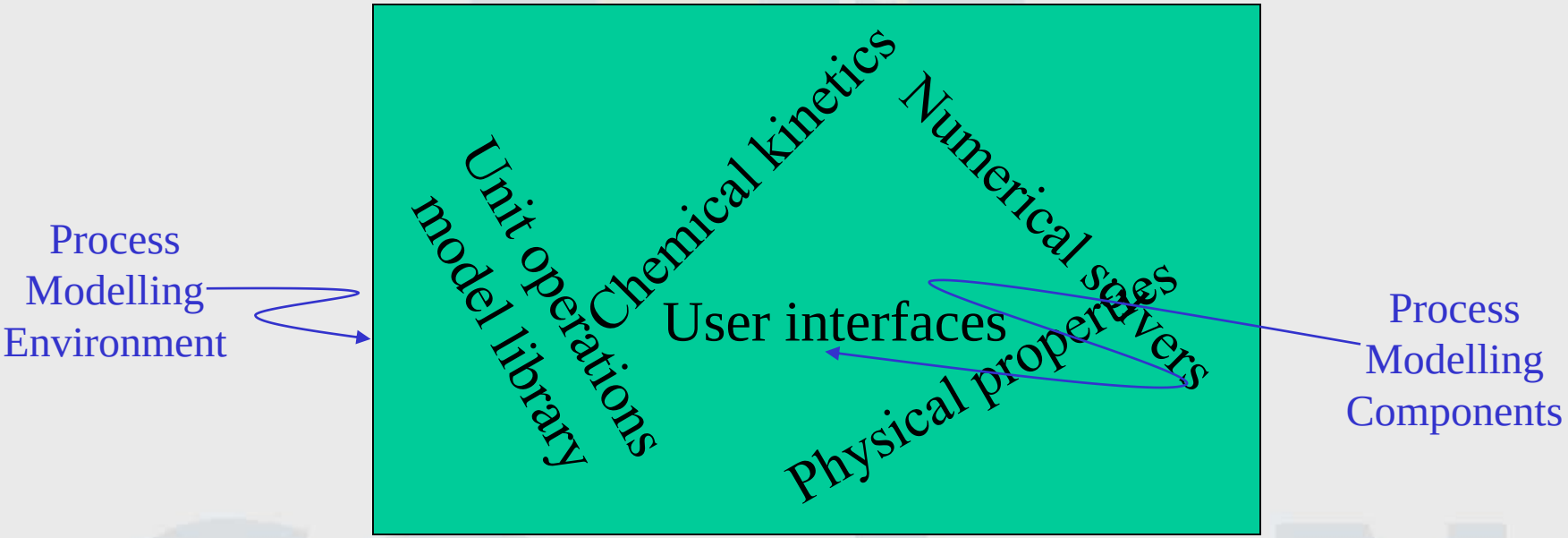
CAPE-OPEN: the technology for integration

- An industry standard for interfaces between software components making up process simulation tools
- The success of a collaboration between software vendors, end-users and academics
- A proven technology implemented in most process simulation tools
- A growing adhesion by process simulation market leaders

General-purpose process modelling tools



The anatomy of process modelling tools – a (somewhat) confusing reality



- Many interacting components…
- …all tightly coupled with each other
- Component boundaries not always clearly delineated

