Automatic Generation Control (AGC) Enhancement for Fast-Ramping Resources

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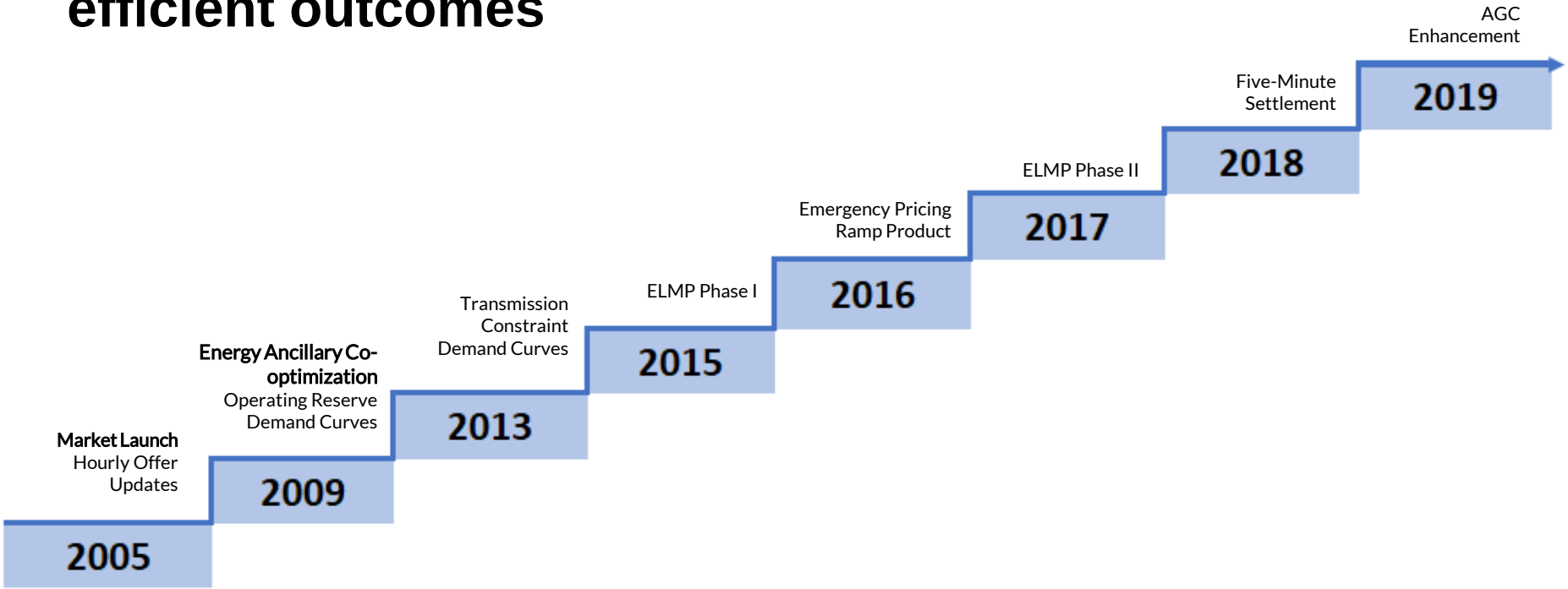
Overview

- **Purpose**
  - Present recent market development on MISO's Automatic Generation Control ("AGC") enhancement

- **Key Takeaways**
  - With increase in renewable generation portfolio, comes an increased need for flexible regulation
  - Opportunities exist to maximize fast-response capabilities of resources
  - MISO's new AGC enhancement provides incentives and means to better use fast ramping resources to participate in Regulation market

Market Vision: Our market vision is to foster wholesale electric markets that deliver reliable and economically efficient outcomes



Note: Please refer to the Market Roadmap page for a complete list of MISO on-going market enhancement projects

MISO Market Roadmap Guiding Principles

- Support an economically efficient wholesale market system that minimizes cost to distribute and deliver electricity
- Facilitate non-discriminatory market participation regardless of resource type, business model, sector or location
- Develop transparent market prices reflective of marginal system cost and cost allocation reflective of cost-causation and service beneficiaries
- Support market participants in making efficient operational and investment decisions
- Maximize alignment of market requirements with system reliability requirements

