Independent Review of the SFC Research Pooling initiative

Submission from The Scottish Informatics and Computer Science Alliance (SICSA)

18th January 2019

The Scottish Informatics and Computer Science Alliance (SICSA) was established in 2009 and is now in its second phase of operation, with a current funding end-date of July 2020.

SICSA is a collaboration of 14 Scottish Universities and it promotes international excellence in University-led research, education, and knowledge exchange for Scottish Informatics and Computer Science.

The information provided within this document comes as a response to the call for evidence from the SFC, dated 23rd November 2018 and it is authored by the SICSA Directorate.

Q1a. What has been the impact of the initial research pooling initiative?

- **Has the pooling initiative met its objectives: to enable Scotland to compete effectively for funding, research staff and doctoral students both nationally and internationally; and provide a more attractive research environment?**

The SICSA Research Pool has met its original objectives and has played a major role in supporting Scotland's position as a world-leader in Computer Science. The first phase of funding enabled SICSA institutions to attract and fund ~90 PhD students. Each SICSA student spent 3-4 years as part of a coordinated programme, creating significant benefits in terms of research outputs, industrial connections and enhanced collaborations. All students were co-supervised at 2 SICSA institutions. The initial investment also facilitated the appointment of ~40 world-leading researchers, whose academic positions have since been substantiated by SICSA institutions. Many of these researchers were brought to Scotland from international Universities and have remained in Scotland, generating significant ongoing research and impact in Human-Computer Interaction, Data Science, Cyber Security, Robotics, and other key areas.

SICSA collaborations have resulted in many large joint projects and hundreds of joint research papers. Major collaborative projects include (but are not limited to:)

- Science of Sensor System Software, EPSRC EP/N007565, 2016-2020, £4M, Glasgow/St Andrews;
- From Data Types to Session Types: A Basis for Concurrency and Distribution (ABCD), EPSRC EP/K034413, 2013–2020, £4M, Edinburgh/Glasgow;
- The Integration and Interaction of Multiple Mathematical Reasoning Processes, EPSRC EP/N014758, 2015-2019, £1.3M, Heriot-Watt/Edinburgh;
- C3: Scalable & Verified Shared Memory via Consistency- directed Cache Coherence, EPSRC EP/M027317, 2015-2019, £669K, Edinburgh/St Andrews;
- Border Patrol: Improving Smart Device Security through Type-Aware Systems Design, EPSRC 2017–2022, £1.7M, Glasgow/Heriot-Watt;
- Exploiting Parallelism through Type Transformations for Hybrid Manycore Systems, EPSRC 2013–2018, £1.5M, Glasgow/Heriot-Watt;
- Pattern Discovery and Program Shaping for Manycore Systems, EPSRC EP/P020631, 2017-2020, £707K, St Andrews/Edinburgh;
- Parallel Patterns for Adaptive Heterogeneous Multicore Systems, EU Framework 7 IST-288570, 2011-2015, €4.2M, St Andrews/Robert Gordon University;
- SICSA Cyber Nexus, UK/Scottish Government, £426K, all SICSA institutions.

The inclusive nature of the Pool, the SICSA funding programmes, its many events and the investment in studentships and academic staff have led to strong links among the 14 member-institutions, creating a genuine collaborative culture throughout the discipline that enables all institutions to engage with world-class research, regardless of size. This is evidenced by, e.g.:

- The creation of clusters of research expertise – the SICSA Research Themes – that enhance Scotland's reputation for international research excellence in Computer Science;
- Providing the expertise, know-how and support to establish The Data Lab, CENSIS and DHI Innovation Centres and underpin this with access to multi-institutional clusters of technical expertise;
- Focusing of the Edinburgh, Tayside and Glasgow Cities Deals on impact areas arising from Computer Science research;
- Creating and delivering multi-institutional and industry collaborative programmes across key sectors;
- Large collaborative research grants and research papers, as discussed above;
- The establishment of the Edinburgh Centre for Robotics (EDI/HWU).