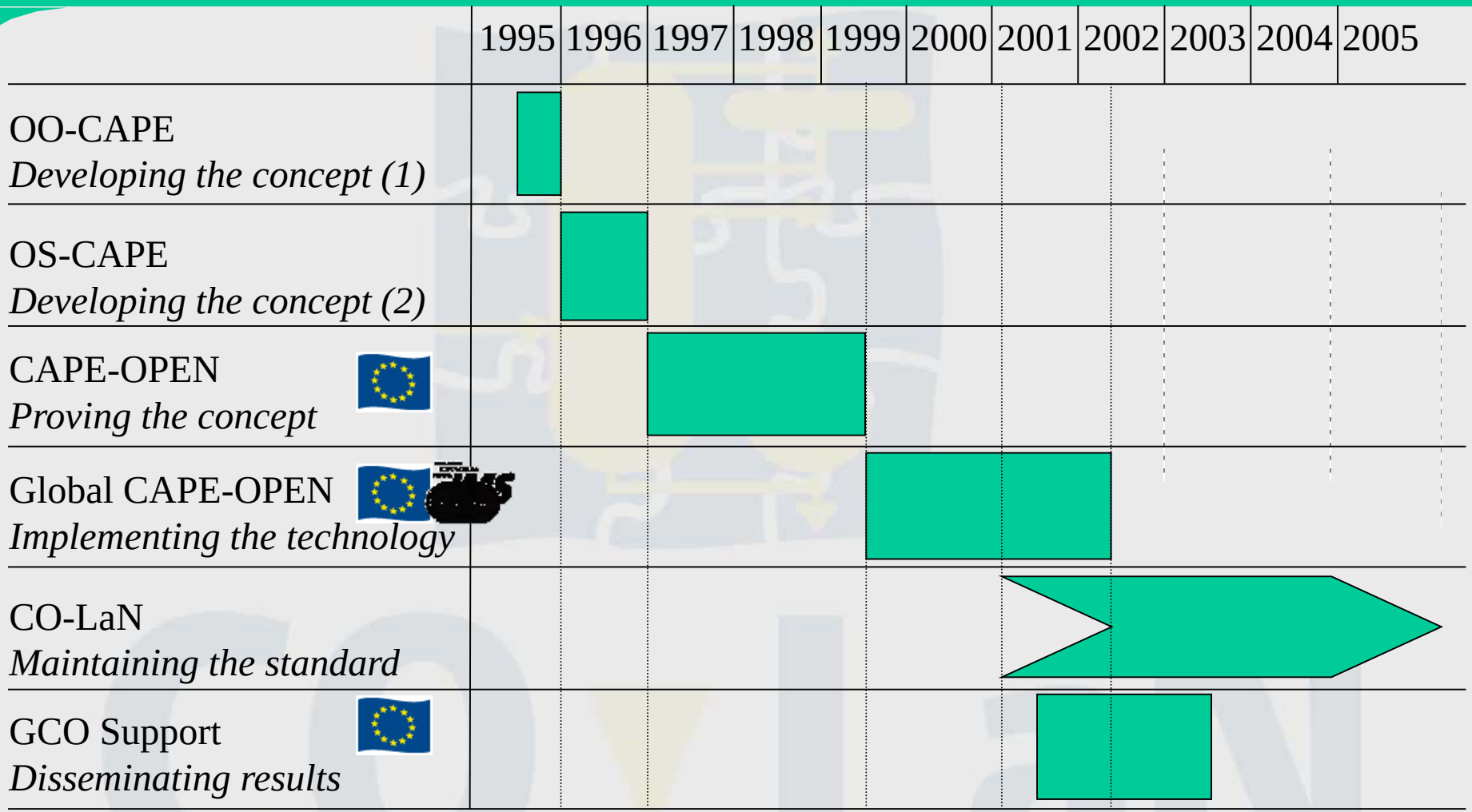
Process modelling: components & environments

- **Process Modelling Components (PMCs)**
  - **well-defined pieces of software, relatively narrow function**
  - **wide range of applications**
    - **physical properties**
    - **unit operation modules**
    - **numerical solvers**
    - **. . . . . .**

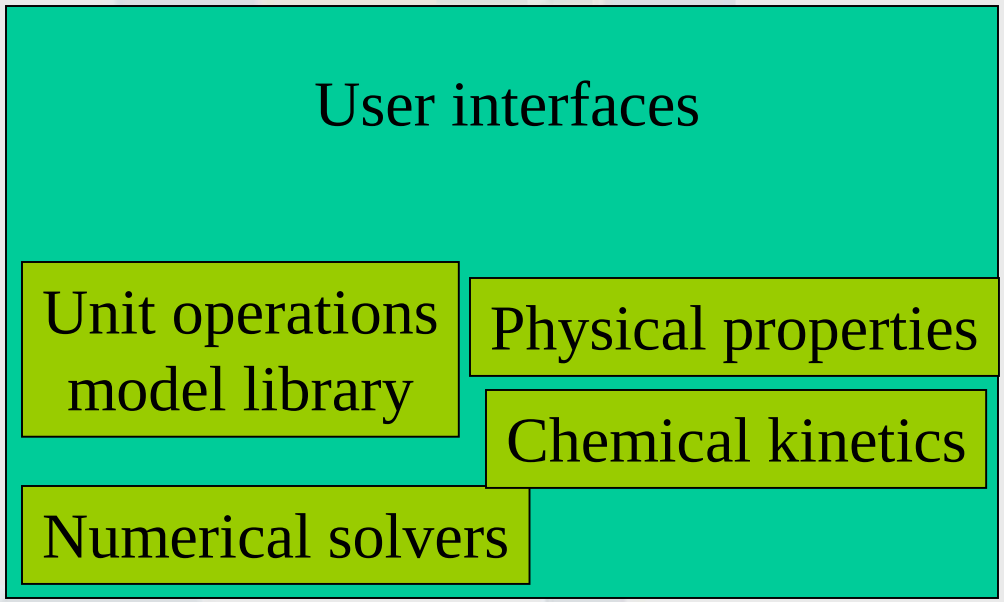
Process modelling: components & environments

