DRONE ENABLE
ICAO's Unmanned Aircraft Systems Industry Symposium
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Potential spectrum and telecom technologies for small UAS

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International Telecommunication Union

International Telecommunication Union

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- Established in1865, based in Geneva, 12 regional and area offices, around 750 staff
- staff from 80 countries, 6 official languages
- 3 ITU Sectors:
  - ITU-R - Radiocommunications – *spectrum, standards for wireless communications*
  - ITU-T - Standardization – *standards for core (wired) networks*
  - ITU-D – Development – *assistance to developing countries*

111 years of managing spectrum and 90 years of standardization

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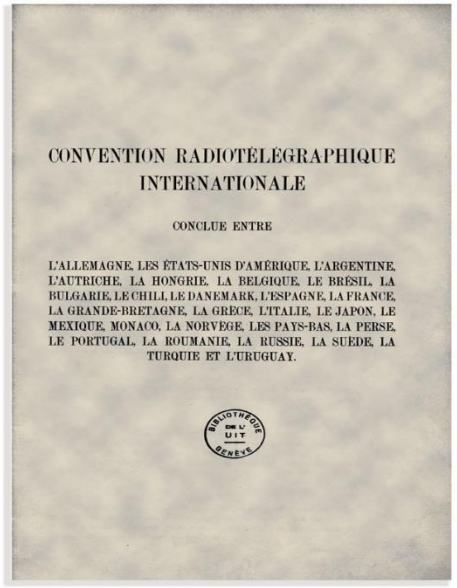
1906 → 2017



From the first International Radiotelegraph Convention, **1906** to the Radio Regulations, **2016**

RR follow and anticipate technological advancements

Radio Regulations (RR)

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- The basic ITU document on spectrum is **Radio Regulations**
- RR is intergovernmental treaty. Ratified by governments –> mandatory
- Allocates frequency blocks to radio services, including aeronautical
- RR deal with radio use having international implications. Main goals:
  - interference free operation of stations (critical for UAS C2 links)
  - harmonization of spectrum (e.g. global aeronautical bands, RPAS bands)
- RR updated every 3-4 years at World Radiocommunication Conferences - WRCs

Frequencies for aviation at world radiocommunication conferences

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- WARC 1927, Washington -> first spectrum to aeronautical service in 315 – 350 kHz
- WARCs in 1938, 1947/59/63/64/66, etc. –spectrum for new aviation technologies
- WRC-12 -> spectrum for terrestrial component of RPAS in 5030 – 5091 MHz
- WRC-15:
  - 8 frequency bands for satellite component of RPAS in K_u and K_a ranges
  - Spectrum for Global Flight Tracking and Wireless Avionic Intra Communications (satellite reception of ADS-B signals)

Delegates at the 1947 Atlantic City Radio Conference

Delegates at WRC-15

Categories of potential spectrum for UAS

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Aeronautical safety bands	Licensed bands (cellular networks, etc.)	Unlicensed bands (Wi-Fi, SRD)
• Exclusive (mostly) • Protected from interference • Managed by ICAO/CAA • Limited capacity and intensive usage • E.g. 5030-5091 MHz	• Shared with other users • Sufficient capacity • Control of interference and Quality of service (QoS) • E.g. 2 110-2 200 MHz	• Subject to general license (power limits) • Available for short-range communications • Good capacity and freedom to use • QoS and protection from interference not ensured • E.g. 2.4 GHz, 5.8 GHz

Feasibility of aviation safety bands for UAS
(example of some bands)

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Range	Frequency band	Current aviation usage	Feasibility for UAs
HF	2.85 – 22.0 MHz	Voice and data	No Congested, subject to careful, formal planning
VHF	117 – 137 MHz	Voice and data	In principle No congested, subject to careful, formal planning
L-band	960 – 1164 MHz	Air-ground coms, DME, UAT, ADS-B…	In principle No Congested
C-band	5030- 5091 MHz	MLS, RPAS C2	Could be studied Mainly for RPAS, but 5030 – 5091 MHz under study for small UAS in some countries

