

BigLever Software Case Study: Engenio



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Engenio made the transition to *software product line* practice in order to keep pace with growing business demand for its products. By using an incremental transition strategy, Engenio avoided the typical upfront adoption barrier – the equivalent development effort of 2 to 3 standalone products – which in their case was projected to be 900 to 1350 developer-months. Engenio discovered that by making an upfront investment of only 4 developer-months, they were able to start a chain reaction in which the incremental returns quickly outpaced the incremental investments.

1. Engenio Overview

Engenio is the recognized leader in the modular, high-performance disk storage systems industry. With a 20-year history of researching, developing, and manufacturing innovative storage solutions, Engenio is positioned in today's market as the original equipment manufacturer (OEM) and partner of choice for some of the largest information technology vendors and resellers in the world.

As a provider of feature-rich storage arrays to major OEM vendors – such as IBM, SGI, Cray, StorageTek and Teradata – Engenio's engineering team faced significant challenges in leveraging their storage technology expertise across all products, while delivering unique and differentiated solutions for each customer. For Engenio, efficient product line engineering is mission critical for meeting its business goals. Furthermore, Engenio (formerly LSI Logic Storage Systems) is separating from its parent company, LSI Logic Corporation, and the ability to extend its product line to attract and retain a growing customer base is key for establishing investor value.

2. Engenio's Product Line Development Challenges

The demand for Engenio's RAID storage server products was rapidly outpacing the firmware development team's ability to create, evolve and maintain the firmware for those products. The company's success, combined with changing product line strategies and turbulent market conditions, put overwhelming pressures on the team to expand their development capabilities. It soon became clear that conventional development approaches – which centered on individual product releases – were no longer viable for keeping pace.

In the midst of market-driven turbulence, the need for a shift within the engineering group at Engenio was not readily apparent. Instead, the need for change gradually became evident as the Engenio team experienced the evolution from a single product to multiple, sequentially released products, and finally, to multiple products released on parallel and intertwined schedules.

Initially, Engenio's firmware was constructed as a single software build, applicable to all deployments. Product variability was resolved at runtime, using downloadable configuration data stored in non-volatile memory. Evolution of the firmware was managed in a sequential manner, where each release was transitioned through the stages of analysis, design, implementation and test. Once a release was complete and shipping to customers, work on the next release would begin.

Over time, as new hardware platforms with substantial differences were added to the portfolio, the development team created separate software builds to manage portions

With approximately 135 developers across four locations, Engenio's Controller Firmware Development team provides firmware for 23 products, with approximately one million lines of embedded software code for each product. Approximately 80% of the code is common among all products.

of the product variability. This solved the immediate problem of supporting the variation among new and existing products; however, it proved to be a less than ideal way to manage the commonality. Eventually, as multi-product development requirements increased, Engenio's "tranquil world" of sequential releases was replaced with the market-driven demand for a half dozen intertwined and overlapping release cycles.

During their evolution to multiple products, Engenio utilized a proven, well-integrated configuration and problem tracking system. While this system did an excellent job in the role for which it was intended, significant issues arose in the management of product variability. For example, variability to satisfy differing platform requirements was managed by branched versions of the same source files. Similar branching was introduced to support the concurrent development of diverse features. Eventually, approximately 30% of the 3300 files in the Engenio source code base had 2 to 16 active branches under development. Managing the resultant branching, merging, duplication and divergence became the dominant effort for the firmware development team.

One of Engenio's software architects observed development quality degeneration due to excessive file branching. Development managers also noted that defect resolutions were becoming increasingly expensive, since a large percentage of development capacity was being spent on analysis, correction, and validation on multiple file branches. Ultimately, the Engenio team came to the realization that a change in their development practice was imperative.

3. The BigLever Solution

In evaluating new development strategies, Engenio concluded that *software product line* approaches posed many potential benefits. However, based on prevalent software product line literature, the Engenio team anticipated a lengthy adoption cycle for transitioning their development efforts, estimating that the transition would require 900 to 1,350 developer-months for re-analyzing and re-architecting controllers, re-engineering and componentizing assets, redesigning production infrastructure and processes, and re-organizing management and development teams.

Rather than attempting to surmount this formidable upfront adoption barrier, Engenio selected BigLever's software product line development tool – Gears™ – to enable them to make an incremental transition into a product line practice. BigLever provided the methodology and tools that Engenio needed to make a series of incremental investments, each of which yielded immediate, order-of-magnitude returns. For example, in their first incremental stage, Engenio discovered that with a relatively small upfront investment of four developer-months, the cumulative returns quickly began to outpace the cumulative investments in terms of time, effort and money. As a result, the "profits" in time, effort and money from their first incremental investment could be used to fuel the remaining steps in their transition.

3.1. Transition Stages

The sequence of incremental steps in Engenio's transition to software product line practice followed these five primary stages:

- Validate the BigLever Software approach. Engenio and BigLever embarked on a 6-week pilot project to validate the strategic benefits of Gears in the Engenio environment. After only 2 weeks, the pilot had exceeded expectations and Engenio made the immediate decision to embrace Gears as its software product line engineering solution, purchasing licenses for its staff of 140 firmware engineers
- Transition the infrastructure from conventional configuration management and builds to first class Gears software product line variation management, configuration management and automated production.
- Transition from team organization by products to team organization by core assets.
- Transition from development processes defined by product releases to development processes defined by feature releases.

- Transition from validation and quality assurance for individual products to validation and quality assurance for all of the software product line assets.

To date, Engenio is in the fourth incremental stage and planning the fifth stage.

4. Results with BigLever

Rapid adoption: Engenio's transition to a software product line practice demonstrated that a development organization with a large legacy code base can make the transition without a major upfront investment – and without disrupting ongoing production schedules. By investing only four developer-months of effort upfront, and 12 developer-months overall, Engenio incrementally transitioned 23 products, each comprising 1 million lines of code, and 135 developers to a sophisticated software product line practice. (This is less than 1% of the effort previously reported for legacy software product line transition efforts.)

Leveraging core software assets and competencies: After creating the production infrastructure and formal core software assets, the Engenio team could readily identify significant benefits of the new methodology and technology. This approach enabled the team to focus more time and energy on creating new features and products, while spending less time on labor intensive overhead. Engenio has experienced a 50% increase in development capacity and this number continues to grow.

As Engenio shifts its development team focus to core software assets rather than products, further reductions in development overhead are being achieved by leveraging the growing domain expertise of asset teams. Engenio anticipates that their new software product line approach will significantly increase their ability to respond to changing customer requirements, as well as strengthen collaboration and effectiveness for their geographically distributed development staff.

5. About BigLever

BigLever Software, Inc. is a leading provider of software product line development tools and services. Located in Austin Texas, the company was founded in 1999 based on more than 15 years of research and hands-on experience in software reuse and software product line technologies. BigLever's patent-pending solution, Gears™, dramatically simplifies the creation, evolution and maintenance of embedded or standalone software for a product line. This leading-edge solution enables software development organizations to bring new product line features and products to market faster, enabling businesses to more reliably target and hit strategic market windows.

BigLever has in-depth experience and proven expertise in supporting successful transitions to a software product line approach. BigLever has helped companies adopt industry best practices and successfully transition to a formal software product line approach in less than 10% of the time and effort required by other approaches.

"As an OEM supplier to many leading storage vendors, our partners depend on us to provide them with differentiated solutions under aggressive development schedules. This leads to a complex software development challenge. Gears from BigLever helps us uniquely leverage our core competency in storage system software to efficiently create, evolve and maintain an entire product line of many differentiated products."

-- Bill Brant, Engenio VP of Engineering