Improving Ad Hoc Routing for Future Wireless Multihop Networks

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Outline

- Motivation
- Ad Hoc Routing
- IEEE 802.11a Coding Schemes
- Link Adaptation
- Prediction Method
- Route Update Mechanisms
- Results & Conclusion

Motivation

- **Long term goal**: Ad Hoc network integration within the fixed infrastructure
- Increasing the quality of the provided service
- Ad hoc networks suffer the most form route breakages and reestablishments
  - Loosing packets, increasing the delay
- That's one of the major problems for TCP

→ Our goal: Increasing the route continuity and avoiding route breakages

Ad Hoc Routing

- Ad Hoc Routing
  - Proactive, Reactive, or Hybrid
- When a built route breaks:
  - Most approaches only react in a proper manner when the link is already broken.
  - Leads to high number of lost packets as well as increased route rediscovery and packet delay
- Solution: Link prediction enables route rearrangements / update
  - ERRA, Early Route Rearrangement
  - ERU, Early Route Update
  - ....

IEEE 802.11a 5GHz

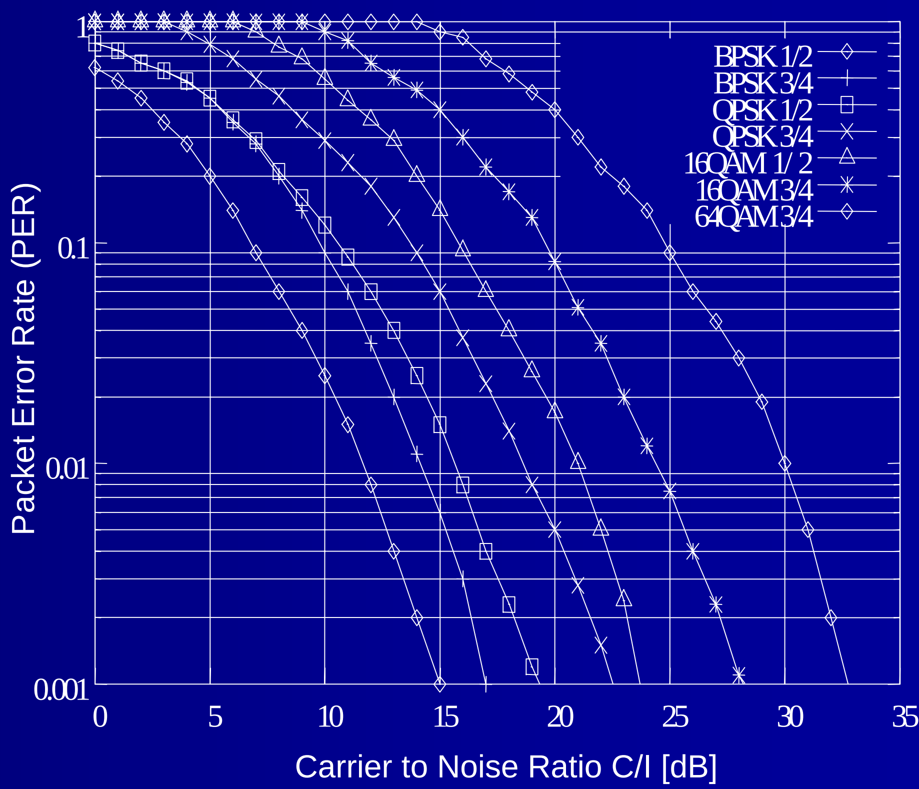
- IEEE 802.11a has up to Eight Different Transmission Modes

Data rate (Mbps)	Modulation	Coding rate (R)	Data Bits per Symbol
6*	BPSK	1/2	24
9	BPSK	3/4	36
12*	QPSK	1/2	48
18	QPSK	3/4	72
24*	16-QAM	1/2	96
36	16-QAM	3/4	144
48	64-QAM	2/3	192
54	64-QAM	3/4	216

