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Is Innovation as big a challenge as security?

Ongoing concerns over security have focused on Huawei, but should worries over security extend to the wider supply chain and our dependence on Chinese technology?

The arguments over allowing Huawei communications network equipment to be used in the roll-out of networks around the world, has raised some interesting questions.

While a recent report from the UK’s National Cyber Security Centre said that the risk from using telecoms equipment supplied by Huawei was ‘manageable’ another report, from the Royal United Services Institute (Rusi), said it would be “naive” and “irresponsible” to allow Chinese tech giant Huawei to access the UK’s telecommunications system.

It’s certainly a tough call for policymakers especially as many security analysts have described and detected espionage, malware, and theft by manufacturers that are affiliated with the Chinese government - Huawei is just one company in what is a very large supply chain with many points that could be compromised.

What about the host of components that make up the internet and are made by firms that are affiliated with the Chinese government and which are used extensively to connect our homes, offices, and businesses?

Many of the apps we use to connect to the internet are made in China and operate on Chinese made mobile phones.

Concerns have been expressed, and reports published, on the collection and processing of data by the likes of Google and Facebook, but much of the data that is processed and stored is done using Chinese data centres.

Increasingly, China drives technological innovation. Take 5G for example, the bulk of papers associated with 5G technologies are published by Chinese scholars from Chinese universities, not Americans or Europeans.

Many of the patents being filed in communications technologies in the EU, are not necessarily filed by Europeans. Huawei, for example, is responsible for most of the patents in this category.

In 2008, 2693 patents were filed in Europe within the telecommunications and connectivity categories. Of these, just 116 were filed by Chinese firms. By 2017 China accounted for 1478 of the 3717 patents granted – that’s a massive increase.

Our concerns over security require much greater insight when it comes to products and services, especially when it comes to managing risk and security.

Smartphones and GPS applications can certainly be abused and we simply don’t know how the data being generated is being collected, stored and used – we need much greater transparency too.

But here’s the problem. Companies in the West will soon not be able to produce the next generation of technology without Chinese patents and input.

A lack of innovation and growing dependence on Chinese technology is, perhaps, as big a concern as that of security.

Neil Tyler
Editor, New Electronics
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Modulation is a process by which characteristics of a high-frequency carrier signal are altered to convey information contained in a lower-frequency— or baseband—signal. Modulation is based on the fact that by “mixing” or “beating” together two signals at different frequencies, two products are obtained—one waveform at the sum and a second at the difference of the two frequencies.

An example of modulation is shown in Figures 1 and 2, which illustrate amplitude modulation, (AM) in the time and frequency domains. The information—or baseband—signal is mixed with the high frequency carrier (RF) signal before transmission, resulting in the amplitude of the carrier frequency varying according to the baseband signal.

In the frequency domain the result is a double-sideband signal, centred on the carrier frequency, with twice the bandwidth of the original signal. By careful choice of the carrier frequency, the modulated signal is shifted to the required point in the frequency spectrum—usually allocated by the relevant regulator, e.g. for radio stations, etc. The other two main types of modulation are frequency modulation (FM) and phase modulation (PM). Several other methods exist which are based on combinations of these basic types.

Modulation enables the more effective use of spectrum by ensuring transmission within the allocated frequency band, and more efficient transmission as radio signals propagate more effectively at higher frequencies.

The main function of a radio receiver is to capture the transmitted RF signal and recreate the original baseband signal— a function known as demodulation, effectively the reverse of modulation, where the baseband signal is recovered from the carrier signal. AM demodulation is usually carried out using either rectification or filtering techniques whereas, in modern radios phase-locked loops, (PLL) are used to demodulate FM signals.

Classic radio receiver design has been based around the superheterodyne approach where the RF carrier is down-converted to one or more intermediate frequency (IF) stages before being demodulated—as shown in Figure 3.

There are several advantages to using this approach:

- By tuning the local oscillator (LO) according to the received RF signal, (ganged tuning), common IF frequencies can be achieved, which simplifies subsequent processing.
- Filter bandwidths increase with frequency, consequently, it’s harder to eliminate unwanted signals at RF frequencies than at IF levels.

Classic AM and FM techniques have been unable to meet the growing demands for high-volume traffic as modern communications systems demand more information capacity, higher signal quality, greater security and digital data compatibility. Recent technological advances have been instrumental in addressing these challenges.

I/Q modulation is one of a number of new modulation methods, when combined with other digital techniques, that enables more efficient use of spectrum and handling of digital data as well as voice.
I/Q modulation uses two carrier signals; the in-phase (I) and quadrature (Q) waveforms, with the Q waveform being generated by shifting the I waveform by 90 degrees.

