Applications in Integrated Diagnostics

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Overview

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1. System Overview

Project Overview

- Legacy Problems
  - Limited Memory
    - Difficult to add new features
    - Maintained multiple code baselines to support different platforms
      - Adds more testing and development
  - Slow Processors
    - System could not process more data
1. System Overview
Project Overview (Cont.)

- Project Description
  - New Hardware
    - Faster processor
    - More memory
    - Added Ethernet
  - Port legacy software
    - Interrupt system to polling system
    - Addition of a partitioned RTOS
1. System Overview
Partitioned Operating System (OS)

• Only one partition may run at a time
• Data can move between partitions when defined by OS
1. System Overview
Partitioned OS (Cont.)

- Different schedules allow different Partitions to run when needed
1. System Overview
   Internal Interfaces

- Ports – Calls through the OS
  - Queuing $\approx 80 \mu$s for read/write access
  - Sampling $\approx 50 \mu$s for read/write access

- Shared Memory - Directly accessible by the partition
  - $\approx 10 \mu$s for read/write access

* Numbers vary based on hardware or the RTOS
1. System Overview

External Interfaces

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<th>Speed</th>
<th>Usage</th>
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<td>10/100 Mbps</td>
<td>Net loading code into RAM</td>
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<tr>
<td>1553</td>
<td>1 Mbps</td>
<td>Communication with other systems and Instrumentation Data</td>
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<td>RS-232</td>
<td>115.2 Kbps</td>
<td>Starting a net load and Default printf</td>
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2. Motivation
General Debugging: Single Partition

Partition time allotted: 1 ms
Partition time used: 800 µs
Partition time unused: 200 µs

Debug statements: ≈ 300 µs
2. Motivation
General Debugging: Multiple Partitions

- Multiple partitions used the same debug media
  - Data overwrites
  - Debug stream contention
2. Motivation
System Performance

- System limitations
  - Processor/memory utilization during normal operation
- System throughput
  - Amount of system inputs
- System latency
  - Response time to system inputs
- System data flow
  - Understanding how information gets from point A to point B within system
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3. Problem Statement

- Avoid Uncertainty Principle
  - Latency introduced by diagnostics drastically affecting system
- Provide as much information as possible
- Introduce as little system interference as possible
- Provide information that is easy for user to understand and analyze
- Scalable for future use
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4. Approach Interface

• Ethernet
  • High bandwidth
• PC Graphical User Interface
  • Real time display
  • Bit/Data analyser
  • Raw/Parsed/Filtered Data
• Storage for post-analysis
4. Approach Rate

- Internal and External considerations
- External Design Considerations

- How often is data required to debug?
- How much data is required to debug?
4. Approach
Rate (Cont.)

Less debug data created than possible
(Is there enough data to debug?)

Too much debug data created
4. Approach
Diagnostics Partition

Partitioned Operating System

Diagnostic Schedule for Schedule B

Schedule C

Time (ms)

Partition 1
Partition 3
Diagnostics
Spare
4. Approach
Diagnostics Application

PC Application

Partition 1 Window
Partition 2 Window
Partition 3 Window

Data

Partition 1
Partition 2
Partition 3
Diagnostics

Partitioned Operating System

Ethernet
Overview

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5. Results
Debugging with Diagnostics

- Diagnostics Debug statements found to take $\approx 10 \mu s$

- Partition allotted 1 ms to run
5. Results

- Found bugs during overnight test cases
- Processor utilization spikes in overnight test cases
- Queue trickling and data buffer overflows
- Other general diagnostic data during normal operation
- Possibilities for optimization
- Requirements verification
- Seeing the inner workings of the system with limited system interference
5. Results

System Interference vs Diagnostic Throughput

- 1553
- Ethernet
- RS232

System Interference (%)

Diagnostic Throughput

Kb  Kb  Kb  Mb  Mb  Mb  Mb
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6. Conclusions

- Lessons learned
  - Keep interface simple for ease of use
  - Make Ethernet output multicast or UDP

- Future ideas
  - Move Diagnostics partition to an RTOS Task to reduce latency and increase throughput
  - Make the interface for partitions more abstract for scalability
  - Work with developers and testers for more synergy in using tool
6. Future Approach
Diagnostics Application

Partitioned Operating System

Partition 1  Partition 2  Partition 3

PC Application

Internet Browser

Data

Ethernet

Diagnostics