

Paris, 16-18 October 2018



Organizer:  TESTING
SOLUTIONS
& SERVICES

Model-based testing for component-based applications

Presented by Wenbin Li, Easy Global Market, France

Outline

- Easy Global Market
- H2020 PHANTOM
- MBT in PHANTOM
- Testing Automation

Easy Global Market



R&D SUPPORT

Involved in +30 EU projects since 2001



ADVANCED TESTING

State of the Art, advanced testing methods
(eg MBT, TTCN3)



PLATFORMS INTEGRATION

Mastering Future Internet (FIWARE) and
IoT platforms (eg OneM2M)



INTEROPERABILITY EXPERTS

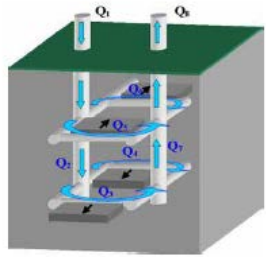
World specialists in technical and semantics
interoperability programs

H2020 PHANTOM

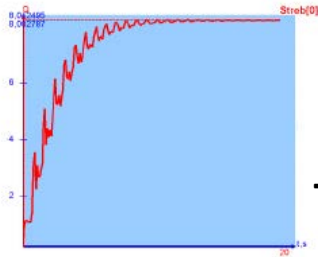
Multi-Objective Programming for Parallel Computing System



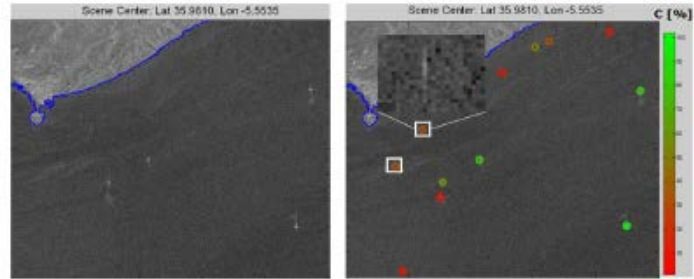
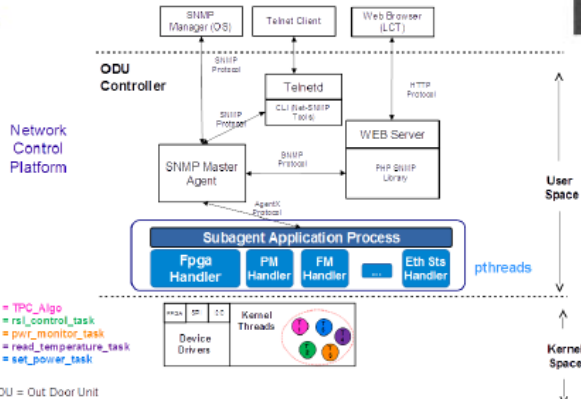
H2020 PHANTOM: Use Case Applications



