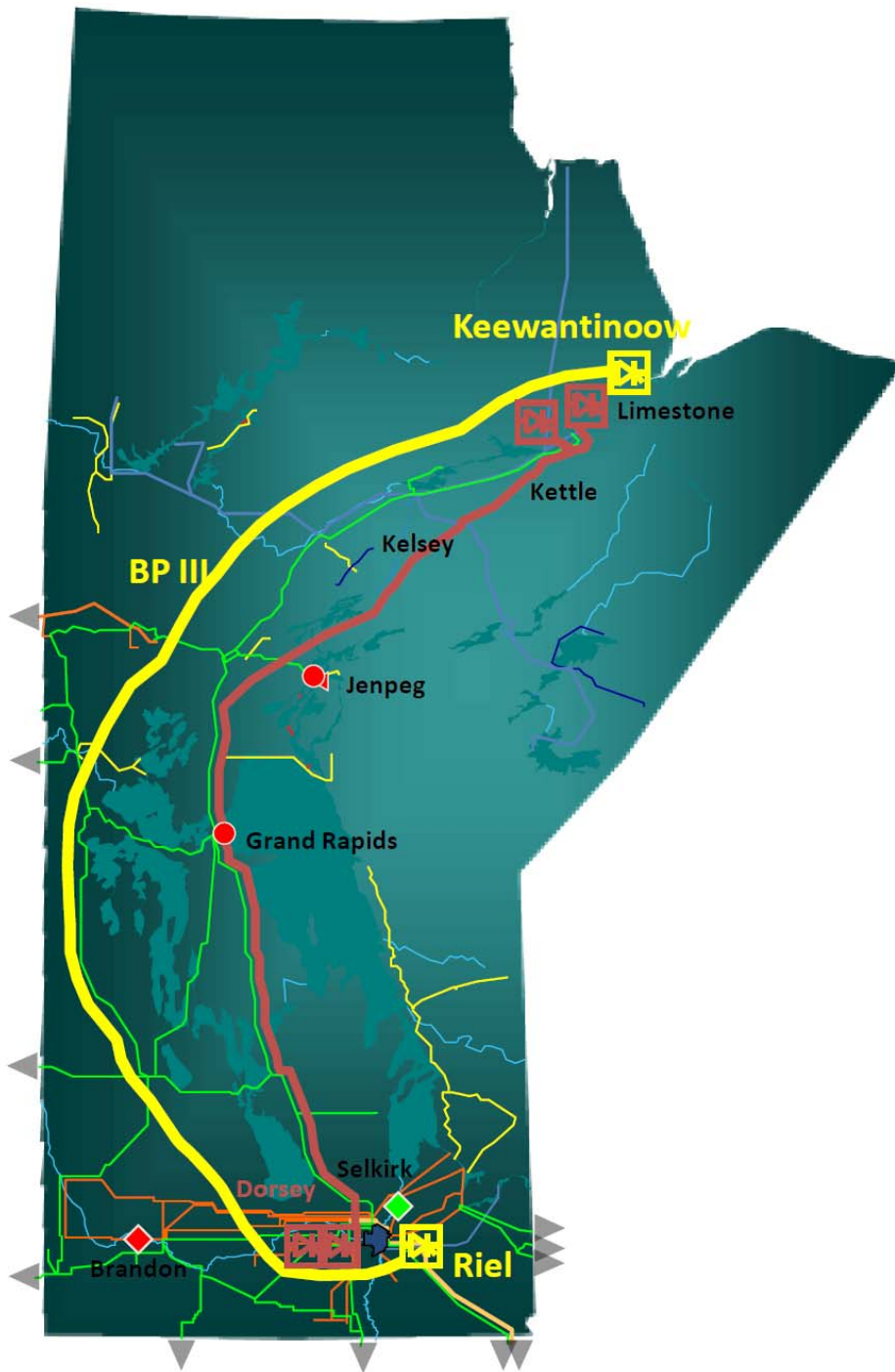




Manitoba Hydro Simulation Centre (MHSC) Development for Nelson River HVDC systems

Zhibo Wang
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MH's HVDC Systems

MH's transmission backbone: (70%+)

BPI&II: 890&930km, LCC HVDC

BPIII: 1,386km, LCC HVDC, ISD 2018

Generating Stations and Interconnections

2011/12 – Energy

80% Nelson R.

