Critical Digital Tech from Finland:

# Driving Growth and Security in Europe

# 1 Foreword

Amid accelerating technological breakthroughs and shifting global dynamics—including disruptive trade wars and the deployment of tariffs—Europe's ability to remain competitive and secure depends on its strength in critical digital technologies. Artificial intelligence, semiconductors, quantum technologies, high-performance computing, advanced connectivity, space technologies, and cybersecurity are not only essential economic enablers—they are strategic assets required to maintain critical functions of modern society.

This policy brief was created to provide a clear, up-to-date overview of Finland's contributions to Europe's critical tech landscape—and to spark dialogue on how to strengthen them further. Drawing on decades of deep-tech expertise, a collaborative innovation culture, and world-class research infrastructure, Finland decisively strengthens Europe's technological resilience and global standing.

We warmly thank all experts, organisations, and partners who contributed to the development of this policy brief. Your insights and collaboration have been essential. The work done so far is intended to serve as a starting point for closer cross-sectoral cooperation in the field of critical technologies in Finland. By fostering tighter collaboration between these technology verticals, we can drive innovation more effectively and address complex challenges with a unified approach.

We invite European and global partners to work with us in scaling these breakthroughs. By combining Finnish strengths with international ambition, we can accelerate innovation, build resilient value chains, and ensure Europe leads in the technologies that define tomorrow.

In Brussels, 20 May 2025

the Finnish Innovation Fund Sitra

Technology Industries of Finland

VTT, Technical Research Center of Finland

## About the Finnish Innovation Fund Sitra

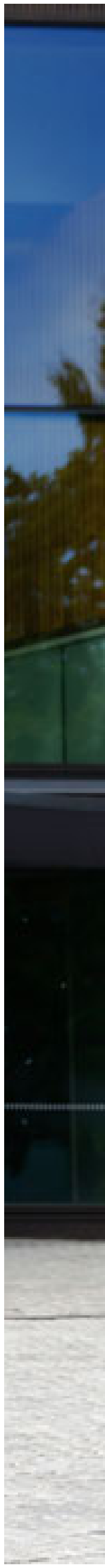
The Finnish Innovation Fund Sitra is a future fund that helps Finland to reform. Sitra anticipates the future and develops solutions to tomorrow's challenges in collaboration with partners. Sitra promotes Finland's well-being and accelerates sustainable economic growth. A better future demands action today.

## About Technology Industries of Finland

Technology Industries of Finland (TIF) is a business and labour market lobbying organisation that promotes the competitiveness and business conditions of Finland's most crucial export industry. TIF has 1,800 member companies. They extensively represent the electronics and electrotechnical industry, mechanical engineering, the metals industry, information technology, and consulting engineering.

## About VTT, Technical Research Center of Finland

VTT is one of Europe's leading research institutions. VTT is owned by the Finnish state. Through scientific and technological means, VTT turns large global challenges into sustainable growth for businesses and society. VTT brings together people, business, science and technology to solve the biggest challenges of our time.



# 2 Executive summary

In an era marked by geopolitical fragmentation, rapid technological advances, and intense competition for talent and resources, critical digital technologies are shaping the global balance of power and economic security. In this context, Europe's collective ambition is to bolster its technological sovereignty while remaining open to international collaboration. Finland, with its deep-tech expertise and robust innovation culture, plays a vital role in reinforcing Europe's competitiveness, resilience, and security across key technology domains. This policy brief is grounded in the critical technologies framework as defined by the European Commission, which identifies the technologies most essential to Europe's strategic interests.

### Global trends: Convergence and competition

Global competition for critical technologies—particularly in areas such as semiconductors, high-performance computing (HPC), artificial intelligence (AI), quantum, connectivity, space, and cybersecurity—continues to intensify. These domains lie at the heart of modern societies, driving both civilian and military capabilities. As digital and green transitions gain momentum, nations must secure access to these technologies to sustain their industrial base and protect critical infrastructure. Moreover, rapid technological convergence—where breakthroughs in one domain immediately bolster advances in others—has elevated the importance of cross-sector collaboration and integrated policy approaches.

### The EU's positioning: Fostering open strategic autonomy

The European Union seeks to balance openness and security through strategic initiatives that reduce vulnerabilities in essential tech domains. Recognising that no single Member State can achieve full self-reliance, the EU's approach emphasises collaborative innovation, reliable value chains, partnerships with like-minded countries, and alignment with broader policy frameworks like the Chips Act and emerging legislation on quantum and AI. Increasingly, the EU looks to Member States for leadership in building robust, future-proof digital ecosystems. In response, Finland has prioritised cutting-edge research, industrial capabilities and collaborative practices that can be scaled up across Europe.

## Finland's strengths and contributions: A trusted driver of innovation

Finland's leadership in critical digital technologies is underpinned by decades of investment in research, world-class education, and synergistic industry structures. Notable strengths include:

- **Semiconductor technologies:** Through the Chips from the North strategy, Finland aims to triple semiconductor-related revenue by 2035, bolstered by strong pilot lines and specialised expertise in advanced materials, process technologies, micro-electromechanical systems, photonics and chip design.
- **High-performance computing:** Finland hosts LUMI, one of Europe's most powerful supercomputers, enabling breakthroughs in AI development, climate modeling, and more. Seamless integration between quantum computing and HPC further cements Finland's reputation as a testbed for convergent technologies.
- **Artificial intelligence:** From Europe's first AI strategy (2017) to the thriving AI startup scene, Finland excels in AI research, talent development, and multilingual large-model training. High-profile success stories and acquisitions underscore the global competitiveness of Finnish AI ventures.
- **Quantum technologies:** Building on strong cryophysics and superconducting chip expertise, Finland's quantum sector is expected to expand rapidly, supported by initiatives like Kvanttinova. This enables the country to be a leading contributor to Europe's quantum ecosystem.
- **Connectivity technologies:** As a pioneer in 5G and 6G research, Finland combines telecommunications know-how, AI-powered networks, and semiconductor innovation. Industry champions such as Nokia drive both global standardisation and open network architectures.
- **Space technologies:** Finland's growing space sector—driven by agile startups and strategic investments in satellite technologies and ground infrastructure—supports digital connectivity, climate monitoring, and secure communications.
- **Cybersecurity:** As digital threats grow more complex, Finland's cybersecurity expertise reinforces Europe's resilience through trusted solutions in threat detection, secure infrastructure, quantum-safe cryptography, and privacy technologies.

## Policy recommendations for the EU: Strengthening common levers for technological leadership

This policy brief recommends a focused set of EU-level actions to strengthen Europe's competitiveness in critical digital technologies. The proposals below aim to boost company-led innovation, attract global talent, modernise regulation, and enhance strategic capabilities across the tech ecosystem:

1. Company-led approach to EU RDI funding
2. Excellence-driven EU budget for critical digital technologies
3. European Critical Tech Fund
4. Europe as the primary destination for global tech talent
5. Future-fit EU tech regulation
6. Innovative procurement of critical digital technologies
7. EU leadership in standardisation for critical digital technologies
8. Europe's global influence through secure digital infrastructure

Together, these actions would enable the EU to more effectively mobilise private capital, accelerate technology deployment, and reinforce its position as a global leader in digital innovation.

## Policy recommendations for Finland: Mobilising national capabilities for strategic impact

At the national level, this policy brief proposes targeted measures to strengthen Finland's position in critical digital technologies. The following actions focus on scaling strategic collaboration models, attracting top talent, boosting investment, and aligning defence and digital innovation agendas:

1. Expansion of the Lead Company Model for development and convergence of critical digital technologies
2. Finnish framework for attracting and retaining global tech talent
3. Increased investments in Finland's critical digital tech ecosystem
4. Alliance-based funding model for critical technology data ecosystems
5. AI-native software development for critical digital technologies
6. Enhanced RDI focus in the Finnish defence budget

Through these measures, Finland both advances its own technological edge and contributes to the EU's broader objectives in digital resilience and sustainable growth.

## Public-private collaboration in Finland: Toward shared foresight and faster scale-up

Finland's long-term success in critical technologies depends on deep, sustained collaboration between government, industry, and research institutions. As global competition intensifies, fostering public-private alignment is essential to ensure strategic coherence and agile decision-making. To this end, this policy brief proposes the creation of dedicated platforms that promote shared vision-building, policy leadership, and coordinated national action:

1. Policymaker tech leadership program
2. Critical Tech Forum
3. Critical Tech Summit
4. Prime Minister's roundtable on critical technologies
5. Finnish Critical Tech Playbook

These measures aim to break down silos, accelerate trust-building, and ensure that Finland speaks and acts with one voice where it matters. By embedding structured collaboration into the national ecosystem, they strengthen Finland's ability to anticipate emerging trends, mobilise resources effectively, and lead with credibility in international arenas.

## About this policy brief

This policy brief provides a comprehensive overview of Finland's role in critical digital technologies and its alignment with EU strategic priorities. It explores:

- Why certain technologies are considered critical, focusing on their role in growth, security and geopolitical competition, and how technological convergence is reshaping innovation while prompting Europe to strengthen capabilities and reduce dependencies (Chapter 3).
- Finland's alignment with EU policies and strategic priorities, highlighting how Finland supports European technology sovereignty, economic security and competitiveness, while also actively engaging in international partnerships beyond the EU to strengthen global cooperation in critical technologies (Chapter 4).
- Finland's unique strengths in critical digital technologies, detailing the country's leadership in seven areas: semiconductors, high-performance computing, AI, quantum technologies, connectivity, space technologies, and cybersecurity (Chapter 5).
- Recommendations for policymakers and stakeholders, offering insights on how the EU and Finland can further strengthen their technological leadership and competitiveness in an increasingly complex global landscape (Chapter 6).
- Proposals for public-private collaboration in Finland, exploring how government, industry, and other stakeholders could work together to enhance the country's role in the critical technology landscape (Chapter 7).

By addressing these themes, the policy brief aims to inform decision-makers, industry leaders, and others about the importance of Finland's contributions to Europe's critical technology ecosystem—and how the right policies can strengthen and elevate it to the next level.

## CRITICAL DIGITAL TECH FROM FINLAND:

# Driving growth and security in Europe

Unique capabilities in quantum-safe cryptography, secure comms, and AI-driven threat detection.

Rapidly growing space sector with strong satellite expertise, innovative startups, and key role in EU space programs.

Leader in 6G development, with strong wireless research, edge cloud expertise, and Nokia driving global telecom innovation.

Top tier research, dense startup ecosystem, and leadership in applied AI and ethical frameworks.

Leading end-to-end quantum computing hub with industrial pilot line, quantum-classical integration, and superconducting chip R&D.

Home to LUMI supercomputer and AI Factory with strong integration of data, computing, and quantum systems.

Global niche leader in advanced materials, process technologies, MEMS, design, and photonics with 5 EU pilot lines hosted.

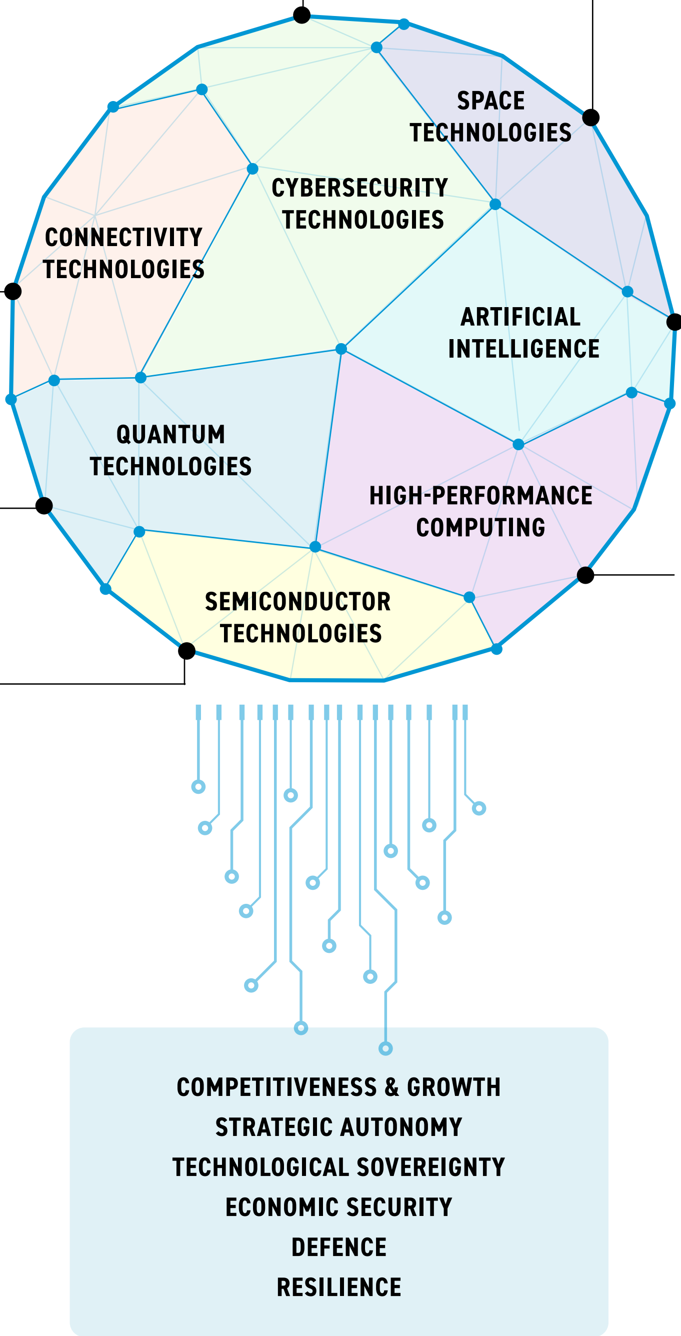



**Exhibit 1:** Finland's critical digital technology sectors and their contribution to EU objectives

# Tiivistelmä

Geopoliittisen pirstoutumisen, nopean teknologisen kehityksen ja kovenevan kilpailun aikakaudella kriittiset digitaaliset teknologiat muovaavat globaalia valta-asetelmaa ja taloudellista turvallisuutta. Tässä kontekstissa Euroopan yhteinen tavoite on vahvistaa teknologista suvereniteettiaan ja vaalia samalla kansainvälistä yhteistyötä. Suomi on vahvan osaamisensa ja innovaatiokulttuurinsa tähden keskeisessä asemassa, kun Euroopan kilpailukykyä, resilienssiä ja turvallisuutta vahvistetaan tärkeimmillä teknologiasektoreilla. Tämä julkaisu perustuu Euroopan komission määrittelemään kriittisten teknologioiden viitekehykseen, jossa tunnistetaan Euroopan strategisten etujen kannalta keskeisimmät teknologiat.

## Globaalit trendit

Kilpailu kriittisistä teknologioista – erityisesti puolijohteissa, suurteholaskennassa, tekoälyssä, kvanttiteknologiassa, tietoliikenneyhteyksissä, avaruusteknologiassa ja kyberturvallisuudessa – kiihtyy maailmanlaajuisesti. Nämä teknologiat muodostavat nyky-yhteiskuntien ytimen ja tukevat sekä siviili- että sotilaskapasiteetteja. Kun digitaalinen ja vihreä siirtymä etenee, valtiot pyrkivät turvaamaan pääsyn näihin teknologioihin teollisuutensa ja kriittisen infrastruktuurinsa suojaamiseksi. Teknologinen konvergenssi, jossa edistysaskeleet yhdellä alalla kiihdyttävät kehitystä toisilla, lisää yhteistyön ja toisiaan täydentävien politiikkatoimien merkitystä.

