Applications in Integrated Diagnostics

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Authors: Tim Palmer and Jimmy Simmons

Overview

1. System Overview
2. Motivation
3. Problem Statement
4. Approach
5. Results
6. Conclusion

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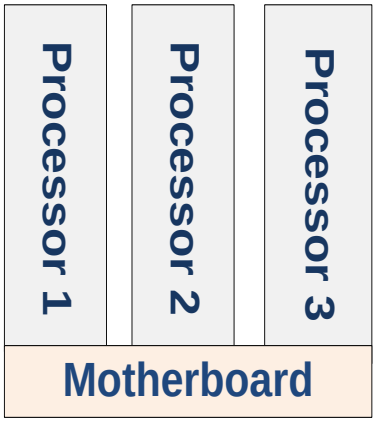
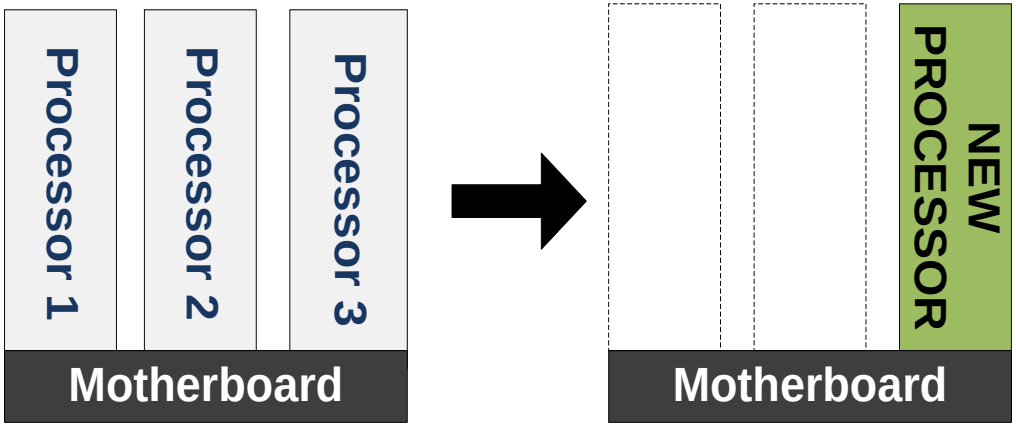
1. System Overview
Project Overview

- **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**

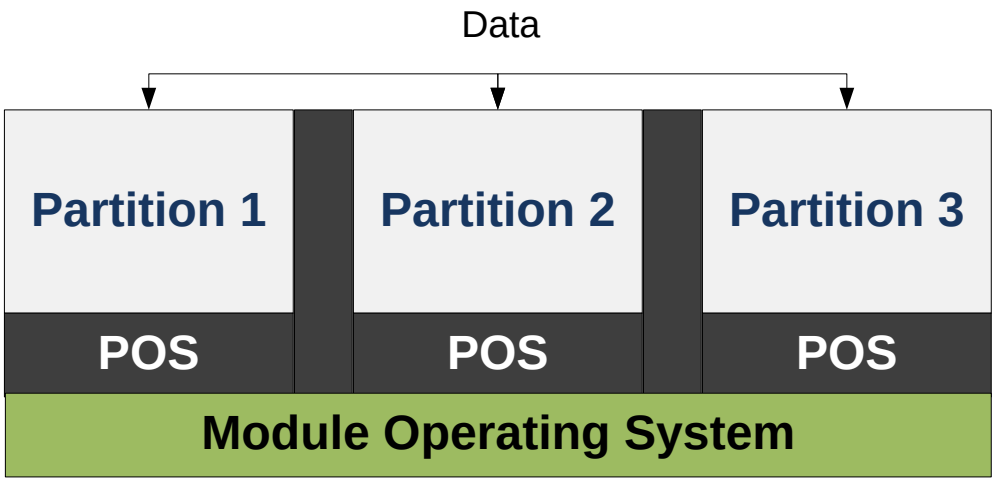


1. System Overview
Project Overview (Cont.)

- Project Description
  - New Hardware
    - Faster processor
    - More memory
    - Added Ethernet
  - Port legacy software
    - Interrupt system to polling system
    - Addition of a partitioned RTOS

