Utilizing Ensembles into Fully Integrated Network Models

Topic: Making Decisions under Uncertainty

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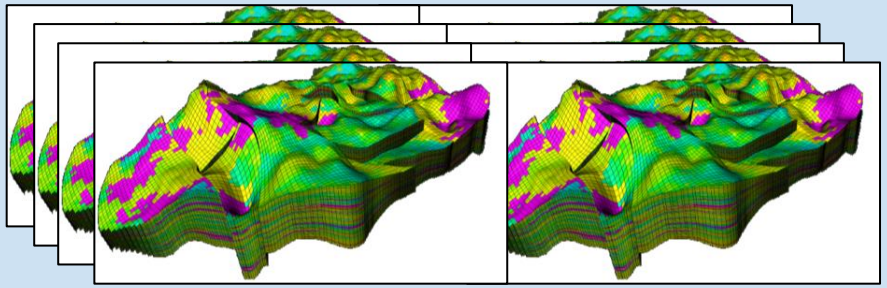
Introduction

- AkerBP has started to utilize reservoir model ensembles into fully integrated network models.
- The development is a result of collaboration across Digital Improvement domains.

- **This presentation will discuss:**
  - Technical descriptions of tools and methodologies.
  - Overall workflow and integrations points.
  - Discussions around methodology.

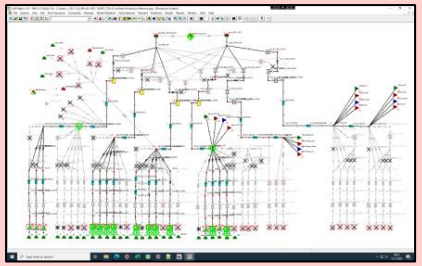
- AkerBP mainly uses the Petex IPM tools, but the tools are not the main point of this talk.

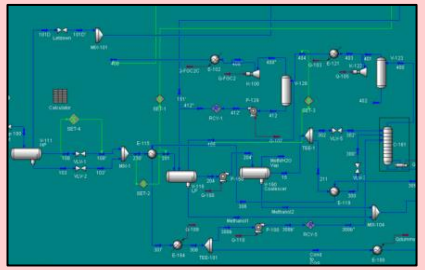
DIGITAL: Uncertainty modelling and ensembles



