Utilization of Adaptive Transmission Rates in Dispatch

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Overview

- Adaptive Transmission Rates (ATR) concept
- ATR Proof-of-Concept (POC) implementation
- Some ATR results

Formulation

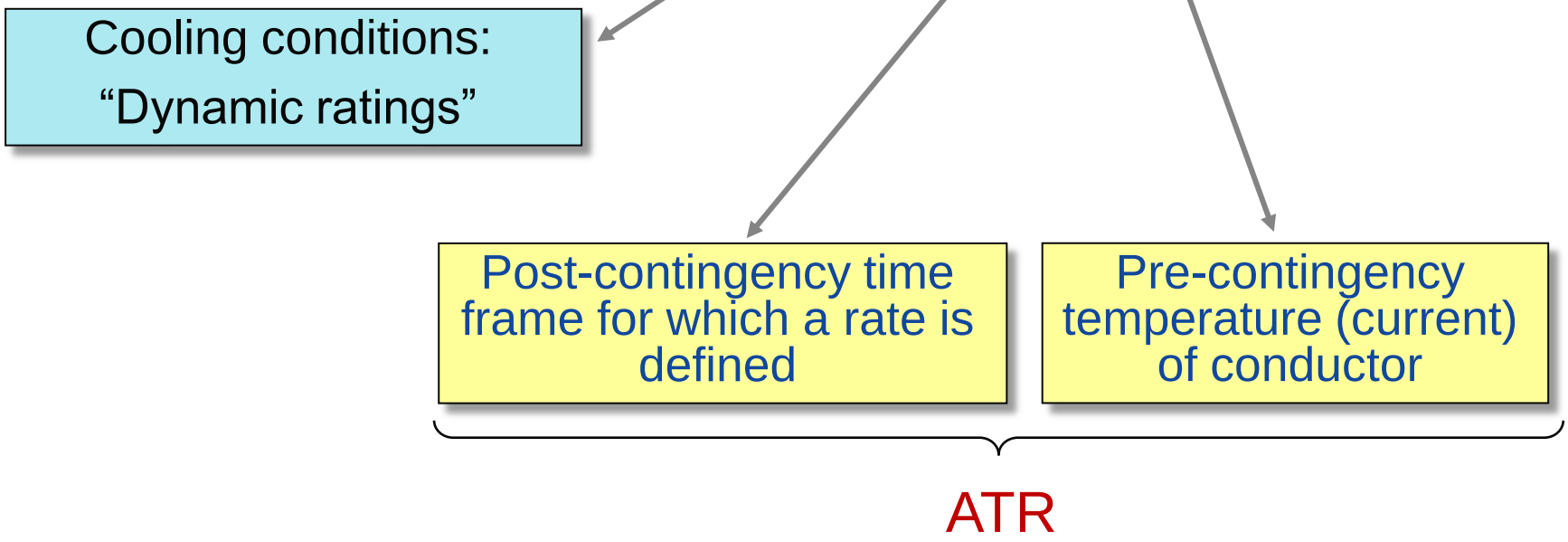
- Post-contingency thermal transmission constraints are based on transient Emergency Ratings of lines and transformers:

$$\text{Post contingency flow} \leq \text{Emergency Rate}$$

- Emergency Rate is typically a static parameter and equals to Long-Term Emergency (LTE, 4 hours) or Short-Term Emergency (STE, 15 min) rate
- $STE \geq LTE$ → Which rate to use?
- Adaptive Transmission Rate (ATR) concept intends to adaptively select Emergency Ratings by accounting for the post-contingency dispatch and pre-contingency conductor loading

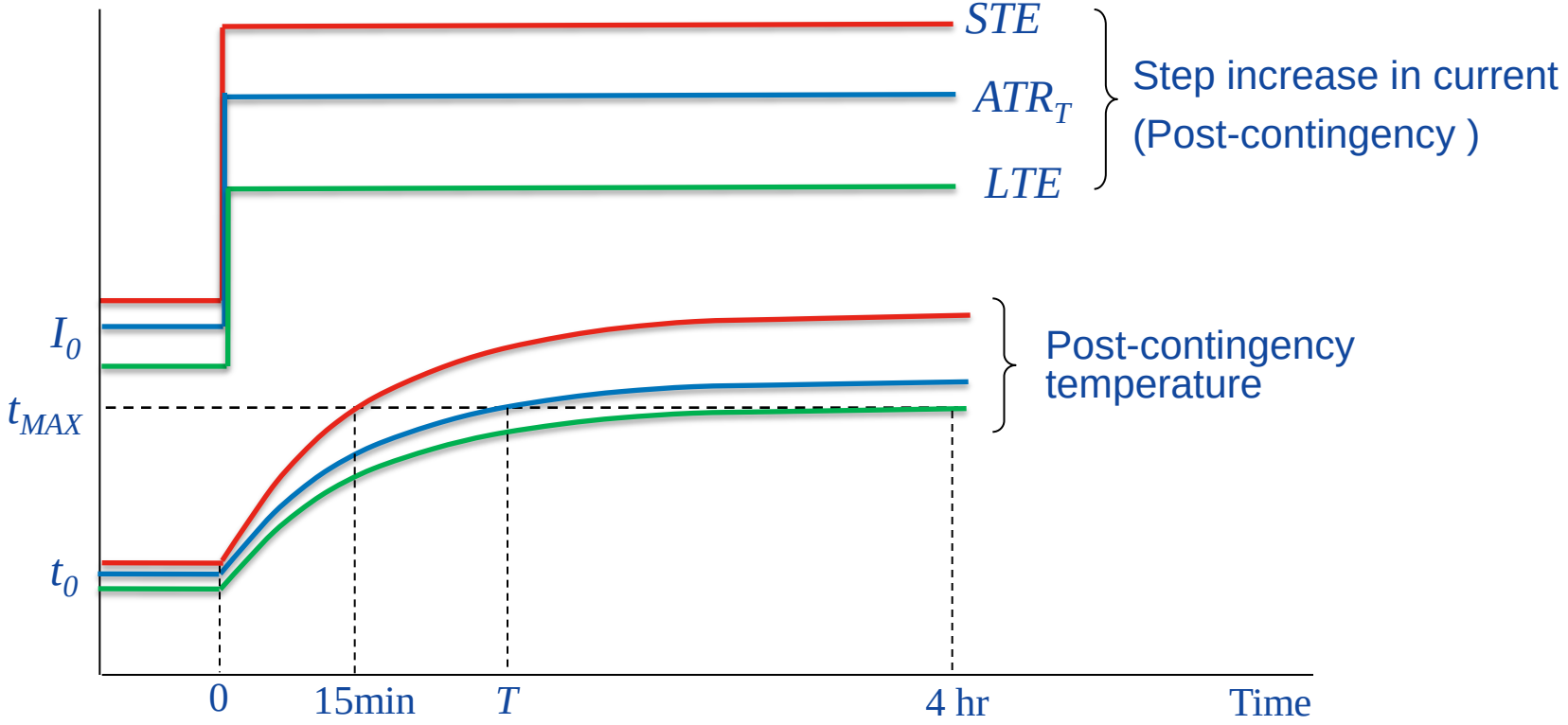
Transient Emergency Rate

Rate = Function of (Weather, Time, Load)



