THE EDGE OF NOW

THE OPPORTUNITIES, CHALLENGES, AND SOLUTIONS TO THE ARTIFICIAL INTELLIGENCE OF THINGS (AIOT) MARKET, ACCORDING TO ELECTRONICS ENGINEERS AROUND THE WORLD

JUNE 2022

XMOS

Bringing technology to life

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BLAZING A TRAIL TO TOMORROW'S SMART HOMES

2022 is the third year of our annual Edge research, covering key trends related to the artificial intelligence of things (AIoT) market. The report series explores the approach of electronics engineers towards AIoT technologies, the market forces that are impacting their adoption, and how the future of the technology is taking shape.

Our 2021 report examined the increasing viability of the AIoT to deliver smart home architectures, which engineers saw as a proving ground for the wider expansion of AIoT technologies. We also reported that, while barriers were beginning to fall for the AIoT's adoption, the pandemic's impact upon the supply chain slowed that progress in places.

Twelve months on, we are pleased to report positive findings that suggest even the most serious barriers to the widespread adoption of the AIoT are beginning to fall. Challenges like power, cost, and others have not been eliminated, but have never been as surmountable as they are in 2022.

As a result, electronics engineers are more optimistic than ever about their ability to capitalise on the AIoT by integrating more processing power, and artificial intelligence, into their products. Almost two thirds (64%) will launch a device within six months that has the on-board processing required to support AI. 64% also said that the majority of their product ranges will have the processing power to support the AIoT in the next 2-3 years; for 26% of them, their entire range will be AIoT-compatible.

Indeed, many engineers believe that the AIoT will make a significant difference to the world. According to Research and Markets, by 2026 the global market value of the AIoT is expected to be approaching almost $80 billion.

This new Edge of Now report will investigate that optimism and potential. It will chart the growth of the AIoT, explore the reasons behind such positivity, and detail a range of applications which – in combination with falling market barriers – will pave the way for the AIoT to make a game-changing impact across a myriad of industries.

To provide context for the report, XMOS commissioned research with over 100 electronics engineers responsible for developing various devices across a range of industries. We asked them about their current commercial and design priorities, and the barriers holding the market back.

This report captures those perspectives and offers unique insights into the way forward for the AIoT, gauging the temperature across several industries and helping to clarify a technical roadmap for hardware manufacturers seeking to enable the AIoT.

PRODUCTS THEY DESIGN

Consumer:	26%
Battery-powered:	19%
Low-power:	17%
Industrial:	16%
Handheld:	10%
Rugged:	7%
Other:	5%

INDUSTRIES THEY'RE IN

Consumer tech:	38%
Other:	18%
Smart home:	13%
Automotive:	7%
Manufacturing:	7%
Smart cities:	5%
Healthcare:	5%
Telecoms:	6%
Retail:	1%

THE STATE OF THE AIOT IN 2022

Before we assess the barriers to the AIoT, and the potential solutions, we must first recap how we define the AIoT and explore how it will change the face of technology as we know it.

The artificial intelligence of things is the synthesis of two major technologies:

1. Artificial intelligence (AI), the combination of machine learning/neural networks and robust datasets to mimic the comprehension and problem-solving skills of humans; and
2. The internet of things (IoT), the development of machines that are able to communicate with each other as part of a network.

The AIoT is the point of convergence of these two technologies. It's the term we give to products with embedded processing that can make intelligent decisions on-device — sensing, extracting, and interpreting information from the environment, and making decisions and/or taking actions based on that context, without the need for cloud intelligence.

The AIoT is currently viewed as a powerful strategic differentiator for product developers, with 63% of respondents citing greater product functionality as the most common product priority for 2022.

This appetite for more complex and sophisticated functionality in products leads to a growing need for more embedded processing capabilities. Our data indicates a large majority of products in development (70%) will require high-end on-board processing. This is consistent with last year's results, where 73% of engineers said their on-device processing requirements were already "high" or "very high."

The demand for local processing clearly hasn't abated, with notable interest across a range of applications. Consumer technologies (43%) and smart home products (25%) are being mentioned most frequently as the biggest opportunities for the AIoT.

Interestingly, one notable focus is on low-energy scenarios. Battery-powered products make up more than a third of the field between them.

