Modeling and Simulation of Operating System Behavior

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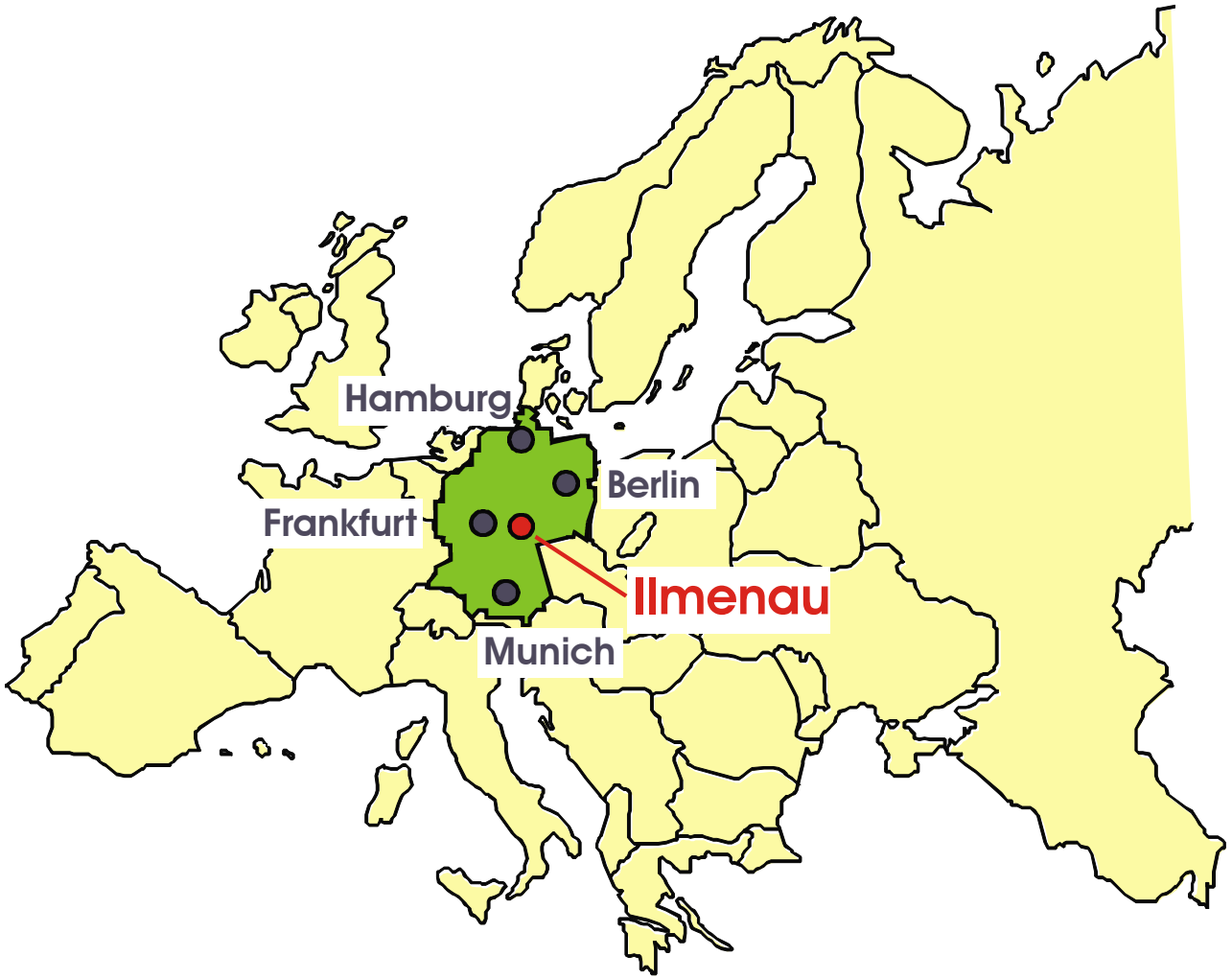
Where is Ilmenau?