The 4 original SICSA Research Themes enabled Scottish Universities to create critical mass in the key areas of research interest in Scotland – fostering collaboration among SICSA institutions and setting an independent research agenda. The collective success of the Human-Computer Interaction (HCI) community came directly as a result of SICSA: Scotland now punches very much above its weight, with a disproportionately high number of published HCI papers coming from Scottish Universities. The highly-respected 2019 ACM CHI Conference will be held in Glasgow – its first occurrence in the UK. CHI regularly attracts over 5000 international HCI researchers, and will yield significant economic impact to Glasgow and the West of Scotland. Other key strengths supported by the SICSA Research Themes include Robotics, Data Science and Cyber Security as well as foundational research.

The SICSA funding programmes and events have also created a rich collaborative environment for Computer Science researchers. These, plus the evolved research themes, have been the main focus of the second phase of SICSA funding. They have proven to be a low-cost, high-value, means to encourage collaboration and ensure that Scotland continues to be a great place to be a researcher in the discipline. For example, the SICSA Distinguished Visitor Fellowship enables eminent researchers across the globe to visit Scotland for up to 3 months at a time and interact with SICSA researchers. SICSA has funded upwards of 100 Distinguished Visitor Fellowships since 2008. The SICSA PhD Conference is another long-standing example of a healthy Scottish collaborative research environment. This annual event aims to sow the seeds for future collaborations and attracts over 150 PhD students every summer.

SICSA works closely with a broad range of stakeholders, including (but not limited) to: The Scottish Funding Council; EPSRC; UKRI; EU; Scottish Innovation Centres; Interface; Scottish Government; Scottish Enterprise; and Highlands & Islands Enterprise, ScotlandIS; Scottish Business Resilience Centre (SBRC); and a vast range of SMEs and corporates. This creates pan-Scottish opportunities for funding and impact activities. The SICSA network ensures wide access to these opportunities.

- **Examples of the ways that pooling has impacted on the relations between pooling partners and on how individual partners work with other external bodies; and**
- **Evidence that the partnerships associated with pooling have had broader impacts on Scottish HEIs.**

The SICSA Research Pool has been instrumental in creating an environment of collaboration and trust among the 14 member-institutions and this continues to develop during the second-phase of funding, despite the loss of SICSA funding for PhD Studentships.

The SICSA Research Themes have brought together clusters of expertise across Scotland, facilitating approximately 40 multi-institution, often multi-disciplinary, research workshops in the 7 core areas of Computing Science research in Scotland, per year. These have led to an increase in multi-institutional funding proposals and published papers. The SICSA Research Committee is a recently formed group (comprising SICSA Research Theme leaders), which meets biannually to discuss major developments in Computing research, helping to facilitate cross-disciplinary research further among the established clusters.

The SICSA Committee (Governance Board), comprises all 14 of the Departmental/School Heads of Computer Science, who meet regularly throughout the academic year. The Committee provides a forum to share ideas, insights in the Scottish Computing research landscape and to discuss developments within their own institutions. This group also makes collective decisions around the Governance of SICSA and the strategic direction of the Pool. It is hard to imagine a situation where all 14 Heads of Schools were regularly brought together in this fashion, without the existence of SICSA.

The initial investment in PhD Studentships (2008-2015), created/reinforced links between SICSA member institutions through co-supervision. This was further bolstered by the SICSA PhD Conference, which helped to form a "cohort effect". Anecdotally, some students felt as much a part of SICSA as they did their home University; and this led to high engagement with wider SICSA activities. This included membership of the SICSA PhD Conference organising committee; research exhibits at DemoFest; and involvement in further SICSA funding opportunities (such as SICSA-funded Industry Internships and Summer Schools). Example short case studies from SICSA-funded PhD students can be found at http://www.sicsa.ac.uk/research/phd-studentships/.

The cultural change bought about by SICSA has also been evident during a number of major developments in the wider research landscape. For example, in 2014, the Pool coordinated a group of all 14 member-institutions to create a joined up and collaborative approach to REF2014. The group, comprised of Departmental/School REF champions, initiated a number of information-sharing workshops to ensure a joined-up approach to that exercise, with the result of increasing Scotland's overall standing in the discipline.

