Optimizing linepack usage and intraday operations of a gas transmission network, a new approach on GRTgaz network

Baptiste Rossi, GDF SUEZ
François Martin, Félix de Carpentier, GRTgaz

IGRC 2014, Copenhagen, 17-19 Sept 2014

BY PEOPLE FOR PEOPLE

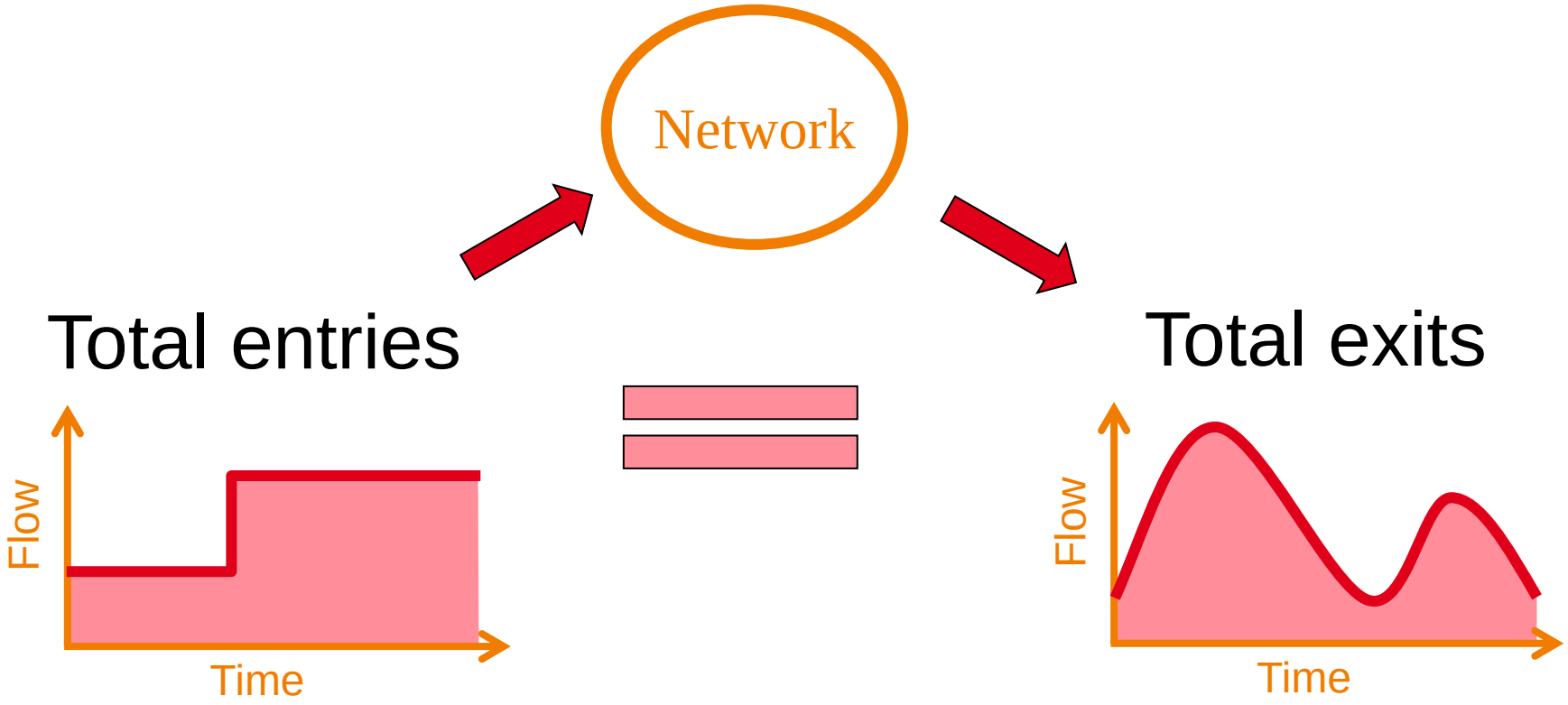
Contents

- The complexity of operating a natural gas transmission network
- Building HELP : an hourly GPS for the transmission network
- Benefits in operations

