Simulating Autonomous Mobile Programs on Networks

Natalia Chechina

Dependable System Group,
Heriot-Watt University

June 22, 2009

Aim of the Research

- Obtaining a detailed map of AMP behaviour;
- Estimation AMP capabilities;
- Investigation AMP behaviour on wide area networks (WANs).

Taxonomy of Load Balancing Methods

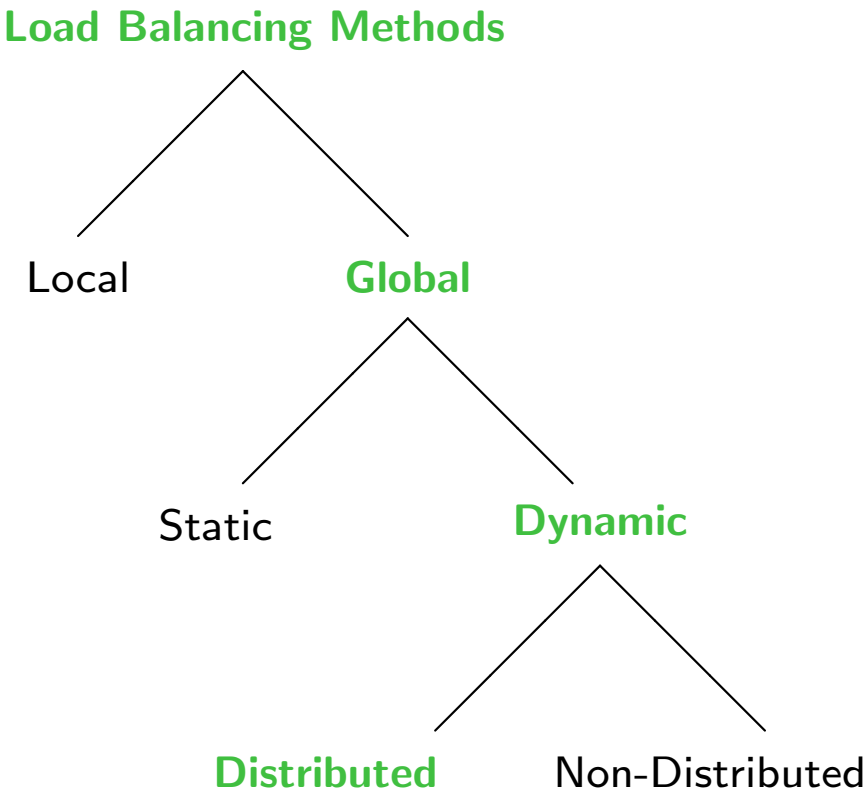

Figure: General [CK88]

