Interference-Aware Channel Assignment in Multi-Radio Wireless Networks

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Motivation

- If the capacity problem is the major concern,
  - Why not considering multiple radios for mesh-net backbone routers?
- Multiple radios is expensive than single radio
  - Still worth looking into for future
- With multiple radios,
  - Static vs dynamic channel allocations
  - If dynamic,
    - Local or global?

Constraints

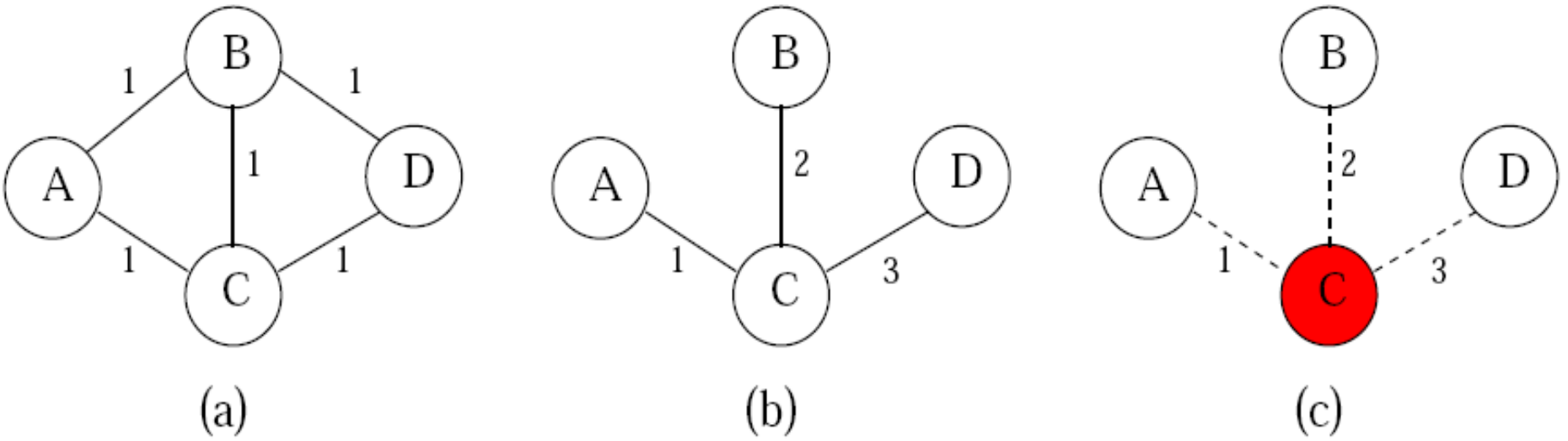

Fig. 1. Network topology with varying channel assignments.

