34th Annual INCOSE international symposium

hybrid event

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Three Dimensions of Precision Digital Engineering

Precision Digital Engineering

- Digital Engineering
  - Models and relationships to enable humans and advanced computation to better comprehend, analyze, and reason about engineering lifecycle data
  - Shift from traditional reliance on subject matter experts, human memory, verbal communication, and textual communication

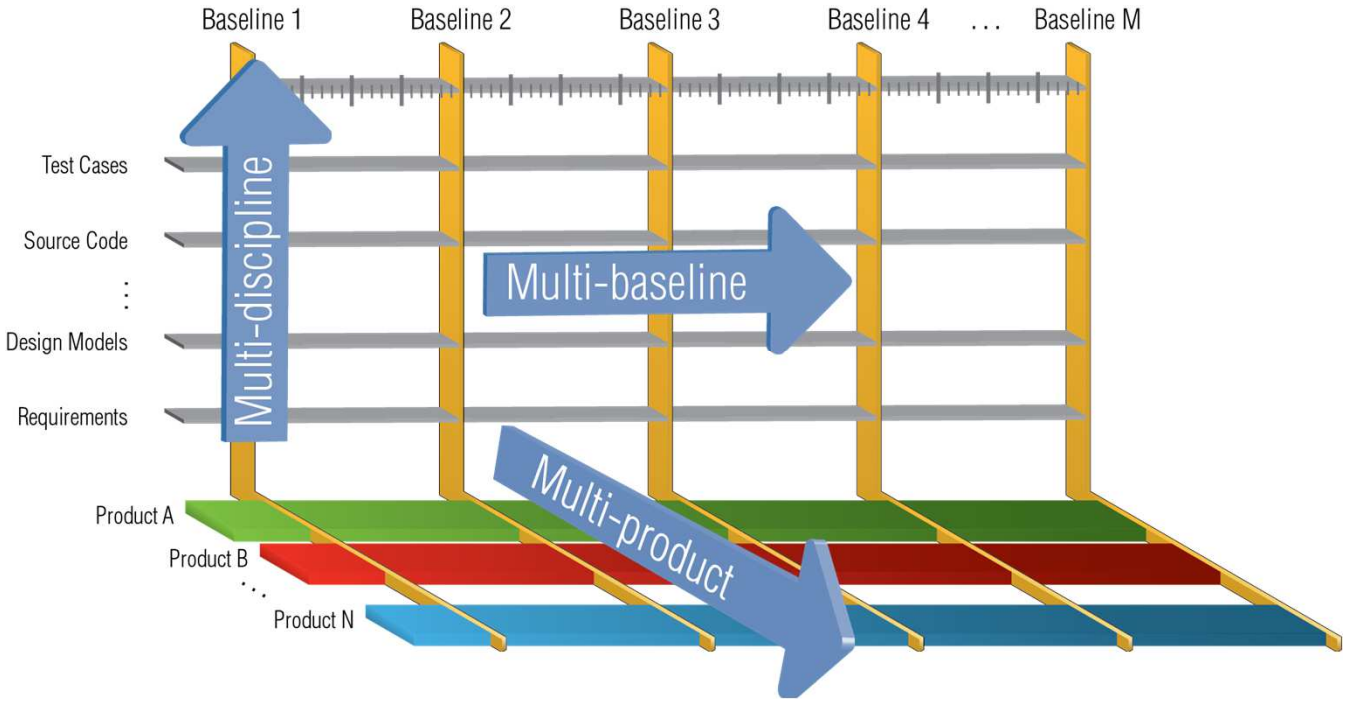
- Precision Digital Engineering
  - Interconnected concerns that enable a concise holistic solution that is necessary and sufficient for managing the enormous scale and complexity of the overall digital engineering data, structures, and tools
  - People and process are implicated, but not the primary focus today

Three Dimensions of Precision Digital Engineering

Multi-discipline
Product line lifecycle assets, architecture and traceability

Multi-baseline
Product line change management and baseline management

Multi-product
Feature-based variation management and automated production line



Multi-product Dimension

Feature-based Product Line Engineering, or System Family Engineering

Multi-product Dimension

- Virtually all systems engineering is performed in the context of a product line
  - A family of similar systems with variations in features and functions
- For Digital Engineering, conventional engineering practices don’t scale
  - Those based on cloned copies of intricate engineering models and digital threads for each member of a family are intractable
- Cloned asset copies are consolidated into a Shared Asset Superset
  - Feature models and variation points realize the distinguishing characteristics among family members
- Shared Asset Supersets are the foundation for each of the other two dimension