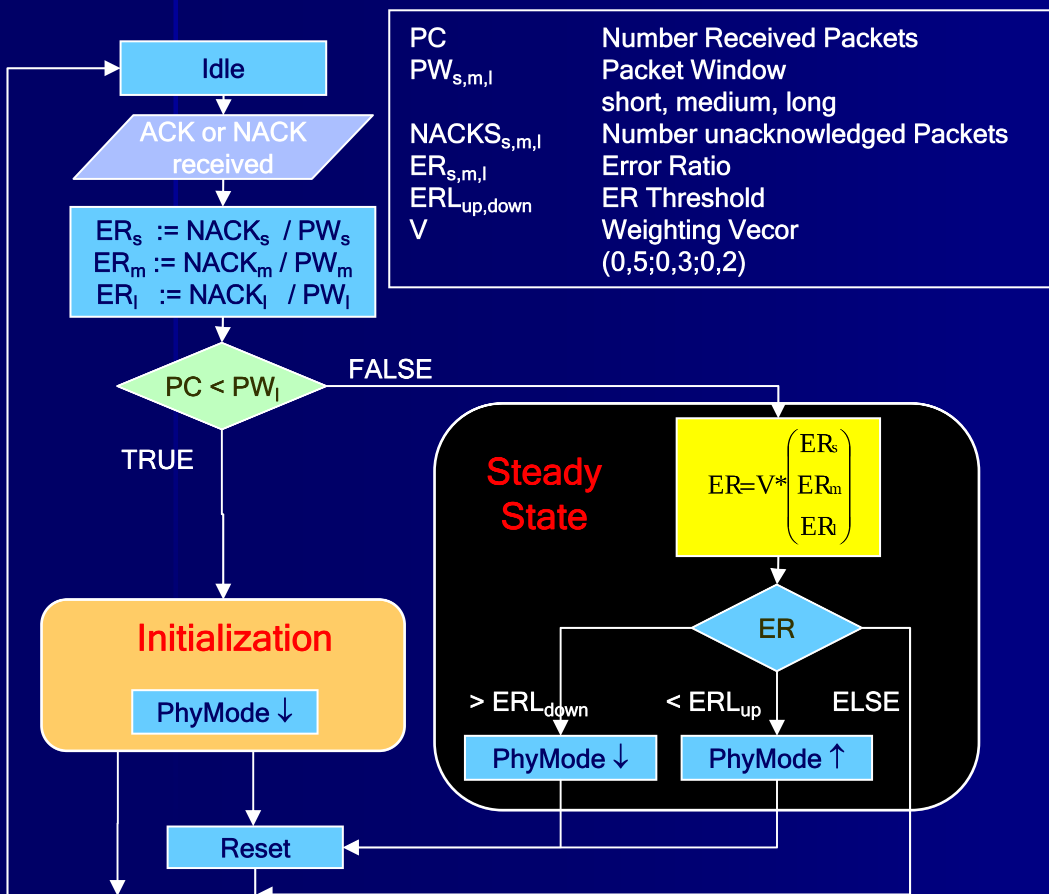
* Support is mandatory

IEEE 802.11 5GHz Channel

- Packet Error Rate (PER) versus C/I (Carrier to Interference Ratio)
  - Higher PhyModes are capable to deliver higher data rates.
  - Nevertheless, they also need a remarkable higher C/I.
  - Lower Modes are more stable and can be used under difficult conditions.



