Comparison of N-1 and the probabilistic approach

Testing the functionality of the GQP

Tournebise Pascal

RTE R&D ENGINEER

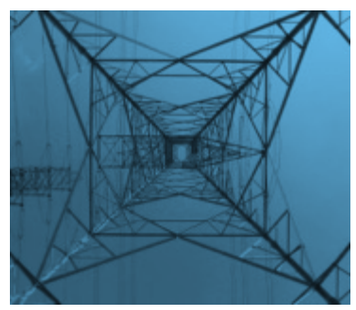
RTE

FRANCE

Testing the functionality of the GQP








Pilot test objectives

Risk management problematic considered

GARPUR Quantification Platform (GQP) main features for the test

RMAC problems and test methodology

Test results

Closing remarks

Pilot test objectives

RMAC comparisons using the GQP

Pilot test objectives

- Highlight the differences between the classical “N-1” reliability management criteria and more probabilistic ones using the GARPUR Quantification Platform prototype (GQP)
- Assess risk management on operation on an illustrative real example
- Highlight the challenges for further appropriation by the TSOs

Risk management problematic considered

RMAC comparisons using the GQP

Risk management problematic considered

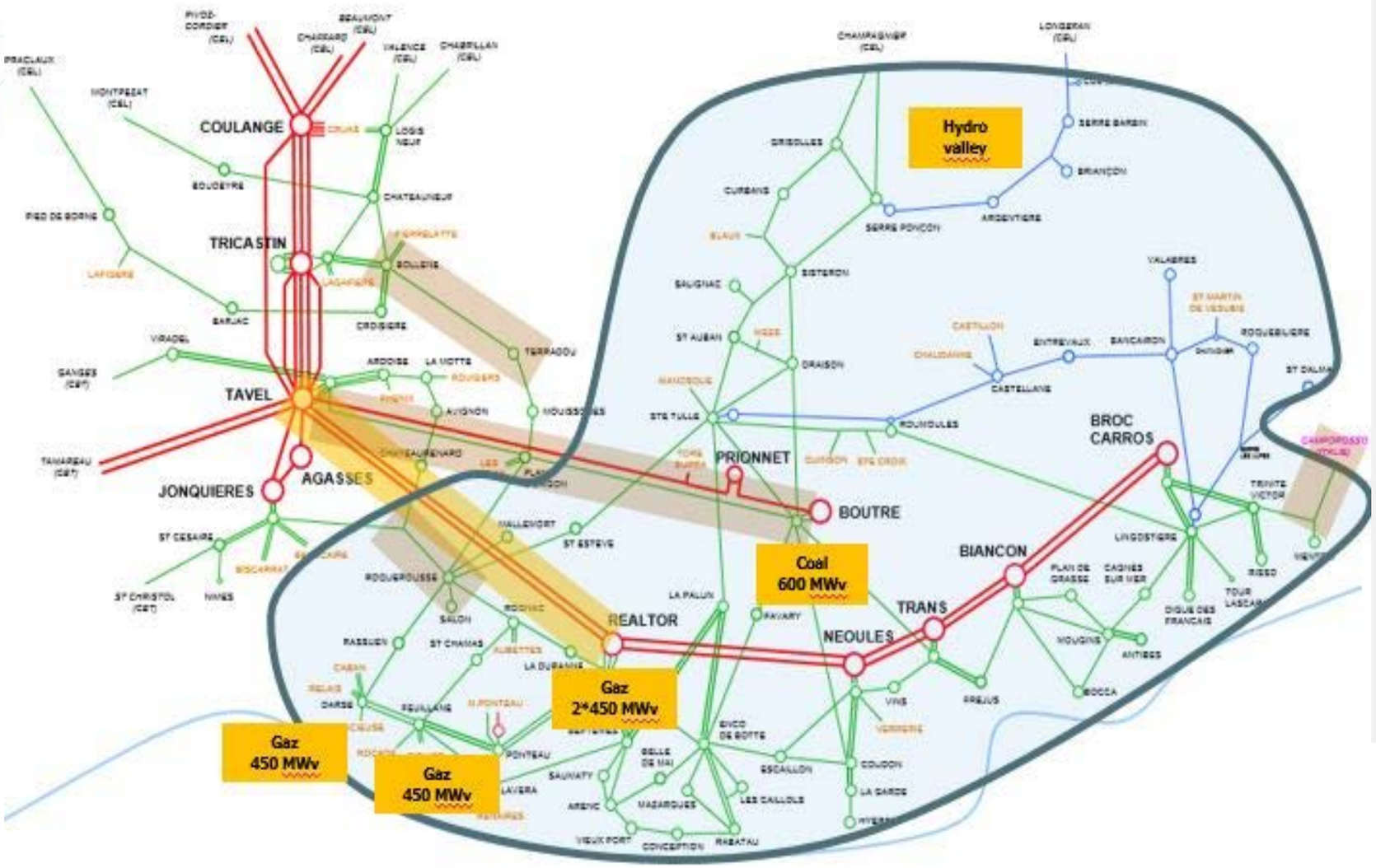
- Congestion flow management on the South-East region of France

- Focus on the so called “Tavel-Realtor” corridor responsible for 2 third of RTE congestion costs in 2013

- Risk management on day ahead (after market clearing) decisions vs Real-time decisions