Multi-product Dimension According to ISO 26580

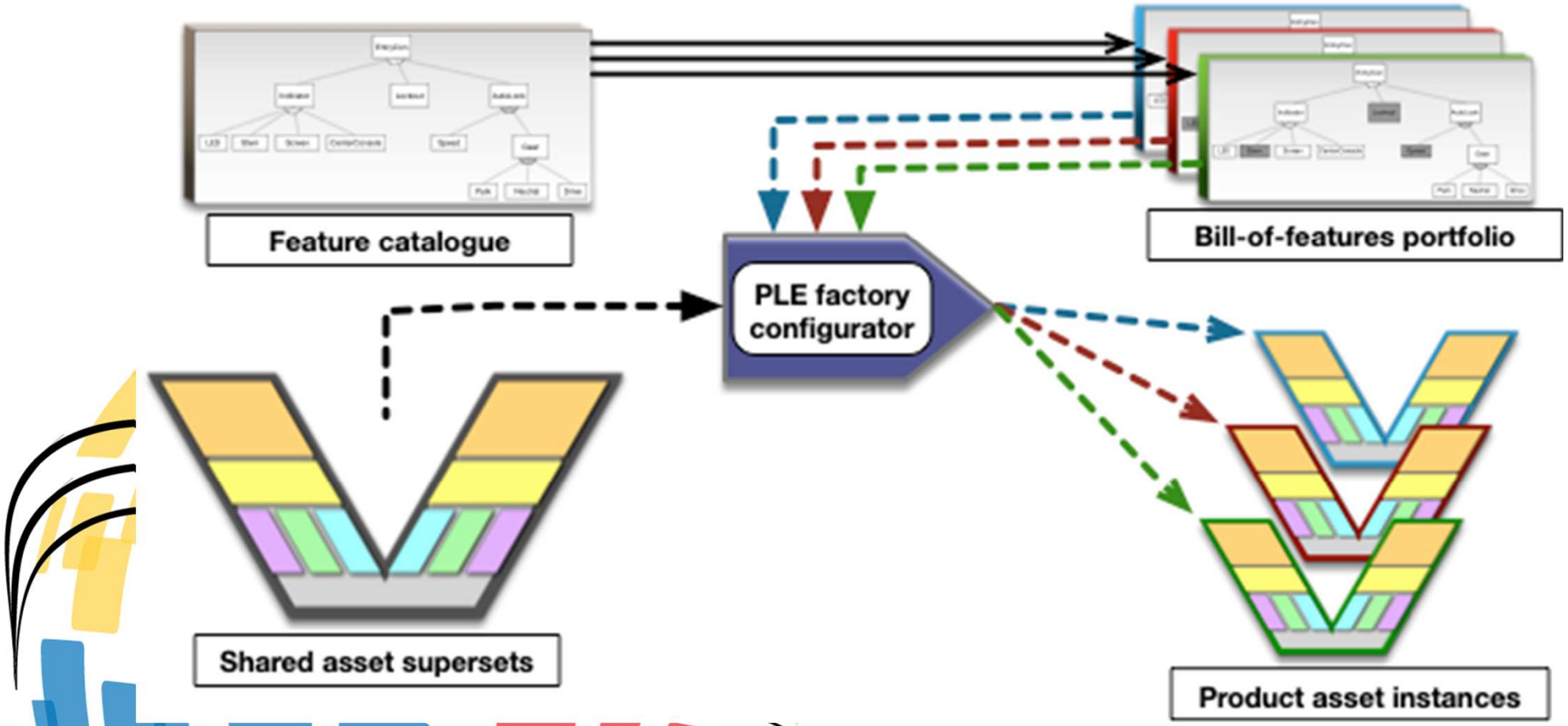


Figure from ISO/IEC 26580

Multi-baseline Dimension

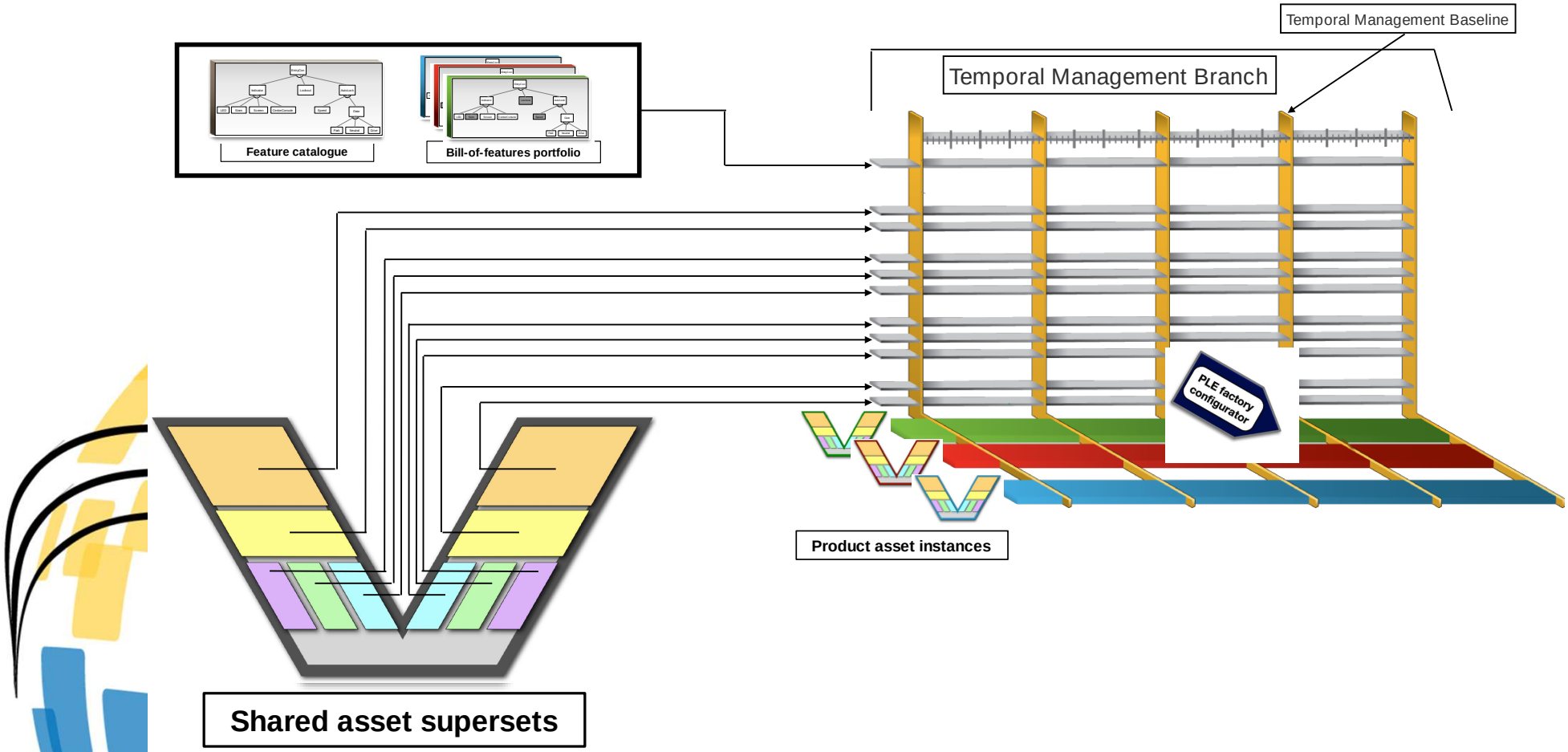
A System-of-Systems for Configuration Management

Multi-baseline Dimension

- Engineering tools typically provide a mechanism for configuration management (CM)
  - Versions
  - Branches
  - Baselines
- However, these CM mechanisms are often siloed in each tool and aren't designed to work with CM mechanisms in other tools from other vendors
- Precision Digital Engineering requires precise alignment of the versions of engineering assets across all of the engineering lifecycle disciplines, in support of all the members of a system family
- The key is to create a higher order CM from constituent CM mechanisms of the Shared Asset Supersets in each discipline
  - Temporal Management: CM-system-of-CM-systems

