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electronics update

Internet of Things

Spotlight: Digital Retrofitting with IoT

Image credit: Magicle on Unsplash

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By Electronics Update

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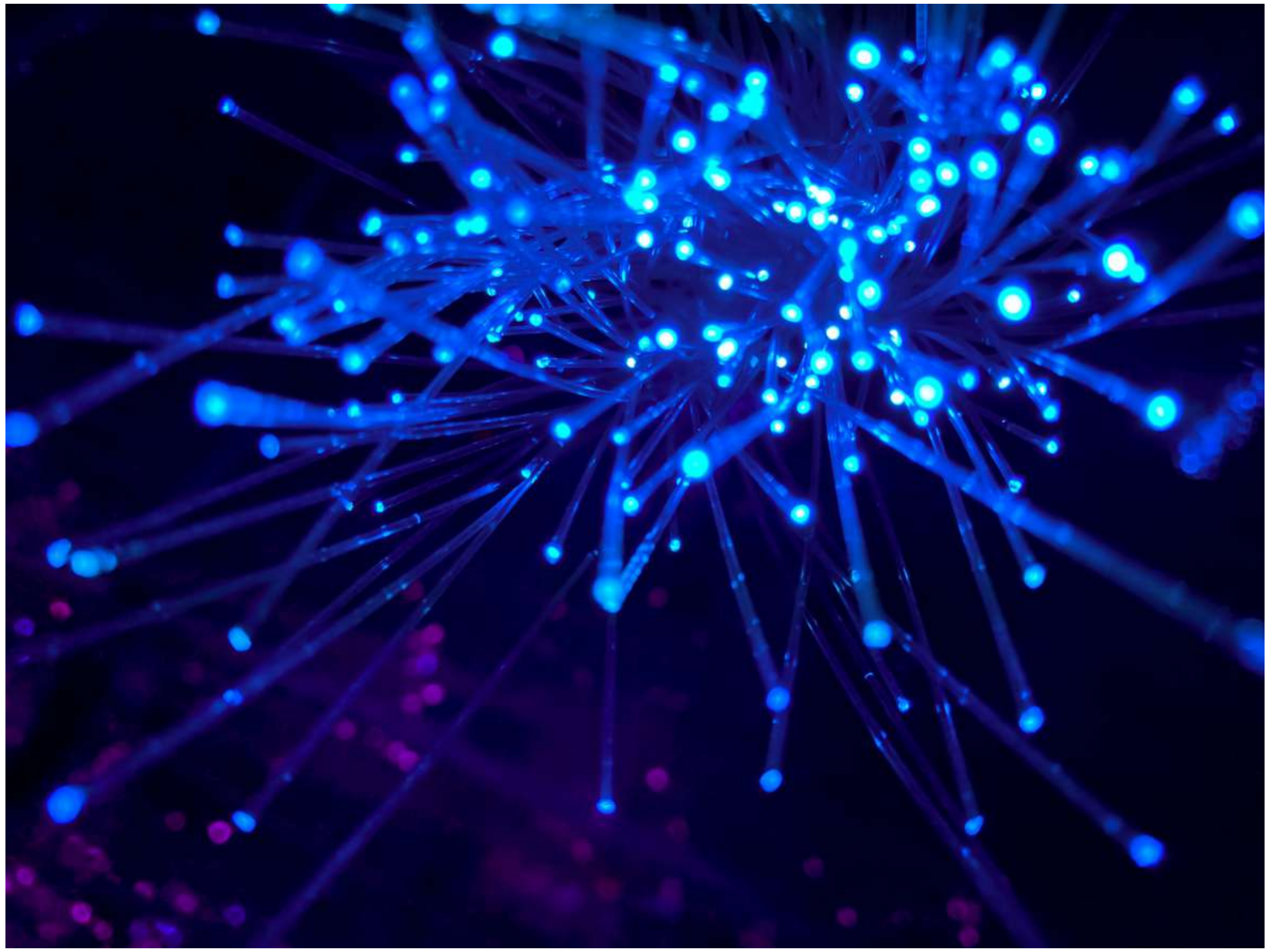


The Internet of Things (IoT) is a broad concept. In essence, it is a collective term that describes a global infrastructure that connects devices theoretically and physically to a worldwide accessible network.
To realize this, there are numerous technologies, components and software products necessary. A good example is a fitness tracking watch, that monitors the vital signals of the customer via sensors, transmits the data via a wireless connection to a smartphone, or uploads it directly into a cloud. The data is then accessible to the customer at any time. The only requirement is an internet connection. Which, in 2021, is available almost everywhere and 24/7.

Global IoT Market

The global market volume of the Internet of Things was around $187.33 billion in 2018, according to Industry Research. at a CAGR of 18.07%, it will expand to $487.3 billion by 2024.
Industry Research identified Wireless technologies as the biggest trend for the IoT. The biggest growth restriction factor is data regulations, which might strangle the free flow and collection of data. Professional service providers, that focus on system integration are projected to be the biggest winners of IoT growth. The geological region with the biggest market share is currently North America.[1]

Industrial use of the IoT (IIoT)

Of course, connecting devices, machines and entire systems with each other is a concept that can be used in many different use cases. One of them is the industrial sector. The IoT helps to monitor the status of a machinery park and allows the operator to undergo maintenance and repairs only when needed. This is in contrast to traditional maintenance schedules, where parts are changed in fixed intervals, no matter if they are actually faulty or not. This predictive maintenance approach saves time and money, saves resources, and limits downtime of production due to repair schedules. This is just one example, to show the practical capabilities of IoT in an industrial context.

Marketsandmarkets is a market research company based in India and the United States. They cover a broad portfolio of reports on more than 100 different markets, including high niche technologies.
According to their Industrial IoT insights, the IoT sector had a global volume of $77.3 billion in 2020. At an estimated growth rate of 7.4%, the Industrial IoT market is expected to grow to $110.6 billion in 2025.
Furthermore, the report identifies connectivity and network solutions as the biggest growth drivers, as these are the backbone of the whole concept of the Internet of Things.
Interestingly, the smart agriculture sector is named as one of the markets with the biggest CAGR. APAC as the global main hub of production held the highest market share in 2019 and is estimated to drive growth in the IIoT in the future. Included in these volumes and growth figures are the sub-areas of electronic components, software and connectivity solutions.[2]

Grandview Research is based in San Francisco and covers mostly technology areas, such as semiconductors or material science. According to Grand View Research, the Industrial IoT market had a global volume of $161.14 billion in 2018 and will grow to a staggering $949.24 billion in 2025 at a CAGR of 29.4%.
These numbers differ greatly from the ones calculated by marketsandmarkets. The reason for this is that Grand View Research defines the IIoT segment a lot broader and includes the whole software, consulting and service providers into their consideration. Which, in return, leads to a much higher market volume.
The Grand View Research Report comes to the same conclusion, that the APAC region is and will remain the main focus region, that drives growth within the Industrial Internet of Things. Also, they regard connectivity solutions as the most important technology for IIoT growth.[3]

Consumer IoT

Apart from the utilization of connecting devices in an industrial use case, the next big topic is consumer electronics. The introduction and unseen success of the smartphone started a new era of smart and connected objects. Nowadays, the average citizen owns a variety of such devices, from fitness trackers to wireless speaker systems, the spectrum of possibilities to connect with your surrounding tech objects is manifold.

In addition to its analysis of the Industrial IoT market, **Marketsandmarkets** also analyzed the IoT market under the perspective of a consumer focus. The market value in 2018 was around $46 billion and will exceed $104 bn by 2024 at a CAGR of 17.39%.
The biggest driver in this development is the smart home sector, and the main growth area is North America.[4]

These insights are confirmed by research conducted by **Verified Market Research**. The US-based research company calculated a global market volume of $44.46 billion in 2018, which is estimated to grow to $153.8 bn by 2026, at a CAGR of 16.69%.[5]

Conclusion

To understand a market, it is important to not just focus on raw numbers. Key knowledge is the composition of sub-segments of a market and its trends. As for the Internet of Things, key business drivers are wired and wireless connectivity solutions. They represent the core concept of the IoT: Connect devices and People.
The broad field of possible application areas for the IoT present great growth potential for companies that succeed in developing powerful and easy to use devices and systems. As well as professional system integrators that focus on the realization of connected networks.

We have carefully selected the content contributors for this magazine, to provide you with the best overview of trends and state of the art technological developments.

Make sure to stay up to date and visit our IoT focus page regularly at

electronics-update.com/iot

Sources and further reading:

1 Industry Research
2 Marketsandmarkets - Industrial
3 Grand View Research
4 Marketsandmarkets - Consumer
5 Verified Market Research

Digital Retrofitting with IoT

By Alexis Leibbrandt, Senior Growth Marketing Manager at Akenza

The Hycleen Automation System digitally retrofitted thanks to the akenza platform. Image credit: GF Piping Systems

What is Digital Retrofitting?

Imagine you are operating several CNC milling machines. Each machine needs to be controlled and maintenanced by a worker. Is there enough drilling oil provided? Are the tools still in good shape? Are all machines up and running? Adding a remote, wireless tool to check fluid levels, RPM and more vital details from a centralized spot turns the individually operated machines into a machine grid – you have successfully retrofitted your machine park.
In essence, digital retrofitting describes the process of evolving your existing assets into connected devices, and make them „smart“.

A connected infrastructure is a more effective, cost-saving operation method, that also enables additional opportunities. However actually most organizations wrestle with an inherited framework and conditions that can‘t always keep up the development pace that is needed to stay ahead of your competition.
Being stuck in limited efficiency due to outdated processes, and the needed investments to develop into a more digitalized entity, is connected with huge cost. The Internet of Things and digital retrofitting can be a solution to this topic, since upgrading a machine park is a more cost-effective way than replacing it altogether.
The Internet of Things (IoT) changes and re-shapes limits, creating entirely new industries. New products and services are changing the very texture and the idea of rivalry, exposing weaknesses and strengths alike in companies, while also showing new opportunities.

Reshaping competitive advantage

In the last century, trains have predominantly been operated with steam power. The whole vehicle was a big mechanical system that functioned without any electronic components. Nowadays, trains are intelligent super-machines, submitting their position and other status updates to an external controlling mechanism. This is a great anecdote of how upgrading technologies and connectivity will result in a massive gain in efficiency.

And it is happening at great speed. Products are constantly evolving into more and more complex and interlinked systems, that combine hardware, sensors, data storage, software, and connectivity. The unprecedented growth of connected products is found in the vast improvements in processing power, device miniaturisation and the network benefits of ubiquitous wireless connectivity, unleashing a new era of innovation. Instead of replacing what already is existing, companies can now think about upgrading their existing products, infrastructure and frameworks.

Connect to the future today

Digital retrofitting is the process of upgrading an existing but previously undigitised product into a connected device through the addition of equipment, sensors or services; by doing so, the products get “smarter”. The added connectivity layer extends the basic features of existing products. This digital transformation is changing the way humans interact with products and services. Ultimately, retrofitting enables organisations to use existing resources, bringing old products up to date and preparing for the demands of tomorrow.

Benefits of digital retrofitting

- Cost savings
- Increased efficiency
- Improved product lifecycle management
- Extended product features
- Business Transformation

Retrofitting is a very valuable alternative to transform analogue infrastructure and products into smart, connected ecosystems. There are remarkable benefits, especially for products with a long lifespan. Following some simple points will allow you to avoid potential pitfalls and enable you to profit from a transformation towards connecting your world.

Saving Power in Low Power Wireless Radio Systems

By Dunstan Power, Director at ByteSnap Design

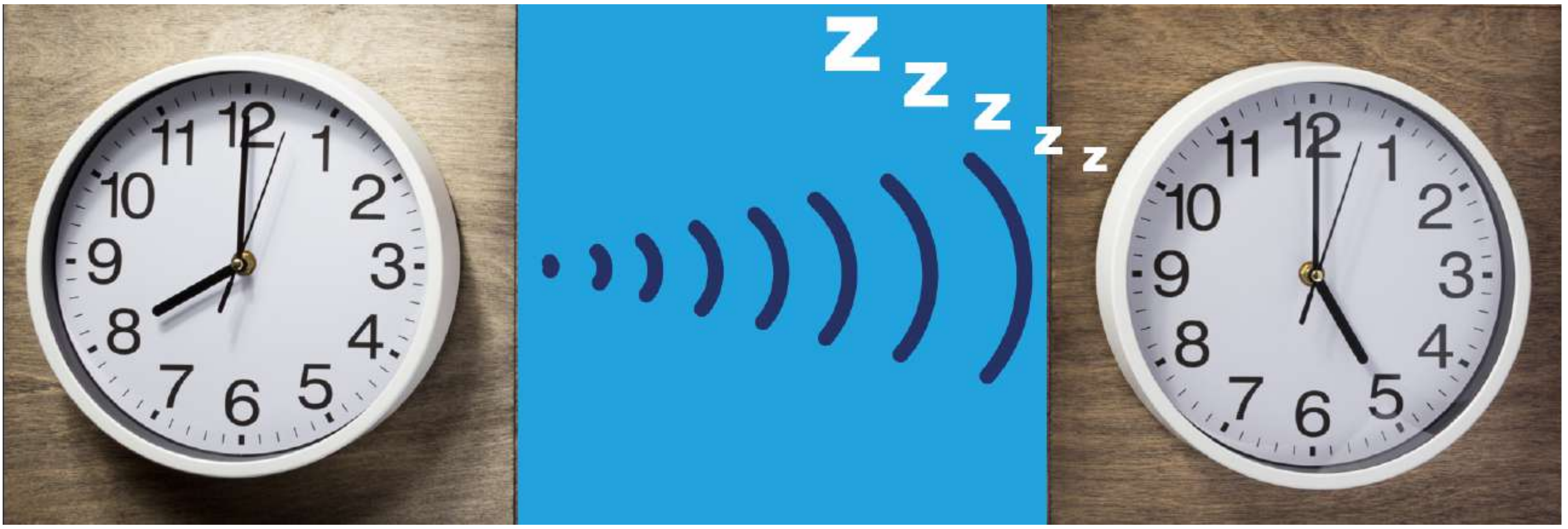


Image credit: ByteSnap Design

In July 2020, industry analyst IDC forecasted that 55.7 billion connected devices will be in use by 2025. This is easy to believe, as connected devices are a huge part of everyday life - even having spread to household whitegoods such as fridges and washing machines.

Despite this rapid growth, developing wireless devices remains a challenging process. The increased use of connected (IoT) devices is matched by an increasing reliance on small batteries, so the pressure to reduce physical battery size while also improving a device's functionality is immense.

When ByteSnap is approached with a new concept for a low power wireless device, there are two key requirements:
What the device needs to be able to do (e.g., range of connectivity), and how long the battery needs to last.

The balancing act

Reducing power consumption while trying to achieve the desired functionality is one of the most challenging aspects of low power design. Compromises have to be made, in areas such as UI, battery, link budget, and transmission and reception.

System choices

Designing for low power from the outset is fundamental to ensuring that a product performs as expected. Decisions made at the beginning of a project dictate what can be achieved and include:

- The type of radio - short range, long range, or cellular
- Radio wavelength
- Choice of microcontroller
- Battery type

The type of battery you choose to power your low power device is vital to its success. Many low power devices are now being powered by batteries, and there are several varieties available, each with different characteristics.

To find the best candidate, it is worth trialling a few types that fit your specifications. This table showcases a characteristics of some common battery types:

Type	Cell Voltage	Energy Density	Typical discharging temperature range (°C)	Standby Lifetime	Rechargeable?	Max Current
Li Ion	3.6	High	0 – 50	Low	Yes	High
Alkaline	1.5	High	-18 – 55	High	No	Medium
NiMH	1.2	Low	-20 – 65	Low	Yes	High
Li Coin Cell	3	Low	-30 – 60	High	No (usually)	Low
LiSoCl2	3	High	-80 – 125	Very High	No	High

Image credit: ByteSnap Design

Use a watt-hour meter
Including a watt-hour meter will make determining the actual amount of power taken by the device easier. A standard meter is insufficient because most of the time it's inactive and is too slow to measure transmission on and off pulses.

Determine component compatibility
Low power wireless design requires attention to details that are easily ignored in systems where the power consumption is unimportant.
To combat this, you can add active components such as FETs (Field Effect Transistors).
Part of the design work is ensuring the device's components will work within the voltage range required. Check for internal regulators that can affect the voltage performance, and consider including initial design zero-ohm series resistors into the power rails of all of the active components. You can replace them later with low ohm resistors.

Tune the antenna
Even if range is important in your design, remember to tune your antenna so you can minimise the transmission power needed to achieve the desired range.

Balance responsiveness and waking
A low power wireless device must reach a 'useful' state rapidly. Find the balance between battery power consumption and response time so as not to damage user experience.

This could be done by keeping transmissions short by using a higher baud rate, or turning off/switching to low power mode unnecessary components.

Synchronisation of receiver and transmitter
Many low power radio devices communicate with each other to receive data or instructions, making it essential that the receiver is on. Both ends must be synchronised and stay synchronised, however you'd want to minimise the receiver usage required to achieve this.
Each data packet sent is not guaranteed to get through, even if the devices are in time. This could be due to being out of range, or interference from other communicating devices, or corrupted data.

Factor in drift
It is vital that drift is taken into account when designing the system as it can lead to an increase in battery power consumption. Note environmental factors that could lead to time differences between active devices.

Keep transmit pulses short
When the transmitter is on, a low power radio is at its maximum power state. Therefore, it makes sense to minimise that on time, by reducing the amount of data that is transmitted. Send data compressed by using a zip format or just by sending the data as a binary. This would reduce the amount of data to a tenth of the size. However, this is fundamentally a software issue, so power improvements can be made later.

Update radio systems
There are two ways to update your radio system: manually, and over the air (OTA). OTA updates are generally more efficient, but there is an increased chance of something going wrong, so fail safes are vital.IoT security is a present hot topic in the media. There are a number of schemes used to secure data on radio links, but you should be aware that some have more overhead than others. They can not only increase your CPU power and your transmitter on-time, but also receiver on-time.

Batch testing
Batch testing is worthwhile to ensure any variation in device characteristics won't compromise device operation. To avoid pains during mass production, simulating some of the simpler design aspects using a SPICE simulator, like temperature and voltage extremes is recommended.

Record and analyse
Whether you are using a sophisticated project management tool or spreadsheets, these can be incredibly useful in determining what compromises should be made to ensure a workable design. They allow you to estimate the power usage of your device, determine transmission length, and calculate regulator efficiency.

While minimising power is going to become more of a priority as IoT devices are adopted more widely, user experience and expectations are also vital considerations. You could design a fantastically low power system that doesn't satisfy the end user because they may be expecting it to respond a lot faster than it actually does…and that's where some of the compromises

Distributor Design Resources for IoT Engineers

By Robbie Paul, Director, IoT business development at Digi-Key Electronics

Gone are the days of needing to start from scratch on each new invention or project – today's engineer can focus on their unique value-add, thanks to the evolution of modern design techniques. Even so, it's estimated that about 75% of Internet of Things (IoT) projects don't come to fruition due to the lack of a business case. It's easier than ever to get IoT-connected, but it's worth questioning the value of each IoT invention.

For example, a connected kitchen gadget like a blender that allows you to blend smoothies from your phone. Why would you need that invention? What's the business case for a connected blender? However, something like a connected device for a barbeque smoker allows you to track and adjust temperatures from your phone remotely would be useful to a wider audience.

Several trends have recently arisen in the IoT design space that engineers should leverage in order to reduce the time required to complete a project, allowing them to focus on more important aspects of the process, such as the business case and unique value the invention brings to the space.the magnetic field response from the patient can be altered. Any alteration of the signal reduces MRI accuracy; hence MRI machines are typically now made with non-magnetic RF interconnect and contacts, which

are tested to ensure they yield no magnetic response.

Rapid Prototypes

Rapid prototyping is one trend in the IoT space that engineers should keep in mind. It's essential not to over-engineer a prototype; the goal should simply be the most viable product. There is a plethora of resources available to help engineers reach that goal more quickly, such as Digi-Key's reference design library (RDL). Taking a modular-based approach can also reduce time investments – many complete ecosystems already exist for engineers to build into, such as Adafruit Feather, Arduino and Raspberry Pi. After that, there are other add-on technologies like Click boards, Xbee, feather wings, hats, shields and more, or expansions via connector ecosystems like Qwiic or Grove for creating an initial proof of concept.

Furthermore, each engineer does not need to be an expert in radio

„Rapid prototyping is one trend in the IoT space that engineers should keep in mind.“

frequency (RF) – these days, communications are simplified by the availability of modules that allow easy implementation of Bluetooth, WiFi, NB-IoT, LoRa and more. The best part is that design engineers don't even have to know the differences between each different type of tech – others have already completed that work.

Free tools such as the Scheme-It platform from Digi-Key helps designers produce professional schematic designs and roll out fully-completed cloud IoT solutions, minimizing the overall time to data visualization with a simplified design flow.

Leverage Existing Tools

IoT devices are almost always better suited for a team approach when it comes to design, due to the variety of different specialty components – hardware, software and cloud to name a few. It's great to have a team of specialists, but the multiple disciplines can make it difficult for engineers to switch gears to another area.

Startups may see this as an obstacle – they don't necessarily have a full team of specialized engineers on hand. The good news is that there are many online communities that freely share knowledge to further product design – even Google and Amazon provide open-source code that engineers can pull in with the right APIs.

