Using Negotiation to Reduce Redundant Autonomous Mobile Program Movements

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Autonomous Mobile Programs (AMPs)

- AMPs are mobile agents
  - aware of their resource needs;
  - sensitive to the execution environment;
  - periodically seek a better location.
- $T_h > T_n + T_{comm}$

  Time on the current location $>$ *Min time in the network* $+$ *Time to transfer*
- Been investigated using
  - Mobile languages (e.g. *Java Voyager* [Den07]);
  - *Simulation* [CKPT09].

Greedy Effects

- are redundant movements:
  - locally optimal choice;
  - globally non-optimal choice.
- occur when AMPs rebalance after a termination or new AMPs start.
- are observed in other distributed systems.

Scenarios

- Scenario 1: 25 AMPs on 15 locations with CPU speeds 3193 MHz ($Loc1 - Loc5$), 2167 MHz ($Loc6 - Loc10$) and 1793 MHz ($Loc11 - Loc15$).
- Scenario 2: 20 AMPs on 10 locations with CPU speeds 3193 MHz ($Loc1 - Loc5$), 2168 MHz ($Loc6$) and 1793 MHz ($Loc7 - Loc10$).
- Scenario 3. 10 AMPs on 3 locations with CPU speeds 3193 MHz.

Location Thrashing

Lack of information about other AMPs intending to move to the same location

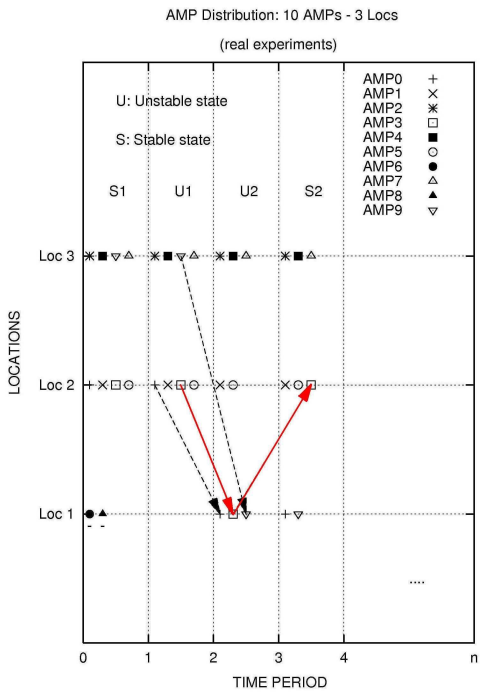


Figure: Redundant rebalancing

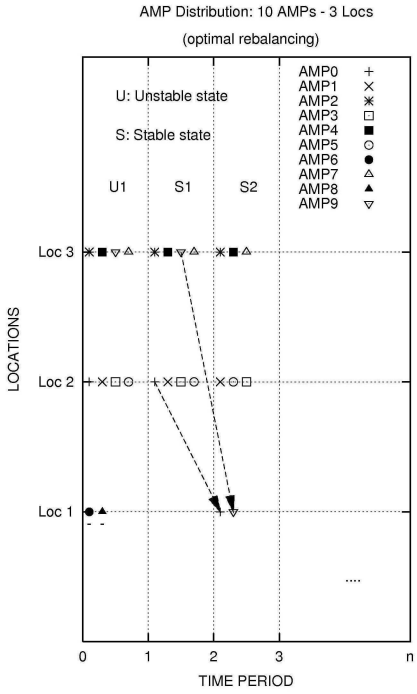


Figure: Optimal rebalancing

Location Blindness

Lack of information about the remaining execution time of other AMPs.

