



ICSP2008

International Conference on Software Process

Project Assets Ontology (PAO) to Support Gap Analysis for Organization Process Improvement based on CMMI v.1.2



มหาวิทยาลัยศรีปทุม
SRIPATUM UNIVERSITY

Suwanit Rungratri
suwanit_r@hotmail.com

Sasiporn Usanavasin
sasiporn.us@spu.ac.th

Doctor of Philosophy in Information Technology Program
Graduate School, Sripatum University

61 Phaholyothin rd. Jatujak, Bangkok 10900, Thailand

Agenda



- 1. Motivations and Problems**
- 2. CMMI v.1.2 Model**
- 3. Related Works**
- 4. Project Assets Ontology (PAO)**
- 5. PAO for CMMI Gap Analysis**
- 6. Conclusions and Future Works**
- 7. References**

Motivations and Problems (1 / 3)



- High competition in software industry
- Focusing on product quality and process improvement
 - Adopt CMMI Model
 - To obtain CMMI certified is not easy and it is costly
- Gap analysis is an important step for an organization to perform CMMI Maturity level assessment

Motivations and Problems (2/3)



- Problems found in Gap analysis process [6]:
 - time-consuming
 - many document reviews
 - meetings and interviews are needed
- The existing tools such as [Appraisal Assistant Beta 3](#) [8], [CMMiPa1.0](#) [9] still require a consultant to manually review all the documents and manually input information to support the generation of Gap Analysis reports

Motivations and Problems (3/3)



- **Purpose of this study:**
 - Project Assets Ontology (PAO)
 - CMMI v.1.2 based Gap Analysis Assistant Framework (CMMI-GAAF)
 - To support an organization to conduct an automatic Gap Analysis for CMMI Maturity/Capability level assessment, which can lead to time and cost reductions



CMMI v.1.2 Model (1/4)



- Capability Maturity Model Integration for Development version 1.2 [4]
- Developed by Software Engineering Institute (SEI) at Carnegie-Mellon University, USA
- Consists of best practices in 22 Process Areas (PAs) that address development and maintenance activities applied to products and services in many industry

CMMI v.1.2 Model (2/4)



- **Provides two representations:**
 1. *Continuous representation*
 - To evaluate capability level of one or more process areas (PAs) within an organization
 2. *Staged representation*
 - To evaluate maturity level of an organization
 - Level 5: 22 PAs, Level 4: 20 PAs,
Level 3: 18 PAs, Level 2: 7 PAs

CMMI v.1.2 Model (3/4)



Continuous representation (capability levels)

- 4 categories of Process Area (PAs) to improve the performance of organization are:
 1. Process Management
 2. Project Management
 3. Engineering
 4. Supporting

<i>Process Area</i>	<i>Category</i>	<i>Maturity Level</i>
Causal Analysis and Resolution	Support	5
Configuration Management	Support	2
Decision Analysis and Resolution	Support	3
Integrated Project Management	Project Management	3
Integrated Supplier Management	Project Management	3
Integrated Teaming	Project Management	3
Measurement and Analysis	Support	2
Organizational Environment for Integration	Support	3
Organizational Innovation and Deployment	Process Management	5
Organizational Process Definition	Process Management	3
Organizational Process Focus	Process Management	3
Organizational Process Performance	Process Management	4
Organizational Training	Process Management	3
Product Integration	Engineering	3
Project Monitoring and Control	Project Management	2
Project Planning	Project Management	2
Process and Product Quality Assurance	Support	2
Quantitative Project Management	Project Management	4
Requirements Development	Engineering	3
Requirements Management	Engineering	2
Risk Management	Project Management	3
Supplier Agreement Management	Project Management	2
Technical Solution	Engineering	3
Validation	Engineering	3
Verification	Engineering	3

PAs in supporting category

Continuous representation (capability levels)



CMMI v.1.2 Model (4/4)

Table 1 Stage Representation (Five Maturity Levels)

Level	Focus	Process Areas	Acronym
5 Optimizing	Continuous Process Improvement	Organizational Innovation and Deployment Causal Analysis and Resolution	OID CAR
4 Quantitatively Managed	Quantitative Management	Organizational Process Performance Quantitative Project Management	OPP QPM
3 Defined	Process Standardization	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management for IPPD Risk Management Decision Analysis and Resolution	RD TS PI VER VAL OPF OPD OT IPM+IPPD RSKM DAR
2 Managed	Basic Project Management	Requirement Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management	REQM PP PMC SAM MA PPQA CM
1 Initial			

