iTesla Project

Innovative Tools for Electrical System Security within Large Areas

Workshop « Innovative Tools Needed for Future and Stable System Operation »

Thursday June 21, 2012

Generalities

- **Role of a TSO:**
  - ✓ Maximizing power capacities while maintaining a given level of security over the grid.

- **Main challenges facing a TSO in this task:**
  - ✓ A more integrated European market that acts as an optimizer and pushes the system to its limits.
  - ✓ An increasing number of uncertainties mainly due to renewables integration (variability of wind and solar generation)
  - ✓ Difficulties to build new overhead lines
  - ✓ The increasing number of more sophisticated leverages of control leading to more end more complex mechanisms to maintain the security of the grid (DC lines, SVCs, PSTs, specific automatons,…)
  - ✓ ➔ A network operated closer to its limits

Identified ways of improvement to help a TSO to successfully accomplish its task:

- **Help operators to have a better understanding of uncertainties:**
  - ✓ The expected error on some forecasts ➔ be conservative enough
  - ✓ Find correlation between different sources of uncertainties ➔ not being too conservative
  - ✓ Take into account the probability of some events happening on the grid ➔ discriminate between different events

- **Work on a more accurate modeling of the grid➔ have a clearer picture of the true limits of the system:**
  - ✓ Use results from dynamic simulations closer to real time operation
  - ✓ Offer to the operator a better understanding of the different successive events on a grid
  - ✓ Have a methodology making a clear distinction between preventive and curative actions

Identified ways of improvement to help a TSO to successfully accomplish its task (2):

- **Work at an European scale:**
  - ✓ Enable a true integration of the European generator mix
  - ✓ Allow dynamic simulation on large networks to study pan-European phenomena and find coordinated solutions

- **Lower the cost of operation :**
  - ✓ Make use of all available curative actions to lower the cost of the system operation

- **Display clear results to the operator:**
  - ✓ Indicate unacceptable states
  - ✓ If corrective actions are not sufficient help operators to chose appropriate preventive actions to pass through unacceptable states while maintaining an acceptable level of security on the grid

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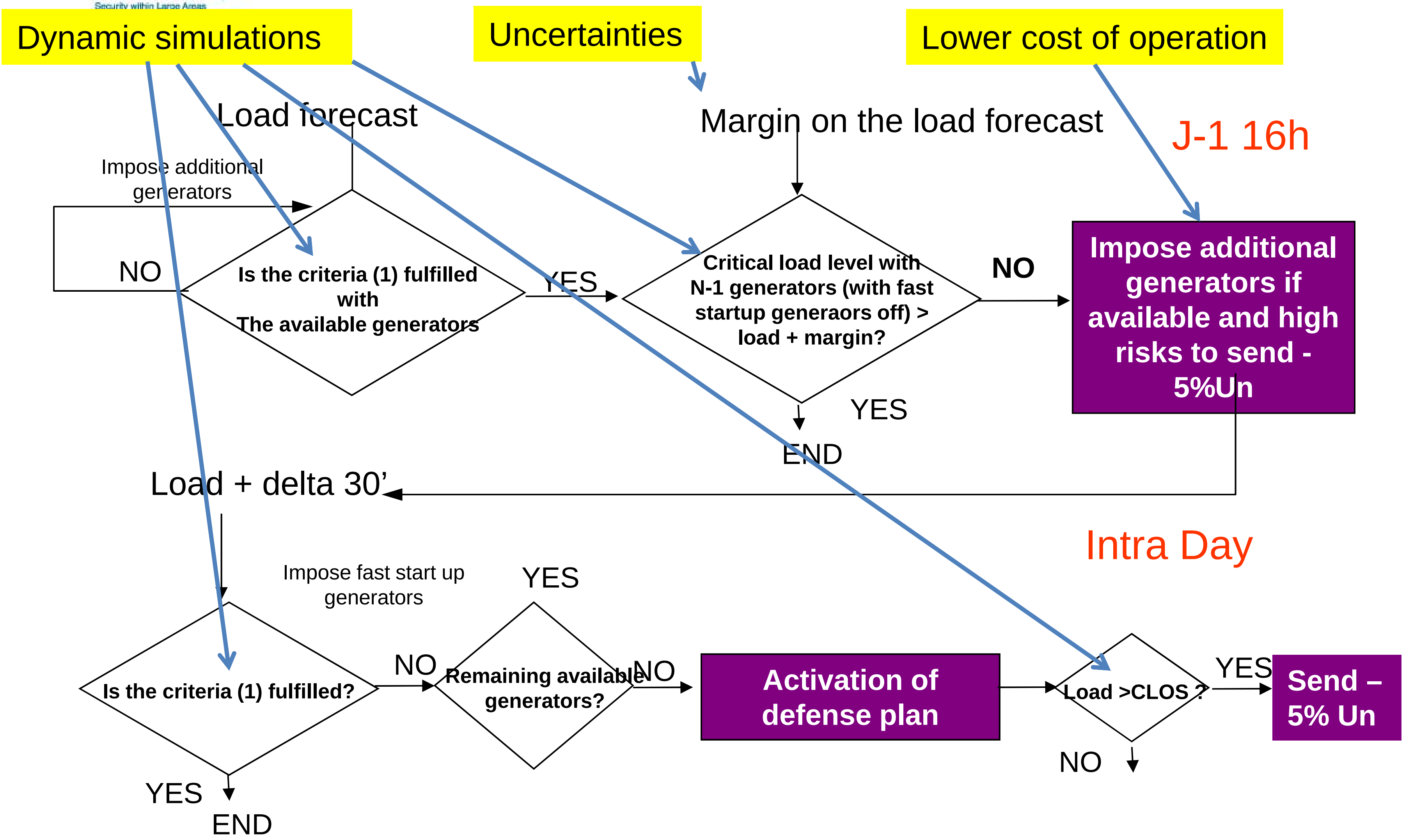
An example: imposition of generators for voltage stability needs on the french grid

