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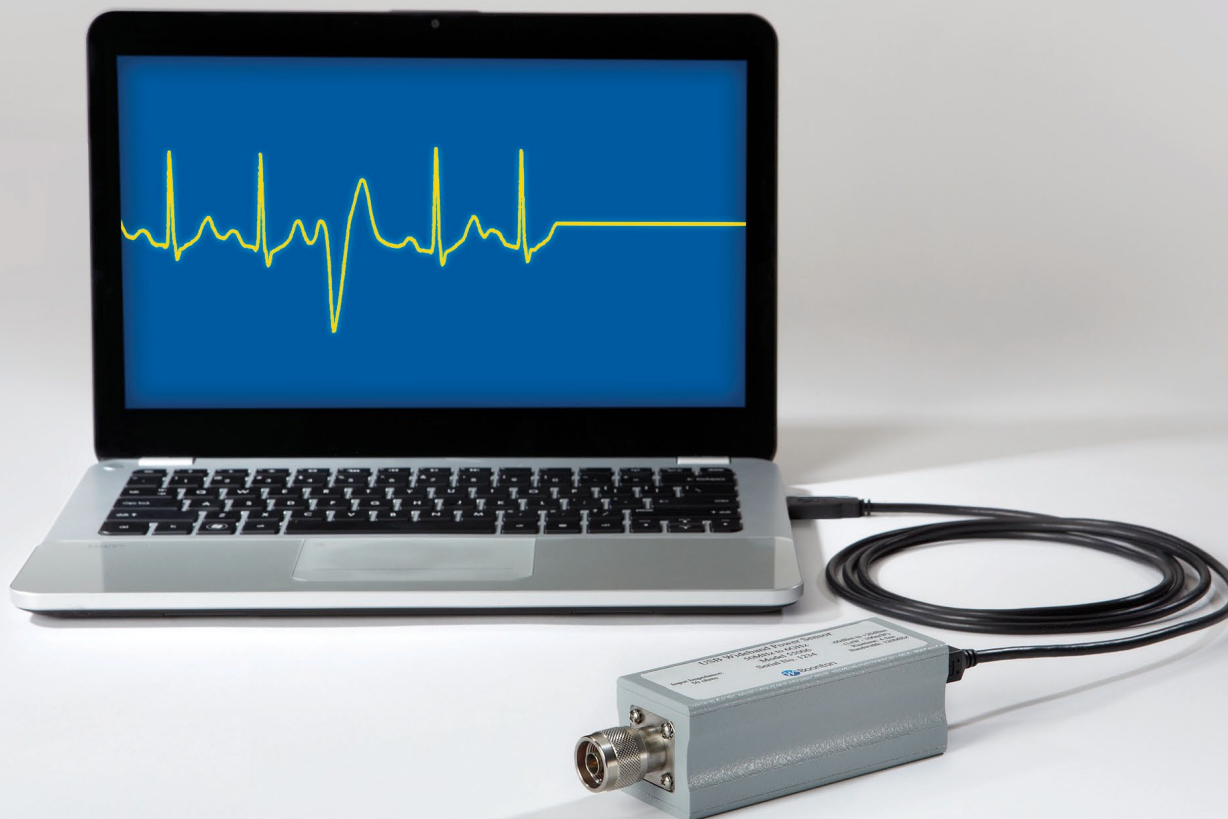
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Analog optical fiber forges RF link

Bill Schweber observes that optical fiber is becoming a preferred domain for carrying analog signals at radio frequencies.

Co-axial copper cables have long been used as conduits of analog RF signals but there is now a medium for electromagnetic energy that is starting to compete with coax: optical fiber. A recent article in Microwaves & RF, 'Why More RF Engineers Are Choosing Fiber Connectors', explains the whys and hows of using fiber for both short distance as well as in-building longer runs, in small-cell applications and distributed-antenna systems (DAS).

The much-lower attenuation of fiber (around 1 dB/km) compared to coax (roughly tens of dB/km) makes it especially attractive in the latter cases. Fiber's immunity to EMI/RFI is a big plus, too, especially in wide-area installations that have to deal with building motors and equipment, well-known and notorious interference sources.

Key to using fiber is the RF-to-optical (aka electro-optical, or E/O) converter at the source end and the complementary optical-to-RF converter at the receiver. For the transmitter, a distributed-feedback (DFB) semiconductor laser is used when wide dynamic range and low noise are critical, while for applications with lower-performance requirements, a Fabry-Perot (FP) laser is generally chosen. At the receiver, a PIN diode captures the photons and coverts them into electrical signals.

There's an element of irony here: although we associate fiber-optic links with high-speed digital signals, as in the Gbit/s cables and links which are the foundation underpinning the physical layer of the Internet and its data flow, this use of optical fiber for RF is entirely in the analog domain – as so much of RF still is. Thus, the traditional analog issues of noise, linearity, distortion, clipping, limiting, and similar play their usual roles. Once again, analog circuitry and functions are necessary and unavoidable, and the optical drivers and receivers need to be optimized for their analog-performance and parameters rather than the digital ones. Goodbye to eye-pattern woes, hello again to linearity headaches.

Of course, using fiber is not a trivial exercise. For engineers and installers whose experience and expertise are only with coax, there's a new world of optical-cable specifications, the fiber plus the protective jacketing, optical connectors, bend radius, E/O converters and components, and more. In addition, it's often makes sense to run a fiber-optic cable assembly which has unused fibers inside for additional capacity in the future, known as dark fiber. In contrast, running extra coax in parallel with the in-use coax

Avionics is a place where RF-over-fiber is essential in a system that needs light weight and to be immune to EMI.

is much more costly and occupies much more space.

Have you ever wished you had a performance- and cost-effective alternative to coaxial cable? Have you explored using analog fiber for RF? What concerns and issues would you have from a technical as well as personal standpoint?

Bill Schweber, is an electronics engineer and author who has written for EE Times, was analog editor at EDN and prior to that worked in marketing communications for Analog Design and was also editor of its technical journal.

This article first appeared on EE Times' Planet Analog website.

Making drones safer and smarter

As more and more drones take to the air, safety is becoming a concern. One common problem is that drones can run out of power, forcing them to land immediately. In such situations they must be able to detect safe landing spots and properly execute landing operations.

Another potential crash situation arises when a drone temporarily loses its GPS position information, for instance, when flying close to buildings where GPS signal is weak. In such situations, it is essential that drones can rely on back-up systems and regain stable flight. To this end, the UZH research group has equipped drones with a single camera and acceleration sensors. Their orientation system emulates the human visual system and sense of balance. As soon as a toss or a failure situation is detected, computer-vision software analyses the images to identify distinctive landmarks in the environment and restore balance. All image processing and control runs on a smartphone processor

One of the drones from UZH research group. Image courtesy of UZH.

onboard the drone. This renders the drone safe and able to fulfil its mission without any communication or interaction with the operator.

"Our new technology allows safe operation of drones beyond the operator's line of sight, which is crucial for commercial use of drones, such as parcel delivery," says Prof. Davide Scaramuzza, co-inventor and Director of the Robotics and Perception Group at the University of Zurich.

The same software builds a 3D model of the environment, which is used to group the terrain beneath the drone into "risky" and "safe" landing sites. If an emergency landing is required due to low battery or system failure, the drone will automatically detect and land on a flat, safe location without any human intervention.

Wearable 3D home theater sound system

Nordic Semiconductor has announced that further to a successful Kickstarter campaign, French startup 3D Sound Labs is employing Nordic nRF51822 Systems-on-Chip (SoCs) to provide Bluetooth® Smart wireless communications to smartphones and tablets in its Neoh 3D audio headphones that start shipping in June.

The Neoh headphones are claimed to produce a truly immersive, 3D spatial sound using the company's binaural algorithms (3D sound over headphones) that use advanced 9-axis motion-sensing (comprising gyroscopes, accelerometers, and a magnetometer) to track even the smallest of micro-movements of the user's head. 3D Sound Labs says nobody remains completely motionless while watching a movie and compensating for the tiniest movements is paramount as the brain uses those micro-movements for sound localization. This means that in the Neoh headphones the sound field remains static even if the wearer moves their head just like in a conventional cinema or home theater sound system.

Audio reproduction has evolved from mono (one speaker or 'channel') through stereo (two channels) and later into the original surround sound format used for film soundtracks: Dolby Pro-Logic. This comprised left and right stereo channels, a center 'speech' channel (primarily used for on-screen dialogue), and mono rear channels used to produce 'surround' sound effects.

3D Sound Labs says this further evolved into 5.1 offering five separate surround sound channels (i.e., the rear channels are stereo rather than mono) plus a dedicated channel for a bass subwoofer (represented by the '.1' in 5.1); 6.1 (the rear stereo channels get an additional center mono channel; and the latest 7.1 (the rear channels are split into two sets of stereo channels) formats; not to mention some upcoming "true" 3D audio formats that promise even more channels for an even more realistic sound experience.

www.nordicsemi.com

IDT wireless charging comes to IKEA

Integrated Device Technology has announced that IKEA has picked its wireless power transmitters to embed in its furniture and accessories for convenient wireless charging of enabled portable devices.

The P9030 magnetic induction transmitters from IDT are embedded in new IKEA products including side tables and lamps. The products will soon be available in stores throughout North America and Europe.

In addition to the furniture, IKEA has developed a line of charging pads as well as a wireless charger that consumers can build into furniture themselves — all built around the IDT wireless power semiconductor.

"IKEA revolutionized the furniture industry, and it continues to prove itself an innovation leader with the integration of IDT wireless charging transmitters into its products," said Arman Naghavi, IDT's vice president of Analog Power Technology. "The company's adoption of our Qi technology underscores the traction we're seeing as the wireless power ecosystem continues to expand."

The P9030 transmitter complies with the Wireless Power Consortium's (WPC) Qi standard, delivering a 5-W single-chip system in a compact package. IDT wireless power transmitters and receivers have also been designed into smart phones, phone accessories, wearables and charging stations.

www.IDT.com

Brain-computer interface for smartphones

Mind Solutions has started pre-orders of its mobile BCI (Brain-Computer-Interface) — believed to be the smallest on the market. The company has developed a wireless headset that detects and processes real time brain activity patterns (small voltage changes in the brain caused by the firing of neurons), software then translates these brainwaves into action on a user's computer and or smart phone. By using non-invasive electroencephalography (EEG), it is possible to observe each person's individual electrical brain activity, and then translate this into actions powered by thought.

The BCI takes the form of the common Bluetooth ear piece. The EEG signal is obtained via a small ear piece that is uses the ear canal to pick up the brain's electrical activity. Programmes have been developed to operate electric wheel chairs, control a computer by opening and controlling web browsers, a well as compose and send e-mails.

www.MindSolutionsCorp.com

52-Mpixel camera ready for production

Imaging startup Light Co., (Palo Alto, CA) has revealed some details of its array camera approach and is reportedly close to announcing a licensing and investment deal with Hon Hai Precision Industries of Taiwan, better known as Foxconn. The main claim that Light is making is that it will allow smartphones to take photos even closer to digital SLR quality. Even though it is still at a pre-prototype stage it has reportedly said it expects the first light cameras to appear in smartphones in 2016 with the 52-megapixel resolution.

Light's approach is similar to that of array camera pioneers such as Pelican Imaging Corp., and LinX Computational Imaging Ltd., However, Light does not restrict itself to an array of identical sensors but uses multiple sensors with lens set at different fixed focal lengths so that it can simulate a zoom lens after a photo has been taken. It can still use computational effects after a photo has been taken – in reality a series of photos – to get enhanced resolution similar to other plentoptic approaches.

www.light.co

Wearable cameras a boom for image sensors

Annual shipments of wearable cameras will surpass 30 million units by 2020 according to market research firm Tractica. GoPro rugged and waterproof cameras for sports applications are leading the field at present but more general consumer, enterprise and public safety applications are not far behind and will drive strong growth in the second half of this decade, Tractica claims.

Wearable cameras are a logical extension of the smartphone camera, enabling hands-free functionality that allows users to capture both planned and spontaneous moments by using body or head mounts or by clipping the camera to clothing.

