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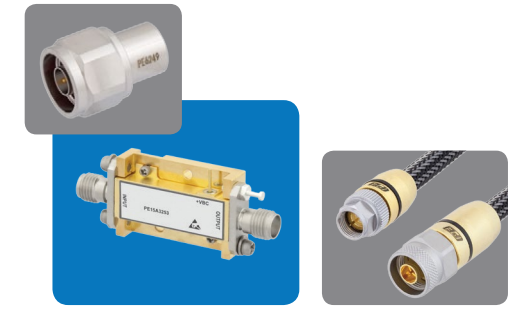

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The economic implications of 5G

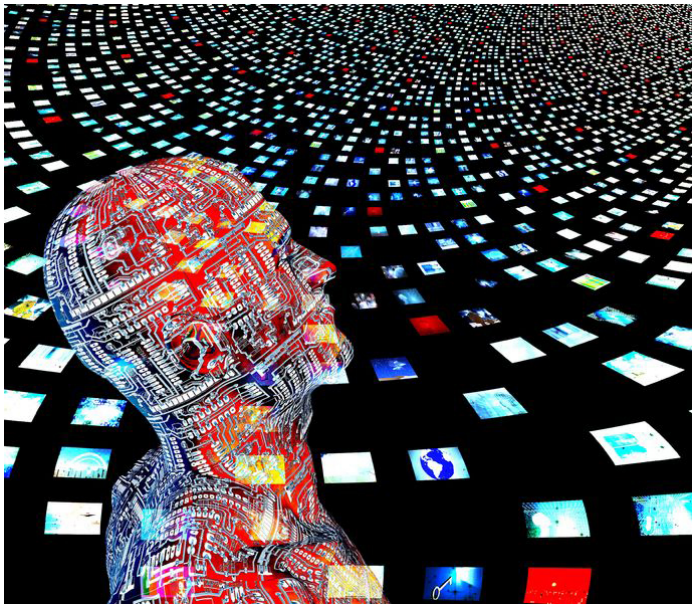
The wireless world is currently undergoing an innovative period where the fundamentals of networks that have been in place for decades are experiencing rapid change and upheaval. This is underpinned by the drive to 5G whatever the final technology and network architecture that might arise.

Consider that as we move to NFV (Network Functions Virtualisation) and SDN (Software Defined Networks) the architecture of a network can be configured in a matter of days rather than months. Cloud resources for the control plane can be added incrementally at the click of a button. Operators can configure resources on the fly and allocate resources where demand is needed. Intelligence will appear at the edge of the network as well as the core and routing protocols can look to local needs first, even going directly from one UE to another without the need for brute force IP routing through the network core.

Even the antennas, which have not changed much in architecture are not immune. Massive MIMO and 3D beam forming hold the promise of boosting throughput ten fold while reducing power requirements. Then with 5G comes the prospect of mm-Wave bands running along side traditional sub-6-GHz bands ramping up the available spectrum by one or two orders of magnitude. Combine all this with more efficient modulation schemes and intelligent software defined networks and the economic case for 5G becomes apparent.

Consumers want fully functional video anywhere they find themselves such is the demand being placed on mobile broadband. Needless to say, everyone sees the need for a network that offers throughput that is at least 10 to 100x better than what 4G can deliver today, and with strict latency requirements, all at lower power levels. Further businesses are looking at the IoT to reduce costs and streamline operations. Here 5G needs to deliver the latency requirements so that critical operations do not fail. Such use cases include delivery of medical data by remote monitors, the remote operation of heavy machinery, or telemetry of critical equipment. Remote surgery or remote medical intervention by doctors while a patient is on the way to hospital in an ambulance are further examples, but they both require high bandwidth and low latency to be trusted.

What does this mean for economics? One key aspect here is that 5G will open up many more use cases for the network and give birth to new businesses as did the advent of the smartphone. However, what it gives with one hand it will take with the other. 5G will result in much better efficiencies and higher productivity. An analogous technology that did this was the rise of the PC. Will 5G destroy jobs? It will but it will also create new jobs and enable industries that are not feasible without the IoT. For example,



consider solar farms with thousands of panels that track the sun and use a wireless sensor network to control and monitor all these panels. If, for example, such an installation could leverage a 5G network for a fraction of the cost of a proprietary network it would have a better economic case both in terms of CAPEX (standard wireless sensor network) and OPEX (no need to maintain the network or upgrade it).

Another industry that would be able to implement huge savings costs and add many new capabilities is medicine. As people age the need for monitoring becomes important. We already see systems being sold such as panic alarms that contact the relevant paramedics when there is a problem, but a smartphone and 5G network would enable cost-effective remote monitoring of the quality that is available in a hospital today. Further, it would enable monitoring in real-time with low latency keeping many people out of hospitals and lowering costs. Many new monitoring use cases will also arise. Data captured for specific events such as sleep apnea, for example, would empower doctors and save lives.

As we move to self-aware cars, and autonomous driving, there is a lot of discussion on the networks that need to be built to enable intelligent highways and such. A 5G network would provide a low latency, cost effective alternative to custom systems. However, latency in emergency situations would be critical. For the first time a vehicle could transmit important bio data on the victims in a car crash long before the emergency services arrive.

Needless to say, data throughput, latency and the IoT are all critical elements to a 5G network, which in the end will embrace multiple standards and segments of the spectrum from sub-6-GHz right through to mmWave up to 60 GHz and beyond. In terms of economics, 5G will drive productivity and enable many new use cases. In fact, it holds the key to enabling energy efficiency through monitoring of devices via the IoT both at the consumer and industrial level, and will be key to managing a vast network of renewable energy collectors from solar panels to wind turbines. The energy network will be born through the IoT and 5G will ensure coverage and cost efficiency through economies of scale.

In fact the origins of this are already starting with LTE-A, though there are many issues to solve such as coverage, latency and power requirements, which is why we need 5G. Much like the railroad revolution and motor vehicle revolution the impact of the first real information super highway in the form of LTE-A and 5G should not be underestimated.

Alcatel-Lucent helps China Mobile to launch VoLTE services

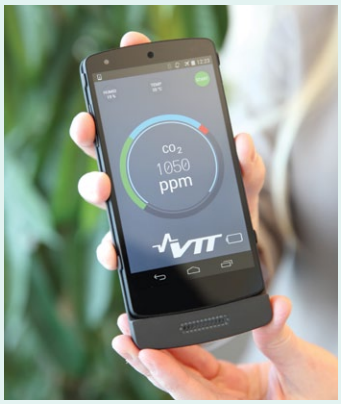
Alcatel-Lucent is to deploy its Rapport™ communications software with China Mobile, enabling it to simplify and consolidate video, voice and messaging services onto a single platform. As a result, China Mobile will be able to offer high-quality, high-definition VoLTE (voice over LTE) services for the first time in China.

China Mobile will be able to leverage Rapport's native APIs and WebRTC (Web Real Time Communications) capabilities to create new contextual applications and services, enabling subscribers to personalize how they connect with others using video, voice and messaging on any connected device. The deployment will also set the stage for China Mobile to offer new services through the use of voice over Wi-Fi®. In addition to enhancing the subscriber experience with all-IP services, VoLTE allows communications providers to migrate 3G networks to LTE and re-use spectrum, to realize new cost and operational efficiencies.

www.alcatel-lucent.com

Miniature gas sensor for mobile devices

VTT Technical Research Centre of Finland has developed a miniature gas sensor that can be connected to mobile devices. Gas measurements made with smartphones will make activities such as the detection of internal air problems easier. In addition, sleep quality will be measurable with greater precision, using mobile healthcare applications which gauge carbon dioxide quantities.



The miniaturised gas sensor is based on Fabry-Pérot interferometers (FPI) — adjustable optical filters. Over the years, VTT has developed these for various spectroscopy-based applications, such as hyperspectral cameras for nanosatellite- and drone-based environmental monitoring, the early detection of skin cancer and fuel analysis.

Many sensor developers are interested in using smartphones to measure gas concentrations.

"This is probably due to the spread of the Internet of Things (IoT), which enables indirect observations of a range of environmental factors based on data gathered from single sensors or sensor networks. Many day-to-day issues, such as precision and efficiency in the workplace, can depend on carbon dioxide levels and internal air quality," says Anna Rissanen, leader of the VTT research team.

Using a mobile device to measure carbon dioxide will also enable new applications for smartphones: for example, sleep quality can be monitored by measuring the sleeper's exhalations.

www.vttresearch.com

Microchip and Intel to work on IoT privacy and security

Microchip Technology has announced a collaboration with Intel to implement Intel® Enhanced Privacy ID (Intel® EPID) technology into its products. Intel EPID is a sophisticated, proven approach to device authentication that provides both security and privacy for the on-ramp to the Internet of Things (IoT). Intel EPID provides authentication, allowing a service provider to verify that an end user belongs to a group authorized to access the service. It also helps protect end-user privacy, enabling them to receive the service without revealing their identity.

"By utilizing Intel EPID technology, Microchip's customers can maintain end-to-end security and privacy in their IoT products and services, which helps them to protect data from device to cloud, minimizes unauthorized access of end-points and gateways, and will promote a common security framework for IoT platforms," said Lorie Wigle, general manager of Internet of Things Security at Intel.

www.microchip.com

Hackers could exploit phone batteries to track users

A European team of security researchers have identified a potential privacy invasion 'black hole' that could exploit phone batteries to pinpoint their owners and track them around the internet.

The security issue centres around a feature of the HTML5 specification that allows websites to find out how much battery power a visitor has left on their laptop or smartphone. The security researchers, Lukasz Olejnik and Claude Castelluccia from INRIA Privatics with Gunes Acar and Claudia Diaz of KU Leuven, ESAT/COSIC and iMinds warn in their paper that the information can be used to track browsers online.

The battery status API is currently supported in the Firefox, Opera and Chrome browsers, and was introduced by the World Wide Web Consortium (W3C) in 2012 to help websites conserve users' energy. The energy saving feature enables a website or web-app to check when the phone user has little battery power left to allow the phone to switch to a low-power mode by disabling extraneous features to eke out the battery's energy. The same information can be used to identify phones as they move around the internet.

Websites and the scripts that run on them do not have to ask users' permission to see how much charge is left. The information can then be used as a way of identifying the phones themselves, without their users' knowledge. A website could put those two numbers together and watch for a phone with an identical or similar profile appearing on other pages, for instance. Malicious people could then put those two events together and work out that the same phone had accessed both websites, which can usually be hidden.

Technology such as VPNs and private browsing are designed to keep people from following a user around the internet. However, the security features identified by the research team show that a phone's software could be used to sidestep the precautions.

http://eprint.iacr.org/2015/616.pdf

Simplifying the Maintenance and Troubleshooting of Satellite Earth Stations

By Tom Hoppin, Keysight Technologies

With every type of communication system, operators face a shortlist of crucial needs: enhance system performance, increase data throughput, maintain system uptime, lower the cost of service and reduce customer churn. In the satellite business, the engineering portion of the problem is easy to summarize: pack more bits into the available spectrum, achieve faster data throughput, and do so in a power-efficient manner. Developing a viable solution is much more complicated and is driving technological shifts such as wider bandwidths and spectrum reuse.

These innovations only add to the challenges for those who maintain and troubleshoot satellite earth stations. All of the major elements—antennas, transmission lines, transmitters and receivers—as well as the overall system have unique test requirements. Completing the necessary range of tests often requires five or six instruments, and these have typically been bulky benchtop units—spectrum analyzers, vector network analyzers—that were transported into the field.

Today's newest all-in-one handheld analyzers cover millimeter-wave frequencies, reaching up to 50 GHz. These can be configured to provide all of the required capabilities, enabling faster validation of system performance and diagnosis of faults, all in a single unit that weighs just 3.2 kg (Figure 1).

Figure 1: *A single all-in-one such as the Keysight FieldFox handheld combination analyzer—RF, microwave or millimeter-wave—eliminates the need to transport multiple benchtop instruments to harsh, remote sites.*

OUTLINING THE MAJOR TRENDS

There are three significant technology trends in satellites: wider bandwidths, spectrum reuse and complex modulation formats. Wider bandwidths enable higher peak data rates for a single user and also increase overall system capacity by expanding the number of available channels. Multiple channels are multiplexed together, creating a wider-bandwidth signal that is sent as one transmission through a single transponder.

Spectrum reuse is enabled by the use of narrow spot beams. The ability to create spot beams allows more power to be instantly focused onto high-demand areas. Increased power also helps overcome rain fade (e.g., weather attenuation) and thereby enables the use of the Ka-band. This lets system operators access spectrum that is less crowded and in so doing achieve higher bandwidths and greater throughput.

The third trend is toward the use of increasingly complex modulation formats. These support higher data rates through greater spectral efficiency and a better signal-to-noise ratio; however, this requires tradeoffs between capacity, power efficiency and link performance.

Industry innovations such as high-throughput satellites (HTS) and digitally regenerative payloads are the embodiment of these shifts. Both have architectures that are quite different from conventional analog "bent-pipe" designs. Instead, these are mixed-signal systems that carry analog and digital representations of modulated signals. Digital modulation formats may be wideband, higher-order or custom, but all provide greater spectral efficiency.

TAKING A CLOSER LOOK AT THE EARTH STATION

Operators use various types of satellite systems for applications such as broadcast, bidirectional data, navigation, remote sensing and mobile communications. Every system has two major parts: the space segment and the ground segment. The focus here is on the ground segment.

The earth-bound portion of a typical system has at least three sub-segments: the satellite control system; gateways and hubs; and user terminals. The control system provides tracking, telemetry and command (TT&C), which determines the satellite's orbital position and sends commands to adjust altitude, orientation and trajectory. Bidirectional TT&C also relays information regarding the condition and operational status of the satellite payload.

Communications, including voice, video and data, are carried between the gateways, hubs and user terminals. Gateways connect satellite communications to terrestrial phone systems, cellular networks, Internet service providers, and more. Hubs provide connections between elements such as user terminals and other hubs.

In all cases, the ground station transmits uplink signals and receives downlink signals. A typical earth station contains at least one transmitter channel and one receiver channel, and the simplified block diagrams in Figure 2 highlight the RF and IF sections of each signal path.

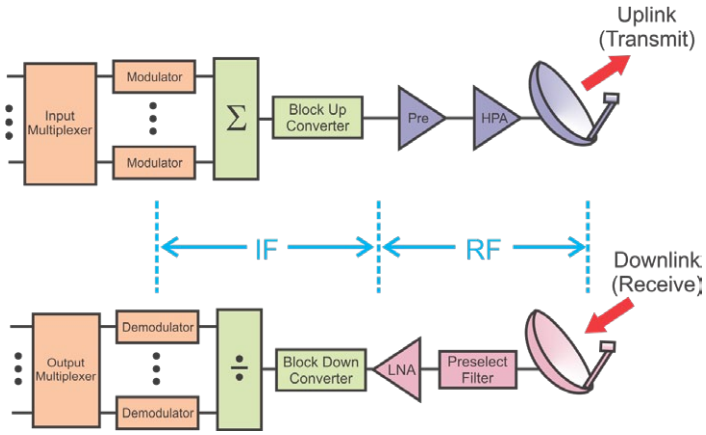


Figure 2: *These simplified block diagrams of transmitter and receiver channels illustrate the elements field personnel can measure, characterize and troubleshoot using an all-in-one handheld analyzer.*

Starting with the input multiplexer, the transmit path manages multiple data streams and sends each one to the appropriate modulator. These may produce a modulated IF at 70 MHz with a channel bandwidth of 40 MHz or a modulated IF at 140 MHz with an 80 MHz channel bandwidth. The channels are summed and upconverted to the RF carrier, which may be in the L, C, X, Ku, K or Ka band.

The receiver side reverses the process, starting with a preselection filter that rejects out-of-band spectral content. A low-noise amplifier (LNA) boosts the incoming signals before downconversion, and a divider routs the received signals to the appropriate demodulator. The output multiplexer then sends the signals to their appropriate destinations.

MAPPING OUT EARTH STATION TEST REQUIREMENTS

Effectiveness in maintenance and troubleshooting requires testing of the overall system and its key elements: antenna, transmission lines, transmitter and receiver. Example measurements include return loss (antenna), fault location (transmission lines), high-power amplifier performance (transmitter), LNA performance (receiver), and carrier-to-noise measurements (system-level). Table 1 provides expanded lists, though these are still a subset of what is required for system installation, verification, maintenance, and troubleshooting.

	Antenna	Transmission lines	Transmitter	Receiver	System-level
Test requirements	• Return loss • Alignment • Polarization • Cross-polarization • Sidelobe levels	• Cable & waveguide loss • Rotary joint VSWR • Fault location	• HPA performance • Converter performance • Frequency stability	• LNA performance • Converter performance • Interference • GPS (mobile applications)	• Equivalent isotropic radiated power (EIRP) • Gain/temperature (G/N) • Carrier-to-noise ratio (C/N) • Bit error ratio (BER) • Radio frequency interference (RFI)

Table 1: *This listing of the essential tests for an earth station is a subset of the total test requirements.*

Completing the full complement of tests requires six essential instruments: power meter, spectrum analyzer, vector network analyzer (VNA), line sweeper (return loss, distance-to-fault and time-domain reflectometry), RF source (continuous wave and swept), and DC source with voltage and current meter.

MAKING PRECISE MEASUREMENTS IN THE FIELD—CONVENIENTLY

The latest combination analyzers can be configured to provide all of the required capabilities in a single unit. This makes it possible to validate system performance with fast, detailed analysis of uplink and downlink signals.

For example, calibrated cable and antenna test (CAT) and VNA measurements help field personnel maintain cable, waveguide and antenna systems consistently and efficiently. The combination of network analysis, spectrum analysis, and power measurements enables faster diagnosis and repair of faults.

The new wave of combination analyzers is designed for field testing with 3.5-hour battery life and 7.1-pound weight. The rugged, fully sealed enclosure has no fans or vents and is compliant with US MIL-PRF-28800F Class 2 requirements and has been type tested to MIL-STD-810G Method 511.5, Procedure 1 requirements (operation in explosive environments). The analyzers have also been type tested to IEC/EN 60529 IP53 requirements for protection from dust and water, extending instrument durability in even the harshest environments.

Comparable benchtop instruments are specified to operate at a set temperature and require lengthy warm-up times. In contrast, Keysight developed an automatic internal alignment function that enhances spectrum analysis by compensating for temperature changes over a range of –10 to +55° C. With this feature, Keysight's handheld is ready to make highly accurate spectrum measurements at turn-on and through any temperature changes over the specified range. This function also enables the built-in power meter to make accurate measurements without an external power sensor.

Figure 3: *The iOS app emulates the combination analyzer's front panel, enabling remote control, monitoring and analysis. (Photo courtesy of INTELSAT)*

Equally important, time- and frequency-domain measurements have been shown to correlate with benchmark data acquired using benchtop instruments in the development lab and at system installation. The combination analyzer achieves S-parameter results that track the world's highest performance VNA within a few hundredths of a decibel, and it matches results from the world's highest performance spectrum analyzer to within tenths of a decibel. This level of correlation increases confidence in measured results and also reduces the risk of accepting bad systems, subsystems or components, or of failing good ones.

The analyzers also support remote operation through an application that runs on a variety of Apple iOS devices. This is ideal for environmental conditions in which it may be advantageous to control and observe the analyzer from the shelter of a vehicle or structure. This feature also enables collaboration between personnel, one example being an engineer working at a dish and another engineer below, analyzing measurement results through an iPad or iPhone (Figure 3).

REDUCING MAINTENANCE COSTS

For more than 20 years, satellite operators around the world have been using portable spectrum analyzers to handle the signal analysis portion of maintenance and troubleshooting. Today, some of the most popular models are no longer in production and will move into the "extended support" phase in 2017. Fortunately, a single combination analyzer can replace not only the portable spectrum analyzer but also the other RF instruments traditionally used for measurements in the field.

A key benefit of migrating to modern, field-ready technology is a reduction in overall capital and operating expenditures. Moreover, the combination analyzer requires just one calibration per year, reducing annual maintenance costs compared to the traditional array of equipment, which requires multiple calibrations per year plus calibrations of any spare instruments.