- Process Modelling Components (PMCs)
- Process Modelling Environments (PMEs)
  - ➲ support construction of process model
    - from first-principles and/or library of unit operation models
  - ➲ support a number of model-based applications
    - simulation, optimisation, …
  - ➲ may make use of one or more PMCs

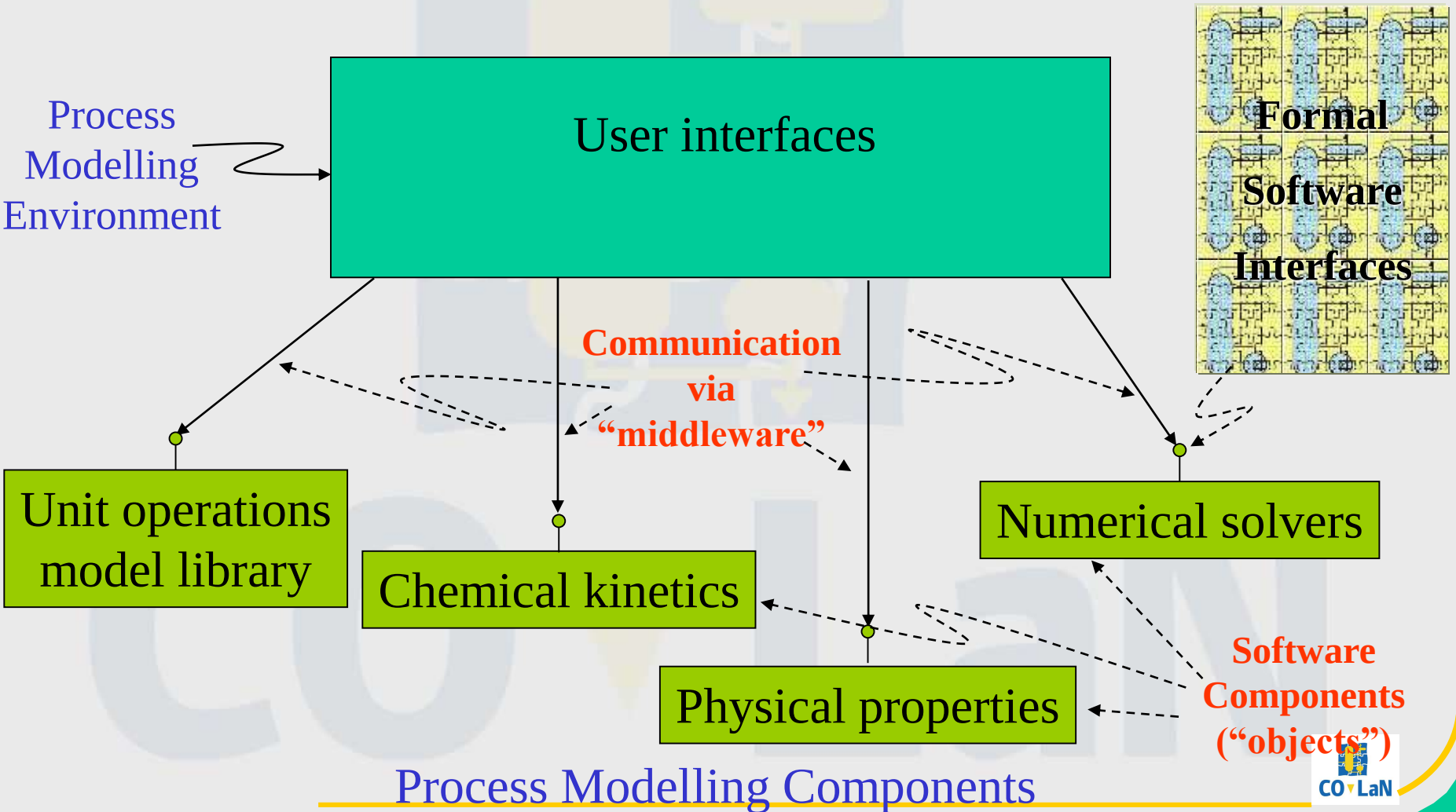
Making a visionary idea a reality



Clarify boundaries between key components



…and break tool into 1 PME & multiple PMCs



CAPE-OPEN : definitions

- COSE : CAPE-OPEN compliant Simulator Executive

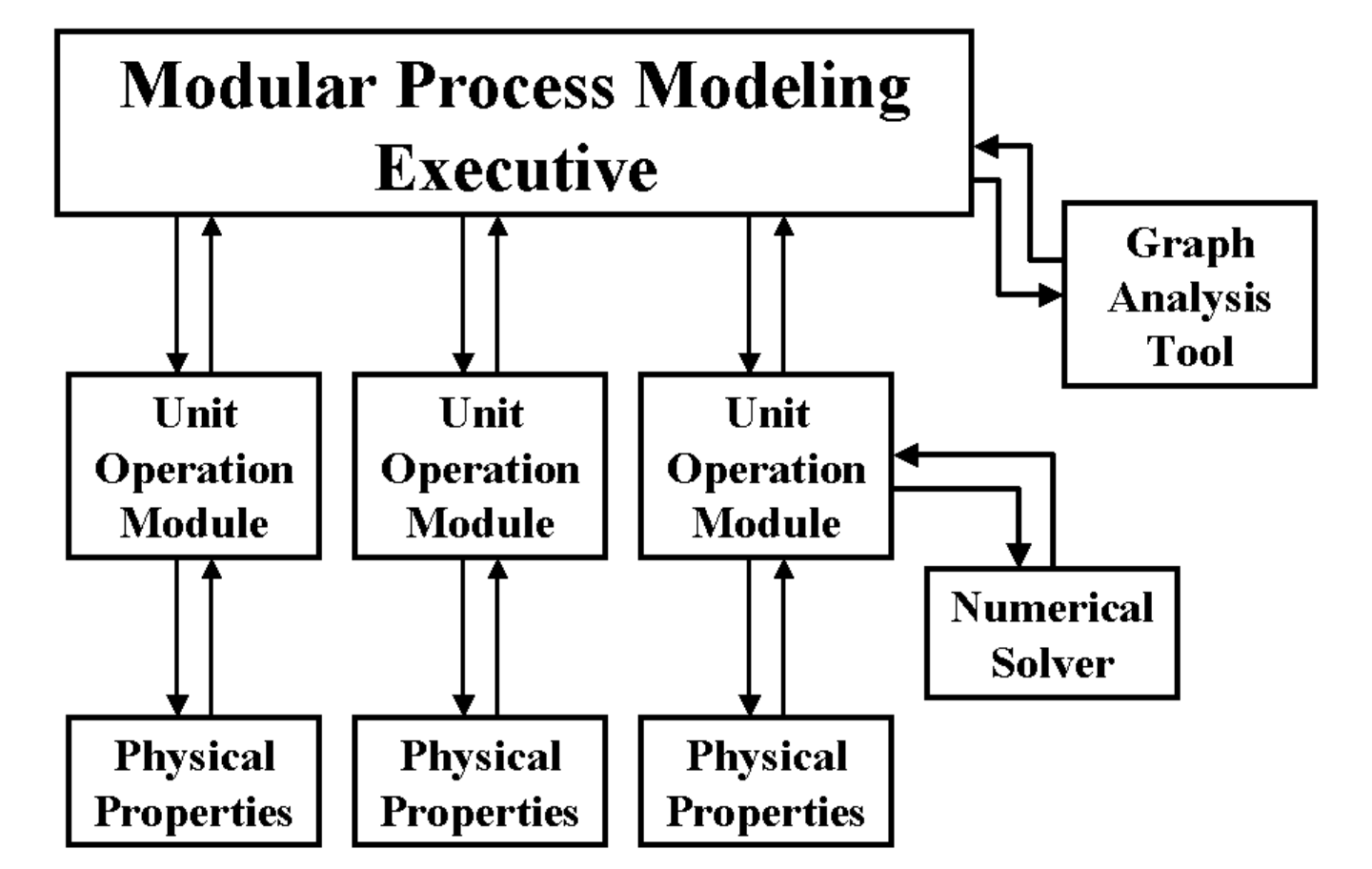
  or

- CO-PME: CO-compliant Process Modelling Environment

