Detailed AC System Modelling in RTDS

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Outline

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- Network Reduction
- Results
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Introduction

- With the addition of HVDC and FACTS devices today's power systems is more complex
- The dynamic behaviour of these devices is dominated by the controls
- There is a need to study the interactions and behaviour between the devices and its impact on the ac system
- To perform such studies one must have:
  - Accurate system models
  - Accurate control models (Control replicas can be used here)

System Models

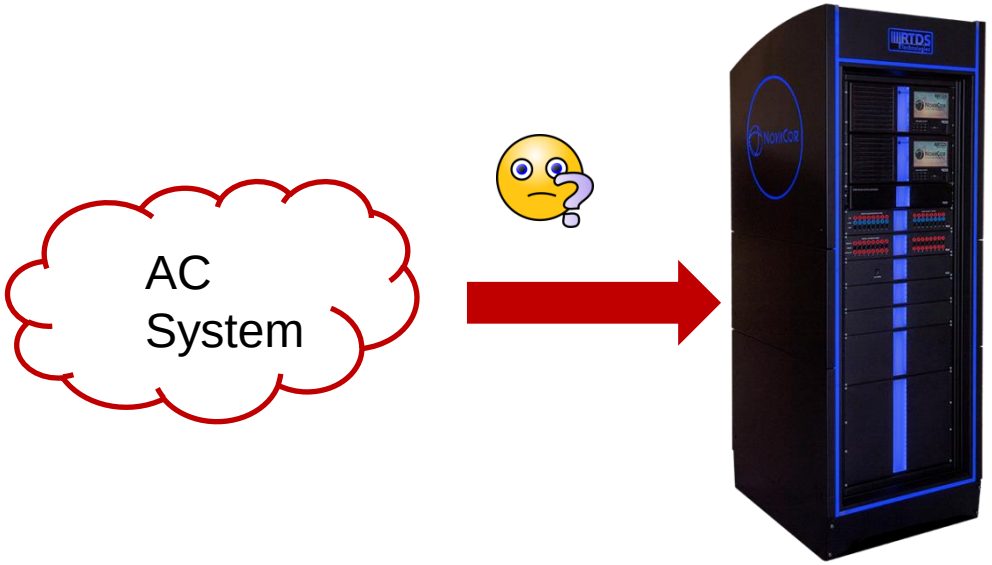
- Detailed AC system models in RTDS is used for
  - AC systems studies
  - Interaction studies
  - Operator training with replicas
  - Dynamic performance testing (DPT) of HVDC and FACTS devices

Integrated AC System Models

- Developing an RTDS model of a large power system
  - More than 6000 buses in the network
  - Number of buses needed to be reduced by about 90%
  - Around 30 HVDC FACTS terminals was needed to be modelled
  - The steady-state and dynamic responses at all the terminals needed to be matched with the full system

