

Cross Layer Workshop Washington 2004

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Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE 01 DEC 2007		2. REPORT TYPE N/A		3. DATES COVERED	
4. TITLE AND SUBTITLE Cross-Layer Simulation and Aggregation Techniques for Wireless Ad Hoc Networks				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institut National des Telecommunications, Evry, France				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 31	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Outline

- **Introduction**
- Cross Layer Design
- MAC layer Approach in Ad Hoc networks
- Network Layer Approach in Ad Hoc networks
- On going work

Introduction

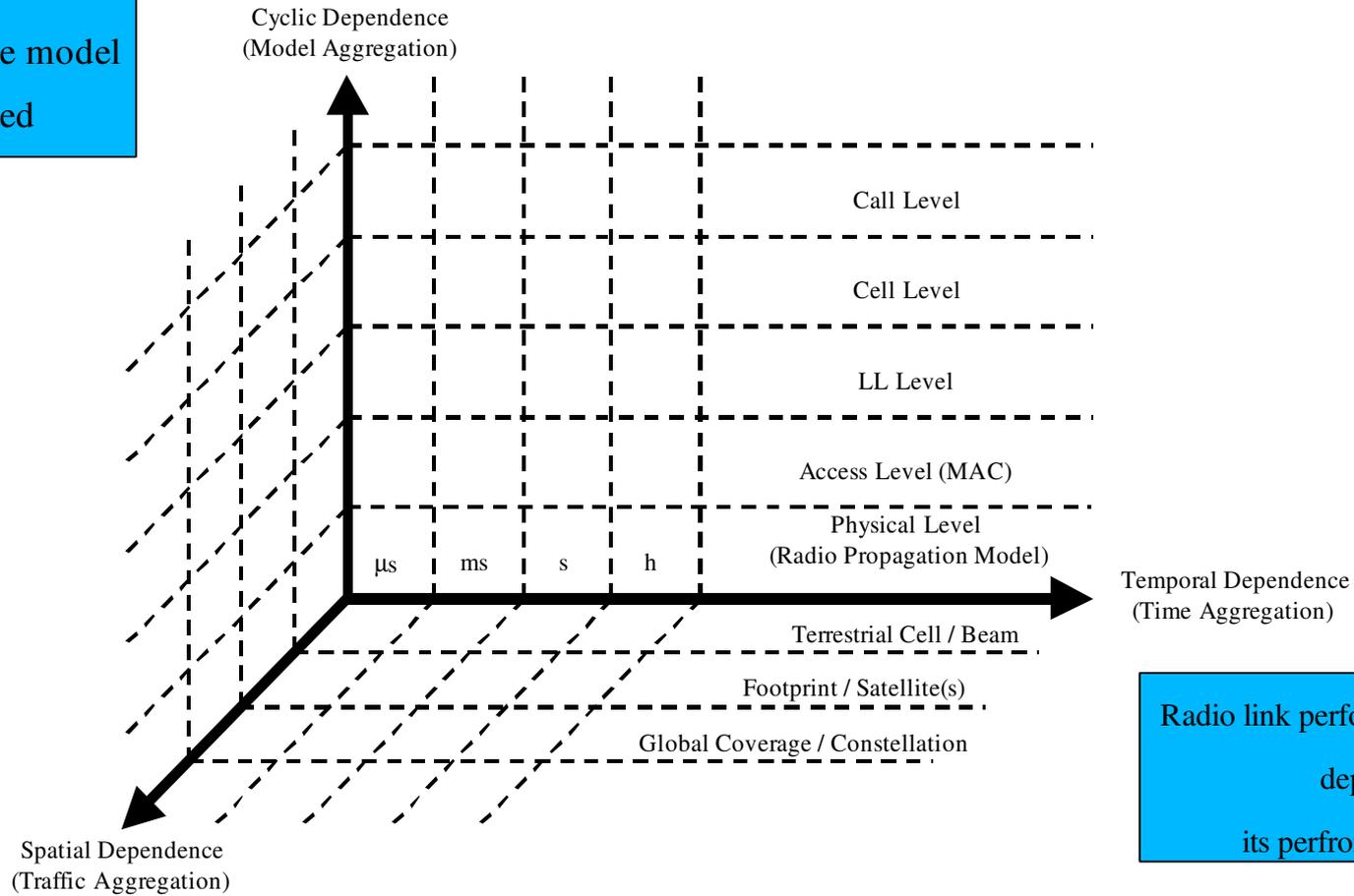
- Goal of Cross Layer:
 - Improve the performance of the whole network stack
- How to improve performance
 - The information in a layer could be use by other layers
- How to share information between layers
 - Change the stack design

Introduction

- Aggregation methods are used to solve complex problems
- A complex problem is divided into sub-problems
- This method may be exact
- It is often an approximate method
- It is often recursively applied: a fixed point method until convergence of parameters

