SJWS#2 – 26 January 2016

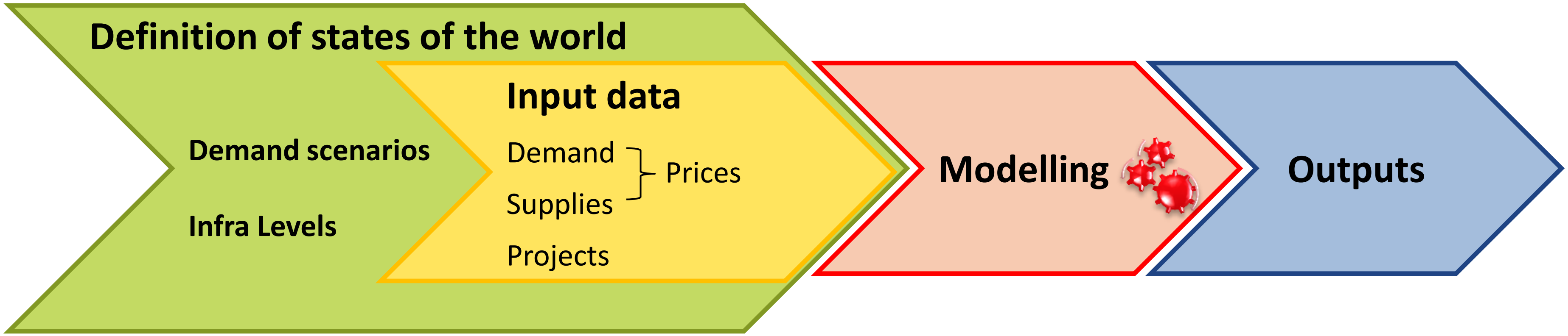
SJWS#2 – Part 2

Introduction to modelling

ENTSOG Sysem Development Area

Image Courtesy of Thyssengas

TYNDP overview



Overview of the modelling

Modelling – an overview

TYNDP is based on a simulation tool consisting in several important blocks

> The input data
> The topology
> The algorithm

What does it deliver?

> The tool is run for different simulation cases
> As a result it provides a number of outputs

Modelling – the topology

The topology

> A nodes / arcs topology representing the EU+ gas system at balancing zone level

> Nodes: information attached corresponds to
  - Demand: 1 node per country or balancing zone
  - National indigenous production
  - Supply potential and prices (for import points nodes)
  - Additional topology nodes when required, for example to reflect specific network contraints

> Arcs: existing and planned capacities

> ENTSOG continuously improves the topology to ensure the most accurate representation of the gas system

