CIM University
Review of IEC 61970-456
SSH

5 June 2018

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Project Consultants, LLC

Overview

- IEC 61970-456
- Use Cases
- CIM Canonical Model and Profile
- Bus-branch & Node breaker topology
- UML of all SSH data

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CIM Profiles Overview

- Data with slow change rate
  - Equipment — IEC 61970-452 / CGMES EQ
  - Diagram layout — IEC 61970-453 / CGMES DL
  - Dynamics data — IEC 61970-457 / CGMES DY
  - Geographical location — CGMES GL
  - CGMES Extensions — IEC 61970-600 / CGMES
- Data with medium change rate
  - Topology and Switch statuses — IEC 61970-456 / CGMES TP
- Data with high change rate
  - Steady State Hypothesis — IEC 61970-456 / CGMES SSH
  - Power flow solved state variables — IEC 61970-456 / CGMES SV
- Serialization format, CIMXML — IEC 61970-552

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IEC 61970-456 Editions

- Ed1 based on CIM14
  - Topology (TP) and State Variables (SV)
- Ed1Am1 based on CIM15
  - Small but important documentation changes
- Ed2 based on CIM16
  - SSH added
    - Equipment injections
    - Regulation targets (voltage, flow…) and control settings
    - Limit values
- All profiles
  - HVDC

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Why Steady State Hypothesis

- Initially Topology and State Variables used both for
  - Output
  - Input
- Didn't work, Power Flow solutions drifted
  - Need to remember starting conditions and target values
- Steady State Hypothesis solved this and..
  - It only depends on EQ so it works with
    - Bus-branch models
    - Node-breaker models

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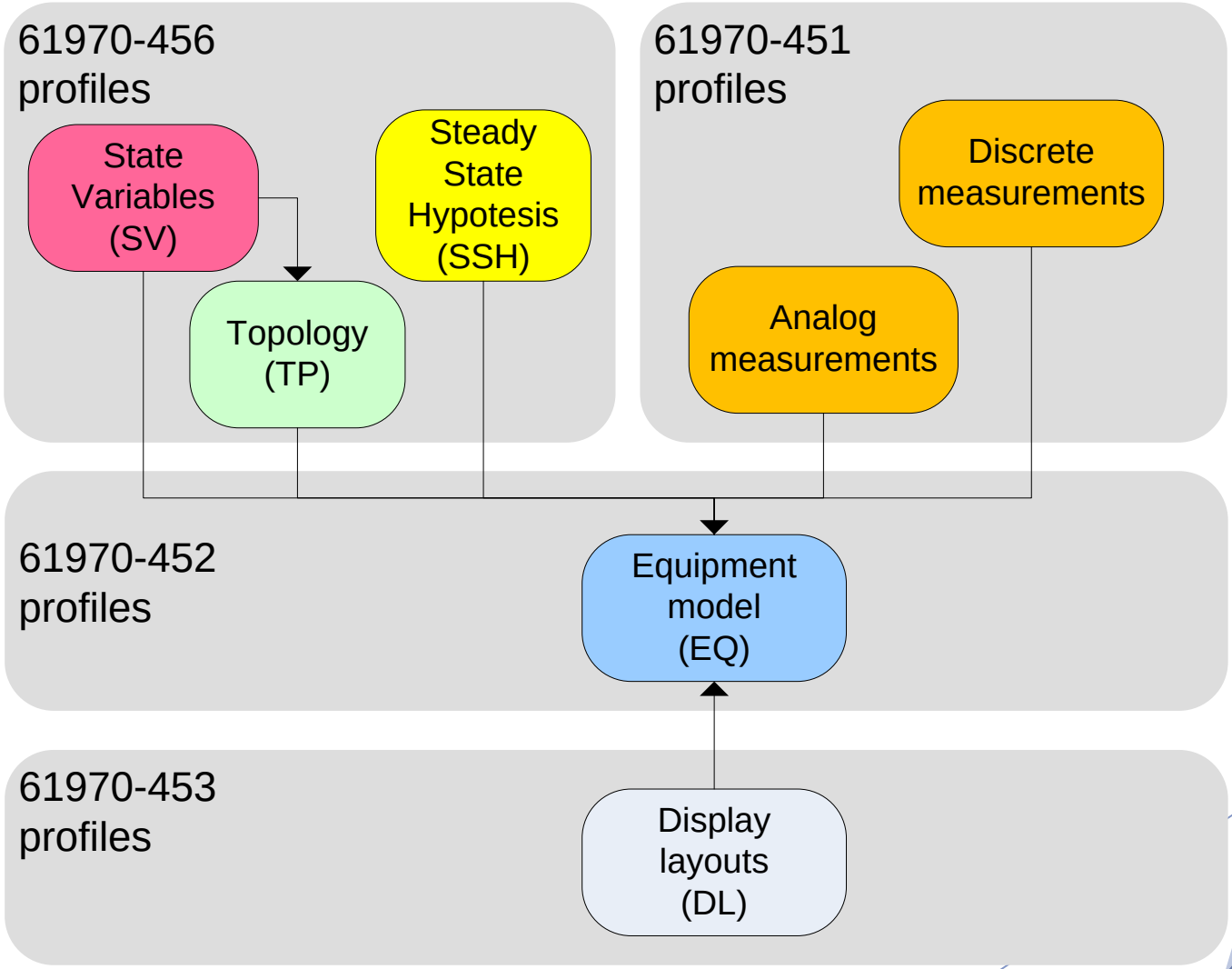
CIM Profile Dependency Relationships



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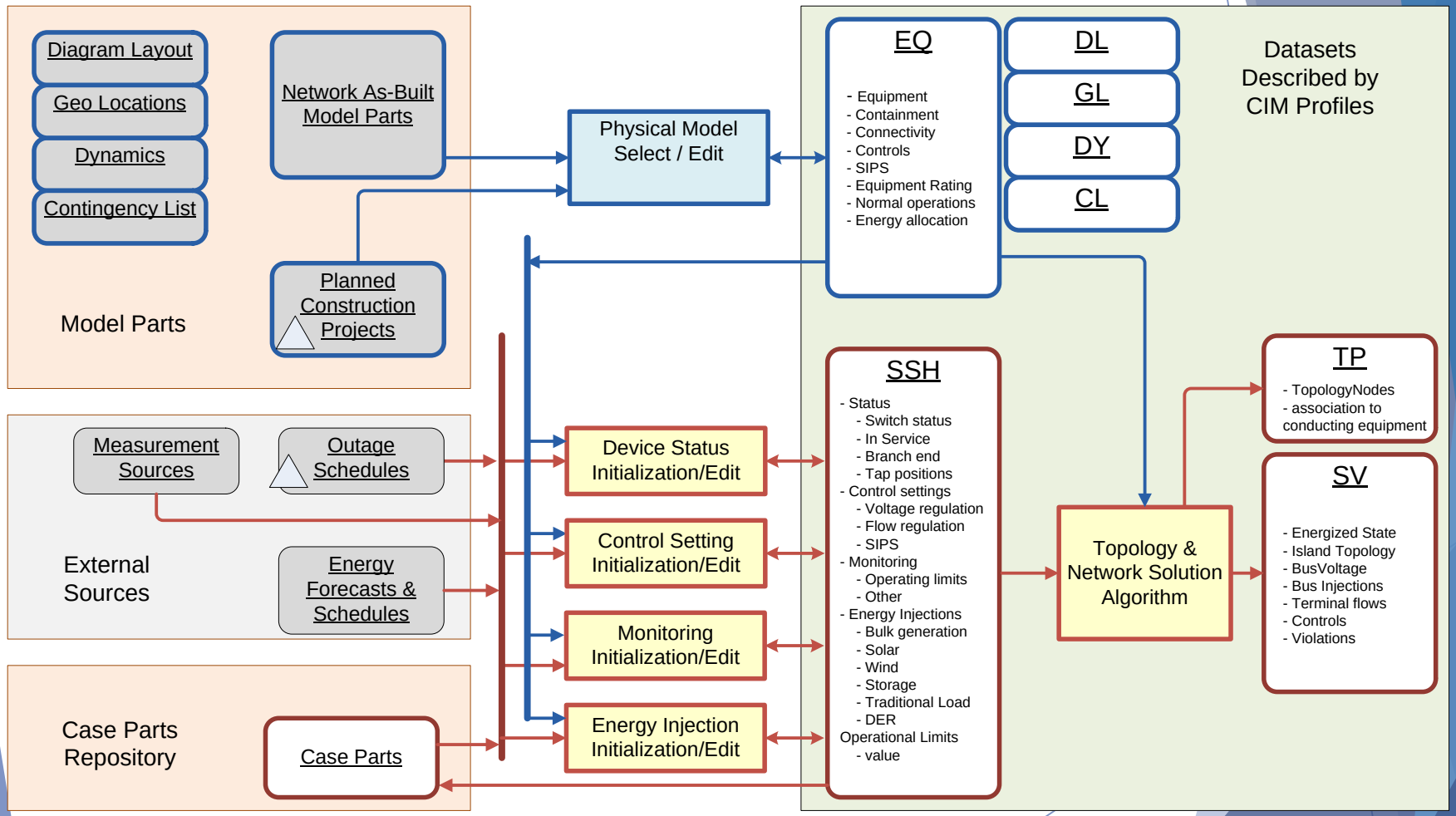
Power Flow Inputs



