OPUS One

An Artificial Intelligence - Multi Agent based Intelligent Tutoring and Adaptive Learning Environment

September 2009

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Concept and Implementation Philosophy

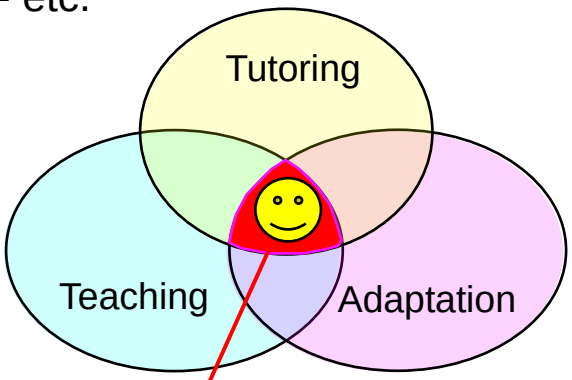
Vision and Research finality – Global Overview of Concept Objectives

Tutoring

-AI-,Profile-, Subject Matter based
-Human Tutor support
-Real time "AI-Behavior Recorder"
-Rule Engine, Rules based
-Subject Matter Knowledge base
-Allows Human Tutor interventions
-Selectable "Surveillance Modes"
- CTAT based Hint facility
- etc.

Teaching

-Pedagogical "freedom"
-Teaching habits
-ID Model transparency
-Collaborative functions
-Authoring tools
-Context based hint facility
-"One on one" facility
- etc.



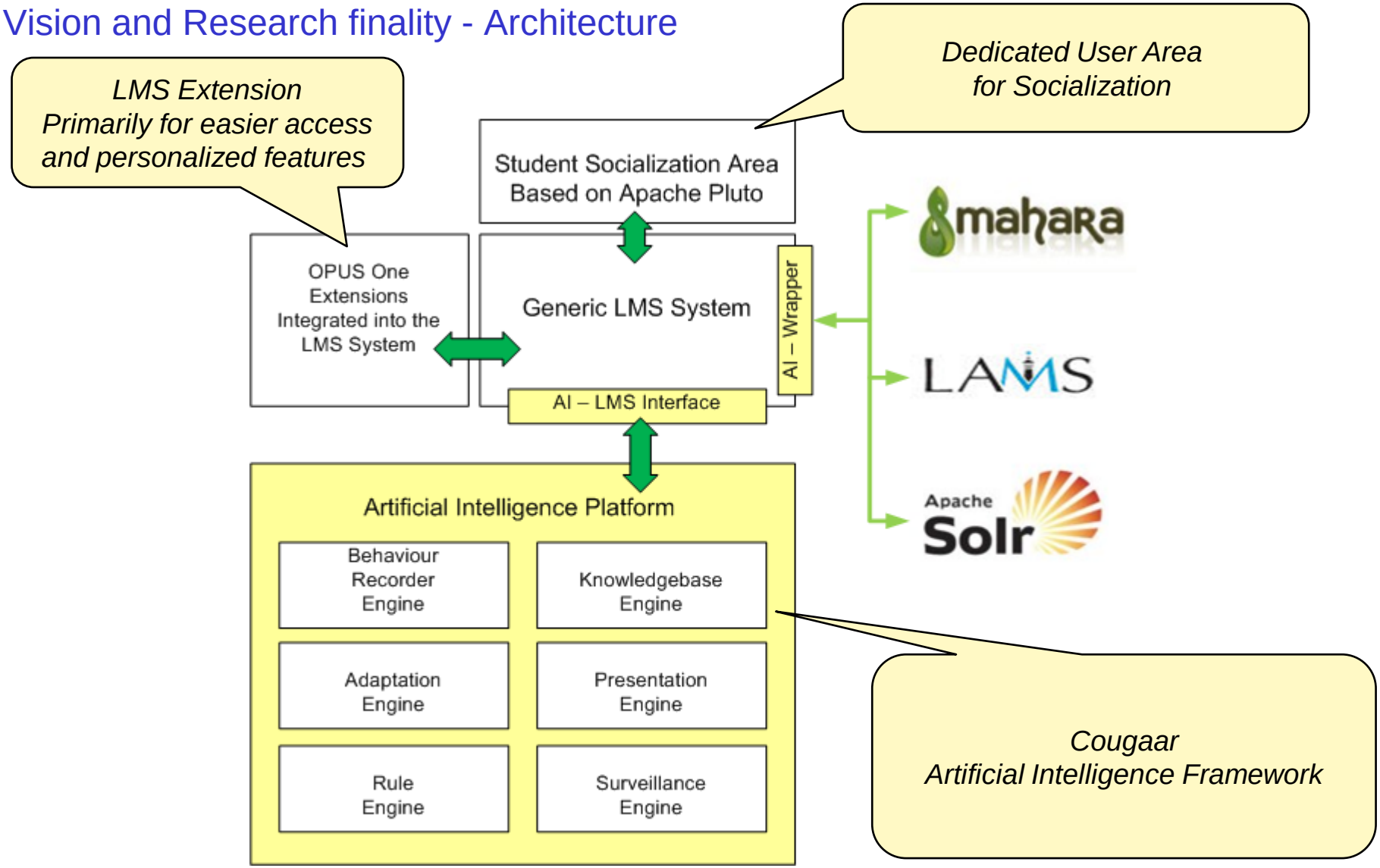
Adaptation

-Tightly coupled with Tutoring
-Human Tutor interface
-Own Presentation-, Adaptation Engine
-Rule Engine, Rules-, Profile based
-Dynamic Course-, Navigation structure modification
-Selectable "Adaptation Modes"
-etc.

Student or Group (called "Learning Entity") centered
Focusing on Learning Success and Student Satisfaction

Concept and Implementation Philosophy

Vision and Research finality - Architecture

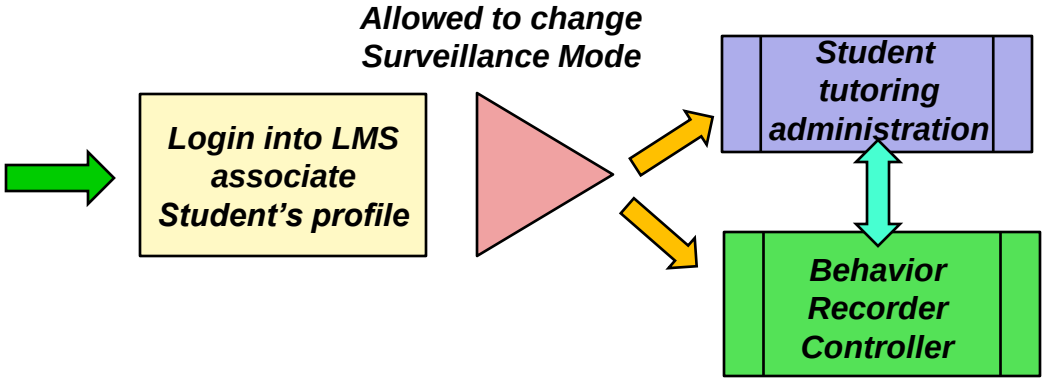


OPUS One – OLAT LMS extensions

Student Environment and Characteristics

- Profile driven with synchronized Course curriculum

- Mode selection
. Tutoring Mode (if enabled in profile)
. Surveillance Mode only
e.g. Logging, Tracking and Behavior recording in silent mode
. Walk trough Mode (standard mode if tutoring disabled in learner profile)
Walk trough Mode can be considered as standard LMS (OLAT) exercise mode



OPUS One – OLAT LMS extensions

Student Environment and Characteristics
extended "native" LMS functionalities

-Personalization

. Personalized "Home Page" with the following features :
- My Courses
- My Groups
- My Tutors per Course / I am Tutor in Courses
- My Achievements, my Grade book
- My e-Portfolio
- My Tutoring Section (autonomous Window)
- My News , Messages and Dashboard

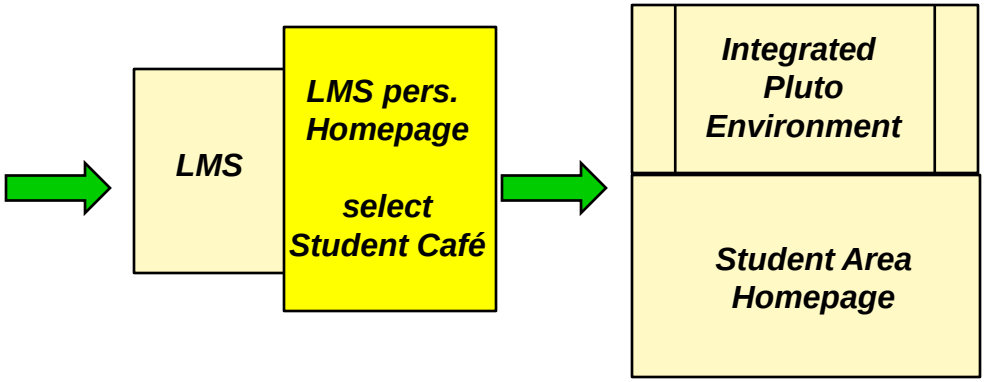
. Personal Folder / Personal Resources / Free Open Courses Catalog by Faculty

OPUS One – OLAT LMS extensions

OPUS One additional functions

. ***Global Student Area***

- *Student Cafe / Global Forum / Global Wiki etc.*



OPUS One – OLAT LMS extensions

OPUS One additional specialized functions

- ***Bidirectional asynchronous Wrapper***
  Tight integration of external systems for bidirectional Data- / Data structure transfer

- ***Chat and Scribe collaborative Function***
  The Scribe Activity is used in 'dual-screen' roles, such as with a Chat activity it allows a group of Learners to collaborate and create a written collaborative document describing the outcomes of a chat session including features like attachment uploads, scheduling of subsequent activities etc.

