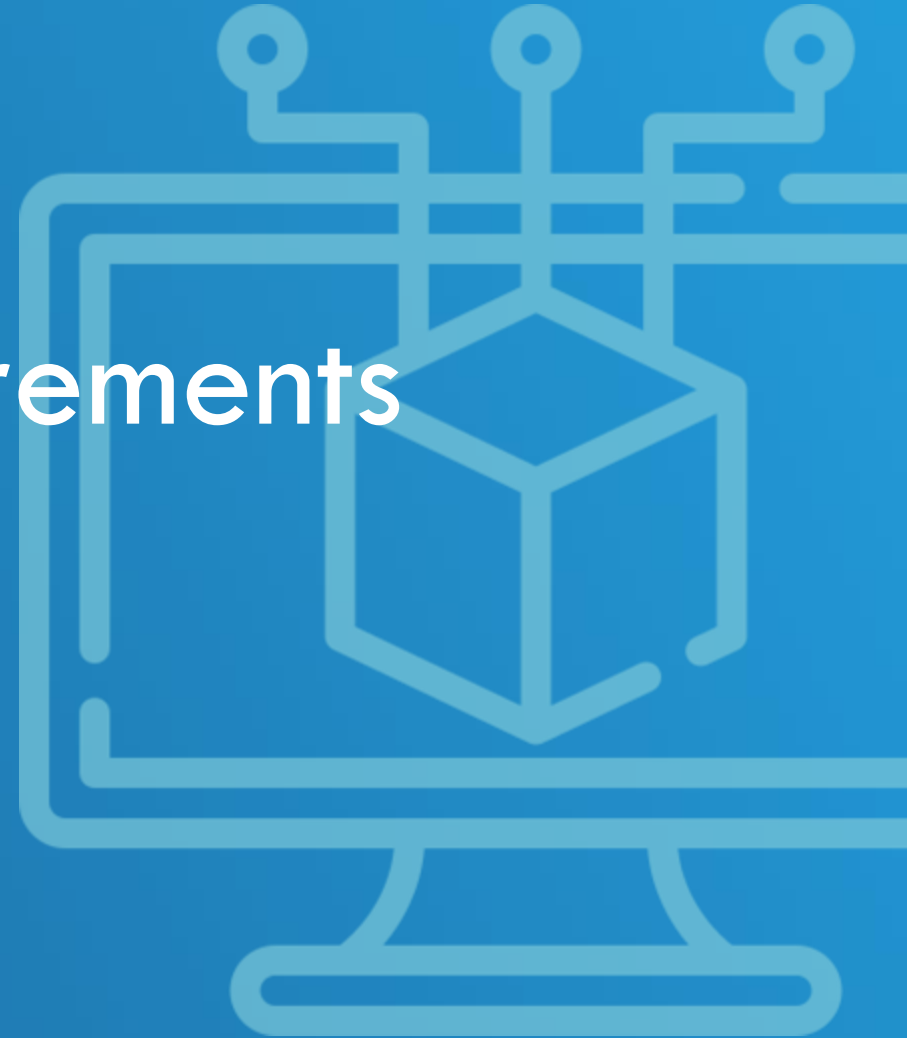


SOFTACUS

IBM BASED SOLUTIONS

Product Line Engineering: Reuse Techniques for Requirements

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PLE: Definition

Product Line Engineering (PLE):

PLE is a way to engineer a portfolio of related products in an efficient manner, taking advantage of products' similarities while managing their differences. ¹⁾

