

Visualising Product Line Requirement Selection Decision Inter-dependencies

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Software Product Line Engineering

- A software product line is defined as
a set of software products sharing a set of common features satisfying the needs of a particular market but containing significant and predictable variability (Weiss, 1999)
- In Software Product Line Engineering (SPLE) variability is represented through a set of **variation points** (VPs)
- Each VP represents a **requirement selection decision** (i.e. Decision) that have to be made for developing a new product
- Each VP is associated with a set of possible **variants** representing its possible **solutions**
- **Successful** SPLE requires to make **decision** at variation points **effectively** and **efficiently**

SPLE Issues and Challenges

- ❖ Requirement variability is **crucial** but very **complex** in SPL
 - ❖ **Large** population of VPs
 - ❖ **Exponential** number of inter-dependencies (IDs)
 - ❖ **Different types** of IDs
- ❖ SPL complexity transforms requirement selection decision activities into an **error-prone** activity
 - ❖ Requirement engineer often forgot something that should be in the final product or include something that should not be in the final product
- Difficult to represent and present visually a **holistic view** of the full set of decision
- Difficult to produce a **consistent** and **coherent** models of decisions and IDs
- Difficult to see the full **impact** of a decision change and selection

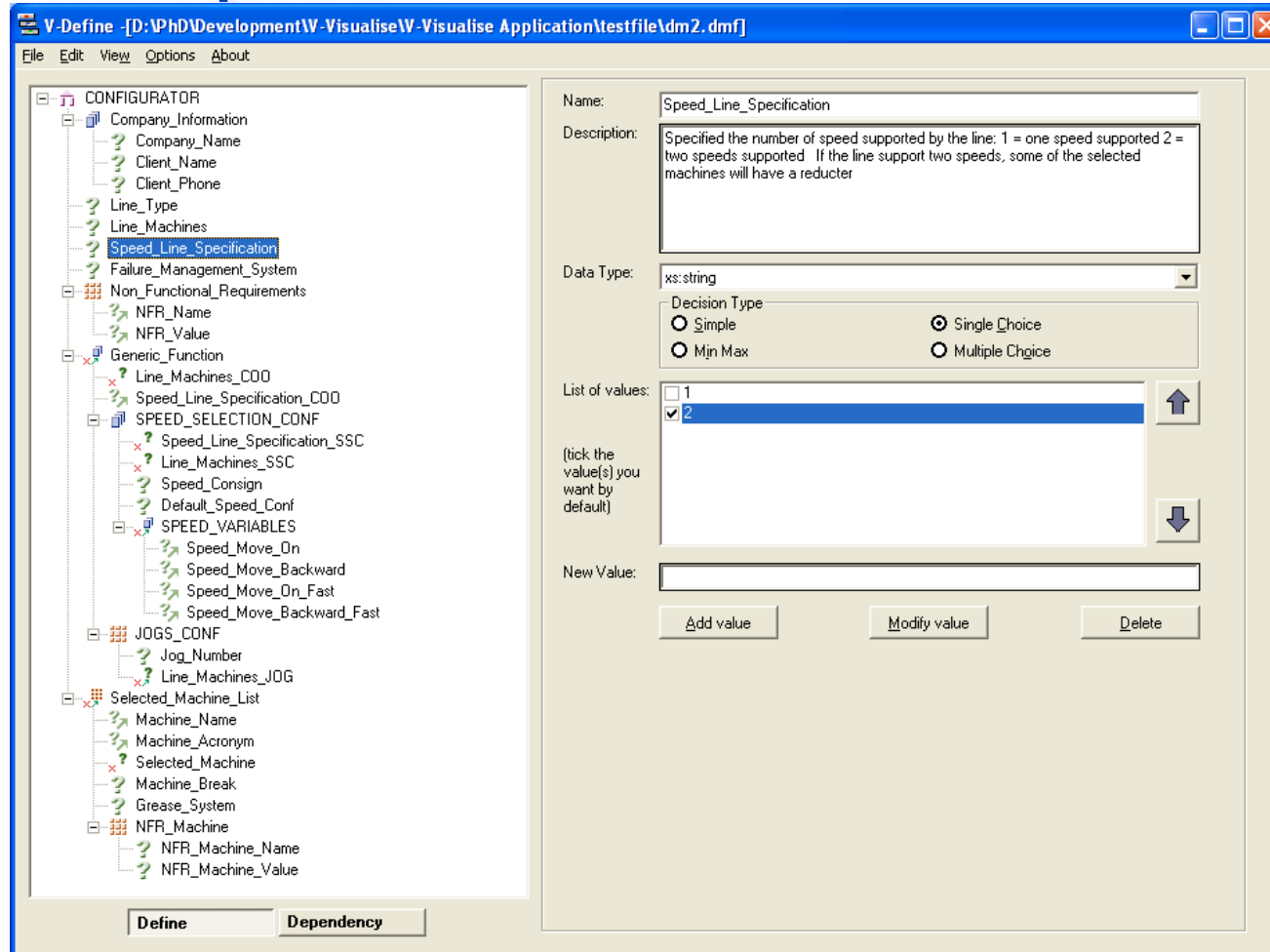
Decision & Inter-dependency Model

A Decision Model is defined as

A document that defines the decisions that one must make to specify a member of a domain (Weiss, 1999)

- A DM gathers **all decisions** that should be made for developing a specific product and represent and structure them in a **logical way** for supporting the requirement selection decision making
- An Inter-dependency Model (IM) gathers **all inter-dependencies** that have to be respected when a new product is developed

DM Examples



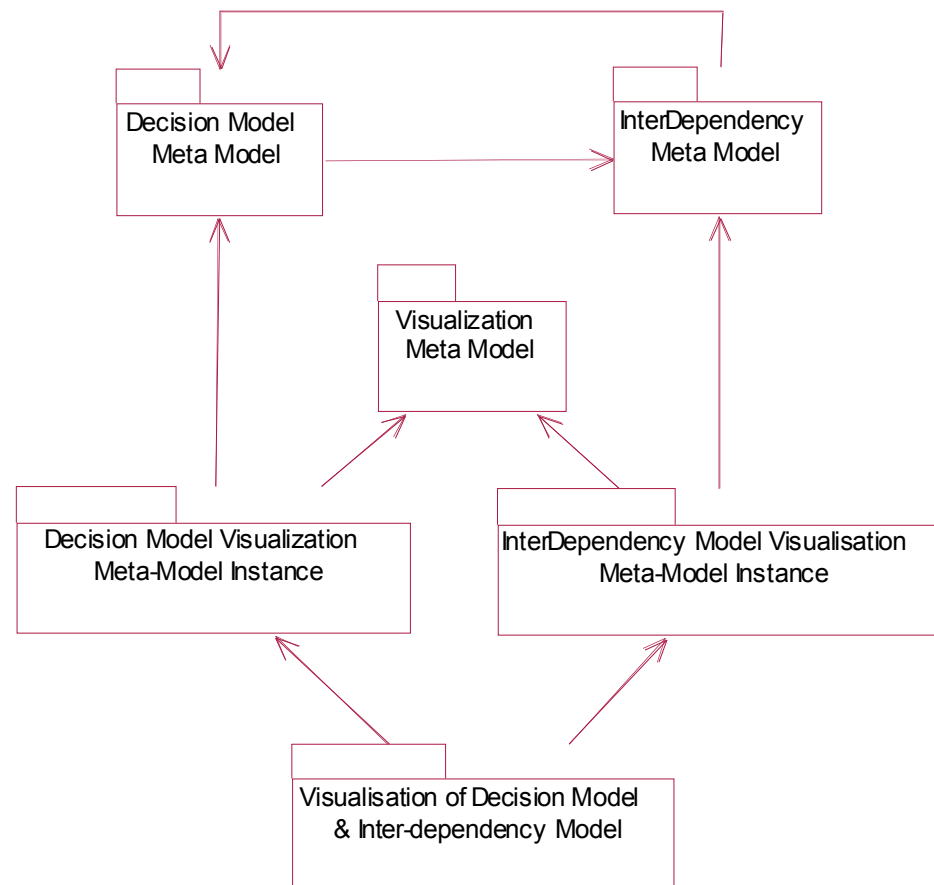
Visualisation and SPLE

Visualisation techniques can support SPLE:

- **Understanding** the whole **structure** of a DM, the decisions **relationships** and their **inter-dependencies**
- **Understanding** the **consequence** of a requirement selection decision making on the decisions
- **Preventing** and **avoiding** inter-dependencies **conflicts**
- **V-Visualise** is a tool for visualising DM and IM which includes **functionalities**:
 - Searching
 - Highlighting decision and inter-dependency operation
 - Browsing decision and inter-dependency operation
 - Highlighting inter-dependency length (priority and cost evaluation)
 - Spanning


