RMAC comparisons using the GQP

Tavel-Realtor Corridor



Operational context

- Situation could be problematic in case of High imports
- The « under-realtor » important generating units are in limited number/costly
- Specific hours, seasonal aspects + Hydro and RES variations (Photovoltaic) to consider

RMAC comparisons using the GQP

Tavel-Realtor Corridor

Present operating rule:

- The N-2 Tavel-Realtor is preventively taken into account depending on weather conditions
- Different worst-case situations are considered to prevent operational difficulties, to decide to start or not costly power plant units, to reach an agreement with the Italian TSO on the cross-border PST, to rely on corrective actions
- Load shedding, as a last resort issue, is considered

GARPUR Quantification Platform (GQP) main features for the test

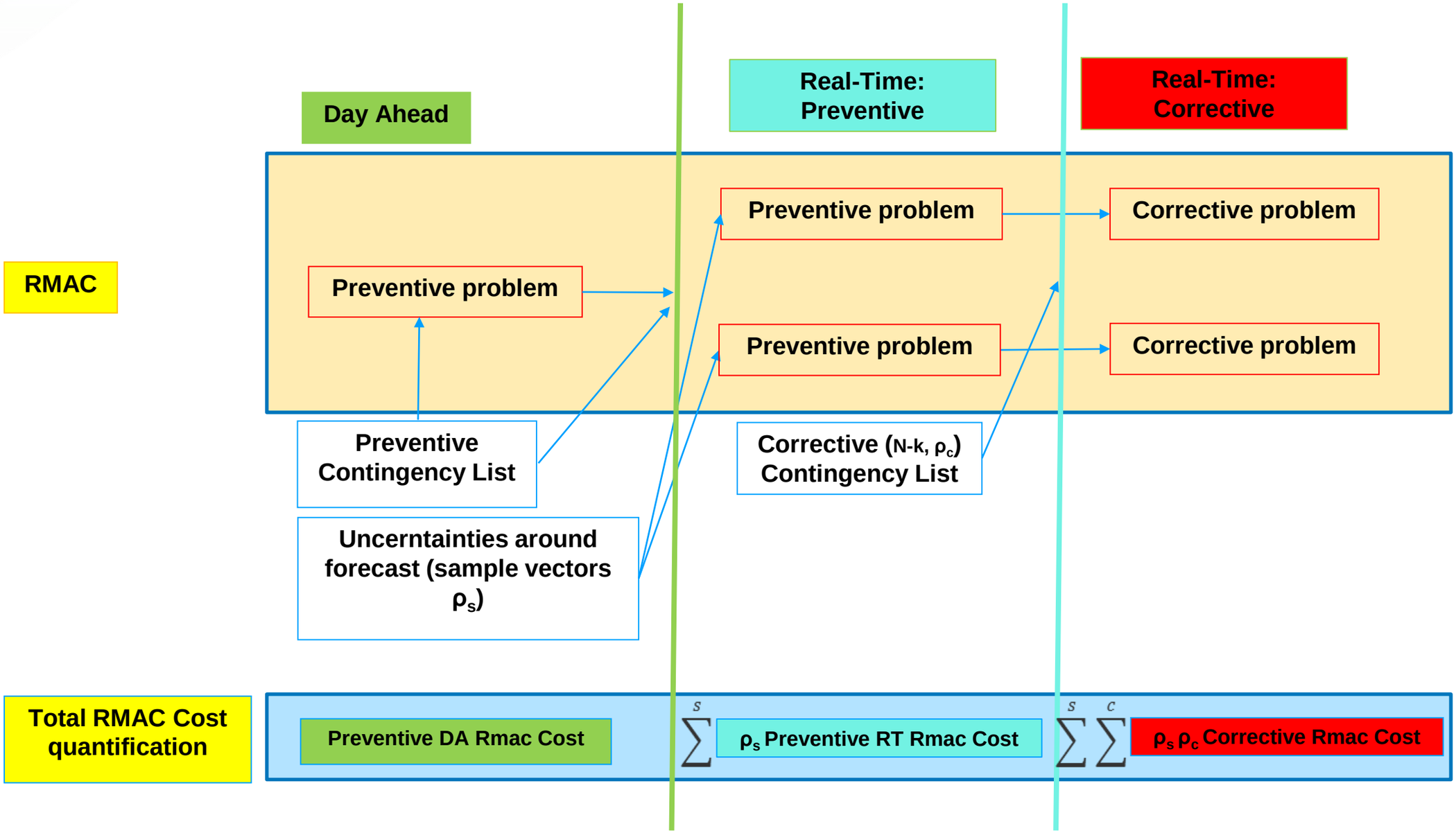
RMAC comparisons using the GQP

GQP main features for the pilot test

- DACF CIM import + csv complementary files
- Two level optimization problem for arbitration between preventive and corrective actions to build a preventive solution
- Complex MILP solver:
  - to model those arbitrations
  - to take into account TSO acceptability constraints
  - to model generation startup, PST and topology shifts
  - to model failure of corrective actions
  - to perform contingency relaxation
- DC computations vs AC checks

RMAC comparisons using the GQP

3 steps approach



RMAC comparisons using the GQP

GQP validation and performances

GQP Performances have highly impacted the test methodology:

- The computational performances are linearly impacted by the number of hourly points/ samples/ corrective contingencies considered, regarding preventive contingencies the impact on performances is polynomial
- Due to hardware (only 6 processors) / MILP implementation and combinatory aspect of the problem/depends on situation complexity
- Necessity of test adaptations

