Use of CIM in a Centralized Remedial Action System (C-RAS) for Wide Area System Protection

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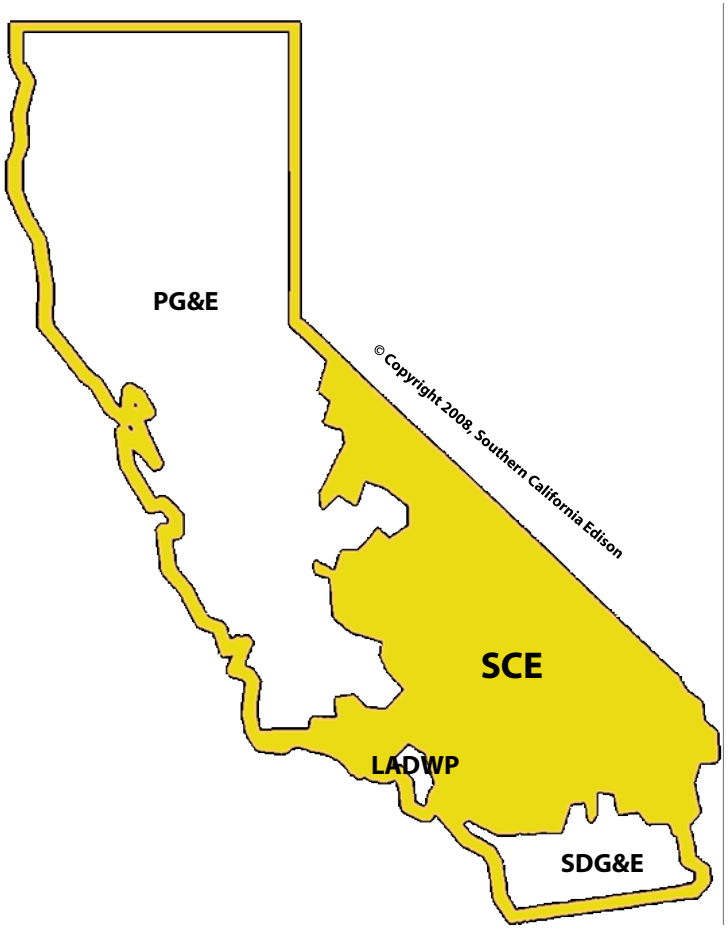
Outline

- About SCE
- Traditional RAS/SPS Implementation
- Centralized Remedial Action System (C-RAS)
- Importance of Data Models
- Data Models Overview
  - IEC 61850 for IED models
  - IEC 61970 for power system (EMS) models
- CIM Extensions for C-RAS
  - Contingency Modeling
  - C-RAS Modeling
  - IED Modeling using IEC 61850
- Configuration Process
- Summary

SCE Overview

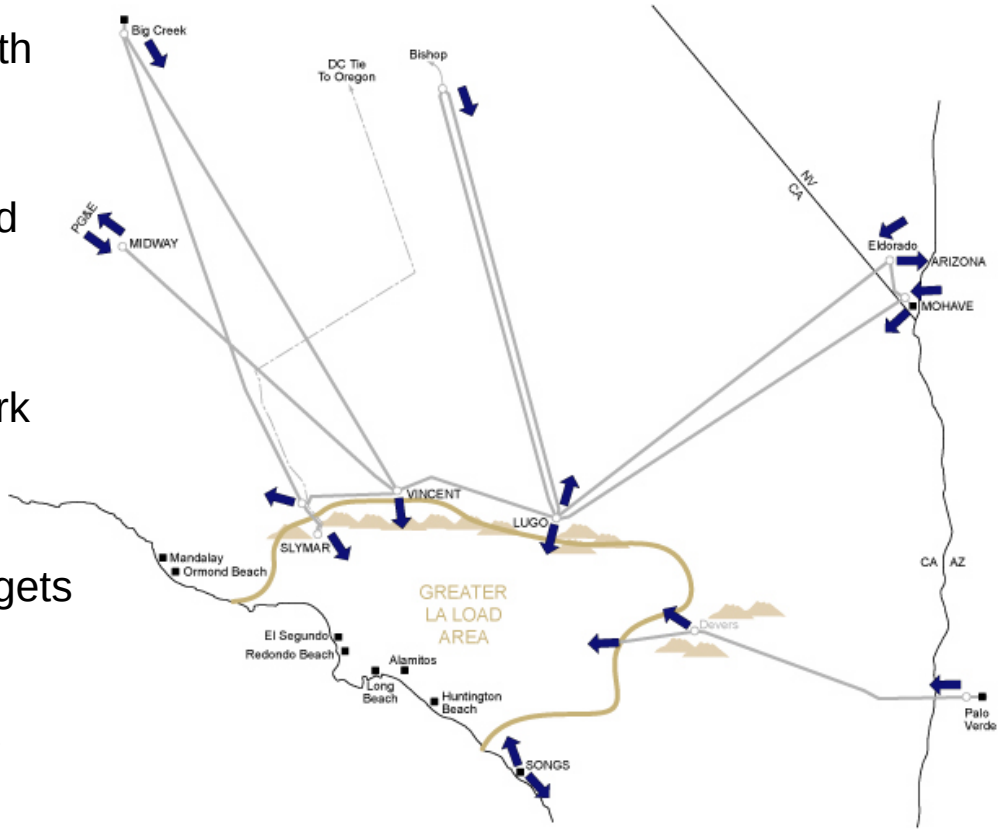


- Service Area
  - 50,000 Square Miles
  - 5.3 Million Electric Meters
- Assets
  - 4,990 transmission and distribution circuits
  - 12,000 circuit miles of transmission lines
  - 111,500 circuit miles of distribution lines
  - 5,000 MW of generating capacity in nuclear, hydroelectric, and fossil-fuel power plants
  - 80 Transmission Substations
  - 850 Distribution Substations

