Framework for Capability and Maturity Evaluation of Service-oriented Enterprise Architectures

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Abstract – SOAMMI - a new framework for evaluating capabilities for change of enterprise and service-oriented software architectures is introduced. Current approaches for assessing maturity of software architectures are intuitively developed, having sparse metamodel foundation and being hardly validated. This is a real problem because enterprise and software architects should know what the successful path for introducing and change of service-oriented enterprise architectures is. Our innovation key is to extend existing SOA maturity models to accord to a clear metamodel approach based on the well understood and standardized CMMI model, which is originally used to assess software processes and not architectures. Our specific architecture capability evaluation approach is the result of a metamodel-based synthesis and conception and was founded on the current TOGAF standard for enterprise architectures. Our maturity framework was applied in consecutive assessment workshops with global vendors of service-oriented platforms. Ongoing validations of SOAMMI and framework improvements provide an additional base for future extensions on architecture diagnostics, prognostics and simulations.

Keywords - SOAMMI, SOA, CMMI, TOGAF, service-oriented architecture, enterprise architecture, capability and maturity diagnostic, assessment, architecture maturity, metamodel integration, maturity framework

1 INTRODUCTION

Innovation oriented companies have introduced in recent time SOA (service-oriented architectures) to assist in closing the business and IT gap by delivering efficiently appropriate business functionality and integrating legacy systems and standard application platforms. Our approach of investigating the SOA ability of standard platforms in practical use [Buckow, et al. 2010] assembles elements from convergent architecture methods and technologies like EA (enterprise architecture), SOA (service-oriented architecture), and packaged based standard software applications. The hypothesis of our research [Zimmermann 2009] is as follows: CMMI [CMMI 2006] is a suitable framework to assess software processes - nevertheless CMMI can be extended to evaluate capabilities for change of enterprise and service-oriented architectures.

TOGAF as the current standard [TOGAF 2009] for enterprise architecture provides the basic blueprint and structure for our architecture domains: Architecture Strategy and Management, Business Architecture, Information Architecture, Application Architecture, Technology Architecture, Service & Operation Architecture, and Architecture Realization.

The ACMM framework is included in TOGAF and was originally developed by the US Department of Commerce. The main scope of ACMM [ACMM 2007] is the evaluation of enterprise architectures in internal enterprise architecture assessments. The goal of ACCM assessments is, to enhance enterprise architectures, identifying quantitatively weak areas and to follow an improvement path for specific identified gaps of the assessed architecture. The ACMM framework consists of six maturity levels and nine specific architecture elements ranked for each maturity level. Following maturity levels provide the basic part of the model and define – deviant from CMMI - different degrees of the analyzed architecture capability and maturity:

- Level 0: None
- Level 1: Initial
- Level 2: Under Development
- Level 3: Defined
- Level 4: Managed
- Level 5: Measured.

Service-oriented architecture (SOA) is the computing paradigm that utilizes services as fundamental flexible and interoperable building blocks for both structuring the business and for developing applications. SOA promotes a business oriented architecture style, based on best of breed technology of agnostic business services, and delivered by applications in a business focused granularity. A basic positioning into fundamental SOA concepts, technologies and case studies is offered by [Erl 2005] and for SOA-aspects on Enterprise Application Integration in [Krafzig, et al. 2005]. To provide agile composition of services within the worldwide environment and to enable flexible integration of published and discovered components, SOA uses a set of XML-based standards like WSDL, SOAP, UDDI and others. A main innovation introduced by SOA is that business processes are not only modeled but consistently used within a model-driven architecture-approach [MDA 2003] to generate new and agile orchestrations or compositions of web services based on process diagrams. Early definitions of SOA were technology-focused and the differences between SOA and web services were often blurred. SOA Technologies emerged due to the expansion of the Internet technology during last years and produced an abundance set of specifications and standards developed by open standard organizations like W3C, OMG, OASIS, and The Open Group.

In the following Section 2 we provide our model synthesis for SOAMMI - SOA Maturity Model Integration - by assembling and shifting previous elements into our conceptual model for architecture maturity diagnostics. We finish in Section 3 with conclusions and validation results from assessments and present some idea on future work.

2 SOAMMI – SOA ARCHITECTURE MATURITY FRAMEWORK

2.1 Requirements

Main requirements for our SOAMMI Maturity Framework concern a clear metamodel-based integration of analyzed models, frameworks and architecture standards. Based on these elements we have to synthesize our capability evaluation framework using a metamodel integration approach. The result of this integration should be a framework for investigating change opportunities in service-oriented enterprise and software architectures including the added value check of SOA in heterogeneous environments.

