Project: IEEE P802.15 Working Group for Wireless Speciality Networks (WSN)

Submission Title: Overview on IEEE Std 802.15.3 (Presentation to joint 802.15/802.1 Meeting)

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Re: n/a

Abstract: This document provides an overview on IEEE 802.15.3

Purpose: Information of IEEE 802.1 on IEEE Std 802.15.3

Overview on IEEE Std 802.15.3

Presented to the Joint IEEE 802.1/802.15 Meeting, March 15 2023

Thomas Kürner, TU Braunschweig

Chair IEEE 802.15 TG3mb

Chair IEEE 802,15 SC THz

Agenda

- History of IEEE 802.15.3
- Applications and key facts of the amendment IEEE Std 802.15.3d-2017
- Main features in the ongoing revision project (IEEE P802.15.3mb)
- Status of features of relevance to IEEE 802.1
- Discussion

History of IEEE 802.15.3 (1/2)

- Initial project started March 2000
  - –New MAC/PHY combination
  - –Completed 2003 => **IEEE Std 802.15.3-2003**
- First amendment failed to complete
  - – UWB PHY, but unable to get 75% approval
- Second amendment to fix MAC issues
  - – **IEEE Std 802.15.3b**
- Third amendment added mmWave alternative PHY
  - – Supports beam forming, aggregation **=> IEEE Std 802.15.3c**

History of IEEE 802.15.3 (2/2)

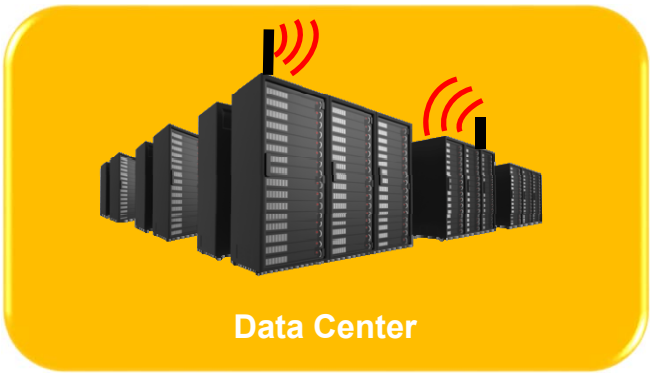
- 1st Revision project
  - – Roll-up of all mendments => **IEEE Std 802.15.3-2016**
  - –Completed 2003 => **IEEE Std 802.15.3-2003**
- Amendment for a specific 60 GHz PHY
  - – for High-Rate Close Proximity (HRCP) => **IEEE Std 802.15.3e-2017**
- Amendment for a THz-PHY
  - – MAC inherited from IEEE Std 802.15.3e-2017 => **IEEE Std 802.15.3d-2017**
- Amendment to extend mmWave up to 71 GHz
  - – **=> IEEE Std 802.15.3f-2017**

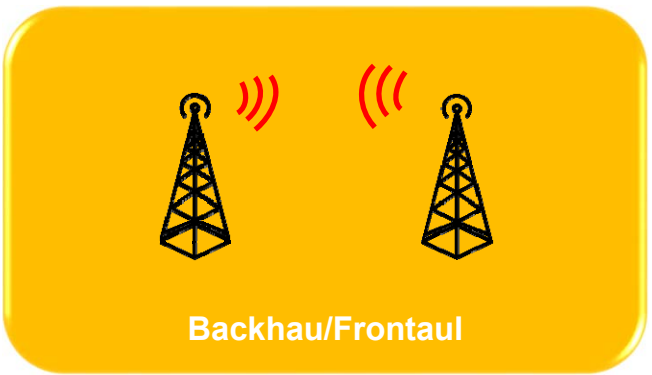
Main Applications and Drivers for IEEE 802.15.3d-2017 (1/2)

