UNIVERSITAT ROVIRA I VIRGILI

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MULTI-AGENTS SYSTEM

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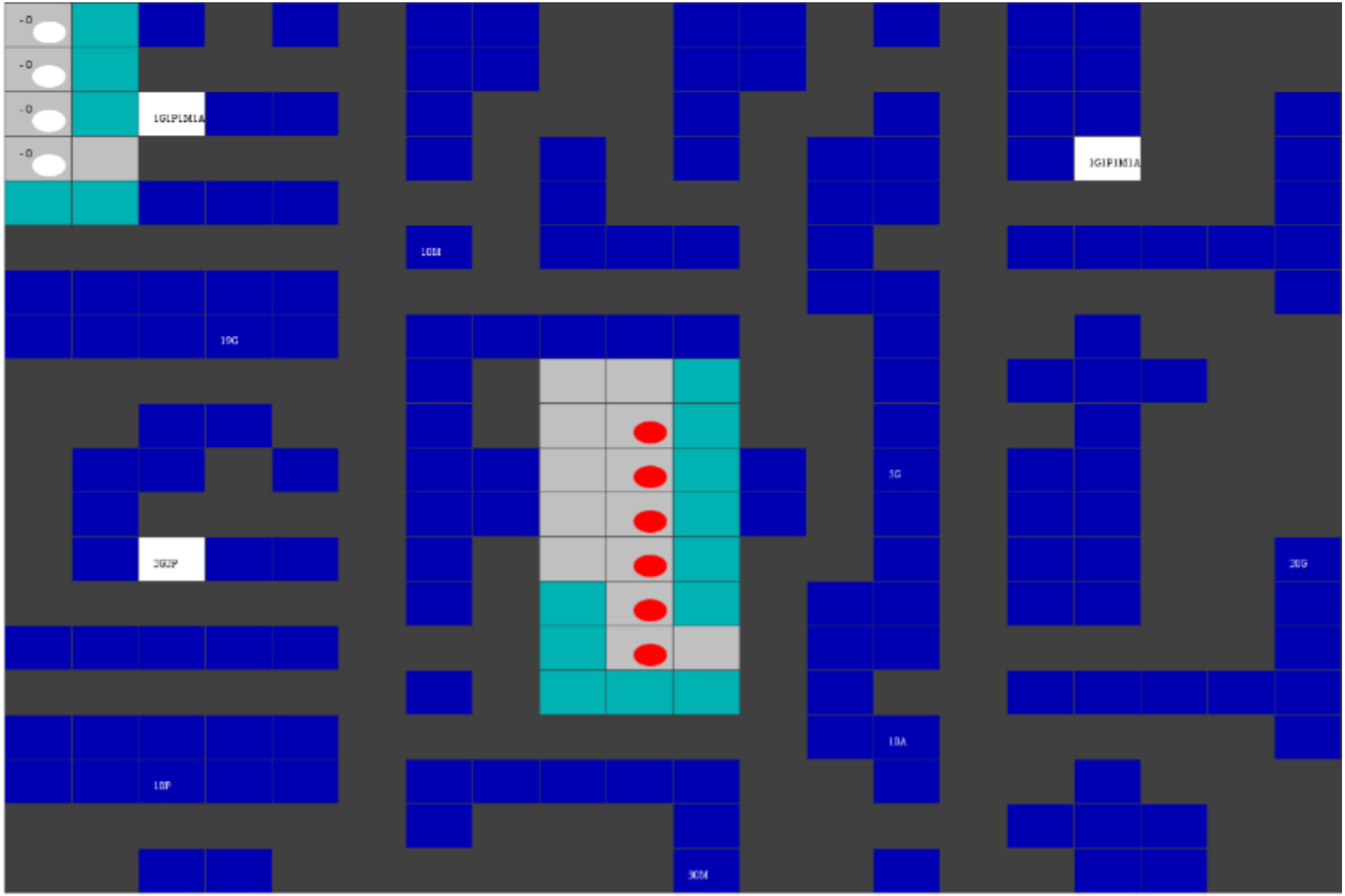
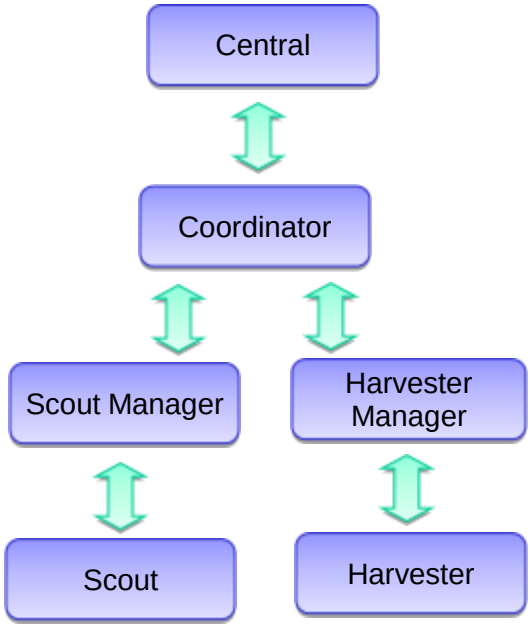
The Problem



Our Solution

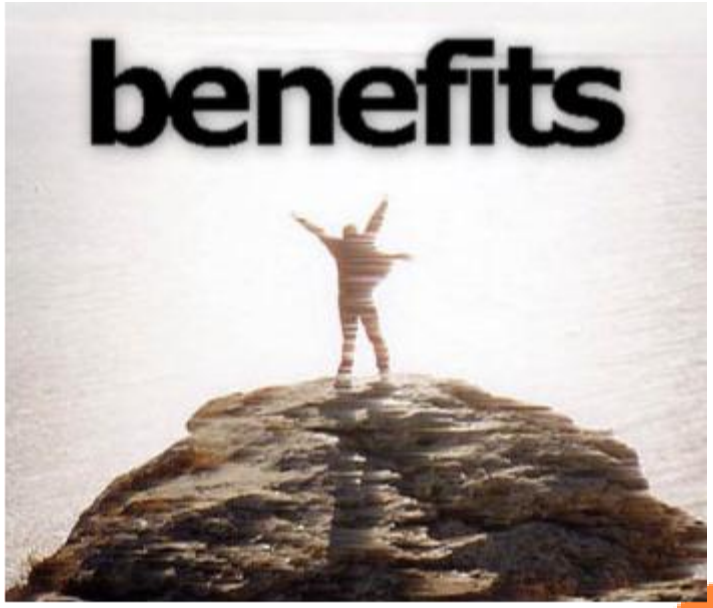


Our Policy

- Goals, paths and strategy is **computed** again on **every turn**
- Simulation is **protected** against cheating
- We consider **risky movements**, like including on our path an undiscovered zone.

