Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Vehicular Wireless Media Network (VWMN)]
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Abstract: [A distributed broadband MAC for inter-vehicle communication]

Purpose: [Presentation in 802.15 WNG SG]

Vehicular Wireless Media Network (VWMN)

A distributed broadband MAC for inter-vehicle communication

Overview

- Motivation
- Problem statement
- VWMN MAC specification
- Benefits of VWMN
- Challenges
  - Synchronization
  - Dynamic topology control
- Conclusion and outlook

Will 802.15 address mobility in WPAN?

- WLAN & WPAN standardization is facing similar general problems
  - Coverage extension
  - Growing demand on throughput
  - Changing network topology

	WLAN	WPAN
Mesh networking	802.11s	802.15.5
High data rate	802.11n	802.15.3a/c
High mobility	802.11r/p	???

Vehicular Applications

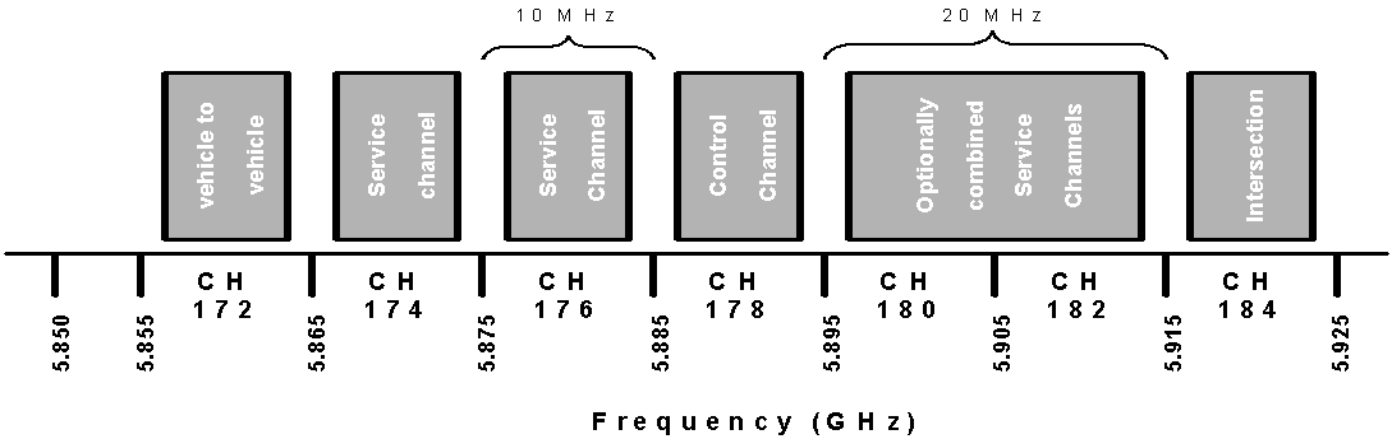
- Media type applications
  - Internet on the road
  - Access to the company network
  - Download latest customer data
  - Working context transfer
  - Entertainment
  - Content (media) sharing

- Safety
  - Traffic jam warning
  - Hazard warning
  - Emergency car approaching
  - Cooperative driving

Mobility oriented Applications for WPANs

- Interconnection among handheld devices
  - Audio (cordless headset)
  - Content download (MP3 player, photo camera)
  - Internet file transfer & audio/video streaming (PDA, cell phone)
- Temporarily & rapidly set-up mesh network
- Indoor location based services
- Healthcare
  - Hospital personnel and equipment tracking
  - Inventory tracking
  - Patient monitoring/management
- Sensor networks
- Premium service e.g. Voice over IP

