Implementation of Centralized Remedial Action Scheme

- An Important Step towards WAMPAC

IEEE PES General Meeting

Smart Grid Super Session

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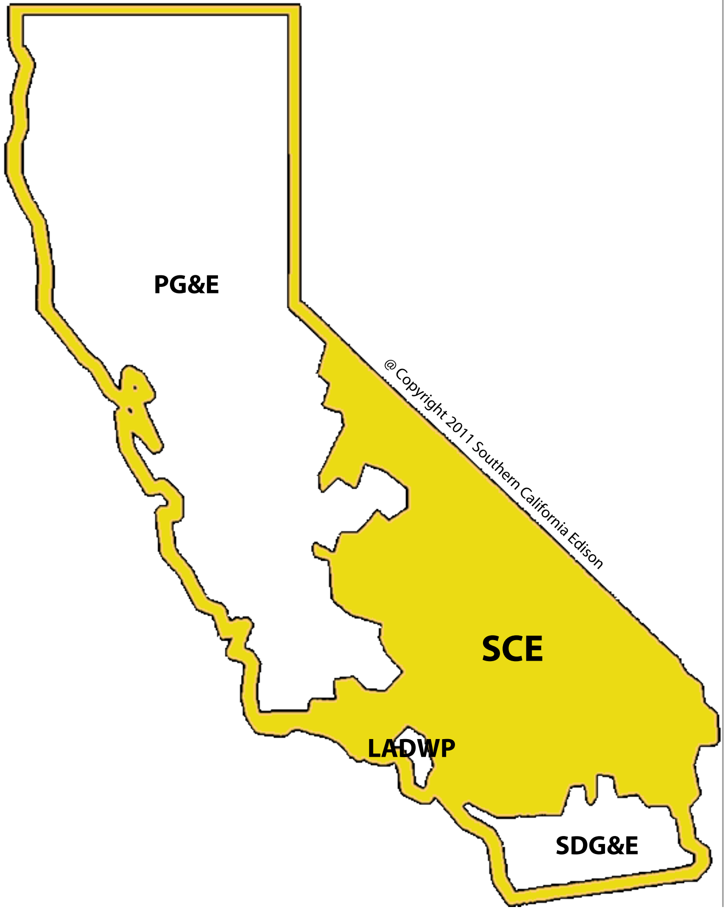
Challenges and Needs

- ❑ Utility resource mix and attributes are changing, make power system more complex for planning, operation, and protection
  - Older central generation steam plants are slowly being retired or replaced by fuel efficient combined cycle and geographically dispersed new renewable generation
  - Different generation technologies, locations and characteristics, especially new renewables, require innovative grid operation strategies
- ❑ Tighter operating margins in power system planning and operation
  - Difficulty of building new transmission means that existing asset utilization needs to be optimized by leveraging new advanced technology to maintain grid reliability and stability
- ❑ Data acquisition and processing in traditional EMS/SCADA is near real-time, but not actual real-time
  - True real-time data measurement and fast protection and control automation is needed to respond to large unplanned system condition changes

Technology Enablers for WAMPAC

- WAMPAC
  - Wide Area Monitoring, Protection, and Control
- Advanced technologies
  - Powerful computing hardware and software
  - Intelligent Electronic Devices (IED) in the field
  - Fast, variable and secure communication solutions
- Industry Efforts in Standards and Interoperability
  - IEC 61850 (90-5 coming)
  - IEEE C37.118

Southern California Edison (SCE)



- Serves a population of more than 14 million people in a 50,000-square-mile service area within central, coastal and Southern California
- 5 million electric meters
- 12,000 circuit miles of transmission lines and more than 111,500 circuit miles of distribution lines
- 7000+ miles of high speed fiber and microwave circuits
- 5,000 MW of generating capacity from interests in nuclear, hydroelectric, and fossil-fueled power plants