Policy Strengths

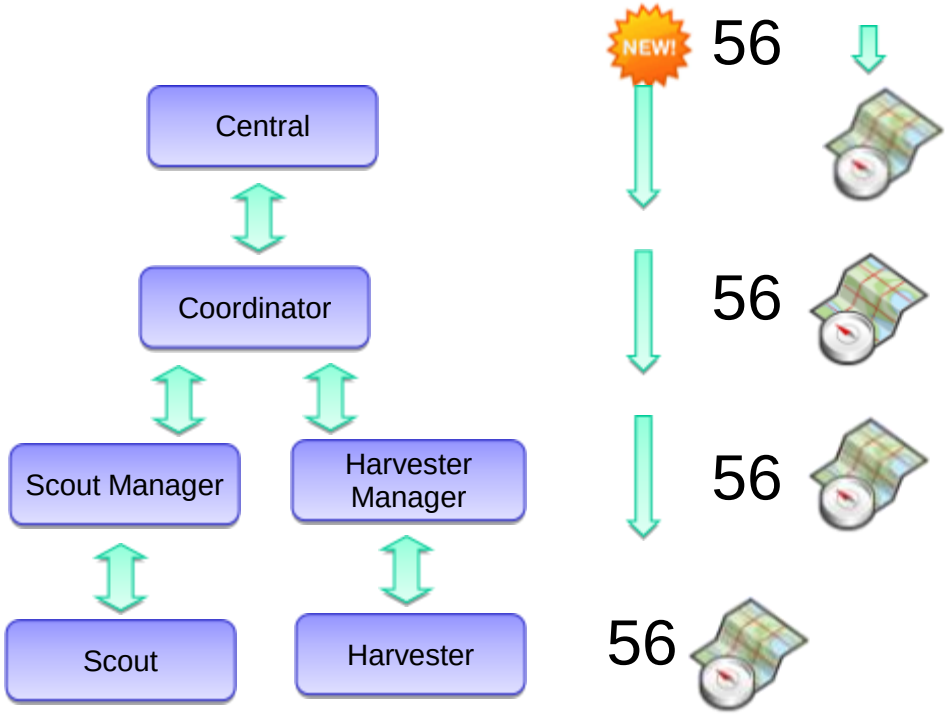
- Reactions to changes in the dynamic environment are good.
- Our score is true.
- Benefits of risk are high



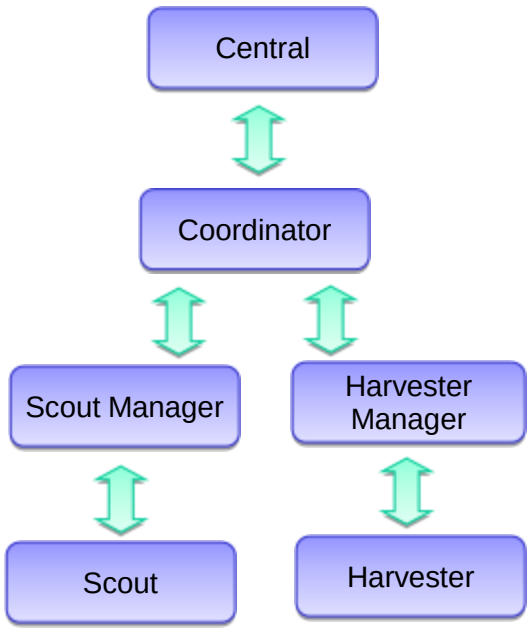
Policy weaknesses

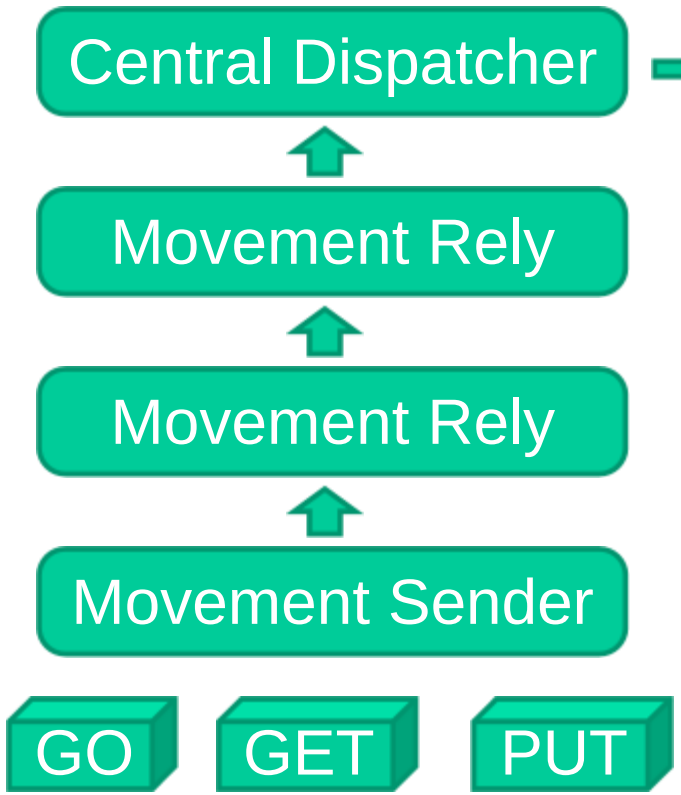
- High computing requirements
- In dense mazes, it may appear as Agents are constantly changing of goals, due they are avoiding blocked paths.

Turn Propagation



Movement Orders





Security

- Agent has not moved yet on this turn
- While Moving
  - Destination is an empty Street
  - Destination is inside the map
  - Direction is UP/DOWN or SIDE/SIDE
- While Getting Garbage
  - Agent can carry that garbage type
  - Agent is not full
  - There is Garbage on the building
  - There is a building to get it from
  - The agent is not carrying garbage of different type
- While dropping garbage
  - Destination is a recycling Center
  - Destination accepts the garbage
  - Agent has enough garbage to drop

Statístics

- Earned and maximum points
- Collected and total garbage
- Turns needed to finish
- Discovered buildings with garbage
- Total buildings with garbage
- Time to discover all buildings
- Number of moving turns for each Agent

Results

EASY MAZE

Simulation Finished
****

Points earned: 65
Max points: 90
Percentage earned: 72.22222222222223%
Garbage collected: 35
Total garbage: 35
Turns to finish: 161
Buildings discovered: 4
Total Garbage Buildings: 4
Percentage of Garbage Buildings discovered :100.0%
Turns to find all garbage buildings: 67
Agent S6: 90 movements
Agent H2: 108 movements
Agent H5: 85 movements
Agent S1: 65 movements
Agent S4: 81 movements
Agent S3: 122 movements

****

HARD MAZE

Simulation Finished
****

Points earned: 184
Max points: 258
Percentage earned: 71.31782945736434%
Garbage collected: 104
Total garbage: 104
Turns to finish: 365
Buildings discovered: 7
Total Garbage Buildings: 7
Percentage of Garbage Buildings discovered :100.0%
Turns to find all garbage buildings: 116
Agent S5: 146 movements
Agent S4: 133 movements
Agent H1: 188 movements
Agent H3: 237 movements
Agent H6: 217 movements
Agent S2: 122 movements