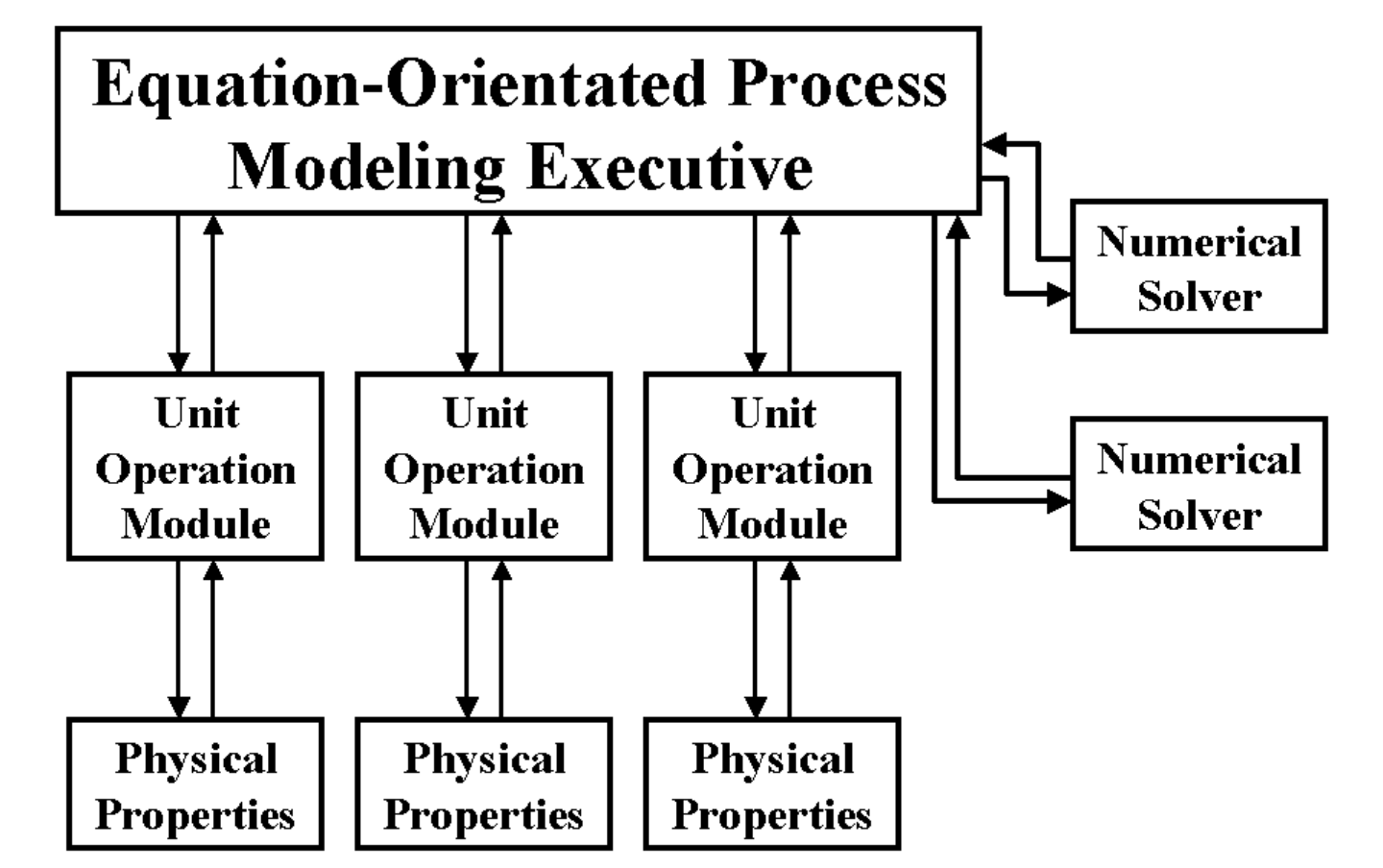
- CO-PMC: CO-compliant Process Modelling Component

- CO Interface specification:
  - List of interfaces/Methods/Arguments together with documentation and IDL
    - Documentation contains Textual Requirements, Use Cases, UML Diagrams, descriptions of methods and some examples.

