Potential Frequency Bands for RPAS Line-of-Sight Links

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Potential Frequency Bands for RPAS LOS Links

OUTLINE

- Bandwidth Requirements for RPAS Command and Control (C2) Links
- Data Requirements and Structures for C2 Links
- Potential Frequency Bands for LOS
  - C-Band
  - L-Band
- Summary

Potential Frequency Bands for RPAS LOS Links

Bandwidth Requirements for RPAS C2 Links

- **Bandwidth Requirements for the RPAS C2 Links have been identified in ITU-R M.2171**
  - **34 MHz required for radio line-of-sight (LOS) RPAS C2 communication**
  - **56 MHz required for beyond radio line-of-sight (BLOS) RPAS C2 communication**

Potential Frequency Bands for RPAS LOS Links

Data Requirements and Structures for RPAS C2 Links

- **Categories and rates of command and control data communication between the ground control station (GCS) and RPAS**

Uplink (GCS to RPAS)

Activity	bps
Telecommand	4593
Navigational Aid Setting	666
ATC Voice	4800
ATS Data	49
Total	10108

Downlink (RPAS to GCS)

Activity	bps
Telemetry	7595
Navaid Display Data	1137
ATC Voice	4800
ATS Data	59
DAA	4800
Weather	27770
Video	270000
Total	316161

Ref: RTCA, "UAS Command and Control (C2) Data Link White Paper," WP-2_C2, March 2014, 88 pp.

Potential Frequency Bands for RPAS LOS Links

Data Requirements and Structures for RPAS C2 Links

- **Four RPAS service classes**

Types of Communications Traffic in RPAS Service Classes

Small RPAS operating in a remote area at low altitude may only require uplink control and downlink telemetry (Service Class 1)

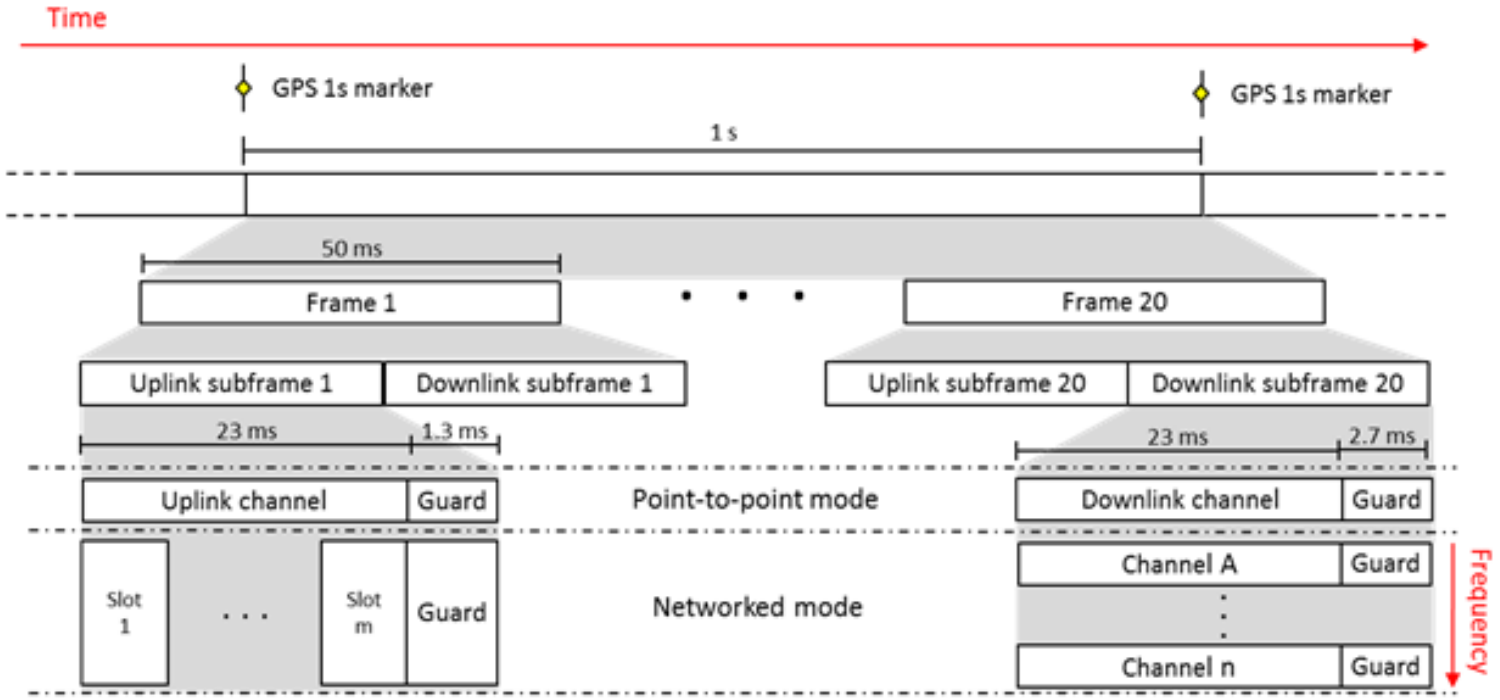
	Telemetry	Voice	Navigational Aids	Aircraft Targets	Weather Radar
Service Class 1	✓				
Service Class 2	✓	✓			
Service Class 3	✓	✓	✓	✓	
Service Class 4	✓	✓	✓	✓	✓