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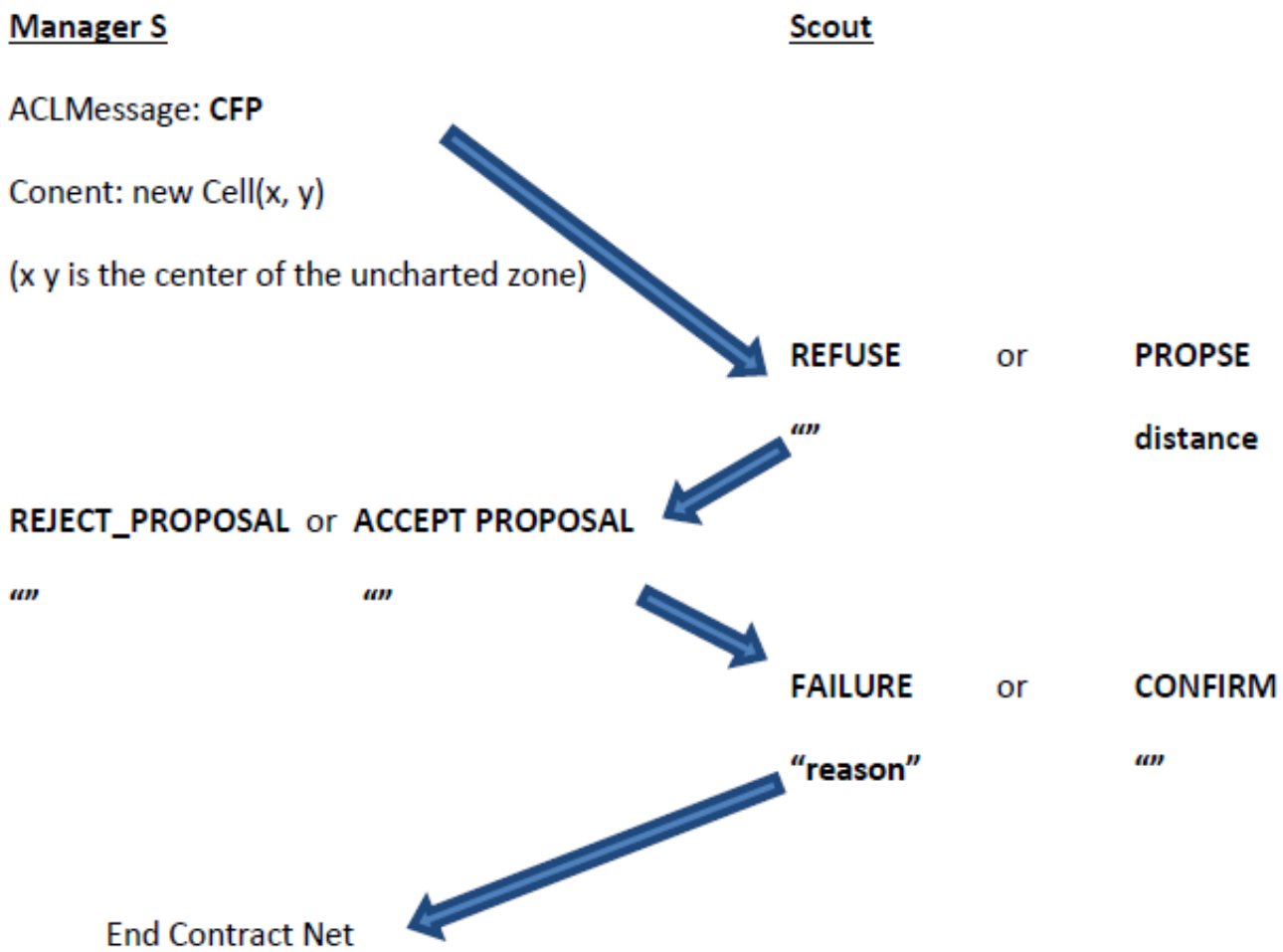
SCOUT MANAGER

- Communication protocol
  - FIPA Contract Net: In each turn search points of the map to send the scouts to discover.



SCOUT MANAGER

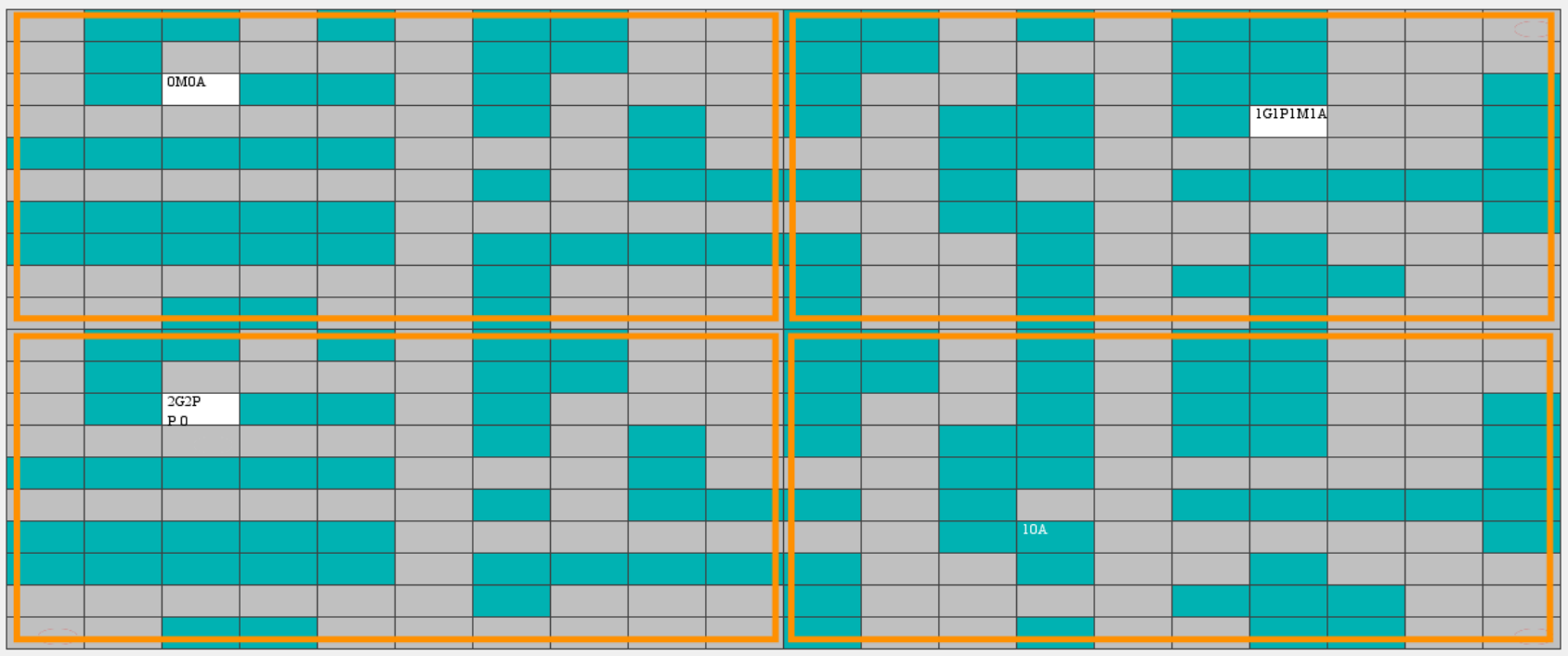
- Strategy
  - It divides the map into n parts named quadrants, being n the number of scouts.
  - Assign a scout to a quadrant.
  - Redivide the map into quadrants, but this time, n is the twice the number of scouts.
  - For each quadrant, search its uncharted zones.
  - For each zone, determine a central point.
  - Which of these points is selected?
    - The one from the biggest uncharted area.
    - The one nearest to the previous point
      - This helps to avoid that a scout leaves an area that is still discovering.
  - Mount a contract net for the selected point.

