Penta

PROJECT PROFILE

19011

Highly flexible and energy-efficient antennas can expand wireless comms market and attract smaller integrators and apps developers

[HEFPA]

The 'Flexible Phase Array System for High Efficiency and Scalable Millimeter Wave Wireless Communications' (HEFPA) project is developing scalable unit array front-end components. These can be used as flexible building-blocks in implementing larger and more diverse antenna arrays in the upper bands of Frequency Range 2 (FR2), which includes frequency bands from 24.25 GHz to 52.6 GHz.

Thanks to the rapid growth in wireless-data traffic, millimetre wave (mmW) communications are set to become a major data conduit for fifth generation (5G) wireless communication systems. That said, mmW signals are highly susceptible to blocking and tend to have communication limitations owing to their poor signal attenuation compared to, say, microwave signals. This factor necessitates the usage of phased-array antenna systems to overcome signal-path loss.

Antenna configurations and array sizes (determined by the target applications) may vary from large arrays (such as 512 x 512 antenna elements) to small ones (such as 2 x 8 elements) that are more suited to mobile handsets and IoT (internet of things) devices. The phase relationship of the radio frequency (RF) signal between adjacent antenna elements enables steerable directivity of the radio signal, as compared to an omni or parabolic antenna (often used in fixed-link microwave and mm-W communications). In addition, electronic control of the signal phase and amplitude at each antenna in the array enables beam steering and network control of the signal power, along with the tracking of mobile-radio users.

These are some of the issues the HEFPA project is set to address and resolve.

Scalable and efficient building-block

The strategic objective of HEFPA is a highly flexible and energy-efficient RF front-end component that enables the creation of mmW transceiver systems. Under radio standards, such as 5G, mmW communications will rely on phased-array antennas that focus the RF signal in one or more directions in order to improve radio-link margin.

In particular, HEFPA will develop scalable unit-array front-end components intellectual property (IP) that can be used as a flexible building-block in the implementation of larger and more diverse antenna arrays. Embedded within each HEFPA module will be highly efficient, mmW signal generation and conditioning power amplifiers, phase shifters, switching functions and low-noise amplifiers. In addition, new techniques to provide control, RF signal distribution, phase/time coherence and calibration among the unit elements, will be developed. These will ensure effective interaction between HEFPA components. Furthermore, the MIMO (multiple-input, multiple-output) order, link separation and the number of target users will be incorporated into a flexible scheme of analogue and digital communications between the respective HEFPA components.

Within a single HEFPA component, all the core RF functions for mmW (at 39GHz) radio signals are incorporated, including mmW signal-generation and conditioning, such as amplification, phase shifting and filtering, antenna elements and integrated circuit (IC) packaging. . More importantly, it can be placed into a cluster of other identical HEFPA components in order to create larger arrays. This modularity will enable mmW product-developers to quickly and flexibly build specific phased-array antenna configurations, as well as, hybrid combinations of phased arrays using MIMO technology by deploying a number of HEFPA modules.

The key innovations of HEFPA will be:

- A highly optimised and energy-efficient RF signal generation and amplification in a compact form factor. This will reduce energy consumption by 30% as compared to existing solutions in a multitude of radio links leveraging the mmW frequency bands;
- The implementation of a chip-on-board technology, which combines the technological advantages of conventional wafer-level-packaging approaches with the cost-efficiency and thermal-management capabilities of panel-level, printed-circuit-board fabrication (system-in-PCB);

KEY APPLICATION AREAS

- Energy
- Digital Industry

ESSENTIAL CAPABILITIES

- Systems and Components: Architecture, Design, and Automation
- Connectivity and Interoperability
- Process Technology, Equipment, Materials and Manufacturing for Electronic Components & Systems

PARTNERS

C-COM Satellite Systems Inc

Carleton University

Eindhoven University of Technology

NXP Semiconductors Netherlands BV

Semiconductor Ideas to the Market (ItoM) BV

Skyworks Solutions Canada Inc.

University of Waterloo

COUNTRIES INVOLVED

- Canada
- Netherlands

PROJECT LEADER

Estelle Holopherne & Dominique Defossez
NXP Semiconductors Netherlands BV

KEY PROJECT DATES

01 July 2020 to 30 June 2023

- System and digital integration of an arbitrary number of HEFPA components, working cooperatively to form the mmW beam(s).

There will be two main project deliverables:

- Pre-commercial prototypes of the HEFPA components, comprising all the integrated RF syntheses and front-end signal circuits, heat sinking-elements and integrated antennas;
- A system demonstration board with flexible MIMO order-forming and/or beam-forming capability, along with beam steering (+/- 45 degrees in azimuth and elevation). It will use project-developed hardware and software overlays, which enable HEFPA components to work collaboratively.

Notable project resources

The HEFPA project consortium will leverage its partners' strengths in use-case definition, IC design, packaging and system engineering in order to implement the core HEFPA building-block. Their expertise will also be used in deploying the antenna elements in various phased-array and hybrid-beam-forming configurations.

Technology drives business and markets

HEFPA will deliver a competitive advantage by combining several key component-innovations into a single RF front-end. Furthermore, this fully integrated assembly will also combine an innovative design with the best attributes of IC and low-loss packaging and thermal management to offer an additional advantage over other approaches.

Target markets will be very broad in the sense that any use-case, which is going to be reliant upon high-bandwidth and large data-throughput wireless communications, will benefit from being able to deploy HEFPA components in building phased arrays. Commercial impacts are primarily time-to-market, flexibility (including reuse of supporting infrastructure) and low energy consumption.

Significantly, the HEFPA IP and components will also reduce complexity in the formation and deployment of mmW radio-links, thereby expanding the market reach of data communications using this allocated band of RF spectrum. This will enable smaller system integrators and RF application developers to use HEFPA components to quickly build flexible phased-array antennas (with all the associated RF generation and signal-conditioning circuitry) using the upper band of FR2 frequency-bands (as allocated in each regional jurisdiction). New applications that will leverage high-bandwidth wireless communications will also be made possible through HEFPA components.

Finally, regarding future market numbers, we see that existing mmW base-station and point-to-point systems have unit deployments of, perhaps, several 100,000 systems per year. In contrast, consumer-grade cellular or WiFi systems have a market size of over one billion radio systems per year. It is anticipated that mmW-based radio handsets, for example, will be over 100m units per year by 2022. Even larger markets are anticipated for VR/AR (virtual reality/ augmented reality) systems, which leverage mmW radio systems for very-high-bandwidth data applications.

Aeneas Office
44 rue Cambronne
F-75015 Paris - France
Tel. +33 1 40 64 45 80
Fax +33 1 40 64 45 89
Email penta@aeneas-office.org
www.penta-eureka.eu

Penta (E! 9911), the EUREKA Cluster for Application and Technology Research in Europe on NanoElectronics, will bring about technological leadership for a competitive European information and communications technology industry.

EUREKA
innovation across borders