Adaptive Medium Access Control in Wireless Networks

Research *Works in Progress Session*

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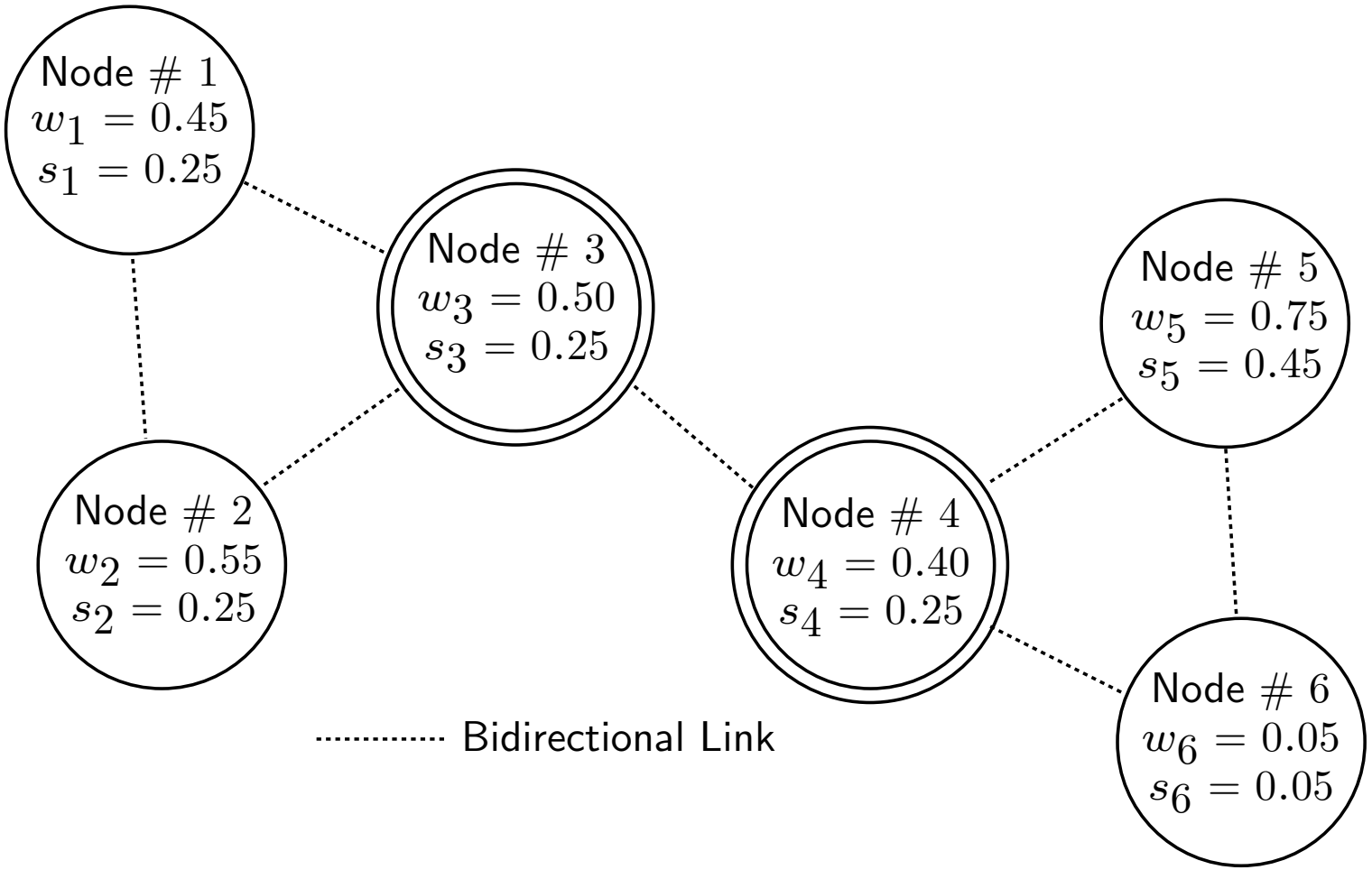
Overview

