

Visualizing gem5 via ARM DS-5 Streamline

Dam Sunwoo (dam.sunwoo@arm.com)

ARM R&D

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The Challenge

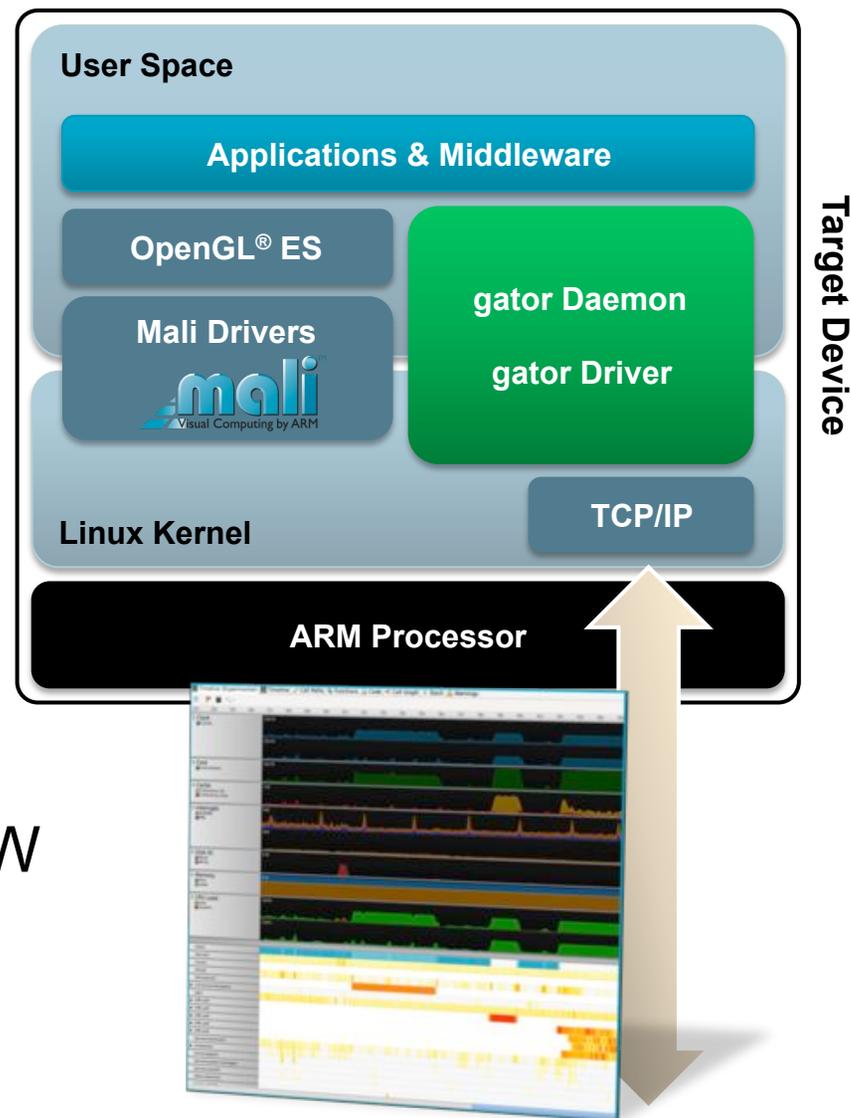
- System-level research and performance analysis becoming ever so ***complicated***
 - More cores and IPs in system
 - More threads in workloads
- Many interesting aspects of system remain in ***thread-level*** and ***temporal*** behavior
- Many architectural simulators (including gem5) only provide text-based statistics
 - Hard to get insight into complex system-level behavior



Good visualization is key!

