Wind River Sensor Point Technology

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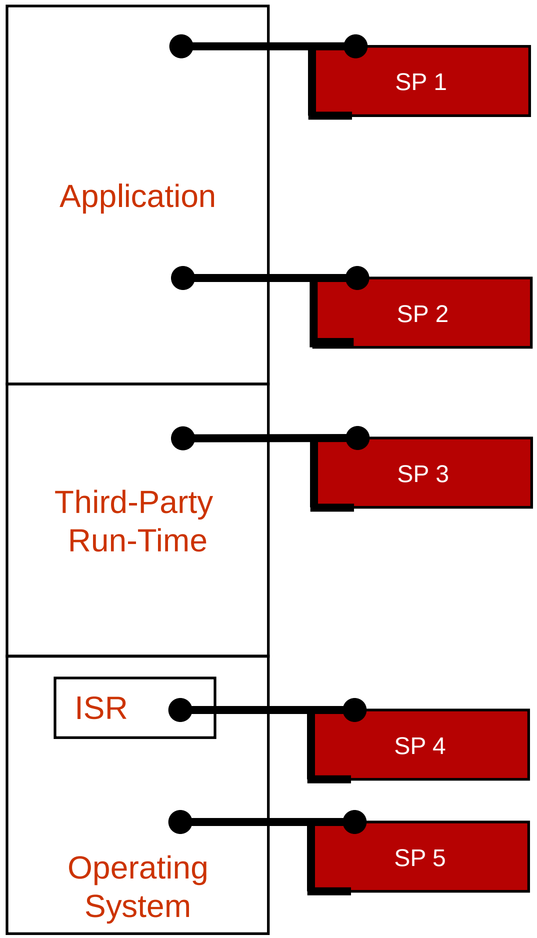
Sensor Points

- Dynamic instrumentation of functions running on "live" devices or systems
  - Instrument applications written in C or C++
  - Instrument kernel, ISRs, and device drivers
  - Instrument third-party code
  - No pre-instrumentation required
- Software instrumentation modules
  - Sensor points written in ANSI-C with custom directives
  - No application, kernel, or third-party source code needed
  - Same scope as any function in which it is inserted
    - Access to local and global variables
- Highly efficient, minimal overhead logging framework
- Minimally intrusive
- Small footprint



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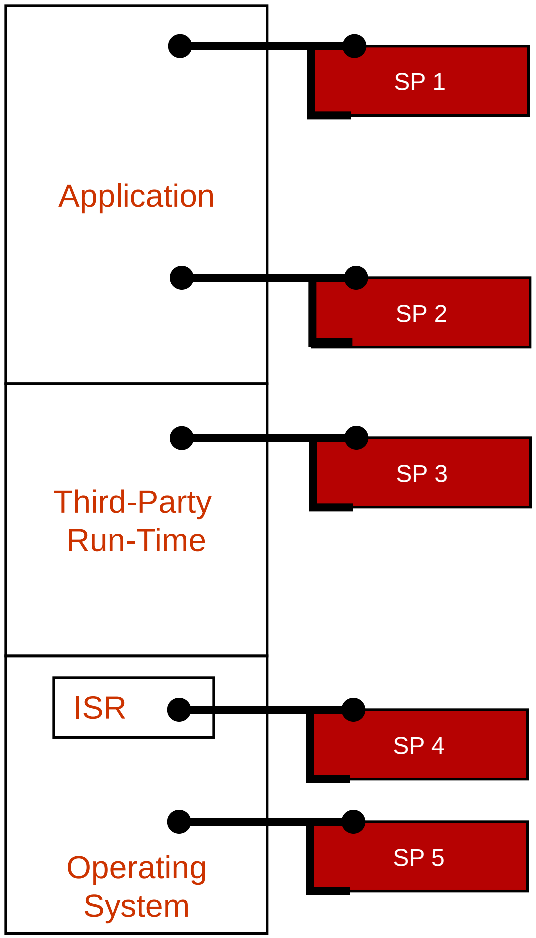
Major Use Cases

- **Dynamically probe running Systems**
  Ex. Retrieve and modify variables, data and execution flow
- **Capture system state at point of failure**
  Ex. Eliminate need to reproduce in lab
- **Rapidly iterate to isolate root causes**
  Ex. 'What if' analysis w/o recompile/restart
- **Patch running equipment**
  Ex. 'hot patch' to verify fixes before committing to code base
- **Enhance QA process**
  Ex. Inject faults, Measure performance, Code coverage, simulate I/O



