THE EDGE OF TOMORROW

OVERCOMING THE BARRIERS TO THE ARTIFICIAL INTELLIGENCE OF THINGS (AIoT) AND UNLOCKING THE FUTURE OF TECHNOLOGY

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XMOS

Bringing technology to life

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PAINTING A PICTURE OF TOMORROW

VERY FEW TECHNOLOGY PAIRINGS are as exciting or important as artificial intelligence and the internet of things.

Over 10 billion internet of things (IoT) devices already surround us in our everyday lives. Its extraordinary growth will be further accelerated by the roll-out of 5G –Business Insider believes there will be more than 64 billion IoT devices worldwide by 2025.

Alongside the growth of the IoT, artificial intelligence has emerged as the next technology phenomenon. In an interview with Forbes, Jim Goodnight (often cited as the "godfather of AI" thanks to his work on a technology to improve crop yield 45 years ago) described AI as a "game changer for society", with the potential to revolutionise our relationship with technology.

Naturally, it was only a matter of time until these technologies came together to form the "artificial intelligence of things" - or AIoT. While the internet of things connects "dumb" devices to the internet, artificial intelligence gives them a "brain" and, with it, the ability to act independently. Together, they will change the world as we know it.

It's clear the AIoT has huge potential, but there has been little commercial traction to date. There is much talk of a burgeoning new market for electronics manufacturers and the wider technology sector, but for the most part the AIoT remains a concept rather than a reality. To get some insight into this dichotomy, we spoke to the people on the frontline of making the AIoT a reality — the electronics engineers involved in the design and manufacture of the devices that will ultimately make up the AIoT.

XMOS commissioned research with 200 electronics engineers to ask them for their views regarding the technology building blocks of the AIoT, the barriers holding the market back, and their own design and commercial priorities for the future. This report captures those perspectives and offers unique insights into the way forward for the AIoT — with a clear technical roadmap for hardware manufacturers.

PRODUCTS THEY DESIGN

Battery-powered:	48%
Handheld:	29%
Low-Power:	49%
Rugged:	27%
Consumer:	38%
Industrial:	49%

INDUSTRIES THEY'RE IN

Consumer Tech:	26%
Automotive:	24%
Manufacturing:	42%
Smart Cities:	9%
Smart Home:	26%
Healthcare:	13%
Retail:	6%
Other:	27%

HOW THE AIoT WILL CHANGE EVERYTHING

OUR RESEARCH SHOWS that electronics engineers are acutely aware of the potential of the AIoT: 40% say that the AIoT will radically change technology for the better – and 44% say that it is critical to improving the way humans interact with technology.

So many potential applications for the AIoT have yet to be imagined, but immediate opportunities can be seen across all market verticals. Emerging capabilities (like face and image identification, voice control and presence detection) together with on-device intelligence and low-power processing, make for a transformative experience and a seismic shift in the impact technology has on our lives.

With all this potential within reach, companies are hungry to convert it into commercial success. Our study shows that 82% of electronics designers believe artificial intelligence will enable them to increase the competitive advantage of their device(s) — and 42% believe it will increase their competitive advantage significantly.

COMMERCIAL OPPORTUNITIES IDENTIFIED BY ELECTRONICS ENGINEERS

Autonomous Vehicles:	23%	Healthcare:	25%
M'facturing/Industry 4.0:	41%	Retail:	9%
Smart Cities:	23%	Other:	21%
Smart Home:	39%		

So, given this appetite for the AIoT, where are the products?

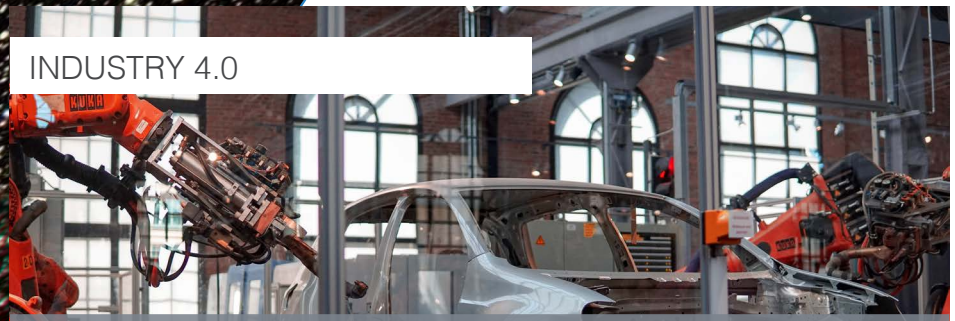
SMART HOME

THE AIoT OPENS UP OPPORTUNITIES FOR GREATER SAFETY, CONVENIENCE AND AUTOMATION. IT ENABLES TOTAL CONTROL OF THE HOME ENVIRONMENT WITHOUT THE NEED TO DIVERT ATTENTION.