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Creation of IEC 61970-456 Data

- IEC 61970-456 describes one point in time
- Schedule and forecast time steps become 456 data
- Mapping schedule and forecast entities to injections
  - Area load forecast to load points (e.g. EnergyConsumer)
  - Area production schedules to unit injections
  - Renewable production
    - Forecasted if not in a market
    - Scheduled if part in a market
    - May result in back feed if resource behind a load point

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Two Levels of Detail in Modeling

- Bus-branch has
  - Powerflow buses (cim:TopologicalNode)
  - Impedance branches and shunts
  - Retained switches possible
- Node-breaker has
  - Nodes (cim:ConnectivityNode)
  - Switches (including non-retained) (cim:Switch and specializations)
  - Bus name markers (could be partially specified with Bus-branch model)
  - Schedule Data
- Steady State Hypothesis works with both!
  - So do Measurements (if not on non-retained switch terminals)

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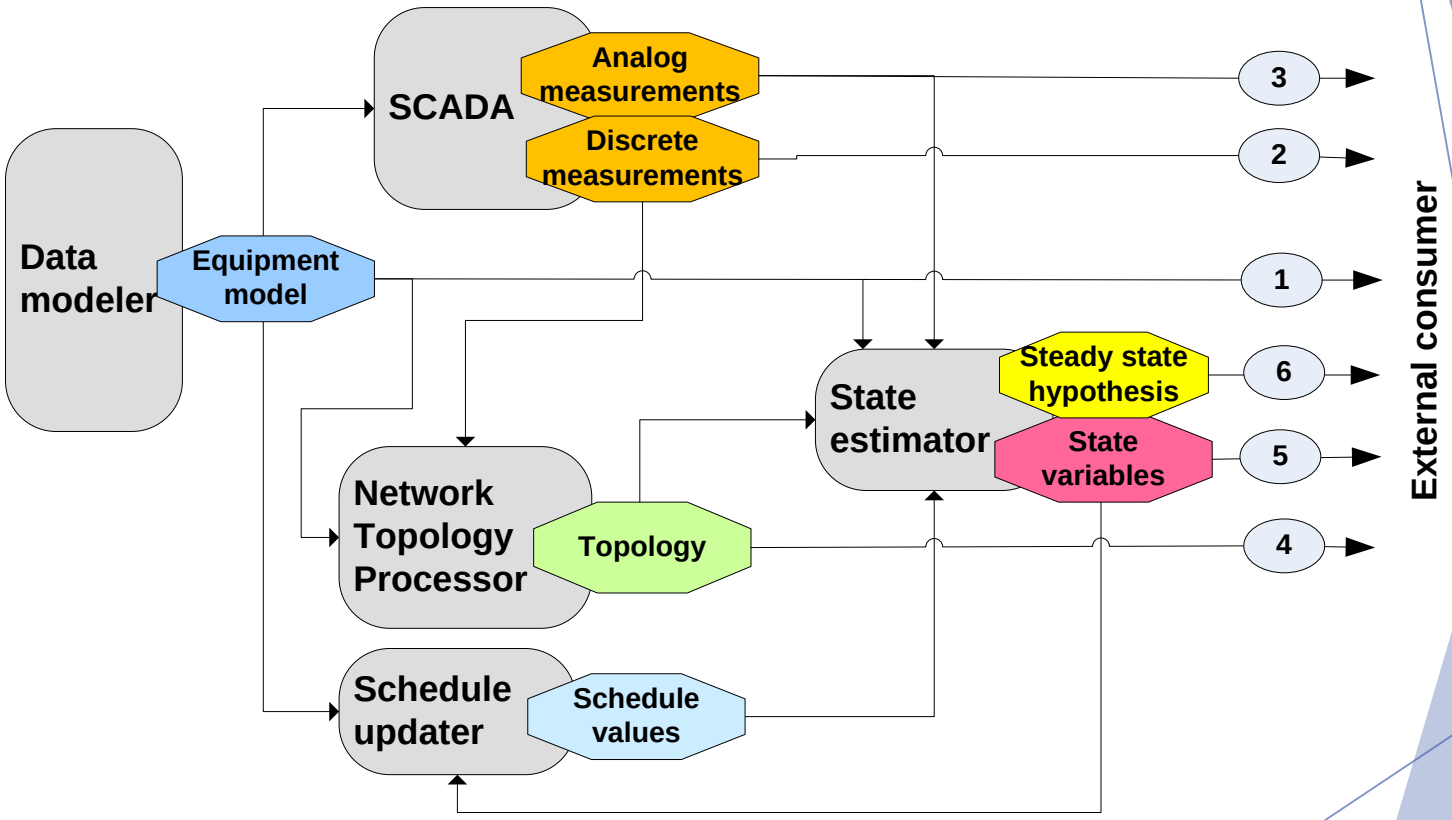
Node-breaker State Estimator Use Case