Typical modular process modelling tool



Typical Equation-Orientated process modelling tool



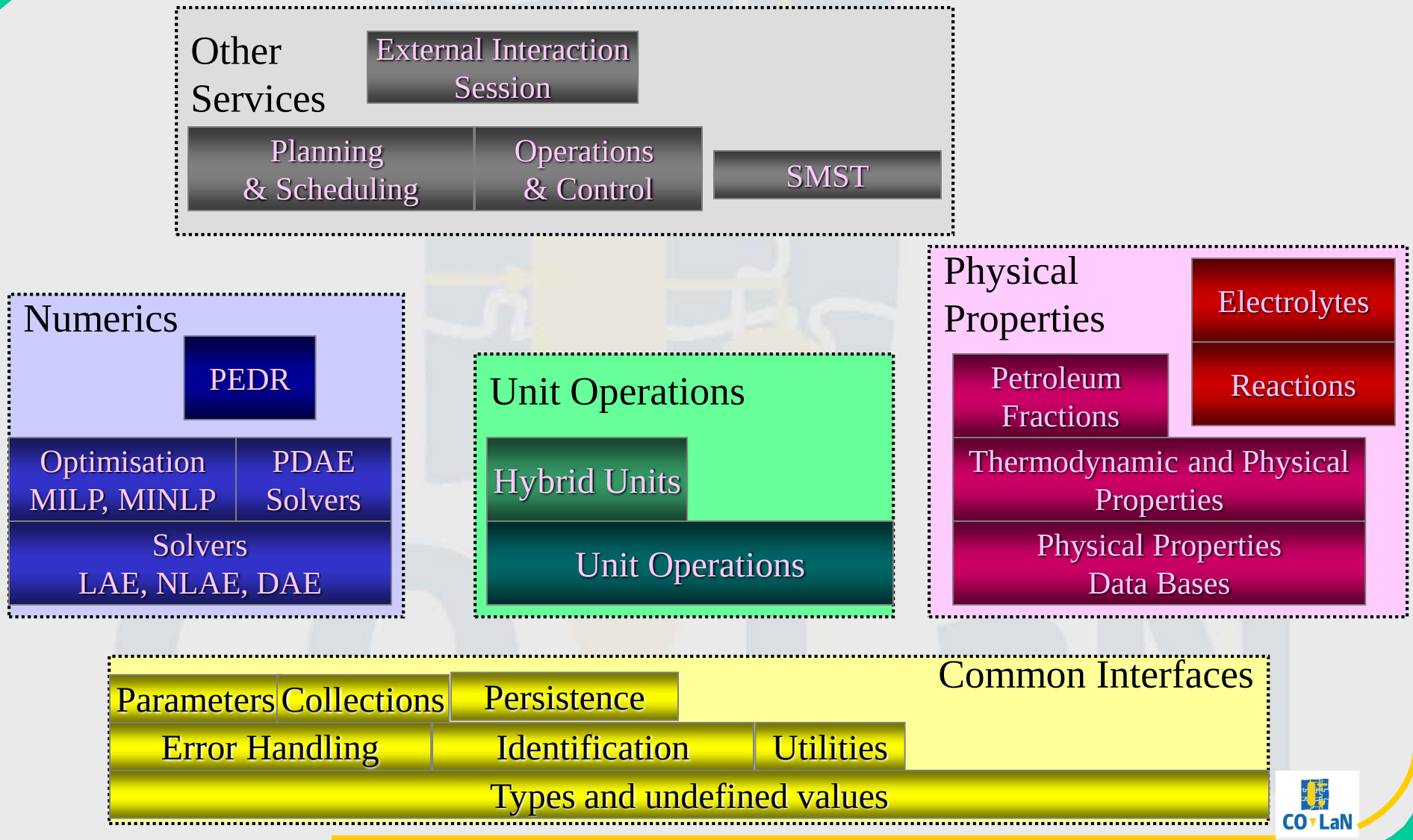
CAPE-OPEN architecture

- **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.
- **COSE/PME 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/PME interfaces. They support basic functions and are always independent of Business and COSE/PME Interfaces.

CAPE-OPEN Implementation

- Object-oriented approach based on software components
- Extensive use of “middleware”
  - CORBA - Object Management Group's Interface Definition Language
  - COM - Microsoft's Component Object Model Interface Definition Language

CO Interfaces for PMCs



CO interfaces releases

0.9 (CAPE-OPEN)
0.93 (GCO 2001)
1.0 (GCO 2002)
Unpublished drafts

Other Services
External Interaction Session
COSE/PME Services
Planning & Scheduling
Operations & Control
SMST

Numerics
PEDR
Hybrid Solvers
Optimisation MILP, MINLP
PDAE Solvers
Solvers LAE, NLAE, DAE

Hybrid Units
Unit Operations

Physical Properties
Electrolytes
Reactions
Petroleum Fractions
Polymers
Thermodynamic and Physical Properties
Physical Properties Data Bases

Common Interfaces
Parameters
Collections
Persistence
Error Handling
Identification
Utilities
Types and undefined values

