# Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

**Submission Title:** Review of the Results of WRC 2012
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**Re: IEEE 802.15-10-0450-01-0thz, doc. IEEE 802.15-11-0462-00-0thz**

**Abstract:** This document is a follow-up and update of doc. IEEE 802.15-10-0450-01-0thz and doc. IEEE 802.15-11-0462-00-0thz. It provides an overview on the results of agenda item 1.6 at WRC 2012, its implications for future THz communication systems operating beyond 275 GHz and discusses the next steps.

**Purpose:** Information of THz IG on results of WRC 2012

# Outline

- Introduction to agenda Item 1.6 of WRC 2012
- Preparatory work towards WRC 2012
- Results of WRC 2012
- Consequences and next steps for THz communictions

# Agenda Item 1.6 at WRC 2012


- 1.6: to review No. 5.565 of the Radio Regulations in order to update the spectrum use by the passive services between 275 GHz and 3 000 GHz, in accordance with Resolution 950 (Rev.WRC-07), and to consider possible procedures for free-space optical-links, taking into account the results of ITU-R studies, in accordance with Resolution 955 (WRC-07);

# Pre-WRC 2102 Situation in Radio Regulations

**Footnote 5.565** The frequency band 275-1 000 GHz may be used by administrations for experimentation with, and development of, various active and passive services. In this band a need has been identified for the following spectral line measurements for passive services:

- radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz;

- Earth exploration-satellite service (passive) and space research service (passive): 275-277 GHz, 294-306 GHz, 316-334 GHz, 342-349 GHz, 363-365 GHz, 371-389 GHz, 416-434 GHz, 442-444 GHz, 496-506 GHz, 546-568 GHz, 624-629 GHz, 634-654 GHz, 659-661 GHz, 684-692 GHz, 730-732 GHz, 851-853 GHz and 951-956 GHz.

Future research in this largely unexplored spectral region may yield additional spectral lines and continuum bands of interest to the passive services. Administrations are urged to take all practicable steps to protect these passive services from harmful interference until the date when the allocation Table is established in the above-mentioned frequency band. (WRC-2000)

# Implication of AI 1.6 on Active Services

- In the pre-WRC 2012 version footnote 5.565 of the Radio Regulations active services are explicitly mentioned.
- Since under agenda item 1.6 passive services only are under discussion there was a possibility that the term *active services* may have disappeared in the footnote.
- Moreover, identification of certain bands for passive services should not preclude future consideration of these bands for active services.
- Stakeholders of active services started in 2008 to contribute to the WRC preparation mainly through the regional groups and the IEEE 802.15 IG THz

# CPM-Proposal for WRC 2012

- **5.565** A number of bands in the frequency range 275-1 000 GHz are identified for use by administrations for passive service applications. The following specific frequency bands are identified for measurements by passive services:
- – radio astronomy service: 275-323 GHz, 327-371 GHz, 388-424 GHz, 426-442 GHz, 453-510 GHz, 623-711 GHz, 795-909 GHz and 926-945 GHz;
- – Earth exploration-satellite service (passive) and space research service (passive): 275-286 GHz, 296-306 GHz, 313-356 GHz, 361-365 GHz, 369-392 GHz, 397-399 GHz, 409-411 GHz, 416-434 GHz, 439-467 GHz, 477-502 GHz, 523-527 GHz, 538-581 GHz, 611-630 GHz, 634-654 GHz,657-692 GHz, 713-718 GHz,729-733 GHz, 750-754 GHz, 771-776 GHz, 823-846 GHz, 850-854 GHz, 857-862 GHz, 866-882 GHz, 905-928 GHz, 951-956 GHz, 968-973 GHz and 985-990 GHz.
- The use of the range 275-1 000 GHz by the passive services does not preclude use of this range by active services.
- Administrations wishing to make frequencies in the 275-1 000 GHz range available for active service applications are urged to take all practicable steps to protect these passive services from harmful interference until the date when the Table of Frequency Allocations is established in the above-mentioned 275-1 000 GHz frequency range.
- All frequencies in the range 1 000-3 000 GHz may be used by both active and passive services. (WRC-12)