Topics

1. Introduction and Overview
2. Modeling Methodology
3. Simulation and Evaluation
4. Conclusion

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1. Introduction

- Model the behavior of Real Time Operating Systems (RTOS)
- Goal: Quantitative Estimation of Properties
- Methodology to model the system behavior in discrete event manner

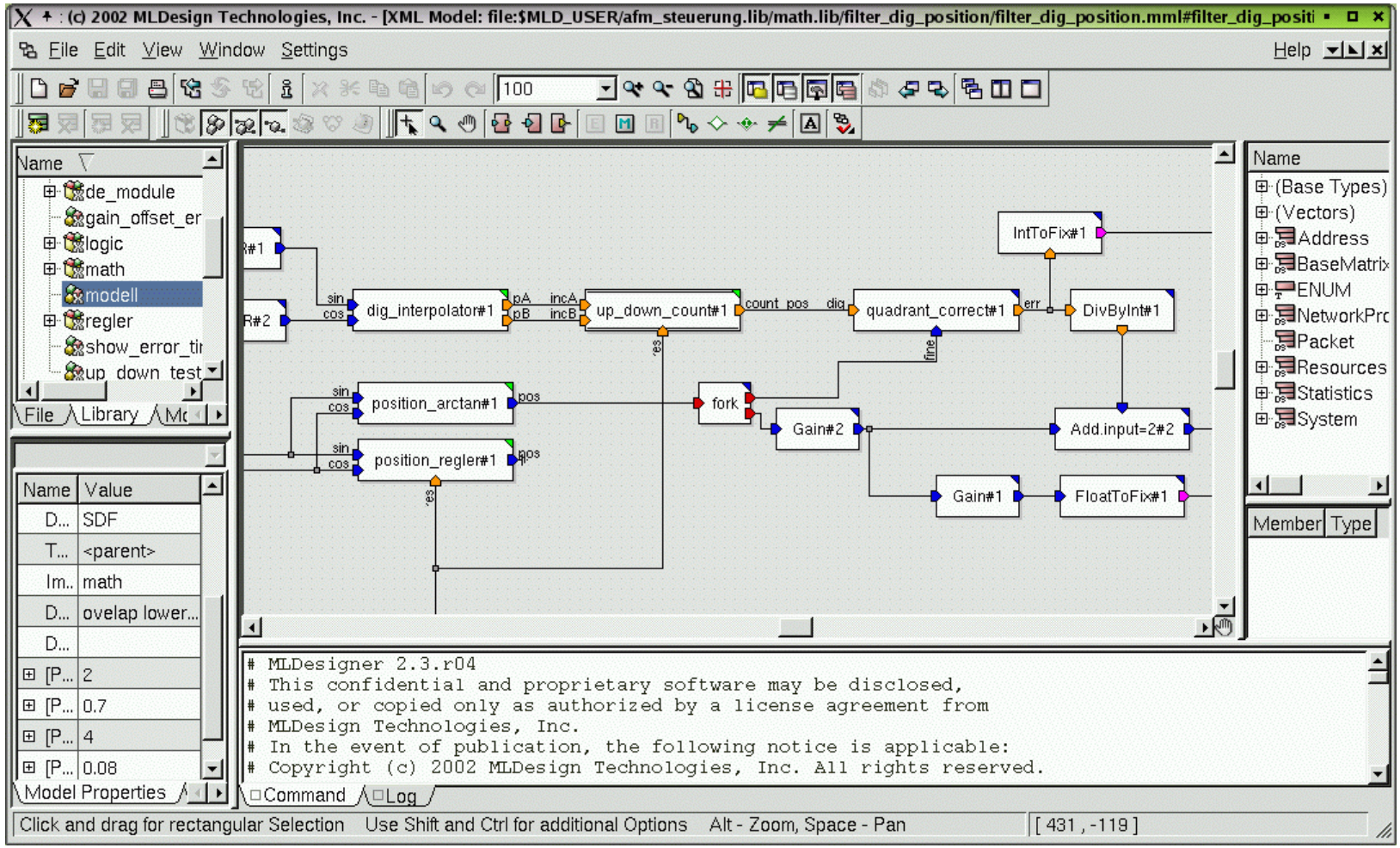
Features of the RTOS

- Multiple scheduling strategies
  - Cooperative task's
  - Non-cooperative task's
- Resource management
- Circular memory buffer

