



Networking for Communications Challenged Communities:
Architecture, Test Beds and Innovative Alliances
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ABSTRACT

The Deliverable 2.4 is divided in two separate reports. The Deliverable 2.4.1 reports internal organization such as number of women and men involved and ethical issues. The purpose of this report, Deliverable 2.4.2 is to direct the attention to current and strategically relevant topics with respect to gender, ethnicity and technical development. Two main themes are furthered;

- The issue of women, remote communities and the socio-economic aspects of the project process, and;
- The relation of the technical practices developed in the project, to the current discourse on knowledge development in science and technology

The N4C project has a background in local and national activities for furthering indigenous economies in remote areas of Scandinavia. Knowledge society goals such as technology transfer which were first formulated for national and regional levels have been realized in the FP7 European consortium. Several women have been engaged in the project process in leading and central positions. It is not obvious that this is a step forwards in terms of gender equality as these women were already before the project included in high status male dominated professions and networks. In the competitive global economy it is important however, to be able to defend also a status already achieved.

The research process has given rich opportunities to connect concerns and ideals within gender studies to the European Union initiative FIRE (Future Internet Research and Experimentation). Questions about methodology and objects have been furthered within FIRE and FIA (Future Internet Assembly) activities during the N4C project time. Current trends in philosophy of science and science and technology studies have been mirrored in the N4C process, for instance through paying attention to the experiences of nature as co-actor in the remote test beds which have been developed during the project time.

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Experimentation for a Future with the Internet

Introduction

The internet is a profoundly effective innovation that has grown to incredible success. In most any aspect of the economy, innovations building on the internet are encouraged through policies and associated financial support measures (project funding and other); the business and industry, the energy sector, communications, production, administration, education, media, finance, health care and other service. Advanced research and development in the information and communication technologies (ICT) is found necessary for securing competitiveness. Concurrently, there is increasing concern that without further actions, the internet's material and organizational structures might not much longer respond to the strategic importance and tremendous volume of use and users it has gained. Measures are taken at national, regional and global levels and by industry actors, to meet this challenge to economic growth and social stability.¹ Actions within the European Union include the institution of the Future Paradigms and Experimental Facilities objective in the 7th Framework ICT programme (FP7 ICT). This implies funding of an array of pan-European research and development projects, aligned to the Future Internet Research and Experimentation initiative (FIRE) and the Future Internet Assembly (FIA). In this setting, a "STREP" project named *Networking for Communications Challenged Communities: Architecture, test beds and innovative alliances* has been running since May 2008 and will end in April 2011. The project acronym is N4C.

The designation STREP in FP7 indicates the size and scope of a project – in FP7 terms a more limited project. In our case this has meant a total budget of slightly over five million euro, being twelve partners in eight countries and having a three year scope for the effort. As indicated by its name, N4C is an arena where social concerns are expressed together with technical goals, or as put in the work plan abstract: "The target of the N4C project is the deployment and testing of ubiquitous and pervasive networking for communications challenged communities in a manner consistent with an overall vision for a future Internet that can encompass not just users and applications in well connected regions, but that can also reach out to rural areas." The aim is to make use of an emerging networking paradigm, Delay Tolerant Networking, which is designed for use where the TCP/IP is not applicable. In N4C this technology is furthered and combined with air-interface technologies, and applications are developed for generic as well as specific business related purposes relevant for remote areas.²

¹ The term internet is here used broadly for all layers of interacting physical, software and organizational structures and dynamics. Organization and global strategies are debated in the Internet Governance Forum and other instances. In technical terms, updates and changes are carried out continuously. One of the most known actions is the IPv4 to IPv6 transition. For recent concerned debates among technologists, see for instance the Swedish debate on infra structure strategy initiated by Löwinder et al (2011).

² The different Deliverables to the European Commission describe this work. They are available through www.n4c.eu or ETS, Luleå University of Technology, S-97187 Luleå, Sweden www.ltu.se. A few Deliverables contain information not open to the public and cannot be distributed, but these are a minority.

