

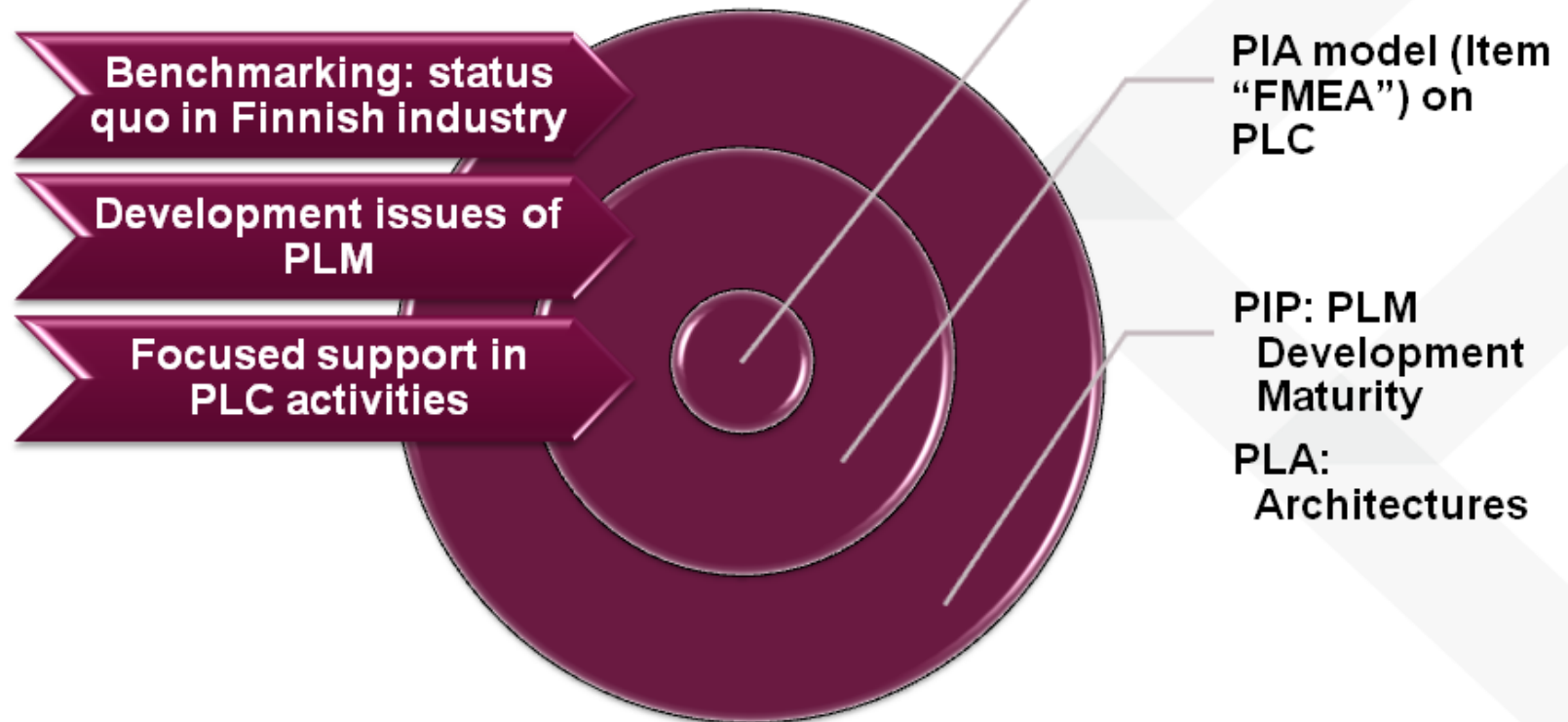


Systematic Benchmarking and Comparison of PLM Development, Maturity and Architecture in Industry

Global Processes for Variant Products (GP4V)
5th Annual Seminar of FIMECC

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Fudge: Setting the target for Future



Content

- Research context & material
 - Global manufacturing companies
 - Early birds of adopting PLM
- Methods of study
 - Benchmarking & comparative case study
 - Good example of industry / research co-operation
- Results
 - PLM architecture, maturity, future targets

Six global manufacturing companies as a sum

- Turnover Σ ~ 16 billion € (2010)
- Personnel Σ ~ 90 000 (2010)
- Typically
 - Most functions are globally decentralized
 - Personnel: more than half abroad (all)
 - Businesses:
 - market leaders / top3 in some business areas
 - B2B deliveries, service contracts (30-60% of turnover)
 - Products:
 - standard parts in service
 - deliveries and service operations mostly configurable
 - projects utilizing configuration (partially configurable)
- Long experience of deploying and utilizing PLM (5/6 already in 1990's)

