A UK Roadmap for Neuromorphic Computing: 2050 Vision

View the roadmap

NeuroWare
THE UK INNOVATION & KNOWLEDGE CENTRE IN NEUROMORPHIC COMPUTING HARDWARE

UKRI Innovate UK

UKRI Engineering and Physical Sciences Research Council

Introduction

Neuromorphic computing (also known as brain-inspired computing) is an emerging technology that draws inspiration from biological neural systems to **process AI and complex data at greater speed, security and efficiency, all while using only a fraction of the energy required by traditional computing**. Rather than replacing existing systems, neuromorphic computing complements them, enabling new capabilities for edge intelligence, autonomous systems, healthcare, manufacturing, security, and many other applications.

The UK has a unique opportunity to become a global leader in this rapidly developing field. Building on recent national investments and the establishment of NeuroWare, NeuroSYNC and NeuMat, this roadmap provides a shared vision for how the UK neuromorphic ecosystem could develop to 2050.

This roadmap takes an ambitious long-term view, exploring how neuromorphic computing could transform the UK's technological, economic, and societal landscape over the next 25 years. It is an interactive resource organised around five strategic themes: Industrial Applications & Leadership, Technological Innovation, Sustainability, Education & Skills, and Resilience. Each section describes key aims within that theme and the important surrounding context; it then sets out the milestones and actions that can be taken today to achieve those aims. It is intended to stimulate discussion, align stakeholders around a common direction, and evolve over time as the technology, policy landscape and wider ecosystem continue to develop.

Roadmap Overview

This table summarises all 26 aims across the roadmaps five themes. Each dot represents a milestone the UK could achieve by 2030, 2040 or 2050 – more dots means more milestones targeted in that period, and lighter dots represent longer time horizons

Theme	Aim	2030	2040	2050
Industrial Applications & Leadership	1.1 Improved accessibility to design and production	●●●●	●●●●	●●
	1.2 Expanded global competitiveness	●●●●	●●●●●	●●●
	1.3 Established sovereignty specialisms	●●●●	●●●	●●
	1.4 Built national testbeds and validation infrastructure	●●●●●	●●●	●●
	1.5 Implemented governance and standards	●●●●●	●●●	●●●
	1.6 Widespread industry adoption	●●●●	●●●●	●●
Technological Innovation	2.1 Neuromorphic computing integrated into UK compute ecosystem	●●●●	●●●	●●
	2.2 Achieved data-efficient learning	●●●●	●●●●	●●
	2.3 Delivered real-time, low-energy reliable processing	●●●	●●●●	●●
	2.4 Integrated hardware and algorithmic design	●●●●	●●●	●
	2.5 Built advanced manufacturing capabilities	●●●●	●●●●	●
	2.6 Effectively used across industries	●●●●	●●	●●
Sustainability	3.1 Reframed sustainability beyond AI reduction	●●●	●●	●●
	3.2 Contributed to net zero and UN SDGs	●●●●	●●●	●
	3.3 Achieved energy-efficient hybrid integration	●●●●	●●	●●
	3.4 Established end-to-end lifecycle metrics and circular economy	●●●	●●	●●
	3.5 Cross-community collaboration drives sustainability	●●●●	●●	●●
Education & Skills	4.1 A clear narrative attracts diverse talent and adoption	●●●●	●●●●	●●
	4.2 Built international concensus and strategy	●●●	●●●●●	●●●
	4.3 Industry alignment for workforce-ready skills across UK	●●●●●	●●●●	●●
	4.4 Embedded neuromorphic computing across curricula	●●●●	●●●●	●●●
	4.5 Integrated UK-wide multidisciplinary training	●●●●	●●	●●
Resilience	5.1 Integrated within UK infrastructure	●●●●	●●●	●●
	5.2 Built robust and transparent supply chain	●●●	●●●	●
	5.3 Secured UK's position in global supply chains	●●●●	●●●●	●●●
	5.4 Community's experience applied to future technologies	●●●●	●●	●●

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Vision Statement

By 2050, the UK will be a global leader in safe, sustainable and accessible neuromorphic computing – powering intelligent, low-energy technologies that benefit everyday life.

Neuromorphic technologies will bring intelligence to where it is currently impossible and advance beyond today's traditional computing to deliver new brain-inspired designs, flexible hybrid chips, new applications, and data-efficient learning. This will enable smart, privacy-first computing directly on local devices without reliance on the cloud.

These advances will help tackle major challenges such as unsustainable power consumption, and how we meet increasing demand for intelligent processing at the edge while accelerating progress towards Net Zero and ensuring equitable societal benefit.

Neuromorphic systems will underpin breakthroughs across a range of sectors from defence and security to healthcare and communications, to finance, energy and smart infrastructure. Realising this potential will require collaboration across industry, academia and government to advance research, invest in education and skills, share expertise, and translate innovation into real-world impact, driving economic growth and creating high-value jobs across the UK.

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Context

What is Neuromorphic Computing?

Neuromorphic computing is a family of brain-inspired technologies that includes new approaches to hardware, software and computing systems. Neuromorphic systems fundamentally rethink how computation is done by taking inspiration **from the best existing computing system** – the human brain. Unlike conventional computers, the brain can perform complex tasks such as recognising faces, understanding speech and making decisions while using only around 20 watts of power, roughly the same as a household light bulb. Neuromorphic computing seeks to capture some of these principles to create computing systems that are faster, more energy-efficient and better suited to processing AI and complex data in real time.

Currently, existing systems separate computation from much of the memory they rely on, requiring data to move frequently between processors and memory. This creates a major bottleneck in both speed and energy efficiency. Neuromorphic computing will embed sparse, event-driven intelligence on local devices that tightly integrate compute and memory. This will remove the need to transfer data between memory and processing units, which will speed up processing time and reduce the energy use involved. **So, in a world facing an AI energy crisis, neuromorphic computing is one of the most promising solutions**.

Neuromorphic computing may not be a common term, but its impact could be felt in everyday life in profound ways. Every business investing in AI today faces the same constraints: rising compute costs, growing energy bills, data privacy risk, and latency that limits what's possible at the edge. Neuromorphic computing addresses all four simultaneously, not by replacing existing systems, but by adding a layer of brain-inspired intelligence that processes faster, uses less power, and keeps sensitive data on-device. **For businesses already building with AI, neuromorphic is not a disruption; it is an upgrade**.

Purpose of the roadmap:

Modern computing relies on many interconnected components, including software, algorithms, hardware, memory, and manufacturing. This roadmap treats neuromorphic computing as part of this wider low-energy computing ecosystem. Achieving its full potential will require coordinated advances across the entire computing stack, from software and chip design to manufacturing, testing, and performance evaluation.

The milestones presented in this roadmap are intended as strategic outcomes rather than detailed delivery plans. In subsequent implementation phases, the roadmap will be supported by defined deliverables and measures of progress. As such, it should be viewed as a living document that will continue to evolve alongside technological developments, policy priorities, and the needs of the wider ecosystem.

This roadmap's ambitions are explicitly UK-wide, spanning all four nations. The mechanisms it proposes, from shared open-access facilities to regional innovation clusters, are designed to distribute capability and opportunity across the UK rather than concentrate them in a small number of locations.

Why 2050?

The roadmap looks to 2050 to provide a sufficiently long-term horizon for a technology that is still in its early stages of development. The years 2030, 2040, and 2050 represent indicative milestones along this journey, aligning with wider national priorities such as the UK's Net Zero target and reflecting the timescales often required for emerging technologies to move from research to widespread deployment. Given the pace of technological change, these milestones should be viewed as directional ambitions rather than fixed delivery commitments.

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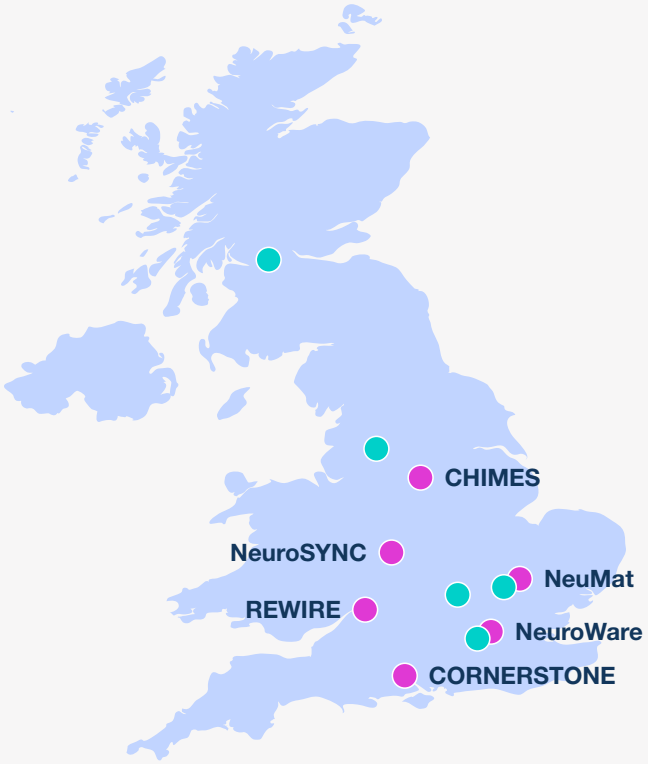
UK landscape

The UK has identified advanced computing, AI, semiconductors, and future digital technologies as strategic priorities. The UK's National AI Strategy highlights compute, talent, data, and finance as critical enablers of future competitiveness, while the National Semiconductor Strategy identifies future computing architectures as an area where the UK can establish global leadership. More recently, the UK AI Hardware Plan has signalled growing government recognition of the importance of next-generation computing hardware and infrastructure in supporting future AI capabilities, including an expanded advanced market commitment of £150m to purchase novel, high-performance inference chips, followed by a further £250m procurement for additional specialised hardware. Together with the £2 billion UK Compute Roadmap to 2030, these initiatives demonstrate **increasing policy attention on the technologies that will underpin the UK's future compute ecosystem and the key role that neuromorphic computing will have for the UK**.

Alongside these investments, the UK is developing strategies and roadmaps across a range of frontier computing domains, including a photonics roadmap and quantum strategies. The UK possesses internationally recognised strengths in semiconductor design, computing research, and neuromorphic innovation, supported by world-leading universities, research institutions, and centres – some of which are highlighted on the UK map.