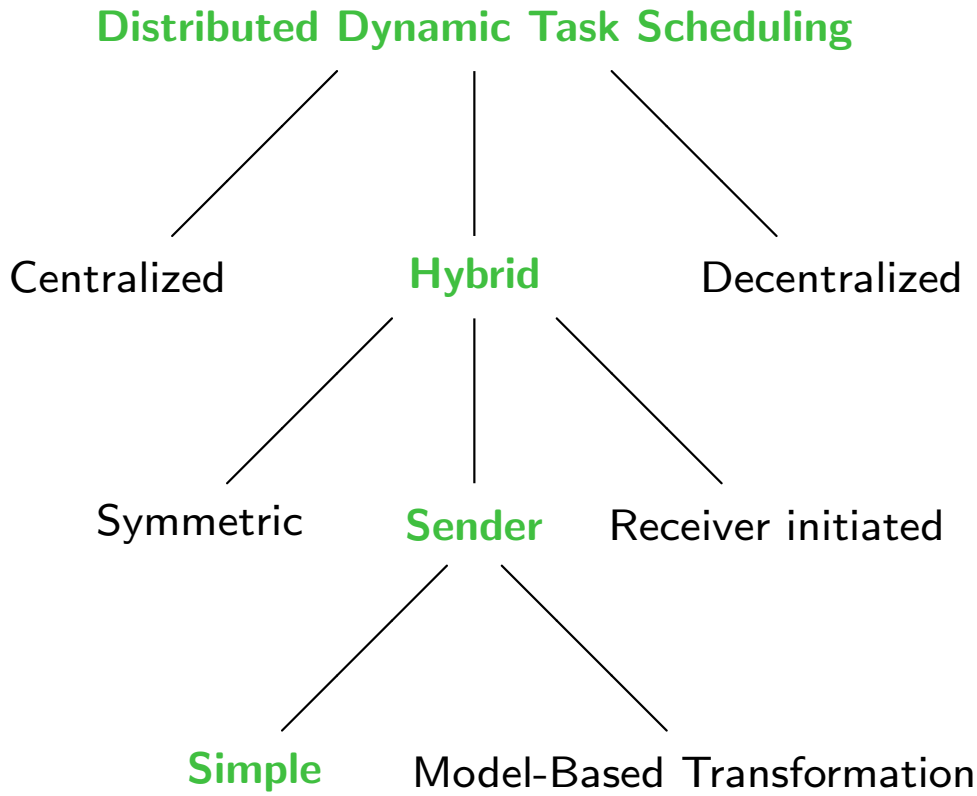

Figure: Dynamic Scheduling [Rot94]

Cost Model for AMPs

$$T_h > T_n + T_{comm} \quad (1)$$

$$T_{total} = T_{Comp} + T_{Coord} + T_{Comm} \quad (2)$$

$$gran > \frac{T_{coord} \cdot S_h}{O} \quad (3)$$

T_h - execution time on the current location;
T_n - execution time on new location;
T_{Comm} - total time for communication;
T_{total} - total execution time;
T_{Comp} - time for computation;
T_{Coord} - total time for coordination;
$gran$ - part of work that must be executed between searches of better location;
O - overhead.

Simulation Model

- AMPs have previously been measured using mobile Java Voyager on LANs;
- A network is a fully connected graph of locations;
- At initial time all AMPs start on the first location;
- The simulation model is implemented on the OMNeT++ network simulator;
- Experiments:
  - Homogeneous network: 4 sets of experiments;
  - Heterogeneous network: 2 sets of experiments.

Homogeneous Network

	5 AMPs	7 AMPs	9 AMPs	10 AMPs	13 AMPs
3 Locations					
real	1/2/2	1/3/3	1/4/4	-	-
simulation	1/2/2	1/3/3	2/3/4	-	-
4 Locations					
real	-	1/2/2/2	-	1/3/3/3	1/4/4/4
simulation	-	1/2/2/2	-	1/3/3/3	2/4/4/3
5 Locations					
real	-	-	1/2/2/2/2	-	-
simulation	-	-	1/2/2/2/2	-	-

