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Test & Measurement

5G Developments

The European journal for the microwave and wireless design engineer

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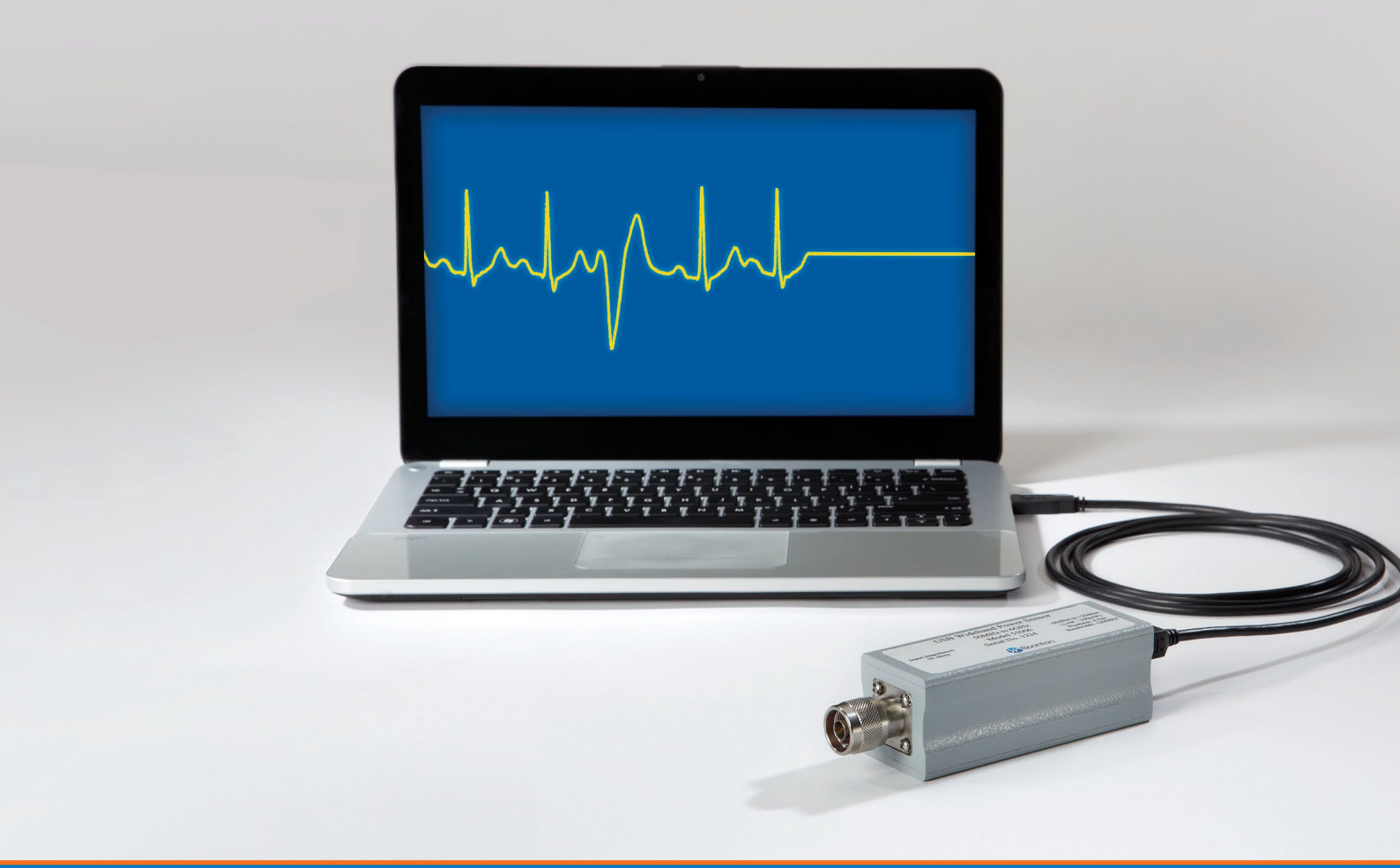

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KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

LiFi — the start of an optical renaissance

Today, fibre optics is considered an expensive option for most communications needs, and although it offers massive capacity benefits compared to radio technologies, it is used mainly for big data pipes and backhaul for radio masts in congested areas.

With the roll-out of LTE and LTE-Advanced we are seeing data rates to the device increasing to tens of Mbps. Eventually, data rates are expected to surpass 100 Mbps for 4G networks. Even though 5G is not defined yet, it is expected to reach 1 Gbps.

The trend here is obvious and it poses a serious question with respect to the viability of radio technology such as Wi-Fi, especially public Wi-Fi. One technology that offers the data rate capacity to eventually complement 5G and replace traditional Wi-Fi is Li-Fi. As Li-Fi is essentially an optical technology, it offers very high data rates. Combined with smart light bulbs and fibre-optic broadband, it could potentially revolutionize in-door wireless for the home and for public spaces.

One company in this space, pureLiFi, a spin out from the University of Edinburgh, has recently completed a £1.5 million round of investment and is shipping a full wireless Li-Fi networking system, called Li-Flame.

Li-Fi – a term coined by pureLiFi's Chief Science Officer (CSO), Professor Haas – is a technology based on visible light communication (VLC) that provides full networking capabilities similar to Wi-Fi but with significantly greater spatial reuse of bandwidth.

Li-Flame turns off-the-shelf light fixtures into Li-Fi access points that deliver bi-directional simultaneous communication to a plurality of users. The system consists of a battery powered Li-Fi mobile unit, which is attached to a laptop screen and allows user roaming within a room, or indeed an entire building.

Also working on Li-Fi, Grenoble-based CEA-Leti together with LUCIOM, a French company which develops visible-light communication using light-emitting diodes (LEDs), have launched

a project to develop high-data-rate Li-Fi transceivers.

With this technology, LUCIOM plans to offer by mid-2015 one of the first high-data-rate bidirectional light-fidelity, or Li-Fi, products that can work with different LED lighting sources, and on mobile devices.

According to Leti CEO Laurent Malier, LUCIOM was one of the first companies to see that LEDs and Li-Fi can offer a powerful, secure and highly energy-efficient communications alternative to Wi-Fi. He says that based on an earlier first proof of concept and the company's expertise in RF, data-transmission rates in excess of 100Mb/s with traditional lighting based on LED lamps are expected.

One of the highlights at the Electronica exhibition in Munich last November, The Fraunhofer Institute for Photonic Microsystems IPMS in Dresden demonstrated communication modules that can wirelessly transfer data at a speed of up to 1 Gbps over a distance of up to 10 meters.

The system developed by Fraunhofer IPMS is based on light in the infrared range and uses the internationally non-regulated spectrum of light with bandwidths of several Gigabits per second. The system has the potential to transmit data up to ten times faster than available wireless systems, with minimal bit error rates ($<10^{-9}$) and using significantly less energy than wireless systems in use today.

Li-Fi offers a multitude of benefits such as high data rates, robustness, low energy consumption, data security and networking capability. Combined with fibre-optics to the house or building, a powerful, high capacity optical communications system can be realized to support 4K TV, video streaming and virtual reality.

As the demand for data soars new technology is needed to cost-effectively address demand. Li-Fi and optical fibre can deliver these data rates in-doors in the near future. By using LED lighting, Li-Fi can leverage an infrastructure that is already in place. Wireless networks will struggle to meet demand due increasingly complex techniques such as massive MIMO and limited spectrum. Li-Fi solves the problem by offering much more available spectrum from the start.

The beginning of an optical renaissance could be in the making.

By Jean-Pierre Joosting

Mobile networks using a mix of radio sizes cut energy usage

According to a collaborative research project called IntelliSpektrum today's ultra-broadband mobile networks can make significant energy savings and performance gains by deploying a mix of macro and small cell radio base stations.

The IntelliSpektrum project brought together Bell Labs, the Fraunhofer Institute for Applied Solid State Physics, the Fraunhofer Heinrich-Hertz-Institute and Intel Mobile Communications GmbH. The project demonstrated how, even as mobile data traffic rises, and the number of devices connecting to a network increases, base stations can be dynamically adapted to better manage traffic loads and save energy without any adverse affects to end-user service quality. Specifically the project found that significant energy savings are possible in 'heterogeneous' (HetNet) mobile networks that comprise a mix of radio base stations, including Macro, Metro, Pico and Femto. Energy savings of over 50% were seen in mobile networks with a high number of small cells compared to those comprised only of macro base stations.

While the number of radio base stations in close proximity within today's ultra-broadband networks can create a risk of Inter-cell interference (ICI) and degrade service quality, when interference coordination is employed it not only reduces the risk of ICI but also shows gains in energy and performance — throughput gains of 10% in downlink (when the base station connects to the mobile device) and more than 50% in uplink (when the mobile device connects to the base station) were seen.

www.alcatel-lucent.com

Intel aims at connected home with Lantiq acquisition

Bolstering broadband network technologies that enhance connected experiences in the home, Intel Corporation has signed a definitive agreement to acquire Lantiq, a leading supplier of broadband access and home networking technologies.

The transaction is subject to customary closing conditions and regulatory approvals. It is expected to close in approximately 90 days.

Smart gateways and intelligent access networks are important elements in Intel's efforts to make everything smart and connected, best with Intel. This acquisition would expand Intel's success in the cable residential gateway market and broaden its offering to other gateway markets, including DSL, Fiber, LTE, retail and IoT smart routers.

"By 2018, we expect more than 800 million broadband connected households worldwide," said Kirk Skaugen, senior vice president and general manager of Intel's Client Computing Group. "Intel has been a global leader in driving broadband into the home and to connected compute devices. The combination of our cable gateway business with Lantiq's technology and talent can allow global service providers to introduce new home computing experiences and enable consumers to take advantage of a more smart and connected home."

The combined team would have a comprehensive range of connectivity solutions and home cloud technologies for OEMs, service providers and companies innovating new applications for the home. Together with Intel's IoT solutions, Intel® Security products and Intel-based client devices, Intel can deliver exciting new connected experiences for consumers.

www.intel.com

ALPS signs gyroscope agreement with Qualtré

ALPS Electric has signed a sales agreement with Qualtré, Inc., its partner in gyroscope development. The agreement reinforces the partnership between the two companies and strengthens ALPS' sensor business.

ALPS and Qualtré began joint development of gyroscopes and other inertial sensors in 2008. Since then, ALPS has made strategic investments twice, in 2013 and 2014, valued at US$3 million and US$4 million respectively, while Qualtré has stepped up the pace of sensor development. The three-axis gyroscopes completed last year have been well received by the market due to their outstanding shock and vibration immunity and low power consumption. The agreement permits both companies to sell the gyroscopes under their own brands to their respective customers. Sales promotion activities are being advanced with an eye to starting mass production in 2015.

www.alps.com

A billion Android smartphones shipped in 2014

Market research firm Strategy Analytics has found that global smartphone shipments grew 30 percent annually to reach a record 1.3 billion units in 2014. Android accounted for 81 percent of all smartphones last year and shipped over 1 billion units worldwide for the first time ever.

Linda Sui, Director at Strategy Analytics, said, "Global smartphone shipments grew 30 percent annually from 1.0 billion units in 2013 to a record 1.3 billion in 2014. Emerging markets, such as China and Indonesia, drove the industry's growth last year and they will continue to do so through 2015."

Neil Mawston, Executive Director at Strategy Analytics, added, "Android shipped 1.0 billion smartphones worldwide in 2014, rising from 0.8 billion units in 2013. Apple iOS shipped 192.7 million smartphones worldwide in 2014, capturing 15 percent share."