Project repositories and online forums like GitHub enable millions of developers to share their expertise in order to build better solutions, and leveraging these open-source communities can remove barriers to system design for faster implementations. Engineers who design in an open-source environment, such as EDA KiCad, are exposed to myriad resources for everything from a comprehensive community support network to basic design creation how-tos and tutorials.

Engineers can also tap into design service providers if further expertise is needed, such as Digi-Key's Design & Integration Services program, which is a network of design firms that offer fee-based prototyping, development, manufacturing and systems integrations services.

Scaling Quickly

Scaling can bring an array of new challenges to designers. Getting to the prototype stage is often quick, but scaling takes significantly more bandwidth. There are additional considerations to keep in mind for a full-fledged deployment, such as security elements, cloud services, remote management, maintenance and more.

For example, recent trends have made over-the-air (OTA) updates more commonplace – think of the last time your phone updated – and these types of provisioning tools are important to consider when talking about a large-scale deployment.

Testing is also a critical piece of scaling and advanced deployment requirements, particularly if wireless and RF are involved – these can be a major pain point for many designers. If possible, consider partnering with a testing agency like CETECOM to coordinate and improve the testing hit rate.

Security should be every designer's first priority. What other systems does your invention connect to? Data breaches are becoming increasingly common, and hackers can find their way to sensitive customer data through even the least conspicuous channels, like an HVAC system that connects to the same network as the credit card system.

It's essential for designers to ensure their environment is secure, and that their data services and elements are robust in order to prevent any privacy concerns. Remote management should be accessible at all times.

Innovating through IoT

Digi-Key has the breadth of product and suppliers providing different pieces of the solution, which positions us to bring everything together in an easily digestible format. What designers find on our website is the most important information across a solution, not just a specific product. The IoT Component Selector tool gives engineers a one-stop-shop for assistance with product selection. The IoT Resource Center gives a broader selection of products and services from the IoT ecosystem.

Digi-Key also provides many other tools to help IoT solution designers succeed, such as the Startup Survival Guide, Design Roadmap, Design Dashboard and Scheme-It.

In the fast-paced world of IoT design, engineers and designers don't have to re-invent the wheel these days, and can instead focus on leveraging existing tools and resources to develop their world-changing ideas. So, what's your next idea? I'd love to hear about it!

What is 802.11ax, Wi-Fi-6, and Wi-Fi 6E?

By David Meaney, Vice President Global Technical Sales & Marketing at ECS Inc. International

The demand for wireless access from users has shifted from a luxury, to a necessity. The need for bandwidth is growing exponentially. This has caused network performance to become critical for businesses and consumers alike. Everyone has come to expect their Wi-Fi connection be reliable and fast.

Technology has come a long way in just a few short years. The rapid increase in the need to work from home as well as the types of usage and traffic the networks are contending with has caused the current networks to be over tasked. Because of this the wireless standards need to keep pace. Besides bandwidth, the biggest issue with networks is latency. Latency is the pause in connection as the network tries to keep up with traffic. This has adverse effects on any live event like video conferencing, gaming, voice, and IoT traffic.

To help alleviate the problem of latency, there was a need to develop wireless networks that are more efficient in handling the expanding bandwidth hungry traffic. A new

standard called 802.11ax was introduced in 2018. The Wi-Fi Alliance renamed it Wi-Fi 6. One of the main focuses of Wi-Fi 6 was to enhance the efficiency of how access points handle multiple devices.

Speed is no longer the measuring stick for a Wi-Fi network. It is now about how the network would handle many clients at once without dreadful latency issues.
We can now look at it as not having more speed to move data, but as having wider bandwidth. Essentially you would have more simultaneous network connections instead of a single connection trying to move data as fast as possible.
Wi-Fi 6 (802.11ax) offers a better overall solution for moving large amounts of data and accommodating many network connections.

„It is expected that by 2030 the global market for connected devices will exceed 25 billion.“

What is Wi-Fi 6?

Wi-Fi 6 is the latest standard from the Wi-Fi Alliance based on the 802.11ax protocol, and provides critical capabilities needed for next generation enterprise requirements.

Wi-Fi 6E: The Future!

Wi-Fi 6E grants access to the underutilized 6 GHz frequency band and yields amazing new promises for wireless networking.
These latest Wi-Fi protocols are essentially adding a turbo feature to our existing Wi-Fi that builds upon todays Wi-Fi capabilities. They will be used in technologies from AI and IoT, to supporting 5G. Wi-Fi 6 should all but eliminate latency in time critical applications.

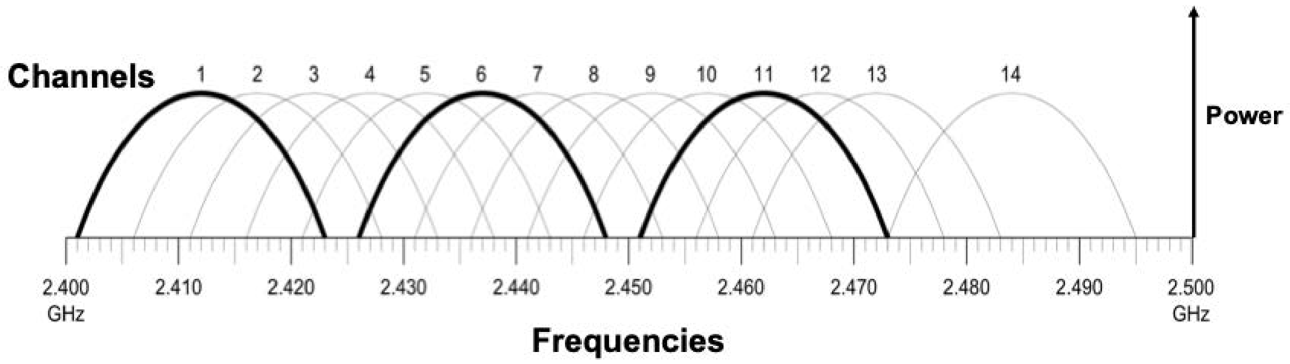


Figure 1: 2.4 GHz bandwidth using multiple channels

2.4 GHz, 5.9 GHz, and 6 GHz: Fast Forward to the Future

Why does the FCC need to open the 2.4 GHz and 5 GHz spectrum when they are already delivering fast multi-gigabyte speeds and ultra-low latency? In 2019, there were 7.6 billion connected devices. It is expected that by 2030 the global market for connected devices will exceed 25 billion. These connected devices will generate over 150 zettabytes (ZB) of data, that number is equal to 150 trillion gigabytes. These wireless devices would be connected through many different wireless protocols including Wi-Fi 6, 5G, C-V2X, Bluetooth 5, Zigbee, Z-Wave, and many others being developed today. Based on projections of growth the FCC has determined that it will need to allow unlicensed use of up to 1.6 GHz of mid-band spectrum by 2025. The 2.4 GHz band has 100 MHz of bandwidth, and the 5 GHz band has 665 MHz of bandwidth. While opening the 5.9 GHz band adds an extra 45 MHz of bandwidth, the new 6 GHz band will provide as much as 1,200 MHz of bandwidth. When these additional bandwidths become available it will open the door for virtually everything to be wireless. For example, autonomous vehicle communications will be possible.

What makes WiFi 6 work?

The Wi-Fi 6 standard uses new advancements in wireless technology such as OFDMA, MU-MIMO, and TWT to support dozens of high bandwidth connections at a time. Wi-Fi 6 addresses the biggest challenges for all Wi-Fi networks: the increasing number of devices and the diversity of their applications. In order to handle these challenges, 802.11ax increases bandwidth throughput by as much as four times over that of the previous 802.11ac standard.

Other Wi-Fi 6 improvements include the ability to use both the 2.4 GHz and 5 GHz bandwidths to manage traffic. However, the biggest advancement in the 802.11ax is the multi-user performance called OFDMA (Orthogonal Frequency Division Multiple Access). This allows many devices with different bandwidth needs to be connected and access the network simultaneously. This is an upgrade to older wireless standards when devices needed to queue up and compete with one another to send and receive data.

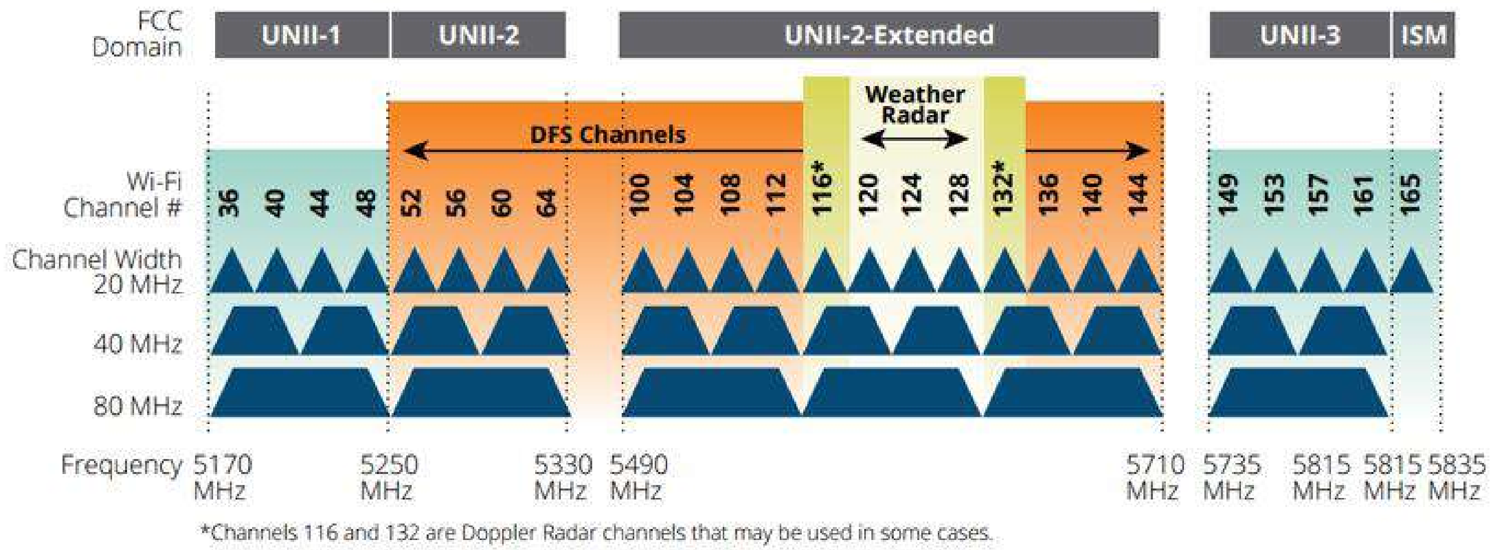


Figure 2: 2.5 GHz bandwidth range

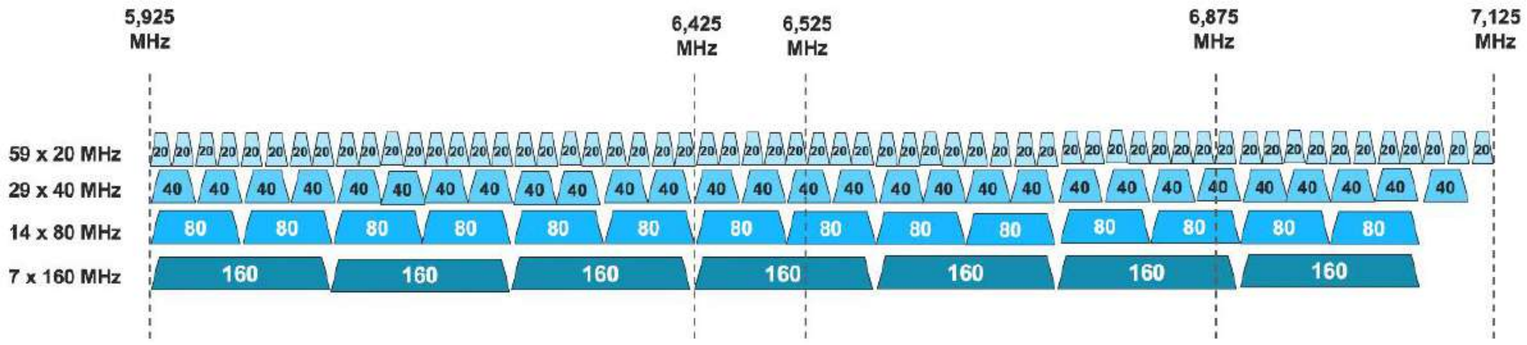


Figure 3: The new 6E GHz bandwidth

When accessing through an 802.11ax network there is no competition since each device is simultaneously able to transmit and receive data independently.
Managing the available bandwidth using the 802.11ax protocol allows the network to handle large amounts of data.
Those that are latency sensitive such as voice and video, can be handled simultaneously.

Another protocol for handling high traffic from multiple devices is Time Multi-User Multiple Input/Multiple Output (MU MIMO) originally introduced in 802.11ac. It has been upgraded for use with 802.11ax and is now capable of supporting up to eight devices to transmit and receive simultaneously using a dedicated channel per device. MU MIMO has the added benefit to support large amounts of data such as streaming HD video while low bandwidth data from IoT devices and voice data would be better handled using OFDMA. An additional benefit of the Wi-Fi 6 protocol is that it supports Target Wake Time (TWT) which lets devices remain inactive until it's their turn to transmit data using a scheduling scheme negotiated with the access points.
Since devices can go into an inactive mode, the battery life of smart phones, tablets, and IoT devices is extended as an underlying benefit. IoT greatly benefits from TWT with an operating mode for low-power devices, low-bandwidth devices like sensors, industrial automation and medical devices. The 802.11ax access point is going to separate devices between a 2.4 GHz or 5GHz bands based on their data requirements. The efficiency advancements of the 802.11ax are clearly seen as a much faster network and improved access for all the clients on the network. The 802.11ax protocol does greatly enhance the ability of Wi-Fi networks to handle much more traffic, including voice and video streaming in high-density environments. The introduction of 802.11ax comes at the perfect time, as it better utilizes both the 2.4 GHz, 5 Ghz, and 6 GHz Wi-Fi spectrums.

Reliable Electronic Component Manufacturing for Wi-Fi 6 Applications

As a leading manufacturer of electronic components for wireless technology, ECS Inc. has developed many new products designed to enhance the performance of wireless connectivity. ECS Inc. works closely with the engineering community to develop products to meet today's stringent performance requirements. ECS Inc. understands which component is best suited for industrial, medical, automotive, communications, and all IoT wireless applications. ECS is proud to serve our global OEM designers and the engineering communities. By helping them receive the engineering support and customer service care that they need.

How Wi-Fi 6-Enabled ESP32-C6 will Benefit the IoT Landscape

By Amey Inamdar, Technical Marketing Director at Espressif

In today's world of wirelessly connected devices, Wi-Fi has remained an important connectivity method, because it allows the devices using it to speak the same "Internet language" and share a common infrastructure that is already widely used. So far, these devices have been using Wi-Fi 4 (802.11 b/g/n), operating in a 2.4 GHz frequency band, due to its low cost and low power requirements. Nevertheless, with an ever increasing number of devices and just three nonoverlapping channels in the 2.4 GHz frequency band, congestion has become the most important hurdle causing increased latency in device communication. Also, with Wi-Fi radio's receive-andtransmit power consumption being traditionally high, it has been difficult to build battery-operated Wi-Fi devices that remain incessantly connected over a Wi-Fi 4 network.

In February 2021, IEEE 802.11ax was finalized and is now commonly known as the Wi-Fi 6 standard, which addresses the above-mentioned connectivity issues with Wi-Fi 4. In April 2021, Espressif, a leader in the Wi-Fi MCU industry, announced the upcoming release of its ESP32-C6 SoC, which supports the 802.11ax protocol. Let's see how the features of 802.11ax can benefit customers building their IoT devices with ESP32-C6.

Reduced Power Consumption with Target-Wake-Time (TWT)

Traditionally, devices connected to a Wi-Fi access point, while in a power-saving mode, need to wake-up frequently (approximately once every 100 to 300 milliseconds) to turn on the radio and check if the access point has any packets to be delivered to the device. Usually, this practice results in increased power consumption on average, even in the absence of incoming data for a longer duration.
However, the 802.11ax protocol adds a feature called Target-Wake-Time (TWT), with which the devices can specify when exactly and how frequently they will wake up to receive data. This way, the devices can maintain their sleep mode for longer, with the radio being turned off. This also improves the devices' spectral efficiency, since the contention for Internet connection among multiple devices is reduced. The TWT feature in ESP32-C6 enables Wi-Fi devices to be always connected to the access point and, hence, to the Internet. At the same time, they consume much less power and, therefore, can run on a battery even for years.

Improved Latency with OFDMA

Orthogonal Frequency-Division Multiple Access (OFDMA) allows the same channel to be split into multiple subcarriers which can be assigned to individual users. This facilitates transmitting multiple data packets at the same time, thus increasing spectral efficiency. OFDMA works in both a downlink mode, where the access point can deliver data to multiple clients in a single transmission, and an uplink mode, where multiple clients can transmit data at the same time as per the resource allocation guided by the access point. This feature greatly helps in reducing latency, especially when legacy clients, with lower data rates, take a long time to deliver data to the access point. ESP32-C6 supports both uplink and downlink OFDMA.

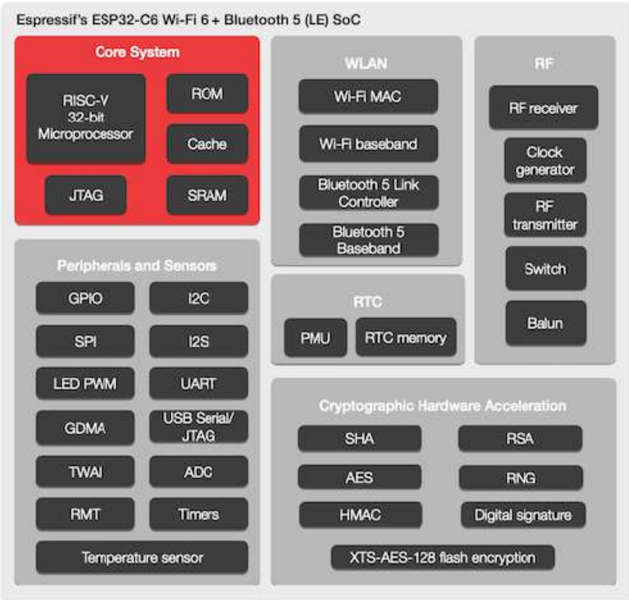


Image cedit: Espressif

Improved Performance with MU-MIMO

Multi-User-Multiple-Input-Multiple-Output (MU-MIMO) is a complementary 802.11ax feature that can improve the overall performance of the network. This implements the spatial separation of various devices from an access point to create separate directional beams. Thus, an access point can send data to multiple devices at the same time. This is called downlink MU-MIMO and it is supported by ESP32-C6.
In conclusion, not only does ESP32-C6 have the 2.4 GHz 802.11ax standard, which is still compatible with 802.11 b/g/n protocols, but it also comes with a variety of other features that are especially designed for IoT device use-cases. ESP32-C6 has a 32-bit RISC-V microcontroller, capable of running at 160 MHz, with 400 KB of SRAM, 22 programmable GPIOs, and Bluetooth LE 5.0 (long range) connectivity that can co-exist with its Wi-Fi capability. Thus, developers can build products by using ESP32-C6 only as a host and a communication processor, or they can use ESP32-C6 in hosted mode, providing other microcontrollers with connectivity. These features allow for a manifold increase in the application scenarios for ESP32-C6, empowering the creativity of all those developers who will choose to build next-generation IoT devices with Espressif's latest Wi-Fi 6-enabled SoC.

In the know: Improving situational awareness, safety and productivity through connected wearable IIoT ecosystems

By Alvaro Goncalves, Technical Director at Wearin'

„The challenge for design engineers and integrators of IIoT ecosystems is to develop and deploy wearable solutions that address the known pain points [...].“

Connected wearable technology and sensors integrated into day-to-day equipment help improve workers' situational awareness, mobility and communications. Moreover, AI-driven and smart real-time data capture and analysis can help organizations make proactive improvements, avoiding risks before they occur. Here's an insight into how connected wearable ecosystems and digital twins are helping make hazardous work environments safer and more productive across all industries.

With the advent of industry 4.0, organizations are scrambling to digitalize their operations. The creation of digital twins is all the rage. These provide digital images of operations, useful for refining processes, virtualizing tests, running projections, trying out innovations digitally, and speeding up implementation in real-world settings. The problem is, they tend to focus on infrastructure and industrial processes. Less attention is paid to individual workers.

Lone workers in particular face a high risk of accidents. One way of improving safety is to recruit more people or invest in additional systems, thereby increasing costs. A better way is to develop smart, holistic wearable ecosystems that save lives, save revenue and increase overall performance.

Organizations are looking for innovative solutions that address their pain points and overcome technology silos. Siloed devices throw up operational challenges, such as needing to charge batteries for multiple devices. Devices have to cache data when connectivity is unavailable, and compete for bandwidth. Moreover, each device's data remain independent, it is difficult to know who is wearing which device, and separate or opaque privacy policies make employees distrustful. An ideal life-saving solution would deliver real-time data both on the worker and in the control room, and enable a bi-directional information flow between them. It would allow easy and seamless integration of different types of IoT-enabled sensor – e.g. for advanced biosensing, biometrics measurements, indoor and outdoor geolocalization, real-time location systems (RTLS), social distancing, gas detection, fall detection, and collision prevention. It would also be easy for workers to use, maintain and clean without the need for lengthy training. Above all, it would respect the individual's privacy.

