Time for a paper...

Industry Case: Philips Consumer Electronics

- 16,000 employees, €10 Billion turnover (1/3 is TVs)

- 250 developers

- Single SPL for mid- and high-range TVs

- SPL developed 1996-2000, in use since then

- Trends, more complex SW:

  - More features (MPEG4, Sound processing, HW->SW)

  - Globalized market

  - Shorter product cycles and TTM

  - Product convergence

Industry Case: Philips Consumer Electronics

- Hundreds of Variability parameters -> Hierarchy

- Evolution rules: What can be changed without affecting other parts? (HW dependencies)

- Compositional approach technically

  - Describe which components to combine into new product

  - Simplified convergence (DVD+TV, TV+VCR, ...)

Industry Case: Philips Consumer Electronics

- Koala Component Model

  - Component = Specification + Implementation

  - Hierarchical - group of components can be one component at higher level

  - Implemented in C, interfaces in separate files

  - Component descriptions to generate build/make files

    - Interface Description Language + Tools to work with it

  - No extra run-time costs (resource-constrained HW)

Industry Case: Philips Consumer Electronics
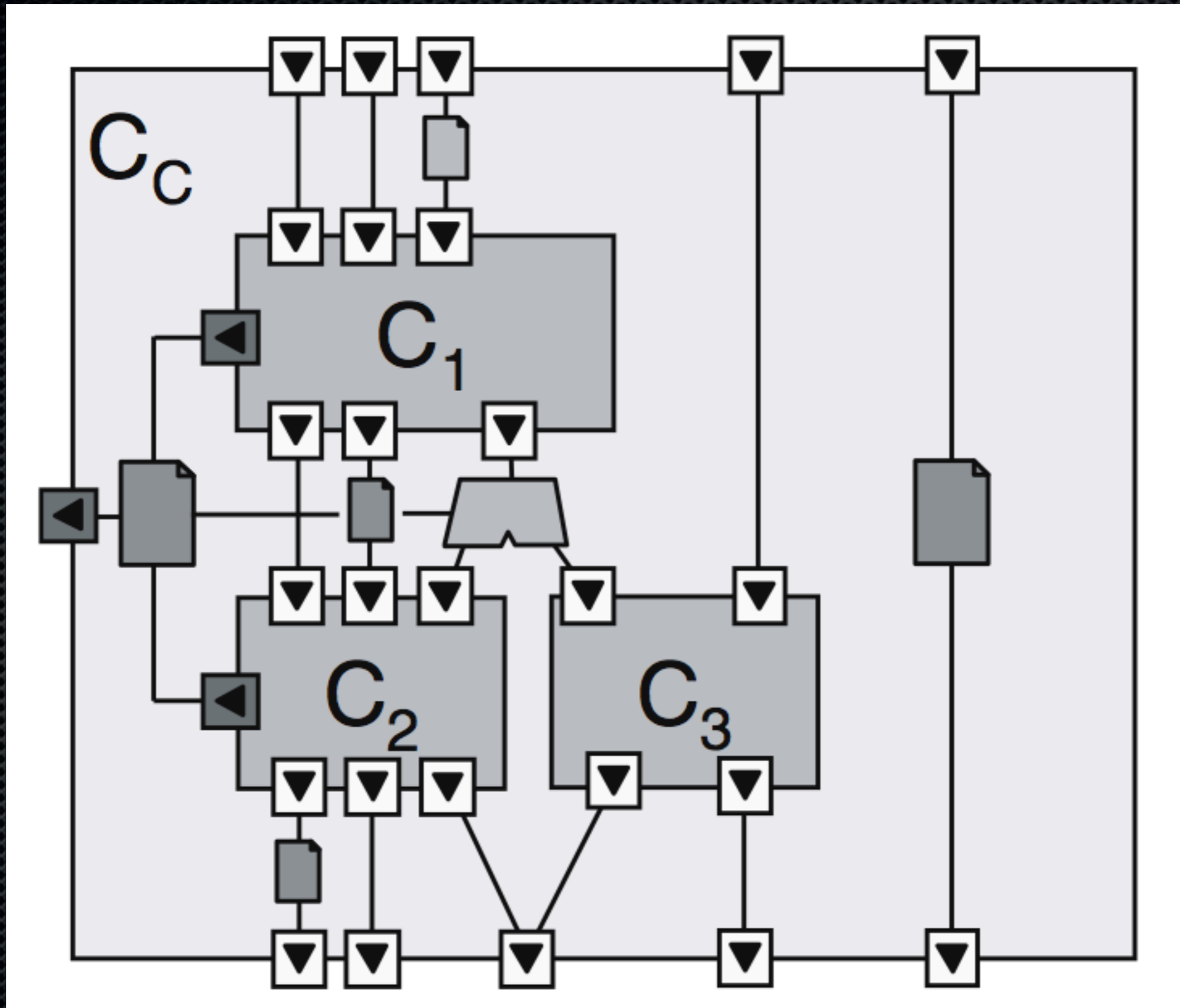
Industry Case: Philips Consumer Electronics

