The Ring

The Newsletter of the University of Cambridge Computer Laboratory Graduate Association
Chairman: Professor Ian Leslie
President: Stephen Allott

A PACKET SWITCH TO SERVE 1 MILLION HOUSEHOLDS

A talk to the Cambridge Laboratory for Communications Engineering and to the Cambridge Computer Laboratory

11 November 2003

Notes by Stephen Allott
Director of Development
Cambridge University Computer Lab

Laboratory graduate Sandy Fraser (Fitzwilliam 1959) drew a large audience for his talk on simplifying the architecture of the Internet. After a BSc at Bristol in Aeronautical Engineering, he came to the Computer Lab for his PhD. He became Assistant Director of Research in the Lab and wrote the file system for the Atlas 2 computer, England's first time sharing system. He also developed a language and a compiler for the Ferranti Orion computer. Sandy's career then took him to AT&T Bell Labs in 1969 where he invented the DataKit Virtual Circuit Switch and the Spider Ring Network both of which anticipated ATM and had a long and distinguished career with many inventions. As Vice President for Research, he founded AT&T Labs Research in 1996 and became AT&T Chief Scientist in 1998. After his retirement from AT&T, he founded Fraser Research, a non-profit research company, in January 2002 which is located close to Princeton University. Both Professor Andy Hopper and Professor Ian Leslie came to act as hosts for his talk and there were many familiar faces in the audience including Sir Maurice Wilkes.

The abstract for the talk said that a topdown study of a network for 100 million households suggests a much simpler network topology than is presently evolving for the Internet. Just as Federal Express discovered that computer networks and air transport enable a more efficient centralized architecture for package delivery, so it is apparent that fibre and the practicality of very high capacity switches point the way to a more efficient communications infrastructure. The question until now has been whether switches of sufficient capacity can be constructed. This talk seeks to show that indeed they can. Clos and Benes developed the principles which enabled large telephone switches to be made from many small switches. In recent years the study of large packet switches has found inspiration in the work of Clos and Benes even though their analytic results do not apply in a packet switched world. The problem is that bad traffic patterns cause points of severe congestion and it is hard to manage large and diverse traffic flows without triggering significant side-effects, like loss of proper sequence in the delivered data. Quite by accident an organizing principle for large switching networks has been found. Simulation results confirm the possibilities. Simple calculations lead to the belief that switches with capacity in excess of 1 Pb/sec are practical.

Sandy said that the Internet is now at a critical point in its evolution and there is still no good link to residential users. The local loop is more a question of service and cost than performance at the moment. There are plenty of plans for fibre to the home. Overall his research programme is looking at the long range future of the internet. There are many service problems today with the internet including security, reliability, complexity and scale.

His overall proposal is to simplify the Internet using a meshed optical backbone linked to large regional switching centres. Each centre would serve around 1m homes meaning that in the domestic US, there would be between 70 and 100 of these regional centres. The regional switches would be transparent to the traffic they carried. In other words, they can carry any service. Today, by comparison there are thousands of regional switching centres in the telephone network. From the regional centre down to each home a series of multiplexors would aggregate traffic in a hierarchical tree structure. An Edge Node carrying 155 Mbits/second would connect houses to the network. The last mile could be wired or wireless. This is a different architecture to today and is much simpler. The circuit switched core makes routing much simpler.

Sandy is exploring the practicalities of this model at Fraser Research and one of the questions that has emerged is "Can one build a router that can handle the required 100 terabits per second in each regional switching centre?"

Charles Clos researched building large switches by grouping small switches together; a "Clos network". Networks have been looked at which use a large number of packet switches to build larger networks. Interference however can occur in the traffic flows causing hot spots. These broadly reflect the blocking points which Clos found in his research. Some work has been done to randomise traffic to avoid these hot spots developing. Another strategy is to connect and disconnect but this doesn't work either. The limiting factors today in network devices are mechanical problems with heat and electrical signal interference.

Sandy's idea is to develop the mux demux model to concentrate signals. One would use a tree of multiplexors to concentrate and re-concentrate signals. This reduces the number of signals but needs faster transmission speeds, which double for each concentration. One can think of an alternative to doubling speeds as being the doubling of the number of connecting wires. Looking at this as a flat design means that a Clos network can be a non-blocking switch although people have not looked at it this way before.

Making the 100 terabit switches will be a great challenge. Memory speed is the big issue. Although transmission and processor speeds have grown, memory speeds have only grown from 10 MHz to 14 MHz. A current leading edge chip stores 1Gb of data. This is 32,000 bits being multiplexed down to 16 pins. Memory throughput of 160 Gb/sec is possible within a single chip.

Making this overall design work also requires synchronising packet movements which makes the Clos network non-blocking. Packets have to travel in fixed time slots. Sandy showed a plan of a switch with 4 paths from each input path to each output path and the switch uses all 4 paths to transmit data through the switch. Data goes from serial to parallel (to cross the switch) and back to serial. Empty spaces are filled with null packets. Packets have to wait until a synchronised set of packets traverses the switch.

He has simulated a 512 by 512 switch and found that the delay was 50ms whatever the type of traffic. This switch behaves differently from ordinary switches. The more traffic that comes in, the less waiting time there is to form a group and therefore performance stays constant whatever the load (until extremely high loading is reached).

