TERAPOD is a research project supported by the European Commission through Horizon 2020 under Grant Agreement 761579.

TERAPOD project newsletter #3

July 2019

Welcome to the third TERAPOD project newsletter!

This newsletter includes items covering:

- A B5G Cluster workshop at the IEEE 5G World Forum
- THz channel characterisation measurements by TU Braunschweig at a Dell EMC data centre
- Progress on the phase distribution chip from VLC
- Packaging development by Bay Photonics.

More info is available on the project website
www.terapod-project.eu

Workshop: From Evolution to Revolution, A Roadmap for Beyond 5G

IEEE 5G WORLD FORUM

BEYOND5G

30-Sep to 02-Oct-2019; Dresden, Germany

The Beyond 5G Cluster will host a workshop at the IEEE World Forum this autumn, on the topic of a roadmap for B5G. 5G is not yet fully deployed, but it is already clear that even more challenging performance will be required in future. 5G is more like a new environment than a distribution modality of the internet. From the inception of 5G, it has evolved and transformed. It was an evolution, now it is a revolution. This workshop intends to stimulate deep thinking on vision and directions for the beyond 5G revolution. The seven H2020 projects of the Beyond 5G Cluster are already working with different approaches to form the future of 5G. The workshop will extend concepts and discussion to a wider audience for sharing and stimulate views on evolution, revolution and beyond the revolution.

For more info please see the workshop website: http://wp.lancs.ac.uk/wf5gworkshopb5g

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THz channel characterisation

Novel high data rate communication systems at THz frequencies raise the need for suitable channel models that enable performance prediction in different environments. The Technische Universität Braunschweig (TUBS) is developing new channel models in the framework of the TERAPOD project and is working on a comprehensive characterisation of the physical layer. The reference for the channel modelling work is provided by a measurement campaign that was carried out in the Dell EMC Research Data Centre (Cork, Ireland) with TUBS's ultra-wide band (UWB) real-time channel sounder at 300 GHz. During the three week trip various channel measurements were recorded that investigated general propagation effects in a data centre, including the top-of-rack propagation between different racks and the intra-rack propagation within one rack.

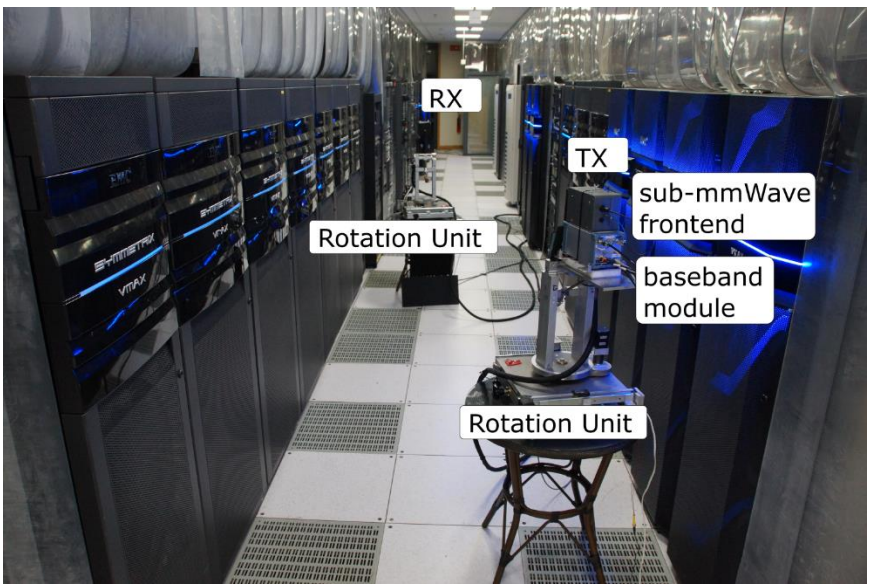

Fig. 1: Measurement set-up for an omnidirectional rotational measurement by TU Braunschweig at Dell EMC.

Fig. 1 shows the set-up for a scanning measurement that determines all paths in the horizontal plane by providing the amplitude, delay, angle of arrival and angle of departure. An exemplary result is visualised in Fig. 2 showing that there are multipath components with only 3 dB lower channel gain than the direct path. Ray tracing simulations will be used to understand the propagation in the individual set-ups and to predict the behaviour in new scenarios.

Therefore a detailed model of the Dell EMC Research Data Centre was drawn up that can be easily modified and adapted to other data centre configurations. The simulated channel impulse responses will be fed to the physical layer simulator that is integrated in TUBS's in-house built Simulator for Mobile Networks (SiMoNe). Bit error rates up to 10^{-7} can be simulated in 40 min taking into account different modulation and coding schemes defined in the 802.15.3d standard.

