



TU Clausthal

# A Peer-To-Peer (P2P) based Product Collaboration Platform (PCP) supporting decentral collaborative product development

Patrick Stiefel  
Institute of Computer Science  
Research Group “Business Information Systems”

March 7th, 2007





## Agenda

- Problem Statement
  - Motivation: PLM, PDMS & the Integrated Product Model
  - State of the art: CPD with classic PDMS
  - Problems and resulting challenges on CPD
  - Related Work
  - Current Research Work
  - A Peer-To-Peer based approach to CPD
  
- Product Collaboration Platform (PCP)
  - Use Case: Request and Proposal
  - PCP Architecture and Core Operations
  - Prototypical Implementation
  
- Conclusion and Outlook



## PLM & PDMS

- Product Lifecycle Management (PLM)
  - A strategy that helps managing and using integrated product related data through all life cycle phases: from development, construction and use up to recycling [STAR06]



**The tool to perform this task is named PDMS**

- Product Data Management System (PDMS)
  - Computer-aided database and communication systems that store, administrate and provide product data at product lifecycle. [ARNO05]



**The basic element of a PDMS is the Integrated Product Model**



## The Integrated Product Model (IPM)

- The IPM is a formal (ISO normed e.g.) collection of all relevant information corresponding to a single product. [ARNO 05]
  
- It consists of several partial models and contains
  - Master data
    - Product Specification [number, name, ...]
    - Geometric Data [3D / 2D CAD]
    - Calculations [FEM]
    - Process Data [Working Plans,...]
    - ...
  - Structural data
    - Relations between several master data values like a components affiliation to its corresponding assembly



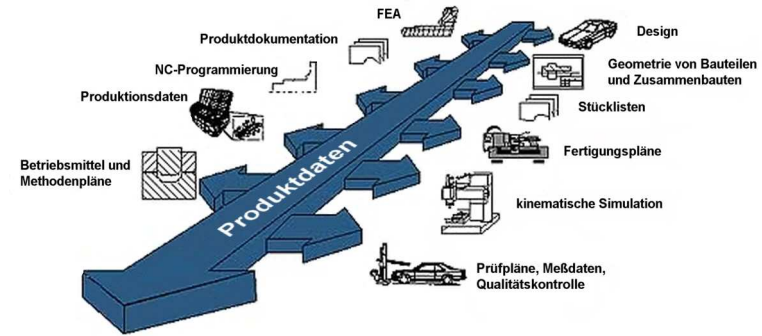
## IPM Examples

### ■ STEP (ISO 10303) [ANDE00, UNGE02]

- STEP is a standard to describe product data through the whole product life cycle
- Offers a formal, standardized and redundancy-free mapping of all relevant product information
- Collects geometrically and non-geometrically (organizationally or technologically) data

### ■ PDX (IPC 2571 / 2578) [IPC01]

- PDX is an XML-based standard for non-geometrically product data exchange
- The XML Schema allows definition of contents like bill of materials (BoM), changes, approved manufacturer lists (AML), etc.
- Especially used by PLM supporting systems like “Agile Advantage” e.g.





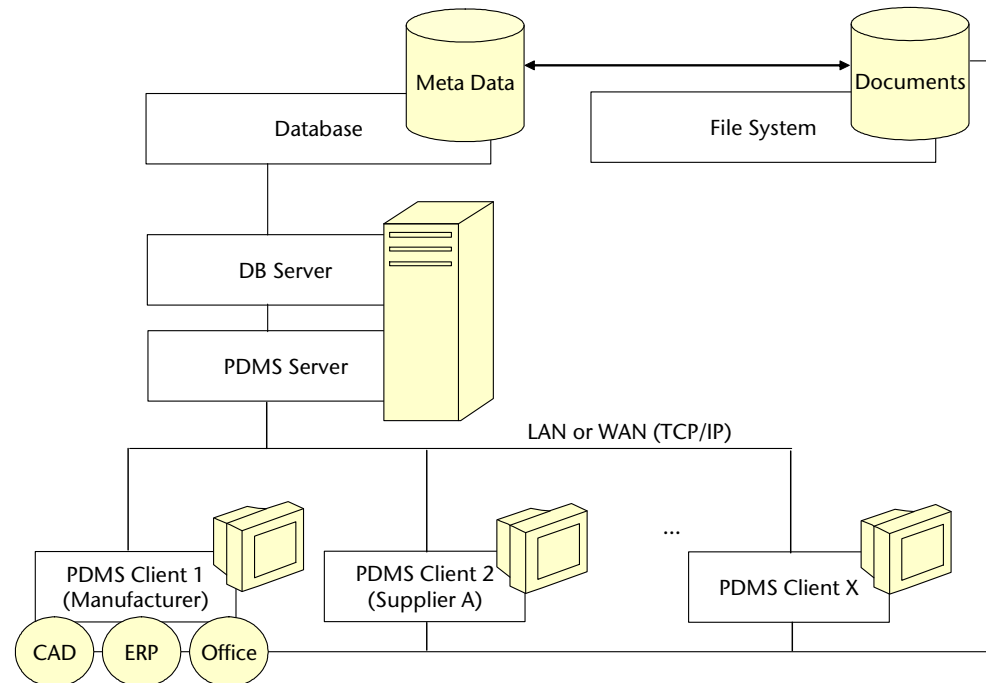
## Collaborative Product Development (CPD)

- CPD is an essential part of the PLM concept and describes the corporate development, realization and optimization of new innovative products across companies borders and independent from geographical distances of developer teams. [SCHAL06]
  
- Assumption:
  - 70% of the total product costs incur at the first phase of product lifecycle (product development phase) [SELB04]
  
- Claim:
  - Coordinated and efficient team work minimizes working process repetitions and results in less production costs
  - Example: Development of already designed product models



## State of the art: Collaborative Product Development with classic PDMS

- Common PDMS market solutions are based on Client/ Server technology (Agile Advantage e.g.) [SCHO 99]
- They integrate all authoring tools involved into product development process.





## Problems and resulting challenges in CPD (1)

- Collaborative Product Development with classic PDMS means to administrate a PDMS Server that hosts collaboration relevant data for all members (manufacturer, supplier, distributor,...)

1

→A collaboration solution is needed, that is independent from existing enterprise IT infrastructure and highly flexible!

- Team building is a dynamic procedure
- Collaborations do not exist permanently
- Each collaboration consists of a choice of development partners with domain specific knowledge

2

→Costs have to be minimized by establishing world-wide on demand ad-hoc collaborations!



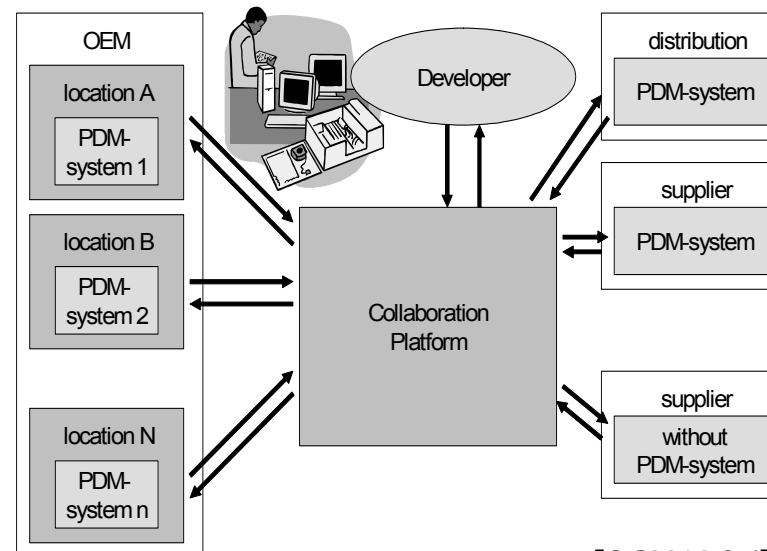
## Problems and resulting challenges in CPD (2)