Introduction

Several part of the model are correlated



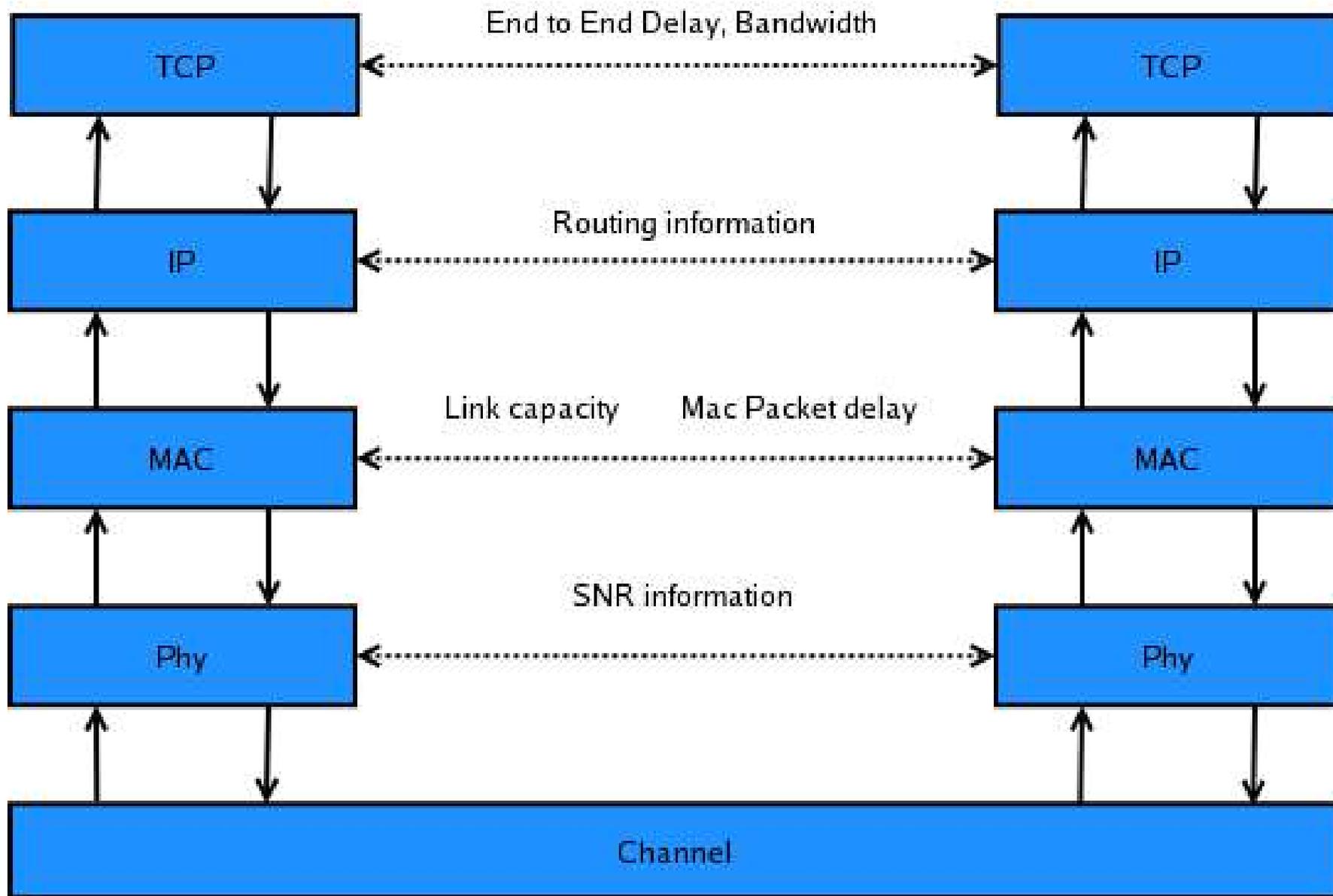
Radio link performance at time $t + I$ depends on its performance at time t

Performance on site S at time t is related to the performance on a close site S' at t or near t

