CMMI EVALUATION

CAPABILITY MATURITY MODEL INTEGRATION MAPPING TO ISO/IEC 15504-2:1998

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1 Introduction and Purpose

This document presents the results of an analysis of the compatibility of the representations of the Capability Maturity Model Integration to ISO/IEC 15504-2:1998 - *Software Process Assessment - Part 2: A Reference Model for Processes and Process Capability*. The analysis was performed by the Software Quality Institute under the terms of the contract with the Defence Materiel Organisation, to support the evaluation of the suitability of the CMMI for use by the Australian Defence Department in managing the acquisition of software intensive systems. The report and its attachments comprise deliverables 1, 2 and 3 of Phase 1 of the Contract between DMO and Griffith University.

This document incorporates a brief introduction to the project, and provides details of the rationale and significance of the analysis of compatibility. It also gives an outline of the approach taken in conducting the mapping of the CMMI Representations to ISO 15504-2. The detailed mappings are contained in the attached Excel Workbooks, SQI-CMMI-P1-D1.xls (continuous) and SQI-CMMI-P1-D2.xls (Staged). The initial mapping was performed against Release 1.0 of the CMMI Continuous Model; in some instances, reference was made to Release 1.02 to clarify unresolved issues, and in general, no evidence has been found that Release 1.02 contains any significantly different mapping outcomes. Release 1.02 of the Staged Representation was used to confirm mappings to the staged model. The mapping covers only the systems and software engineering aspects of CMMI; no attempt has been made to address the Integrated Product and Process Development (IPPD) features, or the draft Software Acquisition extension.

As part of the Defence Materiel Organisation (DMO) Software Acquisition Reform program the Directorate of Software Acquisition Reform (DSWAR – now Directorate of Systems Engineering and Software Acquisition Management – DSE&SAM) is considering approaches for evaluating potential contractor's systems and software engineering process maturity. The DMO is considering using process maturity evaluation as a means of determining a tenderer's ability to satisfactorily deliver Major Capital Equipment development projects. In addition to process maturity, other factors such as demonstrated domain expertise and past project performance can also be taken into consideration. Assessments can therefore be used to support objectively informed source selection decisions. Weaknesses identified in a preferred tenderer's processes can also be made subject to a contractually agreed improvement program to mitigate the associated development risk.

DSWAR research conducted on capability models and assessment methods has identified the Software Engineering Institute's (SEI's) Capability Maturity Model Integration (CMMI) as providing potentially suitable candidate models for DMO use. These models effectively integrate both the software and systems engineering processes applicable to development of defence technologies. They can ascertain a potential contractor's systems and software engineering process maturity in a single assessment, avoiding the need for multiple assessments necessary if separate models are used. However, DSWAR research indicates the potential cost of CMMI assessor certification would be an impediment to Australian industry embarking on internal process improvement to meet defence (yet to be) identified capability maturity policy.

The CMMI Project is a collaborative effort sponsored by the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD/AT&L), and the National Defence Industrial Association (NDIA), with participation by government, industry, and the Software Engineering Institute (SEI). The project's objective is to develop a product suite that provides industry and government with a set of integrated products to support process and product improvement for systems engineering, software engineering and integrated product and process development. Details of the aims and conduct of the CMMI Development Project can be found at http://www.sei.cmu.edu/cmmi/. The intent is for the CMMI models to eventually replace existing Capability Maturity Models, including SW-CMM, SE-CMM (EIA IS

731) and IPD-CMM. The plan is that such replacement would take place two years after the full release of the CMMI Product Suite currently scheduled for early 2002.

Griffith University, through the Software Quality Institute, has been contracted to undertake an evaluation of the suitability of the CMMI process models as a basis for process assessment in the Australian context. In particular, in order to address DAO needs and industry concerns relating to assessor training and certification the objectives underlying this project are:

1. to evaluate the suitability of the CMMI as a tool for evaluating the systems and software engineering process maturity of defence contractors; and
2. to ascertain whether a ISO 15504 compliant appraisal/translation method, can be adapted for use with the CMMI model.