- **Medium access control in wireless networks**
  - ⇨ Idea that a node's persistence should depend both on topology and load
  - ⇨ Computed by REACT distributed auction
  - ⇨ Integrate into IEEE 802.11 protocol
  - ⇨ Testbed implementation and experimentation

Topology- and Load-Aware Persistence

- **Desirable properties:**
  - ⇨No receiver is overrun
  - ⇨No transmitter gets a persistence greater than it can use
  - ⇨No transmitter is permitted to monopolize the channel
  - ⇨Persistences are maximized subject to the constraints of the first three properties
- **Computed by REACT, a distributed auction**

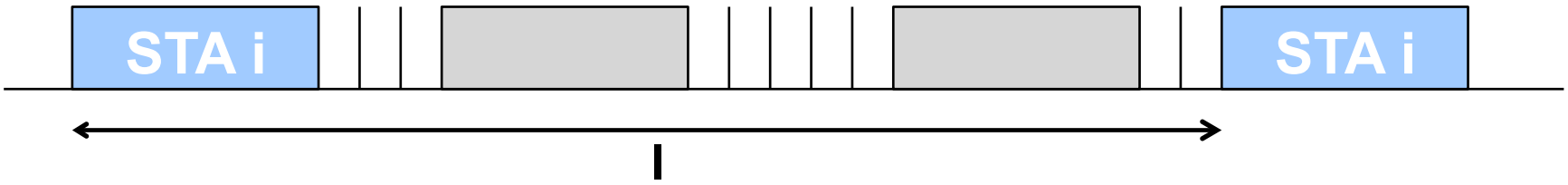
Example of REACT



IEEE 802.11 with REACT

➔How to move from a persistence to a contention window?

- ⇨Let I be the time interval between consecutive channel accesses in slots
- ⇨Let T be the DATA-ACK duration in slots

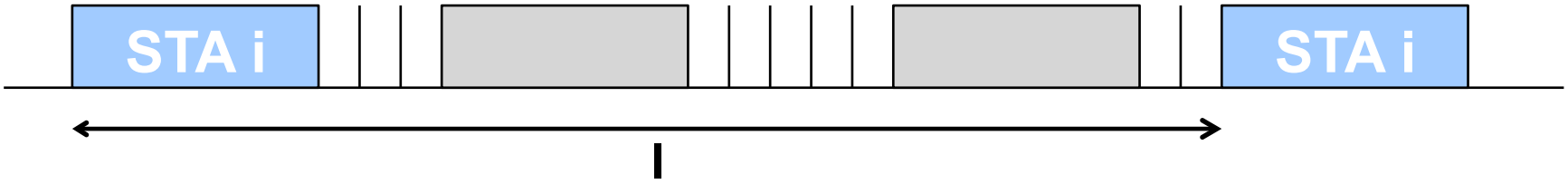


- ⇨Then the allocated rate for node i is: $s_i = T/E(I)$

IEEE 802.11 with REACT (cont'd)

➔**The expected duration of the idle time is therefore:**

$$E[idle] = E[I] - E[busy] - T$$



⇨E[idle] must equal the expected time backing off,

$W/2\sigma$,

where σ is the slot width

⇨Solve for W!

How to Experiment with a New MAC?