Unlike some frontier technologies, there is currently no established pathway for neuromorphic technologies to become a mainstream component of national computing infrastructure, despite its potential to build on existing semiconductor manufacturing capabilities and offer opportunities for near-term deployment. Given future computing systems are likely to combine multiple technologies rather than rely on a single architecture, **neuromorphic computing must be considered as part of a wider compute ecosystem**, requiring coordination across national strategies, infrastructure planning, investment programmes, standards development, and technology roadmaps, rather than being pursued in isolation.



Locations of the UK's neuromorphic computing and semiconductor Innovation and Knowledge Centres (IKCs) – **NeuroWare** (UCL), **CHIMES** (University of Sheffield), **CORNERSTONE** (University of Southampton) and **REWIRE** (University of Bristol) – together with two closely affiliated centres, **NeuroSYNC** (Aston University) and **NeuMat** (University of Cambridge). The turquoise dots represent NeuroWare's partner institutions across the UK. The map illustrates the wider network of centres driving progress in neuromorphic computing and the broader UK semiconductor industry.

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International landscape

The international landscape is rapidly evolving, with the global neuromorphic computing market forecast to grow from $5.3 billion in 2023 to $20 billion by 2030, reflecting the rising demand for low-power, real-time AI processing across edge computing, robotics, and autonomous systems.

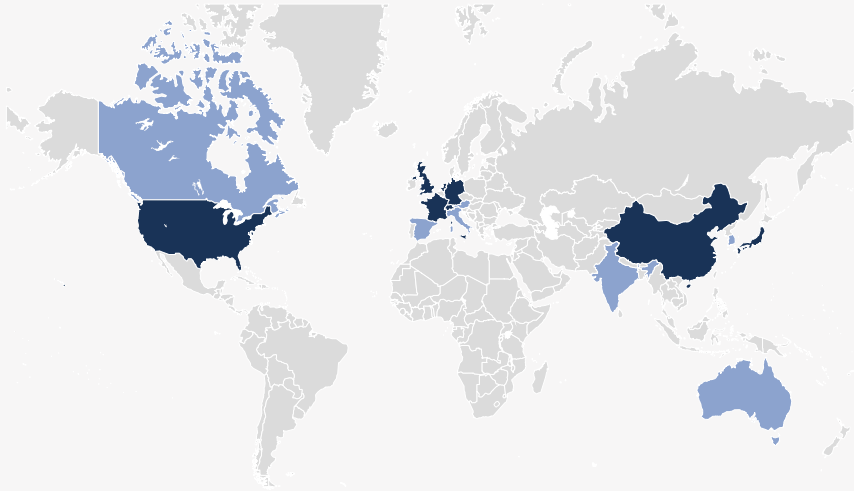
The United States and China remain the dominant players, underpinned by significantly higher levels of public and private investment in research, infrastructure, and commercialisation. In the United States, neuromorphic computing is supported through major federal programmes (e.g. DARPA) and strong industry leadership, while China is advancing rapidly through coordinated state-backed initiatives and integration with broader AI and semiconductor strategies.

Across Europe, countries are accelerating efforts to establish their own footing in this space. For example, the Netherlands has emerged as a notable frontrunner, recently launching a €30m initiative to develop a national neuromorphic ecosystem, including a €9m grant from the Dutch Research Council. In addition, Germany, France, and Switzerland are investing in brain-inspired computing as part of their wider AI and digital innovation strategies, often linking neuromorphic approaches to energy efficiency and next-generation hardware development.

Beyond Europe, Singapore is investing in next-generation AI and advanced semiconductor research, while India is expanding its ambitions through wider investments in semiconductors, AI, and indigenous computing capability.

Taken together, these developments signal a clear global shift: neuromorphic computing is transitioning from a niche academic discipline to a strategic technology priority. Governments are increasingly viewing capability in this area as critical to future AI competitiveness, energy-efficient computing, and digital sovereignty.

Within this context, international partnerships are becoming increasingly important. Initiatives such as the Canada-UK CANUTE Network+ and the UK-Netherlands Innovation Partnership demonstrate the value of cross-border collaboration in research, skills development, and ecosystem building, helping to connect national strengths and accelerate progress.



Key players — China, USA, UK, Netherlands, Germany, Japan, Switzerland, France

Emerging players — Australia, Spain, Italy, Canada, South Korea, India, Singapore, Austria

Methodology note: Countries are categorised based on visible evidence of neuromorphic computing engagement, including dedicated research centres, public funding initiatives, national or regional programmes, industrial activity, international partnerships, and participation in neuromorphic hardware, software, or systems development. The map is intended as an indicative view of global activity rather than a comprehensive quantitative ranking.

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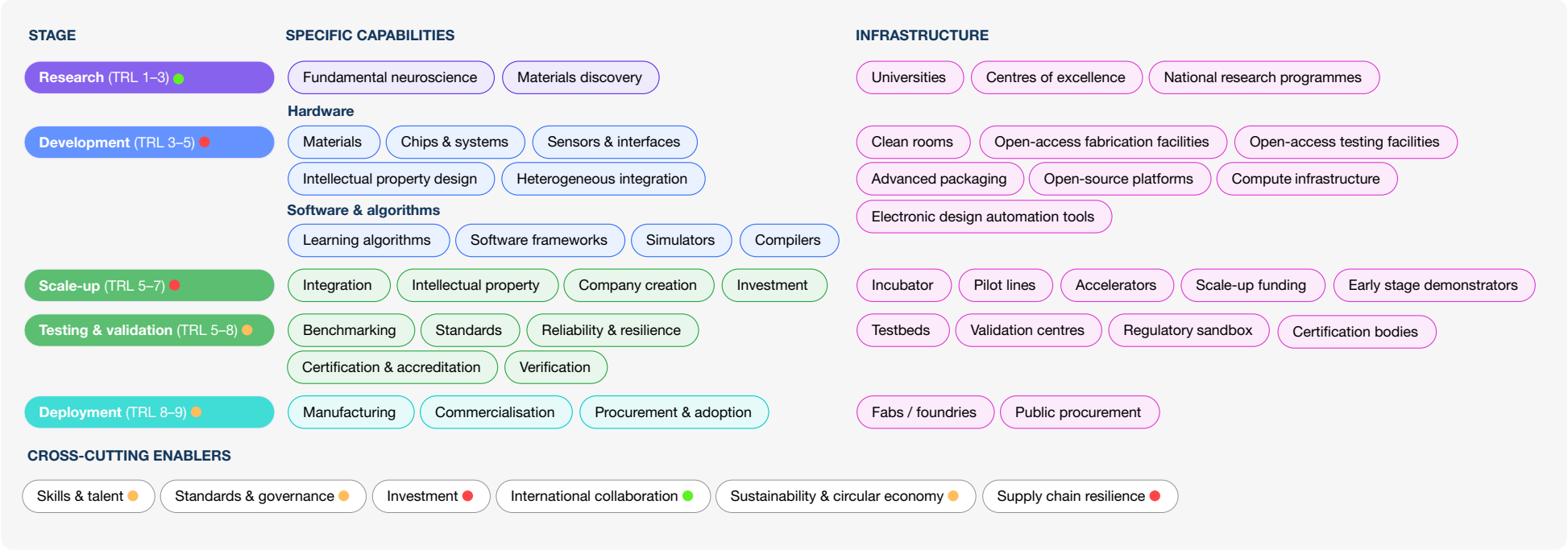
The neuromorphic computing ecosystem

The neuromorphic computing ecosystem spans from fundamental research through to real-world deployment across key sectors. The UK's position varies significantly across this ecosystem. Research is a genuine strength, underpinned by world-leading universities and a strong base in neuroscience and materials discovery, and the UK's international collaboration networks are similarly well-placed. However, capability weakens from hardware and scale-up onwards, where access to manufacturing infrastructure and commercialisation funding becomes more limited. Software tooling, testing, deployment, skills, standards, and investment infrastructure are all still developing. Supply chain resilience also remains a significant gap, reflecting the UK's reliance on overseas manufacturing and semiconductor supply chains.

The figure maps the key capabilities, supporting infrastructure, and cross-cutting enablers that underpin the neuromorphic computing (and wider semiconductor) ecosystem. The technology readiness level (TRL) ranges shown are indicative and illustrate the typical stages of technology development – in practice, many capabilities span multiple TRLs and evolve iteratively. The colour coding indicates where the UK currently has established strengths, where capability is developing, and where significant gaps remain, helping to identify priorities for future investment and action.



No single nation is likely to lead across the entire neuromorphic value chain, and the UK should not try to. Instead, the UK should aim to be the producer and shaper of neuromorphic computing by becoming world-leading in a small number of critical elements that other countries depend on. The UK's greatest opportunity lies in translating research excellence into real-world impact through application development, systems integration, standards leadership, and targeted industrial capability. Doing so would not only accelerate the adoption of neuromorphic technologies but also help position the UK as a leading contributor to the future compute landscape while generating long-term economic value from domestic innovation.

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Application and use cases

Neuromorphic computing is a foundational technology capable of supporting a wide range of future applications. Those shown below are examples expected to emerge first with many more likely to follow as the technology matures.

Applications

Edge AI
Real-time, on-device inference without reliance on cloud connectivity

Healthcare
Low-power, privacy-preserving local processing of sensitive patient data

Telecommunications
Low-latency signal processing and energy efficiency at network scale

Security & resilience
Intelligent sensing and operation in environments where communication with cloud infrastructure is limited or unavailable

Robotics
Fast, real-time processing for responsive robotic control

Autonomous systems
Rapid decision-making under strict power and latency constraints

Critical infrastructure
Continuous monitoring, predictive maintenance, and the efficient processing of large volumes of sensor data

Energy & utilities
Efficient processing of distributed sensor data with minimal overhead

Transport
Real-time perception and decision-making in safety-critical settings

Cybersecurity
Event-driven anomaly detection that keeps data local and private

Satellite communications
Extreme power efficiency and autonomous on-board processing

Neuromorphic computing will fulfil computing needs that cannot be met by existing computing technologies due to constraints related to energy consumption, latency, data requirements, connectivity, or operating environments. Rather than replacing existing computing approaches, neuromorphic technologies are expected to complement them by addressing these specific challenges because of the clear advantages of low-power, event-driven, and real-time processing.