Sandy's conclusion therefore was that a Clos network with memory in each node can implement a mux demux network which eliminates hot spots using a 100 terabit switch. The audience then asked some questions. One questioner asked if the small number of regional nodes were a security risk. Sandy said that each switch would have several redundant planes and that switch over from one plane to another would only take 50ms. Another questioner asked about market structure and whether this design would allow competition. Sandy said he had focused on engineering, not business issues.

Sir Maurice Wilkes pointed out that one needed to look at economics when the system was poorly loaded, not when it was full. Sandy said that the regional nodes would not be the significant cost, rather the fibre to the home. The final questioner asked if Sandy was piloting his design in South Korea and he said no, the pilot would run in the Princeton cable TV network.

Lock-free programming

Dr Tim Harris – Lecturer and member of the Systems Research Group

At some point it will no longer be possible to make conventional CPUs run any faster. When that happens it will be necessary to have alternative ways of building more powerful machines and one of the most promising is to construct parallel systems which can run many tasks at the same time on separate CPUs.

This shift is already being seen in high-end desktop machines and workstations – technologies such as Intel's HyperThreading allow a single Pentium-IV Xeon CPU to execute two completely separate tasks at the same time.

However, in order to exploit parallel hardware effectively, it is necessary that software be able to provide enough work for all of the CPUs to remain busy. Unfortunately, while server software is often intrinsically parallel, the kinds of application run on single-user machines are rarely able to use more than one processor.

If mainstream programmers are to be able to develop effective parallel systems then it is important that programming languages and libraries develop appropriate abstractions to support them. Parallel execution imposes a very difficult environment to develop programs – as a programmer you would have to consider all of the possible operations that the different CPUs may be doing at the same time, for example making sure that two CPUs are not trying to access the same resource at once, or making sure that two CPUs don't get stuck with the first waiting for the second while the second is waiting for the first.

In fact, looking at languages like Java and C#, there have been few developments in this aspect of mainstream languages since the 1970s. Most systems provide multiple threads and use mutual-exclusion locks and condition variables to control access to shared data.

For instance, consider implementing a shared buffer which can hold a single integer value. In this example it will support two operations – a 'get' operation to take a value from the buffer (waiting until one has been placed there) and a 'put' operation to store a value into the buffer (waiting until the buffer is empty if it is already full).
The core of the design of 'get' could be:

```
public synchronized int get() {
  int result;
  while (!full) wait ();
  full = false;
  result = value;
  notifyAll ();
  return result;
}
```

This mess of 7 lines is the subject of several hours of lectures in the Part 1B course! It hides many intricacies, such as why a 'while' loop is needed while waiting, exactly what the 'notifyAll' operation does toward the end of the code and also the need to consider problems such as deadlock and priority inversion – problems which can only really be handled with reference to the complete source code of the entire system.

Our research is developing practical alternatives to these facilities. In fact, our solution returns to one of the oldest proposals for controlling parallelism – Tony Hoare's conditional critical regions (CCRs). Using CCRs we can re-write the previous 7-line example using only 5 lines:

```
public int get() {
  atomic (!full) {
    full = false;
    return value;
  }
}
```

The 'atomic' keyword indicates that the following statements should appear to execute in a single indivisible step no matter what the other CPUs in the machine are doing – the programmer directly says which pieces of their program should execute atomically and the system works out how to achieve it, rather than having the programmer manually implement concurrency control with features such as 'synchronized', 'wait' and 'notify'.

Our recent work on practical lock-free concurrent data structures has led us to develop a new implementation technique which lets us provide the first practical implementation of CCRs. We map CCRs onto a software transactional memory (STM) which groups together series of memory accesses and makes them appear atomic. It has many desirable properties - for instance, different CPUs can execute 'atomic' blocks at the same time as long as the don't try to access the same pieces of data.

Furthermore, our lock-free approach provides features that are extremely hard to develop using only the standard facilities of the Java programming language. In particular we provide strong progress guarantees that ensure that any given CPU will be able to make useful progress with the application that it is running – in contrast, lock-based approaches must use manual deadlock avoidance which can complicate the software's design or limit the parallelism that the hardware can exploit.

Our recent paper at OOPSLA 2003 evaluates our technique under a number of different scenarios ranging from small multi-processors to a large server with 106 CPUs. In our results, algorithms using CCRs can vastly out-perform those using the original languages facilities. At all times they remain competitive with a well-engineered mutex-based scheme; under many workloads, our CCRs perform and scale better.

We are currently developing our work in a number of directions. One of these is to evaluate lock-free programming techniques in large existing software systems – the Linux operating system kernel is a likely testbed for this work, as is the Xen virtual machine monitor from our XenoServers project. The goal is to see the effects on whole-system performance of changing from mutual exclusion to lock-free synchronization. Even if the performance of individual data structures is changed, does this effect system-level benchmarks? Do we observe effects on robustness or predictability of performance?

A second direction is to determine how easy it is to take existing code and to modify it to use CCRs. Are there any substantial simplifications possible by not needing to avoid deadlock? Are there any coding styles that are particularly difficult to move to lock-free techniques?

We believe that our work stands to make significant contributions to the practical implementation of parallel programs and the understanding of how easily they can be used in large systems.

Profile – Envisional

In the fourth in the series of articles profiling companies founded by Computer Lab graduates, 'The Ring' was delighted to talk to Ben Coppin, co-founder and Chief Operating Officer of Envisional. Ben is a graduate of Queens' College.