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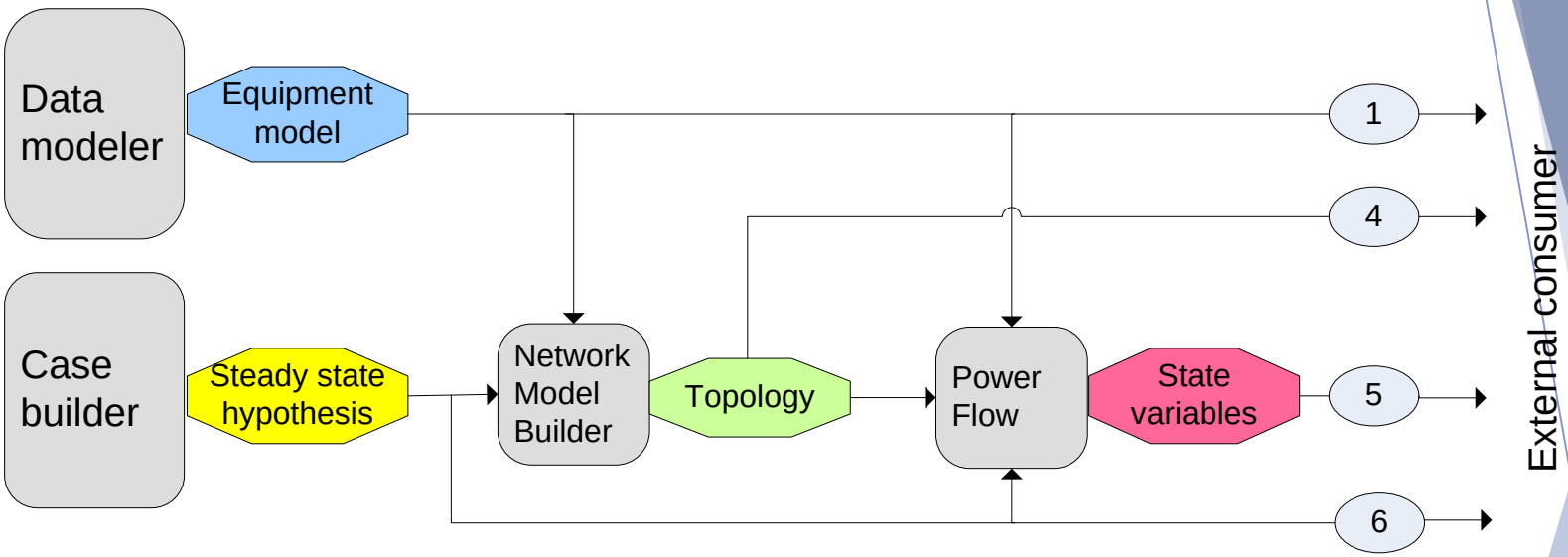
Node-Breaker Power Flow Use Case



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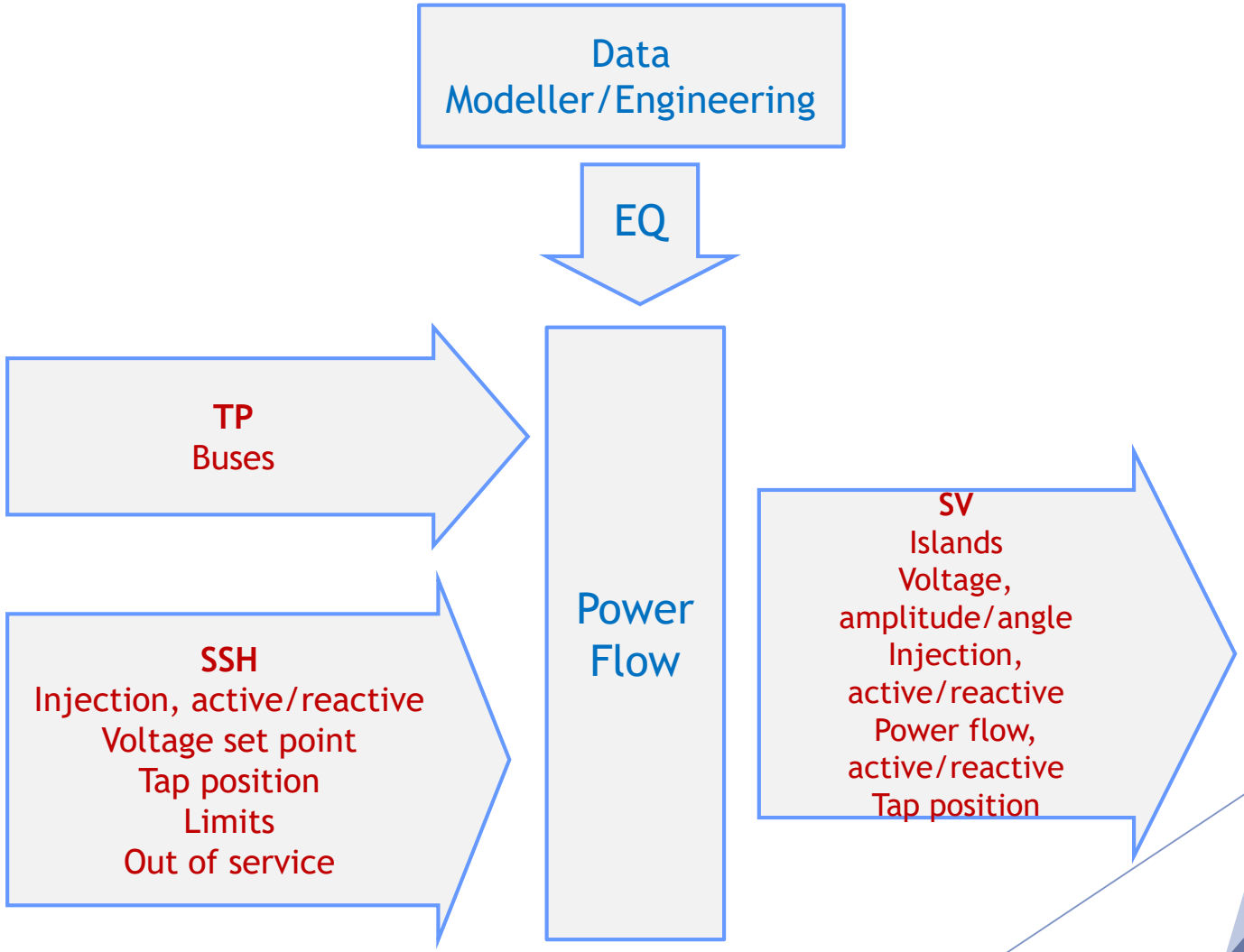
Node-Breaker Power Flow Use Case



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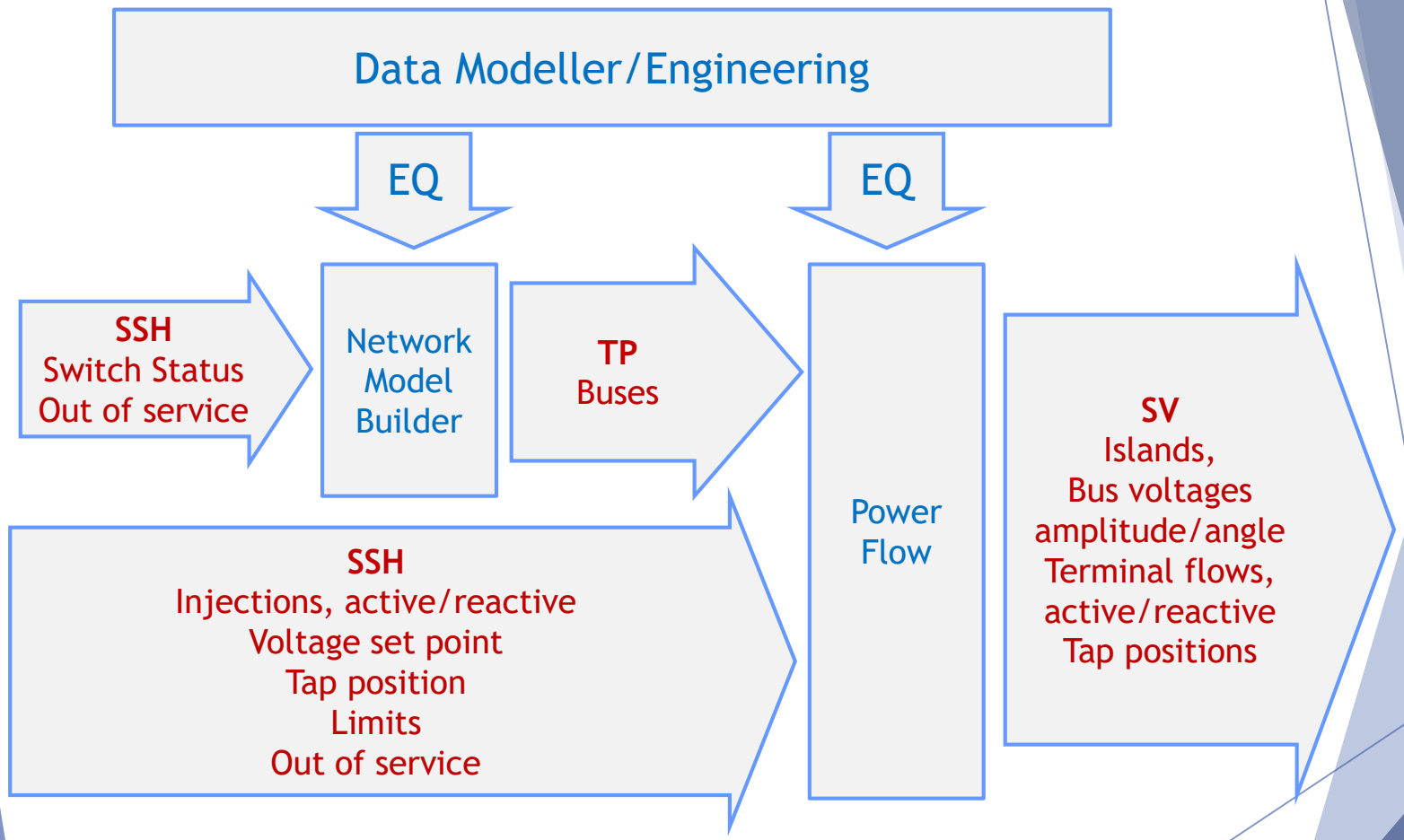
Node-Breaker Power Flow Inputs and Outputs