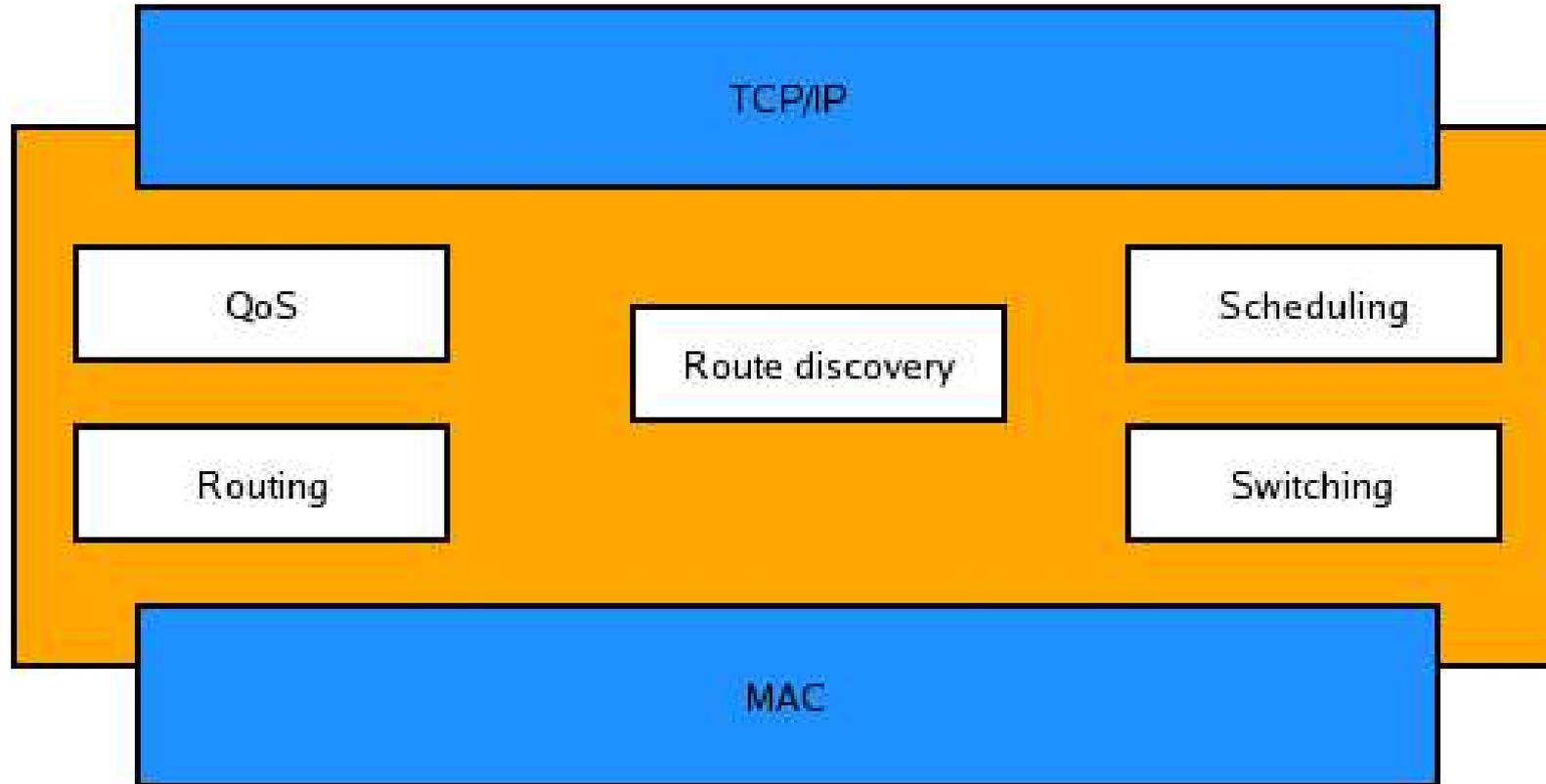
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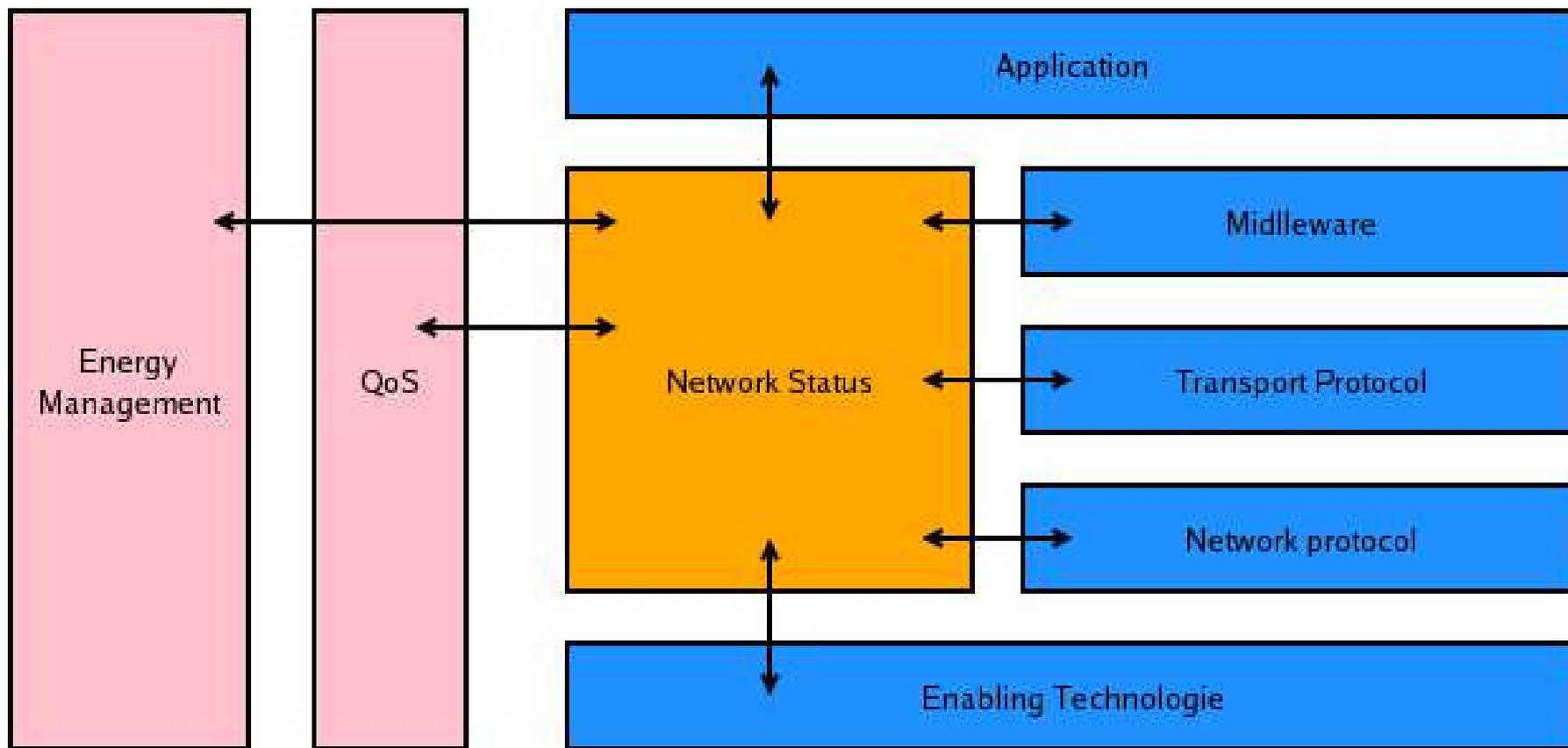
Cross Layer (1/4) : Current Stack



Cross Layer (2/4) : Current way of research



CrossLayer (3/4): New Design



Cross Layer (4/4): New Design

DME: Device Management Entity
LME: Layer Management Entity



Vijay T. Raisinghani, Sridhar Iyer. **Cross-layer design optimizations in wireless protocol stacks.** *Computer Communications (Elsevier)*, 2003

Cross Layer Goals

- Use of several optimization methods at the same time
- Share information
- Ad-hoc Network Protocol Architecture can lead to optimize performance by exploiting environmental parameters across different layers