TR: Ben, can you start by giving me a brief description of Envisional in terms of history and product?

BC: We founded Envisional in 1999 with seed funding from business angels. We started out as a purely technology focussed company, developing our core Discovery Engine technology, although we had an eye on the commercial side of things right from the beginning, which gave us a solid base to build on. After the first year began marketing a number of products based around the idea of monitoring the Internet for intellectual property infringements. Now we have a number of clients and partners around the world for whom we provide services ranging from investigating the sources of spam to preventing people abusing a company's logos and trademarks.

TR: What edge does Envisional have over other players in the market?

BC: Our edge definitely comes from the technology, and from the fact that we are still a relatively small company, and so are able to be flexible. We were lucky being based in Cambridge, as it gave us access to some really talented programmers in our early days which meant that we were able to develop technology that far exceeded our initial expectations. Nowadays we bring a personal touch to a service that can be truly unhelpful if not done properly. Companies that offer intellectual property protection and monitoring services need to fully understand their clients, and need to tailor the offerings to exactly suit each client's needs. Envisional has the technology and the flexible approach to enable us to do that.

TR: If you could pinpoint Envisional's biggest industry innovation what would it be?

BC: Our technology has provided a way to automate a task entirely that otherwise would have involved an enormous amount of manual effort, and which was impossible to do accurately or reliably. As a result, companies who use our service are able to rely on us to ensure that if a fraudulent web site is set up, or someone misuses their copyright or trademark, that we'll make sure the client knows about it before it causes any real damage.

TR: The National Hi-Tech Crime Unit has stated that hi-tech crime is now one of the major threats posed to the UK by organised crime. What trends in cybercrime have you seen? Do businesses fully comprehend the dangers?

BC: Well, it's certainly not going away! We've seen an increase in nearly every kind of hi-tech crime. The area in which we've seen the greatest increase, and which is causing the greatest concern is online fraud.

There has been a spate of sites being set up recently that are designed to look like official sites of High Street banks, and which take information such as bank account details and PINs from consumers. This is known as "phishing", and is causing a real problem for banks and other financial institutions who are finding that it is increasingly difficult to prevent this kind of fraud.

TR: What effect, if any, has the introduction of the Copyright, etc and Trade Marks (Offences and Enforcement) Act 2002 had on copyright and trademark violations?

BC: None at all, really. The DMCA (Digital Millennium Copyright Act) in the United States has been widely used by copyright holders to have infringing material taken down, but current attitudes towards intellectual property in general, and on the Internet in particular, are such that most people don't think there's anything wrong in the majority of infringements that take place. Clearly the existing laws need to be updated to take account of the Internet, but whether this change favours the rights holders or the consumers more remains to be seen.

TR: What are the key factors and challenges to Envisional's ongoing success?

BC: Public attitudes towards intellectual property are certainly important to us. Companies are becoming more and more concerned about the threats from online fraud, trademark abuse and so on, and as a result we're getting more and more companies signing up with us. Naturally we hope that this trend will continue, but I think it's also vital that we are ready to adapt – as the environment changes, we need to be able to bring out new products and new services that match the current requirements of the market place. I think our uniquely powerful and flexible technology gives us the ideal basis to achieve that adaptation.

TR: Where do you see the company within the next 3 years?

BC: It's hard to predict. If you had asked me that question three years ago I would have predicted something very different from where we are now, because the world has changed so much since then. It's starting to feel as though things are settling down a bit now, though, which ought to make it easier to make a prediction. I'd like to think we'll be a much bigger company, particularly in terms of public recognition and numbers of clients, but hopefully we will maintain the small company ethos and not become a faceless corporation!

TR: Finally, what advice would you give to other graduates thinking of starting their own business?

BC: First be sure of your business model. It's no good setting up a company with just a brilliant new technology idea if you have no idea how you're going to sell it, and to whom. You need a proper business plan (not just for investors but for your own benefit) which should be updated regularly. If you are starting a company that's going to require a large initial injection of cash, don't assume that it's going to be easy to get – four years ago it was relatively easy, but these days it's very much more difficult.

Cambridge Computer Lab Ring Q1 events calendar (see also www.camring.ucam.org)

January 15th 2004
AGM
16:45 William Gates Building, Lecture Theatre 2

Library House presents its Cambridge Cluster Report
17:15 William Gates Building, Lecture Theatre 2

Mark Littlewood of Library House will present the findings of the Library House Cambridge Cluster Report. Based on an analysis of 1568 technology companies in Cambridge, Mark will focus on the 898 innovation based businesses in the area. This is a welcome update to the Cambridge Phenomenon Revisited.

February 12th 2004
Joint Meeting with the Judge Institute and Centre for Technology Management
Making the Numbers – Secrets of Software Sales
18:30 The Judge Institute

Speaker: Stephen Allott, former president and CFO, Micromuse Inc

March 15th 2004
Lab Update and Annual Dinner

Booking form enclosed

April 20th 2004
Hall of Fame Case Study: Sophos anti-virus
17:15 William Gates Building, Lecture Theatre 2

Speaker: Dr Jan Hruska, founder and Chief Executive Officer of Sophos

The talks are unticketed but capacity is limited so to reserve a place please email jan.samols@cl.cam.ac.uk or phone 01223 763585.

The Diploma celebrates 50 years

The course was founded in October 1953 as The Diploma in Numerical Analysis and Automatic Computing, and was the first taught course in computing in the UK.