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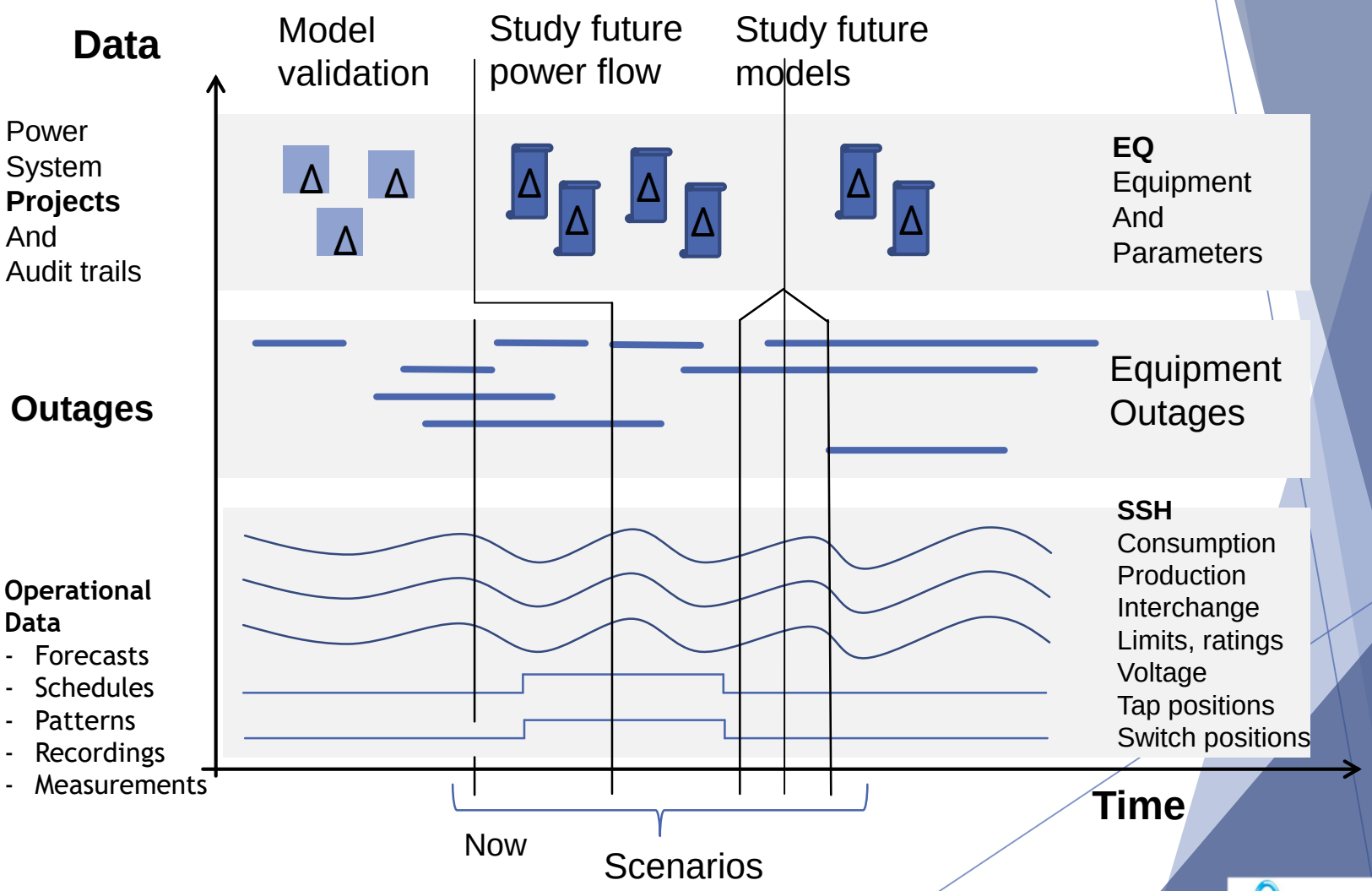
Case Building



