

NOVEMBER - DECEMBER 2016

European  
business press

# MICROWAVE engineering europe

www.mwec.com

**Bluetooth/Wi-Fi/IoT**

The European journal for the microwave  
and wireless design engineer

**Digi-Key**  
ELECTRONICS

**Open  
Accounts  
Available**

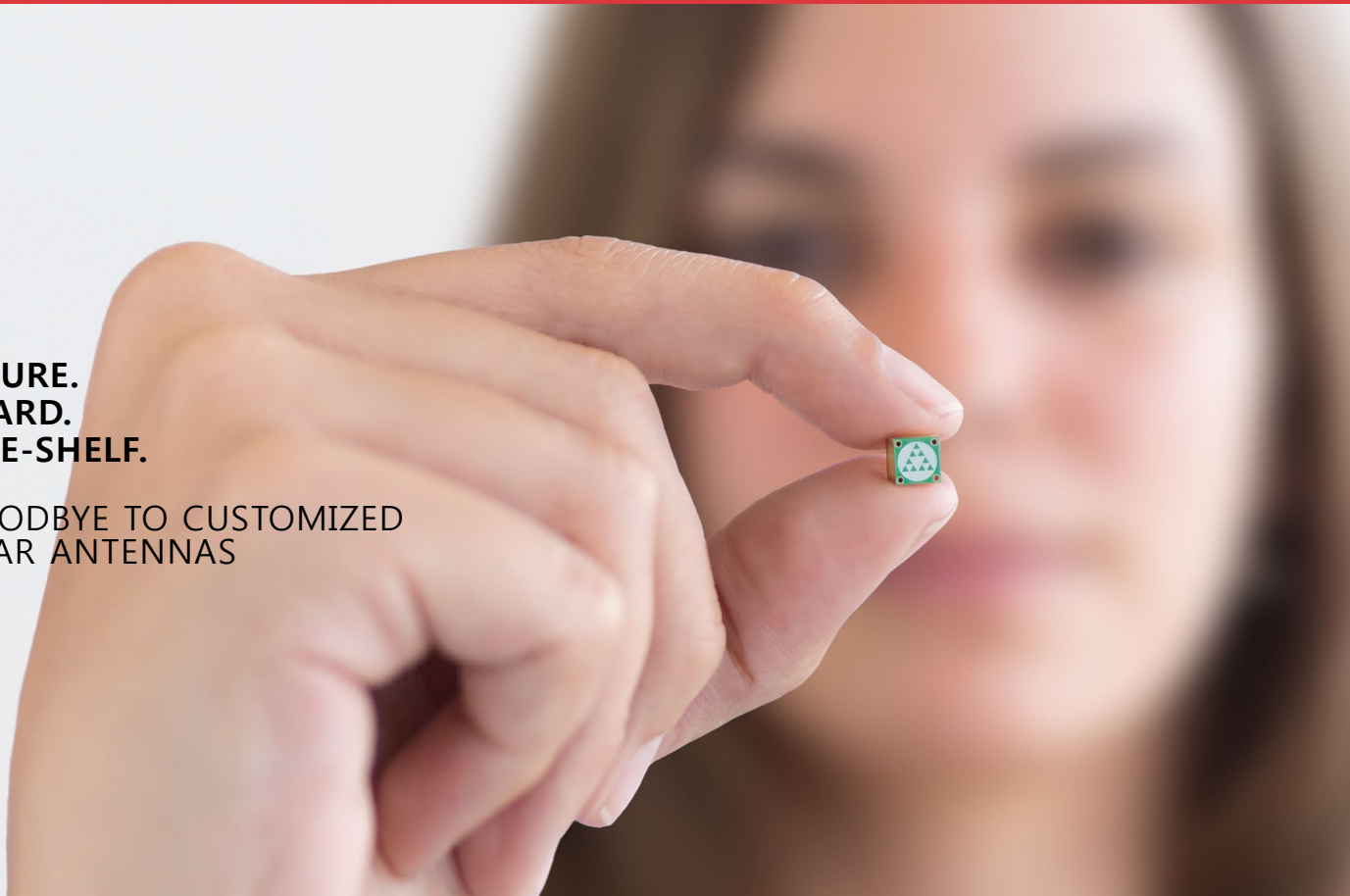
For Qualifying Customers

**DIGIKEY.COM/EUROPE**

# FRACTUS ANTENNAS

**MINIATURE.  
STANDARD.  
OFF-THE-SHELF.**

SAY GOODBYE TO CUSTOMIZED  
CELLULAR ANTENNAS



**FR01-S4-250**  
698-2690 MHz / 5x5x5 mm



**FR01-S4-232**  
698-2690 MHz / 10x3.2x3.2 mm



**FR01-S4-224**  
698-2690 MHz / 12x2.4x3 mm



**FR01-S4-220**  
698-2690 MHz / 24x12x2 mm

## SMT MULTIBAND ANTENNAS FOR MOBILE AND WIRELESS DEVICES

The mXTEND™ antenna booster leverages Fractus Antennas' Virtual Antenna Technology to replace time-consuming, high-NRE custom antenna solutions with miniature, standard, off-the-shelf components.

mXTEND components enable worldwide coverage, with GSM850, GSM900, GSM1800/DCS, GSM1900/PCS, UMTS, LTE700, LTE800, LTE850, LTE900, LTE1700, LTE1800, LTE1900, LTE2000, LTE2100, LTE2300, LTE2500 and LTE2600 operation.



**LEARN MORE**  
[www.richardsonrfpd.com/fractusantennas](http://www.richardsonrfpd.com/fractusantennas)



**Your Global Source for RF, Wireless, Energy & Power Technologies**  
[www.richardsonrfpd.com](http://www.richardsonrfpd.com) | 800.737.6937 | 630.262.6800



**FREE  
SHIPPING**  
ON ORDERS OVER €65\*



**THE WORLD'S LARGEST SELECTION  
OF ELECTRONIC COMPONENTS  
AVAILABLE FOR IMMEDIATE SHIPMENT™**

**NOW more than 5 MILLION PRODUCTS  
from over 650 SUPPLIERS**

FIND CONTACT AND ORDERING INFORMATION FOR YOUR REGION AT

**[DIGIKEY.COM/EUROPE](http://DigiKey.com/Europe)**

\*A shipping charge of €18.00 (£12.00) will be billed on all orders of less than €65.00 (£50.00). All orders are shipped via UPS for delivery within 1-3 days (dependent on final destination). No handling fees. All prices are in euro and British pound sterling. If excessive weight or unique circumstances require deviation from this charge, customers will be contacted prior to shipping order. Digi-Key is an authorized distributor for all supplier partners. New product added daily. © 2016 Digi-Key Electronics, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

ecia  
MEMBER

ecsn  
member

CEDA  
MEMBER



# MICROWAVE engineering europe

## 6 Comment

5G technology makes inroads into mmWave, automotive and IoT



## 7-9 News

Small Cell Forum calls for dense HetNets deployment for 5G

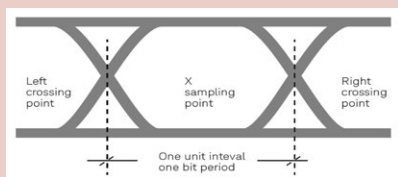
VoWLAN market to grow quickly through to 2022



## 10, 12

IoT: Promise of IoT – the next big application

Beating the jitter bug – how to apply multiple measurement strategies to identify noise source



## 16

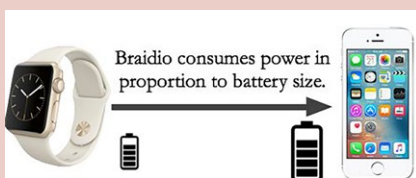
IoT: Over-the-Air testing is vital if MIMO is to deliver good QoE – the smaller they get, the more gets packed into them...



## 19, 21

Radio on a power budget: let wearables take the smallest share

Harvesting cellphone RF energy to boost battery life



## 22-26 Products

Energy-harvesting for Bluetooth LE

Signal analyser delivers continuous-sweep from 3 Hz to 110 GHz



**Editor In Chief**  
**Jean-Pierre Joosting**

Tel. +44-7800 548-133

email: jean-pierre.joosting@eetimes.be

**Advertising Production**  
**Lydia Gijsegom**

Tel +32 (0) 2 740 00 50

email: lydia.gijsegom@eetimes.be

**Circulation & Finance**  
**Luc Desimpel**

Tel +32 (0) 2 740 0055

email: luc.desimpel@eetimes.be

**Art Manager**  
**Jean-Paul Speliers**

Tel +32 (0)2 740 0052

email: jean-paul.speliers@eetimes.be

**Accounting**  
**Ricardo Pinto Ferreira**

Tel +32 (0)2 740 0051

email: financial@eetimes.be

**Publisher**  
**Andre Rousselot**

Tel +32 (0)2 740 0053

email: andre.rousselot@eetimes.be

**European Business Press SA**  
533 Chaussée de Louvain  
1380 Lasne - Belgium  
Tel: +32 (0)2 740 00 50  
Fax: +32 (0)2 740 00 59  
www.microwave-eetimes.com  
VAT Registration: BE 461.357.437  
RPM: Nivelles  
Company Number: 0461357437

© 2016 E.B.P. SA

- All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage or retrieval system without the express prior written consent of the publisher.
- The contents of Microwave Engineering Europe are subject to reproduction in information storage and retrieval systems.
- Microwave Engineering Europe is published ten times a year. Apply for a free copy of the journal online at [www.microwave-eetimes.com/subscribe](http://www.microwave-eetimes.com/subscribe)
- Subscriptions: Microwave Engineering Europe is available on subscription to others at 150 Euro. Refunds on cancelled subscriptions will only be provided at the Publisher's discretion, unless specifically guaranteed within the terms of the subscription offer. Paid subscription queries tel: +32 2 740 00 50
- Printed by Corelio



# ***RF Solutions From RF Engineers***

***Largest Selection ✓***

***Expert Technical Support ✓***

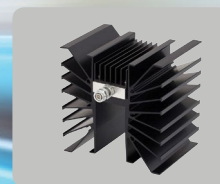
***Same Day Shipping From the U.S. ✓***



***Applications  
Engineers  
Available***



***24/7  
Support***



*Armed with the world's largest selection of in-stock, ready to ship RF components, and the brains to back them up, Pasternack Applications Engineers stand ready to troubleshoot your technical issues and think creatively to deliver solutions for all your RF project needs. Whether you've hit a design snag, you're looking for a hard to find part or simply need it by tomorrow, our Applications Engineers are at your service.*

USA (949) 261-1920 • AUSTRIA (49) 89 4161 5994 0 • BELGIUM (31) 229 50 34 78 • CZECH REPUBLIC (420) 235 365 207  
DENMARK (46) 8 554 909 50 • FINLAND (46) 8 554 909 50 • FRANCE (33) 1 47 95 99 60 GERMANY (49) 89 4161 5994 0  
IRELAND (44) 0 1420 544789 • ISRAEL (972) 9 741 7277 • ITALY (39) 06 4071603 • KAZAKHSTAN (7) 495 961 34 43  
LUXEMBOURG (31) 229 50 34 78 • NETHERLANDS (31) 229 50 34 78 • NORWAY (46) 8 554 909 50  
POLAND (48) 22 855 34 32 • PORTUGAL (34) 91 636 3939 • RUSSIA (7) 495 961 34 43 SLOVAKIA (420) 235 365 207  
SPAIN (34) 91 636 3939 • SWEDEN (46) 8 554 909 50 • SWITZERLAND (49) 89 4161 5994 0 • TURKEY (90) 216 504 07 87  
UKRAINE (7) 495 961 34 43 • UNITED KINGDOM (44) 0 1420 544789

[www.pasternack.com/Europe](http://www.pasternack.com/Europe)

**PE PASTERNAK**  
THE ENGINEER'S RF SOURCE



## 5G technology makes inroads into mmWave, automotive and IoT

As advances are made towards 5G technology, operators and technology companies are not waiting for the eventual standards – either working to influence or second guess them.

It is quite possible that 5G eventually swallows a large portion of the IoT and automotive market as well. Such a broad reach would encompass multiple standards from low sub 700 MHz frequencies through to mmWave frequencies, such as 28 GHz and 60 GHz.

For example, the recently announced Qualcomm Snapdragon X50 will initially support operation in millimeter-wave spectrum in the 28 GHz band. It also employs MIMO antenna technology with adaptive beamforming and beam tracking techniques, which facilitates robust and sustained mobile broadband communications in non-line-of-sight (NLOS) environments. Bandwidth support up to 800 MHz enables peak download speeds of up to 5 gigabits per second.

However, the modem also supports LTE as Qualcomm sees Gigabit LTE as an essential pillar for 5G, as it can provide a wide coverage layer for nascent 5G networks. LTE is also one means to addressing the IoT and automotive markets.

Recently, Telstra and Cohda Wireless successfully trialed Vehicle-to-Infrastructure (V2I) technology over Telstra's 4G network in South Australia, a pivotal first step in developing Vehicle-to-Everything (V2X) technology.

Telstra believes its 4G and future 5G networks can play a vital role in supporting the faster rollout of intelligent transport systems and V2X applications, making implementation of the technology cheaper and more efficient. Telstra's Director of Technology Andrew Scott said that the successful V2I trial marked the first phase of Telstra's plan to show how V2X technology can be supported via Telstra's 4G network.

However this is only the first phase of the project with additional trials lined up for testing Vehicle-to-Vehicle and Vehicle-to-Vulnerable (bicycles and pedestrians).

Taking a separate road, a cross-industry alliance of Audi, BMW and



Daimler along with telecommunications equipment providers Ericsson, Huawei and Nokia as well as semiconductor vendors Intel and Qualcomm will bundle their R&D resources to evolve, test and promote 5G communications for connected mobility.