Collaboration across digital initiatives

DIGITAL: Production optimization and energy management





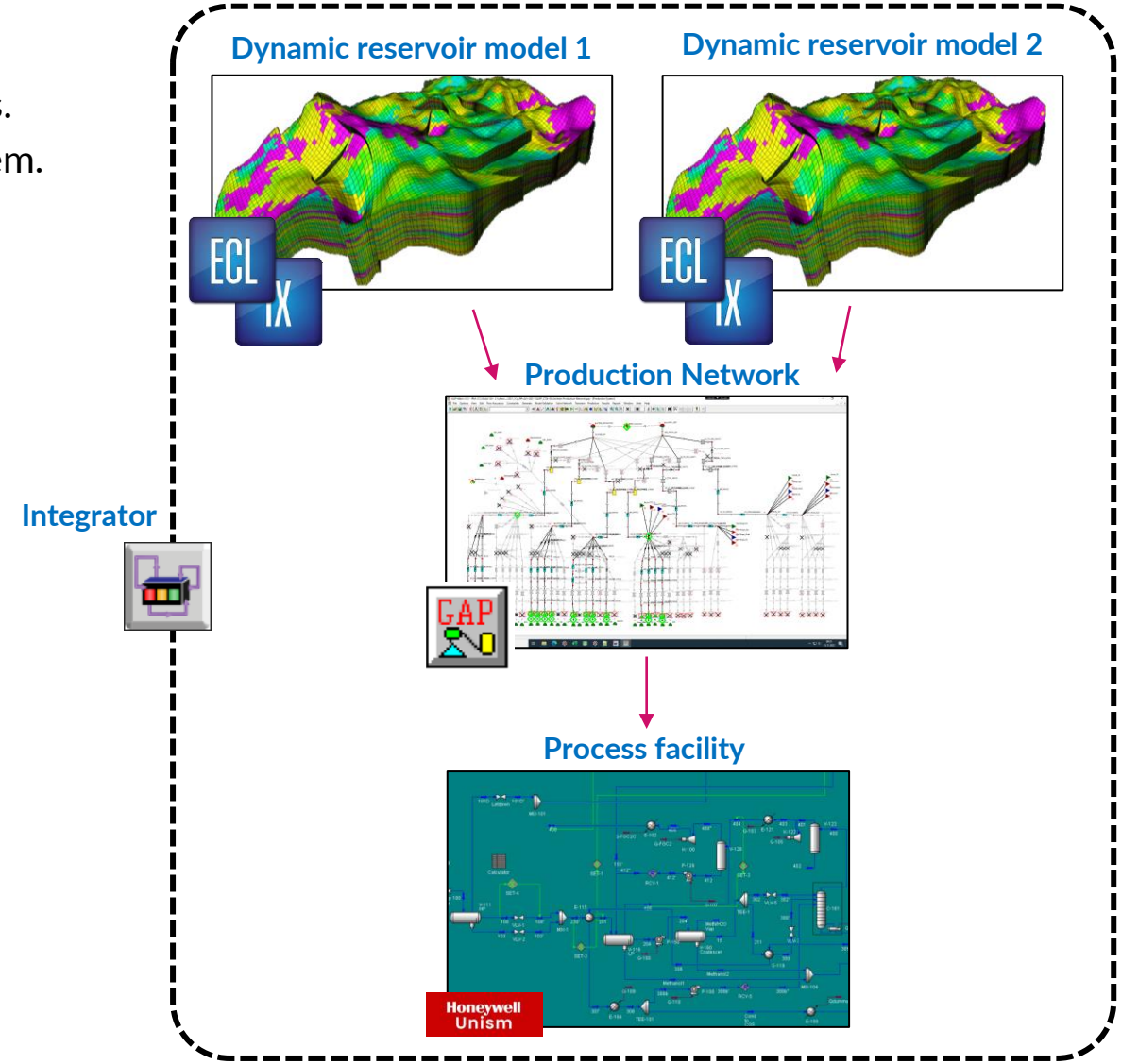
Why Network Modelling?

- **What is Network Modelling in this context?**
  - Modelling topside equipment with Dynamic reservoir models.
  - Coupling multiple reservoir models to the same topside system.

- **Why don't we just use VFP tables in the reservoir simulator?**
  - *Equipment*: pressure, temperature and constraints.
  - *Integration*: multiple reservoirs, third party softwares.
  - *Optimizers*: integrated optimizers and workflows.
  - *Collaboration*: with downstream disciplines.

- **When do we need Network models?**
  - When wells and fields have strong backout effects.
  - Multiple reservoirs competing for capacity and priority.
  - Equipment upgrades ←→ Field development

- **Main challenge**:
  - Computing power and runtime.
  - Limited by the slowest dynamic model.