- Use of bandwidth of several 10s of GHz to achieve ultra-high data rates 100 Gbps and beyond
- At the time when IEEE P802.15.3d was kicked-off, technology was mature enough for fixed point-to-point links without the need for extensive device discovery and beam-forming.
- Use of high-gain antennas to overcome high path loss at 300 GHz

  => Reduced requirements on interference mitigation and „fight for access“ (same assumptions as for IEEE Std 802.15.3e)

Main Applications and Drivers for IEEE 802.15.3d-2017 (2/2)

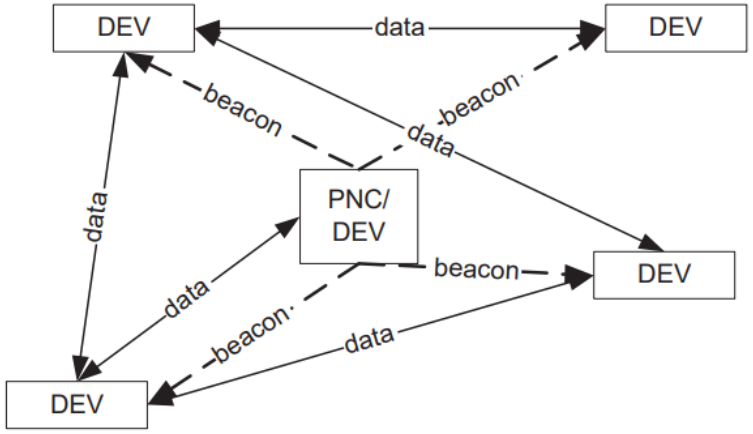




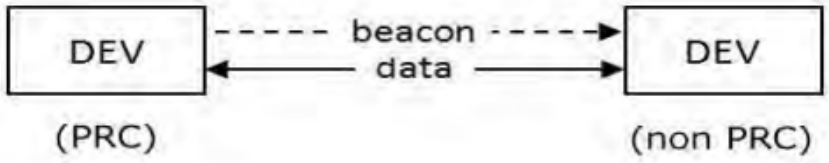
Key features of IEEE Std 802.15.3d-2017

- IEEE Std 802.15.3d-2017
  - defines an alternative physical layer (PHY) at the lower THz frequency range, between 252 GHz and 325 GHz for fixed point-to-point links along with the necessary MAC changes to support this PHY.
  - The amendment builds on the concept of pairnet, introduced in IEEE Std 802.15.3e-2017, and inherits the corresponding MAC changes defined there.
  - Some of the key features and additions are as follows:
    - Usage of eight different bandwidths between 2.16 GHz and 69.12 GHz.
    - Designed for data rates of up to 100 Gb/s.
    - Selectable PHY modes (single carrier and on-off keying) to achieve either ultra high-speed operation or system simplicity

