The New Intelligent Edge

Four Drivers of Digital Transformation at the Intelligent Edge and the Key Questions That Will Help Architect Your Success

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It's About How You Transform — Not If

On the IT side of your organization, the constant drumbeat around digitally transforming the company dominates conversations.

Digital is not just an idea. It is part of the new DNA for organizational success — so much so that over 68% of publicly traded companies mention the progress of their digitally transforming activities in their quarterly filings, because they know it matters.[1] Look around your own company. **If you have a chief digital officer in your corporation, you are as much as 54% more likely to be successful in digitally transforming than your peers who do not have one.**[2]

54%

The embedded part of the business needs to refocus on the digital conversation, because it's not just the size of the Internet of Things (IoT) market that matters (more than 75 billion devices are predicted by 2025[3]). Equally important is how devices in IoT work together to add value to and through the edge, which is increasingly 5G based. **That edge, Gartner believes, will create and process more than 50% of enterprise-generated data by 2022.**[4]

> "Digital success should be the number-one focus as we modernize our development processes for our organization's embedded technologies."
>
> **— Michael Gale,**
> *Wall Street Journal* bestselling author of the number-one selling book on digital transformation, *The Digital Helix*

50%

Gartner predicts that by 2022, more than 50% of all enterprise-generated data will be created and processed at the edge.

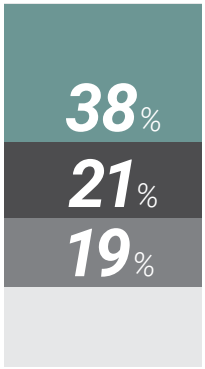
1 *inc.digital*
2 *Forbes/inc.digital, 2019*
3 *IDC, 2019: www.idc.com/getdoc.jsp?containerId=prUS45213219*
4 *Gartner, www.gartner.com/document/3991568*

An AI-Infused, Always-Secure World Is Ours to Make

The volume of data and the urgency of its application for digital success mean that the way we modernize embedded devices, from development through deployment and management, is changing right in front of us.

Technology such as AI and machine learning will need to work transparently and easily with these devices. And, because needs evolve, devices must be adaptable over their lifecycle.

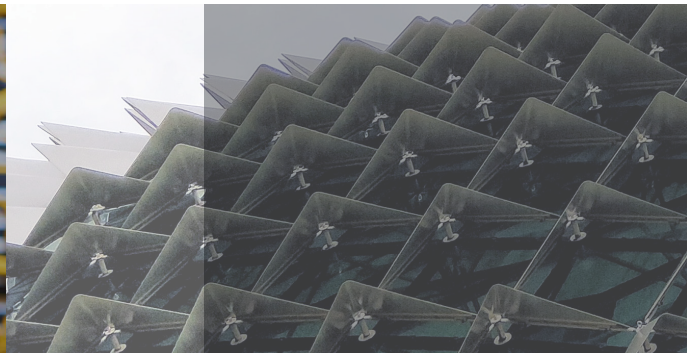
Obviously, there are development challenges. One third of all developers are currently building cloud-native architectures, and another 30% plan to do so within the next year. But the edge can be a hostile region for these cloud-native developers. Physical access and security are challenging, and edge devices are not standardized or interchangeable like servers in a data center. **Among these IoT developers, two of the top three concerns, after security (38%), are connectivity (21%) and data collection and analytics (19%).**[5] Concerns linger throughout the line of use, given that 93% of automation technologists surveyed feel unprepared or only partially prepared to tackle the challenges associated with smart machine technologies.



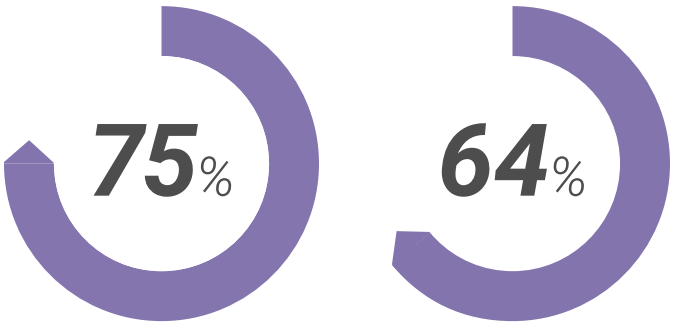
IoT developers named connectivity and data collection and analytics as two of their top three concerns, after security.

