



BIGLEVER NEWSLETTER: **Special Series**

At the Edge of the Product Line Engineering Envelope Part 1: Introduction

Greetings from Dr. Charles Krueger, BigLever CEO:

Systems and Software Product Line Engineering (PLE) is a broad, deep and dynamic field. This is true across the spectrum, from applied research to commercial practice. Although the field has been actively expanding since the early days 30 years ago – when we talked about primordial things like *application generators* and (in my dissertation) *modeling and simulating a software architecture design space* – at any point in time it has never been clear whether the field was approaching its plateau or whether the envelope of concepts, knowledge, tools, methods, techniques, benefits, and experiences would continue on its ascending trajectory.

Yet year after year we continue to see the envelope expand, where PLE science becomes routine practice, PLE art becomes well understood science, and heretofore unknowns emerge as compelling new art at the leading edge of the PLE envelope. Many of the new advances at the leading edge of practice are visible only to those who are actively engaged in new or expanding PLE deployments, so to increase visibility to the broader PLE community we are kicking off a newsletter series that spotlights some of the compelling new art at the leading edge of PLE.

This newsletter is the first installment in the series, *At the Edge of the PLE Envelope*.

Multistage Configuration for Product Family Trees

Many of the latest PLE innovations are occurring at the interface between engineering and the larger enterprise, in support of strategic business operations such as product marketing and portfolio planning. In

BigLever's 3-tiered PLE Methodology, shown in the illustration, this is the interface between the middle and top tiers. [Click image to enlarge.]

Feature-based methods, using PLE constructs and tools that were traditionally confined to the engineering



■ BigLever at SPLC 2013

BigLever Software will present a variety of sessions at the **17th International Software Product Line Conference (SPLC 2013)** on August 26th - 30th at Waseda University in Tokyo, Japan.

The SPLC agenda is designed to enable practitioners, researchers and educators to explore trends, experiences, achievements, and new directions for the future growth of the field. BigLever sessions include technology overview and case study presentations, as well as participation in a panel discussion addressing the barriers to PLE adoption, a tutorial regarding second generation PLE, and a demonstration of BigLever's Gears PLE Lifecycle Tool and Framework.

In a session entitled *Multistage Configuration Trees for Managing Product Family Trees*, BigLever will spotlight the new feature-based product family tree management capability addressed in this issue of the newsletter.

>> [See Multistage Configuration paper.](#)

■ Case Studies and Hall of Fame Nomination

General Dynamics will join BigLever at SPLC to present the challenges of applying a Service-Oriented Architecture to the U.S. Army's Live Training Transformation (LT2) product line.

>> [See General Dynamics / U.S. Army case study.](#)

General Dynamics will also be nominated for the **Software Product**

organization, are proving to be highly effective for product portfolio planning, resource and capacity analysis, and other business facets that need to be explored well before engineering begins.

*Multistage Configuration for Product Family Trees*¹ is a new development at the top (business) tier of the PLE methodology, in direct response to customer needs that only came into clear focus over the last year. It is a good example of emerging practice at the edge of the PLE envelope. Multistage configuration trees support complex product family trees, where feature decisions are incrementally staged throughout the nodes in a product family tree. Feature decisions made at any node are inherited by all descendants of that node, thereby defining a product family subtree.

In successful commercial product line organizations, the number and diversity of products delivered can grow to be extremely large, partially due to the efficiencies made available by the latest generation of PLE tools and methods. In market segments ranging from automobiles to industrial systems, it is not unusual for companies to manufacture millions of products every year, in thousands of different "flavors". This extreme product line diversity creates major challenges for engineers implementing the product line, product marketers defining the space of available products, and customers selecting from the array of available products. To provide order and clarity about their product groupings and offerings within this type of complex product space, enterprises often organize their products into a *product family tree*.

Multistage configuration trees is a result of applying the product family tree concept to feature management in PLE. A systems architect from a customer made an insightful comment that illustrates how this represents a different way of thinking: "We are more focused on identifying the features that we don't want in a particular [subfamily] than we are on specifying the features we do want on any particular product." In other words, the internal nodes in a product family tree are more important than the product nodes at the leaves of the tree. Contrast this to the traditional PLE focus on techniques for selecting and solving for features in a product instance.

In multistage configuration trees, a traditional *feature model* (the full collection of feature choices available in a product line) serves as the root of the tree and fully bound *feature profiles* (feature choices made for each particular product instance) are found at the leaves of the tree. A new construct is introduced for the internal nodes of the tree – the *partially bound feature profile* – where some feature decisions have been made or restricted and other feature choices remain available.

A partial profile is more than just a partially filled out feature profile. There are special semantics for *unbound* and *downselected* feature decisions.

- *Unbound* means that the modeler has explicitly made their decision to leave a decision open, so that other descendants in the multistage configuration tree can make their own decision – possibly different in different subfamilies – about this feature choice.
- *Downselection* reduces the available diversity for a feature, while

[Line Hall of Fame](#), which represents distinguished members of the community recognized for highest achievement in the field.

In a separate case study presentation, BigLever will explore how Lockheed Martin is utilizing a new PLE-based auditing method to protect restricted content in derived products.

