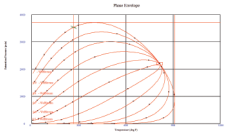
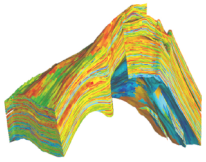
RESOLVE

ADVANCED INTEGRATION
A VENDOR NEUTRAL SOLUTION FORMULATION PLATFORM

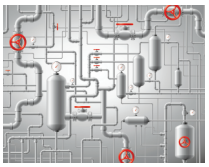
ADVANCED PVT HANDLING



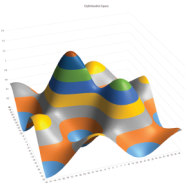
INTEGRATION OF SUB-SURFACE AND SURFACE MODELS



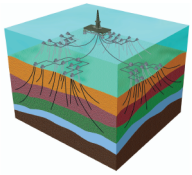
PROCESS



GLOBAL OPTIMISATION

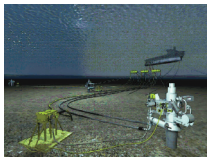


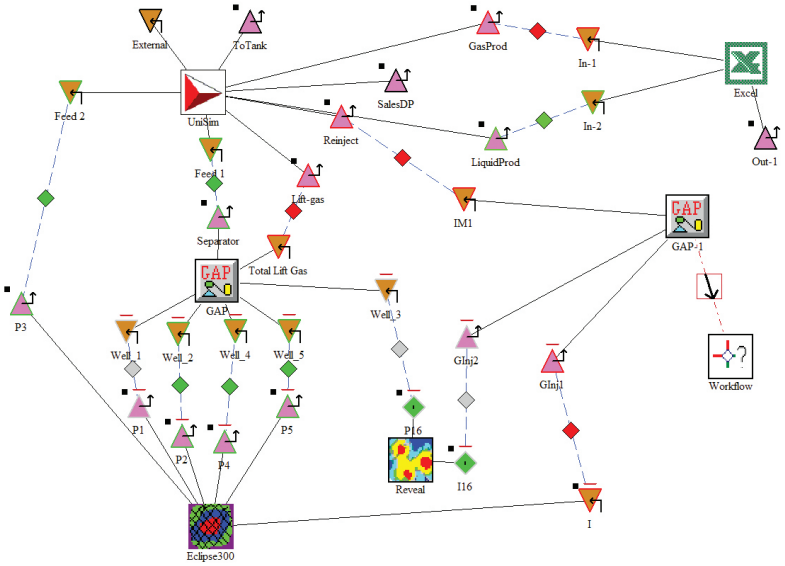
WELL PERFORMANCE



CHEMICAL DOSING

FLOW ASSURANCE





ECONOMICS

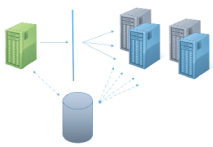
VISUAL WORKFLOWS

SCENARIO MANAGEMENT

PROBABILISTIC STUDIES

DATA OBJECTS

CLUSTERING & HYPERTHREADING



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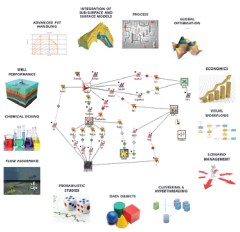

RESOLVE

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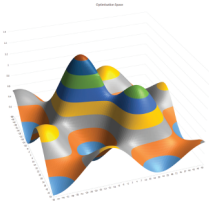
ECONOMICS

RESOLVE has been extensively tested on many fields all over the world, and its fast calculations (e.g. tight gas, shale oil/gas etc…) have been proven time and again for field development and Economic analysis. NPV, IRR and other Economic analysis can be easily used to drive a simulation and make decisions on operational strategy.

GLOBAL OPTIMISATION

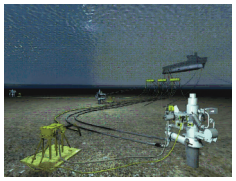


There is no "one solution fits all" optimiser algorithm that exists which can be universally applied to the upstream oil and gas system (because the problem is defined as a **Mixed Integer Non-Convex Non-Linear Optimisation** Problem). **RESOLVE** contains an SLP and Routing optimiser, combining this with the NLP optimiser in **GAP** allow for potentially a three tiered optimisation, where the user must formulate a way in which to make all of these search algorithms interact, to find the global maxima. As such **RESOLVE** has multiple levels of sophistication in the way it combines it's **multi tiered optimisation problems**, using linear, non linear and integer algorithms together to address the complexity of interaction that exist within the upstream system. All of which can be triggered and controlled dynamically from **Visual Workflows**.