Product based information is highly sensible

- Collaboration partners do not want to share confidential company-owned data in external databases

3

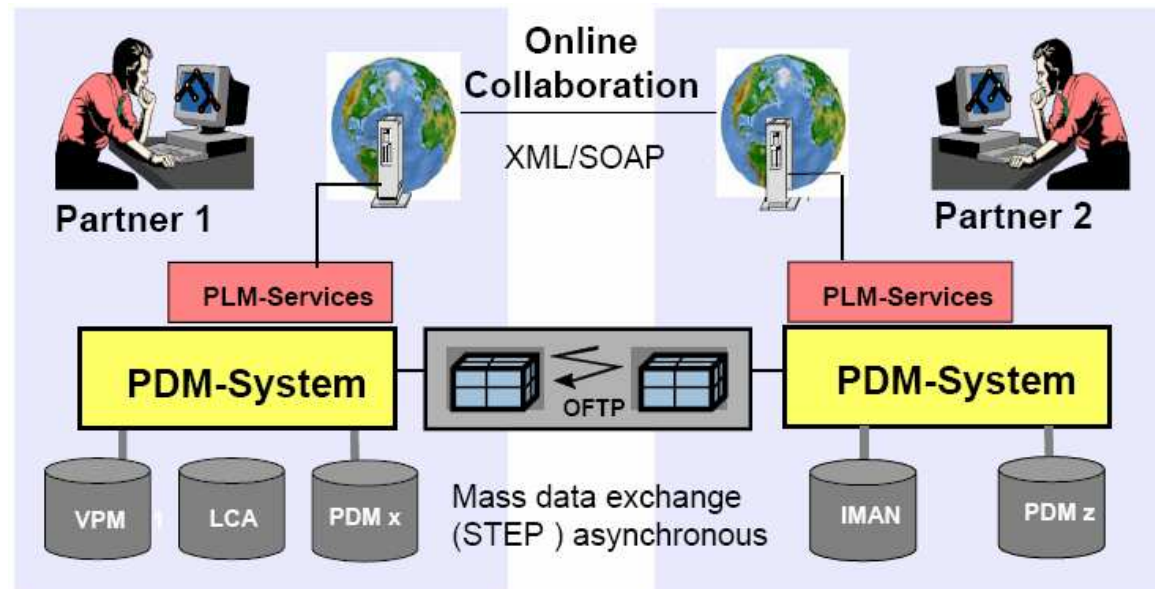
→ Existing product descriptions have to be integrated, not using central databases and based on existing standards!



[SCHAL06]

## Related Work

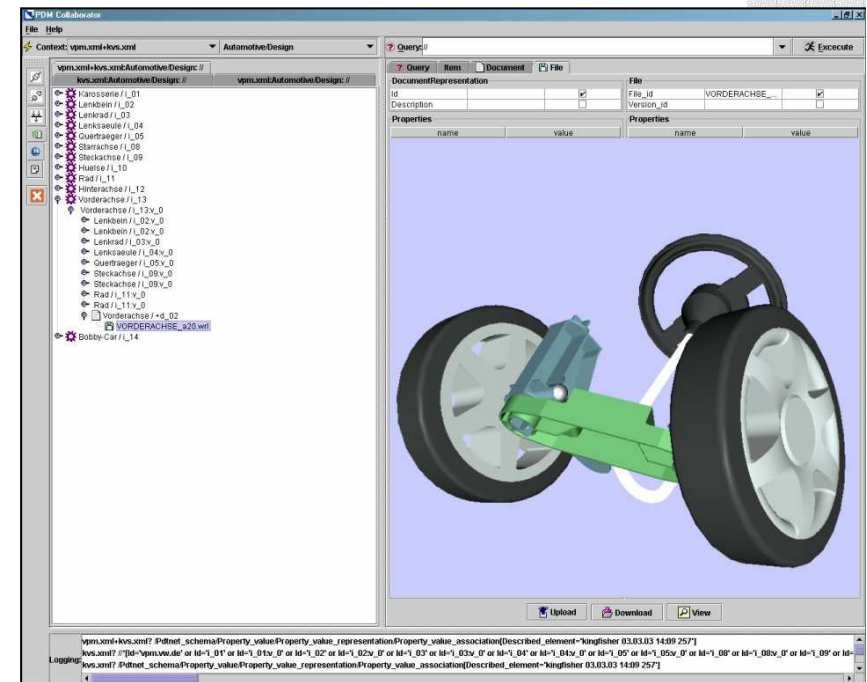
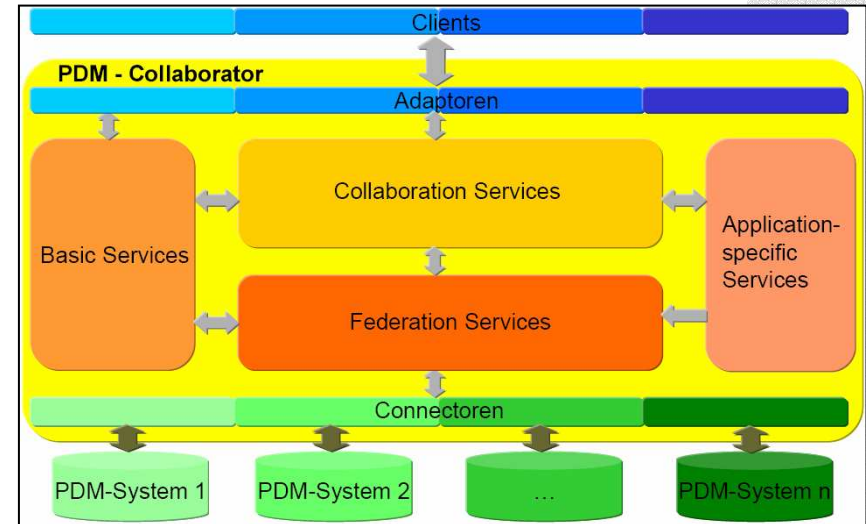
- Industrial Project XPDI (Extended Product Data Integration), enforced since 2004 by ProSTEP iViP Association and several OEMs. [PROS 05]
- Provides the first published XML Web Services framework to realize Collaborative Product Development based on a platform independent data model (STEP)
- Specification “Product Lifecycle Management Services 1.0”, accepted by OMG
- The disadvantage of this solution is that a PLM Services Reference Server is needed for the whole time of the collaboration and not only for the collaborative formation process!





## Related Work (2)

- BMBF research project “PDM Collaborator” established by Fraunhofer IPK, Berlin [PDMC03]
  - A new integrative data model was implemented to support different PDM data formats.
  - Development of a virtual PDM system to integrate product data for enabling cross enterprise engineering.
  - The architecture is based on connectors that allows import of product data from different PDM systems. Furthermore adaptors allow the connection of clients to handle with product related services.
- The disadvantage of this solution is the needed care of the integrative data model.