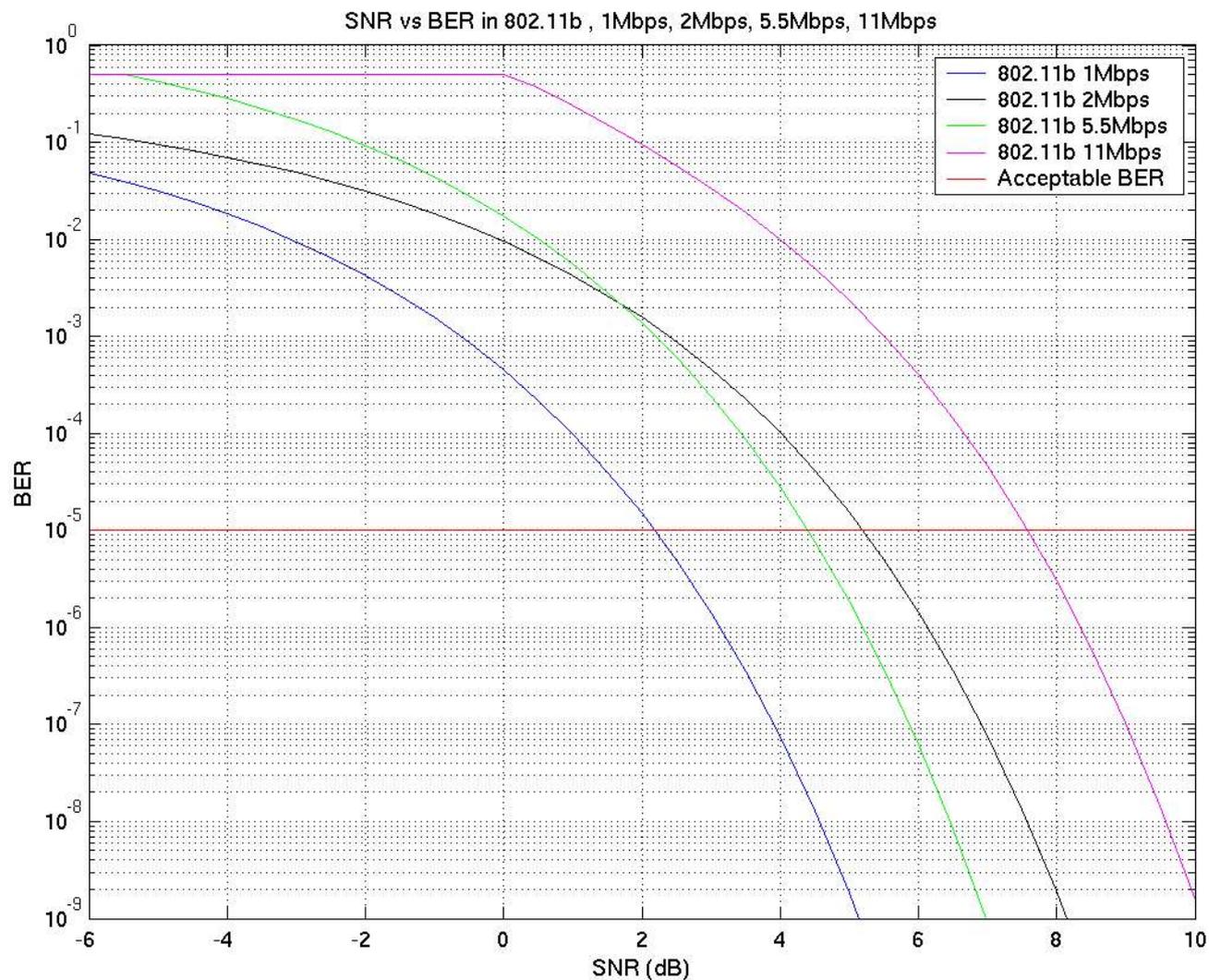
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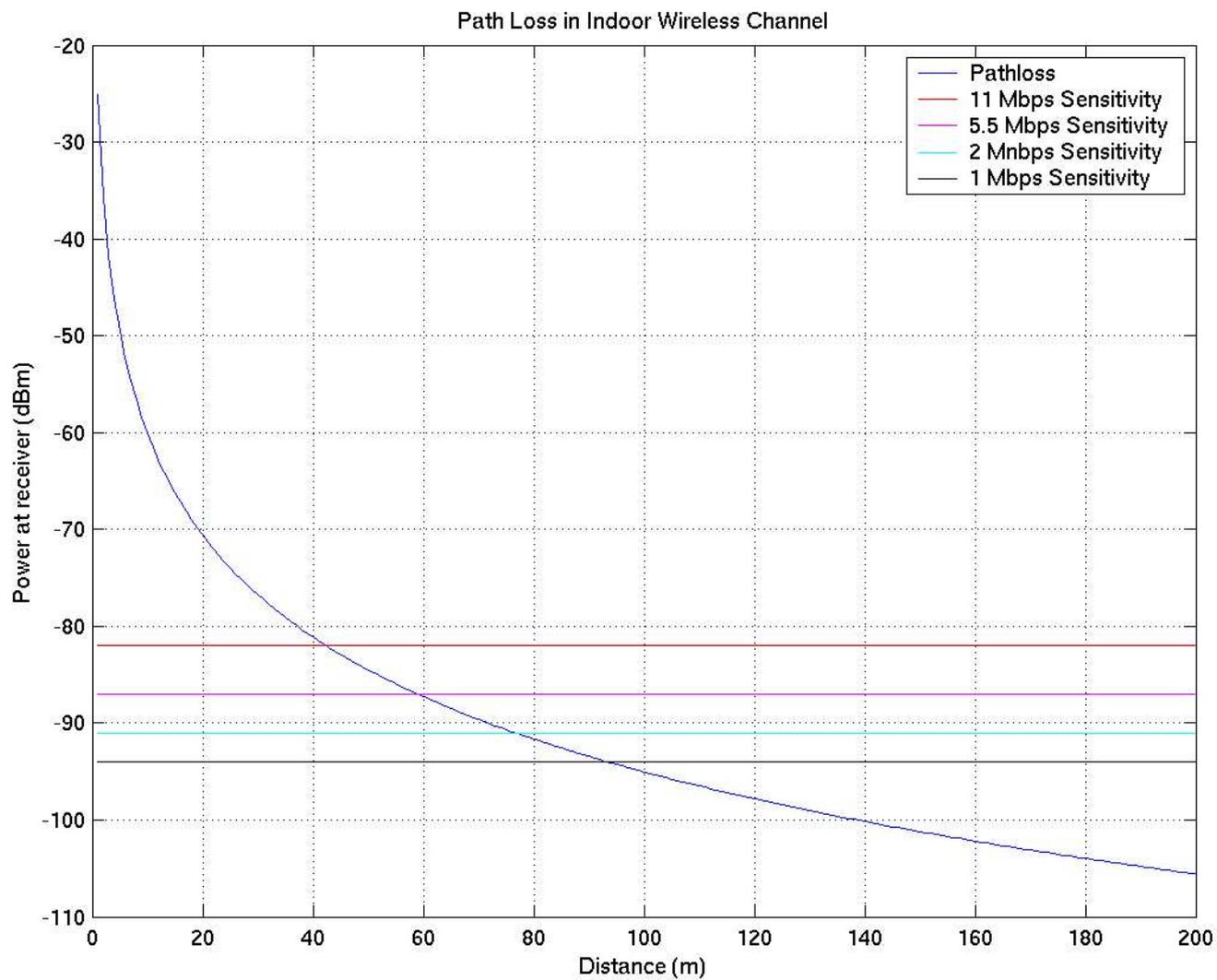
Introduction