EU+ = EU + Switzerland + part of Energy Community Contracting Parties

Modelling – the algorithm

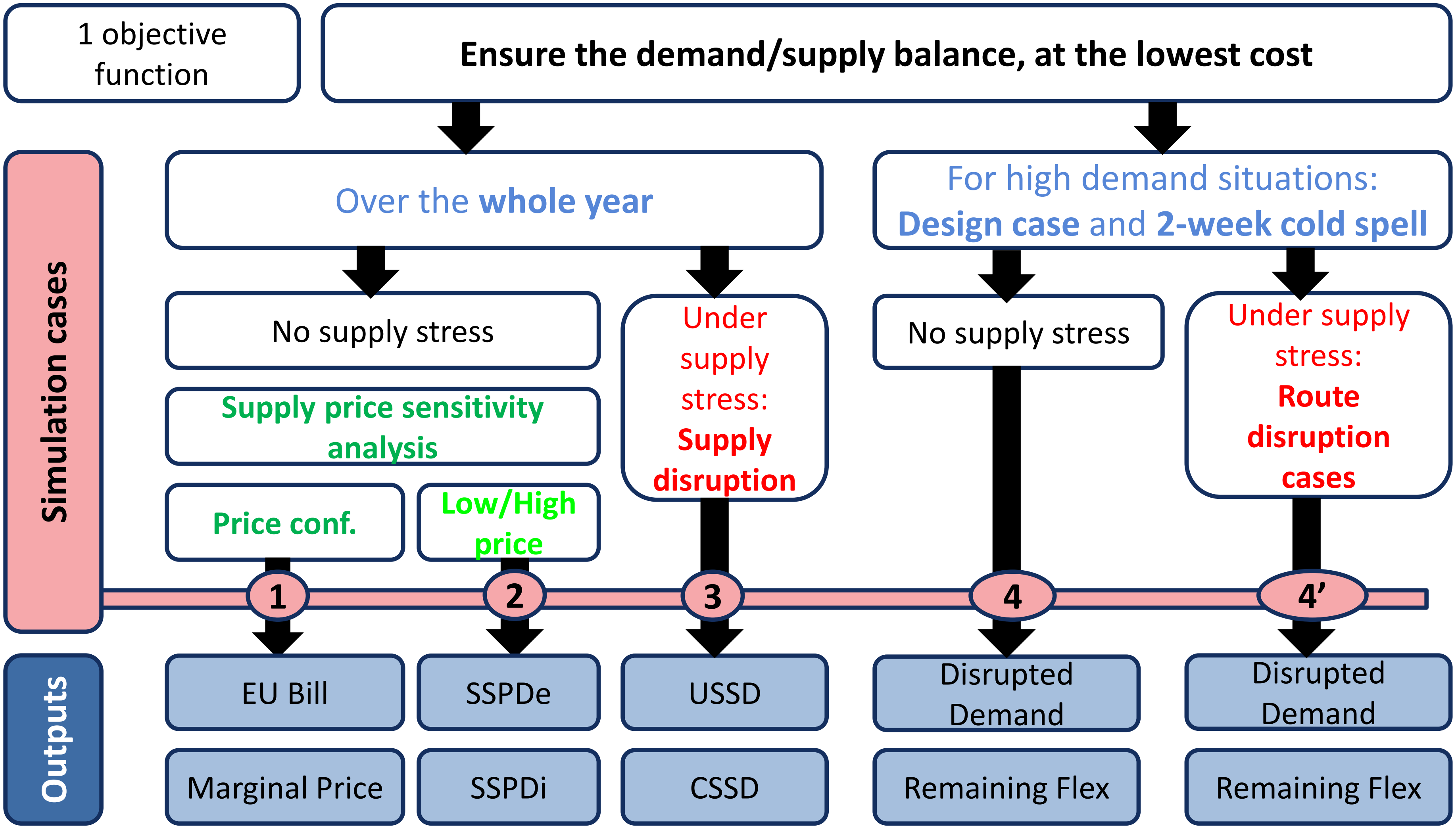
The algorithm

- The objective function:
  - **Ensure the EU demand/supply balance, at the lowest cost**
  - The solution **has to** satisfy demand and to respect arc capacities and supply limits (min/max): these are hard constraints
  - The **chosen solution** is the one minimising the cost, based on supply prices mainly*

- This is a classical minimum cost network flow programming problem:
  - Use of Jensen solver** (open source)

- (*) But also arc costs implemented for modelling reasons
- (**) Jensen solver: developed by Paul Jensen for the Texas University in Austin (https://www.me.utexas.edu/~jensen/ORMM/index.html)

The simulation cases



Outputs will be detailed in a later SJWS

TYNDP 2017: States of the world

States of the world

Infrastructure Levels

Demand Scenarios	Low Infrastructure Level	Mature Infrastructure Level	High Infrastructure Level	PCI Infrastructure Level
Green Revolution	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035
Blue Transition	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035
Slow Progression	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035	2017, 2020, 2025, 2030, 2035

Time Snapshots

Demand Scenarios may not all be assessed in the TYNDP. Decision will be taken at a later stage.

Mapping of TYNDP outputs

TYNDP 2015 basis

	Name	Granularity	Simulation cases: Period	Supply stress	Price configurations												
					Neutral	LNG cheap	LNG expensive	RU cheap	RU expensive	NO cheap	NO expensive	DZ cheap	DZ expensive	LY cheap	LY expensive	AZ cheap	AZ expensive
Outputs	EU Bill	EU	Year	None													
Outputs	Marginal Price	country/BZ	Year (Summer and Winter)	None													
Outputs	SSPDi	country/BZ	Year	None		LNG cheap (flat)		RU cheap (flat)		NO cheap (flat)		DZ cheap (flat)		LY cheap (flat)		AZ cheap (flat)	
Outputs	SSPDe	country/BZ	Year	None			LNG exp. (flat)		RU exp. (flat)		NO exp. (flat)		DZ exp. (flat)		LY exp. (flat)		AZ exp. (flat)
Outputs	USSD / CSSD	country/BZ	Year	Supply disruption: LNG, RU, NO, DZ, LY, AZ	Neutral												
Outputs	Disrupted Quantity / Disrupted Rate / Rem. Flexibility	country/BZ	Design Case 2-week cold spell	None Route disruption: Ukraine, Belarus, Franpipe, Langeled, Transmed, MEG, Green Stream, TANAP	Neutral												