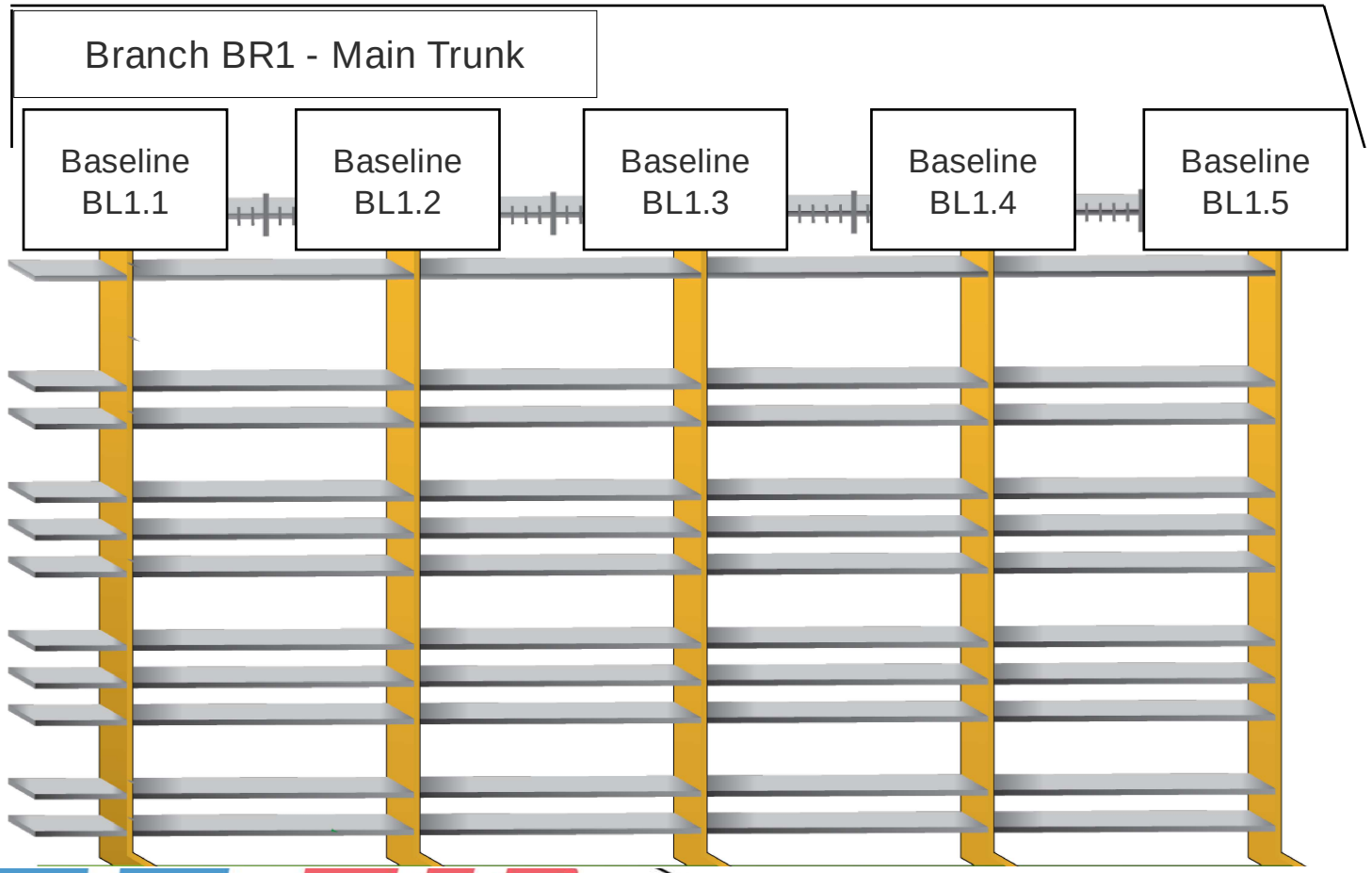
Multi-baseline Dimension According to pending ISO 26581