SCOUT MANAGER

- Strategy (unusual cases)
  - When just one quadrant is entirely discovered, all quadrants become merged. At this point, the contract net has full sense as well all scouts can go to any point of the map.
  - When the map is completely discovered, the scouts are sent to the corners so they can't interfere with the harvesters.
  - If no scouts can move, due, for instance, to a conflict with a harvester, they are sent to the corners.

SCOUT MANAGER

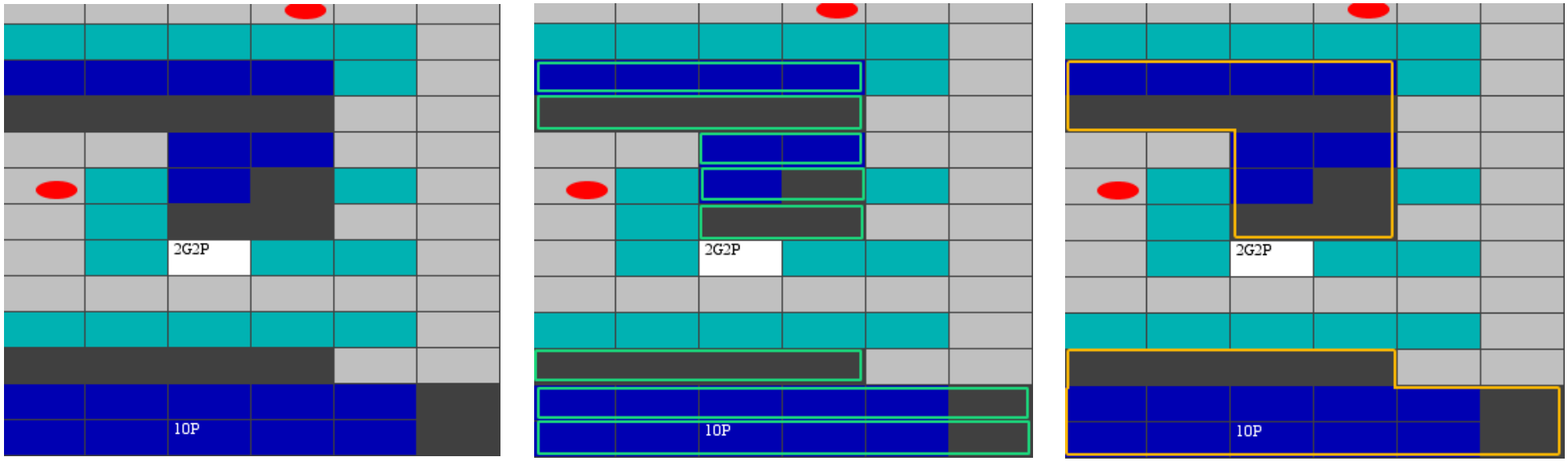
- How to divide the map into quadrants:



1. The map is divided by N quadrants to choose points to send in contracts, where N is the double of the number of the scouts.

SCOUT MANAGER

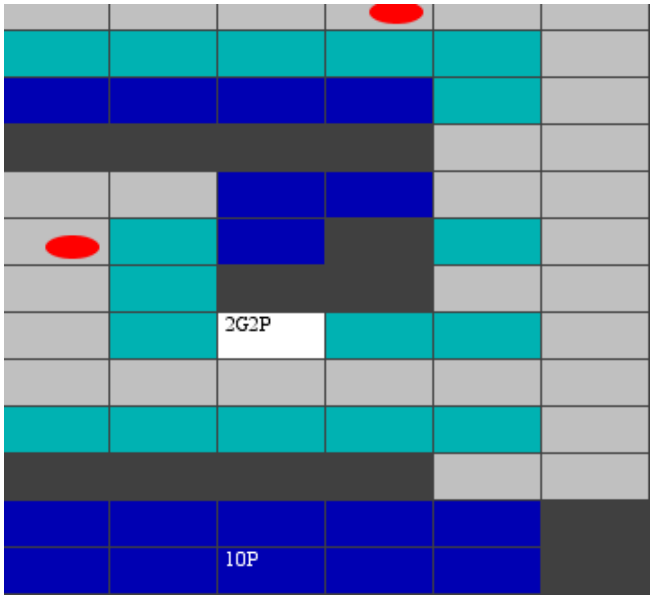
- How to determine the uncharted zones:

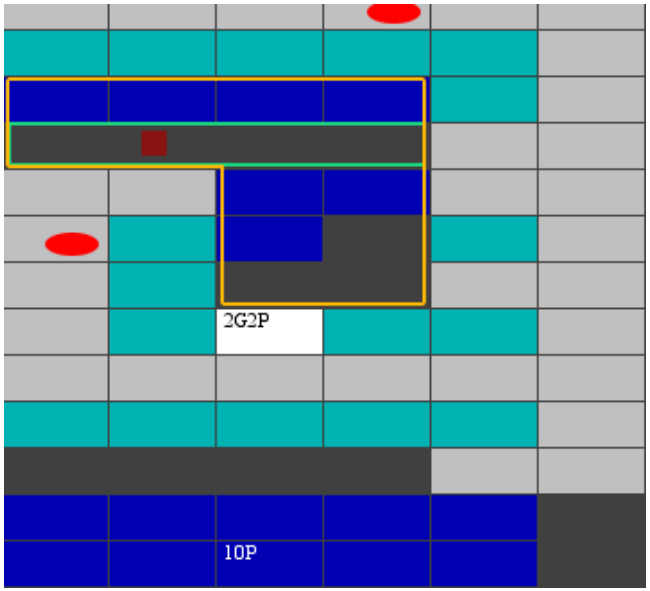


1. It is determined, row to row, the rectangles of the quadrant that are uncharted.
2. Those rectangles are grouped if they are in contact.