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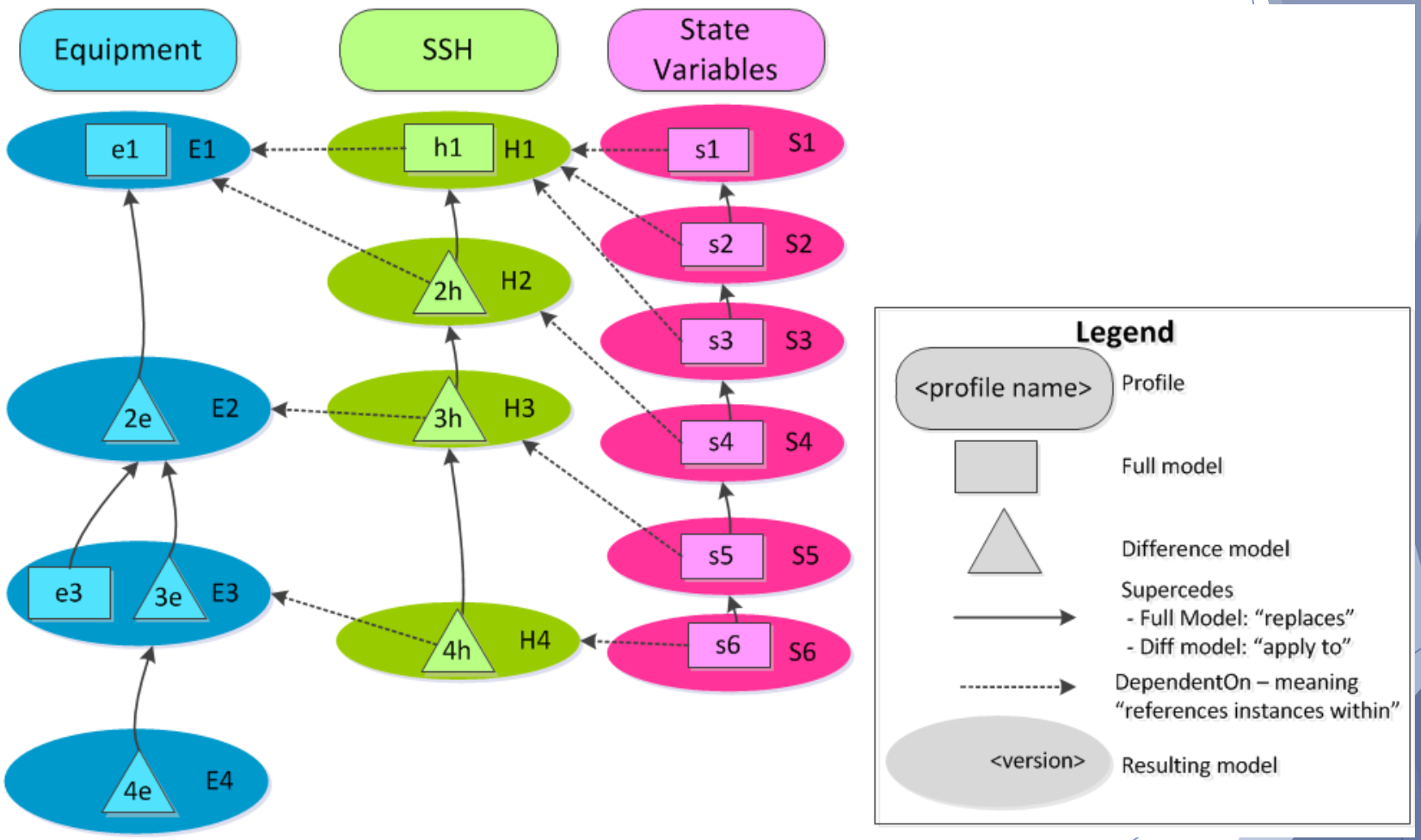
Model Part Headers



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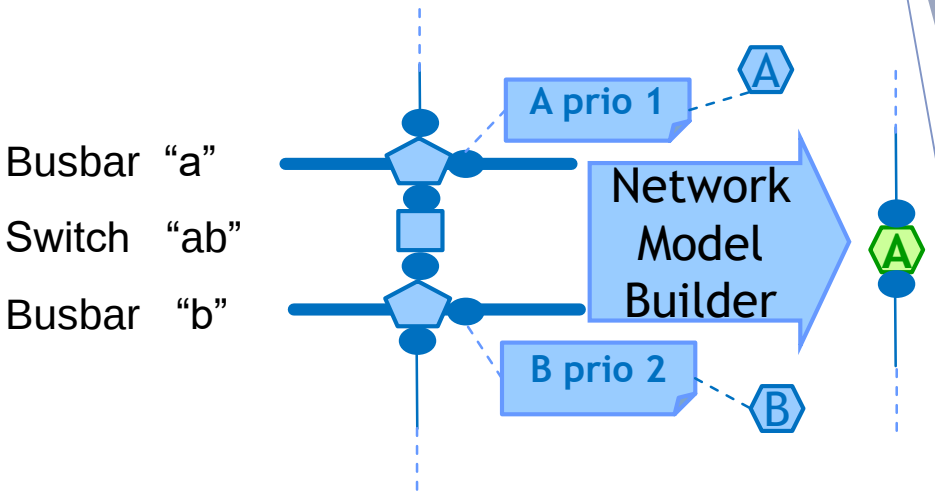
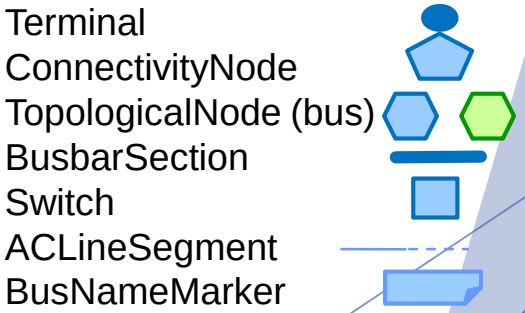
SSH Bus Split Example



Switch "ab" is a bus coupler or tie switch cases

- "ab" closed
  - busbars "a" and "b" one bus "A"
- "ab" open,
  - Busbar "a" forms bus "A"
  - Busbar "b" forms bus "B"