2 Rationale

The increasing adoption of process assessment, both for internal process improvement and as a technique useful in supplier selection and management, led to the development of the emerging international standard for software process assessment, ISO/IEC TR 15504. This standard establishes a framework for process assessment employing any process model that is compatible with the defined reference model, allowing for the expression of results based upon different models to be expressed in the same terms. ISO 15504 contains requirements that permit models to be constructed for the purposes of assessment that will be compatible with the Reference Model. These requirements are expressed in the following terms:

Purpose

A model must be based on good software engineering and process management principles and be suitable for the purpose of assessing software process capability. There are many different types of modelling techniques available for describing, specifying and enacting processes. Models that have not been specifically developed for the purpose of process assessment will not yield reliable results.

Scope

A model must address all or a continuous subset of the levels (starting at level 1) of the capability dimension of the reference model for all of the processes within its scope. Since each level includes all the attributes of lower levels, any model must start from Level 1. However, the model may only cover part of the scale - for example, from Level 1 to Level 3. The scope of coverage in the terms of both the process and capability dimensions of the reference model must be declared.

Model elements and indicators

The basic elements of the model must address the purposes of all the processes in the model, and the achievement of all the process attributes. The model elements must be shown to include indicators of both process performance and capability; this will enable judgments of process capability to be soundly based on objective evidence.

Mapping

The fundamental elements of the model must be mapped to the fundamental elements of the Reference Model; the assessor has to have access to the details of the mapping of the elements of the model to the reference model. The mapping must be complete, clear and unambiguous; such mapping helps to substantiate the claims of scope of coverage of the model. The mapping may be simple, as is the case in the embedded assessment model contained in ISO 15504-5; however, where the structure of the model is significantly different from the reference model, the mapping may be quite complex.

Translation

> A compatible model must provide a formal and verifiable mechanism for converting data collected against the model into a set of process attribute ratings for each Reference Model process directly or indirectly assessed. The mechanism for translation may be manual, or computer based. It may require the inclusion of additional information collected during the assessment. It may involve further judgment on the part of the assessor. The rules for translating the results should be clear and unambiguous, and are to be provided by the model developer.

Thus, all models that meet the requirements for compatibility should be able to provide results in the form of Process Profiles as defined in the Standard: a set of process attribute ratings for each instance of each process assessed. Compatibility of an assessment model to the Process Reference Model of ISO 15504-2 must be established to confirm the suitability of the model for use in performing process assessments conformant with ISO 15504. This is a significant issue for any acquisition agency wishing to consider capability-related issues in supplier management, as it allows suppliers to maintain their own desired approach to assessment, reporting results as common profiles. A principal goal of the CMMI Project is to establish compatibility with the international standard for software process assessment.

A proposal to revise ISO 15504 has been accepted by the Software Engineering Standards Committee, and this work is now in progress. A key revision principle is to extend the assessment approach to include other domains beyond the processes of the software life cycle. This is to be achieved through the removal of the Process Reference Model from the scope of the Standard, with reliance placed on external sources for the Process Dimension. In the area of software engineering, this role will be fulfilled by the amendment to ISO 12207. In addition, other reference models may be used to extend the technique to broader domains. A key candidate for the extension will be the Systems Engineering domain, through the definition of a Reference Model based upon the new Standard for Systems Life Cycle Processes, ISO/IEC 15288 (currently at Committee Draft stage).

3 Approach to demonstrating Compatibility

In evaluating the CMMI in meeting the requirements for compatibility, each area was addressed as follows:

3.1 Purpose

The CMMI provides ample evidence that meets the requirements of this aspect of compatibility. In Chapter 1, we find:

"CMM Integration places proven practices into a structure that helps your organization assess its organizational maturity or process area capability, establish priorities for improvement, and implement these improvements."

The Practices and subpractices in the CMMI models represent a broad view of good practice for systems and software engineering; the intention that the model forms a basis for assessment is clearly and explicitly stated.

3.2 Scope

The CMMI covers both systems and software engineering within its scope. The coverage of the models in terms of the processes described in ISO 15504-2 was determined through a detailed mapping exercise, and is documented below.

3.3 Model elements and indicators

The requirement in ISO 15504 is to establish "an explicit mapping from the fundamental elements of the (candidate assessment) model to the processes and process attributes of the reference model"; the mapping must be "complete, clear and unambiguous". In order to establish this, a clear understanding of the "fundamental elements" of both the Reference Model and of the CMMI needs to be established.