Spectrum allocation



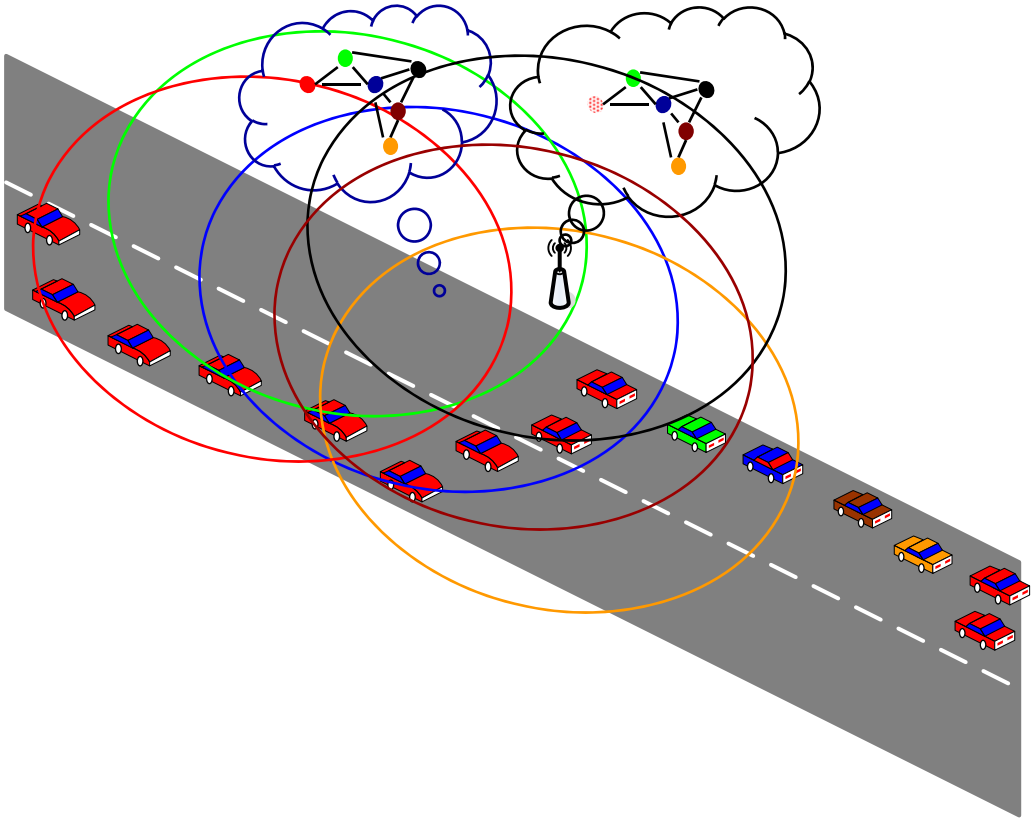
- Spectrum allocation for Dedicated short range communication (DSRC)
  - Multiple channels
  - Broad band
- High data rate (Media Type) applications
  - Mobile-to-mobile
  - Mobile-to-infrastructure

Problem statement for Mobile Ad-hoc Network (MANET) MAC

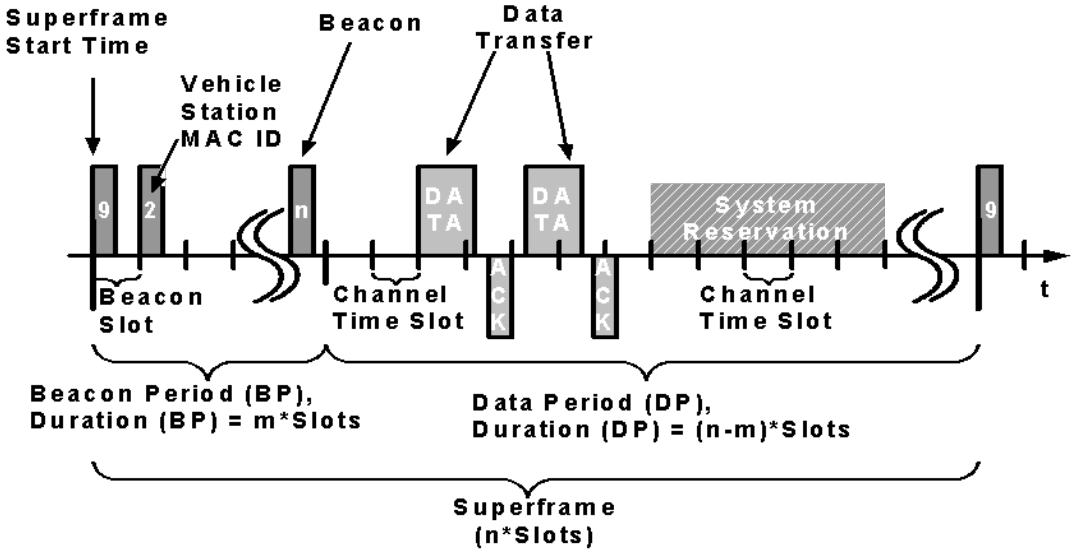
- Application supports
  - Premium (Safety relevant) applications
  - Media type applications
- Considering changing network topology
- MAC efficiency
- Quality of Service
- Ad-hoc, self organization
- Multi-channel support
- Multi-hop extension