<http://www.pdm-collaborator.de/>



## A Peer-To-Peer based approach to CPD

- Supporting CPD with decentral methods will provide the following advantages:
  - A Peer-To-Peer (P2P) software architecture for collaborative product development reduces systems total costs by using existing IT infrastructure and allocates them between collaboration partners
  - Since product data is shared redundantly at P2P network there is no single point of failure that could tie up the hole system like in classic Client-/Server architecture
  - Collaboration Participants (Peer Nodes) are directly connected
    - There is no central instance filtering and delaying communication so that real-time arrangements are possible
  - Accessing multiple resources comes along with a better load-balancing

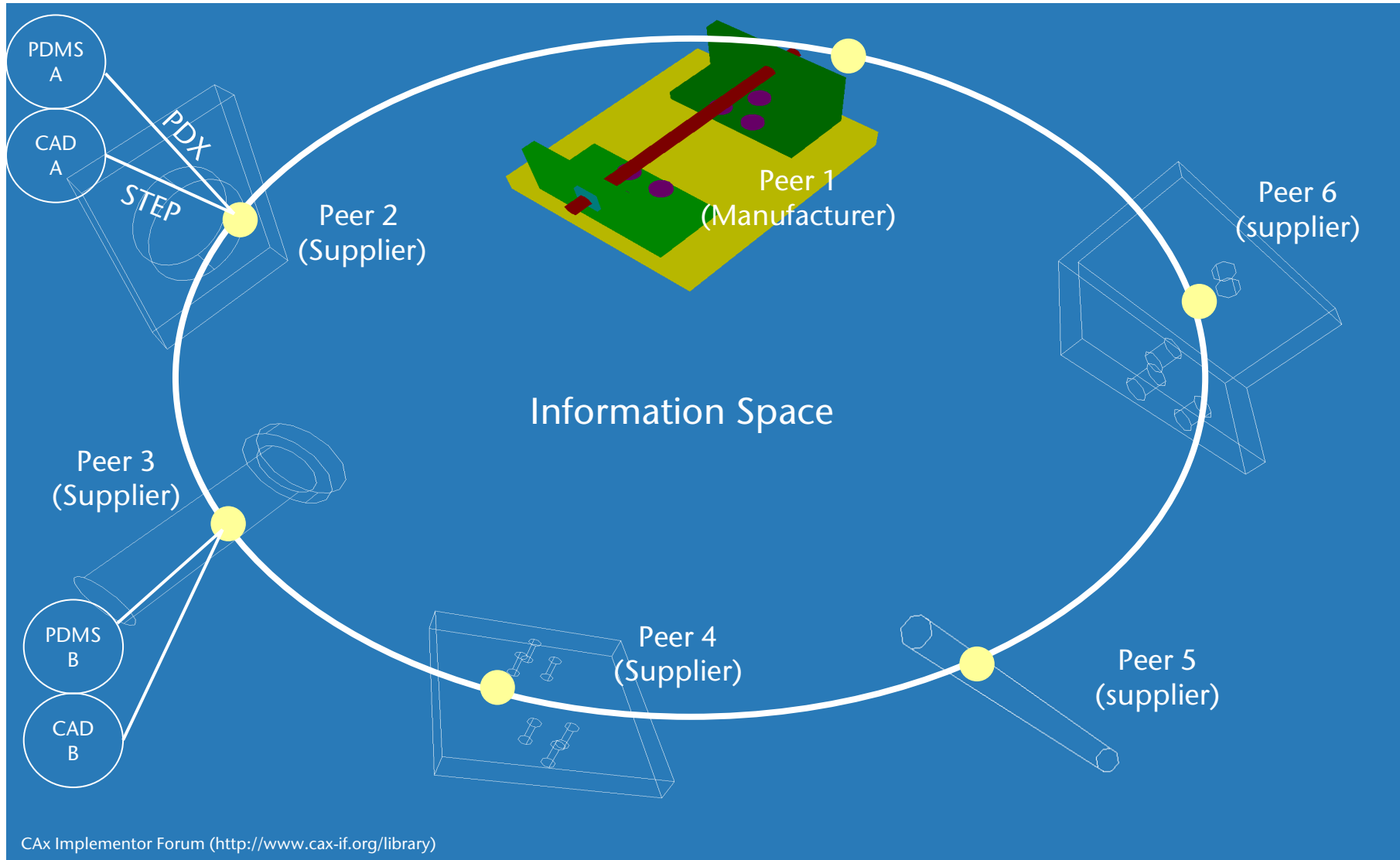


## A Peer-To-Peer based approach to CPD (2)

- Reverse Engineering of existing market solutions for CPD (Classic PDMS, PLM Services, PDM Collaborator) and analyzing product data exchange formats.
- Implement methods that support collaborative work based on a P2P system and based on selected product data exchange metadata
- Implement CPD functions for P2P systems that guarantee seamless system availability
- Evaluate system behavior and scalability by implementing a P2P based Product Collaboration Platform



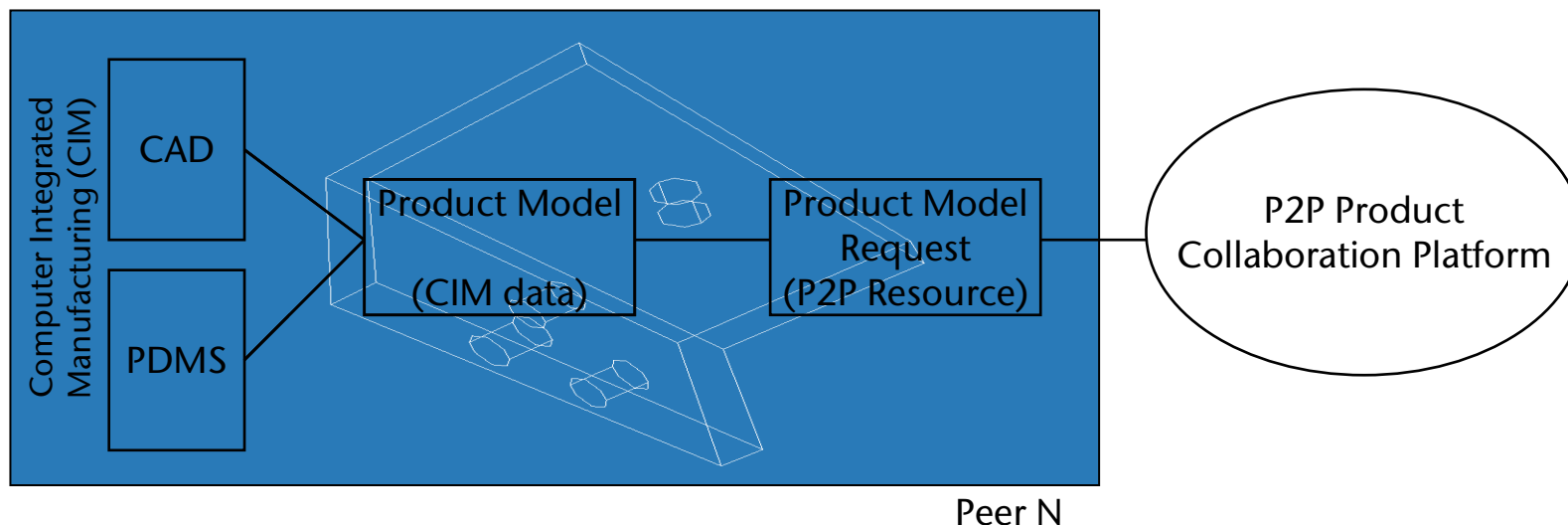
## PCP Use Case (Overview)