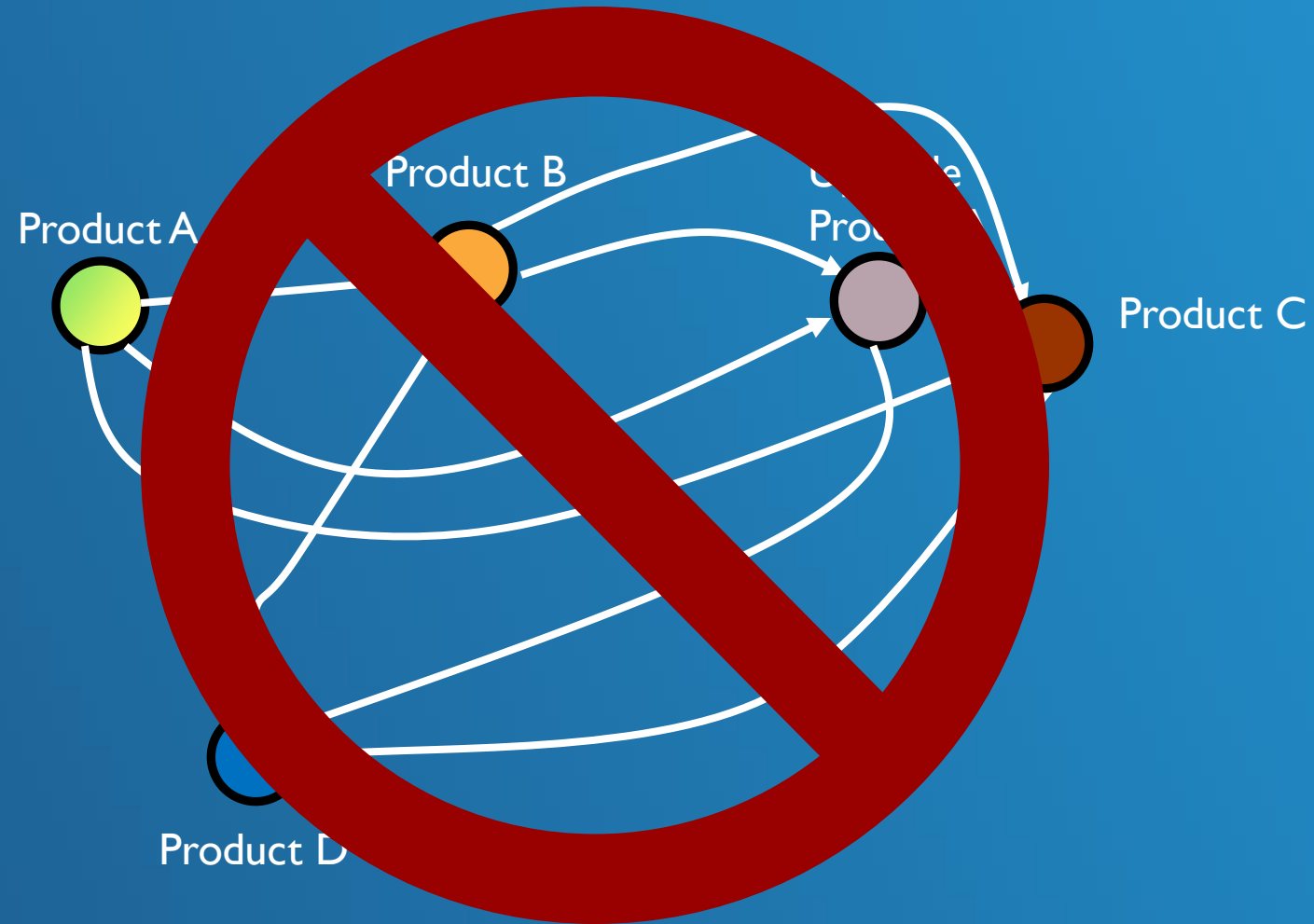
Examples are smartphones, cars, medical devices, many more.

Goals (among others):