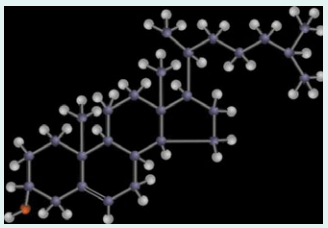
MOVING FORWARD

Today's most advanced handheld combination analyzers are equipped to handle routine maintenance, in-depth troubleshooting and anything in between. Better yet, they deliver precise measurements up to 50 GHz virtually anywhere on Earth a satellite maintainer may need to go.

For more information, please visit www.keysight.com/find/fieldfox.

Could black phosphorus take out graphene?

A Korean team of scientists have tuned the band gap of black phosphorous (BP) to form a superior conductor, allowing for the application to be mass produced for electronic and optoelectronics devices



The research team operating out of Pohang University of Science and Technology (POSTECH), affiliated with the Institute for Basic Science's (IBS) Center for Artificial Low Dimensional Electronic Systems (CALDES), reported a tunable band gap in BP, effectively modifying the semiconducting material into a unique state of matter with anisotropic dispersion. This research outcome potentially allows for great flexibility in the design and optimization of electronic and optoelectronic devices like solar panels and telecommunication lasers.

To truly understand the significance of the findings, it's useful to understand the nature of 2-D materials, and for that one must go back to 2010 when the world of 2-D materials was dominated by a simple thin sheet of carbon, a layered form of carbon atoms constructed to resemble honeycomb, called graphene.

Graphene is extremely thin and is stronger than steel yet many times lighter, more conductive than copper and more flexible than rubber. All these properties make it a tremendous conductor of heat and electricity. For all its promise there is however a disadvantage; graphene has no band gap. Graphene has a band gap of zero in its natural state — the semiconductor potential can't be realized because the conductivity can't be shut off, even at low temperatures. This obviously dilutes its appeal as a semiconductor, as shutting off conductivity is a vital part of a semiconductor's function.

www.ibs.re.kr/en

Microwave heating to usher in quantum dot lighting

Advances at Oregon State University in manufacturing technology for "quantum dots" may soon lead to a new generation of LED lighting that produces a more user-friendly white light, while using less toxic materials and low-cost manufacturing processes that take advantage of simple microwave heating.

The cost, environmental, and performance improvements could finally produce solid state lighting systems that consumers really like and help the nation cut its lighting bill almost in half, researchers say, compared to the cost of incandescent and fluorescent lighting.

The same technology may also be widely incorporated into improved lighting displays, computer screens, smart phones, televisions and other systems.

A key to the advances, which have been published in the Journal of Nanoparticle Research, is use of both a "continuous flow" chemical reactor, and microwave heating technology that's conceptually similar to the ovens that are part of almost every modern kitchen.

The continuous flow system is fast, cheap, energy efficient and will cut manufacturing costs. And the microwave heating technology will address a problem that so far has held back wider use of these systems, which is precise control of heat needed during the process. The microwave approach will translate into development of nanoparticles that are exactly the right size, shape and composition.

"There are a variety of products and technologies that quantum dots can be applied to, but for mass consumer use, possibly the most important is improved LED lighting," said Greg Herman, an associate professor and chemical engineer in the OSU College of Engineering.

www.oregonstate.edu

Unit shipments of 4G smartphones doubles

According to the latest global smartphone sales data from GfK, almost six in ten (58 percent) smartphones sold in Q2 2015 were 4G-enabled. Further, with a major operator launching 4G services in India at the start of this month, 4G is now available in all key countries. GfK forecasts 4G smartphone penetration to continue to grow at the expense of 3G, which is currently at 38 percent of smartphone units and is forecast to decline by another percentage point by Q4 2015.

Kevin Walsh, director of trends and forecasting at GfK comments, "India is expected to be the largest contributor of absolute smartphone unit growth globally this year. The main reason behind this is the currently low smartphone penetration in the market."

There are significant regional differences in 4G take up: price polarization in North America, saturation in Western European markets, local brands tackling global players in India and China, and intense competition in emerging markets.

www.greenfieldscommunications.com

Acal BFi and Stollmann announce distribution agreement

Acal BFi and Stollmann E+V GmbH have entered into an agreement to distribute Bluetooth modules throughout Europe.

Acal BFi will incorporate Stollmann's Bluetooth modules into their product portfolio effective immediately. Based in Hamburg, Germany, Stollmann has specialised in the development of Bluetooth and Bluetooth Low Energy modules for years. With the intelligent embedded standard modules, Bluetooth or Bluetooth Smart can be quickly and cost-effectively integrated to enable communication with smartphones, tablets, and PCs even without Bluetooth know-how.

The Bluetooth Low Energy modules have been specially developed for use in demanding applications. Thanks to its extremely low energy consumption, the "BlueMod+S" single-mode module is especially well-suited for use in sensors and other battery-operated applications.

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Qualcomm adds xDSL and G.fast networking with Ikanos acquisition

Qualcomm Atheros, Inc., has entered into a definitive agreement to acquire Ikanos Communications, Inc., a high performance broadband networking semiconductor and software provider enabling both central office and home gateway products. Pursuant to the agreement, Qualcomm Atheros, through a wholly-owned subsidiary, will commence a tender offer to acquire all of the issued and outstanding shares of common stock of Ikanos for $2.75 per share in cash, and assume all outstanding indebtedness.

The acquisition is intended to expand Qualcomm Atheros' footprint in the carrier fixed line segment with the addition of high performance broadband access and modem technologies critical to enhancing users' connected experiences in the home. The home gateway extends Qualcomm Atheros' leadership in carrier Wi-Fi and wired connectivity, while providing a central hub for Internet of Everything (IoE) enabled devices, services and 3G/LTE small cells.

www.qualcomm.com

Emergency services and public safety LTE to grow rapidly

ABI Research estimates that the total number of public safety LTE user subscriptions will reach 11 million worldwide by 2020, with a market size of US$5.1 billion. Recently, LTE has emerged as a challenger to existing public safety communication protocols. Continual refinements from 3GPP Releases and commercial collaboration between TETRA and P25 vendors with LTE vendors are turning first responder and public safety LTE into a reality.

Due to stringent operability requirements, the public safety community is generally risk averse. Legacy public safety protocols such as TETRA and P25 maintain high desirability due to their stability and performance consistency, while LTE vendors continue to improve its mission-critical features.

Since Release 10, 3GPP has incorporated various enhancements to improve the mission-critical capabilities of LTE.

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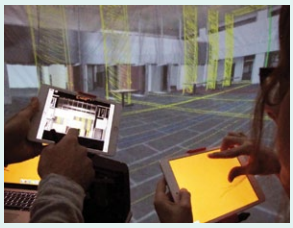
A 3D cursor for a 3D world

With advcent of smartphones and smartwatches how users interact with computers or smart devices in an inherently 3D world begs rethinking. To this end, researchers at the University of Montreal have developed techniques that enable computer cursors to interact in 3D in single or multiuser, local or remote collaboration scenarios. The system, unveiled at the SIGGRAPH 2015 Conference in Los Angeles, is not so much about turning Word into an IMAX experience as offering designers an opportunity to navigate through and modify their creations manipulating 3D objects with 3D interactions.



"Our new technology challenges the notion of what a cursor is and does," explained lead researcher Professor Tomás Dorta, of the university's School of Design. "The cursor becomes a drawing and controlling plane. The techniques we're unveiling today involves using a tablet to control the cursor, but as it does not necessarily rely on external tracking of the user's movements, eventually other devices could be used, such as smart phones or watches."

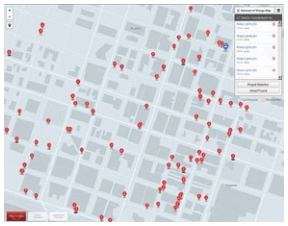
What does control plane mean? "We use a Butterfly-net analogy to explain how the cursor selects objects in space, the users simply sweep the 3D cursors through," Dorta said. "For the manipulations of objects, the users can use gestures and movements such as pinching and orientation."

The cursor is in fact being demonstrated within the researchers' Hyve-3D design system, a full scale immersive 3D environment that enables users to create drawings on hand-held tablets, which can then be manipulated on the tablets to create a 3D design within the space. The immersive images are the result of an optical illusion created by a high-resolution projector, a specially designed 5m-diameter spherically concave fabric screen and a dome mirror projecting the image onto the screen. Specialized techniques render the 3D scene onto a spherical projection in real-time

Drone detects ZigBee to map hackable IoT devices

Using a flying drone capable of detecting Internet-connected devices, information security firm Praetorian (New York, NY) was able to identify over 1,600 unique IoT devices in a test flight over Austin, TX.

Part of an IoT Map Project designed to map and examine the security of connected devices, the drone is able to collect data on ZigBee-connected devices up to 100 meters away by tracking their communications. According to the company, the drone can detect devices' security settings and manufacturers, as well as whether the devices are used in commercial, residential, or industrial areas.



"[The IoT devices] communicated over a wireless protocol called ZigBee. This protocol is open at a network level. So when the devices start connecting they send out beacon requests. We capture data based on this," says Praetorian vice president Paul West Jauregui.

The "ZigBee-sniffing" drone was outfitted with custom hardware from open-source DIY hardware company Adafruit. The majority of the devices it detected were in residential areas - many of them connected products from Sony and Philips Lighting.

Currently the project is focused on the exploration and mapping of connected devices. Ultimately the company plans to analyze the collected data and determine security vulnerabilities.

More drone flights are planned in other U.S. cities. The company also plans to release a "how to build your drone" guide shortly, to encourage more people to join the project and create their own "tech-tracking" drones.

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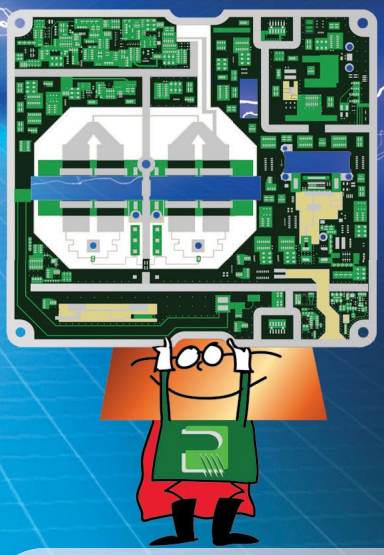

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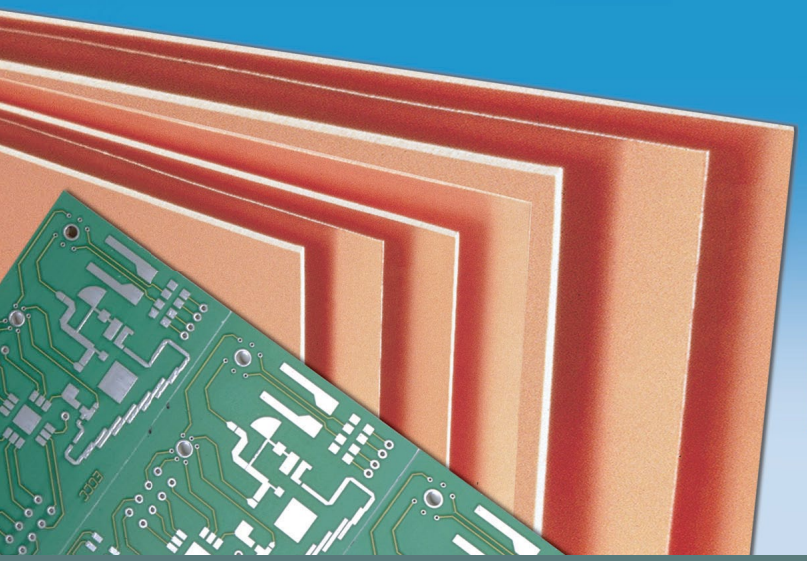

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5 years to 5G: Enabling rapid 5G system development

By David Hawke, Xilinx; David Squires, BEEcube

The goals for the so-called 5G Radio Access Network (RAN) are lofty indeed and have been discussed at length by industry experts. What has received far less airtime is, "What exactly is the best path to 5G?" This article lays out some of the challenges of the 5G RAN and ways in which ideas can be implemented in hardware, both for prototyping, which needs to happen over the next 3 years, and ultimately for production deployment, which is slated to commence in 2020.

5G: EVOLUTION, REVOLUTION OR BOTH?

The goal of 5G is to provide a 1000x increase in capacity, supporting 100+ billion connections with data rates to 10 Gbps and less than 1 msec latency. However, these new networks will not just support the fastest links and fattest data pipes; they also aim to improve upon the capabilities of current networks. For example, today's wireless networks lack support for the low data rates and long battery life required for M2M (machine-to-machine) and sensor-type technologies.

Developing 5G networks that meet these goals will require a combination of existing systems such as LTE-Advanced and WiFi, combined with revolutionary technologies designed to support new uses such as the Internet of Things, augmented reality, immersive gaming, and UHD (ultra-high-definition) streaming video.

Today, 5G standards are far from final, but many of the elements that will form part of the 5G architecture are already crystalizing. These new networks will employ many new frequency bands to augment existing wireless frequencies, enabling delivery of high capacity. Such tremendous connectivity and capacity will demand many more basestation nodes. These will be small cells and high-capacity cloud or virtual RAN architectures serving many hundreds if not thousands of radio heads. Content caching and processing at the edge will all have a place in the new 5G networks, enabling high speed streaming video and reality augmentation for coverage of major sports and other high-demand events. Major innovation is also needed at the lowest levels to accommodate broad requirements for both video and augmented reality. The needs of M2M networks will drive innovation in the physical layer, air interface definition, and control plane structures.

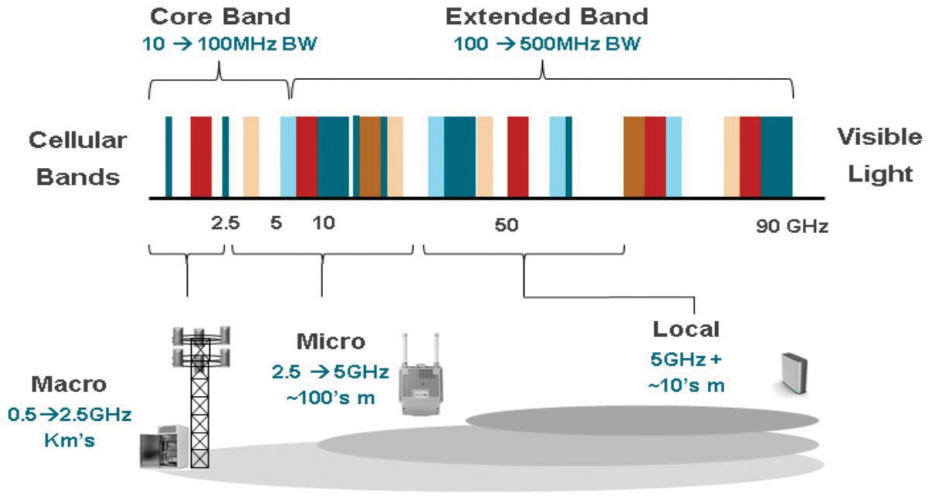

Figure 1: Existing and likely 5G frequency bands.

NEW FREQUENCY BANDS

5G will see some of the spectrum below 6 GHz being re-purposed for use with newer technologies, particularly for non-line-of-sight (NLOS) requirements. Existing cellular bands will be augmented with new spectrum allocations above 6GHz, able to supply much wider contiguous spectrum. Additionally, carrier aggregation techniques will be used to combine chunks of spectrum that are not co-located within the same band to further improve peak data rates. The core bands will provide up to 100 MHz of instantaneous bandwidth and the new extended bands will provide contiguous chunks of spectrum with as much as 500 MHz in bandwidth, perhaps more.

MASSIVE MIMO

Release 12 of the 3GPP standard, slated for freeze in 2015, provides for early massive MIMO systems. These systems take active antennas to a new level. Large arrays of radiating elements (16x16 to 256x256 MIMO) require horizontal and vertical beam forming to significantly increase capacity and coverage. Massive MIMO in turn requires significantly more processing power.

ADVANCED PHYSICAL LAYER

Current 4G OFDM air interfaces deliver high-speed data with limited support for low-power M2M communications. As a result, air interface technology and the 5G physical layer will be augmented using new bands of spectrum as they become available. Many new candidate air interfaces are being considered to provide support for sub-1-msec latency with 10Gbps throughput. Other interfaces that can cater to the needs of simple sensor data transmission will not require such low latency or high data throughput so it's likely that 5G will not employ a single air interface technology. Equipment will need to support multiple air interfaces, potentially simultaneously.

In addition, the physical layer will require new coding and modulation schemes, protocols, and framing structures brought about by disparate end-user requirements. The 5G infrastructure must automatically determine the type of channel needed and adapt based on conditions such as precipitation or moving objects such as trains, airplanes, or cars affecting line of sight. Cognitive radio techniques and advanced adaptive coding and modulation schemes will allow equipment to provide the best possible connections.

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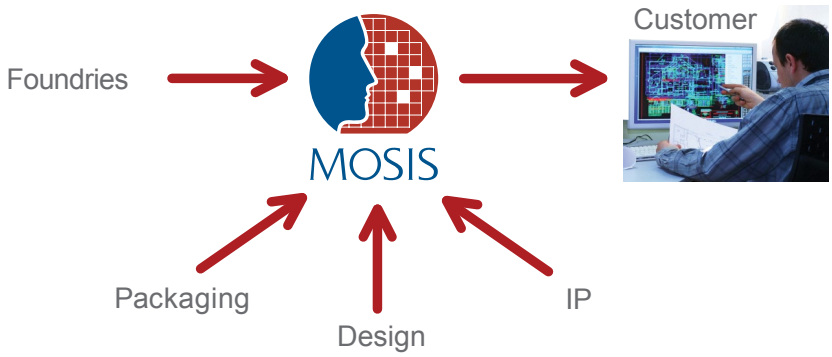

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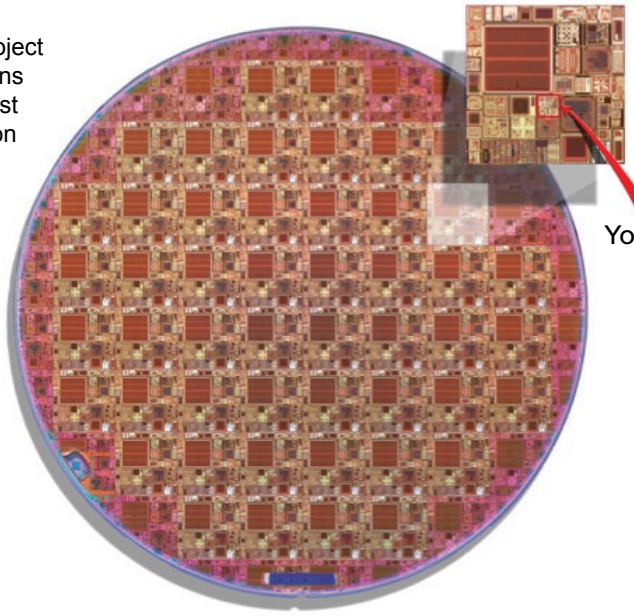

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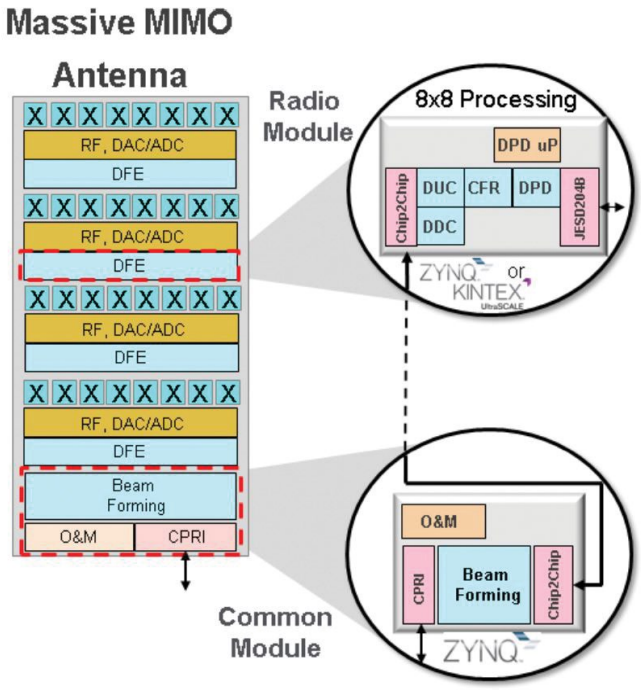

Figure 2: Massive MIMO concept leveraging FPGAs and APSoC.