GQP validation for the test:

- No existing equivalent, no GUI, has represented about 80% of the test allocated time
- Definition of simple use cases/comparative RMAC problems/dedicated outputs
- Close collaboration between RTE and KUL development team

RMAC comparisons using the GQP

Test adaptations

Reduction of the physical model:

- EHV network: 450 nodes/650 Lines/6 PST/200 Generators/600 Loads

Reduction of binary variables and control actions:

- Limited list of preferential topological actions to combine
- Topological actions limited to preventive or N-1 corrective problems

Reduction of the number of contingencies to consider:

- 22 N-1/231 N-2/1540 N-3 shrink to 10/45/120 (failure rate multiplier)
- Selection of 26 contingencies only for the preventive problems (10 N-1/16 N-2)

Reduction of the number of hourly situations:

- Identification of 250 hourly points with congestions, selection of 10 representative hourly points for the test report

Reduction of the number of samples:

- Analysis using observed real-time deviations and sensitivity comparison with 20 selected samples for the test report

RMAC comparisons using the GQP

Using the GQP

Use-case generation and selection:

- DACF reduction + CIM export (RTE EMS)
- Input complementary csv file generation (R statistical software) to control the GQP behaviour

Interacting with the GQP on KUL server:

- Using dedicated input/output private directories
- Using a common directory for anomaly reproduction and correction
- GQP launching using Matlab

Result interpretation:

- Definition of dedicated outputs for the tests
- Use of R statistical software at RTE + French EMS for specific validation

RMAC problems and test methodology

RMAC comparisons using the GQP

4 RMAC comparative problems

2 Classical RMACS

- N-0 problem: No contingency to build the preventive solutions
- N-1 problem: Only N-1 contingencies to build the preventive solutions (ρ_c=1), trade-off with corrective actions not authorized

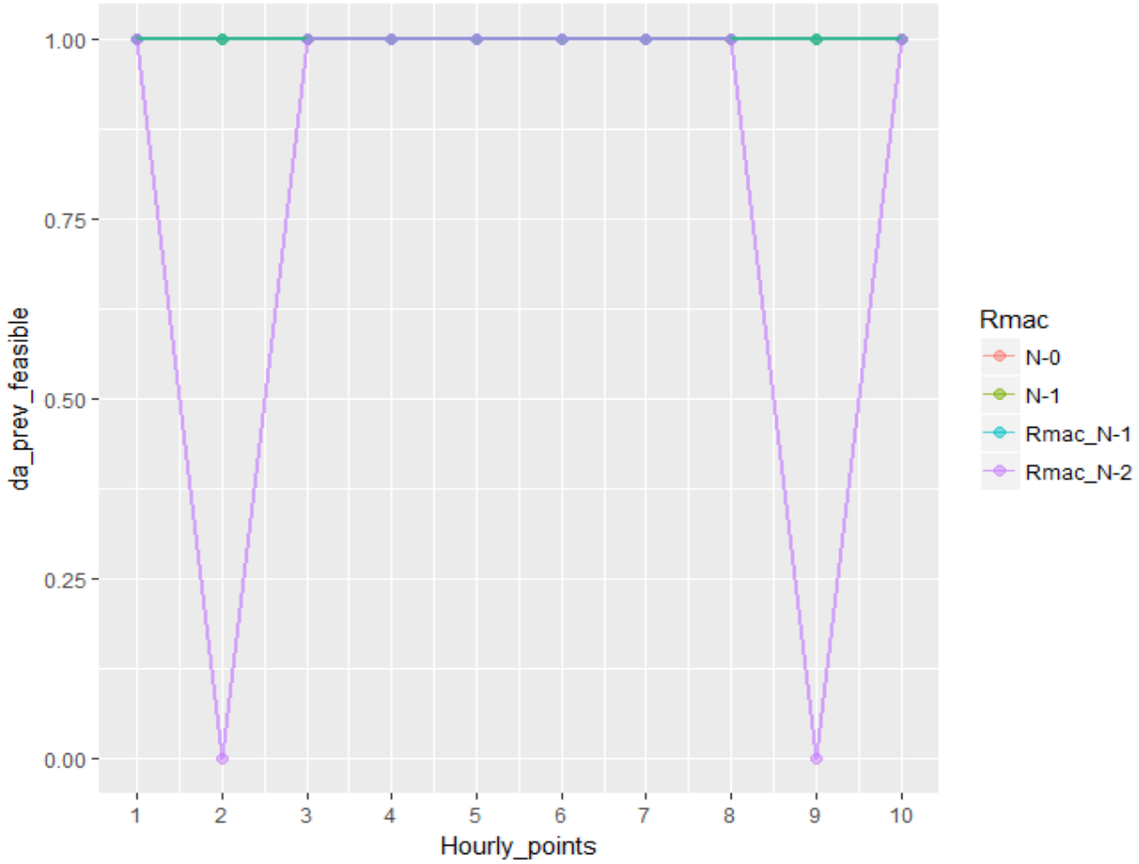
2 Statistical RMACS

- RMAC_N-1 problem: Only N-1 contingencies to build the preventive solutions (ρc), trade-off with corrective actions authorized
- RMAC_N-2 problem: N-1+N-2 contingencies to build the preventive solutions (ρc), trade-off with corrective actions authorized