Decision & IDs Model Visualisation

- 2 visualisations: one for DM, one for ID Model
- DM and ID model are underpinned by meta-model
- DM and ID model visualisations are underpinned by a visualisation meta-model











Visualisation Meta-Model

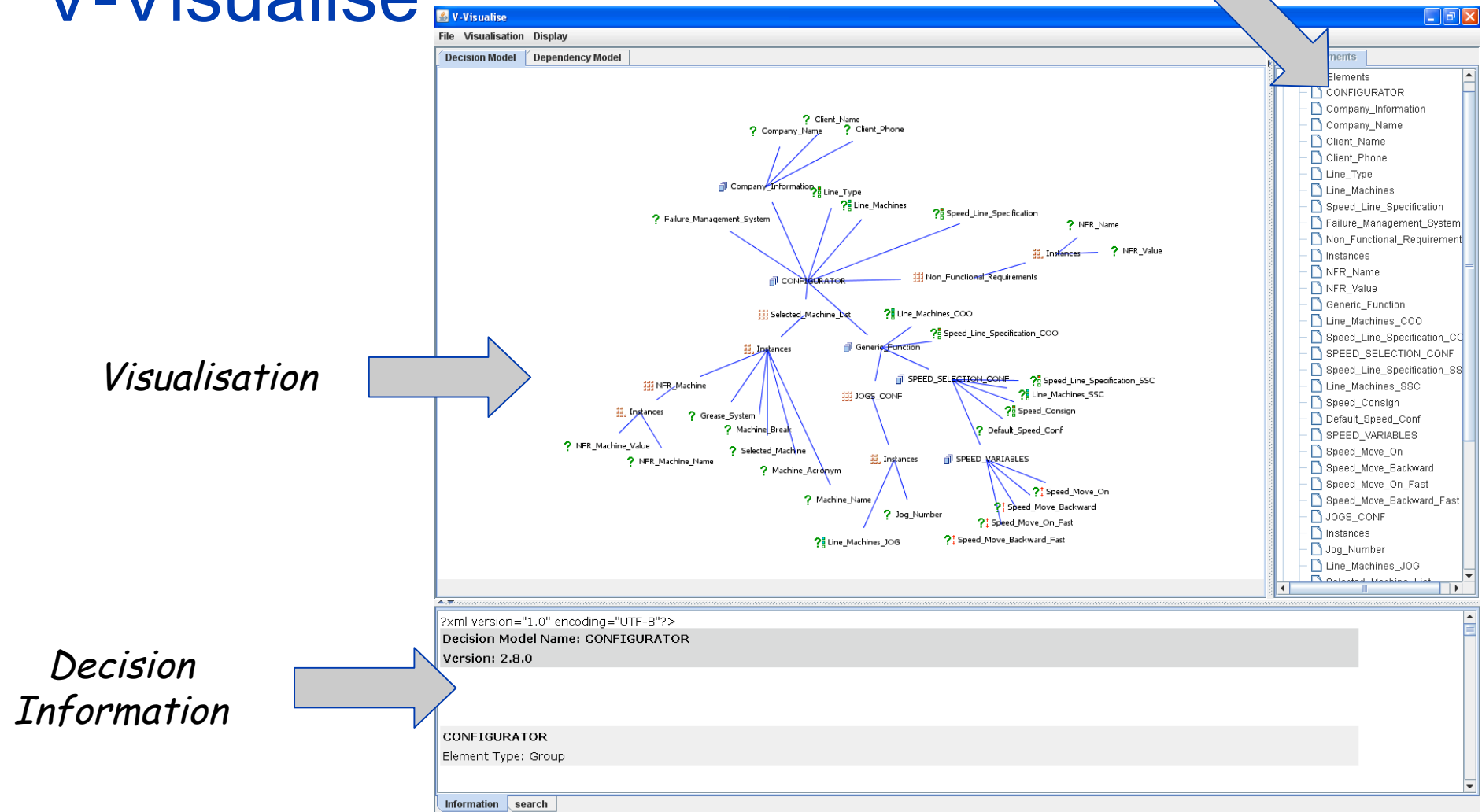
Visualisation Elements

	DM Visualisation		ID Model Visualisation	
DM Element	Visu. Element	Repr	Visu. Element	Repr
Decision Model	Graph-Map-Tree	Graph	Graph-Map-Tree	Graph
Classes				
DM (Root)	Node		Node	
Decision	N/A	N/A	N/A	N/A
Unrestricted decision	Node		Node	
Bounded decision	Node		Node	
ChoiceListDecision (Simple choice)	Node		Node	
ChoiceListDecision (Multiple choice)	Node		Node	
Choice	N/A	N/A	N/A	N/A
DecisionGroup	Node		Node	
Collection	Node		Node	
Instance	Node		Node	
Hierarchical relationship	Edge		N/A	N/A

