Analysis of Mulit-hop Access Probability and End-to-End Delay Performance

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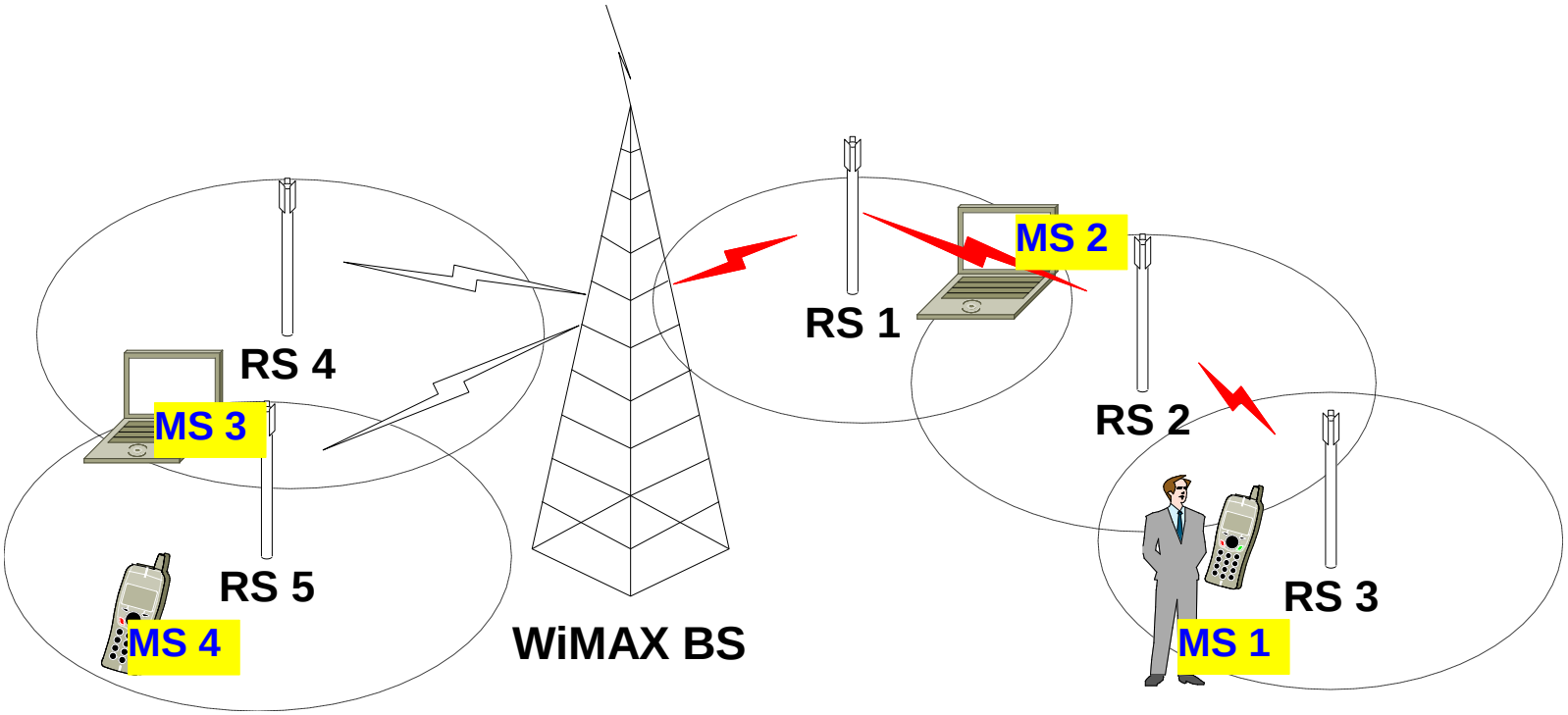
Outline

- Introduction of MMR networks
- Why do we adopt cross-layer simulations?
- How do we establish multi-hop cross-layer simulations?
- Results

Mobile Multi-hop Relay (MMR) Networks



Advantages and Challenges

- Advantages of the MMR Architecture
  - Capacity Enhancement
  - Coverage Increase
  - Cost Reduction (deployment, maintenance and etc.)
- Challenges of the MMR Architecture
  - End-to-end Quality of Service, i.e., **packet delay**, **jitter**, packet loss and so on.
  - Security

Analysis of Multi-hop Access Probability

- Multi-hop Access Probability and Connectivity Probability in Infrastructure-based Cooperating Object Networks
  - To solve the problem of how far away should we place a Sink to keep a good network connectivity performance and What is the relationship between some key parameters and the access and connectivity probabilities? The parameters are including: Distance between Sinks (L), Coverage radius of Sinks and COs (R and r), network density and Number of hops allowed (K)

Why Cross-layer Simulations?

