PETRONAS

FDP Digital Ecosystem

Enhancing Cross Discipline Collaboration and Acceleration of FDP Projects

Presentation at Schlumberger Digital Forum

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Presentation Outline

- FDP Digital Ecosystem in PETRONAS
- BD Cluster: Field Background, Challenges and Solution
- FDPlan Workflow Enhancement
- Recommendation & Way Forward

From the lens of Program Coordinator

FDP insight from BD Cluster team

DELFI Technology to Enable Resource Acceleration and Robust Project Delivery

Remote connectivity

- Work from anywhere, anytime
- Collaborating ‘live’ with team

Packaged profiles

440 profiles

Cloud Based Petrotechnical Tools (G&G, RE, PP, PE)

- Economic of scale across EDP
- Subscription vs perpetual license
- High end Virtual Machine

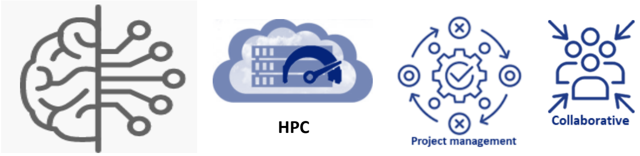
Processing & Storage

- Information backed up and secured.
- Storage and processing elastic capacity.
- Parallel processing.

Resources & Organization

- Department Managers
  – track compute utilization
  – assign domain PTS profile

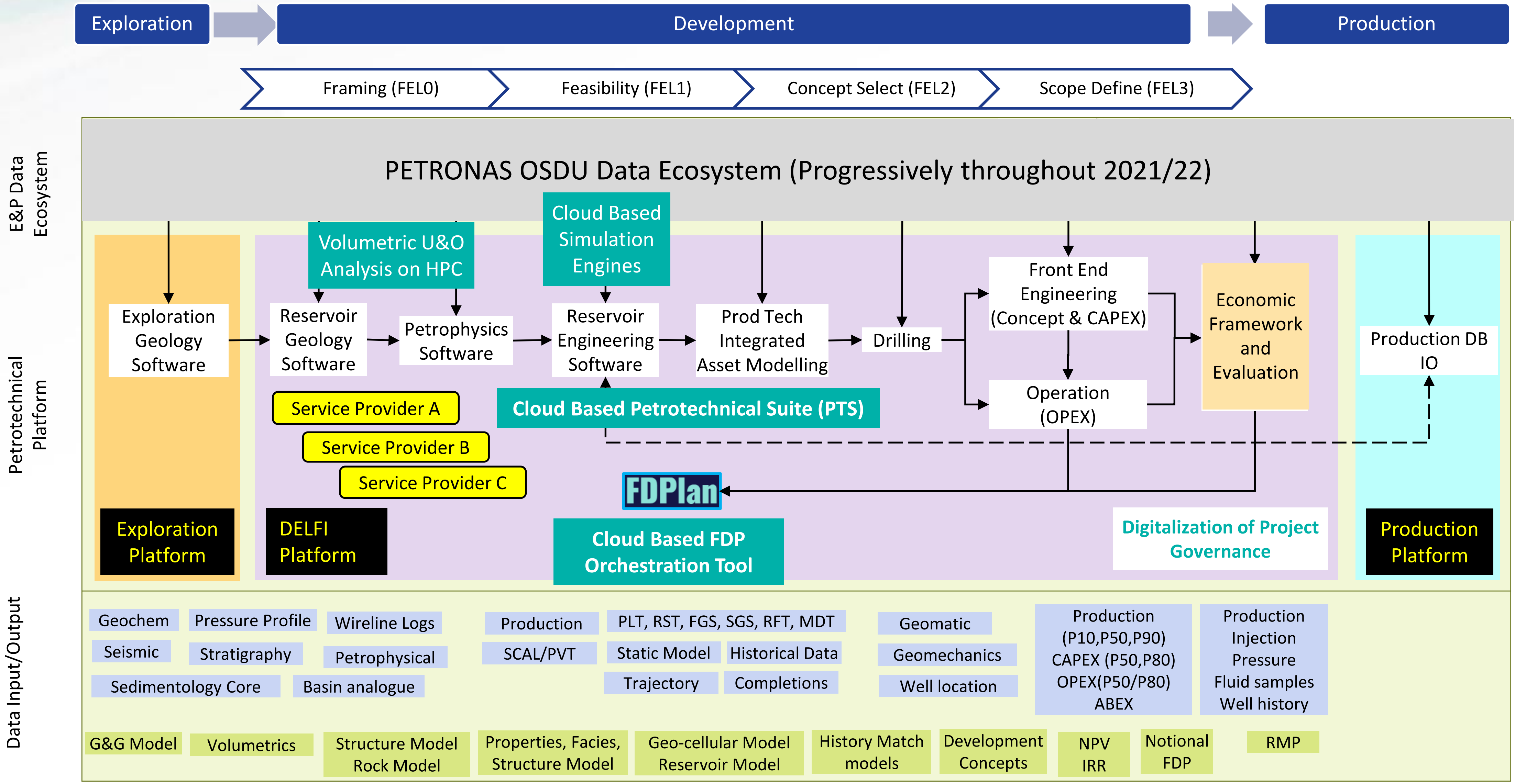
Data Analytics, HPC, ML, AI



- Faster compute times via HPC
- Native cloud application, data analytics, Machine Learning and AI applications

FDP Digital Ecosystem

Digital FDP To Be Ecosystem at a Glance



- ✓ *Open Subsurface Data Universe (OSDU) Compliant*
- ✓ *Open Environment, not exclusive from single Vendor*
- ✓ *API Connector Ready with 3rd Party Integration Platform*