> "Whereas we formerly lived in a world of design once, deploy once, and manage through life, going forward we will live in a world of constant digital adaptability."
>
> — **Paul Miller,**
> Chief Technology Officer,
> Wind River

5 *Eclipse Foundation, 2019: drive.google.com/file/d/17WEobD5Etfw5JnoKC194IME_XCtPNGGc/view*



This is not the territory for customized, roll-your-own applications, especially given that agility is essential in an ever-changing world. But while the 28% of enterprises that are digitally transforming successfully recognize that the future has a volatile, uncertain, complex, and ambiguous (VUCA) feel to it, they are also 250% more positive than their peers that they can handle it, because they are reimagining how to run the entire enterprise.[6] They aren't wrapping themselves in digital concepts — digital is a fundamental component of their existence. **In fact, 75% of businesses say AI will allow them to move into new ventures, and AI is seen by 64% of CEOs as a way to lower overall OPEX.**[7] These trends show that original device designs and intent will need to be reengineered with software throughout their lifecycles, as AI is increasingly infused into everything in order to realize substantive changes in immediate economic as well as long-term differentiated value for the enterprise, especially through the cloud.



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6 *Forbes/inc.digital*
7 *Forbes/inc.digital*

In a New Era, Data Will Lead

The estimated 41 billion-plus connected devices that will be in operation by 2025 will be generating some 80 zettabytes of data.[8]

In that data lies enormous value. Fifty-seven percent of leading digitally transforming corporations recognize that forms of and ideas about data will radically transform over the next few years. **Those that get it right will be able to design, collect, and manage all of this data, most of which will be coming through the edge.**

The new trends driven by AI, 5G, and intelligent edge systems demand developers with new skills and deep interest not only in app development but in all areas of code development, hardware interface, and relevance of data.

See sidebar (and appendix for more details): "Top 10 Skills for IoT Developers."

Meanwhile, legacy code runs in dated languages in almost every enterprise, and while the generation of developers who understand this code is retiring, colleges and universities have not prepared the younger generation to maintain it. These coders prefer newer languages such as Rust (83.5%) and Python (73.1%),[9] and in just a few short years they will be in the majority — Millennials and Generation Z will comprise almost 75% of the total workforce by 2025.[10]

Top 10 Skills for IoT Developers

- Machine learning & AI
- Designing for data
- Automation
- IP networking
- Hardware interfacing
- Mobile development
- UI/UX design
- Information security
- Business intelligence
- Teamwork

8 *IDC, 2019: www.idc.com/getdoc.jsp?containerId=prUS45213219*
9 *World Economic Forum*
10 *IDC, 2019: www.igel.com/wp-content/uploads/2019/06/IDC-Infobrief-Leverage-Linux-to-Transform-Endpoints-Jun-2019.pdf*

How We Handle Legacy Embedded Devices Will Matter

Historically, exceptional design has meant inherent complexity. But as the world itself gets more complex, design cannot become still more inherently complex.

Building the solution from the bottom up, adding more and more, does not solve this fundamental challenge. **Automation helps, but the paradox of having to simplify in order to handle new complexities is difficult to turn into real-world design.**

The key is to develop more from off-the-shelf components, abstracting from frameworks and leveraging the combined knowledge and effort of others — in effect, creating intelligently. The big change for most embedded developers will be to move away from a curating mindset to that of a general-purpose magician who understands how to put systems together.

The shift in workforce from Boomer to Millennial creates an opportunity to realign the future of the intelligent edge around the newer skills and thinking that Millennials employ, opening up new design dynamics (detailed on the following page). These workflows go beyond the traditional control plane that has dominated success in the embedded industry for decades. Virtualization, the infusion of AI, and building in containers are practical solutions to the explosion in data — and they will demand a different architectural focus.

Clearly there will be overlay architectures for legacy systems. Another approach argues that it is less about the device and more about the value of the data: How does the data from the device drive better real-time decisions inside the wider ecosystem? In transport, manufacturing, energy, and aviation and defense, this new lens for handling legacy devices may add fundamentally important value.