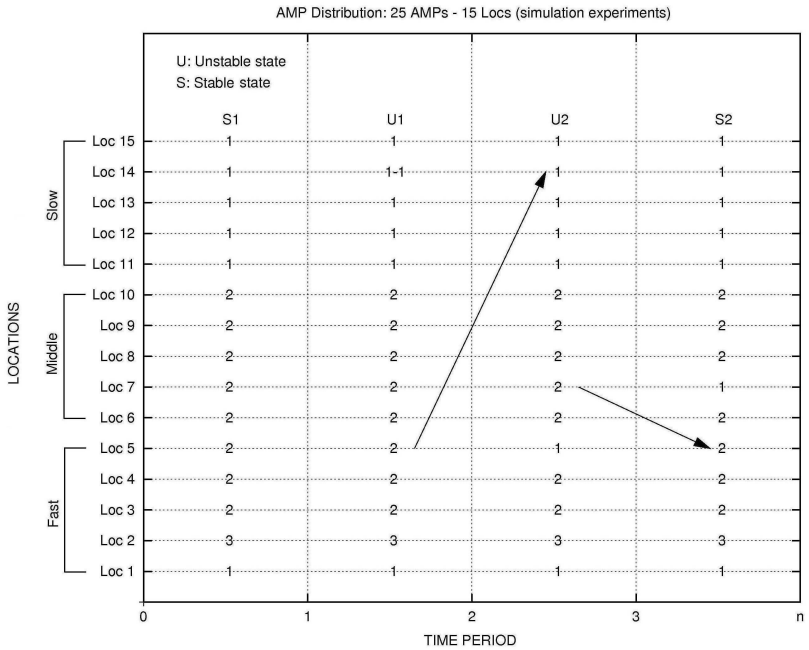


Figure: Redundant rebalancing

