

Control System Framework Instantiation for the PERC Platform

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Overview

- Conceptual formulation
- The AOCS Framework
- Instantiation of the AOCS Framework
- Runtime platform - PERC/VxWorks
- Results
- Conclusions

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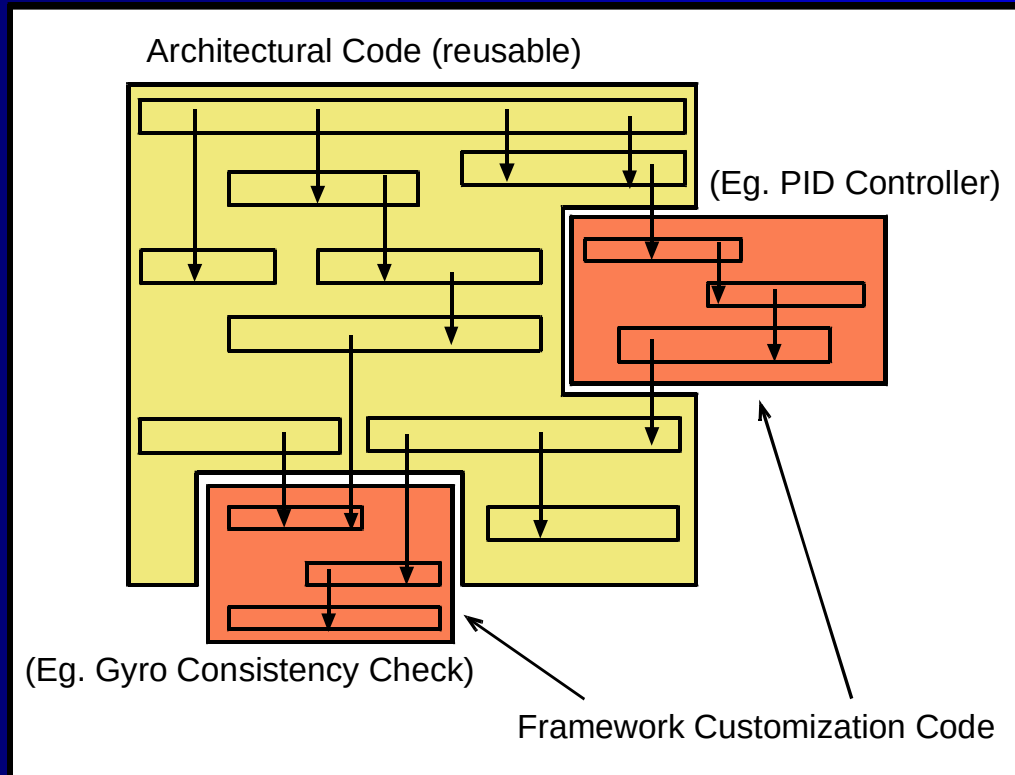
Conceptual formulation

- Study the AOCS Framework
- Develop an application for the SMM by instantiating the AOCS Framework (AOCS = Attitude and Orbit Control System)
- Use PERC as Java runtime environment
- Port application to VxWorks
- Performance measurements
- Publish results in the Web

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The View of the AOCS Framework



- Abstract Interfaces : definition of sets of related services without their implementation
- Components : binary units of reuse implementing one or more interfaces
- Domain-Specific Design Patterns : optimized solutions to recurring design problems in fw domain
 - Design patterns are the vehicles through which architecture (the interconnections of the components) is made reusable

The Java version of the AOCS Framework was developed by IfA.

