Date: 18th April,2017

Software Agents
And
Agent Systems
SPAMMING SCENARIO TESTING FOR JADE

FARDIN MOHAMMAD

FILIP MATRACKI

IVAN MATYAZH

Table of Contents

Introduction

The aim of this experiment is to test characteristics / boundaries of messaging in the JADE agents platform.

In agent-based systems, groups of agents coordinate their actions to achieve a common goal. To do this, they exchange messages. The number of messages exchanged can be huge.

We want to test the message exchange capabilities of JADE platform under different situations. The method to achieve this goal is to implement and test a "spamming scenario".

Scenario

The scenario is designed to flood the system with messages. It has three types of agents:

- Spammer Agent (SA): sends N messages of size M to all MCS's when it receives a START message from EMA.
- Message Consuming Agent (MCA): receives and processes the messages sent by SA's. When all messages have been processed, it sends message DONE to the EMA. It knows how many messages from each SA should receive.
- Experiment Master Agent (EMA): initializes the experiment sending START message to all SA's and measures the total time of processing all messages by all MCA's.
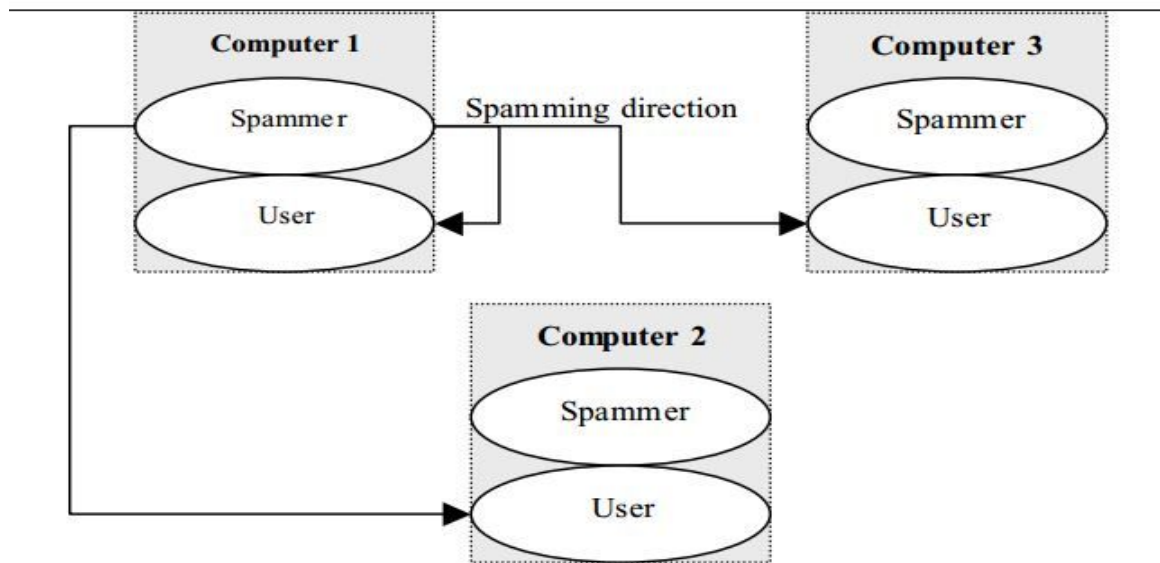
Remarks:

- Each container hosts a pair of agents SA-MCA.
- EMA is located in the Main Container.
- The processing of the message in our case it is just log it.
- Time of message: time of sending, receiving and precessing a single message.