Calling themselves the "5G Automotive Association", the 5G mobile networks the partners plan to roll out will also include V2X applications – but not on the basis of the widespread IEEE 802.11p standard currently favored by many players, but instead based on mobile networks, cloud connectivity and cellular connectivity (C-V2X). The partners believe that 5G will end the current bandwidth bottleneck in today's networks and offer shorter latency, enabling better support for mission-critical functions for safer driving and enhanced vehicle-to-everything communications.

"We expect 5G to become the worldwide dominating mobile communications standard of the next decade", said Christoph Grote, Senior Vice President Electronics at carmaker BMW. "For the automotive industry it is essential that 5G fulfils the challenges of the era of digitalization and autonomous driving."

Turning to the IoT, two carriers in the USA and a group of module makers will use a Qualcomm chip implementing the latest low-power LTE standards for the Internet of Things.

AT&T plans to pilot a LTE-M (formerly known as Cat M1) network and module technology in the San Francisco market starting in November and launch the technology across their commercial LTE network in 2017. In this pilot, the Qualcomm MDM9206 modem will help deliver new, intelligent and cost-effective IoT services, and use cases to industrial, commercial and smart cities customers.

Verizon is integrating the MDM9206 modem with its Thingspace IoT platform to accelerate the delivery of connected services specifically tailored for rapidly growing markets like smart metering for utilities including electric, gas and water."

The module makers, which include Quectel, Telit, U-Blox, Simcom and Wistron NeWeb Corp., are all planning to use the MDM9206 in modules supporting Cat-M1 and NB-1 services. Module OEMs are expected to launch MDM9206-based Cat M1 capable modules in early 2017. A software upgrade for Cat NB-1 is expected to be available shortly thereafter.

To conclude we see advances in LTE blurring into 5G technology and an almost certain role for LTE in a future 5G world for quite some time. As 5G takes on the role of an all pervasive communications fabric, encompassing everything from cellular to automotive through to the IoT.

*By Jean-Pierre Joosting, Editor, MWE*



## Sprint selects DragonWave backhaul

DragonWave Inc., has announced that Sprint has selected its microwave backhaul equipment for network deployment as part of the company's densification and optimization strategy.

DragonWave was selected for the combination of its dual channel capability and industry leading system gain, as well as its advanced network security capabilities. The microwave backhaul equipment will be used as part of Sprint's strategy to significantly densify its network through the deployment of small cells and other systems, with the goal of further improving network performance and the customer experience by adding more capacity and faster data speeds.

"Microwave backhaul is a cost-efficient, reliable alternative when used in the right ring structures, and it's a key part of the extension of our overall toolkit as we work to provide customers with more consistent coverage, better reliability, and even faster data speeds," said Günther Ottendorfer, COO of Technology at Sprint.

[www.dragonwaveinc.com](http://www.dragonwaveinc.com)

## Small Cell Forum calls for dense HetNets deployment for 5G

In the absence of the necessary frameworks to enable next generation network roll-outs, the Small Cell Forum (SCF) warns that 5G deployments are likely to be significantly impacted. To address this issue the SCF is calling upon industry regulators to help build a consistent and supportive regulatory environment for the deployment of dense HetNets worldwide.

To support this initiative, SCF is developing different best practice guidelines for states, regulators and municipalities in North America in collaboration with 5G Americas, in Latin America in collaboration with the GSMA, and through working with leading carriers in the Middle East and Asia.

In Europe, SCF is preparing responses to the UK Digital Economy Bill, which is currently before the Public Bill Committee and closely following the review

of the European telecom framework, the Electronic Communication Code that contains regulatory proposals aimed to

facilitate the deployment and operation of small cells. SCF aims to disseminate best practice to all stakeholders and help drive global alignment.

At the same time, SCF is continuing to urge national governments to strengthen deployment provision in support of the societal and commercial benefits associated with enhanced connectivity.

SCF believes that dense HetNets represent a fundamental shift in telecoms infrastructure, providing the underlying communications backbone for pervasive and robust connectivity, and more efficient utilization of spectrum and network resources.

[www.smallcellforum.org](http://www.smallcellforum.org)



## Global RFID market on a steep growth trajectory

As the IoT industry booms, the global RFID market has grown rapidly, with the market size exceeding USD10 billion in 2015. According to the latest market intelligence from RnRMarketResearch, this figure is expected to surpass USD17 billion in 2020. At present, the global RFID industry is mainly concentrated in European and American markets, where RFID technology has more mature applications, accounting for nearly 70% of the global total in 2015.

In contrast, China is at the stage of RFID exploration and has no mature standards and technologies, thus leading to lower market penetration. In future, with improvements in RFID standards, technical breakthroughs, lower tag costs, as well as the advancement of smart IoT industry, the Chinese RFID market is expected to grow at an annual rate of around 20% in 2016-2020. A large number of enterprises have already entered the market.

[www.rnrmarketresearch.com](http://www.rnrmarketresearch.com)

## Modem crams early 5G technology into a chipset

Claiming to be the first company to announce a commercial 5G modem chipset, Qualcomm Technologies, Inc., (QTI) has announced the Qualcomm Snapdragon X50, which is designed to support original equipment manufacturers (OEMs) that are building the next generation of cellular devices, as well as aid operators with early 5G trials and deployments.

The Snapdragon X50 5G modem will initially support operation in mmWave spectrum in the 28 GHz band. It will employ Multiple-Input Multiple-Output (MIMO) antenna technology with adaptive beamforming and beam tracking techniques, which facilitates robust and sustained mobile broadband communications in non-line-of-sight (NLOS) environments.

With 800 MHz bandwidth support, the Snapdragon X50 5G modem is designed to support peak download speeds of up to 5 gigabits per second. Designed to be used for multi-mode

4G/5G mobile broadband, as well as fixed wireless broadband devices, the Snapdragon X50 5G modem can be paired with a Qualcomm® Snapdragon™ processor with an integrated Gigabit LTE modem and interwork cohesively via dual-connectivity.

With the Snapdragon X50 5G modem, operators deploying mmWave 5G networks can now work closely with QTI to conduct lab tests, field trials and early network deployments. Additionally, OEMs utilizing the Snapdragon X50 5G modem will have an opportunity to gain an early start in optimizing their devices for the unique challenges associated with integrating mmWave. Incorporating the Snapdragon X50 5G modem in devices on a live 5G network can yield valuable insight into the challenges of integrating emerging technologies in form-factor accurate devices.

[www.qualcomm.com](http://www.qualcomm.com)



## Plastic 500 dpi flexible fingerprint sensor

FlexEnable together with ISORG have jointly launched a flexible fingerprint sensor with an image resolution of 500 dots per inch (dpi). Only 0.3 mm thick, the flexible optical sensor is suitable for applications requiring standard-compliant fingerprint enrolment and/or identification.

Its conformability makes it easy to integrate into products

such as fingerprint scanners, smart-cards, mobile phones and wearables.

As well as detecting fingerprints, the sensor can capture veins, providing a second level of security since each user's finger vein pattern is unique and requires the user to be alive for positive detection.

Made of organic electronics on a plastic foil, the large area sensor has been paired with Green Bit's image enhancement software to prove its ability to cre-



ate FBI-certifiable images. For additional security, the sensor can be made in large areas to detect five fingers, it can be

curved and applied to almost any surface, for example wrapped around mobile phones or car steering wheels.

The high resolution of the flexible

sensor has been enabled by FlexEnable's organic thin-film transistors that boast better electrical performance than amorphous silicon and very low-leakage. ISORG supplied the photodiodes able to capture the finger print and developed all the reading electronics and the related algorithms.

[www.flexenable.com](http://www.flexenable.com)  
[www.isorg.fr](http://www.isorg.fr)  
[www.greenbit.com](http://www.greenbit.com)

## Phone power amplifier market driven by LTE

According to a new Strategy Analytics report, LTE smartphones led to a bump in sales of RF power amplifiers in 2015 and the first half of 2016. Over the next five years, highly integrated multiband PA modules that include switch and filter content similar to the PAs used today in the flagship Apple iPhone 7 and Samsung Galaxy S7 will ship in increasing numbers into lower-tier smartphones.

According to Christopher Taylor, author of the report and Director, RF and Wireless Components, "The need for smartphones with more LTE bands has led to multiband PAs that contain more RF filters and switches, capturing more front-end phone content for the suppliers, contributing to a growth of the PA market that will continue at least until 2020 and 5G."

Eric Higham, Director of Advance Semiconductor Applications at Strategy Analytics, added, "GaAs forms the basis of most of the PAs in LTE smartphones, although the PAs now contain more CMOS control, SOI switches and SAW / BAW filter elements than in the past."

[www.StrategyAnalytics.com](http://www.StrategyAnalytics.com)

## Wireless power startup working with smartphone companies

NuVolta Technologies Inc., (Milpitas, CA), a wireless power chip company startup that already has a number of successful chip designs under its belt, is now working with smartphone companies for the launch of custom chips in 2017. NuVolta was founded in 2014 by a team of six engineers, of which many came from Texas Instruments.

The company's main thrust is into the 6.78 MHz frequency charging for resonant inductive transfer that is being standardized by the AirFuel Alliance. NuVolta has also produced power transfer chip sets compliant with the WPC (Wireless Power Consortium) v1.2 standard. In both areas its route to market is to produce power management ICs that can connect directly to the coil for transmission and reception.

The company's latest introduction is the NU1000 an integrated transmitter power management IC, incorporating a proprietary magnetic resonance architecture at 6.78 MHz. With a small opening on the metal cases, NuVolta's solutions

can transfer fast-charging compatible power with small receiver and transmitter coils at high transfer efficiency. In a typical application with a 25 mm transmitter coil and a 25 mm receiver coil, more than 10-W can be transferred at about 70 percent efficiency through an aluminum plate with an opening as small as 15 mm, the company claims.

NU1000 is a power management IC integrating all key functional blocks to implement proprietary controlled magnetic resonance architecture in a power transmitter, including power MOSFETs, gate drivers, current sensing, and I2C interface. It can be used for a wide range of applications, ranging from wearable devices with a fraction of a watt to smart phones and laptop computers with tens of watts.

[www.nuvoltatech.com](http://www.nuvoltatech.com)  
[www.airfuel.org](http://www.airfuel.org)  
[www.wirelesspowerconsortium.com](http://www.wirelesspowerconsortium.com)

## Orange Spain selects Anite to optimize LTE

Anite, part of Keysight Technologies, has announced that Arca Telecom, a leading professional services supplier in Spain, has chosen Anite's Nemo Xynergy for a major benchmarking project with Orange Spain. Arca Telecom provides network deployment and operation services to the main telecom operators in Spain.

Arca will be using the Nemo Xynergy Drive Test module for automated processing and centralized online management of collected data from Orange Spain's LTE network. Nemo Xynergy will gather data from benchmarking campaigns into one repository and automatically generate consolidated reports and interactive dashboards. The data will also be used by Orange engineers for optimization of the network.

Nemo Xynergy is a powerful, scalable, and easy-to-use web-based enterprise level platform for analyzing drive test, OSS call trace, small cell/DAS, and network management data.

[www.anite.com](http://www.anite.com)

## IoT network available for free in London

The government supported Digital Catapult organization has launched a LoRaWAN wireless network across London intended to foster IoT-based services. The network is free for small and medium sized enterprises to use. LoRaWAN uses a star-of-stars topology in which gateways forward messages between nodes and applications in the backend.

In London the initial network consists of 50 basestations featuring LoRa technology. Digital Catapult is collaborating with British Telecom, Imperial College London, Kings College London, UCL, and Queen Mary University of London to create an IoT incubator program.

Some of the ideas proposed for the network include: using sensors to make roads safer for pedestrians and cyclists by telling them where not to go; using sensors to monitor the environment; for optimizing the flight paths of delivery drones. The work is being done under a program called "Things Connected."

[www.semtech.com](http://www.semtech.com)  
[www.digicatapult.org.uk](http://www.digicatapult.org.uk)

## VoWLAN market to grow quickly through to 2022

The latest market research report from MarketsandMarkets finds that factors such as growing demand for low-cost and efficient Wi-Fi, high indoor coverage, better voice quality, high performance and speed are driving the growth of the VoWLAN market.

According to the report the VoWLAN market was valued at USD 15.01 Billion in 2015 and is expected to reach USD 34.68 Billion by 2022, at a CAGR of 11.65% during the forecast period.

Healthcare expected to hold the largest market share during the forecast period

The healthcare sector held the largest share of the VoWLAN Market in 2015, followed by the logistics and transportation sector. The hospitals were one of the first users of VoWLAN solutions, majorly due to the need for emergency 'verbal exchange of information' and

effective communication required among the medical staff for saving the lives of patients.

Services play an important role because in VoWLAN the quality of voice, performance and speed are the major challenges. The VoWLAN system is susceptible

to external changes and disturbance while connected with the network, which may affect coverage and call quality, and therefore, it requires continuous monitoring, maintenance and support, hence the service market is expected to grow as compared to hardware market.

Several initiatives have been taken up by the Government of India such as 'Make in India' and 'Digital India', which is one of the major factors supporting the growth of the VoWLAN market in APAC.

[www.marketsandmarkets.com](http://www.marketsandmarkets.com)



## Globes Elektronik and Link Microtek create JV

Specialist RF components distributors Globes Elektronik of Germany and Link Microtek of the UK have created a new company to deliver their services and distribute microwave and RF components in France, as Transtech Technologies SAS. The new company will act as a technical representative in France for manufacturers of microwave and RF products.

The managing directors of the two companies, Ulrich Blievernicht and Steve Cranstone, are both directors of Transtech, and sales activity will be spearheaded by Véronique Subrebois, who has more than 30 years' experience in the microwave sector in France.

Transtech has already signed up three principals from the USA: Ferrite Microwave Technologies, the manufacturer of high-power microwave components; Lark Engineering, which produces microwave and RF filters; and Communication Components Inc., (CCI), which supplies mobile infrastructure products.