AGC Design Principles

Goal	Design Concern	Principles
Reliability	Fast Signal design	Maintain system reliability before meeting individual unit needs
	Coordinate fast-slow signal	Avoid fast/slow competing against each other
		Keep in mind slow resource capability
Efficiency	All regulation reserve for system reliability	Avoid using charging fast regulation resources with slow regulation resources
Flexibility	Technology Independent	Signal flexibility to attract various technology for reliability and market efficiency

To maintain reliability, improve efficiency and flexibility these design principles are followed

Fast AGC Logic

- **Deploy and un-deploy fast resource first**
  Flexibility & efficiency; will increase mileage payments

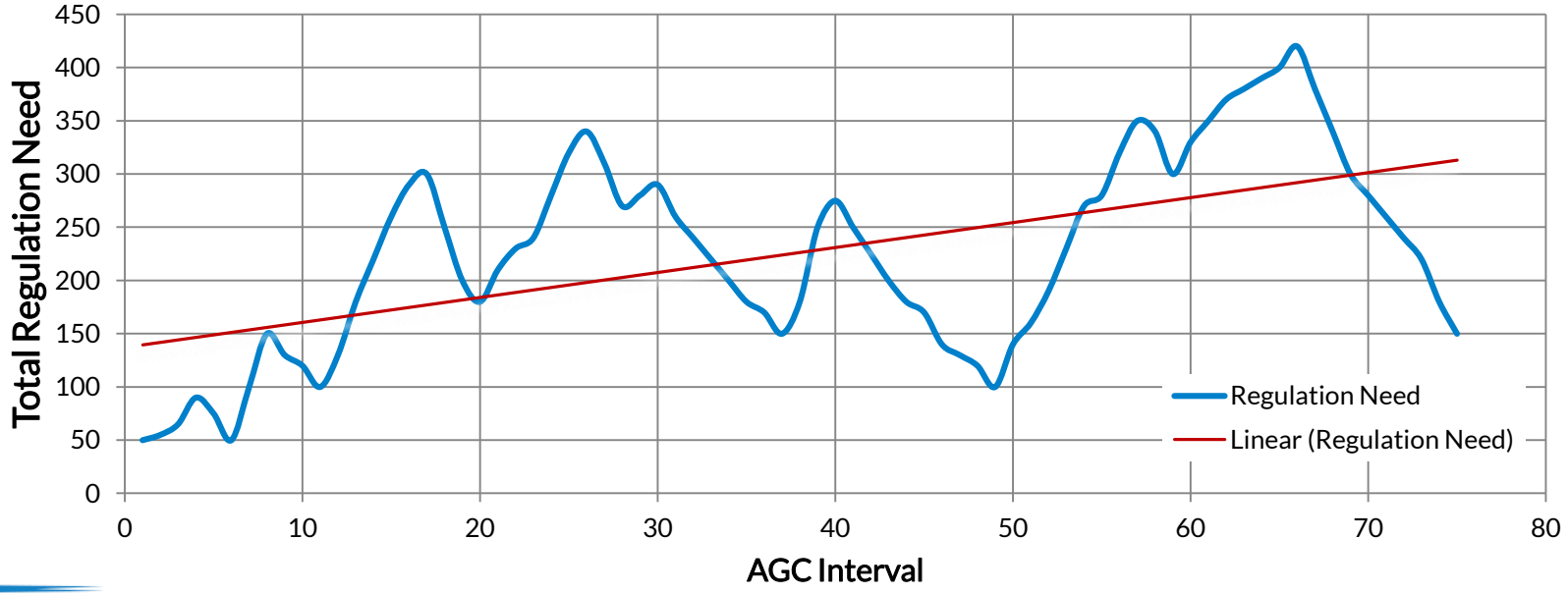
- **Gradually replacing deployment on fast resources with slow resources after first response**
  Efficiency & reliability; uses resources for greatest contribution

- **Align both direction of slow and fast signal with total deployment**
  Efficiency & reliability; resources do not fight & less liability