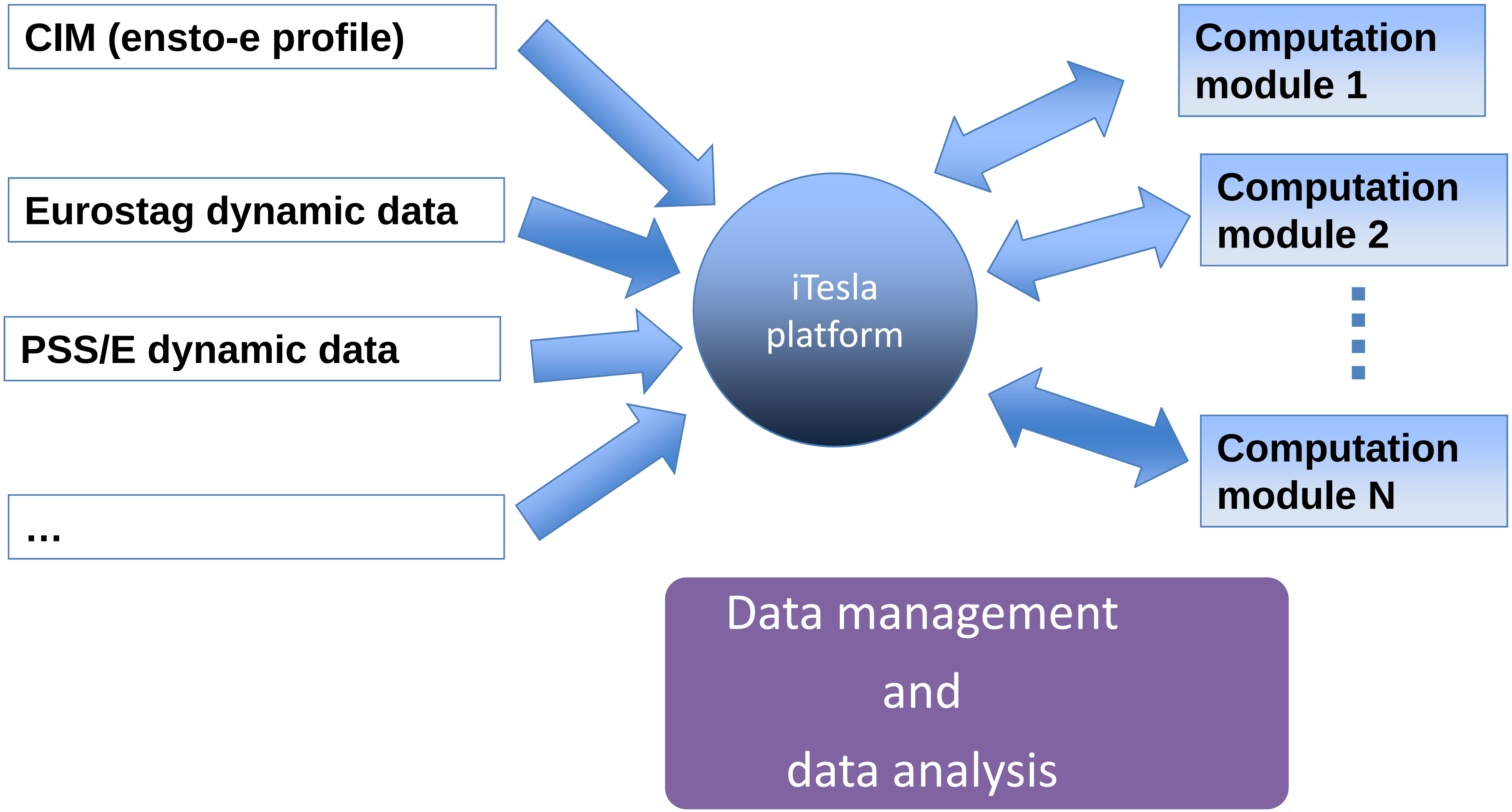


Solutions proposed in iTesla :

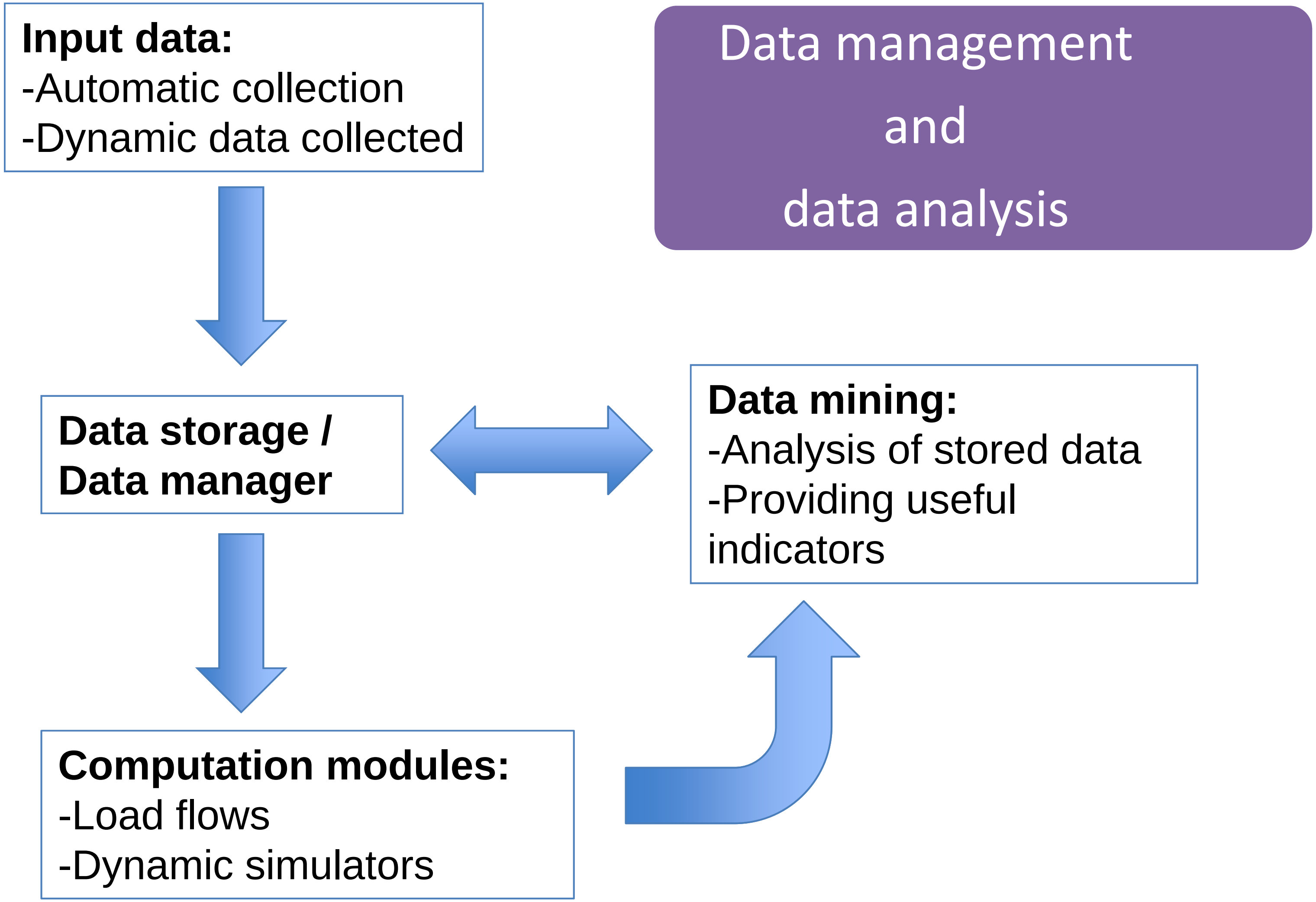
- **A better data management:**
  - ✓ A flexible data collector capable to support different formats in input (static and dynamic data)
  - ✓ An appropriate storage of the data allowing powerful data mining methods to run efficiently
  - ✓ A modular organization allowing external modules to plug in thanks to open interfaces

