

Manufacturing Software Interoperability and Assurance using Standardized Capability Profiling : An ISO 16100 Proposal

presented by

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Backgrounds

Major changes in the area of manufacturing software systems

- Trend to the open system architecture from a software embedded type system architecture.
- Globalization from building a manufacturing system by developing all software units by themselves to building a manufacturing system by combining software units which are provided by various vendors.
- Conversion of the optimization target from local optimization of each system unit to total optimization of the whole manufacturing system.



Key technologies to reduce development time and development cost:

how to find and use skillfully manufacturing software units which are provided by various vendors and how to reuse existing software units.

Objectives of ISO 16100

International Standard ISO 16100 :

Manufacturing Software Capability Profiling for Interoperability

developed by ISO/TC 184/SC 5/WG 4

- To provide a standardized mechanism to search for good and proper manufacturing software.
 - To provide a standardized mechanism to show the precise capability of the manufacturing software.
- 
- To provide a standardized methodology for the interoperability and assurance of manufacturing software units using capability profiling.

History of ISO 16100 Series

Development of ISO 16100

1998 Dec.: ISO/TC 184/SC 5 Study Group proposed

NWI : Manufacturing Software Capability Profiling

1999 Jun.: New work item proposal was accepted

2000 Nov.: ISO/TC 184/SC 5/WG 4 started to develop ISO 16100

Title of ISO 16100:

Manufacturing Software Capability Profiling for Interoperability

Part 1: Framework (editor from USA) 2002

Part 2: Profiling methodology (editors from Japan) 2003

Part 3: Interface protocols and templates (editor from Germany) 2005

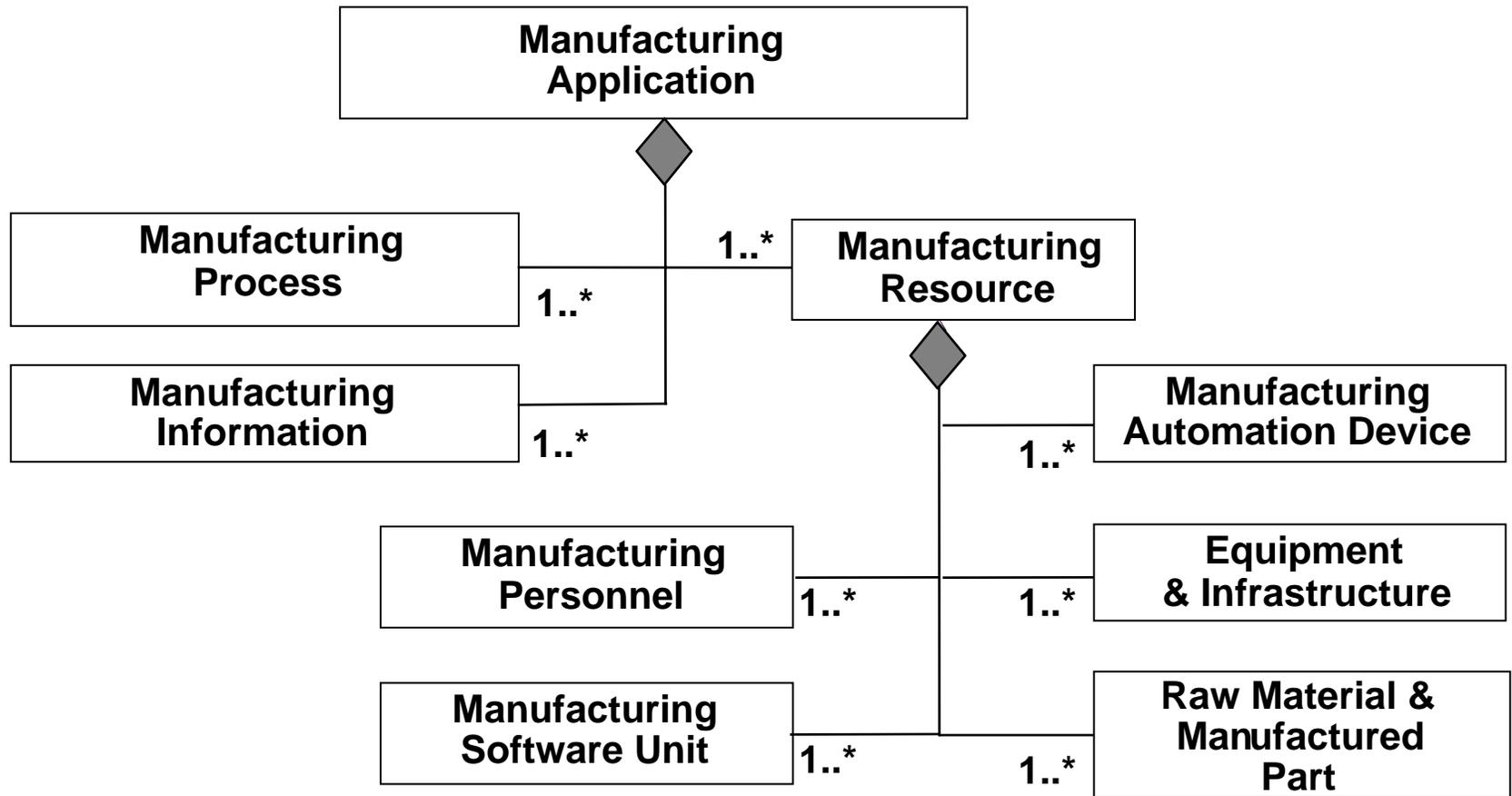
Part 4: Conformance test method, criteria and reports

