Agent driven Peer-to-Peer Cloud Robotics

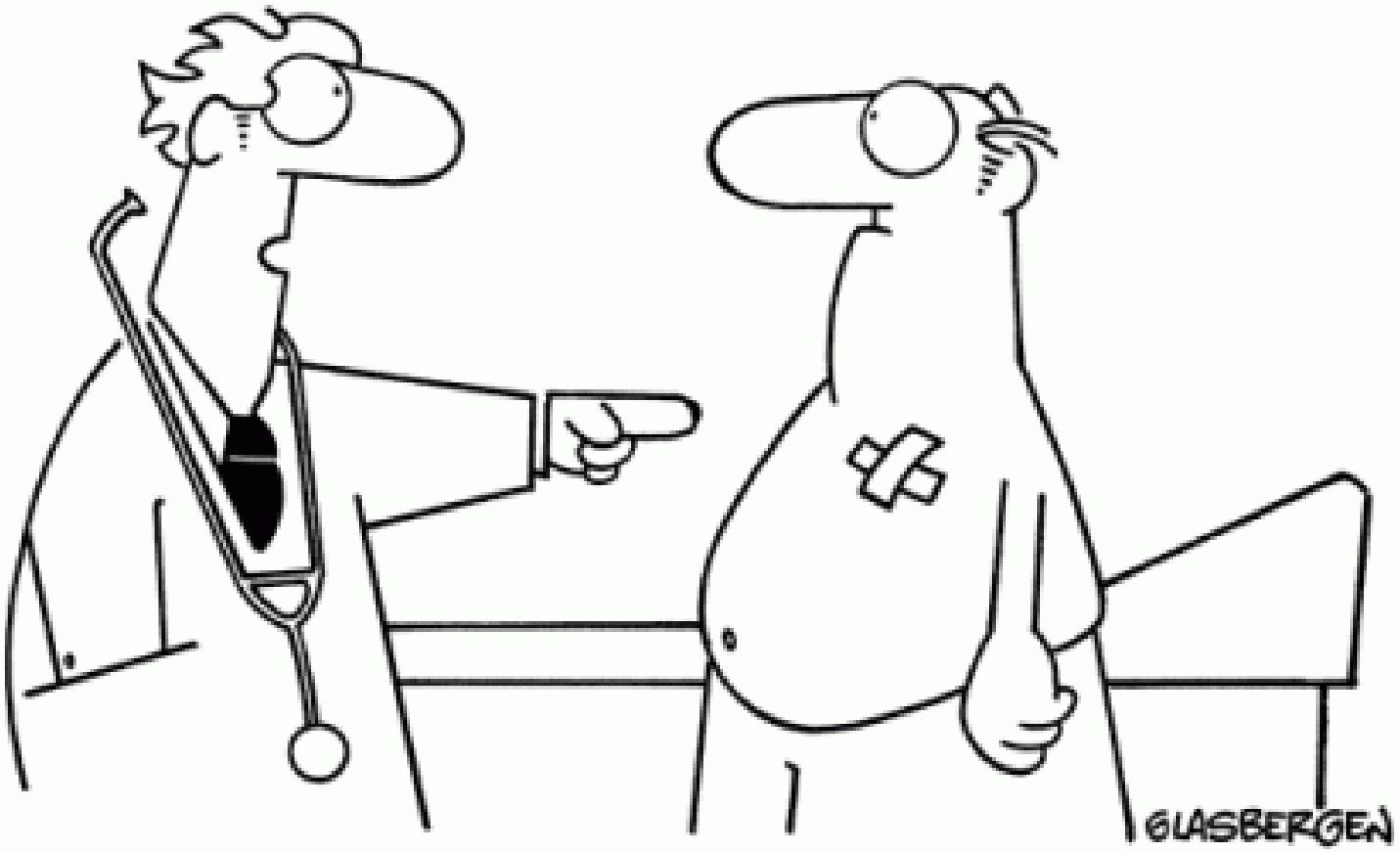
NAGRATH Vineet[1], MOREL Olivier[1], MALIK Saeed[2], SAAD Naufal[2], MERIAUDEAU Fabrice[1]

UB-France[1], UTP-Malaysia[1]

Simple Questions…

- What is a **ROBOT**?
- What is **NOT** a **ROBOT**?
- **Does it really Matter?**

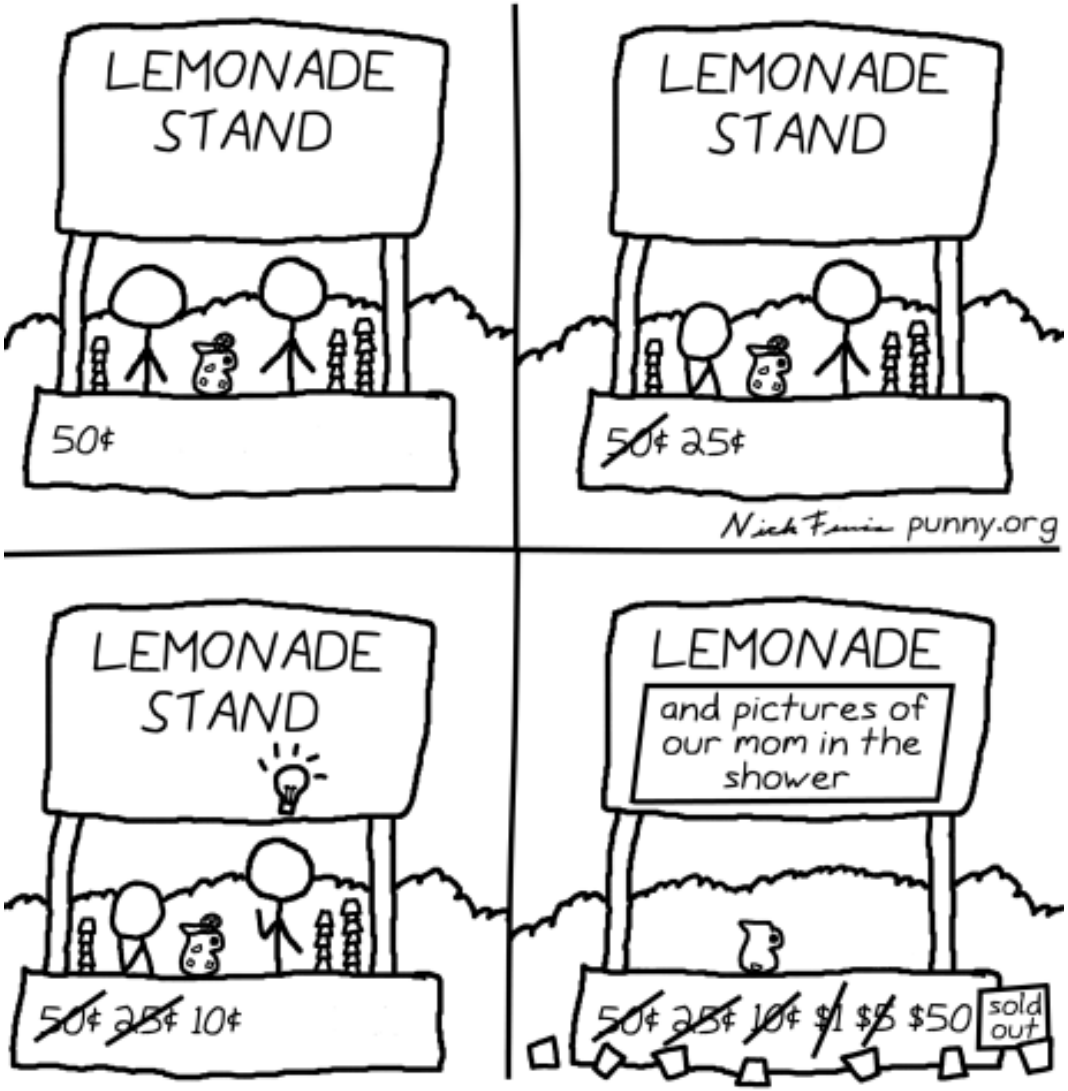
Copyright 2006 by Randy Glasbergen.
www.glasbergen.com



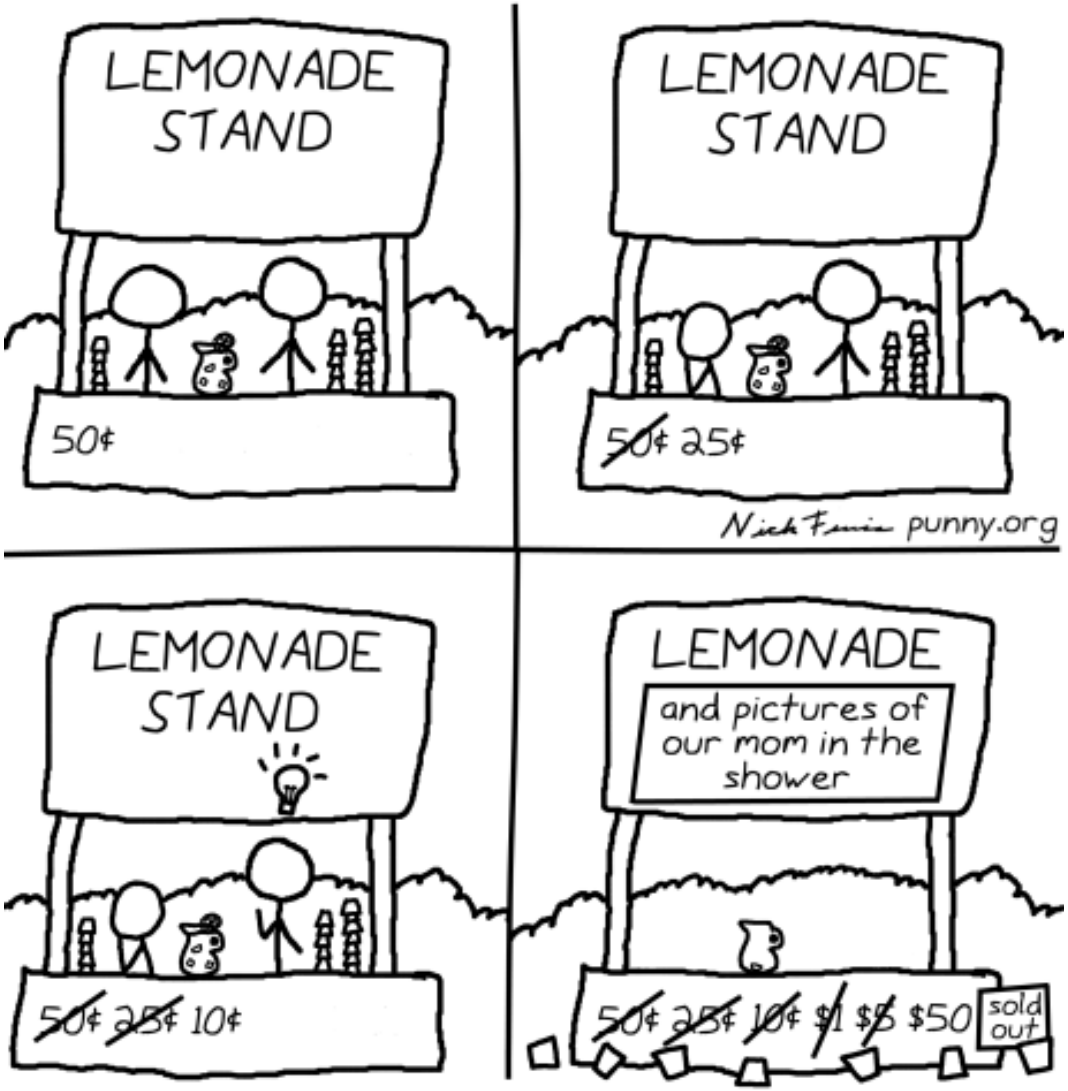
"Whenever your cholesterol gets too high, a sensor will send out a signal that automatically locks the kitchen door and turns on your treadmill."