- Variability

  - Compound components can have "Diversity parameters"

  - Switches to choose sub-components

- Packages group components and interfaces to larger units

  - Also the packages are hierarchical

- Product is a selection of packages

Industry Case: Philips Consumer Electronics

- Reference architecture?

- What are the Variability mechanisms? (Adaptation, Replacement, Extension)

- Documentation of variability?

Industry Case: Philips Consumer Electronics

- Reference architecture?

  - No, since it would not help for creating combi-products

  - Maybe for small line of TVs, not for whole range over multiple years

- What are the Variability mechanisms? (Adaptation, Replacement, Extension)

- Documentation of variability?

 - Only: Component & Interface data sheets + sub-system design notes

Industry Case: Philips Consumer Electronics

- Results / Lessons learned

  - Diversity of products produced on time, Variability not a problem

  - Late-joining architects don't understand Koala's motivation

  - Architecture has lasted longer than any previous

  - Took three years to be successful

  - Config Management system fails at sub-file level variability

    - Better to solve variability in arch & use traditional CM

Evolving a Reference Architecture

- Evolution is a must:

  - Market changes

  - Features or products become redundant

  - Company mergers

  - 3rd party component updates

  - New technology

- Unintentional evolution:

  - Software/documentation rot, Maintenance, Erosion

  - Refactoring can counter

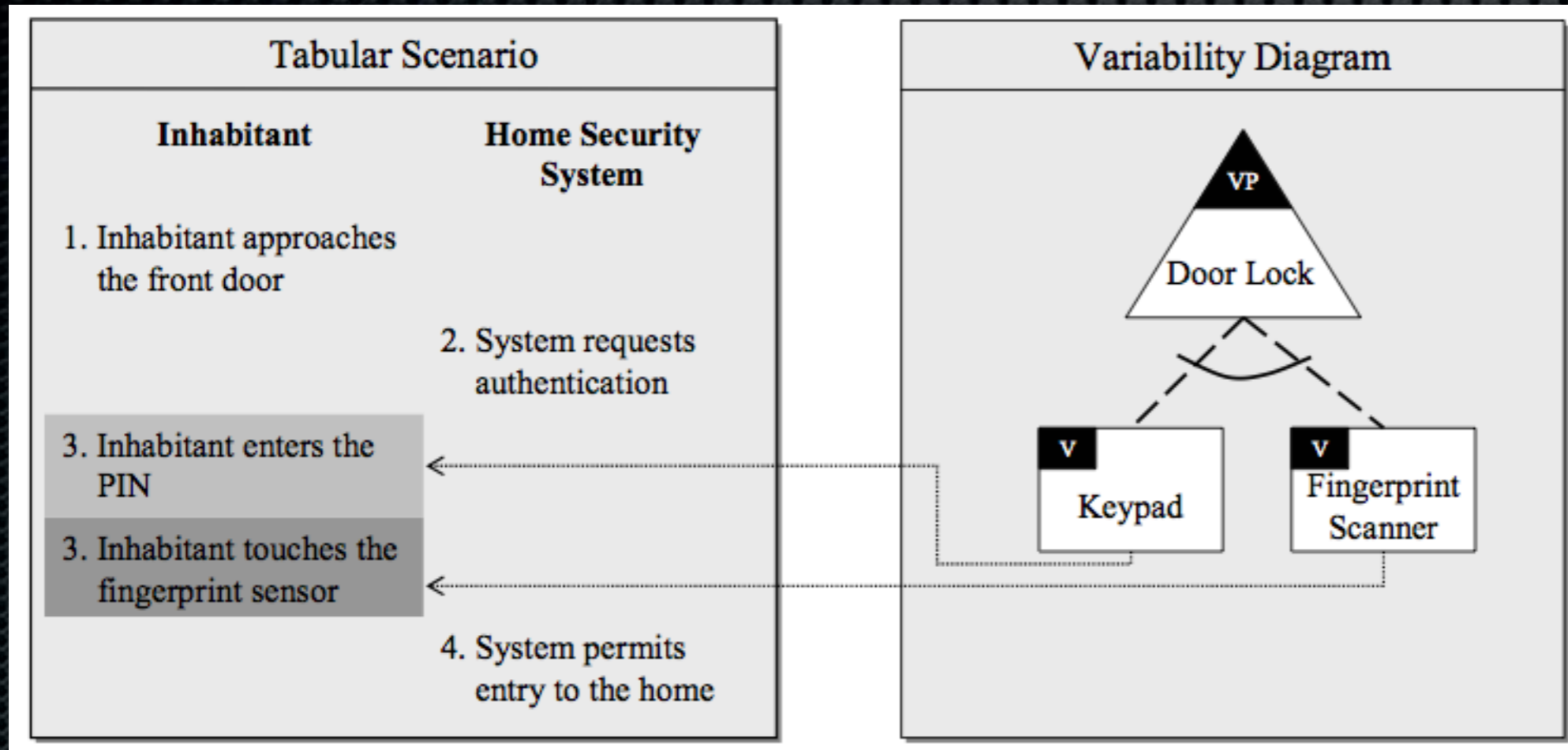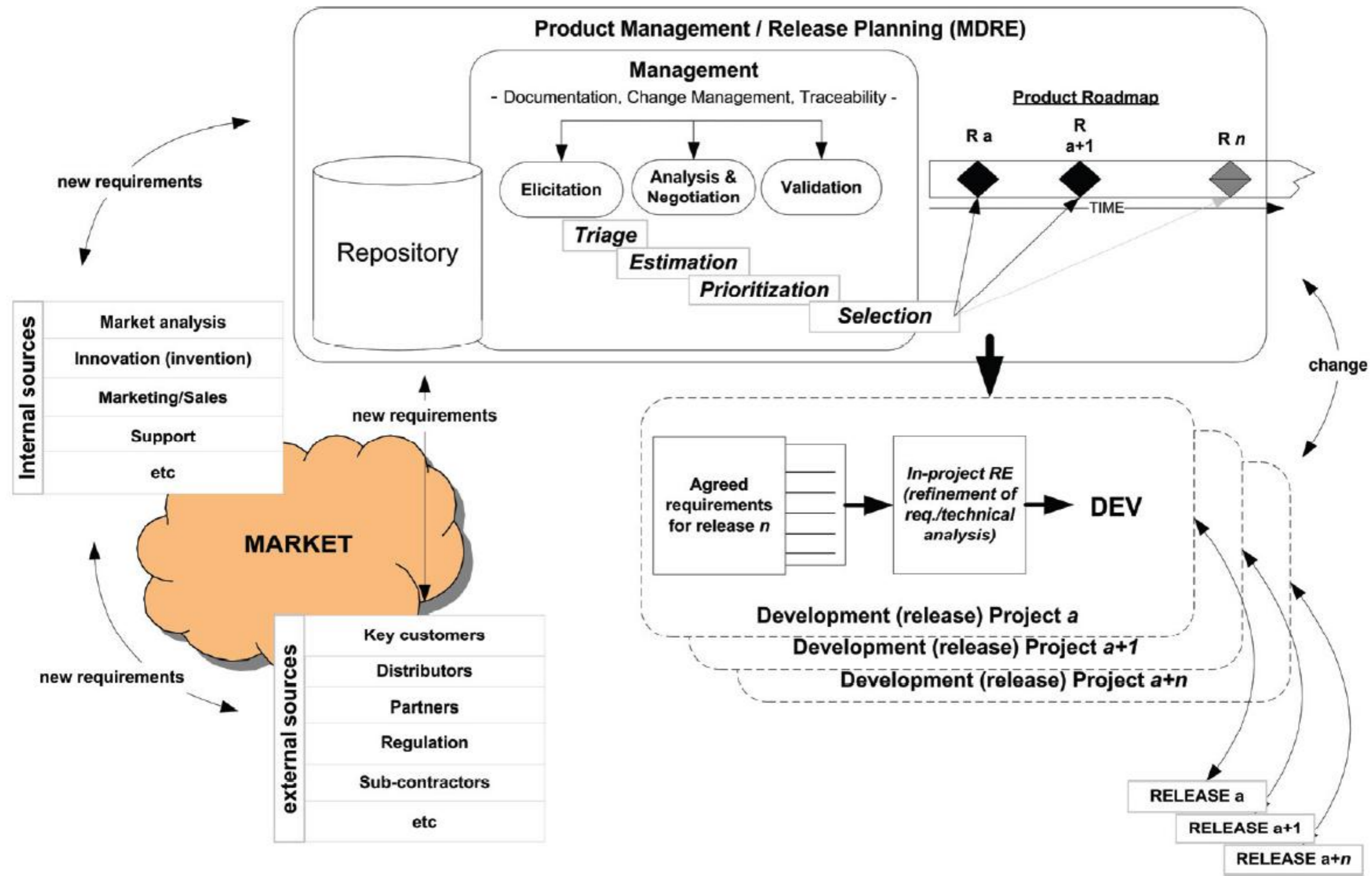# Domain and Application Engineering
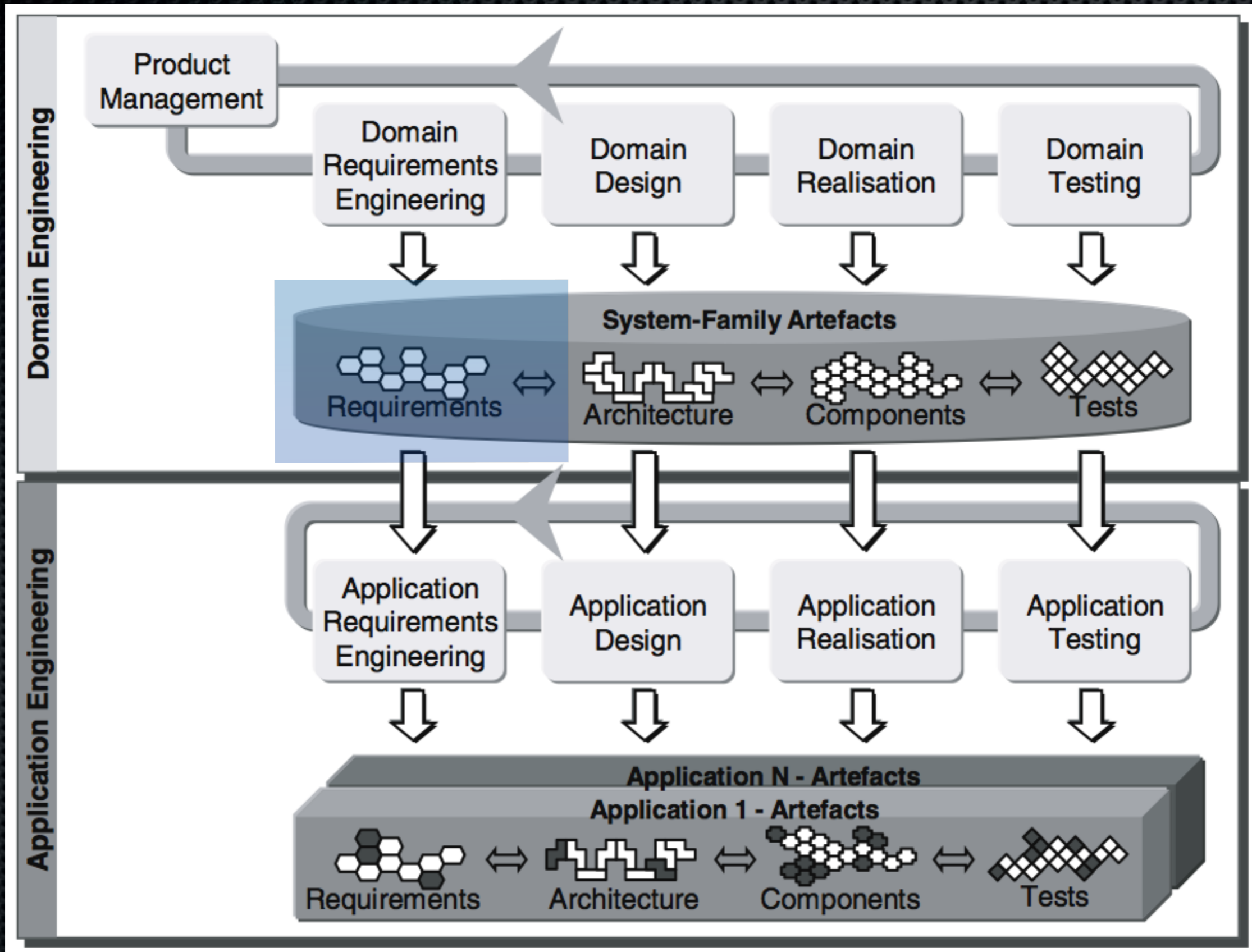
Requirements Variability - Textual

