UK COMPUTING RESEARCH COMMITTEE

UKCRC Briefing Document: Government and Policy Makers

Introduction
This document is one of three articles that articulate the message the UK Computing Research Committee wishes to communicate to different audiences. This one is aimed at government, politicians and policy makers.

The key messages for this audience are:

- UK Computing Science research is vibrant and one of the UK's foremost intellectual outputs.
- The impact of Computing Science research is huge: computing powers and empowers society. Computing research has changed the world.
- UKCRC can help government.
- There are numerous example research challenges.
- The pipeline of researchers in Computing Science is a concern.

1. UK Computing Science research – healthy community

Research in Computing Science has never been more exciting. It covers a wide range of challenges, from how to design and build systems that are fit for purpose, to the impact of computational thinking on the physical and social sciences, to the next generation internet and new paradigms such as quantum computing. The recent RAE review of research across 81 UK institutions found the subject healthy and growing, more rigorous, more interdisciplinary, more experimental and more user-oriented than ever. One fifth of all publications were world leading, with nearly two thirds rated as internationally excellent.

2. Impact of Computing Science research and why there is a problem

Computing Science is the hidden discipline. Much of the research in Computing Science in the UK is hidden inside other industries because the software industry is horizontal (e.g. there is no UK "Microsoft"). Many research challenges are embedded within other societal, science or engineering challenges. This can have the effect that government perceives CS as a service industry that can be outsourced and many computing research challenges and successes are often overlooked.

Computing Science has a huge impact on how large socio-technical systems are designed, implemented, maintained and enhanced, and why and when we can have confidence in them. Computing scientists are working with researchers from ever-increasing areas of expertise – many of which are in fields where such collaborations are, to say the least, unexpected. For example, they are applying programming

languages to model cell biology, retrieving documents from the internet based on quantum theory, and building new kinds of massively parallel computers that mimic the human brain. In many respects computer science is becoming a key enabling tool for interdisciplinary research, and computer science methods and "computational thinking" are influencing other disciplines. There is especially strong interdisciplinary work with biology (bioinformatics, system biology and synthetic biology), medicine (e-health), linguistics, physics & astronomy and the earth sciences (GIS). Although some of this is the application of known computing formalisms and techniques to the problems of other disciplines, new computing research must also be developed to meet the new challenges.

The impact on industry is through a considerable number of start-ups, spin-outs collaborations with SMEs and multi-national companies, and of course the pipeline of graduates who are ready to innovate, design and build the infrastructure and applications of the future.

3. How UKCRC can help government

UKCRC can offer expertise in a wide range of areas, from the security and safety of systems, to ensuring successful delivery of a computer system involving diverse users.

Examples where UKCRC can help Government:

- Procurement of ICT systems and how to avoid problems by using good CS research (ref. RAEng/BCS report).
- Interoperability and integration of ICT across government, from healthcare to transport to security. For example, do we need a chief systems architect, alongside each chief scientist; who in government owns integrated capability? Who sets standards and protocols?
- Does government know who to consult when faced with a decision with a computing aspect? Given the nature of the UK software industry and academia, it is not always obvious.

4. Example research challenges

Computing systems are getting both bigger and smaller, and more distributed and more tightly coupled. Our research challenges range from high-power, large-scale systems to low-power, small scale, ubiquitous systems; from safety and security critical, to emergent behaviour. Many Computing Science research challenges are best illustrated when they are embedded in other domains.

Examples of embedded challenges:

- Computing for healthcare and assisted living.
- Computing for eradicating road fatalities.
- Computing for better use of environmental resources: from computing to reduce power consumption to reduced power consumption for computing.
- Systems biology and medicine: predictive models, synthetic biology, identification of drug targets.

- Formal verification of a major government IT system.
- Cloud computing: how to scale and structure data, how to model data and processes.
- Electronic (robotic) JobCentre Plus counter assistant able to handle all basic job seeker assistance tasks.
- Automatic tagging of video content for intelligent retrieval such as "I want to see all video clips that contain a blue leather jacket like that one".
- Understanding, visualising and mining huge databanks.

5. Pipeline of researchers

There is a societal need for both ICT-training and for education about core concepts in computing science. To attract talented young people into the latter there is a clear need to distinguish between the two: separating the *use* of computing technology from education *about* the deeper principles that underpin computing science and the major advances it has made in the sciences, medicine, engineering, and business. As analogies, ICT training compares with computing education in the same way as literacy training compares with Higher or A level English; or as driving a car compares with the design, construction and maintenance of that car; or as following a cooking recipe compares with an understanding of the physical and chemical processes taking place while the food cooks.

Currently, UK school curricula currently focus on training, which has the effect of discouraging a generation of talented young people from pursuing Computing Science in higher education.

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