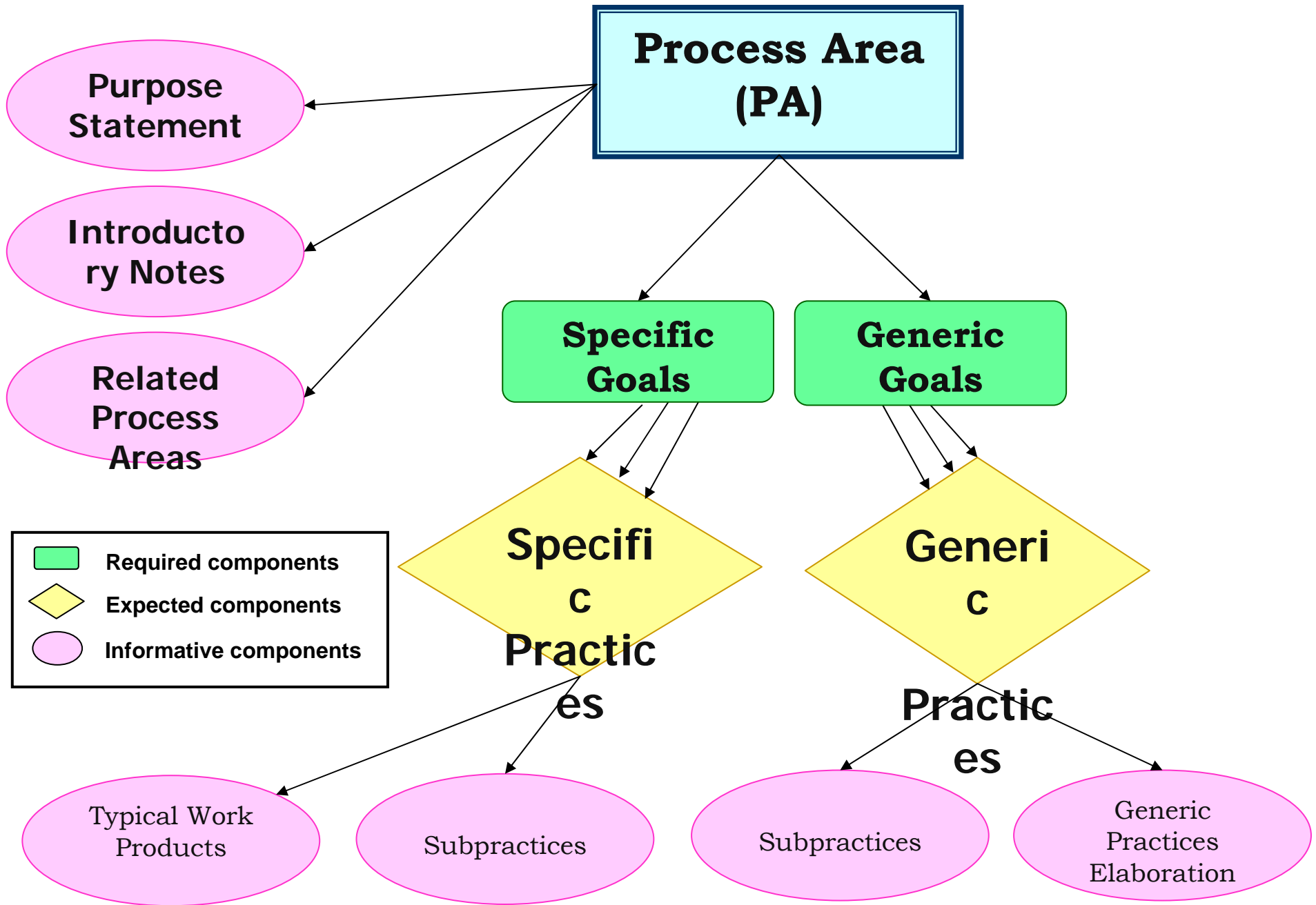


Fig. 1: CMMI v.1.2 Model Components [10]





Related works

1. An OWL Ontology for Representing the CMMI-SW Model [6]
2. Ontology-based Intelligent Decision Support Agent for CMMI Project Monitoring and Control [7]
3. The Appraisal Assistant Beta 3 [8]
4. CMMiPal 1.0 [9]



An OWL Ontology for Representing the CMMI-SW Model



Soydan & Kokar, International Workshop on Semantic Web Enabled Software Engineering (SWESE 2006), 2006.

