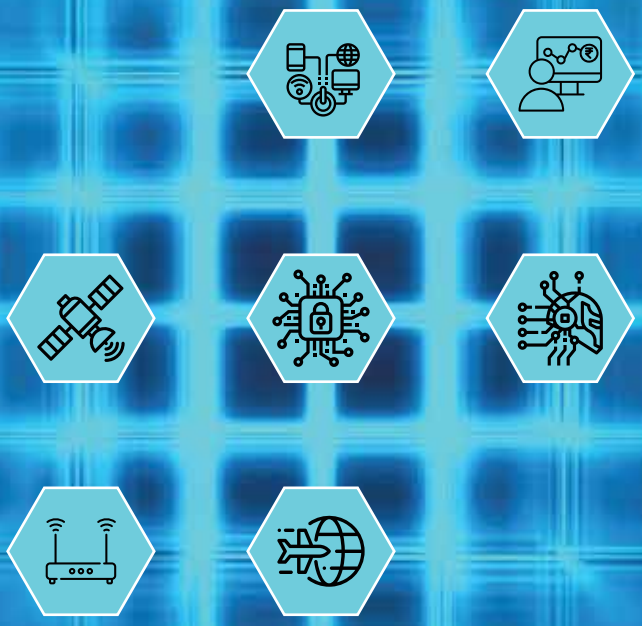
The Course of Action for Europe's ICT Partnership with Australia, New Zealand and Singapore

Results and Recommendations from EPIC



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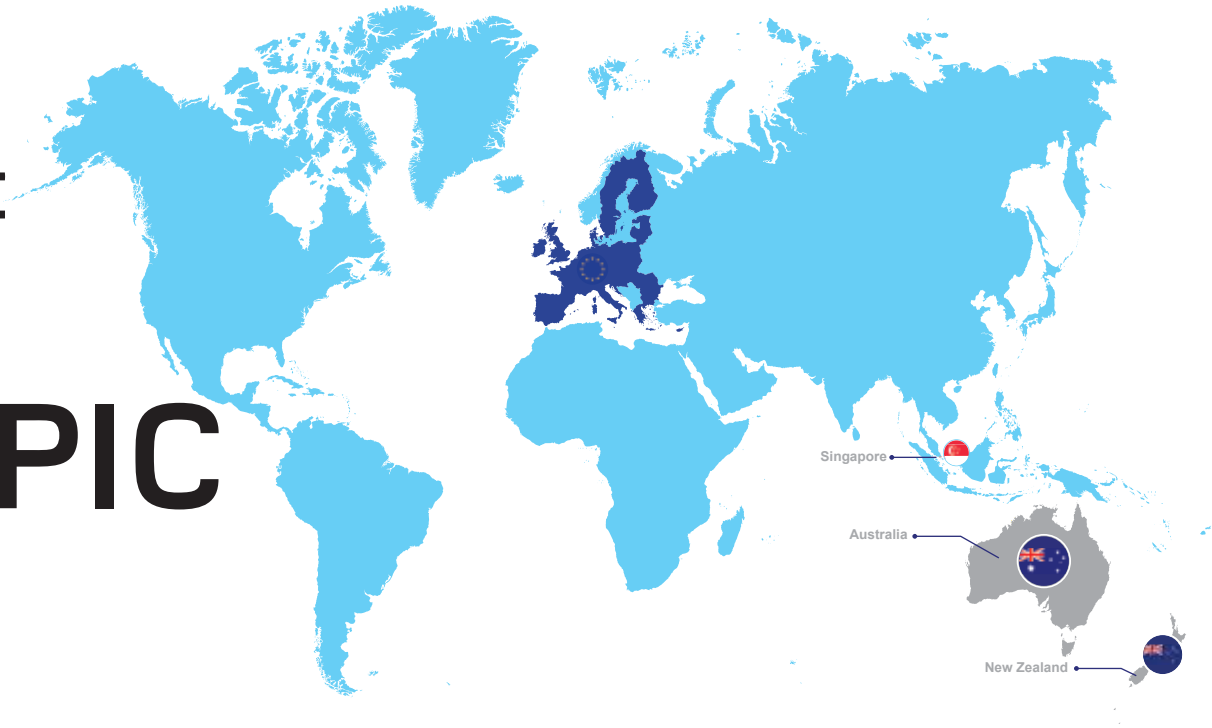

about EPIC

The EPIC initiative was created in response to an EU call for projects to support dialogues between the EU/EC and its strategic partner countries to foster cooperation in ICT R&D. The aim of the call was to organise events, support policy dialogue meetings, strengthen cooperative research links and reinforce industrial collaboration as well as coordination with other EU level initiatives.

EPIC, therefore, aimed to **improve the research and innovation collaboration** between the EU and its strategic partner countries **Australia, New Zealand, and Singapore** in the area of **information and communication technologies.** It targeted both the strategic, more policy-oriented level and the direct cooperation of researchers/innovators in academia and industry. The aim was to exploit mutually beneficial opportunities and to prepare new grounds for future collaborations.

EPIC aimed to help overcome the current lack of dedicated cooperation support actions and improve the low visibility of Europe's ICT RDI capabilities in the target countries. The project followed a topical methodology: the focus was on specific areas of ICT research of high strategic importance. Topics included artificial intelligence, Internet of Things (IoT) including wearables, cybersecurity, ICT in transport, digital economy, Next Generation Internet and spatial intelligence.

The specific objectives of the project were to:

- Identify priority research topics for collaboration and identify synergies between the *Digital Single Market* and 3rd countries/regions' ICT strategies
- Organise and support events targeting research, industry, and policy makers and an event demonstrating impact and highlighting recommendations for future cooperation
- Identify common policy opportunities and the potential for joint activities
- Create a series of policy briefs to foster stronger cooperation building on researcher exchanges and joint projects for lasting cooperation
- Deliver a handbook for EU researchers on opportunities in Australia, New Zealand and Singapore and information material to disseminate the objectives and results of the project among relevant stakeholders

This course of action describes recommendations for stronger collaboration in ICT research and development between the European Union on the one side, and Australia, New Zealand and Singapore on the other.

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executive Summary

The purpose of this *course of action* is to provide recommendations for enhanced ICT collaboration in select future oriented areas between the European Union and the Asia Pacific countries of **Australia, New Zealand,** and **Singapore**. This document has been developed and delivered by the Horizon 2020-funded EPIC project - *the* European-Pacific partnership for ICT collaboration in research, development and innovation. Its goal is to identify and share recommendations that will enable policy stakeholders in the partner states to further strengthen ties in these areas - the scope of which includes the **Digital Single Market, Digital Economy, cybersecurity, artificial intelligence, spatial intelligence, Internet of Things** (**IoT**) **and wearables, and ICT in transport** - through academic, industrial and political collaboration.

Between 2017 and 2019 EPIC worked to bolster cooperation in the project's DSM adjacent focus topics via a series of events, meetings and other interactions which took place in the partner countries and the EU. The content and outcome of these initiatives have enabled the project coordinator to present the recommendations and findings that follow to inform ICT policy makers and stakeholders in the EU, Australia, New Zealand and Singapore.

EPIC was undertaken against a backdrop in which **the international ICT environment is changing:**

- **Global power shifts** and a changing **geopolitical framework** are creating new opportunities for strengthening Europe's partnerships with Australia, New Zealand and Singapore including those in information technology, research and innovation.
- The dynamic growth of Internet platforms and global technology companies has motivated smaller countries to consider new allies – including Europe – when rethinking regulatory frameworks.
- **EU values** relating to ethics and privacy attract increasing attention as the rate of technological advancement increases and as concerns about privacy and security are growing.
- There is strong international interest in Europe's Digital Single Market development and concepts, both from a business perspective and from academic researchers.

EPIC partner countries: Recommendations overview

Australia

With more than 4,000 ICT researchers in publicly funded organisations, Australia offers identifiable strengths in key areas and significant ICT research capability - thus making it an interesting and well-suited EU - and EPIC - partner. The federal government has issued a list of science and research priorities comprising a broad range of disciplines including food, soil and water, transport, *cybersecurity,* energy, resources, *advanced manufacturing,* environmental change and health. Given EPIC's focus on ICT, the topical areas of highest project relevance were transport, cybersecurity, energy, and advanced manufacturing. Three focal topics emerged which merited dedicated policy briefs: **e-Research, AI** and **digital disruption.** The list of immediate policy recommendations for how collaboration can be strengthened between the EU and Australia in these areas includes:

e-Research	Artificial Intelligence	Digital Disruption
		
To strengthen collaborations between academia, industry and government agencies, work on standards for data, services and infrastructure to ensure access, interoperability and ease-of-use along with the development of supported services. Easily applicable funding models for realising EU-AU e-Research projects should become a primary target of future EU-AU e-Research cooperation. Provide evidence for the benefits of e-Research beyond academia, i.e. for industry and society. Create joint virtual EU-AU labs to ensure reusable data and associated services. A joint AU-EU initiative could help address the shared challenge to improve current data management plans, e.g. through best-practice and support tools. Australia and the EU should provide trials of dedicated data markets for clean and packaged data or data-as-a-service models. Australia and the EU have e-Research ties in application domains from astronomy to biology, genetics, climate and medical research, and music. Further collaboration is possible in areas of the United Nations' Sustainable Development Goals (SDGs).	Develop a global repository of AI strategies and policies to ensure greater transparency and accessibility to the general public and relevant stakeholders, such as policy makers. Such a repository can help develop a governance structure for ensuring accountability and transparency in the development of AI. Encourage greater knowledge sharing between Australia and the EU and its member states to foster a more collaborative environment, e.g. through mutual event invitations and consultations including scholars in other fields such as law, political science and humanities. Australia and Europe both have many expat researchers in AI from the other region. Maintain the opportunities for peer-to-peer collaboration with support for exchange visits and smaller-scale research collaboration. Exchange good practices in AI education for the young, for teachers, and a broad public. Where applicable, this should include citizen science and art/AI initiatives. Collaborate in content creation, best-practice exchange and sharing of access to online training courses for AI – at the vocational and university level. Europe has a long tradition of data and IT ethics regulation based on human rights, while other jurisdictions focus on different principles, e.g. property rights. Australia and the European Union should investigate frameworks to support citizen rights while facilitating dynamic industry innovation.	Support experiments with long-distance interactions facilitated by digital technologies using state-of-the-art and forthcoming technologies. Promote opportunities for exchange between researchers, artists, engineers and a broad public in order to detect and address adverse effects as well as opportunities of digital technologies. Policy makers should take advantage of the specific role that creative interaction with technology and science plays in reaching out to broad public audiences. Art is inherently communicative and investments in art/science usually imply investments in public communication of science. Start joint trials with online digital education. This could include creative concepts to inform ethical insights about the implications of new and emerging digital technologies and foster a creative and productive approach.