(editor from China) 2006

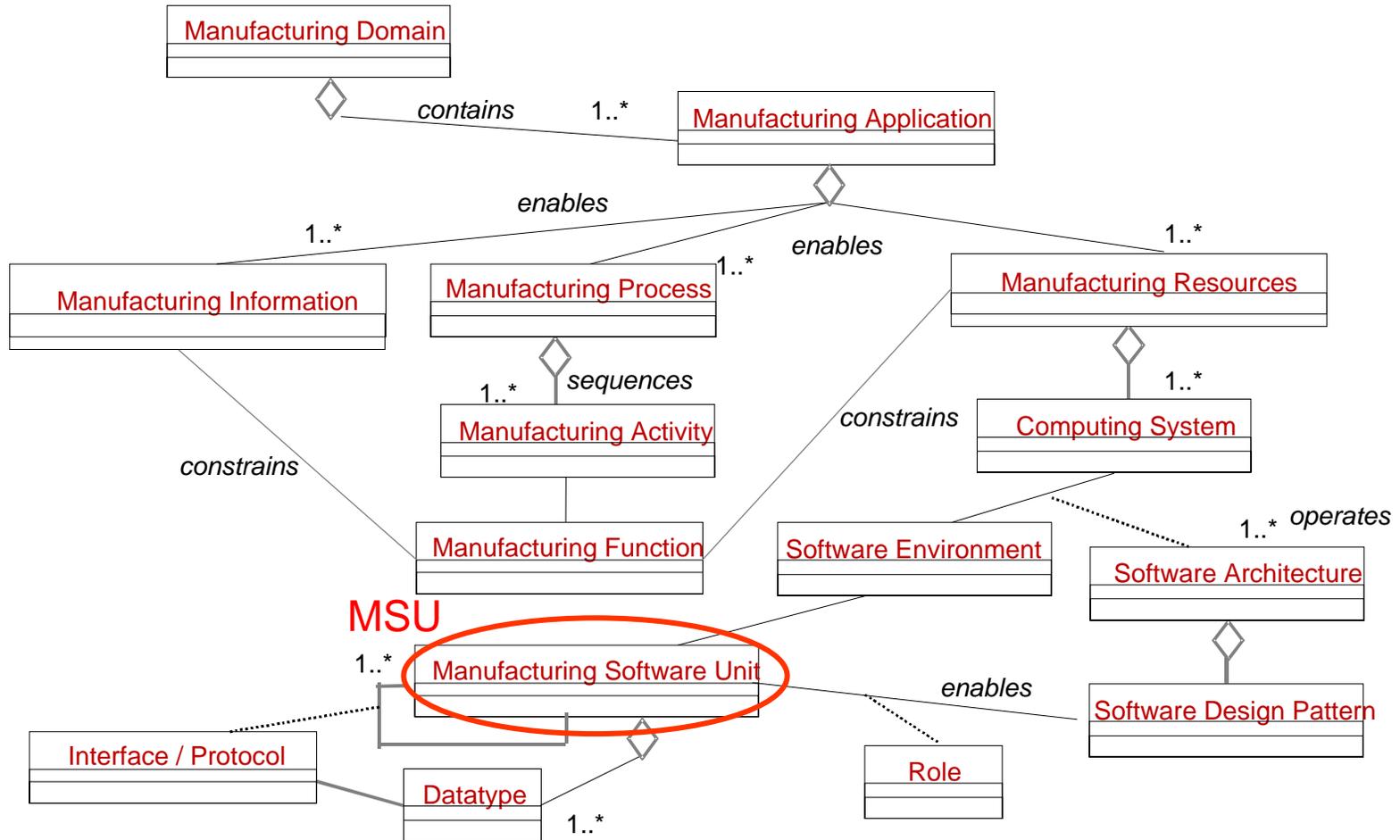
**Part 5: Methodology for profile matching using
multiple capability class structures**