## EU:n asemoituminen

Euroopan unioni pyrkii tasapainottamaan avoimuutta ja turvallisuutta toimilla, jotka vähentävät haavoittuvuuksia kriittisillä teknologiasektoreilla. Koska mikään jäsenvaltio ei voi olla teknologisesti täysin omavarainen, EU:n lähestymistapa korostaa yhteistyöhön perustuvaa innovointia, luotettavia arvoketjuja, kumppanuuksia samanmielisten maiden kanssa sekä unionin laajuisia politiikkakehyksiä ja säädöksiä. Yhä useammin EU katsoo jäsenvaltioiden suuntaan, kun se tavoittelee johtoasemaa digitaalisissa ekosysteemeissä. Suomi on osaltaan panostanut huippututkimukseen, teollisiin kyvykkyyksiin ja yhteistyömalleihin, joita voidaan skaalata koko Euroopan laajuisesti.

## Suomen vahvuudet ja panos

Suomen johtoasema kriittisissä digiteknologioissa perustuu vuosikymmenten tutkimuspanostuksiin, korkeatasoiseen koulutukseen ja synergiaa luoviin toimialarakenteisiin. Keskeisiä vahvuuksia ovat:

- **Puolijohdeteknologiat:** Chips from the North -strategialla Suomi tähtää sirualansa kolminkertaistamiseen vuoteen 2035 mennessä. Tavoitetta tukevat vahvat pilottilinjat sekä erityisosaaminen kehittyneissä materiaaleissa, prosessitekniikoissa, mikroelektromekaanisissa järjestelmissä, fotoniikassa ja sirusuunnittelussa.
- **Suurteholaskenta:** Suomi ylläpitää LUMI-supertietokonetta, joka on yksi Euroopan tehokkaimmista. Se mahdollistaa läpimurtoja muun muassa tekoälykehityksessä ja ilmastomallinnuksessa. Kvantti- ja suurteholaskennan yhdistäminen vahvistaa Suomen asemaa toisiaan lähentyvien teknologioiden koekenttänä.
- **Tekoäly:** Ensimmäisen eurooppalaisen tekoälystrategian (2017) laatinut Suomi on edelläkävijä tekoälytutkimuksessa, osaajakehityksessä ja monikielisten tekoälymallien koulutuksessa. Menestyksekkäät startupit ja yritysostot korostavat suomalaisten tekoälytoimijoiden globaalia kilpailukykyä.
- **Kvanttiteknologiat:** Suomen kvanttiala kasvaa nopeasti hyödyntäen vahvaa kryofysiikan ja suprajohtavien sirujen osaamista sekä aloitteita kuten Kvanttinova. Suomi on keskeinen toimija Euroopan kvanttiekosysteemissä.
- **Tietoliikenneteknologiat:** Suomi on 5G- ja 6G-tutkimuksen edelläkävijä. Tieto- ja viestintäteknologian osaaminen yhdistyy tekoälypohjaisiin verkkoihin ja puolijohdeinnovaatioihin. Nokian kaltaiset toimijat johtavat standardointia ja avoimien verkkoarkkitehtuurien kehitystä.
- **Avaruusteknologiat:** Suomen kasvava avaruussektori ja sen ketterät startupit ja satelliitti- sekä maa-asematekniikkaan kohdistuvat investoinnit tukevat konnektiviteettia, ilmastoseurantaa ja turvallista viestintää.
- **Kyberturvallisuus:** Kasvavien digitaalisten uhkien aikakaudella Suomen kyberturvaosaaminen tukee Euroopan resilienssiä muun muassa uhkien havaitsemisessa, turvallisessa infrastruktuurissa, kvanttisalauksessa ja yksityisyysteknologioissa.

## EU:n politiikkasuositukset

Tämä julkaisu suosittelee kohdennettuja EU-tason toimia, joilla parannetaan Euroopan kilpailukykyä kriittisissä digiteknologioissa. Suositellut toimenpiteet keskittyvät yrityslähtöiseen innovaatioon, huippuosaajien houkutteluun, sääntelyn modernisointiin ja strategisten kyvykkyyksien kehittämiseen:

1. Veturiyritysmalli EU:n TKI-rahoitukseen
2. Kriittisiin digiteknologioihin painottuva, huippuosaamiseen perustuva EU-budjetti
3. Euroopan kriittisen teknologian rahasto
4. Eurooppa kansainvälisten teknologiaosaajien ensisijaisena kohteena
5. Tulevaisuuden kestävä EU-sääntely kriittisille teknologioille
6. Innovatiiviset julkiset hankinnat kriittisissä teknologioissa
7. Johtoasema teknologioiden standardoinnissa
8. Globaali vaikutusvalta turvallisten digitaalisten infrastruktuurien kautta

Näiden toimien avulla EU voi paremmin mobilisoida yksityistä pääomaa, nopeuttaa teknologioiden käyttöönottoa ja vahvistaa asemaansa globaalina innovaatiojohtajana.

## Suomen politiikkasuositukset

Julkaisu esittää seuraavat kansalliset toimenpiteet Suomen aseman vahvistamiseksi kriittisten digiteknologioiden alalla. Ne keskittyvät skaalautuvien yhteistyömallien rakentamiseen, huippuosaajien houkutteluun, investointien lisäämiseen sekä puolustuksen ja digitaalisten innovaatioiden yhteensovittamiseen:

1. Veturiyritysmallin laajentaminen kriittisten teknologioiden kehittämiseen ja konvergenssiin
2. Suomen malli globaalin teknologiaosaamisen houkutteluun ja pitovoimaan
3. Lisää investointeja kriittisten digiteknologioiden ekosysteemiin
4. Allianssipohjainen rahoitusmalli kriittisten teknologioiden dataekosysteemeille
5. Tekoälylähtöinen ohjelmistokehitys kriittisissä teknologioissa
6. TKI-panostusten vahvistaminen puolustusbudjetissa

Näillä toimilla Suomi sekä vahvistaa omaa teknologista edelläkävijyyttään että tukee EU:n tavoitteita digitaalisessa suvereniteetissa, resilienssissä ja kestävän kasvun edistämisessä.

## Julkisen ja yksityisen yhteistyö Suomessa

Suomen menestys kriittisissä teknologioissa riippuu tiiviistä ja pitkäjänteisestä yhteistyöstä valtion, elinkeinoelämän ja tutkimuslaitosten välillä. Globaali kilpailu edellyttää strategista yhtenäisyyttä ja ketterää päätöksentekoa. Tämän tueksi julkaisu ehdottaa seuraavia yhteistyömuotoja:

1. Päättäjien teknologiavalmennusohjelma
2. Kriittisten teknologioiden foorumi
3. Kriittisten teknologioiden lippulaivatapahtuma
4. Pääministerin kriittisten teknologioiden pyöreä pöytä
5. Suomen kriittisten teknologioiden pelikirja

Tavoitteena on purkaa siiloja, rakentaa luottamusta ja varmistaa, että Suomi puhuu ja toimii yhdellä äänellä. Vahvoille rakenteille perustuva yhteistyö parantaa kykyä ennakoida, saattaa liikkeelle resursseja ja johtaa uskottavasti myös kansainvälisesti.

## Julkaisun jäsennys

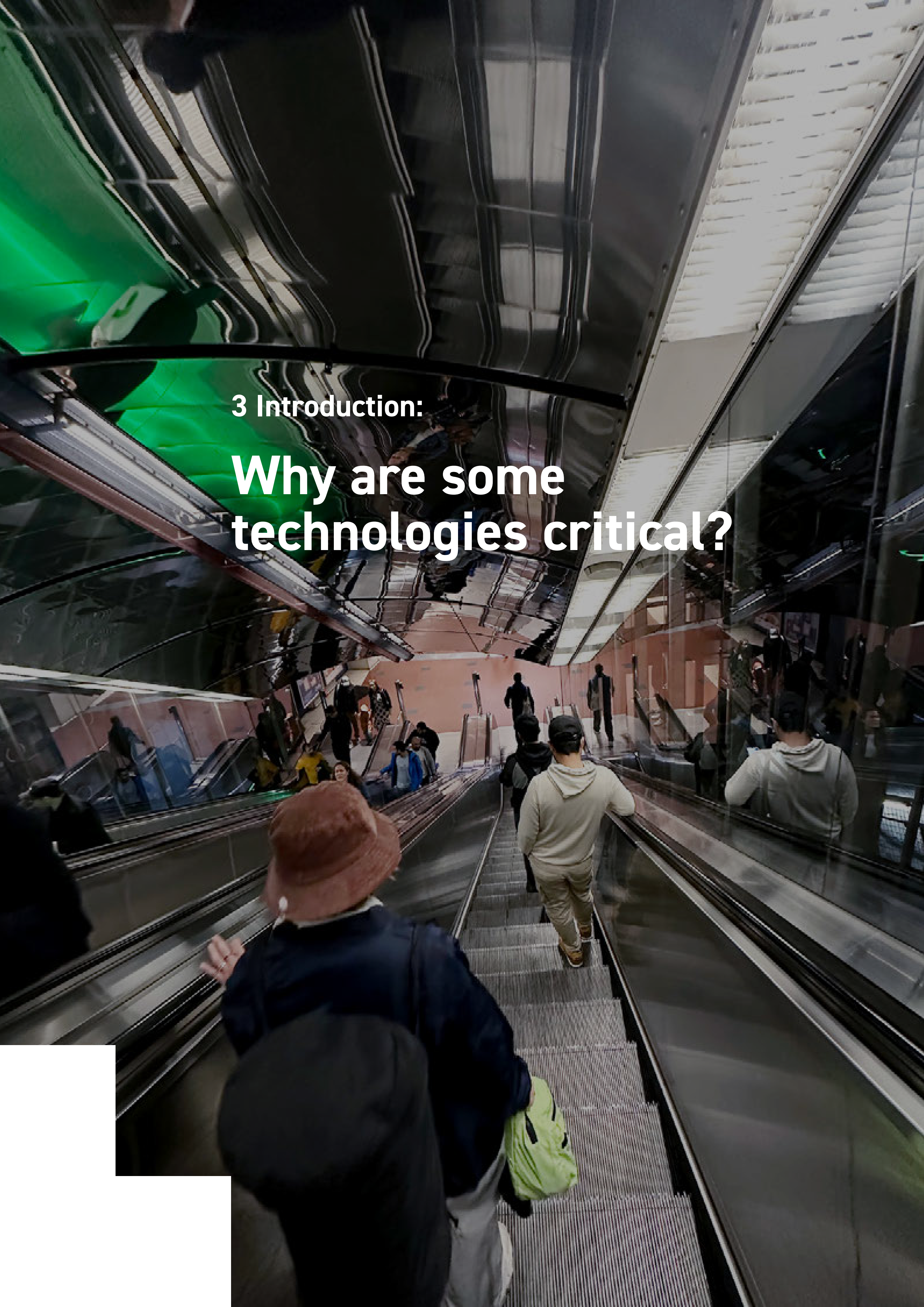
Tämä julkaisu tarjoaa kokonaisvaltaisen katsauksen Suomen rooliin kriittisissä digiteknologioissa ja siihen, miten se vastaa EU:n strategisiin tavoitteisiin. Se tarkastelee:

- Miksi tietyt teknologiat ovat kriittisiä kasvun, turvallisuuden ja geopoliittisen kilpailun kannalta sekä miten teknologinen konvergenssi muuttaa innovaatiodynamiikkaa (luku 3).
- Miten Suomi tukee EU:n teknologisen suvereniteetin, taloudellisen turvallisuuden ja kilpailukyvyn tavoitteita sekä osallistuu kansainväliseen yhteistyöhön myös EU:n ulkopuolella (luku 4).
- Suomen erityisvahvuudet seitsemällä teknologiasektorilla: puolijohteet, suurteholaskenta, tekoäly, kvanttiteknologiat, tietoliikenneteknologiat, avaruusteknologiat ja kyberturvallisuus (luku 5).
- Suositukset päättäjille ja sidosryhmille siitä, miten EU ja Suomi voivat vahvistaa teknologista johtajuuttaan ja kilpailukykyään (luku 6).
- Julkisen ja yksityisen sektorin yhteistyömahdollisuudet Suomessa kriittisten teknologioiden kehityksen edistämiseksi (luku 7).

Julkaisu pyrkii tarjoamaan tietoa ja suuntaviivoja päätöksentekijöille, elinkeinoelämälle ja muille toimijoille siitä, miten Suomi voi entistä vahvemmin tukea Euroopan kriittistä teknologiakehitystä – ja miten oikeilla politiikkavalinnoilla tämä potentiaali voidaan lunastaa.

## 3 Introduction:

# Why are some technologies critical?



In an era of relentless technological progress, escalating geopolitical rivalries and trade wars, certain technologies emerge as indispensable pillars of economic prosperity and resilience, national security, and societal well-being. Technologies such as artificial intelligence, semiconductors, and advanced connectivity are not just enablers of modern economies—they are the very backbone of digital transformation, powering innovations that redefine industries and reshaping the balance of global influence. Their dual-use nature, spanning both civilian and military domains, underscores their strategic significance.

Take quantum computing, for example. Its potential breakthroughs in cybersecurity, medicine, and materials science are poised to grant nations a decisive edge in global markets and critical infrastructure protection. Yet, this importance makes these technologies potential flashpoints in international power struggles. Critical technologies provide strength and stability to societies, but they also reveal weak spots—vulnerabilities exposed to economic pressures, trade dependencies, and security risks. Furthermore, dependencies in critical technologies should be analysed through their entire value chains, since the availability of critical materials and components is essential for strategic autonomy.

As the technological landscape evolves, a new phenomenon is reshaping the way we understand innovation and governance: technological convergence. The boundaries between once-discrete fields are dissolving, challenging the traditional siloed approach to policy and strategy. Technological convergence appears once previously isolated technologies become interlinked and functional together, developing into new applications. This shift is not merely academic; it is redefining the frontier of global competition.

Emerging hybrid fields, such as quantum-AI, illustrate this transformation. Advanced AI models of the future will not only be enhanced by quantum computing but will also require it to unlock unprecedented capabilities. Similarly, the development of 6G networks will benefit a seamless fusion of quantum and AI technologies. The governance of technological convergence emphasises complementarity and interdependence of technological fields, including data, talent and techniques. The aim of the approach is to create hybrid solutions that can be effectively implemented and scaled.

For nations seeking to maintain an edge in global markets, technological convergence is no longer an abstract concept—it is a defining force that will shape the next era of innovation. Forward-thinking governance frameworks must adapt to this reality, fostering collaboration across disciplines while anticipating new risks.

Against this backdrop, the European Union is sharpening its focus on technological sovereignty, as it currently relies heavily on imported digital infrastructure and technologies. Europe's fragmented digital landscape complicates progress, underscoring the importance of a unified effort. Finland—home to a strong deep-tech ecosystem—is well-positioned to contribute to this shift. Europe's ability to harness this technological interplay will be crucial as it strives to reduce reliance and to secure a leading position in the critical technologies of tomorrow.