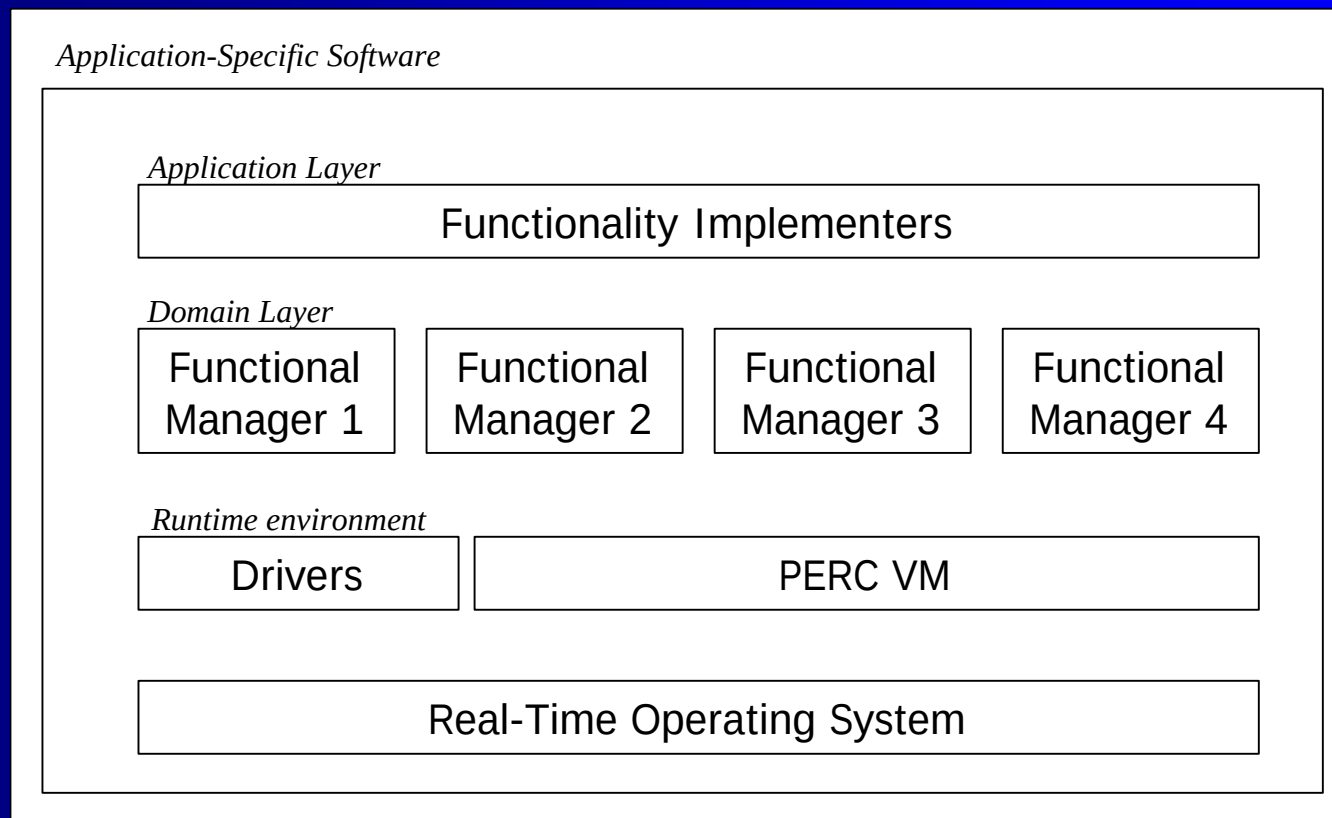
<http://www.aut.ee.ethz.ch/~pasetti/RealTimeJavaFramework/index.html>