(editors from Japan) *under DIS ballot*

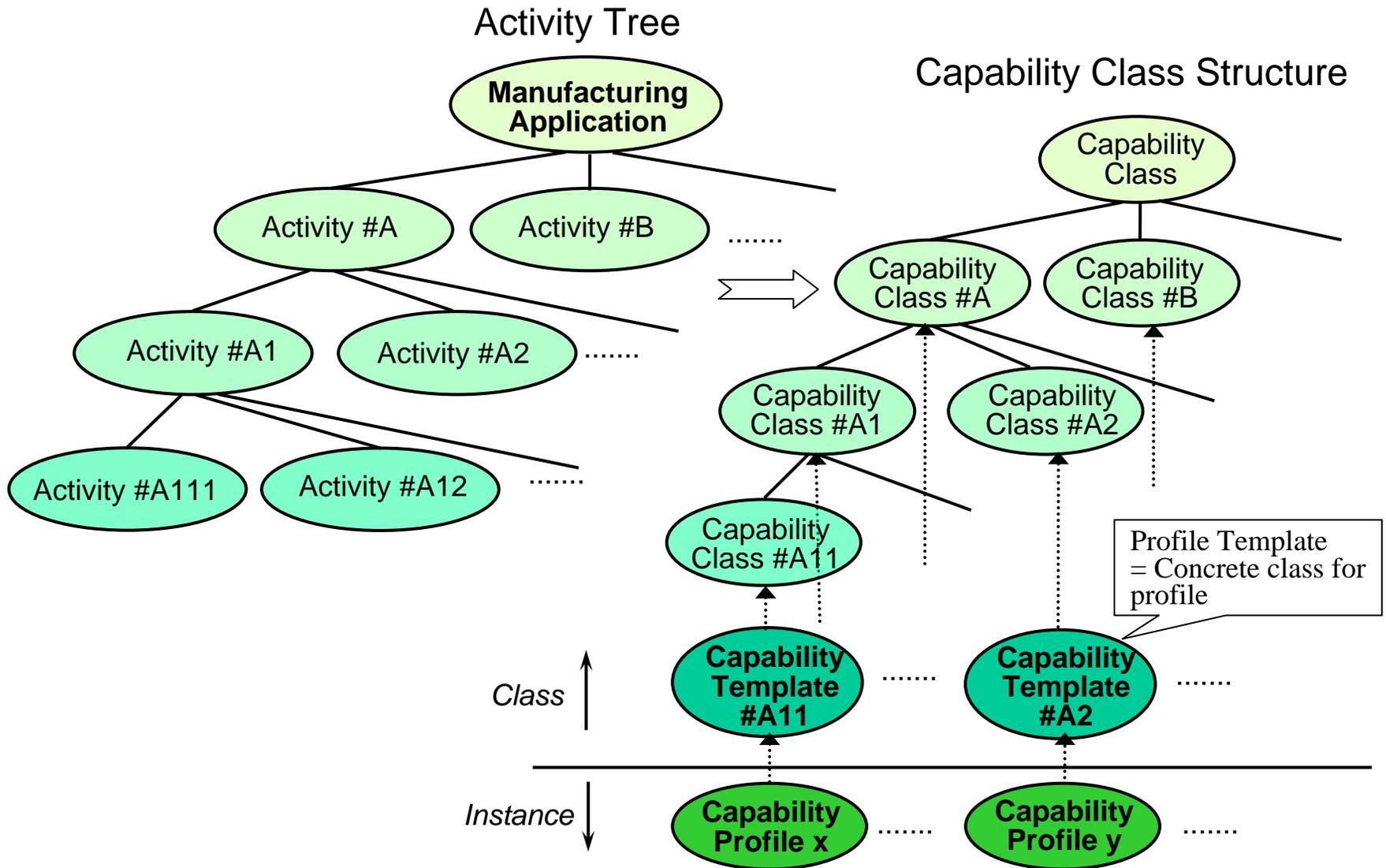
Manufacturing Application Model



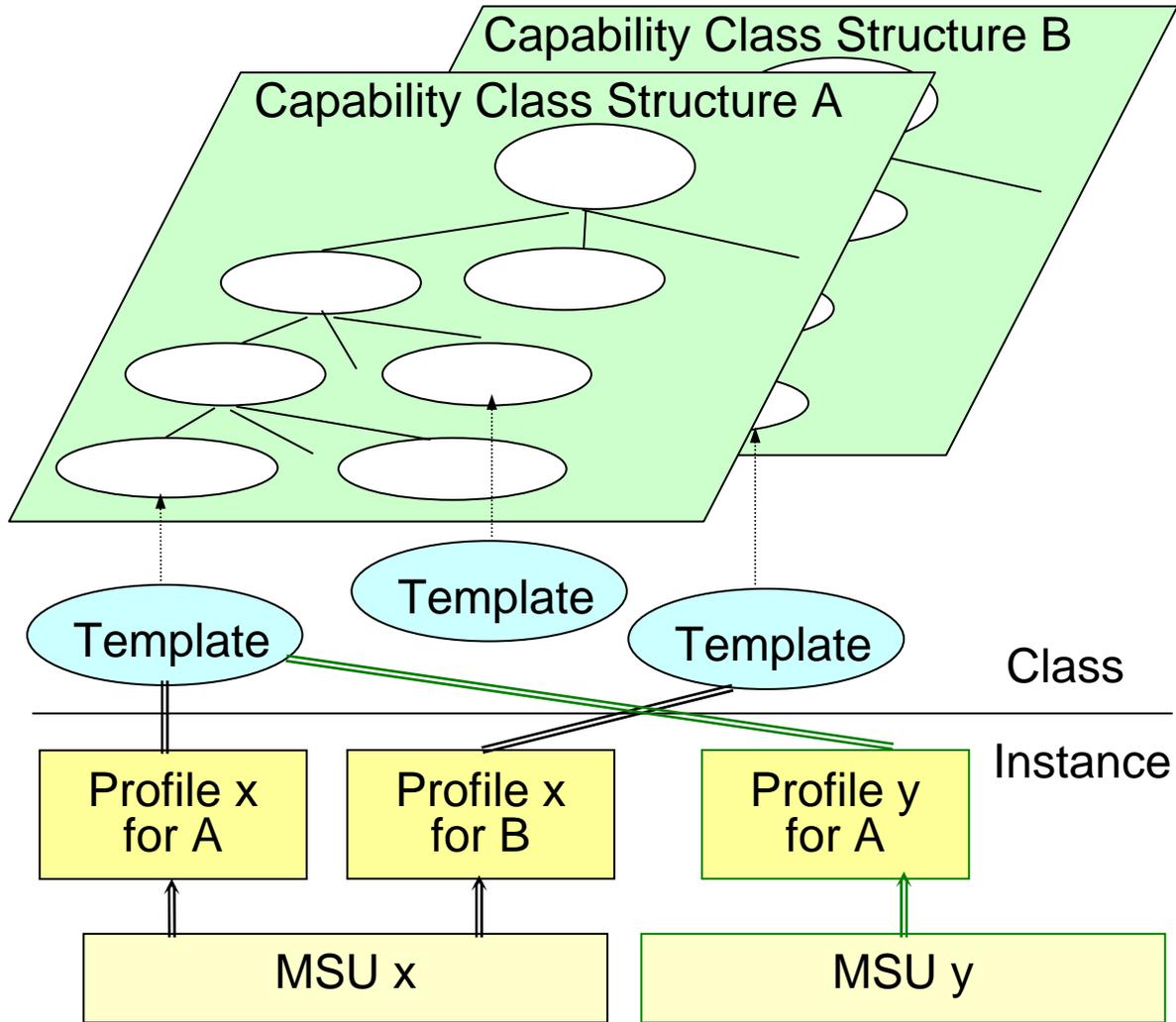
A Manufacturing Software Unit and Its Surroundings



