Software Quality Standards and Approaches from Ontological Point of View

Konstantina Georgieva
Otto-von-Guericke University Magdeburg
Department of Computer Science, Software Engineering Group
Outline

- Motivation
- Models
- Our Ontology
- Conclusion
The software industry is the main industry of this century.

This pervasive aspect of the software as a major new business factor

the establishment of new global demands for safety and quality

the need for international agreements on software quality assessment and assurance
Standards and Approaches

- **CMMI, SPICE** - frameworks for improvement of the development process and the resultant software quality

- **ISO 9001:2000** - assurance of the process by which a product is developed

- **ITIL** - the most widely accepted approach to information technology service management (ITSM)

- **ISO 12207** - common framework for the creation and managing of software

- **ISO 9126** - evaluation of the quality of the end product
What is an Ontology

Ontology - the basic categories and relationships of existence and entities and the connections btw them.

In computer and information science

“An ontology is a formal, explicit specification of a shared conceptualization.”

Ontology of software quality standards - represents the terminology, concepts and structures on the subject of quality with respect to software.
Process Improvement

“The act of changing a process to reduce variability and cycle time and make the process more effective, efficient and productive”

Bauer, Duffy & Westcott, p. 194

- **Business Process Reengineering (BPR)**
  - Very Radical; Focuses on core business processes

- **Benchmarking**
  - Find and implement best practices; The best practice usually come from another part of the organization.

- **Process Reengineering or Workflow Management**
  - Focuses on functions at the work place or at the flow of work

- **Reverse Engineering**
  - Finding out how a process works better based on the way it worked before

- **Model based process improvement**
  - Selects predetermined focus areas
CMMI

- Capability Maturity Model Integration developed by SEI as a process improvement framework that addresses three areas of application:
  - CMMI for Development
  - CMMI for Services
  - CMMI for Acquisition

- 22 Process Areas – required, expected and informative components
  - Goals- Generic and Specific (required components)
  - Practices- Generic and Specific (expected components)

- Types of representation: Staged and Continuous
  - Staged Representation – 5 Maturity Levels
    - Initial, Managed, Defined, Quantitatively Managed, Optimizing
  - Continuous Representation – 6 Capability Levels
    - Incomplete, Performed, Managed, Defined, Quantitatively Managed, Optimizing
Life-Cycle Relationships between CMMI Process Areas
| Primary Processes | Organizational Process Performance (OPP)  
GP 4.2 Stabilize Sub-process Performance  
Supplier Agreement Management (SAM)  
Requirement Management (REQM)  
Requirement Development (RD)  
Technical Solution (TS) |
| Supporting Processes | Configuration Management (CM)  
GP 2.6 Manage Configurations  
Process and Product Quality Assurance (PPQA)  
GP 2.9 Objectively Evaluate Adherence  
Validation (VAL)  
GP. 5.2 Correct Root Causes of Problems |
| Organizational Processes | Project Planning (PP)  
Project Monitoring and Control (PMC)  
Quantitative Project Management (QPM)  
GP 2.1 Establish an organizational policy  
GP 2.2 Plan the process  
GP 2.3 Provide Resources  
GP 2.4 Assign Responsibility  
GP 2.7 Identify and Involve Relevant Stakeholders  
GP 2.8 Monitor and Control the Processes  
GP 2.10 Review Status and Higher Level Management  
GP 3.2 Collect Improvement Information  
GP 4.1 Establish Quantitative Objectives for the Processes  
GP 2.5 Train People |
ISO 9001:2000

- Quality Management System
  - Includes organizational structure, people, processes, documentation and other resources applied to fulfill the requirements

- ISO Management Standards based on quality management principles
  - ISO 9000: fundamentals and vocabulary
  - ISO 9001: requirements
  - ISO 9004: guidelines for performance improvement
  - ISO 19011: guidelines for quality and environmental management system auditing

- ISO 9001:2000 Process Model
  - 5 Areas
  - 8 Principles

- Audit Standard
  - Benchmark for measurement of management system
  - External Audit: performed by certified body
  - Internal Audit: performed by staff trained for this purpose
ISO 9001:2000 Process Model

Continual Improvement of the Management System

- Continual Improvement
- Customer Focus
- Leadership
- Involvement of People
- Supplier Relationships
- Resource Management
- Management Responsibility
- Process Realization
- Measurement, Analysis & Improvement
- Product