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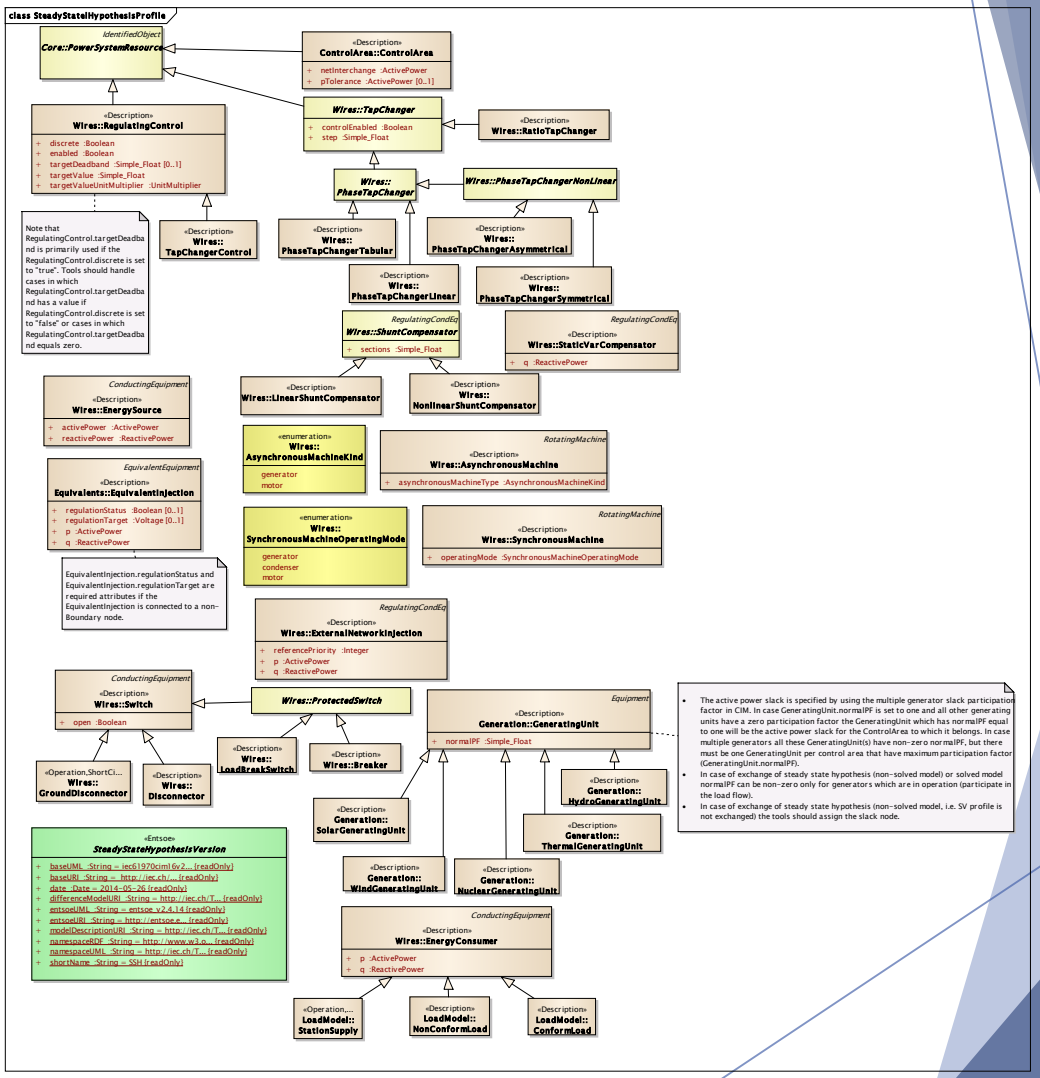
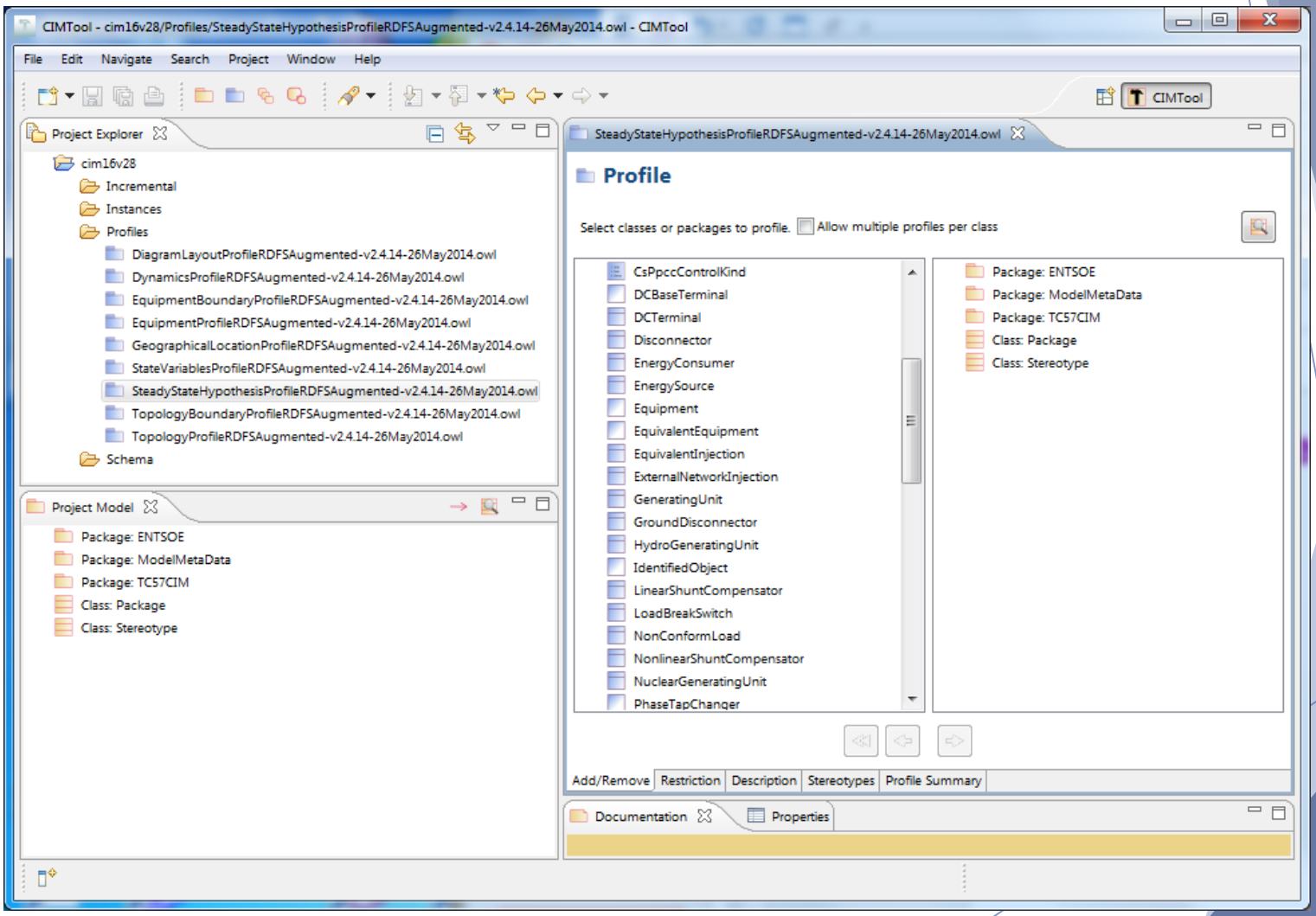
Steady State Hypothesis Profile in UML

1) SSH attributes on existing equipment

2) No new SSH classes (different from SV)



Steady State Hypothesis Profile in CIMTool



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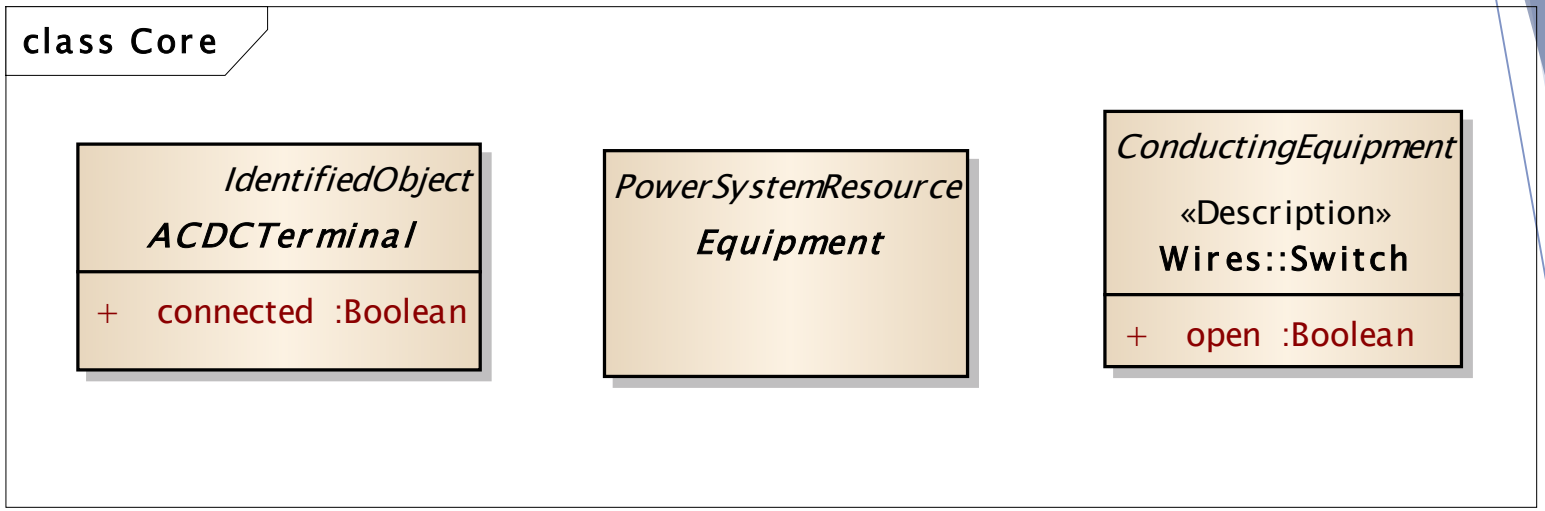
SSH Profile - Topology detail in UML



- ENTSO-E added inService.Equipment attribute
- IEC 61970-456 does not contain inService.Equipment attribute yet