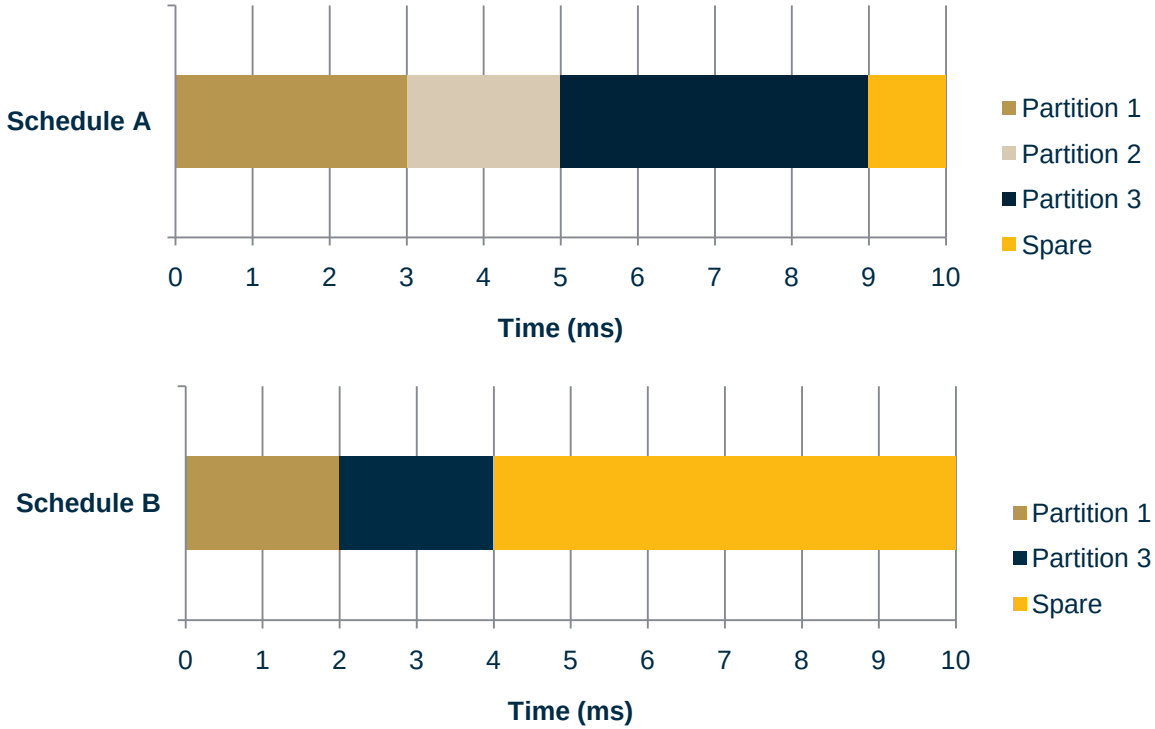


1. System Overview
Partitioned Operating System (OS)



- 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 ≈ 80 µs for read/write access
  - Sampling ≈ 50 µs for read/write access
- Shared Memory - Directly accessible by the partition
  - ≈ 10 µs for read/write access

* Numbers vary based on hardware or the RTOS

1. System Overview
External Interfaces

Interface	Speed	Usage
Ethernet	10/100 Mbps	Net loading code into RAM
1553	1 Mbps	Communication with other systems and Instrumentation Data
RS-232	115.2 Kbps	Starting a net load and Default printf
RS-422	9.6 Kbps	Legacy debug