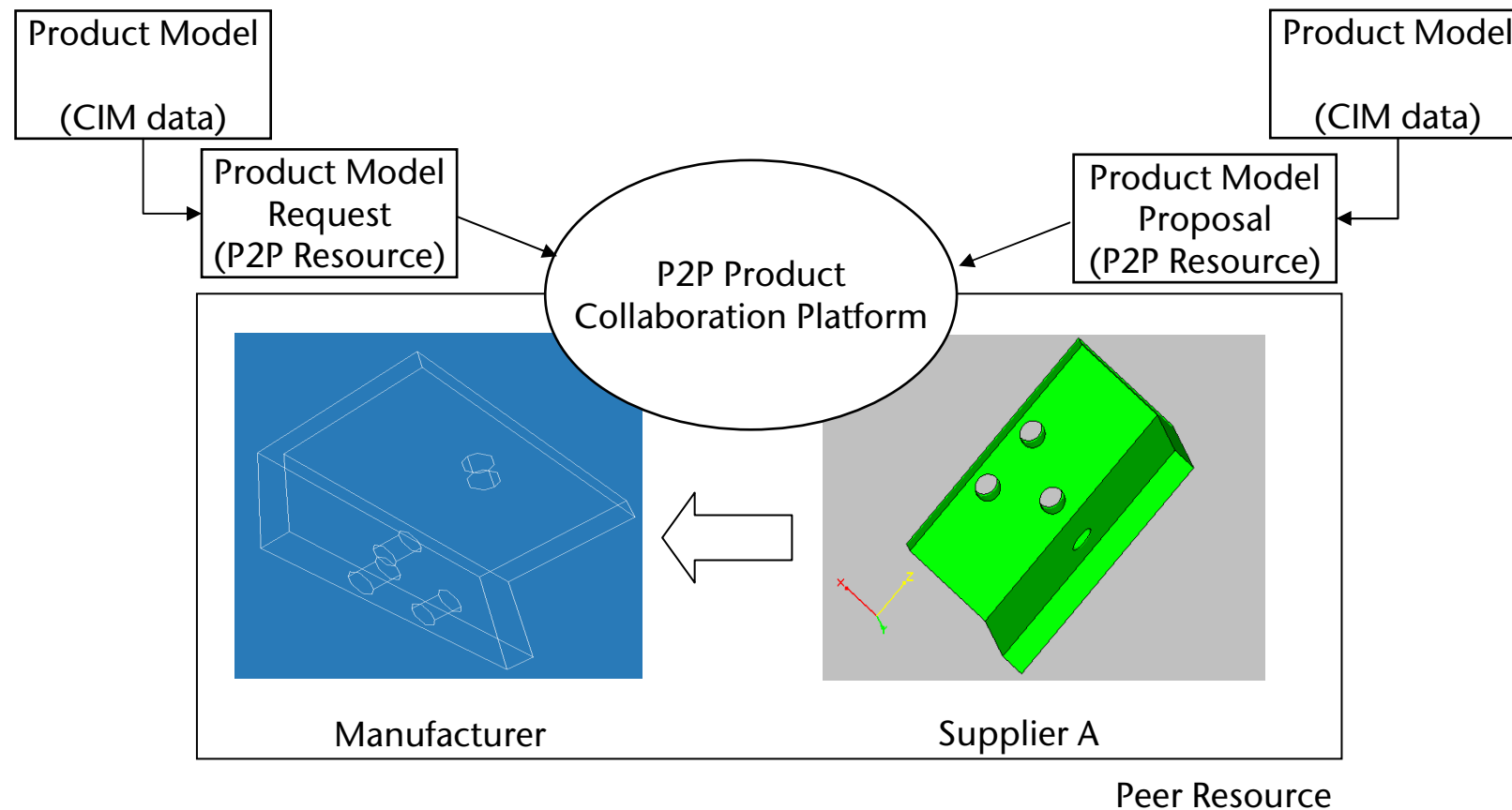
## PCP Basic Elements: Requests

- Initial point: A “manufacturer” wants to product an assembly but misses required know-how
- He would like to ask partners for a manufacturing collaboration
- All available information results from local CIM systems (CAD and/ or PDMS p.e.)
- New PCP Requests have to be formed based on the imported assembly. Respectively one request per assembly component.



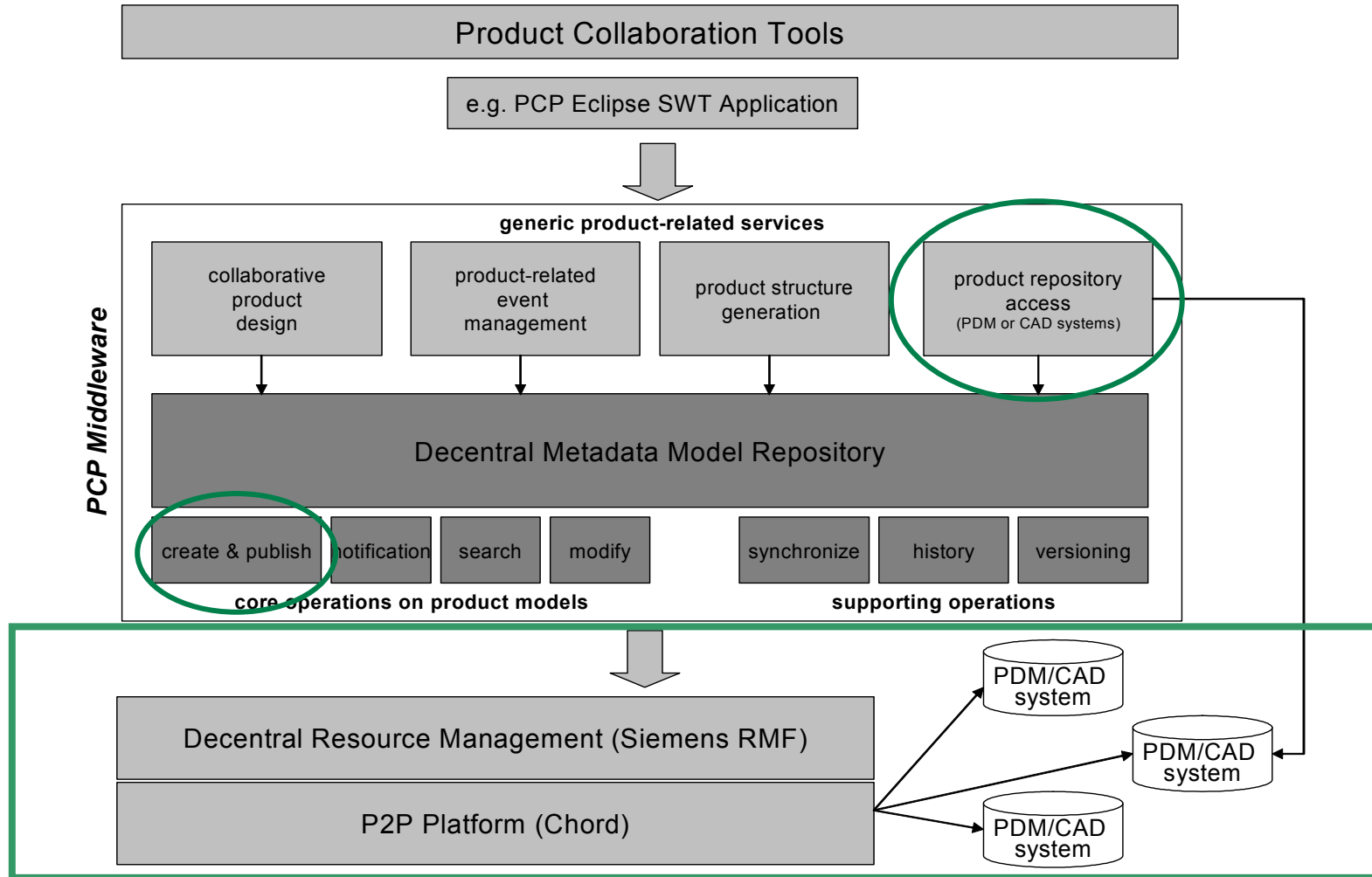
## PCP Basic Elements: Proposals

- Possible supplier can publish construction proposals based on the given manufacturer request