9% Wpg. R.

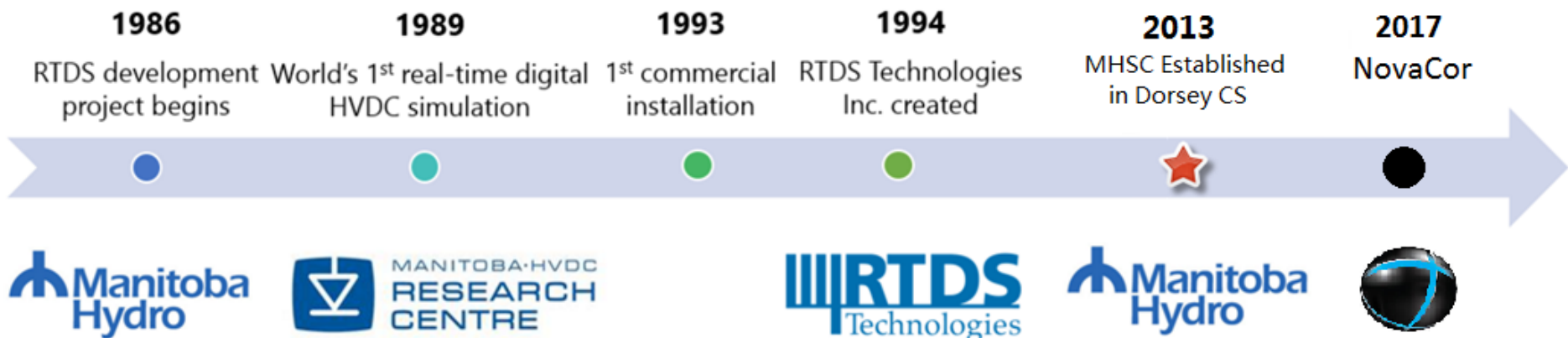
7% Sask. R.

3% Wind

1% Thermal & Imports

Manitoba Hydro Simulation Centre (MHSC) Using Real Time Digital Simulator (RTDS)

- RTDS, a trade mark for RTDS technologies Inc. in Manitoba.
- Started as a research project in Manitoba Hydro (MH) for HVDC and became a private company in 1994
- 1st RTDS cubicle purchased by MH in 1990's
- MHSC founded and developed in 2013
- 20 RTDS racks installed in MHSC, capable of modeling main MH PWR SYS.
- NovaCor advantages for MHSC.



Supporting new and existing systems

Installation

Facilitate BPIII installation and future refurbishments projects
Within the corporation, serving as the testing platform for HVDC controls, static exciter, protection, SAS, and other control systems