- The game should support **Variation point**
  - ... either 32-bit color output... **Variation 1**
  - ... or 16-bit color output... **Variation 2**
  - ... from the graphics engine.

Requirements Variability - Use Cases

Variability has to be mapped to requirements
-Decision support – DE or AE
-Risk, priority, timeline, cost

Product Management / Release Planning (MDRE)

Management
- Documentation, Change Management, Traceability -

Repository

- Elicitation
- Analysis & Negotiation
- Validation

Triage
Estimation
Prioritization
Selection

Product Roadmap

R a   R a+1   R n

TIME

new requirements

change

Internal sources
- Market analysis
- Innovation (invention)
- Marketing/Sales
- Support
- etc

new requirements

MARKET

new requirements

external sources
- Key customers
- Distributors
- Partners
- Regulation
- Sub-contractors
- etc

Agreed requirements for release *n* → *In-project RE (refinement of req./technical analysis)* → **DEV**

Development (release) Project *a*
Development (release) Project *a+1*
Development (release) Project *a+n*

RELEASE a
RELEASE a+1
RELEASE a+n

Time for a paper

- Variability challenges in industry

Chen, Babar, "**Variability Management in Software Product Lines: An Investigation of Contemporary Industrial Challenges**", SPLC, 2010

ID	Title	Experience	Country	Domain	Company size	Type of company
1	Principle member of research staff	8+ years in SPL; has been working with 40 SPLs.	Finland	Mobile phones	112,262	In-house
2	Senior member of the technical staff; Principal	Worked in SPL since 1990; consulted various companies.	USA	Various	<50	Consultant
3	Project manager in SPL	5 years in SPL	Spain	Embedded	51-200	Consultant
4	Software engineer, SPL supporter	SPL initiative started about 6 or 8 months	USA	Defence, aerospace	106,000	In-house
5	Chief software architect.	20 years in SE; 7 years in SPL	USA	Embedded	73,000	In-house
6	Software architect and software development process manager	Introduced the SPL approach 4 months ago;	Germany	Embedded	4,000	In-house
7	Director	10 years in SPL; consulted various banks and insurance companies	Australia	Finance	40	Consultant
8	Research scientist	Work three days per week in the company since 2004	Netherlands	Health-care	123,801	In-house
9	Software architect	25+ years in SD; around 5 years in SA and SPL.	USA	Embedded	263,000	In-house
10	Global software process and quality manager	6 years in SPL	Switzerland	Embedded	128,000	In-house
11	Senior scientist	About 8 years in SPL	Netherlands	Embedded	33,500	In-house