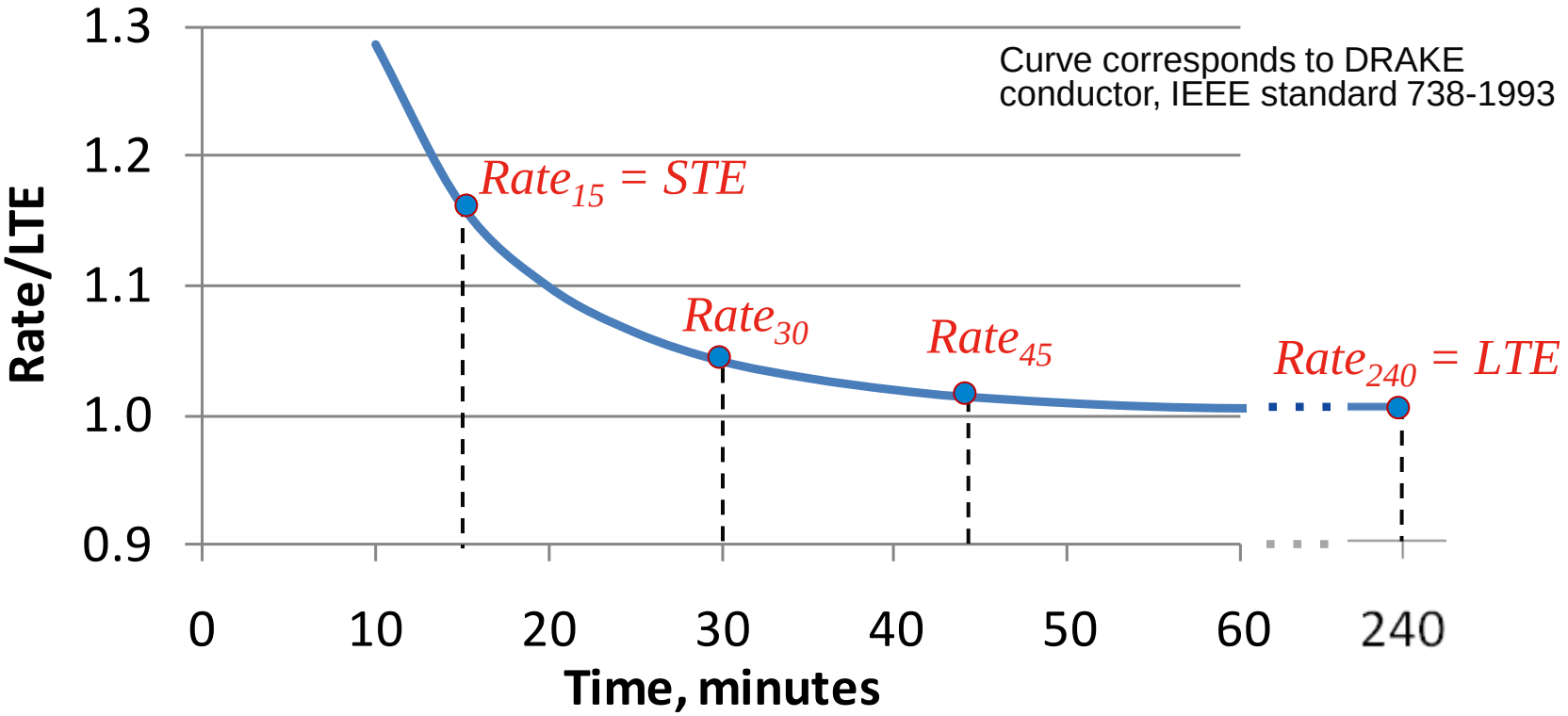
Definition of Emergency Transient Rate

IEEE 738-1993 standard: “The transient thermal rating is that final current that yields the maximum allowable conductor temperature (t_{MAX}) in a specified time (T) after a step change in electrical current from some initial current (I_0).”



Rate(time) characteristic

- *Rate(time)* is a physical characteristic and can be developed for each line by using the same methods as for calculation of *STE* and *LTE*
- Any point on a curve can be used as an Emergency rate

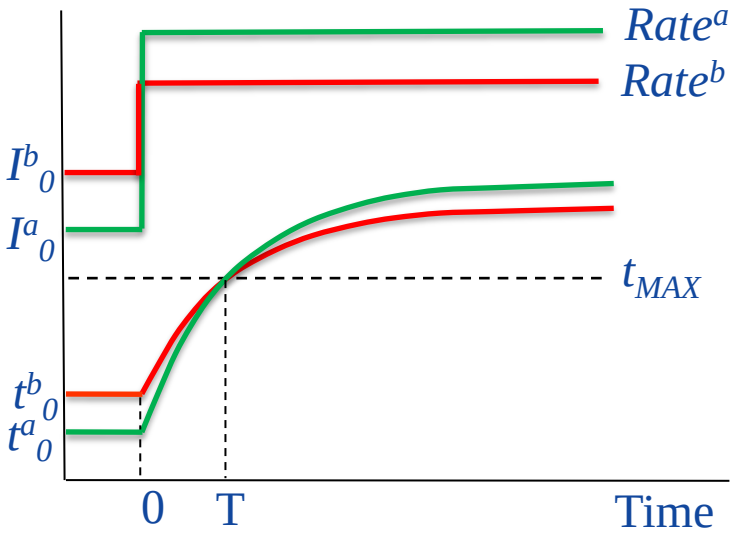


How initial load impacts *Rate*?

- The lower the initial load is the higher is *Rate* value

  $I^a_0 < I^b_0 \rightarrow Rate^a > Rate^b$

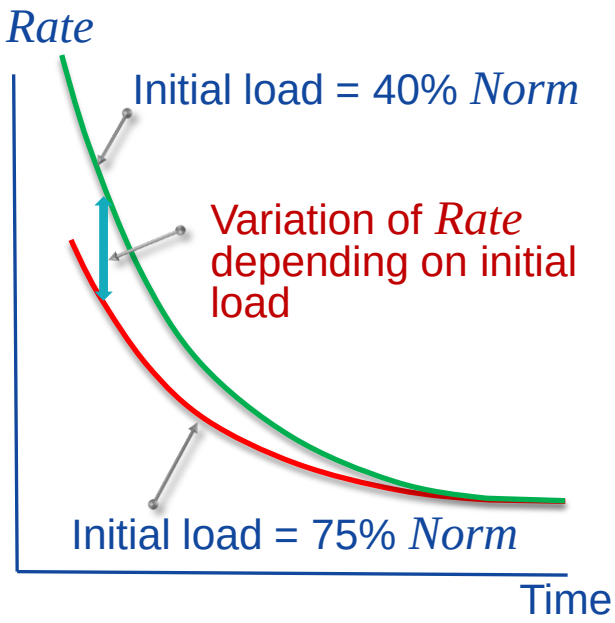
- Typical assumption for pre-contingency loading of a conductor is 75% of *NORM* rate



