Estimating Operating System Resource Occupation by Simulation

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Topics

1. Introduction
2. Model Overview
3. Model Details
4. Simulation and Evaluation
5. Conclusion

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1. Introduction

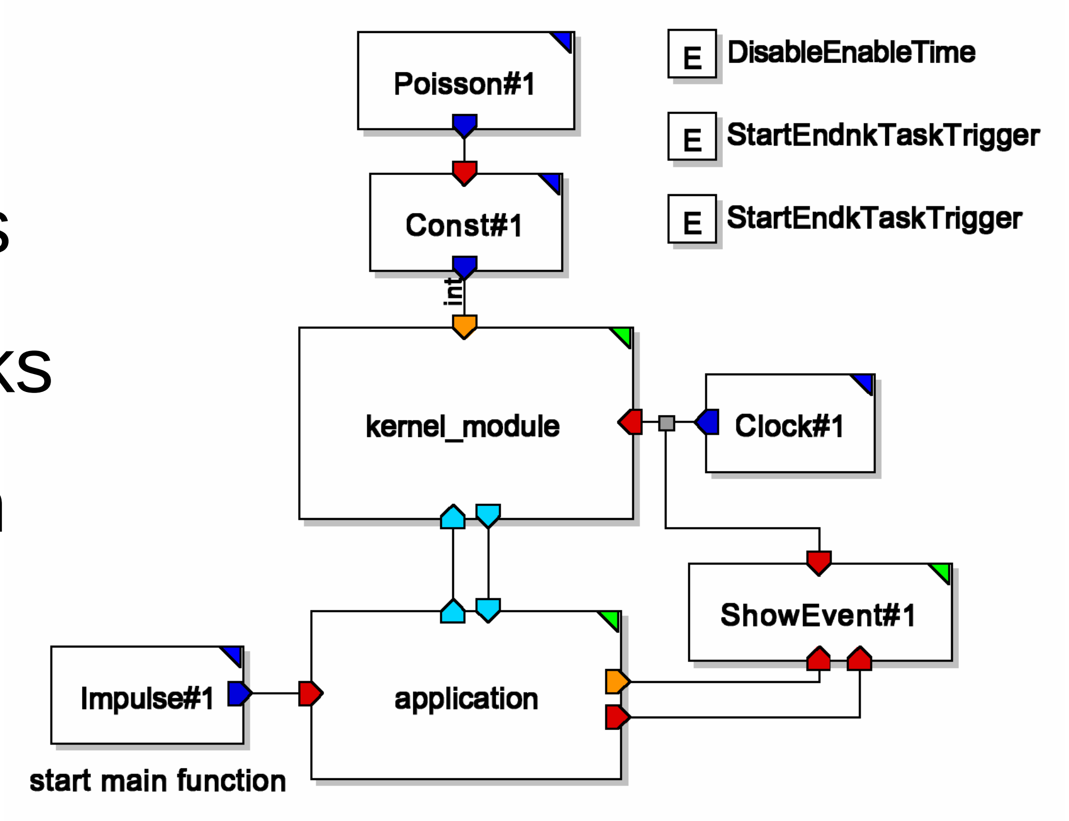
- Modeling Real Time Operating Systems (RTOS)
- Kernel and application levels
- Goals:
  - Functional validation
  - Quantitative estimation of properties
- Hierarchical discrete-event models
- MLDesigner tool used

Operating System *e*RTOS

- Study based on special system ‘eRTOS’
- Developed for high performance DSP systems
- Multiple scheduling strategies:
    - Rate monotonic
    - Preemptive
- Resource management:
    - Device, memory, message
- Circular memory buffer (FIFO)