SCE Transmission Network

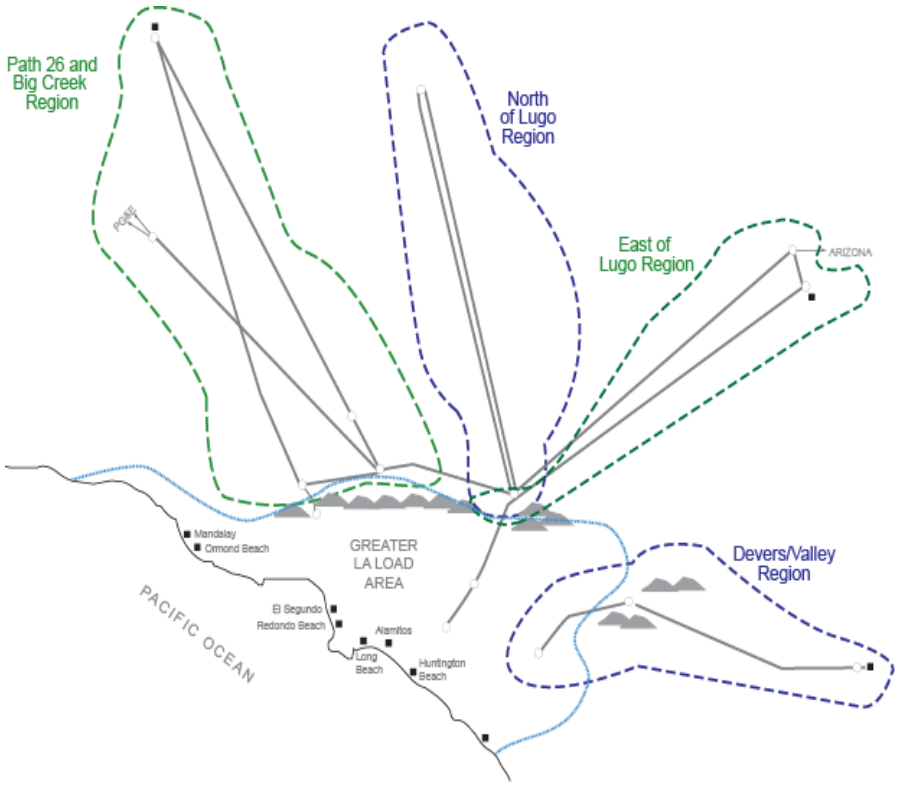
Key Transmission Planning/ Operational Issues

- Congested transmission corridors/ network
  - Ever increasing customer load growth
- Long lead time to build transmission
  - Transmission lagging generation and customer load growth
- Integration of new generators including renewables into the transmission network
  - Uncertainty on new generation siting/locations
  - Legislative/regulatory renewable targets mandate
- Increasing transmission voltage support requirements
- Extensive use of “Remedial Action Schemes (RAS)”



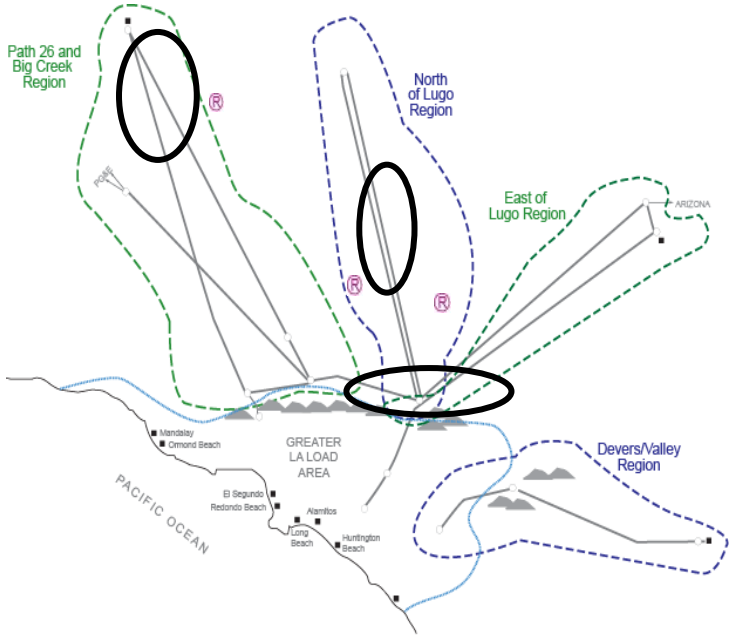
Why RAS is Needed

- Long lines separating load and generation need protection to prevent damage from generation tripping.
- Increasing reserve margins to protect lines reduces available energy.
- Maintaining system stability during anomalous conditions challenges operators to respond quickly to prevent cascade failure
- More transmission capacity in the same corridor is subject to the same contingencies and results in increasing reserve margins.



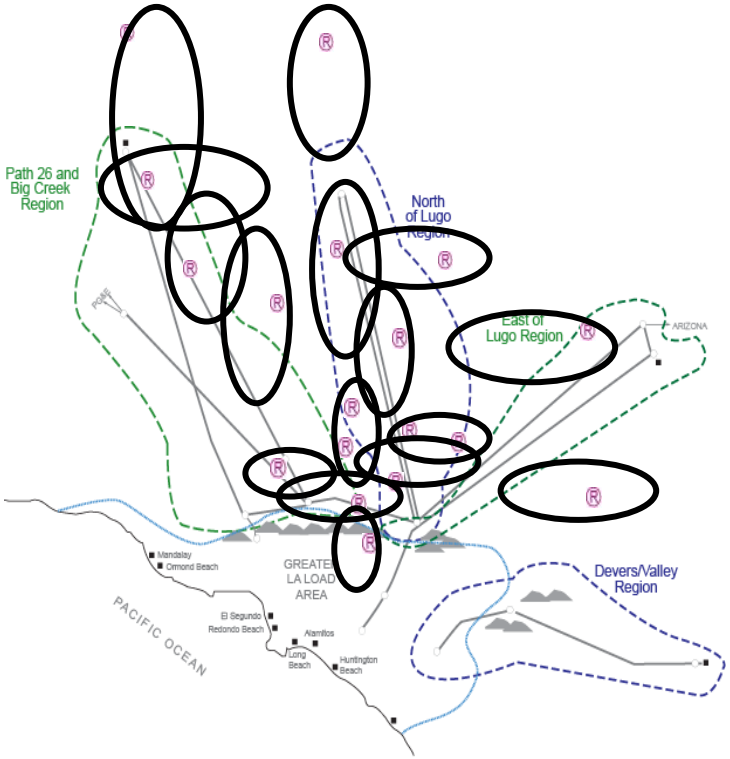
Individual Remedial Action Schemes and Special Protection Systems (RAS/SPS)

- Protects lines from damage during anomalous conditions.
- Individual RAS are available using traditional approaches involving hardwired devices within local areas.



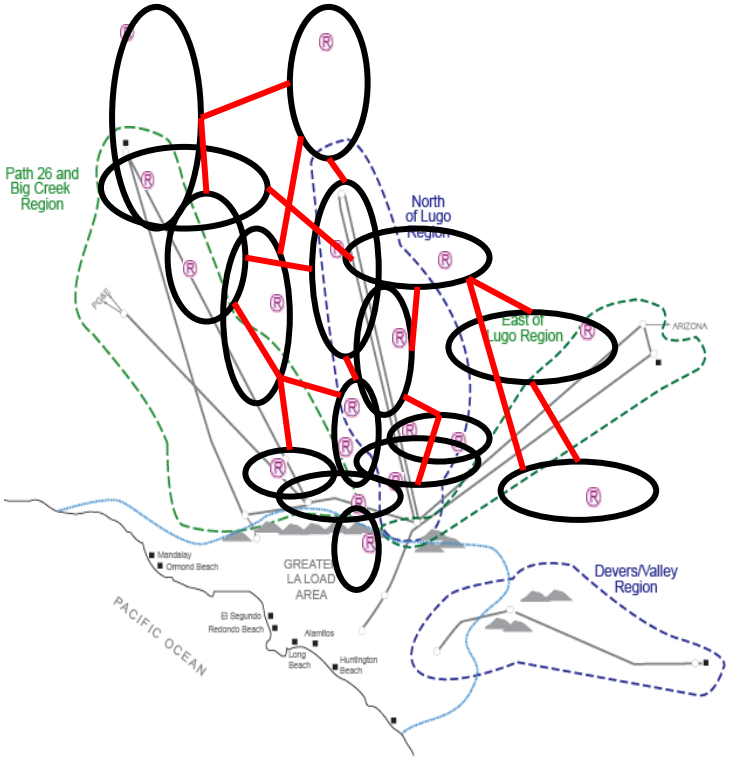
Multiple Individual RAS

- Deploying multiple individual RAS practical because little interaction between RAS.
- Difficult to maintain and update as number of RAS increases.



