

ExtremeCom – To Boldly Go Where No One Has Gone Before

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ABSTRACT

Research on networks for challenged environments has become a major research area recently. There is however a lack of true understanding among networking researchers about what such environments really are like. In this paper we give an introduction to the ExtremeCom series of workshops that were created to overcome this limitation. We will discuss the motivation behind why the workshop series was created, give some summaries of the two workshops that have been held, and discuss the lessons that we have learned from them.

Categories and Subject Descriptors

C.2 [Computer Systems Organization]: COMPUTER-COMMUNICATION NETWORKS

General Terms

Experimentation, Human Factors

Keywords

Challenged networking, Delay/Disruption Tolerant Networking, ICT4D

1. INTRODUCTION AND MOTIVATION

Networking: the final frontier. These are the stories of the workshop ExtremeCom. Its continuing mission: to explore strange new remote areas, to seek out new challenging network installations and new local communities, to boldly go where no one has gone before.

Over the past years, research on networks for challenged environments such as opportunistic communication, delay and disruption tolerant networking, and networking for rural and developing regions have blossomed and become very popular. These environments present very unique characteristics that makes traditional networking solutions infeasible to use, and create many interesting new research challenges to solve (this can be in terms of providing connectivity through data mules to a very remote and totally disconnected region, to ways of better coping with low bandwidth and unreliable power sources, and many other challenges). A problem with this field is however that many researchers that are working on these problems are based in urban regions of well-developed countries and have no first-hand experience with the environments for which they are designing systems, and the challenges that can occur there. This

means that there is an inherent risk of creating purely academic research problems that are interesting for researchers to solve, but that have no real bearing or impact on the real world.

As the research field has grown in popularity, a number of workshops and conferences dedicated to this type of research has been created, and papers on these topics are also present in most mainstream networking conferences now. These conferences and workshops do however present the same problem as outlined above: while the papers in these venues discuss networking for challenged and extreme environments, the conference is usually held at a five-star conference hotel in a major city. Thus, participants discuss research on networking for challenged environments, but once again never is offered an opportunity to experience it in real life.

In order to address some of the problems identified above, The Extreme Workshop on Communication (ExtremeCom) was founded in 2009 to bring together researchers and practitioners in areas related to delay tolerant networks and other networking paradigms for rural and remote areas, in order to gain experience and insight into the challenges that such environments pose for the network and the users. The unique point that differentiates ExtremeCom from other workshops on similar topics is its focus on allowing the participants to gain first-hand experience of the environments for which they design systems and networks. This is done by selecting appropriate locations for the workshop, where a real-life challenged network is deployed in some extreme environment. The program combines a more traditional technical workshop where normal research papers and demos are presented with a multi-day field trip where participants get to experience real life in this region, giving them a better understanding of the challenges that they need to address when designing systems for this environment. A vital part of this is also to involve the local population and allow workshop participants to interact with them, which also helps them understand how people in other cultures are likely to use technology and what the intended end-users want to get out of a networking system.

The workshop location should be appropriately selected. While we want the workshop to be in an “extreme” environment that gives the participants a unique experience, this is not a goal in itself and it is therefore not of interest to just select any exotic location. The location should have limited communication infrastructure, or exhibit other types of communication challenges. Preferably, there should also be a



Figure 1: Left: Anders Lindgren and Pan Hui, General co-chairs for ExtremeCom 2009 and 2010. Top right: Karin Kouljok and Susanne Spiik from Tan-nak AB, local arrangements for ExtremeCom 2009. Bottom right: Arti Sinha and Michael Ginguld from AirJaldi.org, local arrangements for ExtremeCom 2010.

local organization (company, NGO, or university) working on building or planning real networks with real potential users in the area. Whenever possible, the workshop should assist in developing the communication in the area it visits, either through physical expansion of network infrastructure, through deployment of new applications, or simply through knowledge transfer and inspiration to the local community. Interaction between international participants and the local community should also be encouraged, and economical means should be sought to ensure that people from the local community have the possibility to attend the workshop.