Airflow Simulation

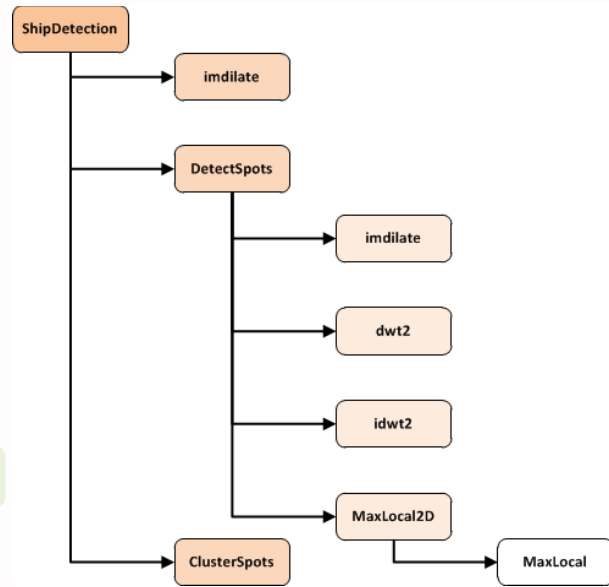
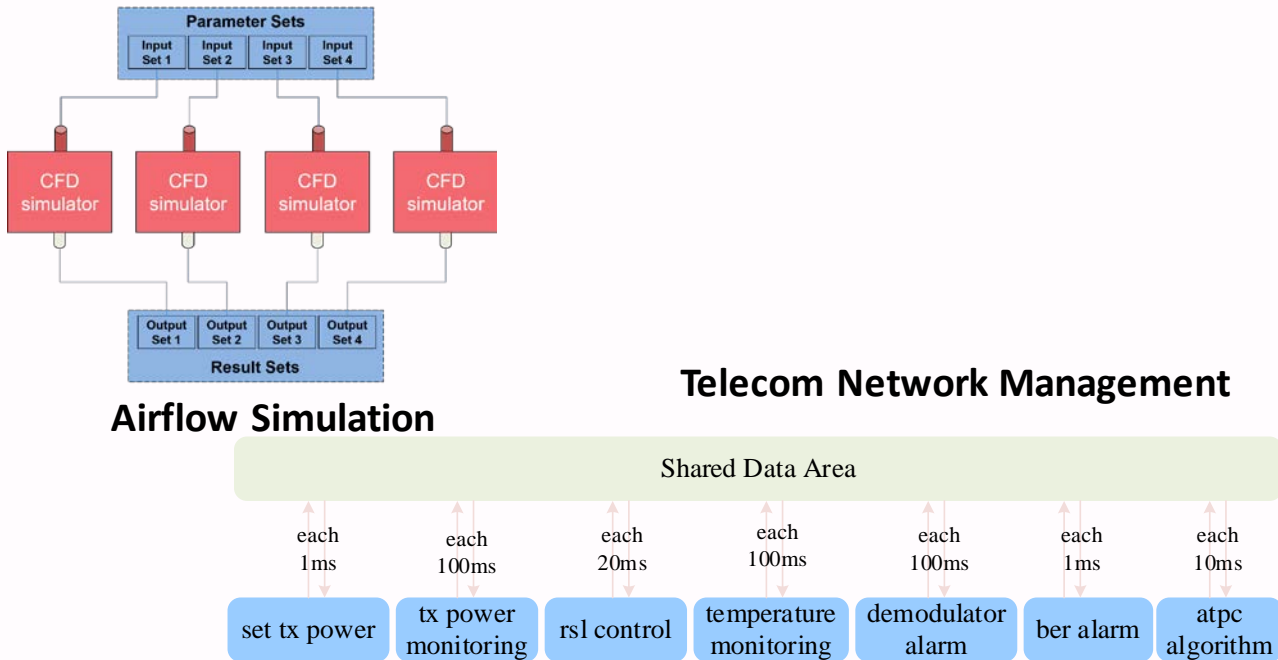


Telecom Network Management



Surveillance Image Processing

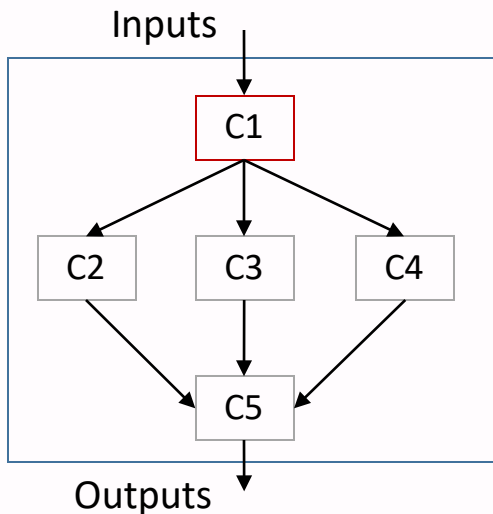
H2020 PHANTOM: Component-based applications