- How the SNR affects throughput
- How the number of hops affects the throughput
- Detect the SNR level to improve the path throughput
- Effect of the multi-rate

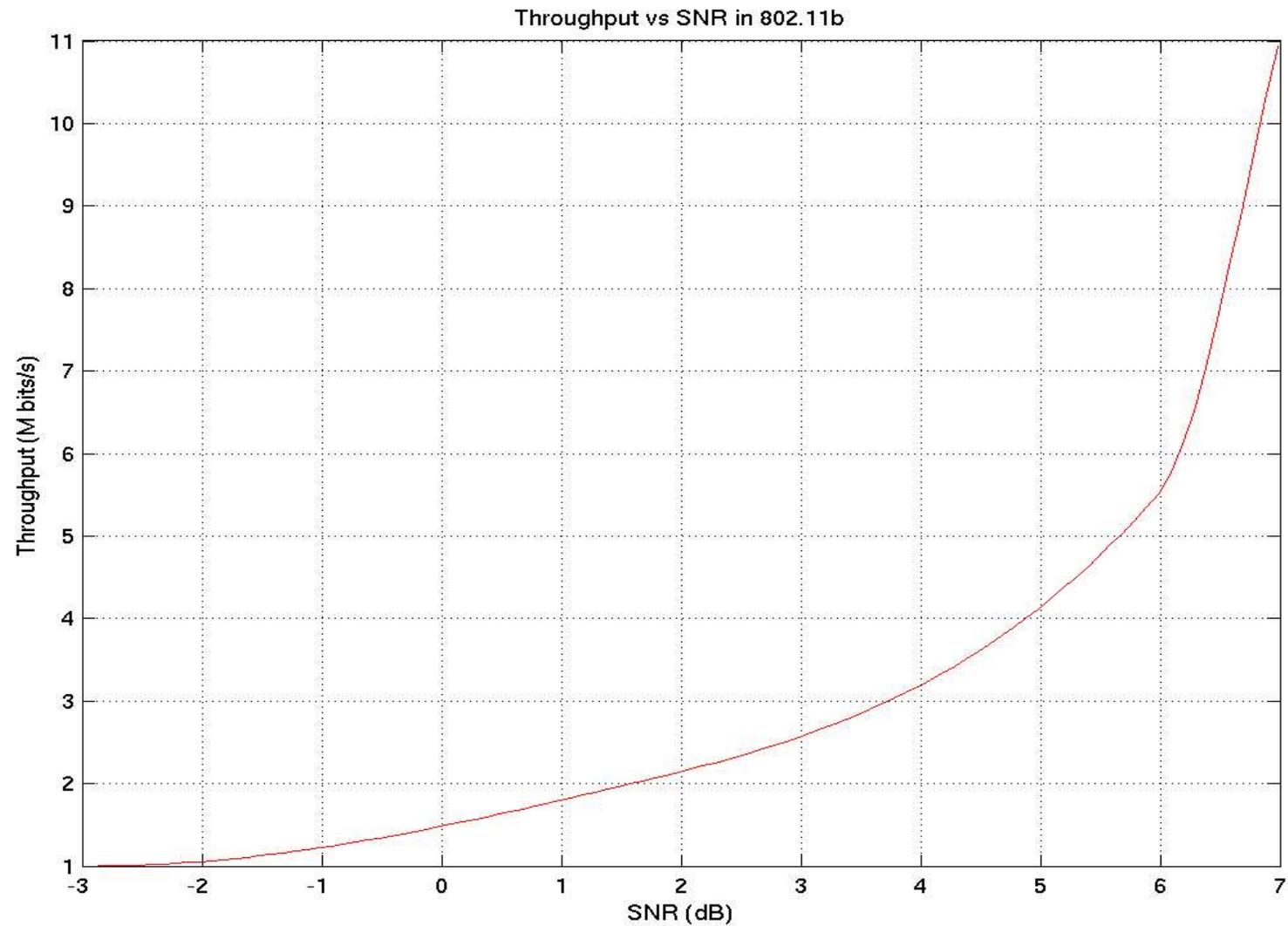
BER vs SNR simple models



Path Loss



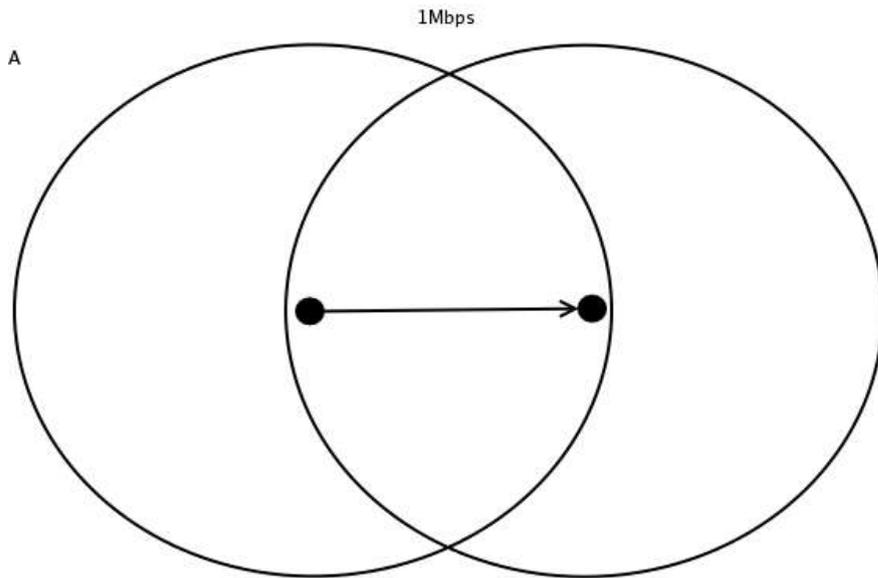
Throughputs vs SNR



Effect of Multi-rate in 802.11b

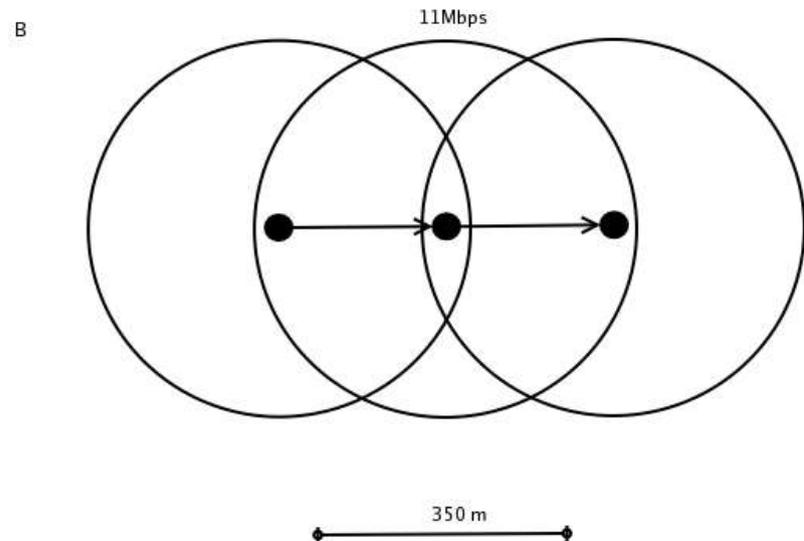
- SNR affects the throughput
- Selecting the best available throughput is equivalent to select the best SNR along the path
- Need to change the metric
- Hops count versus throughput

Path Selection



- Long distance = low throughput

- The number of hops is not always the best metric



- Determine the best trade of between hops and throughput

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Multiuser Diversity