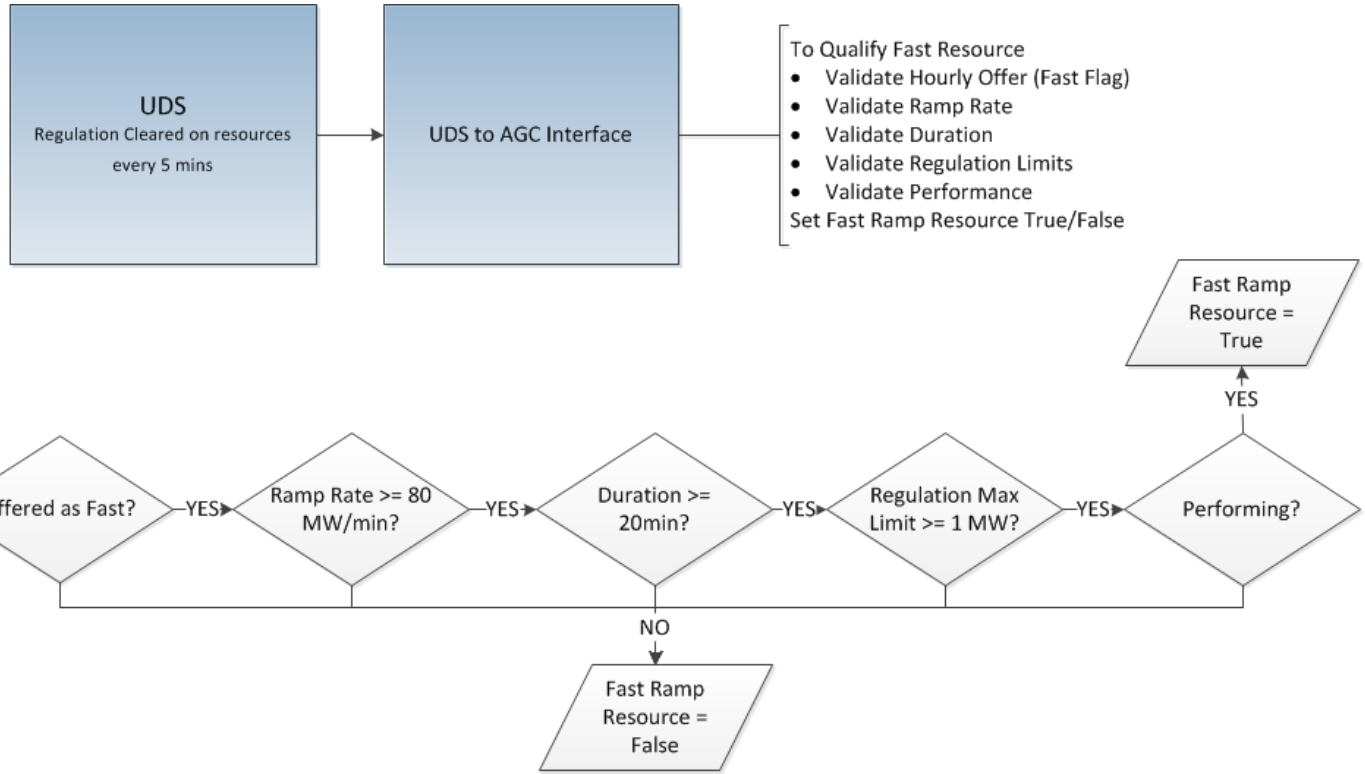
- **Move limited-duration resources back to neutral whenever situation permits, based on the state of charge**
  Flexibility; keep resources participating as long as desired

