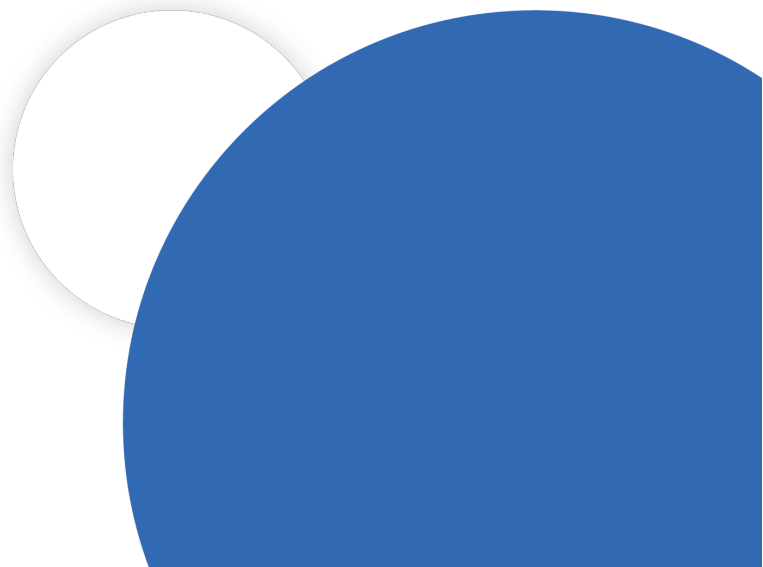# Siemens EDA accelerates software defect resolution with Undo

How Catapult engineering team unblocked their customer's silicon design pipeline

The challenge

Reproducing a production defect under time pressure and IP protection constraints

Jason Gouger, Architect with the Digital Design & Implementation Solutions Division (DDISD) of Siemens EDA (formerly known as Mentor), faced a classic programmer's challenge: he needed to capture and diagnose a production defect in controlled settings that mirror the customer's environment.

> "There was a file system-related issue we were looking to track down, and we had an idea of where the problem was occurring. This would be a simple case to debug if you could run it in the debugger given the same environment/file systems as the customer.
>
> Jason Gouger, Architect | **Siemens EDA**

Gouger works in the engineering team for the Catapult™ HLS Platform - a High-Level Synthesis (HLS) tool enabling designers to use ANSI C++ and/or SystemC to describe functional intent — moving up levels of abstraction and accelerating productivity.

As with most enterprise software vendors, Siemens EDA's engineers need to find ways to recreate bugs as they occur in their customers' environment and get them fixed quickly. Meanwhile, customers want to protect their proprietary information while getting defects resolved promptly.

The reported problem Gouger encountered was related to a unique customer environment set-up, making it very difficult to reproduce the exact issue on a local system. Specifically, the problem was due to unusual behavior when saving data to a temporary storage location. This problem only manifested itself on the customer's site, and Gouger could not reproduce it locally and get full disclosure of the issue.

A tedious and prolonged debugging workflow

In order to gather information and diagnose the problem, the typical response is to send Field Application Engineers (FAEs) to the customer's site or to arrange remote-access to a specially set-up machine at the customer's location.

However, FAEs are severely constrained by some customers' IP protection protocols when they encounter an issue while running the Catapult HLS tool.

Typically, FAEs cannot install new debugging software onto customers' machines, take binary data off customers' machines, and, in some cases, take any data or logs off customers' machines. This means that FAEs cannot indiscriminately collect data for later offsite diagnosis. Instead, FAEs must diagnose the problem "live" at customers' sites and gather enough information so that Siemens EDA R&D engineers can later reproduce the problem back at base using the knowledge that FAEs have gained on-site.

FAEs are further hampered in their actions by Siemens EDA's own IP protection protocols. Commonly, developers will generate a special debug build of the application and negotiate to get it installed at the customer site. FAEs then have to remember to delete it once the debug session is complete.

These limitations mean that FAEs are often limited to just re-running Catapult HLS on the customer's design with additional logging enabled - hoping that the problem will reoccur and information about the problem will be revealed in the logs.

Alternatively, they might try to use a debugger to extract the revealing internal state from the program without access to source code and/or symbolic information. This makes diagnosing the customer's problem extremely time-consuming and tedious - often requiring repeated visits to the customer's site in order to extract more information.

Introducing Software Failure Replay

Gouger integrated LiveRecorder — Undo's Software Failure Replay capability — into the Catapult HLS Platform.