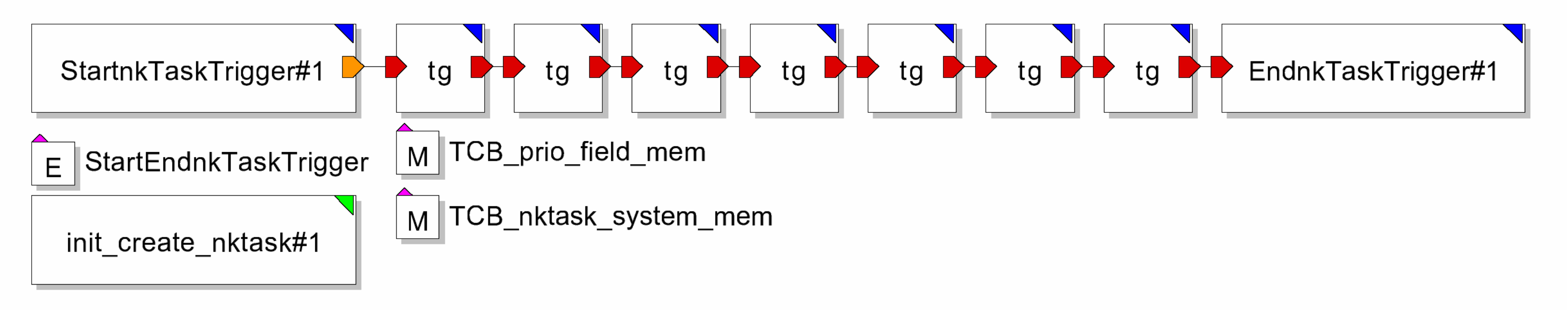
2. Model Overview

- DE domain
- Parts:
  - Kernel modules
  - Application tasks
  - Instrumentation (e.g. triggers, displays)



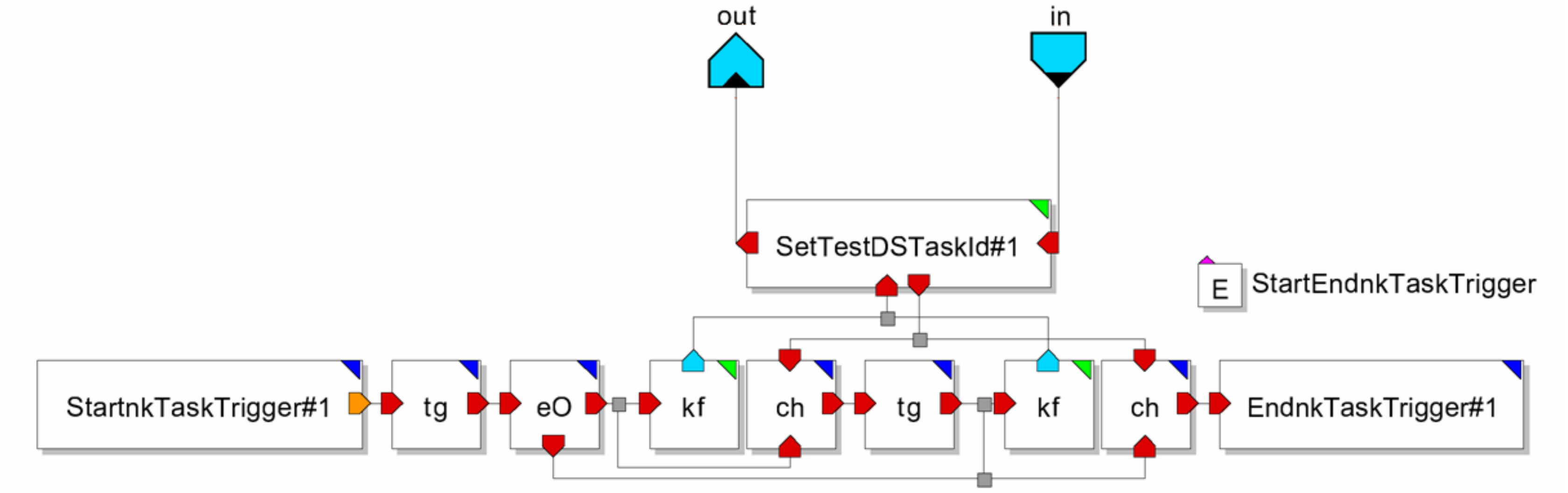
3. Model Details: Basic Task Model

- Atomic blocks with known time consumption
- Task switch at block boundaries only
- Time info collected by instrumentation blocks (not shown)