Each waveform can be modulated separately enabling the creation of a variety of different modulations.

Direct Conversion (DC) receivers have emerged to meet the growing demand for smaller radios that offer lower power consumption, for applications such as mobile telephony and IoT applications.

DC, which also employs I/Q modulation, involves down-converting the RF signal directly to baseband in a single stage by matching the LO frequency to the RF carrier frequency. This technique removes the need for the bandpass filters required in superheterodyne receivers, resulting in a more compact receiver.

Although the origins of DC can be traced back to 1924, it’s only over the last 20 years or so that market forces, combined with the development of semiconductor process technologies, have enabled this technology to gradually supplant superheterodyne designs.

Figure 4 shows the basic structure of the DC receiver.

A single local oscillator is used to shift the incoming RF signal down to baseband. Baseband contains two paths, I-path and Q-path, corresponding to in-phase and quadrature paths. Each path is then digitised separately.

The two variants of DC are near-zero IF – where the LO frequency is slightly different from the carrier – and low IF, where the difference is a little greater, but not as great as that used in a superheterodyne receiver.

The Challenge

Although the DC receiver has benefits over the superheterodyne receiver in terms of bandwidth and compactness, implementation of this technology does face a number of challenges:

- I/Q imbalances: Can occur due to slight mismatches in sections of the receiver chain when dealing with the I and Q signal paths. These mismatches can occur if there is any variance in the 90 degree delay between I and Q signals and can also arise from any slight mismatch in overall gain for each of the signal paths. These imbalances need to be corrected over both frequency and temperature.
- Non-linearities: Higher (2nd and 3rd) order intermodulation products, derived from strong out-of-band interference or blocking signals can produce harmonics and intermodulation terms, which will then appear in the baseband. In DC, second-order non-linearity of the mixer is critical, as it produces baseband signals that appear as interfering signals in the down-converted desired signal. This can be alleviated by extremely well-balanced circuit design.
- DC offset: A strong, nearby signal, including the receiver’s own LO, can mix with itself down to zero-IF (this is known as “self-mixing”) and generate a DC level appearing as interference at the centre of the desired band. As well as interfering with low frequency components in the desired baseband signal, DC offset changes the average voltage of the signal waveform, as
shown in Figure 5, leading to issues with the dynamic range of the ADC converters.

**The Solution**

DC receiver architecture has become an attractive solution for meeting the demands of the commercial market for low-cost, low-power, wide bandwidth, and highly integrated RF circuitry.

CML’s CMX994/A/E family of DC receivers are designed to provide exceptional interference immunity, in terms of second order intermodulation and blocking, suitable for professional radio designs, whilst also offering low power modes. DC offsets are handled in several ways; the receivers are specified with a typical mixer IIP2 performance of +79dB, which attenuates any second order mixer intermodulation products appearing at 0Hz (DC). A commonly used DC offset correction method in DC receivers is to apply small correction voltages at the mixer outputs, before the baseband signals are amplified. The CMX994 devices enable this using an on chip register – the Rx Offset register – which can be accessed by the microprocessor or DSP that processes the I/Q signals from the CMX994. Access to the register is via the device’s C-BUS interface and the value of offset applied is controlled by the 8-bits in this register.

The offsets applied to I and Q signals are independent, with bits 0 -3 controlling the offset applied to the I Channel and bits 4 – 7 controlling the Q channel. Since the level of DC offsets can vary with frequency and gain, a number of measurements should be taken, ideally without a signal being present, whilst setting up the system. The signal processing algorithm can then be set up accordingly in order to apply the correct offset voltages during operation.

DC conversion presents a solution for high performance, low power and low cost radio receivers with fewer filters and a lower bill of materials than the traditional superheterodyne design. This enables a high level of silicon integration, while recent advances in technology have enabled designers to overcome many of the challenges inherent to DC conversion.
Embedded Systems

New embedded Linux solution
Introducing a new Siemens enterprise-class embedded Linux solution for embedded systems development

With the growth of Internet of Things (IoT) and other smart devices, it is becoming increasingly more complex and expensive for manufacturers to develop embedded, Linux-based applications.

With that in mind, Siemens introduces a new enterprise embedded Linux solution, Mentor Embedded Linux based on Debian which provides manufacturers with secure, scalable, and configurable distributions for industrial, medical, aerospace, and defence applications. This commercially proven and configurable distribution includes a robust operating system (OS) platform for embedded systems development – the result of the continued integration between Siemens AG and Mentor, now a Siemens business. The solution is based on Debian, a broadly utilised, enterprise-class, open source Linux OS.

