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Design and Implementation of an Assessment Database for Mathematics Education

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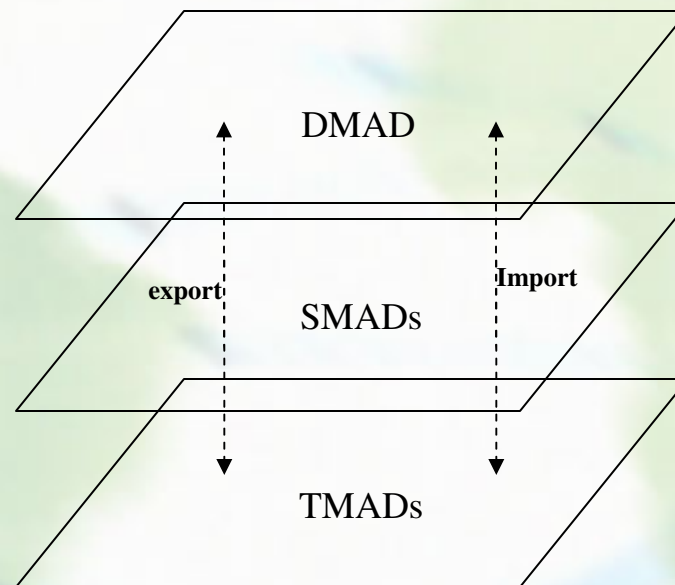
Introduction

- Teaching and learning Mathematics on the Web are increasingly popular with school teachers, educational experts and even by normal people due to easy Internet accessibility, flexibility, and interactivity.
- At the Institute for Computational Mathematics (ICM/Kent), we are developing WME (Web-based Mathematics Education) as a system for supporting, enhancing, and delivering mathematics education at all levels. A pilot project puts WME to in-class trial at Kimpton Middle School (Munroe Falls, Ohio) .
- Assessment, measuring the effects of educational concepts, student performance and comprehension, is a very important.
- Why DMAD system?
- it is a good idea to consider a more integrated, flexible and systematic way to support assessment for mathematics education.
- **DMAD** is a way of helping Math teachers to quickly and easily author, edit, and share questions with other teachers either from same or different schools.