Operation

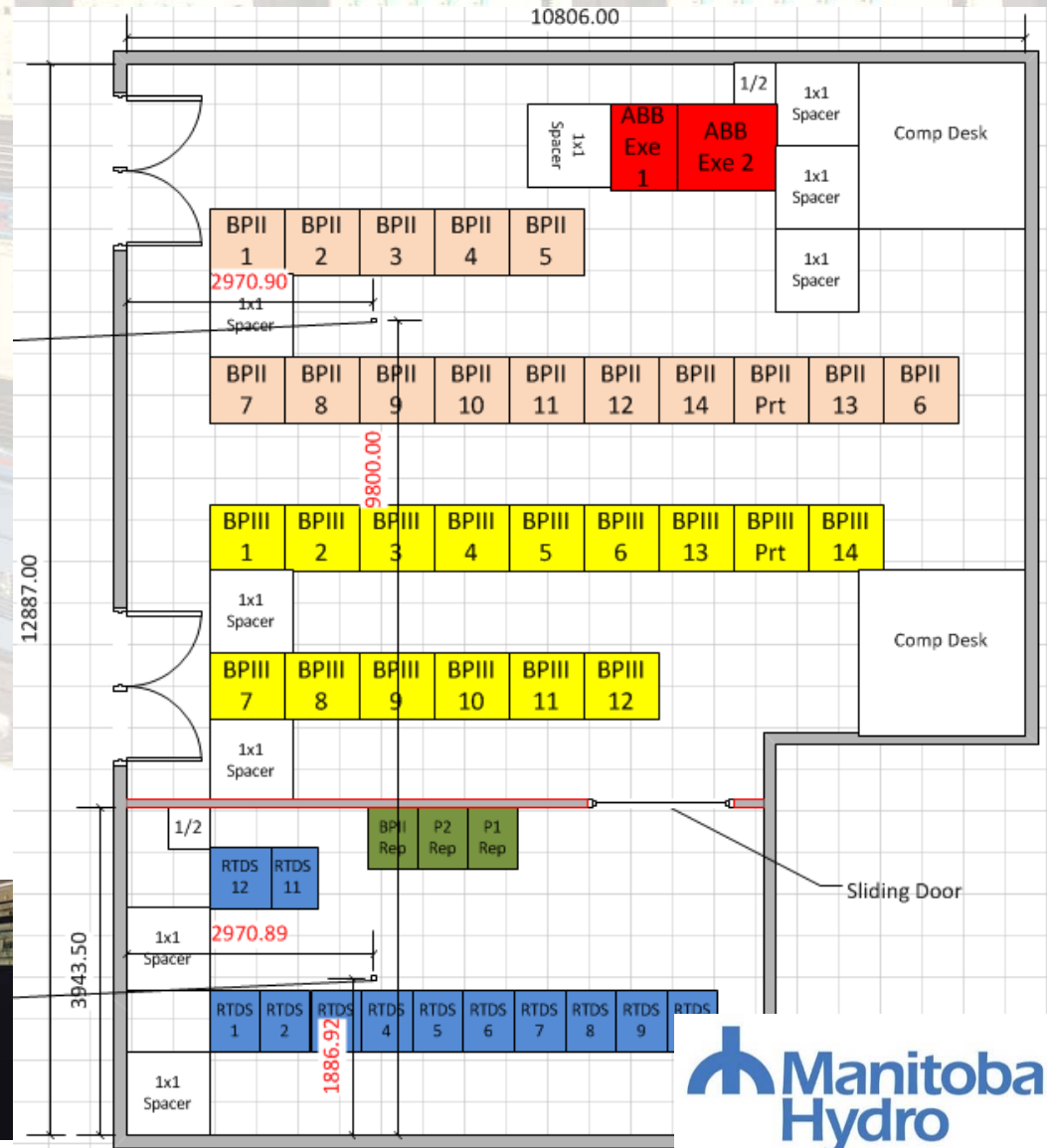
FAT, model validation, and special control studies
Actual control interfaced with RTDS to support day to day Op
Unique studies done such as : Exciter tuning, JVC/JLC design, POW Transformer Energization Studies and Generator Black Start close loop testing

Maintenance

On going system model benching mark and validation
for RTDS, PSCAD comparing to replica controls and system events

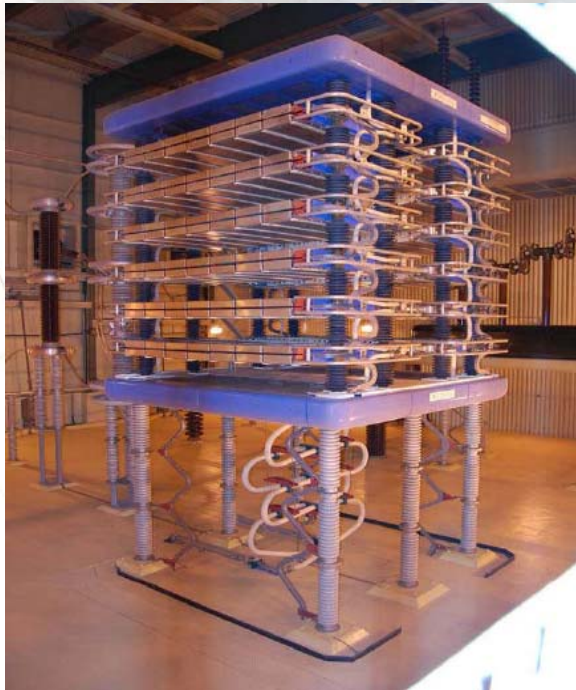
Real time simulators and control replica

- Main Manitoba Hydro Transmission system modeled in RTDS
- MHSC moves to Riel Converter Station near Winnipeg in 2018
- Contains: 20 RTDS racks, 1 Exciter replica and 4 HVDC control replicas