EVOLVING ARCHITECTURES

Existing basestation architectures consist of a cabinet housing radio units, power amplifiers, and baseband cards along with control and backhaul access. More recent architectures move the radio units to the mast, adjacent to the antennas, to eliminate lossy coaxial feeder cables and improve energy-related OpEx.

New architectures including Cloud RAN and Virtual RAN take a more centralized approach for greater CapEx and OpEx savings. Centralizing baseband processing and backhaul functions to serve many hundreds or thousands of remote radios enables the use of GPU-centric server farms with localized data-center processing at the edge. This change places significant challenges on the fronthauling aspects of the networks, where the data from many hundreds of radios must be transmitted to data centers over various media (copper, fiber, over the air). 5G infrastructure will also push in other directions including core virtualization components such as Software Defined Networks (SDN) and Network Functions Virtualization (NFV); resulting in a more software-centric, server-based architecture that allows use of commodity servers and distributed processing.

IMPLEMENTING MASSIVE MIMO TODAY

The benefits of Massive MIMO are undisputed but the cost of implementing Massive MIMO is enormous due to the computational burden involving large matrices and linear algebra for beam forming calculations for each antenna. As a result, Massive MIMO will hugely increase both connectivity and signal-processing requirements. High-speed connectivity is required between the digital front end (DFE) processing and the analogue domain–many of the data converters are migrating to JESD204B–and between the baseband processing and the radio processing, which require some form of serial transceiver. DSP for DFE and beamforming algorithms demands wide bandwidths and high sample rates, necessitating agile, high-performance signal-processing.

Today Massive MIMO antenna algorithms can be realized with current technology, as shown in Figure 2, but as Massive MIMO systems scale to larger and larger arrays of antenna elements, greater levels of integration will be required and made possible by future device generations.

FPGAS AND SOCS ENABLE MASSIVE CONNECTIVITY AND CAPACITY

The capacity and latency goals that 5G demands will have a knock-on effect to the requirements of the infrastructure equipment. 5G systems must support massive connectivity and massive capacity that can only be served through the use of high-throughput communications including 10Ge, 40Ge, PCIe, and future evolutions of CPRI. Capacity increases will come from new modem architectures, advanced radio technology, and new modulation schemes–which all require huge increases in signal processing capabilities.

FPGAs have long been used in wireless infrastructure equipment due to their high performance, which permits rapid implementation of complex signal-processing algorithms. The latest Xilinx 20nm UltraScale™ FPGA devices can support over 8 TMACS and more than 5 Tbps of serial transceiver bandwidth. Xilinx All Programmable SoC devices couple a high-performance FPGA fabric with a fully integrated processing subsystem based on dual ARM® Cortex A9 MPCore™ processor's, which can be used to efficiently implement higher layers of the complex 5G protocol stacks.

HIGH END FRONTHAULING

Fronthauling is an evolving market driven heavily by the centralization of baseband processing, which in turn drives the need for IQ data fronthauling by wireless, copper, or fiber media. Current connectivity standards exist in the form of CPRI and OBSAI. Figure 3 shows a state-of-the-art CPRI aggregator implemented in FPGA.

5G is likely to have a different implementation for some processing elements. For example, Layer 1 baseband processing may move to the radio to reduce overall payload bandwidth, which drives greater integration in the radio domain. Whether Layer 1 is integrated within the radio or not, 5G development will continue to focus on baseband processing and the radio and on associated fronthauling technologies.

ADVANCED PHYSICAL LAYER EVALUATION TOOL FLOWS

Development of the physical layer for 5G is underway with many candidate tech-

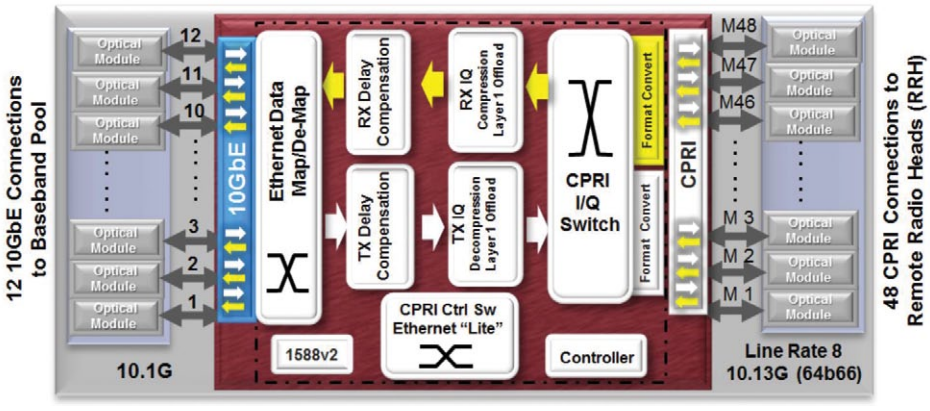

Figure 3: FPGA implementation of CPRI Fronthaul Aggregator.

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nologies. Evaluating the relative merits of new candidate air-interface technologies and their associated Layer 1 processing needs is best done with FPGAs, which enable rapid implementation of required algorithms and interfaces. The inherent re-programmability of FPGAs permits rapid design changes to demonstrate improvements or to add features with very little schedule impact.

High-level synthesis tools ease development of advanced 5G algorithms. For example, Xilinx's Vivado® HLS enables algorithm developers and system architects to design in C/C++ and then synthesize to RTL as shown in Figure 4. Popular 3rd party tools including MATLAB and Simulink can also be used for front-end design. With the advent of All Programamble SoCs, such as the Xilinx Zynq® SoC family, ARM processors are readily available for implementing scheduling and other higher-level protocols. All of the normal tools in the ARM ecosystem are also available for these designs.

5G PROTOTYPING PLATFORMS

5G standards do not yet exist but companies are still keen to start prototyping. Creating custom hardware and software to implement 5G functions is both time consuming and costly. BEEcube has developed a range of 5G prototyping hardware that takes much of the pain out of developing such systems. System architects can focus on where they can add value—with the development of new 5G candidate technologies.

BEEcube provides several platforms (see Figure 5) that can easily be tiled together to create huge amounts of DSP processing power (>100 TMACs) and large amounts of optical connectivity (>10Tb/s) for CPRI aggregator fronthauling designs. Each platform supports the VITA-57 FMC analog cards to be fitted easily for direct RF sampling or for interfacing 1GHz of bandwidth to a 60GHz transceiver. BEEcube also delivers of all the required 5G interfaces, enabling the system designer to focus on developing the algorithms without getting stuck on the interface standards.

5G PRODUCTION TECHNOLOGY

FPGAs will be used for prototyping 5G wireless infrastructure over the next few years. There really are no other alternatives. However, when it comes to deployment technology, cases can be made for both ASICs—the traditional choice for high-volume manufacturing—or FPGAs.

The decision of whether to keep a design in an FPGA or migrate to an ASIC for production is a question of economics. With more serial transceivers, DSP slices, block RAMs, DLLs, PLLs, processor sub-systems, memory interfaces, PCIe interfaces, and other blocks, the FPGA's hardware penalty for re-programmability continues to diminish. In parallel, the risk of severe ASIC design bugs increases exponentially as overall 5G system complexity increases.

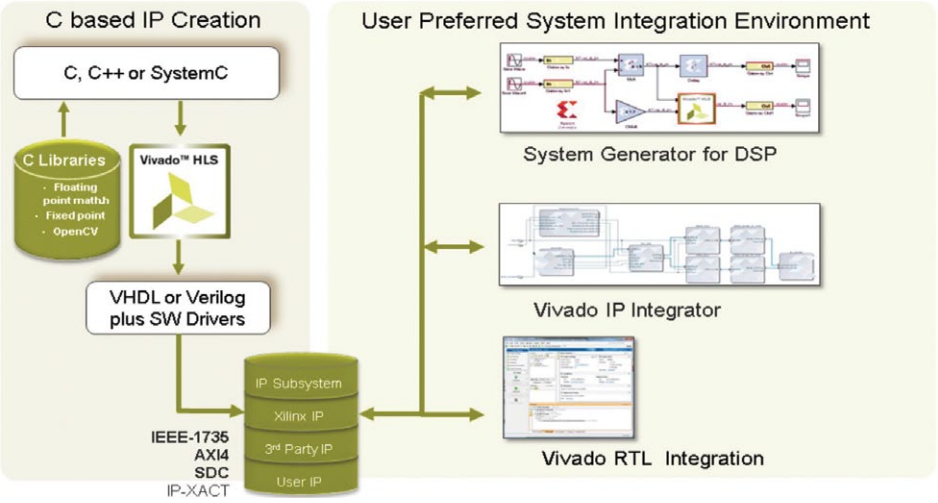

Figure 4: 5G IP creation using C/C++, RTL or System Generator for Simulink.

Designers once agonized over whether to load software into ROM or PROM. Today, no-one stores program code in a non-re-programmable memory. Now it all goes into Flash memory, which can be upgraded and reprogrammed in the field. The same trend is happening with hardware. It is likely the 5G wireless infrastructure OEMs will bet on programmability to reduce design risk and speed time to market.

SUMMARY

The race is on to solve many 5G technical challenges. We're still five years away from commercial deployment but many companies need to prototype these emerging algorithms and applications now as standards begin to firm up. Xilinx FPGAs and Zynq SoC devices coupled with commercially available 5G prototyping platforms such as those from BEEcube can save significant development time versus the development of custom prototyping platforms. These tools allow system architects and designers to get on with the job of finding the best architectures and algorithms, rather than spend their time architecting the platform on which to prototype.

As we look to 2020 for widespread 5G deployment, it is likely that most OEMs will sell production equipment based on FPGAs and All Programmable SoCs. The hardware complexity of 5G's physical layer is just too challenging to guarantee that ASIC implementations will be free of severe hardware bugs. Keeping the hardware soft will be the wise path chosen by the smartest OEMs.

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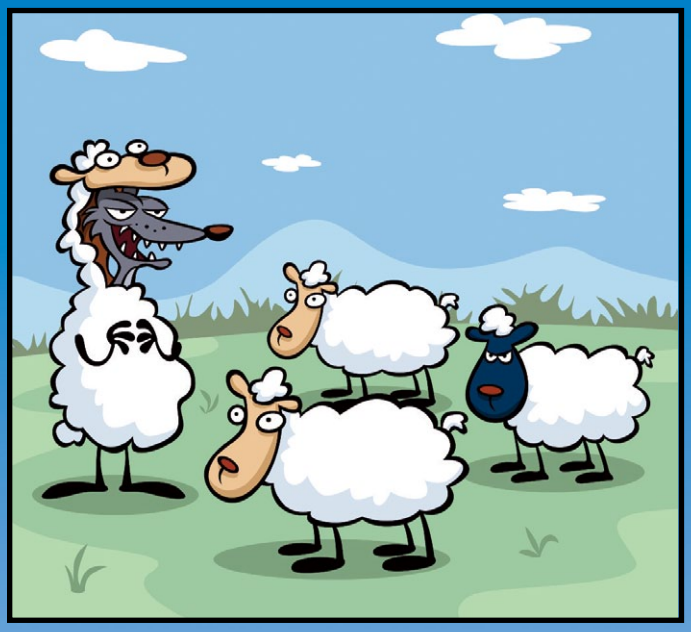
# MIMO Ch/Rack	144 - 576	256	NA

Figure 5: – BEEcube 5G development platforms.

Imitators Can be Dangerous...



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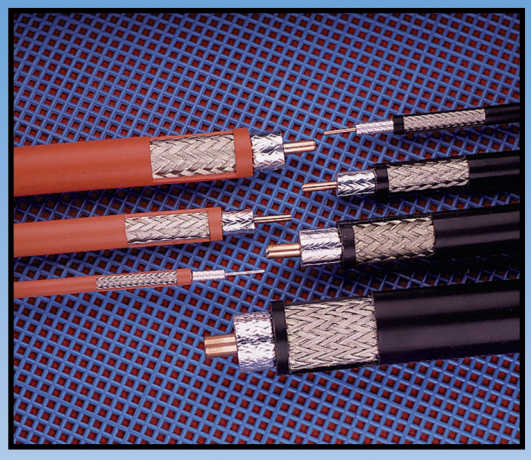

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The road to 5G is progressing rapidly, but prototyping is essential

By Jean-Pierre Joosting, MWEE

5G networks hold a lot of promise in providing 1 to 10 Gbps throughput anywhere with complete transparency at lower power requirements than today's networks and handsets, while offering strict levels of latency for critical applications. Such networks by nature will be software defined so that they can be configured on the fly to cater for changing demand dynamics and to allocate resources quickly where needed. Separation of the control and data planes is essential to achieve this aim as well as to lower costs through virtualization and to implement strict latency requirements for critical applications. Further, network intelligence needs to be pushed out to the edge as well and protocols for more efficient local routing implemented, for example, enabling direct routing between handsets.

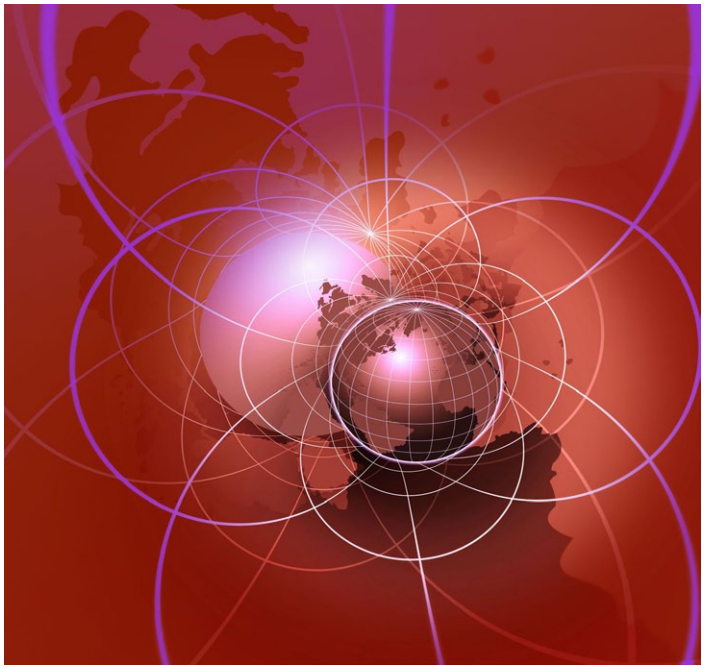
Researchers are working on multiple fronts and at the moment are jostling to get their ideas accepted into the standards. For example, at the recent NI Week in Austin Texas, Samsung demonstrated a commercially viable Full Dimensional (FD) MIMO for spectrum bands currently in use in an attempt to be first to market with 5G capabilities. FD MIMO increases the number of antennas in a basestation enabling more users to be supported with high data rates and reliability. Samsung achieved this by implementing 3D beam forming, which enables beam energy to be directed to specific users in 3D space, and is not limited to the 2D plane as in currently the case in 4G.

James Kimery, Director of Product Marketing for RF at NI says, "FD MIMO is a first step to Massive MIMO and will probably be incorporated into LTE by 3GPP."

James contends that 3GPP, which was created to deliver world harmonization, is where the debate and most of the standardization of 5G will take place. He expects that Massive MIMO will be a key part of the 5G standard with the promise of delivering a ten-fold boost to throughput.

TO BE 5G OR 4G, THAT IS THE QUESTION

It is expected that as progress is made towards systems that are fundamentally different in architecture to 4G, that these elements will form the basis of the 5G standard. When bodies such as 3GPP eventually sign off on 5G, there will be many blurred lines between 4G implementations and early 5G proposals, in much the way 3G stole some of 4G's thunder.



However, the key here is that a fundamental rethink on the architecture of the network to the way antennas are implemented as well as spectrum that is used needs to take place. To get 10x and 100x increases in throughput require radical re-engineering of the way wireless networks are built is required. To ensure latency and throughput improvements in the sub-6 GHz part of the spectrum, Massive MIMO at the moment holds the key and represents an architectural shift in antenna design.

Anite, recently acquired by Keysight, has joined the 5G Innovation Centre at the University of Surrey ("5GIC"), the largest UK academic research centre dedicated to the development of the next generation of mobile and wireless communications.

Professor Rahim Tafazolli Director of 5GIC and Institute of Communication Systems had this to say, "5G will intelligently understand the demands of users in real time, dynamically allocating network resources depending on whether the connected device needed voice or data connectivity."

Rahim adds, "Anite's contribution to our 5G research programme will enable the development and testing of future technologies in a real environment and in an end to end manner."

At the heart of the 5GIC, which is backed by both the UK government and leading global industry players, is a state-of-the-art test-bed for trialing emerging 5G ideas, proving concepts, validating standards and vendor interoperability testing.

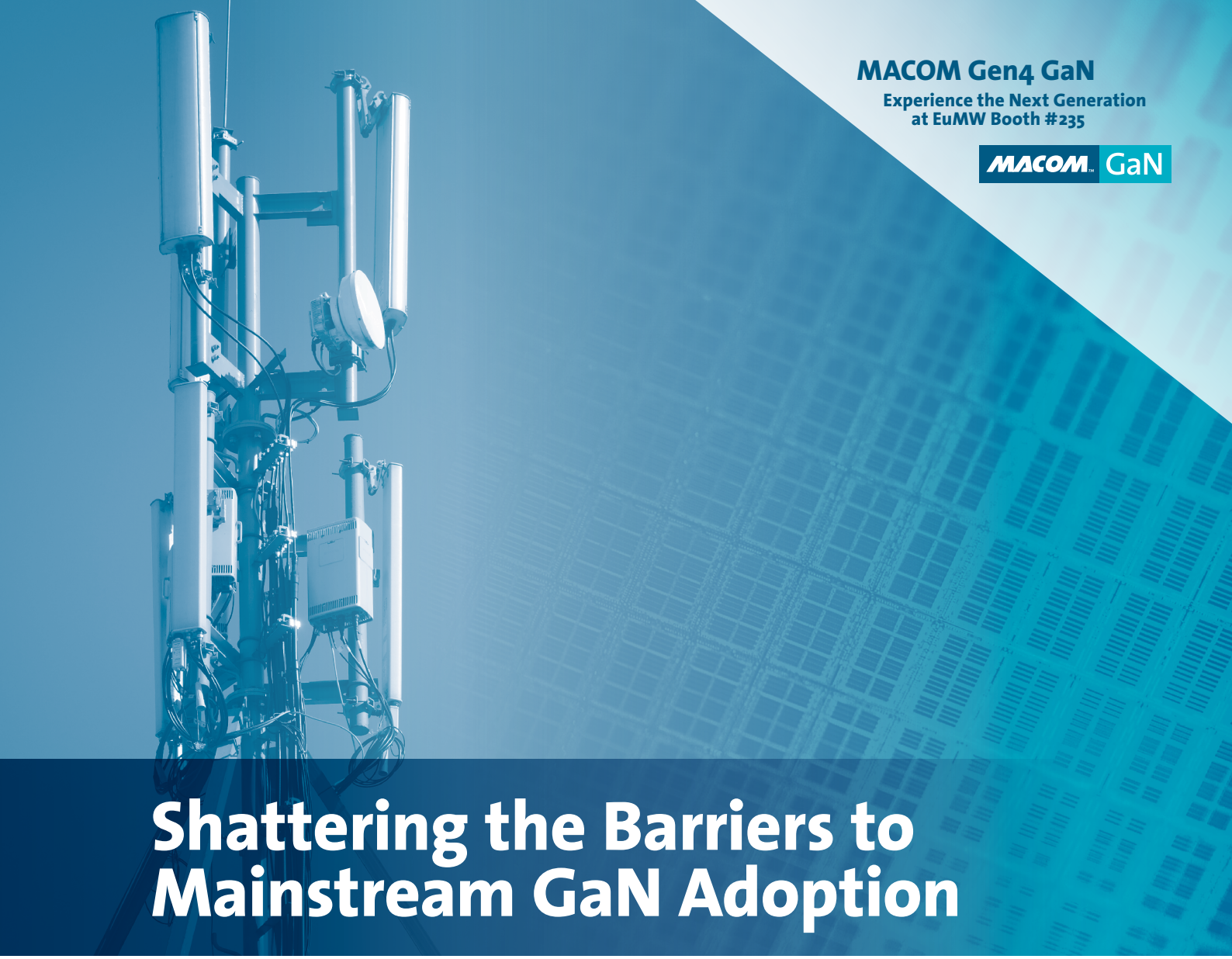
James Goodwin at Anite expects the air interface of 5G to be different to 4G and unlikely before 2020, although some elements will end up in 4G.