- ***Group based Video conferencing facility using DimDim***
  Tight integration of DimDim Videoconferencing facility as collaborative Group function as part of a Course.

- ***Text analyzing Agent***
  Allows to analyze "any type of free form text" from collaborative activities based on predefined rules and associated parameters like :
  - presence and sequence of terms
  - amount of words, number of modifications, number of interventions
  - search activities (internal, external)
  etc.

OPUS One – OLAT LMS extensions

OPUS One future functions (alpha-/beta state)

- ***Graphical Course Editor***
  Development of a graphical interface for the OLAT LMS course editor allowing to build courses using "drag and drop"

- ***Subject Matter (CTAT) Hints Authoring Tool***
  Development of an easy to use authoring tool to create "subject matter" specific tutoring- / adaptation rules

- ***Subject Matter course simulator***
  Development of a script based course simulator, able to react on predefined "misconception" conditions to test the tutoring-/ adaptation reaction of the AI system.

Concept and Implementation Philosophy

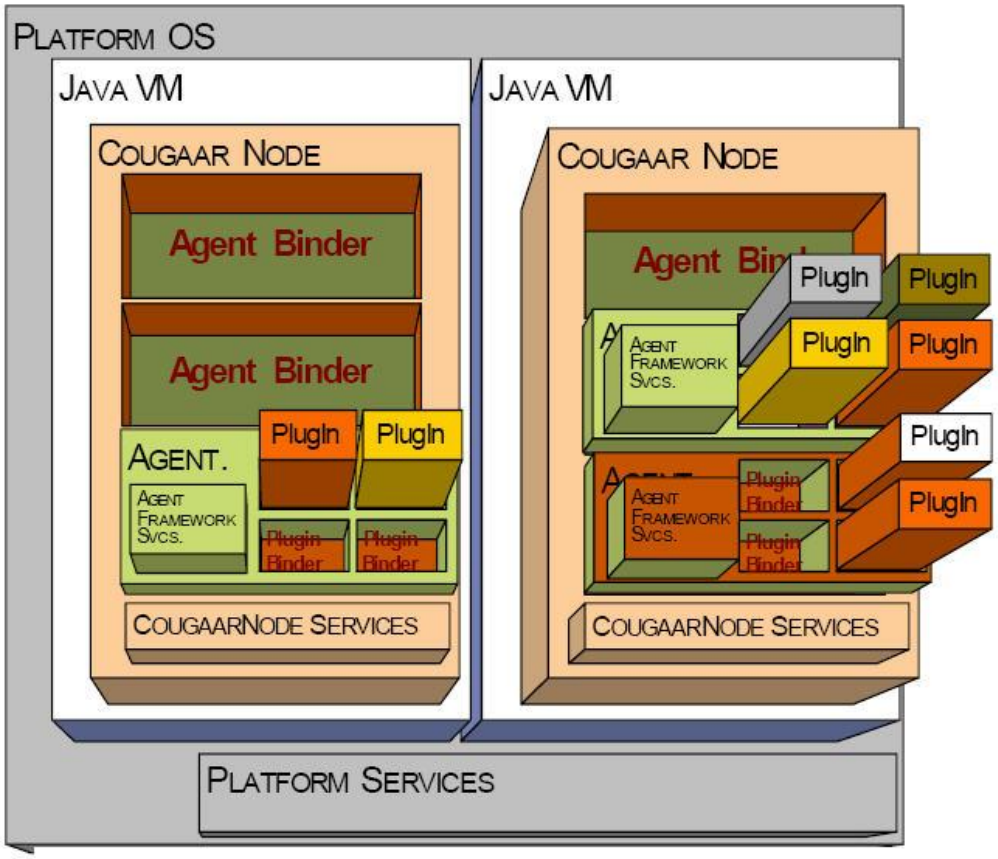
Vision and Research finality – How to make an Agent dedicated

Cougaar plugins are software components that provide a specific piece of application business logic to the agent

The behavior of an agent depends primarily on its set of loaded plugins.

Agent profiles are parameter structures intended to characterize the agent in question.

OPUS One - eTutor profiles are developed and loaded as Cougaar plugins



Concept and Implementation Philosophy

Our "Learning Path Adaptation" Approach

Why adapt →

. To ensure personal learning success
Target driven, Student centered, considering actual knowledge, learning style

When adapt →

. On recognized situations of "learning difficulties"
. On recognized "under performance" compared to "subject matter" specific performance indicators defined in the profile.
. On the learners personal request.

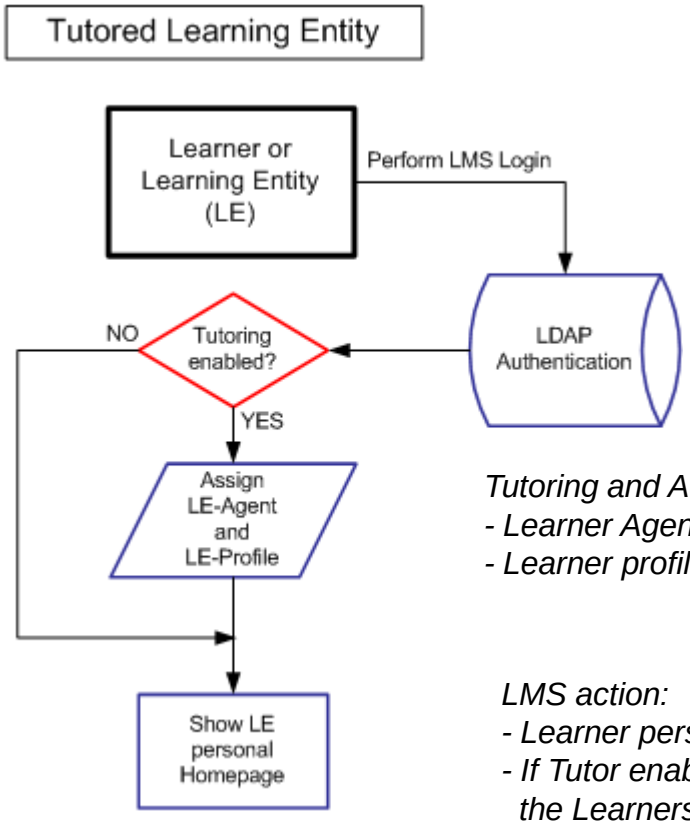
What adapt →

. The content presented according to a predefined profile, driven by "subject matter" adaptation rules
. The actual "learning path" of the learner according to his profile and "subject matter" adaptation rules
. Additional "subject matter" content upon the learners personal request

How to adapt →

. Based on profiles and rules by the AI – adaptation agent community
. On "Human Tutor" intervention request via AI - API
. On the learners personal request defining his personal learning approach via AI - API

Concept and Implementation Philosophy



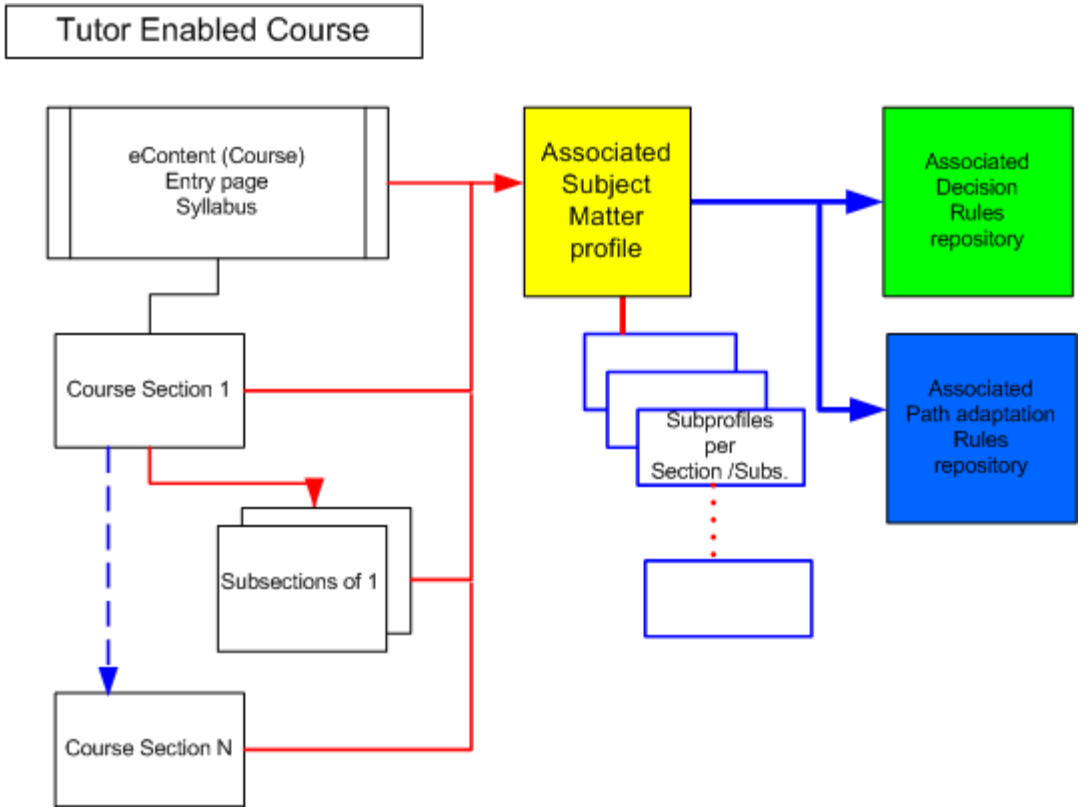
To be "Tutoring and Adaptation" enabled Learner (LE) must be :
- *Personal profile*
- *Subscribed for a "tutored" Course*
- *Have a "curriculum" (e-Portfolio)*