Benchmarking & Comparison

- 6 Initial interviews
 - 2-4 researchers
 - 1-2 company representatives
 - Written documentation
- 6 Benchmarking site visits
 - 6-10 researchers
 - 12-18 industrial visitors
 - 2-4 hosts
 - Audio recording
- Material refinement
 - Recordings transcribed
 - Written reports: companies checked their own report
 - Distributed to consortium
- Qualitative comparative analysis (QCA) by Ragin
 - Development of Frame
 - Filling the truth tables
 - Comparisons

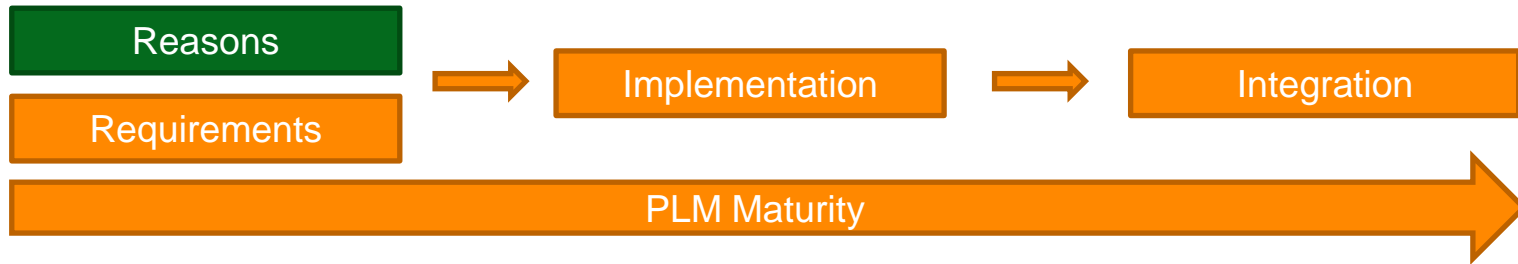
Benefit of the method

for practitioners / industry:

- Quick overview and comparison of
 - PLM implementations
 - Development approaches
 - Present issues
 - Future challenges
- Material for future development
(GP4V Final report 2012,
Pulkkinen 2012)

for researchers / academic:

- Information collection
 - Validated by instant review
 - Verified by host review
 - Large amount of data
 - Fast, actual & real
 - Efficiency of data collection vs. Data quality apparently better than with other methods (Pulkkinen et al. 2011)



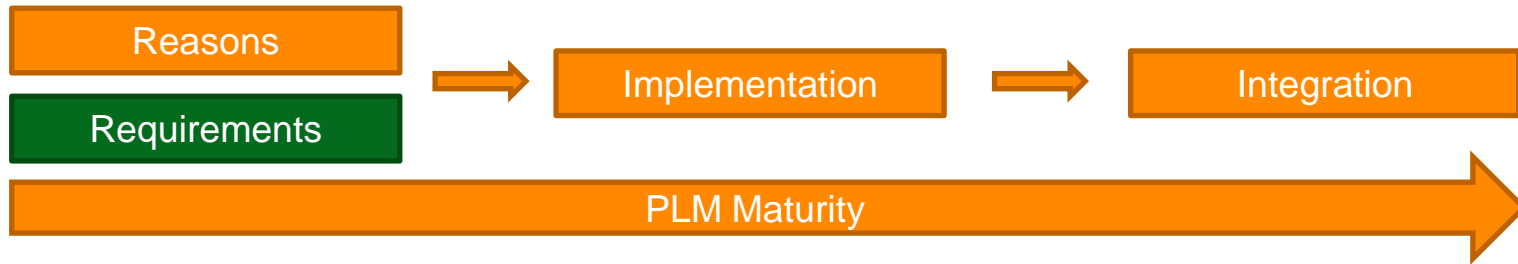
Internal forces

- Product innovation
- Customer satisfaction and loyalty (product customization)
- Operations excellence in
 - Value chain activities
 - Linkages between the activities

External forces

- Globalization
- Environmental awareness
- Shrinkage in product lifecycle
- Increase in product complexity
- Push into supply chain





Functional requirements

- Real-time data acquisition
- Closed loop information flow
- Interoperability between devices and application systems
- Integration with existing systems and services
- Collaborative environment

Data level requirements

- Use of standardized data
- Data interoperability
- Traceability of individual product information
- Data encryption and user authentication

