A Demonstration of a Relaying Selection Scheme for Maximizing a Diamond Network's Throughput

INTRODUCTION

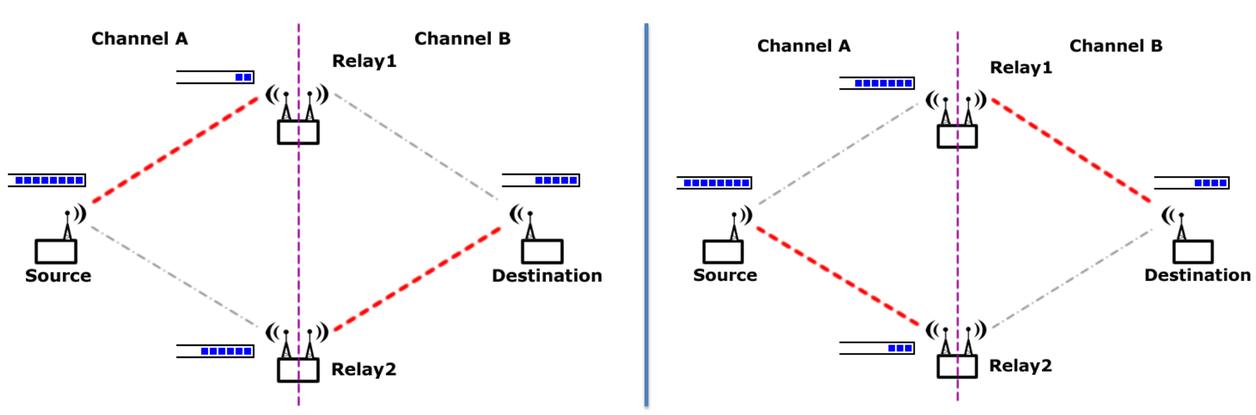
Aim: Maximize throughput while achieving network stability.

Goal: Select schedules in the Diamond Relay Network, towards maximizing the total network's throughput.

Method: Rely on optimization theory tools and Lyapunov drift to obtain optimal schedules. A network controller a(t), chooses the optimal between two feasible scheduling activation sets.

Implementation: Per packet-level configuration using Click Modular Router and Ath9k driver.

Access Method: A TDMA framing over WiFi .



a(t)=1 a(t)=0

Red lines denote the activation of two feasible scheduling sets by controller a(t).

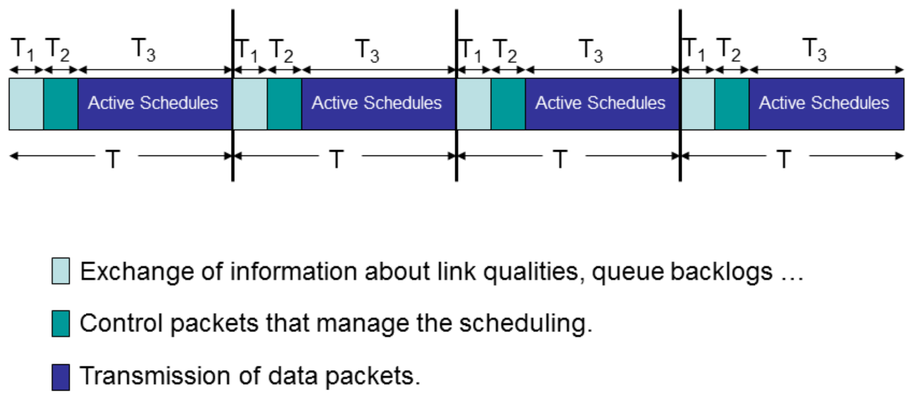
SYSTEM SETUP

- ✓ **1** Source, **2** Relays, **1** Destination.
- ✓ Each node maintains a backlog data queue **Q(t)**.
- ✓ Channel States: **S(t),** Service Rates**: μ(t)**.
- ✓ Lyapunov function**:** $L(Q(t)) = \sum_i Q_i(t)^2$
- ✓ Drift Expression: $\Delta(t) = \mathrm{E}[L(Q(t+1)) - L(Q(t)) \mid Q(t)]$
- ✓ Slotted time, TDMA frame structure.
- ✓ T1 intervals for gathering Network State Information, T2 for reporting schedules and T3 for actual transmission .

SOLUTION APPROACH

- ✓ Minimize a bound on the drift expression with respect to **a(t)**

$$\min_{\mathrm{a}(t)} \Delta(\mathrm{a}(t), t)$$



TDMA frame structure.

IMPLEMENTATION ISSUES

- ✓ Operating in a single frequency with CSMA prevents us from enabling parallel transmissions i.e. S→R1 and R2→D without collisions.
- ✓ *Solution:* Use of two different channels operating in each hop, in order to enable independent schedules.
- ✓ Scheduling decisions are taken in the IP layer rather than the MAC layer, since gathering and handling control data is more flexible with Click Modular Router.

MAX WEIGHT RULE AlGORITHM

- ✓ <u>T1 interval:</u> Source Node gathers Network State Information from its neighbors.
- ✓ <u>T2 interval:</u> Source takes a scheduling decision.
  - If $\Delta Q_{SR_1}(t)\mu_{SR_1}(t) + Q_{R_2}(t)\mu_{R_2D}(t) < \Delta Q_{SR_2}(t)\mu_{SR_2}(t) + Q_{R_1}(t)\mu_{R_1D}(t)$
  - Set **a(t)=1,** and transmit over the first feasible set.
  - Otherwise, set **a(t)=0,** and transmit over the second feasible set.
- ✓ <u>T3 interval:</u> Transmit over the selected schedule set with rate **μ(t)**.

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