Constraints

- Subsequent node failures --> network partitions
- Topology alterations can result in sub-optimal routes wrt some metrics
- Altering network topology affects existing flows
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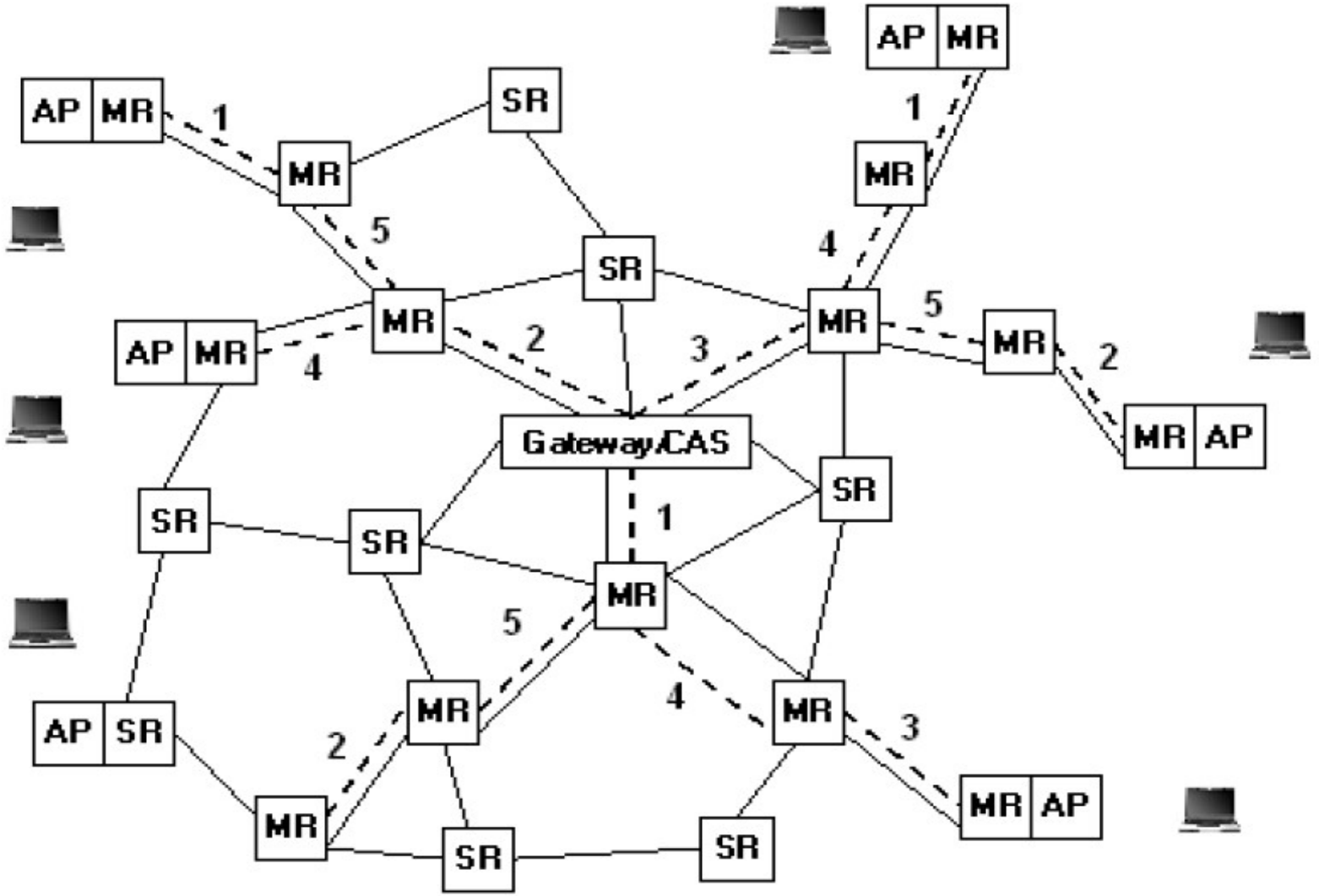
- Suggestion: default radio interface for both control an data!
  - Flow redirection

Centralized Approach

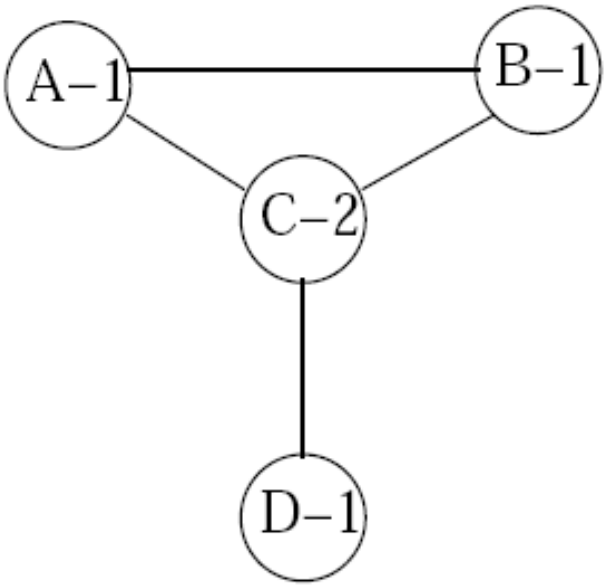


Centralized Approach

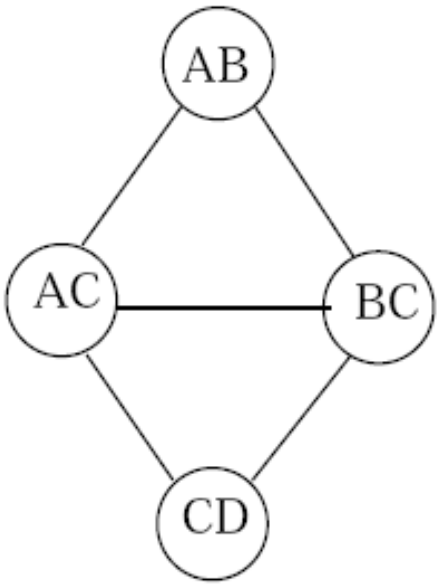
- Minimize interference between routers in the mesh
- Minimize interference between the mesh network and wireless networks co-located with the mesh!- huh?

