SYSTEM OPERATION

Key results, migrations & validation

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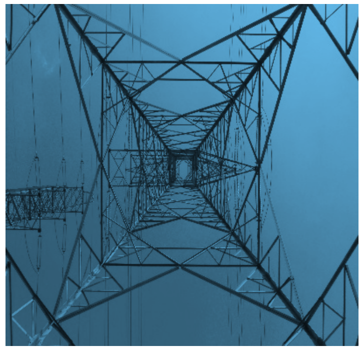
Key results, migrations & validation

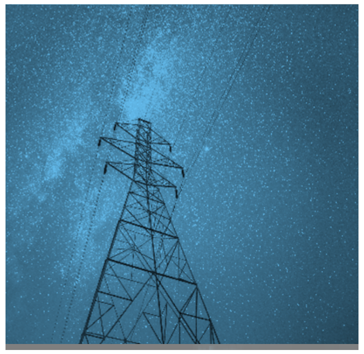
Outline

Barriers & drivers

Reliability management criteria declinations

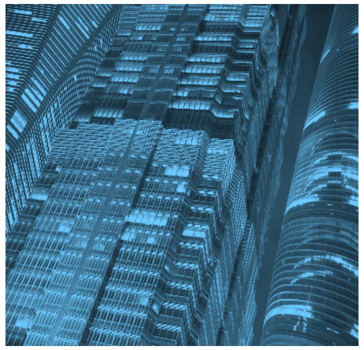


RMAC comparisons using the GQP: Key results



Challenges on tools and algorithms

Bridging the gap in terms of data and models



Migrations & validation

Barriers and drivers

Key results, migrations & validation

Barriers and drivers

Underlying difficulties inherent to the statistical approach:

- Modelling complexity
- High Data requirements
- Tools and computational requirements, tractability
- Operator decision-making and training
- Tso coordination (sharing and risk mitigation)

Drivers:

- Increasing variability: RES
- System accelerated evolution: smart solutions
- More and more information available