Technical issues

- Handling complexity

    - RE – visualize and communicate

    - Managing change

- Knowledge harvest and management

    - Legacy

- Extracting variability from technical artifacts

- Evolution of variability

- Variability modeling and documentation

    - Usability

- Design decisions management and enforcement

- Tool support

- Testing

Non-technical issues

- People

  - Competent architects – holistic view

- Mindset change

- Management support

- Organizational structure

- Business model

  - Focusing on reuse

No/few approaches have been proposed	Several/many approaches have been proposed
– People – Mindset change – Management support – Organizational structure – Business model – Handling complexity – Knowledge harvest and management – Evolution of variability – Design decisions management and enforcement – Extracting variability from technical artifacts – Testing	– Variability modeling and documentation – Tool support

Scoping

- Defining the scope of the product line

  - Which products are within the boundaries of the SPL?

  - Which products are not supported by the SPL?

  - Product Portfolio Scoping

  - Technical, Marketing and Strategic Decision

- Other levels (built on PPS):

  - Domain scoping = Identify major domains relevant for SPL

  - Asset scoping = Define functionality for reusable components

- Active research area

Technical specifications

Open all specifications in detail ☐   ☑ Show key differences only

|	**9000 series – 27 000 sek**	**7000 series – 11 000 sek**	**5000 series – 7 000 sek**
▼ Picture/Display			
Brightness	500 cd/m²	450 cd/m²	450 cd/m²
Dynamic screen contrast	10,000,000:1	500,000:1	500,000:1
Response time (typical)	0.5 (BEW equiv) ms	2 ms	2 ms
Display	LCD Full HD, 2D segmented LED backlight	LCD Full HD, edge LED backlight	LCD Full HD, direct LED backlight