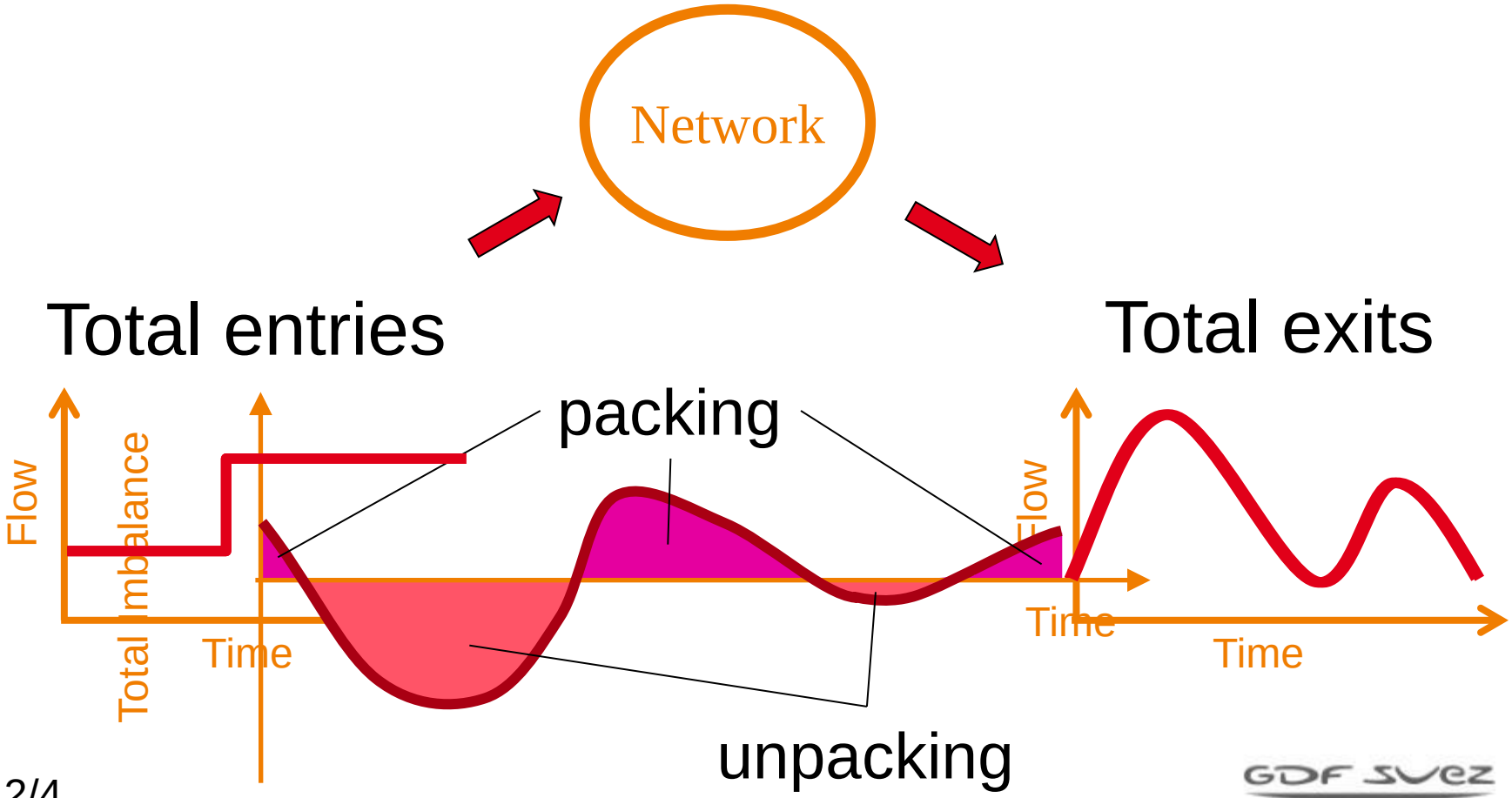
Balancing rules :

➔ **Designed to enhance fluidity for shippers, easy to use**

Every shipper has to balance input and outputs in balancing zones



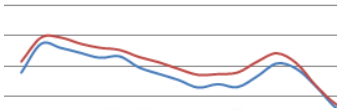
Balancing rules :
For TSOs : the network is never balanced

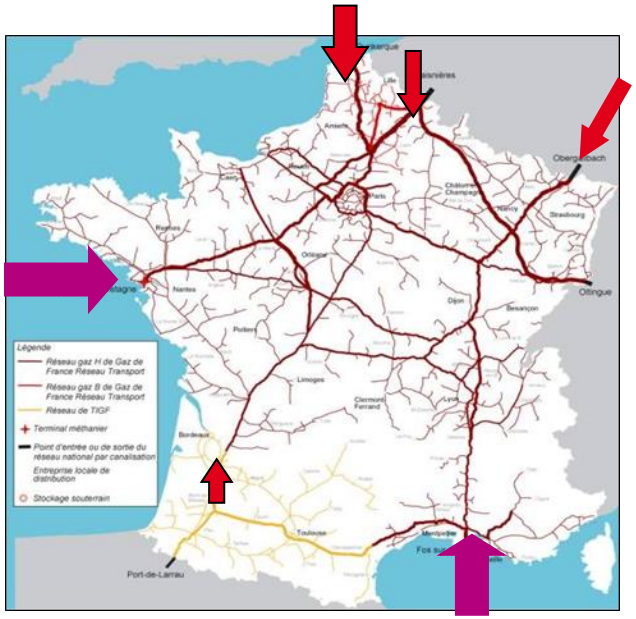


TSOs operate a physical network, not a contractual one !
Complexity of operating a physical network