Testing Intro

Part 1:

1. Increasing number of machines

2. Varying message size
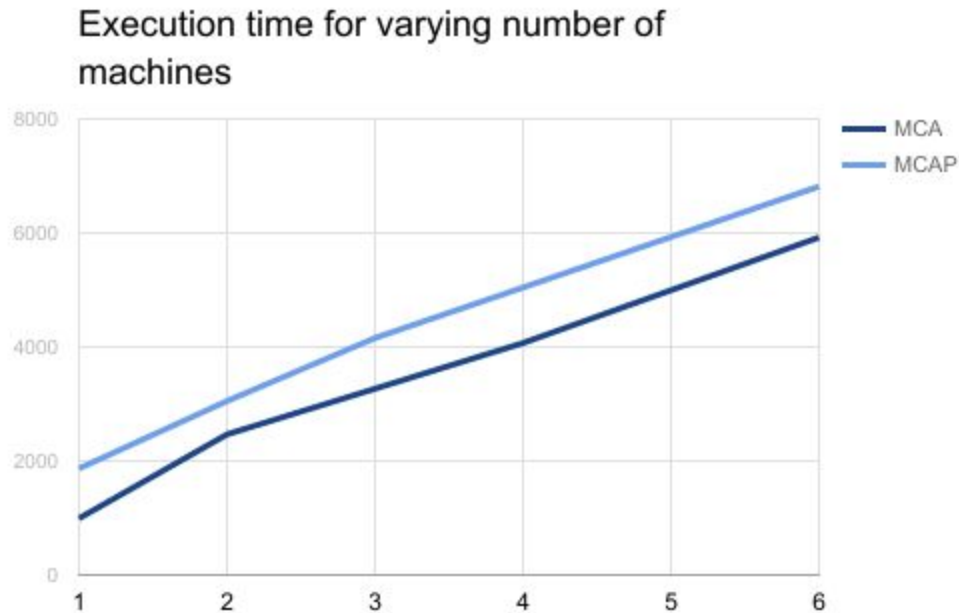
3. Varying number of messages

Part 2:

1. In this second part, the way that Message Consuming Agent (MCA) consumes the messages was modified:

2. It looks for a message from a specific Spammer Agent (SA) first, and when there are none, it processes the remaining messages in FIFO order.

3. We repeated the same tests with these modification, but giving priority to the messages of the spammer agent in priority .

Tests And Results

1. **Varying number of machines**

We performed the experiment with fixed message size (M=100) and with fixed total number of messages (N=1000), so that nothing will influence the results of the experiment.

On the following graph the basic results are gathered (in order to see the detailed results please visit the log section). On the y axis you can observe the execution time of the application measured in milliseconds. On the x axis you can observe the number of machines on which the agents were running.

Execution time for varying number of machines

2. Varying message size (M)

We performed the experiment with fixed number of machines (this number is equal to 2) and with fixed total number of messages (N=1000), so that nothing will influence the results of the experiment.
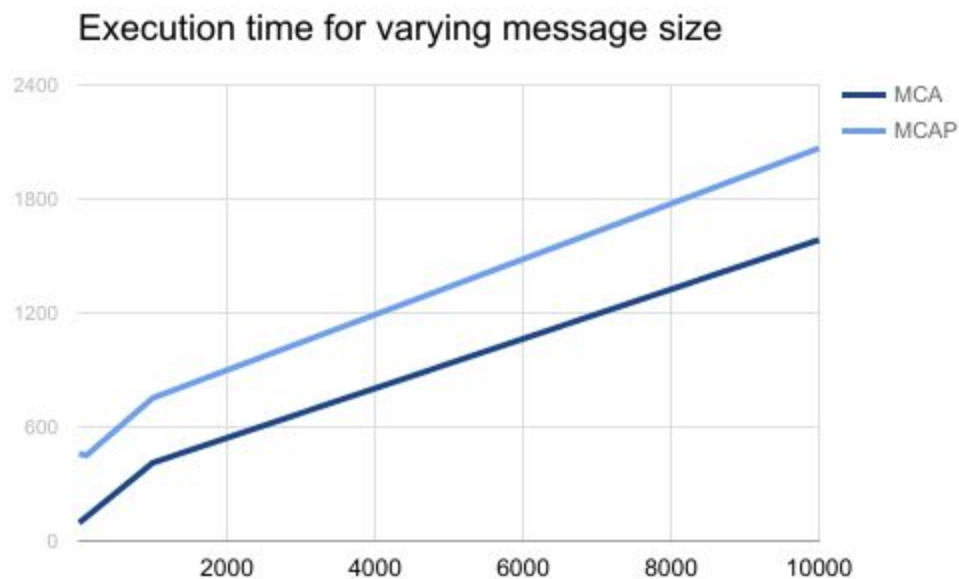
On the following graph the basic results are gathered (in order to see the detailed results please visit the log section). On the y axis you can observe the execution time of the application measured in milliseconds. On the x axis you can observe the size of message sent by each SA's.