The SOA maturity of a vendor platform should be evaluated in the context of real case scenarios of applying and using SOA in practical use and integrate SOA solutions with standard and legacy applications. Beside of getting a differentiated diagnosis of the SOA maturity, a scenario-based path for systematic improvements of the enterprise and service-oriented software architecture should be determined. This improvement information should provide information on how these integration architectures looks like in the context of future organizational and technical integration capabilities.

The key question is - how the SOA approach can help to achieve agility, when changing business strategy, partners, products, services, business processes, actors and organizations, and how to maintain flexibility over the long term life cycle of application families, due to system maintenance or replacement by other applications and services.

2.2 Metamodel of SOAMMI

We have integrated specific analysis views using a consistent meta-model approach, which is based on correlation analysis of intrinsic model elements. Therefore we have transformed CMMI [CMMI 2006] from a primal assessment framework for software processes, into a specific framework [Zimmermann 2009] to diagnose systematically the maturity of enterprise and software architectures.

Our maturity assessment approach was done basically from the customer's perspective, having experience from specific business domains and analyzing SOA vendor products for heterogeneous environments of legacy and standard applications. Hereby we have used assessment criteria, maturity domains, architecture capabilities, and level rankings from state of art SOA maturity models [ACMM 2009], [Inaganti/Aravamudan 2007], [Sonic 2009], [ORACLE 2009]. Additionally we have selected for our architecture maturity model specific architecture elements [TOGAF 2009] and [essential 2009].

Our architecture maturity framework SOAMMI introduces new architecture areas and organizes them within extended architecture domains, which are mainly based on TOGAF. Our intention was to leave most parts of the original CMMI metamodel untouched and to extend CMMI logic quiet carefully.

The metamodel of SOAMMI (Figure 1) has similarities with the CMMI metamodel and defines additionally specific elements of our architecture evaluation purpose.

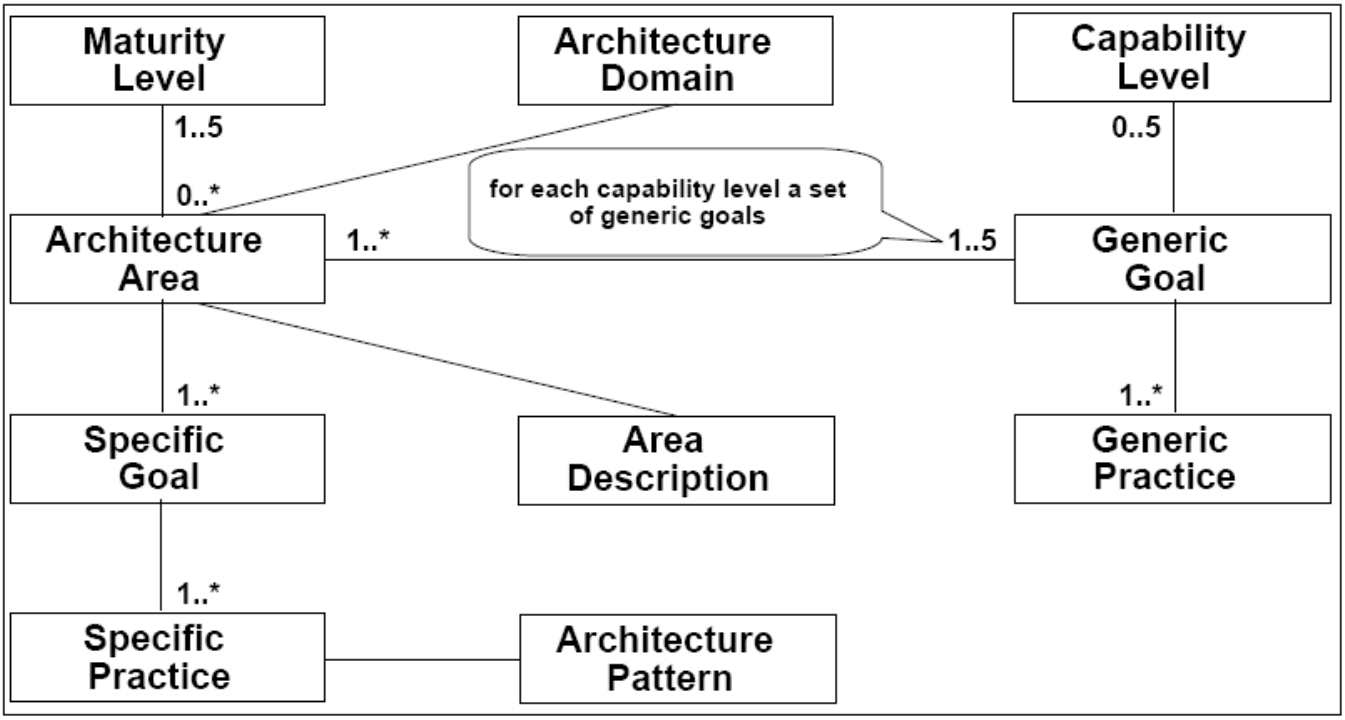

Figure 1: Element Types of SOAMMI

2.3 Maturity Levels

The following maturity levels (Figure 2) are used to measure the architecture maturity of vendor products in respect to requirements from customer-oriented domain models:

- Maturity Level 1: initial
- Maturity Level 2: managed
- Maturity Level 3: defined
- Maturity Level 4: quantitatively managed
- Maturity Level 5: optimizing.

