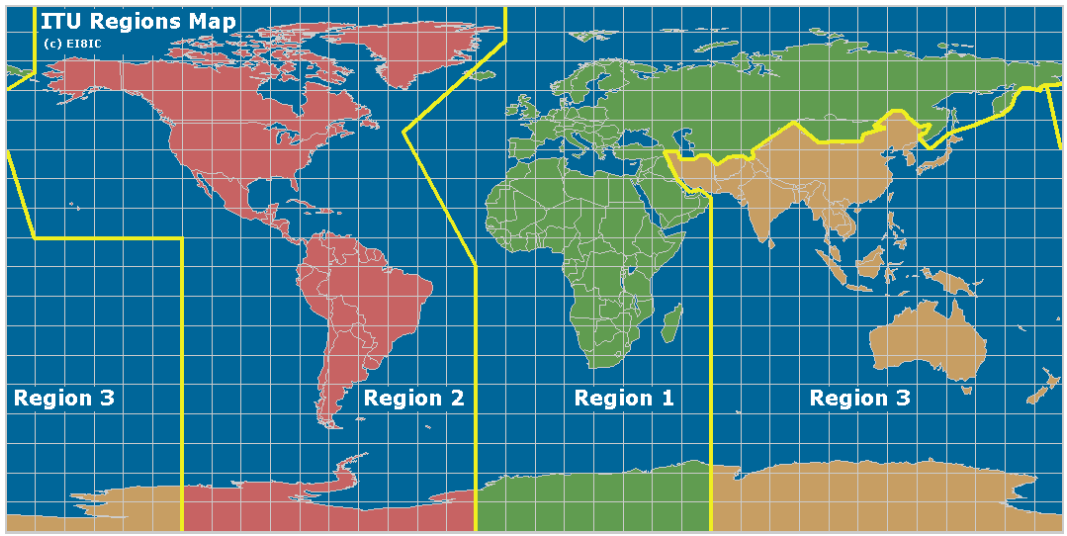
Spectrum Regulation and Radio Astronomy: Keeping the Window Clean

Andrew CLEGG
U.S. National Science Foundation
aclegg@nsf.gov

International: The ITU

- Specialized agency of the United Nations
- Radiocommunication sector of the ITU (ITU-R) manages radio spectrum and satellite orbits
  - ITU-R maintains the *Radio Regulations*, a treaty-level document
- Revisions to the *Radio Regulations* are the result of periodic World Radiocommunication Conferences