Table 1: EPIC recommendations for Australian-EU ICT policy stakeholders

New Zealand

In New Zealand, the geographic location emphasises the need for international cooperation, positioning the EU as a collaboration partner with strong potential. The growth of the Internet has helped the IT sector to participate in the global marketplace. New Zealand ICT companies have a reputation in 3D graphics, health IT, services, bioinformatics and security. Here, EPIC's main topics were IoT, including Industry 4.0 and wearable technology, geospatial intelligence and artificial intelligence. Three focal topics emerged which merited dedicated policy briefs: **IoT, Agritech** and **AI**. The list of immediate policy recommendations for how collaboration can be strengthened between the EU and New Zealand in these areas includes:

Internet of Things	Agritech	Artificial Intelligence
		
New Zealand can provide an excellent environment for testing the suitability of Industry 4.0 and IoT solutions for small and medium-sized enterprises including in less digitized sectors, e.g. agriculture and health.	Investigate options for joint RTDI activities in technology areas in combination with other policies of interest to both regions, for example smart specialisation, AI and agritech, etc.	Include collaboration on AI, AI ethics, AI innovation, labour and society aspects in the work of the Joint Science and Technology Committee to jointly investigate impacts and issues, set guidelines for best practice and publish learnings.
Jointly address environmentally beneficial and energy-efficient solutions for sustainable development, e.g. in applications covering large and remote areas.	Maintain and expand existing opportunities for research exchange. Given the relatively small number of experts, even small amounts of funding can trigger significant exchanges.	New Zealand's geographical position and diverse bilateral trade and cultural relationships with the two largest global "AI giants", the US and China, afford it a relatively unique position between the East and West for collaborative international AI policy development for global issues, i.e. climate change or human trafficking.
The EU and New Zealand should continue initiatives that further the exchange of experts, i.e. similar to the EPIC experts supporting the C-Prize.	Improve collaboration between centres of excellence to increase research scale, effectiveness, long-term relationships and stimulation of new ideas.	Europe and New Zealand should share experiences and approaches to include a broad public in the design of AI systems. New Zealand's indigenous experience and Europe's diverse cultural setting provide ample opportunities for best practice exchange.
Given the lack of skilled people in both regions, New Zealand and Europe should collaborate on IoT and Industry 4.0 education and training including vocational training.		Offer an AI pilot for online courses or MOOCs to enable Europeans and New Zealanders at all stages of education to rapidly increase their practical AI skills to help meet the market demand.
Governments in Europe and New Zealand should exchange experiences and practices for ensuring that customers in industry and consumers understand the security risks of IoT and I4.0 systems and can take appropriate steps.		
Jointly investigate whether legal frameworks cover the unauthorised use of IoT devices and similar risks. Europe and New Zealand should cooperate to better understand what international and extraterritorial jurisdiction issues arise from the proliferation of IoT devices and develop shared approaches.		

Table 2: EPIC recommendations for New Zealand and EU ICT policy stakeholders

Singapore

An information and technology hub for the Asia Pacific region, and home to many of the world's top ICT multinational corporations, Singapore constitutes a strong, regionally significant potential ICT partner for the EU. Here EPIC's main focus topics were **spatial intelligence** and **cybersecurity/privacy**. The list of immediate recommendations for how collaboration can be strengthened between the EU and Singapore in these areas include:

Spatial Intelligence	Cybersecurity/Privacy
Research Earth observation data use-cases based on their respective existing developments. This requires the collaboration of government, industry and academia.	Intensify the discussion about collaboration in cybersecurity, especially related to other digital areas such as Internet of Things or AI.
Develop collaborative or matching funding models in the field of Earth observation for high priority areas such as air pollution mitigation and urban transport research to leverage existing resources.	Perform joint research focusing on ethics of data use.
Develop joint activities that go beyond the sharing of satellite data.	Jointly showcase technologies demonstrating the benefits of guaranteed privacy and security, e.g. using differential privacy.
Investigate options for developing marketplaces for European satellite data and joint applications.	Jointly address the education of citizens and SMEs to understand the risks, but also solutions in the area of privacy and security. Inform about new possibilities for anonymisation and synthetic data models.
	Collaborate in privacy-improving and privacy-preserving technologies for Smart City and Smart Nation developments and in health.

Table 3: EPIC recommendations for Singapore and EU ICT policy stakeholders

Recommendations for all three target countries

A major learning from EPIC discussions with researchers, academics, and policy makers concerns the **role of expats** for RTDI collaboration in ICT. Expats – both permanent and short-term – are key drivers behind new joint projects and initiatives. There is currently no expat network at EU level and none specifically in ICT. Even small investments in this area including for example short-term exchanges could vastly impact collaboration. Leading experts should be drivers behind an expat ICT network to ensure long-term interest. A new network should build on strong and engaged national expat networks. Relatively small funding can help sustain efficient networks – for instance, to distribute information, organise future events, and continue exchange.

New **collaboration models** are required to go beyond the joint calls, which can be useful but are complicated to prepare. The EU should leverage existing organisations and centres with organisational support to turn them into dedicated activity centres. A simplified third country status could help to alleviate the challenging administrative burden for participants in those countries.

Support actions for the programme can be useful but are necessarily limited in scope and durability. More durable initiatives, e.g. centres of competence that support Europe's international RTDI activities can help address this. This includes dedicated ICT collaboration experts at EU missions.

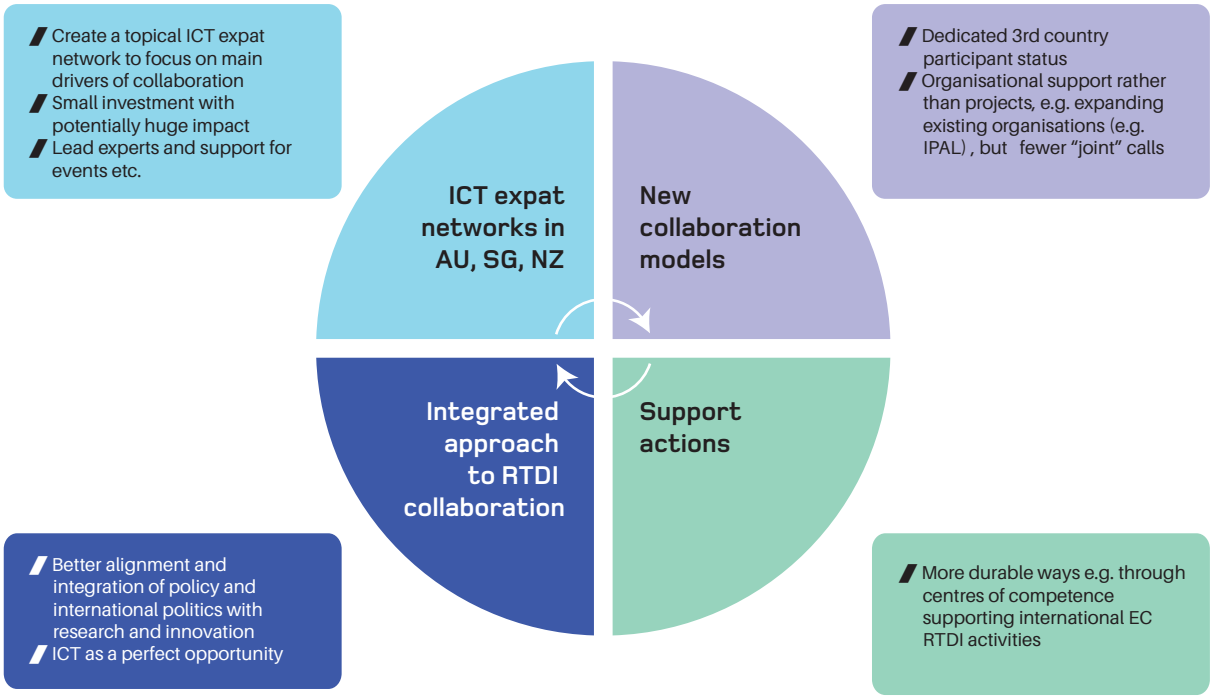


Figure 1: Recommendations for all three target countries resulting from EPIC project findings.

Finally, a new and **integrated approach to RTDI collaboration** should better align international politics with research and innovation, technology policies, and collaboration in innovation. ICT as a cross-cutting, pervasive and global technology is perfectly aligned for this.

Europe's Digital Single Market

In parallel to EPIC, the EU and its member states worked hard to realise the **Digital Single Market** (DSM). This meant the launch of a broad range of policy initiatives in fields such as **digital technology, privacy regulation, research and technology development, roaming charges** and **copyright questions.** Most of these initiatives resulted in the adoption of new regulations or the creation of new funding and support measures. In terms of technologies, the DSM addresses all EPIC priority topics – some only broadly, most with dedicated strategies. Perhaps surprisingly, the DSM is of strong interest to Europe's Asia Pacific partners and is also widely known. In recognition of the interest found in Australia, New Zealand and Singapore, EPIC has developed the following recommendations for the way forward:

- An **integrated approach to international ICT policy** is needed. Such an approach should consider research and innovation in the context of other policy areas such as global collaboration, trade and business, social politics or the arts.
- Artificial intelligence, privacy and security and questions of values have brought together new groups with **multidisciplinary backgrounds,** not just the traditional engineers. Future debates and discussions should incorporate perspectives from the humanities, arts, law and other backgrounds.
- Europe should offer **support** on the Digital Single Market and what its **impacts** for international businesses and research trends might be. Information about the EU can be confusing for many in third countries, for example around the roles of member states versus the European Commission.
- Europe should capitalise on the DSM as an **opportunity** to demonstrate and publicise **global excellence** in the associated ICT topic areas and to thus create or drive opportunities for international research collaboration.