Complex Task Model

- Branches and forks (here: *eO*)
- Kernel function calls: *kf, ch*
- Call and return ‘busses’ carry named events

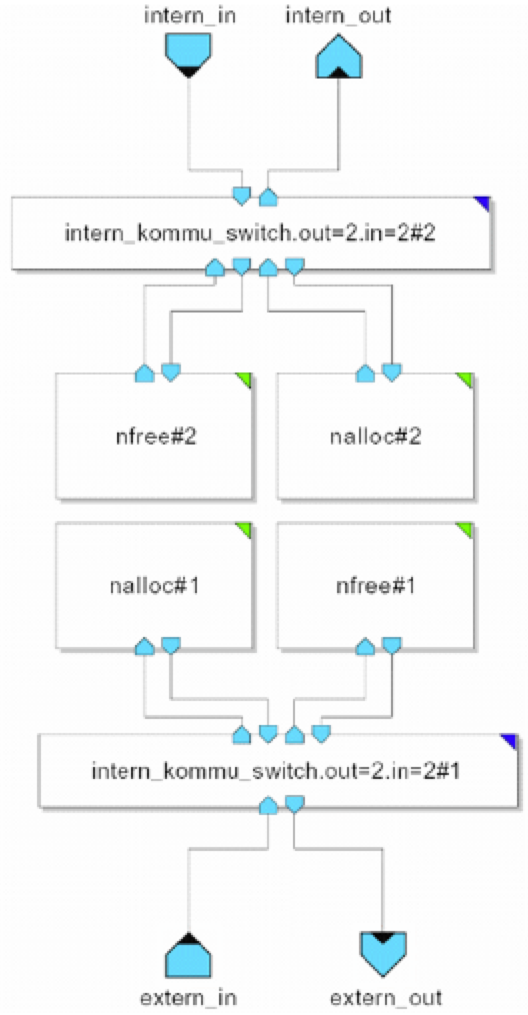


Kernel Model Overview

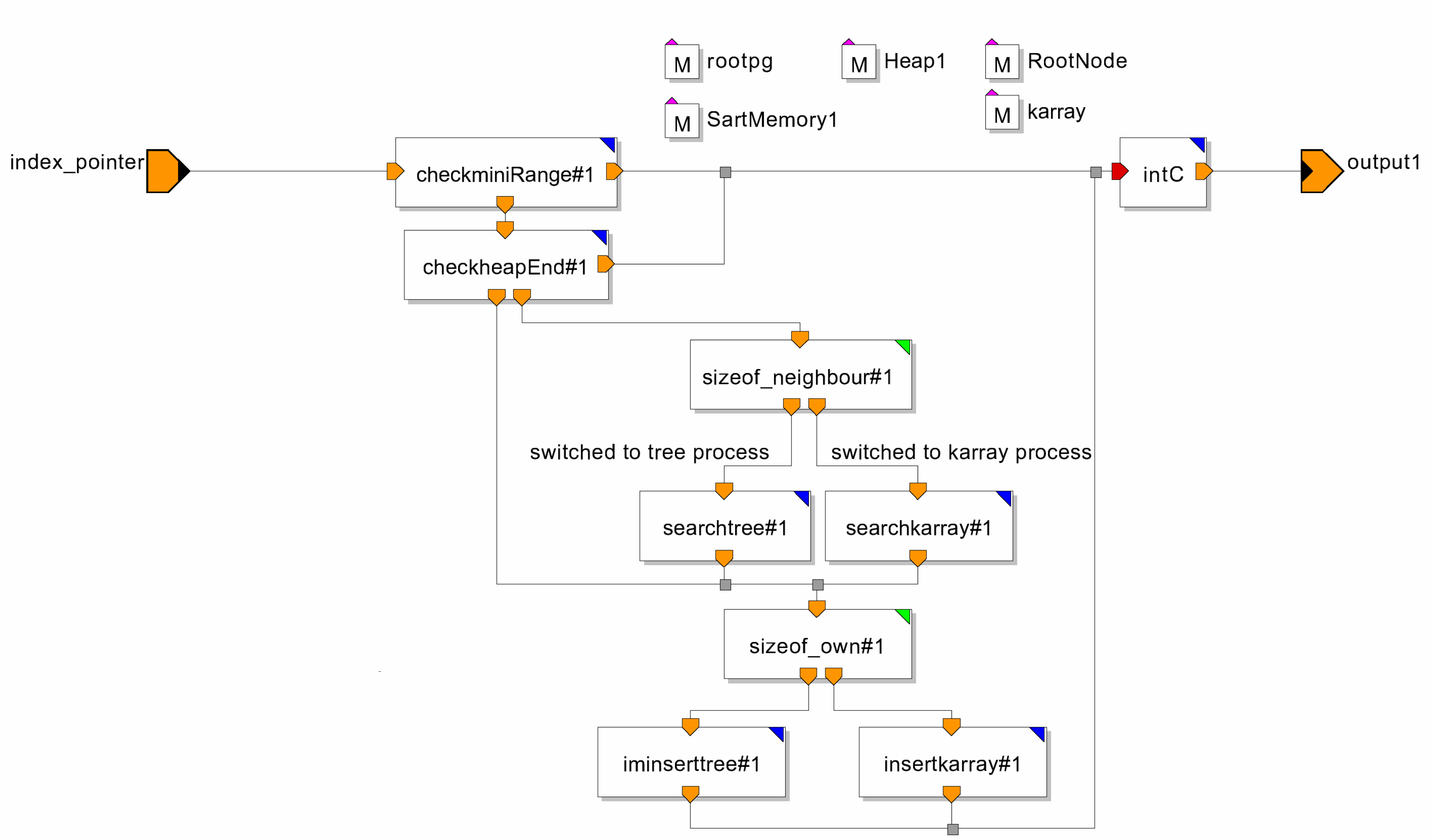
- Scheduler:
  - Combined (rate monotonic + preemptive)
- System services: Pair of blocks for each
  - Interface to application tasks
  - Interface to other kernel modules
- Invoced by events
- States represented by shared objects

Memory Management Module

- Functions shown:
  - *nalloc()* allocating memory
  - *nfree()* releasing memory
- Linked by shared variables
- Info for logging purposes provided