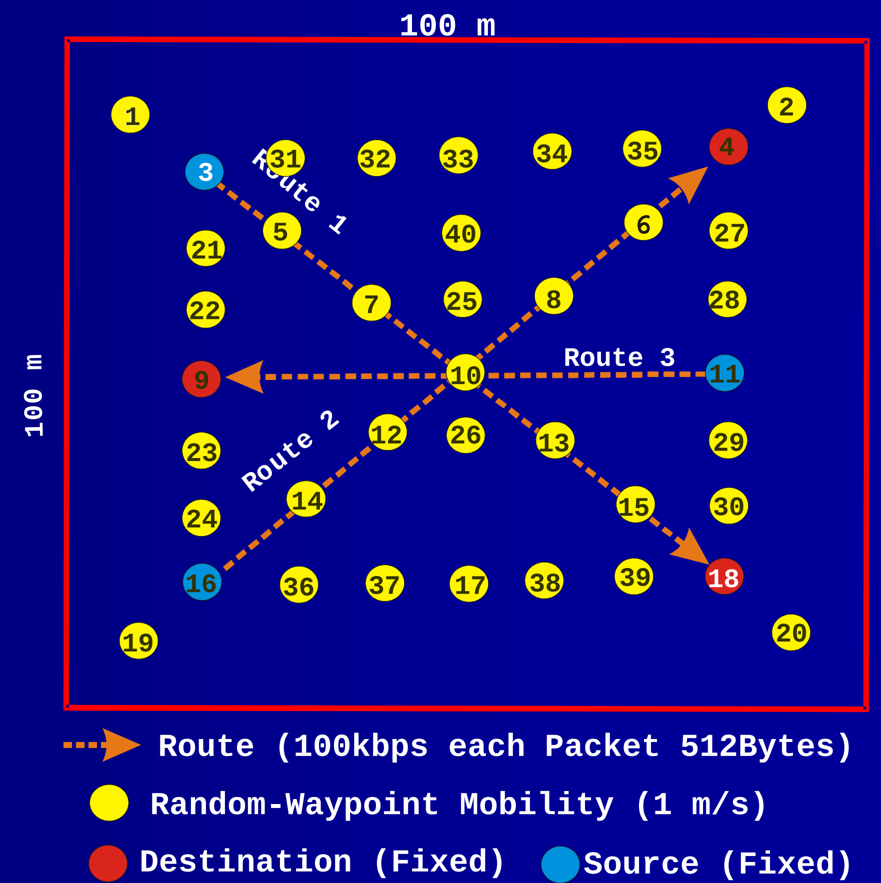
Link Adaptation
Extended Auto Rate Fallback (ARF)



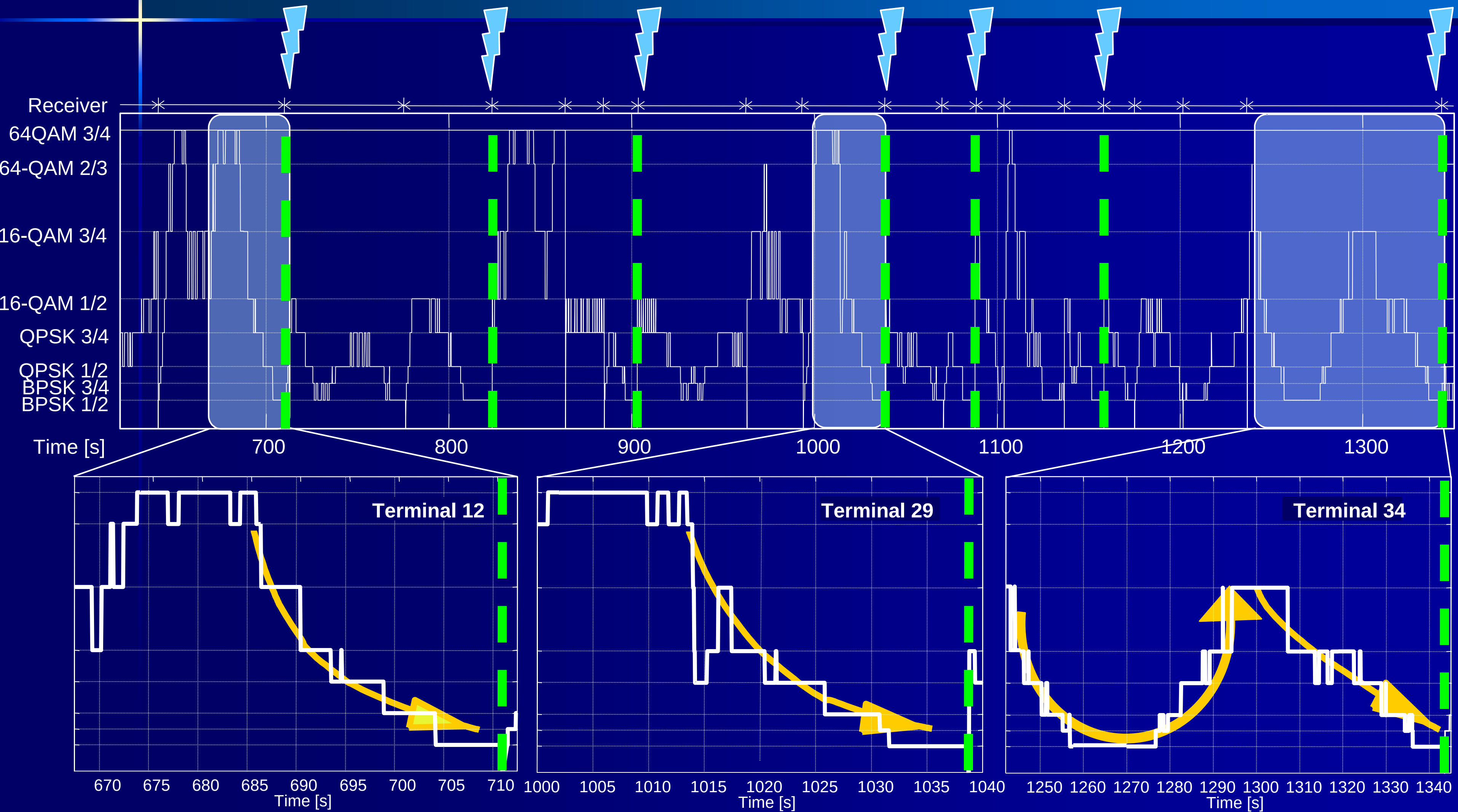
- Controlling uses the packet error rate
- Short and long term reaction are realized via different packet buffers
- Bidirected link adaptation, adapting outgoing connection and monitoring incoming connections
- Timer mechanisms to prevent stale information