The N4C process is part of a long term effort. From ideas about making genuinely novel technology to presenting real alternatives, there is much work to be done. In N4C, the focus has been on realizing the idea and making it available as a technically realistic alternative. Yet, the mainly technically oriented work plan, included work with business models and, there is also one task devoted to seminars on gender and cultural issues in technology development. This task has been aimed at keeping the opportunities and dilemmas raised by N4C, in contact with the front line of experiences and discourses from science and technology studies, and the areas of gender equality, gender mainstreaming and studies of intersectionality (where gender, ethnicity, class and other factors are considered together). This seminar is directly connected to the project management. The coordination of N4C has been lead by the Division of Gender and Innovation in the Department of Human Work Sciences, Luleå University of Technology (LTU). The seminar and the ongoing discussions have followed several different threads. The purpose of this report, is to be a summary which directs the attention to strategically relevant topics. To achieve this two main themes are furthered;

- The issue of women, remote communities and the socio-economic aspects of the project process, and;
- The relation of the technical practices developed in the project, to the current discourse on knowledge development in science and technology

Thus, this report takes a discourse oriented stance. In parts it draws on material already published by Udén (2009, 2010, forthcoming) and Lindberg & Udén (2010). In parallel to this report, Wamala (2011) has prepared a report regarding the internal organization which is based on the ethical issues table which is part of the FP7 Final report template. Wamala's report is built on ethnographical interviews and several persons in N4C have been



interviewed. The topics include such as number of women and men employed in the project, which will thus not be reported here. End user input is addressed in an assessment of the Living Labs aspects of N4C by the Division of Social Informatics at Luleå University of Technology.³ The relevance of socio-economic aspects is obviously a main theme in relation to the *future of the internet* as it is in relation to *the future internet*. Within the FIRE initiative, emerging methodologies such as network experimentation and the building of tests beds are considered part of what determines the parameters the future internet. In N4C, this interest is combined with a socio-economic agenda for rural areas and communications challenged communities.

Figure 1: Leading the Spanish N4C efforts, from left Javier Guillen from Albentia, with professors Santiago Zazo Bello and Javier Jiménez Leube from Universidad Politécnica de Madrid. Photo: Darko Popovicz

All twelve project partners and staff have their own unique background that leads to an interest and ability to contribute to this evolution, combining front line technical development

³ This report is made for presentation together with the N4C Final report to the European Commission in May 2011 and made publicly available through www.n4c.eu and the project coordinator.

with socio-economic goals. One example of the experiences and competence brought to the project by partners is Albentia. Albentia Systems S.A. is a Spanish “small-to-medium” sized company developing and selling WiMAX equipment and solutions. Their experience portfolio includes setting up networks in remote villages in Spain. In N4C, their role and interest has been to further develop a technical edge in air-interface technologies, in particular by extending the spatial range of WiMAX technology, thus allowing them to continue offering globally competitive products.

The N4C Consortium included three universities; Luleå University of Technology (LTU, the Project Coordinator), Universidad Politécnica de Madrid (UPM), and Trinity College Dublin (TCD); one major industry actor (Intel, Ireland); and five small to medium sized enterprises, so called SMEs. These were: Spanish Albentia, Slovenian MEIS storitve za okolje d.o.o, the Swedish companies Tannak AB and PLAB, and Folly Consulting in the United Kingdom. The consortium was completed by three research and development institutes, all of which are in the SME size range: Polish ITTI, Portuguese Instituto Pedro Nunes (IPN) and the Norwegian partner Northern Research Institute Tromsø AS.

The N4C project⁴

The Networking for Communications Challenged Communities (N4C) project was funded from 2008 to 2011 under the EC's Framework Programme 7 initiative. The project was set to look at ways to extend Internet access to remote regions that do not have reliable and affordable network access today. Many of these regions are sparsely populated, spread over very large areas and with a relatively poor economic base making it unlikely that conventional access technologies can be economically deployed at any time in the near future. With a total budget of about 5 million euro we have aimed to make a positive difference for these areas. Combined with the large distances involved, this means that the “always on” paradigm of constant connectivity and essentially synchronous access enjoyed in many urban areas today will not be available to these areas.