Fast Ramping Resource Utilization

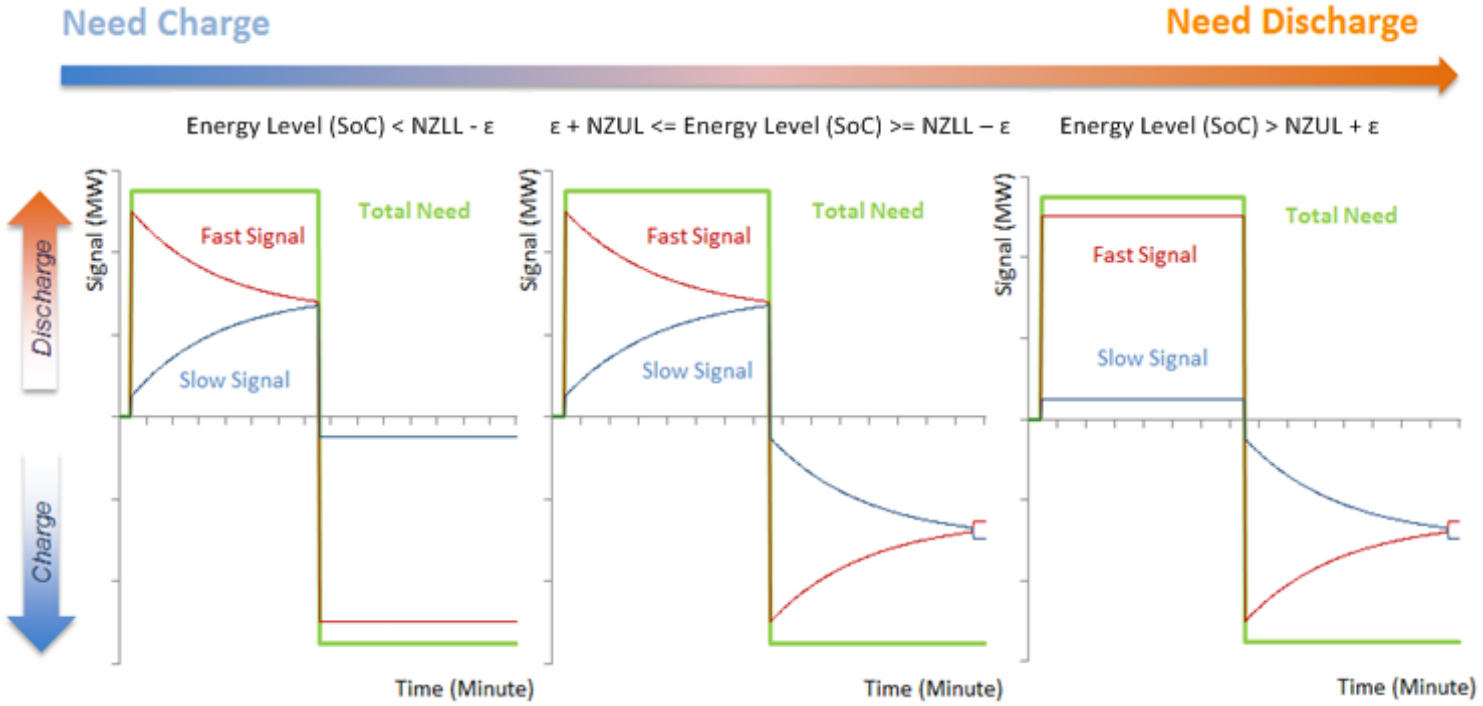
- Fast Ramping Resources will address the rapid regulation needs (i.e. for ACE turn around)
- Slow Ramping Resources will handle load following requirement



