

Report on

New Directions in Applied Probability: Stochastic Networks and Beyond

Edinburgh, 10-14 July 2006

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1 Overview

This workshop, made possible by a grant from EPSRC and ICMS, dealt with the latest trends and directions in applied probability with emphasis on applications to stochastic networks and related stochastic systems.

The main goal was the discussion of mathematics behind a variety of applications and, to achieve this, we invited a number of researchers, beyond the traditional area known as “Stochastic Networks.” In the workshop, we explored relations between different sub-areas of Theoretical and Applied Probability and how these can be used to boost further directions in Stochastic Networks.

One of the aims of the workshop was to strengthen UK involvement in this rapidly developing field that has several important industrial applications, e.g. in communications, in transportation, in the power industry, and in biology.

The outcomes of the workshop were a deep exchange of ideas. Several of our colleagues have already pointed out to us that such workshops are what we ought to have more frequently, for they had the opportunity to discuss things beyond the ones they are usually involved with.

In what follows, we discuss, in some detail, the various topics presented in the workshop (Section 2), give the list of all 39 participants (Section 3), the detailed programme of talks and events (Section 4), and, finally (Section 5), a summary of the participants’ responses to a questionnaire.

2 Description of themes and talks

The workshop had several related themes which we discuss next, along with brief descriptions of the talks for each category. It should be mentioned that some talks reported research results that belong to more than one of the categories.

2.1 Stability, performance and simulation

One of the most fundamental questions arising in the study of a stochastic network is that of its stability. During the past decade, several new classes of networks with interesting stability properties were discovered. The performance of a (usually stable) network is also an important question in all kinds of applications. MacPhee discussed stability criteria for a network of quite general type that includes re-entrant lines and expressed the stability criteria in terms of the drifts of the stochastic process describing the network. Tsoukatos presented stability criteria for a stochastic

network in a CDMA telecommunications application. Harrison discussed new results on the classical problem of a reflected Brownian motion on the orthant; this usually appears as a diffusion limit of a stochastic network in manufacturing applications. Mairesse discussed the stability and performance of a new type of networks called “zero-automatic” and which appear in computer science applications; interestingly, his point of view is that of a random walk on a semi-group or a monoid, which brings interesting algebra into the topic. Leskela discussed networks with repacking, models of circuit-switched networks (e.g. in telephony) and studied their monotonicity in order to derive results on their performance. Kendall gave an overview of perfect simulation techniques which are methods for simulating a stochastic system in its steady-state.

2.2 Rare events

The understanding of rare events has both theoretical and applied interest. The theory of large deviations has led to new ways to understand extreme behaviour. In applications, catastrophic phenomena, which are hard to estimate or simulate can be understood by means of the theory of rare events. Puhalskii discussed the theory of large deviations for systems with discontinuous dynamics which are particularly important in the area of stochastic networks. Stolyar considered a model with randomly-varying capacity and multiple queues and addressed the problem of devising scheduling algorithms for the control of large deviations. Vladimirov and Rybko gave related talks on the Poisson hypothesis of networks; this states that a network when it becomes too large in a way that individual traffic intensities go to zero, then it can be approximated by a network where the internal flows are Poissonian. Rybko discussed a proof of this hypothesis in the mean field case, and Vladimirov related the hypotheses to a time-varying M/GI/1 queue and non-linear Markov processes.

2.3 Statistical mechanics methods

Statistical mechanics is an area which is of great interest to physicists. In it, probabilists have found a wealth of interesting problems some of which remain extremely hard (e.g. spin glasses). Occasionally, there have been intersections between statistical mechanics methods and stochastic networks research but these remain rather meagre and must be explored further. This was the aim of Grimmett’s talk who discussed Ising and Potts models and gave an overview of a variety of results on phase transitions and percolation. Hryniv also gave a talk on phase transitions for some two-dependent Markov chains. Martin spoke about growth models with competition on their interfaces, giving results on the growth of clusters and their interfaces, by relating the models to an asymmetric exclusion process.

