Visualizing the Runtime World of Embedded Software
Benefits and Examples

Dr. Johan Kraft, CEO/Founder Percepio AB
Software behavior depends on **timing**

Source code alone does not give the full picture...

Visualizing the Runtime World of Embedded Software - Benefits and Examples

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Tracealyzer shows what’s going on!

Software-Defined Tracing
+ Easy to use
+ No extra hardware required
+ Always applicable

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How does it work?

Percepio provides a trace recorder library for FreeRTOS, embOS, Micrium, RT Labs ...

Tracealyzer for Linux uses “LTTng” (also Android)

Tracealyzer for VxWorks uses Wind River’s recorder
20+ Cleverly Connected Views

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Increasing Development Efficiency, Software Quality and Performance

Debugging
RTOS and timing issues

Validation
Code running as intended?

Profiling
RAM and CPU usage per task?

Training
Learn RTOS concepts & services

Documentation
Visualize designs or issues

“In less than 5 days from running the tool, we improved the performance of our graphic rendering engine by 3x!”
Terry West, CEO, Serious Integrated Inc.

“FreeRTOS+Trace has doubled our development speed. Problems that otherwise would take days to solve are obvious with this tool and just a quick fix. We use it all the time.”
Alex Pabouctisids, Lead Firmware Engineer, Flyability.
In today’s tough competition with time-to-market pressure constantly increasing, visualization support is natural for software developers in order to produce software of higher quality, in shorter time and at a lower cost. We choose Tracealyzer from Percepio.

Jörgen Appelgren, R&D Manager, Atlas Copco Rock Drills

Percepio’s tracing tool allowed me to quickly understand and solve serious multi-threading issues, that otherwise would have taken least two weeks to analyze. I got started and solved the first issue in a single day. I strongly recommend Percepio’s tracing tools.”

Chaabane Malki, Embedded Systems Engineer, CGX Aero

ABB Robotics is using the first generation Tracealyzer in all of the IRC5 robot controllers shipped since 2005. The tool has proven its value many times in all corners of the world.”

Roger Kulläng, Global System Architect, ABB Robotics.

"The many system views of the Tracealyzer from Percepio makes it easy to quickly find solutions that we have not seen using (Wind River) System Viewer. The visualization has several advantages over the system viewer and makes it easier to understand system behavior. This tool would be of great use for us.”

Johan Fredriksson, Software Architect, SAAB AB.

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Customer Example 1: Unexpected Timing

What is causing the variations in timing?

Data points = executions of "SamplerTask"
X-axis: activation time
Y-axis: time between activations
Let’s check the task scheduling...

But why didn’t "SamplerTask" preempt "ControlTask"?
Scheduling enabled? Let’s check the OS tick...

Why does ControlTask disable the scheduler?

~2.6 ms, should be 1 ms
Scheduler disabled here!
Let’s check the kernel services called...

ControlTask should use "FS_Mutex" instead of disabling the scheduler!

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Let’s try using FS_Mutex instead

Before: disabling interrupts

After: changed to Mutex
Result

Before: disabling interrupts

After: changed to Mutex

Problem Solved!
Customer Example 2: Watchdog Reset

Watchdog sometimes expire and resets the system! Why?
Let’s check why "SamplerTask" is not clearing the watchdog...

Blocked on "xQueueSend". Why?
Let’s check the operations on “ControlQueue”

The queue is full. ”ControlTask” not receiving fast enough! Why?
Let’s check the CPU Load Graph

"ServerTask" steals the CPU time for "ControlTask" - need to change priorities!
With Changed Priorities...

Problem Solved!

User Event Signal Plot

CPU Load Graph

[Graphs showing data with labels: Watchdog margin, startup, ServerTask, ControlTask, SamplerTask]
User Examples within **Validation**

- We get a good overview of the application
- Great tool to understand what you have coded
- Really need to know what is going on, otherwise we are not doing our job right
- Helps us avoid “decay” in software design
- Verified that tasks had stopped running when relocating the code from flash to RAM.
User Examples within **Profiling**

- Found high response time caused by excessive context-switching
- Discovered that 20% of the CPU time was used for polling the keypad.
- In less than a week, we tripled performance.
- Measured the start-up time of our device
User Examples within Documentation

• The visualization makes it easier to discuss problems and designs with my team.
• Have used screenshots in design documents to show task interactions and timing.
• I like to keep track of runtime metric as the system evolves, CPU usage of tasks and ISRs.
Questions or comments?

johan.kraft@percepio.com

www.percepio.com