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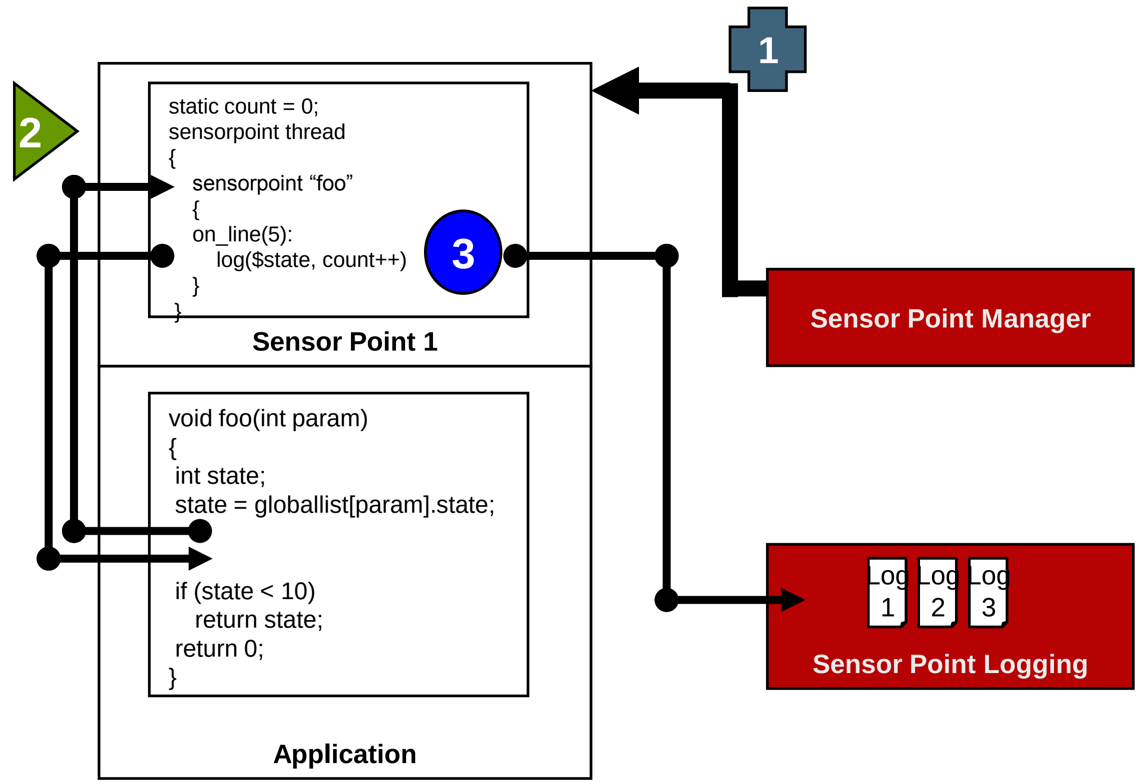
Sensor Point Architecture

