Transportation Wireless Communications: Standards and Specifications Development Organizations Overview

V2X STANDARDIZATION AND SPECIFICATIONS

- Current V2X Standards in the US
- International Telecommunication Union (ITU)
- Third Generation Partnership Project (3GPP)
- 5G Automotive Association (5GAA)
- SAE International (SAE)
- Institute of Electrical and Electronics Engineers (IEEE)
- International Context

CURRENT V2X STANDARDS IN THE US*

SDO	Standard No.	Standard Title
ASTM	E2213-03	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications
IEEE	IEEE 802.11-2016	Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
	IEEE 1609.0-2013	IEEE Guide for WAVE – Architecture
	IEEE 1609.2 -2016	IEEE Standard for WAVE – Security Services for Applications and Management Messages
	IEEE 1609.3 -2016	IEEE Standard for WAVE – Networking Services
	IEEE 1609.4 -2016	IEEE Standard for WAVE – Multi-Channel Operations
	IEEE 1609.11-2010	IEEE Standard for WAVE – Over-the-Air Electronic Payment Data Exchange Protocol for ITS
	IEEE 1609.12-2016	IEEE Standard for WAVE – Identifier Allocations
SAE	SAE J2735 March, 2016	Dedicated Short Range Communications (DSRC) Message Set Dictionary
	SAE J2945/1 March, 2016	On-board System Requirements for V2V Safety Communications

* https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2445-2018-MSW-E.docx (Table 35)

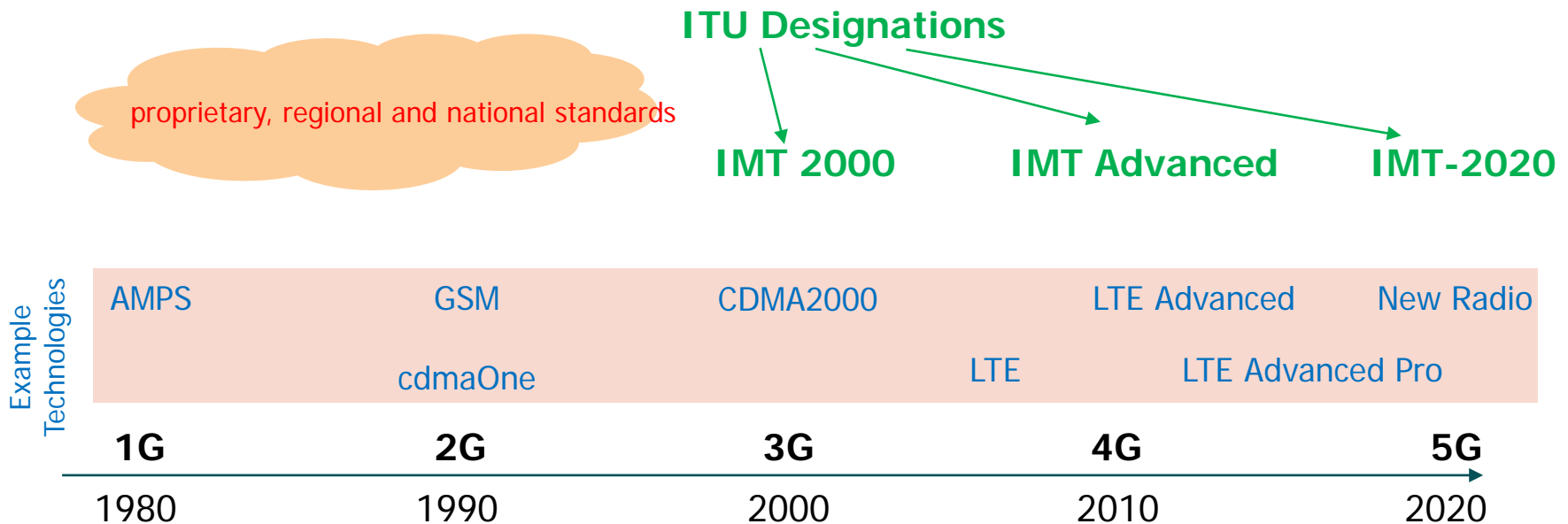# INTERNATIONAL TELECOMMUNICATION UNION (ITU) - ORGANIZATION

- The ITU is the United Nations specialized agency for information and communication technologies – ICTs[1]