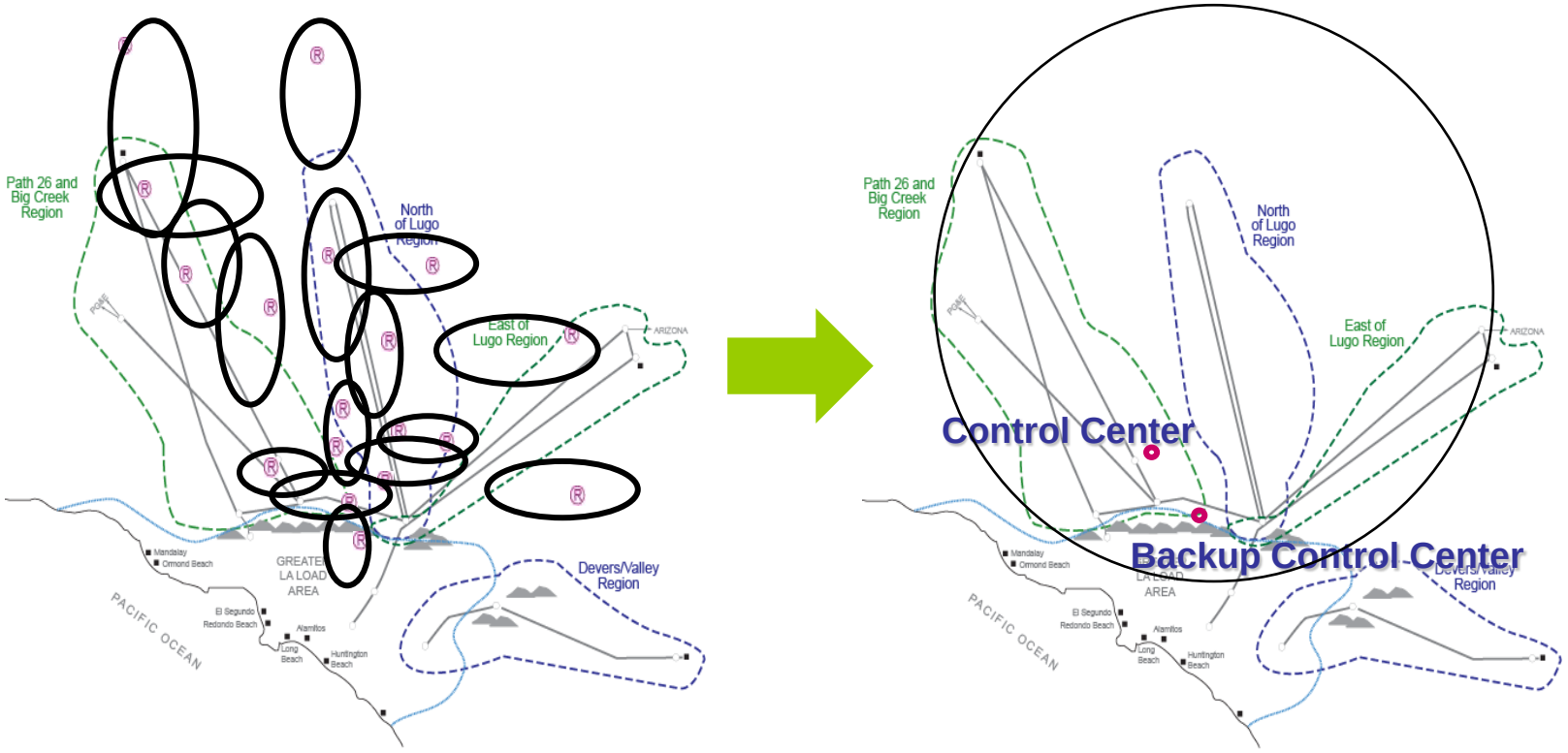
Integration of Multiple Individual RAS into a Distributed RAS

- Addressing system stability requires integration of multiple RAS over a wide area.
- Information sharing and interactions between individual RAS using traditional techniques increases complexity and cost beyond what is practical.



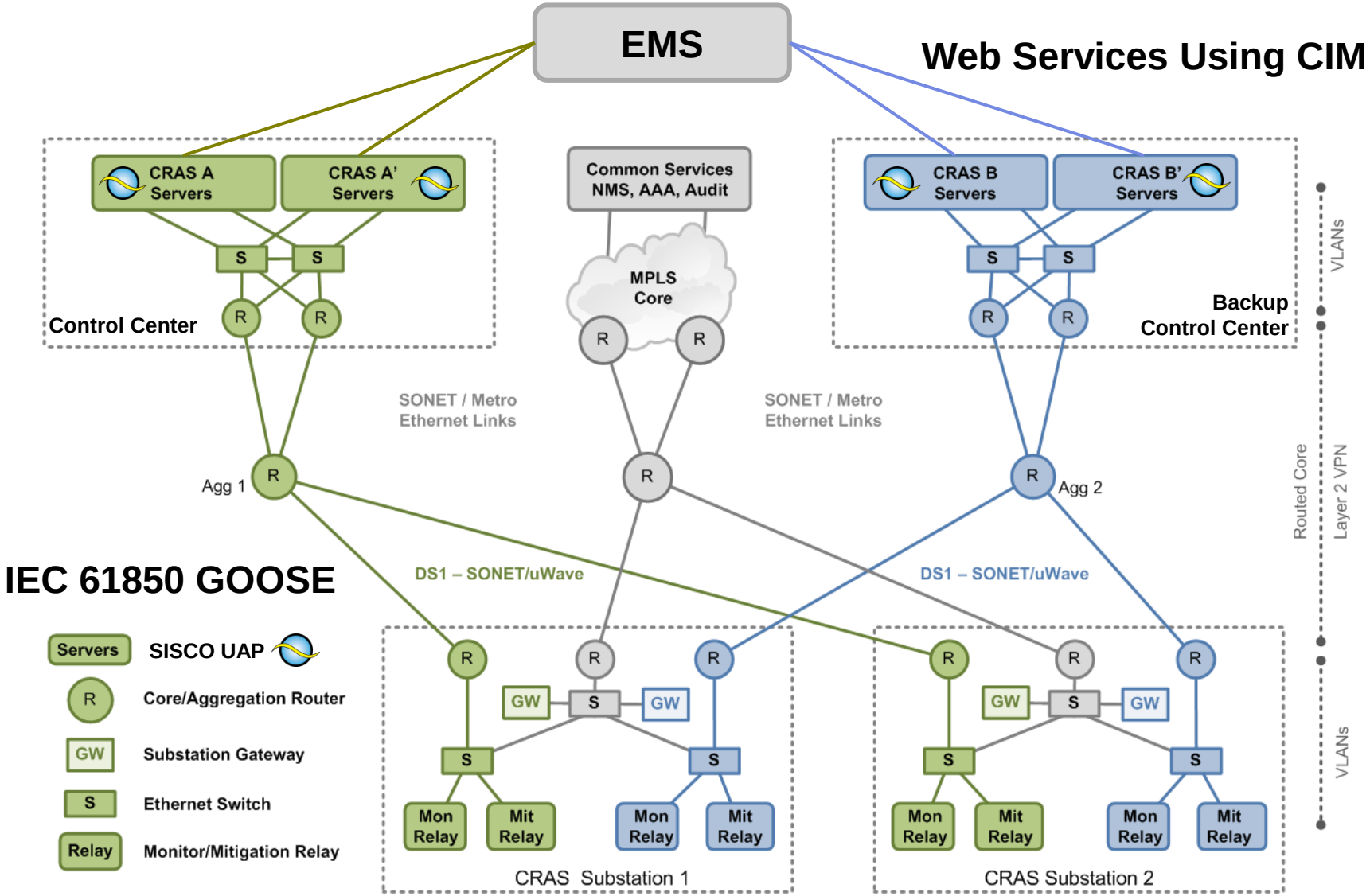
Centralized Remedial Action Systems (C-RAS)