While edge intelligence is expected to be an important early application area, future opportunities may also emerge in larger-scale computing environments. Neuromorphic technologies could become part of hybrid computing systems that combine conventional, neuromorphic, photonic, and quantum approaches, supporting scientific computing, optimisation, simulation, and next-generation AI workloads.

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Use Case: Event Camera Technology

Event cameras (also known as neuromorphic cameras due to their bio-inspired design) operate very differently from conventional cameras. Rather than capturing complete image frames at fixed intervals, each pixel functions independently and only responds when it detects a change in brightness (i.e., an event). This event-driven approach is inspired by the way neurons in the human retina process visual information.

By recording only changes in a scene, event cameras generate highly efficient streams of data that can be processed to identify motion, anomalies, and other dynamic events. This makes them particularly effective for applications where conventional cameras struggle.

Key advantages include:

Ultra-low power: consume far less energy than conventional sensors which extends operational life in energy-constrained systems such as satellite payloads.

High speed: rapid detection of fast-moving objects without motion blur.

High dynamic range: reliable operation across both very bright and very dark conditions so no events are missed in complex lighting environments.

Faster decision making: data is only captured at the level of individual pixels, instead of full images, so images can be processed faster.

These capabilities are already driving commercial interest and deployment across a range of sectors. Applications include industrial inspection and automation, where defects can be detected in high-speed manufacturing processes; automotive safety, through improved sensing for autonomous and assisted driving systems; drone detection and tracking, particularly in complex or low-visibility environments; and space operations, where low-power, high-speed vision systems can support autonomous navigation, docking, and coordination between spacecraft.

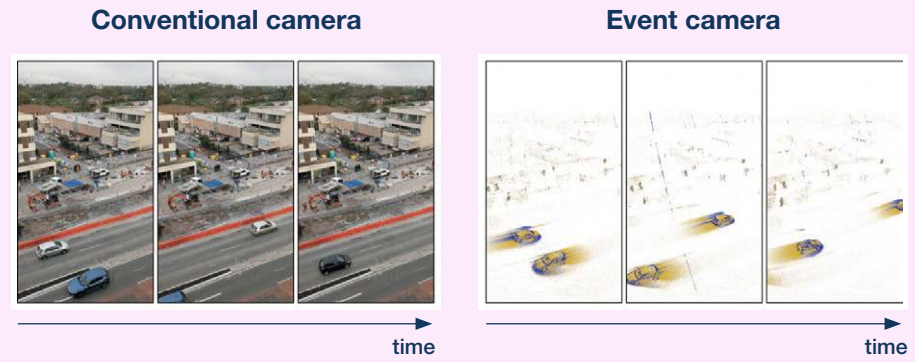

Image: Image compares a conventional and an event camera assessing movements on a busy street. The event camera does not capture multiple frames with redundant data, but instead pixels only respond when their intensity changes by a threshold percentage. Source: Alexandre Marcireau, Optera

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Theme 1: Industrial Applications and Leadership

The UK has world-class research capabilities but faces challenges translating scientific excellence into large-scale commercial success. There is a risk that the UK will produce research, but fail to capture the commercial value, losing out to other countries such as the US. Building an ecosystem that enables industry adoption, sovereign capability, global competitiveness and public trust is essential to realising the economic and societal potential of neuromorphic technologies.

Delivering on these ambitions requires capability distributed across the whole of the UK. The UK's regional strengths, including the M4 corridor semiconductor cluster spanning Bristol, Reading, and Swansea, the Manchester neuromorphic heritage, and emerging clusters in Scotland and Northern Ireland, represent a genuine national asset that community should build on.

Aim 1.1 Achieved greater accessibility to the design and production of neuromorphic technologies

2030

- Researchers and companies have easier access to UK and international facilities e.g. IMEC – including visa agreement and funding
- Wider access to shared design tools and IP libraries
- Established open facilities for use case experimentation and demonstration
- Created open-access facilities for designing, prototyping, and scaling neuromorphic technologies

2040

- Established public-private partnerships in neuromorphic computing e.g. Fraunhofer model in Germany
- Scaled shared design platforms and services
- Open access UK pilot lines are available to universities, SMEs, and spin-outs
- Built the capability to adopt and integrate future emerging technologies alongside neuromorphic computing

2050

- Achieved industrial infrastructure capable of rapid adaptation to new device technologies
- UK operates world-leading open neuromorphic computing design and manufacturing platform

Act now

Government

- Fund programmes that reduce barriers to developing and manufacturing neuromorphic technologies such as open-access and shared facilities
- Create networking opportunities that connect technology developers, manufacturers, investors, and end users
- Strengthen international agreements that improve UK access to specialist semiconductor infrastructure

Industry

- Mapping of key design and manufacturing capabilities across the UK
- Engage with Government to fund open-access facilities, including pilot lines

Academia

- Develop open-source tools and frameworks
- Scope shared infrastructure model and identify hosts

Others

- Networks to collaborate and reduce barriers for facility access for SMEs

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 1.2 Maintained and expanded our global competitiveness – the UK is an environment in which trillion-pound technology companies can build, scale, and thrive

2030

- Government-backed financial incentives accelerate investment for UK neuromorphic technology production and commercialisation
- Industries investing in commercialisation pathways and scale-up activities
- Established industry-led partnerships that connect neuromorphic developers, suppliers, and end users to accelerate
- At least one major technology company has an active neuromorphic programme with UK partnerships

2040

- Neuromorphic venture capital (VC) fund (UK/EU) established including acceleration programmes
- Foreign direct investment in neuromorphic technology continues to grow
- Regional neuromorphic innovation clusters drive local economic growth
- Achieved 20 neuromorphic spin-outs in the UK
- UK neuromorphic companies routinely scale through UK and European innovation networks and retain significant domestic talent, IP, and investment

2050

- UK-based neuromorphic technology giants established
- UK recognised as global neuromorphic hub
- Neuromorphic technologies contribute significantly to UK productivity, exports, and economic growth

Act now

Government

- Support a clear long-term vision for the UK's role in neuromorphic computing and future compute technologies
- Proactively engage major global technology companies on neuromorphic computing
- Map UK neuromorphic companies currently facing scale-up barriers and at risk of relocating operations internationall and use this information to support companies in accessing funding and to establish a dedicated retention mechanism
- Act as early an early customer for UK neuromorphic technologies
- UKRI to coordinate VC, public, and private financial investment pathways and bring in other key organisations such as British Business Bank (BBB)

Industry

- Create an industry engagement programme e.g. consortium membership for industries to engage with neuromorphic computing
- Develop leadership programmes for top neuromorphic computing talent

Academia

- Build closer links with investors and industry partners to accelerate translation

Others

- EPSRC to map existing early-stage funding mechanisms

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 1.3 Established sovereignty specialisms in neuromorphic technologies

2030

- Conducted overall SWOT analysis and system level review of the neuromorphic computing landscape, including needs, technologies, funding, and skills
- Identified priority sovereign specialisms and initiated prototyping capabilities
- Established National Council for Neuromorphic Technology
- Developed a sovereignty-aligned framework for neuromorphic startup and scale-up retention domestically before international acquisition

2040

- Deployed sovereign technology across the UK at strategic scale and across sectors
- Developed UK manufacturing capabilities for specialised neuromorphic hardware with secure supply chains

2050

- Sovereign neuromorphic capabilities protect UK security, economic resilience, and industrial independence
- UK leads in trusted, secure neuromorphic technology integrated across sectors

Act now

Government

- White paper on ‘lessons learned’ and why the UK lags in manufacturing
- Analysis of UK strengths in neuromorphic systems and research on security-critical supply chain gaps
- Establish neuromorphic computing as a priority area for the UK Sovereign AI Unit

Industry

- Invest in niche areas where the UK can build internationally recognised expertise

Academia

- Focus research efforts on areas where the UK can establish global leadership

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 1.4 National testbeds, innovation, and validation infrastructure enable start up, benchmarking, and scale-up

2030

- Established neuromorphic incubator / innovation hub as a startup launchpad
- Access to testbeds via expanded AI Research Resource (AIRR), AI Growth Zones, and National Computing Centres
- Established standardised benchmarking frameworks
- Established validation and verification infrastructure for neuromorphic technologies (physical UK centre for validation)
- Established a publicly accessible catalogue (neuromorphic zoo) of hardware platforms, software tools, and capabilities

2040

- Advanced validation infrastructure supports deployment in real-world operational environments
- Established independent, accredited testbeds capable of verifying neuromorphic device performance to automotive, aerospace, and medical standards
- National infrastructure routinely supports the scale-up and commercialisation of neuromorphic technologies

2050

- Mature national innovation ecosystem supporting startups, scale-ups, and industry leaders
- The UK is internationally recognised for world-leading neuromorphic testbeds, benchmarking, and innovation infrastructure

Act now

Government

- Ensure SMEs and start-ups can access infrastructure and technical expertise
- Assessed national infrastructure needs for neuromorphic computing
- Investment to support independent accreditation infrastructure
- Adopt adaptive regulatory approaches that enable timely review and updating of policies as technologies mature

Industry

- Participate in pilot projects and validation activities
- Engage with independent test and accreditation bodies to begin scoping the validation and verification requirements for neuromorphic deployment in target sectors

Academia

- Establish open benchmark suites with strong conventional baselines

Others

- All stakeholders to initiate early dialogue with relevant regulators e.g. Medicines and Healthcare products Regulatory Agency (MHRA), Civil Aviation Authority (CAA)

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 1.5 Implemented governance, standards, and certification frameworks for neuromorphic technologies

2030

- Clear technical standards for neuromorphic hardware, software, and interoperability established
- Published UK neuromorphic ethical principles
- Certification pathways, security accreditation, and trust verification established for neuromorphic systems and integrated in regulated and safety-critical sectors
- Engaged with international standard bodies (e.g. European Committee for Electrotechnical Standardisation (CENELEC)) so UK standards are internationally recognised