More recently, SICSA established a working group to ensure a joined-up approach to the 2018 EPSRC Centres for Doctoral Training (CDT) call. This brought together representatives from all 14 SICSA institutions to share ideas and potentially create consortia. SICSA organised a number of well-attended workshops and wrote supporting letters for 8 Scottish proposals, including several multi-site proposals. The Pool also took an active role in mock interviews for Scottish proposals – coordinating mock interviews for those that required them and lending expertise in the form of SICSA panels.

Since 2008, SICSA has helped to facilitate rich interactions between the Scottish Computing Science research community and key external bodies. For example, SICSA ensures that the discipline is well-embedded with the SFC Innovation Centres, CENSIS and The Data Lab in particular.

From 2017, SICSA has worked directly with the UK and Scottish Governments to establish the SICSA Cyber Nexus – A Scotland-wide initiative that brings together SICSA researchers, Government, industry and the public & third sectors to establish a vibrant Cyber Security community – further enhancing Scotland's capability in this area of research. The Cyber Nexus has grown Scottish Cyber Security and Cyber-Resilience capability, promoting research, innovation and educational activities across Scotland. It has funded international and industrial research exchanges, conferences, workshops, early-stage innovation, conference travel; created new links with national and international bodies; provided strategic advice and input to government; created links with industry; and enabled new research funding to be obtained (e.g. the USTAN-coordinated EU Horizon 2020 Serums project, starting in 2019). It will work with new initiatives such as the Edinburgh and Tay Cities Deals to establish an international presence in Cyber Security.

The University of Edinburgh is NCSC accredited as an Academic Centre of Excellence. Furthermore, lab facilities at University of Glasgow for critical national infrastructure, the Cyber Academy at Edinburgh Napier University, the Blockchain Centre at University of Edinburgh; and the recently announced Tay Cities Deal and future development of the Abertay Cyber Quarter illustrate the rapid growth currently taking place, in which SICSA is playing a major role.

The Digital Skills Partnership (DSP) is a ScotlandIS project, supported by SFC and SDS. The partnership has an action-based model and has a number of workstreams that aim to ensure that colleges and universities are aligned with the changing skills requirements for Computing Science. Example workstreams include sharing careers advisor knowledge, software engineering projects involving both colleges and universities, and the creation of case studies to help students transition from study to employment. There has also been a focus on using Cyber Nexus lecturing expertise to support the DSP college training activities. The SICSA Director is DSP Deputy Chair, and the Director of Education sits on the DSP Advisory Board.

The SICSA Smart Tourism initiative was a £600k SFC funded programme from 2011 – 2014, securing a total investment with partner/industry contributions of over £1.25 million. The Smart Tourism programme demonstrated the strength of SICSA in delivering a collaborative industry and academia innovation programme across Scotland. All 14 SICSA Universities were involved, 15 case studies were produced, 2 new spinout companies were created, and 1 IP license and 7 new products were produced. Over 70 SMEs and several large corporates were involved; as well as a range of tourism organisations including museums, Historic Scotland, Visit Fort William, Festivals Edinburgh, and Scottish Tourism Alliance. Research contributed to REF 2014 and papers were published at major international conferences. Valuable lessons were learned from Smart Tourism around developing templates for inter-University contracts and agreements to allow transfer of funding and resources to projects across our institutions. Lessons were also learned in providing speedier contracts between Universities and industry. A fast track process for projects to be initiated and delivered was established and executed.

- **Examples of other outcomes of research pooling, and how they have impacted on the Scottish research landscape.**

In August 2012, when the SICSA Prize Studentship programme was in operation and preparations for REF 2014 were at their height, we noted that every single SICSA-funded student who had studied at least two years with us was an author of at least one paper that their supervisor had listed in the internal REF exercise. In addition, one of them was involved in a spin-out company that was the basis of a REF impact case study. This supports the general observation that these studentships brought the best young minds from all over the world to Scotland, where they made a huge contribution to the University, to the SICSA community as a whole, and in many cases to the Scottish economy.