(Lee et al. 2009)



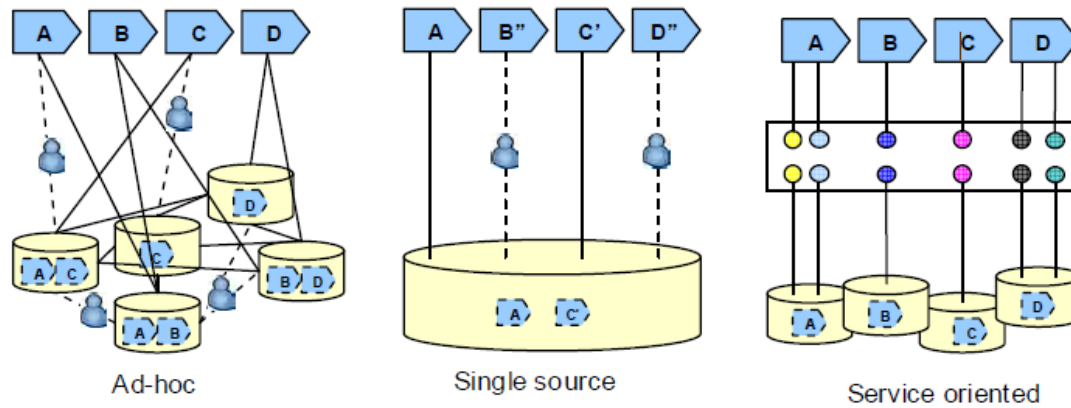
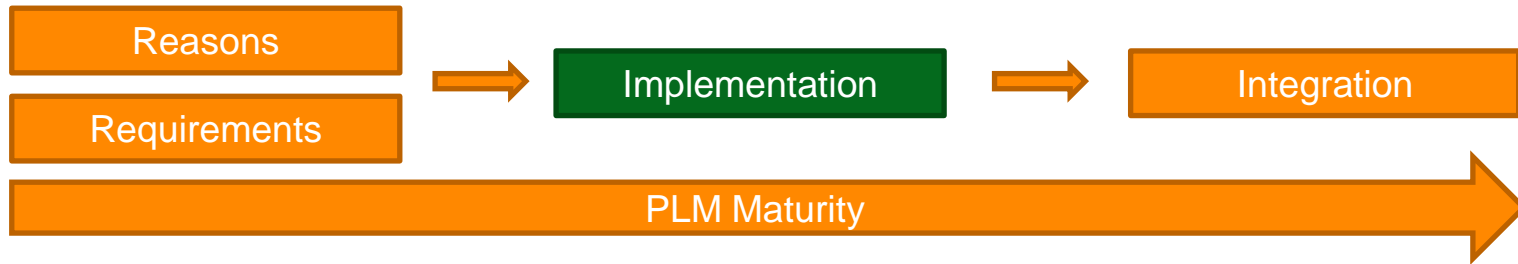
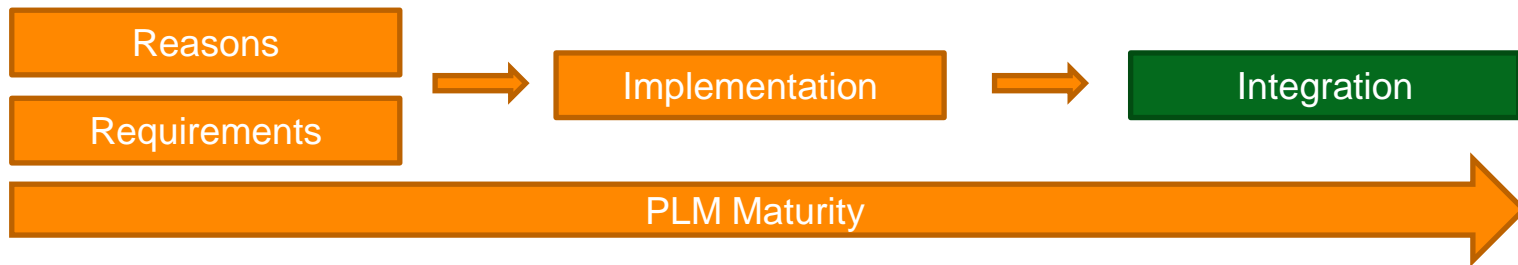


Figure 3. Architectures for Integration (Čatić et al 2008)

Legacy PLM environment
 Single source architecture
 Service-oriented architecture