- Developed an ontology of the capability maturity model, CMMI v.1.1
- Created based on OWL-DL specification
- Not sufficient for enabling a tool that can automatically identify what practices conform to CMMI and which are missing for the sake of an organization's maturity level assessment
- To extend the ontology that was developed by Soydan and Kokar [6]

Ontology-based Intelligent Decision Support - Agent for CMMI Project Monitoring and Control



Lee, Wang, Chen and Hsu, Fuzzy Information Processing Society, 2006.
NAFIPS 2006. Annual meeting of the North American

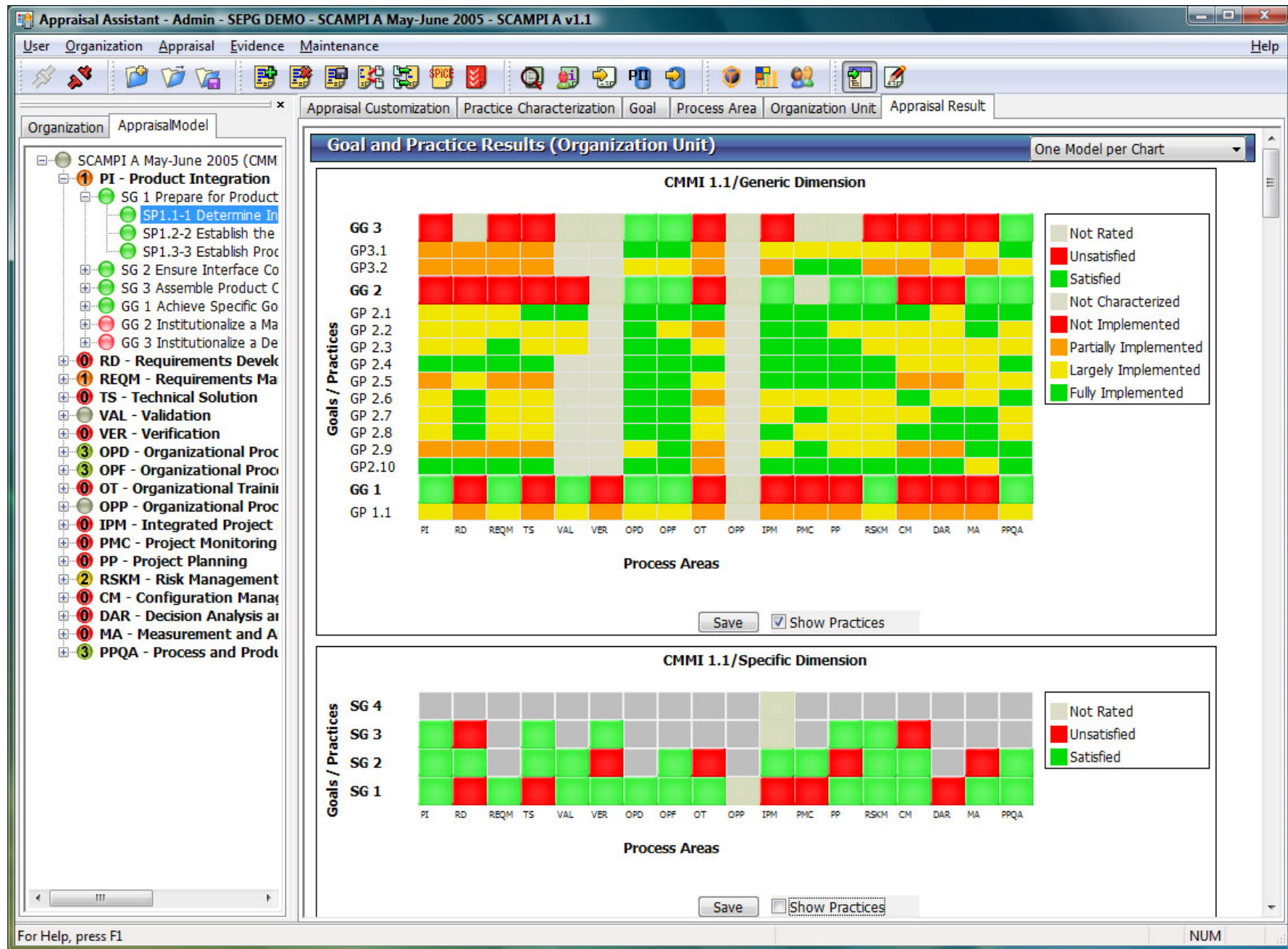
- Proposed an ontology-based intelligent decision support agent (OIDSA) for supporting CMMI *Project Monitoring and Control (PMC)* process area
- In their study, they only focused on CMMI Maturity Level 2 so their ontology only covers seven process areas referenced in CMMI model