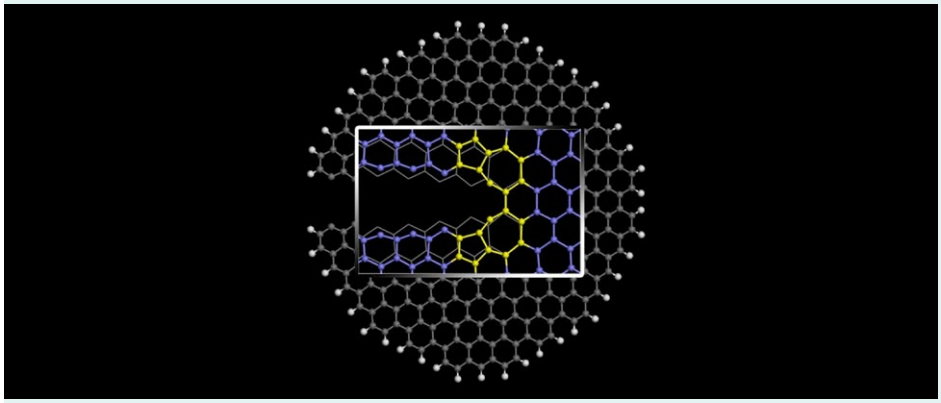
www.strategyanalytics.com

Tailor-made graphene edges fine tune material properties

A study by theoretical physicists at Rice University has worked out how researchers can fracture graphene nanoribbons to get the edges they need for applications.

The latest research by Rice physicist Boris Yakobson and his colleagues shows it should be possible to control the edge properties of graphene nanoribbons by controlling the conditions under which the nanoribbons are pulled apart.

The way atoms line up along the edge of a ribbon of graphene — the atom-thick form of carbon — controls whether it's metallic or semiconducting. Current passes through metallic graphene unhindered, but semiconductors allow a measure of control over those electrons.



Since modern electronics are all about control, semiconducting graphene (and semiconducting two-dimensional materials in general) are of great interest to scientists and industry working to shrink electronics for applications.

In the work, which appeared this month in the Royal Society of Chemistry journal Nanoscale, the Rice team used sophisticated computer modeling to show it's possible to rip nanoribbons and get graphene with either pristine zigzag edges or what are called reconstructed zigzags.

Perfect graphene looks like chicken wire, with each six-atom unit forming a hexagon. Turning the hexagons 30 degrees makes the edges "armchairs," with flat tops and bottoms held together by the diagonals. The electronic properties of the edges are known to vary from metallic to semiconducting, depending on the ribbon's width.

"Reconstructed" refers to the process by which atoms in graphene are enticed to shift around to form connected rings of five and seven atoms. The Rice calculations determined reconstructed zigzags are the most stable, a desirable quality for manufacturers.

However, one still has to know how to make them.

"Making graphene-based nano devices by mechanical fracture sounds attractive, but it wouldn't make sense until we know how to get the right types of edges — and now we do," said ZiAng Zhang, a Rice graduate student and the paper's lead author.

Yakobson, Zhang and Rice postdoctoral researcher Alex Kutana used density functional theory, a computational method to analyze the energetic input of every atom in a model system, to learn how thermodynamic and mechanical forces would accomplish the goal.

Their study revealed that heating graphene to 1,000 kelvins and applying a low but steady force along one axis will crack it in such a way that fully reconstructed 5-7 rings will form and define the new edges. Conversely, fracturing graphene with low heat and high force is more likely to lead to pristine zigzags.

http://msne.rice.edu

CommScope acquires TE Connectivity businesses

CommScope Holding Company, Inc., has agreed to acquire TE Connectivity's Telecom, Enterprise and Wireless businesses in an all-cash transaction valued at approximately $3 billion. This is an important and transformative acquisition for CommScope, bringing together complementary geographic and customer coverage, products and technologies for the benefit of our stockholders, customers and employees, said Eddie Edwards, CommScope president and chief executive officer.

The transaction is expected to provide CommScope with the opportunity to expand into the adjacent wireline telecom networks/fiber-to-the-X (FTTx) market and meet the steadily growing demand for broadband services in developed and emerging markets. It also adds approximately 7,000 patents and patent applications worldwide from TE Connectivity.

www.CommScope.com

Mineral scarcity presents opportunities

According to the VTT Technical Research Centre of Finland Ltd, as mineral resources are dwindling, it is becoming increasingly important to know how even the tiniest amounts of minerals can be recovered from waste — or how minerals can be substituted for other materials in industrial use. VTT Technical Research Centre has launched an innovation programme for developing new technologies for the recovery of metals and other minerals, and improving the recycling of raw materials by means of ecological product design. The objective is to turn threats, in other words raw material scarcity and environmental challenges, into new business activity and jobs in Finland and in Europe.

Olli Salmi, Research Professor at VTT: "The current recovery methods are too crude, and in the future, they have to be replaced with more refined methods that save the environment."

http://www.vtt.fi

Seeing What Others Can't

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Benoit Neel
Vice President and General Manager
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You've known us as Hewlett-Packard, Agilent Technologies and, now, Keysight Technologies. For more than 75 years we have been helping you unlock measurement insights.

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Those seemingly separate activities are connected by something profound: the "Eureka!" that comes with a moment of insight. When those happen for us, the results are innovations that enable breakthroughs for you.

Enabling the right idea at the right time

This is our legacy. Keysight is a company built on a history of firsts, dating back to the days when Bill Hewlett and Dave Packard worked in the garage on 367 Addison Avenue in Palo Alto, California. Our firsts began with U.S. patent number 2,268,872 for a "variable-frequency oscillation generator." Appropriately, the centerpiece of Bill's design was a light bulb, which is often used to symbolize a new idea.

Our future depends on your success, and our vision is simple: by helping engineers find the right idea at the right time, we enable them to bring next-generation technologies to their customers–faster.

Offering expertise you can leverage

This is happening in aerospace and defense applications where increasingly realistic signal simulations are accelerating the development of advanced systems that protect those who go in harm's way. It's happening in research labs where our tools help turn scientific discovery into the discovery of new sciences. It's taking place with DDR memory, where our line of end-to-end solutions ranges from simulation software to protocol-analysis hardware. And in wireless communications we're providing leading-edge measurement tools and sophisticated, future-friendly software that support the development and deployment of LTE-Advanced.

Within those systems, there are more standards than a single engineer can keep up with. That's why so many of our engineers are involved in standards bodies around the world. We're helping shape those standards while creating the tools needed to meet the toughest performance goals.

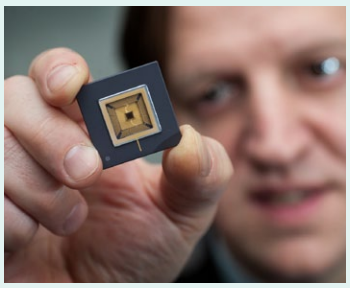
Enabling your next breakthrough

To help Keysight customers continue to open new doors, we're concentrating our effort and experience on what comes next in test and measurement. Our unique combination of hardware, software and people will help enable your next "Eureka!" moment, whether you're working on mobile devices, cloud computing, semiconductors, renewable energy, or the latest glimmer in your imagination. Keysight is here to help you see what others can't–and then make it reality.

KEYSIGHT TECHNOLOGIES

Wireless Li-Fi networking system starts to ship

Having raised £1.5 million in its latest round of investment as the pioneering Li-Fi company, pureLiFi has shipped what is claimed to be the world's first full wireless Li-Fi networking system. Valuing the 2012 University of Edinburgh spin-out at over £14 million, a VC funding round is in process and the company expects to make a announcement on additional funding during the second half of 2015.



The funding news comes as pureLiFi ships the world's first full wireless Li-Fi networking system. Li-Fi – a term coined by pureLiFi's Chief Science Officer (CSO), Professor Haas – is a technology based on visible light communication (VLC) that provides full networking capabilities similar to Wi-Fi but with significantly greater spatial reuse of bandwidth.

Investors participating in the latest round were led by London & Scottish Investment Partners (LSIP), a Scottish-based angel group supported by investors from London and Scotland, with additional funding from the Scottish Investment Bank (SIB) and Old College Capital, the venture investment arm of the University of Edinburgh, in a process managed by Edinburgh-based corporate finance firm, Quest Corporate. The investment will be used to support the development and roll-out of the product roadmap and growing the marketing and sales function.

In Q4 of 2014, the pureLiFi team launched and shipped the world's first Li-Fi network product – Li-Flame – to industry customers worldwide. The system turns off-the-shelf light fixtures into Li-Fi access points that can simultaneously communicate to a plurality of users in a bi-directional fashion. The system consists of the world's first battery powered Li-Fi mobile unit which is attached to a laptop screen and allows user roaming within a room, or indeed an entire building. Li-Flame continues to see strong demand in Q1 of 2015.

Harald Haas, CSO and co-founder of pureLiFi, said: "Li-Fi is increasingly viewed as a transformative technology that can change the way we use the mobile internet as part of future 5G cellular networks and at the same time be an enabler of the emerging Internet of Things."

http://purelifi.com

5G research and trial investments to hit $5 billion by 2020

Market research firm, MarketResearch.com in its latest report claims that R&D and trial network investments based on 5G wireless technology are expected to reach $5 Billion annually by 2020. Driven by regional, national government, and wireless carrier and vendor initiatives, it is expected that 5G R&D and trial investments will account for nearly $5 Billion by 2020, with a CAGR of nearly 40% over the next 5 years.

While LTE and LTE-Advanced is still being used, wireless carriers and vendors are already working on developing the potential "5G" technology, with hopes for commercialization by 2020. 5G aims to be revolutionary in wireless networking to support the future bandwidth of augmented reality applications, connectivity, and the future of M2M devices. Although 5G is not standardized, some of the attributes of the technology include: new air interface transmission schemes, new spectrum bands, spectrum aggregation, Massive MIMO, beamforming, D2D (Device to Device) communications and self-backhauling, among others.

www.marketresearch.com

Infinera and Telstra demonstrate PM-8QAM across submarine cable

Infinera and Telstra have successfully demonstrated the next generation submarine super-channel technology, which is expected to increase the capacity of a single fiber by 50%. The test, which was conducted across 2,200 kilometers of Segment F of the Reach North Asia Loop (RNAL), included Polarization Multiplexed 8 Quadrature Amplitude Modulation (PM-8QAM), and a range of advanced Flex-Coherent™ modulation formats, along with transmitter and receiver-based signal processing technologies. Segment F runs between Wada in Japan and Pusan in South Korea.

PM-8QAM is a key technology for the optimization of the capacity of a fiber, in order to increase the value of established submarine cable systems around the world.

www.infinera.com/go/subsea

Self-organizing network market in rapid growth

Operators rely on self-organizing networks (SONs) to speed up the planning, configuration, optimization and healing of mobile telecom networks. Self-organizing networks offer three key functions that make them an integral part for 3G and 4G/LTE wireless cellular technologies — self-configuration, self-optimization and self-healing.

In its latest report, MarketsandMarkets predict that the self-organizing network market is estimated to reach $6,419.41 million by 2020 — growing at a CAGR of 10.07% from 2014 to 2020. According to the marketing firm, the factors which are driving the self-organizing network market includes rising demand for broadband services, low cost management and installation, CAPEX and OPEX savings, and increasing deployments of LTE. The emergence of smart devices and increased use of data driven services will continue to drive operators to deploy SONs

www.marketsandmarkets.com

Using a pulsed network analyzer to gate reflections in an anechoic chamber

By Dennis Lewis, Rich Kanemitsu, David Savage

One of the classic problems with characterizing antennas in an anechoic chamber is dealing with multiple internal reflections within the range. We will discuss how the vector network analyzer with pulsed measurement capability is used to remove or 'gate out' these range reflections.