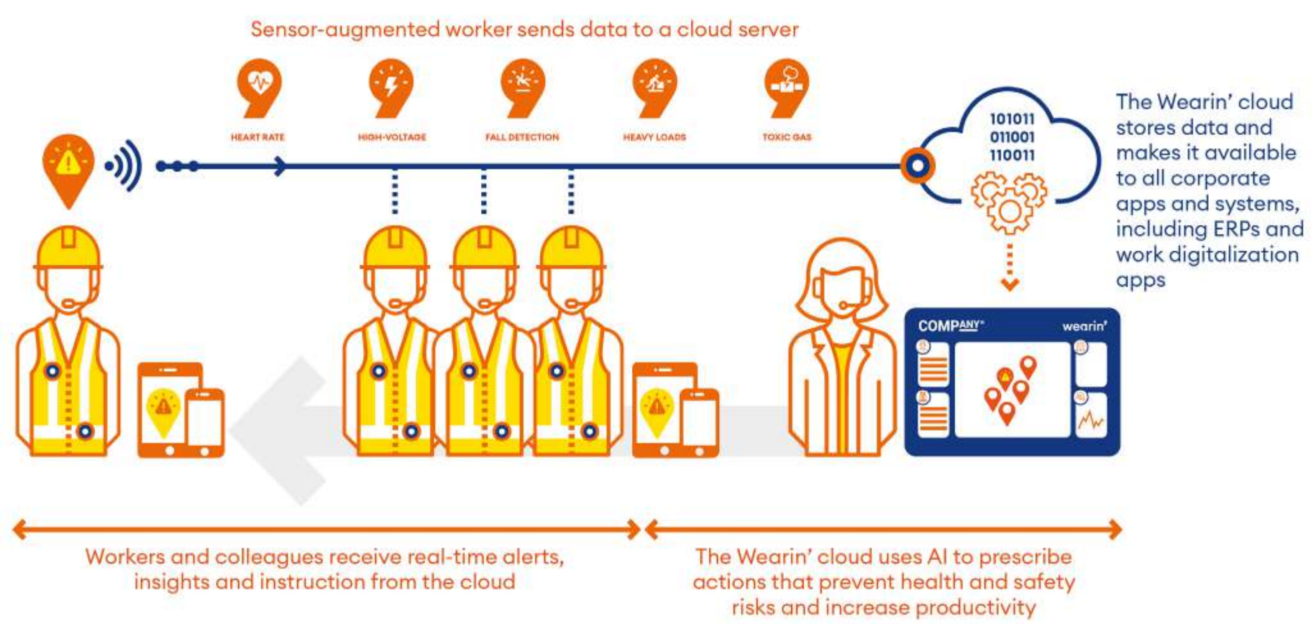
The challenge for design engineers and integrators of IIoT (Industrial Internet of Things) ecosystems is to develop and deploy wearable solutions that address known pain points and: dramatically reduce the number of injuries per year; reduce or prevent errors and mistakes; provide real-time insights to drive accurate data-driven decision making for long-term result improvements; help reduce the cumulative effect of sub-optimal processes: ensure the continuous improvement of efficiency; reduce staff turnover thanks to improved safety standards. Apt solutions put humans at the center and link up the two worlds of infrastructure and people. For example, in digital-twin initiatives, they add a digital picture of workers to those of machines and operations, giving context to the data collected and prescribing intelligent AI-based actions.

This is the unified, "connectivity-by-design" approach adopted by Wearin', the spinoff created by the Swiss-based Fischer Connectors Group. It gives users combined intelligence and a holistic view by leveraging all types of data from different sources. It embeds electronics onto workers, and between workers and the control room. For example, a safety vest may integrate: plug-and-play rugged connectors for numerous devices – like noise, gas or posture sensors; a retractable smartphone or tablet with apps to leverage data and alarms; a lightweight in-garment hub to centralize data and power, optimize their management, and send data to the cloud; in-garment power and data cables; a bi-directional SOS button; and a single, central, in-garment battery to power all devices for up to 12 hours. Unified identification means workers are automatically associated with the sensors they carry. Unified data connectivity means that data are cached and high-priority data are transmitted first. Unified privacy means that data privacy is uniform, scalable and easy to understand.

The solution that design engineers and integrators need in today's IIoT world is characterized by versatility, unity and security. It allows the seamless integration of any type of sensor to capture data relating to workers in any industry, their environment and impacts on health and safety. Smart data collection informs processes, work orders, checklists, reporting and business intelligence. Data analysis in the Wearin' cloud provides real-time alerts, monitoring and visualization to improve efficiency. It also enhances predictive safety and maintenance, by preventing accidents, injuries or long-term health impacts. Workers can report actual or potential errors and participate proactively in maintenance, e.g. via a live video feed to draw management's attention and discuss potential improvements. Increased productivity comes from giving workers contextual information relating to their skills, tasks, next steps or environment. Enhanced situational awareness helps them do their jobs better, cutting out bureaucracy and paperwork.

Data privacy and high-level security are critical across all industries, and both have been embedded in Wearin's product since day one. Each sensor has three configurable levels of privacy: some personal data remain on the worker's equipment and are used only to generate alarms and protective actions to increase the individual's safety; some data are available to the control room and used only to generate alarms and trigger protective actions; some data are freely available in the back-end, e.g. alarms raised by the worker, or levels of dangerous gas. Different regional privacy regulations and concerns, e.g. GDPR in Europe, can easily be accommodated.

Improving individuals' awareness and respecting their privacy have many beneficial consequences beyond improving workplace safety. Helping them focus on doing their jobs better, be more involved in the business, and understand their roles better, increases staff motivation and reduces staff turnover. People who are well-informed and protected feel reassured and more valued by their employer.



Wearin's unified, human-centered approach generates smart, real-time insights by capturing and leveraging worker sensor data
Image credit: Wearin'

Leveraging the 5G Network to Wirelessly Power IoT Devices

By Anne Wainscott-Sargent, Research News at Georgia Institute of Technology

Researchers at the Georgia Institute of Technology have uncovered an innovative way to tap into the over-capacity of 5G networks, turning them into "a wireless power grid" for powering Internet of Things (IoT) devices that today need batteries to operate.
The Georgia Tech inventors have developed a flexible Rotman lens-based rectifying antenna (rectenna) system capable, for the first time, of millimeter-wave harvesting in the 28-GHz band. (The Rotman lens is key for beamforming networks and is frequently used in radar surveillance systems to see targets in multiple directions without physically moving the antenna system.)
But to harvest enough power to supply low-power devices at long ranges, large aperture antennas are required. The problem with large antennas is they have a narrowing field of view. This limitation prevents their operation if the antenna is widely dispersed from a 5G base station.

„ In demonstrations, Georgia Tech's technology achieved a 21-fold increase in harvested power compared with a referenced counterpart, while maintaining identical angular coverage ."

"We've solved the problem of only being able to look from one direction with a system that has a wide angle of coverage," said senior researcher Aline Eid in the ATHENA lab, established in Georgia Tech's School of Electrical and Computer Engineering to advance and develop novel technologies for electromagnetic, wireless, RF, millimeter-wave, and sub-terahertz applications.
The findings were reported in the Jan.12 issue of the journal Scientific Reports.
The FCC has authorized 5G to focalize power much more densely compared with previous generations of cellular networks. While today's 5G was built for high-bandwidth communication, the high-frequency network holds rich opportunity to "harvest" unused power that would otherwise be wasted.

Tapping Into 5G High-frequency Power

"With this innovation, we can have a large antenna, which works at higher frequencies and can receive power from any direction. It's direction-agnostic, which makes it a lot more practical," noted Jimmy Hester, senior lab advisor and the CTO and co-founder of Atheraxon, a Georgia Tech spin-off developing 5G radio-frequency identification (RFID) technology. With the Georgia Tech solution, all the electromagnetic energy collected by the antenna arrays from one direction is combined and fed into a single rectifier, which maximizes its efficiency.

"People have attempted to do energy harvesting at high frequencies like 24 or 35 Gigahertz before," Eid said, but such antennas only worked if they had line of sight to the 5G base station; there was no way to increase their angle of coverage until now.
Operating just like an optical lens, the Rotman lens provides six fields of view simultaneously in a pattern shaped like a spider. Tuning the shape of the lens results in a structure with one angle of curvature on the beam-port side and another on the antenna side. This enables the structure to map a set of selected radiation directions to an associated set of beam-ports.

Image credit: Georgia Institute of Technology

The lens is then used as an intermediate component between the receiving antennas and the rectifiers for 5G energy harvesting.
This novel approach addresses the tradeoff between rectenna angular coverage and turn-on sensitivity with a structure that merges unique radio frequency (RF) and direct current (DC) combination techniques, thereby enabling a system with both high gain and large beamwidth.
In demonstrations, Georgia Tech's technology achieved a 21-fold increase in harvested power compared with a referenced counterpart, while maintaining identical angular coverage.

This robust system may open the door for new passive, long-range, mm-wave 5G-powered RFID for wearable and ubiquitous IoT applications. The researchers used inhouse additive manufacturing to print the palm-sized mm-wave harvesters on a multitude of everyday flexible and rigid substrates. Providing 3D and inkjet printing options will make the system more affordable and accessible to a broad range of users, platforms, frequencies, and applications.

Replacing Batteries With Over-the-air Charging

"The fact is 5G is going to be everywhere, especially in urban areas. You can replace millions, or tens of millions, of batteries of wireless sensors, especially for smart city and smart agricultural applications," said Emmanouil (Manos)Tentzeris, Ken Byers Professor in Flexible Electronics in the School of Electrical and Computer Engineering. Tentzeris predicts that power as a service will be the next big application for the telecom industry, just as data overtook voice services as a major revenue producer.

The research team is most excited by the prospect of service providers embracing this technology to offer power on demand "over the air," eliminating the need for batteries.
"I've been working on energy harvesting conventionally for at least six years, and for most of this time it didn't seem like there was a key to make energy harvesting work in the real world, because of FCC limits on power emission and focalization," Hester said. "With the advent of 5G networks, this could actually work and we've demonstrated it. That's extremely exciting — we could get rid of batteries."

This work was supported by the Air Force Research Laboratory and the National Science Foundation (NSF) - Emerging Frontiers in Research and Innovation program. The work was performed in part at the Georgia Tech Institute for Electronics and Nanotechnology, a member of the National Nanotechnology Coordinated Infrastructure (NNCI), which is supported by the NSF (Grant ECCS-1542174).

Image credit: Georgia Institute of Technology

Signal meets Power meets Data

By Niklas Wittler, Global Product Manager Board to Board Solutions at HARTING Technology Group

„The miniaturization of devices is also a steady process in the industry"

The miniaturization of devices is also a steady process in industry. This means that components such as connectors need to shrink ever more. To not only keep up with this, but also be able to cover solutions for the requirements of tomorrow and the day after, connectivity specialist HARTING has developed the har-flex® connectors. The flexibility in the pin count from 6 – 100 and stacking height from 8 - 20 mm lets developers enjoy all freedoms in the development of their devices.
This factor is increasingly gaining in importance because every case is unique in the construction of industrial devices. Every housing needs to cater to different sizes, shapes and requirements. The PCBs inside devices are thus also constantly required to make up for other spatial conditions. Every board needs to be at a firmly defined position for interfaces with the housing wall or other electronic components. These vary depending on the device and use. To achieve the required miniaturization here, the har-flex interface makes for a particularly space-saving option with its 1.27 mm pitch.

Signal meets Power

To enable the simultaneous transfer of signals and power from one PCB to the other, HARTING is expanding the har-flex® family by the new Hybrid variant. The claim to small, flexible, robust applies here as never before. har-flex® Hybrid enables signal and power contacts to be combined in one insulator. A current carrying capacity of 18 A permits the desired power to be space-savingly transferred by way of few contacts. In the past, several signal contacts needed to be combined in this for power transmission, which was linked with greater space requirements, as well as the use of a separate connector just for the power supply. And the throughput times in production are also improved as the placement of an additional power connector can be avoided.
To prevent the power from inductively interfering with transferable data, adjoining pins can be earthed. Whoever has the room and still wants to transfer power in a small space can bank on the separate har-flex® Power connector. This is of the same type as the already familiar har-flex® Signal connectors and thus offers the ideal complement. Besides the pin counts, users can choose between SMT fixing or with additional hold downs in the Hybrid or Power variant, depending on the application. The power pins are all available as THR or SMT contacts. While the SMT contacts will leave the back of the board virtually untouched, the THR contacts offer a better heat dissipation and higher stability. The new har-flex® Hybrid & Power variants have been created in already familiar designs and thus offer solutions for mezzanines, motherboard-to-daughterboard and extender card connections.

Image credit: HARTING

har-flex® HD Card Edge for High Data Rates

Advanced Ethernet for IIoT applications is also an important topic on the circuit board. With the introduction of the har-flex® HD (= high density) card Edge, this is now advancing into even smaller ranges of board connectivity and bringing GBit Ethernet to the PCB from autumn 2020. The start is made with the har-flex® HD card series Edge in a 0.8 mm pitch, which transfers up to 25 Gbit/s from board to board. The series is designed as a one-piece-connector with pin counts from 20 to 140 contacts, meaning that the mating contacts are directly integrated in the board layout and no further connector is required. For the stability required in industry, there is a solution with additional hold downs in SMT und THR. These boost the mechanical robustness in general, and particularly against transverse forces.

With a Constant Eye on Quality and Precision

To cater to the increasingly automated production, all har-flex® connectors are pick & place capable and contactable in the reflow soldering process. To also support users in their processing, HARTING sets great store by absolute precision with its components.
To be mentioned in this context is coplanarity. This describes how parallel and evenly signal contacts and retaining pins are mutually oriented in a SMD connector, which is decisive for the later quality of the solder connection. If connecting pins deviate too much from one another, the connection can be of a bad to faulty quality. To ensure good solderability, the coplanarity of all contacts is thus continuously monitored in the production already. This guarantees the high quality and HARTING's own claim to reliable interfaces. Besides an optical monitoring in keeping with IPC-A-610 Class 3 standards, which is based on externally visible criteria such as the wetting angle and filling degree, the HARTING labs also use metallographic specimens and radiotechnology to monitor the quality of soldered joints.
Also of relevance for a good connection besides the correct position of the contact pins is their coating. har-flex® contacts are equipped with a tin coat that forms a reliable bond with the solder pad in the reflow process.
The great variance, new heights, and continuous monitoring of their high quality standards make har-flex® from HARTING the ideal interface for circuit boards inside the device.

Robust Interconnect Solutions for IIoT Applications

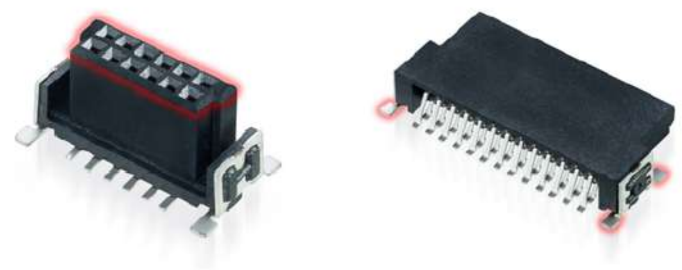
By Ben Green, Head of Marketing at Harwin

Analyst projections show that the global Industrial Internet of Things (IIoT) market will expand considerably in the coming years, with tens of billions of nodes being deployed in a multitude of applications.
A recent report available from Market Reports World predicts that the global industrial IoT market is expected to reach approximately US$751.3 billion by 2023, registering a CAGR of 23.88% during the forecast period 2021-2023.
This technology will be pivotal in accelerating the onset of Industry 4.0 as it enables high degrees of automation within manufacturing and processing facilities, helping companies achieve greater levels of efficiency, productivity and output quality. The IIoT will also allow assets within the supply chain to be tracked, preventing loss or theft, and providing real-time data and analytics that enable maintenance work to be well-planned and executed.
The IoT nodes will often be situated in remote locations, however, and this has major implications in regards to their ongoing upkeep. Servicing and repairing hardware will be very difficult (and in some cases almost impossible). Reliability of components therefore is key.
In this article, we will look at the implications this has with regard to the connectors being specified.

Coping with exacting demands

IIoT devices must be able to function when subject to extreme temperatures. If they are located inside petrochemical plants or steelworks, for instance, they can be exposed to sustained high levels of heat. Units that are used in smart farming or pipeline monitoring may have to cope with intense ambient temperatures during the day, as well as freezing conditions during the night. Connector solutions with an extensive industrial-grade operational temperature range will be best-suited in these situations. Thermal shock testing, in compliance with EIA-364-32C Condition III, may be needed to make certain that the connectors are suitably robust by subjecting them to thermal cycling between -55°C to +125°C. The test procedure puts connectors through 10 cycles between these two temperatures, with 30 minutes being spent at each extreme on every single cycle. EIA-364-17B Method A testing is another way of verifying connector components' temperature credentials. This test procedure exposes them to 125°C temperature levels for a 96-hour period.
Another important characteristic for connectors being used in an IIoT context is their resistance to vibrational forces. Close proximity to industrial drives and other heavy machinery means that vibrations are unavoidable. One future development could see the IIoT nodes actually being powered by these vibrations – relying on energy harvesting technology to convert them into the electricity the nodes need to function. Vibrations can lead to a discontinuity between connectors' mating surfaces, resulting in loss of data. If vibration is likely to be a worry, then connectors that have been tested to the EIA-364-28D Condition IV standard should be specified. Here, the mated connector elements must not show signs of any electrical discontinuity over a 12-hour testing period while having a vibration amplitude of 1.52mm applied at frequencies cycling from 10Hz to 2000Hz. The test also deals with shock, with the connectors experiencing 196m/s² accelerations.

The positioning of IIoT nodes in remote outdoor locations without human supervision puts them at greater risk of damage through vandalism or even industrial sabotage.



Examples of connectors with shrouds and surface-mount hold-downs included
Image credit: Harwin

Image credit: Harwin

And, as general wear and tear is also a concern, a rugged construction is necessary for them to cope with the different stresses they will undergo.

Though the majority of IIoT nodes will remain in the same place, others will be in motion like the connectors in robots, industrial drones and automated guided vehicles (AGVs). In these applications, connectors should possess all of the attributes already outlined, as well as some additional ones, as the disconnection and reconnection of cabling will happen much more often than for stationary nodes. This could be for updating firmware, diagnostic analysis, downloading captured data, or charging. The connectors specified must exhibit elevated levels of mating durability and a shrouded design is recommended to protect the contacts from being damaged. Polarisation will also be beneficial to prevent mis-mating.

Cabling can sometimes be pulled away by an external force and if this is a concern, retention mechanisms should be included. Surface-mount hold-downs have proved to be a good way of providing the necessary strain relief and, if more acute forces are going to be an issue, backpotting is also an option. As well as being particularly robust, connectors used in IIoT hardware should also be a cost-effective solution due to the volume of components required. The expansive IIoT networks now being rolled out can consist of thousands (sometimes hundreds of thousands) of nodes. Though the connectors incorporated will need to be resilient to all the different environmental conditions discussed, they must also be at an attractive price point to be a viable solution.

An Optimised Solution

The 1.27mm pitch Archer Kontrol connector series from Harwin is currently being used in a variety of IIoT-based use cases. These high-density board connectors have been designed to possess all the essential attributes for implementation in challenging industrial environments, while also occupying price points that make them attractive to the market. They support data transfer rates of 3Gbps, in line with what is needed by the latest industrial automation systems. Parallel, edge-to-edge and space-saving right-angle versions are available. The 1000MΩ insulation resistance of these Harwin connectors prevents crosstalk, while their 3-finger contacts maintain a connection even under uncompromising circumstances. Up to 80 contacts can be incorporated, with each of these able to carry currents of 1.2A. A fully shrouded design (with polarisation included) prevents damage, as well as averting mis-mating. Comprehensive EIA-364-28D vibration and EIA-364-32C thermal shock testing has been conducted on the connectors, proving that they can handle the roughest of treatment.

Conclusion

There are a multitude of different dynamics that need to be looked at when selecting effective connectors for use in IIoT scenarios. By working through each of the key points covered in this article, it will be possible to find an interconnect solution that fully addresses all the appropriate performance and functional criteria – thereby offering prolonged trouble-free operation.

Case Study : IoT supported Avocado Crop Monitoring

Project Background

ICT International develops sensors, IoT Nodes, data loggers and telemetry systems enabling continuous real time monitoring of critical plant, soil and atmospheric parameters.In late 2018 ICT International and NBNCo. installed a monitoring program in an Avocado orchard with the specific objective to reduce rates of fruit drop (abscission) hence yield loss by improved irrigation scheduling.
Avocados are particularly sensitive to heat at the time of flowering and fruit set. Water stress can result in flower and fruit drop, thereby reducing yield. By forecasting the risk factors which contributing to plant water stress, notably low soil moisture and high VPD, management decisions can be implemented to minimise the risk of fruit drop.
The outcome of this monitoring is now used in ongoing farm operations and informs broader industry practices.

