NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

The 10th Annual Monitoring and Situational Awareness Technical Conference – Session 2

Post Pandemic --- New Normal in Energy Management Systems

NERC EMS Working Group
October 6, 2022

Today's Agenda

- Frequency Response Monitoring and Mitigation
  - Raja Thappetaobula, RC West
- ERCOT Real-time Assessment Activity Summary
  - Karthik Gopinath, ERCOT
- **10-minute Break**
- Cloud Computing
  - Larry Collier and Wei Qiu, NERC
  - Maggy Powell, AMAZON AWS
- Session Summary
  - Phil Hoffer, Chair of NERC EMS Working Group, AEP

RajaShekar Thappetaobula

RajaShekar Thappetaobula is currently working as a Director Of Operation Engineering Services at CAISO/RC West and has over 21 years of experience in utilities system operations and system planning. Has extensive knowledge of both MISO's and CAISO's energy markets and reliability operations.

California ISO

Frequency Response Monitoring and Mitigation

RajaShekar Thappetaobula
NERC 10th Annual Monitoring and Situational Awareness Conference
10/03/2022

Agenda

- Presentation on ongoing work of the RC West Frequency Response Monitoring and Mitigation process.
  - Background, Scope and Objectives
  - Current Status

Background and Motivation

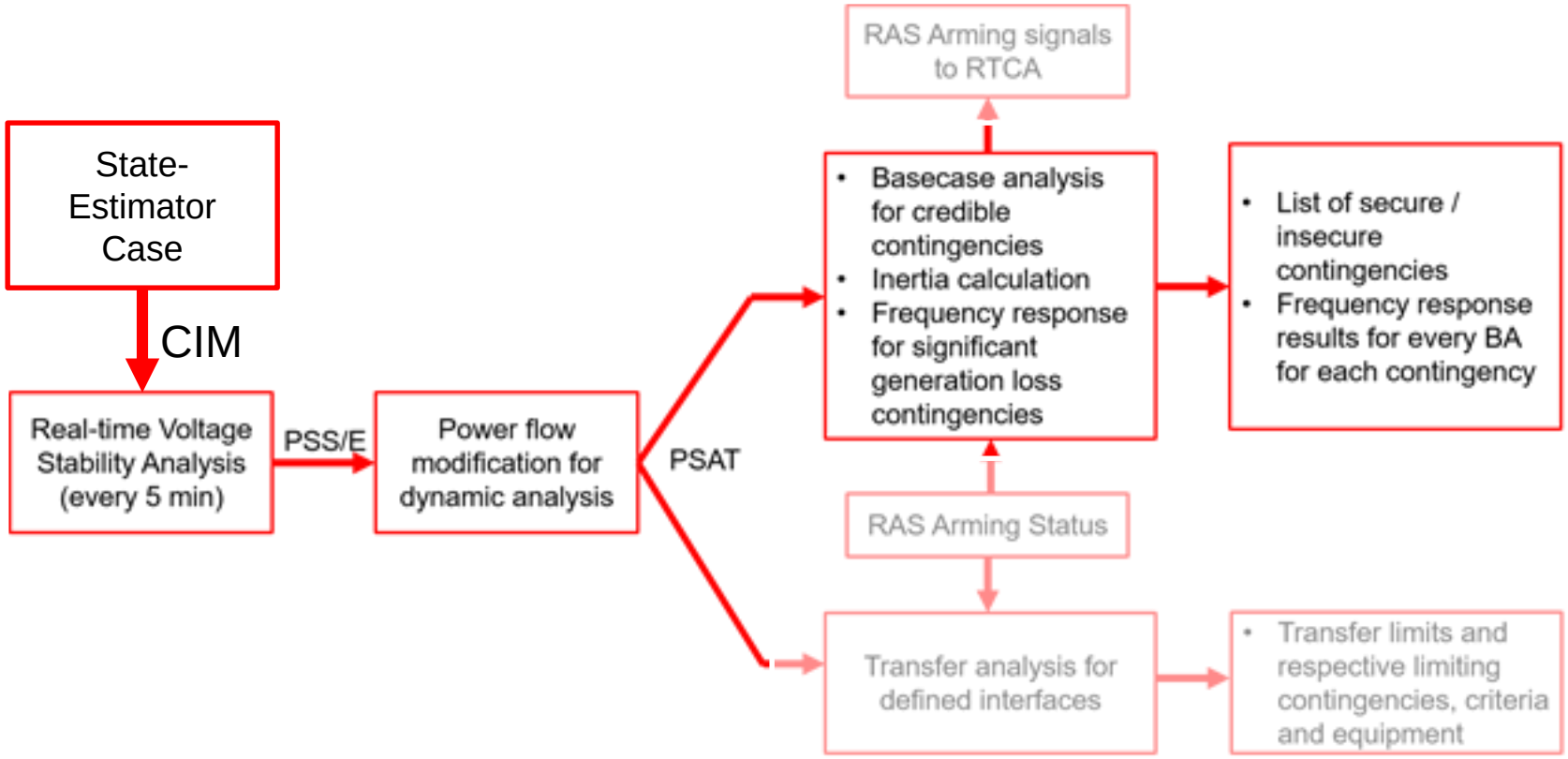
- Concerns about post contingency Frequency response triggering UFLS in Western Interconnection with resource mix transition to renewables and reduction in system inertia.

- RC West developed a concept to monitor post contingency Frequency Response (FR).

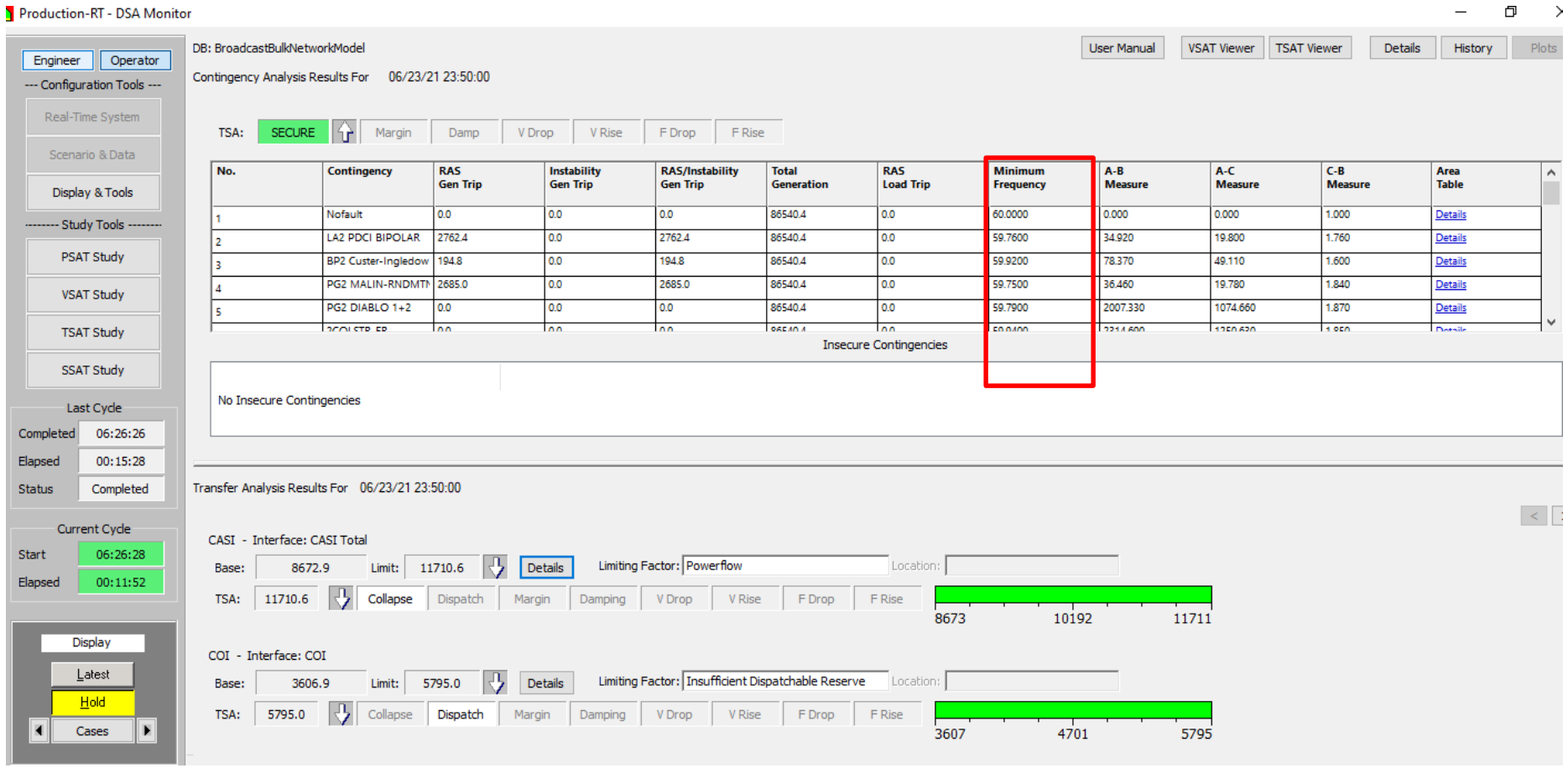
- RC West SOL Methodology:

Transient System Performance	Required for Single Contingencies and Credible MCs
1. The BES must remain transiently stable, and must not Cascade or experience uncontrolled separation as described in this SOL Methodology. 2. System frequency in the interconnected system as a whole must not trigger UFLS. 3. Any controlled islands formed must remain stable. 4. No BES generating unit shall pull out of synchronism	Yes[12]

Tool - Real-Time Transient Stability Assessment Setup

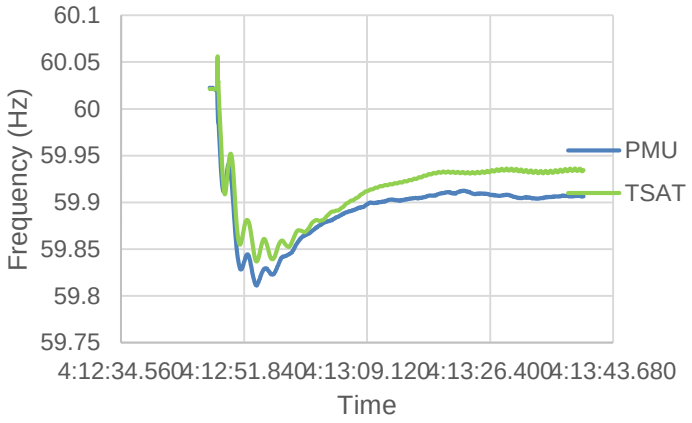


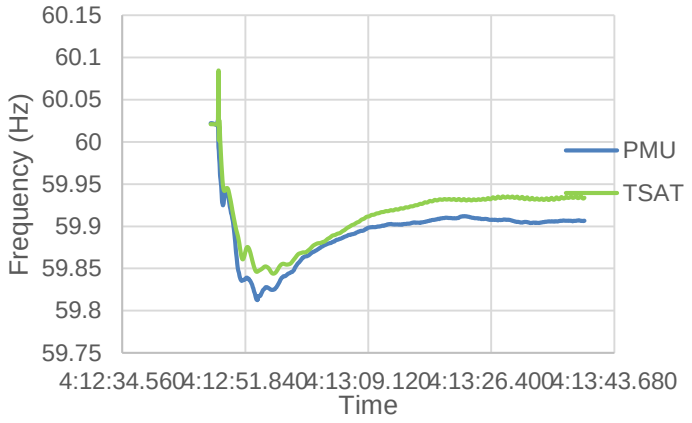
Real-Time Transient Stability Assessment Setup

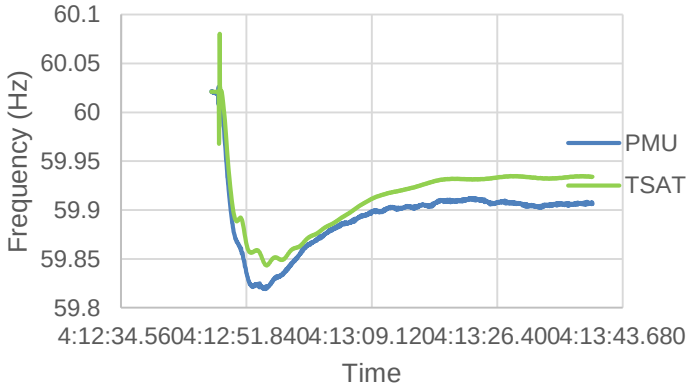


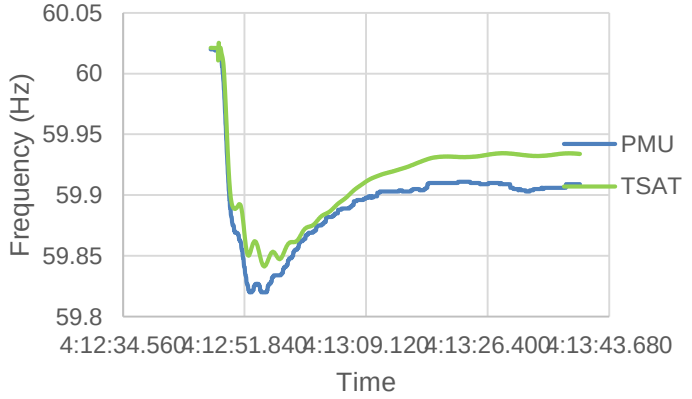
- Provide PI Display to Operators to show Min-Freq results adjusted for starting frequency

Example of Frequency Response Results Comparison









- Compare more recent events with PMU data.