> "This fundamental transition to digital transformation is an incredible opportunity, but using archaic tools and processes to solve new challenges is not logical in a rapidly evolving world."
>
> **— Michael Gale,**
> *Wall Street Journal* bestselling author of the number-one selling book on digital transformation, *The Digital Helix*

The Six New Design Dynamics of the Digital World

What was once a single, focused design aperture will widen significantly as devices gain the power to take autonomous action based on the intelligence they are gathering and managing.

1. **The view is system centric:** Silos constitute one of the three strongest inhibitors to digital transformation success.[11] A shift is required in a world where electrical engineers are now only part of the team. Organizations that struggle with this intermingling of IP and resources will be hampered by trying to use old-world models to solve digital-world paradigms.

2. **Lifecycle thinking is vital:** Products will not follow the build-once-and-ship-forever tradition. They will be dynamically adjusted to take in new data, mainly through the edge, and offer changing assets and experiences throughout their lifecycles. *5G and other connectivity methods will make over-the-air (OTA) updates common practice.*

3. **The design process must scale:** The need to go system-centric means thinking about scaling during the design process, and digital transformation will break old ideas about what scale means. In a world of 41 billion (and growing) connected devices, architecture must be designed to handle near-infinite scale from the outset. Think of a call center versus a website: A call center is limited by the number of people who staff it. A website is limited only by its technology backbone.

4. **Understanding specific functionality is critical:** The always-on nature of the digital world means we cannot land the plane to change the parts — entire system upgrades cannot happen all at once. *The capacity to perform hitless updates of live systems at scale must coexist with the ability to update applications at the thread and microservice levels.*

5. **The speed, accuracy, and value of data matters in real-time decisions:** The ability to extract, manage, and infuse AI components is an imperative. CEOs in sectors such as industrial manufacturing already understand it as truly differentiating: 28% use infused AI in data collection and ongoing management, and they are getting 2.6 times the ROI of their peers who do not.[12] Developers for the intelligent edge need to be active players in that scenario.

6. **The nature of security is changing:** Security has always been a priority — but historically that was the security of the platform. Now that every device can interact with every other device, the need for security is amplified almost infinitely. Building in intelligence and adaptability is key for a dynamic yet secure-everywhere, secure-in-every-moment construct.

11 *Forbes*
12 *Forbes/inc.digital*

Deployment Will Require a More Adaptable Approach

In a hyper-agile world, deploying with feature completeness is not practical.

Instead, taking a highly secure minimal viable product to market and making enhancements over time will become the norm. Deployment becomes an ongoing process. (Tesla cars are a perfect example.)

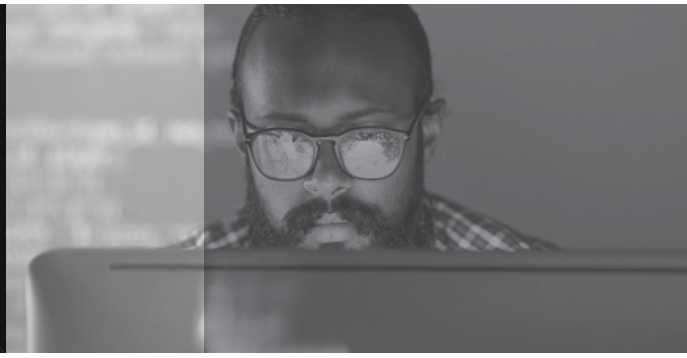
We will need to pay more attention to customer use cases and visions of the future, and to what those mean for development. For example, security and cybersecurity are key parts of this equation; as the threat horizons change over time, the ability to drive agile deployments will be vital.

Changes will materialize, but slowly at first: An estimated 9.5 years are still needed for 72% of the Global 2000 to evolve to a mature digital state.[13] The speed of digital transformation from today's capabilities to a fuller digital performance is currently less than 11.5% CAGR.[14] The embedded arena has not driven hard toward the modular, cloud-based development models used in IT. Digital IT is focused on virtualization because it is responsive to today's rapid changes, but it needs underlying hardware and architecture to give the required adaptability. **Virtualizing in the cloud will become far more common as more automation and AI are built into devices. Prototyping and simulating will be the norm in the digital future.** These are the engines of change that need to be embraced for a faster transformation process.

