



SPE 110864

## Integrated Flow Modeling Platform Using CAPE-OPEN Standard

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This paper was prepared for presentation at the 2007 SPE Annual Technical Conference and Exhibition held in Anaheim, California, U.S.A., 11–14 November 2007.

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### Abstract

The design and the operation of petroleum field facilities are facing technical challenges that require numerous and detailed simulations to optimize investments and maximize production. Such calculations rely on a global understanding of production processes that an integrated model from well-bore to topside facilities can supply. To develop such a model, seamless integration of third-party modeling and simulation technologies in a unique software platform is useful and even necessary in many cases.

First, this paper presents the R&D Transient Integrated Networks Analysis (TINA) project that was set up by TOTAL and IFP to address user requirements in term of model coupling, problem solving and data consistency. The TINA's domain of application is design and verification of flowlines from well-bore to topside facilities with a compositional approach. To achieve this objective, the CAPE-OPEN industry standard defined for Computer Aided Process Engineering (CAPE) applications has been used within the INDISS™ platform. The project relies on this platform for integrating modules, on IFP's research knowledge for pipe flow calculations and on third-party software components. TOTAL has brought to the project their knowledge of network design end operational characteristics, as well as the definition of functional requirements of TINA. Validation against field data has also been a profitable input to the project.

Then, this approach is illustrated through several examples integrating three-phase pipe models, valves and surface equipments and also third-party physical and thermodynamic property servers to simulate a deep-water production network.

At last, the paper expresses that the integration of a physical properties calculation server together with advanced pipe models in a software platform dedicated to steady-state and transient simulation enables to simulate deep-water production networks without having to rely on one single

simulation solution provider. The interchangeability allows the end-user to choose the most convenient software components for the purpose of a study, and the interoperability allows integrating the latest research improvements together with third-party software components into a global model.

### Introduction

The petroleum industry has to deal with more and more sophisticated software solution across technical disciplines. End-users ask for having consistent models and also open software platforms to build in their own way the physical system that they need to study and to evaluate. Moreover, there are several specialized models available within each discipline and some crossed comparison tests are required to evaluate their performance and accuracy and to select the most appropriate integrated solution. Thus, software platforms have to provide flexibility for integrating physical models in order to build and simulate complex systems.

One of the main challenges is the seamless construction of an integrated model across technical disciplines. The different technical disciplines use various tools and models describing their special technical fields. These models are often highly specialized and there is no common interface across disciplines.

The TINA project is a R&D project that was set up by TOTAL and IFP to prove the feasibility of integrating complex physical models coming from different software providers into a simulation platform while insuring data and model consistency. To achieve this objective, the CAPE-OPEN standard has been used as the basis of all developments. The CAPE-OPEN standard provides a seamless way for integrating models: it specifies interfaces for manipulating unit operations within a flowsheeting environment and for dealing with all sorts of thermodynamic calculations. The standard has been applied to many kinds of Computer Aided Process Engineering (CAPE) applications. At the beginning those applications were mostly in the downstream market but they proved also convenient in the upstream market. Consequently, CAPE-OPEN is proving more and more useful in upstream (Banks et al., 2005). TOTAL is actively supporting the CAPE-OPEN standard as it represents a solution for integrating models proceeding either from funded research developments or from software suppliers.

The TINA domain of application is dedicated to flow assurance studies from well-bore to topside. Modeling systems are composed of productivity index modules, wells, pipes,