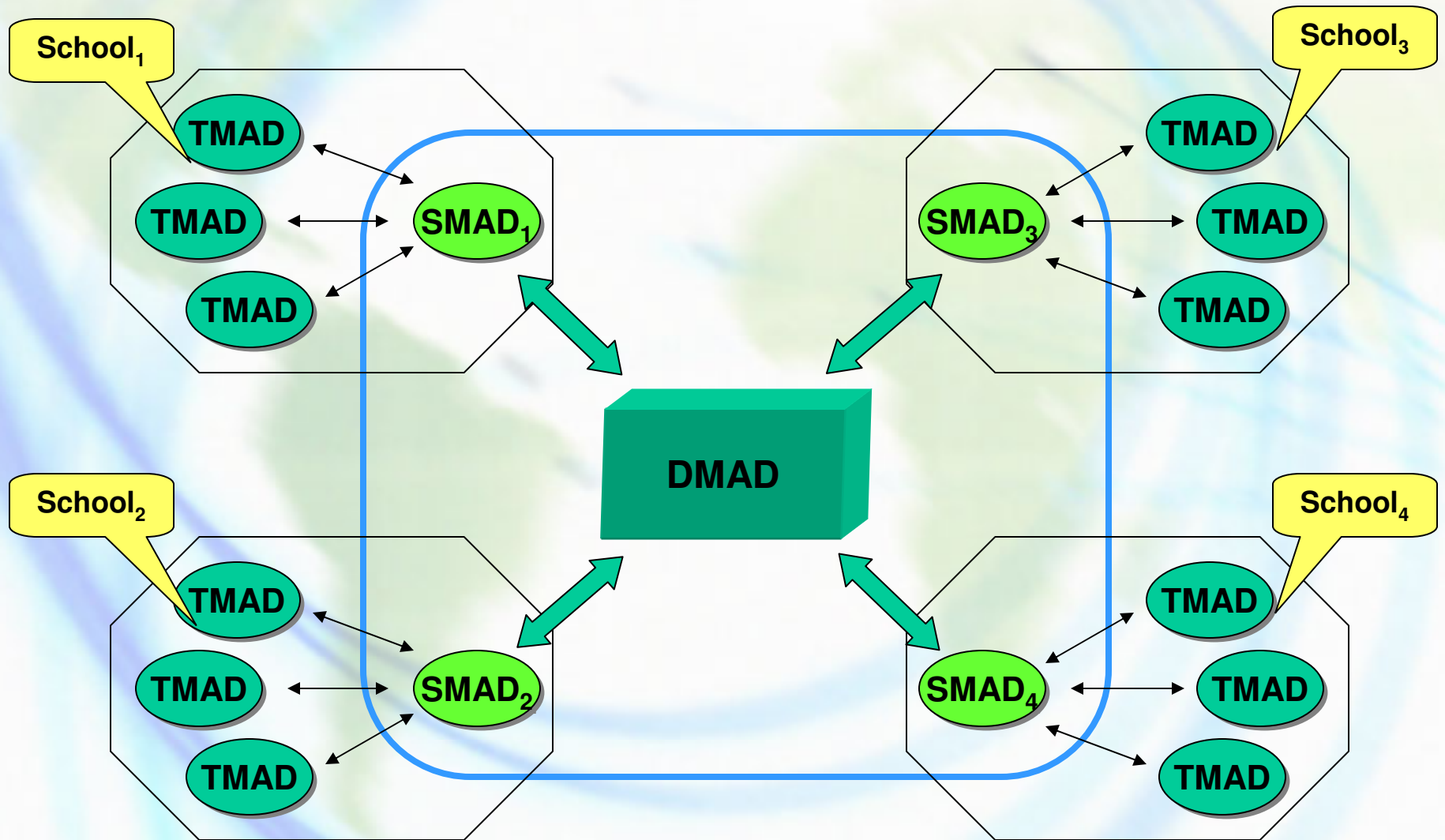
Definitions and Terminologies

- **DMAD** (Distributed Mathematics Assessment Databases): *is a distributed database with local databases at different school sites.* Within DMAD we have:
 - **TMAD** (Teachers Mathematics Assessment Database): *is a database assigned to mathematics teachers of same school.*
 - It stores and manages assessment tests, homework assignments, questions, student answers, grades, statistics and other info for each individual teacher.
 - **SMAD** (School Mathematics Assessment Database): *is created for individual school as part of its school site.*
 - A SMAD connects TMADs within the school and SMADs at different schools through the DMAD system.
 - The SMAD performs a critical role in enabling the sharing of assessment materials within and without a school.