Last stage corrective problem identical for all RMACs: Residual risk estimation

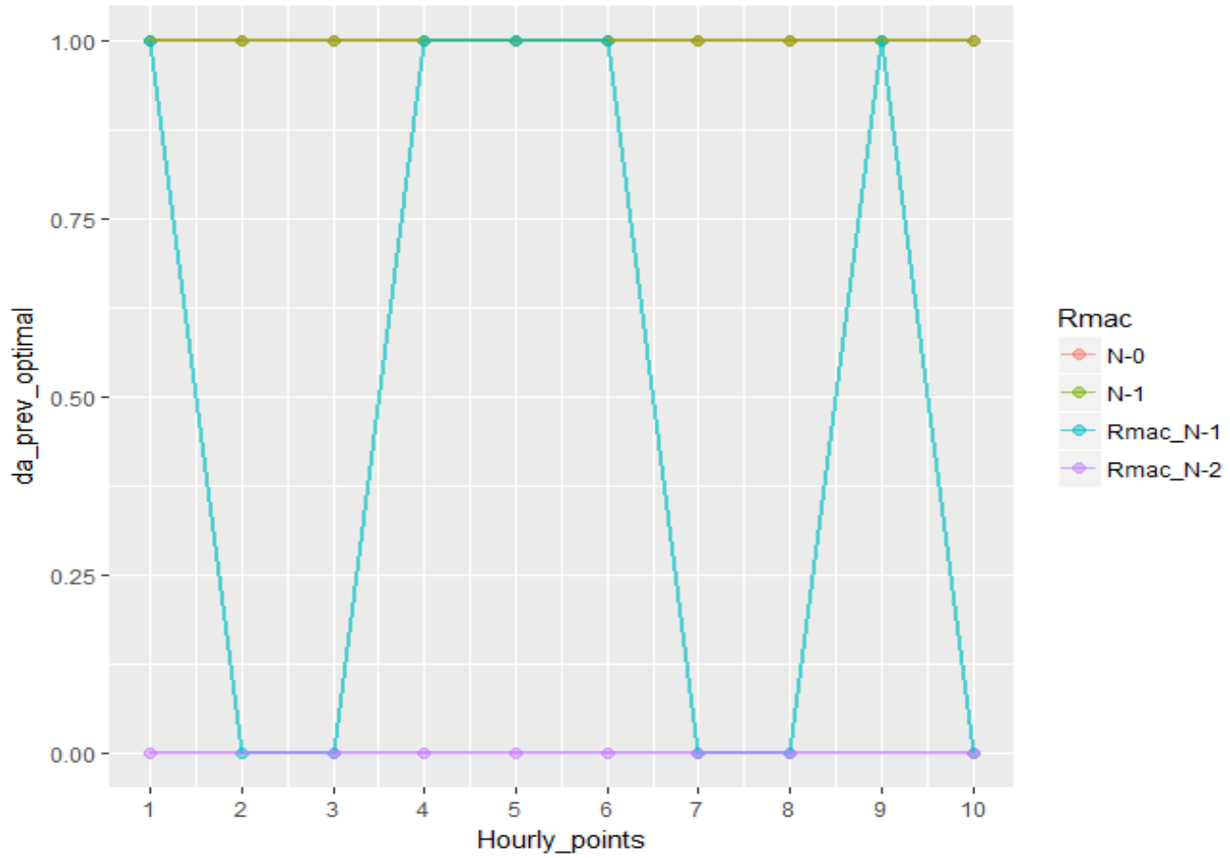
RMAC comparisons using the GQP

Feasibility and optimality indicators



Feasibility indicators: No solution

- concerns mainly the RMAC_N-2 problem

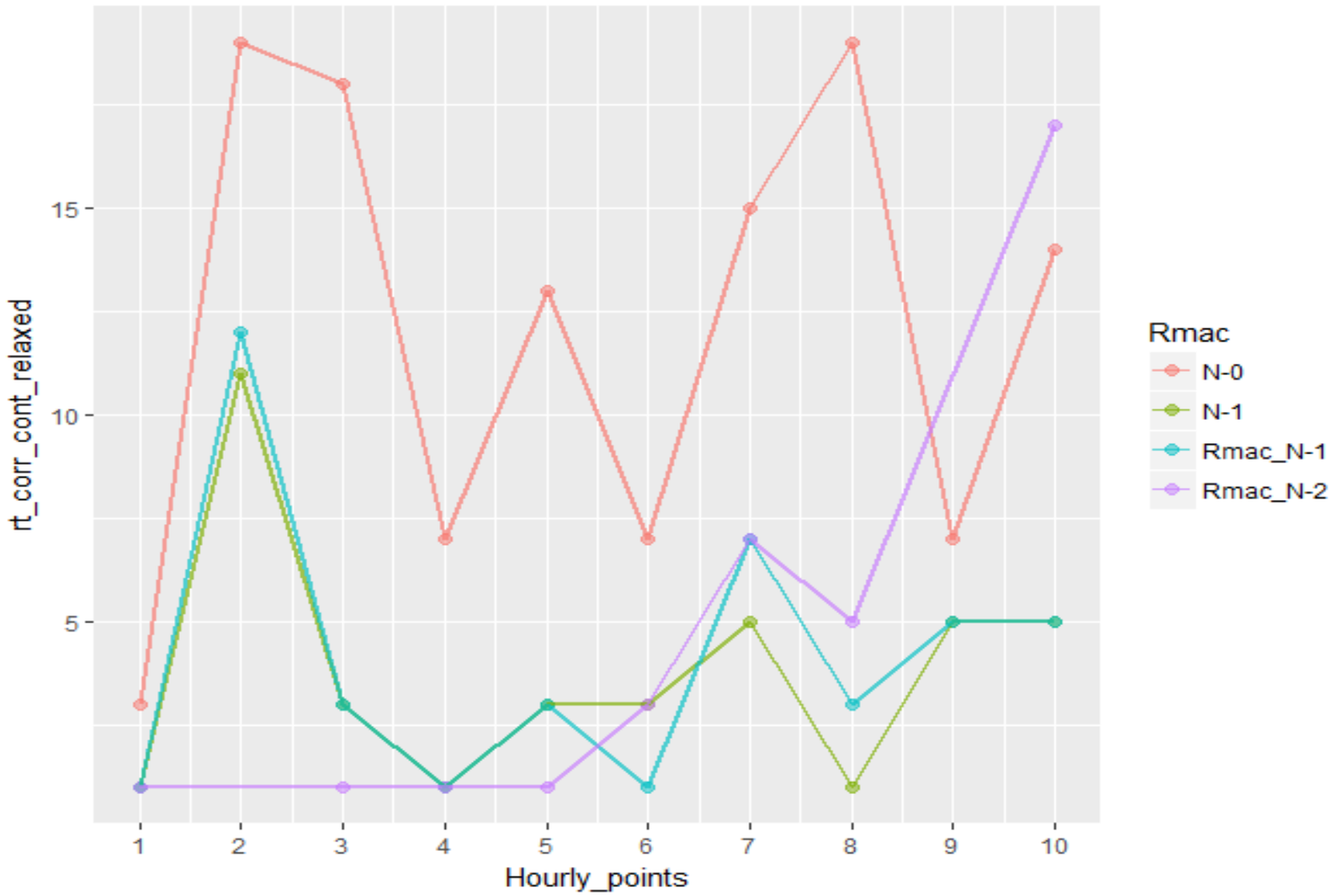


Optimality indicators: Optimality not guaranteed

- Output usable, related to time limit

RMAC comparisons using the GQP

Contingency relaxation indicators



Relaxation indicators:

Problem harshness, concerns mainly

- The Rmac_N-2 (preventive solution)
- The N-0 problem (last stage corrective solution)

Test results

RMAC comparisons using the GQP

Test methodology

Base case parametrization:

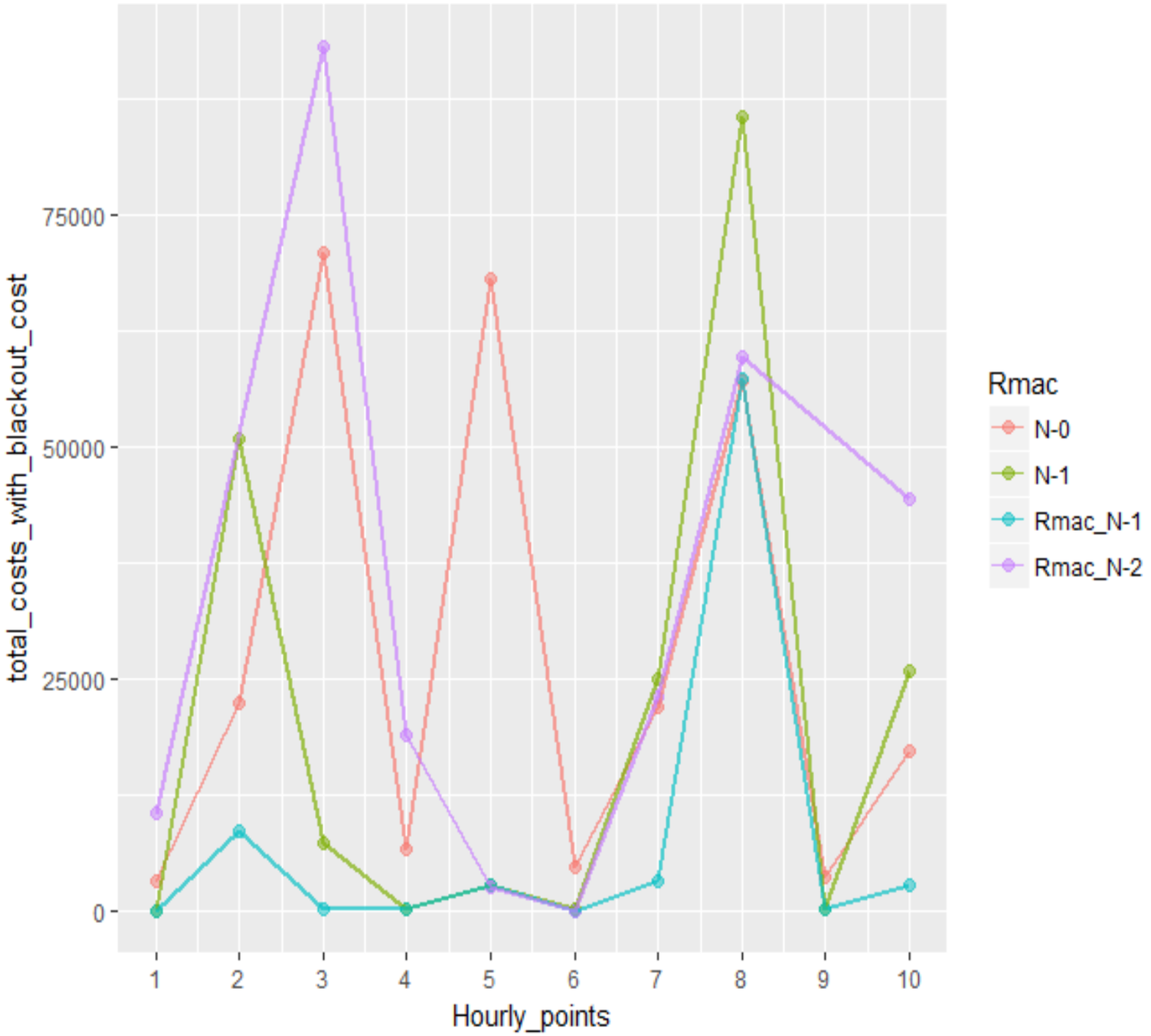
- Compare the 4 different RMACs

Sensitivity to:

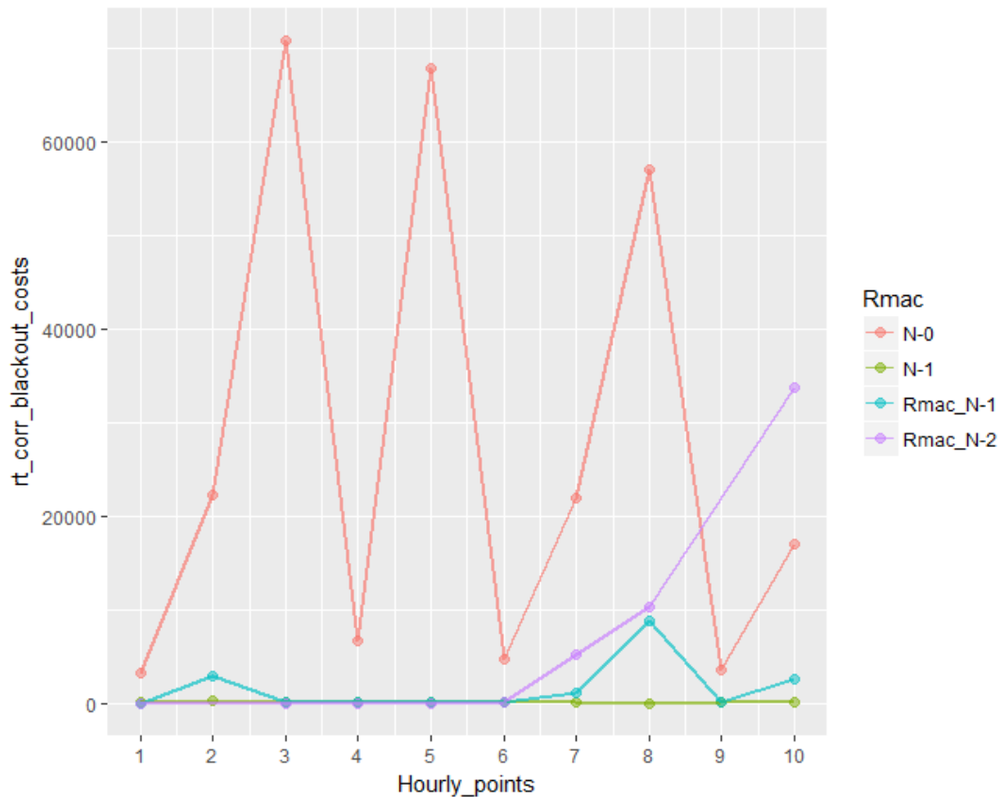
- Contingency failure rates
- Uncertainties around the forecast
- Acceptability constraints and failure of corrective actions
- Control actions
- N-k contingencies (k>2)

RMAC comparisons using the GQP

Base case parametrization



- N-0: could be over costly due to the fact that the residual risk is not mastered
- N-1 could be over costly compare to RMAC_N-1 for a similar control of the residual risk
- RMAC_N-2 could be over costly than other RMACs for no better control of the residual risk