Table: Optimal Balance

	6 AMPs	5 AMPs
3 Locations		
real	1/2/3	-
simulation	1/2/3	-
2 Locs		
real	-	2/3
simulation	-	2/3

Table: Near-Optimal Balance

Homogeneous Network

Adding More AMPs

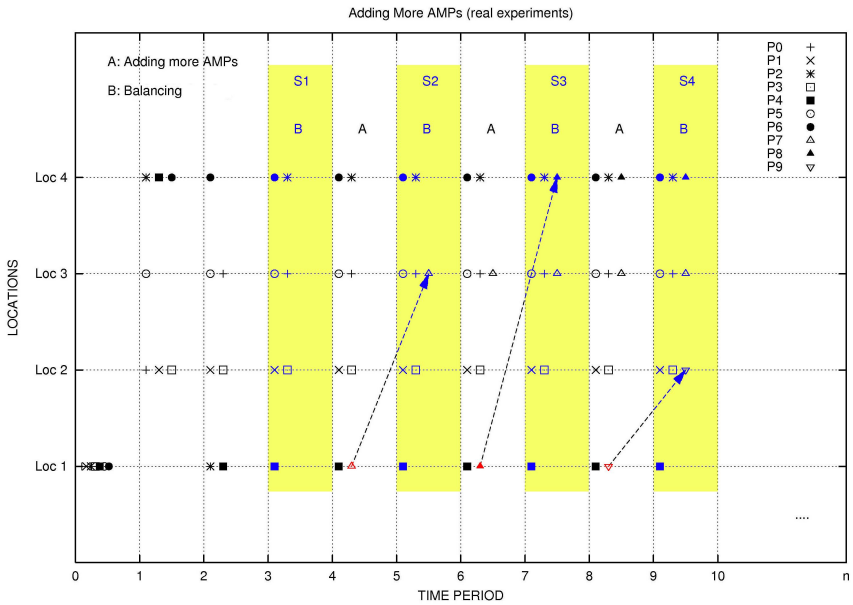

Figure: Real experiments

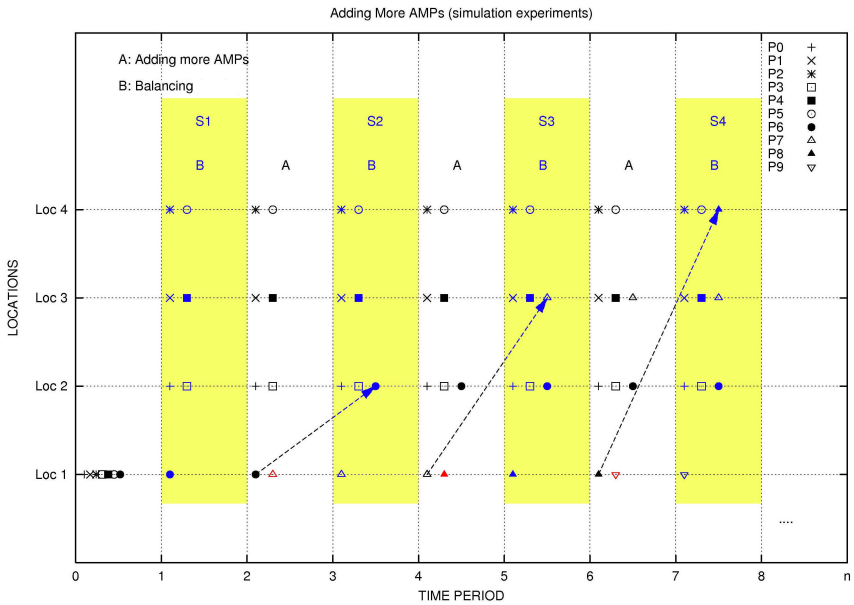

Figure: Simulation experiments

Homogeneous Network

Removing AMPs

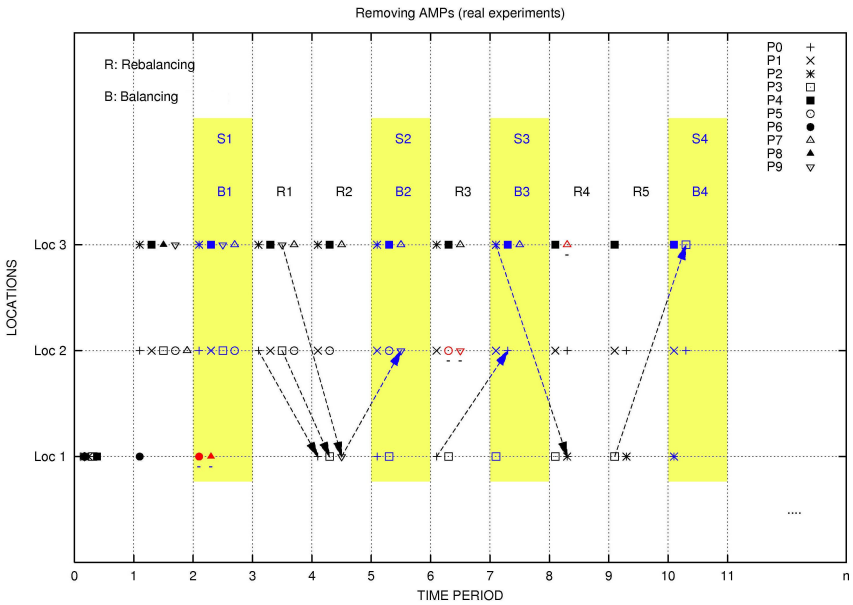