Temporal Management system comprising the constituent CM systems



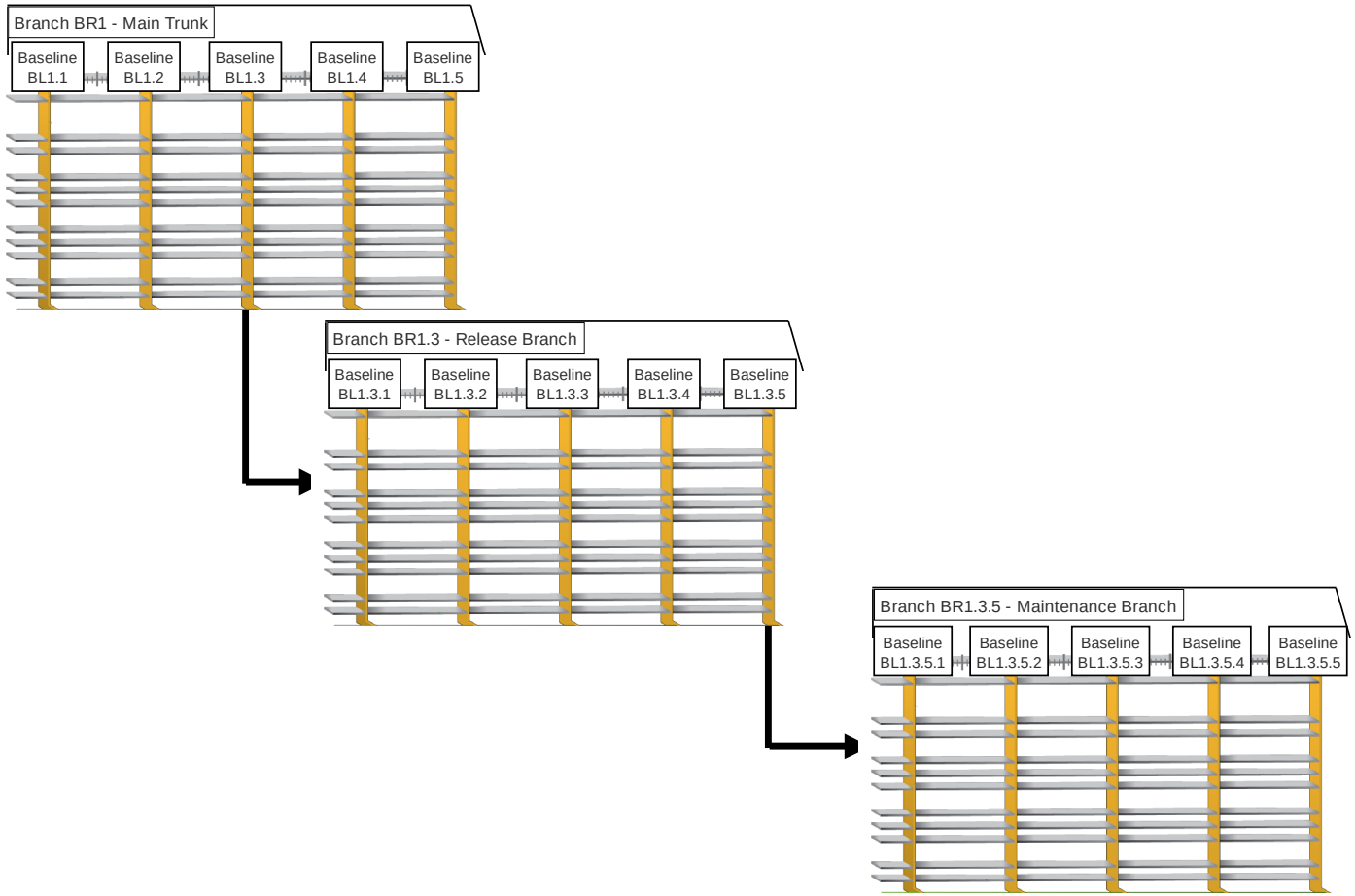
Multi-baseline Dimension According to pending ISO 26581