Reliability management criteria declinations

Key results, migrations & validation

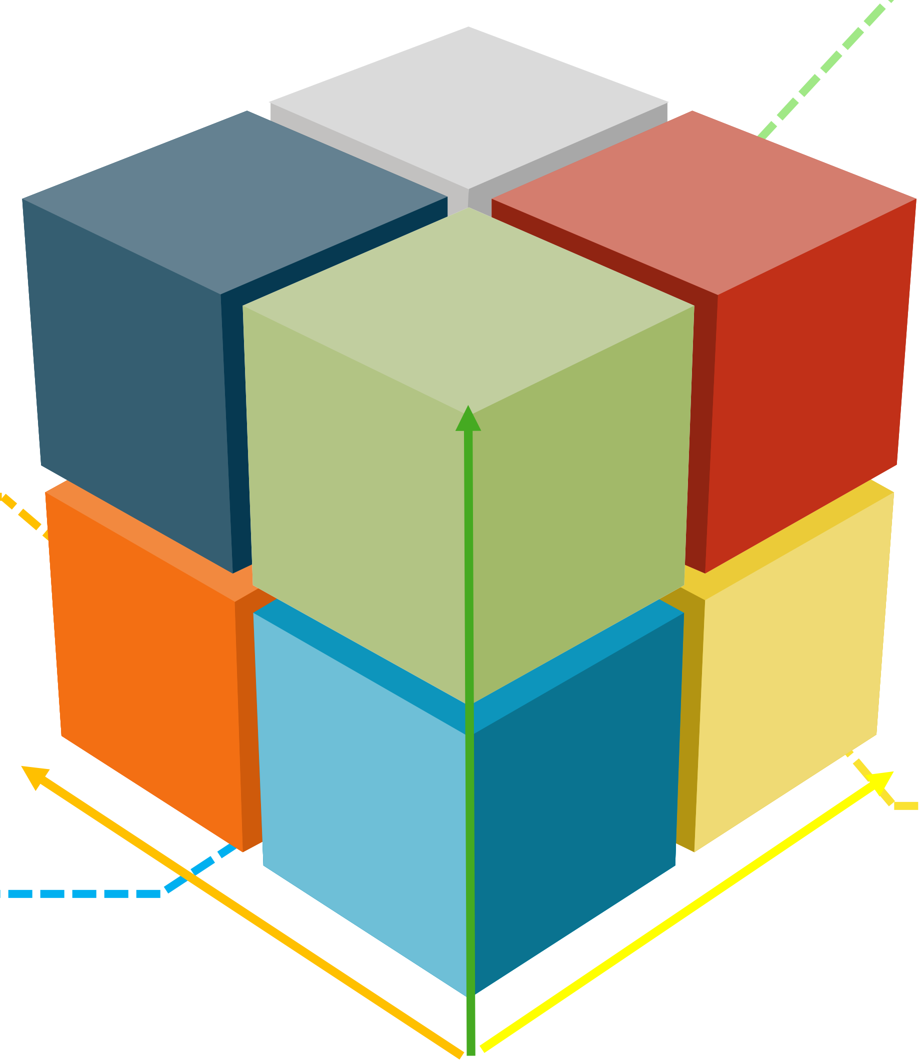
RMAC declinations

ENTSOE network code on operational security

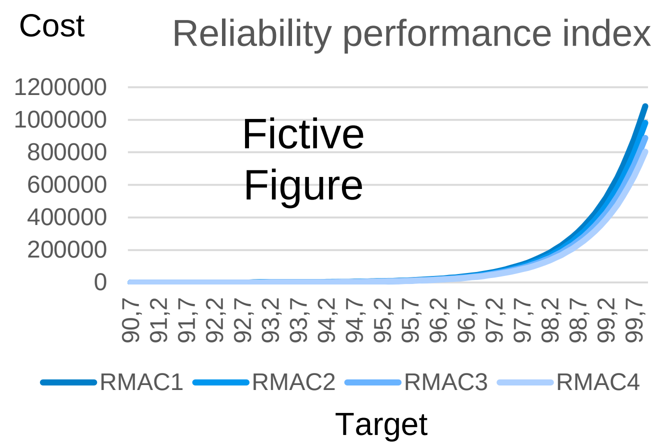
TSO current practices

Taking into account more threats

Classical N-1
- **Purely preventive**
- **Forecast or worst-case situation**
- **N-1 contingencies**



