**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |  |
| --- | --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | | |
| Title | Input from the TERAPAN Project to the TG3d Call for Contributions to the Response on the Liaison Statement from ITU-R WP1A | | |
| Date Submitted | [January 18, 2016] | | |
| Source | Sebastian Rey, TU Braunschweig  Ingmar Kallfass, Universität Stuttgart  Thomas Merkle, Fraunhofer IAF  Thomas Kürner, TU Braunschweig | | E-mail: rey@ifn.ing.tu-bs.de |
| Re: | | doc. IEEE 802.15-15-0082-00 | |
| Abstract | Input from the TERAPAN Project to the TG3d Call for Contributions to the Response on the Liaison Statement from ITU-R WP1A | | |
| Purpose | Providing technical input to the response on the Liaison Statement from ITU-R WP1A | | |
| Notice | This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. | | |
| Release | The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15. | | |

**Input from the TERAPAN Project to the TG3d Call for Contributions to the Response on the Liaison Statement from ITU-R WP1A**

# The TERAPAN-Project

TERAPAN is a collaborative project supported by the German Federal Ministry of Education and Research (BMBF) in its VIP (Validating the social and technological Innovation Potential) framework [1,2]. The project started on 1st August 2013 and runs until 31th July 2016.

* 1. **Project Goals**

The final objectives of the TERAPAN project are to demonstrate an adaptive wireless point-to-point terahertz communication system for indoor environments and in addition to validate its performance for distances of up to 10 m at data rates of up to 100 Gbps.

A first demonstration of mechanical beam-steering at 300 GHz with data rates of more than 10 Gbit/s has been realized [3]. A data rate of 64 Gbit/s has been reported in [4].

The demonstrator is based on 35nm InGaAs/GaAs mHEMT technology with THz cutoff frequencies and is realized in compact realization in waveguide modules. A cost efficient fully integrated 300 GHz transmitter and receiver MMIC (Monolithic Microwave Integrated Circuit) are validated together with beam-steering algorithms, which are required by the necessary highly directive antennas.

* 1. **Consortium**

Within TERAPAN three partners from Germany have joined their complimentary expertise in millimeter-wave and terahertz high-speed wireless communication systems, namely the University of Stuttgart (UST), the Fraunhofer Institute for Applied Solid State Physics (IAF) and the Technische Universität Braunschweig (TUBS).

# System Setup

The system setup has been presented to IEEE802 in [3].

# Application Scenarios

TERAPAN does not aim at a highly specific application scenario but addresses point-to-point links for WPAN-like applications in a rather generic way. Thus, the project focuses on short distances of up to 10 m for indoor use. At least two scenarios have come to mind from the very beginning of the project [1]:

* Smart Offices: Ultra high data rates for a huge number of point-to-point links with high frequency reuse due to the highly directive antennas.
* Wireless Links in Data Centers: Reconfigurable wireless links in addition to the fibre networks provide the opportunity to optimize the routing between certain racks according to the actual traffic demands.

Nevertheless, the TERAPAN demonstrator can in principle also be used in applications like backhaul or fronthaul for cellular mobile networks, if a suitable antenna can be attached.

# System Characteristics

In a first published transmission experiment [4] the following system characteristics haven been demonstrated/distinguished:

A data rate of 64 Gbit/s has been achieved with a simple QPSK modulation over a distance of 2 m at a center frequency of 300 GHz. The symbol rate was limited to 32 Gbaud/s due to the available measurement equipment. Therefore, even higher data rates are probably realizable by slightly increasing either the symbol rate or the modulation order. The transmitted power of approx. -4 dBm has been derived from the measurements, as well as, a noise figure of approx. 6.6 dB at the receiver and the transmitter. In addition a conical horn antenna with a gain of 24.2 dBi has been used at the receiver and at the transmitter. The final system targets at a bandwidth of 50 GHz.

In a previous demonstration [3] mechanical beam steering has been realized with a very similar setup. A demonstration of electrical beam steering with improved MMICs is currently in preparation.

# References

[1] <http://www.terapan.de/>

[2] <https://www.bmbf.de/files/VIP_Ingenieurswissenschaften.pdf>

[3] TERAPAN, “TERAPAN: Ultra-high Data Rate Transmission with steerable Antennas at 300 GHz,” IEEE 802.15 Document 15-15-0167-02-0thz, Berlin/Germany, March 2015.  
<https://mentor.ieee.org/802.15/dcn/15/15-15-0167-02-0thz-terapan-ultra-high-data-rate-transmission-with-steerable-antennas-at-300-ghz.pdf>

[4] I. Kallfass, I. Dan, S. Rey, P. Harati, J. Antes, A. Tessmann, S. Wagner, M. Kuri, R. Weber, H. Massler, A. Leuther, T. Merkle and T. Kürner, “Towards MMIC-Based 300 GHz Indoor Wireless Communication Systems,” IEICE Trans. Electron., vol. E98-C No. 12, pp 1081-1090, December 2015.