I. Introduction

Anechoic chambers were mainly developed to help isolate the antenna under test (AUT) from the signal rich environment outside. This allowed the characterization of these antennas in a controlled environment. However, one of the trade-offs that had to be considered was that the measurement system itself interfered with the desired measurement due to reflections of the signal off chamber walls, ceilings, floors, antenna mounts, and so on.

Absorbing material of various types can be used to minimize this effect. These 'absorbers', however, are effective only over specific frequency ranges. Lower frequency measurements require different characteristic absorbers than do measurements at higher frequencies. Also, absorber material is extremely expensive.

Figure 1 shows a microwave antenna range, 40 feet long, 30 feet tall, and 30 feet wide. In this particular chamber, the transmit antenna is about 10 feet from the left wall, and the AUT is about 30 feet away from the transmit antenna. Assuming the propagation time of an RF signal is about 1 ns per foot in free space, then the time it takes for the signal to reach the AUT will be about 30 ns, as shown on path 1. The bounce path from the transmitter to the AUT is about 43.4 feet or 13.4 feet longer, i.e., 13.4 ns longer. Hence, approximately 13.4 ns after our main signal reaches the AUT, a second multipath signal reaches the AUT.

In a screen room, this 'multipath' signal will arrive at a signal level slightly below the main signal. In an anechoic chamber, this signal will arrive attenuated by an amount that corresponds to the type of absorber used and the frequency of the signal.

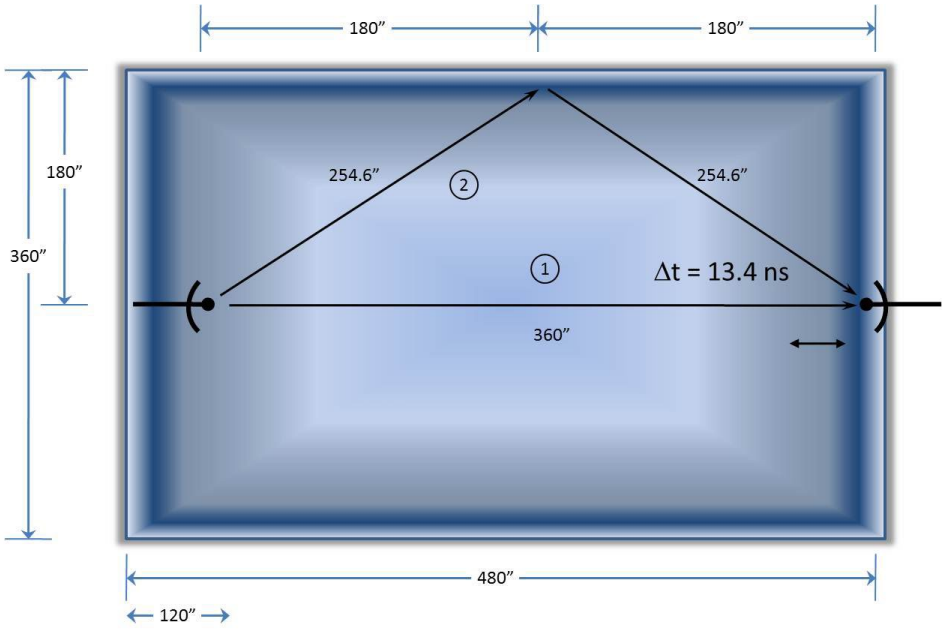


Figure 1: Antenna aange layout.

II. Time gating signals

With the Agilent Performance Network Analyzers (PNAs), the ability to create a pulsed RF signal enables antenna engineers to create signals of varying pulse widths and duty cycles. Figure 2, shows the timing used for a 50 ns pulse width. Note here that 50 ns represents about 50 feet of signal propagation.

Let's examine the measurement timing of the signal from the transmitter to the AUT and how the multipath signal interacts with this signal.

For this setup, RF switches turn on and off the test signal. These 'gates' are placed at both the transmit port and receive ports of the PNA. A 2-channel pulse generator allows us to individually 'open and close' the gates for each port. It also allows us to delay the receive gate relative to the transmit gate to account for signal propagation time. Hence, the gate at the transmitter pulses the RF signal being generated by the PNA, and the gate at the receiver opens the port long enough to 'catch' the RF pulse.

In Figure 2, the Tx PNA, shows a signal being generated from a PNA. Its pulsed RF parameters are as shown: Pulse Width = 50 ns, PRI (period) = 184 ns. The PRI is set to allow the pulsed RF signal to propagate out of the PNA through the feed line, then out of the transmit antenna. The cable at port 1 is approximately 275 feet long, so if we account for the propagation time in the teflon dielectric cable to be about 8 inches per ns, then about 184 ns from the PNA, the signal appears from the transmit antenna.

The AUT receives the pulsed signal 30 ns later (30 foot range). The signal continues into the AUT for another 50 ns. About 45 ns later, the PNA receive gate opens and begins to receive the signal. Ideally, we would like to have this gate close before any other signal arrives.

Note that since the gate time is open for 50 ns, the multipath signal has a chance to be received before the gate closes. You can see there is an overlap on the signal gate times for the reflected signal, multi-path signal and the direct path signal into the receiver, Rx PNA.

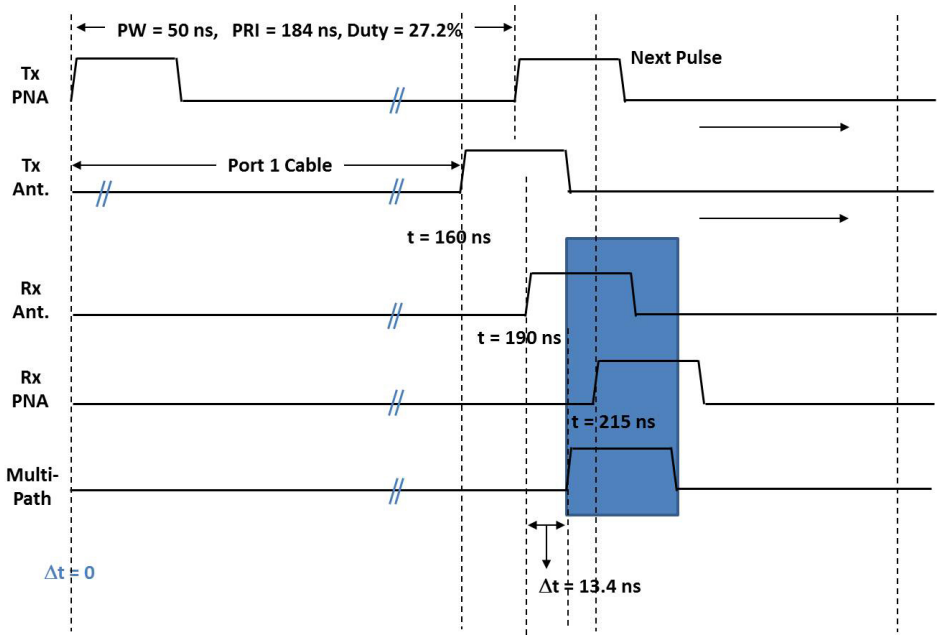


Figure 2: RF propagation timing diagram.

Figure 3 shows the effect of using narrower pulses and gate times for the same measurement setup. In this case, the pulse gate (or pulse width) was set to 10 ns.

It still takes 184 ns to propagate our test signal through the feed cables, and there is still about 30 ns required for our signal to traverse the anechoic chamber in free space from the transmit antenna to the AUT.

As can be seen in this timing chart, the multipath signal is shorter in duration (as expected) and the Rx PNA is able to open and close quickly enough, receiving only the test signal. At this point, the multipath signal has been completely gated out of our measurement.

III. Signal propagation in a compact range

Further investigation of this gating technique was applied in an indoor compact antenna range.

The basic setup for this antenna range is for the transmit antenna in the lower center of the range to create a signal that bounces off the reflector to create a flat phase front incident on the AUT on the left. Port 1 from the PNA transmits the signal that Port 2 of the PNA will receive.

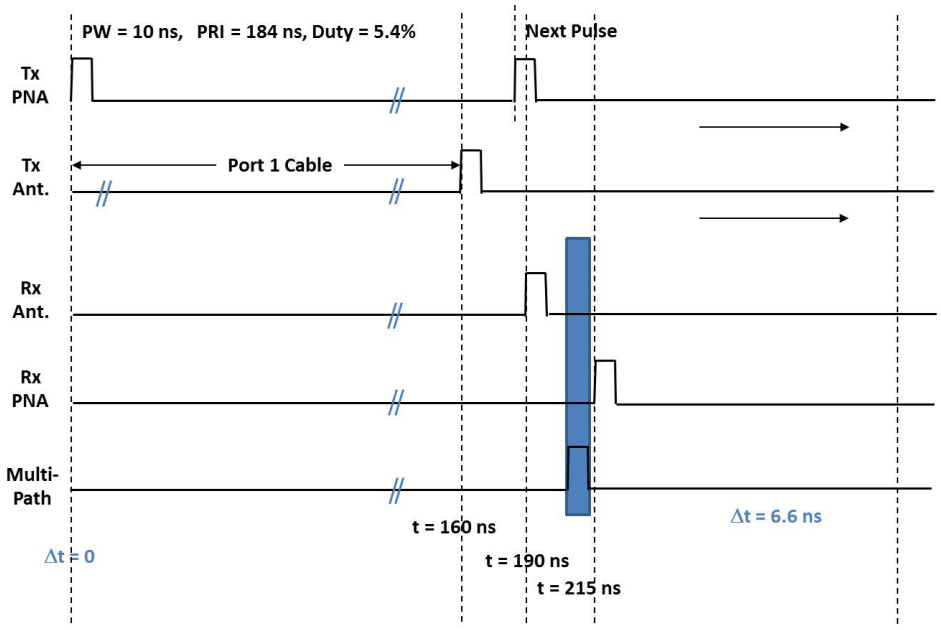


Figure 3: Timing diagram with narrower gate times.

As shown in Figure 4, the RF gates were placed at the ports of the PNA. The signal out from Port 1 routes to the transmit pedestal and a reference signal is coupled back just before the transmit antenna. The signal bounces off the reflector to the antenna under test. A cable from the antenna under test brings the signal back to Port 2 on the PNA.

The system measurement errors are calibrated by disconnecting the RF feed cables from the transmit and the receive antennas and connecting them directly for a simple S21 response cal.

IV. Other signal paths of interest

Other than the measurement path in the chamber, there are other signal paths to the antenna under test that interfere with this measurement.

Let's examine these signals in Figure 5. In Figure 5, path 1 represents the main signal measurement path for the compact antenna range. Although care has been taken to shield the direct path from the transmit antenna to the antenna under test, there is still some signal propagating directly to the antenna under test, path 2.

Path 3 shows a subtle, but interesting measurement path the signal takes to interfere with our measurement. When the signal leaves the transmit antenna, a small amount of it bounces off the reflector and propagates back into the transmit antenna. This signal gets back though the coupler and finds its way back into the reference channel receiver.

To illustrate and identify the different signals in the range, the time domain feature of the PNA (option 010) is used. These time locations can be correlated with the geometry of the compact antenna range.