FDP Digital Ecosystem

How PETRONAS Manages High Risk Projects through Digital Technology

Screening Evaluation and Criteria

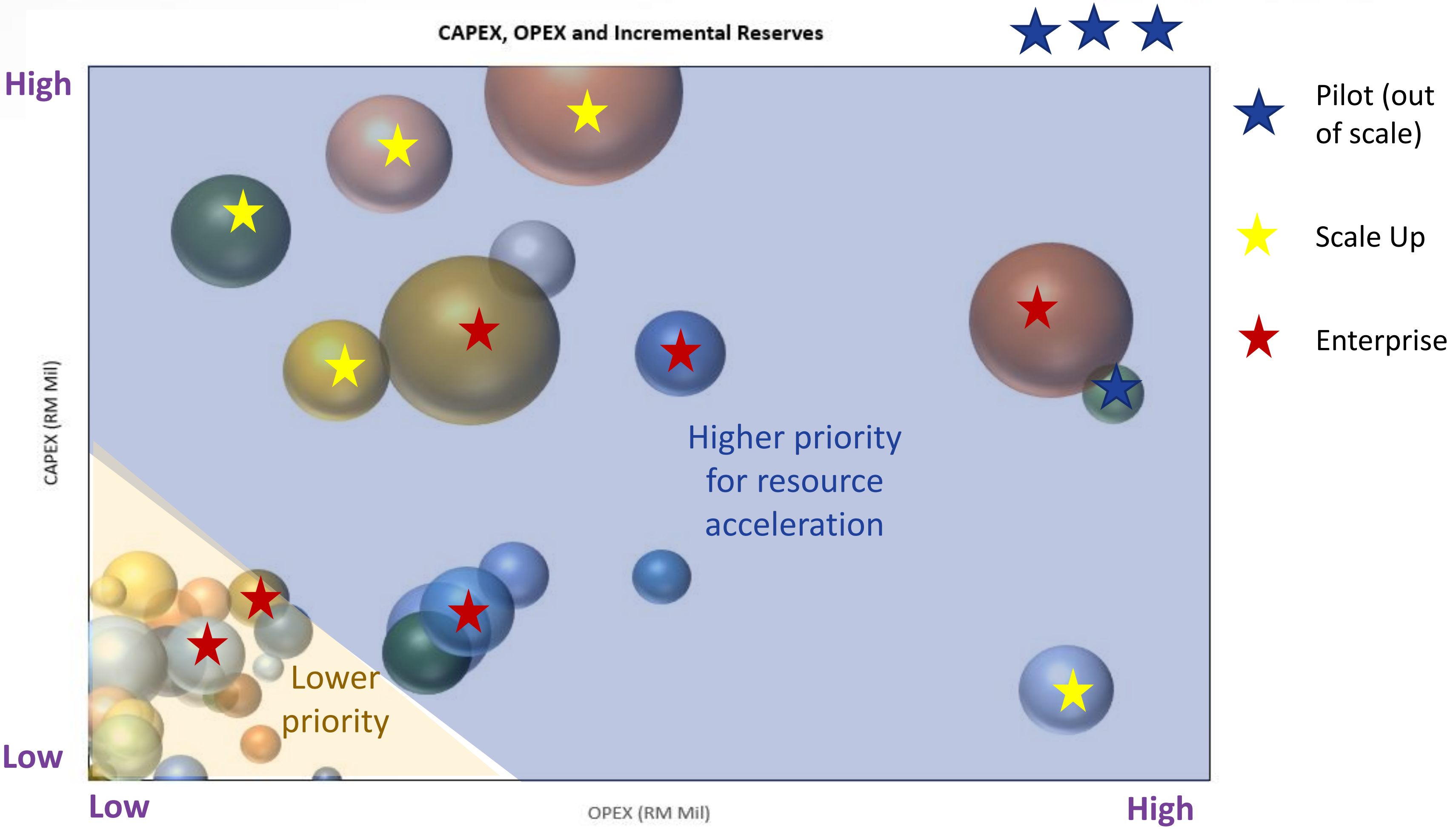
All CR1 Projects
as per ARPR database

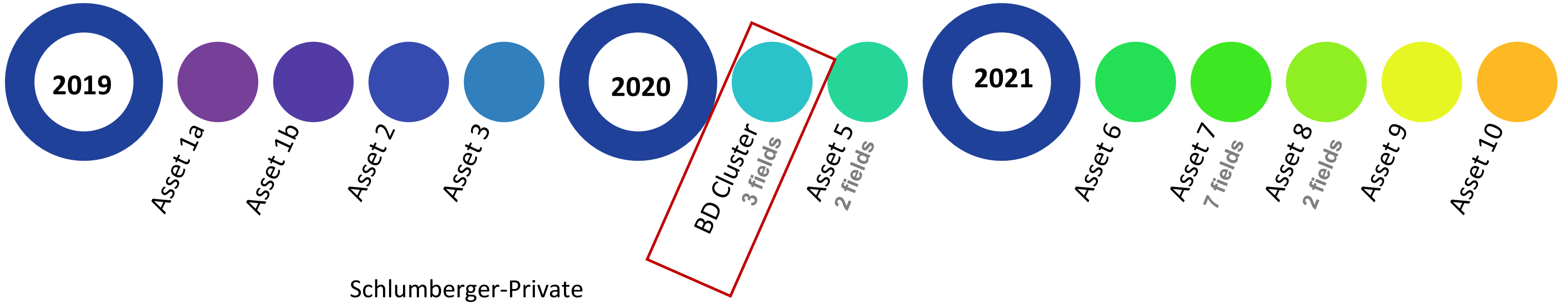
Project cost
High CAPEX + OPEX

Incremental reserves
High Reserves

Current FDP stages
Feasibility, Concept ID

Multiple development scenarios
Integrated facility concept

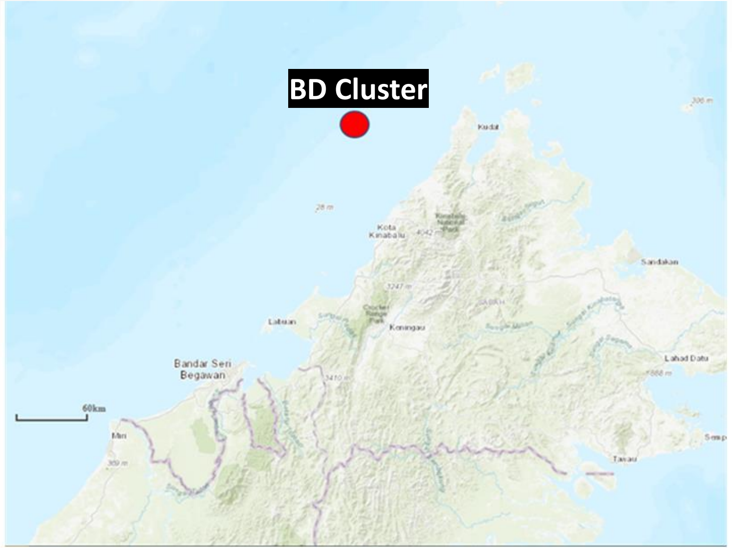


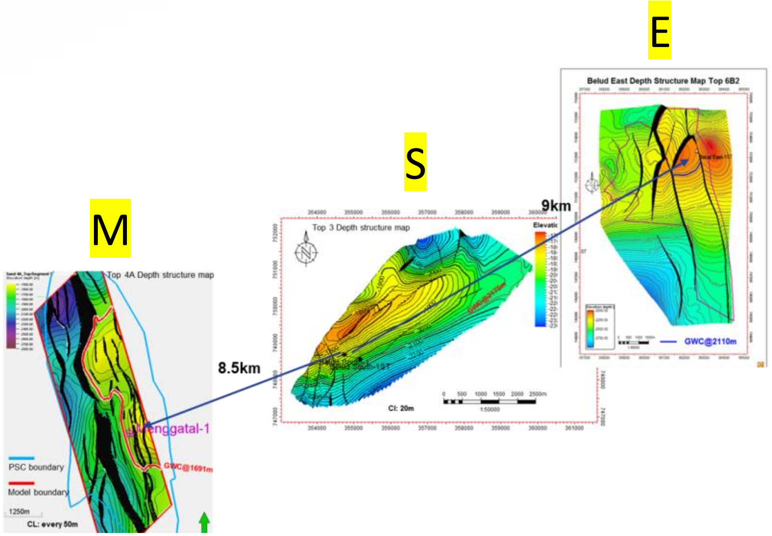


FDP Digital Ecosystem

Case Study of BD Cluster : Development Challenges

BD Cluster : Field Overview





Data availability

- Poor to fair seismic imaging
- Sparse well coverage (5 wells)
- Very limited core data (1 well)
- Borehole Image logs (3 wells)
- LWD and MDW logs
- Pressure data
- Limited check shots data

High uncertainties

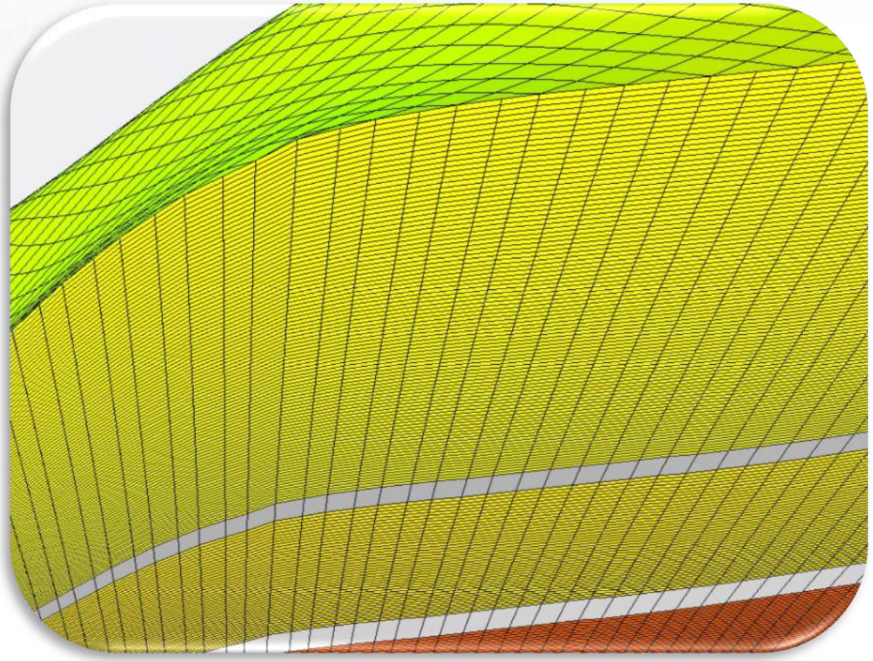
Geological Complexity

- > 30 multi-stacked stratigraphic units
- Highly faulted, compartmentalized structure
- Multiple fluid contacts per zone
- High structural uncertainty due to limited well and check shot data