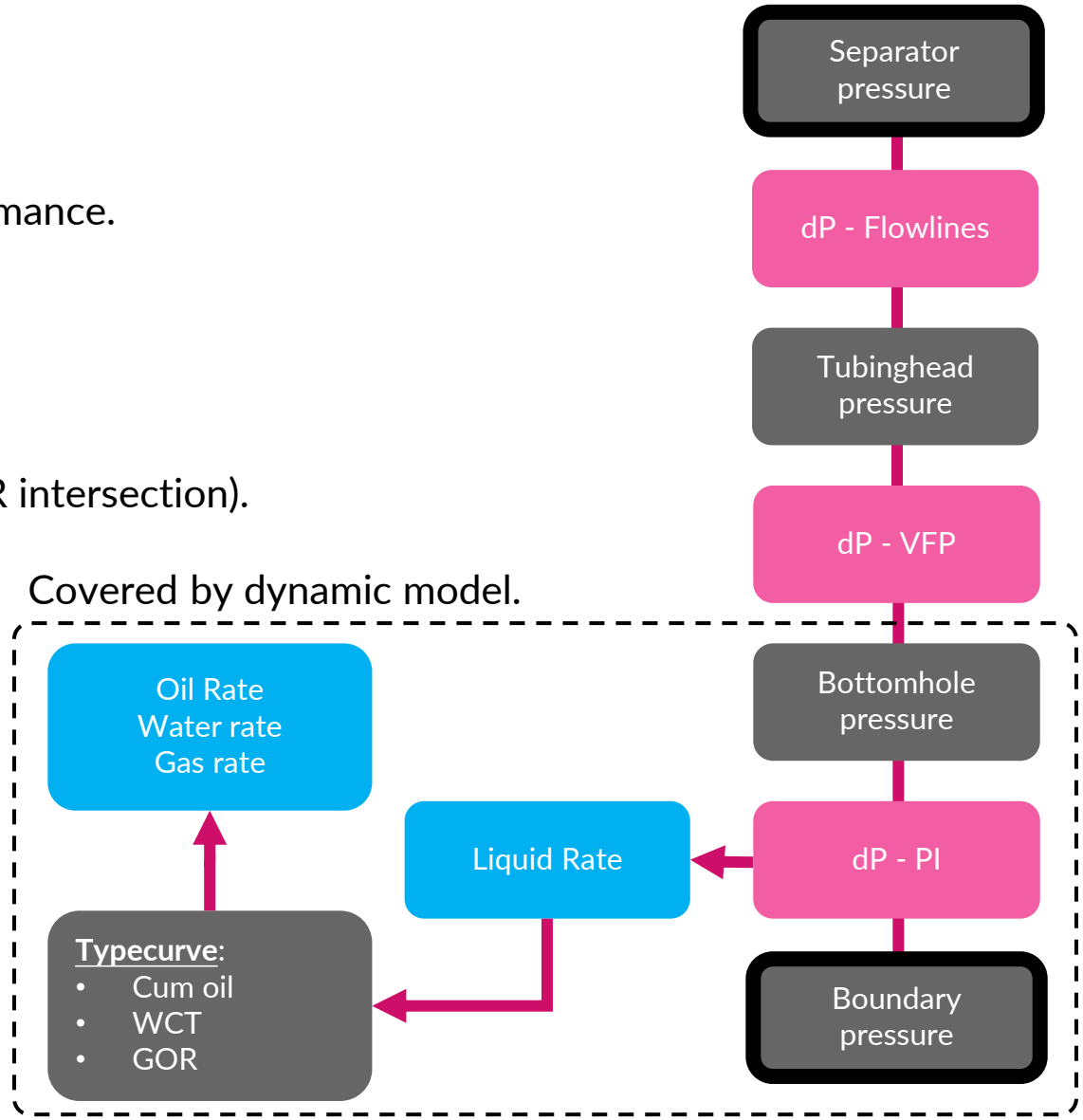


Typecurve proxies in Network Models

- **What are typecurves in this context?**
  - Tables of volumes and phase fractions describing well performance.
    - *In GAP:* ***Decline Curve Well*** *with* ***Tank.***
      - *Cumulative oil vs Water Cut, GOR.*
      - *Cumulative oil vs Reservoir Pressure.*
      - *Productivity Index.*
  - Enough information provided to do a network solve (VLP/IPR intersection).

- **Benefits of Typecurves:**
  - Runs significantly faster than dynamic simulation.
  - Captures main behaviour decently for many reservoirs.
  - Allows for acceleration and deceleration of profiles.

- **Downsides with typecurves:**
  - Only valid for the drainage strategy that is simulated.
  - Not valid if there are a lot of reservoir dynamics.
  - Injection schemes are particularly challenging.



