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Research poster: HTSMA: a hybrid temporal-spatial multi-channel assignment scheme in heterogeneous wireless mesh networks

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HTSMA: a Hybrid Temporal-Spatial Multi-Channel Assignment Scheme in Heterogeneous Wireless Mesh Networks

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Overview of WMNs

MAC-multichannel Why?

Increases network capacity

B = bandwidth of a channel

User bandwidth = ω

Channel bandwidth = B

Classification

Centralized

Graph Based

Network Flows

Distributed

Network Partitioning

Gateway Centered

Peer Channeled

Existing problems

Utilization of a dedicated channel for the transmission of necessary control messages—waste of limited bandwidth resource

Utilization of time synchronization across all the nodes—excessive system overhead

Routing=CA is still a NPC problem

A distributed heuristic algorithm is feasible

Proposed Algorithm-HTSMA

Hybrid Temporal-Spatial Multi-Channel Assignment (HTSMA) scheme

Neither a dedicated channel nor time synchronization is needed

Each host is equipped with single radio interface—feasible for small and low-cost devices

The gateway utilizes available channels freely by switching channels in a round-robin fashion to collect the packets from other nodes—temporal property of HTSMA

Other nodes simultaneously utilize different orthogonal channels within their neighborhoods—spatial property of HTSMA

Initialization of HTSMA

Communication Graph Formation Algorithm:

Phase I: Initialization

1. Switch to a predefined, common channel for each a ∈ S(U(GW)).
2. Set the hop count of gateway 2GW = 0.
3. Set 3GW = 0 for each a ∈ S(U(GW)).
4. Set S(a) = φ and broadcasted 0 for each a ∈ S(U(GW)).
5. Gateway broadcasts a hello message with its radio range r0 and 2GW.

Phase II: Main Processing (at host id):

1. While (b) (broadcasted 0 and current clock time is t >= t) we S(a) is φ
2. If (host a receives a hello message from host b)
3. Else (b) b requests the receiving signal intensity, s
4. If (s ≥ t<sub>λ</sub>)
5. Else (s < t<sub>λ</sub>)
6. If (t < NO)
7. Else (t ≥ NO)
8. Initialize a back-off system timer t
9. Else (b) hosts does not requests hello message
10. Broadcasts a hello message piggybacking its radio range (t<sub>λ</sub> and r0).

Case 1: h-hop host (h≠1) - a spatial CA scheme

Case 2: gateway-a-temporal CA scheme

Assumption: each h-hop host, say host M, is labeled with its ID and the (Ba(M), M(M)) pair, where Ba(M) is the available buffer size and M(M) is the number of transmissions between M and the gateway before round

Example: given B=50pks and NO=50, N(50pks,5) is the total number that the gateway has switched, when 6=2, when the gateway switches to channel 1, based on the 25 of next pages, we have T(M)=0.43Tneg and T(Q)=0.34Tneg, which means host Q can be a sender on channel 1; given 6=8, we have T(M)=0.21Tneg and T(Q)=0.87Tneg, which means host W can be a sender on channel 1. Similarly, host W and host P also can obtain the chance to communicate with the gateway on channel 2, channel 3 respectively.

Performance Evaluation

Three MAC CA schemes:
1. conventional single-channel IEEE 802.11
2. multi-channel synchronization-based MAC protocol MMAC [So et al. 2004]
3. HTSMA

Three performance metrics:
1. Aggregate network throughput
2. Saturation network throughput-maximal throughput that a network can accommodate
3. Collision ratio

Metric I: Aggregate network throughput in a 500m×500m area

(a) 4-channel

(b) 9-channel

Metric II: Saturation network throughput in a 500m×500m area

(a) 4-channel

(b) 9-channel

Metric III: Collision ratio in a 500m×500m area

(a) 4-channel

(b) 9-channel

User bandwidth = \( \omega \)

Channel bandwidth = B

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