The market for wearable cameras is an early stage and experiencing rapid growth as the use cases for wearable cameras expand. Tractica forecasts that wearable camera shipments will increase from 5.6 million in 2014 to 30.6 million units annually by 2020. That is equivalent to a CAGR over the period of about 32 percent.

www.tractica.com

Study shows fibre-optic components suit future railway gigabit networks

Fiber optic technology is good for creating Gigabit networks for use on trains and HUBER+SUHNER products have proven themselves' is the conclusion of an SBB trial report — a major field test confirmation. A Swiss Federal Railways (SBB) one-year study has concluded that optical fiber is a suitable technology for use on rolling stock. During the trial SBB tested a variety of connectivity components for gigabit networks on trains, including fiber optic cables, connectors and databus cables from HUBER+SUHNER. All the products tested passed with excellent results.

With ever-increasing data usage demands due to new, complex multimedia applications, train networks in the future will require at least ten times the bandwidth than is currently being delivered. In response to this development, the SBB has installed a Gigabit Ethernet network in a railway vehicle. The network was tested over a one-year period, enabling SBB to test the technologies and products already available on the market.

www.hubersuhner.com

NFC turns e-Ink into a fashionable wearable device

Take a flexible e-Ink display foil, shape it and turn it into a wearable accessory, then control the black and white display using your smartphone through an NFC connection, uploading any design to match your outfit.

That's the pitch of Hungarian start-up Liber8 Technology with its 'Tago Arc' electronic bracelet. Founded in 2013, the company is currently ramping up the production of its curved e-Ink bracelets, tying them to a dedicated app for users to easily upload new designs.

Only at the touch of their smartphone, the 150ppi 16-color greyscale display will refresh with the wearer's latest pattern selection. The tago app also includes a picture editor so users can design and upload their own artwork, in fact, the bracelet could certainly double up as a particular tag during large social events.

And what will strike the users of this peculiar type of wearable electronics is that the bracelet never needs to be charged, it operates battery-less, harvesting RF energy from the smartphone's NFC reader during the image file transfer. Energy harvesting and hassle-free power is were true wearable autonomy lies and is becoming a must have for a better user experience.

http://liber8tech.com

Nano 'sandwich' makes better smartphone battery

Tiny "sandwiches" made of nanosheets could lead to better smartphone batteries and other rechargeable electronics, according to mechanical engineering research from Kansas State University.

Gurpreet Singh, assistant professor of mechanical and nuclear engineering, and his research team are improving rechargeable lithium-ion batteries. The team has focused on the lithium cycling of molybdenum disulfide, or MoS_2, sheets, which Singh describes as a "sandwich" of one molybdenum atom between two sulfur atoms. The team has found that silicon carbonitride-wrapped molybdenum disulfide sheets show improved stability as a battery electrode with little capacity fading.

Molybdenum disulfide sheets. Image courtesy of Kansas State University.

In their research, Singh's team observed that molybdenum disulfide sheets store more than twice as much lithium — or charge — than bulk molybdenum disulfide reported in previous studies. The researchers also found that the high lithium capacity of these sheets does not last long and drops after five charging cycles.

"This kind of behavior is similar to a lithium-sulfur type of battery, which uses sulfur as one of its electrodes," Singh said. "Sulfur is notoriously famous for forming intermediate polysulfides that dissolve in the organic electrolyte of the battery, which leads to capacity fading. We believe that the capacity drop observed in molybdenum disulfide sheets is also due to loss of sulfur into the electrolyte."

Singh and his team now want to better understand how the molybdenum disulfide cells might behave in an everyday electronic device — such as a cellphone — that is recharged hundreds of times. The researchers will continue to test the molybdenum disulfide cells during recharging cycles to have more data to analyze and to better understand how to improve rechargeable batteries.
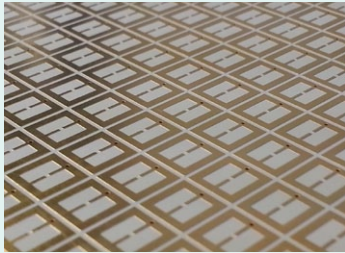
The findings appear in Nature's Scientific Reports in the article "Polymer-Derived Ceramic Functionalized MoS_2 Composite Paper as a Stable Lithium-Ion Battery Electrode."

Harvesting energy from electromagnetic waves

Researchers from the University of Waterloo in Canada have reported a novel design for electromagnetic energy harvesting based on the "full absorption concept." This involves the use of metamaterials that can be tailored to produce media that neither reflects nor transmits any power — enabling full absorption of incident waves at a specific range of frequencies and polarizations.

The technology targets alternative energy as well as wireless power transfer to power remote devices such as in RFID and energy harvesting.

"The growing demand for electrical energy around the globe is the main factor driving our research," said Thamer Al-moneef, a Ph.D. student. "More than 80 percent of our energy today comes from burning fossil fuels, which is both harmful to our environment and unsustainable as well. In our group, we're trying to help solve the energy crisis by improving the efficiency of electromagnetic energy-harvesting systems."

Since the inception of collecting and harvesting electromagnetic energy, classical dipole patch antennas have been used. "Now, our technology introduces 'metasurfaces' that are much better energy collectors than classical antennas," explained Omar M. Ramahi, professor of electrical and computer engineering.

Metasurfaces are formed by etching the surface of a material with an elegant pattern of periodic shapes. The particular dimensions of these patterns and their proximity to each other can be tuned to provide "near-unity" energy absorption. This energy is then channeled to a load through a conducting path that connects the metasurface to a ground plane.

http://scitation.aip.org

Future smartphones could offer 3D cameras

Imaging technology based on LIDAR and coherence that fits on a tiny chip has been developed that can form a high-resolution 3-dimensional image of an object on the scale of micrometers.

Future smartphones and mobile devices could use this technology, enabling users to take a snapshot of an object via an integrated 3-D imager. This image can then be sent to a 3-D printer, and within minutes, a replica accurate to within microns of the original object can be reproduced — all due to a tiny high-resolution 3-D imager developed at Caltech.

3-D imaging has been around for decades, but currently the most sensitive systems generally are too large and expensive to be used in consumer applications.

A cheap, compact yet highly accurate new device known as a nanophotonic coherent imager (NCI) promises to change that. Using an inexpensive silicon chip less than a millimeter square in size, the NCI provides the highest depth-measurement accuracy of any such nanophotonic 3-D imaging device.

The work, done in the laboratory of Ali Hajimiri, the Thomas G. Myers Professor of Electrical Engineering in the Division of Engineering and Applied Science, is described in Optics Express.

In a regular camera, each pixel represents the intensity of the light received from a specific point in the image, which could be near or far from the camera — meaning that the pixels provide no information about the relative distance of the object from the camera. In contrast, each pixel in an image created by the Caltech team's NCI provides both the distance and intensity information. "Each pixel on the chip is an independent interferometer--an instrument that uses the interference of light waves to make precise measurements- — which detects the phase and frequency of the signal in addition to the intensity," says Hajimiri.

www.caltech.edu

Nokia, Alcatel-Lucent leapfrog Huawei Wireless

Nokia Corpopration bid to acquire Alcatel-Lucent in a USD16.6 billion deal that would create the world's second largest provider of telecommunications systems. With about USD28 billion in revenues, the combined companies would leapfrog China's Huawei, the current second place vendor, but still fall behind Ericsson. The merger anticipates savings of about a billion dollars a year by 2019. Executives said the savings would come in part from eliminating overlapping products, sales and administrative staff and wireless R&D as well as lower real estate costs.

"There will be a lot of redundancies on the wireless side from an engineering perspective," said Stefan Pongratz, a wireless analyst with Dell'Oro Group.

Part of Nokia's rationale for the merger is to broaden its base beyond the radio access systems where it is strong but the $35 billion annual market is declining about one percent on a compound basis through 2019, according to Dell'Oro. By contrast the $13 billion router market where Alcatel-Lucent is strong is rising about three percent through 2019, Pongratz said.

In-building wireless market to double

The latest report from Mobile Experts presents deep insight into the convergence of multiple in-building architectures: DAS, Small Cells, CRAN, and Wi-Fi. The market research firm predicts that the market for in-building will double over the next three years. With the demand for data growing and expectations for connectivity amongst consumers to be available in hotels, stadiums, airports, convention and conference centers, hospitals, colleges/campuses, corporate buildings, shops and shopping malls, in-building coverage is becoming a necessity for enterprises and businesses.

Joe Madden, Principal Analyst at Mobile Experts commented, "Recent product announcements show a clear migration toward inexpensive twisted pair cabling and simpler, lower cost signal sources for in-building deployment. We have laid out a future roadmap for these new architectures to take the next step, resulting in a low-cost, multi-operator system that will be easy for an enterprise to buy."

www.mobile-experts.net

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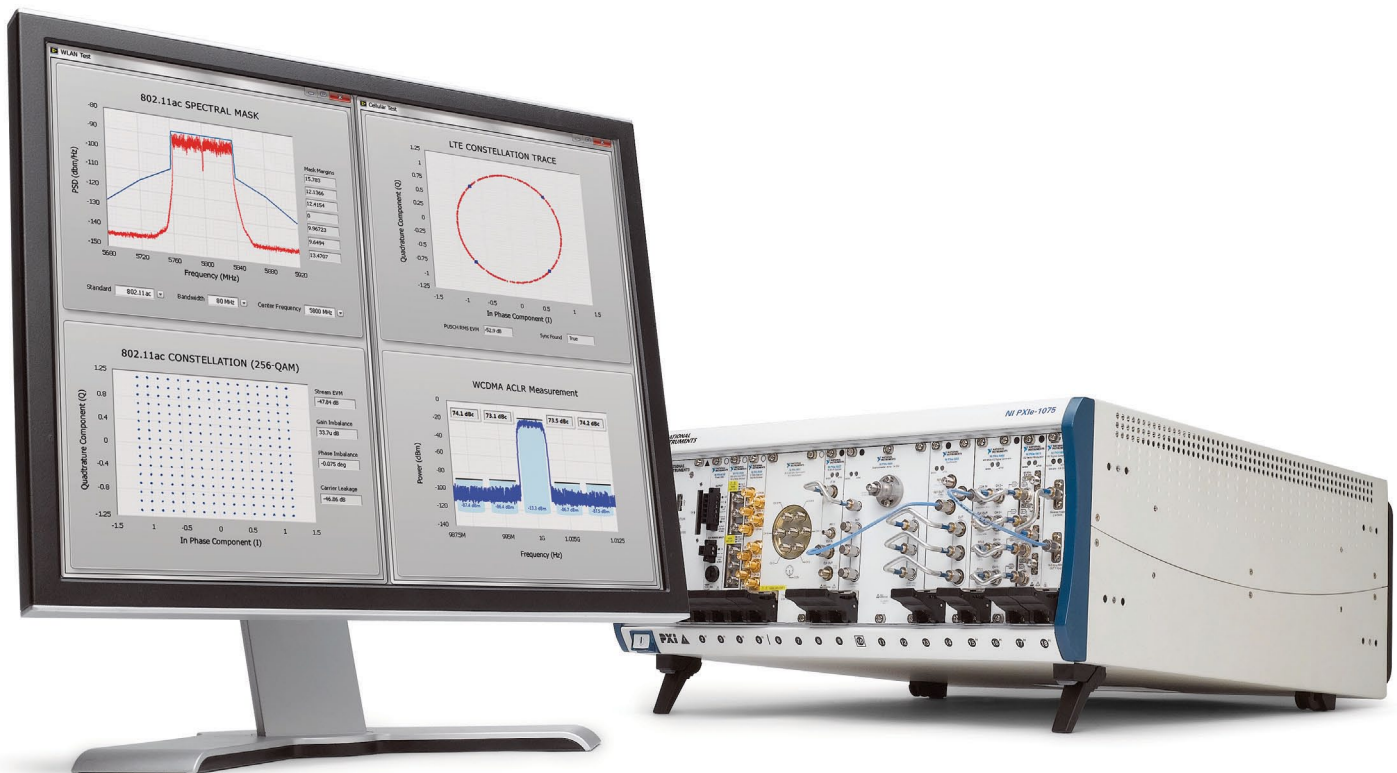
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NATIONAL INSTRUMENTS

A Review on 3rd Order Sigma Delta Modulator Fractional N Synthesis Phase Noise

By Akmarul Ariffin Bin Salleh, R&D CTD

Abstract – Sigma Delta Modulator (SDM) based fractional N is widely used in RF instrument to provide, fractional number division, scalable output frequency accuracy that does not depend on the reference frequency, and allow wider loop bandwidth for faster switching time. This article will review the operation of 3rd Order SDM and how the synthesis phase noise is derived.