The site

Located on the Mid-North Coast of NSW the farm had previously suffered crop losses caused by water stress during flowering and fruit set and was seeking a solution to better detect this risk in real time to enable pro-active management of irrigation and canopy humidity.

The solution

In collaboration with NBNCo, ICT International installed an integrated crop monitoring network.
The sensors provide farm management with the real time information needed to monitor and forecast plant water stress.
Remote sensors are installed at three locations on site:
- Soil moisture / temperature sensors
- Micro-climate sensors outside and within the canopy measuring temperature, relative humidity and calculated VPD.
- High resolution dendrometers measuring trunk diameter.

Data from the sensors is transmitted over a LoRaWAN network to a Gateway utilising NBNCo. fixed point network connection.
Eagle.io is used for data storage and visualisation and alarming of soil moisture, VPD and maximum daily trunk contraction (MDC).
Eagle.io provides the tool for ICT International to transform the raw sensor data to information that could be directly used by farm management to inform operations. The system is also used to notify operators (via sms and email) when irrigation is necessary to avoid plant water stress and potential fruit drop, hence crop loss.

The Outcome

The sensor network was installed in December 2018, prior to a month of extreme heat which occurred during flowering and fruit set. Over January during fruit set the sensor network detected two significant plant water stress events, with local VPD levels rising above 5kPa. Low soil moisture during the second event resulted in severe plant water stress which was reflected by higher levels of maximum daily contraction of the trunk (MDC).
Managers observed high numbers of fruit drop coinciding with the second event.
These events are depicted on the graph below.
Remotely controllable irrigation systems are currently being installed. The monitoring system will provide property owners the information required to remotely control irrigation to reduce plant water stress events.

Image credit: ICT International

Use System-in-Package technology and ultra-small RF modules for IoT wireless communications

By Nick Wood, Vice President Sales & Marketing at Insight SiP

System-in-Package provides a complete system in a single component similar externally to a chip in a QFN package, but internally integrates increasingly sophisticated systems incorporating semiconductors, passives and RF components.

SiP & IoT Advantages

Compared to traditional PCB modules, a SIP component is smaller in all dimensions, without compromising performance or adding to cost. All the advantages of the module approach remain equally true for a SIP module and make the technology ideal for IOT product developers seeking to pack as much RF functionality into as small a version of their products as possible.

Discreet Vs. Module solution

To take a discreet component or module approach is one of the key IoT design decisions when including an RF function such as Bluetooth Low Energy in a solution.

„The advantages of the module approach are considerable."

With a discreet approach you can, at face value, end up with a lower cost, if you focus narrowly on the BOM price.
However, the advantages of the module approach are considerable. Firstly, the engineer can completely forget about the analogue/RF parts of the design, making only a digital connection to the module. This lowers the time and cost of the design cycle, and perhaps more importantly reduces risk, as RF is a complex area where it is easy to make mistakes.
Second, the module will normally come pre-certified, removing another time consuming and costly step in the development process.
Lastly, the final procurement and assembly of the end-product is simpler with a pre-tested module replacing many individual components.

It is also unlikely that the customer will be able to design a solution as small as specialist RF developers can, as achieving this level of miniaturisation takes significant R&D. The final choice depends on the particular circumstances of a project. Unless the volumes for a product are going to be very high at several hundred thousand pieces per year, it is unlikely a discreet design will make sense when all factors are taken into account.

Typical IoT Application

SIP Technology was previously limited to custom devices for high volume producers, principally mobile handset vendors. However Bluetooth SIP module devices are now available to all types of manufacturers in the IoT and general electronics design community using flexible off the shelf products.
Bluetooth Smart modules can be found in many IoT applications including bionic arms for children (Limbitless Solutions), hydration measurement water bottles (My_SmartBottle), DNA-based healthier food selection app (DnaNudge), Security Bubble Covid-19 for social distancing (Insight SiP), wearables to measure sleep quality (SleepTuner), gas measurement (Microtronics H2S sensor), industrial control (TeepTrak), wearable fitness monitor (Arion), Vernier Caliper (Sylvac), car park barrier control (ComThings) plus many more.

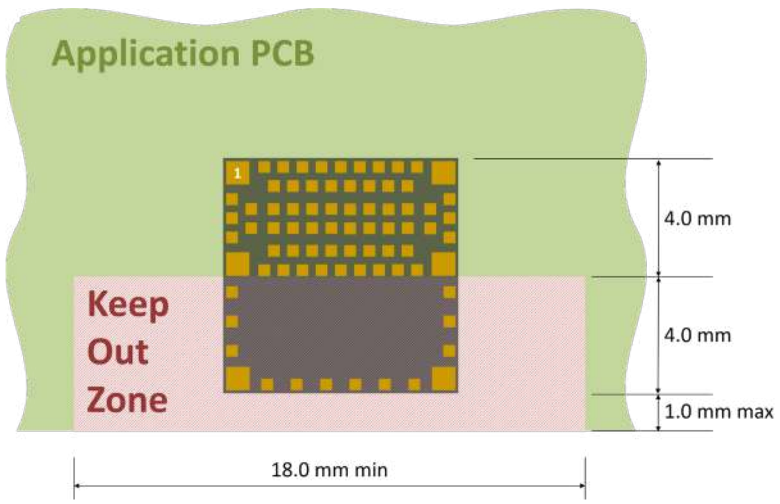
The smallest modules on the market measure only 8 x 8 mm in x/y dimension, with a thickness less than 1mm and can include a single antenna and technology such as BLE, UWB or LoRa or in some cases, a combination of technologies and antennas embedded into the module.

RF Design matters for IoT Developers - RF & Antenna Challenges

When using Smart Bluetooth modules, there are very few special requirements apart from being careful to ensure that the antenna area is devoid of metal. The drawing below indicates the ideal antenna keep-out zone:

Following the above rule ensures a good RF transmission from the PCB. Normally the application PCB sits in housing and is free of anything in the complete solution that might adversely affect the radio connection. Whilst all engineers are aware that you cannot put an RF solution in a metal box(!), RF interference effects can be subtle, and early testing of the complete solution is advised.

The range achieved by modules is an important factor. RF product specifications quote a range under ideal conditions, typically 1m above ground with no obstructions. Most real-life situations are not straightforward. For example, any solution close to the human body in a wearable or hand-held solution, significantly reduces the real range. So whilst RF developers confidently state that their modules can achieve a range of over 50m in ideal circumstances, it is important to test an application under realistic conditions.
A further aspect of any antenna is the directional performance. If the orientation of the IoT application device is not fixed, it is important that the antenna has an omnidirectional performance and the module a largely spherical radiation pattern. A more directional antenna is fine if the orientation of the solution is fixed. If not, the solution can stop working under certain conditions e.g. if the system radiates mainly into the human body.



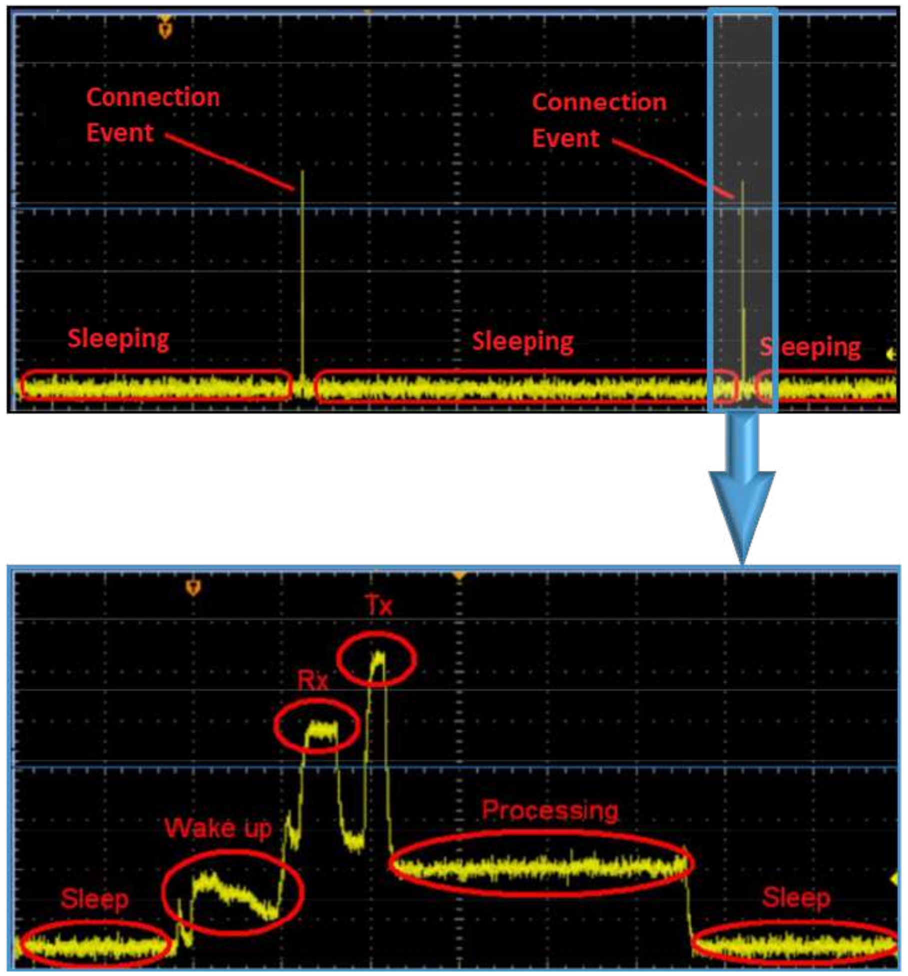


Image credit: Insight SiP

Power Consumption

Power consumption for BLE based IoT solutions is often a key design feature if the application runs for a long period – months or maybe even years – off a coin cell battery. Vendors often focus on key performance numbers such as peak Rx/Tx current, but the issue of actual power consumption is more complex.
BLE achieves its low power performance by mostly being in a deep sleep state. When it is connecting, the transmit and receive cycles are quite short, although these require the highest current. There is also a processing cycle, where the radio transmission is off, but the processor active.
So the overall power consumption of a solution depends on several factors – the frequency of connection required; the chip's wake up speed; the quantity of data transmitted and length of the transmission cycle; and the amount of processing required andspeed of the processor. By looking at the above figures, one can see that peak Rx/Tx current is only one factor in assessing the performance of different BLE solutions, and not necessarily the most important factor.
Optimising the power consumption is a question of designing the application software appropriately. Nonetheless it is useful to understand the underlying process to produce the best design.

A further element related to power consumption is the inclusion of a crystal in the solution. This crystal is not essential for the solution to function correctly, but it does improve power consumption, by improving the timing of the wake up cycle, and thus maximising the "sleep" time.

Certification

Whilst certification is not strictly speaking a "design" activity, it is a task typically expected of the engineering department

Requirements vary according to territory, but normally RF enabled IoT solutions require certification by the relevant national or supra-national body. This involves engaging a third-party accredited laboratory to carry out tests to ensure that the RF application is "well-behaved" e.g. it only radiates in the bands that it is meant to, and at the power levels expected. Failed tests require a re-design.

Each product must be individually certified even if it shares some design with a similar product.

Certification is an area where a module can save time and money, where modules are pre-certified for global markets by the FCC (USA), CE (Europe) and Telec (Japan).

Getting Started

To support product developers, most RF module vendors offer a complete development kit together with sample software that provides everything required out of the box to start developing a solution on day one. A complete breadboard can be built using the kit together with external sensor development kits so that software development can proceed in parallel with hardware design.

Energy harvesting: Printed thermoelectric generators for power generation

By Karlsruhe Institute of Technology

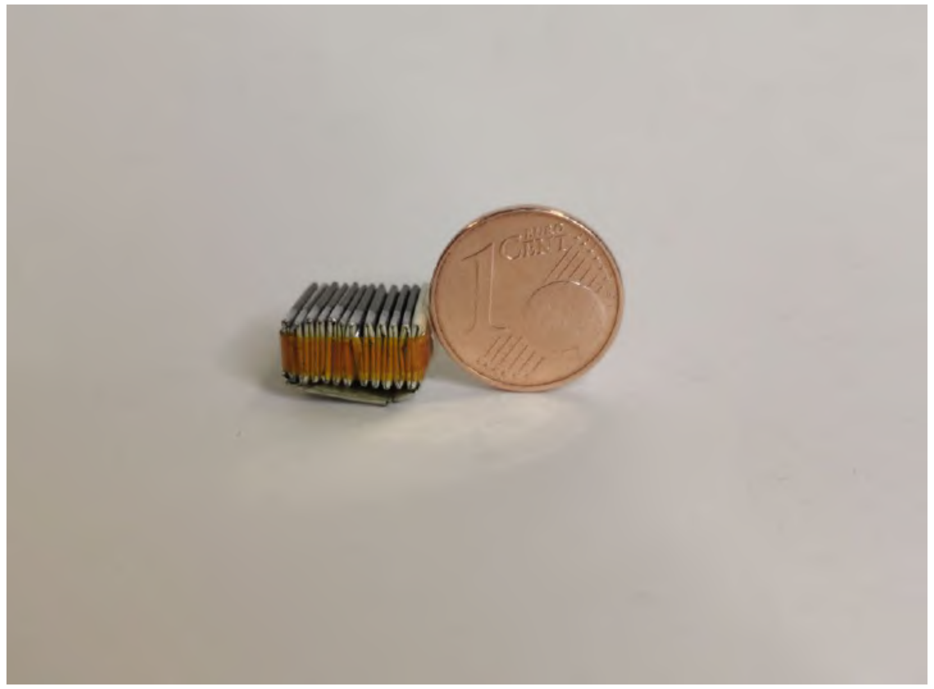


Image credit: Karlsruhe Institute of Technology

Thermoelectric generators, TEGs for short, convert ambient heat into electrical power. They enable maintenance-free, environmentally friendly, and autonomous power supply of the continuously growing number of sensors and devices for the Internet of Things (IoT) and recovery of waste heat. Scientists of Karlsruhe Institute of Technology (KIT) have now developed three-dimensional component architectures based on novel, printable thermoelectric materials. This might be a milestone on the way towards use of inexpensive TEGs.

„Thermoelectric generators directly convert thermal into electrical energy. This technology enables operation of autonomous sensors for the Internet of Things or in wearables, such as smart watches, fitness trackers, or digital glasses without batteries," says Professor Uli Lemmer, Head of the Light Technology Institute (LTI) of KIT. In addition, they might be used for the recovery of waste heat in industry and heating systems or in the geothermal energy sector.

New Printing Processes Thanks to Customized Inks

„Conventional TEGs have to be assembled from individual components using relatively complex manufacturing methods," Lemmer says. „To avoid this, we studied novel printable materials and developed two innovative processes and inks based on organic as well as on inorganic nanoparticles." These processes and inks can be used to produce inexpensive, three-dimensional printed TEGs.

The first process uses screen printing to apply a 2D pattern onto an ultrathin flexible substrate foil using thermoelectric printing inks. Then, a generator having about the size of a sugar cube is folded by means of an origami technique. This method has been developed jointly by KIT researchers, the Heidelberg Innovation Lab, and a spinoff of KIT. The second process consists in printing a 3D scaffold, to the surfaces of which the thermoelectric ink is applied.

Cost Reduction by Printing Technologies

Lemmer is convinced that scalable production processes, such as roll-to-roll screen printing or modern additive manufacturing (3D printing) are key technologies. „The new production processes not only enable inexpensive scalable production of these TEGs. Printing technologies also allow the component to be adapted to the applications. We are now working on commercializing the printed thermoelectrical system.

Developers Find New Frontiers at the Edge

By Bill Pearson, Vice President IoT Group at Intel

„Developers play a crucial role in creating the magic needed for business transformation […]"

As the world emerges from the devastation of the COVID-19 pandemic, enterprises and businesses have embraced digital transformation at breakneck speed, driving a strong demand for IoT applications. But developers working to innovate in this space are confronted by complex requirements, unique connectivity needs and disparate edge infrastructures that can stifle progress. Therefore, it is critical to understand industry trends and developer pain points so we can offer the right tools and solutions developers need in this fast-changing market.

Industry Trends

1. Cloud Capabilities at the Edge:
While the cloud continues to offer exciting opportunities for developers focused on cloud native technologies, containers, and orchestration, these solutions are quickly becoming available for edge developers as well. Embedded developers who worked on IoT applications, like moving a robot or monitoring weld defects, can now take advantage of a plethora of cloud capabilities for new and exciting edge applications. Developers today have access to a rich set of real time or near-real time data that shows what's happening in say, a factory line, in a retail store or in a hospital. They can then apply AI to figure out how companies should use that data, and finally, process that data and apply AI in a way that leverages all the cloud innovations we've seen in the past few years.

2. AI at the Edge:
Although AI has been around as a concept for a while, it's only recently we've seen it take off with the advent of compute power necessary to process data and implement AI at the edge. Imagine a scenario where all the data from sensors in a factory have to be sent to the cloud, since that's typically where all compute and development has happened so far. But what if the factory does not have persistent connectivity? The bandwidth cost of sending video streams from hundreds of cameras to the cloud can be enormous. Also, there could be security or privacy concerns that require keeping data on site. Today developers can bring compute to where the data exists. They can process, analyze and take action without having to send the data anywhere. For example, with AI at the edge, a retailer can look at foot traffic patterns and make real-time updates on where to place hot selling products in the store without having to send their data to the cloud and back.

3. 5G and the Edge:
Another trend with promising potential is the integration of 5G and IoT. With 5G added to the edge and AI, businesses can get the data closer to a warehouse, retail store, or hospital — all while ensuring they have the right latency, bandwidth, and secure connectivity that was not available before.

4. The Democratization of AI:
Edge developers today have access to resources unlike previous generations of developers, and code is increasingly becoming simpler. There is a growing movement to make AI a low-code/no-code or drag-and-drop environment. This will democratize AI and increase the number of people who can create new solutions at the edge.

Working with the Developer Community

While developers have historically wanted code samples, these days they also want reference implementations that can be applied easily. For example, if developers are building a traffic management solution, we can take technologies like networking and edge inference, and put the code samples together in a practical way that solves the specific problem. The idea is to show them how to do it next time so they can deploy solutions on their own the next time. In fact we make reference implementations for many use cases available at Intel® Edge Software Hub.

Another way to empower developers is to ensure that they write code once that can be deployed anywhere. Previously, developers had to write custom code for each kind of silicon in their network. But we want to make life simple for them. That's why we developed the Intel® Distribution of OpenVINO™ toolkit, an edge inference resource that allows developers to write code once, express their purpose, and then deploy it across a variety of Intel hardware.

While the OpenVINO toolkit can solve developers' inferencing needs, choosing the right silicon for their applications can be challenging. To make things easier, we've deployed the OpenVINO toolkit in our Intel® DevCloud for the Edge. So developers no longer need to purchase multiple types of silicon to test, we've put it all in the cloud, making it easy to test solutions across a mix of hardware – right from home. This way, a developer can easily bring in their programs, their models, and run it against Intel's hardware to understand how it will perform and which hardware is best, given their constraints.

Developers play a crucial role in creating the magic needed for business transformation that can yield significant gains for enterprises. With the right tools and a creative environment, edge developers can unleash innovation to help businesses and society reap invaluable benefits.

Power supplies for automation technology

By Frank Cubasch, Chief Operating Officer at Magic Power Technology GmbH

Just switch on the mains and 24V or ATX voltages would get out... Unfortunately, it is often not as simple as it seems working on the lab bench in practice. Temperatures, lifetime, voltage tolerances - there are many pitfalls. The following article describes some of the most important problems and their solutions. The selection of a power supply suitable for a (dynamic) load is not easy. Several parameters have to be considered, some of which are not known at the time of design.

Step 1: Power Terms

For the selection of the power supply in terms of power, the following considerations and terms about the power supply specification are important in the first step:

Nominal power: continuous power at a specified temperature and cooling condition. Please note, often there will be given different numbers for different operating conditions.

„Unfortunately, it is often not as simple as it seems working on the lab bench in practice“

Peak power: Maximum possible power as well as the underlying duty cycle. This may be supplemented by repetition frequency and/or time information.

Channel maximum power: For multi-voltage power supplies, maximum power per output voltage, considering the power of the other outputs as well.

Based on these values, a rough preselection can already be made quickly. But how exactly do you measure the power requirements of your application?

The exact determination of the required continuous and peak power requires a measurement of the output current over a longer period and in all operating conditions. For systems with single voltages, this is still possible with manageable effort e.g. oscilloscope with a current clamp.With multiple voltages (e.g. ATX), all output powers must be recorded simultaneously to determine the total power. An effort, which can be worthwhile, however. Because multi-voltage power supplies offer the possibility to permanently load individual outputs significantly higher, as long as the total power remains within the limit. This measurement can be facilitated by checking each output in advance for complying with the maximum channel power. If this is given, one can estimate whether an intended multiple voltage device is suitable by measuring the input power over time and considering the efficiency.

The measurements have another benefit:
Depending on the construction of the power supply, the outputs are divided into main and auxiliary. The main voltage is the voltage that contains a control loop with the primary side. This voltage, therefore, has a very low voltage tolerance that is almost independent of the applied current. The auxiliary outputs have no direct control loop. They are coupled into the main output feedback loop, if at all, through a common output choke. The regulation of the auxiliary lines is, therefore, less accurate than that of the main output.
A minimum current is required on the main output can be accurately co-determined when measuring the output currents.

