

CAPE-OPEN (CO) standards: implementation and maintenance

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Abstract

A standardization body (CAPE-OPEN Laboratories Network – CO-LaN) has been established to maintain and disseminate the software standards in the Computer Aided Process Engineering (CAPE) domain that have been developed in the international projects CAPE-OPEN and Global CAPE-OPEN. The CO-LaN ensures that software tools used by the process industries reach a level of interoperability that will help ensure sustained growth and competitiveness. Goals and means of the CO-LaN are described, especially its work process related to testing procedures applied to software components in order to assess their compliance with the published CAPE-OPEN interface specifications.

Introduction

Chemical manufacturers use a collection of software (in-house, commercial, and/or academic) instead of just one tool to perform Computer Aided Process Engineering (CAPE) activities because the market for process simulation has been so far one of incompatible proprietary products. This situation constitutes a hindrance to increased competitiveness within the process industries.

The EU-funded CAPE-OPEN project (BRPR-CT96-0293 from January 1997 till June 1999) defined a set of standards [1] to allow communication between software from different sources (software and equipment vendors, universities, and "home grown"). Global CAPE-OPEN (GCO) runs as a EU-funded as well as an Intelligent Manufacturing Systems (IMS) project (BRPR-CT98-9005 from July 1999 till December 2001) that builds on the results of CAPE-OPEN (CO). The GCO consortium involves a wide range of leading process industry companies, researchers, and software vendors in Europe, Asia, and North America. Consortium members include Air Products, AspenTech, BASF AG, BP, Carnegie-Mellon University, DECHEMA e.V., Denmark Technical University (DTU), The Dow Chemical Co., Honeywell Hi-Spec Solutions, AEA Hyprotech, ICI, IFP, Imperial College, Institut National Polytechnique de Toulouse (INPT), JGC (Japan), Kyoto University, Mitsubishi Chemical Corporation, Norsk Hydro, Norwegian University of Science and Technology (NTNU), Protesoft Corporation, Rheinisch-Westfälische Technische Hochschule Aachen (Lehrstuhl für Prozesstechnik and Lehrstuhl für Informatik V), SIMSCI, Tokyo Institute of Technology, TotalFinaElf, Universitat

Politecnica Catalunya (UPC), University of Massachusetts at Amherst, University of Virginia, and UOP.

Global CAPE-OPEN

The major result of GCO will be the global acceptance of CAPE-OPEN standards. The implementation of these standards gives a true plug-and-play capability of process modelling components into process modelling environments, i.e. process simulators. This will lead to the availability of process simulators and software components offered by software and equipment vendors, research organisations, and specialised suppliers that will enable the process industries to reach new quality and productivity levels in designing and operating their plants. This constitutes an opportunity for major reductions in capital and operating costs, software maintenance and training costs, as well as in cycle time of process simulation projects. A significant new market for the suppliers of innovative simulation components is arising. A market survey conducted by a project partner evaluated the number of potential component suppliers around 2000 companies. Most importantly the major vendors of process modelling environments are taking an active part in GCO, ensuring a wide availability as well as a wider market for CO compliant simulators.

Once the GCO project ends, the CAPE-OPEN Laboratories Network (CO-LaN) will serve to perpetuate the CO interface standards. Operation of CO-LaN will be mainly conducted through a web portal [2] where visitors will find the CAPE-OPEN interface specification documents as well as additional resources for implementing CO compliant components (FAQs, discussion board, how-to's, etc.). The main goals of the CO-LaN are to provide a means to label software as CO compliant, to insure maintenance and addition of needed interface standards, and to facilitate the implementation of the CO interface standards in the CAPE community. Information on CO labelled pieces of software will be stored and made available on the CO-LaN web site. The CO-LaN, a not-for-profit society, has begun operation during the GCO project both to establish itself as the labelling and testing body for CO as well as to offer a way for organisations who are not members of GCO to become involved in the project.

CO-LaN software for CAPE-OPEN labelling and testing

The CO interface specifications are publicly available and readily accessible to software component suppliers and developers [2]. Based on these specifications, a CO Tester is developed by the CO-LaN. Both the binary and source codes, as well as a detailed description of the testing procedure, are publicly available to ensure transparency of the labelling process. The CO Tester acts as a basic simulation environment where software components can be plugged in. It has been designed to automatically carry out a number of testing scenarios. Each test generates one or several messages within report files. It helps a component developer to make his/her component CO compliant. The reports enable the CO-LaN to assess the compliance of a piece of software with the CO interface specifications.

