**DySectAPI: Scalable Prescriptive Debugging**
Enabling users to construct probe trees for automatic, event-driven debugging at scale

**Motivation**
- Current parallel debugging models are largely inadequate for extreme-scale systems
- Traditional model quickly overwhelms developers even at moderate scale
- Lightweight model, where information is sacrificed for scalability, scales well but can significantly limit debug information
- We need a new debugging model that can scale while still providing affordable information levels

**Anatomy of a Debugging Probe**
- Events trigger probes. An event can be either a source code location or a signal
- Must be satisfied for the actions to be taken
- Defines set of tasks in which to install this probe
- Defines the wait time before aggregating the actions across the domain

**Probe Tree for a Real Use Case**

**Contributions**
- A novel debugging model that can strike a balance between scalability and capability
- A prescriptive model
- Allows programmers to codify their debug intuition
- DySectAPI, an implementation of this model
- Performance and scalability evaluation
- Case study to demonstrate DySectAPI’s effectiveness

**Source Code**
Open source code available at: https://github.com/scalability-llnl/DysectAPI

**Demonstrating Scalability**
- Goal: show the scalability of our prescriptive debugging model
- Uses the STAT infrastructure, including MRNet, for scalable tool communication and data processing
- Use an analytic runtime-overhead model to predict scalability at large scale
- Logarithmic scaling demonstrated experimentally and modeled
- Our overhead model predicts a four probe chain-shaped tree would incur 118 ms in debugging the entire Cab system (20,736 cores)
- Pruning debug information via a probe tree significantly reduces information presented to programmers
- Four chained probes and pruning of 50% of the processes in each probe leave just 12.5% of the original processes

**Impacts**
- A novel debugging model that can scale without sacrificing key debug information presented to programmers
- Already proven effective in isolating an MPI bug that manifested itself only at or above 3,456 processes
- Debugging of common debugging scenarios using probe-tree templates
- Future work includes advanced probes using dynamic binary instrumentation

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**Figure:** Debugging scalability based on strategies and amounts of details.

**Figure:** Actual and modeled execution time on Cab with 16 cores per node for a flat and deep probe tree.

**Figure:** Probe-tree debugging session for an MPI bug only manifesting itself at 3,456 processes.