DMAD System Levels



DMAD System Structure



DMAD General Views



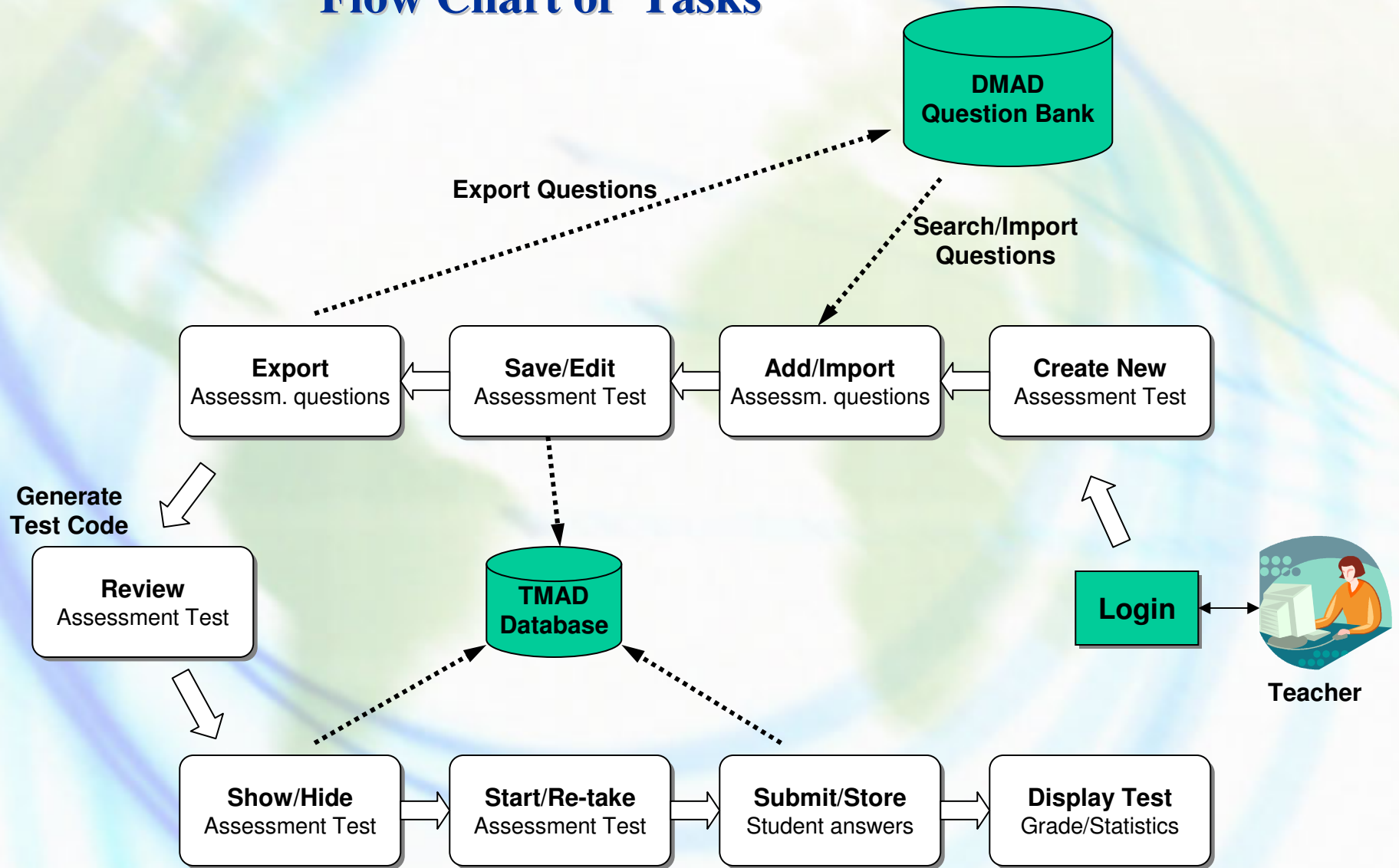
(1) Local View

- Authoring tool for teachers (author/view/edit/delete questions).
- Managing Assessment Tests
 - (prepare/save/show/hide/re-take/print tests).
 - online and paper testing.
 - Automatic test grading (statistics).
 - Storing/Retrieving student's answers.
- Security of online Testing (using especial per-test 'test codes').