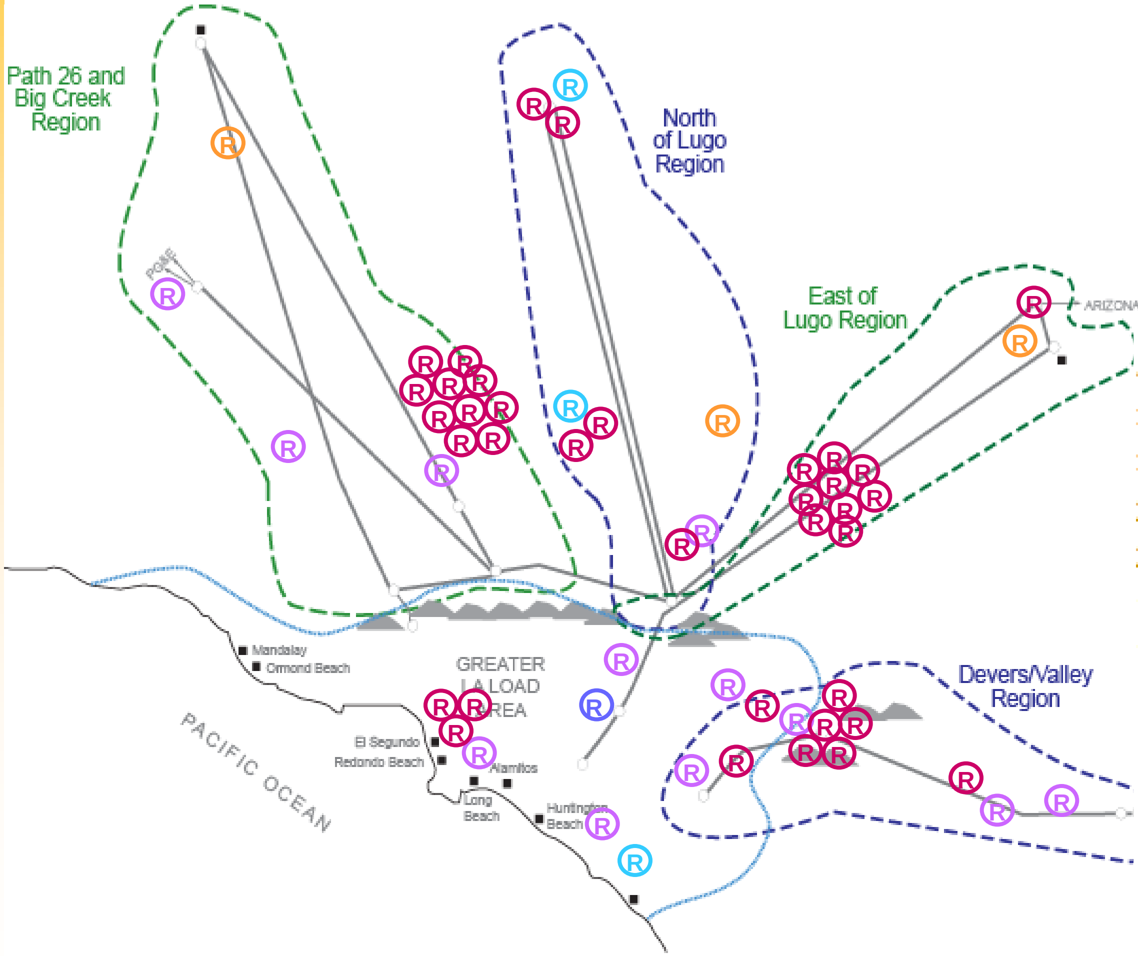
SCE Efforts

- ❑ Centralized Remedial Action Scheme (CRAS)
  - – Wide Area Protection (WAP) system, a key component leading to WAMPAC
- ❑ Wide Area Situational Awareness System (WASAS)
  - – Wide Area Monitoring (WAM) system, a key component leading to WAMPAC
- ❑ Unified Communication Architecture
  - – A unified communication infrastructure to support all present and future communication and networking needs of various control and operation systems and business needs
- ❑ SCEnet2 Deployment
  - – As part of Unified Communication Architecture, SCEnet2 is an on-going effort to establish a future communication backbone for grid applications
  - ❑More...