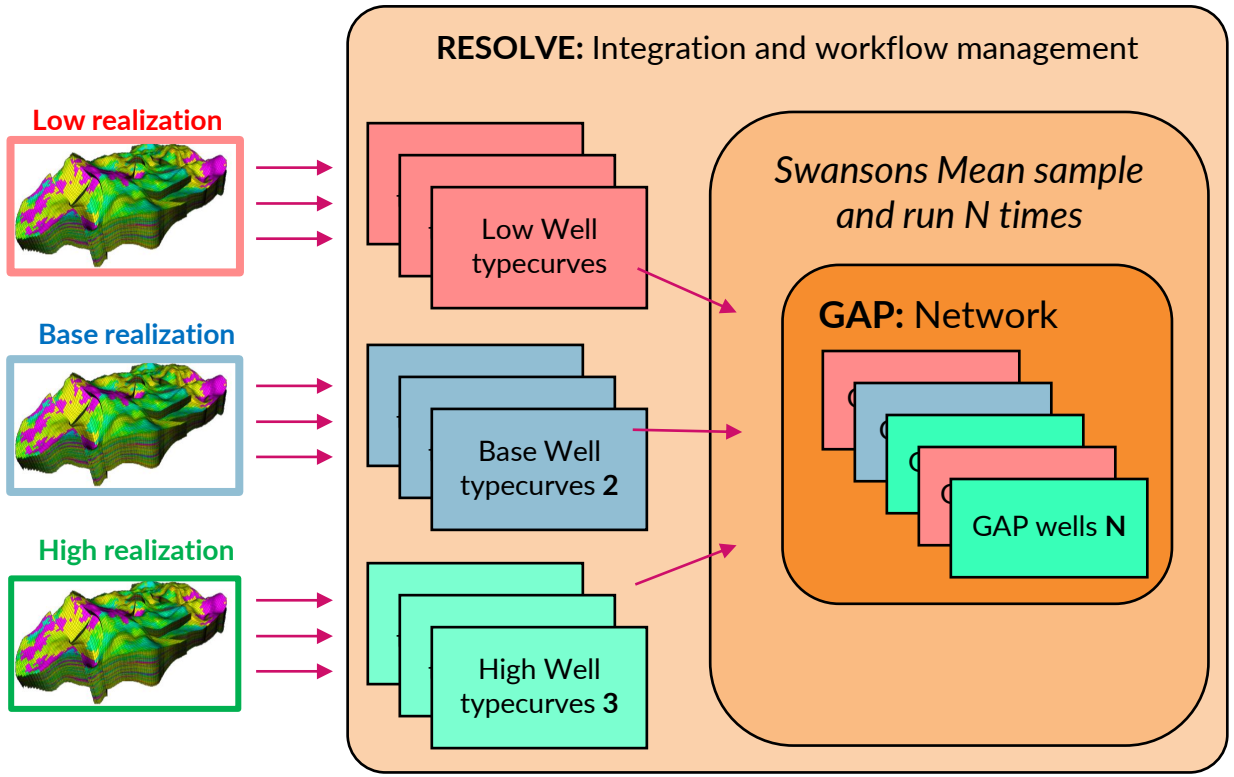
“Traditional” workflows

- **Deterministic cases: (Typically Low, Base, High)**
  - Deterministic: single cases, often P10, P50, P90 cases or specific sensitives.
  - From Ensemble: selected cases from ensemble, representatives of P10, P50, P90 for some metric.

  - *All cases are internally consistent with reservoir models.*
  - *Does not account for the full uncertainty range.*
  - *Selecting cases from ensemble is not ideal.*

- **Our first iteration of ensemble integration:**
  - From low-base-high models, extract typecurves.
  - Workflow to sample 30-40-30 (Swansons Mean).
  - Run 100 cases with varying combinations.

  - *Can give a reasonable spread in uncertainty.*
  - *Decent approach if no ensemble available.*
  - *Likely combinations of unrealistic cases.*
  - *Need robust sampling and correlations.*