➔**Find a 'programmable' hardware platform**

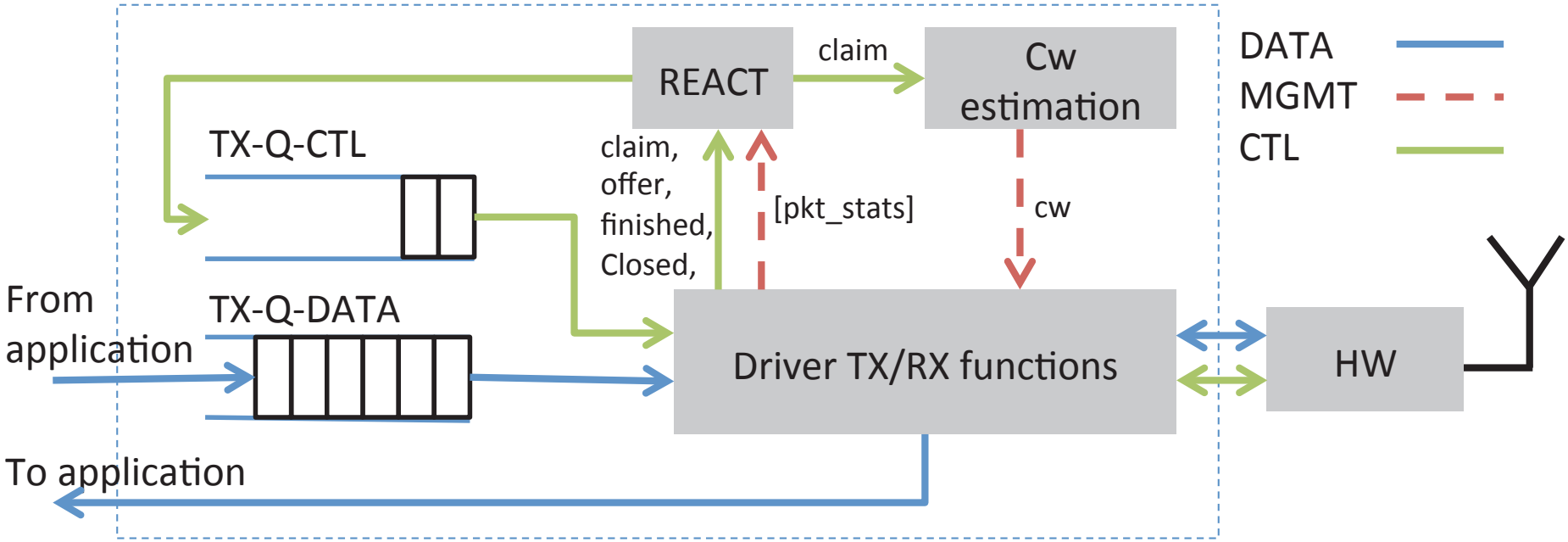
- ⇨SDR platforms have performance limits
- ⇨FPGA platforms can be too complex
- ⇨*Commercial WiFi cards with open-source driver/firmware (Atheros/Broadcom)*

How to Experiment with a New MAC?

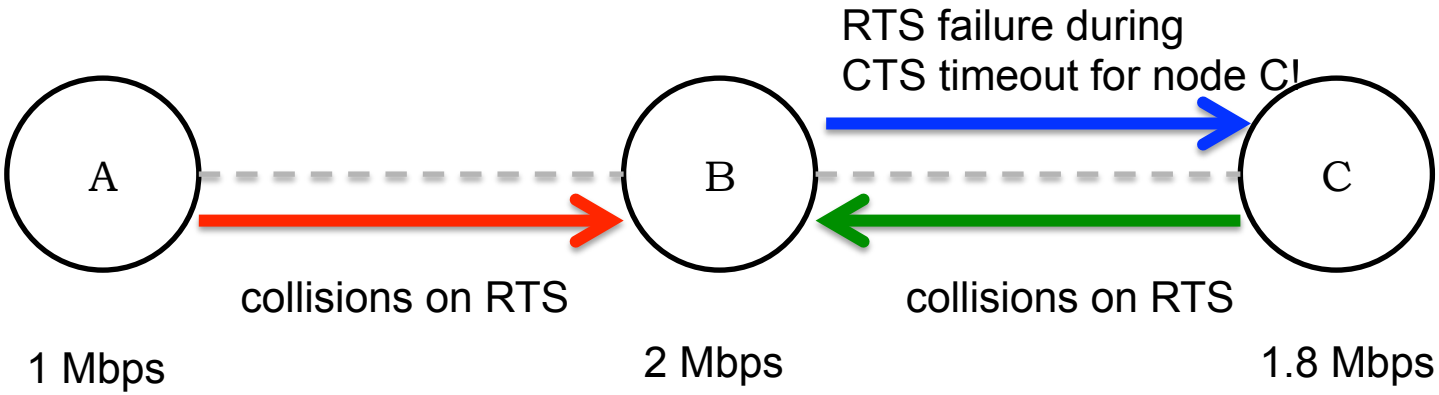
➔Build your own testbed or use a remote available testbed

- ⇨*CREW federated testbed!*
- ⇨Not only wireless platforms, but also advanced programming interfaces
- ⇨Availability of control tools for experiment set-up and monitoring
- ⇨Large-scale node deployment (about 200 nodes available!)