[www.transtech-technologies.com](http://www.transtech-technologies.com)

## Next generation protocols for a 21st century Internet

The ETSI Industry Specification Group on Next Generation Protocols (NGP ISG) has released its first specifications, GS NGP 001: Next Generation Protocols; Scenarios Definitions. This document defines key scenarios to evolve the current Internet Protocol (IP) suite architecture and addresses the future technologies that will be embedded in next generation networks. The aim is to provide all stakeholders with harmonized requirements that will be suitable for multi-access communication including wireless, wired and cellular. IP protocols have been defined in the 1970's but a ubiquitous internet requires a different approach today, with new security, addressing and mobility issues to take care of.

"Current and future use cases include 4K videos on various devices, massive IoT, drone control or virtual reality to name but a few: use cases that have nothing to do with those of the 70's. A modernized network protocols architec-

ture had to be triggered and this is why NGP ISG was created in January this year", says Andy Sutton, Chairman of NGP ISG.

GS NGP 001 scenarios comprise addressing, security, mobility, context-awareness, performance improvement and content enablement as well as multi-access, Internet of Things, virtualization, mobile edge computing and energy saving. With this document, ETSI NGP hopes to influence the key communications standards bodies (e.g., 3GPP, ETSI, IEEE, IETF, ITU-T) to shape their protocol evolution for 5G systems and 21st century networking technology so as to address the issues identified and meet the recommendations provided. The document also compares and contrasts existing IP suite protocols with next generation networking and internetworking protocol architecture proposals.

[www.etsi.org](http://www.etsi.org)



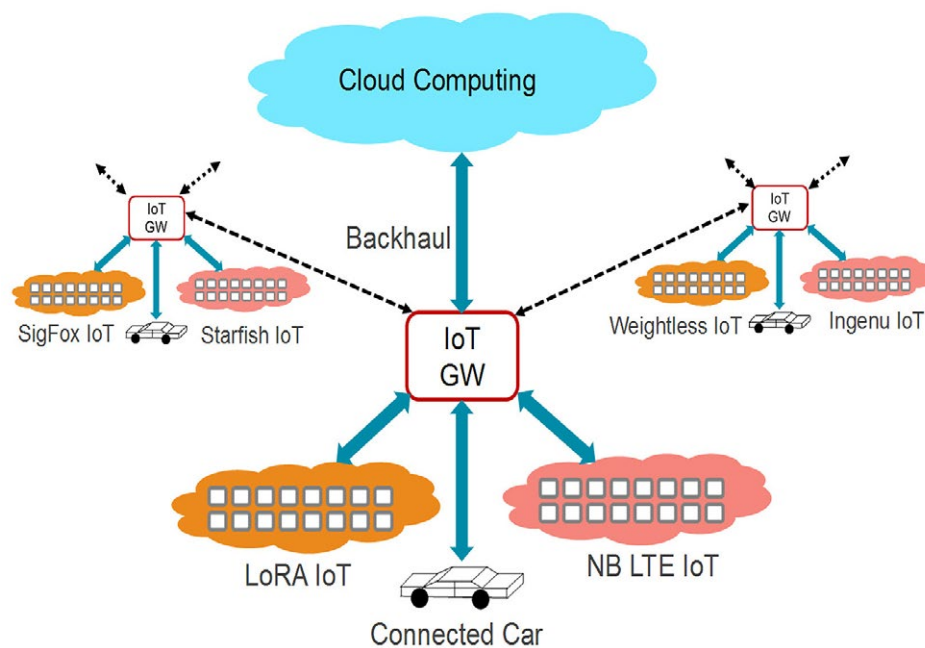
# Promise of IoT – the next big application

By Harpinder Singh Matharu, Xilinx Inc.

**C**ontinuous evolution of mobile broadband networks and related technologies is critical to address the growing demand for connectivity and bandwidth. It is equally important to incorporate capabilities and mechanisms to monetize the network in order to sustain continued investments. Considering currently deployed services, the LTE based mobile broadband consumer market is approaching maturity and saturation from a revenue standpoint. Targeting new applications, use cases, and markets is a must have to set the stage as the industry embarks to prepare for 5G deployment in 2020. Internet of Things, IoT, is emerging as a major growth area that holds the answer to this quest. IoT is happening today with leading operators reporting millions of connected devices in their networks. Proprietary low power wide area (LPWA) protocols are leading in the market for providing IoT connectivity while 3GPP wrestles with diverse proposals to arrive at industry standard protocols for IoT in Release 13. The fast emerging ecosystem for IoT has solutions in sight for building low-cost IoT end nodes that can have battery life of >10 years.

A large number of IoT networks and services are expected to be deployed in the next 3-5 years. In order to monetize these IoT networks, operators, existing or new, need to successfully grapple with three key issues. First, operators need to accept existence of both proprietary and standards-based IoT connectivity and prepare for hybrid IoT networks. Second, a focus on connectivity will not be sufficient to monetize IoT networks. Comprehensive data analytics will be needed to process data gathered from millions of connected devices to drive new applications and use cases. IoT network security and reliability is the third issue that is critical for commercialization and broader adoption. Programmable and flexible IoT gateways or hubs supporting multiple radio protocols, intelligent data gathering/ dissemination between Cloud and connected devices, and ensuring up-to-date secure links will play a pivotal role in solving these issues.

IoT requires low-power long range communication, asymmetric asynchro-



**Figure 1: Conceptual diagram depicting role of IoT gateway in IoT network**

nous low data rate connectivity, and low-cost end nodes with long battery life (>10 years). Attributes of IoT connectivity and devices are likely to vary based on the end market/ applications. 5G industry forums have classified IoT into two broad use cases: low energy massive machine communication and low latency mission critical machine type communication. Machine to machine communication is envisaged to be an integral part for both of these use

cases. An example of low energy massive machine communication is a network of connected sensors and actuators that have the potential of bringing significant productivity and efficiency to industries such as health-care, shipping, agriculture, food industry, water and energy management, smart homes and buildings. Connected wearable gadgets are an integral part of this use case scenario and the hold promise of improving every aspect of our lives. The



# Your partner in testing the Internet of Things

Internet of Things applications for smart homes, connected cars, smart cities, smart utilities, wearable devices and smart industries are becoming ubiquitous. Rohde & Schwarz supports manufacturers and suppliers with T&M solutions for developing and producing wireless M2M communications systems for the Internet of Things.

- Worldwide network of development and service locations
- World leader in T&M solutions for technologies such as Wi-Fi, Bluetooth®, GSM and LTE
- Member of international standardization bodies

[www.rohde-schwarz.com/ad/IoT](http://www.rohde-schwarz.com/ad/IoT)

Visit us at  
**electronica**  
in Munich  
hall A1, booth 307



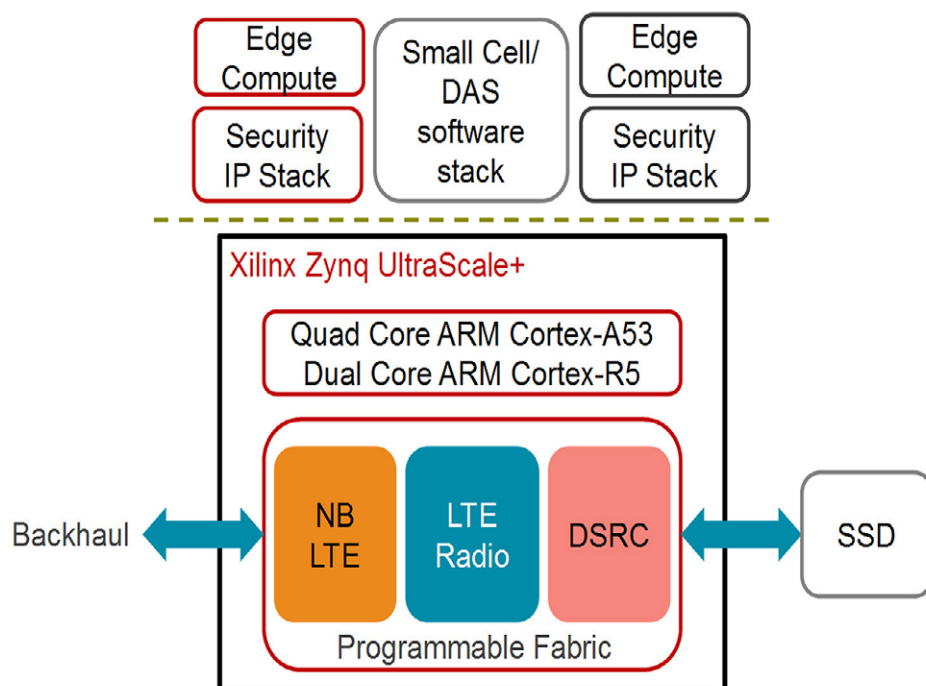


cost of a device, battery life, ease of deployment, and efficient asynchronous communication are the key requirements for low energy, massive machine type communication. Typical data rates per IoT node are in the range of 100 Kbps.

Industrial IoT, automotive, smart energy grids, traffic safety, and emergency response services are some of the examples of low latency machine type communications. Reliability, resiliency, and low latency are critical components for this segment. Typical data rates are in the range of 100 Kbps to 1 Mbps. Industrial IoT will bring multiple vertical markets within the fold of mobile broadband networks, opening new healthy revenue streams for operators.

Proprietary low power wide area network technologies such as LoRa, SigFox, Ingenu, Starfish, and Weightless exist today for IoT deployments. These technologies use unlicensed bands. For automotive, dedicated short range communication (DSRC) as known in the US and cooperative intelligent transport system (ITS) elsewhere are emerging. Vehicle to Everything (V2X) radio connectivity solutions. This is primarily geared for safety applications. DSRC uses 75 MHz bandwidth, seven 10 MHz channels in a 5.9 GHz licensed spectrum. LTE offers a good framework to harmonize proprietary technologies and fragmented standards to provide scale, ease of deployment and maintenance. LTE-M, extension of LTE for machine to machine communication, as part of 3GPP RAN Release 12, narrow band LTE (NB-LTE) as part of 3GPP RAN Release 13, and extended coverage GSM (EC-GSM) as part of GERAN Release 13 are standards based technologies that will use licensed spectrum.

Programmable and flexible IoT gateways or hubs distributed across the network, as shown in Figure 1, will play a pivotal role. In order to support hybrid technologies, IoT gateways will need to support multiple radio protocols depending on the installation point or service type. System flexibility and agility to harmonize existing proprietary technologies and evolving standards is a critical component for building economy of scales in the ecosystem to augment broader commercialization. Not only intelligent data gathering/ dissemination between Cloud and connected devices but also performing edge compute functions would be necessary in these gateways. For many



**Figure 2: Xilinx Zynq UltraScale+ MPSoC All Programmable platform as an integrated IoT gateway.**

IoT applications, data may be location specific and meaningful only for a short duration. In many cases, application latency constraints will necessitate distributed data processing. Edge compute and local storage could be essential in IoT gateways to overcome low latency requirements. System functions to secure links to connected devices and Cloud will also be needed in these gateways.

In addition to solving critical system issues, IoT gateways can act as test beds for running pilots for new applications and use cases for IoT networks. Instead of waiting for availability of optimal solutions or a complete ecosystem, operators can use these test beds to work closely with the supply chain in defining system requirements. These reasonably well-defined pilot case studies and associated business findings can help steer optimal solutions and network evolution to maximize revenue potential latent in IoT. IoT gateway with sufficient compute can also stimulate open source industry standard application development framework and a development community. Further, support for broadband LTE radio could enhance integrated services for applications such as personal smart phones to control smart homes or vehicular and passenger mobile broadband connectivity.

All programmable FPGAs and SoCs offer a good solution to meet the challenging requirements of IoT gateways

and IoT test bed platforms to instantiate different radios on a need basis with built-in flexibility to adapt to evolving standards, perform edge compute, and secure links. Figure 2 shows a programmable and flexible IoT gateway conceptual block diagram that can be built using Xilinx 16nm Zynq UltraScale+™ MPSoC platform. The Xilinx Zynq UltraScale+ platform has quad-core ARM® Cortex-A53 running up to 1.5GHz, a dual-core ARM Cortex-R5 real time processing unit, integrated peripherals and connectivity cores, and built in advanced security, safety, and reliability functions. It has rich programmable fabric to host multiple radio technology instances along with backhaul and local storage connectivity. Xilinx baseband, radio, foundation DSP, and connectivity IPs can be leveraged in combination with the rich ARM software ecosystem to build flexible and extensible IoT gateway application development framework. The inherent flexibility and programmability of FPGA fabric allows easy updates to radio implementation independent of the application stack residing on the integrated processors. Standardizing on such platforms, stimulating open source industry standard application development framework and running pilot case studies are essential steps to jump start development and deployment of IoT based new services.

## Beating the jitter bug – how to apply multiple measurement strategies to identify noise source

By Andrea Dodini, European Marketing Manager, Keysight Technologies

**D**igitising an analogue signal can improve the chances that the information it represents arrives at its destination uncorrupted by electrical noise. However, digital signals can be corrupted if noise signals alter their timing enough to push the transitions in the bitstream out of sync with the sampling point. This 'jitter' means the bitstream is misinterpreted, and can be a particular problem at very high data rates.

The first step to beating the jitter bug is to know your enemy.

### WHAT CAUSES JITTER?

There are several causes of jitter. Some of them are as follows:

- *System phenomena*, such as cross-talk from radiated or conducted signals, dispersion effects, and impedance mismatches.
- *Data-dependent phenomena*, due to the pattern of data in the bitstream data. This can result in inter-symbol interference, duty-cycle distortion, and pseudorandom periodicity in the bitstream.
- *Random-noise phenomena*, caused by thermal effects, noise associated with electron flow in conductors, shot noise caused by electron and hole noise in semiconductors, or pink noise spectrally related to the inverse of the clock frequency.

### RANDOM VERSUS DETERMINISTIC

Jitter sources are often categorised as 'bounded' or 'unbounded'.