It is tempting to state, for example, that the basic elements of the Reference Model are the Processes and Process Attributes, and no more; however, it is far easier to obtain a clear and consistent mapping - and to identify areas of incompleteness - if the lower level element are recognised: the process outcomes, and the characteristics for the process attributes. Together with the process and attribute definitions, this provides an average of approximately 45 “basic elements” for each process - a total of around 1800 elements in the entire model. In the revision of ISO 15504, the mapping requirement is stated explicitly to be to the "process outcomes" of a reference model. In undertaking this mapping, therefore, we have considered the basic elements of the reference model to be the "process outcomes" for each Process, and the "achievements" for each Process Attribute in the Capability Dimension.

In exploring the CMMI, the level at which the mapping is performed is again an issue. The rating elements in the CMMI are the Goals (Specific and Generic); however, the rating of goals is performed on the basis of evidence recorded against each Practice (Specific and Generic). It is evident, therefore, that the Practices are "indicators" of process performance and process capability in the terms of ISO 15504. The status of the subpractices, however, is not as clear.

The CMMI describes subpractices as "detailed descriptions that provide guidance for interpreting specific or generic practices". In CMMI terms, subpractices are "an informative component in the model meant only to provide ideas that may or may not be used for process improvement." It could be held, therefore, that subpractices should not be referenced in any mapping.

ISO 15504 requires that the "indicators of process performance and process capability" in an assessment be mapped to the Processes and Process Attributes. An indicator, in ISO 15504, is defined as "an objective attribute or characteristic of a practice or work product that supports the judgment of the performance of, or capability of, an implemented process." ISO 15504-5 contains guidance on the definition and use of assessment indicators; it describes the function of indicators as follows:

> *The indicators in this model give examples of evidence that an assessor might obtain, or observe, in the course of an assessment. The evidence obtained in the assessment, through observation of the implemented process, can be mapped onto the set of indicators to enable correlation between the implemented process and the processes defined in this assessment model. These indicators provide guidance for assessors in accumulating the necessary objective evidence to support their judgements of capability. They are not intended to be regarded as a mandatory set of check-list to be followed, but as guidance for an assessor in accumulating the necessary objective evidence to support they judgement of capability.*

It can be seen, therefore, that the subpractices can be regarded as indicators in the terms of ISO 15504, and should therefore be included in the mapping.

4 Continuous Representation Mapping

4.1 Scope of the Model

In performing this mapping, we have explicitly mapped every subpractice in the CMMI Continuous Representation to the corresponding elements in ISO 15504-2. In many cases

the mapping is to a single process outcome or attribute achievement; it is not uncommon, however, for the mapping to be more complex. The mapping definitions were then "rolled up" to the Practice; judgement was used to determine whether all elements of a subpractice mapping would be incorporated in the references at the Practice level. Following completion of the mapping, a detailed matrix showing all of the relationships was developed, and from this any elements of ISO 15504-2 that had not been mapped were identified; this information was used as part of final validation of the model. The Practice mappings were also "rolled up" to give a picture of the elements of ISO 15504-2 associated with each Goal.

The results of the mapping are provided in the attached Excel Workbook (SQI-CMMI-P1-D1.XLS). These record the relationship between each Goal and Practice and the elements of ISO 15504-2. The more detailed mappings at the subpractice level are omitted for clarity; this data is retained by the SQI and can be provided on request.

In the mapping table, the elements of ISO 15504-2 are referenced using the Process Identifiers defined in the standard. In referencing processes, individual outcomes are indicated by "O" and are numbered sequentially. Thus, "CUS.3/O.2" refers to the second defined outcome in the Requirements Elicitation Process. In referencing process attributes, individual achievements are numbered sequentially without and additional identifier; thus "PA2.2/3" refers to the third defined achievement for the Work Product Management Attribute. Where significant issues are identified, they are noted in comments.

The findings in terms of the scope of the Continuous Representation are as follows:

1. The CMMI Continuous Representation addresses all of the processes of the Process Dimension of ISO 15504-2, with the exception of the processes specifically identified below.
2. The CMMI Continuous Representation addresses all of the process attributes of the Capability Dimension of ISO 15504-2. Not all aspects of these attributes are contained in the Capability Dimension of the CMMI Continuous Representation.
3. Some elements in the CMMI Continuous Representation - the whole of the Decision Analysis and Resolution process area and parts of the Technical Solution process area - are outside the scope of ISO 15504-2.