Dealing with corrective actions



Dealing with more situations

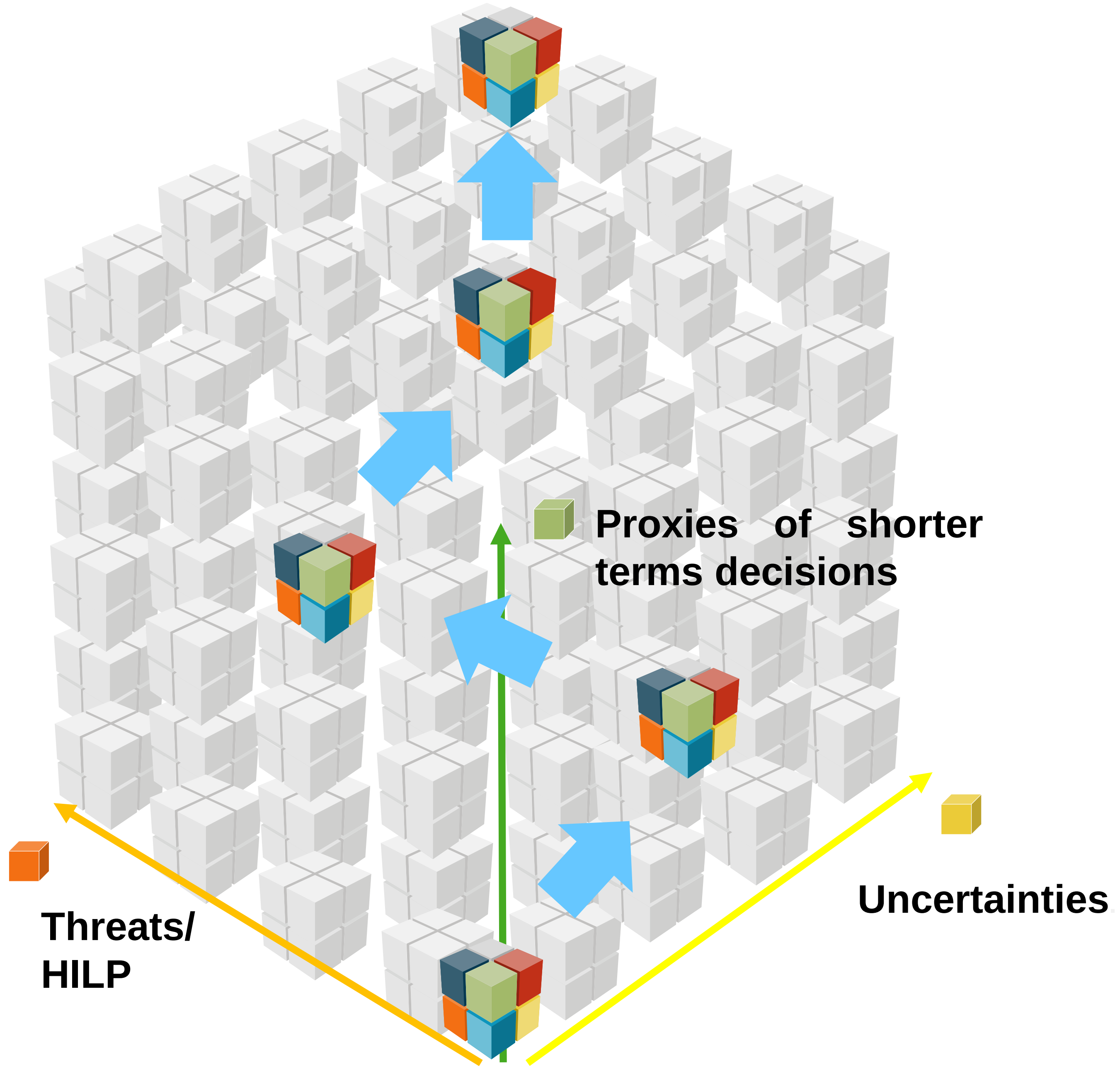
Key results, migrations & validation

RMAC declinations

Garpur RMAC follows the same principles, only the scale of the approach is changing

Migration toward a better RMAC is necessarily a step by step process considering:

- Reliability/Economic gains
- Performances/tractability
- R&D, Tools and data progress
- Needs for harmonization between the TSOs



RMAC comparisons using the GQP: Key results

Key results, migrations & validation

RMAC comparisons: Keys results

Rmac comparisons using the GARPUR Quantification Platform prototype

- Confirmation that statistical RMACs could be more efficient than classical N-1 (more economic for a same control on the residual Real-time risk)
  - Introduction of N-k (k>1) contingencies in the preventive problems should be economically weighted and justified
  - High preventive costs could be justified in case of difficult operational conditions

Current GQP and data limitations

- The GQP is a research grade prototype, with some current limitations:
  - Performances and tractability/result interpretation and validation
  - Limited RMAC implementation

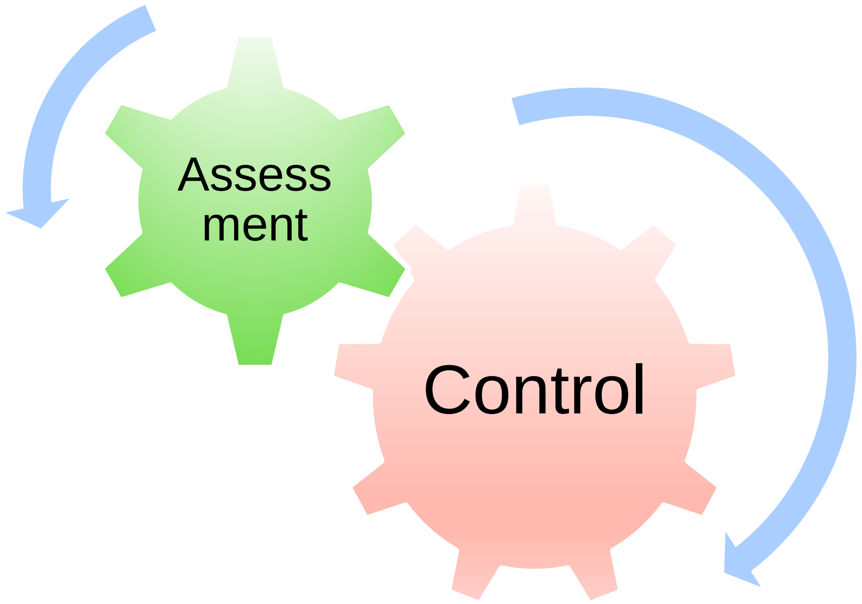
- Regarding data: RMAC high sensitivity to the blackout cost, failure rates and failure of corrective actions was observed: a better confidence in the estimation of those three parameters will ease the acceptance of the statistical RMACs by TSOs