INPUT

OUTPUT

CUSTOMERS

Satisfaction

Factual Decision Making

Konstantina Georgieva
University of Magdeburg
## ISO 9001:2000

<table>
<thead>
<tr>
<th>Category</th>
<th>Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Processes</strong></td>
<td>Design and development (7.3)</td>
</tr>
<tr>
<td></td>
<td>Purchasing (7.4)</td>
</tr>
<tr>
<td></td>
<td>Customer-related processes (7.2)</td>
</tr>
<tr>
<td><strong>Supporting Processes</strong></td>
<td>Document Control (5.5.6)</td>
</tr>
<tr>
<td></td>
<td>Validation for processes for production and service provision (7.5.2)</td>
</tr>
<tr>
<td></td>
<td>Internal Communication (5.5.3)</td>
</tr>
<tr>
<td></td>
<td>Design and development validation (7.3.4)</td>
</tr>
<tr>
<td></td>
<td>Design and development verification (7.3.6)</td>
</tr>
<tr>
<td></td>
<td>Internal audits (8.2)</td>
</tr>
<tr>
<td></td>
<td>Control of measuring and monitoring devices (7.6)</td>
</tr>
<tr>
<td><strong>Organizational Processes</strong></td>
<td>Planning of product realization (7.1)</td>
</tr>
<tr>
<td></td>
<td>Infrastructure (6.3)</td>
</tr>
<tr>
<td></td>
<td>Improvement (8.5)</td>
</tr>
<tr>
<td></td>
<td>Competence, awareness and training (6.2.2)</td>
</tr>
</tbody>
</table>
Information Technology Infrastructure Library

- United Kingdom’s Office of Government Commerce
- The concept of ITSM (Information Technology Service Management)
- Guidance on all aspects of Service Management: people, processes, products and partners

ITIL Framework

- Areas: Service Management, Information Communication Technology, Planning to implement, Business Perspective and Application Management
- ITSM: Service Delivery and Service Support
  - Service Delivery: processes related to the planning and delivering of IT services in the long term
  - Service Support: processes related to the support of IT services in the short term
ITIL: Framework
| ITIL |
|-----------------|-------------------|
| **Primary Processes** | **Supporting Processes** |
| Service Portfolio Management | Risk Management |
| Financial Management | Availability Management |
| Problem Management | IT Security Management |
| IT Operations Management | Compliance Management |
| Project Management | IT Architecture Management |
| Release and Deployment Management | Change Management |
| | Service Validation and Testing |
| | Application Development and Customization |
| | Knowledge Management |
| **Organizational Processes** | **Event & Incident Management** |
| | Request Fulfillment |
| | Access Management |
| | Capacity Management |
| | Supplier Management |
| | Service & Process Evaluation |

Konstantina Georgieva  
University of Magdeburg
Software Process Improvement and Capability dEtermination (SPICE)

SPICE Process Model
- Processes for Acquisition, Supply, Development, Operation, Evolvement, and Support of Software
- 40 Processes defined by base and generic practices
- Process Categories: organizational, management, engineering, customer-supplier and support processes

SPICE Capability Levels:
0. Incomplete Process
   1. Performed Process
      2. Managed Process
         3. Established Process
            4. Predictable Process
               5. Optimizing Process
SPICE: Process Model

Organizational life-cycle processes
- ORG. 1 Organizational alignment
- ORG. 2 Improvement Processes
  - ORG. 2.1 Process establishment
  - ORG. 2.2 Process assessment
  - ORG. 2.3 Process improvement
- ORG. 3 Human Resource Management
- ORG. 4 Infrastructure
- ORG. 5 Measurement
- ORG. 6 Reuse

Primary life-cycle processes
- Engineering process category
  - ENG. 1 Development
    - ENG. 1.1 System requirements analysis and design
  - ENG. 1.2 Software requirements analysis
  - ENG. 1.3 Software design
  - ENG. 1.4 Software construction
  - ENG. 1.5 Software integration
  - ENG. 1.6 Software testing
  - ENG. 1.7 Software integration and testing
  - ENG. 2 System and software maintenance

Supporting life-cycle processes
- Support process category
  - SUP. 1 Documentation
  - SUP. 2 Configuration management
  - SUP. 3 Quality assurance
  - SUP. 4 Verification
  - SUP. 5 Validation
  - SUP. 6 Joint review
  - SUP. 7 Audit
  - SUP. 8 Problem resolution