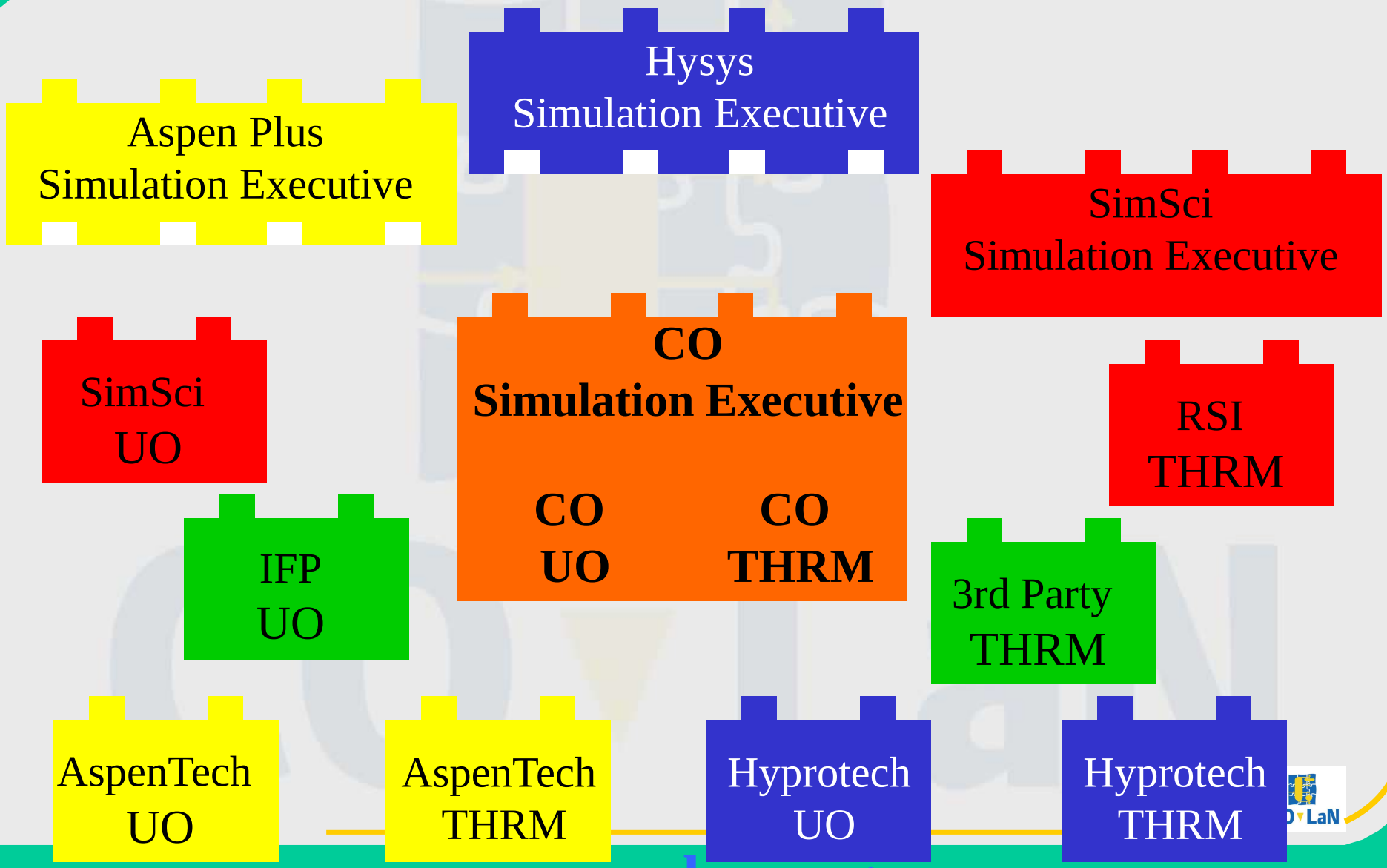
The CAPE-OPEN Standard: What it permits

Direct Benefits

Cheaper, better and faster design, operation and control of processes

- **Plug-and-play :**
  - Ability to seamlessly integrate a component from the library of foreign objects (unit operations, thermo models, solvers etc.);
  - Ability to seamlessly integrate in-house proprietary components in commercial environments;
- **Niche software**
  - Ability to link specific niche modules to the simulators. Small and niche software vendors will provide CO-compliant components.
- **ROI**
  - Individual studies will cost less because of the technical advantages of being able to mix-and-match.
  - Plug-and-play capacity will stimulate the market and create new opportunities