Step 2: Derating and Operating Temperature

Furthermore, it is important to consider the derating curves from the power supply specification:

1. Temperature derating
While at elevated temperature and operation with fan often no reduction of power is necessary, at convection operation above a certain temperature the (continuous) power must be reduced. This reduction must be ensured on the application side, i.e. the power supply unit does not reduce the power by itself! To avoid an overload of the power supply at high temperatures, the required (continuous) power and the ambient temperature must be calculated back to the nominal power in the datasheet:

Pspec= necessary specified power according to datasheet at temperature Tspec
Ptemp= required power at highest operating temperature Ttemp

Both the derating factor as well as the setpoint, from which the power must be reduced with increasing temperature, play a very important role in the selection of a suitable power supply. This also has a direct and huge influence on size, lifetime and price. The following comparison of two commercial 2“x4“ open frame power supplies with the MPE-S065 shows the extreme difference in performance at temperatures above 40°C:
For this range of 60W power supplies a size of 2 „x4“ with a derating of -2.5%/K starting at 40°C - 50°C is typical. Using this kind of power supplies at 70°C ambient temperature, which is a temperature which easily will be reached in a industrial application, results in a continuously output power of just only 15-30W. The MPE-S065 on the other hand has a derating of only -0.75%/K from 50°C. Thus, it still delivers continuous power of 51W at 70°C which is up to +240% higher as the other units.
If, as in this example, a power of 50W at 70°C is required, the following power supply power classes would have to be selected (assuming the same derating values):

Comparison device 1: Power supply with 200W nominal power at 40°C
Comparison device 2: Power supply with 100W nominal power at 50°C
MPE-S065: 60W nominal power at 50°C is sufficient

It is easy to imagine that with the same 2 „x4“ size, the 200W, 100W and 60W power classes have very different price points.
Even if the differences are not always that serious in practice, it is definitely worthwhile to consider the derating issue in detail.

For convection operation, most PSU manufacturers require that the PSU is mounted with the component side facing upwards and that no heat buildup occurs above it. If the mounting position differs from this and/or there is not enough space above the power supply, several component temperatures specified by the power supply manufacturer should be measured. Alternatively, you can contact the power supply manufacturer if he offers support to check the power supply in the application or if he is able to simulate the application conditions. In this simulation case, the power supply unit is measured in the original or in a replicated housing. Loads and temperatures correspond to the later application conditions. This is the safest way to prove the suitability of a power supply.

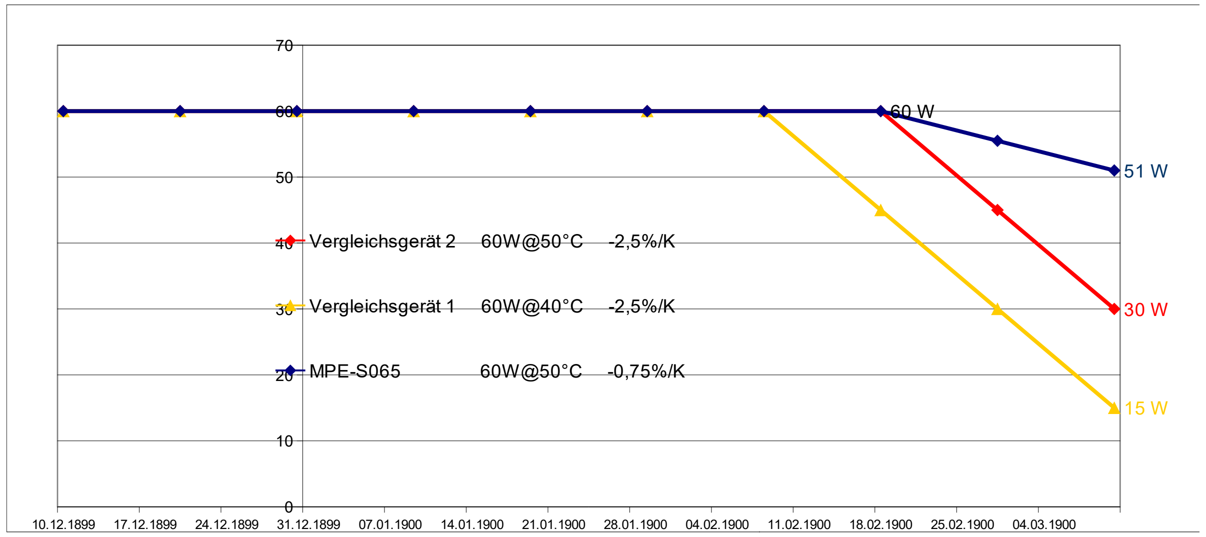


Fig 1: Temperature Derating | Image credit: Magic Power GmbH

2. Input voltage derating

Similar considerations apply to power derating with respect to the input voltage. A power supply operates from 85 - 264VAC, depending on the design. It is understandable that low input voltages as in the USA or Japan require higher currents on the primary side. This leads to higher losses at the active components (e.g. rectifier or switching transistors) and at the passive components (e.g. EMC chokes). Therefore, for input voltages <100VAC, a discount similar to that of the temperature rating is usually applied. This indicates what power can be drawn at what input voltage.

3. Effects in practice

A switching power supply basically works reliably for a certain time even at too high temperatures or loads. To protect them from destruction by overload, the power supplies are equipped with an overcurrent limitation. This is typically set at 20-30% above the peak load. If a power supply is operated permanently at this limit, it will not cause failures on the lab bench or during a prototype phase.
The same is true for elevated temperatures. Power supplies from about 200W often have a thermal switch, which switches off in case of overtemperature. However, it does not ensure that the power supply can automatically be operated only within the defined operating range. The thermal switch is used for fire protection and is designed to ensure that all datasheet values are adhered to. So also in this case the power supply will run for a certain time without negative signs. However, the electrolytic capacitors are affected first. The trend towards higher packing densities creates air layers around the capacitors with significantly higher temperatures than the ambient temperature of the power supply per se. The use of 85°C capacitors in power supply design should therefore be taboo. For 105°C types, each power supply manufacturer must decide between 1kh, 2kh, 5kh types or more. In general, according to the Arrhenius equation, a reduction of 10 Kelvin in the environment of electronic components allows their lifetime to be doubled. In practice, 90°C can quickly be reached at 50°C operating temperature and high loads directly at the capacitor. Therefore, 105°C types with 1000h should generally not be used in high-quality power supplies. Depending on the position, temperature at the point, ripple and frequency, 105°C capacitors with 2000h, 5000h or even higher values are usually used.

Step 3: EMC - Emission and Interference

IEC61000-3-2

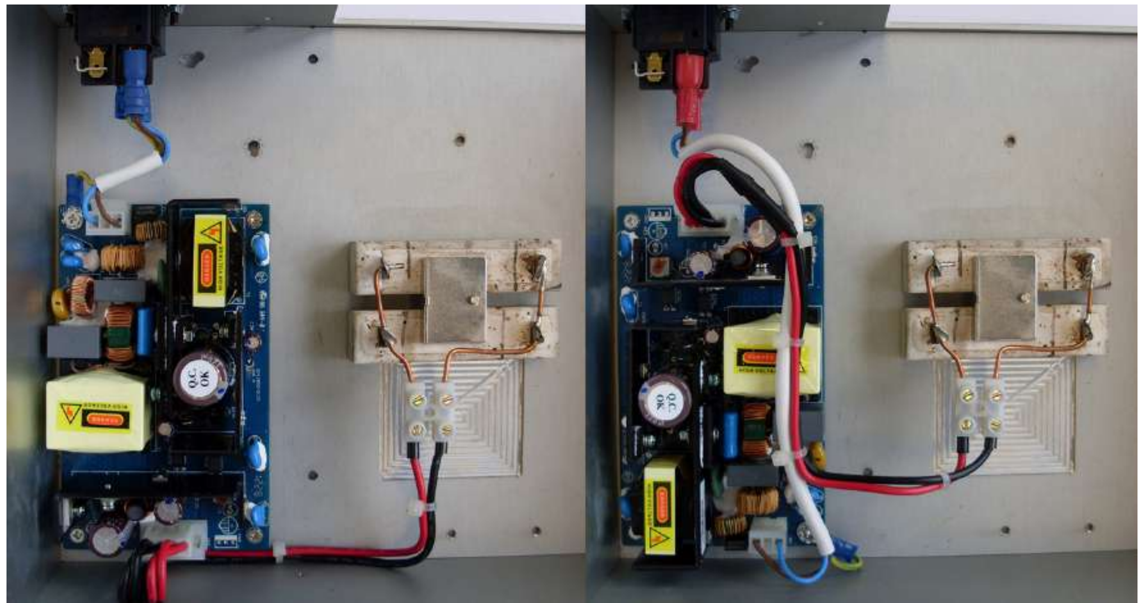
A normative point directly related to the output power is IEC61000-3-2. When connected to the public network with max. 16A and input power between 75-1000W, the power supply must comply with appropriate limits in terms of harmonic current levels. The corresponding limits are obtained from the final product, taking into account the following groups:

Class A:
3-phase devices
All devices that do not fall under B, C and D
Class B:
Power tools
Class C:
Lighting systems
Class D:
TV
PC/IT

Here, too, costs can be saved with appropriate preselection. The manufacturing effort for a class D PFC is greater than that for class A. For the majority of products, however, class A is perfectly adequate.

EMC pre-tests

Better safe than sorry. Every developer knows that EMC compliance must be demonstrated at the end of the entire process. Often the limits are not reached in the 1st run, and time and money must be spent to improve.
The solution is EMC pre-tests at an early stage of development. The later these take place, the higher is the possibility that problems arise in the cooperation of the individual components.
Of course, the emissions can also be brought back below the limit at the end in a kind of violent action. However, the additional input filters, chokes, shielding plates, flap filters, etc. that are then required cause effort and costs in production, and this over the entire product life cycle.



In many cases, it is only small things that significantly change the result. To illustrate this, we have wired a protection class I switched-mode power supply with a corresponding resistive load in a sheet metal housing. Both input and output cables are as short as possible. We then measured the emissions conducted and the radiation in the TEM cell. Both measurements were well below the corresponding limits in the sweep (overview measurement over the relevant frequency range). The result was completely different when the power supply was rotated. The power line ran across the power supply unit and ran parallel to the load line. Obviously, compliance with the limits is not clearly given here. For the designer, on the other hand, the difference between the two installation variants in production is rather small. Practice shows that at low levels of emission, the various immission measurements often pass without complications (e.g. H-field or E-field irradiation).

Conclusion

Know where and how: It‘s often the little things that optimize a design. But the reward for an optimally selected power supply is a gain in reliability, service life, time and costs over the entire life cycle of the application.

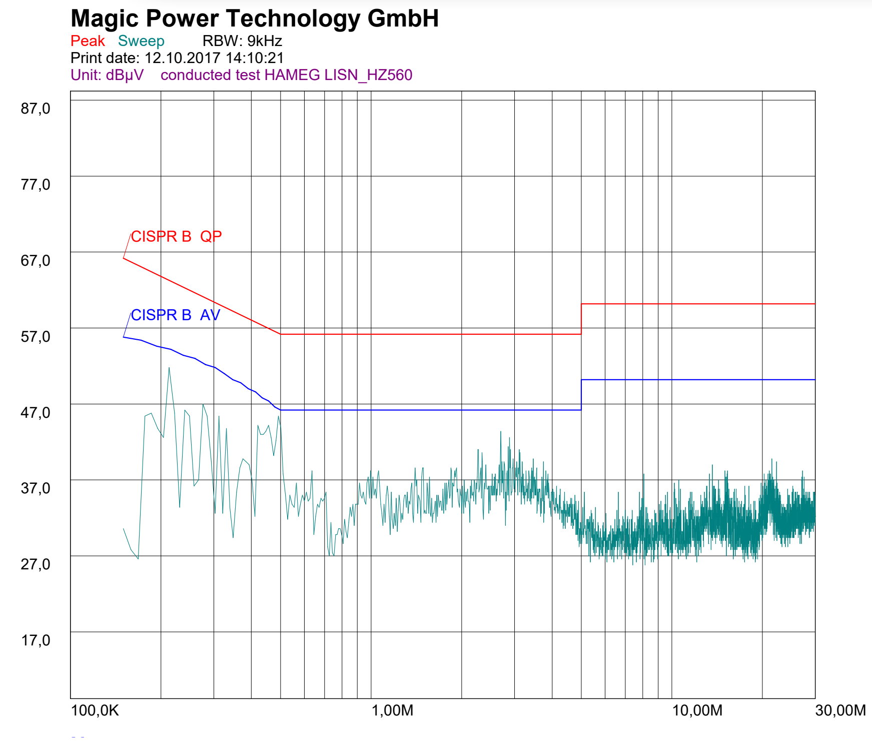


Fig. 2 Conducted interference voltage peak with short internal cabling (above) and long internal cabling (below)

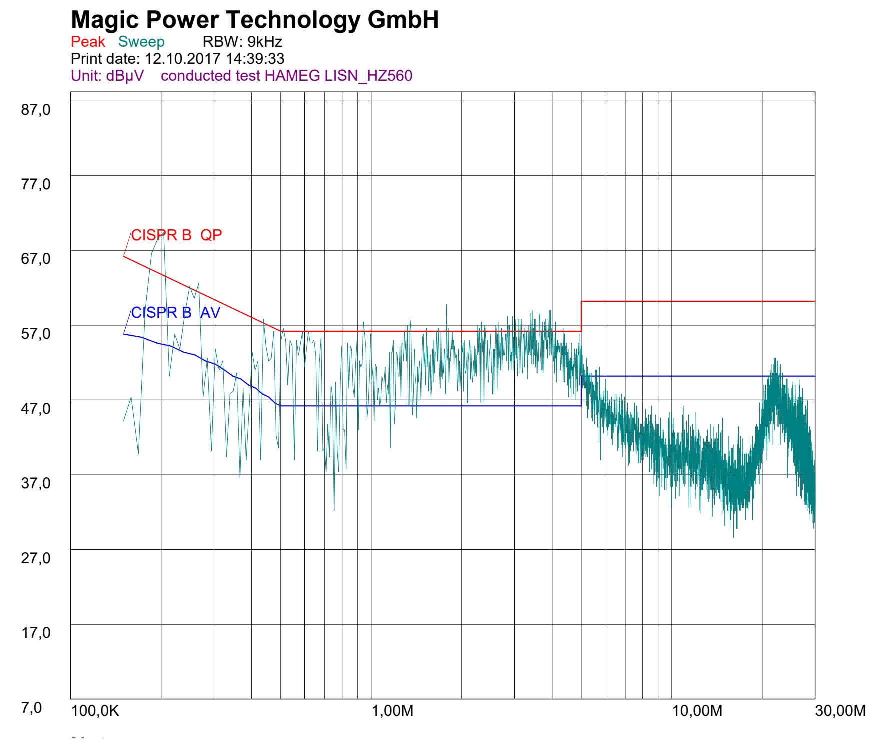


Image credit: Magic Power GmbH

Three Considerations for Designing IoT Devices of the Future

By Stephen Drinan, Director of Micro Connectivity at Molex

The potential of the Internet of Things (IoT) to transform connected applications holds great promise despite ever-increasing complexities. While IoT will impact everything from consumer gadgets to industrial devices, application developers face significant barriers, both in terms of designing products to integrate with future technology as well as retrofitting existing applications with IoT capabilities.

While IoT emerged as a viable solution for embedding smart processors in devices, such as doorbells or security systems, the technology has evolved to include sophisticated networking and intelligence systems—with the ability to collect real-time data and transmit it wirelessly through radio frequency (RF) systems. What started out as a smart refrigerator that lets users adjust the temperature with their voices, for example, now has expanded into customizable mobile alerts about a door left ajar or an expired water filter.

„Users demand superior RF performance and expect devices to work all the time."

With the increased functionalities of processors, which has fueled the expansion of software-defined features, more sophisticated RF hardware is widening the range of options for network applications and services. This development becomes especially relevant in non-traditional markets, like white goods and industrial. As software evolves and becomes more valuable, dependency on availability and performance of wireless networking increases.

Users demand superior RF performance and expect devices to work all the time. Despite constantly evolving requirements, designers can follow three best practices to help ensure IoT devices are built with the components needed to achieve optimal performance—both now and in the future.

I - Be Aware of Connectivity Requirements and Seek RF Expertise

Build awareness of the increasing connectivity requirements into the design process. This is the first step to ensuring that RF components are treated as essential to the application and not an afterthought. For example, without proper planning, developers might build a sleek housing or display, but it might lack optimal space to incorporate RF electronics and antenna feeds.

Currently, many IoT projects involve taking an established device and adding in wireless capabilities. In other words, these projects are transformational and require expertise in this area. While a product team might be experienced in the design and production of the device, they may lack the knowledge to effectively incorporate RF elements into the design.

Bringing an RF expert onto the design team from the start is an excellent way to alleviate challenges by anticipating all necessary components and then designing around them. Thoughtful design insights, such as metal versus plastic housing, antenna placement within or outside the housing and optimal printed circuit board sizing, can make the difference between an average and a high-performing IoT device.

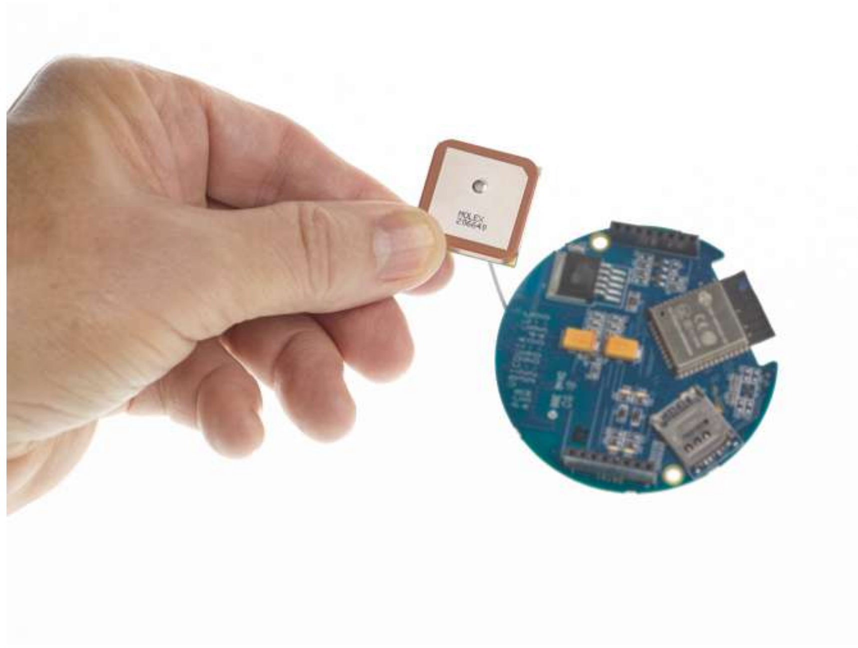


Image credit: Molex

II - Identify the Application Requirements and Anticipate the Lifecycle

From the study carried out by professors Yano and Nakano, it is clear that there is a great deal of potential for ozone gas to be used in preventing the aerial transmission of SARS-CoV-2 by inactivating the virus. This means that there could be a new role for the Murata MHM series ozonizer/ionizer products discussed here to take on. Though they are normally focused on general sanitizing and deodorizing tasks, tests have shown that they can offer a successful method via which the propagation of COVID-19 can be tackled. There is a great deal of potential for these units to be deployed in hospitals, hotels, restaurants, bars, shopping malls and indoor public places – generating low levels of ozone on an ongoing basis to combat airborne SARS-CoV-2. Accompanying fans could keep the ozone circulating, so the generated molecules remain effective for longer.

III - Strive for Resilient and Back-up RFs

The need for robust and responsive RF performance has resulted in technologies, such as multiple-input-multiple-output (MIMO) antennas. On a basic level, MIMO antennas are redundant antennas that are spatially and angularly diverse. This increases the likelihood that one or more of the redundant antennas will catch or broadcast a signal better than the one next to it. They also enable increased bandwidth and can better collect signals that might be present through micro-reflections of the RF wave.

The RF electronics that the antennas connect to need to support MIMO when it is used. For cellular applications, especially 5G, it is not uncommon to use MIMO antennas for higher-performance devices that need high speed data and excellent RF connectivity.

Additionally, it is becoming more common for devices that require the highest reliable RF connection to utilize multiple protocols and frequencies, such as Wi-Fi + LTE. LTE (4G or 5G) as a backup to Wi-Fi can help ensure that the device will work, even when Wi-Fi is down.

When deliberating on how to integrate RF into IoT, designers must plan carefully. Use RF expertise, consider the demands of the application and understand the intricacies of designing for future trends. If the project is a next-generation or new product that uses a significant amount of bandwidth, the focus should be on 5G capabilities and redundancy. For most household IoT devices, however, a less costly RF strategy should suffice, although designers should stay abreast of expanding uses for the devices.

Take Advantage of the Future of IoT Cloud Data Management Today

By Brandon Young, Vice President of Information Systems at Monnit

How to create an agile data management system with secure openness

Many articles about the Internet of Things (IoT) and data management begin by outlining the deluge of data today and its predicted impact in the future. It's clear that data's volume, velocity, and variety call for IoT cloud data management best practices now and in the future.
Openness—accessible, compatible, integratable—in IoT data management systems is critical.
So is:
- IoT infrastructure modernization
- Data governance and security
- Metadata management
- The combined power of central and edge processing

The current and unimagined future value of IoT data lies at the intersection of these must-have data management strategies and

„The current and unimagined future value of IoT data lies at the intersection of [...] must have data management strategies"

how they counter common data management problems. For data management, modeling, and analytics systems to capture this value, organizations must have a clear vision of making IoT data work for them to proactively pivot with our evolving connected world.