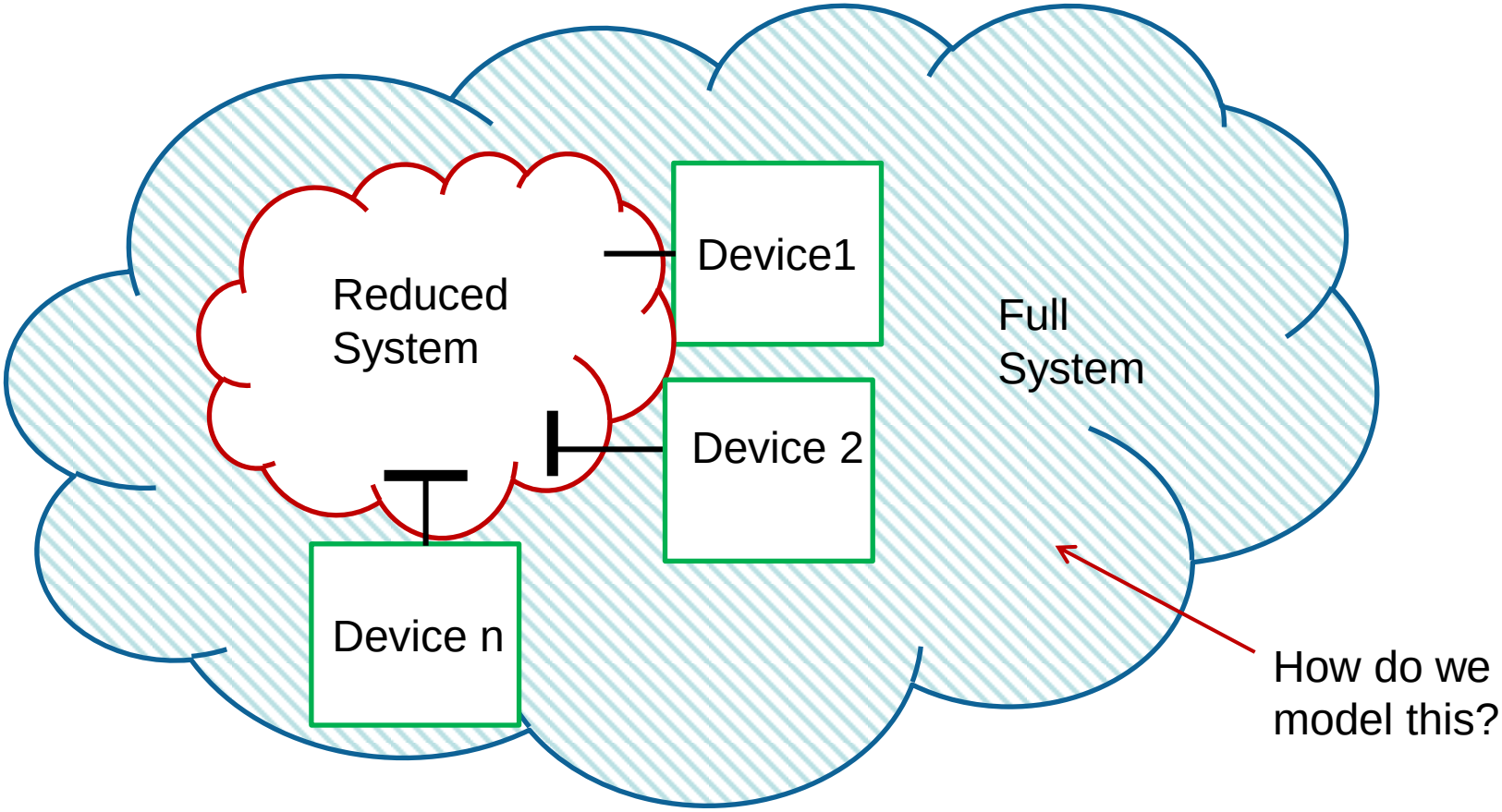
Challenge!

- Only a limited number of RTDS racks are available



- Able to fit
- Accuracy
- As detailed as possible

AC Network Reduction



AC Network Model

- Static equivalents
  - Good steady state performance
- Co-simulation
- Dynamic equivalents
  - Good steady state performance
  - Good dynamic performance at selected buses

