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

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Re: IEEE 802.15-13-0130-01-0thz_Launching

Abstract: This documents follows the discussions at the previous IEEE 802 plenary on the application of wireless data centers when launching a study group on “Beam switchable wireless point-to-point 40/100 Gbps links”. The document summarizes some requirements on wireless data centers based on a literature study.

Purpose: Information of IEEE 802.15 IG THz

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Literature Review on Requirements for Wireless Data Centers

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Introduction

- To the best knowledge of the author the first publication on wireless data centers has been made in 2008 [7].
- Since then a couple of papers on this topic have been published.
- This contribution briefly summarizes the key findings from a literature review focussing mainly on requirements for wireless data centers

Reasoning for introducing wireless links in data centers (from [1])

- Pure wired data centers are static and can not be reconfigured dynamically
- Cabling complexity
  - wastes much space
  - is hard to maintain
  - requires adequate cooling

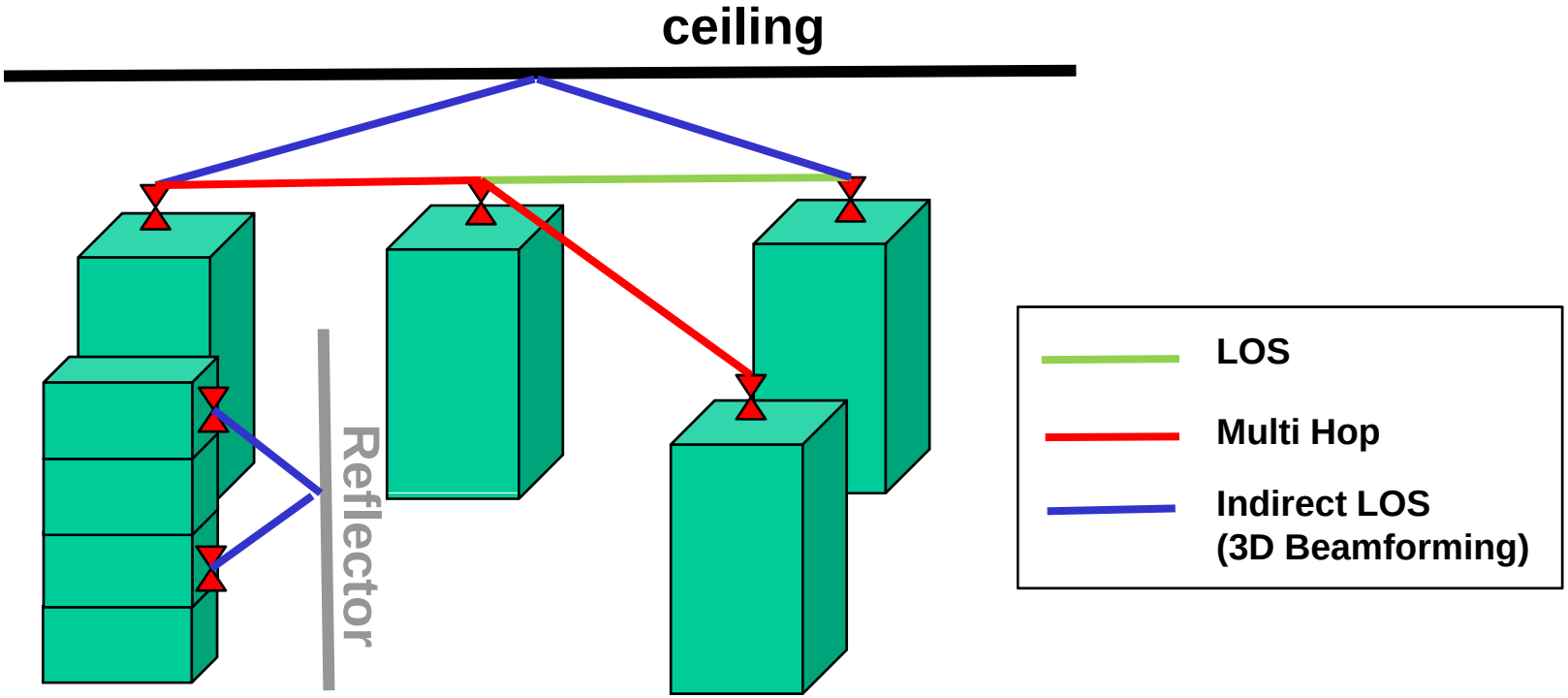
General Requirements on Wireless Connectivity in Data Centers (from[7])