Frequency Response Monitoring and Mitigation Task Force

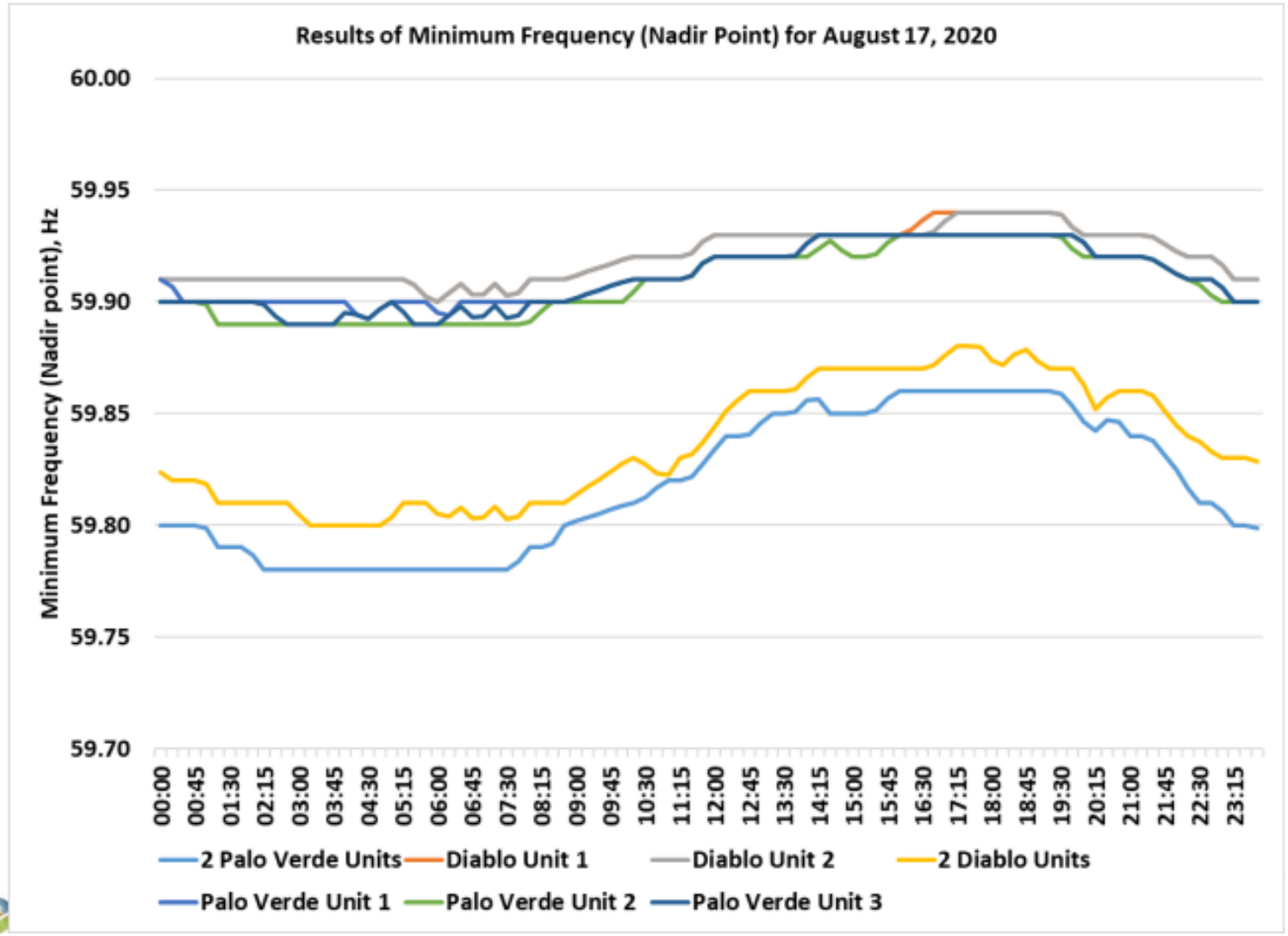
- Task Force formed to develop guidance for RC operators on needed coordination and operating instructions to prevent triggering of widespread UFLS due to contingencies

- Representation from multiple TOPs and neighboring RCs

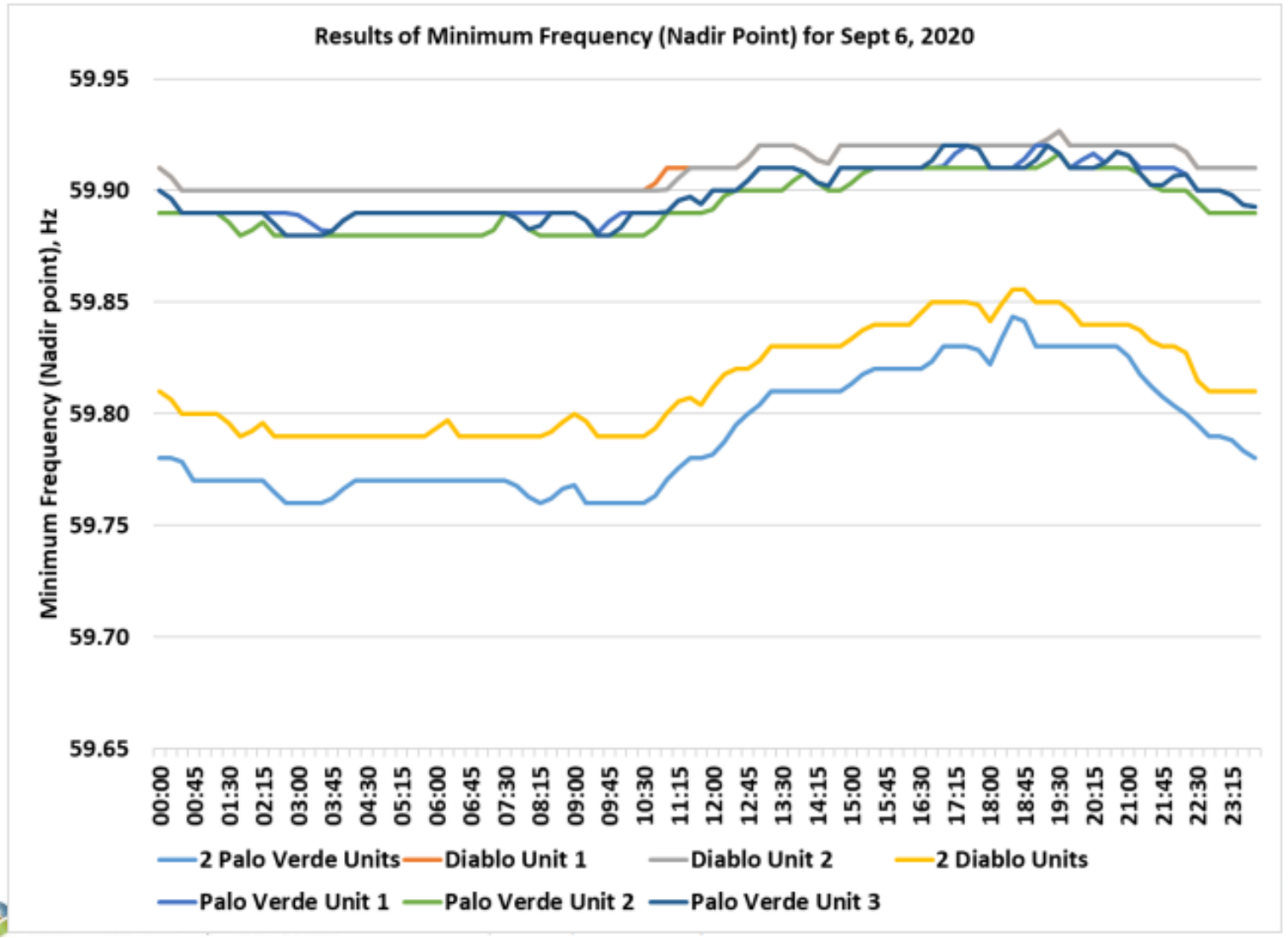
Scope and Objectives of Task Force

- Review Historical Data
- What should be monitored?
  - What contingencies to run
  - Tool and Modeling assumptions
- Triggers for Coordination and RC Instruction
  - Alert Level
  - Critical Level
- Guidance for Mitigation Actions

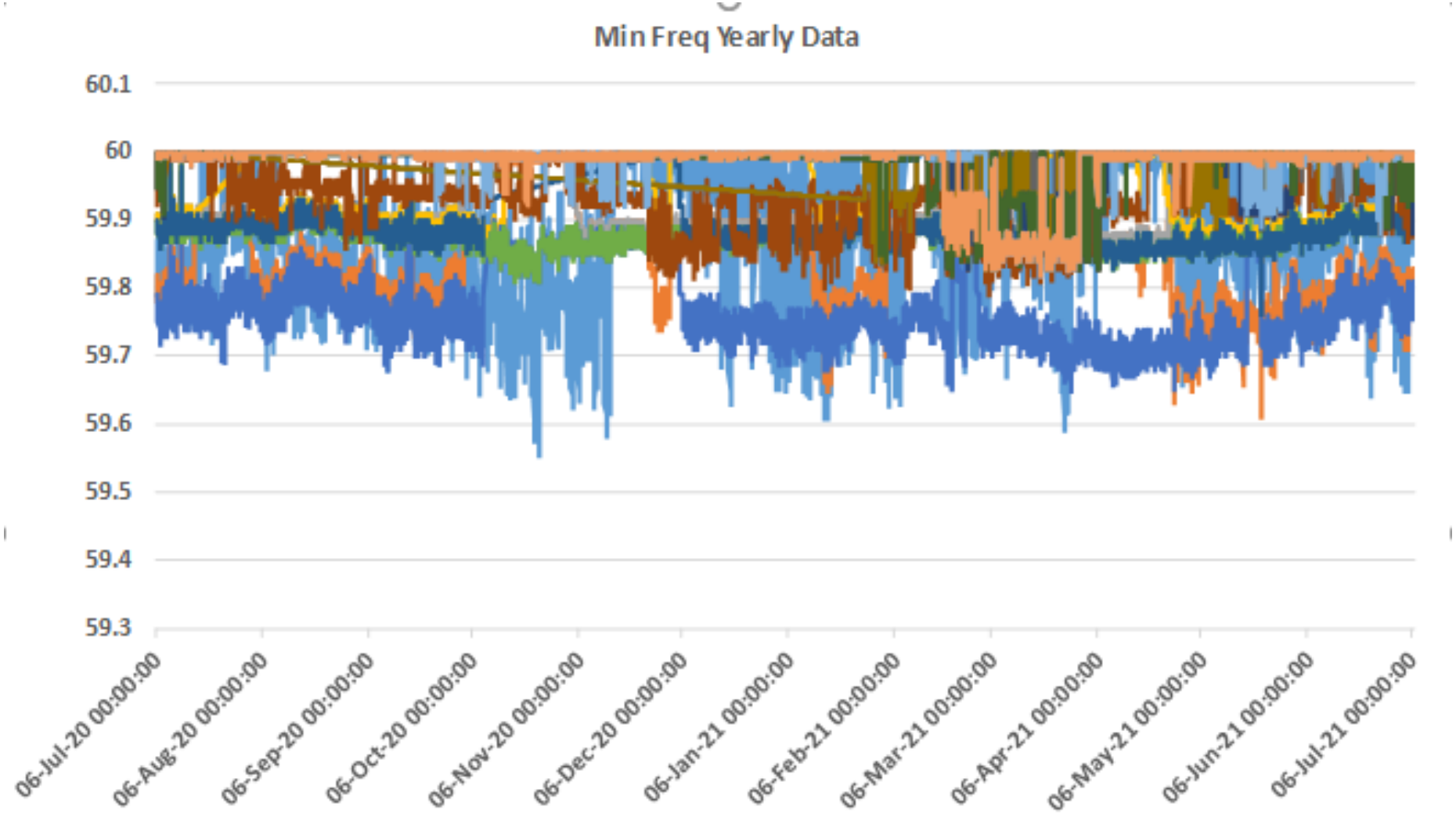
Frequency Response Study results for Aug 17, 2020