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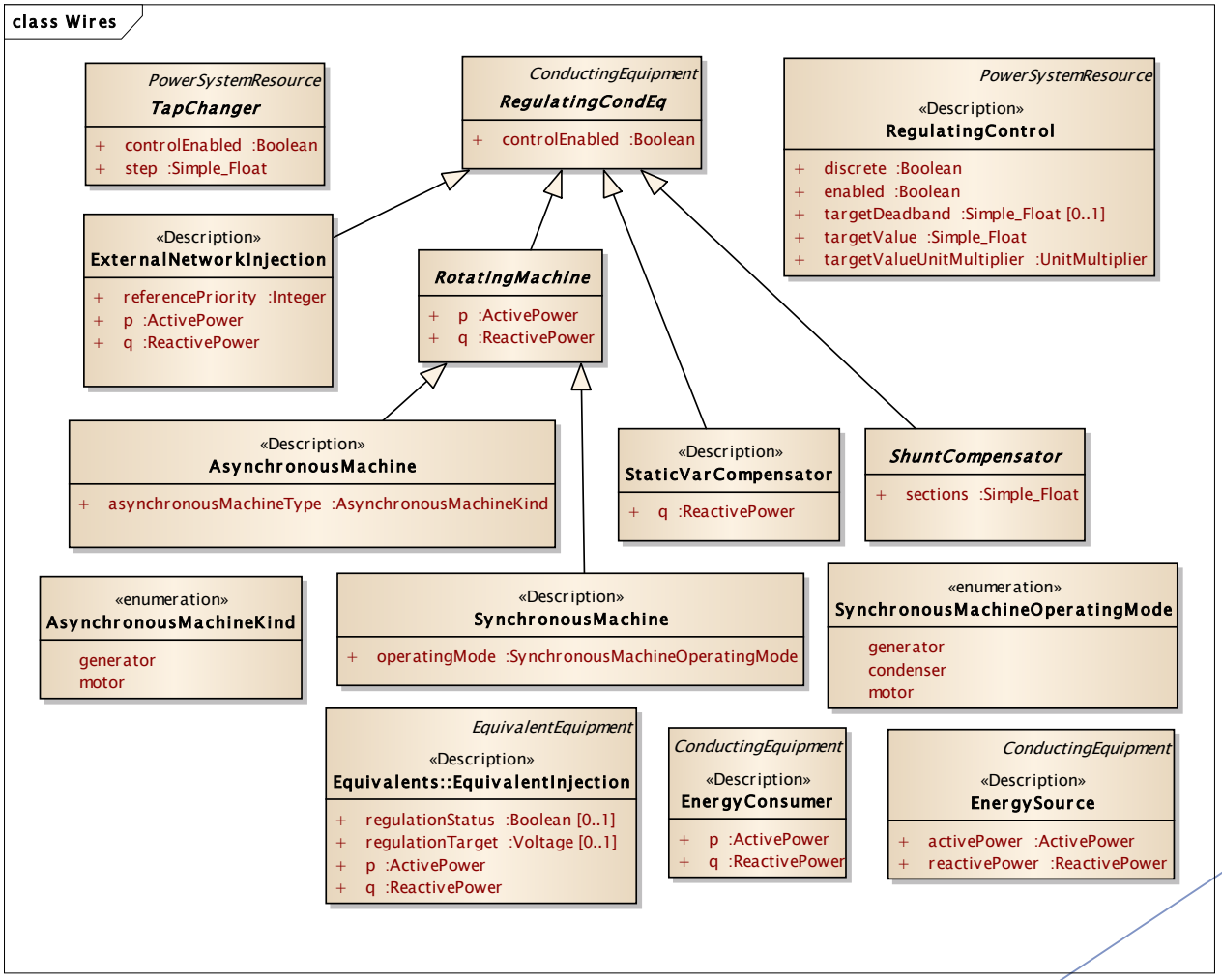
SSH Profile – Injections, Voltages, and Controls



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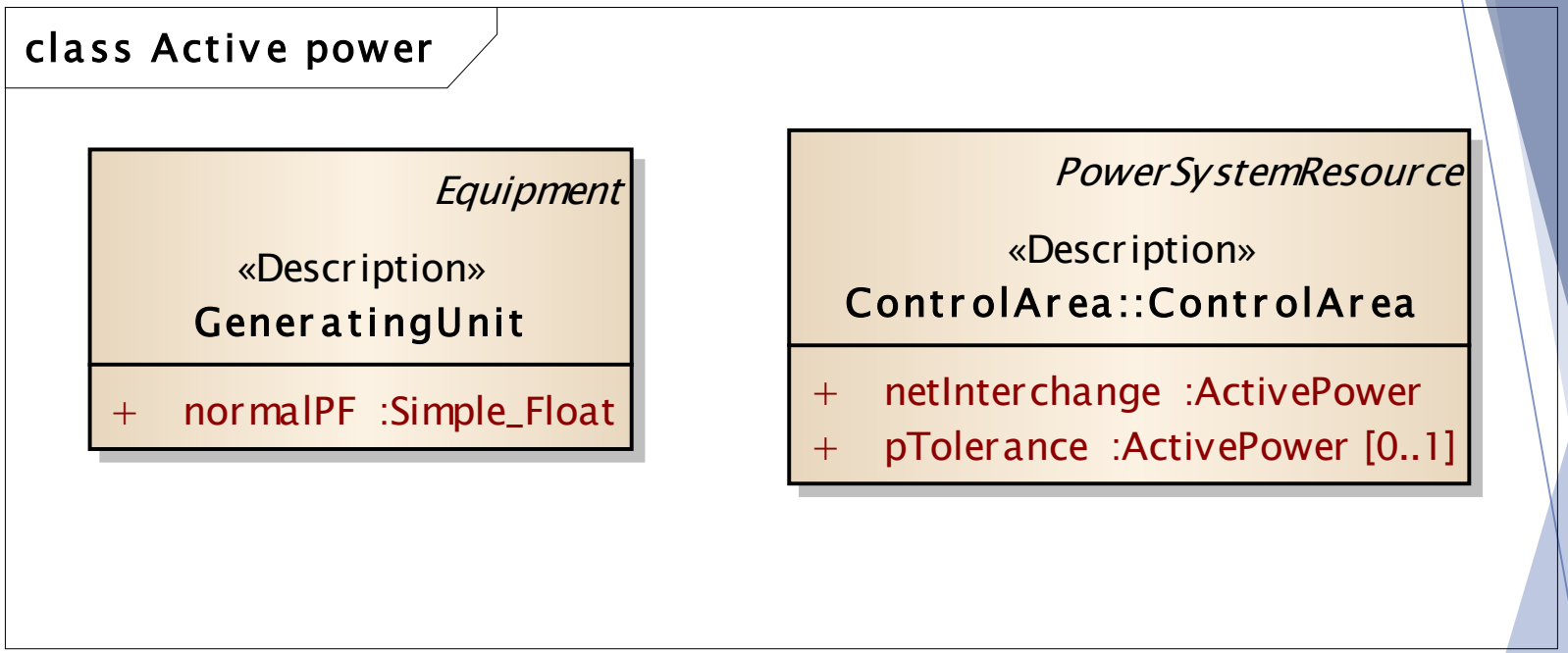
SSH Profile – Active power slack distribution