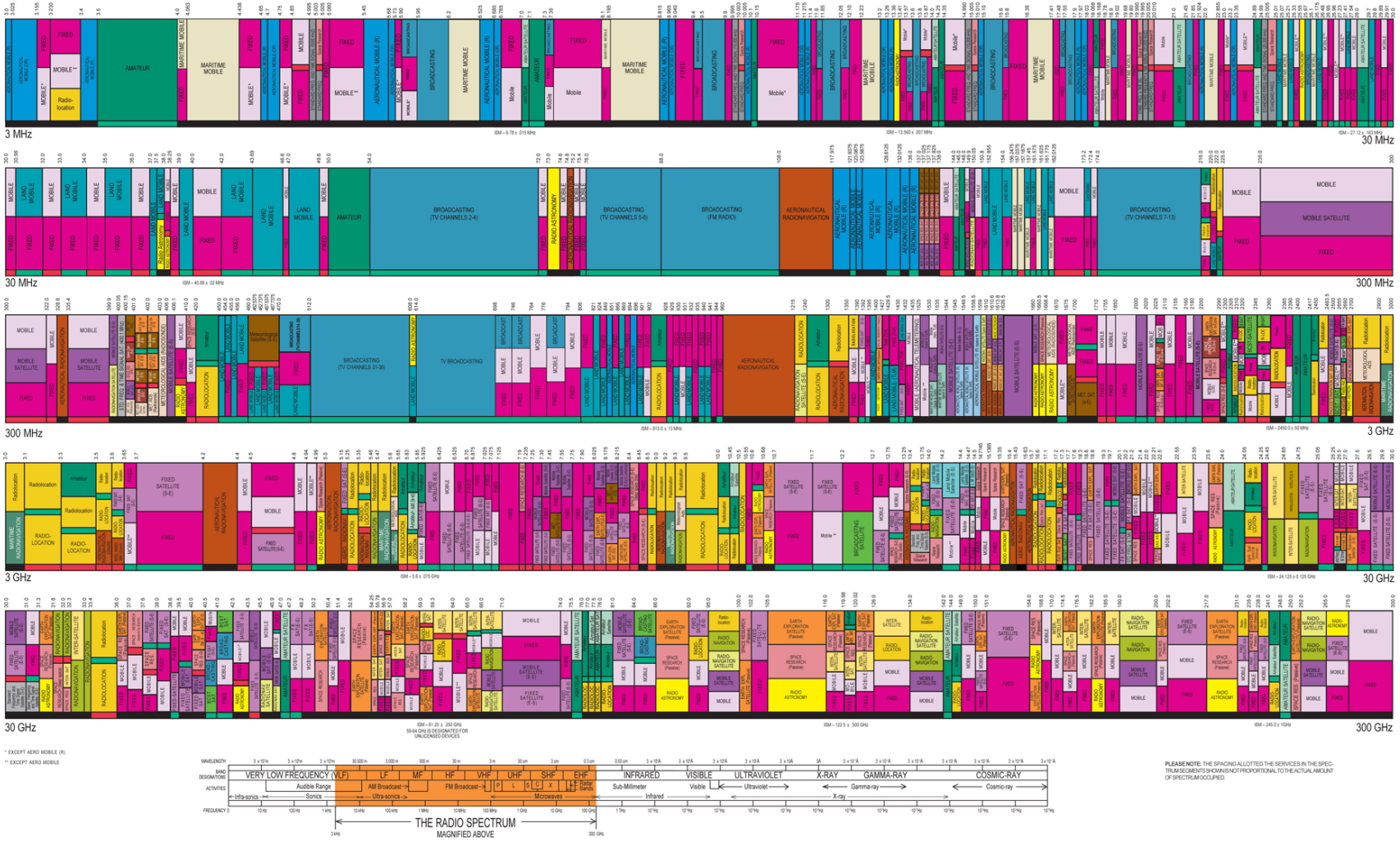


Regional/National

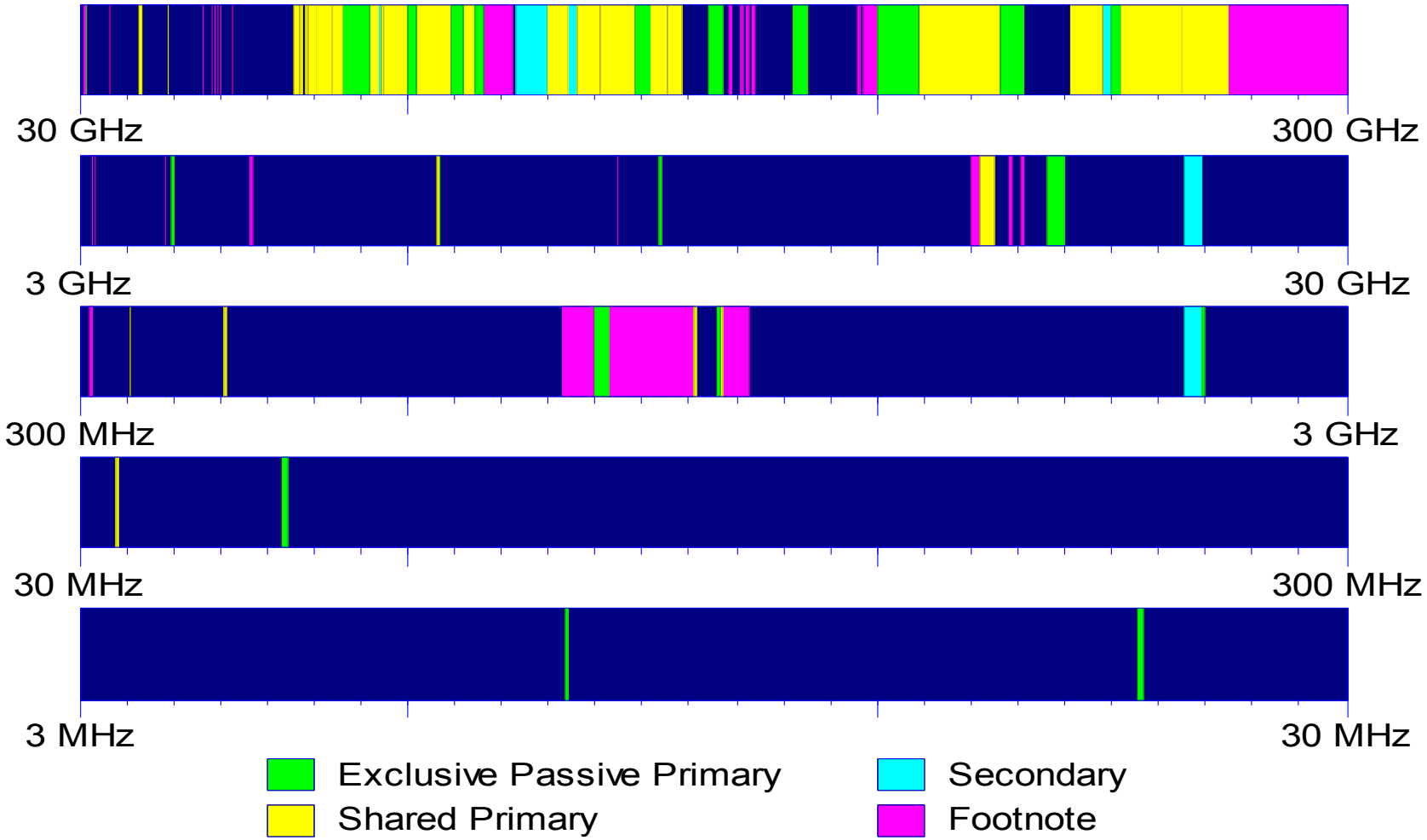
- Regional Coordination
  - La Comisión Interamericana de Telecomunicaciones (CITEL)