## Navigating the global landscape: Key drivers, trends, and Europe's imperative

The global landscape for critical technologies is shaped by several major forces. In an increasingly multipolar world, technological capabilities are becoming crucial instruments of both economic and political power. Simultaneously, the European Union faces unique challenges tied to its past assumptions, present pressures, and future ambitions. The following points capture the overarching trends while highlighting Europe's position:

- **Geopolitical fragmentation:** Heightened competition among major powers is driving technological rivalries and trade conflicts. As the perception of shared values erodes, Europe is forced to reevaluate its international partnerships and to ensure that its strategic autonomy is not compromised by the heavy outsourcing of technology and resulting skill gaps.
- **Security and competitiveness:** Governments worldwide are prioritising resilience and self-sufficiency in key technology sectors. Fragmented EU funding and reluctance at the national level to commit to clear technology choices have hampered Europe's competitiveness, despite Europe's strong—but narrowly specialised—pockets of expertise.
- **Digital and green transitions:** Critical technologies underpin the shift to both digitalisation and sustainability, ranging from AI-driven automation to green-tech innovation. However, short-term threats such as Russian invasion of Ukraine are increasingly displacing the focus on longer-term risks like climate change, redirecting resources and compromising sustainability policy agendas.
- **Technology rivalries and convergence:** The strategic competition between the US and China, especially in AI and semiconductors, illustrates how technological leadership determines global influence. Europe's response involves not only strengthening its own capabilities in emerging fields but also recognising that many of these technologies share talent, infrastructures, and resources, thereby creating interdependent ecosystems rather than standalone sectors.
- **Competition for talent and overcoming skill bottlenecks:** Deep expertise is essential for the development of critical digital technologies. Yet Europe's talent pipeline has not kept pace with growing demand, partly due to a cultural hesitancy to take risks. Public and private actors must collaborate to broaden expertise beyond a narrow group of high performers and address persistent skill shortages.
- **Return of industrial policy and defense-driven R&D:** The emphasis on competitiveness and security has sparked renewed interest in industrial policy and defense-related R&D, fueling discussions around a 'European DARPA'. Historically, conflicts have propelled technological breakthroughs, underscoring the importance of consistent, well-funded innovation ecosystems that can respond to both immediate security concerns and long-term strategic needs.
- **Data and digital resilience:** As technologies develop, end-to-end supply chains, control over data, and the protection of data from unauthorised access or destruction become increasingly crucial. Strengthening Europe's hold on digital infrastructure, critical materials and data, from hardware to software, will be pivotal in ensuring strategic autonomy.
- **Global partnerships and new frontiers:** While the US and China dominate technology headlines, India's growing role (e.g., the India Stack, semiconductor ambitions) also demands attention.

In this evolving environment, Europe's future success hinges on recognising the interlinked nature of emerging technologies, establishing an inclusive innovation culture, and articulating clear strategic choices.

## The EU's approach to critical technologies

The European Union has responded to these challenges by advancing a plethora of policies that balance openness and security, aiming to reduce strategic dependencies while maintaining its role as a global economic power. This approach is shaped by several key policy concepts.

- **Technological sovereignty:** Ensuring Europe retains the ability to develop and control critical technologies without undue reliance on external actors. This does not mean developing all technologies independently, but rather ensuring access to key technologies that are not the EU's strengths.
- **Open strategic autonomy:** Striking a balance between technological self-sufficiency and global collaboration to secure supply chains and maintain competitiveness.
- **Economic security:** Safeguarding the EU's industrial base, mitigating external dependencies, and preventing the weaponisation of economic linkages.
- **Security and defence:** Recognising the dual-use nature of many critical technologies, with growing investment in capabilities that enhance both economic and military resilience.

The interplay between critical technologies, economic resilience, and geopolitical pressures presents a difficult balancing act for the European Union and its Member States. Efforts to reduce dependencies risk stifling innovation and isolating Europe from valuable global partnerships. Yet overreliance on external actors leaves the bloc vulnerable to supply chain disruptions and strategic coercion.

How can the EU pursue technological leadership while preserving openness where it matters? Can industrial policy, trade strategy, and security concerns be aligned without creating inefficiencies or unintended consequences? As the landscape evolves, finding the right equilibrium will determine Europe's ability to remain both resilient and competitive.

### THE EU'S LIST OF 10 CRITICAL TECHNOLOGY AREAS

The European Commission has identified ten critical technology areas as essential for economic security and is conducting further risk assessments on them. These areas are enabling and transformative, with potential for civil–military fusion. This policy brief focuses on the highlighted digital technologies.

1. **Advanced semiconductors:** Microelectronics, photonics, high-frequency chips, and semiconductor manufacturing equipment.
2. **Artificial intelligence:** HPC, cloud/edge computing, data analytics, computer vision, and language processing.
3. **Quantum technologies:** Quantum computing, cryptography, communications, and sensing.
4. **Biotechnologies:** Genetic modification, new genomic techniques, gene drive, and synthetic biology.
5. **Advanced connectivity & digital technologies:** 6G, cybersecurity, IoT, virtual reality, digital identity, and navigation.
6. **Advanced sensing:** Electro-optical, radar, chemical, biological, and underwater sensing.
7. **Space & propulsion:** Space surveillance, PNT, secure communications, and hypersonics.
8. **Energy technologies:** Nuclear fusion, hydrogen, net-zero tech, smart grids, and energy storage.
9. **Robotics & autonomous systems:** AI-driven drones, exoskeletons, and robot-controlled precision systems.
10. **Advanced materials & manufacturing:** Nanomaterials, additive manufacturing, and recycling of critical raw materials.

## Finland's position and contribution

With deep expertise in several key technology areas which underpin digital societies, Finland plays a vital role in strengthening European resilience and competitiveness. Finnish companies and research institutions contribute significantly to innovation in artificial intelligence, high-performance computing as well as quantum computing, semiconductors, telecommunications, and cybersecurity, aligning with the EU's strategic objectives. Furthermore, Finland's strong emphasis on technological trustworthiness and sustainability enhances Europe's ability to develop reliable and competitive digital solutions.

As global power dynamics shift, Finland is well-positioned to strengthen the EU's technological sovereignty while remaining an active player in international partnerships. Through strategic investments, policy leadership, and industrial collaboration, Finland reinforces its role as a key contributor to Europe's critical technology landscape.

### FINLAND:
### A RISING HUB FOR DEEP TECH

Finland's deep tech sector is experiencing strong growth, with €363 million in venture capital and growth investments in 2024, a 41% increase from the previous year. Major funding rounds have focused on quantum computing, AI, semiconductors, and sustainable materials. Deep tech refers to breakthrough technologies based on advanced scientific research and engineering. Many of these deep tech fields—such as AI, quantum technologies, and semiconductors—are also classified as critical technologies, meaning they are considered essential for economic resilience and national security. In practice, most critical technologies originate in deep-tech research and development. These innovations often require long-term development but have the potential to transform industries. (Tesi: Deep Tech Study Finland 2024.)

## 4 The Critical Core:

# Finland’s alignment with EU policies and readiness for international partnerships

Europe's future competitiveness hinges on the seamless integration, development, and commercialisation of artificial intelligence (AI), high-performance computing (HPC), semiconductors, quantum technologies, space technologies, connectivity, and cybersecurity, ensuring these innovations transition effectively to new competences, research excellence, industrial adoption and societal impact. Together, these technologies form what this policy brief defines as the Critical Core—strategic technological building blocks essential for Europe's competitiveness, economic resilience, and security. By boosting and aligning these domains, Europe can reduce dependencies and strengthen its position in global markets.

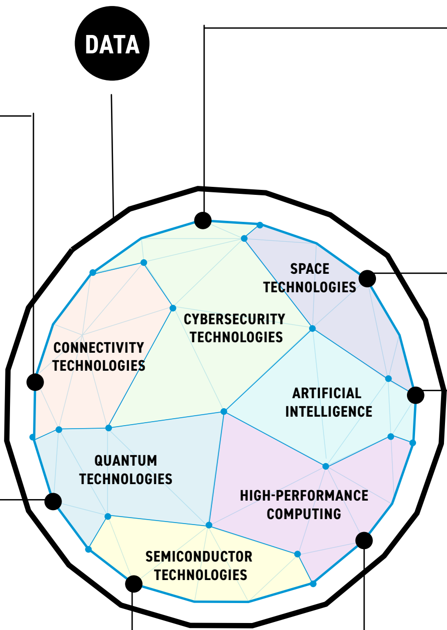
## Synergies across critical digital technologies

These critical digital technologies form a mutually reinforcing ecosystem, where convergence—the deep integration and interdependence of different technological domains—amplifies capabilities and accelerates innovation. See the graph below for an illustration of the Critical Core and how these domains intersect. Advances in one area, such as AI, are not isolated but instead drive progress in others.

At the core of these technological advancements lies **data**—its availability, quality, and security directly impact the effectiveness of AI models, the performance of HPC systems, and the reliability of quantum and secure communications. Europes ability to process and utilise massive datasets while ensuring data sovereignty will be instrumental in allowing industries to fully harness the potential of interconnected digital technologies.

**Cybersecurity** serves as a cross cutting enabler, safeguarding all layers of this interconnected ecosystem. AI-driven threat detection, quantum-resistant encryption, and secure-by-design semiconductor architectures will be crucial to ensuring Europe's digital resilience in an era of increasing cyber risks and geopolitical uncertainty.

**Connectivity**, including 5G and future 6G networks, acts as a backbone for real time AI applications, industrial automation, and secure digital infrastructure. Ultra reliable, low latency communications will accelerate edge AI, smart manufacturing, and autonomous systems, with direct implications for cybersecurity, quantum communications, and next generation computing.




**Space technologies** provide a critical infrastructure for global connectivity, earth observation, and AI-driven analytics. The fusion of AI with satellite imagery enhances climate monitoring, disaster response, and autonomous navigation, while space-based quantum encryption will play a key role in securing global communications.

**Quantum computing** and communications hold the potential to revolutionise problem solving, encryption, and secure networks, benefiting from HPC, AI, and next generation connectivity. Quantum computers, in synergy with AI, will address optimisation challenges in logistics, materials science, and drug discovery, while quantum-secured networks will redefine the security architecture of Europe's digital backbone.

**Artificial intelligence (AI)** relies on high-performance computing (HPC) and advanced semiconductors to process vast datasets, simulate complex models, and develop next-generation AI systems. Breakthroughs in AI architectures, such as neuromorphic computing, further drive the demand for specialised semiconductors and scalable computing power.

**Semiconductors** are the foundation of all digital technologies, with their fabrication and supply chain playing a decisive role in ensuring technological sovereignty. Advances in semiconductor manufacturing will enhance AI efficiency, quantum-processing capabilities, and ultra-secure communication networks.

**High-performance computing (HPC)** fuels AI model training, quantum simulations, and secure communications, requiring cutting-edge semiconductor architectures optimised for massive computational workloads. As HPC infrastructure evolves, it enables faster AI-driven scientific discovery, financial modeling, and climate simulations, reinforcing Europe's technological edge.

**Exhibit 2:** Synergies across critical digital technologies

- **Artificial intelligence (AI)** relies on **high-performance computing (HPC)** and **advanced semiconductors** to process vast datasets, simulate complex models, and develop next-generation AI systems. Breakthroughs in AI architectures, such as neuromorphic computing, further drive the demand for specialised semiconductors and scalable computing power.
- **High-performance computing (HPC)** fuels AI model training, **quantum simulations,** and **secure communications,** requiring cutting-edge **semiconductor architectures** optimised for massive computational workloads. As HPC infrastructure evolves, it enables faster AI-driven scientific discovery, financial modeling, and climate simulations, reinforcing Europe's technological edge.
- **Semiconductors** are the foundation of all digital technologies, with their fabrication and supply chain playing a decisive role in ensuring **technological sovereignty.** Advances in semiconductor manufacturing will enhance AI efficiency, quantum processing capabilities, and ultra-secure communication networks.
- **Quantum computing and communications** hold the potential to revolutionise **problem-solving, encryption, and secure networks,** benefiting from **HPC, AI, and next-generation connectivity.** Quantum computers, in synergy with AI, will address optimisation challenges in logistics, materials science, and drug discovery, while quantum-secured networks will redefine the security architecture of Europe's digital backbone.
- **Space technologies** provide a critical infrastructure for **global connectivity, earth observation, and AI-driven analytics.** The fusion of AI with satellite imagery enhances climate monitoring, disaster response, and autonomous navigation, while space-based quantum encryption will play a key role in securing global communications.
- **Connectivity, including 5G and future 6G networks,** acts as a backbone for **real-time AI applications, industrial automation, and secure digital infrastructure.** Ultra-reliable, low-latency communications will accelerate **edge AI,** smart manufacturing, integrated sensing, communications and computing, and autonomous systems, with direct implications for cybersecurity, quantum communications, and next-generation computing.
- **Cybersecurity** serves as a **cross-cutting enabler,** safeguarding all layers of this interconnected ecosystem. Governing the cybersecurity risks of digital products, software, information systems, and communication networks is essential for maintaining trust, processes, and services in a digitalised society. AI-driven cybersecurity risk management and response, quantum-resistant encryption, and secure-by-design software and hardware—from semiconductor architectures to life-support systems in hospitals—will be crucial for ensuring Europe's digital resilience amid growing cyber risks and geopolitical uncertainty. AI can be misused to create convincing fake information and sophisticated cyberattacks, posing risks even in legitimate applications. This highlights the urgent need for robust solutions to ensure digital content authenticity, security, and trust.
- At the core of these technological advancements lies **data**—its availability, quality, and security directly impact the effectiveness of AI models, the performance of HPC systems, and the reliability of quantum and secure communications. Europe's ability to process and utilise massive datasets while ensuring data sovereignty will be instrumental in allowing industries to fully harness the potential of interconnected digital technologies. Compliance with European common criteria-based cybersecurity certification scheme ensures high security level of ICT products and services.

By capitalising on these synergies, Europe can develop a self-sustaining innovation ecosystem, where cross-sector collaboration drives exponential technological progress. Strengthening public-private partnerships, R&D investments, and strategic value chains will be key to harnessing these interconnections and reinforcing Europe's leadership in critical digital technologies. With considerable strengths in all of these critical domains, Finland is uniquely positioned to leverage these interconnections for the country's industrial leadership and to the EU's benefit throughout the Critical Core.

(c) Fade Creative

## AN EXAMPLE OF TECH CONVERGENCE: LUMI AI FACTORY

The LUMI AI Factory is a one-stop hub supporting AI startups, SMEs, and researchers with everything they need—from powerful computing resources to expert guidance and training. It helps both public and private users build advanced AI models and applications.

A key strength of LUMI lies in the convergence of AI, high-performance computing, advanced data services, and experimental quantum technologies. Users get access to top-tier computing (including GPUs and the LUMI-IQ quantum platform), fast storage, and a fast track for high-potential startups. Data services include hosted and dynamic datasets, tools for managing and scaling AI projects, and a cloud-like data environment.

Beyond tech, the Factory prioritises people. It offers tailored training, partnerships with AI centres, co-working and student spaces, and company consulting—from feasibility checks to regulatory guidance.