ARM DS-5 Streamline: System Performance Analyzer for Linux and Android

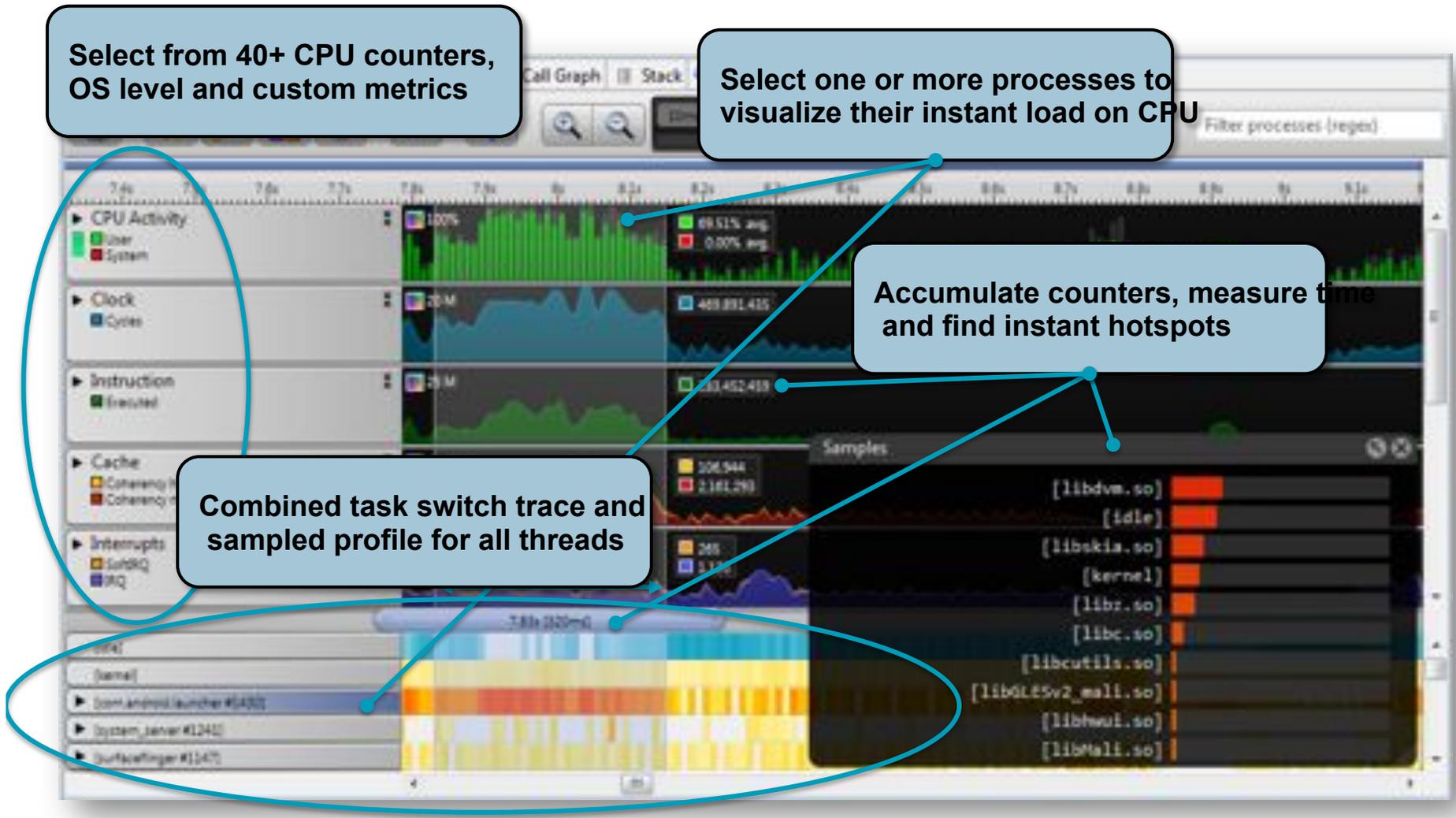
- Software based solution
 - Support for Linux kernel 2.6.32+ on target
 - Eclipse plug-in or command line
- Lightweight sample profiling
 - Time- or event*-based sampling
 - Process to C/C++ source code profiler
 - Low probe effect; <5% typically
- Multiple data sources
 - CPU and GPU H/W and S/W counters
 - Tracepoints
 - Code instrumentation
- Originally developed for real H/W platforms