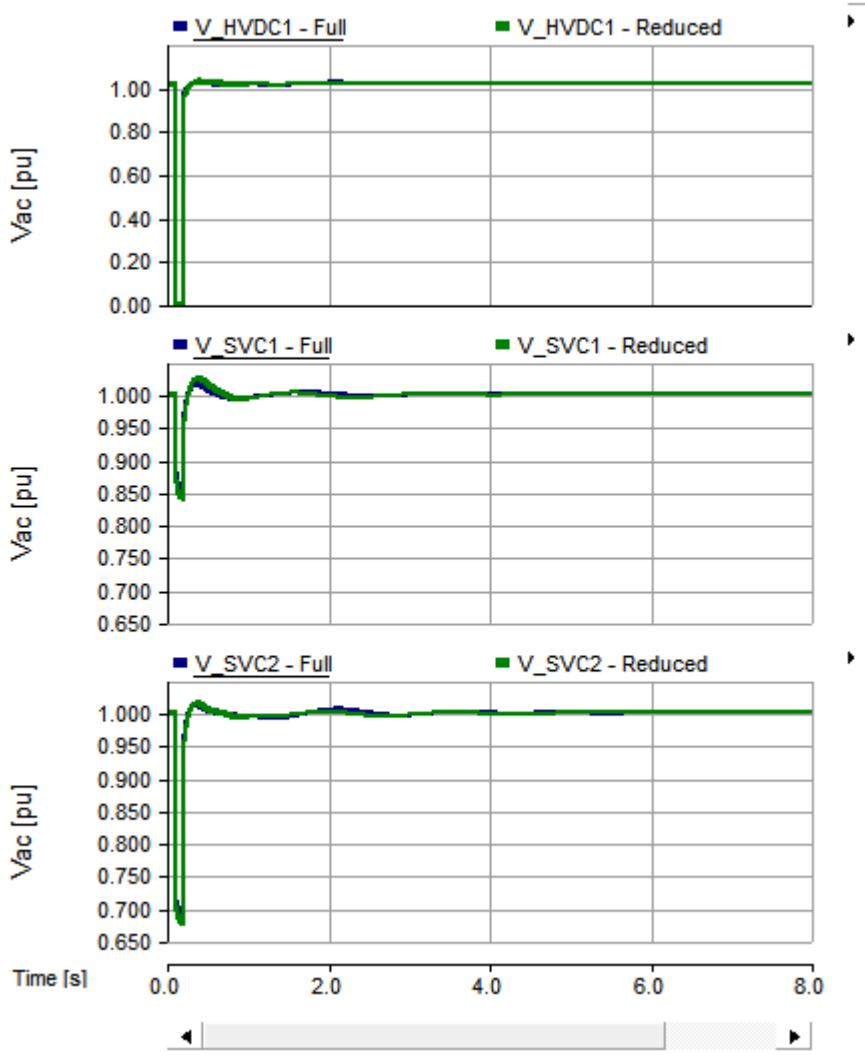
Network Reduction in PSS/E

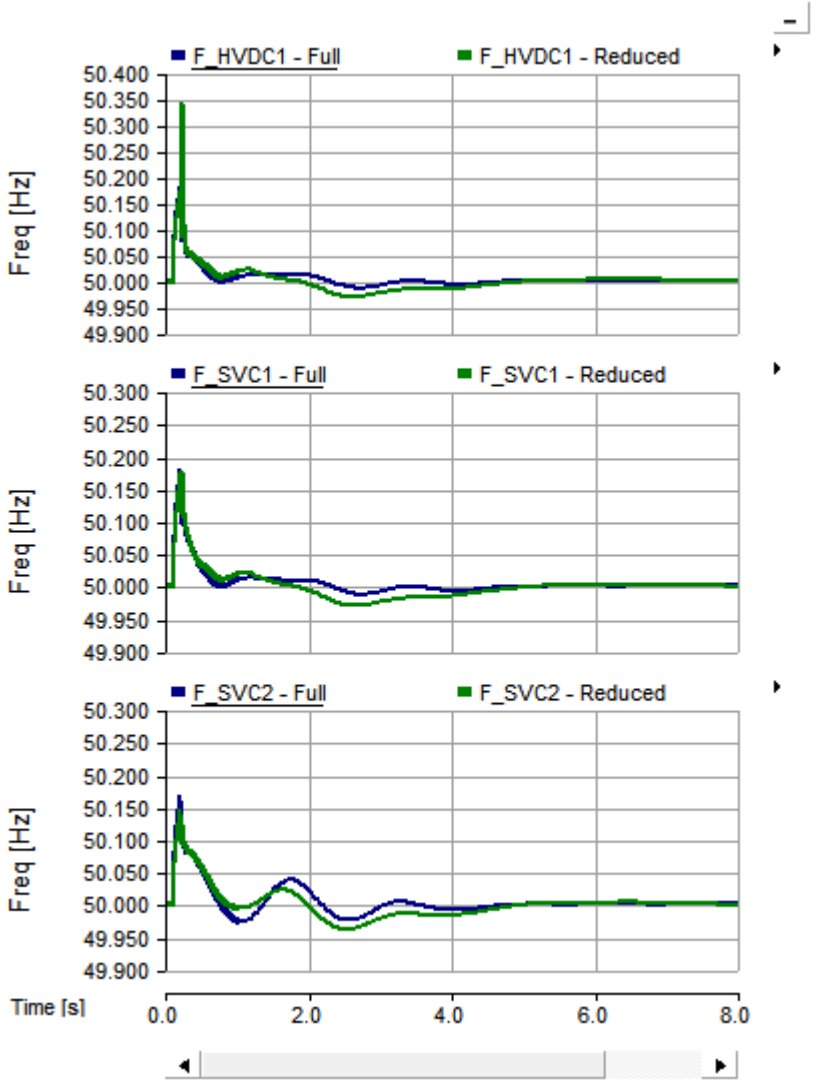
- The Full network model is given in PSS/E
- Step 1
  - Identify the area to be retained in detail
  - Aggregate multiple generators on the same plant to a single generator
  - Aggregate the coherent generators together
- Step 2:
  - Create a short-circuit equivalent of the area out side the area to be kept
  - Verify the power flow
- Step 3:
  - Dynamic response of the voltage and the frequency at the device connection point is matched with the full network
    - The parameters for the equivalent generators at the boundary busses will be tuned

Target Accuracy Levels

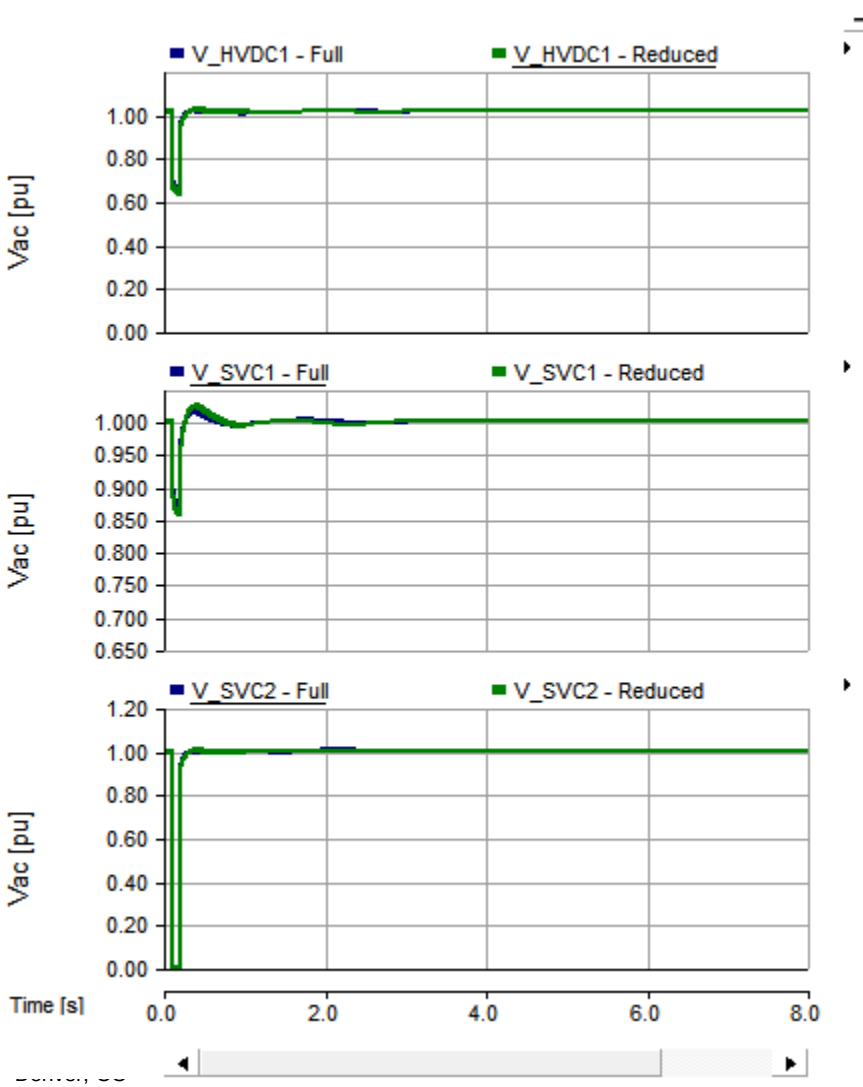
- Short-circuit level – <±5%
- Voltage magnitude - <±1%
- Voltage angle - $<\pm 1^{0}$
- Power flow
  - <±5% for flows below 100 MW/100 Mvar
  - <10 MW, Mvar for flows above 100 MW/100 Mvar