For those nostalgic for their student days, below are some exam questions from the 1954 Diploma paper to wile away the hours. If you are feeling a bit rusty and would like to reacquaint yourself with the Computer Science course, University graduates are welcome to attend current lectures at no charge. Other subjects, however, do not extend such a welcome and any lecture attendance requires permission from the Old Schools (along with payment of a nominal fee). Information about Computer Science lectures can be found online at http://www.admin.cam.ac.uk/reporter/2003-04/special

Paper I, Monday 31 May 1954

Derive Newton's formula for interpolation at unequal intervals of the argument, together with a remainder term.
Hence, or otherwise, obtain Gauss's formula for interpolation with central differences, namely

$$f_\theta = f_0 + \theta\Delta f_0 + \binom{\theta}{2}\Delta^2 f_{-1} + \binom{\theta+1}{3}\Delta^3 f_{-1} + \binom{\theta+1}{4}\Delta^4 f_{-2} + \binom{\theta+2}{5}\Delta^5 f_{-2} + \ldots$$

in which $f_\theta = f(a + \theta h)$

Paper II, Wednesday 2 June 1954

Give an account of the application of Boolean algebra to the design of switching circuits. Illustrate your answer by considering a circuit which accepts a four digit binary number x and gives a single output t such that t =1 if $3 \le x \le 12$ and t = 0 otherwise; write down and reduce to its simplest form the switching function for t and interpret this function by means of a logical diagram composed of gates, "or" circuits, and reversing valves. Show also how a diode matrix with the required properties may be constructed. (No more than 14 diodes should be necessary.)

Discuss the practical advantages and limitations of Boolean algebra as an aid to circuit design.

Jobs Bulletin Board
(www.camring.ucam.org)

The Job Bulletin Board is there for you! If you're looking to employ new staff or looking for a new job, why use the board! There are currently 16 jobs advertised on the Bulletin Board. If you would like to post a job but have lost your website login details, please contact the Ring office at jan.samols@cl.cam.ac.uk.

School Visit Programme
Help the hunt for talent

Stephen Allott, Director of Development, Cambridge University Computer Lab

Ring members are encouraged to visit a local school, their old school or any school that might benefit, to give a presentation to school teachers and children about the opportunity to study Computer Science at Cambridge University.

The goal is to attract the very best sixth formers to come to Cambridge to read Computer Science. This can mean giving children from schools unfamiliar with Cambridge the confidence and information they need to make an application. It can also mean giving sixth formers considering applications for maths and natural science, the information to realise that they could study computer science instead.

We provide a powerpoint presentation which has great detail on the current course content as well as listing many other reasons to choose Cambridge. We suggest you also talk about your own time studying Computer Science at Cambridge, why you liked it and what your career path has been subsequently.

No preparation is therefore needed by you because the slides cover Cambridge comprehensively and you can talk about your own experience from memory.

The target audience for the presentation is not only sixth formers but also their teachers and careers advisers. Many sixth formers take advice from their teachers on possible degree courses. Briefing the teachers is therefore important. Although there may well be plenty of school teachers with Maths and Science degrees, we imagine that there are relatively few with Computer Science degrees so it is important to make sure they have full information and can recommend Computer Science enthusiastically. Many schools organise people from varying careers to come in to sixth forms to give talks, so they should welcome it if you volunteer.

Volunteering to give a talk to a school will be a great gift of your time for 3 reasons. First, you can help someone make a decision to study Computer Science and encourage disadvantaged children to apply to Cambridge. Second, you can increase the flow of talent into the Computer Laboratory which will be strongly welcomed by the faculty. Third, your gift of time will help build our community of Cambridge computer scientists.

Please review the powerpoint on line (www.camring.ucam.org). If you would like to use it, please email jan.samols@cl.cam.ac.uk for a copy. Please also let her know which school you are visiting. We would like to keep a tally of each one we do so that we can report back to the membership on a regular basis.

FREE Expert Advice
Cambridge Enterprise Surgeries

You can now go online and book a free and completely confidential face-to-face session with a professional that you choose from a range of highly relevant subjects such as marketing, venture capital and patenting. Top firms have devoted their time to these Surgeries at no charge so that you can get the best advice from the Cambridge area. These sessions have proven to be invaluable to those thinking about starting a business and needing to write a business plan.

You can book for any time until Easter by going to http://www.entrepreneurs.jims.cam.ac.uk/community/surgeries/index.html

Women@CL

Ursula Martin, Professor of Computer Science and Director of Research in Computer Science at Queen Mary University of London, is currently seconded part-time to the Computer Lab as Director of the Women@CL project. The project aims to lead local, national and international initiatives for women in computing. This position is the first of its kind in a UK University. It has been made possible with support from Microsoft Research and Intel Cambridge Research.

Throughout her career, Ursula has been deeply committed to raising the profile of women in computing and IT fields. She is currently chair of the ACM's committee on Women in Computing which celebrates, informs and supports women in computing and works to improve the working and learning environments for women. Women@CL will provide a forum for women Computer Science researchers to come together to exchange ideas, form new collaborations and meet more senior women role models. In addition, networking events are planned to support undergraduate women computing to introduce them to women computing professionals.

You can read more about the project at www.cl.cam.ac.uk/women, and Ursula would be delighted to hear from Ring members who would like to be put on the mailing lists or get involved more closely with the project. She can be contacted at Ursula.Martin@cl.cam.ac.uk.