Execution time for varying message size

				MCA
				MCAP

3. Varying number of messages sent by SA's (N)

We performed the experiment with fixed number of machines (this number is equal to 2) and with fixed size of messages (M=100), so that nothing will influence the results of the experiment.
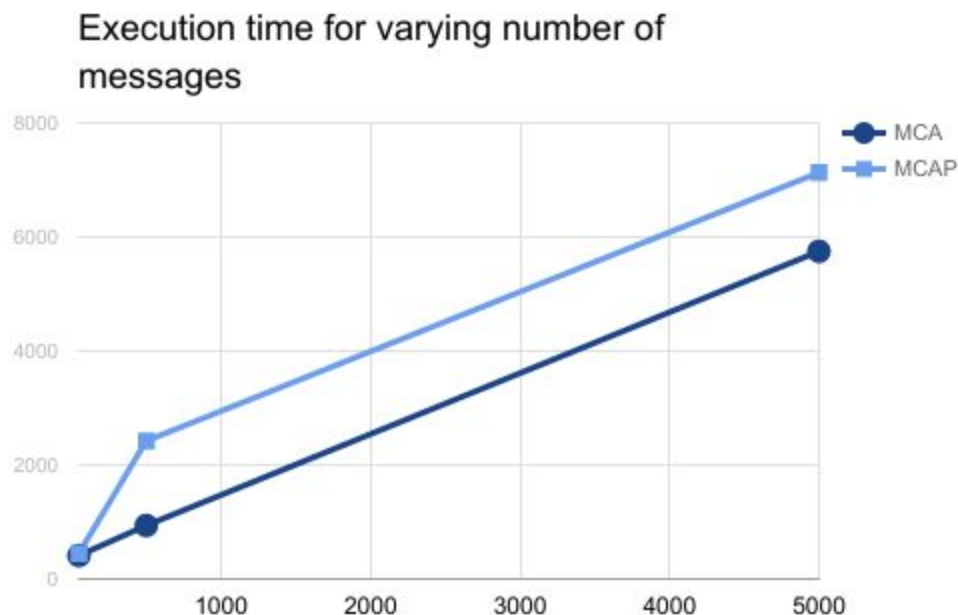
On the following graph the basic results are gathered (in order to see the detailed results please visit the log section). On the y axis you can observe the execution time of the application measured in milliseconds. On the x axis you can observe the number of messages sent by each SA's

Execution time for varying number of messages

Result Discussion

Initial Message Takes the Longest To Process by MCA

One can notice by looking at the statistics that the longest time it takes to process a message is usually much higher than the shortest time. The longest message to process is most likely the first one. This is due to the fact that we need to initialize variables and the MessageTemplate and the overhead of doing so can delay receiving the actual message. The shortest message time is somewhat the same for all agents, it's always under 1 millisecond.

Priority Message Consuming Agent Is Slower Than Regular MCA

By looking at the logs below and the graphs above, one can notice that the priority agent is slower in processing messages than the standard MCA (Message Consuming Agent). The reason why can be easily inferred. The MCAP (Message Consuming Agent w/ Priority) delays processing of messages that are not from the

priority spammer agent by adding them to a FIFO (first in first out) queue. Therefore if multiple agents send messages to the MCAP then the overall execution time is slower since we only process messages from the priority spammer agent, while we could be processing all messages from every agent. Basically the MCAP is not as busy as the MCA, since he adds messages to the queue while he could be processing them. Selectively processing messages (of equal size) will almost always be slower than processing messages as soon as possible, which the MCA does.