In this paper, we (the general co-chairs for ExtremeCom 2009 and 2010) intend to give the background and motivation behind the ExtremeCom series of workshops, and to give a short overview of the two installments that have been held so far. We also intend to give some insight into lessons learned from the experience of organizing these workshops and hope to spark an interest in the reader for getting an understanding through hands-on experience of whatever environment that they may be designing systems for.

2. EXTREMECOM 2009 – THE MIDNIGHT SUN EXPEDITION

ExtremeCom 2009 was arranged in the Padjelanta national park in Lapponia, Sweden. The Padjelanta national park in Lapponia, Sweden is the home of the Saami population of semi-nomadic reindeer herders. The Saamis try to preserve the traditional ways of life as reindeer herders, partially relocating over the year as the reindeer moves. It is however hard to make a sustainable living solely from the reindeer herding business, so most Saamis also live a modern life in nearby cities or villages. Thus, they have a need to communicate with the outside world even when they are in the mountains with the reindeer in order to maintain business relations, family contacts, educational resources for the children, and for many other reasons as well. Due to the lack of infrastructure in this area (and the fact that it is a UNESCO World Heritage site, so large antenna towers or other invasive infrastructure cannot be installed), a DTN-based networking system for the area has been developed by



Figure 2: Top: Harvesting power with solar panels during one of the stops during ExtremeCom 2009. Bottom: Resting from the hiking.

the SNC and N4C² projects. During the summer of 2009, the fourth summer of deployment and testing for this system took place, which made this a unique opportunity to experience a real deployment of a DTN system.

ExtremeCom 2009 was organized together with people from the local Saami community and the N4C project in order to leverage all the local knowledge that they possess and to give participants the best opportunity to truly understand the circumstances under which people live in this region.

The workshop started with a 3.5 day hike into the mountain regions where the N4C DTN system was deployed. During this time, participants were given the opportunity to see Saami settlements and meet the local population and users of the system. Several people from the local Saami village also participated during the entire workshop, and participants had many interesting discussions with them. After the hike, a 1.5 day technical workshop was held in a more traditional setting, with paper and demo presentations.

2.1 Technical Program

The workshop was very successful and had great international participation (19 different nationalities). All participants were happy with the workshop and considered it to be a very good experience. During the technical part of the workshop, technical papers were mixed with presentations of demos and three invited keynote speakers. Elwyn Davies gave a keynote talk about the importance of time in DTN systems, while Fritz-Åke Kuoljok and Asta Mitkijá Balto gave a Saami perspective on the topics of the workshop. Fritz-Åke talked about communication in a regions like this from the perspective of an indigenous people and

²<http://www.n4c.eu/>

Table 1: Workshop numbers

	ExtremeCom 2009	ExtremeCom 2010
Workshop dates:	August 8-14	September 4-10
Hike/field trip:	August 8-12	September 5-8
Technical workshop:	August 12-14	September 8-10
Participants for the hike:	20	23
Participants for technical workshop:	30	27
Technical program content:		
Technical papers:	12	9
Demos:	5	2 ¹
Invited keynote speakers:	3	2
Panel:	-	1

Asta talked about traditional Saami knowledge and cultural understanding and how that impacts the population in modern times. In addition to the talks during the workshop sessions, a talk accompanied by a photo slideshow was given by one of the local reindeer herders during the workshop dinner, which showed the life of the Saami and the yearly cycle that they go through with their reindeer.

2.2 Lessons Learned

What do the users really want? – As the N4C system deployed in this regions provides connectivity through a delay tolerant network using the Bundle Protocol (BP), there is a need for application level gateways in order to use most legacy applications. The system provides such gateways for email, chat, and limited web access. In talking to the local about what kind of applications from the outside world they expect to be able to access, some of the most desirable applications are podcast, news report, and emails – all applications that lend themselves fairly well to a delay tolerant system. Many adults do however have a wish to be able to do banking over the network and the youth would like to access social network services such as Facebook. These types of applications are harder to provide access to in a delay tolerant manner without explicit collaboration with the service provider. The possibility to virtualize parts of the services and run them locally could be a potential solution to some of these problems.