70 MEMBERS VOLUNTEER FOR CAREERS ADVISORY PANEL

One of the Ring's principal goals is to promote members' careers. We want every member to achieve their career aspiration and reach their personal potential at every stage of their career. To achieve this, the Ring has formally launched a Careers Advisory Panel of volunteers from the membership who are available to provide informal careers advice to other members.

The Careers Advice programme is supervised by the newly formed Careers Advisory Committee which had its first meeting here at the Lab on 13 November 2003. Youssef Bouguerra (Pembroke, 1998); Peter Cowley (Fitz, 1977), Nathan Dimmock (Jesus, 2001) and Richard Hadden (Queens, 1997) attended along with Stephen Allott and Jan Samols.

First we discussed the vision of how the informal Careers Advice programme will work. Members have questions like "should I move on and look for a new job - how long should I stay in this one?"; "What sectors should I move into?"; "Would it be better to join a large or small company?"; "Should I be getting any additional education or qualifications?". Finding someone with a helpful perspective on these types of questions or simply someone with a common background to talk it over with should be helpful. Careers Advisory Panel members are easy to find through the Ring Who's Who on the Ring Web site. Click "Yes" in the "Willing to offer Careers Advice" in the directory search and this will produce a list of members who are happy to be approached for advice. You can find a good person to talk to by looking at their Who's Who entry. Look at their role, employer, sector, location, age, experience and other interests to decide who you want to talk to. If you cannot find anyone suitable, ask Jan Samols for suggestions as she knows each Ring member individually.

As the volume of advice sought and given grows, we shall collect information from our volunteers about questions they are asked frequently, share best practice on how to counsel and coach people and even lobby on important issues that emerge. The Ring therefore provides an easily accessible network of personal contacts who are willing to help with career related questions.

As well as extracting value from the system, we expect members will be keen to volunteer to help others. Not only can you feel good by helping someone else make progress in their career, but one frequently can learn something from the interaction and broaden your own network.

If you would like to volunteer as a member of the Careers Advisory Panel, please edit your Who's Who profile. If you would like to attend Careers Advisory Committee meetings, please contact Jan Samols. If you have any suggestions for the Ring's Careers Programme, please contact any of the Committee members mentioned above.

Business Hall of Fame

Thank you to all those who contacted us to add a company to the list. They are as follows. The full list can be found on www.camring.ucam.org.

Joe Dixon *F* BA PhD
Applied Generics (f.1999)
Provides advanced mobile phone location and road traffic information solutions to the mobile communication industry

Lee Fedder *Q* PhD92
Spark! Data Systems (f.1996)
A development company that produces bespoke database and Management Information solutions for the desktop and inter/intra/extranet based on the Microsoft Platform

Sandy Fraser ***F*** **Dip59**
Fraser Research Inc (f.2002)
A not for profit organisation established to provide research in science and technology in support of national communications infrastructure and to provide support for graduate education in telecommunications.

Rurik Turton *PEM* Dip85
ePlantData Inc
Provides software connectivity solutions for the process industry

Industry Legends

We are compiling a list of Computer Lab grad industry legends. We hope these may act as an encouragement and inspiration to students and graduates. To add a Lab industry legend to the list please contact the Ring office.

Steve Bourne *T* Dip66 PhD70
Designed the UNIX Command Language or "Bourne Shell" which is used for scripting in the UNIX programming environment as well as the ADB debugger tool. In 1983, Dr Bourne published his book called "The UNIX System" which was a best seller. He has held senior engineering management positions at leading computer systems and networking companies including Cisco, Sun Microsystems, Digital Equipment and Silicon Graphics.

Stan Kelly-Bootle *DOW* Dip54
Author of the "Devil's Advocate" column for UNIX review and "The Computer Contradictionary". In addition, Stan has had a parallel showbusiness career and has performed with Paul Robeson, Spike Milligan, Bill Connolly and The Spinners amongst others. His songs have been recorded by a number of artists including Cilla Black. His tribute to Liverpool Football club outsold the Beatles on Merseyside for 3 weeks in 1976.

Sandy Fraser *F* Dip59
Invented the DataKit Virtual Circuit Switch and the Spider ring network and created the UNIX Circuit Design Aids System. Sandy co-developed a technique for computer instruction set optimization using a portable compiler and this led to the design of a reduced instruction set machine. He also co-invented the Universal Receiver Protocol and INCON, a cell-based network which operated at 2 Mb/s on home telephone wire. Sandy founded AT&T Lab Research and was appointed At&T Chief Scientist in 1998. Since his retirement from AT&T he has founded Fraser Research Inc (see Business Hall of Fame).

Bjarne Stroustrup *CHU* PhD79
Designed and implemented the C++ programming language. He is the author of 'The C++ Programming Language' and 'The Design and Evolution of C++'. Bjarne is currently College of Engineering Professor in Computer Science at Texas A&M University and retains a link to AT&T Labs - Research as a member of the Information and Systems Software Research Lab.

Enterprise Launch Pad Business Plan competition

It's time to get your entries in for the 6th Cambridge Enterprise Conference's Enterprise Launch Pad Business Plan competition. The competition provides a unique opportunity to present to over 300 potential investors, partners, customers and technology experts.

Up to 100 entrants will be invited to exhibit their technology at Deal Day on March 26th 2004 and make a short presentation to an audience including VCs and business angels.

