DSRC - WAVE

VITMMA10 – Okos város MSc mellékspecializáció

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Overview

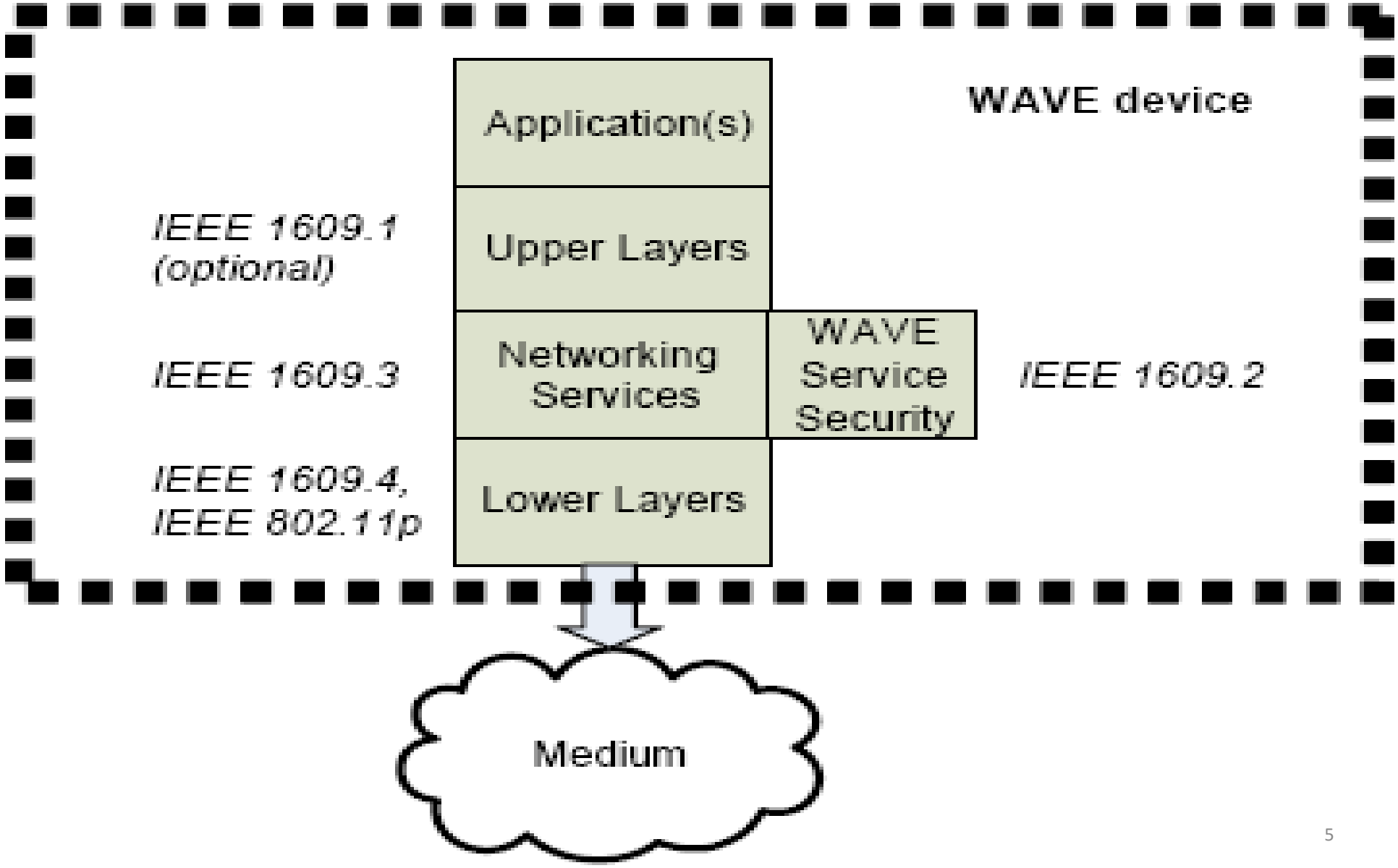
- DSRC
  - Dedicated Short-Range Communications
  - ASTM Standard E2213-03, based on 802.11a
  - ITS communications on 5.9/5.8GHz band
- WAVE
  - Wireless Access in Vehicular Environments
  - Mode of operation used by IEEE 802.11 devices to operate in the DSRC band
- IEEE 802.11p
  - Based on ASTM Standard E2213-03