- ITU Mission includes[2]:
    "…to maintain and extend international cooperation among all the Member States of the Union for the improvement and rational use of telecommunications of all kinds"
    "…to ensure rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those using satellite orbits, and to carry out studies and adopt recommendations on radiocommunication matters"

[1] http://www.itu.int/en/about/Pages/default.aspx;
[2] https://www.itu.int/en/ITU-R/information/Pages/mission-statement.aspx

CELLULAR GENERATIONS

- Beginning with IMT-2000*, the ITU has established new performance goals for cellular technologies roughly every 10 years to encourage global standards harmonization

- Achieving these performance goals qualifies a technology to be considered part of that cellular generation

ITU Designations

proprietary, regional and national standards

IMT 2000   **IMT Advanced**   **IMT-2020**

Example Technologies				
AMPS	GSM	CDMA2000	LTE Advanced	New Radio
	cdmaOne		LTE LTE Advanced Pro	
1G	**2G**	**3G**	**4G**	**5G**
1980	1990	2000	2010	2020

* IMT stands for "International Mobile Telecommunications

ITU IMT-2020 = "5G"

"In early 2012, ITU–R embarked on a programme to develop "IMT for 2020 and beyond", setting the stage for 5G research activities that were emerging around the world.

In September 2015, ITU–R finalized its "Vision" of IMT for 2020 5G mobile broadband connected society. The technical standards for IMT-2020 will be finalized by ITU–R in 2020. While enhancing mobile broadband communications, 5G will also extend the application of this technology to use cases involving ultra-reliable and low latency communications, and massive machine-type communications. In addition, the ITU World Radiocommunication Conference 2019 (WRC-19) will address the need to identify additional spectrum to support the future growth of IMT."*

[*] https://www.itu.int/en/itunews/Documents/2017/2017-02/2017_ITUNews02-en.pdf

TODAY'S CELLULAR IN TRANSPORTATION

- Network-based cellular communications is currently used for vehicle telematics, e.g.: navigation, traffic information, vehicle diagnostics, entertainment, and mayday-type safety systems

- Current cellular equipment usage in vehicles includes:
  - Embedded vehicle systems
  - Applications on handsets carried into vehicle

- Direct-mode of operation (i.e., V2V without network intervention) is not included in currently-deployed cellular technologies

- Direct-mode operation is required to support V2V / V2I crash-avoidance safety and mobility

3GPP SPECIFICATIONS FOR CELLULAR TECHNOLOGY

3GPP specifications are adopted as standards by its partner regional standards development organizations, such as the Alliance for Telecommunications Industry Solutions (ATIS) for North America.

"The 3rd Generation Partnership Project (3GPP) unites [Seven] telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

The project covers cellular telecommunications network technologies, including radio access, the core transport network, and service capabilities - including work on codecs, security, quality of service - and thus provides complete system specifications. The specifications also provide hooks for non-radio access to the core network, and for interworking with Wi-Fi networks.