2040

- Ethical governance frameworks embedded within research and industry with continuous monitoring
- International alignment on ethical principles and technical standards
- Public trust and transparency strengthened in neuromorphic systems

2050

- Achieved responsible, ethical, and secure large-scale deployment of neuromorphic technologies
- Strong public trust in innovative neuromorphic ecosystem with societal benefits maximised
- International interoperability standards enable seamless integration across the global neuromorphic ecosystem

Act now

Government

- Ensure neuromorphic computing is considered within wider AI, semiconductor, and emerging technology governance discussions
- Commission a mapping of existing neuromorphic deployment activity within UK to identify where certification support is most urgently needed
- Support the development of standards, certification and assurance infrastructure for neuromorphic technologies

Industry

- Identify regulatory, standards, and certification gaps

Academia

- Investigate the ethical, societal, and governance implications of neuromorphic technologies
- Survey public perceptions on neuromorphic technology and publish evidence database to influence policymakers
- Establish shared definition and taxonomy covering analogue, digital, mixed-signal, photonic, and emerging-device routes

Others

- All stakeholders to involve regulatory bodies early and proactively engage with them, including joint working on sandboxes (e.g. Regulatory Innovation Office (RIO), Financial Conduct Authority (FCA), British Standards Institution (BSI))
- National Cyber Security Centre (NCSC) to support work on hardware security vulnerability assessment and Common Vulnerabilities Exposure (CVE) registration

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 1.6 Widespread industry adoption of neuromorphic technologies

2030

- Built industry facing narrative demonstrating the business value of neuromorphic technologies
- Enabled existing catapults to emulate Fraunhofer-like technology R&D hubs
- Industry awareness of neuromorphic technologies and their applications has significantly increased
- National neuromorphic consortium established to coordinate government, academia, industry, and end-users around flagship application areas

2040

- Government procurement of neuromorphic technologies supporting scale-up and market pull
- Neuromorphic technology applied in key industries e.g. healthcare, finance, security, and transport
- Established neuromorphic growth zones with measurable regional adoption and jobs across UK
- Developed neuromorphic platforms outside of key sectors enabling experimentation and expertise building across a wide range of industries

2050

- Neuromorphic technologies are embedded across the economy and society
- Neuromorphic technologies deliver measurable impact on productivity, resilience, and sustainability across sectors

Act now

Government

- Implement a large-scale flagship project to build public visibility and secure support
- Relevant government departments e.g. DfT, MoD, DSTL should engage with academics and industry to align goals around neuromorphic computing strategy
- Establish a dedicated programme office liaison responsible for neuromorphic procurement pathway development

Industry

- Strong funding for industry and academic collaboration

Academia

- Focus research on industry-led challenges and commercially relevant applications
- Secure letters of endorsement or intent from key industry players

- Map stakeholder and industry to find key beneficiaries of neuromorphic technologies
- Showcase pilot use cases
- Develop a TRL tracker to support new neuromorphic technologies

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

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Theme 2: Technological Innovation

Neuromorphic computing can redefine how intelligent computing is designed, built and deployed. By drawing inspiration from the human brain, it promises a step-change in energy efficiency, speed, adaptability and real-time intelligence that will enable capabilities beyond those of today's computing systems. Achieving this vision will require breakthroughs across the entire innovation ecosystem – from algorithms and hardware to manufacturing, software, and system integration – supported by compelling demonstrations that accelerate investment, adoption and global technological leadership.

Aim 2.1 Neuromorphic paradigms are established as a viable part of the compute eco-system, well-integrated alongside conventional computing

2030

- Defined neuromorphic computing and intelligence, and established community taxonomies
- Demonstrated fundamental enabler technologies and initial priority use cases
- Established early hybrid conventional-neuromorphic architectures with feasibility testing
- Established a coordinated UK wide strategy for the development and integration of neuromorphic computing

2040

- Integrated neuromorphic systems with other computing paradigms (e.g. quantum and photonics) and exploiting synergies (e.g. hybrid ANN-SNN)
- Established interoperable co-processing architectures and conventional computing, supported by defined standards
- Demonstrated integration within UK high-performance computing for suitable workloads

2050

- Neuromorphic computing is seamlessly integrated within the wider computing ecosystem alongside conventional, photonic, and quantum technologies
- Neuromorphic computing is a leading technology for AI, autonomous vehicles, healthcare, transport, security etc.

Act now

Government

- Prioritise sustained investment in neuromorphic capabilities as a strategic technology for UK competitiveness and resilience
- Wider recognition of neuromorphic computing within future computing and semiconductor strategies

Industry

- Launch collaborative programmes between universities, industry, and government laboratories to define shared benchmarks and standards

Academia

- Embed ‘neuromorphic computing’ into UK photonics and semiconductor roadmaps
- Development of new neuromorphic computing paradigms
- Focus skills development on inter-disciplinary research with PhDs focused on convergence of technology

Others

- Engage with national and international standards organisations to help develop common technical standards for neuromorphic computing

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 2.2 Achieved data-efficient learning that reduces reliance on training large-scale datasets

2030

- Established a robust collaborative ecosystem for data-efficient learning
- High-impact applications for data-efficient learning identified and validated across priority sectors
- Integrated benchmarks comparing neuromorphic learning efficiency against conventional baselines in technology development
- Neuromorphic systems demonstrate learning from limited data and real-world interactions

2040

- Achieved 100x reduction in network size or training complexity compared to current networks as of 2026
- Research ecosystem converges in low-data and continual learning
- Prototyped and developed new architectures beyond GPU-based for data efficient learning technologies
- Integration between neuromorphic computing and AI model design

2050

- Widespread deployment of neuromorphic systems in applications where data availability, privacy or compute constraints limit conventional AI
- Adopted technology standards for low-power and data-efficient training

Act now

Government

- Fund research programmes focused on data-efficient learning approaches

Industry

- Invest in development and commercialisation of data-efficient neuromorphic algorithms
- Partner with academia on real-world use case validation
- Develop technology standards specifically for low-power, data-efficient training
- Design data centres for the long term, when neuromorphic computing will change how they operate

Academia

- Publish benchmarks comparing neuromorphic learning efficiency against conventional baselines
- Development of new neuromorphic computing paradigms specifically for efficient and secure data transfer e.g. AI models
- Identify and train people with the required skills

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 2.3 Brain-inspired computing delivers real-time, low energy, and reliable processing

2030

- Proof-of-concept edge deployments demonstrate measurable practical advantages over conventional systems in key sectors e.g. healthcare, transport, infrastructure, and security
- Established neuromorphic metrology and benchmarking protocols
- Implemented validation and verification infrastructure to assess reliability of neuromorphic technologies

2040

- Next-generation of neuromorphic sensing and edge intelligence systems deployed in real-world environments
- Novel advanced material breakthrough enables scale of memristor-based neuromorphic technology
- Neuromorphic accelerators demonstrate clear energy-efficiency advantages over conventional approaches
- Neuromorphic hardware achieved reliability comparable to conventional digital computing, with reduced reliance on software-based error correction

2050

- Broad commercial adoption of brain-inspired low power neuromorphic devices across markets delivering real-time and reliable processing relative to conventional computing
- Achieved GHz-rate neuromorphic processing with ultra-low latency

Act now

Government

- Promote neuromorphic computing within wider energy-efficient computing initiatives

Industry

- Identify high-value use cases where latency and power consumption are major constraints
- Implementation in specific relevant areas e.g. enhanced robotics, healthcare, 6G infrastructure

Academia

- Demonstrate measurable improvements in energy efficiency and latency with neuromorphic approaches
- Develop edge computing for signal detection and neuromorphic low power sensors
- Develop system-level energy-to-quality metrics on realistic workloads

Others

- Defence primes to procure neuromorphic chips for autonomous systems

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 2.4 Hardware and algorithmic design are fully integrated across the community

2030

- Established a standard neuromorphic programming framework
- Shared benchmarks, datasets and evaluation methodologies enable cross-stack development
- Demonstrated co-designed neuromorphic systems where hardware architectures and algorithms are developed together from the outset
- Established a national coordination mechanism e.g. regular cross-stack working groups, shared platforms

2040

- Achieved routine deployment of integrated neuromorphic platforms across key sectors
- Automated hardware-algorithm optimisation and iterative co-design across disciplines becomes standard design practice
- A mature open-source software ecosystem enables automated testing, quality assurance, and seamless access to neuromorphic hardware

2050

- Seamless co-design methodologies, standards, and interoperable tools enable efficient development, optimisation, and deployment of neuromorphic systems

Act now

Government

- Promote and fund collaborative programmes across existing semiconductor, AI, and computing initiatives that bring together the full technology stack

Industry

- Skills development for both hardware and software design

Academia

- Establish common research frameworks linking neuromorphic hardware development with algorithm design
- Initiate a regular joint forum or working group to bring both strands of researchers together
- Develop useable software stacks, mapping tools, simulators, and reference flows

Others

- Catapult Network to continue exploring and supporting co-design between academia and industry

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 2.5 Advanced manufacturing and integration capabilities support scalable production of neuromorphic hardware

2030

- Advanced materials breakthroughs demonstrated in the UK are validated for foundry compatibility and nontoxic manufacturing processes
- Shared manufacturing infrastructure operational serving neuromorphic, photonics, and quantum
- Strengthened engagement with the Semiconductor Catapult
- Shared access to prototyping, packaging, test, and measurement facilities

2040

- Developed proven mid-scale manufacturing processes
- Coordinated manufacturing supply chain for specific neuromorphic systems e.g. sensors
- Established UK-based heterogeneous integration and advanced packaging capability
- Flexible prototype and pilot lines available that are open access to universities and spin-outs, funded by government and industry

2050

- Fully developed advanced manufacturing ecosystems for fabrication of neuromorphic technologies

Act now

Government

- Provide targeted tax incentives and financial support to reduce the cost of developing and scaling advanced manufacturing capabilities
- Commission a feasibility study on shared prototyping infrastructure that simultaneously serves neuromorphic, photonic, and quantum development by mapping existing UK facilities
- Develop a tiered system supporting prototyping from early stage (academic facilities) to pre-production (centralised facilities) with funding throughout

Industry

- Assessment of UK manufacturing capability
- Increase funding for pilots
- Establish partnerships with Semiconductor Catapult (previously CSA Catapult)