2.4 Stochastic geometry and random graphs

The area of stochastic geometry and the study of random graphs (e.g. in a Euclidean space) has found new applications in the area of wireless networks which became

very important in mobile communications. Penrose gave a talk on nearest-neighbour graphs and objects associated with it and presented results on limiting behaviour of their length and other quantities. Reittu discussed a new model of power-law graphs (conditionally Poisson) and its limiting behaviour where the sizes of various components are precisely classified (e.g. the core of the network). Lelarge presented joint work with Aldous on scaling exponents of minimal spanning trees.

2.5 Applications of stochastic networks

We had a group of talks that were chosen directly due to their applications. Meyn presented a model of electric power networks that captures competition in pricing of electric markets, and gave results on their control. Ganesh spoke about the use of stochastic epidemics (threshold behaviour) in preventing the spread of viruses on a network such as the Internet. De Wilde gave an interesting talk on how stochastic networks can be used as models of the human brain. Kaj gave a talk on the modelling of sensor networks in space via Brownian motions.

2.6 Stochastic fluid networks

When we look at networks macroscopically, especially at large time scales, we often see a stochastic fluid. A study of stochastic fluids is important for all kinds of applications, but also because of its intrinsic mathematical elegance. In particular, Brownian motion and Lévy processes play an important role in this type of networks. Boxma gave a talk on queues driven by Lévy processes that contain vacation periods of sizes which are dependent on the preceding busy periods. Denisov spoke about precise asymptotics of first passage times of Lévy processes. Mandjes spoke about a fluid stochastic system where the inputs and outputs are coupled.

2.7 Long-range dependence and heavy tails

During the 90's it was noticed that new statistical features were responsible for the strange behaviour of many communication networks. Specifically, people started looking at long-range dependence as well as the use of heavy-tailed distributions in modelling traffic. A prototype of a long-range dependent process is a fractional Brownian motion and a large class of heavy-tailed distributions are the stable ones. Valkeila gave a talk on how to characterise a fractional Brownian motion by extending the equivalent characterisation, due to Lévy, for Brownian motion. Utev spoke about probability inequalities for weakly dependent random variables. Zuyev presented interesting characterisations of stable distributions on convex cones.

3 List of participants

| | |
|------------------------|---|
| Boxma, Onno | EURANDOM and Eindhoven University of Technology |
| De Wilde, Philippe | Heriot-Watt University |
| Denisov, Denis | EURANDOM and Eindhoven University of Technology |
| Duffy, Ken | Hamilton Institute, NUIM |
| Foss, Serguei | Heriot-Watt University |
| Ganesh, Ayalvadi | Microsoft Research, Cambridge |
| Grimmett, Geoffrey | University of Cambridge |
| Halliday, Samuel | Heriot-Watt University |
| Harrison, J Michael | Stanford University |
| Hryniv, Ostap | Durham University |
| Jerrum, Mark | University of Edinburgh |
| Kaj, Ingemar | University of Uppsala |
| Kendall, Wilfrid | University of Warwick |
| Konstantopoulos, Takis | Heriot-Watt University |
| Kumar, Dinesh | INRIA |
| Lelarge, Marc | University College Cork |
| Leskel, Lasse | Centrum voor Wiskunde en Informatica (CWI) |
| MacPhee, Iain | Durham University |
| Mairesse, Jean | CNRS, Universit de Paris VII |
| Mandjes, Michel | University of Amsterdam |
| Martin, James | University of Oxford |
| Meyn, Sean | University of Illinois |
| Moriarty, John | University College Cork |
| Norros, Ilkka | VTT Technical Research Centre of Finland |
| Penrose, Mathew | University of Bath |
| Puhalskii, Anatolii | CU Denver and IPPI Moscow |
| Rajaniemi, Hannu | University of Edinburgh |
| Reittu, Hannu | VTT Technical Research Centre of Finland |
| Rybko, Alexandre | Institute for Information Transmission Problems |
| Sapozhnikov, Artem | University College Cork |
| Shneer, Seva | Heriot-Watt University |
| Sousi, Perla | cole Normale Suprieure, Paris |
| Stolyar, Alexander | Bell Labs |
| Tsoukatos, Kostas | University of Thessaly |
| Utev, Sergey | University of Nottingham |
| Valkeila, Esko | Helsinki University of Technology |
| Vladimirov, Alexander | Institute for Information Transmission Problems |
| Zachary, Stan | Heriot Watt University |
| Zuyev, Sergei | University of Strathclyde |