Fast Ramp Resource Qualification in Real Time 5min interval



AGC Fast Signal Design for Energy Limited Resources



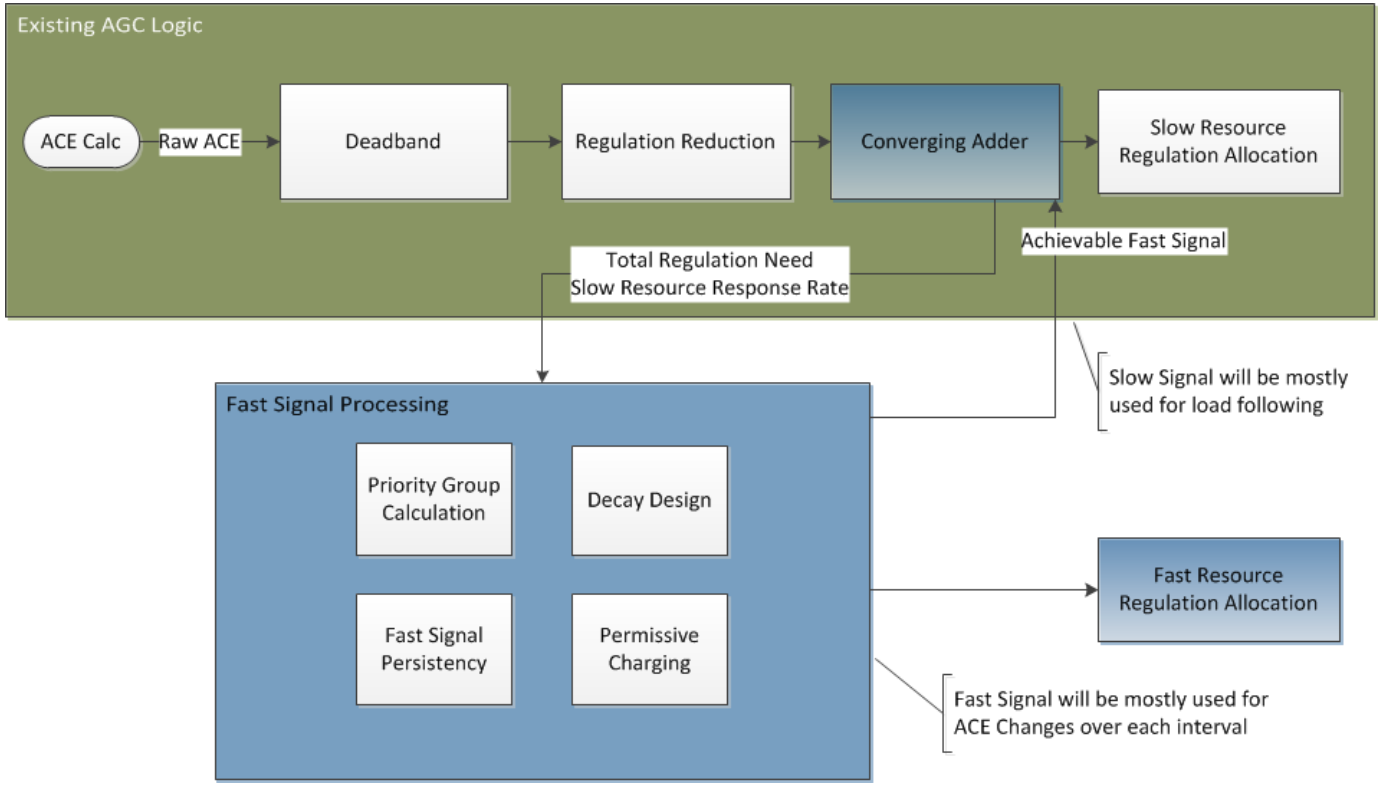
NZUL: Neutral Zone Upper Level NZLL: Neutral Zone Lower Level Ɛ: Change

AGC Input Data Changes

- **AGC will receive State of Charge for Energy Limited Resources via ICCP at 4 second frequency**

- **AGC will receive below additional data from UDS on each 5 min interval**
  - Fast Ramp Resource qualification
  - Default priority grouping based on available ramp rate
  - Neutral Zone Upper and Lower Limits for Energy Limited Resources

AGC will be changed to have two signals - fast and slow



Cost Benefit Study

- **Benefit**
  - With fast ramping resource providing regulation reserve, production cost reduced from freeing up resources to provide energy or contingency reserves
  - Estimated annual saving with 200 MW fast ramp resource into MISO market is $14 million
- **Fast resource Revenue**
  - Fast resources benefit from extra regulation mileage payment
  - Simulation results shows with recommended design fast resource mileage roughly doubled comparing to current logic
  - Estimated annual extra mileage payment is $3 million