(2) Global View

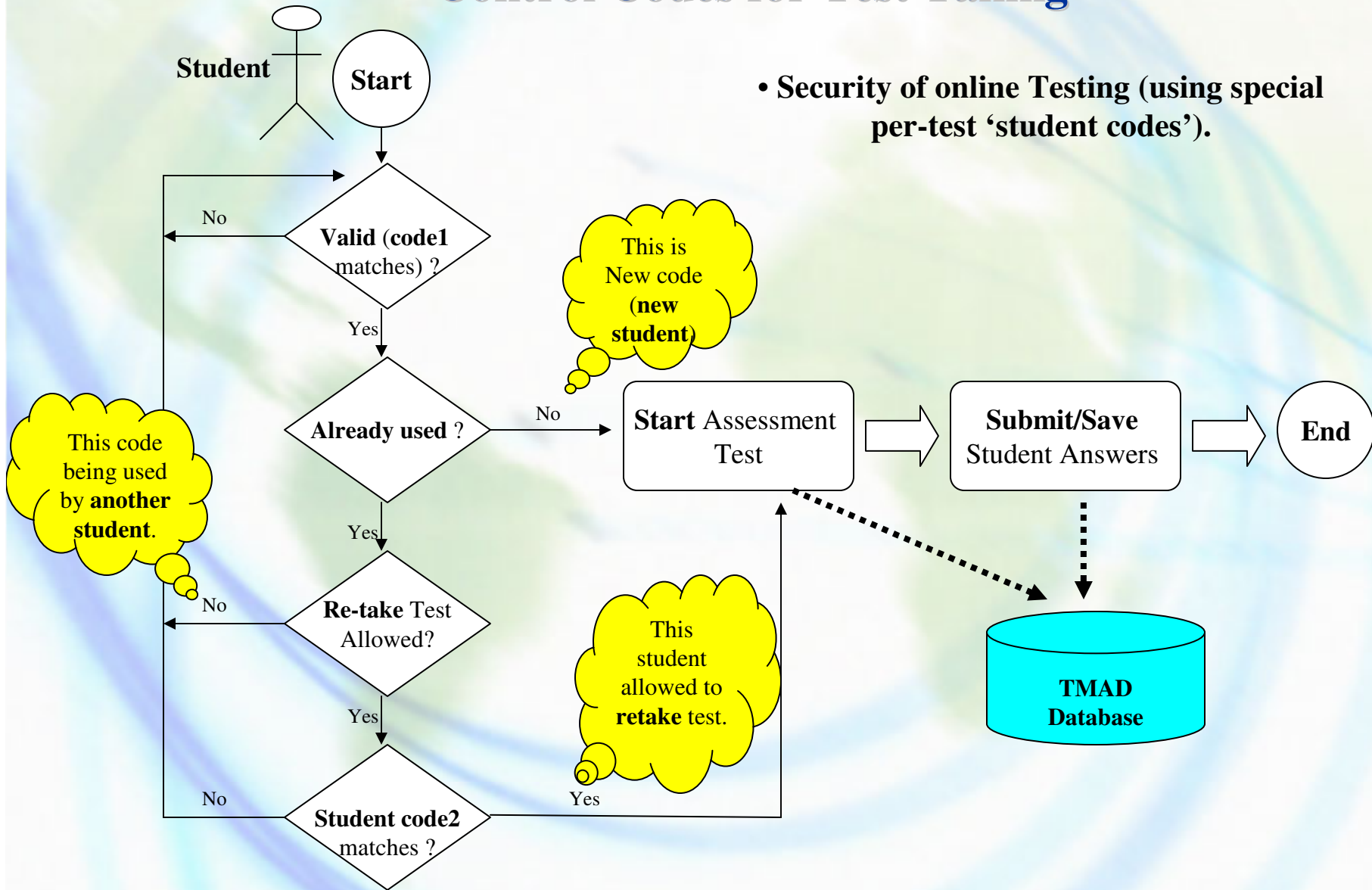
- DMAD system as a huge collection/bank of assessment questions. This includes:
 - Importing/Exporting assessment questions.
 - Searching DMAD.
 - Adding/Deleting TMADs/SMADs to/from DMAD.
 - Support Web services (XML).
 - etc.

Flow Chart of Tasks



Control Codes for Test Taking

- Security of online Testing (using special per-test 'student codes').