I. INTRODUCTION

In a Phase Locked Loop (PLL), SDM Fractional N is used in the feedback path, where its input is VCO signal Fout, and its output is a frequency "equals" to Fref, as illustrated in Figure 1.
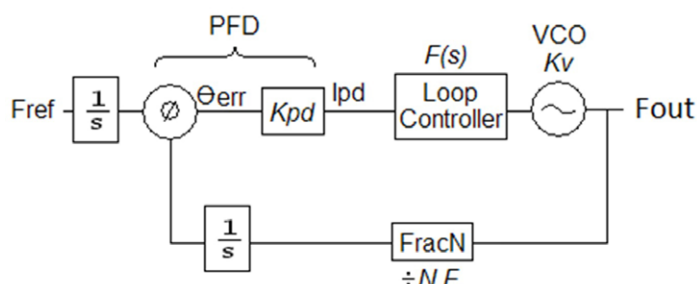
Figure 1: PLL Diagram

Most of the time, as widely can be found in the industry, 3rd order SDM is used. The characteristics and behavior of this SDM are will understood. This article will review the synthesis phase noise of 3rd order SDM; what is the phase noise equation and how it is derived. The phase noise equation will be derived at the input of fraction N, which is Fout node. Defining it at Fout node will make it easier for loop phase noise analysis. But before that, it is quite important to understand how 3rd order SDM operate.

II. OPERATION OF 3RD ORDER SDM FRACTIONAL

A 1st order SDM is simply a single digital accumulator with overflow bit, which can be implemented easily in hardware. The output of the overflow bit is added with the integer portion N, and this gives the sum of integer part N and fractional part F. Let called this sum N.F. Shown in Figure 2 below is the diagram of 1st order SDM.
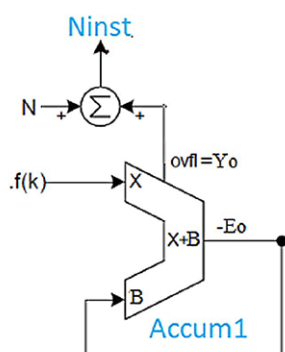
*Figure 2:
1st order SDM Fractional N*

Referring to Figure 2, N is the integer part, and .f is the fractional part. The letter k specify the bit width of the accumulator, which is also the size of .f number. There is a feedback loop from the output of the accumulator, to the input B of the accumulator. Since the adder output is limited by the overflow, this feedback loop is unconditionally stable. The output is defined as –Eo, as this definition will be used later in the noise analysis. The size of k determine the frequency resolution, based on the equation below,

Freq_resolution=Fref/(2^k)

Fref is the reference frequency. For example, if k=3bit width and Fref=10MHz, then the frequency resolution is 10Mhz/(8)=1.256MHz. If more accuracy is needed, then higher size of k need to be used. Another thing to note is, no matter what the size of k is, the overflow output ovfl=Yo is always 1 bit, which is either 0 (low) or 1 (high). This means the Ninst could either be N or N+1. So if N.F=3+3/8=3.375, the Ninst will toggle continuously and pseudo randomly, such that the average of Ninst is 3.375. .F has 8 in the denominator as in this example k=3. Shown in Figure 3 is the actual Ninst, with N.F=3+3/8=3.375.
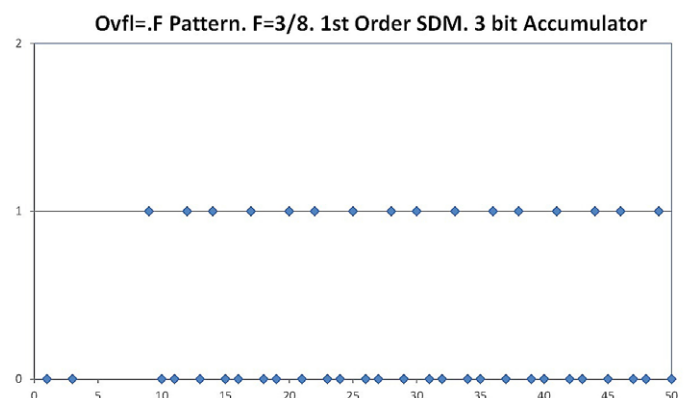
Figure 3: Ofvl or .F pattern for 1st order SDM with 3 bit accumulator. .F=3/8.

Figure 3 shows the .F or the ovfl bit pattern. Quick analysis show that for every 8 cycles, 3 bits are high. This gives a .F ratio of 3/8. (Note: ignore the first few bits as this is startup transient).

Most of the time, to design 3rd order SDM, Multistage Noise Shaping (MASH) techniques is used. There is a few benefits when constructing 3rd order SDM using MASH. First, the simple accumulator as in Figure 2 is used as one of the building block. Secondly, simple additional building blocks like adders, and FF are required, and there is no other feedback loops, other than intrinsic to each accumulator. This mean, higher order SDM using MASH will be unconditionally stable and will be relatively easy to construct in hardware. Figure 4 shows the block diagram of 3rd order SDM, constructed using MASH.

There are 3 adders and 2 delays element required. The delay element is indicated by the Z^{-1} block, which can be
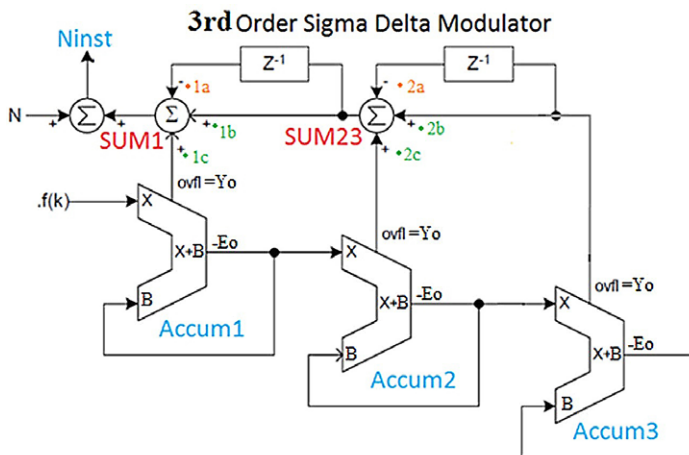
Figure 4: 3rd order SDM for fractional N, employing MASH

easily implemented using D flip flop. It can be seen that there is no other feedback loop other than the ones internal to the accumulators. Thus the diagram in Figure 4 should be unconditionally stable. In 1st order SDM, it was shown that the Ninst can vary by 0 or +1. This results to N or N+1. For 3rd order SDM, the max deviation and the min deviation on Ninst can be figured out quite easily by visual inspection on Figure 4. On the 2 adders on the right side, the max deviation on Ninst will occur when points 2b=1, 2c=1, 1c=1 and 1a=-1. This result to max Ninst deviation of +4. 1a is the previous value due to Z^{-1} block. Take note that point 1a cannot be any lower than 1a=-1 (eg 1a=-2). Similarly, the min deviation on Ninst will occur when 1c=0,1b=-1, and 1a=2. This result to min Ninst deviation of -3. To conclude, for 3rd order SDM, the Ninst will vary between N-3 to N+4, in order to provide average of N.F. Figure 5 shows the plot of Ninst for 3rd order SDM.
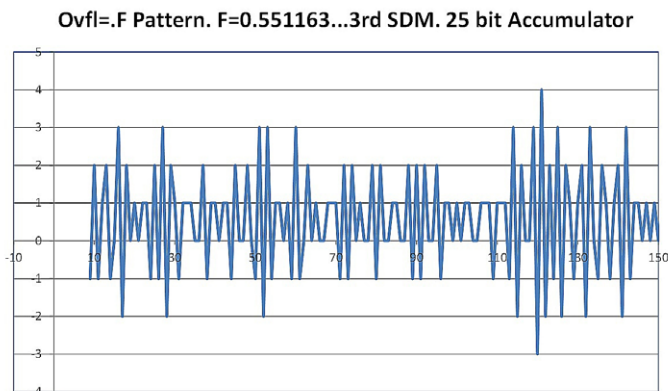
Figure 5: Ofvl or .F pattern for 1st order SDM with 25 bit accumulator.

In Figure 5, the .F is irrational so that the .F pattern is not structured. If there is a structural pattern, it would result to a spur called, structure spur. From visual inspection on Figure 5, it is hard to see and pattern or repetition. Now, using the irrational .F, and the same 25 bit accumulator, the 1st order SDM output is analyzed. This is shown in Figure 6. Obviously, from Figure 6, the output is quite structured, and this will result to structure spur. Comparing 1st order SDM to 3rd order SDM, as far as spur performance, 3rd order SDM is superior. One of the main reason is, 3rd order SDM has 8 different Ninst to jump to, whereas 1st order SDM only has 2. This superior spur performance is another reason why 3rd order SDM is favorable.
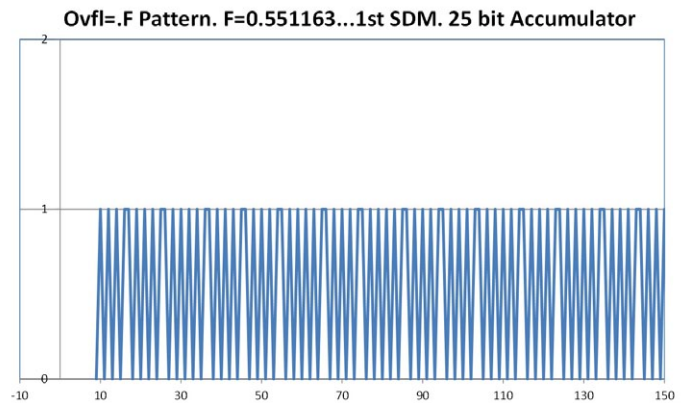
Figure 6: Structured output of 1st order SDM.

III. NOISE ANALYSIS OF 3RD ORDER SDM

To analyze the noise of the 3rd order SDM shown in Figure 4, we need to analyze the noise of the accumulator, one of the building block. To do that, let's look at what is is inside the digital accumulator. This is shown in Figure 7. Similar to Figure 2, X is the input or the .F. Yo is the overflow port. The sum out node is defined as -Eo. Po is the unbounded accumulator output. The block between Po and ovfl is a 1 bit quantizer. Let's analyze the signal and the noise transfer function. The input noise is the quantization error Eo, added by the 1 bit quantizer.
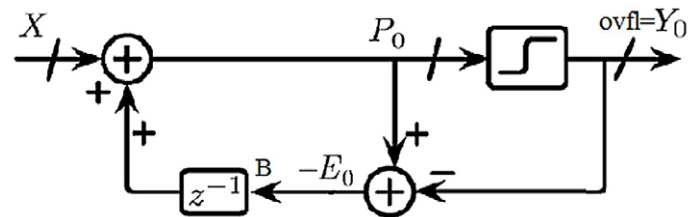
Figure 7: Signal flow diagram of digital accumulator.

Refer to Figure 7. First equation is derived around the 2nd summing junction

$$Po(z) = X(z) - Eo(z) \cdot z^{-1} \qquad \text{eq1}$$

The second equation is derived around the 2nd summing junction

$$-Eo(z) = Po(z) - Yo(z) \qquad \text{eq2}$$

Solving for Yo(z), we have,

$$Yo(z) = Po(z) + Eo(z)$$
$$Yo(z) = X(z) - \left(1 - z^{-1}\right) \cdot Eo(z) \qquad \text{eq3}$$

From the inspection of eq3, the signal X(z) transfer function is 1, and the noise Eo(z) transfer function is shaped by $(1-z^{-1})$. When MASH techniques is used to get higher order SDM, in this case 3rd order will be used for calculation, the diagram is shown in Figure 8. The block after Y2 and Y3 represent the delay and the through path as in Figure 4.
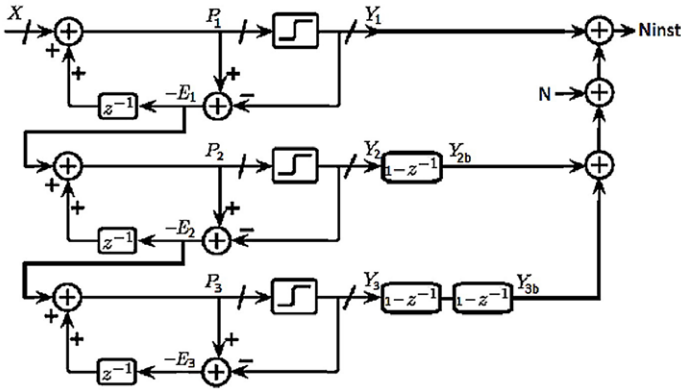
Figure 8: 3rd order SDM signal flow diagram.