The bigger goal is to build widespread AI capabilities in Europe. Through integrating HPC, AI, and quantum computing, LUMI aims to keep Europe at the forefront of innovation, research leadership, and the growth of new industries.

| ↘ Enables / Depends on | AI | HPC | Semiconductors | Quantum | Space | Connectivity | Cybersecurity | Data |
|---|---|---|---|---|---|---|---|---|
| **AI** | — | Needs large-scale training on supercomputers | Drives demand for specialised chips | Supplies error-mitigation and optimisation algorithms for quantum devices | Provides on-board analytics and autonomy for satellites | Generates traffic for 'edge AI' in 5G/6G cells | Powers adaptive threat-detection and response tools | Requires plentiful, high-quality datasets |
| **HPC** | Accelerates AI model training and inference | — | Depends on cutting-edge semiconductor nodes | Performs quantum-system simulation and error-correction workloads | Crunches vast Earth-observation datasets from space missions | Feeds ultra-fast 'edge' computation close to 5G/6G base-stations | Must be shielded against intrusions and data leaks | Processes peta-byte-scale inputs |
| **Semiconductors** | Supplies AI-specific chip designs | Provides high-bandwidth memory for supercomputers | — | Enables control electronics that operate at cryogenic temperatures for quantum chips | Delivers radiation-hardened components for spacecraft | Manufactures radio-frequency front-ends for 5G/6G | Integrates secure-by-design hardware 'roots of trust' | Embeds on-chip data-protection features |
| **Quantum** | Works with AI to solve complex optimisation tasks | Uses HPC clusters for quantum-circuit simulation | Relies on ultra-pure semiconductor fabrication lines | — | Hosts space-based quantum-key-distribution links | Needs synchronised, low-latency 5G/6G channels for control | Provides quantum-safe encryption | Requires high-integrity, verified datasets |
| **Space** | AI interprets high-resolution satellite imagery | HPC fuses data from many on-orbit sensors | Uses advanced semiconductors for imaging sensors and payloads | Will carry quantum repeaters and atomic clocks | — | Offers satellite backhaul for 5G/6G in remote areas | Demands secure 'telemetry, tracking & command' links | Generates geospatial big-data streams |
| **Connectivity** | Brings real-time data to AI at the network edge | Interconnects geographically distributed HPC centres | Requires dense-input/output and phased-array radio chips | Can transport quantum keys over optical fibre or free-space links | Provides up- and down-links for mega-constellations of satellites | — | Needs end-to-end secure 'network-slicing' and 'multi-access edge computing' | Streams massive, distributed datasets |
| **Cybersecurity** | Protects the AI supply chain and trained models | Secures supercomputers, job schedulers and data | Ensures trusted semiconductor intellectual property | Develops encryption resistant to quantum attacks | Shields navigation and satellite-payload links | Hardens network slices, base-stations and edge nodes | — | Maintains data integrity, authenticity and privacy |
| **Data** | Determines AI accuracy, fairness and bias | Influences reliability of scientific simulations | Guides semiconductor process control and yield improvement | Trains hybrid quantum-classical systems | Underpins Earth-observation climate insights | Optimises traffic flow in 5G/6G cores | Needs confidentiality, provenance and verifiable lineage | — |

**Table 1:** Examples of synergies between critical digital technologies

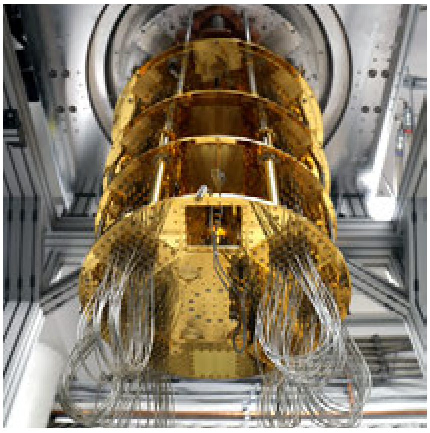
## EU and Finnish initiatives underpinning critical digital technologies

To accelerate progress in the digital domains forming the Critical Core, the EU has introduced or is preparing funding programs, regulatory frameworks, and strategies. These efforts aim to enhance Europe's technological capacity, support innovation, and ensure secure and competitive digital infrastructure.

Finland has developed its own strategic initiatives to complement and enhance EU policies, ensuring a comprehensive approach to advancing critical technologies. National efforts such as the LUMI-AI supercomputer, the Chips from the North strategy, the 6G Strategy, the AI Finland network, the ELLIS institute, and the Quantum Strategy demonstrate Finland's commitment to aligning with European measures, facilitating greater integration, collaboration, and leadership in key digital domains.

With a highly skilled workforce, a robust public-private innovation model, and a strong commitment to European collaboration, Finland serves as a testbed for emerging technologies and policy implementation. Its proactive approach to regulatory integration and investment in strategic sectors ensures that it benefits from EU initiatives and actively shapes their direction.

The illustration below maps the interplay between EU initiatives and Finland's undertakings and national strategies across the Critical Core. It outlines initiatives tied to critical technology domains while highlighting horizontal policies supporting multiple sectors.



(c) VTT

**HARDWARE AND SOFTWARE: STRATEGIC CONSIDERATIONS FOR FINLAND AND THE EU**

In critical technologies, hardware and software are deeply interconnected—hardware enables software capabilities, while software maximises hardware potential. For example, advancing fields like quantum computing and AI requires breakthroughs in both, each playing a distinct but complementary role. Software scales rapidly, driving commercial value, while hardware provides the essential foundation and long-term strategic leverage.

For Finland and the EU, investing in quantum and AI chip manufacturing could create a competitive edge that is difficult to relocate. These sectors require specialised talent, infrastructure, and processes, making them resilient to offshoring. A strong hardware ecosystem supports software development and also attracts high-skilled jobs, investment, and knowledge spillovers.

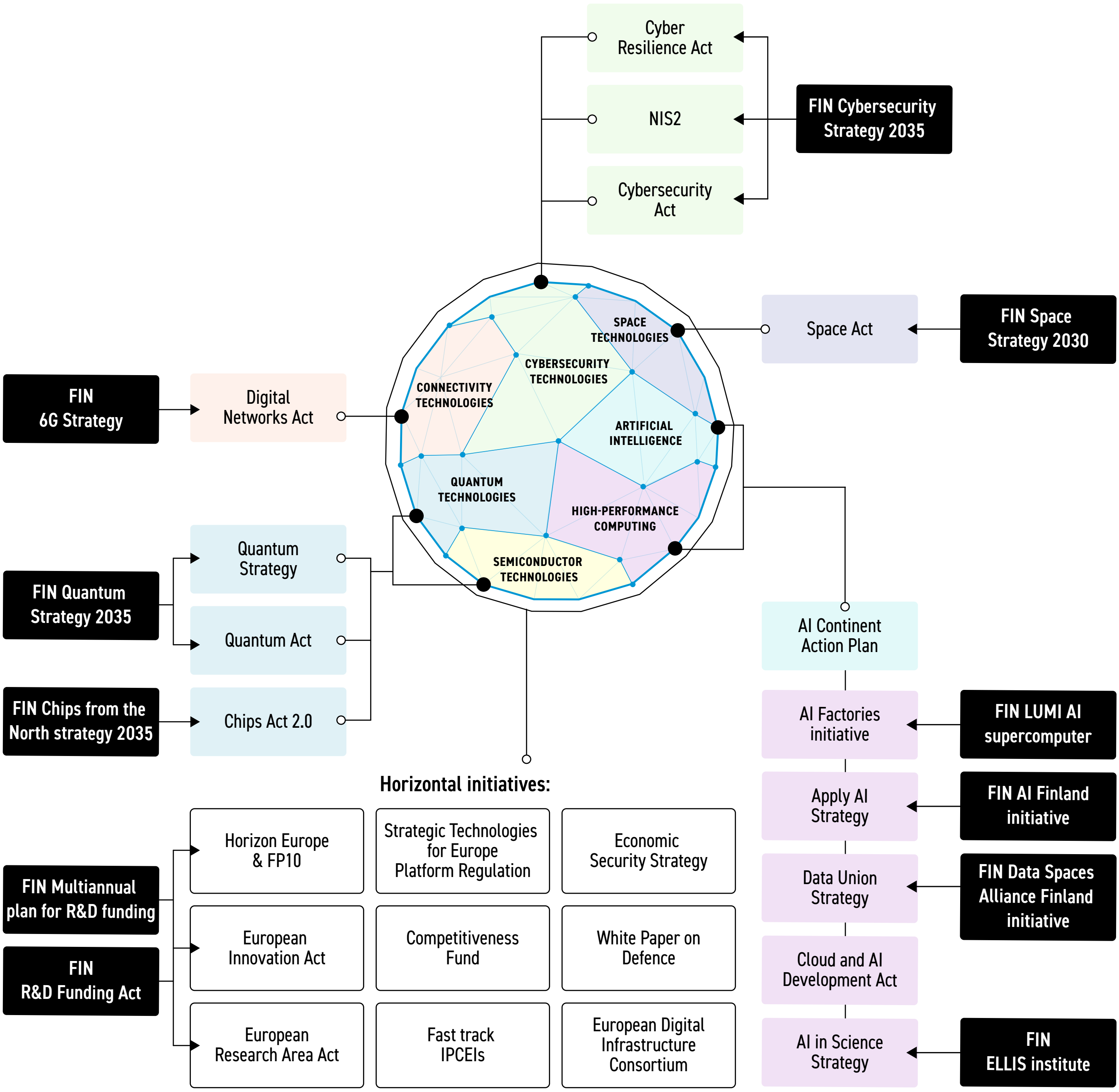
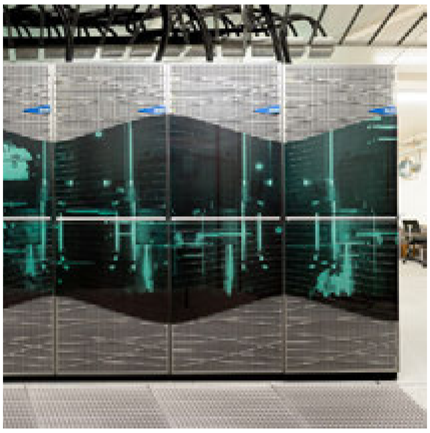



**Exhibit 3:** EU and Finnish initiatives underpinning critical digital technologies

## Finland as a trusted global partner

Finland has long been recognised as a reliable and forward-thinking partner in the global technology arena. Beyond its robust engagement within the European Union, Finland actively cultivates partnerships with key countries outside the EU. These collaborations span pivotal areas reflecting the breadth and depth of Finland's expertise. By engaging with like-minded partners around the world, Finland not only boosts its own research and development capabilities but also furthers the EU's broader strategic objectives in critical technology domains. For example, Finland is involved in international collaboration initiatives in the fields of connectivity, quantum technologies, and supercomputing.



(c) CSC

**CASE EXAMPLE**
**HANAMI: FINLAND–JAPAN COOPERATION IN SUPERCOMPUTING**

The HANAMI project (HPC Alliance for Applications and Supercomputing Innovation) is promoting HPC collaboration between the EU and Japan. Launched in March 2024 with funding from the EuroHPC Joint Undertaking, HANAMI includes joint development of HPC applications in various scientific fields, and mutual access to supercomputers in both regions to test, optimise and improve knowledge about extreme-scale architectures. This cross-utilisation enhances the performance and adaptability of HPC applications on diverse architectures, thereby strengthening the EU's position in critical technologies. CSC, Finland's IT Center for Science, plays a significant role in HANAMI. CSC participates in scientific projects on climate and weather modeling and biomedicine and leads the development of a sustainable HPC collaboration roadmap between Europe and Japan.

# 5
# Finland's unique strengths in critical digital technologies

Finland's edge in critical digital technologies is no accident. Decades of strategic investment, world-class research, and deep-rooted industrial expertise have positioned the country as a leader in fields ranging from semiconductors and high-performance computing to AI, quantum, and cybersecurity. Its legacy in connectivity and emerging strengths in space technologies further reinforce its role in shaping the digital infrastructure of the future. The following section explores Finland's unique advantages in these domains—and how they can be leveraged for European and global impact.

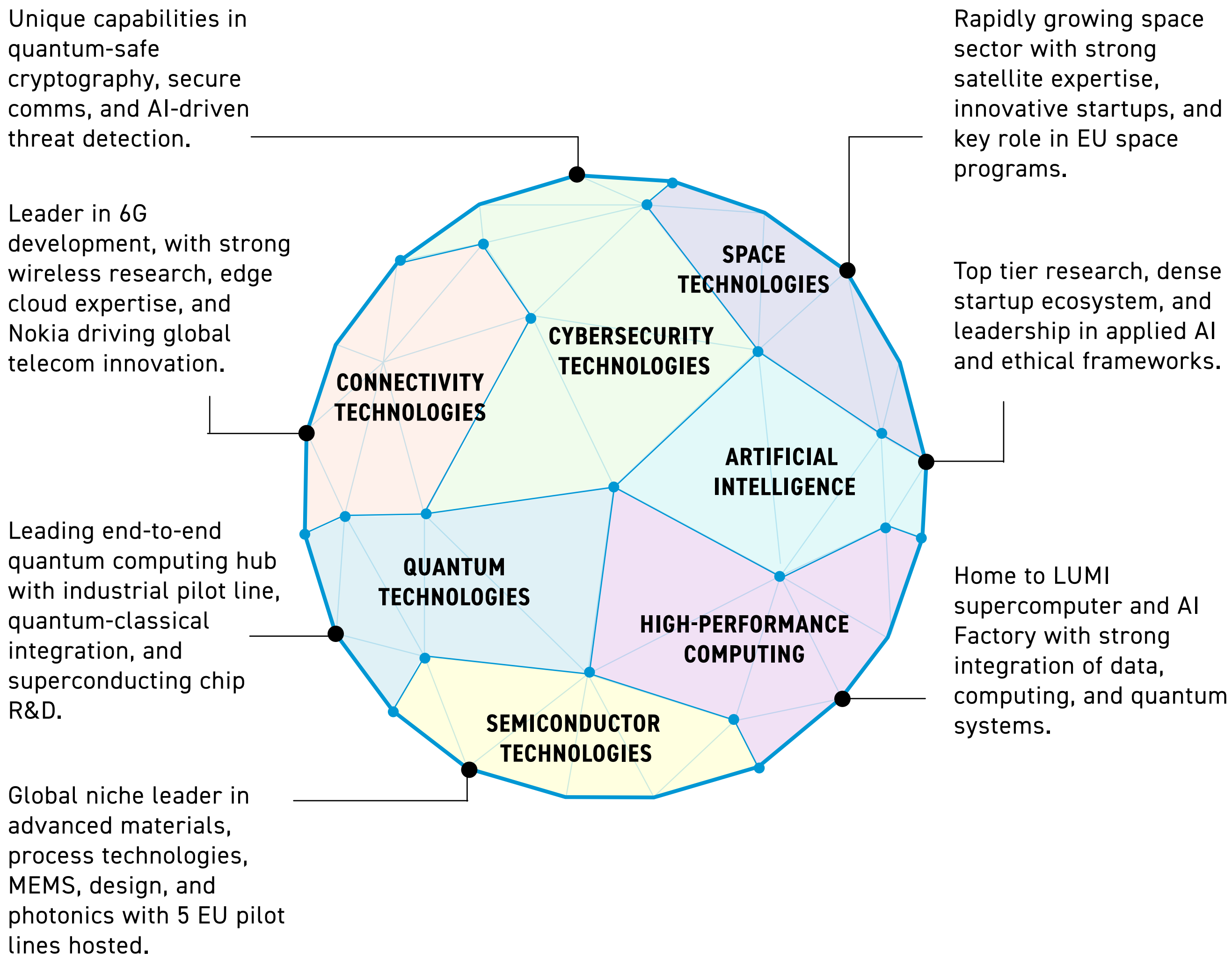
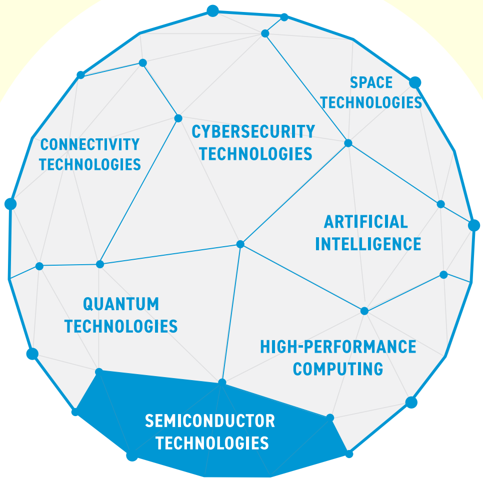



**Exhibit 4:** Finland's strengths in critical digital technologies

## SEMICONDUCTOR TECHNOLOGIES

# Revitalising Europe's chips industry with Finnish innovation




The global semiconductor market is set to expand from €570 billion to over €1 trillion by 2030, presenting Finland with a strategic opportunity to solidify its position in this high-stakes industry. Though a relatively small player on the global stage, Finland's semiconductor and microelectronics sector—generating €1.6 billion in revenue and employing 7,000 people in 2022—has emerged as a force with considerable potential. Its strengths lie in specialised technologies, bolstered by sustained investments in education, research, and industry collaboration. With the right policies and strategic focus, Finland is well-positioned to carve out a critical role in shaping the future of semiconductors, particularly within Europe's evolving chip ecosystem.