James adds, "5G will include mmWave but it is expected to appear in later variants of 5G. This is new technology and there are cost challenges in handsets to be addressed, but more importantly a unified spectrum plan is required. The WRC meeting in 2019 is the first opportunity to discuss mmWave frequencies on a global basis."

Earlier this year, Anite announced that the Anite-led task group within the METIS project finalised the first 5G radio channel models, which will help to accelerate the development of 5G radio access technologies and future mobile industry standards.

THE ROLE OF IP

A leading supplier of IP, Imagination Technologies has also joined the 5G Innovation Centre to collaborate in



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exploring, developing and defining underlying technologies that will power the next-generation 5G mobile communications network.

Richard Edgar, Director of Communications Technology at Imagination Technologies says, "We expect IP to dominate the wireless SoC market and consequently 5G. The progression at Imagination started in broadcast, then moved to short-range wireless (Wi-Fi and Bluetooth) and will be followed by IoT."

According to Richard, 5G will be comprised of many standards. The 3GPP is primarily focused on cellular and this emphasis takes less account of Wi-Fi, White Space spectrum, and the emerging IoT.

Richard adds, "At the moment there are around 29 candidate spectrum bands being considered for 5G, some old ones, others new, spanning 600 MHz to 60 GHz."

Why spend all this energy on a modulation scheme to span 600 MHz to 60 GHz when solutions already exist as every vendor has a complete Wi-Fi stack. 60 GHz can be added to the stack as an amendment and currently 60 GHz chips are small and the antennas required are also small.

Carriers are embracing Wi-Fi as a critical addition to their networks, and though it does not have the command and control of cellular (QoS), it is getting much better. Richard expects Wi-FI to remain a useful component of 5G and expects other standards to also become part of the 5G scenario such as 15.4.

"5G will be a fully comprehensive suite of wireless technology with intelligence built into the handset. The network will be very different in design and expect IP to be the way to go for small devices."

IP will be key in providing the communications expertise to the multitude of companies that are expected to embrace the IoT, home automation, Industrial IoT and so on. IoT and 5G are also set to revolutionize medicine. The key here is the billions of sensors involved and the need to communicate. Most companies will not have RF or microwave communications expertise and IP is the best way of buying this in.

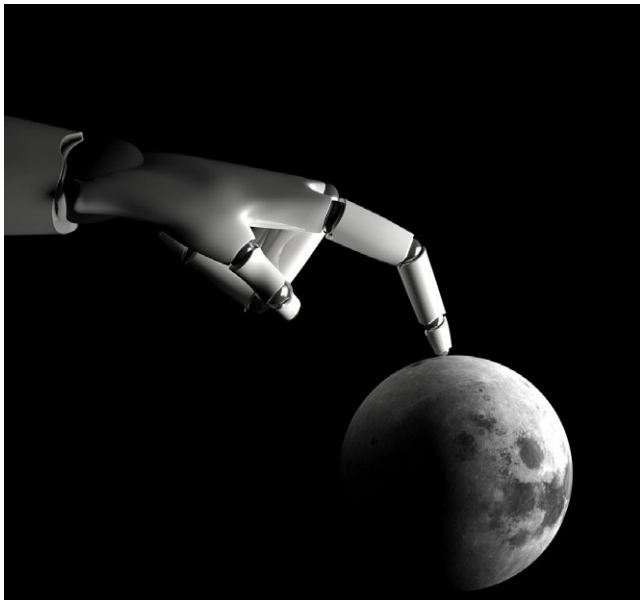
Richard comments, "Companies can either buy a wireless SoC or integrate IP into their own silicon — believe that the second choice will dominate as volume costs are very important."

5G AND THE IOT

The IoT poses a specific challenge to 5G. IoT is typically low bandwidth, uses small data packets, has low communications overheads and is very low power as most devices are battery powered or use energy harvesting. Further, the battery needs to last the specified life of the product. However, some elements of IoT require very low latency. It is combining all these needs in to 5G that is challenging. Incorporating multiple standards into 5G seems to be a logical progression.

IoT is independent of 5G but to capitalize on the economics of widespread networks, it will need 5G.

At NI Week, Stanford University Andrea Goldsmith remarked that the next-generation of networks need to support an exponential rate in data growth and a surge in diverse wireless devices. 5G research is not just about more data but these networks need to be more reliable, predictable and energy efficient, which is required by the emerging IoT.



This is key to enabling diverse applications such as remote surgery, autonomous vehicles, and health/wellness monitoring. The key aspect here is diversity of needs and an explosion of sensors communicating data.

PROTOTYPING IS KEY

James Kimery at NI says the company has a leading role to play in 5G with its ability to enable researchers and organizations to rapidly prototype wireless technology with its LabView-defined PXI platforms.

For example, Nokia at NI Week demonstrated a 73 GHz system that delivered a peak rate of 10 Gbit/s. The use of mmWaves poses a whole set of challenges including penetration loss, diffraction loss, beam steering, and the efficiency and cost of RFICs. Started two years ago the Nokia project is resolving many of these issues such as beam forming and recently achieved a 200-m range. Key to their success is the ability to implement rapid prototyping and rely on ready to use platform.

According to James Kimery thousands of research papers are written on wireless but there is a need to move beyond simulation and go to prototyping. NI is alleviating this problem and enabling researchers to implement prototyping and have their voices heard. Standardization bodies require a prototype otherwise the idea lacks credibility — it is difficult to invest in an idea without a prototype. Prototyping provides a glimpse of the road to commercialization.

All the companies involved, of which only a few have been covered in this article are looking at different aspects of 5G. While we can agree on what 5G will do in terms of throughput, latency, power efficiency, reliability and so on, what is more opaque is how such a network is realized. Researchers looking to define 5G and companies looking to leverage these standards will need to do a lot of testing and prototyping of complex and emerging technologies. While 5G might encompass many standards already in existence, the network will need the intelligence to select the best protocol for the required use case and implement in the most efficient manner possible. New standards will come into play to take advantage of spectrum that is unlicensed or in the mmWave bands, but it suffices to say that at this level of complexity prototyping and network test beds will be essential in getting to the point where 5G can be implemented. As is the case with complexity, it is best dealt with reuse, whether on the test side or implementation side in the form of IP.

To conclude, there is significant progress being made on 5G the point where standards start to come into play is near. Most of the next decade will be dominated by 4G and improvements to 4G, but the seeds for 5G have been sewn.

Why beam-forming antennas are essential to the next phase of growth in mobile network capacity

By Victor Fernandez EMEA Regional Wireless Specialist, Anritsu
www.anritsu.com

Before 2014, LTE technology deployments worldwide were principally of the frequency division (FD-LTE) variety. It was only in 2014 that the other, time division (TD-LTE) flavour of LTE began to gain serious attention from the mobile telephone industry.

As this article will show, one of the main benefits of TD-LTE is its ability to support the use of beam-forming (that is, highly directional) transmitting antennas. Beam-forming antennas offer network operators important benefits, enabling a more flexible and efficient use of network infrastructure and, in some circumstances, a markedly better quality of service to customers.

This means that both manufacturers and users of antennas and base transmitter station (BTS) equipment are currently exploring new approaches to the design, production, installation and use of beam-forming antennas. This article outlines methods engineers may use to design and build beam-forming antenna prototypes, and the role that specialised RF measurement instrumentation can play in the evaluation of such prototypes.

COMPARISON OF MULTI-ANTENNA OPERATING MODES

The radio access technologies used in modern communications networks rely to a large extent on various multi-antenna systems to achieve high data rates or to improve the quality of transmission to users at the perimeter of a cell. These multi-antenna systems may be of the multiple-input, multiple-output (MIMO) type, single-input, multiple-output (SIMO) or multiple-input, single-output (MISO).

In a BTS, a multi-antenna system may be used to transmit signals by one of two opposing and clearly differentiated techniques. (These techniques are commonly confused.)

One use of multiple antennas is to transmit a different data stream through each antenna. This is possible when there is a low degree of correlation between the different transmission paths, for instance because the transmitter is in an environment which tends to scatter RF transmissions, causing each data stream to attempt a different path to the receiver. In this case, the receiver sees each antenna as an independent signal source, and readily distinguishes the different data streams. The effect is to increase the overall data rate. This technique is called spatial multiplexing.

The other use of a multi-antenna system is possible when all the transmission paths are closely correlated, and every signal is affected by the transmission medium in a similar way – for example in an environment subject to negligible scattering, or when the antennas are mounted close to each other. In this case, the multiple antennas can operate as though they were a single, high-power antenna with its main lobe illuminating a specific area.

When an antenna array is used in this way, it is a beam-forming antenna. The effect is to concentrate the available bandwidth in the targeted area, improving the quality of transmission or the signal-to-interference-plus-noise ratio (SINR).

FD-LTE can employ multi-antenna systems for spatial multiplexing very effectively, since the multiple-carrier waveforms it uses, such as orthogonal frequency division multiplexing (OFDM), can be perfectly matched to this kind of transmission system architecture.

TD-LTE, on the other hand, can make particularly good use of beam-forming antennas, as the uplink and downlink are duplexed in the time domain and, more important, transmitted and received signals are at the same frequency.

Beam-forming antenna technology, then, is important to the deployment of today's TD-LTE technology, but it is also expected to play an important part in 5G network infrastructure, which will combine enhancements to LTE with new radio access technologies. This is because of the requirement to support 'network densification'– that is, the deployment of small cells with a single carrier waveform to serve small areas packed simultaneously with many subscribers. This will be achieved through the implementation of so called 'massive MIMO' beam-forming techniques.

TECHNIQUES FOR REALISING A BEAM-FORMING ANTENNA

A beam-forming antenna may be realised either mechanically or electronically.

The mechanical method requires the physical manipulation of the antennas to adjust their position and orientation, in order to ensure that all their transmissions are in phase or highly correlated in relation to the target area. While easy enough to understand, its implementation is impracticable in the field, because of the need to frequently and precisely change the position and direction of the beam as user equipment or sources of interference move. Moreover, the mechanical method requires the use of antennas with an extremely precise radiation pattern characterised by a narrow main lobe, in order to clearly focus their RF output and enable a quick estimation of each required mechanical movement.

Fortunately, the same beam-forming operation can be implemented electronically, using static antennas. Electronic control of an antenna array's radiation pattern is possible because two or more identical antennas may be configured in such a way that they behave as one single equivalent antenna with a known radiation pattern.

This radiation pattern depends on the type of antenna being used in each element of the array, the position of each element relative to the other elements, and the amplitude and phase of the signal fed to each one. This enables 'smart' antennas to modify their radiation pattern in response to an internal feedback loop while the antenna system is operating. This ability to dynamically alter the direction and shape of an

antenna's beam offers great advantages to network operators, improving the efficiency and flexibility of a wireless communication system. For instance, in a thinly populated area, a conventional BTS will have a fixed, wide area of coverage. If there is only a single active user in the coverage area, most of the radiated power will be wasted. On the other hand, a beam-forming antenna enables the entire BTS signal can be directed to the single user, providing a stronger signal, and consequently a higher data rate and better quality of service.

Likewise, at events such as outdoor concerts or sports matches which have a dense but temporary concentration of subscribers, an antenna's beam can be temporarily directed towards the mass of people to make the best use of the scarce available bandwidth.

DESIGN OF A SMART, BEAM-FORMING ANTENNA

Smart antennas are phased arrays. Indeed, a base station with – from the point of view of other network elements – a single (SISO) antenna can form a beam, if its internal structure consists of multiple antennas in a phased array. The principles underlying this use of a phased array are not new, but its implementation in a mobile network environment has become possible because of the characteristics of the downlink RF channel, and the new potential for advanced signal processing in modern, highly sophisticated handsets.

So how is a phased-array signal generated?

Let us take s(t) to be the signal to be transmitted through a phased array of M elements. Each element of the array will be fed with the same signal, which is modified incrementally in phase and, optionally, in weighting (that is, relative amplitude). This can be expressed as follows:

$$y(t) = \mathbf{w}^H \cdot \mathbf{a}(\theta) \cdot s(t),$$

where y(t) is the complete signal to be transmitted, wH is the weight vector and a(θ) the steering vector.

The formula for calculating the steering vector is as follows:

$$a(\theta) = \begin{bmatrix} 1 \\ e^{-j\theta} \\ e^{-j2\theta} \\ \dots \\ e^{-j(M-1)\theta} \end{bmatrix}$$

The weighting and steering vectors may be dynamically adjusted to provide the best possible signal to a UE at a specific location. Computing these vectors is an essential step in realising a beam-forming antenna in an LTE system. An effective combination of steering and weighting vectors allows the operator both to point the signal in the direction of a target UE and aim counter-signals at known interferers.

Of course, in practice there is no 'perfect' balance of weighting and steering vectors: the network must constantly strive for an effective combination of provision of signals to multiple users and the placement of radiation nulls addressing (potentially multiple) interferers (see Figure 1).

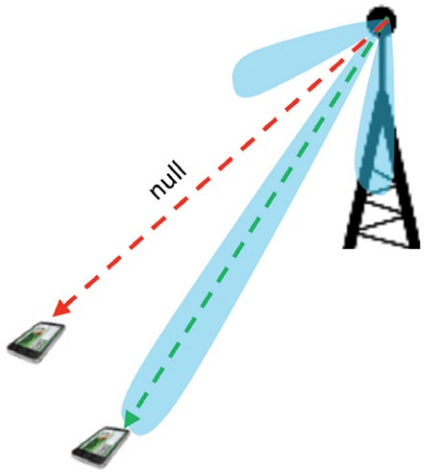


Figure 1: a beam-forming antenna enables signals and nulls to be precisely directed from a BTS.

Several algorithms have been developed to help network controllers to calculate the most effective beam-forming weightings. In one method, suitable for reasonably directional antennas separated by half or less of the signal's wavelength, the direction of arrival (DoA) from the uplink signal may be used to calculate the weighting.

TD-LTE uses a different method, based on the channel estimation or SINR reports from the user equipment. Because the uplink and downlink take place on the same frequency in a TD-LTE system, the uplink sounding reference signals can be used directly to estimate the channel characteristics: these data can then be used to derive the weighting for the downlink beam-forming. The capability of 3GPP networks to support beam-forming is shown in Table 1.

HOW TO GET STARTED WITH BEAM-FORMING

As Table 1 shows, a more complex beam-forming transmission system provides more capabilities to the network controller. But a first foray into beam-forming can be made quickly and easily in the laboratory, using just two basic antennas and a signal generator.

Transmission modes	Support for beam-forming
7	One-layer beam-forming, using channel estimation based on UE-specific reference signals.
8	Dual-layer beam-forming – the BTS weights two layers individually at the antennas. UE-specific reference signals are used.
9	Eight-layer transmission gives enhanced beam-forming performance, suitable for serving multiple users at the same time, or a single user with more than one beam.

Table 1: how 3GPP transmission modes support beam-forming.

An instrument such as the Anritsu MG3710A signal generator may be used for this purpose. The instrument's two RF outputs are exactly 7.3cm apart. Assuming that the array elements will be separated by ≤λ/2 to allow for weighting computation based on the DoA from the user equipment, the minimum wavelength is 14.6 cm, which implies a maximum frequency of 2.05GHz. This allows for operation at 1.9GHz, a popular LTE band.

Using two simple dipole antennas 160mm in length (see Figure 2), the MG3710A can load and save two signals with the same amplitude but a different phase and/or weight applied. A common software tool such as Matlab may be used to configure the waveform. When the MG3710A transmits the different signals through each RF port simultaneously, a beam-formed pattern is made.

Figure 2: beam-forming antenna set-up using the Anritsu MG3710A signal generator's two RF ports.

The advantage of using a tool such as Matlab is that it enables the user to calculate the radiation pattern that the transmission should create. The omni-directional pattern of a single dipole antenna becomes narrower when it forms

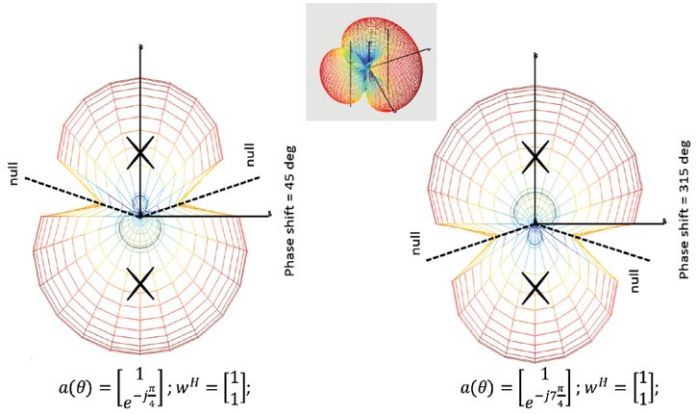


Figure 3: the radiation pattern from a two-element array changes as the degree of phase shift changes.

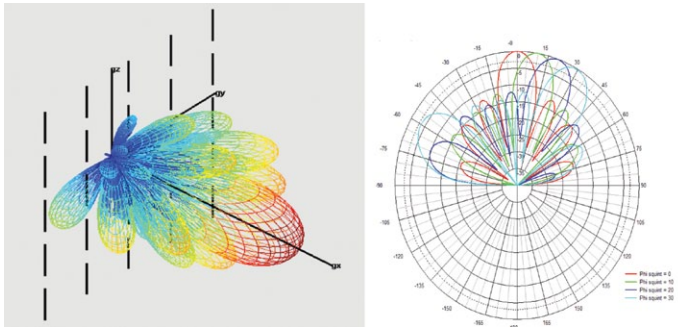


Figure 4: radiation patterns from a 5x5 phased-array antenna.

part of a two-element array. Feeding the antennas with signals of the same amplitude, but different phase, it becomes possible to project the main lobe in a specific direction (see Figure 3).

This laboratory implementation using a MG3710A signal generator introduces the engineer to the basic operation of a two-element phased-array antenna. By adding more elements to the array, the antenna will generate narrower lobes (with the energy more concentrated towards the target areas).

Figure 4 shows the radiation pattern of a 5x5 antenna array: it is much more complex than the two-element pattern shown in Figure 3. In the left-hand diagram is shown the 3D radiation pattern when the entire array is fed with signals at the same phase. The right-hand diagram shows the effect of phase shifts between the elements, changing the radiation pattern in the azimuthal plane, and creating many more beams. It will also help to generate more nulls, and to focus the main lobe in a very specific direction.

This shows how the implementation of beam-forming in cellular communications systems can increase their effective capacity, by directing the signal to where it is most needed. Compared to conventional wide-coverage BTS antennas, beam-forming antennas help to reduce interference and multi-path propagation, achieve better coverage in target areas and improve network flexibility. And while the control of these antennas' multi-element phased arrays is inevitably complex, the basic principles and methods of control may be learned with the simple two-element array described in this article.

Design, Optimization and Production of an Ultra-Wideband Receiver

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This article is an overview of the design process for an ultra-wideband (UWB) receiver, including both the RF circuit design and the printed circuit board (PCB) layout for manufacturing. This case history of an actual product development will provide some guidance and inspiration for the readers' own design assignments.

PROJECT DESCRIPTION

For this actual design of a complete RF UWB receiver, the total time from start to prototype construction was seven months. Beginning with the high level design and system performance optimization, the design then progressed to a complete schematic, RF layout and electromagnetic (EM) design optimization. The layout was implemented on a PCB with six metal layers. Rigorous design efforts and careful attention to layout details resulted in a prototype that successfully met performance requirements on the first pass.