- Constraints on pressure (safety / security / contracts)
- Maintenance issues
- Hazards & differences between forecasts and real life !
- Large number of options in a meshed network
- Example of GRTgaz





- 32 000+ km / 20 000+ miles of pipes
- 6 supply nodes

(gas from Norway, Algeria, Russia,…)

- 14 storage facilities
- 36 interconnection (28 compression) stations
- Pressures 40-90bar
- Meshed structure

Optimization :
a good tradeoff between Safety, Security & OPEXs

- Safety & Security : constraints
- OPEX : 2 parts : Compression & Flexibility sourcing

➔ Solution developed : two tools communicating

MinOPEX :

Optimization of compressions costs on daily scenario (steady state)

Large combination of flow patterns / compressions scheme studied

➔ Dimensioning compression usage

HELP Hourly Enhanced Line Pack

Optimization of linepack usage & flexibility sourcing on hourly basis (transient)

➔ Optimized hourly schedule

Compression configuration is an input

Contents

- The complexity of operating a natural gas transmission network
- **Building HELP : an hourly GPS for the transmission network**
- Benefits in operations

HELP : an hourly GPS for TSOs

■ « Driving hourly the network from here to a target in 24h »

➔defining « here » and « destination »

Current state: reconstructed in real time from sensors

➔ GRTgaz & CRIGEN : developed accurate reconstruction from 1500+ pressure sensors

Targeted state : linepack target for each pipe

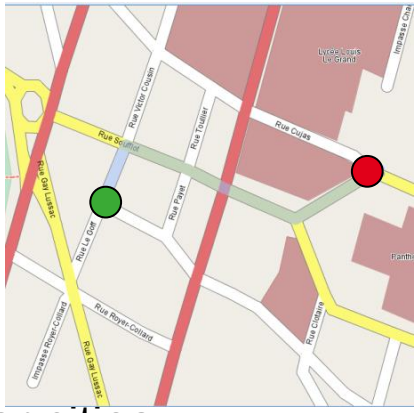
➔ Preparing the network for tomorrow

HELP Hourly Enhanced Line Pack

HELP : an hourly GPS for TSOs

- Driving following an optimized trajectory

- « Driving indications » : for each hour
  - — Flows at each end of pipes in the network
  - — Flows at storage facilities
  - — Flows at LNG terminals



- Linepack trajectories for pipes and large areas around major cities

➔HELP finds a « way » a « good » way

Finding a way / Finding a good way

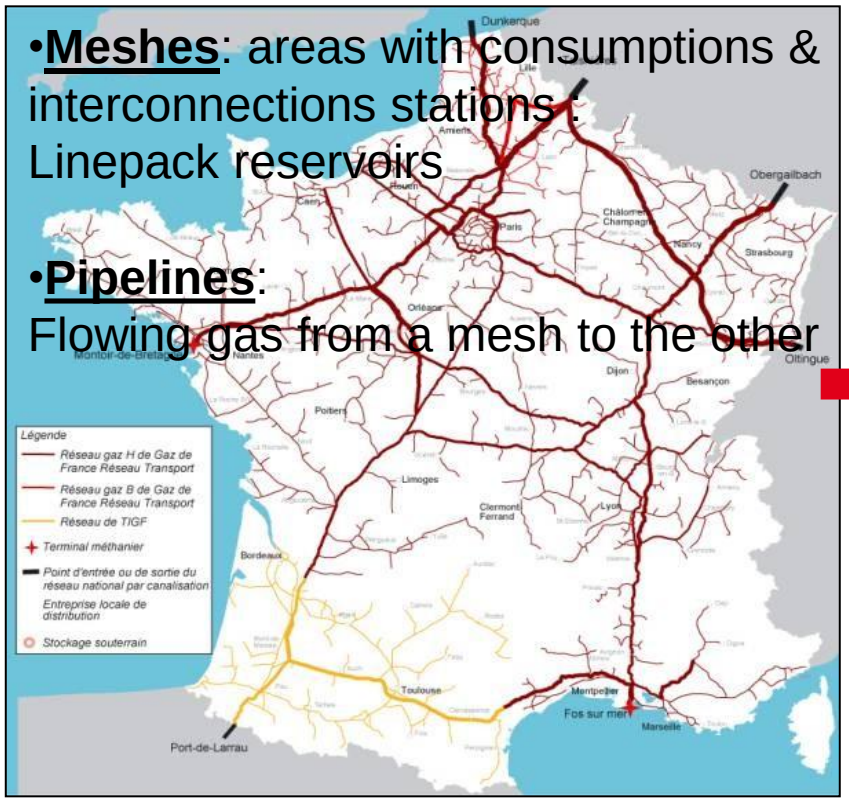
- A way : respecting the physical & operational **constraints**
  - Pressures at points always within bounds all day long
  - Contracts with storage facilities / LNG …
  - Security margins to cover temporary failures