The Appraisal Assistant Beta 3

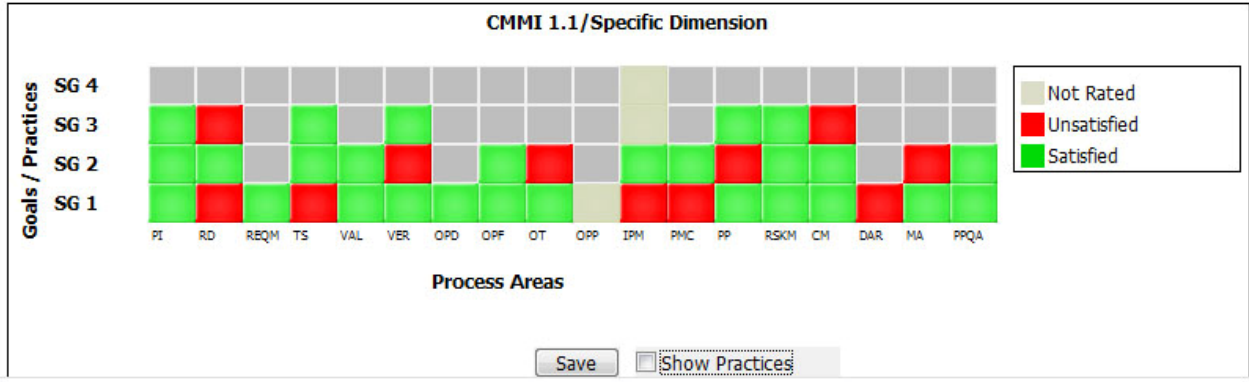
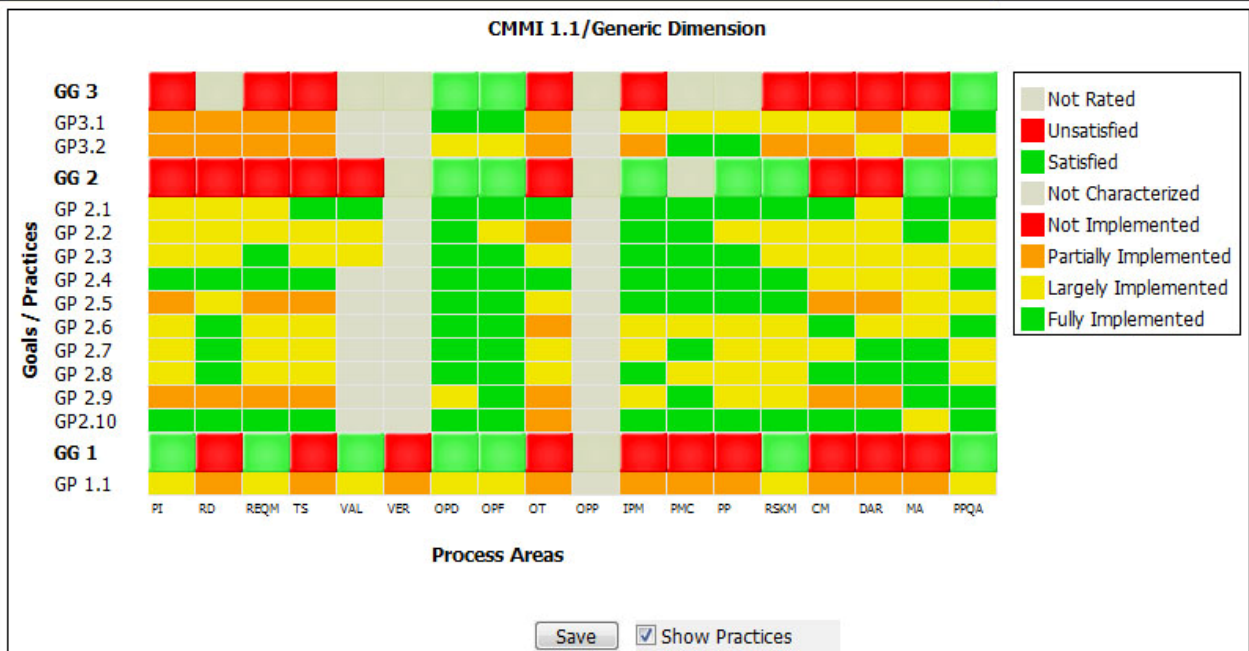


The Software Quality Institute, Griffith University. 2007

- To support the assessment and appraisal processes
- This tool can generate a variety of reports such as appraisal/assessment findings as well as strength/weakness summaries of an organization
- The appraisers still have to manually review many project assets and input a lot of information regarding those assets into the system, which is time-consuming



Goal and Practice Results (Organization Unit) One Model per Chart



CMMI appraisal result preview



CMMiPal 1.0

Chemuturi Consultants, India. 2007.