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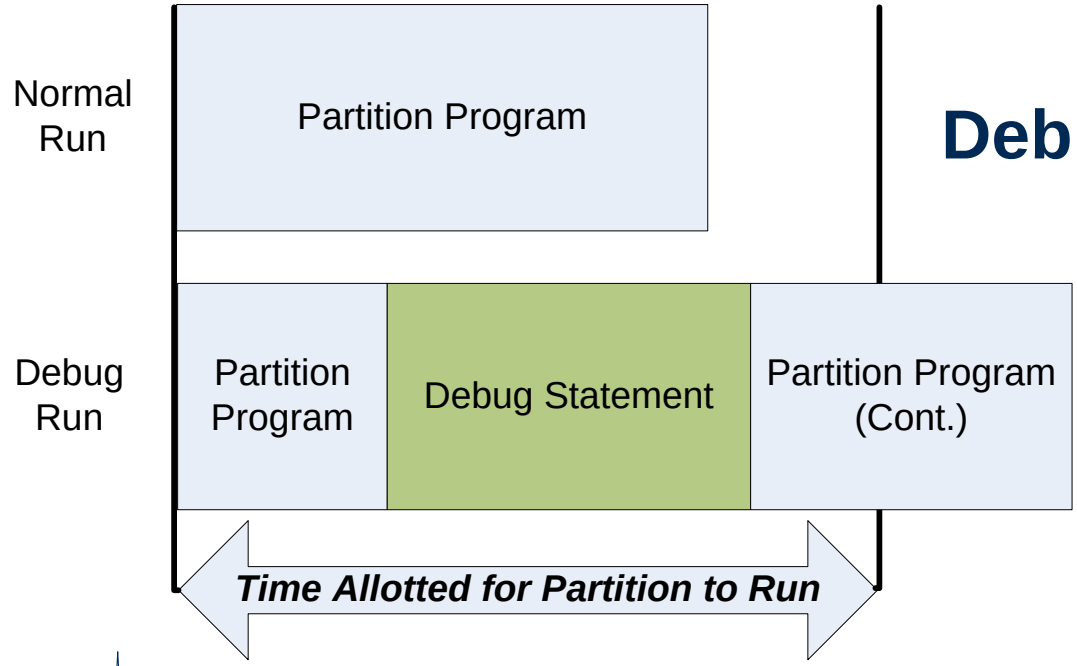
2. Motivation
General Debugging: Single Partition