First the existence of the required CO interfaces within the tested software is

checked. This constitutes the Basic test. Then each method of each interface is tested on its arguments (existence and type), and on its functionality. This constitutes the Function test.

At this stage, two sets of CO interface specifications, those corresponding to unit operation modules (UNIT) and those corresponding to thermodynamic property calculations (THRM), can be tested with the CO Tester. For these tests, the CO Tester is provided with a set of Material Objects which, in the context of CO standards, can be considered as containers of information on material streams commonly found in process simulators. Only software components using COM middleware can be put to test at this point, but a CORBA tester is in development.

The tests performed may be considered mainly as checks of the basic conformity to the CO specifications rather than tests of the actual runtime behavior of a software component. For the moment the tests cannot fully replace tests within actual commercial process simulators while still providing valuable information. Already, for the Function test on components implementing the UNIT interface specifications, a scenario is run in order to better assess the runtime behavior of the tested component. This scenario handles a number of basic operations commonly made by a process simulator end-user such as connecting and disconnecting a stream, changing the value of a parameter, saving and restoring the data pertaining to a unit operation module. The same is true of the Function test regarding the THRM interface specifications, where the implemented sequence of calls is similar to the one used by actual simulation environments. Currently, the CO-LaN is not checking for CO compliance of the process simulation environments.

Requesting the CO label

The developer internally tests his/her component with the CO Tester, which is made available on the CO-LaN web site [2]. The Tester needs only to be downloaded (free of charge) and installed. It comes with a help functionality explaining how to use the tool and its various features. The development and test loop is repeated until the component is considered, by its developer, ready to be labelled as CO compliant. In that sense the CO Tester can be considered as a help for development.

The CO-LaN web site has a built-in feature which enables users to automatically request the labelling of a component for a fee. When requesting a labelling, the component supplier is provided with an identifier which serves to uniquely designate the request as well as with an encryption key to be used to encrypt the reports submitted to the CO-LaN by the CO Tester. The reports produced by the CO Tester are sent back automatically to the CO-LaN instead of being kept as before by the developer.

Meanwhile, under its own responsibility, the component supplier provides information (technical data description, licence model, etc.) on the component to be tested. These pieces of information are stored in a component dictionary which will help potential users of this component to find it through intelligent search facilities.

The CO-LaN checks components for compliance using the test reports provided by the CO Tester. This check implies an analysis of the messages created by the CO Tester. The CAPE-OPEN interface specifications are constituted both by Interface Definition Language files scripting the specifications, and by textual requirements gathered in accompanying documents. So the compliance tests can not be made fully automatic, at least at this stage. Upon successful check, the CO-LaN provides the requested compliance label to the software supplier. The CO labelled component can then be published within the CO-LaN component dictionary.

Information on each CO labelled software component is automatically stored in a database which can be searched by visitors of the CO-LaN web site. The database can be searched, for example, by type of calculation performed by a piece of software, thus enabling a process engineer to find the right tool to perform any piece of process engineering work, while being sure that the found piece of software will plug easily in his/her CAPE-OPEN compliant simulation environment such as Hysys[®] from AEA Technology Hyprotech or AspenPlus[®] from AspenTech.

Perspectives on CO Tester development

In the future the CO Tester will also act as a software component in simulation environments. Hence simulation environments will also be tested for compliance. It will also be possible to test software components which are using CORBA middleware. Additional CO interface specifications will be put to test: those concerning Physical Properties Data Banks, Numeric Solvers, Graph Analysis Tools, Mixed Integer Linear Programming (MILP) and MINLP tools, etc ...

Conclusion

The CO-LaN founding members, including Air Liquide, BP, BASF AG, The Dow Chemical Company, IFP, Mitsubishi Chemical Corporation, TotalFinaElf, Norsk Hydro, AEA Technology Hyprotech, ProSim SA, Shell International Chemicals, DECHEMA e.V., Institut National Polytechnique de Toulouse, RWTH-Aachen (Lehrstuhl für Informatik V and Lehrstuhl für Prozesstechnik), Denmark Technical University, Universitat Politecnica de Catalunya, as well as individual members are contributing to an organisation providing the tools required to sustain the CAPE-OPEN standardisation effort by checking the compliance of software with the released interface specifications.

Literature

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