Product Line Engineering (PLE) Defined

- **Product Line**: a family of similar products with variations in features and functions

- **Product Line Engineering**: the engineering of a product line using a *shared set of engineering assets*, a *managed set of features*, and an *efficient means of production*…
  - taking advantage of the *commonality* shared across the family
  - efficiently and systematically managing the *variation* among the products
Model Based Engineering (MBE) Defined

• A **Model** is an approximation, representation, or idealization of selected aspects of the structure, behavior, operation, or other characteristics of a real-world process, concept, or system (IEEE 610.12-1990), i.e. an abstraction.

• **Model-based systems engineering** is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases (INCOSE-TP-2004-004-02).

BigLever at a Glance

• **Industry leader** in Product Line Engineering solutions
  - 15 years of commercial practice with PLE tools, methods & organizational change

• **Industry standard** PLE framework, ecosystem & methodology
  - *Gears PLE Lifecycle Framework™* and *PLE Ecosystem* of third party integrations
    • IBM, Aras, Microsoft, ANSYS, Open Source, MadCap, Sparx, No Magic…
  - *BigLever 3-Tiered PLE Methodology™*

• **Industry’s only** service provider with **proven success** in organizational change management for transition to PLE practice
<table>
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<tr>
<th>Who are they?</th>
<th>What is their product line?</th>
<th>Driving problem</th>
<th>PLE results</th>
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<tr>
<td><strong>Lockheed Martin</strong></td>
<td>AEGIS Weapon System</td>
<td>High cost of old approach threatened loss of entire contract</td>
<td>Over 100 ship deployments: $47 million saved per year(^1)(^2)(^3)</td>
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<td><strong>General Dynamics</strong></td>
<td>Live Training Transformation, family of large-scale training systems for US Army, Air Force, and Marines</td>
<td>Innovative low-cost solution required to win and keep major contract</td>
<td>Over 300 training range deployments: $520 million saved over 12 years(^4)(^5)</td>
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<td><strong>World's #1 auto-maker</strong></td>
<td>Largest, most complex product line comprising over 10,000,000 instances</td>
<td>Vehicles taking too long to bring to market; expensive and error-prone processes</td>
<td>Will save “hundreds to thousands of man/years per year, worth tens to hundreds of millions of dollars per year” for one asset type alone(^6)(^7)(^8)</td>
</tr>
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<td><strong>NetApp</strong></td>
<td>High-end server storage systems</td>
<td>Unable to accommodate growth in market</td>
<td>2x-5x improvements in scalability, productivity, time-to-market, and product quality(^9)</td>
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<td><strong>HomeAway</strong></td>
<td>Product line of e-commerce web sites hosted in over 200 countries worldwide</td>
<td>Broad variation in sites around the world; needed to go live ASAP</td>
<td>First product went live in 60 days(^10)</td>
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<td><strong>Leading aviation supplier</strong></td>
<td>Whole-aircraft avionics product line</td>
<td>High cost of product certification</td>
<td>8:1 improvement in time to produce certification documents</td>
</tr>
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**Common Motivation in PLE Success Stories:**

**Competitive Advantage**

- **Discontinuous Competitive Jump**
- **New Frontier with Product Line Engineering**

- **Competitive Advantage**
Shared assets are like the factory’s supply chain.
Features describe capabilities that vary among products.

- **Feature Catalog**
  - Driven by Marketing, modeled by Feature Engineering

- **Bill-of-Features**
  - Driven by Portfolio, modeled by Product Engineering

Assets are configured according to the feature profiles of the products you want build.
Features come in.

A product comes out.

Assets are configured.

Just like a factory.

In contrast, product-centric coordination that has to occur for a portfolio of $N$ products is proportional to $N^2$. 
The Challenge of Product Line Engineering: Harnessing Complexity

Processes, tools and techniques cannot overcome the exponential complexity.

A new approach is required...

The Gears PLE Lifecycle Framework
The Gears PLE Lifecycle Framework

The PLE Technical Solution
A Single Source of the Feature Truth
Automated Production Line in Operation

Shared PLE Asset Supersets

Product A Asset Subsets

Product B Asset Subsets

Product N Asset Subsets

The PLE Ecosystem

Engineers want to work in environments familiar to them.

There must be an integration between their tools and the configurator, which requires technology partnerships.
**Ecosystem of Bridges for the Gears PLE Framework**

**No Magic**

Unified PLE solution for engineering tools and integrated development environments across the full lifecycle:

- Requirements Engineering
- Modeling and Design
- Software Development
- BOM & Mechanical Engineering
- Test Case Engineering
- Slideshow Development
- Spreadsheet Development
- Document Management
- Configuration Management
- Build Management

**Model-based PLE**

Model-based tools and their assets can be included in the PLE ecosystem.
PLE Feature Models — a New Dimension in MBE

Holistic concerns in a PLE Technical Solution

- **Multi-product.** Feature-based variation management and automated production line
- **Multi-discipline.** Product line lifecycle assets, architecture and traceability
- **Multi-baseline.** Product line change management and baseline management
MBE Models vs Feature Models

- MBE Models and PLE Feature Models are distinct and orthogonal abstractions in different dimensions
- MBE Models are for domain concepts and system behaviors
- PLE Feature Models are for differentiating characteristics among members in a product family

MBE is not an Island

- MBE is an interconnected member in the multi-discipline dimension across the engineering lifecycle ‘V’
- PLE cannot be applied internal to just MBE models — or any other asset type
3-Tiered PLE Methodology

Business Tier

Organizational Tier

Technology Tier

Competitive Advantage with PLE

Discontinuous Competitive Jump

New Frontier with Product Line Engineering

Competitive Advantage

Time

You
Your Competition