- Apply multiuser diversity to wireless ad-hoc networks
- By using cross-layer mechanism to get the signal strength

R. Knopp and P. A. Humblet. **Information Capacity and power Control in Single-Cell Multiuser communication.** *In Proc. Int. Conf. On communications.* Seattle, Jun 95

R. Dube and C. Rais and K. Wang and S. Tripathi. **Signal stability based adaptive routing (SSA) for ad hoc mobile networks.** *IEEE Personal Communication.*

AODV-UU

We have implemented a cross layer mechanism with AODV-UU 0.8

- follow the RFC 3561 standard
- simulation with NS2, and testbench with Linux performed easily

AODV-UU available at

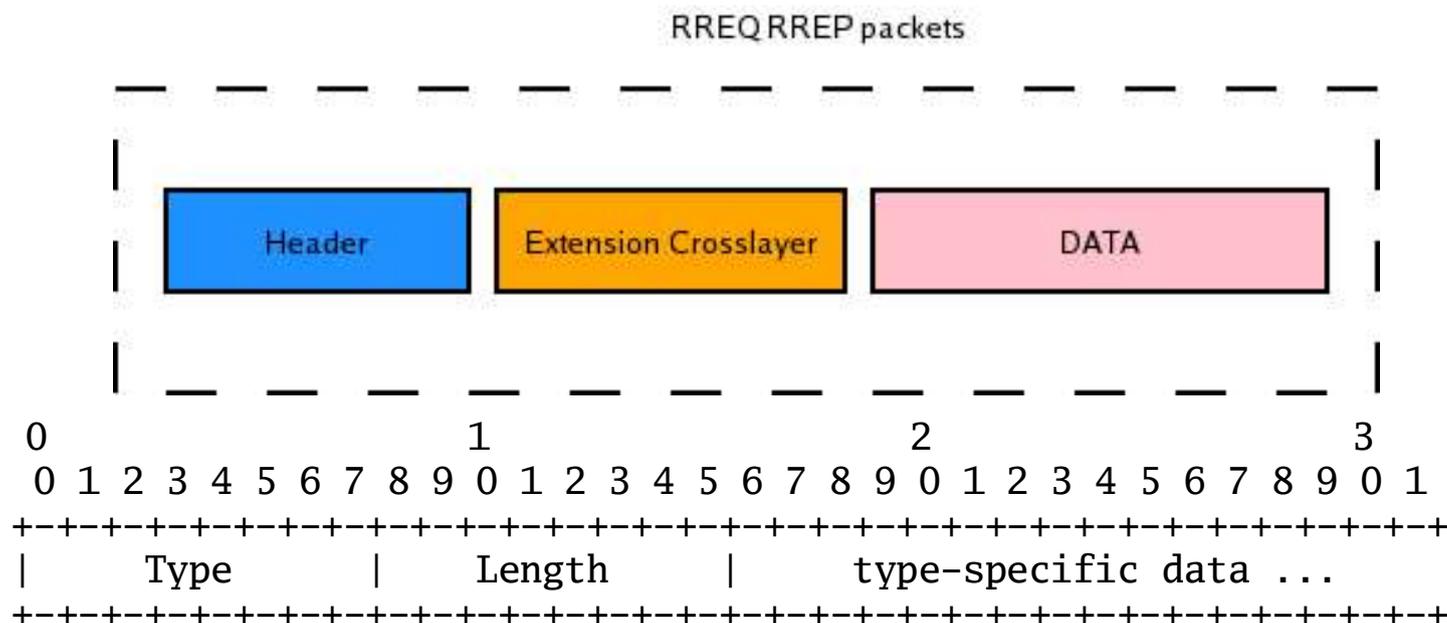
Ref aodv-uu : <http://user.it.uu.se/~henrikl/aodv/>

AODV-UU + Cross-Layer extension available for NS2 simulation and Linux TestBench at