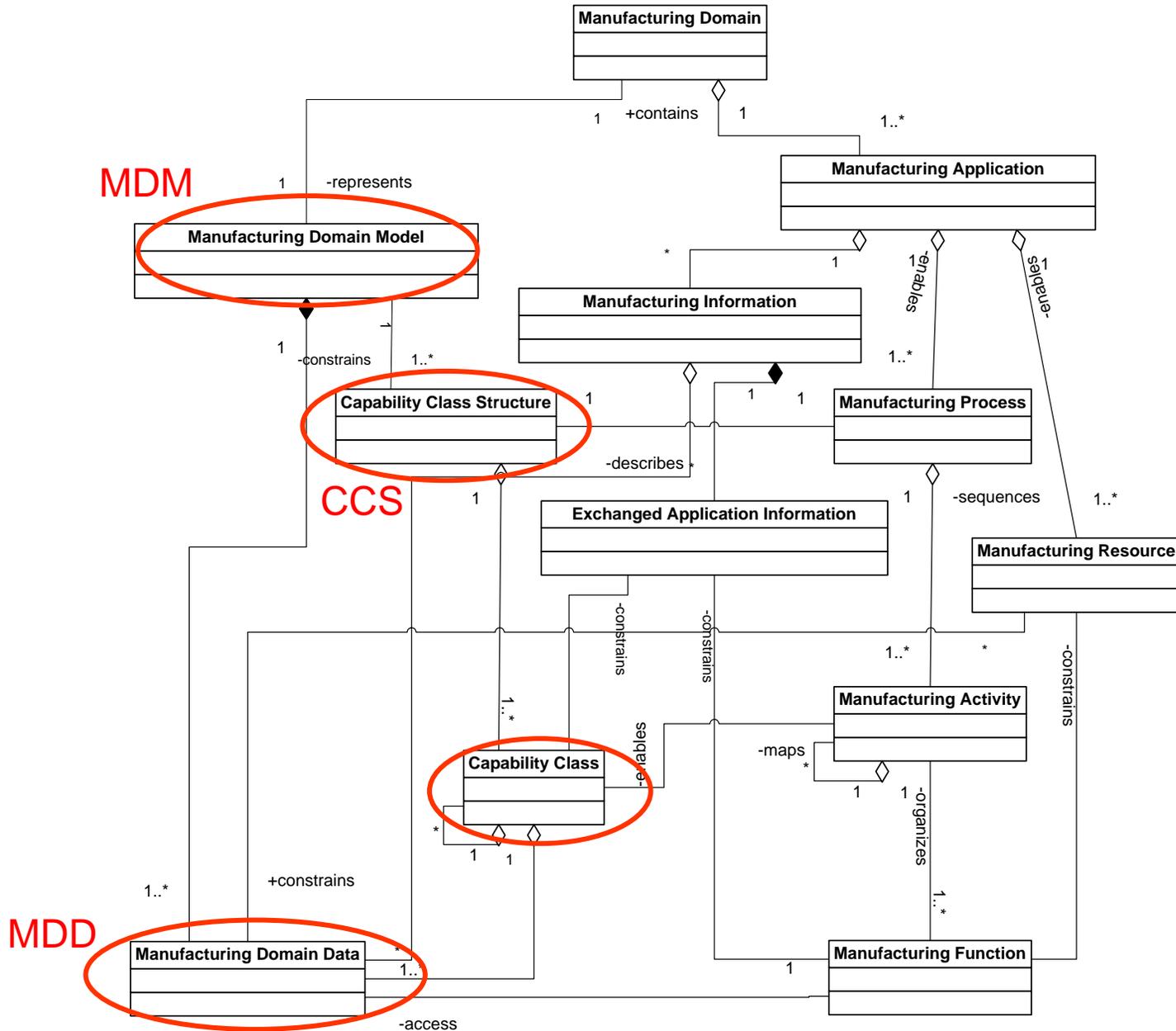
MSU Capability Profiling Based on the Activity Tree



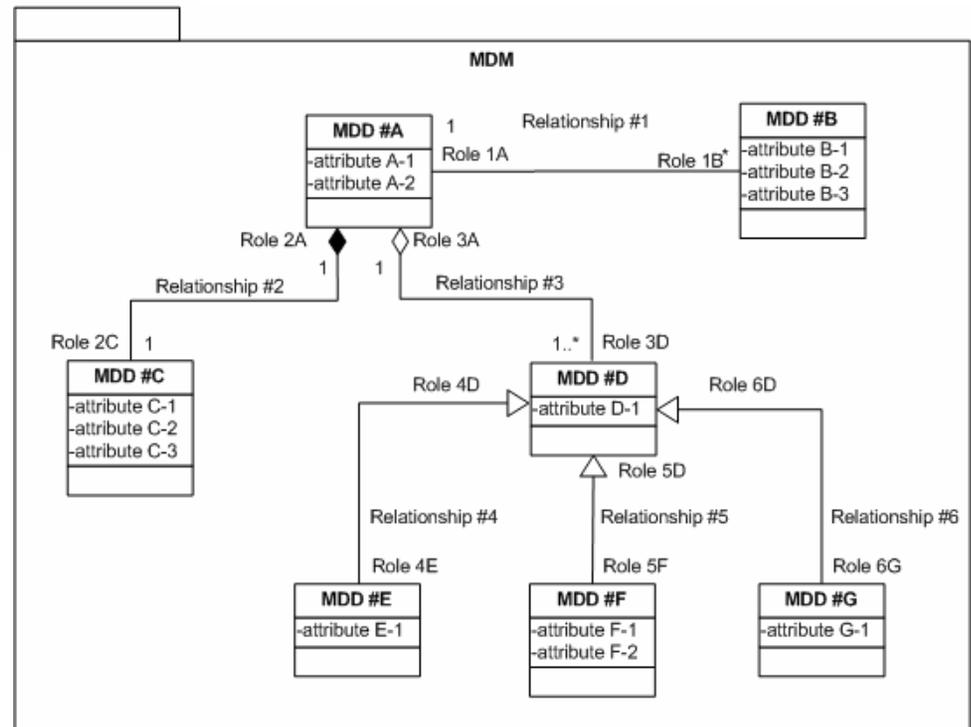
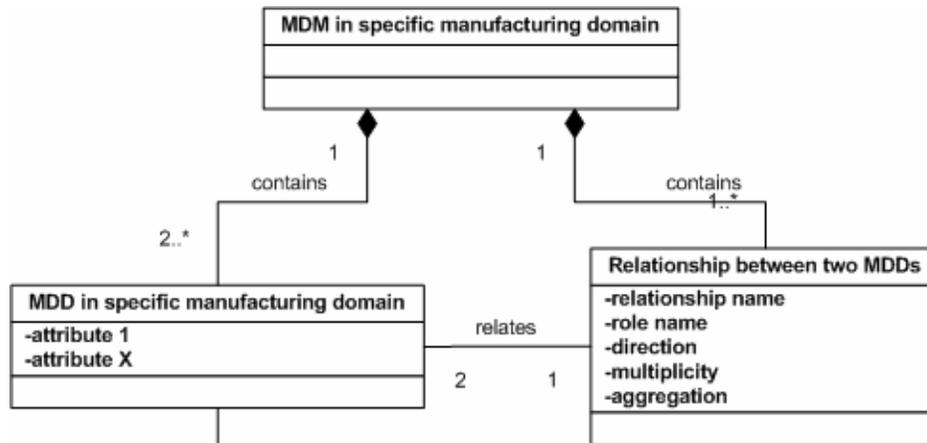
Capability Template and MSU Profile