### UNDERSTANDING SEMICONDUCTOR TECHNOLOGIES

Semiconductors are the tiny yet powerful building blocks of our digital age—acting as the 'brains' behind our smartphones, computers, cars, and countless other devices, quietly orchestrating the flow of information and energy that powers modern life. They form the foundation of all digital technologies, making their development and supply crucial for technological sovereignty.

## Chips from the North: Finland's strategic vision

Released in 2024, Finland's *Chips from the North* strategy outlines an ambitious plan to triple industry revenue to €5–6 billion annually by 2035, create 20,000 direct jobs, and support over 15,000 ancillary roles. These efforts are expected to drive an indirect economic impact of €90–180 billion over the next decade, positioning Finland as a powerhouse in critical semiconductor technologies.

The strategy highlights six core opportunities to capitalise on market growth:

- **Chip design:** Finland's expertise in mobile networks, edge AI, and ultra-low-power system-on-chips places it at the cutting edge of global design innovation.
- **MEMS and sensors:** Next-generation microelectromechanical systems and sensor technologies are driving advances in communications, healthcare, and automotive applications.
- **Photonics:** With leadership in photonics value chains and system-in-package designs, Finland is enhancing the integration and performance of photonic technologies.
- **Quantum technologies:** Breakthroughs in quantum research, fabrication, and integration highlight Finland's role in the next wave of technological advancement.
- **Advanced materials:** Pioneering the development and application of cutting-edge materials, Finland underpins the growth of high-performance semiconductors.
- **Process technologies:** Innovations in sustainable thin-film deposition and flexible microelectronics are paving the way for environmentally conscious production processes.

## Building Europe's semiconductor resilience

In alignment with the EU Chips Act, Finland contributes significantly to Europe's semiconductor resilience and competitiveness. Finland's role extends beyond technological development to include promoting cross-border partnerships and advocating for a more integrated European semiconductor value chain. By leveraging its expertise in critical niches, Finland is accelerating advancements that directly support Europe's objectives for technological sovereignty and supply chain security.

Finland's investments in R&D infrastructure, including EU-supported pilot lines for advanced chip materials and processes and the Finnish Chips Competence Center, strengthen Europe's innovation capacity. VTT, a leading Finnish RTO, contributes to semiconductor production through the FAMES, NanoIC, PIXEurope, and APECS pilot line projects. Tampere University participates in the Wide-band-Gap pilot line.

**FINLAND PLAYS A STRATEGIC ROLE IN EU SEMICONDUCTOR COMPETITIVENESS BY:**

- Co-hosting all five EU pilot lines (APECS, FAMES, NanoIC, PIXEurope, WBG).
- Leading the consortium for the upcoming superconducting quantum pilot line, SUPREME.
- Participating in the EU Design Platform Coordination TEAM (PCT).
- Establishing the Finnish Chips Competence Centre (FiCCC) with all key national players.

## Strengthening innovation and talent

With this integrated policy approach and strong commitment to Chips JU investments, Finland is poised to shape the future of EU chips policy and enhance the competitiveness, leadership, and resilience of the EU semiconductor value chain. Amid geopolitical tensions and global economic turbulence, this commitment will be implemented in close collaboration with businesses and like-minded partners across Europe and globally.

Finland's world-class chip innovation infrastructure—Kvanttinova (VTT, Aalto University, City of Espoo) and SiPFAB (Tampere University)—supported by Chips JU funding, provides EU industries with opportunities to pilot and scale new technologies.

Finland's education and research ecosystems are also key. Leading hubs in Oulu, Tampere, Turku, Helsinki, and Espoo collaborate with top global institutions, driving research in telecommunications, healthcare, AI, and sustainability. Expanded microelectronics programs, doctoral initiatives, and industry-academia partnerships ensure a skilled workforce to sustain industry growth.

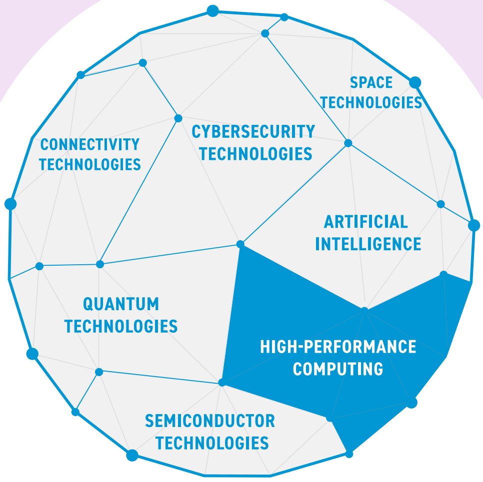
## Driving innovation and creating value

Through targeted investments, cross-sector collaboration, and a skilled workforce, Finland is set to amplify its role in the semiconductor ecosystem. The Chips from the North strategy, alongside with other public and private initiatives such as Microelectronics Finland and Photonics Finland, fosters innovation within the country and serves as an important component of Europe's broader ambitions to lead the next chapter of the semiconductor revolution.

## HIGH-PERFORMANCE COMPUTING

# Finland as a hotspot for Europe's supercomputer infrastructure

Finland has successfully established a vibrant ecosystem for high-performance computing (HPC), integrated seamlessly with advanced digital infrastructures for data management. This ecosystem enables powerful synergies between data and computational resources, fostering efficient and impactful use of information across various sectors. Finland's cool climate, affordable clean energy, robust digital infrastructure, skilled workforce, and proactive investment in technology have collectively made it a hotspot for supercomputing innovation and leadership.




### UNDERSTANDING HPC

High-performance computing (HPC) is like a turbocharged engine for computers, combining immense processing power and speed to tackle complex calculations and tasks that ordinary computers simply cannot handle. HPC enables breakthroughs across science, industry, and innovation by rapidly solving problems that once seemed unsolvable. HPC powers AI training, quantum simulations, and secure communications, requiring high-performance semiconductor architectures.

## Beyond technology: Empowering people and data

Unlocking the full potential of data goes beyond merely providing technology, computing power, or infrastructure. It demands meticulously managed data and skilled professionals who deeply understand technology—how it functions, how best to apply it, and its broader societal implications. Finland has recognised this early on, emphasising the development of expertise alongside technological capacity.

The societal and economic impacts of HPC investments are substantial. An independent study conducted in 2023 demonstrated that each euro invested in HPC services generated between €25 to €37 of direct economic benefit. Moreover, as data intensity continues to escalate exponentially across industries, the productivity potential and indirect benefits multiply considerably, underscoring HPC's transformative role in modern economies.

## LUMI: Driving Europe's AI development

At the core of the Finnish HPC ecosystem is CSC – IT Center for Science Ltd., which hosts Finland's national supercomputers, the pan-European EuroHPC LUMI supercomputer, and the EU's forthcoming AI Factory. CSC's unique service concept extends beyond traditional computing support; it actively educates and empowers HPC users and stakeholders, facilitating tailored applications of advanced computational technology within their specific research or business contexts. This strategic commitment to knowledge transfer and skills development significantly contributes to Finland's—and Europe's—technological competitiveness and sovereignty.

The LUMI supercomputer stands among the world's most powerful AI platforms. It provides European companies and researchers with the computational infrastructure necessary for groundbreaking developments, including open-source large language models tailored to European languages and numerous AI applications across diverse sectors. Through LUMI, Finland contributes significantly to strengthening Europe's technological sovereignty and global leadership in AI.

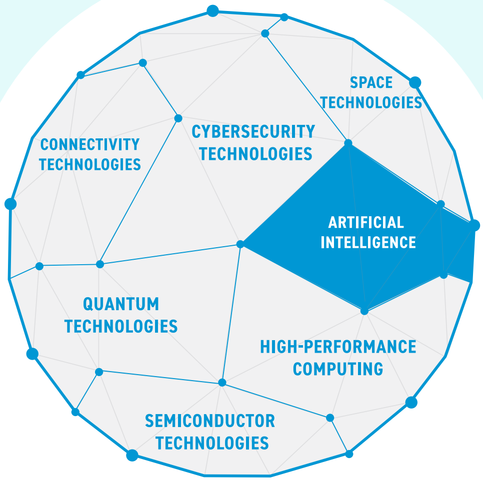
## Pioneering quantum integration with HPC

Finland is also at the cutting edge of quantum technology integration. It is among the first countries globally to successfully connect a quantum computer—VTT's Helmi—to a supercomputer, LUMI. This integration paves the way for companies and researchers to harness quantum computing capabilities seamlessly, placing Finland at the forefront of this revolutionary technological convergence.

## AI TECHNOLOGIES

# How Finland is shaping the future of digital intelligence

Finland has emerged as a dynamic force in artificial intelligence, blending world-class research, a thriving startup ecosystem, and a highly advanced digital infrastructure. The nation's AI landscape spans pioneering academic work, globally recognised AI-driven enterprises, and a public sector that actively explores AI-powered solutions. With a strong foundation already in place, Finland is well-positioned to elevate its AI industry to new heights, fostering more large-scale success stories and further strengthening its global standing.




### UNDERSTANDING AI

Artificial intelligence (AI) can be imagined as a digital nervous system, continuously learning, reasoning, and making decisions by analysing vast amounts of data. Like electricity in the past century, AI is rapidly becoming a transformative force, powering innovation and reshaping industries around the globe. AI depends on HPC and advanced semiconductors to process vast datasets and develop next-generation AI models.

## A strong global standing with opportunities for growth

Internationally, Finland is a recognised AI leader. In 2024, the country ranked 15th globally in the *Global AI Index,* making it the sixth-strongest AI nation in Europe. Finland also stood out in *Stanford's Global AI Vibrancy Ranking*, where it placed among the world's top AI ecosystems relative to population size. These rankings highlight Finland's exceptional research capabilities and robust infrastructure, key elements that support innovation and drive AI adoption.

Building on this strong foundation, Finland is also actively contributing to the OpenEuroLLM project, which develops open-source, multilingual European language models to advance AI capabilities and strengthen Europe's digital sovereignty. Complementing these efforts, Finland is also a global leader in AI literacy: the free online course Elements of AI, launched by the University of Helsinki, has become one of the world's most popular resources for learning the basics of AI, reaching over one million people in 170 countries and translated into 26 languages.

Finland benefits from strong governmental support for AI adoption. Finland was one of the first countries to adopt a *National AI Strategy,* releasing it in 2017. This strategy has laid a foundation for sustainable AI development, and initiatives like *AI 4.0* focus on integrating AI into key industrial sectors. Finland's public-private collaboration model, particularly through organisations like Business Finland and the Finnish Center for Artificial Intelligence (FCAI), ensures that cutting-edge research transitions effectively into industrial applications.

## AI startups and enterprises: A thriving ecosystem with scaling potential

Finland's AI startup scene continues to expand, with companies developing cutting-edge solutions in healthtech, fintech, quantum computing, and enterprise AI. Growth companies like Iceye and Oura have demonstrated that Finnish AI-driven firms can compete on a global scale, securing significant international investments. One of the biggest milestones in 2024 was the acquisition of Silo AI by AMD for €615 million, a major success for the Finnish AI ecosystem and a signal of the country's AI expertise being recognised worldwide.

Despite Finland's strong research and startup landscape, scaling AI companies to the next level remains a priority. The *Nordic State of AI* report highlights that Finland has an opportunity to foster more AI unicorns by enhancing access to late-stage venture capital and strengthening international business networks. Encouragingly, Finland is already home to one of the highest densities of AI startups per capita in Europe, indicating strong entrepreneurial momentum.

## World-class AI research, AI Finland, and supercomputing advancements

Finland's strength in AI is deeply rooted in its research institutions. The country's AI expertise dates back to pioneering work in the 1970s, and today, Finnish universities continue to produce groundbreaking research in machine learning, generative AI, and natural language processing. The establishment of the ELLIS Institute Finland in 2024 reinforces Finland's role as a European AI leader and strengthens its ability to attract top global talent.

LUMI AI Factory, hosted in Finland, is one of Europe's most powerful supercomputing centers, providing state-of-the-art computing resources to support AI research and large-scale model training. By offering high-performance infrastructure, Finland ensures that its companies and researchers have the tools needed to develop next-generation AI technologies. Moreover, Finland's commitment to ethical AI and sustainability is reflected in its leadership within the European AI policy landscape, ensuring responsible AI deployment across industries.

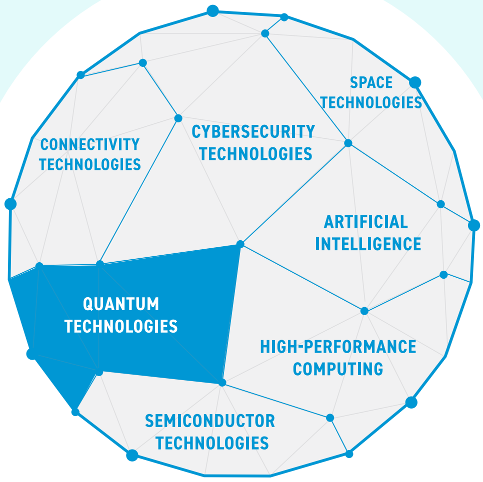
A recent key initiative driving Finland's AI leadership is AI Finland, a national network dedicated to accelerating AI adoption across industries and fostering collaboration between academia, businesses, and policymakers. AI Finland plays a crucial role in ensuring that AI innovations transition seamlessly from research labs to real-world applications, strengthening Finland's competitiveness in the global AI landscape.

**QUANTUM TECHNOLOGIES**

# Finland at the forefront of emerging industry-ready applications

Finland has solidified its position as a key player in the European quantum landscape, leveraging decades of expertise and strategic investment in quantum technologies. In the near term, many public entities, research and technology organisations, and major enterprises expect significant returns on their investments in quantum technology (QT) within the next 3-5 years. According to a recent Capgemini survey, 43% of 200 large organisations experimenting with QT anticipate that it will be ready for at least one major commercial application by 2027-2029.

The 2025 *National Quantum Strategy* outlines ambitious growth targets, reinforcing Finland's commitment to scaling its quantum ecosystem and ensuring its role as a key player in the global quantum economy. In 2023, the sector reported a turnover of €130 million, supported by €50 million in investments and employing close to 500 people. By 2035, the industry aims to reach a turnover of €3 billion, investments of €400 million and employment of 10,000, showcasing its rapid expansion and economic potential. Quantum computing now stands out as Finland's strongest suit, reflecting the country's excellence in cryophysics, superconducting technologies, photonics, and quantum algorithms. This robust ecosystem ensures Finland's leadership in the global race for quantum innovation.