Scenario

- Square: 100x100m
- 40 Nodes
- 3 Routes with 100 kbps
- Gamma: 2,5
- Broadcast PhyMode: 16 QAM ½
- CBR traffic

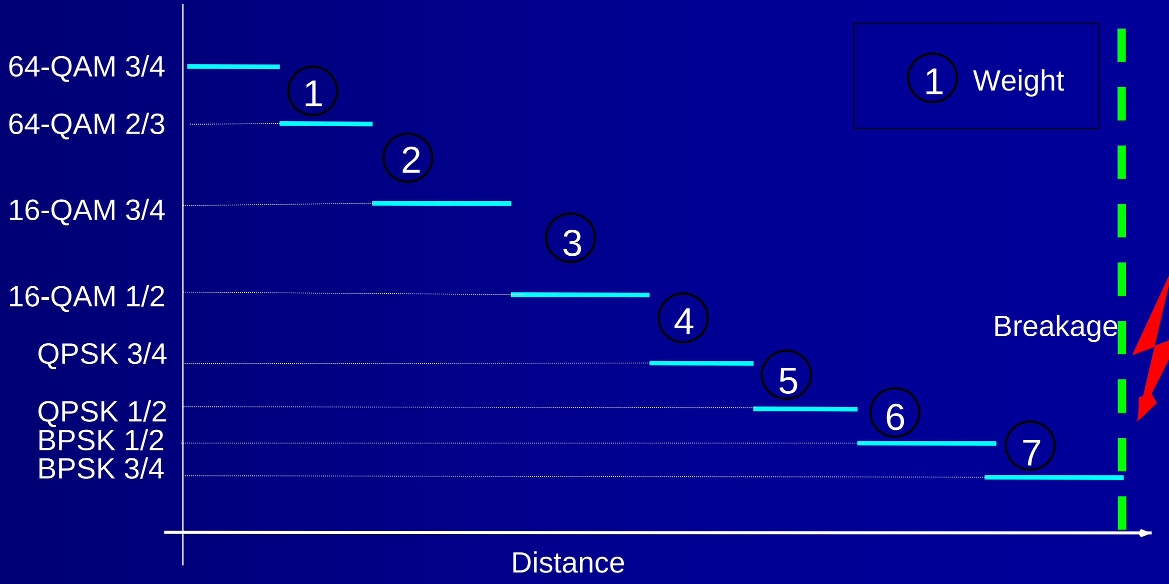


Channel Monitoring

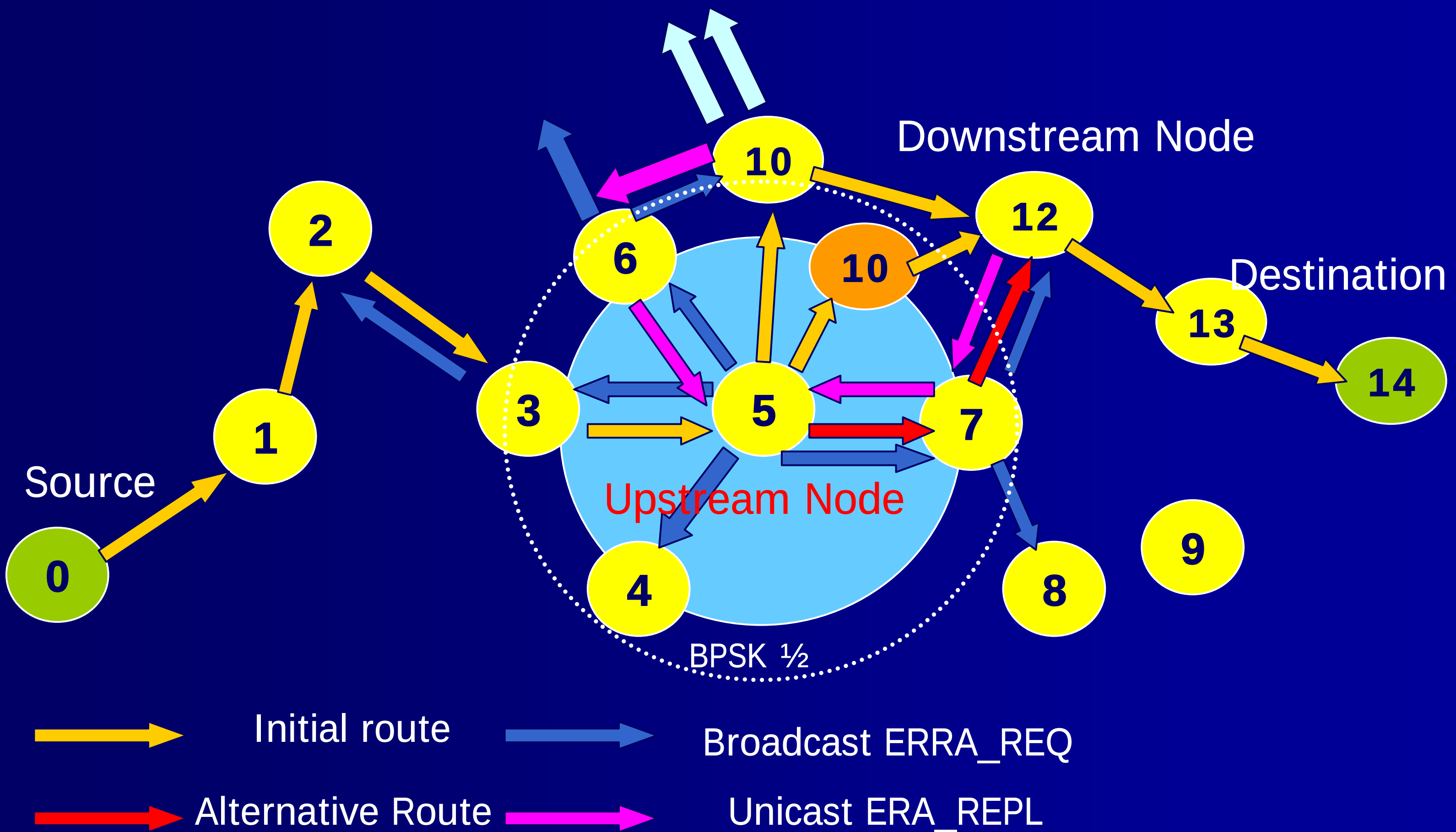