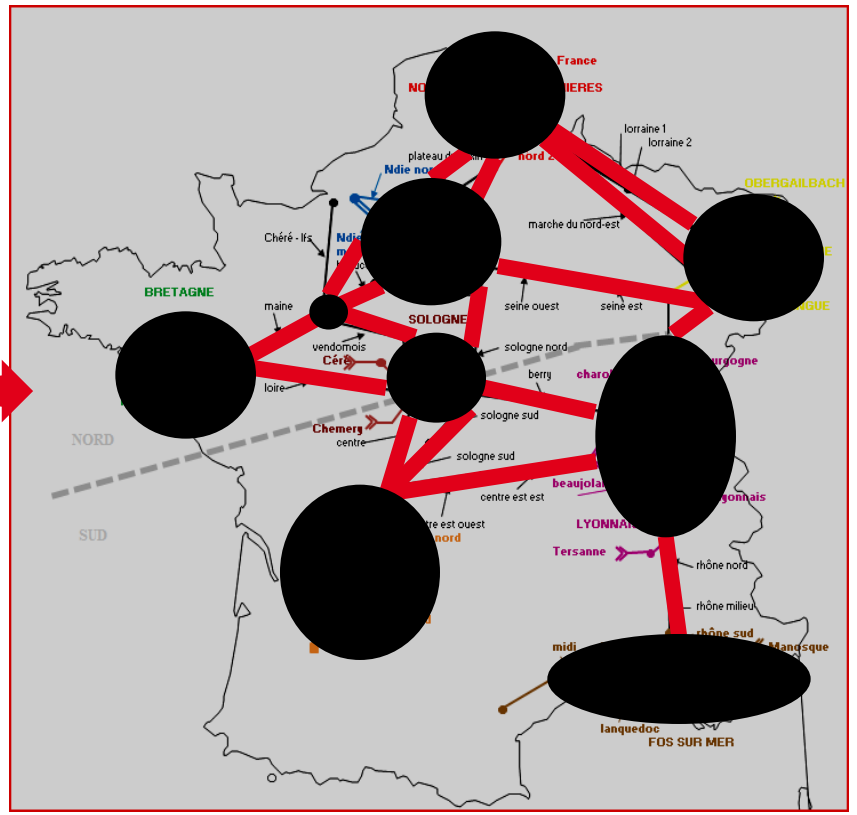
➔**Complex constraints** (non linear/non convex Fluid Mechanics equations)

- A good way : multicriteria : minimizing costs
  - Contracts with storage facilities / LNG …
  - Distance to target
  - Reasonable solutions : eg smooth changing flows

➔ There is not one absolute optimal because of multicriteria, it's a trade off

Describing the “ways”/ feasible set : modeling the network





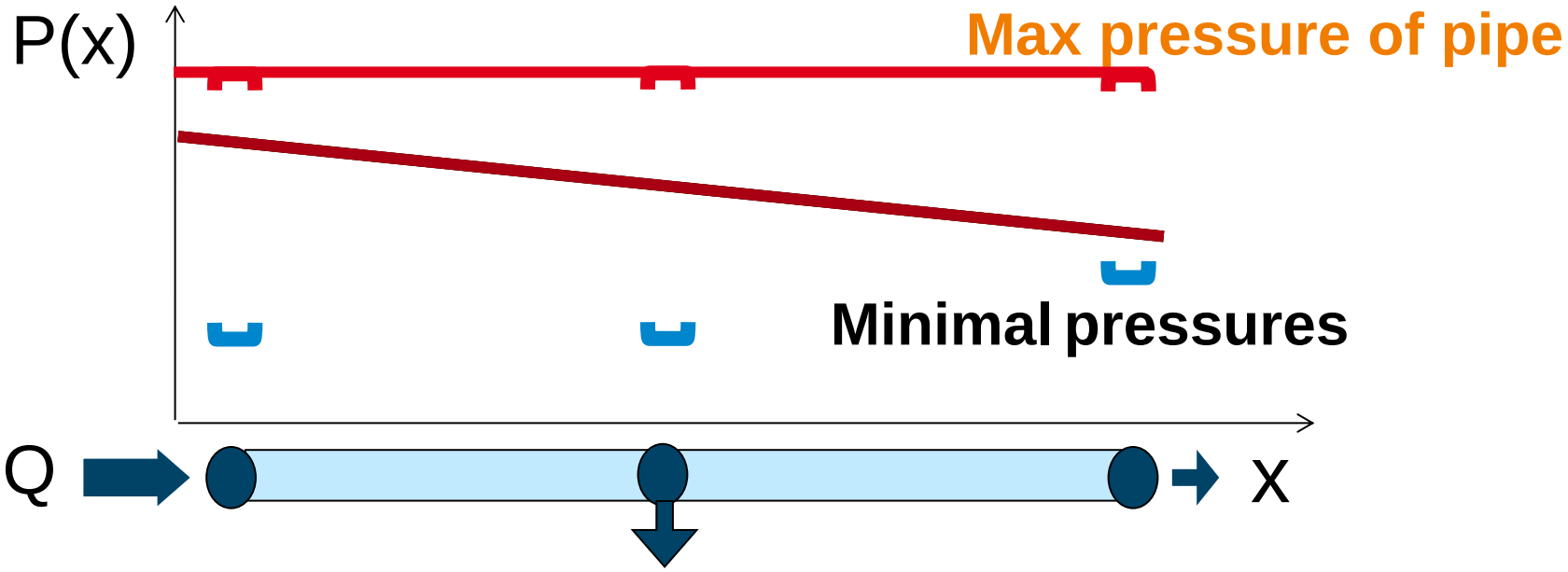
A trajectory = hourly flows at each end of pipes + storages + LNG