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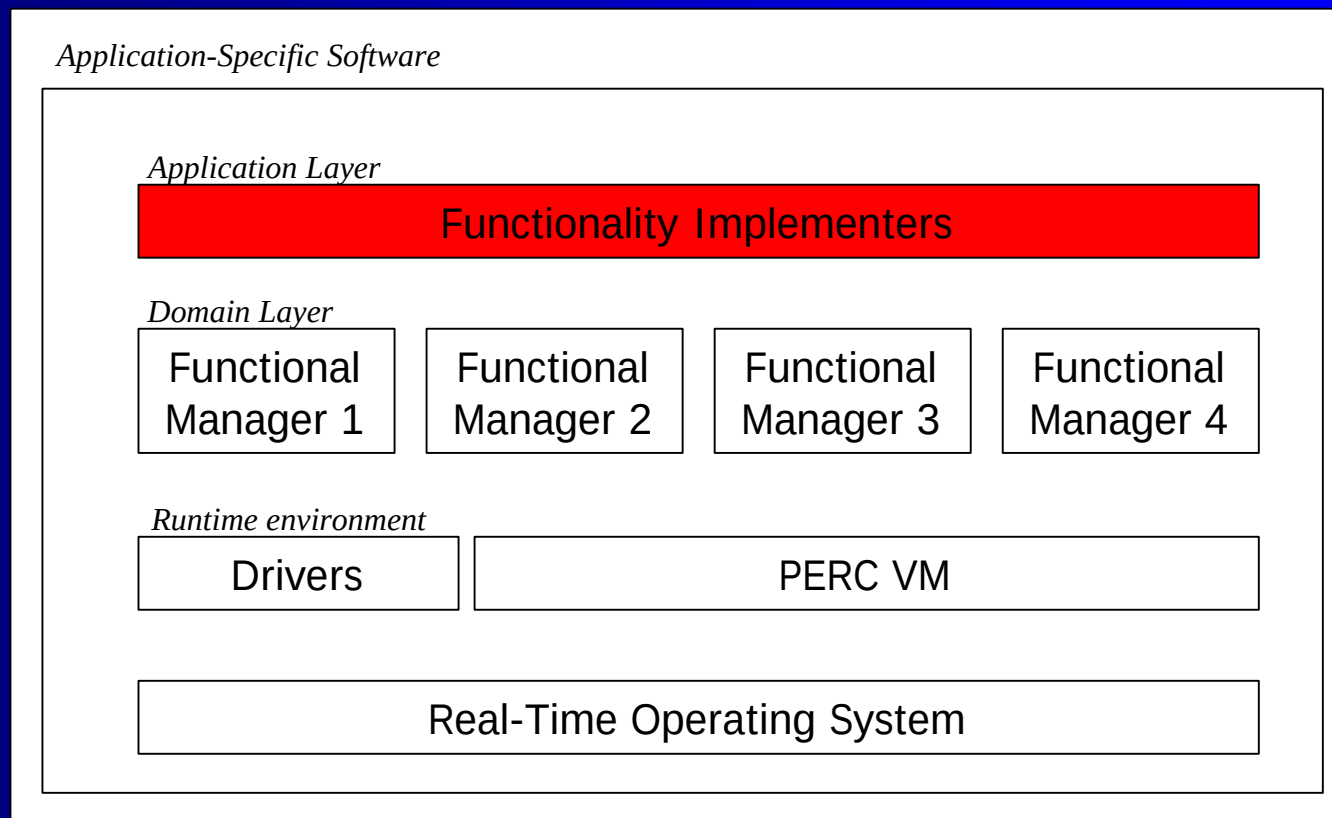
Structure of Applications Instantiated from the AOCS Framework

- The structure can be divided into 4 layers:



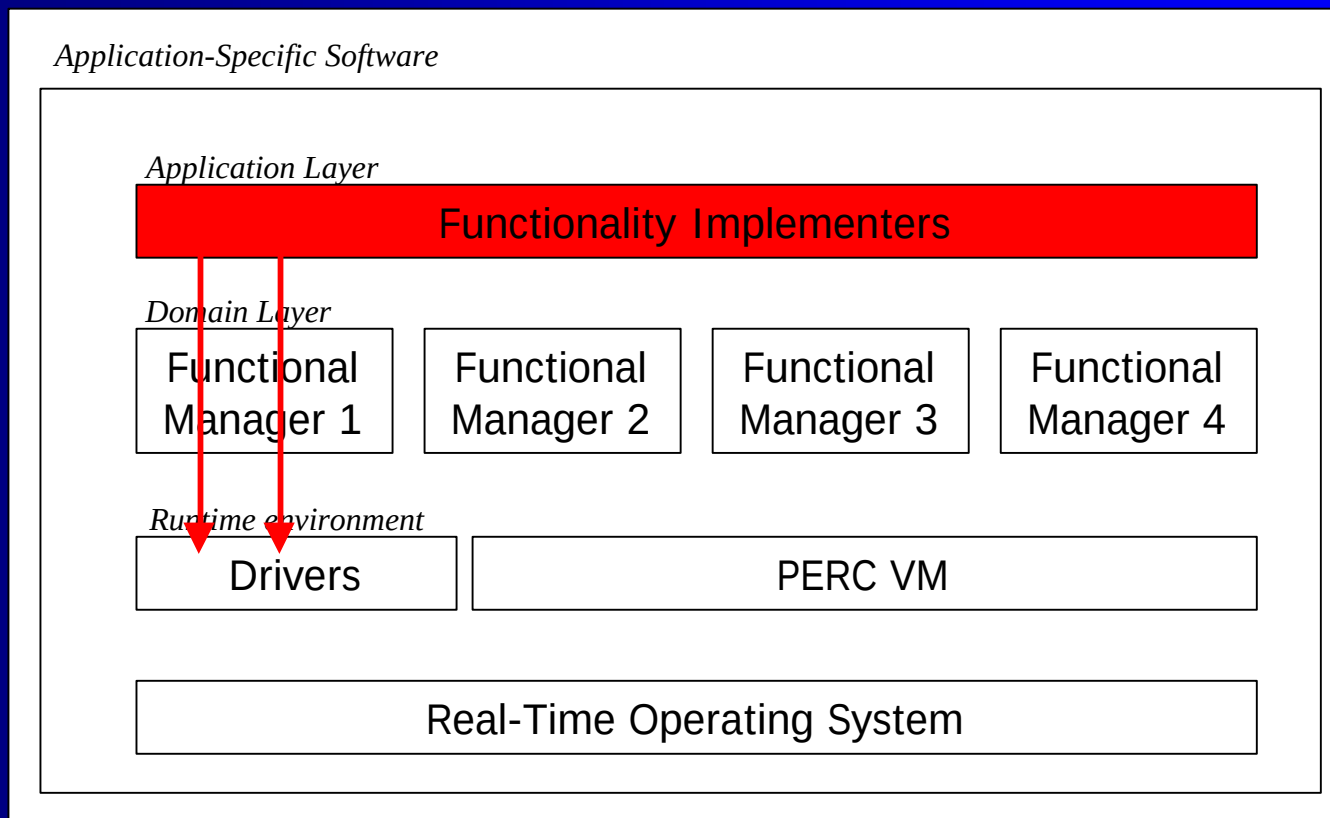
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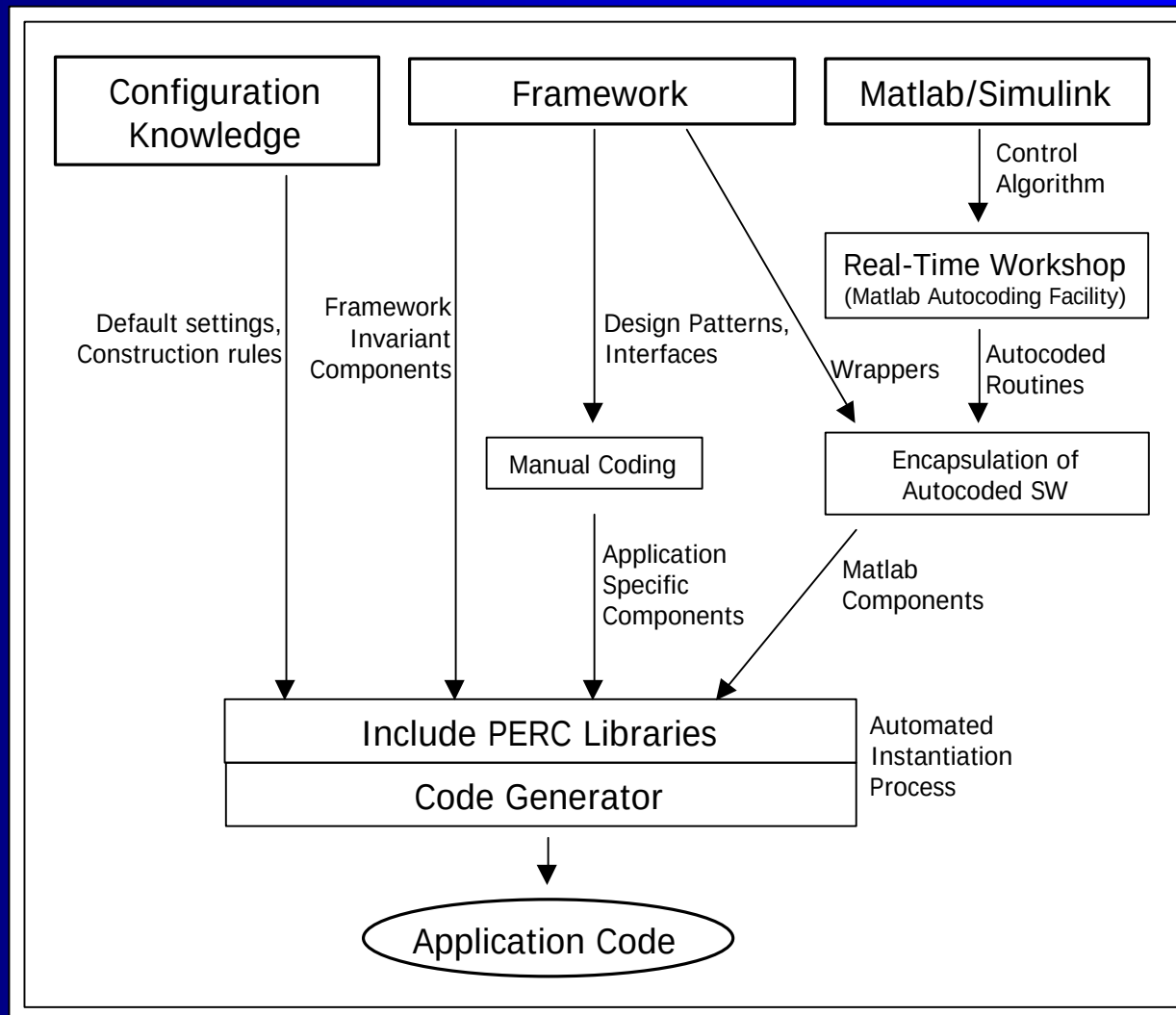
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Instantiation of the AOCS Framework