Weighting the LA Switches

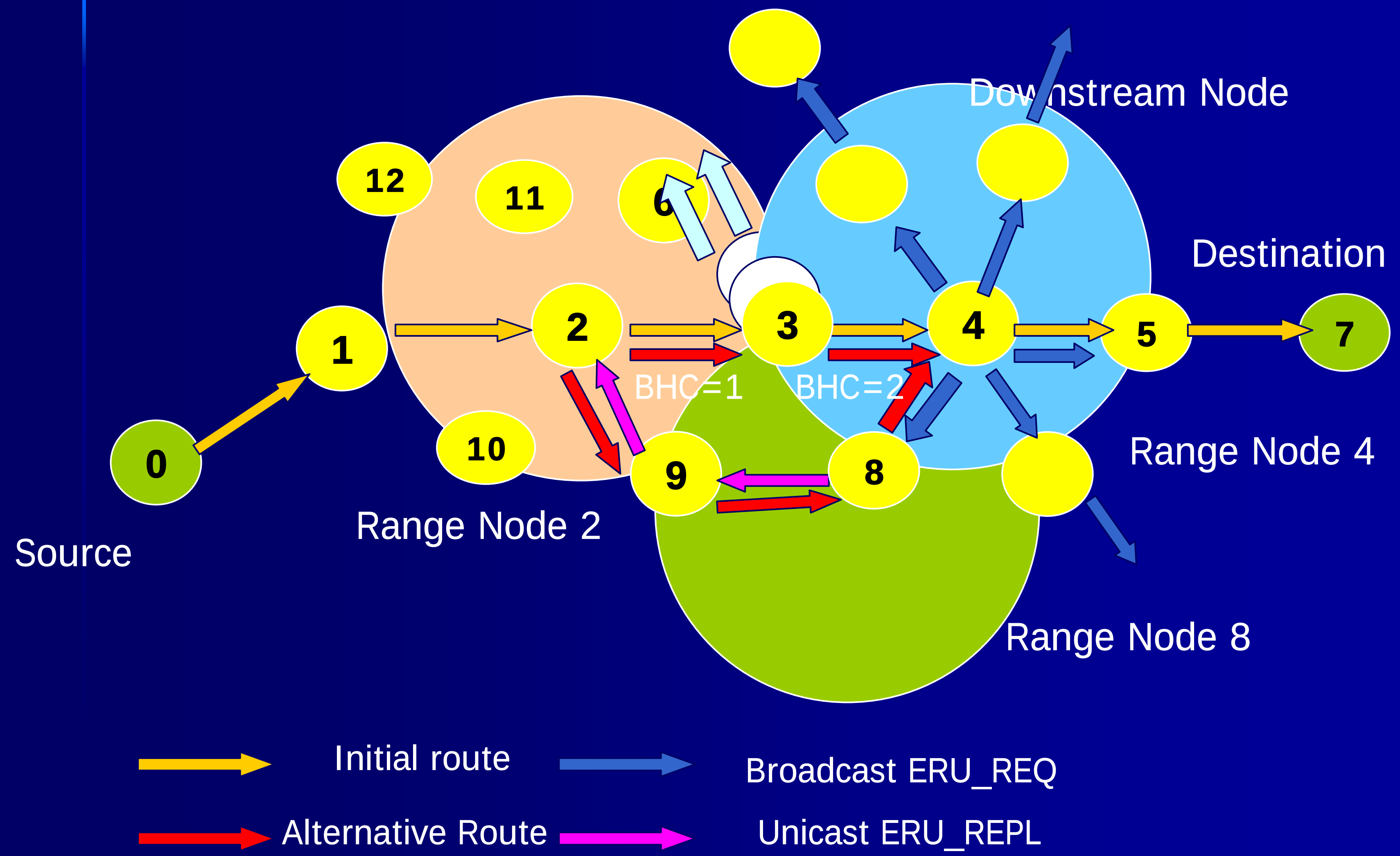
- Each step is weighted
  - Declining order
  - Higher weights are more important regarding a possible breakage
- We sum-up all switching steps within a certain time period