The Postdoctoral Early Career Researcher Exchange programme (PECRE) and the Pools Engagement in European Research (PEER) programme have also been highly effective. SICSA has funded 55 Early Career Researcher Exchanges and 47 PEER awards in total; facilitating cross-institutional and multinational collaborations, research grants and research papers. Evidence from post-exchange reports, and the high volume of applications, show that PECRE is particularly valued by Early Career Researchers, who have used it to kick-start their research careers.

- **What has happened that would not have happened without research pooling? Please give examples.**

Many, many things. As discussed above, the major investments in PhD funding and world-leading appointees to SICSA member-institutions would not have taken place without the Research Pooling initiative. Along with the major long-term benefits to the Scottish research community that these investments have created, the substantial investment also helped to pave the way for a truly collaborative research culture in Computer Science across Scotland, which did not exist previously. Whilst this major investment ended in 2015, this environment has continued to be sustained by the Research Themes, events and funding activities delivered by the second-phase of SICSA.

Increased levels of collaboration among Scottish Computer Science researchers and the initial significant investment in staff and research students has led to increased strengths in key areas of the discipline, and to new directions. These include Human-Computer Interaction, Robotics, Data Science, Cyber Security and Digital Health. SICSA played a fundamental role in establishing The Data Lab Innovation Centre; and remains fully embedded in its long-term strategy. The Pool is also closely linked to the CENSIS and Digital Health & Care Innovation Centres. Furthermore, collaboration among SICSA partners in the area of Cyber Security have recently led to the formation of the Cyber Nexus, a Scottish Government funded initiative, administered by SICSA.

SFC funding for SICSA has led to increased number of events and pan-Scottish activities among SICSA member-institutions that would not have occurred without the investment. These activities, coordinated by SICSA and research staff from within the member institutions, have generally received high-levels of engagement from SICSA researchers and students and include (over the lifetime of SICSA):

- 25 SICSA sponsored International Conferences, held in Scotland;
- 107 Distinguished Visiting Fellows;
- 16 SICSA funded International Summer Schools, held in Scotland;
- 10 SICSA PhD Conferences across Scotland;
- 11 DemoFests across Scotland;
- > 400 Research Theme workshops across Scotland;
- 36 Events associated with Computer Science Education;
- 55 Postdoctoral Research Exchanges
- 21 Industrial Internships
- 6 Early Career Industry Fellowships

- **What has been the impact of pooling outside of the academic sector, on policy and industry? Can you provide examples of this?**

SICSA DemoFest and other Knowledge Exchange activities have created an excellent framework for innovation and impact. Examples of major successes include, among many others, ZoneFox, Marty the Robot, Husky – University of Glasgow's water-carrying robot, the Edinburgh Centre for Robotics, the recent NCSC awards for excellence at the Universities of Napier, Edinburgh and Abertay. SICSA provides advice on research directions, impact and strategy to Scottish Government, to ScotlandIS, CENSIS, The Data Lab, SBRC, Scottish Government and other organisations through its high-level connections. It provides opportunities for industrial and academic collaboration through organised workshops, DemoFest and other activities. It also provides opportunities for industry to meet and recruit talented early career researchers through the annual PhD Conference, DemoFest, Research Theme events, Summer Schools and Distinguished Industrial Visitor Fellowships.

The SICSA Cyber Nexus programme integrates with Scottish Government strategy and was designed to deliver results within the 5 cyber resilience action plans - to provide the learning and skills required, to grow the research capacity, to drive innovation, and to translate this into economic growth. The Scottish Government "Safe, Secure and Prosperous: A cyber resilience strategy for Scotland 2015" recognised the importance of our universities' role in ensuring Scotland's cyber resilience. This has been reinforced in the recent Programme for Government 2018-19 and the Scottish Government's 5 cyber resilience action plans to deliver these. Using SICSA as a 'portal' to their 14 universities across Scotland via a host University allows easy placement of contracts and funding. SICSA's ability to internally, seamlessly carry out activities and projects across their community through their SICSA established inter-University contracts and agreements gives easy access to the Universities' expertise.