Ten finalists will be invited to attend the Cambridge Enterprise Conference and make a short presentation to all conference delegates.

The winner will receive the £5000 Enterprise Launch Pad Award.

More information can be found at www.cambridgeenterprise.co.uk

Computer Laboratory News

David Wheeler made Fellow of the Computer History Museum

In October 2003, Professor David Wheeler was made a Fellow of the Computer History Museum for his invention to the closed subroutine, his architectural contributions to the ILLIAC, the Cambridge Ring, and computer testing.

Science, Engineering & Technology Student of the Year Awards, 2003

The Science, Engineering & Technology Student of the Year Awards (SET) are the Oscars of British science and technology education. This year, the IEE Award for Best Information Technology Student has been awarded to James Murphy of Jesus College. This is the third year running that a Cambridge student has received the SET award for best IT or CS student.

Part 1b project team wins national competition

The final of the 2003 IBM ThinkPad Challenge saw 18 of the top UK Universities battling it out for honours. The winners were the Computer Lab's Part 1b project team. Congratulations to:
Arthur Taylor (Churchill)
Christian Steinruecken (King's)
Andrew Owen (Girton)
Muntasir Ali (Corpus Christi)
Rui Wang (Sidney Sussex)
Sean Moran (St Catharine's)

GRADUATES IN THE NEWS

View from the Top: Jan Hruska (DOW BA78) of Sophos Cans of worms and viruses

(*This article was first published in the Financial Times on September 3rd 2003)*

Jan Hruska is co-founder and chief executive of Sophos, the privately-owned British antivirus software maker. He is also a very clever man who does not suffer fools gladly.

Born in Croatia in 1957 to a Czech academic father and a German engineer mother, he was educated at English boarding school and has a first degree from Cambridge [*BA comsci 78*] and a doctorate from Oxford. By some sort of cultural osmosis, he has acquired a very British ironic humour, maybe to disguise his impatience with ideas that do not make the grade.

Asked whether companies should combat virus infections by "locking down" PCs – preventing employees from adding new software – he immediately counters: "I have a much better idea! Let's not only lock these machines down, let's bury them in concrete and switch them off."

He has also acquired the British flair for understatement. "I'm not entirely convinced about the benevolence of Microsoft," he says. That, it turns out, is putting it mildly.

The role of the antivirus software supplied by Sophos and it competitors is in question. It is being increasingly commoditised and incorporated into multifunctional software suites that perform a range of functions, not just antivirus protection. In addition, new technologies are emerging that could downgrade the importance of antivirus software – or maybe even replace it.

For example, some experts argue that companies can protect their networks by only running software that has been inspected and digitally "signed" as safe to run. This "signing" model, a close cousin of the "locking down" model that Mr Hruska despises, has powerful backers, including Microsoft.

Mr Hruska is unimpressed. "This is impressive in theory, but unworkable because of the amount of administration involved; IT administrators are already hard-pressed enough to keep systems running," he argues.

Signing programs theoretically eliminate risk, but act as a straightjacket on PC users, hampering their effectiveness as employees. "Organisations have to

take some risks if they want to achieve anything," Mr Hruska argues. "We live in the real world where you carry on driving your car knowing that thousands of people die each year on the roads." Microsoft's enthusiasm for program signing is less than benevolent, Mr Hruska believes.

"Microsoft wants to do something very Big Brotherish in cahoots with Intel. They want a brave new world where only executables [programs] signed by Microsoft are allowed to run on a computer," he says. "That may well be a very good antivirus measure, but it also puts incredible power into Microsoft's hands to decide which companies are allowed to create software. Can you imagine Microsoft signing something produced by Sun?"

More interesting, and technically innovative, is behaviour-blocking security software. Classic antivirus software works by taking a snapshot of any program a computer is asked to run, or of any file it is asked to open, and then compares that snapshot to a "rogue's gallery" of known viruses and malicious programs.

Its efficiency depends on that rogue's gallery being completely up-to-date. The problem is that updating takes time and effort.

Behaviour-blocking software, by contrast, by-passes this rogue's gallery. Instead, it recognises viruses and malicious programs from their behaviour, and blocks any suspicious actions which a program attempts to carry out.

The chief advantage is that new viruses, not yet added to the rogue's gallery, get blocked. If it works well enough, it could even replace the traditional approach.

Again, this gets short shrift from Mr Hruska. "This sort of behaviour-blocking approach has been tried before, but the problem is that it has too many false negatives, where the software doesn't react to a virus," he argues. "I don't really think this is suitable for serious use."

Meanwhile, new avenues for infection are popping up, including instant messaging services, file-swapping services, and dodgy websites from which corrupt code can be downloaded on to PCs even without the user realising what is going on.

"Virus writers are like water; they will find the crack in the container and will get through it," Mr Hruska says.

Sophos is figuring out how viruses and worms will in future spread through devices such as smart phones and wireless PDAs. As these devices become more powerful and functional, they become more attractive to virus writers. But antivirus software needs a lot of memory; which is something that PDAs and phones do not have at present.

"Once the power of PDAs gets to the point where they can sensibly carry several megabytes of antivirus software, then yes, sure, we'll have our software on PDAs. I'd say that will be in two or three years," he says.