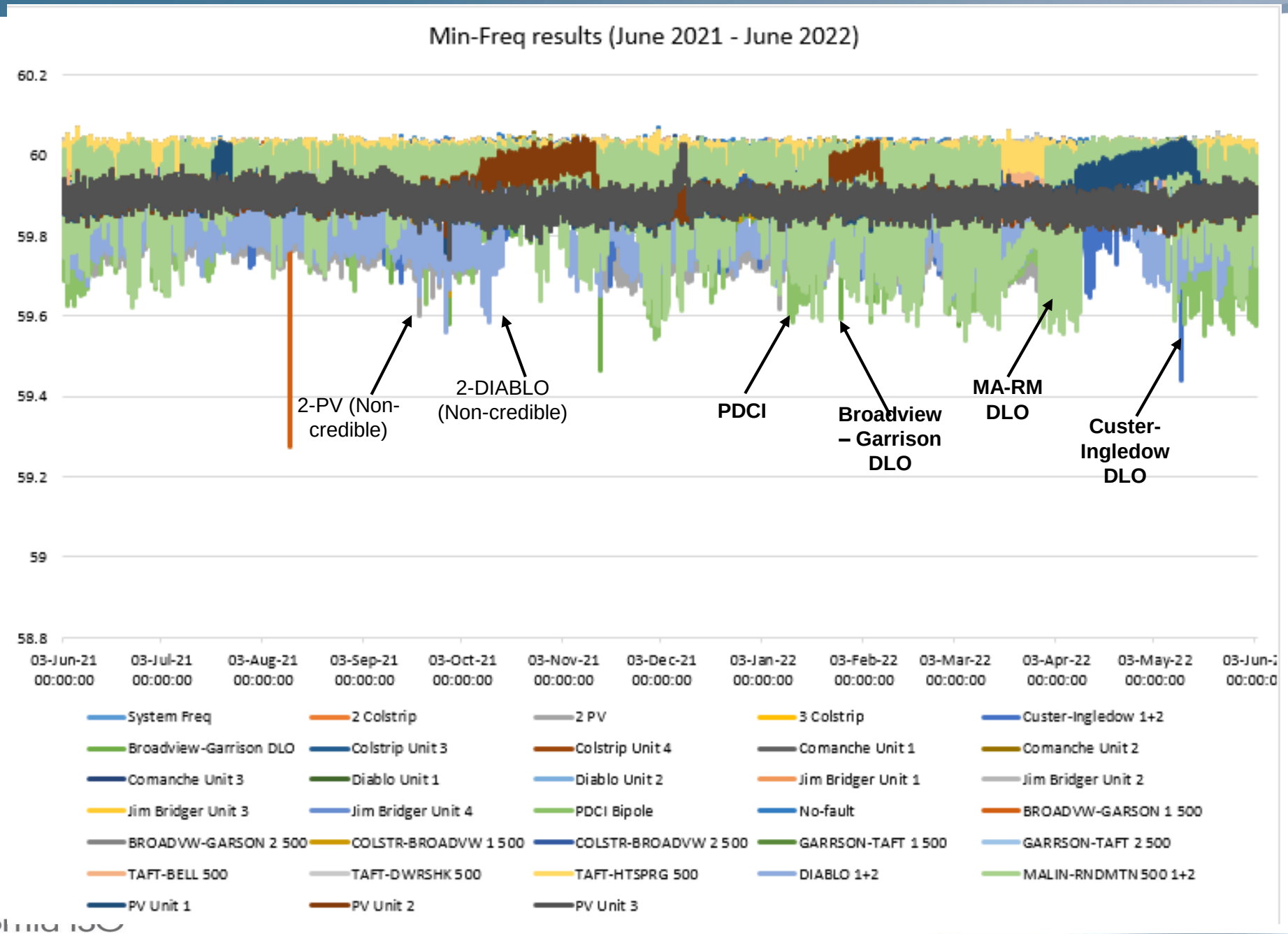


Frequency Response Study results for Sept 6, 2020



Historical Min-Freq Data (Simulation Results)




Min-Freq results (June 2021 - June 2022)
60.2
60
59.8
59.6
59.4
59.2
59
58.8
03-Jun-21 00:00:00
03-Jul-21 00:00:00
03-Aug-21 00:00:00
03-Sep-21 00:00:00
03-Oct-21 00:00:00
03-Nov-21 00:00:00
03-Dec-21 00:00:00
03-Jan-22 00:00:00
03-Feb-22 00:00:00
03-Mar-22 00:00:00
03-Apr-22 00:00:00
03-May-22 00:00:00
2-PV (Non-credible)
2-DIABLO (Non-credible)
PDCI
Broadview – Garrison DLO
MA-RM DLO
Custer-Ingledow DLO
System Freq
2 Colstrip
2 PV
3 Colstrip
Custer-Ingledow 1+2
Broadview-Garrison DLO
Colstrip Unit 3
Colstrip Unit 4
Comanche Unit 1
Comanche Unit 2
Comanche Unit 3
Diablo Unit 1
Diablo Unit 2
Jim Bridger Unit 1
Jim Bridger Unit 2
Jim Bridger Unit 3
Jim Bridger Unit 4
PDCI Bipole
No-fault
BROADVW-GARSON 1 500
BROADVW-GARSON 2 500
COLSTR-BROADVW 1 500
COLSTR-BROADVW 2 500
GARRSON-TAFT 1 500
GARRSON-TAFT 2 500
TAFT-BELL 500
TAFT-DWRSHK 500
TAFT-HTSPRG 500
DIABLO 1+2
MALIN-RNDMTN 500 1+2
PV Unit 1
PV Unit 2
PV Unit 3

What should be monitored?

- Discussion on Contingencies to monitor
  - Contingencies dropping a large amount of generation
  - Known contingencies with Gen drops due to RAS
  - N-1 or Always credible N-2 contingencies in RC West with large amount of gen drop
  - Contingencies from external RCs
    - Work with other RCs to get their largest credible contingencies

Triggers for Coordination and Operational Guidance –

- Alert Level: When adjusted Min-Freq < 59.65
  - Get frequency back to schedule / Look at BAs that are leaning more on the interconnection
  - Those with negative ACE (could lead to bringing on more generation)
  - Operating instruction from RC to operate within L_{10}
  - Contact BAs that are in EEA3 for correction
  - Coordinate with external RCs

- Critical Level: When adjusted Min-Freq < 59.60
  - Identify location of contingency
  - Coordinate with external RCs
  - Redispatch to reduce the amount of generation loss due to the contingency or the RAS actions

Current Status and Next Steps

- Final Draft Procedure sent out for review. Internal and External Feedback received.
  - Discussion with impacted entities to determine RT validation process to review frequency at load buses with UFLS
- RCs and Impacted TOPs expected to start Parallel Operations for procedure in July to:
  - ensure RMOEs and RCs are trained on validation process (Monitoring frequencies of load buses with UFLS)
  - TOPs have a chance to review the cases where there may be risk of UFLS triggering for credible contingencies
  - RC West and impacted entities are in agreement on process to reduce path flows (e.g. COI, PDCI)
- Procedure expected to be in-effect by start of Winter

Questions and Answers

Karthik Gopinath

Karthik Gopinath is the Manager of Grid and Market Solutions (GMS) Applications Engineering Team focused on Grid applications at Electric Reliability Council of Texas (ERCOT) based in Austin, TX. He joined ERCOT as Power Systems Applications Engineer, with focus on Real time Application support to ERCOT control room operations. He has progressively taken up more challenging roles in Real time Application areas and contributed as Subject Matter Expert in State Estimator, Contingency Analysis, Stability Analysis, Automatic Generation Control, Operator Training Simulator modules, growing to be a manager.

Karthik received his bachelor's in engineering degree from Anna University, Chennai, India and M.Sc. degree from Clemson University, South Carolina, USA, with specialization on Electric Power Systems.

Real-Time Assessment Activity Summary

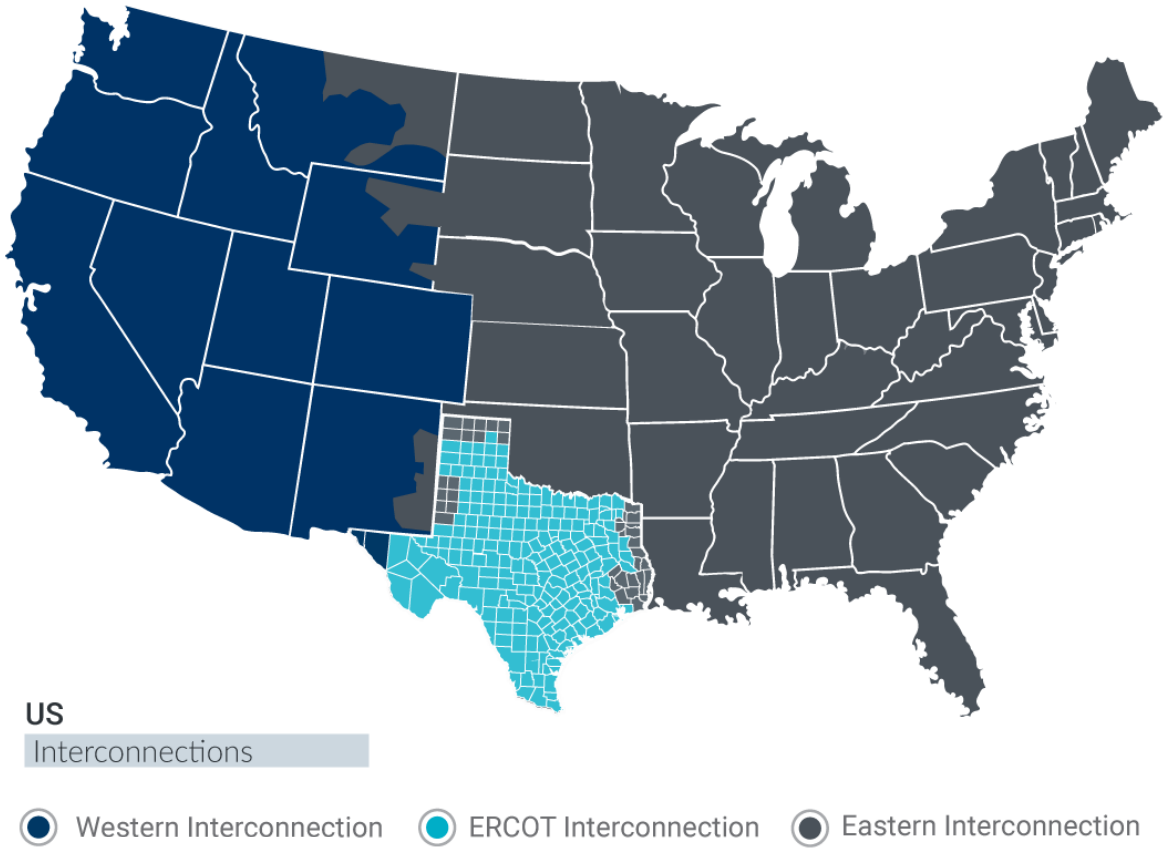
Karthik Gopinath
Manager, GMS Application Engineering - Grid

October 6, 2022

The ERCOT Region

The interconnected electrical system serving most of Texas, with limited external connections

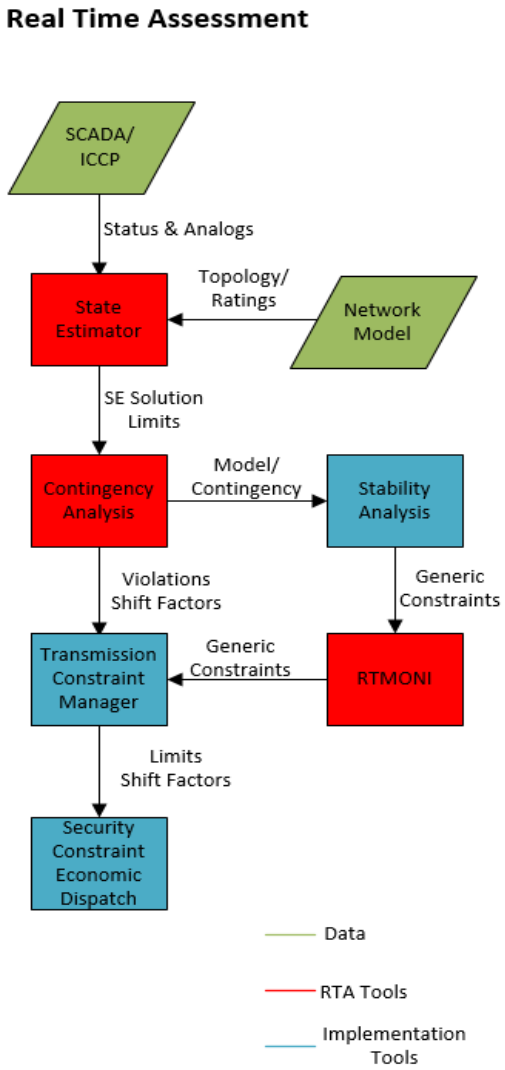
- 90% of Texas electric load; 75% of Texas land
- 80,038 MW peak, July 20, 2022
- More than 52,700 miles of transmission lines
- 1030+ generation units (including PUNs)