However, existing movements of people and transport within these areas provide opportunities to carry data, admittedly more slowly and without constant connectivity. The N4C idea has been to use existing and novel enabling technologies to spread pervasive computing into communications challenged communities by creating an opportunistic networking architecture to exploit these communication opportunities. A key role was played by the emerging Delay and Disruption Tolerant Networking (DTN) technology. DTN technology addresses a wide range of technical problems, from interplanetary applications to terrestrial applications where it is not possible to reduce latency to the values needed for today's Internet. DTN can support asynchronous web surfing, email, file transfer etc. DTN uses a store and forward paradigm that avoids the need for constant connectivity and can use different transport protocols in different parts of the network which is key to exploiting whatever communication opportunities are available. N4C worked to extend DTN on such a way that it can integrate seamlessly with today's Internet and support applications that provide capabilities as closely matched as possible to the familiar applications available in the always-on paradigm. N4C also investigated how wireless networking technology can be harnessed

⁴ This section up to the heading “The test bed as ...” is with minor changes and additions developed from the N4C wiki presentation by Elwyn Davies, Folly Consulting, UK. (ref) and a set of figures produced by Mr. Davies for various presentation purposes. Elwyn Davies was work package leader for WP2 Architecture, where the gender and culture seminar was placed.

for use in environmentally sensitive areas with terrain that cannot utilise line-of-sight connections and where power, even solar power, is at a premium, especially in winter.

N4C was thus designed to provide technology that can support the diverse cultures and ways of life that currently exist in communications challenged areas in Europe and around the globe. The goal was to provide the networking tools that will allow the economies of these areas to tap into the growth and wealth being stimulated by the tools of the Internet without forcing them to conform to the cultural and economic models usually associated with the existing Internet. The ambition was to help to slow, and maybe reverse, the depopulation of rural areas that is continuing at present. A core activity was a set of extensive field trials based in two communications challenged areas; the Kočevje region in Slovenia and Swedish Lapland. The idea was to involve prospective users both in the specification of the trial applications to be developed, and in the set of extensive and one or two sustainable test beds. The concept of extensive and ongoing test beds is central in the FP7 FIRE initiative, and the intentions were that at least one of the two original N4C test beds would be maintained after the end of the project in 2011. (Over the project time several other locations have been used for single or few tests, such as in Spain, Norway and Ireland.)

The test bed as template for the technical design

Two test beds have been built within the N4C project and used for all six test cycles (three summer and three winter cycles in the three year project, see figure 4). Their location was planned already previous to the project start:

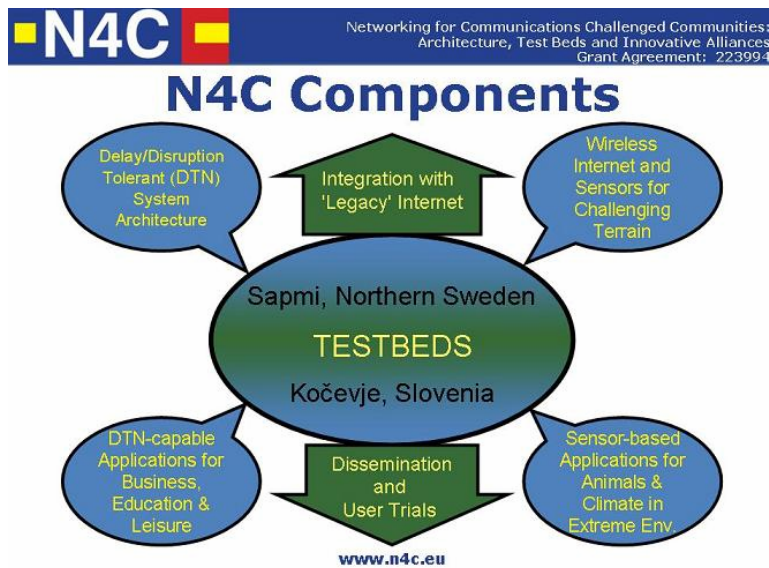
- The Kočevje region in Slovenia
- Swedish Lapland, the Jokkmokk-Gällivare area

Both areas are mountainous, rich with forests and wild life and sparsely populated. They represent quite different European climates though, and their political history differs. While Swedish Lapland is the home of an indigenous Sámi population combined with forestry and hydro power production, Kočevje is a formerly closed defence zone of former Yugoslavia, which was first depopulated in connection to the World War Two. The sites are described in N4C Deliverable 8.3 (Udén 2009). Figure 2 shows examples of typical landscape views in the two test areas.