CAPE-OPEN supports all combinations of components



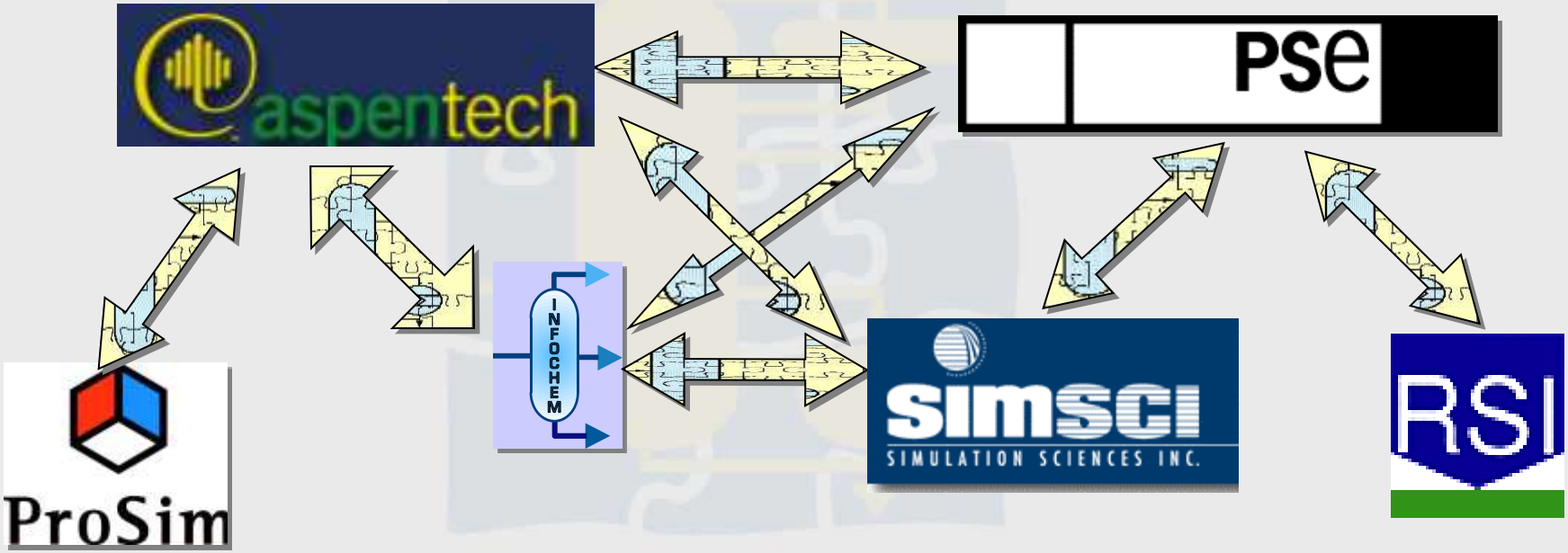
Example of use 1

- **A physical and thermodynamic properties calculations PMC** developed by a supplier**, can be used the same way within several CO-PMEs**.
- e.g. Infochem's , Multiflash, can be used the same way in Aspen+, gPROMS or Hysys.
- The user saves the time needed to configure the properties calculations parameters for those environments, and gets consistent results by using the same methods and data.
- This is simply obtained by wrapping the thermo server with CAPE-OPEN standard interfaces.

Example of use 2

- **A Unit Operation model** such as a proprietary chemical reactor model, developed by an operator or a process licensor, **can be used transparently in CO-compliant PMEs**.
- e.g. IFP ’s FIBER (FIxed BEd Reactor) generic reactor model can be used the same way in most commercial PMEs without any change, whitout any coding or compiling.
- The process licensor can easily serve clients who demand the use of a specific PME in their contracts.
- This is obtained from putting the reactor model to the Unit Operation standard: introduction in a flowsheet, connection of input-output ports, specification of parameters, validity checking, calculation, publication of results.

Commercial Interoperability of Unit and Thermo



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

Available CO-compliant software

- **Software providers**
  - AspenPlus, AspenProperties
  - Hysys, COM Thermo, Distil
  - SimSci: Pro/II
  - PSE: gPROMS
  - Belsim, Infochem, ProSim, Dechema, RSI, HTRI, Fluent, ...
- **Operating companies**
  - IFP, Total, BASF, Norsk Hydro, Shell…
- **Universities**
  - DTU, INPT, UPC, RWTH.LPT, CMU...
- **CO-LaN**

The Aspentech-FTC agreement

- **IV.IT IS FURTHER ORDERED that, for a period of five years from the date of divestiture of the Engineering Software Assets: Respondent shall maintain technical standards with respect to Respondent's Hyprotech Process Engineering Simulation Software to provide:**
  - **1. compatibility of HYSYS cases … and**
  - **2. support for:**
    - **a. version 1.0 of the CAPE-OPEN Thermo and Units Standards;**
    - **b. upgrading HYSYS to CAPE-OPEN Thermo Standard 1.1;**
    - **c. new versions of the CAPE-OPEN Thermo and Units Standards as new versions become available; and**
    - **d. new CAPE-OPEN Standards on Math solvers and Reactors."**

Conclusion

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

- Use it!

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