The UWB receiver had a target sensitivity of -90 dBm with pulses occupying >1 GHz bandwidth. Our task was to develop the RF receiver—from antenna to digital interface. The goal was to complete the design entirely using NI AWR Design Environment™ software, inclusive of Microwave Office and AXIEM technologies, taking advantage of the efficiency of a single development platform.

ANTENNA

The receiver uses an antenna previously designed by the company for UWB radar devices. The antenna uses a non-standard elliptical radiator with floating reflector for gain enhancement. Figure 1 shows the antenna and its radiation patterns. Figure 2 is the input reflected power (S11) performance over the intended frequency range.

RECEIVER ARCHITECTURE

An I/Q direct conversion architecture was selected, with analytical signal extraction at baseband. Figure 3 shows the overall functional diagram, from an-

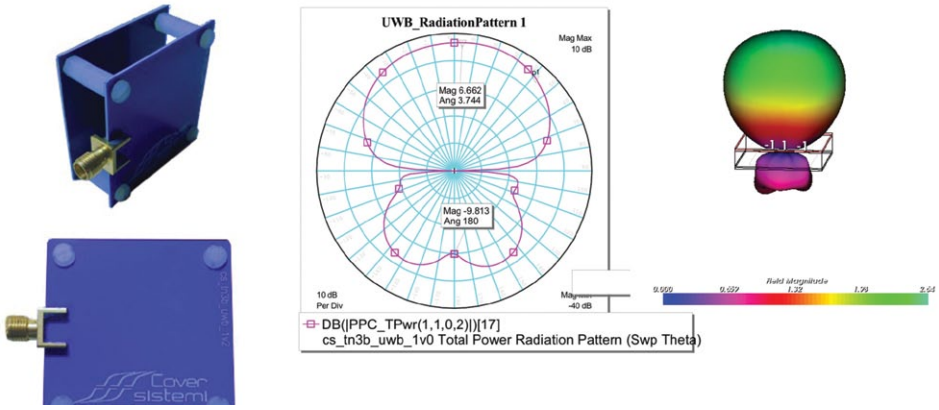


Figure 1: UWB antenna and its radiation patterns.

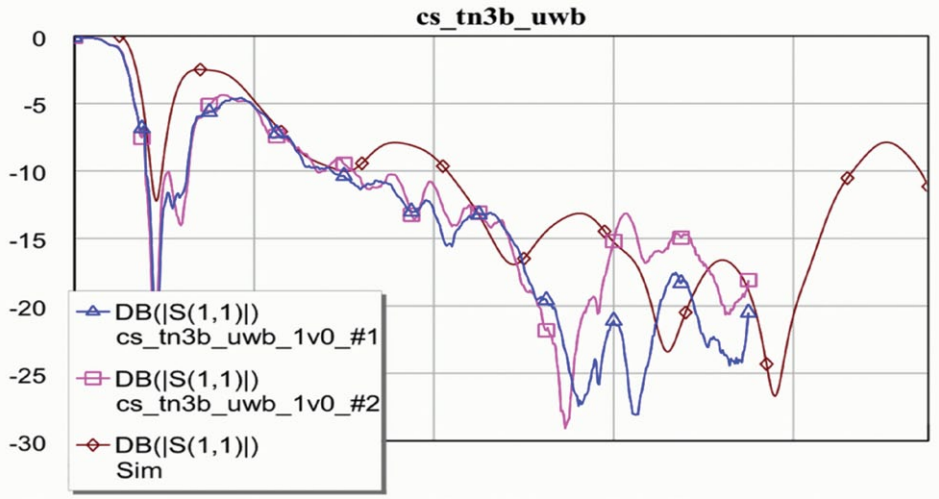


Figure 2: S11 plot for the antenna over the UWB frequency range.

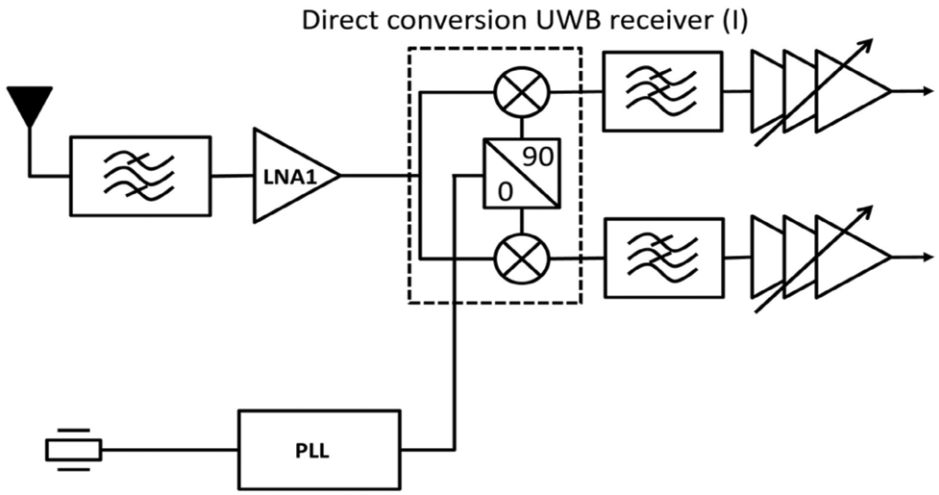


Figure 3: Overall function diagram of direct conversion receiver architecture.

tenna and input bandpass filter, through a low noise amplifier (LNA) to a pair of mixers fed with quadrature LO signals, to baseband lowpass filters, amplifiers, then finally summed at the output for delivery to the next stage; analog-to-digital (A/D) conversion and digital processing.

LNA

The LNA design was executed using NI AWR Design Environment's EM simulation tool of AXIEM, including the bias-tee that provides DC power to the active devices. The core amplifier and RF filter were co-designed to simultaneously obtain the desired out-of-band rejection, gain and noise figure performance. Figure 4 shows nonlinear performance using real data as input.

Figure 5 shows the preliminary bias-tee design and optimization results, with the layout on the left and the isolation performance plot on the right. A full layout EM validation was performed to confirm the performance. The results are shown in Figure 6.

Mixer

The I/Q downconverting stage uses a broadband commercial mixer. Performance was tailored by means of distributed input filtering. EM simulation using AXIEM of the I/Q downconverter is shown in Figure 7.

FULL-CHAIN SIMULATION / VALIDATION

The entire signal chain was simulated at the post-layout level, with each block using its AXIEM model (hierarchical extraction). Simulation used two different domains (RF/ZIF) with huge number of harmonics, as required for a UWB signal.

The multi-rate harmonic balance (MRHB) engine within Microwave Office circuit analysis software was used to perform the simulation of the entire receiver up to the A/D converter. Real data from transmitted signal measurements were imported for the MRHB simulations. Figure 8 presents the results nonlinear signal-to-noise ratio (SNR) evaluation versus input power.

FORMAL CHECK / SIGN OFF / PRODUCTION PHASE

The entire board (6 metal layers) was designed in Microwave Office, thus the entire design and simulation flow used NI AWR software.

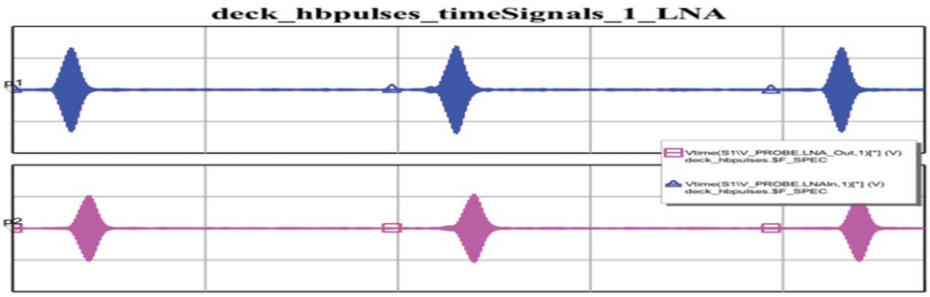


Figure 4: LNA nonlinear performances evaluation with real data as input.

This sequence of pre-production steps was followed, to avoid missing steps:

† Design rule check (DRC): need to verify that no PCB supplier rules are violated;
† Layout versus schematic (LVS): are we OK with layout?
† Production / fabrication data:
- Gerber;
- Validation data for customer's approval of production steps;
- BOM;
- Pick & place.

Redesign of the schematic and layout with another EDA tool for PCB manufacturing was considered, but such an additional task would be time consuming, and require licensing costs if the tool was not already available in-house. There is also the risk of errors in exporting/importing the layout between tools.

Design Rule Check
DRC easy with declaration of layout rules based upon PCB supplier specifications for the following (see Figure 9):

- Metal min size/spacing;
- Via Aspect Ratio/Covering;
- Minimum solder mask opening in presence of leads;
- Solder paste.

Layout versus Schematic
LVS analysis assures that there is connectivity on each layer, layer connections by vias, and device connections to top/bottom layer by means of solder mask openings (Figure 10).

Production Files: Gerber/Drill
Gerber and drill echelon files were extracted and sent for board production.

Bill of Materials / Pick & Place
The NI AWR Design Environment software platform lacks a built-in BOM/pick & place extraction feature. On a small board with few components, this would be easy to do by hand, but in this case there are >500 components. Exporting the layout to a different tool for this task has the risk of errors due to file incompatibility. Performing the generation of BOM / pick & place data with custom programming initially seems extremely time consuming and risky, especially on dense PCBs with many components.

The solution is the use of scripting tools (Figure 11). The scripting editor within Microwave Office software is

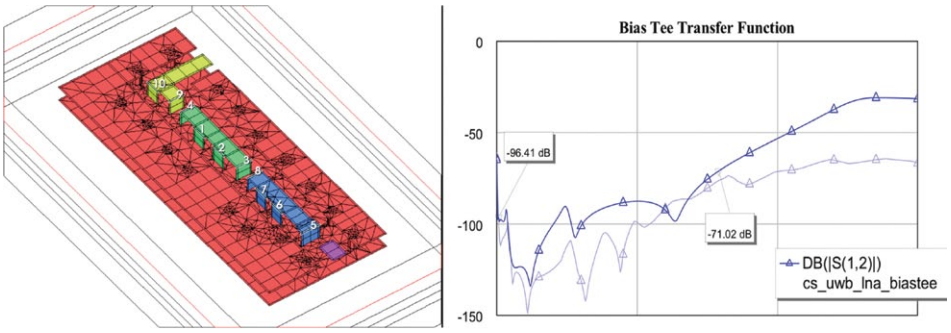


Figure 5: Preliminary bias-tee layout and isolation plot.

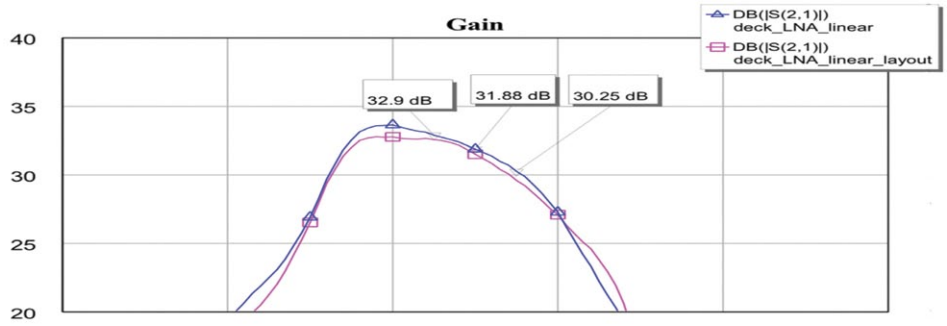


Figure 6: Gain versus frequency results of the full layout EM simulation compared to the circuit simulation.

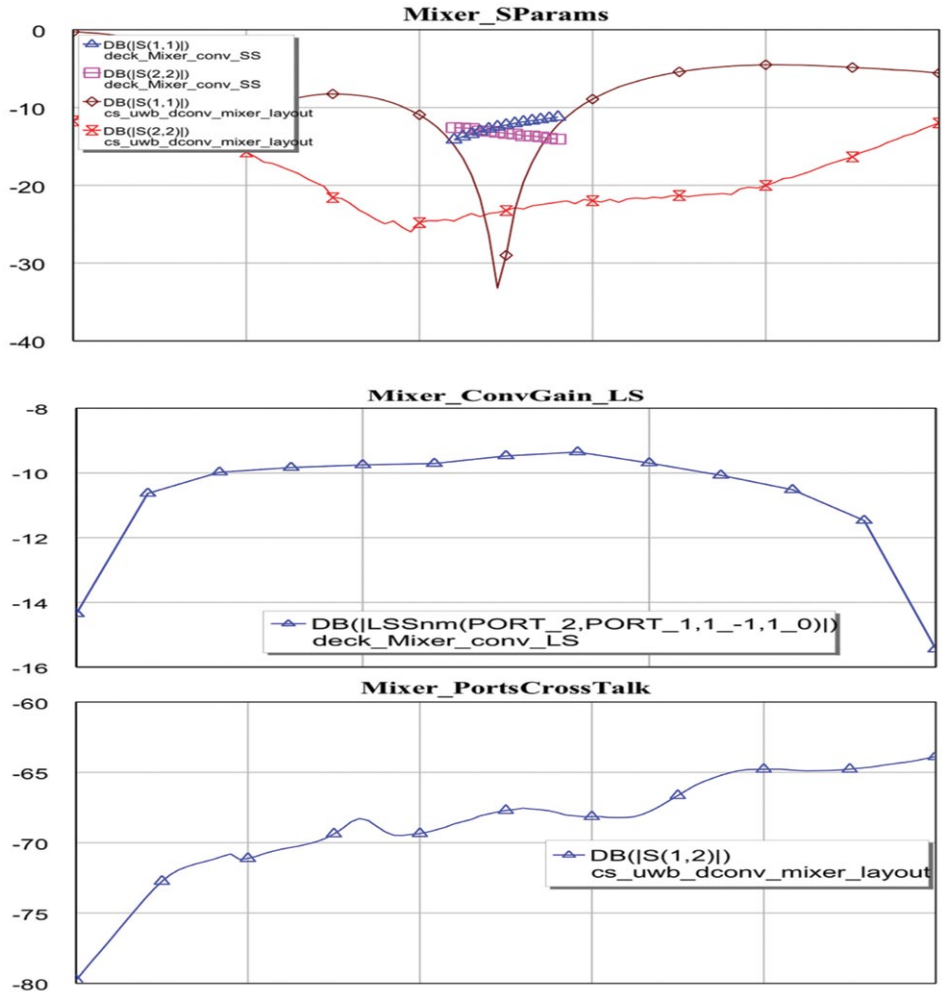


Figure 7: I/Q downconverter performance: RF and LO port S-parameters (top), conversion gain (mid), and LO feedthrough (bottom).

useful for non-standard operations. It has syntax highlighting and automatic completion, and requires little knowledge of Visual Basic (classes and variables) to start programming your own functions. Documentation of the class hierarchy is user-friendly, and there is the possibility of Excel spreadsheet creation. The programming flow chart for pick & place is shown in Figure 12.

Hint

In order to avoid errors when designing your own cell view representing a device, draw it with the same rotation specified by the supplier in the Tape & Reel specifications. Figure 13 shows an example using an LNA part from Avago.

The pick & place output file includes the data listed below and included in the table of Figure 14:

- RefDes (unique string ID of the device);
- Component ID (from AWR Vendor Libraries) for material acquisition;
- Library;
- X coord from board origin.

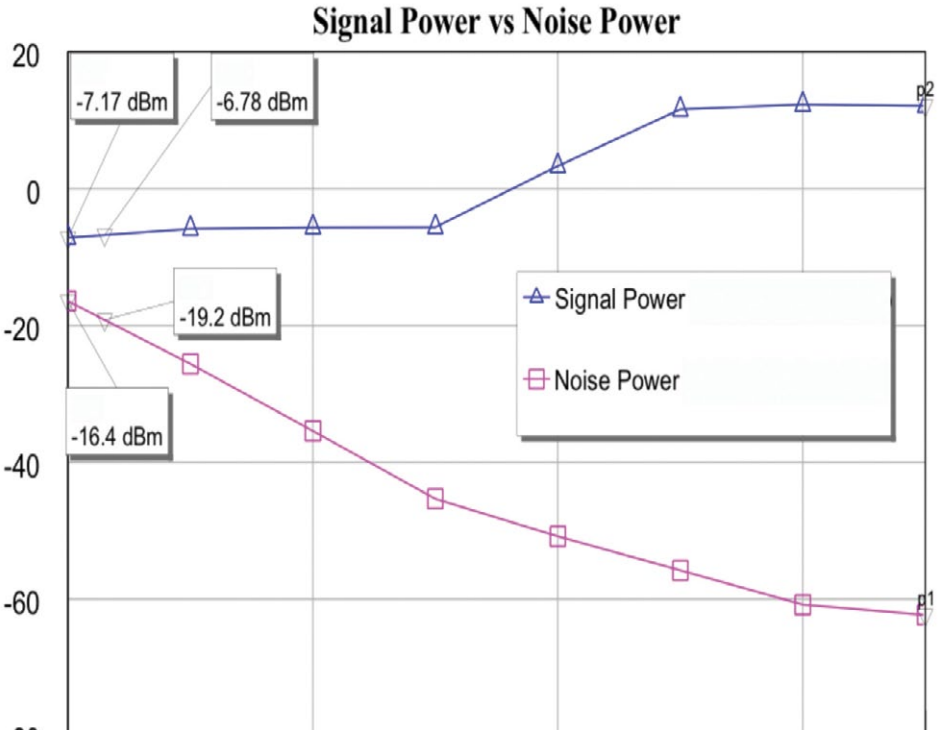


Figure 8: Nonlinear SNR evaluation vs. input power.

- Y coord from board origin;
- Rotation (degrees);
- Mounting layer.

SUMMARY

A complete UWB RF receiver (antenna to A/D input) has been described as an example of development using Microwave Office circuit design software for all phases of the design. Circuit design and layout, EM simulation (AXIEM), harmonic balance simulation, and PCB design were all done using NI AWR Design Environment software.

Bill of materials and pick & place specifications are not included in the tool set, so custom programming for these operations was done via the Microwave Office scripting tool. Although a significant task, this was done in a straightforward manner, allowing these manufacturing setup capabilities to be included in the same design platform. The result of this development process was a prototype with first pass success.

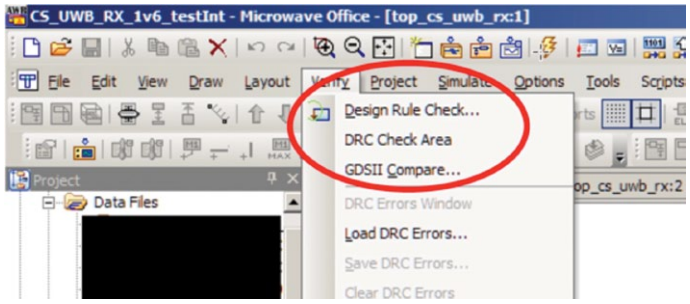
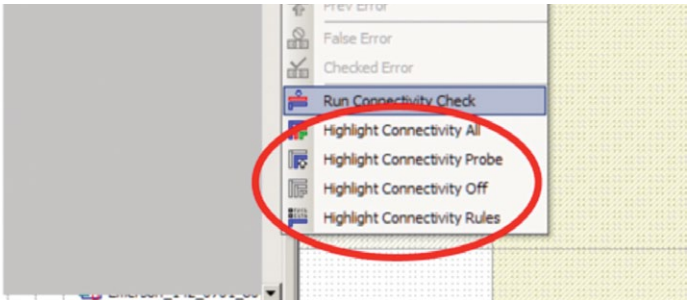


Figure 9: DRC checking menu selection within Microwave Office design environment.