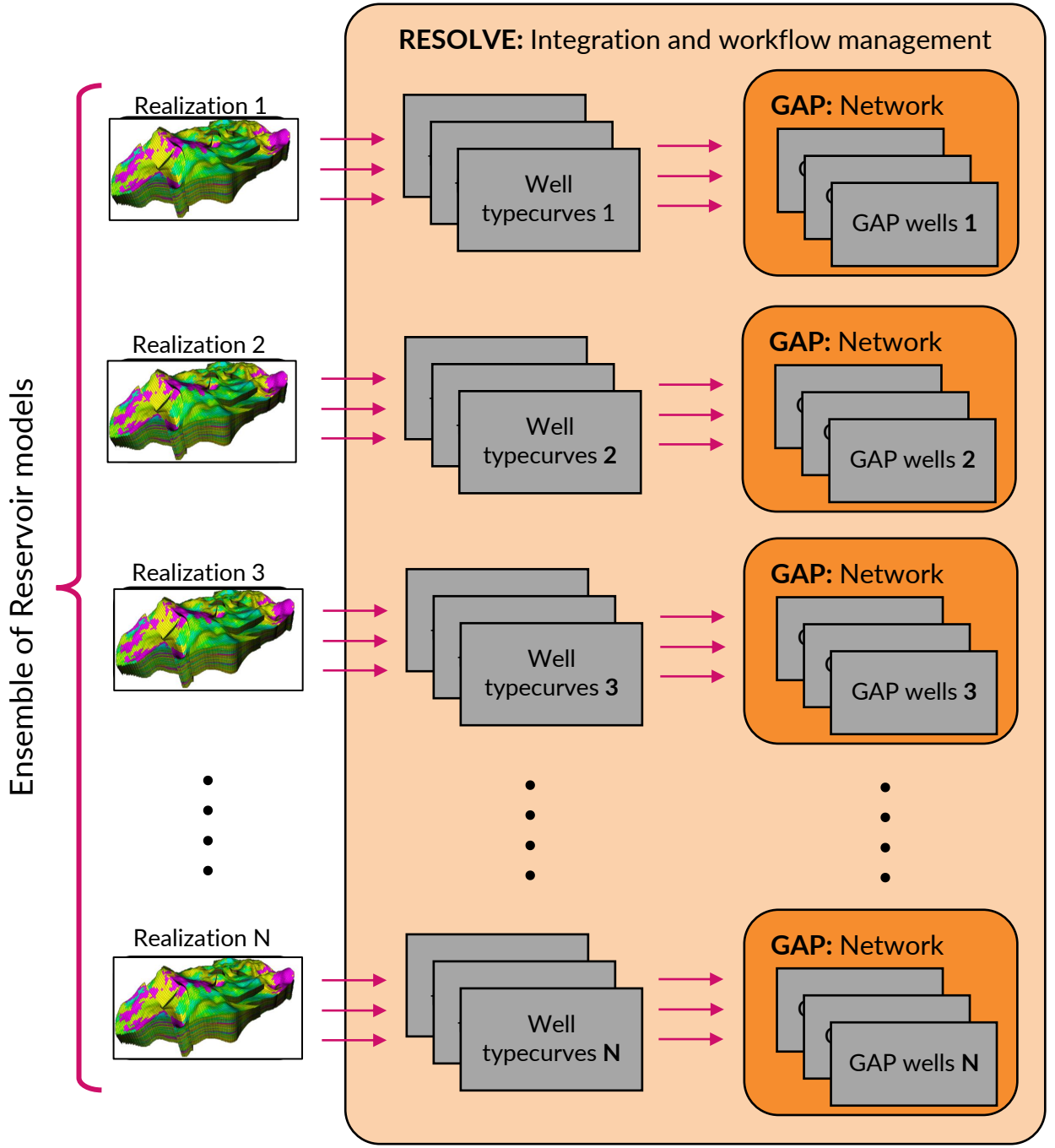


“New” workflow

- **Utilizing all ensemble realizations directly**
  - Extract typecurves from all realizations.
  - All typecurves are mapped directly per realization.
  - Essentially N x deterministic models.

  - *No sampling needed; all cases are internally consistent.*
  - *Need robust and automated dataflow to set up.*

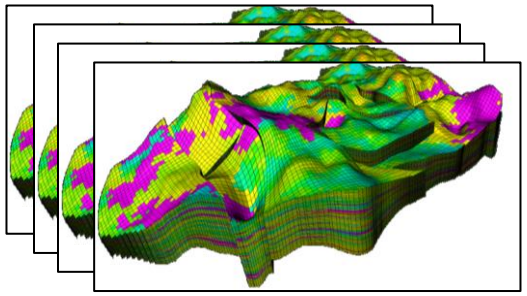
- **We can combine this method with the previous methods:**
  - Some reservoirs may have all realizations, while others use low-base-high, or scenario based.
  - Other uncertainties may be added as well:
    - *Startup times.*
    - *Capacities.*
    - *Uptimes.*
  - Need to be more careful with sampling when combining different methods.