Temporal Management baseline comprising the constituent CM baselines



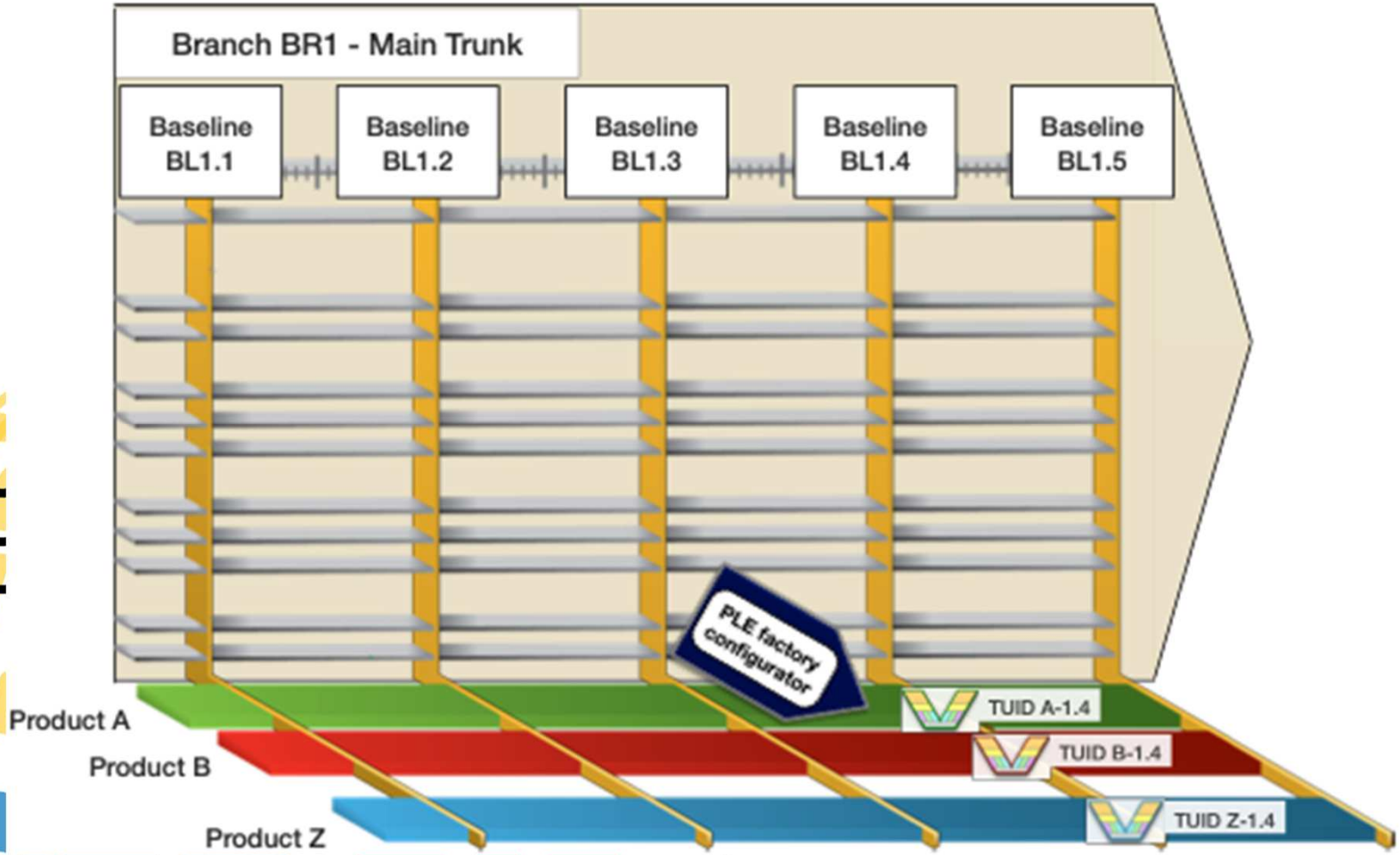
Multi-baseline Dimension According to pending ISO 26581

