Timing analysis of TASTE models for reconfigurable software





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Overview

- Context
 - MOSAR Project
 - TASTE Toolset
- Case Study for SW reconfiguration
- AADL Timing analysis
- Conclusion





Context





MOSAR Project



MODULAR SPACECRAFT ASSEMBLY & RECONFIGURATION CHANGING THE FUTURE OF SPACE MISSIONS





ThalesAlenia SITAEL



MOSAR is a propert to-funded by the Heritain 2020 programme of the European Commission (Grant 821966)

NOSAR WILL CHANGE OUR VISION OF SPACE SERVICING FOREVER

Servicer satellite

(6)

Client satellite



tions

applications

application

SERVICES











Case study for SW reconfiguration







Configurations

batOnly





withOSP2









withOSP1and2

















Data View

1	DATAVIEW DEFINITIONS ::=
2	BEGIN
3	ID-Integer ::= INTEGER (0 9)
4	OP-Integer ::= INTEGER (0 99)
5	Value-Integer ::= INTEGER (0 999)
6	
7	Message ::= SEQUENCE {
8	id ID-Integer,
9	op OP-Integer,
10	value Value-Integer,
11	}
12	<pre> Regex +{id:[0-9]}{op:[0-9](2)}{value:[0-9](3)}+</pre>
13	END

Packet	Id	Operation	Value	Action
001000	0	01	000	Ask battery level top BAT payload.
102000	1	02	000	Take a picture with 0SP1 payload.
203001	2	03	001	Take a picture with 0SP2 payload.
306002	3	06	002	Change current mode to mode 2 with mode automaton.











Interface View













Deployment View





Adding AADL modes to TASTE

```
SYSTEM IMPLEMENTATION OBC. others
SUBCOMPONENTS
  PUS_Services : SYSTEM interfaceview::IV::OBC::PUS_Services::PUS_Services.others {
    Taste::coordinates => "22895 112321 73565 134241";
   Taste::Fill Color => "#5656E4";
  };
  BAT_Module : SYSTEM interfaceview::IV::OBC::BAT_Module::BAT_Module.others {
    Taste::coordinates => "52704 79206 103372 101177";
   Taster Fill Color -> "#1/16F0".
  } IN MODES ( onlyBat, withOsp1, withOsp2, withOsp1and2 );
 USP2_Module : SYSTEM interfaceview:::v::UBC::USP2_Module::USP2_Module.others {
    Taste::coordinates => "39501 48405 90281 70413";
   Taste::Fill Color => "#1614E6";
  } IN MODES ( withOsp2, withOsp1and2 );
  OSP1_Module : SYSTEM interfaceview::IV::OBC::OSP1_Module::OSP1_Module.others {
    Taste::coordinates => "22680 18908 73367 40866";
   Taste::Fill_Color => "#1611E6";
  } IN MODES ( withOsp1, withOsp1and2 );
  Mode_Automaton : SYSTEM interfaceview::IV::OBC::Mode_Automaton::Mode_Automaton.others {
   Taste::coordinates => "67800 136591 106923 155684";
   Taste::Fill_Color => "#FF68BB";
  };
```











Concurrency View

```
thread implementation 0sp2_Zed_Control
properties
```

Initialize_Entrypoint_Source_Text =
Compute_Entrypoint_Source_Text =
Dispatch_Protocol =
Period =
Dispatch_Offset =
Compute_Execution_Time =
Stack_Size =
Priority =
Deadline =

```
annex behavior_specification {**
  variables
     local, raw : int;
  states
     s : initial complete final state;
  transitions
      t : s -[on dispatch]-> s {
         --active !>;
         local := active;
         --active !<;</pre>
=
         if (local > 0)
=
            computation(8ms);
=
            for (i in 0 .. 4) {
=
                  computation(2ms);
                  MOSAR::Marshalling::marshal!(2, 5, i, raw);
=
                  OUTPORT_R_Icu_Osp2_Tm!(raw)
=
=
         end if
      };
  **}:
  end Osp2_Zed_Controller_Trigger.others;
```