Messages From Different PCs Were Handled Slower

By looking the the logs below one can see the the MCA's and MCAP's running on different machines were slower than the ones running on localhost. This is quite an obvious observation because it will take a longer time for the messages to reach agents running on different host machines since the packets need to travel through the network. If a PC is very far in the network sense (high hop count between routers) then the spammer agent can cause more damage to the MCA and cause him to wait longer. If the MCA blocks in between receiving and processing messages then a lot of execution time will be wasted on blocking in the behavior. How to alleviate the downsides? One could do something instead of blocking, such as run a separate thread or behavior.

Conclusions

Part 1

- Increasing the number of pairs SA-MCA in new containers increases the time per message in a linear way.
- Increasing the size of the messages increases the time per message in a linear way.
- Increasing the number of messages in the platform doesn't seem to affect the time per message.

Part 2

- Looking for the messages of a specific SA before processing the rest of messages doesn't seem to vary the execution time, at least with the amount of messages and sizes that we tested.

General

- As we scale up the system the processing time increase no longer than in a linear way.

MCA LOGS

1. <u>Varying number of machines</u>

1 computer (M=100, N=1000)
- Execution time: 992.633379ms
- Num of Messages: 1000 Average time to process 1 spam msg: 0.992633379ms
- Shortest time to process 1 spam msg: 0.185305ms
- Longest time to process 1 spam msg: 23.217401ms

2 computer (M=100, N=1000)
- Execution time: 2466.033433ms
- Num of Messages: 4000 Average time to process 1 spam msg: 0.61650835825ms
- Shortest time to process 1 spam msg: 0.083245ms
- Longest time to process 1 spam msg: 122.21806ms
- MCA_1: INFO: Sending statistics, longestTime: 60.358399 shortestTime: 0.13342 NumOfMessagesProcessed: 2000
- MCA_2: INFO: Sending statistics, longestTime: 122.21806 shortestTime: 0.083245 NumOfMessagesProcessed: 2000

4 Computers(M=100, N=1000)
- Execution time: 4069.841889ms
- Num of Messages: 16000 Average time to process 1 spam msg: 0.2543651180625ms
- Shortest time to process 1 spam msg: 0.029418ms
- Longest time to process 1 spam msg: 269.519183ms
- MCA_1: INFO: Sending statistics, longestTime: 88.736225 shortestTime: 0.029418 NumOfMessagesProcessed: 4000
- MCA_2: INFO: Sending statistics, longestTime: 269.519183 shortestTime: 0.03152 NumOfMessagesProcessed: 4000
- MCA_3: INFO: Sending statistics, longestTime: 23.483218 shortestTime: 0.03182 NumOfMessagesProcessed: 4000
- MCA_4: INFO: Sending statistics, longestTime: 120.133704 shortestTime: 0.030018 NumOfMessagesProcessed: 4000

6 Computers(M=100, N=1000)
- Execution time: 5922.283795ms

- Num of Messages: 36000 Average time to process 1 spam msg: 0.16450788319444445ms
- Shortest time to process 1 spam msg: 0.021313ms
- Longest time to process 1 spam msg: 483.102536ms
- MCA_1:INFO: Sending statistics, longestTime: 362.884657 shortestTime: 0.033321 NumOfMessagesProcessed: 6000
- MCA_2:INFO: Sending statistics, longestTime: 483.102536 shortestTime: 0.03272 NumOfMessagesProcessed: 6000
- MCA_3: INFO: Sending statistics, longestTime: 405.256048 shortestTime: 0.033021 NumOfMessagesProcessed: 6000
- MCA_4: INFO: Sending statistics, longestTime: 179.738115 shortestTime: 0.021313 NumOfMessagesProcessed: 6000
- MCA_5: longestTime: 191.058558 shortestTime: 0.022514 NumOfMessagesProcessed: 6000
- MCA_6: INFO: Sending statistics, longestTime: 264.441663 shortestTime: 0.025216 NumOfMessagesProcessed: 6000