Partition time allotted: 1 ms

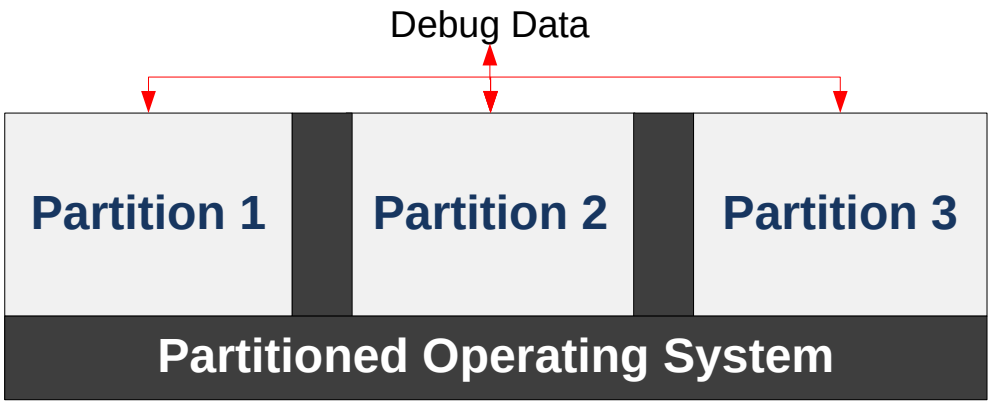
Partition time used: 800µs

Partition time unused: 200µs



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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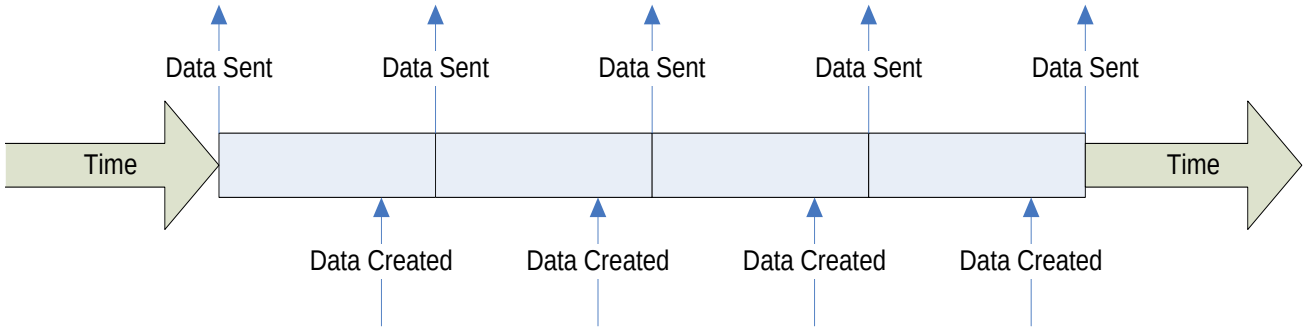
4. Approach
Interface

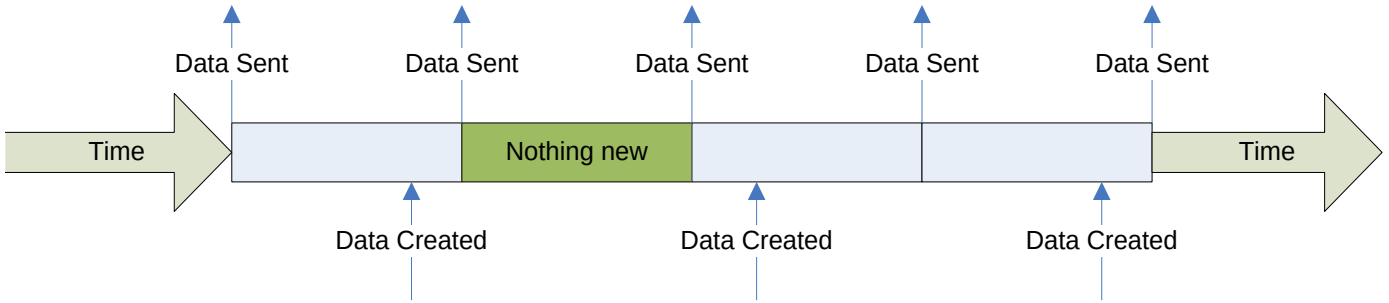
- Ethernet
  - High bandwidth
- PC Graphical User Interface
  - Real time display
  - Bit/Byte analyzer
  - Raw/Parsed/Filtered Data
- Storage for post-analysis

4. Approach
Rate

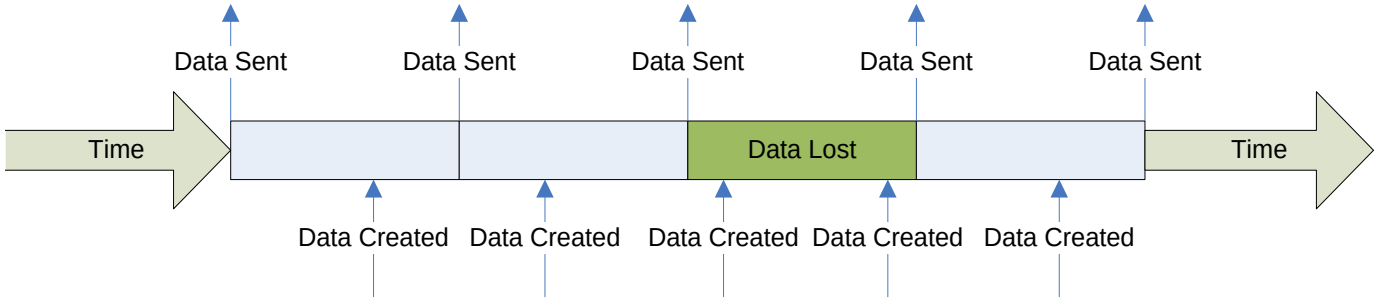
- Internal and External considerations
- External Design Considerations
  - How often is data required to debug?
  - How much data is required to debug?



