Modes in asynchronous systems

J-F. Rolland - M. Filali - J-P. Bodeveix
D. Thomas -D. Chemouil

ASTRIUM - IRIT - CNES

UML-AADL
April 2008

Outline

Outline

Context of the study

- general study : superpose to AADL precise description standard a formal description.
- provide a formal specification for :
  - simulators.
  - verification tools.
  - code generators.
  - general purpose tools base of model transformations.
- approach : use of TLA.

Modes in real time systems

- Real time systems imply a fixed set of tasks
- Number of real time system have different behaviors
  $\longrightarrow$ multi-moded systems
- A mode is characterized by :
  - A set of functionalities
  - A set of tasks
  - And a set of active hardware

Example

- Typical example : the aircraft
  - take-off
  - landing
  - cruise
- Another example : Satellite inboard software
  - Launch
  - Operational
  - Safe
  - Low power

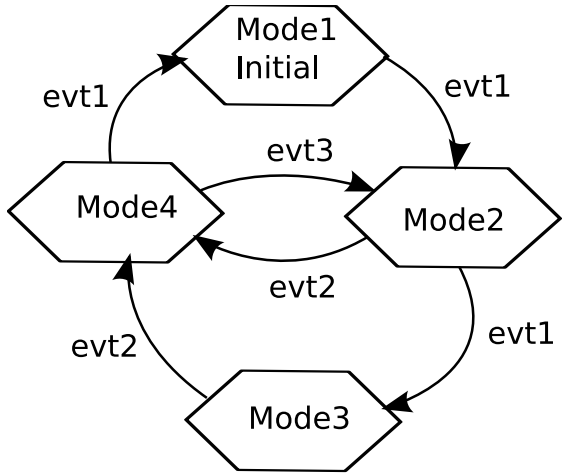
Outline

Modes in AADL

- Describe different operational states
  - Software and hardware components
  - Connections
  - Properties
- Each component can have different configurations
- Mode transition : a complex behavior

The mode automaton

- State → Mode
  - Name
  - One must be initial
- Transition
  - Name
  - Associated to an event
  - Deterministic transitions



Mode dependent architecture

- Subcomponents

```
Main_Gps: process Gps_Sender.Basic
          in modes (Dualmode, Mainmode);
Backup_Gps: process Gps_Sender.Basic
          in modes (Dualmode, Backupmode);
```

- Connections

```
data port Main_Gps.Position -> Position
          in modes (Dualmode, Mainmode);
data port Backup_Gps.Position -> Position
          in modes (Backupmode);
```

- Properties

```
bool1 => false in modes (M1);
bool2 => true in modes (M2);
```

Outline

Abstract specification of modes

- Focus on the mode transitions :
  - No scheduling
    - Active
    - Inactive
    - Awaiting Mode
  - No communications
- A simple deterministic mode automaton

