Introduction

Example Application Scenario

A Distributed MPEG-2 Decoder

Video Interface

Output

Input

Playback buffer

PB9

PB3

 PE2

Processing
Element

stream LR

stream HR

stream HR

stream LR

PE1

PE3

PE4

PB4

PB5

PB6


Problems

Analyse a heterogeneous stream processing distributed embedded system for:

- Minimum and sufficient buffer spaces in each node
- Maximum end-to-end delays
- Minimum and sufficient resource capabilities for each node
- Maximum stream data rates handled by the system

Method

1. Use Variability Characterization Curves to model:
   - Data streams – characterize the burstiness in the arrival pattern of events;
   - Resource capabilities – characterize the variability in the service provided by a hardware resource;
   - Buffer readouts – characterize the variability of the number of items being read from a buffer

2. Define reusable abstract components that model the real-time properties of concrete HW/SW components:
   - Processing elements – components which contain one or more greedy processors;
   - Readout buffers – components containing only a buffer

3. Define Rate Interfaces based on Real-Time Interfaces and Assume/Guarantee Interfaces (Henzinger et al.) for the abstract components with input and output predicates which define compatibility of two components: their interfaces are compatible if the rates of the outputs of one interface are compatible with the rates of the inputs of the other interface. Compatibility guarantees buffer underflow and overflow constraints

4. Define Real-time Calculus relations (based on Network Calculus) in the abstract components to allow for distributed systems and explicitly model the buffer sizes

5. Compose a model of the system from the components and check compatibility at each interface connection while composing

Experimental Results

- Check the interfaces between PE1 and PE2 given different initial buffer fill-levels in PB9
  - 2 video streams (704x576 pixels) in a picture-in-picture MPEG-2 decoder with 3 processing elements and 2 readout buffers
  - 704x576 pixels, CBR, 8Mbps, 25fps, SimpleScalar models with the PISA instruction set, macroblock granularity
  - RTC Toolbox and Matlab – www.mpa.ethz.ch

References