>> [See Lockheed Martin case study.](#)

■ [SPLC 2013 Schedule: BigLever Sessions](#)

Tutorial: *Second Generation Systems and Software Product Line Engineering*

Tuesday, August 27, 2:00 pm

Presenters: Dr. Charles Krueger and Dr. Paul Clements, BigLever Software

Presentation: *Multistage Configuration Trees for Managing Product Family Trees*

Wednesday, August 28, 11:00 am

Presenter: Dr. Charles Krueger, BigLever Software

Tool Demo: *Systems and Software PLE with BigLever Software Gears*

Wednesday, August 28, 1:45 pm

Presenters: Dr. Charles Krueger and Dr. Paul Clements, BigLever Software

Presentation: *A PLE-Based Audit Method for Protecting Restricted Content in Derived Products*

Thursday, August 29, 1:45 pm

Presenters: Dr. Charles Krueger and Dr. Paul Clements, BigLever Software

Presentation: *The Challenges of Applying Service Orientation to the U.S. Army's Live Training Software Product Line*

Thursday, August 29, 3:45 pm

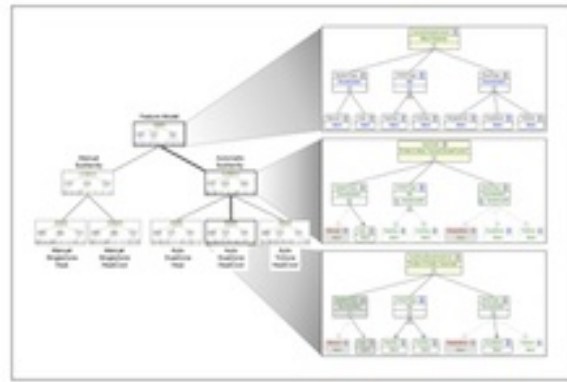
Presenters: Rowland Darbin, General Dynamics; Dr. Charles Krueger and Dr. Paul Clements, BigLever Software

Panel Discussion: *Barriers for SPL Practice and Paths to Get Over*

still leaving some diversity open in an unbound decision.

For example, this screen shot provides a view of an expanded feature-based product family tree -- including feature downselection, selection and inheritance -- for a home heating and cooling system.

[Click image to enlarge.]



Any connected path from the root node to a leaf node must be a monotonically non-increasing sequence in the space of available feature choices. That is, children must honor the feature decisions made by their ancestors and may optionally decide to make additional feature decisions that further constrain the space of available feature choices.

Multistage configuration for product family trees has broad applicability for scenarios across different systems and software engineering domains, including:

- In aerospace and defense, defining subfamilies for exportable versus legally restricted, non-exportable feature content
- In automotive, organizing the millions of product instances that need to be produced each year into a tree of manufacturing platforms, models, regional configurations, trim packages, and user offerings
- In consumer electronics, structuring different product levels, from low-end to high-end
- For OEMs, maintaining strict separation among customer-specific proprietary intellectual property

Multistage configuration for product family trees is one of the most influential new concepts to emerge at the leading edge of the PLE envelope. It is being adopted by new and strategically important organizational roles for PLE – by people who analyze, plan and define product portfolios. These roles have traditionally been dealing with their complex product family tree issues using things like large and intricate spreadsheets, so adopting formal PLE concepts, languages and tools provides significant enhancements to the way they work. One organization is starting their PLE transition here, moving the typical PLE adoption beachhead one step upstream from the engineering organization.

Stay tuned for more installments in the series, *At the Edge of the PLE Envelope*.

Best Regards,

Charles W. Krueger
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Them

Friday, August 30, 11:00 am

Panelists: Dr. Kentaro Yoshimura, Hitachi; Dr. Paul Clements, BigLever Software; Julia Rubin, IBM

■ SD Times: Gears 7.2

The release of Gears 7.2 -- the latest version of BigLever's industry-standard PLE solution -- was recently featured in an article by David Rubinstein, editor-in-chief of *SD Times*. The article provides a view into how the new feature-based product family tree management capability impacts the way companies build and deliver their product lines.

>> [See SD Times article.](#)

>> [See press release.](#)

■ Learn more about PLE

The [BigLever website](#) offers a comprehensive collection of informational resources regarding the latest advances in PLE technologies and methods including case studies, white papers, articles, conference publications, and more.

>> [See learn more section.](#)

BigLever's introductory video – [Product Line Engineering for Systems and Software](#) – conveys the technical and strategic business impact of PLE, in a way that crosses all organizational boundaries.

>> [View Introduction to PLE video.](#)

BigLever also supports the PLE community by producing and maintaining [ProductLineEngineering.com](#). This educational website provides an introductory overview of basic PLE concepts and benefits, PLE success stories, and proven approaches for PLE adoption.

>> [See Product Line Engineering website.](#)

■ About BigLever

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¹ Patent Pending

BigLever Software, Inc.TM is the leading provider of systems and software product line engineering framework, tools and services. BigLever's patented GearsTM solution enables organizations to reduce development costs and bring new product line features and products to market faster, enabling businesses to more reliably target and hit strategic market windows.

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