Project Title: European – Pacific Partnership for ICT collaboration in research, development & innovation

Acronym: EPIC

Grant Agreement Number: 687794

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>D 3.3 Roadmap for stronger collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated WP</td>
<td>WP3</td>
</tr>
<tr>
<td>Associated Task</td>
<td>All</td>
</tr>
<tr>
<td>Due Date</td>
<td>30/06/2019</td>
</tr>
<tr>
<td>Date Delivered</td>
<td>31/07/2019</td>
</tr>
<tr>
<td>Prepared by (Lead Partner)</td>
<td>eutema</td>
</tr>
<tr>
<td>Partners Involved</td>
<td>All</td>
</tr>
<tr>
<td>Authors</td>
<td>Erich Prem, Jonathan Miller, Pawel Miedzinski, Georg Melzer-Venturi, Franz Berghuber, Mark Sanderson, Marc Bailey, Tan Chee Seng, Sam Ge, Christoph Bartneck, Jonathan Arthur</td>
</tr>
<tr>
<td>Dissemination Level</td>
<td>Public</td>
</tr>
</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>About EPIC</td>
<td>4</td>
</tr>
<tr>
<td>Executive Summary</td>
<td>5</td>
</tr>
<tr>
<td>EU Research Collaboration with its Partners Australia, New Zealand, Singapore</td>
<td>6</td>
</tr>
<tr>
<td>SWOT Analysis</td>
<td>9</td>
</tr>
<tr>
<td>The Future of Australian European e-Research Cooperation</td>
<td>21</td>
</tr>
<tr>
<td>AU-EU Cooperation in Digital Technologies and the Arts</td>
<td>26</td>
</tr>
<tr>
<td>Getting AI right: Australian-Europe Collaboration Potential in AI</td>
<td>30</td>
</tr>
<tr>
<td>Connecting Things Around the World: EU-NZ Industry 4.0 and IoT Cooperation</td>
<td>36</td>
</tr>
<tr>
<td>Europe-New Zealand AI Collaboration Future</td>
<td>40</td>
</tr>
<tr>
<td>The Future of Singapore-Europe Earth Observation Research Cooperation</td>
<td>45</td>
</tr>
<tr>
<td>Security, Privacy and The Role of AI: The EU-Singapore Potential</td>
<td>49</td>
</tr>
<tr>
<td>Further Recommendations</td>
<td>53</td>
</tr>
<tr>
<td>References</td>
<td>56</td>
</tr>
</tbody>
</table>
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, strengthening cooperative research links and reinforce industrial collaboration as well as coordination with other EU level initiatives.

EPIC, therefore, aims 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 targets both the strategic, more policy-oriented level and the direct cooperation of researchers/innovators in academia and industry. The aim is to exploit mutually beneficial opportunities and to prepare new grounds for future collaborations.

EPIC aims to help overcome the current lack of dedicated co-operation support actions and improve the low visibility of Europe’s ICT RDI capabilities in the target countries. The project follows a topical methodology: the focus is on specific areas of ICT research of high strategic importance. Initial topics include artificial intelligence, internet of things including wearables, cyber security, ICT in transport, digital economy, next generation internet and spatial intelligence.

The specific objectives of the project are 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 roadmap for 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 report describes a roadmap 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. The report presents a SWOT analysis of ICT RTDI collaboration and focuses in on seven priority areas for future enhanced cooperation.
Executive Summary

The international environment for research collaboration is experiencing significant changes. From power shifts in geopolitics to global technology companies, the face of RTDI collaboration is changing, also in ICT research. This provides new opportunities for Europe and its international partner countries Australia, New Zealand, and Singapore to jointly tackle many of the emerging challenges. These challenges range from climate change to privacy concerns, from a global artificial intelligence race to new cybersecurity threats.

Australia, New Zealand, and Singapore are relatively small countries in terms of their population and compared to the European Union. However, they are high-income countries with an excellent research base, educated population, and strong cultural ties with Europe including many expats. They are therefore logical partners for Europe to establish strong links in ICT research.

Australia is a trusted nation with strong ICT infrastructure investments and excellent universities. It has world-class ICT research, for example in AI and robotics and the current free trade negotiations will be leading to new collaboration opportunities. New Zealand is an extremely entrepreneurial country with a strong export orientation to be reinforced by an emerging EU-NZ free trade agreement. In ICT, it is known for its strengths in 3D graphics and HCI. Singapore is one of the business-friendliest nations in the world. It has invested large amounts in its research and development base and provides an excellent location for accessing sizeable Asian markets.

Although there are good links between EU research organisations and ICT companies with all three countries, there is room for improvement. During the EPIC project, several potential focus areas emerged. For improved collaboration with Australia this includes digital technologies and the arts; artificial intelligence including ethics and regulation; and e-Research. For New Zealand, improved ICT collaboration should focus on research and development in industry 4.0 and the Internet of Things as well as on agritech solutions powered by new robotic systems and artificial intelligence. For Singapore, EPIC identified collaboration opportunities in earth observation and in targeting joint challenges in privacy preservation and cybersecurity.

Beyond these bilateral recommendations, Europe and its partner countries should aim to better exploit the large network of European expats in Australia, New Zealand, and Singapore. It is recommended to create a true European ICT expat network that can strengthen international, inter-organisational and intersectoral links. The European Union should also develop new models for collaboration that are lightweight and easy to use for its international partners. New centres of contact in Europe’s partner countries can be tools to support research collaboration efficiently. Finally, Europe should develop an integrated policy approach that embeds its ICT and research diplomacy in the international demand for collaboration to maximize the benefits of ICT whilst minimizing its potential dangers.
EU Research Collaboration with its Partners
Australia, New Zealand, Singapore

The underestimated potential of small nations

In terms of population, Australia, New Zealand and Singapore are relatively small countries. Of course, the OECD calls them “medium-sized”, but compared to Europe’s 512 million people the three countries targeted in the EPIC initiative are comparatively small. However, their size in population does not match their role and importance where all three countries score well above their relative weight.

<table>
<thead>
<tr>
<th></th>
<th>Population in millions 2017</th>
<th>GDP per capita 2018 in constant 2010 US$</th>
<th>R&amp;D expenditure in % of GDP</th>
<th>Researchers in R&amp;D per million</th>
<th>IP service charges (current US% ‘000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>24.6</td>
<td>56,914</td>
<td>1.92</td>
<td>4,539</td>
<td>935</td>
</tr>
<tr>
<td>New Zealand</td>
<td>4.8</td>
<td>38,000</td>
<td>1.26</td>
<td>4,052</td>
<td>432</td>
</tr>
<tr>
<td>Singapore</td>
<td>5.6</td>
<td>58,247</td>
<td>2.16</td>
<td>6,730</td>
<td>8,727</td>
</tr>
<tr>
<td>EU</td>
<td>512</td>
<td>37,417</td>
<td>2.03</td>
<td>3,749</td>
<td>139,098</td>
</tr>
</tbody>
</table>

(Source: data.worldbank.org; latest available years)

Firstly, Australia is a large country as regards territory. In fact, it nearly matches the size of Europe. More importantly, all three countries are highly developed economies with GDP per capita easily outperforming the European Union’s average. All three countries are modern, highly developed market economies with an excellent research and innovation base. All three countries have put policies and strategies in place to foster the development of information and communication technologies and aiming to exploit digitization for the development of their economies and societies. Finally, all three countries have a history of reliable collaboration with Europe based on strong cultural ties and trade.

In ICT research and development, Australia acquired international fame for the development of the wireless communication hardware (WiFi) without which our modern computing systems would be nearly unthinkable. New Zealand has gained a reputation for its interface and computer graphics research base, not last since the *Lord of the Rings*. Singapore – being the world’s most business-friendly environment – is globally renowned for its Smart City architecture.

Power shifts in geopolitics and global tech

The world has been experiencing global shifts in power in recent decades. The latest changes started with a dramatic acceleration of development and international presence of Asia on the world stage.¹ What started as a change in global production patterns ensued in other sectors from trade to technology and

foreign politics. All three EPIC partner countries, Australia, New Zealand, and Singapore have been strongly affected by these trends although not always in the same ways.

More recently, these changes have become ever more visible as traditional power constellations and allies started to change. The changing role of the United States of America are a good example here. The US dollar has lost much of its exclusive position as the world’s reserve currency — a clear indication that other regions and allies have become more visible internationally. China has become the world’s largest exporter and is now strongly present in international politics as evidenced in its presence in multinational institutions.

Nations are no longer the only large power players on the globe. In the last decade, the visibility, importance, and even the politics of large companies has become a major factor in geopolitics. Large ICT enterprises including Amazon, Facebook, Alphabet (Google), and Alibaba have started to become powerhouses of innovation on more than just a product and service front. With research budgets exceeding those of medium-sized countries, social networks comprising a significant portion of the world’s population, and data access of near universal and ubiquitous reach the tech giants are becoming political powers. The fact that world leaders are regularly meeting with tech giant CEOs may provide some evidence for this claim.

Contrary to smaller countries, the large tech companies are truly international players with near global presence. Their size and reach is challenging traditional conceptions of state-level regulation. While this may be theoretically possible in some cases, smaller economies may hesitate to interfere with the large tech firms given the dominant role they play in some economies and in society.

Larger countries or multinational blocks may still have significant market power to get a grip on unwanted developments in dominant firms. On the flip side this means that smaller countries may need to look for international allies. This not only concerns the regulation of market players, it includes understanding the consequences of approaches, principles, mechanisms of those big players and separating wanted from unwanted developments — a huge challenge in an ever more dynamic high-speed environment of technological change.

The discussions at the EPIC events provide evidence that there is a demand for a much clearer perspective on how to best deal with large technology providers. Countries such as Australia and New Zealand are weighing the options on whom to team up with. With its emphasis on human rights, e.g. in the discussion of data ethics, the European Union has gained international visibility. It is notable that this may often have happened through enterprises leading the way, e.g. in accepting GDPR as a de-facto standard. But the European Union is by no means the only player and if anything, then EPIC has demonstrated again how important the dialogue with its international partners is on topics from cybersecurity to artificial intelligence etc.

The changing face of RTDI collaboration

International research and technology collaboration is undergoing changes similar to what the world is experiencing in terms of geopolitical power shifts. As larger industrial technology conglomerates shifted their production to low-income countries, domestic enterprises in those countries emerged and started to grow. The old saying that research and technology development moves with the production has proven true at least form some countries. China has now become one of the largest producers of scientific and especially technological knowledge in the world. Even if it may not yet have fully reached a state of technological dominance, there are signs that it may become such a player soon.

Even more important for international RTDI is the fact that companies are now sourcing results internation-
ally. They are no longer just limited to a few countries but seek to develop knowledge and technology wherever it is possible, acquire talent and patent from wherever it is available, and quickly adapt to new and changing conditions on a global scale. This trend is not exclusive to companies as many universities and research labs have also become international actors sourcing knowledge or students globally and catering to an increasingly global industry base. Both developments may be regarded as improving the efficiency of the international S&T system and there are dynamic markets in engineering, research services, intellectual property etc. that are now global.

Research and technology policy, however, have not fully followed this trend. Research politics and efforts to turn technological development into societal benefits have largely remained national endeavours. There are of course counter examples at the level of large players including the EU and there are also multinational initiatives such as those at OECD level. But overall, many economies and jurisdiction still focus on a mostly national perspective and national approaches as indeed suggested by the very reality of possible measures.

Regulation – as mentioned above – is only one aspect. But there is also the question of international strategies for research. During the course of the EPIC projects, our events have made it very clear that there are usually many different options for our future, not just one given approach and certainly not just one that a multinational tech giant may prefer. For example, the EPIC events in Singapore have demonstrated the diversity of approaches to joining data privacy and leading-edge developments in AI. But this may require much more concerted efforts to develop these alternatives in alliances with like-minded societies than what we are used to.

The way forward

This report describes options for strengthening the collaboration between Europe and its international partner countries Australia, New Zealand, and Singapore. It is based on 2.5 years of collaboration between strategic consultants, research universities, research support organisations, and government agencies from all four involved regions. The project’s core activity was to organise many events in all four regions. Several thousand people participated in these events to discuss current ICT research topics and policies in the light of international cooperation. This included ICT researchers and policy makers, representatives from businesses and business support organisations as well as members of associations and interest groups.

These meetings provided a rich source for improving our understanding of strengths and strongholds, and also of current challenges and weaknesses in international ICT research and innovation collaboration between the involved nations. Dedicated focus groups in all three target countries (AU, NZ, SG) provided input for an analysis of strengths, weaknesses, opportunities and threats (SWOT analysis). Often these discussions also suggested what should be done in order to improve the current collaborations – and also to maintain what already works well.

As a result, EPIC created policy briefs related to seven focus areas for future collaboration. These briefs were often started in one of our events and later refined with the help of experts from the corresponding countries. Naturally, EPIC consortium members from the corresponding countries were also heavily involved in this process.

This report is designed to present the results of the analysis together with options to take the next steps. It starts with a SWOT analysis for Australia, New Zealand, and Singapore. It then presents European ICT research from the point of view of these countries. This is followed by seven chapters on potential RTDI focus areas and recommendations for policy makers and researchers to strengthen collaboration in these fields. The report concludes with four non-topical recommendations about expat researchers, new models for collaboration, future support actions, and a more integrated policy approach to international RTDI cooperation.
SWOT Analysis

Australia

Strengths

Australia has long entertained close relations with many EU member states and the European Union based on durable cultural and political ties. Today, European experts form an essential part of the Australian research system, especially nationals from the UK, Germany and France. In addition, high-level policy goals in Australia support international ICT RTD collaboration. The resulting good level of research collaboration is reinforced in many initiatives of EU member states that fund research collaboration with Australia. Although these programmes are generally small, they are important drivers of cooperation in research and research and innovation policies.

The Australian population provides a multi-cultural environment that is still close to European culture despite a strong Asian influence. The workforce is generally highly educated with many trained talents in the ICT domain. There is high level of ICT innovation in business and in the private take-up of new ICT applications.

Australia provides an excellent ICT infrastructure and has launched several national initiatives in ICT including initiatives in health, cybersecurity and Artificial Intelligence. The Australian government provides funding for CSIRO and its ICT-branch Data61. These organisations also have resources for international collaboration and frequently participate in international research partnerships. Today, there is a good level of peer-to-peer collaboration with EU countries (e.g. funded by ARC) and NHMRC funding was available in Australia for EU Framework Programme Health projects. Many of Australia’s key ICT researchers are well networked also with European actors and there are some institutional linkages in areas such as High-Performance Computing, e-Research, cybersecurity, robotics etc.

There is high-quality ICT research in Australia with some critical mass in certain areas such as advanced networking and embedded systems. Other areas where ICT research in Australia is strong include future internet, robotics, Artificial Intelligence, optimization and constraints programming. There are major corporate ICT research labs in Australia including those with strong European ties: SAP is showing leadership in boosting Australia-Europe collaboration. Thales has a strong presence. In addition, there are significant Australian corporate research labs established in Europe such as Cochlear and Resmed.