SCOUT MANAGER

- How to choose a point:



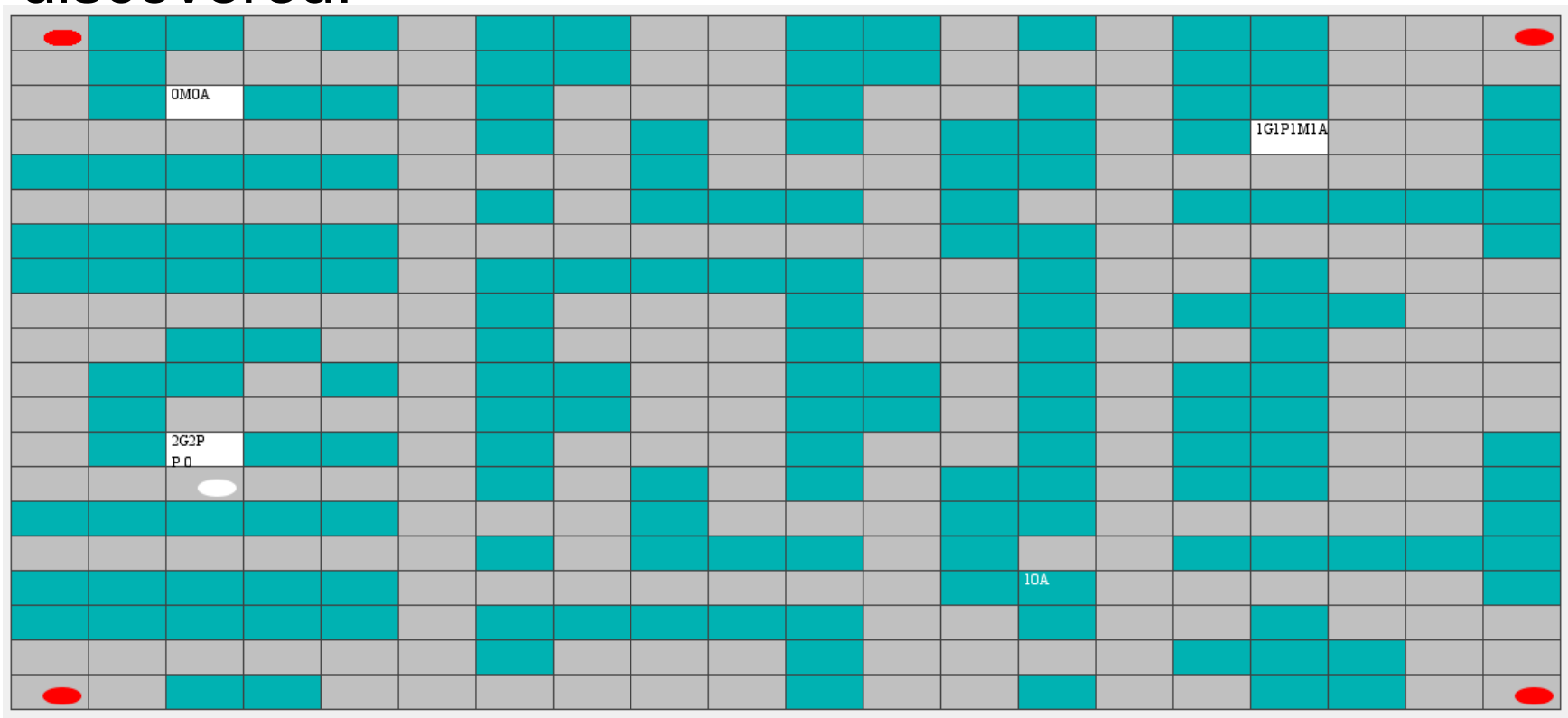


1. The target row will be numRows / 2 of the area.
2. The target column will be the centre of the target row.

Maybe it's not strictly exact, but it is almost and it works. Besides, the next turn, the point will move again to a more accurate point of this area, and at the end, the area is always entirely discovered.

SCOUT MANAGER

- Move to the corners when the map is entirely discovered:



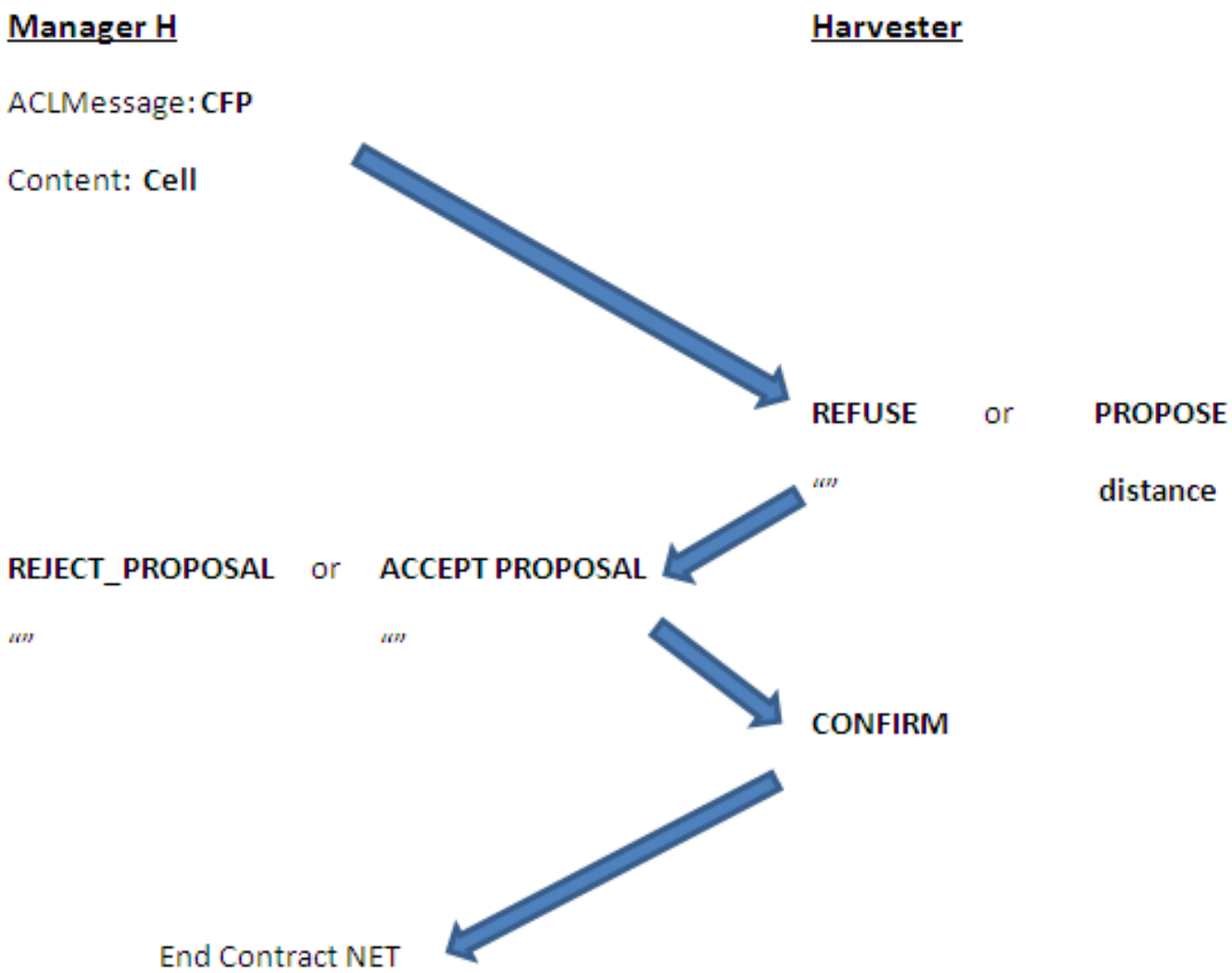
1. A contract for each scout is submitted, sending each scout to a corner.

HARVESTER MANAGER

- Functions:
  - Bridge between Coordinator and Harvester
    - Turns
    - Movements orders
  - Coordinate Harvesters
  - Detect garbage in buildings
  - Choose the best Harvester for recollect garbage
  - Choose recycling center for downloading garbage.