Elements of the Reference Model not addressed

The following processes in ISO 15504-2 are not addressed in the CMMI:

- CUS.4 - Operation Process
- MAN.1 - Management Process
- ORG.1 - Process Alignment Process

The following processes are not completely addressed in the CMMI:

- CUS.1.1 - Acquisition Preparation Process (and by inclusion, CUS.1 - Acquisition Process);
- CUS.2 - Supply Process
- ENG.2 - Software Maintenance Process
- ORG.3 - Human Resource Management Process
- ORG.6 - Reuse Process

An examination of a later draft of CMMI, including Acquisition process areas, shows that CUS.1.1 is completely addressed in that section of the model.

This detailed mapping is used as a key input in developing a Translation Mechanism for CMMI assessments, described below.

4.2 Issues and Anomalies

Although the coverage of the model is good, there are a number of areas that cause concern in relation to their impact on the achievement of a mechanism for conversion of CMMI assessment data to ISO 15504 standard process profiles. In some instances the areas of concern constitute potential problems in the structure or content of the CMMI Model.

Process Attributes

Two of the process attributes of the Capability Dimension of ISO 15504-2 are not addressed in any of the Generic Practices of the CMMI Continuous Model. These are:

- PA3.2 - Process Resource Attribute
- PA5.1 - Process Change Attribute

These elements are addressed in Process Areas of the CMMI so that coverage of all elements is achieved. PA3.2 is addressed in OPF, OPD, OT and IPM. PA5.1 is addressed in OID and CAR.

This causes an issue in the translation of results, in that it implies that these processes must be included in the scope of any assessment where translation to cover Level 3 (PA3.2) or Level 5 (PA5.1) is required.

Dispersed and Diverse Mappings

Some processes - notable SUP.1 - Documentation Process and ORG.4 - Infrastructure Process - are addressed weakly over a wide range of process areas. It is probable in an assessment that insufficient data would be collected to permit rating of these processes using any feasible translation mechanism.

In some process areas - notably REQM and IPM - mapping, even at the sub-practice level, is to a wide range of process outcomes. This will lead to significant problems in attempting to use observations recorded in these process areas in any translation. It also implies that the definition of these process areas is inadequately detailed; for example, REQM has only one Specific Goal and four Specific Practices.

Advanced Practices

The mapping raises concerns relating to the use of advanced practices in the Continuous Model. In most instances, where an Advanced Practice represented an increased level of capability of an equivalent basic practice, the only additional material relates to mappings to process attributes (as expected). In some cases, however, there are additional process outcomes included in the mappings to the advanced practice, and in one case (TS SP 1.1-1, SP1.1-2) there is one outcome addressed in the Basic Practice that is not covered in the Advanced Practice. This is an issue with the overall design and integrity of the Model.

5 Staged Representation Mapping

5.1 Scope of the Model

This mapping took the established correspondence to the Continuous Model as the starting point for the mapping. All Basic Practices with corresponding Advanced Practices were removed, as these do not form part of the Staged model. In addition, the consolidated practices at the Goal level were reviewed to ensure that all Advanced Practice mappings had been incorporated.

The primary difficulty in mapping the Staged model is in relation to the Capability Dimension. In the Staged Model, only Level 2 and Level 3 Generic Practices are explicitly identified, and these are established within each Process Area, rather than being seen as common capabilities across all areas. In undertaking this mapping, therefore, the mapping to the

Generic Practices previously established was taken, and in each process area the relevant Process Attributes were seen as applying to the cited Processes. In describing this coverage, the following guidelines were adopted:

- If all outcomes of a Process are addressed in the Basic Practices of the Process Area, the attributes derived from the relevant Generic Practices are seen as applying *completely* to that Process.
- If more than one outcome of a Process is addressed, the attributes derived from the relevant Generic Practices are seen as applying *partially* to that Process.
- If only a single outcome of a Process is addressed, the attributes derived from the relevant Generic Practices are regarded as applying *slightly* to that Process.

Within a single Process Area, therefore, the Performance Management, Work Product Management and Process Definition process attributes (for Process Areas at Level 3 and higher) can be seen as applying to different extents to different Processes in the Reference Model. The mapping is presented in the attached spreadsheet (SQI-CMMI-P1-D2.XLS)

In terms of the scope of the model, it is clear that the process dimension of the CMMI Staged Representation covers the same scope as does the Continuous Representation. In relation to the Capability Dimension, however, the picture is more complex. Specific issues are noted below; however over the full scope of the model, all process attributes are addressed over all process areas.