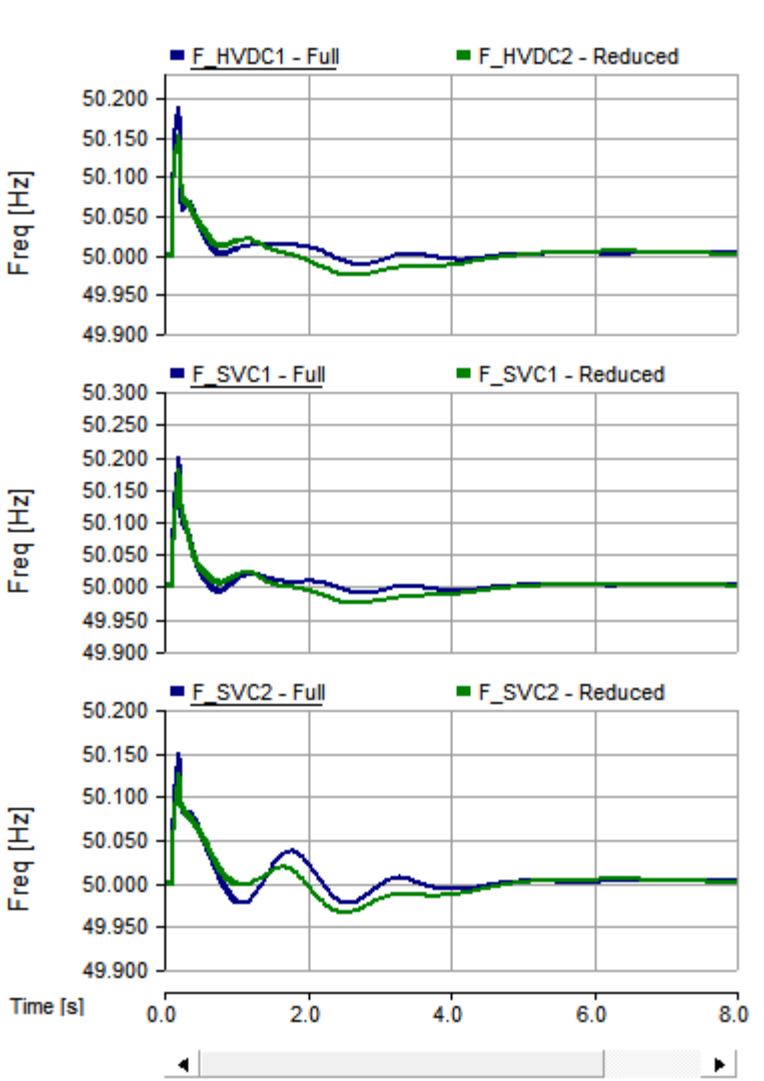
Response for Three-phase to Ground Fault at HVDC1 Terminal 1





