Channelization in Multi-Hop Wireless Networks

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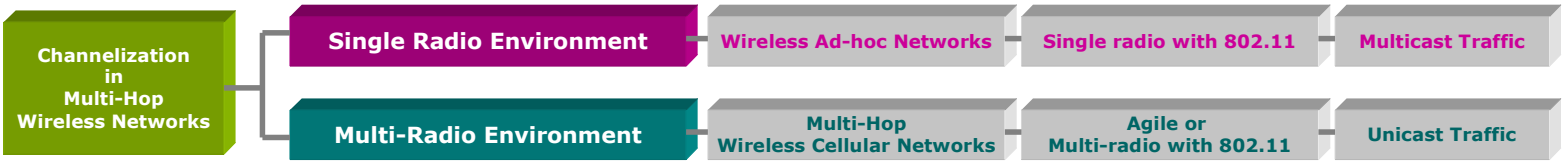
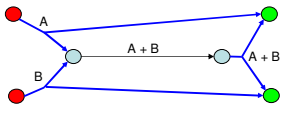
Categorization



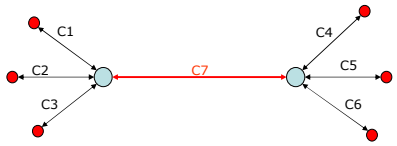
Channelization - Single Radio

- Environment – Single Radio with 802.11 Phy
  - Channels – TDMA slots
- Emphasis on multicast traffic in MANETs
  - Hyperarcs



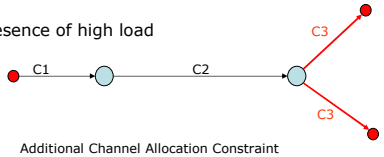
Canonical Network Coding Example with Hyperarcs

- Network Coding
  - Network Capacity
- Channel Access for Network Coding
  - Contention Based – 802.11
  - Scheduling Based
    - Centralized - TDMA
    - Distributed – NAMA, LAMA, PAMA, HAMA,



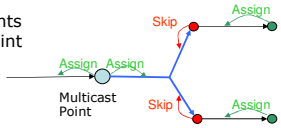
Channel Allocation Constraint

- Contention Based Channel Access
  - Low network throughput in the presence of high load
  - High control overhead



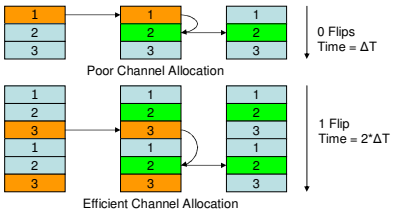
Additional Channel Allocation Constraint For Multicast Flows

- Drawbacks of channelization
  - Two Hop Information Required
- Channel Allocation Scheme
  - Forward propagation of used channel information
  - Reverse propagation of used channel information with Channel Allocation
- Channel Allocation Conflict at multicast points
  - Nodes downstream from a multicast point allow it to allocate channel



Skipping Channel Allocation to avoid conflict at multicast points

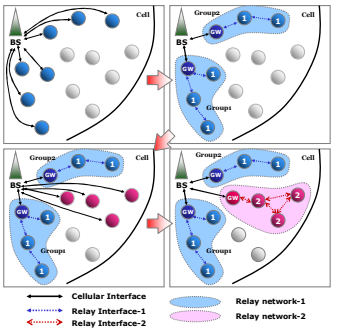
- Channelization constraints specify possible channels to allocate
  - Different ways to select channel



- Extent of channelization
  - Network load
  - Number of available channels
- Possible channel access schemes
  - Pure contention
  - Pure channelization
  - Contention and channelization
- Network Coding Performance factors
  - Richness of communication graphs
  - Increasing Channelization
    - Low Delivery Delay, Low Richness
  - Tradeoff – Increasing Channelization vs. Increasing Richness

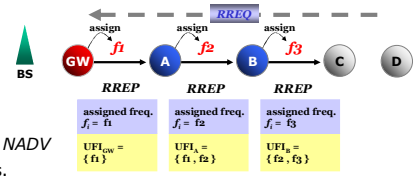
Channelization – Multi-Radio

- **Environment** – Multi-radio, Multi-hop Wireless Cellular Network
  - Relay networks are dynamically formed.
  - Each relay network can be operating in different frequency.
  - Relay network formation algorithm provides a simple and distributed frequency assignment scheme.
  - It also provide an enhancement to improve network throughput of resulting relay networks.



- **Frequency/Channel Assignment Scheme**
  - While returning the RREP, the GW and intermediate nodes on the reverse path are responsible for assigning a non-interfering frequency to links on the path.
  - ***UFI$_i$*** (Used Frequency Information) : The set of frequencies used on its all incident links of node *i*
  - ***AF$_i$*** (Available Frequency) : The set of available frequencies of node *i*
  - When node *i* receives *UFI$_j$* from the *NADV* generated by node *j*, it recalculates.

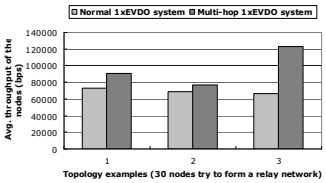
$$Af_i = Af_i \cap \overline{UFI_j}$$



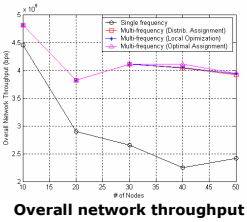
  - When node *i* receives a *RREP* from node *i-1*, it further recalculates.

$$Af_i = Af_i \cap \overline{UFI_{(i-1)}}$$

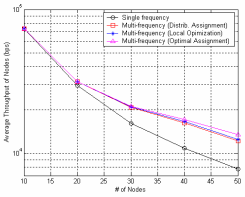
  - It then assigns a frequency to its next-hop-link by choosing from the resultant Af_i .
- **Local Optimization Scheme**
  - Interference from remote nodes causes a drop in received SNIR at the interfered node so that it experiences a higher bit error rate.
  - 2-phase algorithm
    - Each node measures received SNIR of all its incident links periodically
    - It reassigns a new frequency to the interfered link if SNIR of the link has fallen off markedly.
- **Performance Evaluation**
  - Simulation using OPNET v.11.5



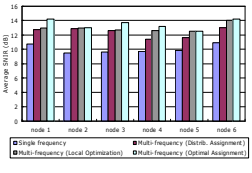
Throughput gain of multi-hop cellular network



Overall network throughput



Average throughput of the nodes



Improvement of node's SNIR

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