- Deep Water Turbidite reservoirs
- High lateral and vertical heterogeneity
- Poor understanding of reservoir connectivity

High resolution models required to capture heterogeneity

FDP Digital Ecosystem

Digital adoption enabling the possibility to build and run these complex models leveraging on Cloud technology



Fine lateral and vertical resolution grid

3D grid construction criterion

- 3D Grids suitable for both Static and Dynamic modeling (no upscaling)
- Lateral I&J increments to capture lateral heterogeneity
- K layer thickness should capture vertical heterogeneity observed on the core and log data

Final resolution of the geocellular grids

Model Name	Number of zones	Grid dimension (m)	Number of cells (MM)
Model E	27	25 x 25 x 0.3	**91 MM**
Model S	33	50 x 50 x 0.4	**11 MM**
Model M	10	50 x 50x 0.3	**28 MM**

High uncertainties + Fine scale modes = Run time is high → Performance challenge

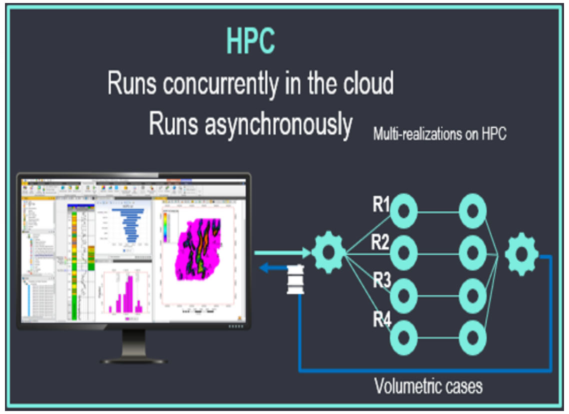
Comprehensive 3D static modelling and extensive uncertainty analysis studies to be performed within tight timelines.