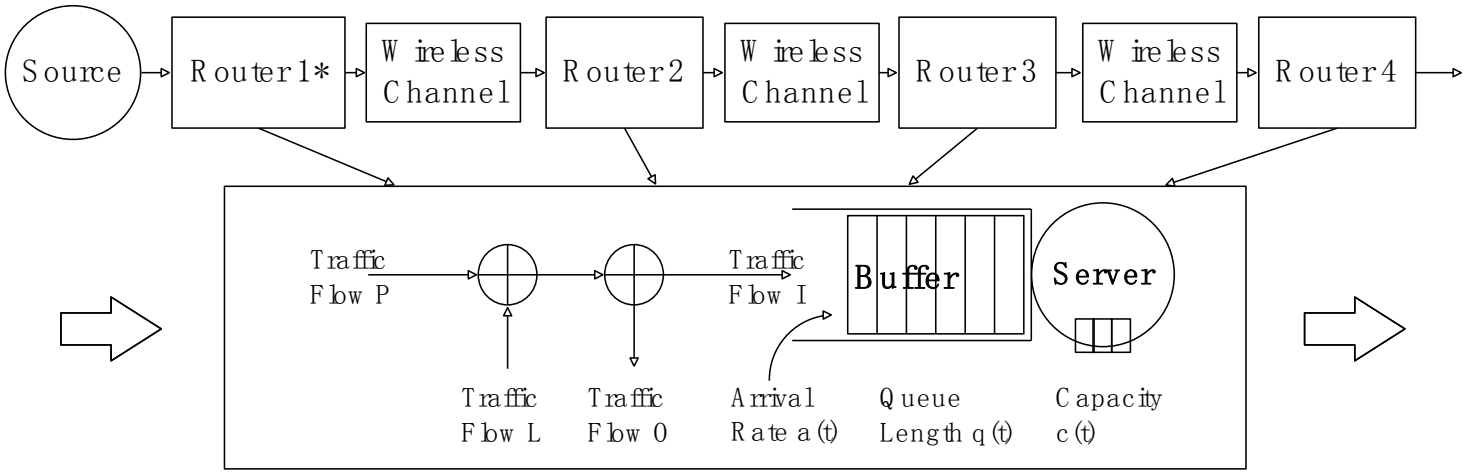
- Continuation of work of [1] which mainly focused on the analysis of end-to-end delay performance
- Packet delay is a connection-level metric of Quality of Service (QoS) and requires the support of cross-layer simulations

[1] Y. Chen, Y. Yang, and I. Darwazeh, "A cross-layer analytical model of end-to-end delay performance for wireless multi-hop environments," in *Proc. IEEE Globecom '10, 2010.*

Contributions

- established realistic cross-layer simulation platform based on the WiMAX PHY layer
- Validated the analytical model in [1]

How to build a Multi-hop Cross-layer Simulations?