Architecture



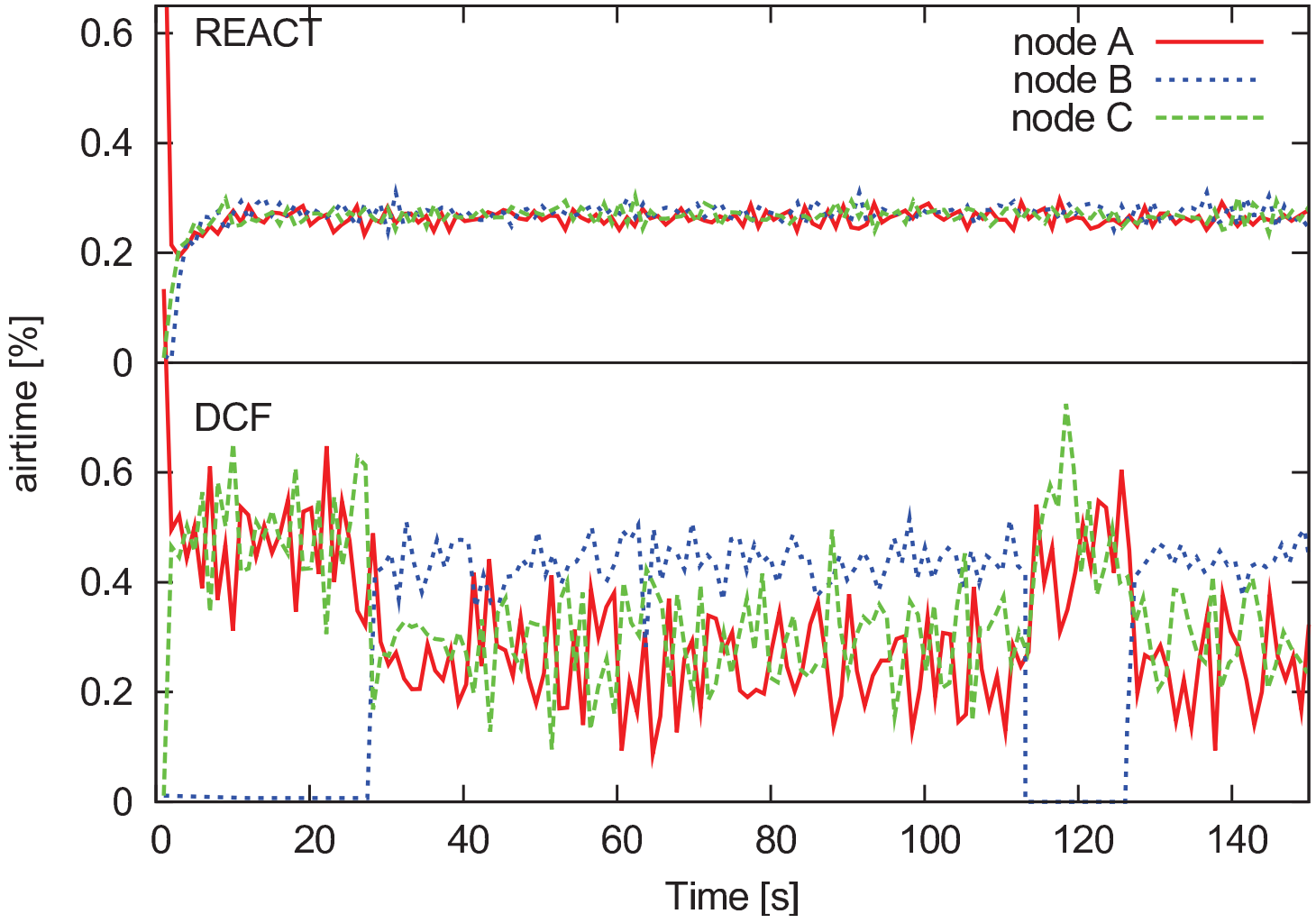
Simple Chain Topology



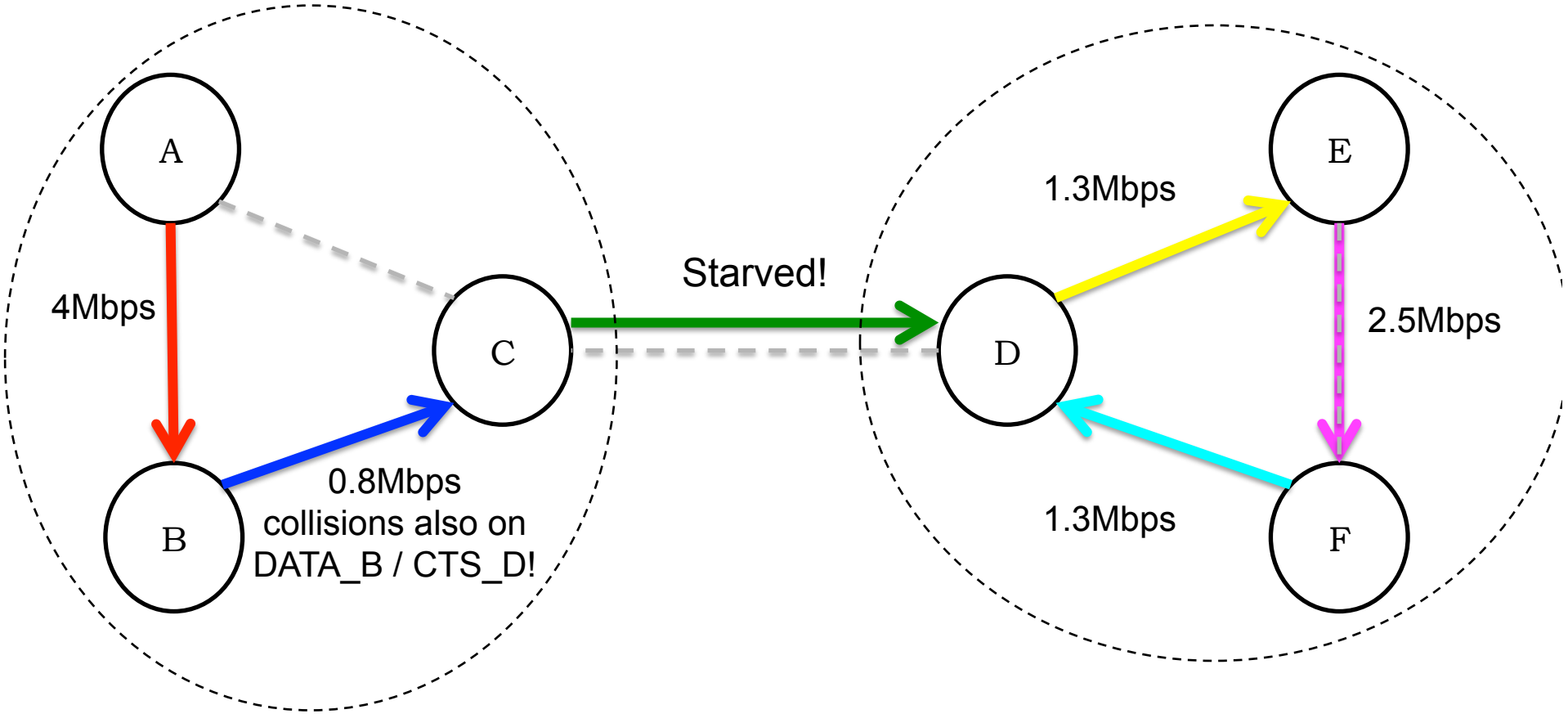
Under standard DCF:

- When RTS frames sent by node B fail (because node C was waiting its CTS), only **node A considers the channel busy** for the whole NAV
- **Asymmetries** on channel busy time imply heterogeneous channel allocations and throughput