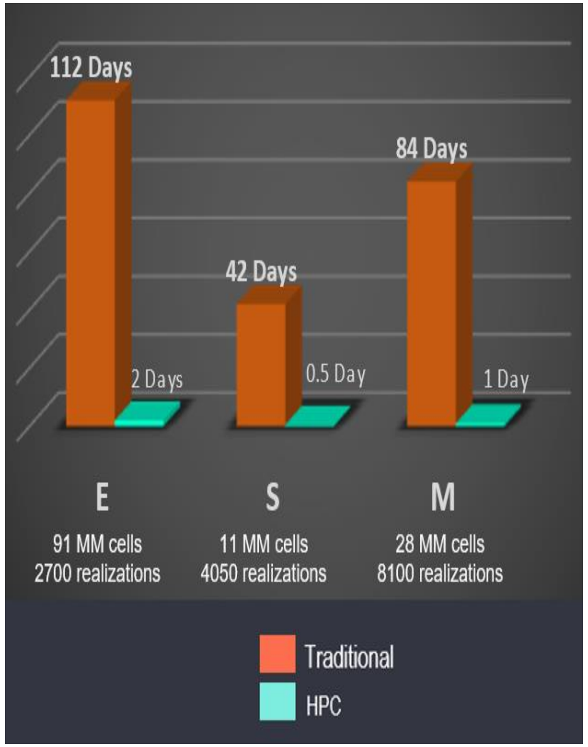
Case Study Proof Point From Geological Modeling Perspective

BD Cluster : Volumetric U&O Analysis on HPC

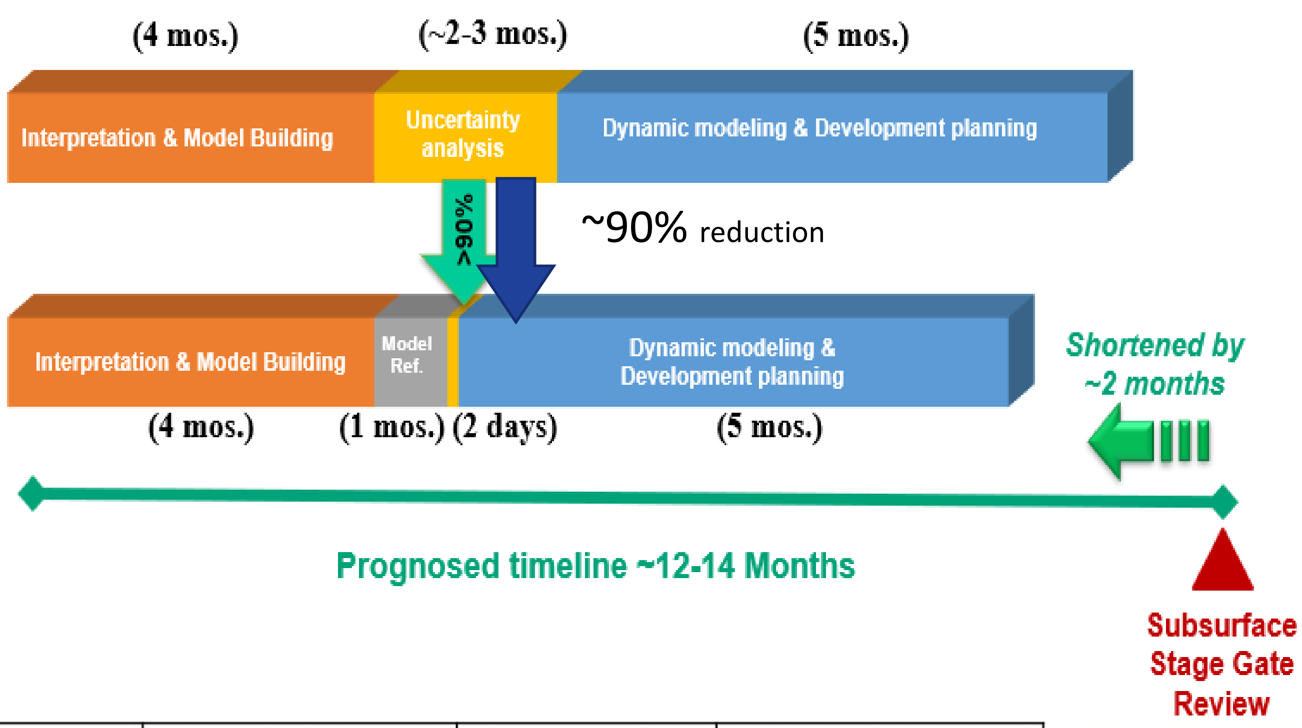
Run Time Improvement

High Performance Computing





Value Creation

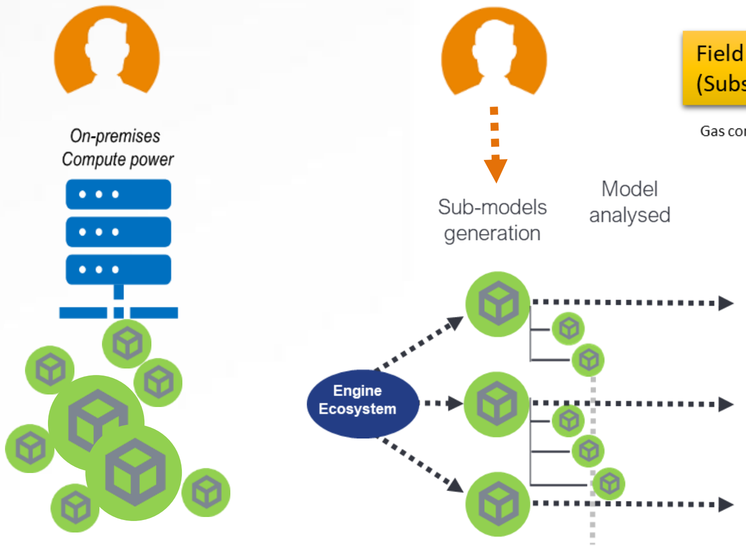


Model Name	Number of cells (MM)	One realisation run (min)	Total realizations	Time to complete conventional (days)	Time to complete on HPC (days)	Efficiency gain
Model E	91 MM	60	2700	112	2	56 times
Model S	11 MM	15	4050	42	0.5	84 times
Model M	28 MM	15	8100	84	1	84 times

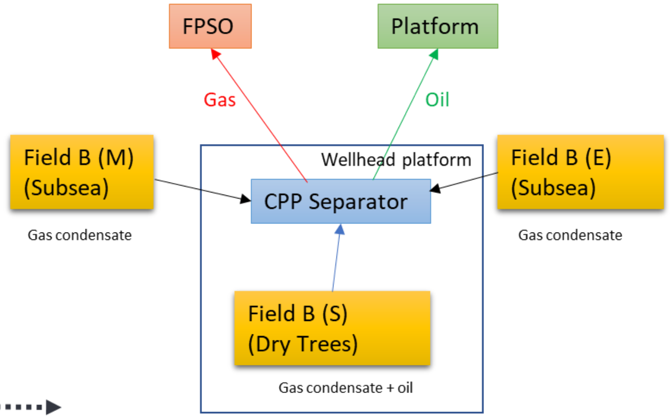
Case Study Proof Point From Reservoir Modeling Perspective