  - Helps foster consensus across the Americas on issues under consideration at the ITU
- National Regulation
  - Purview of national authorities, e.g., FCC (USA), SUBTEL (Chile), COFETEL (Mexico), ...

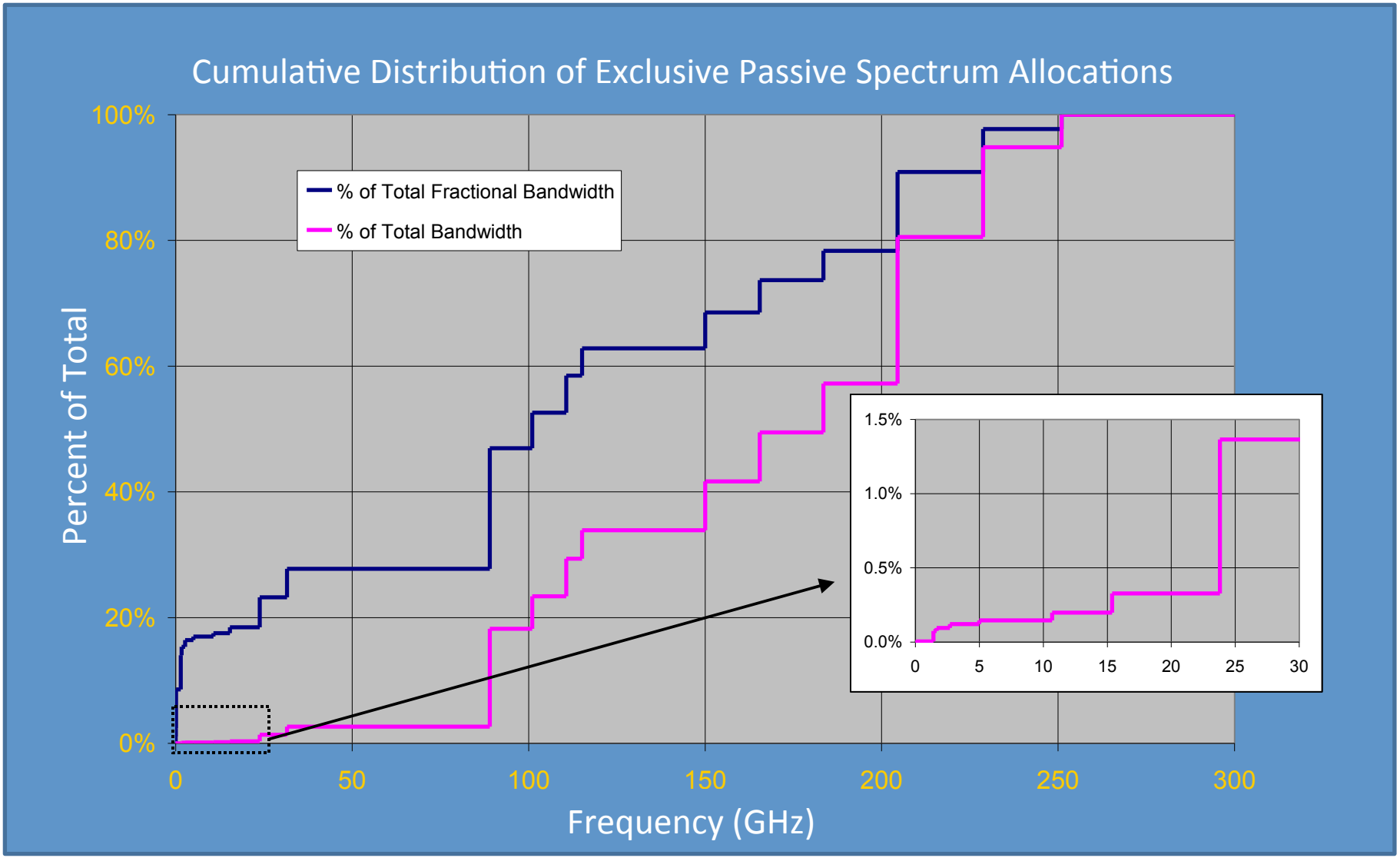
Allocations



Radio Astronomy Allocations

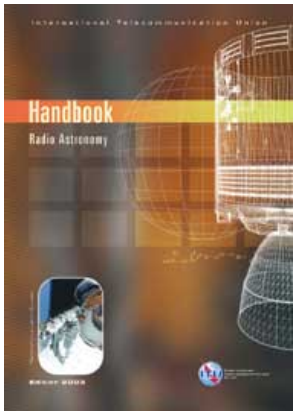


Radio Astronomy Allocations



Radio Astronomy at the ITU

- Work of the ITU-R is divided into Study Groups and their Working Parties
- Study Groups and Working Parties:
  - Draft technical bases for WRCs
  - Develop Recommendations and Reports
  - Compile Handbooks
- Radio astronomy is addressed in Working Party 7D (Radio Astronomy) under Study Group 7 (Science Services)

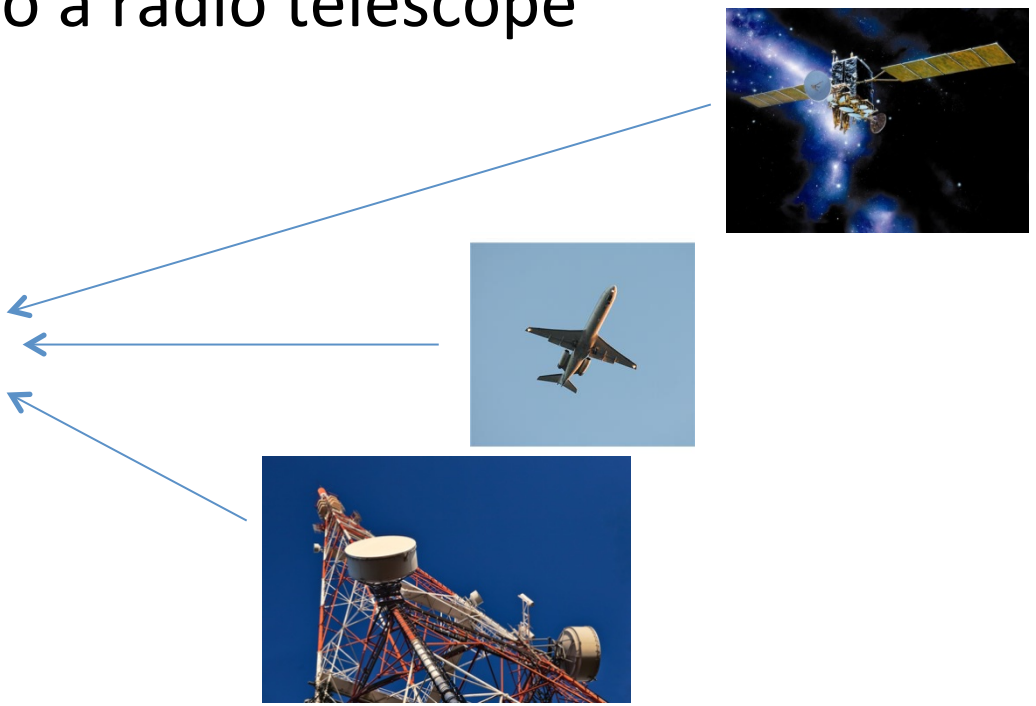


WP7D Recommendations

- WP7D presently has 14 formal ITU-R Recommendations in place
- General topic areas covered by WP7D Recommendations:
  - Preferred frequency bands for radio astronomy
  - Technical characteristics of radio astronomy systems
  - Protection criteria for radio astronomy systems (in-band, adjacent-band, and unwanted emissions)