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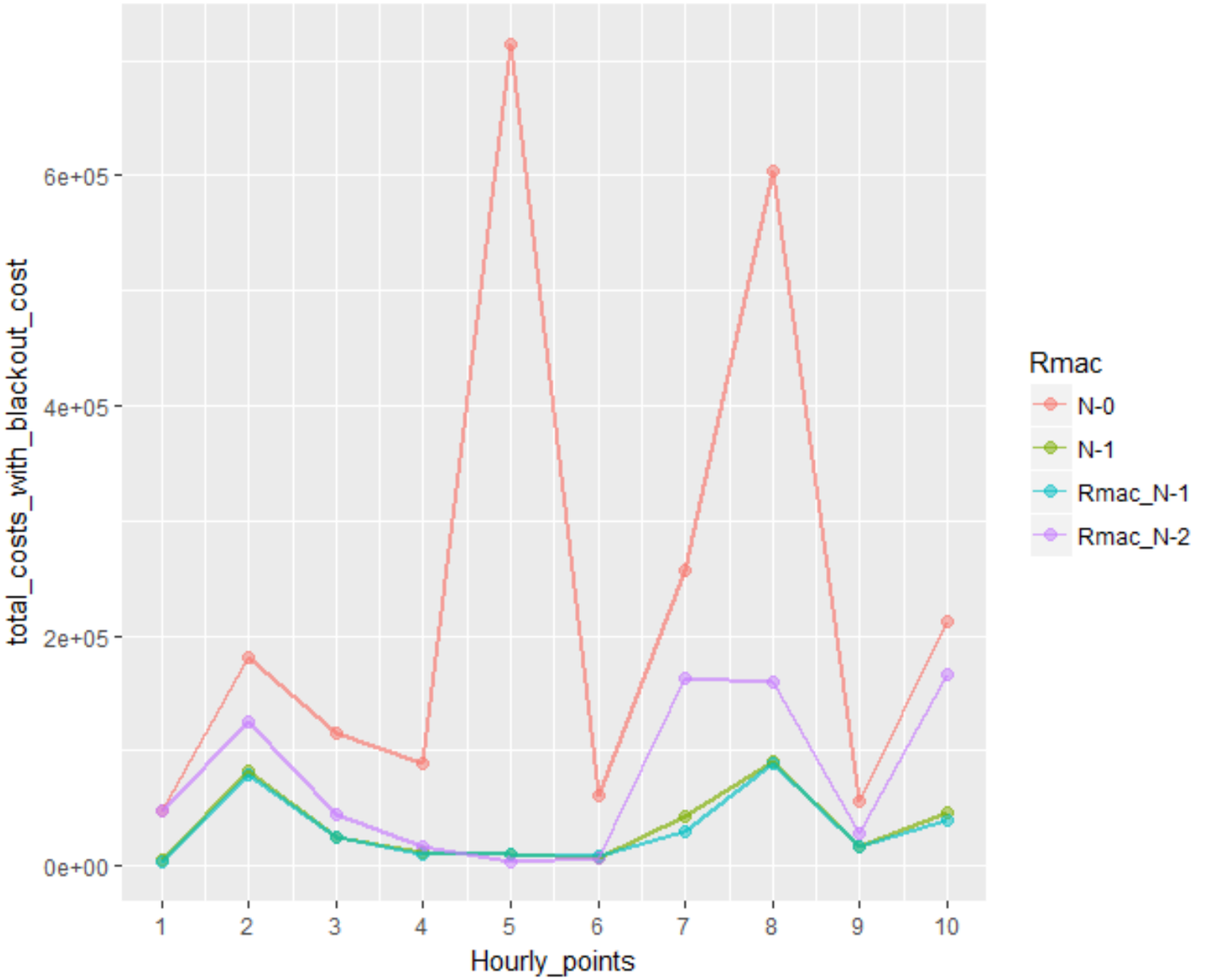
Sensitivity to contingency failure rates