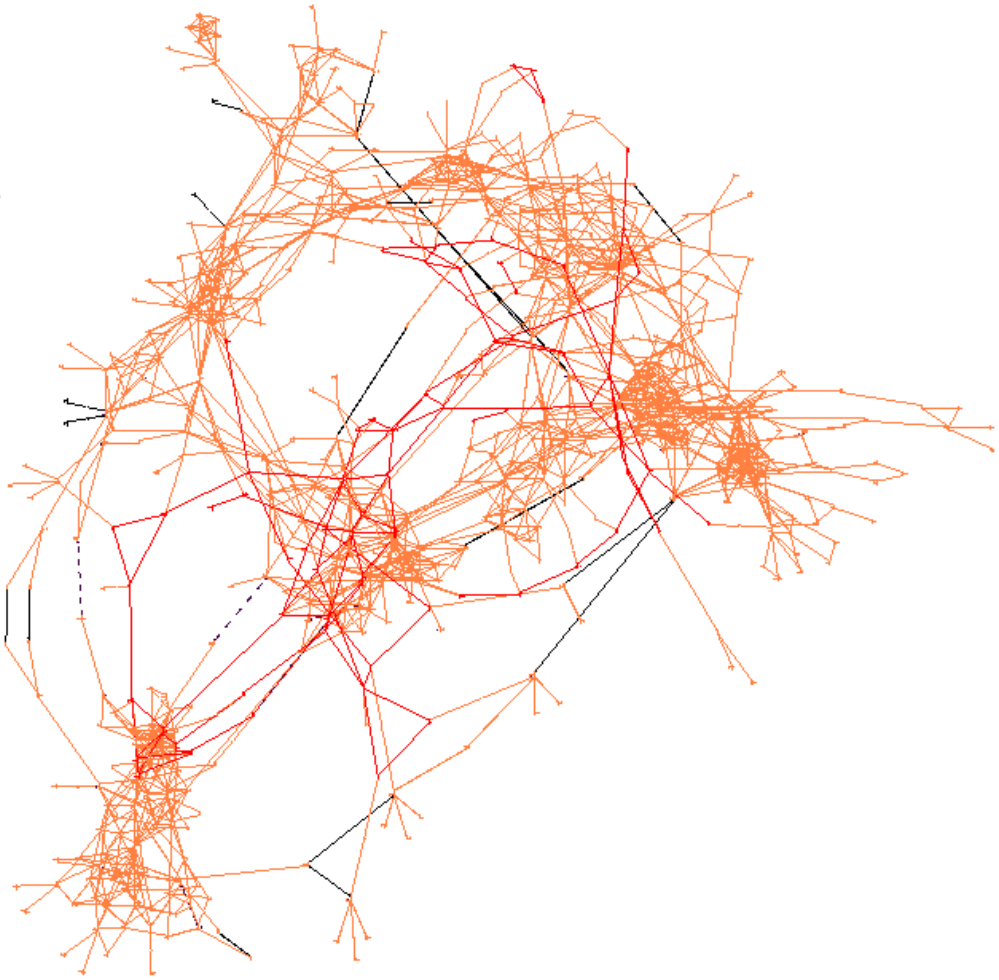
Response for Three-phase to Ground Fault at SVC 2 Terminal





