Using Hardware-In-the-Loop testing to increase confidence in the control system delivery of Drilling Vessels

Tom Pedersen – Marine Cybernetics
CONTENTS

- The Software Challenge
- Concept of HIL testing
- Drill HIL experience
- Return on Investment for Drill HIL
SOFTWARE IS FANTASTIC

Software allows us to design, build and operate amazing machines.

Software allows us to plan and conduct extremely complex missions.

Software has changed the way we live.
SOFTWARE IS EVERYWHERE

- **In your hand**
  - phones, pads, gadgets, …

- **In your home**
  - computers, kitchen appliances, stereos, TVs, smart devices, …

- **In critical infrastructure**
  - power distribution, water, sewage, banks, telecommunication, finance, health care, the internet, …

- **In transportation**
  - planes, cars, ships, …
SOFTWARE IS FRAGILE

L_M_BV_32 := TBD.T_ENTIER_32S ((1.0/C_M_LSB_BV) * G_M_INFO_DERIVE(T_ALG.E_BV));

if L_M_BV_32 > 32767 then
  P_M_DERIVE(T_ALG.E_BV) := 16#7FFF#;
elsif L_M_BV_32 < -32768 then
  P_M_DERIVE(T_ALG.E_BV) := 16#8000#;
else
  P_M_DERIVE(T_ALG.E_BV) := UC_16S_EN_16NS(TDB.T_ENTIER_16S(L_M_BV_32));
end if;

L_M_BH_32 := TBD.T_ENTIER_32S ((1.0/C_M_LSB_BH) * G_M_INFO_DERIVE(T_ALG.E_BH));

if L_M_BH_32 > 32767 then
  P_M_DERIVE(T_ALG.E_BH) := 16#7FFF#;
elsif L_M_BH_32 < -32768 then
  P_M_DERIVE(T_ALG.E_BH) := 16#8000#;
else
  P_M_DERIVE(T_ALG.E_BH) := UC_16S_EN_16NS(TDB.T_ENTIER_16S(L_M_BH_32));
end if;
HIL TESTING OF DRILLING UNITS

- Power/VMS Management Systems (PMS/VMS)
- *Steering, Propulsion, Thruster (STP)
- *Dynamic Positioning (DP)
- Blow-Out Preventer
- Crane
- Jacking/Fixation system
- Skidding system,
- ESD
- Drill floor
- MPD/DGD

*Applicable for Semi-subs and drill-ships
NORMAL OPERATION

The PLC’s are connected with the driller’s chair and drilling equipment.
GENERIC HIL TESTING SETUP

PLC Controllers

Driller’s Cabin

Drilling Equipment

HIL Simulation PC

Marine Cyb I/O MarineCyb Sim-code

HMI test interface
Activation of failure modes

Marine Cyb I/O MarineCyb Sim-code

Marine Cyb I/O MarineCyb Sim-code

Marine Cyb I/O MarineCyb Sim-code

HIL test tools

Test cases
Monitoring
Logging
Analysis

MC 3D Graphics
DELIVERABLES AND ADDED VALUE

**DELIVERABLES**
- Kick-off and Test plan
- Test programs
- Test results
- Test summary report
- Closure meeting

**Planning**
- Improved stakeholder interaction
- Thorough documentation review
- Early risk identification

**Preparation**
- Customer review of control system functionality

**Commissioning & Testing**
- Improved stakeholder interaction

**Reporting & Follow-up**
- Safe Software – Safe Operations

**Closing**
- Test plan
- Test programs
- Test results
- Test summary report

**ADDED VALUE**
- Improved stakeholder interaction
- Thorough documentation review
- Early risk identification
- Customer review of control system functionality
- Improved stakeholder interaction
- Safe Software – Safe Operations
THE HIL TEST PROCESS

Test process

Test results

MC

Vendor

Customer

Class

Oil Co.

Finding
• A: breach of class req.
• B: breach of other req.

Observation
• Useful information

Void
• Test setup error
• Misunderstanding

2014 © Marine Cybernetics | www.marinecyb.com
HIL TEST FEEDBACK

Yard representative: “……initially I was not very eager for this HIL-testing, but based on what I have seen after the two first days of testing I think all such systems must be HIL-tested. You have found items revealed during System Integration Testing, but in addition you have found a lot more….”

Vendor: “Marine Cybernetics’s HIL testing was a very valuable experience to us. The professionalism and experience of the Marine Cybernetics employees facilitated constructive discussions between the customer and us as the supplier, ultimately leading to a better and safer product.”

Customer: “Marine cybernetics have done an outstanding job and have acted very professionally. There has been three parties involved in the HIL test and we have never felt that MC have put any of the parties in favour. The paper work and the monitoring of the findings was good.”
CASE STUDY: DRILL-HIL

What can go wrong and consequences

Situations that can be caused by software errors

- Anti collision system not working properly
- Sensor errors not detected
- Clamps opened unintentionally
- Machine creep not detected
- Interlocks not working
- Insufficient alarms

Potential consequences

- Collision between machines
- Personnel injury
- Environmental damage
- Rig damage
- Machine damage
- Loss of pipe
- Non productive time
CASE STUDY: DRILL-HIL
HIL – RETURN ON INVESTMENT