BD Cluster : Probabilistic Dynamic Simulation Studies

Traditional Simulation vs Cloud



On-prem



Challenges:

- On-prem infra and license limitations constraints large-scale ensemble-based probabilistic studies
- Uncertainty management via multi realization simulation of giant coupled reservoir model

Case for Change:

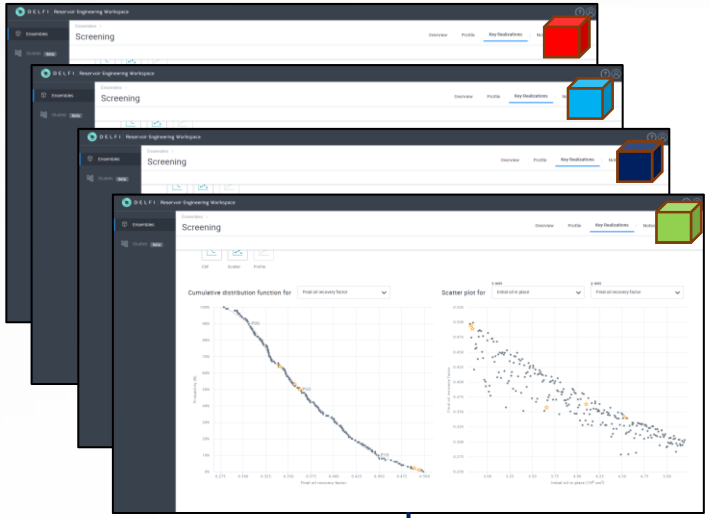
- Leveraging on scalable cloud computing power for ensemble-based reservoir simulation studies
- Empower team to sample all possible development planning scenarios - running dynamic simulations simultaneously
- High level economics screening for all reservoir realization for concept selection

Field	Active cells	Simulation runtime (hours)	No. of concurrent simulations	No. of processors per simulation	Estimated simulation time to complete all concurrent simulations
Field B (M)	2.1 MM	5.1	500+	48	1 day
Field B (E)	1.3 MM	4.0	500+	32	1 day
Field B (S)	2.5 MM	6.3	500+	40	1 day

FDP Digital Ecosystem

Case Study Proof Point From FDP Orchestration Perspective

Dynamic Simulation Outputs from Cloud Based Petrotechnical Tool & Simulation Engines



Manage the Plan
Integrated, coordinated team planning

Frame the Opportunity
Early stage planning with greater insight

Build and Evaluate
Live planning fueled with economic and technical rigor

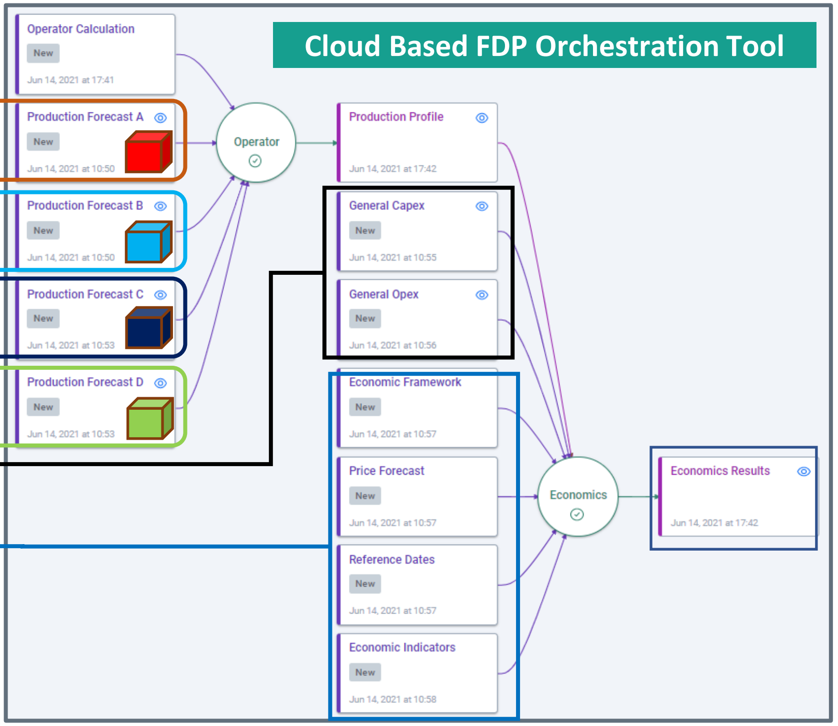
Compare and Decide
Accelerated decision-making aligned with business needs

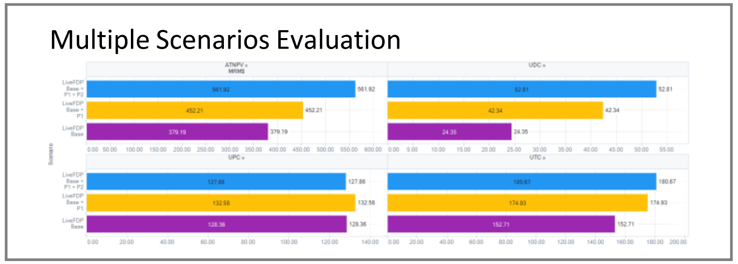
Field B (E)
Field B (S)
Field B (M)
Field B (L)

Production Forecast

Costing (CAPEX & OPEX)

Economic Framework



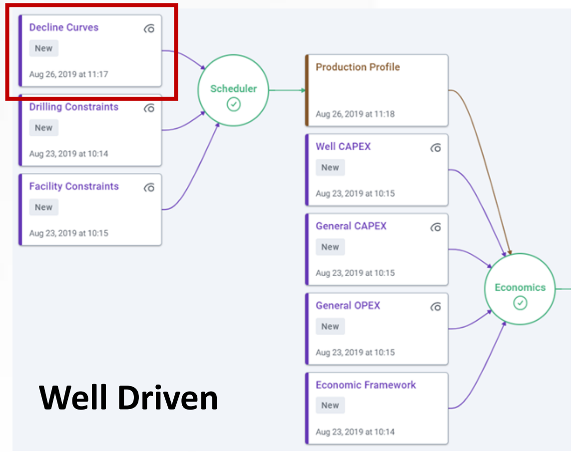


18 Development Scenarios Evaluation in 2 weeks' time @ FEL 1 - ready with Live & Intuitive Platform to optimize for next FEL stages