Interference Modeling

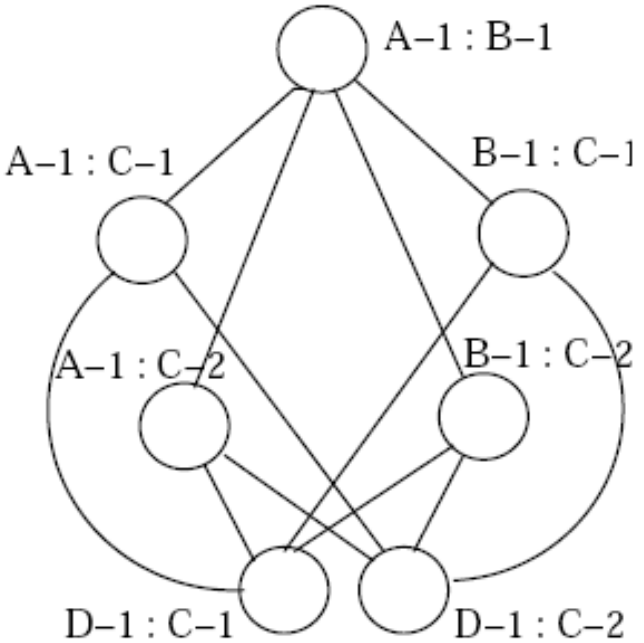
- Multi-radio Conflict Graph (MCG)



(a)



(b)



(c)

Dynamic Channel Assignment

- Default channel selection
  - The least interfered channel
  - $$R_c = \frac{\sum_{i=1}^{n} Rank_c^i}{n}$$
- Non-default channel selection:
  - Create MCG
  - breadth first search (BFS)
- Channel re-assign strategy:
  - Interference estimation, how frequently? 100ms?
  - How frequently?: 10 (ms, s, m)

Algorithm 1 BFS-CA Algorithm

1: Let V = $\{v|v \in$MCG$\}$
2: **while** `notAllVerticesVisited`$\{V\}$ **do**
3: Let h = `smallestHopCount`(V)
4: Q = $\{v|v \in V$ and `notVisited`(v) and `hopcount`(v) == $h\}$
5: `sort`(Q)
6: **while** `size`$(Q) > 0$ **do**
7: $v_{current}$ = `removeHead`(Q)
8: **if** `visited`$(v_{current})$ **then**
9: continue
10: **end if**
11: `visit`$(v_{current})$
12: $V_n = \{u|u \in$ MCG and `edgeInMCG`$(u, v_{current})$ == TRUE$\}$
13: permanently assign highest ranked channel c from $v_{current}$'s channel ranking that does not conflict with u_i, $\{u_i \in V_n$ and $0 \leq i <$ `size`$(V_n)\}$
14: **if** c does not exist **then**
15: permanently assign random channel to $v_{current}$
16: **end if**
17: $L = \{v|v \in$MCG and v contains either radio from $v_{current}\}$
18: `removeVerticesInListFromMCG`(L)
19: tentatively assign c to radios in L that are not part of $v_{current}$
20: Let r_f be router with interface in $v_{current}$ that is farthest away from gateway
21: Let $Tail$ = list of all active v ($v \in$ MCG) such that v contains an interface from r_f
22: `sort`(T)
23: `addToQueue`$(Q, Tail)$
24: **end while**
25: permanently assign channels to radios that are unassigned a permanent channel.
26: **end while**

Implementations?

- Channel assignment protocol
  - Assume a reliable broadcasting protocol which delivers a new channel assignment to all nodes
- Interference estimation
  - Every 100ms
- Link delay estimation
  - ETT (Expected Transmission Time)