Surveillance Image Processing

H2020 PHANTOM: Component Network

Application and components



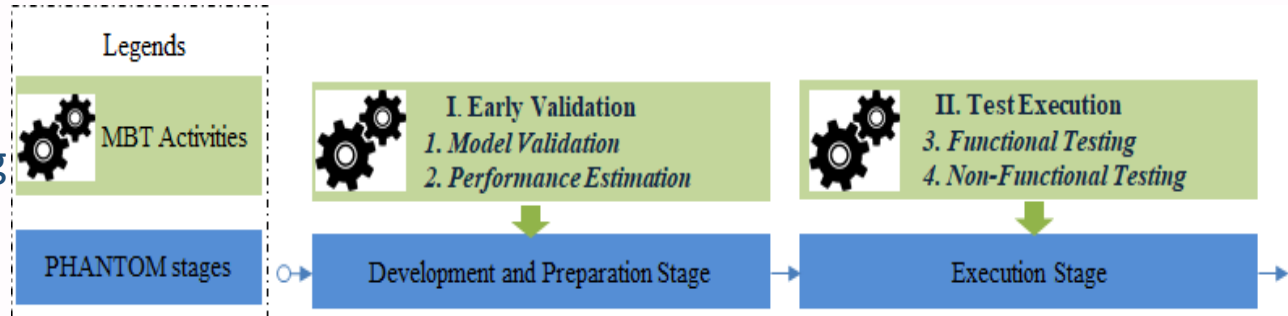
```

43 <component name="ShipDetection" type="asynchronous">
44 <!--Parallelisation Directives-->
45 <PT:parallelisation-directive set-by="PT" name="subcomponents" max_number =
46 <!--Estimated Computation Time-->
47 <MBT:estimated-computation-time value = "700" measurement-unit = "ns" /> <
48
49 <!-- Component ShipDetection Requirements-->
50 <requirements set-by="USER" name="component_ShipDetection_requirements" tar
51 <!--Non-functional-->
52 <non-functional name="ShipDetection_WCET" type = "execution-time" max-v
53 <!--Monitoring-->
54 <monitoring name="ShipDetection_monitor" type = "execution-time" /> <!--
55 </requirements>
56
57 <!--C code behavioral description files-->
58 <header lang="cpp" path="\src\components" file="ShipDetection.h"/>
59 <source lang="cpp" path="\src\components" file="ShipDetection.cpp"/>
60
61 <!--Communication Interface -->
62 <port name="ISDport" type="in" peer-object="InputSD" peer-name="out"/>
63 <port name="OSDport" type="out" peer-object="OutputSD" peer-name="in"/>
64
65 <port name="IIMport" type="out" peer-object="InputIM" peer-name="in"/>
66 <port name="OIMport" type="in" peer-object="OutputIM" peer-name="out"/>
67
68 <port name="IDSport" type="out" peer-object="InputDS" peer-name="in"/>
69 <port name="ODSport" type="in" peer-object="OutputDS" peer-name="out"/>
  
```

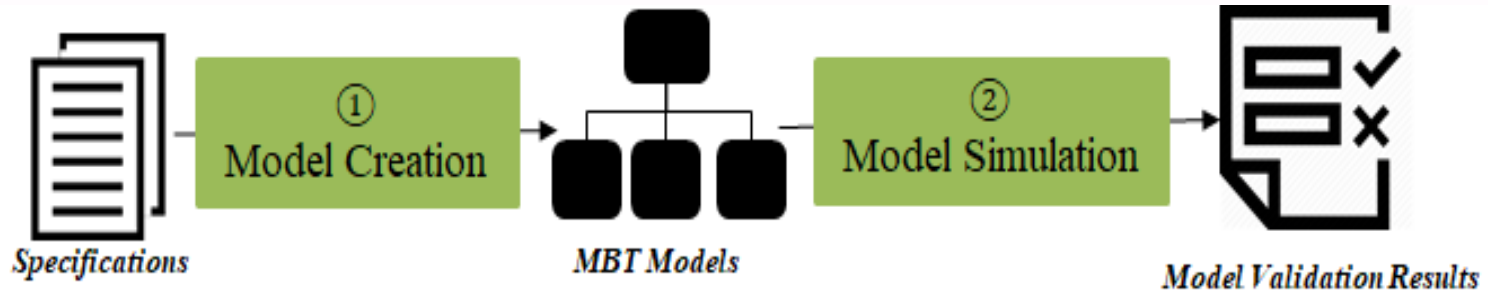
Model Based Testing in PHANTOM

MBT: testing based on or involving models

- Early Validation
 - Model validation
 - Performance Estimation
- Test Execution
 - Functional Testing
 - Non-functional Testing