Comparisons

	DSRC/WAVE	Wi-Fi	Cellular	Mobile WiMAX5
Data rate	3-27Mbps	6-54Mbps	< 2 Mbps	1-32 Mbps
Mobility	> 60 mph	< 5mph	> 60 mph	> 60 mph
Nominal Bandwidth	10MHz	20MHz	< 3MHz	< 10MHz
Operating Band	5.86-5.92GHz (ITS-RS)	2.4GHz, 5.2GHz (ISM)	800MHz, 1.9GHz	2.5 GHz
IEEE std.	802.11p (WAVE)	802.11a	N/A	802.16e

WAVE overview

IEEE WAVE Standards



IEEE P1556

- Standard for Security and Privacy of Vehicle/Roadside Communication Including Smart Card Communication
- Is now replaced by IEEE 1609.2

IEEE P1609/WAVE

- IEEE P1609 family are standards for WAVE
- Defines…for vehicular wireless communication
  - Architecture, Communications model, Management structure, Security mechanisms, Physical access
- Architectural components
  - On Board Unit (OBU)
  - Road Side Unit (RSU)
  - WAVE interface

IEEE P1609/WAVE CCH & SCH

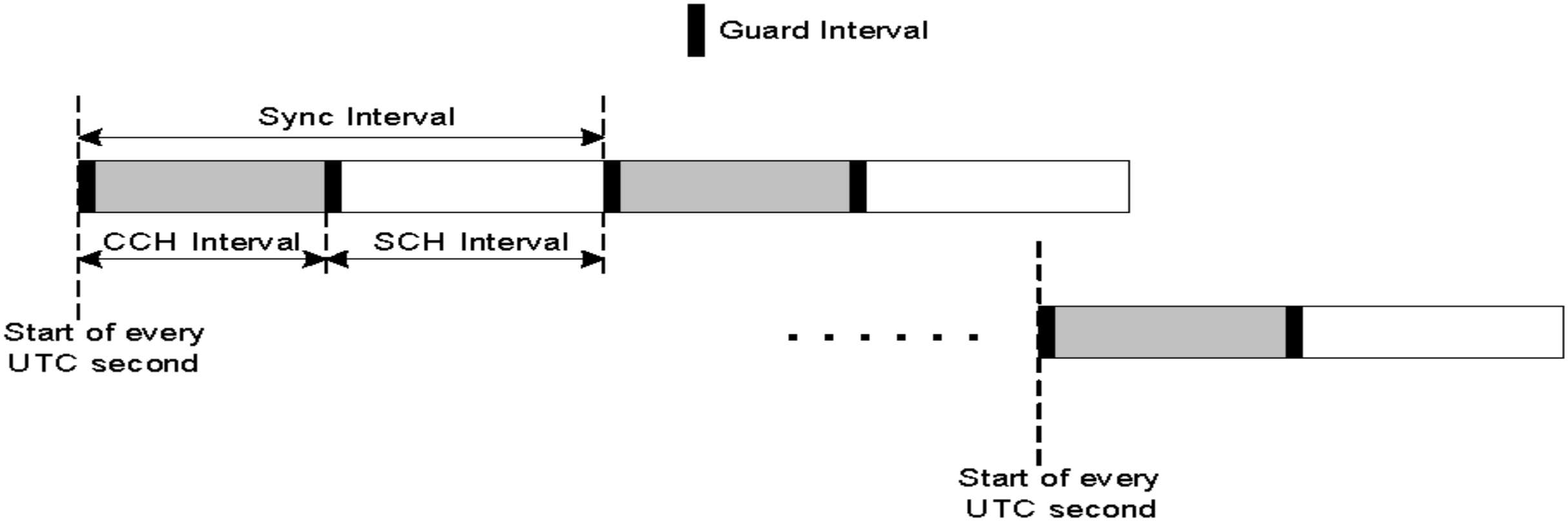
- WAVE devices shall be able to accommodate an architecture that supports a Control Channel (CCH) and multiple Service Channels (SCH)
- CCH
  - Transmit WAVE Short Messages (WSM)
  - Announce WAVE services
- SCH
  - Application interactions/transmissions