Workflows and Dataflow

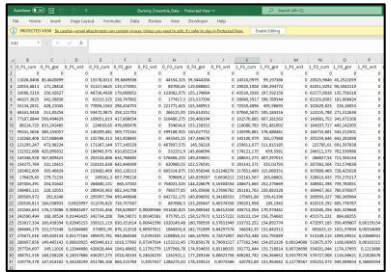
Other applications

Reservoir model ensemble

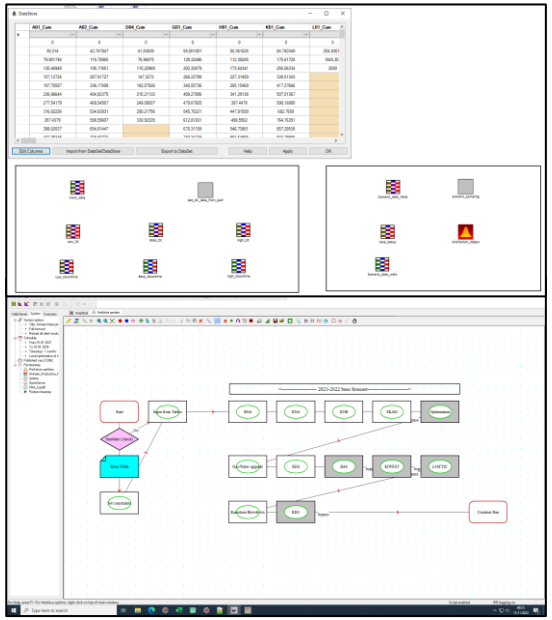


python™

Excel: Extracted and transformed typecurves

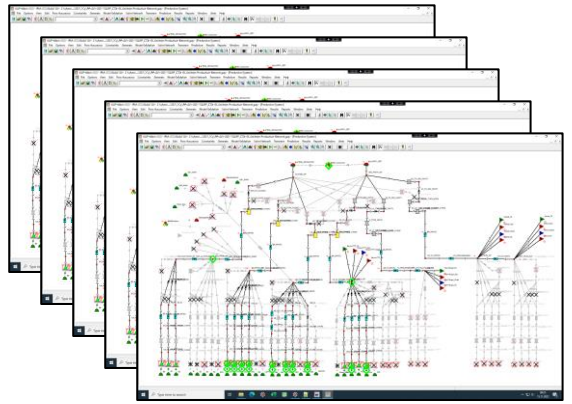


RESOLVE: Typecurves stored in tables. Workflows to run uncertainty

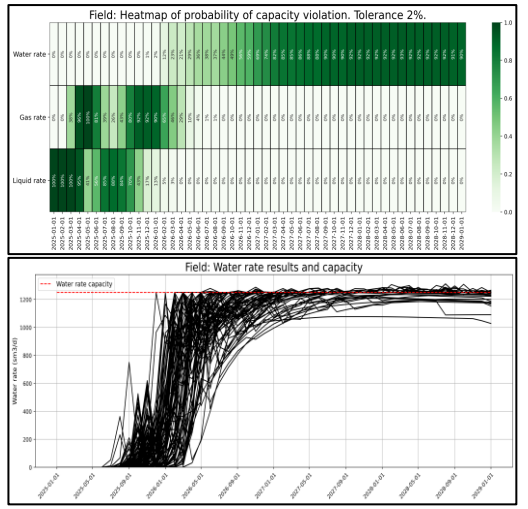


python™

GAP: Network model



Analysis and Dashboards



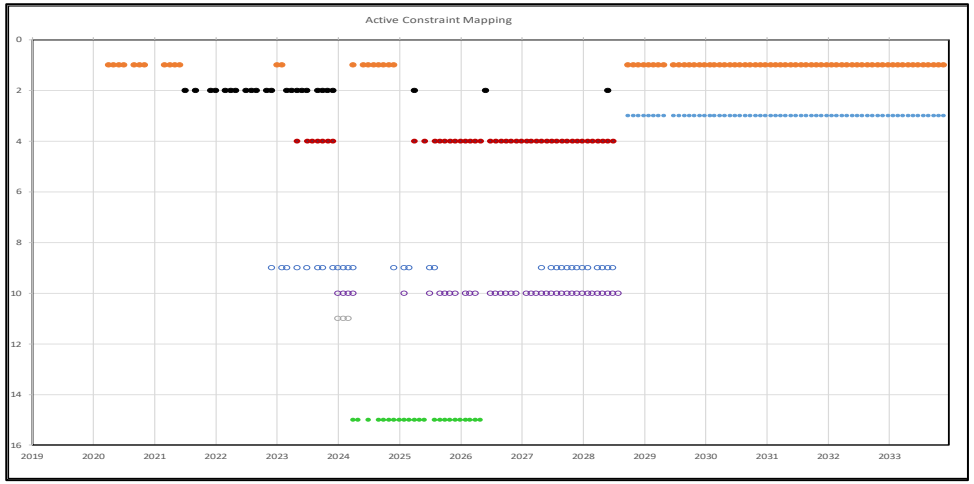
Some results…

- **What have we been able to do?**
  - Pilot the workflows on a producing field with multiple reservoirs.