To calculate the transfer function at Ninst, so that we can later on calculate the noise, firstly, we need to calculate and Y1, Y2 and Y3. This can be done quite easily, based on eq3.

$$Y1(z) = X(z) + \left(1 - z^{-1}\right) \cdot E1(z)$$

$$Y2(z) = -E1(z) + \left(1 - z^{-1}\right) \cdot E2(z)$$

$$Y3(z) = -E2(z) + \left(1 - z^{-1}\right) \cdot E3(z)$$

The Y2b and Y3b are the delayed modified version of Y2 and Y3. They are defined as,

$$Y2b(z) = -\left(1 - z^{-1}\right) \cdot E1(z) + \left(1 - z^{-1}\right)^2 \cdot E2(z)$$

$$Y3b(z) = -\left(1 - z^{-1}\right)^2 \cdot E2(z) + \left(1 - z^{-1}\right)^3 \cdot E3(z)$$

We now have the ingredients to calculate the transfer function of Ninst.

$$Ninst(z) = N + Y1(z) + Y2b(z) + Y3b(z)$$

$$Ninst(z) = N + \left[X(z) + \left(1 - z^{-1}\right) \cdot E1(z)\right] + \left[-\left(1 - z^{-1}\right) \cdot E1(z) + \left(1 - z^{-1}\right)^2 \cdot E2(z)\right] + \left[-\left(1 - z^{-1}\right)^2 \cdot E2(z) + \left(1 - z^{-1}\right)^3 \cdot E3(z)\right]$$

Simplifying the above, we arrive at equation eq4

$$Ninst = N + X(z) + \left(1 - z^{-1}\right)^3 \cdot E3(z) \qquad \text{eq4}$$

As mentioned in the Introduction, the phase noise will be defined at Fout node. Thus, leveraging on eq4, we arrive at eq5. The unit of Fout(z) in eq5 is in Hz.

$$Fout(z) = (N + X(z)) \cdot fref + \left(1 - z^{-1}\right)^3 \cdot fref \cdot E3(z)$$
eq5

From eq5, as far as noise, the noise is contributed by E3(z), and shaped by $(1 - z^{-1})^3$. So the next step is to defined the noise of E3(z), and then convert the noise equation from z domain to s or f domain. s domain since this is the domain used for loop dynamic analysis or loop noise analysis.

The quantization error E3(z) is assumed to have uniform distribution. It has a variance of 1/12 over bandwidth of fref. The PSD is then,

$$S_{E3}(z) = \frac{1}{12 \cdot fref} \qquad \text{eq6}$$

The frequency PSD at the Fout can then be calculated using eq5 and eq6,

$$S_f(z) = \left[\left|\left(1 - z^{-1}\right)^3 \cdot fref\right|\right]^2 \cdot S_{E3}(z) \qquad \text{eq7}$$

As we want to calculate the phase noise, we need to convert eq7 from frequency psd to phase psd. Simple rectangular integration need be used. For a discrete signal, the frequency is defined as

$$\omega(k) = \frac{\phi(k) - \phi(k - 1)}{\Delta t} \qquad \text{eq8}$$

Rearranging the term in eq8, we have

$$\phi(k) = \phi(k - 1) + \omega(k) \cdot \Delta t \qquad \text{eq9}$$

Δ t is the time step between discrete samples, which is Ts. As Δt is simply approximately 1/fref we can now convert from discrete k domain in eq9 to z domain.

$$\phi(z) = z^{-1} \cdot \phi(z) + \omega(z) \cdot Ts = z^{-1} \cdot \phi(z) + \frac{2 \cdot \pi \cdot f(z)}{fref}$$

$$\phi(z) = \frac{2 \cdot \pi}{fref \cdot \left(1 - z^{-1}\right)} \cdot f(z) \qquad \text{eq10}$$

The phase psd in z domain can now be calculated by converting eq10 to psd by squaring it, and then substituted eq7 in. Then rearrange for simplest form.

$$S_\theta(z) = \left[\left|\frac{2 \cdot \pi}{fref \cdot \left(1 - z^{-1}\right)}\right|\right]^2 \cdot \left[\left|\left(1 - z^{-1}\right)^3 \cdot fref\right|\right]^2 \cdot \frac{1}{12 \cdot fref}$$

$$S_\theta(z) = \frac{\pi^2 \cdot \left(\left|1 - z^{-1}\right|\right)^4}{3 \cdot fref} \qquad \text{eq11}$$

The expression in the above is in z domain, we need to convert it to frequency domain. We start with the basic transformation from z to s. z^{-1} is a delay of 1 cycle. A delay in s domain is $e^{-s \cdot Ts}$. Ts is the sampling time or the rate at which the Ninst is output. The steps below to show the derivation of $|1 - z^{-1}|$ in f domain.

$$z^{-1} = e^{-s \cdot Ts}$$

$$1 - z^{-1} = 1 - e^{-s \cdot Ts}$$

$$1 - e^{-s \cdot Ts} = 1 - e^{-i \cdot \omega \cdot Ts}$$

$$e^{i \cdot \omega \cdot Ts} = \cos(\omega \cdot Ts) - i \cdot \sin(\omega \cdot Ts)$$

$$1 - e^{-i \cdot \omega \cdot Ts} = 1 - (\cos(\omega \cdot Ts) - i \cdot \sin(\omega \cdot Ts))$$

Therefore,

$$1 - z^{-1} = 1 - (\cos(\omega \cdot Ts) - i \cdot \sin(\omega \cdot Ts))$$ eq12

As in eq11, we actually need the magnitude of eq12. The magnitude of eq12 is calculated below,

$$\left|1 - z^{-1}\right| = \sqrt{(1 - \cos(\omega \cdot Ts))^2 + \sin(\omega \cdot Ts)^2} = 2 \cdot \sin\left(\frac{\pi \cdot f}{fref}\right)$$

The phase psd is f domain, or the phase noise can be finally calculated by substituting eq13 into eq11.

$$S_{\theta\_3rd}(f, fref) := \frac{\pi^2 \cdot \left(2 \cdot \sin\left(\frac{\pi \cdot f}{fref}\right)\right)^4}{3 \cdot fref}$$ eq14

All the steps we used to arrive to eq14 has been two sided PSD, the single sideband phase noise can be defined as,

$$L(f) = S_{\theta\_3rd}(f)$$

As can be found in some literatures, the phase noise equation in eq14 is further simplified. As offset frequency of interest in the PLL is much lower than the fref, eq 14 can be simplified to eq15, for a small offset frequency f.

$$S_{\theta\_3rd\_small}(f, fref) = \frac{\pi^2 \cdot \left(2 \cdot \sin\left(\frac{\pi \cdot f}{fref}\right)\right)^4}{3 \cdot fref} = \frac{\pi^2 \cdot \left[2 \cdot \left(\frac{\pi \cdot f}{fref}\right)\right]^4}{3 \cdot fref} = \frac{(2 \cdot \pi)^2}{12 \cdot fref}\left[\frac{f}{\left(\frac{fref}{2\pi}\right)}\right]^4$$

eq15

Shown in Figure 9 is the plot of the 3rd order SDM, based on eq14 and eq15.
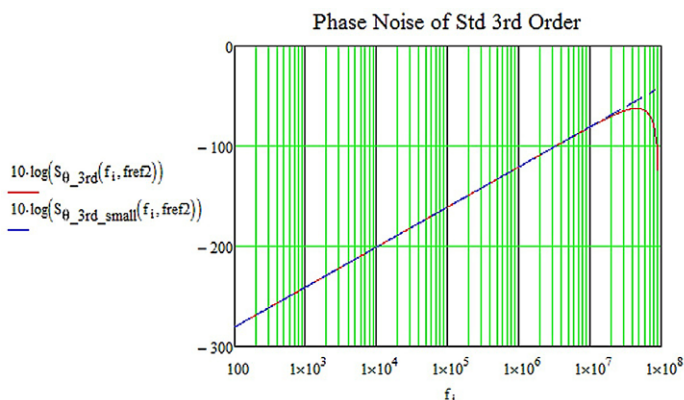
Figure 9: Plot of 3rd Order SDM phase noise.

IV. CONCLUSIONS

The operations of 3rd order SDM was explained, and its benefits compared to lower order SDM. Following that, the phase noise representation at the input of the fractional N divider was derived in details. As an alternative, a simplified phase noise equation assuming small offset frequency was derived and the plot comparing the actual phase noise equation with the simplified phase noise equation was included.

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Wi-Fi in a 'Carrier' Class of Its Own

By Steve Hratko, Director of Service Provider Marketing at Ruckus Wireless

More and more mobile operators are integrating Wi-Fi into their RAN infrastructure to supplement data network coverage, support LTE rollouts, and even introduce new Wi-Fi calling services. Steve Hratko, Director of Service Provider Marketing at Ruckus Wireless, explains how operators can make the most of integrating Wi-Fi into their network core.

Today's subscribers demand seamless wireless data access, and operators – both mobile and fixed line – are under pressure to meet this insatiable demand. Mobile network operators have responded to this surge in demand by investing in LTE network technology to deliver high-speed broadband, but the rollout of LTE services continues to be costly, and thus, gradual in many parts of the world. In order to maintain a judicious pace of network expansion while still meeting subscriber expectations, operators are turning to Wi-Fi to accommodate the huge surge in data traffic on their networks. They have discovered that Wi-Fi is not just a secondary channel to offload data traffic, it has become integral to their network infrastructure.

Wi-Fi provides an attractive option to operators looking to cost-effectively scale the capacity, efficiency and footprint of their existing networks. Where Wi-Fi was once seen as a competing technology to cellular, it is now an essential part of an operator's mobile offering. Tier one operators are now looking to leverage smart, carrier-class Wi-Fi solutions to deploy a complete, end-to-end, managed wireless infrastructure that provides reliable mobile data access.

Wi-Fi, of course, didn't begin life as a carrier technology. It was originally conceived as primarily a consumer and enterprise focused Internet access technology, restricted to indoor, high-density locations. Mobile operators were originally reluctant to adopt Wi-Fi, as it used unlicensed spectrum, which was looked upon as difficult to manage and unreliable. This was an alien concept for MNOs that had built their businesses on (and have spent billions of dollars on) licensed spectrum, over which they had total ownership and control. But the perception of Wi-Fi has changed. This is largely due to the fact that Wi-Fi solutions are now comprised of highly efficient and focused access points (APs) and network management software and hardware, much of which supports a new protocol called Hotspot 2.0 Release 2. This ensures the delivery of reliable, carrier-class Wi-Fi that seamlessly integrates with existing cellular networks.

There is no doubt that Wi-Fi has undergone a major transformation. What was once regarded as a risky option by carriers has now become a cornerstone network technology. In fact, last year, over 80% of smartphone traffic was carried over Wi-Fi.

So how did Wi-Fi become so important to the operators? To fully understand this we should first examine exactly what a carrier class Wi-Fi network is comprised of and what it can deliver for the operators.

IMPROVED DATA NETWORK COVERAGE

Making sure that users can pick up a strong signal from anywhere in the coverage area – that's the epitome of what it means to be carrier class. Carrier class Wi-Fi offers cutting-edge technology like adaptive antennas embedded in access points to guarantee the strongest possible signal whilst minimising radio frequency (RF) interference.

STAYING CONNECTED

Ensuring that subscribers remain connected is an integral part of what carrier class Wi-Fi can help deliver. This has traditionally required user intervention, but Hotspot 2.0 Release 2 empowers operators to automate the manual process of getting people connected to a Wi-Fi hotspot. This enables users to seamlessly 'roam' on and between Wi-Fi hotspots. Hotspot 2.0 achieves this through a revolutionary overhaul of the Wi-Fi connection procedure, automating the manual configuration and decision-making process as well as ensuring a secure, reliable connection.

UNLIMITED SCALABILITY

Finally, carrier class Wi-Fi networks must be able to scale to hundreds of thousands of access points, if required, mirroring the scale of existing cellular networks. This requires a wireless LAN (WLAN) management platform that has the requisite scalability (e.g., capable of to managing up to 10,000 access points).