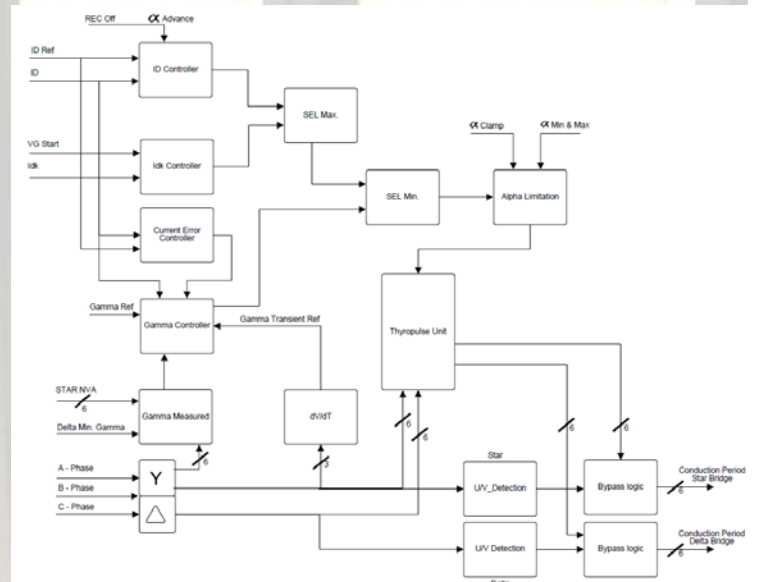
Bipole I & II Replica Development

- Bipole 1 first commissioned in Sept 1971, $\pm 463.5\text{kV}$, 1854MW, 3 x 6-pulse VG/Pole
 - Pole 1 valves replaced with electrically triggered thyristor (ETT), VG control was replaced with analog controls and re-commissioned in 1992.
 - Pole 2 valves were replaced with light triggered thyristor (LTT), re-commissioned in 2004 and original VG control stayed
- Bipole 2 installed in three stages in 1978 and during 1984-85, $\pm 500\text{kV}$, 2000MW
 - Original control still in service, due for replacement



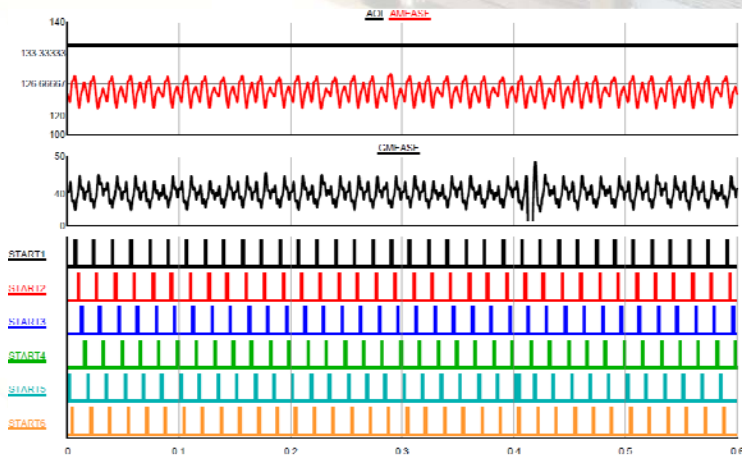
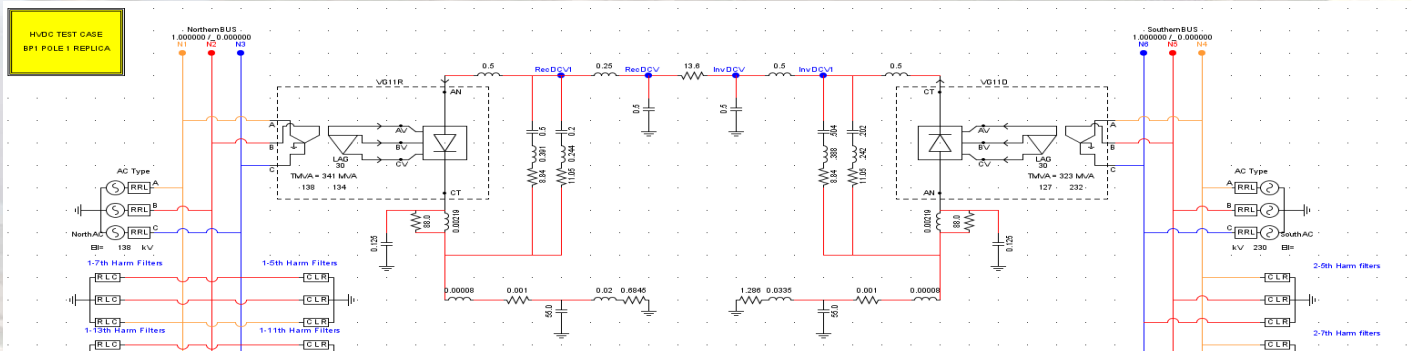
Bipole I & II Replica Development