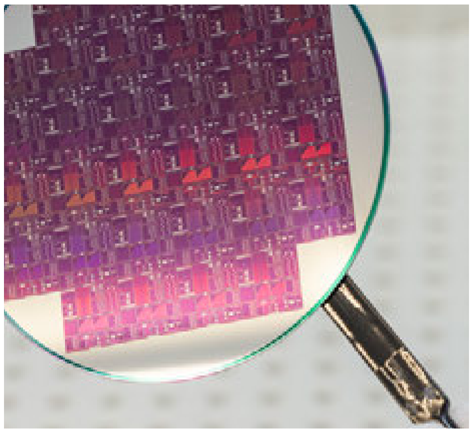

**UNDERSTANDING QUANTUM TECHNOLOGIES**

Quantum technology harnesses the peculiar properties of quantum mechanics—where particles dance in multiple places simultaneously—to unlock unprecedented computing power, ultra-precise sensing, and secure communication beyond traditional limits. It represents a leap into a new technological era, akin to moving from candlelight to electricity. Quantum technologies promise breakthroughs in problem-solving and secure networks, benefiting from HPC, AI, and connectivity.

## Collaborative ecosystem driving quantum progress

The Finnish QT industry is characterised by a strong foundation in advanced research, driven by collaboration between universities, research institutes, and private enterprises, enabling dynamic progress and innovation. Pioneering facilities such as Otanano, Micronova and the upcoming Kvanttinova pilot line enhance the nation's capacity for cutting-edge research and development. Furthermore, initiatives like FiQCI provide a solid computational infrastructure, including advanced quantum computers, such as the 50-qubit system developed in partnership between VTT and IQM, a Finnish scaleup. The quantum computer is connected with LUMI, an EuroHPC supercomputer located in Kajaani, Finland.

Finnish companies also collaborate through industry alliances and national networks like InstituteQ and Business Finland's Quantum Computing Campaign. These networks provide platforms for companies to exchange knowledge, find partners, and explore joint projects. The ecosystem has also been active in collaborating in policy work, showcasing the power of working together to amplify shared messages. The development of a local supply chain for quantum components, including superconducting chips, cryogenic systems, and measurement devices, have supported ecosystem growth. These achievements underline Finland's reputation as a trusted partner and innovator in quantum technology.



(c) VTT

**A PIONEER IN QUANTUM CHIP FABRICATION**

Finland is a global leader in quantum chip fabrication, thanks to strong industry collaboration, world-class research, and advanced facilities. Once operational, the Kvanttinova centre in Espoo will offer pilot manufacturing and development services for quantum and microelectronic technologies, supporting both small-scale and scalable production.  VTT's activities and capabilities in the Chips JU pilot lines will take place within the Kvanttinova facility.

In 2022, IQM opened Europe's first and largest private quantum chip fabrication facility in Finland, with support from the European Investment Bank. This major milestone enables Finland to produce key quantum components independently, boosting self-sufficiency and strengthening its global role.

Finnish fabrication expertise covers a wide range of technologies, including acoustic RF filters, advanced memory and photonic devices, and quantum packaging. Researchers are also developing cutting-edge solutions in superconducting quantum technologies, cryogenic electronics, and integrated photonics.

## Finland's role in Europe's quantum ambitions

On the European stage, Finland actively contributes to the bloc's quantum objectives, including the EU Quantum Strategy for 2025 and Quantum Act planned for 2026, by influencing its inception and implementation with Finnish expertise and infrastructure. Finland has already built the Helmi 5-qubit, 20-qubit and 50-qubit quantum computers and based on the National Quantum Strategy, aims to develop a 1,000-logical-qubit quantum computer by 2035, which will enable Finnish companies to develop commercial quantum applications that can compete in the global market. The country's leadership in standardisation and research security lays the foundation for Europe's resilience and competitiveness in the global quantum arena. Finnish initiatives serve as a model for collaboration and innovation, significantly bolstering the EU's ability to lead in this transformative field.

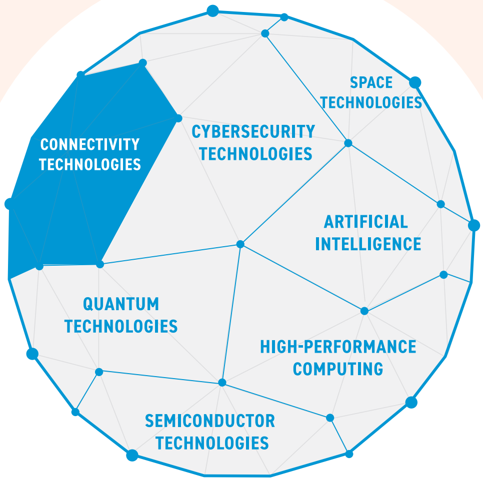
## Enabling technologies and industry impact

A distinctive feature of Finland's quantum strategy is its focus on enabling technologies, such as cryogenic systems, superconductors, and lasers. The nation's advancements in quantum sensing and algorithm development are pivotal for transformative applications in areas like healthcare, climate modeling, and secure communications. These innovations not only demonstrate Finland's technical expertise but also its ability to drive practical solutions for global challenges.

In addition, Finland has a unique opportunity to leverage its strengths in wider data-intensive sectors, particularly in the convergence of AI, supercomputing and quantum computing. By combining these technologies, Finland can enhance its national strengths in areas like space and communication technologies, as well as cybersecurity.

**CONNECTIVITY TECHNOLOGIES**

# Finland as a global leader in telecommunications innovation




Finland stands at the forefront of global development of telecommunication technologies, pioneering the research and technological breakthroughs that will define the next era of connectivity. The country's deep-rooted expertise in wireless communications, AI, microelectronics, and software solutions is shaping the future of digital infrastructure. With a strong foundation in telecommunications and a history of groundbreaking innovation, Finland is uniquely positioned to lead the transition to 6G and beyond.

**UNDERSTANDING CONNECTIVITY TECHNOLOGIES**

Connectivity technologies are the invisible threads weaving our digital world together, enabling instant communication, seamless interactions, and effortless access to information. Just as roads and bridges link cities, digital connectivity connects people, devices, and data, forming the vital infrastructure for modern society and innovation. Connectivity in its many forms passing through copper and fiber optic cables or radio spectrum (such as 5G and 6G) power real-time AI applications, industrial automation, and secure digital infrastructure.

## At the cutting edge of connectivity research and innovation

Finland is setting the pace for 6G development, combining expertise in wireless technology, AI-driven networks, and semiconductor innovation. The country leads in 6G radio frequency research, enabling unprecedented data transfer speeds and ensuring resilient, self-optimising networks.

With advanced networks gaining more computing power, we have the potential to enhance this further. This means opportunities among other things in Integrated Sensing, Communication, and Computing. Optimising where computing occurs within the chain—cloud, far edge, near edge, user device—could significantly impact various areas, such as energy efficiency, by ensuring computing is done in the most sensible location.

Open, software-defined architectures further strengthen Finland's role in building flexible, secure digital infrastructure. In addition, Finnish advancements in semiconductor technology are laying the groundwork for high-performance, energy-efficient components critical for future telecommunications.

Finland's leadership in 6G research is reinforced by the 6G Finland network, a national collaboration bringing together universities, research institutions, and industry leaders. This initiative accelerates the development and deployment of next-generation connectivity solutions, ensuring Finland remains at the forefront of global telecommunications innovation.

## Nokia: A pillar of Finland's connectivity leadership

At the core of this transformation is Nokia, Finland's telecommunications powerhouse and a global force in next-generation connectivity. With a legacy of pioneering mobile networks, Nokia continues to drive advances in network infrastructure, cloud solutions, and AI-powered automation. Its leadership in open network architectures ensures interoperability and security across global networks, reinforcing Finland's position as a trusted digital technology provider.

By spearheading global standardisation efforts and investing heavily in leading-edge research, Nokia and its partners ensure that Finland and Europe remain at the heart of the global connectivity revolution powering AI applications that rely on cloud computing connected by networks. This interdependence is further emphasised with the advent of Edge Cloud transforming cloud computing from centralised data centers to the edge where data is generated to reduce latency, enhance security, and improve the performance of applications.

Its contributions extend beyond commercial applications to critical sectors such as defence, healthcare, and smart cities, where high-speed, ultra-reliable communication networks are indispensable. As Europe and the world transition toward 6G, Finland's technological leadership and innovations will be instrumental in shaping a secure and efficient digital future.

## Critical enabler of Europe's digital infrastructure

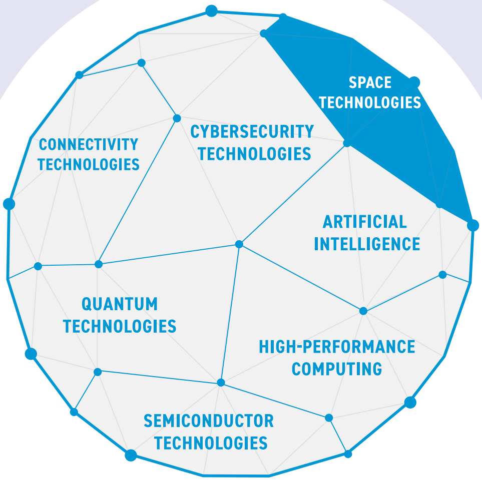
Finland's role in the EU's connectivity landscape extends beyond technological leadership to strategic influence in shaping European digital policy. As the EU advances initiatives such as the Digital Decade, Finland's expertise ensures that Europe's connectivity infrastructure matches that of its competitors and meets both sustainability and security standards. By fostering innovation in energy-efficient network technologies and promoting interoperability across member states, Finland supports the EU's goal of reducing digital dependencies and strengthening strategic autonomy.

The country's leadership in next-generation connectivity drives the development of robust digital infrastructure, supporting industrial digitalisation, cross-border data flows, and the seamless integration of AI-driven communication networks across Europe. With a proactive approach to regulatory frameworks and standardisation, Finland is shaping policies that will define the continent's digital competitiveness for decades to come.

**SPACE TECHNOLOGIES**

# From Finland to orbit: A rising space industry

The Finnish space industry is a dynamic and rapidly growing sector with notable achievements and strong future potential, as outlined in the newly released *Space Strategy 2030.* Over the past few years, it has tripled its revenue, with over 200 companies generating more than €62 million in 2022. This growth is supported by significant international investments, ranking Finland fourth in Europe for private funding in the space sector.




**UNDERSTANDING SPACE TECHNOLOGIES**

Space technologies are like bridges connecting Earth to the cosmos, enabling us to see further, communicate instantly across continents, and navigate with pinpoint accuracy. They encompass satellites, advanced communications, Earth observation systems, and innovations that quietly shape our daily lives, from weather forecasts to global security.

## Cutting-edge applications driving progress

Finnish companies are at the forefront of cutting-edge applications, excelling in satellite communications, climate monitoring, and defence solutions. These services are integral to national security and critical infrastructure, supporting sectors such as finance, logistics, and environmental management. By leveraging satellite-based services, Finland strengthens its societal resilience and cybersecurity, ensuring the continuity and efficiency of vital operations.

## A dynamic startup ecosystem

A vibrant startup ecosystem drives much of the industry's momentum. Emerging companies are key partners across security, defence, and commercial sectors, supported by initiatives like European Space Agency's (ESA) Business Incubation Centre and Phi-Lab in Finland and Business Finland's Defence and Digital Resilience program. This collaborative environment fosters innovation, turning research into practical applications that benefit both private and public stakeholders.

## Contributions to the EU's space capacity

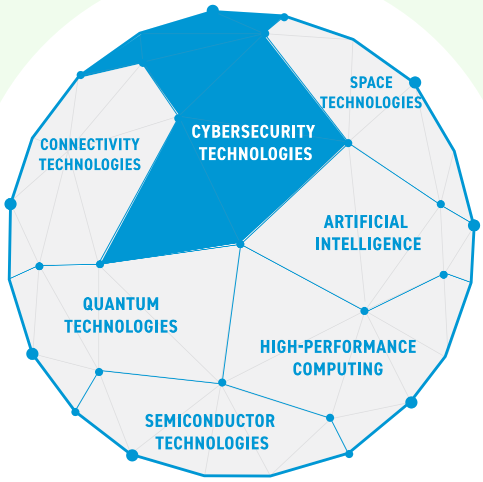
The Finnish space industry plays a crucial role in advancing the EU's strategic objectives by providing cutting-edge Earth Observation capabilities—through innovators such as ICEYE and Kuva—alongside satellite communications and ground station infrastructure, exemplified by Northbase. Finland's active participation in the ESA, the EU Space Programme, and NATO reinforces this contribution. Meanwhile, companies like Aurora are developing ADCS components for small satellites, helping to reduce reliance on third-country suppliers. Finland's Arctic location further strengthens Europe's satellite and ground station operations and NATO's High North Capabilities, enhancing the resilience required in the critical space sector.

## Vision 2030: A global space leader

The Finnish vision for 2030 is ambitious: to establish the country as the world's most advanced space ecosystem. This vision is built on principles of sustainability, equity in space access, and robust rules-based international collaboration. Through these efforts, Finland aims to integrate space innovations deeply into society, enhancing quality of life while driving economic and technological growth. The Finnish space industry exemplifies how pioneering technologies can intersect with national resilience and global leadership.

## CYBERSECURITY TECHNOLOGIES

# Safeguarding Europe's digital future with Finnish solutions




There is an urgent imperative to lower strategic vulnerabilities in Europe by mitigating the risks posed by malicious actors, and safeguarding competitive and strategic assets. Robust cybersecurity is indispensable for maintaining the operational resilience and economic competitiveness of the European economy. It ensures the reliable functioning of critical infrastructure, effective data processing, secure information flows, and dependable information systems and networks. These aspects form the backbone of successful digital transformation and a thriving data-driven economy. Development in cybersecurity must align with international law, emphasising the rule of law and economic prosperity.

### UNDERSTANDING CYBERSECURITY TECHNOLOGIES

> Cybersecurity technologies are digital gatekeepers—tools and practices designed to protect our online world from intruders, much like locks, alarms, and surveillance cameras secure our workplaces and industrial facilities. They defend computers, networks, and information from unauthorised access, misuse, or harm, ensuring the safety of our increasingly interconnected lives.

## Finland's commitment to cybersecurity leadership

Finland, reinforced by a dedicated government resolution, is committed to positioning itself among international leaders in cybersecurity expertise. A dynamic and robust cybersecurity ecosystem is vital for Finland's digital security, economic resilience, and security of supply, strengthened by the industry's vibrant international trade relationships and sustained investments in research and development.

The cybersecurity market in Finland is approximately €1.3 billion, demonstrating strong and sustained growth even compared to much larger EU member states. Customer segments show significant accumulated 'repair debt' (i.e., cybersecurity risk mitigation measures) indicating urgent and substantial investment needs in cybersecurity solutions across industries. The sector is characterised by numerous small and medium-sized enterprises, underscoring its entrepreneurial dynamism and innovative capacity, alongside several larger companies that significantly influence the industry's development and growth.