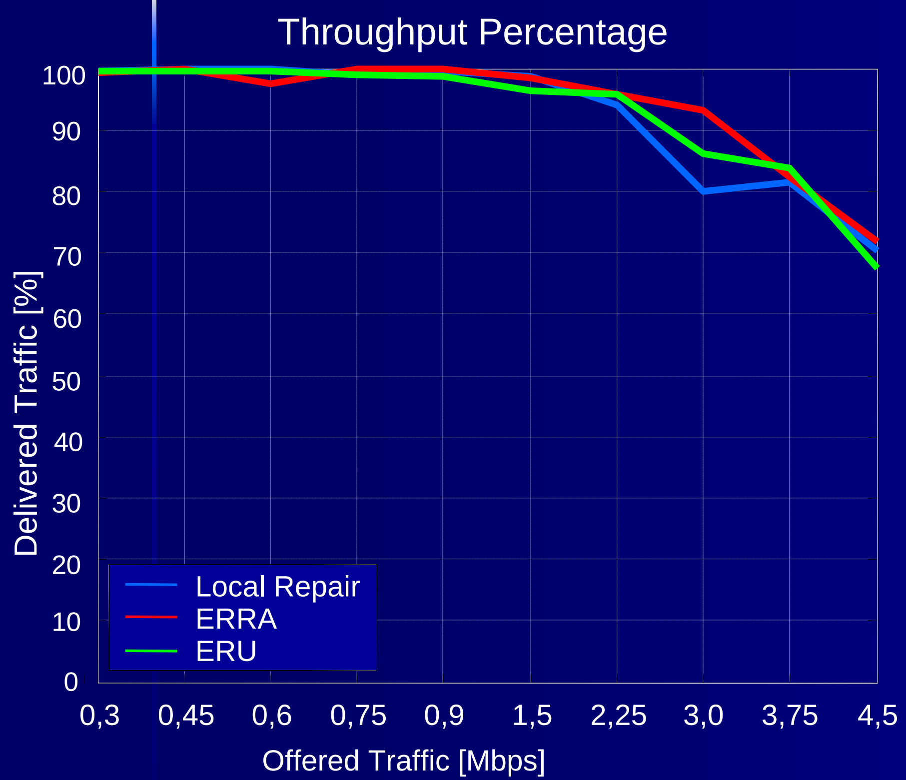
Early Route ReArrangement (ERRA)

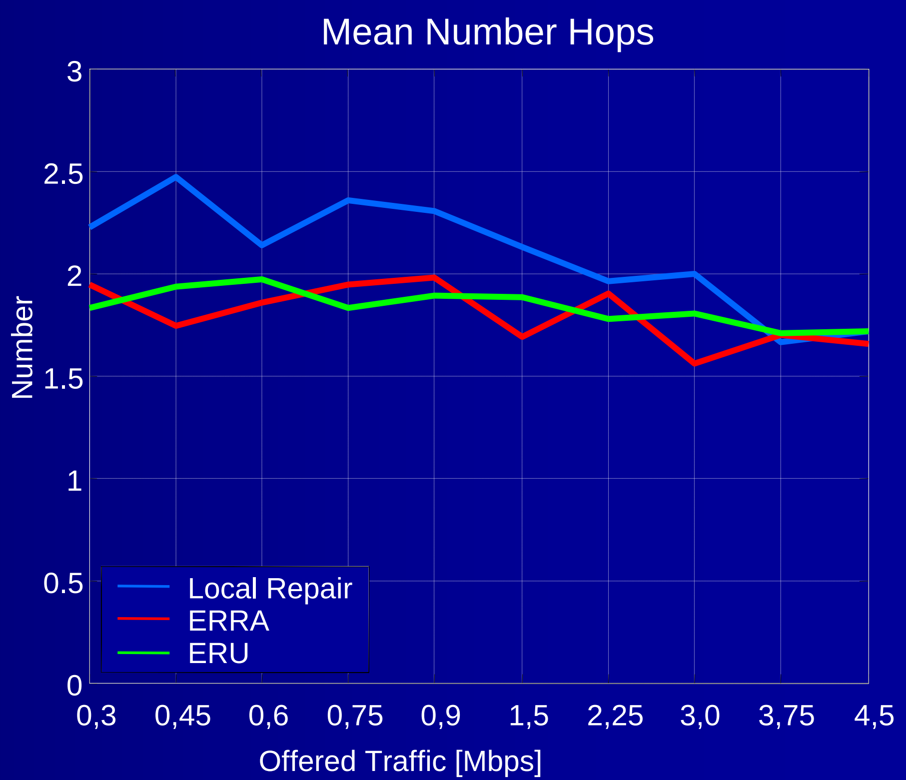


Early Route Update (ERU)