* Event-based sampling is available on kernels 3.0 or later

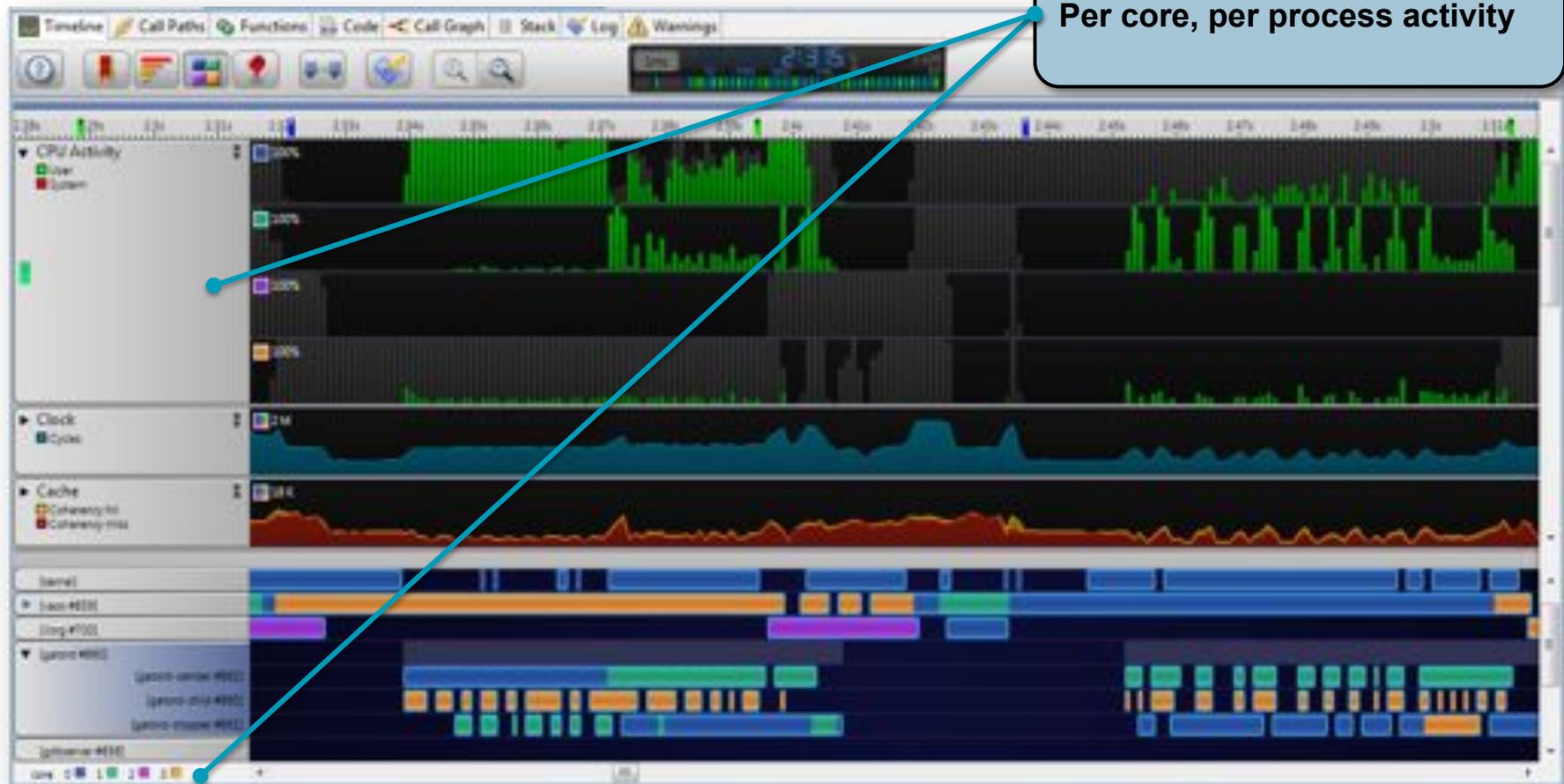
Timeline: The Big Picture

- Find hotspots, system glitches, critical conditions at a glance



SMP Analysis