Power is king – Power is very scarce in remote mountain areas and thus it is important to save power whenever possible and also to harvest it from all possible sources. During the workshop, we noted that whenever we stopped for some rest, the second most popular activity for many participants was doing power harvesting. Immediately when we stopped for a break, people would take out their solar panel to charge their mobile phones (even when there was no coverage). Some of them even kept the charges on top of their backpacks to charge their devices while hiking. We could also see the operation of hand crank charging devices, water turbine charger, and small (stationary) wind power collectors.

3. EXTREMECOM 2010 – THE HIMALAYAN EXPEDITION

ExtremeCom 2010 had the theme *The Himalayan Expedition* and was organized in and around Dharamsala in the Indian Himalayan region of Himachal Pradesh. Dharamsala is located in the Himalayan foothills and is the starting point



Figure 3: All participants at ExtremeCom 2009.



Figure 4: Views over lakes during ExtremeCom 2009.



Figure 5: Participants assembling one of the AirJaldi network installations at ExtremeCom 2010.

to a number of trekking trails, going through beautiful, but challenging, nature into remote areas where no traditional infrastructure is available. Dharamsala provides a dynamic environment where locals mix with tourists that visit because of the great trekking opportunities or because of the Dalai Lama. The presence of the Dalai Lama and the exiled Tibetan government in this area also means that there is a large Tibetan community here.

Due to the lack of infrastructure in this area, The Dharamsala Wireless-Mesh Community Network came to life in February 2005, following the deregulation of WiFi for outdoor use in India by the AirJaldi³ social enterprise. By the end of February 2005, the mesh had already connected 8 campuses. Work on extending this network with more nodes and new long-range links has been ongoing ever since the start and there are now over 2,000 computers connected to the AirJaldi network. During the fall of 2010, AirJaldi is still planning to extend the network coverage further to serve more local communities, which gave workshop participants a great opportunity to be involved in a real non-profit network deployment.

The workshop started with a four-day trekking field trip into the mountain regions surrounding Dharamsala, where there are many Tibetan and Gaddi settlements. Participants were given the opportunity to choose between two treks (one “easy” and one “challenging”, with the two groups rejoining each other at the last evening spent in the mountains) to hike along the trails in the mountains, meet some of the local population and experience the nature that is breathtakingly beautiful, but also provides challenges as it makes it hard to build reliable infrastructure. Not did it give a better idea of both the technical and user requirements of systems built for this region, but it also gave many opportunities for informal research discussions between the participants. During the treks, participants had the opportunity to work with AirJaldi staff to mount and set up additional networking equipment (a relay and two different access nodes (one permanent and one temporary)) to extend their network to a larger area.

There were 23 participants (plus 2 guides, 2 medical doc-

³<http://www.airjaldi.com/>



Figure 6: ExtremeCom 2010 participants.

tors, several people working with logistics such as building our camps and providing food, and several mules to carry equipment for us) that joined for the hike, and 27 people that took part in the technical workshop (plus some locals sitting in on some sessions). The local arrangements were done by the AirJaldi.org organisation and they did an excellent job with everything, from food, workshop pack with some local souvenirs, hike arrangements, travel arrangements, and anything else that anyone needed help with on the fly.

3.1 Technical program

After the end of the field trip, two days of paper presentations, demos, keynotes, and a panel were held at the House of Peace in the Tibetan Children’s Village (a boarding school for Tibetan children in Dharamsala). Once again, the ExtremeCom workshop was very successful, with lots of good technical discussions. Participants started discussing technical issues during the hiking part of the workshop, both regarding their own research and related to practical issues that came up during the hike, and this created a very open and informal discussion atmosphere. This atmosphere continued into the technical part of the workshop, which created some very good discussions. Given the experiences from the hike, people felt comfortable discussing openly with each other, and could also related to events that occurred during the hike in their discussions.

There was a very good mix of participants at the workshop, including university researchers working on disruption tolerant networking (DTN), people sceptical to the usefulness of DTNs, practitioners building real life long-range



Figure 7: Indrahar pass – the highest point of the ExtremeCom 2010 hike.