MLDesigner Basics

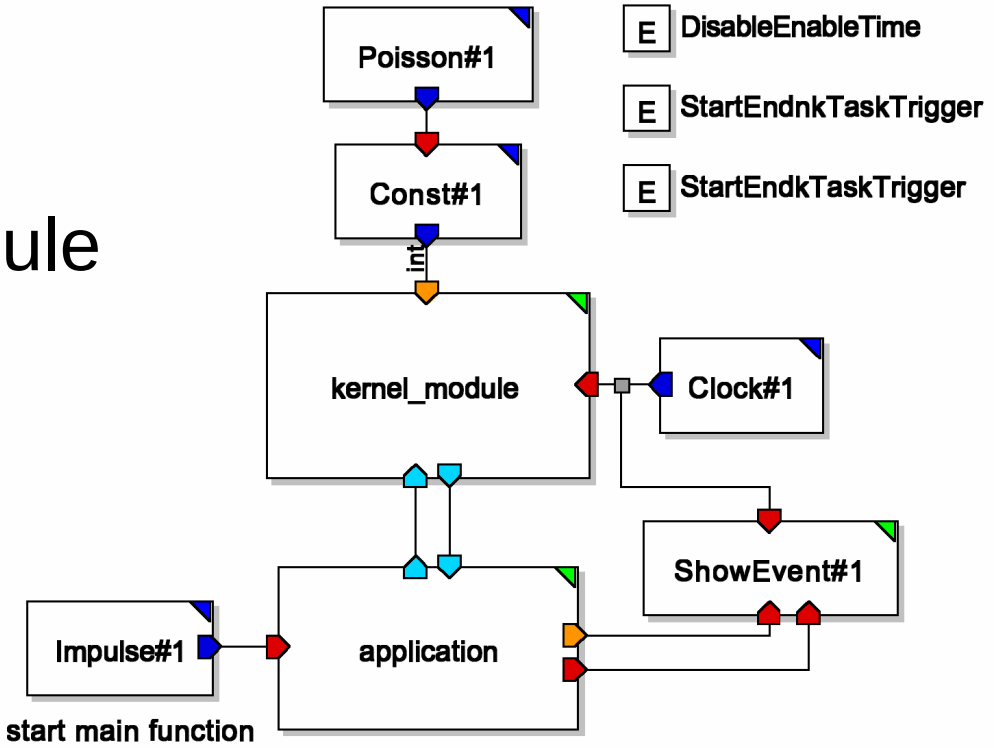
- Hierarchical multi domain modeling framework
- Covers module, system and strategy („mission“) levels
- Combines numerous modeling domains (discrete and continuous paradigms)
- Capabilities for simulation, design check, code generation, export
- Derived from well-known Ptolemy tool (University of Berkeley)

MLDesigner Sample Workspace



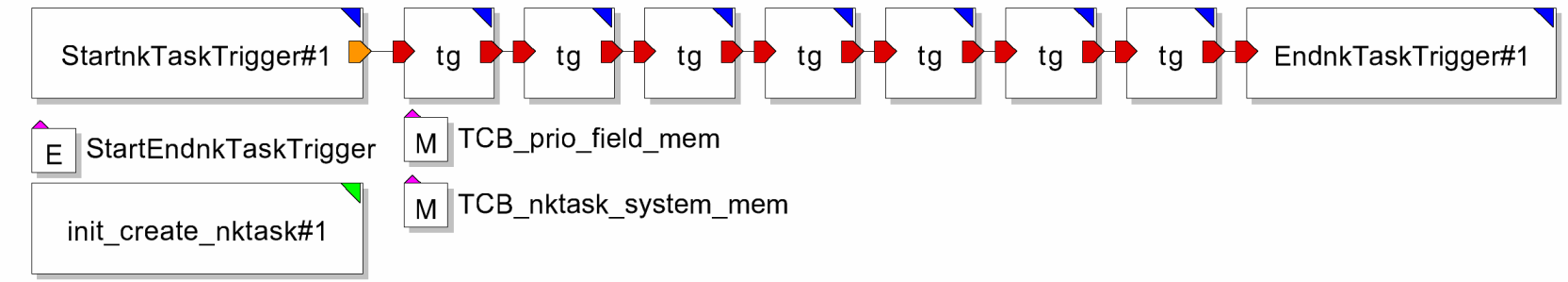
2. Modeling Methodology

- Discrete Event Domain of MLDesigner
- Main Parts
  - Kernel Module
  - Application Module