Australia’s Cooperative Research Centres (CRCs) are highly relevant highlights of Australian RTDI competences some of which are now industry-led. Although many excellent ones are not in the ICT sector in the narrower sense, e.g. in mining or in agriculture, these often include ICT topics. Recent CRCs have been started in digital health and in AI following a dedicated AI government initiative.
Weaknesses

Australia suffers from a small domestic ICT market. Despite its pockets of excellent research, Australia has a fragmented ICT research sector with a national focus, low levels of strategic direction and cohesion across universities, research institutes and industry. Monetizing research output remains a significant challenge for many Australian universities.

Despite of many supportive policies, there are not always significant follow-up activities to policy agreements. Collaboration between Australia and the EU has often been hampered by a lack of straightforward co-funding for EU projects with the exception of the health domain. This concerns universities in particular, but also industry. Today, there is no funding programme supporting international team-level collaboration available in Australia. Such group-level collaboration exists only in a few instances (e.g. CSIRO-EPFL) and scaling up peer-to-peer collaboration between Australia and Europe to organisational levels and for longer terms is rare.

From the Australian perspective, Europeans are insufficiently aware of Australian expertise in ICT research. Collaboration suffers from the problems related to working over long distances and challenging time-zone differences. While many Australians are used to travelling long distances and using teleconferences, this is not always true for their European counterparts.

Opportunities

The already strong trade links between the EU and Australia are likely to be strengthened further in case of successful completion of the current Free-Trade Agreement (FTA) negotiations. The FTA will also address a range of topics relevant for ICT and ICT innovation such as services and data ethics (privacy).

Many European nationals are visiting Australia regularly and there are new EU countries now collaborating on Australian working visas for young people. Australian universities have strengthened their presence overseas, some including representations in Europe (e.g. RMIT’s Barcelona office).

The Australian government has renewed its interest in ICT as offering potential solutions to major societal challenges. Australia has started to invest in Artificial Intelligence through AI-specific funding of CRCs, and there is now significant investment in the major robotics hubs in Queensland.

Threats

There is a possibility international RTD collaboration is not very high on the political agenda, also due to RTDI budget constraints and other Australian policy priorities. The Australian government has suggested that international activities should be funded within existing national programs, i.e. with no additional funding for such activities. It is not clear whether important funding programmes in Australia such as the International Science Linkage programme will be continued.

The new EU Framework Programme may change the conditions for 3rd country participants, but a dedicated strategy for EU-Australian ICT collaboration is not yet clear.

In the past, there has occasionally been some confusing information about EU project participation for Australian researchers and frustration of AU researchers not able to contact the right networks or the right programmes (e.g. Joint Technology Initiatives). Also, there is a risk that good researchers avoid EU programmes because the time spent on administrative aspects (including Intellectual Property Rules), negotiations, reviews and partner politics is greater than the benefit of project participation.

There is a threat that Europeans only focus on short-term visits and collaboration without true sustainability and long-term co-operation. Also, Australians may be marginalized in projects because of distance and lack of continuous physical presence.
TABLE 1 SWOT ANALYSIS FOR ICT RTDI COLLABORATION WITH AUSTRALIA

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trusted nation with strong government support for collaboration; good bilateral collaboration with many EU member states</td>
<td>Lack of munificent domestic market</td>
</tr>
<tr>
<td>Strong investment in infrastructure including research; a multi-cultural nation open to ICT innovation; government programmes in relevant fields including cybersecurity, AI, robotics etc.</td>
<td>Follow-up activities to policy agreements can be slow</td>
</tr>
<tr>
<td>Excellent ICT research base and skilled workforce</td>
<td>Lack of co-funding for EU projects</td>
</tr>
<tr>
<td>Strong personal networks and peer-to-peer research collaboration</td>
<td>Difficult funding for international ICT RTD cooperation</td>
</tr>
<tr>
<td>Cooperative Research Centres are highlights of Australian RTDI competence</td>
<td>Lack of monetizing research output</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong and growing trade links with the EU</td>
<td>Lack of explicit RTD funding options for Australian researchers</td>
</tr>
<tr>
<td>ICT RTD capabilities identified (Embedded Systems, robotics and AI, water technology etc.)</td>
<td>Insufficient policy follow-up and strategy for the support of RTD collaboration with Europe</td>
</tr>
<tr>
<td>Leverage EU citizens living in Australia and Australians visiting Europe</td>
<td>Frustration of Australian researchers with expectations not met and negative experiences with Framework Programme bureaucracy and Intellectual Property Rules</td>
</tr>
<tr>
<td>Continued attractiveness of Australia for European students</td>
<td>Overly strong focus on only short-term visits without sustainability</td>
</tr>
<tr>
<td>New strategic interest in ICT topics at government level, e.g. for AI, data ethics, digitization, and cybersecurity</td>
<td></td>
</tr>
</tbody>
</table>

New Zealand

Strengths

New Zealand is an extremely entrepreneurial country with a strong export orientation. It offers a strong societal environment with free and open markets, high levels of personal freedom and one of the easiest environments for doing business. The Pacific island state offers a well-educated and skills base and flexible workforce for its enterprises including ICT and digitization skills. New Zealand’s government has been committed to growth and innovation for extended periods of time.

In New Zealand, ICT businesses are generally positive about the developments in Europe’s single market. From GDPR to free-flow of non-personal data and portability of content – many of these concepts have become quite well known in Australia and New Zealand. In many cases, they are regarded as good practices – or at least as good starting points to tackle important challenging problems. Similarly, there is a strong interest from the New Zealand government in ICT policy developments in Europe. Government officials in New Zealand are often knowledgeable about concepts such as GDPR, e-ID and even general understanding of Europe’s Digital Single Market is
often very good. Most importantly, New Zealand policymakers are often well aligned with the underlying digital innovation policy objectives in Europe in their own work.

Many of New Zealand’s leading research institutions (e.g. the University of Auckland) also have strong ICT research groups. Many of these groups include European expats and nationals, often in leading positions, who drive EU-New Zealand ICT RTDI collaboration. New Zealand’s ICT research has gained international reputation in areas such as human-computer interfaces, computer graphics, simulation, AI and robotics. ICT research is also strong in application fields such as agriculture, bioinformatics, and health. Often addressing markets that are less in the mainstream, New Zealand companies have been found to herald AI-solutions world-wide. Examples include Xero in accounting and Orbica in spatial intelligence.

Weaknesses

New Zealand currently holds a relatively weak position in the OECD innovation rankings. Business and industry digitalization is sometimes hampered by prevailing traditional processes many of which are not fully digital, i.e. paper-based. Industry 4.0 remains in the awareness stage and is not yet a strategic focus in the NZ manufacturing industry compared to other OECD countries.

A considerable challenge remains the low level of R&D investment, the presence of only a few multinational enterprises especially in the technology sector, and a sectorial mix that is not as diverse as elsewhere. For example, agriculture is still an important economic sector. And while innovative businesses provide new technology solutions for agriculture (e.g. using Artificial Intelligence, autonomous drones etc.), the vast majority of the sector remains relatively little innovative as regards technology.

Despite of all the new developments in communication technologies, New Zealand’s geographical position remains a challenge. It involves considerable costs and a lot of time to attend international business meetings or conferences. Although many international conference series may also stop in Australia, not all of them do and only a few make it to New Zealand. Attending even a short meeting for business purposes is very costly and in most cases will mean an absence from home for at least a full week.

As regards innovation policy, the improvement of academia-industry cooperation remains a focus for the government in New Zealand (e.g. MBIE\textsuperscript{11}). There is a certain lack of opportunities for the two sectors to meet. In the NZ view, Europe has addressed this challenge with some success. In New Zealand, technology incubators have been created to partially address this need, but more needs to be done and an exchange of good-practices in this field would certainly continue to be interesting for New Zealand.

Opportunities

The NZ government has developed new strategies to foster innovation – both in the private and public sector. For industry, a new R&D tax incentive scheme has been prepared that offers 15% tax saving for company R&D investments with the long-term goal to support raising New Zealand’s R&D expenditure to 2% of GDP by 2027. Another important objective of the new policies is to better link companies in general and start-ups in particular to the international scene. This has become clearly visible in the EPIC events many of which addressed smaller companies and how they can better link with Europe.

Raising awareness for international and digital opportunities therefore is an important strategic objective for the NZ government. There is currently not sufficient discussion about the opportunities of new digital technologies in New Zealand in the industry sector. Initiatives such as EPIC are therefore greatly appreciated in targeting improved collaboration, but also awareness about technology – and policy – directions and opportunities.

From the NZ government’s point of view, improvements of NZ productivity remain a key objective. New Zealand therefore follows Europe’s smart specializa-
A sectoral/regional approach to innovation is a promising concept for New Zealand and international partnerships in this area could be especially interesting. This includes ICT-related topics such as digitization, agricultural technologies and perhaps the interface and visualization technologies. The digital creative sector has been recognized for many years now and while it has moved to new technologies such as VR (virtual reality) and AR (augmented reality) it is still a relevant NZ strength.

Businesses across the ICT sector are increasingly turning to a software-as-a-service model to commercialise their technology, as it better allows them to compete internationally. This also affects international R&D collaboration including participation in European programmes. However, given the entrepreneurial mindset in New Zealand the main driver is often doing business. In this domain, experts are often highly skilled and open to international cooperation, experienced with and open to online forms of communication and ICT products and services tend to be inherently internationally oriented. In addition, English is often a common language in the ICT sector including for IT products and services.

Cybersecurity is another topic where more awareness, tools, and cooperation is required in New Zealand. In many cases, NZ still requires debates about these topics. This includes aspects of ethical approaches to technology development. The European Union's activity in this domain have been closely monitored and have also inspired New Zealand new data protection legislation, for example. However, a debate is also required regarding the benefits of these new technologies, for example in healthcare. There are potentially exciting gains from new technologies such as Artificial Intelligence and it is important to weigh them against the concerns regarding privacy etc. Wellbeing is a focus area for the NZ government. This of course includes public services and generally improvements in the area of a responsive government. These are potential topics for further EU-NZ cooperation. A reasonable next step may be to focus on good practice, for example regarding government use of Artificial Intelligence.

New Zealand has entered into Free Trade Negotiations (FTA) with Europe. Their successful completion has the potential to further facilitate ICT trade including services. It could further boost collaboration in ICT innovation and potentially research including researcher exchange.

**Threats**

In the past, the UK provided a straightforward entry point for New Zealanders into the European market. Although many companies are now also looking into Ireland or continental Europe, there is a certain risk that Brexit may impair the ease of doing business with the EU.

Other regions in the world are expanding their networks and exploring their opportunities world-wide including in New Zealand. Asian nations are an important partner for New Zealand and Europe needs to present clear visions and strategies for maintaining or potentially increasing its current level of collaboration.

---

### TABLE 2 SWOT ANALYSIS FOR ICT RTDI COLLABORATION WITH NEW ZEALAND

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trusted nation with strong government support for collaboration; bilateral collaboration with many EU member states put in place</td>
<td>Small domestic market, especially for ICT</td>
</tr>
<tr>
<td>Strong entrepreneurial mind-set and export orientation</td>
<td>Lack of scaling up of individual researcher cooperation</td>
</tr>
<tr>
<td>Excellent ICT research base in relevant application fields, e.g. HCI, agricultural robotics, AI, and bioinformatics</td>
<td>Distance from Europe implies large time-zone difference and very long travel times</td>
</tr>
<tr>
<td>Strong personal networks with Europe and a solid level of student exchange in ICT research exchange</td>
<td>ICT-driven innovation not yet massively taken up</td>
</tr>
<tr>
<td>Good level of follow-up on collaborative ICT RTD policies with Europe</td>
<td></td>
</tr>
<tr>
<td>Strong cultural ties with Europe</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong interest and policy support for ICT-driven innovation, e.g. IoT, AI</td>
<td>Lack of explicit RTD funding options for researchers</td>
</tr>
<tr>
<td>Excellent ICT RTD capabilities identified (Embedded Systems, robotics and AI, water technology etc.)</td>
<td>Increasing difficulty for NZ companies to enter the EU market in case of a hard Brexit</td>
</tr>
<tr>
<td>Strong and growing trade links with the EU</td>
<td>Decreasing relative importance of RTD collaboration with Europe given the increase of research intensity in Asian countries</td>
</tr>
<tr>
<td>Leverage EU citizens living in New Zealand and New Zealanders visiting Europe</td>
<td></td>
</tr>
<tr>
<td>Continued attractiveness of New Zealand for European students</td>
<td></td>
</tr>
<tr>
<td>Renewed interest in EU driven by Brexit</td>
<td></td>
</tr>
</tbody>
</table>

### Singapore

**Strengths**

Singapore is consistently ranked as a top destination in the world for doing business: It ranked 2nd for global competitiveness in 2018.\(^\text{13}\) The island state boasts a high level of political stability of law—a single-party brand of governance that has engineered phenomenal economic growth and development for the country and is largely supported by its citizens. Businesses benefit from low taxes, logistical support and other financial incentives attractive for foreign companies to set up their Asia operations. There is strong adherence to the rule law, including protection of intellectual property. A highly- and English educated international workforce with many professionals, managers and technicians plugs Singapore into global human resource networks with strong Asian linkage. Singapore’s solid financial reserves are invested in state-of-the-art physical infrastructure, including an

---

\(^\text{13}\) World Economic Forum (WEF) Global Competitiveness Index 4.0, an updated version of the annual ranking
island-wide next generation ICT broadband network. The unique geo-economic position of Singapore provides access and reach to major cities and financial centres in Asia-Pacific. In sum, Singapore’s world-class infrastructure creates a safe and conducive business environment that is open to foreign companies and other investments.

Singapore’s excellent framework conditions are reflected in the strong presence of industry partnerships for technology commercialization. Several member states of the European Union have created dedicated bilateral initiatives for supporting the trade and business cooperation and a Singapore-European Free Trade Association FTA is put in place. Many multinational corporations use Singapore as a gateway to launch into different Asian markets. Europe is represented with technology companies of which many also engage in local collaboration including co-operation in the field of ICT research and innovation. This includes the likes of ATOS, Thales, Fraunhofer, IPAL, Peugeot, EDF or TÜV Süd.

Despite of a certain degree of increasing openness in China, Singapore remains to be an important entry point to the ASEAN countries with its 600 million people market. For many international companies it is important to be present in Southeast Asian markets while being based in a modern market economy. The conditions in Singapore are still very different from Europe. As a good example in energy innovation, in the REIDS project a large EU consortium set up a micro grid (with NTU) to experiment with tropical conditions. These harsh tropical conditions are different from Europe, but for example also help testing equipment to facilitate sales in Africa and elsewhere in the world. The same can be said for cybersecurity or smart city technologies. For Europeans, it is much easier to set-up and experiment such innovations from within Singapore than in Europe.

From the point of view of Singapore, it is easier to work with Asian organisations in Singapore, e.g. with Alibaba than in their home countries (e.g. China). Singapore is a good partner at the border of East and West: it is close to China with many Chinese residents, but it is not China.

In ICT research areas, IPAL has been very successful with a model of pairing researchers from the EU (France) with counterparts from Asia. This helps to establish longer-term partnerships, not just at peer-to-peer level, but also from a more institutional perspective. The case of IPAL has been a very fruitful collaboration in the past. One of the drivers behind the CNRS expansion to Asia was the motivation for having various evaluation sites. Topics of particular interest include digital health, inclusive digital city, cybersecurity etc. A major motivation has also been to develop staff competencies and further the international embedded of CNRS institutes. Another driver was the testing or adaptation of novel technologies in particularly Asian contexts. This ranges from typically Asian social situations, user preferences and attitudes to the South-East Asian climate.