Bounded jitter sources reach maximum and minimum phase deviations within an identifiable time interval.

Bounded jitter is due to systematic and data-dependent phenomena. Unbounded jitter sources are random, and can (in theory) have infinite amplitude.

The total jitter on a signal, defined as its phase error, is the sum of the deterministic and random jitter affecting it.

The deterministic jitter component is defined by adding the maximum phase advance and phase delay it produces, while the random jitter is the sum of all the random noise sources affecting the signal.

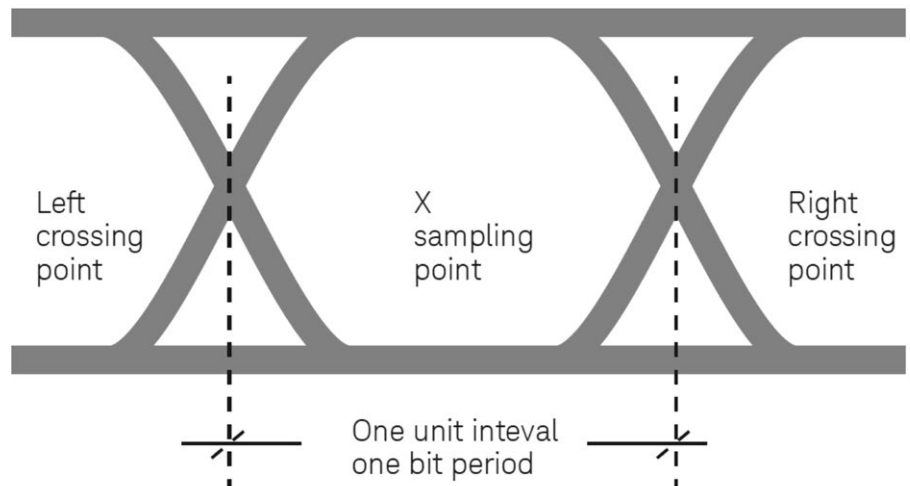


Figure 1: An idealised eye diagram (Source: Keysight Technologies).

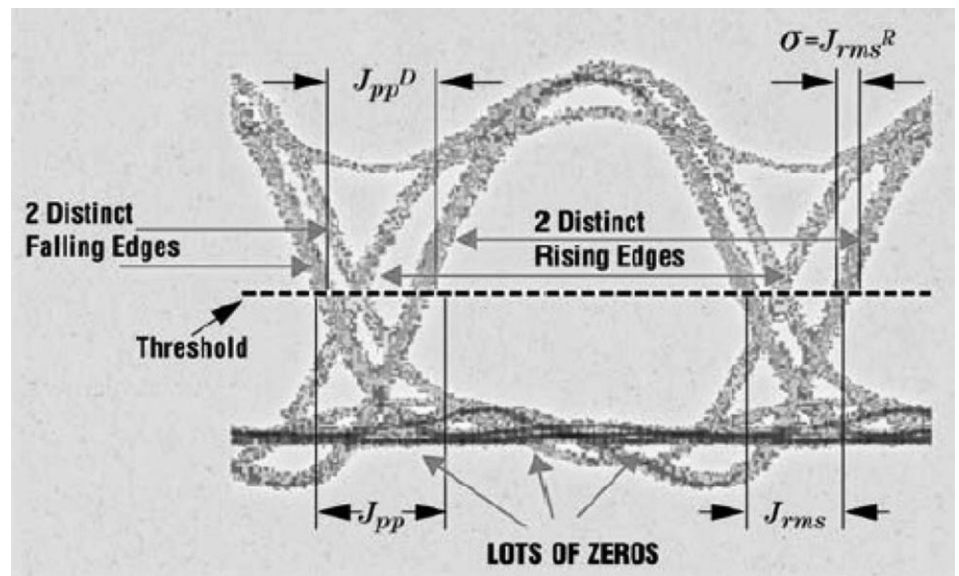


Figure 2: An irregular eye diagram offers a wealth of information (Source: Keysight Technologies).

### LOOKING JITTER IN THE EYE

How do you know how bad your jitter problems are? An eye diagram can help, superimposing all the bit periods of a captured waveform, as in Figure 1.

This eye diagram has smooth transitions at the left and right crossing points forming a large, wide-open 'eye' in the centre. At point X, the waveform should have settled and so can be sampled with

the least chance of a bit error. Figure 2 shows a more realistic eye diagram, which reveals a lot about the signal.

Let's list them:

- The amplitude of the bottom of the waveform varies less than that at the top, so the signal seems to carry more 0s than 1s;



- There are four different trajectories in the bottom, so at least four 0s in a row are possible;
- There are only two trajectories at the top of the waveform, so it carries a maximum of two 1s in a row;
- The waveform has two different rising and falling edges, showing that it is subject to deterministic jitter;
- The rising edges have more spread than the falling edges, and some of the crossover points intersect below the threshold level, showing that duty cycles are being distorted causing 0s to have a longer On time than 1s.

## OTHER WAYS TO THINK ABOUT JITTER

There are other ways of visualising jitter, and applying several of them to a signal can help identify the sources of jitter.

### The histogram

A histogram plots the range of values exhibited by a parameter along the x-axis versus the frequency of its occurrence on the y-axis. In jitter analysis, histograms can plot waveform parameters such as rise time, fall time, period, or duty cycle, to reveal conditions that can be correlated with circuit conditions.

The histogram in Figure 3 shows period jitter in a clock signal. The double peak at right suggests that the signal includes second and fourth harmonics.

### The bathtub plot

The bathtub plot in Figure 4 graphs the bit error rate (BER) of a signal versus its sampling point. The horizontal scale represents the time it takes for one symbol to be transmitted. BER is represented on a vertical log scale.

When the sampling point is at or near the transition points (0 and  $T_B$ ), the BER is 0.5 meaning it is equally likely that a bit will or will not be transmitted successfully. The curve is fairly flat in these regions, dominated by deterministic jitter. As the sampling point shifts away from the transition point, the BER drops off rapidly as the jitter becomes dominated by random processes. The bathtub plot shows that, as in Figure 1, the best time to sample the signal is halfway between its symbol's transitions.

### In the frequency domain

Looking at the frequency distribution of jitter spectra can reveal deterministic jitter sources, which appear as line spectra. This approach can also reveal phase noise or jitter-versus-frequency offsets from a carrier or clock.

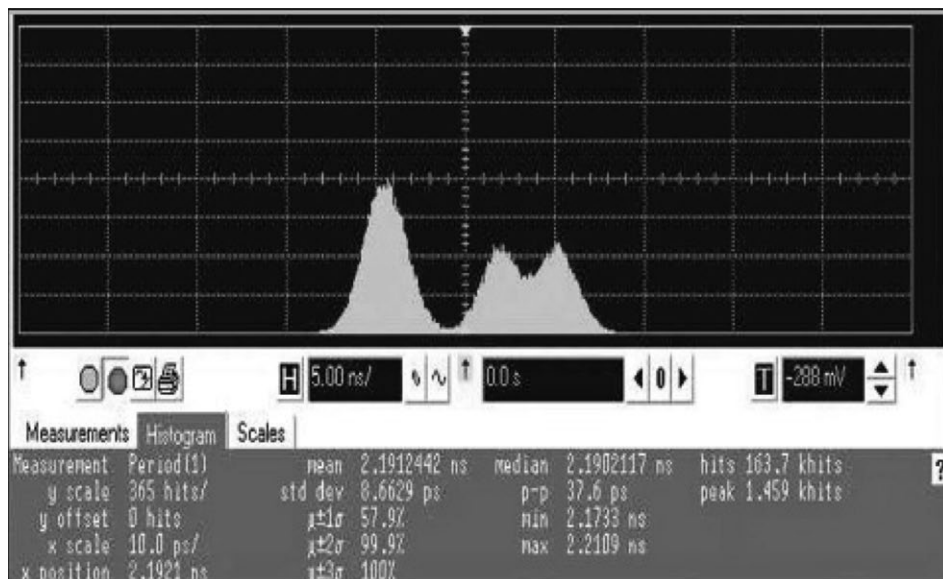


Figure 3: Histogram of period jitter (Source: Keysight Technologies).

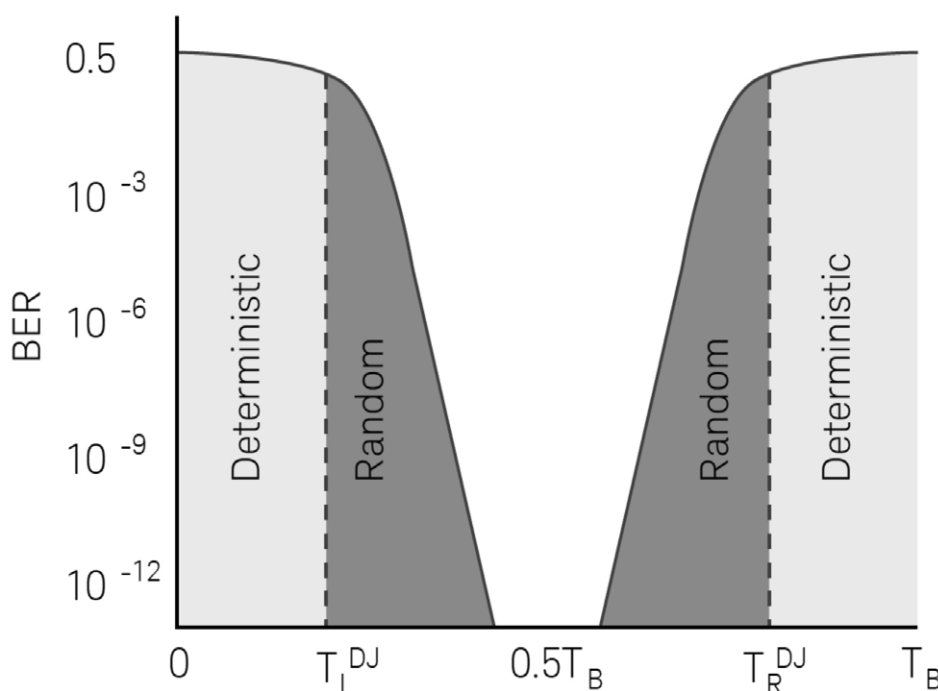


Figure 4: Bathtub plot (Source: Keysight Technologies).

Phase-noise measurements provide insights into phase-locked-loop or crystal-oscillator designs, and can help identify deterministic jitter due to spurious signals. Such measurements can help optimise clock-recovery circuits and reveal internal noise sources.

Figure 5 shows the intrinsic jitter spectrum of a phase-locked loop. The noise peaks at a 2 kHz offset. There are also lines that identify deterministic jitter sources from 60 Hz to approximately 800 Hz, probably generated by the power lines. Frequency lines are also evident from 2 to 7 MHz, probably de-

rived from the reference clock. Another way to obtain a frequency-domain view of jitter is to take a fast Fourier transform (FFT) of the time interval error data (the phase difference between the signal being measured and the reference clock), an approach that can reveal high-level phenomena quickly.

## CONCLUSION

Jitter robs digital signals of their power to protect the information they carry from interference. Applying multiple measurement strategies can provide more insights about the characteristics

and sources of noise than might be expected from what at first seems like a simple time offset of the signal – and so help engineers beat the jitter bug.

## AUTHOR

**Andrea Dodini** is Marketing Manager at Keysight Technologies for Small and Middle Size Enterprises (SME) and for Keysight Core Product Lines in Europe, the Middle East, Africa and India (EMEA).

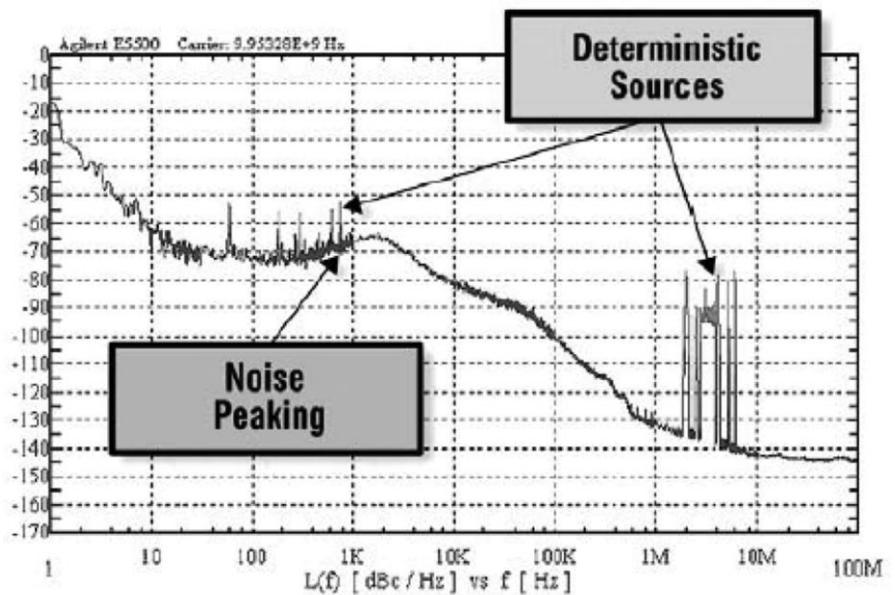


Figure 5: Intrinsic jitter spectrum (Source: Keysight Technologies).

## V2X reference for the autonomous-driving

Renesas Electronics and Cohda Wireless have announced a collaborative effort in the fields of automotive vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications.

By bringing together the V2X R-Car system-on-chips (SoCs) from Renesas and V2X and CAV software from Cohda Wireless, the companies deliver a V2X reference design that supports European and North American communications standards for V2X system development.

In response to the industry expectations for U.S. Department of Transportation (USDOT) to mandate V2X to improve road safety and efficiency in addition to the recent deployment of V2X technology in Japan, targets have been set to widely introduce secure V2X technology in multiple global regions. With over a decade of R&D on IEEE 802.11p protocol, WLAN-based technology has proven to offer reliable and secure communication for Cooperative Intelligent Transport Systems (C-ITS). Critical and time-sensitive information on all road users and roadway elements, such as traffic control devices, are expected to be shared among for improved safety and efficiency. According to USDOT estimates, V2X technology can minimize over 80 percent of non-impaired crash types.