LDAP – Authentication profile:
- *Learner tutoring parameter extension*

Tutoring and Adaptation setup actions:
- *Learner Agent will be selected and activated*
- *Learner profile associated to the LE Agent*

LMS action:
- *Learner personal (personalized) Homepage presented*
- *If Tutor enabled additional tutoring functions enabled in the Learners Homepage*

Concept and Implementation Philosophy

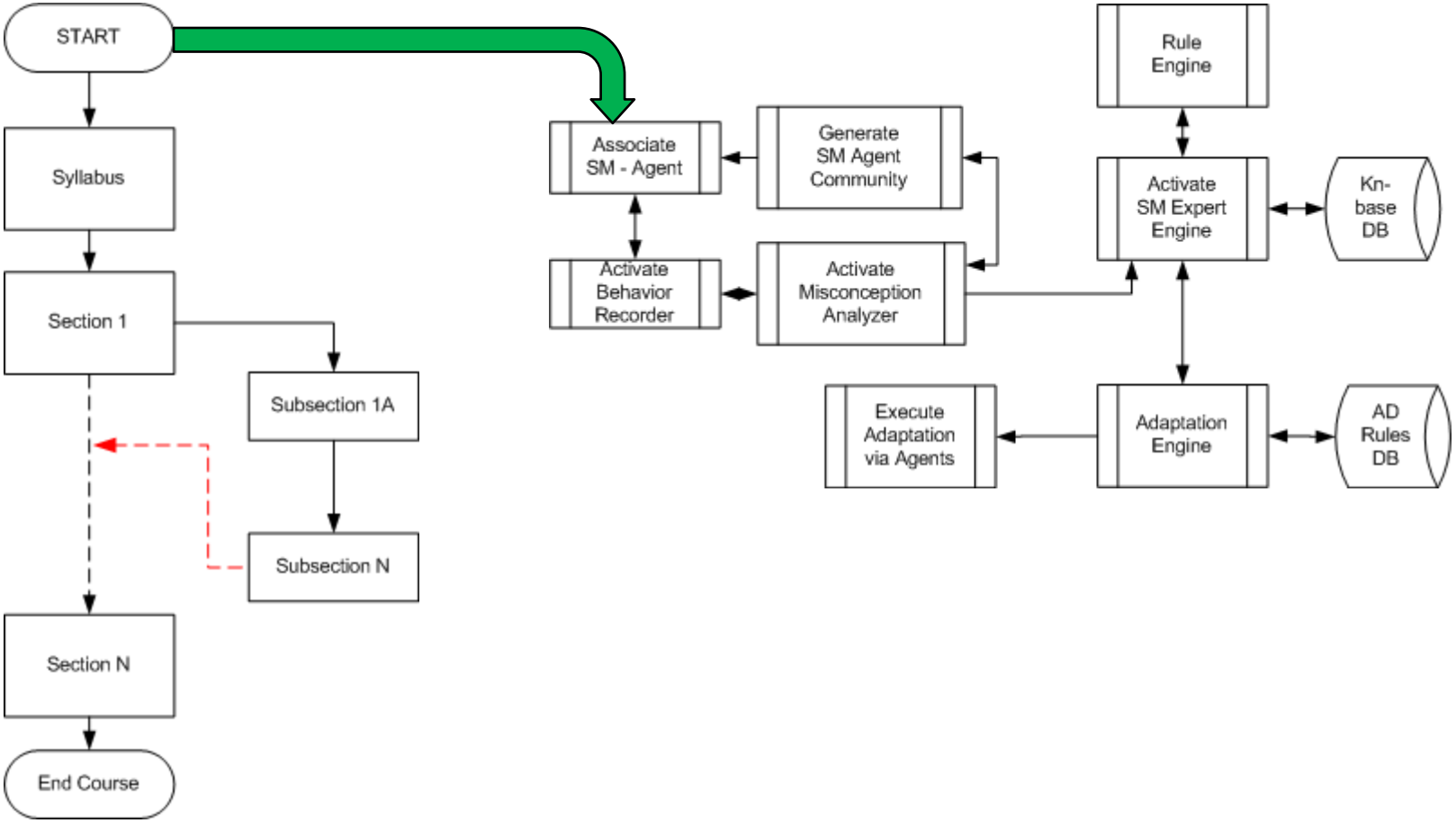


A Tutor enabled Course consists of:
- *Standard LMS Course*
- *AI Course Wrapper*
- *Main "Subject Matter" Profile and associated Sub profiles (per Section)*
- *Linked "Decision rules"*
- *Linked "Path adaptation rules"*
- *Misconception Surveillance*

Concept and Implementation Philosophy

OLAT - LMS Course Environment

OPUS One Tutoring and Adaptation Environment



"personalizing / adapting" Concept

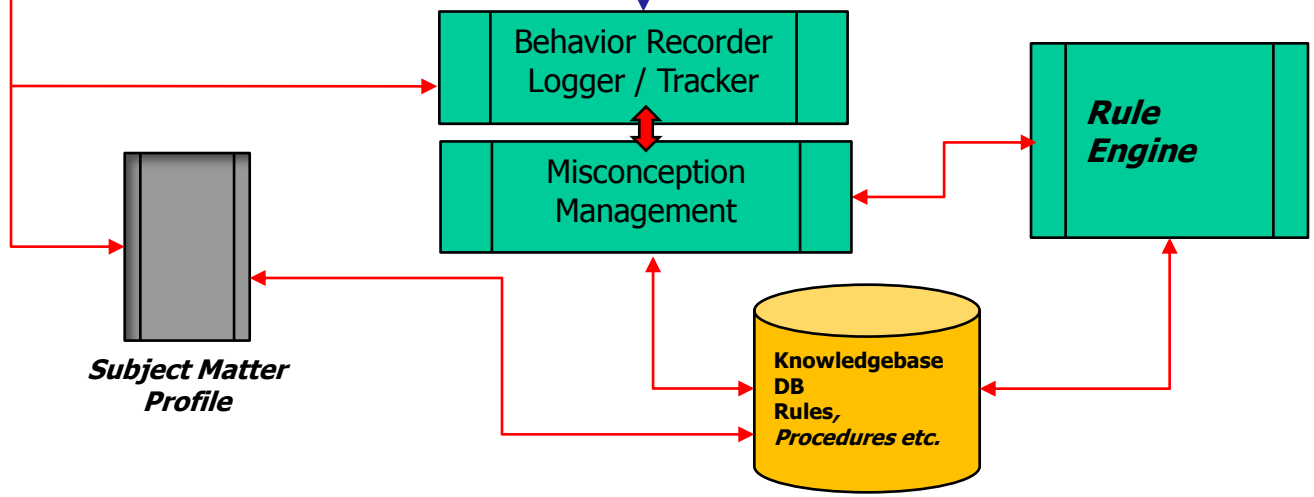
Tutor enabled , adaptive "Subject Matter"