WHAT THE AIOT CAN OFFER US

SMART HOME

The AIoT opens up significant opportunities for higher functioning, more intelligent smart homes, by packing more capabilities into a range of devices to make the domestic experiences more convenient and more energy efficient. These include set-top boxes, TVs, and low power appliances.

SMART CITIES

The deployment of AI-capable processors at a mass-producible price point will introduce scalable infrastructures that can form the foundation of the smart city. This extends to voice enablement, power consumption of street lighting, improving city parking, and regulating traffic flows by monitoring road conditions and detecting violations.

CONNECTED HEALTHCARE

Developers can automate data sharing, extend the use of condition monitoring, and enhance digital healthcare services. This enables improved diagnosis and treatment from hospitals to homes.

AUTOMOTIVE

The coming decade will see a technological revolution take place behind the wheel. Not only will autonomous vehicles require huge numbers of new electronics, but we'll also see voice functionality added to standard cars, as well as sensor enhancements for dashcams.

INDUSTRY 4.0

Intelligent sensors will deliver hands-free precision with machinery operation, while improving safety and security. Real-time data and inferencing will also be used for defect detection and maintenance. Smarter industrial environments will be safer, more efficient and more reliable.

THE TECHNOLOGICAL FUTURE OF THE AIOT

While the prospect of impacting so many industries so powerfully is immensely exciting, it's important to stay grounded and examine the granular mechanics of that impact. What features are AIoT-enabled products going to offer?

When asked what specific benefits the AIoT could enable, it becomes clear that versatility is one of its main strengths. Engineers cited the following as potential applications:

SENSOR PROCESSING

USER INTERFACE IMPROVEMENTS

REMOTE MONITORING

COMMUNICATIONS

DATA INTEGRATION

PREDICTIVE MAINTENANCE

94% of respondents stated that they believe the AIoT is going to make a difference on a global scale. Being able to offer so many different functionalities is part of what underpins that belief; the versatility of the AIoT gives it huge scope to manifest change.

What's perhaps even more exciting is that the majority of respondents are actively working towards these capabilities. Almost two thirds (64%) are working on projects expected to hit the market in the next six months, which include sufficient on-board processing capabilities to support on-device AI. We're not talking about hypothetical devices, but products that are actively on the way.

This isn't just a niche section of their product range, either. Two-fifths (38%) of engineers surveyed stated that their entire product range will have suitable on-board processing power to support AIoT functionality in the next 2-3 years. For another quarter (26%), 70% of their product range will have on-device AI capability.

In other words: for most engineers, the vast majority of products will soon boast the onboard processing required for the foundations of the AIoT.

FALLING BARRIERS TO DEVELOPMENT

Previous iterations of our Edge report have focused on the significant technical barriers to the development of the AIoT. Traditionally, any ambitions that engineers had to introduce AI into their products have been thwarted by an impossible balancing act between cost and power.

There has always been an appetite to solve this problem. Device processing power requirements are continuing to increase for 75% of respondents – consistent with 77% from 2021, and 70% from 2020. On the AI front, 82% of product developers see the integration of AI into their products as a competitive advantage.

However, solving the problem takes more than appetite. With that in mind, it's worth readdressing on the design challenge that engineers have been faced with.

To start with cost, the processors with the horsepower to enable AIoT functionality were prohibitively expensive in years gone by. Such hardware would usually have been designed for highly specialised purposes, include cutting-edge technologies that were expensive as standard, and incorporate licensed technologies that the designer also had to accommodate in the price.

This all served to drive up costs. And if the product design changed substantially during development, the custom hardware could be rendered obsolete on arrival. From a power perspective, meanwhile, such hardware often also consumed significant power.

This impossible juggling act meant that engineers often had to shelve their plans for more intelligent products.

COST AND POWER CONSUMPTION

However, this has changed markedly over the last few years. Our research results for this year demonstrate that developers are feeling more confident about their abilities to negotiate these challenges than ever before.

Having asked engineers about the specific barriers that have prevented them from integrating onboard processing and/or AI into their products, it's hugely encouraging to see the marginalisation of both cost and power as significant challenges.

Previous Edge reports have seen sizable percentages of engineers lamenting both obstacles, but 2022 has seen a significant drop across the board that should be celebrated. On cost, just 24% of engineers see cost as a barrier to deploying higher on-device processing capabilities. That's exactly half of the 48% in 2021's report, and even further reduced from the 64% of 2020.