Radio Astronomy Protection Criteria

- Recommendation ITU-R RA.769, *Protection criteria used for radio astronomical measurements*
- Standard reference for determining if a signal may cause interference to a radio telescope



Recommendation ITU-R RA.769

TABLE 1

Threshold levels of interference detrimental to radio astronomy continuum observations

Centre frequency [1] f_c (MHz)	Assumed bandwidth Δf (MHz)	Minimum antenna noise temperature T_A (K)	Receiver noise temperature T_R (K)	System sensitivity [2] (noise fluctuations)		Threshold interference levels [2] [3]		
				Temperature ΔT (mK)	Power spectral density ΔP (dB(W/Hz))	Input power ΔP_H (dBW)	pfd $S_H \Delta f$ (dB(W/m^2))	Spectral pfd S_H (dB(W/(m^2 · Hz)))
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13.385	0.05	50 000	60	5 000	–222	–185	–201	–248
25.610	0.12	15 000	60	972	–229	–188	–199	–249
73.8	1.6	750	60	14.3	–247	–195	–196	–258
151.525	2.95	150	60	2.73	–254	–199	–194	–259
325.3	6.6	40	60	0.87	–259	–201	–189	–258
408.05	3.9	25	60	0.96	–259	–203	–189	–255
611	6.0	20	60	0.73	–260	–202	–185	–253
1 413.5	27	12	10	0.095	–269	–205	–180	–255
1 665	10	12	10	0.16	–267	–207	–181	–251
2 695	10	12	10	0.16	–267	–207	–177	–247
4 995	10	12	10	0.16	–267	–207	–171	–241
10 650	100	12	10	0.049	–272	–202	–160	–240
15 375	50	15	15	0.095	–269	–202	–156	–233
22 355	290	35	30	0.085	–269	–195	–146	–231
23 800	400	15	30	0.050	–271	–195	–147	–233
31 550	500	18	65	0.083	–269	–192	–141	–228
43 000	1 000	25	65	0.064	–271	–191	–137	–227
89 000	8 000	12	30	0.011	–278	–189	–129	–228
150 000	8 000	14	30	0.011	–278	–189	–124	–223
224 000	8 000	20	43	0.016	–277	–188	–119	–218
270 000	8 000	25	50	0.019	–276	–187	–117	–216