CONNECTED HEALTHCARE

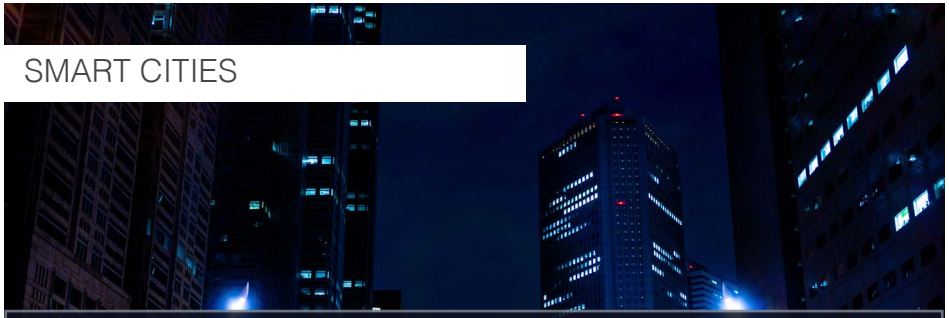
PRODUCT DEVELOPERS CAN EXTEND MONITORING CAPABILITIES (HEART RATE & BREATHING PATTERNS), ADD ADVANCED DIAGNOSTICS AND ENABLE EARLY ‘MEDICAL’ ALERT CAPABILITIES, SO HEALTH PROFESSIONALS CAN MONITOR PATIENTS REMOTELY.

INDUSTRY 4.0



SOPHISTICATED FAR-FIELD VOICE CONTROL DELIVERS HANDSFREE PRECISION OPERATION, IMPROVING STANDARDS, SPEED AND SAFETY. EDGE-AI WILL BRING REAL-TIME DATA CAPTURE AND INFERENCING FOR DEFECT DETECTION AND TARGETED MAINTENANCE.

SMART CITIES



WE’LL SEE IMPROVEMENTS IN SAFETY, SECURITY, CONVENIENCE AND EFFICIENCY. AI WILL OPTIMISE TRAFFIC FLOW, VEHICLES WILL SENSE FREE PARKING SPACES, STREETLIGHTS WILL POWER-UP ON PRESENCE DETECTION AND VOICE (VERSUS TOUCH) CONTROL WILL HELP SUPPRESS VIRAL CONTAGION.

MARKET LEVEL BARRIERS TO THE AIoT

SECURITY

In our research, 45% of electronics engineers cite DATA SECURITY as the biggest barrier to success - and it's easy to see why. As technology becomes smarter, consumers and enterprises are increasingly protective of their data, fearing a loss of control, potential misuse and cyber-crime.

In the AIoT, data needs to be shared across devices - think controlled 'hive learning' within set parameters. Edge-AI makes this compelling, because data processing, inferencing and decisioning can take place on-device rather than in the cloud, which reduces the (perceived) risk of data leakage and vulnerability.

CONNECTIVITY

According to our research, 38% of engineers highlight NETWORK BANDWIDTH LIMITATIONS as a serious concern for the AIoT. The forecast proliferation of devices and explosion of data will create challenges around processing and transmission.

32% of engineers believe that latency is impacting the development of smart devices. In applications where safety is paramount, actions need to be instantaneous, so connectivity and bandwidth aren't just 'nice to have', they're critical. Devices need to collect, collate and process data from multiple sensors (based on the changing environment around them) to deliver an immediate action or Recommendation. Vehicle sensors are a good example: when detecting a potential collision, there isn't enough time for the sensors on the car to detect the hazard, send the data to the cloud (assuming there is a connection) and wait for a return 'stop' command. Industrial machinery also needs to maintain safety and security in potentially dangerous environments.

SCALABILITY

While the IoT relies on the cloud, 24% of electronics engineers believe that CLOUD COMPUTE CAPABILITIES cannot scale sufficiently to allow the IoT to support the kinds of applications the AIoT will enable. The number of intelligent devices is set to explode over the next few years, and these connected devices will be sending more data than ever before. This is going to place unrealistic demands on the cloud – it simply isn't designed for the scale of the AIoT, or the speed at which much of the inferencing and decisioning needs to happen.

DEVICE LEVEL BARRIERS TO THE AIoT

The market barriers alone are significant, but engineers have also pointed to some serious, device-level technical hurdles that need to be addressed.

65% SAY POWER CONSUMPTION IS A CHALLENGE

49% SAY DESIGN COMPLEXITY IS A BARRIER TO SUCCESS

48% ARE WRESTLING WITH HOW TO REDUCE BOM COSTS

40% WANT MORE ON-DEVICE PROCESSING POWER

THE COST AND POWER TRADE OFF

Cost remains one of the biggest barrier for electronics engineers. The high-end CPUs used by AI systems traditionally are cost and power prohibitive for most end-point IoT devices. Enabling the AIoT economically, is going to require a serious boost to the processing power and capabilities of today's low-cost microcontrollers.

