Welcome!

- I’m Richard Mortier of the Systems Research Group (SRG)

- We are legion
  - Well, quite big (10 Academics, 7 Researchers, 16+ PhD Students ... )

- We build better useful stuff
  - Strong focus on building concrete artefacts to evaluate in a realistic environment, and (hopefully!) transition to deployment

- We cover a lot of bases:
  - Networks, Operating Systems, Distributed Systems, Programming Languages, Databases, Modelling, Security, Hardware.
  - Significant industrial funding from Google, Microsoft, Facebook, ARM, Qualcomm, Samsung, Xilinx, British Telecom, etc...
  - Work with DTG, Security, Architecture, Theory, Programming Languages, ...
Who Are We?

http://www.cl.cam.ac.uk/research/srg/netos/people/
What Have We Done?

- Founder Xensource, Bromium
- Google Director in charge of web indexing and crawling
- Author of AltaVista
- Director of Toshiba Research
- Co-author of Gimp
- Video-system architect for Nokia N8
- Former University of Cambridge Pro-Vice Chancellor
- Research Director VMWare
- Design Engineer at TomTom
- Architect of the first hard-disk MP3 player (NOT apple!)
- Author of C++
- Co-architect of Microsoft 360 Natal / Kinect

(From a presentation by a professor at the University of Cambridge)
Where Have We Gone?

…the ONLY qualification that guarantees a job here is a good systems PhD from Cambridge…

(Director of a research lab in Palo Alto)

You will find SRG PhDs in Microsoft, Google, Intel, Sun, AT&T, IBM,… AND founding a lot of other places too….

Citrix Acquiring XenSource for $500 Million

August 15, 2007

Globespan to buy Virata for $1.3 billion to create DSL-chip powerhouse

January 10, 2001
Example: Xen Hypervisor

• Core technology that enables the cloud
  • Xen hypervisor fakes virtual computers on top of a real one

• Xen powers over >1 million physical servers and 100s of millions of virtual machines in worldwide cloud providers (Amazon, Rackspace, Oracle)
  • PhD students worked on specific parts of the original system, and used it as a base for their own research ideas
  • Acquired 2009 by Citrix for $500M
# A Selection of SRG Projects

<table>
<thead>
<tr>
<th>Area</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>INTERNET</td>
</tr>
<tr>
<td>Theory</td>
<td>Resilient Clouds (MRC)</td>
</tr>
<tr>
<td>Languages</td>
<td>REMS</td>
</tr>
<tr>
<td>Embedded</td>
<td>CADETS</td>
</tr>
<tr>
<td>Privacy</td>
<td>OCaml Labs</td>
</tr>
<tr>
<td>Mobile</td>
<td>Horizon</td>
</tr>
<tr>
<td>Datacenter</td>
<td>Networks-as-a-Service</td>
</tr>
<tr>
<td>Legal</td>
<td>User Centric Networking</td>
</tr>
<tr>
<td></td>
<td>EmotionSense</td>
</tr>
<tr>
<td></td>
<td>Cloud Law</td>
</tr>
<tr>
<td></td>
<td>Data Centric Systems</td>
</tr>
<tr>
<td></td>
<td>CHERI</td>
</tr>
</tbody>
</table>
Getting Into the PhD Programme

• Two key steps to becoming a PhD candidate:
  • Getting an offer of admission
  • Finding funding for the entire program

• Getting an offer:
  • Talk to other PhD students and faculty
  • Your proposal doesn’t map out all 3 years, but it needs to demonstrate the elements of research
  • Basing a research proposal on existing group projects can help, but isn’t necessary
Getting Funding

• Limited, highly competitive source of central funds
• You can self-fund, but this is expensive and you need to show evidence for all 3 years
• Talk to faculty about ongoing research projects
  • Be wary of constrained funding...
  ...but sometimes it can’t be helped
Stuff

- Hub of All Things: personal data business models
  http://hubofallthings.org/
- Cloud Legal: http://www.claw-workshop.org/
- Internet Science: http://www.internet-science.eu/
- Liquid Networking: http://trilogy2.it.uc3m.es/
- Energy Aware Networking:
  http://www.internet-project.org.uk/
Programming languages meets operating systems

• OCaml Labs: [http://ocaml.io](http://ocaml.io)
  • Real World Functional Programming
  • Maintaining the core OCaml compiler toolchain and ecosystem
  • Buildsystem tooling, Ctypes

• Unikernels
  • Mirage: Type-safe unikernel OS [https://mirage.io/](https://mirage.io/)
  • Irmin: Branch-consistent git-like database library [http://github.com/mirage/irmin](http://github.com/mirage/irmin)
  • nqsb-TLS, Jitsu

• OPAM
  • Large scale package management and solving [http://opam.ocaml.org](http://opam.ocaml.org)
  • jsOPAM for web applications, Windows port
All aspects of mobile systems

• Mobility Modelling with Data
  • Prediction models, complex network models, recommender systems

• Sensor Systems
  • Continuous sensing, new sensing modalities, sensing applications on wearables and phones

• Applications to health and behaviour monitoring generally
Network software meets network hardware

- One language for all network hardware, firmware, and software [www.naas-project.org](http://www.naas-project.org)
- Open Hardware and 100Gb/s Research Reality [www.netfpga.org](http://www.netfpga.org)
- Useful Measurements: Merging Cause and Effect [www.metrics-itn.eu](http://www.metrics-itn.eu)
- Datacenter heal thine self: Emulating 1 million machines [http://selena-project.github.io](http://selena-project.github.io)
- SSICLOPS: secure (fast) clouds for everyone [www.ssiclops.net](http://www.ssiclops.net)
- ENDEAVOUR: exploring Software Defined Networking for Internet-wide switches
Intersecting systems with HCI to make things better

- **Homework** redesigned home network technologies [http://homenetworks.ac.uk](http://homenetworks.ac.uk)
- **User-Centric Networking** is rebuilding network technologies [http://usercentricnetworking.eu](http://usercentricnetworking.eu)
- **Human-Data Interaction** seeks to use these developments to put people at the centre of our data-driven world [http://hdiresearch.org](http://hdiresearch.org)

Inferences, often opaque to users, are drawn from input data and used to drive actions. One action may be to feed inferences back into input data for subsequent analysis. Actions based on our data and that of others affect our subsequent behaviour.
OSs, ISAs, and program analysis/transformation for security, performance, and sometimes (pragmatic) correctness

- Capsicum: POSIX + the capability-system ideal
  - POSIX + microkernels/capability systems → support application sandboxing
  - Started as FreeBSD sandboxing technology; Google has ported to Linux

- Network- and storage-stack specialisation for performance
  - Clean-slate network-stack and storage designs for performance
  - Microarchitecturally aware optimisation; 60+Gbps before we ran out of PCI buses

- CHERI: Revisiting RISC for the age of risk
  - Processor ISAs for security: fine-grained memory safety, compartmentalisation
  - FPGA prototypes / tech transition: time for systems software researchers!

- CADETS: DARPA new-start project on security via distributed tracing
  - Tracing distributed systems, LLVM-based program transformation

- PhD studentships available for multiple of the above projects
Summary

• Work across all systems areas
  • Hardware up to cloud & mobile applications
• Work with wide range of industry
  • Microsoft, Google, Amazon, Facebook, etc
• Funded from many sources
  • EU, UK, US, industry, government
• We also welcome visitors!