Antivirus software is slowly being incorporated into larger security suites. Norton, for example, sells antivirus software bundled with firewalls and PC administration tools as part of its SystemWorks suite. Sophos has no plans to launch a suite to rival SystemWorks, however. Mr Hruska thinks that stand-alone antivirus packages can survive, if only because customers will pay a premium for the best products to protect them from financial and reputational damage. Similarly, he thinks that Microsoft's possible entry into the antivirus market will not change the landscape. In June 2003, Microsoft bought the assets of Romanian antivirus specialist GeCAD Software.

However, Mr Hruska doubts that Microsoft will bundle a full antivirus product into Windows, or even launch a stand-alone product. "If they were going for market acquisition, they would have bought one of the giants," he says.

Even if Microsoft does enter the market, Mr Hruska says businesses will continue buying from established antivirus suppliers. "Over and over again there are examples of companies that offer over and above the nuts-and-bolts solutions that Microsoft usually provides, and customers are willing to pay a premium for that. This will continue," he says.

While insisting that stand-alone antivirus software can survive, Mr Hruska has ordered his engineers to develop new software that filters out spam, the unsolicited commercial e-mails that increasingly clog up networks.

Sophos has developed software that can "quarantine" spam, filtering it into special mailboxes where the recipient decides whether to delete it or not. He says the software works "extremely well", though he will not be drawn on when, or indeed if, he will release it.

Mr Hruska is an academic at heart, and he is clearly troubled by the philosophical aspects of spam. "The bit that worries me is that in the long-term, software companies could be put into a position of having to decide what is spam and what isn't," he says.

"Most reasonable people can agree about 95 per cent of spam, like unsolicited e-mails promising penis enlargement. But it's the remaining 5 per cent where you get squeals if you try to block it," he says. "One man's spam could be valuable information to someone else. It is a can of worms." It is a typically reflective approach, but one that seems to work.

Dr Jan Hruska will be speaking at the Hall of Fame event on April 20th 2004. Please see events calendar for details.

John Bennett (C PhD53)**: Educating the technology generation**

(*The following extract comes from an article that was first published in Information Age, the official publication of the Australian Computer Society, in August 2003)*

John Bennett was the first research student in the Laboratory.

With a degree in civil engineering and four years' experience in ground radar with the RAAF at the end of WW2, he [John Bennett] was entitled, as he was under 21 when he graduated and by dint of his war service, to enrol in any university course. He opted for further studies in electrical engineering, physics and mathematics.

A summer stint at the electrotechnology division of the Council for Scientific and Industrial Research in 1945/6 (now CSIRO) where David Myers was working on analogue and digital computing brought him in touch with the scientific discipline on which half a century of his pioneering academic life would be founded.

It was there that he met Trevor Pearcey who went on to design and build CSIRAC in 1951, Australia's first stored program computer.

Their meeting also spawned a drive by the pair to found computer societies initially in NSW, Victoria and Canberra, and in 1966, the Australian Computer Society with Bennett as its first president and Pearcey as vice president (and its president in 1967).

"To me, it was a matter of spreading the gospel; I knew that computers were here to stay and I knew that they offered enormous possibilities for taking the grind out of repetitive calculations," Bennett said.

He knew about repetitive calculation: joining the Brisbane City Electric Light Company in 1946, his work on its power distribution network brought plenty of it but a chance hearing of a radio talk about the ACE computer being developed by the National Physical Laboratory outside London offered a solution to his mathematical grind, and would set his career path.

He applied to the nearby London University Imperial College's electrical engineering department for a research studentship. Fortuitously his application was passed to Douglas Hartree of Cambridge University Mathematical Laboratory, who arranged for him to join the Electronic Delay Storage Automatic Calculator (EDSAC) development team, headed by lab director Maurice Wilkes (now 90 and knighted), in 1947.

War surplus technology

EDSAC would become the first stored program electronic computer in regular operational use.

"We used war surplus valves bought by the pound" and I/O equipment based on uniselectors scrounged from the Cambridge Post Office to build EDSAC in what had previously been the dissecting room of Cambridge's anatomy school.

"It had a useful goods lift big enough for two cadavers, but on the other hand the smell of formalin-soaked floorboards pervaded everything in hot weather."

It was on EDSAC, and later in Manchester, that Bennett carried out what were to be the first structural engineering calculations on an electronic computer, resolving problems like flutter in aircraft airfoils, the work forming the basis of his PhD.

Later joining Ferranti Ltd in Manchester, the young and free-ranging computer industry offered a variety of pursuits for Bennett including various marketing assignments, machine specification and running a programming group initially including six women.

Moving to Ferranti's London Computer Laboratories in 1953, he found himself working within 100 metres of the site of Charles Babbage's house. Known as the "father of computing", the 19th century mathematician's Difference Engine Number 1 was the world's first successful automatic calculator. (Babbage later developed his Analytical Engine [1856]), which was intended as a general symbol manipulator, and had some of the characteristics of today's computers. He died in 1871, embittered and disappointed by government failure to support the production of his machines…)

Bennett worked in a team led by Bill Elliott, and which included Charles Owen whose plug-in units were designed so that logical design of complete computers using them could be done by non-engineers. Owen went on to design the IBM 360/30.

"Whatever we touched was new; it gives you a real lift. We weren't fully aware of what we were pioneering. We knew we had the best way but we weren't doing it to convert people – we were doing it because it was a new tool which should get used.

"We knew we were ploughing new ground. We were top of the heap."