The EPIC Partner Countries

Australia

Selected actors and organisations[1]

- 3A Institute, Australian National University - Genevieve Bell, Director
- Cooperative Research Centres - Dr Anthony Peacock, CEO
- CSIRO Data 61 - Dr Sue Keay, Research Director
- Department of Industry, Innovation and Science - Elizabeth Kelly, Deputy Secretary
- Intersect Australia - Marc Bailey, CEO | Jonathan Arthur, National Services Manager
- Optus Macquarie University Cyber Security Hub - Christophe Doche, Executive Director
- RMIT University European Union Centre - Prof. Bruce Wilson
- Rozetta Institute - Peter Clare, CEO | Dr Andrew Lepone, Chief Research Officer
- University of Technology, Sydney
  - Advanced Analytics Institute (Big Data) - Prof. Bogdan Gabrys, Director
  - Centre for Artificial Intelligence - Ian Burnett, Dean
- University of Sydney UBTECH AI Centre - Prof. Dacheng Tao, Centre Director
- Swinburne University of Technology - Dr Amir Aryani, Head of Social Data Analytics Lab
- Australia Research Data Commons - Ross Wilkinson, Director, ARDC Global Strategy
- National Computation Infrastructure - Clare Richards, Senior HPC Innovations Project Manager
- SAP - Nicholas Nicoloudis, Senior Business Innovation Strategist (Asian Pacific - Japan)
- Queensland University of Technology - Manufacturing with Advanced Materials, Prof. Leonie Barner, Principal Research Fellow. Science and Engineering Faculty
- Monash University Data Futures Institute - Prof. Jon Whittle, Dean, Faculty of IT
- Australian Institute of International Affairs - Allan Gyngell, National President

EPIC findings

In Australia, EPIC's 2.5-year project duration encompassed 11 events which attracted more than 1,200 expert level attendees. These activities, combined with other initiatives aimed at a variety of project stakeholders, generated four main findings:

- EU expats and their networks play an important role in generating projects and links with their home region. They are drivers of ICT research collaboration and act as a source of ideas and anchors for collaboration.
- There is great interest in the EU DSM and its underlying concepts because of the potential impacts upon Australian organisations conducting business in the EU.
- Ethical and regulatory questions of ICT gain increasing importance for international technology policy. These topics are no longer just a subject for engineers but bring together experts from multidisciplinary backgrounds in the humanities, law, tech and many more.
- Policy makers in Australian states (e.g. Victoria) discovered Europe's Smart Specialisation Strategy as a good-practice example, especially in relation to digital technologies.

Background

With more than 4,000 ICT researchers in publicly funded organisations, Australia offers identifiable strengths in key areas and significant ICT research capability. Australian universities rank well internationally *with app. 30 universities supporting ICT research.* Business funded ICT R&D is undertaken by corporate labs, small to medium enterprises (SMEs) and companies in the telecommunications, finance and mining sectors. The Australian ICT R&D sector has researchers and research groups with world-class expertise in a range of ICT fields in established and emerging areas. Some of Australia's key ICT capabilities are in the areas of wireless and future Internet, artificial intelligence and software systems including embedded enterprise systems.

The federal government has issued a list of science and research priorities with the aim to increase investment in areas that are of critical importance to Australia and 'its place in the world'. The selection of priorities is aligned with the ***Australian Industry Innovation and Competitiveness Agenda***[2] and with Australia's efforts to boost the return from research[3]. Both strategy papers emphasise the role of international competitiveness and cooperation based on excellence and improved capabilities.

The research priorities list includes practical research challenges and comprises a broad range of disciplines including food, soil and water, transport, *cybersecurity,*[4] energy, resources, *advanced manufacturing*, environmental change and health. Given EPIC's focus on ICT, the topic areas of highest relevance are transport, cybersecurity, energy, advanced manufacturing and health.

1: Key actors involved in the EPIC activities such as events, policy roundtables, briefings...

Advanced manufacturing

The Australian priorities list also includes an overview of Australian research strengths with a focus on cross-cutting or key enabling technologies. For example, in the area of advanced manufacturing, Australia has identifiable research strengths in robotics automation and simulation, but also in the material-based aspects such as additive manufacturing, advanced materials, nanotechnology and photonics. Australia aims to strengthen its manufacturing sector through reinforced engagement between research and industry (particularly small- to medium-sized enterprises), scaling-up existing activities and improving Australia's capability in cyber-physical system interfaces. Very much in this line, the recently released strategy ***Australia 2030: Prosperity through Innovation***[5] argues that the emergence of cyber-physical systems and the IoT present an important strategic opportunity for Australia.

Cybersecurity

Australia exhibits particularly strong research capabilities in cybersecurity. In terms of citation impact as an indicator of research quality, Australian research in this area ranks 1st out of 15 compared to selected European countries, Canada, New Zealand and the USA[6]; and it ranks 1st out of 11 when compared against selected Asia Pacific countries. However, Australian research is often focused on niche areas such as quantum technology, wireless technology and trustworthy hardware. In the area of cybersecurity, the Australian government explicitly expresses the need to leverage international partnerships.

Other areas and the business perspective

In line with the crosscutting nature of ICT, in other areas such as transport, energy and health, digital technologies are also identified by policy makers as providing important opportunities. The related practical challenges include:

- technologies for individuals to manage their own health care including apps and monitoring as well as online access to therapies in health;
- improved logistics and autonomous transport, sensor technologies and real-time data and spatial analysis for transport;
- and more efficient integration of Australian electricity grids.

Australia still exhibits a huge potential in the area of digitizing businesses. While digital growth has doubled over the last five years, the traditional and asset-intensive Australian sectors still show general lower levels of digitization than their peers (e.g. USA).[7] Although Australia has pockets of impressive digital performance such as world-leading mobile banking engagement and one-of-a-kind mine automation deployment (including the world's largest robots), there is plenty of room for innovation and research in areas ranging from product and service design to business model innovation, enhancing customer experiences, and streamlining internal processes and operations. In 2018 Australia released its digital economy strategy **'Australia's Tech Future'.** It covers digital infrastructure, digital business capability, and building digital skills and inclusion. Digitalization could contribute 'between AU $140 billion and AU $250 billion to Australia's GDP by 2025, based on currently available technology alone'.[8] Combining the above-mentioned other areas and the digitization potential clearly points to the economic benefits of the Internet of Things, but also the potential impact of big data and advanced analytics.

Course of Action Recommendations: Digital Disruption *(Australia)*

1. Support experiments with long-distance interactions facilitated by digital technologies using state-of-the-art and forthcoming technologies.

2. Promote opportunities for exchange between researchers, artists, engineers and a broad public in order to detect and address adverse effects as well as opportunities.

3. Policy makers should take advantage of the specific role that artistic interaction with technology and science plays in reaching out to broad public audiences. Art is inherently communicative and investments in art/science usually imply investments in public communication of science.

4. Start joint trials with online digital education. This could include creative artistic concepts to inform ethical insights about the implications of new and emerging digital technologies.

2: Industry and Innovation Competitiveness Agenda. An action plan for a stronger Australia. Australian Government, available at: https://www.pmc.gov.au/sites/default/files/publications/industry_innovation_competitiveness_agenda.pdf

3: Boosting the commercial returns from research. Australian Government; available at: https://submissions.education.gov.au/Forms/higher-education-research/Documents/Boosting%20Commercial%20Returns%20from%20Research%20%20-%2024102014.pdf

4: There is also a cybersecurity research collaboration of Oxford University and the government of Victoria: https://www.oxfordmartin.ox.ac.uk/news/14-12-15-cyberagreement/

5: https://industry.gov.au/Innovation-and-Science-Australia/Australia-2030/Pages/default.aspx released on January 30, 2018.

6: Selected EU countries: AT, BE, DK, UK, FI, FR, DE, IE, SE; Norway and Switzerland.

Artificial intelligence

The new strategy ***Australia 2030: Prosperity through Innovation***[9] also makes the case for data science and artificial intelligence, especially machine learning, optimisation, sensing, robotics, visualisation and distributed ledgers. Australia has strengths in AI research and hosts several industrial labs with solid track records of transitioning AI technologies into practice.[10] The strategy document recommends prioritisation of the *development of advanced capability in artificial intelligence and machine learning in the medium- to long-term to ensure growth of the cyber-physical economy.*

The Australian government committed to fund AI under its **Cooperative Research Centres (CRC) Program.** CRCs are industry-led partnerships bringing together industrial and academic research expertise with the aim to improve Australia's competitiveness. The CRCs include both large and small industries that identify research needs to develop innovative products, services, or processes. They typically run for three years and often develop proof-of-concept prototypes. For its last available round of funding in 2018, the Department of Industry, Innovation, and Science provided additional funding to help strengthen the link between research organisations engaged in AI and machine learning and industry wishing to solve problems through AI. The aim is to address gaps in Australia's AI capability and deliver tangible outcomes for the companies developing or using AI technology. The department announced 13 new centres[11] with additional funding from the 2018-19 budget for projects with a focus on AI (total project value). Application areas range from wastewater treatment to optimised air conditioning, mining, and agriculture and especially health.

Their topical focus and the collaboration of industry and academia make CRCs interesting initiatives for international collaboration. They have passed a competitive evaluation and target demanding research challenges in industrially and socially relevant areas. In addition, CRCs can be more flexible than other research organisations in entering international collaboration. They frequently organise workshops and conferences and often have strong links with education, for example through their university partners.

Course of Action Recommendations: AI *(Australia)*

1. Develop a global repository of AI strategies and policies to ensure greater transparency and accessibility to the general public and relevant stakeholders, such as policy makers. Such a repository can help develop a governance structure for ensuring accountability and transparency in the development of AI.

2. Encourage greater knowledge sharing between Australia and the European Union and its member states to foster a more collaborative environment, e.g. through mutual event invitations and consultations including scholars in other fields such as law, political science, and humanities.

3. Australia and Europe both have many expat researchers in AI from the other region. Maintain the opportunities for peer-to-peer collaboration with support for exchange visits and smaller-scale research collaboration.

4. Exchange good practices in AI education for the young, for teachers, and a broad public. Where applicable, this should include citizen science and art/AI initiatives. Collaborate in content creation, best-practice exchange and sharing of access to online training courses for AI – at the vocational and university level.

5. Europe has a long tradition of data and IT ethics regulation based on human rights, while other jurisdictions focus on different principles, e.g. property rights. Australia and the European Union should investigate frameworks to support citizen rights while facilitating dynamic industry innovation.

7: Digital Australia. Seizing the opportunity from the Fourth Industrial Revolution. Digital/McKinsey, March 2017. This study report also acknowledges research cooperation with the Australian Federal Department of Communications and the Arts.

8: Blackburn, S, Freeland, M & Gärtner, D. (2017) Digital Australia: seizing opportunities from the Fourth Industrial Revolution, McKinsey & Company.

9: https://industry.gov.au/Innovation-and-Science-Australia/Australia-2030/Pages/default.aspx released on January 30, 2018

10: Walsh T. (2017) The AI revolution. Education: Future Frontiers occasional paper series, NSW Department of Education, Sydney.