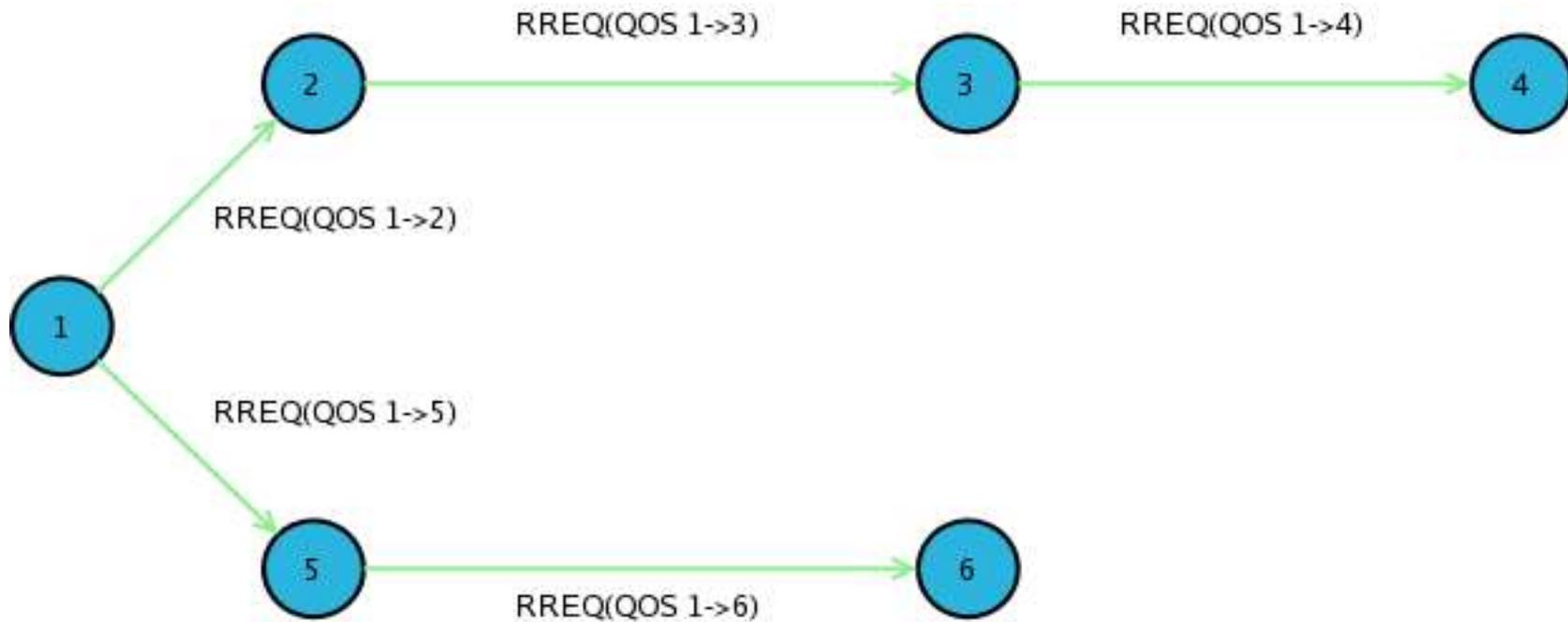
<http://www-rst.int-evry.fr/~gauthier/>

AODV-UU CrossLayer Extensions

- Add new extension to AODV
 - Type = 5 => CrossLayer extension
 - Data = add the new Metric

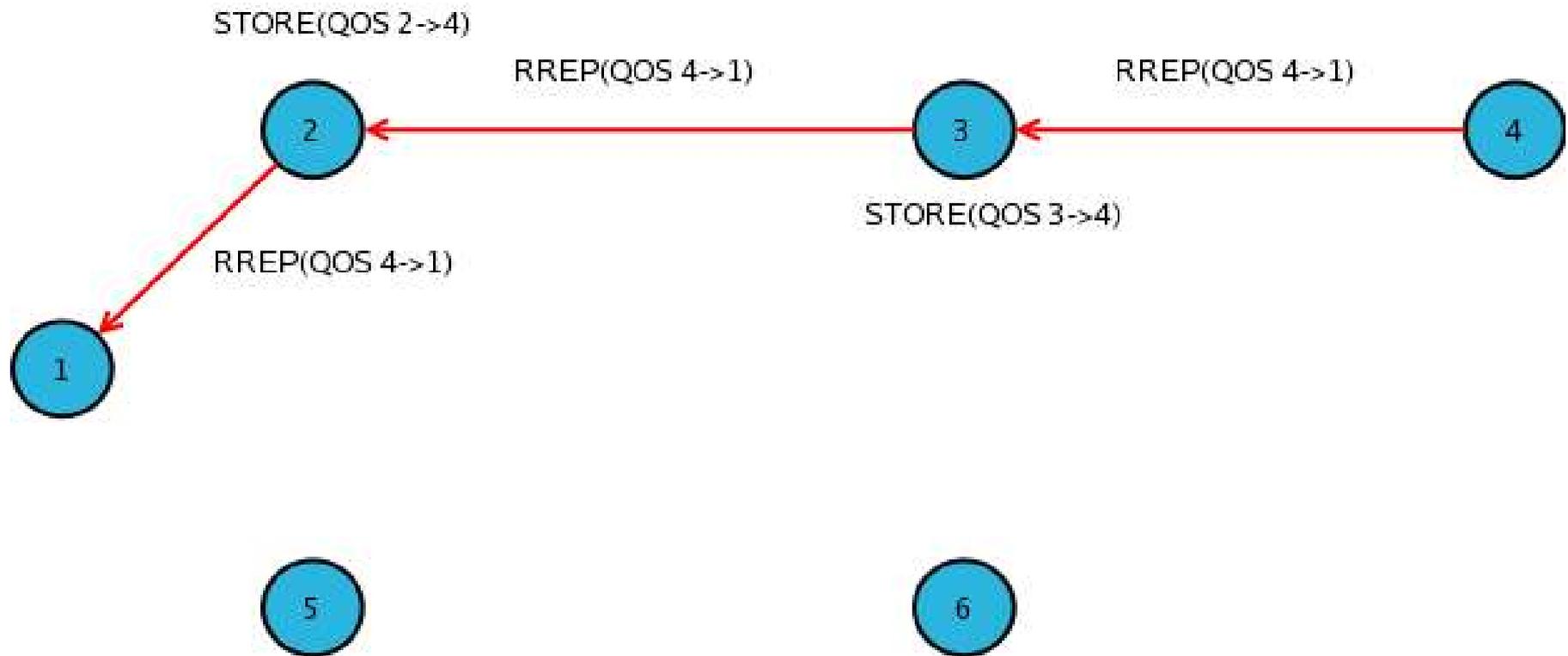


Cross Layer and Ad-hoc Networks(3/4)