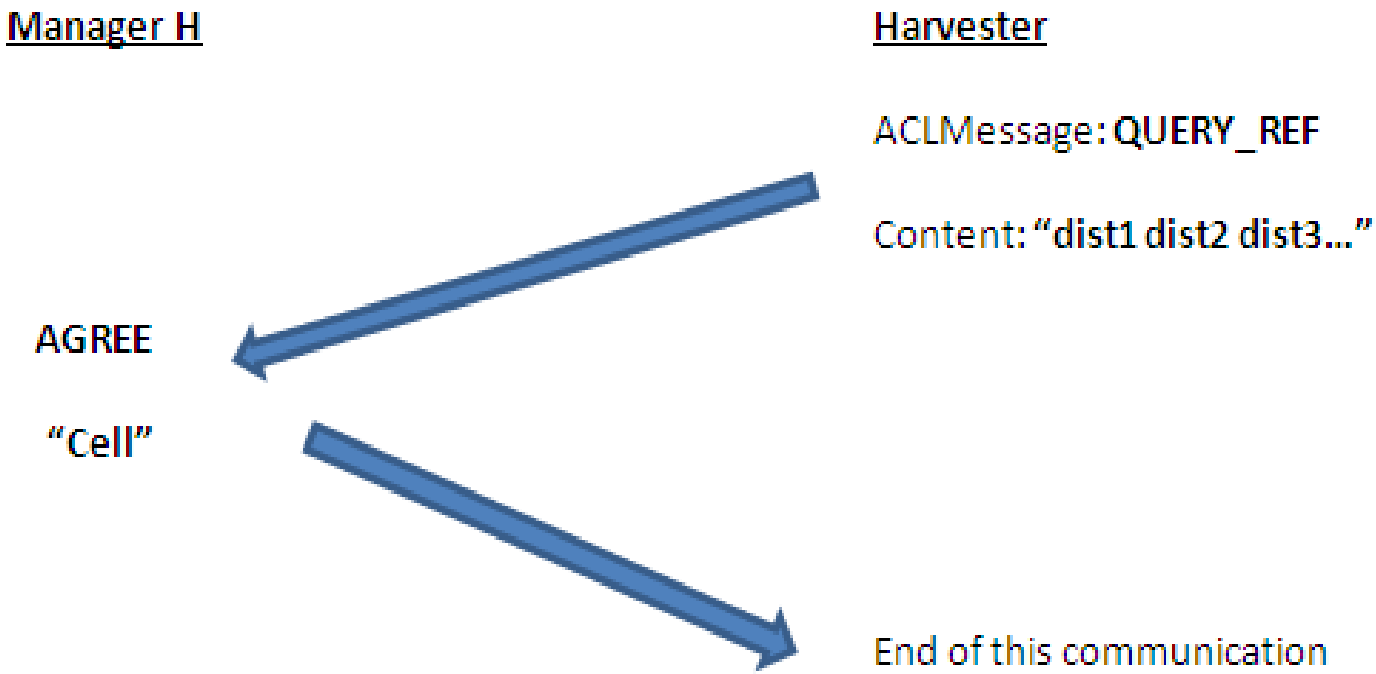
HARVESTER MANAGER

- Communication protocol
  - FIPA Contract Net: In each turn search garbage and assign it to the Harvesters.



HARVESTER MANAGER

- FIPA Query with any change: Harvester informs Manager that he finishes load garbage. Manager chooses the recycling center.

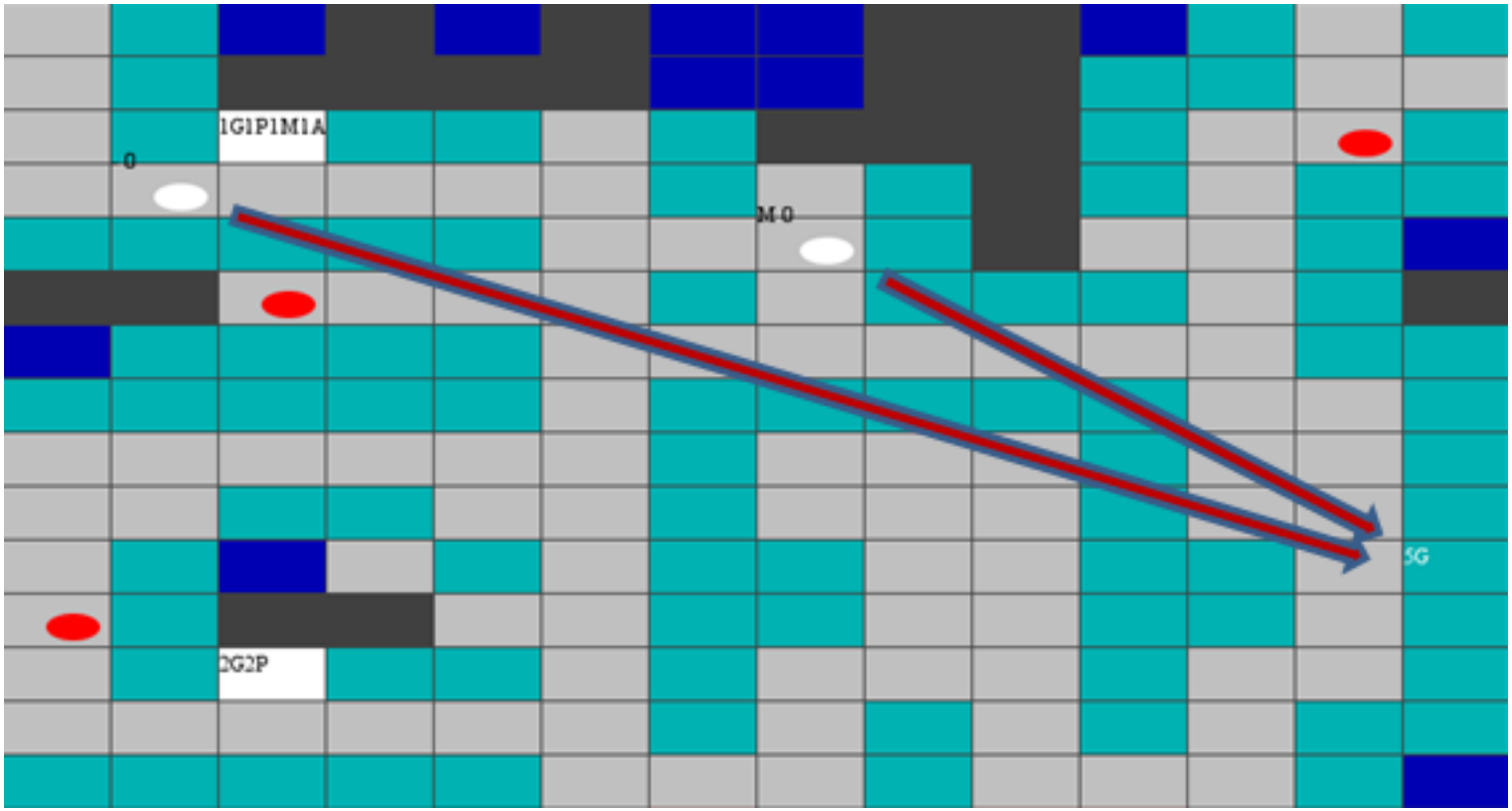


HARVESTER MANAGER

- Harvester Informs manager that he finishes download garbage.