3GPP specifications and studies are contribution-driven, by member companies, in Working Groups and at the Technical Specification Group level."*
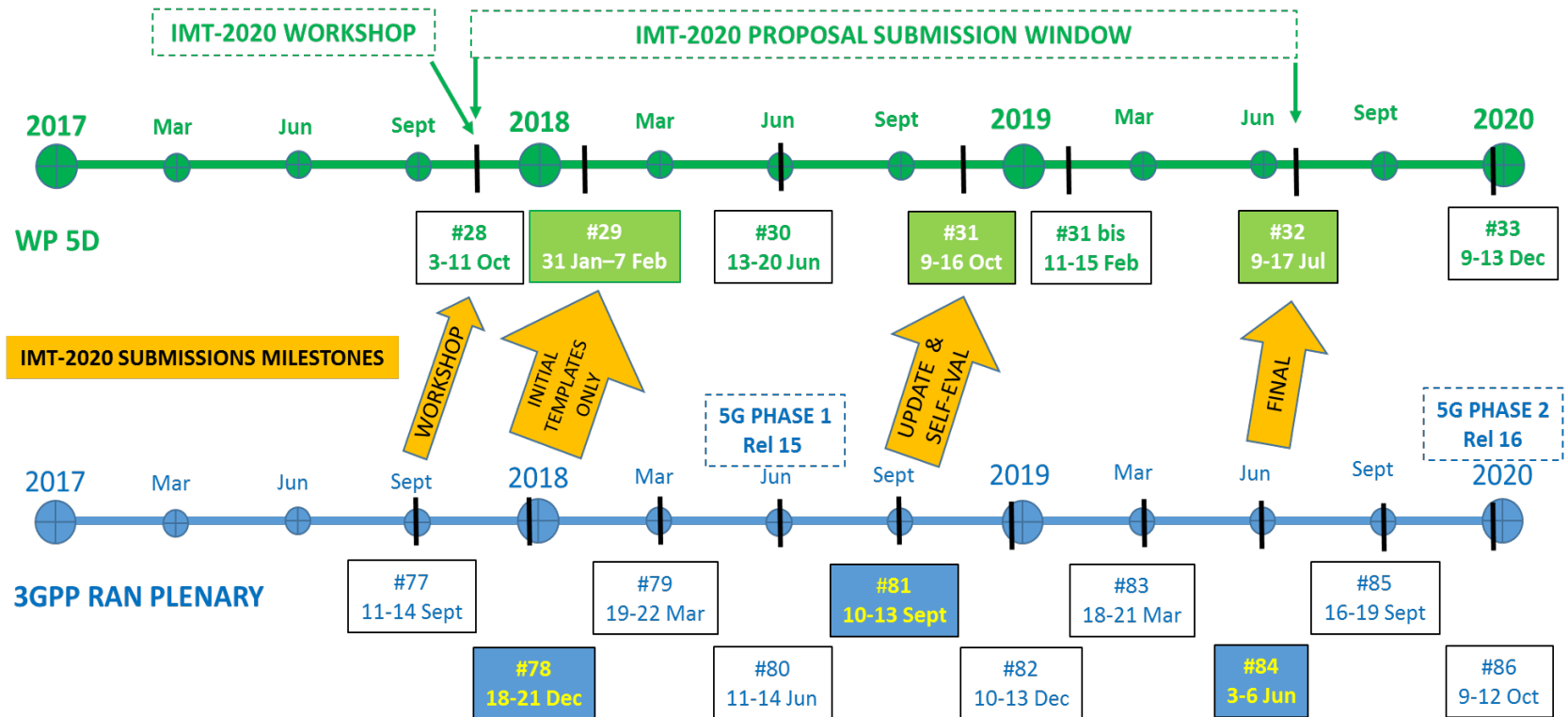
* http://www.3gpp.org/about-3gpp/about-3gpp

3GPP RELEASE 14

- Note: public safety = mission critical (in 3GPP terminology)

- 3GPP Release 14 (4G LTE) main focus areas*:
  - Improvements of the Mission Critical (MC) aspects, in particular by introducing Video and Data MC services
  - Introducing Vehicle-to-Everything (V2X) communications, in particular for Vehicle-to-Vehicle (V2V) Basic Safety use cases
  - Improvements of the Cellular Internet of Things aspects, with 2G, 3G and 4G support of Machine-Type of Communications

*https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3179

3GPP "5G" TIMELINE*

IMT-2020 WORKSHOP

IMT-2020 PROPOSAL SUBMISSION WINDOW

2017 Mar Jun Sept 2018 Mar Jun Sept 2019 Mar Jun Sept 2020

WP 5D

| #28 3-11 Oct | #29 31 Jan–7 Feb | #30 13-20 Jun | #31 9-16 Oct | #31 bis 11-15 Feb | #32 9-17 Jul | #33 9-13 Dec |

IMT-2020 SUBMISSIONS MILESTONES

WORKSHOP

INITIAL TEMPLATES ONLY

UPDATE & SELF-EVAL

FINAL

5G PHASE 1 Rel 15

5G PHASE 2 Rel 16

2017 Mar Jun Sept 2018 Mar Jun Sept 2019 Mar Jun Sept 2020

3GPP RAN PLENARY

| #77 11-14 Sept | #79 19-22 Mar | #81 10-13 Sept | #83 18-21 Mar | #85 16-19 Sept |
| #78 18-21 Dec | #80 11-14 Jun | #82 10-13 Dec | #84 3-6 Jun | #86 9-12 Oct |