Pipeline: the feasible set, steady state computations

- Pressure constraints on a pipe :

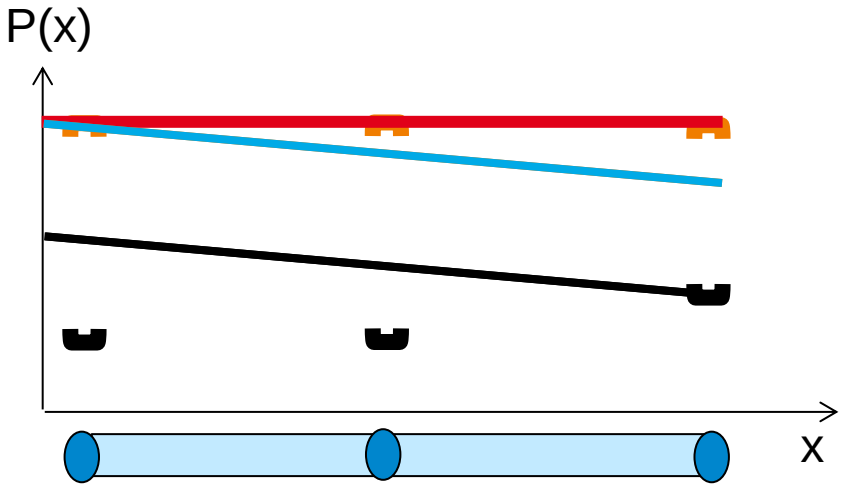
For a given transmitted flow Q : steady state pressure drop profile

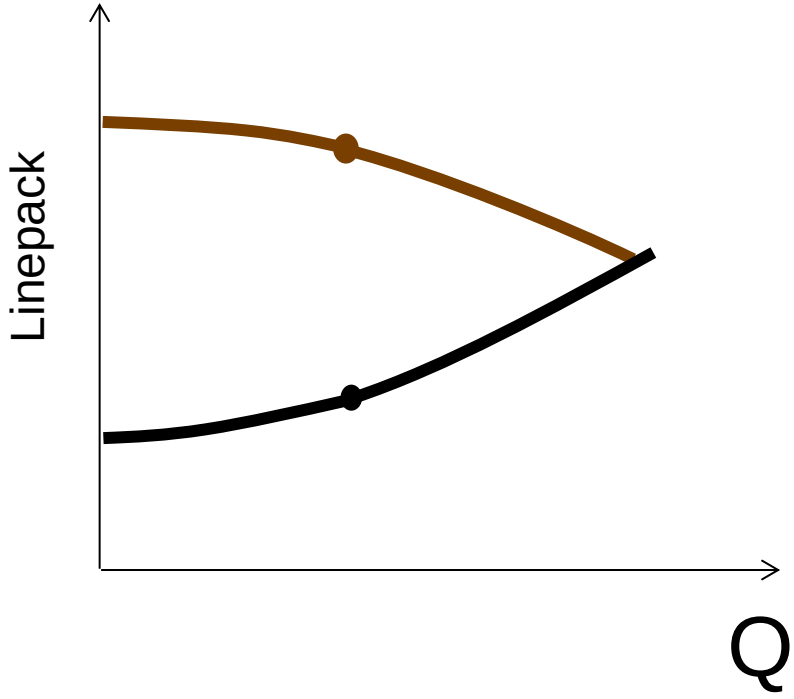
➔ **What are the limits on linepack to ensure feasibility ?**