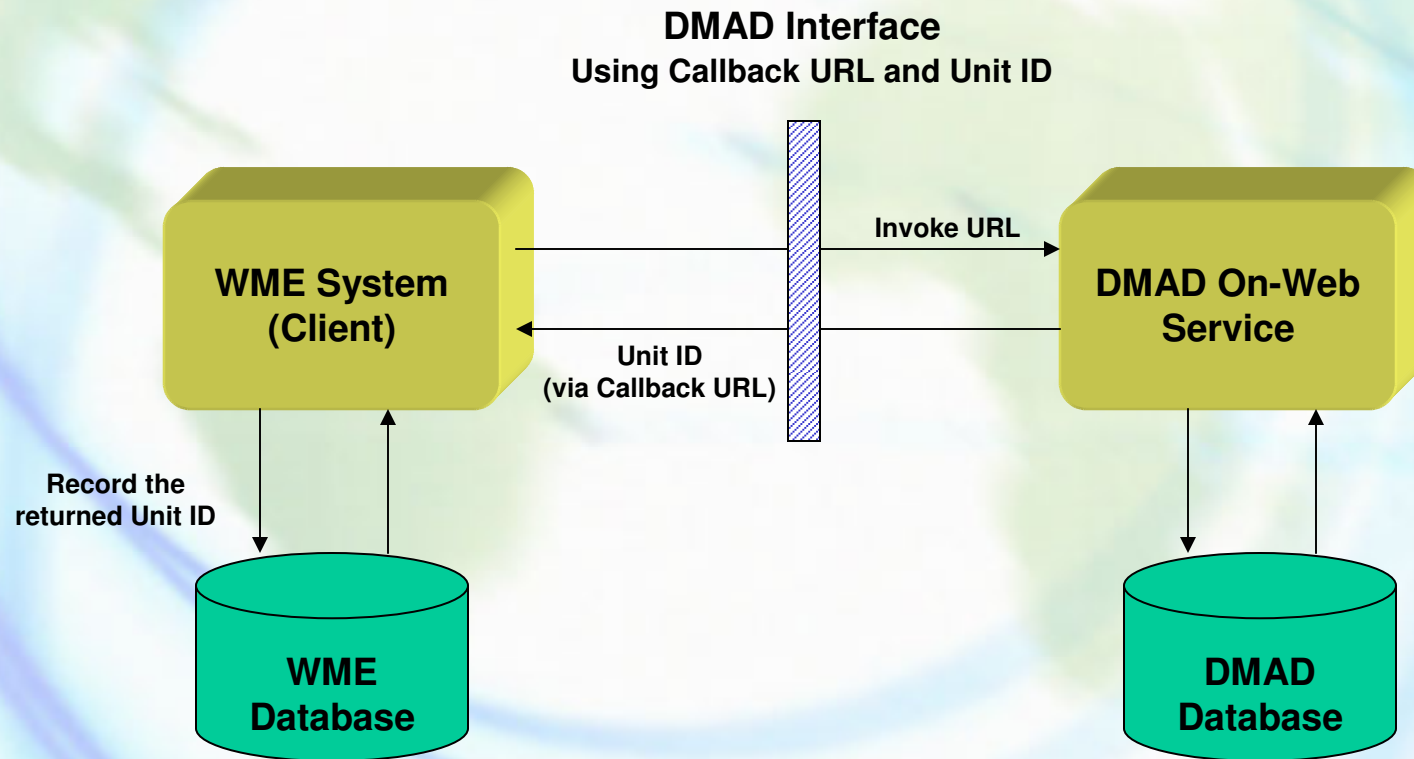


On-Web Service

- ✓ Client systems use DMAD by invoking it on the Web via well-defined forward and call-back URLs.
- ✓ DMAD Interface: the purpose of this interface is to isolate the two systems (Web Service and Client Service) that are being connected by this interface.
- ✓ Thus, The DMAD Interface will capture all the info of interaction between the Web Service and Client Service.

Integrating DMAD with WME

(DMAD as On-Web Service in WME)



Integrating DMAD with WME (Cont.)