The new Siemens Mentor Embedded Linux based on Debian offering combines the stability, full features, and ease-of-use benefits of an enterprise solution with the performance, customisability, and footprint of an embedded OS.

Originally developed by an internal team of embedded Linux experts for Siemens automation equipment, this commercially available solution helps embedded developers mitigate the costs and risks of moving to Linux.

Comprising numerous and integrated pre-built and fully tested binary packages, Mentor Embedded Linux based on Debian offering provides all the general features and parameters necessary to allow large numbers of users to apply it with ease and efficiency. The Siemens binary Linux solution includes a stable kernel, a robust toolchain, and broad community support, enabling high-development productivity and agility.

In addition to Debian, Mentor Embedded Linux based on the Yocto Project, is also available. For more information, visit: https://www.mentor.com/embedded-software/linux/omni/
The audio market for wireless Bluetooth headsets is growing rapidly. People have gotten used to wireless audio systems, and the mobile phone industry is pushing towards a world without audio connectors and cables. Most average users who think about Bluetooth audio, picture clumsy, over-ear headsets with very little extra functionality.

The trend for modern audio systems however, goes towards physical miniaturisation, while maximising the functionality and user experience. This demand leads to a new audio category called True Wireless Headsets (TWS headsets).

Looking at these new in-ear systems, at first glance they look like rather simple devices, but as you can imagine, the devil is in the details. TWS systems do require a lot of electronics to be smart and user-friendly, as illustrated in a high level system overview in Figure 1.

When thinking about TWS headsets in daily use, there are several ways to enhance the customer experience and hassle-free user interface integration. One of the main issues TWS system designers are facing is playtime, because...
battery space is usually very limited in TWS headphones.

Typical battery sizes of 60-150mAh can be reached, which results in a playtime of 2-4 hours. Once the battery goes flat, the earbud needs to get a fresh charge before it’s ready to be used again.

Currently, the most advanced TWS headphones are shipped with a charger cradle rather than having a wire connected to each of the earpieces for charging the batteries. The cradle acts as a handy compartment, since losing the tiny earphones is very easy, and includes a bigger battery. This allows the user to charge the earbuds on-the-go without being dependent on a power outlet.

The goal of this cradle/earbud configuration is to guarantee fully loaded batteries at any time, because realising at the beginning of a workout that your earbuds are not ready to use because of empty batteries is one of the most frustrating things a user can experience.

Another aspect to enhancing user experience is automatic start-up and pairing of the earbuds. The user does not want to wait for the devices to pair or start when the earbuds are already inserted in the ear. It should be a seamless process without pressing any buttons to start the pairing process.

In order to help a standard TWS headset to be smart and user-friendly, a key requirement is the possibility to exchange data between charger cradle and earbuds.

If the cradle knows about the battery status of the earbuds, it can automatically start re-charging the earbuds. This continuous re-charging process is necessary due to the quiescent current consumption caused by the always-on Microcontroller Unit (MCU) as shown in Figure 2 (see page 12).

Vice-versa, if the earbud knows about an empty charging cradle, it can automatically inform the user via Bluetooth notification to charge the cradle’s battery.

In terms of automatic start-up and pairing, a smart connection would also be beneficial. If the cradle informs the earpiece that the lid of the compartment has been opened, the earbuds can wake up from its sleep mode and prepare the Bluetooth pairing process rather than pressing a button on the earbuds to enable the devices.

Besides the enhanced user experience, a link between cradle and earbud could enable better industrial design, software updates, personalisation of earbuds (name, EQ data) and transfer of music data to the earbuds, to name just a few application examples of a feature-rich and differentiating product in the market.

To get a clearer picture about the technical implementation, let’s dig deeper and have a look at the system in more detail.

On the cradle side, the most important thing is of course the Li-Ion battery and a charger to enable charging the cradle’s battery with the help of a standard 5V supply coming from an USB outlet.

Power management blocks like LDOs and DC/DC converters distribute required supply voltages to the MCU and other devices placed inside the cradle. A dedicated 5V supply is mandatory to provide power to the earbuds for charging its battery. The always-on MCU acts as the central control unit of the cradle and is usually connected to several other sensors (lid detection, earbud detection) as well as to the charger to get an update about the battery status of the cradle.

After a trigger event such as opening the lid, inserting an earphone or a request sent by the earphone, it would exchange the needed information or send commands/data to the earbuds.

On the earphone side, the topology is basically very similar, but of course the Bluetooth SoC is also required. The MCU in the earbud would directly communicate with the MCU on the cradle side, exchanging information back and forth.