Inter-dependency Visualisation Elements

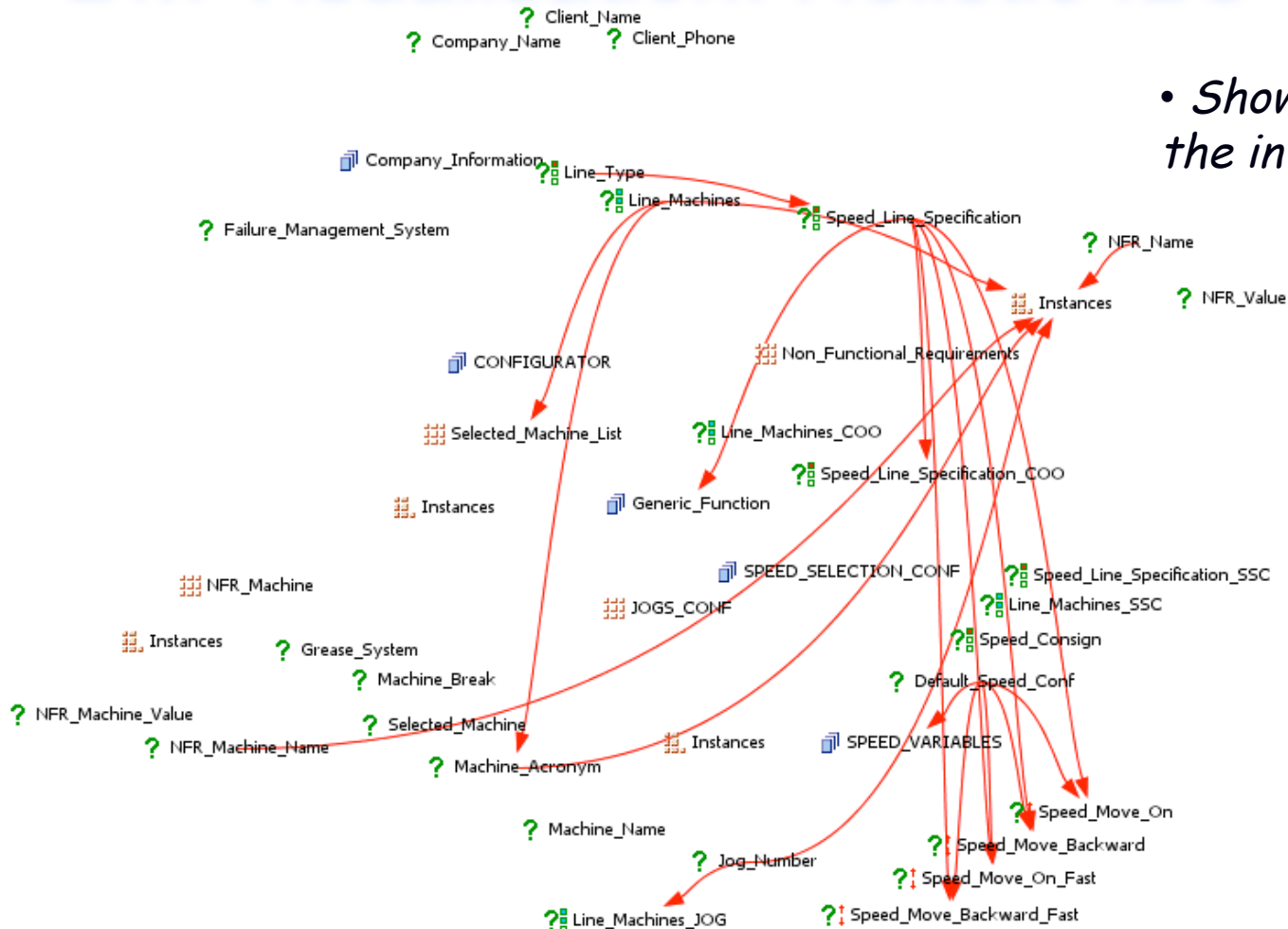
	ID Model Visualisation	
Inter-dependency Model Element	Visu. Element	Repr
Inter-dependency	Node	
Inter-dependency triggered by a decision model element	Edge	
Inter-dependency affecting a decision model element	Edge	
Inter-dependency Actions		
SetValue	Edge	
Set ListValue	Edge	
SetDefaultValue	Edge	
SetValidity	Edge	
SetRestriction	Edge	