4. Approach
Rate (Cont.)

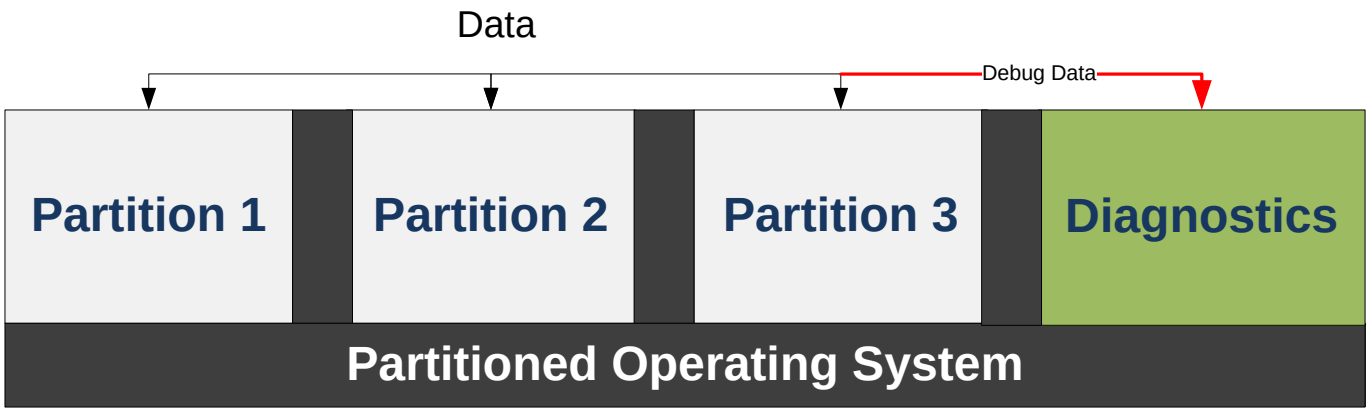


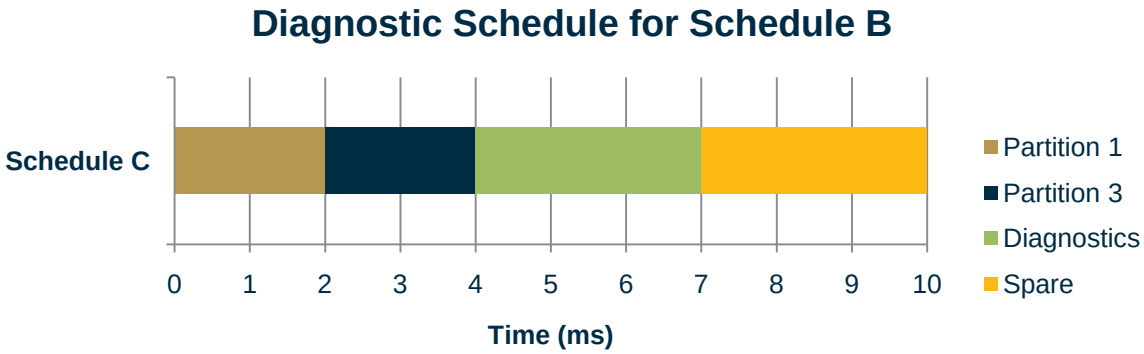
Less debug data created than possible
(Is there enough data to debug?)