FDP Digital Ecosystem

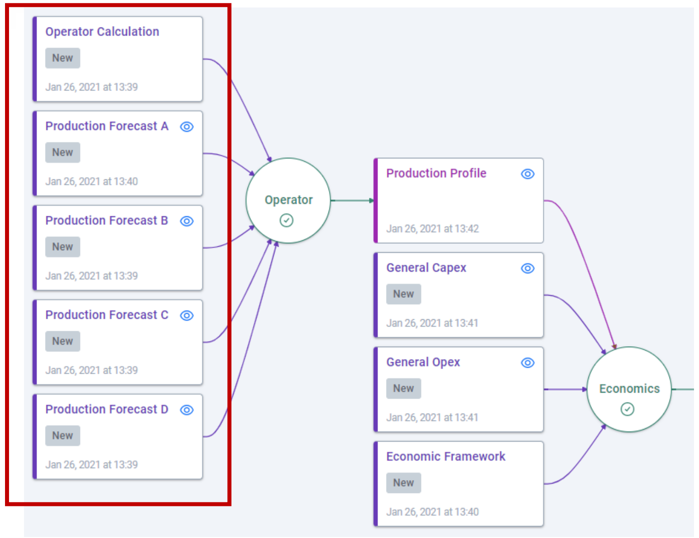
Adopted Agile Methodology to Enhance User Experience via integration with other Corporate Digital Application

FDPlan Workflow Evolution



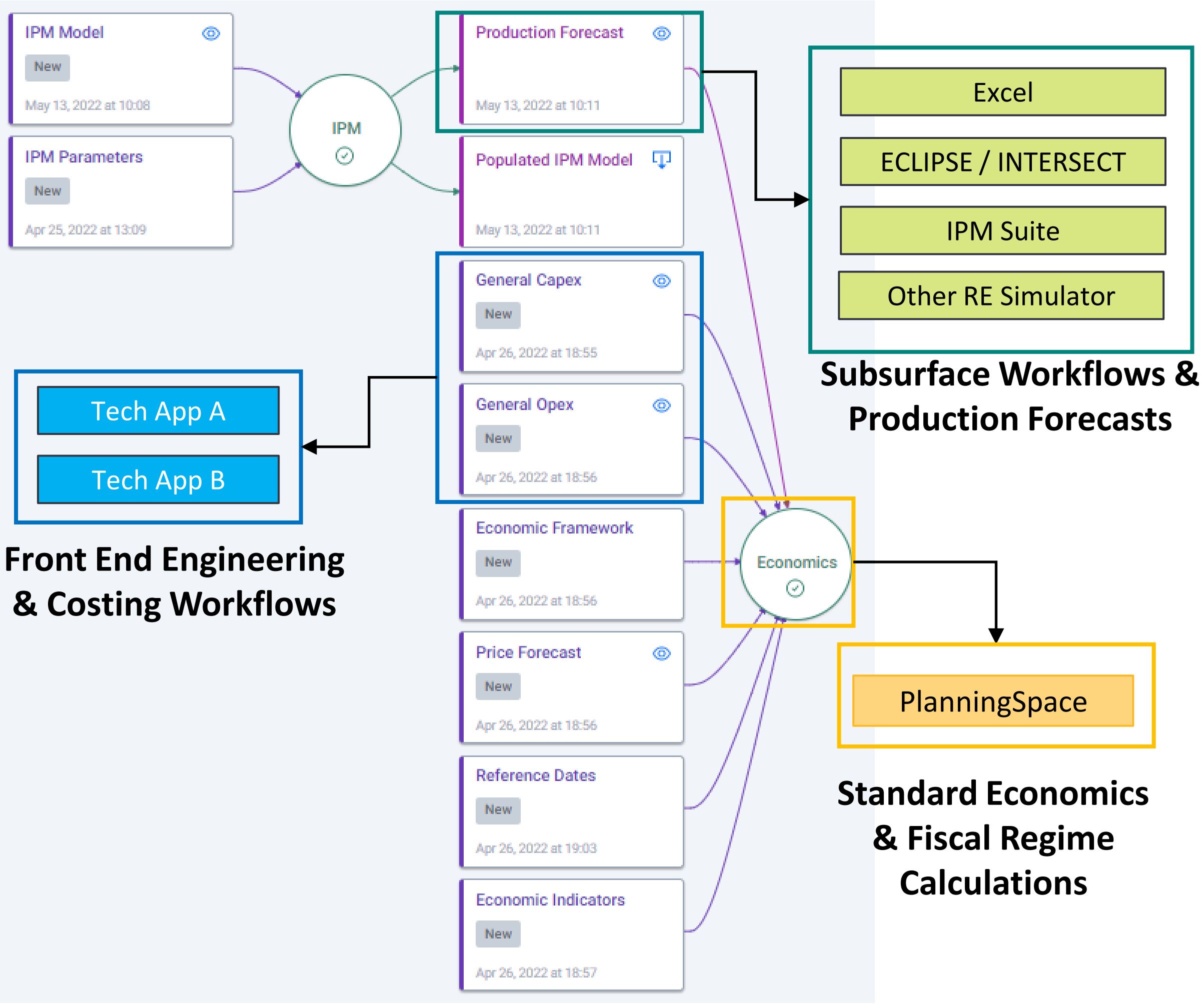
Well Driven

Field Driven (Single Prod)