WiFi networks, people with mesh network deployment experience, etc. This also spurred many interesting (and sometimes heated) discussions about slightly different topics, and also different approaches to solving similar problems. This mix of people with different view on the topics being discussed was highly valuable in order to provide a “reality check” for everybody to think once more about their own research and consider whether or not it has potential for real impact.

In addition to paper and demo presentations, the technical program contained a panel on the topic “*DTNs and legacy networks working together for ICT4D - technological, societal, and business challenges*” and two interesting keynotes. Prof. S. Keshav from University of Waterloo gave a keynote on “*The challenge of challenged networks*”, in which he among other things talked about the iterative process that is often required when designing a real-life system (if you are going to build something that works, you will probably have to throw away what you have done and start over based on your experiences a couple of times). Michael Ginguld, the CEO of AirJaldi.org, also gave a keynote and spoke about the work that they have been doing, building a network in the Dharamsala region and all the challenges that they have had to face.

3.2 Social Impact

One of the main motivations in starting the ExtremeCom series of workshops was not only to give researchers a better understanding of the technical challenges present in extreme environments, but also to offer an opportunity for interaction with the local population in a way that is beneficial to both parties. During ExtremeCom 2010, participants took part in the installation (together with AirJaldi staff) of three new network sites for the AirJaldi network during the hike. One of these installations was temporary in order to provide connectivity at one of the camps during the hike (but this is a common camp site, so this was also a test to see if it would be viable to install a permanent node there later). The other installations was an access node in a school in a remote village, and a relay at an elevated point, connecting this school to the central AirJaldi campus in Dharamsala.

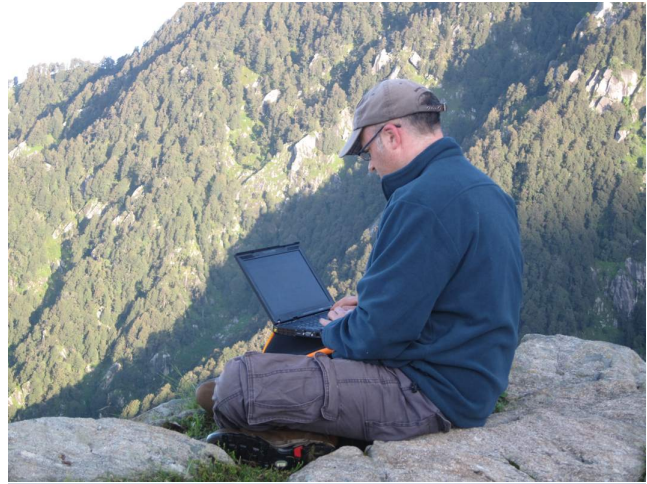


Figure 8: Trying to access WiFi network from Dharamsala while at Triund in the mountains.

The village of this school had no prior Internet connectivity, but now the school is connected, which also makes the additional cost of connecting other parts of the village smaller. As a way of giving back to the local community, these installations connecting the school was funded by part of the workshop registration fee.

3.3 Lessons Learned

Under the right conditions, regular off the shelf equipment can provide surprisingly good results. The AirJaldi network uses long-range WiFi links to connect different sites, usually with directional antennas. Some of our participants did however find out that as long as they found a good spot with a line of sight to the main campus of AirJaldi or some other relay station, they could often manage to get a usable WiFi signal just using their regular laptop with standard hardware. Therefore, a common question became “**Where is David?**”, referring to one of the participants, and he could often be found sitting on a cliff with his laptop facing the direction of the village, several kilometers away, as shown in Figure 8.