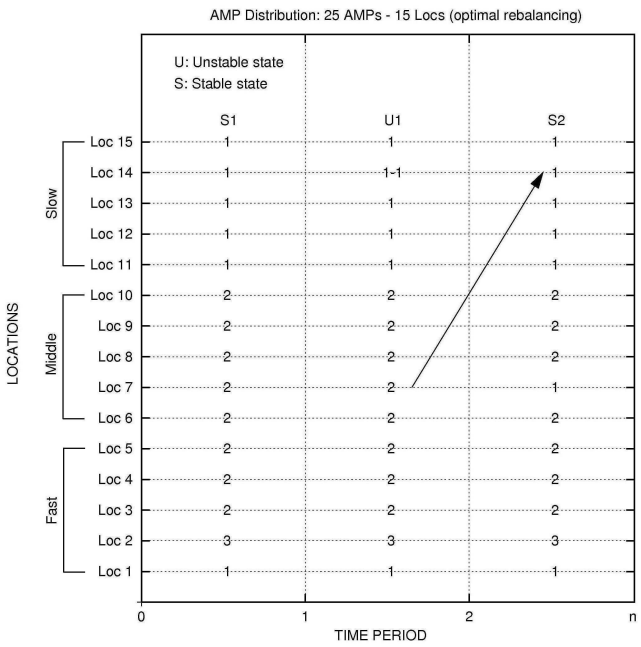
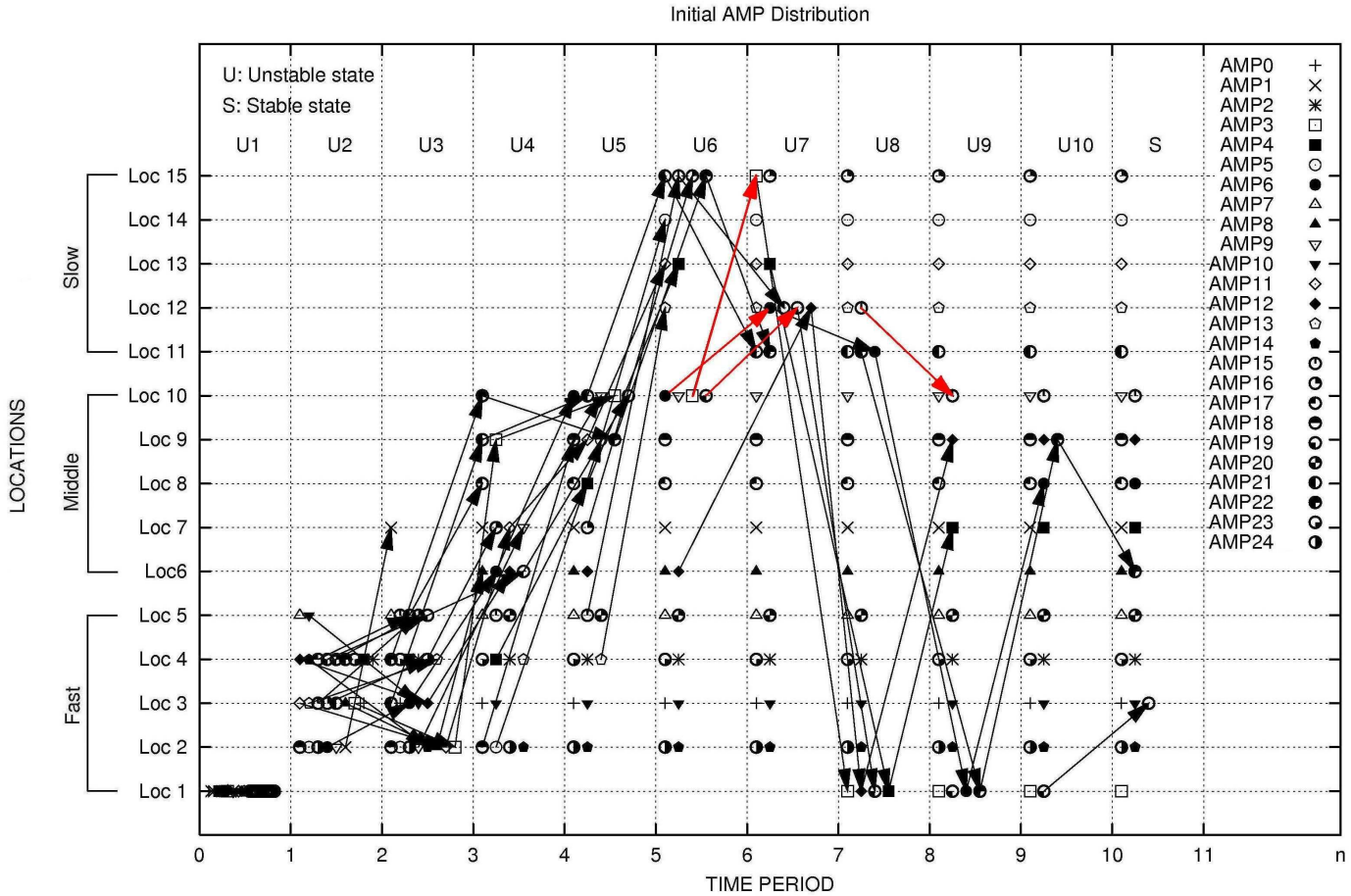