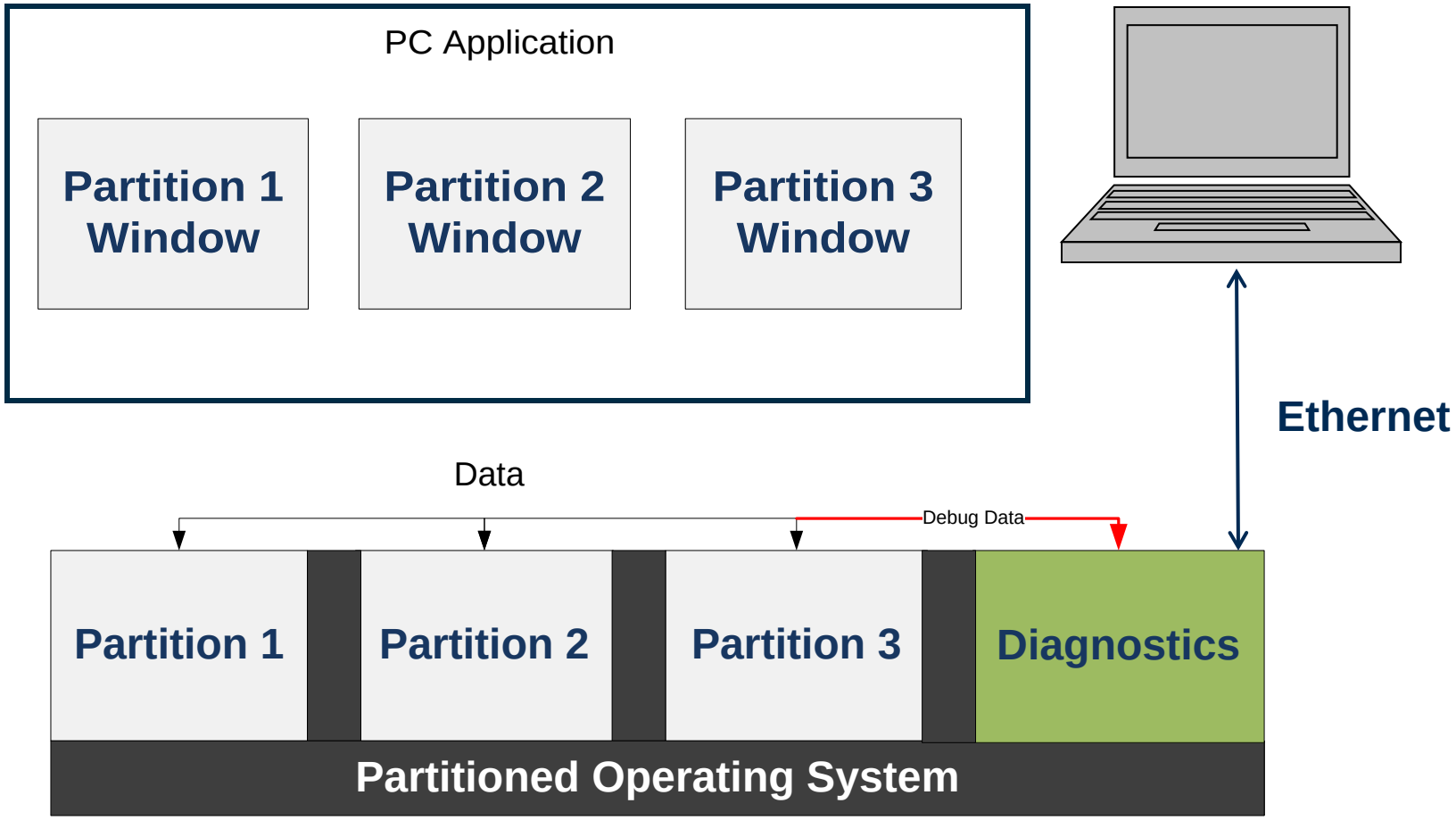
Too much debug data created

4. Approach
Diagnostics Partition





4. Approach
Diagnostics Application