4 Detailed programme

Monday 10 July

- 08.30-09.15 Registration
- 09.15-09.30 Welcome
- 09.30-10.15 J Michael Harrison (Stanford University)
Reflected Brownian motion in a quadrant: tail behavior of the stationary distribution
- 10.15-10.45 Coffee
- 10.45-11.30 Iain MacPhee (Durham University)
Stability criteria for queueing networks
- 11.45-12.30 Jean Mairesse (CNRS, Universit de Paris VII)
Zero-automatic queues and networks
- 12.30-14.00 Lunch
- 14.00-14.45 Kostas Tsoukatos (University of Thessaly)
Fairness, stability and energy efficiency in CDMA stochastic networks
- 15.00-15.45 Anatolii Puhalskii (CU Denver and IPPI Moscow)
Large deviations of stochastic systems with discontinuous dynamics
- 15.45-16.15 Coffee/Tea
- 16.15-17.00 Alexander Stolyar (Bell Labs)
Large deviations of queues under quality-of-service scheduling algorithms
- 17.15-18.00 Alexander Vladimirov (Institute for Information Transmission Problems)
The smoothing effect of certain queueing networks

Tuesday 11 July

- 09.30-10.15 Geoffrey Grimmett (University of Cambridge) Stochastic geometry and statistical mechanics
- 10.15-10.45 Coffee
- 10.45-11.30 Mathew Penrose (University of Bath) The random on-line nearest neighbour graph and related topics
- 11.45-12.30 James Martin (University of Oxford) Competition interfaces and interacting particles
- 12.30-14.00 Lunch

- 14.00-14.45 Hannu Reittu (VTT Technical Research Centre of Finland) On the robustness of power law random graphs
- 15.00-15.45 Marc Lelarge (University College Cork) Minimal spanning tree and scaling exponents
- 15.45-16.15 Coffee/Tea
- 16.15-17.00 Wilfrid Kendall (University of Warwick) Perfect simulation: a survey

Wednesday 12 July

- 09.30-10.15 Onno Boxma (EURANDOM and Eindhoven University of Technology)
Queues and Levy processes
- 10.15-10.45 Coffee
- 10.45-11.30 Denis Denisov (EURANDOM and Eindhoven University of Technology)
Tail asymptotics for first passage times of Levy processes and random walks
- 11.45-12.30 Michel Mandjes (University of Amsterdam)
A fluid system with coupled input and output, and its application to bottlenecks in ad hoc networks
- 12.30-14.00 Lunch
- 14.00-17.30 Free afternoon
- 17.30-18.30 Reception at ICMS, 14 India Street
- 19.00 Workshop Dinner at Howies Restaurant, 29 Waterloo Place

Thursday 13 July

- 09.30-10.15 Sean Meyn (University of Illinois)
Dynamics of prices in electric power networks
- 10.15-10.45 Coffee
- 10.45-11.30 Ayalvadi Ganesh (Microsoft Research, Cambridge)
Threshold behaviour for epidemics on networks
- 11.45-12.30 Philippe De Wilde (Heriot-Watt University)
Coupled networks in the brain
- 12.30-14.00 Lunch
- 14.00-14.45 Ostap Hryniv (Durham University)
Phase transition for a class of two-dependent Markov chains

15.00-15.45 Esko Valkeila (Helsinki University of Technology)
An extension of Levy's characterization theorem to fractional Brownian motion