DATA OBJECTS

A number of **unique** and **efficient** computational functionalities are abundant across the **IPM** suite: this is what makes the **IPM** tools industry leading in terms of the diversity of analysis that can be performed in a single suite of applications. It is these capabilities/functionalities that have been isolated and exposed for the user as **Data Objects**: in this way all of the features are no longer native to the application in which they originated, rather they are available for a user to expose to any logic or workflow as needed. In addition to all the **IPM** calculations, there are also many other functions that are included. The list is continuously expanding, and today include data objects related to PVT, Data Stores, Maths Libraries, Wells, Tight Reservoirs, SAGD Processes, Multi-Well Allocation, Smart Well (ICD) Analysis, Probabilistic tools and Transient calculations.

FLOW ASSURANCE



Flow assurance studies centre around the **detection** of specific phenomena that are a function of the fluid PVT or the pipeline hydraulics (e.g. Slugging, Liquid loading, Wax formation, Hydrate formation , etc.). The underlying applications detect the phenomena, whilst the controlling logic in **RESOLVE** provides the mitigation action that is in line with field strategy. **Transient hydraulic/Thermal** simulations are usually done in isolation of steady state models, using rates, pressure and PVT that may not represent the dynamically changing nature of the field. In **RESOLVE**, qualifying criteria can be setup in **Visual Workflows**, and these would then trigger the transient simulation (LedaFlow®) using consistent pressure, rates, PVT and field specific data (i.e. well/pipe deviation). Having performed the transient analysis, the steady state analysis would continue. This ensures that steady state and transient calculations are done according to where they are most useful and coupling of the two methods allows for formidable workflows to be constructed. Currently **RESOLVE** has the driver to link to the transient simulator LedaFlow®.

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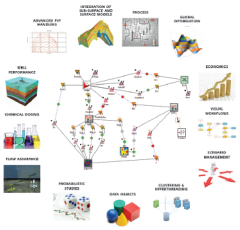

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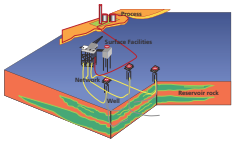
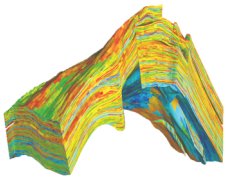
OIL AND GAS FIELDS ARE NATURALLY INTEGRATED



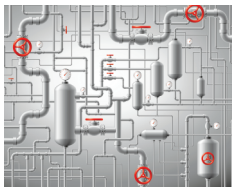
The concept of Integration was pioneered by Petroleum Experts in 1990 and it involves the elimination of artificial boundary conditions that would otherwise have existed if engineers study each individual element of a field in isolation. The same concept is expanded in **RESOLVE** as a vendor neutral system, by enabling the link between any application (from any vendor) that describes a part of the system to other software in a dynamic and fully integrated fashion. Reservoir simulators can therefore be connected to well models, surface facilities, process, re-injection and any other element that the user requires as part of their formulation. As part of this process, PVT handling, physical models of correcting IPRs, a variety of coupling schemes and other means that ensure that these connections are not only mechanically simple, but physically robust and efficient were invented by Petex and are available to the users as part of the unique collection of features of **RESOLVE.** Integration is the starting point of formulating robust **solutions** to petroleum engineering challenges and this is the base level of the capabilities of **RESOLVE** and the starting point of using the other features available.