11:https://www.business.gov.au/Assistance/Cooperative-Research-Centres-Programme/Cooperative-Research-Centres-Projects-CRC-Ps/Current-CRC-P-selection-round#crcp6

EPIC Supports Artificial Intelligence

In February 2019, in collaboration with the 3A Institute, the Australian National University College of Law, the National Security College and the Crawford School of Public Policy, EPIC hosted the one-day symposium *International Dimensions of Artificial Intelligence.* The event helped to build new or enhance existing bonds between Australia and the EU in AI, e.g. by discussing new models to facilitate cooperation and a more dynamic international exchange of concepts and ideas. Discussion focused on how public policy, research and industry are approaching the opportunities and risks of AI in an international context, and emphasised opportunities for joint EU-AU action. In the policy session, DIIS Deputy Secretary Elizabeth Kelly and representatives from EU embassies discussed the need to jointly regulate AI while academics and researchers from different fields discussed progress and cooperation opportunities.

The International Dimensions of Artificial Intelligence event in Canberra examined how public policy, research and industry are approaching the opportunities and risks of AI in an international context.

EPIC Expert Visits Success Story: Spatial Intelligence

EPIC expert Prof. Rui Zhang from the University of Melbourne visited the Max-Planck Institute for Informatics in Saarbruecken, Germany where he collaborated with Professor Gerhard Weikum on a project studying relation extraction for knowledge base enrichment. A paper on their work was submitted to the Annual Meeting of the Association for Computational Linguistics, a top conference in the field. Possible future collaborations between the University of Melbourne and Max-Plank Institute were discussed in the following areas: Building geographic relationships knowledge into the geographic knowledge base, identification of the most salient features of geographic entities, information extraction for a few specific applications, and chatbot and dialogue systems.

Spatial intelligence

In the area of spatial intelligence, the joint Australia and New Zealand CRC for Spatial Information (CRCSI, http://www.crcsi.com.au/) has played a key role since its inception under the Australian Government Business Cooperative Research Centres Programme. One of the core research themes at the CRCSI is a modernisation of Australia and New Zealand's spatial infrastructure to support real-time, precision, mobile geodata utilisation. This includes the creation of a Spatial Knowledge Infrastructure (SKI) and research addressing the application of AI in this field. The CRCSI collaborates with several SMEs – often with an interest in agricultural markets. CRCSI's head office is located in Carlton, Victoria; further locations are in ACT, NSW, QLD and in Wellington, New Zealand. The topic was not addressed in dedicated events but was covered in the context of EPIC's e-Research activities.

FinTech

Initially EPIC also included Financial Technologies – or Fintech for short - as another potential focus area for EU-Australian ICT collaboration. It attracted the interests of policy makers: For example, following statements from the Australian Treasury,[12] the Turnbull Government aimed to support and attract FinTech innovators in order to develop and refine new products and services in the Australian market. However, this was less of a research initiative and more an aspect of the regulatory system that allows FinTech innovators to deploy their business models into domestic and global markets. An important component of the strategy was the regulatory 'sandbox' approaches introduced, which allowed businesses to test certain financial and credit services for up to 12 months without the need to apply for a licence.

12: https://fintech.treasury.gov.au/

EPIC supports e-Research

The EPIC Digital Science and International Cooperation Workshop was organised as part of **eResearch Australasia 2018.** It was attended by high-level experts and identified joint challenges in Australia and the EU. The event highlighted new opportunities for digitally enabled cooperation, helped define the necessary next steps towards improved EU-AU collaboration in ICT research and innovation. Input from this workshop enabled EPIC to produce a policy brief on the topic of EU-AU e-Research collaboration potential with a series of recommendations for policy stakeholders.

e-Research

In the area of e-Research, Australia and the EU have already collaborated in key domains such as biological science, astronomy, ocean and climate research. The European Commission currently finances the **Mesopp project**[13], for example, which delivers good scientific results on ocean e-infrastructures. A recent round of panel sessions on EU-Australian research cooperation identified key trends for future internationalisation of e-Research with a focus on long-distance collaboration.

Science and research are increasingly digitally-driven and digitally-dependent. The acceleration of wide-spread sensorisation, coupled with large databases of historic data, promises new opportunities for researchers to utilise a wealth of data. A new generation of young researchers is eager not only to exploit these resources, but also to openly share their data, tools, and solutions with peers and the public. This digitization of science is a major driver behind the internationalisation of research, leading to a workforce shortage of individuals with appropriate skills. Thus, it has become a necessity, particularly for industry, as innovation and knowledge for innovation are sourced globally.

Course of Action Recommendations: e-Research *(Australia)*

1. To strengthen collaborations between academia, industry and government agencies, work on standards for data, services and infrastructure to ensure access, interoperability, and ease-of-use along with the development of supported services.
2. Easily applicable funding models for realising EU-AU e-Research projects should become a primary target of future EU-AU e-Research cooperation.
3. Provide evidence for the benefits of e-Research beyond academia, i.e. for industry and society.
4. Create joint virtual EU-AU labs to ensure reusable data and associated services.
5. A joint AU-EU initiative could help address the shared challenge to improve current data management plans, e.g. through best-practice and support tools.
6. Australia and the EU should provide trials of dedicated data markets for clean and packaged data or data-as-a-service models.
7. Australia and the EU already have e-Research ties in domains from astronomy to biology, genetics, climate and medical research, and music. Further collaboration is possible in areas of the United Nations' Sustainable Development Goals (SDGs).

13: 1 http://www.mesopp.eu

New Zealand

Selected actors and organisations

- AI Forum NZ - Ben Reid, Executive Director
- Auckland University of Technology
  - Centre for AI Research (CAIR) - Prof. Albert Yeap, Director
- Callaghan Innovation - Jonathan Miller, Future Insights Manager | Hamish Mitchell, Customer Manager - Digital
- Engineering Research Institute - Centre for Advanced Manufacturing Technology - Prof. Zhan Chen
- Minister for Broadcasting, Communications and Digital Media, and Government Digital Services - Hon. Kris Faafoi
- Ministry of Business, Innovation and Employment - Hon. David Parker, Minister of Economic Development
- NZ Chief Technology Officer - pending
- University of Auckland - Associate Professor Giovanni Russello, Head of School of Computer Science
  - Intelligent Systems and Informatics Group
  - Innovative Manufacturing and Materials Programme
- University of Canterbury Cyber Security Lab - Prof. Richard Green, Head of Department
- University of Canterbury - Human Interface Technologies Lab (HIT Lab) - Christoph Bartneck, Associate Professor & Director of Post Graduate Studies
- NZTech, Member Relations Team
- New Zealand IoT Alliance - Kriv Naicker, Chair
- Orbica - Peter Rose, Orbica Europe Director
- University of Waikato STRATUS cybersecurity project & CROW lab - Dr Richard Nelson, Senior Lecturer

EPIC findings

In New Zealand, EPIC's 2.5-year project duration included 14 events which attracted more than 2,100 expert level attendees. These activities, combined with other activities aimed at innovators, researchers and policy makers, generated three main findings:

- With its strong tradition in and focus on agriculture, New Zealand's SMEs face challenges relating to ICT and I4.0: It can be difficult to suitably adapt offerings from larger companies for the average New Zealand SME. Europe shares this challenge, which brings opportunities to collaborate.
- There is great interest in Europe's DSM concepts including GDPR from businesses, academia, and policy makers in New Zealand. There is high level of understanding of their potential impacts upon New Zealand businesses and potentially for regulation.
- There is also great interest, at the researcher level, on ethics relating to, and the regulation of, AI, future Internet, and robotics technology.

Background

New Zealand's geographical location emphasises the need for international collaboration. Technology has the potential to become New Zealand's largest source of export revenue. The growth of the Internet has helped the IT sector to participate in the global marketplace. NZ ICT companies have a reputation in 3D graphics, health IT, services, bio informatics, and security. The government's future vision includes a technology-driven economy in which researchers are fully integrated and actively contributing to strategy, government policies and daily activities.

In New Zealand, the **Ministry of Business, Innovation and Employment** (MBIE) is also in charge of the overall science and innovation system. It places strong emphasis on boosting the number and impact of knowledge-intensive firms. New Zealand's isolated geographical position and relatively small economy accentuate the need to ensure that its firms and researchers are internationally well connected. Both characteristics also underline the importance of strategic choices in priority topics and areas for New Zealand's international competitiveness.

The MBIE has therefore identified a selection of priority topics that range from a strategic plan for science in society (**'curious minds'**) to innovation and international science partnerships, and also include a focus on the digital economy. The fact that New Zealand decided to establish a **Chief Technology Officer** role accountable to the Prime Minister and to the Minister for Broadcasting, Communications and Digital Media, and Government Digital Services indicates the importance of the subject area. The CTO

will provide independent expert advice to ministers and senior leaders on digital issues.

The underlying rationale of this and related policies is the widely acknowledged power of digital technologies to disrupt many aspects of society and to create new ways of learning, new forms of personal expression and to change what it means to be part of a 'community'. The New Zealand government focuses on the opportunities arising from digital disruption and has therefore published several programmes targeting digital technological innovation. Its business growth agenda is entitled **'Building a Digital Nation'** and ranges from the digital sector and businesses to digital New Zealanders and government. It also puts strong emphasis on *Security and Privacy*.

Regarding the science system, in October 2015 the MBIE published its *National Statement of Science Investments*[14] which demonstrates a relatively high ranking of computer science within New Zealand's academic research output in terms of frequently cited publications. The report also points to the important role of private investments in ICT in New Zealand: more than 80% of ICT R&D is funded by industry, the rest from higher education sources. The level of ICT skills is high (New Zealand ranks 6th of 148 countries) and the quality of ICT infrastructure is good (ranking 12th out of 143 countries). However, the report also acknowledges that stronger academic research is needed to support ongoing innovation and talent development. The report asks for a more secure long-term basis for ICT rather than crowding out near-to-market, industry-led research. This should include new investments in basic ICT research.

Internet of Things and artificial intelligence

The action plan for supporting a thriving digital sector[15] includes support for a nation-wide **Techweek** event, attracting investors to New Zealand's technology sector, focusing on *Internet of Things* technologies and accelerating the adoption of *AI* technologies. The actors in charge of realising elements of this strategy include the MBIE and EPIC partner Callaghan Innovation. The strategy also explores options to promote itself as a place for international entrepreneurs and multinational corporations to invest in the development and testing of emerging technologies. Another action to accelerate the safe adoption of AI technologies is the formation of the **Artificial Intelligence Forum** in a collaborative effort of the MBIE, Callaghan Innovation and NZTech.[16]

Course of Action Recommendations: AI *(New Zealand)*

1. Include collaboration on AI, AI ethics, AI innovation, labour and society aspects in the work of the Joint Science and Technology Committee to jointly investigate impacts and issues, set guidelines for best practice and publish learnings.
2. New Zealand's geographical position and diverse bilateral trade and cultural relationships with the two largest global "AI giants", the US and China, affords it a relatively unique position between the West and the East for collaborative international AI policy development for global issues, for example climate change or human trafficking.
3. Europe and New Zealand should share experiences and approaches to include a broad public in the design of AI systems. New Zealand's indigenous experience and Europe's diverse cultural setting provide ample opportunities for best practice exchange.
4. Offer an AI pilot for online courses or MOOCs to enable Europeans and New Zealanders at all stages of education to rapidly increase their practical AI skills to help meet the market demand.