Data's Abundance Naturally Creates DataOps Challenges

There's a double-edged sword to the volume of data. On one side, too much data can be unwieldy. It may be challenging to gain real-time visibility into what's going on in your organization. You can't see the forest for the trees. But on the other side, if you have the open or compatible resources to compute through your data, you can pull out actionable insights that offer real value to your business.
You can overcome the potentially overwhelming weight from large amounts of data through best practices that handle data's gravity. In this way, volume produces value. Meaning as data volume grows, it adds or attracts applications to create value from the data. The applications then add more data volume leading to greater insight. Ultimately, the greater the data volume, the more value it has. This is why you need a secure, scalable, and stable IoT infrastructure to handle the data influx and its management. Not having an agile IoT data infrastructure—processing, management, and storage systems—is a significant challenge to achieving the highest data value. It's essential now and from now on to rethink your approach to solve data volume, IoT infrastructure, and other IoT data management challenges.

Image credit: Monnit

Data Governance and Security

Your company's data which includes data from customers and partners, is one of your most valuable assets. That means you should use, manage, and protect it like it is. A robust data governance initiative to create and enforce rules and policies helps ensure data compliance, privacy, and accuracy throughout its life cycle. Data security plays a vital role in this initiative. IoT devices on your network must follow the strongest security best practices. You can't put all of your safeguards in firewalls, routers, policies, and other typical strongholds, but leave the temperature sensor on the lobby's fish tank vulnerable to network data breaches. Vetting the security of every IoT device from the edge to the core is vital for business continuity. Plus, cloud applications need to be securely open to access, ingest, prepare, analyze, and govern data quickly.

Metadata Management

Context is critical to make fast and actionable data-based decisions. The best metadata prompts IoT sensors to send alerts based on preset parameters combined with sensor type, function, location, time, date, manufacturers, serial numbers, and more contextual information. For example, a sensor's reading of 36 degrees or an alert that water is present is mostly irrelevant if you don't have all of the context data—the metadata—to go with it.
Flexible, integrated tools make metadata management work. Closed IoT systems without representational state transfer application programming interfaces (REST APIs) and webhooks can't provide the compatible metadata and integrated analytics required to allow accurate and timely action.
Centralized data management is essential when you have many IoT devices and data at the edge to control and analyze. A central system relies on over-the-air (OTA), two-way communication with sensors and edge gateways. This is how you can update and configure a wide variety and potentially thousands of devices quickly. Metadata is key to making a central cloud and edge data management system run seamlessly in real time.

Edge Data Processing

Edge processing or computing shifts data resources related to aggregation and bandwidth from central data centers and clouds closer to IoT devices at the network's edge. Edge devices can do a lot of work to prepare data for the cloud. A good IoT data management system offers the combined benefits of edge processing and central cloud computing.
It's ideal for sensors and gateways to handle edge processing like filtering out inaccurate records or readings such as false-positive temperature data before ingestion into a cloud data stream or lake. IoT edge devices that help manage preconfigured parameters or thresholds are also ideal. These smart edge devices can provide metadata such as timestamps and location data points to support faster and better analytics.
Edge gateways can handle much of the OTA management with sensors. IoT edge devices can do the following data management:
Sensors and gateways process and temporarily store data if needed.
Gateways securely distribute configurations to the sensors and sensor data to the cloud.
Sensors and gateways can also smartly process and summarize data before sending it to the central cloud data management system.

Image credit: Monnit

Critical Capabilities of Current IoT Data Management Systems

Current IoT infrastructures need to be ready to scale with ease. Foresight is vital, so organizations should foster strategies and plans for the future by first asking:

Will our existing network and IoT systems scale to sustainably manage possible massive data volumes?

Is our IoT cloud data management system open, and can it seamlessly integrate with cloud storage and data analytics systems using APIs and webhooks?

Are we ready to integrate current and future artificial intelligence (AI) and machine learning (ML) applications?

At the minimum, today's IoT data management systems must:

1. Summarize data and openly source metadata in the cloud and at the edge efficiently for real-time action.
2. Simultaneously provide data aggregation, storage, logging, and auditing capabilities for more robust analytics.

Those organizations that are already facilitating the open integration of AI and ML applications and other new IoT data analytics advancements lead in the IoT game. They're ready for the next near-future phases of IoT data management.

Build a Data-Driven Future

It's been a minute since we just used file storage. We moved from relying solely on relational and adding in NoSQL (not only SQL) databases. NoSQL is an answer to Big Data because we can store more and access data faster with these databases. They're also lighter on the resources with large data sets.

But today, we see more and more edge computing to prefilter data before it goes to the cloud. We're expanding capabilities to run a hybrid IoT data management model depending upon the industry application for the foreseeable future. We'll continue to handle, store, and analyze both the raw data in the cloud and preprocessed edge data. It's harder to do at the edge, but cloud data set cross-pollination also powers current data management practices. If you run an open, compatible system, you can quickly access, integrate, and analyze disparate data sources in one data management solution. For example, you can combine your smart building's security, energy, occupancy, traffic, IT, maintenance, staffing, and more system data sets for a comprehensive view of your operations.

Moving forward, we'll want to continually cross-pollinate, simplify data system integrations, and mix in ML and AI centrally and at the edge—all to provide preemptive maintenance of things and streamline the spectrum of processes. The benefits of this actionable intelligence are exponential in greater efficiency and cost-effectiveness.

Actionable Data is the Prize

The value of the IoT is in its data. Organizations that can capitalize on their data insights the fastest far outperform their market competitors. Forward-thinking enterprises don't just put sensors on things and connect them to the Internet. They make sense of the data through a future-ready IoT cloud data management solution so they can continually make actionable decisions faster and better with high ROI.

The IoT is the New Normal

By Svein-Egil Nielsen, Chief Technology Officer & Director of Strategy at Nordic Semiconductor

To remain viable in a post COVID-19 world, businesses and whole industries are being forced to embrace the IoT on a massive scale. There will be no going back

There's been quite a bit of publicity recently about "long COVID", the symptoms and health issues that persist long after an individual has contracted COVID-19, even if they only had what was initially a relatively mild case.

As a recent news story published by the BBC, a U.K. public broadcaster, put it: "For most people, COVID-19 is a brief and mild disease but some are left struggling with symptoms including lasting fatigue, persistent pain and breathlessness for months [and this is] having a debilitating effect on people's lives, [with] stories of being left exhausted after even a short walk now common."

With such persistent bad news about COVID-19 it can be hard to see any positives coming from the pandemic that continues to threaten the physical and economic health of billions of people. Yet, as counterintuitive as it may first seem, the long-term impact of COVID-19 could be highly positive for the world.The pandemic seems to be dramatically accelerating the adoption of IoT technologies in a way that wasn't happening before. This is ushering in a wave of long-promised connectivity benefits that were previously struggling to gain traction.

"COVID-19 has put a rocket under global IoT adoption," says Nordic Semiconductor CTO, Svein-Egil Nielsen. "What may have previously been regarded as a 'nice to have' has been transformed into a 'must have' for many businesses and organizations that wish to remain operationally viable during this pandemic. In fact, if a business or organization doesn't now embrace the IoT that organization may well not exist a few years from now."

IoT becomes mandatory

The view is echoed by a recently published survey by Vodafone, a U.K.-based global telecoms company, of 1,639 businesses worldwide. The survey found around seventy five percent of respondents expressed the belief that if they failed to embrace the IoT now, they expected to be lagging behind their competitors within five years.

In a separate survey, Gartner, a business analyst, found that around half of all businesses are now planning to increase their investment in IoT because of, rather than despite, the impact of COVID-19.

"IoT-driven changes that were previously years or decades away, are happening today," says Nielsen. "These changes will be permanent and extraordinarily far reaching. And probably most important of all they will happen at economies-of-scale that will have the potential to improve the lives of people around the world in previously unthinkable ways, far sooner than would have ever occurred otherwise."

Although video conferencing, remote working and online grocery shopping have been among the earliest high profile shifts, deeper and arguably more fundamental shifts are now occurring that will be equally impactful on how we will be living and working in the not-too-distant future.

A perfect example of such a shift is occurring in the healthcare industry. Pre-pandemic, the sector was notoriously conservative and riddled with inertia. Even though low cost medical IoT devices and solutions did exist, there was no real sense of urgency to adopt them beyond being forced by, for example, end-of-life equipment cycles. Pre COVID-19 the healthcare industry was reliant on multiple outdated—and often manual—processes that were all prone to human error and inefficiency. Although it was never the intention of the medical industry's management, by failing to fully embrace the IoT they deprived patients of advanced modern technologies. Such technologies could speed up waiting times, make healthcare more affordable and accessible, improve patient comfort, reduce the risk of infections and improve chronic disease management and patient outcomes.

Lost and Found

One example of the medical sector's failure to embrace the IoT is illustrated by asset tracking. According to one report, published by Becker's Hospital CFO Report, even the most diligent U.S. hospitals are losing around $12,000 per bed per year due to inefficiencies in the way they track and utilize medical equipment assets. Yet until COVID-19 struck the country with full force, there was no real drive to address this issue using modern IoT technology. The pandemic changed everything. During the surge in SARS-CoV-2, hospitals quickly realized that even if they were lucky enough to have enough ventilators, for example, these were of no use if they couldn't be located when needed. Lives were being lost while staff searched for missing machines. But now the medical sector is turning to low cost wireless IoT solutions to solve the problem and are unlikely to stop. There is also a wholesale shift towards wireless medical devices such as pulse oximeters. The devices are a particularly powerful diagnostic and monitoring tool for many diseases, including respiratory ailments like influenza and COVID-19, because a decrease of oxygen saturation in the blood is an early warning that the virus is getting on top. Wireless pulse oximeters linked to the IoT allow patients to be monitored remotely and minimize the infection risk to front line staff, are much more comfortable for patients to wear, and enable continuous remote monitoring for the first time. This means any sudden negative health changes can be spotted immediately and health outcomes significantly improved. Wireless tech also means the end to tedious and repetitive manual observations of not only blood saturation, but also, with a range of commercially available wireless monitors, blood pressure, heart rate and rhythm, temperature and respiratory rate. The result is precise, timely and comprehensive monitoring that can go directly to a server for software analysis to pick up any worrying trends.
A second example, while somewhat more prosaic, nonetheless illustrates how the IoT is permeating the medical sector. Enter the world's first totally automatic, bladder function medical measurement device. Until now, taking accurate bladder function measurements was both a labor-intensive and notoriously inaccurate process involving patients keeping manual logs of urination (or 'voiding').

"Voiding measurements are to a bladder dysfunction doctor what blood sugar measurements are to [an endocrinologist]," explains Dr. Brent Laing, CEO of U.S. medical device startup, ClearTrac Technologies. "But until now, every time I sent 10 patients home to keep a voiding diary ... just one of the 10 would have successfully completed the task."

The answer is a small, battery-powered portable handheld device that allows patients to measure voiding patterns from anywhere. Called CarePath and using Nordic Semiconductor's nRF9160 SiP, the device is used in a similar way to a pregnancy test whenever a patient urinates. Laing says COVID-19 has significantly increased interest in his device from hospitals that are now keen to minimize unnecessary patient contact as well as avoid having nurses tied-up doing labor-intensive manual medical measurements of any kind.

CarePath from ClearTrace is the world's first totally automatic, bladder function medical measurement device | Image credit: Nordic Semiconductor

The Taste of COVID-19

Another area that COVID-19 is transforming is the food and restaurant industry. While there were some exceptions, the sector's practices had by-and-large remained unchanged for decades - and not necessarily for the benefit of consumers. COVID-19 has enforced change and a prime example of this shift is the use of smartphone app-based ordering to minimize customer-to-server contact.

"Once restaurants start using this technology, it's unlikely they will go back to the old ways," stated a recent post on The Wise Marketer website. "[There are] plenty of restaurants where you can just scan a QR code at the table to access the menu, which is a safe and effective way of deciding what you want to order without interacting with a waiter."

The change accelerated by the IoT means that as a customer you no longer have to wait for a server to place your order, the possibility for 'lost in translation' errors in manual order taking is minimized and, because the order goes straight to the kitchen, the customer will probably get their food faster too. Contactless dining is here to stay. Airline meals are another area of the food industry that COVID-19 has revealed was ripe for transformation (even though consumers and airlines had probably not realized it). The seated service dates back to the earliest days of the modern consumer airline business and a time when plane tickets cost a small fortune because the only class was first. Fast forward to today, and even pre COVID-19 airline tickets in economy class had fallen to such a low price that airlines were struggling to provide food. When they did it was notoriously low in quality and had to be manually ordered. Now, in a pandemic world, that dubious pleasure is not worth the risk of catching the virus.
Once again the IoT will provide the solution. When boarding a Transavia flight from Amsterdam (in a tie-up with Amsterdam Airport Schiphol, iFleat and Takeaway. com) customers can now order their in-flight food from their restaurant of choice (operating at or near the airport). Because these restaurants prepare and deliver the food to the plane, the airline doesn't have to worry about supplying food on a severely restricted budget and it gets paid a healthy sales commission by the restaurant.
Better yet, the customer gets a meal they genuinely enjoy. The power of the IoT means passengers can even leave it as late as up to one hour before their flight to order their food.

COVID-19 will change everything

The examples above are but a few of the IoT-driven shifts now occurring across the world. While some changes brought about by COVID-19 will be temporary—for example, it's unlikely anyone will want to wear a face mask for a second longer than they have to—the transitions now being powered by the IoT look set to be permanent. Because of the powerful benefits the IoT has brought in areas such as efficiency gains, cost reductions, staff safety and customer comfort, it's hard to see the world ever going back to how it was before the pandemic.

Take, for instance, working from home: The Economist, reports, for example, that Will Gosling from Deloitte, a professional-services company, believes the pandemic has brought about a "five-year acceleration" of a trend that was already under way. It has shown that working from home is feasible and has made it more acceptable. A fortuitous knock-on effect is less congestion and fewer flights and rail journeys leading to a major decrease in carbon emissions.

COVID-19 is propelling IoT adoption forwards with a sense of urgency that previously didn't exist. And if in the longer term the world regards COVID-19 as a turning point that generally made the world into a slightly better place via the IoT, then at least something positive will eventually have emerged from this terrible pandemic.

It could well be that the distribution of the SARS-CoV-2 vaccines themselves will prove to be the application that cements the IoT into the public perception. When people are given the injections that return the world to normal, albeit a 'new normal', they will remember how it happened with fond and lasting memories. Then there there will be no going back.

Specifying Plastic Enclosures For Industry 4.0 Electronics

By Kay Hirmer, Head of Marketing at OKW Gehäusesysteme

Electronics manufacturers know the importance of Industry 4.0 only too well. The race is on to create the next generation of robotics, computing, sensor and HMI products that will take manufacturing to the next level and beyond. OEMs face huge pressure to meet burgeoning demand in this rapidly growing market sector. And all this IIoT sensor technology must be housed within enclosures robust enough to meet the challenging demands of the modern smart factory. That in itself has created a mini-boom segment in the electronic enclosures market. But until recently there was something missing from would-be IoT/IIoT housings – innovation. Enclosure manufacturers have been under such pressure to meet demand that many have simply repurposed existing designs and rebadged them as IIoT sensor cases. Few manufacturers offered any genuinely new customisable standard enclosures created specifically for IoT/IIoT and Industry 4.0. Not least because standard enclosures – by their very nature – have tended to be less specialised; they must remain versatile and be all things to all designers. But all that is changing. A new generation of IoT/IIoT-focused housings is now available to electronics designers vying to satiate demand for Industry 4.0 solutions.

Image credit: OKW Systemgehäuse

Dedicated Enclosures For IoT/IIoT Sensors

So what makes a good IIoT enclosure? What separates it from the myriad of other plastic enclosures? Industry 4.0 involves collecting vast quantities of data to hone the manufacturing process. So smart factory operators must install large numbers of sensors – sometimes in challenging locations. This requirement inspired us to add key design features to our new EASYTEC range of IoT/IIoT enclosures:
- Versatile lugs at each end that offer not just screw holes but also apertures for cable ties, making installation extremely rapid
- A concave recess in the rear section – enabling stable and secure mounting on poles and rails (without compromising wall mount stability)

Which Plastic For IIoT Enclosures?

Today's new IIoT enclosures need to be stronger and more resilient than the average plastic housing. So ABS – as a good a plastic as it is – may not be the first choice of material. For this reason, EASYTEC is moulded from a flame-retardant ASA+PC-FR blend. ASA provides the enhanced UV stability while the polycarbonate (PC) offers greater impact resistance.

Why Pole-Mounted Enclosures Need To Be Ergonomic

EASYTEC's design also features something more commonly found in handheld enclosures: ergonomic soft contours. Enclosures must look as smart, modern and futuristic as the 21st century factories they inhabit. And ideally, they should feature the same design language as other enclosures in the factory.

Cornering The IoT/IIoT Enclosures Market

There are plenty of sloping front housings available for the desktop market but surprisingly few true wedges that would fit snugly in a 90° corner. And yet this has been a prime requirement for the surveillance market for decades – and is likely to be even more important over coming years as demand for IoT/IIoT enclosures increases. We're meeting this demand with SMART-CONTROL, a wedge-shaped enclosure that can also be mounted on flat surfaces. Its versatility provides the answer to one of the key dilemmas facing enclosure designers.
- Two sizes, M (173 x 101 x 59 mm) and S (142 x 81 x 46 mm)
- Convex version or version with recessed operating area for membrane keypads
- High-quality ASA+PC-FR material with high UV protection in the standard colour off-white (RAL 9002)
- Screwed together on the rear of the enclosure using Torx stainless steel screws
- Special wall suspension element (accessory) for mounting the enclosure in 90° inside corners or on flat surfaces

Image credit: OKW Systemgehäuse

What is next in cellular IoT?

By Jörg Köpp, Market Segment Manager at Rohde & Schwarz

„Besides latency and communication reliability, network availability and security are of utmost importance for mission- and business-critical applications in the industrial environment"

Over the last couple of years, the cellular IoT (C-IoT) ecosystem and especially the 3GPP standardization has focused on enabling the massive machine type communication (mMTC) market for applications such as water metering, cow monitoring, smart parking or asset tracking. The base technologies NB-IoT (Cat-NB1/2) and eMTC (Cat-M) were developed in Rel. 13/14, with dedicated features for very low power consumption (eDRX, PSM) and coverage enhancements (CE modes). In the meantime, around 140 mobile operators around the world have deployed LTEM or NB-IoT networks, and the Global mobile Suppliers Association (GSA)* has counted more than 500 devices supporting either Cat-M1, Cat-NB1 or Cat-NB2.
Emerging IoT applications in several industries as well as the global phase out of 2G and 3G networks drive the need for more application-specific extensions.
Therefore, 3GPP is continuously working on improvements for NB-IoT and eMTC to cover specific application demands (**Figure 1**). Examples are features like wake-up signal or early data transmission, as introduced in Rel. 15. Both help to further optimize power consumption and reaction times. But in the long term, there is a need for a smooth transition to the era of 5G.

C-IoT in the era of 5G

5G was the first mobile network generation designed from the beginning to support not only the mobile broadband market (eMBB) but also the growing IoT market. Already in the first 5G release, the foundation was laid for the transition of mMTC (NB-IoT/eMTC) from 4G to 5G and for very low latency and ultra-reliable communication (URLLC) features as demanded, for example, by factory automation. 5G NR characteristics such as very flexible numerology, wide frequency support, built-in security and several layers of virtualization create the base to support the essential 5G use case scenarios: eMBB, mMTC and URLCC.

Essential for the future of mMTC in the 5G era are two factors: The coexistence of NB-IoT and eMTC in 5G thanks to very flexible use of radio resources; and the support of related features by the 5G core. Coexistence features as specified in Rel. 16 will allow 5G capable NB-IoT and eMTC devices to connect to standalone 5G network.

Industrial Internet of Things

Factories of the future will rely on deep integration of information and automation, enabled by ubiquitous connectivity. Therefore, the industry is looking for a very reliable and secure wireless communication technology that can be used for different applications on the factory floor. There might be alternatives to address one or the other case, but only 5G has the potential to address them all:
5G mMTC optimized for low power and deep coverage will be a perfect fit for the tracking of tools and goods, or connecting sensors.
5G eMBB optimized for mobility and high data throughput will suit the task of connecting VR glasses and handhelds used by workers.
5G URLCC with the new features developed for in Rel.16/17 will enable full automation for controlling robots or automated guided vehicles.
URLCC is a completely new application area for cellular communication with very explicit requirements regarding latency, timing and reliability. 3GPP has spent reasonable efforts to address these requirements and now provides a comprehensive URLCC toolset. It will help optimize the latency on the radio interface, thanks to features such as short symbol time and mini slots, together with enhancements such as fast and flexible repetition process, or grant-free uplink transmission. Network virtualization, traffic prioritization and multi-access edge computing will largely improve the end-to-end latency. The communication reliability can be improved by applying robust coding schemes, packet duplication and repetition as well as dual connectivity schemes. This toolset also includes the support of time sensitive networks (TSN) or LAN-type services via 5G, as mainly developed in Rel.16. Further improvements for time synchronization or operation in unlicensed environment are in development in Rel.17.