Sensor-wise, there may be additional devices such as proximity sensors for ear-insertion detection, accelerometer sensors, heart rate sensors...
for fitness devices, temperature sensors and touch sensors.

As shown above, multiple pins are necessary to implement the smart functionality of charger cradle and the earpieces. A fact that comes with several disadvantages: in order to reach a high customer acceptance level, TWS solutions must not be dramatically bigger than its wired colleagues. Therefore, the placement of additional poles on the earbud always leads to compromises between space and features. In addition, the design and appearance is also affected in a negative way if several poles need to be placed on the earpiece.

Certainly, one option would be implementing a BLE (Bluetooth Low Energy) connection link, but this would affect the bill of material cost significantly and increase software implementation efforts.

A more elegant way to work around the compromises would be to enhance the features of the standard two poles that are used for charging (GND and 5V) the earbuds. If the functionality of the two wire connections gets extended to allow for charging and simultaneous communication to the earpiece in parallel, all the smart and user-friendly features could be realised without drawbacks in physical space or design expectations.

The resulting experience for the user can be improved even more with a dedicated app, which benefits from the load of information the earbud is now able to provide to any smart device.

**A few examples include:**
- Battery status left
- Battery status right
- Cradle battery status
- Pairing status
- Name of left and right earbud or if it is matching
- Temperature
- Check for software updates for charger cradle
- Notification info about empty cradle battery (especially with altered battery)

The TWS system evolution is at the very beginning, but will soon reach its peak due to a strong and rapid growing competitive market and high demanding customers.

Besides the miniaturising and design improvements, adopting features and functionalities already known from standard Bluetooth headsets, like active noise cancellation, wireless charging, heart rate tracking or voice-enabled devices, will become more feasible due to reducing the power consumption of involved devices.

On the other side, TWS headphones may also have the chance to be a part of a future, where information and connectivity is integrated into our daily lives more than ever.

Wearing earphones that can be used for a full day and are empowered due to a connection to the Internet would open new doors and create a whole range of new devices and applications.

Augmented hearing, hands-free navigation or understanding foreign languages due to real-time smart translation are just a few of the types of applications one could imagine.

Once the technical hurdles are overcome, TWS headphones may find their way into everyone’s life without even being noticed.
Chip fuse for highest demands

SCHURTER Electronics Ltd specifically design chip fuses for low-loss overcurrent protection in secondary circuits. In a range of six different chip sizes from 0402 to 1206, SCHURTER Electronics’s chipfuses guarantee compact and effective protection in the event of a fault.

When regular fuses are exposed to pulse-shaped current peaks and high temperature fluctuations, their properties change. Every pulse makes it a little weaker, every temperature fluctuation a little more susceptible.

This is not the case with the SCHURTER UAI 1206.

Pulse and temperature resistant

Thanks to the special fuse construction, the resistance to current pulses smaller than the melting integral (I2t) could be massively increased. The UAI 1206 has practically no derating compared to other products of this type. The ingenious design of the fuse body also dampens temperature fluctuations to a high degree. The SCHURTER UAI 1206 is also hermetically sealed against potting compound.

Areas of application

The new chip fuse, which is offered in two versions with rated currents of 5.3A and 7.5A, has been specifically developed for automotive applications. The SCHURTER UAI 1206 meets all requirements according to AEC-Q200 regarding Mechanical Shock and Terminal Strength.

However, it is also suitable wherever maximum pulse resistance, thermal resistance and high mechanical loads meet.

Chipfuse Range

SCHURTER Electronics range of chipfuses have a cURus approval. The range is halogen-free and RoHS-compliant, therefore they can be used for lead-free soldering processes. The solid construction of the chipfuses reinforces the resistiveness to vibrations and pulse loads.

For further information on our range of products visit: www.schurter.co.uk
Building a hardware business is often seen as a more difficult route for start-ups than software. Most of the entrepreneurs who approach Mercia, an investment group that looks to identify and then fund and help scale innovative businesses with high growth potential, have conducted basic research into their market and competitors, but have failed to consider six vital questions that make a business plan stronger and more attractive to potential investors. These six questions give entrepreneurs a clearer idea of whether their technology is likely to be adopted and, if so, how long this could take:

1. Does your new device require a change in behaviour?
A new technology requiring a customer to change behaviour could delay time-to-market. While change is often good, especially when it leads to efficiencies, there may be resistance within management and on the shop floor for manufacturing-related technology.