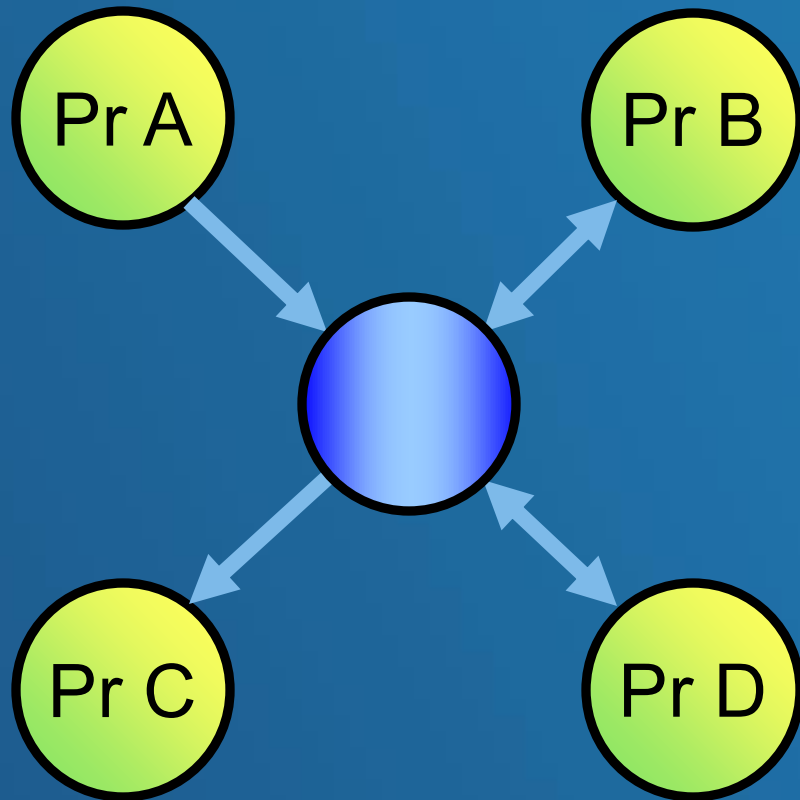
- Reduce development effort
- Shorten time-to-market
- Improve quality
- Provide a self-contained set of documentation
 - => reuse starts with requirements

1) INCOSE, [PLE Working Group](#), ISO 26580

SIMPLE COPY & PASTE



WORKING WITH A COMMON BASE



- Base, Repository, Core, 150% Model, Pool etc.
- Derived Products

REUSE MECHANISMS FOR REQUIREMENTS

Attribute based variants

Method for less complex use-cases. Each variant has associated its specific attributes. The variants are shown based on saved filters.

Id	Requirement	Status	Pr A	Pr B	Pr C	Pr D
100	The system shall allow...	approved	x	x	x	
101	The system shall respond...	approved		x	x	x
103	The shell color shall be green	draft			x	x
103	The shell color shall be green	draft			x	x

ADVANTAGES

- Can be done in spreadsheets etc
- Easy to understand
- Easy comparison between products

DISADVANTAGES

- Multiplication of attributes (look at "Status" – there should be Status A, Status B etc.)
- Traceability – links are usually to a requirement not to a specific attribute
- Difficult to manage with multiple authors.
- Potential accidental changes for other products than the one in scope

Copy, Paste & Link

Very similar to Copy & Paste. When copying, link of your choice is created between original and copied requirement.

ADVANTAGES

- Direct reference to the original requirement
- Link validity can be used to spot the changes between requirements
- Link + Link Validity = Keeping control of the copy

DISADVANTAGES

- Duplication of the data

Widely used technique in all industries where you need to track the source requirements during your project.

Module – Master specification

100 User shall ...

135 Diagram

180 System shall allow...

300 System shall respond...

Module – Variant 2 specification

122 System shall respond...

195 Diagram

188 System shall allow...



Artifact based reuse

The best option for providing high integrity and a single source of truth.

- Requirements can be reused across several specifications
- Any change to a requirements in any specification is immediately propagated to all instances in other specifications

ADVANTAGES

- Preserving high integrity

DISADVANTAGES

- Giving up control of the text and attributes for individual documents
= changes are harder to control and need to be agreed with other projects.
- Depending on the tool, there might be restrictions what can be reused into which documents.