Field Driven (Multiple Prod) with RE Operators

Expansion beyond Subsurface Domain



Subsurface Workflows & Production Forecasts

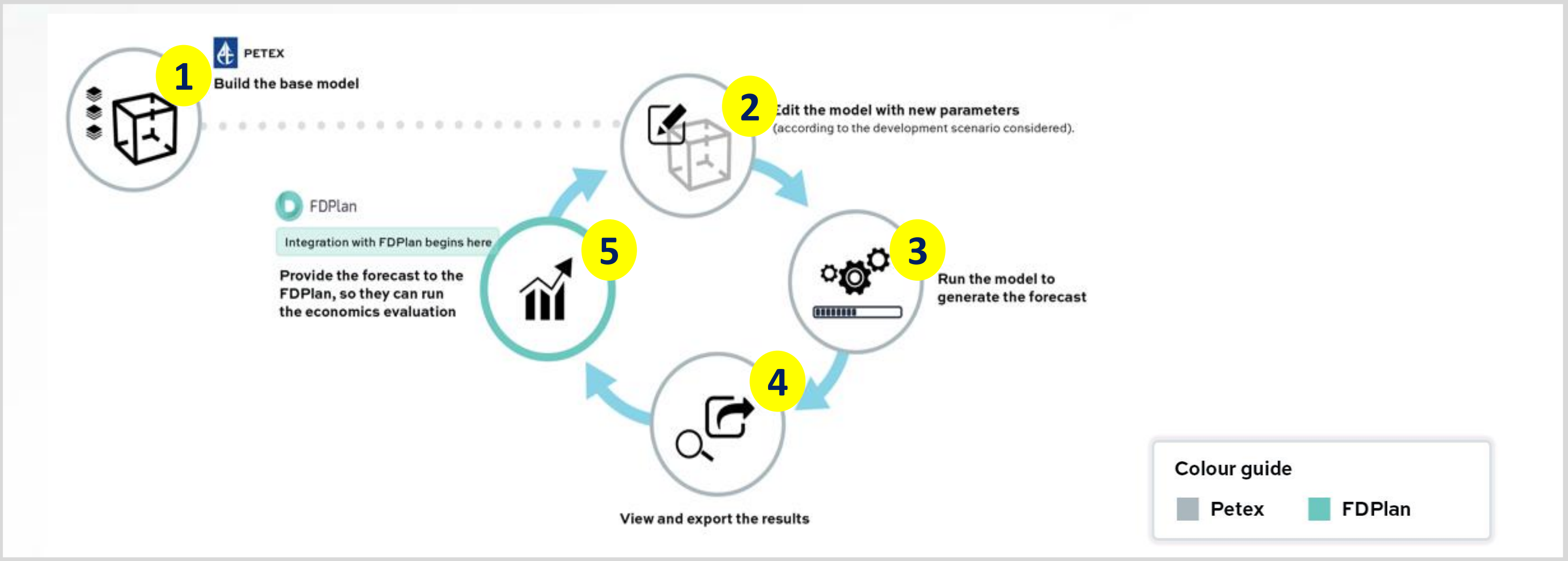
Front End Engineering & Costing Workflows

Standard Economics & Fiscal Regime Calculations

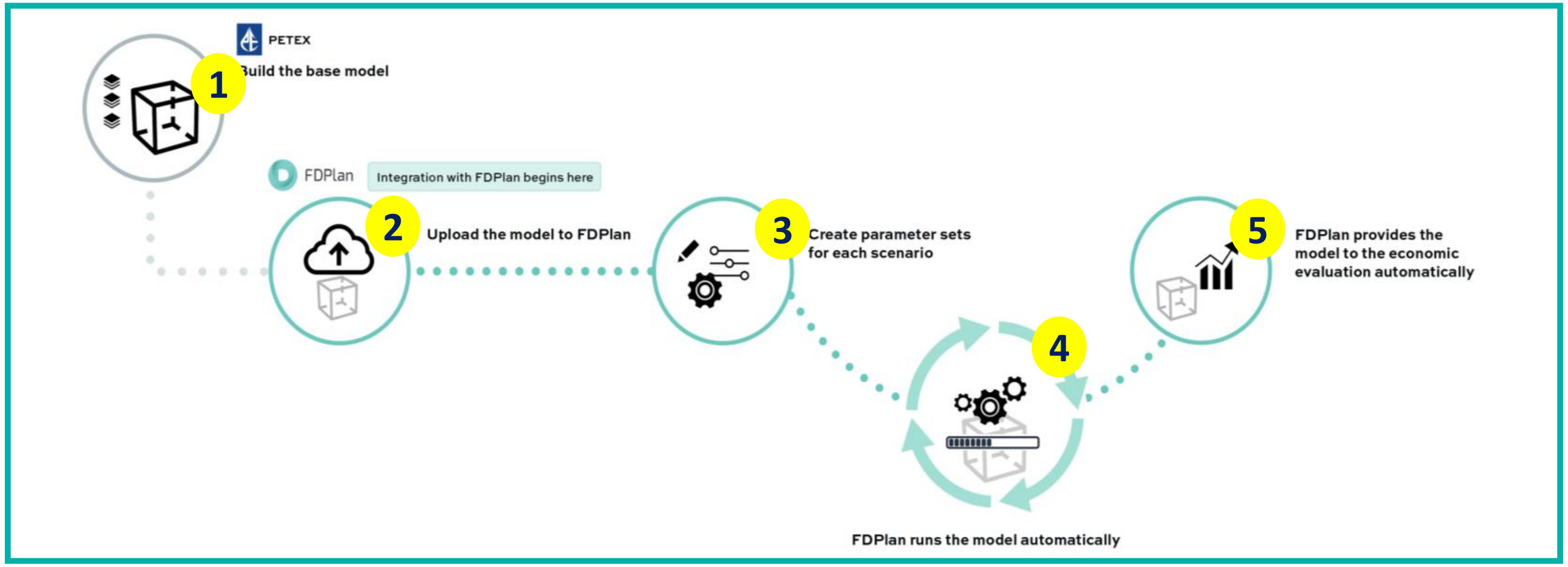
FDP Digital Ecosystem

FDPlan – PETEX Integration
Eliminate manual export and upload data for seamless decision making

Existing Workflow



Integrated Solution



Existing Workflow

- Export production profile from PETEX
- Manually reformat to FDPlan template before upload into FDPlan.