Besides latency and communication reliability, network availability and security are of utmost importance for mission- and business-critical applications in the industrial environment. Therefore, the industry has been looking to operate private 5G networks that could be deployed as stand-alone non-public network (NPN) using private spectrum or public-network-integrated NPNs using network virtualization as specified in Rel.16.

NR Light

The comprehensive feature set of 5G adequately addresses a wide range of IoT applications, e.g. for extreme low cost, extreme low power and limited mobility with NB-IoT. But there are plenty of IoT applications like children's safety wearables that would need long battery lifetime, very good coverage, but in conjunction with full mobility and reasonable data rates. Other examples are emergency sensors that need extreme coverage, but also very low latency and low power consumption. In order to address these mid-range IoT applications, 3GPP started to study the application requirements under the name NR Light and is now in Rel. 17 going to standardize a new reduced capability (RedCap) device type with the focus on the typical requirements of industrial sensors, smart wearables and surveillance cams (**Figure 2**).

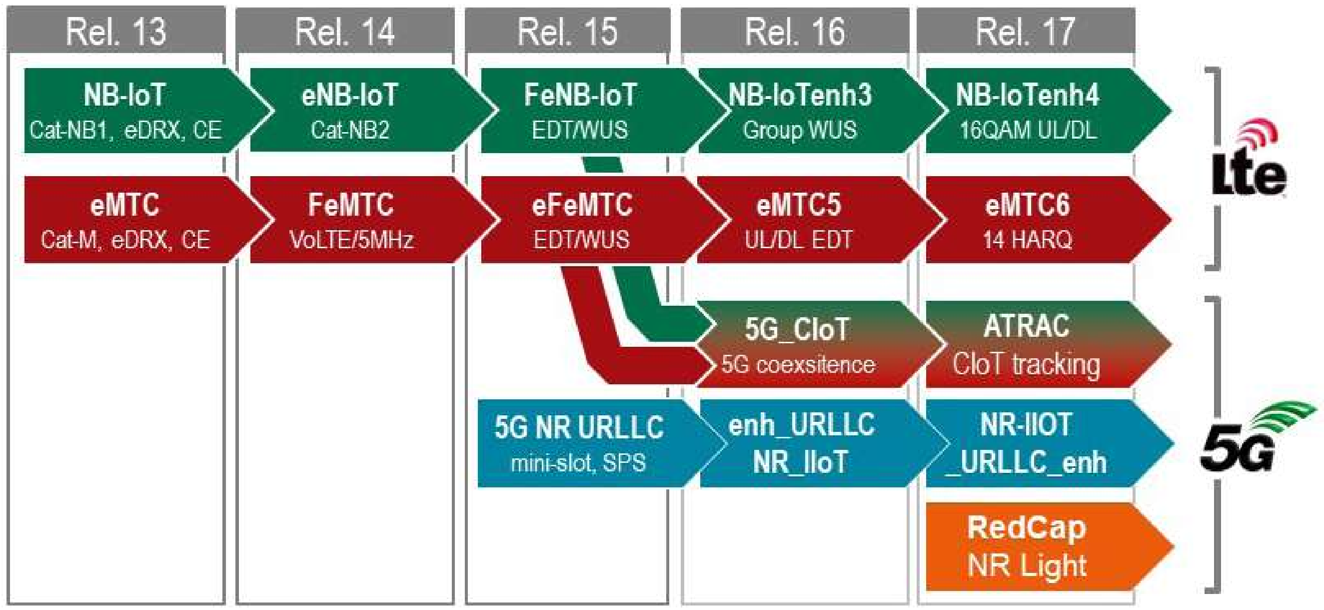


Fig. 1: 3GPP standardization efforts in supporting the cellular IoT ecosystem
Image credit: Rohde & Schwarz

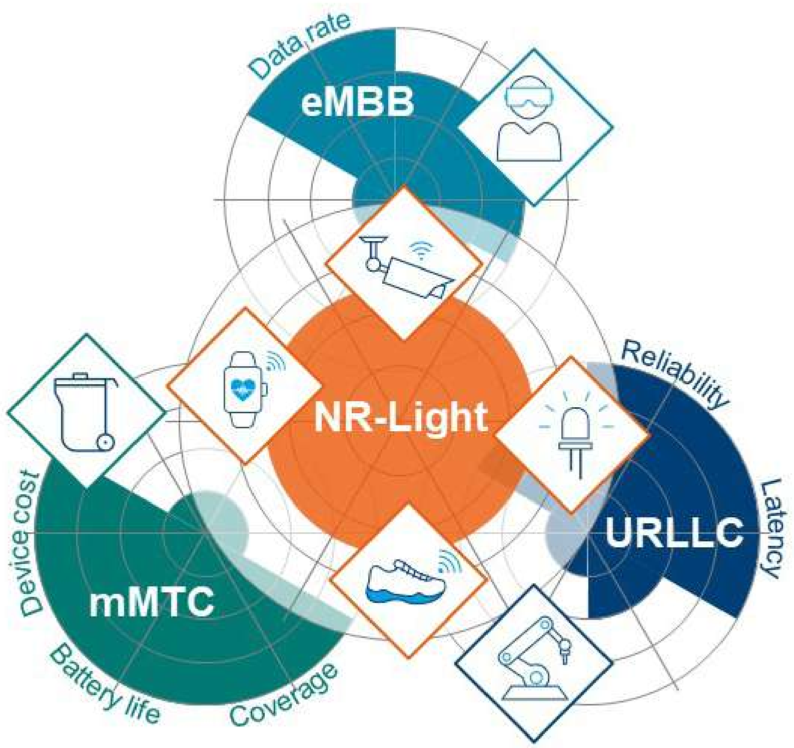


Fig. 2: The center of IoT addressed by NR Light
Image credit: Rohde & Schwarz

Non-terrestrial networks (NTN)

Mobile networks as of today can cover more than 80% of the global population but only 40% of the land surface and less than 20% of the Earth's surface. The only worthy alternative to addressing IoT applications of global sensing, tracking and monitoring is the use of non-terrestrial networks by using, for example, tiny low earth orbit (LEO) satellites. In Rel. 17, 3GPP is working on the integration of satellite components in the 5G NR architecture in general and studies initially the use of LTE based NB-IoT and eMTC via NTN.

The power of testing

3GPP is continuously driving the standardization to meet today's and tomorrow's requirements for the IoT ecosystem. The large diversity of features and network scenarios, together with very specific IoT application requirements, will accelerate the demand for test and certification over the complete lifecycle of devices and network components. With the rising number of business- and mission-critical applications using cellular technologies, testing aspects such as latency, reliability and power consumption becomes increasingly important. The continuous monitoring of networks regarding performance, quality, security over all network layers, from the RF spectrum to the application, become essential.

The IoT race is on and Rohde & Schwarz is ready to help device makers, operators, and infrastructure manufactures accelerate the introduction of IoT applications and services with a comprehensive test solution portfolio. This is achieved by embracing service offerings and worldwide application support by well-educated engineers.

Making the Choice for IoT System Connectivity: Chipset or Module?

By Vishal Goyal, Group Manager Technical Marketing South Asia and India at STMicroelectronics

According to Stastita[1], by 2025 IoT devices are expected to number more than 75 billion, far outnumbering the UN's forecast of 8.1 billion people on earth by that year[2]. IoT is probably one of the biggest drivers for technology companies. Probably the most important feature of an IoT device is that it is connected.
Wireless connected devices have a RF radio, antennae and associated circuit to convert electrical signals in electromagnetic waves and vice versa. Designers have two options to implement this circuit – a) Using an RF chipset and design associated RF section and b) Use a module with RF chipset and associated RF section already mounted. In this article we will compare both the approach and help designers to take informed decision.

RF section using chipset and module

Implementation of RF section using chipset approach consists of RF IC, Antennae, Balun and Filters, matching networks, crystals and other passive elements. Below is the reference schematic of the implementation using STMicroelectronics BlueNRG BLE SoCs.

Implementation using Module approach is much simpler. The same circuit as in figure1 can also be implemented using readily available module. Below is the pin-out and internal block diagram of BlueNRG-M2SA module from STMicroelectronics. The module is implemented using BlueNRG-2 SoC and associated circuit.

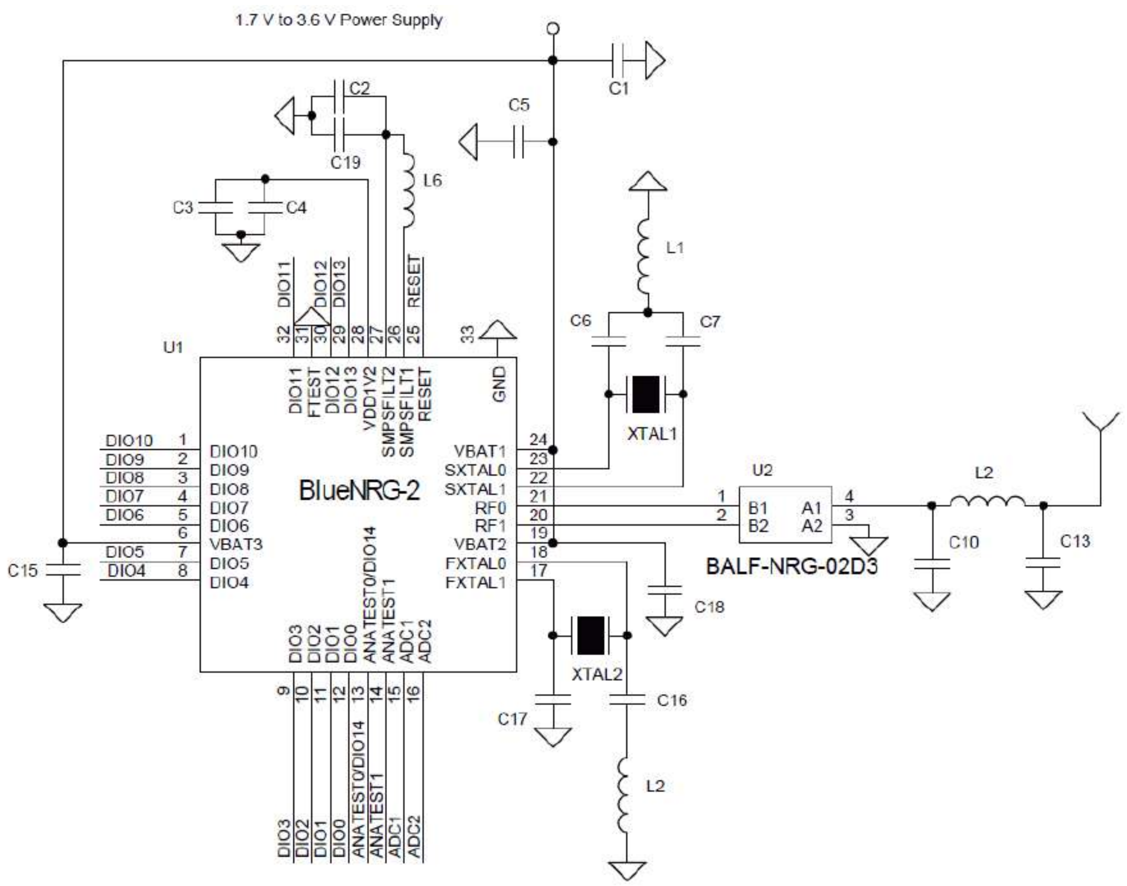


Fig. 1: BlueNRG-2 reference schematic
Image credit: STMicroelectronics

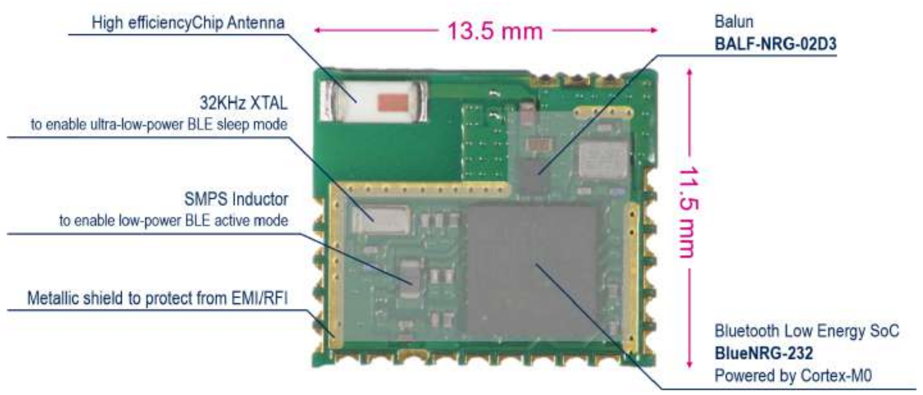


Fig. 2: BlueNRG-M2SA pinout and internal blocks
Image credit: STMicroelectronics

Comparison between chip-set and module approach

Up to 21% of women and 31% of There are three main aspects to be considered while selecting a right approach - a) Time to Market, b) Certification and c) Cost. We will review each of these aspects to arrive at logical understanding.

Time to Market
Some steps to design RF section using chipset are as follows:
I - Designing schematic and layout
II - Developing PCB from PCB maker
III - Mounting PCB
IV - Fine tuning values of passives for optimized performance
V - Ordering all the components of the module and manufacturing it
VI - RF tests and certifications

Designing a RF section with chipset consume almost three-six months. It also requires multiple resources such as RF designers, supply chain and multiple service partners such as PCB makers and EMS companies. This approach is suitable for a very high volume production, but is not desirable for prototyping and low volume production.

Modules are designed for fast time to market. Adding connectivity using modules does not require any prior RF expertise. Wireless connectivity is easy like a modular drop-in add-on as the designers get a readily available RF section, the implementation using modules is very quick. So, designers can bring their product into market very quickly. This is particularly very important for prototyping and low volume production.

Certification
Virtually any electronic device undergoes general emission testing. Besides devices which have RF sections are also treated as intentional radiators. So, they require an additional certification to ensure they do not emit power more than allowed, or disturb other devices or frequency bands. There is no global certification, and every country or region have their own standards.

Often the standards are similar, but they still require an application and associated processes.
Besides, most of the RF technologies such as BLE, Wi-Fi or GPRS comply to a standard defined by those specific organizations. So, they go under those certifications also.
Let us understand certification aspect using devices under consideration – BlueNRG SoCs and BlueNRG-M2SA module from STMicroelectronics.
A Bluetooth Low Energy enabled device need to be certified by Bluetooth SIG – a governing body of Bluetooth to use Bluetooth Logo. They also need to get RF certification from different Countries and Regions. Certification defined by some of the countries and regions are FCC (US), RED (Europe), WPC (India), IC (Canada), SRCC (China) and Type (Japan).
As modules are already tested and certified as radiated device, designs implemented using module not require further radiated device certification and will be treated as yet another electronic device. Below is the comparison of cost using chipset and module.
Process of certification is time taking, tedious and costly. If the volume of production is large the cost can be amortized by economy of scale but not efficiently by small scale production.

Certification	Item	Chipset based	Modules based	Estimated Savings
Bluetooth	Testing	8000	0	8000 €
	Listing	8000	8000	
CE	Safety	3500	3500	2000 €
	EMC	2500	2500	
	RF	3500	1500	
FCC		4000	1500	2500 €

Fig. 3: Estimated Savings in Chipsets and Modules
Image credit: STMicroelectronics

Technology	IC	Module	Description
BLE	BlueNRG-MS network processor	BlueNRG-M0A	Full featured / Low power
		BlueNRG-M0L	Low Cost
	BlueNRG-2 Application processor	BlueNRG-M2SA	Full featured / Low power
		BlueNRG-M2SP	Low Cost
RF SubGhz 433MHz, 868Mhz, 915Mhz	SPIRIT1 radio	SPSGRF-868/915	In-built Antennae
		SPSRFC-433/868/915	UFL connector for external antennae

Fig. 4: STM RF Chipsets and Modules
Image credit: STMicroelectronics

Cost
Some of the elements of cost are already discussed in this article. In general cost of

- Cost of circuit design
- Cost of designers, supply chain and production Cost of certification
- Cost of opportunity

In general, these costs are justified if volume of production is above 100-150Kpcs per year, or the product form factor does not allow a dedicated module to be incorporated.

Module offering from STMicroelectronics

STMicroelectronics is a leading semiconductor company and wire wide range of low power RF devices and modules. Some of the RF chipsets and associated modules offer by STMicroelectronics are in **Figure 4**.

Conclusion

Chipset approach should be adopted if the end device form factor cannot adjust module or production volume is very large to justify cost of design, production and certification. Modules should be preferred if company want to focus on its core competencies and avoid hassles of RF design. Modules are also preferred for prototyping and low volume production. STMicroelectronics is a leader in Low Power RF technologies and provide wide range of chipsets and Modules for wide range of usage scenarios as discussed in this article.

Sources and further reading:

1 Statista - Number of Connected Devies
2 USAToday - Number of humans on Earth

AI and Edge Computing are Must-Haves for Maximizing IoT's RoI

By Mohamad Nasser, Vice President of IoT Solutions at Taoglas

The faster cellular networks get, the more tempting it is to just upload everything that IoT devices collect. But that approach can create big problems — and even undermine IoT's RoI.
Roughly 5.8 billion IoT endpoints were in service worldwide by the end of 2020, Gartner estimates. That's a 21 percent increase from 2019, with no growth plateau for the foreseeable future.

These numbers highlight the data deluge problem. Whether it's a factory, farm or smart city, organizations frequently and quickly get overwhelmed by the sheer amount of data that their IoT sensors produce. It's difficult to find the nuggets of actionable insights in the terabytes of raw data flooding in each week or month — a drawback that they often overlook or underestimate when developing an IoT strategy.

„Whether it's a factory, farm or smart city, organizations frequently and quickly get overwhelmed by the sheer amount of data their IoT sensors produce"

Some IoT applications have additional challenges. A prime example is video. For example, many retailers now use video surveillance not only for security, but also for understanding shopper behavior, such as dwell times and the paths that consumers take through a store.

The catch is that a small army is required to monitor all of those feeds just for catching shoplifters. A retailer would need even more people to study shopper behavior. And even if the chain could afford a staff that large, they inevitably would become fatigued over the course of a shift and start to miss things, such as whether a target demographic stops to look at an end cap. There's also the cost of uploading all that video and data, plus the cost of storing it. As a surveillance network scales up, the human-centric, manual-monitoring model quickly falls apart.

Analysis at the Edge

Fortunately there's an alternative: edge computing. As the name implies, this architecture puts compute resources at the network edge. Now the analytical capabilities that traditionally resided in a central location — such as a security operations center — exist near or in each camera. This change creates several operational and bottom-line benefits.

For starters, cameras no longer have to upload all of their video in real time to a central location for humans to review. Instead, artificial intelligence (AI) at the edge is trained to look for specific things, such as smoke, people where there aren't supposed to be any, a bag left unattended or, in the case of thermal cameras in a refinery, a heat signature indicating a pump that's starting to seize. When the AI detects those conditions, it turns on the live feed to the operations center and alerts a human to take a look. This AI-powered edge computing saves bandwidth and storage — and in turn money — because the video is uploaded only when necessary, and only metadata is used for regular transmission. It also minimizes the risk that something important will get overlooked because staff monitor only the feeds that the AI flags. Hence, the idea of only smart data is uplifted to the cloud and the bulk of the analysis is done at the Edge.

Edge-based AI also is faster and more efficient than humans when it comes to certain tasks, such as license plate recognition. Instead of a person watching a school parking lot camera feed and manually entering plate numbers into a computer, AI automates the process of checking them against a database. This frees the school's security staff to focus on other tasks because they'll be alerted only when the AI detects a plate associated with, say, a noncustodial parent or a registered sex offender.

There are myriad other existing and potential video applications, such as:

- Using facial-recognition-style capabilities to identify and track animals on a farm.
- Analyzing excavation and other work on construction sites, and alerting supervisors when certain criteria are met.
- Detecting when a senior citizen has fallen or been sitting for too long. This could enable seniors to continue to live safely at home. Or it could help ensure their safety in retirement communities while enabling staff to work more efficiently because they check residents only when alerted of a potential problem.
- Counting products on a conveyor belt, or detecting damaged ones in a highly automated factory.
- Verifying social distancing in the workplace, including to meet insurance company policy requirements.

The migration to the edge is a trend that's been underway for several years. For example, in 2018, Gartner estimated that roughly 10 percent of enterprise-generated data was created and processed outside a traditional centralized data center or cloud. By 2025, it expects the amount to hit 75 percent. "As the volume and velocity of data increases, so too does the inefficiency of streaming all this information to a cloud or data center for processing," said Santhosh Rao, Gartner senior research director at Gartner.

Key capabilities to look for

When developing a IoT AI edge computing strategy that involves video, organizations should look for several key capabilities in vendor solutions:
Stereo vision, including 3D measurement (size, position, velocity).

- Scene illumination control, dark- and flat-field correction, and region-based auto exposure, all of which are critical for overcoming challenging environments, such as heavy shadowing.
- Understanding what an image shows and then classifying it accordingly, such as a shopper from the target demographic.
- Action recognition, such as alerting security staff when people are seen running in a place where they typically don't.
- Human pose estimation, which could be used to analyze a football team's movements or to identify a fallen senior citizen.
- Audio recognition, such as glass breaking, smoke alarms and other sounds that justify turning on the video feed and alerting a human.