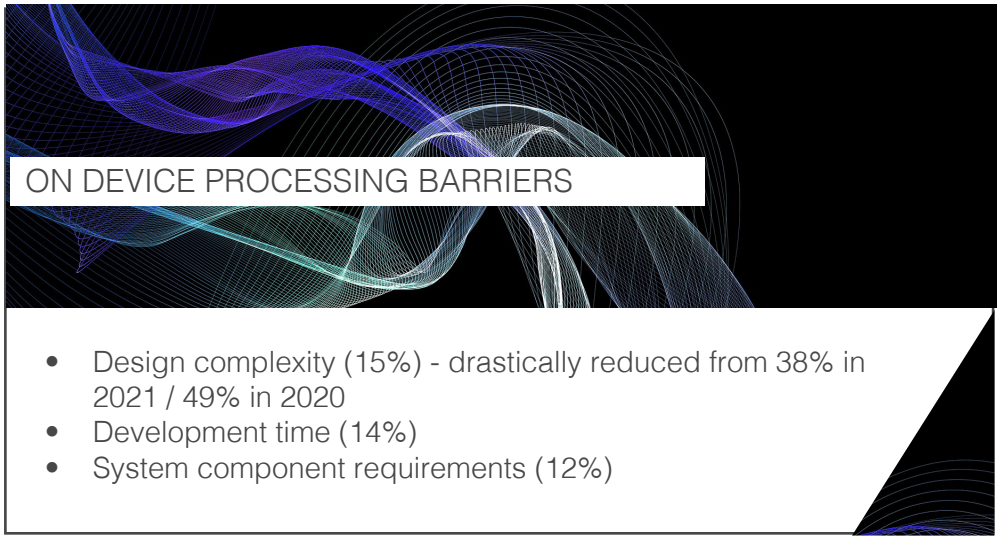
An even lower percentage – just 16% - see cost as a barrier to the adoption of AI in their products, while a mere 12% suggested that the cost of IoT "will be prohibitive to product development."

On the power consumption front, the optimism is similar. Less than a quarter of engineers, just 23%, see power consumption as a barrier to increasing the onboard processing power of their products. As with cost, it's a massive drop from the 53% of last year, and barely a third of the 65% from the year before.

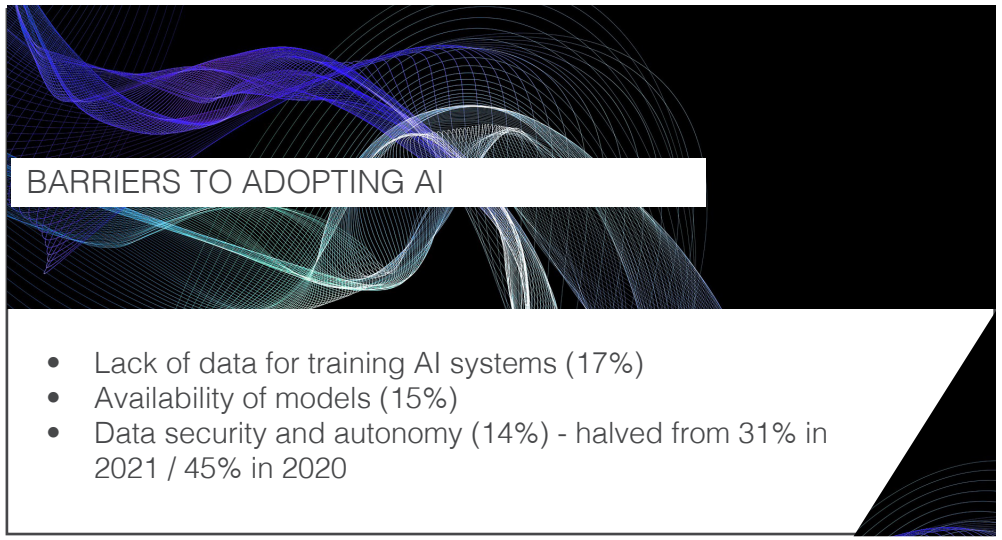
Again, energy consumption is also not seen as a major concern in the adoption of AI, either. Barely a tenth (13%) of engineers see it as a barrier.