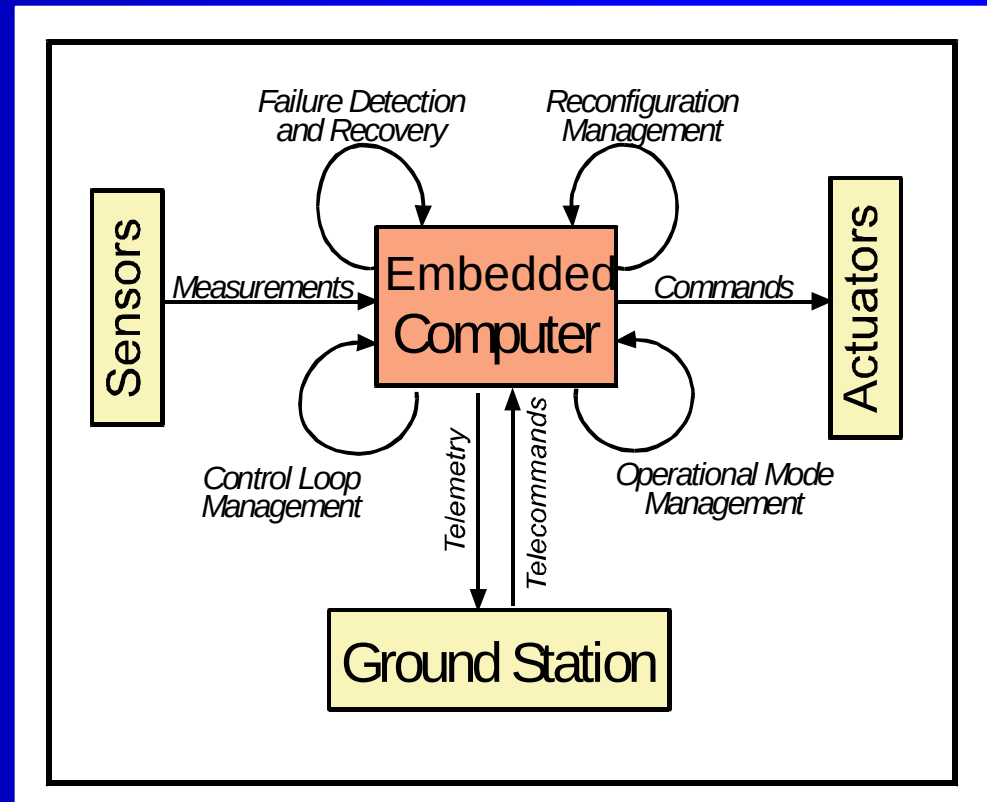
- Instantiation:
 - create framework components
 - create application specific components
 - plug them together and customize them
 - include PERC libraries
 - implement native interfaces
 - testing on Windows
 - port to VxWorks