The bottom line is that AI and edge computing are now critical for large-scale IoT deployments, especially those involving video. Both technologies save money by minimizing bandwidth and personnel requirements while ensuring that organizations get the kinds of deep, actionable insights that only IoT can provide.

At Taoglas, we specialise in designing AI IoT solutions at the edge. We can demystify the process for our customers - from the initial strategy definition right through to the design, build, deployment and management of IoT projects.

We are hardware and software experts and will work with you from the beginning of your IoT project, to ensure connectivity is properly integrated into your device, ensuring a connected, easy-to-use, low-power, secure and market-ready solution.

Taoglas can also provide finished IoT devices for immediate deployment, as well as EDGE™ IoT Starter Kits you can use for fast prototyping. With a flexible offering covering most connectivity, global positioning standards, vision AI and sensors, the Taoglas EDGE™ portfolio is a complete edge-to-cloud enablement platform comprising hardware, a cloud-based management platform and connectivity.

IIoT Network Trends and the Role of SPE

By Ruud van den Brink, Product Manager for Industrial Communications at TE Connectivity

We are in the middle of the fourth revolution. Or, otherwise known as the Industrial Internet of Things (IIoT). Following the first three waves of rapid changes in technology — first the steam engine, then electricity, then the computer — IIoT is now the primary driver for change.
Because of IIoT, factories are getting smarter, machines are more connected, and productivity is increasing. As companies look to further optimize IIoT systems, they must be able to effectively gather data from each part of the IIoT network. This requires interconnecting each data source with secure, reliable connections so each data point is stored in a larger database for further analysis.

IIoT network trends

As IIoT networks become more common, they become more complex. More complex networks mean the number of devices per network increases. At the same time, networks have become decentralized due to increased amounts of connectivity locally and on the factory floor. This movement underscores the need for more dustproof and waterproof solutions in order to withstand the harsh environment. IP20 regulations won't hold up and instead IP67-compliant products need to be used. Another industry trend that impacts IIoT networks is the rise of miniaturization. The cost of nodes is decreasing and they're getting smaller. Plus, the connectivity per device is increasing. In order to fit the expectations of increased connectivity while making products smaller, a new style of industrial connector is necessary to realize the interconnect. Lastly, today's automation networks are built out of different communication protocols, ranging from serial to BUS to Ethernet communication. With increased complexity, decentralization and miniaturization, streamlining communication protocols will help increase overall productivity and establish a free flow of data from the network to the database. In addition, combining an Ethernet-based network with an IP will give you an IP addressable network. This means the entire network is easier to access and add additional devices to.

Ethernet network architecture

In order to build a productive and effective Ethernet-based IIoT network, there are multiple levels and stages to consider. The first is the servo and motor drive portion of the network, which is created by various OEMs.

The OEM chooses which connectivity types to use, which then impacts the larger system in which it will eventually be used — the second level of our network architecture. For example, robotics applications or control cabinets utilize servo and motor drives, so the machine will need to be constructed in a manner that will connect securely to the OEMs original connector type. This is where it's important to select the right cable connectors and field installable connectors.

The last level of the network is handled by installers, where multiple pieces of equipment are interconnected as part of a larger build. In these situations, cordsets and field installable connectors are used to create a cohesive network on all levels.

IIoT networks of tomorrow

Looking at where the industry is headed and the need for fully Ethernet-based networks, Single Pair Ethernet (SPE) offers a promising solution. SPE only requires two wires (rather than eight) to transfer data and power.

SPE technology is designed in a way that, over an entire network, all machines can talk in the same language. The need for translation between the various communication standards is eliminated compared to older network styles. SPE provides one network with one language in communication that all machines can understand and use.

Image credit: TE Connectivity

Besides improved efficiency, the benefits of SPE include reduced complexity and costs, increased flexibility in designs, and a scalable foundation to go beyond previous limited speed and interoperability. While SPE has been in use in the high-volume environment of the automotive industry — where space saving, high performance and shared weight solutions are especially valuable — SPE is relatively new to the industrial space. However, its benefits are quickly proving obvious in the industrial automation sector and in the industrial internet of things (IIoT). Both require increasingly complex systems yet are built on an outdated legacy of multiple communication standards. At TE Connectivity, we believe SPE is essential to helping IIoT drive industrial automation forward.

As an enabler of IIoT, SPE allows barrier-free communication from the sensor to the cloud. It also provides movement freedom to applications and supports the rise of miniaturization. SPE enables cross-network real-time communication without any loss in information, which helps industrial engineers build a more streamlined, unified automation ecosystem that are more cost-effective than the traditional ethernet solutions of the past.

The industry is at a tipping point, with an exponential increase in innovation and technology just around the corner. The "smart tech" trends that have overtaken everything from watches and cars to mobile phones and thermostats are coming for industrial automation and IIoT.

These types of smart solutions will come to the industrial market and Single Pair Ethernet will help in accelerating this trend, because it enables the underlying communication to take place seamlessly throughout an expanding IIoT network infrastructure.

Machine learning to accelerate green internet development

By Tine Berg, Communication Partner at Technical University of Denmark

Machine learning and artificial intelligence are becoming increasingly important tools in the development of the energy efficient internet and data transmission of the future.
DTU is strengthening the area with the appointment of Group Leader Darko Zibar as Professor at DTU Fotonik.
It is a well-established fact that machine learning and artificial intelligence can find connections in large data sets—e.g. in the health sector—but it is relatively new that researchers are beginning to see how the methods can be applied in developing energy-saving solutions in such fundamental internet technologies as optical communication and intelligent optical systems.

The internet currently consumes about nine per cent of the world's total electricity consumption—and about two per cent of man-made CO2 emissions. Already within the next decade, the need for

„Next generations of optical communication systems will be so complex that machine learning will be a relatively quick way to find solutions that can transport huge amounts of data in the most energy efficient way.“

- Prof. Darko Zibar

data capacity and bandwidth will increase dramatically as a result of all the things society is constantly connecting to the internet. There is therefore a need to find ways of accelerating the development of energy-efficient technology that will ensure a green internet in the future—and newly appointed professor Darko Zibar is in no doubt about what can drive development forward.
"Machine learning and other intelligent systems can play a key role, and we therefore need to research this field if we are to achieve the UN's SDGs on sustainable development and the reduction of global CO2 emissions. The next generations of optical communication systems will be so complex that machine learning will be a relatively quick way to find solutions that can transport huge amounts of data in the most energy efficient way," says Darko Zibar.

Image credit: Technical University of Denmark

Intelligent systems essential for development

The advantage of machine learning is that the computer is able to analyse huge amounts of data and find algorithms and connections without being pre-programmed.
"We can use machine learning to identify models that can describe the relationship between transmitter and receiver when we develop lasers, frequency combs, networks, etc. to transport large amounts of data. Indeed, there are many optical system factors that need to be assessed in the hunt for the most energy-efficient solution—e.g. bandwidth, channel power, frequency noise, traffic route, and much more," says Darko Zibar.

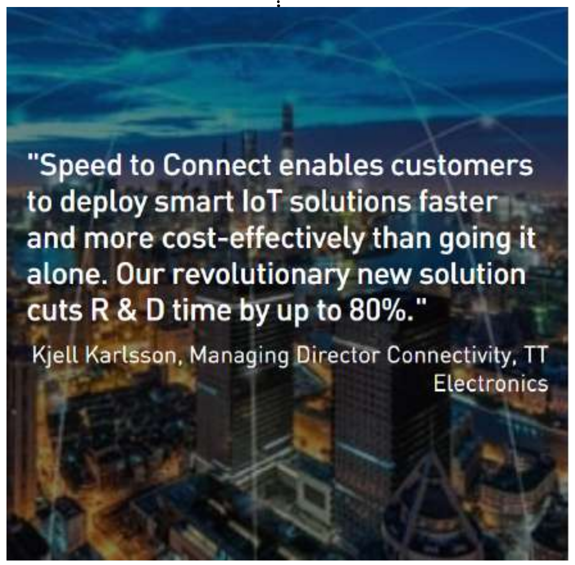
He explains that the increasing focus on quantum technology to improve internet security makes the task of designing optical communication solutions even more challenging because it requires coexistence and control of classic channels and quantum channels in the same optical network. This creates the need for the development of intelligent optical receivers that can distinguish between classical signals and quantum signals—so here too it is necessary to use machine learning and artificial intelligence in the development process.
"There will also be potential in using artificial intelligence in optical measurement systems—e.g. current optical instruments used to analyse the quality of the signal can't distinguish between different disturbances and determine whether they originate from the transmission channel or the components themselves. If signal analysers can learn to distinguish between the different disturbances, we will be able to design more efficient transmitters and receivers from the signal processing algorithms."
Developing efficient optical communication systems and networks is demanding, and many initiatives using different technology approaches are needed. That said, the need is urgent, and Darko Zibar and his group are therefore actively researching areas where they believe machine learning and artificial intelligence will have an impact on next-generation optical communication systems.

TT Electronics: Faster, Easier IoT Deployments with Telit's Bluetooth Low Energy Module

By TT Electronics and Telit

Utilities, smart cities, manufacturers and other organizations will deploy another billion Internet of Things (IoT) devices in 2020, Gartner predicts. That's 5.8 billion worldwide, a 21% increase from 2019 and nearly the same growth rate as 2018.

Those numbers are impressive considering all the hardware, software, networks, services and other components required for a successful IoT deployment. Most organizations have little or no in-house IoT expertise. That means they struggle to identify the right components to meet their requirements and then assemble them into a system they can deploy quickly and cost-effectively. The longer the lead time, the longer the organization must wait to start achieving IoT benefits, such as increased efficiency and productivity from automation.



These challenges can be even more daunting for large-scale IoT deployments. An electric smart grid, for example, can easily be tens of thousands of endpoints spanning multiple cities or states.

Rapid IoT Deployment for Rapid RoI

To help organizations overcome those challenges, TT Electronics created Speed to Connect, a seamless, end-to-end IoT framework of hardware, connectivity, infrastructure and user experience solutions. Launched in June 2020, Speed to Connect is initially targeting applications such as asset tracking, smart homes and cold chain logistics.

"Speed to Connect simplifies an often seemingly daunting process, empowering customers to get up and running with an IoT solution in a matter of weeks," says Kjell Karlsson, Managing Director Connectivity, TT Electronics. "From proof of concept to programs of scale, we can deliver the hardware, connectivity and user experience to connect, sense, track and monitor."

By streamlining development and deployment for IoT devices, Speed to Connect also helps organizations achieve goals such as improving efficiencies, eliminating unnecessary maintenance, reducing their carbon footprint and enabling data-led business decisions.

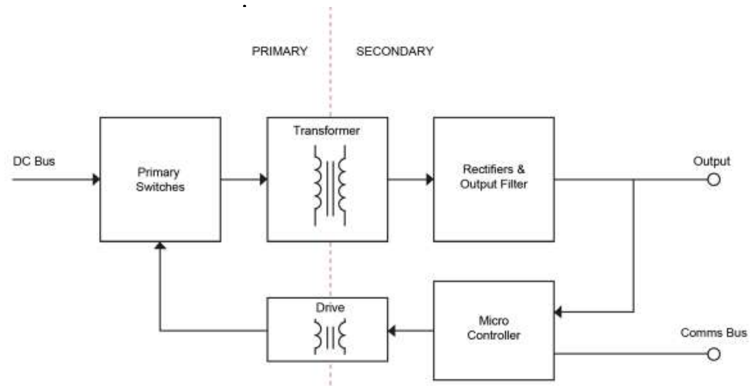
Digital control in power supplies supports Industry 4.0, IoT and application specific requirements

By Gary Bocock, Technical Director at XP Power

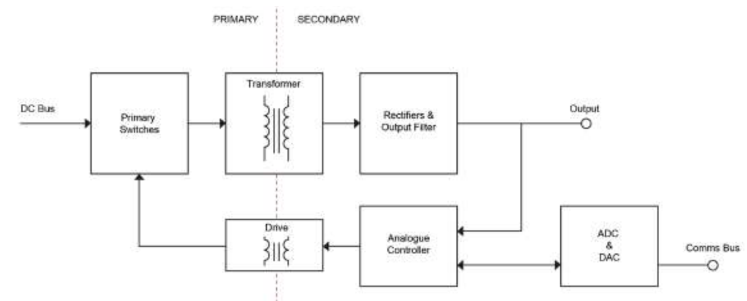
The implementation of digital signal processing (DSP) control in power supplies & power systems brings a wealth of benefits. From communications & control to support networked factories and efficient smart manufacturing, known variously as industry 4.0, the 4th industrial revolution or more broadly as the Internet of Things (IoT), through to flexibility & efficiency in stand-alone applications by communication & control within the end equipment and/or, by tailoring the power supply during the end equipment development phase to ensure efficient integration & optimised performance characteristics. Here, we look at the background, possibilities & benefits that true digital control offers when integrating power supplies and power systems into both connected and standalone applications & equipment.

Background

Digital control in power supplies and power systems broadly fits into two implementations. The more common approach is a digital interface between the traditional analogue control system and the outside world providing signals & alarms and various levels of control via a communication bus.
Simple, low cost microcontrollers have also been implemented in power applications for many years for functions such as fan speed control, protection functions & alarm detection.
Increasingly manufacturers are using digital signal processing (DSP) via a micro-controller for power system control bringing more sophisticated functions and greatly enhanced flexibility, allowing user programmable features and characteristics.
Without doubt, DSP is higher cost when compared to an off the shelf analogue controller but the cost of a microcontroller capable of implementing full DSP control has decreased over time, making this an increasingly attractive and desirable solution given the significant benefits it provides, especially as the power rating increases. The mixed domain architecture required, combining power analogue design principles with efficient code and stabilisation of the control loop in the discrete time or z-domain, rather than the frequency or s-domain, is well proven and understood by the product design & development teams within the major power manufacturers.
While the development, documentation, verification and approval of efficient, robust firmware takes significant time and resources to ensure a robust and reliable power supply, once the initial investment has been made the significant benefits of digital power and the ability to reuse the firmware across a broad range of products and platforms with relatively minor changes can be realised.



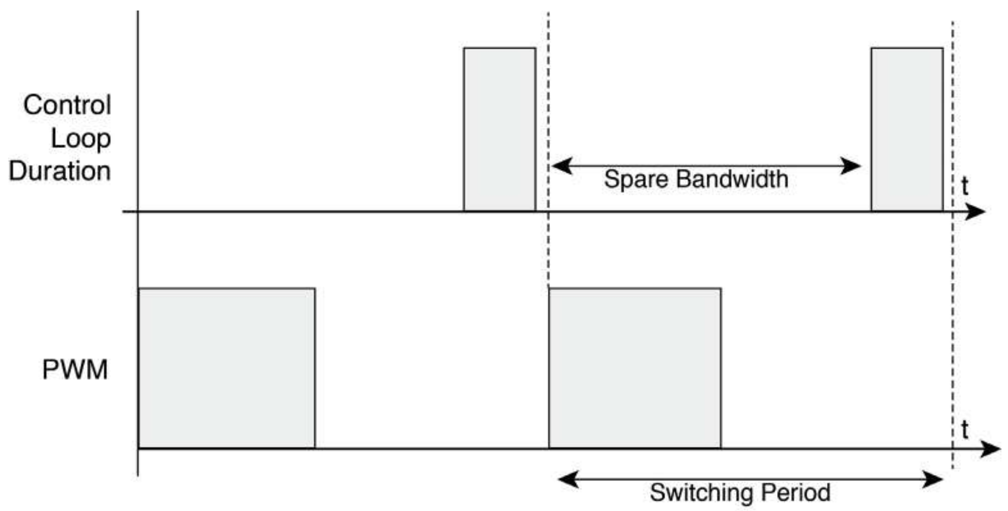
Top: Analogue power supply with digital interface
Bottom: DSP controlled digital power supply



Digital control loops have the advantage of being insensitive to changes in environment, temperature, ageing and tolerances of components. They can be calibrated at the point of manufacture to further improve accuracy and they enable monitoring of the performance of the power system in real time and adjust parameters to tune for optimal performance at the operating point, increasing efficiency and reducing power losses.

Features & Benefits of Digital Signal Processing (DSP)

Fully digital power supplies are able to offer unparalleled flexibility and adjustability to suit a wide range of applications without the hardware changes and adaptations which traditional analogue control systems have historically demanded.
DSP control loops bring the capability of output voltage and current adjustment over ranges as wide as 0 to 105-110% by tailoring the converter operational mode to the demand. They ease the implementation of constant current overload characteristics, which can be complex and costly in modern resonant switching topologies, without the need to compromise efficiency.
This entails the employment of multiple switching schemes and control algorithms in the same power conversion stage to achieve optimal performance at the required operational point, an extremely complex, if not impossible task, in a traditional analogue control scheme with fixed hardware drive and compensation schemes. This wide range control can be implemented as a continuously variable power supply to maximise system flexibility and efficiency or, exploited during the system development phase, to optimise the supply characteristics to the application without the need for hardware updates.
DSP also enables the user to determine start up ramp times, soft start characteristics and slew rates in software, another feature that would result in hardware changes in traditional control systems.
Warning levels and fault conditions such as input over/under voltage, output over/under voltage, output under/over current, temperature warnings & fault conditions can be set by the user to suit the application via software. The use of DSP further allows the response type & delay times applied to individual warning or fault conditions to be user specified. Options under warning or fault conditions may be as varied as continuing operation for a short delay & then disable, continuing operation indefinitely, disable & retry (including how many times to retry & time between retries before shutdown) and disable & resume when OK or disable & latch, all user selected.
Digital control systems also allow users to set the polarity of signals, alarms and controls to suit the system demands. A good example is the ability to set the remote on/off control to operate as inhibit or enable simply by toggling a digital switch.
Information from the power system is readily available through the communication interface enabling reporting and status such as model, revision, serial number, run time, operating temperature & fault/event logs.
This level of flexibility and user control is possible as the latest microcontrollers for digital power applications contain DSP functionality that allows the digital control loop to execute within a fraction of one switching period, every switching period. In the simplified example below, the output voltage is sampled once per switching cycle. An ADC conversion time of a few hundred nanoseconds is typical.



Simplified example of control loop & spare bandwidth

The time that the MCU does not spend executing the controller is spare bandwidth and this spare bandwidth can be used to perform other tasks or functions. Low priority tasks are run in a slow loop and are interrupted whenever a high priority task occurs, such as the ADC interrupt to run the control loop code.
The provision for analogue control of digital power is usually also provided for systems that use traditional 0-5V or 0-10V control signals by the implementation of an Analogue to Digital Converter (ADC) within the power supply and all alarms & controls can usually be accessed through conventional connections as well as digitally through the communications bus.

Connected Systems

Communication and control are increasingly important with the rise of connected, smart factory and IoT applications benefiting from real time status information from power systems as well as adjustment and control inputs, allowing real time adjustments to maximise process efficiency where it benefits from accurate voltage and/or current supplies and the ability to tune these to suit the environment and application.
Digital power products are able to report warnings, fault conditions, power delivery information, run time, thermal data and event logs in addition to enabling the real time adjustments to output voltage, current and power delivery to maximise system efficiency in sensitive processes or test applications.
A range of digital interfaces and protocols ranging from the commonly used I2C/PMBus & RS232/RS485 serial buses to DeviceNet & EtherCAT enabled interface solutions are available to suit a wide range of environments, applications and requirements.
While not all end applications require communication to the outside world, the ability to communicate with and adjust the parameters of the power system within an end equipment can enhance features & operating characteristics and has the potential to save cost by replacing the external hardware controls that are required for traditional fixed output supplies. DSP enabled power supplies can support dynamic requirements for output voltage, current and power delivery that are normally associated with far higher cost laboratory supplies, where tolerances are acceptable, and enable complex test, burn-in & process routines directly from a cost-effective power source.

Stand-alone Applications

In end equipment where there is no requirement for communication, either external or internal, there are still benefits to be gained in tailoring the power supply to suit the application, easing integration and removing the need for an application specific solution requiring a modified standard or custom power solution.
Output voltage, output current, power delivery, warnings, alarms, protection & controls can be adjusted, evaluated, amended and finalised during the development stage, creating a set of unique characteristics in firmware which are then implemented by the power supply provider at the point of manufacture for the end equipment production phase. These iterations of characteristics can be implemented on the same standard product saving considerable time and cost compared to the hardware changes required in traditional power products.
End applications employing analogue controls for voltage or current adjustment still benefit from the ability to determine the warning and fault condition settings & responses and polarity settings of alarm and control signals again, without resorting to application specific or fully customised power solutions with the time delays, risks and inevitable costs that are involved in development, EMC and safety agency approvals.
Manufacturers of digital power supplies commonly offer a Graphical User Interface (GUI) to enable users to define the requirements for just this purpose as well as enabling speedy evaluation of capabilities for connected applications.

In summary, there are clear and realisable advantages to implementing DSP control in power supplies and power systems in many, usually higher power (1kW+), applications which benefit from the flexibility and the time and cost savings it brings. For simple, lower power applications it is likely to be overly complex and cost prohibitive, with standard off the shelf analogue controllers enabling fast time to market combined with low acquisition cost for the commonly used topologies.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