## Unique Finnish expertise in cybersecurity innovation

Finland possesses internationally recognised, and in certain areas, unique expertise within the cybersecurity sector, built upon decades of experience leveraging machine learning and AI in cybersecurity products, services, and solutions. Finnish companies and institutions excel in developing innovative technologies and solutions such as:

- Quantum-safe cryptography and other highlevel encryption solutions
- Identity and access management solutions
- Security chips
- Early warning systems for digital threats
- Personal information security solutions
- Continuous security education systems
- Cutting-edge Extended Detection and Response (XDR) solutions
- Innovative network security capabilities
- Automated response and recovery solutions
- Ultra-secure mobile communications including tactical comms and secure smartphones
- Secure and resilient mobile network infrastructures

## A trusted global partner in digital security

The Finnish cybersecurity industry is exceptionally well-positioned to deliver reliable, state-of-the-art cybersecurity solutions, playing a crucial role in fostering secure global digitalisation. Finland remains steadfast in protecting the confidentiality of private information and communications, resisting short-sighted arguments that seek to compromise digital privacy in the name of collective security. These innovative solutions protect critical infrastructures, effectively prevent and respond to cyberattacks, and safeguard individual and corporate privacy. Finland's proven expertise and commitment make it a trusted international partner in cybersecurity.


# 6
# Policy recommendations for advancing critical digital technologies

To strengthen Europe's strategic autonomy and enhance Finland's global competitiveness, targeted policy actions are needed to accelerate the development and deployment of critical digital technologies. This chapter outlines concrete recommendations for both the EU and Finland to foster innovation, attract investments, and ensure long-term resilience across key technology domains. The proposals are intentionally horizontal in nature, aiming to support multiple—if not all—critical technology areas highlighted in this policy brief, rather than focusing on any single domain. Crucially, policies must also create predictability and trust in rules and norms, as these are foundational to a stable innovation environment and effective public-private collaboration.

**RECOMMENDATIONS FOR THE EUROPEAN UNION:**

# Strengthening common levers for technological leadership

## 1 Company-led approach to EU RDI funding

Boosting Europe's digital competitiveness requires rapid breakthroughs in critical technologies and a faster transition from lab to market. The Lead Company model operated by Business Finland, an innovation funding agency, has demonstrated how empowering companies to steer the RDI agenda leads to stronger ecosystems, higher private investment, and faster growth. Now is the time to scale this approach to the European level. The model is fully compatible with existing EU instruments like Horizon Europe and the European Innovation Council—and ready for immediate deployment. By aligning EU RDI funding with a company-led model, Europe can pool its top talent, channel funding into mission-driven projects, and foster globally competitive, resilient ecosystems. This approach would accelerate the renewal of European industries through excellence—instead of operational subsidies.

**KEY ELEMENTS**

1. **Empower leading companies to drive strategic RDI:** Let Europe's technology frontrunners define high-impact RDI missions in areas of strategic importance. These companies lead the project design and select the most capable partners—startups, SMEs, and research organisations—forming dynamic, goal-oriented ecosystems.
2. **Mobilise EU funding through agile co-investment:** Use existing EU RDI instruments to co-fund large-scale lead company projects (e.g., €20 million for lead companies, €50 million for ecosystems) alongside strong private investment. Prioritise speed and simplicity in proposal, evaluation, and negotiation processes to ensure rapid mobilisation and high private-sector commitment.
3. **Build flexible, open ecosystems across Europe:** Ensure project structures are adaptable over time and open to new partners, enabling collaboration across borders and sectors. Protect IPR fairly while encouraging knowledge exchange, and link project goals directly to Europe's digital sovereignty and competitiveness objectives.

## 2 Excellence-driven EU budget for critical digital technologies

The European Union should shift its funding strategy under the Multiannual Financial Framework (MFF) to place a stronger emphasis on supporting critical technologies, with clear differentiation between excellence-based and cohesion-based funding mechanisms, each governed by separate rules. In particular, funding for research and innovation in critical technologies should prioritise excellence, as cohesion-based allocations are not suited for driving breakthroughs in highly competitive and fast-moving technological domains. For example, the Strategic Technologies for Europe Platform's (STEP) approach on research and innovation has not delivered strong results in promoting excellence, underscoring the need for a more targeted and performance-driven funding model.

**KEY ELEMENTS**

1. **Prioritise excellence-based programs:** Funding for critical digital technologies should be channeled predominantly through instruments based on excellence, not cohesion. Coherence among funding schemes must be ensured by applying consistent, high-quality selection criteria. This alignment boosts efficiency and directs resources toward initiatives with the strongest innovation potential and long-term impact.
2. **Encourage cross-border collaboration:** Cross-border collaboration among leading research institutions, industry, and universities boosts knowledge sharing, strengthens Europe's research base, and speeds up tech commercialisation. Partnerships should be driven by excellence and complementary expertise—not geographic quotas.
3. **Implement evaluation and agile reallocation to meet evolving needs:** Ongoing performance monitoring, paired with flexible funding mechanisms, ensures that support is responsive to results and adapts swiftly to emerging technological developments.

## 3 European Critical Tech Fund

Europe must close its critical tech investment gap to remain globally competitive. Efforts like VentureEU and InvestEU are helpful but fragmented. A new European Critical Tech Fund would unify these initiatives, pool public and private capital, and focus on the most promising companies developing technologies vital for the EU's prosperity and security. By establishing this fund—and completing the European Savings and Investments Union—Europe would streamline investments, foster industrial champions, and lead the development of critical technologies for the digital age.

**KEY ELEMENTS**

1. **Accelerate innovation immediately:** Provide patient capital to promising EU-based startups and scaleups, ensuring they can rapidly innovate and reach global markets while staying headquartered in Europe.
2. **Invest strategically in deep tech:** Invest in transformative technologies like quantum computing and next-generation AI to secure Europe's leadership and technological sovereignty.
3. **Scale up funding ambitiously:** Launch with €10 billion, scale to €150 billion in five years, and ultimately aim for €300 billion by 2035—financed by EU member states, institutional investors like pension funds, private capital, and the European Investment Bank.

## 4 Europe as the primary destination for global tech talent

As Europe's demand for highly skilled professionals in critical digital technology sectors grows rapidly, the EU has a unique opportunity to position itself as a global magnet for talent. Traditionally, the United States has been the primary destination for international tech experts and scientists. However, recent shifts—such as tightening immigration policies and declining attractiveness due to political and social uncertainty—have made the US a less certain choice for global talent. This presents a pivotal opportunity for the EU to step up. By responding with agile, forward-looking policies and robust, well-funded support structures, the EU cannot only fill this gap but firmly position itself as the world's premier destination for digital talent.

**KEY ELEMENTS**

1. **Create tailored EU-wide tech visa pathways:** Simplify and harmonise work visa processes across Member States. Introduce a dedicated 'EU Tech Talent Visa' to streamline and speed up entry for experts and scientists in key fields like AI, cybersecurity, and semiconductors. Consider special provisions for mobile researchers and specialists to further remove barriers and support cross-border collaboration.
2. **Strengthen public-private collaboration on talent development:** Foster partnerships among governments, universities, and tech companies to co-fund specialised attraction, training, and education programs. Offer compelling incentives for entrepreneurs and researchers, coordinate region-wide events to attract foreign talent, and align academic curricula with industry demands.
3. **Prioritise support for tech talent abandoning or avoiding the US:** Actively target skilled tech professionals who may be leaving or opting against the US due to immigration hurdles and the shifting political or social climate. Offer specialised incentives, streamlined recognition of prior work experience, and dedicated relocation assistance to attract these high-value experts to the EU.

## 5 Future-fit EU tech regulation

To lead in critical digital technologies, Europe must modernise its regulatory approach. Today's framework is fragmented, analog in design, and often burdensome—especially for smaller companies. A new regulatory model must be simple, digital-first, and built for cross-border innovation. 'Future-fit tech regulation' would deliver this shift by embedding digital logic into EU lawmaking, coordinating enforcement, and enabling compliance through technology. Impact assessments must also be strengthened to more accurately evaluate both the growth potential and possible negative consequences of regulation, ensuring a balanced and evidence-based approach. By adopting this approach, the EU would turn regulation into a competitive advantage—harmonising the Single Market, supporting innovation, protecting rights, and powering Europe's digital leadership.

**KEY ELEMENTS**

1. **Use simplification as a strategic tool:** Undertake a rolling 'digital fitness check' to eliminate outdated, unclear, or overlapping regulations. Streamline compliance by prioritising clarity, coherence, and proportionality—making it easier for companies to innovate without legal confusion or duplication. Refrain from regulating emerging technologies too early, giving them space to mature and realise their full potential before imposing constraints.
2. **Ensure new legislation is 'born digital':** Mandate that all new EU tech legislation be machine-readable, API-ready, and built to enable automation. This ensures that rules can be integrated directly into business systems, enabling real-time compliance, lower costs, and faster implementation.
3. **Coordinate enforcement across Member States:** Establish joint mechanisms for enforcement across Member States, supported by expert bodies like the AI Office and the European Data Innovation Board. Foster shared interpretation, joint oversight, and modern training to reduce fragmentation and increase legal certainty. Avoid directives as legislative solutions as much as possible and boost harmonisation elements within EU acts.
4. **Leverage RegTech to enable smarter compliance:** Promote regulatory technology (RegTech) tools that simplify compliance—especially for SMEs. Launch an EU-wide RegTech platform to fund development, connect innovators with regulators, and deliver practical tools through existing hubs and networks. While RegTech should not be seen as a substitute for better regulation, it can help alleviate the administrative burden that EU rules often place on businesses.

## 6 Innovative procurement of critical digital technologies

As Europe strives for strategic autonomy, public procurement must become a driver of European innovation in critical technologies. A shift toward advanced, risk-sharing procurement methods—such as pre-commercial procurement and innovation partnerships—can unlock breakthrough solutions, catalyse private investment, and sustain a globally competitive industrial base. By lowering the risks for public procurers—for example, through phased funding, co-financing mechanisms, or outcome-based payments—and creating predictable demand, Europe can accelerate the development and uptake of emerging technologies.

**KEY ELEMENTS**

1. **Leverage procurement to accelerate innovation:** Use advanced methods—such as pre-commercial procurement, innovation partnerships, and outcome-based models—to reduce risk and enable public buyers to engage in high-uncertainty projects. These approaches incentivise private sector participation by distributing risks across stages. The EU should support Member States with guidance, training, and funding to overcome administrative hurdles. In parallel, experimental legislation and regulatory sandboxes should be used to test and scale novel solutions in real-world settings.
2. **Use procurement to fast-track deployment of key technologies:** Target procurement efforts toward specific priority areas—such as secure cloud infrastructure, AI systems, and cybersecurity tools. Design procurement calls that focus on piloting and scaling these technologies in real-world public sector settings, helping European innovators move from lab to market faster.
3. **Develop a common European procurement toolbox:** Establish joint EU procurement instruments and shared frameworks to consolidate demand, enable cross-border pilots, and increase efficiency. Ensure inclusive governance and broad Member State participation to align incentives and deliver mutual benefits.

## 7 EU leadership in standardisation for critical digital technologies

Europe's technological leadership depends on shaping global norms and standards for key emerging technology fields. By setting guidelines and specifications early on, European businesses gain a clear competitive advantage, paving the way for patents, commercialisation, and solutions rooted in democratic values. Active engagement within organisations such as the International Telecommunications Union ensures the EU's principles of neutrality, security by design, and sustainability are embedded globally, while also addressing geopolitical tensions around technology development.

**KEY ELEMENTS**

1. **Prioritise joint positions and strategic guidance:** Develop a unified EU stance before international negotiations. Ensure that technical experts and digital policy specialists work in tandem, anticipating geopolitical considerations and aligning responses for major conferences or decision-making fora.
2. **Build coalitions and expand global partnerships:** Coordinate with partner countries and regions to amplify Europe's voice in key standardisation forums. Actively seek to harmonise or mutually recognise standards with important third countries. Leverage multistakeholder platforms to reinforce democratic and transparent approaches to emerging technologies.
3. **Reinforce the link between research, industry, and policymakers:** Strengthen collaboration between European research institutions, the tech sector, and public authorities to anticipate standardisation needs, address technical challenges, and support smaller companies' involvement in shaping EU and global norms.

# 8 Europe's global influence through secure digital infrastructure

Europe's single market, with its harmonised regulatory framework and robust financing instruments, can be leveraged more effectively to advance secure connectivity and other information security technologies worldwide. Strategic partnerships should drive the deployment of trusted 5G networks and other vital technologies in third-country markets. At the same time, greater emphasis on export funding and technical assistance will help European businesses remain competitive while reinforcing global cybersecurity requirements and standards and sustainable digital transformation.

**KEY ELEMENTS**

1. **Prioritise connectivity and data infrastructure:** Focus on Trade and Technology Councils, digital partnerships, and the Global Gateway to align strategic investment with clear deliverables for secure, high-quality networks and services.
2. **Enhance cooperation among financing and export mechanisms:** Pool resources from both Member States and EU-level funds to enable trusted European vendors to submit competitive bids in open tenders worldwide.
3. **Strengthen export promotion and market access:** Develop tailored digital economy packages to equip European enterprises with the tools they need to compete globally while advancing European standards of data protection and network security.
4. **Strengthening Trade and Technology Cooperation:** Given the current trade policy perspective, it is imperative to emphasise the need for new trade agreements as well as the timely ratification of negotiated agreements. To ensure strategic partnerships and strengthen the global competitiveness of the European innovation ecosystem, we propose the creation of a forum to enhance cooperation on technology and trade issues. This forum would foster closer collaboration with key non-EU countries on technology policy, thereby bolstering our collective innovation capabilities and securing a robust economic future.

RECOMMENDATIONS FOR FINLAND:

# Mobilising national capabilities for strategic impact

## 1 Expansion of the Lead Company Model for development and convergence of critical digital technologies

Finland's proven Lead Company Model (veturiyritysmalli) can be further developed to spark rapid innovation and adoption of critical digital technologies across the European economy. By empowering industrial champions to co-develop and pilot digital innovations with startups, SMEs, and research organisations, Finnish technology providers gain early access to large-scale use cases, accelerated funding, and strategic partnerships. This dynamic environment enables faster development, commercialisation, and scaling of advanced solutions—boosting global competitiveness for Finland's digital tech ecosystem while strengthening productivity and resilience in traditional industries like manufacturing, energy, healthcare, and logistics.

**KEY ELEMENTS**

1. **Target public RDI funding at identified strengths:** Prioritise public RDI investments in critical digital technology fields where Finland holds proven expertise and potential.
2. **Launch strategic RDI missions to drive technology development and deployment:** Support large-scale RDI projects in critical digital technologies—led by major Finnish companies with recognised market leadership. Require these champions to form inclusive consortia that bring together startups, academic researchers, and other industry partners, including customers, ensuring fast-track experimentation and deployment.
3. **Establish adoption and convergence hubs within Lead Company ecosystems:** Create dedicated hubs within Lead Company ecosystems to integrate critical digital technologies into traditional industries through real-world pilots. Co-led by industry, research, and SMEs, these hubs support tech transfer, cross-disciplinary collaboration, and validation of scalable solutions in sectors like manufacturing, healthcare, and energy.

## 2 Finnish framework for attracting and retaining global tech talent

Finland's progress as a leader in digital innovation hinges on attracting the world's brightest minds in critical digital tech sectors. Building on recent improvements, we must continue shaping a forward-thinking immigration policy that streamlines entry processes, fosters long-term integration, and enhances the overall appeal of Finland as a destination for tech talent. At the same time, Finland must boldly seize the opportunities emerging from the shifting landscape of global talent flows, particularly in light of recent developments in the US. This comprehensive approach ensures that Finland not only attracts critical digital tech talent but also nurtures their growth and integration.