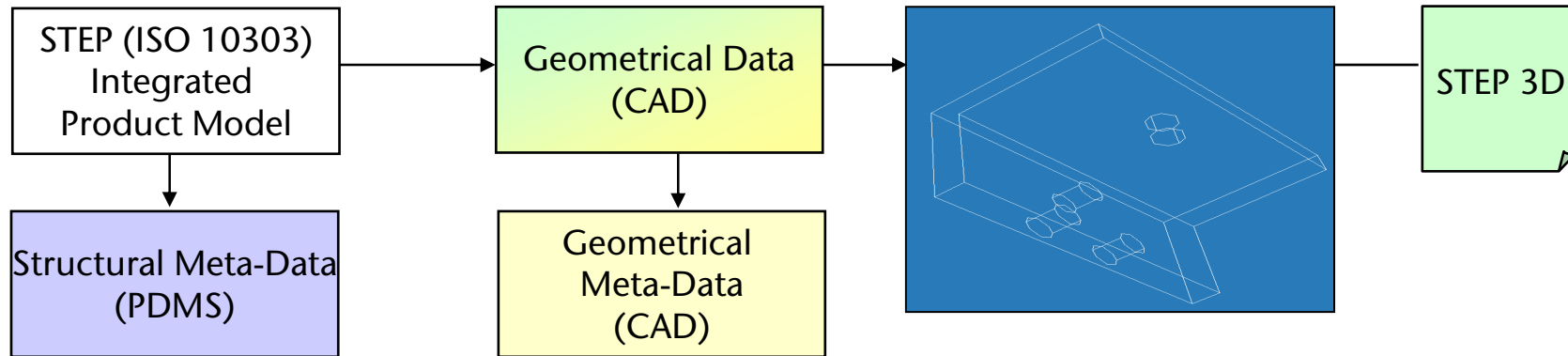


## From CIM Product Model to PCP Resource





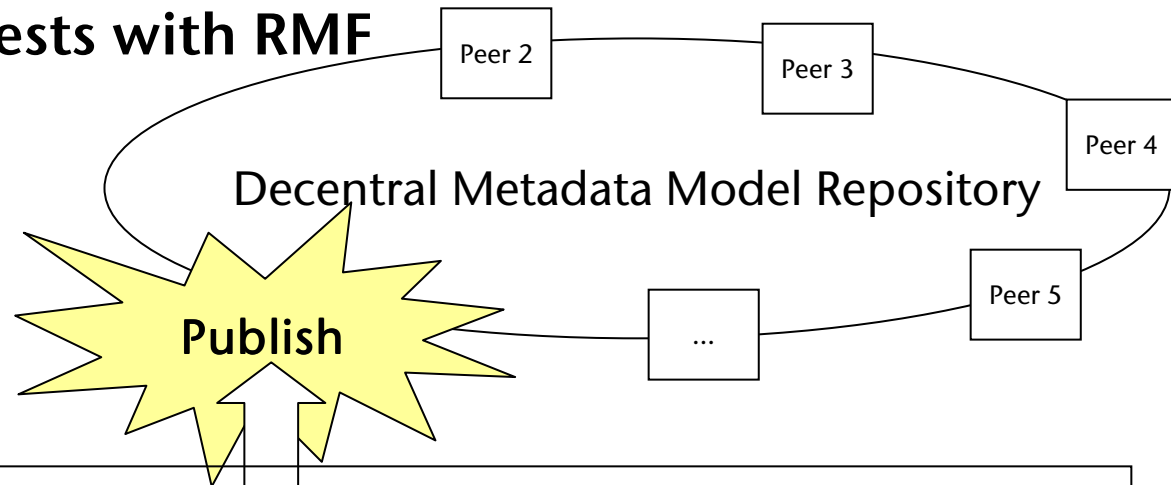
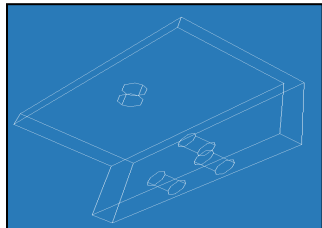
## From CIM Product Model to PCP Request Resource (2)



```
<PCP_Resource>BOM.001-ET.139.174.100.183/3453-1.0</PCP_Resource>
  <STEP_Request>
    <STEP_Request_NAME>l-bracket-component</STEP_Request_NAME>
    <STEP_Request_TYPE>component</STEP_Request_TYPE>
    <STEP_Request_DESC>ext. from STEP assembly as1-tc-214.stp</STEP_Request_DESC>
    ...
    <STEP_Request_HOST>139.174.100.249</STEP_Request_HOST>
    <STEP_Request_LINK>C:\STEPImport\as1-tc-214.stp</STEP_Request_LINK>
    ...
    <STEP_Request_A01NAME>length</STEP_Request_A01NAME>
    <STEP_Request_A01VALUE>50.00000</STEP_Request_A01VALUE>
    <STEP_Request_A01UNIT>mm</STEP_Request_A01UNIT>
    ...
  </STEP_Request>
</PCP_Resource>
```



## Publish PCP Requests with RMF



```

PCP_Resource pcp = new PCP_Resource();
pcp.setNum("BOM.001-ET.139.174.100.183/3453-1.0");

STEP_Request s = new STEP_Request();
s.setName("1-bracket-component");
...
STEP_Request_Attribute[] sa = new STEP_Request_Attribute[5];
sa[0].setName("length");
sa[0].setValue("50.000000");
sa[1].setName("colorRGB");
sa[1].setValue("0-255-0");
..
pcp.setRequest(s);
registrar.publish(pcp);

```

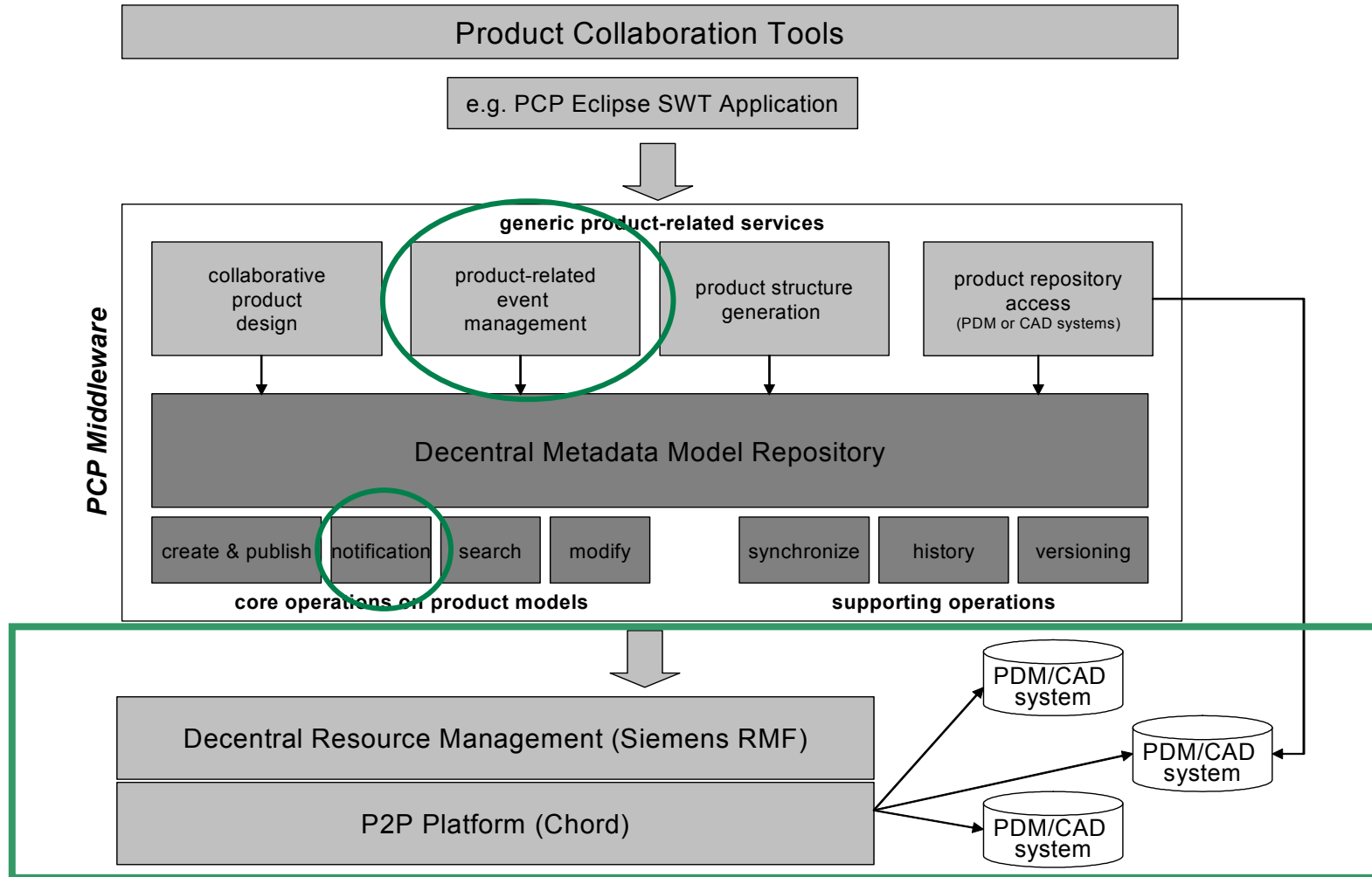
PCP Request Resource (Java Object)