(Bergsjö et al. 2008)



Architecture models and integration approaches

- Crnkovic et al. 2003:
 - Full integration
 - Loose integration
 - No integration
- Bergsjö et al. 2006:
 - Best-in-class
 - One system as integrator
 - All-in-one integration
 - Peer-to-peer integration

Architecture models

Crnkovic et al. (2003)

Bergsjö et al. (2006-2009)

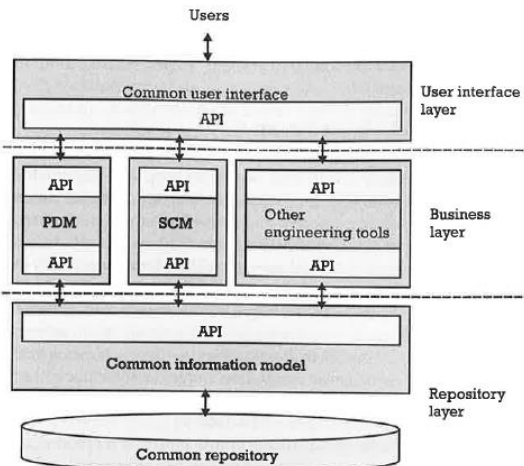


Figure 6.1 PDM and SCM integration—Common API and common repositories.

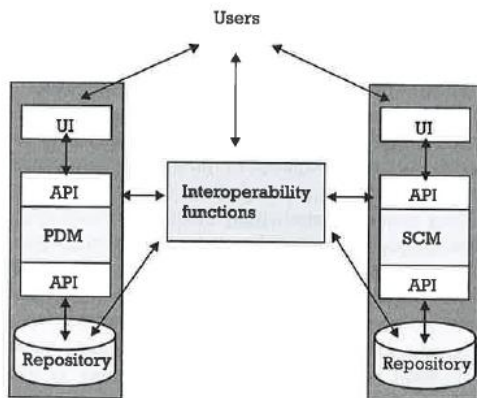


Figure 6.2 PDM and SCM loose integration.

Table 1: Comparison of different approaches

Approach 1 Best-in-class	Approach 2 One system as integrator	Approach 3 All-in-one integration	Approach 4 Peer-to-peer integration

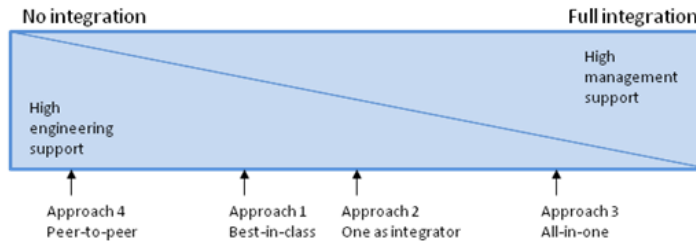


Figure 3.X. Relation between integration level and support level [adapted from Bergsjö 2009 B11].

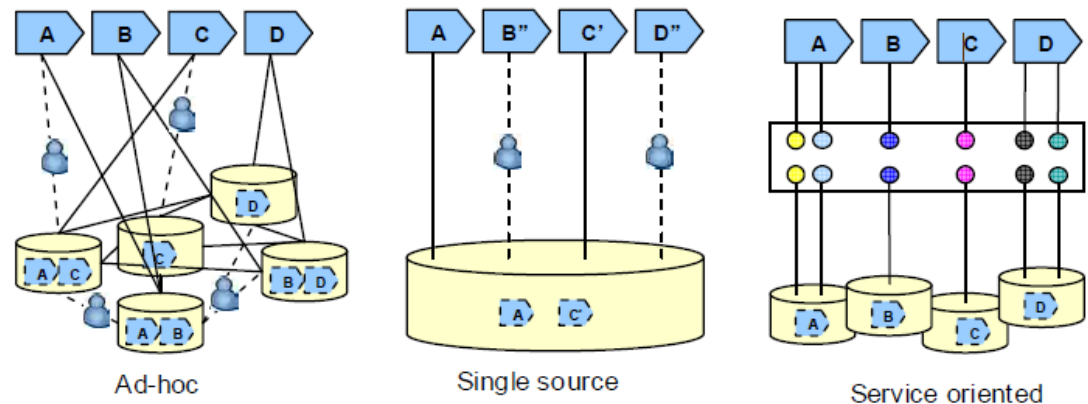
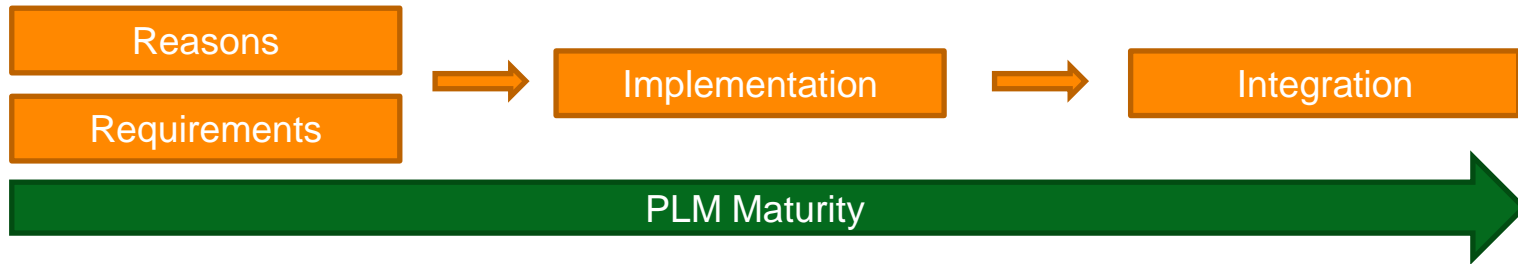