This Mapping Table forms the basis for the definition of a series of "standard profiles" representing the equivalent ISO 15504 Process Profile associated with key CMMI achievements.

5.2 Issues and Anomalies

The issues raised in respect of the Continuous Representation apply also to the Staged Representation. In addition, there are concerns relating to the non-inclusion of Generic Practices for Levels 4 and 5 into the relevant Process Areas.

There is also an apparent anomaly in respect of capability of lower-level Process Areas. With the Continuous Representation, Process Areas such as Configuration Management or Requirements Management can be seen as evolving over a full range of capabilities; thus it is meaningful to speak of a “Level 4 (capability) Requirements Management Process Area”. In the Staged Representation there are no expectations visible for evolution of such capabilities beyond the original described capability. Thus, in an organisation assessed as Level 5 Maturity, there is no (notional) need for Supplier Agreement Management (for example) to be at any capability beyond Level 2. The anomaly is usually implicitly addressed during assessments through interpretations of the scope of process assets, but is nonetheless present.

6 Process Profiles

6.1 Approach

In the staged representation of the CMMI model, Process Areas within the model are grouped according to organisational maturity levels. These Process areas have a number of Specific Goals and Practices with corresponding Generic Goals and Practices at each level. In ISO15504 processes have a number of outcomes that are expected to be implemented when an organisation fully employs the process and a series capability levels for each process comprising of nine process attributes as shown in Table 1.

Table 1 – Process Attributes in ISO 15504-2

Capability Level	Process Attribute
1	PA1.1 Process performance
2	PA2.1 Performance management PA2.2 Work product management
3	PA3.1 Process definition PA3.2 Process resource
4	PA4.1 Measurement PA4.2 Process control
5	PA5.1 Process change PA5.2 Continuous improvement

To determine the equivalent ISO15504 process capability profile, the mapping from each the Specific and Generic Practices for each Process Area in the maturity level was compared to the outcomes and process attributes of the ISO15504 processes. To include an ISO15504 process in the maturity level profile, all outcomes for an ISO15504 process and process attribute achievements needed to be covered by the mapping from the Specific Practices and Generic Practices from the CMMI Staged representation.

During this exercise, it was noted that the Specific Practices of the CMMI Process Areas at a maturity level usually covered a number of outcomes of ISO15504 processes. However, an ISO15504 process could not be included in the profile until all outcomes were covered.

6.2 Results

This exercise has demonstrated that the results of a CMMI Staged model assessment can provide sufficient evidence to support a comprehensive series of ISO15504 process profiles to be produced. At each maturity level in the Staged CMMI the profiles for following ISO15504 process can be assessed as shown in the following tables.

Table 2 – Maturity Level 2 Equivalent Processes

Maturity Level 2	
CUS.1.2	Supplier Selection Process
CUS.1.3	Supplier Monitoring Process
CUS.1.4	Customer Acceptance Process
SUP.1	Documentation Process
SUP.2	Configuration Management Process
SUP.3	Quality Assurance Process
SUP.6	Joint Review Process
SUP.7	Audit Process
SUP.8	Problem Resolution Process
MAN.2	Project Management Process
ORG.5	Measurement Process
Process Attributes	PA1.1 PA2.1 PA2.2

Table 3 – Maturity Level 3 Equivalent Processes

Maturity Level 3	
CUS.1.2	Supplier Selection Process
CUS.1.3	Supplier Monitoring Process
CUS.1.4	Customer Acceptance Process
CUS.3	Requirements Elicitation Process
ENG.1.1	System requirements analysis and design process
ENG.1.2	Software requirements analysis process
ENG.1.3	Software design process
ENG.1.4	Software construction process
ENG.1.5	Software integration process
ENG.1.6	Software testing process
ENG.1.7	System integration and testing process
SUP.1	Documentation Process
SUP.2	Configuration Management Process
SUP.3	Quality Assurance Process
SUP.4	Verification Process
SUP.5	Validation Process
SUP.6	Joint Review Process
SUP.7	Audit Process
SUP.8	Problem Resolution Process
MAN.2	Project Management Process
MAN.4	Risk Management
ORG.2.1	Process establishment process
ORG.2.2	Process assessment process
ORG.5	Measurement Process
Process Attributes	PA1.1 PA2.1 PA2.2 PA3.1 PA3.2