Figure 2 Lapland and Kočevje, landscapes of the test beds. Photos: Ewa Gunnarsson, Marija Zlata Boznar

The choice of test bed sites in N4C has not come after the technical design but is intrinsic to the technology strategy and concrete progress. The manner in which DTN is utilized for communications challenged communities in N4C was originally developed for the Lapland location and its semi nomadic Sámi population (reindeer herders). The connection to Slovenia was established during tests in Lapland previous to N4C. The Slovenian partner MEIS was informally involved through a staff member being advisor for the DTN implementation used in the first nomadic DTN tests August 2006⁵. The choices of applications developed in N4C are directly generated from these circumstances, such as the applications reindeer tracking for Sámi herders and meteorology observations systems. Meteorology and pollution observations are a commercial service of MEIS. Both being situated in remote and sparsely populated



areas, the Slovenian test bed provided an extension to the Lapland test bed, but with different climate conditions and socio-economic contexts, something which extended the N4C scope as compared to earlier efforts.

Figure 3. Real life tests in communications challenged areas were central in N4C. The figure is developed for N4C by Elwyn Davies, Folly Consulting.

Figure 3 shows the conceptual role of the test beds in the project design. Three of the project partners are based in or adjacent to these areas (Luleå University of Technology and Tannak in Sweden and MEIS in Slovenia) and six of the other partners have worked in these areas during the project time. Figure 4 depicts the project process related to the test cycles of summer and winter tests.

Between the test occasions, technical and conceptual development prepared for next sequence. During the process preliminary results were reported to EC once a year, and results and experiences were related to FIRE and FIA activities via attendance in meetings.

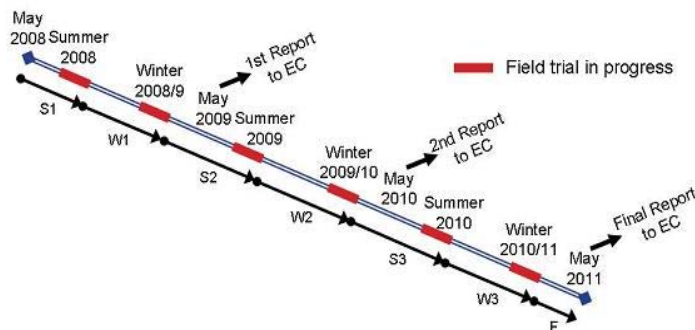


Figure 4. Sequence of test occasions. Summer tests (Sx) and winter tests (Wx). The figure is developed for N4C by Elwyn Davies

⁵ This was an implementation of the PRoPHET dynamic routing Algorithm and protocol.

The outline of analysis

The analysis of the N4C process provided in this report is based on a gender and technology studies tradition, which first developed in the 1980's and 1990's at among other places Luleå University of Technology. Gender studies can be described as "research from a gender perspective". This is easily misunderstood as "research about gender". Gender studies have a connection to women's studies, where the motive explicitly is to better the situation of women and girls. The genealogies and topical agendas are connected. In the LTU tradition this connection has been strong. Furthermore, gender and technology studies are directly linked to feminist science and technology studies, where important theoretical contributions have been developed. However, men's identities and different experiences are gradually garnering more attention, and intersectionality is a perspective reminding how race, class, sexual orientation, age and other designations of identity and experience intersect with gender. Last but not least, the gender studies tradition is profoundly interdisciplinary. This colors its methodologies, styles and strategies of research, curricula, action and presentation. From the 1970's and the early years of women's studies (foregoing gender studies as they were), the very terms and concepts of research and science as such, have been at the centre of attention. With this type of work, an exploratory or even experimental aspect is induced. Perhaps the most influential scholar with regards to the relation of gender studies to science and technology is Donna Haraway (2004). In the 1990's she made the *cyborg* concept a point of departure. Cyborg is short for cybernetic organism. An example can be when a human uses a computer or vehicle and thus increases her capacities. The contribution of Haraway's cyborg concept is the way it



allows replacement or even displacement of what in many people's eyes, are alienating sets of objectivity and subjectivity in accounts of science and technology, for instance the connection between women and technology.

Figure 5. Elisabeth Nejne Vannar on her snow mobile in the high mountains of the Sirges territory. Documentation from the *Woman in the Sámi village* project.