Konstantina Georgieva
University of Magdeburg
| **Primary Processes** | CUS 1 Acquisition Process  
CUS 2 Supply Process  
CUS 3. Requirements elicitation  
CUS 4 Operational Use Process  
ENG 1 Development Process  
ENG 1.1, 1.2 System and Software requirements analysis and design  
ENG 1.3 Software design process  
ENG 1.4, 1.5 Software Construction and Integration process  
ENG 1.6 Software Testing Process  
ENG 1.7 System Integration and Testing Process  
ENG 2 System and software maintenance process |
| **Supporting Processes** | SUP 1 Documentation process  
SUP 2 Configuration management process  
SUP 3 Quality assurance process  
SUP 4,5 Verification and Validation process  
SUP 6 Joint review process  
SUP 7 Audit process  
SUP 8 Problem resolution process |
| **Organizational Processes** | MAN 1 Management process  
MAN 3 Quality management process  
MAN 4 Risk management process  
ORG 1 Infrastructure Processes  
ORG 2 Improvement Processes  
ORG 3 Human resource management process  
ORG 5 Measurement and ORG 6 Reuse Processes |
ISO 12207

- ISO 12207: a common framework for software practitioners to create and manage software

- Reference Model: describes *what* needs to be done not *how*

- ISO 12207 Process Model
  - Primary Life-cycle Processes
  - Supporting Life-cycle Processes
  - Organizational Life-cycle Processes
ISO 12207: Process Model

Organizational life-cycle processes
Part 7

- 7.1 Management
- 7.2 Infrastructure
- 7.3 Improvement
- 7.4 Training

Primary life-cycle processes
Part 5

- 5.1 Acquisition
- 5.2 Supply
- 5.3 Development
- 5.4 Operation
- 5.5 Maintenance

Supporting life-cycle processes
Part 6

- 6.1 Documentation
- 6.2 Configuration Management
- 6.3 Quality Assurance
- 6.4 Verification
- 6.5 Validation
- 6.6 Joint Review
- 6.7 Audit
- 6.8 Problem Resolution
ISO 9126

- ISO 9126: Evaluation of Software Products
- Quality in the Life-Cycle
  - Process quality, Software Product Quality and Quality in Use
- Six Characteristics of quality:
  1. Functionality
  2. Reliability
  3. Usability
  4. Efficiency
  5. Maintainability
  6. Portability
| ISO 12207 and ISO 9126 | Supply  
|------------------------|--------------------------------------------------|
| **Primary Processes**  | Development (1 internal, 114 external and 12 quality in use metrics)  
|                        | Operation (93 external and 15 quality in use metrics)  
|                        | Maintenance (48 external metrics)                   |
| **Supporting Processes** | Documentation  
|                        | Configuration Management  
|                        | Quality Assurance (1 internal, 14 external metrics)  
|                        | Verification (59 internal metrics)  
|                        | Validation (13 internal, 47 external and 11 quality in use metrics)  
|                        | Audit  
|                        | Joint Review (59 internal metrics)  
|                        | Problem Resolution (4 internal, 1 external metrics)  |
| **Organizational Processes** | Management  
|                        | Infrastructure  
|                        | Improvement  
|                        | Training  

Konstantina Georgieva  
University of Magdeburg  
22/27
## Similarities in the process models

<table>
<thead>
<tr>
<th>Component Model</th>
<th>Sub-system</th>
<th>Category</th>
<th>Process</th>
<th>Sub-Process</th>
<th>Practice</th>
<th>Process Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMMI</td>
<td>Category</td>
<td>Process Area</td>
<td>Specific Goal</td>
<td>Specific Practice</td>
<td>Process Attribute</td>
<td></td>
</tr>
<tr>
<td>SPICE</td>
<td>Category</td>
<td>Process</td>
<td>Component Process</td>
<td>Base Practice</td>
<td>Process Attribute</td>
<td></td>
</tr>
<tr>
<td>ISO 9001:2000</td>
<td>Sub-system</td>
<td>Main topic area</td>
<td>Management Issue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 12207</td>
<td>Category</td>
<td>Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 9126</td>
<td>Category from ISO12207</td>
<td>Process from ISO 12207</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion and Future Work

Conclusions:

- All standards deal with the same type of software quality: process quality.
- All standards are reference models, which use the same type of process improvement approach: model-based process improvement.
- The Software Process Ontology serves as a comparison between the structures of the standards.

Future Work:

- Improving the Software Process Ontology: increasing its level of specification and adding more standards to its structure.
- Mapping between the standards
Thank You
for
Your attention!
References


ISO. *ISO 12207 International Standard: IT Software Lifecycle Processes*.

ISO/IEC. *ISO 15504- SPICE Software Process Assessment, Part 1 Introductory Notes*.