New Workflow

- Integrate PETEX production engine and sensitize the parameters within FDPlan
- Simulation result consumed directly for seamless economic runs and analytics

Enhancement

- Automation with improved UI
- Allow dynamic linking to decision and optimization parameters in FDPlan

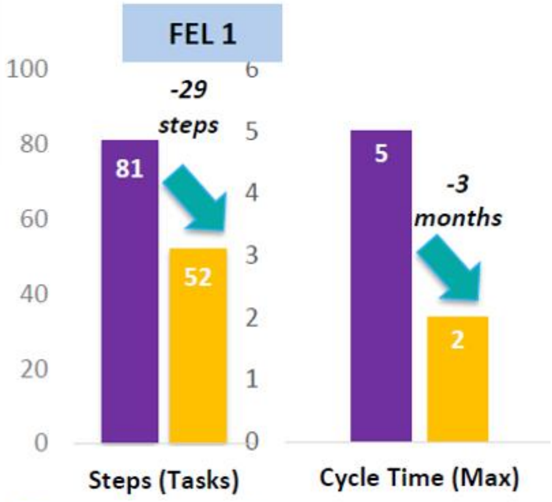
Process Cycle Efficiency Analysis
'Conventional vs FDP Digital Ecosystem'

Key Value Delivery

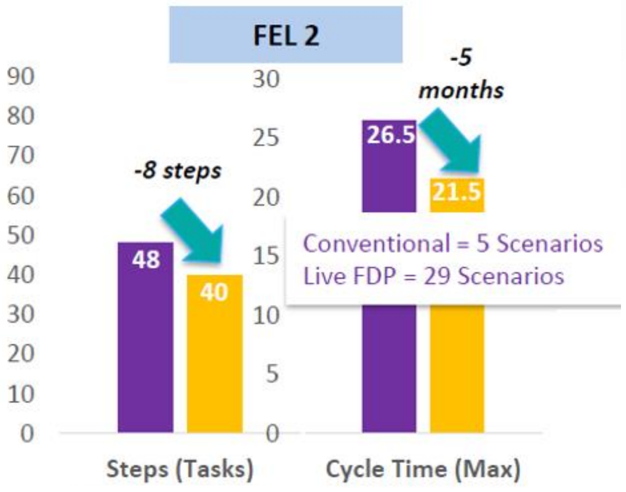
- Improve FDP cycle time up to 6 months via cloud computing and high-level project economics screening
- Minimize iteration cycle time (FDP team, TA/TP reviews, Stage Gate reviews)
- Collaborative platform between Subsurface and Surface in delivering FDP

$$\text{PCE} = \frac{\text{Value Added Time}}{\text{Total Lead Time (VT + BVA + NVA)}}$$

Feasibility



Concept Select

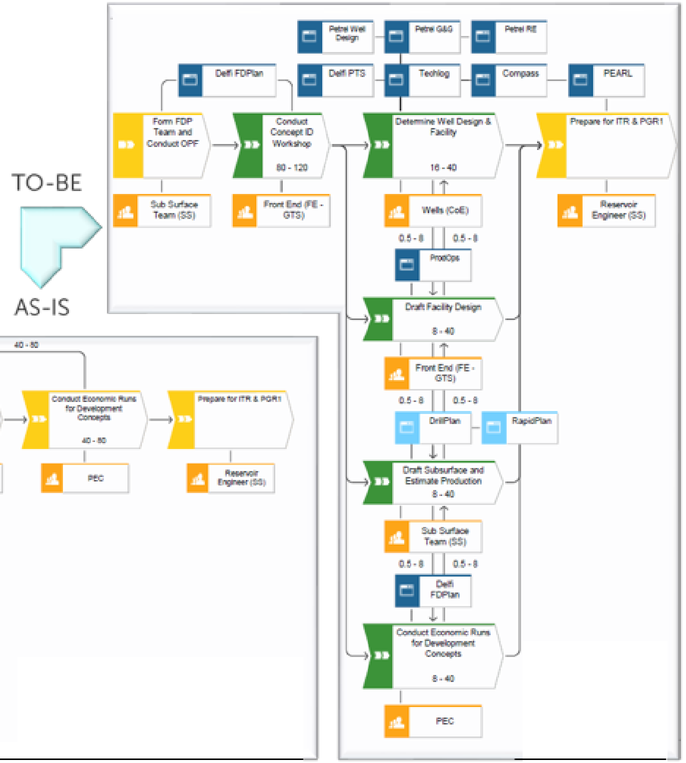


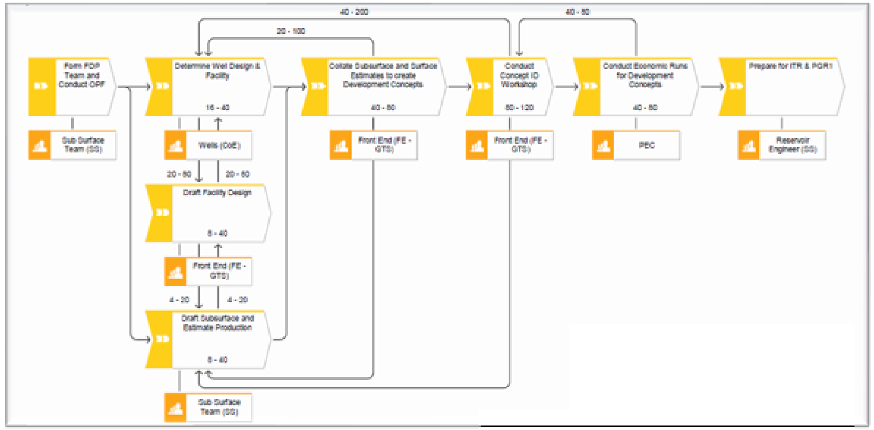
Conventional FDP Digital Ecosystem

Gap analysis for FEL 1 – Conduct Feasibility Study

VALUE AREAS	AS IS	TO BE
TOUCHPOINT REDUCTION	81 STEPS	52 STEPS
CYCLE TIME	IN MTHS	IN MTHS
MIN	2	1
MAX	5	2
OTHER VALUE GENERATION		

- ✓ Front ending of techno commercials for improved concept creation
- ✓ Increased quality and completeness of development scenarios
- ✓ Reduced cyclical involvement of resources





Recommendation & Way Forward






	Technology	Business Model	Competency
Existing Solution	Subsurface centric Operator centric (enhancement) Service provider centric	Profile based subscription (named user) for PTS and FDPlan	High dependency to Vendor for technical support and tech apps familiarity
Constraints	API readiness for cross FDP platform integration (Front end concept, Economics)	Limited scalability – the need for a fit for purpose access model	Not sustainable for digital adoption – require cross domain integration to deliver end-to-end workflow for users to be self sustainable
Forward Plan	The industry (Operators and Technology Providers) must collaborate and be more open to integration	Concurrent user subscription (Enterprise FDPlan access to FDP team rather than by engineer)	Super user within disciplines fraternity on DELFI technology

REINVENTING UPSTREAM
Safe | Resilient | Low Cost | Low Carbon