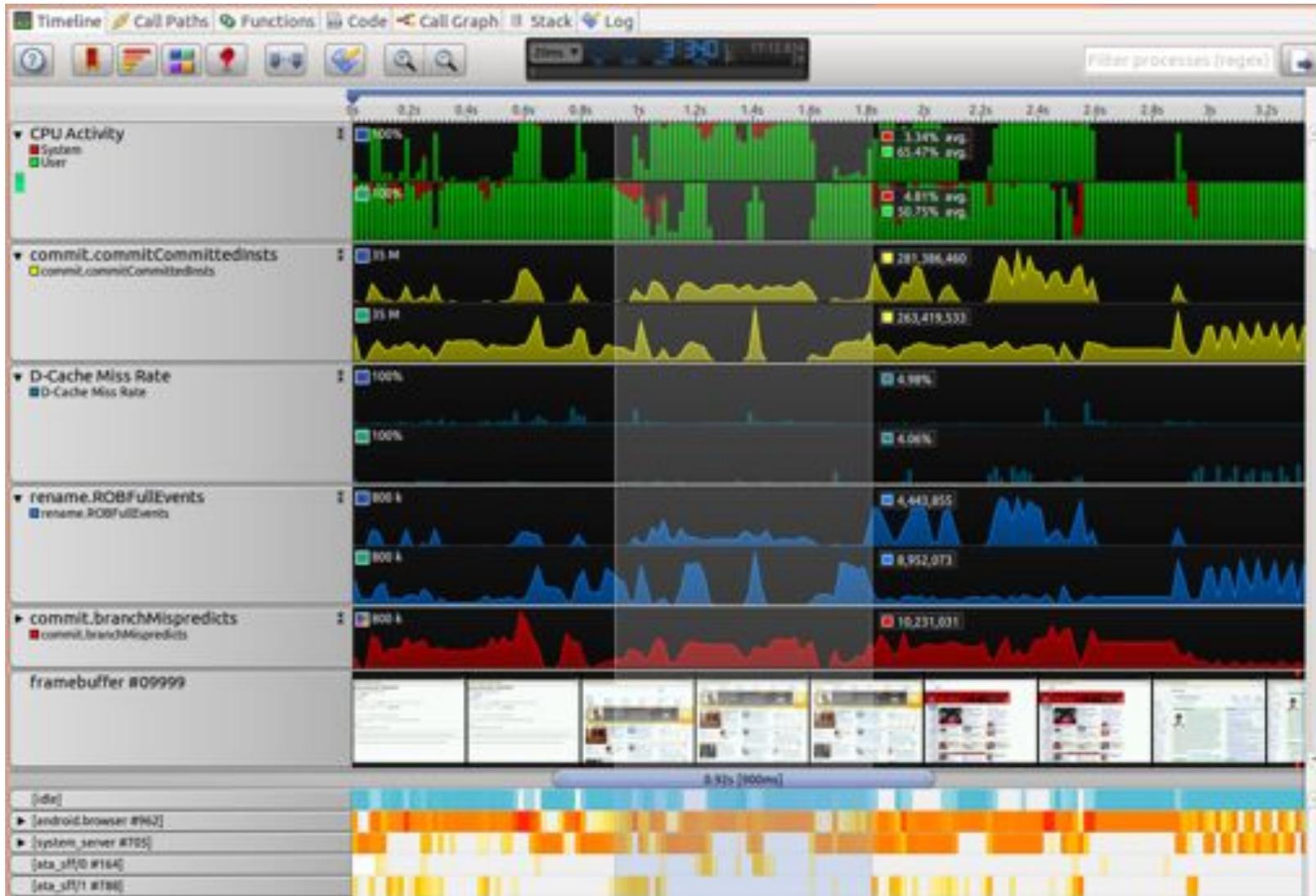
- Take advantage of multicore SMP platforms
 - Visually trace core migration and per-core statistics
 - Spot non-optimal thread synchronization and improve parallelism