DESIGN COMPLEXITY

Designing in the AIoT has the potential to be an extremely complex undertaking - design complexity is a significant barrier. AIoT systems require many different classes of compute — signal conditioning, inference and classification, communications, control and connectivity. These are typically provided by discrete solutions with individual development environments, making system design complex and time consuming.

WHERE THOSE BARRIERS LEAVE US

Clearly the AIoT has the potential to improve the competitive advantage of products and change the world as we know it. But, as our research makes plain, currently designers are left frustrated by the numerous hurdles that need to be overcome in order for them to capitalise on the market opportunity the AIoT presents. However, overcoming these hurdles is in itself a major technical challenge.

First, we need to reduce our reliance on the cloud. This is a huge shift from the operational model that has quickly established itself with the IoT. 70% of electronics engineers agree that more on-device/edge processing will be necessary to deal with the exponential growth of data from the IoT devices and to enable the transition to the AIoT.

But moving away from the cloud also tackles some of the other hurdles in the way of the AIoT. By moving key tasks to on-device processing, the security and latency concerns around the IoT reduce significantly — ultimately it frees the AIoT to scale free from the compute limitations of the cloud.

Of course, there is an obvious knock-on consequence of this shift. We need to massively increase the available on-device processing power. Indeed, 77% of electronics engineers expect device processing power requirements to increase for future products (with 25% saying it'll increase significantly). However, we need to deliver this extra computing power without adding to the BOM cost or the power budget of what are inherently low-cost, low-power devices. These might sound like paradoxical demands that might be impossible to resolve, but help is on the way.

XCORE.AI: SOLVING THE MARKET BARRIERS

Our research shows that engineers working to bring AIoT products to market need a flexible, performant processing core that enables short time-to-market and doesn't come with a problematic price-tag. xcore.ai is that chip. With fully programmable ports, fast processing and neural network capabilities, xcore.ai enables developers to unlock the AIoT market with smart products that enhance our everyday lives.

NEAR INSTANT DECISIONING

With up to 3200MIPS of compute, xcore.ai can handle the most challenging edge-AI operations, eliminating bandwidth constraints and latency issues. Fast, flexible and economical, xcore.ai combines AI acceleration, powerful DSP, connectivity and general-purpose compute in single device - ideal for developers working on smart products that enhance our everyday living.

FAST AND FLEXIBLE ACTION

xcore.ai is a new crossover processor, offering the fastest reacting I/O for the price. So fast, it is possible to re-create hardware protocols for system communications and control in software. This capability enables embedded system designers to create their own application specific chip and get to market with differentiated solutions at unprecedented speed.

DATA SECURITY

xcore.ai features include secure boot, one-time-programmable key storage, random number generation and custom instructions. The on-device data processing, inferencing and decisioning capability helps reduce the (perceived) risk of data leakage, allay end user privacy concerns and improve the overall experience.

IMMEDIATE SCALABILITY

The AIoT will bring a proliferation of devices. The ability to diversify quickly and economically will be critical for designers. The flexible architecture and combined processing capability of xcore.ai delivers scalability, ensures short time-to-market and fits the required economics. xcore.ai is designed to help designers get to market fast with AIoT products that stand out from the crowd.

XCORE.AI: SOLVING THE DEVICE LEVEL CHALLENGES

THE CAPABILITY WITHOUT THE COST

xcore.ai is a fast, flexible and economical crossover processor for AIoT applications. High performance compute, real-time inferencing, decisioning at the edge, signal processing, control and communications are all wrapped up in a single chip. With prices starting from $1, xcore.ai addresses the issues of cost and performance highlighted by electronics engineers in our research.

xcore.ai is lightning fast and predictable, with execution determinism measured in single digit nanoseconds. Furthermore, xcore.ai takes less than 10 milliseconds to boot from zero-power and nanoseconds to transition from low power standby to full performance.

xcore.ai keeps eBOM costs low, and design potential high.

DESIGN VELOCITY

xcore.ai offers the highest processing power and most flexibility for the price-point, so electronics manufacturers (no matter their size) can embed more intelligence in IoT devices quickly and cost effectively.

In our research, electronics engineers expressed concern around design complexity. In a rapidly evolving AIoT market characterised by product diversity, xcore.ai enables engineers to innovate and upgrade products fast. The flexible, unified programming model ensures that AI, DSP, control and communication capabilities can be developed simultaneously and coexist reliably.

xcore.ai is a game changer for AIoT product designers who need to innovate, launch and upgrade products at pace as the AIoT evolves.