- Assists in mapping of CMMI requirements to organizations' processes and gap analysis
- CMMiPal facilitates in mapping organizational process assets to CMMI requirements (Goals, KPAs, Practices, Sub-Practices, & Work Products)
- Reports the gaps to be fulfilled
- The appraisers still have to manually review many project assets and input a lot of information regarding those assets into the system





Project Assets Ontology (PAO)

- PAO is built as an extension to the CMMI Ontology [6]
- Consists of 601 classes (173 classes of specific practices and 428 classes of typical work products)
- Five objects properties representing different relationships between those classes (i.e., *attains*, *satisfies*, *achieves*, *referTo*, *producedBy*)

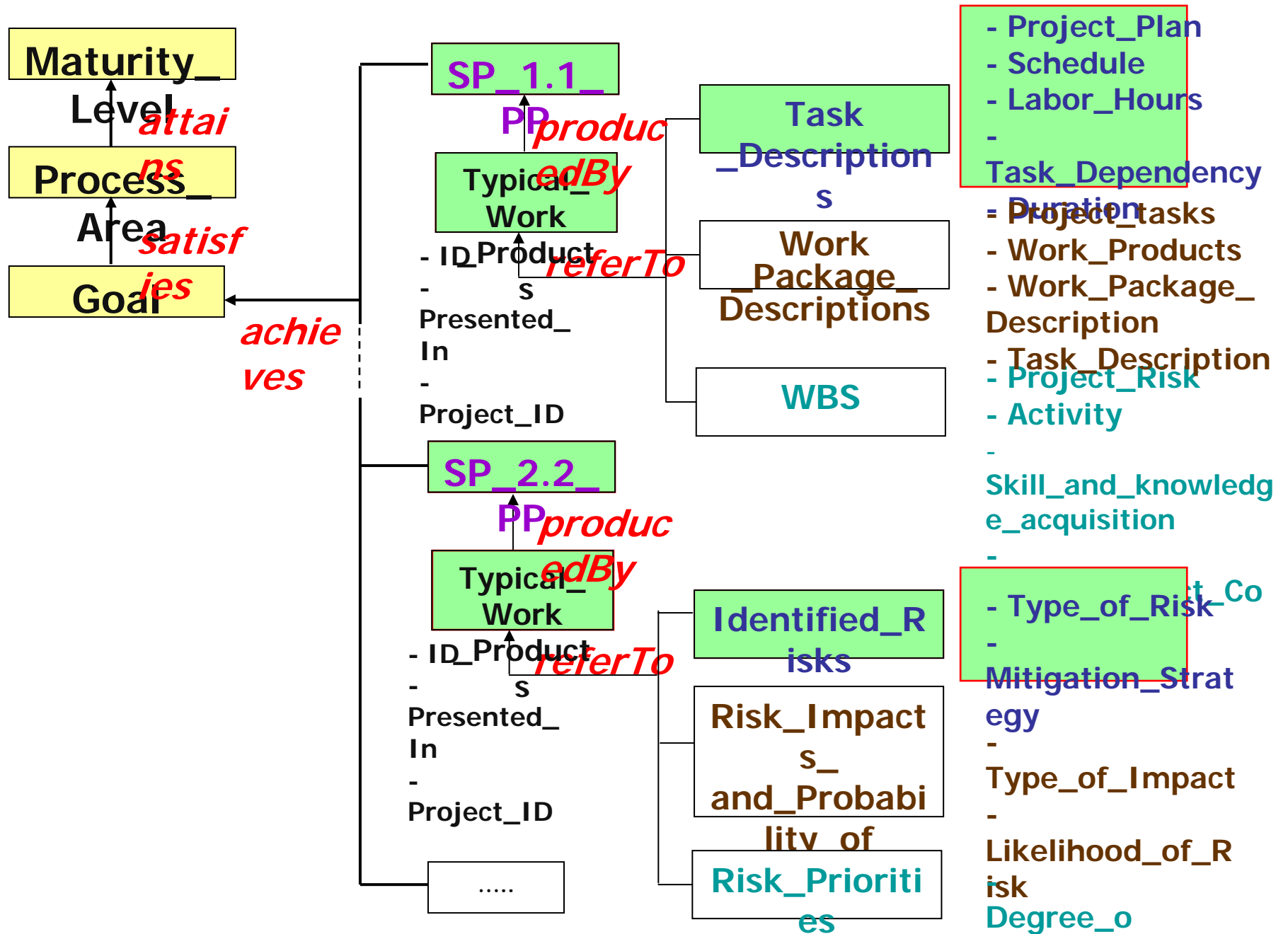


Fig. 2: Partial Example Project Assets Ontology (PAO)