Figure: Optimal rebalancing

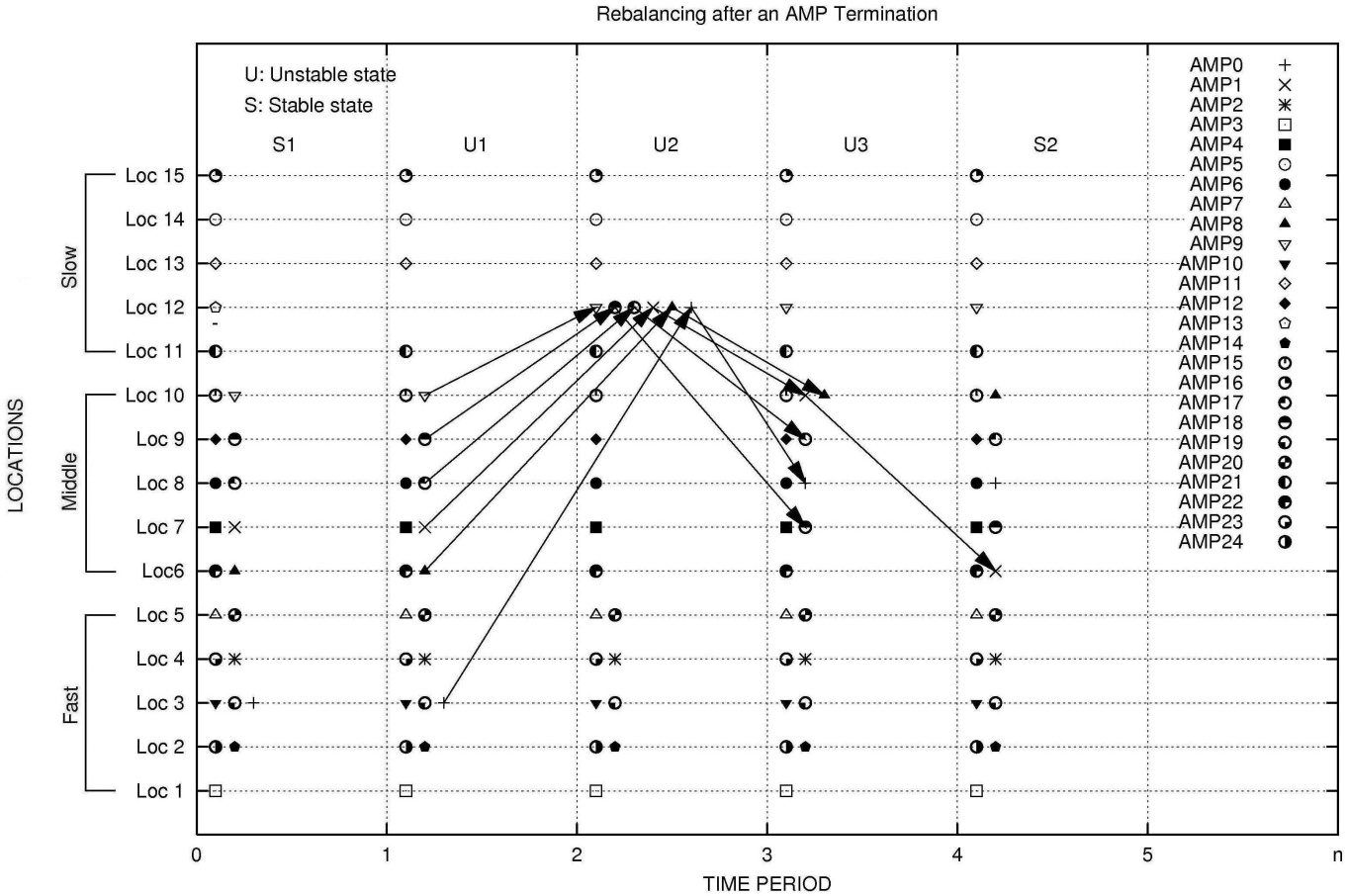
AMPs have a large number of redundant movements.

Configuration	Initial distribution		Rebalancing after an AMP termination		Large AMP execution time, (sec)	
	Mean No. redun. moves	Mean time, (sec)	Mean No. redun. moves	Mean time, (sec)	Mean	Standard deviation
Scenario 1 25 AMPs, 15 loc.	64	60.4	6	22.5	173.8	7.66
Scenario 2 20 AMPs, 10 loc.	43	50.5	11	28.2	182.1	11.5
Scenario 3 10 AMPs, 3 loc.	13	26.8	6	14.1	232.6	9.91

Types of Movements (Scenario 1)



Types of Movements (Scenario 1)



Methods of AMP Negotiation

- Malicious
- Cooperative:
  1. queuing
  2. probabilistic
  3. relationship
  4. competitive.

Negotiating AMPs

- cNAMPs are negotiating AMPs with a cooperative/ competitive scheme:
  - announce their intentions to move;
  - compete with each other for permission to transfer.
- Two values of load:
  - actual load;
  - committed load.
- cNAMPs only reduce location thrashing.