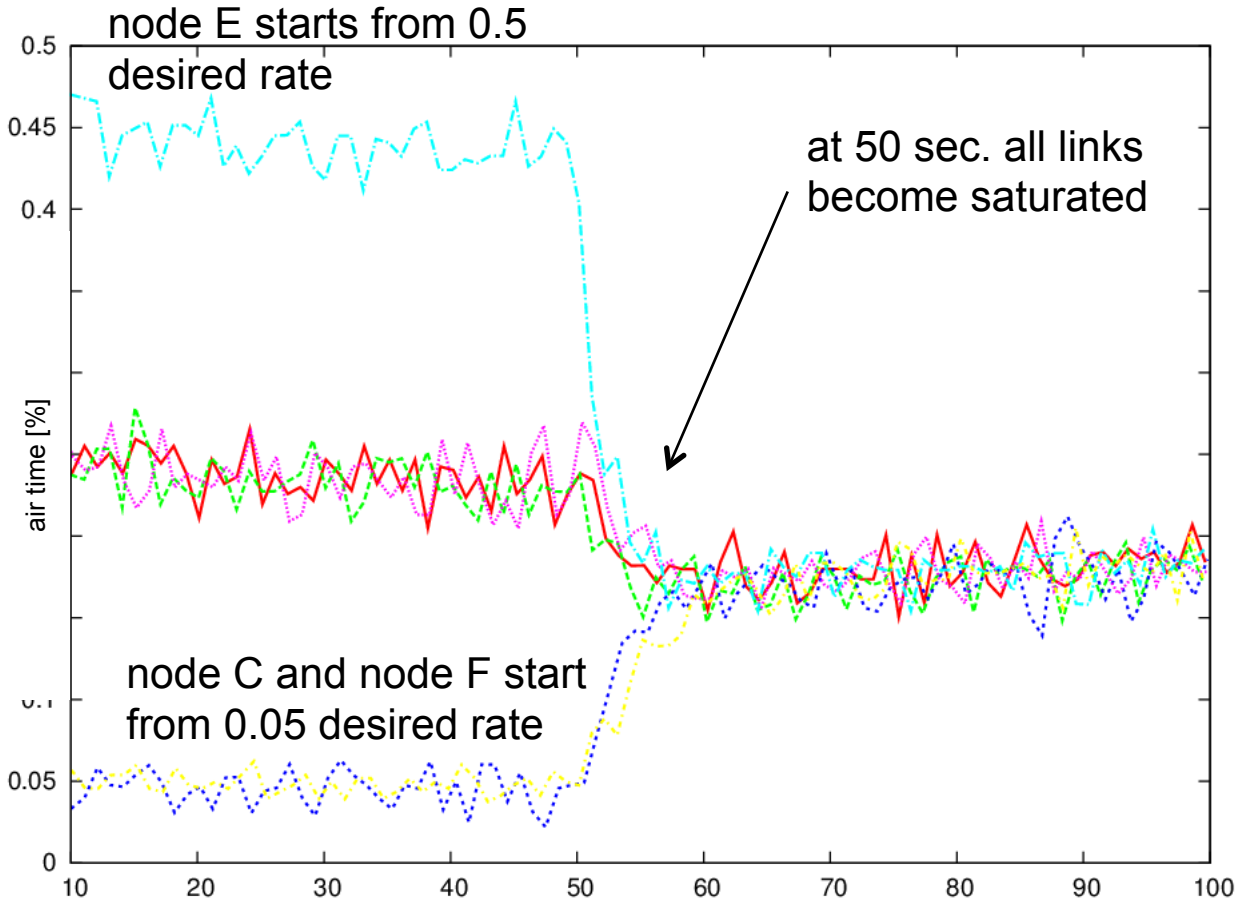
Normalized Airtime as a function of Time



Generalization



REACT under Dynamic Traffic



REACT Benefits in Multi-hop Contention-based Networks

- **➔Avoid flow starvation**
- **➔Mitigate collision rates**
  - ⇨RTS/CTS alone have limited effectiveness
  - ⇨Collisions may also occur on DATA frames with severe resource consumption
- **➔Provision temporal fairness**
- **➔Short-term access fairness (reduced delay jitter)**

Future Plans

- **Improve and extend the MAC programming interface**
- **From context-specific optimized MAC to auto-programmable MAC!**
  - ⇨Implementation of machine-learning mechanisms based on meta-MAC
- **Identify most relevant factors affecting experimental results**
  - ⇨Novel solutions for reducing the design space

Our thanks!

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