- VG control replicas developed include current loop control.
- Using actual spare analog control cards
- Three control replica were developed

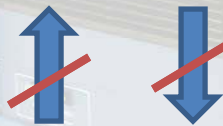


Stage 1 testing: Functional Validation

- Standalone testing with simple RTDS model for functional check



8 digital inputs

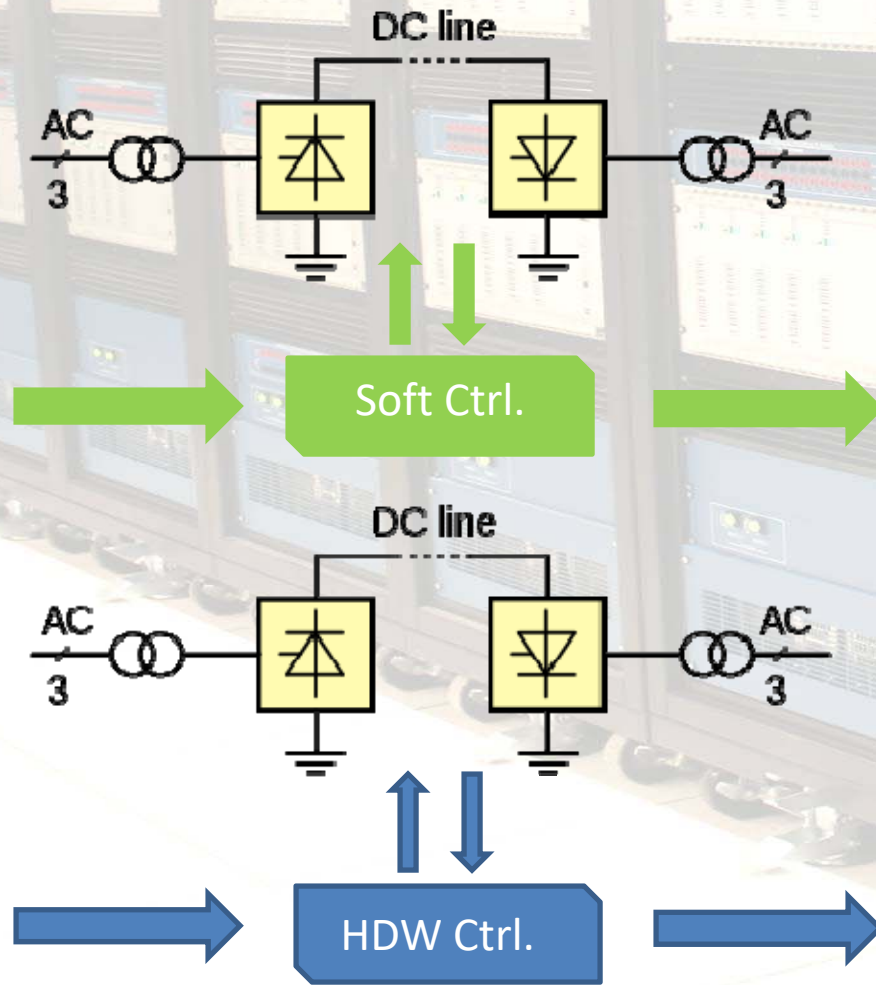


12 analog outputs
5 digital outputs



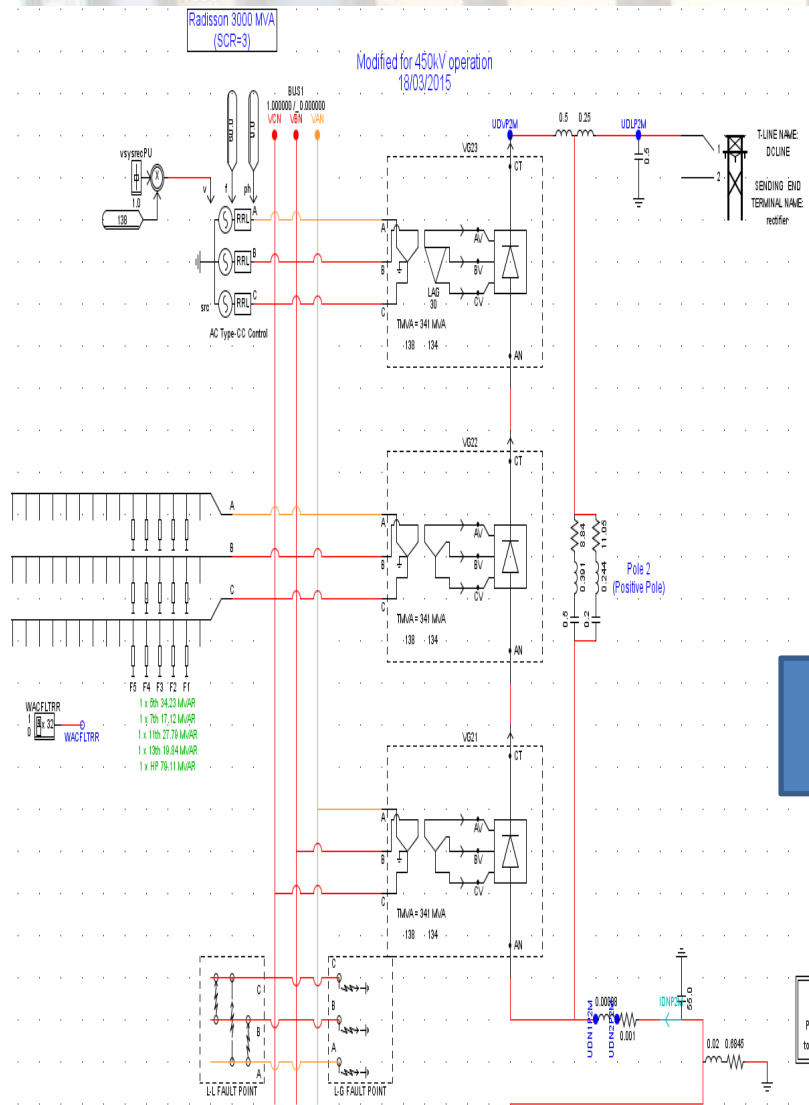
Stage 2 testing: Parallel RTDS with HIL

Run Time
System Controls



Run Time