Challenges on tools and algorithms

Key results, migrations & validation

Challenges on tools and algorithms

Two essential parts of a same problematic



- Assessment problem:
  - Necessitates upgrading of the TSOs assessment tools and algorithms
  - Evaluates RMACs performance and behavior
  - Propels data completeness, exchange and harmonization

- Control problem:
  - Necessitates further R&D works, it can be decomposed as such:
    - Step 1) helping the operator to reach a decision
    - Step 2) proposing and implementing control actions

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Challenges on tools and algorithms

Algorithmic challenges

- Fast & reliable algorithms vs large-scale computational problem
  - Control far more complex and demanding than Assessment
  - System stress and time horizon are to be taken into account
- Modeling the evolving behavior of the power system
  - Dynamic trajectories
- Taking into account the potential actions of the transmission operator
- Taking into account the electricity market
- Taking into account multi-TSO interactions

Bridging the gap in terms of data and models

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Bridging the gap in terms of data and models

Data challenges

- Component failure rates probabilities
- Corrective control failure modes & probabilities
- Power generation & demand uncertainty
- Estimation of the Energy Not supplied
- Value of lost load & socio-economic cost of service interruptions
- Sharing & harmonization

Migration and validation

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Migration and validation

Migration strategy: step by step approach

<u>Progressive adoption of probabilistic reliability management approach by TSOs</u>

- Phase 1: observation based on existing tool adaptations
    - Parallel assessment of the residual risk and its variations
- Phase 2: decision making based on probabilistic tools
- Phase 3: decision making supported by reliability control tools

Considering in parallel

<u>Continuous improvement of data, models and algorithmic performances</u>

<u>R&D works on the development of algorithms for probabilistic reliability control</u>

<u>Validation and proof of gain</u>

- Additional works, experiments sharing
- TSO and Academic collaboration

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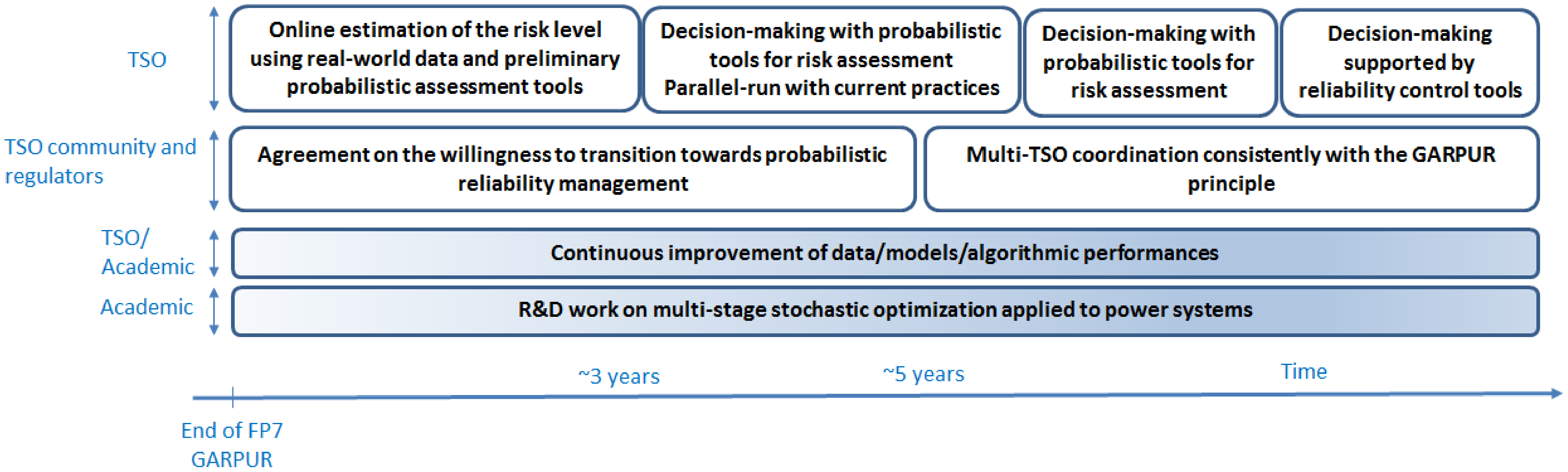
Migration and validation

Migration strategy (Tentative timeline)



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