Talk Outline	Background	Multilevel Network Design	Evaluation of Multilevel Architecture	Conclusion & Future Work
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Autonomous Mobility in Multilevel Networks

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Background

Autonomous Mobile Programs (AMPs)

Multilevel Network Design

Topology Design Alternatives

Evaluation of Multilevel Architecture

Effectiveness Redundant Movements

Conclusion & Future Work

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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.
- Been investigated using
 - Mobile languages (e.g. Java Voyager [DTM06])
 - Simulation [CKPT09, CKT10]
 - Theoretical analysis [CKT11]

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Topology				

Hierarchical Tree Architecture



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Specific Hierarchical Tree Architecture (HA1)



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Simulated HA1 Architecture



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Multilevel Network Alternatives

Number of parental gateways to the nearest upper level





Figure: Single

Figure: Multiple



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Design Alterna	atives			

Gateway and Location Alternatives

2	Gateway functions	Collecting in- formation	Executing cNAMPs and collecting information	
3	Type of information a location provides to the gateway	Available speed, com- mitted load, latency of a state message	Expected rel- ative speed, latency of a state message	Total relative speed, total load, latency of a state message
7	A gateway provides in- formation about	one node	multiple nodes	
8	A gateway chooses in- formation to pass on the basis of	maximum ex- pected relative speed	maximum rela- tive speed	minimum number of cNAMPs

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Design Alterna	atives			

cNAMP and Auxiliary Message Alternatives

No.	Parameters	Alternative 1	Alternative 2	Alternative 3
9	A cNAMP checks possi- bility to move to a re- mote location	every time the cNAMP recalculates parameters	only if there is no opportunity to improve exe- cution time lo- cally	according to a timer, i.e. only after a certain period
10	If a cNAMP awaits a response from a remote location then other cNAMPs from the same location	may consider movements to other locations	may NOT consider move- ments to other locations	may recalculate parameters if the number of requests is less than a certain value
11	A request moves be- tween levels	In any direction	According to some rule	

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Evaluation of Multilevel Architecture

- Network Parameters: number of levels, topologies, number of locations, speed of locations
- cNAMP Parameters: number of cNAMPs, work of cNAMPs, type of cNAMPs
- Type of Rebalancing: initial distribution, rebalancing after adding cNAMPs, rebalancing after termination cNAMPs

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Effectiveness			

Effectiveness: Number of Levels



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Effectiveness: Type of cNAMPs



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Effectiveness			

Effectiveness: Number of Locations



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Redundant Movements					

Redundant Movements: Work of cNAMPs



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Redundant Movements: *Number of Levels and Type of Distribution*



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- Designed and implemented an architecture that supports multilevel networks
- Evaluated effectiveness of the fusion-based multilevel architecture

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Future Work

- Design AMPs for Infrastructure-as-a-Service based Clouds
- Investigation cNAMP alternatives on multilevel networks
- Implementation cNAMPs on Wide Area Networks

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Questions?

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Transfer Delay

$$T_{tr,i} = (224h + 5L + 155) \cdot 15 \cdot 10^{-6} + L_{prog} \left(\frac{1}{R_{tr}} + \frac{R_{tr}}{X \cdot 10^{13}} + \frac{\sum_{j=1}^{h} D_{rp; j} + D_{T}}{X} \right)$$
(1)

 $\begin{array}{ll} h & \text{number of hops} \\ L & a physical distance between two nodes} \\ L_{prog} & a program size in bytes \\ R_{tr} & \text{transmission rate} \\ X & a size of a packet (i.e. 1500 bytes) \\ D_{rp:j} & a router processing delay \\ D_T & \text{the time required to push all packets into the wire} \end{array}$

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Transfer Delay

$$T_{tr} = \sum_{i=0}^{N_{PG-1}} (2T_{tr,i}) - T_{tr,N_{PG}-1}$$
(2)

 N_{PG} is the number of the level of the nearest common parental gateway for both the initial and the target locations

Level	Distance between	Number of Hops	Total Distance
	nodes, <i>L</i> (km)	h	between locations (km)
0	1	1	1
1	1 – 15	1 – 2	3 - 17
2	10 - 65	1 – 2	14 - 96
3	55 – 200	1 – 2	79 - 362
4	160 - 440	1 – 2	294 - 1002

Table: Number of Levels vs. Distance and Hops

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