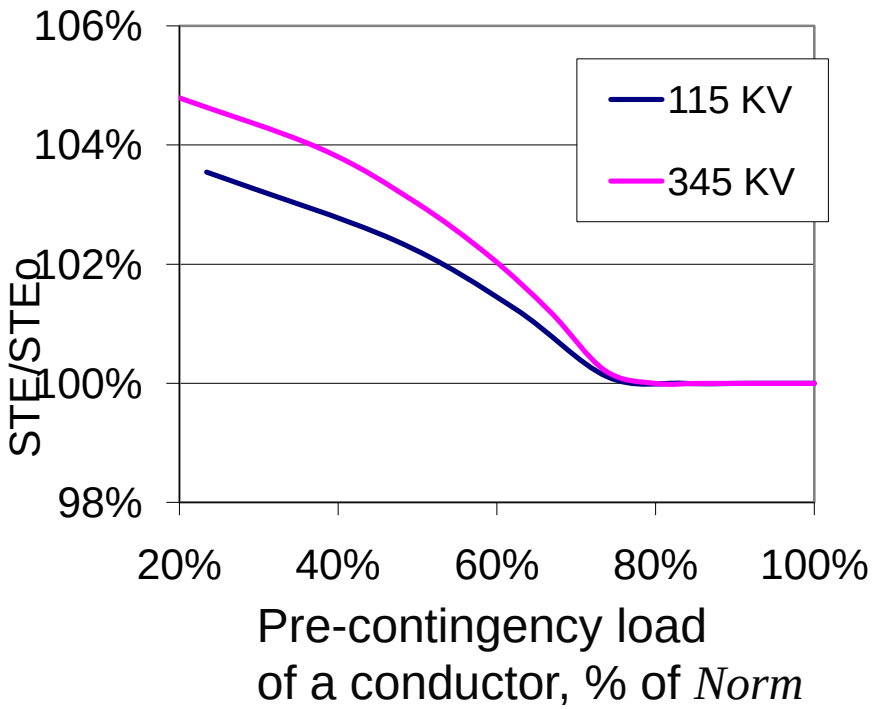
- Real time loading often is less than 75% and that opens an opportunity to recalculate *Rate* according to actual loading of conductor

Change in *Rate(Time)* characteristic

Rate(Time) adjustment per pre-contingency load by standard IEEE technique



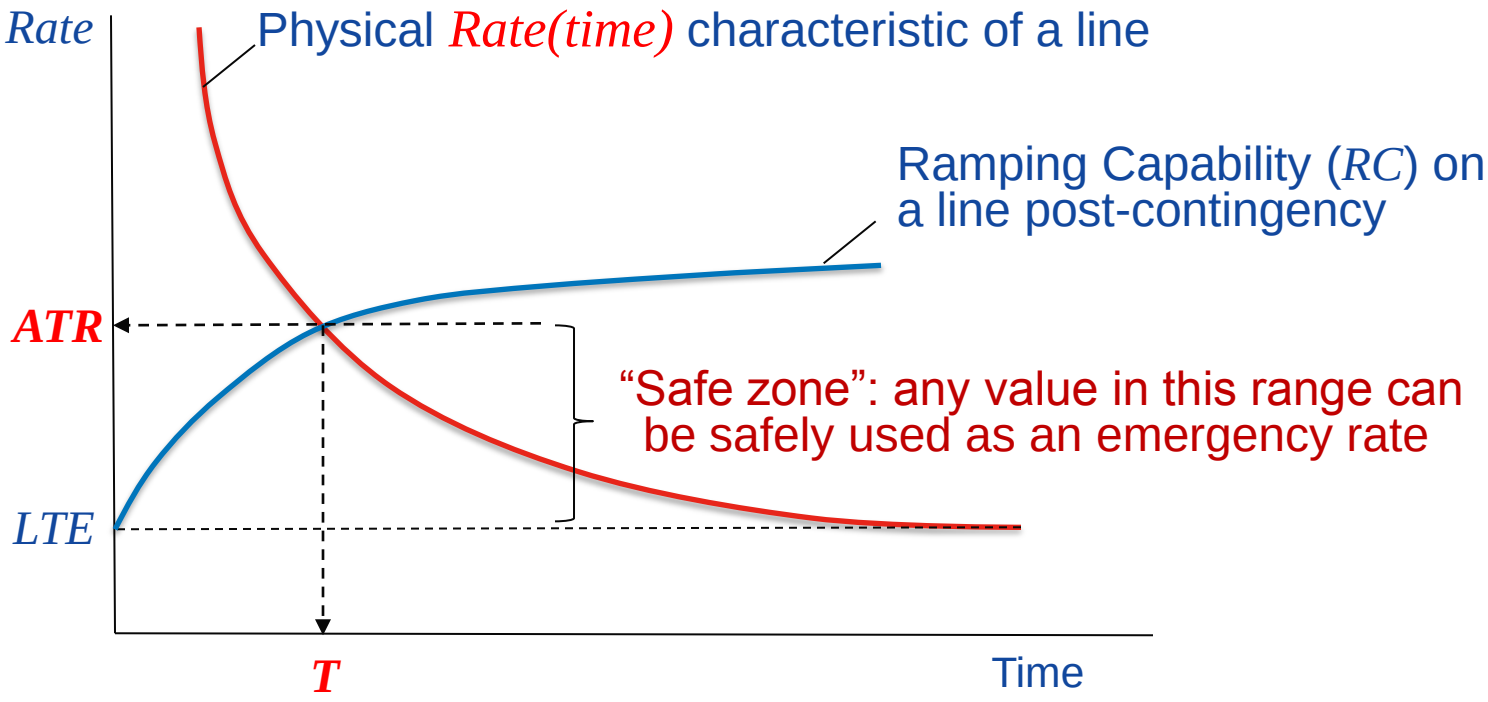
Variation of *STE* rate for overhead conductor



How to Get ATR?

- *ATR* is obtained as the solution of the following equation

$$Rate(time) = LTE + RC(time)$$



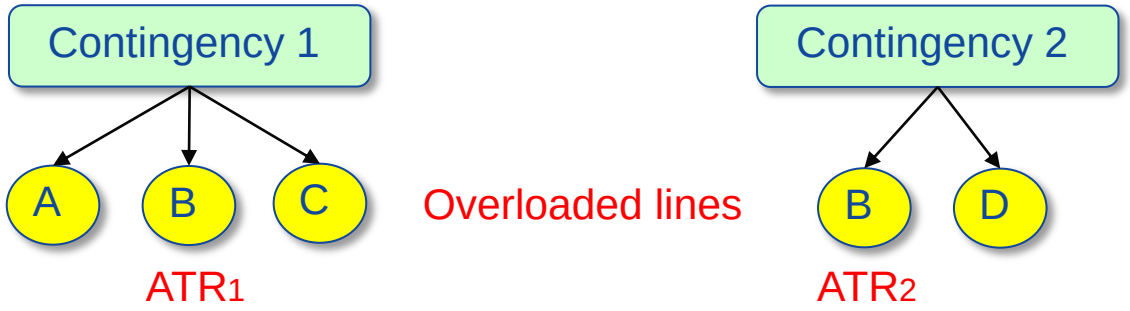
- Conservative reduction of *ATR* range: $LTE \leq ATR \leq STE$

Ramping Capability: *RC(time)*

- *RC* is the change in MW flow in a line of interest over time as a result of economic dispatch after contingency
- Accurate calculation of *RC* requires to model post-contingency dispatch
- Use the same dispatch procedure and input data which are used for Real-Time dispatch
- RC is calculated for each critical contingency causing loading above *LTE* on the line of interest
- For critical contingency, calculate *RC(t)* as the MW flow change in the line of interest by SCED for different look-ahead time intervals 15, 30, 45 and 60 minutes

ATR results

- RC is different for each critical contingency
- The same line can have several ATR values correlated to specific contingencies
- There is no need to enforce the most conservative ATR value for all critical contingencies as it is used in traditional dispatch