ERCOT connections to other grids are limited to ~1,220 MW of direct current (DC) ties, which allow control over the flow of electricity

Real-Time Assessment (RTA) Process

- ERCOT RTA Process



RTA Primary Tools and Capabilities

Data and primary tools used to conduct RTAs:

- ICCP/SCADA – Provides communication pathway between ERCOT and transmission and resource entities
- Network Operations Model – Representation of the ERCOT system
- State Estimator (SE) – Analyzes the current system conditions, using a network model and available SCADA data, to estimate the flows on all transmission elements in a system to identify any pre-contingency SOL exceedances.
- Real-Time Contingency Analysis (RTCA) – Analyzes contingencies in the system model using the base case solution from the State Estimator to identify any post-contingency SOL exceedances
- RTMONI – Uses SCADA to display, validate and monitor specified stability and interface limits to identify any SOL exceedances

RTA Primary Tools and Capabilities

Displays and data used to ensure an RTA is performed every 30 minutes:

- EMS displays monitored by System Operators to ensure the status and accuracy of the data being utilized within the RTA process. Any loss in telemetered data will be flagged by a visual alert.
  - ICCP Communication Status page
- Similarly, the video wall displays alert operators of potential issues with the telemetered data using visual alerts.
  - System Alarms Display
- The video board displays allow the System Operators to monitor the execution times of the RTA process. The displays will change colors to alert operators based on the last execution time.
  - Display for last run time for SE/RTNET, RTCA

RTA Primary Tools and Capabilities

ERCOT incorporates multiple displays to inform System Operators of SOL exceedances in both pre-contingency (base case) and post-contingency. Alerts and notifications are also provided via a Control Room video wall and dashboard displays.

At a high level, System Operators implement their operating plans to address any exceedances by executing the following process:

- Verify modeling, telemetry & solution
- Verify the telemetry of the exceedance against the SE values to ensure accuracy
- Activate constraint for Resource dispatch
- Verify Constraint Management Plans (CMP) available
- If there are no available generation shift factors, develop and/or implement a Constraint Management Plan
- Issue Operating Instructions up to and including firm load shed

Real-Time Data and Analysis Quality

ERCOT System Operators are provided with the following tools to evaluate real-time data quality:

- SCADA Quality
  - GOOD—Point assumed to be valid and accurate
  - REPLACED—Value which has been manually updated
  - SUSPECT—Point has stopped working
  - GARBAGE—Point has never received data
- State Estimator solution status
- ICCP Communication Link Status Indications/Alerts
- Control Room Video Wall and Dashboard Notifications
- Automated Email Notifications from PI
- Operations Engineer monitors and maintains State Estimator on 24/7 basis to immediately analyze and correct any issues

Real-Time Data and Analysis Quality

Support personnel available to address Real-time quality:

- 24/7 Shift Engineer in control room to conduct analysis
- 24/7 Operations Support Engineer on-call
- 24/7 Grid Applications Support Engineer on-call
- 24/7 GMS Production Support Engineer on-call

Real-Time Data and Analysis Quality

Indications operators receive that the modeling and conduct of contingency analysis tools are sufficient:

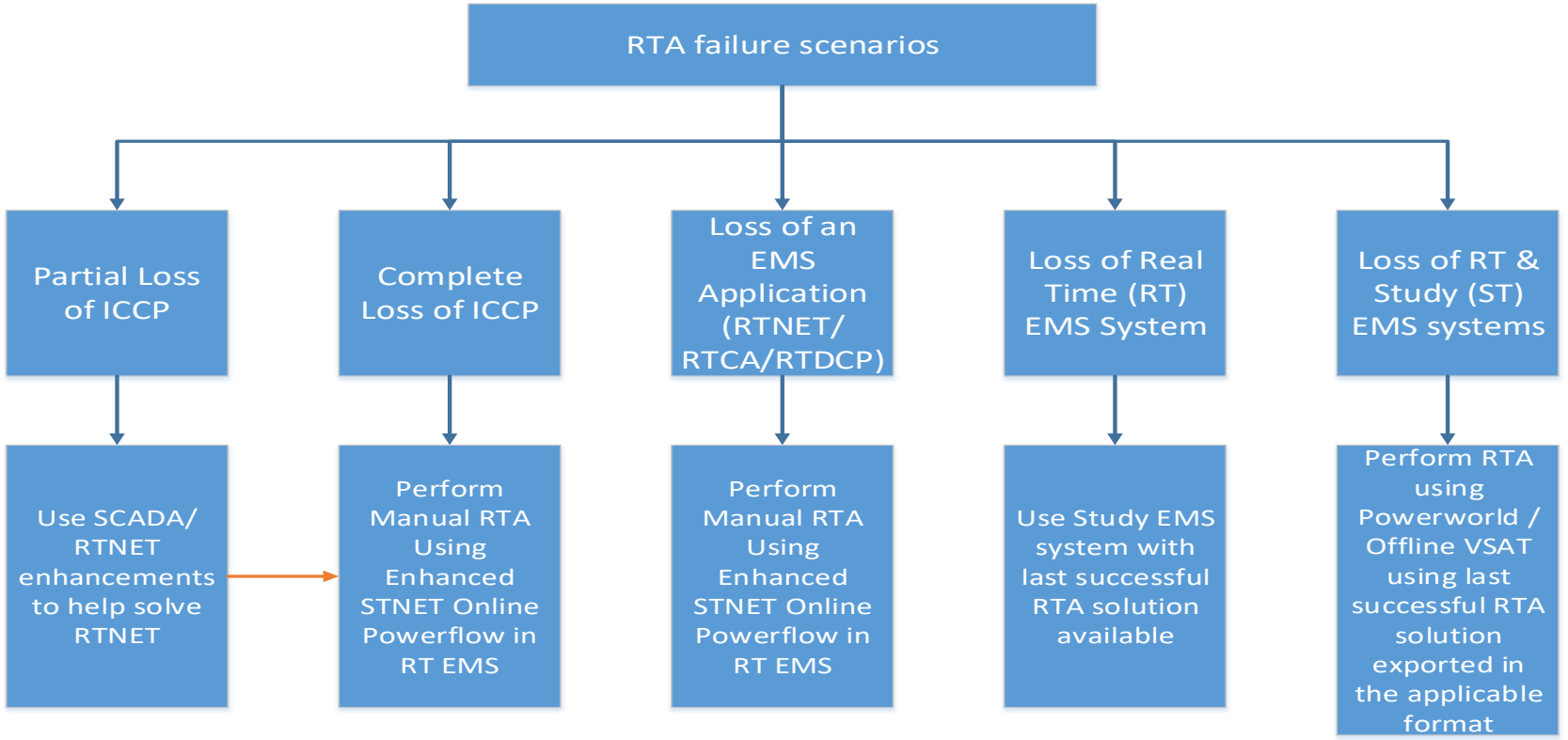
- Weekly model loads, which include updated contingency definitions; submitted by ERCOT Market Participants and validated by ERCOT prior to being uploaded
- Automatic execution of State Estimator and RTCA every five minutes with wallboard alarms if they do not run on-time or have abnormal results
- State Estimator and RTCA tolerances and topology consistency monitoring
  - SE maximum bus mismatch within tolerance
  - RTCA MW/MVAR convergence within tolerance
- EMS displays shows current model name and load date

Real-Time Data and Analysis Quality

Evaluating real-time data quality criteria to ensure that the criteria is sufficient:

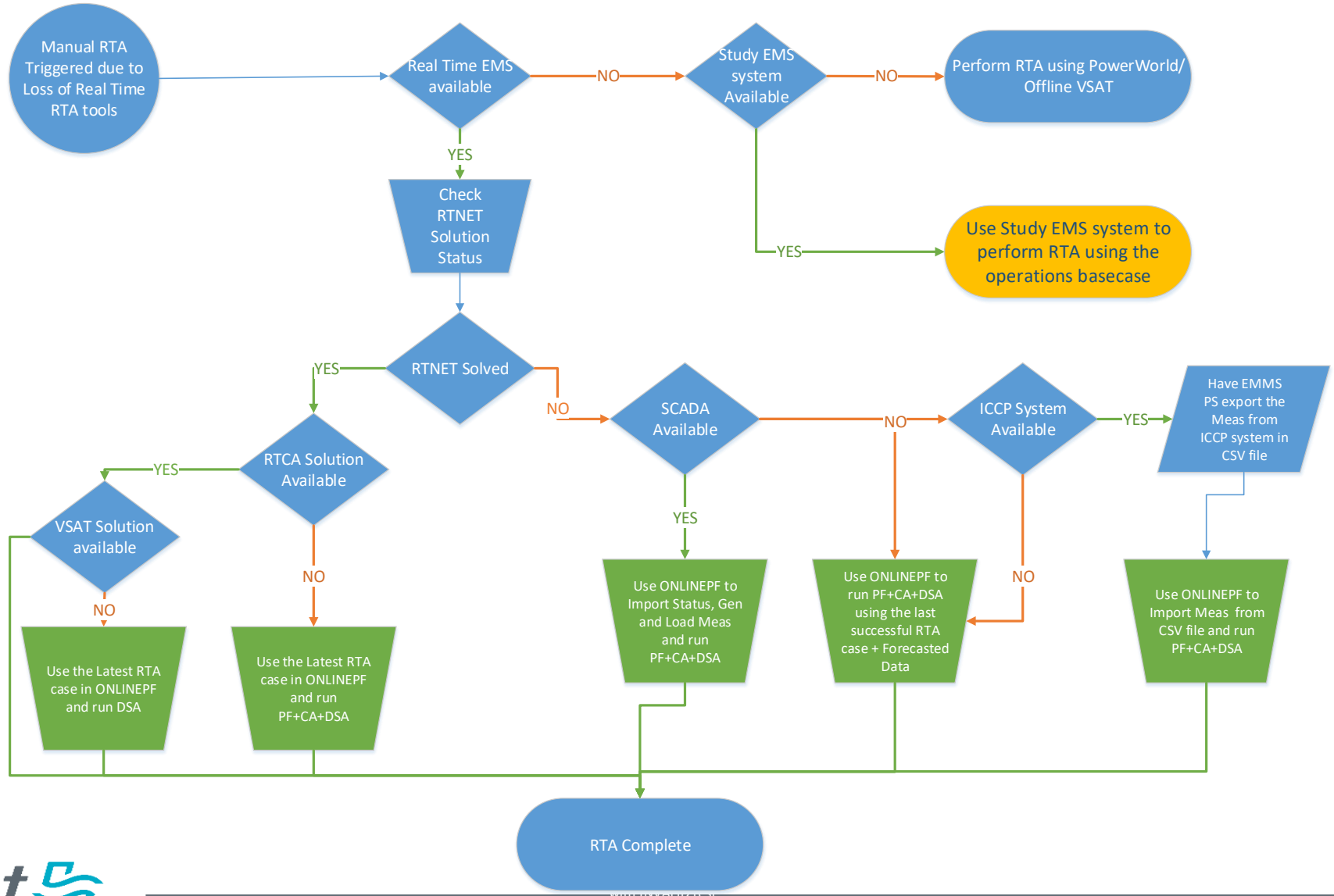
- ERCOT does not wait until an invalid solution happens in SE; we have a daily process by which ERCOT Grid Application Engineers maintain the accuracy of the results produced by SE
  - Residual Analysis
- Operations Support Engineers evaluate the data quality and criteria of a number of different points with the ultimate goal of ensuring the accuracy of the RTA solution
- For real-time telemetry data issues affecting the RTA tools, the ERCOT System Operator will notify the Entity of the data to address these telemetry issues; the Entity has 10 minutes to correct
- For real-time telemetry data issues that do not affect the RTA tools, the Entity should correct within two Business days

Alternate RTA Failure Scenarios



- **Online Power Flow (ONLINEPF) –** Manual application using latest valid State Estimator solution and ICCP data (if available)
- **Automatic RTA –** Automatically executed in background every five minutes with real-time sequence using last successful SE/RTCA saved cases along with available ICCP and forecast data
- **Study Network Analysis (STNET) –** Offline application using various saved cases when real-time network applications unavailable

Alternate Real Time Assessment (RTA) - ONLINEPF/STNET



Alternate Real-Time Assessment (RTA)

ONLINEPF

Enhanced STNET Online Powerflow in real time server.