Another successful model was the establishment of joint structures between France and Singapore, e.g. in proximity to university labs. Such structures can help to minimize the danger of brain drain. This works through organisation-level agreements on staff exchanges, but also on how to deal with intellectual property rights. This also supports the development of mutual trust – a prerequisite for long-term mutually beneficial cooperation.

Weaknesses

In the past, purely project-based collaborations have proven less effective. They are difficult to continue after a few years and although there are often intentions for continued cooperation, it usually is very difficult to create follow-up or new projects. Even where this is successful, it may mean inadequate timing, changes of staff and entering in new constellations, e.g. in most EU projects.

14 http://www.ipal.cnrs.fr/
15 Electricité de France
16 http://erian.ntu.edu.sg/REIDS/Pages/AboutREIDS.aspx
Singapore administration and government are not as transparent and easily accessible as in many European countries. For newcomers, it is usually very difficult to engage with government officials at the policy level although government agencies are typically very open, dynamic and supportive.

Singapore is a challenging and competitive environment. This can put strong pressure on businesses and research to deliver on promises and expectations. Failure to deliver may result in harder and quicker consequences than what may be usual in the European environment.

**Opportunities**

Similar to the experiences in other countries, the impact of expats for collaboration is huge. A*STAR has the SINGA program\(^\text{17}\) bringing in many experts from Italy including in engineering fields. The exchange is typically dynamic, i.e. some experts may stay, others return. Even when they return to Europe after a short visit, they often establish ongoing collaboration. There are also labs at NTU with many EU researchers, e.g. the Fraunhofer activities bring in many German experts. In addition, there is a trend to expand collaboration with companies through different kinds of collaboration agreements. For example, Rolls-Royce has a corporate lab while Fraunhofer are present at the campus (i.e. only co-located with, but not organisationally connected to NUS). They work with graduates from NTU students.

Singapore continues to strive establishing a Smart Nation state and city. A large-scale test-bed for digital technology and smart city is being developed in the district of Punggol.\(^\text{18}\) It is run by Smart Nation Digital Office and A*STAR is participating. There are plans to collaborate with the Alan Turing Institute\(^\text{19}\) and experimentation will address a very broad range of sectors including, for example, transport, energy, security, and other infrastructure. EPIC topics such as privacy, security, AI, etc. will be developed and tested and there is ample opportunity for future collaboration.

European students can enrol in Singapore without fees in cases where there is a Memorandum of Understanding between the universities. A recent visit from the former ERC\(^\text{20}\) president to NTU underlined the interest of ERC in attracting more researchers to their programmes. It was mentioned that researchers could spend up to 50% of their time abroad. Although ERC grants are difficult to get, they are substantial and can be worth the effort for outstanding researchers.

Finally, the typical Singaporean funding/research organisations such as AI Singapore (or various institutes of A*STAR) have often been anchor points for funded collaboration in the past. For AI Singapore programmes, European nationals cannot be principal investigators, but they are allowed to collaborate in funded projects.

**Threats**

There is a potential challenge resulting from a downturn in expected student numbers in Singapore. There is also a restriction in SG on foreign students (10% at Bachelor). Given the current strong demand for AI experts, local students are strongly motivated to receive their degree and start work immediately. In many cases this may mean returning to China, for example and being unavailable as PhD students for research work. Paradoxically, this downturn in student numbers makes collaboration with Europe more interesting. Generally, SG universities are becoming more interested in business collaboration because of budget cuts.

In the field of ICT, there is a danger in the local research system that the focus is too much on short-lived topics, which are overhyped. It is therefore important to seek areas for collaboration with a longer-term perspective. From an organisational viewpoint, well-established and experienced actors such

---

17 Singapore International Graduate Award scheme [https://www.a-star.edu.sg/Scholarships/For-Graduate-Studies/Singapore-International-Graduate-Award-SINGA](https://www.a-star.edu.sg/Scholarships/For-Graduate-Studies/Singapore-International-Graduate-Award-SINGA)


19 [https://www.turing.ac.uk/](https://www.turing.ac.uk/)

20 European Research Council [https://erc.europa.eu/](https://erc.europa.eu/)
as A*STAR, NTU, and NUS can be expected to remain stable and strong for the next years.

Enterprises have recently been complaining about tightened rules for bringing staff – and their families and partners – into Singapore. Although this is a trend also elsewhere, it can potentially harm the open business environment significantly.

**TABLE 3  SWOT ANALYSIS FOR ICT RTDI COLLABORATION WITH SINGAPORE**

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly developed and internationally competitive economy with high level of stability</td>
<td>Lack of long-term track record for ICT RTD, especially in more fundamental areas</td>
</tr>
<tr>
<td>Trusted nation with strong government support for collaboration, good level of collaboration with EU member states</td>
<td>Only a limited eco-system for enterprises (e.g., large companies) and a lack of a munificent domestic market</td>
</tr>
<tr>
<td>Next generation broadband network and excellent ICT infrastructure</td>
<td>Limited follow-up to policy agreements and a more difficult policy environment, especially for newcomers</td>
</tr>
<tr>
<td>Multi-cultural environment emphasizing ICT innovation and strong links to Asia</td>
<td>Lack of co-funding for EU projects and difficult to follow-up on successful projects</td>
</tr>
<tr>
<td>Strong investments in ICT RTD through a number of focused, goal-driven programmes (e.g. A*STAR, AI Singapore)</td>
<td>Lack of mutual industry-focused initiatives</td>
</tr>
<tr>
<td>Instruments for collaboration are in place and there are longer-term collaborative structures for EU-SG RTDI collaboration (e.g. labs)</td>
<td>Hugely competitive environment in both academia and industry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway access to a population of 3.5 billion people in Asia and bottom-of-the–pyramid markets in Asia</td>
<td>Potential downturn in openness for foreign nationals</td>
</tr>
<tr>
<td>Strong focus on developing a smart nation and a smart city including funding of experiments and showcases</td>
<td>Strong business orientation and limited potential to attract students for longer-term research work</td>
</tr>
<tr>
<td>Good presence of the European commission with its EURAXESS programme</td>
<td>Short-term focus on hyped ICT research topics</td>
</tr>
<tr>
<td>Strong trade links and FTA in place</td>
<td></td>
</tr>
<tr>
<td>Many EU citizens living and working in the country with good level of collaboration experience and links to other EU nationals</td>
<td></td>
</tr>
<tr>
<td>Piloting new products and services in multi-cultural environments</td>
<td></td>
</tr>
</tbody>
</table>
### OVERVIEW: RECOMMENDATIONS TO STRENGTHEN COLLABORATION BETWEEN THE EU AND EPIC PARTNER COUNTRIES IN KEY TOPIC AREAS

<table>
<thead>
<tr>
<th>Key Topic Areas</th>
<th>Australia</th>
<th>New Zealand</th>
<th>Singapore</th>
</tr>
</thead>
</table>
| **Artificial Intelligence** | - Supporting the dialogue  
- Joint research and monitoring of AI developments  
- Inclusion and empowerment: Include stakeholders in the development of AI policies  
- Education and training  
- Regulation: Develop fit-for-purpose and technology-neutral regulatory approaches | - Improving the dialogue  
- Inclusion and empowerment: Include a broad public in the design of AI systems  
- Education and training  
- Research: Improve collaboration between centres of excellence | |
| **e-Research** | - Joint open data and e-Research initiatives  
- Establish a collaborative international EU-AU funding model  
- Value beyond research  
- Joint virtual labs  
- Test new ideas of common interest  
- Create market places for data  
- Identify application areas of shared international importance | | |
| **Spatial Intelligence** | | | - Research Earth observation data use-cases based on their respective existing developments  
- Develop collaborative or matching funding models in the field of Earth observation  
- Develop joint activities  
- Investigate options for developing marketplaces for European satellite data and joint applications |
### Key Topic Areas

<table>
<thead>
<tr>
<th>Digital Technologies and the Arts</th>
<th>Australia</th>
<th>New Zealand</th>
<th>Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialogue between art/science and digital technologies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclusion and empowerment: Inform industry about benefits of art/science interaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education and training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funding: Overcome the separation between mechanisms for art and technologies funding</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Privacy and Security</th>
<th>Australia</th>
<th>New Zealand</th>
<th>Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration opportunities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving the dialogue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education and training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research and innovation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Internet of Things (IoT)</th>
<th>Australia</th>
<th>New Zealand</th>
<th>Singapore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting the dialogue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing IoT and Industry 4.0 technologies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education and training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulation: Coordination for future interoperability and seamless integration of solutions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The EU from the perspective of its international partners

Europe’s international partners well noted the recent shifts in the geopolitical environment. Europe is being rediscovered and Europe’s international partners acknowledge its marked differences to China or the U.S. regarding technological collaboration and techno-policies. Similarly, Europe tends to be more open in research and innovation compared to the US and China, for example. This is especially true for strategic topics such as cybersecurity and data ethics.

Europe has a proven record of accomplishment and history of collaborating more openly and of sharing results. The EU Framework Programme has created a massive legacy where practically European research actors have a history of collaborating internationally. This also includes the administration, legal aspects, and management of research which is not necessarily easy with other countries. EU projects really changed the mentality of European researchers. When the EU became an important source of funding, researchers started to collaborate even with competitors and foreigners. This makes it a basis for international collaboration. China has a grand plan that can be limiting for researchers. Many actors in the US are difficult to reach out to or simply too big for a smaller nation such as Singapore and New Zealand or they do not want to share.

On the downside, Europe is a rather complicated construct. Research initiatives at the European level are different from those at EU member state level and it can be complicated for 3rd country researchers to navigate the resulting opportunities. The Framework programme is internationally very well-known and has a good standing, but it also has gained a reputation for tight administrative rules and bureaucratic overhead. The basic concepts (i.e. legal terms) used in the funding agreements and procedures including the online systems can be a surprisingly serious challenge for 3rd countries and in fact may deter potential participants from joining an EU Framework project.

Europe is an attractive place for researchers including because of its cultural heritage. As the founding place of the idea of a university, it builds on a long-standing tradition of academic research that is still attractive for researchers. Although other countries may lead in international ICT university research rankings, Europe still is acknowledged for excellence and autonomous scholarly thinking in many areas relevant to ICT. Finally, Europe remains a key player in selected ICT topics from embedded systems to power electronics. Being one of the three largest markets in the world it also remains a key target for businesses world-wide.
The Future of Australian European e-Research Cooperation

Summary
Science and research are increasingly digitally-driven and digitally-dependent. The acceleration of widespread sensorisation, coupled with large databases of historic data, promises new opportunities for researchers to utilize 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. Australia and the EU have already collaborated in key e-Research domains such as biological science, astronomy, ocean and climate research. The European Commission currently finances the Mesopp project, for example, which delivers good scientific results on ocean e-infrastructures. Continued mutually beneficial exploitation of e-Research opportunities will require new approaches which go beyond open data and new sources of funding, and more nuanced assessments of the benefits of open and digital research.

Introduction
The digitisation of science has arrived
An expanding set of digital tools and improvements to globally accessible digital infrastructure is changing industry practices as much as citizens’ lives. Science has been particularly quick to adopt digital methods and formats in its work practices. This includes data, as well as discourse, tools, and methods; even funding and infrastructure may be accessed digitally.

This digitization of science is a major driver behind the internationalization of research, leading to a workforce shortage of individuals with appropriate skills. Such internationalization is not a luxury. Rather, it has become a necessity, in particular for industry as innovation and knowledge for innovation are sourced globally. However, it is often plagued by significant practical challenges such as travel costs, time zone differences, working styles etc. A recent round of panel sessions on EU-Australian research cooperation identified key trends for future internationalization of e-Research with a focus on long-distance collaboration.

Targeted e-Research developments in combination with good e-Research processes and infrastructure will facilitate easier and more productive cross-discipline and therefore cross-silo collaboration.

Support for e-Research is seen as a significant investment in Europe. Europe’s Digital Single Market policies include specific actions for an improved e-Research environment.

Drivers of e-Research
The motivation behind e-Research activities cannot be limited to “more open” processes, or “data re-use”. Especially in Europe and Australia, three key drivers for agencies to fund e-Research are to (i) improve research quality, especially the reproducibility of research, (ii) enhance the use of more effective research results beyond academia, i.e. research translation, and (iii) increase the productivity of all aspects of research activity.

The effectiveness of these motivations is dependent on the extent to which they are acknowledged when data infrastructure is first established. Simple provision of research data in a repository is not enough – thought must be given to the potential usage of the data. Applications in climate research are at the forefront of international cooperation in e-Research. Similarly, satellite imaging has proven an important driver of Europe’s
cooperation with Australia, in particular since the availability of Copernicus\textsuperscript{22} data for Australia.\textsuperscript{23}

Today, much effort goes into adapting existing data for a specific need, often resulting in individualized and non-standard solutions. A possible way forward, in particular for EU-AU cooperation, is the creation of virtual labs. Such labs provide not only access to data but also tools that facilitate virtual experimentation, and are characterized by clear standards, ease-of-use, and data curation.

Some jurisdictions and research funders have moved to supporting openness in research. For example, the EU’s new Open Science Cloud\textsuperscript{24} provides an opportunity to improve international engagement in initiatives that support collaborative and open innovation. However, making data findable, accessible, interoperable, and reusable (FAIR) across country borders remains a non-trivial challenge which needs to be tackled in close cooperation across jurisdictions. The future lies in strengthened collaborations between academia, industry, and government agencies. At first sight, e-Research and open data/open science approaches often focus on quantitative aspects of “more”, “better”, “faster”, but there are other reasons for supporting e-Research:

Making the best of available data

Several fields of science have been transformed from being non-data driven to highly data-driven. Biology, for instance, is an example of a scientific field that is experiencing an explosion of data. The advent of massively parallel sequencing techniques, and other high-throughput genomic and proteomic approaches, has dramatically increased the amount of data available to biologists. However, many biologists are still developing the skills to make the best use of this available data and rely on collaborative inter-action with bioinformaticians to analyse and interpret these large data resources.

Helping researchers benefit

For researchers, citation rates increase dramatically when they publish their computer code and data alongside their papers. As increased citations lend impact to a researcher’s work, this provides a personal motivation to embrace e-Research when appropriate tools and resources are made available.

Improving research quality

Another reason to invest in e-Research is to drive up research quality. Using international data repositories has become an important driver of research quality, for example through competitions. Also, it helps to establish factual standards which can support the development of common approaches.

Exploiting the translational power of e-Research

Governments have an incentive to increase the use of data beyond the original research environment, i.e. translation into practice within the public and private sectors. Assistance with the transformation of research is needed to achieve this.