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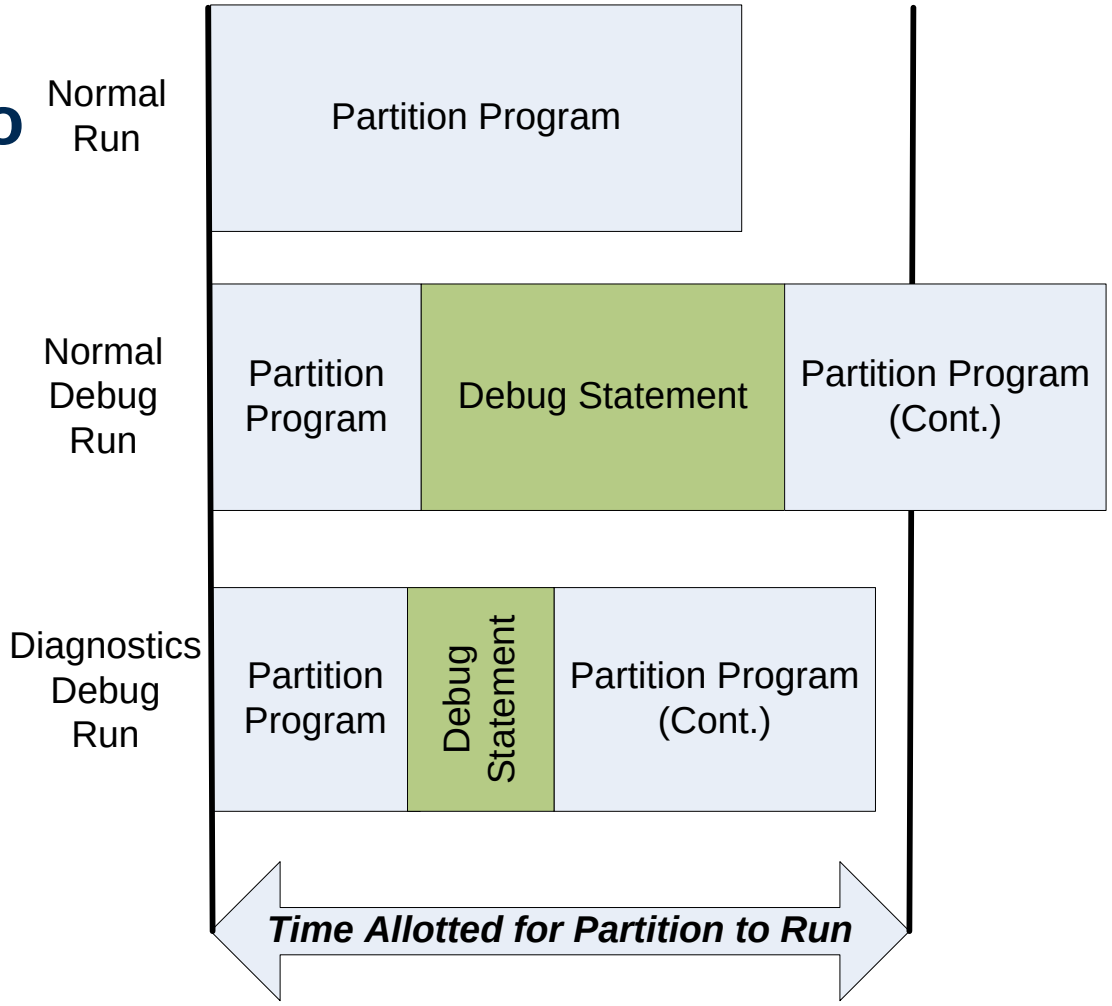
5. Results
Debugging with Diagnostics