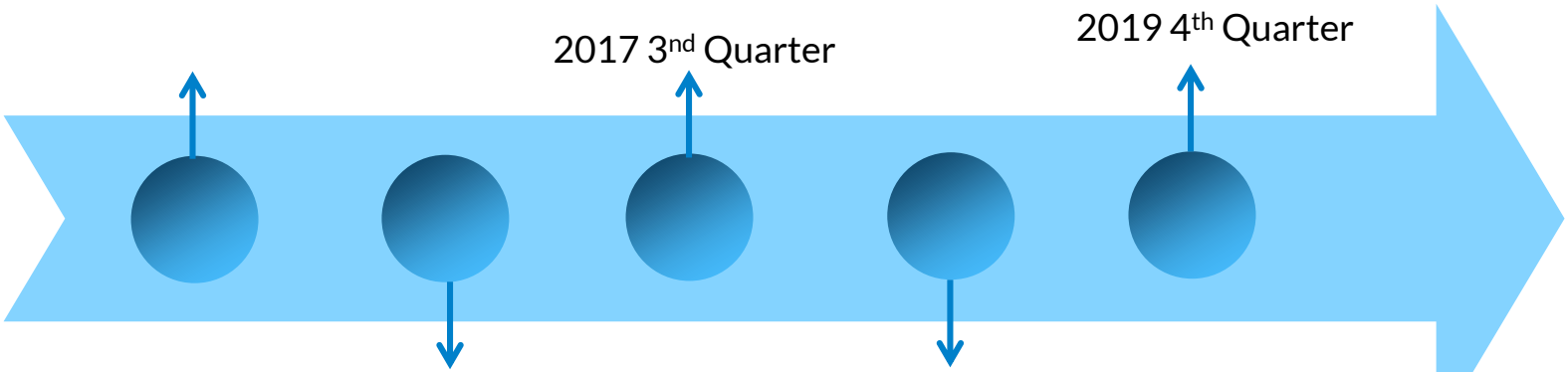
Project Timeline

After Order 755
Stakeholder requested further AGC enhancement

AGC Simulation and Study
Building simulation model and study AGC strategies under various scenarios. Providing options and recommendations.

Implementation
Software construction and business process modification.

2019 4th Quarter



Prioritization
High priority item in MISO Market Roadmap (2015)