The Australian Government has made, and continues to commit to, significant investments in e-Research.\textsuperscript{25} The National Collaborative Research Infrastructure Strategy (NCRIS) provides a national network of world-class research infrastructure facilities that support high-quality research with the aim of fostering greater innovation in the Australian research sector and the economy more broadly. Similarly, Europe’s new Open Science Cloud aims to create a virtual environment with services for research data that are open, seamless, and free at the point of use. It seeks to combine Europe’s data infrastructure with high-performance computing resources and targets 1.7 million EU researchers and 70 million science and technology professionals in data-driven science. In addition, various investments by Europe’s H2020

\textsuperscript{22} http://www.copernicus.gov.au/


\textsuperscript{24} https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud

Europe’s ICT innovation partnership with Australia, Singapore & New Zealand

programme targeted Open Science and the provision of open research data.26

Current challenges

There is increasing demand from researchers to include international research data in their own projects with varying degrees of integration. This presents numerous practical, but also organisational, challenges which are currently being addressed through largely individual and non-standard solutions. Unfortunately, collaborative international funding models of significant size and reasonable simplicity are difficult to find. Although there are many initiatives and working groups, funding for cross-border and joint open e-Research schemes is scarce. Even where collaboration and open access are focused, commercial use of data may come with added administrative burdens and costs.

Human aspects play an important role in the further development of e-Research. This ranges from research in humanities, arts, and social sciences as disciplines with specific challenges for e-Research, to the human aspects in international research cooperation.

Integrated platforms in the domain of humanities, arts and social sciences provide a broad range of challenges. Research in these fields sometimes results in disparate and non-standardised large data sets such as those that exist in disciplines like psychology, sociology, political science, and humanities (e.g. archaeology, linguistics, history). To fully tap into the potential of open e-Research resources for innovation, much more cooperation in these fields will be needed.

Human factors also include the necessity that collaborators from around the globe understand the motivations, objectives and environments of their colleagues. For this, there is no substitute to conducting meetings and work in person. Despite substantial progress in collaborative tools, there is little consensus today on which of these tools to use – from data sharing to word processing to video conferences – especially when working across sectors and continents. Therefore, and for the time being, meeting personally can and should remain a key element, enhanced by the use of digital tools, to ensure efficient international long-distance collaboration.

Digitization of research is opening science not just for scientists, but also for a global public. This enables more widespread access to scientific publications, and also goes much further in making available data, software, even infrastructure together with instructional videos and tutorials. This is a transformative step for scientific knowledge from being a “club good” to a truly public good.

Policy implications

This increased digitalisation is changing the relationship between science and society and, consequently, altering science policy. The boundaries of what is to be considered a national research policy are much less clear today than just a decade ago. Policy makers with an interest in sustaining national competitiveness are faced with large multinational players – in academia and industry – who opportunistically source research and innovation globally. e-Research and the digitization of science therefore need to be integral in the context of domestic policies that address inter-national collaboration in research and beyond.

The intrinsic complexities of inter-national interoperability require an inclusive approach in which all relevant actors from research/academia, government and industry are involved. The specific challenges of not-for-profit versus commercial interests require an open-minded approach. Often today, we are lacking nuanced data that clearly demonstrates the mutual benefits of open and collaborative approaches in e-Research. This is particularly true for cross-border cooperation.

Joint open data and e-Research initiatives

The future lies in strengthened collaborations between academia, industry and government agencies. Inter-
national cooperation provides a particular challenge and has become a necessity. This includes work on standards for data, services and infrastructure to ensure access, interoperability, and ease-of-use along with the development of supported services. Policy coordination (bilateral, multilateral & global) around certain data collections (for example, national surveys) would improve the reusability of such data and coordinating efforts around rewards for the reuse of software may lead to increased efficiencies beyond the reuse of data.

Establish a collaborative international EU–AU funding model

There are clear benefits of open research data and e-Research, and most agencies and research policy makers have astutely become aware of this. However, it remains challenging for Australian and European researchers to initiate e-Research activities due to the lack of fit-for-purpose funding models – with only few exceptions. Easily applicable funding models for realizing EU-AU e-Research projects should become a primary target of future EU-AU cooperation.

Value beyond research

In order to establish longer-term collaborative funding models, it will be necessary to provide evidence of the benefits of e-Research – both scientifically and economically. For example, it may be possible to undertake research around the GDP benefits of wholly open data, as opposed to commercial or free for non-profit arrangements.

Joint virtual labs

A trusted data repository is not simply a place to store data. Making data open does not necessarily make it reusable. A possible way forward, in particular for EU-AU cooperation, is the creation of virtual labs. Such labs would provide not only access to data, but also tools that support virtual experimentation and are characterised by clear standards, ease-of-use, and data curation. Virtual labs eliminate the users’ infrastructure costs of using/visualising the data. Such labs may involve payment for dedicated services, but this in turn opens the possibility of adding quality services on top of the data.

Test new ideas of common interest

Robust workflows are needed to involve users in the design of e-Research platforms, so they are fit for use. Data needs to be evidenced and quality-assured to create trust and a solid basis for further exploitation. This is the first step for research data to become a commodity in trust-building initiatives: processes, policies, paradigms, and ways of working. A joint initiative to test the application of robust data management plans for research endeavours has the potential to assist researchers in their data management activities, but also in improving the often poor quality of current data management plans.

Create market places for data

Using open data can be very expensive, for example because of the lack of quality, metadata, interfaces, interoperability, etc. A data marketplace can provide an incentive to make data available, acquired and utilised. Use of data from such marketplaces would necessarily attribute public recognition to this use, and the original provider. It could work like a stock exchange, which is simply a registry of input and output transactions. Although some data marketplaces already exist, they are by no means common. Most of the necessary work towards such marketplaces is around policies and procedures relating to shared areas of interest, from the medical domain to climate data. The EU and Australia could provide trials of dedicated data markets. It takes time and money to clean and package the data in order to render it fit for use. In many circumstances, it may be more efficient to package the data and charge for this data-as-a-service. In addition, publishers need to find their role. They still rarely apply quality assurance for data that is underlying publications. Europe and Australia are well placed to experiment with such marketplaces at an international level.
Identify application areas of shared international importance

Australia and the EU already have e-Research ties in a broad range of application domains from astronomy to biology, genetics, climate and medical research, and music. Further collaboration in recognized areas of international cooperation is recommended. For example, the United Nations’ Sustainable Development Goals (SDGs) provide an outstanding frame of reference for the development of e-Research collaborations. The SDGs can be used as a guideline for initiating thought around policy and legal frameworks and needs e.g. socially diverse data.
AU-EU Cooperation in Digital Technologies and the Arts

Introduction

Societies worldwide are experiencing technological change at an unprecedented pace. While this is true for many areas of technology, it is especially visible and fast relating to information and communication technologies. Changes induced by digitization are affecting societies at many levels. New computerized systems provide many of our everyday services and have become pervasive in both our private and professional lives. In addition, they have become our means of communication, of starting new partnerships, of artistic expression, and assist in understanding who we are.

Digitization thus not only prompts business changes, but also changes in scientific practices, governance, and in the arts. Indeed, the arts have become a key actor in helping us to understand developments in the digital world, assessing their potential consequences, and making the most of their undoubted potential. Institutions and governments around the world have started to acknowledge the potential of art/science and technology interaction. At the same time, high-tech companies build on the creative ideas of artists to accelerate innovation or develop entirely novel points of views in close cooperation with research labs.

Digital art/science initiatives established in Australia and the European Union

In Europe, the European Commission fosters art/science and technology interactions as part of its STARTS initiative, which is built on the rationale that the funding of art-science interaction can stimulate innovation. STARTS’ main objective is to fund the participation of artists in science and technology projects in the form of residencies. The residencies often result in physical works of art, installations or performances that reach out to broad audiences in exhibitions or at art and science festivals.

For close to a decade, the global Science Gallery Network has also been at the forefront of encouraging public engagement with science and art. With European nodes in Dublin (since 2008), London, Rotterdam and Venice, the Network has expanded globally to Detroit, Bangalore and Melbourne, Australia. Each node is affiliated with a leading university that plays a crucial role in igniting creativity and discovery through its programming. Unique, transdisciplinary exhibitions, events and educational programmes aim to engage young people in connective, participative and surprising ways.

There are even joint initiatives. Ars Electronica, one of the world’s most renowned festivals for the electronic arts, originated in Austria and has now expanded overseas, with Ars Electronica Australia being a recent arrival. Working in a non-franchising model, Ars Electronica is responsively expanding its reach through an emerging, organically growing network of people and activity. Ars Electronica Australia is a consequence of over five years of co-created endeavours and activities that continues to build upon the vision and legacy based on the tenets of Ars Electronica. Ars Electronica Australia is a growing organism powered by Art Thinking (licence holder) that embraces Ars Electronica’s 40-year tradition of exploration at the nexus of Art Technology and Society.

Case study 1: From exhibition to living lab

Science Gallery Melbourne27 (Australia) was created as part of an effort to reach out to young people – especially between ages 15 to 25 – seeking to connect with its host institution, the

27 https://melbourne.sciencegallery.com/
University of Melbourne, by exploring collisions of art and science. The aim is to illustrate new and uncommon ways to engage with science to this demographic. Science Gallery Melbourne organizes dedicated exhibitions, often around special themes, and invites artists to create works that take inspiration from research or build upon ground-breaking innovation. Artworks are usually physical objects and most often with an interactive element. This helps visitors better understand the impact of the individual, the self and society, as well as the impact of science, on the future of humanity. The gallery is currently operating in a pop-up state while the purpose-built gallery is being constructed. From 2020 onwards, Science Gallery Melbourne aims to attract more than 250,000 visitors per year - including from regional Australia and underrepresented groups.

Science Gallery Melbourne is unique in providing a hybrid gallery environment that serves a dual purpose as research environment. The scientific community is invited to participate in artist-driven art exhibits, and vice versa: scientists are given opportunities to showcase ground-breaking academic research. As the gallery turns into a living lab, unique opportunities are created to study user interactions and user-generated feedback in a real-life environment, taking advantage of the heterogeneous and diverse demographic that Science Gallery Melbourne aims to address.

Case study 2: Ars Electronica - Ars Electronica Australia

Ars Electronica has followed, anticipated and analysed the digital revolution and its origins, its successes, even its follies. As a festival for art, technology and society, as well as the cultural and social significance of new technical and scientific developments, Ars Electronica has always been at the forefront of this discourse. The festival originated in 1979 Linz, Austria where it now attracts more than 100,000 visitors each year. It was designed to take the Digital Revolution’s emergence as an occasion to scrutinize potential futures and to focus these inquiries on the nexus of art, technology and society. This idea has now been taken up around the globe.

Ars Electronica Australia was initiated to create opportunities that inspire and empower people to imagine, discover and act in Australia. The focus is always on current developments and possible future scenarios; asking the question of how these will change our lives? Working with individual artists or at city scale, Ars Electronica Australia is intent on bringing the unique creative ecosystems of Ars Electronica to Australia. Building from the platform of the festival; the historic proving ground and DNA of Ars Electronica, the Australian node is to ignite curiosity and action within the industry, education and community. The current short-term scope of business includes education & community of practice, broad dissemination of Art – Technology – Society principles through the festival and programme platforms, and research activity. Through building a community of practice we will facilitate an artistic - scientific think tank and studio lab, based on the Futurelab model. This model is active in research and prototyping ‘future sketches’ that invite discussions and reflections on future concepts and their meaning for our society within our society. The Festival is a key moment of amplification that promotes open access, diversity of voice and broad communication of these ideas and discourses - exampled and discovered through display, presentation, symposia, workshops, and participatory engagement mechanisms.

Potential for EU-Australia digital art/science collaboration

Australia and the EU share a common history and many fundamental values. However, there are also important differences such as geographical positioning, population characteristics, international trading partners, and economic strongholds. Both jurisdictions are experiencing rapid transformations of their societies, at least in part caused by digitization. New cultural and societal challenges are emerging that
provide a rich source of critical and constructive artistic and philosophical discourse.

The question of how to engage citizens in science and how to accelerate the process from scientific results to innovation is high on the policy agendas of both the European Union and Australia. Art/science and art/technology initiatives are now playing important roles, further facilitated by significant initiatives such as Science Gallery Melbourne and Ars Electronica:

- Many art/science initiatives and festivals are international by nature. Australian and European artists share many practices and already meet regularly at science festivals and other events in both the EU and Australia.
- The art/science environment – especially in the digital arena – is highly dynamic and generally less competitive than in industry. There is usually no fear of losing intellectual property and no competition for markets. This makes art/science collaboration a particularly fruitful area for cooperation initiatives.
- In addition, small amounts of funding can trigger interesting and durable collaborations. Typically, artist residencies and commissions start with much smaller price tags than many basic digital research and innovation projects.
- Finally, the international dimension of art/science collaborations and the aesthetic attractiveness of many resulting artworks that often reach broad audiences appeal to policy makers. Festivals and galleries involved in art/science work can be platforms for policy statements or for kick-starting initiatives. They are strongholds of public debates about future technologies, and they frequently attract policy and decision makers from diverse backgrounds and responsibilities.

Current Status & Recommendations

Despite its potential, international cooperation for digital art/science initiatives to date was mostly limited to the field of arts. This is surprising given that art/science interaction has now become internationally recognised as a potential driver for improving our understanding of digitization and a potential accelerator of innovation. Where art/science initiatives exist, they often fail to take into account the full cycle from outreach to citizens as drivers of science and research. Promising changes to the traditional model include specific requirements for public outreach and public engagement in academic grants, e.g. as seen in some Australian Research Council grants.

Dialogue between art/science and digital technologies

- Establish an open dialogue and invite creative minds, including artists, to contribute based on their own creative experiences and work.
- Create opportunities for researchers and engineers to include artists in their research projects – across the continents.
- Support experiments with artistic long-distance interactions facilitated by digital technologies using state-of-the-art and forthcoming technologies.
- Involve citizens in digital art/science projects, both as a form of civic engagement and contribution to active research.
- Inform researchers, scientists, and engineers about the potential benefits of art/science interactions for reaching out to citizens and thus gaining public support for their work.

Inclusion & empowerment

- Promote global-level dialogue and cooperation between engineers, researchers and artists while at the same time increasing local awareness through exhibitions, round tables and other formats open to broad public interaction.
- Inform industry about the potential benefits of art/science interaction for innovation and the early adoption of new technologies. These advantages range from the creation of durable artworks that support sustained dialogues, to the power of artists to co-create innovation in cooperation with citizens and novel feedback loops from artistic interaction with citizens to research.
- Facilitate residency of artists into industry research culture, inspired by globally renowned organisations such as: CERN, MIT Biolab, Welcome Foundation, Ars Electronica FutureLab.
Significant awards that recognise excellence in the field, and future possibilities such as: Ars Electronica Prix Next Idea & EU Commissioner S+T+ARTS prize.

Education & training

- Include art/science training in research education and training on current artistic practices.
- Ensure means for science education and communication to accompany art/science initiatives and vice versa.
- Build art/science concepts into teacher training.
- Evaluate art/science concepts as a means to inform ethical insights about the implications of new and emerging technologies.

Funding

- Increase and diversify the opportunities for small seed funding for the involvement of artists in research projects. Even comparatively small amounts can trigger interesting art/science cooperation.
- Aim to overcome the current strict separation between mechanisms for art funding and for technologies funding. Consider the full spectrum of artistic contribution to and involvement in scientific processes and their impact on the public including citizen scientists and importantly, understanding and agency in the discourse.

Further research & critical discussion

- Support research to improve our understanding of international art/science interaction and its relation to citizens, but also its impact on innovation.
- 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. It serves to establish critical discourse. Investments in art/science usually imply investments in public communication of science to some extent.
- Recognise and support the integration of art/science as or within research infrastructures, e.g. in supercomputing or data facilities. A few large research infrastructure organisations run programmes for artist residencies (e.g. CERN). This should be expanded to smaller organisations including universities, public research institutes etc.
- Improve our understanding of creative processes in both artistic and citizen interaction with science and digital technologies research.
- Promote opportunities for exchange between researchers, artists, engineers and a broad public in order to detect and address adverse effects as well as opportunities.