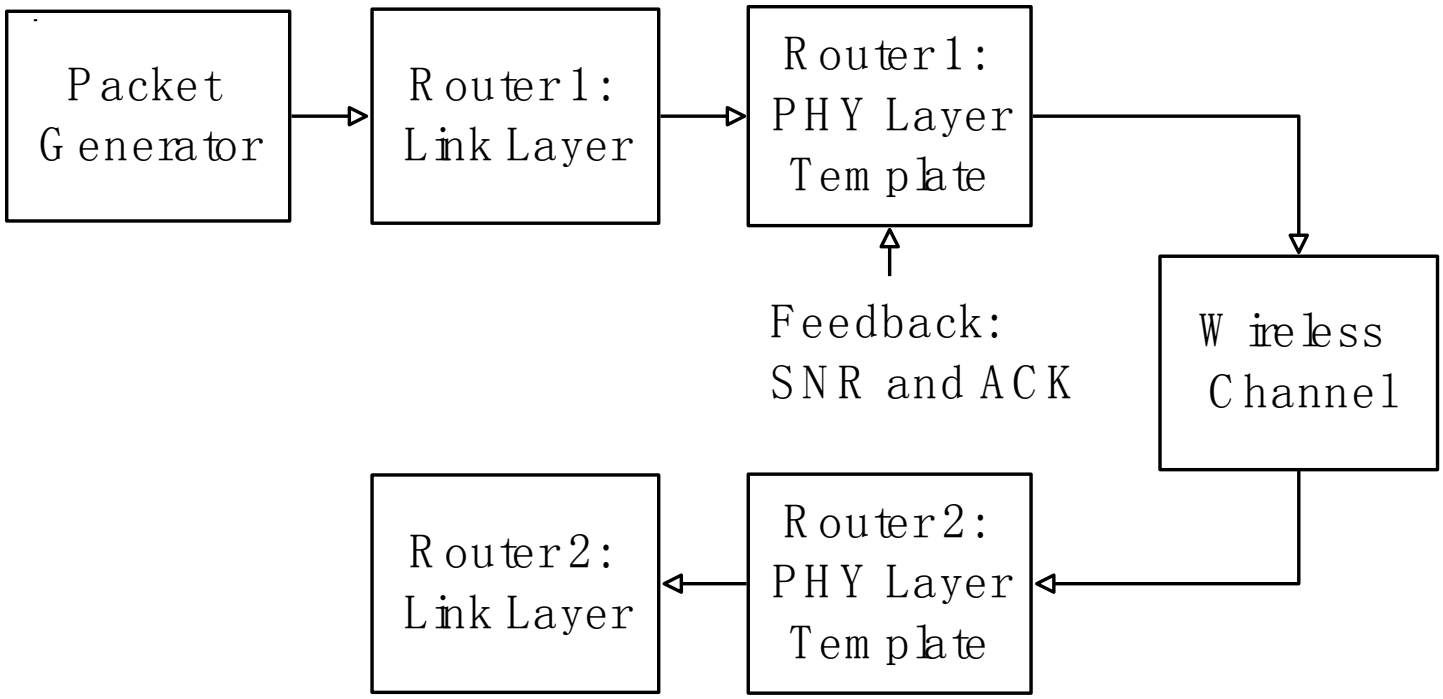
*The input traffic is from Traffic Flow P only

$$p_{in} = \frac{\text{Traffic Flow L}}{\text{Traffic Flow P - Traffic Flow O + Traffic Flow I}}$$

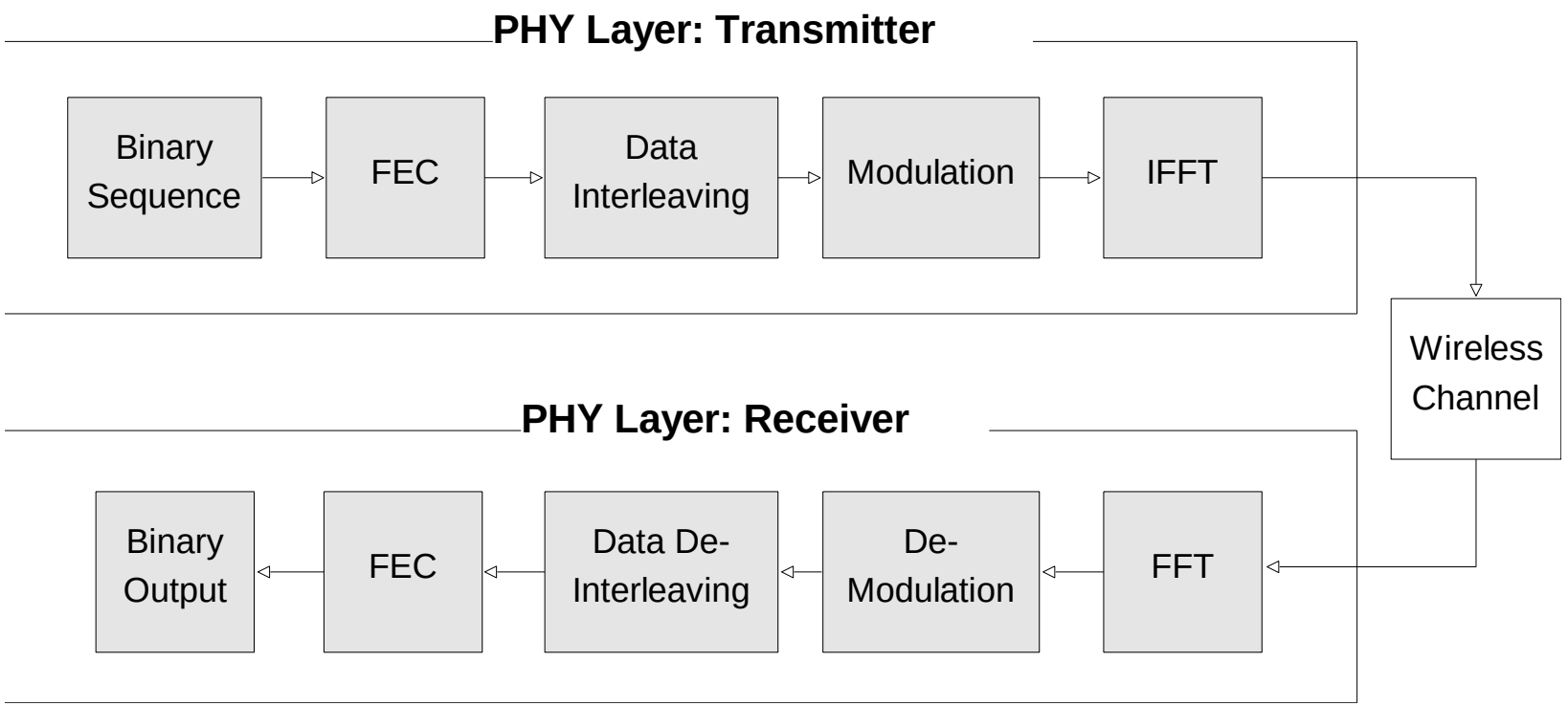
$$p_{out} = \frac{\text{Traffic Flow O}}{\text{Traffic Flow } P}$$