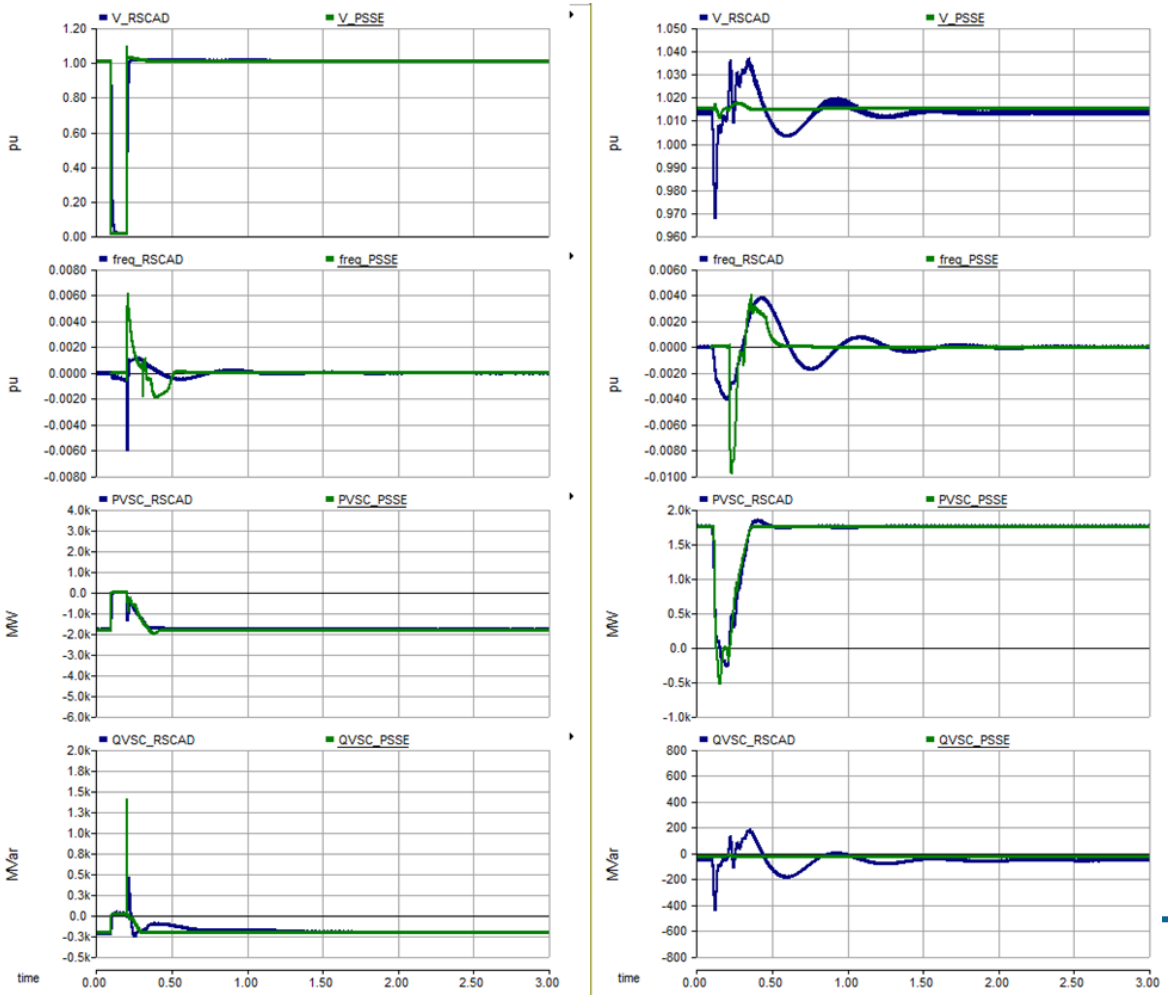
Challenges in Developing the RTDS Model

- Meshed AC network model
- Standard library models in PSSE
  - CDC4
- Collection of data additional data required for detailed RTDS models