1 Dynamically instrument

2 Enable instrumentation

3 Log data



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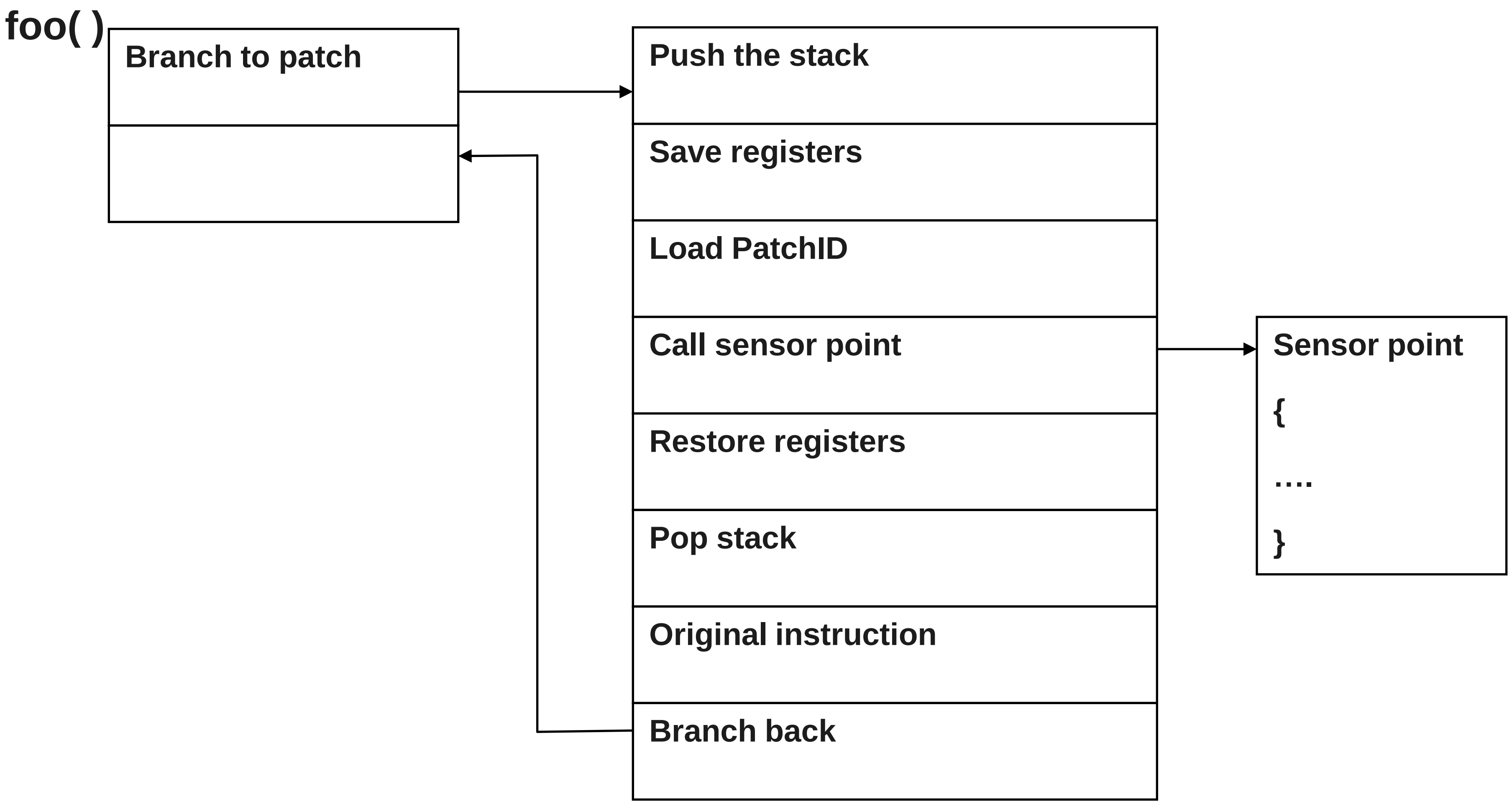
Sensor Point Execution Path



Sensor Point Language (1)

- ANSI C with extensions
  - Language extensions enable Sensor Points to describe instrumentation address, and access symbols in the target application
  - Sensor Points can include all standard C primitives, such as variable and function declarations, type definitions, etc
- Sensor Point Directives
  - sensorpoint
    - The sensorpoint directive describes the context in which subsequent directives execute
  - on_entry
    - Specifies Sensor Point address as the entry of a function, a thread or start of a program (depending on the sensorpoint directive above)
  - on_exit
    - Specifies the exit of a function, a thread or termination of a program
  - on_line and on_offset
    - These directives specify a line number or a hexadecimal offset as the Sensor Point address, within the context of a function

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Sensor Point Language (2)

- **Target expressions allow Sensor Points to reference objects in target application space**
- **Example target expressions**
  - **Access Registers**
    - **$$EAX, $$r3 : Access registers EAX or r3.**
  - **Access local and global variables by name**
    - **$myVar: Access variable myVar in the target application name space**
  - **Positional parameters**
    - **$1: Access first of the function call parameters**
  - **Return value**
    - **$0 or $return: Set the return value of target function (only in on_exit)**
- **Stub Function**
  - **sp_StubRoutine: Skip a function completely (only in on_entry)**
- **Stack Trace**
  - **sp_PrintTraceback, sp_LogTraceback: Print or log stack trace for the target function**

Nesting of Sensor Points

- Sensor Points can be lexically nested.
  - The ability to nest Sensor Points can be a very powerful feature
  - Sensor Points are nested to control the activation of the Sensor Points and to control the up-scope visibility of data items declared in the Sensor Points
- Nesting allows creation of umbrella for nested Sensor Points.
  - The inner Sensor Point is executed only if the enclosing (umbrella) Sensor Point is active.

Logging facilities

- **Logging is designed to be highly efficient and minimally intrusive**
  - High performance locking mechanism allows multiple threads to access log buffers with minimum overhead
  - Binary logs to maximize efficiency during logging
  - Constant data is not logged during execution, instead it is inserted during log formatting
  - Simultaneous writing and reading while maintaining data integrity
  - Built-in logging of context information (thread id, time-stamp) for effective log analysis
    - High precision timer (ns) is used when available
- **Easy to use log visualization tool**

Challenges

- System integration
- Reliable stack walk
- Common log framework
- Variable length instruction patching

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