- **Powerful data mining methods available:**
  - ✓ Analysis of historical data to evaluate expected errors on forecasts
  - ✓ Analysis of past events to refine their probabilities of occurrence
  - ✓ Analysis of computation results to define relevant security rules
  - ✓ Analysis of the correlation between some stochastic variables records to have more consistent forecasts
  - ✓ Evaluate the probability of failure of some controls

Solutions proposed in iTesla (2) :



Solutions proposed in iTesla (2) :

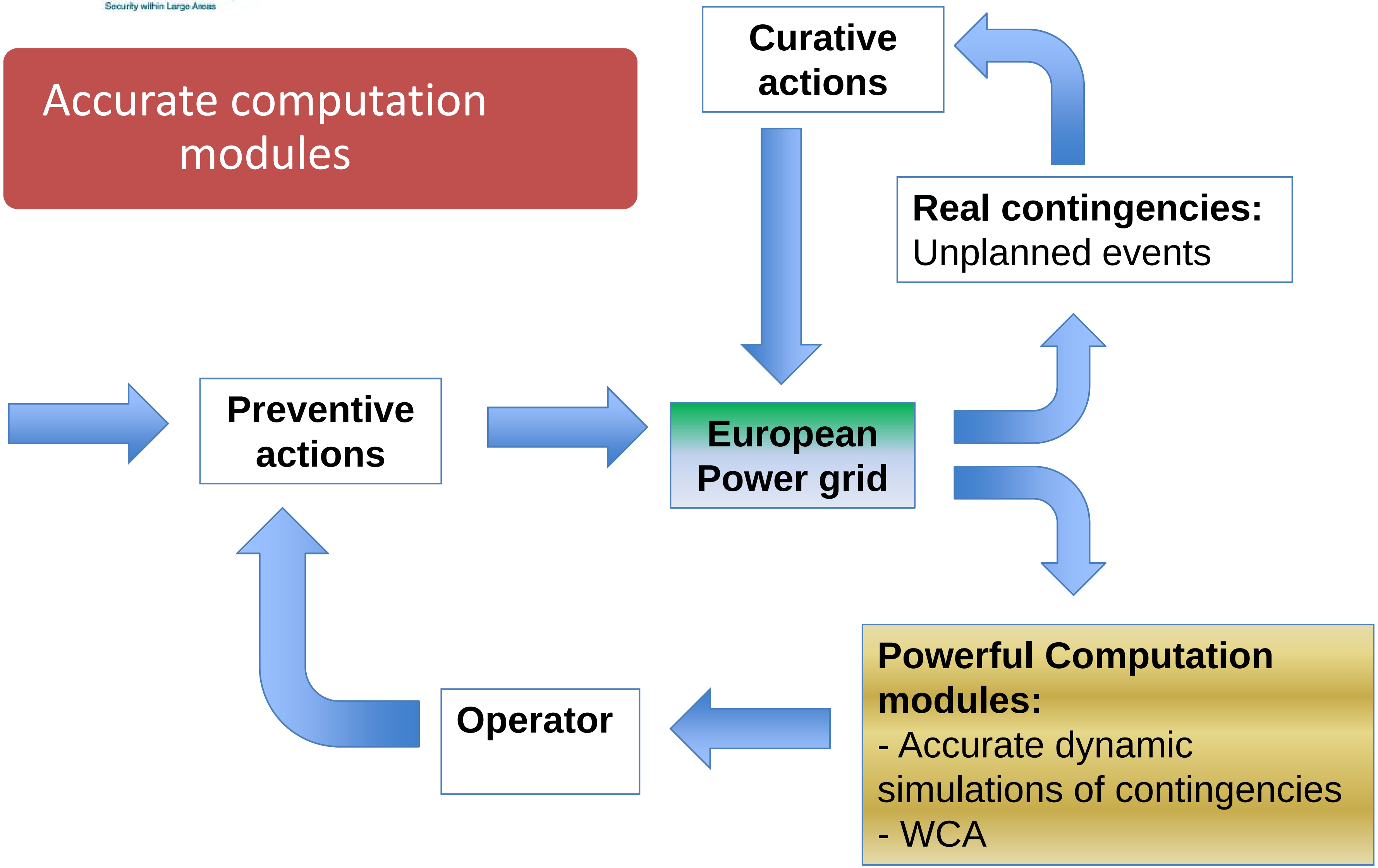


Solutions proposed in iTesla (3) :

- **Use more accurate and more consistent computation modules:**
  - ✓ Use accurate and intensive dynamic simulations
  - ✓ Model properly new devices such as HVDCs, SVCs, wind farms, PV, PST… and run more realistic dynamic simulations
  - ✓ Analysis of cascading effects at a European scale
  - ✓ Compute for different time horizons (D, D-1 and D-2) the minimal needed remedial actions
  - ✓ Define less conservative but safe rules with accurate dynamic simulation results
  - ✓ Use the powerful Worst Case Approach (WCA) to identify critical events that may happen on the grid and unacceptable states

- **Work at an European scale:**
  - ✓ All the computations above will be run at an European level
  - ✓ Cascading effects, defense plans, modal analysis… will be studied at a pan-European level

Solutions proposed in iTesla (4) :



$\max_{s}(\min_{u_e} \delta_c)$

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Solutions proposed in iTesla (4) :

The Worst Case Approach (PEGASE outcome)