In the area of the IoT, MBIE has partnered with NZTech to analyse opportunities within the New Zealand market. This aims at stocktaking of current IoT applications and future potential use. In addition, MBIE supports NZTech in forming an **IoT Alliance.** This will be a collaboration of industry and government working towards IoT adoption.

14: http://www.mbie.govt.nz/info-services/science-innovation/national-statement-science-investment

15: Building a digital nation. Part of BGA Building Innovation. MBIE, March 2017. http://www.mbie.govt.nz/info-services/science-innovation/digital-economy/building-a-digital-nation.pdf

16: NZTech is a non-profit membership association representing over 500 organisations across the New Zealand technology landscape: https://nztech.org.nz/

Course of Action Recommendations: IoT *(New Zealand)*

1. New Zealand can provide an excellent environment for testing the suitability of Industry 4.0 and IoT solutions for small and medium-sized enterprises including in less digitized sectors, e.g. agriculture and health.

2. Jointly address environmentally beneficial and energy-efficient solutions for sustainable development, e.g. in applications covering large and remote areas.

3. The EU and New Zealand should continue initiatives that further the exchange of experts, for example similar to the EPIC experts supporting the C-Prize.

4. Given the lack of skilled people in both regions, New Zealand and Europe should collaborate on IoT and Industry 4.0 education and training including vocational training.

5. Governments in Europe and New Zealand should exchange experiences and practices of ensuring that customers in industry and consumers understand the security risks of IoT and I4.0 systems and can take appropriate steps.

6. Jointly investigate legal frameworks to cover the unauthorised use of IoT devices and similar risks. Europe and New Zealand should cooperate to better understand what international and extraterritorial jurisdiction issues arise from the proliferation of IoT devices and develop shared approaches.

Project Highlights: EPIC Supports Human-centric AI

In New Zealand in 2018, EPIC supported the writing of a new textbook using the Book Sprint method. The objective of the five-day gathering was for a team of six leading experts from Europe and New Zealand, representing different disciplines in the range of human-robot interaction (HRI), to write a full book on the topic. The event further laid the foundation for future fruitful cooperation in upcoming topics relating to HRI. The result is a 210-page book entitled **"Human-Robot Interaction".**

The book will be published with an internationally renowned publishing house. An additional book manuscript on the topic of ethics in AI and robotics was drafted during a second Book Sprint organised by the project in Singapore in 2019. Both books will be published soon, with the first to be published in German by Hanser.

EPIC Expert Visits Success Story: ICT in Transport

In 2018, EPIC expert Dr Yue Cao from Northumbria University (NU) visited Auckland University of Technology's (AUT) Department of Information Technology and Software Engineering with the aim to initiate a collaboration between NU and AUT. In New Zealand, Dr Cao presented the two research seminars, ***"Towards Sustainable E-Mobility: Vision and Challenges"*** and ***"When Geo-centric Information System Meets ICT and Transport"***, as well as the invited talk ***"Enabling 5G Opportunistic Service Relay and Autonomous Valet Parking for Urbanization"*** at the 2018 IEEE New Zealand Wireless Workshop.

Dr Cao used his visit to promote research collaboration between NU and AUT on the research of E-Mobility, and a resulting article entitled ***"MEGEE: Mobile Edge computing Geared v2x for E-mobility Ecosystem"*** was accepted for the IEEE Wireless Communications and Networking Conference 2019. In addition, a poster entitled ***"Unmanned Aerial Vehicle - Assisted Mobile Edge Network for Disaster eHealth Communications and Resource Allocation Services",*** co-authored with AUT researchers was accepted and published in Information Systems for Crisis Response and Management (ISCRAM) Asia Pacific 2018.

Advanced manufacturing

As a government agency, Callaghan Innovation puts strong emphasis on advanced manufacturing. Competencies include robotics and automation, mechanical and electrical engineering, prototype manufacturing, and testing and validation. A particular challenge for the system in New Zealand is the country's large proportion of SMEs, which does not easily facilitate the application of manufacturing concepts designed for larger systems. With respect to ICT, many topics are also covered under the IoT aspect.

Additional government initiatives supporting the digital sector include an attraction strategy for multinationals to perform R&D in New Zealand; driving the digital sector R&D through Callaghan Innovation grants; support of digital sector research through the MBIE's **Endeavour Fund** and support of hi-tech summer internships through **R&D Experience Grants.** The MBIE is also supporting NZTech to form a New Zealand Internet of Things Alliance. This alliance will be a collaboration of industry and government working towards accelerating the adoption of IoT technologies for the economic and social benefit of New Zealand. For this reason, it was decided to include *advanced manufacturing* in *IoT and Industry 4.0* respectively under a more general *digital economy* topic.

Cybersecurity

One of the actions under the *cyber capability* goal of the government's **Cybersecurity Strategy and Action Plan** is to establish a public-private taskforce to address the cybersecurity skills shortage. The taskforce will focus on practical and immediate actions to increase the number of cybersecurity professionals that industry needs, such as developing an alternative pathway into the profession. MBIE has also invested NZ $12.2 million in a leading cybersecurity project at the University of Waikato to create a suite of novel security tools, techniques and capabilities that return control of data to cloud computing users. The aim is to empower users to control the security of their data and to give companies tools and services to sell.

Course of Action Recommendations: Agritech *(New Zealand)*

1. Investigate options for joint RTDI activities in technology areas in combination with other policies of interest to both regions, for example smart specialisation, AI and agritech, etc.

2. Maintain and expand existing opportunities for research exchange. Given the relatively small number of experts, even small amounts of funding can trigger significant exchanges.

3. Improve collaboration between centres of excellence to increase research scale, effectiveness, long-term relationships and stimulation of new ideas.

Singapore

Selected actors and organisations

- AI Singapore - Dr Stefan Winkler, Deputy Director
- A*STAR I²R - Tan Chee Seng, Institute Director
- CREATE Campus for Research Excellence and Technological Enterprise
  - TUMCREATE – Graham Leedman, Technical Director TUM
- Economic Development Board - Beh Swan Gin, Chairman & Chng Kai Fong, Managing Director
- Infocomm Media Development Authority - Chan Yeng Kit, Chairman & Jacqueline Poh, Managing Director
- Integrated Health Information Systems - Paul Chan, Chairma
- IPAL- Image & Pervasive Access Lab - Wei Tsang Ooi, Codirector (NUS), Joo Hwee Lim, Codirector I²R
- National University of Singapore (NUS)
  - Singapore Data Science Consortium - Prof. Ho Teck Hua, Senior Deputy President and Provost
  - NUS-Singtel Cyber Security Research and Development Laboratory - Chan Mun Choon, Principal Investigator
- Ministry of Transport - Khaw Boon Wan, Minister for Transport
  - Land Transport Authority (LTA) - Chan Heng Loon Alan, LTA Chairman
  - Singapore Autonomous Vehicle Initiative
- Nanyang Technological University
  - Cyber Security Research Centre - Prof. Thambipillai Srikanthan, Executive Director
- National Research Foundation Singapore (Prime Minister's Office)
- Office for Space Technology and Industry
- SGInnovate - Steve Leonard, CEO
- Smart Nation and Digital Government Office - Ng Chee Khern, Permanent Secretary Smart Nation and Digital Government

EPIC findings

In Singapore, EPIC's 2.5-year project duration included eight events which attracted more than 1,500 expert-level attendees. These activities, combined with other initiatives targeting a variety of project stakeholders, generated four main findings:

- The coastal setting of Singapore, and its rapid responses to transport challenges make it an ideal collaboration partner for the joint development of solutions in urban transport and local air pollution mitigation advancements.
- Singapore is well positioned to act as a hub and ICT test environment for Asian conditions – from market and regulatory aspects to climate and culture. There is a strong entrepreneurial mindset and collaboration between European actors with a presence in Singapore.
- There are huge opportunities for collaboration with Singapore-based industry and other organisations – both large and small in areas such as industrial Internet, smart city or data privacy.
- There is an opportunity to leverage European actors already present in Singapore to become anchors for future EU projects and initiatives.

Background

Singapore is an information and technology hub in the Asia Pacific region, and home to many of the world's top ICT multinational corporations. The ICT sector has heightened Singapore's international competitiveness, raising productivity and transforming business processes in several industries. It also offers an open, dynamic and competitive business environment into which foreign ICT companies and talent are welcomed and collaboration is encouraged.

In Singapore, the **National Research Foundation** (NRF) is a department within the Prime Minister's Office and a major body in charge of devising and implementing policies, plans, and strategies for research, but also for innovation and enterprise. The NRF aims to transform Singapore into a vibrant R&D hub that contributes towards a knowledge-intensive, innovative and entrepreneurial economy and a magnet for excellence in science and innovation. The

NRF regularly prepares and helps to implement a five-year **Research, Innovation and Enterprise Plan** (RIE2020) – currently for the period 2016 to 2020.[17]

The plan is an important instrument for the coordination of RTDI initiatives in Singapore and has played a major role in continuously improving research organisations, but also research output and impact on the Singaporean economy. For example, Singapore's universities have steadily risen in the global rankings with NUS and NTU in the 12th and 13th positions respectively.[18] Singapore has also been successful in bringing back its researchers from abroad by providing them with significant opportunities. In combination with other policy measures – such as the **Campus for Research Excellence and Technological Enterprise CREATE** – Singapore has become a nexus for international R&D collaboration. For example, CREATE now collaborates with MIT (USA), ETH (Zürich) and many others.

An important actor shaping the RTDI scene in Singapore is **A*STAR** with its 20 research institutes covering fundamental and applied research with a focus on technology and science. These institutes are internationally linked with high-quality research organisations and aimed at strong alignment with industry demand. There are now also significant efforts to create start-up dynamics and Singapore has witnessed its first ICT "unicorn" companies in the ICT sector, Garena[19] and Razer.[20]

RIE2020 puts emphasis on closer integration and coordination of national efforts including mission-oriented research. It also emphasises supporting the best teams and ideas but also flexibility in reprioritising funding towards new economic opportunities and national needs. There is now a strong focus on value creation, for example by supporting companies to expand their absorptive capacity for new technologies. And there are significant investments in the R&I workforce both in the private and public sectors.