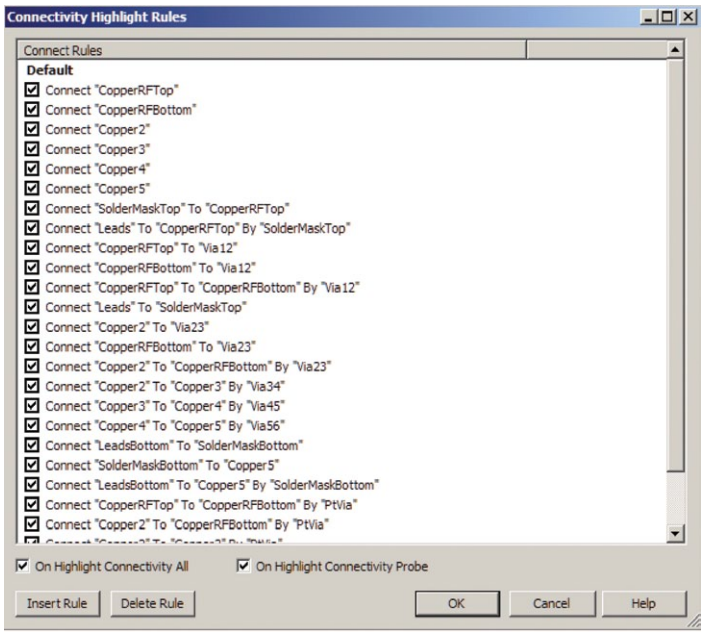


Figure 10: LVS menu selection and result screen within Microwave Office.

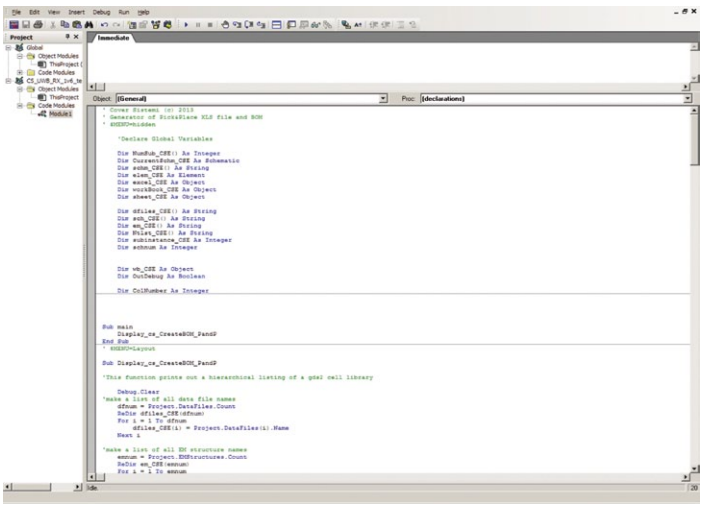


Figure 11: Scripting tools within Microwave Office simplify creation of non-standard operations.

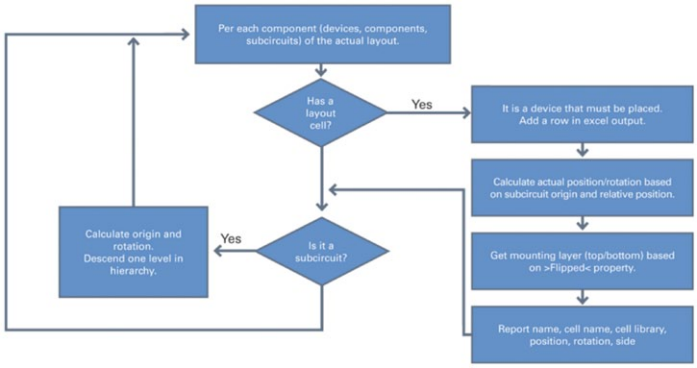


Figure 12: Flow chart for pick & place scripting.

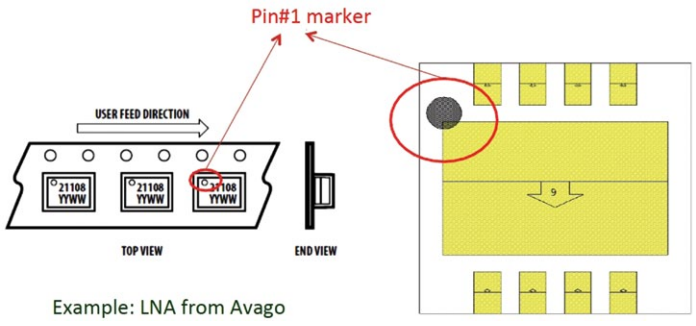


Figure 13: Example of cell view design.

S5.S8.C9	GCM21BR7YA105KA55	SMT:StretchSMT	10.69	11.73	180	Top
S7.S9.C1	GCM21BR7YA105KA55	SMT:StretchSMT	32.87	8.74	-180	Bottom
S7.S9.C11	GCM21BR7YA105KA55	SMT:StretchSMT	26.84	9.96	0	Bottom
S7.S9.C9	GCM21BR7YA105KA55	SMT:StretchSMT	26.90	16.46	0	Bottom

Figure 14: Pick & place output file example.

Characterizing LTE and WiFi power amplifier performance using a USB peak power meter

By Vitali Penso, Applications Engineer, Wireless Telecom Group

In this application note we highlight how broadband LTE and WiFi power amplifier (PA) performance can be characterized using Boonton's high performance USB peak power meter. Figure of merit measurements like input and output crest factor can be performed to characterize amplifier compression using highly dynamic and broadband LTE & WiFi signals. With the use of a directional coupler the USB peak power meter is transformed to make scalar-like measurements such as gain and return loss.

CREST FACTOR AND SCALAR LIKE MEASUREMENTS USING MODULATED BROADBAND SIGNALS FOR POWER AMPLIFIERS

A critical component of a base station is the power amplifier (PA). Over the past two decades the PA has experienced monumental changes in its architecture and performance. Two significant improvements have been in power-added efficiency & bandwidth. Fifteen years ago a 2G basestation PA housed in a ground base station cabinet would output 5 MHz multi carrier CDMA signals at 40 W; running at 5% efficiency it would generate 760 W of heat, taking up a significant amount of space, power and cooling resources and costing thousands of dollars. Today's 4G amplifiers using Doherty architecture with predistortion has improved the efficiency of an amplifier to over 35%, significantly reducing the size and enabling integration of the PA with the transceiver and the duplexer into a remote radio head (RRH) placed near the antenna.

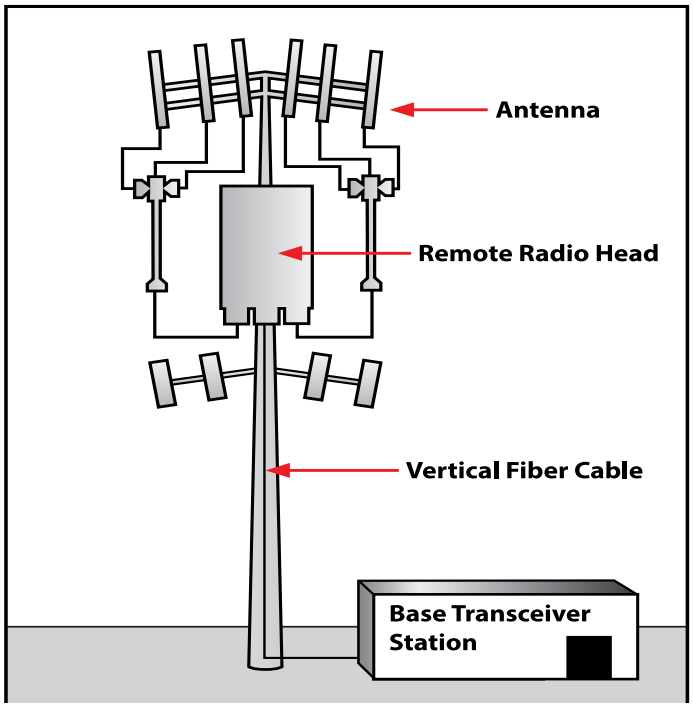


Figure 1: RRH Base station.

The other significant improvement has been in PA bandwidth. Today's RRHs are deployed in systems where the carriers are placed anywhere in a 70 MHz (or wider) frequency band. Measuring and characterizing the performance of the wideband PA requires test equipment that supports the bandwidths used in today's deployments. In this application note we show how using Boonton's high performance peak power meters with directional couplers enables the designer to make input, output and reflected power measurements; facilitating scalar analyzer like measurements such as gain and input return loss using multi-carrier, wide bandwidth (>100 MHz) test signals as opposed to narrowband CW. The statistical analysis tool of the peak power meter provides insight into the amplifier compression by measuring and comparing crest factor of input and output signals of the PA using wideband 4G signals while monitoring both peak and average power.

MEASURING PA COMPRESSION & CREST FACTOR

In an ideal world the PA output signal is an amplified version of the input signal; input power plotted vs output power produces a straight linear line, where the slope of the line is 1. In reality however, as the PA is driven harder, at a certain point the output will not increase as much as the input power; at this point the amplifier is in its non-linear region or is in compression. In the non-linear region the PA generates intermodulation products (Figure 2a.), which cause emission of spurious power into adjacent channels. Aside from effecting adjacent channels, non-linearity also degrades EVM of the desired signal, which causes loss of signal quality. In wireless communication systems modulation schemes such as CDMA (2G), WCDMA (3G), QAM and OFDM (4G-LTE) the signal is highly dynamic where 10 dB crest factor or peak to average power ratio (PAPR) is not unusual. When the amplifier goes into compression driven by a CDMA or OFDM modulated wideband signal, rare occurring peaks get compressed first; so when an amplifier is in 0.2 dB average power compression, its peak can be compressed by 1.0 dB or more. For example, a PA with 40 dB gain, 0 dBm average input signal with a crest factor of 10 dB (peak 10 dBm) would output 39.8 dBm average power but the peak power would be clipped at 49 dBm (crest factor 9.2 dB). While average (true RMS) power meters measure the average power of the signal, they lack the bandwidth to capture the peaks, whereas Boonton's 55 series USB peak power meter in a dual channel configuration can accurately measure both input and output average and peak power in real-time. With statistical analysis capability the 55 series can display the statistical distribution of the signal power level relative to its average power in a format called complementary cumulative distribution function (CCDF). CCDF can give significant insight into the behavior of the PA as it is driven harder into saturation by measuring changes is in PAR and crest factor of the input and output signals simultaneously and providing a graphical view of the compression of the amplifier in real-time (Figure 2b).

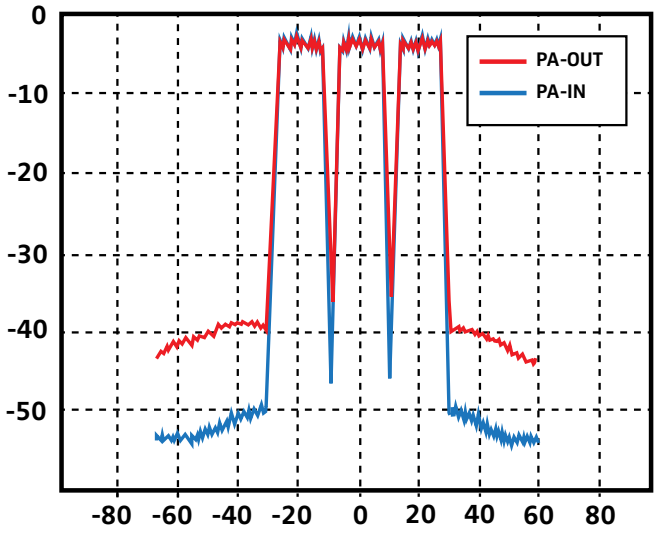


Figure 2a: Spectral regrowth (IMD) in multi-carrier LTE signals. Red trace is PA OUT, blue PA IN.

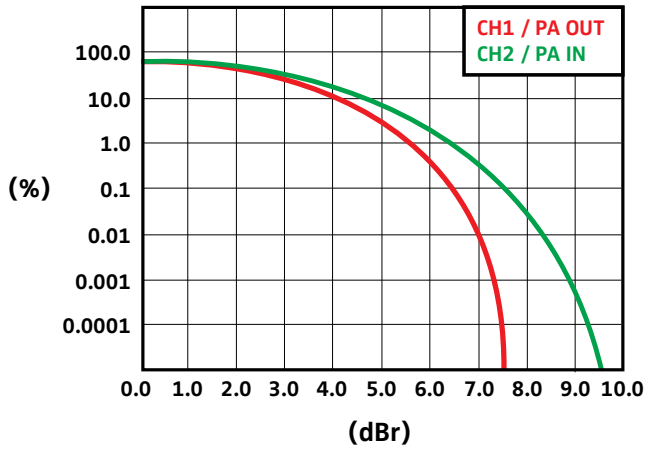


Figure 2b: CCDF curve shows % of time the signal is above its average power (Pavg). For example PA IN is 4.8 dB above Pavg 10% of the time. Example of a dual channel power meter monitoring amplifier.

PERFORMING SCALAR ANALYZER LIKE MEASUREMENTS – GAIN & INPUT RETURN LOSS

Figure 3 shows a typical PA test set-up using peak power meters and a bidirectional coupler to make scalar analyzer like measurements such as gain and return loss. The input power is measured coupling off the input signal to the amplifier by using a bi-directional coupler. The reflected power from the input of the amplifier can be measured using the reverse coupling port of the same bi-directional coupler. Since the typical average power rating of a power meter is about +20 dBm, the output of the PA is attenuated to protect the power sensor while making output power measurements. It is important to note that the bi-directional coupler needs to have excellent directivity.

Before measurements can be taken a basic calibration procedure is required at the frequencies in which the amplifier is going to be tested; all unused ports of the coupler need to be terminated with 50 ohms while making measurements.

- L1: Loss from LTE Generator output to the FWD port of the bi-directional coupler.
- L2: Loss from LTE Generator output to the power amplifier input.
- L3: Loss from amplifier output to the 40 dB attenuator output.
- L4: Loss from amplifier input into the REV port of the bi-directional coupler.

Once the losses are measured, input, output and reflected power measurements can be made:

- P1: Power reading at FWD port of the bidirectional coupler.
- PA input power = P1+L1-L2.
- P2: Power measured at the 40 dB attenuator output.
- PA output power = P2+L3.
- P3: Power measured at REV port of the bidirectional coupler.
- PA input reflected power = P3+L4.

The input, output and reflected power measurements can be used to compute gain (S21) and input return loss (S11).

- PA Gain(dB) = PA output power(dBm)– PA input power (dBm).
- PA input return loss(dB) = PA input power(dBm) – PA input reflected power(dBm).

For example average input power of 0 dBm and output power of 46 dBm would mean 46 dB gain and average reflected power of -10 dBm would be 10 dB input return loss. Making the measurements

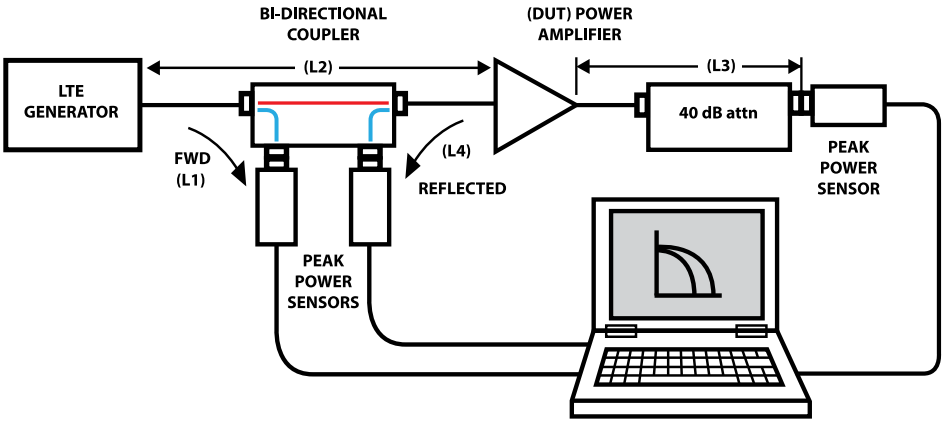


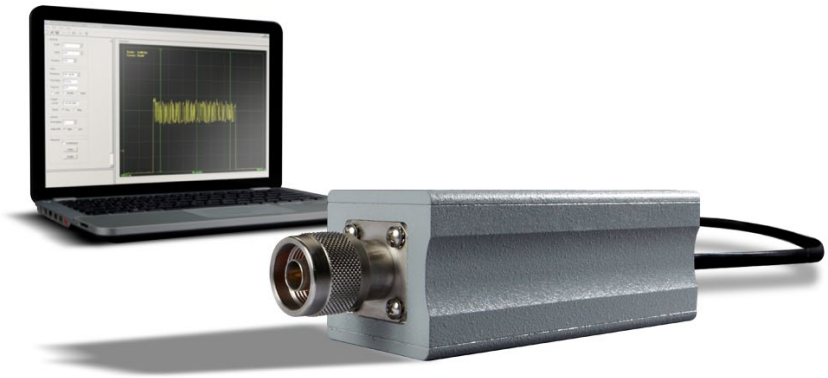
Figure 3: Amplifier test set-up using peak power meters.

in statistical mode provides average power and peak power of all three measurements (input, output and reflected power). Reading average and peak power simultaneously allows monitoring amplifier compression and making crest factor measurements that were described previously.

CONCLUSION

In scalar analyzer-like configuration, three peak power sensors, like average power sensors, can measure input, output and reflected power of the amplifier, enabling average power gain and return loss measurements. Measuring peak power as well as the average power is something average power sensors cannot do and differentiates peak power sensors in RF Power Amplifier characterization. As the input power is increased and the amplifier starts going into compression at the rear peaks, its peak power gain drops much faster than its average power gain; making crest factor a figure of merit in characterizing amplifier performance. However, not all peak power meters can handle today's wide bandwidth signals for crest factor measurements. The ability to measure average and peak power of wideband multi-carrier LTE as well as 802.11ac signals makes the Boonton 55 series USB peak power sensor ideal for highly accurate crest factor measurements. Boonton Peak Power Meter Solutions

Measuring peak power & crest factor of multi-carrier LTE signals (70+ MHz) as well as 802.11ac Wifi signals (160 MHz) requires wide bandwidth peak power meters. Boonton's 55006 USB peak power sensor with 195 MHz video bandwidth can handle the challenging LTE and WiFi 802.11ac signals. 55006 GUI supports up to 8 channel measurements which is more than what is covered in this application note for scalar-like measurements. In statistical mode with sampling speed of 100 million points (samples) per second, crest factor measurements converge rapidly. While the high performance of the sensor makes it well suited for R&D, 100,000 triggered measurements per second also makes it the fastest sensor to use in manufacturing. Affordability allows quality engineers to use the same model sensor used in R&D in verification. The small form factor enables field engineers to use the same R&D equipment in the field for measurements that correlate well with the lab measurements.



How relevant is DevOps to network development?

SDN's implications for the networking industry is still under discussion, but one less obvious change has been the introduction of software's agile development processes, says Daryl Cornelius, Director EMEA Spirent Communications

From a network manager's perspective, Software Defined Networking is a revolution in concept – but the colossal investment in existing infrastructure means that in practice the impact of SDN has been more of a slow evolutionary change. Among the less obvious changes has been the introduction of software development strategies into the networking environment – notably the more agile and interactive practices of Continuous Integration and DevOps where applications get built, tested and upgraded on the fly.

In rolling out hardware on the scale of network infrastructure, you could not afford to get it wrong. So the network development process required exhaustive testing of the structure in the laboratory before deployment, and there is little scope for making serious changes once it is in operational hands. In the flexible world of software, however, the relationship between development and operations is far more agile, allowing any number of minor or major revisions to be made in response to the software's performance in the field – hence the endless series of versions with numbers like V10.8.13.

So when SDN introduces the idea of a virtual network, it brings these two worlds into collision. The network structure can now evolve at software speeds, allowing development to be informed by its behaviour under operations conditions, and this allows a rethink of the relationships between Development, Network Testing, Operations, QA and related departments. DevOps has already become a trendy term in the applications sphere, and it is increasingly relevant to networking.

THE ESSENCE OF DEVOPS

Natural selection begins with a simple hardware model: Development takes place in the egg or maternal womb and gives birth to a unique genetic entity to be tested in the Operations department we call "Life". It either fails the test, dying without issue, or it survives and breeds. It can also pass with flying colours, leaving masses of progeny.

In the simplest organisms – and this includes organisations responsible for pre-SDN networks – Development and Operations exist in separate silos. In nature this means that Development lays the eggs and walks away. In business it means that Development's work ends when the product goes to Operations.