Piconet vs. Pairnet

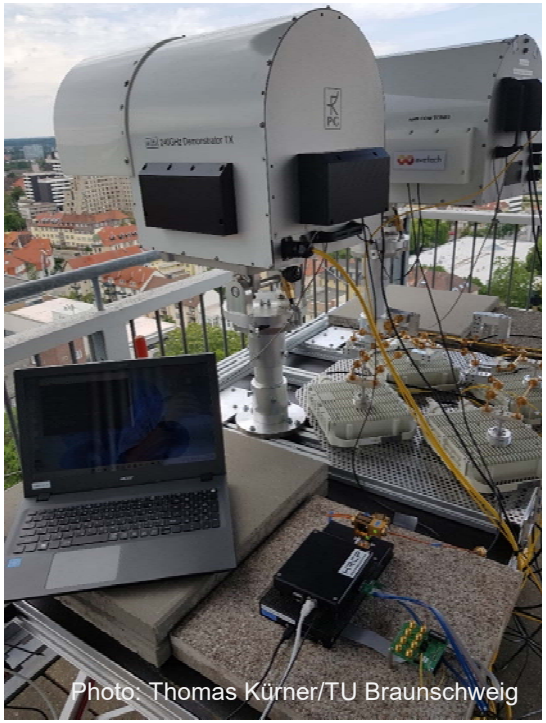


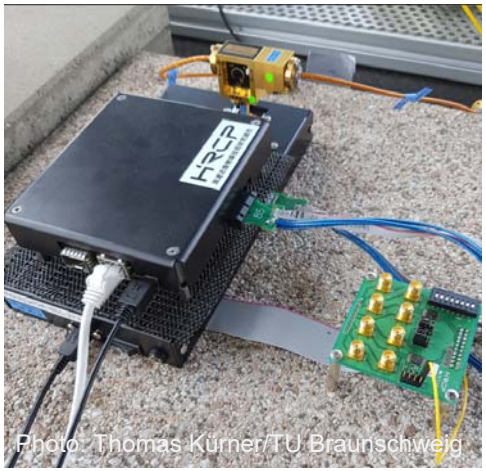
Piconet



Pairnet

Demonstration of Link-Setup-up and Data Transmission for Backhaul Link by the ThoR Project






```
rfpll_calibration3: selected bank: 9 (cal=817,tgt=815)
status = Good
time (us) = 32700163.736
transferred data (MiB) = 4096
data rate (Mbps) = 1050.751
```

Screenshot of the successfull transmision

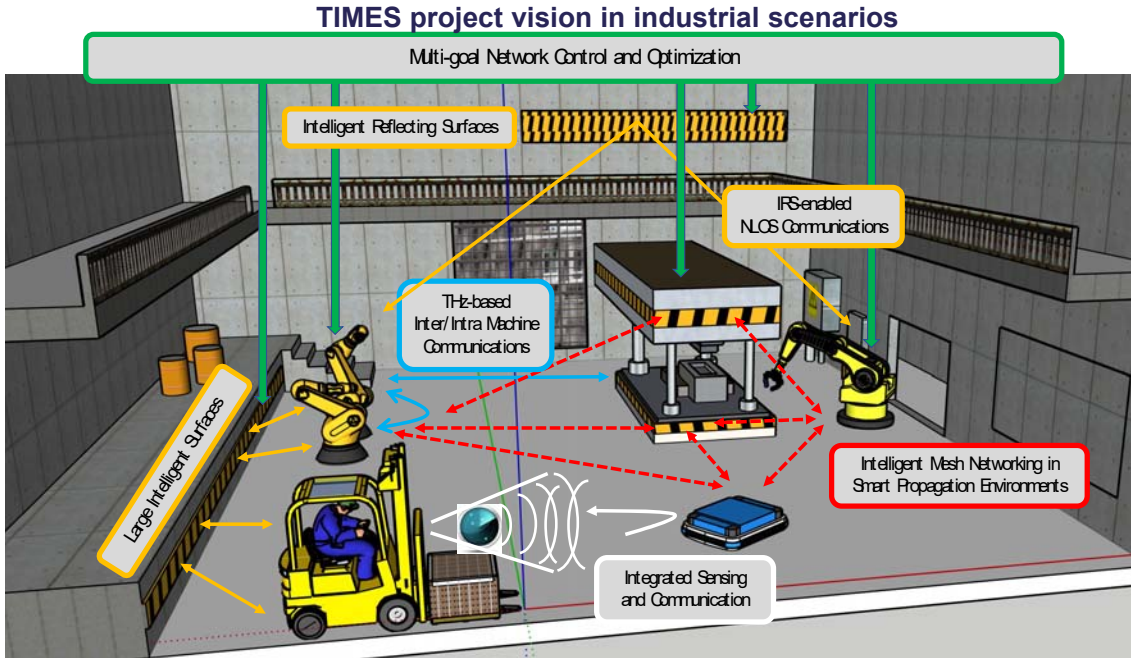
Video of the complete ThoR Hardware demonstration is available at https://www.youtube.com/watch?v=vEBfRHZGSyc

Source: https://mentor.ieee.org/802.15/dcn/22/15-22-0379-00-03ma-demonstrating-a-quasi-compliant-ieee-std-802-15-3d-transmission-for-160m-backhaul-link.pdf