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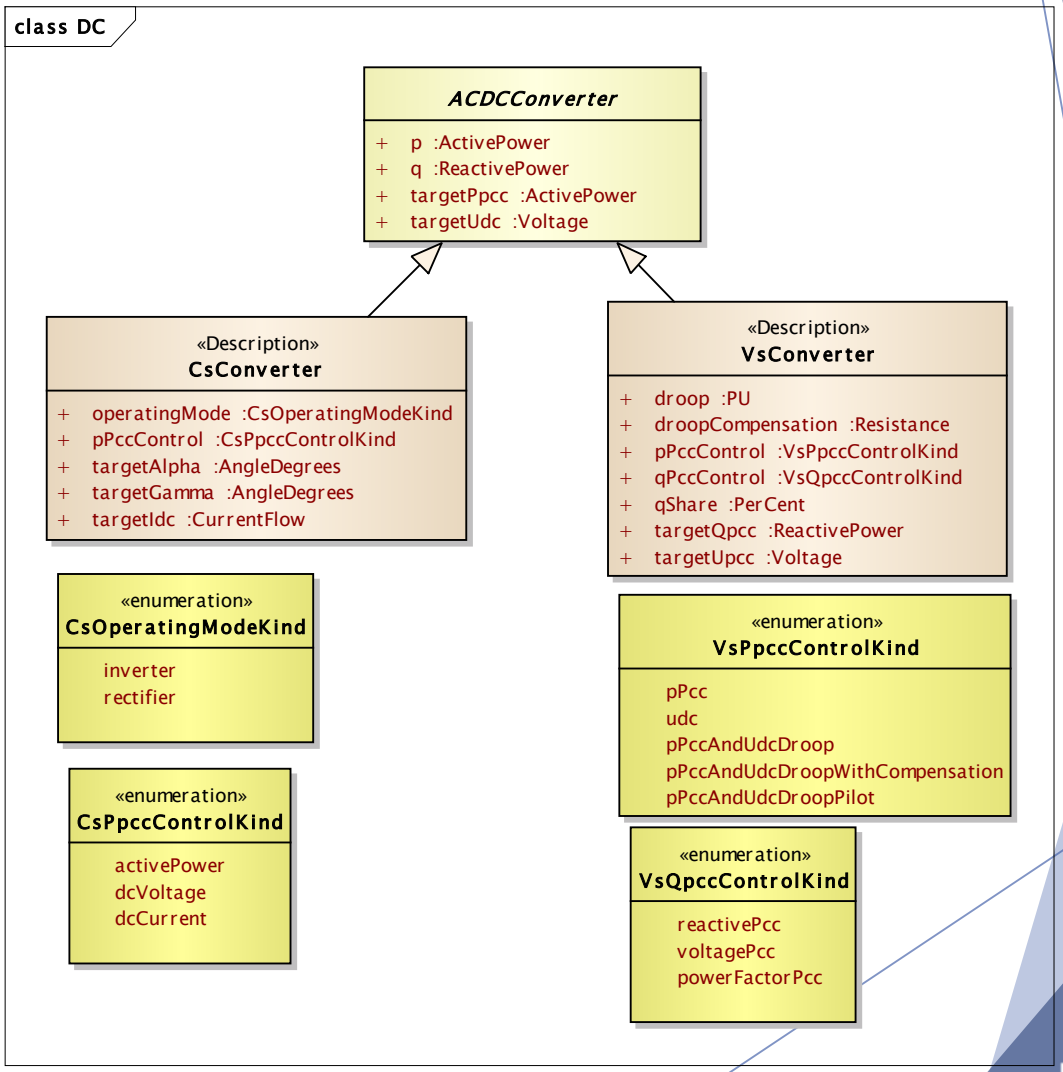
SSH Profile – DC

Two levels of detail:

1) Power flow injection model

2) Detailed converter



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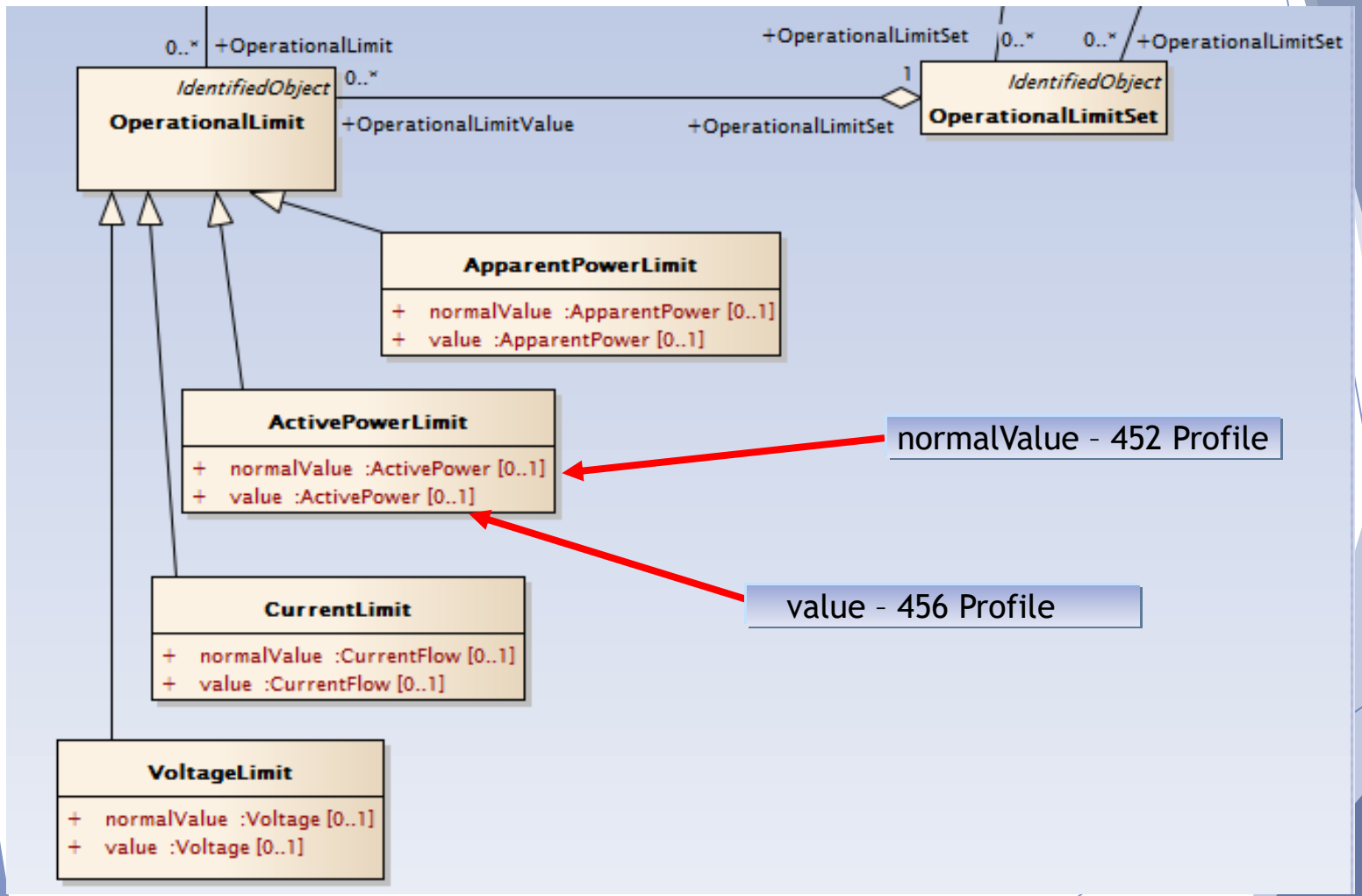
SSH Profile – Operational Limits



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Voltage/Reactive Power Control

- Field device responsiveness
  - Fast: Synchronous Machines, SVC …
  - Slow: Tap changers, switched devices …
- Control schemes
  - Slow devices on schedule
  - Move fast devices to optimal point using slow devices
  - Minimize excessive operation of slow devices
  - Balance reactive flow between parallel devices
- Power flow algorithms
- No CIM standard for control schemes
- Power flow programs differ -> solutions differs

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IEC 61970-456 Summary Points – Take Away

- Enables modularized case construction
  - Operational planning
- Long term and extension planning
- The UML model is stable
- But ENTSO-E conformity process showed different interpretation possible
- ENTSO-E and IEC standards converging on interpretation

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Thanks!

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