Should Robots Evolve to be Like Humans?

Should Robots Do as the Humans Do?

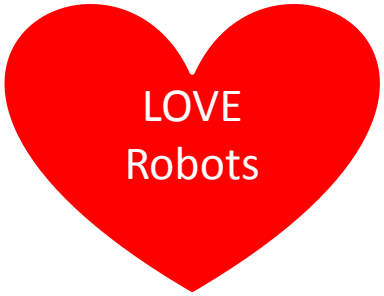


Should Robots Do **BUSINESS** as the Humans Do?



The Human Model is **Easiest** model to understand for Humans. Really?

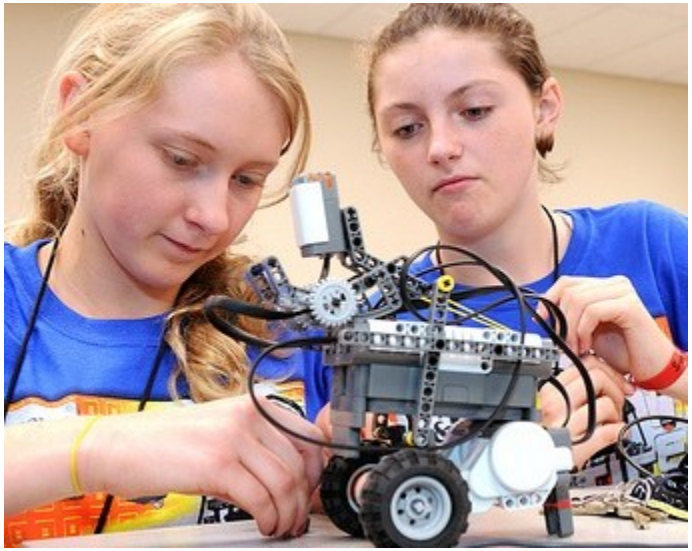
Evolution of a Roboticist !



Evolution of a Roboticist !

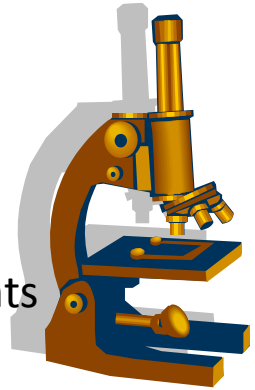
LOVE
Robots

Build Toys

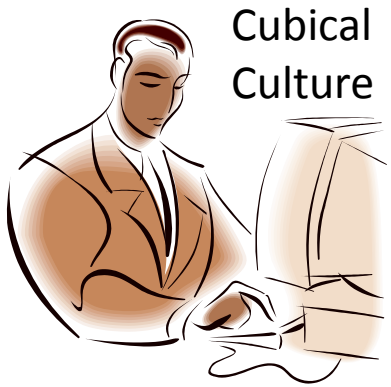


And Then….?

Long
Long
Long
Experiments



Cubical
Culture !



Money !

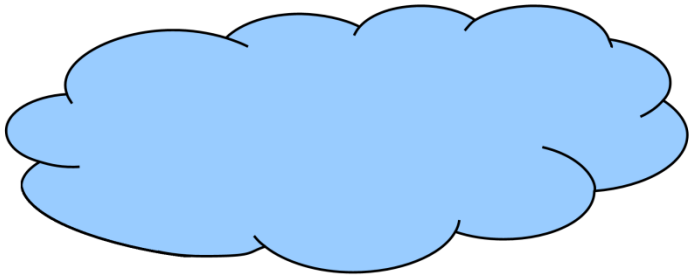
Industry !

Time !

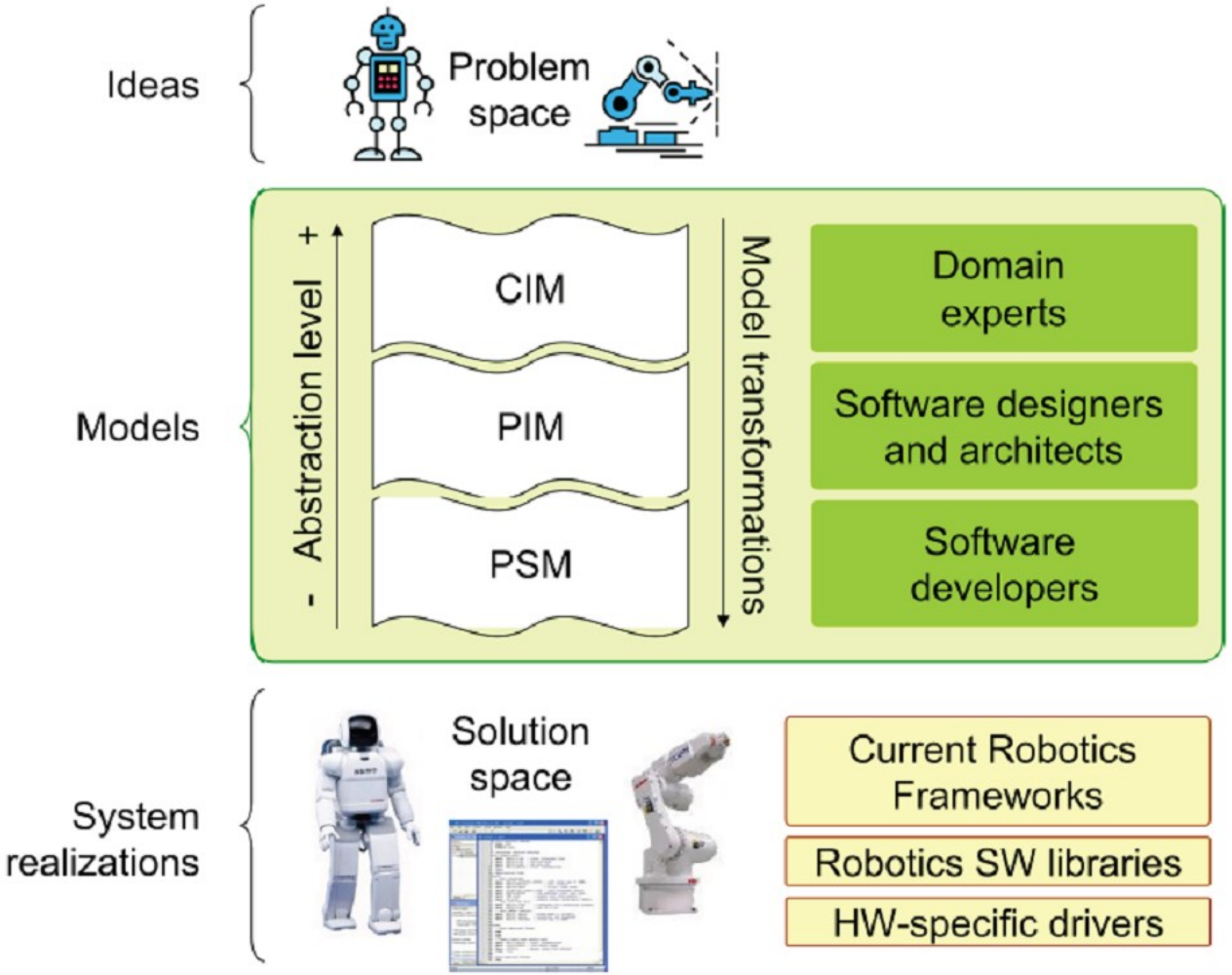
Life !

More Questions…

- What is a Model, Model Driven Architecture?
- Why Industrial Feasibility is Important?
- Is there a Market?
- What is Agent Driven Cloud Robotics?
- What is Peer to Peer Cloud Robotics?

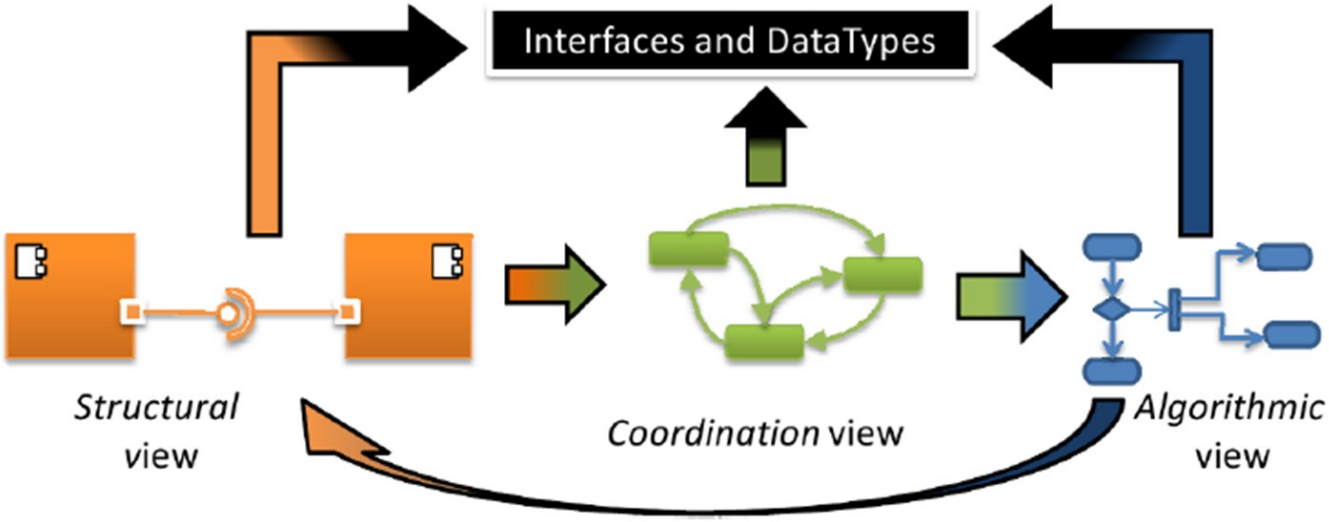


OMG's Model Driven Architecture



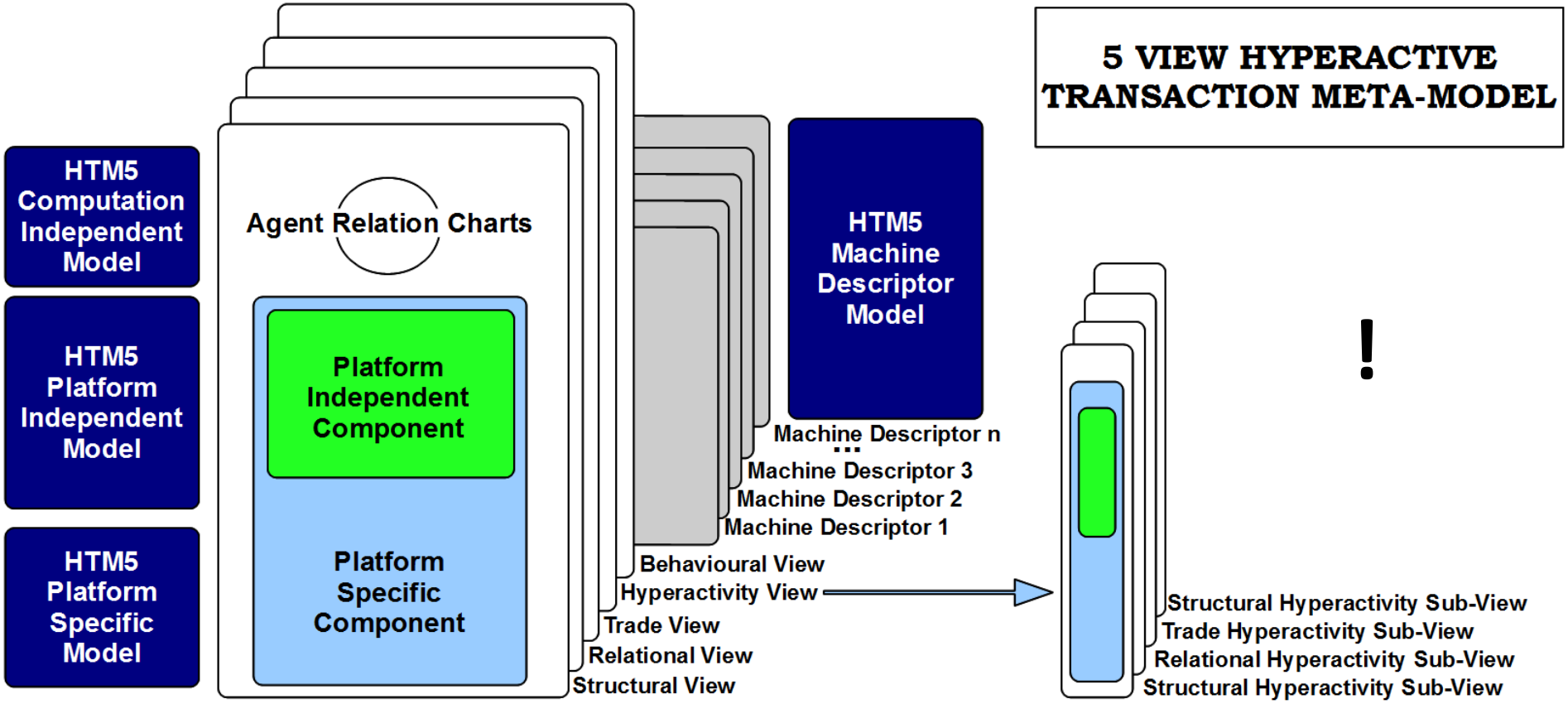
Models Vs Meta-Models

Multi-View Modelling



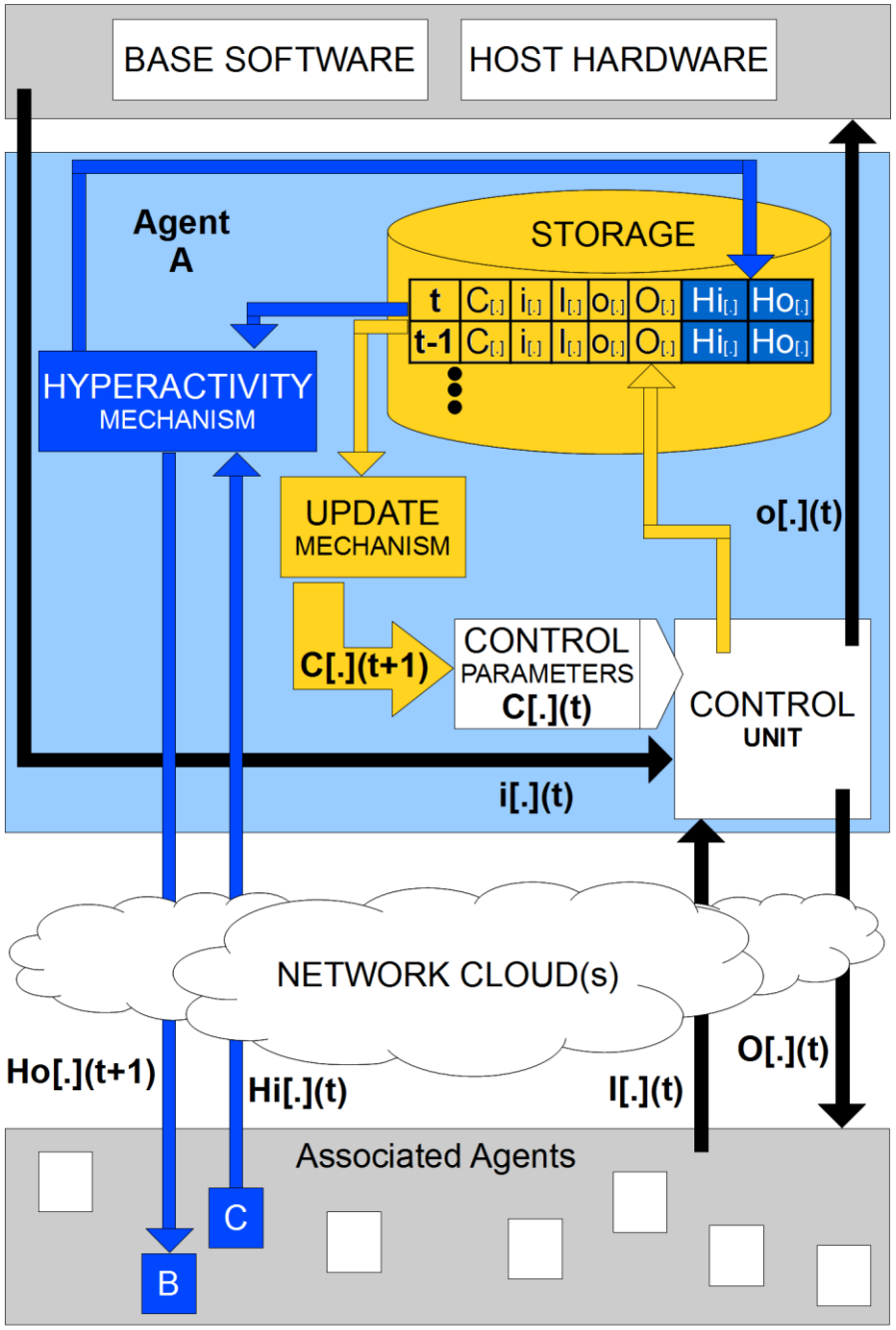
V3CMM Model

HTM5


HTM5 Computation Independent Model
HTM5 Platform Independent Model
HTM5 Platform Specific Model
Agent Relation Charts
Platform Independent Component
Platform Specific Component
Structural View
Relational View
Trade View
Hyperactivity View
Behavioural View
Machine Descriptor 1
Machine Descriptor 2
Machine Descriptor 3
...
Machine Descriptor n
HTM5 Machine Descriptor Model
5 VIEW HYPERACTIVE TRANSACTION META-MODEL
!
Structural Hyperactivity Sub-View
Trade Hyperactivity Sub-View
Relational Hyperactivity Sub-View
Structural Hyperactivity Sub-View

Agents Vs Objects

Agent Autonomy Vs Hyperactivity



C[.](t) Control Unit's (CU) Control Parameters at time t
C[.](t+1) Updated Control Parameters
i[.](t) Inputs to CU from Base software/Host hardware
o[.](t) CU's Outputs to Base software/Host hardware
I[.](t) Inputs to CU from Associated Agents
O[.](t) CU's Outputs to Associated Agents
Hi[.](t) Hyperactivity Inputs from Associated Agent C
Ho[.](t+1) Updated Hyperactivity Outputs from Agent A

Passive | Active | Hyperactive

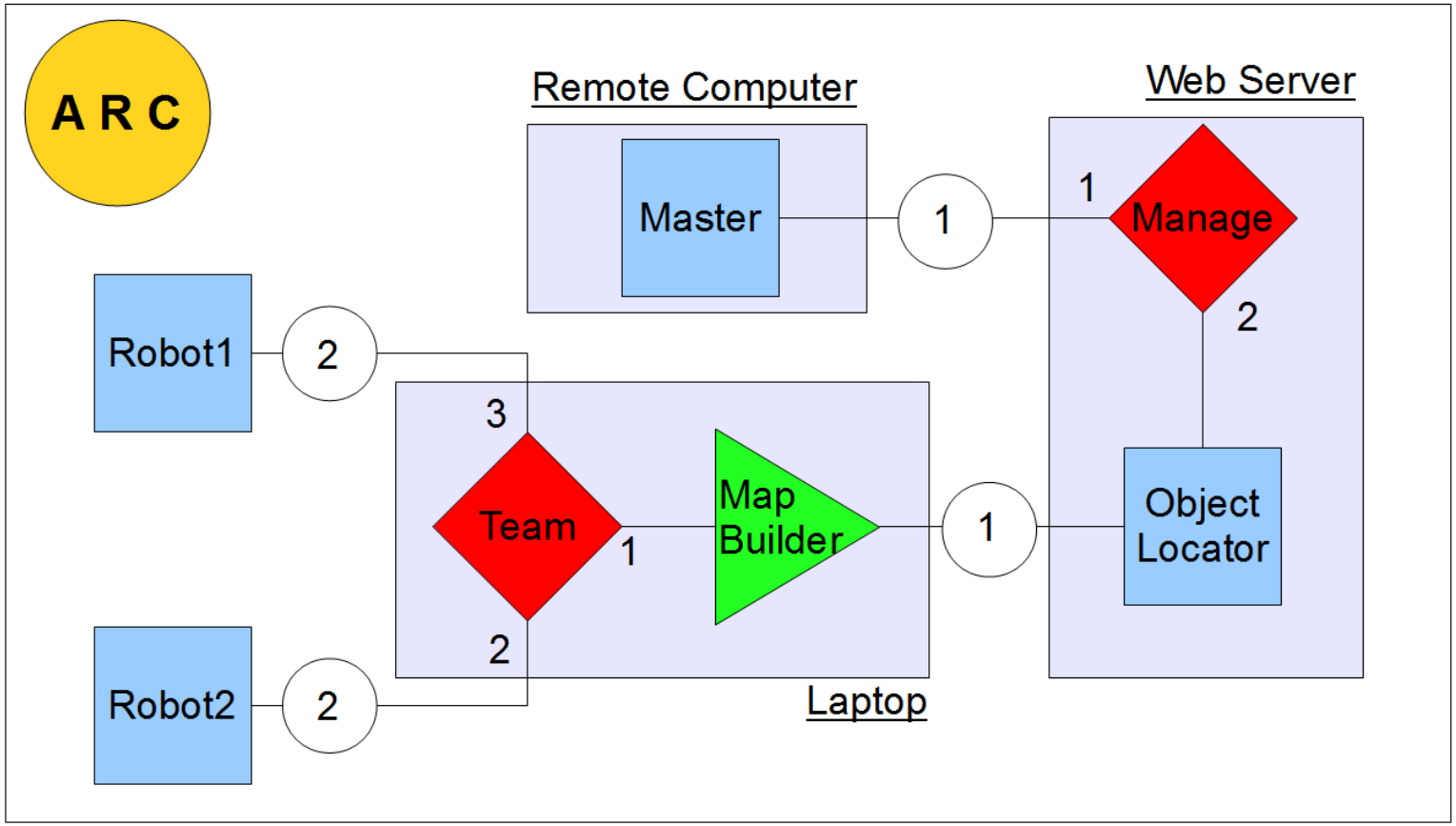
HTM5 Component

AGENT
- Passive Agent
- Active Agent
- Hyperactive Agent

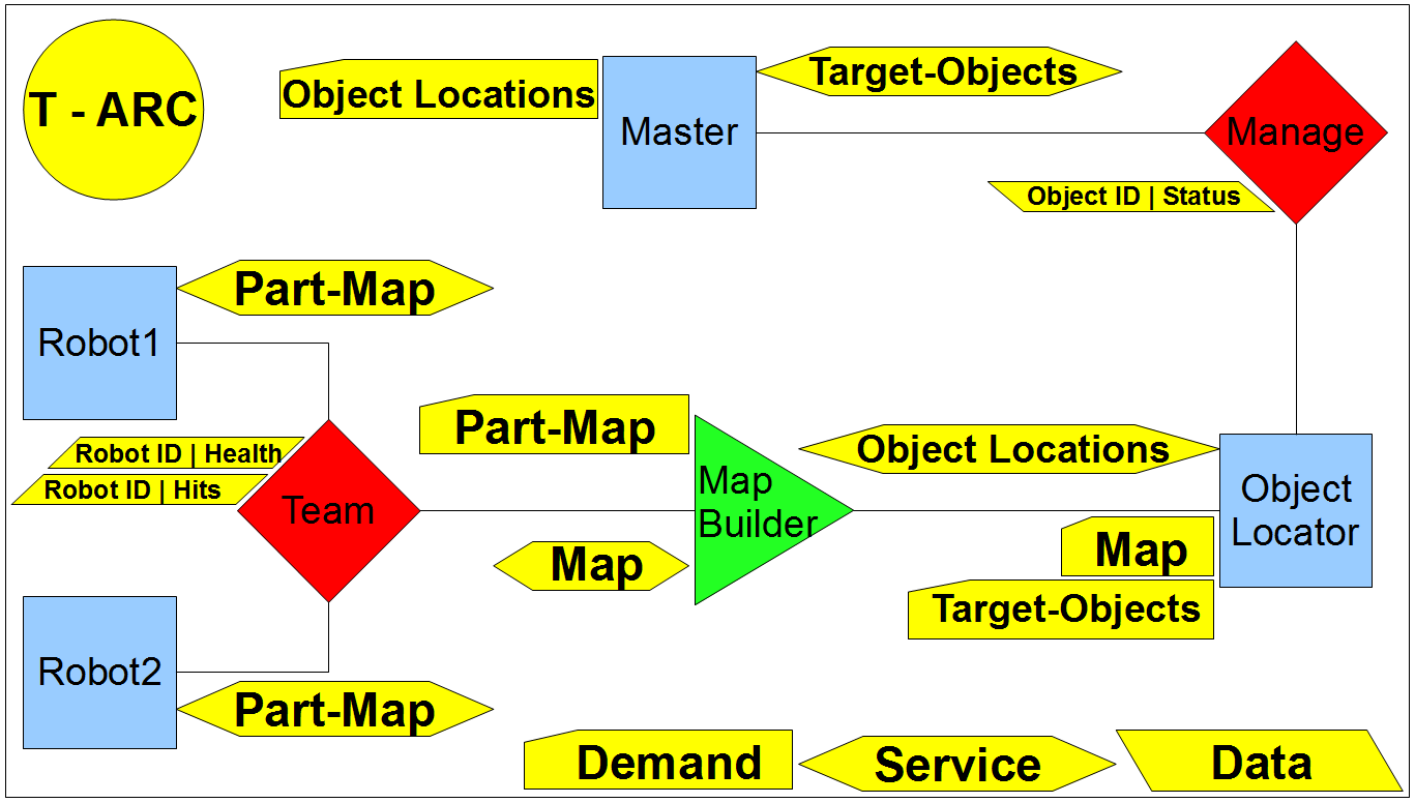
RELATION
- Passive Relation
- Active Relation
- Hyperactive Relation

MERGE
- Passive Merge
- Active Merge
- Hyperactive Merge

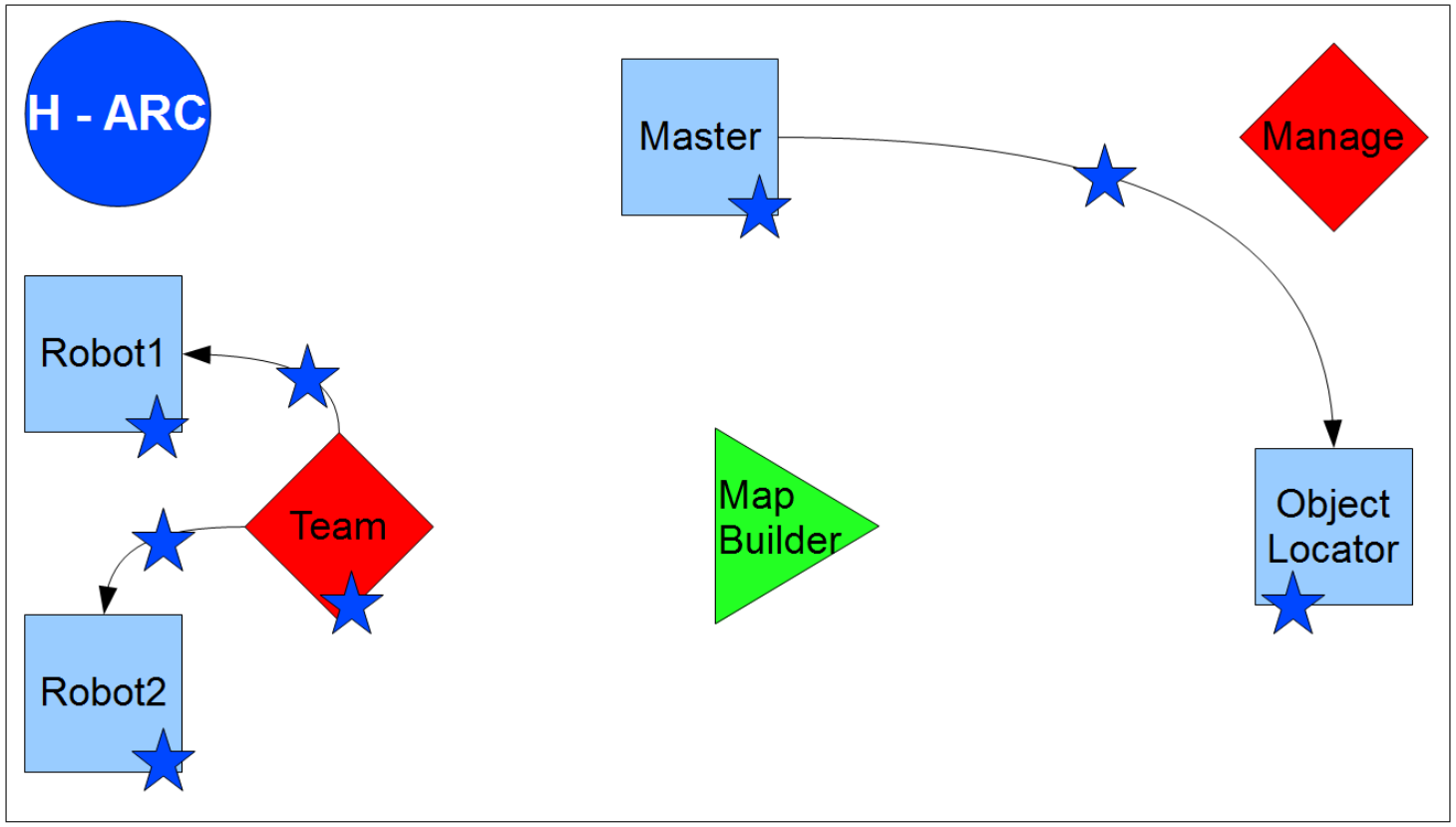
HTM5 Trade View/Model



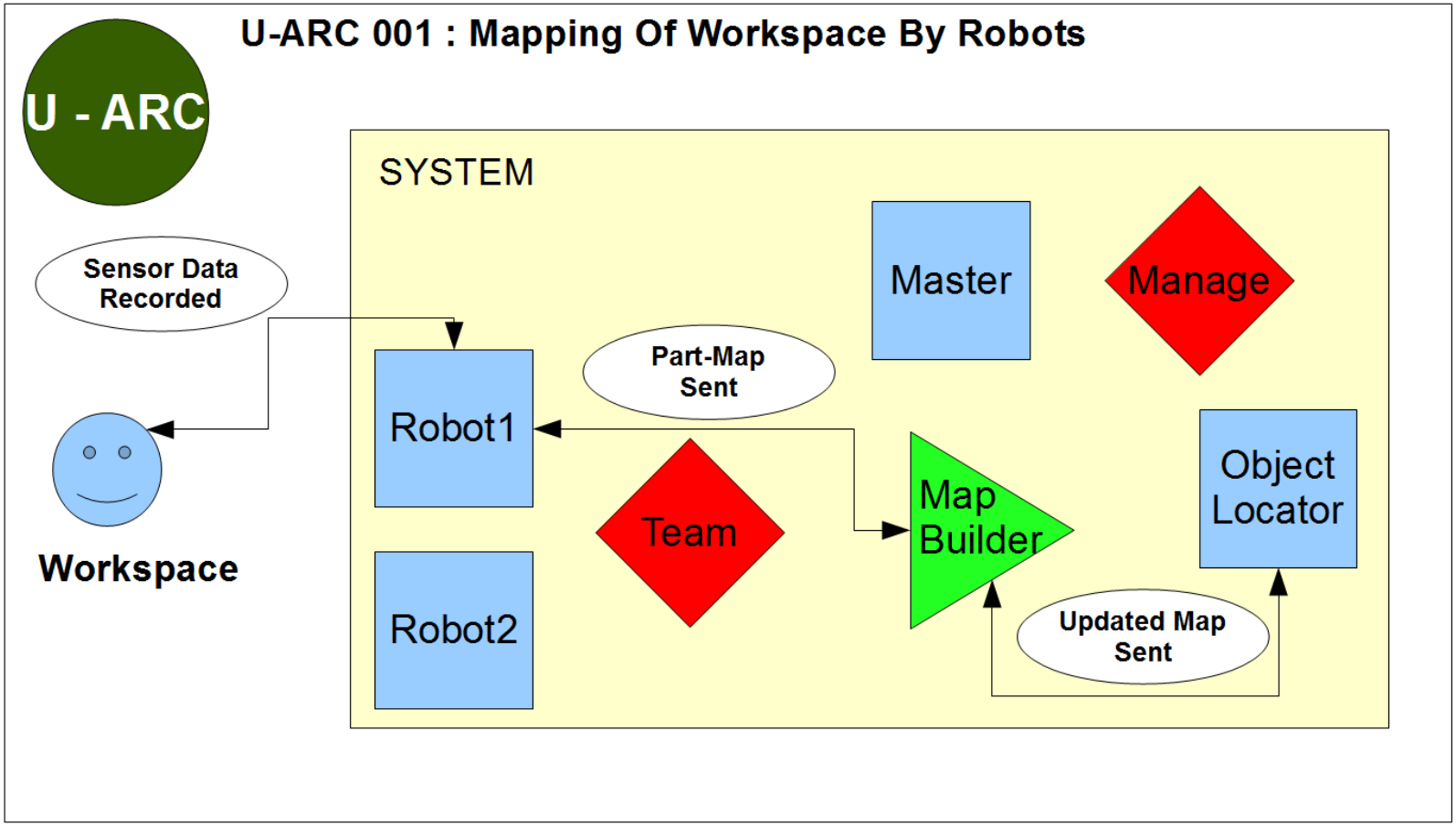
HTM5 Trade View/Model



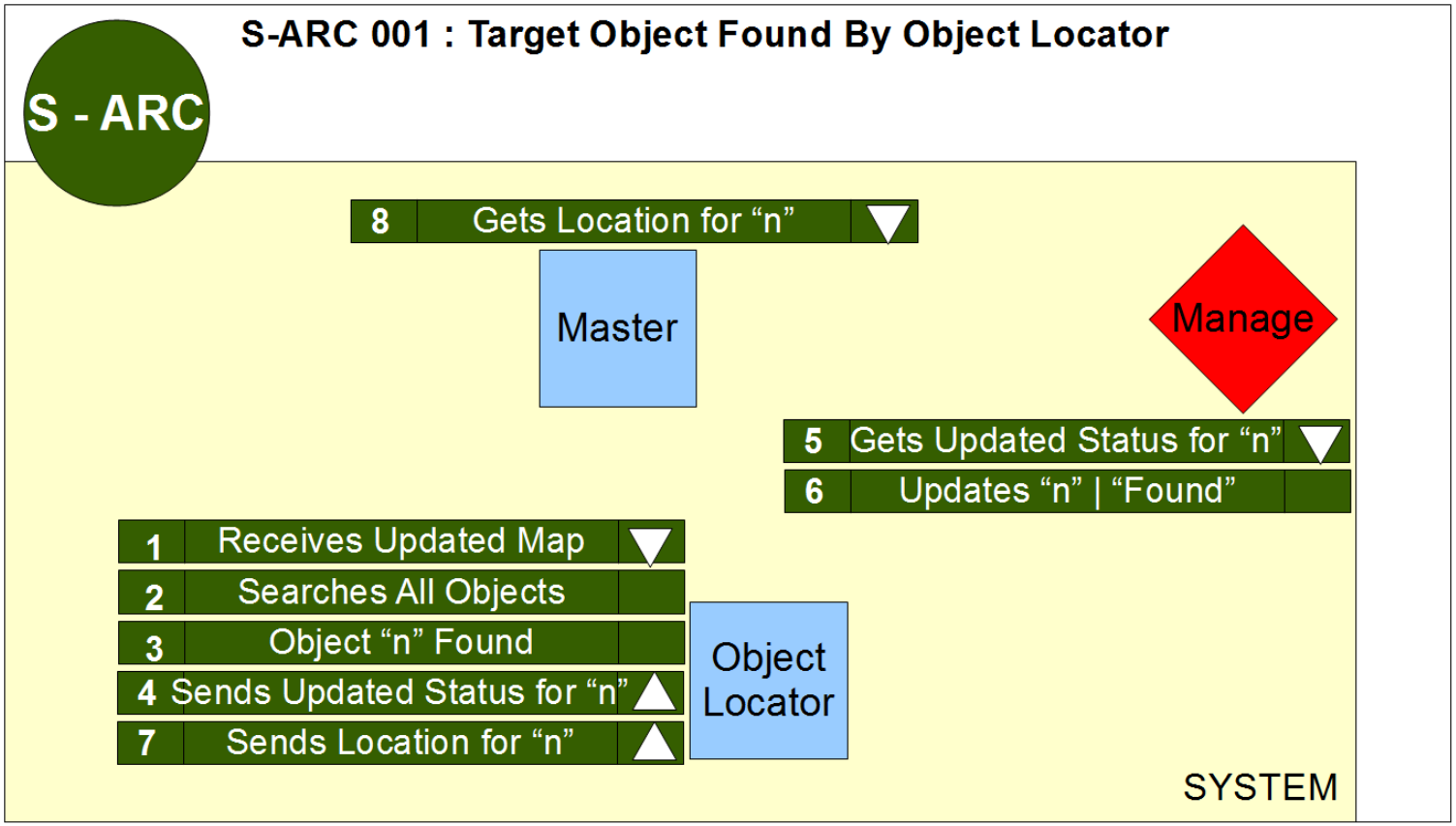
HTM5 Trade View/Model



HTM5 Trade View/Model

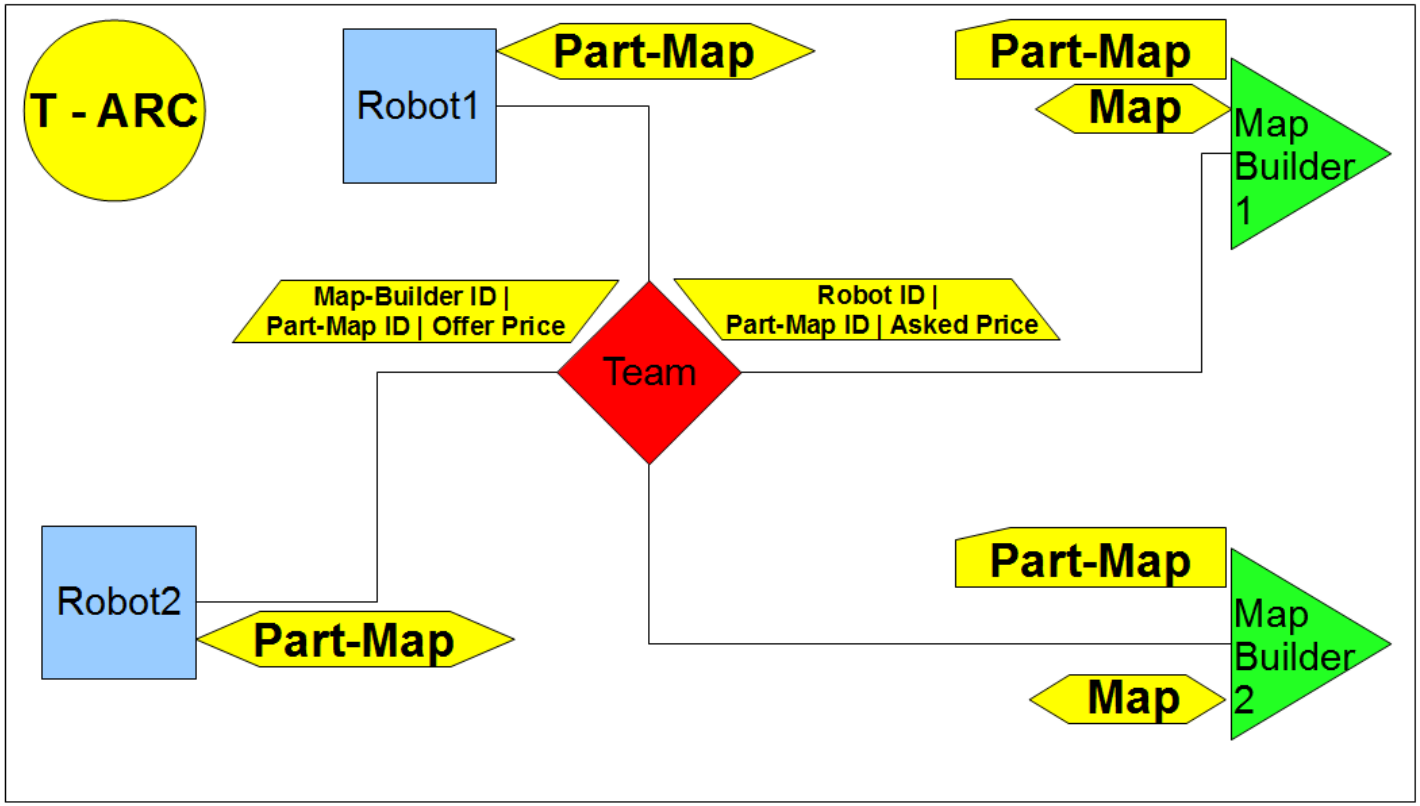


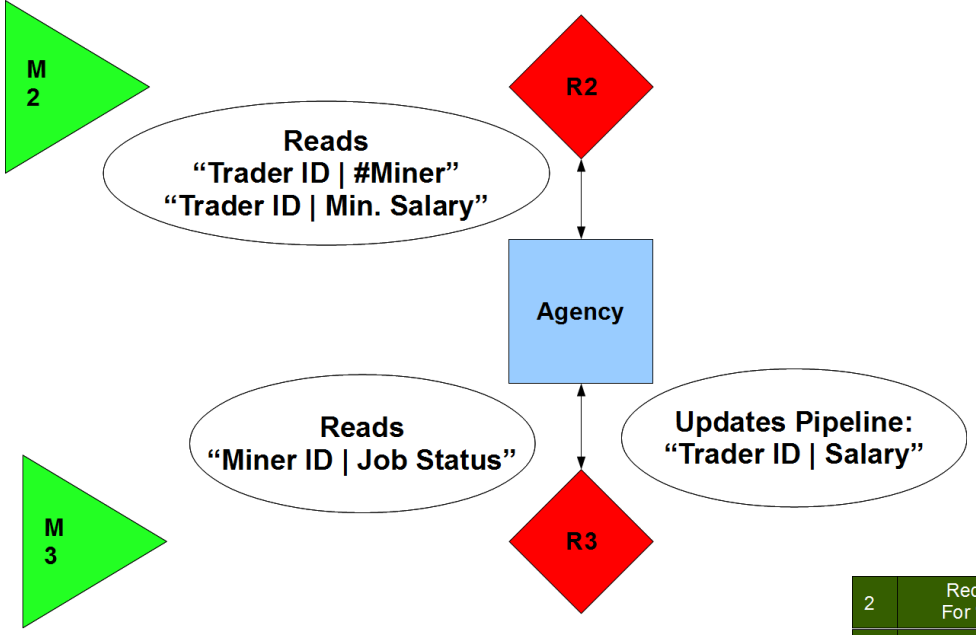
HTM5 Trade View/Model

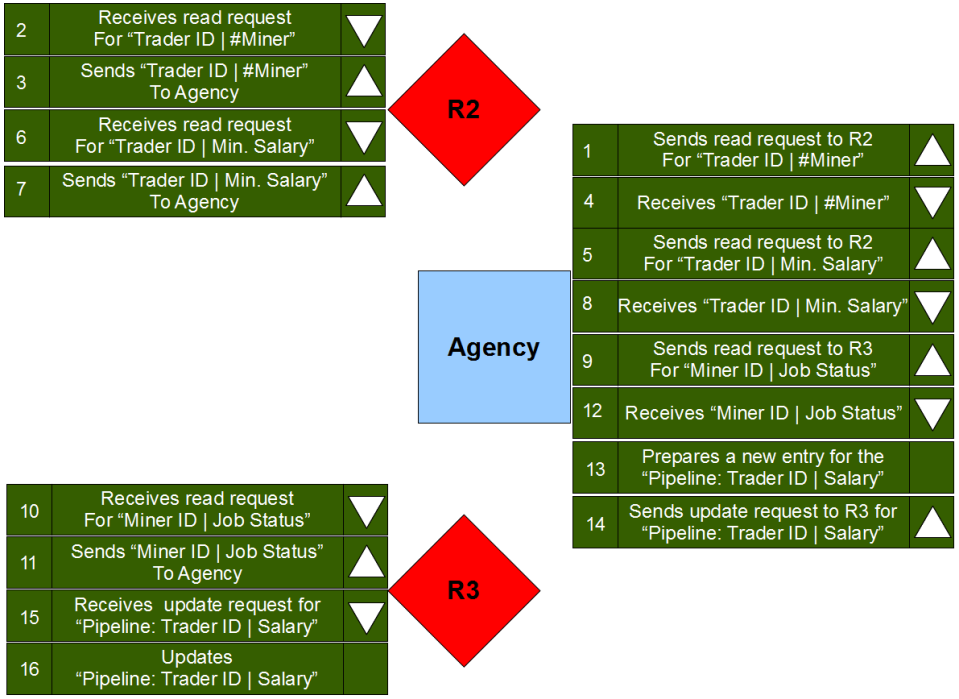


SERVICE DISCOVERY & MATCHMAKING

Lookup Table Scenario




M
2
R2
Reads
“Trader ID | #Miner”
“Trader ID | Min. Salary”
Agency
Reads
“Miner ID | Job Status”
Updates Pipeline:
“Trader ID | Salary”
M
3
R3

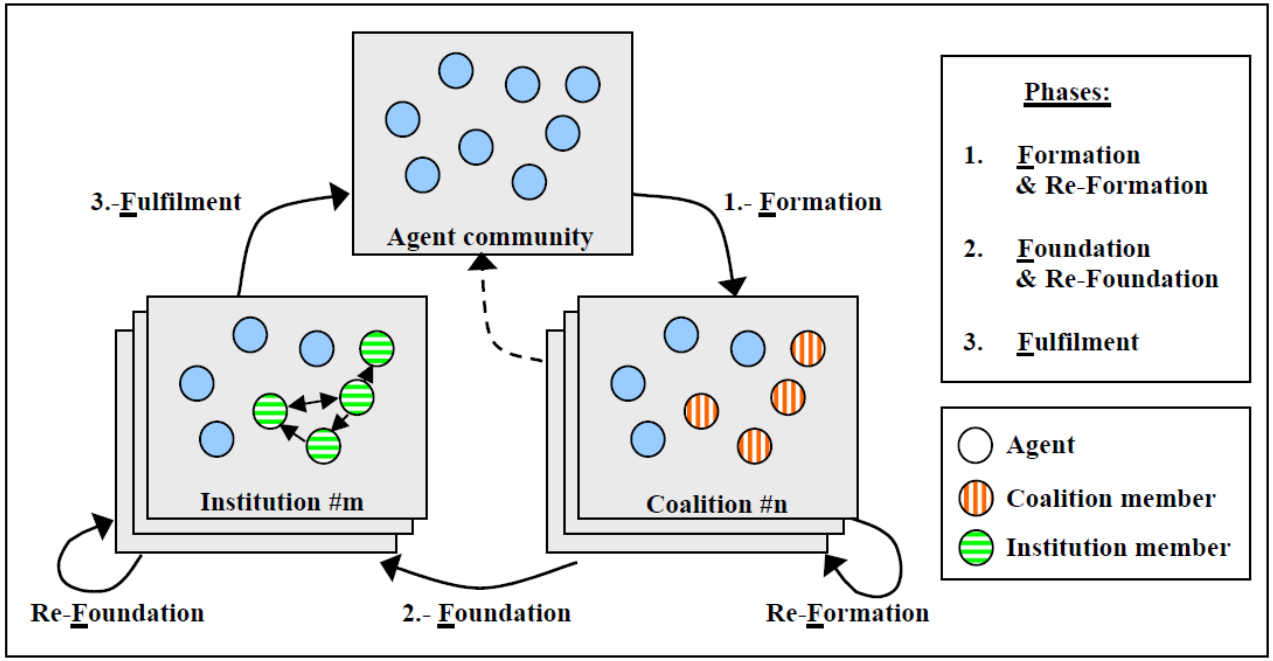

2 Receives read request For “Trader ID | #Miner”
3 Sends “Trader ID | #Miner” To Agency
6 Receives read request For “Trader ID | Min. Salary”
7 Sends “Trader ID | Min. Salary” To Agency
R2
1 Sends read request to R2 For “Trader ID | #Miner”
4 Receives “Trader ID | #Miner”
5 Sends read request to R2 For “Trader ID | Min. Salary”
8 Receives “Trader ID | Min. Salary”
9 Sends read request to R3 For “Miner ID | Job Status”
12 Receives “Miner ID | Job Status”
13 Prepares a new entry for the “Pipeline: Trader ID | Salary”
14 Sends update request to R3 for “Pipeline: Trader ID | Salary”
Agency
10 Receives read request For “Miner ID | Job Status”
11 Sends “Miner ID | Job Status” To Agency
15 Receives update request for “Pipeline: Trader ID | Salary”
16 Updates “Pipeline: Trader ID | Salary”
R3

RELATIONSHIPS AND CONTRACTS

HTM5 Proposals

- Relationships are **relative positioning of agents** into a predefined social construct.
- Each agent has its **personal goals and business logic**, a pre-defined trade relationships help reduce otherwise chaotic system of agents.
- Once agents decide to exchange the services, the relation agent or the agents themselves may bind themselves to **a contract similar to pay per use cloud computing services** available online.
- **The quality of service** between a pair of agents is monitored by the relation agent. The denial of service by a service provider, or a problem with the quality of service after contract initiation is reported by the client agent and is recorded by the relation agent.
- **Counter Actions** could be initiated by the relation agent like termination of the current contract, penalty and/or lowering of **the trust parameter** for the service provider.
- **Administrative and banking agents** as a part of the cloud computing system will be essential in popularizing **cloud robotics as a business possibility.**

HTM5 based
Dynamic Electronic Institutions



Universitat de Girona

Research Partners: Agent Research Laboratory, UdG, SPAIN

[Ref.] Eduard Muntaner-Perich, Josep Lluís de la Rosa Esteva, "Using Dynamic Electronic Institutions to Enable Digital Business Ecosystems", Coordination, Organizations, Institutions, and Norms in Agent Systems II, Lecture Notes in Computer Science Volume 4386, 2007, pp 259-273

Lower Layers

HTM5-PIM-PIC
Platform Independent Component

- Global Data and Methods
- Abstract **PIC_R** Class
- Abstract **PIC_RH** Class
- Abstract **PIC_S** Class
- Abstract **PIC_SH** Class
- Abstract **PIC_T** Class
- Abstract **PIC_TH** Class
- Abstract **PIC_B** Class
- Abstract **PIC_BH** Class
- Algorithms | Flowcharts | Pseudo Codes Of Global & Class Methods (Except Abstract Methods)
- Inter-Class Use-Case Diagrams
- Inter-Class Sequence Diagrams
- Intra-Class Use-Case Diagrams
- Intra-Class Sequence Diagrams

HTM5-PSM-PSC
Platform Specific Component

- **PSC_R : PIC_R** Class
- **PSC_RH : PIC_RH** Class
- **PSC_S : PIC_S** Class
- **PSC_SH : PIC_SH** Class
- **PSC_T : PIC_T** Class
- **PSC_TH : PIC_TH** Class
- **PSC_B : PIC_B** Class
- **PSC_BH : PIC_BH** Class
- Algorithms | Flowcharts | Pseudo Codes Of Class Methods (Including Overridden Abstract Methods)
- Intra-Class Use-Case Diagrams
- Intra-Class Sequence Diagrams

Sandbox_PIC_Robot1

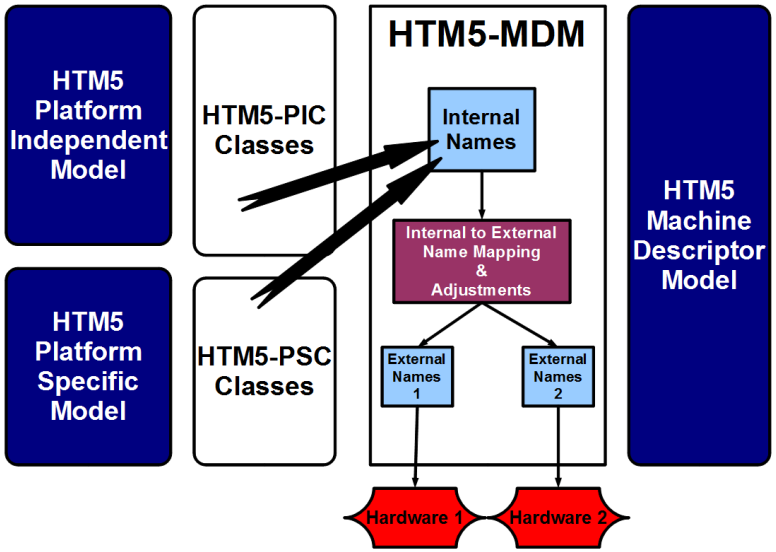
```
/*Global Data*/
/*PSC Class Objects*/
Sandbox_PSC_Robot1_S:   S_PSC;
Sandbox_PSC_Robot1_R:   R_PSC;
Sandbox_PSC_Robot1_T:   T_PSC;
Sandbox_PSC_Robot1_H:   H_PSC;
Sandbox_PSC_Robot1_B:   B_PSC;
```

Abstract Sandbox_PIC_Robot1_T

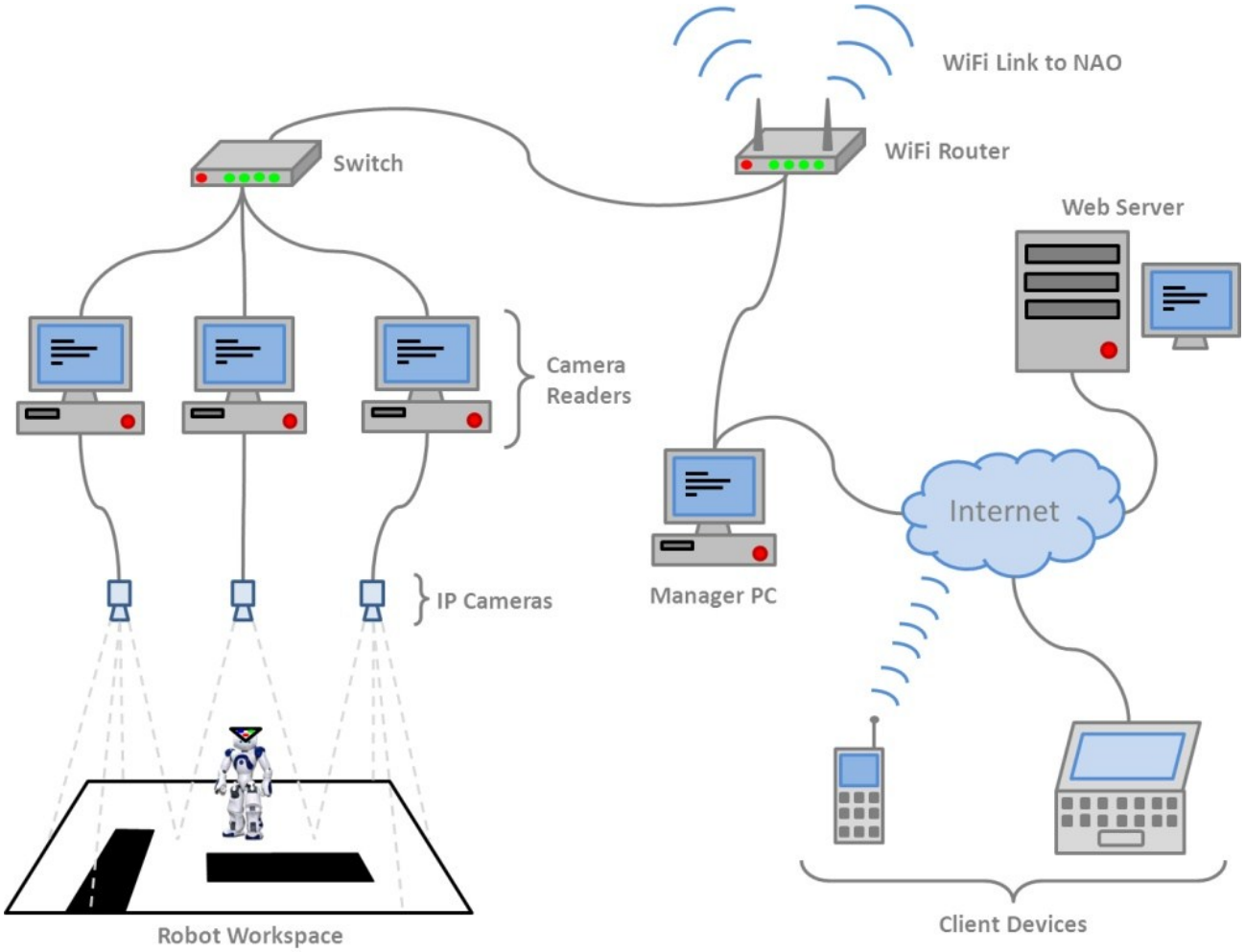
```
/*Platform Independent Data*/
Unsigned long Count;
Etc...
/*Platform Independent Functions*/
Create_Part_Map_File();
Etc...
/*Platform Specific Abstract Functions*/
Abstract Get_System_Time();
Etc...
```

Sandbox_PSC_Robot1_T
Extends Sandbox_PIC_Robot1_T

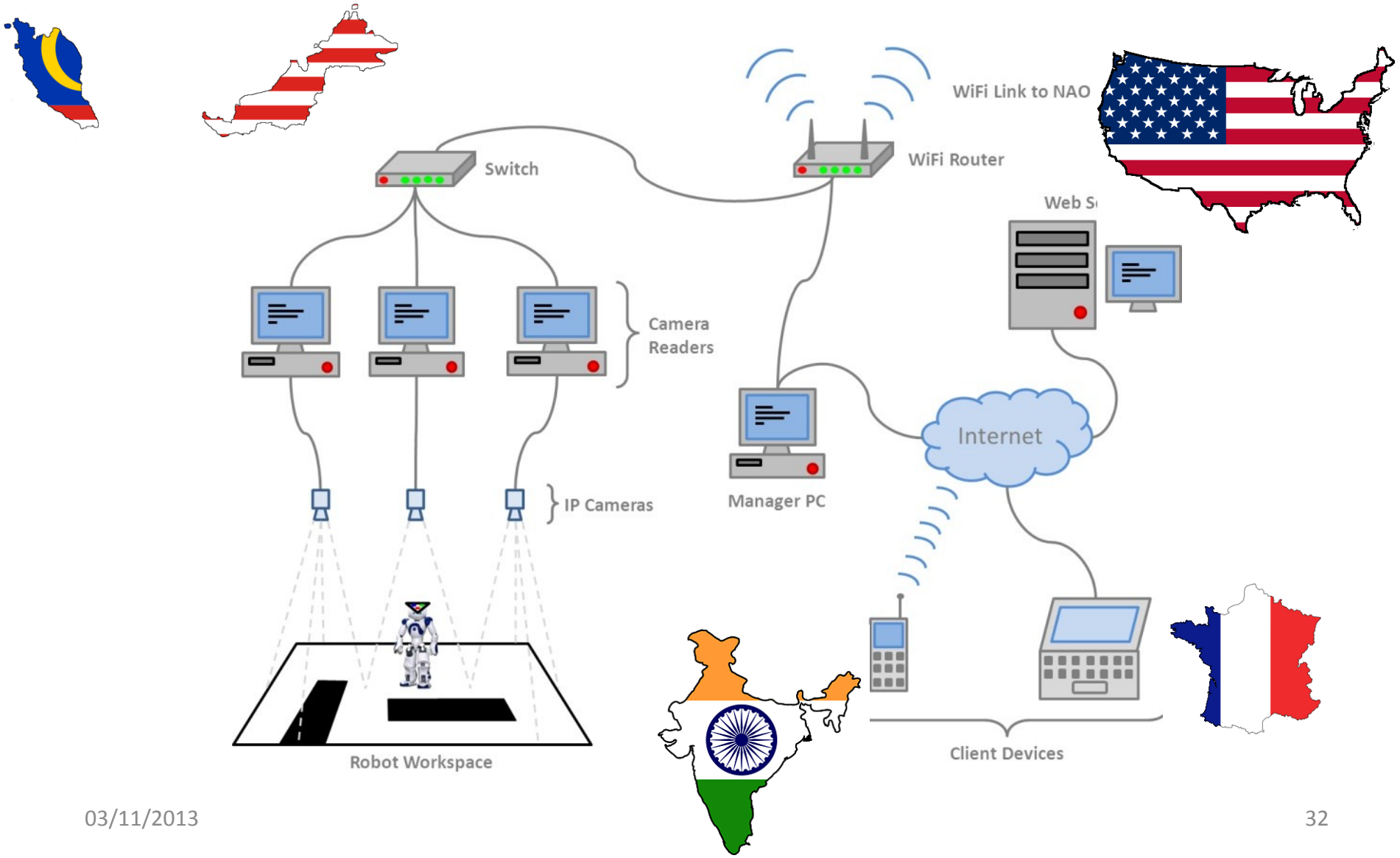
```
/*Platform Specific Data*/
float Available_Power_Percentage;
Etc...
/*Platform Specific Functions*/
Get_System_Time();
Etc...
```

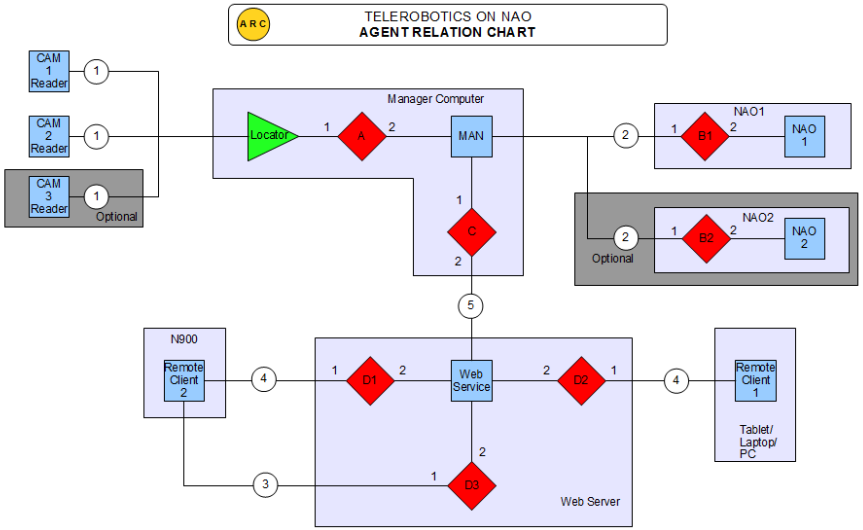


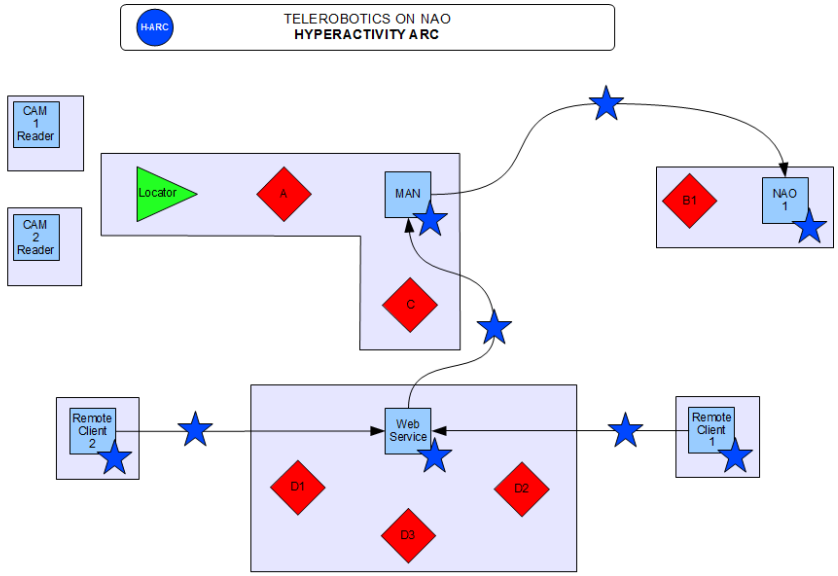
One Case Study…

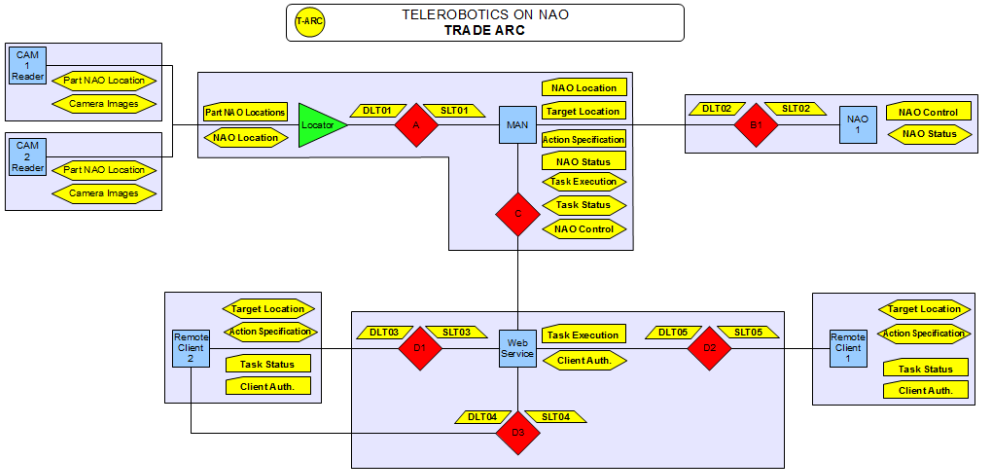


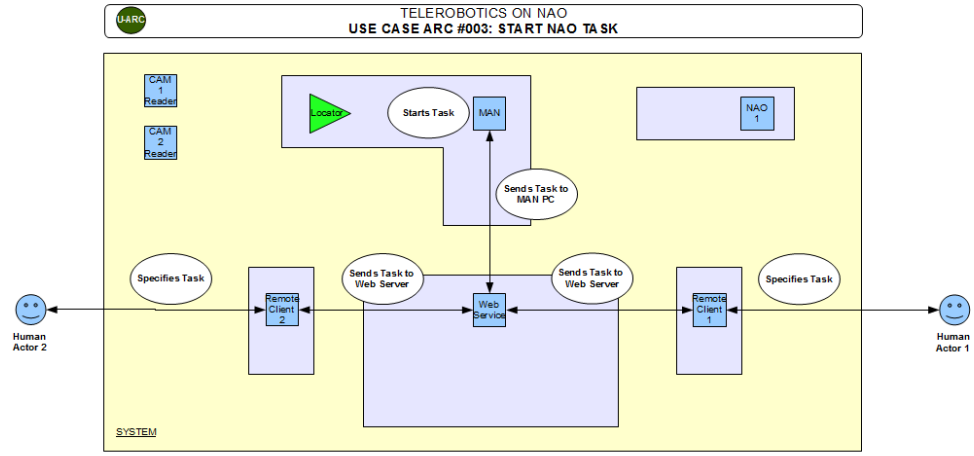
One Case Study…

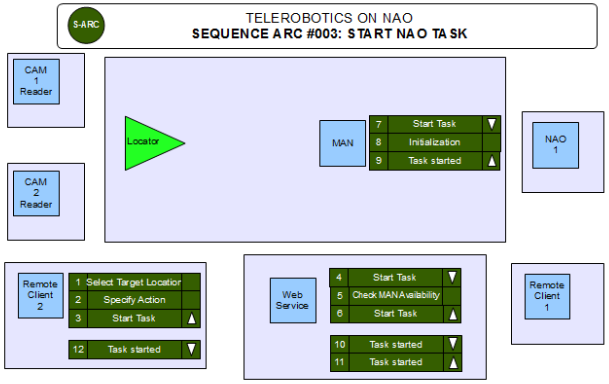


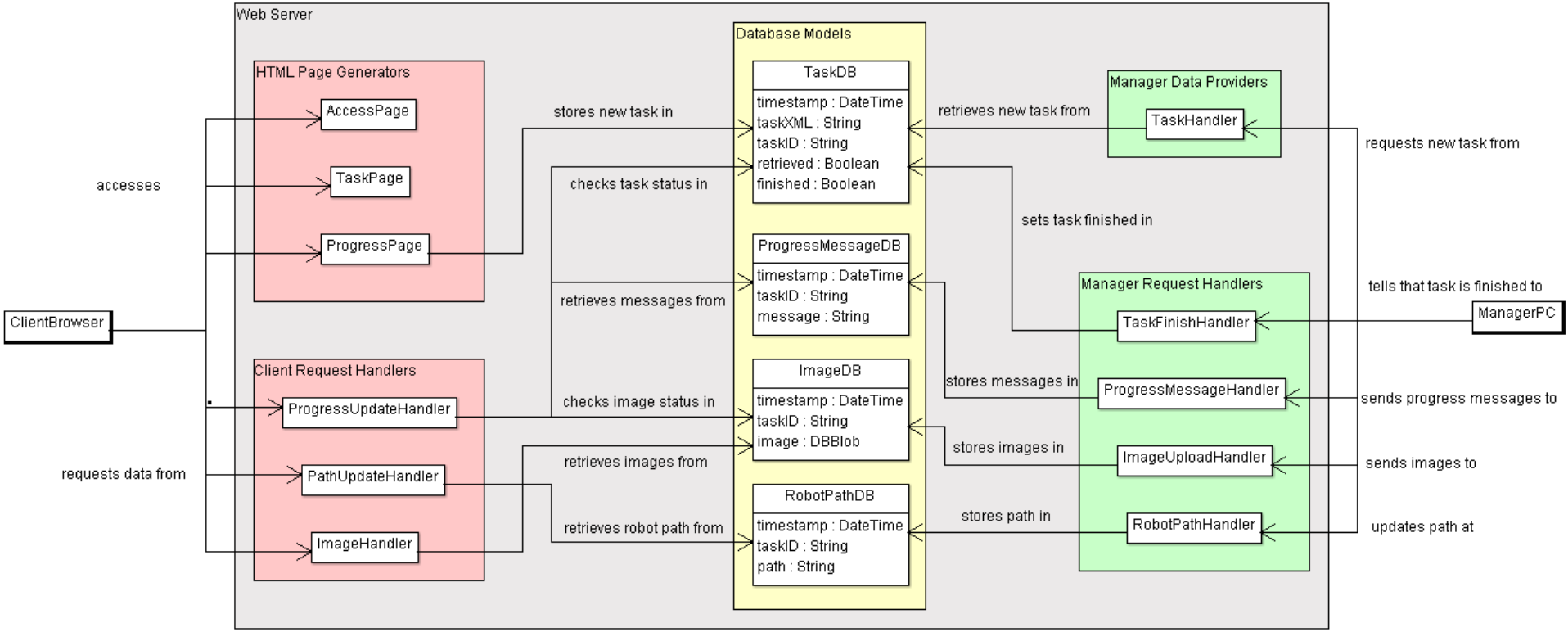

A R C
TELEROBOTICS ON NAO
AGENT RELATION CHART
CAM 1 Reader
CAM 2 Reader
CAM 3 Reader
Optional
Manager Computer
Locator
A
MAN
C
NAO1
B1
NAO 1
NAO2
B2
NAO 2
N900
Remote Client 2
D1
Web Service
D2
D3
Remote Client 1
Tablet/ Laptop/ PC
Web Server


H-ARC
TELEROBOTICS ON NAO
HYPERACTIVITY ARC
CAM 1 Reader
CAM 2 Reader
Locator
A
MAN
B1
NAO 1
C
Remote Client 2
Web Service
Remote Client 1
D1
D2
D3

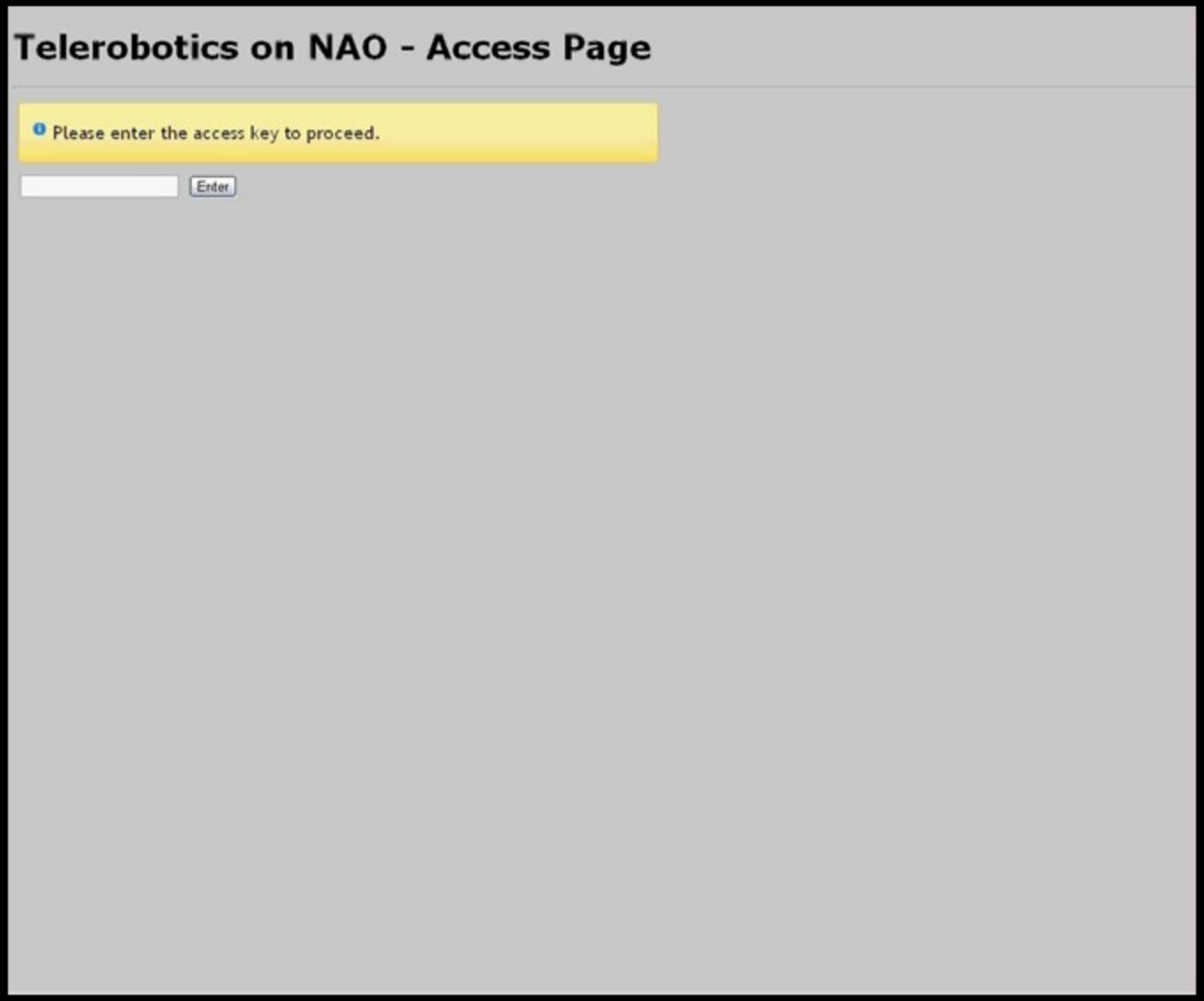

T-ARC
TELEROBOTICS ON NAO
TRADE ARC
CAM 1 Reader
Part NAO Location
Camera Images
CAM 2 Reader
Part NAO Locations
NAO Location
Locator
DLT01
A
SLT01
MAN
NAO Location
Target Location
Action Specification
NAO Status
Task Execution
Task Status
NAO Control
C
DLT02
B1
SLT02
NAO 1
Remote Client 2
DLT03
D1
SLT03
Web Service
DLT05
D2
SLT05
Remote Client 1
DLT04
D3
SLT04
Client Auth.


U-ARC
TELEROBOTICS ON NAO
USE CASE ARC #003: START NAO TASK
CAM 1 Reader
CAM 2 Reader
Locator
Starts Task
MAN
NAO 1
Sends Task to MAN PC
Specifies Task
Remote Client 2
Sends Task to Web Server
Web Service
Sends Task to Web Server
Remote Client 1
Specifies Task
Human Actor 2
Human Actor 1
SYSTEM


S-ARC
TELEROBOTICS ON NAO
SEQUENCE ARC #003: START NAO TASK
CAM 1 Reader
CAM 2 Reader
Locator
MAN
7 Start Task
8 Initialization
9 Task started
NAO 1
Remote Client 2
1 Select Target Location
2 Specify Action
3 Start Task
12 Task started
Web Service
4 Start Task
5 Check MANAvailability
6 Start Task
10 Task started
11 Task started
Remote Client 1

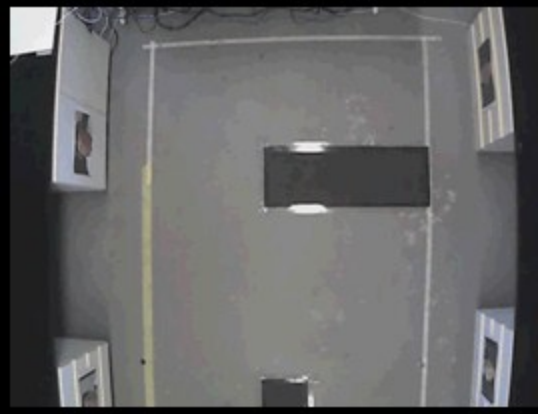

Web Server
HTML Page Generators
AccessPage
TaskPage
ProgressPage
Client Request Handlers
ProgressUpdateHandler
PathUpdateHandler
ImageHandler
Database Models
TaskDB
timestamp : DateTime
taskXML : String
taskID : String
retrieved : Boolean
finished : Boolean
ProgressMessageDB
timestamp : DateTime
taskID : String
message : String
ImageDB
timestamp : DateTime
taskID : String
image : DBBlob
RobotPathDB
timestamp : DateTime
taskID : String
path : String
Manager Data Providers
TaskHandler
Manager Request Handlers
TaskFinishHandler
ProgressMessageHandler
ImageUploadHandler
RobotPathHandler
ClientBrowser
ManagerPC
accesses
requests data from
stores new task in
checks task status in
retrieves messages from
checks image status in
retrieves images from
retrieves robot path from
retrieves new task from
requests new task from
sets task finished in
tells that task is finished to
stores messages in
sends progress messages to
stores images in
sends images to
stores path in
updates path at

Web Page with User Interface



Camera Feed as a Service !

Camera 1



Camera 2

Camera 3