15.45-16.15 Coffee/Tea

16.15-17.00 Sergey Utev (University of Nottingham)
A dyadic induction blocking technique for weakly dependent random variables

Friday 14 July

09.00-09.45 Alexandre Rybko (Institute for Information Transmission Problems)
Poisson hypothesis for information networks

10.00-10.45 Ingemar Kaj (University of Uppsala)
Propagation properties in a simple sensor network with Brownian mobility

10.45-11.15 Coffee

11.15-12.00 Lasse Leskel (Centrum voor Wiskunde en Informatica)
Stochastic monotonicity properties in loss networks with repacking

12.15-13.00 Sergei Zuyev (University of Strathclyde)
Stable distributions on convex cones

13.00-14.00 Lunch

5 Summary of questionnaire responses

As of 14 August, 24 responses received.

Simple responses like 'yes' to Q 4 and 5 were omitted.

1. What, for you, was the highlight of the workshop?

The talks of Mike Harrison and Sean Meyn. And I think that the talk of Sergei Zuyev must also included to the list of highlights.

There was no single highlight. Most of the talks were well prepared. Highlight was the general picture of the research area of the workshop.

The opportunity to meet and discuss with experts in queueing theory and others areas of stochastic networks.

Responses to my own presentation.

I was there just two days (or in fact a day and half). I like the interaction with my colleagues most – for me that's the reason to go to workshops. Among the talks there wasn't any that could be called "highlight".

Interesting talks, creative atmosphere of discussions.

I enjoyed the talks by James Martin and by Lelarge.

Hearing about some research (on zero-automatic queues) which is directly applicable to one of my own projects.

A possibility to bring together specialists on various areas of modern probability/applied probability theory and to exchange new ideas/results.

Meeting many distinguished colleagues, including world leaders, in an informal academic setting.

Getting so many prominent scientists together is already a big achievement.

Typically these workshops are highly insular - the participants know each other, so there are few surprises. This formula is effective since there it is easy to engage in discussion. This meeting was different because it brought together two very different groups of researchers. The stochastic network 'clique' consists of people like myself, Jean Mairesse, Alexander Stolyar, and Michael Harrison. The stochastic geometry members included Geoffrey Grimmett and James Martin. The workshop also included speakers with interests in both areas, but not traditionally associated with either group. The workshop had several highlights. I mention Geoffrey Grimmett and James Martin because they gave beautiful highly accessible lectures. I knew very little of their research area until the meeting. Philippe De Wilde presented a fascinating lecture on modeling and network aspects of the human brain. There were many excellent talks from the stochastic network researchers, though fewer surprises for me. A highlight from this group was Stolyar's lecture on the Poisson hypothesis.

To have an opportunity to talk to prominent mathematicians working in Stochastic Network and other neighbouring areas, to hear about the research problems there.

There was not really one highlight, but I definitely enjoyed several of the talks. I prefer not to mention any to avoid forgetting some...

The Thursday morning; very interesting lectures by Meyn, Ganesh and DeWilde on a wide array of topics, topics about which I do not often hear lectures.

The opportunity to exchange ideas with several leading researchers. Hopefully, this will lead to one or two research collaborations.

There was no particular highlight for me but I was very pleased to see some people at the start of their research career as well as more established people. I was also impressed at the number of research active people who stayed for most of the week and I had interesting conversations with several of them.

Talk by Michael Harrison

Just every working day was very interesting, highest level of talks. For me, personally, the most valuable talk was the one by Prof. Ganesh.

Variety of topics presented and occasion to meet top researchers in these various fields.

Discussing with my coauthor Alexander Vladimirov joint research.

The opportunity to talk at length with colleagues located in Europe, whom I see less frequently than those located in North America. The most notable individual in this regard was Alexander Rybko, whom I admire greatly but see only once per 4-5 years. The value I derived from this contact with Rybko was greatly enhanced by the presence of 5-10 other Russians, including two that I know quite well (Stolyar and Puhalskii) who speak better English and could therefore act as interlocutors.