V-Visualise



DM Visualisation: Holistic IDs Visualisation

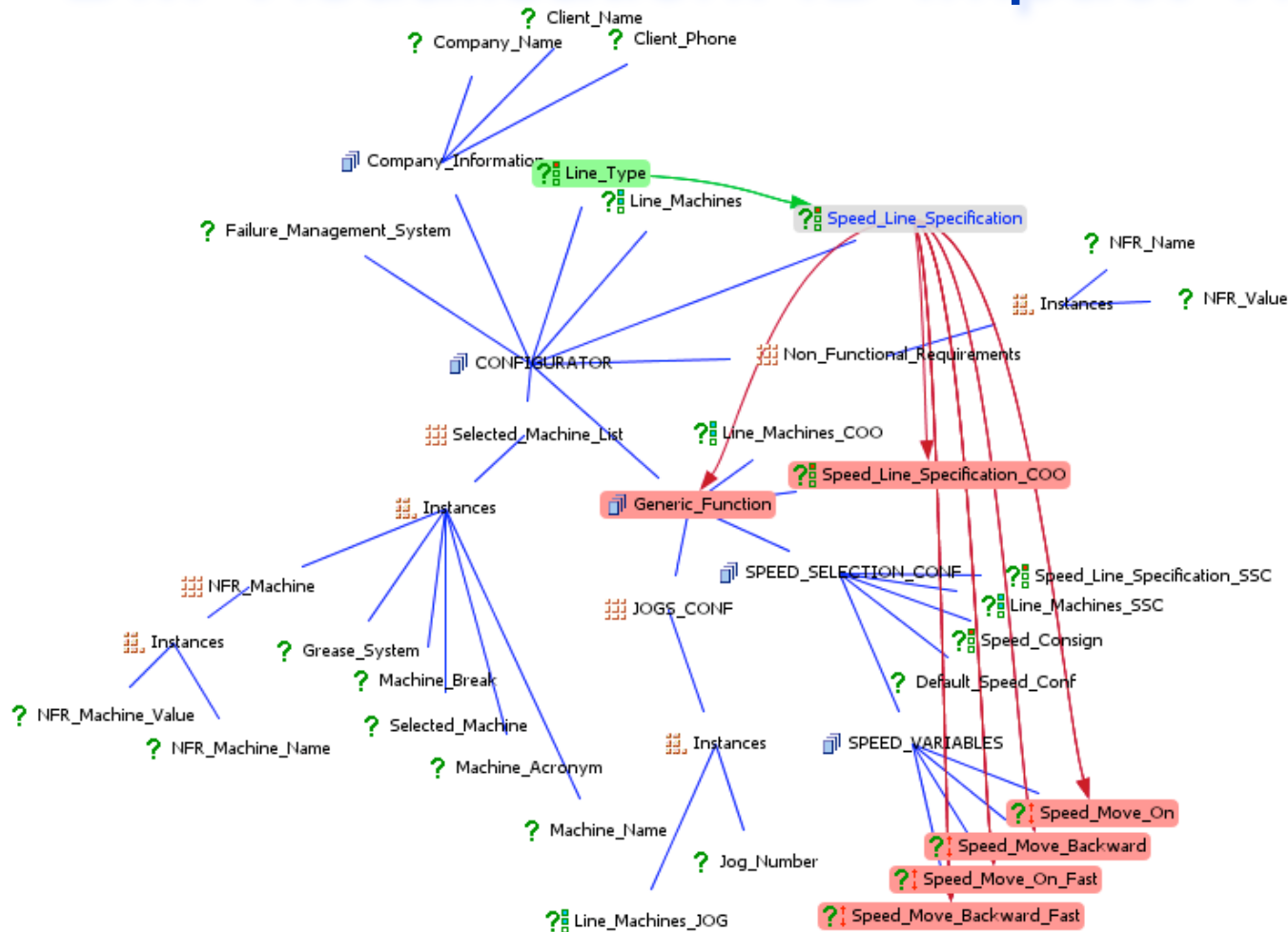
- *Show an holistic view of the inter-dependencies*



[illegible]