Table 4 – Maturity Level 4 Equivalent Processes

Maturity Level 4	
CUS.1.2	Supplier Selection Process
CUS.1.3	Supplier Monitoring Process
CUS.1.4	Customer Acceptance Process
CUS.3	Requirements Elicitation Process
ENG.1.1	System requirements analysis and design process
ENG.1.2	Software requirements analysis process
ENG.1.3	Software design process
ENG.1.4	Software construction process
ENG.1.5	Software integration process
ENG.1.6	Software testing process
ENG.1.7	System integration and testing process
SUP.1	Documentation Process
SUP.2	Configuration Management Process
SUP.3	Quality Assurance Process
SUP.4	Verification Process
SUP.5	Validation Process

Maturity Level 4	
SUP.6	Joint Review Process
SUP.7	Audit Process
SUP.8	Problem Resolution Process
MAN.2	Project Management Process
MAN.3	Quality Management
MAN.4	Risk Management
ORG.2.1	Process establishment process
ORG.2.2	Process assessment process
ORG.4	Infrastructure process
ORG.5	Measurement Process
Process Attributes	PA1.1 PA2.1 PA2.2 PA3.1 PA3.2 PA4.1 PA4.2

Table 5 – Maturity Level 5 Equivalent Processes

Maturity Level 5	
CUS.1.2	Supplier Selection Process
CUS.1.3	Supplier Monitoring Process
CUS.1.4	Customer Acceptance Process
CUS.3	Requirements Elicitation Process
ENG.1.1	System requirements analysis and design process
ENG.1.2	Software requirements analysis process
ENG.1.3	Software design process
ENG.1.4	Software construction process
ENG.1.5	Software integration process
ENG.1.6	Software testing process
ENG.1.7	System integration and testing process
SUP.1	Documentation Process
SUP.2	Configuration Management Process
SUP.3	Quality Assurance Process
SUP.4	Verification Process
SUP.5	Validation Process
SUP.6	Joint Review Process
SUP.7	Audit Process
SUP.8	Problem Resolution Process
MAN.2	Project Management Process
MAN.3	Quality Management
MAN.4	Risk Management
ORG.2.1	Process establishment process
ORG.2.2	Process assessment process
ORG.2.3	Process improvement process
ORG.4	Infrastructure process
ORG.5	Measurement Process

Maturity Level 5	
Process Attributes	PA1.1 PA2.1 PA2.2 PA3.1 PA3.2 PA4.1 PA4.2 PA5.1 PA5.2

To determine the equivalent ISO15504 process capability profile, the mapping from each of the Specific and Generic Practices for each Process Area in the maturity level was compared to the outcomes and process attributes of the ISO15504 processes. To include an ISO15504 process in the maturity level profile, all outcomes for an ISO15504 process and process attribute achievements need to be covered by the mapping from the Specific Practices and Generic Practices of the CMMI Staged representation. The results of this are presented in Figure 1, and in the attached spreadsheet (SQI-CMMI-P1-D4.XLS).

Code	Process Name
CUS.1.2	Supplier Selection Process
CUS.1.3	Supplier Monitoring Process
CUS.1.4	Customer Acceptance Process
SUP.1	Documentation Process
SUP.2	Configuration Management Process
SUP.3	Quality Assurance Process
SUP.6	Joint Review Process
SUP.7	Audit Process
SUP.8	Problem Resolution Process
MAN.2	Project Management Process
ORG.5	Measurement Process
CUS.3	Requirements Elicitation Process
ENG.1.1	System requirements analysis and design process
ENG.1.2	Software requirements analysis process
ENG.1.3	Software design process
ENG.1.4	Software construction process
ENG.1.5	Software integration process
ENG.1.6	Software testing process
ENG.1.7	System integration and testing process
SUP.4	Verification Process
SUP.5	Validation Process
MAN.4	Risk Management
ORG.2.1	Process establishment process
ORG.2.2	Process assessment process
MAN.3	Quality Management
ORG.4	Infrastructure process
ORG.2.3	Process improvement process