Academia

- Coordinate a UK-Netherlands manufacturing collaboration for photonic focused neuromorphic processing chips (e.g. CORNERSTONE and PhotonDelta)

Others

- Semiconductors Fabs to provide access to pilot manufacturing lines and other infrastructure

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 2.6 Neuromorphic technology is being used effectively across a wide range of industries

2030

- Demonstrated best use cases and expanded neuromorphic applications in key areas e.g. robotics, healthcare, security
- Generated robust evidence identifying where neuromorphic computing provides clear advantages over conventional approaches
- Developed application selection frameworks to guide effective deployment
- Integrated demonstrators linking sensors, processors, software, and applications

2040

- Achieved wider adoption of neuromorphic products across multiple sectors
- Neuromorphic computing successfully deployed in environments beyond best use cases e.g. high performance computing

2050

- Achieved seamless integration of neuromorphic technologies across healthcare, robotics, AI, telecommunications, transport, and security
- Neuromorphic computing is a key part of the global technology stack

Act now

Government

- Work with industry to identify high-priority application areas where the UK has existing strengths
- Use public procurement and innovation programmes to support early adoption of neuromorphic technologies e.g. procurement by MoD of new AI drone systems powered by ultra efficient neuromorphic chips

Industry

- Identify initial technologies to be developed in key sectors

Academia

- Translate research work into application-ready prototypes demonstrating commercial value

Others

- Co-design neuromorphic technologies with healthcare providers, clinicians, and patients for healthcare adoption
- Increase early-stage private investment in neuromorphic technologies and application demonstrators

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

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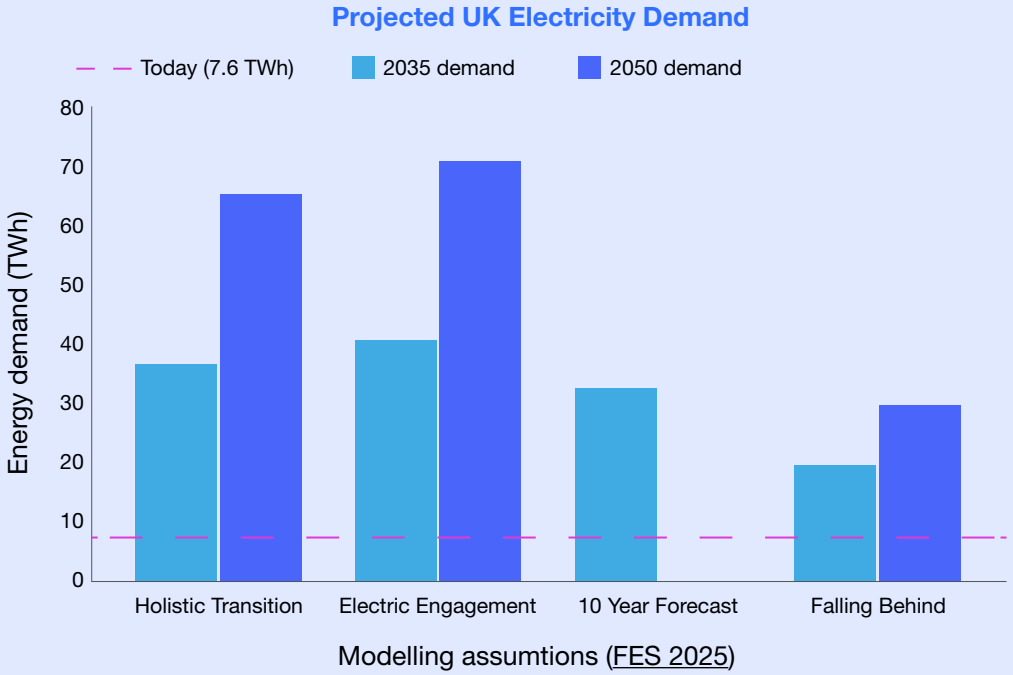
Theme 3: Sustainability

The power demands of the world's computing is unsustainable. AI and computing infrastructure already consume vast and growing amounts of energy and without a fundamental shift in how we process information, that trajectory will only steepen. In the UK, demand from data centres is forecasted by National Energy System Operator (NESO) to grow from 7.6 terawatt hours to between 20 and 41 by 2035, depending on which model is followed. The figure shows how these values significantly increase by 2050. This also means that by 2030, data centres will represent 8.8% of total UK electricity demand.

Neuromorphic computing offers a different path: hardware that processes information the way the brain does, using a fraction of the energy of conventional systems, and capable of operating at the edge without relying on energy-hungry data centres.

For people, this means smarter, longer-lasting devices that do more with less power. For public services, it means infrastructure, from transport networks to healthcare diagnostics, that can operate efficiently, locally, and reliably. For the UK, it means a genuine opportunity to lead a shift toward computing that is not only more capable, but more sustainable by design.



Aim 3.1 Sustainability reframed beyond AI energy reduction to include sensing, edge intelligence, new materials, and reduced latency

2030

- Defined sustainability in the context of neuromorphic computing, recognising the interdependencies between environmental, financial and workforce outcomes
- Established common sustainability metrics beyond AI energy consumption
- Generated robust evidence for the sustainability benefits of sensing, edge intelligence, new materials, and low-latency computing

2040

- Developed long-term UK sustainability framework (beyond AI energy use) for neuromorphic systems with the ability to evolve with application/user needs
- Priority application sectors routinely demonstrate system-level sustainability benefits

2050

- Widespread deployment of adaptive, low-energy neuromorphic systems
- Quantifiable evidence demonstrates environmental, economic and societal benefits enabled by neuromorphic computing

Act now

Government

- Create white papers on public and government perception with plain language and clean examples
- Policy alignment between computing sustainability and clean energy strategy

Academia

- Investigate sustainable materials, device design, and edge computing applications
- Create public media campaign highlighting the sustainability benefits of neuromorphic computing beyond energy reduction

Others

- Continued widespread public engagement utilising media, content creators, and campaigners

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 3.2 Low power computing and green manufacturing contribute to net-zero and UN SDGs

2030

- Developed sustainability measures linked to UN Sustainable Development Goals (SDGs)
- Pilot of sustainable manufacturing launched and backed by government
- Established power-consumption baselines
- Developed neuromorphic technologies that reduce energy consumption and resource requirements relative to conventional computing

2040

- Deployment of neuromorphic systems in key net-zero sectors: power electronics, grid, renewables, and nontraditional energy management
- Demonstrated sustainable manufacturing routes suitable for national scaling
- Per- and polyfluoroalkyl substances (PFAS) designed out of neuromorphic manufacturing processes

2050

- Significant contribution to UK net-zero targets from neuromorphic technology achieved

Act now

Government

- Align neuromorphic computing initiatives with UK net-zero ambitions and wider sustainability strategies
- Provide targeted funding and policy incentives for low-power computing and sustainable semiconductor manufacturing

Industry

- Develop material and device innovations with compatibility of semiconductor processes in mind – use of toxic materials and non-standard manufacturing will not be deployable at scale
- Design out PFAS from neuromorphic manufacturing processes before EU PFAS ban takes effect

Academia

- Investigate sustainable manufacturing processes, materials, and device architectures
- Establish clear evidence linking neuromorphic technologies to wider sustainability outcomes and UN SDGs

Others

- Engagement on neuromorphic technologies contribution to grid-level efficiency by NESO/ National Grid

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 3.3 Achieved energy-efficient and cost-effective integration for hybrid technologies and digital systems

2030

- Developed hybrid computing concept integrating low-complexity digital with analogue neuromorphic
- The compute community maps right tool for right sector to maximise benefit
- Demonstrated 10-50x energy efficiency gains in early edge/IoT cases
- Published white paper or technical proof demonstrating integrated neuromorphic technologies energy and cost advantages

2040

- Achieved a 100x reduction in network size or training complexities
- Integration of neuromorphic systems with other computing paradigms (e.g. photonics, quantum) with demonstratable energy and cost benefits

2050

- Hybrid computing architectures become the default for intelligent computing systems
- Hybrid computing architectures routinely combine digital, neuromorphic, photonic and quantum computing, automatically selecting the most energy- and cost-efficient paradigm for each workload

Act now

Government

- Support collaborative programmes that accelerate hybrid computing integration across complementary technologies

Industry

- Develop common standards and interoperability frameworks to support integration

Academia

- Develop an open-source software roadmap to support interoperable hybrid computing platforms

Others

- Coordinate cross-community initiatives with photonics and quantum communities

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 3.4 Established robust, evolving metrics with focus on end-to-end lifecycle sustainability and enabling a circular economy

2030

- Defined and adopted baseline lifecycle metrics and life-cycle assessment (LCA) methodologies
- Design-for-circularity standards (e.g. design for repair and modularity) adopted by UK neuromorphic hardware manufacturers
- Mapped scope 3 emissions hotspots in the neuromorphic computing manufacturing supply chain

2040

- Defined and introduced system level metrics (not just device level) – going beyond energy per operation
- More than 50% of chip materials reused or recycled at end of life

2050

- Most neuromorphic applications undergo automated end-to-end lifecycle sustainability assessment, including carbon footprint measurement
- UK neuromorphic computing hardware manufacturing operates as a net circular system – end-of-life recovery rates exceed 75%

Act now

Government

- Work with standards bodies to develop consistent approaches for measuring environmental impact

Industry

- Share sustainability data and best practice across supply chains and product lifecycles
- Assess sustainability impacts across the full product lifecycle, not just operational energy use

Academia

- Generate evidence and case studies to validate and refine sustainability assessment approaches
- Implement design for repair and modularity in neuromorphic systems to go beyond material reuse and recovery

Others

- UK and international standards bodies to develop consistent lifecycle assessment standards for computing hardware

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 3.5 Cross-community collaboration drives sustainable innovation and behaviour change

2030

- Developed an international network of neuromorphic computing centres around the world to define global messages to governments and the public
- Established a neuromorphic accelerator to help companies validate, scale, and commercialise applications
- Assembled a taskforce to consult and involve public advocates
- Established a nationally recognised mechanism for coordinating the UK neuromorphic ecosystem

2040

- Achieved radical architecture innovation and cross-community collaboration
- Demonstrated sustainability impact and behavior change across the community