Frequencies

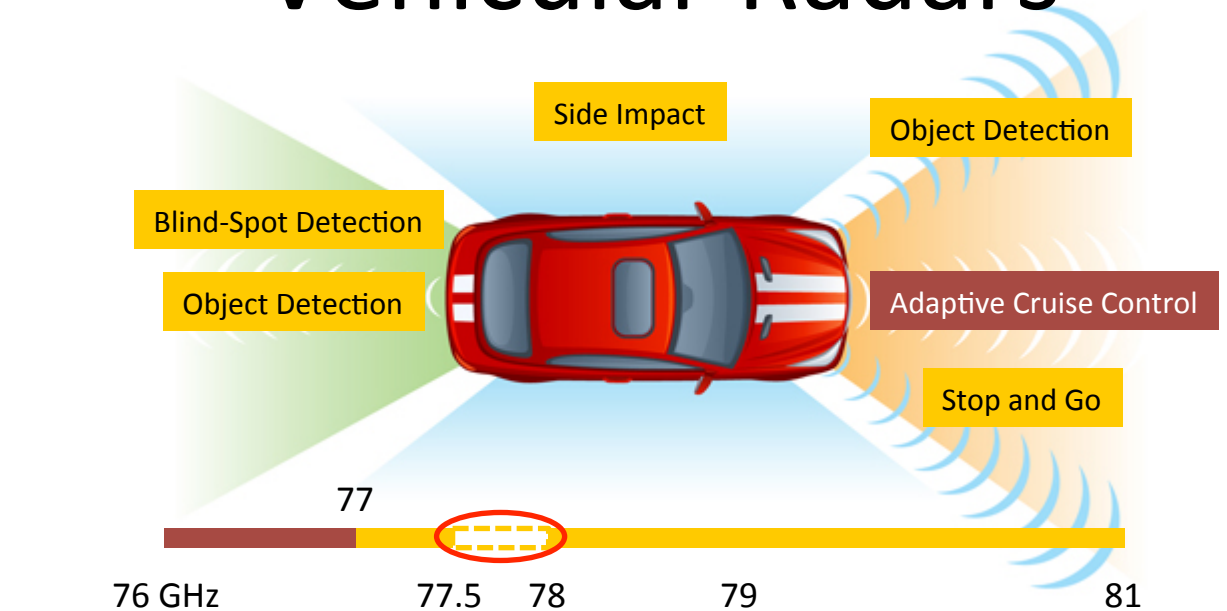
Assumptions

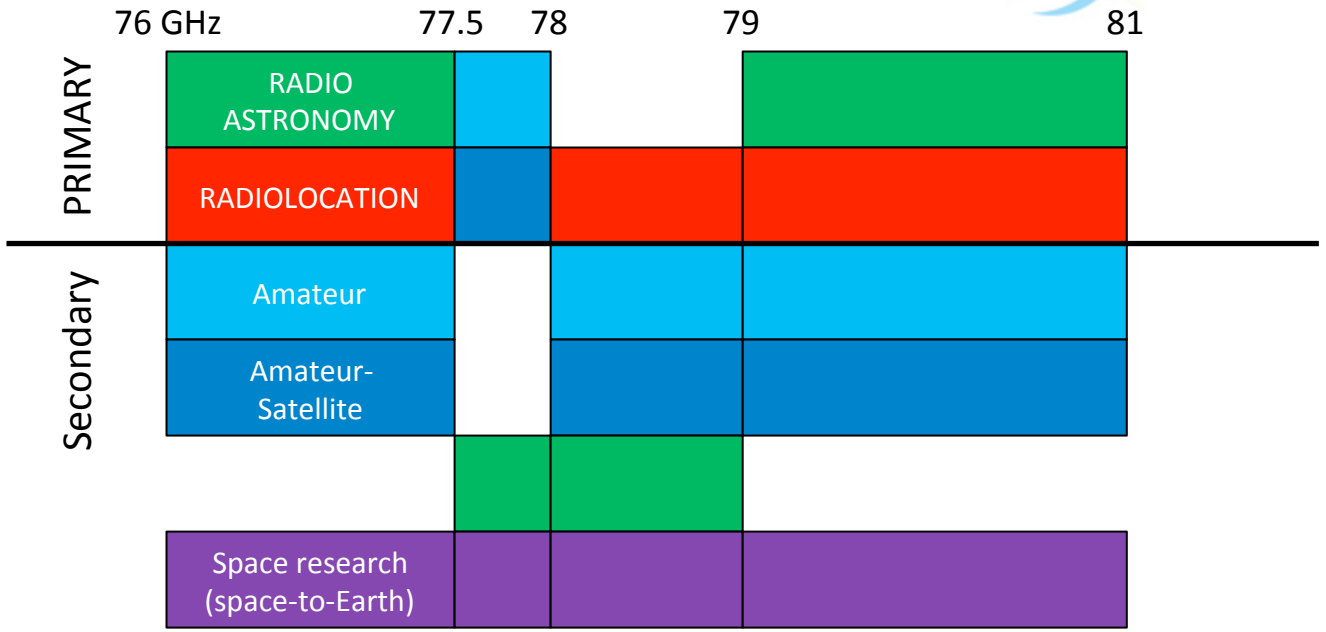
Derived System Sensitivity

Interference Threshold (various units)

Radio Astronomy at the 2015 World Radiocommunication Conference

Vehicular Radars





Other WRC-15

- Mobile Broadband (aka IMT)
- Additional mobile-satellite allocations at 22-26 GHz
- Wireless Avionics Intra-Communications (WAIC)
- Fixed-Satellite in 10-17 GHz (R1) & 13-17 GHz (R2 & R3)
- Earth Stations on Vessels (ESVs)
- Others?

Summary

- Protection of radio astronomy is particularly challenging due to the sensitivity of our instruments
- Vigilance at the national, regional, and international levels is required
- Get involved!