Unlicensed frequency bands

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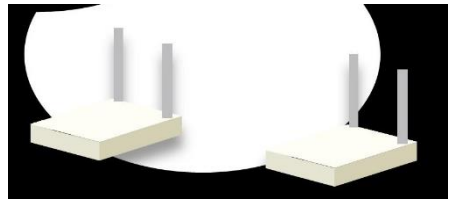
- Two main groups of unlicensed bands, designated for:
  - **Industrial, Scientific and Medical** (ISM) applications. These bands are listed in the ITU Radio Regulations, e.g. 2.4 GHz, 5.8 GHz;
  - **Short-Range Devices**. Designated nationally/regionally/ by ITU
- Main disadvantages : no interference protection, QoS are not ensured
  - Mainly for recreational UAS usage within line-of-site.
  - Possible solution for UAS identification and tracking (UAS radio tags)
  - May be not suitable for BLOS communications and professional UAS
- Usage of unlicensed bands for UAS varies by country.
  Examples: 27 MHz, 34 – 35 MHz, 40 MHz, 2.4 GHz, 5.8 GHz*



* ***Source: ECC Report 268***

Bands for cellular mobile systems (IMT)

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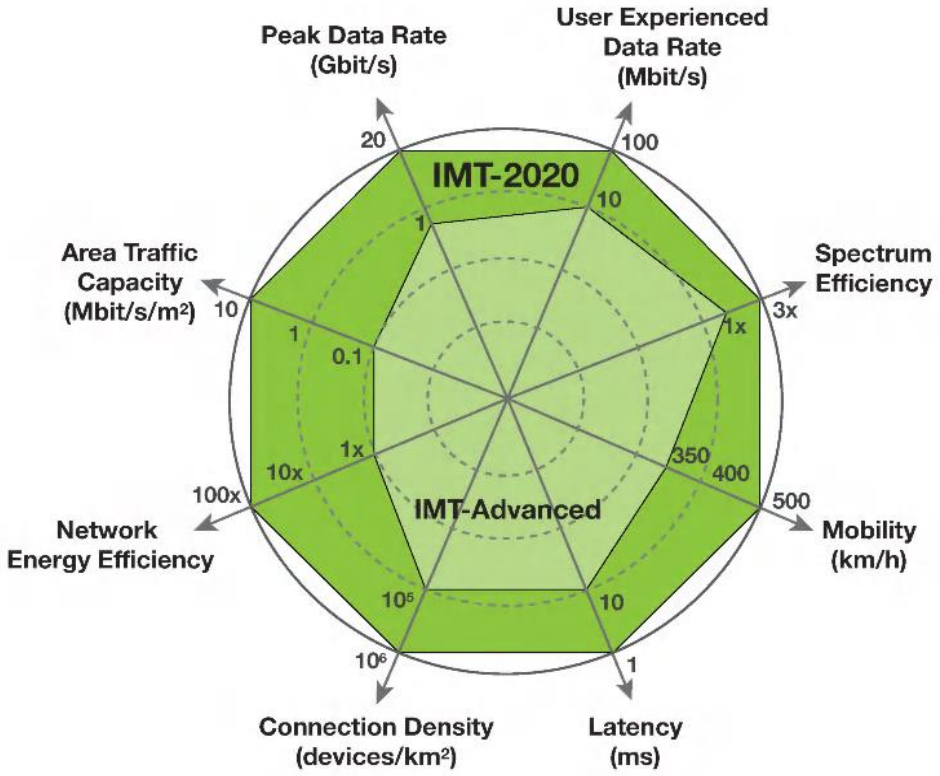
- ITU allocates spectrum for IMT, harmonizes the bands and develops high-level IMT standards
- IMT bands have huge capacity: 1 884 MHz spectrum
- Global harmonization: totally 65% harmonized; some key bands reach almost 100% harmonization
- IMT parameters could meet UAs requirements for C2 and payload, e.g. IMT-2020 (5G):
  - User data rates: 100 Mbit/s (downlink) 50 Mbit/s uplink
  - Latency: 1 – 5 ms
  - Mobility: 120 to 500 km/h
  - Connection density: 1 million devices per km^2