Course section example

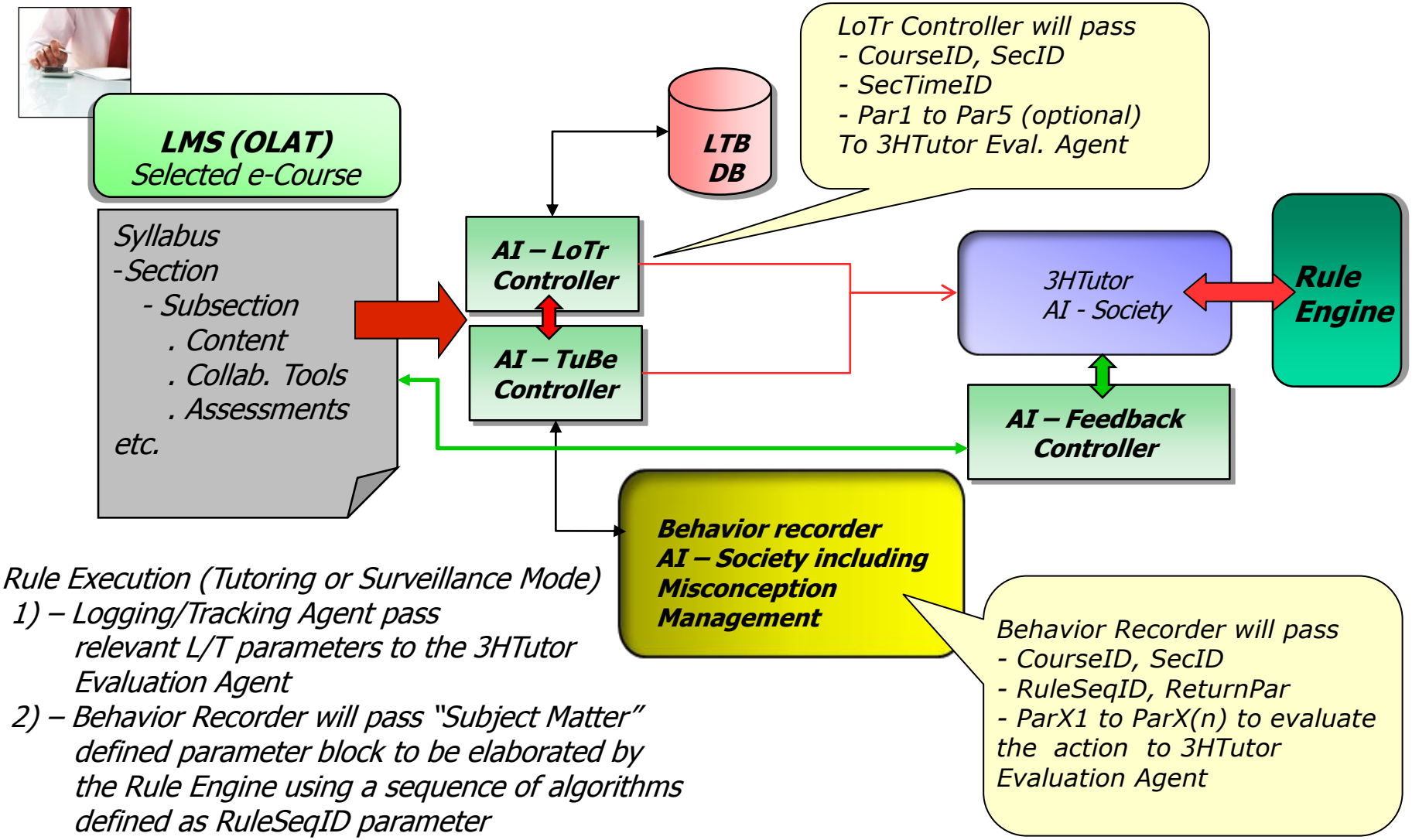
-Section 08
- Subsection 08.1
. Go to HTML page
- Read (page)
. Download PDF doc.
. Discuss File
.....

"Tutor enabled, adaptive" content :

- Profile controlled
- DB based Logging and Tracking
- Behavior Recorder enabled
- Behavior-, Knowledge driven "Learning Path" adaptation
- Section- / Subsection- and Element based deficiency management (Misconception detection and associated actions)
- Event based Rule Authoring and Execution



Cognitive Tutor Concept



Rule Execution (Tutoring or Surveillance Mode)

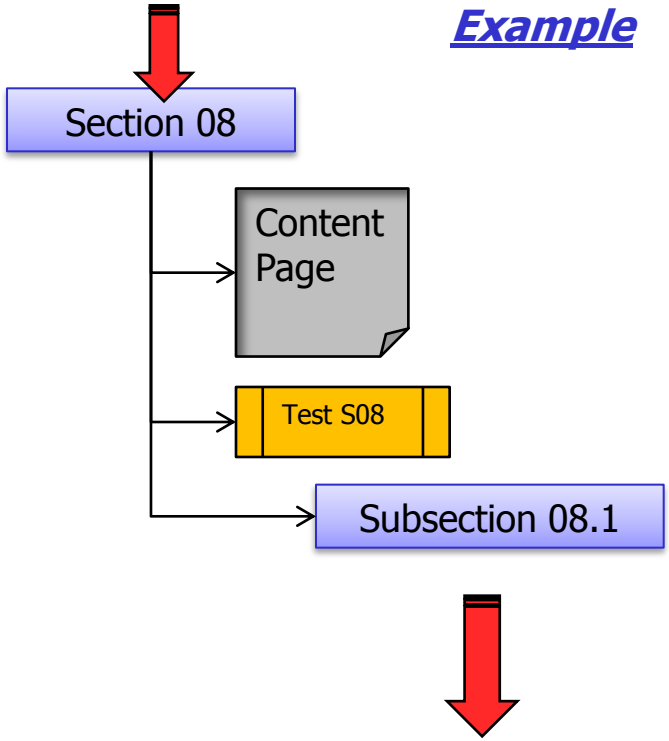
1) – Logging/Tracking Agent pass relevant L/T parameters to the 3HTutor Evaluation Agent

2) – Behavior Recorder will pass "Subject Matter" defined parameter block to be elaborated by the Rule Engine using a sequence of algorithms defined as RuleSeqID parameter

"Adapting Learning Path" Concept (1)

based on the OLAT LMS Platform

The control structure for the "learning path adaptation" is based upon the OLAT course structure and its access and visibility mechanism. We use here the "Score" approach. 3HTutor and its OLAT interface Agents are able to dynamically adapt / modify this parameters based on defined rules, driven by "Student Course activities", transformed in parameters by the "Behavior Recorder" and "Misconception Manager".



Example

Min. Entry Score	*Finish Score*	*Add. Score*
800	**N.A**	**N.A**
800	**10**	**N.A**
810	**N.A**	**Test dependent**
850	**N.A**	**N.A**

The Student will be allowed to follow the original "Learning Path" if he achieve the minimum scoring predefined per Section, Subsections and Course Elements , the score of the single course elements will be considered for possible adaptive actions .

"Adapting Learning Path" Concept (2)

Trace - / Log and Evaluate Example with 3HTutor System

Actual Student course curriculum-score is - 820

-Section 08
- Subsection 08.1
. Go to HTML page
- Read (page)
. Download PDF doc.
. Discuss File
- as collab. Assignment
. Test
*** end Subsection*

Requested Entry score set to 810

Content Element "Read Page" score credit set to 5
- Control param are : - Entry in element
- min read time 120 sec.

Content Element "Download elem." score credit set to 5
- Control param are : - Entry in element
- Download successful.

Content Element "Discuss File" score credit set to Var.
- Control param are : - Entry in element
- Text evaluation (AI –text agent)
- Human Tutor final evaluation.

Content Element "Test" score credit parameters set to
. Min. score to pass / Max. score (example: score 50).
. Control parameters are : - Test attempts
- Test responses / - sequence
- Time for completion
- Test score.

Min. score to pass Subsection : 60

Min. score for next Section: 870

"Adapting Learning Path" Concept (3)

What happens if : - Student globally fails minimum element score requirement

Example – Read page time less then specified

-Section 08
- Subsection 08.1
. Go to HTML page
- Read (page)
. Download PDF doc.
. Discuss File
- as collab. Assignment
. Test
*** end Subsection*

Base parameter structure

Content Element "Read Page" score credit set to 5
- Control param are : - Entry in element
- min read time 120 sec.

Actual Tracking parameters:
- Entry_element = true
- Total_time_element = 32

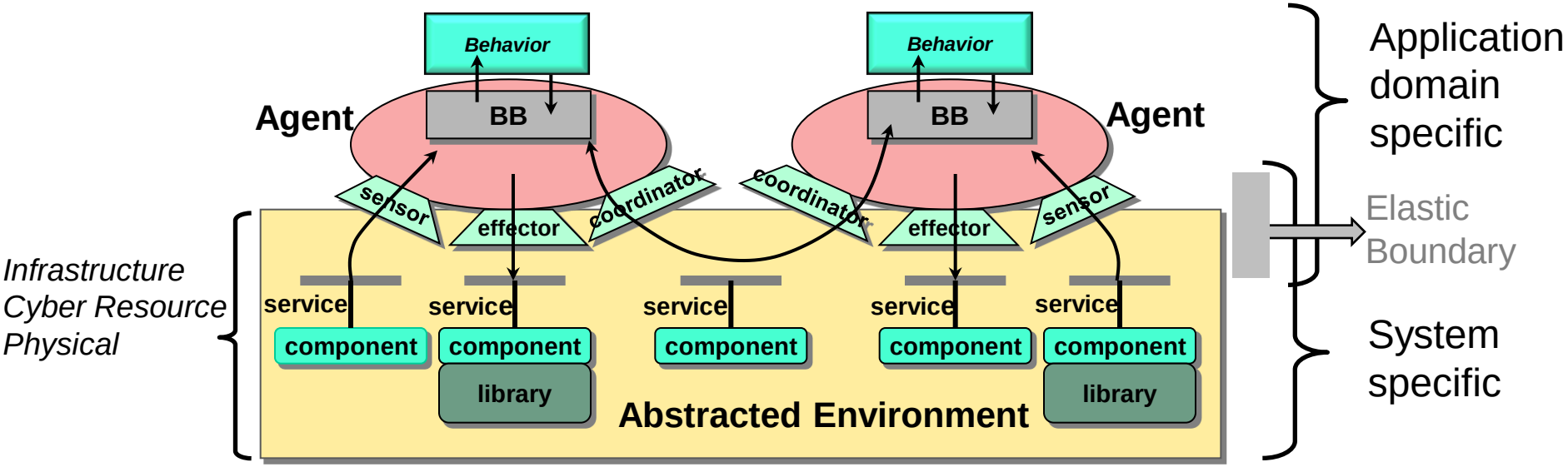
Rule Engine

Sec08_readp_01 rule :
IF Entry_el = true and
Tot_time >=120
then ret_cre = 5;
else ret_cre = 0

AI Subject Matter Agent
- Update ***curriculum*** Score
- if return Code false then activate tutoring activity according to "Subject Matter" profile

Do scheduled Tutoring action according to Subject Matter profile linked exception rules