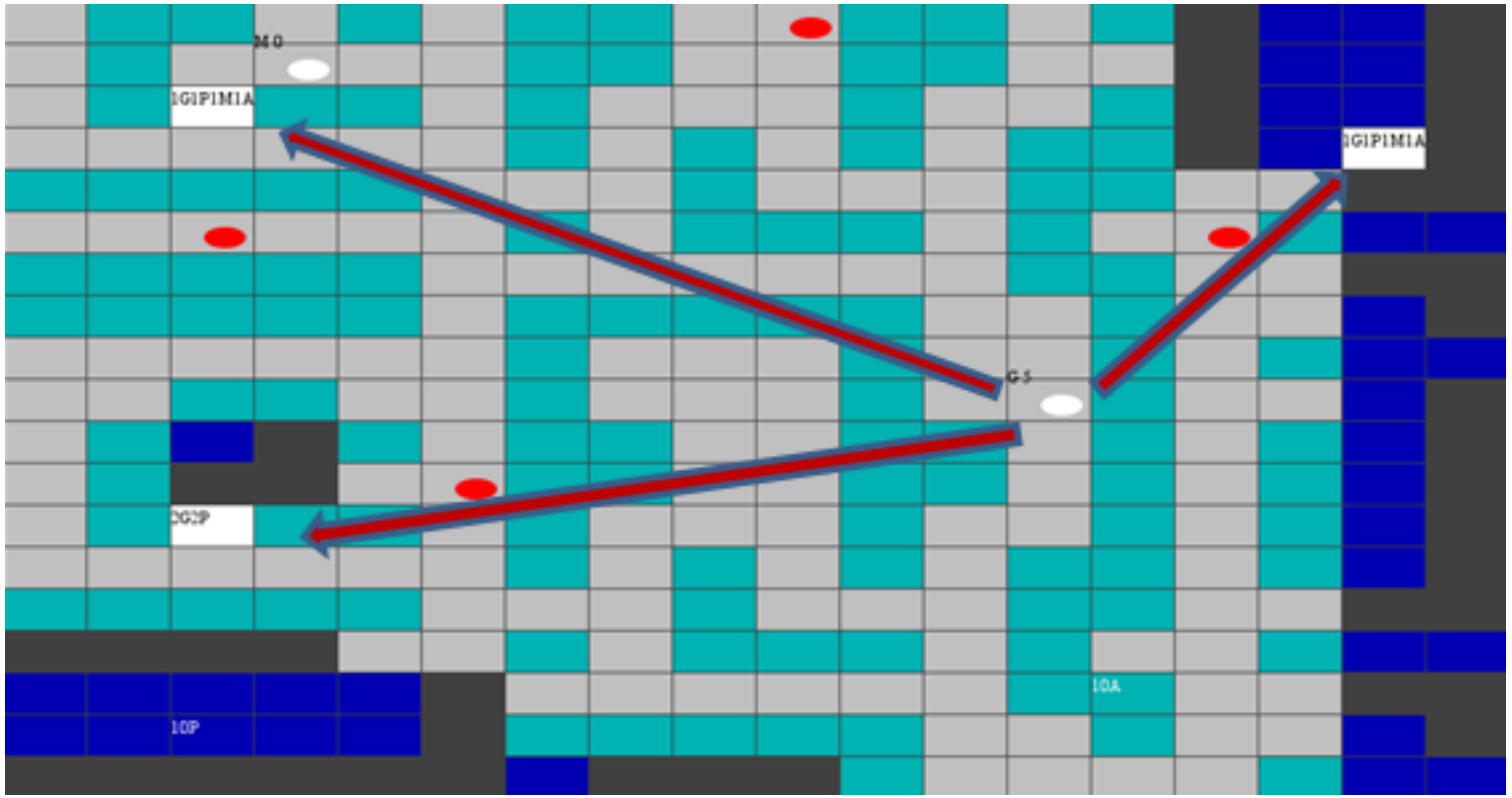
HARVESTER MANAGER

- Non blocking communication. In finish load harvester need blocking.
- Strategy
  - To choose Harvester for load garbage
    - Minimum distance.



HARVESTER MANAGER

- Strategy
  - To choose recycling center for download garbage
    - Choose between minimum distance and score.
      - Recollected all garbage and download in recycling center with minimum turns and maximum score.



SCOUT

- Request protocolContractNet
  - Each scout accepts a request to go to undiscovered cell.
  - Scouts calulates the distances between themselves positons and undiscovered cells.
  - if Scout Manager accepts proposal then scout return the next step of the path.

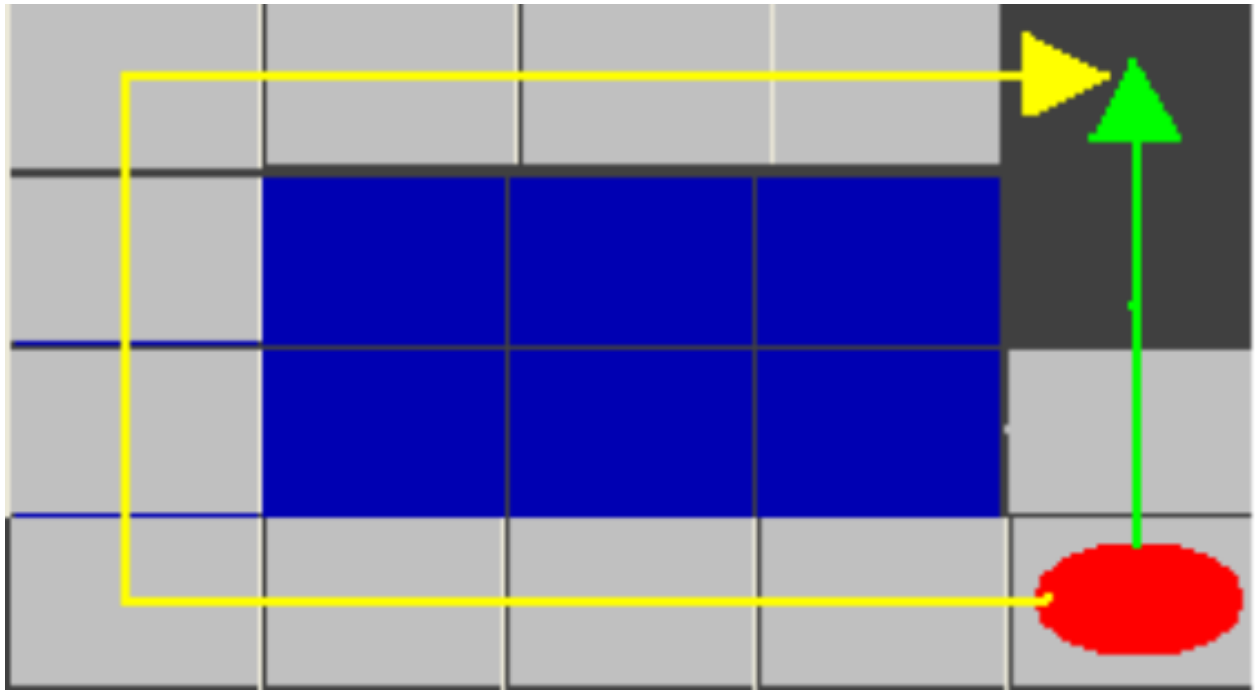
SCOUT & HARVESTER

- A* Path finding
  - It has been adapted to our game
    - 2 paths for propose:
      - First path goes over only discovered cells.
      - Second path goes also over discovered cells and undiscovered cells. (It can discover undiscovered cells while one agent goes to destination point)
      - Discovered cells have a weight of 1
      - Undiscovered cells have a weight of 2
      - The shortest path is the path to propose.