Figure: Real experiments

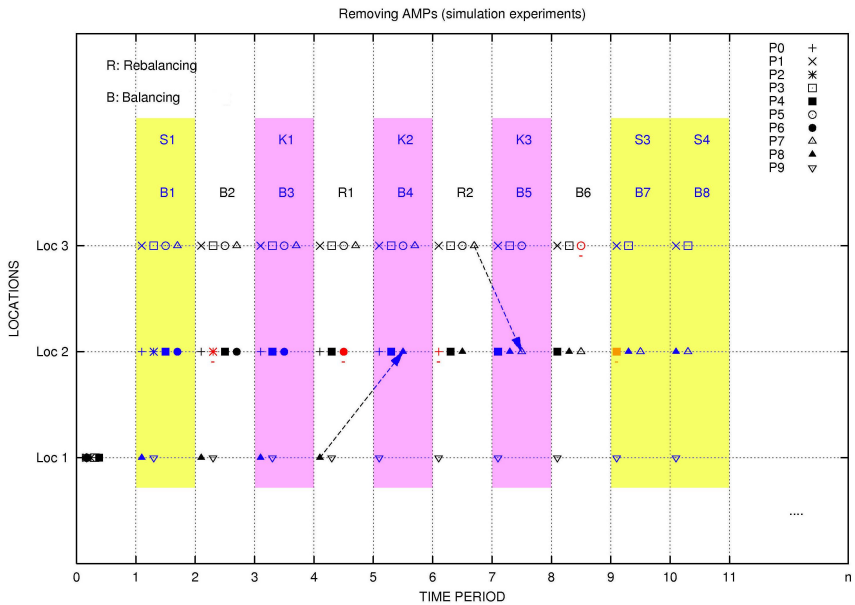

Figure: Simulation experiments

Heterogeneous Network

25 AMPs on 15 locations

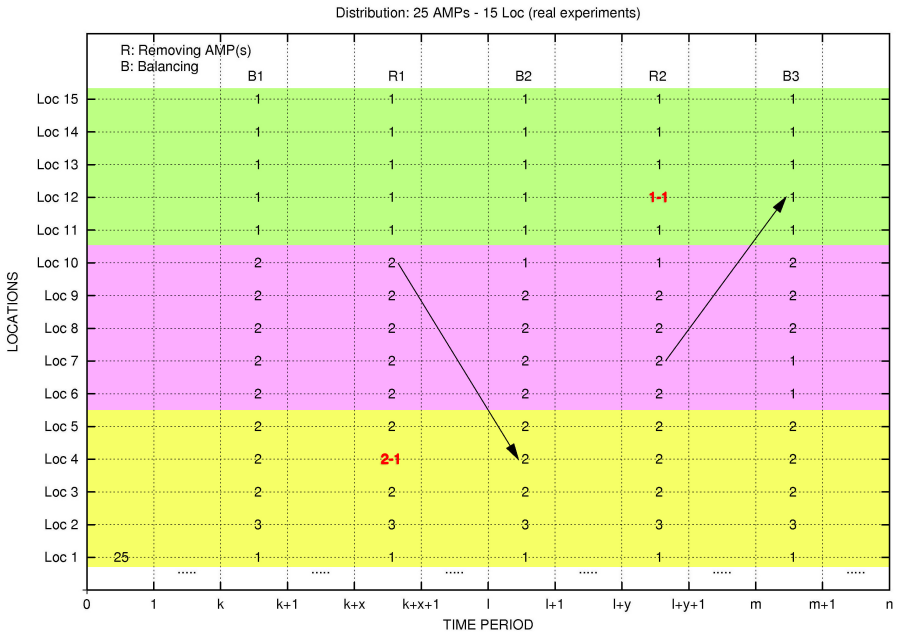

Figure: Real experiments

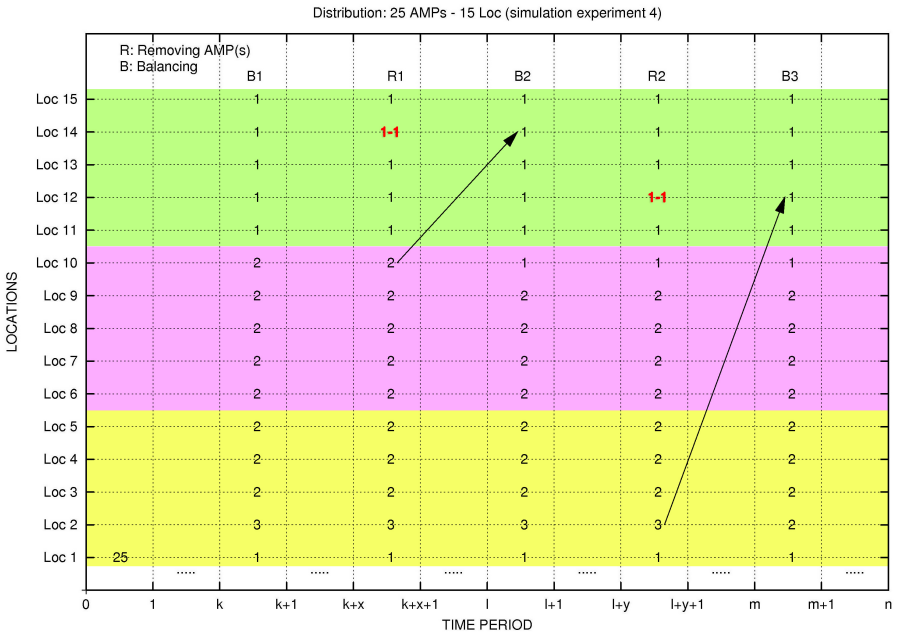

Figure: Simulation experiments

Greedy effect

7% of simulation experiments show the case, when two AMPs move after each removal.

