A comparative study of FIACRE and TASM to define AADL real time concepts

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UML&AADL’09
02/06/2009
Outline

1. Motivation

2. Background
   - AADL
   - Target formalisms

3. Comparative Modeling
   - FIACRE
   - TASM

4. Conclusion
TOPCASED

(Meta)-modeller

Editors

Model Transformations

Intermediate language

Compilers

Model-Checkers

Simulators

Modelling languages

PDL  AADL  SDL  UML  SYSML

ATL, Kermeta

Fiacre

Translation

CADP  Tina  ...

ACADIE
Motivation

- Formal expression of Architecture Analysis & Design Language (AADL) semantics
- Analysis of AADL models
  - end-to-end flow latency
  - schedulability
  - buffer overflows
  - users properties
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AADL

- Hierarchical definition of hardware / software systems
- Real-time models
- Communicating threads: port based or shared memory based communications
  - Periodic or sporadic threads
  - Immediate and delayed communications
  - Execution time of tasks (WCET)
Synchronous subset of AADL

- Periodic threads
- Data port communication
- Immediate and delayed communication
Immediate Communications

AADL implementation of instantaneous communications of the synchronous model
Immediate Communications

\[ f_1 = q_1 \times f \]
\[ f_2 = q_2 \times f \]

(a) synchronous
\( q_1 = q_2 = 1 \)
Immediate Communications

![Diagram showing immediate communications between T1 and T2]

- \( f_1 = q_1^*f \)
- \( f_2 = q_2^*f \)

wr (sample)

T1

T2

rd (sample)

(b) oversampling
\( (q_1=1, q_2=3) \)
Immediate Communications

\[ f_1 = q_1 \times f \]
\[ f_2 = q_2 \times f \]

wr (sample)

T1

T2

rd (sample)

(c) undersampling
\( q_1 = 3, q_2 = 1 \)
Delayed Communications

AADL implementation of the delay operator of the synchronous model

\[ f_1 = q_1 \cdot f \]
\[ f_2 = q_2 \cdot f \]
## Comparison

<table>
<thead>
<tr>
<th></th>
<th>Communication</th>
<th>Synchronization model</th>
<th>Time model</th>
<th>Resource management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIACRE</strong></td>
<td>port/shared data</td>
<td>Communicating Processes</td>
<td>Timed</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Transition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Systems implicit</td>
<td></td>
</tr>
<tr>
<td><strong>TASM</strong></td>
<td>shared data</td>
<td>Calculus Communication Systems</td>
<td>continuous</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>implicit</td>
<td></td>
</tr>
</tbody>
</table>
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Modeling periodic thread execution in FIACRE

Thread automaton

Scheduler automaton

process P1 [dispatch1 : in none,
execute1 : in none,
computation1 : in none,
completion1 : out int] is

states s0, s1, s2, s3
var x : data
init to s0
from s0 dispatch1; to s1
from s1 execute1; to s2
from s2 computation1; to s3
from s3 completion1!x; to s0

process P2 [dispatch2 : in int,
execute2 : in dataOption,
computation2 : in none,
completion2 : out none] is

states s0, s1, s2, s3
var x : data, o : dataOption
init to s0
from s0 dispatch2?x; to s1
from s1
select
execute2?None; to s2
[] execute2?Some x; to s2
end
from s2 computation2; to s3
from s3 completion2; to s0
Motivation

Background

Comparative Modeling

Conclusion

FIACRE

TASM

Modeling communication semantics in FIACRE

Jean-Paul Bodeveix

AADL data communication
component sys is
  port t1 : none in [2,2], t2 : none in [3,3], t3 : none in [4,4], tmp : none in [6,6],
  e1 : none in [0,0], e2 : dataOption in [0,0], e3 : dataOption in [0,0],
  w1 : none in [0,1], w2 : none in [0,1], w3 : none in [0,1],
  d1 : none in [0,0], d2 : int in [0,0], d3 : int in [0,0],
  c1 : int in [0,0], c2 : none in [0,0], c3 : none in [0,0],
  dl1 : none in [2,2], dl2 : none in [3,3], dl3 : none in [4,4]
priority
c1>t1, c2>t2, c3>t3,
t1|t2|t3>d1|d2|d3,
d1>d2, d1>d3,
d1|d2|d3>e1|e2|e3,
e1>e2
par
  P1[d1, e1, w1, c1] || P2[d2, e2, w2, c2] || P2 [d3, e3, w3, c3]
  || Buf_immediate[e2, c1, tmp]
  || Buf_delayed[d3, c1, dl1]
  || scheduler[t1, t2, t3, c1, c2, c3, d1, d2, d3, e1, e2, e3, dl1, dl2, dl3]
end
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FIACRE

Modeling periodic thread execution in TASM

\[
\begin{align*}
\text{t:=Deadline} \\
\text{Processor:=WCET*100/deadline}
\end{align*}
\]

\[
\begin{align*}
y & := f(x) \\
d & := d
\end{align*}
\]

**Periodic Thread**

MAIN MACHINE: Period
Rule: period
\[
\{ 
\quad \text{t := period;}
\quad \text{if Nextdispatch = false then}
\quad \text{Nextdispatch := true;}
\quad d!;
\}
\]

MAIN MACHINE: Execution
Rule: execution
\[
\{ 
\quad \text{t := [0,deadline];}
\quad \text{processor := WCET*100 / deadline;}
\quad \text{if Complete = false then}
\quad \text{Complete := true;}
\quad d?;
\}
\]
Modeling communication semantics in TASM

Immediate communication

Delayed communication

Jean-Paul Bodeveix
AADL data communication
Conclusion

- Schemas for expressing some real-time concepts in FIACRE and TASM.
  - AADL periodic threads.
  - AADL delayed and immediate communications
- FIACRE powerful for real time - verification through timed Petri nets.
- TASM powerful abstraction for resource management (including time) - verification through priced timed automata.

⇝ better understanding of AADL.
⇝ ideas for defining FIACRE extensions.