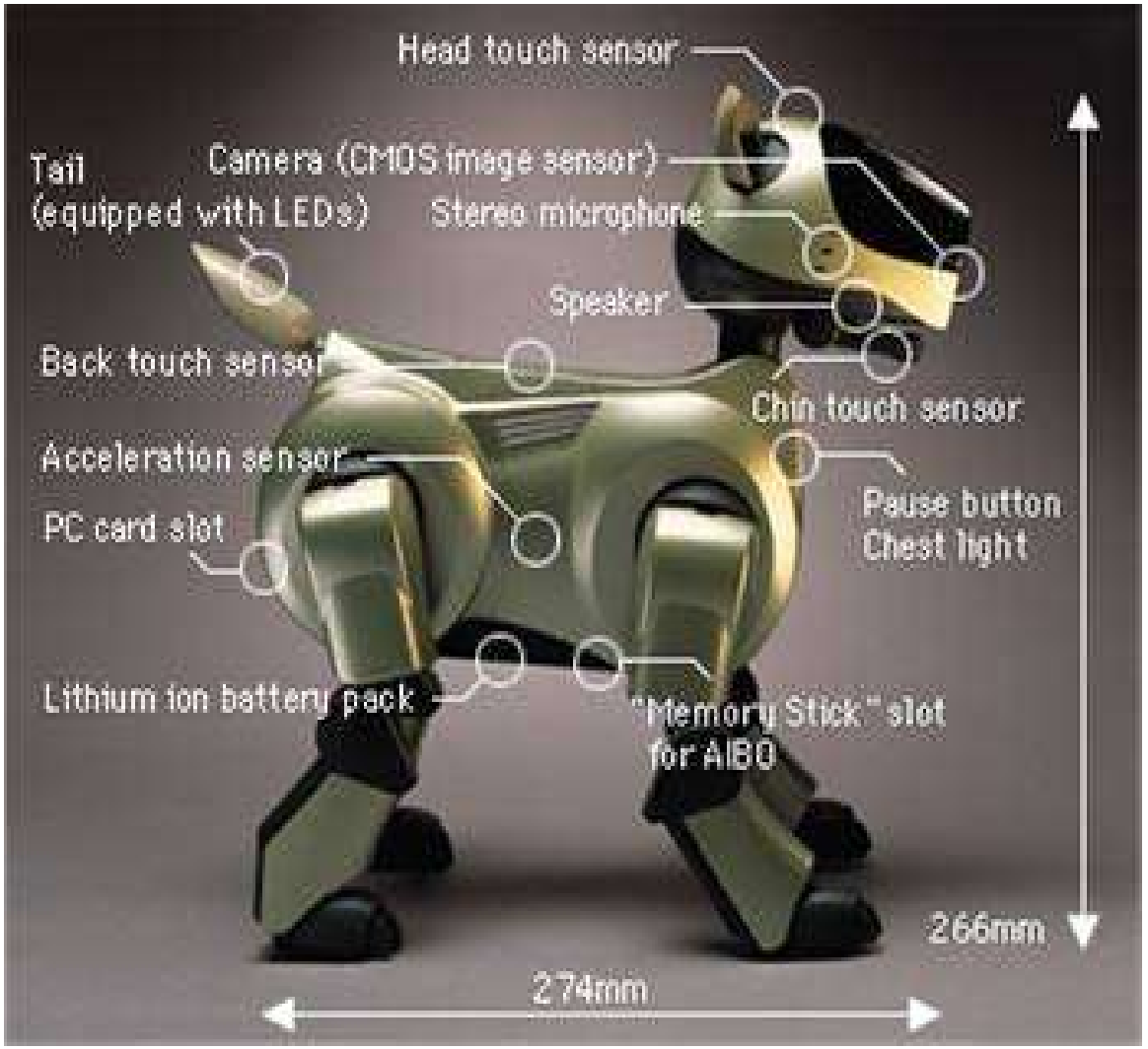
Uppsala Underdogs

Sony AIBO ERS-210



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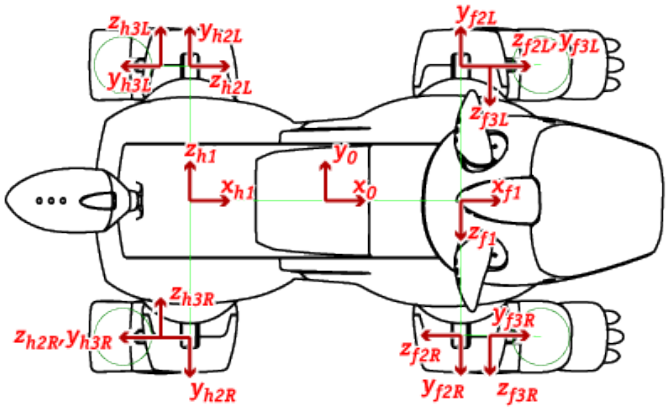
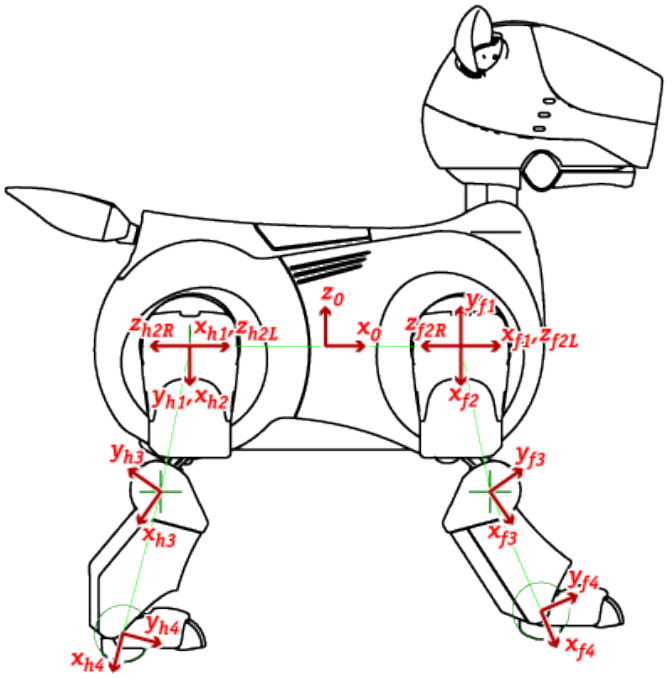


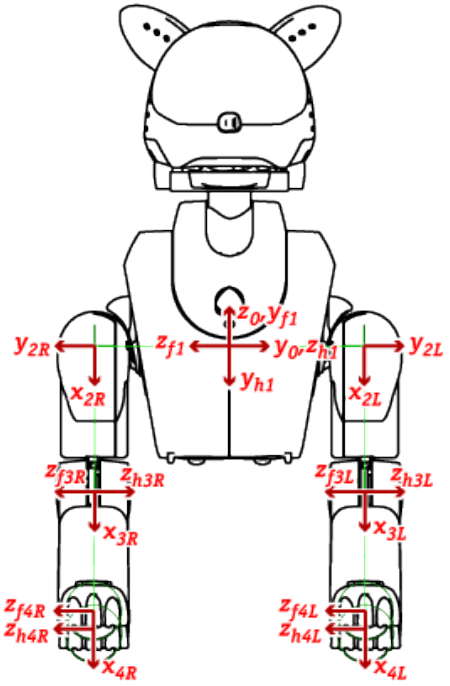
ERS-2xx Legs

	Δx	Δy	Δz
1. - shoulder	59.5	0	0
2. - elevator	0	0	59.2
3. - knee	64	0	12.8
f4. - ball	*55.748*	*-11.708*	0.5
h4. - ball	*60.627*	*-22.171*	0.5

Paw button is intersection of a *24.606* diameter cylinder and a *27.922* diameter sphere

Each link offset is relative to previous link
Legs are shown with knees bent at 35°

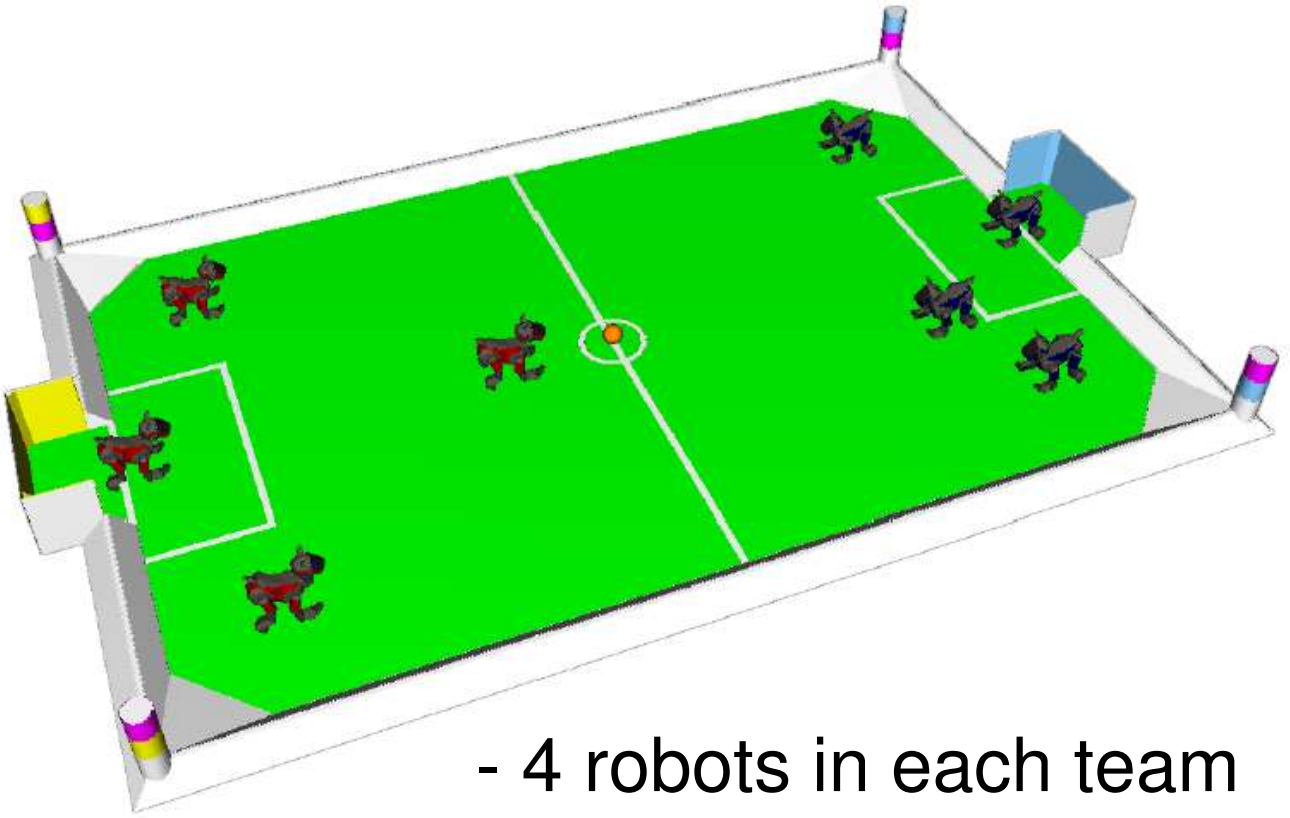




Sony AIBO ERS-210

- AperiOS
- OPEN-R

The field



- 4 robots in each team
- Blue team defends blue goal
- Red team defends yellow goal
- One goalie for each team
- Four beacons

Robot soccer rules

The game:

- 10 min first half

- 10 min half-time break
  (change team color)

- 10 min second half

RoboCup Fouls

Obstructing player

- Ball holding
- Illegal defender
- Pushing
- Penalty: 30 sec
  - if goalie fouls 0 sec time penalty

Tekkotsu

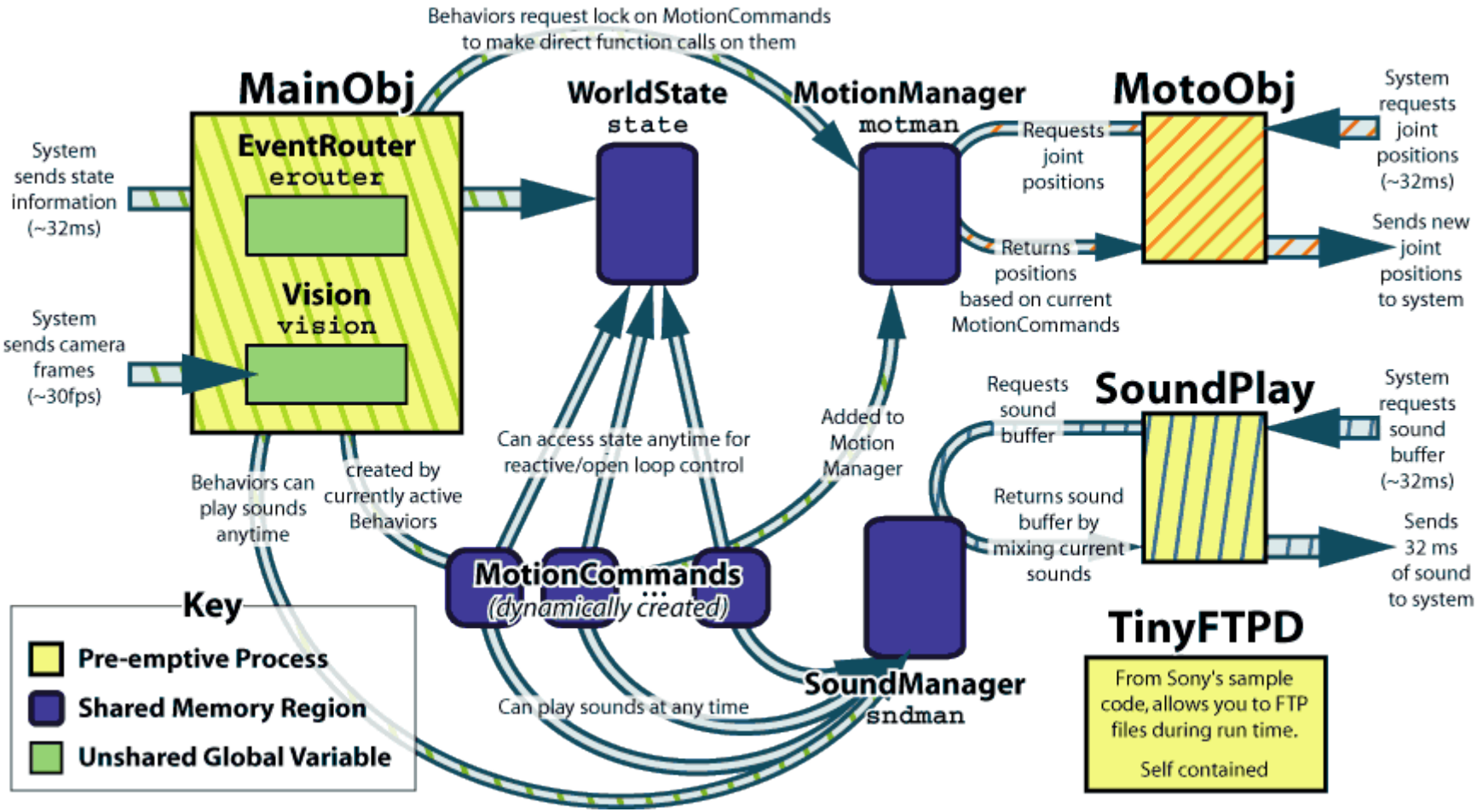
- Application framework for robotic platforms.
- Builds on the basic functionality provided by the AIBOs OPEN-R API.
- The applications are called Behaviors since they are running on a robot.

Tekkotsu - system processes

- MainObj - Does most of the bulk processing
- MotoObj - Handles movement of the robot's joints
- SoundPlay - Handles sound playback

These processes run in parallel, but multiple behaviors that run in the same process can only execute one at a time.

Tekkotsu – overview



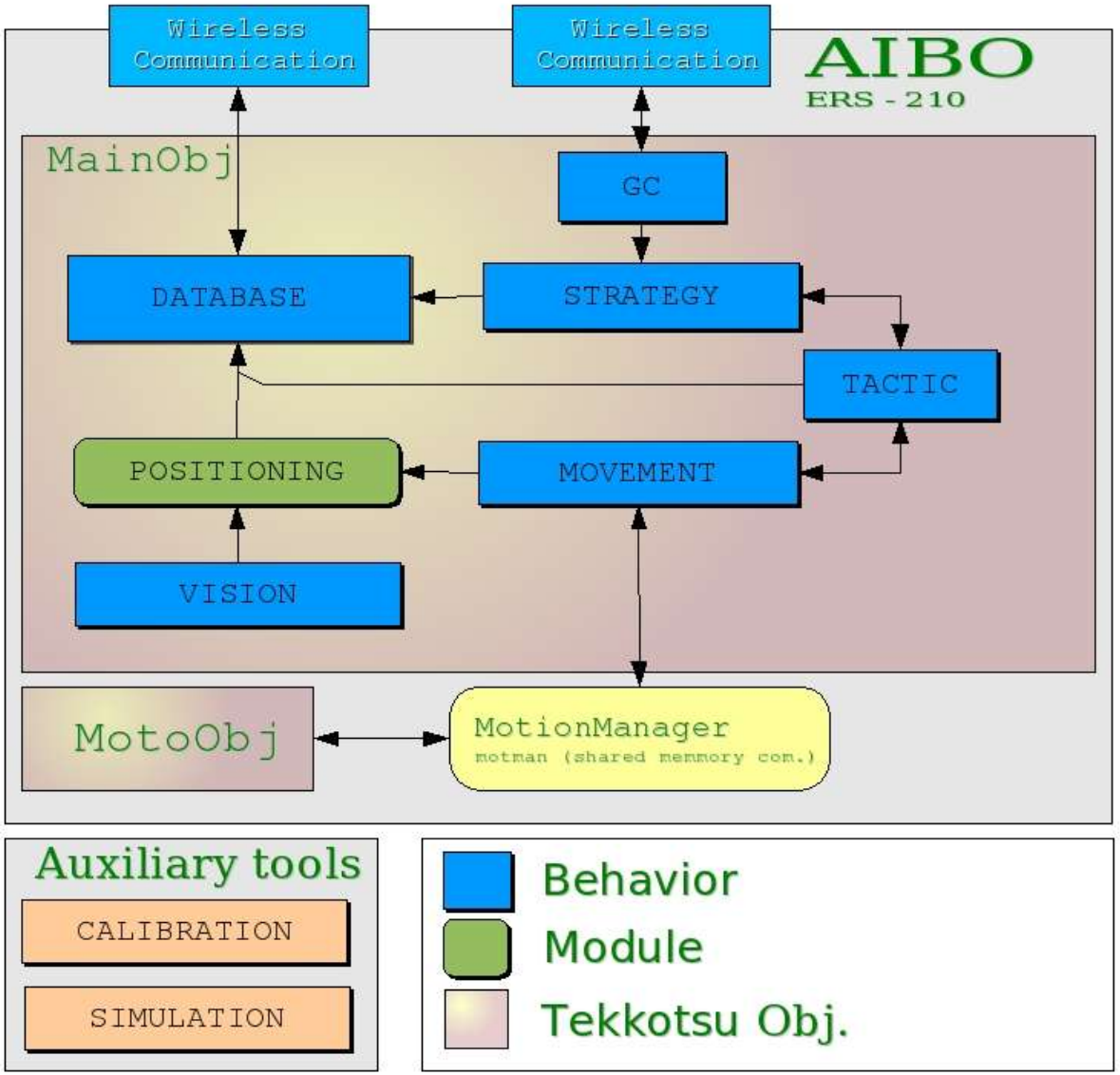
Tekkotsu

- In MainObj we run our own behaviors, this is how we implement most of our modules.
- A behavior can communicate with another behavior via events.
- All events are handled by the EventRouter that schedules behaviors to execute if they have a waiting event.

TekkotsuMon

- A set of tools for monitoring, controlling and calibrating the AIBO

Design


Wireless Communication
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AIBO
ERS - 210
MainObj
GC
DATABASE
STRATEGY
TACTIC
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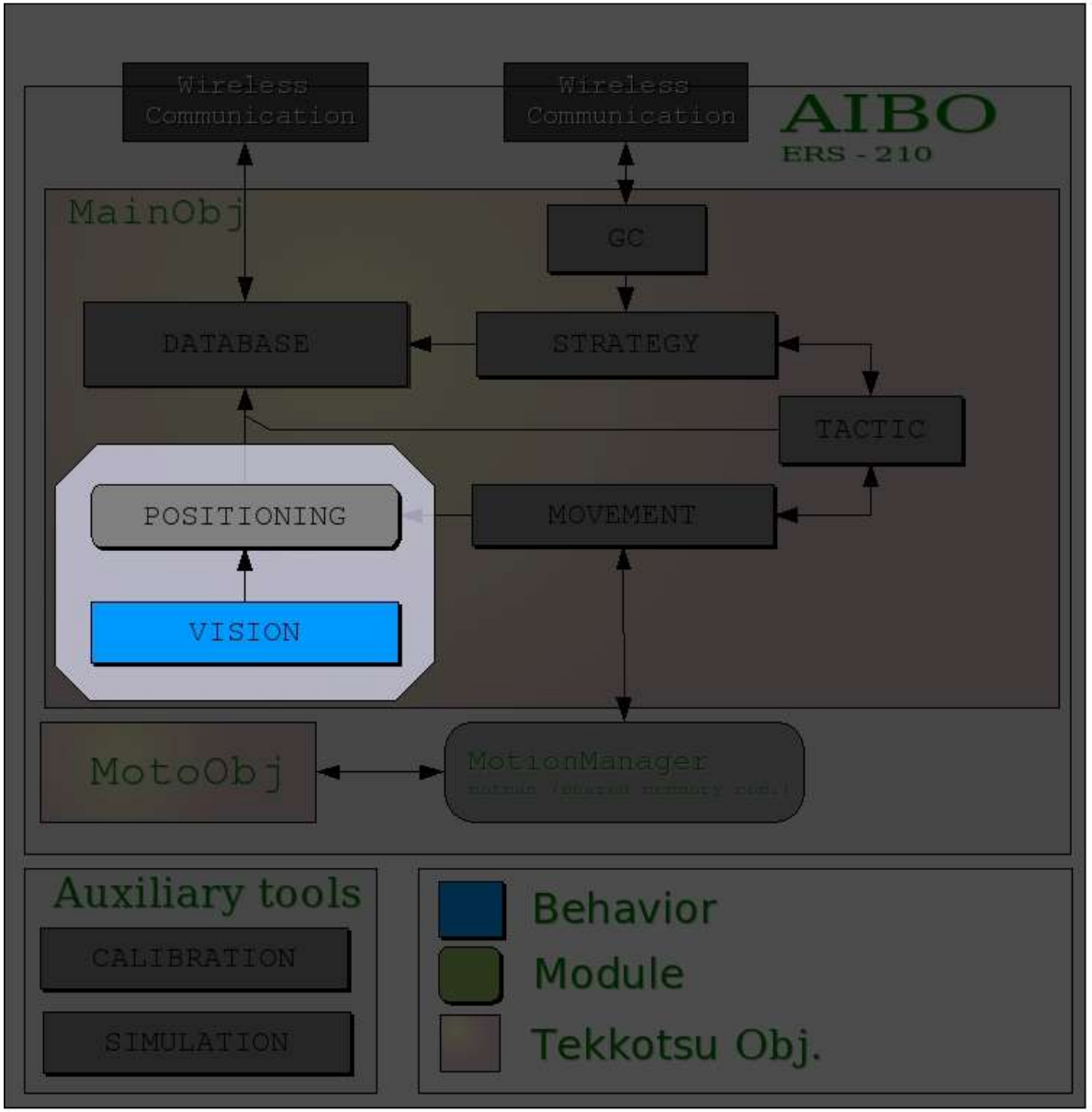
MotionManager
motman (shared memmory com.)
Auxiliary tools
CALIBRATION
SIMULATION
Behavior
Module
Tekkotsu Obj.

Vision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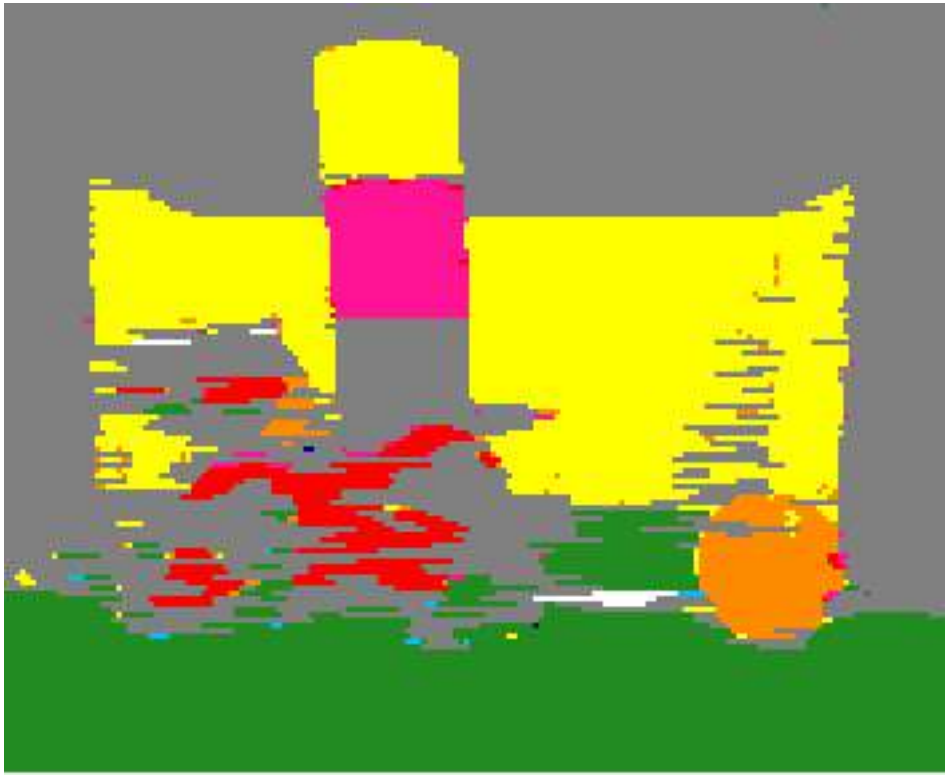
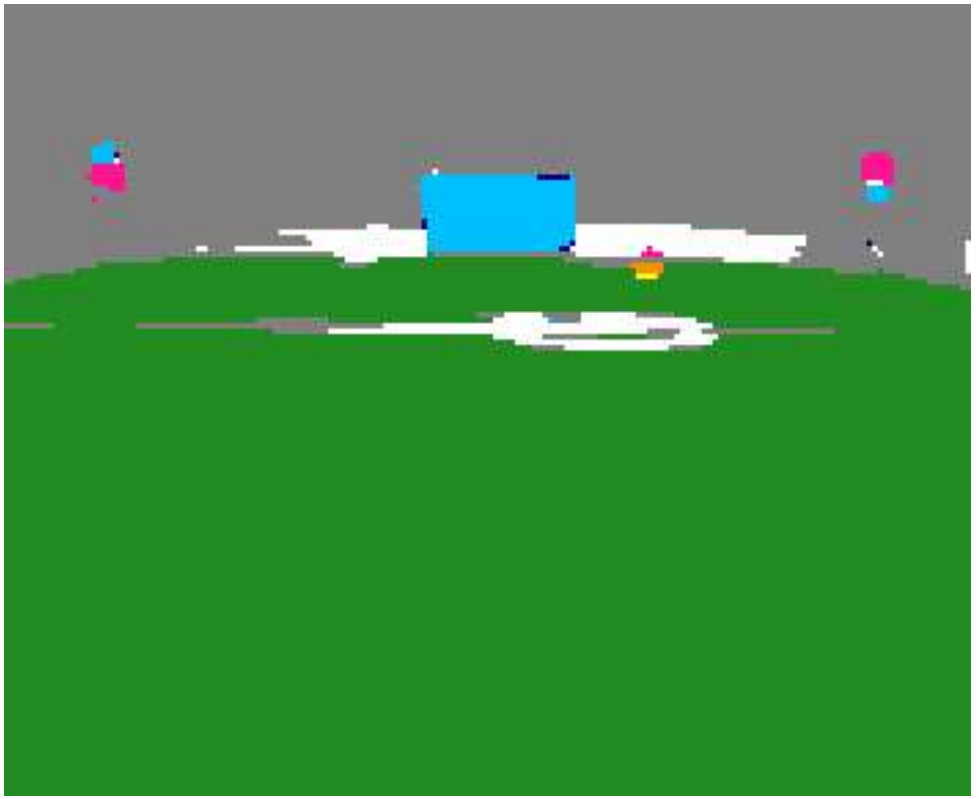
Vision

- Implements image analysis
- Identifies visible objects and calculates their positions relative to the AIBO
- Provides Positioning with object information

Vision – color segmentation



Vision – color segmentation



Vision – class Vision

- Listens for CMVision events
- Converts image data to identifiable field objects by using the ObjectLocalization class
- Calls Positioning module with list of field objects

Vision – class ObjectLocalization

Identifies and calculates robot-relative positions of:

- Balls
- Beacons
- Goals
- Other AIBOs

Vision – field object identification

Identification parameters

- Color
- Area
- Width/height proportion
- Center of gravity
- Height above field
- Neighboring regions
- Previously identified field objects

Vision – distance calculations

Ball

- Maximum width of color region

Beacons

- Average of color regions' median widths

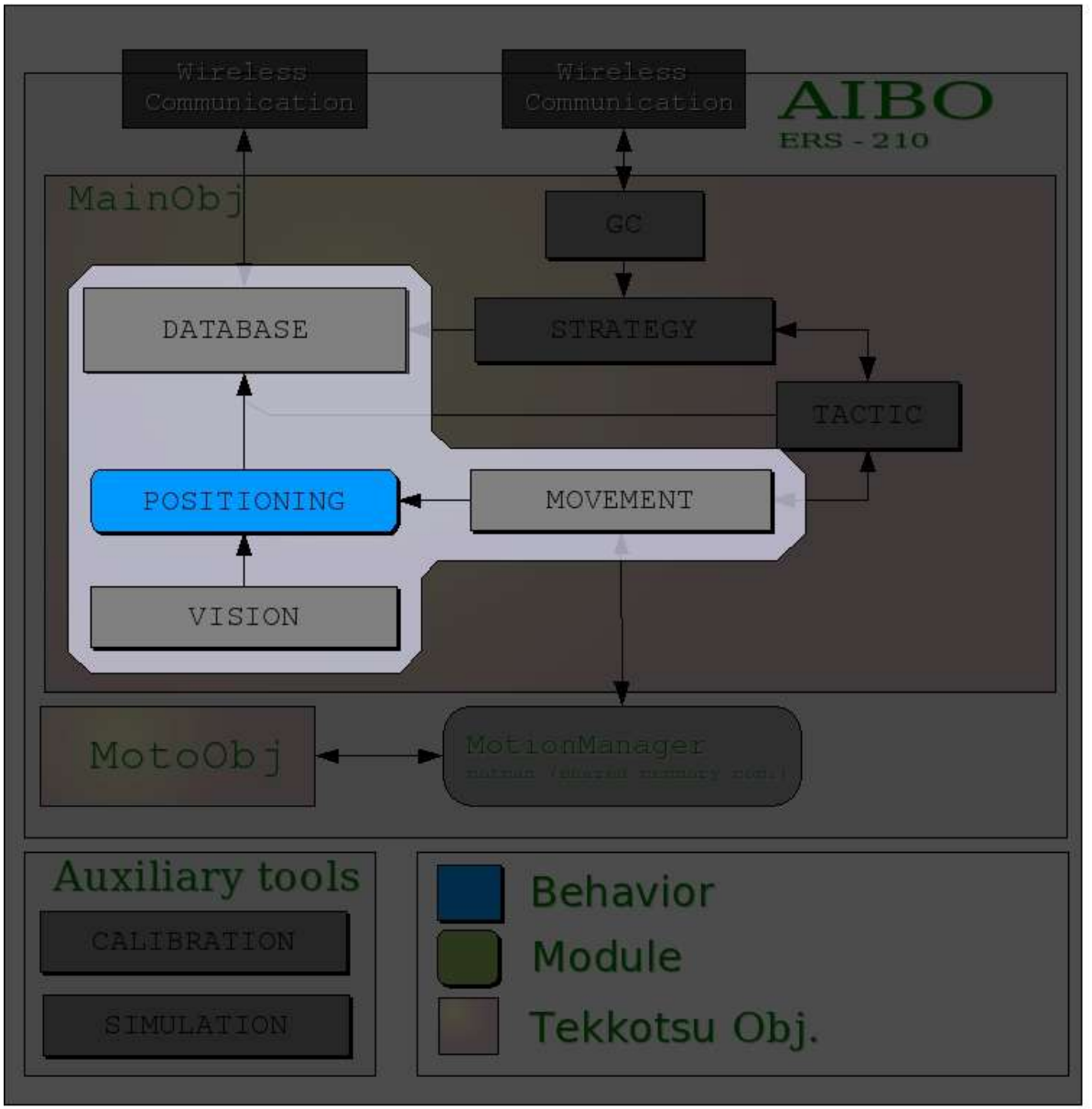
Goals

- Heights near left and right region edges

AIBOs

- Area of color region cluster

Positioning



Positioning

- Calculates AIBO and ball positions
- Inertia added with Monte Carlo Localization (MCL)
- Stores calculated position in DB

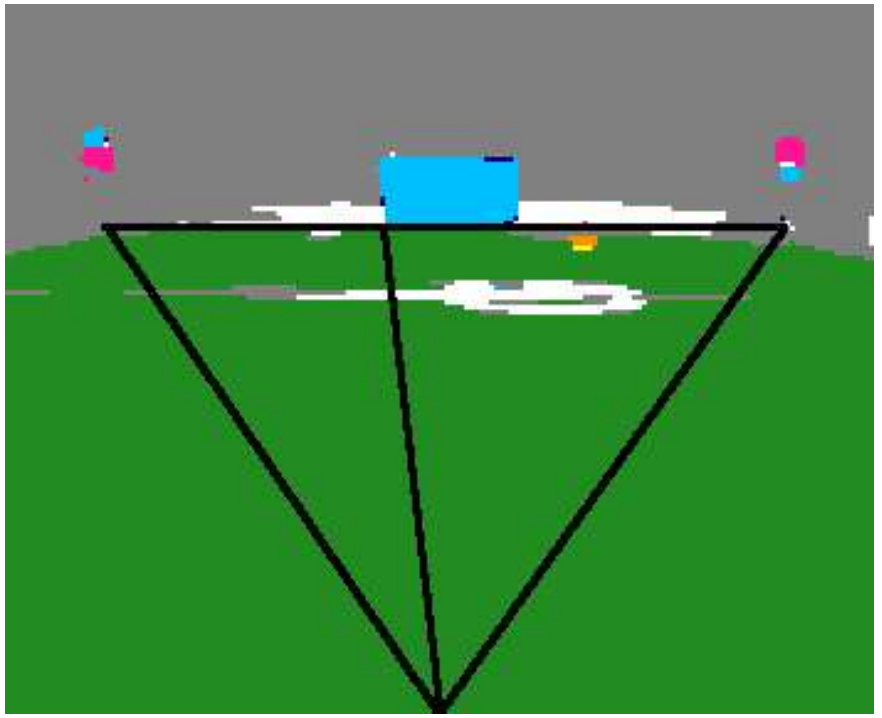
Positioning – AIBO position

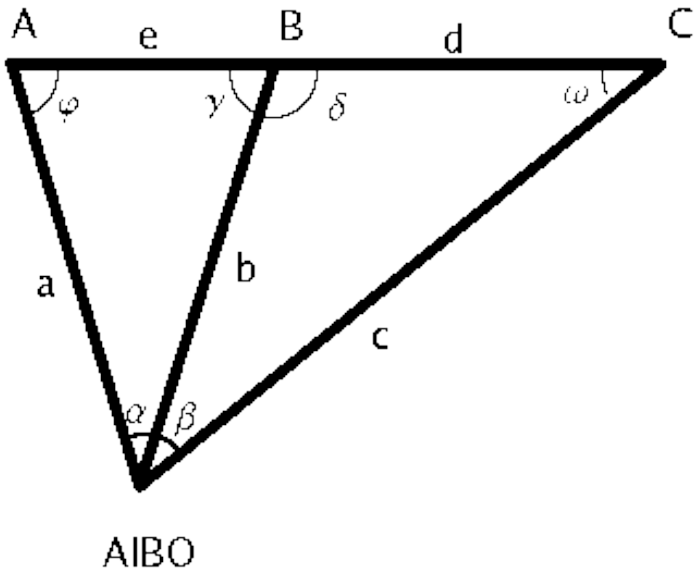
- Two types of input data used:
  - Visible field objects (Vision behavior) for geometrical calculations
    - At least two beacons or goal posts needed
  - Odometric data (Movement behavior) for dead reckoning

Positioning – AIBO position

- Trilateration
  - Uses distance and angle to two landmarks
- Triangulation
  - Bad camera resolution ⇒ bad distance approximations
  - With angles to three landmarks known, we can calculate better distances

Positioning – AIBO position





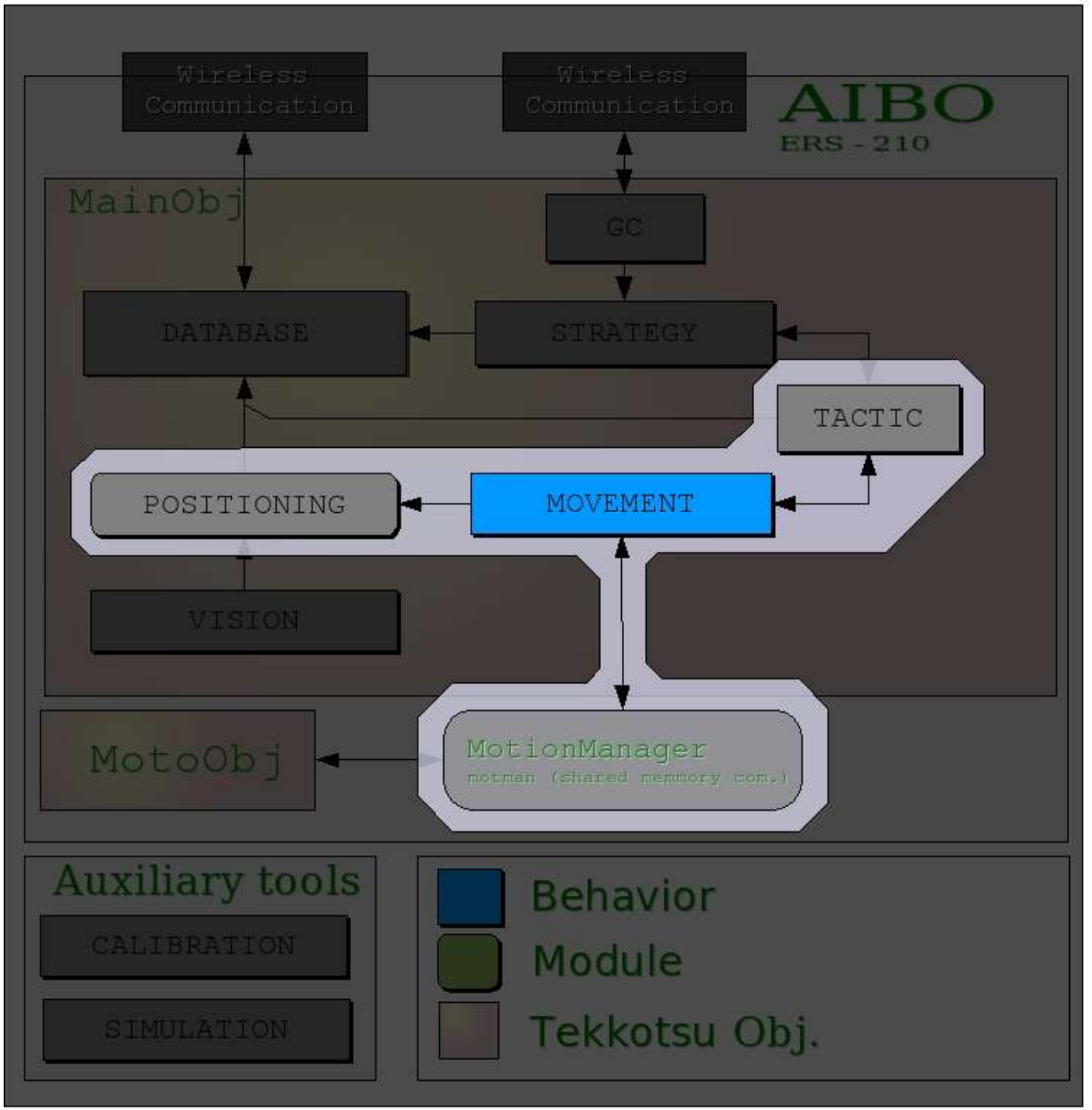
Positioning – Ball position

- Calculate relative ball position
- Add to current AIBO position
- Does not use MCL

Positioning - Monte Carlo Localization (MCL)

- Makes Positioning more tolerant of input data errors
- Keeps a set of positions with confidences
  - confidence updated with new sensor data
  - position updated with new odometric data
  - "best" current position calculated from this set

Movement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Tekkotsu Obj.

Movement

- Responsible for performing the movements by communicating with the Tekkotsu MotionManager
- Executes the instructions given by the Tactic module
- Calculate and report to the Positioning module how far the AIBO has moved since last time it reported its position

Movement – status

The AIBO is able to:

- walk in any direction by walking forward, backwards, strafing or rotating
- push the ball to the right or left with its head
- kick forward, left or right
- wag the tail
- move the head
- get up if fallen

Movement

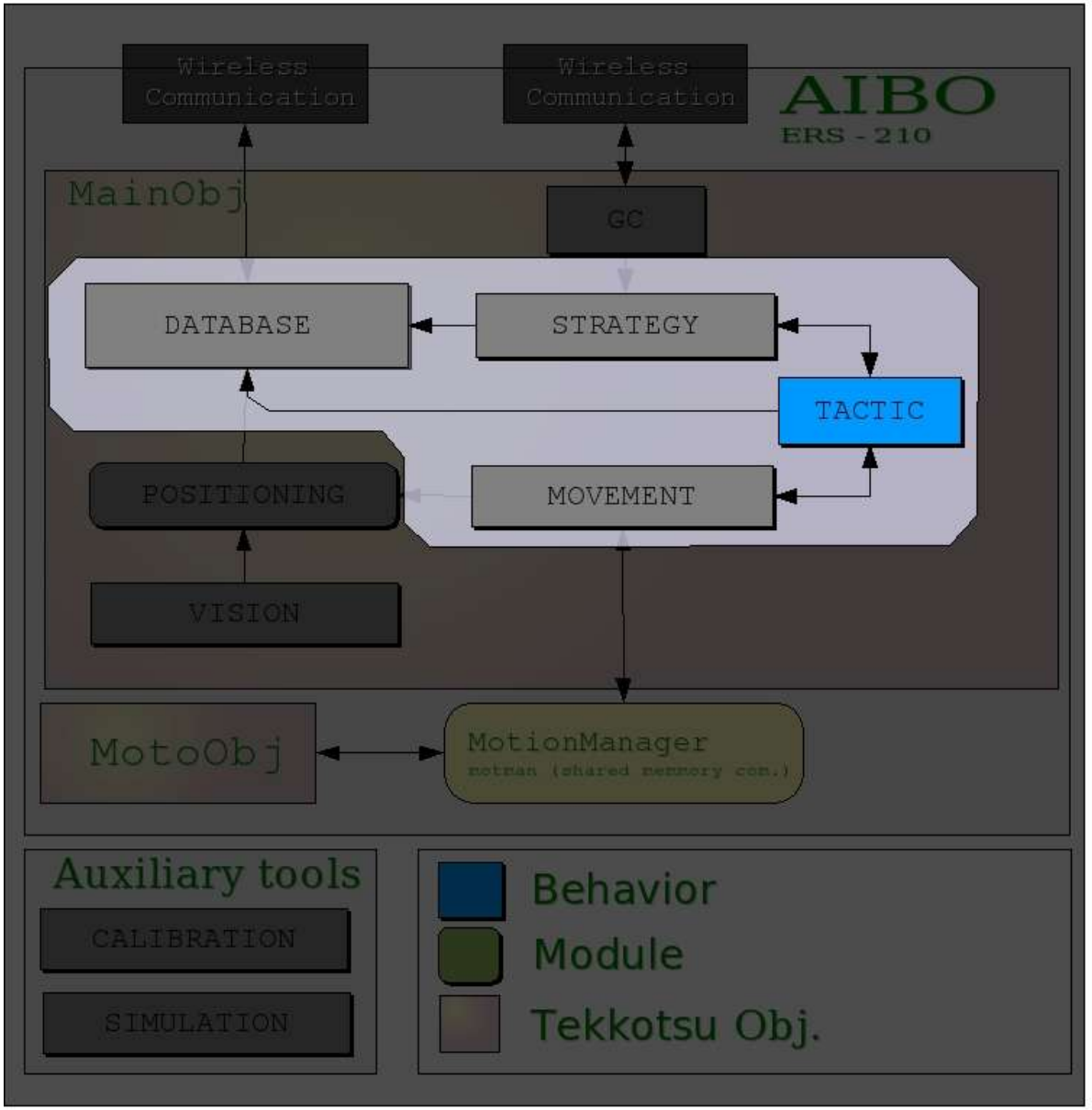
Future work:

- Use a faster walking style to move forward

Problems:

- Difficulties with events disappearing in the eventrouter

Tactic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Tactic

The Tactic module shall be able to:

- decide which walking style to use
- decide which kick to use
- choose the best route to a position so the AIBO avoids walking into its team mates
- locate the ball
- tell the Movement module what to do

Tactic

Status:

- The module has all required functionality

Future work:

- The Dijkstras algorithm will be implemented for obstacle avoidance

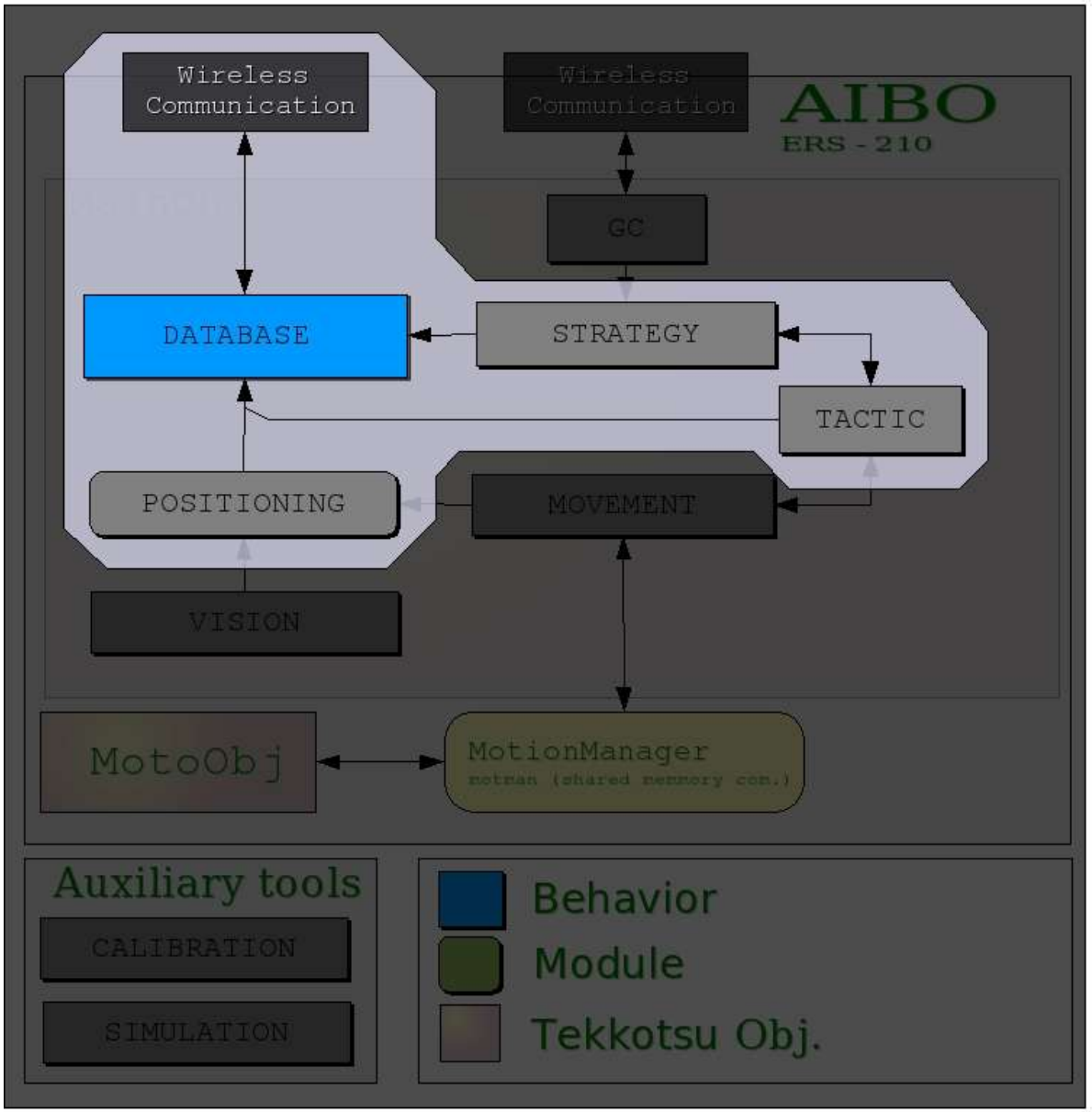
Tactic

Problems:

- Since there have been problems with the positioning it has been difficult to test some parts of the module

- The coordinate system for the field is different from any ordinary coordinate system, which has lead to some misunderstandings.

Database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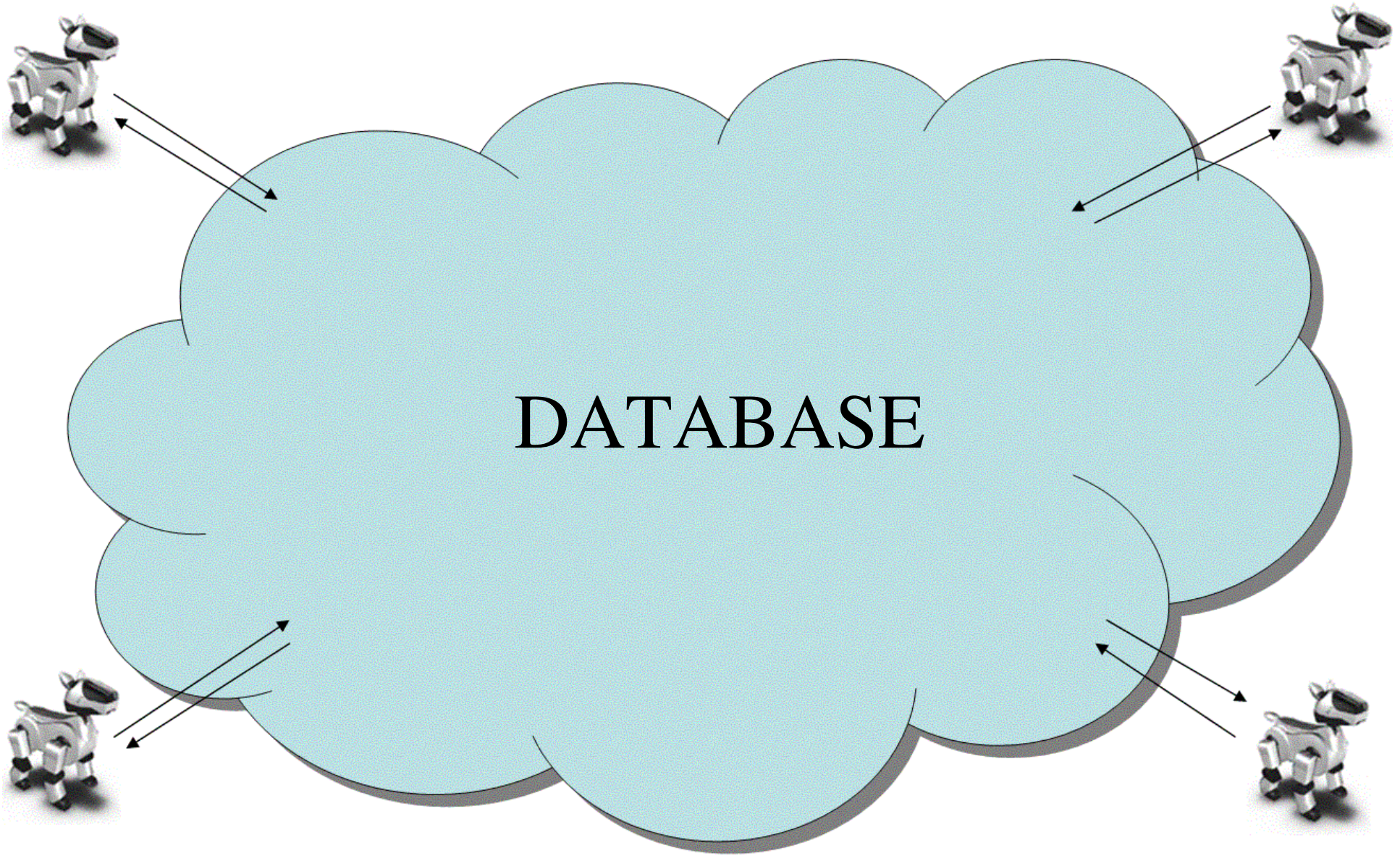
Database

- Provides storage functionality for data
- Replicates data via the network
- All AIBOs have the same replicated data

Database – data distribution



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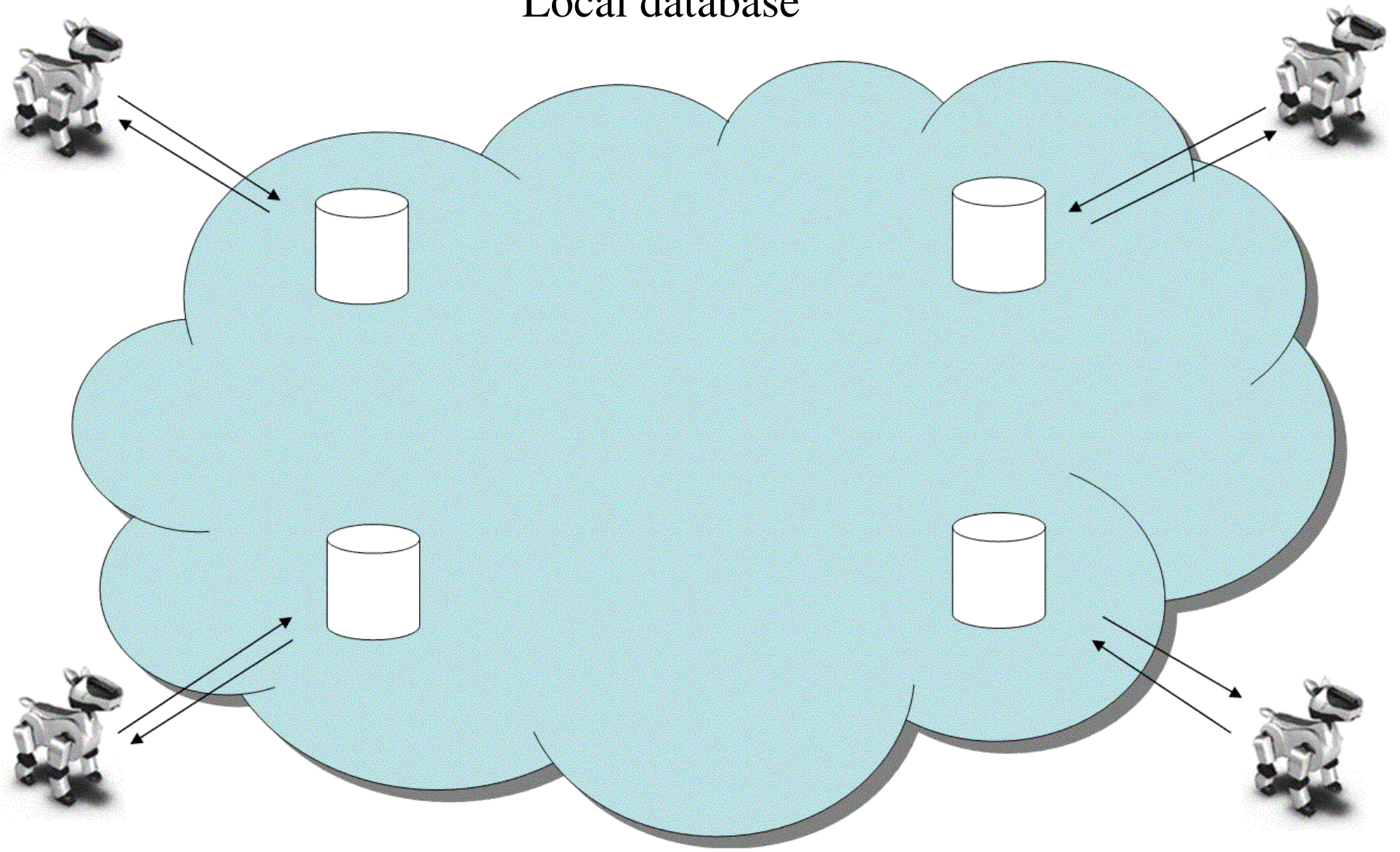
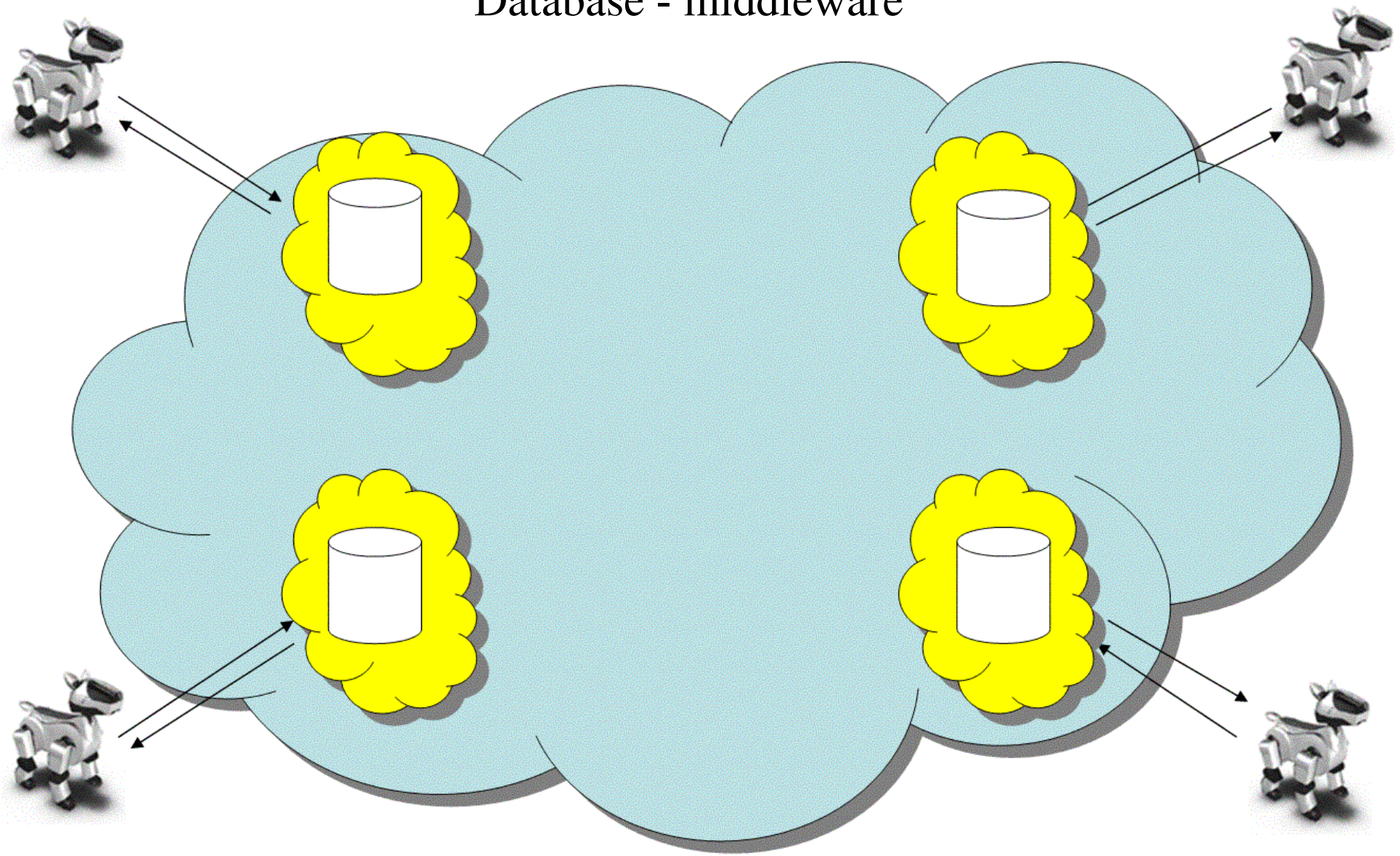


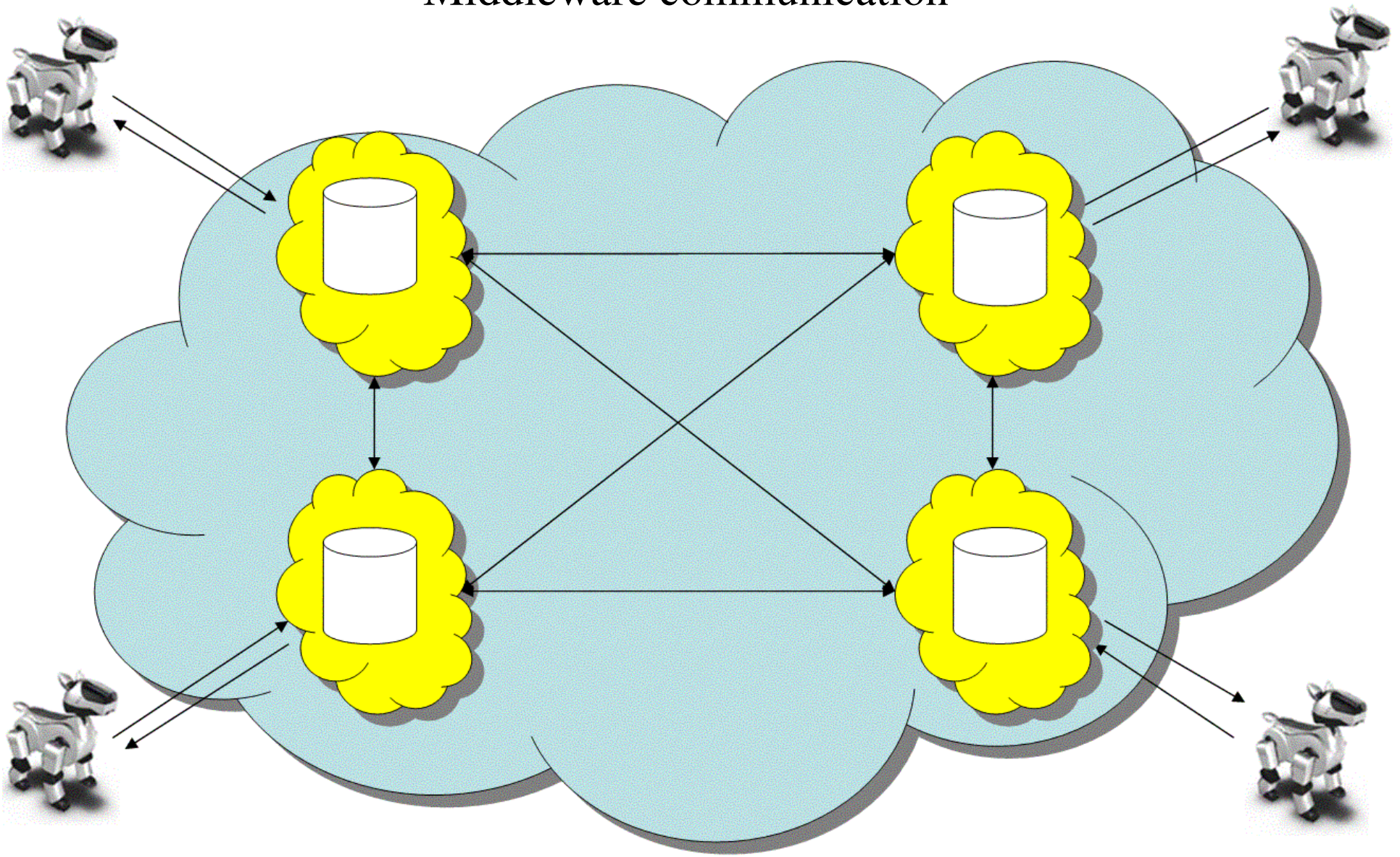
Database – data distribution

Database - middleware



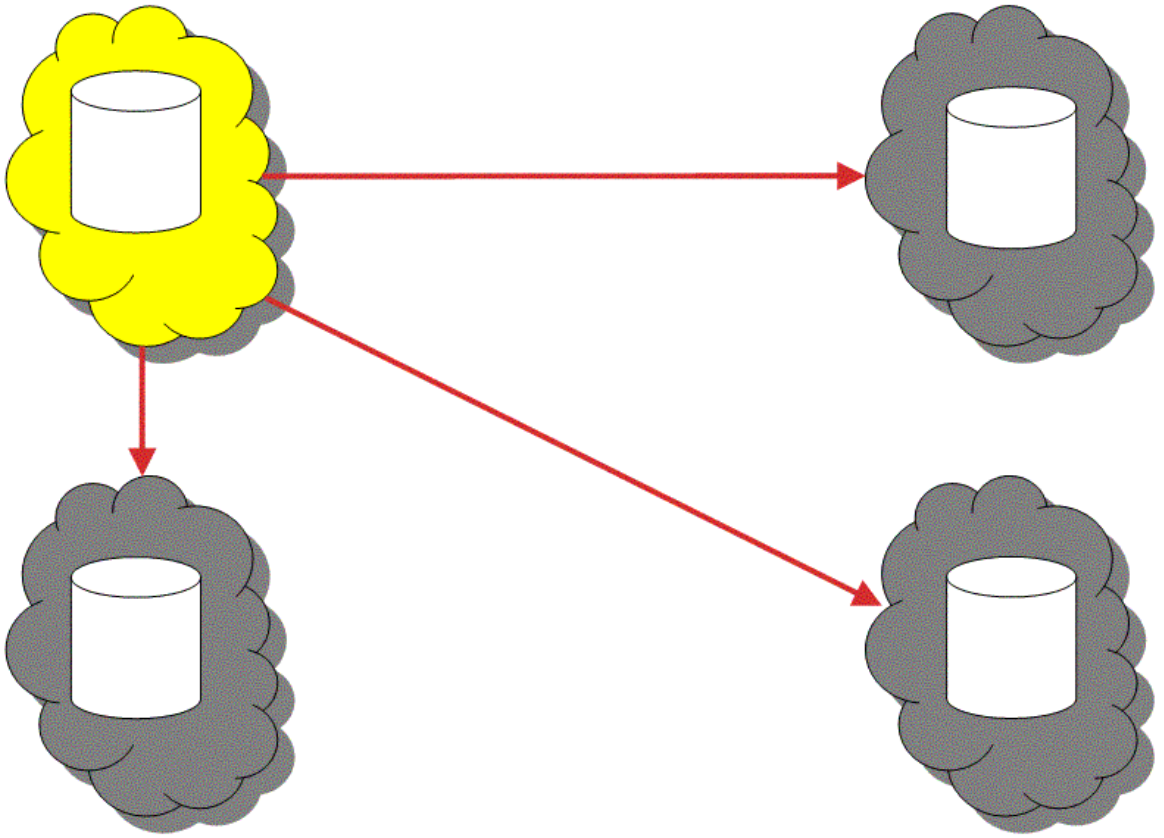
Database – data distribution

Middleware communication

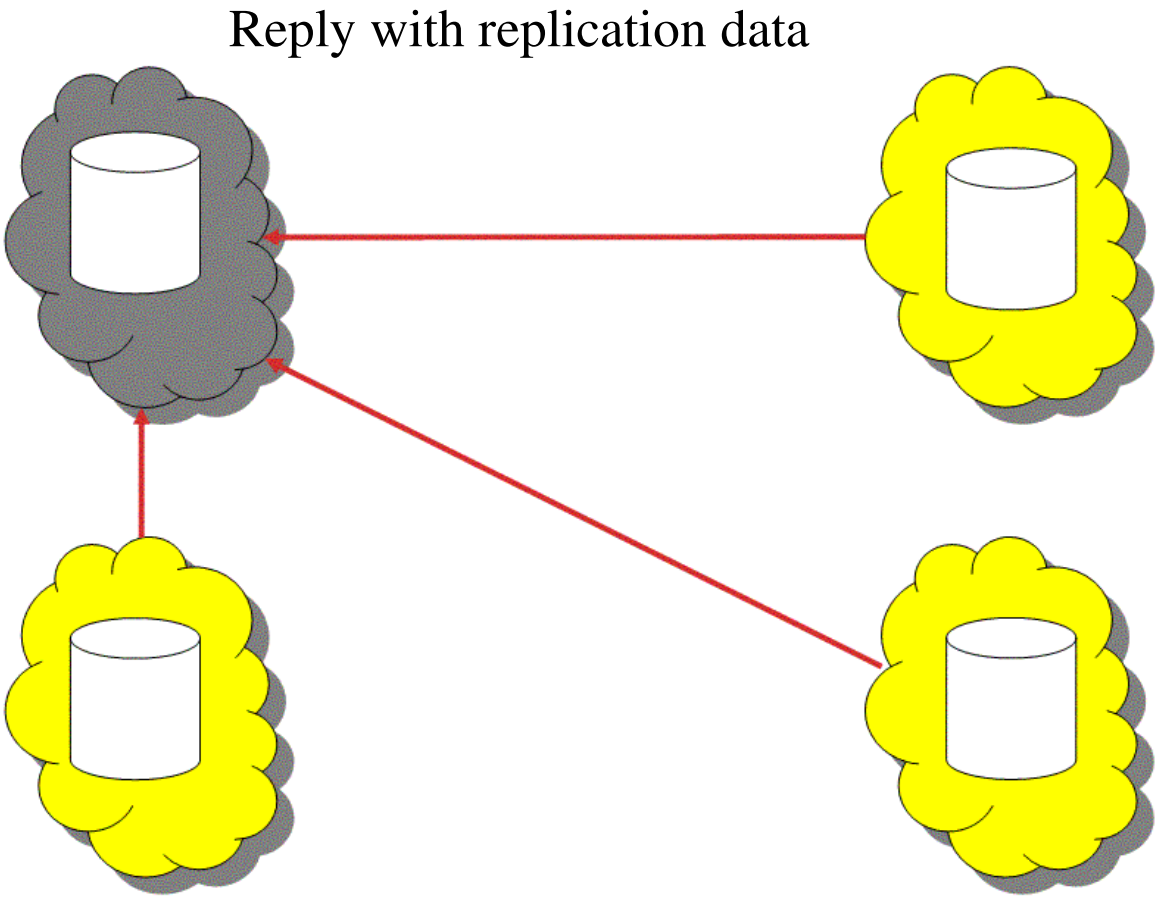


Database – data distribution

Request replication data

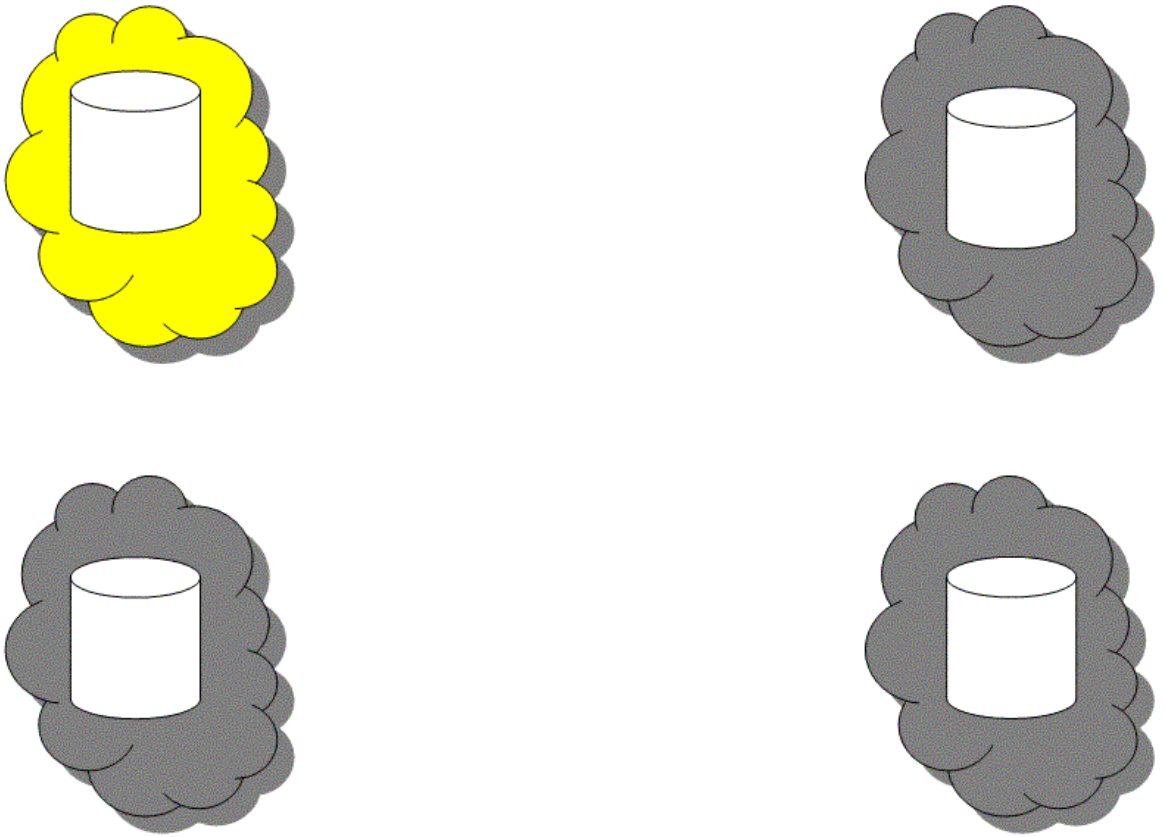


Database – data distribution

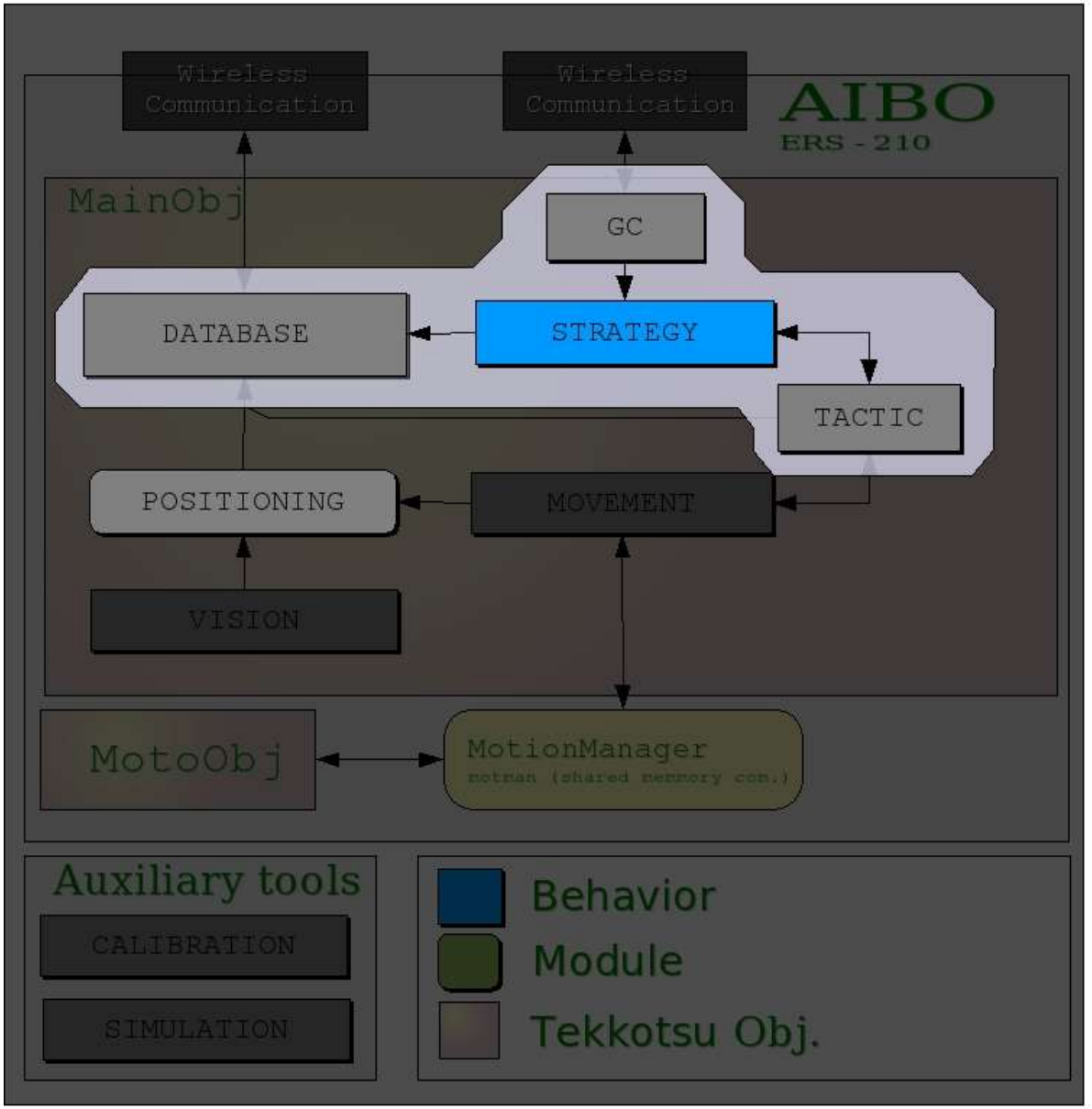


Database – data distribution

Stores and calculates mean values



Strategy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Strategy

- The strategy module coordinates other modules to a playing soccer team.
- Strategic decisions are made locally by each AIBO.
- Local decisions are based on identical data from the database.
- Thanks to the distributed database, a global strategy can be broken down to local decisions made by every AIBO on the field.
- The strategic decisions are then executed by the Tactic module

Strategy

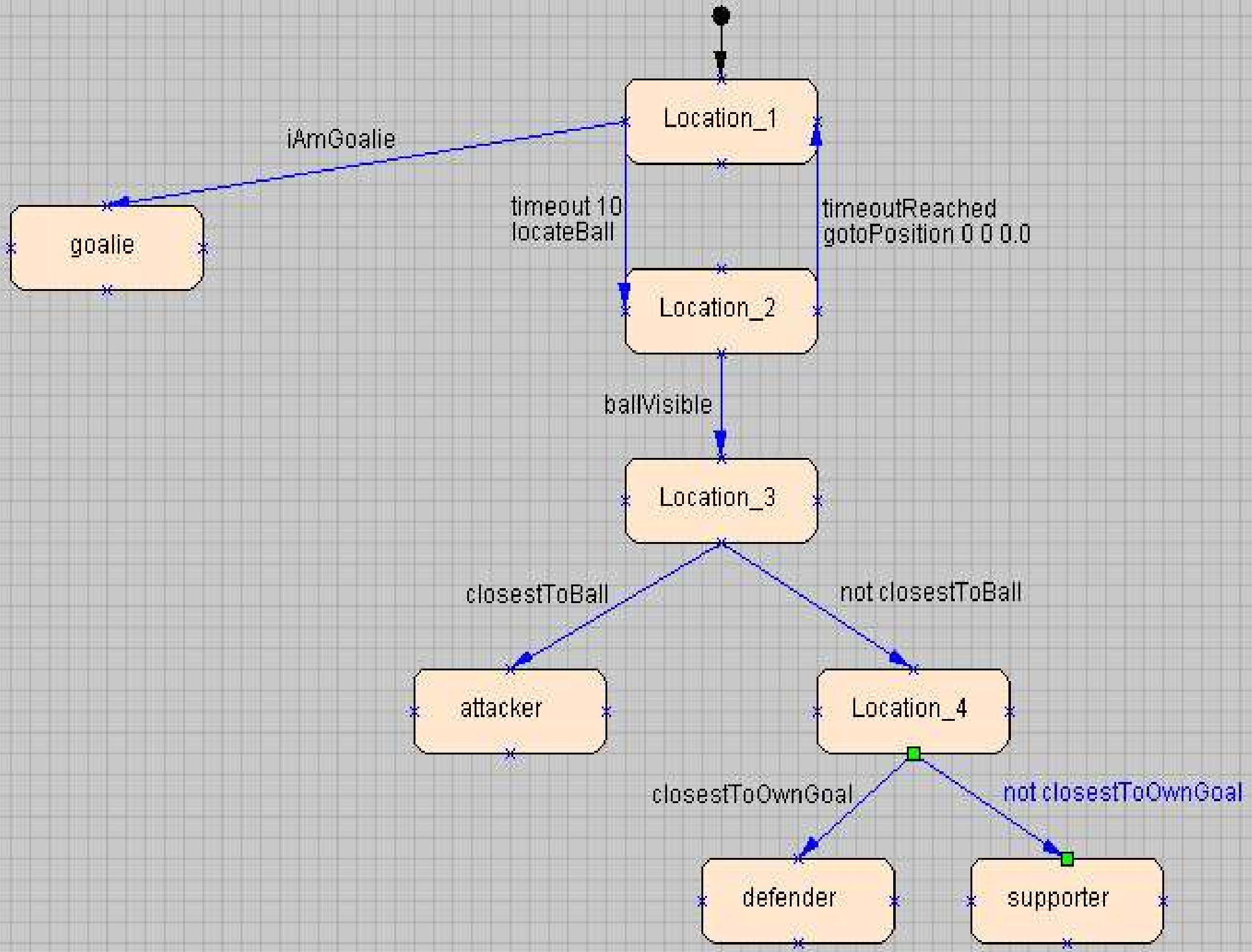
- The strategies are designed visually as automatons, with a language constructed for this purpose.
- These automatons are then exported to XML and later on read by the strategy-engine and translated to an internal representation.
- This makes it possible to change strategy without recompiling.

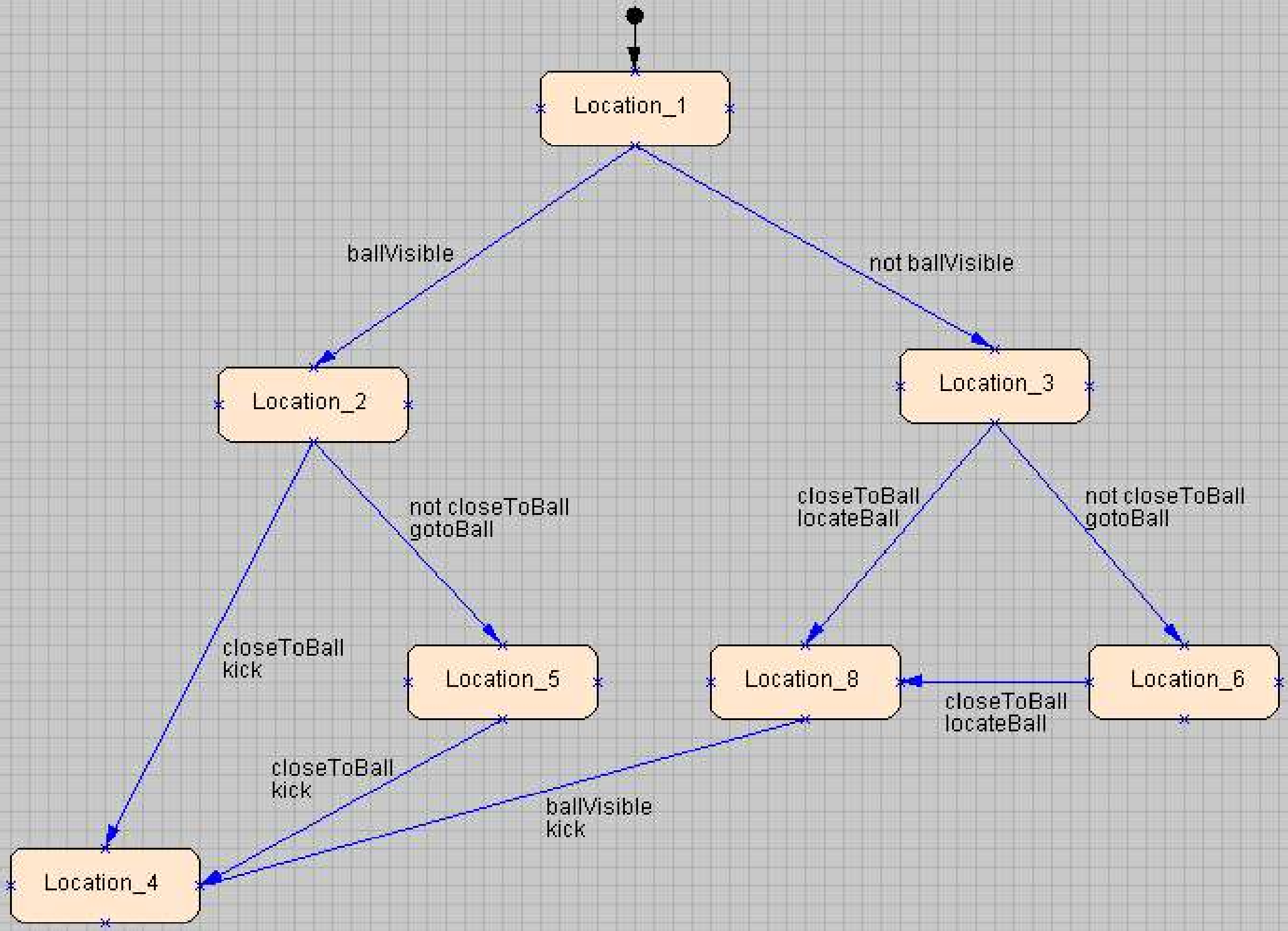
A minimum of three automatons are required;

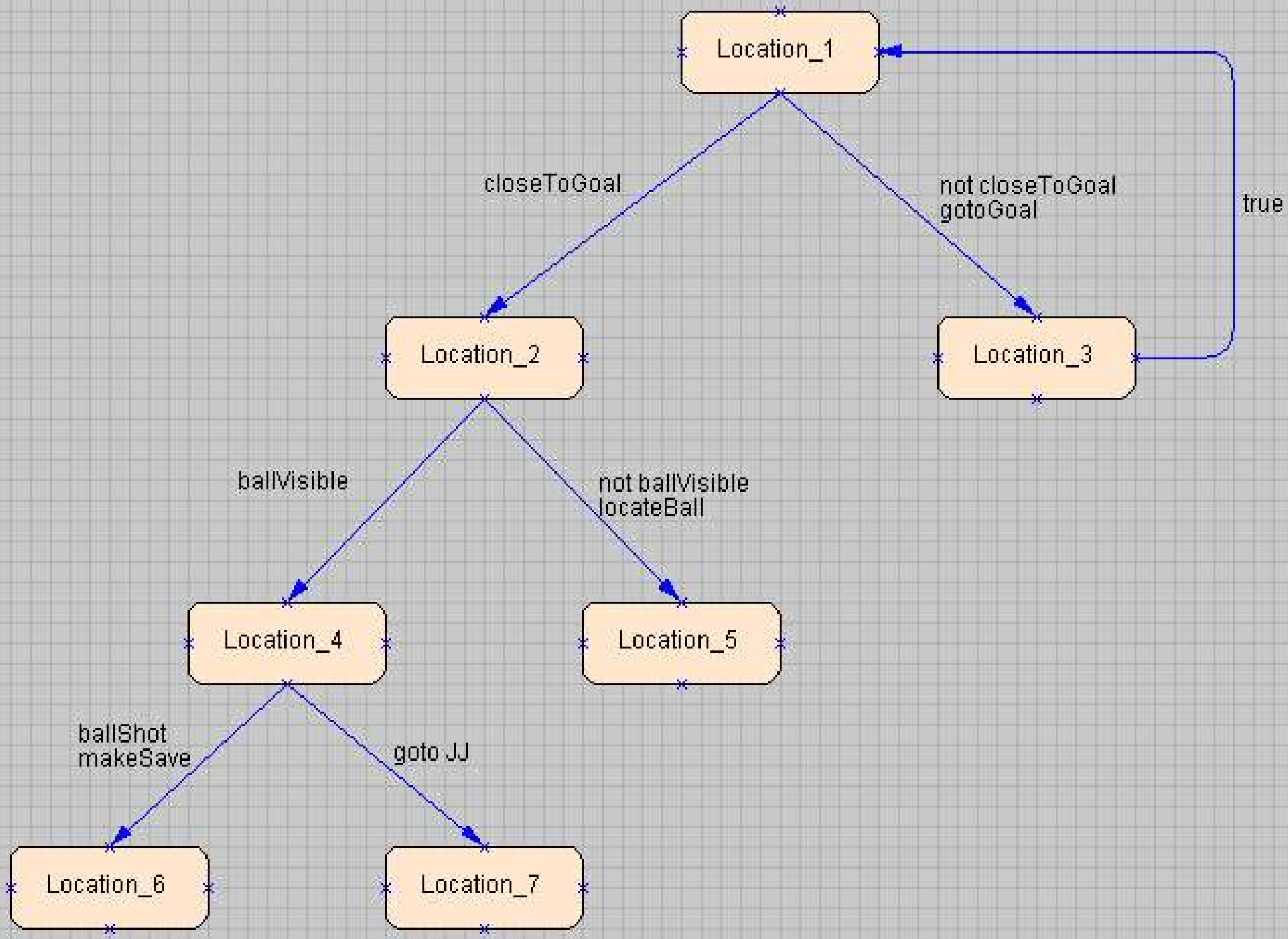
lineup – a description of which roles to use under different circumstances.

rolecaster – decides which AIBO will get which specific role.

role – the local strategy for each AIBO (E.g. goalie or attacker)


Location_1
iAmGoalie
goalie
timeout 10
locateBall
timeoutReached
gotoPosition 0 0 0.0
Location_2
ballVisible
Location_3
closestToBall
not closestToBall
attacker
Location_4
closestToOwnGoal
not closestToOwnGoal
defender
supporter


Location_1
ballVisible
not ballVisible
Location_2
Location_3
not closeToBall
gotoBall
closeToBall
locateBall
not closeToBall
gotoBall
closeToBall
kick
Location_5
Location_8
Location_6
closeToBall
locateBall
closeToBall
kick
ballVisible
kick
Location_4

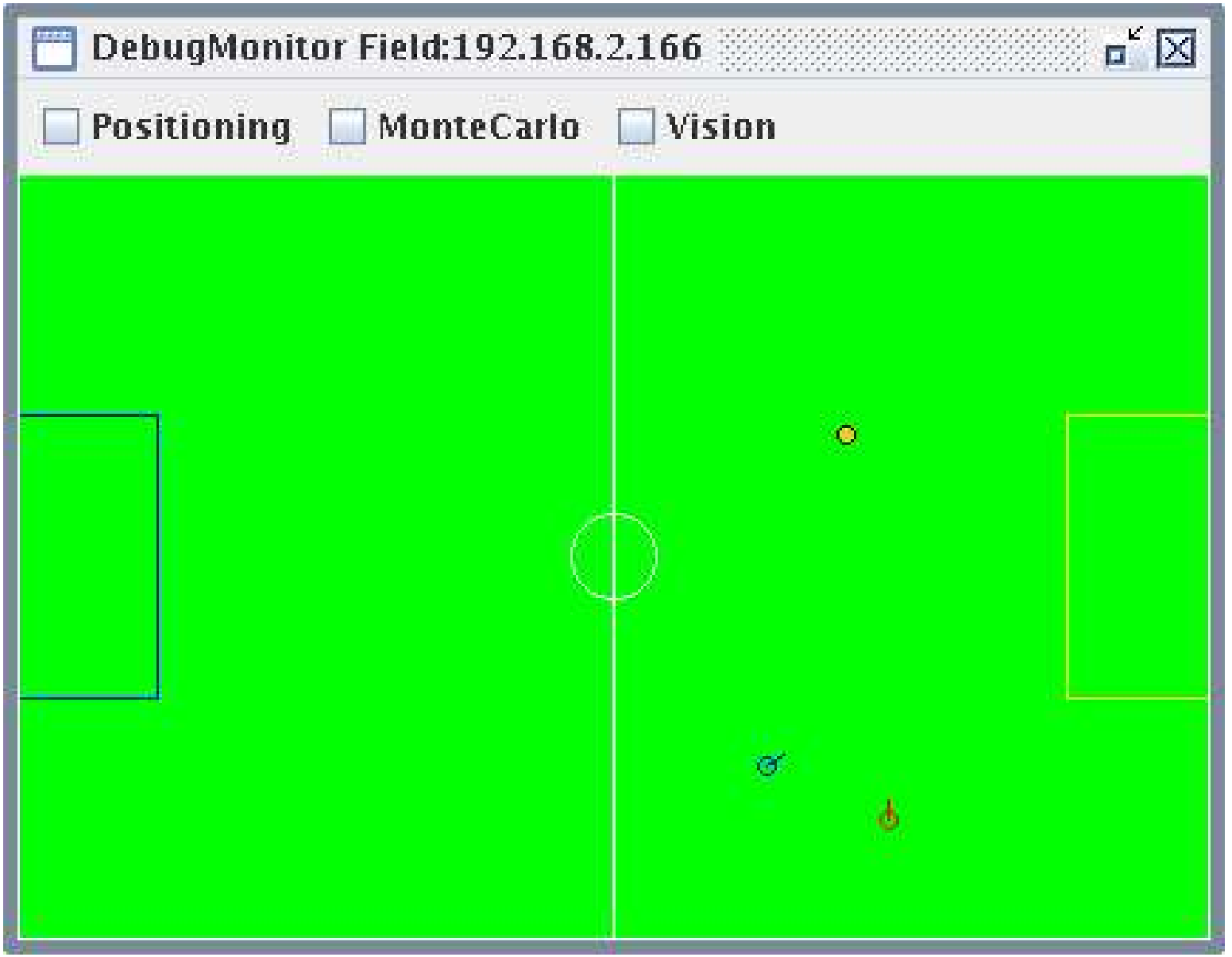

Location_1
closeToGoal
not closeToGoal
gotoGoal
true
Location_2
Location_3
ballVisible
not ballVisible
locateBall
Location_4
Location_5
ballShot
makeSave
goto JJ
Location_6
Location_7

Debug Monitor

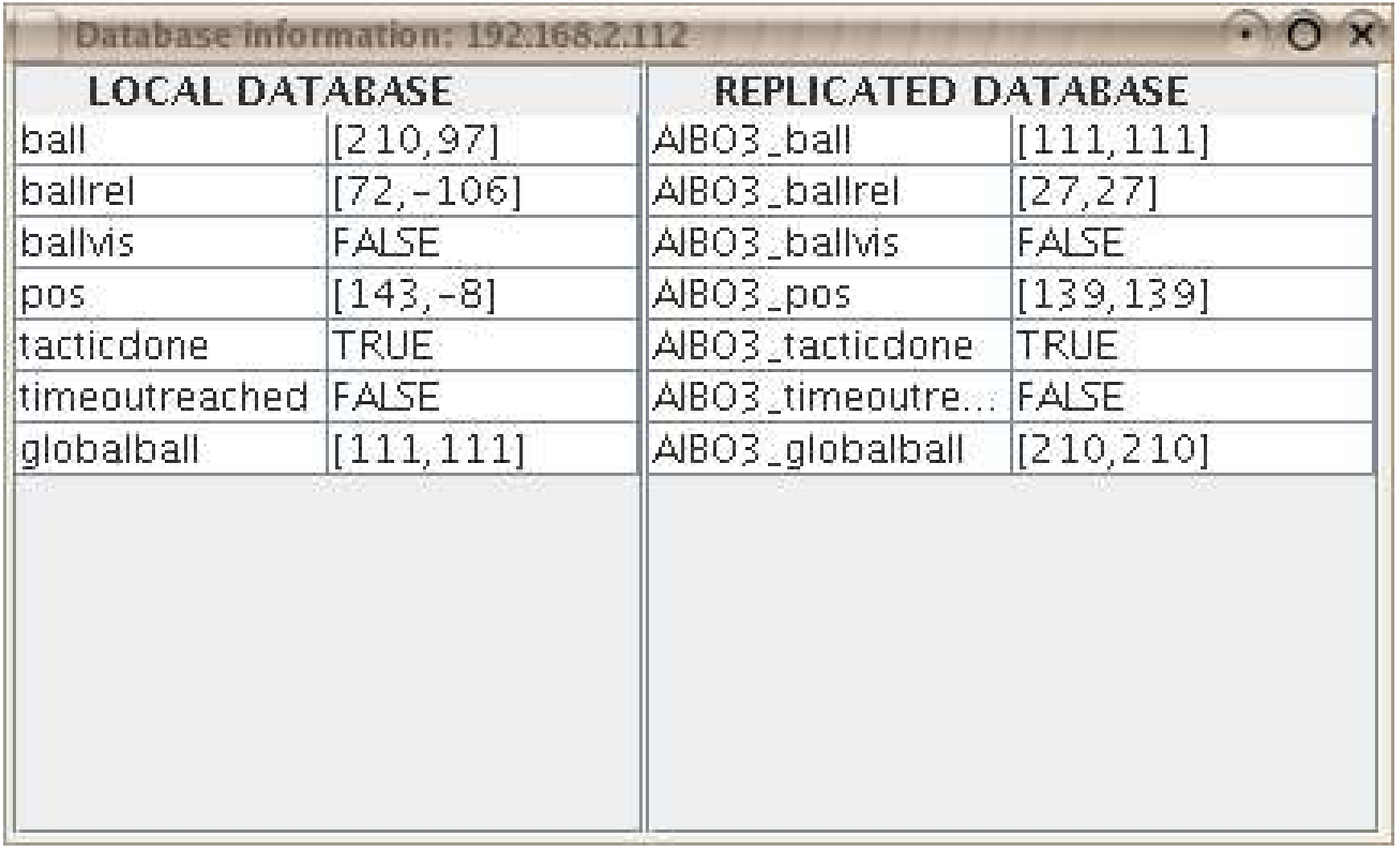
Need to visualize information about

- Positioning
- Database
- Strategy

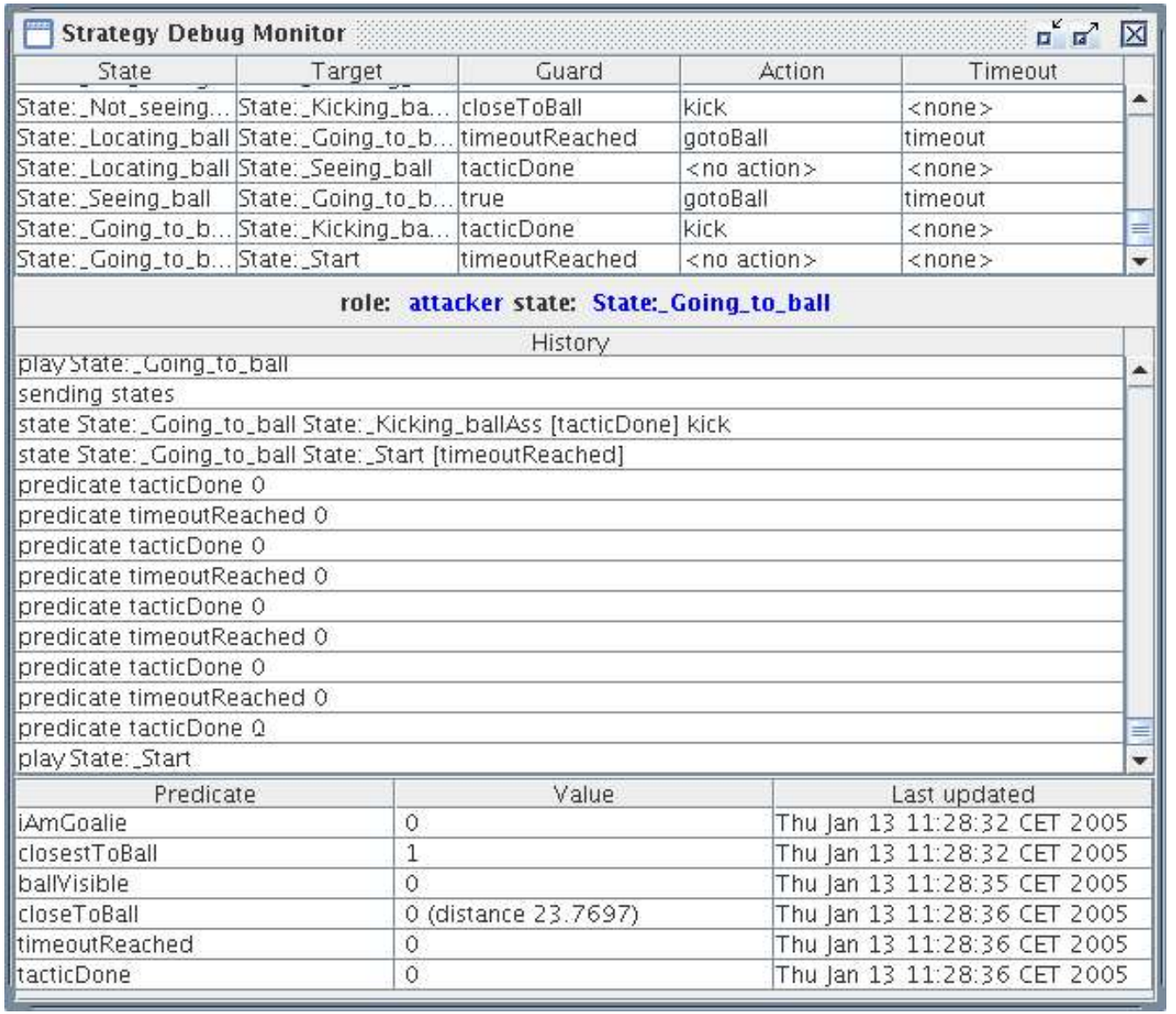
Debug Monitor - Positioning



Debug Monitor - Database



Debug Monitor - Strategy



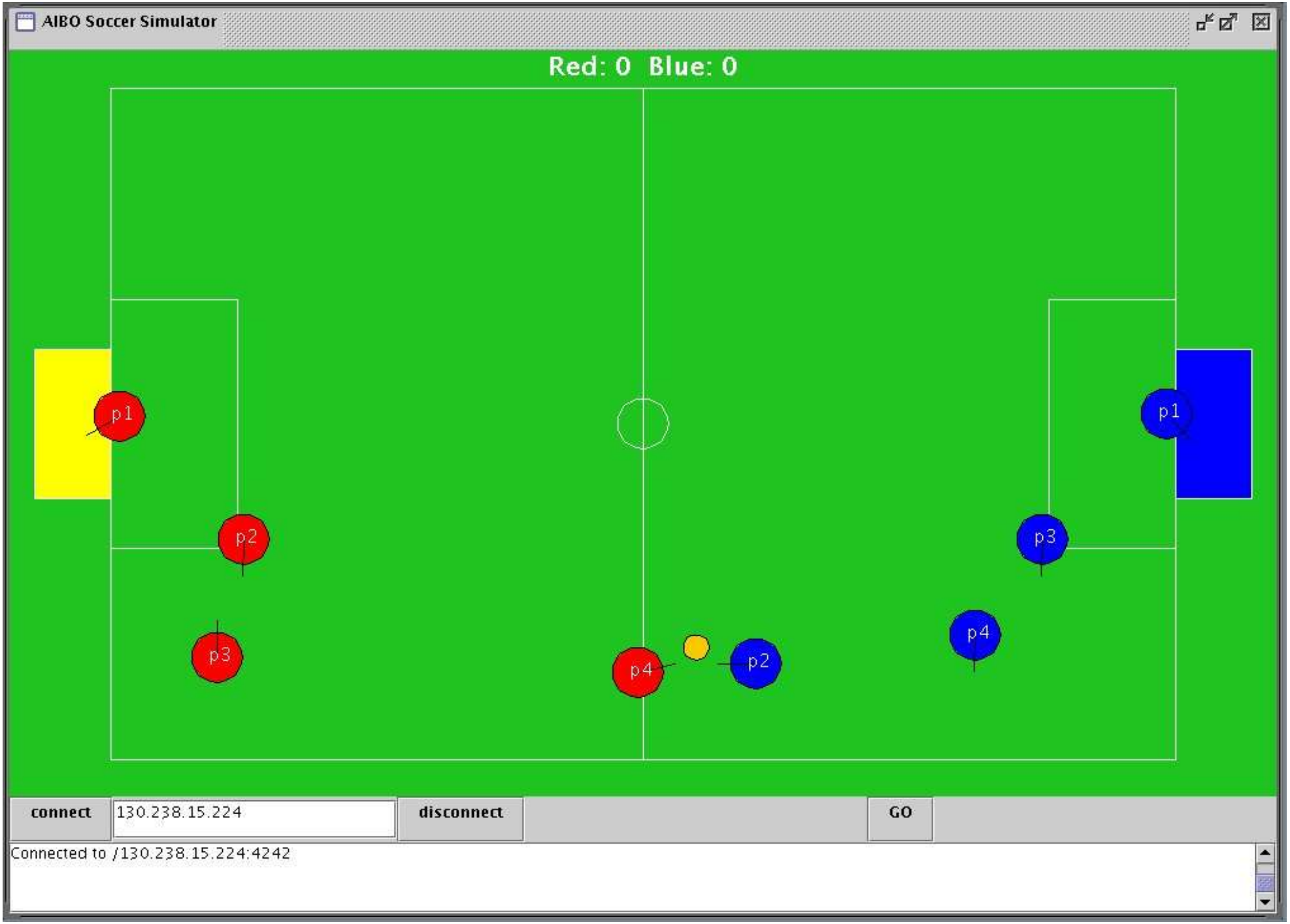
Simulator

- Test environment for strategies
  - Simulate Database interface
  - Simulate Tactic interface
- Simplified representation
- Perfect database

Simulator - description

- Simulator
  - Main class
  - Field
  - Ball
  - DB
  - GC
  - Strategy
  - Tactic
  - Player

- SimGUI
  -User interface


AIBO Soccer Simulator
Red: 0 Blue: 0
p1
p2
p3
p4
p2
p3
p4
p1
connect
130.238.15.224
disconnect
GO
Connected to /130.238.15.224:4242

Questions ?

Code reusage

- Team Dynamo Pavlov 2002 did not use Tekkotsu
- Team Gifr 2003 used incompatible Tekkotsu release, difficult to continue development
- Old solutions were studied although no actual code was reused
- Several modules that no previous team had attempted

Summary

- Despite not complete functionality, we learned a lot about the following:
  - Large projects
  - Working in an unfamiliar environment
  - Teamwork
  - Documentation
  - System design
  - Fancy presentations
  - How to endure a dozen cups of coffee a day :-)

The End