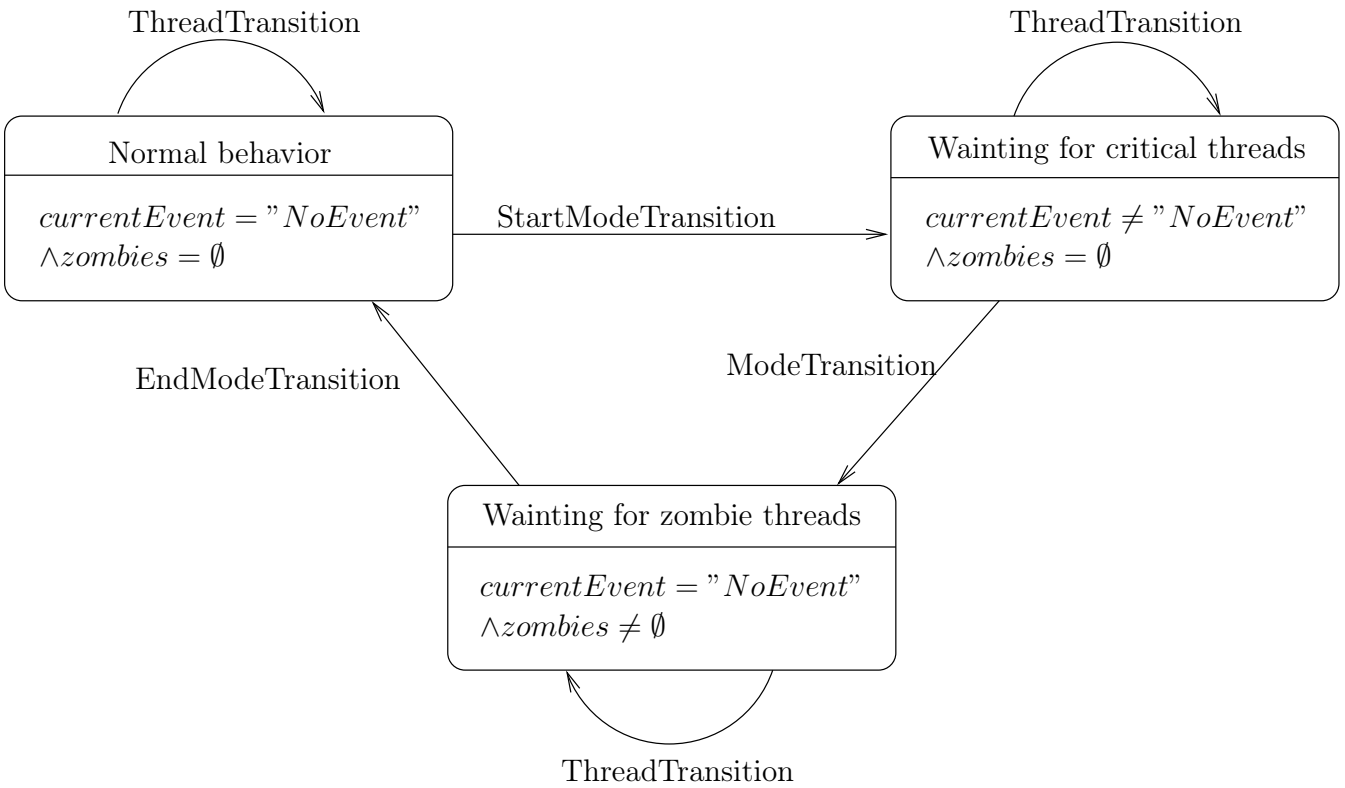
Thread types and transition atomicity

- Thread types :
  - Critical threads must terminate in the current mode.
  - Normal threads can be stopped in the current mode.