- Centralized control reduces complexity of information sharing making implementation feasible.
- Centralization of control requires a network architecture to support very reliable high speed communications of events and controls

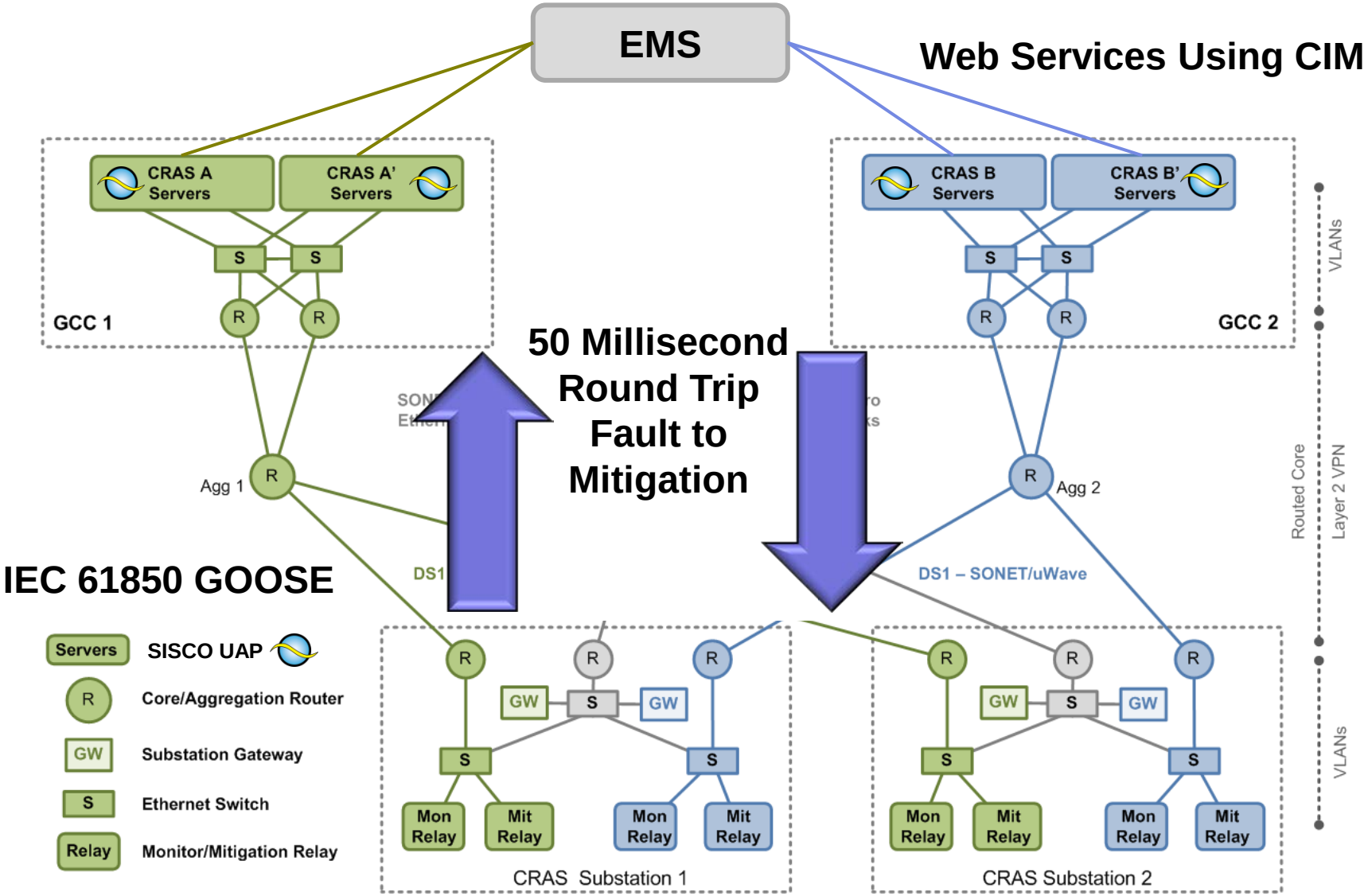


Distributed **Centralized**

C-RAS Architecture



C-RAS Architecture

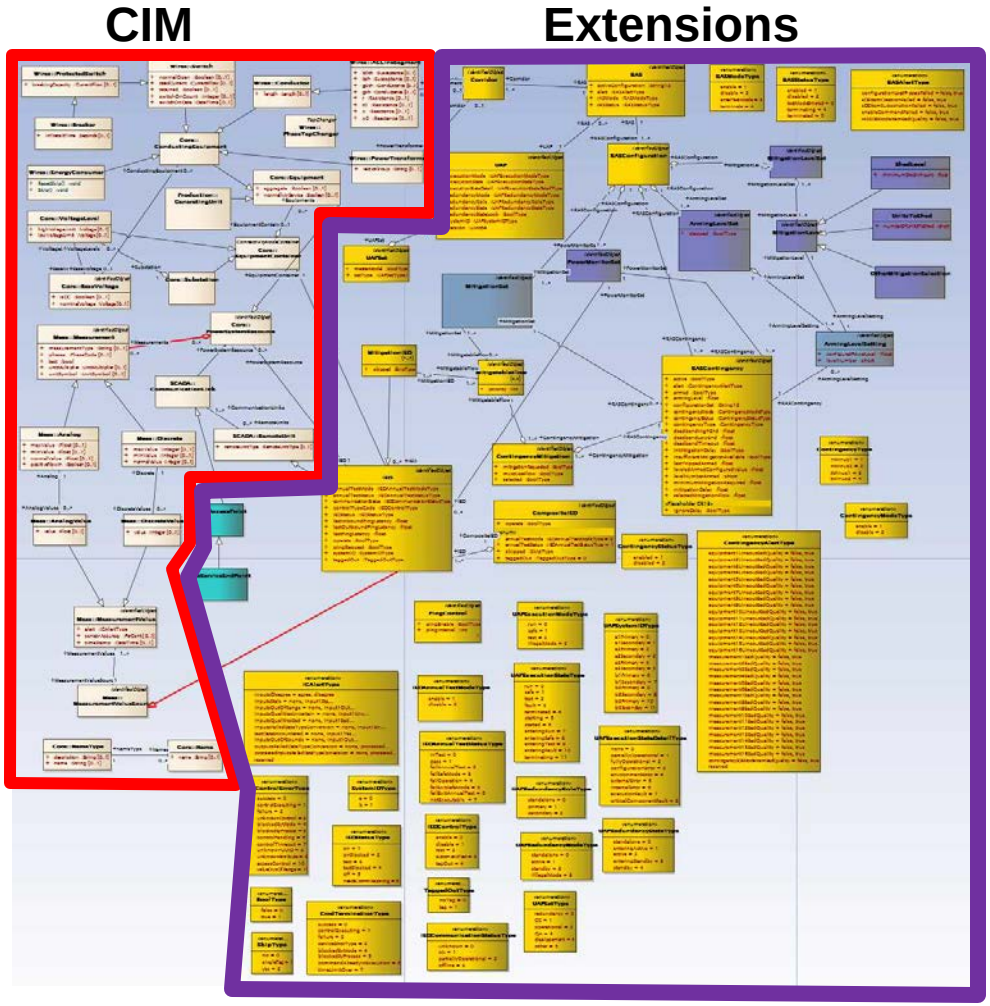


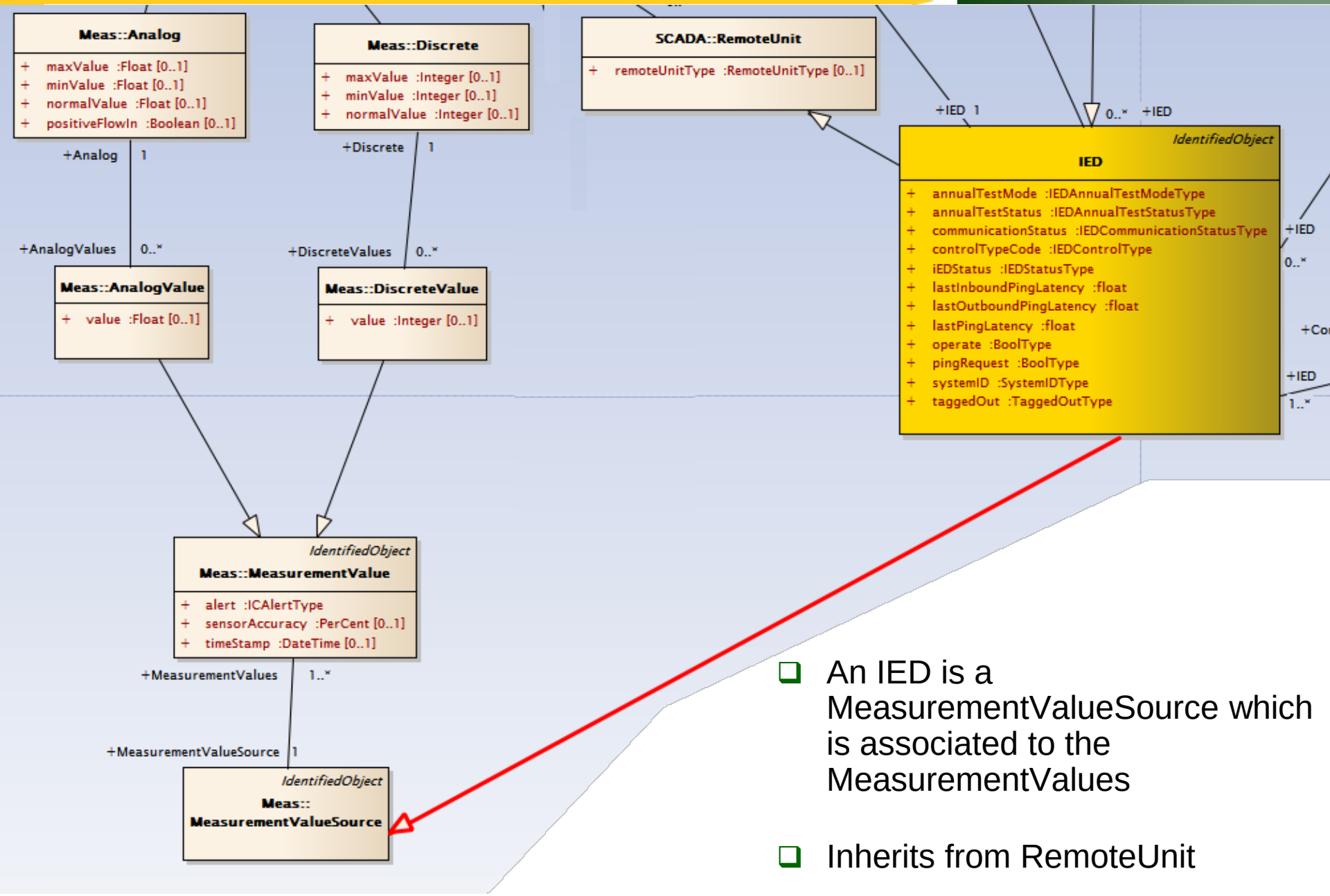
Data Modeling

- Management of system configuration and interaction between systems requires a common data model for data exchange
  - Without common data model each system's understanding of the power system relationships of data could be different.
  - Performing critical control operations on the power system requires absolute certainty of the operations…ambiguity is not allowed
- CIM is used for high-level power system models
  - Existing EMS mapping with CIM already established
  - CIM power system model (IEC 61970-301 and -452 (CPSM))
- IEC 61850 is used for IED modeling
  - Measurement and status naming
  - Configured IED Description (CID) files for GOOSE subscriptions
- Extensions to integrate these models into a "Master Model" used by the C-RAS central controllers