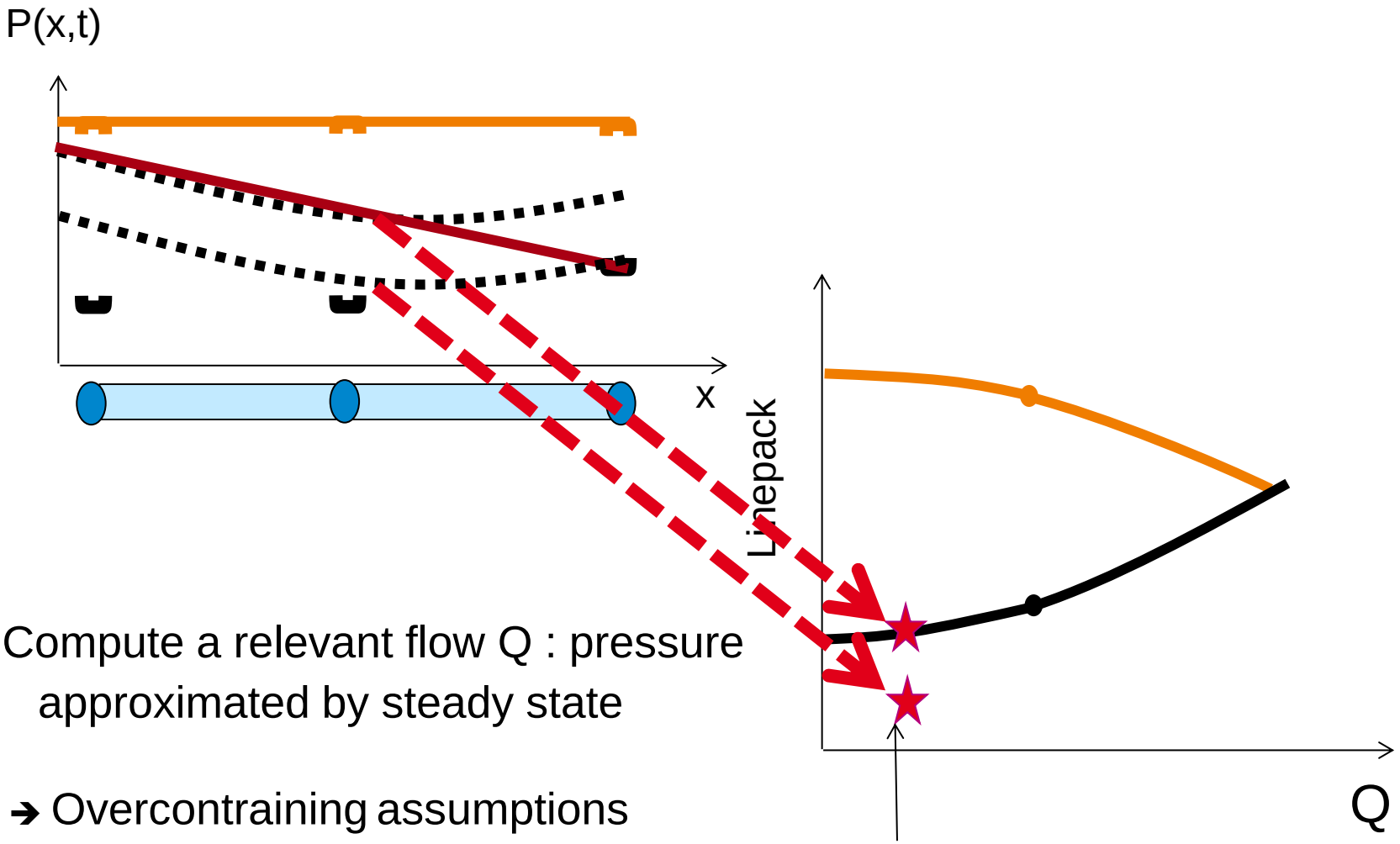
Pipeline: the feasible set, steady state computations

For Q varying : all the steady state feasible set





Real life is transient but “close to steady state”



Compute a relevant flow Q : pressure approximated by steady state

➔ Overcontraining assumptions

Conclusion on Algorithm

In order to solve this hourly scheduling problem

A new approach has been developed : Two steps :

1- Initialization (steady state computations)

2- Optimization phase (transient computations)
enhancing solution / finding solution if phase 1 failed providing feasible / proving optimality of initialization

Solutions found in 2 minutes on a PC !!