OTHER BARRIERS

There are, naturally, a number of smaller challenges that can hinder the adoption of increased on-device processing, or AI, into a product. However, the numbers suggest that most engineers are confident that these obstacles can be effectively navigated during the design process:



- Design complexity (15%) - drastically reduced from 38% in 2021 / 49% in 2020
- Development time (14%)
- System component requirements (12%)



- Lack of data for training AI systems (17%)
- Availability of models (15%)
- Data security and autonomy (14%) - halved from 31% in 2021 / 45% in 2020

In both cases, no challenges surpassed power or cost – which, as we've established, have never been seen more positively by engineers.

However, while these findings are hugely encouraging, it needs to be remembered that these barriers haven't been eliminated. There is still a dearth of hardware that offers a meaningful panacea to these challenges, and that are specifically designed to cater to the AIoT market.

RENDERING THREATS OBSOLETE

What we've established so far, is that the AIoT is experiencing a swell of positivity and ambition. Engineers are feeling more and more capable of surmounting cost, energy, and a myriad of smaller issues in their pursuit of more on-board processing power, which can then facilitate more sophisticated AI functionality.

As such, we can expect to see a surge of products in the next 1-2 years that will feature true AIoT capabilities. From the point of view of processor manufacturers, this is an unprecedented opportunity to deliver devices that will eliminate the lingering challenges to the wider adoption of the AIoT.

This groundswell is going to require unsurpassed access to flexible silicon that continues to drive down the cost and power consumption of designs – intending to ultimately make these issues redundant.

In order to do so, that silicon needs to possess the versatility to empower product designers and engineers. It needs to allow them to manipulate the role of the processor within an evolving design, enabling them to address specific opportunities economically.

This would provide the flexibility for designers to use the same low-cost processor for multiple devices, opening up new opportunities for innovation, proliferation and cost-saving.

XMOS' ROLE IN OVERCOMING THESE THREATS

XMOS' contribution to this immense market need is xcore.ai: a disruptive crossover processor designed to deliver flexible, high performance AI, DSP, control, and IO in a single device.

With its high performance and neural network capabilities, xcore.ai enables data to be processed locally – and actions to be taken on device – within nanoseconds, and without communication with the cloud.

Traditionally, this sort of functionality would require a powerful and costly applications processor, or a lower-cost microcontroller with additional discrete accelerators. Both of these approaches would suffer from the cost and functionality problems that we have already explored.

However, the versatility and performance levels within xcore.ai encompass the capabilities of both an applications processor and a microcontroller without the complexity, energy consumption, or cost.

Indeed, versatility has been at the forefront of the xcore arch since its first generation, with SDK kits and the addition of FreeRTOS compatibility now part of an ongoing support programme.

As a result, companies are deploying xcore.ai within mass-producible devices across different industries. 2022 has seen the announcement of an automatic licence plate recognition (ALPR) reference solution, enabling cost-effective and low-power solutions for automated parking garages.

In the smart home, meanwhile, the Avona voice reference design will introduce a local dictionary-enabled variant of xcore.ai, supporting local speech recognition and action, responding to sensory data without the costly, ethically problematic challenges around its capture.

IN CONCLUSION

When XMOS published its first Edge report, the AIoT was an exciting market, but one that offered potential rather than tangible commercial growth. The hardware and software required to propel technology forward was still being developed. Consequently, engineers were unable to pursue the AIoT designs that they envisioned, hamstrung by an often-impossible balancing act between power, cost, and functionality.

Now, the obstacles on the path to a vibrant, inclusive, and innovative AIoT market are not just changing, but becoming actively marginalised.