For TYNDP 2017, focus on less simulation cases will be considered

Inputs to the modelling

Inputs: capacities

Capacities on the arcs are based on

> Existing capacities, collected from TSOs
> Planned capacities developed by the projects submitted to TYNDP

> Transmission capacities are submitted by TSOs based on their expertise regarding hydraulic behaviour of their network

Depending on which Infrastructure Level is simulated the simulation will consider the capacities of the corresponding projects

Inputs: demand

Gas demand is a <u>fixed input</u> of the simulation

> The demand data is at country level (or balancing zone level for multi-zones countries)

> The demand data depend on the **demand scenario** and on the **simulation case**
- Whole year case: composed of an average summer (7-m) and an average winter (5-m)
- Design case peak day
- 2-week cold spell: demand reached on 14 consecutive days once every twenty years (average daily demand)

> Demand data are provided by TSOs, based on ENTSO-E data for gas for power generation
- These are TSOs estimations elaborated in line with each demand scenario's story line

> The demand data is the aggregation of
- Final gas demand (residential, industrial and commercial usage)
- Gas demand for power generation

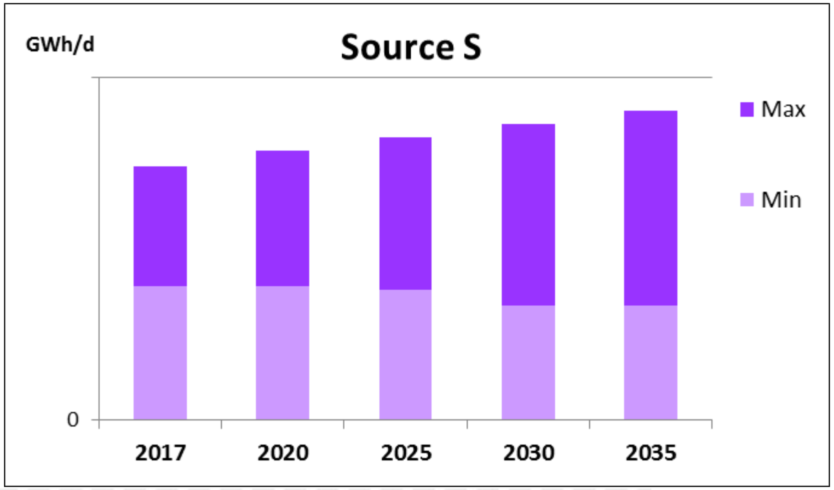
Inputs: supplies

Indigenous production

- The data is collected from TSOs whose systems have an upstream connection to indigenous production
- A distinction is made between
  - Existing national production
  - Non yet developed (non-FID) national production
    - Additional conventional production under consideration (e.g. Black Sea)
    - Potential for biomethane
    - Potential for shale gas

Supplies

- Data are collected from external sources and are used to define minimum and maximum supply potentials
- Supply potentials serve to define the [Min – Max] supply range for the modelling



Modelling of LNG terminal and storages

Modelling of LNG terminal

Modelling of LNG terminals

> Data collected: send-out capacity, LNG stocks kept in tanks for specific events
> Terminals are connected to the LNG source

> Over the whole year simulation: regasification level capped to 80% of the send-out capacity

> Design case (Peak day): regasification level up to 100% of the send-out capacity

> 2-week cold spell: modelling refined from TYNDP 2015 based on a GLE proposal
- Regasification level can go up to 100% of the send-out capacity, but terminal behaviour distinguished between 1st and 2nd week
- 1st week: no additional cargos compared to winter simulation (winter emissions set a cap), but regasification level can be increased using LNG stocks in tanks
- 2nd week: additional cargos can support the regasification level