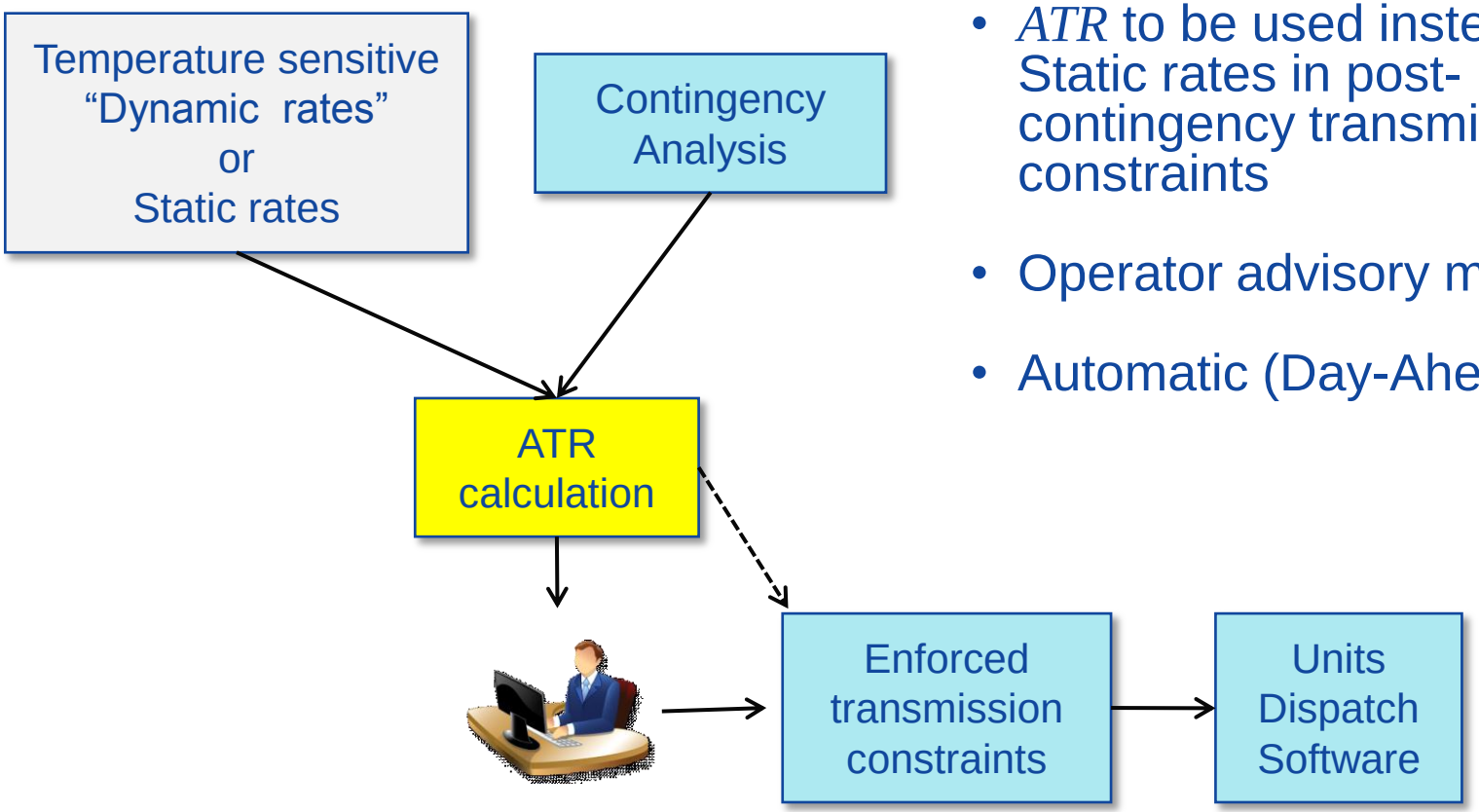


ATR benefits

- Increased utilization of power system transfer capabilities without deterioration of system reliability
- Reduction of electricity production cost. ATR allows enforcing transmission constraints in dispatch at the maximal but safe load level

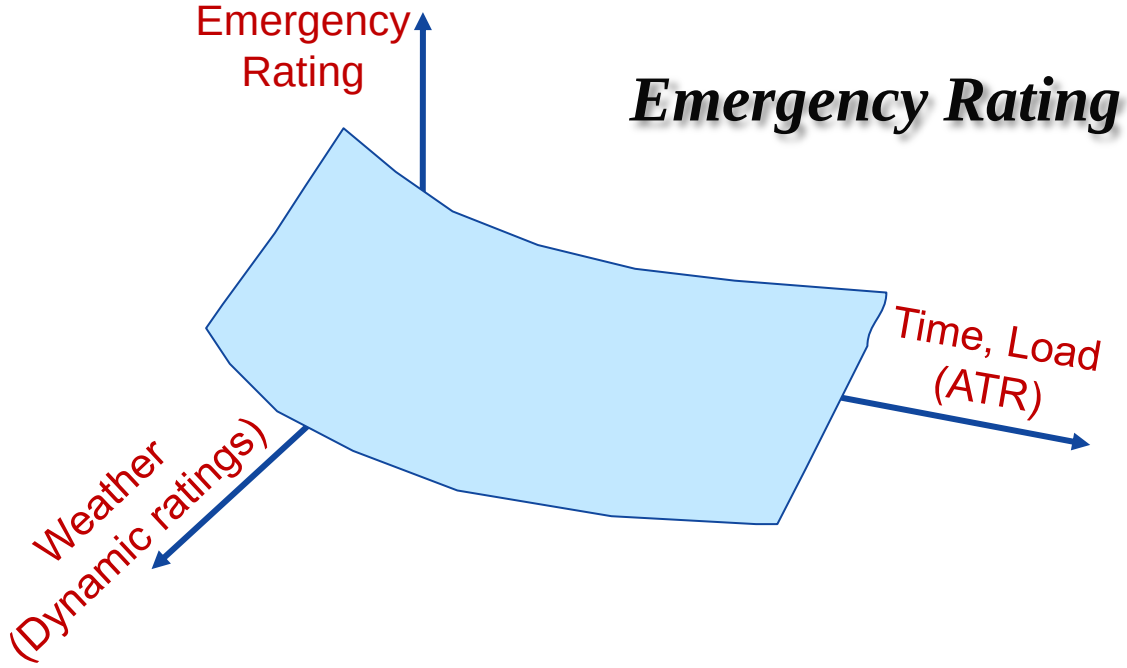
Process	Applicability of ATR
Real Time Operation	Yes, most efficient
Day Ahead Market	Yes
Planning	No

Use of ATR in dispatch



- *ATR* to be used instead of Static rates in post-contingency transmission constraints
- Operator advisory mode (RT)
- Automatic (Day-Ahead)