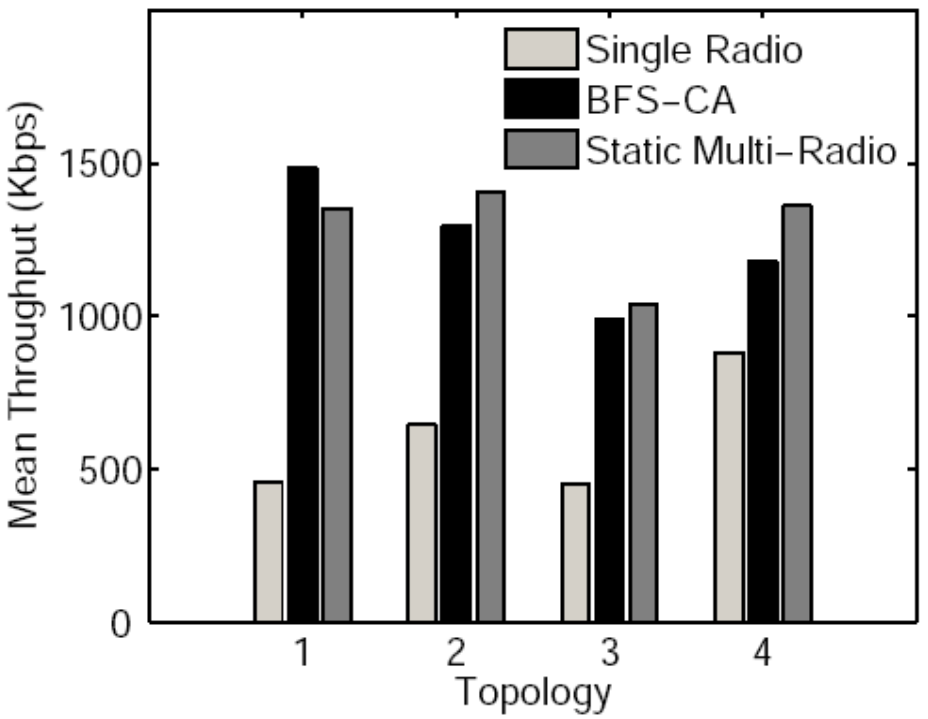
Simulation Setting

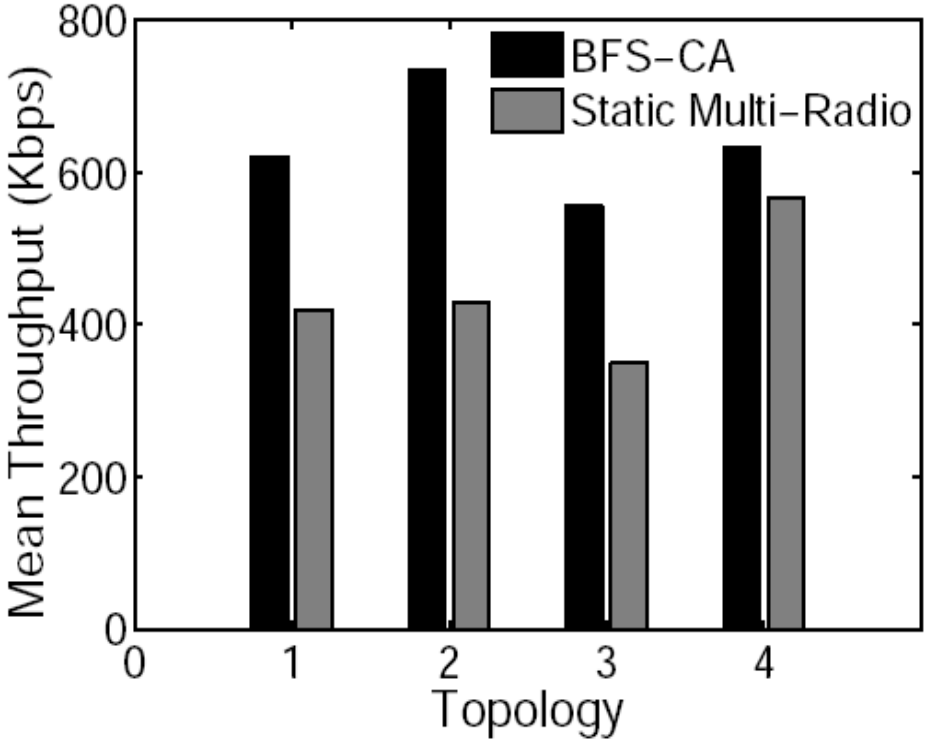
- 30 routers
- 500 x 500 m
- Topologies
  - 1. cells, random distribution in each cell
  - 2. same as 1 with different seeds
  - 3. grid topology (dense network)
  - 4. random in 500 x 500m

Flow scenarios

- Scenario 1: 10 2-minute FTPs from periphery to the gateway, one at each time
- Scenario 2: multiple flows at the same time
- Scenario 3: internal and external interferences

Results (Scenarios 1 and 2)





Results, scenario 3