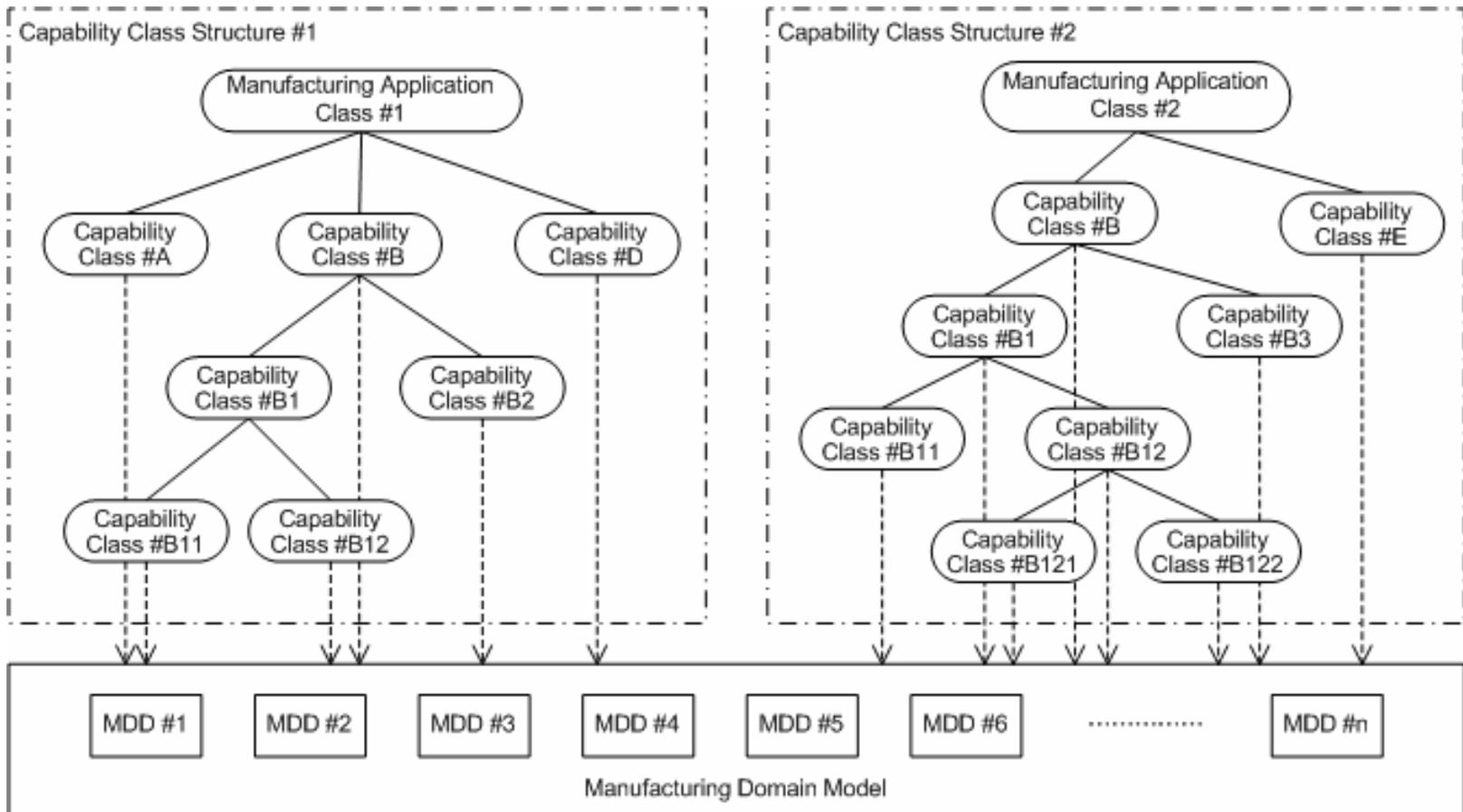
Relationship between manufacturing domain and manufacturing application



