element14

How to Engineer Your IoT Career

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Why Pursue a Career in IoT?

Whether you're an experienced engineer or a new graduate looking to develop your career, the Internet of Things (IoT) offers a wide range of exciting professional opportunities.

2019 marks twenty years since the term IoT was first coined by tech pioneer Kevin Ashton, during a presentation for consumer goods giants Procter & Gamble on the use of RFID in their supply chains. Since then, the term has come to represent a seismic shift in how we interact with the technology that surrounds our daily lives, to the extent that its emergence has been referred to as 'the fourth industrial revolution'.

Today, IoT forms the backbone of hundreds of tech companies operating around the globe, in addition to its rapidly growing presence in other commercial and domestic markets. All of these companies need both hardware and software engineers, making IoT engineers some of the most employable people in the tech sector.

But what does it take to become a successful IoT Engineer? As the world's leading online community for engineers and IoT professionals, element14 recently hosted a series of exclusive webinars on this subject, featuring contributions from industry experts at pioneering tech companies including Amazon, Eaton, Microchip, Microsoft, Molex, and The Things Network.

In this eBook, we gather the key discussion points from those webinars to provide a comprehensive guide to launching and sustaining a career in IoT. We hope you find it valuable.

element14 Community Team

The Internet of Things as a concept has been transformative to the tech and engineering landscape. At the most fundamental level, IoT refers to the proliferation of devices that connect to and communicate with the Internet. But in 2019, what does this mean from a professional standpoint?

WHAT IS IoT?

The term IoT is a useful catch-all to categorise products and services that leverage increasing connectivity between an increasing number of devices, from basic sensors all the way up to complex machines with multiple moving parts.

Many of the basic capabilities have now been around for a number of years, but the ways in which we can apply them are becoming increasingly sophisticated and wide-ranging, allowing us to create solutions that beforehand wouldn't have been possible. This is what makes working in IoT so exciting – the only limit is your imagination.

To give a practical example, imagine a fairly mundane piece of municipal infrastructure, such as garbage collection. The City of Philadelphia currently uses sensor technology in their garbage cans, allowing them to communicate with dispatchers and let them know when they're full and need to be emptied. Consequently, the city has improved efficiency to the tune of around $1 million in savings per year.

That was a simple idea, using everyday technology, incorporating connectivity to create an intelligent system to answer a consumer need. That's just one example, but it demonstrates what IoT can be and how it can be achieved virtually anywhere.

- Dennis Grinberg, Eaton

For me, IoT boils down to the ability to take meaningful information from the analogue world – be it the temperature of my home or the water pressure in a factory pipeline, for example – and collectively harness the power of cloud computing to analyse, aggregate, and most importantly to distribute that data so that it can be accessed anywhere.

Obviously, sensor technology has been around for a long time, particularly in the case of industrial and factory automation. But the advent of connectivity protocols like Bluetooth and WiFi has really made the technology ubiquitous and much easier for the consumer to understand.

- Gagan Luthra, Amazon

This is the age of information and devices. Every day more and more devices are getting connected in homes, stores, factories, cities… practically everywhere. We're still only at the tip of the iceberg in terms of what IoT can achieve in terms of consumer uptake, development and innovation. Right now really is the perfect time to get involved.

- James Blankley, Molex

CHAPTER 2
WHAT DOES AN IoT CAREER LOOK LIKE?

With tech and consumer companies across the globe embracing the rise of IoT, the career opportunities for engineers and developers have never been more plentiful. But what do those jobs actually look like, and how can you identify a career path that's suitable and viable for you?

IoT can span across many domains, which in career terms opens up a lot of opportunities for you to dive deep and become an expert in any one of a wide variety of specific fields.

You could become a networking expert who handles protocols and low power communication – literally helping the 'things' to connect to the internet.

Alternatively, you could focus on becoming a sensor expert, helping to get real world data into Internet-connected products. Or you could become a broad base expert and dedicate your career to systems architecture and how all of the various layers of IoT connect to each other.