AMP and cNAMP Comparison (Scenario 1)

Initial distribution.

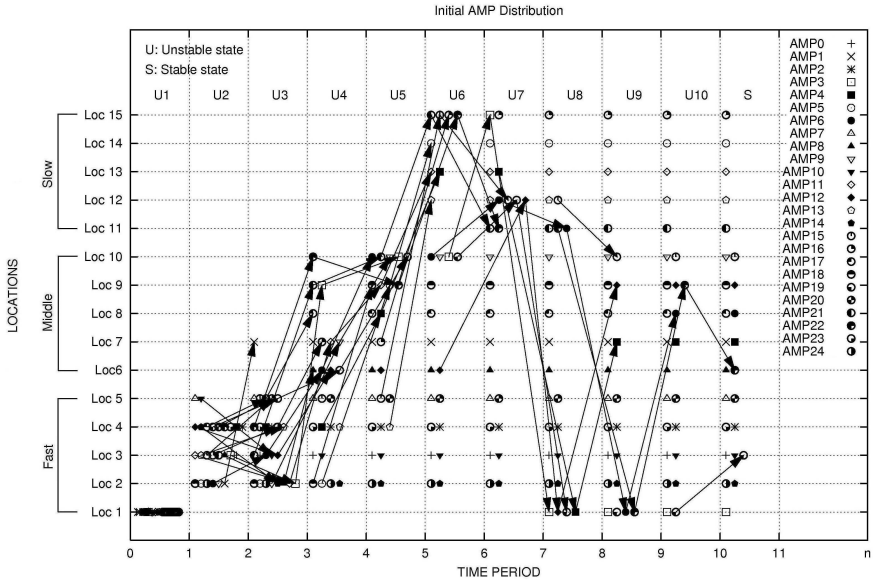


Figure: AMPs

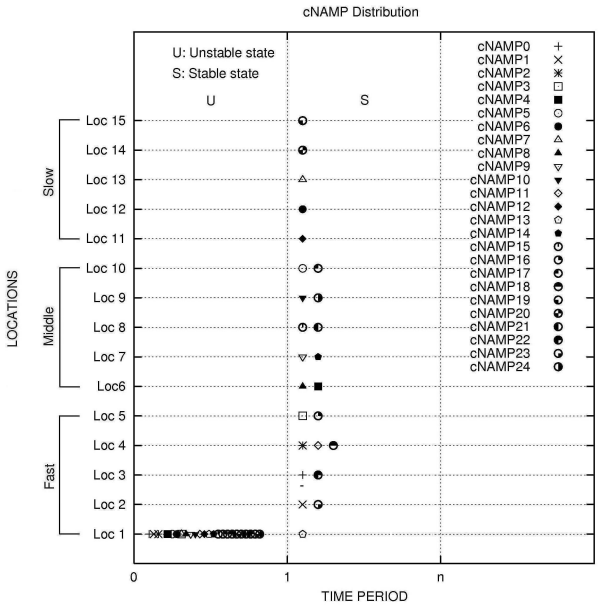


Figure: cNAMPs

AMP and cNAMP Comparison (Scenario 1)

Rebalancing after an AMP/cNAMP termination.