For example, a start-up with an innovative measurement tool was engaged with a global electronics company which was looking to increase productivity. However, the start-up had not initially considered the level of consultancy and training required to bring any workforce using the tool up to speed. In the start-up’s lab, the highly-trained R&D team were able to make the tool work without issue. Conditions on the manufacturing shop floor were very different.

The entrepreneurial team hadn’t anticipated the challenges arising from the language (Cantonese) and the skill level of operatives within a key target market (China). Operatives were also concerned that the introduction of the tool would ultimately lead to reductions in the workforce, and so some were hesitant to adopt it. To resolve this, the start-up business needed to factor in more time to address the concerns and convince all stakeholders of the device’s benefits.

2. Will your hardware innovation require a systemic change?
New technology often needs to be integrated into larger existing systems. We frequently review business plans centred on devices which would enhance the efficiency of diesel engines, motors and even wind turbines. These devices often require some modifications to the installed equipment, which in turn leads to concerns around warranties and aftercare. The economic benefits from the innovation are often not enough to overcome the potential increase in liability.

When this is the case, the team needs to rework its business plan, factoring in additional costs and time for integrating the device into existing equipment and getting buy-in from the manufacturers.

3. How long will it take to bring a product to market in your target sector?
Every hardware industry has a design cycle which can vary widely in length. Start-up founders need to account for this in their business plans. For example, the design cycle for the aerospace industry is measured in decades, whereas the consumer electronics sector releases new devices in just months. Some design cycles are surprisingly long. For consumer home appliances it is around four years.

Entrepreneurs need to show that they are aware of these timescales and recognise that little can be done to change them. For industries with protracted design cycles, we recommend structuring agreements with potential customers which will generate cash before volume sales begin. These
can take the form of development agreements or funded testing. All industries are looking for new technologies, but be prepared for a long qualification process as your customers buy samples and test multiple times.

4. Do you know the different risk appetites for all gatekeepers in the buying process?
You will need to understand the risk appetite of various gatekeepers you may face. For instance, quality control teams tend to be conservative and take low levels of risk, while design teams are more open to innovation and new ideas.

We recommend that you map out the various gatekeepers within your customers’ organisations. Be particularly mindful of procurement teams within larger customer organisations, which may attempt to hold your company to terms which are unsuitable or overly burdensome for small businesses.

Early buy-in from senior management within the prospective client can help to circumvent any unrealistic or tough procurement requirements.

5. Is the evaluation kit buyer the target purchaser?
Multinational companies may purchase evaluation kits early on – generating genuine excitement within your company. But this may not necessarily turn into a large follow-on order. Start-ups should understand that engineers like “shiny things”, and part of their job will be to buy and test devices which appear innovative. Sadly, an evaluation kit purchase does not give a strong indication of whether a company will buy more units. The purchase shouldn’t be given undue weight in business plan projections, unless you have established a concrete connection between the evaluation kit purchaser and the ultimate buyer.

When selling to large corporations where a technology evaluator (e.g. a central R&D facility) may not have strong links with your targeted business area, a multi-pronged approach is advisable. You should identify the ultimate purchaser(s) and build a relationship with them almost as if they were a separate entity.

6. Who will really benefit from your product?
Some start-up teams approach us without a clear understanding of who will really benefit from their technology. This is a problem when the buyer and the benefactor are different.

For instance, we see a number of companies pitching technologies that make buildings more energy efficient. The cost of these products and their installation may fall on the building owner, but the benefit of reduced utilities goes to the buildings’ tenants. In this case, it can be difficult to convince the owner to spend money unless there is some recognition or payback. It may be easy to prove the overall benefits of your technology, but you must be ready to work across the spectrum of stakeholders to ensure that the value is recognised appropriately.

Simply removing inefficiencies in a system is often not enough. Business models between stakeholders sometimes need to change in order for better technologies or processes to be adopted.

A hardware success story
Mobile payments unicorn, Square, is a prime example of a hardware success story. Co-founded by Twitter’s Jack Dorsey, it provides smaller and mid-sized retailers with the ability to process payments easily.

Adoption of Square technology has been simple for both retailers and customers. Installation of Square hardware requires absolutely no behavioural or systemic changes, an important point which is so often overlooked and will cause a product launch to fail. In the case of Square, the hardware plugs directly into smart-phones or tablets via a headphone jack which couldn’t be any simpler.

Further reasons for success include the targeting of the SME retail market, which is fast at adopting new technologies, and offers few gatekeepers. The company has raised $150 million at a $6 billion valuation, has an international user base, and a strong technology portfolio including its first product, the Square reader to the Square terminal launched in October 2018.
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