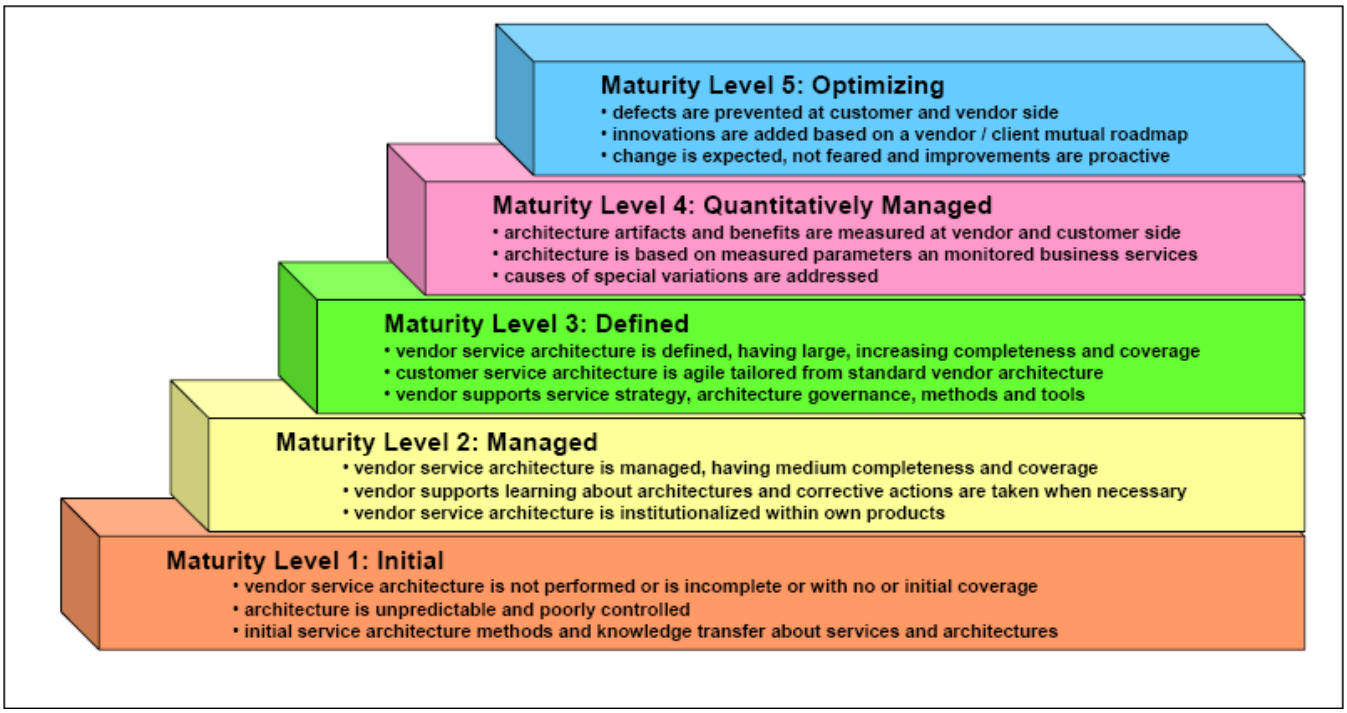

Figure 2: SOAMMI Architecture Maturity Levels

Almost all of this maturity levels correlate to capability levels from the continuous representation. Like in CMMI - there is no maturity level 0 for the staged representation:

2.4 Architecture Domains

Architecture domains were derived mainly from [TOGAF 2009], where they are used as specific architecture subtypes and corresponding phases of the ADM (Architecture Development Method). The top level structure of SOAMMI is organized by the following architecture domains:

- Architecture Strategy and Management
- Business Architecture
- Information Architecture
- Application Architecture
- Technology Architecture
- Service & Operation Architecture
- Architecture Realization.

2.5 Architecture Areas

Architecture areas are correspondent parts of process areas from CMMI. In Figure 3 we define the 22 specific architecture areas of SOAMMI – fitting our architecture diagnostic scope, but different from CMMI – and structure them according to standard architecture maturity levels and according to the mentioned architecture domains. Each architecture area is accurately described by a name and a short identification.