XCORE.AI OFFERS

32 x IMPROVEMENT IN AI PERFORMANCE

16 x FASTER I/O PROCESSING

15 x BETTER DSP PERFORMANCE

21 x 16-BIT MACs

VS ARM CORTEX M7*

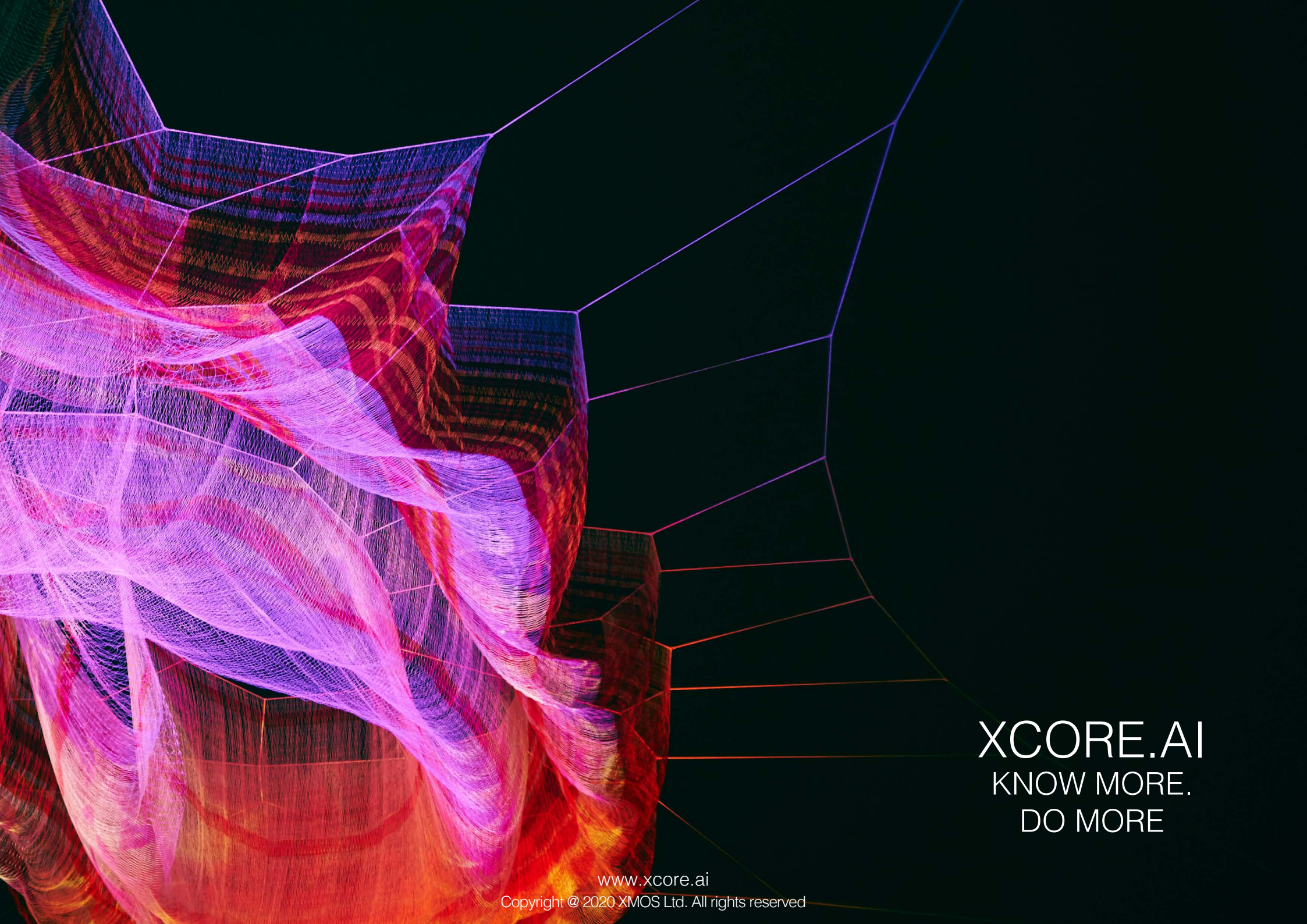
* NXP i.MX RT1060 processor selected as integrated solution appealing to similar markets.

XCORE.AI: THE KEY TO UNLOCKING THE AIoT MARKET

In summary, the majority (82%) of electronics designers believe that incorporating artificial intelligence will increase their competitive advantage — and 40% predict that the AIoT is going to radically transform and enhance the technology sector.

The AIoT industry has hit a tipping point. No matter how far you want to take the concept of AIoT, its success depends on being able to drive one of the most impressive feats of electronics engineering the digital era has ever seen.

XCORE.AI IS THAT FEAT. WELCOME TO THE EDGE OF TOMORROW.



XCORE.AI

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DO MORE

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