Large RPAS operating over a long range and high altitude would require all types of communications services (Service Class 4)

Potential Frequency Bands for RPAS LOS Links

Data Requirements and Structures for RPAS C2 Links

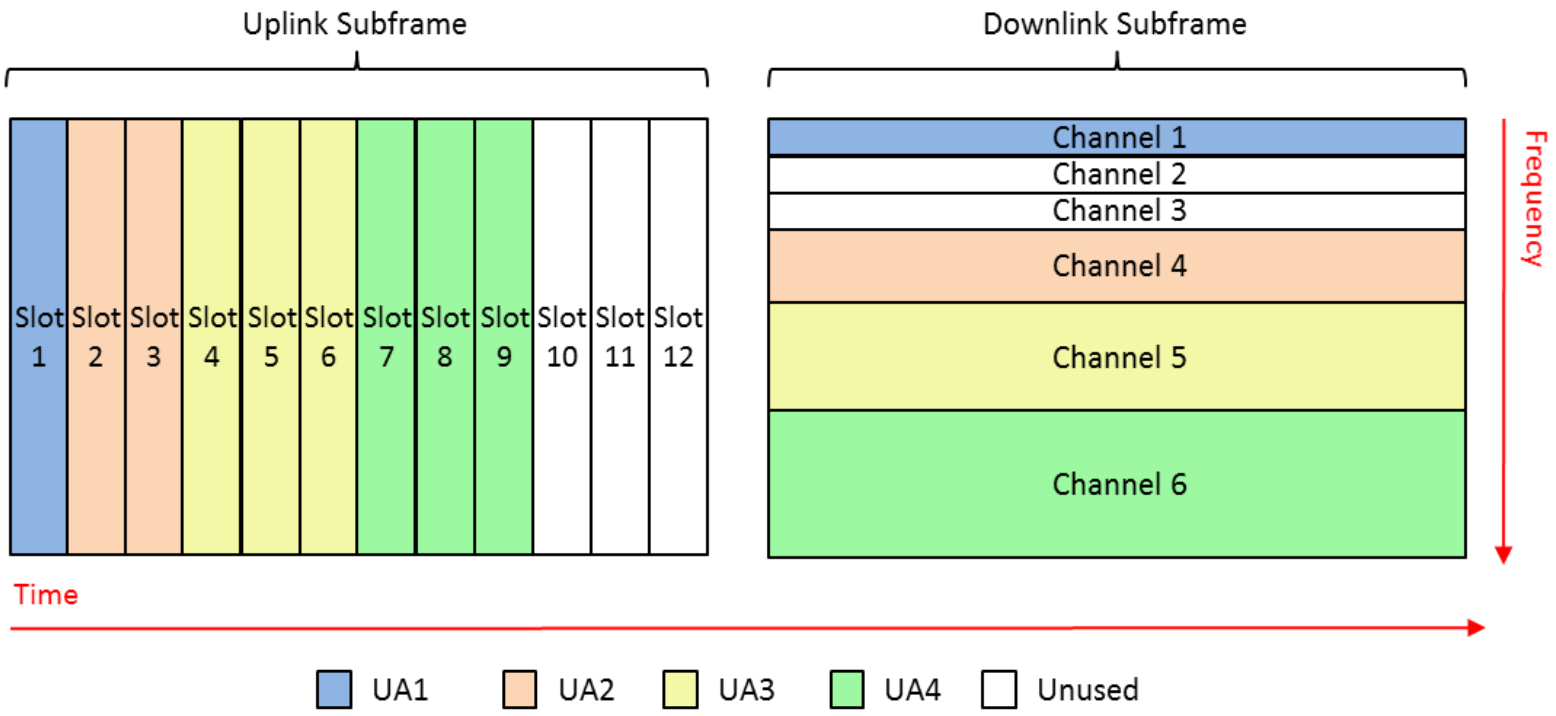
- **Possible RPAS LOS C2 Waveform**
- **TDM uplink, FDM Downlink**