For higher organisms, however, Nature created the concept of Parenting: you don't just leave your children's future to fate, instead you nurture their Development through life itself. It is an agile adaptive and increasingly intelligent process: even if the genes have produced a small or weak child, the parents can still play an important role teaching how to defeat bigger rivals.

In the business environment, this integration of Development and Operations is called DevOps. Like Parenting, it is a concept that makes a lot of sense, it is one that everyone would like to master – but can be a real challenge to implement.

For a start, you can get resistance from those who think that Development is trying to take over Operations as a mere extension of the development process. It is true that the parent has a "higher" role than the teacher or tester, in that a parent can become the teacher rather than the other way round, but no-one welcomes the "bossy parent". So a wise parent learns to listen to the teachers and trainers – just as a good DevOps project is all about two-way sharing between developers, operations, QA and so on down the line, to build a culture of collaboration.

This process has been analysed into four key elements: Sharing, Culture, Automation and Measurement – unfortunately spelling SCAM. So these are normally presented in CAMS sequence as follows:

- Culture: as suggested, this is not about any one department bossing another but about encouraging a culture of sharing or parenting. It is actually something that emerges in the course of attempting DevOps.
- Automation: parenting is a hellishly complex on-going operation that would be impossible without the help of automation. Nature has had several million years to develop automatic parenting instincts (and it still drives youngsters wild when parents just sense that something is bad but cannot argue why). Industry, however, has had barely 3 years to develop automated systems to orchestrate DevOps.
- Measurement: testing has become a continuous process, like life itself, and must be integrated into the automation systems.
- Sharing: should really come first, as it is the feedback process out of which emerges the whole parenting culture. This happens both within a DevOps team and between them, as the whole DevOps concept has also evolved through the shared experience of many teams worldwide.

MIGRATING TO DEVOPS

Telling different departments, which have each evolved their own cultures and ways of working, that they must now work together in harmony is a bit like ordering parents and teachers to do better for their children. Everyone can see it is a great idea, but how do we kick-start the process? What is needed is the tools to handle the heavy work – because the complexity of agile, iterative development makes for a lot of extra routine labour.

Consider the example of "Continuous Integration" (CI), the term used by software engineers for development built on plan/code/build/test/repeat iterations. This requires many inter-operating and well integrated elements: not only a highly efficient, development environment, but also one that can identify all new software updates, control versions in the repository, and schedule their execution. With a large team of engineers CI can lead to hundreds of software builds a day being put through their paces and needing to be revised and integrated. It also demands a massive amount of hardware on standby to handle all the operations on demand.

My company has a tool that turns CI into a workable solution it is called "CLEAR DevOps". It succeeds by automating the complexity of CI and running it on virtual machines. Instead of racks of physical servers on standby, consuming electricity and generating heat while waiting to play their CI build and test role – the "CLEAR DevOps" environment simply spins up virtual machines automatically as required to execute automated tests. In addition, the solution's sophisticated test automation systems do away with the need for specialist coding skills. Instead a simple user interface allows staff to create, snapshot, start, stop or manage virtual machines, while test assets are easily integrated into the workflows to integrate behavioral automation, data parsing and analysis into the DevOps process.

It is a major practical and cultural shift, but we're already showing results

in the real world. One electronic equipment manufacturer, with R&D teams across the globe, had been investing $12.5 million a year on development and testing and $4 million on automated tests and yet in a single software release they still had to correct over four thousand bugs, finding it exceptionally difficult to identify where the problems were located. The benefits of migrating to our solution were immediate: within a couple of months they reported a 70% reduction in bugs, 66% reduction in release time and massive savings in R&D, QA and CAPEX costs.

THE IMPACT ON NETWORKING

DevOps is hot news in applications development and it is seeping into other regions of our increasingly software defined universe. As the parenting example suggests, it calls on a lot of experience and is not something you can simply pick up from a book.

Bear in mind the three great drivers – Quality, Cost and Speed – before deciding how best to proceed. DevOps can improve all three, as our example shows – the customer not only reduced the number of bugs, but also saved money and reduced time to release,. There is no shortage of consultancy companies who can help you save money and get quicker results by migrating to the DevOps approach, they can also help to establish the culture that holds the whole thing together.

But if improving quality is a key driver, then testing must be the central component of the DevOps process, and that requires integrated automatic testing to lift the burden or, as one team put it, “to take the strain out of Development”. According to IDC’s December 2014 survey of Fortune 1000

DevOps Best Practice Metrics, approximately 21 percent of the IT organizations surveyed said they were looking for Testing/QA tools to accelerate DevOps, but those that tried to custom-adjust current tools to meet DevOps practices have a failure rate of 80 percent. So choosing the right test systems is a critical step.

Testing will then be integrated into the combined development and operations, and no longer be a separate, specialist department. So this requires test systems that are simple to set up and operate without coding skills. The results of the tests will become more widely relevant, so it is also important that the system reports results in a consistent and clear format that can be readily assimilated into other parts of the DevOps system.

So, if quality is your objective, you must choose the right test tools, and get advice on how to incorporate them into the heart of the DevOps system, to provide the core around which your dynamic DevOps culture can be formed.

Changes to radio rules

The Radio and Telecommunications Terminal Equipment Directive (R&TTE) was introduced in April 2000, but the European Commission became concerned about the low level of compliance for some categories of radio equipment.

This, coupled with the growth of mobile devices and wireless applications, led the Commission to publish the new Radio Equipment Directive (RED) 2014/53/EU in the Official Journal of the European Union on 22 May 2014.

As the RED will be applicable from 13 June 2016, Member States now have a transition period of less than nine months to transpose the new RED into their national laws. However, manufacturers will have an additional year to comply, as equipment compliant with the current R&TTE Directive before 13 June 2016 may continue to be placed on the market until 13 June 2017.

Within Article 43 of the RED, a “making available on the market” and “putting into service” provision means that products which comply with the R&TTE Directive before 13 June 2016, and which are placed on the market before 13 June 2017, may be sold and brought into service later.

WHERE THE RED APPLIES

Products which fit within the following definition are subject to the RED:

“Radio equipment – an electrical or electronic product which intentionally emits or receives radio waves for the purpose of radio communication and/or radio determination, or an electrical or electronic product which must be completed with an accessory (such as an antenna) so as to intentionally emit and/or receive radio waves for the purpose of radio communication and/or radio determination.”

All radio receivers, including broadcast radio and TV receivers, fall within this definition.

Radio communication means ‘communication by means of radio waves’, while radio determination means the determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to those parameters, by means of the propagation properties of radio waves.

The RED excludes equipment that is “radio equipment exclusively used for activities concerning public security, defence, State security, including the economic wellbeing of the State in the case of activities pertaining to State security matters, and the activities of the State in the area of criminal law”.

Marine equipment that falls within the scope of Council Directive 96/98/EC is also excluded. This includes equipment on board a new European ship, even if it was constructed outside of the EU, as well as replacement equipment or additional equipment installed on an existing European ship. Airborne products, parts and appliances falling within the scope of Article 3 of Regulation (EC) No 216/2008, and custom-built evaluation kits designed for professionals to be used solely at R&D facilities are also excluded.

Another exclusion is radio equipment used by radio amateurs, which falls within the meaning of Article 1, definition 56, of the International Telecommunications Union Radio regulations’. Such equipment must not be available on the market which means:

- Radio kits for assembly and use by radio amateurs;
- Radio equipment modified by and for the use of amateurs;
- Equipment constructed by individual radio amateurs for experimental and

scientific purposes related to amateur radio;
- Increasing compliance levels.

The core goals of the RED are to strengthen the level of compliance, as well as clarifying and simplifying the Directive.

The RED's new requirements are therefore intended to clearly spell out the responsibilities and obligations for every economic operator involved in the supply chain (manufacturer, importer, distributor, authorised representative). This means that all items of equipment that fall within its scope, placed on the European market for the first time, must follow a RED conformity assessment procedure.

The good news is that the general principles for product compliance in the RED are very similar to the R&TTE Directive. This is because compliance is within a set of essential requirements. Harmonised standards also provide a presumption of conformity with the essential requirements.

The RED also requires the use of a Notified Body where no radio or relevant Article 3.3 Harmonised Standard exists.

KEY ELEMENTS

The changes made in the RED are in some instances wide ranging, with Annexes being renumbered and updated. The new Directive also sees the deletion of some unnecessary administrative obligations, which should reduce the organisational overheads of the economic operators that are required to comply.

One completely new element of the RED is intended to support the Commission's push for mobile phones, and other portable devices, use a common charger. Consequently, the RED's Essential Requirements now states that: "radio equipment interworks with accessories, in particular with common chargers", which could represent significant costs for manufacturers, if this requirement is invoked by the European Commission.

Another significant change is that Telecommunication Terminal Equipment (TTE) i.e. fixed line terminal equipment, is now outside the scope of the RED and is instead covered by the EMC and Low Voltage Directives.

The RED now also includes much clearer obligations for economic operators and, to enable full traceability of supply, each economic operator must be able to identify who has supplied them with radio equipment and to whom they have supplied the radio equipment.

Article 10 (Obligations of manufacturers) refers to changes to the system for the Declaration of Conformity (DoC), with manufacturers now having two options within the new Directive. One option is to include a copy of the full DoC covering all applicable Directives with each piece of radio equipment.

The second option is to include a simplified DoC, but this must include the exact Internet address where the full version can be obtained. It must also be available in a language or languages required by the Member State in which the radio equipment is placed.

In fact, while the old Directive made no specific reference to language requirements, the new one requires that the manufacturer's contact details are in a language easily understood by end-users and market surveillance authorities. It also states that the product must be accompanied by instructions in a language which can be easily understood, as determined by the Member State in which the product is being sold.

In most cases English should be acceptable, but there will be some Member States which insist information is translated into their native language before it can be sold. This will of course cost manufacturers both money and time - increasing time to market for new goods.

Article 17 of the new Directive also introduces that for the first time a safety assessment must now take into account reasonably foreseeable usage conditions. This means that a manufacturer must now anticipate how a person might misuse the equipment, not just the intended use as outlined in the equipment's instructions.

New responsibilities for importers have also been introduced with regards to sample testing of products. However, it is not entirely clear at what point this becomes a mandatory requirement as the Directive uses the words "when deemed appropriate with regard to the risks presented by radio equipment", so this is quite subjective. However, to protect the health and safety of consumers, importers will be required to carry out sample testing of radio equipment made available on the market.

Importers must investigate and keep a register of complaints of non-conforming radio equipment and of product recalls, and keep distributors informed of such monitoring. They are also required to keep a copy of the DoC 10 years after the radio equipment has first been placed on the market, as the market surveillance authorities will have a right to request a copy during that period of time.

Re-branded radio equipment is also included in Article 14. An importer or distributor takes on the responsibilities as if he were the manufacturer where he supplies radio equipment under his name or trade mark.

IMPROVING TRACEABILITY

The RED now lays out more clearly the responsibilities of market surveillance authorities, and delivers them improved measures to support their activities, particularly relating to the traceability obligations of economic operators.

Where technical documentation does not comply, a market surveillance authority may ask the manufacturer or importer to have testing carried out at a laboratory acceptable to the market surveillance authority and at the expense of the manufacturer or importer.

Article 5 of the Directive (Registration of radio equipment within some categories) for the first time introduces the requirement to register products, which fall within categories showing low levels of compliance with the Essential Requirements, in a central database. It is intended that this will enhance the efficiency and effectiveness of market surveillance and therefore contribute to a higher level of compliance with the Directive.

The RED's wide ranging changes will require some significant adaptations to how radio equipment is manufactured and supplied. With its enforcement only nine months away, it is vital that those individuals within the supply chain understand their specific obligations, as well as those other economic operators they do business with. This will ensure that their equipment complies within the deadline and can continue to be sold on the European market.

ABOUT THE AUTHOR

Jean-Louis Evans is Managing Director at TÜV SÜD Product Service, a global product testing and certification organisation, and at its sister company, TÜV SÜD BABT, the world's leading radio and telecommunications certification body — www.tuv-sud.co.uk

Bi-directional RF amplifiers

operate up to 3 GHz

Pasternack has introduced a line of bi-directional amplifiers that are used for sending and receiving radio signals in key applications such as unmanned aerial vehicles (UAV), unmanned ground vehicles, L and S band radar, military radio, commercial air traffic control, weather and earth observation, satellites and high gain driver power amplifiers.

The bi-directional RF amplifiers consist of 2 narrow band models that operate in L-Band (1.35 to 1.39 GHz) and S-Band (2.4 to 2.5 GHz). These designs utilize highly linear Class AB LDMOS semiconductor technology. A general purpose broadband model is also offered, which covers 30 MHz to 3 GHz and uses Class A GaAs semiconductors. Typical gain levels for these amplifiers range from 20 to 23 dB with ±0.5 dB gain flatness.

The key advantage of these designs is fast switching capability (1 microsecond typical) between transmit (Tx) and receive (Rx) states where high output power is generated, while at the same time, the sensitive receiver section has a 2.5 dB noise figure and sufficient RF gain levels to maintain a high data rate link.

These models are designed for use in both military and commercial applications and are capable of supporting any signal type and modulation format, including but not limited to 3-4G telecom, WLAN, OFDM, DVB and CW/AM/FM.

www.pasternack.com

Quad-Core 64-bit R10 LTE carrier aggregation SoC platform

Marvell has launched a cost-effective R10 LTE carrier aggregation platform with 20+20 MHz support, the quad-core 64-bit ARMADA® Mobile PXA1918 System-on-Chip (SoC) with leading security and advanced communication features for mass deployment by global operators.

This mobile platform is designed to address the growing demands for high-performance R10 LTE Advanced CA smart phones and tablets. The ARMADA Mobile PXA1918 platform represents the company's latest advancements in Category 7 LTE modem technology development. Additionally, the cost-optimized mobile processor features an ARM Cortex A53 processor and supports today's most popular cellular communication standards including: TD-LTE, FDD-LTE, TD-SCDMA, WCDMA and GSM/EDGE.

The platform provides advanced multi-level security and memory saving technology. It delivers 5-mode support (LTE TDD/FDD, DC-HSPA+, TD-HSPA+, GSM/EDGE) with DSDS, which encompasses R10 LTE Advanced TDD/FDD Carrier Aggregation Cat7, supporting up to 2x20 MHz bandwidths with peak speed of 300 Mbps downlink and 100 Mbps uplink as well as DC-HSPA+ for 42 Mbps downlink and 11 Mbps uplink.

Advanced features include VoLTE, eMBMS, RCS, VoWiFi, IMS, field proven DSDS technology.

www.marvell.com

GSM-band cavity bandpass filter

Anatech Electronics has introduced the AB915B656 rugged indoor/outdoor GSM-band cavity bandpass filter designed for both commercial and defense wireless applications that combines high rejection, low return loss and the ability to remove nearby interference.

The AB915B656 has a passband of 910 to 920 MHz, insertion loss of 1.5 dB, return loss greater than 16 dB, and out-of-band rejection of 75 dB from 850 to 894 MHz and 929 to 950 MHz. It can handle 20 W CW and uses Type-N female connectors (others available). The filter measures 140 x 80 x 53 mm, has an operating temperature range of -45 to +85 °C, and is designed to be weatherproof.

www.anatechelectronics.com

Fully integrated, pre-certified Bluetooth® Smart module

Silicon Labs has introduced a fully integrated, pre-certified Bluetooth® Smart module solution that gives developers the fastest path to low-power wireless connectivity for the IoT.

The BGM111 module is the first in a family of advanced Blue Gecko modules from Silicon Labs delivering best-in-class integration, flexibility, energy efficiency and toolchain support with an easy migration path to Blue Gecko system-on-chip (SoC) designs. The module simplifies Bluetooth Smart design and accelerates time to market for a wide array of applications including smart phone accessories, beacons, connected home devices, health and fitness trackers, personal medical devices, automotive diagnostics, industrial sensors and point of sale terminals.

Based on the company's Blue Gecko wireless SoCs, the BGM111 modules help developers reduce development costs and regulatory compliance effort by providing a plug-and-play Bluetooth Smart design pre-certified for use in key markets including North America, Europe and Asia-Pacific. The BGM111 modules are pre-loaded with the Bluegiga Bluetooth 4.1-compliant software stack and profiles and are field-upgradable using device firmware upgrades to Bluetooth 4.2 and beyond.

The BGM111 module abstracts the complexity out of RF design, the Bluetooth Smart protocol and embedded programming. The Blue Gecko portfolio provides developers with the flexibility to begin Bluetooth development with BGM111 modules and then transition to Blue Gecko SoCs when needed with minimal system redesign and full software reuse.

www.silabs.com/BlueGecko

Wireless power receiver IC

charges mobile devices quickly

Toshiba Electronics Europe has launched a wireless power receiver IC that will enable mobile devices to be charged wirelessly as fast as if they were connected to the charger via a cable.

The TC7764WBG supports a maximum power output of 5 W and is compliant with the Qi standard's low power specification V.1.1.2, defined by the Wireless Power Consortium (WPC).

Toshiba has optimised the circuit design of the TC7764WBG so that maximum output power is increased to 5 W and a maximum power conversion efficiency of 95% is achieved (excluding the influence of the power signal receiving coil and tank capacitor). This enables mobile devices to be charged wirelessly as fast as if they were connected to a cable charger.

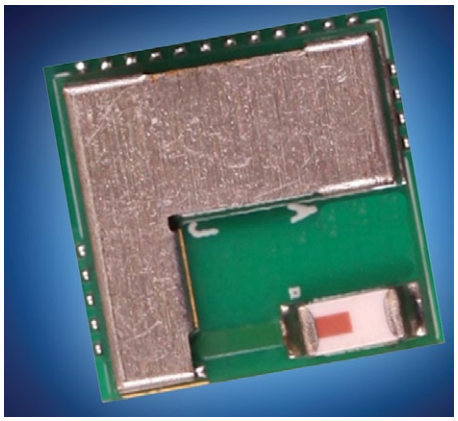
To ensure mobile device safety, the IC integrates a Qi protocol authentication circuit for power transfers, foreign object detection functions, under-voltage lockout (UVLO) and over-voltage lockout (OVLO) functions for the external power supply bypass option as well as thermal shutdown functions (TSD).

The IC is housed in a WCSP28 package measuring just 2.4- by 3.67- by 0.5-mm.

www.toshiba.semicon-storage.com

Mouser ships Cypress Bluetooth module

Mouser Electronics is now shipping the CYBLE-022001-00 EZ-BLE™ PRoC™ module from Cypress. This programmable, SMT-ready, fully certified Bluetooth® Low Energy (BLE) module eliminates RF hardware design and reduces investment by eliminating the certification process. The integration and small footprint of the CYBLE-022001-00 make it ideal for medical, home entertainment, and computing applications.



The CYBLE-022001-00 EZ-BLE Programmable Radio-on-Chip (PRoC) module is a 48 MHz 32-bit ARM® Cortex®-M0 implementation with 128 KBytes of flash, 16 KBytes of SRAM, and a 12-bit analog-to-digital converter (ADC). It features two integrated crystals, an onboard chip antenna, and a programmable architecture that supports a number of peripheral functions (such as ADC, timers, counters, and PWM) and serial communication protocols (including I2C, UART, and SPI).

The 10- x 10- x 1.8-mm module provides up to 16 GPIOs, configurable as open drain high/low, pull-up/pull-down, Hi-Z, or strong output. The module also includes CapSense® capacitive touch-sensing technology and is supported by the PSoC Creator™ integrated development environment.

The CYBLE-022001-00 module includes a royalty-free stack compatible with Bluetooth 4.1 specifications. Designers can use the EZ-BLE PRoC evaluation board for enhanced development and testing, including access to project examples to speed prototyping.

www.mouser.com

LVPECL clock oscillator

provides -162 dBc/Hz noise floor

Crystek Corporation has launched the CCPD-575, an ultra-low phase noise LVPECL oscillator providing a -162 dBc/Hz noise floor.

Compact and powerful, the CCPD-575 has an industry leading phase noise for an LVPECL oscillator – at least 15 dB lower phase noise than most LVPECL oscillators on the market today. Close-in phase noise is also excellent at -90 dBc/Hz for the 100 MHz variant. This overall ultra-low phase noise translates to a typical phase jitter of 85 fs RMS (12 kHz to 20 MHz).