A strength of the SICSA Research Pool is the direct access it has to internal university communications - mailing lists and an established communication process for distributing information across University Computing Science departments. These links to Universities are increasingly being used by external bodies from both private and public sectors.

SICSA is also very effective in being able to reach across broader university communities and departments - business, engineering, medical etc. There is also a wide following on its

digital and social media (e.g. over 2,000 twitter followers), which reaches a range of audiences.

- **Have there been missed opportunities, where pooling could have had an impact but didn't?**

Recent shifts towards CDTs as the primary means of PhD training and reductions in DTA/DTC funding have seen the concentration of PhD students in a smaller number of Institutions and a smaller number of research areas across Scotland. A recent pan-Scotland census conducted by SICSA has illustrated that PhD funding in Computer Science across Scotland is either static or declining for most institutions. This is likely to have serious consequences in terms of research outputs and future research capacity and recruitment: SICSA member-institutions see this as a critical priority. The SICSA Directors see the total cut in funding for PhDs in the second-phase in particular as a missed opportunity, especially given the importance in maintaining a strong research base in Computer Science in Scotland at this time, and in the future. We would strongly encourage policy-makers to consider this as an immediate priority. SICSA continues to work for the whole of Scotland to leverage further funding for PhD students and we aim to capitalise on opportunities for PhD funding where they arise.

Whilst the Pool works efficiently and delivers excellent value for money; reductions in funding (including the above and the cut applied by SFC in 2016) have no doubt reduced the potential impact of SICSA in recent years. Reduced budgets have meant scaling back on various activities, including programmes related to the SICSA Graduate Academy and most notably the SICSA Knowledge Exchange Programmes; including SICSA Industry Internships http://www.sicsa.ac.uk/postgraduate-internship-case-studies/; and Early Career Industry Fellowships. Investment for any future Pooling initiative should be robust enough to ensure that the Pools are able to maintain momentum, create significant impact, and continue to receive strong engagement from the whole community.

Q1b. What lessons can be learnt from the research pooling initiative?

We are interested to hear what lessons can be learnt from the initiative both to identify and share good practice, to understand better collaborative relationships and to inform development and management of future SFC investments. You may wish to comment on:

- **What lessons can be learnt about making collaborations work effectively?**

Research Themes have been a successful element of the SICSA Pool in driving collaboration across the Scottish institutions. It was important for SICSA to ensure that the Research Themes remained relevant in an ever-changing research and funding landscape and as a result, they were reviewed on a regular basis. This has resulted in the scope of themes being changed and new themes being introduced over time. A crucial element of the success of the Research Themes has been to ensure that they are championed by enthusiastic Theme Leaders and these have generally rotated on a biennial basis to encourage continuing momentum. It has also been important for themes to receive an adequate budget, flexibility over expenditure, and a straightforward approach to the administration of funding to promote engagement across the country.

SICSA has always been committed to inclusivity, with the objective of bringing benefits to all Scottish Computer Science Schools/Departments, regardless of size or stature. As a result, 10 of the 14 Scottish Computer Science Schools/Departments were awarded full membership of the first phase of SICSA – all benefitting from investment in research

appointments and PhD Studentships. Latterly, the further 4 Universities joined SICSA, meaning that all 14 Computing Schools/Departments are now members. Whilst we understand that the research eco-systems are varied across the Pooling initiative, an inclusive approach has worked best for Computer Science and has been a major contributory factor in:

- Scotland becoming a world leader in Data Science and the establishment of The Data Lab Innovation Centre;
- SICSA member Universities being fully embedded in the Scottish Government Cyber-Resilience Economic Action Plan;
- Development of uniquely Scottish strengths in Human-Computer Interaction, Cybersecurity, Artificial Intelligence, Robotics, Networks, Foundational Computer Science etc;
- The establishment of the Edinburgh Centre for Robotics.