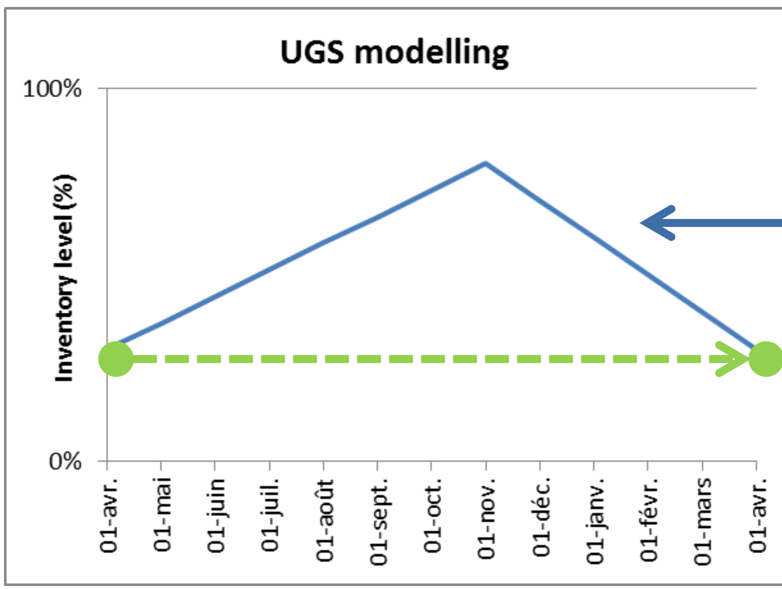
> A technical minimum regasification level is considered: a % of the send-out capacity

Modelling of storages

Modelling of storages

> Data collected: working gas volume, entry and exit capacities, withdrawal deliverability curve

> Over the whole year simulation (volume perspective)