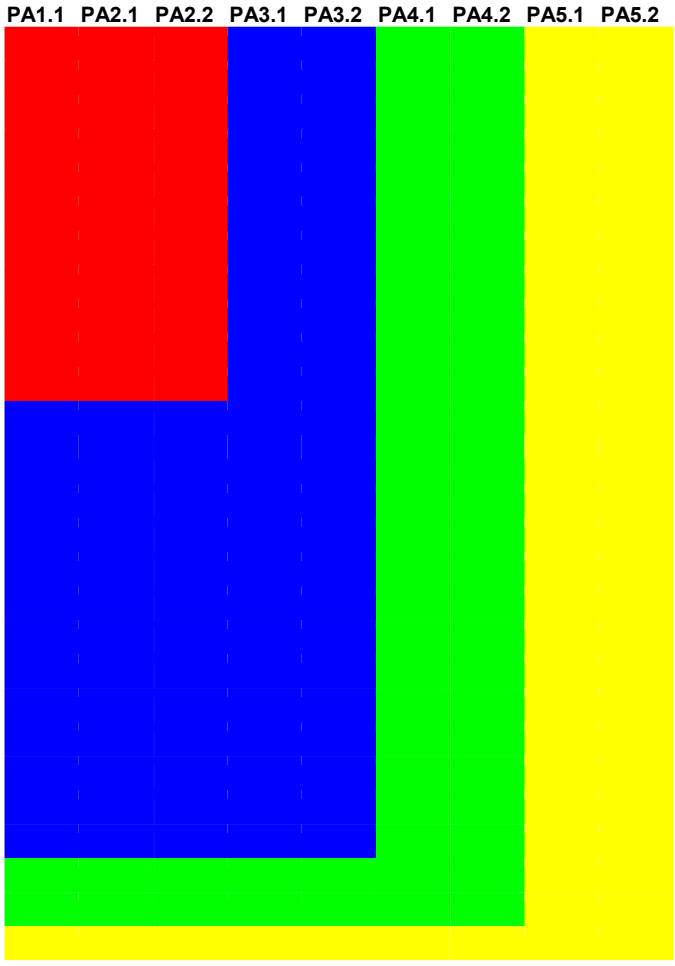

Figure 1 – Process Profile for CMMI

In Figure 1, each maturity level in the Staged representation of the CMMI has a unique colour as follows:

- Maturity level 2 – Red
- Maturity level 3 – Blue
- Maturity level 4 – Green

- Maturity level 5 – Yellow

Processes are not listed in the profile until all defined outcomes have been satisfied. In most cases, some outcomes are addressed at lower levels of maturity; however, all outcomes must be satisfied to demonstrate completeness of process performance.

This exercise demonstrates that the results of a CMMI assessment can provide sufficient evidence to support the production of a comprehensive series of ISO15504 process profiles.

7 Translation Mechanism

The mechanism for translation may be manual, or computer based. It may require the inclusion of additional information collected during the assessment. It may involve further judgment on the part of the assessor. Given the complexity of the mappings, the high level at which ratings are assigned, and the nature of the rating process it is not seen as feasible, given the current state of knowledge, to develop an automatic translation mechanism. Any mechanism will require additional judgement by the assessment team.

The translation approach will also be dependent on the nature of the Assessment Method. The Assessment Requirements for CMMI (SEI, 2000) envisage three different classes of method – A, B and C. Table 6 compares the different Classes of method.

Table 6 - Classes of Assessment Methods (from ARC)

Characteristics	Class A	Class B	Class C
Usage mode	1. Rigorous and in-depth investigation of process (es) 2. Basis for improvement plan	1. Initial (first-time) 2. Incremental (partial) 3. Self-assessment	1. Quick-look 2. Incremental
Principal Outcomes	1. Findings adequate as a basis for process improvement activities 2. Buy-in and ownership of results 3. CMMI measurement framework rating(s) to characterize assessment scope	1. Findings adequate as a basis for process improvement program 2. Buy-in and ownership of results	1. Findings adequate to expose gaps in implementation of processes
Advantages	Thorough coverage; strengths and weaknesses for each PA investigated; robustness of method with consistent, repeatable results; provides objective view; option of 15504 conformance	Organization gains insight into own capability; provides a starting point or focuses on areas that need most attention; promotes buy-in.	Inexpensive; short duration; rapid feedback
Disadvantages	Demands significant resources	Does not emphasize depth of coverage and rigor and cannot be used for level rating	1. Provides less buy-in and ownership of results 2. Not enough depth to fine-tune process improvement plans.
Sponsor	Senior manager of organizational unit	Any manager sponsoring an SPI program	Any internal manager
Team composition	External and internal	External or internal	External or internal
Team size	4-10 persons + assessment team leader	1-6 + assessment team leader	1-2 + assessment team leader
Team qualifications	Experienced	Moderately experienced	Moderately experienced