Cougaar Agent Reference Model



Agents

- Local
- Behavior (plugin)
- State (BB)
- Pub/Sub (BB) API Black Board

Agent/Env. API

- sensor
- effectors'
- coordinator
- active API

Environment

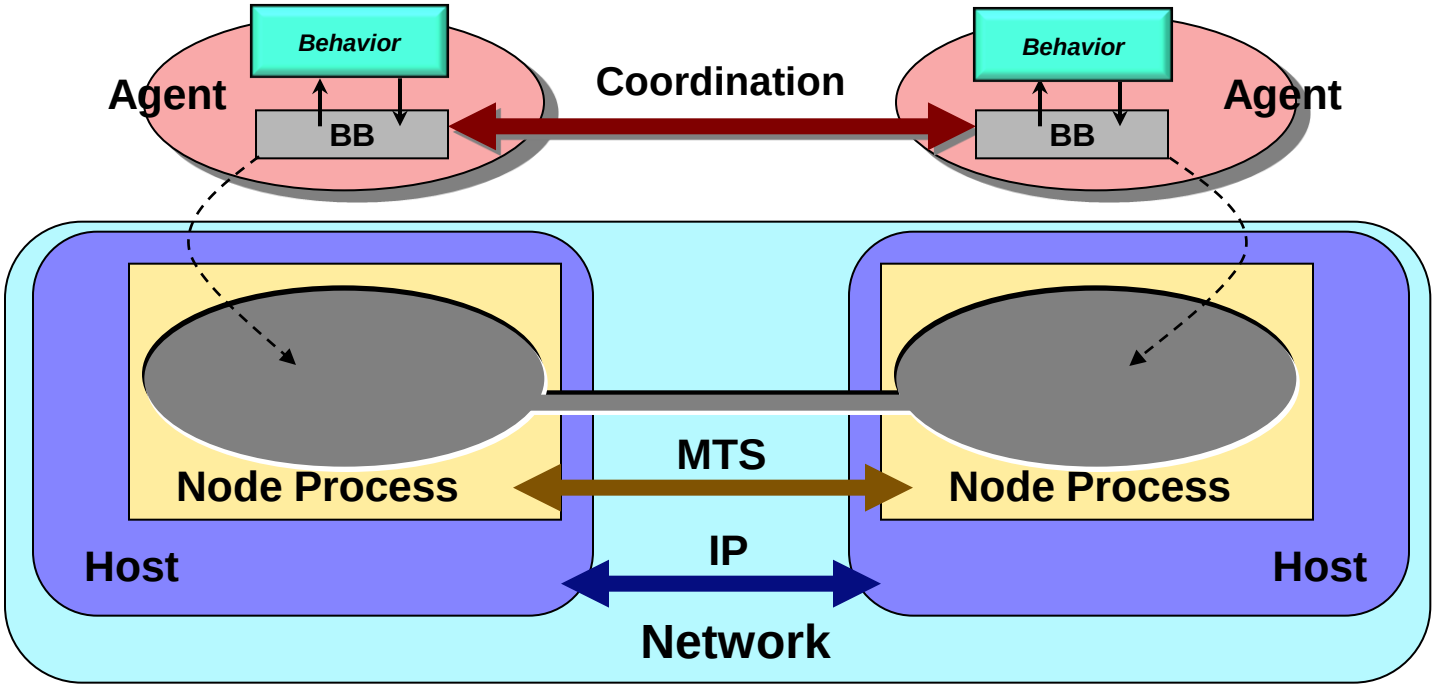
- Distributed
- Services
- Components
- Imported libraries
- Service oriented API

Separation of Application from Environment

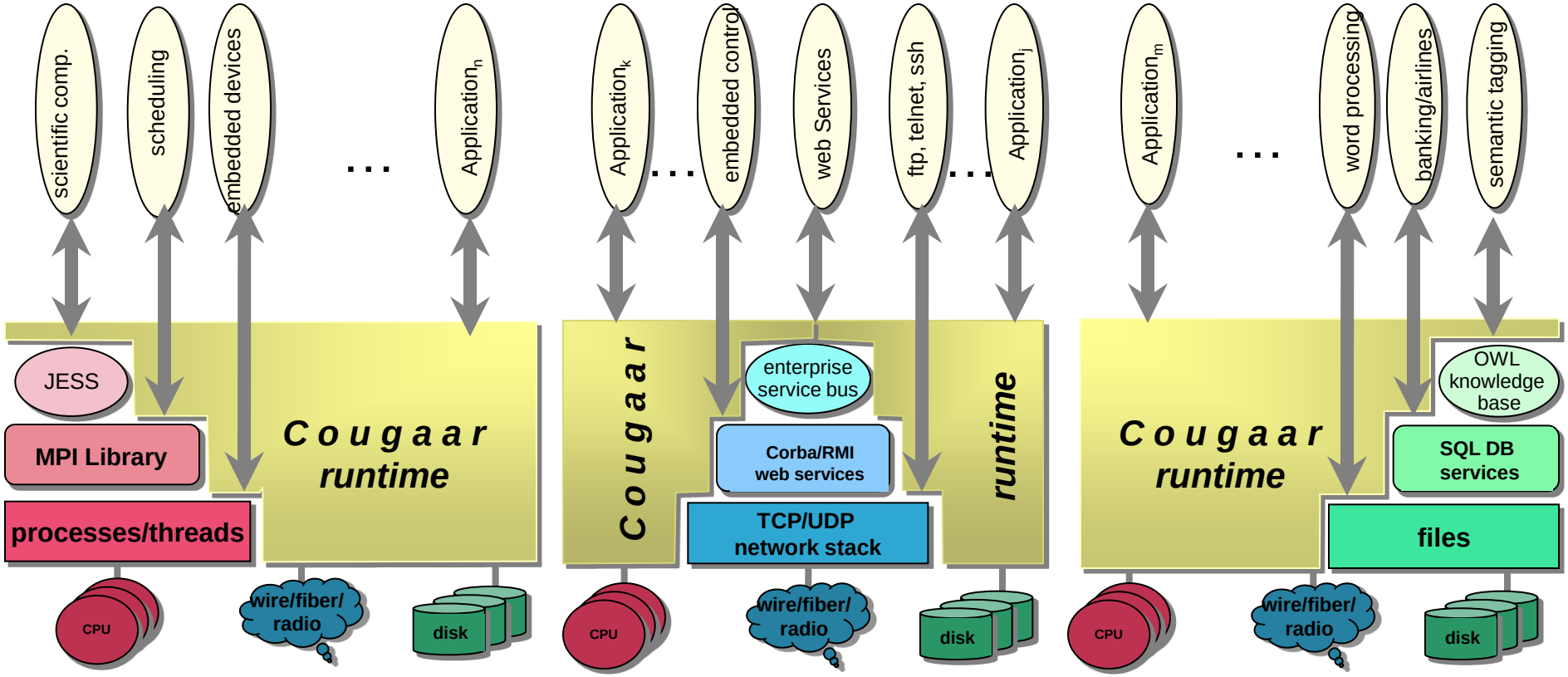
Agents handle Application Behavior

Environment handles Systemic Adaptation

Agents and Environment can be independently developed, tested, and configured, but run together