INTEGRATION OF SUB-SURFACE AND SURFACE MODELS



RESOLVE has **proprietary algorithms** to perform the **physically consistent** coupling between reservoir simulators to well, network and process models (referred to as **IPR Scaling**). Commonly used techniques in the industry, such as the iterative Newton coupling, are computationally expensive, inflexible and restrictive. The Petex IPR scaling method allows for multiple simulation models from multiple vendors to be part of the model, being connected to a surface network that can include multiple levels of optimisation. Adaptive time-stepping allows the granularity in calculations when events occur in the field to be captured. The result is that mass and pressure balance exist across the system, irrespective of the underlying simulators, using fundamentally different physical principles at their core. Currently the following simulators can form part of a **RESOLVE** model: Eclipse (E100, E300), IMEX, GEM, PUMAFLOW, PSIM, NEXUS, VIP, tNavigator and TEMPEST (with more currently under development). In addition, many clients have created connections that are proprietary to their companies and the tools that they use internally.

PROCESS



Complex facilities, compression trains, and heat exchange processes (among others) ready the fluid for export are best captured in process simulators. In reality these systems are directly connected to the upstream system and any change in the feed composition and conditions will have a direct impact on the performance of the process. As such, **RESOLVE** allows the full downstream response, to be captured over time by the integration of these models with the upstream process systems including UniSim, HySys and ProII. As thermodynamic consistency is key to ensuring these dynamic connections happen in a physically consistent manner, **RESOLVE** includes unique **Lumping/Delumping** algorithms that allow the orchestration of PVT transfers between applications. Black Oil models can be delumped to fully compositional descriptions and vice versa, so that the PVT requirements of each engineering application are satisfied.

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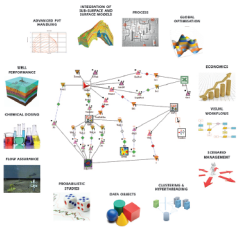

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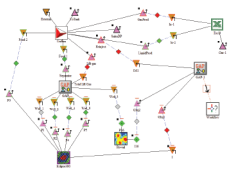
RESOLVE INTEGRATED MODEL

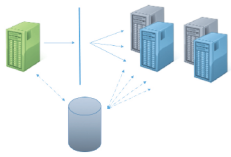


RESOLVE is a platform designed for the engineer to express the engineering ideas and formulate solutions as integrated engineering studies in a vendor neutral environment. The software, commercialized in 2002 as a strategic advancement in the concept of Integrated Production Modelling (**IPM**), moved the development of models from the Petex domain to a vendor neutral platform. From the outset of **IPM** the intention was to expand the capabilities of the tool in such a way that engineers would be able to express their ideas in an easy to use platform that would require no coding at all. Today, **RESOLVE** encompasses many **unique capabilities** listed in this document, including nested optimisation, visual workflows, advanced PVT handling, data objects etc. Each of these items encompasses decades of research and petroleum engineering experience. This ensures that solutions are formulated easily and include the optimum level of physical interactions between each element of the system.

SCENARIO & PROBABILISTIC STUDIES

Within **RESOLVE** the **Scenario Management** capability allows multiple realisations of field strategies or underlying model setup to be run in parallel or on separate nodes using the clustering/hyper threading capabilities built into the tool. There is often a degree of uncertainty in the field information and the operating strategies. For instance reservoir volumes, or well deliverability are assessed on a P10, P50 and P90 basis, and there are many field development scenarios that satisfy the design criteria. The response of the integrated system will change depending upon which assumptions are considered, and these can all be assessed using a combination of the Scenario Manager and the relevant Data Objects (Sensitivity Tools, the Case Manager and links to **CrystalBall™** and **@Risc™** among others).

CLUSTERING & HYPERTHREADING



For efficient processing and faster calculations times **hyperthreading** and **clustering** capabilities are part of **RESOLVE**. In the former the parallelisation of solver algorithms have been implemented, and the use of local (multi core processing) or network (remote machines) computing clusters is available. In the latter context the PXCluster (Petroleum Experts clustering) has been designed to distribute computations over multiple computational nodes.

VISUAL WORKFLOWS

Petex's **Visual Workflows** are a natural evolution of the **Event driven scheduling functionality** (existed in **RESOLVE** for over a decade now), which allow engineers to seamlessly create controlling logic that drives the development and management of the field without entering a single line of code. Logic can be implemented (using Visual Workflows) to control the simulation, and perform additional calculations to assess the likelihood of certain events (e.g. hydrate formation), and even propose mitigation actions (e.g. chemical dosing of MEG to the pipelines). All of this can be automated in a workflow to be dynamically assessed at each timestep.

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