C-RAS Master Model

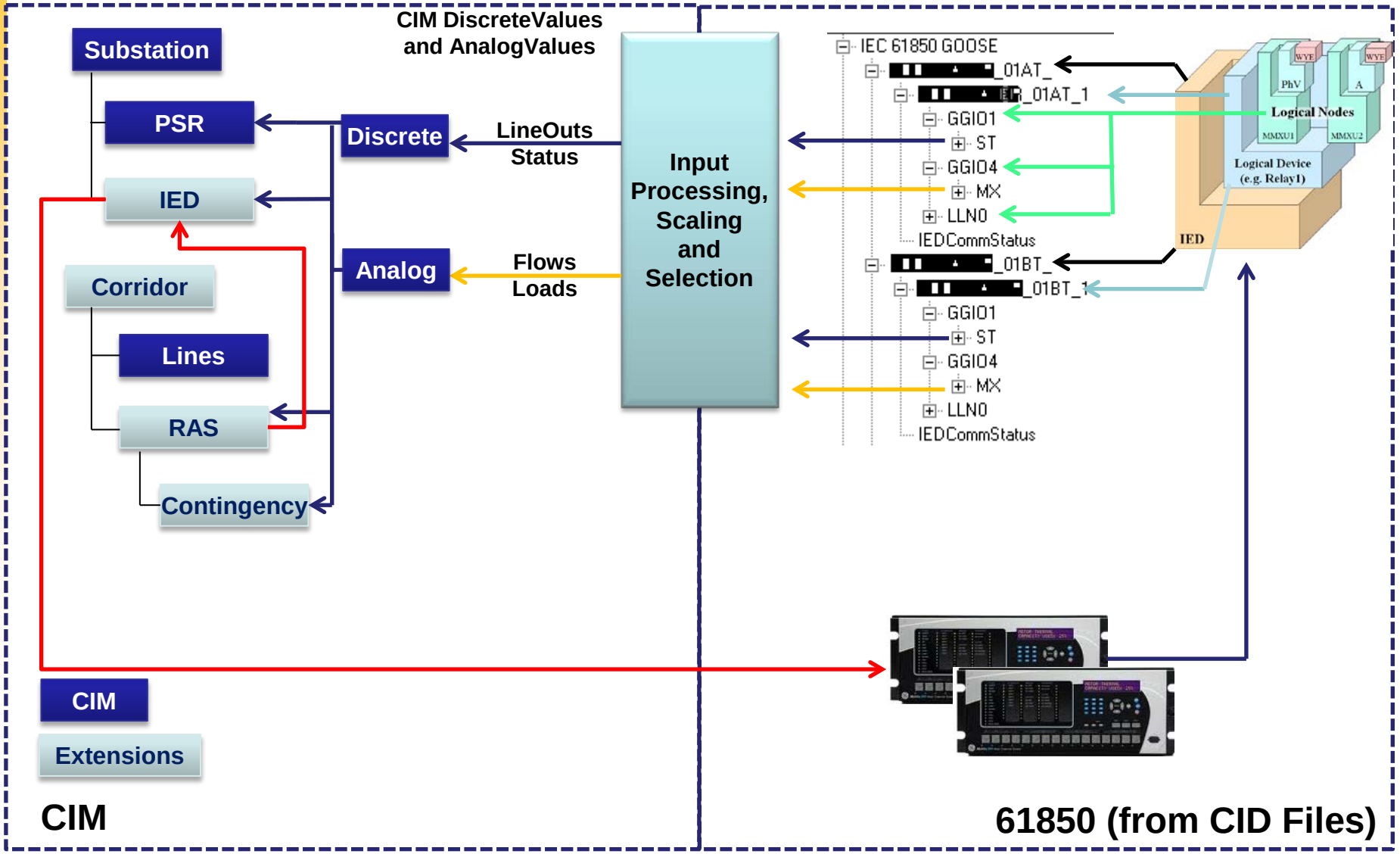
- IEC 61970-452 profile used for power system modeling
- Extensions for modeling of:
  - Contingencies
  - Mitigations
  - RAS Analytics
  - IEDs





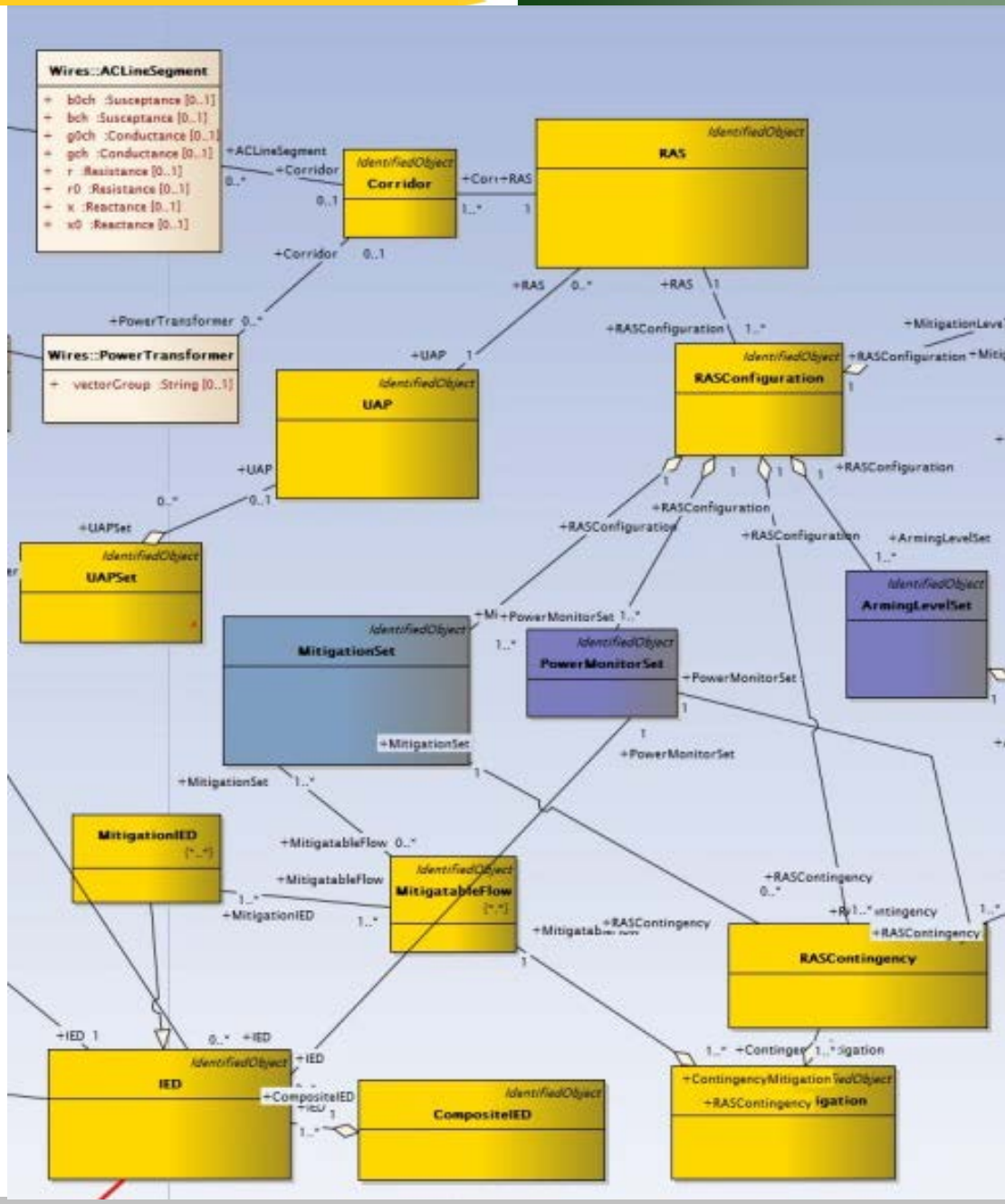
- An IED is a MeasurementValueSource which is associated to the MeasurementValues
- Inherits from RemoteUnit

