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

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Presenters
Yan Jin, Ju-Yeon Jo, Mei Yang, Yoo-hwan Kim, Yingtao Jiang, and John Gowens
HTSMA: a Hybrid Temporal-Spatial Multi-Channel Assignment Scheme in Heterogeneous Wireless Mesh Networks

Authors: Yan Jin, Ju-Yeon Jo, Mei Yang, Yohwan Kim, Hingtai Song, John Gowens

Overview of WMNs

Home Networking in Climate Change

Ubiquitous Sensor Network (USN) based Infrastructure in Climate Change

Overview of WMNs

MAC-multichannel Why?

Problem: Channel Assignment (CA)

Centralized

Network Partitioning

Gateway Centered

Distributed

Peer Centered

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

Overview of WMNs

Initialization of HTSMA

Phase I: Initialization

1. Switch to a predefined, common channel for each $t_i$ ($i.e.,$ GW$)$.
2. Set the hop count of gateway: $T_i(GW) = 0$.
3. Set $S_i(0) = i$ for each $t_i$.
4. Set $S_i(D) = i$ for each $t_i$.

Phase II: Main Processing ($t_i$ host id $= j$)

While $i$ (initialized $i = 1$ and current clock = time-synchronized time)$: we $S_i(x) = \emptyset$

1. If (host $i$ receives a hello message from host $j$): $i = 1$.
2. If ($i \leq m(x)$, $S_i(x) = \emptyset$).
3. Set $S_i(x) = \emptyset$ based on the receiving signal intensity.
4. $i = i + 1$.
5. If ($i \leq m(x)$, $S_i(x) = \emptyset$).
6. If ($i = m(x)$, $S_i(x) = \emptyset$).
7. Set $S_i(x) = i$.
8. Initialize a back-off system timer.
9. Else: ignore this hello message.
10. $B_i = \min \{\min \{R_i(s) \cap S_i(x)\} + 1, M_i(x)\}$.
11. Broadcast a hello message, piggybacking its radio range $B_i$ and $B_i(x)$.

B = bandwidth of a channel

Problem: Channel Assignment (CA)

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 fairly 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

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

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

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