- Use last successful SE solution with available ICCP and forecasted input data to perform RTA
- The Last 1 hour solved cases are available for analysis to Perform Real Time Assessment
- Coordination with the appropriate TO/QSE's
- Update case with current system conditions
  - Topology changes
  - Use the most limiting parameter when determining corrective actions for SOL exceedances
  - System Load changes
  - Generation re-dispatch
- Run Powerflow , Contingency analysis and Stability Analysis

Incorporate all changes and perform a manual RTA at least once every 30 minutes

Automatic Real Time Assessment

RTA process running automatically in parallel using the last successful solution and ICCP data when available.

- RTA solution available periodically without much manual intervention.

- Uses the STNET modules (PF, CA, DSA) to perform the Network Analysis and have a solution available periodically to provide situational awareness to control room
- RTA will Check the availability of the RTNET/RTCA/RTDCP solution and performs specific operations based on the RTNET/RTCA/RTDCP solution status.
- Creates an automatic STNET save case at the end of the sequence

- Use one of Last 1 hour solved cases created by Automatic RTA process for Performing Manual Real Time Assessment using ONLINEPF

Follow steps in ONLINEPF

STNET

Run the real time assessment in Study Application in Study server

- Used when Real Time Network Applications (SE/RTCA/DSA) and the ONLINEPF are unavailable to perform Real Time Assessment
- Constraint data cannot be transferred to TCM/SCED
- Use the following save cases to perform Real Time Assessment in the order of the availability
  - RTA savecases
  - Latest real time snapshot cases (RT_)
  - Use the ZZZZ case with importing the latest SE solution
  - Use XXXX case importing RUC solution, outages, Load Forecast and dynamic ratings
- Update the case with current system conditions

Perform a manual RTA at least once every 30 minutes

RTA Case Study and Lesson Learned

TOP erroneous telemetry status

Lessons learned/Improvements made:

- RTA continuity enhancement project
- SUSPICIOUS quality feature in SCADA – Mark the Points and Analogs as in SCADA as SUSPICIOUS on a single Substation or ICCP-link basis
- Suspicious Quality Tabular display – To keep track of which Analogs and Points are set to SUSPICIOUS
- Maximum number of breaker/switch status change threshold in SE – If the telemetered status changes from a TOP exceeds threshold, all telemetry from the corresponding TOP will be ignored. SE will continue utilizing the last good statuses from this TOP unless operator manually unmarks them in SE.

RTA Case Study and Lesson Learned

TOP erroneous telemetry status (continued)

- Incorporated ability to selectively retrieve State Estimator measurements into Study Power Flow to perform RTA
- Display enhancements to view all the company-level statistics of measurement qualities at Company level and System level
- Automated process to create snapshot case with copy of databases from real-time applications (SE/RTCA) every 5 minutes with copies to the Real-Time and Study servers

RTA Case Study and Lesson Learned

October 4, 2017- 5th Annual Monitoring and Situational Awareness Conference, NERC, Atlanta, GA

Lessons learned/Improvements made:

- Learned about SUSPICIOUS quality feature in EMS from participant from the conference and incorporated in ERCOT's EMS

RTA Case Study and Lesson Learned

RTCA Application Failure

Lessons learned/Improvements made:

- The RTA save case creation process revised to create an RTA save case only after SE and RTCA has successfully completed
- A new offline study and automated process were developed to run studies with the last valid SE/RTCA save case and results on a regular basis
- A change was made to the process to retain the RTA cases for an hour, to provide flexibility to use a previous case when needed
- The RTA cases from the real-time server are also copied to the EMS Study server

Hardened Real-Time Assessment Enhancements

RTA Improvement	Problem(s) Addressed:
• Improved ability to block the source of bad ICCP data (by station or complete source)	• Bad data with Good Quality • Partial Loss of ICCP
• Improved ability to block bulk changes from being consumed into SE due to ICCP issues from the Market Participants	• Bad data with Good Quality • Partial Loss of ICCP
• Ability to import ICCP measurements on the last successful SE solution in STNET to run RTA for situational awareness and constraints management	• Partial Loss of ICCP causing solution issues • Loss of RT EMS Apps
• Enhanced STNET Online Powerflow feature to use last successful SE solution with forecasted input data to perform RTA	• Complete Loss of ICCP
• RTA process running automatically in parallel using the last successful solution and ICCP data when available	• RTA solution available periodically without much manual intervention during the partial or complete loss of ICCP
• Transfer last successful RT snapshot case to EMS Study server to run RTA in STNET	• RT EMS down • Complete Loss of ICCP
• Export the last successful solution in a format to run RTA using Powerworld / Offline VSAT or other appropriate applications	• RT and ST EMS down and no ICCP

Takeaways

- **Maintain system tools and capability to perform RTA at least every 30 minutes.**
- **Continuously review and revise the tools and processes to achieve this goal.**
- **Regular RTA simulation training and lesson learned for Shift engineers and Operators during their training cycles**

Questions and Answers

Larry Collier

Larry Collier is an Electricity Sector OT Cybersecurity Specialist on the Security & Grid Transformation team at NERC. Larry developed his early career as a system and network engineer serving both the private sector and as a DoD contractor before turning his interests to cybersecurity. Working for a municipal electric utility, he developed their information security NERC CIP compliance programs. Larry serves as Coordinator for the Security Integration and Technology Enablement Subcommittee, collaborating with industry on emerging technology and risks.

Maggy Powell

Maggy Powell is a Security Assurance Principal Industry Specialist focused on the Energy and Utilities Sectors. She joined AWS after 14 years in the power & utility industry having worked in a variety of functions - regulatory risk, environmental permitting, reliability compliance and security operations. She was responsible for leading three technical cyber security teams dedicated to real time systems, including security engineering, industrial control systems (ICS) security operations center, and security & compliance.

Maggy was an industry participant in NERC CIP standards development including serving as Chair on CIP Standard Drafting Teams. At AWS, Maggy supports energy and utility customers as they navigate security and compliance challenges for critical infrastructure, and enables cloud adoption to enhance reliability, security, and resilience.

Wei Qiu

Wei Qiu is a Lead Engineer of Event Analysis, in the Reliability Risk Management group at NERC. As an EMS SME, Wei is responsible for analyzing the EMS events reported, understanding the causes, and working with the industry to develop remediation strategies.

Wei earned his Ph.D in Electrical Engineering from Illinois Institute of Technology, Chicago. He is an IEEE senior member.

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Cloud Computing

Larry Collier, Wei Qiu, NERC
Maggy Powell, Amazon AWS
NERC 10th Annual Monitoring and Situational Awareness Conference
October 6, 2022

Agenda

- Roadmap of cloud computing activities moving forward (Larry)
- AWS experience with utility cloud adoption (Maggy)
- Real-time applications in cloud adoption (Wei)
- Q&A (Maggy, Larry, and Wei)

Roadmap of Cloud Activities

- Collaborative whitepaper development on cloud adoption for BES Operations – aimed for Q4 2022 publishing
  - **NERC**
  - **Amazon Web Services (AWS)**
  - **Industry Stakeholder Groups**
    - Security Integration & Technology Enablement Subcommittee (SITES)
    - Supply Chain Working Group (SCWG)
- Follow-up whitepapers with deeper-dive on topics - TBD

Cloud Whitepaper Scope

Breakdown of Whitepaper Scope/Goals - Cloud Adoption for BES Operations

- High-level explanations of cloud concepts and terminology
  - Cloud Service Provider (CSP)
  - Infrastructure as a Service (Iaas) vs. Platform as a Service (PaaS) vs. Software as a Service (SaaS)
  - Geo-Location of Data
- Address perceived hurdles for adoption
  - Does cloud mean applications must connect over the **public internet?**
  - How can connectivity to cloud applications match on-premise **redundancy?**
  - What if the cloud service provider **goes down?**
  - Can BES applications in the cloud be evidenced for **CIP compliance?**

Cloud Whitepaper Scope

- What types of questions should entity's be asking on their roadmap to cloud use?
  - **Questions for entity's to answer internally**
    - Business requirements
    - Technical requirements
    - Vetting current or future application(s) for cloud use case
  - **Questions for application vendors**
    - Is cloud installation OK, and technically supported?
    - Licensing model support
    - Does the application vendor offer a cloud solution of their own? Professional services, installation guidance, or SaaS offering?
  - **Questions for cloud service providers**
    - Service Agreements
    - Security controls and responsibilities
    - Data access, sharing, and breach actions
    - Backups, recovery, and business closure contingencies
    - Internal cyber posture including security and compliance audits, and certification

Cloud Whitepaper Scope

Evidencing CIP with cloud use for BCS & BCSI; Identify roadblocks. Provide recommendations.

- Challenges
  - CSP's do not participate in registered entity audits
  - CSP controls may not be transparent enough to generate usable evidence
  - Auditors need a precedence for acceptable evidence despite these limitations
- Solution Space
  - Research and evaluate methodologies and solutions in alternative areas
    - comparable foreign national requirements such as EU's EPCIP
    - regulatory industries such as PCI DSS, CJIS, HIPAA, SOX
    - federal strategies like FedRAMP certification

Cloud Whitepaper Scope

- **Identify valuable industry use-cases** 
  - Benefits and challenges
  - Innovation trends
  - Recommendations for new adopters
- **Experiences with utility cloud adoption directly from CSP's**
  - *(Upcoming)* More to follow from Maggy Powell with AWS
- **Dedeeper dive into real-time application use cases such as EMS**
  - *(Upcoming)* More to follow from Wei Qiu with NERC

Six cloud topics in twelve minutes

Maggy Powell

Principal Industry Specialist,
Security Assurance
Amazon Web Services

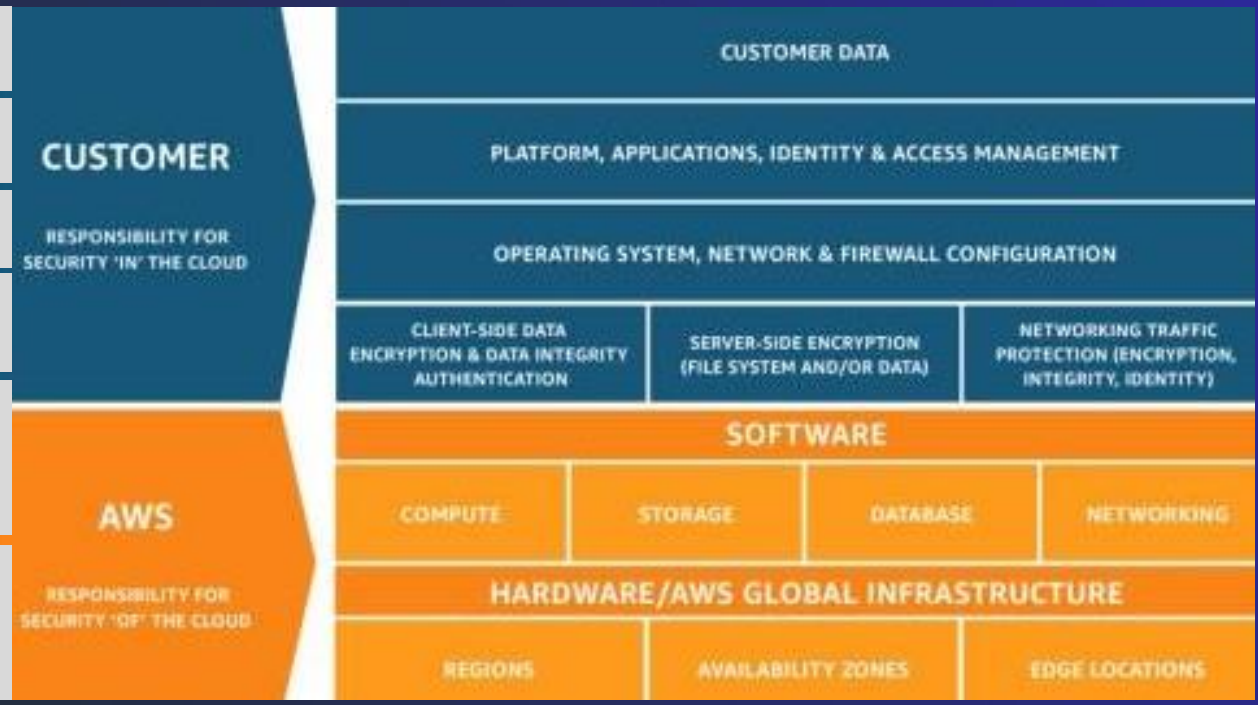
End to End Security vs Shared Security Responsibility

Traditional on-premises security model

Customers
are responsible for end-to-end security in their on-premises data centers

- Customer data
- Platform, applications, identity, and access management
- Operating system, network, and firewall configuration
- Client-side data
  Encryption and data integrity authentication
- Server-side data
  File system or data
- Network traffic
  Protection (encryption, integrity, identity)
- Software
  - Compute
  - Storage
  - Database
  - Networking
- Hardware and AWS Global
  - Regions
  - Availability Zones
  - Edge locations