General Information Flow

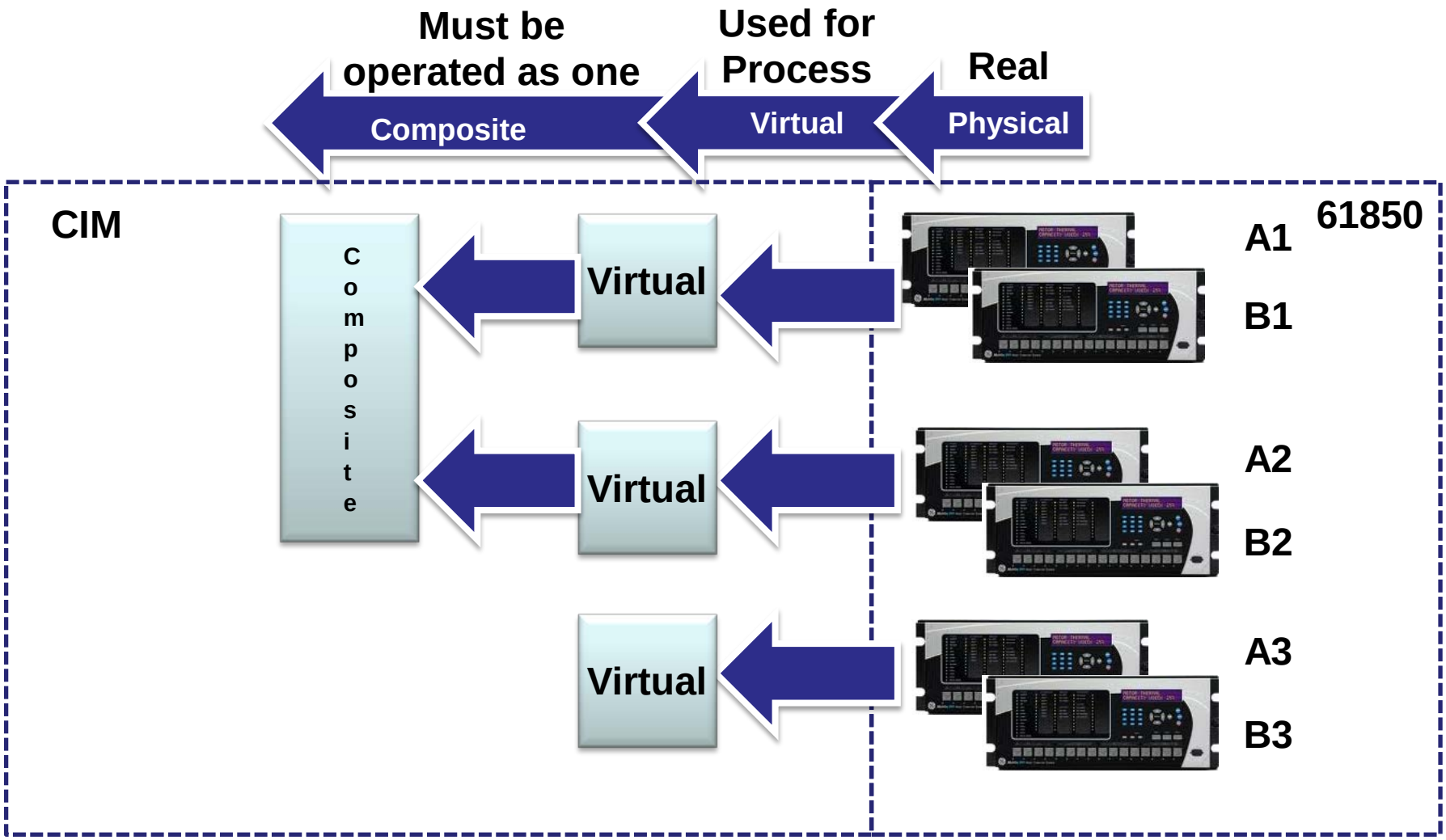


CRAS Modeling

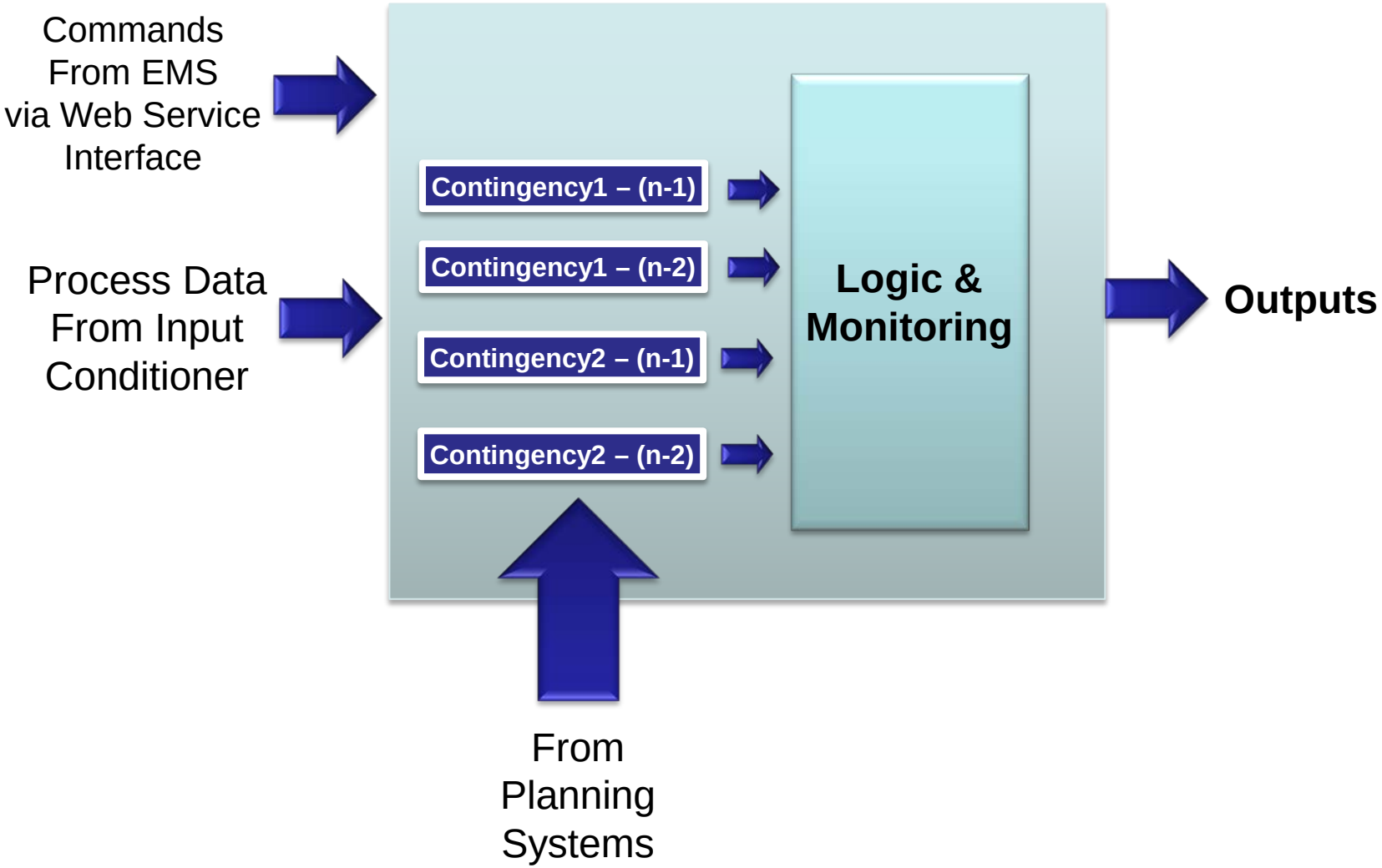
- RAS are associated to AC Line Segments with a Corridor extension
- Virtual IED modeling allows RAS Analytics to treat redundant IEDs as a single device
- Composite IED modeling allows multiple pairs of IEDs to be operated as one device during mitigation