2050

- UK leads global sustainable computing collaborations
- Continued widespread public engagement

Act now

Government

- Develop mechanisms for strategic coordination, convening and knowledge sharing across the UK neuromorphic ecosystem
- AI Energy Council to include representation of neuromorphic computing within broader computing governance

Industry

- Collaborate with academia and government on sustainable technology development and deployment

Academia

- Support knowledge exchange activities across sectors
- Integration with other IKCs and semiconductor community
- Map the compute community and highlight the role it can play

Others

- Funders to design future investments to strengthen coordination across the neuromorphic ecosystem, ensuring new programmes complement rather than duplicate existing capabilities

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

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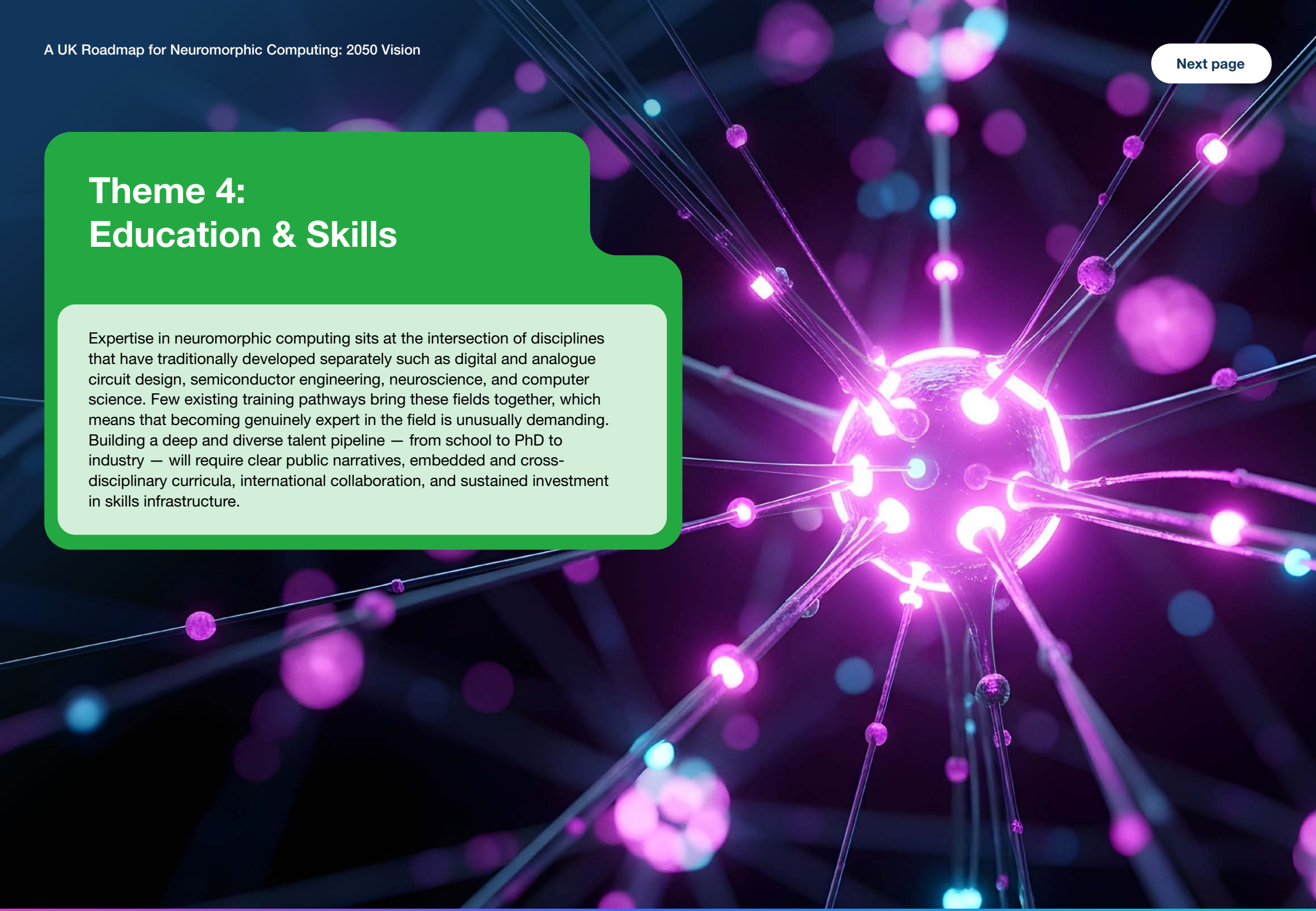
Theme 4: Education & Skills

Expertise in neuromorphic computing sits at the intersection of disciplines that have traditionally developed separately such as digital and analogue circuit design, semiconductor engineering, neuroscience, and computer science. Few existing training pathways bring these fields together, which means that becoming genuinely expert in the field is unusually demanding. Building a deep and diverse talent pipeline — from school to PhD to industry — will require clear public narratives, embedded and cross-disciplinary curricula, international collaboration, and sustained investment in skills infrastructure.



Aim 4.1 A clear and widely understood narrative communicates the value and practical applications of neuromorphic computing to attract and support both future talent and potential adopters

2030

- Launched public engagement programmes – increased visibility and delivered clear narrative of the value of neuromorphic computing
- Established clear definition of neuromorphic computing for public understanding extending beyond academia and industry
- Published evidence of economic and societal benefits
- Broadened diversity of the neuromorphic talent pipeline, including addressing the gender imbalance

2040

- Neuromorphic computing spokesperson prominent in public media e.g. podcasts, TV, lectures
- Adopted neuromorphic computing as a distinct technology area in government forecasting and strategic planning
- UK neuromorphic research produces a landmark demonstrator result that is internationally recognised as a step-change in the field
- Widespread public understanding, engagement, and trust established

2050

- Maintained a clear and widely recognised identity for neuromorphic computing as the field evolves
- Achieved fully integrated diverse education-to-industry pipelines

Act now

Government

- Support public engagement and awareness activities that communicate the opportunities and societal benefits of neuromorphic computing
- Build a clear public engagement strategy and narrative
- Create neuromorphic computing white papers in plain language

Industry

- Provide visible role models, case studies, and industry ambassadors
- Increase visibility of real-world applications and career opportunities across the sector

Academia

- Develop accessible educational resources that explain neuromorphic computing and its applications
- Identify UK neuromorphic champions/ ambassadors

Others

- All stakeholders support in building public narrative by utilising media (BBC, podcast networks, social media) and already established programmes (science festivals etc.)

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 4.2 Built international consensus and strategy for neuromorphic development

2030

- Established an international network of neuromorphic computing centres and strengthened UK links with global neuromorphic communities
- Erasmus+ programme in neuromorphic computing developed jointly with EU partners and including NeuroSYNC, NeuroWare, and NeuMat
- Enhanced UK-Netherlands joint partnership on neuromorphic computing with allocated funding for academia and industry

2040

- Built on previous joint training initiatives to allow UK students to be seconded to EU partners on projects and gain credits
- Established regular international benchmarking to align UK neuromorphic strategy with global developments
- International workforce mobility embedded across the sector
- Integrated resource planning across foundational technology sectors to ensure coordinated investment, skills development, and infrastructure
- Established joint degrees with other major universities outside the UK

2050

- Established UK as a global neuromorphic education leader and skills export
- Established internationally aligned neuromorphic education, skills, and training frameworks
- Achieved an international ecosystem for education and skills exchange with minimal country boundaries

Act now

Government

- Strengthen UK–EU links; identify neuromorphic computing centres in Europe to influence policy together
- Establish complementary strategies to develop domestic talent while attracting and retaining world-leading international talent
- Align neuromorphic skills goals and workforce planning with existing published strategies

Industry

- Assess the current and future market opportunity for neuromorphic computing
- Engagement with the wider semiconductor industry to raise profile of careers and research in neuromorphic computing

Academia

- Develop a workforce roadmap that sits alongside the technology roadmap
- Development of international neuromorphic computing education by the British Council

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 4.3 Alignment with industry to ensure workforce-ready skills and access to training and facilities across the UK – continually evolving to meet future needs

2030

- Implemented regular gap analysis across the whole timeline
- Aligned skills development with government investment, start-up culture, and industrial growth
- Developed core skill set framework for neuromorphic-innovators and continuing professional development (CPD) course
- Diversified skills pathways to include (1) technical (fabrication, clean room operation), (2) research level, and (3) entrepreneurial awareness
- Developed short intensive courses targeting people with adjacent skills

2040

- Ensured the technology is established enough so skills are transferable
- Maintained alignment of supply and demand of technical talent in 5-10 year projections
- Ensured equitable access to training and facilities across UK
- Established greater workforce mobility across academia and industry with metrics for success

2050

- Achieved a sustainable, continuous reskilling ecosystem that adapts to evolving technologies through UK-wide training provision
- Established industry-led skills forecasting to ensure education and training programmes respond to future workforce demand

Act now

Government

- Assess current skills gap for neuromorphic computing
- Ensure skills and training programmes reach institutions and employers across all UK regions, with targeted support for universities and companies outside the major neuromorphic hubs
- Enhance funding for industry-academia collaborations e.g. iCASE
- Align neuromorphic skills goals with existing published strategies (e.g. the semiconductor strategy) to strengthen the case

Industry

- Clearly communicate workforce needs, skills gaps, and emerging capability requirements
- Demonstrate the economic return on investment of neuromorphic skills programmes through improved career outcomes and lifetime earnings
- Increase involvement in curriculum design, training, and workforce development

Academia

- Develop career pathways progression maps
- Develop core set of skills/knowledge for neuromorphic computing experts, undergraduates, and postgraduates through gaining consensus of neuromorphic computing community

Others

- All stakeholders to align with UK Electronics Skills Foundation (UKESF) on semiconductor skills pipeline

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 4.4 Neuromorphic computing embedded across the curricula, supporting both entry and progression

2030

- Implemented Centres for Doctoral Training (CDTs) for neuromorphic computing – combining research and commercial skills
- Teaching/training offered by higher education institutions with expertise in the area from undergraduate to PhD (with provision for technical roles)
- Developed new curriculum and evolved pedagogy
- Increased teaching and recruitment with diversified talent pool

