Cluster for Application and Technology Research in Europe on NanoElectronics

PROJECT RESULTS

CA114 | Non-galvanic wireless connectors impact cost and efficiency in autonomous cars and the Industrial Ethernet [WiCon]

WiCon developed and demonstrated low-cost, highly-integrated electronic systems for data and power transfer. Importantly, they can also replace the troublesome galvanic connectors in the consumer and industrial market segments.

Galvanic connectors (such as USB cables used to connect peripheral devices, like printers, to the PC) are widely deployed in electronic systems. However, these types of connectors come with several key disadvantages:

- Prone to wear and tear leading to functional failure in consumer electronics and in professional systems;
- Connectors for high-speed links increase the cost of the system considerably;
- Reliability problems, such as with SD memory cards which get damaged due to mechanical stress;
- Connectors in professional applications tend to get dirty and/or break after a limited operational time, increasing machine down-time and maintenance cost;
- Physical connectors may limit the operational design freedom in industrial production lines, such as conveyor-belt systems.

Fortunately, advanced CMOS (complementary metal oxide semiconductor, a technology used to produce integrated circuits), enables a new kind of wireline communication which can be deployed to resolve these issues.

Smart mmWave solution for data and power transfer

Semiconductor technology scaling has enabled low-cost CMOS circuits to operate in the mm-wave frequency range (30 to 300GHz) where large bandwidths are available. These bandwidths are exploited in radar applications (automotive at 77GHz) and in high-data rate wireless communications (such as point-to-point link and new 5G radio interface).

Crucially, advanced CMOS also enables a new kind of wireline communication which has two main advantages:

- The "wire" is simply a plastic fibre or hollow tube, which is much lower in cost and weight compared to co-axial, copper-based cabling;
- The coupling of the mm-wave from the CMOS chip into the fibre does not require complex heterogeneous semiconductor implementation, as is the case in optical fibre links.

Based on this advanced technology, the WiCon project developed low-cost, highly-integrated system solutions for galvanic connector's replacement in the automotive and industrial market segments. Smart electronic systems for data and power transfer were demonstrated, exploiting ultra-low-power point-to-point mmWave connections and optimised power-transfer technologies, merging near-field communication (NFC) with wireless-charging applications.

Wicon's main focus areas were:

- A high-data-rate radio frequency (RF) link, such as mmWave, for bi-directional multi-Gbps data-transfer capability;
- An NFC link for interchange of security keys and identification codes, and to set up initial (control) data exchange between base-unit and contactless-unit;
- Wired data interface (such as 10Gbps USB and Ethernet 1G) to extract the data from the wired cable and forward it on the high-data-rate RF channel. At the other end, it will receive the bits from the high-data-rate RF channel and transmit them in a way compliant with next-generation wired standards (like 10Gbps USB and others).

In addition, there were demonstrations of polymer waveguides carrying mmWave signals for data-transfer rates above 10 Gbps (gigabits per second). Importantly, these can be deployed as low-cost replacements for expensive optical components used in the next-generation 10Gbps USB standard. Considerable progress was also made in realising high-speed wireline communication over polymer fibre demonstrators. Most notably, a prototype operated at 140GHz exhibiting 10Gbps data rate. And the building blocks for another prototype operating at 80 GHz, were completed.

PROJECT CONTRIBUTES TO

- Communication
- Energy efficiency
- Digital lifestyle

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KEY PROJECT DATES

01 January 2015 - 31 June 2018

Main project deliverables were:

- Functional requirements for copper cabling replacement in high-speed datacomm;
- Functional demonstration of the high-data-rate links over plastic fibre for Automotive Ethernet and Industry 4.0;
- Polymer mmWave fibre to support high-bandwidth, low attenuation, low dispersion and superior electromagnetic interference (EMI) compliance;
- High-bandwidth 80-120GHz CMOS transceiver integrated circuit (IC) development supporting high data rates;
- mmWave packaging and assembly to connect fibre to transceiver IC;
- Modem to interface the Ethernet physical coding sublayer (PCS) to transceiver IC.

Notably, Ethernet implementations based on mmWave also offer additional benefits over copper: such as electromagnetic immunity, low latency, and environmental resilience (like corrosion), as well as, such advantages as easier field termination, lower weight, and passive contactless, in-line connectivity. In fact, depending on cost, mmWave technology could completely replace traditional copper, significantly increasing mmWave's market potential and 'saleability' of WiCon as a project.

Well-balanced project consortium

The WiCon consortium was a relatively small, but well-balanced, project team comprising a well-known IC manufacturer, whose expertise was complemented by project members from three major European technical universities. These educational institutions, which had excellent track records in electromagnetics-related projects and mmWave circuit design, also co-operated on measurement and characterisation of the polymer waveguide band. Together, these partners had the necessary know-how and production base to turn the emerging technologies of mmWave and polymer waveguides into successful marketable products.

Driving Europe's automotive and industrial sectors

WiCon supports Europe's efforts towards a new class of energy-efficient systems capable of sensing, communicating and actuating in a smart and power-efficient manner. It also reflects the CATRENE programme's vision to develop and deploy communication electronics systems where new technologies and architectures combine adaptability and performances in a novel way.

Importantly, WiCon also secures the competitive power in Europe's two key sectors, where its related products and services can be marketed. The first is automotive, where the driving forces are autonomous and driver-assisted vehicles, in which data-intense technologies are expected to be installed. These include lidar (a detection system which works on the principle of radar but uses light from a laser), GPS, and computer vision. What is more, these applications will further trigger the need to network and distribute that information throughout the vehicle at high data-rates, resulting in a market growth for in-vehicle networks (IVNs) due to increased demand for these data-hungry applications. Reflecting this growth, the annual number of network nodes is expected to increase from 3 billion in 2016 to more than 5 billion in 2022.

The other target market for WiCon is industrial automation, or specifically Industry 4.0 (the fourth industrial revolution), a name given to the current trend of automation and data exchange in manufacturing technologies, including the internet of things (IoT). It incorporates machine learning and big-data technologies to harness the sensor data, machine-to-machine (M2M) communication and automation technologies. However, these trends require that all 'things' are directly IP (internet protocol) addressable, for which Ethernet is the most logical choice. According to Market Research Future, the global industrial Ethernet switch market is expected to reach US$ 2.0 billion during 2017-2023, with a CAGR of 14%. The contributing factors are the adoption of industrial automation and the deployment of the Industrial Ethernet as the preferred networking solution.

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