# Results of WRC 2012

- After second reading the WRC 2012 Plenary has accepted to adopt the CPM proposal without modifications
- Since this solution is acceptable for active services and gives a lot of flexibility in developing systems, Germany has withdrawn it‘s request for a WRC 2015 agenda item on spectrum allocation for frequencies beyond 275 GHz
- The national administrations may allow active services to operate in the frequency bands beyond 275 GHz taking into account the following sentence in the footnote 5.565:
  - *“...Administrations wishing to make frequencies in the 275-1 000 GHz range available for active service applications are urged to take all practicable steps to protect these passive services from harmful interference...”*
- The most critical service, which may be affected by interference from active services is Earth Exploartion Satellite Service (EESS)

# Potential Spectrum for THz Communications where no Sharing with EESS is necessary

| Frequency Bands | Total available Bandwidth | Maximum Attenuation within the Band at 10 m |
|---|---|---|
| 286-296 GHz* | **10 GHz** | 101,8 dB |
| 306-313 GHz | **7 GHz** | 102,4 dB |
| 356-361 GHz | **5 GHz** | 103,7 dB |
| 365-369 GHz | **4 GHz** | 103,9 dB |
| 392-397 GHz | **5 GHz** | 104,5 dB |
| 399-409 GHz | **10 GHz** | 104,8 dB |
| 411-416 GHz | **5 GHz** | 104,9 dB |
| 434-439 GHz | **5 GHz** | 105,8 dB |
| 467-477 GHz | **10 GHz** | 106,5 dB |
| 502-523 GHz | 21 GHz | 107,7 dB |
| 527-538 GHz | 11 GHz | 109,9 dB |
| 581-611 GHz | 30 GHz | 110,0 dB |
| 629-634 GHz | **5 GHz** | 108,9 dB |

| Frequency Bands | Total available Bandwidth | Maximum Attenuation within the Band at 10 m |
|---|---|---|
| 692-713 GHz | 21 GHz/**19 GHz** | 110,1 dB |
| 718-729 GHz | 11 GHz | 111,1 dB |
| 733-750 GHz | 17 GHz | > 145 dB |
| 754-771 GHz | 17 GHz | > 145 dB |
| 776-823 GHz | 47 GHz/**28 GHz** | 111,9 dB |
| 846-850 GHz | **4 GHz** | 111,4 dB |
| 854-857 GHz | **3 GHz** | 111,5 dB |
| 862-866 GHz | **4 GHz** | 111,6 dB |
| 882-905 GHz | **13 GHz** | 112,2 dB |
| 928-951 GHz | **23 GHz** | 112,9 dB |
| 956-968 GHz | 12 GHz | 115,6 dB |
| 973-985 GHz | 12 GHz | 123,3 dB |
| 990-1000 GHz | 10 GHz | 141,8 dB |

* currently under discussion for use by Areonomy

**bold:** bandwith within atmospheric windows

# Spectrum Sharing Options for THz Communications

- THz Communication Systems requires continous spectrum of several 10 GHz
- Sharing is the only possibility to achieve such frequency bands
- Assuming that it will be technically possible to avoid transmission close to the high mountain plateau radio astronomy stations (see e. g. [3]) EESS remains the most critcial service to be considered.
- Use of THz Communications in same bands (sharing option) with EESS requires interference studies.
- A first presentation pointing out potential problems was given to the IG Thz at the Atlanta Plenary meeting [4]
- Interference studies will be one of the next key steps in the development of THz communications
- An overview on potential interference scenarios is given in [5]

# Conclusions

- WRC 2012 in principle provides a lot of flexibility w.r.t. bandwidth and carrier frequencies.
- In case sharing with passive services becomes necessary investigation of potential interference is required.
- Development of interference mitigation techniques to be included in the system design from the beginning
- Starting early dialog with regulatory bodies (FCC, CEPT etc.) will be beneficial

# References

[1] Thomas Kürner, „Status of Preparation Activities for WRC 2012”, doc. IEEE 802.15- 10-0450-01-0thz

[2] Thomas Kürner, “Update on the Status of WRC 2012 Preparation”,; doc. IEEE 802.15-15-11-0462-00-0thz

[3] Andrew Clegg, “Sharing between active and Radio Astronomy services at THz frequencies”, doc. IEEE 802.15-15-10-0829-00-0thz.

[4] Al Gasiewski, “Remote Sensing Applications of THz bands”; doc. IEEE 802.15-15-11-0765-00-0thz

[5] Sebastian Priebe, “Will THz Communication Interfere with Passive Remote Sensing? “, doc. IEEE 802.15-15-12-0102-00-0thz