- *Decisions having inter-dependencies are highlighted by increasing their size*
- *Easy to determine which decisions are difficult to reuse, change, and evolve (i.e. in terms of impact on the other decisions)*

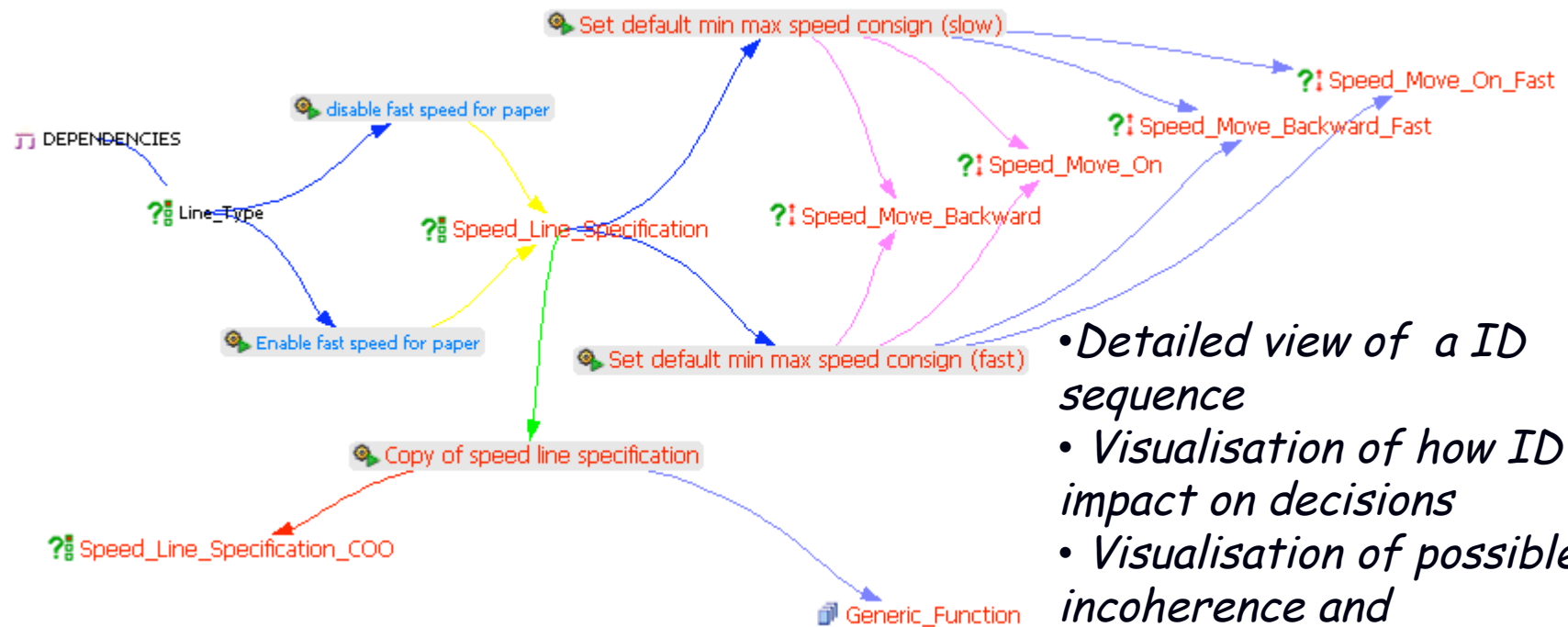
DM Visualisation: ID Impact Visualisation



• Shows IDs triggered by a requirement decision (red arrows)

• Shows IDs affecting a requirement decision (green arrows)

ID Model Visualisation: Detailed ID View



- Detailed view of a ID sequence
- Visualisation of how ID impact on decisions
- Visualisation of possible incoherence and inconsistencies
- Visualisation of detailed impact on other decisions

Discussion and Further Work

- Visualisation techniques provide **significant efficiency** for supporting software product line and Visualisation artefacts (e.g. highlighting, colour) bring **cognitive benefits**
- The mapping of meta-model helps to ground any toolkit in **consistency** of representation and presentation
- V-Visualise application
 - Supports domain model **construction, navigation, and browsing**
 - **Makes straightforward** to determine which decisions are parts of an ID and which ones are affected by an ID
 - **Makes easy** to determine which decisions are difficult to reuse, change, and evolve
- ID visualisation provides
 - detailed support for **understanding interaction** between requirement decisions
 - facilitates the understanding **of large amount of ID**

Thanks

