CONTROL SOFTWARE DEVELOPMENT USING MATLAB TOOLCHAIN

MATLAB EXPO - 2019

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Agenda

- Development Challenges
  - Need of Hour

- Development Approach
  - Software Architecture
  - Concept Generation
  - Software Development
  - Testing Methods
  - Benefits

- Summary/Conclusion
Development Challenges

- Complexity
- Targets

Is there any thing to reuse
Development time
Its very complex
unable to maintain
SW Quality??
how can I test
multiple systems
Development Challenges – Need of Hour

Front Loading Development Approach
Development Approach

Conventional MBD Workflow

System Specs

Sw Architecture

Software Development

Testing

Code Generation

<h file>

.c file

HEX

A2L
Development Approach

Integrated MBD Workflow
Development Approach

Sw Architecture

SWC Architecture
Architecture definition in MATLAB/SIMULINK

Challenges
Quality
- Concept Ambiguity
- Req Elicitation
Time
- Architecture Def

Solution
Quality
- Deliberation
- Cascaded
Time
- Modular Architecture

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Development Approach

Concept Generation

**Functional Test Point & Tagging**

Functionality Test Requirement (Coverage) & **Tagging (Traceability)**

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**Challenges**

Quality
- Concept Coverage
- Traceability
- IO Mapping

Time
- Algo Def

**Solution**

Quality
- Better Coverage
- Better Traceability

Time
- Robust Algo

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Development Approach
Sw Development

Documentation
Automated Documentation

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Chapter 1. Component Description
SchaCtrl

Requirement ID
DefSig_InitialVal_11, DefSig_InitialVal_12, DefSig_InitialVal_13

Model Description
This system calculates the controller output for enabling XH component.
Main components of this system are:
1. Component Enable Function
2. Pump Flow Control
3. Component Enable Control
4. System Signal

Table 1.1: Signals for this sub-system

<table>
<thead>
<tr>
<th>Signal</th>
<th>Signal Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SchaCtlPrepCtrl/PumpCtrlOut</td>
<td>Output/DRF</td>
<td>Pump Flow Control</td>
</tr>
<tr>
<td>SchaCtlOut</td>
<td>Output/DRF</td>
<td>Frame Sensor</td>
</tr>
<tr>
<td>SchaCtlPicOut</td>
<td>Output/DRF</td>
<td>Heart Beat Control</td>
</tr>
</tbody>
</table>

Challenges
Quality
• MDL Consistency
• Traceability
• Future Adaptation

Time
• Short Dev Time

Solution
Quality
• Robust Model
• Sys→ Model Traceability
• Modular/ Reuse

Time
• Quick Development

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Development Approach

Testing Methods

SwC Testing
Open Loop Testing
Sw component → Functional, Coverage

Challenges
Quality
- Test Coverage
- Acceptance
- Testing Phase

Time
- Model Complexity
Development Approach

Test Methods

Simulink Test

Sw Development

SwC Testing

SwSys Testing

SwSys Verified

Test Reporting

Challenges

Quality
- Test Coverage
- Acceptance
- Testing Phase

Time
- Model Complexity
Development Approach

Testing Methods

SwSys Testing
Closed Loop Testing
Sys Level → Functional, Non-Functional

Challenges
Quality
- Test Coverage
- Acceptance
- Testing Phase

Time
- Model Complexity

Solution
Quality
- Better Coverage
- White box/ Black box Testing

Time
- Early Reliability
- SwC/SwSys Test

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## Development Approach

### Benefits

<table>
<thead>
<tr>
<th>Conv MBD Process</th>
<th>Development Phase</th>
<th>Integrated MBD Process</th>
<th>QC Point</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>QC Point</td>
<td></td>
<td>QC Point</td>
<td>Time</td>
</tr>
<tr>
<td>5x</td>
<td>-</td>
<td>Sw Architecture</td>
<td>Req Analysis</td>
<td>Sw Architecture</td>
</tr>
<tr>
<td>2x</td>
<td>-</td>
<td>Sw Architecture</td>
<td>Sw Component Definition</td>
<td>1x</td>
</tr>
<tr>
<td>5x</td>
<td>-</td>
<td>Sw Architecture</td>
<td>Sw Component Definition</td>
<td>Qc2</td>
</tr>
<tr>
<td>10x</td>
<td>Qc1</td>
<td>Software Development</td>
<td>Algorithm Development</td>
<td>Sw Concept</td>
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<td>Software Development</td>
<td>Software Component Development</td>
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<tr>
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<td>Qc2</td>
<td>Software Development</td>
<td>Traceability/ Tagging</td>
<td>Sw Component Integration</td>
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<td>Testing</td>
<td>Sw Component Testing</td>
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<td>Qc2</td>
<td>Testing</td>
<td>SwSys Testing</td>
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<tr>
<td>36x</td>
<td>-</td>
<td>Rework</td>
<td></td>
<td>1x</td>
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<tr>
<td></td>
<td></td>
<td>Overall Development Time</td>
<td></td>
<td>28x</td>
</tr>
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</table>

**More QC point, better Software Quality**
- Rework time is reduced by 67%.
- Higher Coverage.

**Overall Development time is reduced by 22%.**
## Summary

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Approach Outcome</th>
<th>Impact Parameter</th>
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<tbody>
<tr>
<td></td>
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<td>Time</td>
</tr>
<tr>
<td>1</td>
<td>Reduced Complexity</td>
<td>✓</td>
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<tr>
<td>2</td>
<td>Bidirectional Traceability</td>
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<tr>
<td>3</td>
<td>Higher Testing Coverage</td>
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<tr>
<td>4</td>
<td>Robust Algorithm/ Model</td>
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<td>Modular Structure</td>
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<tr>
<td>6</td>
<td>Higher Ease of Maintenance</td>
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<td>7</td>
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Thank You

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