* RP-172098 at http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_77/Docs/

3GPP RELEASE 16

- 3GPP Release 16 to be 5G "Phase 2", meeting all the IMT-2020 requirements
- Planned for completion by 2020
- Only "advanced C-V2X" use cases are planned to use the Release 16 5G New Radio capabilities:
  - Vehicles Platooning
  - Extended Sensors
  - Advanced Driving
  - Remote Driving
- C-V2X V2V Basic Safety use cases not being studied for Release 16 5G New Radio capabilities (at this time)

* http://www.3gpp.org/about-3gpp/about-3gpp

5G AUTOMOTIVE ASSOCIATION

Industry stakeholders have formed a consortium known as the 5G Automotive Association (5GAA), which is comprised of telecom firms, automotive suppliers and manufacturers, as well as chipset manufacturers.

"The 5G Automotive Association (5GAA) is a global, cross-industry organisation of companies from the automotive, technology, and telecommunications industries (ICT), working together to develop end-to-end solutions for future mobility and transportation services."*

"Our mission is to bridge the automotive and telecommunications industries in order to embrace and accelerate the global deployment of intelligent transport and communications solutions. Through this, we aim to address society's connected mobility and transport safety needs."**

* http://5gaa.org/about-5gaa/about-us/
** http://5gaa.org/about-5gaa/vision-mission/

SAE C-V2X TECHNICAL COMMITTEE

Standard under development: J3161 - On-Board System Requirements for LTE V2X V2V Safety Communications[1], intended to:

- Adapt the existing SAE V2V upper layer standards to the LTE-V2X lower layers

- Specify parameter settings for the LTE-V2X lower layers

[1] https://www.sae.org/standards/content/j3161/

SAE ADVANCED APPLICATIONS TECHNICAL COMMITTEE

Standard under development: J3186 - Maneuver Sharing and Coordinating Service[1], intended to:

- Provide requirements to support applications for the Maneuver Sharing and Coordinating service (MSCS) in order to improve road safety and traffic efficiency by sharing and coordinating vehicle maneuvers via V2V, V2I and/or V2P communications

- Develop concepts and use case scenarios for MSCS, and an overview of MSCS systems and operations

[1] https://www.sae.org/standards/content/j3186/

IEEE 802.11bd

- Development just beginning within IEEE[1]

- Planned capabilities[2]:
  - Forward IEEE V2X evolution from DSRC
  - Backward compatibility with DSRC
  - Interoperable co-existence on same channel with DSRC
  - Enhanced reliability and range

- Planned for 5850-5925 MHz spectrum, in current channels, along with existing DSRC

[1] http://www.ieee802.org/11/Reports/tgbd_update.htm
[2] https://mentor.ieee.org/802.11/dcn/19/11-19-0202-01-00bd-tgbd-definitions-and-requirements.pptx

INTERNATIONAL RADIO REGULATIONS

- The Radio Regulations are the embodiment of "the international treaty governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits"*

- International treaty = binding upon Member States

- Established in 1906 (113 years in existence)