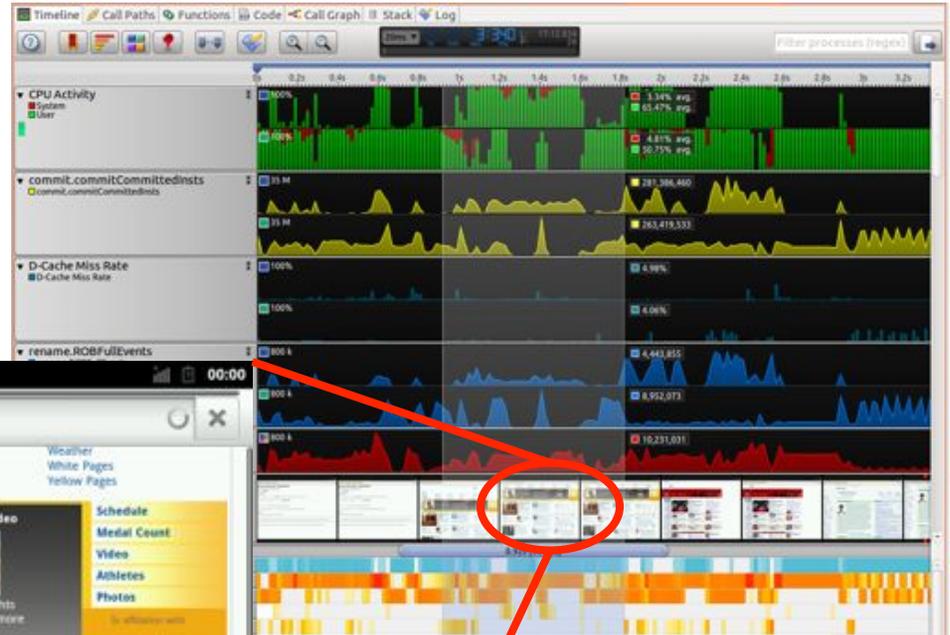
Streamline + gem5

Demo

Sample Screenshot running BBench



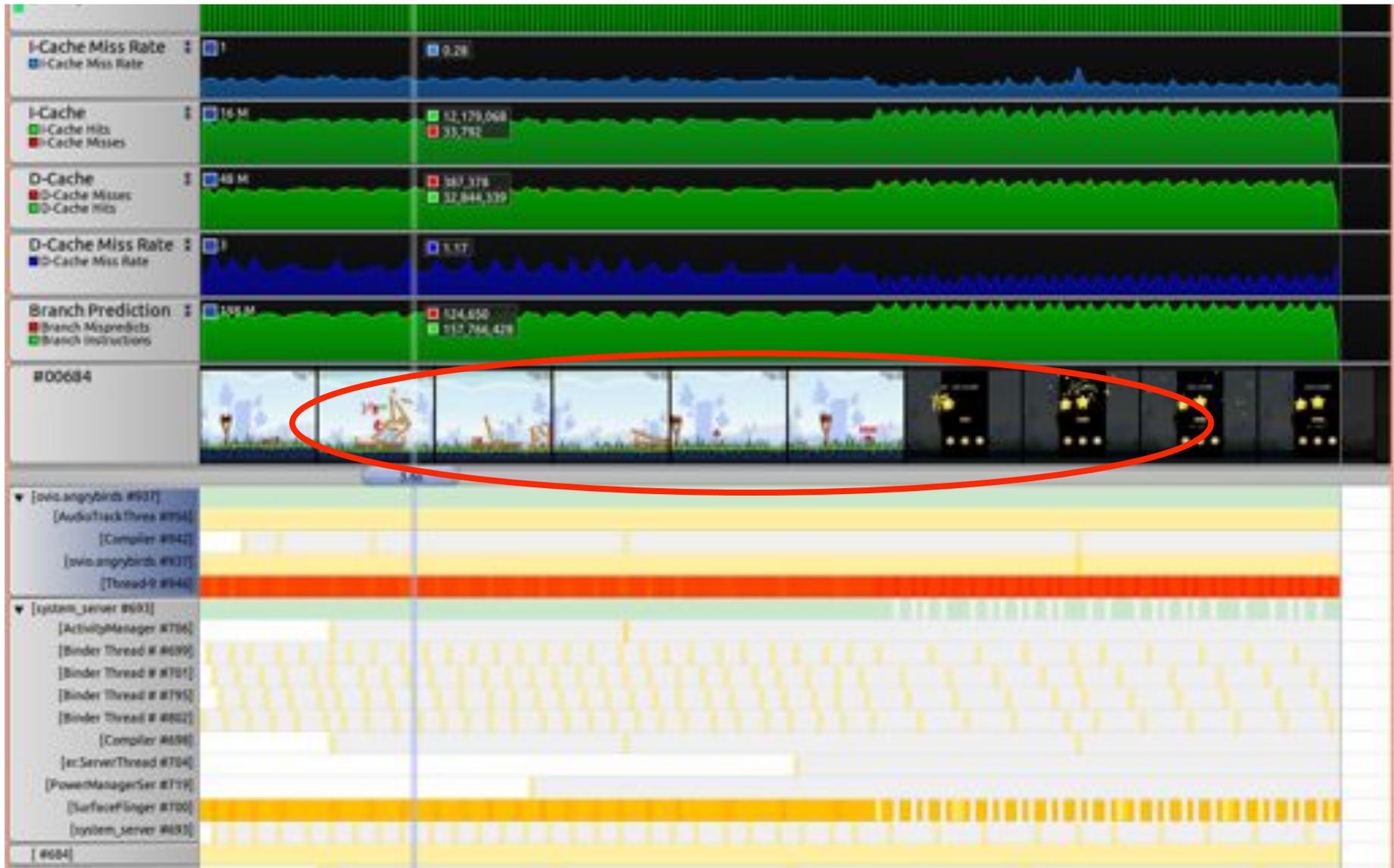
Visual Annotation of LCD Frame Buffers



The screenshot shows an MSN web page with the following sections:

- BEIJING 2008 OLYMPIC GAMES**: Sandy Showdown (Red-hot Rogers & Dalhausser set for tonight's fight for gold).
- MSNBC News**: Alabama workers to pay for carrying extra pounds; Report: IOC probes Chinese gymnast's age; Face transplants could one day be routine; Melting Arctic opens shipping frontier.
- FOX Sports**: NASCAR Chase: 15 drivers, room for 12 ... who's in?; Preseason college football All-Americans | Heisman hopefuls; Krieger: Upshaw's legacy may not be kind; Philly bullpen allows Nats to end long slide; Holdout payoff: Rams' star RB gets \$44M; Sign up for free Fantasy Football on FOX.
- Money**: Surprising purchases that could wreck your credit; Global tensions push oil above \$121 again | Check Dow; Did Buffett bet on the right utility?; Where to turn when you're desperate; Microsoft's new ad weapon: Seinfeld.
- Weather**: San Francisco, CA Clear, 66°; Thursday: 70° / 56°; Friday: 67° / 55°; Saturday: 66° / 56°; Sunday: 69° / 56°.
- Shopping**: Stunning diamond engagement rings; Comfy sofas & loveseats - On sale now; New bedding styles for a bedroom makeover; Women's pants & jeans: Shop hot new fall looks.
- Advertisements**: 50% off contacts, glasses online; AVON: Save up to 50% + Free ship; 9-piece mineral makeup kit: Try free; Circuit City: Super red-hot deals; Find 2008 Olympic gear: Shop now.