**KEY ELEMENTS**

1. **Set increased immigration targets for tech professionals:** Set an ambitious annual net immigration goal specifically for tech professionals, ensuring the growth and sustainability of our tech ecosystem.
2. **Guarantee long-term policy stability:** Establish a coherent, cross-party immigration framework for tech talent that transcends electoral cycles, providing predictability for businesses and professionals alike.
3. **Implement streamlined digital immigration processes:** Implement fully digitalised, 'one-stop' immigration services—from initial electronic identification to integrated support for housing, banking, and language training—accelerating the transition from arrival to active participation in society.
4. **Foster collaborative industry engagement:** Partner with tech companies to create tailored recruitment and retention initiatives, including advisory services, mentorship programs, and localised support networks that address the specific needs of the sector. Leverage Finland's high quality of life as a competitive advantage to attract and retain top global talent.

## 3 Increased investments in Finland's critical digital tech ecosystem

To ensure Finland remains at the forefront of technological innovation and industrial competitiveness, national policy must systematically enhance investment flows into companies working on critical digital technologies. Private capital remains too scarce—especially in late-stage venture capital and industrial-scale deployments. A targeted, multi-layered policy approach is required to strengthen domestic funding channels, leverage EU instruments, and de-risk strategic investments.

**KEY ELEMENTS**

1. **Focus funding on strategic areas and leverage private capital:** Direct public investment tools and co-investment funds toward critical technology sectors where Finland has global potential, using them to attract private capital and grow internationally competitive deep-tech scaleups. As national co-funding for EU initiatives becomes increasingly important, ensure decisions are made early and based on clear strategic priorities to maximise impact and participation.
2. **Use IPCEI to unlock commercial-scale investment:** Expand Finland's participation in fast-tracked Important Projects of Common European Interest (IPCEI) to cover industrial deployment, not just R&D. These EU initiatives enable state support for high-risk, large-scale investments and should align with national goals while removing permitting and financing barriers for key technologies.
3. **Expand strategic R&D infrastructure:** Co-invest in shared technology infrastructures that support business-led research, innovation, prototyping, and pilot production. Align national investments with emerging EU funding frameworks such as the upcoming Chips Act 2.0 and Quantum Act to maximise leverage and ensure Finnish actors remain central in European value chains.
4. **Attract foreign direct investment in critical digital technologies:** Position Finland as a leading destination for greenfield investments and strategic acquisitions in critical digital sectors. Develop targeted FDI promotion campaigns, ensure competitive permitting and incentive frameworks, and leverage Finland's research and talent strengths to draw in global players.

## 4 Alliance-based funding model for critical technology data ecosystems

The development of critical digital technologies, such as AI, demands solutions that enable cross-sector data sharing and collaboration. An alliance-based funding model allows multiple stakeholders to engage in joint data ecosystem projects more flexibly and effectively than current instruments. Integrating an outcome-based investment element ensures that first movers who undertake the risk of establishing data ecosystems are fairly rewarded, mitigating free-rider problems and fostering sustainable, long-term development. No new funding is required, as resources from existing RDI budgets can be reallocated to support this effort. The model's development and piloting could be carried out jointly by the national RDI funding authorities and the Data Spaces Alliance Finland network.

**KEY ELEMENTS**

1. **Coordinate development and pilot funding:** Combine the expertise of the public funding bodies and the Data Spaces Alliance Finland under a shared development process. Allocate resources from existing RDI funds for small-scale pilots across diverse sectors to refine the model before broader deployment, and track outcomes to ensure continuous improvement.
2. **Provide outcome-based industry incentives:** Facilitate open data usage and collaboration across sectors. Encourage companies to join data ecosystems, boosting national competitiveness and fostering innovation. Tie a portion of the allocated funds to measurable data ecosystem usage or demonstrated results.
3. **Ensure scalability:** Design the model so it can expand across various sectors and form a basis for Europe-wide data and technology ecosystems. Use clear indicators to measure the model's growth and impact over time.

## 5 AI-native software development for critical digital technologies

Software underpins every critical digital technology by dictating performance and resilience. AI-native software engineering—where artificial intelligence is embedded across all phases of software design, development, and maintenance—is rapidly becoming prominent. It accelerates innovation, reduces costs, and advances high-impact technologies. A national-level shift toward AI-native approaches will safeguard Finland's competitiveness and ensure robust, future-proof solutions for strategically vital sectors.

**KEY ELEMENTS**

1. **Launch a national AI-native software program:** Drive a hyper-adaptive R&D initiative to embed AI across the software lifecycle, build next-generation infrastructure, strengthen cybersecurity, and accelerate product-based business models and startup growth.
2. **Revamp education and lifelong learning:** Modernise software engineering curricula to focus on AI-native skills, ensure continuous professional development through short-cycle programs, and equip all segments of the workforce to adopt emerging software technologies.
3. **Expand doctoral research and collaboration:** Double PhD positions in AI-native fields, foster deeper partnerships between academia, industry, and public institutions, and accelerate technology transfer to address national priorities in critical digital domains.

# 6 Enhanced RDI focus in the Finnish defence budget

The Finnish defence budget should contribute to the national objective of investing 4% of GDP to R&D. This requires a significant increase in the current level of R&D and innovation appropriations in the defence budget, with a target of allocating at least €50–60 million annually to RDI project activities. This funding should underpin both national and international RDI projects at Technology Readiness Levels (TRL) 1–6, bridging early-stage research with subsequent development programs. By ensuring dedicated, flexible, and well-resourced support, Finland can also accelerate critical digital technologies that serve both civil and defense needs, bolster collaboration through mechanisms like the European Defence Fund (EDF), and maintain the agility to launch ad hoc projects—particularly for international cooperation.

**KEY ELEMENTS**

1. **Designate a clear funding:** Increase the level of annual R&D and innovation spending in the defence budget by allocating €50–60 million annually to support the national objective of investing 4% of GDP to R&D.
2. **Align with NATO and EU-level R&D efforts:** Strengthen interoperability, leverage joint investments, and solidify Finland's position within collaborative security frameworks such as the European Defence Fund. Achieving this demands shared ambition to ensure Finnish expertise and industry have real opportunities to participate significantly in European defence technology development and value networks.
3. **Improve collaboration and innovation support:** Provide dedicated funding outside standard defence procurement to enable rapid prototyping and integration of new technologies. Strengthen open, ongoing dialogue between the Defence Forces and all companies—including both established firms and startups—and support partnerships with mechanisms like grants or pre-orders that do not dilute ownership.

# 7
# Proposals for public-private collaboration in Finland

As outlined in the earlier chapters, Finland has the talent, research excellence, and industry know-how to lead in critical digital technologies. However, staying ahead requires stronger collaboration between government, businesses, and researchers. The following five practical proposals focus on improving policymaker expertise, strengthening foresight, increasing international visibility, and aligning national priorities.

These public-private structures are also vital for shaping and implementing the right mix of policies needed to advance critical digital technologies. By working together, Finland can translate technological advancements into tangible economic gains, stronger security, and a leading role in the digital era. Its collaborative approach offers a model that the EU could look to as it seeks more effective ways to align policy, investment, and technological ambition.

## 1 Policymaker tech leadership program: Strengthening competence in decision-making

To steer the country through choppy waters, Finland's policymakers must have a clear, practical understanding of critical digital technologies and their implications for the economy and security. This program should provide hands-on training, real-world case studies, and expert insights to equip decision-makers with the knowledge needed to craft forward-looking policies. By engaging industry leaders, researchers, and international experts, it ensures that Finnish policymakers can anticipate technological shifts, make informed regulatory decisions, and effectively support innovation.

**IMPACT:** Smarter regulation, faster policy responses, and stronger collaboration between government and industry to drive Finland's digital leadership.

## 2 Critical Tech Forum: A national nerve center for foresight and collaboration

Finland needs a structured forum to connect key players in critical technologies. This initiative should bring together companies, public agencies, and researchers in dedicated sub-groups to exchange intelligence, anticipate risks, and drive collaboration through coordinated action, while also involving industries that mainly use and deploy these technologies—such as manufacturing, energy and healthcare—to ensure their operational perspectives inform decisions. By fostering regular dialogue and sharing insights across the ecosystem, the forum will build the capacity to respond rapidly to emerging risks and opportunities. It should further serve as a key advisory body to help Finland navigate EU-level discussions on technology strategy and sovereignty.

**IMPACT:** A continuously updated situational awareness framework that ensures Finland remains agile, secure, and ahead of the curve in key technology areas.

## 3 Critical Tech Summit: Showcasing leadership and innovation

Finland should position itself as a global leader in critical digital technologies with an annual flagship event that unites industry pioneers, top researchers, and public-sector decision-makers. Through keynote talks, panel discussions, and live demonstrations, the summit should highlight groundbreaking advancements, foster new partnerships, and attract investment. By drawing international participation, the summit could also reinforce Finland's role in European and global technology discussions.

**IMPACT:** A high-impact platform that enhances Finland's tech reputation, fuels collaboration, and turns innovations into real economic and security gains.

## 4 Prime Minister's roundtable on critical technologies: Driving Finland's strategic edge

To keep the country's political leadership up to date on critical technologies, the Prime Minister should regularly convene a high-level roundtable with top industry associations and CEOs, leading researchers, and key government figures. This roundtable should provide strategic direction, align national priorities on emerging technologies, and ensure that Finland asserts itself in EU and global tech discussions. It should also serve as a mechanism for accelerating high-impact public-private initiatives, fostering investment in critical digital infrastructure, and strengthening Finland's resilience against technological dependencies.

**IMPACT:** A results-driven leadership forum that cuts through silos and ensures Finland remains at the forefront of digital competitiveness and security.

## 5 Finnish Critical Tech Playbook: Providing best practices and references

Government authorities, company representatives, think-tank operators and academic experts should pool their resources and expertise to create a single, comprehensive playbook that captures Finland's successful approaches to critical digital technologies. This playbook should highlight best practices, successful public-private initiatives, real-world use cases, and immediately applicable insights on topics like secure connectivity infrastructure, resilient cybersecurity systems, and data-driven solutions, offering a flexible resource for both domestic and international stakeholders.

**IMPACT:** By unifying proven methods in an accessible reference, collaborators should strengthen Finland's standing as a digital leader, support the EU adoption of robust technological solutions, and foster a culture of continuous innovation.

# 8 Conclusion: Finland’s commitment to building security and growth in Europe

Europe stands at a strategic inflection point. We can no longer count on shared values and seamless global interdependence to guarantee growth and security; instead, we must compete for technological leadership in an increasingly contested geopolitical arena. External dependencies threaten economic vitality and—ultimately—Europe's ability to choose its own future. Yet the answer is not isolation. Complete self-sufficiency is neither realistic nor desirable in a world whose progress relies on open exchange. Instead, Europe must build the capabilities and control required to safeguard its interests while remaining a trusted, outward-looking partner.

Finland's experience shows that this dual imperative is achievable. From LUMI's supercomputing power to world-leading 6G research, from resilient cybersecurity solutions to a fast-growing quantum and semiconductor ecosystem, Finland has demonstrated how strategic investment, public-private collaboration, and an ethos of openness can reinforce both security and competitiveness. Each success story proves that when Europe treats digital infrastructure with the same seriousness it reserves for energy, transport, or defence—by designing, building, and governing its own assets—growth follows and resilience deepens.

Regulation will remain essential, but rules alone cannot close Europe's capability gap. The next chapter demands that we complement high standards with high ambition: funding daring R&D, scaling industrial pilot lines into continental value chains, and attracting the world's best talent to our universities, labs, and factories. Finland is committed to leading by example—co-creating lighthouse projects, championing an excellence-based EU innovation agenda, and forging trustworthy partnerships around the globe.

We recognise the urgency. The innovations described in this policy brief are not distant prospects. They are already anchoring new jobs, stronger supply chains, and cutting-edge research across Europe. Our pledge is therefore practical: to mobilise the full breadth of Finnish expertise in support of a resilient European digital ecosystem—one that secures data, empowers industry, and delivers sustainable growth to every Member State.

Together, Europe can convert today's risks into tomorrow's opportunities. By aligning national strengths, prioritising strategic technologies, and embracing responsible openness, we will not only preserve our autonomy but also shape global norms for decades to come. Finland invites partners across Europe and beyond to join us in this endeavour—because a secure, innovative, and competitive Europe is the strongest foundation for shared prosperity in an uncertain world.

# References

AI Finland. 2025. Webpage

AI Finland, Business Finland. 2025. Finnish AI Landscape 2025

AMD Silo AI. 2024. The Nordic State of AI

Bertelsmann Stiftung. 2025. EuroStack – A European Alternative for Digital Sovereignty

CSC– IT Center for Science. 2024. SROI of CSC's high-performance computing services studied: €25–37 return per euro invested

Data Spaces Alliance Finland. 2025. Webpage

DIGITALEUROPE. 2024. The EU's Critical Tech Gap: Rethinking economic security to put Europe back on the map

Elements of AI. 2025. Webpage

ELLIS Institute Finland. 2025. Webpage

Finnish Information Security Cluster. 2025. Webpage

European Commission. 2023. Joint communication to the European Parliament, the European Council and the Council on "European Economic Security Strategy"

European Commission. 2023. Commission recommendation on critical technology areas for the EU's economic security for further risk assessment with Member States

European Commission. 2023. Annex to the Commission Recommendation on critical technology areas for the EU's economic security for further risk assessment with Member States

European Commission. 2024. Science, Research and Innovation performance of the EU 2024 report

European Parliamentary Research Service. 2024. The geopolitics of technology. Charting the EU's path in a competitive world

LUMI supercomputer. 2025. Webpage

Microelectronics Finland. 2025. Microelectronics in Finland - Microelectronics research and education: Strategy and roadmap update for 2025-2027.

Ministry of Economic Affairs and Employment of Finland. 2017. Suomen tekoälyaika

Ministry of Economic Affairs and Employment of Finland. 2022. Suomi kaksoissiirtymän suunnannäyttäjänä – Tekoäly 4.0 -ohjelman loppuraportti

Ministry of Economic Affairs and Employment of Finland. 2025. Avaruusstrategia 2030

Ministry of Economic Affairs and Employment of Finland. 2025. Finland's Quantum Technology Strategy 2025–2035

OpenEuroLLM. 2025. Webpage

Photonics Finland. 2025. Webpage

Prime Minister's Office. 2024. Suomen kyberturvallisuusstrategia 2024–2035

Rodriguez, A. 2025.Technological convergence (to be published by Sitra).

Sitra. 2024. Finland in the Race for Quantum Advantage – Policy recommendations for a National Quantum Strategy

Technology Industries of Finland. 2024. Chips from the North - Semiconductor Strategy for Finland

Tesi. 2024. Deep Tech Study Finland 2024

Tordoir, S., Meyers, Z. 2024. Can the EU hold back the great tech decoupling?

6G Finland. 2025. Webpage

# Acknowledgements

This policy brief was prepared by the Secretariat, drawing on reference materials and input from the Sherpa Group, stakeholders and other subject-matter experts. Generative AI tools were used to support the drafting process. All final editorial decisions were made by human authors.

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**STAKEHOLDER WORKSHOP I, 10 MARCH 2025:** Drivers, trends and public-private collaboration

**STAKEHOLDER WORKSHOP II, 8 APRIL 2025:** Policy recommendations

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