Conclusion

The concepts of digital art/science and art/technology both have long traditions but are also undergoing significant changes. Australia and Europe are active contributors to the digital art/science scene worldwide.

Some synergies between Australia and the European Union are evident: strong cultural ties, joint initiatives, common languages and policy interests, but also similar challenges and changes. Some aspects are more diverse and offer an opportunity for mutual fertilization, e.g. artistic traditions, indigenous diversity, degree of multiculturalism.

Many of the potential benefits of stronger joint EU/Australian art/science practices have scarcely been investigated and are still in their infancy. They are most clearly visible in the establishment of public discourse, for example in galleries and public art/science festivals. There is a huge potential building on existing strengths to significantly change digital art/science collaboration between the EU and Australia. AU-EU initiatives for art and digital technology research have a huge potential for turning even small investments into highly visible and durable partnerships.
Getting AI right: Australian-Europe Collaboration Potential in AI

Summary
As artificial intelligence (AI) technologies are increasingly used across converging technologies, they become ever more difficult to manage and predict. This convergence is not just about technologies but also about the breaching of industry boundaries such as those between media, transportation, entertainment, and retail. While this may create an abundance of new products and services, it may also lead to undesirable consequences.

Australia and the European Union are taking the first steps to ensure the ethical development of AI. Each jurisdiction is working to create principles for AI development and application, and, where necessary, AI regulation. Australia and the EU not only share many of the challenges, but also many underlying ethical values. Australia and the EU are excellently positioned to collaborate in this domain. This includes: research into AI technologies and their implications for society; the exchange of good practices on exploiting AI for innovation while maintaining ethical principles, such as data ethics; and collaboration in AI regulation.

Introduction
With more than four decades of research history, artificial intelligence cannot really be called a new technology – neither as a concept nor as a set of tools and techniques realising AI systems. However, the recent convergence and pace of change makes AI difficult to manage and predict. This convergence is not just about technologies but also about the breaching of industry boundaries. Technology firms (e.g. Alibaba, Amazon) hybridise traditionally siloed services such as media, transportation, entertainment, and retail. While this may create an abundance of new products and services, it could also lead to market distortion and undesirable social consequences, for example “winner-takes-all” phenomena driven by firms that are best positioned to drive AI.

This raises the following questions. How can we ensure that AI is designed respecting ethical principles? How can we do this while creating an efficient environment for AI-based business to flourish? And, how do we deal with the looming job displacement and labour market impacts that will land in the (not-too-distant) future? In short, many governments, including those in Australia and in the European Union, aim to combine technologically enhanced AI solutions with ethical principles, be it: data ethics; fair, impartial, and bias-free decision making; or safety and security. The promises and potential gains of AI technology have resulted in a world-wide race for domination. The dominance of some large enterprises in AI research and AI tools also means that smaller nations are no longer merely competing with one another but also with firms. As much of AI is about machine learning, this race is often perceived as a race for data, including personal data. This poses many ethical questions and the possibility of regulatory intervention. The challenge is all the greater as the technologies in question are still developing and understanding how AI can be best used for everyday life is difficult. Although the gloomy predictions of some economists about massive job losses may not come true immediately, it is necessary to consider key challenges resulting from AI such as: changes in skills and the workforce; data for AI; and legal aspects, including, for example, automated decision making. Finally, the question of how to best regulate a new technology such as AI is particularly important for international collaboration and indeed may itself pose a need to collaborate internationally.

28 Cf. https://www.cigionline.org/articles/global-race-ai-how-do-we-ensure-were-creating-better-world
International AI Policy

Since 2017, many countries around the world have developed national artificial intelligence policies and strategies in which AI technology, the digital economy, data, and the future of work often appear as priorities. However, international discussions have also shown that designing such systems requires an understanding of values and basic principles. During the EPIC events in all three target countries, it became very clear that no nation on its own can claim to have completely addressed the required ethical considerations and that more discussions, and indeed more research, are needed.

The Group of Twenty (G20) has published guiding principles for using AI and on trusted free-flow of data. It calls for human control, shared benefits, fairness, and inclusion in AI; and it emphasises accountability, transparency, security, and privacy. The G20 thus recognises the need for international efforts to develop a global ethical framework for AI. Such principles should avoid the misuse of AI, or even intentional use for immoral purposes, such as surveillance programs used to identify and suppress dissent. In a similar direction, G7 countries are working on principles for the future of AI, e.g. the Charlevoix vision. The Institute of Electrical and Electronics Engineers (IEEE) also describes guiding principles.

A recent white paper by the Australian Human Rights Commission and the World Economic Forum calls for stronger governance and leadership in AI ethics. Australia’s national research organisation CSIRO prepared a discussion paper on AI ethics that is currently under review. The development of an approach to AI based on trust is a key element in Australia’s report on its tech future. Trust is also a key component in Europe’s AI approach in an EU Commission Communication.

In summary, many Australian and European policy papers agree on the importance of trust as a prerequisite to ensure a human-centric approach to AI: the need to ensure accountability and responsibility, while at the same time harvesting social and business opportunities as much as possible.

Addressing all these constraints with practical policies is a huge challenge and many aspects lack a solid research underpinning. From labour impacts, to questions of autonomous decision making, from privacy concerns, to security of AI, more research is needed in areas such as technology, legal and social work, regulation, and many others.

Initiatives established in Australia and the European Union

Europe has started early in developing an ethical approach to AI. The EU AI ethics guidelines for trustworthy AI were designed as a first checklist for its member states. Many of its recommendations are already aligned with principles that are mentioned in Australian papers, studies, and government reports. These include:

- Empower and protect humans and society
- Foster a data economy

---

31 https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead_general_principles.pdf
Exploit the role of the public sector: ensure sector leads, e.g. with human-centric public services

Nurture education: ensure a wide skills base through education and striving towards a work-life-train balance in continuous learning

The European Commission suggests that a European approach should be utilised to safeguard human dignity, transparency, and democracy, and to make sure that AI will have benefits for all business and citizens, whilst also bringing “our society forward together”. In Australia, a new report on its ‘Tech Future’ emphasises how all Australians should be able to engage with technology and participate in a modern economy. In parallel to the ethical aspects, the European Commission has prepared a plan to considerably invest in AI technologies. First initiatives have been started already in the current EU Framework Programme H2020 and more actions are planned during the forthcoming next programme ‘Horizon Europe’. Among the initiatives, the intention to create a vibrant European network of AI excellence centres stands out. Other initiatives include: Digital Innovation Hubs throughout Europe; improved training, including PhD programmes; world-reference testing facilities; and public leadership in AI, including the use of public data. The EU plan for AI also emphasises the need for international collaboration and the alignment of member states’ bilateral policies.

Research

Australia and Europe have numerous excellent research groups at various universities. Australia is internationally renowned for its work on large, autonomous systems, for example, those used in mining. Europe has a solid tradition in autonomous robotics. Both countries are traditionally strong in logic and constraint programming. Europe’s industry is increasingly focussing on embedded AI based on its competence in integrated (embedded) systems. Australia has strong AI applications in health based on initiatives at the federal and state level.

The Australian Government committed AUD $25 million in additional funding for AI in its Cooperative Research Centres (CRC) Program. CRC-Ps are short-term, industry-identified and industry-led collaborative research projects to develop a product, service, or process that will solve problems for industry and deliver tangible outcomes. The department (DIIS) recently announced funding for 13 centres from a dedicated AI focus from the 2018-19 budget. They range from applications in wastewater treatment to health and agricultural applications.

Australia is excellently positioned in some areas to demonstrate AI showcases, in particular in public sector fields. It is a leader in open government data and ranks second out of 49 countries in the 2017 Global Open Data Index. Similarly, Europe has many initiatives aiming to improve public data access and the European Commission has been instrumental in guiding the member states towards more open data policies.

Example 1: Human factors in AI research

French CNRS and French maritime technology, shipbuilding, and energy company Naval Group, have signed a Letter of Intent with Flinders University, the University of Adelaide, and the University of South Australia to develop a proposal to base what would be one of only five industry-linked CNRS international joint laboratories in the world, in Adelaide. The lab would be positioned at the intersection of autonomous systems, artificial intelligence, and human factors.

---

40 https://www.unisa.edu.au/Media-Centre/Releases/2019/first-australia-france-joint-international-research-lab-to-be-based-adelaide/#XsW1Xvpp_A
**Example 2: AI and data science**

The University of Sydney’s multidisciplinary Centre for Translational Data Science and The Alan Turing Institute, the UK’s national institute for data science and artificial intelligence, have signed a Memorandum of Understanding to collaborate on joint research projects. These will include criminology, air quality, and geosciences that will have strategic importance to the Australian economy. The collaboration will be centred around The Alan Turing Institute’s Data-centric Engineering Programme.

**Current Status & Recommendations**

There is a risk that the promised global race for harvesting the economic benefits of AI may limit international cooperation; potentially also between Australia and the EU. However, in some areas such as AI impacts, AI ethics, and AI regulation, international collaboration is the key to success. Only few AI strategies focus on inclusiveness, citizens’ rights, trust, human rights, social justice, peace, welfare, development, and environmental sustainability. Australia and the EU are well positioned to coordinate work in these areas.

Both the research/engineering and the policy/social side demand such cooperation and dialogue to remain at the forefront of the dramatically fast developments in AI technology, tools, and applications. It is vital to build an appropriate knowledge base in AI technology as well as its social and political implications.

Australia and the EU can build on a skilled labour force but may be facing shortages in key digital skills including artificial intelligence and robotics. As the demand for digital skills is increasing globally, policies of attracting skilled labour from abroad may become less effective. Industrialised nations should join efforts in developing their skills base or as a minimum share experiences, exchange good practices, and provide each other access to online training resources.

In the past, collaboration of individual researchers between Europe and Australia has functioned well. Based on contacts of individuals and a strong expat presence in both countries, AI researchers in Australia and Europe have been working together for decades. On the downside, there have been very few successful joint initiatives going beyond such peer-to-peer activities. EPIC thus recommends the following areas for collaboration:

**Supporting the dialogue**

- 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 should include the status of implementation and the level of international alignment.
- Develop a governance structure or platform for ensuring accountability and transparency in the development of AI, in particular as it relates to the social and political impacts of these technologies.
- Europe and Australia should better utilise their expat networks in both regions. A thematically focused network (e.g. in ICT) would help to exploit synergies and go beyond current networks often limited to EU member states, for example. This could also improve inter-sectorial exchange if it includes industry and academia.

**Joint research and monitoring of AI developments**

- Encourage greater knowledge sharing between Australia and the European Union and its member states to foster a more collaborative environment. Mutual invitations and consultations can be a useful instrument, as can improved inter-country and interdisciplinary exchange in AI engineering and
research with scholars in other fields such as law, political science, and humanities.

- Maintain the opportunities for peer-to-peer collaboration with support for exchange visits and smaller-scale research collaboration opportunities.
- Improve information about mutual funding opportunities. There are currently many small programs, e.g. of EU member states, that are only short-lived, and it is difficult to maintain an overview.
- Create opportunities for Australian and European actors to collaborate on development and implementation of a global ethical framework for AI and related emerging technologies.
- Align long-term research - including 20 years out challenges such as in computational neurosciences.
- Invest in studying and comparing the social, ethical, political, and environmental implications of AI, in addition to its security and economic implications.

**Inclusion & empowerment**

- Include diverse stakeholders in the development of AI policies and strategies.
- Promote global-level dialogue and cooperation between engineers, researchers, and artists while at the same time increasing local awareness through exhibitions, round tables, and other formats open to broad public interaction.
- Inform industry about the potential benefits of art/science interaction for innovation and the early adoption of new technologies. These advantages range from the creation of durable artworks that support sustained dialogues to the power of artists to co-create innovation in cooperation with citizens and novel feedback loops from artistic interaction with citizens to research.

**Education & training**

- Include AI training in all computer related education and training courses. Develop accessible, comprehensive education curricula that ensures interdisciplinary understandings of AI and its impacts on society, to enable citizens to make informed decisions in their use of AI and other emerging technologies.
- Exchange good practices in AI education for the young, for teachers, and a broad public. Where applicable, this should include citizen science and art/Al initiatives.
- Collaborate in content creation, best-practice exchange and sharing of access to online training courses for AI – at the vocational and university level.

**Regulation**

- Establish processes to exchange concepts, practices, and experiences with regulation. For example, Australian researchers are already using existing ISO standards to show potential regulation of automated (including AI) systems.
- Develop and share fit-for-purpose and technology-neutral regulatory approaches that strike the balance between safeguarding the community and enabling new technology innovation.

**Further research & critical discussion**

- Support research to improve our understanding of the social impact of AI including its potential contribution to innovation.
- Promote opportunities for exchange between researchers, artists, engineers, and a broad public in order to detect and address adverse effects as well as opportunities.
- While Europe has a long tradition of data and IT ethics regulation based on human rights, other jurisdictions focus on different principles such as property rights. It is recommended that Australia and the European Union share investigations of frameworks that best support citizen rights while enabling industry innovation.

**Conclusion**

Australia and Europe are active contributors to AI innovation. Europe is excellently positioned for its use in embedded and cyber-physical systems and Australia has developed impressive large-scale AI applications. However, they are also faced with global challenges and competition. Neither Europe nor Aus-
tralia possess large AI firms that currently dominate the AI tool base internationally. However, both regions share many values and the fundamental belief that AI requires an ethical approach. General synergies between Australia and the European Union are evident: strong cultural ties, joint initiatives, common languages and policy interests, but also similar challenges and changes.

Europe and Australia should therefore work closely on both the technology and policy fronts to ensure an ethical, inclusive, and trusted approach to the further development and regulation of artificial intelligence.
Connecting Things Around the World: EU-NZ Industry 4.0 and IoT Cooperation

Summary

Internet of Things (IoT) and Industry 4.0 (I4.0) bring together digital technologies to enhance the performance, output, monitoring and control of processes. The Internet of Things (IoT) extends the idea of internet as a computer network to all sorts of physical devices and objects. Industry 4.0 (I4.0) refers to using IoT to enhance the performance, output, monitoring and control of manufacturing processes. Both, IoT and Industry 4.0 solutions, lie at the heart of digitizing our societies, industries, and promise gains in efficiency and productivity, but also in sustainability and quality of living.

The European Union and New Zealand are facing many similar challenges in Industry 4.0 and IoT. Developing ecosystems that can drive innovation based on IoT solutions or I4.0 remains a key mission for policy makers. A central task is to ensure that small and medium sized enterprises in Europe and New Zealand can benefit from and deploy IoT and I4.0 solutions. Another job is to ensure trust in these solutions based on secure systems respecting privacy and other ethical principles. Both regions have already put initiatives in place to foster IoT and I4.0 innovation. Europe has developed successful showcases of I4.0 and developed key legislation relevant for IoT. New Zealand is an excellent test environment for its vast geographical area and business-minded entrepreneurs.