Picture enhancement	Wide Colour Gamut display, Active Control + Light sensor, 2D/3D noise reduction, 400 Hz Clear LCD*, Scanning backlight, Local dimming LED backlight, Segmented LED backlight, Bright Pro, LED Pro, Super Resolution, 3D TV prepared*	Control + Light sensor, 100 Hz Clear LCD, Digital Noise Reduction, Dynamic contrast enhancement, Luminance Transient Improver, MPEG artefact reduction, HD Natural Motion, Super Resolution, Colour booster	100 Hz, 2 ms, Pixel Plus HD, Active Control + Light sensor, Colour Enhancement, 100 Hz Clear LCD, Digital Noise Reduction, Dynamic contrast enhancement, Luminance Transient Improver, MPEG artefact reduction, 2D/3D noise reduction, 1080p 24/25/30 Hz
Colour processing	2250 trillion colours 17bit RGB	4 trillion colours (14-bit RGB)	
3D	3D Ready*		
Colour cabinet	Onyx Black Brushed aluminium	Silver-brushed deco-front with black cabinet	High gloss black deco front with black cabinet
▶ Ambilight			
▼ Supported Display Resolution			
▶ Sound			
▶ Convenience			
▼ Multimedia Applications			
Music Playback Formats	MP3, WMA (v2 up to v9.2), AAC	MP3, WMA (v2 up to v9.2), AAC	MP3
Video Playback Formats	Codec support:, H264/MPEG-4 AVC, MPEG-1, MPEG-2, MPEG-4, WMV9/VC1, Containers: AVI, MKV	Codec support:, H264/MPEG-4 AVC, MPEG-1, MPEG-2, MPEG-4, WMV9/VC1, Containers: AVI, MKV	Codec support:, H264/MPEG-4 AVC, MPEG-1, MPEG-2, MPEG-4
Net TV	Included	Included	
Multimedia connections			USB memory class device
▼ Tuner/Reception/Transmission			
Digital TV	DVB Terrestrial*, DVB-T MPEG4*, DVB-C MPEG4*, MHEG	DVB Terrestrial*, DVB-T MPEG4*, DVB-C MPEG4*	DVB Terrestrial*, DVB-T MPEG4*, DVB-C MPEG4*
TV system		DVB COFDM 2K/8K	PAL I, PAL B/G, PAL D/K, SECAM B/G, SECAM D/K, SECAM L/L', DVB COFDM 2K/8K
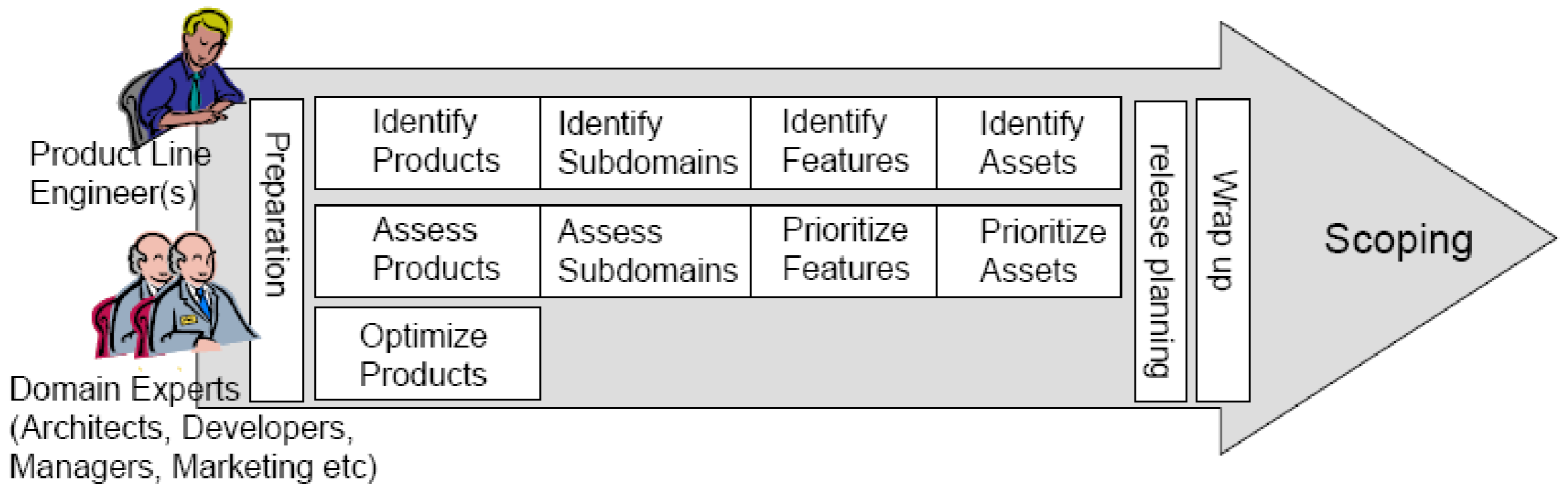
Example scoping: Philips Consumer Elec.

- Main SPL Scope = "Mid- and High-range TVs"
  - Support convergent/combi-products
  - Not low-end TVs
    - Less features => less variability
    - Less product-to-product changes => less variability
    - HW+SW mainly bought from 3rd party
- Flexible and Ongoing Domain Scoping
  - Convergence & short cycles requires new domains
- Asset scoping built into component framework

Product Portfolio Scoping

- 1. Define Product Line Market

- 2. Determine relevant Product Types

  - Product Map = List of example products/types with their main features = Defines the Portfolio

- 3. Analyze Market Position & Define Products

  - KANO Model (next slide)