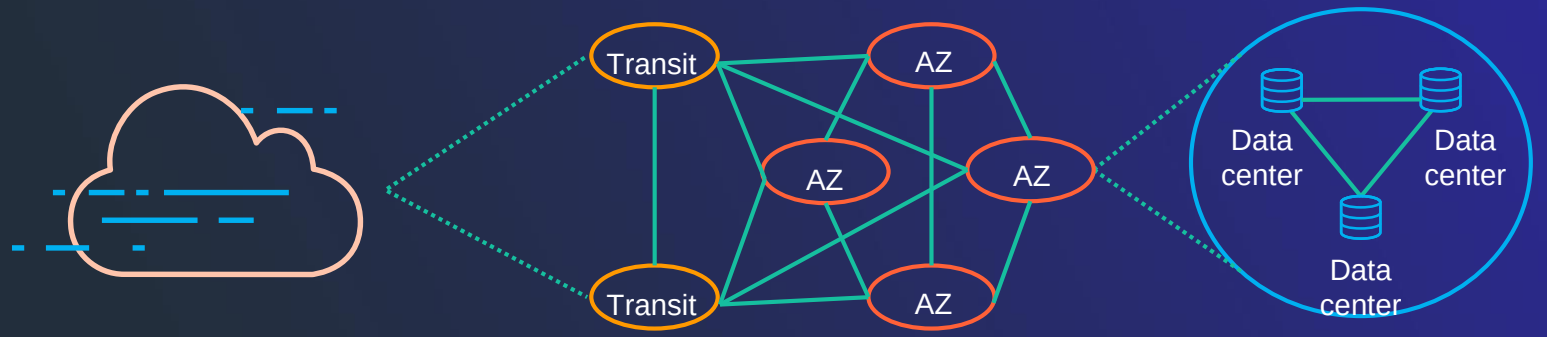
AWS Shared Responsibility Model



On Prem Data Centers vs Hyperscale Cloud Data Centers

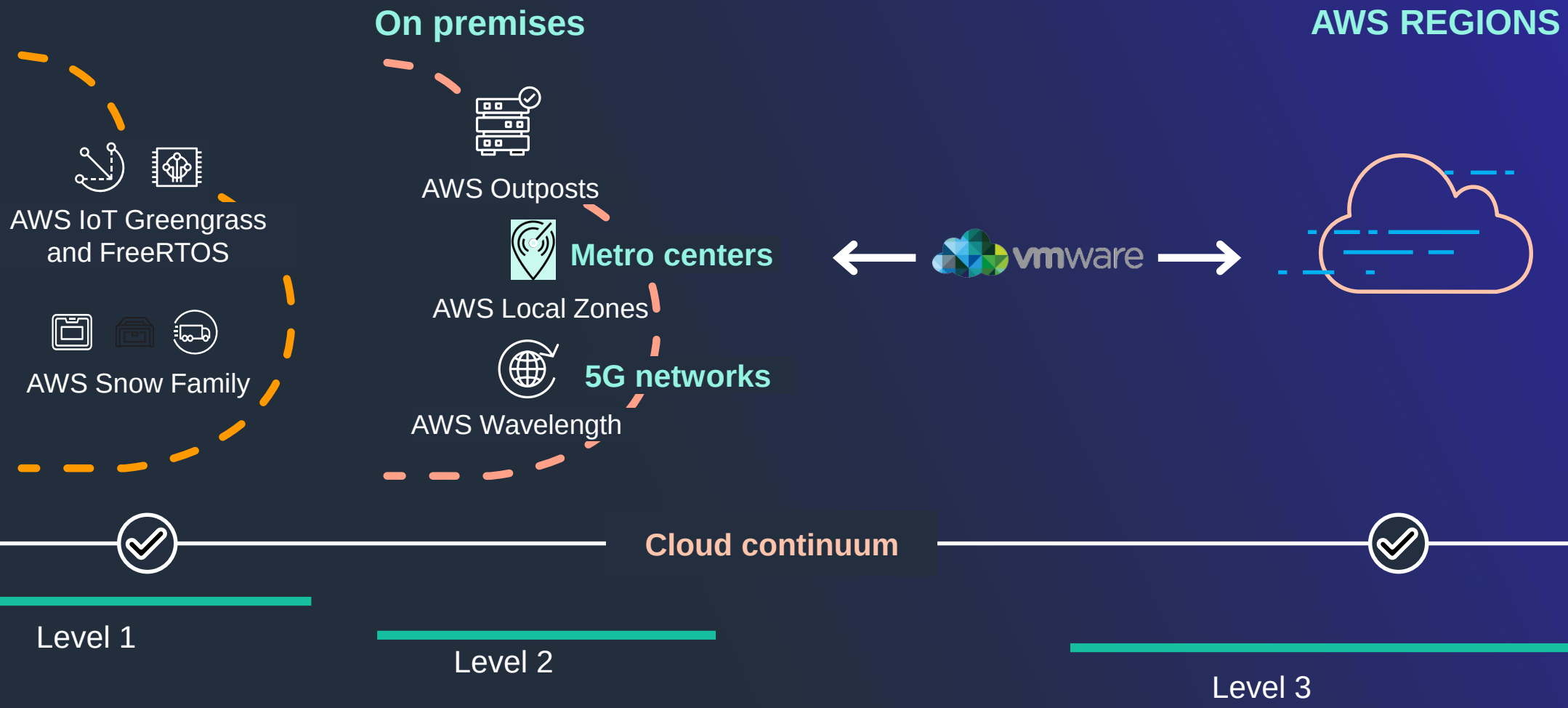
Traditional on-premises Data Centers

AWS Cloud Regions, Availability Zones, and Data Centers



Cloud Technology Continuum

AWS – DELIVERING CLOUD WHERE CUSTOMERS NEED IT



Access Controls, Authorization and Audit Trail

Identity and access management

AWS Identity and Access Management (IAM)

AWS IAM Identity Center (successor to AWS SSO)

AWS Organizations

AWS Directory Service

Amazon Cognito

AWS Resource Access Manager

Detective controls

AWS Security Hub

Amazon GuardDuty

Amazon Inspector

Amazon CloudWatch

AWS Config

AWS CloudTrail

VPC Flow Logs

AWS IoT Device Defender

Compliance

AWS Artifact

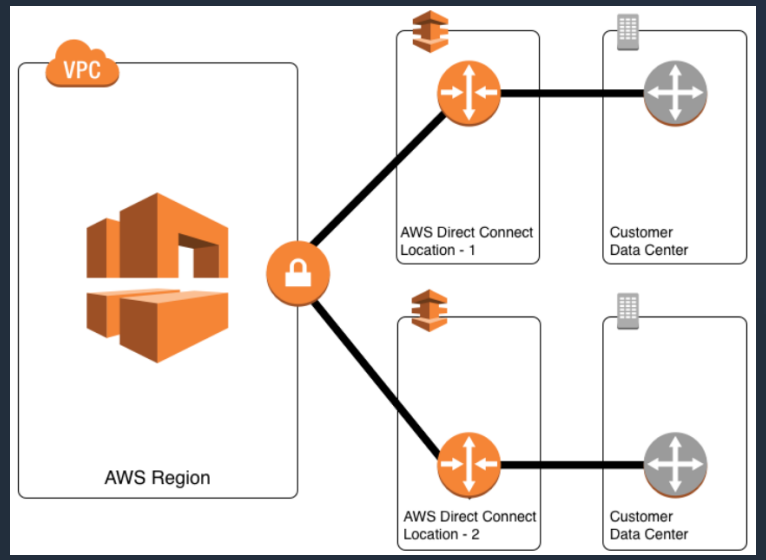
AWS Audit Manager

Infrastructure protection

Data protection

Incident response

Communications Links to the Internet



Private Network Connections

Satellite Communications

5G

Wireless

Cloud Service Providers Vary

Range of Services

FedRAMP Marketplace

Security and Compliance Controls

Certifications

C5	DE	✓	ISO 27001	🌐	✓
Cyber Essentials Plus	GB	✓	ISO 27017	🌐	✓
DoD SRG	US	✓	ISO 27018	🌐	✓
FedRAMP	US	✓	K-ISMS	KR	✓
FIPS	US	✓	MTCS	SG	✓
HITRUST	US	✓	PCI DSS Level 1	🌐	✓
IRAP	AU	✓	SEC Rule 17-a-4(f)	US	✓
ISO 9001	🌐	✓	SOC 1, SOC 2, SOC 3	🌐	✓

Laws / Regulations

Argentina Data Privacy		✓	IRS 1075	US	✓
CISPE	EU	✓	ITAR	US	✓
EU Model Clauses	EU	✓	My Number Act	JP	✓
FERPA	US	✓	UK DPA - 1988	GB	✓
GDPR	EU	✓	VPAT/Section 508	US	✓
GLBA	US	✓	Data Protection Directive	EU	✓
HIPAA	US	✓	Privacy Act [Australia]	AU	✓
HITECH	🌐	✓	PIPEDA [Canada]	CA	✓

Alignments / Frameworks

CIS (Center for Internet Security)	🌐	✓	G-Cloud	GB	✓
CJIS (US FBI)	US	✓	GxP (US FDA CFR 21 Part 11)	US	✓
CSA (Cloud Security Alliance)	🌐	✓	ICREA	🌐	✓
ENS High	ES	✓	IT Grundschutz	DE	✓
EU-US Privacy Shield	EU	✓	MITA 3.0 (US Medicaid)	US	✓
FFIEC	US	✓	MPAA	US	✓
FISC	JP	✓	NIST	US	✓
FISMA	US	✓	PHR	US	✓

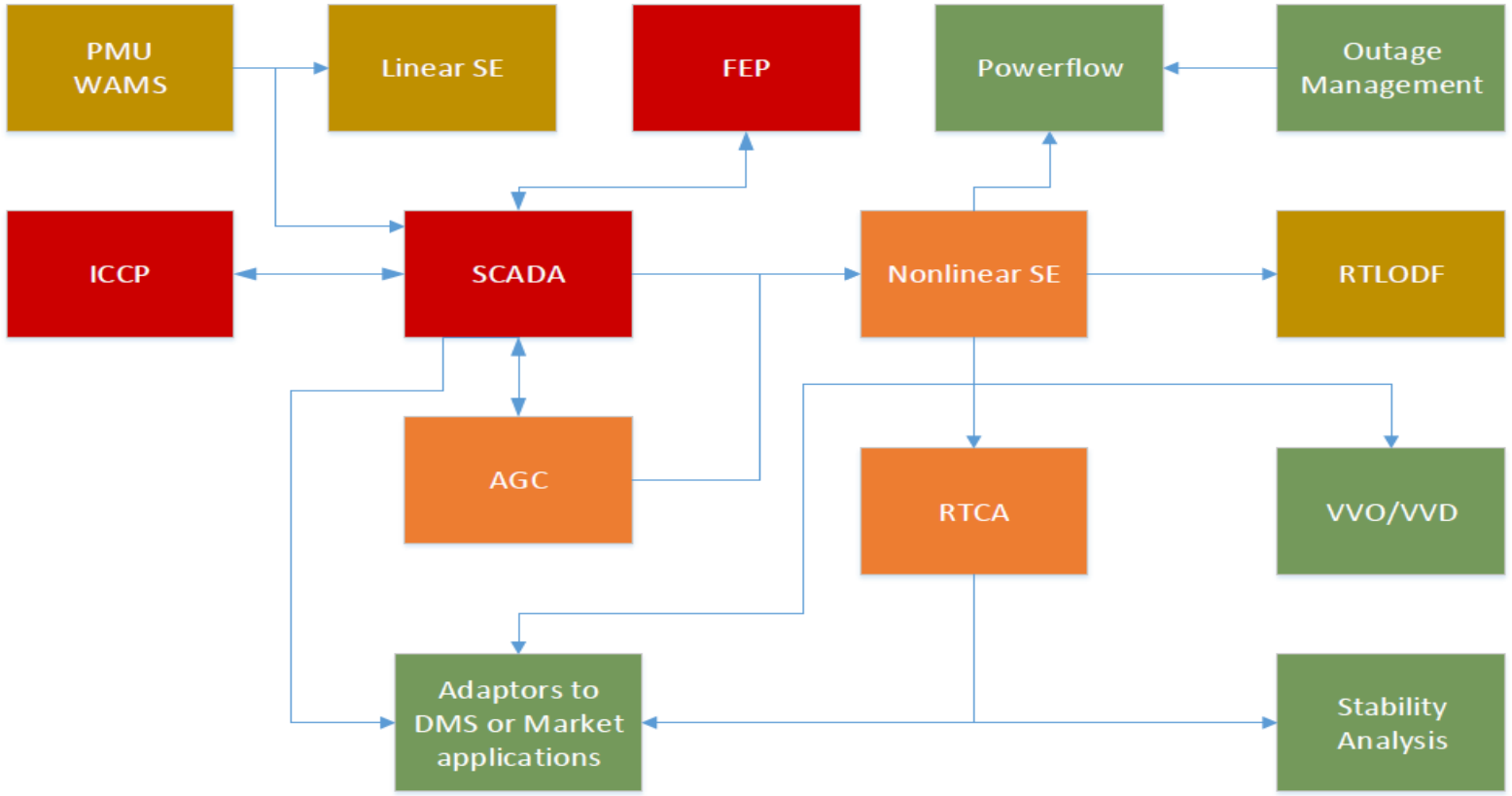
Thank you!