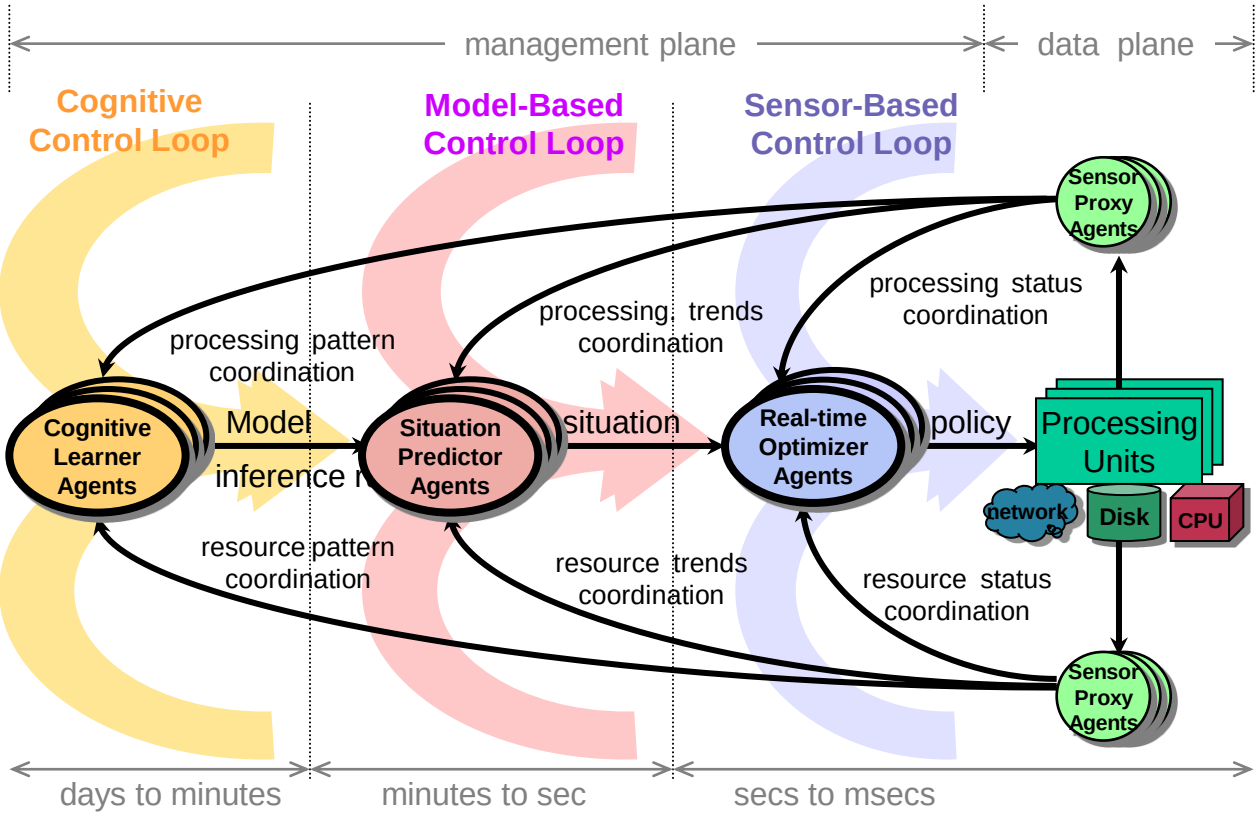
Integration with Legacy Systems



grid-based systems message-based systems DB-based systems

Main Cougaar architectural feature:
imported libraries and component wrappers

Architectural Mapping



Application

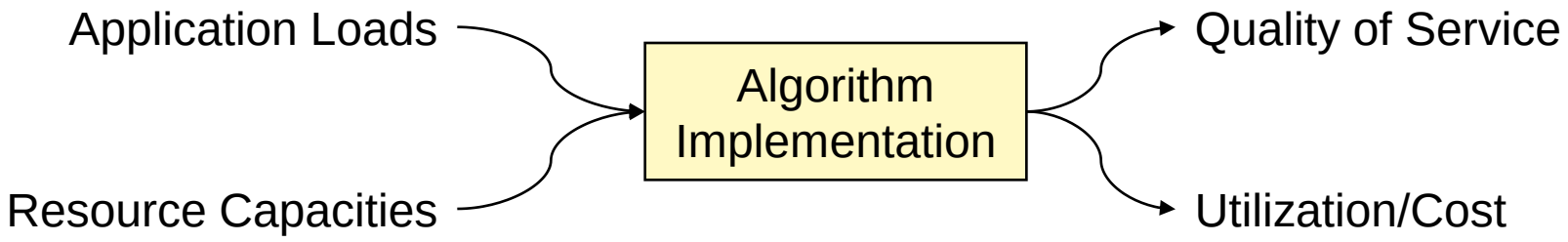
1. Functional modules (oval shaped)
2. Underlying distributed environment
3. Sensor to control loop coordination
4. Evolving degree of human involvement

architectural mapping →

Cougaar

1. Agent societies
2. Cougaar environment
3. Agent coordinations
4. Transitioning of control loops human to automation

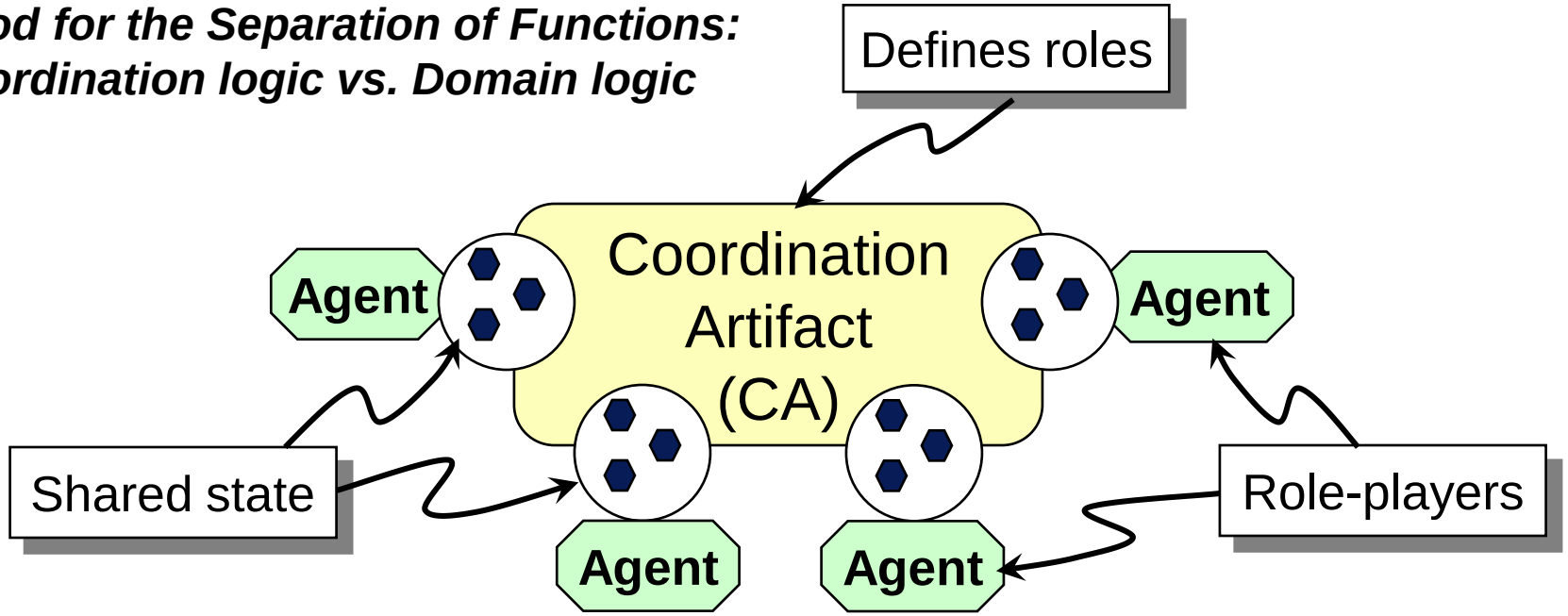
Agent Community Adaptation



- Adaptation picks the best implementation which meets the application QoS requirements within the resource constraints
- To make this tradeoff: adaptive systems must have:
  - Multiple implementations
  - Characterization of each implementation based requirement and constraint conditions
  - A mechanism for detecting the system's conditions
  - A policy for choosing which implementation given the conditions.
  - A mechanism for enabling the implementation

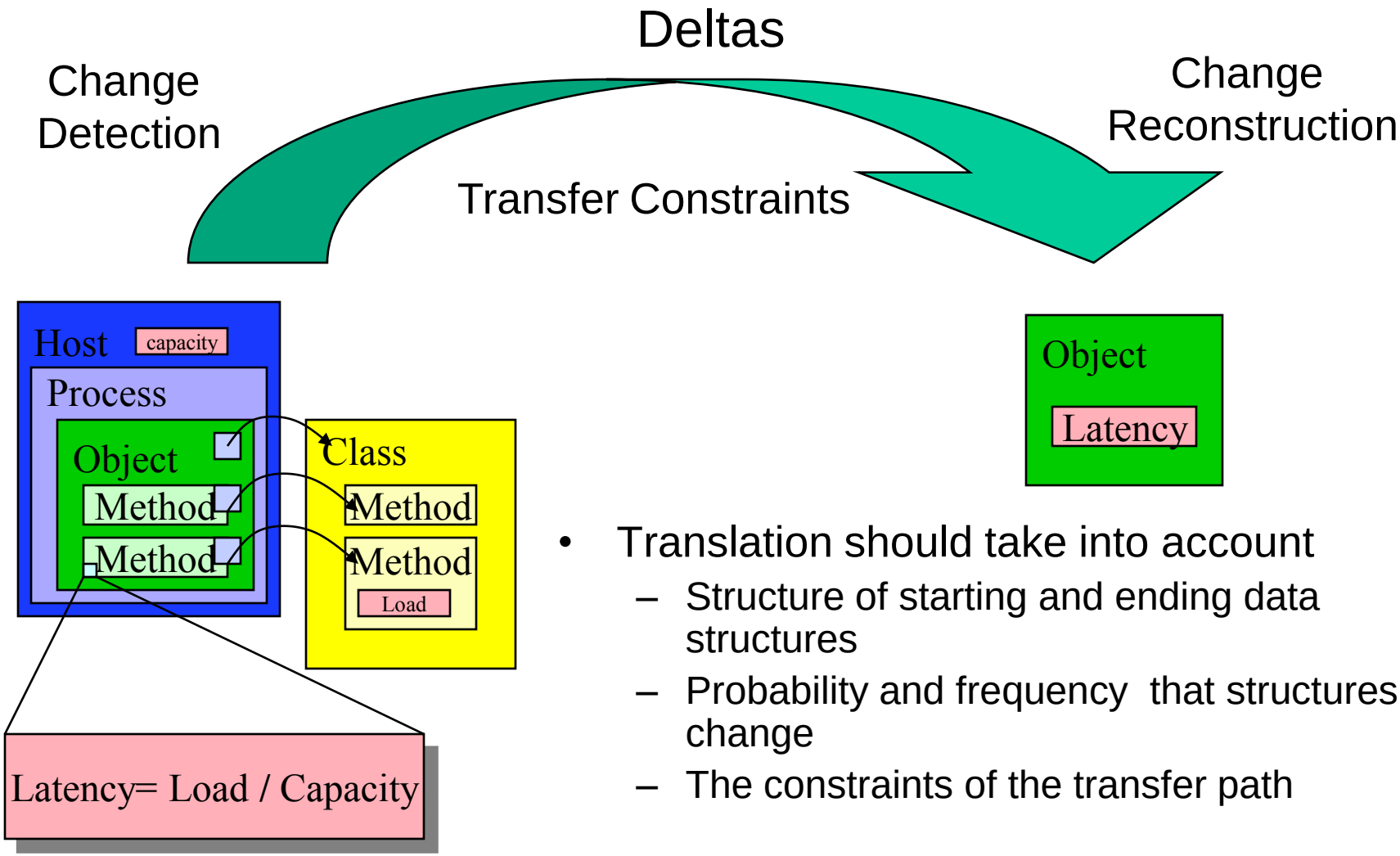
Support for Coordination Artifacts

Method for the Separation of Functions: Coordination logic vs. Domain logic



- Coordination Artifacts: CAs
  - Are first-class entities in MAS. They are designed to separate communication mechanisms from the domain-specific work of any given Agent
  - Define explicit roles for role-players
  - Offer shared state between the role-player & the CA
  - Coordinate behavior among role-players
  - Have distributed implementation