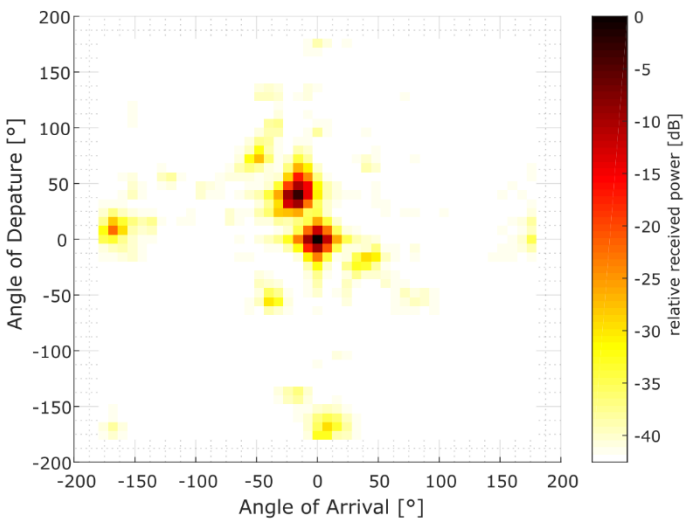

Fig. 2: Power angular spectrum of a top-of-rack omnidirectional rotational measurement.

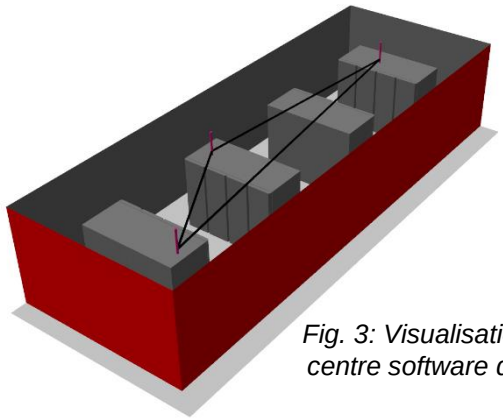

Fig. 3: Visualisation of the data centre software demonstrator.

The simulator also allows to quantify the influence of RF hardware impairments, antenna misalignment and other interfering THz links. The results are visualized in a software demonstrator that is presented in Fig. 3 showing a four by four data centre topology.

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TERAPOD Phase Distribution PIC

The TERAPOD project aims to provide the technology for future ultra-fast short range wireless links for data centres. A crucial part of this approach is the capacity of such systems to find and establish links between devices. In order to optimise the performance and reduce the power consumption, TERAPOD has developed a beam forming system which allows efficient and low power multi-device links by optically controlling the directionality of the antenna.

Exploiting the photonic integration technology for terahertz systems, VLC has developed a phase distribution photonic integrated circuit (PIC) to control the input laser light to four different outputs, which will be coupled into an array of four antenna elements developed by UCL and INESC. Firstly, the power is divided into four outputs by means of a 2-stage Mach-Zehnder interferometer (MZI)-based power splitter. The MZIs are thermally controlled, which allows the antenna array radiation pattern to be modified.

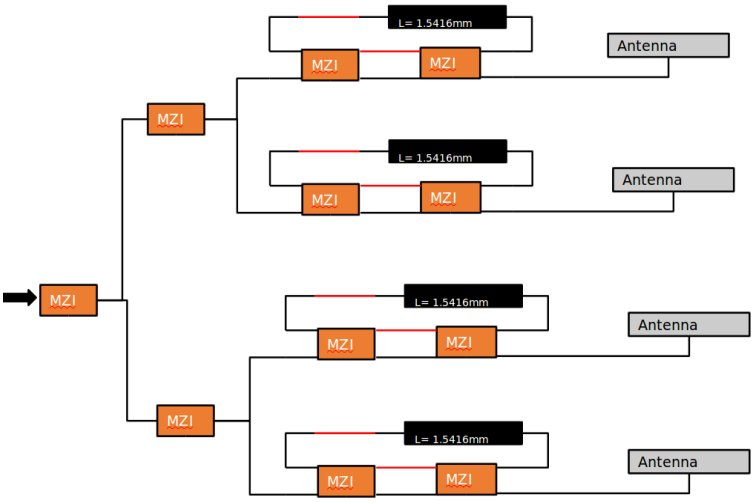

Fig. 4: Schematic of the PIC phase distribution system.

Finally, the pointing direction of the radiation pattern is controlled by the delay of the signal towards each antenna element by means of micro-ring resonators providing true-time delay. The phase distribution system based on ring resonators is shown schematically in Fig. 4.

The phase distribution PIC (fabricated at Ligentec) offers promising performance:

- 50:50 MMI imbalance below 2 %
- MZIs operating in a current-bias range of 35 mA (from 40 to 75 mA) to tune the splitting ratio at the outputs
- Maximum power rejection throughout the system of 24 dB
- The delay introduced by the micro-ring in critical coupling has been shown to be sufficient for a 0.1 THz signal to accomplish ±π/4 beam steering.