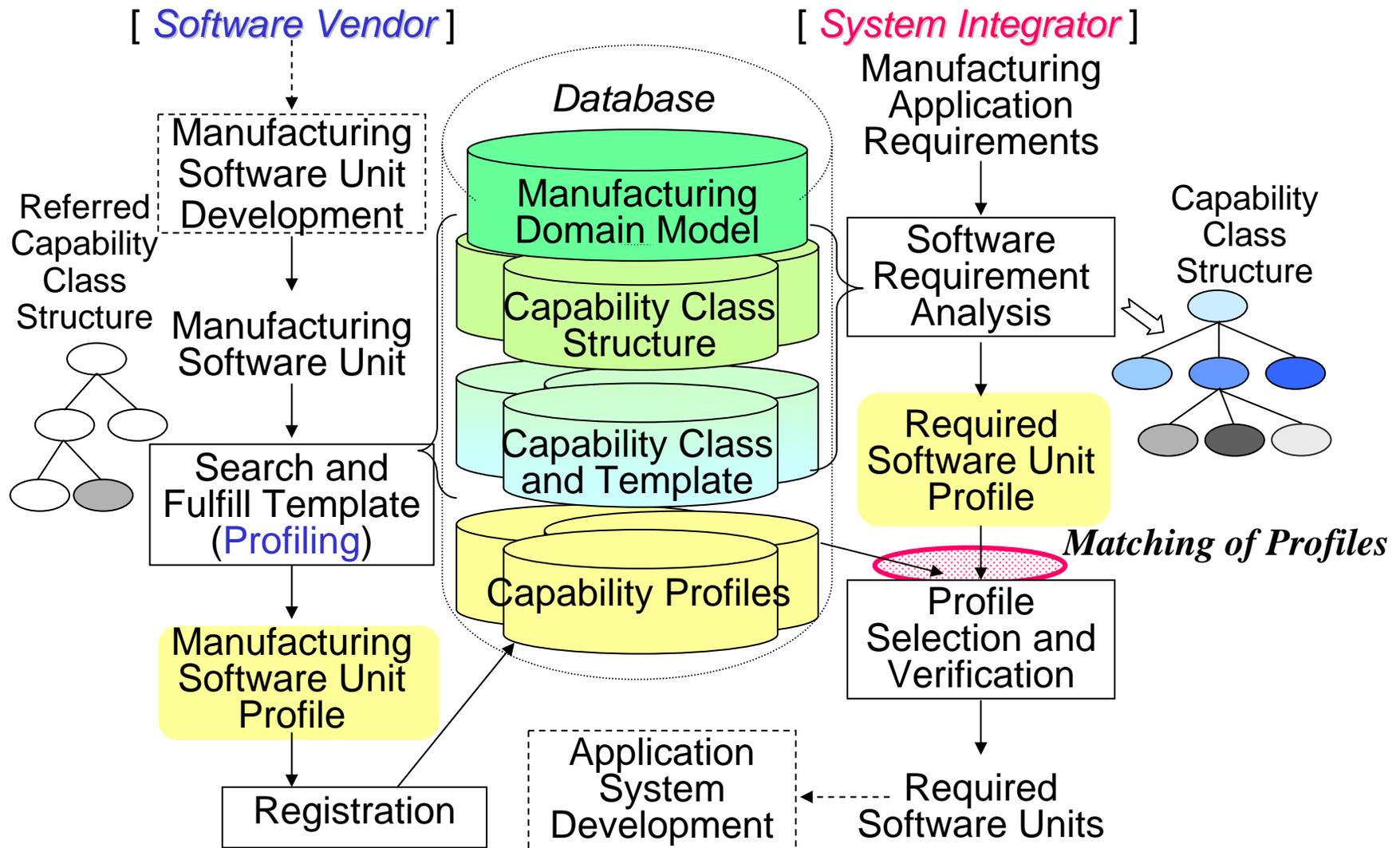
Relationship between MDD and MDM



Multiple Capability Classes Described Using MDDs



Conceptual Framework for Interoperability and Assurance



Conceptual Structure of Templates for MSU Capability Profiling

Capability Profile Template

Common Part

Template ID
Capability Class Name and **Reference CCS**
Software Unit ID
Vendor Name
Version Number & History
Computing Facilities Required
Processor

Capability Class Reference Dictionary Name
Number Of Profile Attributes
Number Of Methods
Number Of Resources

Specific Part

Reference MDM Name
Capability Definition Format
Capability Definition
List of Capability Class Attributes
List Of Capability Class Methods
List Of Capability Class Resources

MDM Template

MDM Name
Domain Reference Dictionary Name
List of MDD Packages
MDD Package
MDD Name
List of Relationships
Relationship
Relationship Type
Relationship Name
Destination MDD Name
Direction
Role Name for MDD
Role Name for Destination MDDs
Multiplicity
Type

MDD Template

MDD Name
Reference MDM Name
List of Attributes
Attribute Name
Attribute Type

CCS Template

CCS Creator Name
CCS ID
CCS Root Node ID
Capability Class ID
Parent Node ID(s)
Child Node ID(s)

Example of MSU Profile

The screenshot shows the XMLSPY application window titled "XMLSPY - [Iso16100ceaSampleWorker02]". The menu bar includes "ファイル(E)", "編集(E)", "XML(X)", "DTD/スキーマ(D)", "スキーマ設計(M)", "XSL 表示(Y)", "ブラウザ(B)", "ツール(I)", "ウィンドウ(W)", and "ヘルプ(H)". The toolbar contains various icons for file operations and editing.

The main text area displays the following XML code:

```
<Common>
  <!--ReferenceClassStructure id="cea_1001" name="TestEvaluationActivity" version="001" url="" /-->
  <MSU_Capability id="AMS-102-0001" version="V01.02.02c" />
  <Owner>
    <name>MSU Developer Inc.</name>
    <street>Winter Ave.7</street>
    <city>Softcity</city>
    <zip>4712</zip>
    <state>CA</state>
    <country>USA</country>
    <comment>Only best experiences!</comment>
  </Owner>
  <ComputingFacilities type="required">
    <!-- type is obvious!! -->
    <!-- see Fig 6 part 2 -->
    <Processor type="INTEL" />
    <OperatingSystemS>
      <OperatingSystem>WINDOWS</OperatingSystem>
      <OperatingSystem>JAVA</OperatingSystem>
    </OperatingSystemS>
    <Language name="EN" />
    <Memory size="77" unit="MB" />
    <DiskSpace size="30" unit="GB" />
  </ComputingFacilities>
  <Performance>
    <ElapsedTime value="61 ms" />
    <TransactionsPerSecond value="621" />
  </Performance>
  <!-- TemplateID ID_Number="Cea_A1_Evaluation_ISO-DIS16100-01" /-->
  <!-- gives the uppest level, relative root; e.g. to level 4-->
  <!--CapabilityClassName id="ccn_1001"> Calculate_FFT </CapabilityClassName -->
</Common>
<Specific>
  <ReferenceClassStructure id="cea_1001" name="CEA_TestActivity" version="001" url="">
    <TestActivities>
      <Formula level="3" ID="ABAA" />
    </TestActivities>
  </ReferenceClassStructure>
</Specific>
```

The right sidebar contains three panels:

- Elements:** Empty panel.
- Attributes:** Empty panel.
- Entities:** Lists entities: Ent amp, Ent apos, Ent gt, Ent lt, Ent quot. The amp entity is expanded to show its definition: `<math display="block">\text{Ent amp} \quad \&`

The status bar at the bottom shows "xmlspy v2004 rel. 2 U Michiko Matsuda (Kanagawa Institute of Technology) で登録されています (C)1998-2003 Altova GmbH & Altova, Inc. 行 1, 桁 1".