2. What was your impression of the overall academic value of the workshop?

This was good. Some of the talks gave new ideas and approaches, which will be useful in our later work.

I would rate the academic value of the workshop to be very good. The overall quality of the talks was on a very high level, in my opinion.

High quality talks, good mix of backgrounds, and high level discussion.

Many extremely good quality presentations from different areas, rarely presented together, can have fertilizing effect in those areas and cause information flow. Good 'role models' for junior researchers.

Great. In fact there is almost any year an event of this type (at HW, but also at EURANDOM, and two years back at Mittag Leffler), and I like these meetings more than large conferences.

Excellent.

Seemed a good forum for exchange of ideas especially between those working in queuing networks.

The workshop provided a very good cross-section of research in stochastic networks and related areas.

Very positive! Higher than expected.

Very high. I thought it gave an excellent overview of recent advances in stochastic networks.

Very high, interesting talks on the frontline of research.

I needn't say more - it was outstanding.

It is a very good idea to gather together people working in different areas, especially when the latter are represented by mathematicians of high calibre.

Very good.

It was one of the best workshops that I have attended in the last few years (and I am attending at least 5 workshops per year). There was a good mixture of senior researchers and talented youngsters, and the scope was broad but sufficiently coherent.

Large scale distributed systems. Bringing together ideas/techniques from probability, computer science, economics.

I attended all of the talks and thought that every speaker made a considerable effort to communicate the key ideas in their recent research (or field of expertise for the summary style talks). This enabled me to learn a lot very quickly about current issues in several fields where I have some knowledge but am not an expert. In addition I had several interesting conversations with researchers from the US and mainland Europe. Overall this was a week well spent.

High value, with lots of active participation

I was impressed with the high quality of the talks throughout the week. It was obvious that almost all participants considered this to be a high profile event, where a lot of effort had been put into presenting new and recent research for a qualified audience.

Highest value, again.

Very good academic value.

Quite valuable.

I felt that the workshop was of high intellectual caliber, and I certainly derived a lot of value from it. I was able to question several participants closely (Rybko, Ganesh, Puhalskii and Meyn) about the subject on which I spoke, and I will acknowledge their contributions and the workshop in the published version of that work.

3. What in your view are the key future research areas / directions in your field?

We continue the study of fractional Brownian motion and its applications. The other area will be the conditional laws of processes and their applications.

I think the key future direction of stochastic networks is the application of the methods in new areas, such as biology, chemistry, and computer science.

It will be important in queueing theory to escape some of the mind frame of past

problems, and identify and solve new problems arising from current and future areas of network theory. In statistical mechanics, the main problems are associated with understanding phase transitions and the structure of the phases for realistic models of physical phenomena.

Principles of wireless communication networks.

Random graphs... models for ad hoc and sensor networks... network models

Asymptotical analysis of behavior of stochastic networks (thermodynamic limit, fluid limit, large deviations).

Realistic network modelling.

Wireless sensor networks.

Stability and continuity of stochastic processes. (Functional) limit theorems.

I'm a little to one side of the networks field, so don't feel qualified to answer this one.

Asymptotic analysis of large systems via dynamical systems, conformal techniques.

There is no doubt that the most important applied research and the most exciting research generally lies at the intersection of fields. I am currently interested in the intersection of control, economics, and networks. Universities all over the world are recognizing the importance of greater involvement in biological research from engineers and scientists in outside fields.

My guess would be that dynamical questions shall become more and more popular in Statistical Mechanics, that in turn might give a new insight into problems of queueing/network type.

One key is presumably the ability of the field to provide interesting ideas and models outside communication networks, for instance for electric networks, epidemic models, biology...

In queueing theory: asymptotics and approximation methods. In performance analysis: wireless/mesh/self-organizing networks. In stochastic networks: it seems challenging to apply queueing-theoretic methods to road traffic networks.