Path 1 is the main measurement path and appears as the largest signal into the PNA receiver. The signal propagates from the transmit antenna, bounces off the reflector and is received by the AUT. The propagation time is about 36 ns from the transmit antenna to the AUT.

As expected, the unintended direct signal path, path 2, is shorter than the main path and appears about 17 ns before the measurement signal, at 20.1 ns from the transmit antenna. It is attenuated about 30 dB from the main

signal. This corresponds to the physical distance being approximately 16 feet shorter.

Path 3 is the signal getting back into the measurement system through the reference channel. The measurement signal bounces off the reflector and gets back into the transmit antenna. It then propagates through the reference coupler and gets into the reference receiver. Remember that all measurements are a ratio of measurements represented as S21, where the receive signal is in the numerator and the reference signal is in the denominator. Any change in this ratio appears as a response in our time domain calculation.

The final path, path 4, represents the main signal bouncing off the back wall behind the AUT. This reflection occurs about 18 ns after the main signal. The back wall is set behind the AUT about 9 feet.

As with the standard anechoic range, all of these signals, other than the main signals are incident on the AUT during a measurement and are intended to be absorbed in the range to minimize the measurement error.

If the measurement was conducted at a single frequency, i.e., CW mode, then the ability to 'gate out' these responses with the PNA cannot be done in time domain as it relies on the use of frequency bandwidth filtering and mathematical processing utilizing the inverse Fourier Transform. Time domain resolution depends on wide frequency sweeps, and antennas are typically banded devices.

Also, if a swept measurement was performed by the PNA, and if you were able to get the time resolution you require, there currently is not a way to turn on a time gate for times starting at t=0 with respect to our measurement plane of reference —i.e., once we calibrate, being able to delay the receive gate to account for the free space propagation within the range can only be done physically with RF gates as we're applying here.

Because of these additional 'other' signals and the limited bandwidth, a physical gate is needed to filter out these parasitic signals that the absorber cannot properly attenuate.

V. Hardware gating in a compact antenna range

Figure 7 shows the result when the RF gates are applied to the measurement. As expected, the main path signal remains, and does not change.

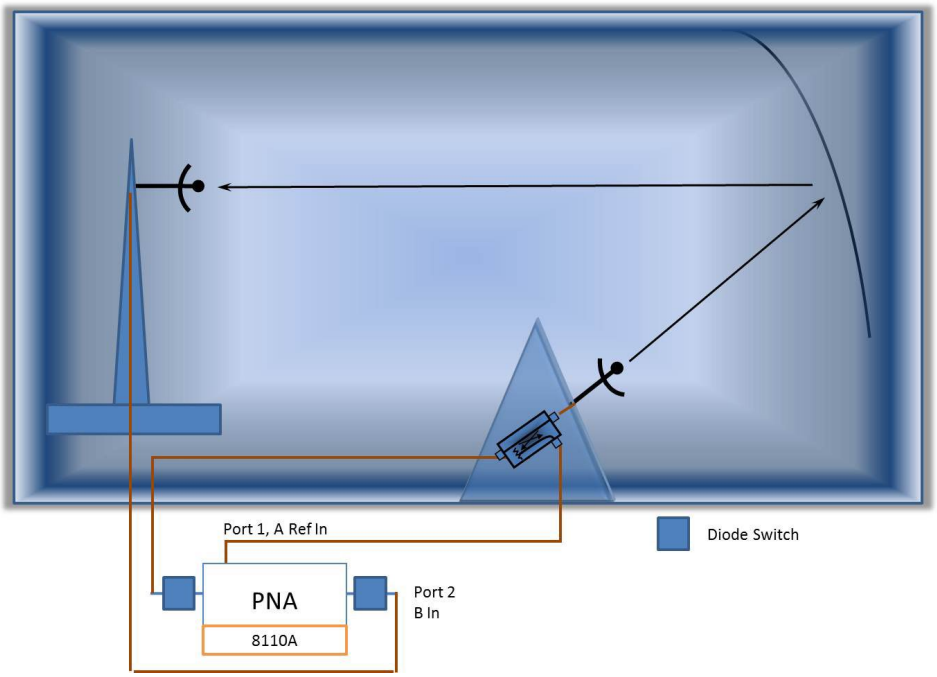


Figure 4: Compact antenna range.

The signals from the direct path and the back wall have been virtually eliminated. It's also interesting to see that the noise floor of this particular antenna range has been lowered about 70 dB below the main signal.

In this plot, the signal from the reference channel still remains. This can be explained by going back to Figure 5, and examining the hardware configuration.

For our measurement setup, the RF switches were placed just after the measurement ports on the PNA. Because we wanted to make a 'referenced' measurement, we bypassed the internal test set coupler and provided an external coupler just before the transmit antenna. We brought this reference directly back into the reference measurement channel through a jumper input. By doing this, we provided an 'ungated' signal path back into the PNA.

For future measurements, the RF gate should be moved further down the

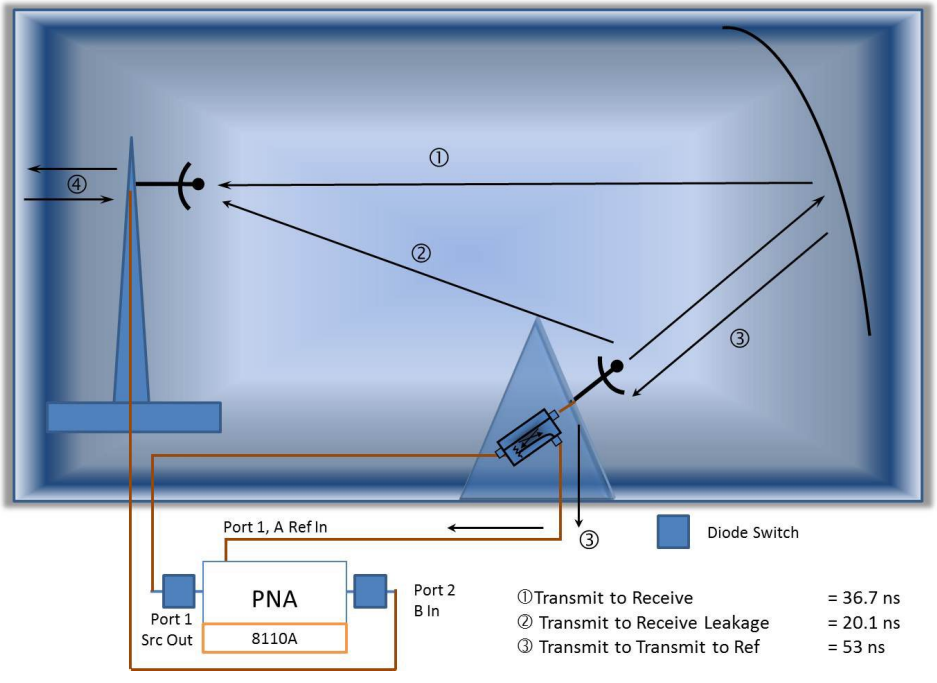


Figure 5: Other signal paths of interest.

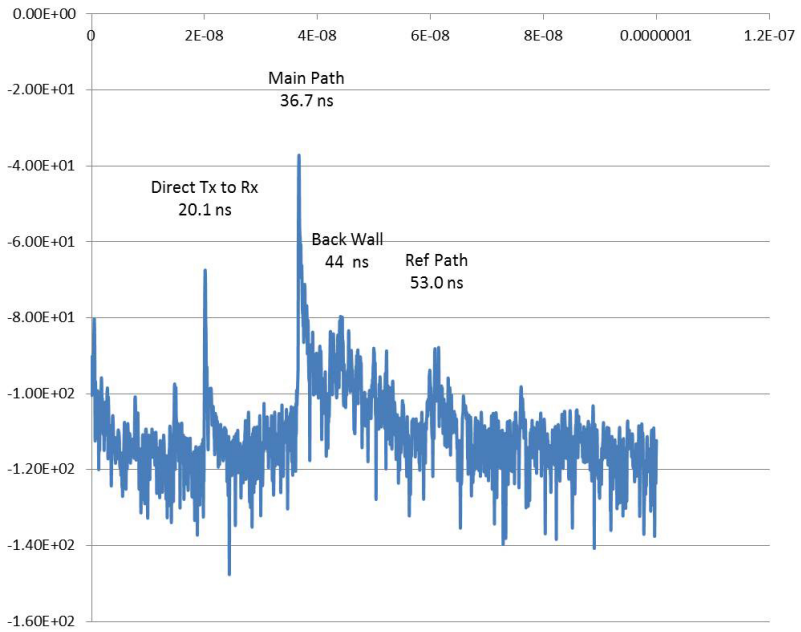


Figure 6: Identifying signals in the compact range.

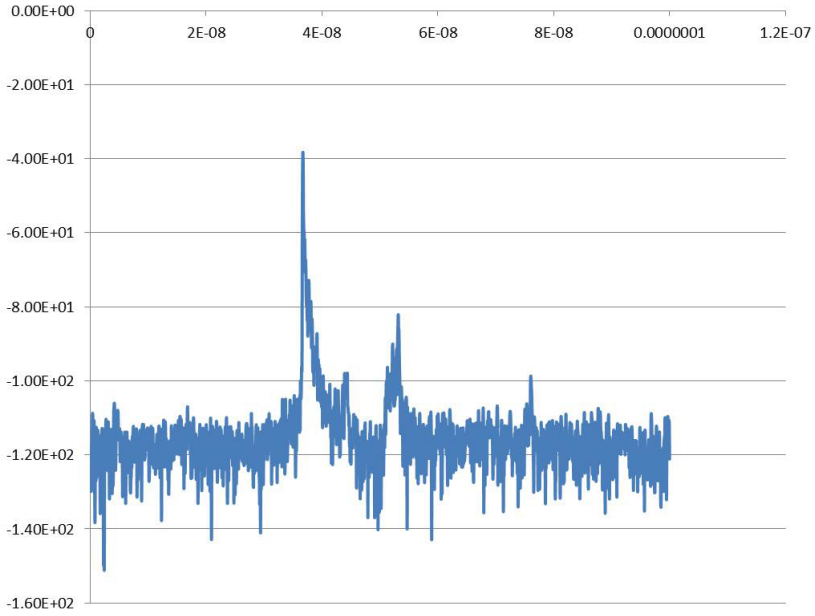


Figure 7: RF gating applied to the measurement.

RF cable, between the external coupler and the transmit antenna. When this is done the reference path response due to path 3, will be eliminated.

VI. Conclusion

We have shown that the PNA using pulse capability in an antenna range has the capability to gate out unwanted reflected and (in the case of the compact antenna range) direct path signals.

In our experiments, we were only able to attain 10 ns gate times which correspond to 10 foot signal resolution. Because the PNA is not a single shot, but a repetitive measurement receiver, it has the capability to measure RF as low as 10 MHz with 10 ns gate times.

In further analysis of our setup, we have concluded that if moving the RF switches further down the RF feed lines that go to and from the transmit antenna and AUT, we can use a faster pulse repetition interval and gain some average power back in our measurement, thereby increasing our signal-to-noise measurement ratio.

The Authors

Dennis Lewis works at Boeing Puget Sound Metrology, while Rich Kanemitsu and David Savage are from Agilent Technologies, Inc.