Renesas has established an eco-system with Cohda Wireless to offer a reference solution that will contribute to the acceleration of V2X system develop-

ment. The latest V2X reference solution complies with European and North America standards from the European



Telecommunications Standards Institute (ETSI), Intelligent Transport Systems (ITS), Society of Automotive Engineers (SAE) and IEEE.

The Renesas V2X starter kit for the V2X reference solution comprises the R-Car W2R, a 5.9 GHz band automotive wireless communication WAVE SoC, and the V2X host processor R-Car W2H SoC with an embedded hardware security module (HSM), which encrypts the communication/messages and protects against cyber-attacks. The R-Car-based starter kit conforms to the IEEE 802.11p communication standard for ITS used in Europe and North America and to all other applicable standards including that for security requirements. The starter kit also meets or exceeds the SAE minimum performance requirements established for the USDOT-funded connected vehicle

pilots, which is widely expected to be the precursor to wider deployment of V2X-enabled infrastructure.

The R-Car W2R delivers industry-leading performance when using Renesas' exclusive radio frequency (RF) system design technology, e.g., suppressing out-of-band transmission signal noise below the -65 dBm stipulated by ETSI. The R-Car W2H V2X Host processor SoC can integrate Japanese, US, and European security methods, communications protocols, and applications. The V2X starter kit is designed and tested to comply with automotive environmental, quality and reliability requirements and is refined for best performance using Renesas' experience and expertise developed over many years as a leading automotive advanced semiconductor supplier.

Cohda Wireless' software consists of network-, facilities-, applications-, management-, and security layers for both IEEE1609 and ETSI ITS-TC stack.

System manufacturers can now select an attractive Renesas – Cohda Wireless V2X reference solution and take advantage of the high maturity level of the hardware and software. Both were deeply validated and proven for reliable operation. The Renesas-Cohda Wireless V2X reference is scheduled to be available in April 2017.

[www.renesas.com](http://www.renesas.com)  
[www.cohdawireless.com](http://www.cohdawireless.com)



# Over-the-Air testing is vital if MIMO is to deliver good QoE – the smaller they get, the more gets packed into them...

By David Garrison, Senior Director Wireless

**M**obile devices and networks are growing ever more complex, not only in terms of features but also in the underlying technologies needed to support those features – technologies such as MIMO (Multi-Input Multi-Output) that require each tiny handset to contain not one but multiple radio antennas.

The more complex the product and service, the more important it is to test every aspect of network performance and the resultant user experience. In response, operators and manufacturers have collaborated with testers to develop a methodology that fully and consistently evaluates baseband modem performance and antenna design for MIMO operation.

The CTIA - The Wireless Association has recently published a testing standard (*Test Plan for 2x2 Downlink MIMO and Transmit Diversity Over-the-Air Performance, Version 1.0*) to gauge the Over-the-Air (OTA) performance level of handsets that employ MIMO antennas.

## NOT ALL MOBILE DEVICES ARE CREATED EQUAL

How important is this standard and test procedure? Do devices really show much variation in performance?

To explore the scale of MIMO device performance variances, Signals Research Group has published the results of a study evaluating fifteen commercial mobile MIMO devices across two different OTA labs (*Chips and Salsa XX: When Iconic Meets Anechoic, Part II* published in *Signals Ahead*, October 2015). It revealed significant performance differences that would have a noticeable effect on user experience. These include: triple-digit differences in data rates, universal under-performance in at least one frequency band, and a minimal relationship between handset price and reception quality.

This study confirmed the importance of OTA testing in evaluating MIMO device performance. Performance issues in the antenna design will translate into



reduced Quality of Experience (QoE), including poor reception, slow downloads, and subpar application performance. For operators, poor QoE becomes a major cause of customer churn, and it forces investment in network infrastructure to compensate for the low quality and reduced capacity.

## WHY OVER-THE-AIR?

Laboratory simulation of “real world” conditions has become very sophisticated, and it is easy to replicate and control tests over cable connections, bypassing antennas. But with MIMO devices, throughput depends so critically on antenna performance in realistic propagation environments, and these cannot be simulated accurately with such conducted testing.

Single-Input Single-Output (SISO) allows for greater separation of baseband and antenna testing because modem performance is not coupled to antenna performance – other than differences in receiver input levels due to antenna performance. Conversely, in MIMO the two are co-dependent: antenna performance not only affects the signal levels present-

ed to the receivers, but also the correlation between the two (or more) receivers. MIMO performance is a function of Signal-to-Interference-plus-Noise-Ratio (SINR) and antenna correlation. How the device sees the wireless environment through the antennas can greatly affect modem performance – environmental conditions will make it harder or easier to decode the different data streams.

MIMO testing over-the-air creates a unique spatial signature that replicates realistic propagation scenarios but in a controlled, repeatable environment.

## MAKING IT REALISTIC

MIMO performance is a function of the wireless channel and the antennas, so testing must combine such characteristics as:

- Antenna gain or efficiency
- Branch imbalance
- Dual polarized channel conditions to replicate the handset environment
- Correlation between antennas

Thanks to the highly controlled environment specified by the CTIA, MIMO

OTA radiated antenna testing is currently the best approximation to real world conditions. It includes the use of an anechoic chamber, enabling spatial channels with the correct field structure so the device under test can observe the realistic expected channel during the test.

The correct field structure is replicated in the anechoic chamber using a special channel emulator and by mapping the signal levels across the probes in the chamber.

#### **INTRODUCING THE CTIA MIMO OTA TEST PLAN VERSION 1.0**

An official CTIA MIMO OTA test must be conducted in an anechoic chamber with 8 dual-polarized probes. The lab validation tests must include ripple test, range calibration, and Signal-to-Interference Ratio (SIR) validation, to ensure the quality of the chamber setup and that evaluation is conducted at the correct power levels without extraneous signal interference. Definitions of measurement uncertainty elements are provided, and an overall measurement uncertainty limit is defined.

All the channel model validation procedures are defined for key items such as: Power Delay Profile (PDP), Doppler/temporal correlation, and spatial correlation. Finally, cross polarization is examined to check if the signal arrives at the device in a way which verifies that the amount of signal, in both vertical and horizontal polarization, is in accordance with the expected model. These channel model validation tests are typically performed by the system provider.

Testing can only take place once the setup has been shown to meet CTIA standards. Performance is measured in terms of MIMO Average Radiated SIR Sensitivity (MARSS). Average SIR over a set of orientations within the test environment provides a more representative assessment of user experience. CTIA also provides reporting templates to ensure that test results are presented in a consistent format.

Further detail on the OTA test procedure is available in a Spirent white paper *Ensuring MIMO Device Performance with Over-the-Air Testing*.

#### **THE AUTHORISATION PROCESS**

So far, CTIA has published the *Laboratory Assessment and Validation Requirements Document V1.1*, which defines authorisation steps for system vendors and test labs and provides a template for reporting measurement uncertainty results.

The next step is to authorise the test system providers. This requires the on-site participation of a Subject Matter Expert (SME) and documents confirming compliance, including: data for MIMO OTA system validation results, a system configuration description, and example test data. System providers must also show baseline parameter file setups that have been verified for test plan compliance. When these steps are complete, validated configurations for hardware and software can be published as "authorised by the CTIA".

Each test lab must also be authorised. Labs must first be accredited to ISO 17025 and have been previously authorised by the CTIA for SISO OTA testing using the same chamber. Labs must submit work instructions, test setup information for previously authorised equipment (identified above), sample test reports, and a measurement uncertainty test report for SME review. Once approved, the lab becomes a *CTIA Authorized Test Lab (CATL)* for MIMO OTA.

Once a critical mass of CATLs has been established, V1.0 will become mandatory for CTIA and PTCRB certification.

[www.microwave-eetimes.com](http://www.microwave-eetimes.com)

# Tektronix®

## RF field realtime spectrum analyser – try it FREE for seven days!

See what you have been missing in your network when trying to:

- Reduce your time installing and maintaining your network
- Locate interference sources
- Identify cable loss and distance to faults
- Verify antenna faults
- Classify signals
- Record and playback signals

Register today for a free  
trial in your individual test  
environment

[uk.tek.com/free-rf-trial](http://uk.tek.com/free-rf-trial)





## CONCLUSION

Examining MIMO antenna performance in realistic propagation environments gives an accurate view of the user experience and helps operators ensure good QoE. V1.0 of the CTIA MIMO OTA Test Plan defines standards for MIMO OTA testing, with upcoming releases already in the works.

Spatial channel emulation is an essential part of MIMO OTA testing and, as wireless networks advance toward 5G, the demands of device testing will become increasingly complex, requiring future-proof test solutions capable of scaling to support ever-higher channel density applications. The good news is that suitable robust channel emula-

tion solutions are already available. These already support the CTIA MIMO OTA Test Plan v1.0 and they are being continually developed to meet the most stringent conditions of future CTIA test plan versions.

## Phasor tests flat panel, electronically steered antenna system

Phasor has taken a critical step forward towards the product release of its groundbreaking flat panel, electronically steered antenna (ESA) system. The company has demonstrated the transmission of live HD video over the Intelsat 903 satellite from its test site in Essex, UK. The Phasor team has spent several months carrying out detailed beam pattern measurements on the system. This has taken place in the company's near-field and far-field test ranges, ensuring that the dynamic beam forming adheres to the regulatory requirements for live transmissions. Following the lab tests, the 8-module Tx (transmit) system (equivalent in aperture area to a 67cm parabolic dish) was deployed to Phasor's outdoor test site.

Maritime IT services integrator, OmniAccess is partnering with Phasor to bring the electronically steered antenna to the super yacht mobile broadband market, and provided its ground station and satellite capacity for testing purposes. The link was successfully

established and has been running flawlessly for over 2 weeks.



The 8-module system achieved an impressive uplink performance of 2 Mbps under the test plan, which involved transmissions from a moving platform demanding rapid beam scanning. The Phasor antenna was able to transmit a full HD video stream using efficient MODCODs (Modulation and Coding techniques), avoiding the need for any form of inefficient spread-spectrum techniques and maintained perfect pointing with no ASI (Adjacent Satellite Interference) throughout.

Based on the achieved 903 performance, and the known performance of uplink-efficient HTS satellites, this small eight-module Phasor array would be able to close return links of well over 15 Mbps. An aperture equivalent to a 1m dish (16 panel system), would achieve a Tx throughput of over 60 Mbps.

"The results of these critical tests have affirmed our robust and game-changing technology" commented David Helfgott, CEO Phasor. "We are extremely positive about the future and look forward to taking this high bandwidth connectivity to our target mobile broadband markets."

Phasor's very low profile antenna provides high-bandwidth connectivity in a more reliable and robust way. The antenna is solid-state, with no moving parts so satellite signals are tracked electronically. The terminal can be scaled to achieve performances better than a 2.4 m parabolic dish.

[www.phasorsolutions.com](http://www.phasorsolutions.com)  
[www.omniaccess.com](http://www.omniaccess.com)

## Leading antenna technology for aviation

Kymeta and TECOM, a Smiths Microwave brand, have announced a Partner Development Program Agreement for the aviation market. Under the terms of the agreement, TECOM will incorporate Kymeta® mTenna® technology into an aviation grade terminal to demonstrate connectivity to a Ku-band satellite.

Kymeta's flat panel satellite antenna technology offers a lightweight, low profile and low maintenance antenna that significantly cuts operational costs of aircraft connectivity by reducing the drag, weight, and maintenance compared to current aircraft satellite terminals. Kymeta is addressing an industry-wide



issue and enabling a level of high-speed, global connectivity that crew and passengers want while in the air.

"Coupling Kymeta's mTenna® antenna technology with our next generation RF transceiver is transformational for the global IFC marketplace. We consistently get requests for flat panel solutions from airlines and IFEC providers. The combination will provide our customers with unique technology that will enable lower operational costs while delivering high quality data throughput," said Greg Lackmeyer, Director, Business Development at TECOM.

[www.phasorsolutions.com](http://www.phasorsolutions.com)  
[www.omniaccess.com](http://www.omniaccess.com)

## Radio on a power budget: let wearables take the smallest share

By Julien Happich

A team of researchers from the University of Massachusetts, Amherst (UMASS Amherst) has devised a new radio architecture that enables wearables and small battery-powered devices to drastically minimize their power consumption when communicating with larger battery-enabled devices such as smartphones or laptops.

Only by adding a few cents' worth of components (similar to what would be found in a passive RFID tag) to an existing Bluetooth Low Energy radio, the researchers were able to expand a connected device's Bluetooth radio to three modes of operation: active, passive, and backscatter.

Presented in a paper "Braidio: An Integrated Active-Passive Radio for Mobile Devices with Asymmetric Energy Budgets" at the Association for Computing Machinery's special interest group on data communication (SIGCOMM) conference, the new radio architecture allows a device to switch between the three modes of operation to only consume power in proportion to the energy availability detected between the two talking devices.

Their initial research started with an analysis of commercial RFID readers (backscatter readers used to read passive tags), accepting some trade-offs in sensitivity to drastically simplify their architecture and raise their energy efficiency.

At reasonably close distances (under one meter), the backscatter mode could sustain 1 Mbps data rates. As the range increased, bit rates supported by the backscatter mode of the receiver decreased to 100 kbps and 10 kbps (at 1.8m and 2.4m, respectively). For longer distances, the modified Bluetooth-enabled IoT device could switch to a passive receiver mode, operating at up to 3.9m at 1 Mbps, or up to 4.2m at 100 kbps. Then for distances over 6 meters, the regular BLE active mode of the two devices would take over.