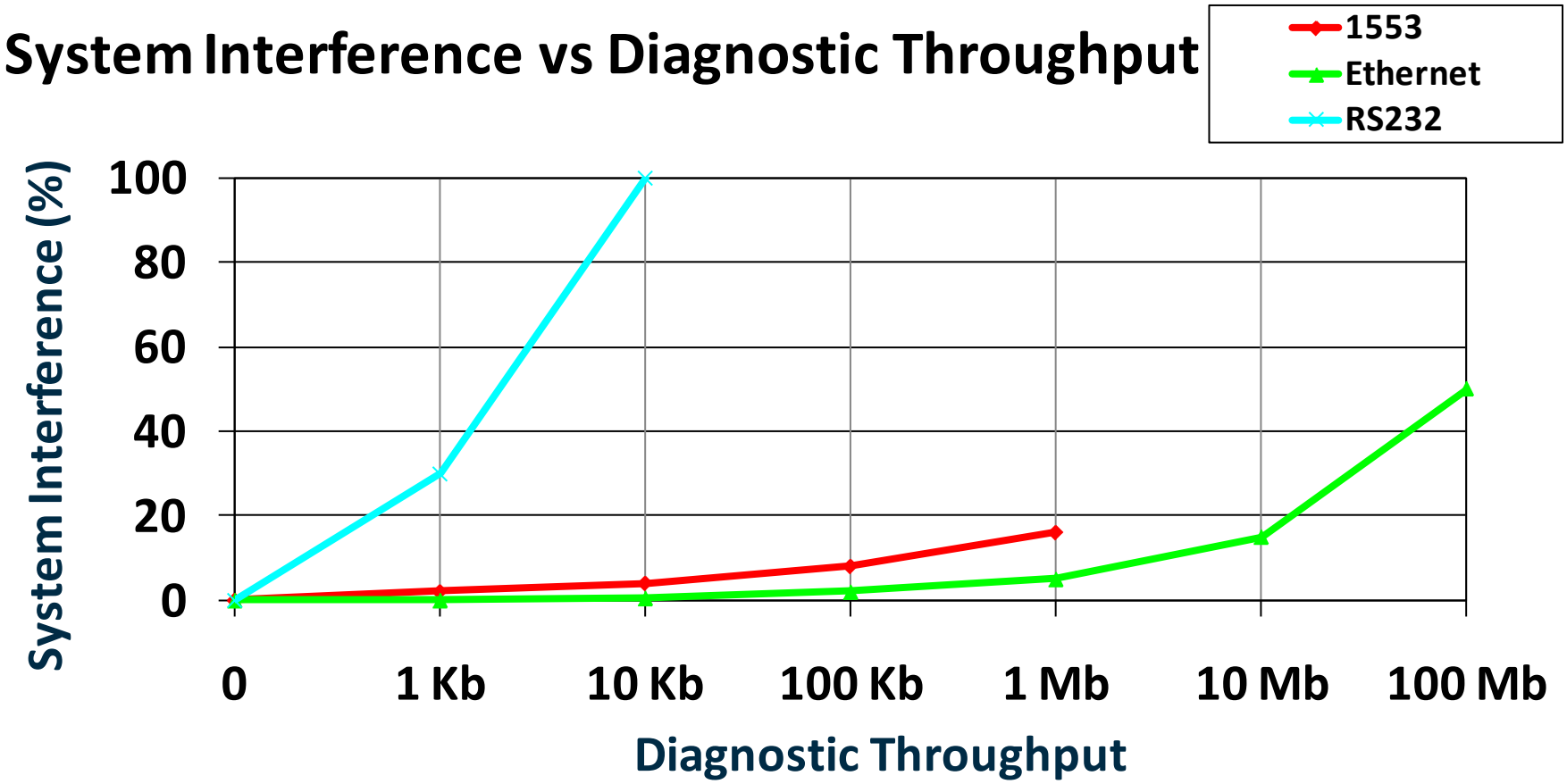
- **Diagnostics Debug statements found to take ≈ 10 µs**
- **Partition allotted 1 ms to run**



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 (%)
100
80
60
40
20
0
0
1 Kb
10 Kb
100 Kb
1 Mb
10 Mb
100 Mb
Diagnostic Throughput

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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