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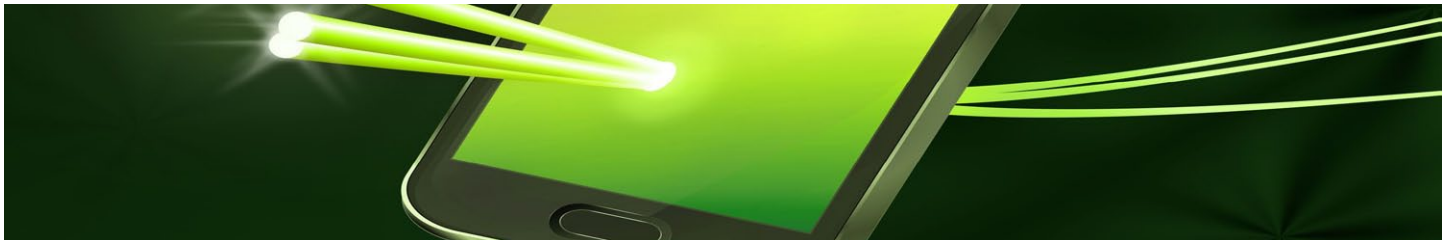

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5G: looking for the next generation wireless infrastructure

By Jean-Pierre Joosting

Today, there is no 5G, no standards. However, there is an idea of where the next generation wireless network would like to be in terms of performance. So called 5G networks will offer at least ten times the capacity of 4G bringing peak data rates to the device of between 1 Gbps to 10 Gbps

What we have today is a collection of research projects looking at what 5G could entail, ranging from massive MIMO to the use of mmWave frequencies. One of the risks to 5G is that LTE-A adopts some of these techniques, much as 3G boosted performance as 4G was being defined. It is certain that 5G will have to use higher frequencies than today to get the required bandwidth necessary to support such high data rates. Further cells will need to shrink significantly, to use spectrum as efficiently as possible.

According to John Spindler, Director of Product Management at TE Connectivity 5G could be ready to start implementation around 2020, but for this to happen specifications would need to defined in around a year or two from now.

Recently, TE Connectivity announced that its FlexWave Prism and FlexWave Spectrum distributed antenna systems (DAS) had been deployed for the 49th NFL championship game that took place on February 1 in Phoenix, Arizona at the University of Phoenix Stadium. The massive deployment includes 96 main hubs, 49 expansion hubs, and 225 remote antenna units to cover the stadium bowl, luxury boxes and service areas. The system supports various 700, 800, 850, 1900 and 2100 MHz LTE, CDMA, EVDO and UMTS services.

John says that going from 3G to 4G with DAS has not posed any problems and expects the same for 5G. However, before any real discussion can take place the operating frequencies for 5G need to be decided and the air interface protocol needs to be defined. Essentially DAS is ready for 5G, the radios will need to be upgraded, but most of the infrastructure in place can be reused. This is in contrast to small cells, which will struggle to cater to 5G without a hardware upgrade, says John

One area where 5G is beginning to take shape is in test and measurement. National Instruments are involved in a number of projects looking at 5G. 5G covers a multitude of emerging technologies along with extreme bandwidth and data rate requirements. These include advances in HetNet architectures, air interfaces that deploy 3D MIMO or massive MIMO, new modulation schemes and possibly the use of higher frequencies such as mmWave. Some possible modulation schemes for 5G include GFDM, Generalised Frequency Division Multiplexing, FBMC, Filter Bank Multi-Carrier, and UFMC, Universal Filtered Multi Carrier amongst others.

The point being that there is a lot of potential technology that could eventually make up the outlines of a 5G standard. However, to get there, researchers need to be able to test their prototypes. In this area, National Instruments is heavily involved in providing test systems so researchers can explore emerging wireless technology.

For example, the company is collaborating with Nokia on advanced research related to 5G, such as exploring peak data rates and cell-edge rates in excess of 10 Gbps and 100 Mbps, respectively. Nokia plans to demonstrate the viability of high-frequency millimeter wave as an option for 5G-radio-access. An experimental 5G proof-of-concept system will be implemented using LabVIEW and PXI baseband modules from National Instruments — to provide a state-of-art experimental system for rapid prototyping of the 5G-air-interface.

Separately, the PXI Express platform based on LabVIEW has been configured to perform all the signal processing, synchronization, control functionality, and I/O necessary to implement the wireless protocols required to meet 5G requirements. When configured appropriately, the modular nature of these platforms provides the flexibility needed to achieve the 10 Gbps, per user target data rate for 5G cellular access technology, and orders of magnitude higher for mmWave backhaul needs. A large-scale European project researching wireless communications, miWaves, uses a similar setup. The miWaveS project is focused on the V-band (57-66 GHz) and the E band (71-76 GHz, 81-86 GHz). The project started in January 2014 and will terminate in December 2016.

Also active in 5G is Anite, which is involved in the EU funded project METIS.

This project aims to lay the foundation for 5G. Anite is involved in leading channel model research in this area.

The Anite-led task group within the METIS project recently published the first channel models for 5G. An essential step towards further development of candidate 5G technologies, the interim channel models were co-authored by eight METIS partners and approved by other key members for publication.

The technical requirements for 5G will be very challenging, thus testing the radio channel is even more important compared to 4G or 3G. It is expected that 5G will adapt to various radio channel conditions in a more efficient way, utilising all dimensions of the radio channel such as delay, frequency, time, location, elevation and polarization.

James Goodwin, Director of Product Management at Anite expects that more will be squeezed out of the LTE standard by improving the air interface with the use of more complex MIMO and even massive MIMO, as well as by allocating new spectrum. James contends that 5G will only be addressed properly at the mmWave level with new modulation schemes. He says that in order for this to progress it is essential that the real-world channel between the radio and mobile device are well understood. As part of the METIS project Anite is building tools to evaluate such channels with different modulation schemes and is leading channel model research in this area

For 5G to go global one key issue is the need for a unified spectrum. James adds that with 5G it is very difficult to do a multi-frequency mobile device at 30 GHz. According to James, a lot of people are skeptical whether mmWave will be a practical answer, but mmWave is beginning to appear in Wi-Fi products and costs are expected to drop, while R&D accelerates.

Anite is also a member of Project Virtuoso, an Intel-led industry project that is researching testing environments to accelerate 4G and 5G technology development and testing. Within this project, Anite aims to enhance its Virtual Drive Testing Tools (VDT) to utilise data measured in the field to “virtually” recreate the field test environment in a laboratory.

According to Janne Kolu, Director, Channel Emulator Products at Anite, by using a variety of tools to take in-field measurements, the data collected can then be used to simulate the environment in the lab. Janne says that by replaying this data in the lab it is currently possible to accurately simulate power level requirements. He adds that the next steps are to implement fast forwarding, multipath and spatial radio channel requirements. By the time the project ends in 2018 some 5G topics will have been addressed.

To conclude, for 5G to start happening a frequency plan needs to be specified followed by a definition of the air-interface. A modulation scheme will need to be adopted, as has been the case for every wireless generation. In general, 5G will need to deliver a peak data rate of round 10 Gbps with a cell edge rate of around 100 Mbps, along with latency of under 1-ms to warrant being the next generation wireless standard. This might seem a tall order, but 4G in the form of LTE and LTE-A will continue to evolve over the next few years.

LTE can cater to all mobile needs from cellular to IoT and M2M

By Jean-Pierre Joosting

There are a plethora of mobile protocols out there developed and implemented globally as the mobile revolution transitioned from analogue radio to 2G, 3G, and now 4G. Then there are last mile technologies such as Wi-Fi. One problem network providers face is balancing the need for the latest most spectrum-efficient technology, which today is 4G or LTE and LTE-A, while at the same time keeping the legacy networks on.

This balancing act is expensive and getting more so as legacy keeps piling up. One tantalizing possibility is that LTE could eventually replace this legacy technology, given the right business models. This runs counter the prevalent thinking that future networks and devices need to support multiple radios and multiple modulation schemes. However, the argument that LTE and LTE-A can replace nearly all legacy modulation schemes and be cost-effective across different markets is gaining traction.

Key to this would be LTE chips that are cost effective in addressing more than just mobile networks as in smartphones and tablets. Markets such as M2M and IoT are also crucial, as is the high-end broadband Internet access market.

The key here is cost and the ability to cater to various data rate requirements from very low at the M2M level to very high at the broadband level.

Altair Semiconductor, an Israeli-based, LTE chip company is looking to provide the ammunition in the form of low-cost LTE silicon to address LTE markets other than the smartphone.

Eran Eshed, co-founder and VP of marketing at Altair Semiconductor believes that LTE can compete and eventually replace 2G, 3G and proprietary protocols. He cites the fact that 2G networks are slowly being wound down in the USA with Europe probably following.

However, in the EU there millions of smart meters still based on 2G. The question is will running 2G networks for such applications be economical in the long run as costs for LTE drop and LTE chips for IoT and M2M applications make their presence felt.

Eran adds that the idea of LTE catering to IoT applications was until recently seen as complete overkill, but as LTE becomes more optimised to each application he says that LTE could have a significant role here. In 2015 Eran expects IoT optimised LTE to be on a par, or lower than 3G costs.

Recently, Altair's FourGee-3800/6300 Category 4 chipset successfully achieved Verizon Wireless chipset certification. The certification accelerates time to market for Altair customers integrating the chipset into their devices by significantly reducing the amount of testing required pre-launch.

The FourGee-3800/6300 is the successor of the Category 3 FourGee-3100/6200 chipset, which shipped in millions of devices to date, including the Verizon Ellipsis 7 tablet, the HP Chromebook 11" LTE, and the ASUS Chromebook 13.3" LTE.

What is significant about these tablets is that they cater for LTE and Wi-Fi only, which brings costs down dramatically as the legacy has been dropped. It is an indication of how some large companies see the market evolving.

Eran contends that LTE will be around for 20 plus years so in terms of network longevity, it is easy to base projects such as smart meters, IoT, or wearable devices on LTE, but only if the cost structure is right.

As far as 2G and 3G are concerned they are adding complexity and by bypassing legacy, companies can cut costs down. Even in the case of smartphones as LTE and LTE-A become more prevalent globally the use case for 3G will drop and though multimode is seen as better today, it is also more expensive.

Altair is targeting three markets. The first is broadband IoT and M2M with data rates of over 200 kbit/s based on low-power and cost-optimised LTE Category 1 silicon.

The second is narrowband IoT based on LTE MTC characterized by very low power and very low cost. LTE MTC optimises battery life, cost, and coverage for applications that could benefit from the ubiquitous coverage, high reliability, and robust security of 4G LTE Advanced, without the high data rate requirements of mobile broadband.

The third is broadband access where performance is key. Technologies in this market include LTE-A, Carrier Aggregation, MIMO, Interference Cancellation.

The company's key aim here is to optimize LTE for these applications and drive costs down. LTE at certain price points could be very disruptive and the early signs are that this year could be a turning point to LTE for everything. Markets that were previously thought unsuitable for LTE are now clearly in its sights, including smart metering, security/automation, and wearable devices.

Interestingly, LTE is still an emerging technology and has a long way to go till it matures. Though it has essentially rolled out globally there are still many areas not covered properly. Further, LTE-A will start rolling out significantly sometime next year and is still evolving, especially with more complex MIMO.

www.altair-semi.com

60 GHz wireless needs better regulations in the EU to flourish

By Jean-Pierre Joosting

Blu Wireless Technology designs and licenses IP for 60 GHz wireless technology, which has indoor applications with a range of 10 to 20 m and outdoor applications with a range of around 200 to 300 m. Also, Wi-Fi is beginning to benefit from 60 GHz technology with products offering Tri-band capabilities at 2.4, 5 and 60 GHz.