➔ Used during the day to adapt schedule to real life conditions

➔ Used on a day ahead mode to prepare the day after and dimension flexibility contracts

Contents

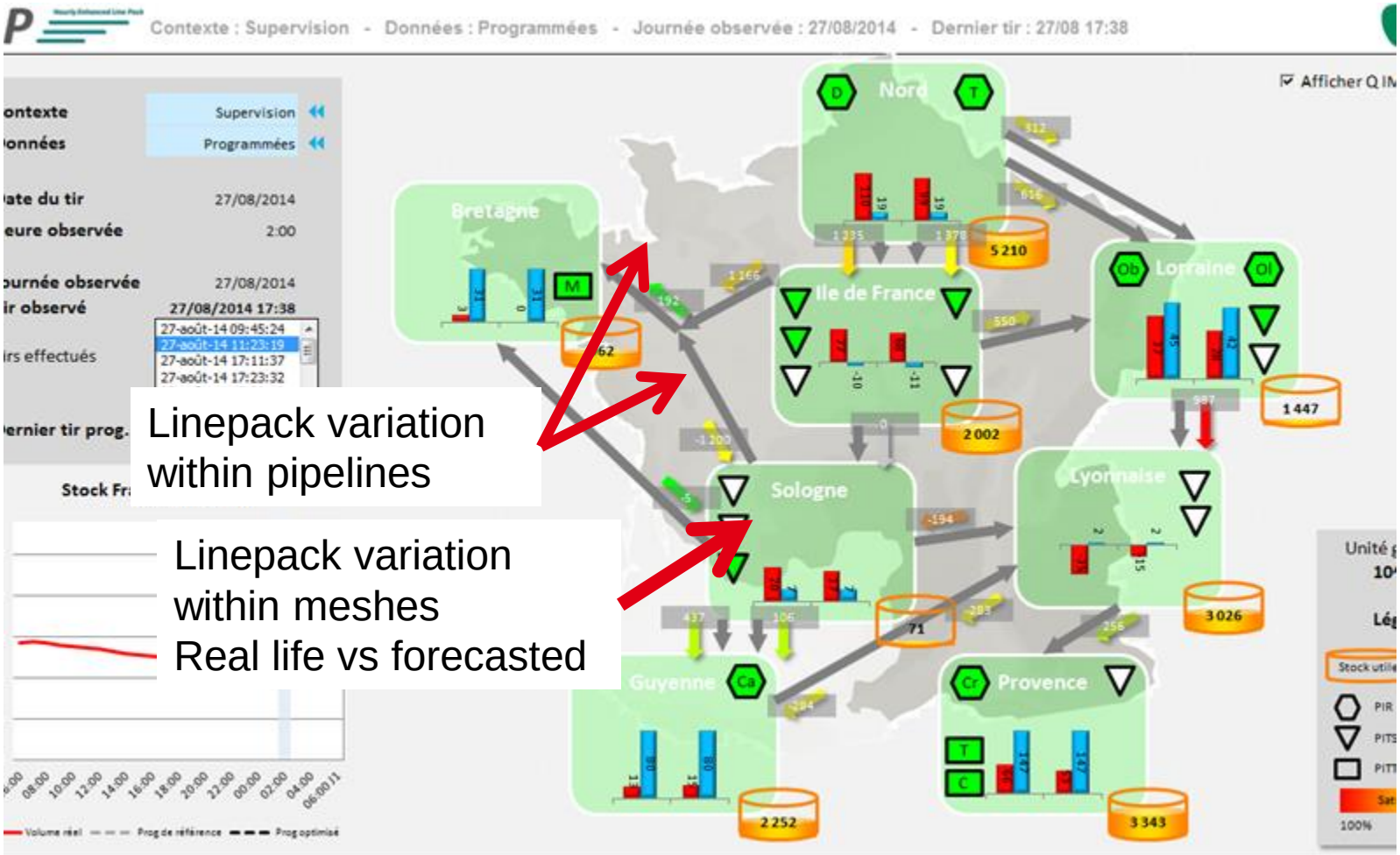
- The complexity of operating a natural gas transmission network
- Building HELP : an hourly GPS for the transmission network
- **Benefits in operations**

Benefits in operations

- Intraday :
- MinOPEX : new compression set up in case of dramatical change
- HELP : new trajectories computed each hour, on demand if needed to help operators decide how to handle the network