Concrete Instantiation Steps



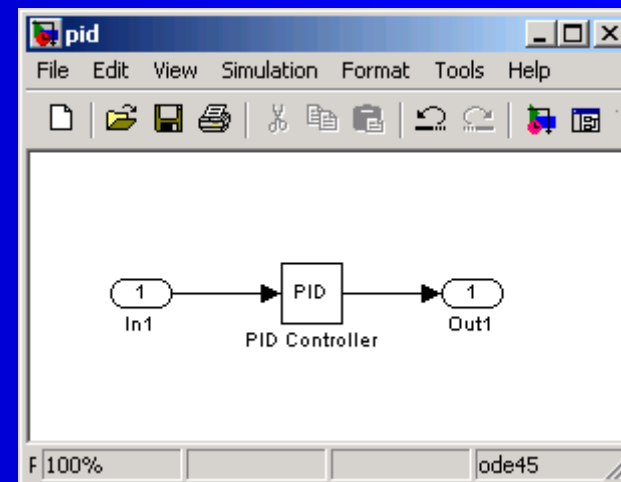
Functionality of the Application

- Three operational modes
 - SBY, Speed, Position
- Failure detection checks
 - Consistency, range, delta
- Autonomous failure recovery
 - Only system reset
- Provision of two alternating TM frames
- Processing of five telecommands
 - Mode change, reset, ramp and wave manoeuvres, set control parameters
- Performance of control profile manoeuvres
 - Ramp and wave profile
- Control cycle of 200 milliseconds



Controller using matlab wrapper

- Single control blocks (P, I, D) are developed with Matlab's Simulink using Realtime workshop
- Matlab wrapper class for every block
- Wrapper classes are plugged together to a PID controller
- One special I-block developed, to improve controller performance:
 - inner state reset on sign change of control error
 - give start help by adding a constant value to the output to take the high static friction into account for position control



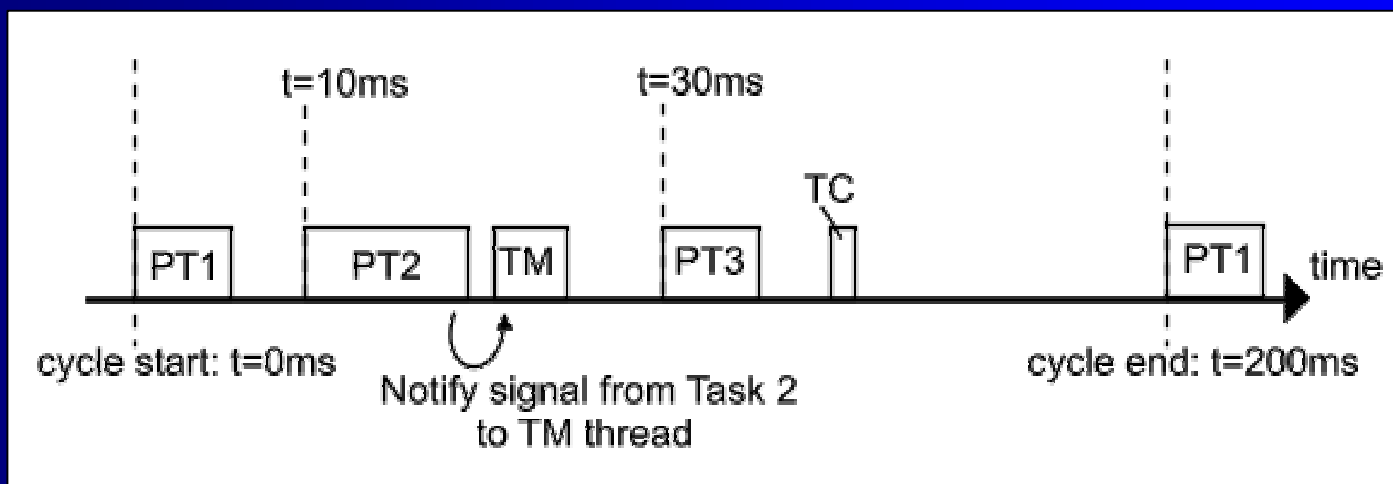
Communication

- Communication by using TCP/IP (Server)
- Telemetry:
 - all telemeterable components can be sent
 - TM1: all event repositories (eg failure, manoeuvre, ...), mission mode manager, system clock
 - TM2: TM1 + data pool, controller manager
 - inner states are read out by calling `writeToTelemetry(...)` and represented as a string of integers

#Elements Framenr. ComponentID Param1 ... ComponentID ...
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Scheduling

- Solved with Timer
- PT = Periodic Tasks (realtime, Timertasks)
- TM = Telemetry Thread (non realtime)
- TC = Telecommand Thread (non realtime)