RAS

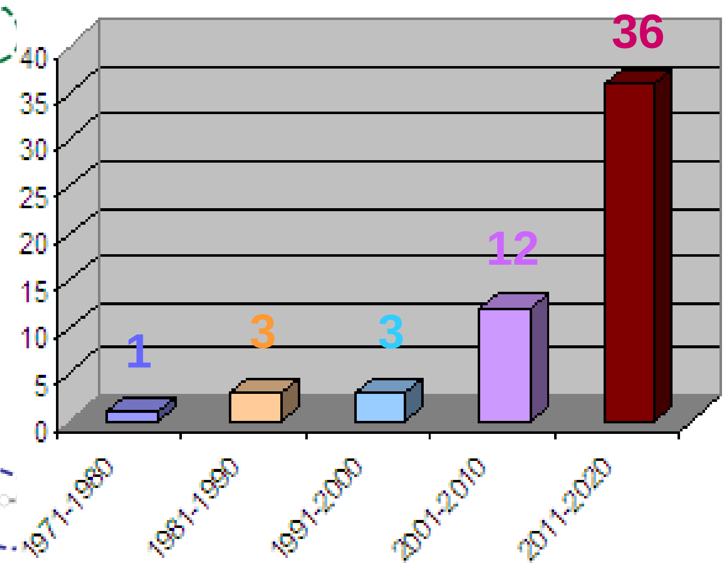
- Also known as Special Protection Scheme (**SPS**), or System Integrity Protection Scheme (**SIPS**)
- **Fast and automated control actions**, utilizing relays and fast telecom network, to ensure acceptable power system performance following critical outages
- Typically considered when other operating and construction options are substantially more expensive or cannot be implemented in time to avoid problems identified in power system studies
- Normally applied where generation is far from load center because of cost of building and difficulty of siting new transmission lines

SCE RAS Statistics and Forecast



The increase is NOT linear!

RAS ADDITIONS



*The forecast assumes that all the generation projects in the queue choose to move forward.

Limitations of Existing RAS Implementation

- Limited logic capabilities
- No information sharing among different RASs
- No equipment sharing among different RASs
- Excess time to manage/update remotely located RASs

Look ahead

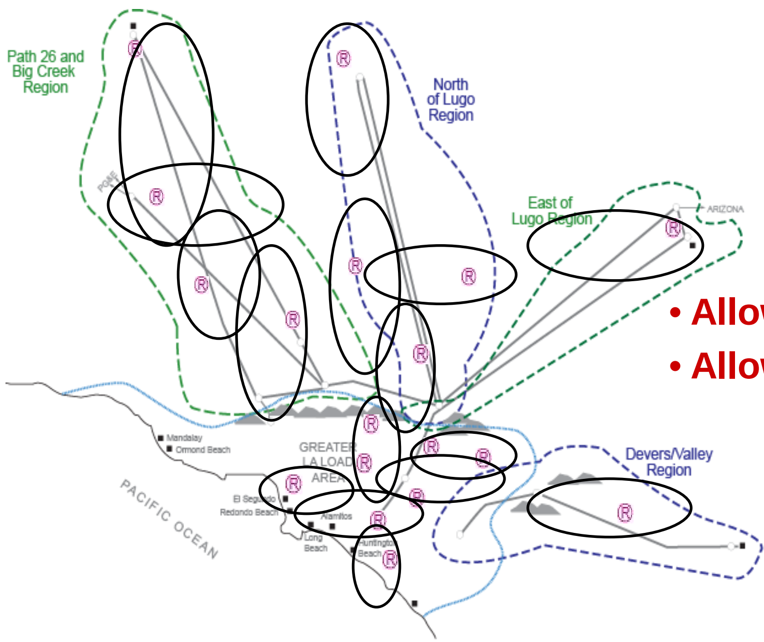
What's the implication for the future?

- Technical feasibility
- System reliability
- Equipment cost and associated labor cost
- RAS implementation speed
- Staffing issue