ERRA / ERU - Results

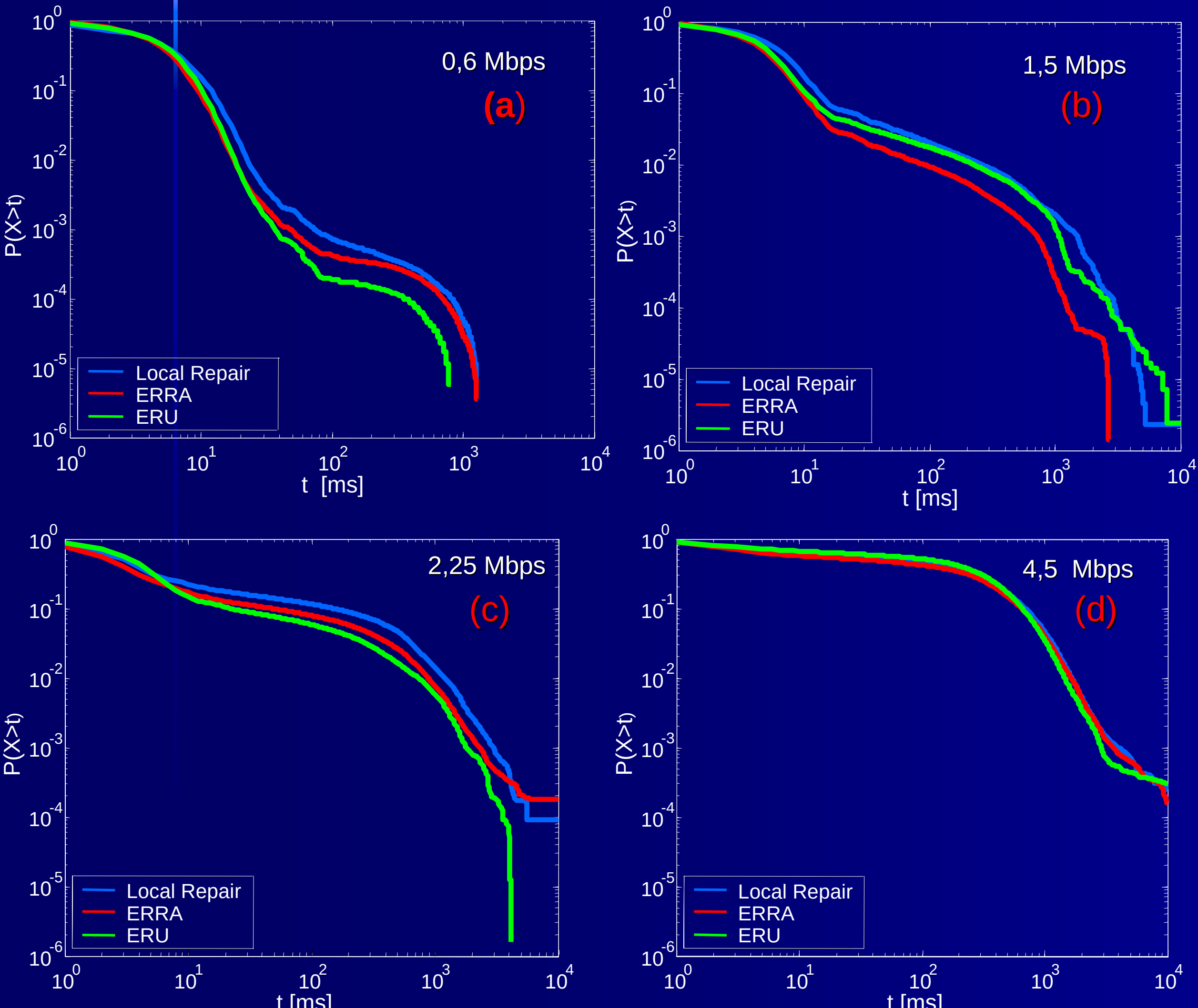




- ERRA/ERU does not influence the throughput
- ERRA/ERU can not overcome the system limits

- ERRA/ERU creates slightly shorter routes

ERRA / ERU Transmission Delay



- Fig. (a): typical AODV Delay Results
- Fig. (b), (c): ERRA and ERU are still better
- No Performance enhancement in overload situation

- Concluding
- the Delay is minimised, and outperforms Local Repair
- Fig (d): Even in overload ERRA/ERU doesn‘t worsen the situation

Conclusions and Outlook

- Derived form the LA behavior it is shown, that predicting the future connectivity has been proven, in our opinion.
- We presented two prediction approaches for different link conditions
- We presented the first promising results enhancing Ad Hoc Routing by cross-layer techniques

- Next Steps:
  - Investigating ERRA/ERU with more realistic traffic (TCP)
  - Increasing the prediction basis
  - Behavior in urban environments
  - Using the prediction also for triggering the Handover decision

Thank you for your attention!

- Further Questions?

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