The annual SICSA PhD Conference has been a successful element of the Pool – helping to create a cohort-effect among the funded SICSA students and in later years, bringing students from all SICSA Universities together to sow the seeds of future collaborations. Having a well-organised and highly popular event has helped to develop the "SICSA brand" among research students. The other large event, DemoFest, has also been an important element of SICSA outreach activities from the very beginning. This event provides a vital link between Scottish Universities, Government, business and key stakeholder organisations (such as the SFC Innovation Centres).

Finally, it has been important for SICSA to maintain a small but able administrative team to manage the operational functions of the Pool and to ensure that momentum continues and that all aspects of the Pool are well organised. It has been extremely useful to have the operational team based at the lead Higher Education Institution for the Pool (University of Glasgow).

- **Were particular elements of pooling more effective than others? From your perspective what evidence can you give regarding what worked well, or didn't? Why? You may wish to consider: academic posts; improved facilities and equipment; graduate schools and studentships.**

In the case of SICSA, the significant investment in PhD Studentships and research staff was a particularly successful element of the initiative. These significant investments brought world-leading researchers to Scotland, many of whom have stayed in Scotland. This investment led to increased research outputs, a growth in research grant funding and increased connections with industry.

The initial investment also led directly to an increased feeling of community among Scottish-based Computer Science researchers and this continues to be supported by the SICSA Research Themes, major annual events, and the SICSA Graduate Academy Programmes.

- **Are you aware of examples of location impacting on or limiting institutions' involvement in research pooling and/or of examples that overcame any limitation?**

Whilst the benefits of SICSA are felt across Scotland, our member institutions in Aberdeen and the University of the Highlands and Islands have required some assistance to ensure that they receive their fair share. We are mindful that many of the SICSA institutions are clustered across central Scotland and there is a risk of the more northerly institutions missing out. To mitigate this issue, the SICSA Directors have made efforts to ensure that these institutions remain well-engaged with SICSA activities and that staff therein are encouraged to bid regularly for SICSA funding and events. We are currently also investigating options to encourage all event coordinators (in the case of seminars and workshops) to use video-conferencing and live-streaming to increase their reach. We have also recently held SICSA Committee meetings in Aberdeen; and the SICSA PhD Conference 2018 was held at Robert Gordon University.

- **What lessons can SFC learn from the initiative on how we design/ implement/ manage projects?**

It is important for all members to have an equal say and equitable stake, regardless of size. Each institution faces its own challenges and issues that must be addressed (geographical location, problems of small scale, problems of large scale). Collective effort and collaboration can greatly enhance the quality, effect, prestige and reach of individual research work. Shared purpose is important to establish and maintain communities.

Section 2: Pooling now and in the future

Q2a. In the current research landscape, what is the perception of, and role for, the pools?

- **Has the changing landscape and funding environment affected evolution of the research pools? Do institutions remain committed to individual pools and the concept of pooling more widely?**

SICSA has evolved significantly to meet the changing research landscape. It now supports 7 rather than 4 research themes and the original themes have changed to match research priorities, using a continuous review process. It has promoted shared expertise in CDT and EU research applications, as well as sharing experiences in Impact activities and REF returns. It promotes mini-themes that can address new interdisciplinary or challenge-led research topics. It also interacts with the Innovation Centres and with other Scottish and other bodies, and it has been highly active in promoting gender and other inclusion across Scotland. Restricted funding in Phase 2 has, however, limited its PhD and Impact activities.

As discussed below, institutions are heavily committed to SICSA. SICSA creates a recognisable and coherent community of international research excellence for Computer Science within Scotland and spanning multiple institutions, who can expand their research capability and reach through collaboration and sharing. Localised strengths can be supplemented by expertise at other institutions, and through industrial and other networks.

- **How does pooling fit with the current focus on interdisciplinarity and challenge led research? What is the current role of pools and how has that changed since the initial phase? Is the current model right? How do pools interact with other SFC investments such as Innovation Centres?**

SICSA has created focused international research communities that are able to tackle challenge-led and interdisciplinary research in Robotics, Artificial Intelligence, Data Science, Cyber Security/Cyber-Resilience, Human-Computer Interaction, Future Networks, Medical Informatics, Smart-Cities etc. SICSA Directors and Theme Leaders connect researchers with the Innovation Centres, with industrial and other users, and with other disciplines, including energy, climate change, space and engineering, as well as engaging with Scottish Government, NCSC and other organisations.