By bringing in LiveRecorder, Gouger gave his team the capability to:

- Record Catapult HLS' program execution as it failed / behaved unexpectedly

- Replay the recording forward and backward (like a CCTV footage) to analyze what the process what doing at that time

With this technology, Siemens EDA engineers were able to capture all non-deterministic data and reliably recreate their application's entire memory and register state on demand at any point in the program's execution with minimal overhead.

Under normal circumstances, this technology can be used with few limitations to capture all of the information relevant to a defect, and export that off-site for review in controlled circumstances. Once a recording has been made, there is no need for original application binaries or run-time environments in order to replay it.

In Gouger's case, the customer was able to use simple instructions to make a recording themselves (capturing all the information relevant to the defect in the process), thereby eliminating the need for FAEs to physically visit the customer's site.

The recording file was sent back to Siemens EDA's R&D engineers, who were able to debug it without wasting time trying to recreate the failure. Engineers went straight to analyzing the recording file using LiveRecorder's reverse debugging functionality (called UDB).

They were able to quickly identify the point in the execution history where the data was saved to storage and to understand the application's current internal state. They swiftly found the issue and delivered a rapid fix.

Additional functionality to support IP sensitive environments

Although this debugging workflow works for most customers, it can prove too revealing for those with concerns about protecting proprietary designs or code.

Undo has therefore developed an IP-sensitive solution (packaged into LiveRecorder) that allows EDA users like Siemens EDA, to leverage the power of Software Failure Replay on air-gapped customer sites. LiveRecorder was integrated as a dynamic library into Catapult HLS; using LiveRecorder's API, recordings can be started, saved and the performance configured.

Use of a dynamic library avoids incurring any memory footprint when not recording (so that semiconductor customers do not need to compromise on their use of Siemens EDA's software). This allows the application to generate recordings that can be replayed directly at the customer site. LiveRecorder also includes a debugger that can be distributed with the vendor's application (Undo Player); so there is no need to upload a separate debugger whenever FAEs go on customer site. It requires no internet connection or licensing infrastructure; and there is no limit to the number of recordings that can be produced or debugged.

In cases where both the semiconductor customer and Siemens EDA allow FAEs to bring source code on-site, FAEs can debug recordings interactively using UDB (LiveRecorder's reverse debugging functionality). Siemens EDA can either equip its FAEs with the program's symbolic information, or bundle it in encrypted form with the Catapult HLS application.

Regardless of whether Siemens EDA's FAEs have access to the source code or not, they can run scripts on the recording to extract the internal state from their program at arbitrary points in the program's execution — adding additional logging facilities to the program long after it has been shipped to the customer.

Successful outcomes for Siemens EDA and its customers

Production failures that emerge at a customer site are a huge challenge for EDA vendors - particularly when the customer has IP-sensitive software or is running IP-sensitive material.

Undo's Software Failure Replay platform offers a unique solution for resolving this strenuous process by allowing EDA vendors to take exact recordings of the failure as it happens in production and in a manner which does not compromise customers' IP - something that has never before been possible.

In Siemens EDA's case, Gouger was able to achieve the following outcomes:

1. **50% reduction in Time-To-Resolution**
   Using traditional root-cause analysis techniques, it would normally take 2 or 3 cycles over several days to get enough data to diagnose software issues in production. The recording file reduced the diagnosis process down to just 1 cycle and the defect was reproduced in hours.

2. **$5,000 savings on support and engineering staff overhead on this minor defect (saving estimates closer to $25,000 for intermittent defects)**
   A single recording (instead of multiple files) was sufficient to capture and store all the information needed to identify the root-cause of the software defect. Siemens EDA was able to reduce their on-site troubleshooting costs by debugging offline and saving a trip to the customer site. This saved the cost of organizing a meeting at the customer site, travel costs, as well as a day of engineering time.

3. **Customer disruption was kept to a minimum**
   Fewer iterations of vendor-customer debug cycle were required - including a reduced effort in negotiating access to the customer's infrastructure.

Undo is the leading Software Failure Replay platform provider for engineering teams building complex systems.

Undo's flagship product, LiveRecorder, is used to fix software bugs faster, accelerate product delivery, and reduce engineering costs.

With offices in Cambridge, UK and San Francisco, CA, Undo's platform is used by thousands of software engineers across leading technology companies including SAP, Juniper, Cadence Design Systems, Micro Focus, and Siemens EDA.

https://undo.io