- GL

Companies routinely hire for roles today that either didn't exist or were extremely limited as recently as ten years ago. These include jobs like user experience design, data science, machine learning, solutions architecture, big data engineering, mobile development and many more.

These opportunities encompass many different engineering disciplines, which presents you with an opportunity to leverage your personal interests and passions into a viable career to an extent that may not have been possible in the recent past.

When thinking about a career in IoT, think about where your passion lies in terms of a specific domain, and then understand its relationship to IoT.

- DG

It's a very broad scope of competencies that you need as an IoT Developer.

There will always be a sensor, a connectivity node, a compute node, an MCU and a transceiver – such as Bluetooth, LoRaWAN or WiFi. So if you want to build an end-to-end solution, you need to be able to understand the dev part, the connectivity part, possess the network knowledge required to connect to the cloud, and the data processing knowledge to build a simple dashboard to handle that data once it gets into the cloud.

All of this really requires you as a developer to be a bit agnostic. But if you're a talented developer, there's no need to worry about whether you'll have a job – it's really about what kind of job gets you excited.

**- Wienke Giezeman,
The Things Network**

CHAPTER 3
GETTING STARTED

Once you've identified where you want to go in an IoT career, what are the first steps you can take to make it happen? Whether you're a recent graduate or an experienced engineer, the first steps are often crucial to determining the arc of your career.

The first thing anyone looking to begin a career in IoT should do is target some companies that they'd like to work for and explore their websites for information. At Microchip, we operate from multiple locations around the world, and we're always interested in speaking to people with enthusiasm and a positive attitude.

If you're a graduate, look into intern programs – sometimes they're based on relationships a company will have with a

specific university or educational body, but there's no reason you can't be pro-active about approaching people. You might

need to do some digging to find the correct person to speak to, but if you can find an appropriate contact via an official website, you'll usually be sent in the right direction.

- Chris MacCallum, Microchip

We live in a time when there's so much opportunity to learn online. Whether it's dedicated YouTube channels or online communities like element14, use every resource available to you to educate yourself on your chosen field.

Wherever possible, get your hands on the tools you need and take a DIY approach. Dev boards can be acquired very cheaply these days, and you can write your own server on most modern laptops.

Secondly, most companies that hire developers will also be looking to hire juniors from time to time. When you go for one of these roles, the expectation isn't necessarily that you'll come in with extensive experience, but that you'll have a good attitude, a drive to learn as much as you can, and

an ability to work as part of a team. If you can demonstrate those attributes, you'll be in with a good chance of securing an entry level position.

Finally, if you are still in University, think carefully about what you want to do for your final thesis, and the relevance it might have to a potential employer. If there's a specific company you'd love to work for, this is your earliest opportunity to focus on them in a way that could bring real value to the rest of your career.

- WG

It's easy to get started with IoT Technology these days. Many of the products that can get you up and running – such as Arduino and Raspberry Pi – have a very low barrier to entry in terms of cost and pre-existing experience. They also have excellent communities around them, so you'll never be short of inspiration and support.

- GL

CHAPTER 4
WHAT IoT EMPLOYERS LOOK FOR

There's a great deal of opportunity when pursuing a career in IoT, but there's also significant competition. Making the right impression with potential employers is crucial, particularly when looking to get a foot in the door…

There's often an assumption that working in the IoT industry is all about how technical you can be. But for us, it's equally important that a potential employee has the ability to understand what the customer wants, and why.

When preparing for an interview, invest time into really understanding the domain and culture of the business. Depending on the project you'd be working on, look out for any ancillary knowledge that you could pick up from other individuals that might be involved.

- Paul DeCarlo, Microsoft

One of my default interview questions is 'When did you fall in love with programming?" The people we want on our

team are individuals with genuine drive and passion, who see programming as a craft and bring a high degree of craftsmanship to the work they do.