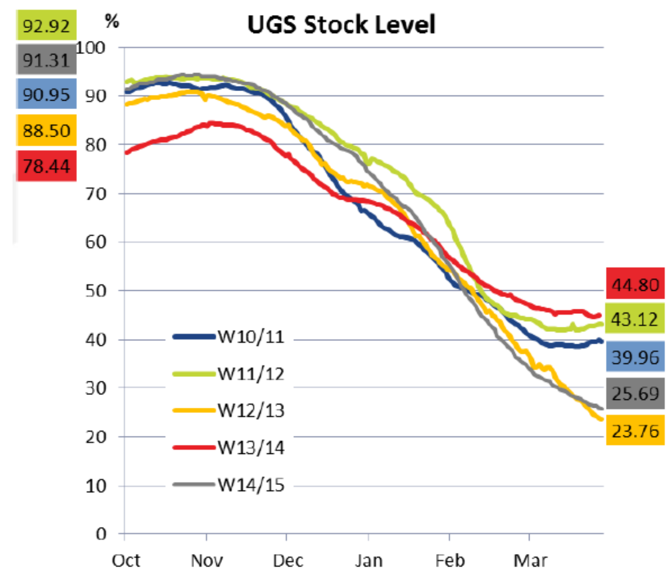


Use of storages driven by supply price curve

Fixed starting level

Proposal: 30%

Ending = Starting level

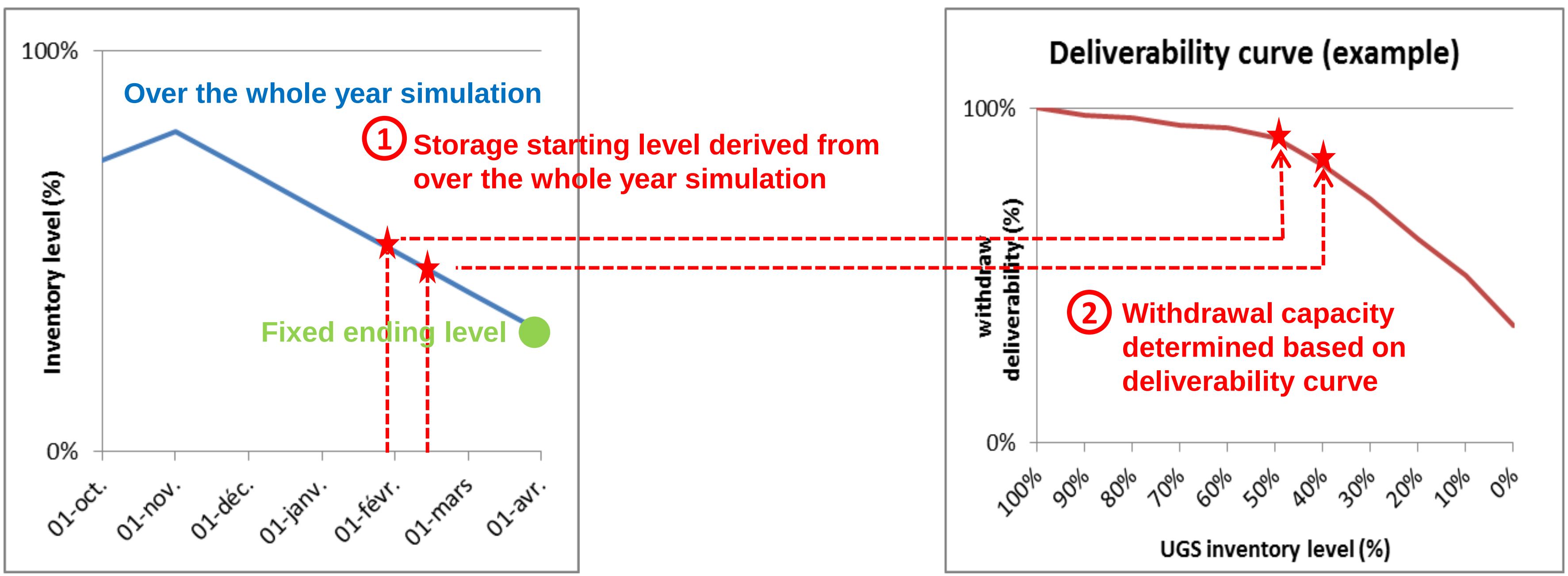


Historical use of storages and ending level (Source AGSI)

Modelling of storages

Modelling of storages

> High demand situations
- Design Case (peak day) considered on 31st January
- 2-week cold spell considered on 2nd half of February



Deliverability curves are computed at country (or balancing zone) level

More on modelling

Modelling assumptions

Perfect market functioning

> That is: free flow of gas and wholesale price equal to the marginal price
> This may not reflect the current situation, but aims at identifying investment gaps that would still be there after the implementation of « software » solutions (full implementation of the Third Package,…)

No consideration of infrastructure tariffs

> To avoid identifying investment needs that would serve to by-pass high tariffs, where it could be handled through « software » solutions
> Additionally
- Tariff of existing capacities may evolve, and are not set for planned infrastructures
- Costs of planned projects are considered independantly in the cost part of the CBA
- Infrastructure costs will have to be recovered, even in case infrastructure use is arbitraged based on tariffs

Modelling assumptions

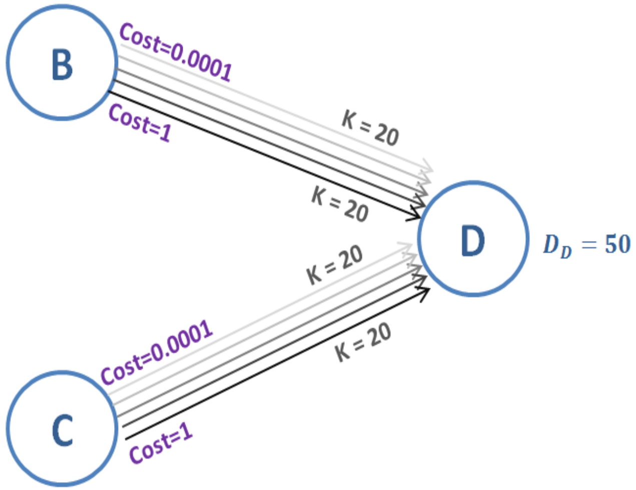
Infrastructure costs

> They are introduced for modelling purpose

> They are kept are at a very low value << 1 EUR/MWh

Modelling of arcs

> Multiple arcs: to force the model to choose a balanced flow solution, all the arcs are splited
- with splitted capacities matching the arc total capacity
- with incremental costs



Example with costs in EUR/GWh

Thank You for Your Attention

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