Ideally, these platforms should be virtualised, making it possible to support almost unlimited scaling.

It's clear these carrier class Wi-Fi features like massive scalability and virtualization (e.g., Network Functions Virtualization) are helping to drive adoption with operators.

SUPPORTING 4G ROLLOUT

Carrier class Wi-Fi networks are now beginning to serve a much more strategic purpose, with operators assessing the long term role for Wi-Fi as a complement to 4G/LTE.

Wi-Fi was initially designed for relatively low mobility, but high capacity environments. Conversely, LTE and other licensed cellular technologies offer macro coverage and relatively high mobility but at a much higher cost. A complementary solution is achieved when the two technologies are deployed in tandem. With no spectrum licenses and no long lead times or complex configuration, Wi-Fi technology delivers reliable indoor and outdoor broadband services at a fraction of the cost and complexity of conventional macro alternatives.

Operators are now starting to integrate carrier class Wi-Fi into LTE small cells. By deploying small cells within their macro networks, it gives operators the ability to create more efficient heterogeneous network services that allow them to more quickly and easily scale capacity and coverage as needed.

Installing a Wi-Fi infrastructure is the first step in securing physical locations that allow mobile operators to introduce Wi-Fi and small cell LTE solutions. Operators who have suitable locations for Wi-Fi offload are not only solving the short term immediate capacity needs of the network, they are also ensuring a much easier transition to small cell LTE and solidifying their longer term strategic needs for the future.

WI-FI FINDS ITS VOICE

With LTE and Wi-Fi integration underway, operators have also discovered other uses cases for Wi-Fi apart from data offload, meaning there is now even an opportunity to monetize Wi-Fi. Many operators have recently launched Wi-Fi calling services. Wi-Fi calling is the ability to place a cellular call using a

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cellular voice stack in a smartphone (in this case LTE) over a Wi-Fi network, and then terminating it on the IP Multimedia Subsystem (IMS) complex in the mobile network operator's data centre. This is very different from over-the-top services like Skype because it is native to the smartphone (not a third party application) and it connects in exactly the same way that a traditional voice call would work. It also supports seamless network handoff as the user moves between Wi-Fi and LTE coverage areas. This has opened up the potential to rollout new voice and video calling services for domestic markets and even for international roaming services.

The key to enabling a true Wi-Fi calling service is again, making use of a smart carrier class Wi-Fi network infrastructure. To address some of the issues that could hinder good Wi-Fi calling, operators need to include adaptive antenna technology, which enables operators to deliver a strong signal to the user's device in almost any situation. Wi-Fi calling solutions should also include mechanisms that prioritise voice traffic, even when it's

encrypted. Additionally, they must be capable of enabling fast handoff to keep users talking while they move around in the coverage area; and call admission control to limit the load of data being transferred across the network.

With these carrier class features in place, a great deal of smartphone voice traffic will be able move over to Wi-Fi.

THE EXTRA MILE

Carrier class Wi-Fi has come of age due to a range of improvements to the technology, as well as the competitive advantages that it offers operators. Smart carrier class Wi-Fi is in now an integral, strategic technology for operators who are looking to provide data where it's needed and whenever it's needed, such as urban environments, which are typically challenging coverage areas from a cellular radio perspective.

The applications of carrier class Wi-Fi are only truly realised when operators use Wi-Fi that meets users' expectations in terms of quality and service. The operators that integrate smart carrier class Wi-Fi into their network offerings will be at a

distinct competitive advantage to those who remain ignorant to its capabilities.

Steve Hratko, Director of Service Provider Marketing at Ruckus Wireless.

Tektronix Communications sees NFV and SDN as key to next generation networks

By Ravi Chittimoori, Tektronix Communications

NFV (Network Function Virtualisation) and SDN (Software Defined Networks) are gaining traction with mobile operators and are considered key to delivering next-generation networks on the road to 5G. It is expected that when 5G eventually rolls out it will fully implement NFV and SDN. Already with LTE, there are many benefits besides cost reduction for those mobile operators moving in this direction.

In fact as we go to print Verizon, working closely with a number of its key technology partners — Alcatel-Lucent, Cisco, Ericsson, Juniper Networks and Nokia Networks — has announced that it is transforming its network by implementing a software defined network architecture, laying the groundwork for new innovative services and applications. According to the company, SDN-based architecture is designed to introduce new operational efficiencies and allow for the enablement of rapid and flexible service delivery to its customers.

In the following Q/A Ravi Chittimoori, Senior Product Manager and lead on network virtualization and NFV at Tektronix Communications highlights the issues and benefits around NFV and SDN.

WHAT ARE THE KEY DRIVERS BEHIND NETWORK VIRTUALISATION AND THE ADOPTION OF NFV/SDN?

Mobile operators are no strangers to change. The launch and evolution of LTE in recent years has required a steady stream of investment to improve network architecture and keep up with the explosion in subscriber data usage. However, despite this costly and time-consuming process, operators still find themselves facing flattening ARPUs and growing competition from OTT players – which has led to a monumental shift in the telecoms landscape.

One of the responses to these challenges that has gained a lot of traction in 2014 has been the move to a virtualised network environment through NFV and SDN. Adopting virtualization approaches gives operators the ability to roll out new services and features in day/weeks rather than months/years. This added "business agility" is extremely crucial to the operators when competing with OTT players. By using the orchestration capabilities of these NFV/SDN compliant solutions, operators also can significantly reduce their OPEX.

HOW WILL OPERATORS CONTINUE TO MONITOR AND OPTIMISE NETWORK PERFORMANCE IN A VIRTUALISED ENVIRONMENT?

Virtualisation will help operators reduce their dependence on network equipment providers that have dictated the pace of network development for so long. But it will not remove the complexity from monitoring the network environment. In fact virtualization of the networks actually increases the complexity of the networks because the network functions are now running in software modules on COTS infrastructure. Operators will increasingly find themselves in system integrator roles as the infrastructure is not from the same vendor who is providing the software network functions. It will lead to a proliferation of vendors and a patchwork of different systems.

Monitoring and optimizing the performance of the virtualized environment becomes even more challenging as the operators now not only need a horizontal network view (EPC plus IMS) but they also need to understand the vertical view (network plus the infrastructure) layered on top of the horizontal network view which will lead into new opportunities connecting both views together.

In the event of a problem or a potential issue, a real time diagnostics tool will not be sufficient to truly resolve the issue, historical data is critical to fully troubleshoot the problem. Visibility of all systems from different vendors will still be integral in a virtualised environment, which depends on having the right service assurance tools in place.

WILL THE NFV MODEL CHANGE THE ROLE OF NETWORK OPERATIONS AND ENGINEERING?

The move to virtualisation gives operators a platform to redesign their operations from the ground up, moving away from being an engineering-led, network-centric organisation towards a service-centric business. Virtualisation will also lead to a fundamental change in the way networks are controlled, which will necessitate a completely different approach to network and employee management.

Network engineers and support teams that have worked with physical infrastructure for decades will need to redesign existing processes. It's inevitable that there will be a period of adjustment for an operator's workforce, which may generate additional jobs as new skillsets are required. With this in mind, although NFV does represent a cost saving in the long run, operators will need to factor in staff training to ensure their work force also makes the transition from a physical to a virtualised environment.

BASED ON THIS NEW DYNAMIC, HOW WILL OPERATORS CONTINUE TO COLLECT AND CORRELATE NETWORK DATA; WILL THIS BECOME THE RESPONSIBILITY OF IT?

By adopting solutions that operate in an "orchestrated NFV/ SDN" and "Big Data Analytics ecosystem" and provide real-time, truly end-to-end "horizontal" and "vertical" views of the network, operators will be able to access meaningful network data and subscriber information that will let them truly fulfil the role of an integrated communications service provider. Once operators have visibility of this data, they will also be able to share it with other internal stakeholders. Each separate business unit will be a position to access data from across the network that's pertinent to their individual department, empowering them to make informed decisions on both a commercial and an operational level.

The limit of the business cases created by this intimate detail of customer knowledge is practically endless. The only restriction is the willingness of the operator to deploy the right solutions and processes that can access this data, then create an ecosystem that innovates delivery to end-user enterprises.

What is even more interesting is the fact this information can be accessed in real-time, empowering operators to make more strategic decisions. This real-time aspect is of huge importance to operators themselves, but also has tremendous potential for third-party organisations looking to leverage subscriber location and usage data.

WILL A VIRTUALISED NETWORK INFRASTRUCTURE BECOME THE LAUNCHPAD FOR NEW SERVICES LIKE VOLTE AND HOW WILL OPERATORS MONITOR THE PERFORMANCE OF THESE NEW SERVICES?

NFV is the key to unlocking a mobile network's hidden potential. It's a tool that will help operators escape being branded as simply data transporters or dumb pipes, and allow them instead to fulfil the role of an integrated communications service provider. This is critical at a time when LTE is becoming a mainstream technology and will soon surpass 3G as the standard service people use on their devices. Networks are becoming the platforms for new services, including VoLTE, which support high-definition voice and video calling features. The move to an NFV framework will give operators the agility and flexibility they have craved and enable

them to behave like digital businesses, displacing the third-party OTT providers that have cannibalised their revenues for years.

HOW WILL OPERATORS MANAGE TO COMBINE THEIR TRADITIONAL NETWORK ASSETS (E.G. RAN EQUIPMENT) WITH AN NFV/ VIRTUALISED FRAMEWORK?

As operators begin to integrate their traditional network assets with virtualised functions, it's vital they partner with a trusted vendor to ensure a seamless process that will not affect network performance or service level agreements. To ensure this level of network consistency, operators need access to the subscriber and network data across their traditional networks as well as the new virtual networks in real-time and on a 24/7 basis.

The adoption of these NFV/SDN enabled networks is a journey. During this journey operators have to figure out cost effective ways to monitor their legacy networks, the exponentially increasing traffic on their relatively new networks and the future virtualized/ NFV networks. Operators that adopt monitoring solutions that can span the entire breadth of these networks in a manner that makes it transparent to the networks operations personnel so that

they can retain their existing business processes and only evolve them as necessary will be able to successfully make this journey.

WHAT ROLE WILL TEKTRONIX COMMUNICATIONS PLAY IN A VIRTUALISED NETWORK INFRASTRUCTURE?

Adopting effective test and measurement tools has always been important for monitoring the performance of a hardware-based network. In fact, Tektronix Communications has built its business on the back of providing a robust and reliable end-to-end service assurance platform for operators. In a virtualised environment, the needs of the operator are the same; they still rely on the ability to quickly diagnose and troubleshoot problems to ensure the highest possible level of customer experience.

Therefore, to avoid the risk of service disruptions, increased churn rates and damaged reputations when moving to software-based network architecture, it's essential that operators have access to a rich set of solutions that are capable of giving the operators the real-time and end-to-end subscriber views. Tektronix Communications will play the role of a trusted partner by bringing to market innovative new solutions that will enable the operators to launch new services in

an agile manner and to ensure network functionality and performance in a fast-moving virtualized environment.

DO YOU THINK TELCOS ACCEPT THAT VIRTUALISATION THROUGH NFV AND SDN IS NOW A REQUIREMENT FOR THEIR FUTURE SURVIVAL?

It's widely accepted that NFV represents the evolution of network design and ultimately holds the key to improving service delivery. The transition from hardware-based to software-defined networks will simplify process management and reduce overall expenditure. But there is also a realization industry wide that this is a journey and challenges remain with virtualizing processing functions that are of very high capacity (ex: user plane packet processing in EPC networks). The question that remains, however, is how operators will manage the move to a virtualised environment. To ensure things run smoothly, its vital operators establish new data and analytics strategies to ensure the process is seamless and new business opportunities are not lost.

In a virtualised environment it's even more crucial to ensure visibility into the traffic as network functions become more dynamic and elastic. Operators really have a lot to consider before switching to NFV/SDN. They are in the early stages at the moment, and each operator will decide based on their own processes and workflows the level and depth that they will adopt the new technologies.

WHAT DEVELOPMENT DO YOU EXPECT TO SEE IN THE SPACE OVER THE NEXT 12 MONTHS?
While the average subscriber's data usage is showing no signs of slowing down, their reliance on traditional carrier-provided services, such as voice calls and text messages, continues to decrease. OTT players are undoubtedly driving down network operators' ARPU, and this trend looks set to continue in 2015.