ATR and Dynamic ratings correlation

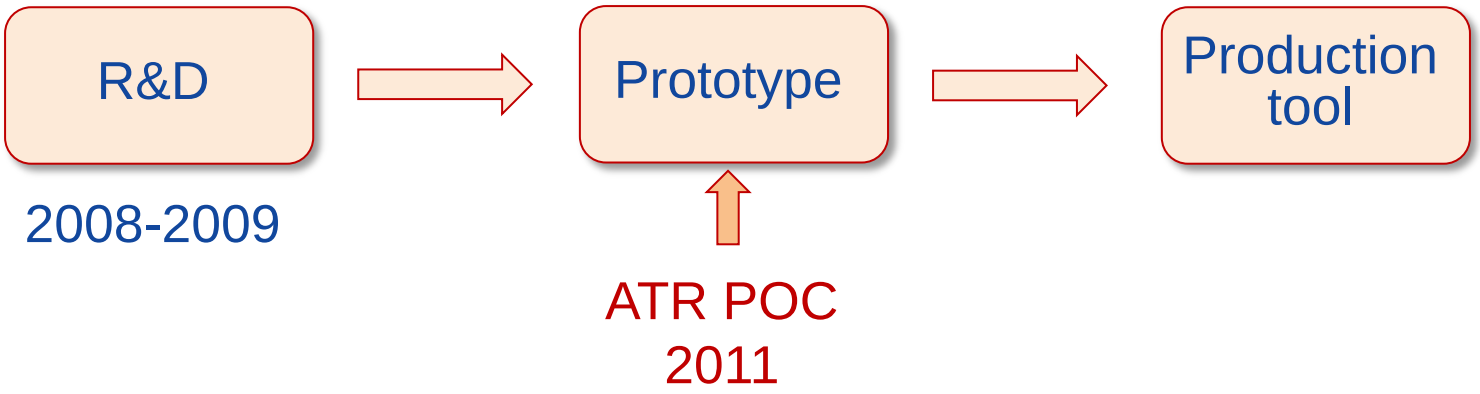


Emergency Rating = f(Weather, Time, Load)

- ATR and Dynamic ratings complement each other
- They could be considered independently
- The best way is to consider them simultaneously

ATR Proof-of-Concept (POC) implementation

Motivation



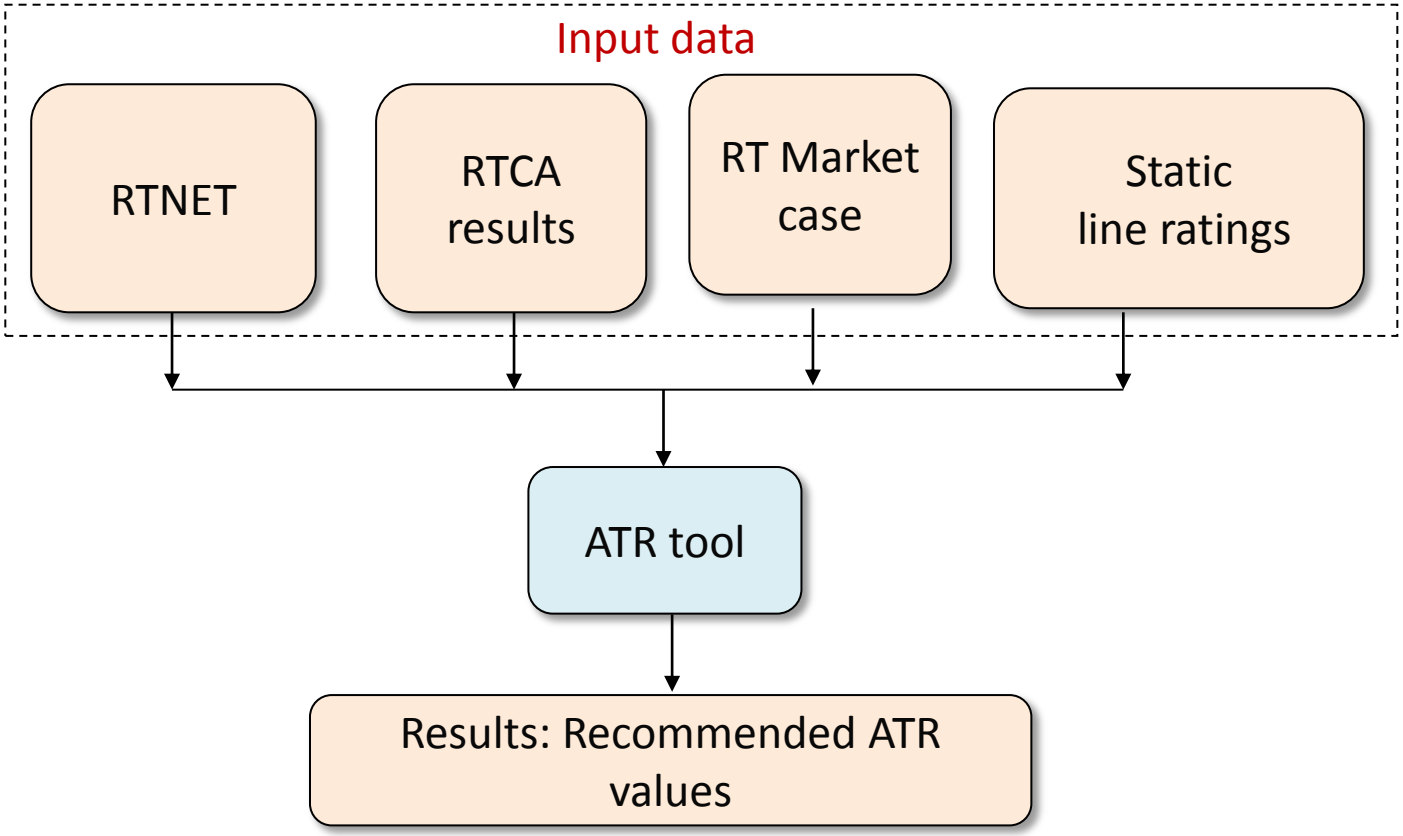
- Joint R&D effort between ISO-NE and Alstom Grid to improve efficiency of market and system operations
- ATR POC is a standalone application which can use real-time EMS and Market data
- Gather more experience with technology and feedback from Operators

ATR POC – Implementation

AIMMS based project and includes two components:

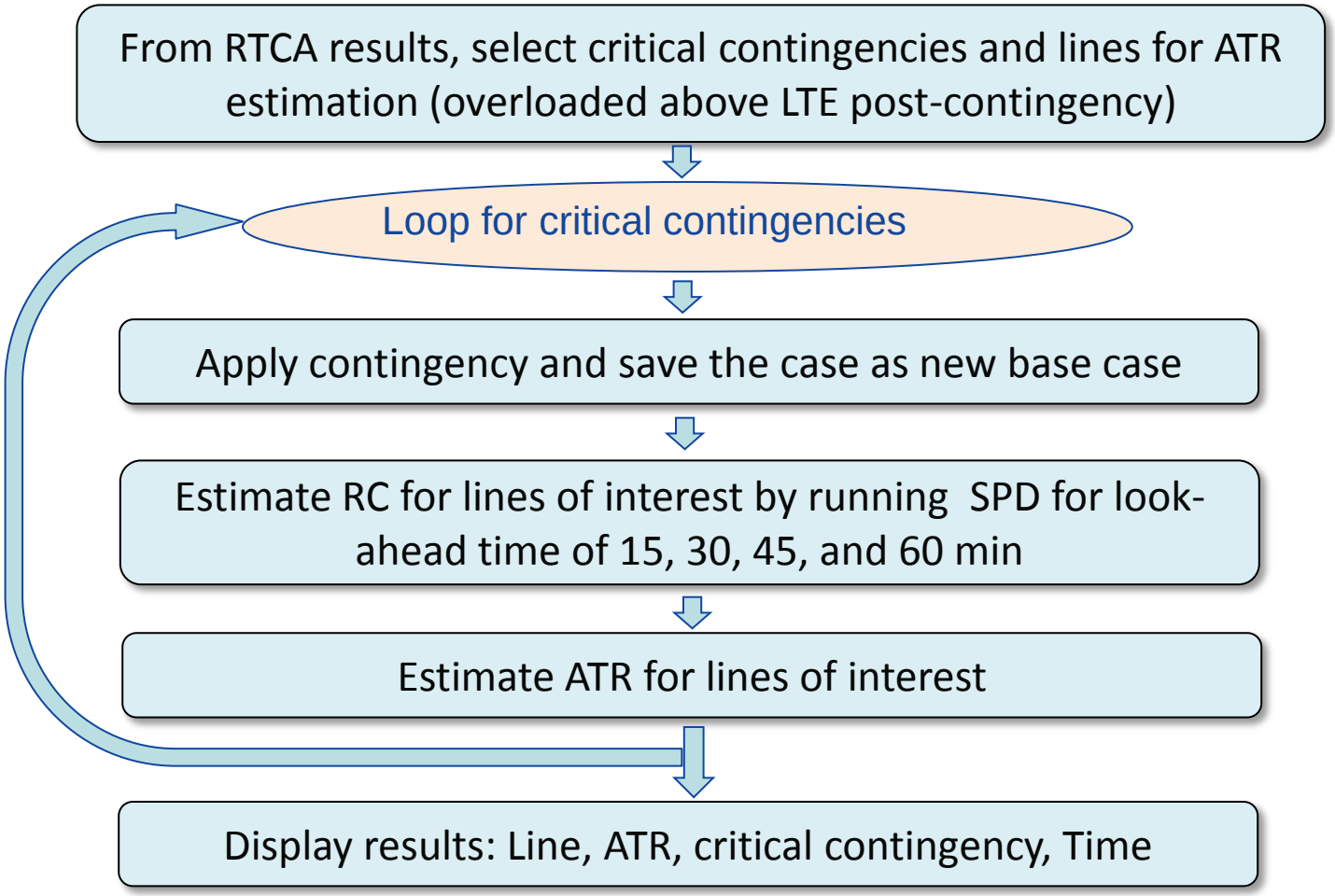
- ATR Scheduling Pricing and Dispatch (SPD)
  - Reuse the production RT SPD code to reduce the maintenance effort (there is no duplicated efforts to port the changes in future RT SPD code)
  - Add New control flow and data processing logic for ATR
- ATR Simultaneously Feasibility Test (SFT)
  - An application that is developed based on the e-terraplatform Contingency Analysis application
  - Provide post-contingency topology and post-contingency Flow