- High inter-node link capacity
- Reliability (predictable performance of links over time)
- Security isolation
- Scalability (interconnecting 10.000s of servers
- Small form factor of networking components

Summary on Proposed Architectures

- Traditional DCN architectures are based on layered 2-tier (3tier-) architectures with core, (aggregation) and access layers [2]
- A couple of specific arrangements of the servers racks exploring the possibilities to introduce wireless links are proposed as well.
- In the following slides some of these proposals are presented

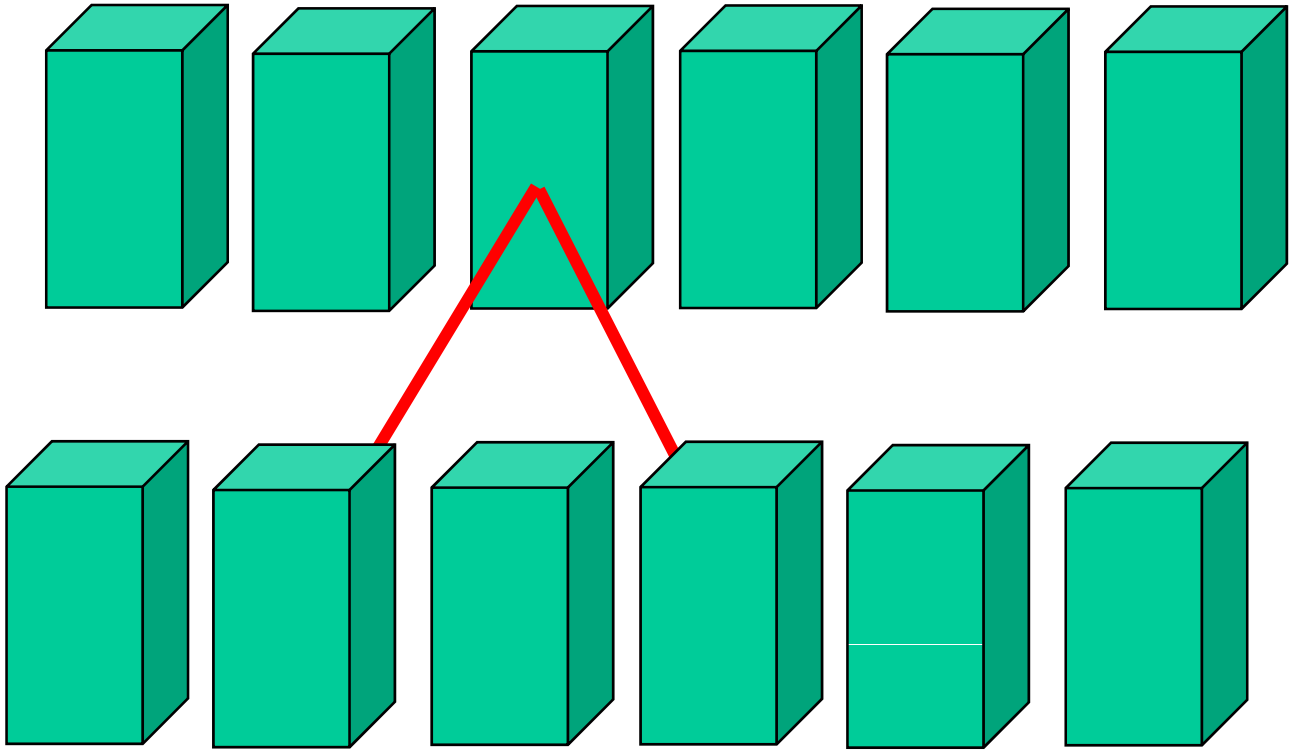
LOS and Indirect LOS Paths [4,7]



