**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | TG3d Applications Requirements Document (ARD) |
| Date Submitted | [January, 2015] |
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| Re: |  |
| Abstract | The ARD contains descriptions on applications and use cases with performance and functional requirements |
| Purpose | Supporting document for the development of the amendment 3d of IEEE 802.15.3 |
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Document Overview

The ARD contains descriptions on applications and use cases with performance and functional requirements. The document will serve as a base line for all other supporting documente developed within TG3d:

* the Channel Modeling Document (CMD)
* Technical Requirements Document (TRD)
* Evaluation Criteria Document (ECD)
* Call for Proposals (CfP)

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# Definitions:

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# Scope

The amendment 3d to IEEE 802.15.3 defines a wireless switched point-to-point physical layer to IEEE Std. 802.15.3 operating at PHY data rates of 100 Gbps with fallback solutions at lower data rates. The purpose is to provide a standard for low complexity, low cost, low power consumption, and high data rate wireless connectivity among devices. Data rates will be high enough to satisfy a set of consumer multimedia industry needs, and to support emerging wireless switched point-to-point applications in

* data centers-
* wireless backhaul/fronthaul
* intra-device communication and
* close proximity P2P applications (kiosk downloading, file exchange)

The commonality of all these applications is their point-to-point character with known positons of transmit and receiving anetnnas and the option to switch between different links.

# Methodology

The descriptions of the applications and use cases with performance and functional requirements as listed in Section 2 are described in chapters 4 to 7 separately for each application using the following structure:

1. *Description of the operational environment* (including a meaningful graphic and a statement on the operations under LOS/NLOS/OLOS conditions)

2. *Definition of a typical transmission range*

3. *Description of the conditions to achive th*e *Target data rate*

4. *Specific issues with respect to regulation*

5. *Specific requirements with respect to the MAC* (e.g. supporting 48/64 bit MAC adreseses, issues with respect to bridging)

6. *Other issues*

# Close Proximity P2P applications

## Description of the operational environment

## Definition of a typical transmission range

## Description of the conditions to achieve the target data rate

## Specific issues with respect to regulation

## Specific requirements with respect to the MAC

## Other issues

## References

# Intra-Device Communication

Intra-device communication includes inter-chip communication to allow for pin count reduction.

## Description of the operational environment

In many wireless communication systems of today, the capacity is improved thanks to larger bandwidths, higher modulation orders and very efficient channel coding schemes. All these techniques permit to reach high data rates achieving several gigabits per second as proposed in the 60 GHz band (IEEE 802.11ad and IEEE 802.15.3c) or in the 5 GHz band (IEEE 802.11ac). However, in some specific applications like high quality audio/image/video transfers between devices and intra-device communications, the need in term of bit rate is higher than the few gigabits per second already addressed by these standards. First ideas of using RF/wireless links for intra-device communication have been published already in 2001 by Chang et. al. [1]. Two bottlenecks appear immediately against the enhancement of the above mentioned standards: the lack of efficient digital to analogue converters allowing many level of quantization at high speeds of sampling, and the absence of allocated large bandwidths allowing simple modulations with maybe two levels of quantization. The sub-millimetre bands may offer significant areas of available spectrum, solving the issues by allowing the use of simple modulation schemes. Recent publications show that data rates of up to 100Gbps are possible at a carrier frequency of 240 GHz [2] [3]. Nowadays this frequency range is also considered for board-to-board communication [4][5].

In board to board communication, some technologies are already available solving the copper issue like Light Peak fiber technology (named Thunderbolt). Light Peak is a high-speed optical cable technology designed to connect electronic devices to each other. Light Peak delivers high bandwidth starting at 10Gbps and up to 40Gbps. It uses PCI express or Display Port protocols.

What about cables and connectors burden?

Indeed, one main issue is the need to use of connectors on the boards which increase the cost and their design complexity. Another issue, which is obvious, is the cable which limit the flexibility when connecting the boards.

**Figure 1. Wireless board to board communication.**

The figure 1 illustrates the targeted use case. High speed terahertz wireless links could connect two boards or more. The terahertz band is huge hence several channels could be used in a small area (i.e. within on device).

## Definition of a typical transmission range

The targeted transmission range is up to 10 cm in the air or through two layers of material reasonably transparent to Terahertz wave (5mm thickness).

## Description of the conditions to achive the Target data rate

The targeted datarates are up to 100Gbps.

Channel bonding (parallelized channels and PHY layers) is needed to achieve 100Gbps.

The Bit Error Rate should be less that 10E-12 after Forward Error Correction. This is similar to LVDS performance and corresponds to one error every 10s at 100Gbps and at 10cm. The modulation should be based on line coding (20Gbps payload throughput maximum per channel).

## Specific issues with respect to regulation

The ITU is actually studying the bandwidth allocation for terahertz frequencies and at this moment there is no frequency allocated for active services between 275GHz and 1THz. The ITU identifies some frequency bands for passive services only [6].

## Specific requirements with respect to the MAC

Very simple Medium Access Protocol is used. Mechanism based on random access by contention is not appropriate since the level of the overhead will be high and a significant amount of bandwidth will be lost. In addition, the huge bandwidth provides the guarantee of a high number of channels that can be used simultaneously by different boards. The transmission range is very low hence frequency reuse is possible.

## Other issues

Xxx

## References

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| 1.
 | M. C. Frank Chang et. al., “RF/Wireless Interconnect for Inter- and Intra-Chip Communications” Proc. of the IEEE, VOL. 89, NO. 4, April 2001. |
|  | S. König et. al, “Wireless sub-THz communication system with high data rate”, Nature Photonics 7, p. 977–981, 2013 |
|  | I. Kallfass, J.Antes, T. Schneider, F. Kurz, D. Lopez-Diaz, S. Diebold, H. Massler, A. Leuther, A. Tessmann, “All Active MMIC-Based Wireless Communication at 220 GHz,” in IEEE Transactions on Terahertz Science and Technology, Vol. 1, Number 2, November 2011. |
|  | G. Fettweis, N. ul Hassan, L. Landau and E. Fischer, Wireless Interconnect for Board and Chip Level in Proceedings of the Design Automation and Test in Europe (DATE'13), Grenoble, France, March 18 - 22, 2013. |
|  | J. Israel, J. Martinovic, A. Fischer, M. Jenning and L. Landau, Optimal Antenna Positioning for Wireless Board-To-Board Communication Using a Butler Matrix Beamforming Network in Proceedings of the 17th International ITG Workshop on Smart Antennas (WSA 2013), Stuttgart, Germany, March 13 – 14, 2013. |
| 1.
 | Radio Regulation, Edition 2012. |

# Fronthauling

 *[Note: This section focuses on RF transmission using optical fiber links. The original title of this section“Backhauling/Fronthauling”was amended.]*

## Description of the operational environment

## Definition of a typical transmission range

##  Description of the conditions to achive the Target data rate

## Specific issues with respect to regulation

## Specific requirements with respect to the MAC

## Other issues

## References

# Backhauling

## Description of the operational environment

xxx

## Definition of a typical transmission range

xxx

## Description of the conditions to achive the Target data rate

xxx

## Specific issues with respect to regulation

xxx

## Specific requirements with respect to the MAC

xxx

## Other issues

xxx

# Data Center

## Description of the operational environment

xxx

## Definition of a typical transmission range

xxx

## Description of the conditions to achive the Target data rate

xxx

## Specific issues with respect to regulation

xxx

## Specific requirements with respect to the MAC

xxx

## Other issues

xxx

## References