  - Zombie threads are allowed to survive in the next mode.

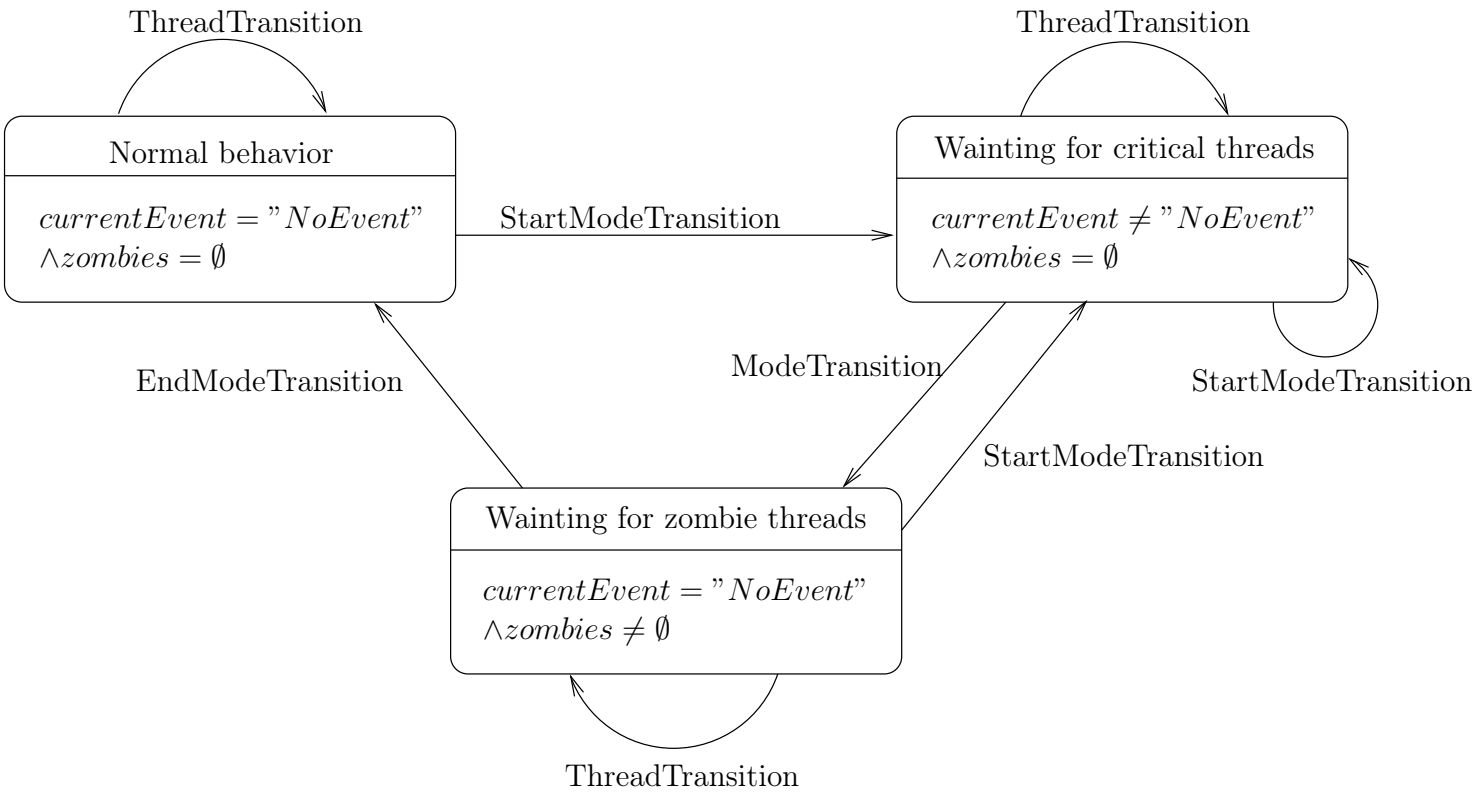
$\rightsquigarrow$ Mode transitions cannot be atomic :