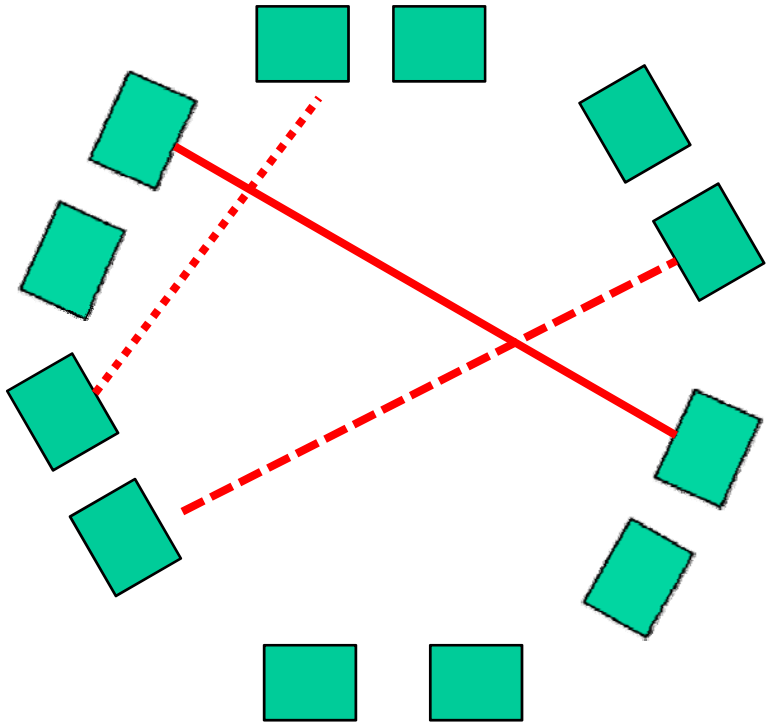
Hardware Components required for 3D Beamforming via Ceiling [4]

- Beamforming capabilities both in azimuth and elevation
- Ceiling reflectors (aluminium plates or other good reflecting materials)
- Electromagnetic absorbers on top of the racks to prevent local reflection/scattering around the antenna

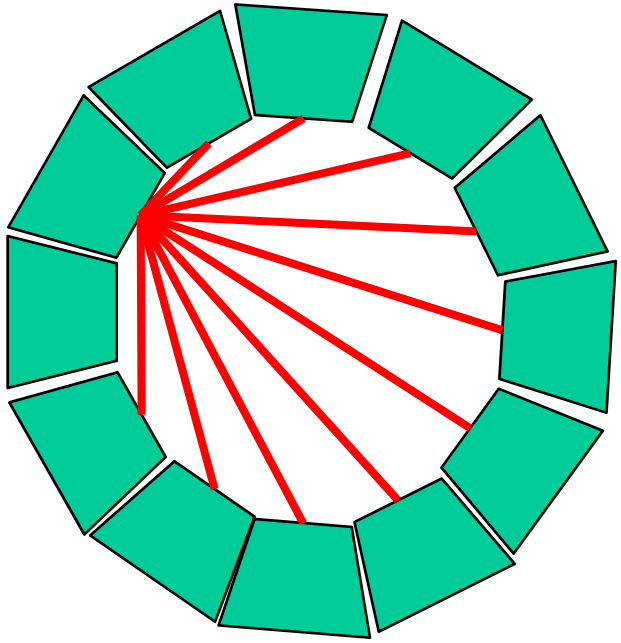
Node Arrangements – Two Parallel Rows [2]