It is by multiplexing these three modes that the two devices constantly adapt their communication scheme to achieve the best bit rate at the lowest power consumption for the device with the least battery capacity.

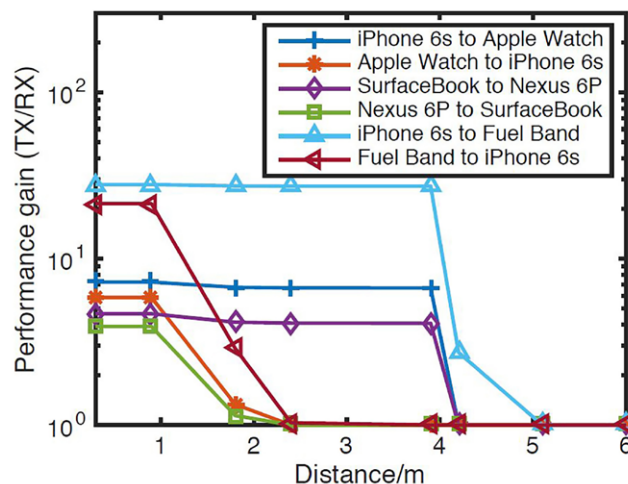


Braidio consumes power in proportion to battery size.



	Nike Fuel Band	Pebble Watch	Apple Watch	Pivothead	iPhone 6S	iPhone 6 Plus	Nexus 6P	Surface Book	MacBook Pro 13	MacBook Pro 15
Nike Fuel Band	-1.43	2.61	3.82	7.37	27.9	44.2	55.6	284	313	397
Pebble Watch	-2.37	1.43	1.83	3.20	11.1	17.4	21.9	110	122	154
Apple Watch	-3.28	1.78	1.43	2.22	7.23	11.1	13.9	69.7	76.8	97.2
Pivothead	-5.96	2.82	2.08	1.43	3.75	5.65	6.98	33.6	37.0	46.8
iPhone 6S	-21.4	8.82	5.85	3.23	1.43	1.83	2.16	8.80	9.65	12.0
iPhone 6 Plus	-33.7	13.5	8.84	4.66	1.78	1.43	1.57	5.73	6.26	7.78
Nexus 6P	-42.3	16.9	10.9	5.66	2.03	1.58	1.43	4.66	5.08	6.28
Surface Book	214	83.8	52.9	25.7	7.03	4.72	3.91	1.43	1.44	1.67
MacBook Pro 13	236	92.3	58.3	28.3	7.67	5.12	4.23	1.49	1.43	1.57
MacBook Pro 15	299	116	73.6	35.6	9.50	6.26	5.14	1.66	1.59	1.43

**A comparison of the performance gains obtained with Braidio over Bluetooth (when the device on the horizontal axis transmits to the device on the vertical axis)**



**Performance gain of Braidio over Bluetooth for transmission over different distances between commercially available devices.**

Associate Professor in the Department of Computer Science at UMASS Amherst, Deepak Ganesan gave this interleaved multi-mode communication scheme the name Braidio as for "braided radios".

The different modes enable two devices to communicate on asymmet-

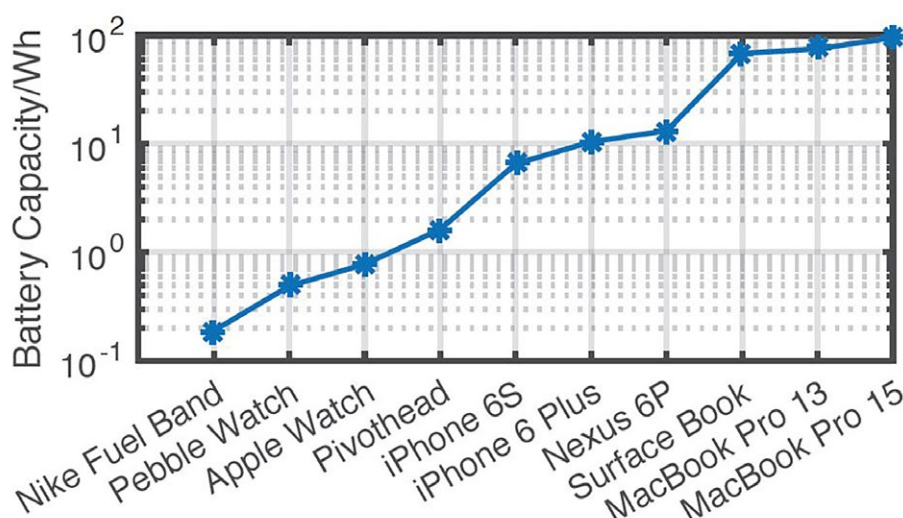
ric power modes, dynamically splitting the power burden of communication between the transmitter and receiver, with the smallest device typically calling for the best power budget (although the larger device could make that call if its larger battery was running lower).



The power-proportional low-power radio pair described in the paper is able to shift through power consumption ratios from 1:2546 to 3546:1 between a transmitter and a receiver, a huge dynamic range (seven orders of magnitude) that addresses a wide range of energy budgets between different devices.

The team also gathered the data of performance gains obtained using Brai-dio over regular symmetric load BLE transmission, across multiple devices from differing battery capacities. The figures are striking!

The “braided radio” was shown to consume between 16  $\mu$ W and 129 mW across the different modes, increasing the total bits transmitted by several orders of magnitude when compared with Bluetooth. The benefits are particularly appealing when there is significant asymmetry in battery levels, making the most energy-constrained device last



much longer than it would if operating in full active mode.

“We are in the process of securing patents and contemplating IP licens-

ing”, conceded Ganesan, though the researchers remain uncertain about future business plans.

## LITE founded to enable collaborative software engineering for the IoT

Linaro Ltd has announced the launch of the Linaro IoT and Embedded (LITE) Segment Group, which working in collaboration with industry leaders will focus on delivering end to end open source reference software for more secure connected products, ranging from sensors and connected controllers to smart devices and gateways, for the industrial and consumer markets.

Industry interoperability of diverse, connected and secure IoT devices is a critical need to deliver on the promise of the IoT market. Today, product vendors are faced with a proliferation of choices for IoT device operating systems, security infrastructure, identification, communication, device management and cloud interfaces. Vendors in every part of the ecosystem are offering multiple choices and promoting competing standards.

Linaro and the LITE members will work to reduce fragmentation in operating systems, middleware and cloud connectivity solutions, and will deliver open source device reference platforms to enable faster time to market, improved security and lower maintenance costs for connected products.

Initial technical work will be focused on delivering an end to end, cross-vendor solution for secure IoT devices

using the ARM Cortex®M architecture. This will include a bootloader, RTOS platform, security, communications, middleware and a choice of application programming tools. LITE will also work on CortexA based smart device and gateway solutions for IoT using Linux.

“Linaro has been very successful in hosting collaboration within the ARM ecosystem to reduce fragmentation and deliver new open source technology into multiple markets, from mobile and digital home to networking and the enterprise data center,” said George Grey, Linaro CEO. “We see an opportunity to apply the same skills to the rapidly emerging IoT software market, and we intend to work with our members to deliver reference open source software platforms that implement nondifferentiating but critical features such as end to end security from the device to the cloud, over the air software updates, emerging IoT standards and protocols, and interfaces to global cloud service providers. This will enable product vendors to focus on their differentiation and value add.”

Linaro has recently joined the Linux Foundation Zephyr Project as a Platinum member, alongside Intel, NXP® and Synopsys. LITE plans to use both Zephyr and Linux as neutral industry

platforms for delivery of its collaborative engineering output. Under the direction of its Steering Committee, LITE will also work with ARM to extend and expand the ARM mbed™ IoT Device Platform and ecosystem. In addition, LITE will evaluate integration of other open source RTOS solutions and platforms from global Cloud service and device management providers.

Founding members of LITE are ARM, Canonical, Huawei, NXP, RDA, Red Hat, Spreadtrum, STMicroelectronics, Texas Instruments and ZTE. Additional ecosystem semiconductor vendors, software companies, service providers and product manufacturers are expected to join LITE over the coming months.

“The success of the ARM ecosystem is built on choice and the work of our many partners,” said Charlene Marini, vice president of segment marketing, ARM. “Linaro has a proven track record in fostering collaboration on developing, optimizing and maintaining software solutions across a diverse range of applications. Linaro will apply those same successful principles to LITE to help rapidly mature the IoT software ecosystem in support of the ARM architecture.”

[www.linaro.org](http://www.linaro.org)  
[www.96Boards.org](http://www.96Boards.org)

## Harvesting cellphone RF energy to boost battery life

By Nick Flaherty

**A** wireless charging startup is looking to boost battery life in mobile phones and tablets by harvesting the RF energy from their radio links. Nick Flaherty talks to Marc Chen, CTO of Radiant Micro-Tech (Fremont, CA).

"Cellphone battery life has been a longstanding issue, so what we did was look at the cellphone and see that 90% of the energy is wasted in the air as RF," said Marc Chen, chief technology officer of California-based Radiant Micro-tech. "So we turn the back of the cellphone into an antenna to absorb the power to boost the battery life."

The company started in 2007, coming from designing the analogue RF chips, with key patents granted in 2013. It is now looking to license its technology to a range of different companies, including wireless charging equipment makers that may already be using the Qi technology from the Wireless Power Consortium.

"We can extend battery life by 30% and also use that extra antenna for wireless charging," said Chen. "Qi charging requires you to put the phone on a platform and for me, that's worse than using a cord. So what we are doing is video frequency RF charger [operating at around 2 GHz] that will be relatively short distance at 15 to 20 ft (5 to 7m). We want to create a product where the user can be walking around or sitting in a coffee shop and the phone is charged fully wirelessly."

The power available is determined by the distance from the charging base and the number of devices to be charged but the power can be focussed in a particular direction. This is achieved through a data backchannel to the cellphone or tablet that uses either WiFi or Bluetooth. "In a larger environment with many users such as a coffee shop maybe the distance is only a few feet, but these things can be worked out dynamically," said Chen.

Balancing the design and placement of the antenna for both RF energy harvesting and free space wireless charging is a challenge. "What is more important is the distance – so the closer the receiver is to the transmitter, the more efficiently the energy can be absorbed,"

he said. "And because it is also used for wireless charging we also have some programmability to make it more efficient for either purpose."

The solution is largely software based. "We don't need a dedicated IC for our technology to be implemented as there is already an RF IC module and power management in the devices so all we need to add is an RF to DC converter which is just a few transistors and everything is in the device already so the additional cost is negligible."

The advantage for the phone maker is reducing the size of the battery to give more space in the design or increasing the manufacturing tolerances to reduce costs. "If you can reduce the battery size by 30% that's a cost saving and gives more space to do things," he said.

However, having an extra antenna on the back of a phone can change the performance of the device, and he is well aware of this. "When the cellphone is transmitting only about 10% of the energy gets to the cell tower – the direction of the cell tower is generally not known but there are things we can do to determine whether our receiver is effecting the link," he said. "One of the things we are doing is working with the algorithms in the transmitter to determine whether it is affecting the transmission."

This is a challenge for all phone makers. "Even the Qi charger or even the camera will affect the transmitter and have to be placed very carefully so we place the antenna close but not too close, so maybe we are collecting 20 to 25% of the energy and even that is enough to make a difference."

The company is looking to license the technology to phone makers but also to wireless charger makers and even phone case suppliers, although this is not an immediate route to market



"Even if it is in an external case it has to make use of the signals from the internal signal processor otherwise you could actually jam the signal – we could have rushed out with the external case but we didn't as we know this has to be designed into the cellphone," he said.

"We are working with potential partners such as RF wireless charger companies as many have been working on this for a number of years – our expertise is working within the cellphone and working with a partner we can get to market much faster."

However, as a small company he is not a big fan of the standards groups that are dominated by the large industry players.

"Generally it's not good to be part of a standard but as the technology is patented we are comfortable. Being part of a standard without patent protection is a problem as without patents the other partners can use the technology and it just becomes a price war. As we have patented technology we can offer a player in a consortium a competitive advantage," he said.

With the need to design into cellphones and develop a wider ecosystem of wireless charging, the technology will not come to market quickly. "A recent IDC report analysed the wireless charger space and by 2020 over half will be truly wireless and not Qi based and that's where we see our technology rolling out," said Chen.

[www.radiantmicro.com](http://www.radiantmicro.com)



## Power limiter combines lightning and high power microwave protection



Huber+Suhner has extended its family of protection devices with the launch of the Series 9078 HF high power limiter, designed specifically to protect sensitive electronic systems.

The Series 9078 power limiter has a threshold level configuration of 6 dBm or 12 dBm and will find application in a variety of defence applications including electronic intelligence (ELINT), signals intelligence (SIGINT), command, control, communication intelligence, surveillance and reconnaissance (C<sup>3</sup>ISR) and ship's signal exploitation.

In applications such as these, highly sensitive sensors monitor and analyze the electromagnetic environment for low-level signals. These high sensitive systems are frequently deployed in hostile environments where the full spectrum of electronic warfare (EW) weapons such as ultra-wideband (UWB) pulses, high intensity radiated fields (HIRF) or high power microwave (HPM) must be expected. The equipment is also installed and utilized in areas where friendly high power radar or jammer signals are in operation.

[www.hubersuhner.co.uk](http://www.hubersuhner.co.uk)

## Wi-Fi modules for embedded and 802.11ac applications

LSR, a Laird business, is introducing two new products that help companies design and certify wirelessly-connected products quickly and successfully. These products, based on Cypress S microconductor radios, expand the Sterling family of Wi-Fi + Bluetooth multi-standard modules, joining the popular Sterling-LWB 2.4 GHz certified module, which is ideally suited for adding wireless connectivity to products employing a microprocessor with a LINUX operating system.

The first product added to the Sterling family is the Sterling-LWB5 certified dual-band 802.11 a/b/g/n/ac Wi-Fi®, Blue-

tooth®, and Bluetooth® Smart module. Like the Sterling-LWB, this module enables companies to easily add wireless capabilities to electronic products typically running Linux, with the Sterling-LWB5 offering the additional capabilities of dual-band Wi-Fi with full support of the IEEE 802.11ac standard.