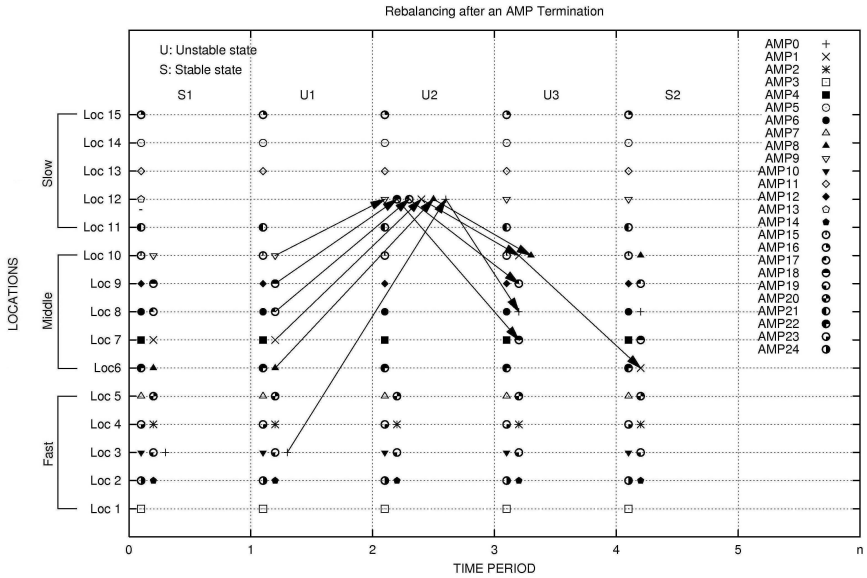


Figure: AMPs

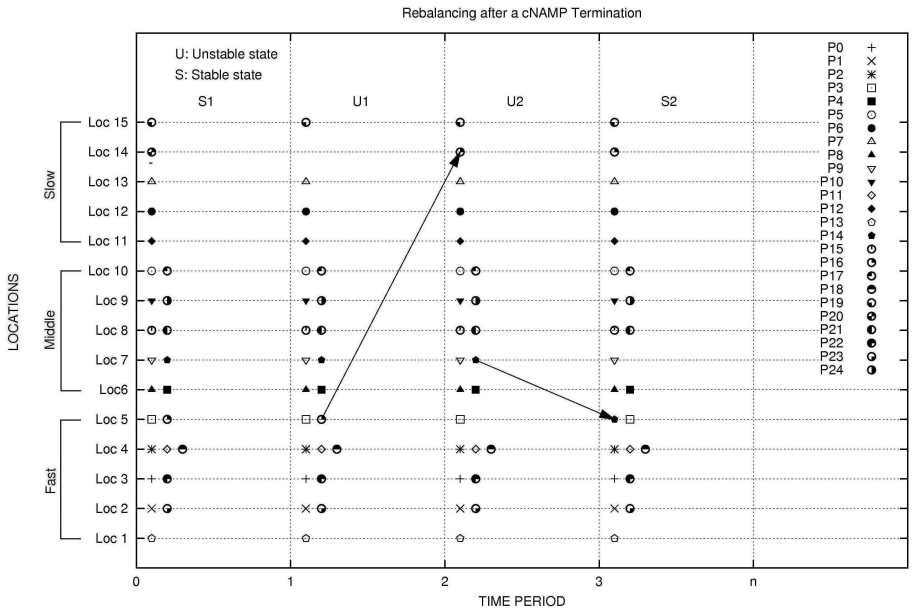


Figure: cNAMPs

cNAMPs make **much fewer** Redundant Movements

Configuration and type of experiment	Initial distribution		Rebalancing after an AMP/cNAMP termination		Large AMP/ cNAMP execution time, (sec)	
	Time (sec)	Mean number of redundant movements	Time (sec)	Mean number of redundant movements	Mean	Standard deviation
Scenario 1						
AMPs	60.4	64	22.5	6	173.8	7.66
cNAMPs	14.7	-	5.9	-	104.8	12.9
Reduction	4.11	64 moves	3.81	6 moves	1.65	
Scenario 2						
AMPs	50.5	43	28.2	11	182.1	11.5
cNAMPs	12.4	-	7.8	1	113.6	9.43
Reduction	4.07	43 moves	3.62	10 moves	1.6	

Conclusion

- Identified two types of AMP greedy effect;
- Investigated extent of AMP greedy effect using simulation;
- Introduced the concept of negotiating AMPs (NAMPs);
- Reduced the greedy effect (cNAMPs).

Future Work

- A mathematical analysis of location blindness on homogeneous and heterogeneous networks to estimate maximum number, and probability of, redundant movements [CKT10];
- Investigation of cNAMP behaviour on wide area networks.

Questions?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