Available corrective actions:

ue

Patterns injections = interval of trust (generation and load):

s

Cost function describing the violation of some constraints:

C

Bi-level optimization:

Max/s(Min/ue(C))

For a given contingency, are available curative actions enough to overcome the worst case scenario?

Solutions proposed in iTesla (5) :

- **Provide clear results to the operator:**
  - ✓ List of contingencies of interest with severity indicators
  - ✓ Explain phenomena and their locations leading to instability
  - ✓ Propose a list of minimal preventive actions needed to overcome some contingency and their “last time to decide” scope of applicability
  - ✓ Provide these results on a sliding mode in D-2, D-1 and on real time operation

Conclusion

- **Answers to the main challenges facing a TSO in this task:**
  - ✓ A more integrated European market leading increasing needs of cooperation of all the actors: Work on merged European grids
  - ✓ The increasing number of uncertainties mainly due to renewable integration (variability of wind and solar generation): Use of powerful data mining techniques on collected data
  - ✓ The increasing number of more sophisticated leverages of control leading to more end more complex mechanisms to maintain the safety of the grid (DC lines, SVCs, PSTs, specific automatons,…): Use of dynamic simulators plugged in iTesla
  - ✓ A network operated closer to its limits due to constantly increasing demand: Use all the points listed above in a “last time to decide” process providing clear solutions to the operator which are not too conservative