Europe and New Zealand should therefore join efforts in areas such as developing and deploying solutions for and with the help of SMEs. There are opportunities for collaboration in technology policy, for example in studying and further developing international regulation and interoperability – especially in the light of a forthcoming EU-NZ Free Trade Agreement. In addition, there still are many research challenges in areas such as energy efficiency, sustainability, privacy and security that New Zealand and Europe can jointly tackle with benefits for both regions.

Introduction

The Internet of Things (IoT) extends the concept of computers networked through the internet to all sorts of physical devices and everyday objects. Using sensors, actuators and embedded computing these devices promise to provide ubiquitous monitoring and control in a large variety of applications. Industry 4.0 (I4.0) is the use of these technologies to enhance the performance, output, monitoring and control of manufacturing processes. It can be broken down into two distinct areas that are not mutually exclusive - Smart Factories and the manufacturing of Smart Products. Industry 4.0 initiatives include process automation, real-time process monitoring, additive manufacturing (3D Printing) and virtual and augmented reality visualisation. Industry 4.0 can be regarded the manufacturing version of the Internet-of-things and indeed in the U.S. sometimes the terms used is industrial internet-of-things.

To understand the importance of Industry 4.0 it is useful to revisit the trend towards offshoring (and outsourcing). In recent decades – starting from the 1970s – many industrialized nations experienced the dislocation of producing industries (i.e. manufacturing) to lower-cost countries, e.g. China. This trend started with consumer products, but in the late 80s and later included work with a high percentage of engineering or technological development. The importance of Industry 4.0 may lie in the ambition to re-shore manufacturing or at least to maximize productivity gains from the digitization and robotization of production together with improved flexibility and
quicker delivery.\textsuperscript{44} These are important objectives for manufacturers in New Zealand and in Europe who are facing many similar challenges related to international trade and labour cost. A study commissioned by the New Zealand IoT Alliance and MBIE in 2017 found that better use of IoT could create at least $2.2 billion in net economic benefit for New Zealand.\textsuperscript{45}

IoT and Industry 4.0 bring together several digital technologies to enhance the performance, output, monitoring and control of processes. In industry the focus is often on improving the speed and quality of business decisions and further enhance manufacturing processes and customer experiences. Although Industry 4.0 as a term now has been existing for a few years, it is still an active area of research and development. As a technology, it is now successfully applied especially in large industrial enterprises who are often global players and keenly aware of competition.\textsuperscript{46} However, harvesting the promised productivity gains of Industry 4.0 has proven difficult. In more consumer-oriented IoT solutions, the focus is often on small, intelligent and networked devices applied in all sorts of applications from entertainment to health.

**Similar challenges**

The European Union and New Zealand are facing many similar challenges in Industry 4.0 and IoT. For example, SMEs form a key portion of the business and manufacturing ecosystems in both regions. In fact, in Europe and in New Zealand SMEs constitute the vast majority of firms in the respective economy. IoT solutions on the other hand are still often focused on large industries. Furthermore, some very interesting applications of IoT solutions are being discussed for sectors that are only slowly taking up digitization. This includes agriculture, food industry, but also health services.

The main challenge for policy makers remains developing ecosystems that would be driving innovation based on IoT solutions. Especially for someone new to Industry 4.0, it can be daunting to navigate the ecosystem of providers (and solutions) available in New Zealand.\textsuperscript{47} But also in Europe, the take-up of I4.0 technologies in sectors such as agriculture has proven slow.

Data security and privacy are important challenges for the development of IoT and Industry 4.0 technologies. The installation and networking of hundreds of ubiquitous components constantly evaluating, transmitting and storing sensor data can be hugely demanding from a security and privacy perspective. In addition, there can be an increasing dependence on such systems – especially in Industry 4.0 applications so that reliability and security become important design criteria. The European Commission and the New Zealand Government share concerns regarding IoT security and privacy. For example, both in Europe and in New Zealand privacy legislation focuses on principles of data minimisation, where organisations should only keep a minimum of personal data. It would be only natural to collaborate on research and technology development as well as policy aspects in this matter.

Future-proofing IoT and Industry 4.0 solutions for the forthcoming Free Trade Agreement should also be a key strategic objective for EU-NZ collaboration. This concerns legislation and regulation, but also practical aspects of international data exchange, EU and NZ standards, and even aspects related to training and education.

**Initiatives in the EU and in New Zealand**

In New Zealand, Callaghan Innovation has been putting the spotlight on Industry 4.0 for several years.


\textsuperscript{47} https://www.callaghaninnovation.govt.nz/sites/all/files/industry40-provider-map.pdf
It runs an Industry 4.0 Hub website that provides a range of information on the topic. The New Zealand Government’s ‘Wellbeing Budget’ unveiled on 30 May 2019 has allocated $NZ6.8m to fund the creation of an Industry 4.0 demonstration network with, up to, two smart factories to prepare New Zealand industry for the future. Already in 2017, Callaghan targeted innovation in the area of IoT where it organised the C-Prize to champion wearable technology. This initiative was prepared with wearable technology seminars with EU experts and were organized in collaboration with the EPIC project. Callaghan will continue to focus on sustainability issues such as sustainable land use, environmental innovation, and the low carbon economy. It is expected that IoT Technology will be a key enabler.

The European Commission has created several initiatives to develop and deploy IoT and Industry 4.0. A digital transformation monitor assists the member states in monitoring and benchmarking the progress in the area. It also helps to network national and regional initiatives. In the Framework Programme, Industry 4.0 and IoT initiatives feature prominently, and the topic is also addressed in other policy areas including, for example, the EU’s Smart Specialisation strategies.

New Zealand’s IoT Alliance has investigated European activities such as the creation of the Alliance for Internet of Things Innovation and the Digital Single Market (DSM). Both aspects (IoT/I4.0 and DSM) also featured prominently in the EPIC event series in New Zealand and a good degree of mutual understanding already exists.

Industry 4.0 research and development strongly features in many European countries and industry has developed showcases and innovation factories. For example, a New Zealand brochure on IoT lists two key examples from Germany:

The Siemens’ flagship factory for Industry 4.0 in Amberg, Germany, is said to be 8 times more productive than 25 years ago (with the same number of employees) thanks to the incorporation of digital intelligence. The Bosch Rexroth factory at Homburg, Germany, adopted Industry 4.0 technology for its production of hydraulic valves for mobile machinery like tractors. Aiming to become more competitive through manufacturing at lower costs with increased flexibility, and higher quality standards, it has reduced set-up time from 450 seconds to zero, reduced inventory days from 3 to 1.5, with a 30% stock reduction. It also cut cycle times from 474 seconds to 438 seconds, with a 10% output increase and saved €500,000 per year.

In New Zealand, the University of Auckland has set up a Laboratory for Industry 4.0 Smart Manufacturing Systems (LISMS), claiming it to be “the leading research institute on Industry 4.0 in New Zealand.” The lab aims to support collaboration with industry and improve the transfer of IoT and other smart solutions to businesses.

**Current Status & Recommendations**

There is ample potential to improve the collaboration potential in the area of Industry 4.0 and IoT solutions between Europe and New Zealand. Europe has excellent research and industry in key enabling technologies for IoT solutions including embedded systems, power electronics, energy efficiency, real-time protocols, and wireless communication. New Zealand entrepreneurs have successfully experimented with IoT technologies and developed creative solutions in new sectors. For example, many of the NZ IoT Alliance members are working on smart city initiatives using IoT connections to help traffic flow safer, make parking easier, improve air quality, manage crowds and help maintenance crews in New Zealand’s major cities and regions. New Zealand entrepreneurs experimenting with IoT and Industry 4.0 solutions benefit from a business environment conducive to innovation and a relatively light regulatory framework.

---

48 [https://www.cprize.nz/](https://www.cprize.nz/)
49 [https://www.cprize.nz/insights-experts](https://www.cprize.nz/insights-experts)
51 [https://iotalliance.org.nz/](https://iotalliance.org.nz/)
Collaboration between the EU and New Zealand can therefore:

- Help to find new ways of supporting local industries in better understanding Industry 4.0;
- Encourage the early demonstration of IoT and Industry 4.0 solutions in less digitized sectors based on collaborations between industry and researchers;
- Showcase and implement the research works at local industries.

Collaboration should focus on

- Adopting IoT and Industry 4.0 solutions that enable small and medium-sized enterprises to easily develop solutions for their customers
- Addressing environmentally beneficial and energy-efficient solutions, potentially covering large areas, for example in agriculture
- Overcoming specific challenges of less digitized sectors or in application fields that suffer from processes without seamless interfaces today, e.g. in food industries
- Deploying safe and secure solutions that foster efficiency, but also trust, e.g. in the health sector

Supporting the dialogue

- 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.

Developing IoT and Industry 4.0 technologies

- New Zealand can provide an excellent environment for testing the suitability of Industry 4.0 and IoT solutions for small and medium-sized enterprises.
- Facilitate collaboration in IoT and I4.0 security and reliability, especially with a view of IoT and I4.0 deployment to SME customers and consumers
- Jointly showcase and advertise innovative IoT solutions that provide clear customer benefits while at the same time preserving people’s autonomy and privacy.
- Investigate the potential of IoT and Industry 4.0 solutions for sustainable development and environmental protection. This should also include potential benefits and negative impacts of IoT solutions deployed over large areas and in remote areas.

Education and training

- New Zealand and Europe should collaborate on IoT and Industry 4.0 education and training including vocational training. There is currently a lack of skilled people required to adopt solutions for the often unique environments of IoT and I4.0 solutions.
- Governments in Europe and New Zealand should exchange experiences and practices of ensuring that customers both in industry and consumers understand the security risks of IoT and I4.0 systems and can take appropriate steps to protect themselves.

Regulation

- Jointly investigate whether existing legal frameworks are adequate 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?
- Both IoT and I4.0 development today offer a plethora of standards and protocols. Although there is room for multiple standards, there should be coordination for future interoperability and seamless integration of solutions.

Conclusions

Technologies such as Industry 4.0 and Internet of Things have nearly become commonplace. This can make it hard to see the potential and the challenges deriving from them. The potential includes important contributions to improving energy and resource efficiency, greater sustainability of production processes and generally increased levels of productivity. Some challenges involve the role of SMEs in proper utilization of the technologies, developing trusted and secure systems, and ensuring benefits for large parts of the society. These are challenges for the European Union and for New Zealand. Both regions can build on excellent researchers and policy initiatives and synergistically bring in their complementary strengths to jointly develop the fields of IoT and I4.0.
Europe-New Zealand AI Collaboration Future

Europe, Aotearoa, Agritech, and AI

Artificial intelligence (AI) is one of the most talked about technologies as it promises to enable massive productivity gains, achieve competitive advantages and generally create novel products and services at an unprecedented scale. Just like their European colleagues, New Zealand policy makers in charge of technology, research, and innovation have been deliberating over the best ways to harvest the benefits of AI without buying into its potentially harmful and dangerous side – from decision bias to safety and security concerns, privacy infringements and unethical use of automated decision-making.

However, developing AI in a small Pacific state poses a range of challenges quite different from those of larger economies such as the EU or the USA. New Zealand boasts the advantages of a well-educated, flexible workforce, plus a government commitment to growth and innovation that make it a great place for business. Yet, New Zealand businesses – just like those in the EU – are often small and frequently active in non-technology prone sectors such as agriculture. Thus, they have yet to fully embraced digitization (just like many in the EU). In addition, New Zealand (again, just like the EU) lacks ownership of globally dominating technology enterprises with their ability to collect data from just about anywhere and anybody in the world and use it for training AI models. Therefore, Europe and New Zealand face many similar challenges despite the obvious differences in size, complexity of governance, global position, and characteristics of domestic markets. On the other hand, some of the apparent differences may be even more interesting for Europe.

A factor that stands out is the significant indigenous (Māori) population. Māori culture has preserved unique social structures and concepts including a fascinating culture and language. Māori have different and unique attitudes about knowledge, how it is constituted and with whom to share it. Similarly, the notion of what is considered “private” can be very different from other – Western – understandings. Although these differences have been known for some time, they have recently attracted new research interest, for example in connection with privacy laws, learning systems (AI) and big data.

Although New Zealand’s economy has diversified in many ways, there still is a dominant agricultural production sector. However, in contrast to at least some EU member states the NZ agricultural sector is largely unsubsidised and as a result more dynamic and entrepreneurial. Business innovators and researchers are developing agricultural technologies from precision farming to robotics.

New Zealand is excellently networked internationally with many allies including the UK and Europe, but it cannot be called a global power. In fact, it is a small nation also compared to some large internet giants, e.g. in terms of research investments. This means that New Zealand can only believably regulate dominant global actors in collaboration with other

52 Aotearoa is the Māori name for New Zealand and increasingly used, e.g. in the bilingual names of NZ government services.
53 Cf. S. Lilley. The last crusade: Māori culture and intellectual property rights. https://www.academia.edu/28585461/The_last_crusade_M%C4%81ori_cultural_and_intellectual_property_rights
55 Cf. The Centre for Precision Agriculture at the University of Massey http://www.massey.ac.nz/massey/learning/colleges/college-of-sciences/research/agriculture-environment-research/agriculture/centre-for-precision-agriculture/centre-for-precision-agriculture_home.cfm or the Precision Agriculture Association of New Zealand: https://precisionagriculture.org.nz/
countries including those in the European Union. A recent report investigated the government use of AI in New Zealand. It also aimed to identify some coherent sub-topics within AI – and in particular, sub-topics where New Zealand could play an important role in a broader international discussion. The report focuses on regulation and employment as two such areas and recommends ‘continued attention should be paid to international initiatives such as the European Union’s General Data Protection Regulation for comparison’.

Although it has not yet published a dedicated AI strategy at government level, New Zealand is keenly aware of AI and its potential. The AI Forum of New Zealand (AI Forum NZ) presented an important industry strategy document and the NZ government published an overview of the role that the public sector can play as an AI leader. Apart from an interest from the NZ government to stimulate productivity, there are also other important policy objectives. These include resource savings both in industry and, potentially in mission-oriented applications; sustainability and social aspects as important objectives. The latter includes topics such as the proper treatment of personal data and understanding or mitigating AI implications, e.g. in labour, skills, and training for which New Zealand already achieved some good international linkages including those with Europe.

The recent industry-led report on ‘Shaping a Future New Zealand’ explicitly proposes to increase international participation: New Zealand should continue building direct links with leading overseas research institutions and commercial organisations to accelerate capability growth. New Zealand researchers and developers should be facilitated to collaborate directly with more international partners. Europe is a natural choice based on shared objectives, cultural values, etc.

Potential for EU–New Zealand collaboration

There is a good level of AI research across all universities in New Zealand, most of it originating from computer sciences departments. However, AI research is crossing into multiple different faculties. ‘Shaping a Future New Zealand’ lists five pronounced centres of AI excellence:

- The University of Auckland has been working on developing life-like artificial systems. One success story is a spinoff AI company Soul Machines. The company develops avatars that are a user interface for AI platforms. Further research includes game AI, applied AI case-based reasoning, multi-agent systems and data stream mining.
- Auckland University of Technology (AUT) has a strong focus on language, speech technologies and mind theory. AUT has an internationally respected team in machine learning and neuromorphic, information processing for large and fast spatio/spectro temporal data using spiking neural networks. Other topics are robotics vision, unmanned aerial vehicles and the monitoring of bees.
- Victoria University of Wellington has an AI team including staff across the Engineering, Mathematics and Computer Science faculties. The group conducts research in machine learning, neural networks, cognitive science and data mining. Research centres on developing Evolutionary Com-

---

56 For example, New Zealand and France collaborate in targeting online hate speech following the ‘Christchurch Call’. [https://www.elysee.fr/emmanuel-macron/2019/05/15/appel-de-christchurch-pour-agir-contre-le-terrorisme-et-l-extremisme-violent-en-ligne](https://www.elysee.fr/emmanuel-macron/2019/05/15/appel-de-christchurch-pour-agir-contre-le-terrorisme-et-l-extremisme-violent-en-ligne)


putation (EC) and machine learning methods to solve real world problems in the areas of engineering, manufacturing and biology.