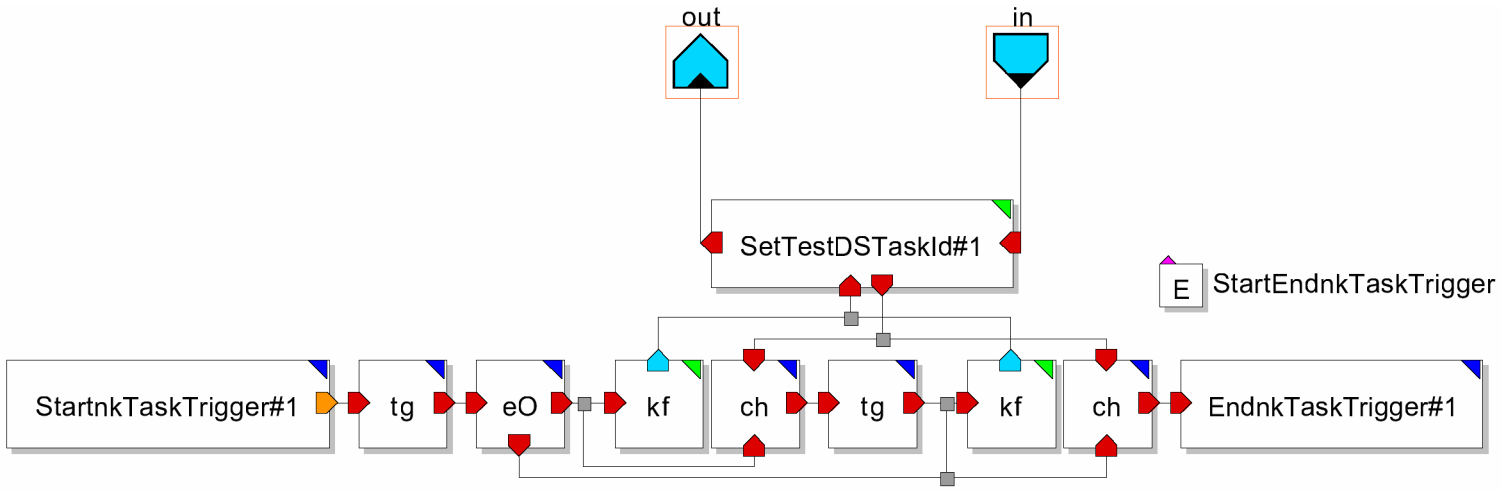
Application Module

- Includes one block for each application task
- Basic elements are atomic blocks (*tg*)
- Task switch on block boundaries



Task Model with Kernel Invocation

- Managed by special interface block
- Each call is initiated by block *kf*
- Block *ch* holds task's control flow