- WG

Tech roles inevitably evolve over time, so one attribute I'm always looking for as an employer is learning agility. We want people who not only can learn and evolve, but who actively want to. If you can demonstrate that you're a lifelong learner, somebody who will actively seek out new experiences and be able to apply acquired knowledge to new situations, then you're always going to be a strong candidate.

- DG

Having relevant academic qualifications is always a major advantage when entering the job market, particularly in highly specialised fields such as IoT. But is an advanced degree in Engineering necessary to get ahead?

CHAPTER 5
EDUCATION VS EXPERIENCE

When looking to hire somebody, sometimes the decision does come down purely to technical needs. But what we're more interested in is trying to build and sustain a culture for our business. So, we may interview a person with a Master's degree vs a person with a Bachelor's degree, but if during our conversations we feel that the person with the Bachelor's degree has more integrity, a stronger work ethic, and more clearly defined goals, those factors do come into play.

We never stop growing and learning as people or as engineers, so if you can show us that you'll be able to understand and evolve with the market, we're not likely to hang too much on your academic background.

- JB

As a company that has several employees with no college degrees at all, one way in which we make assessments during hiring is to look at individuals in the wider engineering community in terms of what they're building and working on in their spare time. Sometimes that helps us to earmark people with high potential that we definitely want to work with.

While degrees are important to set a fundamental baseline, there are certainly ways in which you can bypass or augment them. We really like to hire people who publish public projects on websites like element14 and Hackster. io. When we see a candidate being proactive in this way, it shows us that they have a passion beyond the baseline job. It's not just that they can do the job we're hiring for, we want to see that they're already doing it.

- PDC

At Microchip, we typically expect candidates to have an engineering degree at some level, but a relevant qualification doesn't automatically make it easier to get a job. What is much more critical is that candidates have a passion for technology.

One of the best ways in which a candidate can get this passion across is to have their own independent projects on the go. Not many employers will ask for a portfolio up front, but that doesn't mean you shouldn't take the time to create one. A candidate who can actively show me boards that they've designed and projects they're working on, and can talk about those projects with passion, will always stand out.

In terms of higher qualifications, if you have a masters or PhD there is certainly an expectation that you'll have learned and acquired more skills, so there's a good chance that you might initially start at a different level. However, where you end up depends much more on what you do with the opportunity than the academic achievements acquired before you joined the company.

- CMC

CHAPTER 6
CARVING OUT A CAREER PATH

Ask any successful company what their greatest strength is, and the majority will answer that it's the people who work there. So, it's in the best interests of any company to nurture their employees and not to place limitations in terms of the career paths available to them.

At Microchip, it's part of our culture to invest significant working time into helping our people to select and develop the skills that are important to them and to their long-term career aspirations. We invest heavily in internal and external training programmes, not just for younger employees but also for mature engineers.

Whether you want to go deeper into your own field of specialization or move into a management, marketing or sales role, the path is always open to those with the drive to pursue it.

- Cesar Martin Perez, Microchip

Whether it's becoming a line manager, heading a larger technical team, or simply having access to more advanced projects, taking personal responsibility for

where you want your career to develop is vital. When approaching a company, really think about where you want your career to go, and research what systems they have in place to support you on that path.

One thing we've noticed in terms of career paths for engineers is that it's important to have two very distinct roadmaps available. We offer a purely technical path, where somebody who doesn't necessarily want to have line manager responsibility can advance their engineering career and take on more responsibilities for major technical areas without having to become a people manager.

Alternatively, there's a well-defined management programme for people who want to move into that position. The reason for this dual track system is that, typically as a manager you tend to gradually have less day-to-day involvement in engineering, and a lot of people love that side of their jobs so much that they don't want to lose it.

- CMC

Few people are content to stay in the same job role for the entirety of their working lives. When you join an IoT company, personal development opportunities are likely to be key considerations both for you and your employer. So where can a job in IoT lead in terms of a long-term career?