➤ Procedures:

- ✓ DMAD is invoked via a URL to author a new "Assessment Unit". This URL will receive POST or GET data including a "callback URL".
- ✓ The user can author (or import/export) questions in "Assessment Unit" and a new "UnitID" will be generated for the stored Assessment Unit.
- ✓ When authoring ends, the user will be redirected to the callback URL using something like (...?UnitID=...) appended at the end of it.
- ✓ This call back URL is a program that knows how to take the UnitID and records it in the database for the WME page involved.

Assessment Markup (MAML) and Interoperability

- ✓ MAML is a Mathematics Assessment Markup Language for DMAD.
- ✓ DMAD system aims to support interoperability and inter-communications with other applications on the Web. Thus, many DMAD functionalities are accessible as Web Services.
- ✓ So, a well-defined API (Application Programming Interface) is needed to communicate and serve other applications on the Internet to achieve this goal.
- ✓ This XML markup language MAML (Mathematics Assessment Markup Language) will be used to represent assessment questions and exams and to transmit assessment questions to and from DMAD.
- ✓ MAML defines markup *elements and attributes* such as question head, type, classification, body, rubric, and so on.
- ✓ DMAD Web services will receive and return MAML encoded data.
- ✓ The XSLT style sheet for MAML (maml.xsl) will be responsible to translate MAML markup into XHTML + SVG + MathML.

MAML (cont.)

- Multiple Choice Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="maml.xsl"?>
<dmad>
<question type="multiple_choice">

<q_head>
  <author>Johe Bob</author>
  <keywords>Measurement, Area, Rectangle </keywords>
  <classification>Plan Geometry</classification>
  <answer>choice 2</answer>
</q_head>

<q_body>
  <q_text>What is the Area a rectangle with height=h and base=b?</q_text>
  <q_diagram>
    <svg xmlns="http://www.w3.org/2000/svg">
      <rect x="100" y="20" width="40" height="60" />
    </svg>
  </q_diagram>
</q_body>
</question>
</dmad>
```

MAML (cont.)

• Multiple Choice Example (Cont.)

```
<q_choices>
  <choice id="1">
    <math xmlns='http://www.w3.org/1998/Math/MathML'>
      <mi>h</mi><mo>+</mo><mi>b</mi></math>
    </choice>
  <choice id="2">
    <math xmlns='http://www.w3.org/1998/Math/MathML'>
      <mi>h</mi><mo>*</mo><mi>b</mi></math>
    </choice>
  <choice id="3">
    <math xmlns='http://www.w3.org/1998/Math/MathML'>
      <mi>h</mi><mo></mo><mi>b</mi></math>
    </choice>
  <choice id="4">
    <math xmlns='http://www.w3.org/1998/Math/MathML'>
      <mi>h</mi><mo>/</mo><mi>b</mi></math>
    </choice>
</q_choices>

</q_body>
</question>
</dmad>
```

Conclusions and Future Work

- The DMAD system aims to be an effective and easy to use assessment tool for mathematics education.
- A systematic way of authoring, importing, customizing, and exporting assessment materials can help create an environment in which usage and experience can accumulate and mutually reinforce.
- In fact, we have long way to go to add features and more improvements to DMAD system to make assessment materials ready to deploy on the Web, to conduct tests online, to provide grading help, to generate performance statistics, to provide diagnostics and to suggest remedial materials, while making tests and scores private and secure, controlling access to tests and results.

Conclusions and Future Work (Cont.)

- Our goal is to put DMAD under extensive trial in schools and collecting feedback and suggestions from teachers, students, school administrators and education experts to help us evolve DMAD.
- As more schools adopt WME and DMAD, the distributed nature of DMAD will be demonstrated in realistic situations.

Demo and Q&A

- **Take a look..**

<http://wme.cs.kent.edu/kimpton/assessment/>

<http://wme.cs.kent.edu/develop/kimpton/>