> "Design thinking has to shift from a unique, fixed purpose for devices to thinking about the workflow going into the wider digital enterprise."
>
> **—Michael Gale,**
> *Wall Street Journal* bestselling author of the number-one selling book on digital transformation, *The Digital Helix*

13 *Forbes/inc.digital*
14 *Forbes, inc.digital*

The New World Is Far Larger and More Powerful



By 2025, the new intelligent edge will bear little to no resemblance to the embedded devices of the past.

Nothing is remote or isolated in the digital world. From an enterprise standpoint, the power of new information — coming from the edge, with 5G, and from a highly integrated ecosystem — lies in how dynamic and connected it is.

Even the most successful digitally transforming corporations willingly accept that the future is difficult to define; 97% of them see strategy as a one-step-at-a-time process, not as a five- or ten-year plan.[15] Design and philosophy in the new intelligent edge will need to follow the same thought paradigm.

Industries — and their developers — need to be able to build edge applications that are compatible with cloud-native applications, using modern principles such as continuous integration and continuous deployment (CI/CD). Layers of abstraction will cover infrastructure and hardware complexities, and containers will support traditional RTOS applications and a new class of cloud-native edge applications. Frameworks, open source, and platforms will interface with modern and popular programming languages, and developers will ultimately move to a foundation of DevSecOps.

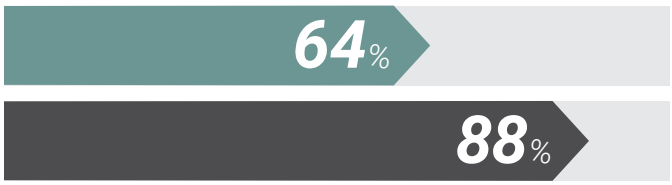
That pioneering spirit, the innovative mindset, and those adaptive capabilities will come to dominate design development. To successfully build edge devices that provide real-time intelligence and support decision-making based on zettabytes of data, the core philosophy will be one of supporting not one life but many stages of a life for every device.

> "There will be system heuristics that track in real time for abnormal or changing patterns, all running in real time from the edge. Our devices will be tasked to help orchestrate far more around security and cybersecurity than ever before."
>
> **— Gareth Noyes,**
> Senior Vice President, Products, Wind River

15 *Forbes/inc.digital*

Going forward, the processes that got us this far will need to be viewed through a new mirror of digital transformation success. What gave us embedded design will not make us adaptive, cloud native, and equipped for longer-term success in a digitally transforming world. We can, however, be incredibly successful if we architect correctly — a fact that is not lost on industry leaders.

In Wind River® research during the COVID-19 crisis (April 2020), more than 65% of DevOps and DevSecOps leaders in the U.S. and China said that, far from stalling, their investment in IoT, AI, application development for the cloud, 5G projects, and container development was going up. C-suite executives were more optimistic — at 88% in China — about the move to open source code because of COVID-19.



Digital transformation will not slow down, even with a global crisis. In fact, the need for it will speed up, creating a sense of urgency for intelligent edge leadership to lean into this total transformation process.

Wind River is a global leader of software for the intelligent edge. Its technology has been powering the safest, most secure devices since 1981 and is in billions of products. Wind River is accelerating the digital transformation of mission-critical edge systems that demand the highest levels of security, safety, and reliability.

Appendix

Are You Ready for the New Intelligent Edge?

Self-test how well you and your organization are transforming for the new digital world. Go through this simple exercise with a few colleagues to see how aligned you are and how much you are designing for the future world of digital-centric enterprises.

Contact us afterward or come to us to collaboratively run this exercise with you and your teams in real time. We have access to experts who work with many of the world's most digitally transformed brands and can bring best practices to bear.

For each statement, respond on a scale of **1** (*we are not even thinking about this*) to **5** (*this is a major differentiator for the company*):

1. Our philosophy about our edge device design is highly connected with the wider digital transformation in our enterprise.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

2. We believe that our devices will have many life stages in their lifecyles.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

3. We have been re-skilling developers to handle our legacy systems.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

4. We see security and cybersecurity as connected challenges/opportunities in development.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. We see automation as an inevitable function that has to be designed and deployed for our devices, given the volume of data and protocols we are building for the new digital world.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

6. We now build our edge systems around highly connected workflows for the whole enterprise.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

7. Infusing AI into everything, or most of the devices we design, will be common practice within the next two years.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