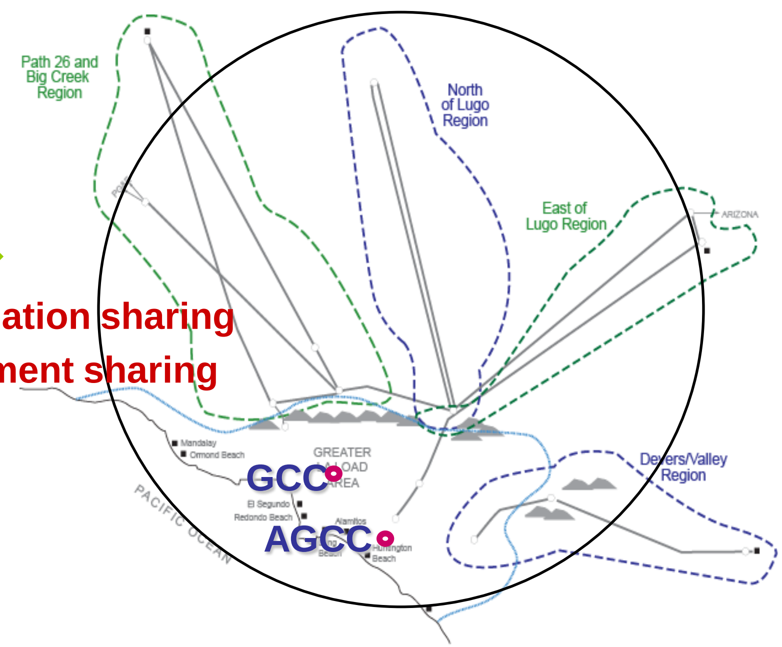
Centralized RAS is the Solution

➢ **Function – Similar to Existing RAS**
Special Protection Scheme, fast and automated control actions, utilizing relays and fast telecommunications network, to ensure acceptable power system performance following critical outages.

➢ **Architecture – from Distributed to Centralized Approach**



• Allow information sharing
• Allow equipment sharing



Fundamental Differences of RAS and CRAS

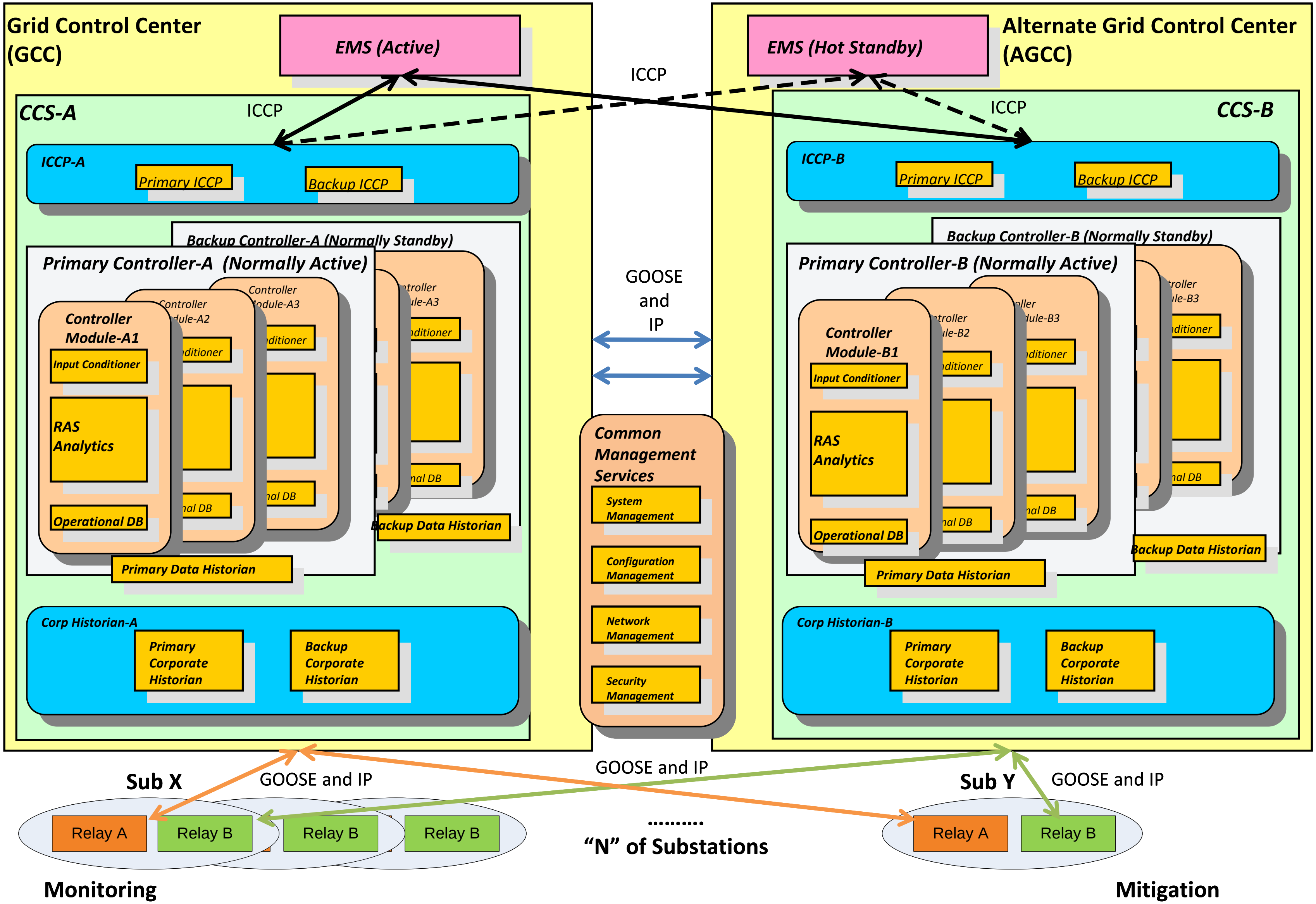
RAS Key Component	RAS	CRAS
Controller	EMS (GCC/AGCC) – Arming Relay (Sub) – Contingency	CCS* (GCC/AGCC) – Arming + Contingency
Relay	Each RAS has a set of dedicated relays – resulting in multiple relays for one line/bank element.	Each line/bank element has dedicated relay – one time installation and commissioning
Communication	Point-to-point proprietary protocol	Multicast international standardized protocol
Algorithm	"Generation-centric" Non-systematic	"Contingency-centric" Systematic