We live in a world where people expect to change jobs several times in their working lifetime. With that in mind, we always try to look to where our employees want to be and how we can help them to get there.

There's increasingly a high demand for a lot of different competencies in the IoT market. Whether you want to go deeper into security, embedded programming, cloud networking or any other specialization, if you're a talented programmer with a strong drive towards personal development, the opportunities to progress won't be in short supply.

- WG

CHAPTER 7
HIGH DEMAND IoT SKILLS

There are many routes available for a successful career in IoT, however some skill sets are in particularly high demand in the current market. By leveraging these skills, you could significantly increase your value in the IoT marketplace.

From a hardware side, we're currently seeing a huge demand for RF engineering. A lot of companies working in IoT – particularly start-ups and Subject Matter Experts (SMEs) – may already have mechanical and electrical engineers on board, but people with a pure focus on RF engineering are harder to come by. If that's a skill or interest that's in your wheelhouse, there's definitely a market for you.

- JB

A relatively new area for data scientists has really opened up in the past few years in direct correlation with the rise of IoT. Whether you're a systems and solutions architect or a specialist in machine learning algorithms, companies are going to need your skill set to analyse the vast amounts of data they work with and to extract meaningful information from that data. As the market continues to grow, the opportunities in these fields are only growing with it.

- GL

There are many software engineers out there who are familiar with Linux, but far fewer can combine that deep knowledge with actually using Linux in an embedded system and in more limited environments. At Microsoft, we're always on the lookout for people with those skills.

- PDC

CHAPTER 8
DEVELOPING COMPLEMENTARY SKILLS

It takes more than pure technical ability to succeed in the IoT landscape. Applying complementary skills and understanding the wider IoT eco-system can be crucial to your personal career development. Employers often place a high priority in seeking out candidates who can demonstrate these skills, so even if it doesn't come naturally, it's well worth investing the time in developing them.

One of the major factors that distinguishes IoT from comparable business models is that an IoT application is almost always a collaboration with multiple different companies and third parties. Any IoT project is likely to encompass multiple areas – from embedded control and wireless networking to security and IT infrastructure.

It's simply not possible to handle all of those areas in isolation, so in addition to teamwork and collaborating with your own colleagues, the ability to network and work constructively with other companies is a really important skill for an IoT engineer to acquire.

- CMC

One of the most important soft skills I can think of is creative destruction. This means not being afraid to get out of your comfort zone and try something new, even if there's a possibility of failure. There are ideas and concepts gaining major traction today that would have been seen as crazy just a few years ago. Stay informed, take calculated risks and don't allow yourself to get stuck in a single mindset in terms of where a project's value might come from.

- JB

Business intelligence is critical. Even an engineer deeply embedded in security, analytics or any other kind of specialization needs to have an understanding of the commercial impact of the work they do, and an ability to be creative and innovative around that. Project management skills are also vital in order to deliver on a brief effectively, anticipate roadblocks and communicate effectively as part of a wider team.

- CMP

CHAPTER 9
RESPONDING TO KEY INDUSTRY CHALLENGES

IoT may be on the rise, but like any commercial industry, there are significant challenges that business leaders and engineers alike have to contend with. An awareness of these challenges can not only help you to better understand the market, but if you can become part of the solution, you have the potential to considerably increase your market value.

One of the major challenges of working with an IoT system or IoT infrastructure is that there are so many different protocols operating so many different levels. Very often in designing an IoT system you need to be considering all the available options and how you can support, upgrade, modify, or change to support new things in the future.

A good level of systems knowledge across these different protocols, and an ability to keep up to date with how

they're developing, are definitely two of the most important skill sets an IoT engineer can cultivate.

- CMC

Security is definitely one of the critical building blocks in any IoT system – and often one of the most challenging. We're starting to throw huge amounts of sensitive data and digital content into the cloud, opening up issues of cyber, hardware and network security.