- Managed by the ITU

CURRENT ITS SPECTRUM ARRANGEMENTS
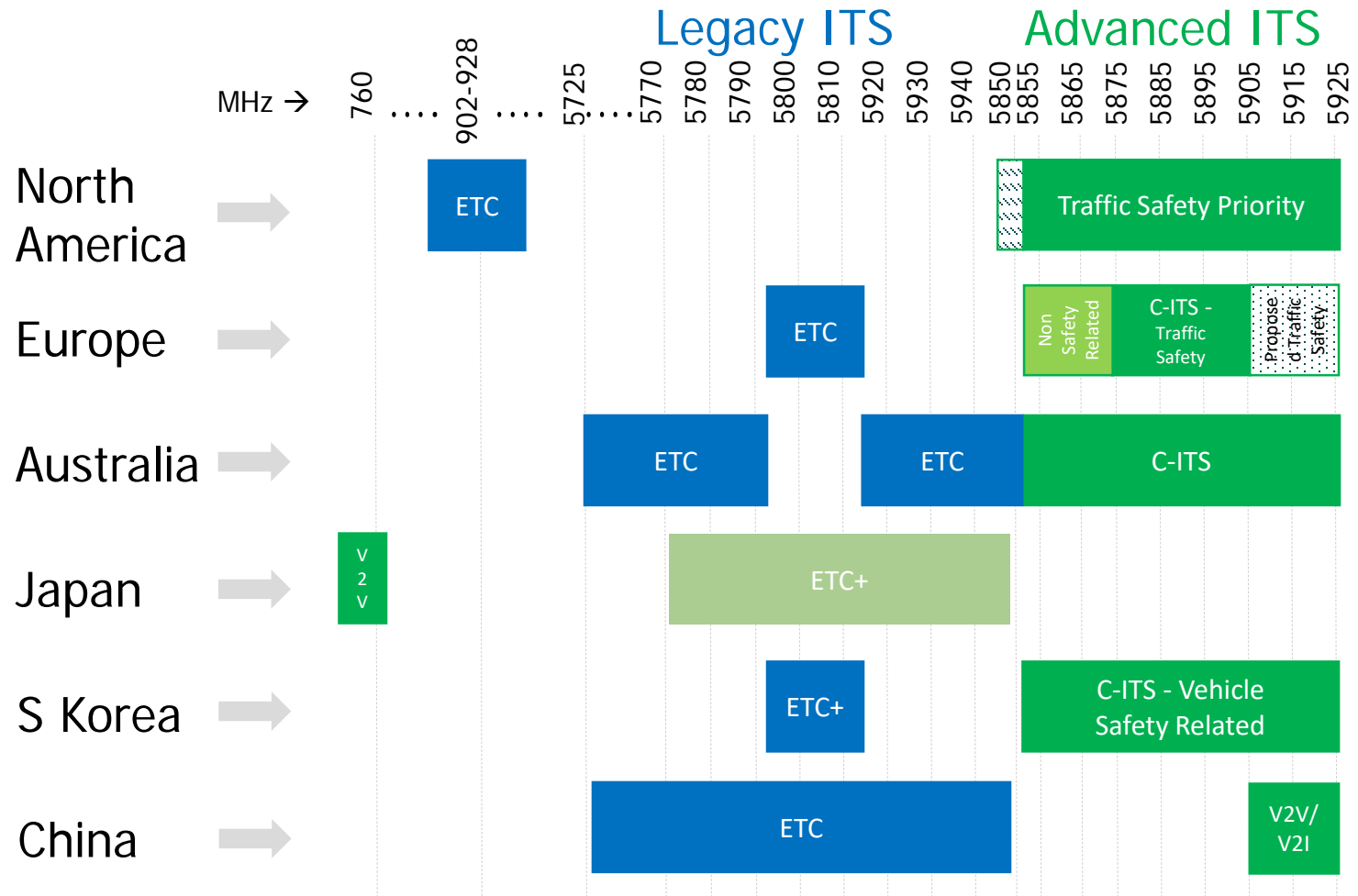
* Based on information from Reports ITU-R M.2444 and ITU-R M.2445

ITU HARMONIZATION OF ITS SPECTRUM

- New Recommendation ITU-R M.2121-0 – Harmonization of frequency bands for Intelligent Transport Systems in the mobile service*, has been approved and published, which recommends:
    1. that, taking into account considering h), Administrations should consider using the frequency band 5 850-5 925 MHz, or parts thereof, for current and future ITS applications;
    2. that those examples of ITS frequency bands in current use, as listed in the Annex, should be taken into account for regional harmonized ITS frequency bands;
    3. that when using harmonized frequency bands for ITS, potential coexistence issues between ITS stations and other applications of the mobile service and/or other services should be taken into account.

- Other new and revised Recommendations and new Reports, for example:
    - Report ITU-R M.2444 – Examples of Arrangements for Intelligent Transport Systems deployments under the mobile service
    - Report ITU-R M.2445 – Intelligent transport systems (ITS) usage

US SPECTRUM SHARING RESEARCH AND MEASUREMENTS

FCC Testing Process:

https://www.fcc.gov/oet/unii-4banddevice

https://apps.fcc.gov/edocs_public/attachmatch/DA-16-1054A1.pdf

DOT DSRC Spectrum Sharing Research Plan:

http://www.its.dot.gov/research_archives/connected_vehicle/pdf/DSRC_TestPlanv3.5.3.pdf

THANK YOU!

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