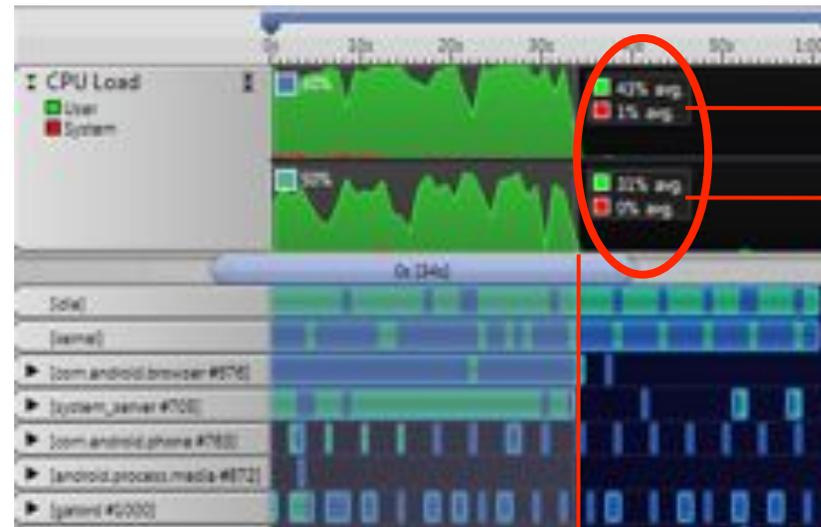
Sample Screenshot running Angry Birds



CPU Load Comparison on “MP-little-big” Config

- The two BBench runs with different schedulers resumed from exact same checkpoint
- aMP-aware scheduler correctly puts more load on big core
- BBench finishes 23% sooner with aMP-aware scheduler in this experiment