The extremely low phase noise performance is very useful in applications such as: digital video, SONET/SDH/DWDM, storage area networks, broadband access, Ethernet, and Gigabit Ethernet.

www.crystek.com

Broadband directional coupler

with 6 dB coupling over 10 to 67 GHz

KRYTAR has announced the continued expansion of its growing line of directional couplers with a model offering 6 dB of coupling over the frequency range of 10.0 to 67.0 GHz, in a single, compact and lightweight package.

This latest addition, Model 110067006, enhances the selection of multi-purpose, stripline designs that exhibit excellent coupling over a broadband frequency range of 10.0 to 67.0 GHz. This coupler is uniquely designed for systems applications where external leveling, precise monitoring, signal mixing or swept transmission and reflection measurements are required.

Model 110067006, offers superior performance ratings including nominal coupling (with respect to output) of 6 dB, ±2.5 dB, and frequency sensitivity of ±0.75 dB to 50 GHz, and ±1.50 dB to 67 GHz. The directional coupler exhibits insertion loss (including coupled power) of less than 4.40 dB, directivity of greater than 10 dB, andmaximum main line VSWR of 1.8. Secondary line VSWR is 1.8 at 10 to 50 GHz, and 2.3 at 50 to 67 GHz. Input power rating is 20 W average and 3 kW peak.

www.krytar.com

Fast tuning 30 to 520 MHz bandpass filters

Pole/Zero have released their reduced SWaP-C line of MINI-ERF™ (G2) tunable bandpass filters. This low-cost, miniature, high-performance tunable bandpass filter uses PIN diodes to deliver high dynamic range while fitting in a 1.75- x 2.40- x 0.387-inch (61- x 44.5- x 9.8-mm) package.

The MN-30-520-(%BW)-S04 covers the entire tactical military tuning range of 30 MHz to 520 MHz and is currently available in either a 4% BW or 7% BW (3dB).

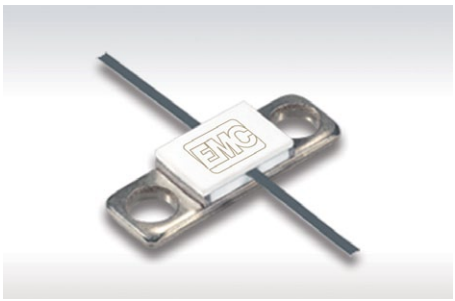
The MINI--ERF™ (G2) Series combines SMT capability with 1-W (input) in band and up to 2-W (input) out of band RF power handling, +40 dBm IIP3, low Insertion loss, good selectivity and fast tune time (15 µs typical at 0 dBm). The digital interface format can be either SPI serial or parallel depending on the state of the SER/PAR pin. All MINI-ERF™ filters are fully pre-aligned by Pole/Zero for labor savings and ease of use. These fast tuning bandpass filters are commonly used in military communication and commercial applications.

www.polezero.com

Low PIM high power flange attenuator

RFMW, Ltd., has announced design and sales support for low Passive Inter-Modulation (PIM) attenuators from EMC Technology.

When comparing the latest 33P7024 (100 W) series to standard attenuators the difference is typically ≥10 dBc. The 33P702403.00F offers 3 dB of attenuation while the 33P702430.00F offers 30 dB attenuation. Designed for demanding infrastructure applications, both the 33P702403.00F and 33P702430.00F operate to 2.7 GHz with a maximum VSWR of 1.30:1.



Featuring a tab launch and integrated heat sink, the 33P702403.00F and 33P702430.00F find applications in mobile network infrastructure, broadcast amplifiers and instrumentation. Nominal impedance is 50 ohms.

www.rfmw.com

Richardson introduces a 2 to 20 GHz benchtop power amplifier

Richardson RFPD has announced that it is stocking a benchtop power amplifier from TriQuint / Qorvo. The RM022020 features Qorvo's patented Spatium™ combining technology to provide high performance in a general purpose laboratory bench top amplifier for applications that include lab work, test and measurement, load pull, EMI test, and anechoic chambers and test ranges.

It is suitable for use a driver/booster amplifier, enabling more power incident

upon the device under test (DUT), which makes it an ideal alternative to traveling wave tube amplifiers (TWTAs). The RM022020 operates instantaneously across the 2 GHz to 20 GHz spectrum, achieving saturated output powers (Psat) greater than 20-W. Front panel manual gain adjustment enables simple, rapid performance optimization.

Built-in-test (BIT) monitors continuously evaluate amplifier performance and provide instant visual indication of anomalous behavior. Custom configurations and optimized screening conditions are available on request.

According to Qorvo, additional key features of the RM022020 include: solid state MMIC reliability; multi-element redundancy; instant on (no warm-up); flat gain response; excellent harmonic and intermodulation characteristics.

www.richardsonrfpd.com

LabVIEW 2015 delivers speed improvements, development shortcuts

NI has announced LabVIEW 2015 system design software, which delivers speed improvements, development shortcuts, and debugging tools. LabVIEW 2015 continues to standardise the way LabVIEW users interact with almost any hardware through the reuse of the same code and engineering processes across systems, saving time and money as technology advances, requirements evolve, and time-to-market pressure increases.

LabVIEW 2015 further equips engineers with support for the following

advanced hardware: Quad core performance CompactRIO and CompactDAQ controllers; 14-slot CompactDAQ USB 3.0 chassis; single-board RIO controllers; controller for FlexRIO; 8-core PXI controller; and a high voltage system SMU.

LabVIEW 2015 also reduces the learning curve for employing a software-designed approach to quickly create powerful, flexible, and reliable systems. With three application-specific suites that include a year of unlimited training and certification benefits, developers have unprecedented access to software and training resources to build better systems faster.

Key features in the latest version designed to help developers open, write, debug, and deploy code faster include:

1) Open code faster—open large libraries up to 8X faster and eliminate prompts to locate missing module subVIs.

2) Write code faster—execute common

programming tasks faster with seven new time-saving right-click plug-ins and develop your own additional plugins to maximise your productivity.

3) Debug code faster—examine arrays and strings in auto-scaling probe watch windows and document findings with hyperlink and hashtag support in comments.

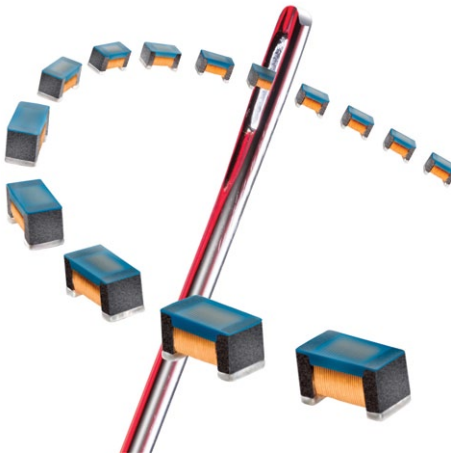
4) Deploy code faster—offload your FPGA compilations to the LabVIEW FPGA Compile Cloud service included with your Standard Service Program membership.

www.ni.com

Chip inductors

reduce DCR in 0402-sized RF chokes

Developed for use in mobile devices and cellular infrastructure equipment, 0402DF series chip inductors from Coilcraft offer higher inductance values and significantly lower DC resistance than other 0402-sized inductors, for RF choke and filtering applications.



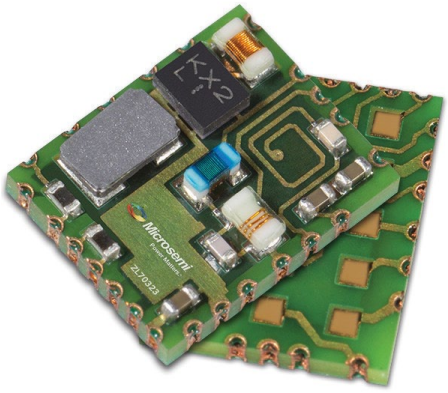
The 0402DF series is offered in 25 inductance values ranging from 20 to 3300 nH, with a 5% tolerance for all values. It offers the lowest DC resistance currently available in a 0402 package. For example, the DCR of the 220 nH value is 0.240 Ohms - 55% lower than the same value in the company's 0402AF Series - suiting it for use as a harmonic filter element for NFC applications.

0402DF series inductors can also be used as a filter element in bandstop and low pass filters, a one-pole filter or RF choke in cellular bands, and for ground-to-ground isolation. They feature a ferrite construction for high current handling.

www.coilcraft.com

RF module targets implantable medical devices

Microsemi Corporation has announced the smallest radio module it has ever produced. The ZL70323 is optimized for implantable medical devices such as pacemakers, cardiac defibrillators and neurostimulators—measuring just 5.5 mm x 4.5 mm x 1.5 mm.



The radio module supersedes the company's ZL70321 and complements its ZL70120 radio module used for external device controllers. Both modules are based on Microsemi's industry-leading ultralow power (ULP) ZL70103 radio transceiver chip, which supports a very high data rate RF link for medical implantable communication applications.

"Our radio modules allow medical device companies to focus more of their research dollars and development efforts on new therapies that enable a better quality of life. The reduction in size makes it easier for companies to design smaller devices that aid patient comfort and reduce risk of infection, as a smaller incision is needed," said Martin McHugh, Microsemi's product line manager for the module.

The ZL70103 family of products allows patient health and device performance data to be quickly transmitted with little impact to the battery life of the implanted device. The device operates in the 402 to 405 MHz MICS band. Multiple low power wake-up options are supported including using an ULP 2.45 GHz industrial, scientific and medical (ISM) band wake-up receive option. The ZL70103 consumes less than 6 mA when transmitting or receiving and consumes only 290 nA when in a periodic sleep/sniff mode (1 second sniff interval).

www.microsemi.com

EMI receivers

add real-time spectrum analysis

Keysight Technologies has announced the availability of real-time spectrum analysis (RTSA) as an option for its standards-compliant MXE EMI receiver.

Adding RTSA to an MXE enables test labs to observe and diagnose transient and wideband emissions during electromagnetic compatibility (EMC) compliance and precompliance testing.

With RTSA, engineers can more easily see and understand high-speed transient signals that are difficult to capture with traditional spectrum or signal analyzers. This is especially useful in applications such as radar, automotive and wireless communications that often experience fast-moving, short-duration emissions.

In RTSA mode, the MXE can provide real-time analysis bandwidth up to 85 MHz below 3.6 GHz and up to 40 MHz above 3.6 GHz, ensuring image-free, over-the-air diagnostics that enable faster, easier analysis of emissions. RTSA offers 100 percent probability of capture for signals with durations greater than 3.7 µs when viewing with an 85 MHz span.

Frequency mask trigger (FMT) capability is also included with RTSA, allowing users to confidently trigger on signals with durations as short as 17.4 µs. In addition, time-qualified triggering capability further enhances FMT by simplifying the task of finding pulse outliers or triggering on specific communications bursts.

RTSA is an upgradeable option on new and existing MXE EMI receivers as well as UXA, PXA and MXA X-Series signal analyzers.

www.keysight.com

DOCSIS 3.1 chipset

supports hybrid fiber-coax networks

The STiD325 DOCSIS 3.1 chipset from STMicroelectronics targets broadband CPE cable modems, embedded media terminal adapters (eMTAs), and gateways, as well as for video gateways when associated to set-top-box chipsets.

DOCSIS 3.1 has been engineered by CableLabs® to allow multi-gigabit data transport on existing Hybrid Fiber-Coax (HFC) networks through improved spectral efficiency using OFDM multi-carrier modulation combined with low-density parity-check-based Forward Error Correction.

The chipset is fully compliant with the DOCSIS 3.1 specification, featuring two 196 MHz OFDM downstream channels; 32 single-carrier DOCSIS 3.0 QAM downstream channels; two 96 MHz OFDM-A upstream channels; an 8 single-carrier DOCSIS 3.0 QAM upstream channels.

Codenamed Barcelona, the high performance chipset relies on multiple 64-bit ARM® CPUs to deliver over 10K DMIPS, with line-rate networking support on every port, and hardware acceleration for routing and switching. It will allow Multiple System Operators (MSOs) to build future-proof CPE platforms with plenty of headroom to support the field introduction of new services. Currently sampling to lead customers, Barcelona comes with pre-integrated RDK-B software, including DOCSIS and Packet-Cable stacks.

www.st.com

Trigger and decoder options extended for digital scopes

Rohde & Schwarz has expanded the range of trigger and decoder options for the RTO and RTE oscilloscopes. With the RTx-K50, the oscilloscopes help users debug serial protocols that employ Manchester or NRZ coding.

The option can be used with a variety of standardized buses such as PROFIBUS, DALI or MVB as well as with proprietary serial protocols such as are typically found in industrial environments and in the aerospace and defense sector. Developers of products that use these types of interfaces can easily find implementation errors and so test and release their designs more quickly.

The option, which covers data rates of up to 5 Gbit/s, supports up to 50 different telegram formats, while the format of the serial bus can be configured flexibly.

Users can define their own preamble, frame ID, data, CRC and other telegram fields. Protocol decoding also takes Manchester code violations into account.

High acquisition rates and minimal blind times are provided by the hardware-based trigger implementation on the RTO and RTE oscilloscopes. Users can trigger on telegram and data content with the RTx-K50 option. The decoded protocol content is displayed in an easy-to-read, color-coded format. Time correlation with the analog signal makes it easy to identify faults caused by signal integrity problems. A tabular list of the protocol contents is also provided.

www.rohde-schwarz.com

Embedded GNSS antenna

enables accurate positioning

Antenova Ltd has announced an embedded GNSS antenna, named 'Sinica', which operates on the 1559 to 1609 MHz satellite bands. This antenna uses a novel design approach and new materials to achieve high performance from an ultra low profile antenna.

Sinica is suitable for all positioning applications on the 1559 to 1609 MHz bands. It operates with all of the public satellite constellations - GPS, GLONASS, Baidou and Gallileo, which means it can provide accurate positioning combined with global coverage.

The Sinica antenna is created from FR4 materials and new dielectric constant laminate substrates. It uses a new approach to antenna design, which has enabled the company to create an antenna with the high performance of a ceramic patch antenna, in a low profile part that can be placed neatly within a small printed circuit board.

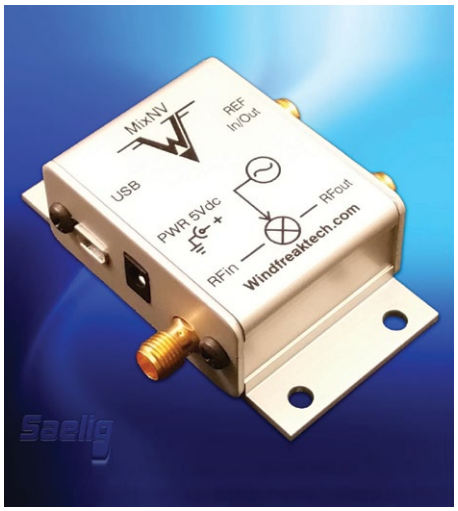
Sinica is designed for devices that need accurate positioning or tracking globally, which means it is suitable to use in drones, network devices and wearable electronics, or any other portable device or tracking application.

The antennas are supplied on tape and reel and are available through distributors worldwide.

www.antenova-m2m.com

Software-programmable RF mixer and signal source

Saelig Company has announced the Windfreak MixNV, an economical 30 MHz to 5 GHz software-programmable RF mixer which can up-convert or down-convert. It features a built in Local Oscillator (LO) that is controlled and powered by a PC running Windows XP, Windows 7 or 8 via its USB port.



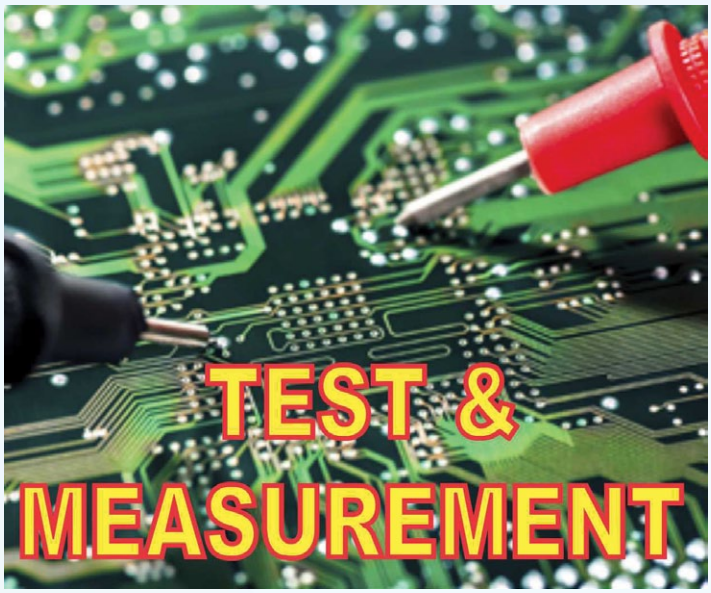
The RF I/O ports can accommodate RF signals in the 30 MHz to 5 GHz range, but the built-in local oscillator can be adjusted from 85 MHz to 5 GHz in 1 Hz steps using an advanced sigma-delta modulator phase-lock loop. This provides very low fractional spurious products and excellent phase noise. The MixNV also features on-board nonvolatile memory so it can be programmed to wake on power-up to any preset oscillator frequency, FSK modulation, or a variety of other settings.

The MixNV is designed as a stand-alone mixer for use in RF and microwave communications products or test setups and has the ability to self-bias the mixer so that it can be used as a signal generator with very fine frequency resolution. It also has the ability to perform two-level FSK (Frequency Shift Keyed) modulation with finely adjustable frequency deviation via software or off-board external 3.3V CMOS drive. The MixNV is very easy to control using the supplied software or other third-party serial communication software.

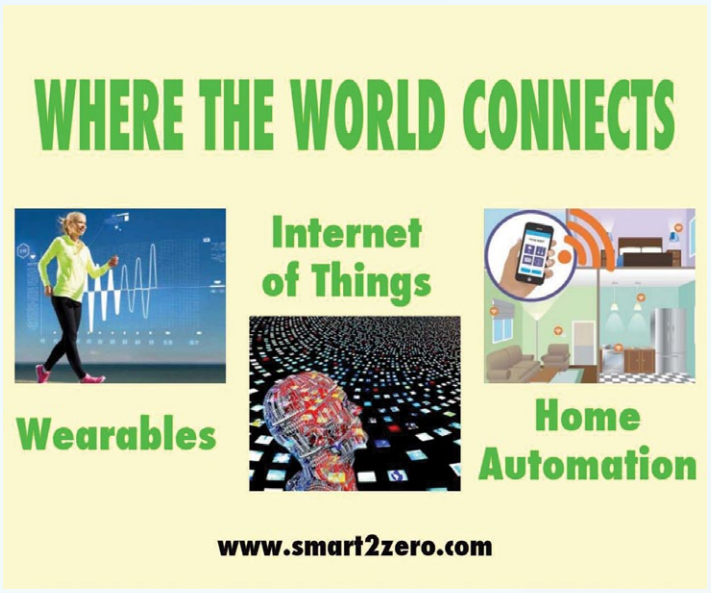
Designed and manufactured in USA by Windfreak Technologies, the MixNV is available now from Saelig Company, Inc.

www.saelig.com

Your Global Link to the Electronics World



www.tm-eetimes.com



www.smart2zero.com

www.electronics-eetimes.com

www.power-eetimes.com

www.automotive-eetimes.com

www.eetsearch.com

Your 5G Eureka moment will happen sooner or later.

We'll help make it sooner.

The fifth generation of wireless communications may seem years away. But if you want to be on the leading edge, we'll help you gain a big head start. We offer unparalleled expertise in wideband mmWave, 5G waveforms, and Massive MIMO. We also offer the industry's most comprehensive portfolio of 5G solutions. Whether you need advanced antenna and radio test hardware or early simulation software, we'll help you with every stage of 5G.

HARDWARE + SOFTWARE + PEOPLE = 5G INSIGHTS

Download our white paper *Implementing a Flexible Testbed for 5G Waveform Generation and Analysis* at www.keysight.com/find/5G-Insight

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Unlocking Measurement Insights