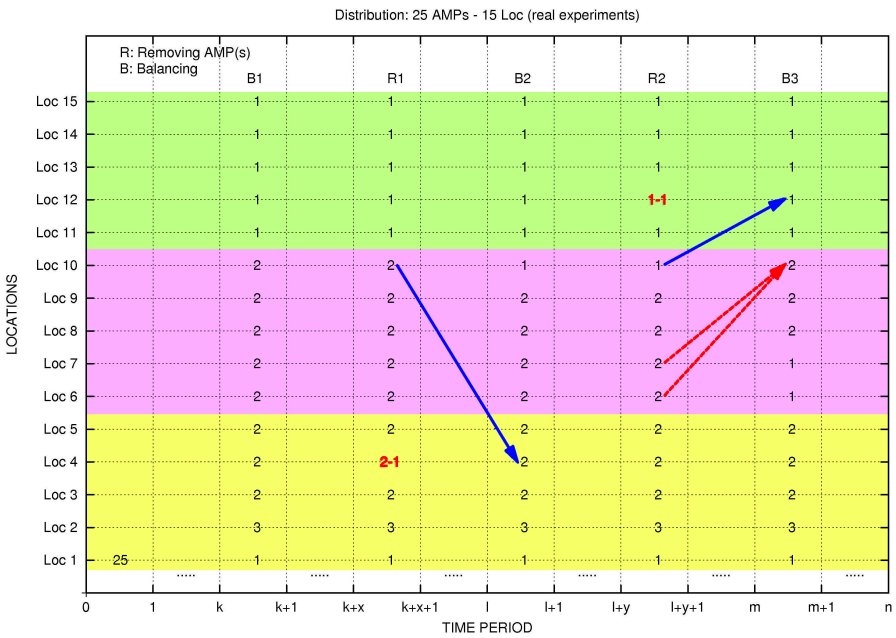

Figure: Real experiments

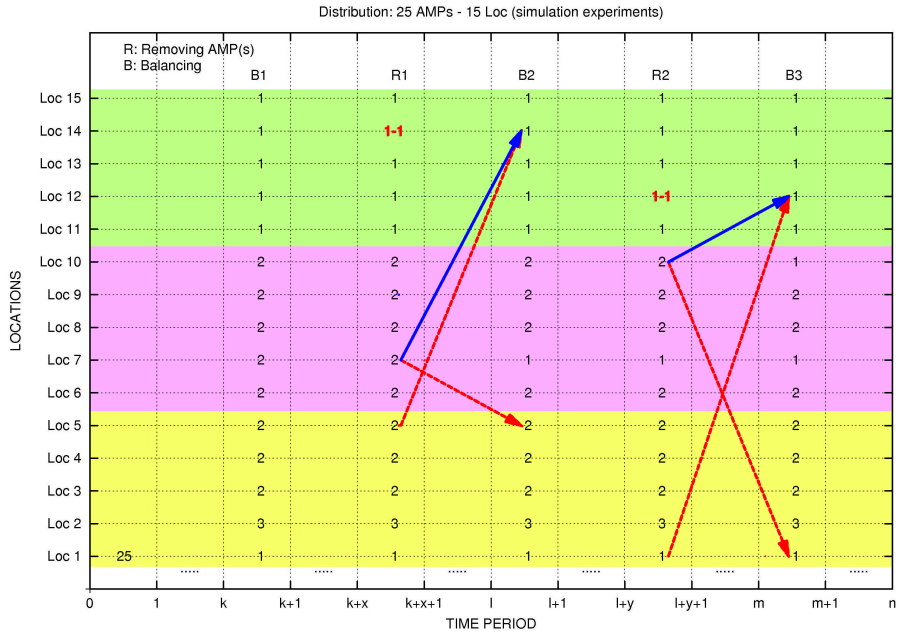

Figure: Simulation experiments

Summary

Homogeneous Network

- Optimal balance. 72% of simulation and real distributions are matched.
- Near-optimal balance. Real and simulation experiments enter identical states.
- Adding AMPs. Simulation and real experiments obtain the same distribution.
- Removing AMPs:
  - all simulation experiments reach 3 of 4 balanced states;
  - 18% of simulation AMPs enter all states of real experiments.

Summary

Heterogeneous Network

- 41% of simulation experiments states enter exactly the same set of states as real experiments;
- the greedy effect that can be observed in the real experiments, can also be seen in the simulation experiments.

Conclusion & Future Work

- Conclusion: other than a small number of explainable deviations our current simulation is an effective model of AMPs on LANs. Hence, we are confident about using the model as the basis for further experiments, e.g. on simulated wide area networks.
- Future work:
  - Analysing the greedy effect.
  - Investigation larger networks with different costs of reacting remote locations.

Questions?


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