Artifact based reuse

Module – Master specification

100 User shall ...

135 Diagram

180 System shall allow...

300 System shall respond...

Module – Variant 2 specification

101 User shall not ...

122 System shall respond...

195 Diagram

Module – Variant 4 specification

311 System shall respond...

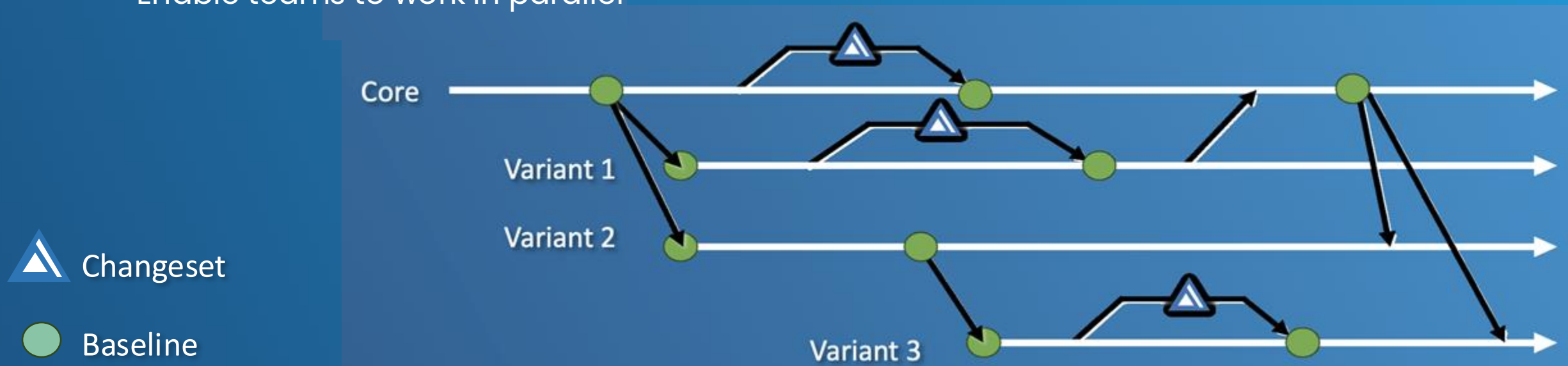
103 User shall ...

Branching & Merging

Key concept in systems and software development. Branch requirements of into several branches or "streams". Streams can later be compared and/or merged.

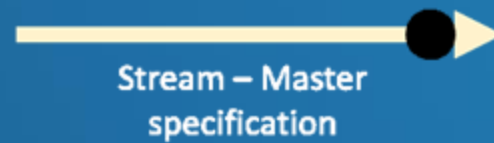
Branches are usually created for:

- Create different variants
- Create streams for experimental work or new features while having a stable release stream
- Control the changes and bug fixes
- Enable teams to work in parallel



Branching & Merging

Stream – Master specification	
100	User shall...
135	Diagram
180	System shall allow...
300	System shall respond...



Using expressions

- Filter relevant requirements using expressions.
- Filtered requirements are reused in another specification.
- Every requirement has its own expression – extremely granular.
- Usually this requires custom scripting.

▼ Category A

Q1. Project Category:

Q2. Priority:

Q3. Price of the Project:

Contents	Formula	Relevant	Satisfied By
1 Introduction			
The AMR is intended for gathering and reporting of water consumption data to facilitate measurement of residential and business customers.	IF(Q2=A)	True	349175:The handheld device sh... Priority: Medium Modified On: Apr 24, 2023 9:02 AM Modified By: Igor Chudacik
The system, when deployed, will initially include water service for residential, commercial and industrial customers inside a 72 square mile area (~79,000 meter connections).	OR(Q1=B,Q2=D)	False	349373:The handheld device sh... Priority: High Modified On: Aug 24, 2023 3:41 PM Modified By: Igor Chudacik
The Stakeholder requirements describe the user needs for a water meter reading system (AMR) including the meter, the method of collecting data from the device, and the means by which the customers will be billed for usage.	AND(Q1=B,Q2=A)	True	349272:The meter interface unit ... Priority: High Modified On: Aug 24, 2023 3:41 PM Modified By: Igor Chudacik
<pre>graph TD; A[Failure of fire protection system] --- B(()); B --- C[Fire detection system fails]; B --- D[Fire suppression system fails]; C --- E[Failure of smoke detector sensor]; C --- F[Failure of heat detector sensor]; D --- G(()); G --- H[No water to sprinklers]; G --- I[Sprinkler nozzles blocked]; D --- J[contact] --- K[Person icon];</pre>	IF(Q3="10-50 Mio €")	True	349309:Individual meter usage d... Priority: Low Modified On: Aug 24, 2023 3:41 PM Modified By: Igor Chudacik 349106:Information captured via ... Priority: Medium Modified On: Aug 24, 2023 3:41 PM Modified By: Igor Chudacik

Parameters

- Parameters are created, changed and stored in a separate document
- Parameter values are embedded into requirements specifications
- Updating the parameters will update parameter values in all specifications

The screenshot shows the 'Parameters' management interface. At the top, there's a search bar with the text 'Filter artifacts by text or by ID'. Below it, a table lists parameters with columns for a checkbox, ID, and value. The first row is selected, showing ID 51962 and value '30cm x 30cm x 1cm'. The table also includes a toolbar with formatting options like bold, italic, underline, and font color.