Singapore has also identified strategic technology domains such as advanced manufacturing and engineering, health and biomedical, urban solutions and sustainability, services and digital economy. The concept of the **"Smart Nation"** provides an umbrella and the RIE2020 Plan is linked with the Smart Nation initiative that heavily draws on digital technologies from digitally enhanced manufacturing to digital health service delivery and digital simulation of fleets of autonomous vehicles.

Artificial Intelligence and Data Science

In May 2017, the NRF announced the launch of ***AI Singapore*** (AI.SG), a national programme to catalyse, synergise and boost Singapore's AI capabilities. Up to S$150 million will be invested in AI.SG over the next five years. Topics of interest include explainable AI systems exhibiting more humanlike learning capabilities as well as adjacent technologies such as the corresponding computing architectures and cognitive science. The initiative is a government-wide partnership which in addition to the NRF also comprises the Smart Nation and Digital Government Office, the Economic Development Board, the Infocomm Media Development Authority, SGInnovate, and the Integrated Health Information Systems.

In the related field of data science, NUS and University College London (UCL) have developed a joint research collaboration initiative that also facilitates staff and student exchanges. It involves the **Singapore Data Science Consortium** (SDSC) hosted at NUS and UCL's Centre for Data Science and Big Data Institute.

ICT in Transport

In general, transportation features prominently on the Singapore policy agenda. The initiatives are often tuned to very specific needs of the small-in-size Singaporean island economy. For example, the **Land Transport Authority** ("LTA") has published a new **Land Transport Master Plan** that sets out a vision for land transport in Singapore for the next 20 years. At the CREATE Future Mobility Symposium 2015, the **Ministry of Transport** outlined future plans on improving Singapore's transport system through the use of new technologies in urban mobility. The symposium brought together researchers from local and international universities to examine trends and challenges in urban mobility and transportation solutions and presented flagship projects from research programmes at **CREATE** (Campus for Research Excellence and Technological Enterprise). The Ministry of Transport and LTA are looking into three areas of technology with the potential to transform public transport services – data analytics, smarter interfaces for commuters and autonomous vehicles.

LTA is also in charge of the **Singapore Autonomous Vehicle Initiative** (SAVI) – a joint partnership between LTA and A*STAR to provide a technical platform for industry partners and stakeholders to conduct research and development (R&D) and test-bedding of AV technology, applications and solutions. One of the focus areas under SAVI is to prepare technical and statutory requirements for future deployment of autonomous vehicles in Singapore.

17: https://www.nrf.gov.sg/rie2020

18: World University Ranking published by Quacquarelli Symonds based on normalised-weighted research citations.

19: https://www.garena.sg/

20: https://www.razer.com/sg-en

EPIC Supports ICT in Transport

TechInnovation 2017 in Singapore introduced EPIC to an audience interested in innovative ICT solutions, with emphasis on *ICT in Transportation*. EPIC was accompanied at the three-day event by Gregor Petri from Vienna-based Fluidtime/Kapsch. Petri aimed to highlight his organisation's work in the ICT in transport field, as well as to showcase the H2020 OPTIMUM project which works on state-of-the-art IT-solutions to improve urban multimodal mobility and transit, freight transportation and traffic connectivity throughout Europe. With some 700 visitors to the EPIC booth and 17 face-to-face meetings for Kapsch / Fluidtime, including with several Singapore-based companies interested in exploring cooperation opportunities, the event was a great success.

Gregor Petri

For Petri, a stand-out meeting with potential partner Singapore Technologies Engineering produced a follow up visit to the Fluidtime/Kapsch head office in Vienna to further discuss future collaborative projects. Watch a testimonial video describing Fluidtime/Kapsch's successful partnering with EPIC on the project website www.epicproject.eu.

EPIC Supports Cybersecurity and Privacy

Cybersecurity and privacy were topics of particular interest to the project's Singaporean stakeholders. In December 2018, EPIC hosted a policy roundtable on the DSM and data protection, with discussion focusing on the policy dimensions of privacy research and potential EU-SG collaboration. Featuring keynote speaker Prof. Nigel Smart from the University of Leuwen's COSIC, the roundtable established contacts with representatives from organisations in Singapore who share an interest in privacy-preserving technology research. This was followed in April 2019 by a second, larger scale, more security focused event which EPIC hosted in cooperation with A*STAR I^2R, AI Singapore and Advantage Austria. Here, an international roster of industry trailblazers and academic experts spoke on the potential challenges and positive aspects facing privacy and cybersecurity. The keynote speakers were Dr Dan Bogdanov, head of the Privacy Technologies Department at Estonian start-up Cybernetica and Mike Anderson, CTO of DEX and founder of Ocean Protocol. Tim Llewellynn, co-founder and CEO of Switzerland-based NVISO and head of the Bonseyes AI Marketplace also presented at the event.

Cybersecurity and Privacy

The NRF runs a national cybersecurity R&D programme. It aims to improve trustworthiness of cyber infrastructures with an emphasis on security, reliability, resiliency and usability.[21] A five-year S$130 million fund will be available to support research efforts into both technological and human-science aspects of cybersecurity. Six research topics have been identified: scalable trustworthy systems; resilience; situation awareness and attack attribution; combatting insider threats; threat detection; analysis and defence; and digital forensics. The NRF recently announced a collaboration with the UK's EPSRC.[22]

21: https://www.nrf.gov.sg/programmes/national-cybersecurity-r-d-programme

22: The Physical Sciences Research Council is the UK's main agency for funding research in engineering and the physical sciences. www.epsrc.ac.uk

Course of Action Recommendations: Security and Privacy *(Singapore)*

1. Intensify the discussion around collaboration in cybersecurity, especially related to other digital areas such as Internet of Things or AI.
2. Perform joint research focusing on ethics of data use.
3. Jointly showcase technologies demonstrating the benefits of guaranteed privacy and security, e.g. using differential privacy.
4. Jointly address the education of citizens and SMEs to understand the risks, but also solutions in the area of privacy and security. Inform about new possibilities for anonymisation and synthetic data models.
5. Collaborate in privacy-improving and privacy-preserving technologies for Smart City and Smart Nation developments and in health.

Course of Actions Recommendations: Spatial Intelligence *(Singapore)*

1. Research Earth observation data use-cases based on their respective existing developments. This requires the collaboration of government, industry and academia.
2. Develop collaborative or matching funding models in the field of Earth observation for high priority areas such as air pollution mitigation and urban transport research to leverage existing resources.
3. Develop joint activities that go beyond the sharing of satellite data.
4. Investigate options for developing marketplaces for European satellite data and joint applications.

Spatial Intellzigence

In the area of satellites and space, it is planned to grow Singapore's R&D capabilities, forge international collaboration and develop talent for the space industry. The **Office for Space Technology and Industry** is designated to develop the industry in the sector. Research topics include satellite technology, satellite remote sensing applications, satellite communication services, satellite components, satellite integration, and satellite-based services

EPIC supports spatial intelligence

At the 2018 Singapore Space Symposium, EPIC hosted a session which brought together European researchers active in H2020 with Singaporean researchers from academia and industry. The event demonstrated European competencies in spatial intelligence, improved awareness of Europe's satellite infrastructure and provided a forum for exchange about future RTDI directions. Dr Hermann Klug from the Paris Lodron University of Salzburg demonstrated an IoT related framework to measure and inform changes to groundwater bodies in near real-time, while Dr Chandra Taposeea from isardSAT presented the H2020 Project AirQuast- air quality services based on Earth observation data.

The topic was once again at the forefront during ICT Vienna 2018, where EPIC hosted GeoAI and GeoBI spatial intelligence talks featuring New Zealand's Orbica. During the session, Orbica Europe Director Peter Rose explained how open data and open source software play a pivotal role in bringing communities and governments together to surface achievements and problems faced by different parts of the community.

EU Digital Single Market and its International Reception

By 2019, the EU and its member states had realised most of the policies for a Digital Single Market (DSM). This meant the launch of a broad range of policy initiatives in fields such as digital technology, privacy regulation, research and technology development, roaming charges and copyright questions, leading to the adoption of new regulations or funding and support measures for novel information and communication technologies. Despite of its European focus, the DSM is of interest to Europe's international partners and is also widely known in Australia, New Zealand, and Singapore.

The DSM as a European policy objective was formally announced in a 2014 resolution by the European Parliament.[23] In its resolution the Parliament calls on member states to address barriers to the development of the DSM to make Europe fit for the digital age. It highlights the potential of e-commerce and of cross-border online services but also the need for consumer protection including the protection from abuse. It thus also addresses the digital divide, data protection and cybersecurity and encourages access of disabled users to digital content and an improved prevention of child exploitation.

Although primarily a European initiative, the DSM is based on concepts and ideas of great relevance to Europe's international partners including Australia, New Zealand, and Singapore. The EPIC events in those countries brought together leading experts and policy makers who discussed DSM topics with enthusiasm. Interests ranged from Europe's approach to (data) roaming to initiatives in AI, data protection and privacy, and the e-ID. From the end of geo-blocking to the *right to explanation* on algorithmic decision-making, new copyright and VAT rules, these policies have changed the playing field for companies around the world.

The EPIC event discussions highlighted how the EU Digital Single Market impacts companies located in international partner countries. The EU's harmonisation of select regulations regarding the DSM and new Data Protection Rules are not just necessary for exporters in those countries, they are often taken up in anticipation and in preparation of such exports or simply to 'comply with the strictest standards world-wide'.

In 2019, a range of DSM policies specifically targeted an appropriate ethical and legal framework for AI. The European Commission welcomed ethics guidelines for trustworthy AI prepared by the High-Level Group on AI.[24] Other technologies that have been discussed as important for the DSM include:

- Blockchains, in particular in the context of Fintech: This is mostly discussed with reference to required new regulation.
- Geo-spatial and metrological data including data from COPERNICUS: The focus of the DSM mid-term review is on take-up and exploitation of Copernicus data and the upcoming *Data and Information Access Services (DIAS).*[25]

The DSM topics of special interest which emerged in the partner countries during the project's rollout were:

- In Australia: AI and e-Research
- In New Zealand: Internet of Things and AI/agritech
- In Singapore: Privacy, cybersecurity and spatial intelligence

23: Digital Single Market. European Parliament resolution of 27 November 2014 on supporting consumer rights in the Digital Single Market (2014/2973(RSP)).