There can be a tendency to lump all of these issues together under the catch-all of IoT security, but it's not realistic to expect any one engineer to be able to handle them all. In order to provide a total systems solution, we need individually specialised people dedicated to all of them. The good news is that this opens up a number of valid career paths that may not have been considered in the past.
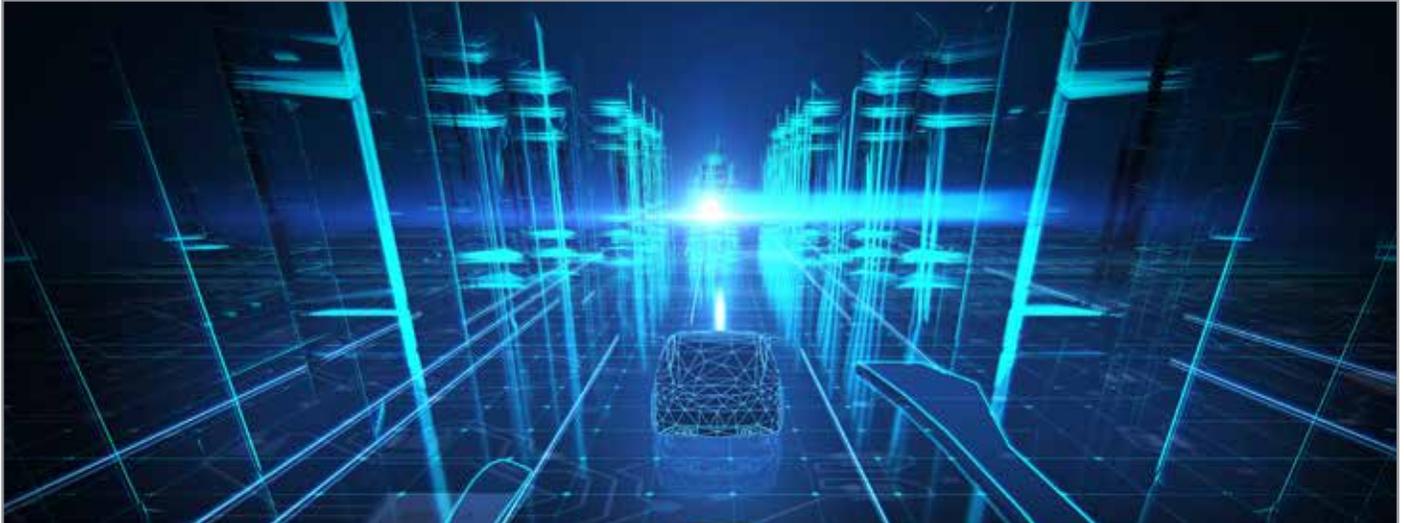
- CMP

Whether it's reducing data payloads down to a size at which they can be sent across the wire or designing in a way that facilitates localised caching on your devices, as an engineer working in the IoT space there are a lot of skills that you could leverage in this area.

- PDC

HOW AI AND MACHINE LEARNING PLAY INTO AN IoT CAREER

Artificial intelligence and machine learning are playing an increasingly prominent role in the application and deployment of IoT, particularly when it comes to processing and analysing data. What trends do the experts expect to see in this area over the coming years – and what impact could it have on IoT as a career?

Artificial Intelligence is both my favourite and my least favourite term. As a marketing professional, it allows me to explain my job and the products that we make in terms that non-engineers can understand, but there's also a certain sense that the term has set up some false expectations about what current technology can achieve.

The term that we as engineers and technologists should focus more on is machine learning: a real, accessible piece of technology with multiple real-world applications. For example, the use of intuitive interfaces such as voice and image recognition, which has had a noticeable impact on the commercial and consumer markets in recent years. As the technology continues to become more sophisticated, machine learning experts are going to be in higher demand – playing an exciting role in the wider evolution of IoT.