Example of Required MSU Profile

XMLSpy - [Iso16100ceaRequirement_001]

```
<Common>
  <Requirement id="AMS-r701-0001" version="V01.01.01a" />
  <Owner>
    <name>MSU User Ltd.</name>
    <street>Spring Blv.2</street>
    <city>Softcity</city>
    <zip>0915</zip>
    <state/>
    <country>France</country>
    <comment>Never seen before</comment>
  </Owner>
  <ComputingFacilities type="offered">
    <!-- see Fig 6 part 2 -->
    <Processor type="INTEL" />
    <OperatingSystem>LINUX</OperatingSystem>
    <Language name="EN" />
    <Memory size="28" unit="MB" />
    <DiskSpace size="30" unit="GB" />
  </ComputingFacilities>
  <Performance>
    <ElapsedTime value="200ms" />
    <TransactionsPerSecond value="200" />
  </Performance>
  <TemplateID ID_Number="Cea_A1_Evaluation_ISO-DIS16100-01" />
  <!-- gives the upper level, relative root; e.g. to level 4 -->
  <CapabilityClassName id="ccn_1001"> Calculate_FFT </CapabilityClassName>
</Common>
<Specific>
  <ReferenceClassStructure id="cea_1001" name="CEA_TestActivity" version="001" url="">
    <TestActivities>
      <FormulaEditor level="4" ID="ABAAA" status="mandatory" />
    </TestActivities>
    <InformationExchange>
      <InputDataTypes level="1" ID="BA">
        <DoubleValue level="4" ID="BAAAA" status="optional" />
        <IntegerValue level="4" ID="BAAAB" status="optional" />
        <DoubleVector level="4" ID="BAABA" status="mandatory" />
      </InputDataTypes>
    </InformationExchange>
  </ReferenceClassStructure>
</Specific>
```

Elements

Attributes

Entities

- Ent amp
- Ent apos
- Ent gt
- Ent lt
- Ent quot

Text | Grid | Schema/WSDL | Browser

Iso16100ceaSampleWorker02 | Iso16100ceaRequirement_001 | Iso16100ceaSampleWorker |

xmlspy v2004 rel. 2 U Michiko Matsuda (Kanagawa Institute of Technology) で登録されています (C)1998-2003 Altova GmbH & Altova, Inc. 行 1, 桁 1

Matching Level in Profile Matching Report

Complete Match — all the manufacturing functions referenced in the required capability profile match completely with all the corresponding functions referenced in the MSU capability profile. This means that both sets of manufacturing functions are fully equivalent in terms of both the MDD objects being equivalent and the time ordering of these objects being equivalent.

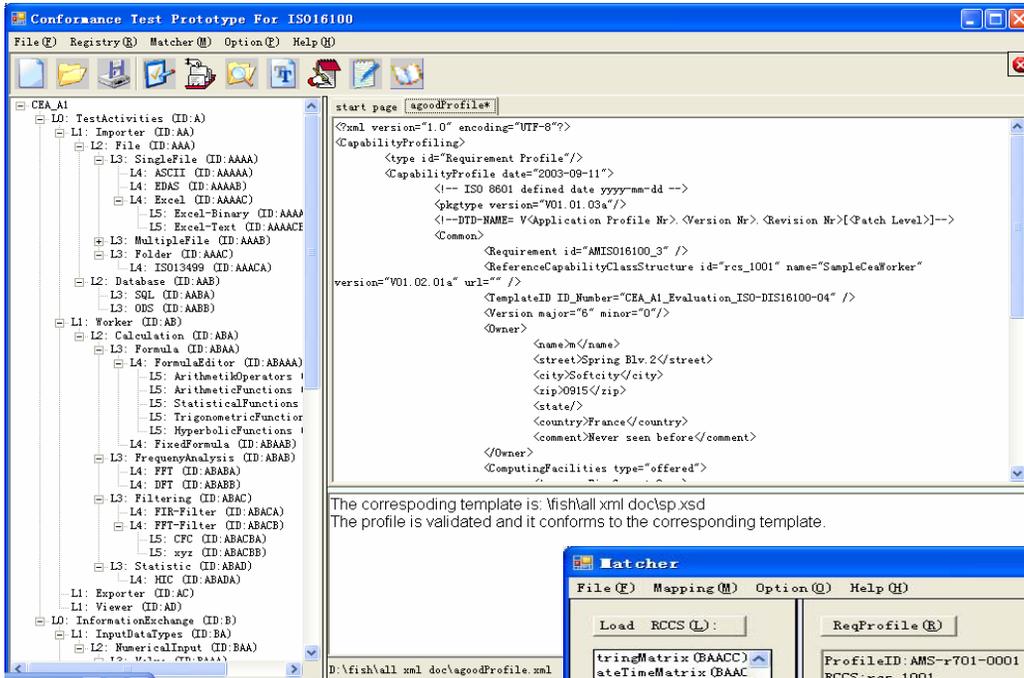
All Mandatory Match — all the mandatory functions in the required capability profile are completely matched with a corresponding set of manufacturing functions referenced in the MSU capability profile. The matching level report includes information about the details of the MSU functions in the corresponding set.

Some Mandatory Match — the required capability profile is matched partially by the MSU capability profile. The matching level report includes information about the details of the MSU functions that matched the functions referenced in the required capability profile.

No Mandatory Match — none of the mandatory functions referenced in the required capability profile match the functions referenced in the MSU capability profile.

