Using Negotiation to Reduce Redundant Autonomous Mobile Program Movements

Natalia Chechina

Dependable System Group, Heriot-Watt University

March 4, 2010

Natalia Chechina

Dependable System Group, Heriot-Watt University

Background

Autonomous Mobile Programs (AMPs)

Greedy Effects and cNAMPs

Greedy Effects AMP Greedy Effect Analysis cNAMPs

Conclusion & Future Work

Natalia Chechina

Dependable System Group, Heriot-Watt University

Background

Autonomous Mobile Programs (AMPs)

Autonomous Mobile Programs (AMPs)

AMPs are mobile agents

- aware of their resource needs;
- sensitive to the execution environment;
- periodically seek a better location.

- Been investigated using
 - Mobile languages (e.g. Java Voyager [Den07]);
 - Simulation [CKPT09].

Natalia Chechina



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

Natalia Chechina

Dependable System Group, Heriot-Watt University



- 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.

Natalia Chechina

Natalia Chechina

Location Thrashing

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

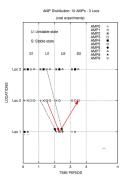


Figure: Redundant rebalancing

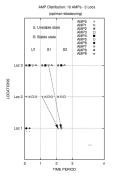


Figure: Optimal rebalancing

Dependable System Group, Heriot-Watt University

Location Blindness

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

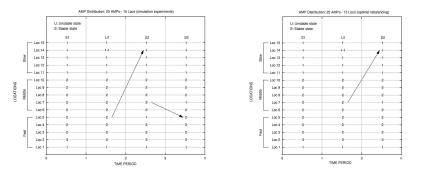


Figure: Redundant rebalancing

Figure: Optimal rebalancing

Dependable System Group, Heriot-Watt University

Natalia Chechina

AMP Greedy Effect Analysis

AMPs have a large number of redundant movements.

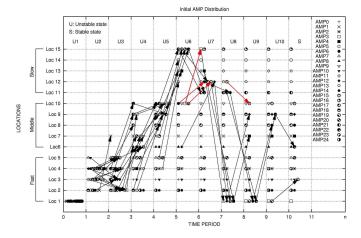
	Initial		Rebalancing		Large AMP	
	distribution		after an AMP		execution	
			termination		time, (sec)	
Configuration	Mean	Mean	Mean	Mean		Stan-
	No.	time,	No.	time,	Mean	dard
	redun.	(sec)	redun.	(sec)		devi-
	moves		moves			ation
Scenario 1						
25 AMPs, 15 loc.	64	60.4	6	22.5	173.8	7.66
Scenario 2						
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

Natalia Chechina

Dependable System Group, Heriot-Watt University

AMP Greedy Effect Analysis

Types of Movements (Scenario 1)



Natalia Chechina

Dependable System Group, Heriot-Watt University

AMP Greedy Effect Analysis

Types of Movements (Scenario 1)

AMPO +U: Unstable state AMP1 × S: Stable state AMP2 ж AMP3 ô S1 U1 U2 UЗ S2 AMP4 . AMP5 Loc 15 -C 0 0 AMP6 ě AMP7 Loc 14 Θ 0 0 AMP ۸ AMP9 V Slow MP10 Loc 13 e ÷ AMP11 ٥ AMP12 Loc 12 MAX I ٠ AMP13 0 AMP14 Loc 11 Ð ٠ AMP15 Ø AMP16 õ 3 Loc 10 -0 V 00 6 0 AMP17 OCATIONS. AMP18 ۲ ٠. Loc 9 -+ O +0 +0 AMP19 ø AMP20 Aiddle ۰ ... AMP21 Loc 8 - O •+ Ð AMP22 AMP23 ē A õ Loc 7 AMP24 ō Loc6 -04 ō. Loc 5 -00 00 40 40 40 Loc 4 - O * •* 0* e¥ · @ * Fast Loc 3 - VO+ **v** 0 ... Loc 2 -0 Loc 1 0 2 3 5 4 TIME PERIOD

Rebalancing after an AMP Termination

Natalia Chechina

Dependable System Group, Heriot-Watt University

Methods of AMP Negotiation

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

Natalia Chechina

Dependable System Group, Heriot-Watt University

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.

Natalia Chechina

cNAMP2 cNAMP3 cNAMP3 cNAMP5 cNAMP5 cNAMP5

CNAMP CNAMP

cNAMP1

cNAMP12 cNAMP13 CNAMP1

CNAMP1

ENAMP17 cNAMP18 cNAMP19

cNAMP24

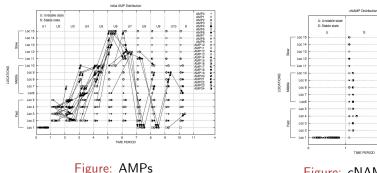
č

÷

cNAMPs

AMP and cNAMP Comparison (Scenario 1)

Initial distribution.



TIME PERIOD Figure: cNAMPs

Natalia Chechina

Dependable System Group, Heriot-Watt University

AMP and cNAMP Comparison (Scenario 1)

Rebalancing after an AMP/cNAMP termination.

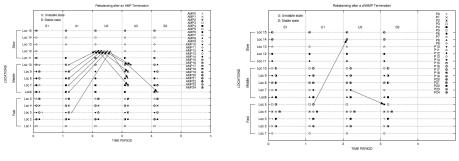


Figure: AMPs

Figure: cNAMPs

Natalia Chechina

Dependable System Group, Heriot-Watt University

cNAMPs make much fewer Redundant Movements

	Initial distribution		Rebalancing after		Large AMP/					
			an AMP/cNAMP		cNAMP execution					
Configuration			termination		time, (sec)					
and type of		Mean		Mean						
experiment	Time	number of	Time	number of	Mean	Standard				
	(sec)	redundant	(sec)	redundant		deviation				
		movements		movements						
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					

Natalia Chechina

Dependable System Group, Heriot-Watt University

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).

Natalia Chechina

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.

Natalia Chechina

Questions?

Natalia Chechina

Dependable System Group, Heriot-Watt University

- Natalia Chechina, Peter King, Rob Pooley, and Phil Trinder. Simulating autonomous mobile programs on networks. In PGNet '09, pages 201–206, Liverpool, UK, 2009.
- Natalia Chechina, Peter King, and Phil Trinder. Complete experimental and theoretical analysis of greedy effects in autonomous mobility. Technical Report 0073, Heriot-Watt University, Edinburgh, UK. 2010.
- X. Y. Deng.
 - Cost Driven Autonomous Mobility.

PhD thesis, School of Mathematical and Computer Sciences, Heriot-Watt University, Edinburgh, UK, 2007.

Natalia Chechina