24: AI HLEG (2019) Building trust in human-centric AI. https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines#Top

25: http://copernicus.eu/news/upcoming-copernicus-data-and-information-access-services-dias

EPIC Supports the DSM

EPIC hosted or supported 11 events focusing on the Digital Single Market across the partner countries of Australia, New Zealand and Singapore, as well as in the EU. The international roster of events attracted more than 550 participants from data science, industry, research and policy backgrounds eager to learn about what the DSM means for their countries, as well as the potential global impacts and associated innovation and business opportunities. Topics included Internet governance, data ethics, and potential future strategic research agendas that might develop in response to the DSM. The reaction of the audiences confirmed the strong interest from researchers as well as the importance to inform third country ICT industry representatives about DSM and, for example, GDPR details.

Presenters at these events included Maarten de Rijke, a professor of AI and information retrieval from the University of Amsterdam, Nicolas Nicoloudis, a senior business innovation strategist at SAP, Jason Gleason, the CEO of eight-wire, and Paul O'Connor, head of analytics at Datamine.

A new European personal data framework with global impact

New rules and regulations to enhance the security of digital services and improve the handling of European citizens' personal data are a direct consequence of the DSM's policy objective to increase trust in digital markets. Two legal initiatives are especially relevant for doing business digitally in Europe or with European citizens: The General Data Protection Regulation (GDPR) and the e-Privacy Regulation (ePR). These initiatives derive from the Charter of Fundamental Rights of the European Union, namely the protection of personal data and a person's right to a private life.[26] These policies changed the way of doing digital business in Europe and affected Europe's international partners. The new rules also created new dynamics in ICT research fields such as privacy, data analysis, or big data.

The increased territorial scope and extra-territorial applicability of GDPR is arguably the biggest change to the data privacy landscape in Europe. Previously, territorial applicability of the directive was ambiguously defined. GPDR now applies to the processing of personal data regardless of whether such processing takes place in the EU or not. It also applies to the processing of personal data of data subjects in the EU, where the activities relate to offering goods or services to EU citizens and the monitoring of behaviour that takes place within the EU. Apart from its impact in areas such as e-Health and online marketing,[27] the new EU rules for data may internationally position the European Union as a kind of *safe haven* for personal data. They offer an internationally unique selling proposition as neither the US nor Asia offer the abovementioned kind or level of protection for private data. It is therefore clear that GDPR is of great importance for anybody wishing to do business with Europe. During EPIC events, business leaders (and policy makers) in Australia and New Zealand showed great awareness of these rules, as did academics in those countries.

DSM impact on research and innovation

New DSM rules reference technical progress in digital services and computing. For example, GDPR foresees a level of protection that is tuned to the state-of-technology suggesting a moving target for levels of IT security. GDPR aims at privacy-by-design rather than only relying on add-on security features (e.g. passwords). Therefore, the new rules have caught the attention of computer scientists for their research. This includes the *Right to Erasure* and the *Right to Explanation* because of the technical challenges resulting from these rights.

One of the biggest challenges will be utilising the developing big data potential while preserving privacy for citizens. It is expected that the market for privacy enhancing technologies (PET) will grow in Europe and in Australia, New Zealand and Singapore for both customers and businesses. Although this will depend on the precise legal frame and practices, many new research topics arise from new DSM privacy rules. The following were discussed as promising areas for joint activities with Europe's international partners:

- Anonymisation: technical means for data anonymity, but also studying effects and limits of pseudonymisation
- Automatic forgetting to support the deletion of personal data from data bases when data is no longer necessary or outdated
- Automizing the process of giving consent for users while maintaining legality and transparency

- Explaining: ways to create meaningful explanations for learned decision-making support
- Data analysis under ethical constraints that maintain privacy
- Privacy-preserving methods that are built into the algorithms and methods of an information system

The policies targeting the creation of a level playing field for digital services also include other, wide-ranging changes that are relevant for international businesses. In addition to GDPR and ePR regulations, there are also initiatives such as international cooperation in Cloud Computing and 5G that are certainly relevant for Europe's international partner countries.

The end of H2020 will provide an opportunity to reconsider international ICT RTDI cooperation. A forthcoming new European Framework Programme for Research (Horizon Europe) should be an instrument to strengthen Europe's international role and collaboration – in research, but also culturally and economically. Other relevant factors of current interest are of course the future relation with the UK and the proposed new EU Free Trade Negotiations with Australia and New Zealand. In summary, there are many reasons to stimulate and expand Europe's international ICT research and innovation partnerships now.

26: Decision on the e-Privacy regulation is expected for 2019. It will cover many aspects of electronic communication, for example unsolicited marketing, cookies, and confidentiality.

27: Goldfarb A., Tucker C. (2011) Online display advertising: targeting and obtrusiveness. In: Marketing Science 30(3), pp. 389–404.

Recommendations for All Three Countries

EPICA – Europe's ICT community in Australia, New Zealand, Singapore

There are strong and important European ICT expat communities based in the EPIC target countries, especially in Australia and New Zealand. These expats are strongly interested in research collaborations with Europe and are often the driving force behind joint research projects. Based on their knowledge, experience, and networks, European expats frequently initiate collaborative EU Framework Programme proposals. Such projects are an important link to their home country and former research groups.

European network opportunities for researchers exist to some extent. For example, the Marie Sklodavska-Curie Actions provide a degree of networking and support for expats. Also, several EU member states aim to maintain relations with their expats. However, those networks are often limited in regional outreach. Most importantly, no *dedicated European ICT network* exists that would support Europe's expats in Australia, New Zealand, and Singapore with information or opportunities to meet and exchange – including information about new developments in Europe.

Proposal for a European expat network in the EPIC partner countries (Australia example pictured here).

In a similar direction, there are some linkages of European research actors in the target countries today. They are often driven by sector or national (i.e. member state) initiatives. However, there is little support for the self-organisation of EU actors developing and researching technology in third countries and smaller sector companies or businesses from smaller countries may be unable to easily partner with similarly minded companies.

It is therefore recommended to address such shortcomings with a dedicated ICT research network. This network can build on member states' activities, link and expand opportunities to meet and provide targeted information relevant to ICT researchers. It should include expats in the ICT industry with the additional benefit of bridging the academia-industry communities.

New models for collaboration

In Europe, the EC Framework Programme helped establish a specific type of project as one of the main forms of scientific and research collaboration. This is the typical consortium with five-to-twelve partners agreeing on a joint research programme with a two-to-four-year duration. These projects typically include partners from academia, research, small and large industry. While this model has worked well in Europe, it may be less suited for third country participation. Other forms supporting research collaboration should also be examined.

EU research projects are of limited duration and do not ensure proper follow-up projects due to the competitive nature of the Framework Programme. Timely co-funding for the partners from Australia, New Zealand or Singapore is difficult to achieve. In addition, the formal aspects of Framework Programme projects can be challenging for third country partners; e.g. contractual aspects, reporting, reviewing, payments, and the EC online portal can all be unusual for research organisations outside Europe. Thus, EPIC makes the following recommendations:

- Dedicated third country participant status: simplified contract, limited rights and more flexible partnerships. This is particularly important when there is only limited funding for the third country participants, such as support for travel costs.
- In areas of continued mutual interest, the set-up or use of an existing organisation should be considered to further joint project support.
- Joint calls are an option only when there is strong political interest and commitment on both sides. In the past, they have proven difficult to set-up and in many cases, it was impossible to sustain a topical collaboration over extended periods of time.

Also, existing European labs (or labs established by EU member states) should become focus points for European collaboration. For example, IPAL Singapore already participates in projects funded by the European Commission even though IPAL is formally an initiative of France's National Centre for Scientific Research (CNRS).

Support actions

The experts propose a follow-up activity to EPIC. Although it took time to make the project known, it soon became a huge opportunity for organising targeted meetings, intensely and openly discussing shared policies, building prospects for collaboration, or simply unveiling joint challenges faced in Australia, Europe, New Zealand, and Singapore. Such support actions can provide access to experienced and knowledgeable partners and help to identify relevant experts for ICT collaboration opportunities. They demonstrate strong European interest in concrete collaboration with third countries both in research and at the political level. By way of reflecting domestic thinking, they can become important means for improving mutual understanding.

It is also clear that the design of general support actions in the Framework Programme faces several challenges. They are limited in their duration; they can only address a limited number of topics; and they have no representative authority regarding RTDI policies in themselves. At best they can be enablers. It is therefore recommendable to develop more durable ways, e.g. centres of competence, that support the European Commission's international RTDI activities, help in devising joint strategic directions with the partner countries, and provide organisational support and linkage between institutions over extended periods in focused regions and in appreciation of an integrated perspective on research and technological innovation. It may thus be advisable to focus on single countries over extended periods of time and/or to strategically focus on shared challenges – including their identification – with the partner countries.

An integrated approach to RTDI collaboration

The reasons and motivations for transnational collaboration in research, development, and technological innovations are diverse. They range from sharing resources and infrastructure to joining complementary competencies for researchers, but they also include less commonly addressed reasons such as an interest to get to know different research groups, to get inspiration from new colleagues, and to enjoy working in a different country. At policy level, reasons for collaborating between nations include improving RTDI systems along with the domestic knowledge base, joining forces in tackling demanding research and policy challenges, and also aspects such as foreign policy, preparation of tighter associations with a country, and improving diplomatic relations.

The EPIC events – addressing both research and policy levels – demonstrated how international research collaboration is increasingly driven by - and influencing - other policy areas. The most prominent example of the influence of ICT regulation on research collaboration concerned Europe's GDPR, which tightly connects with research challenges in data bases, AI, cybersecurity, and many others. It also became clear that governments around the world are facing many similar problems with ICT regulation and digitization of their societies and are consequently looking into concepts and approaches in other countries. Europe's DSM turned out to address many such topics that are of interest elsewhere.

In addition, we also saw how Europe's Smart Specialisation strategy has been observed and even copied in distant regions. The strategy originally arose in regional and innovation policies, but it neatly aligns with research and innovation, especially in ICT. Digitization added intelligence in products and services, medical ICT and other fields are typical focal areas for fostering smart strategic development globally.

It is thus recommendable that RTDI policies are considered in conjunction with other international collaboration policies. This may not always be the case because sometimes focus lies just on complementary research capabilities. However, overlooking the potential synergies of an integrated perspective means missing an opportunity to jointly develop not just technological solutions, but also shared visions, joint approaches, and common solutions or best-practices.