Temporal Management branches comprising the constituent CM branches



Multi-baseline Dimension According to pending ISO 26581

Temporal Management unique IDs for each member product in product line



Multi-discipline Dimension

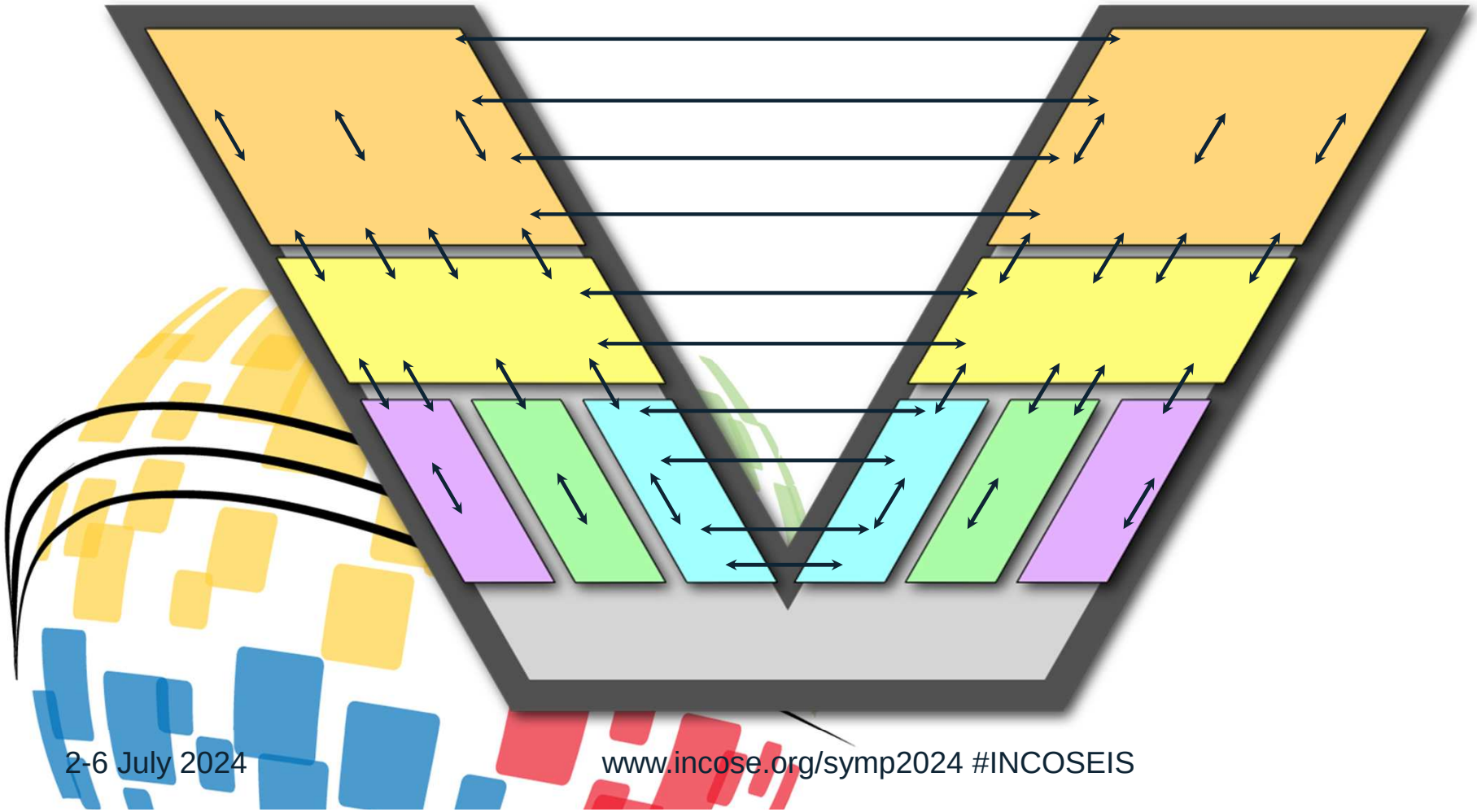
Linked Data across Shared Asset Supersets in Multiple Disciplines