System Controls

Stage 2: Model Validation



Replica Test Benchmark with
RTDS & PSCAD

Conceptual
Testing setup

Dynamic Performance test

Step
Response

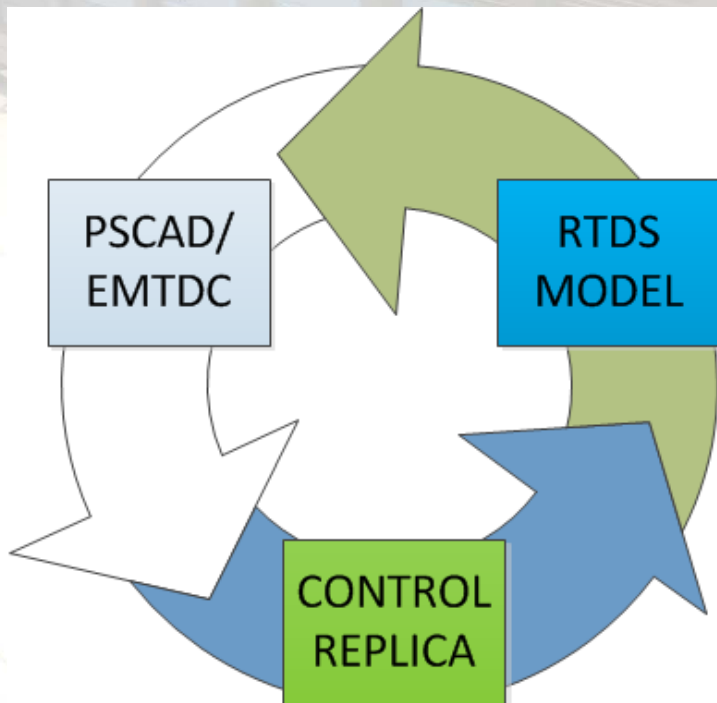
Time Step
Interpolation

Fault
Application

Benchmark reports

Stage 2 Model Validation

- RTDS & PSCAD (EMTDC) control modeling representation based on transfer function and library logical components
- HVDC control behavior and numerical solution compared with replica
- Benchmarking test between RTDS & PSCAD & Replica