Conceptual Design
Stake holder discussion and design

2017 4th Quarter

Contact Information

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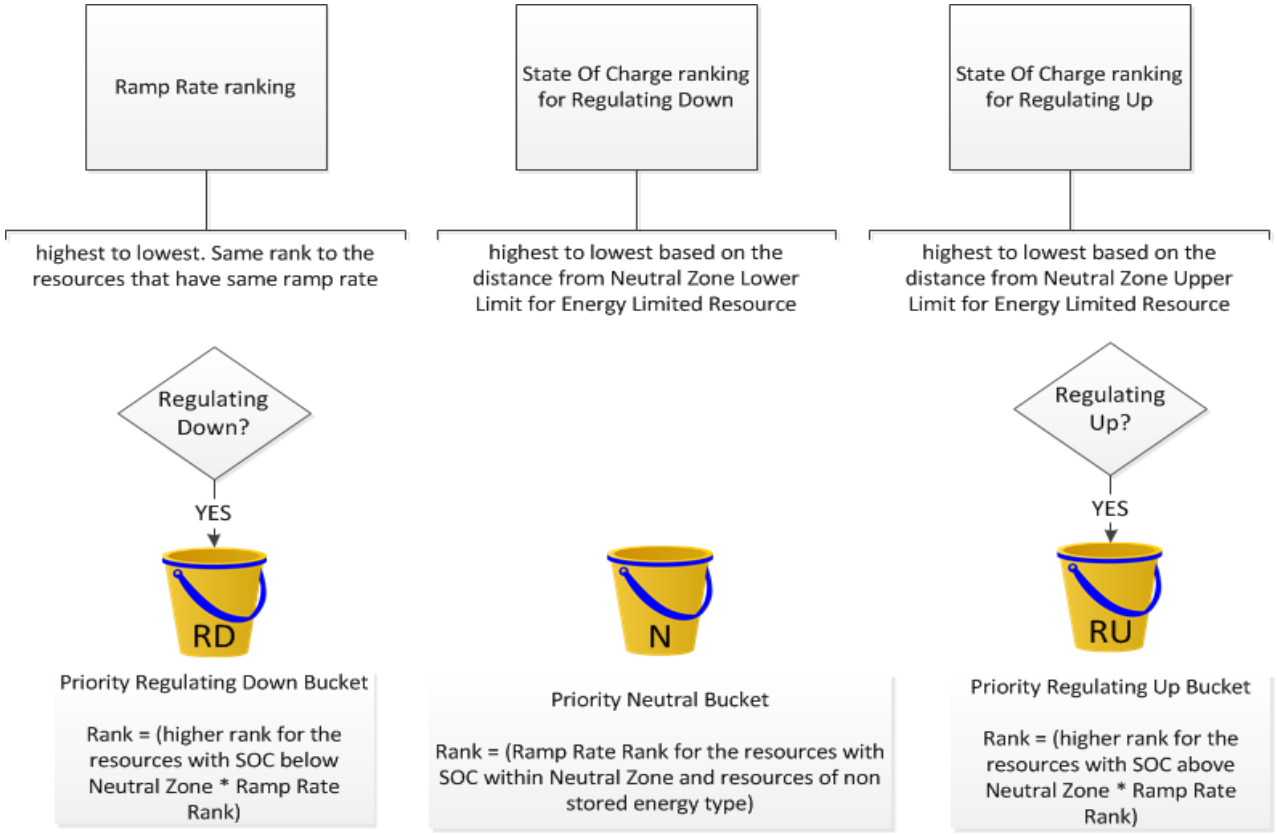
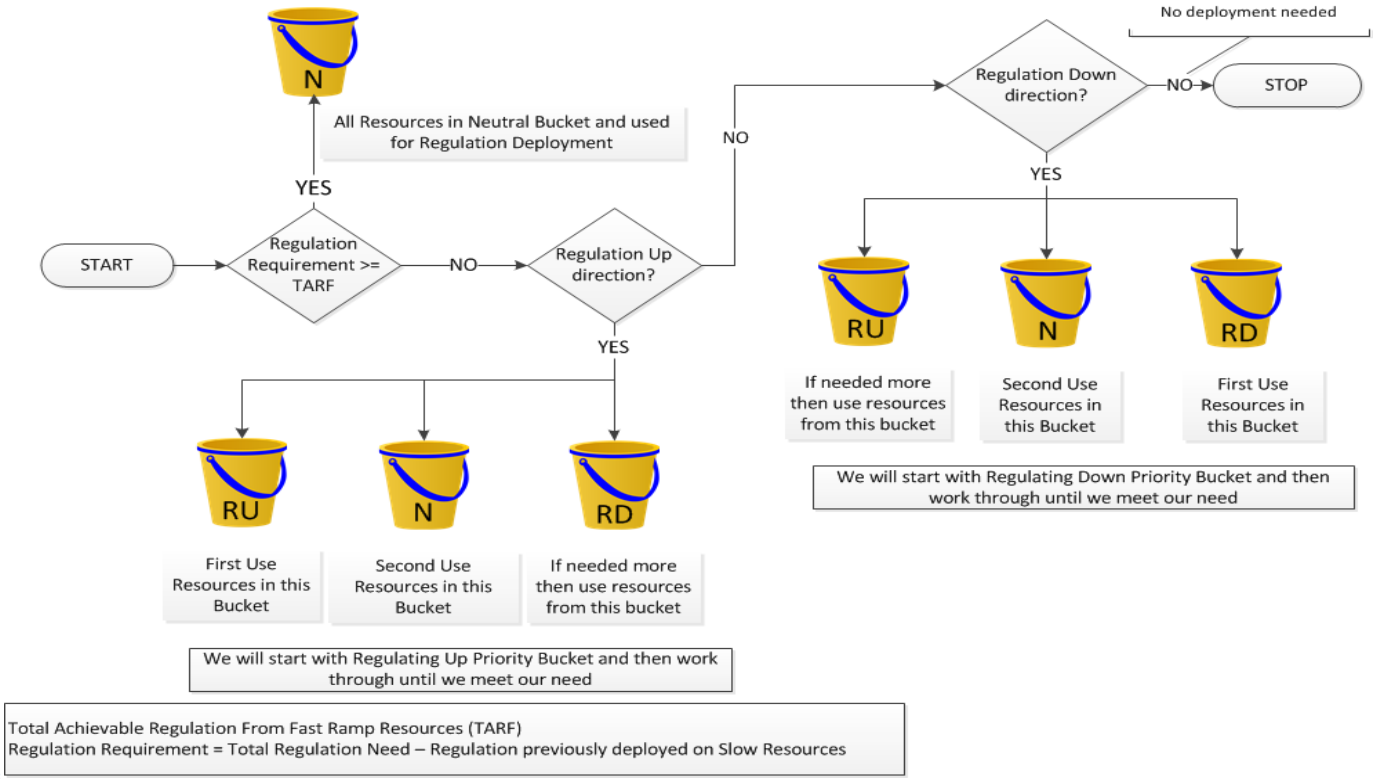
Appendix