2040

- Created specialist pathways in neuromorphic computing within higher education and apprenticeships
- Neuromorphic is a subject broadly available as a specialisation in undergraduate programmes (e.g. EEE or Computer Science) with industry involvement
- Technology established as a recognised academic discipline
- 80-100 PhD students trained in neuromorphic computing at UK institutions

2050

- Established industry-supported degree programmes using mature consumer neuromorphic technologies
- Continued educational evolution aligned with future applications
- Neuromorphic computing career progression embedded from early education through to specialist higher education and training

Act now

Government

- Encourage the inclusion of neuromorphic concepts within relevant STEM programmes
- Create studentships for neuromorphic computing across undergraduate, postgraduate, and technical-based qualifications

Industry

- Make neuromorphic computing internships available
- Incorporate industry placements in education

Academia

- Develop and embed neuromorphic content into existing undergraduate and postgraduate programmes so all graduates have foundational awareness
- Universities to develop new interdisciplinary modules for neuromorphic, co-taught by experts across fields
- Embrace AI tools as part of developing critical navigational skills

Others

- Technical pathway development by apprenticeship levy bodies

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 4.5 Integrated UK-wide multidisciplinary training across algorithms, software, architecture and devices

2030

- Developed multidisciplinary training centers and skills programmes bringing together all strands of neuromorphic technologies
- Created shared skills frameworks covering algorithms, software, architecture and devices
- Established nationally coordinated neuromorphic education working groups
- Improved access to shared facilities, expertise, and learning opportunities across the UK to build a connected talent pipeline

2040

- National facilities support practical multidisciplinary training and guided by workforce metrics
- Open educational online platform in neuromorphic computing underpinned by access to open/shared facilities

2050

- Fully integrated diverse education to industry talent pipelines
- UK-wide connected talent pipeline with no regional gaps

Act now

Government

- Coordinate a national skills-gap assessment to identify priority roles and regional needs
- Identify and connect existing training initiatives
- Establish a working group comprising university, industry, and government partners, and identify priority regions for engagement

Industry

- Define the practical skills, tools and roles needed across the neuromorphic technology stack

Academia

- Embed neuromorphic computing into existing programmes
- Expand interdisciplinary neuromorphic training programmes
- Develop a cross-disciplinary module on the regulation of. neuromorphic technology

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

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Theme 5: Resilience

Neuromorphic technologies must be resilient to geopolitical disruption, supply chain vulnerability, rapid technology change, and infrastructure risk. This theme covers how neuromorphic computing integrates within UK infrastructure, how supply chains are secured and made sustainable, how the UK positions itself globally, and how the community's experience strengthens the UK's long-term capacity for technological change.

Aim 5.1 Neuromorphic computing is compatible with and integrated within UK infrastructure to ensure greater resilience of those systems

2030

- Early deployment of neuromorphic systems in critical national infrastructure (energy, transport, communications, healthcare and security)
- Introduced trusted hardware assurance standards and interoperability requirements
- Security-by-design standards and accreditation established for neuromorphic edge deployments in critical infrastructure
- Increased public awareness of neuromorphic computing and its societal benefit and relation to other technologies

2040

- Neuromorphic technologies are integrated across operational UK infrastructure
- Recognised interoperability standards, security frameworks, and procurement pathways
- Established manufacturing ecosystem across the UK

2050

- Neuromorphic computing forms a standard component of resilient UK infrastructure
- Measurable reduction in infrastructure downtime and energy usage for societal benefit

Act now

Government

- Integrate neuromorphic computing into the UK's future digital and physical infrastructure agenda
- National assessment identifying where neuromorphic computing can enhance UK critical infrastructure e.g. energy, transport, communications, healthcare, and security

Industry

- Assess the skills needed to scale facilities and define the roles, remuneration and outreach needed to recruit the necessary workforce

Academia

- Demonstrate significant energy gains for unequivocal use cases and computational benchmarks

Others

- Relevant regulators (e.g. FCA) to develop white papers and strategies reflecting neuromorphic computing's role as a key strategic technology for their sectors
- Participate in development process of technologies for relevant sector and initiate regulatory sandbox for deployment in infrastructure e.g. MHRA, NCSC, CAA

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 5.2 A resilient, and transparent supply chain underpins development and deployment of neuromorphic technologies – minimising reliance on critical minerals

2030

- The UK has identified its key supply chain strengths and capabilities, including critical mineral dependencies for neuromorphic device classes
- The UK neuromorphic supply chain is fully mapped and transparency framework published covering material source, energy use, end-of-life processing, and established sourcing agreements
- Developed contingency plan for geopolitical disruption of key component sources

2040

- Over 40% of materials used in UK neuromorphic hardware are recovered and reused through domestic circular economy processes
- Closed-loop refurbishment and redeployment systems are operational at industrial scale for neuromorphic components
- Advanced materials for neuromorphic systems are being utilised and recognised as a UK strength (e.g. 2D materials, GaN etc.)

2050

- Critical mineral dependency reduced to strategically manageable levels with diversified sources

Act now

Government

- Align neuromorphic supply chain policy with the Critical Minerals Strategy and UK-US MoU
- Map supply chain dependencies across neuromorphic device classes, identify the top five critical mineral inputs, assess alternative sources, and establish at least two sourcing agreements

Industry

- Adopt design-for-circularity principles in neuromorphic hardware development
- Participate in supply chain transparency reporting
- Awareness activities and training for neuromorphic supply chain development
- Supply chain mapping and sourcing strategy alignment with Critical Mineral Authorities

Academia

- Research sustainable material alternatives and circular design approaches for neuromorphic computing hardware
- Implement design for material substitution (to manage price volatility of critical minerals)

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 5.3 The UK is a vital part of the global neuromorphic technology ecosystem which secures our position within the global supply chains

2030

- Established UK-EU supply chain agreement including strategy and regulation with agility to adapt
- The UK involved in multilateral neuromorphic standards-setting bodies with influence over outcomes
- First UK-designed neuromorphic systems exported to allied partners in security, healthcare or critical infrastructure
- Frameworks established to support collaboration between UK neuromorphic organisations and UK-originated companies operating internationally

2040

- The UK is recognised as a trusted neuromorphic computing global supply chain partner
- The UK is number 1 in its USP
- Allied fabrication access agreements in place, reducing single-nation supply chain risk
- The UK actively shaping international neuromorphic governance frameworks and AI standards

2050

- The UK established as a top-three global hub for neuromorphic technology
- The UK's position in global neuromorphic supply chains is diversified, secure and economically significant
- The UK is a global leader in circular computing supply chains and standards

Act now

Government

- Recognise neuromorphic technology as a strategic sovereign capability
- Develop and publish National Neuromorphic Strategy
- Identification and engagement with international partners beyond current partnerships
- Continuously monitor the international neuromorphic landscape – strategic resource allocation requires knowing when to compete and when to collaborate
- Map UK's current position in the global neuromorphic ecosystem – identify strengths, gaps, and strategic leverage points

Industry

- Invest in capabilities that strengthen the UK's role in high-value parts of the global neuromorphic supply chain

Academia

- Explore neuromaterials as a field to give UK a niche advantage
- Build on current collaborations e.g. University of Manchester and Forschungszentrum Jülich

Others

- Relevant regulators should engage early and proactively with new technical developments

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

Aim 5.4 The neuromorphic community's experience is captured and applied to future emerging technologies – strengthening the UK's capacity to respond to technological change

2030

- Published a freely available document on the experience of developing neuromorphic computing which covers standards, supply chain building, skills pipelines, and public engagement
- First application of neuromorphic-derived frameworks to another emerging technology
- Ongoing knowledge capture mechanism embedded into neuromorphic governance, so lessons are recorded in real time
- Established independent third-party advisory board for neuromorphic computing

2040

- UK recognised internationally as a source of best practice for building resilient emerging technology ecosystems
- Cross-community body established to steward shared frameworks and enable rapid knowledge transfer to future technology waves

2050

- New emerging technologies in the UK benefit from shorter development cycles and fewer avoidable failures as a result of applied neuromorphic learning
- Living framework maintained and continuously updated – drawing on experience across multiple technology generations

Act now

Government

- Develop a knowledge-capture framework to support effective governance and long-term programme delivery
- Fund cross-sector knowledge transfer activities linking the neuromorphic community to other emerging technology fields

Industry

- Participate in case study development and contribute industry perspective to lessons-learned documentation

Academia

- Lead development of frameworks for evaluating and transferring neuromorphic development experience
- Develop core studies to evaluate success and define approaches worth sharing
- Develop a guide for academics/users to work together from early stages to end and maintain as living document

Others

- Innovate UK and Advanced Research and Invention Agency (ARIA) to continue funding cross-sector knowledge transfer

Context | What else would advance the delivery of this aim? | Click for extra reading | Related aims | Click to go back to roadmap

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Glossary

	Description
Accelerator	An accelerator helps companies grow, rather than focusing on manufacturing technology. The programmes provide funding, mentoring, business support, and access to facilities to help scale-up and commercialisation for start-ups.
AIRR (AI Research Resource)	Gives UK-based researchers and developers across sectors access to some of the world's most powerful computing clusters.
ANN (Artificial Neural Network)	An algorithm-based computing system modelled on the human brain and used in modern AI applications.
ARIA (Advanced Research and Invention Agency)	The UK's independent research funding agency that supports high-risk, high-reward research with potential to deliver transformative scientific and technological breakthroughs.
ARM	A UK-founded semiconductor and software design company best known for developing energy-efficient processor architectures widely used in smartphones and edge systems.
BBB (British Business Bank)	The UK Government's economic development bank, established to improve access to finance for smaller businesses. It supports innovation and growth through loans, guarantees, venture capital, and investment programmes, including funding for technology start-ups and scale-ups.
Benchmarking	The use of standardised tests and metrics to compare the performance, efficiency, accuracy, or reliability of different hardware, software, or computing systems. It enables fair comparison and helps demonstrate progress and readiness for deployment.
BSI (British Standards Institution)	The UK's national standards body, responsible for developing standards and best practice guidance across a wide range of sectors.
CAA (Civil Aviation Authority)	The UK's aviation regulator. The CAA is responsible for ensuring the safety, security, and efficiency of civil aviation, as well as regulating airports, airlines, and the use of airspace.
CDT (Centre for Doctoral Training)	A UK postgraduate training programme that brings together universities, industry, and other partners to provide structured PhD training in strategically important research areas. CDTs typically combine research, technical skills development, and collaboration with external organisations.
CENELEC (European Committee for Electrotechnical Standardisation)	The European organisation responsible for developing standards for electrical and electronic technologies, helping to ensure products are safe, compatible, and interoperable across Europe.
Compilers	Software that translates the code a programmer writes into instructions the hardware can execute.
CPD (Continuing Professional Development)	Ongoing learning and skills development undertaken throughout a person's career to maintain and improve professional knowledge and competence.