SOURCE node 1
DESTINATION node 4

Cross Layer and Ad-hoc Networks(4/4)

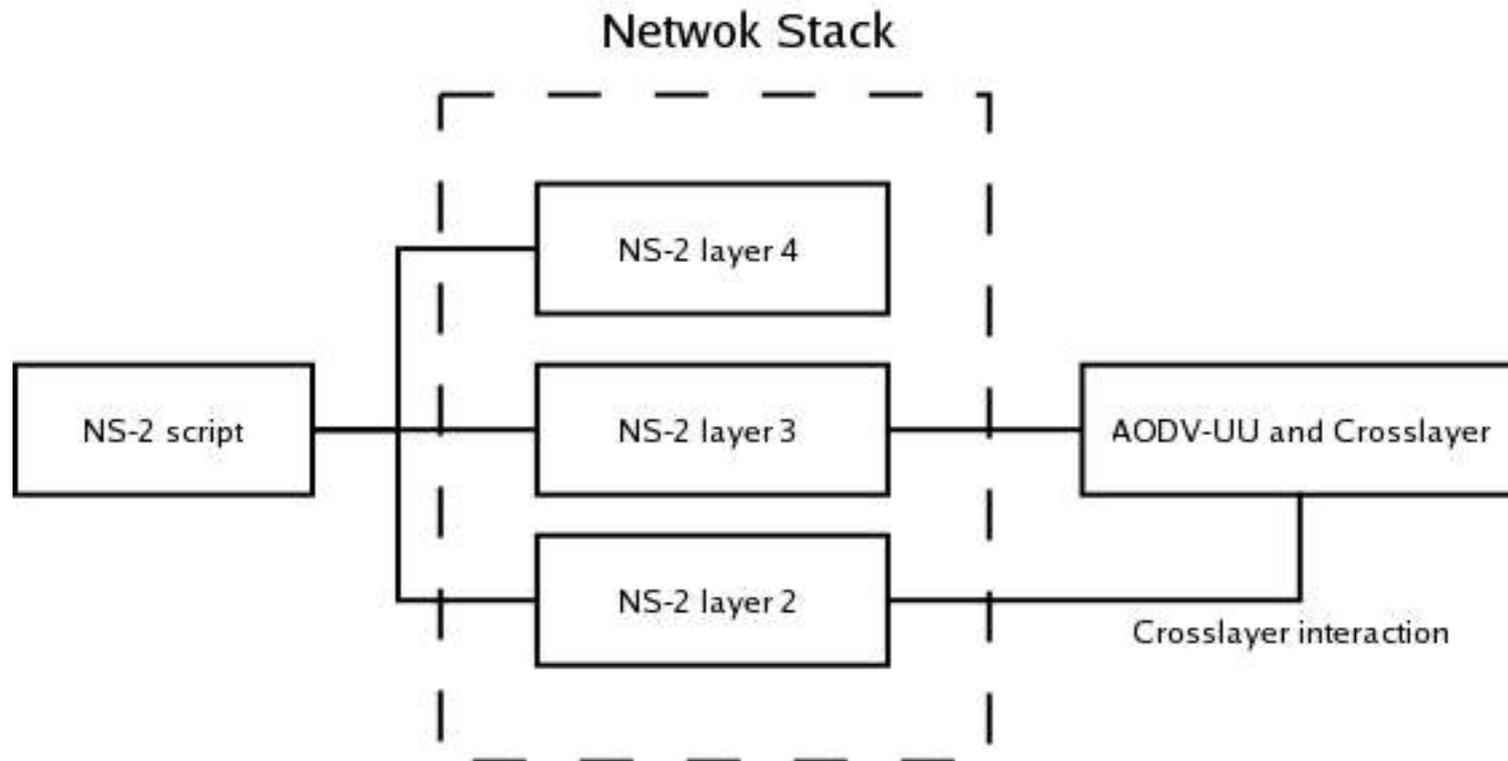


SOURCE node 1
DESTINATION node 4

Cross Layer and Ad-hoc Networks(1/4)

- Check the interlayer interaction with AODV
- RREP and RREQ to carry interlayer info
 - Use aodv extension field to carry informations
- Create interfaces MAC/routing layer
- Change the network metrics

Cross Layer and Ad-hoc Networks(2/4)



Expected results

- Multiuser diversity improves the network capacity
- Select an high quality route
- Select the best route
- Monitoring of the quality of the route over the time

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On progress Works

- Simulate the effects of :
 - Multiuser Diversity
 - Best available path rate
- Difficulty to perform significant simulation with multi-layer interaction
 - Aggregation Techniques
- Create a new stack design

References

Vikas Kawadia and P. R. Kumar. **A Cautionary Perspective on Cross Layer Design.** *Submitted to IEEE Wireless Communication Magazine 2003*

Douglas S. J. De Couto and Daniel Aguayo and Benjamin A. Chambers and Robert Morris. **Performance of Multihop Wireless Networks: Shortest Path is Not Enough.** *Proceedings of the First Workshop on Hot Topics in Networks (HotNets-I), ACM SIGCOMM, 2002*

Andrea J. Goldsmith and Stephen B. Wicker, **Design Challenges for Energy-Constrained Ad Hoc Wireless Networks,** *IEEE Wireless Communication, 2002*

Baruch Awerbuch and David Holmer and Herbert Rubens, **High Throughput Route Selection in Multi-Rate Ad Hoc Wireless Networks,** *First Working Conference on Wireless On-demand Network Systems (WONS 2004)*

Thanks

Questions ?