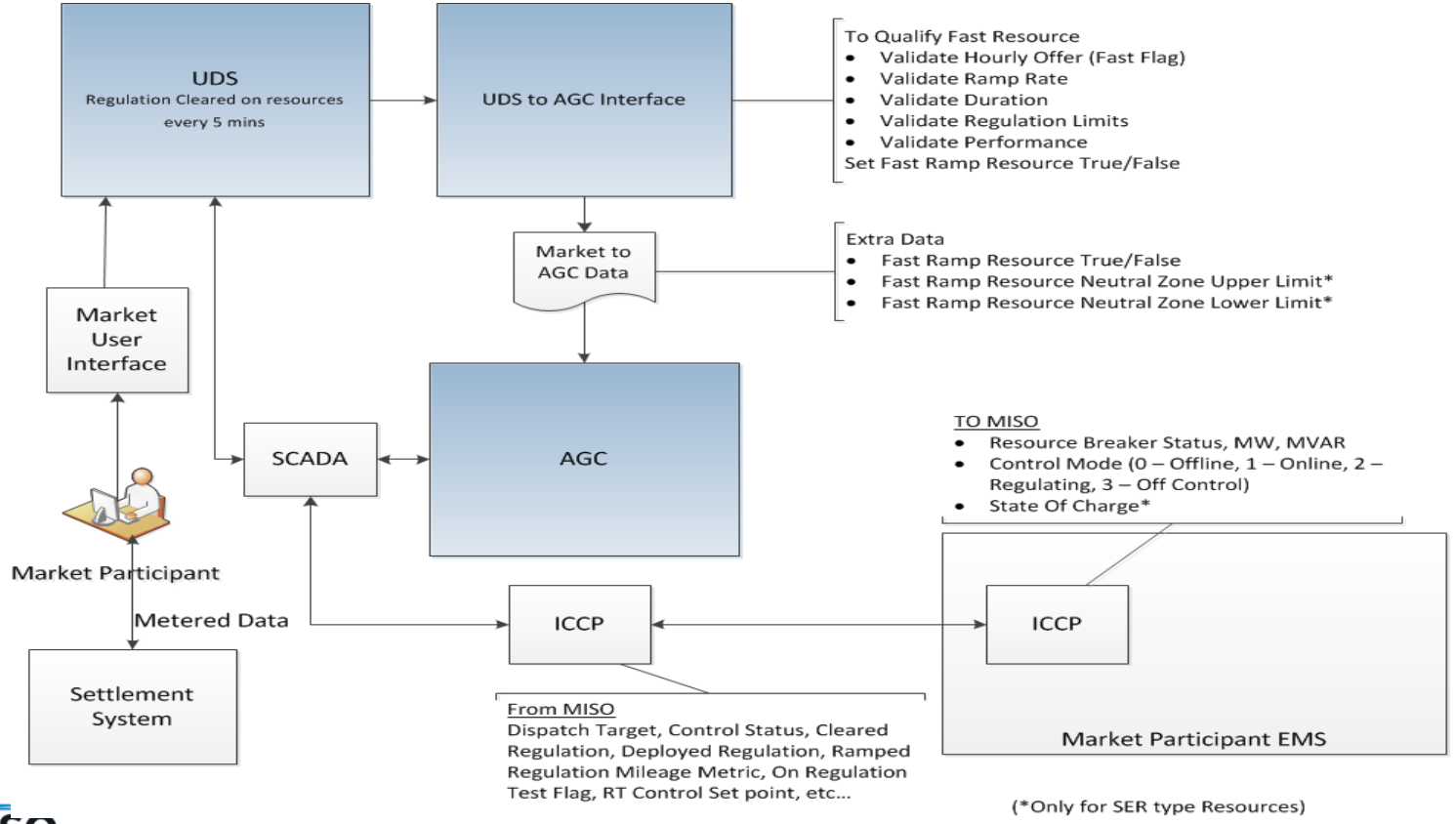
Priority group Calculation in AGC



AGC deployment for Fast Ramping Resources (Using Permissive Charging)



System Flow


UDS
Regulation Cleared on resources every 5 mins
UDS to AGC Interface
To Qualify Fast Resource
Validate Hourly Offer (Fast Flag)
Validate Ramp Rate
Validate Duration
Validate Regulation Limits
Validate Performance
Set Fast Ramp Resource True/False
Market to AGC Data
Extra Data
Fast Ramp Resource True/False
Fast Ramp Resource Neutral Zone Upper Limit*
Fast Ramp Resource Neutral Zone Lower Limit*
Market User Interface
SCADA
AGC
TO MISO
Resource Breaker Status, MW, MVAR
Control Mode (0 – Offline, 1 – Online, 2 – Regulating, 3 – Off Control)
State Of Charge*
Market Participant
Metered Data
ICCP
ICCP
Settlement System
From MISO
Dispatch Target, Control Status, Cleared Regulation, Deployed Regulation, Ramped Regulation Mileage Metric, On Regulation Test Flag, RT Control Set point, etc...
Market Participant EMS
(*Only for SER type Resources)