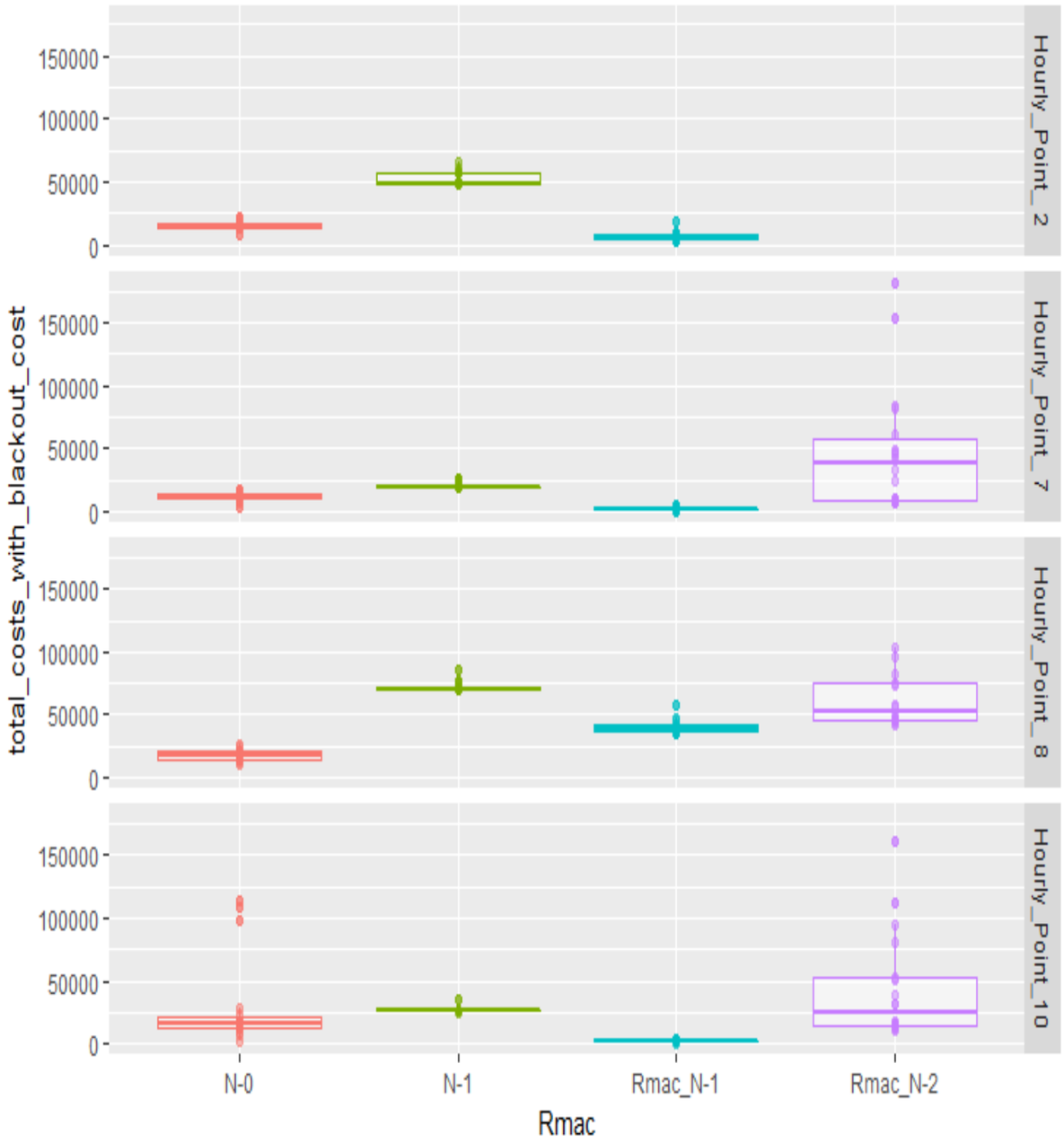


Failure rates * 10: adverse weather conditions

- N-0 is getting worse
- RMAC_N-1 tends to mimic N-1
- RMAC_N-2 behavior is not better

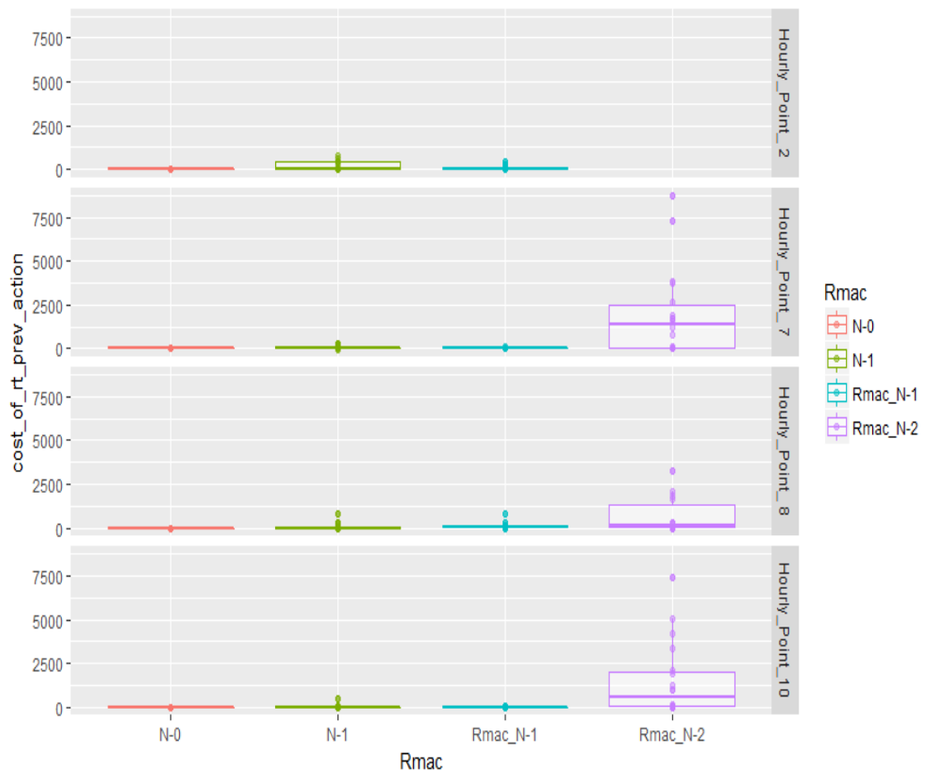
RMAC comparisons using the GQP

Sensitivity to uncertainties around forecast



20 sample vectors

- Good stability of RMAC_N-1
- RMAC_N-2 over sensitive to uncertainties



RMAC comparisons using the GQP

Complementary sensitivity tests

Sensitivity to failure of corrective actions and TSO acceptability constraints

- By reducing failure or corrective actions or acceptability constraints the preventive costs diminished but necessity to closely monitoring the residual risk

Sensitivity to topological control actions:

- Topological actions do reduce the preventive costs

Sensitivity to N-k (k>2):

- N-3 not significant for this problem

3 difficulties have to be first considered when introducing N-2 contingencies:

- are the consequences of those sufficiently well computed
- could we trust automatically generated remedial actions
- do they justify extra preventive costs

Closing remarks

RMAC comparisons using the GQP

Closing remarks

Sensitive issues to consider

- The GQP is a research grade prototype, to perform such studies one should consider:
  - Performances and tractability/result interpretation and validation
  - But also more complete RMAC implementation such as:
    - Taking into account uncertainties in the day-ahead preventive problem
    - Taking into account larger problems
    - Taking into account reactive and dynamic phenomena
    - Taking into account Multi-TSOs interactions
- 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

RMAC comparisons using the GQP

Closing remarks

Regarding the benefits of the approach

- the statistical RMAC_N-1 is well positioned, consistent with intuitions
- 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

THANK YOU FOR YOUR ATTENTION!

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