Adaptive Schedulability Analysis

Luca Santinelli

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Real-Time Systems

• Applications
• Resource reservation mechanisms
• Other system elements (memories, buses, shared resources mechanisms, etc)
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• Resource reservation mechanisms
• Other system elements (memories, buses, shared resources mechanisms, etc)...

Guarantee timing constraints!
Schedulability Analysis

- Classical real-time analysis: **Processor Demand Criterion, Response Time Analysis**
- Abstractions and analysis:
  Curves -> dbf, sbf, wbf (and bdf), Real-Time Calculus, etc.
  Schedulability conditions -> Comparison among curves
Schedulability Analysis

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Adaptivity

From Artist website: “Adaptive Real-Time: “This is a more recent approach to embedded systems design, where temporal constraints can be relaxed, which allows optimized use of resources. This includes applications – where managing the Quality of Service (QoS) is essential, such as telecommunication systems, multi-media, and wide-area networked applications. In this relatively new area, there is a recognized lack of design theory and tools.”

Adaptivity is the capability to adapt to changing conditions

- Applications: tasks (C,T,D) required to change
- Resource reservation mechanisms: servers (Q,P) required to adapt

Adaptivity both in terms of modeling and analysis
Present the model first, then discuss the analysis...
Mode Change

resource

application

mode II

? \( \delta \)

mode II

\( t_{req} \)

\( t_{go} \)
**Mode Change**

- **Applications:** changes at task levels (task activation, deletion, modifications), mode I to mode II, mode transitions taken into account - “almost” done

- **Resource reservation mechanisms:** TDMA servers, periodic servers (stable states and transition characterized); contract-based approaches - in progress

- **Other system elements** - not considered
Mode Change cont.

The mode change analysis:
Requires characterization of the steady states and the transitions
With applications -> Delays
With resource reservations -> Delays?

Tight and safe bounds... for an accurate analysis
Mode Change cont.

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Tight and safe bounds... for an accurate analysis

Limited and constrained analysis:
 a) Synchronous mode changes
 b) Macro changes
 c) [Binary] analysis: schedulability or not (at most deriving a delay)
 d) Transitions: definition of transient - when does it ends (stable condition)?
Mode Change cont.

How to integrate application, resource reservations and other element mode changes?
Mode Change cont.

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That’s an open problem...
Adaptivity in practice

Guarantee timing constraints in each condition!

• Complex transitions
  Sequences of transitions (multiple transitions)
  Asynchronous transitions
  Active and passive elements - centralized (application and server monitors) or distributed (which possible complex mechanisms to be developed?) management and analysis

• Composability
  Component-based real-time systems: isolation of the analysis and interface-based adaptivity analysis
What else?

- Another model than the multi-mode?
- Another analysis?
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These are open problems...
To open the discussion...

- Transition [reactive] strategies: how to define a real-time (guaranteed) sequence of intermediate steps from mode I to mode II
- From micro-modes to a fluid-mode model: how can it be developed a more fine grained model and analysis?
- How to develop cooperative strategies? [Active and passive elements + transition manager]