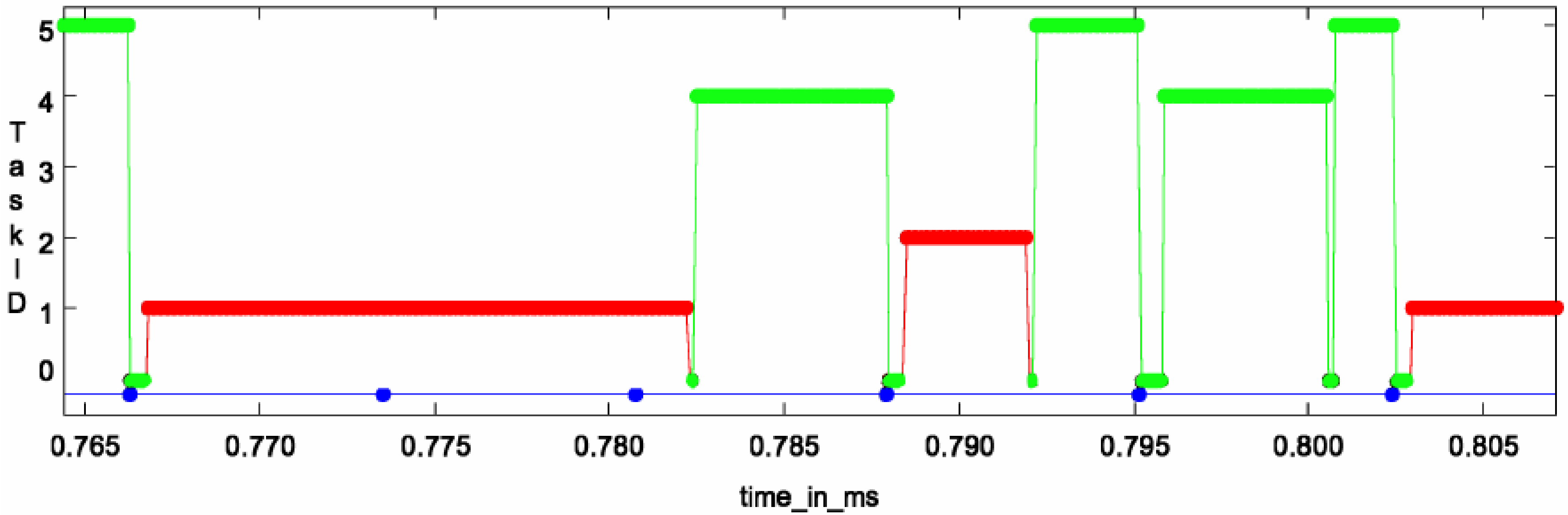
Module ‚nfree‘ in Memory Management



4. Simulation and Evaluation

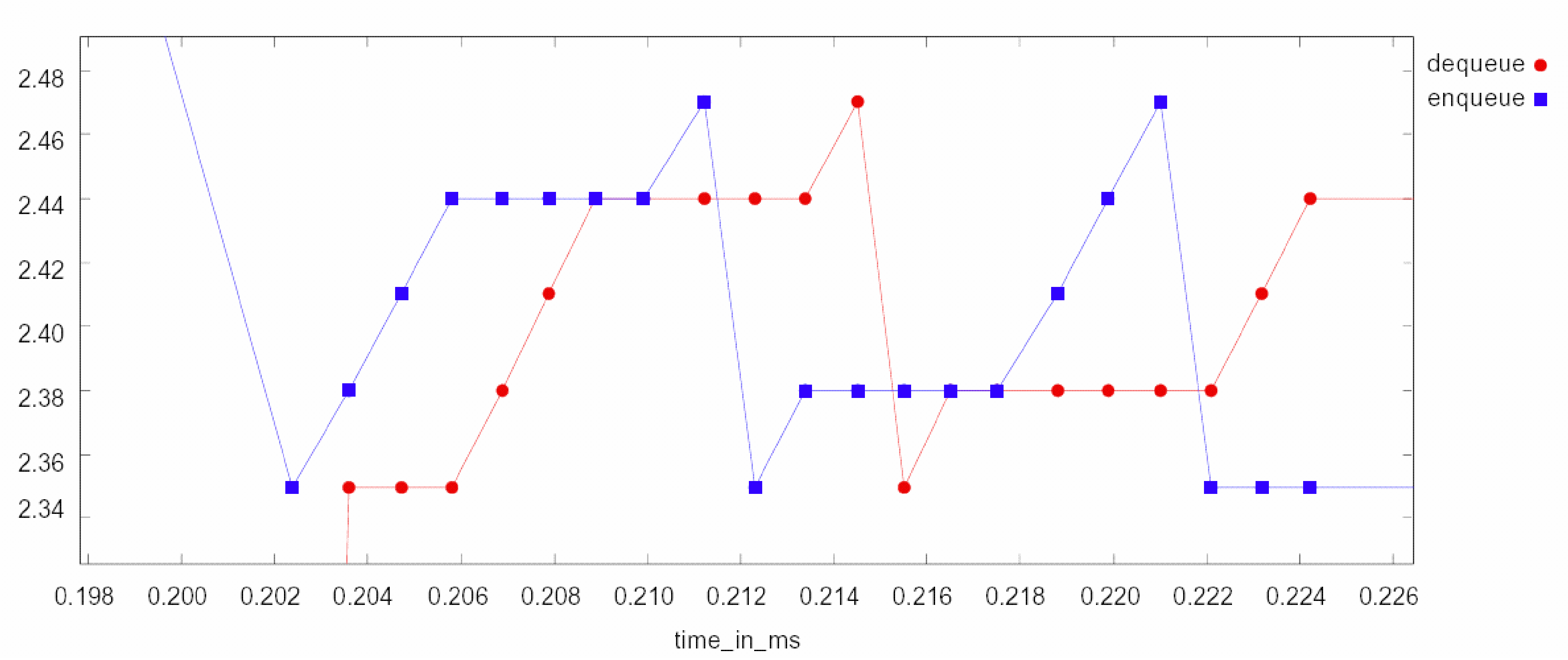
- Runtime scenario for simulation
- Information collected:
  - Time stamps
  - Task status vs. time
  - Resource status vs. time
  - ….
- Visualized by standard MLDesigner components