P2P Request Resource (XML)

Peer 1

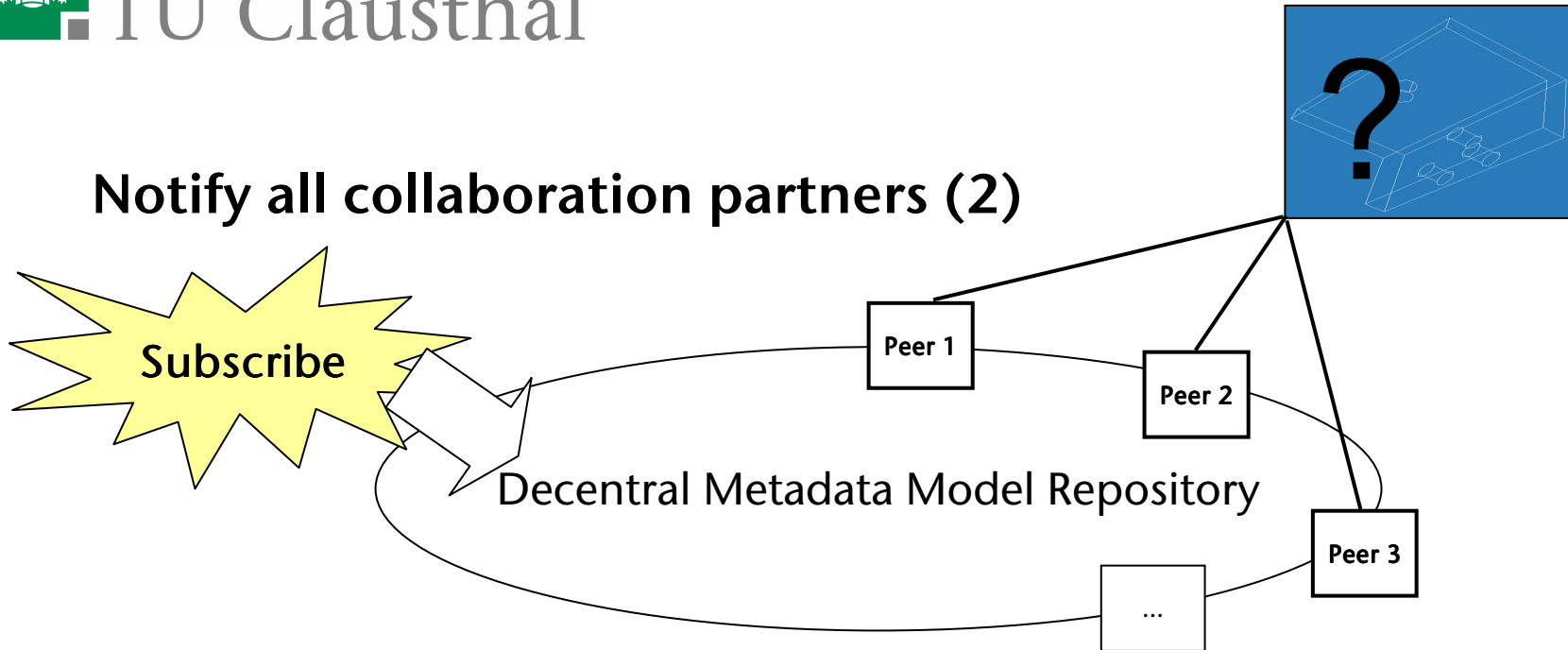


## Notify all collaboration partners





## Notify all collaboration partners (2)



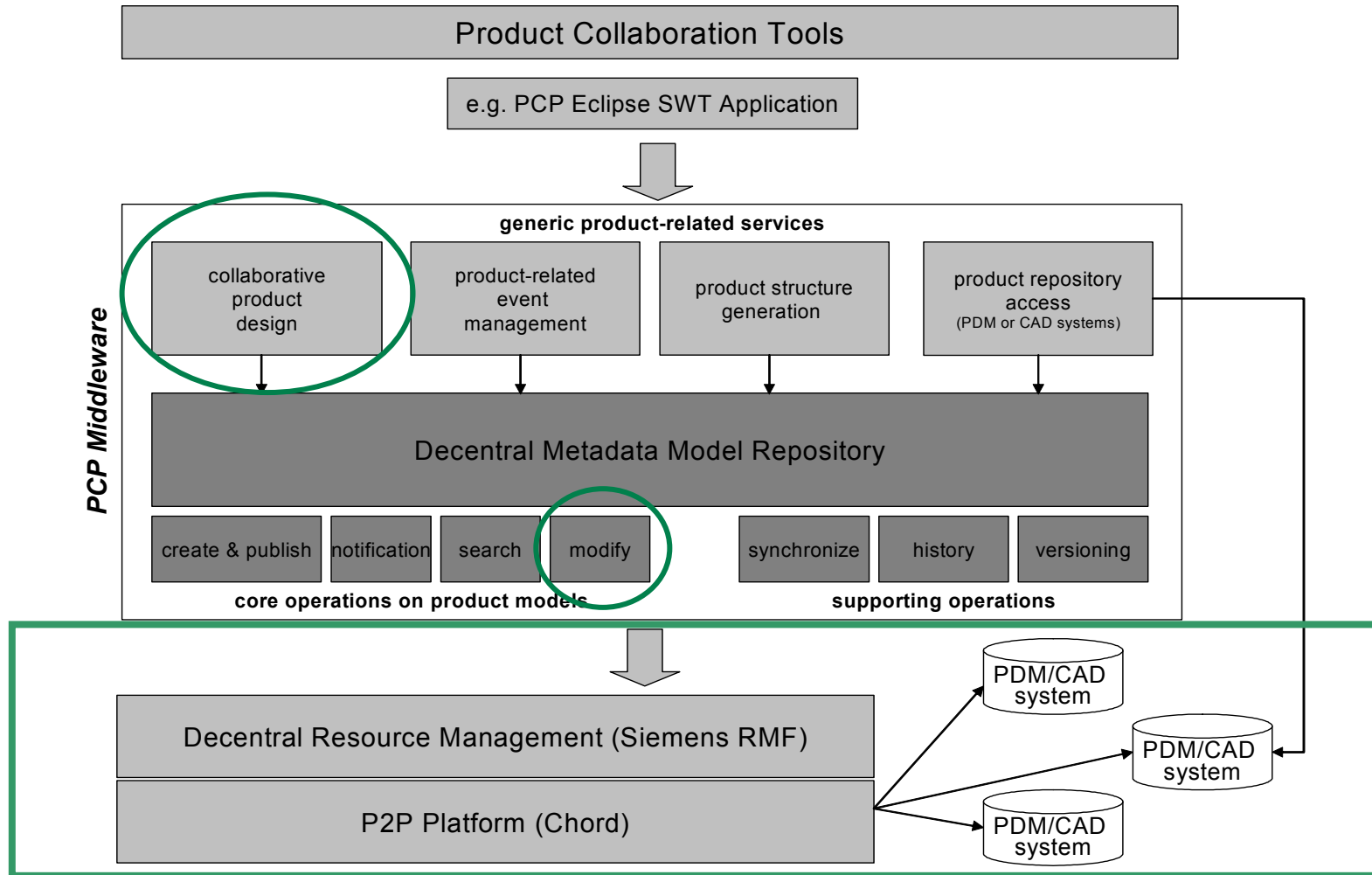
```
String[] keywords = new String[] {"BOMcomponent"};
String query = "/*[STEP_Request:character = 'component']";

RegistrarSubscribeCallback callback = newRegistrarSubscribeCallback(null) {
    public void registrarOnEvent(...) {
        try {
            PCP_Resource pcp = new PCP_Resource(resource.getElement());
        }
        ... }
} registrar.subscribe(keywords, query, ..., callback);
```

- By using the RMF subscription concept, all collaboration partners get informed about new existing requests!