Synchronization

- To make sure all devices are monitoring CCH during CCH interval
- IEEE 1609.2 Security
- Single-channel device
  - Must have Coordinated Universal Time (UTC)
    - Ex: GPS pulse per second (PPS)
  - Or it shall continuously monitoring CCH
- Multi-channel device
  - Monitor CCH
    - Ex: Timestamp field of IEEE 802.11

IEEE 1609 Sync Tolerance

- Guard interval is used for synchronization

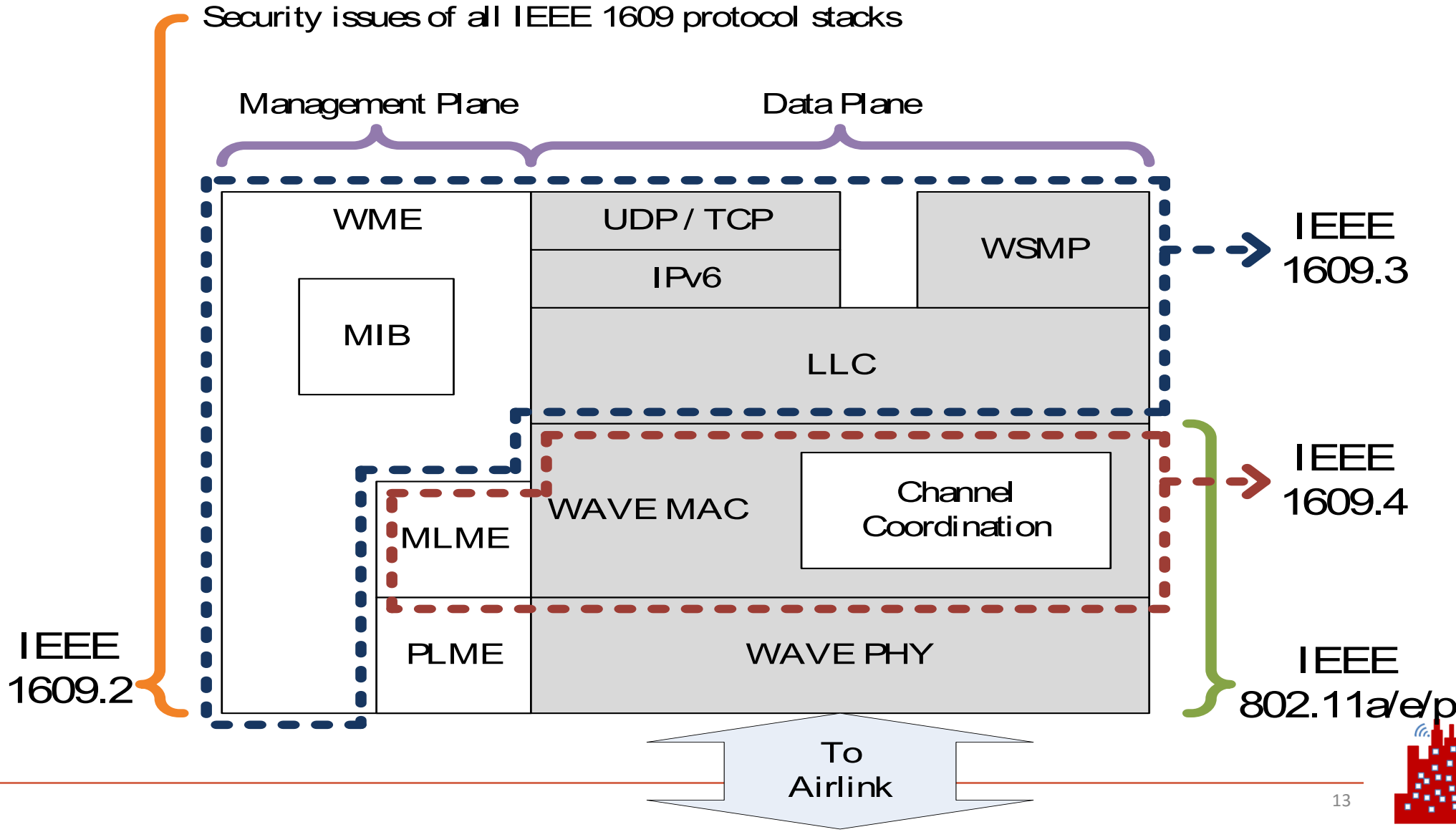


WAVE standards

IEEE 1609/WAVE

- IEEE 1609.1
  - Resource Manager
- IEEE 1609.2
  - Security Services for Applications and Management Messages
- IEEE 1609.3
  - Networking Services
- IEEE 1609.4
  - Multi-Channel Operations

IEEE Protocol Stacks



IEEE 1609.3 Data Services

- Logical Link Control (LLC)
- IPv6
- UDP & TCP
- WAVE short message (WSM) and protocol (WSMP)

IEEE 1609.3 Management Services

- Application Registration
  - Register application to WAVE Management Entity (WME) so service flow can map to correct IP address & port
- WAVE Basic Service Set (WBSS) management
  - WBSS actions
    - Ex: Joining & ending a WBSS
  - WBSS parameters management
    - Ex: SSID, MAC address, SCH number, Timestamp

IEEE 1609.3 Management Services

- Channel usage monitoring
  - Ex: QoS, avoid using congested channel
- IPv6 configurations
- Received channel power indicator (RCPI) monitoring
  - Ex: provide RCPI for applications
- Management information base (MIB) maintenance
  - Management parameters

IEEE 1609.4 User Priority (UP)

- Use IEEE 802.11e EDCA mechanism
- Mapping UP to Access Category Index (ACI)