- The University of Otago is investigating the potential impacts of AI in law and society in a project funded by the New Zealand Law Foundation. The Pattern Recognition and Machine Learning Lab are applying machine learning to environmental sensing, event detection and wireless sensor networking. The AI and Neural Networks lab focuses on computer vision, and models of human memory and language.

- The University of Canterbury’s AI research centres on machine learning and algorithm engineering, and neuromorphic computing. Research includes application and optimisation of AI and machine learning technology and real-time passive brain-computer interfaces, particularly for detection/prediction of attention lapses from electroencephalogram (EEG). Canterbury also has significant crossover into the humanities, researching AI technology’s wider impact on society, policy and law.

The vast majority of New Zealand businesses are SMEs and the New Zealand government has taken steps to support especially SMEs in innovation, for example through its government body and EPIC consortium partner Callaghan Innovation. Europe and New Zealand therefore share the strategic objective to improve technology take-up for SMEs and this naturally includes AI. Like most nations, New Zealand is a small player on the international technology stage and does not have the depth of capital resources to create platforms at global scale.

New Zealand’s strong agricultural sector provides ample opportunities for developing innovative technological solutions. Consequently, Agritech is a particularly interesting application area for Europe’s AI collaboration with New Zealand.

Case study: Orchard robotics

![Kiwi fruit picking robot](image-url)  
*Figure* Kiwi fruit picking robot: a collaboration of Auckland University, Robotics Research Group, Robotics Plus, Plant and Food Research and Waikato University. https://thoughtsexperiment.co.nz/2018/11/12/aucklanduniversity-robotics-lab/

New Zealand engineers at the University of Auckland have developed some of the world’s most advanced agritech robots to undertake artificial pollination, for example. The Multipurpose Orchard Robotics project is a four-year collaboration with industry and universities. This NZ$10 million initiative brings together robotics, software and machine vision with expertise in horticultural engineering and plant knowledge. Research at Auckland University also addresses decision support in agriculture and other robotic applications such as fruit picking and more generally precision agriculture.

Robotics for orchards is also an important area of European RTDI. The EU funded accelerator KATANA, for example, lists 10 early-stage robotic developments from vineyard robots to robotic weeder. The European coordination hub for open robotics includes agritech robotics as a focus area. The European robotics platform Eurobots has recently published centres of EU agritech robotics research in its brief on the 16M EUR Agri-Food Robotics Digital Innovation Hub.

---

61 [https://www.callaghaninnovation.govt.nz/](https://www.callaghaninnovation.govt.nz/)
63 Barnett, J. et al., Robotic pollination – targeting kiwifruit flowers for commercial application. [https://pdfs.semanticscholar.org/4a18/1a0b-74b7c0b5fcd9baeccdd50c978d8a566615.pdf](https://pdfs.semanticscholar.org/4a18/1a0b-74b7c0b5fcd9baeccdd50c978d8a566615.pdf)
Current Status & Recommendations

The science and innovation relationship of New Zealand and the EU is supported by the 2009 Science and Technology Cooperation Agreement\(^67\) which has been instrumental in creating stronger links with New Zealand. The general level of research collaboration\(^68\) is very good for example in food and research infrastructure, but less intense with ICT programmes at EU-level. An exception was the collaboration in a joint EU Framework Programme call on the Virtual Physiological Human. Despite its potential, cooperation in ICT has not yet gone much beyond peer-to-peer collaboration in academic research which is significantly supported through the Marie-Sklodovska Curie actions of the EC. Collaboration of company research is less pronounced and less visible at the RTDI policy level today. In the area of agritech and robotics research, Europe and New Zealand have excellent research environments, entrepreneurial and academic competencies, and often complementary boundary conditions suggesting fruitful collaboration potential. EPIC thus recommends the following actions to help improve Aotearoa-EU collaboration on AI and agritech:

**Improving the dialogue**

- 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.
- Continue to engage with the international AI labour policy community. The AI Forum’s membership of *The Partnership on AI*\(^69\) provides a natural interface to both international policy debate and best practice development.
- Prepare for a successful conclusion of the EU-NZ Free Trade Agreement talks and investigate the implications for ICT including AI.
- Europe should treat New Zealand as an individual partner. Although it can be useful to cluster it with Australia or Asia from an EU perspective, its special characteristics and international autonomy merit it attention in its own right.
- 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 to be a “bridge between the West and the East” for collaborative international AI policy development for global issues - for example leveraging AI for solutions to climate change or people trafficking.
- Similarly, in 2019 the New Zealand government adopted a “Wellbeing framework” which will underpin government budgeting targeted to indicators and outcomes other than just GDP. The application of AI towards wellbeing outcomes is a key theme to be explored going forwards.

**Inclusion & empowerment**

- 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.
- The New Zealand government has a number of initiatives targeted at increasing digital inclusion across the population and this will consider the access to AI-enabled technology throughout society.

**Education & training**

- Offer an AI pilot in partnership with online courses or MOOCs. Implement a pilot to
- Enable Europeans and New Zealanders at all stages of their career and education to participate in internationally recognised online courses which rapidly increase their practical AI skills to help meet the market demand.

---


\(^68\) [https://cdn1.euraxess.org/sites/default/files/nz_roadmap_2017_0.pdf](https://cdn1.euraxess.org/sites/default/files/nz_roadmap_2017_0.pdf)

\(^69\) [https://www.partnershiponai.org/](https://www.partnershiponai.org/)
Research

- Improve collaboration between centres of excellence to increase research scale, effectiveness, long-term relationships and stimulation of new ideas.
- Maintain and expand existing opportunities for research exchange. Given the relatively small size, even small amounts of funding can trigger significant exchanges.
- Investigate options for joint RTDI activities in technology areas in combination with other policies of interest to both regions, for example AI and data ethics, smart specialisation and agritech, etc.
- Europe should monitor New Zealand research on non-mainstream concepts of knowledge and privacy such as those of the Māori culture. It should link with European expats undertaking this research at leading universities in New Zealand and ensure proper knowledge transfer to Europe to enrich its discussion of ethical values, design principles and regulation.

Conclusion

The European Union and New Zealand can benefit in successfully deploying AI technologies from expanding their good level of collaboration by exchanging best practices, bringing their relative strengths in research to the table, and fostering a shared approach to AI technology governance and applications. These activities need not be costly. Many objectives can be supported through existing structures and forums, while others may need support in the form of conferences and travel. More ambitious collaboration would target joint research actions and mutual targeted participations in programmes and calls.
The Future of Singapore-Europe Earth Observation Research Cooperation

Summary

Earth observation and other technologies based on satellite imagery are increasingly dependent on accurate and timely data. Satellite data from European Earth observation offers a vast amount of current and historic data which can be used to develop novel applications in fields such as climate research and transportation. 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.

Europe and Singapore should jointly develop the existing potential applications in the field of spatial intelligence. Promising application fields include air pollution monitoring and mitigation and applications in transport. Joint activities should include research and innovation actions, and options for developing spatial intelligence marketplaces.

Introduction

The space sector – especially the areas of sensing and spatial intelligence – is undergoing a deep transformation. A growing number of public and private players, and new opportunities brought by the digital revolution and advances in engineering – from micro-satellites to artificial intelligence – are opening new pathways for Singapore’s collaboration with the European Union and its member states.

Singapore’s premier location in South-East Asia has led to a high number of European researchers working there. The Strait of Malacca is one of the world’s most important maritime passages and Singapore’s proximity to large and growing markets has been attractive for many EU companies (for example Thales, Siemens, Infineon and many other major European ICT companies).

In the past, Europe and Singapore have fruitfully collaborated in satellite data and spatial intelligence. The recent EU-SG Free Trade Agreement has further reinforced this cooperation. It includes the joint intention to use global satellite navigation systems, to establish a dialogue in transport policies and to collaborate in environmental protection, e.g. in climate change related best-practices. The agreement also includes cooperation in ICT-related research. In addition, the EU Commission has adopted new partnerships with Asia, for example in the area of digital connectivity – and satellite data may be one of its most demanding use cases.

The potential for European satellite data in Singapore

Technological evolution, especially in terms of availability and accessibility, has made Copernicus the largest space data provider in the world, currently producing 12 terabytes per day. The clear majority of data and information delivered by the Copernicus space infrastructure and the Copernicus services are made available and accessible to any citizen and any organisation around the world on a free, full and open access basis. Copernicus Data and Information Access Services are available to everyone through the Copernicus Open Access Hub or the Copernicus Data and Information Access Services platform providers (see references).

---

71 https://www.bundeskanzleramt.gv.at/documents/131008/1028587/29_7_abk_en.pdf/ca84f964-55ae-4b61-863a-a648445c5fb0
72 http://www.spacetechasia.com/interview-dr-philippe-brunet-director-for-copernicus-on-the-programmes-asia-angle/ Dr Philippe Brunet, Director for Copernicus, on the programme’s Asia angle.
The European Commission has acknowledged the importance of Singapore; in September 2018, it organised a Copernicus event there which brought together representatives from the European Commission with European and Singaporean companies and Singaporean authorities working in Earth observation or environmental monitoring. The significant investment by the EU into Copernicus and the open access to its data should be used as a door opener to new research collaborations.

**Drivers of research and innovation**

The availability of Earth observation data is a strong push factor for activities in both research and innovation. In Singapore, a key driver for agencies funding research is the development of financially viable products and services. Applications of new methods for spatial intelligence are increasingly taken up by markets both in Europe and in Singapore.

“There are many potential benefits of Copernicus for Singapore. The programme’s free and open satellite data and information from the Copernicus Services can be used for a variety of applications relevant to the city-state’s particular situation. These include biodiversity monitoring, maritime surveillance, disaster risk reduction and emergency management are just a few examples of the Copernicus-related areas of benefit,” says Dr Philippe Brunet, Director for Space Policy, Copernicus and Defence at the European Commission.

Furthermore, the persistent cloud cover in the South-East Asia region renders current optical imagery difficult to use for monitoring. Therefore, access to Sentinel-1, the only free and open source of Synthetic Aperture Radar (SAR) imagery in the world which can see through clouds, can also be a major game changer.

The effectiveness of these possibility-driven motivations is assisted by dedicated services such as Intellectual Property Intermediary (IPI), established under Singapore’s Ministry of Trade and Industry, which bring together the needs of industry with innovations and developments of researchers. Copernicus currently only provides data in a repository, which is not enough. Thought must be given to the potential usage of the data, as well as common goals identified to convince Singaporean agencies to co-innovate with European researchers and innovators.

Some examples include:

- Applications in urban transport are at the forefront for international cooperation with Singapore. Major European organisations have local branches which develop innovative technologies for future transportation concepts in the city-state.
- Climate research — especially on local air pollution — and maritime transport are potential fields for increased collaboration.
- Environmental monitoring, which includes water quality monitoring around the shipping lanes, haze from forest fires, predicting marine ocean quality and fishing grounds, offers potential business cases for satellite data analytics.

**Current challenges**

In Singapore there exists a strong demand for foreign expertise and spatial intelligence is no exception. Once a technology has been deemed strategically...
important for research and development in the region. Singapore has been known to invest in key technologies and in attracting people. This relative ease of access to substantial funding increases Singapore’s attractiveness to European researchers, although the number of European researchers are comparatively small as Singapore also attracts large numbers of researchers from Asian countries. In addition, a sizeable proportion of young Singaporeans are keen to explore work opportunities outside Singapore. Establishing collaborative international funding models would have the benefit of keeping EU researchers more closely linked to their EU host institutions, especially compared to other researchers expatriating to Singaporean research institutes.

The interest in Singapore for collaboration with EU researchers and innovators is high. Current limitations include both a lack of international funding and the difference in the time to contract. Several bilateral agreements with European countries have been very effective — Germany and Singapore launched a joint call on Industry 4.0. Similarly, there have been joint calls between Singapore and France. To boost the research cooperation with Singapore, a coordinated effort at EU level is necessary. There are, however, no significant programmes in Singapore funding researchers in Europe. European Union funding for researchers in Singapore is mostly limited to the highly competitive Marie Skłodowska Curie programme. However, this is not a limiting factor, as funding can be split. Furthermore, researchers from Singapore are welcome to participate in the calls of Horizon 2020 and can use Copernicus Sentinel data and Copernicus services free of charge for their research.

Technical challenges

The past five years have seen a rapid increase in the launch of private Earth observation (EO) satellites. Five companies are situated at the forefront of this, deploying between 100 and 300 satellites each. However, only one is based in the EU (until BREXIT) and it has yet to launch any satellites.

These small satellites challenge the EU’s position as the leading source of open EO data (i.e. from Copernicus). Joint activities between companies such as Planet and the EU, for instance, lead to further dependence on American satellite data sources and may discourage European start-ups from pursuing similar objectives and providing an EU source for private EO data.

Programme-level collaboration

Building on existing strengths

At the programme level, there is good collaboration between European Union member states and Singapore. For example, the PHC Merlion Program is a joint French-Singaporean collaboration, managed by the Institut Français de Singapour in partnership with Singaporean institutions, to encourage and support new scientific research development between French and Singaporean laboratories through funding the scientists’ trip exchanges. 2018 marked the 13th annual call since the programme’s launch. Following its inception, nearly 200 bilateral collaboration projects have been funded.

In addition, the French Centre National d’Études Spatiales (CNES) has established a targeted innovation dialogue in areas such as environmental and transport applications with key players in Singapore, for example with Nanyang Technological University (NTU), the Economic Development Board (EDB), and the Singapore Space Technology Association (SSTA). Boosting EU-SG cooperation.

Joint initiatives that address common Singaporean and EU research goals provide the most promising
incentives to increase collaboration. There have been calls in Horizon 2020 that addressed Singaporean partners\(^81\), but the funding situation made the proposals unattractive for Singaporean organisations to join. Of the currently funded projects\(^82\), none have a Singaporean entity as partner. A more coordinated approach with a defined funding strategy can reduce these uncertainties and increase participation. It would be beneficial if Singapore proactively establishes a mechanism to fund researchers applying in the Horizon 2020 consortia.

Initiatives to foster deployment of processing and exploitation capacities for Sentinel satellites’ data, Copernicus services information and other Earth observation data would support the European Union’s intentions to cross-fertilize different data sets, encourage the development of innovative products and services and to maximise the socio-economic benefits of Earth observation data in Europe.\(^83\) In addition, such collaboration could provide additional leverage of Europe’s Open Science Cloud, for example through federating Copernicus data and added-value services and potentially in the context of the OECD Global Science Forum.\(^84\)

**Recommendations**

Singapore and the EU should jointly:

- Research Earth observation data use-cases based on their respective existing developments. This requires the collaboration of government, industry and academia.
- 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.
- Develop joint activities that go beyond the sharing of satellite data.
- Investigate options for developing marketplaces for European satellite data and joint applications.