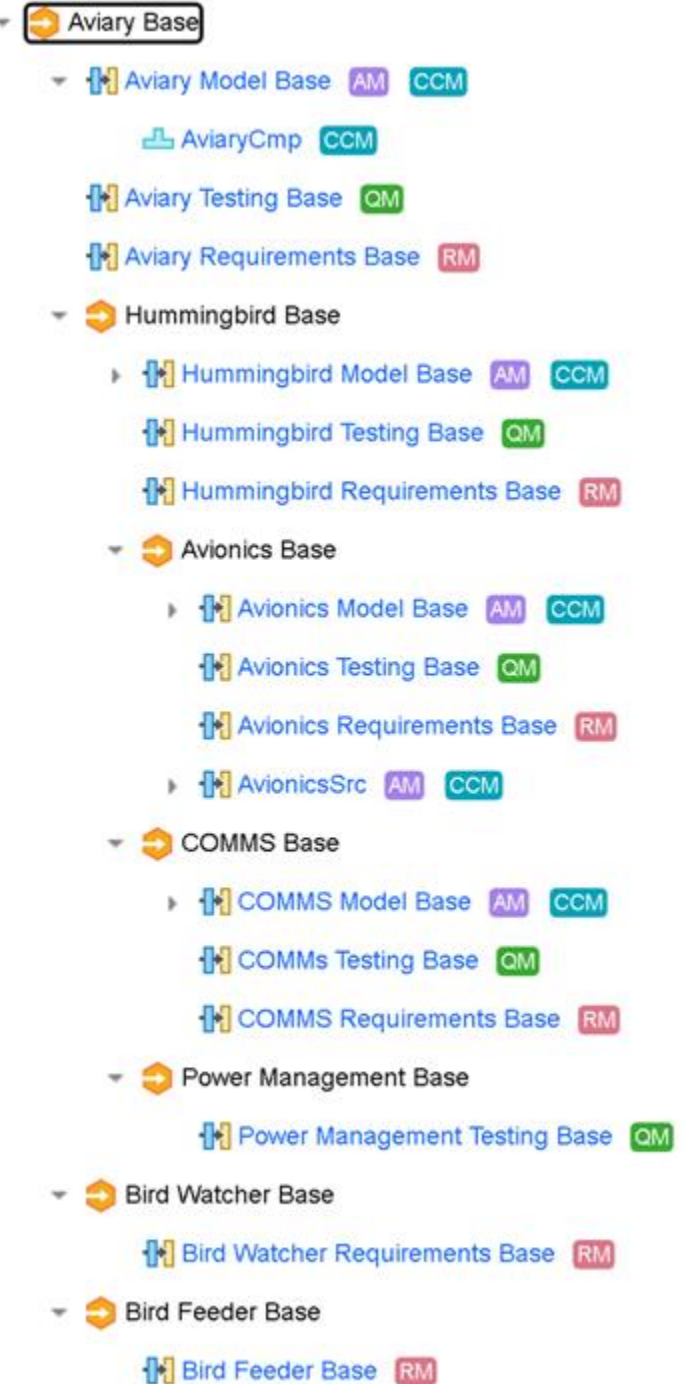
	ID	Value
<input checked="" type="checkbox"/>	51962	30cm x 30cm x 1cm
<input type="checkbox"/>	51963	3kg
<input type="checkbox"/>	51964	-5°C
<input type="checkbox"/>	51965	50°C
<input type="checkbox"/>	51966	99%

The screenshot shows a 'Requirements Specification' document titled '51450 AMR System Requirements Specification'. It features a 'Create' button and a search bar. Below, a table lists requirements with checkboxes, IDs, and content. Several requirements use parameter values from the left interface, such as '30cm x 30cm x 1cm', '3kg', '-5°C', and '50°C'.