Maturity Level	Architecture Domain	Architecture Area	ID
5: Optimizing	Architecture Strategy & Management Architecture Strategy & Management	Architecture Innovation a. Dev. Causal Analysis and Resolution	AID CAR
4: Quantitatively Managed	Architecture Strategy & Management Architecture Strategy & Management	Organizational Perf. Monitoring Quantitative Archi. Management	OPM QAM
3: Defined	Architecture Strategy & Management Architecture Strategy & Management Architecture Strategy & Management Business Architecture Business Architecture Information Architecture Service & Operation Architecture Architecture Realization	Enterprise Arch. Management Architecture Req. Development Architecture Governance Business Capabilities & Services Business Products & Services Business Information Alignment Service Design & Transition Architecture Contracts	EAM ARD GOV BCS BPS BIA SDT ACO
2: Managed	Architecture Strategy & Management Business Architecture Business Architecture Information Architecture Information Architecture Application Architecture Application Architecture Technology Architecture Technology Architecture Architecture Realization	Requirements Management Business Domains & Capabilities Business Processes & Rules Data Entities & Components Business Objects System Services & Capabilities System Domains Platform Services Technology Services & Capabilities Architecture Standards & Compliance	ARM BDC BPR DEC BOB SSC SDO PFS TSC ASC
1: Initial			

Figure 3: SOAMMI Architecture Areas and Maturity Levels

2.6 Architecture Capability and Maturity

SOAMMI supports both the staged representation and the continuous representations. The same staging rules as in CMMI apply to SOAMMI and should therefore enable the flexible adoption of both model representations: continuous for assessing single architecture areas and staged for assessing the whole architecture. Similar to CMMI is the continuous representation of SOAMMI, which uses levels to denote the capability and the incrementally improvement path for specific architecture areas. The assessment of capability levels could be applied to iterate specific architecture areas or to assess or improve a focused innovation aspect, involving one ore more architecture areas. To verify and support the persistent institutionalization of architecture areas we have introduced in the SOAMMI framework generic goals and practices. All architecture areas are affected by the same generic goals and associated generic practices. Therefore we have defined the following generic goals and generic practices for SOAMMI:

- GG 1: Achieve all Specific Goals
  - GP 1.1: Perform Base Practices on Architecture
- GG 2: Institutionalize a Managed Architecture
  - GP 2.1: Establish an Organizational Policy for Architectures
  - GP 2.2: Plan the Architecture
  - GP 2.3: Provide Resources for the Architecture
  - GP 2.4: Assign Responsibility for different Architecture Area
  - GP 2.5: Train People
  - GP 2.6: Manage Architecture Configurations
  - GP 2.7: Identify and Involve Relevant Stakeholders
  - GP 2.8: Monitor and Control the Architecture
  - GP 2.9: Evaluate Architecture Compliance
  - GP 2.10: Review Architecture Status
- GG 3: Institutionalize a Defined Architecture
  - GP3.1: Establish a Defined Architecture
  - GP3.2: Collect Improvement Information for the Architecture
- GG 4: Institutionalize a Quantitatively managed Architecture
  - GP 4.1: Establish Quantitative Objectives for the Architecture
  - GP 4.2: Stabilize Architecture Variants
- GG 5: Institutionalize an Optimizing Architecture
  - GP 5.1: Ensure Continuous Architecture Improvement
  - GP 5.2: Correct Root Causes of Problems of Architecture.

3 CONCLUSIONS

A new method for evaluating capabilities of enterprise and service-oriented architectures has been introduced. In this paper we have motivated the necessity to extend existing SOA maturity models to accord to a clear metamodel approach due to the well understood und verified CMMI model. Based on the related work to CMMI, which is an assessment and improvement model for software processes, we have integrated suitable models for the evaluation of SOA capability and maturity. Our specific architecture evaluation approach from the SOAMMI framework was founded on the current TOGAF standard for enterprise architectures. SOAMMI – The SOA Maturity Model Integration – is the result of a metamodel-based conception and synthesis to provide a sound base for practical evaluations of service-oriented standard platforms in heterogeneous environments. A SOAMMI-dashboard was developed to support practical assessment processes, which were aligned both with the SCAMPI process for CMMI and with empirical questionnaire and interview methods. The presented SOAMMI framework was applied in consecutive assessment workshops with two global vendors of service-oriented platforms and provided transparent results for subsequent change processes. Our empirical validation and framework improvement is an ongoing process, which has to be synchronized with future cyclic evaluations of SOA platforms and their growing number of services. Extended validations of customers of service-oriented technologies are planned for the next phase on framework research and development. A forward-looking idea of model generalization is to extend the architecture areas and to provide separable views for architecture maturity diagnostics of vendor architectures, customer's abilities to handle application architectures, and for suppliers of integration technologies and solutions. Future work respects conceptual work on both static and dynamic architecture complexity, and in connecting architecture diagnostic procedures with prognostic processes on architecture maturity and on simulation of enterprise and software architectures.

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