Characteristics	Class A	Class B	Class C
Assessment team leader requirements	Lead assessor	Lead assessor or person experienced in method	Person trained in method

The need to be able to achieve translation to ISO 15504 Process Profiles is a requirement in the ARC, but is applicable only to Class A methods. It may be possible however to achieve some level of translation from other methods, providing Requirement 4.5.2(c) of the ARC is met – "*The observation is relevant to the assessment reference model and can be associated with a specific model component."* From the ARC, it appears that this is a requirement applicable to all methods (Ref Appendix A).

The basic approach for translation proposed is as follows:

1. Collect data and generate observations for all Specific Practices in Process Areas within the scope of the assessment.
2. Using the mapping tables, assign the data observations to all Process Outcomes and Attributes indicated from the mapping. Thus, if a Specific Practice maps to multiple Process Outcomes, assign the data to all of the possibilities.
3. Review the assigned data and remove observations that are not relevant.
4. Judge whether the remaining data is adequate to enable judgement of achievement of the outcomes.
5. Where adequate data is available, consolidate the data to the process level and rate the performance of the process.
6. Repeat the exercise for the Generic Practices and Process Attributes. Note that in some cases, evidence from Advanced Practices may also be relevant to a particular Process Attribute for a specific Process or set of Processes.

8 Summary and Conclusion

8.1 Overview of Results

This exercise has demonstrated the achievement of a detailed mapping from CMMI Continuous Representation to the Process Reference Model of ISO 15504-2. All significant elements of the model have been successfully addressed, and the exceptions were in areas that were expected. The mapping has led to significant insights into the structure and consistency of the CMMI, and has some impact on the overall goal of this project. Some problems and anomalies have been identified; these have been reported to the CMMI Product Development Team in the form of Change Requests. The mapping was extended to also address the Staged Representation of the CMMI. Some additional problems in relation to the inclusion of expressions of attributes of process capability were noted. From the Staged Representation mapping it has been possible to identify standard Process Profiles that correspond to the levels of maturity expressed in the Model.

These mapping exercises provide a foundation for the development of a translation mechanism to enable the expression of CMMI assessment results into standard ISO 15504 Process Profiles. The Translation Mechanism will need to be validated through field studies. Initial studies will use results of assessments conducted previously as a basis for generating ISO 15504 Process Profiles. As opportunities arise, these will be extended to translation during the period of the assessment.

The principal impact of use of the translation mechanism will be to increase the cost and duration of assessments in which translation is required. This can be mitigated through use of a sub-team with specific ISO 15504 knowledge and understanding to conduct the

translation. Since there is already consensus on the observations, there should be no additional data to consider and the involvement of the entire team should not be necessary.

8.2 Future Work

The primary initial concern is to progress the work towards the production of a formal statement of conformance of CMMI to ISO 15504-2. In order to achieve this, the translation mechanism proposed must be validated through actual use. In order to achieve this, an appropriate tool set that will make use of the translation mechanism feasible is needed. A high-level specification for this tool has been defined, and a prototype version is being developed. Without tool support, it is not considered that performance of translation will be feasible. Once the translation mechanism is demonstrated to be accurate and feasible, the formal statement of conformance can be issued.

If the benefits from this study are to be effectively deployed, further work will be required. The most obvious issue is the forthcoming revision of ISO 15504. When this is published (late in 2002) the existing mappings to ISO/IEC TR 15504-2 will become irrelevant; under the new version, the Process Reference Model for Software Engineering will be drawn from the Amendment to ISO 12207. The mapping will therefore have to be repeated against ISO 12207. The existing results will be of substantial value. Given the timeframe for the proposed release of Version 1.1 of CMMI, the best option will be to map the new model against the revised standard.

The opportunity also exists to extend the scope of mapping to address systems-specific issues, through use of ISO 15288 (when published) as reference model for this domain. We have already indicated that some of the scope issues in the current mapping are addressed in ISO 15288.