  - Used the results in forecasting and reserves evaluations.

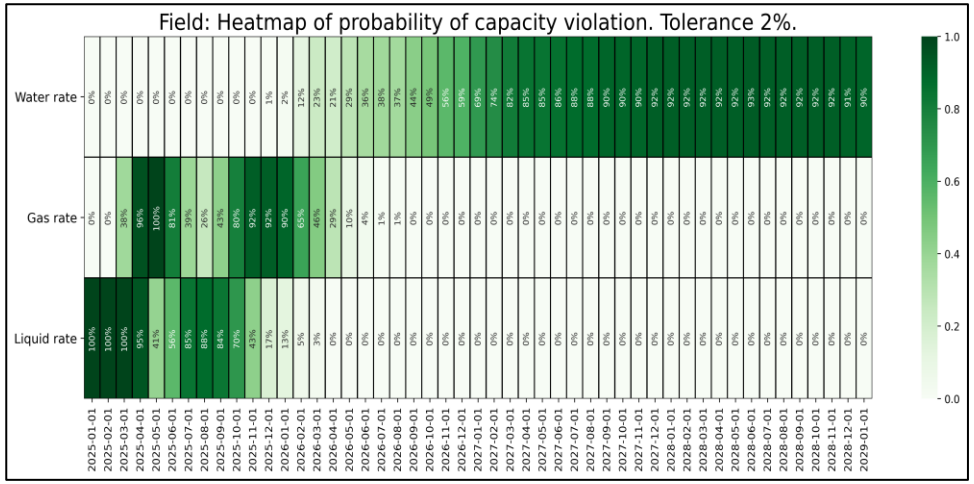
- **Benefits:**
  - Integrated multiple ensembles into the same network model.
  - Accounted for network and commercial licence constraints.
  - All cases are optimized in the network.
  - We retain most dependencies and correlations in the reservoirs.

- **Challenges:**
  - Runtime is high, even with the simplifications.
  - Challenging to parallelize this workflow and software stack.
  - Large amount of data to handle, many models to QC