Such optical phase distribution systems will be co-integrated with an array of UTC-PDs, as antenna elements, for the coherent transmission on a demonstrator package soon, as discussed below. This work has involved close collaboration between the partners.

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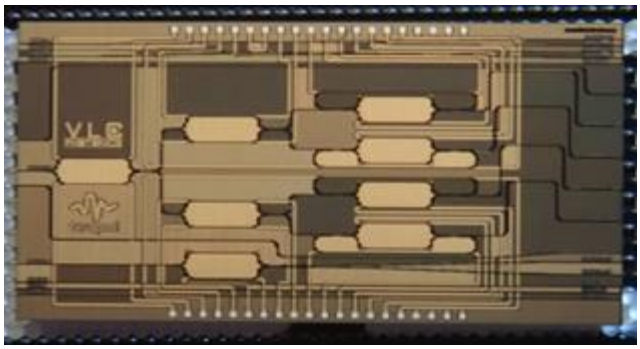

Fig. 5: Photo of a TERAPOD phase distribution PIC. (Die area 5×10 mm².)

TERAPOD packaging solutions underway

Bay Photonics is an independent, flexible design and build facility offering reduced time to market, reduced technical risk and reduced product development cost solutions for low volume, high technical difficulty packaging problems that require broad engineering knowhow and specialist assembly capability.

In TERAPOD, Bay Photonics has been working closely with the photodiode array team at UCL and the phase distribution chip experts at VLC (see above). A CAD drawing of the design is shown in Fig. 6 and the build is already underway to deliver samples for the TERAPOD demo. Results will be presented in future newsletters and conference papers.

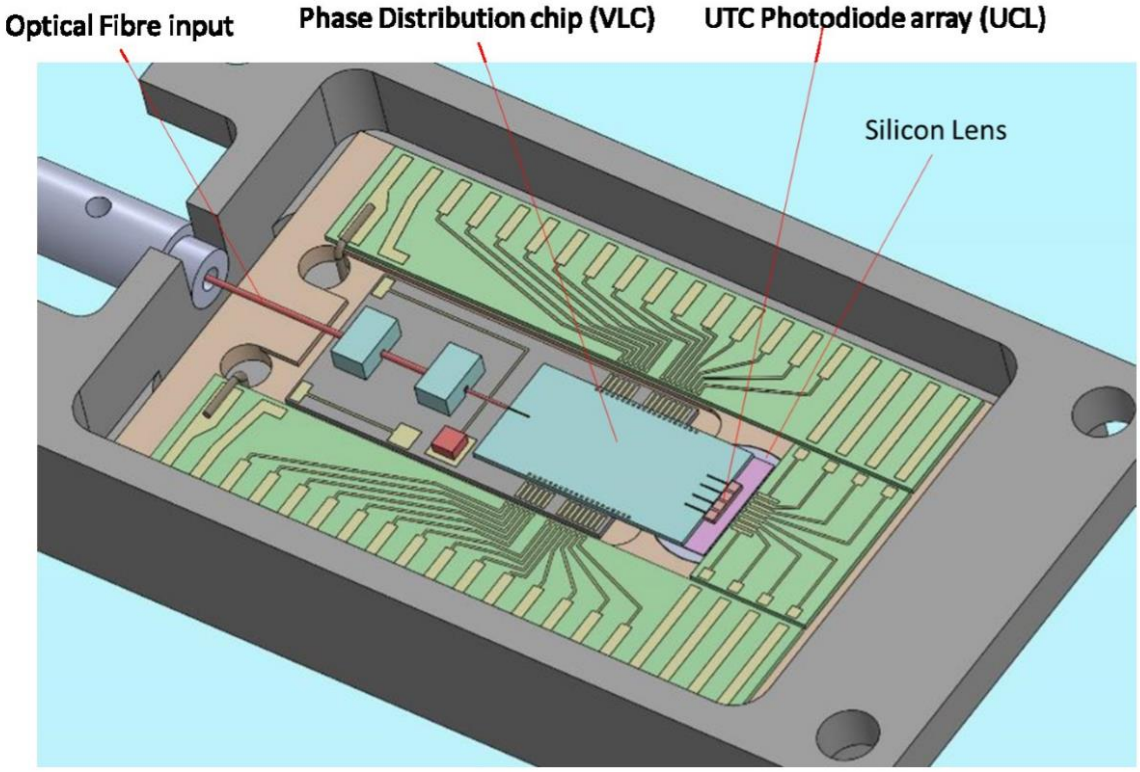

Fig. 6: Bay Photonics package design for TERAPOD fibre-coupled UCL photodiode array with VLC phase distribution chip.

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