▪ Default Scheduler

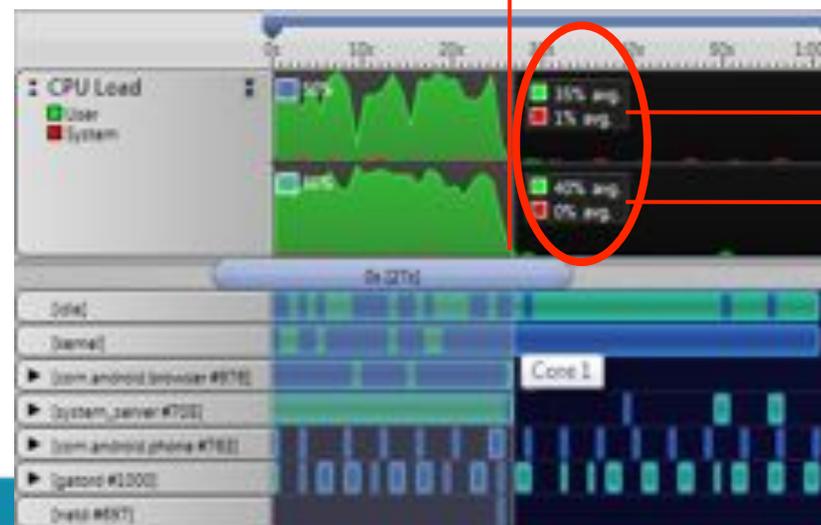


CPU loads out of 50% per core

Little Core Load

Big Core Load

▪ aMP-aware Scheduler

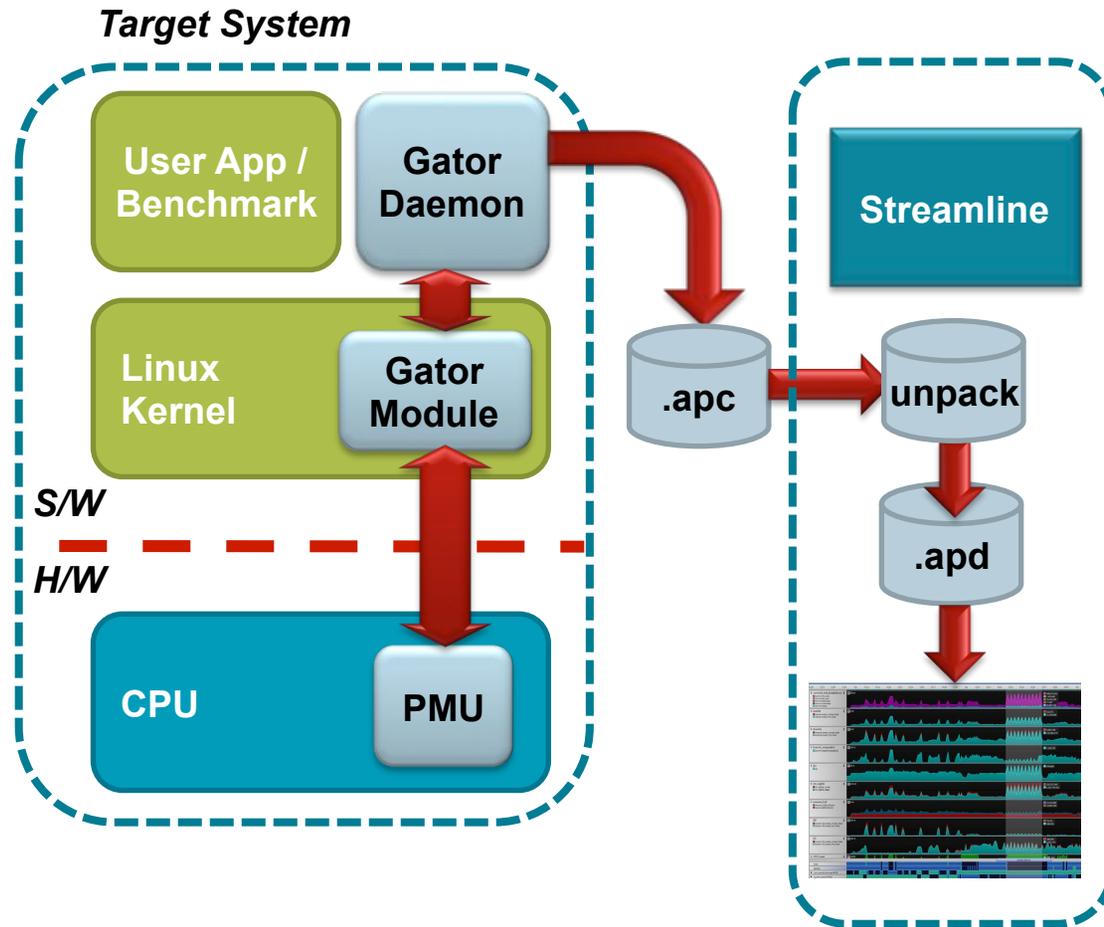


23% improvement

Little Core Load

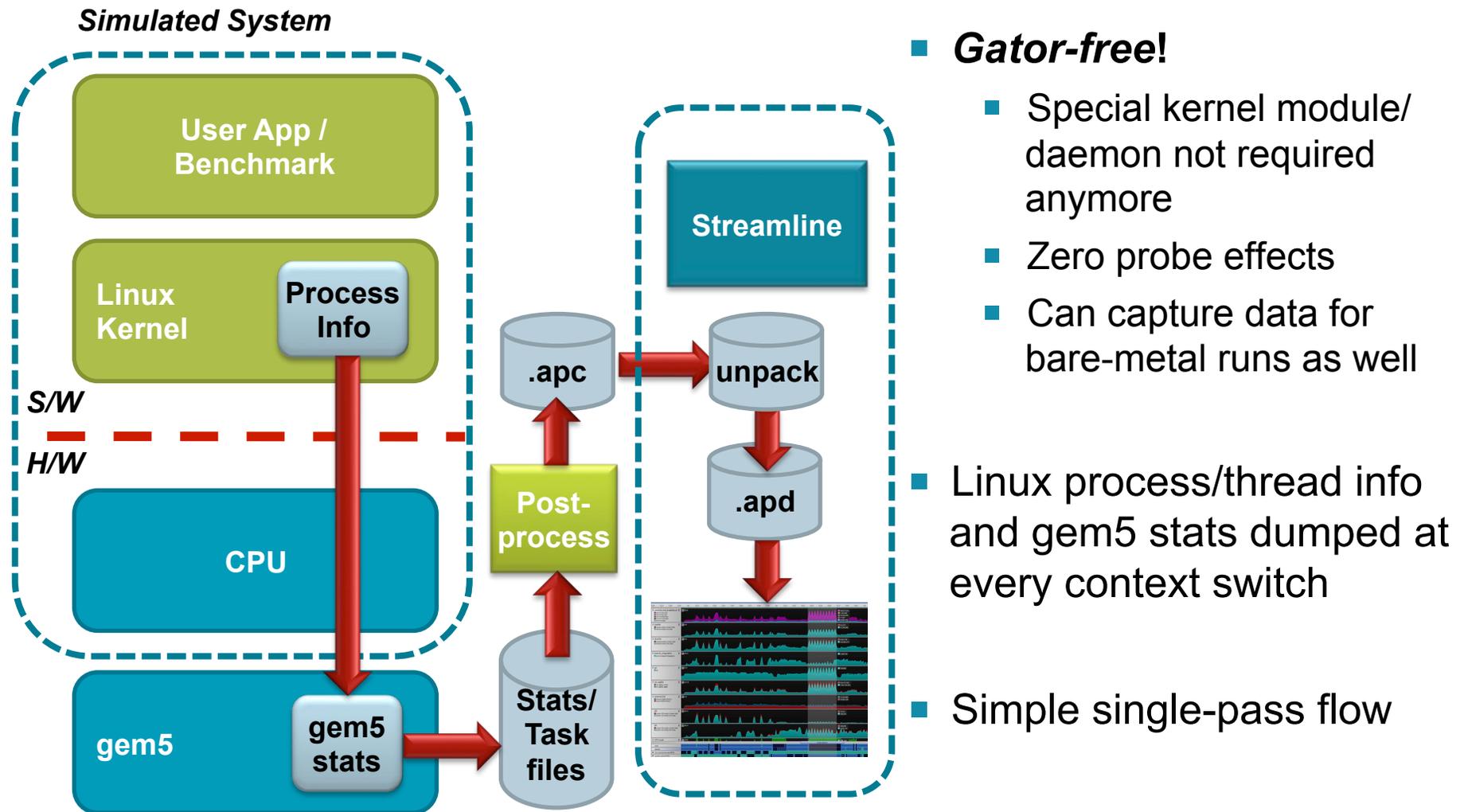
Big Core Load

Original Streamline Capture Flow



- Relies on “gator” kernel module and daemon
- Reads out counters and process information and dumps to file

Streamline+gem5 Flow

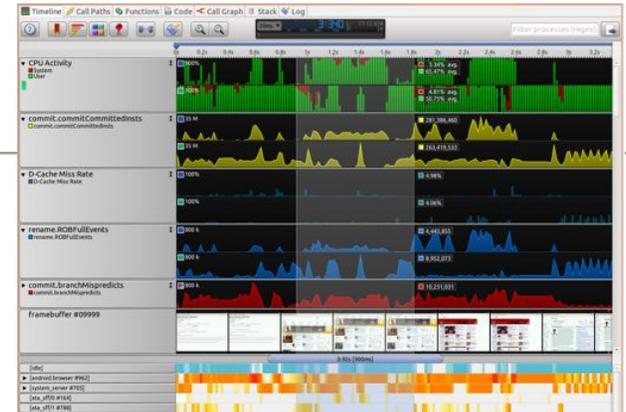


How do I get started?

- Streamline 5.12 Community Edition available now for free!
 - Details on <http://www.arm.com/products/tools/streamline-for-gem5.php>
- Slightly modified Linux/Android kernel
 - Add “m5struct” to let gem5 know of offsets of certain kernel struct fields (pid, tgid, comm (task name), mm (mem map), etc.)
- Enable enableContextSwitchStatsDump flag in LinuxArmSystem
 - Dumps stats at context switches (callback for __switch_to())
 - Dumps process info (pid, tgid, task name, cpu id) at context switches
- Enable frame_capture (optional)
 - Dump frame-by-frame output in gzipped bmp format for visual annotation
- Post-process script
 - Uses gem5 stats / process info / frames to generate Streamline .apc project file from scratch (without gator)

**Streamline available for download now!
gem5 changes and scripts to be available very shortly. Stay tuned!**

Summary



- **Streamline+gem5** enables great *visualization* of complex system behavior in an effortless manner
 - Process / Thread information
 - Crucial in understanding OS scheduling behavior in complex multi-threaded benchmarks
 - Temporal behavior of benchmarks
 - Easier to digest than Giga-bytes of text in stats file
 - Better visualization
 - Various features and views to help better understand results
 - Pretty screenshots for papers and presentations 😊
- Any questions or feedback are welcome (dam.sunwoo@arm.com)