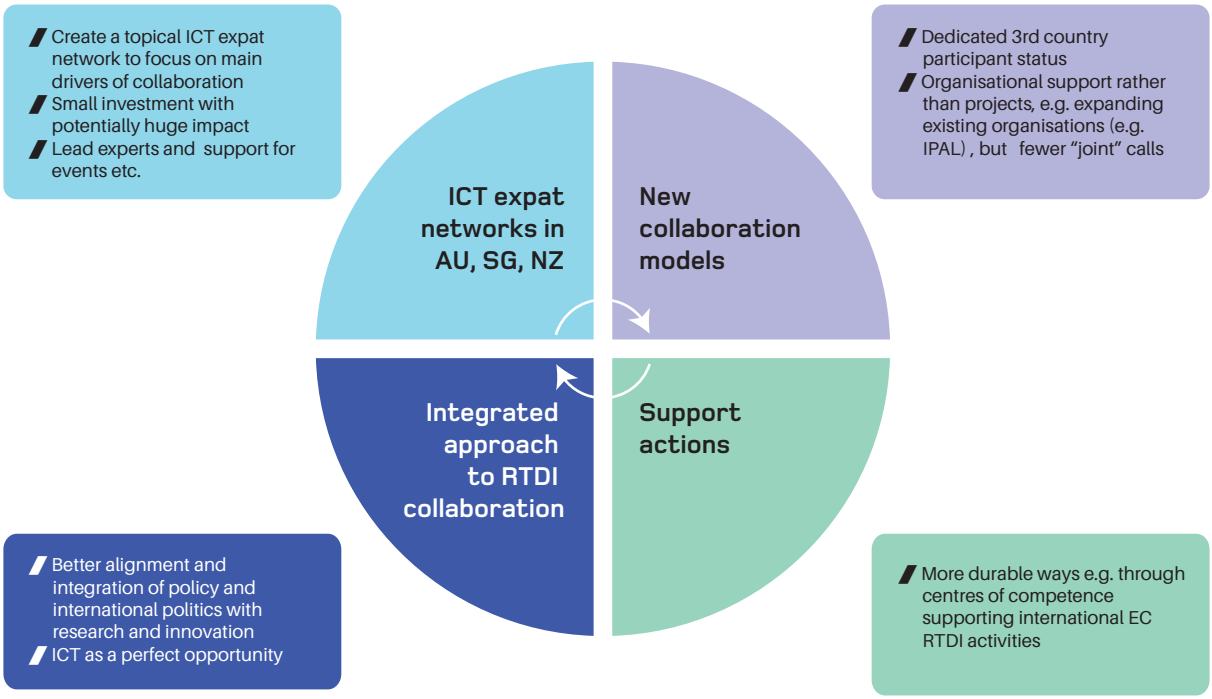
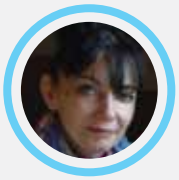
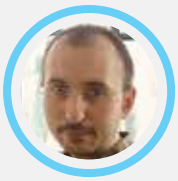
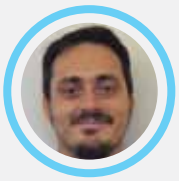


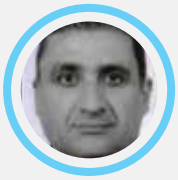
Figure 1: Recommendations for all three target countries resulting from EPIC project findings.

Annex 1 EPIC Experts

Expert	Visited Institution/s	EPIC Topics	Specific Topic
 **Earl Barr** University College London, UK	Monash University, Australia University of Adelaide, Australia	Digital Economy	A new perspective on software engineering and programme analysis: Bimodal programme analysis
 **Lynn Batten** Deakin University, Australia	Radbound University, Netherlands	Cybersecurity, Digital Economy	An investigation of blockchain-based digital portfolios
 **Ann Borda** University of Melbourne, Australia	University College London, UK University of Cambridge, UK	Digital Economy	New modes of public participation and digital knowledge creation in health and biomedical research
 **Gustavo Carneiro** University of Adelaide, Australia	Technical University of Munich, Germany Instituto Superior Tecnico – Lisbon, Portugal	Artificial Intelligence	A new optimisation method based on randomisation algorithms to model different deep learning approaches, and new training methods for large-scale datasets
 **Janne Korhonen** Aalto University, Finland	University of Technology, Sydney, Australia RMIT University, Australia	Digital Economy	Digital capability framework
 **Liyanage Madhusanka** University of Oulu, Finland	Data61, Australia The University of Sydney, Australia	Cybersecurity, Digital Economy	Blockchains for online banking system for citizens of rural areas without real-time bank connectivity
 **Ella Peltonen** University College Cork, Ireland	University of Melbourne, Australia	Machine Learning and AI	Smartphone energy management
 **André van Schaik** Western Sydney University	University of Kent, UK	AI and IoT	Neuromorphic engineering

Expert	Visited Institution/s	EPIC Topics	Specific Topic
 **Rui Zhang** University of Melbourne, Australia	Max Planck Institute, Germany	Spatial Intelligence	Knowledge base of geographic entities with information inference capability
 **Thanh Thi Nguyen** University, Australia	German Research Center for Artificial Intelligence	Artificial Intelligence	New learning frameworks, deep reinforcement learning for controlling multiple intelligent agents with human-in-the-loop
 **Lihong Zheng** Charles Sturt University, Australia	Libelium, Spain	IoT, AI and Computer Vision	Cloud-based wireless sensor networks for environmental monitoring
 **Gilad Rosner** Privacy & Technology Policy Researcher, Spain	Law School and Centre for Software Practice at the Univ. of Western Australia	IoT and ICT in Transport	Privacy, data protection, identity management, safety and innovation policy dimensions of connected devices
 **Alexandru Vulpe** University Politehnica of Bucharest, Romania	Engineering School at the RMIT University in Melbourne, Australia	Cloud Computing	Social impact and technical aspects of new ICT technologies in electronic governance
 **Zhengguo Sheng** University of Sussex, UK	Nanyang Technological University, Singapore	AI, Cybersecurity, ICT in Transport and IoT	Design and analysis of communication protocols for vehicular communication and the IoT
 **Neetesh Saxena** Bournemouth University, UK	National University of Singapore	ICT Security	Cybersecurity, cyber-physical system security, cellular network security
 **Cullen Bryant Owens** National University of Singapore	DAQRI Vienna	Artificial Intelligence	Biological neural network processing differences between real and virtual worlds

Expert	Visited Institution/s	EPIC Topics	Specific Topic
 **Giancarlo Fortino** University of Calabria, Italy	National University of Singapore	IoT and AI	IoT computing, agent-based computing, body area networks, wireless sensor networks, pervasive and cloud computing
 **Yue Cao** University of Northumbria, UK	Auckland University of Technology, New Zealand	ICT in Transport	E-Mobility, transportation planning and network communication through technologies
 **Faraz Hasan Massey** University, New Zealand	Ulster University, UK	AI and Next Generation Internet	Computer communication networks, electrical and electronic engineering, and wireless communication
 **Petia Radeva** University of Barcelona, Spain	University of Otago, New Zealand	Artificial Intelligence and Machine Learning	Continuous data capture across psychological, physiological and environmental di¬mensions
 **Giacomo Boracchi** Politecnico di Milano, Italy	Auckland University of Technology, New Zealand	Artificial Intelligence	Machine learning, anomaly detection and domain-adaptation algorithms
 **Vincenzo Piuri** University of Milan, Italy	Massey University, University of Auckland, Auckland University of Tech., New Zealand	AI, Internet of Things	Machine learning, signal and image processing, cloud/fog/edge computing, IoT, security, privacy, data protection, digital signal processing
 **Russel Butson** University of Otago, New Zealand	University of Barcelona, Spain	Digitization	The role of ICT in the academic development of faculty and students
 **Oscar Camara** Universitat Pompeu Fabra, Spain	University of Auckland and the Auckland Bioengineering Institute (ABI), New Zealand	Artificial Intelligence	Clinical data processing and computational models for the automatic building of decision trees from medical databases

Expert	Visited Institution/s	EPIC Topics	Specific Topic
 **Albert Bifet** Telecom ParisTech Universite Paris-Saclay, France	University of Waikato, New Zealand	Artificial Intelligence, IoT, Big Data and Deep Mining	Deep learning with streaming data
 **Firas Al-Ali** Manukau Institute of Technology New Zealand	Malardalen University, Sweden	Artificial Intelligence	Computer architecture and processor design, high-performance computing, reconfigurable and adaptive computing, and AI/ML/NN on chip

Annex 2 Selected Speakers from EPIC Events

Speaker	Organisation	Event	Topic
 **Mike Anderson**	DEX (CTO) Founder of Ocean Protocol	Security and Privacy: The Role of AI	Cybersecurity
 **Dr Dan Bogdanov**	Cybernetica - Head of Privacy Technologies Department	Security and Privacy: The Role of AI	Security, Privacy and Artificial Intelligence - Your choices matter! (AI & Cybersecurity)
 **Prof. Ian Chubb**	Former Chief Scientist of Australia	Research Requires Collaboration	Australia's Science: Engagement in the Global Context (e-Research)
 **Prof. Hugh Durrant - Whyte**	New South Wales Chief Scientist & Engineer	Policy meeting	AI & International Collaboration
 **Elizabeth Kelly**	Deputy Secretary Department of Industry, Innovation and Science	Policies for International Collaboration in Artificial Intelligence	Australia's Tech Future
 **Sebastian Kielmann**	CEO Picalike	Canterbury Tech Summit	AI-Related Advertising
 **Prof. Hermann Klug**	Department of Geoinformatics – Z_GIS (University of Salzburg)	Singapore Space Symposium	SMART Aquifer Characterisation (Spatial Intelligence)
 **Tim Llewellynn**	CEO Nviso	International Dimensions of Artificial Intelligence	Building Distributed & Decentralized AI Systems of Systems: Security & Privacy Challenges

Speaker	Organisation	Event	Topic
 **Dr Anthony Peacock**	CEO, Cooperative Research Centres Australia	Webinar - What's up Downunder?	Cooperative Research Centres as a Mechanism for International Research Collaboration
 **Gregor Petri**	Sales and Business Development, Kapsch Fluidtime / Kapsch OPTIMUM	TechInnovation 2017	ICT in Transport
 **Prof. Robert Riener**	Department of Health Sciences in Technology (ETH Zurich)	C-Prize 2017	Wearables
 **Ass. Prof. Claus A. Foss Rosenstand**	Department of Communication & Psychology (Aalborg University) Consortium for Digital Disruption	Digital Disruption Cooperation	Digital Disruption – from Technologies to Services, Communication and the Sharing Economy
 **Prof. Nigel Smart**	Department of Electrical Engineering - COSIC (KU Leuven)	Workshop on Privacy Preserving Information Technologies	Computing on Encrypted Data: How to do the Impossible

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