It is crucial, therefore, that operators adapt to the changing telecoms environment and seek to establish new revenue streams and cost reductions through NFV and SDN. Operators cannot afford to ignore the need for virtualisation, and as MWC 2015 made clear, the next 12 months will see progressive operators moving from planning and testing virtualised networks to implementing them on a larger scale.

Massive real time data monitoring for NFV, SDN and hybrid networks

By Jean-Pierre Joosting

As a natural part of its evolution and in response to customer needs for increased capacity, greater deployment flexibility and enhanced visibility of total cost of ownership (TCO), Tektronix Communications has added to the GeoProbe platform with the launch of its latest GeoSoft ™ and GeoBlade ™ probing systems, sharing the same software architecture providing scalable and elastic and future proof capabilities.

GeoSoft is a revolutionary software-only or 'virtual' probe that has been developed in response to a number of carrier needs, including the move towards virtualized network environments. It supports both physical and virtual networks providing real-time and historic end-to-end session trace data, network-wide KPI visibility and enables the delivery of more innovative services, thereby improving customer experience as new services are launched.

With its ability to run on COTS hardware, GeoSoft represents a highly cost effective system, with a number of benefits including analytics enablement. Traditionally, in parts of service provider's networks characterized as "distributed low-band-

width environments", expensive methods such as traffic backhauling and aggregation methods were needed to get visibility of the data into the tool fabric. GeoSoft provides a solution for carriers of all sizes to measure remote or rural geographies that may not have had a sufficiently strong business case to support the higher CAPEX requirements of traditional solutions.

GeoSoft's Virtual Monitoring Function (VMF) is elastic, scalable and completely NFV-compliant to work in harmony with other NFV solutions. It delivers a highly flexible answer for monitoring next generation networks as they scale and develop, enabling carriers to purchase precisely according to current and future requirements, rather than wasting unused capacity, or running 'hot' on limited capacity. GeoSoft is an essential component in measuring and understanding the quality of the new services that the service operators desire to launch in an agile manner using NFV enabled networks.

As operators launch and operationalize the new NFV networks, the existing, physical networks will still be in place for a long time to come. The need to get an overall view of the network (physical and virtual)

is even more important. GeoSoft's VMF works within the context of the best-in-class Iris Applications to enable the users to get a single view of the network.

GeoBlade™ combines elastic software and modular hardware, to cope with the demands of today's massive data traffic growth, whilst providing the opportunity to scale at speed whenever needed. GeoBlade has the ability to support data transfer speeds from 10 Gbps to 100's of Gbps, collecting and correlating massive amounts of data in real-time.

The GeoBlade platform enables the operators to optimize OPEX due to the ingrained capability of handling network topology, configuration and capacity management in a programmatic and automatic fashion, and improves data integrity with a built in innovative load balancing architecture. This capability to interact in real-time with service operators' orchestration management layer also makes the GeoBlade platform a perfect choice to operate in a NFV environment where there is a need for a high density probing infrastructure.

www.tekcomms.com

NXP to focus on all CMOS radar

By Junko Yoshida

In announcing the planned acquisition of Freescale Semiconductor, NXP Semiconductor CEO Rick Clemmer explained how he expects the new entity — NXP and Freescale combined — to lead the growing automotive electronics market. In briefings, Clemmer casually mentioned, without elaborating, that making today's "big and clunky radars" small is one of the keys to next-generation advanced drivers' assistance systems. It turns out that the small radars Clemmer referenced aren't from Freescale's, a company known for its fine 77 GHz packaged radar front-end chipset using SiGe technology.

Clemmer was talking about an RF CMOS-based 80 GHz radar front-end transmitter chip — currently a working prototype — developed at NXP.

Called Dolphin, NXP's 80 GHz chip uses digital CMOS process technology, an accomplishment long believed impossible.

Lars Reger, vice president strategy, new business, and R&D for automotive at NXP, said that the working prototype is currently in the hands of "our lead customers [Tier Ones and OEMs] under non-disclosure agreement."

Asked about the tiny radars Clemmer cited, Reger said, "This isn't a story about small radars. It's about up-integration. We've found a path to integrate front-end radar transmitter with a baseband — all in CMOS."

Keeping the front-end chip in a process technology like BiCMOS would make it hard to advance integration, said Reger. Just as NXP has won the global car audio market by integrating FM, AM, satellite radio chips with silicon tuners — all in CMOS, "Our goal is to do the same up-integration with radar chips," he added.

During his interview with EE Times, Clemmer said NXP's AM/FM car radio chips are used on "27 out of 28 car audio platforms of choice" used by Tier Ones and car OEMs.

FROM GAAS TO SIGE, NOW TO CMOS?

The first commercial radar systems of the late 1990's were based on GaAs chips. But then Infineon started developing systems based on bipolar process SiGe chips. So did Freescale. Those SiGe radar chips are already designed into radar collision warning systems.

Reportedly, automotive radar developers have already warmed up to SiGe radar chips and begun switching from GaAs. But here's a big question: Will the new millimeter-wave sensors made in plain CMOS prompt them to switch again — this time from SiGe to CMOS?

That's the big market shift NXP is betting on. And certainly NXP isn't alone thinking along these lines.

About a year ago, IMEC announced a 79 GHz radar transmitter implemented in 28nm CMOS and designed for automotive radar systems. At that time, IMEC, which developed it in collaboration with Vrije Universiteit Brussel, called it "the world first," explaining, "With an output power above 10 dBm, the transmitter front-end paves the way towards full radar-on-chip solutions for automotive and smart environment applications."

Asked if NXP's Dolphin was spun out of IMEC's development, Reger said no. He said it's an internal project three years in the making.

RADAR OR VISION?

As to the future of ADAS, the auto industry isn't choosing radar over vision or vice versa. Euro NCAP isn't mandating either radar or vision. Nor is it asking carmakers to have both.

A carmaker can rely on a more advanced radar system combined with a lighter vision system or, conversely, choose to go with a more advanced vision sensor with a lighter version of radar.

Vision technologies excel in tasks like detecting lane markings and other road information, such as reading traffic signs, reliably detecting pedestrians, and lighting functions such as controlling the high/low beams.

On the other hand, vision technologies can't handle some jobs, like seeing through snow and fog. Dirt renders vision sensors blind. Unlike radar, vision technology can't see very far. Long-range radar (LRR) can comfortably handle between 30 and 150 meters, and short-range radar (SRR) can detect objects within 30 meters.

The automotive industry is looking for both solutions as a package. Freescale is doing exactly that. Freescale recently unveiled its S32V microprocessor.

Inside the automotive vision SoC is CogniVue's second-generation APEX Image Cognition Processing technology. The SoC additionally supports the fusion of vision data captured by the S32V device. Fused in are other data streams, including radar, LiDAR and ultrasonic information to enhance resolution and image recognition, Freescale said.

Meanwhile, Freescale has its own radar solution. Its MR2001 is a high-performance 77 GHz radar transceiver chipset "scalable for multi-channel operation enabling a single radar platform with electronic beam steering and wide field-of-view to support [multi-range] applications across automotive safety, communications infrastructure, and industrial systems," according to Freescale.

In vision Freescale and NXP have solutions using different vision algorithms experts. Freescale works with CogniVue and NXP is partnered with Mobileye.

In radar technologies, the merged entity is likely to profit from each other's diverging technology and market experience (Freescale's SiGe-based radars; NXP's nascent efforts for CMOS radar front-end transmitter chip).

WORK HAS ONLY BEGUN

NXP's Reger acknowledges that the work has only begun on a single-chip all CMOS radar transceiver in future.

Aside from integrating the radar front-end chip with MCUs to make a complete system-level solution for ADAS applications, antenna developments also need to come along to shrink the module.

Obviously, CMOS is lower cost, better integrates digital circuitry and benefits from technology scaling, compared to a SiGe bipolar process, but some say that's not enough. The maximum available gain at millimeter wave frequencies is known to be lower for CMOS, and its low supply voltage reportedly limits output power.

NXP's Reger, however, noted that the team is working on "the best radar illumination," to make more powerful, accurate and high-performance millimeter wave sensors that work for various range applications including mid and short-range.

The team is also working on a new scheme to connect multiple CMOS radar front-end chips via automotive Ethernet, so that they work as one.

ABOUT THE AUTHOR:

Junko Yoshida, Chief International Correspondent, EE Times.

Virtualised VoLTE and the mobile operator opportunity

Mark Windle, Head of Marketing at OpenCloud, explores how by harnessing open, cloud-based VoLTE infrastructure to capitalise on 4G, mobile operators can drive the transition to all-IP communication services and become more agile, innovative and profitable in the process.

In today's digital age, technology innovation is commonplace for internet companies and OTT service providers. Not a month goes by without some new-fangled service or application – Periscope and Meerkat the latest examples – being introduced to the public. But it's a different story in the telecoms world. The innovation cycle is much slower, due in part to the difficulty operators have in getting their ideas implemented quickly and inexpensively by equipment vendors; and in part due the emphasis on the physical deployment, integration and commission of new hardware into the network. This process, which happens first for the test network and then for the live one, can prove to be costly and time-intensive, and ultimately impacts how quickly operators can modify and improve their networks. The result is often a telecoms industry that is left lagging behind in an otherwise fast-changing technology market, as operators struggle to react, innovate and ultimately compete.

VOLTE AS THE VEHICLE FOR INNOVATION

Operators therefore need to find the missing cog in the wheel that will help the cycle of innovation move that little bit faster. While VoLTE has been purported to be the vehicle for much-needed service innovation, vendor and operator views on the technology point to it simply being an exercise in recreating today's voice-calling experience on an IP-network, rather than anything too ground breaking. Many telecoms experts still perceive VoLTE as little more than layering an old service onto a new technology – albeit with some network efficiency gains – so it's no surprise that operators aren't rushing in to it. According to Ovum, only 4% of 4G networks operating today have launched VoLTE services.

THE BARRIERS TO ADOPTING VOLTE

So what's turning operators off VoLTE? The perceived costs and time constraints associated with implementing the necessary changes to their core networks, for one. Add to that the uncertainty of how quickly they can undergo the migration of their subscriber base, and the availability (or lack thereof) of VoLTE-enabled handsets, and the gap between the theory and the real-world application of VoLTE becomes ever wider in their minds. Many of these assumed barriers are based on the idea that the traditional deployment of telecoms equipment is required, which is no longer the case. Virtualisation can provide a better path to innovation.

EVERY CLOUD HAS A VOLTE LINING

Harnessing a cloud-based service-layer can help operators transform their communication networks and support the deployment of new services, such as VoLTE, more competitively. Not only does the use of cloud servers negate the need for the physical deployment of network equipment, but it also allows operators to scale cloud-based solutions up or down, depending on the need for capacity at any given moment, in a matter of minutes. By reducing deployment costs, this 'grow-on-demand' scalability acknowledges the uncertainty many operators feel towards VoLTE migration rates. Virtualisation plays a crucial role as an enabler for operators in deploying innovative services like VoLTE with more speed and urgency. While there are standards for VoLTE (a common set of services and features) that will remain the same for all operator implementations, real differentiation will be borne out of moving beyond the "standard". Operators are missing opportunities to differentiate by ignoring the potential of virtualisation for improving service innovation.

HARNESSING THE CLOUD FOR SERVICE INNOVATION

The cloud can offer so much more to operators when used to improve service innovation. For example, traditional test networks do not provide flexibility in terms of making improvements quickly and easily – new changes need to be scheduled in advance, and wait their turn in the queue. Furthermore, the test network is an expensive, scarce resource: some new ideas get blocked simply because uncertainty in the reward fails to secure a slot for the innovation in the test schedule. But virtualisation opens up a new model – instead, it pro-

vides developers with a completely new cloud-based 'test' network.

This DevOps mentality (an innovation model where development and operational deployment are closely linked) is a useful tool for those operators looking to win and retain high-value enterprise customers. With cloud-based virtualised network functions, each developer group can have their own miniature test network: they can then develop, deploy and test without hindrance. It's how it happens in other industries, so why not telecoms? By developing new services in this agile DevOps manner operators can provide their customers with innovation that enriches the communication experience.