H2020 PHANTOM: Model Validation



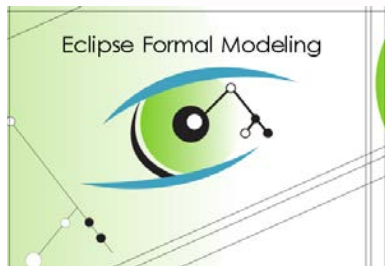
H2020 PHANTOM: Model Validation

```
@machine:
stateMachine< or > HPCApplicationMachine
{
    @private:
    port input RequestExecute(CommandLine, Experiment, integer, VaryingParameter);
    port output ResponseExecutionResult(CommandLineResult);
    port output CheckResult(ExperimentResult);
    port input ResponseEndExecution(VaryingParameter);

    state<initial> State_Initial_Non_Functionnal
    {
        transition StartExperiment1 --> State_TimeStampModulation
        {
            TimeStamp = TimeStampMin;
            vCurrentExperiment = EXPERIMENT_1;
        }

        transition StartExperiment2 --> State_TimeStampModulation
        {
            TimeStamp = TimeStampMin;
            vCurrentExperiment = EXPERIMENT_2;
        }

        transition StartExperiment3 --> State_TimeStampModulation
        {
            TimeStamp = TimeStampMin;
            vCurrentExperiment = EXPERIMENT_3;
        }
    }
}
```



```
REPORT
STOP CRITERIA PROCESSOR
The CONTEXT count : 8532
The STEP count : 2190

The Max HEIGHT reaching : 19
The Max WIDTH reaching : 6311
The RUN#EXIT count : 6055
TRANSITION COVERAGE PROCESSOR
All the << 58 >> transitions are covered !
Number of nodes cut back: 8367

step: 0 , context:+oo , height:+oo , width:+oo
stop: 0 , context:8532 , height: 1 , width: 1
--> 0ns @ Mon Jul 30 12:50:52 2018

REPORT
STOP CRITERIA PROCESSOR
The CONTEXT count : 8532
The STEP count : 0

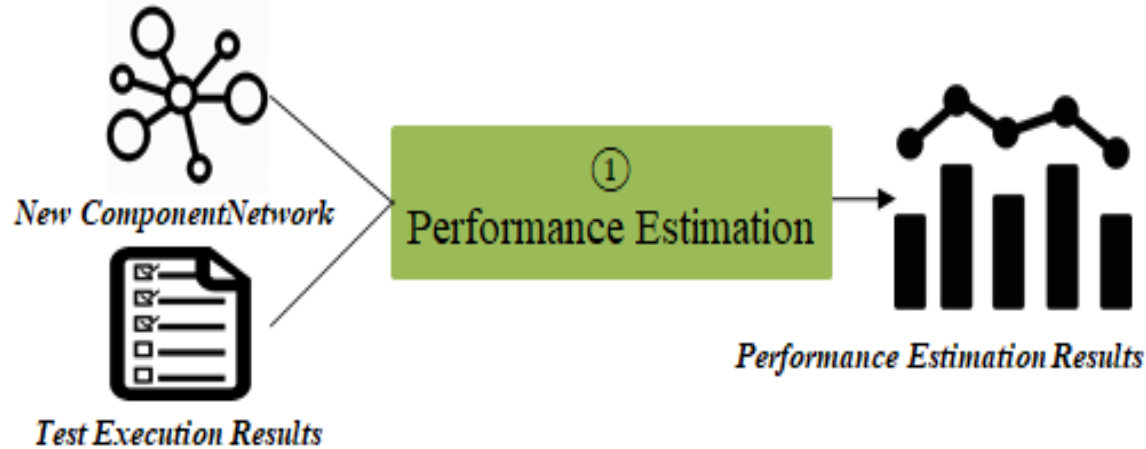
The Max HEIGHT reaching : 1
The Max WIDTH reaching : 1
EXECUTION CHAIN
TRACE GENERATOR
The TRACE count : 29
DONE !
```