The second product is the Sterling-LWB for WICED reference platform, which provides electronics developers everything needed to add both embedded Wi-Fi and Bluetooth Low Energy (BLE) connectivity in one device where a microprocessor is not needed or used. This comprehensive reference platform and documentation enables engineers to use the popular Cypress WICED software development kit (SDK) for Internet of Things (IoT) development for microcontroller-based applications.

Practical applications might include security and building automation, making enterprise or personal devices "wireless" to connect to the internet, medical devices, M2M applications, vehicle telematics, smart gateways, and other uses to provide wireless connectivity to a multitude of devices and equipment.

Both the Sterling-LWB and Sterling-LWB5 utilize latest-generation silicon technology that Cypress acquired from Broadcom in July 2016. The Sterling-LWB5 uses the powerful Cypress BCM43353 chipset to create one of the very first commercially available certified modules that offers IEEE 802.11ac capabilities for ultra-high data rate 5 GHz band Wi-Fi connectivity.

[www.lsr.com](http://www.lsr.com)

## PCB connectors for applications up to 65 GHz



The SMPM line of high performance products from Amphenol RF offer high performance in a sub-miniature package, with versatile connectivity options.

SMPM cable connectors are available in straight and right-angle configurations, for 0.047- and 0.086-inch diameter semi-rigid and conformable cables, as well as RG-178 flexible coax. The connectors are made from beryllium copper or brass with gold plating, for durability of use and maximum electrical performance.

SMPM PCB connectors are also machined from brass and plated gold for

solderability and high-frequency electrical performance. PCB connectors are available in many configurations, including surface mount, through-hole leg, or edge mount terminations. When used in conjunction with SMPM bullet adapters, a minimum PCB spacing of 8.65 mm can be achieved, and are ideal for blindmate situations.

The connectors are designed to operate in high frequency board to board applications up to 65 GHz, or with cable systems optimized to meet the frequency limits of the cable. SMPM connectors have a snap-on mating style similar to the SMP, and are suitable for a wide range of precision and miniaturized applications including antennas, handheld radios, military communication systems, and instrumentation and measurement equipment.

[www.amphenolrf.com](http://www.amphenolrf.com)

## Single slot PXI frequency synthesizers cover 250 MHz to 16 GHz

Micro Lambda Wireless has announced the production release of a smaller and lower cost frequency synthesizer designed to fit into a single slot PXI chassis.



Standard frequency models the MLMS-series frequency synthesizers are available covering 250 MHz to 6 GHz, 2 to 8 GHz, 6 to 13 GHz and 8 to 16 GHz. Special customer defined frequency ranges within the entire frequency range are available on special order.

Standard models are specified to operate over the 0 to +65°C temperature range, but extended temperature versions covering -40 to +85°C are available on special order.

This series of frequency synthesizers have been designed in a miniature package that will fit within a single slot PXI chassis. Dimensions are 6.35- x 6.35- x 1.65-cm (2.5- x 2.5- x 0.65-inches) tall. Units come with a 9 pin molex connector for all input voltages and signals as well as a standard USB mini-b connector.

Applications include wide band receivers, automated test systems, telecom,

satcom, UAVs and drones and a variety of military and commercial test applications.

[www.microlambdawireless.com](http://www.microlambdawireless.com)

## E-band polarized conical horn antenna

The Model SAC-2309-125-S2 from Sage Millimeter is an E-band conical horn antenna that operates from 68 to 77 GHz.



The antenna offers 23 dB nominal gain and a typical half power beam width of 11 degrees on the E-plane and 13 degrees on the H-plane. When used with a polarizer, model SAS-773-12512-F1, the conical horn can support horizontal, vertical, and left and right-hand circular polarization. For convenient integration, model SWT-12125-SB can be offered as an efficient mode transition from the 0.125-inch diameter circular waveguide interface of the polarized horn to a WR-12 rectangular waveguide.

[www.sagemillimeter.com](http://www.sagemillimeter.com)

## 802.11ax Wi-Fi access point chip set

Quantenna Communications claims to offer the industry's first 802.11ax access point chip set, called QSR10G-AX. It is built on the company's QSR10G Wave 3 Wi-Fi platform and adds support for the draft 1.0 of the IEEE specification 802.11ax standard.

The QSR10G-AX will support 12 total streams: 8 streams in the 5 GHz band and 4 streams in the 2.4 GHz band. The chip set adds support for downlink and uplink OFDMA (Orthogonal Frequency-Division Multiple Access), providing superior network efficiency in dense environments as well as high uplink performance. OFDMA dedicates different sub-carriers for individual client devices. This allows multiple devices to be simultaneously served.

QSR10G-AX is designed to enable a very easy and fast transition for existing QSR10G customers. The QSR10G-AX chipset is pin-to-pin compatible with QSR10G, Quantenna's Wave 3 12-stream dual-band 802.11ac and 802.11n access

points. As a result, customers designing with QSR10G will be able to drop in the new QSR10G-AX.

[www.quantenna.com](http://www.quantenna.com)

## Ku-band SSPA delivers 4-W over 14.4 to 15.5 GHz



The TA1149 SSPA from Triad RF System is designed for Ku band UAV data and video links for both GCS and air vehicle installation.

The unit contains many standard features including auto gain leveling, fault detection, and operates from a wide 12 to 30 VDC input range.

[www.triadrf.com](http://www.triadrf.com)

## Power divider with integrated bias tee



MECA Electronics, Inc., has made available 2-way power dividers with integrated DC injector port rated at 7 A.

The power dividers are optimized for performance across all wireless bands from 700 MHz to 2.7 GHz. Their rugged construction makes them ideal for both base stations and in-building wireless systems configurations for 4G/LTE applications. Type N and SMA interfaces are available.

[www.e-MECA.com](http://www.e-MECA.com)

## Rugged, low-profile multi-output synthesizer



The THOR-16000-XA is a multi-output frequency synthesizer with a single 800 MHz and dual 16 GHz RF outputs. The fully-custom hermetically-sealed package offers a low profile design for use in a hyper-velocity projectile system capable of withstanding extreme vibration and shock profiles; over 220 Gs.

The THOR-16000-XA locks to an external 50 MHz reference and exhibits low phase noise at both RF output frequencies. At 100 KHz offset, phase noise is <-118 dBc/Hz at 800 MHz and <-94 dBc/Hz at 16 GHz. All three outputs have output power of +10 dBm, harmonics <-30 dBc, spurs <-70 dBc, and draws 570 mA current while supplied to +5V.

This ultra-rugged package (3.1- x 1.1- x 0.4-inch) features GPPO RF connectors and a 3-pin hermetic feed-thru header for I/O and operates over the temperature range of -40° C to +85° C with extended temperatures available.

[www.emresearch.com](http://www.emresearch.com)

## Energy-harvesting for Bluetooth LE

EnOcean, developer of energy-harvesting wireless technology, has announced its first energy-harvesting wireless modules for 2.4 GHz BLE (Bluetooth Low Energy) systems. The new modules complement the existing EnOcean wireless technology in the sub-1 GHz band and ZigBee wireless products in the 2.4 GHz frequency band.

The first product in the EnOcean 2.4 GHz BLE portfolio is the batteryless PTM 215B switch module, which also comes with an NFC function for pairing and set-up, making it easier to train and configure the switch. The PTM 215B is based on the established form factor of the PTM 21x module, invented by EnOcean, and can be integrated into a large number of existing switch designs. The switch is also available as a white label end product. EnOcean aims to enable product manufacturers to develop



reliable and self-powered solutions on the 2.4 GHz frequency band for use in smart homes and modern light control all over the world.



Manufacturers of BLE-based systems for the 2.4 GHz band can now incorporate energy harvesting technology from EnOcean into their portfolios and develop batteryless, room-based wireless controllers. If they choose to use the standardized PTM 21x form factor, switch manufacturers can integrate the new 2.4 GHz module into their existing product ranges and use maintenance-free BLE systems that produce energy from motion.

"By adding a BLE-based wireless module to our portfolio, we have taken another important step toward fully networking devices in the Internet of Things (IoT)," explains Wald Siskens, CEO of EnOcean.

The radio-based PTM 215B switch can be trained through direct contact with NFC-capable devices without any manual actuation. A number of parameters can also be configured automatically, permitting, for example, protocol data to be modified or additional information to be transmitted, such as group assignments. New devices can thus be integrated into existing systems, substantially reducing their susceptibility to faults.

In addition to the radio-based switch module, the 2.4 GHz BLE portfolio from EnOcean also includes white label end products: energy harvesting wireless single-rocker (ESRP) and dual rocker (EDRP) switches for the American market. Solar-based sensor modules will be added to the switch module in 2017, including a door and window sensor, a temperature/moisture sensor and a light sensor. The switches use kinetic energy harvesting; that is, the mechanical action of the switch's operation is used, by way of coils and permanent magnet, to generate sufficient power to complete the wireless transaction.

EnOcean has also disclosed a change in its branding for energy harvesting wireless modules; the company will market its energy harvesting wireless modules and

white label products under the Dolphin brand, with the tag line, "Dolphin – Self-powered IoT by EnOcean".

[www.enocean.com](http://www.enocean.com)

## Broadband GaAs MMIC frequency doubler

Custom MMIC has released a GaAs MMIC frequency doubler, the CMD225C3, that operates with an input frequency range of 4 to 8 GHz.

This passive frequency doubler can be driven with a +15 dBm input signal with a low conversion loss of 13 dB, and boasts excellent  $F_o$  and  $3F_o$  isolations of at least 47 dBc. The CMD225C3 is a 50 ohm matched design to eliminate the need for RF port matching.

This frequency doubler comes in a Pb-free RoHS compliant 3- x 3-mm surface mount package and is ideal for low phase noise frequency synthesizers and local oscillators.

[www.custommmic.com](http://www.custommmic.com)

## Signal analyser delivers continuous-sweep from 3 Hz to 110 GHz



Boasting industry-leading continuous frequency coverage from 3 Hz to 110 GHz, with displayed average noise level as low as -150 dBm/Hz above 50 GHz, the Keysight N9041B UXA X-Series signal analyzer claims to be the first to provide frequency coverage to 110 GHz with a maximum analysis bandwidth of up to 5 GHz.

Announced at recent European Microwave Week 2016 in London, the N9041B UXA exemplifies the company's unique capabilities with attributes such as advanced front-end circuitry that achieves low loss and efficient mixing, providing a displayed average noise level (DANL) as low as -150 dBm/Hz when characterizing wideband modulated signals in the millimeter-wave band.

"This new UXA is a clear example of Keysight's leadership in providing the

tools our customers need to achieve their time-to-market goals in the fast moving communications market," said Mike Gasparian, president, Keysight Communications Solution Group. "Together with the 802.11ad RF test solution, the UXA adds a new level of insight to millimeter-wave applications such as 5G, 802.11ad and automotive radar, and it is the next step in our program to bring technology above 50 GHz to commercial applications."

To eliminate compromises, the N9041B UXA provides two input connectors. The dedicated 1.0 mm input connector is machined to exact tolerances to ensure continuous sweeps and valid measurements up to 110 GHz. A robust and economical 2.4 mm input connector covers measurements up to 50 GHz.

The challenges of designing systems at these frequencies are significant, and this increases the need for integrated tools in design, simulation, measurement and analysis. Keysight software for design and simulation provide an efficient workflow that accelerates development of next-generation devices and systems. These tools were used in the development of the N9041B UXA and enabled first-time-correct designs of its millimeter-wave circuits.

[www.keysight.com](http://www.keysight.com)

## NXP Airfast-3 RF power transistors target smart cities

NXP Semiconductors N.V. has introduced its third generation of Airfast products which include four LDMOS transistors for cellular macro base stations.

The latest Airfast 3 technology raises the bar in technology and meets the stringent requirements of all current wireless standards with wide instantaneous bandwidths to cover an entire cellular band using a single device. Airfast 3 delivers industry-leading performance in key areas that include efficiency, gain, RF output power, and signal bandwidth, while significantly reducing the footprint required to deliver a given level of RF output power.

When compared to Airfast 2, this third generation delivers up to four percent greater efficiency (53 percent final-stage efficiency and up to 50 percent lineup efficiency), a 20 percent improvement in thermal performance, up to 90 MHz full-signal bandwidth, and space savings up to 30 percent.

The four new Airfast 3 LDMOS RF power transistors designed for asymmetrical Doherty amplifier architectures include:

- A3T18H450W23S: 1805 to 1880 MHz, 89 W average RF output power, 17.2 dB gain, 51% efficiency;
- A3T18H360W23S: 1805 to 1880 MHz, 56 W average RF output power, 17.5 dB gain, 53% efficiency;
- A3T21H450W23S: 2110 to 2200 MHz, 89 W average RF output power, 15.5 dB gain, 49.5% efficiency;
- A3T26H200W24S: 2496 to 2690 MHz, 37 W average RF output power, 16.3 dB gain, 50% efficiency;

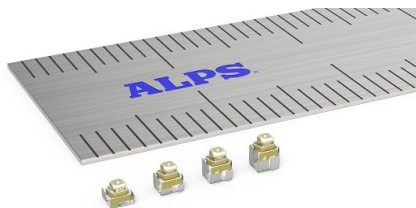
These transistors are the first Airfast products to be housed in air-cavity plastic packages that combine exceptional RF performance with a lower thermal resistance reducing overall system heat dissipation.

The Airfast 3 RF power transistors are currently sampling with production expected starting in Q4 2016. Reference circuits for various frequencies are also available.

[www.nxp.com](http://www.nxp.com)

## Spring contact has insulation coating for RF antennas

Alps Electric added the SCTA B series to its product line of spring contacts, a model with insulation coating and boasting the industry's smallest dimensions at 1.4x1.4mm.