I'm not expert enough with interacting particle systems to hazard any predictions there but there are a host of interesting questions arising from the physical sciences and a growing class of models is being studied with some success. The talk by Philippe De Wilde was fascinating but the books I have subsequently borrowed from my university library make it clear how much investment of time and effort would be needed to get to the point where techniques from other networks could be brought to bear (I have very little idea what sort of questions could be answered using the models I have read about so far). My particular area of research has been in network models of queues and

loss systems motivated by issues from teletraffic and computer networking. Recent work by Mike Harrison and by Jim Dai generalising the traditional models seems interesting to me.

Stochastic Networks is a solid subject area which combines nicely traditional applied mathematics research such as queueing theory with central topics of modern probability theory such as random graph theory, particle systems, percolation, etc. Researchers in stochastic networks should ideally look for simple models related to the most recent technology and use advanced mathematical tools to study their properties.

Non-stationary processes and phase transitions in queueing networks.

Applications of stochastic geometry, percolation and statistical physics to the study of networks.

Spatial models

To me the big topic in stochastic networks over the last ten years has been resource allocation rules that achieve system stability (like Max Weight); I think it is still the most interesting research area in the field.

4. Did the workshop help you to develop/sustain contacts likely to result in new research? [see footnote]

Yes, with I. Kaj we started to reprove some limit theorems related to renewal counting processes and fractional Brownian motion. Probably. Time will tell.

Definitely yes. Will try to keep in mind the footnote. I expect to collaborate strongly in the future with Prof Foss, and the workshop helped me a lot in developing this.

Most of the participants are well known to me. Yes, it helps me to sustain the contacts and keep well informed. There is no question. I have known many participants for almost two decades, but have been out of touch. This is true in particular for Takis Konstantopoulos. I was reminded that he is a true scholar - I can only think of a few like him in the U.S.. I suspect that I have made several new long-term friends such as Ken Duffy and Sergei Zuyev (another amazing scholar) .

Yes, it raised my interest in queueing/network type of problems. As usual, the workshop mostly helped me to remain aware of what is being done elsewhere in the area. I have also picked up some new ideas, but it is much too early to know if they will turn out to be fruitful. Throughout the meeting I had discussions about current research with many of those present. Quite possibly. Two other participants approached me during the workshop with interesting ideas that we have started to discuss and decided to follow up after the summer period. I'm not sure As noted above, it had a lot of value for research of mine that was already under way. I can't think of anything I learned that is likely to generate new work for me.

5. Did the programme result in new ideas or the acquisition of new techniques or methods?

Yes, the material in the talk by S. Meyn will be useful in some later research. Yes. I found new research ideas of my own, and I also learned new methods (related to simulation and stability of stochastic models) as well as interesting new modeling aspects (e.g. the pricing of electricity, and wireless sensor networks) .

Possibly, I must think about this more.

Possibly

Yes. The alternative is to read journals and to check websites. Attending this workshop is much nicer and quicker.

Yes, a few.

Yes, I've learnt a lot. I was particularly grateful to learn about network blocking phenomena from world experts.

Definitely. It is yet to see, how productive these ideas are.

Yes. In discussing some simulation results with Ken Duffy and Ayalvadi Ganesh I have completely rethought my views on simulating networks. Most likely we will write a joint paper. Regarding the footnote, I will keep this in mind.

Rather applications of known techniques (as Large Deviations) to new areas.

Very good and friendly support from the staff. Excellent lecture room facilities; I particularly liked the revolving blackboards.

New problems – yes, new techniques – no.

As a result of meeting Michel Mandjes I plan to go to a EuroNGI meeting at CWI, Amsterdam in November and it may be that some ideas I have can be developed to make them relevant to resource allocation models.

Certainly. There were 3-4 talks directly relevant for my own research, where I have collected references and where I plan to follow up soon.

Everything was just excellent apart from, may be, some very excusable problems with the Internet.

I became aware of new ideas that could be useful for my research

Doesn't seem to have

Yes – the fusion of large deviations theory and stochastic control that Alexander

Stolyar spoke on. This is of great interest to me, and I was able to learn a lot about the method in conversation with Stolyar. I would like to use similar techniques in my future work.