ATR POC - Data flow chart

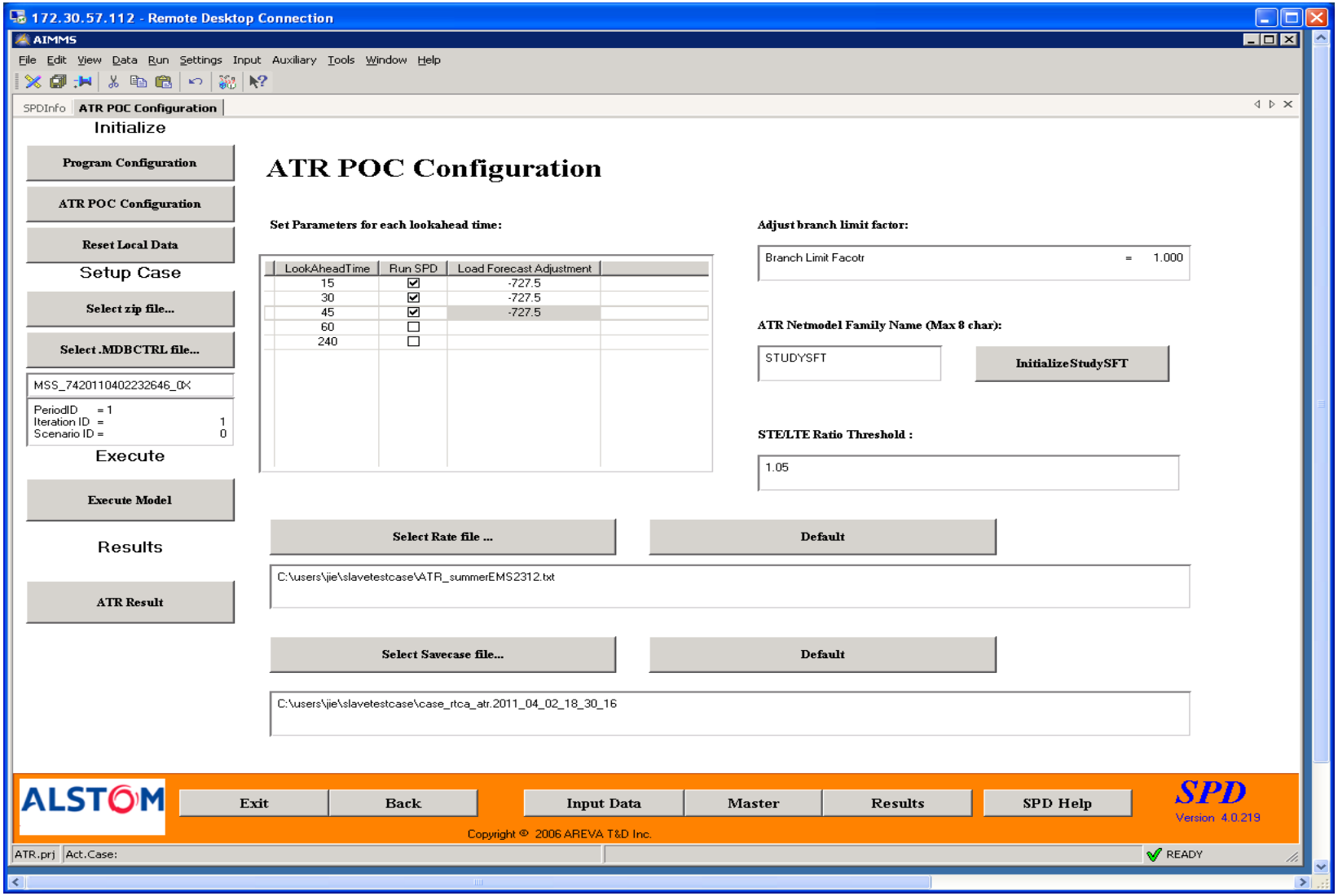


Impact of initial loading on ATR is not considered in ATR POC

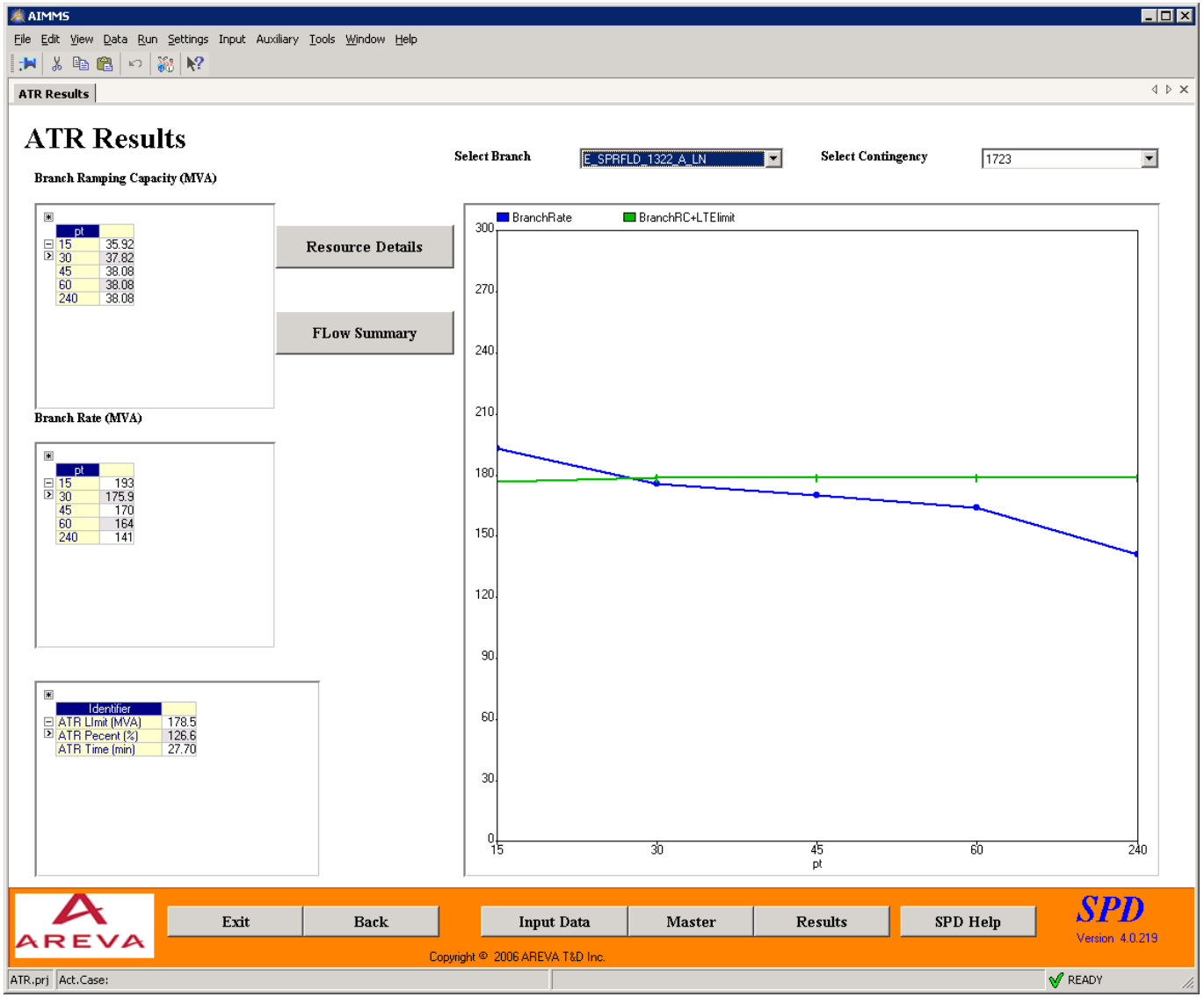
ATR POC - Flow diagram



ATR POC - Configuration



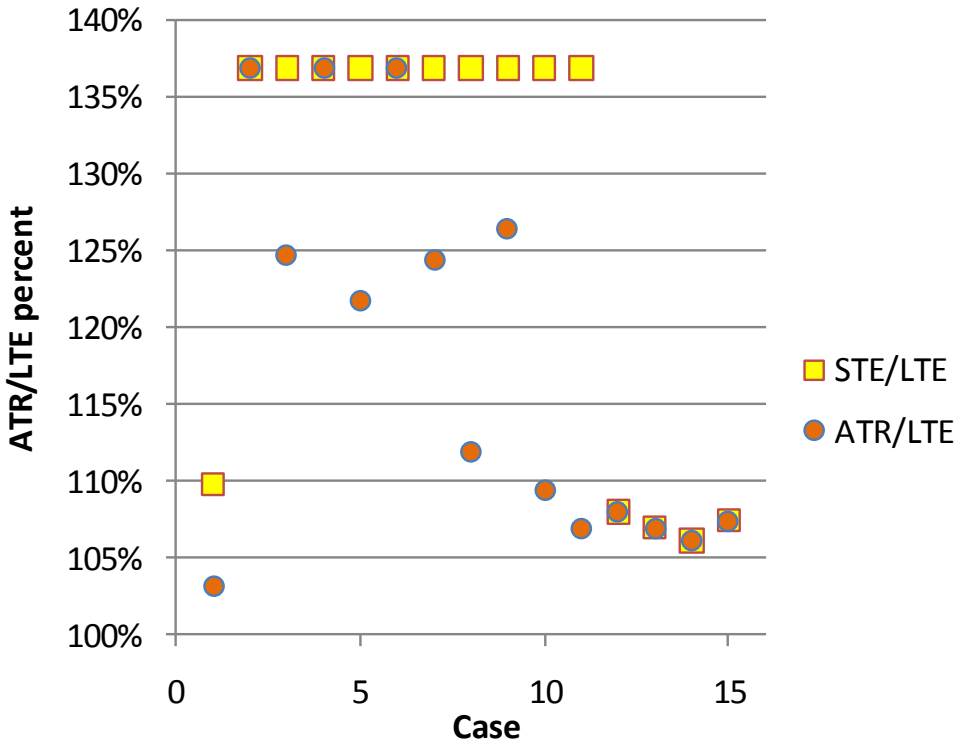
ATR POC - Results



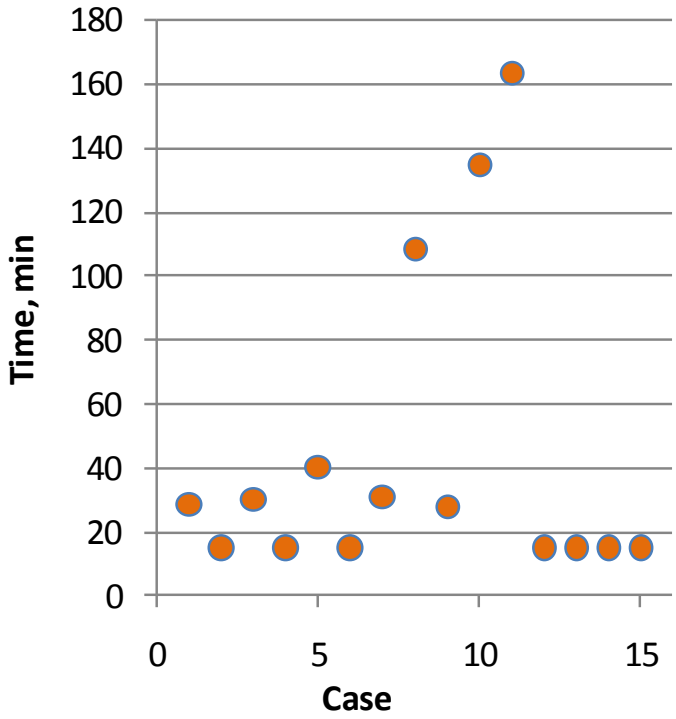
ATR values for Real-Time binding constraints