Maggy Powell

MaggyP@amazon.com

Real-time Applications in Cloud Adoption

Real-time Applications



AGC: Automatic Generation Control
DMS: Distribution Management System
FEP: Front End Processor
ICCP: Inter Control Center Protocol
Linear SE: Linear State Estimator
Nonlinear SE: Nonlinear State Estimator

PMU/WAMS: Phasor Measurement Unit/Wide Area Measurement System
RTCA: Real-Time Contingency Analysis
RTLODF: Real-Time Line Outage Distribution Factor
SCADA: Supervisory Control and Data Acquisition
VVD: Volt-Var Dispatch
VVO: Volt-Var Optimization

Risk-based Approach

Why

- Business Requirements
- Pain Points

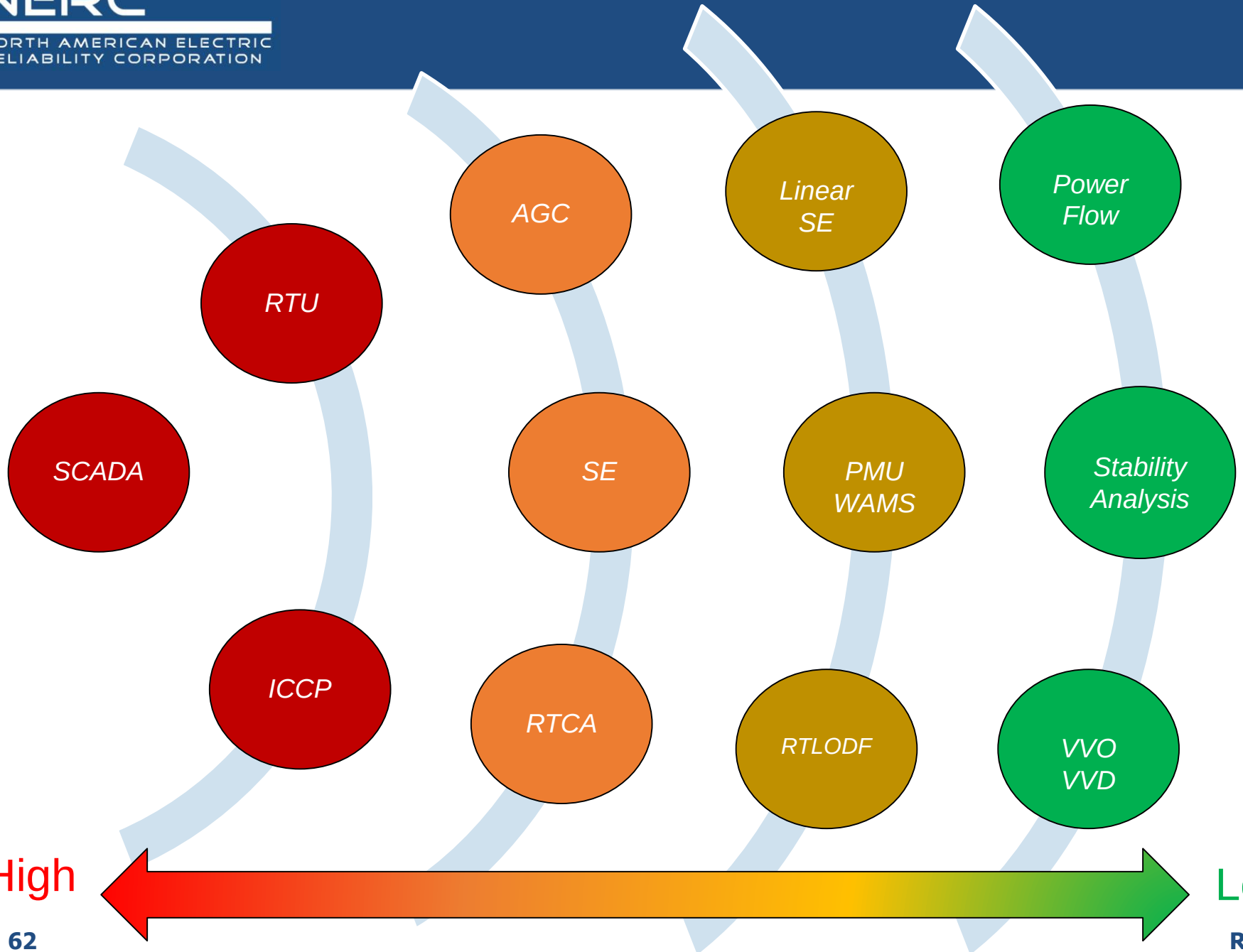
What & How

- Functions
- Dependency

What-if

- Impact of Loss: ***Complete vs. Partial***

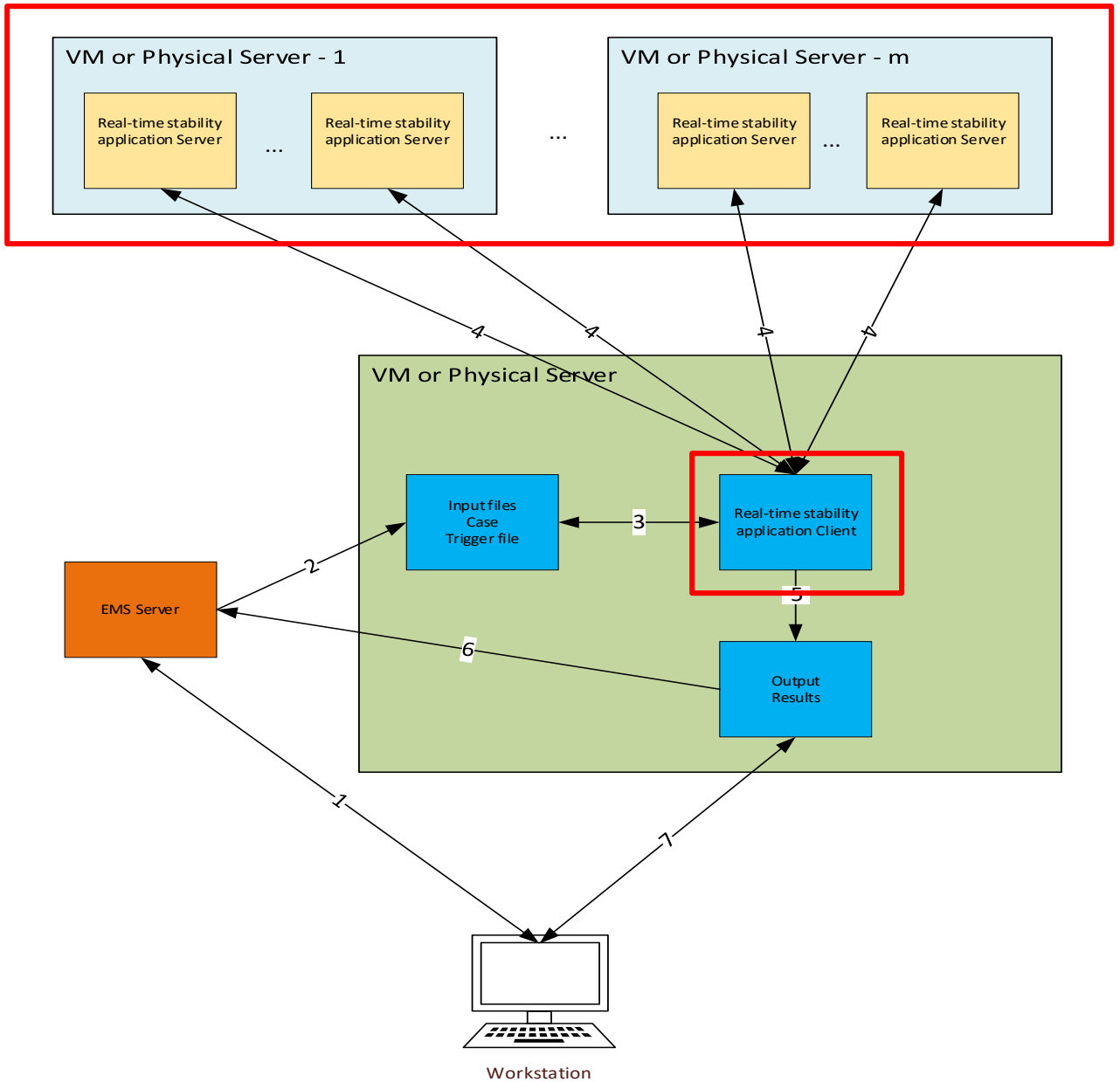
Risk Assessment



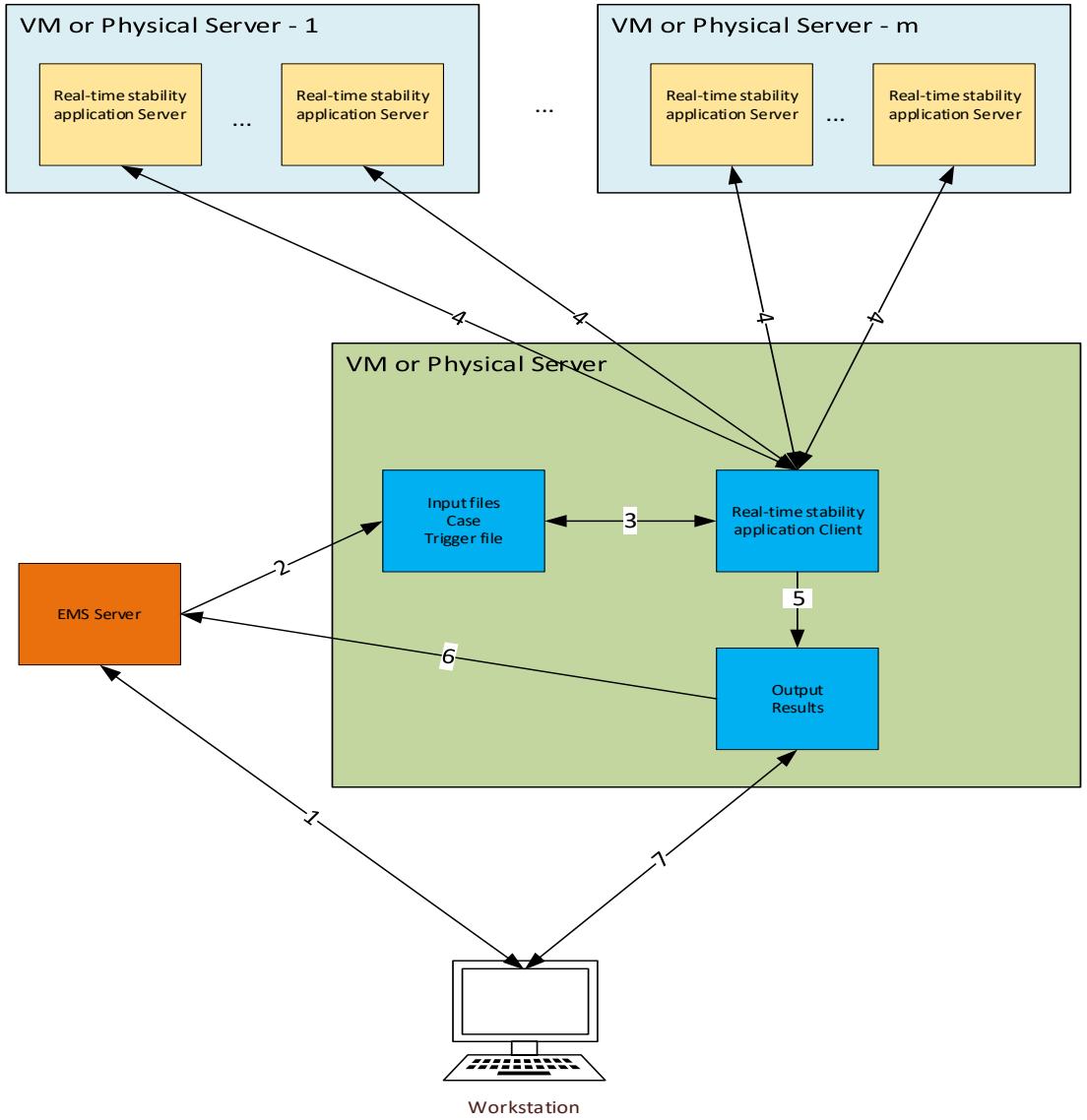
Example - Stability Analysis

- Why
  - Studying involving rotor angle, voltage, or frequency stability
  - Time consuming --- 20-30 minutes (transient stability)
  - Limited study scenarios
  - High cost on hardware
- What & How
  - Depending on RTCA
  - Dedicated Servers & file transferring
- What-if
  - No impact on SCADA, AGC, SE, or RTCA