2. Varying message size

Note, MCA_2 was run on different PC than the GUI platform. MCA_1 ran on the same PC as platform (localhost)

2 computer (M = 1, N = 50)
- EMA output: Execution time: 96.865722ms
- Num of Messages: 200 Average time to process 1 spam msg: 0.48432861000000005ms
- Shortest time to process 1 spam msg: 0.192721ms
- Longest time to process 1 spam msg: 10.238922ms
- MCA_2: INFO: Sending statistics, longestTime: 9.731841 shortestTime: 0.192721 NumOfMessagesProcessed: 100
- MCA_1: INFO: Sending statistics, longestTime: 10.238922 shortestTime: 0.198726 NumOfMessagesProcessed: 100

2 computer (M = 100, N=50)
- Execution time: 126.356789ms
- Num of Messages: 200 Average time to process 1 spam msg: 0.631783945ms
- Shortest time to process 1 spam msg: 0.203229ms
- Longest time to process 1 spam msg: 19.961696ms
- MCA_2: INFO: Sending statistics, longestTime: 19.961696 shortestTime: 0.208632 NumOfMessagesProcessed: 100

- MCA_1: INFO: Sending statistics, longestTime: 6.971041 shortestTime: 0.203229 NumOfMessagesProcessed: 100

2 Computer (M=1000, N=50)
- Execution time: 412.206675ms
- Num of Messages: 200 Average time to process 1 spam msg: 2.061033375ms
- Shortest time to process 1 spam msg: 0.154898ms
- Longest time to process 1 spam msg: 23.362842ms
- MCA_1: INFO: Sending statistics, longestTime: 15.152152 shortestTime: 0.154898 NumOfMessagesProcessed: 100
- MCA_2: INFO: Sending statistics, longestTime: 23.362842 shortestTime: 0.17501 NumOfMessagesProcessed: 100

2 Computer (M=10000, N=50)
- Execution time: 1584.758091ms
- Num of Messages: 200 Average time to process 1 spam msg: 7.923790455ms
- Shortest time to process 1 spam msg: 0.785296ms
- Longest time to process 1 spam msg: 19.212723ms
- MCA_1: INFO: Sending statistics, longestTime: 17.472029 shortestTime: 0.846239 NumOfMessagesProcessed: 100
- MCA_2: INFO: Sending statistics, longestTime: 19.212723 shortestTime: 0.785296 NumOfMessagesProcessed: 100

3. Varying message number sent by SA's

Note, MCA_2 was run on different PC than the GUI platform. MCA_1 ran on the same PC as platform (localhost)

2 computer (M = 100, N=50)
- Execution time: 126.356789ms
- Num of Messages: 200 Average time to process 1 spam msg: 0.631783945ms
- Shortest time to process 1 spam msg: 0.203229ms
- Longest time to process 1 spam msg: 19.961696ms
- MCA_2: INFO: Sending statistics, longestTime: 19.961696 shortestTime: 0.208632 NumOfMessagesProcessed: 100
- MCA_1: INFO: Sending statistics, longestTime: 6.971041 shortestTime: 0.203229 NumOfMessagesProcessed: 100

2 Computer (M=100, N=500)
- Execution time: 938.494421ms
- Num of Messages: 2000 Average time to process 1 spam msg: 0.4692472105ms

- Shortest time to process 1 spam msg: 0.043528ms
- Longest time to process 1 spam msg: 17.734397ms
- MCA_2: INFO: Sending statistics, longestTime: 15.615853 shortestTime: 0.043528 NumOfMessagesProcessed: 1000
- MCA_1: INFO: Sending statistics, longestTime: 17.734397 shortestTime: 0.044128 NumOfMessagesProcessed: 1000

2 Computers(M=100, N=5000)

- Execution time: 5748.223319ms
- Num of Messages: 20000 Average time to process 1 spam msg: 0.28741116595ms
- Shortest time to process 1 spam msg: 0.021614ms
- Longest time to process 1 spam msg: 55.599917ms
- MCA_1: INFO: Sending statistics, longestTime: 55.599917 shortestTime: 0.025816 NumOfMessagesProcessed: 10000
- MCA_2: INFO: Sending statistics, longestTime: 33.500539 shortestTime: 0.021614 NumOfMessagesProcessed: 10000