- GL

Several reports are already showing a significant shortage of machine learning and data scientists compared to the demand. As a result, major tech companies are being very proactive in ensuring that they have access to the top tier talent from the best engineering schools. Obviously, this is good news for the scientists, and it speaks to both the benefits machine learning is bringing to the industry today, and the potential it has to open up even more opportunities in the future.

- PDC

In industrial companies, one of the primary uses of AI – or subsets and specializations within AI – relates to reducing costs and increasing productivity in manufacturing. Using sensor technology, data analytics and machine learning, we can now predict certain operating conditions and identify parameters that could be adjusted to improve maintenance and reduce wear and tear. This is very attractive to manufacturing businesses – and it's AI practitioners, data scientists and machine learning experts leading the way.

- DG

CHAPTER 11
IoT START-UPS

Pursuing a career in IoT doesn't necessarily mean joining an established company. Many engineers are leveraging their technical and creative skills into launching their own IoT Start-ups. What strategies can an IoT professional use to succeed outside the confines of an established company?

One area in which I've seen a lot of hardware start-ups succeed is in the employment of rapid prototyping devices. Many leading manufacturers will make modules with software, sensors and actuators actually built in, helping you to accelerate your project and get it off the ground. Getting to market faster is one of the most important benefits of choosing the start-up route, and the sooner you can get your product out there, the more effectively you can start to fix initial issues and build in redundancies.

- JB

Many people stumble when getting into a hardware project for the first time, because they find themselves focusing excessively on achieving the final design. The reality for most of these projects is that the hardware is constantly going to be iterated on.

The most important thing is to build something that works. It might be rough around the edges, but keep working on it and get your design processes in place so that it's ready for deployment into an enterprise or consumer environment.

- PDC

An important consideration when launching an IoT-based start-up is how you're going to generate value beyond the point of sale. Can the data your device is collecting be used to create recurring revenue streams? If you're selling a device and putting up cloud infrastructure to make sense of the data that comes through, but not using that data to give value back to the customer, you're missing a key benefit.

A useful comparison would be with mobile app development, where the vast majority of success stories involved not only engaging users to use the app all the time, but also gathered additional data for marketing and advertising purposes, with the end goal of generating revenue and impressions.

- PDC

CHAPTER 12
IoT TRENDS FOR 2019

One major trend that I've been seeing is the extent to which intuitive interfaces are making IoT and smart home technology more meaningful to the average consumer. For example, over 28,000 devices are known to work with the Amazon Echo, while voice interfaces can be easily used to perform routine tasks such as switching on the lights when you walk into a room – making the vision of the future smart home finally look like a reality.

- GL

I'm really interested to see how the democratization of AI is going to impact the market. It took a huge amount of work and research from the industry to get to a point where tools such as intuitive interfaces that respond to the human voice are as viable and useable as they are today. Now those APIs are accessible and available to virtually anybody who wants to make use of them. That's certainly going to have an impact across our industry.

- DG

Expertise in wireless networking is in incredibly high demand right now. At Microchip, many of our customers have a lot of expertise in making modules, but now that they have to add connectivity to turn their devices into IoT applications, they're running up against the limits of their experience.

- CMC

Data is going to be the true value driver of the IoT environment going forward, more so even than revenue from selling the devices themselves.

Machine learning and AI are currently in their infancy, but as people start to grow into the IoT field and looking for opportunities, I think that's going to be a really good space for an engineer.

- JB

Back in the days when engineers primarily worked with monolithic software architectures, it was possible, perhaps even beneficial to work alone. Those days are gone. The industry right now is built primarily on APIs and smaller components that have to interact. You have to write your software in a way that allows other people to easily understand what you're doing. We live in an open source ecosystem. When you publish a code, you do so because you want to collaborate. The younger generation is really used to high bandwidth, constant communication, using modern efficiency tools like Slack, GitHub and GitLab. In this highly fragmented and complex industry, the necessity of co-operation and teamwork are among the few constants.

- WG

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