The current role of SICSA is to act as a conduit for shared collaboration, to share research expertise, to build research capacity, to create a community of researchers, to promote impact activities through DemoFest etc, to support early career researchers, to support the development of the Computer Science curriculum, and to enable access to EU, UKRI and other funding opportunities; as well as providing peer-reviewed funding for research exchanges, proposal preparation, workshops, summer schools and other activities. It no longer funds research students, has scaled down its impact/KE activities, but has expanded the number of research themes from 4 to 7. As discussed earlier, the lack of funding for research students is particularly problematic: the funding landscape is highly fragmented and competitive, and the lack of research students throttles the people and skills pipeline, to the future detriment of the discipline. The Innovation Centres partly replace previous SICSA Impact activities, but are focused on particular topic areas. While Innovation Centres are highly valued, this does mean that Impact is less effective across the broad spectrum of Computer Science research, with some important areas effectively ignored (e.g. Networks, Human-Computer Interaction, Robotics).

SICSA enables the Innovation Centres to connect to the community of over 500 active researchers easily and effectively. It provides advice and expertise to the Innovation Centres. It enables SFC funding to be channelled efficiently and fairly, through a network of peer reviewers. It also works with the Digital Skills Partnership to promote skills training and enhancement.

Q2b. Should research pools have a continuing role in the Scottish research base?

- **Will the concept of research pooling remain relevant in the developing research landscape? How can/should the model evolve to fit that landscape?**

Pooling has created a pan-Scottish and mutually supportive research, that has evolved and adapted to meet changing needs; and that has been able to seize important research opportunities and engage proactively with Innovation Centres, Government, trade bodies such as ScotlandIS and the Scottish Business Resilience Centre. The need for this pooling will continue and expand in the uncertain future funding landscape that will be shaped by BREXIT and other political realities; and to embrace future industrial and other impact opportunities.

The SICSA model of flexible and changing research themes and proactive engagement has proved to be highly effective. However, impact activities and research student support should be expanded. Although the costs of Computer Science research are predominantly in terms of people, and there is already some sharing (e.g. the Edinburgh Centre for Robotics), there are also possibilities in some areas to promote sharing of expensive

equipment between institutions (High-Performance Computing, Smart-Cities, Robotics, Cyber Security, Medical Informatics, data lakes/swamps etc). There may also be opportunities to set up shared software frameworks (e.g. “sandboxes” for ethical hacking).

- **What happens when the five years continuation funding comes to an end?**

A recent informal census among the SICSA member-institutions (Heads of Schools) demonstrated widespread support for the continuation of the Pool beyond 2020. There was a consensus that the Pool is managed effectively, provides great benefit; and represents good value for money. The SICSA member-institutions informally indicated that they would be happy to continue providing matched financial contributions to the Pool beyond 2020. However, additional funding beyond the current level is needed to maintain and expand SICSA activities and to take full advantage of the substantial SFC, Scottish Enterprise, Scottish and UK Government investments in the Innovation Centres, Cities Deals etc. Parallel to the SFC independent review of the Pools, the SICSA Directors are exploring options for sustainability post-2020, including potential future models for the Pool.

Section 3: Anything else

• Any further perspectives on the introduction, implementation and impact of research pooling are welcome.

Pooling has been highly successful in creating a successful and growing Scotland-wide research environment in Computer Science to the benefit of all SICSA members. It has enabled new opportunities in Data Science, Cybersecurity, Robotics, Artificial Intelligence and other areas. It has fostered the creation of the Innovation Centres and other activities, created significant opportunities for research impact, created new international connections and collaborations and promoted Scottish research excellence on the world stage, enabled industry and government to access Scottish research talent and enabled Scottish institutions to take advantage of new opportunities.