Collision Avoidance in Multi-hop Wireless Networks

Tech ID: 33008 / UC Case 2022-827-0

BACKGROUND

In most wireless ad-hoc multi-hop networks, a node competes for access to the same wireless communication channel, often resulting in collisions (interference) and ineffective carrier sensing. These issues have been targeted through the medium access control (MAC) interconnection layer by a variety of channel access schemes, towards improving how the nodes share the wireless channel and achieve a high quality of service. For example, there are contention-based MAC schemes, like Carrier-Sense Multiple Access (CSMA) and Additive Links On-Line Hawaii Area (ALOHA), and contention-free MAC schemes, like time division multiplexing access (TDMA). However, the former is a poor performer in hidden- and exposed-terminal environments, and the latter, where the node system is time-synchronized and the time frame is divided and multiple time-slots are allocated to the nodes, has limited data rates (bandwidth) and undesirable latency.

Over the years, there have been many other MAC schemes that address interference and conflict, as well as improving criteria like throughput, fairness, latency, energy, and overhead. These modern protocols implement more sophisticated distributed transmission queues consisting of a sequence of transmission turns that grows and shrinks on demand. However, challenges remain in these more recent MAC protocols, such as long delays for allowing nodes to join the network, and/or the use of transmission frames with complex structures to allocate time slot portions to signaling packets for elections.

TECHNOLOGY DESCRIPTION

To overcome these challenges, researchers at UC Santa Cruz (UCSC) have developed a new networking protocol called Key-Activation Multiple Access (KAMA). KAMA is designed to match the high throughput of topology-dependent scheduling schemes based on elections with the transmission frame simplicity of topology-independent scheduling schemes, like TDMA. The novel protocol processes new node arrivals without the need for special signaling packets (i.e., does not require bandwidth) and without dedicating time slots for such packets or the use of mini-slots. UCSC research results showed in concept that KAMA is the state-of-the-art in distributed transmission scheduling scheme by achieving near-optimal channel utilization in steady state.

APPLICATIONS

ad-hoc multi-hop networks

ADVANTAGES

- Combines the spatial reuse of CSMA/CA with the collision-freedom of TDMA.
- Achieves near-optimal channel utilization in steady state.
- Expected improvement in both energy cost and fairness over CSMA/CA.

RELATED MATERIALS

- D. Cirimelli-Low and J. J. Garcia-Luna-Aceves, "Key-Activation Multiple Access (KAMA)," 2021 13th IFIP Wireless and Mobile Networking Conference (WMNC), 2021, pp. 92-99, doi: 10.23919/WMNC53478.2021.9619064. - 12/02/2021

CONTACT

Marc Oettinger
marc.oettinger@ucsc.edu
tel: 831-502-0253.

OTHER INFORMATION

KEYWORDS

collision avoidance, data packet, Multiple Access Interference, networking, network protocols, networks, wireless networks, multi-hop wireless networks, CSMA, TDMA, medium access control

CATEGORIZED AS

- **Communications**
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