Statistics for March-June, 2011

ATR value



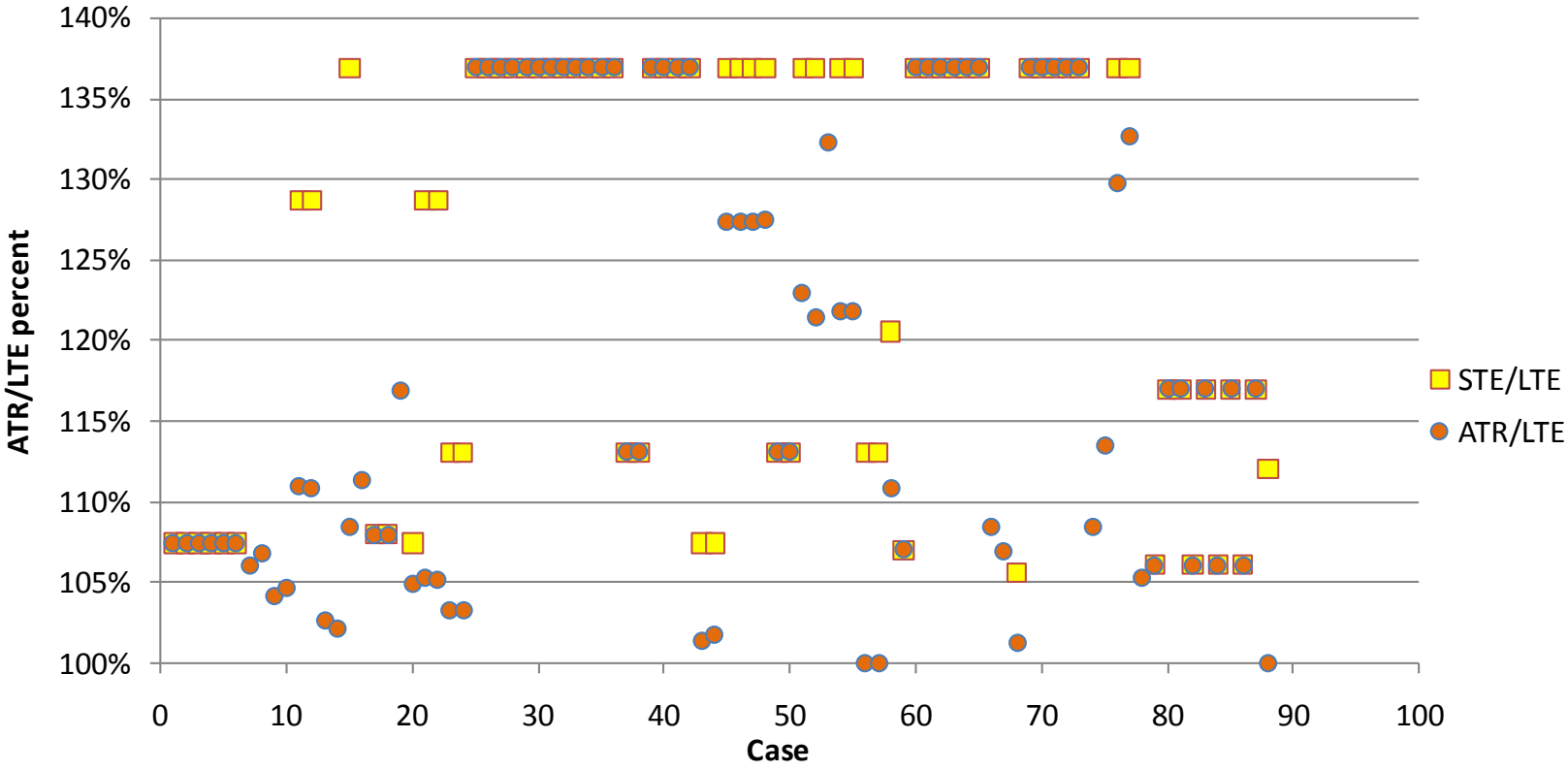
ATR time



Average increase in capacity over LTE is 27%

ATR values for Real-Time constraints

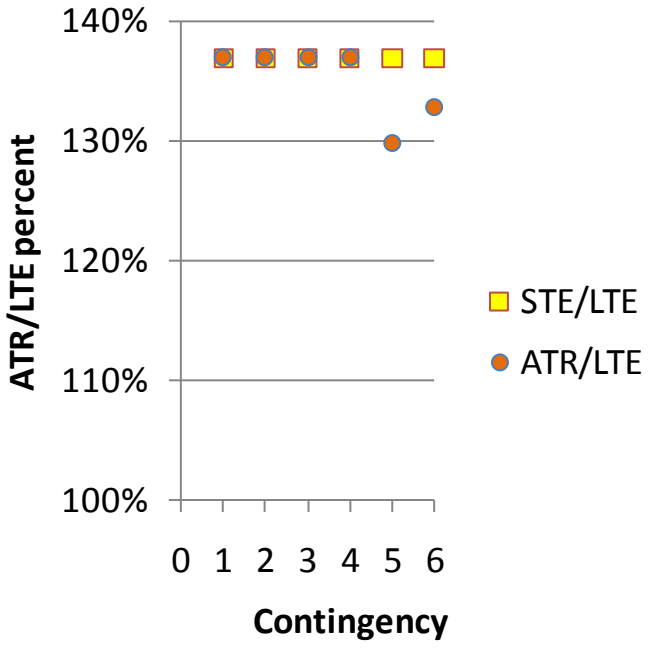
Statistics for March-June, 2011



Average increase in capacity over LTE is 19%

Enforcing constraints. RT case, June 2011.

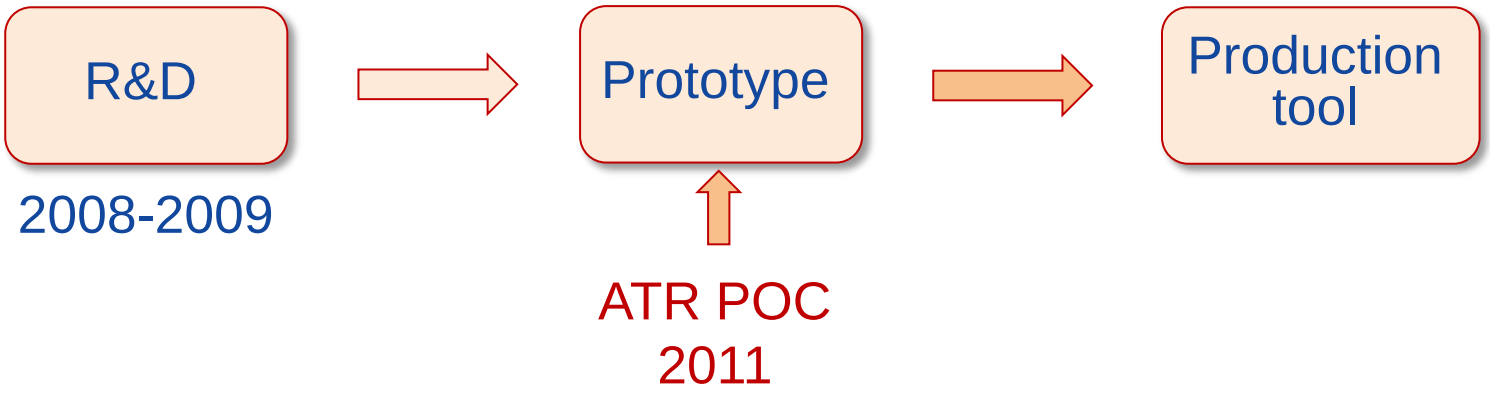
- The same line is thermally overloaded by six contingencies resulting in six transmission constraints
- ATR value is individual to a specific contingency
- Each constraint can be enforced at individual ATR value



Contingency	Limit to enforce, % of LTE
1	137%
2	137%
3	137%
4	137%
5	130%
6	132%

What is next?

- Continue to use ATR POC to obtain more statistics and experience with the new technology
- Gain more feedback from Control Room to optimize technology
- Implementation in Production tool



Thank you