MCAP LOGS

1. Varying number of machines

1 computer (M=100, N=1000)

- Execution time: 1867.07183ms
- Num of Messages: 1000 Average time to process 1 spam msg: 1.86707183ms
- Shortest time to process 1 spam msg: 0.196709ms
- Longest time to process 1 spam msg: 60.202742ms

2 computer (M=100, N=1000)

- Execution time: 3051.262446ms
- Num of Messages: 4000 Average time to process 1 spam msg: 0.7628156115ms
- Shortest time to process 1 spam msg: 0.076973ms
- Longest time to process 1 spam msg: 89.490762ms
- MCA_2: INFO: Sending statistics, longestTime: 85.604471 shortestTime: 0.079824 NumOfMessagesProcessed: 2000
- MCA_1: INFO: Sending statistics, longestTime: 89.490762 shortestTime: 0.076973 NumOfMessagesProcessed: 2000

3 Computers(M=100, N=1000)

- Execution time: 4157.915292ms
- Num of Messages: 9000 Average time to process 1 spam msg: 0.461990588ms
- Shortest time to process 1 spam msg: 0.028818ms

- Longest time to process 1 spam msg: 79.14788ms
- MCAP_1: INFO: Sending statistics, longestTime: 23.613342 shortestTime: 0.029118 NumOfMessagesProcessed: 3000
- MCAP_2: INFO: Sending statistics, longestTime: 33.261889 shortestTime: 0.030019 NumOfMessagesProcessed: 3000
- MCAP_3 :INFO: Sending statistics, longestTime: 79.14788 shortestTime: 0.028818 NumOfMessagesProcessed: 3000

6 Computers(M=100, N=1000)
- Execution time: 6816.417458ms
- Num of Messages: 36000 Average time to process 1 spam msg: 0.1893449293888889ms
- Shortest time to process 1 spam msg: 0.021614ms
- Longest time to process 1 spam msg: 375.899521ms
- MCAP_1: INFO: Sending statistics, longestTime: 119.812921 shortestTime: 0.021614 NumOfMessagesProcessed: 6000
- MCAP_2: INFO: Sending statistics, longestTime: 129.812921 shortestTime: 0.021619 NumOfMessagesProcessed: 6000
- MCAP_3: INFO: Sending statistics, longestTime: 129.487307 shortestTime: 0.022514 NumOfMessagesProcessed: 6000
- MCAP_4: INFO: Sending statistics, longestTime: 65.619005 shortestTime: 0.022214 NumOfMessagesProcessed: 6000
- MCAP_5: INFO: Sending statistics, longestTime: 65.354435 shortestTime: 0.028218 NumOfMessagesProcessed: 6000
- MCAP_6: INFO: Sending statistics, longestTime: 375.899521 shortestTime: 0.028818 NumOfMessagesProcessed: 6000

2. Varying message size

Note, MCAP_2 was run on different PC than the GUI platform. MCAP_1 ran on the same PC as platform (localhost)

2 Computers (M=1, N=50)
- Execution time: 460.413819ms
- Num of Messages: 200 Average time to process 1 spam msg: 2.302069095ms
- Shortest time to process 1 spam msg: 0.33355ms
- Longest time to process 1 spam msg: 112.92996ms
- MCAP_1: INFO: Sending statistics, longestTime: 15.354159 shortestTime: 1.114116 NumOfMessagesProcessed: 100
- MCAP_2: INFO: Sending statistics, longestTime: 112.92996 shortestTime: 0.33355 NumOfMessagesProcessed: 100