Potential Frequency Bands for RPAS LOS Links

Data Requirements and Structures for RPAS C2 Links

- **Example for a 4 RPAS C2 system**



Potential Frequency Bands for RPAS LOS Links

Candidate Frequency Bands for LOS

- **C-Band – 5030-5091 MHz**
  - **As of WRC-12, this band has both an AM(R)S and AMS(R)S allocation**
- **L-Band – 960-1164 MHz**
  - **ANRS allocation**
  - **AM(R)S allocation added by WRC-07**
- **Testing of prototype systems has been done in both bands, and RTCA MOPS for terrestrial LOS C2 are completed.**

Potential Frequency Bands for RPAS LOS Links

C-Band – 5030-5091 MHz

- **The 5030-5091 MHz will be shared in some fashion by AM(R)S (terrestrial LOS RPAS C2) and AMS(R)S (satellite BLOS RPAS C2)**
- **Sharing of 5030-5091 MHz is under study**
  - **A partition between the AM(R)S and AMS(R)S is being considered, with AM(R)S occupying the middle portion between the AMS(R)S forward and return links**

5030 MHz 5091 MHz

Potential Frequency Bands for RPAS LOS Links

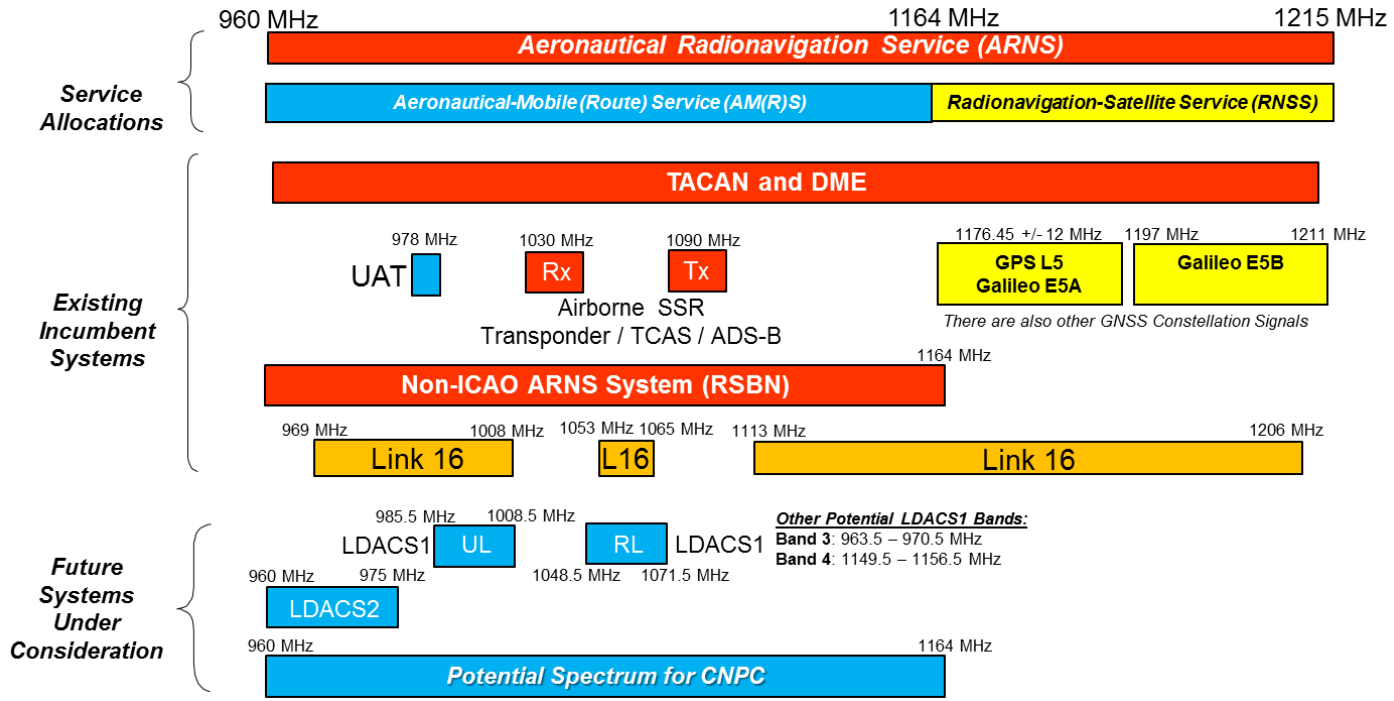
C-Band – 5030-5091 MHz

- 5030-5091 MHz partition may be static or flexible
  - Flexible partition would allow different implementations in different regions depending on requirements for terrestrial vs. satellite
  - Static partition would enable common global equipment design
- The amount of 5030-5091 MHz available for LOS links is not yet known

Potential Frequency Bands for RPAS LOS Links

L-Band – 960-1164 MHz

- **Heavily used by navigation systems**



SC203-CC021_Compatibility of Terrestrial L-Band CNPC with In-Band and Adjacent-Band Systems_vD_15March2013
Frank Box, Leo Globus, Warren Wilson, John Ashley, Michael Neale