In discussions with AirJaldi staff and locals, it also became evident that when building a system like this, it is vital that you have cheap, but still reliable, equipment. Some research

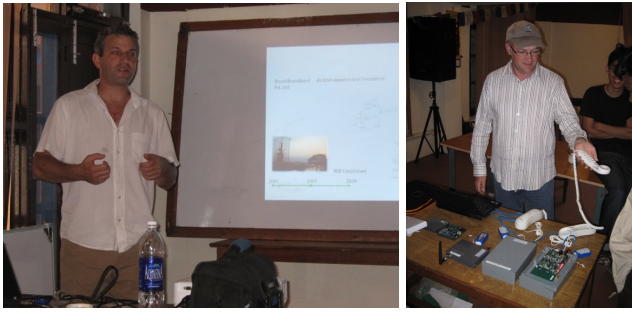


Figure 9: Left: Michael Ginguld giving his keynote at ExtremeCom 2010. Right: David Rowe giving a demo of the “Mesh Potato”.

projects have suggested using rather specialized and costly hardware for systems like this, but in this system all of the equipment was very cheap and easy to locate for purchase.

In one of the demos, David Rowe, from Village Telco, demonstrated his Mesh Potato devices for setting up a mesh network for telephony in developing regions (shown in Figure 9). One interesting observation that he had made when working on real deployments of this system was that local communication might be more interesting than global communication. When end-users at first were told about the possibility to make cheap long-distance calls with the system they were initially trying to deploy, the interest was rather low, as people had most of their contacts in a geographically small region and simply did not have any long-distance contacts to call. The users were however on the other hand very interested in being able to use the system to call someone in the other side of the village or on the other side of the valley, locations that are easily reachable with a local mesh network. This experience shows us that it is important to not only consider the physical challenges that are present in a region, but also to understand the social fabric and behavior of the intended end users.

3.4 Grants

In order to make it possible for more people to attend the workshop, thanks to generous corporate sponsorship, we were able to offer 3 participation grants to students, which payed for their registration fee. To also facilitate participation from researchers based in India (where the economic situation is very different from in Europe and US), the registration fee for Indian based participants was greatly reduced.

4. CONCLUSIONS

What started out as a somewhat crazy idea in discussions between us and some other people has now turned into two successful workshops. Organizing a workshop like this requires a lot more work than for a traditional workshop, but it has still been extremely rewarding to organize these workshops.

It has helped both ourselves and the other participants to gain a much better understanding about the conditions in the areas in which the workshops have been held. The contacts and friendships that we have made with the local communities there are invaluable, and we will continue to keep this contacts, hopefully also being able to leverage them in future research.

The informal atmosphere and the workshop format where so much time is spent together in nature, hiking and talking, has also helped to build very good relations to the other researchers (and among themselves) that have taken part in the workshops. With this format, it is possible to build much stronger contacts than in traditional conferences, and such contact networks are also likely to have a positive effect in terms of future research collaboration.

Finally, we can conclude that while we as general chairs have had a good idea of what we want to achieve with the workshops, in order to organize a workshop like this, it is absolutely vital to have good and dedicated people to do the local arrangements. As the conditions and the social protocol in the areas where these workshops have been held often are unknown to us or different from what we are used to, someone with a good knowledge of the local region and local customs and people is necessary. For both installments of the workshop, we have been fortunate to have excellent people to help us with local arrangements and they have gone above and beyond what we expected from them.

In searching for potential locations for future ExtremeCom workshops, it is thus important to find a location which is not only exotic and has an extreme nature, but that also has real communication challenges, and some local group who is working with this and is willing to assist with local arrangements. The intention of the workshop is that it should not only be a great place for international researchers in challenged networks to meet and interact, but that it should also have potential impact for the local community. If the reader has suggestions for future locations of ExtremeCom and local groups that would be willing to help with the local arrangements, please feel free to contact us.

Acknowledgments

We would like to give our greatest thanks to the local organizers of both editions of the workshop. In 2009, Karin Kuoljok and Susanne Spiik at Tannak AB were responsible for all the local arrangements in Lapponia, and in 2010, Michael Ginguld and Arti Sinha from airJaldi.org were responsible for the local arrangements in and around Dharamsala. The local organizers for both years did an amazing job at their tasks and provided us with better service than we could have ever imagine. It would have been completely impossible for us to organize these workshops without your help, so you have our deepest gratitude.

We would finally also like to thank all the participants for attending the workshops and making them into the success that they were.

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