Demonstration of Conformance Testing for ISO 16100

presented by
Prof. Qian Wang
(Southeast Univ., CHINA)



start page | agoodProfile.xml

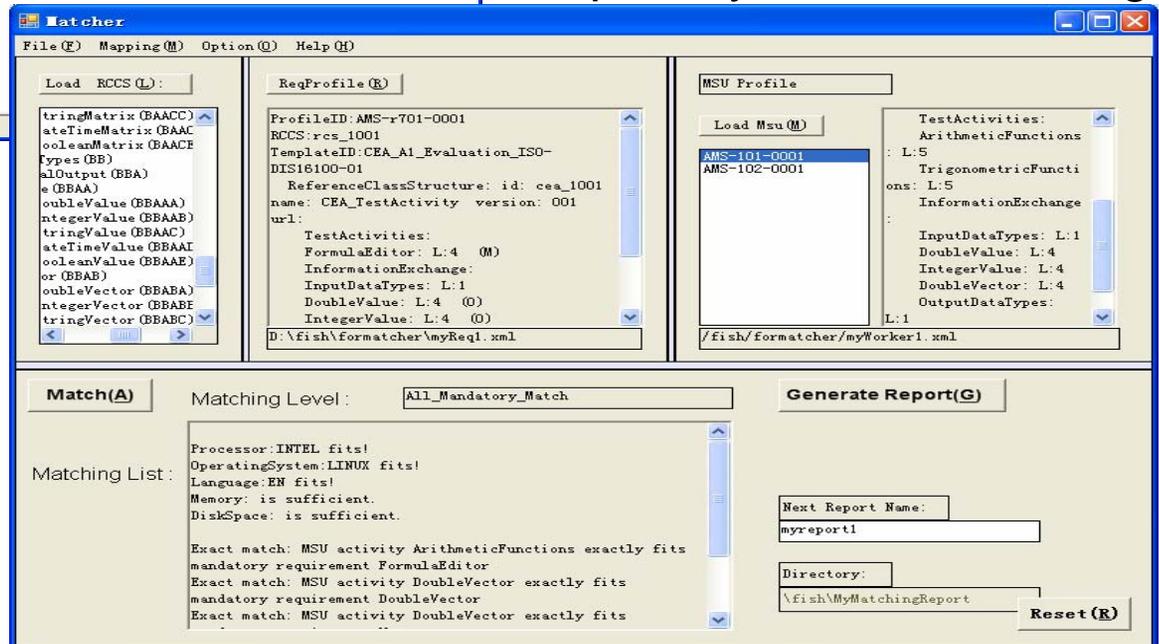
```
<?xml version="1.0" encoding="UTF-8"?>
<CapabilityProfile>
  <type id="Requirement Profile"/>
  <CapabilityProfile date="2003-09-11">
    <!-- ISO 8601 defined date yyyy-mm-dd -->
    <pkgtype version="V01.01.03a"/>
    <!-- DTD-NAME= V\Application Profile Nr.> <Version Nr.> <Revision Nr.>[<Patch Level>]-->
    <Common>
      <Requirement id="AMISO16100_3" />
      <ReferenceCapabilityClassStructure id="rcs_1001" name="SampleCeaWorker"
        version="V01.02.01a" url="" />
      <TemplateID ID_Number="CEA_AI_Evaluation_ISO-DIS16100-04" />
      <Version major="6" minor="0"/>
    </Owner>
    <name%></name>
    <street>Spring Blv. 2</street>
    <city>Softcity</city>
    <zip>0915</zip>
    <state>
    <country>France</country>
    <comment>Never seen before</comment>
  </Owner>
  <ComputingFacilities type="offered">

```

The corresponding template is: fishall.xml doc\sp.xsd
The profile is validated and it conforms to the corresponding template.

Capability Profile Matching

Main Interface



File (F) Mapping (M) Option (O) Help (H)

Load RCCS (L):

- tringMatrix (BAACC)
- ateTimeMatrix (BAAC
- ooleanMatrix (BAACE
- Types (BB)
- alOutput (BBA)
- e (BBAA)
- oubleValue (BBAAA)
- ntegerValue (BBAAAB)
- tringValue (BBAAAC)
- ateTimeValue (BBAAI
- ooleanValue (BBAAE)
- or (BBAB)
- oubleVector (BBABA)
- ntegerVector (BBABF
- tringVector (BBABC)

ReqProfile (R)

ProfileID: AMS-r701-0001
RCCS: rcs_1001
TemplateID: CEA_AI_Evaluation_ISO-DIS16100-01
ReferenceClassStructure: id: cea_1001
name: CEA_TestActivity version: 001
url:
TestActivities:
FormulaEditor: L:4 (M)
InformationExchange:
InputDataTypes: L:1
DoubleValue: L:4 (O)
IntegerValue: L:4 (O)
D:\fish\formatter\myReq1.xml

MSU Profile

Load Msu (M)

- AMS-101-0001
- AMS-102-0001

TestActivities:
ArithmeticFunctions : L:5
TrigonometricFunci ons: L:5
InformationExchange :
InputDataTypes: L:1
DoubleValue: L:4
IntegerValue: L:4
DoubleVector: L:4
OutputDataTypes: L:1
/fish/formatter/myWorker1.xml

Match(A) Matching Level: All_Mandatory_Match Generate Report(G)

Matching List:

```
Processor:INTEL fits!
OperatingSystem:LINUX fits!
Language:EN fits!
Memory: is sufficient.
DiskSpace: is sufficient.

Exact match: MSU activity ArithmeticFunctions exactly fits
mandatory requirement FormulaEditor
Exact match: MSU activity DoubleVector exactly fits
mandatory requirement DoubleVector
Exact match: MSU activity DoubleVector exactly fits
```

Next Report Name: myreport1
Directory: \fish\MyMatchingReport
Reset (R)

Future plans for ISO 16100 Project

Intent of ISO 16100

- To provide methodologies and technologies together into solutions that dramatically reduce the time and cost associated with the development and integration of software capability and assurance.
- To manage interoperability and assurance of manufacturing software units through their profiles which describe their capabilities.

ISO/TC184/SC5/WG4 Meetings	16100-5 editor: Japan	16100-6 editor: China
2007-3-8/9 Rosslyn, USA	(undergoing DIS ballot)	initial discussion
2007-05-07/09 Los Angeles, USA	(undergoing DIS ballot)	Kick-off 16100-6 project
2007-10-01/03 London, England	Review and resolve DIS comments	Review of 1st WD
2008-01 Location TBD	Review and resolve DIS comments	Review of 2nd WD