The contact features a unique double-spiral spring construction ensuring high resilience against vibration and impacts, and therefore high contact reliability. As a connection component, a single square contact or multiple contacts can be used, offering added flexibility on component layout. Insulation coating around the outer surface of the spiral spring prevents any changes in the signal path, ensure that connected devices such as RF antennas retain a stable high-frequency performance. The series has four mounting heights variety; 0.85, 1.6, 1.8, and 2.0 mm. The springs are rated for up to 1A and operate in the -30 to +85°C temperature range.

[www.alps.com](http://www.alps.com)

## Compact two-stage Doherty amplifier for 4.5 G and LTE Advanced Pro

A family of integrated Doherty power amplifier devices aimed at LTE Advanced Pro and 4.5G massive-MIMO base station applications, just released by Ampleon, are compact, highly efficient devices that are much smaller and easier to use than a traditional discrete Doherty amplifier designs.



Capable of being used also as power amplifiers in small cells, these devices comprise a dual-stage Doherty amplifier with two stages of gain and feature 50 ohm matched inputs and outputs (on certain variants). Significantly simplifying the design process, these ultra compact amplifiers occupy the minimum of footprint, essential for today's space constrained applications and offer the performance consistency required in multiple-antenna systems.

The first devices available cover the 1.8 to 2.2 and 2.3 to 2.7 GHz bands, an example being the BLM9D2527-20AB product. This LDMOS-based PQFN packaged device has a P3dB of 43.5 dBm, a gain of >28 dB and an efficiency of 44-percent at 8 dB OBO when operating in the 2575 to 2634 MHz band. Similar products using a 0.25  $\mu$ m GaN process technology are currently being designed for higher frequencies and will be sampled in the 4th quarter of 2016. Modularity is a key feature of this new family, allowing the same mechanical format to be re-used for different base station variants using different frequencies and power outputs.

[www.ampleon.com](http://www.ampleon.com)

## Tiny antenna receives global satellite signals

Beltii (part number SR4G013) from Antenna Ltd is a new embedded antenna which operates with all global public satellite constellations, with a footprint of only 15.6- x 3.3- x 4.4-mm.



Designed with novel materials, the antenna beats the typical larger, ceramic patch antennas on all counts: it is smaller, more efficient, and performs better, claims the company. The antenna has been cleverly designed to work over a very small ground plane on a small PCB, where it can be placed in a corner position, and does not need any ground clearance.

Beltii works with all of the world's public satellite constellations: GPS, GLONASS, BEIDOU and GALLILEO, and can add a positioning capability to any small, light-weight device. It is suitable for wearable electronics, trackers, drones, navigation devices, and sports applications. Antenna provides detailed datasheets with advice on integrating the antenna, and offers the services of its engineering team to help customers and OEMs with antenna integration if required.

[www.antenova-m2m.com](http://www.antenova-m2m.com)

## E-band linear-circular polarizer delivers exceptional cross-pol discrimination



The Millitech brand of Smiths Microwave Subsystems has released an ultra-wide bandwidth E-band linear-circular polarizer boasting a low axial ratio of < 0.6 dB, low insertion loss of < 0.5 dB, and a typical VSWR of 1.25:1 within the high and low unlicensed communication bands of 71 to 86 GHz.

With over two times the bandwidth of similar products and an industry leading axial ratio performance, this polarizer enables antenna system designers to achieve dual circular-polarized E-band systems with exceptional cross-pol discrimination. It measures 1-inch in length and can be easily integrated with the Millitech product line that leverage the 0.125-inch circular waveguide. These devices can also be easily customized



for other bands from 18 to 110+ GHz. Standard models in other common bands are on the horizon.

[www.millitech.com](http://www.millitech.com)  
[www.smithsmicrowave.com](http://www.smithsmicrowave.com)

## Low pass thin film filter in 0805 outline

The LP series filters from AVX exhibit low insertion loss and extremely sharp roll-off, delivering high frequency performance in wireless applications including mobile communications systems, satellite TV receivers, GPS, vehicle location systems, and wireless LANs.

These 750-MHz 0805 high performance, low pass integrated thin film (ITF) SMD filters exhibit low insertion loss and extremely sharp roll-off in high frequency wireless applications spanning 746 MHz to 756 Hz, including: mobile communications systems, microcell and picocell base stations, satellite TV receivers, global positioning systems (GPS), vehicle location systems, and wireless large area networks (LANs). Based on thin film multilayer technology, the filters deliver high frequency performance, and feature an ultra miniature 0805 chip size.

[www.avx.com](http://www.avx.com)

## Frequency selectable RF power sensor



The Power Master MA24507A from Anritsu Company is an ultraportable, millimeter wave (mmWave) power analyzer that enables simple, numeric, frequency based measurement of RF power from 9 kHz to 70 GHz. Claiming to be the first frequency selectable RF power analyzer, the MA24507A leverages Anritsu's patented Shockline technology to address the growing number of test requirements in mmWave applications, including test of 802.11ad, Wireless HD, and E-band products, at every stage of the product lifecycle.

As signal frequency increases, attenuation due to the air or cabling grows, which can make power measurements particularly difficult at mmWave frequencies. The small size of the MA24507A overcomes this challenge by enabling users to place it directly at the signal source, including on-wafer measurements. When system losses are unavoidable, the MA24507A can make measurements as low as -90 dBm at 70 GHz, making it a superior alternative to large benchtop instruments, which can be unwieldy in the field. USB-powered, the Power Master MA24507A measures approximately 15.2- x 7.6- x 2.5-cm and weighs less than 425 grams – slightly bigger than a smartphone.

Because the MA24507A enables frequency selective power measurements, users can differentiate intended signals from unintended signals for the first time. With spans from 1 kHz to full span over the entire frequency range, the power analyzer can zero in on a signal of interest in harsh environments, including those with unintended signals that can impact power readings. This enables measurements such as channel power and adjacent channel power to be made, while avoiding spurs and harmonics.

[www.anritsu.com](http://www.anritsu.com)

## Mesh networking module supports Thread and ZigBee



The MGM111 Mighty Gecko module from Silicon Labs focuses on mesh networking applications with support for best-in-class ZigBee and Thread software.

The 12.9- x 15-mm multiprotocol device combines a 2.4 GHz Mighty Gecko SoC (2.4 GHz transceiver plus 40 MHz ARM Cortex-M4 core and 256 kB flash and 32 kB RAM), high-efficiency chip antenna, crystals, and RF matching and shielding into a complete, ready-to-use mesh networking module. This high level of integration frees developers from complex RF/antenna design and testing and allows them to focus on their end applications.

The MGM111 complies with the IEEE 802.15.4 standard used in ZigBee and Thread stacks and will be pre-certified for compliance with the following regulatory requirements: FCC (North America), IC (Canada), CE (Europe), RCM (AU/NZ) and KC (Korea).

[www.silabs.com](http://www.silabs.com)

## USB power sensors deliver 100000 measurements/s over 6 kHz to 6 GHz



The RTP4000 series of real-time true average power sensors from Boonton, a Wireless Telecom Group company, deliver a dynamic range from -60 dBm to +20 dBm, a frequency range down to 6 kHz and an industry leading measurement rate of 100,000 measurements per second.

Built with the company's Real-Time Power Processing™ technology which eliminates gaps in acquisition and provides zero measurement latency, RTP4000 sensors deliver lightning-fast performance in a compact USB form factor. The true average capabilities of these sensors enable accurate capture and measurement of pulsed, modulated and CW signals. Unlike many average power sensors, the RTP4000 true average power sensors go beyond reporting numeric power measurements and provide a pulse profiling trace mode with 175 kHz video bandwidth.

The Power Analyzer Software Suite from Boonton turns any computer into a powerful RF power meter with an intuitive software interface that provides a wide range of powerful measurement and advanced analysis tools. The robust API included with the software suite is ideal for leveraging the 100,000 measurements per second in remote control and ATE environments. Multiple sensors can be connected to a single computer or test system.

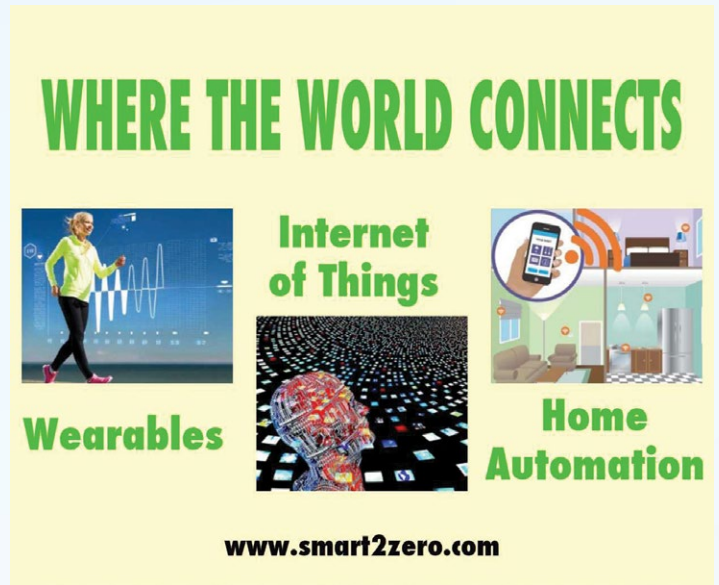
The RTP4000 series power sensors are available in two models: 6 kHz to 6 GHz and 10 MHz to 6 GHz, in a small, lightweight, portable form factor for real-time power measurement and analysis.

<http://boonton.com>

# Your Global Link to the Electronics World



[www.analog-eetimes.com](http://www.analog-eetimes.com)



[www.smart2zero.com](http://www.smart2zero.com)



[www.electronics-eetimes.com/newsletters](http://www.electronics-eetimes.com/newsletters)



[www.ledlighting-eetimes.com](http://www.ledlighting-eetimes.com)



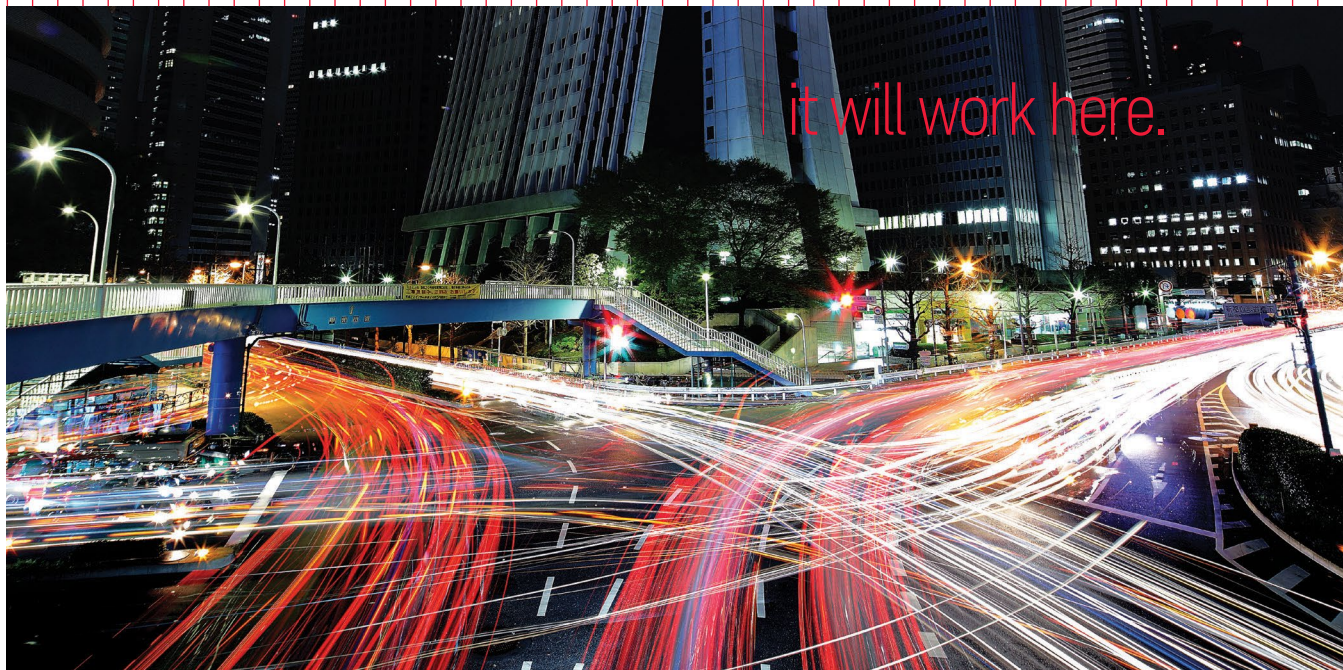
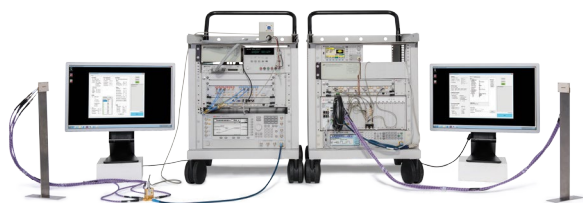
[www.microwave-eetimes.com/](http://www.microwave-eetimes.com/)



[www.eetsearch.com](http://www.eetsearch.com)



If your 5G idea works here...



it will work here.

## Autonomous vehicles navigating through traffic. Hands free.

Soon it will be reality. A world connected as never before. Always available. Low latency. Ultra reliable. That's the promise of 5G. New spectrum. New waveforms. Millimeter-waves. More. Keysight offers the world's first 5G simulation, design and test environment able to emulate your real-world 5G wireless thesis. With deep expertise to help you navigate 5G risk and complexity. So you can go from 5G ideas to 5G reality faster.

**HARDWARE + SOFTWARE + PEOPLE = 5G INSIGHTS**

**5G** Get the latest app notes,  
white papers and tutorials  
[www.keysight.com/find/5G-Insight](http://www.keysight.com/find/5G-Insight)



Unlocking Measurement Insights