2 Computers (M=100, N=50)
- Execution time: 449.842833ms
- Num of Messages: 200 Average time to process 1 spam msg: 2.24921416499999997ms
- Shortest time to process 1 spam msg: 0.451576ms
- Longest time to process 1 spam msg: 60.041954ms
- MCAP_2: INFO: Sending statistics, longestTime: 60.041954 shortestTime: 0.451576 NumOfMessagesProcessed: 100
- MCAP_1: INFO: Sending statistics, longestTime: 22.208196 shortestTime: 0.634602 NumOfMessagesProcessed: 100

2 Computers(M=1000, N=50)
- Execution time: 753.384683ms
- Num of Messages: 200 Average time to process 1 spam msg: 3.766923415ms
- Shortest time to process 1 spam msg: 0.679075ms
- Longest time to process 1 spam msg: 56.650001ms
- MCAP_1: INFO: Sending statistics, longestTime: 33.33282 shortestTime: 0.751487 NumOfMessagesProcessed: 100
- MCAP_2: INFO: Sending statistics, longestTime: 56.650001 shortestTime: 0.679075 NumOfMessagesProcessed: 100

2 Computers (M=10000, N=50)
- Execution time: 2068.802595ms
- Num of Messages: 200 Average time to process 1 spam msg: 10,344012975ms
- Shortest time to process 1 spam msg: 0.69561ms
- Longest time to process 1 spam msg: 69.144177ms
- MCAP_2: INFO: Sending statistics, longestTime: 69.144177 shortestTime: 0.806793 NumOfMessagesProcessed: 100
- MCAP_1: INFO: Sending statistics, longestTime: 66.49858 shortestTime: 0.69561 NumOfMessagesProcessed: 100

3. **Varying number of messages sent by SA's**

Note, MCAP_2 was run on different PC than the GUI platform. MCAP_1 ran on the same PC as platform (localhost)

2 Computers(M=1000, N=50)
- Execution time: 753.384683ms
- Num of Messages: 200 Average time to process 1 spam msg: 3.766923415ms
- Shortest time to process 1 spam msg: 0.679075ms
- Longest time to process 1 spam msg: 56.650001ms

- MCAP_1: INFO: Sending statistics, longestTime: 33.33282 shortestTime: 0.751487 NumOfMessagesProcessed: 100
- MCAP_2: INFO: Sending statistics, longestTime: 56.650001 shortestTime: 0.679075 NumOfMessagesProcessed: 100

2 Computers (M=100, N=500)

- Execution time: 2422.53958ms
- Num of Messages: 2000 Average time to process 1 spam msg: 1.21126979ms
- Shortest time to process 1 spam msg: 0.13456ms
- Longest time to process 1 spam msg: 313.647008ms
- MCAP_2: INFO: Sending statistics, longestTime: 313.647008 shortestTime: 0.201271 NumOfMessagesProcessed: 1000
- MCAP_1: INFO: Sending statistics, longestTime: 77.74294 shortestTime: 0.13456 NumOfMessagesProcessed: 1000

2 Computers (M=100, N=5000)

- Execution time: 7129.406217ms
- Num of Messages: 20000 Average time to process 1 spam msg: 0.35647031084999997ms
- Shortest time to process 1 spam msg: 0.074122ms
- Longest time to process 1 spam msg: 407.228753ms
- MCAP_1: INFO: Sending statistics, longestTime: 167.660191 shortestTime: 0.075262 NumOfMessagesProcessed: 10000
- MCAP_2: INFO: Sending statistics, longestTime: 407.228753 shortestTime: 0.074122 NumOfMessagesProcessed: 10000

Bibliography

[1]: Krzysztof Chmiel, Maciej Gawinecki, Pawel Kaczmarek, Michal Szymczak, Marcin Paprzycki, Efficiency of JADE Agent Platform. Scientific Programming vol. 13, no. 2, 2005, 159-172.

[2]: Krzysztof Chmiel, Dominik Tomiak, Maciej Gawinecki, Pawel Kaczmarek, Michal Szymczak, Marcin Paprzycki, Testing the Efficiency of JADE Agent Platform. In: Proceedings of the ISPDC 2004 Conference, IEEE COomputer Society Press, Los Alamitos, CA, 2004 49-57.