Example of Partial PAO Ontology In OWL Description

```
1 <?xml version="1.0"?>
2     All required Name Space declaration go here.
3 <owl:Class rdf:ID="SP_1.1_PP">
4     <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
5         Specific Practice 1.1 for Project Planning based on CMMI v.1.2 </rdfs:comment>
6     <owl:equivalentClass rdf:resource="#CMMI_Ont/# SP_1.1_Estimate_the_Scope_of_the_Project"/>
7 </owl:Class>
8     ....
9 <owl:Class rdf:ID="SP_2.2_PP">
10    <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
11        Specific Practice 2.2 for Project Planning based on CMMI v.1.2 </rdfs:comment>
12    <owl:equivalentClass rdf:resource="#CMMI_Ont/#SP_2.2_Identify_Project_Risks"/>
13 </owl:Class>
14 <owl:Class rdf:ID="Typical_Work_Products"/>
15 <owl:Class rdf:ID="Task_Description"/>
16 <owl:ObjectProperty rdf:ID="producedBy">
17     <rdfs:comment rdf:datatype="&xsd:string">
18         This relationship specifies that a work product is an output from a specific practice. </rdfs:comment>
19     <rdfs:domain rdf:resource="#Typical_Work_Products "/>
20     <rdfs:range rdf:resource="#SP_2.2_PP"/>
21 </owl:ObjectProperty>
22 <owl:ObjectProperty rdf:ID="referTo">
23     <rdfs:comment rdf:datatype="&xsd:string">
24         This is a relationship between a Typical_Work_Products and a possible set of assets such as a task
25         description.
26     </rdfs:comment>
27     <rdfs:domain rdf:resource="#Risks_Identification "/>
28     <rdfs:range rdf:resource="#Typical_Work_Products"/>
29     ...
30 <owl:DatatypeProperty rdf:ID="ID">
31     <rdfs:domain rdf:resource="#Typical_Work_Products"/>
32     <rdfs:range rdf:resource="&xsd:string"/>
33 </owl:DatatypeProperty>
34 <owl:DatatypeProperty rdf:ID="PresentedIn">
35     <rdfs:domain rdf:resource="#Typical_Work_Products"/>
36     <rdfs:range rdf:resource="&xsd:string"/>
37 </owl:DatatypeProperty>
38 <owl:DatatypeProperty rdf:ID="Project_ID">
39     <rdfs:domain rdf:resource="#Typical_Work_Products"/>
40     <rdfs:range rdf:resource="&xsd:string"/>
41 </owl:DatatypeProperty>
42 <owl:DatatypeProperty rdf:ID="Type_of_Risk">
43     <rdfs:domain rdf:resource="#Risks_Identification"/>
44     <rdfs:range rdf:resource="&xsd:string"/>
```