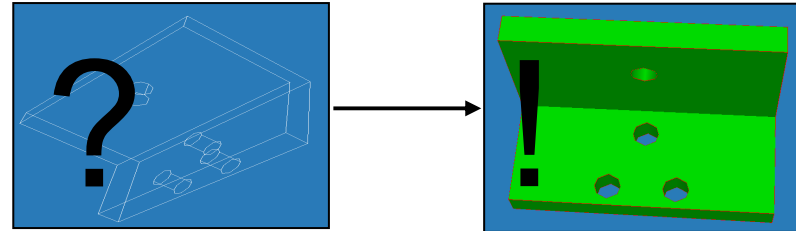


## Making a proposal





## Making a proposal (2)



```
PCP_Resource pcp = (Resource) RMF.search("BOMrequest",  
"pcp_resource:request_dentifier='BOM.001-ET.139.174.100.183/3453-1.0'")
```

```
STEP_Proposal1 p1 = new STEP_Proposal1();  
p1.setName("1-bracket-component proposal from supplier A");  
p1.setHost("139.174.100.222");
```

...

```
STEP_Proposal2 p2 = new STEP_Proposal2();  
p2.setName("1-bracket-component proposal from supplier B");  
p2.setHost("139.174.100.249");
```

...

```
pcp.setSTEP_Proposal1(p1);  
pcp.setSTEP_Proposal2(p2);
```

```
RMF.modify(pcp);
```

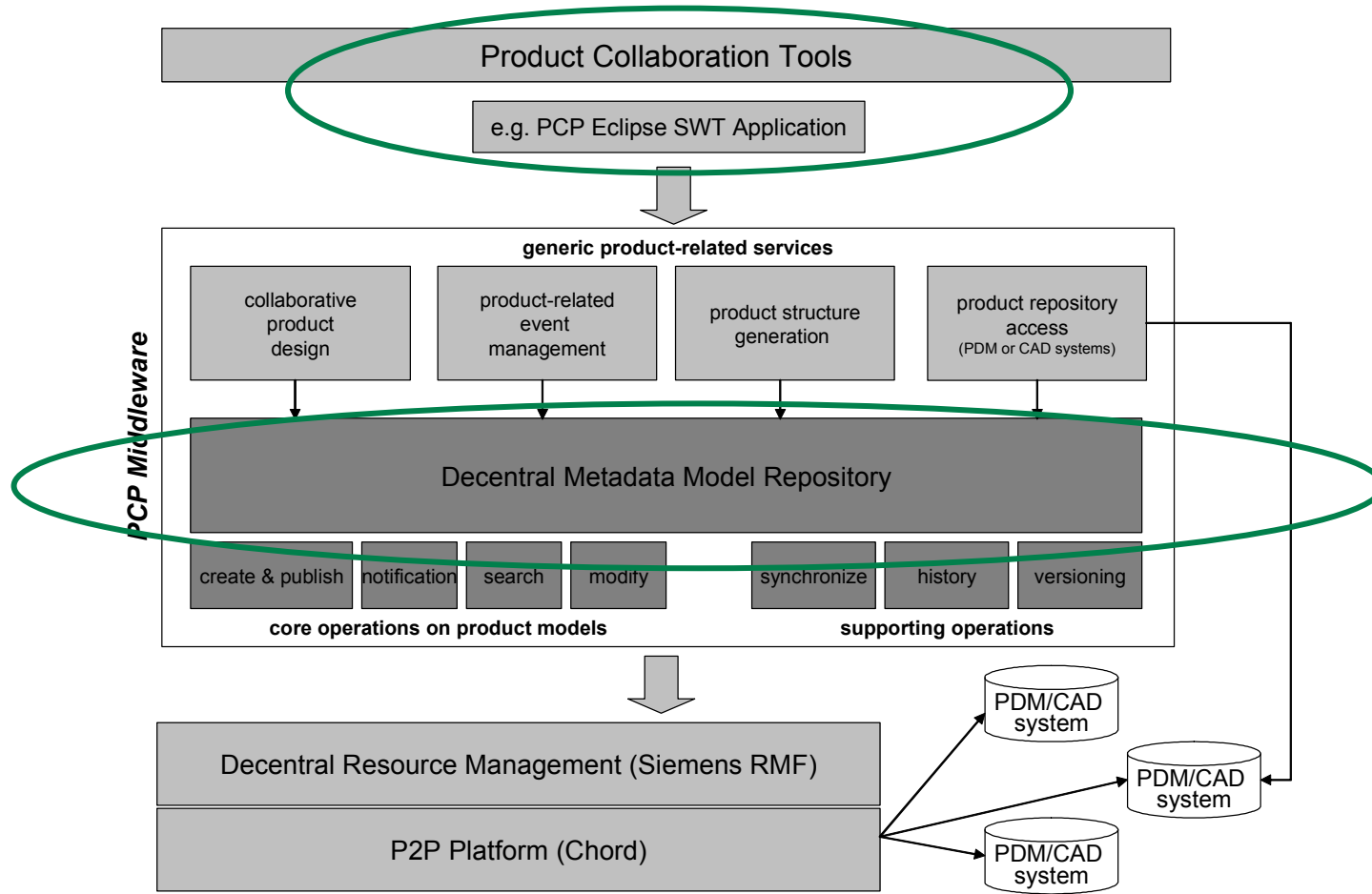
Proposal  
from  
supplier A

Proposal  
from  
supplier B

- At least five proposals (given by several suppliers) can be stored upon a corresponding request into one and the same XML file.