Figure 3. Architectures for Integration (Ćatić et al 2008)



Table 5.12. Identification of case companies' architecture and integration types.

Company	A	B	C	D	E	F
Production type	Configurable, Standard, Project	Project, Configurable	Project, Configurable, Standard	Configurable, Configurable in project	Configurable, Standard, Project	Project
Service business' share	Half of the net sales	Less than half of the net sales	Less than half of the net sales	More than half of the net sales	<i>Figure not available</i>	Less than half of the net sales
As-is Architecture	Legacy	Legacy, Best in class	Legacy	Legacy, Peer to peer	Single source	Legacy
Integration	Loose	Loose/Full	Loose	Loose	Full	Loose/No
To-be Architecture	Legacy, Best in class	Single source or SOA	Best in class, One system as an integrator	Single source	Single source, One system as an integrator	Legacy
Integration	Loose	Loose/Full	Loose	Full	Full	Loose



- Stage 1: Traditional / No investment
- Stage 2: Awakening / Departmental level
- Stage 3: Adapting / Organizational level
- Stage 4: Modern / Inter-organizational level

- Level of PLM application
- Employee and management involvement and understanding
- Departmental/organizational integration and interoperability

(Stark 2005; Batenburg et al. 2005)



Table 2.2. PLM maturity level summary

	Level A	Level B	Level C	Level D
Application of PLM	Non-existent	Local initiatives exist, but there is no overall vision	Company-wide understanding of the importance of product data is taking shape	PLM is seen as a business problem spanning the whole product lifecycle
Involvement and understanding	From few to none people involved	Few people understand PLM	It is clear for everyone where the company is and where it wants to be	Widespread understanding of PLM in the company and in its extended enterprise
Integration	No integration	Simple departmental integrations between some PDM tools	Integration between PDM tools and simple integrations with for example ERP	PDM tools are fully integrated and there is widespread integration with related systems such as ERP
Level of interoperability	Between individual tools only	On a departmental level	On a cross-departmental level	Across the extended enterprise
General description	There is no PLM investment and individual legacy systems are used.	PLM is realized as individual applications integrated on a departmental level. There is no overall PLM vision.	PLM is understood relatively well and integrated on a cross-departmental level	PLM is integrated across the supply chain. PLM is utilized in state-of-the-art ways, for example in a closed-loop fashion.

Observations / Architectures

- Architecture models become apparent in case companies' landscapes
 - The strengths and weaknesses mentioned in the theoretical models can also be found in the reports from the case companies.
- More or less all the case companies still have a legacy architecture
- Common future objectives were discovered
 - E.g. harmonization of data and reduction of redundant systems
- PLM systems focus and are used mostly in the activities of Beginning of Life (BOL: product design and development, manufacturing)
- **Service business and project products seem to be the most challenging fields in PLM**



Observations / Maturity & Development

- Product maintenance and/or after sales tasks are supported in PLM at the most mature cases.
- Many data quality requirements were not fulfilled in the companies which
 - didn't not support the maintenance and after sales in their PLM implementations.
- Often the companies didn't offer purely configurable or standard product (configuration in projects, pure projects).
- **Positive combination:**
 - **Applying product configuration &**
 - **Real PLM approach (also Middle & End of Life) &**
 - **PLM support for Service**



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