    - Second path is very important for Harvesters
      - Scouts can discover cells more faster crossing dark zones.
      - When one scout discovers garbage, harvesters can go to this point and it assumes scout behavior.

SCOUT & HARVESTER

- A* Path finding



HARVESTER

- For each turn
  - Let's see if the harvester is full and then send a list of distances to points of recycling to know where go to recycling
  - Control that the harvester catch all garbage of a point but hasn't full
  - Control if harvester is transport the garbage
    - Go
    - Download

HARVESTER

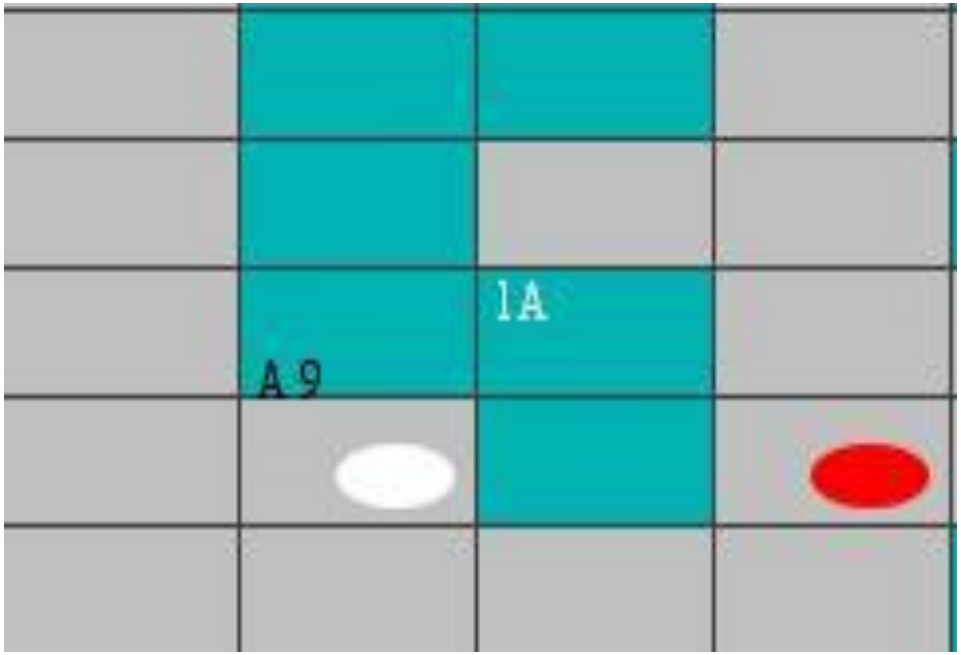
- Request protocolContractNet
  - Each harvester accepts a request to go catch garbage and control if possible
  - If harvester have some garbage look if the same type of garbage and if possible catch more garbage
  - The others case Harvesters refuse to go catch garbage

HARVESTER

- Accept protocolContractNet
  - If the harvester, have the garbage around that said ManagerHavester catch this garbage
  - Else, haverseter go to catch the garbage

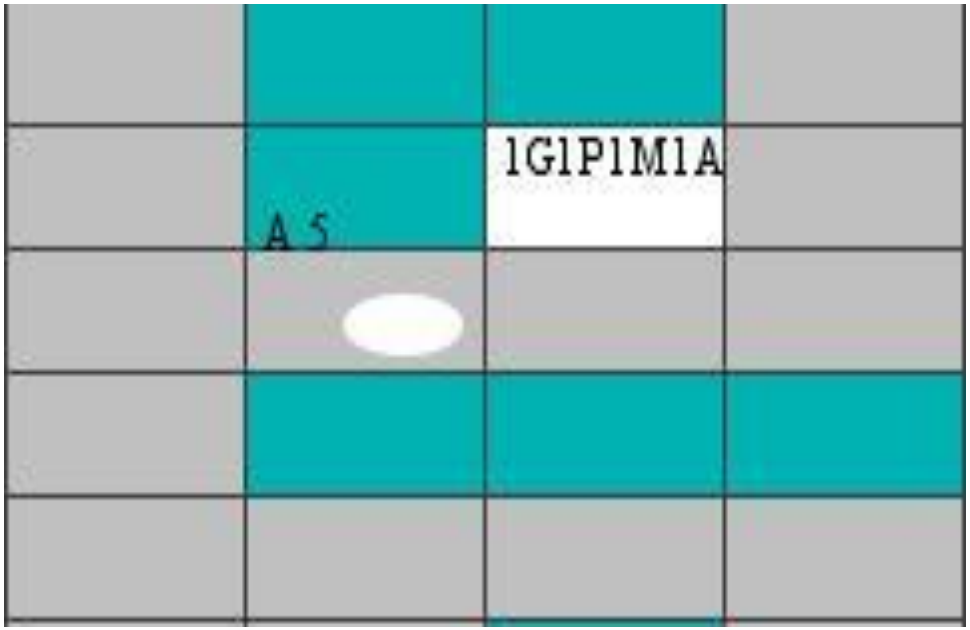
HARVESTER

Loading garbage in diagonal



HARVESTER

Downloading garbage in diagonal



HARVESTER

- Other communications types
  - SendFinishLoad
    - Harvester finish load garbage in a point
  - SendFinisDownload
    - Harvester finish download garbage in a point

Tests

- Number of scouts and harvesters on a easy maze city:
  - Under 2 agents of each type, there is a significant impact on performance
  - Over 3 agents of each type, there is no more increasing performance
  - More than 8 Agents on a 20x20 city, provokes a lot of blocks
- City topology and size
  - Open topologies are always solved (square cities)
  - Easy Mazes are almost completely solved with good score
  - Extremely complex mazes are solved at almost the turn limit or not solved
- Distribution of the garbage
  - Dense garbage zones provoke a lot of blocking paths
  - Dispersed garbage are easy to handle
- Number of recycling centers
  - Recycling centers are crucial entities as the less they are, the more blocking problems arise
  - On well distributed cities, with high accessibility to recycling centers, the easiest the solution.

Improvements

- Implement an unblock strategy for inactive Agents (done with scouts, todo with harvesters)
- Improve message performance, bypassing the hierarchical structure. With such turn propagation or movement rely
- Inactive harvesters being like scouts when inactive
- Multiple harvesters going to a single garage point at a time

References

Source code SVN:
https://ia2-jade.googlecode.com/svn
Project Activity:
http://code.google.com/p/ia2-jade/updates/list
Wiki Documents:
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