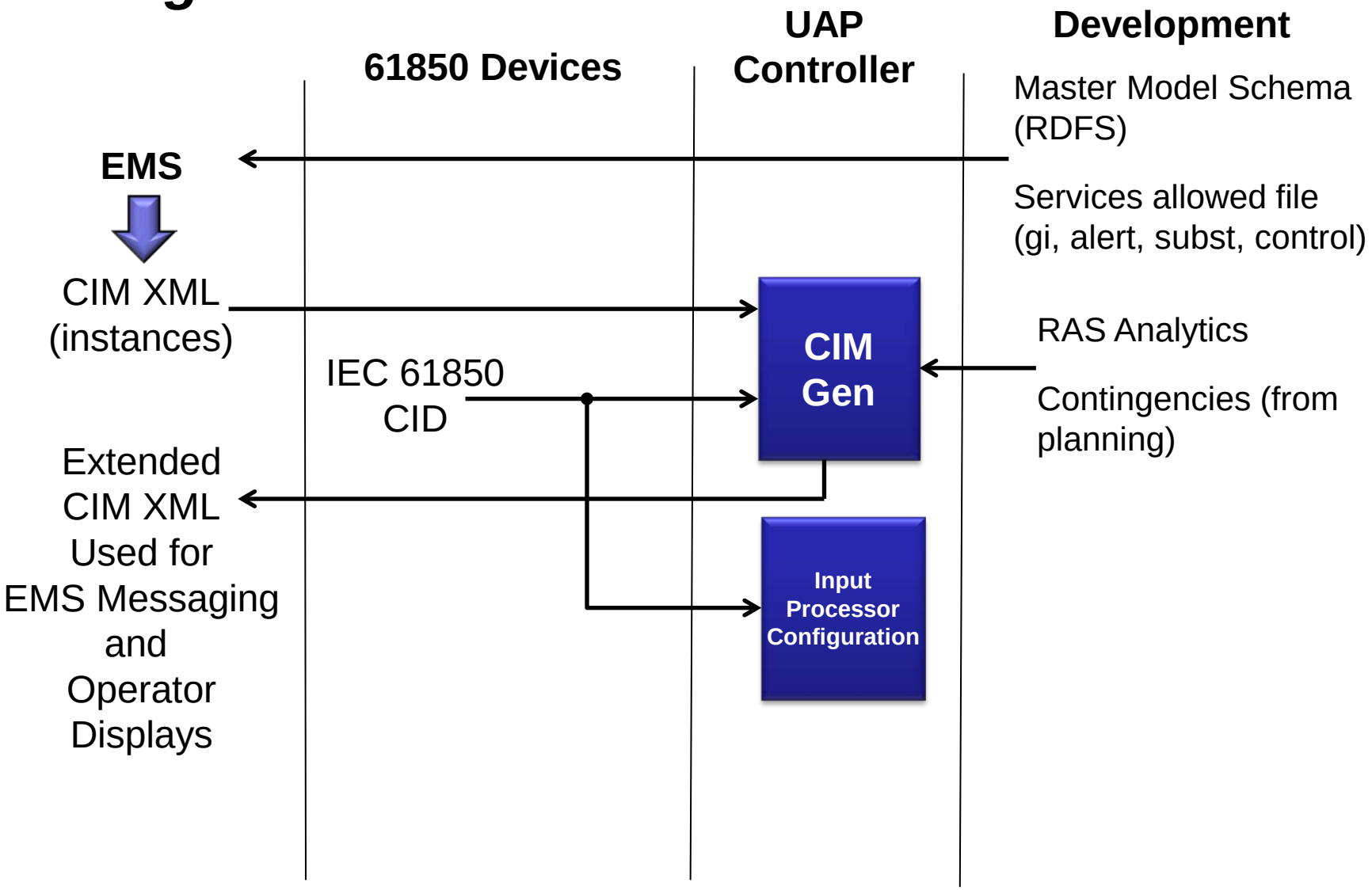
IED are Virtualized and Composited



RAS and Contingencies



Configuration Flow



Web Service Messaging

- Commands from EMS use web service messages containing CIM based data references that enable mapping of data to power system models:
  - Control
    - Enable/Disable (RAS and Contingency)
  - Overrides
    - Uses IEC 61850 Substitution Model
      - Allows overrides to be easily removed
  - Writes
    - Used to set configuration and some attribute values
  - Alert
    - Typically turned into alarms in EMS
  - General Interrogation
    - Updates client to current state information
  - Read

Summary

- Data Modeling critical to helping manage the complexity of system configuration
- CIM and IEC 61850 models offer off-the-shelf basis to build the system model and they are available from EMS
- Extensions to CIM for RAS and IED modeling relate to AC line segments and MeasurementValueSource in CIM
- RAS use IEC 61850 CID files for configuring GOOSE and naming
- Processes being implemented to automate configuration tasks albeit not soon enough

Why Use CIM?

- CIM was supported and off-the-shelf in EMS
- Extension process leverages the existing CIM model while enabling unique and special requirements to be addressed.
- CIM will be an effective tool for creating solutions that meet unique requirements where data needs to be associated to power system resources is required:
  - Data modeling for subsystem configuration
  - Non-disruptive messaging for existing systems requiring integration with C-RAS

Thank you

Questions?

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