- 4. Analyze interrelations between products

  - Competition - PL Cannibalization

  - Support - Entry-level sells premium-level

Identifying Commonality and Variability is natural in scoping => SPL good fit

KANO Model
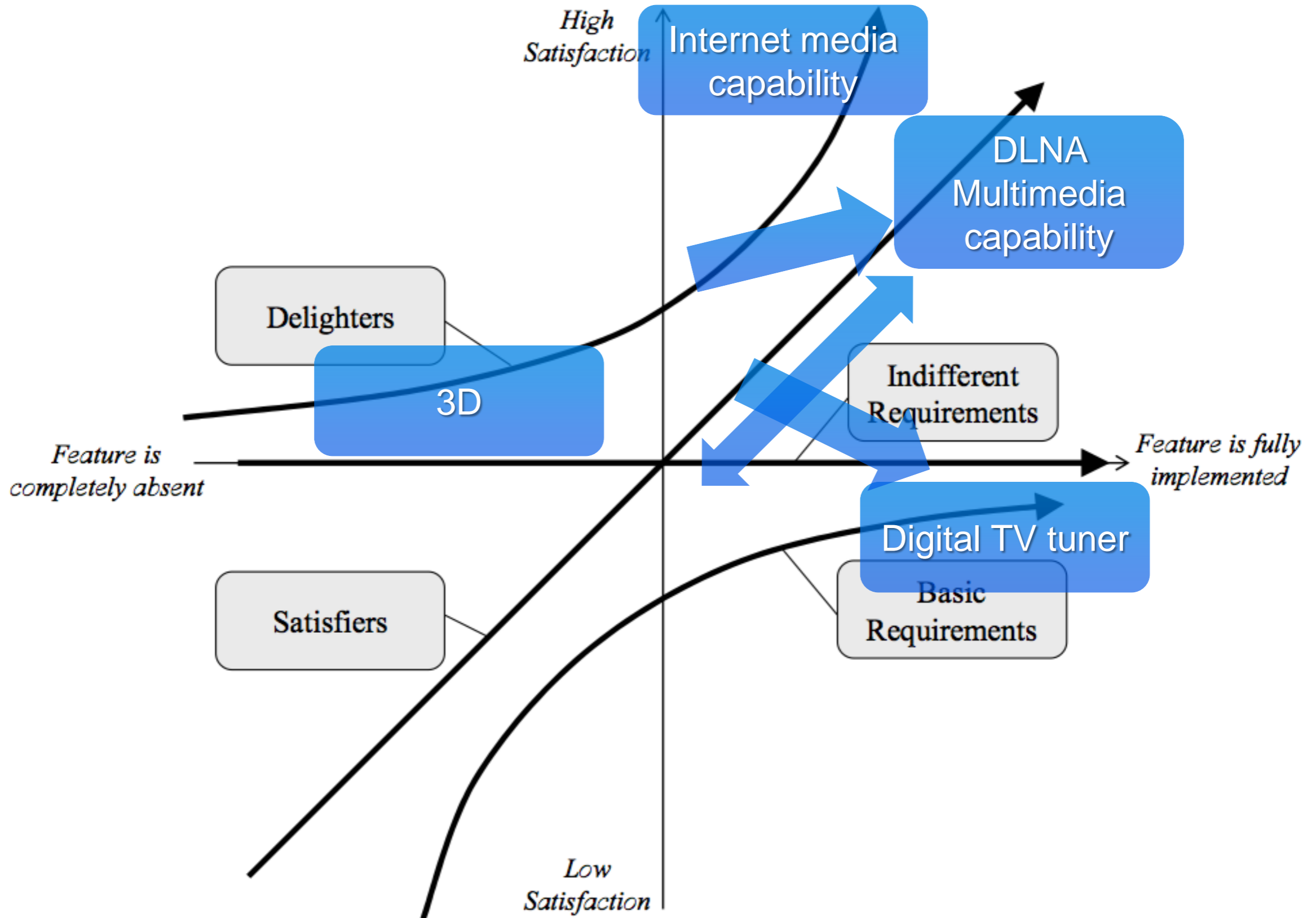
Domain Requirements Engineering & Analysis

- Normal RE and Analysis but Precise Variability Defs
  - Commonality Analysis
  - Variability Analysis
  - Variability Modeling
- Methods
  - App-Req Matrix
  - Priority-based Analysis (KANO)
  - Checklists