PAO for CMMI Gap Analysis

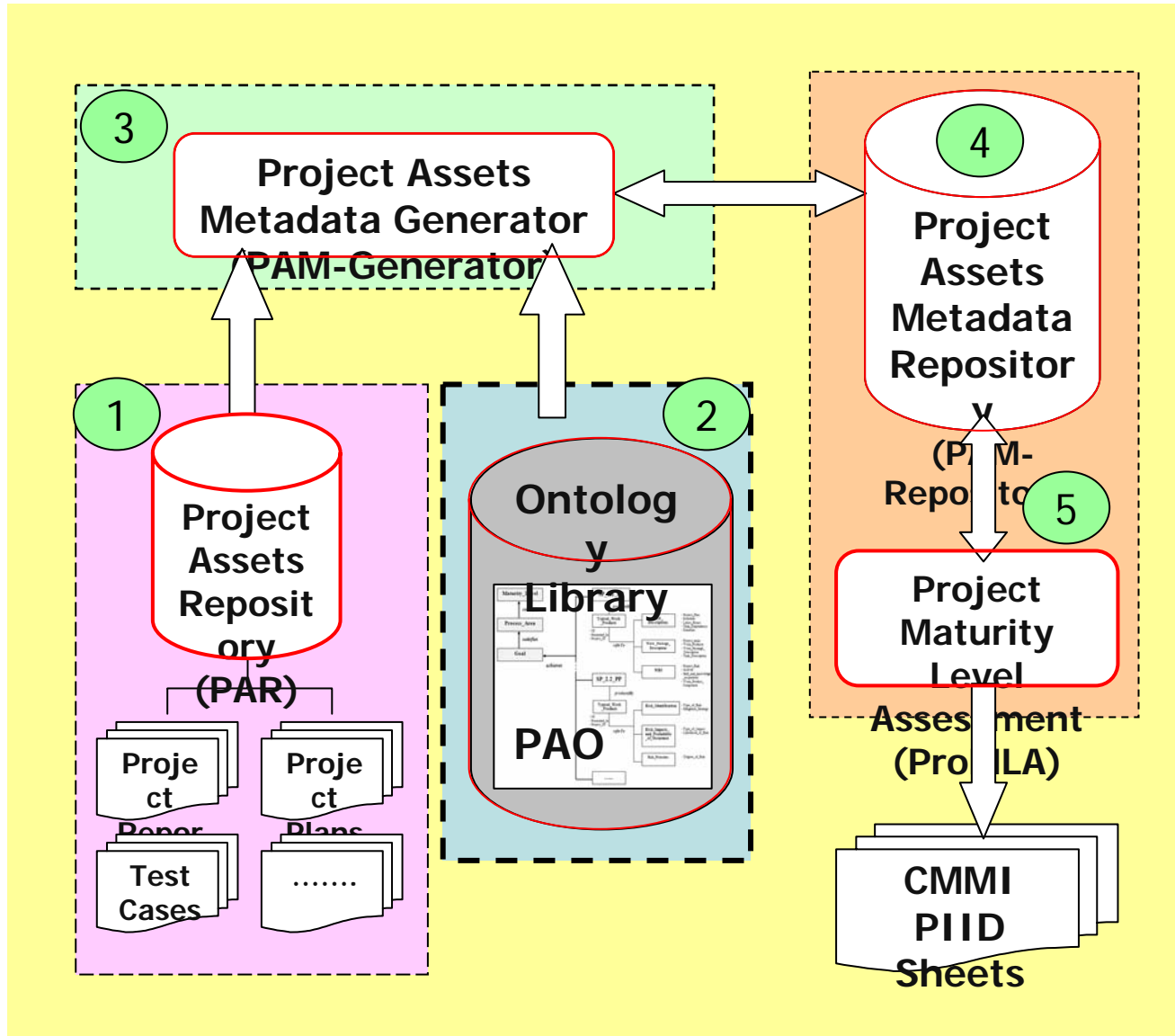


Fig.3: CMMI v.1.2 based Gap Analysis Assistant Framework (CMMI-GAAF)



PAM-Generator: generate metadata descriptions of assets

Initial Project Risk Assessment

+

Risk	Risk Level L/M/H	Likelihood of Event	Mitigation Strategy
Project Size			
Person Hours	H: Over 20,000	Certainty	Assigned Project Manager, engaged consultant, comprehensive project management approach and communications plan
Estimated Project Schedule	H: Over 12 months	Certainty	Created comprehensive project timeline with frequent baseline reviews
Team Size at Peak	H: Over 15 members	Certainty	Comprehensive communications plan, frequent meetings, tight project management oversight
Number of Interfaces to Existing Systems Affected	H: Over 3	Certainty	Develop interface control document immediately
Project Definition			
Narrow Knowledge Level of Users	M: Knowledgeable of user area only	Likely	Assigned Project Manager(s) to assess global implications
Available documentation clouds establishment of baseline	M: More than 75% complete/current	Likely	Balance of information to be gathered by consultant
Project Scope Creep	L: Scope generally defined, subject to revision	Unlikely	Scope initially defined in project plan, reviewed monthly by three groups (Project Manager and Steering Committee) to prevent undetected scope creep

Fig.4: A Portion of a Project Planning document (a Sample Project Asset)



Metadata description

```
1 <WP:Typical_Work_Product >
2   <WP:ID> Identify_Risks </WP:ID>
3   <WP:PresentedIn> Initial Project Risk Assessment.doc 4 </WP:PresentedIn>
4   <WP:Project_ID> </WP:Project_ID>
5   <WP:producedBy> SP_2.2_PP </WP:producedBy>
6   <WP:Risk_Assessment>
7     <WP:Type_of_Risk>Person_Hours</WP:Type_of_Risk>
8     <WP:Degree_of_Risk>Over 20,000</ WP:Degree_of_Risk>
9     <WP:Likelihood_of_Risk>Certainty</ WP:Likelihood_of_Risk>
10    <WP:Mitigation_Strategy>Assigned Project Manager, engaged 6 consultant,
11      comprehensive project management </ WP:Mitigation_Strategy >
12  </ WP:Risk_Assessment >
13  <WP:Risk_Assessment>
14    <WP:Type_of_Risk>Estimated Project Schedule</WP:Type_of_Risk >
15    <WP:Degree_of_Risk>Over 12 months</ WP:Degree_of_Risk>
16    <WP:Likelihood_of_Risk>Certainty</WP:Likelihood_of_Risk>
17    <WP:Mitigation_Strategy>Created comprehensive project timeline with
18      frequent baseline reviews </WP:Mitigation_Strategy >
19  </WP:Risk_Assessment >
20  ....
21 </WP:Typical_Work_Products>
```