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	Description
CPU (Central Processing Unit)	General purpose processors that can handle a wide variety of computing tasks with sequential decision-making.
CVE (Common Vulnerabilities and Exposures)	globally recognised system for identifying, naming and cataloguing publicly disclosed cybersecurity vulnerabilities, providing a common reference for organisations to assess, track and address security risks..
DARPA (Defense Advanced Research Projects Agency)	The research and development branch of the U.S. Department of Defense involved with funding breakthrough technologies for military use.
Demonstrator	A demonstrator is usually a prototype deployment designed to show capability so to attract investment and showcase benefits.
EDA (Electronic Design Automation) tools	Software used to design, simulate, and verify semiconductor chips before fabrication, helping engineers optimise performance, power consumption, reliability, and manufacturability.
Event-driven Computing	A computing approach that processes information only when relevant events occur, rather than continuously processing all data, which reduces energy consumption and allows the system to respond quickly to changes.
Fab (Fabrication Facility)	A manufacturing facility where semiconductor devices are physically produced. Its purpose is to manufacture chips and commercial devices at scale.
Facility of Excellence / National Centre	Usually, a hub or expertise comprising researchers, equipment, training programmes, demonstrators, and industry engagement. Its purpose is to coordinate activity, train people, and act as a focal point for the field.
FCA (Financial Conduct Authority)	The UK's financial services regulator. The FCA is responsible for regulating financial markets and firms, protecting consumers, promoting competition, and ensuring the integrity of the UK's financial system.
Foundry	A company that operates manufacturing plants to build chips for external clients on a contract basis. Some foundries also operate pilot lines or support process development before technologies move to high-volume manufacturing.
GCOT (Global Coalition on Telecommunications)	An international partnership of like-minded countries that works to strengthen the security, resilience, and innovation of global telecommunications networks and supply chains, including the development of future communications technologies.
GPU (Graphics Processing Unit)	Specialised processors that perform many calculations in parallel, making them effective for AI and large-scale data processing.
Hardware-algorithm co-design	Designing computer hardware and software algorithms together so they are optimised to work with each other, improving overall system performance.
IMEC (Interuniversity Microelectronics Centre)	A world-leading research and innovation centre based in Belgium that specialises in nanoelectronics, semiconductor technologies, and digital innovation. It works with academia, industry, and government to develop and commercialise next-generation technologies.

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	Description
In-memory Computing	A computing approach that brings memory and processing closer together, reducing the energy and time needed to move data. It is an important principle underpinning many neuromorphic technologies.
Incubation centre	A centre to help researchers and entrepreneurs turn an idea into a viable company through access to technical facilities, business advice, early funding, and networks (investors, industry partners etc.)
Innovation hub	A broader eco-system builder bringing together stakeholders and accelerating innovation, adoption, and commercialisation.
Latency	The delay caused by the time it takes for data to travel from one point to another.
LCA (Life Cycle Assessment)	A method used to evaluate the environmental impacts of a product, process, or technology across its entire lifecycle.
Memristor	A type of electronic device whose resistance can be changed and retained, allowing it to store information without continuous power.
MHRA (Medicines and Healthcare products Regulatory Agency)	The UK government agency responsible for regulating medicines, medical devices, and healthcare products.
NCSC (National Cyber Security Centre)	The UK's national authority for cyber security. It provides guidance, expertise, and support to help organisations and individuals protect systems, networks, and data from cyber threats.
NESO (National Energy System Operator)	The independent organisation responsible for planning and operating Great Britain's electricity system and supporting the transition to net zero.
Neuromorphic Computing	A class of brain-inspired computing approaches that take inspiration from biological neural systems to perform computation.
Neuromorphic Systems	Integrated products or platforms that incorporate neuromorphic technologies to deliver a specific function or application.
Neuromorphic Technologies	The hardware, software, materials, devices, and enabling tools that support the development and implementation of neuromorphic computing.
Neuromorphic Zoo	A community resource that provides access to a range of neuromorphic computing systems, enabling researchers and developers to test, compare, and develop new algorithms, software, and applications across different hardware platforms.

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	Description
Open access facility	Shared infrastructure available to multiple users e.g. cleanrooms, testing equipment.
PFAS (Per- and polyfluoroalkyl substances)	A group of human-made chemicals used in a wide range of products and industrial processes due to their resistance to heat, water, and oil. Often referred to as 'forever chemicals' as they break down very slowly and can accumulate over time.
Pilot line	Sits between laboratory research and full manufacturing. It demonstrates that a technology can be manufactured reliably before large-scale investment.
Regulatory sandbox	A controlled environment that is used to understand the opportunities and risks associated with specific innovation.
RIO (Regulatory Innovation Office)	A UK government initiative that works with regulators, industry, and researchers to help remove regulatory barriers to innovation.
SNN (Spiking Neural Network)	A brain-inspired model that closely mimics the dynamics of biological neurons in the brain.
Software stack	A collection of components such as software, tools, and programming frameworks that work together to develop a functional platform.
Sparse Computing	A computing approach that identifies and skips unnecessary computations to process large quantities of data more efficiently.
Standards Bodies	Organisations such as IEEE, CENELEC, and BSI that develop and maintain technical standards to support the safe, reliable and interoperable development and use of technologies.
System-level benchmarking	The process of evaluating the performance of an entire computing system, rather than individual components.
Testbed	An environment where technologies are trialled in realistic conditions in order to demonstrate performance, validate use cases, and reduce adoption risk.
Validation Facility / Validator	This facility independently assesses whether a technology performs as claimed e.g. evaluating energy efficiency or latency. Its purpose is for benchmarking, verification, and development of standards.

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A full list of contributors is listed on the NeuroWare website.

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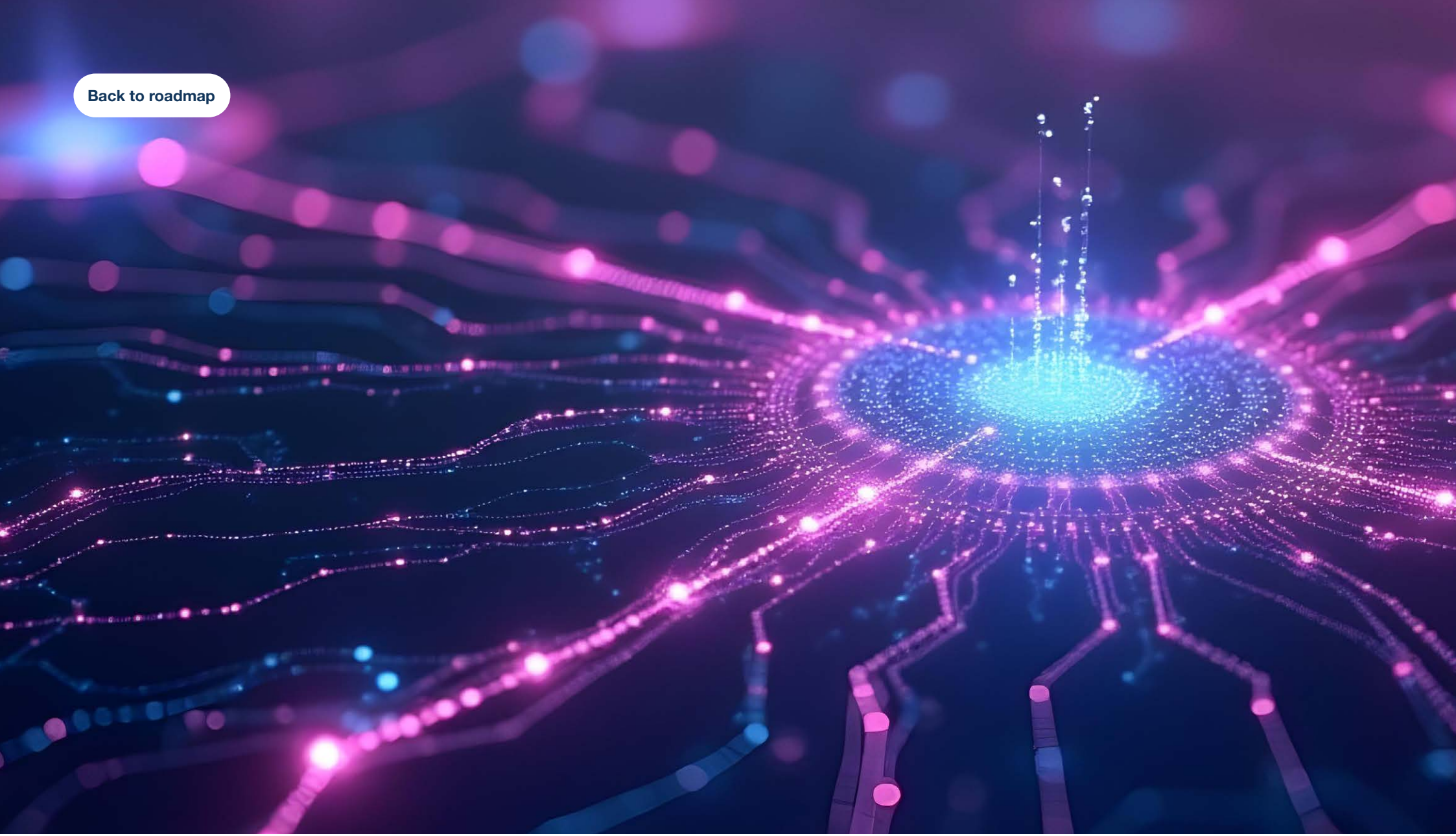

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