Of course, there is a tacit assumption here: that the developers themselves have independent freedom to develop, without reliance on equipment vendors to implement the innovation. That would require products that were open to third party development – another conversation altogether.

The innovative and competitive benefits for the operator are clear – in addition to reducing time and cost usually spent on traditional deployment, virtualisation of the service-layer significantly and positively impacts communication service innovation, as well as competitive differentiation for consumer and enterprise services.

VIRTUALISATION AS THE PATH TO TRANSFORMATION

As Thomas Edison once said: "If there's a way to do it better, find it." To remain competitive, the telecoms industry can no longer follow traditional processes and let the chips fall where they may. Instead, it needs to be proactive in finding more efficient ways to achieve innovation at a faster pace, in order to become more agile and better serve customers in the longer-term. Cloud-based service-layers, underpinned by virtualisation, offer a path to transformation, providing operators with the tools they need to collaborate alongside vendors, developers and end-users to create unique VoLTE services. Some operators are already leading the charge of this new model. The question for the rest of the operators in the industry is whether they will follow, or allow others to vault over them when it comes to making the most of the VoLTE opportunity.

Mark Windle, *Head of Marketing, Open-Cloud.*

Chinese researchers highlight promising technology for 5G

By Jean-Pierre Joosting

Will 5G be on track to roll by 2020? It will probably be close but the research so far is promising and indicates that technology will be up to the task. 5G will be the first meaningful unified wideband mobile communication system.

A recent study has systematically overviewed the latest progress on the 5G research and highlighted the network architecture and several promising techniques which could be employed in the future 5G systems. The research also foresees potential research keypoints and directions.

The 4G LTE systems, supporting up to 100Mbps data rate, have been globally deployed and are offering several multimedia services such as HD video, which greatly enriches and changes people's life. However, with the development of the mobile internet and internet of things (IoT), especially by the year 2020, current 4G systems cannot satisfy the explosive growth of mobile data, massive device connection, and a variety of emerging services and application scenarios, which drives the research on 5G system. It is expected that 5G systems would offer maximum 1 Gbps user experienced data rate, tens of Gbps peak data rate, tens of Tbps/km2 traffic volume density, millisecond level of end-to-end latency and support 500+km/h mobility.

The related research paper "Key techniques for 5G wireless communications: network architecture, physical layer, and MAC layer perspectives" has been published on SCIENCE CHINA

Information Sciences, vol. 58, no. 4, 2015 , and its authors are Ma Zheng, Zhang zhengquan, Fan pingzhi, Li hengchao at Southwest Jiaotong University, China and Ding Zhiguo at Lancaster University, UK.

The research presents an overview of potential network architecture and highlights several promising techniques which could be employed in the future 5G systems by deeply analyzing 5G requirements and current research. These techniques include non-orthogonal multiple access (NOMA), massive multiple input and multiple output (MIMO), cooperative communications and network coding, full duplex (FD), device-to-device (D2D) communications, millimeter wave communications, automated network organization, cognitive radio (CR), and green communications etc. The state-of-art and implementation issue of these techniques are also addressed.

"The quest to improve the spectral efficiency has been regarded as the most important but yet challenging task in the design of future wireless communication systems," the authors wrote in the paper. It seems that NOMA, Massive MIMO, full-duplex, and D2D communications etc. would be the sharp weapons.

Global wireless communications would suffer from the "Spectrum crisis" and radio spectrum resource has gradually become the bottleneck of development of broadband wireless communications. There are two main ways to overcome this problem: one is to develop the rich millimeter wave frequency spectrum, the other is to fully utilize current spectrum resource by the cognitive radio technique.

It seems that the highly smart and automated network organization is the legitimate way of managing such a huge and complex multi-RAT and multi-layer heterogeneous network in 5G era.

Handheld spectrum analyzer is web enabled

Anritsu Company has introduced Web Remote Tools for its Spectrum Master™ MS2720T handheld spectrum analyzer that allows the instruments to be controlled from any web-enabled device, including laptops, tablets, and smart phones, over an Ethernet link.

Web Remote Tools gives field technicians greater flexibility when conducting measurements and makes it more time- and cost-efficient to conduct RF spectrum monitoring, as well as test Remote Radio Heads (RRUs) and other inaccessible radio units at 3G and 4G base stations.

Once configured, a field technician's laptop, tablet, or smart phone can be used to control the Spectrum Master handheld spectrum analyzer, download files, or view monitoring results. The easyTest feature of Spectrum Master simplifies complex spectrum monitoring requirements and allows for one-button measurement sequences directly from the web-enabled device. Transferring test results is simplified with Web Remote Tools, as all instrument files, directories and sub-directories can be downloaded as a zip file.

Setup is very quick with Web Remote Tools. Short-range links of up to 300 feet can be created using a pocket Wi-Fi router. Long-range links can be easily established via wired backhaul, as well. Up to five traces per second can be updated using the Spectrum Master fast mode feature, for unprecedented responsiveness.

www.anritsu.com

Glitch-less RF digital step attenuators

Peregrine Semiconductor has announced three UltraCMOS® glitch-less RF digital step attenuators (DSAs) — the PE43711, PE43712 and PE43713.

Next generation to the company's existing DSA portfolio, these glitch-less attenuators feature an extended temperature range, a wider power supply, a faster switching speed, broader control logic support, increased ESD tolerance and, glitch-less attenuation state transitions. The PE43711 and PE43712 are designed for wireless-infrastructure devices, land-mobile-radio (LMR) applications and point-to-point communication systems, while the PE43713 is ideally suited for test-and-measurement applications.

When switching attenuation states with a DSA, there is a brief "glitch" or transient spike in output power. This glitch, if left alone, could lead to degraded signal quality and possible damage to power amplifier sub-assemblies. To minimize this glitch, engineers deploy a software or firmware workaround that reduces the effect of this transient spike. With these latest glitch-less DSAs, this output power glitch is significantly reduced to less than 0.3 dB, enabling customers to decrease their engineering overhead and prevent damage to expensive sub-assemblies.

The UltraCMOS® PE43711, PE43712 and PE43713 are 50-ohm, 7-bit DSAs that support a broad frequency range from 9 kHz to 6 GHz. They cover a 31.75 dB attenuation range with flexible attenuation steps of 0.25 dB, 0.5 dB and 1 dB. These DSAs are capable of maintaining 0.25 dB monotonicity through 4 GHz, 0.5 dB monotonicity through 5 GHz and 1 dB monotonicity through 6 GHz.

www.psemi.com

RF relay switches
guarantee performance up to 10 million life cycles

Fairview Microwave has launched a portfolio of electromechanical relay switches that cover ultra-broadband and millimeter-wave frequencies up to 40 GHz.

These high-reliability RF switches are guaranteed to perform up to 2 to 10 million life cycles, which make them ideal

for demanding industries and applications related to defense and commercial aviation, radar, wireless communications, satellite communications, test and measurement and many others.

These coaxial relay switches are available in multiple varieties from SPDT (Single Pole Double Throw) to SP12T (Single Pole 12 Throw) and are designed with either SMA, Type-N, or 2.92 mm depending on the frequency range. Frequencies for these RF switches range from DC to 40 GHz depending on the model, power ratings range from 5 W to 700 W, operating voltage ranges from +12 V to +30 V and have high isolation up to 85 dB and low insertion loss of 0.15 dB at 1 GHz.

The company's latest relay switches have a patented design of the actuator and the transmission link has been optimized for magnetic efficiency and mechanical rigidity, which is what guarantees operation up to 10 million life cycles. The MIL-STD-202 qualified construction of each switch is designed to withstand exposure to sine and random vibration and mechanical shock.

www.fairviewmicrowave.com

GaN LNA meets need for high RF power survivability

Custom MMIC has announced the addition of the CMD219C4, a GaN low-noise amplifier, to their standard product catalog. The CMD219C4 is a broadband MMIC low-noise amplifier fabricated in GaN technology that operates from 4 to 8 GHz with a gain of 22.5 dB, a noise figure of 1.0 dB, and an output 1 dB compression point of +17 dBm. In terms of survivability, the CMD219C4 can withstand RF input power levels of up to 5 W without permanent damage. The device is housed in a leadless 4x4 mm ceramic package.
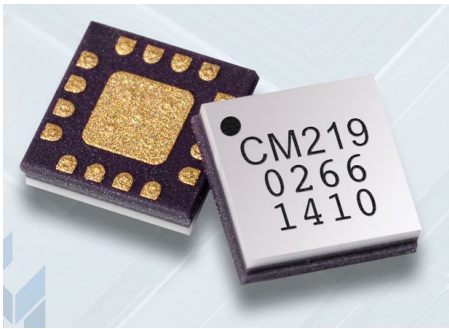
The CMD219C4 is ideally suited for microwave radios and C-band applications where small size and high input power survivability are needed, such as point-to-point and point-to-multi-point radios, military and space, and test instrumentation.

www.custommmic.com

SMT GNSS global positioning module
supports all satellites

Featuring a sensitivity of -167 dBm with its built-in antenna for an easy integration, the 9.6 x 14.0 x 1.95 mm CAM-M8C module from u-blox is a low profile GNSS positioning module that offers simultaneous GNSS operation for GPS/GLONASS, GPS/BeiDou, or GLONASS/BeiDou.

Delivering accurate, jamming-resistant and reliable positioning anywhere in the world, the unit integrates a u-blox M8 satellite receiver, crystal oscillator, SAW filter and low-noise amplifier. It also has an input for an external active antenna and when using this option the internal antenna acts as a backup.

A novel antenna design maintains the module's performance regardless of physical orientation. This makes the product highly suitable for mobile applications with frequent change of bearing. The CAM-M8C is manufactured in ISO/TS 16949 automotive-certified production sites, ensuring the highest quality and reliability. An evaluation kit is available.

www.u-blox.com

RFID tag
built-in cryptographic security

The UCODE DNA from NXP Semiconductors is one of the first UHF RAIN RFID tags to combine long-range read performance with cryptographic authentication, giving developers contactless performance and security in a single IC.

Cryptographic authentication provides dynamic security with each transmission being different from the one before, minimising the ability for data to be emulated. The UCODE DNA delivers ISO/IEC 29167-10 standardised cryptographic security using a 128-bit key based on AES (advanced encryption standard) algorithms. It is also compliant with the GS1 EPC Gen 2 V2 air interface standard, which supports cryptographic authentication in RFID systems operating in the UHF range (860 MHz to 960 MHz).

NXP Semiconductors offers developers a service for trust provisioning, which generates and inserts the cryptographic keys into the UCODE DNA tag IC during the manufacturing process. In addition, the device provides up to 3 kbits of user memory with block permalock, up to 448 bits of EPC (electronic product code) memory, and read sensitivity of -19 dBm.

www.nxp.com
www.rainrfid.org

Benchtop scanners
enable real-time near-field testing of PCBs and antennas

Designers of antennas and high-speed printed circuit boards can cut testing times drastically by using scanners introduced by MDL Technologies. The benchtop scanners from EMSCAN provide real-time images of EMI and antenna emissions, enabling designs to be evaluated in seconds. The EHX scanner can be used for testing PCBs at frequencies as high as 8 GHz, allowing engineers to visualise the root causes of potential EMC and EMI problems. It is ideal for boards designed for high speed, high power and high density or complexity.

Being able to resolve even intermittent problems early in the design process helps optimise designs and avoid unexpected EMC compliance test results. Emission, immunity, filtering, EMI shielding, broadband noise and common mode testing are some of the applications that can be addressed in seconds.
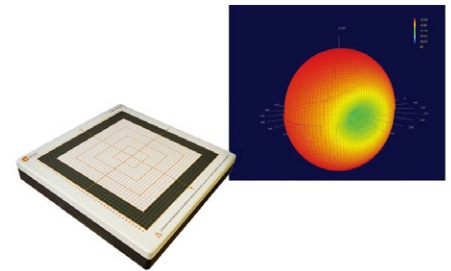
For antenna testing, the RFX scanner can show far-field patterns, bisections, EIRP and TRP. Novel near-field results, including amplitude, polarity and phase, can give insights into the root causes of antenna performance problems and help troubleshoot far-field radiation patterns.

It allows real-time analysis of embedded antenna designs, giving the possibility of multiple design iterations at each stage of the design process. This provides wireless engineers with the freedom to carry out rapid prototyping and explore new designs, forms and materials.

www.mdltechnologies.co.uk

RFID EPC functionality through NFC

The EM4423 from EM Microelectronic claims to be the first RFID circuit available that features a UHF EPC Gen2V2 RF and an NFC Type 2 interface.