8. We see the edge and 5G as important development environments for us.

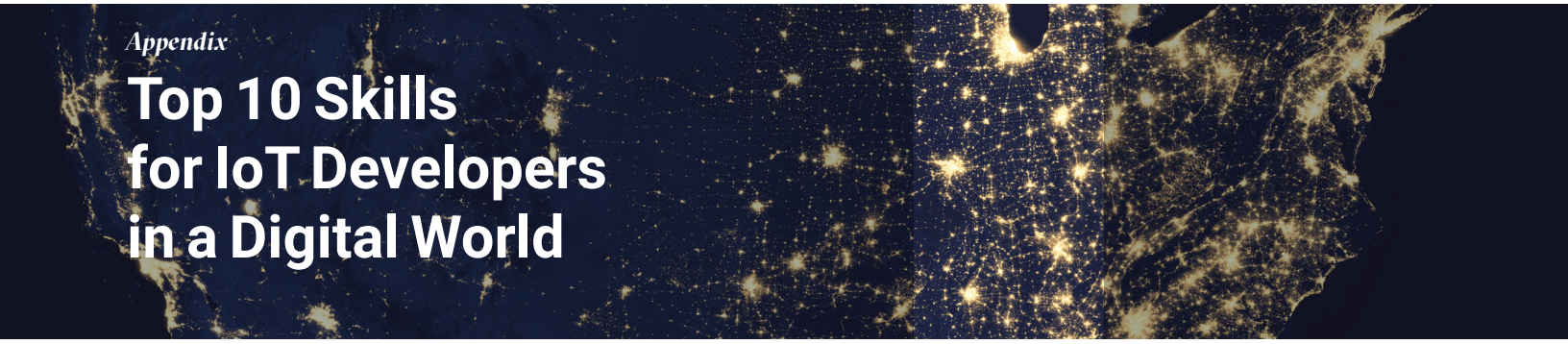
○ 1 ○ 2 ○ 3 ○ 4 ○ 5

9. Open source and container-based development for the native cloud is a design requirement for us.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

10. IT DevOps and DevSecOps now share similar design philosophies and processes.

○ 1 ○ 2 ○ 3 ○ 4 ○ 5



Appendix

Top 10 Skills for IoT Developers in a Digital World

Machine learning & AI

Gathering and analyzing large amounts of data requires deciphering patterns and predicting outcomes. As IoT becomes more complex and ubiquitous, AI will need to handle more tasks and make autonomous decisions.

Designing for data

Big Data drives IoT, and the job of software engineers, network engineers, and UX engineers is to make the data work seamlessly for users. The ability to read and interpret data in a meaningful way will be valuable.

Automation

A McKinsey survey found that 40% of the value of IoT is in its operability. Given a large amount of data and interfaces, developers who can connect automatic API testing with manual testing will be the ones who get their products to market.

IP networking

In IoT, embedded sensors interact with their environment, collecting information to send for analysis. That information must flow through a network that is flawless, secure, and reliable, and also able to handle enormous traffic. Developers must know the basics of OSI stack, the latest standards in IoT communication, and how connectivity protocols work.

Hardware interfacing

Hardware programming is essential for IoT engineers. They must know how to program interfaces, such as GPIO and I2C; understand at least one operating system, such as Linux; and know one embedded system, such as Contiki.

Mobile development

Most IoT devices will be managed through smartphones. The ability to develop apps that communicate with external hardware and sensors is highly marketable.

UI/UX design

The interfaces between the device and the user must be effective and user friendly, or the consumer won't buy. Responsive web design and service design that keeps the end user in mind are valued.

Information security

Security is critical for IoT devices. Developers who are familiar with vulnerability assessment, public key infrastructure (PKI) security, ethical hacking, and wireless network security will be key players.

Business intelligence

IoT is all about collection, storage, and analysis of streams of data from smart devices. Needed skill sets include sensor data analysis, data center management, predictive analytics, and programming in Hadoop and NoSQL.

Teamwork

A basic IoT team includes an electrical engineer, a mechanical engineer, an industrial designer, an embedded systems designer, one back-end developer, one front-end developer, and a product manager. The better each team member understands every other role, the purpose of the system, and the end user of the system, the better the entire system will function.

Adapted from https://iotify.io/top-10-iot-skillsets-for-developer