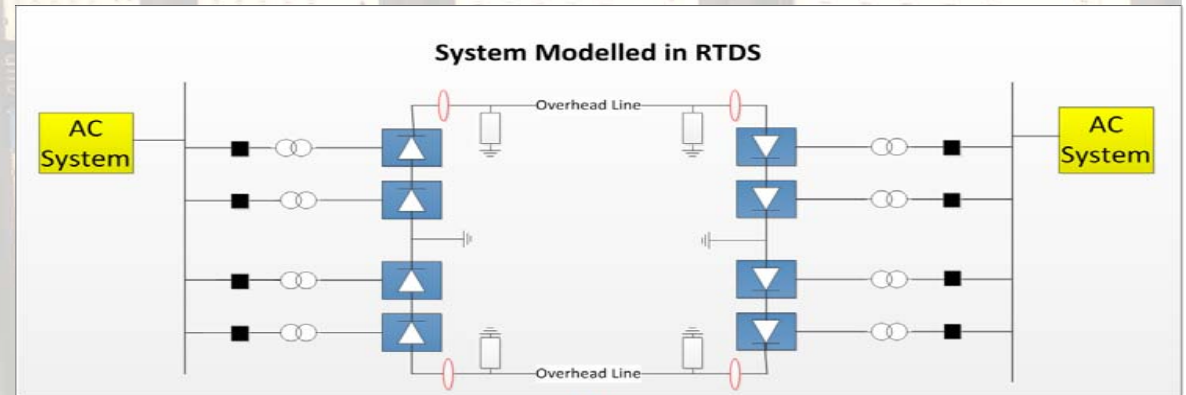
“Ongoing model maintaining and validation through system changes and upgrade”

BPIII Replica

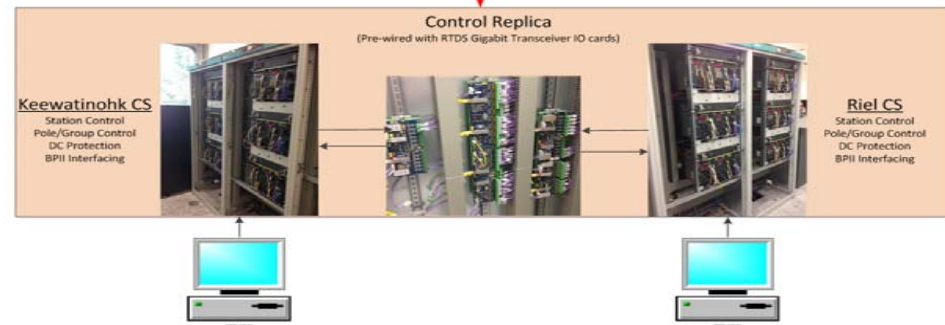
- Supplied by Siemens
- Used for FPT/DPT by supplier
- Moving to MHSC for further multi-infeed studies
- Will be used to conduct pre-commissioning test with system operating data.



***Supporting
maintenance,
operation, and special
dynamic performance
studies***

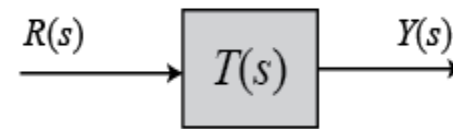


Fiber Optic



Ctrl Replica VS. RTDS Model

- Developing BPIII controller RSCAD model using control replica for validation.
- Challenge process, however beneficial for future system refurbishment or replacement



MHSC (Manitoba Hydro Simulation Centre)

Other Projects

- Wuskwatim /Long Spruce JVC & JLC FAT
- GS Black start Studies
- Riel AC transformer POW Switching
- Sync 21 Start and Stop PLC pre-commissioning
- ABB 6800 exciter response test for Sync 21, and Sync 2
- Pole 1 Minimum Gamma control study



Conclusions

- MHSC is developed to facilitate new BPIII commissioning, system integration, and to support ongoing operation, maintenance and further development of HVDC and AC systems in MH.
- Faced number of challenges dealing with analog controls during replica development for BPI&II
- Control replica is a very useful tool for model validation and control interaction studies
- Looking forward to utilize NovaCor to solve simulation issues

Thank You !!!



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