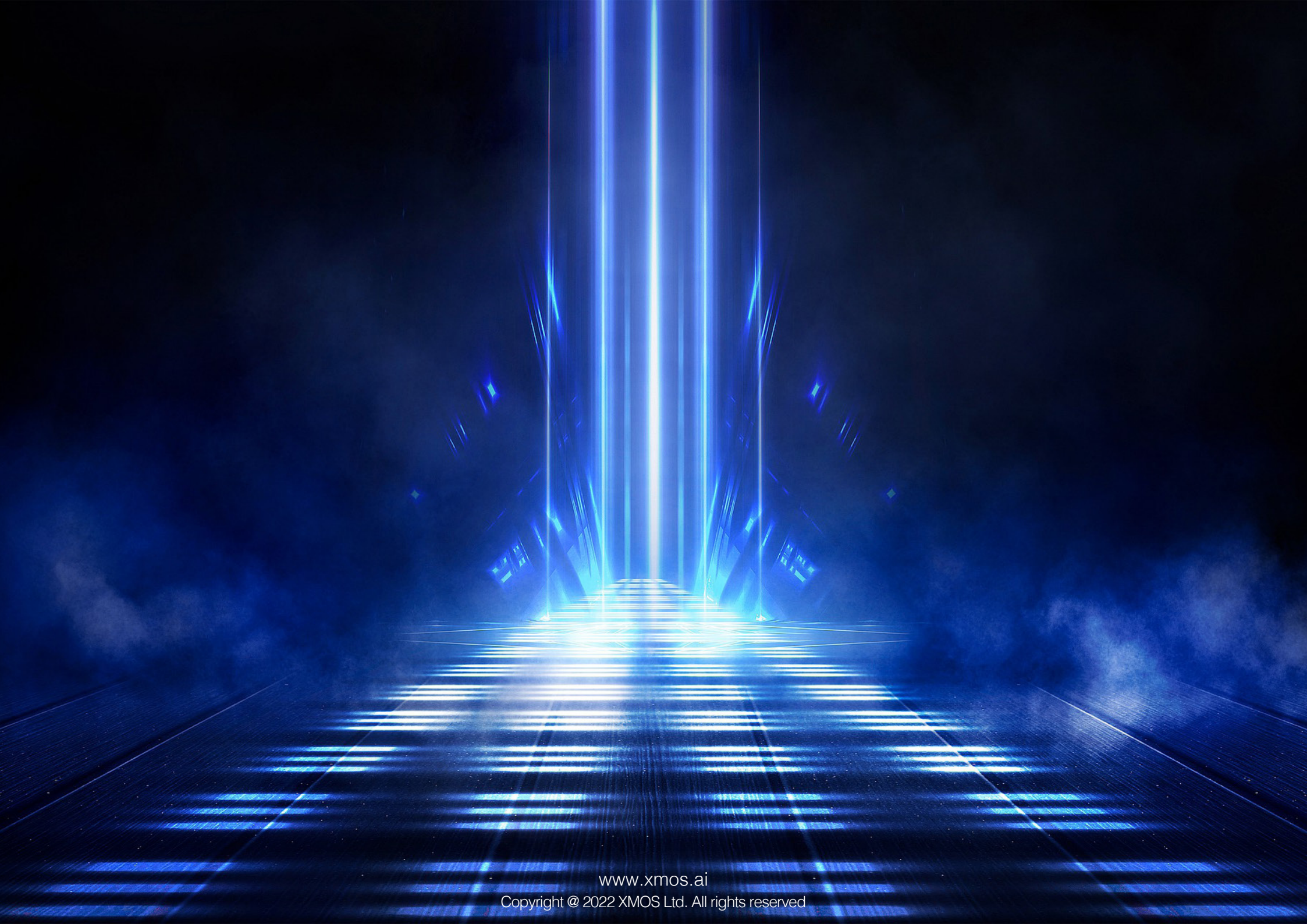
Power and cost were significant, intimidating barriers two years ago: now, they don't concern the majority of engineers. There are low-power options available to them that aren't priced out of deployment in mass-market scenarios, and that offer the versatility required to tackle smaller problems as they crop up.

As a result, engineers are feeling more and more positive about the potential for the AIoT to fundamentally change the ways in which we live. We are starting to see an increased number of AIoT-enabled products enter our everyday lives, with the smart home becoming the first arena in which we are acclimatising to regular AIoT interactivity.

In the longer term, from the smart home to the smart city, these developments are going to open up a multi-billion-dollar market for technologies that will genuinely change how we live on a day-to-day basis.

The foundation for this market explosion will be silicon that prioritises versatility and cost-effectiveness above all else. It requires hardware that is cheap enough to be deployed at scale, and that can offer the engineer a canvas upon which to rapidly develop the perfect solution for their device.

Whether it's the convenience of a smart garage saving you a ticket, or the life-changing impact of a smart healthcare gadget pre-empting a heart attack, the AIoT has the potential to revolutionise the way that we live. To see significant barriers falling on the way to that future, so quickly, is a real endorsement of that potential, from those with the power to propel the industry forward.



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