The generated metadata description from PAM-Generator

Practice Implementation Indicator Description (PIID sheet)

Maturity Level	PA	SG1							SG2							SG3				
		SP1.1	SP1.2	SP1.3	SP1.4	SP1.5	SP1.6	SP1.7	SP2.1	SP2.2	SP2.3	SP2.4	SP2.5	SP2.6	SP2.7	SP3.1	SP3.2	SP3.3	SP3.4	SP3.5
5	OID	NA	NA	NA	NA				NA	NA	NA									
	CAR	NA	NA						NA	NA	NA									
4	OPP	NA	NA	NA	NA	NA														
	QPM	NA	NA	NA	NA				NA	NA	NA	NA								
3	RD	S	S						S	S	NA				S	S	NA	NA	NA	
	TS	S	S						S	S	S	S			S	S				
	PI	S	S	S					S	S					S	NA	NA	NA		
	VER	S	S	S					S	NA	NA				S	S				
	VAL	S	S	S					NA	NA										
	OPF	NA	S	S					S	S					S	S	NA	NA		
	OPD+IPPD	NA	S	S	S	S	S		S	NA	NA									
	OT	S	S	NA	S				S	S	NA									
	IPM+IPPD	S	S	S	S	S	S		S	NA	NA				S	NA	NA	NA	NA	
	RSKM	S	S	S					S	NA					NA	NA	NA			
	DAR	S	NA	NA	S	S	S													
2	REQM	S	S	S	S	S														
	PP	S	S	S	S				NA	S	NA	S	S	NA	S	S	NA			
	PMC	S	S	S	NA	NA	NA	NA	S	S	NA									
	SAM	S	S	S					S	S	S	NA	NA							
	MA	S	S	NA	NA				NA	S	S	S								
	PPQA	S	NA						S	S										
	CM	S	S	NA					S	S					NA	NA				

Fig. 5: Example of a resulting PIID Sheet





Conclusions

- Introduce an ontology called ***Project Assets Ontology (PAO)***
- Introduce ongoing work called ***CMMI v.1.2 based Gap Analysis Assistant Framework (CMMI-GAAF)***
- Illustrate how PAO can be applied in order to support an organization to conduct a gap analysis process more effectively to assess its Maturity level.

Future works



- Complete the implementation of the *CMMI-GAAF*
- Perform a number of experiments based on real project's work products
- Evaluate our framework based on the accuracy of the gap analysis findings



References (1 / 3)



- [1] Kulpa, K., Johnson, A.: Interpreting the CMMI: A Process Improvement Approach. Taylor & Francis, Abington (2003)
- [2] Loon, H.: Process Assessment and ISO/IEC 15504: A Reference Book. Springer, Heidelberg (2004)
- [3] Berauer, R.: The Use of Tailored Practice Implementation indicators for Process Definition and Assessment Preparation. In: National Defense Industrial Association 3rd Annual CMMI Technology Conference and User Group Denver, Colorado(2003)
- [4] CMMI Product Team: CMMI for Development Version 1.2: Improvement Processes for Better Products. Carnegie Mellon. Software Engineering Institute, USA (2006)

References (2 / 3)



- [5] Ontology, <http://en.wikipedia.org/wiki/Ontology>
- [6] Soydan, G., Kokar, M.: An OWL Ontology for Representing the CMMI-SW Model. In: International Workshop on Semantic Web Enabled Software Engineering (SWESE 2006), USA (2006)
- [7] Lee, C., Wang, M., Cheng, J., Hsu, C.: Ontology-based Intelligent Decision Support Agent for CMMI Project Monitoring and Control. In: Fuzzy Information Processing Society (NAFIPS 2006), IEEE Press, Canada (2006)
- [8] Software Quality Institute, Griffith University: The Appraisal Assistant Beta 3, <http://www.sqi.gu.edu.au/AppraisalAssistant/about.html>

References (3 / 3)



- [9] Chemuturi Consultants: CMMiPal 1.0: CMMiPal Description, <http://www.softpedia.com/get/Others/Finances-Business/CMMiPal.shtml>
- [10] Chrissis, M., Konrad, M., Shrum, S.: CMMI: Guidelines for Process Integration and Product Improvement. Addison-Wesley, New York (2007)
- [11] The World Wide Web Consortium (W3C): Web Ontology Language (OWL), <http://www.w3.org/2004/OWL>



Questions ?

Thank you