IEEE 1609.4 UP on CCH & SCH

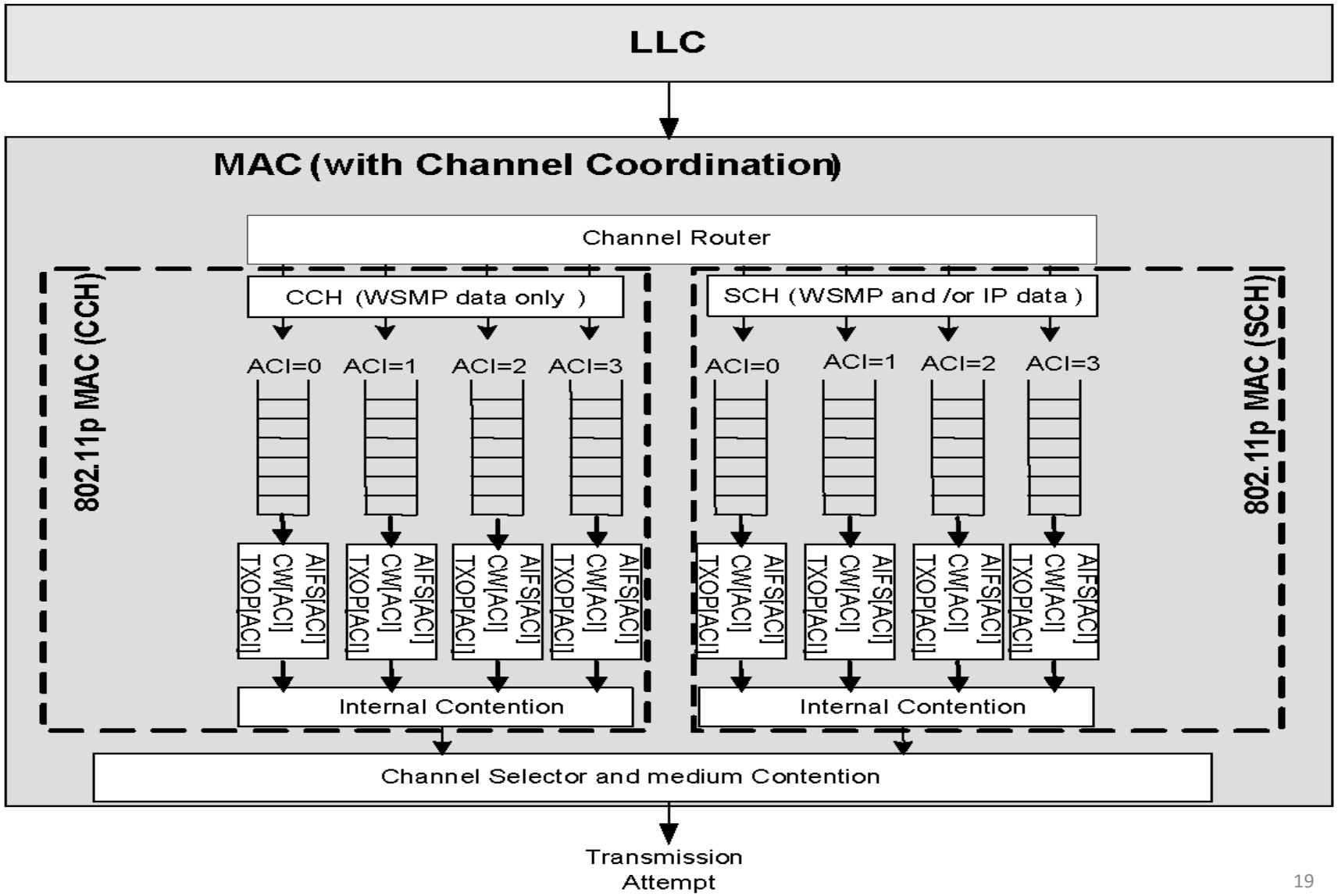
CCH

ACI	AC	CWmin	CWmax	AIFSN	TXOP Limit OFDM PHY
1	Background	aCWmin	aCWmax	9	0
0	Best effort	(aCWmin + 1)/2 – 1	aCWmin	6	0
2	Video	(aCWmin + 1)/4 – 1	(aCWmin + 1)/2 – 1	3	0
3	Voice	(aCWmin + 1)/4 – 1	(aCWmin + 1)/2 – 1	2	0

SCH

ACI	AC	CWmin	CWmax	AIFSN	TXOP Limit OFDM/ CCK-OFDM PHY
1	Background	aCWmin	aCWmax	7	0
0	Best Effort	aCWmin	aCWmax	3	0
2	Video	(aCWmin + 1)/2 – 1	aCWmin	2	0
3	Voice	(aCWmin + 1)/4 – 1	(aCWmin + 1)/2 – 1	2	0

IEEE 1609.4 Channel Coordination



802.11p

IEEE 802.11p

- Define enhancements to 802.11 required to support ITS applications
- Lower layer of WAVE
- Supports two different stacks
  - IPv6
    - only on SCHs (not CCH)
  - WAVE Short Message Protocol (WSMP)
    - can be sent on any channel
    - allows applications to directly control physical characteristics

IEEE 802.11p

- Communication between 802.11 STAs …
  - Without becoming a member of a BSS is possible
    - Do not have to be associated with the same BSSs
  - Direct & Immediate
  - Avoid the latency caused by BSS association
  - May use a dedicated frequency band

IEEE 802.11p MAC

- DCF – CSMA/CA
  - IBSS & Infrastructure
  - Communication outside BSS
- HCF contention-based channel access => EDCA
  - EDCA is an enhanced variant of DCF
  - EDCA parameters
    - Outside BSS: default
    - Inside BSS: given by associated BSS or AP

DSRC – spectrum allocation

DSRC Worldwide - ISO

- ISO (International Organization for Standardization)
  - Working Group 15
    - Upper layer
  - Working Group 16
    - Lower layer