Deterministic: Active constraints mapping

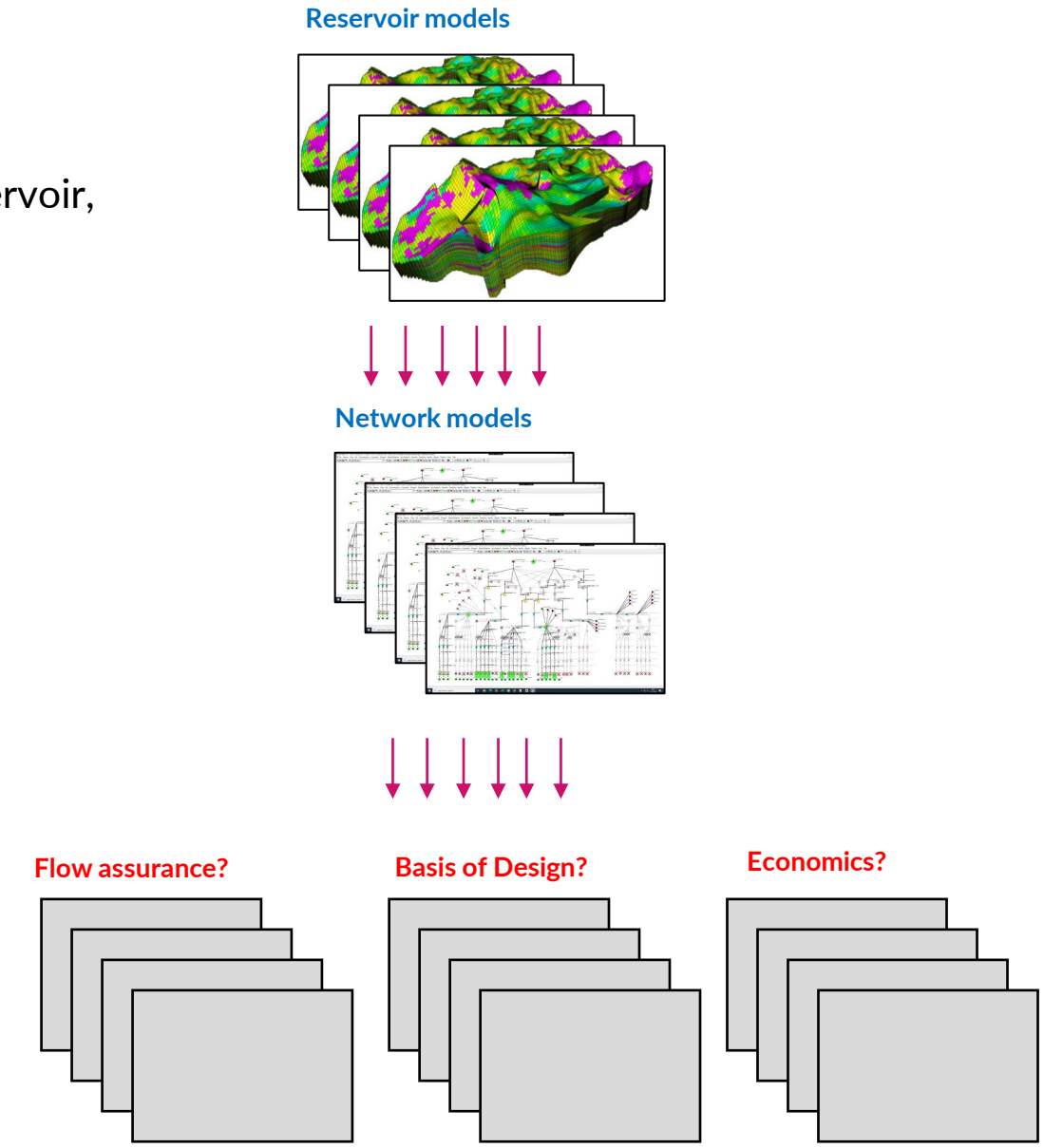


Probabilistic: Active constraints mapping



Discussions

- **What is good enough?**
  - The typecurves cause us to lose some dynamic detail in the reservoir, but allow for the complex network effects to be modelled.
  - In this case, we consider:
    - The network effect ***important enough*** to model it.
    - The typecurves ***good enough*** to accept them
- **Do the benefits outweigh the simplifications?**
  - If we bother modelling an ensemble, why not use it all?
  - Don't need to worry about internal consistency across cases.
  - When do we need full physics, and when can we use proxies?
  - Enables integration with other disciplines.
- **Where do we go from here?**
  - Potential to propagate into even more disciplines?
  - Can we do Facility evaluations based on probabilities?
  - Need robust architecture, dataflow and QC tools.



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