For out door use, the 60 GHz band is seeing growing interest in providing backhaul for small cells. However for outdoor 60 GHz backhaul a phase array antenna system is a necessary ingredient to meet to the cost, size, performance and reliability needs of the market. Blu Wireless is developing a backhaul system using electronically steerable antennas for a customer deployment in the second half of 2016.

A key challenge at 60 GHz is how to overcome the additional signal losses due to oxygen absorption. If transmit powers and antenna gains were equal, at 60 GHz the received signal would be 1000x weaker than a Wi-Fi signal. To address this challenge, millimetre wave systems need electronically steered high gain antennas to track users as they move within the network.

The problem is that electronically steerable antennas or phase array systems will violate EU CEPT REC(09)01 rules. According to Mark Barret Chief Marking Officer at Blu Wireless Technology the problem stems from how the EU regulations specify EiRP.

ETSI EN 302 217 specifies an EiRP limit of 55 dBmi but limits maximum conducted power to +10 dBm and the minimum antenna gain to +30 dBi.

In the USA, under FCC Part 15.255 the EiRP limit is specified at +40 dBmi. However, it allows a trade-off of conducted power up to 27 dBm with antenna gain as long as EiRP does not exceed +40 dBmi. Further, the FCC allows outdoor link operation between fixed points to use an even higher EIRP of up to +82 dBmi.

By allowing a more flexible trade-off between gain and power the USA enables the use of lower cost active phased array antennas for 60 GHz wireless backhaul. For companies that want to deploy 60 GHz networks for operation in Europe the current regulations require the use of mechanically steered high gain antennas since the antenna gain must exceed +30 dBi and conducted power must be under +10 dBm).

Phase array antennas are ideal for 60 GHz backhaul applications since they enable costs to be minimized, size to be reduced and set-up to be automated (defined in WiGig 11ad).

The 60 GHz frequency is ideal for short range outdoor use of around 200 to 300m, though longer ranges are possible under 1 km. Since at this frequency oxygen absorption is around 15dB/km so longer ranges are not on the cards.

Mark adds that absorption at 60 GHz in the 200 to 300 m range is not a big issue, representing 3 to 6 dB, making backhaul systems at 60 GHz ideal for dense urban environments. He adds that small cell backhaul in particular will benefit from absorption as it means that there is no significant spill over into other cells.

As cells shrink to take advantage of frequency reuse it is envisaged that the equipment will be considered street furniture and consequently need to minimize size while maintaining acceptable aesthetics. Phase array antennas enable this to be achieved, in contrast to mechanically steered antennas, which are expensive, bulky and not as reliable.

These small cell sizes (500m or less) require increased numbers of small base stations to be deployed on street furniture, which in turn need to be connected via high bandwidth data links to the core network (backhaul). This backhaul requirement has been typically serviced through a combination of fibre optic and licensed point to point microwave radio links, operating at selected bands from 6 to 38 GHz. However, the high link cost of licensed bands is acting as a significant break on the roll out of these point to point links.

The unlicensed 60 GHz band offers 7 GHz of bandwidth. It also offers the benefits of increased frequency re-use due to oxygen absorption at 60 GHz (which limits its range to under 1km). As a result this frequency band is set to become one of the main options for small cell backhaul.

According to Mark, Blu Wireless is working with larger customers to advance the technology and have made the case to Ofcom, the British regulator, for the direct deployment of phased array technology for backhaul. By building a trial network in Britain using phase array technology, we will be able demonstrate to customers the advantages of 60 GHz and use the trial network as an example in discussions with EU authorities, says Mark.

Consequently, there is a need to review and harmonise EU 60 GHz radio regulations with the USA to stimulate deployment of low cost 60 GHz wireless backhaul in Europe.

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How wireless technologies can enable Eastern European operators to unlock mobile infrastructure and roll out profitable unified communications

By Dr John Naylon, Chief Technology Officer at CBNL

The rapid global growth in mobile subscriptions has seen an increasing gap between mobile and fixed broadband connectivity. With the ITU predicting that worldwide mobile penetration will reach more than 95 per cent by the end of 2014, this discrepancy looks set to widen even further.

Within Europe there are two contrasting scenarios. Whilst the majority of Europe has fixed broadband penetration at an average of 27.7 per cent, in the Commonwealth of Independent States (CIS), it sits at just 14.3 per cent. With the CIS having a staggering 140 per cent mobile penetration, the region has one of the largest gaps between mobile and fixed penetration in the world. This high level of mobile penetration has resulted in mobile networks playing a critical role in the socioeconomic development within CIS and in Eastern Europe in general. However, with the mobile market experiencing near saturation, operators need to look to alternative business models to create new, monetisable services and secure the future revenues of their business.

Unified communications opportunity

Despite the dominance of mobile, providing fixed connectivity to the unconnected population in Eastern Europe presents operators with huge opportunities for growth. In Western Europe, fixed connectivity has become increasingly important to a growing number of operators as they look to generate new revenue opportunities by offering bundled tariff packages. These bundled packages, where operators provide mobile and fixed internet services under a single bill, have undoubtedly gained rapid momentum in recent years, with a unified communications approach becoming central to operators' business models. In their 2014 annual statement, for example, Vodafone commented that they have seen "more and more businesses and individual consumers seeking unified communications, or converged fixed and mobile services." For Vodafone, the advantages of adopting the approach are clear, with the report stating that "mobile customer churn is typically three times higher than that of customers taking combined fixed and mobile services." This sentiment is echoed by Dutch operator KPN, who noted that "bundled services are at the heart of our strategy," as a unified approach will enable them to "reduce churn and optimise customer lifetime value."

The shift towards a unified communication strategy is starting to be seen in several Eastern European nations. However, the lack of fixed infrastructure in the region severely hinders operator's ability to profit from this opportunity. The high infrastructure costs needed to roll out fixed networks to address this have often led to operators struggling to make the business case for investment. This has meant that whilst operators across Western European profit from bundled packages, many across Eastern Europe are not afforded the same opportunity.

Need for a low cost per bit

Deploying traditional fixed network infrastructure has historically required extensive capital (CAPEX) and operating (OPEX) expenditure. Building a fibre backhaul network, for example, not only

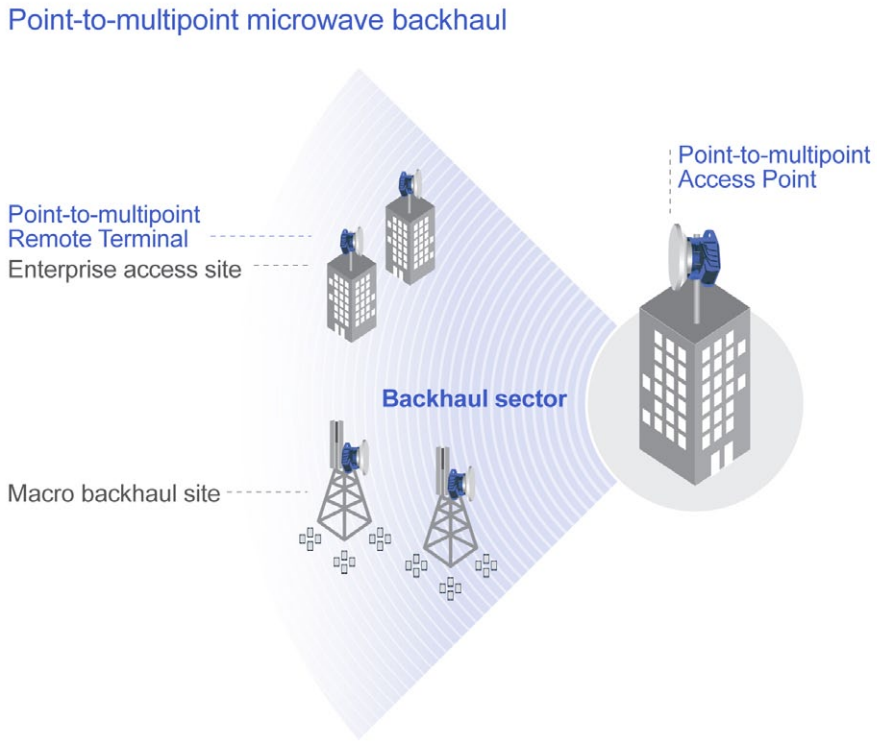


Figure 1: Point-to-multipoint microwave backhaul.

necessitates a high initial cost outlay, but can also require a lengthy time to market and extensive regulation. These factors all mean that fibre networks can drastically reduce an operator's ROI, deterring them from investing in fixed connectivity. This is a particularly challenge in Eastern European where operators have a substantially lower average revenue per user (ARPU) than Western Europe and other global regions. Operators in the region are therefore tasked with driving innovation and running networks at a much lower cost per bit in order to draw new revenue from the market. This presents a challenge: how can operators unlock the potential opportunities from fixed connectivity whilst maintaining low CAPEX and OPEX?

To address this challenge, operators in many countries have turned to a new wave of advanced microwave technologies. An example is point-to-multipoint (PMP) microwave, which enables the co-existence of mobile backhaul and enterprise access services over the same infrastructure, allowing operators to meet market demands for a fraction of the cost.

An innovation in wireless backhaul

With high levels of investment into mobile infrastructure across Eastern Europe, wireless technology offers operators a means of capitalising on this and maximising the underutilised opportunity presented by fixed broadband. One wireless innovation that has successfully generated revenues for operators in other low ARPU markets is PMP microwave. PMP microwave is already established in Europe, however recent developments have created a growing trend for operators across Africa and the Middle East to use the technology to deliver converged backhaul and enterprise access services.

In these markets, operators have been able to drastically increase their revenue opportunities by utilising spare capacity in their mobile backhaul networks to roll out fixed connectivity to businesses. This co-existence of multiple virtualised services within the same physical network is made possible through intelligent software now available through the latest PMP microwave technology.

PMP microwave technology, such as CBNL's VectaStar platform, works by creating a sector of coverage from a single hub site. Multiple sites can be served by a single sector which enables equipment, spectrum and site rental costs to be amortised across a number of links. Analyst consultancy Senza Fili found this allows PMP microwave to deliver total cost of ownership savings of up to 50 per cent over fibre or point-to-point microwave.

The software defined networking (SDN) ability of VectaStar provides the flexibility to customise virtual networks and maximise the return on existing backhaul infrastructure. For example, dedicated capacity can be allocated to backhaul at the same time as defining tiered connectivity offers for enterprise access.

Importantly, PMP microwave (which operates above 6 GHz) has the capacity to handle the most demanding LTE

networks and is already proven in LTE backhaul deployments in other regions of the world. The high capacity which CBNL's VectaStar PMP solution offers has led to it being deployed across 13 countries in Europe, as well as a further 30 worldwide.

Growth prospects for operators

The near saturation of the mobile market in Eastern Europe has meant that operators need to adopt innovative strategies to unlock new revenue opportunities. Whilst fixed connectivity was once unlikely to offer a strong ROI due to a lack of infrastructure, PMP microwave has created a profitable means for operators to capitalise on the opportunity. With the rise in market demand for bundled tariffs further compounding the case for operators to adopt a unified approach, converged networks looks set to play a major role in increasing connectivity in the region.

The long term growth prospects for wireless broadband in Eastern Europe are enormous, as operators are finding consumers and businesses hungry for transformational mobile and internet services. As operators look to efficiently scale network capacity whilst generating revenue, wireless technology holds the key to delivering the performance and profits operators require to enhance network competitiveness and agility in the region.

About the author:
Dr John Naylon is the Chief Technology Officer at Cambridge Broadband Networks (CBNL), a company he co-founded in 2000. CBNL is the global leader in carrier-class, multipoint microwave backhaul and access solutions. John has led development of CBNL's VectaStar multipoint microwave product which is one of the leading systems for enterprise access, macro and small cell backhaul — www.cbnl.com.