**Further references and links**

Copernicus website with access to data and services:

Copernicus Data and Information Access Services platforms:
- Creodias - [http://www.creodias.eu](http://www.creodias.eu)
- Onda - [http://www.onda-dias.eu](http://www.onda-dias.eu)
- Sobloo - [http://www.sobloo.eu](http://www.sobloo.eu)
- MundiWebservices - [www.mundiwebservices.eu](http://www.mundiwebservices.eu)
- Wekeo - [http://wekeo.eu](http://wekeo.eu)

Copernicus in Singapore:

---

\(^81\) DT-ART-01-2018, DT-ART-02-2018 – Calls are also open in 2019  
Security, Privacy and The Role of AI: The EU-Singapore Potential

Summary

Concerns about secure computing systems and personal data protection have risen internationally in parallel to the development of novel AI technology. There are fears that new and powerful AI will be able to break into virtually any IT system, to correlate non-personal data into personal findings, and to generally depend on being fed large amounts of confidential information. On the other hand, there is a massive opportunity in developing AI-related technology to make computer systems safer and keep personal data confidential and under the control of people. The EU with its world-wide recognised data ethics and Singapore with its massive testbed and development of the Smart Nation concept should work together to develop these technologies so that they ensure ethical principles while at the same time maintaining security of systems and utilising the potential power of AI.

Introduction

Security – from cybersecurity to the Internet of Things – and privacy have become major concerns for citizens, in industry, and also in policy. Artificial intelligence plays an important dual role in this domain: as a source of concern, but also as a source of potential solutions.85

Meanings of terms for this brief:86

- Artificial Intelligence – any decision support mechanism that is strongly data-driven such as those based on decision trees, machine learning, or statistics etc.

- Privacy - the ability to exercise control over the processing of one’s data and the ability to minimise data that another party learns about you
- Security – refers to ensuring the confidentiality, integrity, and availability, in some contexts it also concerns safety.

It is easy to see how AI, security, and privacy go hand in hand: AI often requires large amounts of training data. In many cases solutions are based on heaps of personal data posing challenges for people’s privacy. Secondly, AI itself may enable privacy intrusion at an unprecedented scale through intelligent ways of sifting through and correlating previously uncorrelated data so that it becomes personal. AI-enabled solutions also create new exploit challenges for system security as AI operates an increasing number of networked and internet-connected systems and can also become victim to malicious attacks.

On the other hand, AI can be your friend when it comes to security and privacy. A range of innovative and often young companies use machine learning or intelligent pattern recognition technologies to detect security threats in computer systems or to help keep personal data private. Concerns about AI security have created new research and innovation challenges for researchers in the AI and security fields. This research has benefitted from stricter privacy rules around the world. Europe’s data ethics as expressed in its famous General Data Protection Regulation and other related laws has become a model for policy makers internationally, and it has also stimulated the demand for new solutions and approaches.

Given the interconnections of today’s computing systems and the massive trend towards connected intelligent things and embedded AI, there is a clear need

---

85 Two EPIC events hosted by A*STAR I²R clarified both the industrial and academic research directions and potential, i.e. the EPIC workshop on ‘Privacy Preserving Information Technologies’; December 10-11, 2018 and the conference on ‘Security and Privacy - The Role of Artificial Intelligence’ on April 9, 2019.
86 Dan Bogdanov, Cybernetica at the EPIC Privacy/AI Event, Singapore, 2019.
for international collaboration. International forums exist, for example, to discuss cybersecurity (e.g. at the level of the OECD\textsuperscript{87}, G7\textsuperscript{88} and to a lesser extent the G20\textsuperscript{89}). The topic is also discussed in the UN Group of Governmental Experts\textsuperscript{90}.

The European Commission has been active in co-ordinating cybersecurity with the member states and with international partners; it has also reach out internationally to explain and further its data ethics and privacy principles. It has created ENISA – the EU Agency for Cybersecurity\textsuperscript{91} and addressed important regulation as a part of the Digital Single Market (DSM) initiative. The EU endorses the voluntary non-binding rules of responsible State behaviour by the UN Group of Governmental Experts. Similarly, Singapore follows a strategic approach in cybersecurity and has entered into cooperation partnerships with countries in ASEAN, the US, and Canada, and also with the EU and the UK.\textsuperscript{92}

In privacy, the international picture is somewhat less coherent. Depending on the legal system, it is considered a human right (e.g. in the EU), a consumer right or ownership right (as in the US). Also, this is a topic that is still very much emerging, and the international dialogue has really only gained momentum after Europe announced its GDPR and other regulations (DSM). In Singapore, personal data is protected under the Personal Data Protection Act (PDPA). Many companies including large global players followed and decided to adopt a system compatible with European Union laws. This also means that there are huge opportunities for collaboration, innovation opportunities for the industry, and research challenges for academics – from ICT to law, social sciences, and the humanities.

Research initiatives in the European Union and Singapore

The Singapore government has been a forerunner in e-government and smart city technologies. It now also follows a whole-of-government initiative to promote collaboration among agencies, academia, research institutes and the private sector in cybersecurity. A dedicated national cybersecurity R&D programme led by Singapore’s National Research Foundation aims to improve the R&D expertise in cybersecurity for Singapore, coordinate and prioritise R&D efforts in cybersecurity across agencies, and create platforms for R&D collaborations among agencies, academia, research institutes and industry. The programme focuses on the development of trustworthy systems, cyber-physical systems security, cyber forensics, and mobile security and cloud security.

A National Cybersecurity R&D Laboratory (NCL) provides computing resources, vulnerable environments, and data sets for repeatable cybersecurity investigation and experimentation environments. The iTrust labs offer a rich set of testbeds for research and businesses to design critical infrastructure.\textsuperscript{93}

Singapore has declared privacy a priority for its Smart Nation ambitions: ‘Cybersecurity is a key enabler of our Smart Nation. We recognise the possible risks, and prioritise privacy of data and safeguarding of critical systems and networks, even as we make them smart.’\textsuperscript{94} Although there have been concerns in Europe about the political system in Singapore, for example about legal limitations potentially reducing freedom of speech,\textsuperscript{95} such doubts should not hinder collaboration in science and research, especially not as regards privacy-preserving technologies.

\textsuperscript{87} http://www.oecd.org/sti/ieconomy/information-security-and-privacy.htm
\textsuperscript{88} https://www.banque-france.fr/en/economics/international-relations/international-groups-g20g7/focus-g7-cyber-expert-group
\textsuperscript{89} http://www.g20.utoronto.ca/2016/160905-digital.html
\textsuperscript{90} https://www.nti.org/learn/treaties-and-regimes/united-nations-groups-governmental-experts/
\textsuperscript{91} https://www.enisa.europa.eu/
\textsuperscript{92} http://www.csa.gov.sg/~/media/csa/documents/publications/singaporecybersecuritystrategy.pdf
\textsuperscript{93} https://itrust.sutd.edu.sg/
\textsuperscript{94} https://smartnation.sg/why-Smart-Nation/transforming-singapore
\textsuperscript{95} Having continually improved its position over the last years , SG ranks 66th in the Democracy Index ranking of The Economist’s Economic Intelligence Unit. https://infographics.economist.com/2019/DemocracyIndex/
The NUS Centre for Research in Privacy Technologies (N-CRiPT) will be based in the National University of Singapore (NUS) School of Computing and affiliated with the NUS Smart Systems Institute. While the primary goal of N-CRiPT is to help prevent privacy leaks, the centre will also look into privacy risk management which includes quantifying the practical risk and potential costs involved in the case of data leaks. N-CRiPT will develop new privacy-preserving solutions for structured and unstructured data, and solutions to protect data throughout its life cycle, from collection and curation to processing and sharing. One technique that N-CRiPT is expected to explore is the generation of synthetic data that mirrors the proportion of the original data sets.

The Strategic Centre for Research in Privacy-Preserving Technologies & Systems (SCRIPTS) will be based in Nanyang Technological University, Singapore (NTU). It will be led by Professor Lam Kwok Yan, Programme Chair (Secure Community) at NTU Graduate College. To translate research into applications, SCRIPTS is expected to provide off-the-shelf solutions to businesses for differential privacy and computing on encrypted data.

Finally, AI Singapore is a national programme in artificial intelligence that was launched in 2017. Its purpose is to catalyse, synergise and boost Singapore’s AI capabilities to power its future, digital economy. AI Singapore brings together all Singapore-based universities and research institutions as well as the vibrant ecosystem of AI start-ups and companies developing AI products, to grow the knowledge, create the tools and develop the talent to power Singapore’s AI efforts.

In Europe, many research centres now started to investigate privacy preserving technologies including the use of AI. Also, there are several research centres in the EU that closely collaborate with companies in this field including start-ups. Privacy-preserving technology research is already funded in the EU H2020 Framework Programme. This is expected to continue throughout the next Framework Programme ‘Horizon Europe’. The European Commission put forward a proposal to network the more than 660 cybersecurity centres in Europe.97

Joint activities

The challenges of cybersecurity are global and do not respect national boundaries. Solutions to the problems with which we are faced will need to be developed and implemented in a shared way to reflect this fact. Some collaboration between the European Union and Singapore exists:

- The inaugural Singapore-UK Joint Grant Call for Cybersecurity Research was launched in May 2015 and continued with a follow-up call in 2018. The programme focuses on strengthening knowledge and capabilities in cybersecurity, as well as fostering closer collaboration in cybersecurity research between researchers from Singapore and UK.
- Sopra Steria and A*STAR I²R established a joint R&D laboratory to collaborate on the development and testing of new cybersecurity technologies for the infocomm technology sector. Sopra Steria, a European leader in digital transformation, provides one of the most comprehensive portfolios of offerings on the market.

Two EPIC events on privacy were able to bring several key European players in this field to Singapore, both from academia and in business. The events initiated a range of collaboration talks followed-up by the planning of research and development actions (e.g. between A*STAR I²R –and the French research institutes represented by the IPAL joint lab).

Collaboration opportunities

Singapore is ideally located to mediate between the East and the West and has proven to be a place to test new technologies in an environment with a different societal embedding of new IT compared to the EU.

---

96 The EPIC Privacy & AI event in Singapore included starts-ups from the EU, from Singapore, and also companies founded by EU expats now based in Singapore.
or the US. The human factor is a key component in both security and privacy and societal and cultural differences can become decisive factors. This includes understanding of cultural aspects such as data ethics, but also the openness to address shortcomings, for example. Thirdly, both security and privacy aspects are usually more densely interwoven with policy and regulation than purely technical systems. This makes international collaboration an imperative.

Therefore, the European Union and Singapore should take the following actions:

**Improving the dialogue**

- Intensify the discussion about collaboration in cybersecurity and artificial intelligence
- Perform joint research focusing on ethics of data use
- Jointly showcase technologies combining the benefits of AI with guaranteed privacy and security

**Education & training**

- Target the education of citizens to better understand the risks, but also solutions in the area of privacy, security and AI. Although data mining – and AI - are game changers and potential threats for personal data protection, there are new exciting possibilities for anonymisation and synthetic data models using machine learning. It is important that more people understand that these technologies and how to use them.
- Facilitate an improved exchange between competent players in AI-enabled privacy and security to foster collaboration and dialogue

**Research and innovation**

- Demonstrating solutions to inform businesses – including small and medium-sized ones – about the potential for new privacy preserving technology
- Collaborate in privacy-improving and privacy-preserving technologies for Smart City and Smart Nation developments
- Take action to inform key actors in research, technology, and policy about the potential power of ICT to preserve people’s privacy while at the same time harvesting the benefits of AI. Inform about the future research and innovation potential in this field, for example through participation in and organisation of conferences and mutual invitations to leading scientists and entrepreneurs.

**Conclusion**

Recent developments in AI, security, and privacy demonstrate how innovation and policy can mutually stimulate each other. Europe’s privacy rules have inspired jurisdictions around the globe thereby also pushing innovation for privacy-preserving technologies. Singapore’s aim to develop a Smart Nation requires technologies trusted by its people. The EU and Singapore can jointly advance privacy-preserving technologies and secure systems with and for AI technologies. Most importantly, Singapore and the EU can help citizens to not feel victimised by technology development, but rather empowered to influence its design.
Further Recommendations

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 their former research groups.

European network opportunities for researchers exist to some extent. For example, the Marie Sklodowska-Curie Program provides networking and support for expats to some degree. 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, opportunities to meet and exchange— including information about new developments in Europe.

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 European actors developing and researching technology in 3rd countries and smaller sector companies or businesses from smaller countries may not be able to easily team up with similarly minded companies.

It is recommended to address such shortcomings with a dedicated ICT research network. This network could 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. This would of course require a joint European approach and perhaps trigger various topical networks; and it could build on and support networks that have already been put in place such as those of larger member states (e.g. AFRAN).

New models for collaboration

In Europe, the EC Framework Programme helped establishing a specific type of project as one of the main forms of scientific and research collaboration. This is the typical consortium with 5 to 12 partners agreeing on a joint research programme with a duration between 2 and 4 years. These projects typically of partners from academia, research, small and large industry. While this model has generally 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 have a limited duration and it is quite difficult to ensure proper follow-up projects because of 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 3rd country partners. This includes contractual aspects, reporting, reviewing, payments, and the EC online portal which may all be cumbersome and unusual for research organisations outside Europe.

- Dedicated 3rd country participant status: simplified contract, limited rights and more flexible partnerships. This is particularly important when there is only limited funding for the 3rd 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. They have in the past often proven difficult to set-up and in many cases it was not possible to sustain a topical collaboration over extended periods of time.

There may be an opportunity for expanding existing labs driven by a single EU member state today to become focus points for European collaboration. For example, IPAL Singapore already participates in projects funded by the European Commission, so this extension in the sense of including more European actors practically exists already even if IPAL is formally an initiative of 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. In particular, such support actions demonstrate strong European interest in concrete collaboration with 3rd countries both in research and the political level. By way of reflecting domestic thinking, they can become important means of reflection and improving mutual understanding.

It is also clear that the design of general support actions in the Framework Programme faces a number of 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, 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 include less commonly addressed reasons such as an interest to get to know different research groups, get inspiration from new colleagues, and enjoy the pleasure of working in a different country. At policy level, reasons for collaborating between nations include improving RTDI systems including the domestic knowledge base, joining of forcing in tackling demanding research and policy challenges, and also aspects such as foreign policy, preparation of tighter association with a country, and improving diplomatic relations.
The EPIC events – both addressing research or policy levels – clearly showed 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 during the EPIC initiative concerned Europe’s GDPR that tightly connects with research challenges in databases, artificial intelligence, cybersecurity, and many others. Also, it became clear that governments around the world are facing many similar problems in 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 learned how Europe’s Smart Specialisation strategy has been observed and even copied in regions at a maximum distance from home. 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 of regions all over the world fostering smart strategic development.

It is thus recommendable that RTDI policies are considered in conjunction with other policies when considering international collaboration. This may not always be the case because the focus is sometimes just on complementary research capabilities. However, missing 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.
References


E. Prem (2014) Identifying international research cooperation capabilities in information and communication technologies, Science and Public Policy (pp. 1-15).


Logic model: https://fyi.uwex.edu/programdevelopment/logic-models/bibliography/