- Knowing better the limits of the network

Overview of HELP :
a global view of the network at a given hour



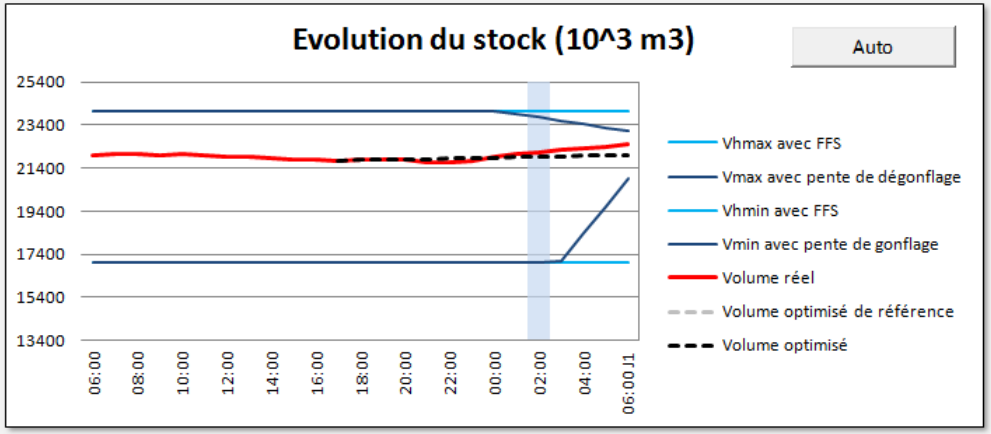
Specific view : seeing the trajectory in a mesh

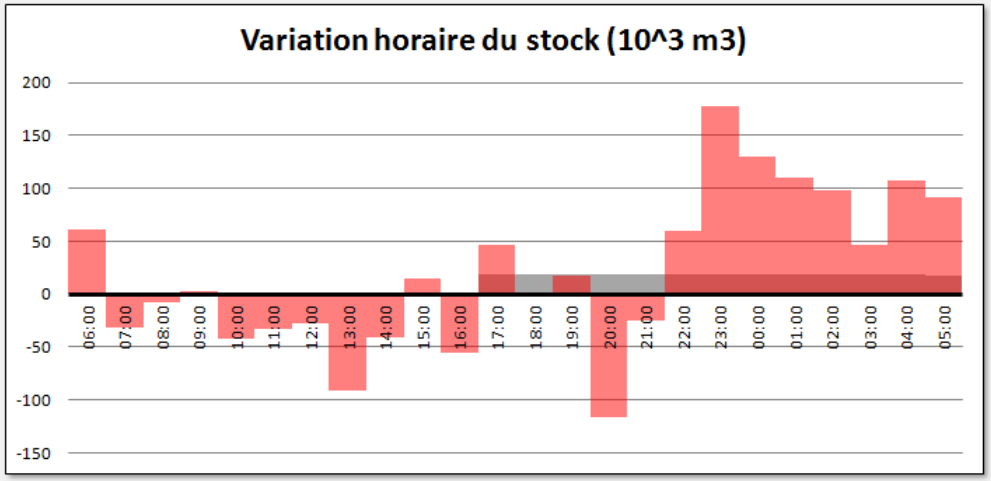
HELP — Contexte : Supervision - Données : Programmées - Journée observée : 27/08/2014 - Dernier tir : 27/08 17:3

Maille	Nord	Etat	

Valeurs exprimées en 10^3 m3

Type	Nom (sens du flux)	Q max (IM)	Q entrée (IM) ou IR	Q sortie (IM)	Etat
Intermaille	Plateau du Vexin -Moussy >> Cuvilly	1 489	1 235	1 235	
Intermaille	Nord 1&2 -Cuvilly >> Taisnières	2 629	1 378	1 366	
Intermaille	MNE -Morelmaison >> Taisnières	972	616	616	
Intermaille	Lorraines 1&2 -Laneuvelotte >> Taisnières	425	312	220	
PIR	Dunkerque -Entrée		1 656		
PIR	Quevy - Blarégnies -Entrée		1 980		
PIR	B vers H Gournay -Arrêt		0		
PIR	B vers H (Taisnières) -Entrée		62		
PIR	Adaptateur -Arrêt		0		
PIR	H vers B (Taisnières) -Sortie		-50		





Conclusion on HELP

- Transient optimization in practice, used daily

- Whole integrated software :
  - —From reconstruction to desired target
  - —Day ahead preparation based on forecasts
  - —Intraday operations adjustments

Conclusion :
GRTgaz optimizes its operations using 2 softwares : MinOPEX & HELP

- TODAY at GRTgaz : a combination of two decision help tools :
  - MinOPEX : Optimized compression schemes on a daily basis
  - HELP : Optimized linepack usage and flexibility sourcing, on an hourly basis

➔ Working together :

- MinOPEX : savings at GRTgaz ~11M$/ (2013 over 73 M$ of compression costs)
- HELP : savings at GRTgaz >2.5M$/year

Thank you for your attention

Questions ?

Baptiste Rossi – baptiste.rossi@gdfsuez.com

Meet GDF SUEZ @ Booth 23 in the Conference Hall