6. Have you any comments on the facilities (at the workshop venue) and/or accommodation or on the administrative arrangements?

Everything was very well organized. Even I was able to find the way in the university labyrinth thank to good instructions.

I think that the organizers did very good job in marking the directions clearly in the corridors of the Heriot-Watt University. That was really helpful. I also think that the timetable of the workshop was very well planned, leaving enough time for discussions with colleagues. The only slight complaint is the lack of wireless network access, which is nowadays freely and automatically available in many campus areas, but not in Heriot-Watt.

It is a weakness of the Heriot Watt campus that there are limited attractive places for socializing, and it is far from town. It would be preferable to have good quality dining facilities wuthin walking distance.

Everything was very smooth.

No, it was excellent.

High level of organization.

These were fine for me.

Everything went smoothly.

All good except for email provision at Heriot Watt, which was random and haphazard to a surprising degree. My own institution makes a special point of being *much* better (typically providing WiFi in conference accommodation free of charge, and making sure their provision actually works).

I was commuting from Glasgow, so cannot comment on accommodation, but administrative support was perfect.

I hadn't been to Scotland before. Edinburgh is beautiful, and the Heriot-Watt campus also beautiful. The accommodations were excellent. My only complaint is the potato scones at breakfast which would be better used for a hockey puck. The administration was absolutely flawless. I know it takes a great deal of time to put on a workshop like this. The organizers and staff did a tremendous job.

Everything seemed to work very smoothly, thanks to all people involved in organisation of the workshop! The only downside was the quality of the computer access (unfortunately, this was out of organisers' control).

The facilities and administrative arrangements were perfect, in my opinion.

Good.

The organisation was excellent, the facilities and accommodation were fine and the weather was great too! There were a lot of talks but spacing them out a little was very helpful.

Yes, I was quite happy with the smooth arrangements. The nearby accomodation and the food fascilities made the stay very comfortable and enjoyable. Excellent lunches.

The one exception had to do with the computer access service. On July 17 I explained my concern with an email sent to support@hwresnet.hw.ac.uk, copied below. There was no answer so far. During the week July 9 - 15 I was a visitor at the ECC Heriot Watt for a conference organized by the International Centre for Mathematical Sciences. I purchased 12 hours online time and used the Ethernet access Sunday July 9 to Wednesday July 12. The room was LHA 316. I had noticed minor problems at login earlier, but it must have been some time Thursday July 13 that the automatic redirection to the ECC login page stopped functioning. I was not able to reach the number 01189 657 340 from the room. The staff at the conference centre suggested I buy further telephone services which I declined. The network itself seemed to work properly, which could be checked using the written instructions available in the rooms. I tried to login several times during Friday and also Saturday morning but the problem remained. Because of the problems I was able to use only about 8 hours time instead of 12. This is quite disappointing, in particular taking into account the very high price for the service. I will mention these experiences to the conference organizers.

Everything was just excellent apart from, may be, some very excusable problems with the Internet.

Excellent!

Adequate.

The university facilities were adequate, the restaurant dinner on Wednesday was magnificent, and both the organizers and the staff did their jobs very ably – there was no hitch.

7. Have you any other comments?

Thank you for your help

My thanks to the organisers and the ICMS staff.

My Best Regards to Mrs. Tracey Dart and to Mrs. Audrey Brown.

Thank you to the organisers.

How lucky we are with having a very supportive ICMS staff in Edinburgh!!!

I very much appreciated ICMS' excellent work in providing this workshop.

Just general warm Thank you!

A great job! Thanks again!

Thanx for all!

No; thanks again!

Many thanks to the organizers and all the staff.

Important domains of research for networks were missing: economics of networks and sharing of resources, modelisation of MAC access.

This was my second long stay at Heriot-Watt, and both have been both enjoyable and professionally enriching experiences. The academic staff there have gotten steadily stronger in my field of interest over the last 10 years, and I hope to return for another such event before too many years go by.