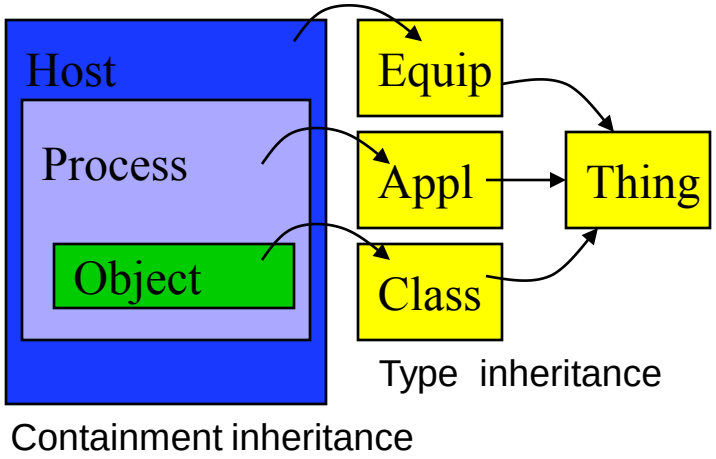
QoS-Adaptive Translation



- Translation should take into account
  - Structure of starting and ending data structures
  - Probability and frequency that structures will change
  - The constraints of the transfer path

Frame Set Knowledge Representation

- Java Objects are code generated
  - Frames and relationships defined using XML
  - Support multiple Java interfaces
    - Cougaar Blackboard,
    - JESS Shadow Facts,
    - Java Beans
    - Web Server
- Slot inference (Real-time)
  - Type (is-a)
  - Containment (has-a)
  - Visitor Pattern (composed-of)
  - Aggregation (summary-of)
- Relationships are also Frames
  - Benefits from Frame inheritance
- Meta-data tags
  - Defined at compile-time
    - Slots, frames, framesets
  - Example Slot meta-data
    - Type, default-value, units, path, doc, member, warn, immutable, notify-blackboard, notify-listeners, transient

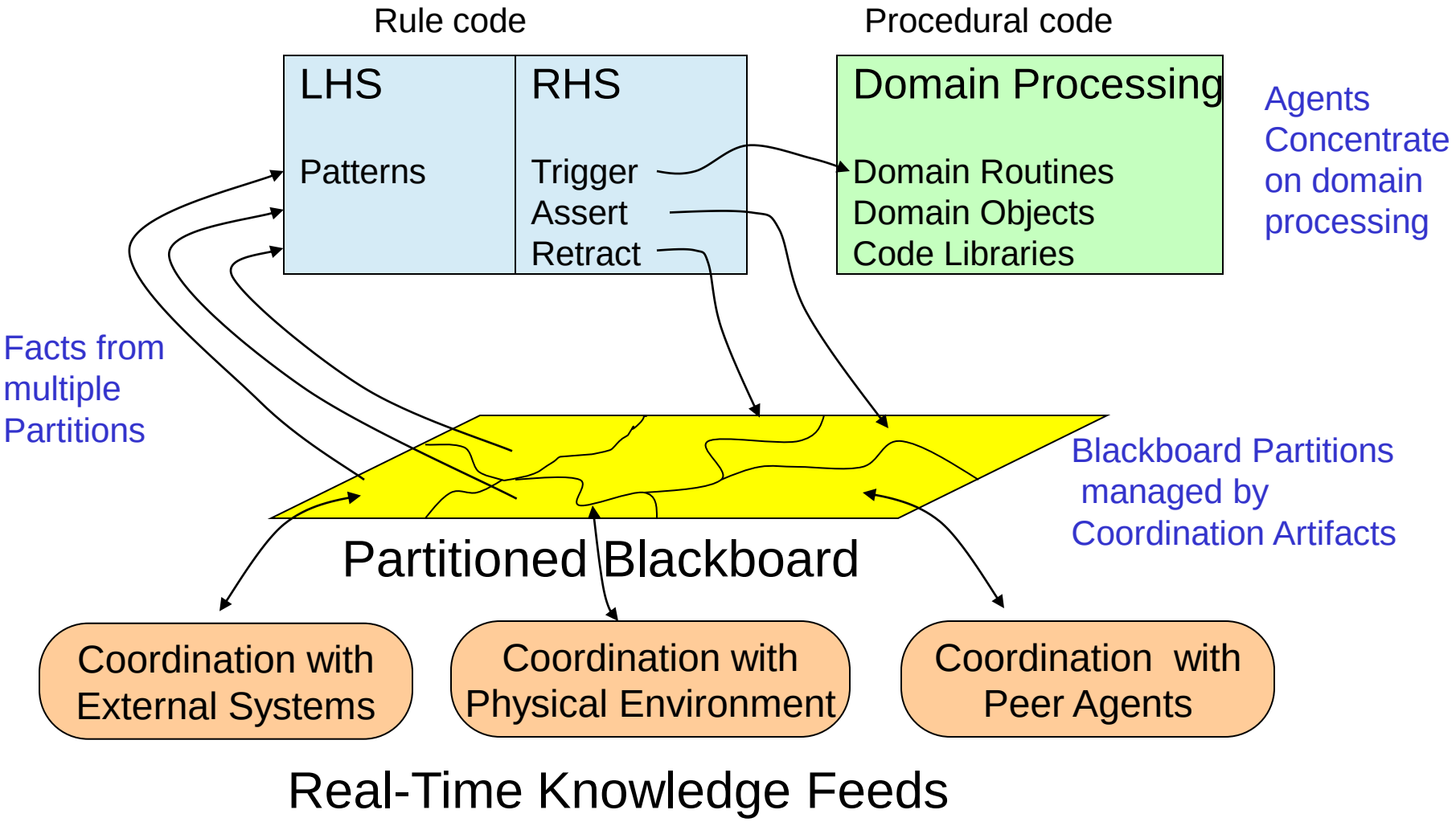


Frame
name value
name value
name value

Relationship
parent-name value
child-name value

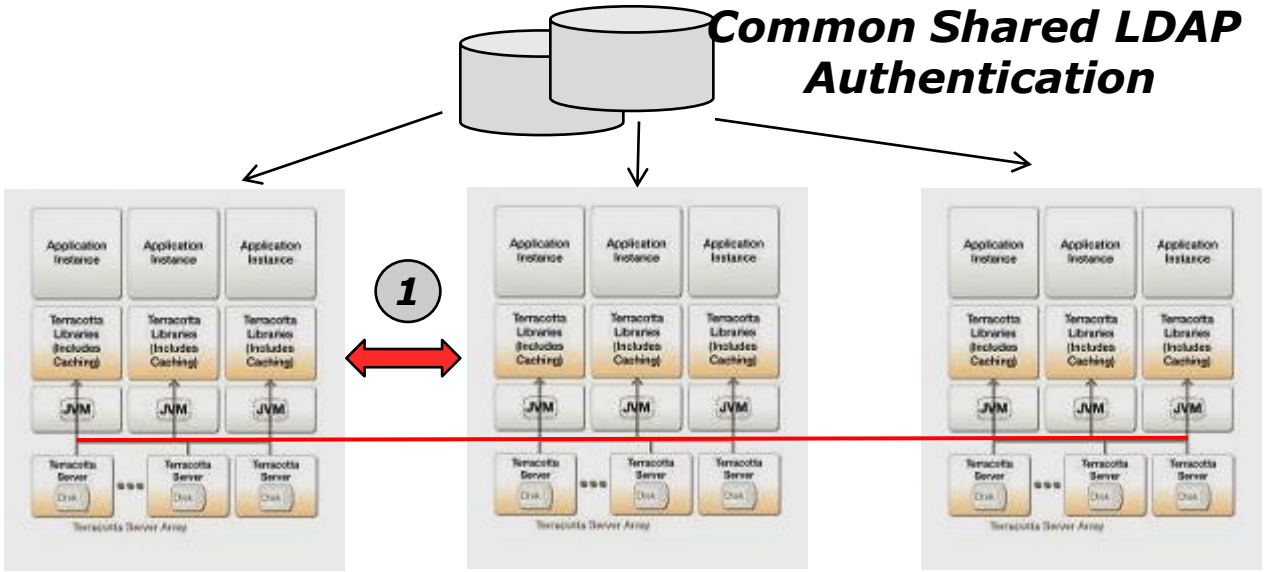
Multiple Knowledge Processing Frameworks