Communicating Finite State Machine in xLia

DIVERSITY

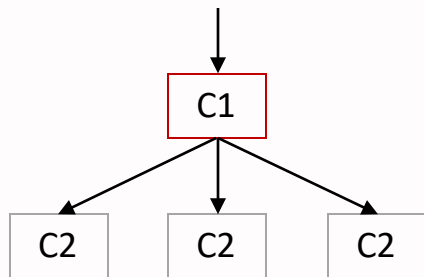
Model Validation Result

H2020 PHANTOM: Performance Estimation



H2020 PHANTOM: Performance Estimation

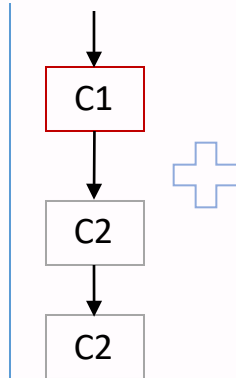
Application1



Testing results

Object	Execution Time
C1	100 ms
C2	20 ms
Application1	120 ms

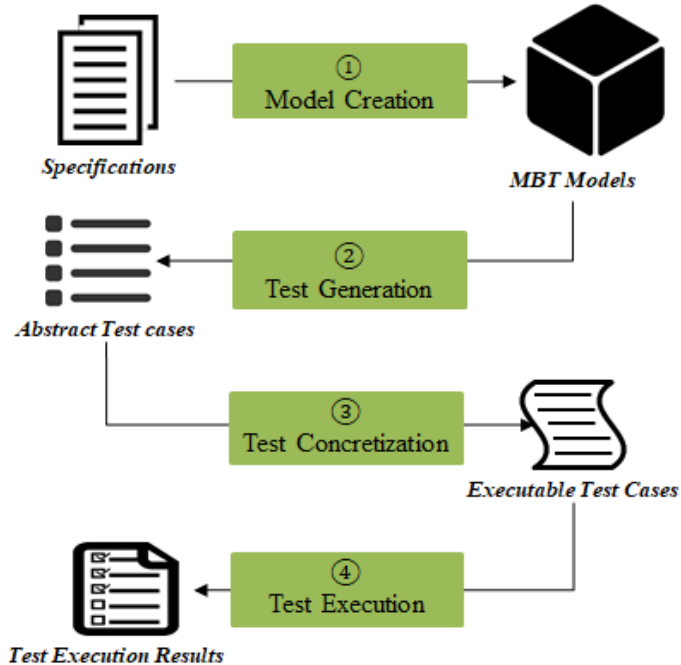
Application2



Property Name	Estimation Methods for Composition Patterns			
	Sequence	Parallel	Condition	Iteration
Execution Time (ET)	$\sum_{i=1}^n et_i$	$\max(et_i)$	$\max(et_i)$	$(et)*k$
RAM Usage (RU)	$\sum_{i=1}^n ru_i$	$\sum_{i=1}^n ru_i$	$\max(ru_i)$	$(ru)*k$
Reliability (RE)	$\prod_{i=1}^n re_i$	$\prod_{i=1}^n re_i$	$\min(re_i)$	$(re)^k$
Energy Consumption (EC)	$\sum_{i=1}^n ec_i$	$\sum_{i=1}^n ec_i$	$\max(ec_i)$	$(ec)*k$

Execution time = 140ms

H2020 PHANTOM: Functional & Non-functional testing



```

@machine:
  statemachine: or > HPCApplicationMachine
  {
    @private:
    port input RequestExecute(CommandLine, Experiment, Integer, VaryingParameter);
    port output ResponseExecutionResult(CommandLineResult);
    port output CheckResult(ExperimentResult);
    port input ResponseEndExecution(VaryingParameter);

    stateinitial: State_Initial_Non_Functional
    transition StartExperiment1 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_1;
    }
    transition StartExperiment2 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_2;
    }
    transition StartExperiment3 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_3;
    }
  }
  
```

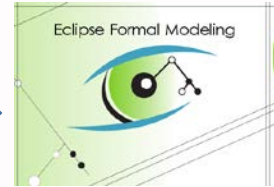
xLia Model

```

@machine:
  statemachine: or > HPCApplicationMachine
  {
    @private:
    port input RequestExecute(CommandLine, Experiment, Integer, VaryingParameter);
    port output ResponseExecutionResult(CommandLineResult);
    port output CheckResult(ExperimentResult);
    port input ResponseEndExecution(VaryingParameter);

    stateinitial: State_Initial_Non_Functional
    transition StartExperiment1 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_1;
    }
    transition StartExperiment2 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_2;
    }
    transition StartExperiment3 --> State_TimeStampModulation
    {
      TimeStamp = TimeStampIn;
      xCurrentExperiment = EXPERIMENT_3;
    }
  }
  
```

Testing Verdicts



DIVERSITY

```

testcase TC_trace2() runs on runOn_SSH system SSH {
  //activate(RTOS_fall());
  map(mtcc:Env1, system: cEnv1)
  map(mtcc:Env2, system: cEnv2)
  cEnv1.send(networkinput_trace2_LINK_0_param0)
  cEnv2.send(branchinput_trace2_LINK_1_param0)
  cEnv2.receive(branchoutput_trace2_LINK_2_param0)
  setVerdict(pass)
}

testcase TC_trace3() runs on runOn_SSH system SSH {
  //activate(RTOS_fall());
  map(mtcc:Env1, system: cEnv1)
  map(mtcc:Env2, system: cEnv2)
  map(mtcc:Env3, system: cEnv3)
  cEnv1.send(networkinput_trace3_LINK_0_param0)
  cEnv2.send(branchinput_trace3_LINK_1_param0)
  cEnv3.receive(vertexoutput_trace3_LINK_3_param0)
  setVerdict(pass)
}

testcase TC_trace4() runs on runOn_SSH system SSH {
  //activate(RTOS_fall());
  map(mtcc:Env2, system: cEnv2);
  cEnv2.send(branchinput_trace4_LINK_0_param0)
  setVerdict(pass)
}
  