# Prototypical Implementation





# Prototypical Implementation (Request and Proposal)

**1** STEP 3D Viewer to display components

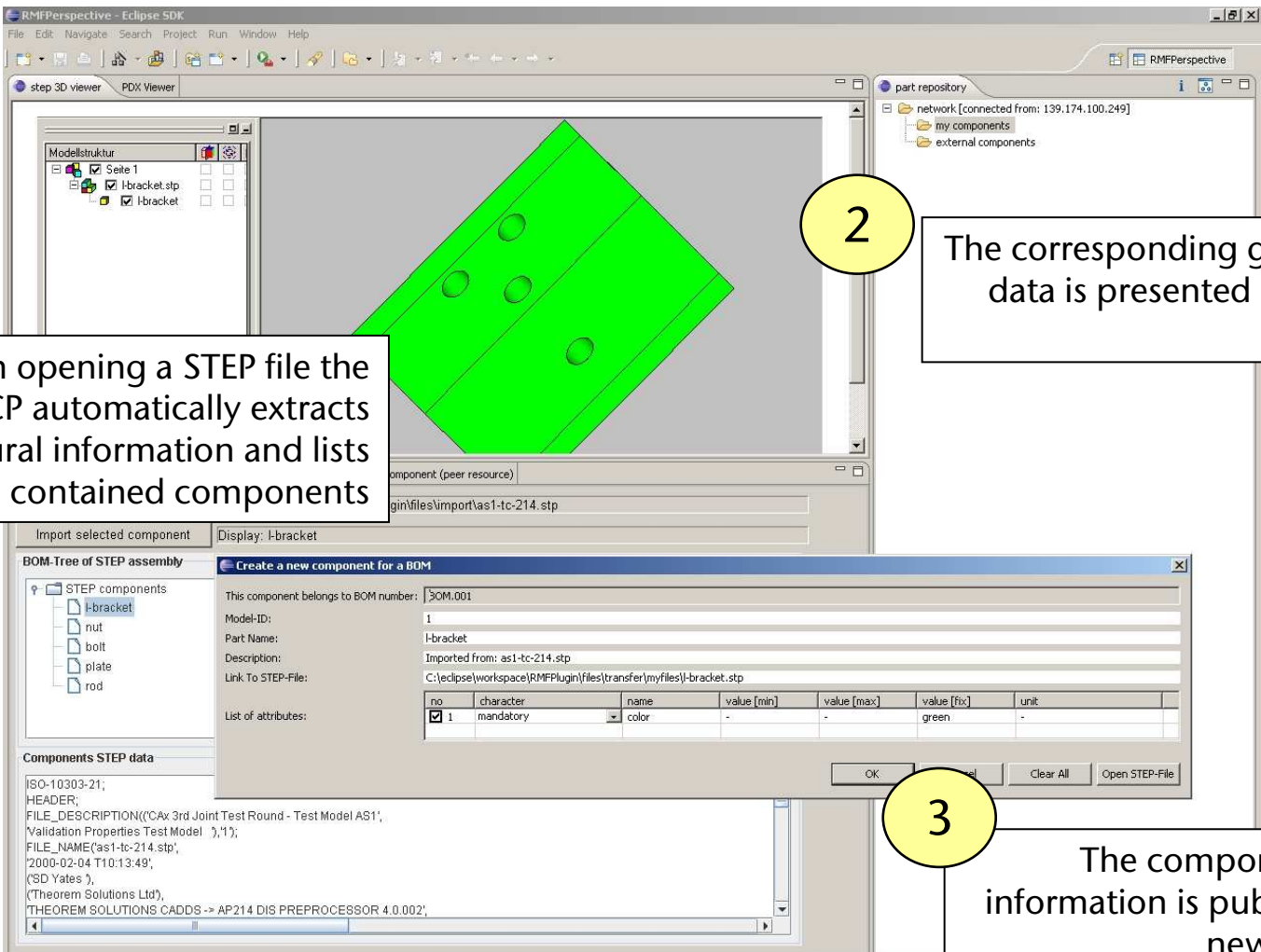
**2** Components structural and geometrical meta information

**3** Requests and corresponding proposals are listed in the model repository browser

The screenshot shows the RMFPerspective Eclipse SDK interface. The top window is the 'step 3D viewer' displaying a red 3D model of a bracket. The bottom window is the 'selected part (general information)' panel, which contains a form for component details and a table of attributes. The right window is the 'part repository' browser showing a tree structure of components.

no	character	name	demands	your proposal
01	mandatory	color	green	red

## Prototypical Implementation (STEP CIM Proposal Import)



**1** When opening a STEP file the PCP automatically extracts structural information and lists contained components

**2** The corresponding geometrical data is presented in the STEP 3D viewer

**3** The components meta information is published as a new proposal.

**BOM-Tree of STEP assembly**

- STEP components
  - l-bracket
  - nut
  - bolt
  - plate
  - rod

**Components STEP data**

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(('CAx 3rd Joint Test Round - Test Model AS1',
'Validation Properties Test Model ', '1');
FILE_NAME('as1-tc-214.stp',
'2000-02-04 T10:13:49',
('SD Yates '),
('Theorem Solutions Ltd'),
'THEOREM SOLUTIONS CADD5 -> AP214 DIS PREPROCESSOR 4.0.002');
```

**Create a new component for a BOM**

This component belongs to BOM number: SOM.001

Model-ID: 1

Part Name: l-bracket

Description: Imported from: as1-tc-214.stp

Link To STEP-File: C:\eclipse\workspace\RMFP\plugin\files\transfer\myfiles\l-bracket.stp

no	character	name	value [min]	value [max]	value [fix]	unit
1	mandatory	color	-	-	green	-



## Conclusion

1. Provided important arguments for supporting collaborative and cross enterprise product engineering with decentral methods.
2. Presented highly practicable use case and the architecture of the Peer-to-Peer based Product Collaboration Platform (PCP) that supports decentral methods.
3. Implemented PCP core components in an Eclipse SWT based Product Collaboration Tool.



## Outlook: Current diploma thesis

- PLM Customization (cand. Wirt.-Inf. Christian Hausknecht)
  - The existing PLM system at our PLM lab, Agile Advantage, has to be customized and prepared for handling decentral collaboration scenarios based on exemplarily corporate structures.
  
- PDX Integration & Role concepts (cand. Wirt.-Inf. Thomas Dokters)
  - We try to implement a role concept for decentral collaboration environments.
  - We want to adopt existing user infrastructures and relations from existing PDM systems into PCP.
  - After having established a stable collaboration, we have to store existing relations and corresponding product data into manufacturers PDM system (like Agile Advantage e.g.)



## Outlook: Current diploma thesis (2)

- Collaborative product design (cand. Wirt.-Inf. Lei Meng)
  - We implement possibilities to automatically change component based geometric data through PCP interface without using external CIM tools, like CAD applications e.g.
- PLM Webservices (cand. Wirt.-Inf. Sara Bessling)
  - PCP requires as an input a stable constitution of collaboration partners [P1,...Px]. To organize this arrangement it would rather be necessary to provide appropriate services.
- Concept generalization & evaluation (cand. Wirt.-Inf. Robert Braxein)
  - Actually we work on context independent models to expand the PCP to a Collaboration Platform that also supports decentral, collaborative software development e.g.



**Thank you for your attention!**  
**Questions?**



## Literature

- [ANDE00] Anderl, Reiner: STEP, Standard for the Exchange of Product Model Data - Eine Einführung in die Entwicklung, Implementierung und industrielle Nutzung der Normenreihe ISO 10303. Teubner Verlag, 2000
- [ANDE06] Anderl, Reiner: Skript zur Vorlesung: Produktdatentechnologie A (CAD-Systeme und Cax-Prozessketten) und Produktdatentechnologie B (Produktdatenmanagement). TU Darmstadt, 2005
- [ARNO05] Arnold, V. et al.: Product Lifecycle Management beherrschen: Ein Anwenderhandbuch für den Mittelstand, Berlin, Heidelberg, 2005
- [IPC01] IPC: IPC-2578, Sectional Requirements for Supply Chain Communication of Bill of Material and Product Design Configuration Data – Product Data eXchange (PDX), Bannockburn, 2001
- [PDMC03] Verbundprojekt PDM-Collaborator: Unternehmensübergreifende Kooperation auf PDM-Ebene, Abschlussbericht, 2003
- [PROS05] ProSTEP iViP Association; ISO; OMG, Inc.: Product Lifecycle Management Services, Convenience Document, 2005
- [SCHAL06] Scheer, August-Wilhelm; Boczanski, Manfred; Muth, Michael; Schmitz, Willi-Gerd; Segelbacher, Uwe: *Prozessorientiertes Product Lifecycle Management*. Springer Verlag, 2006
- [SCHO99] Schöttner, J.: Produktdatenmanagement in der Fertigungsindustrie: Prinzip – Konzepte – Strategien, München, Wien, 1999
- [SELB04] Selbach, Elmar P.: *Die neuen Werkzeuge der Produktentwicklung*. Vortrag Automotive Harness Forum München, 2004
- [STAR06] Stark, J.: Product Lifecycle Management: 21st Century Paradigm for Product Realisation, 3. Auflage, London, 2006
- [UNGE02] Ungerer, M.; Buchanan, K.: Usage Guide for the STEP PDM Schema V1.2, Release 4.3, 2002