Multi-discipline Dimension

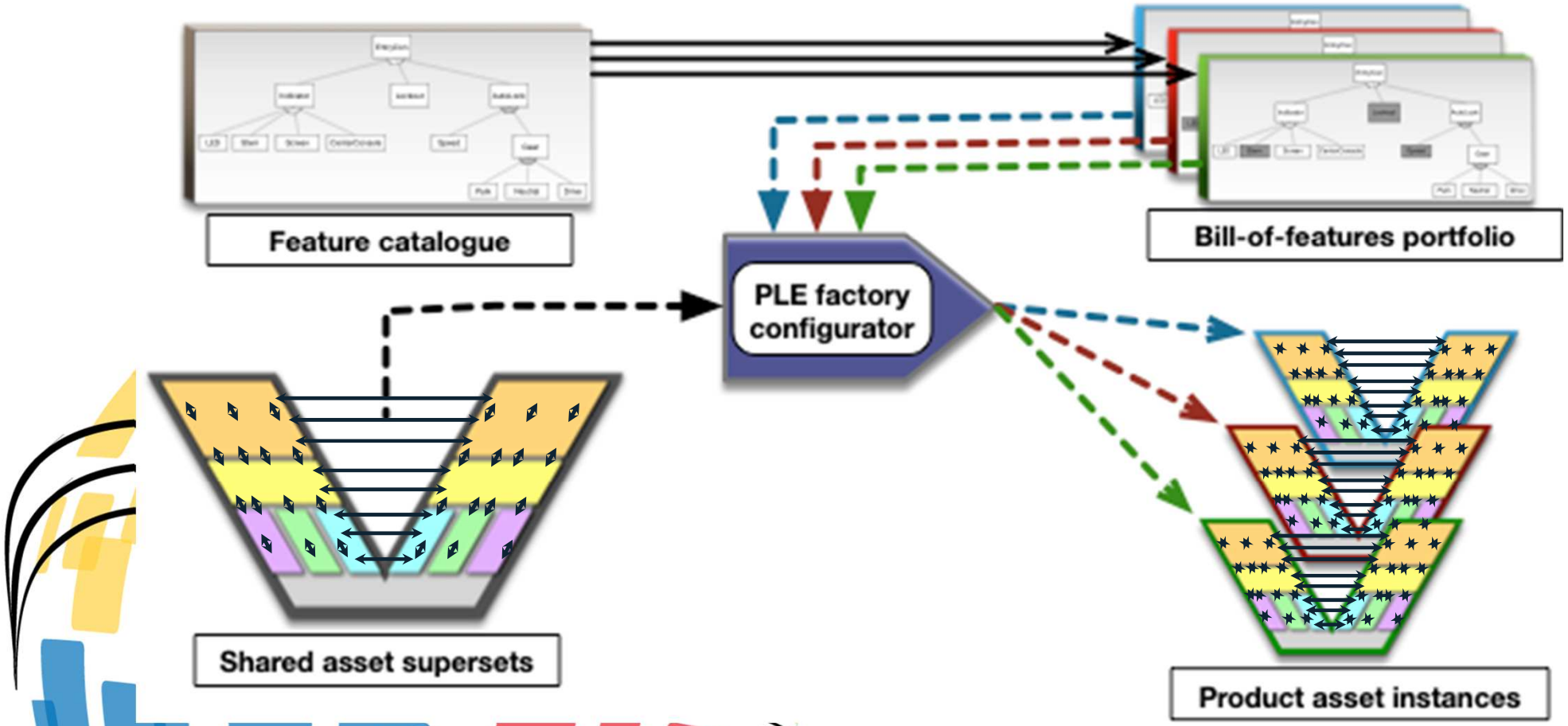
- The key is to create digital threads on the Shared Asset Supersets and use PLE configuration to derive the digital threads for each of the member of the system family

- When a digital thread originates and/or terminates on variation points in a superset, the instantiation of that superset into a member product should result in
  - Digital thread is automatically removed if variation points on both end are removed
  - Error or warning is issued if a dangling link results from a variation point on one end being removed and not the other end

Digital Threads among Shared Asset Supersets



Deriving Digital Threads across Multi-disciplines for Multi-products



Conclusion

- A successful, practical, production-ready Digital Engineering solution requires more than the precise digital representations of multi-discipline digital assets and cross-discipline digital threads
- Precision Digital Engineering provides the interconnected concerns to enable a concise holistic solution that is necessary and sufficient for managing the enormous scale and complexity of the overall Digital Engineering data, structures, and tools
- Precision Digital Engineering is enabled by focusing on Shared Asset Supersets in Three Dimensions
  - Multi-product
    - Supersets rather than per-product cloned copies
  - Multi-baseline
    - Configuration manage supersets rather than instances
    - Temporal Management: CM-System-of-CM-Systems
  - Multi-discipline
    - Digital Threads on the supersets automatically derive Digital Threads on the instances
- Precision Digital Engineering can be applied broadly across Systems Engineering approaches, such as System-of-Systems, Product-Lines-of-Product-Lines, DevOps, Scaled Agile Framework

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