```

TTCN-3 Test Cases



Eclipse TITAN



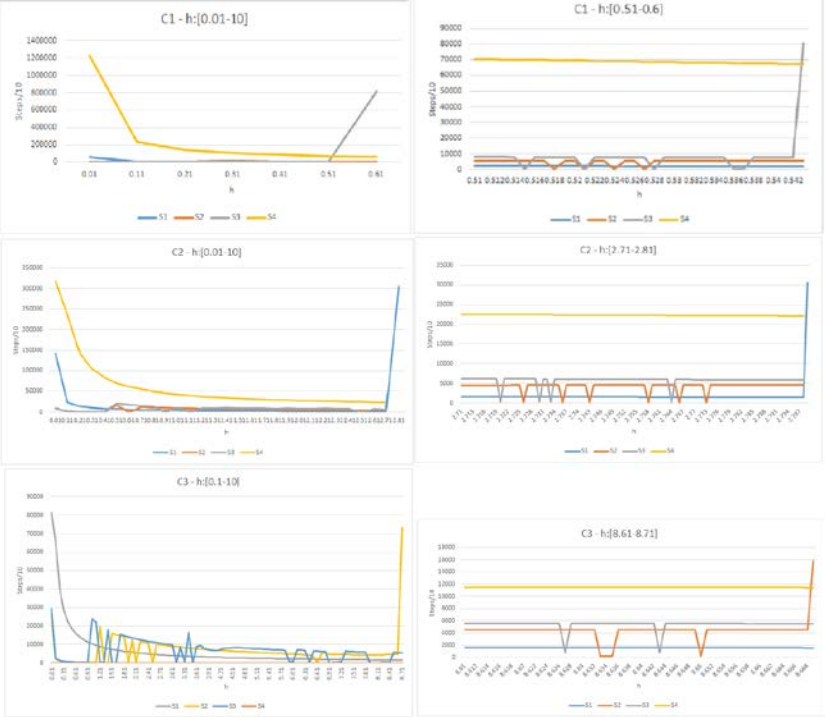
Testing Automation

- Model validation
 - Require automation of model creation
- Performance Estimation (Automated Process)
- Functional Testing
 - Require automation of model creation
- Non-functional Testing
 - Require automation of model creation

Testing Results

```

artemis@artemis-EGM: ~/git/titan_phantom/MBT-Titan/Intecs_v2
MTC@artemis-EGM: Default with id 1 (altstep RTDS_fall) was deactivated.
MTC@artemis-EGM: Stop timer t_phantom: 100 s
MTC@artemis-EGM: Port cPortGeneric_Port was stopped.
MTC@artemis-EGM: Component type TTCN_Component.TestComponent was shut down inside testcase TestCase_71.
MTC@artemis-EGM: Waiting for PTCs to finish.
MTC@artemis-EGM: Setting final verdict of the test case.
MTC@artemis-EGM: Local verdict of MTC: pass
MTC@artemis-EGM: No PTCs were created.
MTC@artemis-EGM: Test case TestCase_71 finished. Verdict: pass
MTC@artemis-EGM: Execution of control part in module TTCN_TestSuite finished.
MC@artemis-EGM: Test execution finished.
Execution of [EXECUTE] section finished.
entc
MC@artemis-EGM: Terminating MTC.
MTC@artemis-EGM: Verdict statistics: 0 none (0.00 %), 57 pass (80.28 %), 0 inconc (0.00 %), 14 fail (19.72 %), 0 error (0.00 %).
MTC@artemis-EGM: Test execution summary: 71 test cases were executed. Overall verdict: fail
MTC@artemis-EGM: Exit was requested from MC. Terminating MTC.
MC@artemis-EGM: MTC terminated.
MC2> exit
MC@artemis-EGM: Shutting down session.
HC@artemis-EGM: Exit was requested from MC. Terminating HC.
MC@artemis-EGM: Shutdown complete.
    
```



Conclusion and Future Work

- **Early testing** in parallel with application development
- **Thorough test execution** for functional and non-functional aspects
- **End-to-end test automation** for component-based applications

- ❖ Offline testing solution,
To combine testing automation with online testing
- ❖ Rely on previously modeled/tested components,
To consider/tolerate non-tested components in automation

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Organizer:  **TESTING
SOLUTIONS
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Thank you!



Dr. Wenbin Li
Research Engineer

wenbin.li@eglobalmark.com