Back in Australia he joined Harry Messel's School of Physics group in 1956 to head operations on SILLIAC, the Sydney version of ILLIAC, the University of Illinois Automatic Computer. Considerably faster than any machine then available commercially, its individual sections engineered by Brian Swire were built under contract by STC, making it in a sense the first computer built by Australian industry.

John Bennett became Australia's first Professor of Computer Science, heading up University of Sydney's Basser Department.

NEWS OF MEMBERS

Mohamad Afshar, *K* PhD99, is Director of Product Management for Oracle9i Application Server.

Geoff Bowron, *W* Dip70, a partner at Mazro Consulting, has won the tender to undertake the BCS's Code of Practice project. Geoff beat off 9 other tenders. Richard Sizer, the Ethics Expert Panel chairman, said "The Code of Practice project will benefit from Geoff's experience gained in the development of appropriate standards and procedures in a wide variety of industry sectors."

Andy Clark, *K* BA02, is a test engineer with Smartner in Cambridge. He is acting test project manager responsible for testing of mobile email software.

Ben Coppin, *Q* MA96, is COO at Envisional which he co-founded in 1999 (see company profile on page 3). His book 'Artificial Intelligence Illuminated' is due for publication in March 2004.

Peter Cowley, *F* BA77, founder of Camdata, has bought Microscribe, tripling Camdata's size. Microscribe has been supplying rugged hand-held terminals and computers for over twenty years. The products are IP65 water-proof and drop-proof. Applications include tunnel boring, industrial ink-jet printing, data logging, stock checking and various military uses.

Shaw Chuang, *K* PhD01, is currently chief product architect for Network Clarity in Seattle.

Sarah Flannery, *PET* BA03, is a Research Associate at Wolfram Research.

Nitin Kumar Goel, *F* BA01, is working as a Software Design Engineer in the Secure Windows Initiative Attack Team at Microsoft Research, Redmond.

Ubisense, the company founded by **Prof Andy Hopper**, *TH* PhD78, has received its first DTI SMART award. The £45k award will enable Ubisense to fund a feasibility study into extending its existing Ultra Wide Band sensor technology, to provide a fully scalable sensing solution.

Sapna Jethwa, *CL* BA01, is a Management Consultant with Mercer Oliver Wyman.

Dr Chong Woo Kim, *JN* Dip 1999, has returned to South Korea where he is working as a senior engineer for Samsung Electronics.

Artimi, the company founded by **Jack Lang**, *EM* Dip71, has opened an operation in California.

Yu Lu, *Q* PhD02, is an Associate Technical Architect at Convergys.

Derek McAuley, *F* Dip85 PhD, is director of Intel Research Cambridge. He has an affiliated lecturer position at Cambridge University.

Martin Mamo, *M* Dip95, is now working at Operis, a specialist financial advisory and modelling services company founded by another lab grad, **David Colver**.

Roman Marszalek, *CTH* Dip99, is a director of Applepro Ltd, a computer consultancy he set up in 2001.

Richard Mason, *Q* BA84, has returned to Cambridge this year to do an MBA at the Judge Institute.

Mantsika Matooane, *T* Dip97 PhD02, is working for Standard Bank of South Africa in Johannesburg as Product Manager of Transaction Products.

Fiona Miller, *T* MA83, a fellow in cardiothoracic radiology at Papworth Hospital, is nearing the end of maternity leave following the birth of Peter James Campbell White on April 24th 2003.

Claire Morgan, *SID* BA02, is a systems consultant for Royal Blue, a leading supplier of global financial trading software.

Tony Morgan, *W* PhD, is Professor and VP of Enterprise Informatics at Northface University.

Paul Menage, *M* BA96 PhD00, is now at Google. He is working on backend infrastructure.

Giles Nelson, *CL* PhD98, is Director of Business Development at Apama, a company he co-founded in 1999.

Glen Slade, *JN* BA87, is a director at BrandFind Ltd.

Mark Sutton, *JE* BA01, is a software engineer at Qubesoft Ltd. He is currently working remotely from New Zealand but will be returning to London early in 2004.

Dominik Wee, *K* BA03, is working as a management consultant for McKinsey in Munich.

Gordon Woo, *CHR* Dip80, is a catastrophe risk consultant for RMS, specializing in mathematical aspects of catastrophe risk modelling. Since 9/11, he has developed a quantitative framework for modelling terrorism risk. Prior to this, his main focus had been on natural hazards. Dr Woo is author of 'The Mathematics of Natural Catastrophes'.

We would welcome news of any appointments, distinctions gained or honours and awards made to graduates of the Laboratory. Please contact the Cambridge Computer Lab Ring office.

Join The Ring

Cambridge Computer Lab Ring is growing. The key to our success is strength in numbers and the more members we have, the stronger we become, enabling us to accomplish more.

There have been several success stories over the past few months – putting members in touch with faculty to help solve problems, successfully matching a start-up Lab grad founded company with a lab grad VC, helping a Hall of Fame company recruit a lab graduate.

To become part of a powerful body of computer scientists contact the Ring office for an application form – membership costs just £4 a month (or is free if you've graduated within the last 3 years) – or go to the website at www.camring.ucam.org.

If you think the Ring is doing a good job and is a worthwhile association, please encourage your friends to join. You can get a list of the people in your college and your year from the Ring Who's Who. Contact a friend and get them to come with you to the next Annual Dinner.