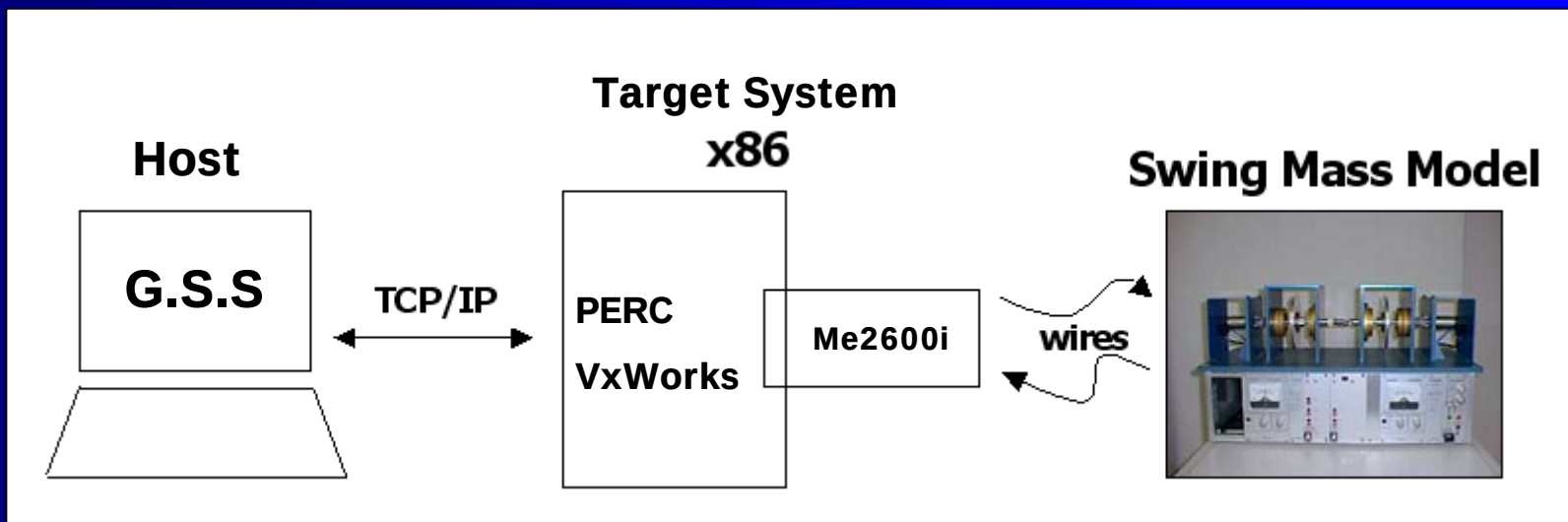


Ground Station Simulator

- Communication with Application as client
- Telemetry and Telecommands (scaling)
- Representing Telemetry Data (also graphically)
- Thread oriented (Period: 40 ms)
- Secure change between modes done by GUI

Prototype Environment

- Target System:
 - Intel PIII 1GHz
 - Me2600i PCI-Card
- SMM:
 - Speedsensor
 - Positionsensor with offset
 - 1 motor used as actuator
 - 1 motor used as disturbance



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PERC

- Java runtime environment (JDK 1.3)
- Oldest RT VM on market
- Optimization tools like ROMizer and Accelerator
- PNI: Perc Native Interface
- Running on several Operating Systems
 - VxWorks, Windows, Linux, OSE
- Using priority inheritance and round robin
- Possibility to disable GC
- Not yet compatible with Tornado2.2!

VxWorks / Windows2000

- VxWorks:
 - World famous RTOS
 - Strong tools
 - Well matured
 - Difficult for beginners
 - Good for running RT applications
- Windows2000:
 - World famous non RTOS
 - Strong 3rd party tools
 - Well matured
 - Easy for beginners
 - Good for development and testing of applications

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Measurements

- Fast processor + bad time accuracy => special Measurement application
- Measurement app. makes automation possible
- Generating worst Cases
- Measure every task on its own

Timing and Memory Requirements

Time:

- PT 1: 71.5 us
- PT 2: 333.4 us
- PT 3: 26.8 us
- TM: 800 us
- TC: 50 us
- Sending: unknown

Memory:

- Application: 1.5MB
- PERC runtime environment: 9MB!

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- Advantages:
 - Fast Instantiation of the AOCS Framework
 - PERC also running on Windows
 - Once working: PERC/VxWorks = good combination
- Disadvantages:
 - Difficult to get VxWorks running for a beginner
 - PERC needs a lot of memory
 - No class dependency recognition in PERC
- Results presented on Webpage and in Ifac-Paper