Other IMT advantages

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- The bands are sufficiently large to accommodate both C2 and payload – important due to carriage limitations of small UAS
- Ubiquitous coverage of cellular networks enables BLOS operations
- Potential for tracking UAS over mobile networks, similarly to mobile phones
- IMT bands are harmonized, which assists in trans-border operations, facilitate UMT unification
- IMT technologies will evolve and integrate into future heterogeneous networks (cellular + Wi-Fi + WiMAX + fixed …) -> better coverage, dynamic data traffic management

Limitations of current cellular networks

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- Uncovered areas
  - Current 3G/4G coverage is from 40 to100 % of population *. Example: host country 99.3%, but 0.7% of population may live at large territories having no coverage
- Network topology: reduced cell coverage towards the sky
  - Base stations serve the land, not the sky -> typical base station antennas look horizontally or to the ground
- QoS in some cases may not be sufficient to meet UAS safety requirements
  - Current mobile-cellular dropped call ratio vary from 0.01 to 3.35 % *

* ***Source: ITU telecommunication indicators, 2016***

Ecosystem of future 5G

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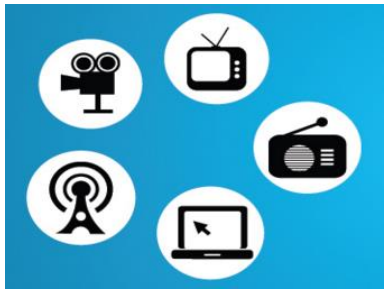
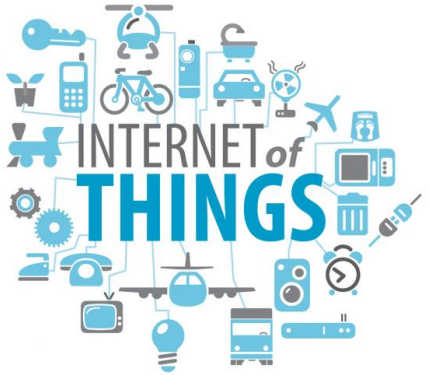
- 5G is wider than just mobile industry. It will accommodate verticals (industry sectors)
- Future 5G networks will be capable to adapt to a specific application

Automotive

Railways

Media





Industrial and home automation

Public safety

Drones

- 3GPP (3rd Generation Partnership Project) and telecom industry consider UAS as a potential 5G vertical

Summary

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- Possible approach: UAS categories -> requirements for operation range and channel QoS -> choice of spectrum and technologies to meet the requirements
- Spectrum for UAS C2
  - Licensed spectrum or dedicated bands for professional UAS and BLOS operations
  - Unlicensed bands for recreational UAS operated at LOS
- Candidate telecommunication technologies – probably no new, dedicated networks, rather use of existing ones and adapting them:
  - IMT and satellite networks for BLOS operations
  - WiFi and SRD for LOS operations
  - Possibly some aeronautical systems for LOS/BLOS

International cooperation

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- Studies on spectrum and technologies for UAS C2/payload/tracking are taking place both in ICAO and outside the aviation community:
  - Regional telecommunication organizations, e.g. CEPT
  - 3GPP and main telecommunication industry players – accommodation of UAS under 5G
  - ITU-T Study Group 20 dealing with IoT - identification of UAV as a digital object
- Possible assistance of ITU:
  - Adapting regulations to allow UAVs usage in IMT, if chosen
  - Global harmonization of spectrum for small UAS, if decided

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Thank you!