- `StartModeTransition`.
- `ModeTransition`.
- `EndModeTransition`.

Mode transitions



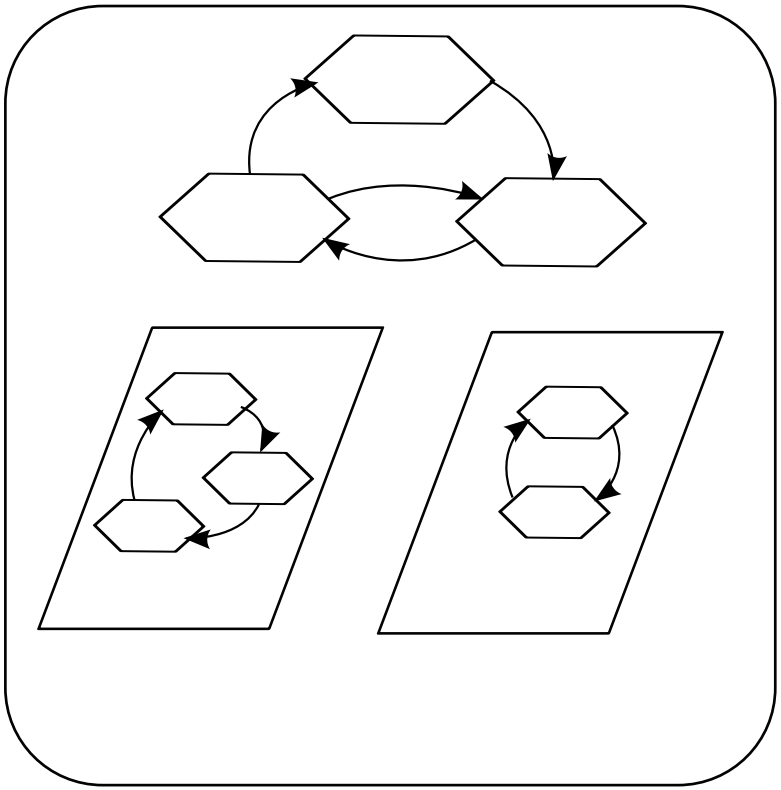
Mode transitions



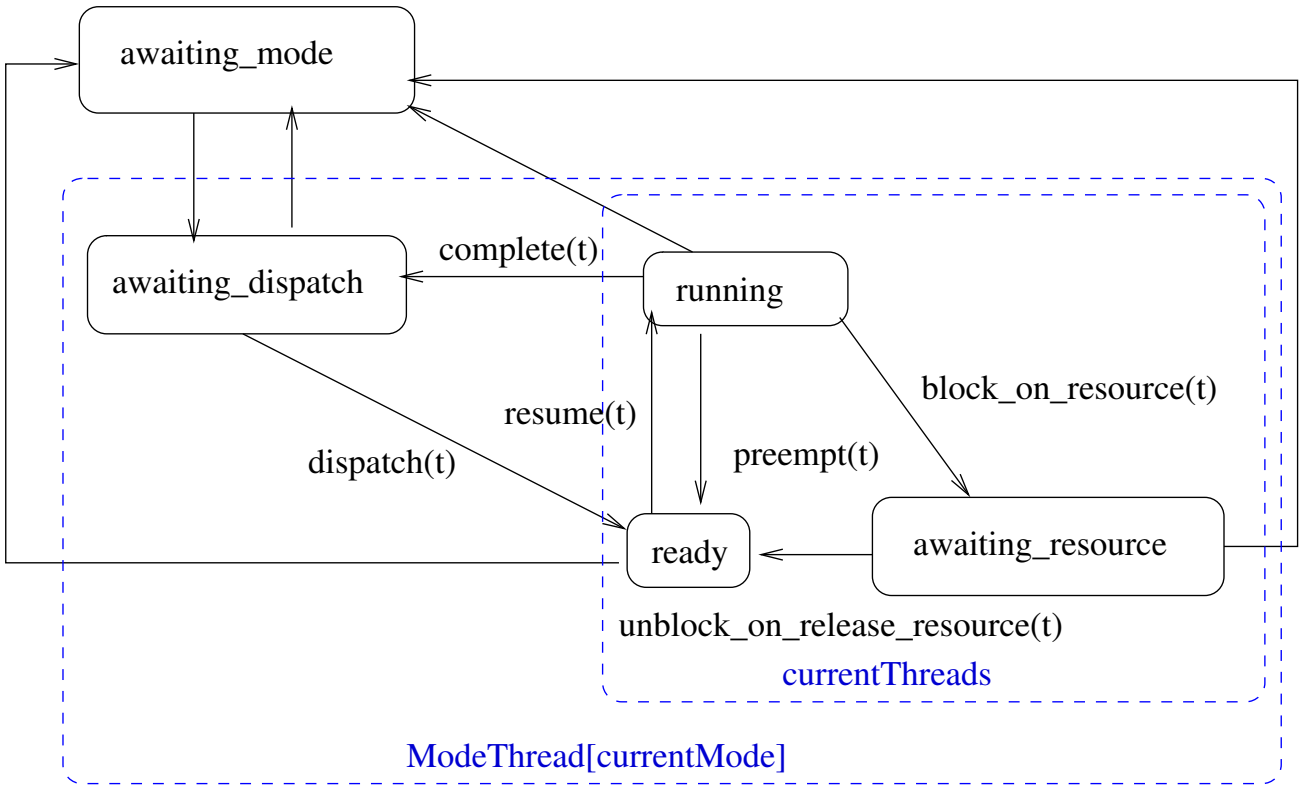
Outline

Correspondance with AADL modes

- In AADL mode may be defined at different hierarchical levels
- Only one level for the abstraction : flat automatons
- Equivalent to the mode automata of the instance model



Scheduling abstraction



Properties correspondence

- Synchronized property :
- Active_thread_handling_protocol property :
- Urgency property :

Properties correspondence

- Synchronized property :
  - Periodic threads
  - Mode switch only occurs at the hyperperiod of synchronized threads
  - In AADL V1 : a boolean value
  - Evolution : A list of transition name

  $\longrightarrow$ Corresponds to critical threads
- Active_thread_handling_protocol property :
- Urgency property :

Properties correspondence

- Synchronized property :
- Active_thread_handling_protocol property :
  - Define the protocol used to process buffers of the thread
  - Allow specific thread to end their execution in the new mode

  $\longrightarrow$ Equivalent to zombie threads
- Urgency property :

Properties correspondence

- Synchronized property :
- Active_thread_handling_protocol property :
- Urgency property :
  - Used in the dispatch of aperiodic thread
  - Used to choose a mode transition

  $\longrightarrow$ Corresponds to the priority of the transition

Outline

Status of the specification

- Model of AADL execution platform :
  - scheduling (Fixed priorities)
  - shared resources (IPCP)
  - Timed communications through ports and shared resources
  - Modes
- Checked properties
  - Schedulability
  - Size of buffers
  - Integrity of shared data
  - No deadlock

Outline

Conclusion

- formal description of AADL modes
  - abstraction of AADL modes
  - concretization of the abstraction
- perspectives :
  - provide early verifications for models based on modes.
  - study some implementations schemes.

the end

thank you for your attention.
Questions ?