*CCS stands for Central Controller System

Benefits of CRAS

- Increase system reliability
- Allows easy implementation of new “control” algorithms and philosophies
- Speed up generation interconnection
- Reduce work load of what otherwise would be
- Substation equipment and space savings
- Labor savings

CRAS Conceptual Architecture



Key Functional Components

- Dual triple-redundant centralized controllers at both grid control centers
- Centralized RAS analytics for easy management and enhancement
- Input conditioners to ensure data accuracy and consistency
- Historians to store data that can serve different users/purposes
- Secure ICCP to interface with EMS/SCADA
- Monitoring and mitigation relays in substations
- Secure and fast communication system includes router/switch and extensive fiber communication network
- Ready for enterprise common services integration

Key Design Features

- Centralized information enabling wide area protection and control
- Improved speed performance to maximize transfer capability
- Standardized substation layout approach
- System monitoring and active diagnostics
- Centralized configuration management
- Centralized data management
- Sequential automated end-to-end testing
- Compliance reporting tools

Standards and Interoperability

- NERC PRC and CIP standards
- WECC RAS Design Guideline
- IEC 61850-8-1
- IEC 61850-90-5 (coming)
- IEC 60870-6
- IEC 61131-3
- IEEE 1613 Class 2 and IEC 61850-3
- Service Oriented Architecture (SOA)

Deployment Challenges and Considerations

- Not a traditional protection system
  - Information Technology plays an important role
  - Quality, integrity and security of data are critical
  - Cross domain expertise and knowledge exchange are required
- Not a stand-alone system
  - Leverage existing infrastructure, such as security management
  - Integrate with existing system, such as EMS
  - Align with concurrent and new system development, such as WASAS, SA-3
- New functions, new roles of responsibility, and new work process
  - Training is important
  - Organization change management and participation of all affected stakeholders are critical to the success of the project
  - Standards shall be established for new work process

Looking into the Future

- The wide area protection system CRAS is a key component leading to WAMPAC
  - New way of managing grid reliability
  - Upfront technical and organizational work required, but will bring long-term benefit

- CRAS also enables wide area control of grid assets
  - Protection and control is a matter of definition
  - CRAS infrastructure and technology enables both

- Additions of large number of PMUs from nation wide PMU deployment
  - Advanced analytics are desired to manage different granularities of real-time data received from SCADA, RAS, and Synchrophasor System

- The line between “Planning” and “Operation” is becoming blurred

Thank you!

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DISCLAIMER: Dr. Jun Wen served as the Technical Lead of the CRAS project in SCE and prepared this presentation. The statements expressed in this presentation do not necessarily represent SCE's final plan.