Shape memory alloy optical image stabiiser debuts in smartphone

Taiwanese smartphone brand InFocus has launched its latest handset, marking the debut of SMA OIS actuators developed by Cambridge Mechatronics (CML) to the consumer marketplace. This follows over three years of development at Cambridge Mechatronics facilities, resulting in over 20 patents covering the design of smart metal micro actuators, precision control algorithms and drive electronics.

OIS (optical image stabilisation) actuators from CML are actuated using a proprietary smart metal technology. Force and motion are created by shape memory alloy (SMA) wire — a smart material that provides huge force and strain when heated with an electric current. The company's competition comes from classical voice coil motor (VCM) technology that uses long lengths of copper wire and a series of magnets in order to actuate its components. The number, size and complexity of parts used in VCM OIS products are significantly greater than smart metal actuators from CML. The company is able to make smaller and lower cost products than VCM manufacturers.

The SMA OIS actuator is assembled into a standard camera using the same processes and manufacturing tolerance requirements of established production lines. This ensures that no significant investment in equipment or process development is required by the module integrator.

The SMA OIS actuator is attached between the image sensor and AutoFocus actuator. Module integrators can choose image sensors and AutoFocus actuators from their preferred suppliers. The motion of the OIS actuator moves the lens relative to the image sensor, counteracting any shake measured by a gyroscope and thereby stabilising the image.

The use of smart metal has a number of other benefits over the incumbent VCM technology. Cameras using smart metal technology feature increased speed and accuracy to enhance the smartphone user's photography experience, giving a sharp image with a minimum of shutter lag. Further, the ultra-compact design of smart metal actuators enables significant camera miniaturisation, which allows smartphone handset manufacturers more freedom to create slimmer, sleeker designs.

The InFocus M530 is a 5.5-inch screen device powered by the octo-core Mediatek MT6595 processor. The 13Mpixel OIS camera is supplied by Foxconn and includes an SMA OIS actuator produced by CML's manufacturing partner Hutchinson Technology (HTI). HTI and Foxconn are in full mass production of SMA OIS actuators and cameras respectively in their manufacturing facilities in the US and China.

Benchmarks of the M530 camera demonstrate comparable shake suppression to flagship OIS handsets from the leading worldwide and Chinese brands. The design of CML's SMA product makes it particularly rugged to mechanical impact (drop testing) and provides high image quality by reducing optics de-focus from motion tilt. The simple structure also allows camera integration to ramp quickly to high capacity.

Gartner analysts forecast the size of the mobile device market to be over 2.1 billion units in 2015. CML and HTI are expanding their automated production lines to supply additional program awards and in preparation for the significant ramp of OIS adoption in smartphones by the middle of this year.

www.cambridgemechatronics.com

Zero-cost hosted small cell networks

solve operator coverage issues

Cloudberry Mobile has announced a zero-upfront-cost, hosted small cell service that allows network operators to address coverage blackspots.

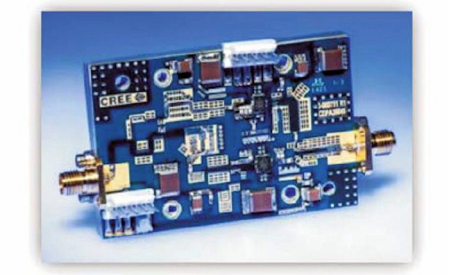
While many enterprises and consumers are facing coverage problems, operators have struggled with the necessary specialist integration skills and business models to deploy small cells. Cloudberry's years of small cell network deployment expertise, allows the company to rapidly integrate and deploy hosted small cells for any network operator with no upfront costs — providing a rapid answer to the increasing problem of poor mobile network coverage.

The Cloudberry service involves minimal installation at no expense to the operator. Cloudberry installs and monitors the device by hosting a small cell gateway and operating logistics remotely with no interference to the ongoing core network which allows operators to focus on core revenues. In spite of this, operators still maintain control of their network with the ability to view and control all small cells that sit within their infrastructure.

www.cloudberrymobile.com

Doherty PA reference design

targets small cell applications



To address the needs of small cell designers, Cree, Inc., has introduced the CDPA35045 asymmetric Doherty power amplifier (PA) reference design for the 3.5 to 3.7 GHz band.

This band is an additional spectrum space intended to complement small cell technology by providing increased wireless system capacity for both licensed wireless carrier services and unlicensed public use, such as WiFi.

Providing 10 W average output power and excellent predistortion (DPD) correctability, this proven Doherty PA design utilizes Cree's 30-W CGHV27030S and 15-W CGHV27015S GaN HEMT devices, which can operate with either 50 V or 28 V drain supplies and enable enhanced design flexibility for telecommunications, wideband tactical radio, and radar applications spanning low frequencies to 6 GHz.

The CDPA35045 was evaluated by engineers at Xilinx in a 3.5 GHz test radio platform that implemented Xilinx® CFR and DPD SmartCORE™ IP on a Xilinx ZC706 evaluation board featuring the company's Zynq® 7Z045 All Programmable System-on-Chip (APSoC) as the processing engine. The evaluation proved that this combination of Xilinx Zynq APSoC devices and Cree® GaN devices results in highly efficient, low cost, and low power products that enable full flexibility of control processing and the radio signal.

Consequently, the Cree® CDPA35045 asymmetric Doherty PA combined with Xilinx radio signal processing IP is an effective solution for small cell implementation in the 3.5 to 3.7GHz wireless band.

www.cree.com/rf

Ultra-low noise amplifier

ideal for demanding RF applications

Guerrilla RF has introduced an ultra-low noise amplifier (Ultra-LNA) with industry-leading broadband RF performance for small cells, macro base stations, distributed antenna systems (DAS) and other wireless devices in the 700 to 2700 MHz band.

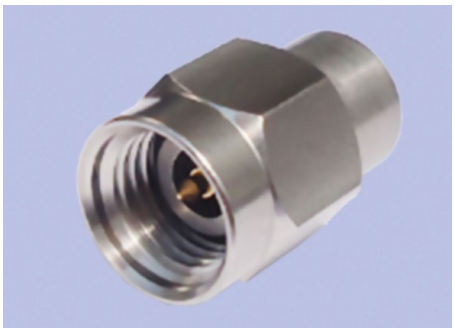
The GRF2104 is a broadband Ultra-LNA designed for small cells and other high performance applications requiring a single device, which can support multiple frequency bands with a minimum of external components. Its flat 20 dB gain, along with outstanding NF and linearity over 700 to 2700 MHz, make it ideal. Internal prematching to 50 ohms results in a compact, low-cost device, while its flexible biasing offers high levels of reuse — within a design and across platforms. GRF2104 is offered in a thermally efficient 1.5 x 1.5 x 0.5 mm plastic package.

Samples and evaluation boards are available now, with full production scheduled for the second quarter.

http://guerrilla-rf.com

Microwave terminations

cover DC to 40 GHz



Coaxial Components Corporation (Coaxicom) has released their 2.92-mm, 1-W termination the 022900M-9, which is designed to minimize reflected power that often impedes transmission quality. Used across a spectrum of multi-port microwave devices including directional couplers, isolators and high-power transmitter applications, terminations absorb energy and prevent RF signals from reflecting back from open-ended or unused circuit ports. The termination is specified at DC-40 GHz, with VSWR of 1.25:1 maximum.

The low thermal impedance of the 022900M-9 allows it to conservatively dissipate 1 W average power at 25°C. It operates over the temperature range of –65°C to 125°C, and derates linearly to 0 at 125°C. Peak power is 250 W. The coupling nut is stainless steel and is available in either a gold plated or passivated finish.

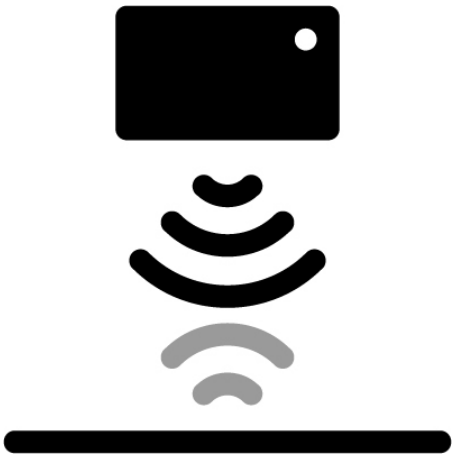
www.coaxicom.com

77 GHz radar sensor

for surveillance and safety in harsh environments

Targeting surveillance and safety in harsh environments, Sivers IMA is expanding its radar sensor portfolio by launching a 77 GHz radar sensor.

"The need for measuring distance, depth, speed or position in different products operating in harsh environments



is growing and our radar sensors provide an excellent and cost effective way of doing that. ", says Robert Ekström, CEO of Sivers IMA.

With its radar sensors, based on FMWC technology, Sivers IMA has helped customers fulfil their high standards in measuring distances and positions in tough environments. These include conditions such as fog, smoke or gas where mechanical alternatives, lasers, ultra sound or video-based systems don't fulfil requirements. Infrastructure security and industry automation as well as level measurements in silos and tanks are examples where customers have successfully used Sivers IMA's technology.

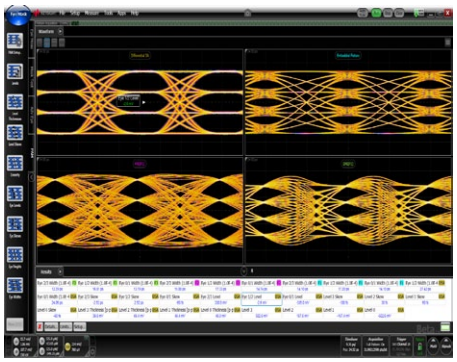
The latest 77 GHz sensor complements the existing sensors in the 10 and 24 GHz frequency bands. With its higher frequency, it delivers a signal with an even higher accuracy. Furthermore the small antennas at 77 GHz make the sensor especially suitable for applications where larger products don't fit.

This launch is part of an initiative that Sivers IMA is undertaking to enable application developers to cost efficiently implement the features of radar sensors in their products.

www.siversima.com

Oscilloscope series gets PAM-4 analysis capability

Keysight Technologies has introduced measurement capability designed to help engineers quickly and accurately characterize PAM-4 (pulse amplitude modulation with four amplitude levels) signals using the Keysight 86100D DCA-X wide-bandwidth oscilloscope platform. The 86100D-



9FP PAM-N analysis software provides comprehensive analysis of optical and electrical PAM-4 signals.

Several industry groups and standards bodies are using, or actively considering using, PAM-4 technology to jump to the next-generation speed class and enable higher data rates for a given channel bandwidth compared to traditional non-return-to-zero (NRZ) signaling. While PAM-4 technology adapts some traditional NRZ measurement algorithms for PAM-4 signals, to fully analyze system performance, unique PAM-4 measurements and parameters are also required.

The 86100D-9FP PAM-N analysis software offers measurements such as: eye width, eye height and eye skew; level amplitude, level noise and level skew; and amplitude level linearity.

The PAM-4 option may also be combined with existing DCA-X software options to provide even more powerful analysis capability: PAM-4 equalizers (LFE, CTLE, DFE) using 86100D Option 201; embedding/de-embedding of PAM-4 channels using 86100D Option SIM InfiniiSim-DCA; and jitter and amplitude analysis on IEEE JP03 patterns using 86100D Option 200/300.