Potential Frequency Bands for RPAS LOS Links

L-Band – 960-1164 MHz

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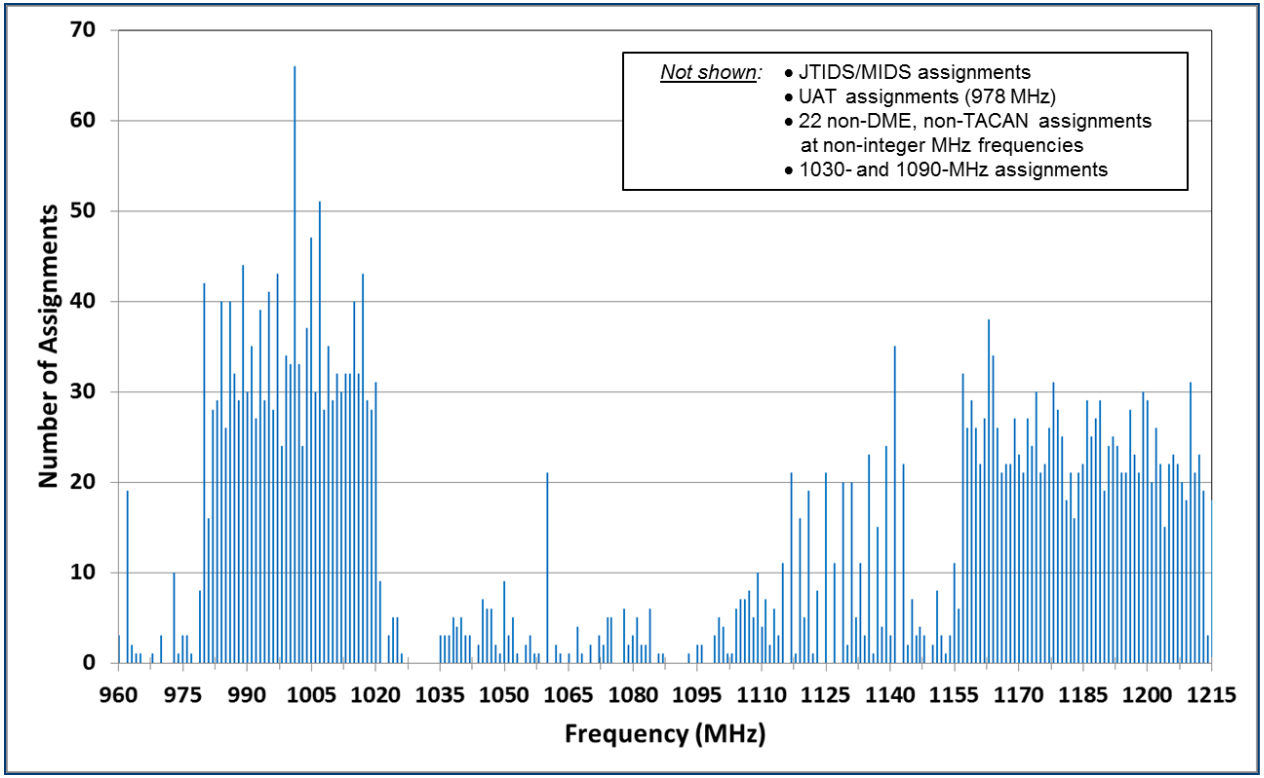
Fixed U.S. and Canadian Assignments, March 2012



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Potential Frequency Bands for RPAS LOS Links

L-Band – 960-1164 MHz

- 960-977 MHz band is considered promising for RPAS LOS C2, however there are some systems being used in this band (in the US at least) which constrain RPAS LOS
- 1020-1040 MHz and 1080-1100 MHz unavailable due to protection of SSR transponders
- Fitting RPAS LOS in between other navigation systems is very challenging
  - E.g. DME and TACAN interference threshold and receiver selectivity of the DME or TACAN receiver
  - More study is needed

Potential Frequency Bands for RPAS LOS Links

L-Band – 960-1164 MHz

- Two AM(R)S systems are being studied for possible implementation in L-Band
- LDACS1 is an OFDM-based waveform
  - Bandwidth is approximately 500 kHz, centered on channels situated between the DME frequencies
  - An LDACS-1 channel may be sufficient to support LOS RPAS
- LDACS2 is a TDD system
  - Planned for 960–977 MHz sub band
  - A single channel may be insufficient for the highest RPAS LOS data rates required
- Actual implementation of either LDACS1 or LDACS2 is still unknown

Potential Frequency Bands for RPAS LOS Links

Summary

- A requirement of 34 MHz has been identified to support RPAS LOS C2 communications
- Two bands have been identified as having potential to support RPAS LOS C2
- L-Band – 960-1164 MHz has an AM(R)S allocation but is heavily used by navigation systems and thus is difficult to apply to RPAS LOS C2. Further study on possible L-Band implementations is needed.
- C-Band – 5030-5091 MHz has AM(R)S and AMS(R)S allocations requiring a likely partition of the band between the two services. The amount of bandwidth to be available for RPAS LOS C2 is not yet determined.
- Prototype systems have been tested in both bands and Standards (MOPS) have been developed.