Example Task Switch Diagram



(enlarged detail)

Example Memory Occupation View

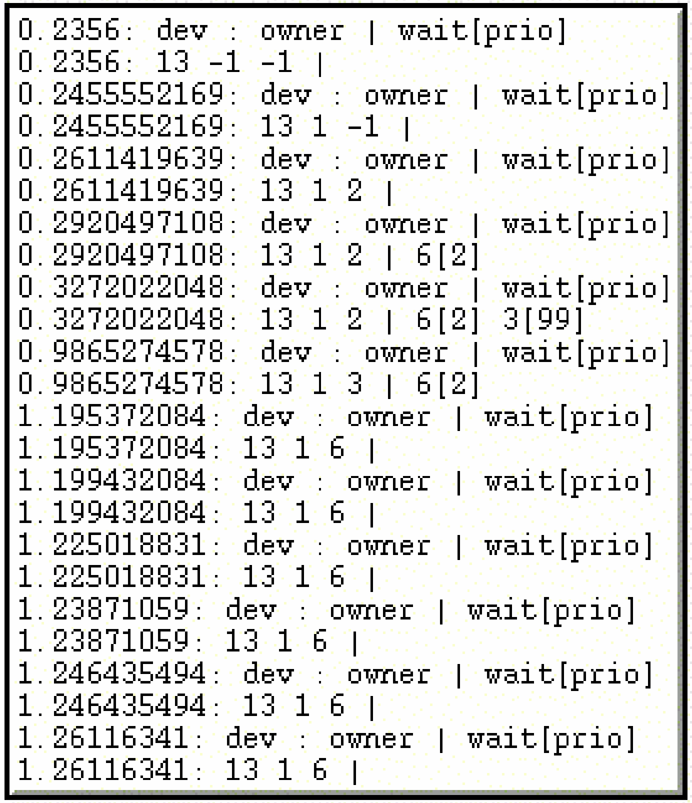


- Shows FIFO memory

(enlarged detail)

Example Device Occupation View

- Colums:
  - Time stamp
  - Device id and state
  - Current owner
  - Pending requests
- Live listing



```
0.2356: dev : owner | wait[prio]
0.2356: 13 -1 -1 |
0.2455552169: dev : owner | wait[prio]
0.2455552169: 13 1 -1 |
0.2611419639: dev : owner | wait[prio]
0.2611419639: 13 1 2 |
0.2920497108: dev : owner | wait[prio]
0.2920497108: 13 1 2 | 6[2]
0.3272022048: dev : owner | wait[prio]
0.3272022048: 13 1 2 | 6[2] 3[99]
0.9865274578: dev : owner | wait[prio]
0.9865274578: 13 1 3 | 6[2]
1.195372084: dev : owner | wait[prio]
1.195372084: 13 1 6 |
1.199432084: dev : owner | wait[prio]
1.199432084: 13 1 6 |
1.225018831: dev : owner | wait[prio]
1.225018831: 13 1 6 |
1.23871059: dev : owner | wait[prio]
1.23871059: 13 1 6 |
1.246435494: dev : owner | wait[prio]
1.246435494: 13 1 6 |
1.26116341: dev : owner | wait[prio]
1.26116341: 13 1 6 |
```

5. Conclusion

- Contributes to validation and testing
- Formal analysis not supported
- **Further work:**
  - More detailed modeling of control flow inside tasks
  - Support for protocol verification
  - Generating software from model

Questions?