$p_{in} = p_{out}$ (The assumption used in the paper and simulation)

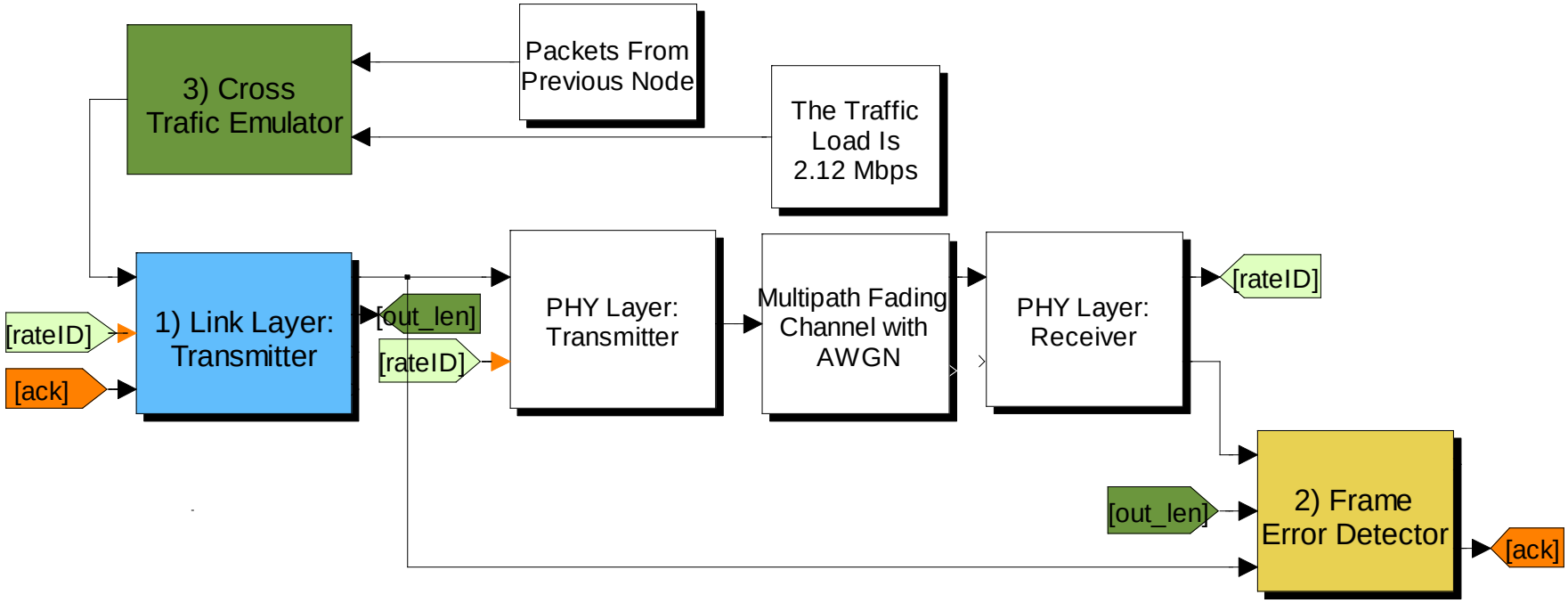
Single-hop Cross-layer Simulation



PHY Layer in Each Pair of Transceiver



Link Layer in Each Pair of Transceiver

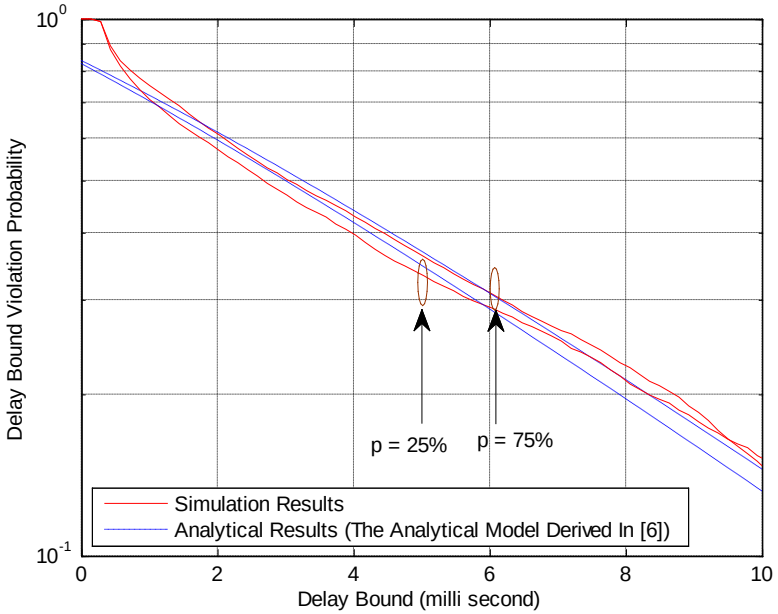


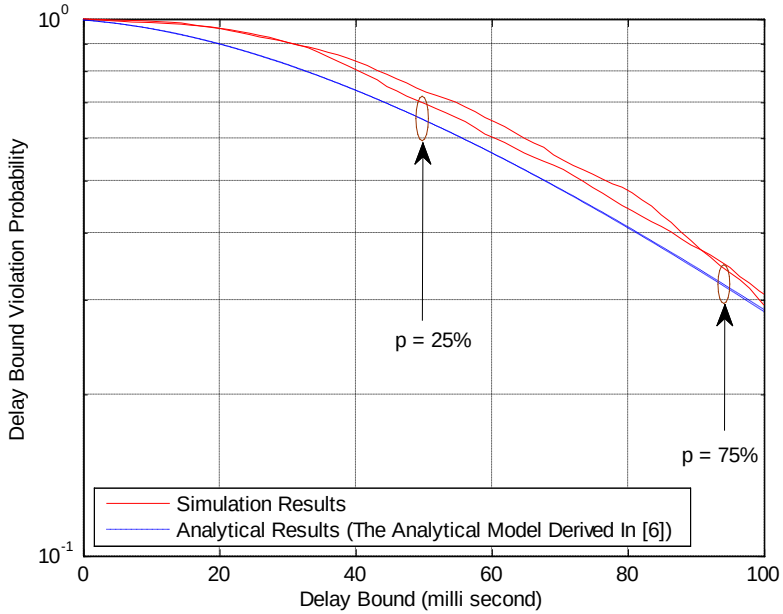
What are the results? -- Simulation Settings

- Simulation parameters

Parameter	*Value*
Channel model	Rician Multi-Path Distribution
Average SNR	15dB
Maximum Doppler rate: fm 30Hz	10Hz
Average traffic load: μ	2.12 and 2.65 Mbps
K-factor: k	3
Traffic correlation index: p	25% and 75%
Delay Vector	[0 0.4 0.9]*1e-3 ms
Gain Vector	[0 -5 -10] dB
Bandwidth: BW	3.5 MHz
OFDM Symbol time: Ts	0.072 ms

Analytical and Simulation Results-1





Analytical and Simulation Results-2

- Average Delay and Jitter Performance

	Delay Mean	***Jitter***
Wireless Situation	μ= 2.12Mbp and p = 0.25	
Simulation/Analytical Results (ms)	4.94 / 4.56	7.80 / 6.35
Wireless Situation	μ= 2.12Mbp and p = 0.75	
Simulation/Analytical Results (ms)	5.27 / 4.82	8.32 / 6.60
Wireless Situation	μ= 2.65Mbps and p = 0.25	
Simulation/Analytical Results (ms)	79.67 / 78.70	88.94 / 85.01
Wireless Situation	μ= 2.65Mbps and p = 0.75	
Simulation/Analytical Results (ms)	80.02 / 79.07	91.01 / 86.00

Conclusion

- It is beneficial to use cross-layer simulations in certain cases
- Analytical model gives a simple way of predicting end-to-end packet delay

The End

- Thanks, any question?