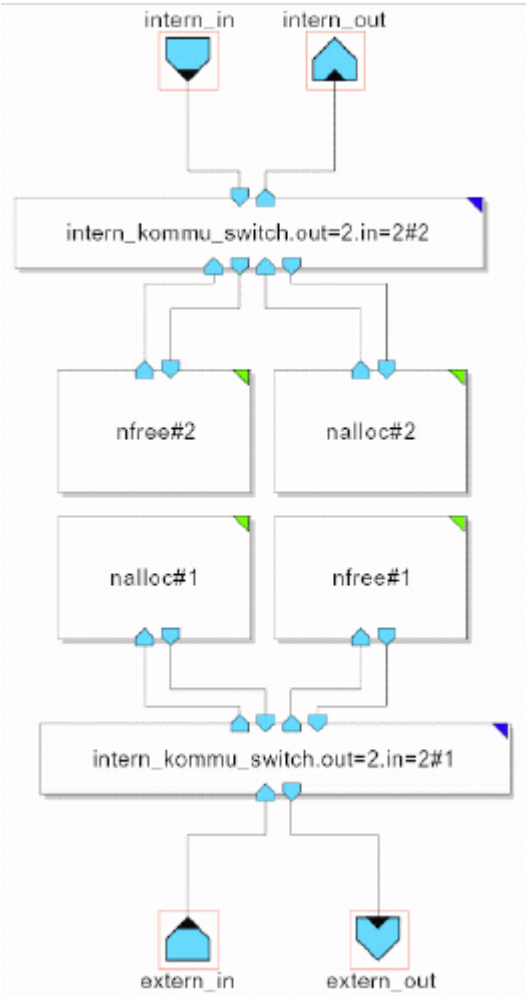


Kernel Module

- Block for task scheduling
- Blocks for system services (messaging, device and memory management)
  - Refer to certain groups of kernel functions
  - Hold specific information (resource occupation)

Memory Management Module

- Simplified structure
- 4 blocks encapsulating basic memory management
  - nalloc (modified malloc())
  - nfree (modified free())
- Blocks share resources

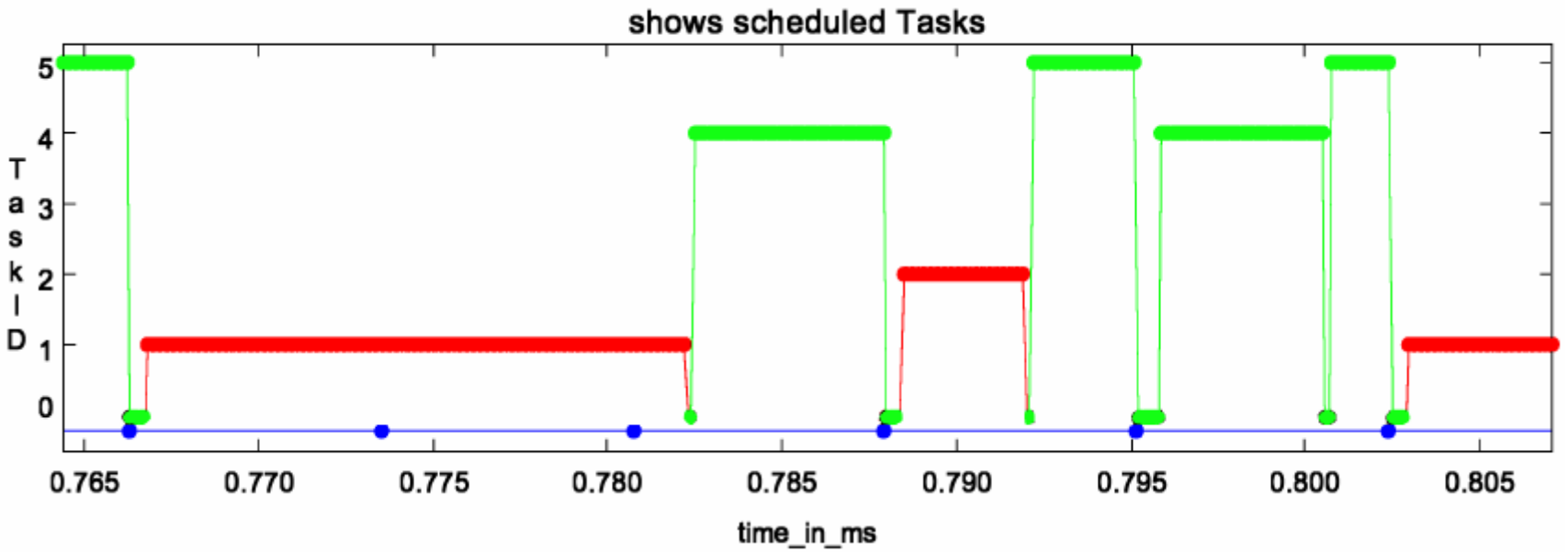


3. Simulation and Evaluation

- Simulation with MLDesigner tool
  - Collects information about timing, task status and resource status
- Different views for evaluation