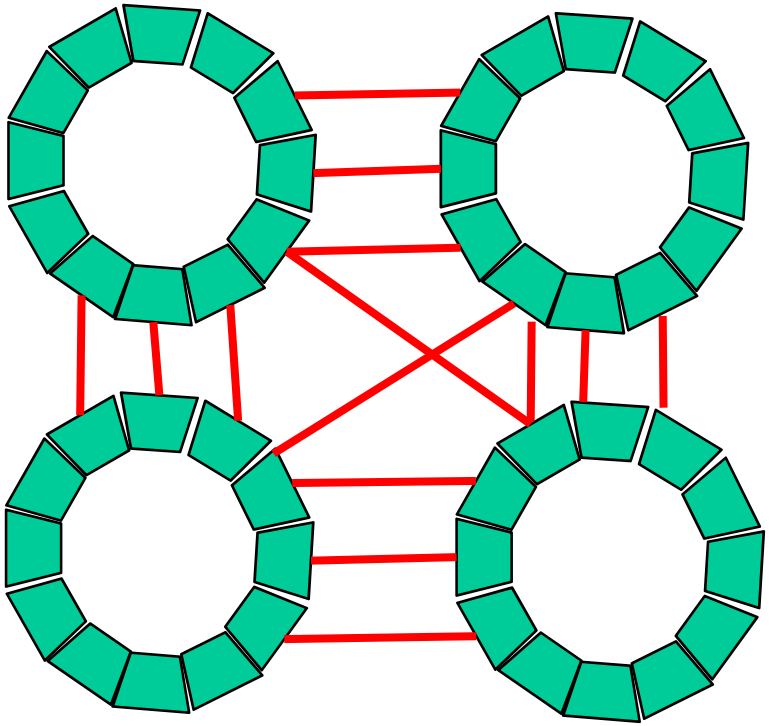
Node Arrangements – Hexagonal Shape [2]



Caley Data Center Design [6]



Intra-Rack Links



Inter-Rack Links

PHY/MAC Issues discussed in the literature (1/3)

- [2] uses the SC PHY of IEEE 802.15.3c due to low power requirements (asuming no non-LOS links are required)
- LOS 60 GHz links set-up at rack height provide stable performance [5]
- Assumption of stable channel conditions enable optimisation of beam-steering parameters during initialisation using look-up tables until reconfiguration [3]

PHY/MAC Issues discussed in the literature (2/3)

- Optimisation of Steered-beam table entries with respect to reachable neighbour nodes in order to avoid interference [3]
- Directional antennas can isolate links and enable spatial reuse [5]
- Results in [5] show that directional antennas are necessary to achieve high throughput over links above 1m

PHY/MAC Issues discussed in the literature (3/3)

- Efficient spectral re-use inherently reduces collision probability [3].
- In [5] it is shown that due to the low collison probability maximum TCP throughput could be increased by reducing unnecessary TCP overhead
- Discussion of using out-of-band signalling at lower frequencies [3].
- Channel Allocation and Scheduling asepcts are discussed in detail in [8,9]

List of References (1/2)

[1] Kaishun Wu, „Rethinking the architecture design of data center networks", Front. Comp. Science, Review Article, 2012 (9 pages)

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[3] Katayama Y, Takano K, Kohda Y, Ohba N, Nakano, "Wireless data center networking with steered-beam mmwave links", in: Proceeding of 2011 IEEE Wireless Communications and Networking Conference. 2011, pp. 2179–2184

[4] Zhang W et. al, „3D beamforming for wireless data centers", in Proceedings of the 10th ACM Workshop on Hot Topics in Networks. 2011

[5] D. Halperin et. al, „Augmenting Data Center Networks with Multi-Gigabit Wireless Links", SiGCOMM 2011

[6] „On the feasibility of Completely Wireless Data Centers", http://www.cs.cornell.edu/courses/cs6452/2012sp/papers/cayley.pdf

[7] K. Ramchadran„60 GHz Data-Center Networking: Wireless Worry less?", 2008

List of References (2/2)

[8] Y. Cui at. Al, „ Channel Allocation in Wireless Data Center Networks“, IEEE INFOCOMM 2011

[9] Y. Cui at. Al, „ Wireless Link Scheduling for Data Center Networks“,ICUIMC‘11, February 21-23, 2011, Seoul, Korea