Development of Unified Test and Research platform for EO Tracking and Gun Control System

(Using Matlab & Simulink with Real Time HIL Simulation)
Outline

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- Solution – Model Based Design Approach
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- Overview of an Electro-Optic Tracking System
- MBD Using MATLAB & Simulink Tools
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  - The Unified Test & Research Platform
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- Conclusion
Problem Statement – The Scenario

Project committed & Delivery date “4 months”

Will you Deliver on time???

Lead Time 8-12 Weeks

Mechanical Design & Fabrication 12-14 weeks

Inadequate time for System Integration & Software Testing
Solution – Model Based Design Approach

Model Based Design

Early Customer interaction

System Fault Identification at Design stage

Model Based Design

Cost & Time Reduction

System Testing & Validation

Complete Software Development

Design Change
MBD Approach – Comparison

Conventional Design Cycle
- Specification
- Hardware Development
- Software Development
- Integration & Testing
- Prototype
- Release

Design Cycle Employing Virtual HW/SW Integration
- Specification
- Hardware Development
- Integration & Testing
- Prototype
- Time Saving

MBD with Tool Chain
- Specification
- MBD with Tool Chain
- Virtual Prototype
- Integration & Testing
- Hardware Development
- Prototype
- Time Saving
Overview of an Electro-Optic Tracking System
MBD Using MATLAB & Simulink

- CAD-Simulink translator
  - CAD Models (sldasm,prt,iam)
    - vrml file
  - xml
- Mechanical Model (Simulink)
  - Mathematical Model of Motor Drives & Control Algorithm (Control Design & SimPower Sys)
- User Interface
- VR Sink - Virtual world containing 3d Model of Mechanical system, Optics, Terrain & Viewpoints (Simulink 3d)
- Drive & Motor parameters (m file)
- Target Dynamics
Tool chain Integration – MATLAB & Simulink

- System Design Parameters
  - ATP
  - Accuracy Measurement
  - System Test Reports

- Control Design Parameters
  - Bandwidth, System Response

- Control Design
  - Verification & Validation
  - Report Generator

- System & Control Design

- MATLAB & Simulink
  - Simulink
    - 3d Animation
  - Simscape
  - SimPower System
  - Software in Loop
    - S-Function
    - Embedded IDE Link
  - Simulink Coder
    - Embedded Coder
  - Processor in Loop
    - Target Support Package
    - Embedded Coder

- Optics
  - CAD Software
    - Solidworks, Inventor, ProE

- Mechanical

- Electrical
  - Devices & Machines
    - IGBT, DIODES
    - PMDC, BLDC, PMSM

- Software
  - IDE
    - Visual Studio, CCS, Eclipse, etc

- HIL Simulators
  - Opal – RT
  - dSpace
  - Speed Goat

- Target Board & Processors
  - TI-C2000, C6000
  - MPC555
  - C166
Mechanical & Drives Simulation

Three Mass System - Simulink

Three Mass System – Simscape (with Kinematics Chain)

Frequency Response
Torque – Speed
(Showing Resonance & Anti-Resonance)
HIL Simulation – MATLAB & Simulink, Opal-RT

Simulink Model – Drive & Mechanical System

Compiled to C Code

Real Time Signal

Opal-RT HIL Simulator
(Real Time Redhat Kernel, Quad core Intel Xeon processor
32 Analog I/O, 32 Digital I/O, 12 Serial Port, 2 CAN Port)
Development Phase I – PDR
Development Phase II – CDR
The Unified Test & Research Platform

**Monitoring System (8 ms)**
- Monitoring
- Gyro Disturbance
  - Vector CAN-ANALYSER

**MATLAB Host (40 ms)**
- VR SINK
  - Optics Simulation
    - (Virtual World Containing Platform, 3D System Model & Target)

**Data Logger (8 ms)**

**HIL Target (100 us)**
- Platform Dynamics
- Target Dynamics
- Servo Model

**System Under Evaluation**
- CAN Open
  - UDP/Ethernet
  - Position & Orientation (4 Axis, Platform, Target)

**EO Tracking System**
- System States
  - Encoder Pos
  - Gyro

**User Interface**
- VGA - PAL
- RS232
Results

- Stabilization Accuracy (APG)

Stabilization Accuracy plots (Az & El)

- Az_Lab (mils) Accuracy (1 Sigma): 0.38 mrad
- El_LAB (mils) Accuracy (1 Sigma): 0.95 mrad

With Stabilization

Without Stabilization
Results

- Stabilization Simulation
Results

- Automatic Target Tracking:
Results

- Customer Interactions at initial stage
- Gun & Sight Alignment check
- Ballistic Correction Simulation
- The Simulation platform can be used to evaluate any Electro Optic & Fire Control Systems
Conclusion

- 30% saving in time over the traditional method.
- Prototype development and testing can be completed within 6 months.
- Extensive testing of both control hardware and software to meet the end specification.
- Customer involvement and requirement from design stage onwards.
- Virtual Simulation facilitates testing of system under dynamic scenarios which will be difficult to perform with actual system.
- Development time and man hour cost is reduced.
THANK YOU