	ID	Contents
<input type="checkbox"/>	51708	Warranty - 3 years parts on-site labor, next business day
<input type="checkbox"/>	51473	3.2.1.2 Handheld Unit
<input type="checkbox"/>	51662	The handheld unit shall be no larger than 30cm x 30cm x 1cm
<input type="checkbox"/>	51799	The handheld unit shall have a mass no greater than 3kg
<input type="checkbox"/>	51792	The handheld unit shall function in environments from -5°C through 50°C
<input type="checkbox"/>	51626	The handheld unit shall function in environments with 99% ambient humidity.
<input type="checkbox"/>	51656	The handheld unit external case shall have no sharp edges and no pointed corners.
<input type="checkbox"/>	51580	3.2.1.3 Assumptions and Dependencies
<input type="checkbox"/>	51776	The control computer shall be capable of operating in a normal office environment using normal office power supply. Uninterruptible Power Supply; the control computer shall include a UPS of at least 4 hours.

Reuse of system components

- **Configurations:** Most advanced and most powerful form of reuse across the entire engineering lifecycle. Tool needs to support this kind of configuration management.
- Components make it possible to reuse and combine parts of the system across V model, into different versions, variants or products.
- Inside each component some of the previously mentioned approaches can be applied.
- **Disadvantage** – Increased complexity requires certain level of process maturity in your organisation, regarding variants management and PLE



COORDINATION

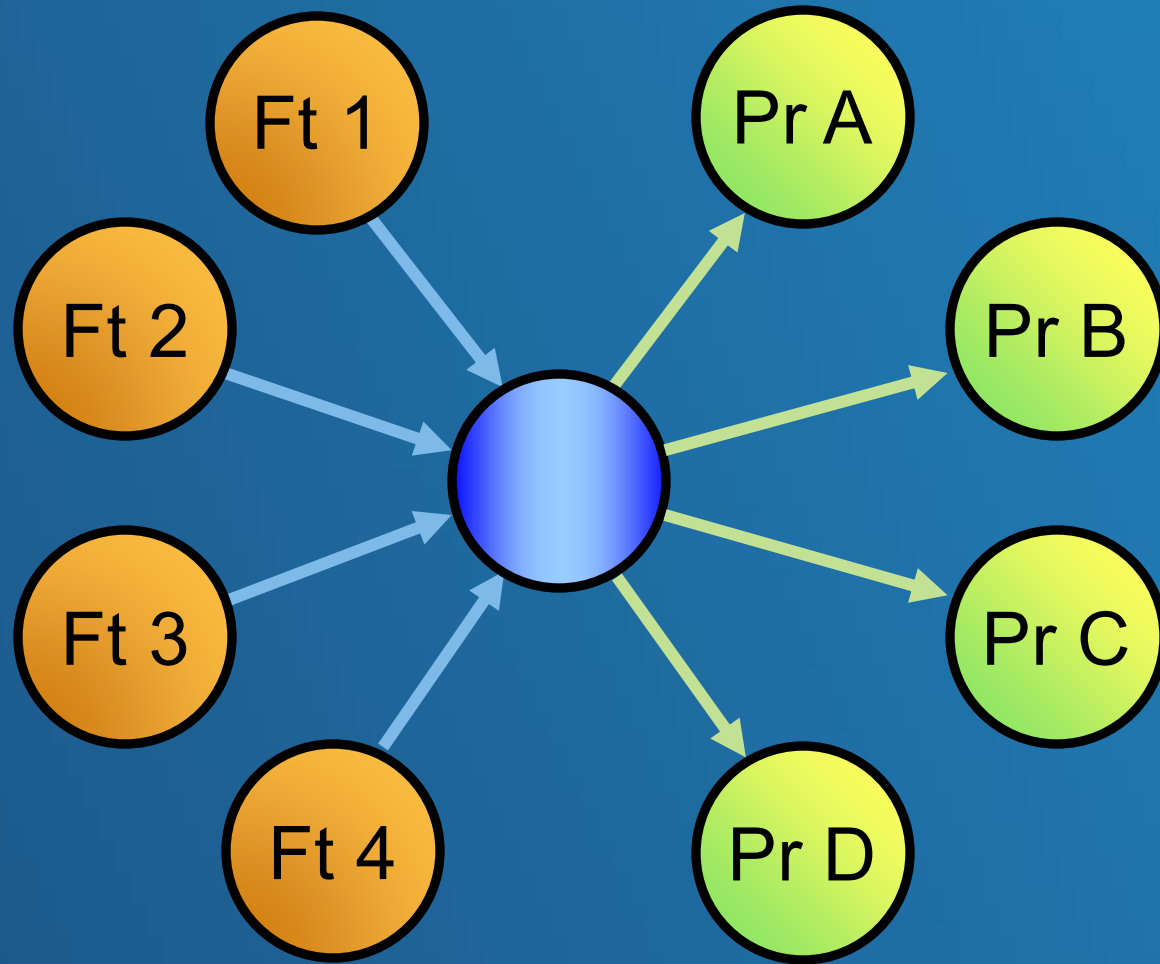
A re-use approach requires coordination for RE:

- Formal check of new requirements before approval to ensure consistent quality.
- Promoting new requirements to the repository.
- Maintenance of the repository in regards to structure and content.

General responsibilities:

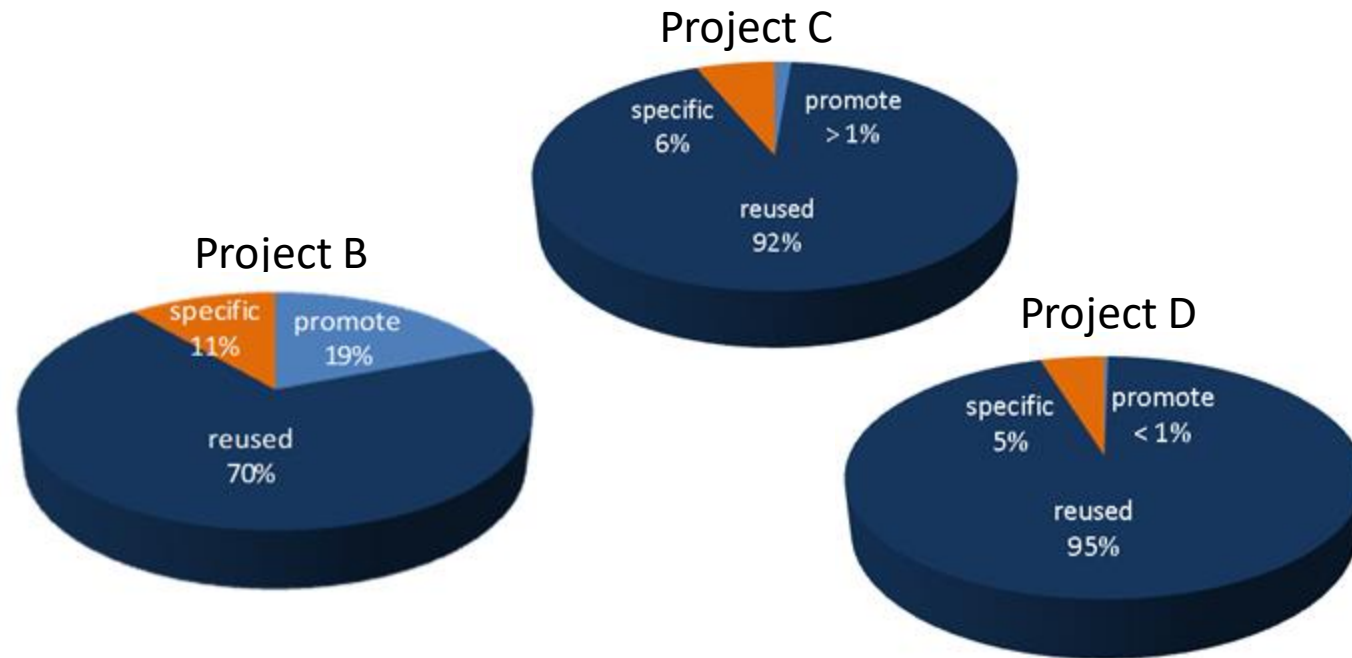
- How to apply re-use with the selected requirements management tool.
- Work with process management to define PLE processes so they integrate with the project management processes.

PLE PROCESSES – what is developed where and when?



- Feature development projects
- Base, repository, core, 150% model, pool etc.
- Derived products – configuration & reuse only

SUCCESS STORY (data from real projects)



Mechanism used: “Copy, Paste & Link”, later PLE based PM & development process

- Re-use >70% already for the 2nd product.
- Follow-up products >90%

=> Reduced effort for approval meetings and discussions for existing features.

=> Reduced effort for implementation because of configurable features.

Thank you for your attention 😊

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