Agent Domain Processing



Conclusion - Where do we stand today

Preproduction Test System
Demo System scheduled availability end October 2009



OLAT / Tomcat6 Cluster

Cougaar AI - MAS Cluster

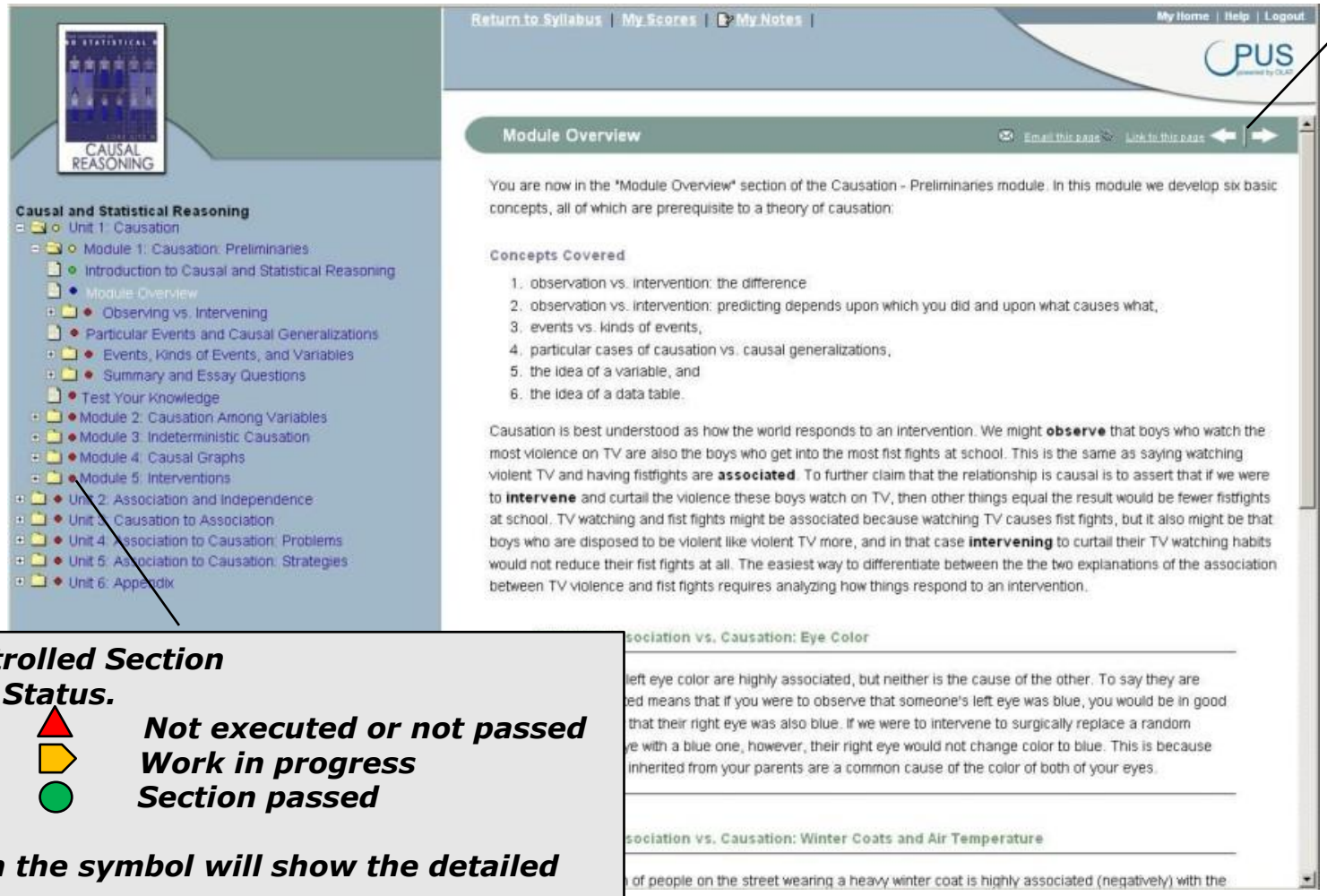
Pluto – Student Area
Mahara – e-Portfolio
SOLR – Archive Server

1) Tight Integration OLAT Cougaar AI – MAS via dedicated Agent - Portlets

Conclusion - Where do we stand today

eTutor enabled "Course page" OLI Layout on OPUS One / OLAT 6.1.x

Course
- Forward / Back function



eTutor controlled Section Subsection Status.

- ***RED*** – ***Not executed or not passed***
- ***Yellow*** - ***Work in progress***
- ***Green*** - ***Section passed***

-***Clicking on the symbol will show the detailed STATUS***

Conclusion - Where do we stand today

OLAT – 3HTutor Integration - eTutor Functions (OLAT Header bar)

3HTutor Status
Enabled ● */ Disabled* ▲

eTutor Function
Available eTutor functions are User profile depended.
Using the eTutor facility, a eTutor "enabled" User is able to switch between 3 eTutor – Modes :

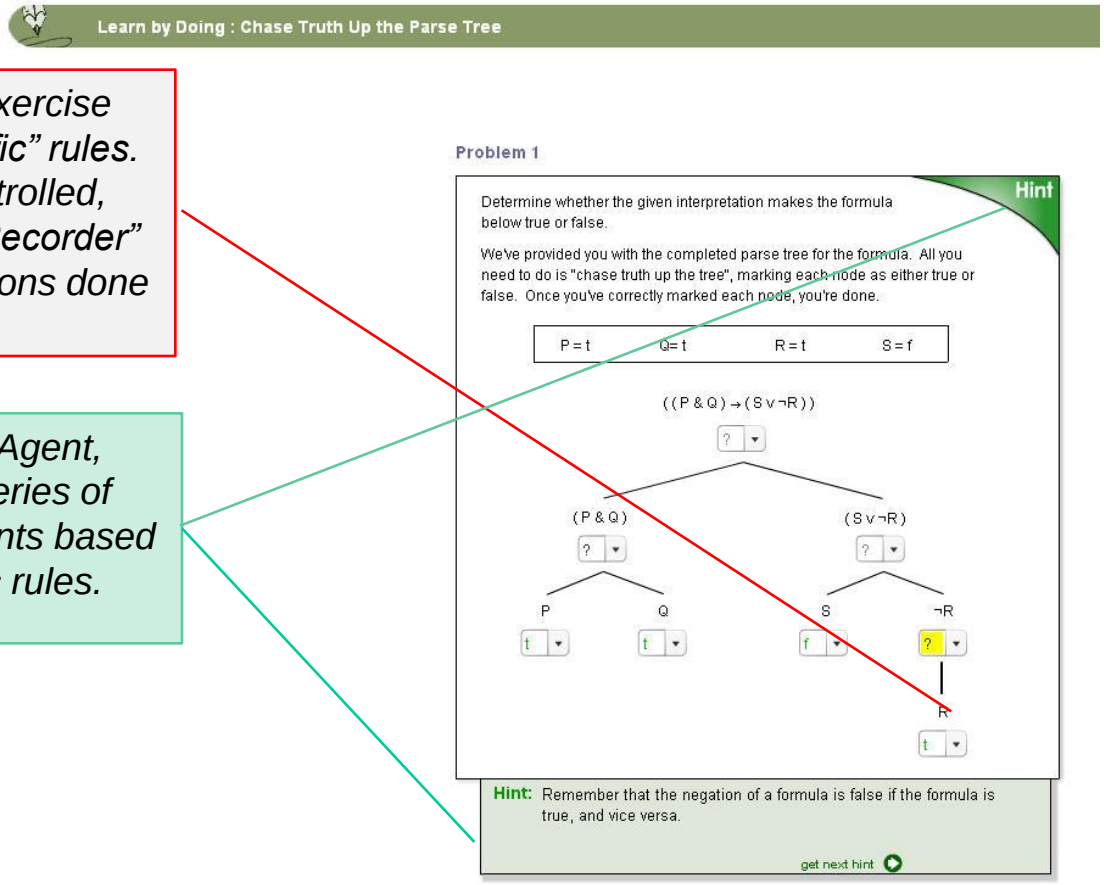
1) *eTutor active – request to adapt "tutoring" level (if allowed in the profile).*
2) *Request eTutor help – (Tutoring on demand function)*
3) *Switch to "Walk trough" mode – this means "Exercising mode" , an optimized "Exams" preparation mode.*

Conclusion - Where do we stand today

- *eTutor – Request "Tutoring on Demand" Example – Active AI Agent (3HTutor)*
- *Hint- / tutoring on demand is performed using the CTAT approach proposed by a dedicated presentation engine.*

eTutor request will open Exercise according to "Context specific" rules. The exercise has rule controlled, responses. The "Behavior Recorder" will log and supervise all actions done by the Student.

Context sensitive AI Hint Agent, will display a cascading series of problem context sensitive Hints based on subject matter specific rules.



Conclusion – Future developments

- *Research on standardization of the "Adaptation engine approach"*
- *Course construction using "dynamic reusable learning objects" loaded on demand from the learning object repository (DSPACE).*
- *Learning path creation using "Student personalized" schema approach*
- *Integration of GLO Maker interactive learning resources*
- *Make the 3HTutor environment LMS independent*
- *Generic independent bidirectional asynchronous Wrapper based on Cougaar AI-MAS Agent Community*
- *Integration interface for LAMS, Sakai 3 and Moodle*

THANK YOU FOR YOUR ATTENTION

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