The chip enables manufacturers and brands to embrace the Electronic Product Code (EPC) functionality for retail logistics and inventory control, while allowing them to communicate directly with the consumer for marketing and advertising, product authenticity, and product registration on a per-item level.

With common rewritable memory areas, a common Unique Identifier (UID) and value-added privacy and security features, the EM4423 also simplifies adoption of EPC inventory control procedures by smaller retailers who are not willing or able to make the substantial
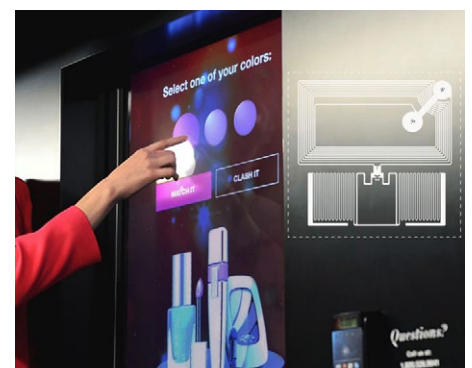
investment required for specialized RFID equipment and software. Similar functionality can be achieved through the use of mobile devices, such as smartphones and tablets and applications.

The single chip NFC/EPC solution features a dual-interface memory access (NFC and/or EPC), it offers more than 2-Kbit of user data.

www.emmicroelectronic.com

Low power Bluetooth Smart sensor beacon
enables motion and context awareness

On the heels of its EMBC01 multi-protocol proximity beacon, EM Micro-electronic has launched the EMBC02 sensor beacon. The unique combination of sensors with the company's low-cost, low-power and fully certified beacon technology will be an enabler of many real-world Internet of Things (IoT) applications.

EMBC02 beacons integrate a 3-axis accelerometer in the same easy-to-use, tiny form factor as EMBC01, enabling a wide range of motion-based beacon applications. By attaching EMBC02 to objects or people, both, proximity and motion, can be monitored by a smart-phone or tablet application. EMBC02 can be programmed to transmit proximity and identification data, like standard beacons, but it can also provide motion data (movements, vibrations, acceleration) as well as specific motion-based alarms based on accelerometer data, originating from shock, free-fall or taps. The accelerometer can maximize battery life by "beaconing" data only when required, for example, while in motion, or when an alarm condition occurs.

The EMBC01 Bluetooth Smart proximity beacon can operate for more than 12 months on a single CR2032 coin cell. It offers even longer battery life with optimized usage scenarios where the beacon sleeps (or transmits infrequently) until the accelerometer detects movement.

www.emdeveloper.com

High frequency PCB probe
specified to 44 GHz

D-COAX has introduced high performance TDR–VNA probe assemblies through 44 GHz in the 2 configurations.

Testing for small discontinuities on non-planar PCBs is now possible on a 40 GHz VNA or very fast TDR because of the durable and repeatable probe design.

The probes deliver excellent uncorrected return loss and low insertion loss. The OmniJet probe 40 GHz insertion loss is better than -1.5 dB and the return loss is better than -10.0 dB at 40 GHz.

www.D-COAX.com

Rubidium miniature atomic clock
targets basestations

According to Microsemi, its enhanced Quantum rubidium miniature atomic clock (MAC) SA.3X family exceeds wireless LTE base station and mission-critical defence infrastructure holdover requirements.

As one of the smallest, lightest and highest-performing MACs, the enhanced Quantum MAC SA.3X family is based on the company's coherent population trapping (CPT) technology, to meet all traditional, broad market frequency reference application needs.

Featuring mechanical robustness and temperature performance, the MAC SA.3X family is only 25% of the volume of the nearest competing clock in the same category. This small size, combined with its very low power consumption, makes the SA.3x series ideal for a broad variety of platforms that mount directly on printed circuit board assemblies (PCBA), eliminating the need for a heat sink or fan.

Microsemi notes that it designed the Quantum MAC SA.3X family specifically to meet essential frequency accuracy and stability requirements in applications that include wireless base stations, wire line network infrastructure, defence systems and test and measurement instruments. These types of systems can benefit from the low-power Quantum MAC SA. 3X that provides the ability to operate across a wide range of temperatures.

The Quantum Rubidium MAC family delivers superior holdover accuracy over extended time periods, exceeding all wireless LTE base station and mission-critical defence infrastructure requirements. The MAC-SA.3x will meet the LTE holdover requirements for several days, a significant feature.

www.microsemi.com

Bluetooth Smart wearable-on-chip device claims world first

Dialog Semiconductor has released details of its DA14680 'Wearable-on-Chip' Bluetooth Smart (v4.2) device. The small, ultra-low power integrated circuit includes the key functionality to create a fully hosted wearable computing product.

The DA14680 features flexible processing power, flash memory for virtually unlimited execution space, dedicated circuitry for sensor control, analogue and digital peripherals optimised for wearable products, and an advanced power management unit. It eliminates several external chips from wearable product design, facilitating smaller form factors, lower system cost and lowest power consumption.

Addressing the wearable market predicted to reach approximately 170 mil-

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www.eumweek.com

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  (including Asia and US as well as Europe)

The Conferences:

- European Microwave Integrated Circuits Conference (EuMIC)
- European Microwave Conference (EuMC)
- European Radar Conference (EuRAD)
- Plus Workshops and Short Courses
- In addition EuMW 2015 will include
  the 'Defence, Security and Space Forum'

EuMA
European Microwave Association

Official Publication:
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lion units by 2019 (Market source, Berg Insights, 2014), the DA14680's ultra-low power 30 uA/MHz ARM® Cortex™-M0 application processor may be programmed to a maximum clock frequency of 96 MHz. Security features include a dedicated hardware crypto engine with elliptic curve cryptology (ECC), delivering end-to-end banking-level encryption, ensuring personal data security.

The device integrates 8 Mbit flash memory, audio support with PDM and I2S/PCM interfaces, two separate I2C and SPI buses, three white LED drivers, a temperature sensor, multi-channel DMA, and an 8-channel, 10-bit ADC. Intelligent power management, including system power rails and a Li-ion/LiPo battery charger and fuel gauge are also on-chip.

Product development is accelerated using Dialog's SmartBond development kits. These include the SmartSnippets™ software development environment, example application code and a power profiler for real-time, power-optimised coding.

The DA14680 will be sampling in the second quarter of 2015.

www.dialog-semiconductor.com

High power low-pass filters
handle up to 2500 W

RLC Electronics offers low-pass filters that are designed for high power systems in the frequency range of 100 to 8000 MHz.

These filters are designed to handle 2500 W average under extreme temperature and altitude conditions, while offering low loss of 0.15 dB typical and maximum VSWR of 1.5:1. The company provides customers the flexibility of choosing the cutoff frequency, number of sections and connector type (N, SC, HN, 7/16) for a true custom high power low pass product.

www.rlcelectronics.com

3000 MHz VCO
delivers high linearity

The CVCO55CC-3000-3000 voltage controlled oscillator (VCO) from Crystek operates at 3000 MHz with a control voltage range of 0.5 V to 4.5 V.

This VCO features a typical phase noise of -110 dBc/Hz at 10 kHz offset and has excellent linearity. Typical output power is +7.0 dBm. Engineered and manufactured in the USA, the model CVCO55CC-3000-3000 is packaged in the industry-standard 0.5-i x 0.5-inch (1.27- x 1.27-cm) SMD package.

The device has an input voltage of 8.0 V, with a typical current consumption of 35 mA. Pulling and Pushing are minimized to 1.0 MHz and 0.2 MHz/V, respectively, while second harmonic suppression is -15 dBc typical.

www.crystek.com

Ultra-broadband portable amplifiers
for harsh environments

Pasternack has announced a range of portable bench top amplifiers that cover extremely wide frequency bands up to 40 GHz. These rugged RF amplifier modules are designed to meet MIL-STD-202F environmental test conditions for humidity, shock, vibration, altitude and temperature cycle which makes them ideal for use inside high traffic test labs in industries such as aerospace, defense, optical, industrial, telecom and R&D.

The RF amplifiers range includes four models covering multi-octave bandwidths between 1 GHz to 40 GHz and exhibit flat gain response. The bench top amplifiers offer up to 60 dB small signal gain with high dynamic range, low noise figure of 5 dB and output P1dB compression power ranges from +10 dBm to +22 dBm.

These portable and compact amplifiers have an operating temperature range -40°C to +85°C and allow a storage temperature of -40°C to +100°C. The 20 GHz modules use SMA female connectors, while the 40 GHz versions utilize 2.92-mm connectors.

The ultra-broadband portable bench top RF amplifiers use a single AC voltage supply with internal voltage regulation, are fuse protected, and are designed with convenient front panel access with an on/off switch and RF input/output connectors. No export license is required for these products.

www.pasternack.com

Wideband amplifiers
deliver dependable network connectivity

As the success of more military operations relies on the ability to communicate and exchange information via mobile devices, AR Modular RF has introduced a number of devices in support of network connectivity.

The AR-20R and AR-55L wideband networking amplifiers help ensure a strong, dependable network connection even in extreme conditions, when connectivity is often needed most.

Model AR-20R provides 20-W of power across the 225 MHz to 1.9 GHz frequency range. Model AR-55L covers the 1.2 to 1.9 GHz range with 50-W of power. These powerful booster amplifiers are designed for use with the latest networking formats, such as ANW2, WNW and SRW. Both models include a switchable low noise amplifier and filters to help keep local high-power transmissions out of the receiver channel.
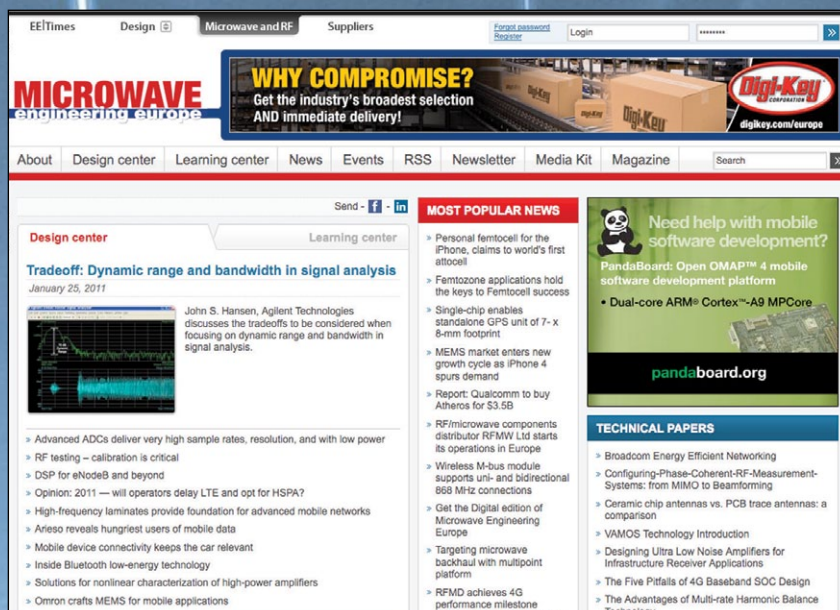
The company designs its booster amplifiers to be rugged, dependable and simple to operate.

www.arww-modularrf.com

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$$C = BW * \log_2\left[1 + \frac{S}{N}\right]$$

mmWave — Massive MIMO

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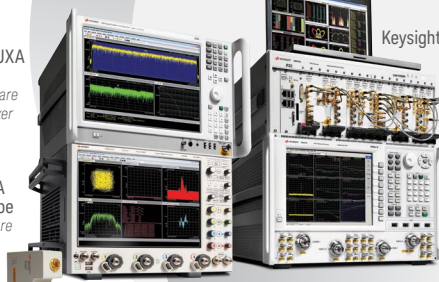Keysight N7608B Signal Studio
for custom modulation

Keysight N9040B UXA signal analyzer
with 89600 VSA software and M1971E smart mixer

Keysight 89600 VSA software

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Keysight M8190A arbitrary waveform generator

Keysight M9703A high-speed digitizer/ wideband digital receiver

Keysight MIMO PXI test solution
M9381A PXI VSG and M9391A PXI VSA - Up to 8x8 phase-coherent MIMO measurements

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