Example - Stability Analysis – On-premise

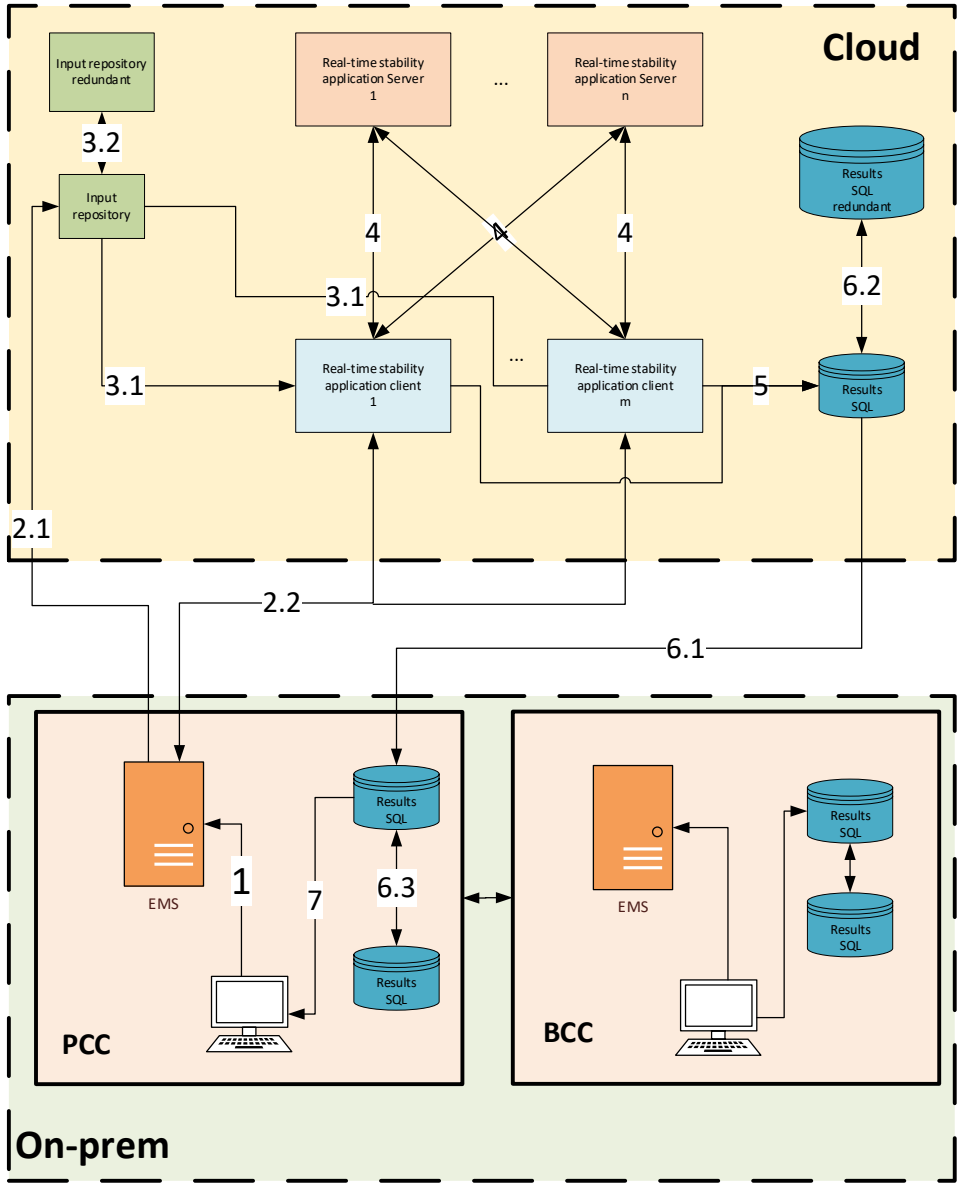


Example - Stability Analysis – On-premise

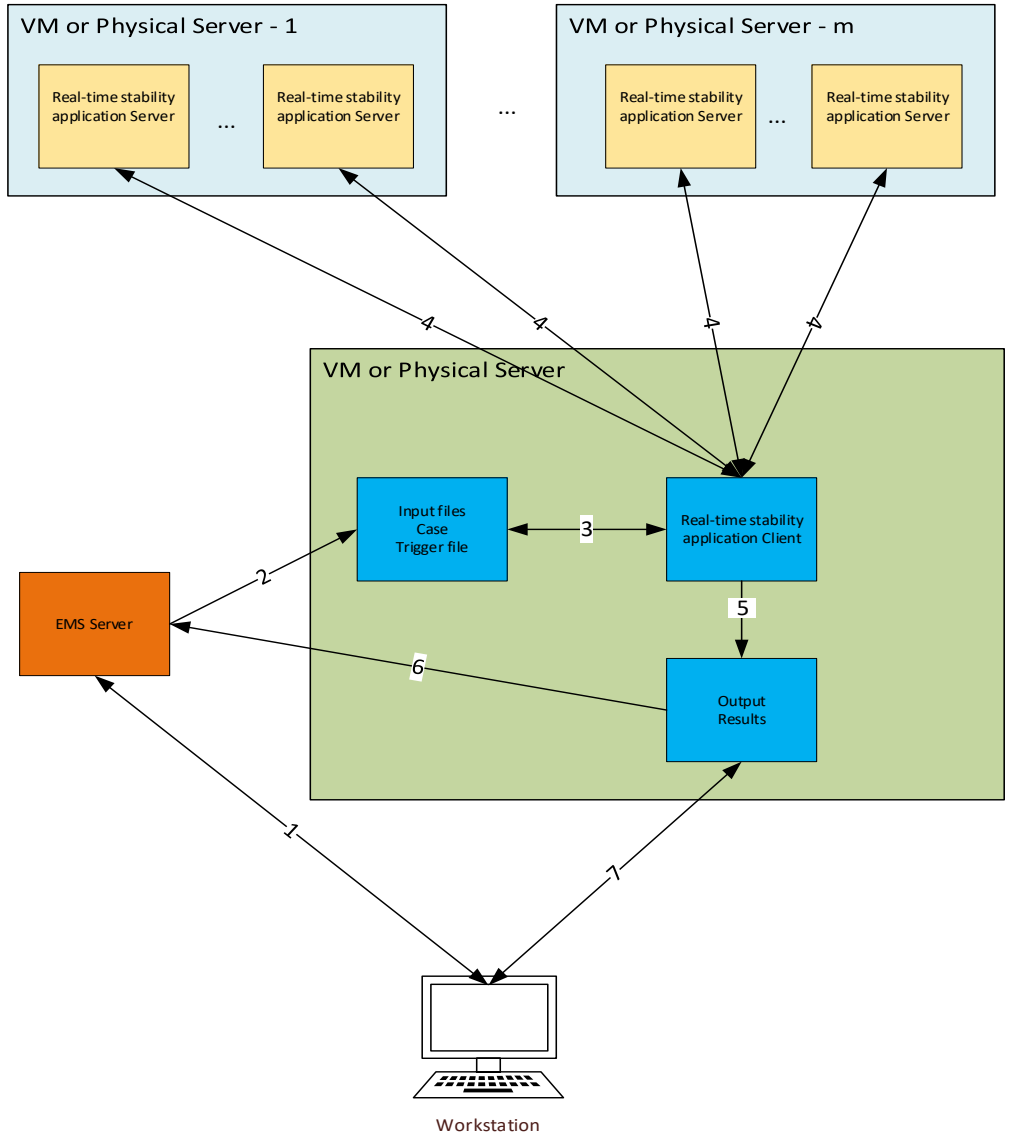


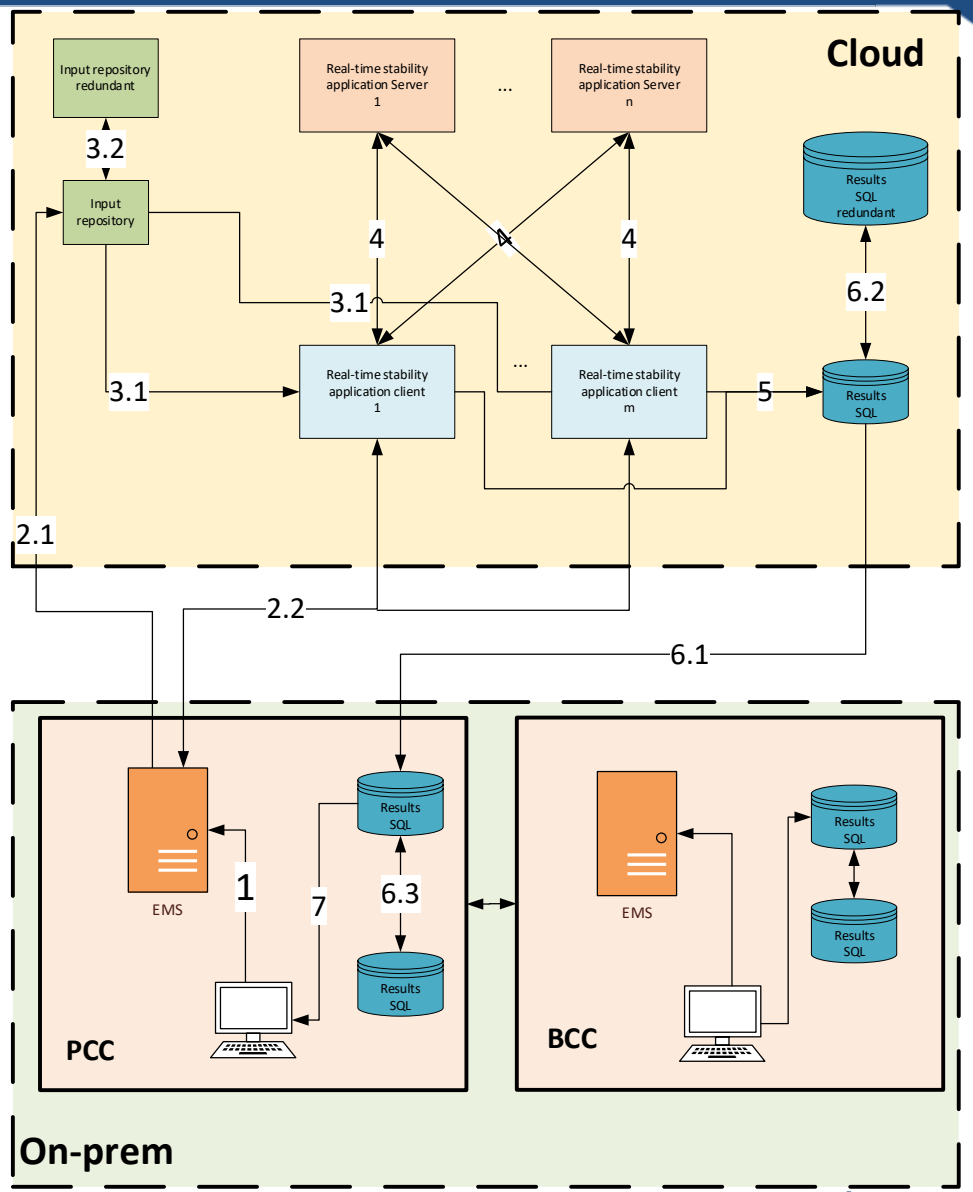
Path	Method
1	Remote Desktop
2	SFTP/Samba Share/ Windows Universal Naming Convention
3	Reading input files and cases
4	Multi-thread Solution Process
5	Result Post-processing
6	EMS Result processing
7	Remote Desktop

Example - Stability Analysis – Cloud



Example - Stability Analysis – Comparison





Takeaways for Real-time Applications in Cloud Adoption

- Primary Benefits: increased speed and efficient disaster recovery
- Risk-based Approach
  - Why
  - What & How
  - What-if
- An Example --- Stability Analysis

Questions and Answers

Recap for Session 2

- Frequency Response Monitoring and Mitigation
  - Raja Thappetaobula , RC West
- ERCOT Real-time Assessment Activity Summary
  - Karthik Gopinath, ERCOT
- Cloud Computing
  - Larry Collier and Wei Qiu, NERC
  - Maggy Powell, AMAZON AWS

Future Session

- Session 3
  - Theme: Vendor Discussion Panel
  - Time: 1:00 PM – 3:00 PM ET
  - Date: Thursday, 10/20/2022
  - Panelist: GE, Hitachi Energy, OSI, and Siemens

Please scan: