



GTSOC – Blackbox Controller Simulation on RTDS



RTDS.COM

AGENDA

- Introduction to GTSOC
- GTSOC- Blackbox Controller
- Case Study-VSC HVDC system
- Questions and Answers
- Demonstration (Coffee break)



Introduction to GTSOC

- New generation of FPGA platform
- GTSOC - integration of FPGA and Multi-Processor System-on-Chip (MPSoC)
- New applications using processors:
Specifically targeted for vendor Blackbox models
 - Accurate model
 - Manufacturer IP protection



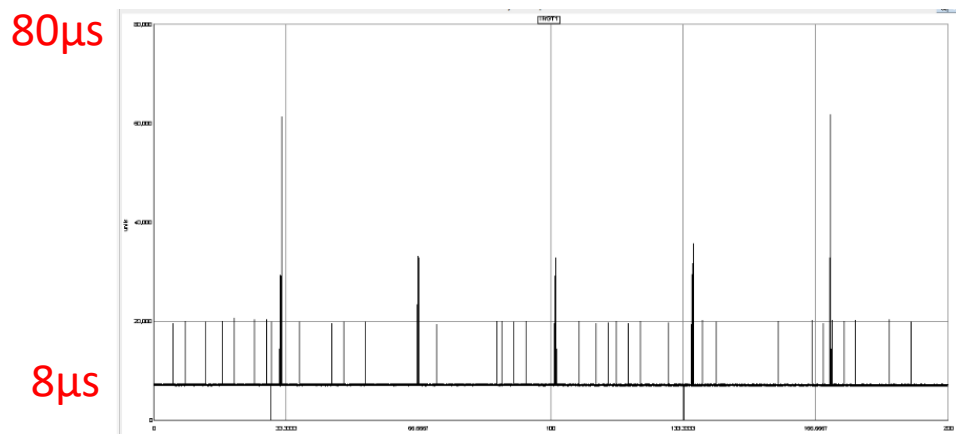
Introduction to GTSOC

Real-time required!

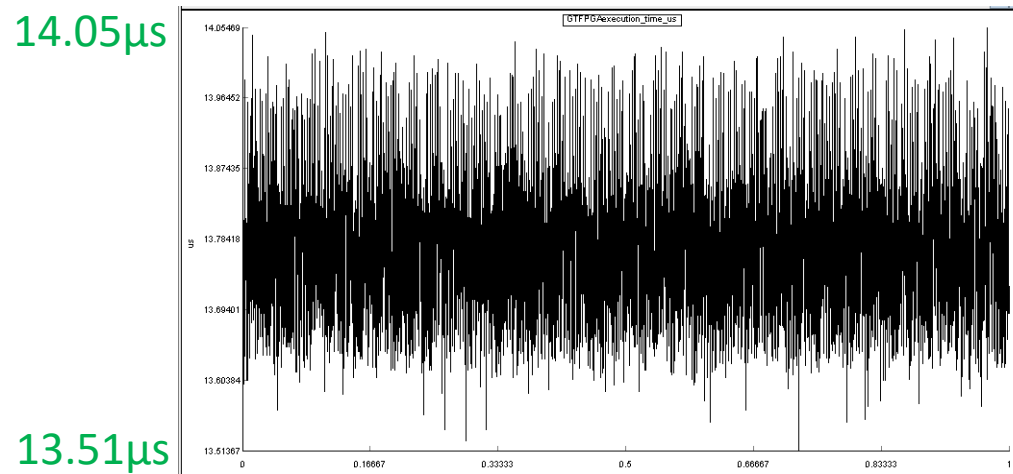
- Hardware
- Operating system
- Dynamic or Static library

		Operating System		
		Windows	Linux	Bare Metal
Hardware	PC	Dynamic: .dll Static: .lib	Dynamic: .so Static: .a	X
	ARM	X	Dynamic: .so Static: .a	Static: .a

- × **Linux OS** running dynamic library (.so)
Indeterministic execution time spike
Hard to eliminate the spikes without third-party real-time OS support.



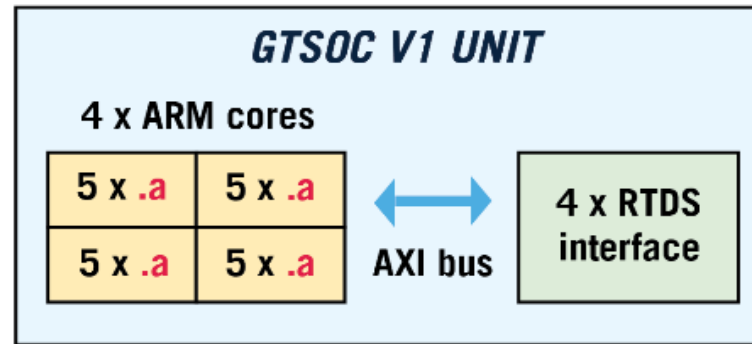
- ✓ **Bare-Metal** running static library (.a)
Bare metal guarantees **deterministic** timing:
<1µs spike.



Blackbox Controller –Capability

- GTSOC is compatible with NovaCor
 - Fiber cables connection
 - Communication via RTDS interface runs in parallel on FPGA fabric
 - Applications runs on 4 ARM Cores
 - Ability to run at a different timestep from the NovaCor timestep.

DOTA					
#1	#2	#3	#4	#5	
11	22	35	45	59	
15	26	36	48	50	
Name: DOTA					
EnDOTA: EnDOTA					
DotaStep(us): 50					
S/W: 0000.00.00					
Port: 1					



↔
Fibre cables

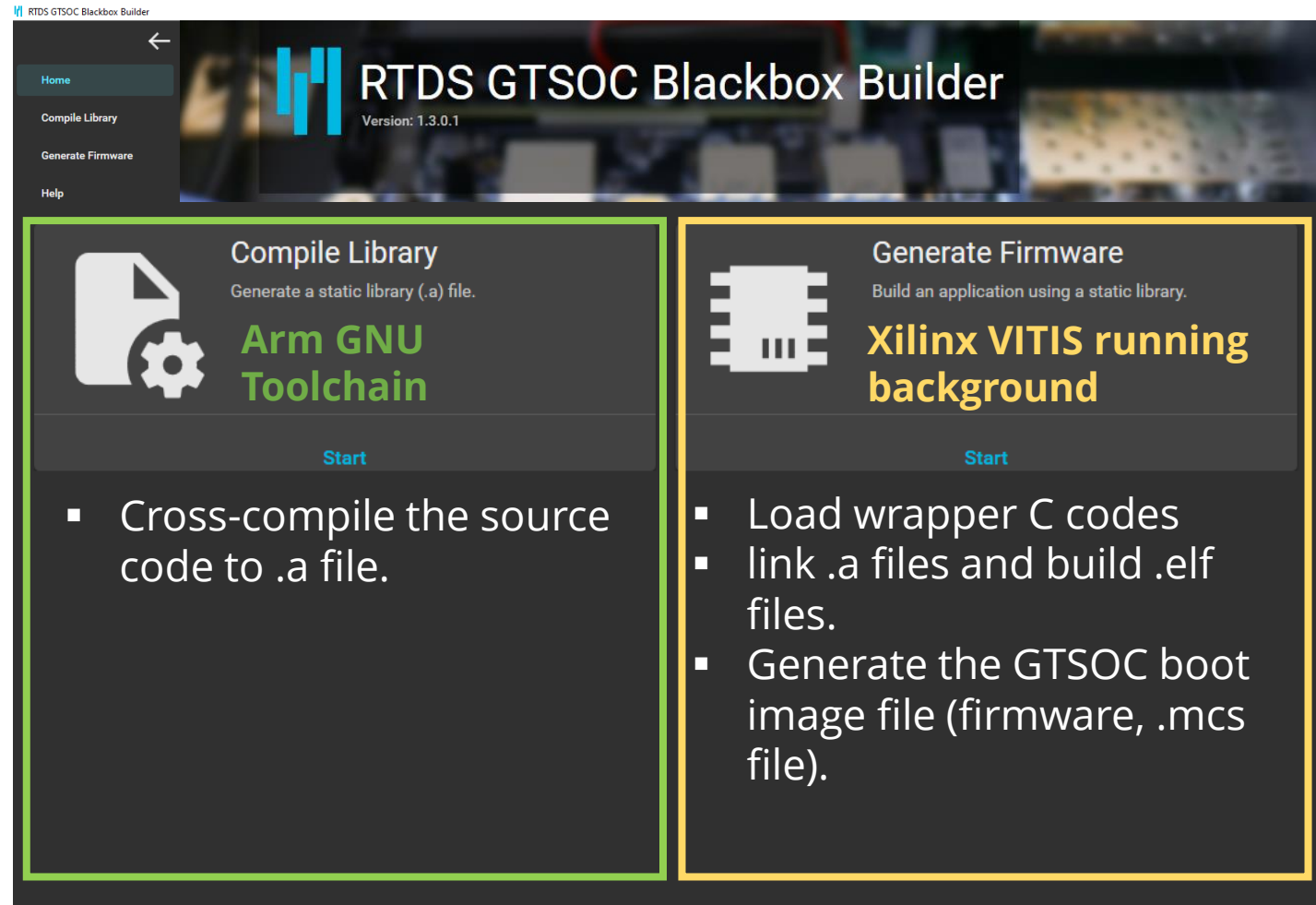


Blackbox Controller – GTSOC Blackbox Builder

GTSOC Blackbox Builder

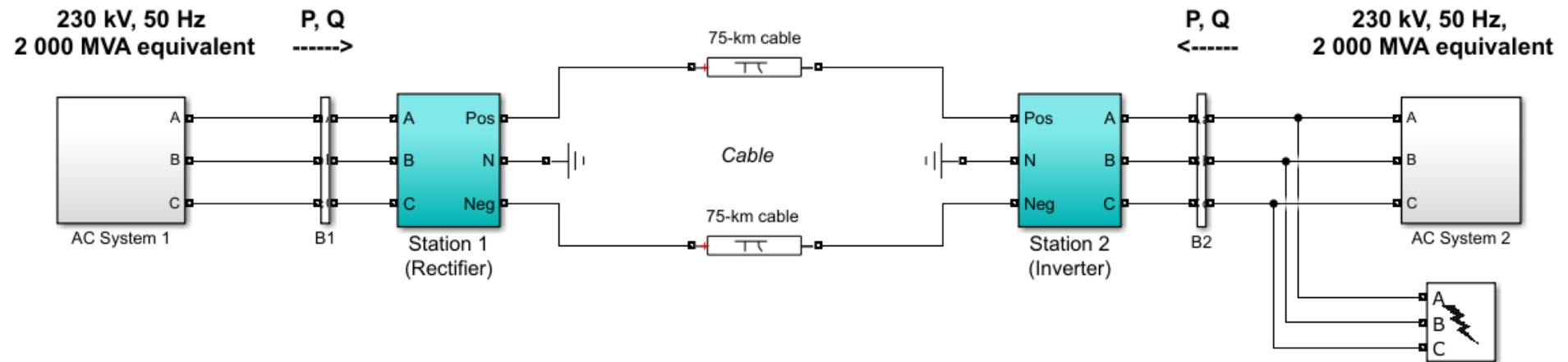
Establish Blackbox Controller simulation on GTSOC automatically and quickly.

- From MATLAB Simulink
- From manufacturers (C/C++/Fortran)



Case study- VSC-HVDC System

Simulink Demo VSC-HVDC System (Electrical System)



Note: Go insider to Convert "SubsystemCtrl" Box

Open this block
to visualize
recorded signals

Data Acquisition
Station 1

VSC
Pole Control

TwoStation_Controller

Open this block
to visualize
recorded signals

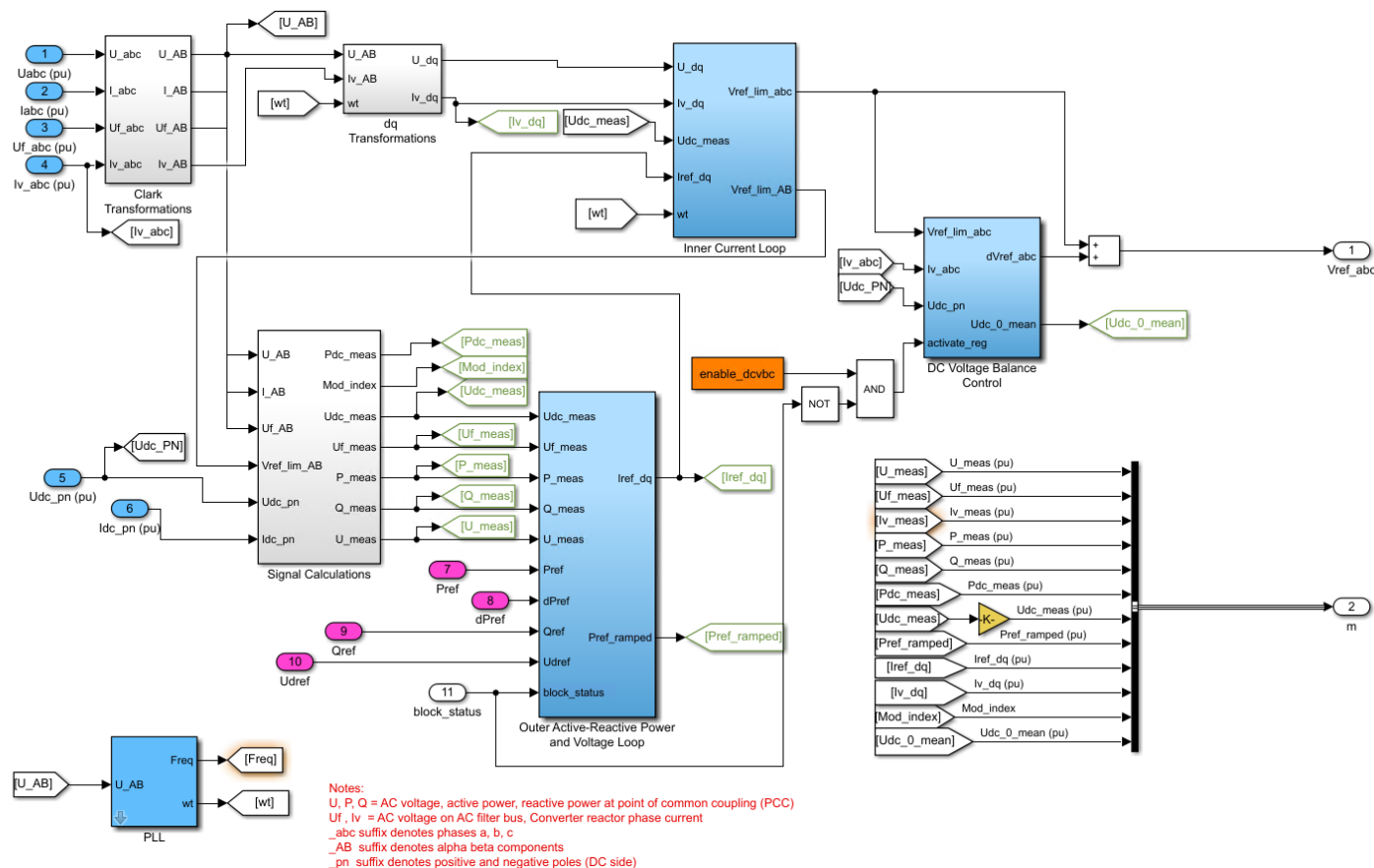
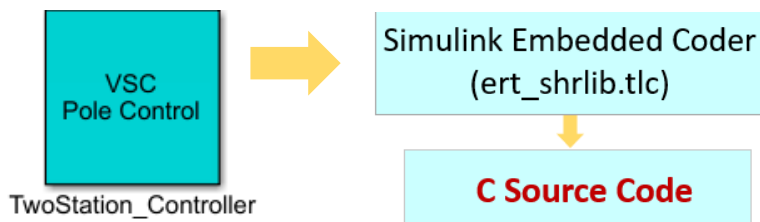
Data Acquisition
Station 2

power_hvdc_vsc.slx

Case study- VSC-HVDC System

Simulink Demo VSC-HVDC System (Control System)

- **Signal processing**
 - Filtering and measurements
 - Clark Transformation
 - Signal calculation
- **Outer loop control**
 - Active & Reactive power control
 - Or DC voltage & Reactive power control
 - Current reference calculation
- **Inner loop Current control**



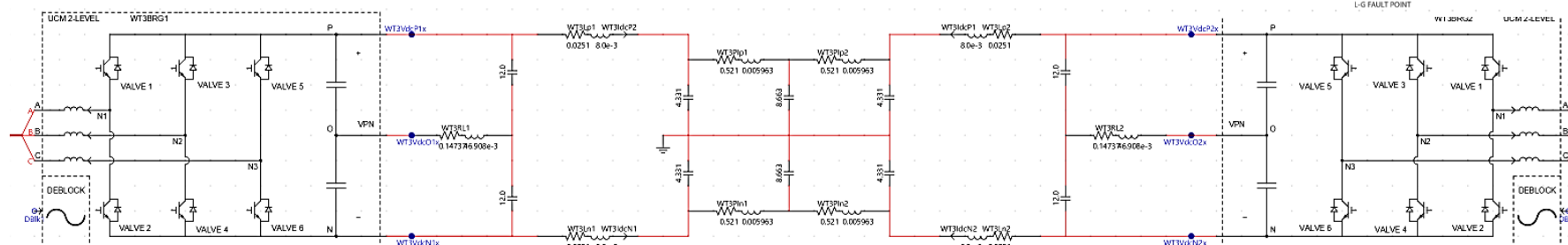
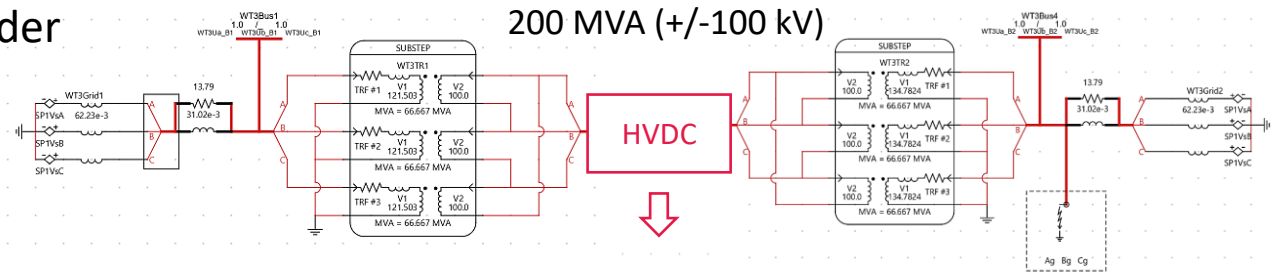
Case study- VSC-HVDC System

NovaCor + GTSOC Simulation

- Generate firmware using GTSOC Blackbox builder
- Build Power System and DOTA on NovaCor
- Upgrade firmware on GTSOC

VSC-Based HVDC Transmission Link

200 MVA (+/-100 kV)



Firmware Upgrade

Firmware Upgrade

NOVACOR

GTFPGA

GTFPGAs	Current Version	New Firmware Version	Current License	New License	Request License
<input type="checkbox"/> rack43 port: 1 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 2 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 3 pos: 1	DOTA HW 1005 S/W 00000000	<div>gtfpga_A15_VSCHVDC_1003_04B40301.mcs</div> <div>gtfpga_A15_Statcom_1003_04B40101.mcs</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 4 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 5 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 6 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>
<input type="checkbox"/> rack43 port: 7 pos: 1	DOTA HW 1005 S/W 00000000	<div>keep current version</div>	VALID	<div>keep current license</div>	<input type="checkbox"/>



DOTA

#1

44

34

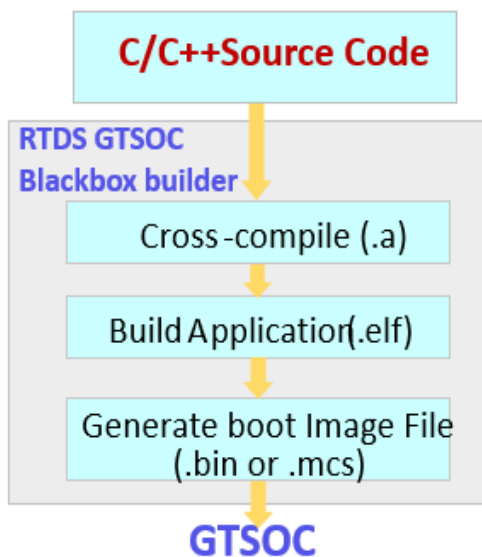
Name: DOTA

EnDOTA: EnDOTA

DotaStep(us): 50

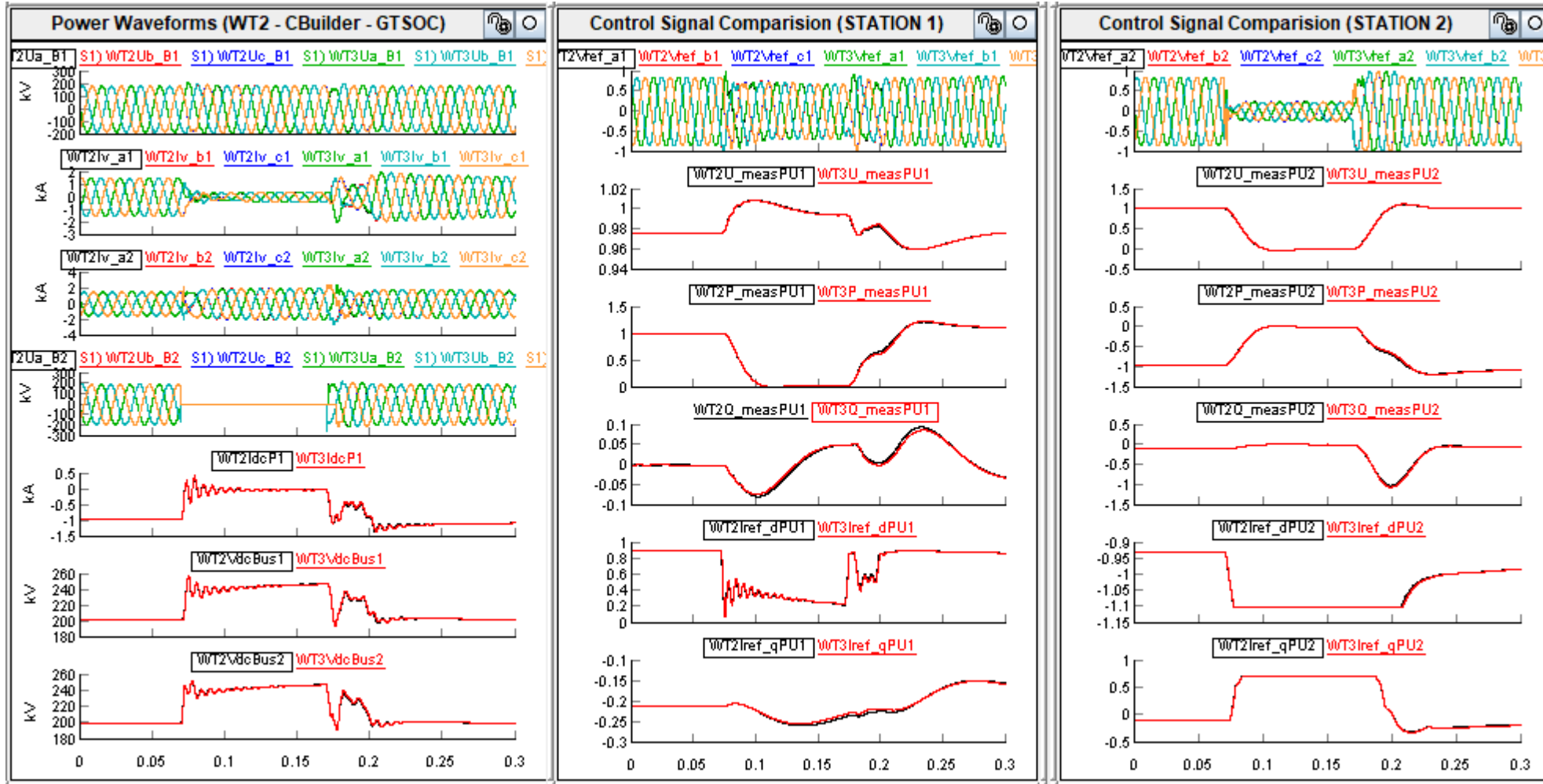
S/W: 0000.00.00

Port: 1



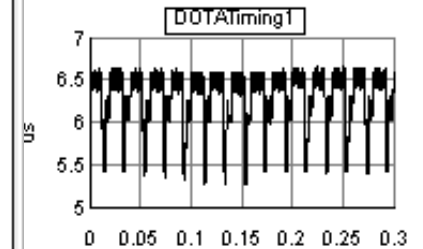
Case study- VSC-HVDC System

3ph Fault Event Results



Simulation
Time Step:
50 μ s

GTSOC
Execution Time

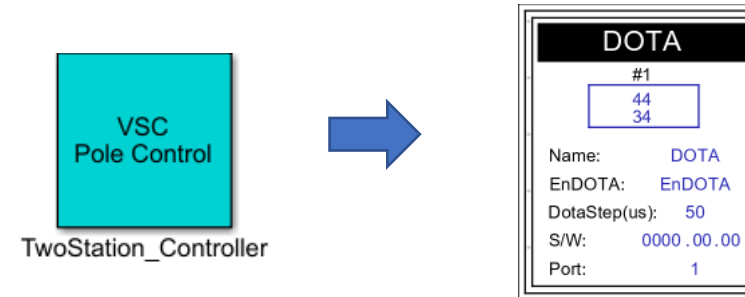


GTSOC Applications– HVDC Controllers

- **Simple controllers:**

Implement controllers for multi-terminals in one ARM core

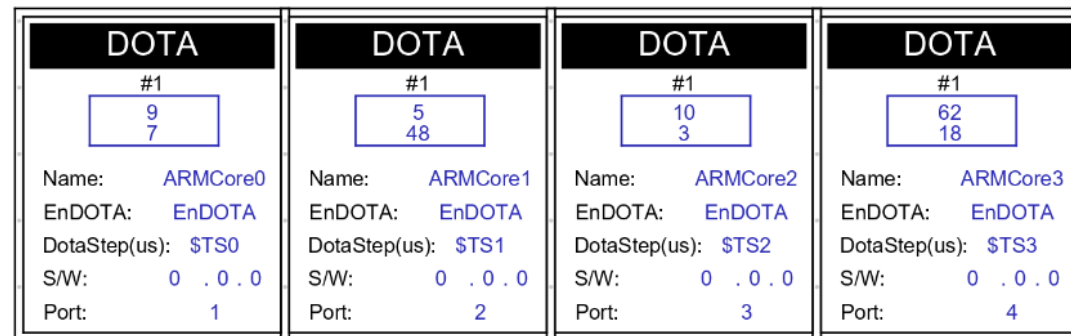
Simple controllers



- **Complex controllers:**

Implement controller for one terminals in multiple ARM cores (up to 4 per GTSOC unit)

Complex controllers



Vendor's GTSOC Applications

- PV
- Wind
- Battery energy storage
- Synchronous machine exciter and governors
- HVDC





**THANK YOU!
QUESTIONS?**



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