Overview on VWMN MAC

- Key Assets
  - Distributed beaconing algorithm
  - Learning topology through beaconing
  - Contention free channel access based on topology information
  - Contention based channel access optional
- Synchronized MAC
  - More efficient premium service
  - QoS for media type app.
  - Supports multiple channels

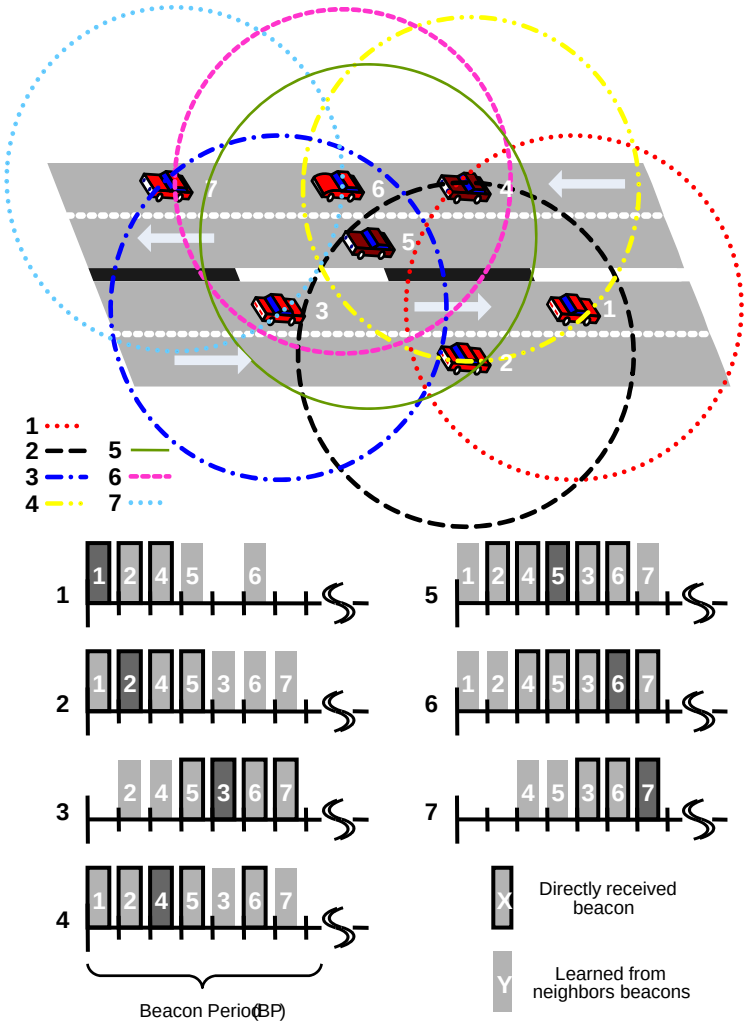


Synchronized Superframe Structure



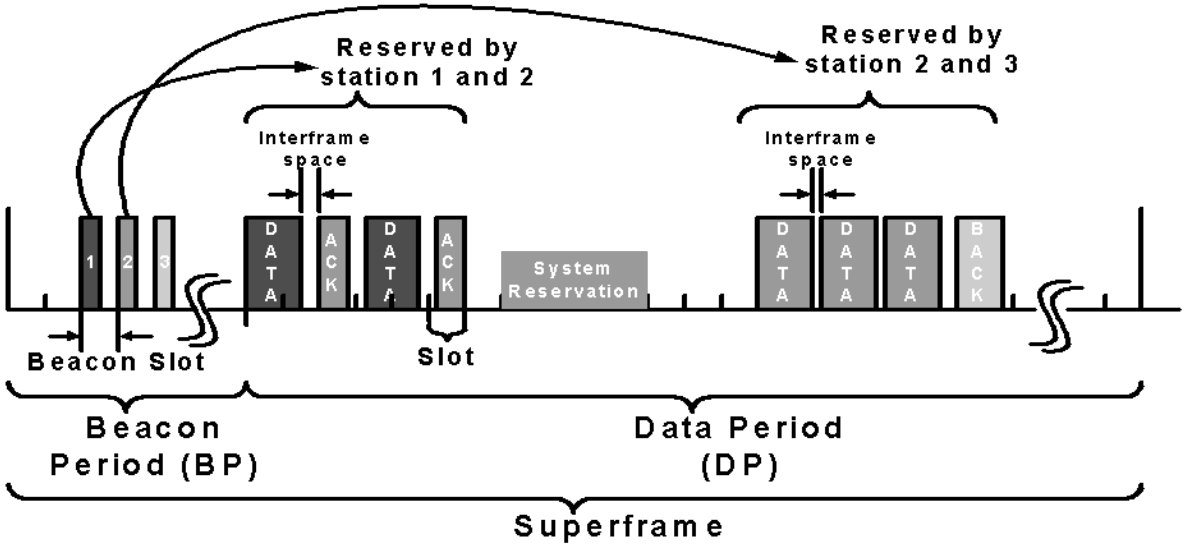
- Synchronized superframe consisting of n channel time slots
- Beacon period (BP) (m beacon slots) for beacon transmission
- Data period (DP) (n-m slot) for data exchange

Distributed Beaconing Scheme



- Information in Beacons
  - MAC ID & beacon slot number
  - GPS information
  - Beacon period bitmap (neighborhood bit map)
  - Channel reservation information
- Purpose of beaconing
  - Synchronization
  - Topology control
  - Channel access coordination

VWMN Channel Access Methods



- Distributed Resource Reservation Protocol (DRRP)
  - Reservation is made for the following DP
  - Reservation information is broadcasted in beacons
- Contention based channel access (EDCA)
  - Make use of the unreserved channel resource
  - Similar to EDCA in IEEE 802.11e

Benefits of VWMN MAC

- QoS support for
  - Time critical (safety relevant) applications
  - Media Type applications
- Higher MAC efficiency with reservation based channel access
- Support for multi-channel
- Capable of multi-hop connection

Challenges of VWMN MAC (1/2)

- Synchronization issues
  - Clock inaccuracy
  - Time shifts between independent beacon groups
- 3-level approach for synchronization
  - Packet syn. through PHY preamble
  - Intra-group syn. through beaconing algorithm
  - Inter-group (global) syn. through GPS

Challenges of VWMN MAC (2/2)

- Dynamic topology control / mobility management in VWMN
  - Beacon collision probability raises in high mobility environment
- Proposed solutions
  - Multiple beacon periods for groups of vehicles with high relative speed
    - Reduces beacon slot contention
    - Prevent synchronization between unlikely communication partners
  - Transmission power control
    - limits the number of vehicles contenting for the same beacon period

Conclusion & Outlook

- A synchronized and distributed VWMN MAC is proposed for mobile media applications
- Synchronization and distributed topology control are essential issues

- Feedback from 802.15 is highly appreciated
- Does the concept fit into WPAN?
- Is high mobility a topic 802.15 will address?

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