Main Issues covered in the ongoing Revision Project (IEEE P 802.15.3mb)

- Roll-up of all amendments since the last revision
- Include all new frequency bands above 275 GHz identified by WRC 2019
- Fix RIFS timing parameter issue
- Replace reference to IEEE Std 802.1D by reference to IEEE Std 802.1Q
- Introduce two new modulation schemes (16-APSK, 32-APSK)

Future Applications of THz Communications may include mobility and mesh-networks



Source. https://mentor.ieee.org/802.15/dcn/23/15-23-0133-00-0thz-overview-on-the-horizon-europe-6g-sns-project-times.pdf

Status of Features with Relevance to IEEE 802.1

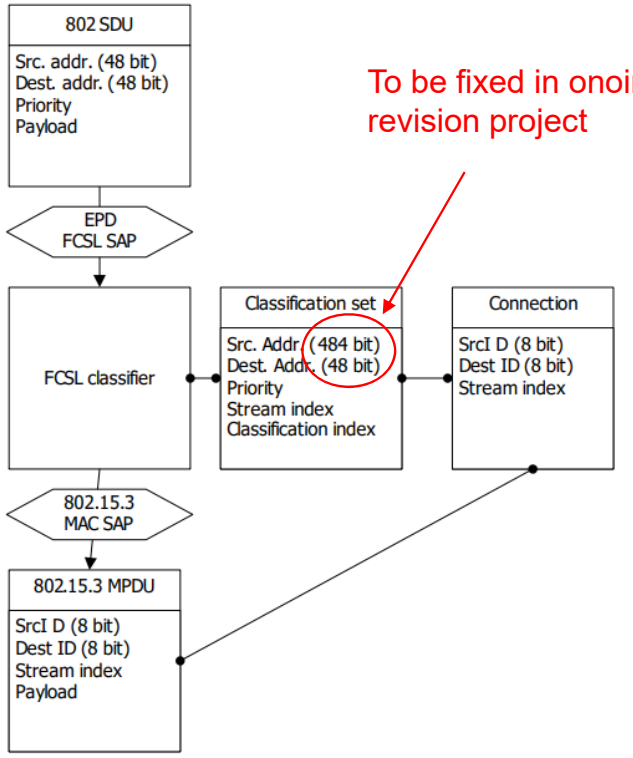
- Recap: Joint 802.17802.15 Meeting July 2022

802.1 Features to 802.15 Mapping

Std	Relevant?	Issues?	Bridging	Dynamic Addressing	EPD	QoS	TSN
15.3	Yes	?	Done	Not yet	Done	Yes	Not yet

Changes made in the Context of the Development of IEEE 802.15.3-2016 and IEEE Std 802.15.3d

- Changing from 64 bit-adresses to 48 bit adresses
- Developing IEEE Std 802.1ACct™-2021



In ongoing revision project: Revised Annex B.3.2 EPD FCSL QoS support

- Reference to 802.1D replaced by reference to 802.1Q;
- Traffic type table revised

Table B-1—Traffic types

UserPriority	Traffic type	Used for	Comments
0 (default)	Best effort (BE)	Asynchronous data	Default piconet traffic
1	Background (BK)	Asynchronous data	Bulk transfers
2	Excellent effort (EE)	Isochronous data	For valued customers
3	Critical applications (CA)		Guaranteed minimum bandwidth
4	Video (VI)	Isochronous data	< 100 ms delay and jitter
5	Voice (VO)	Isochronous data	< 10 ms delay and jitter
6	Internetwork control (IC)		Large networks comprising separate administrative domains
7	Network control (NC)		Maintenance of network infrastructure

TSN / Dynamic Adressing

- TSN:
  - Not considered yet in the context of THz communciations at 300 GHz
  - Might be checked for potential fronthauling applications
- Dynamic Adressing:
  - Might become of interest for future mobile applications

- Discussion and next Steps?