AADL timing analysis







• Marzhin simulation

• Cheddar worst case analysis

• Cheddar SCM worst case analysis

• Discussion











Simulation scenario



Mode withOsp1and2





Marzhin timelines







Cheddar worst case analysis

Data View Interface View Deployment View Concurrency View AADL

	🛹 THE SITI		
	test	entity	result
Þ	Task response time computed from simulatio	bat_x86_linux	No deadline missed in the computed scheduling : the task set is sched
D 🜔	Task response time computed from simulatio	ground_x86_linux	Some task deadlines will be missed : the task set is not schedulable.
- √ 🤅	Task response time computed from simulatio	obc_x86_linux	One or several tasks did not complete their execution.
	Number of preemptions	obc_x86_linux	0
	Number of context switches	obc_x86_linux	4
	Task response time computed from simulatio	obc_x86_linux.obc.bat_module_obc_bat_tm	worst = 19, best = 19 and average = 19.00000
	Task response time computed from simulatio	obc_x86_linux.obc.mode_automaton_target	worst = , best = and average =
	Task response time computed from simulatio	obc_x86_linux.obc.osp1_module_obc_osp1_tm	worst = 50, best = 50 and average = 50.00000
	Task response time computed from simulatio	obc_x86_linux.obc.osp2_module_obc_osp2_tm	worst = 30, best = 30 and average = 30.00000
	Task response time computed from simulatio	obc_x86_linux.obc.pus_services_tc	worst = 3, best = 3 and average = 3.00000
Þ	Task response time computed from simulatio	osp1_x86_linux	No deadline missed in the computed scheduling : the task set is sched
Þ	Task response time computed from simulatio	osp2_x86_linux	No deadline missed in the computed scheduling : the task set is sched
Þ	Task response time computed from simulatio	r_icu_x86_linux	No deadline missed in the computed scheduling : the task set is sched
- ⊽ 🧕	Task response time computed from simulatio	ground_to_obc	Some task deadlines will be missed : the task set is not schedulable.
	Number of preemptions	ground_to_obc	0
	Number of context switches	ground_to_obc	2
	Task response time computed from simulatio	ground_to_obc.ground_to_obc_channel.obc.bat_module_obc_bat_tm.outport_tm.ground.ground_tm.inport_tm	worst = 20, best = 20 and average = 20.00000
	Task response time computed from simulatio	ground_to_obc.ground_to_obc_channel.obc.osp1_module_obc_osp1_tm.outport_tm.ground.ground_tm.inport_tm	worst = 51, best = 51 and average = 51.00000
	Task response time computed from simulatio	ground_to_obc.ground_to_obc_channel.obc.osp2_module_obc_osp2_tm.outport_tm.ground.ground_tm.inport_tm	worst = 31, best = 31 and average = 31.00000
Þ	Task response time computed from simulatio	obc_r_icu	No deadline missed in the computed scheduling : the task set is sched
Þ¢	Task response time computed from simulatio	r_icu_bat	No deadline missed in the computed scheduling : the task set is sched
Þ	Task response time computed from simulatio	r_icu_osp1	No deadline missed in the computed scheduling : the task set is sched
Þ	Task response time computed from simulatio	r_icu_osp2	No deadline missed in the computed scheduling : the task set is sched





Cheddar SCM worst case analysis







Discussion of the results

	Marzhin Simulation	Cheddar Worst Case	Cheddar SCM
onlyBAT			
withOSP1			
withOSP2			
withOSP1and2		×	
	optimistic	pessimistic	less pessimistic
M B 20 S E			2

Conclusion





Conclusion

- MBSE helps with early detection of major schedulability issues.
- Strong semantics at model level is a requirement (AADL).
- MOSAR project has increased the maturity of timing analysis tools.
 - TASTE editors version 2.4 include these enhancements (except the Cheddar SCM scheduling analysis prototype)
 - Commercially supported solution for AADL Scheduling, safety and cyber-security analysis tools is available with AADL Inspector
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Thank you for watching