DSRC Worldwide - Europe

- CEN (European Committee for Standardization)
  - EN 12253:2004 Dedicated Short-Range Communication - Physical layer using microwave at 5.8 GHz (review)
  - EN 12795:2002 Dedicated Short-Range Communication (DSRC) - DSRC Data link layer: Medium Access and Logical Link Control (review)
  - EN 12834:2002 Dedicated Short-Range Communication - Application layer (review)
  - EN 13372:2004 Dedicated Short-Range Communication (DSRC) - DSRC profiles for RTTT applications (review)
  - EN ISO 14906:2004 Electronic Fee Collection - Application interface

DSRC Worldwide - Japan

- ARIB (Association of Radio Industries and Businesses)
  - STD-T55: Electronic Toll Collection System
  - STD-T75: Dedicated Short-Range Communication System
  - STD-T88: DSRC Application Sub-Layer

DSRC Worldwide - US

Old – 915MHz

New – 5.9GHz

The lead organization is ASTM

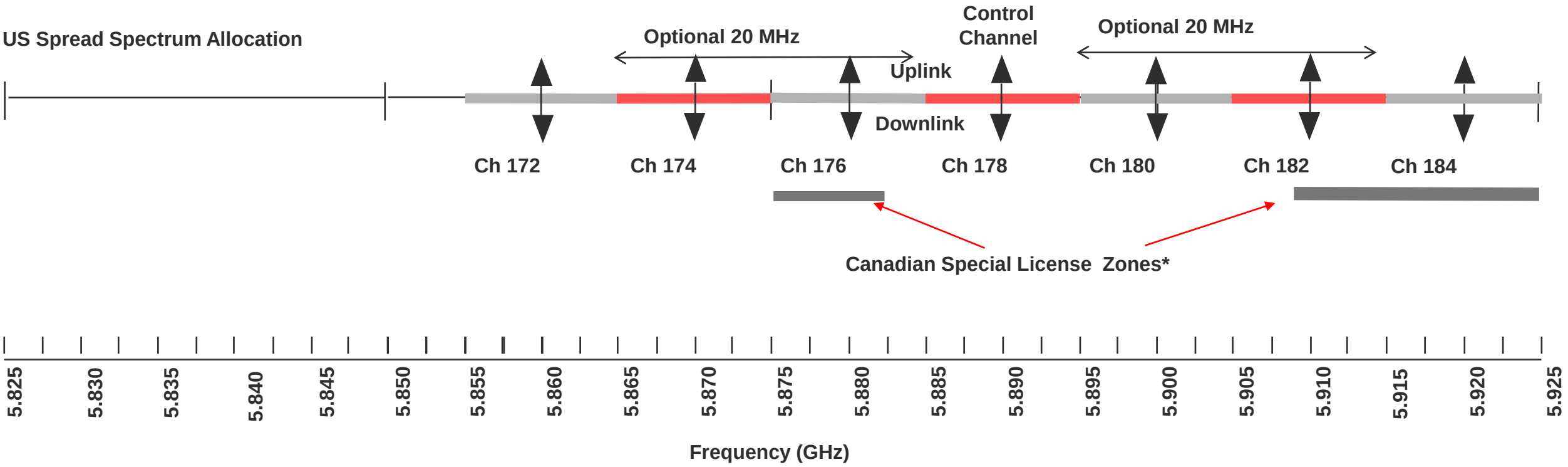
- Range < 30 meters
- Data rate = 0.5 mbps
- Designed for ETC, but can be used for other applications
- Single unlicensed channel
- Requires special (custom) chip set & software
- Vehicle to roadside
- Command-response

- Range to 1000 meters
- Data rate 6 to 27 mbps
- Designed for general internet access, can be used for ETC
- 7 licensed channels
- Uses open off-the-shelf chip set & software
- Vehicle to roadside & vehicle to vehicle
- Command-response & peer to peer

US DSRC Spectrum

- 75 MHz band has been allocated by FCC at 5.9 GHz
- Initial band use rules accepted
- No auction expected
- Band allows both safety and commercial applications to coexist

US DSRC Channel Plan



* - The channels overlapping these zones may be restricted in some locations in Canada. In these cases use channels 1, 2, and 3 in their place.

US DSRC Performance Envelope