Multilevel signaling systems are particularly susceptible to noise, so the 86100D's low-noise, wide-bandwidth plug-in modules are particularly well suited for characterizing PAM signals. The 86100D Option 9FP PAM-N analysis capabilities are supported by all 86100D DCA-X plug-in modules, such as the 86108B precision waveform analyzer module for accurate analysis of electrical signals to 32 Gbaud or the 86105D-281 for accurate analysis of high-speed optical signals. Additionally, engineers can perform offline analysis on saved or simulated PAM signals using N1010A Option 9TP PAM analysis software installed on a PC.

www.keysight.com

Miniaturized low-pass filter for LTE

TDK Corporation offers a multilayer low-pass filter for LTE and other next-generation high-speed wireless communication systems that is more than 50 percent smaller than existing products and equal or better performance.

Thanks to thinner ceramic layers, finer conductor lines and an optimized internal electrode design, the latest filter, designated DEA071910LT-4003B1, achieves a miniaturized footprint of 0.65 mm x 0.5 mm and a slimmer insertion height of just 0.3 mm (form factor of 06505) to enable low-profile designs and module integration. As a result, the multilayer low-pass filter is more than 50 percent smaller than previous components with a conventional case size of IEC 1005 (1.0 mm x 0.5 mm x 0.4 mm).

At the same time it offers equal or even superior insertion loss and attenuation performance. For example, the maximum insertion loss in the 1.71 GHz to 1.91 GHz range is just 0.55 dB, while the minimum attenuation in the range of 5.13 GHz to 5.73 GHz is 20 dB.

www.global.tdk.com/worldwide

Bias-T devices

power and protect LTE installations

HUBER+SUHNER have announced key additions to their Bias-T product portfolio with two devices designed for installation close to base receiving stations (BTS) or near to the antenna.

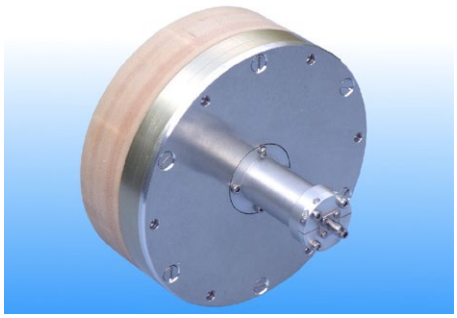
Covering the full LTE bandwidth 690 to 2700 MHz, these latest Bias-T's inject or extract DC power into or out of coaxial cable with the appropriate DC voltage and current. Although the target applications are LTE installations, these Bias-T devices also support other cellular installations such as GSM and UMTS.

Both the 3410.41.0038 and 3410.41.0039 Bias-T's have built-in lightning protection and offer guaranteed and stable RF performance and protection even after multiple 20 kA (8/20 µs) strikes as well as a single strike of 30 kA (8/20 µs).

They are designed to operate with a DC supply up to 48-V at a maximum current of 3.5 A. Both devices can handle up to 500-W RF CW power and exhibit an excellent PIM performance. They have a robust, Sucoplated brass housing, are IP67 rated and have an operating temperature range of -40°C to +85°C.

www.hubersuhner.co.uk

Circularly polarised 0.5 to 8 GHz spiral antenna



UK based designer and manufacturer, Steatite has released a new 0.5 to 8 GHz right hand or left hand circularly polarised spiral antenna fitted with an SMA type connector, designated QSP-RC-0.5-8-S-SG.

A derivative of the company's highly successful 0.5 to 22 GHz spiral antenna, this antenna is ideally suited for spectrum management direction finding 360° antenna arrays and is targeted to provide high quality performance at an attractive price.

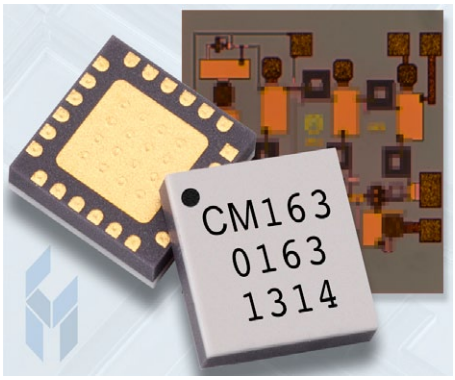
After thorough development and testing, this antenna is the latest addition to the company's growing range of spiral antennas. These currently provide wideband performance up to 42 GHz, with either left or right hand circular polarisation.

The antenna also features 2-W continuous-wave power handling, maximum VSWR of 4.5:1 (<1.4:1 above 1 GHz), gain of 6.5 to 1.4 dBiL, and an axial ratio of <2 dB (above 1 GHz). The 3 dB beamwidth is 48 to 139 degrees, the 10 dB beamwidth is 112 to 176 degrees, and squint comes in at under 10 degrees.

www.steatiteqpar-antennas.co.uk

Ultra low noise MMIC amplifier

covers 17 to 27 GHz



Custom MMIC has released the CMD163, a 17 to 27 GHz low noise amplifier (LNA) in die form, to their growing line of standard GaAs amplifier products.

The CMD163 has a gain of +24 dB, a noise figure of less than 1.3 dB, and an output 1 dB compression point of +19 dBm across the 17 to 27 GHz bandwidth. Additionally, the CMD163 utilizes an all-positive bias scheme, thereby eliminating the need for negative voltages and expensive sequencing circuitry. Bias conditions are Vdd = 4 V at 120 mA and Vgg = 3.0 V.

The CMD163 is ideally suited for military and space applications, as well as point-to-point and point-to-multipoint communication systems where small die size and high linearity are needed. The LNA is an internally matched 50 ohm design that does not require any external components, aside from bypass capacitors. Additionally, the LNA is available in packaged form as the CMD163C4 with similar performance.

www.CustomMMIC.com

IC enables one-step design-in of 3D gesture recognition

The second member of the patented GestIC® family from Microchip, the MGC3030 3D gesture controller features simplified user-interface options focused on gesture detection, enabling true one-step design-in of 3D gesture recognition in consumer and embedded devices.

Housed in an easy-to-manufacture SSOP28 package, the MGC3030 expands the use of highly sought after 3D gesture control features to high-volume cost-sensitive applications such as toys, audio and lighting.

The simplicity of gesture-detection integration offered by the MGC3030 is also achieved through the company's free, downloadable AUREA Graphical User Interface (GUI) and easily configurable general-purpose IO ports that even allow for host MCU/processor-free usage. An on-chip 32-bit digital signal processor executes real-time gesture processing, eliminating the need for external cameras or controllers for host processing, and allowing for faster and more natural user interaction with devices.

Further simplifying the design process and accelerating time to market, the MGC3030 makes full use of the GestIC family development tools. For example, Microchip's Colibri Gesture Suite, an on-chip software library of sophisticated yet easy-to-use gesture features. Intuitive and natural movements of the human hand are recognised, making the operation of a device functional, intuitive and fun. Without the need to touch the device, features such as Flick Gestures, the Air Wheel or proximity detection perform commands such as changing audio tracks, adjusting volume control or backlighting, as well as many other commands. All gestures are processed on-chip, allowing manufacturers to realise powerful user interfaces with very low development effort.

www.microchip.com

No screen oscilloscope

uses Wi-Fi to connect to tablets

As the first digital storage oscilloscope geared towards tablet computers labels Belgian reseller Velleman NV its WFS210 oscilloscope. The 2-channel instrument takes the fact into account that some tablet computers do not have any cable interfaces: For data exchange with the backend computer it utilises a Wi-Fi connection.

The WFS210 offers two vertical signal channels, full auto setup function, signal markers, a hold function, and DVM functionality. The suitable x1/x10 probe has to be ordered separately. Input sensitivity can be selected in 12 steps between 5mV/div and 20V/div; the integrated signal ADC has a resolution of 8 bit. The signal bandwidth is 10 MHz for each one of the two channels. It also offers a sample rate of 2 x 10 Msps and a sample buffer of 4K per channel.

Battery-powered, lightweight and compact (180 g, 100 x 100 x 35 mm), the WS210 fits into any briefcase and serves for quick measurements. The signal is displayed either via a tablet or a PC. Downloadable apps for iOS, Android 4.0 and PCs are available.

www.velleman.eu

High linearity 4-W Ka-band power amplifier

M/A-COM Technology Solutions has introduced a high linearity 4-W power amplifier, ideally suited for Ka-Band high data density satellite communications.

The MAAP-011139 is offered in both bare die format and a 5- x 5-mm 32-lead QFN package. The device delivers 24 dB of linear gain, 4 W of saturated output power and 23% efficiency. It provides greater than 27 dBm Pout/tone while maintaining IM3 levels of 30 dBc, which the company believes is twice the linear performance of competing alternatives.

This two-times linearity performance allows the MAAP-011139 to replace two equivalent competing alternatives with a single device while operating in an overall more efficient mode. Furthermore, the device in bare die format and measures 3.1- x 2.8- x 0.05-mm, ideal for real estate constrained customers.

www.macom.com

Lock-in amplifier with integrated digitizer

Zurich Instruments has developed what it claims to be the world's first lock-in amplifier with an integrated digitizer.

Offering the best of both worlds, the UHFLI allows raw signals to be acquired with the full bandwidth of the digitizer, available for later post-processing, whilst simultaneously the lock-in amplifier is able to extract the smallest signals from the noise.

The instrument comes with two separate signal inputs, each with a sampling rate of 1.8 GSamples/s, and 12-bit signal resolution at a bandwidth of 600 MHz. The 1 GB internal memory allows up to 128 Million samples to be saved before the data is transferred to the PC.

One of the major advantages of this combination is that the data acquisition can be started by a trigger from the demodulated signal (lock-in amplifier) or at a certain signal level of the input signal (digitizer). The reduced complexity of the measurement set-up increases set-up stability and leads to higher measurement productivity.

Included with the instrument is the LabOne software package that supports simultaneous signal measurement in the frequency and time domains and offers a suite of analysis tools (FFT spectrum analyzer, sweeper, oscilloscope, plotter, software trigger, periodic waveform analyzer).

www.zhinst.com

Private mobile radio common platform processor

CML Microcircuits has released a PMR common platform processor to support digital/analogue FDMA PMR/LMR and 2-slot TDMA digital systems.

During the migration of Two-way Radio from analogue to digital, a number of digital FDMA and TDMA PMR/LMR systems have emerged along with the on-going requirement for a radio platform to support legacy analogue. With each system potentially having different requirements and specification down to radio architecture level, the radio manufacturers' goal of a single cost-effective radio platform to fit all has become complex.

The CMX7241/7341 PMR common platform processor sets out to address this. It provides a common platform that can deliver FDMA digital PMR/LMR, TDMA digital PMR/LMR and legacy analogue. Based on CML's proprietary FirmASIC© component technology, a Function Image™ (FI) can be uploaded into the device to determine the CMX7241/7341 overall functions and operating characteristics.

The first Function Image focuses on digital and analogue FDMA PMR/LMR. It provides a comprehensive feature set including auxiliary functions to support the whole radio. When combined with the company's CMX994 direct conversion receiver IC it presents a flexible, highly integrated, small PCB footprint, high performance radio platform solution.

www.cmlmicro.com

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Monday, 18 May 2015 - 17:30-19:00

- Dr. John Rogers

Swanlund Chair, Professor of Materials Science and Engineering,
Professor of Chemistry
University of Illinois, Urbana-Champaign

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RF AND MICROWAVE TECHNOLOGY FOR THE HEALTHCARE INDUSTRY

Thursday, 21 May 2015 - 16:30-18:00

- Dr. Darlene J.S. Solomon

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