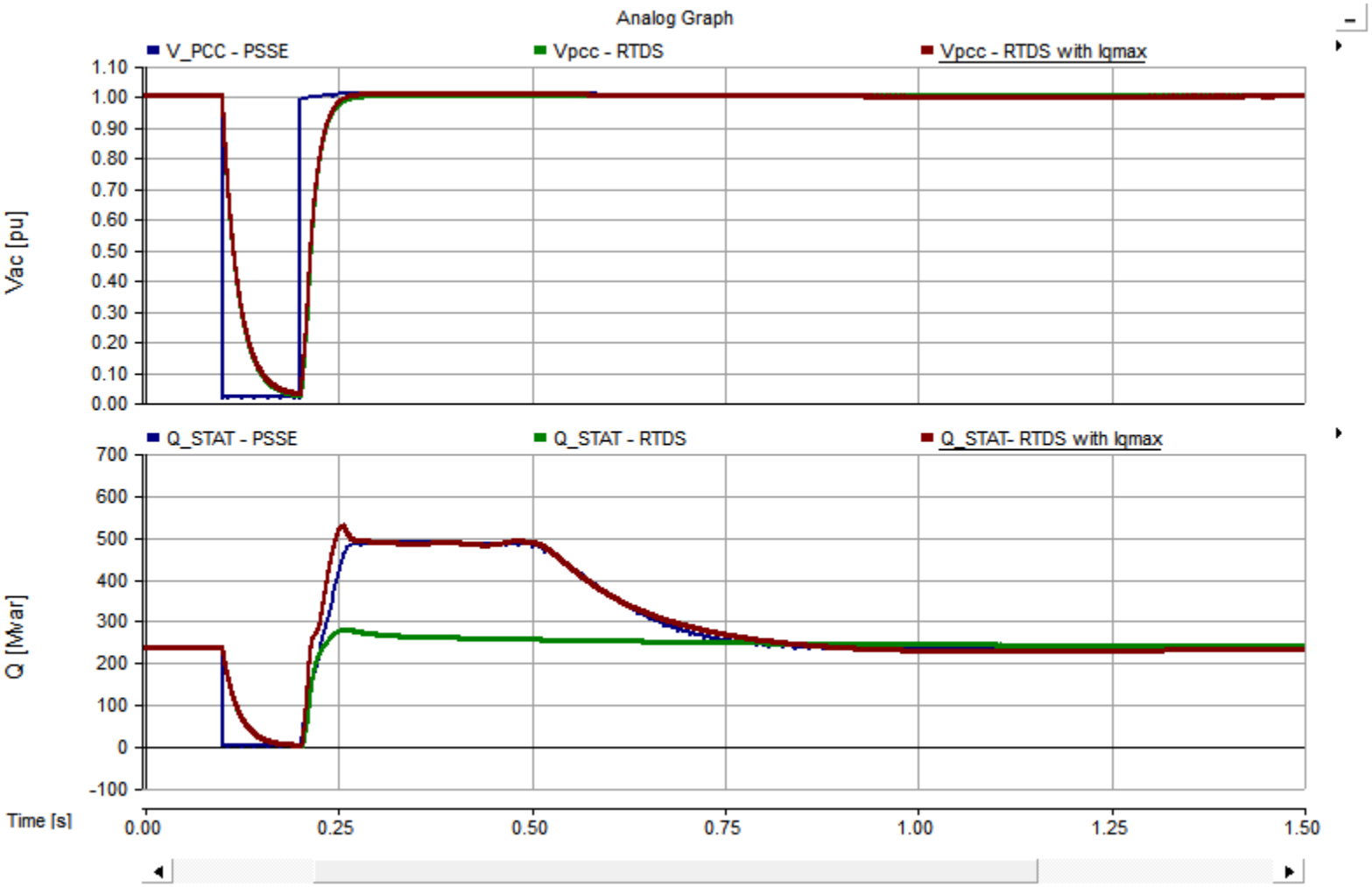


VSC-HVDC Model
Vendor specific PSSE Vs Generic RTDS

- 3ph-G Fault at Rectifier



STATCOM Model
Standard PSSE Vs Generic RTDS



Conclusion

- The need to model a large power system in RTDS is increasing because of the presence of non conventional devices
- It's a challenge to create a small AC system which can fit into the available RTDS
  - Need to match the steady-state performance
  - Need to match the dynamic response
- Dynamic equivalents can address both these requirements successfully
- A detailed AC network model of a large power system is currently being developed using this method

Thank you!

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