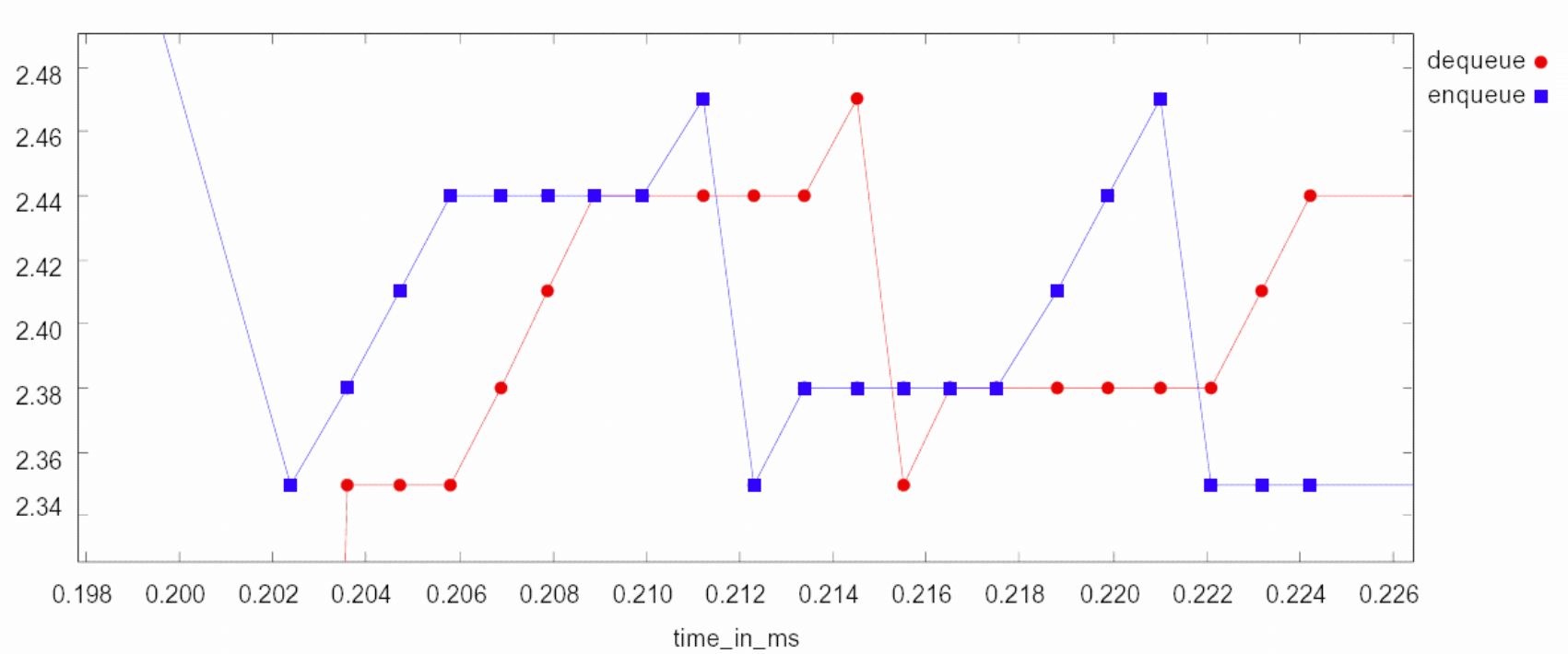
Task Switch Diagram

- Task‘s identified by task-ID
- Shows with task is active at any time



Memory Occupation View

- Activity of a task, that manages memory as a circular buffer



Device Occupation View

- First column shows absolute time
- Second the actual occupation
- Last the queued requests

```
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 |
```

Conclusion

- Can replace some testing
- Cannot replace formal analysis

- Further work:
  - Improvement of the methodology
  - More elements for control flow (loops)
  - Implement software directly from model