Responsibility begins in our dreams

Christina Mörtberg, originally trained as a mathematician, is one of the first generation programmers in Swedish industry. She also is one of the pioneers to have built gender and technology studies at LTU and in Scandinavia. In the anthology *How do we make a difference?*, she argued that *responsibility is born in our dreams*. In this manner feminism, Mörtberg wrote, "is a resource that can be used to formulate alternative goals, visions and dreams about our existence". (Mörtberg 2003, p. 57) The quest would be how gender studies can grow into resources in the creation of alternative technosciences. Equal opportunities and coming to an end with explicit and implicit exclusion of women from science and from technical professions are obvious goals. Yet, as Mörtberg states, from a feminist perspective, "there is no automatic relation between gender balance and change". (ibid p. 60)

Consequently, programmes that propose feminist interventions should “challenge and renegotiate our understandings of science, of the relation between science and society, between quality and objectivity” (Egeland in Mörtberg 2003 p.60). Feminism is a political agenda, which in the academy is closely connected to gender studies. Currently, feminist intervention increasingly occurs as a theme in feminist and gender studies. In 2011 *Feminist Interventions in Theories and Practices* is the main themes of the 6th European Conference on Gender and ICT held in Umeå, Sweden: “Feminist Interventions in Theories and Practices seeking contributions to advance our understanding of how gender and feminist research can contribute to sustainable futures of ICT-based practices” (GICT 2011). *Feminist Transformations* is the theme of the National Women’s Studies Association NWSA annual congress in Atlanta, U.S.A. The conference home page says: “The conference explores a central question: how are we transforming thinking about social change, social movements, knowledge production and agency and how are these shifts transforming our thinking?” (NWSA 2011) We are not currently speaking of ascertained programs though, which are ready to be rolled out. This sense is strong in feminist and gender studies of science and technology but not less pressing in other areas. Below, the sense is caught by philosopher Rosi Braidotti where she identifies the ethical questions for a sustainable future:

“On the analytic front: what means do social and cultural critics have at their disposal in order to make sense of and account for the structural paradoxes of a historical era? On the more normative front, the question is: what are our hopes of finding adequate ways of expressing empowering alternatives and of having them socially enacted? How does this consumerist and socially enhanced emphasis on the *new* fit in with the rejection of in-depth changes? How do they join forces in reiterating old and established viewpoints? What are our hopes of finding adequate ways of handling them?” (Braidotti 2006, p. 4)

One of the distinct strategies that reoccur in feminist and gender studies strategies is the challenge of boundaries. Feminist and gender studies maintain that the reason for women and feminists to be especially suspicious about the nature/culture dualism which permeates the western culture of science and technology is the role women have been assigned in this relation. “The emancipatory project of modernity entails a view of ‘the knowing subject’ /.../ which excludes several ‘boundary markers’ also known as ‘constitutive others’. These are: the sexualized other, also known as women, the ethnic or racialized others and the natural environment.” (Braidotti 2006, p. 32) A focal point in feminist critique of science and engineering during the 1980’s and 1990’s, as well as a point of departure for experimental construction of alternative ways for science and engineering, was that “the making of women and men has affected the making of science” (Keller 1985, p. 4)”. Writes Keller, referring in particular but not exclusively to Francis Bacon: “For the founding fathers of modern science, the reliance on the language of gender was explicit: They sought a philosophy that deserved to be called ‘masculine’, that could be distinguished from its ineffective predecessors by its ‘virile’ power, and its capacity to bind Nature to man’s service and make her his slave.” (Keller 1985, p. 7) Women’s supposed closeness to nature, has come with an assumption that women are unsuitable to master nature, for example to be scientists and engineers. A logic that runs in parallel to this perspective is putting ‘women’ forth as bringers of alternative, ‘softer’ views to almost any aspect of society and not least technology. This Rosseauvian idea has caused trouble as much as opportunities for feminist strivings. Connell (1987) noted how easy it is for women’s movements to give in to this stereotype. After all, it offers arguments for increasing women’s social domains. Connell noted that, from an original emphasis on gender as socially constructed, socio-biological notions were again generated within the

women's movement already during the 1970's. Among these was found: "...the idea that women as nurturers must save the world from male wars and technology" (ibid, p. 67)

The knowledge society and issues of inclusion

N4C is about communications for communities that are presently excluded from genuine ICT access and also about including people from such communities already in the alliances that produce the technical solutions that will provide the connectivity and access. For inclusion of marginal groups and locations in the knowledge society, a crucial question is what the first step would suitably be. Is there a one best practice? One technique to address challenges for knowledge society inclusion is, to take stance against the "success-stories" of economies already thriving. Starting from the examples of such achieved successes, David and Foray found the following characteristics decisive for a knowledge economy (David & Foray 2002);

1. *The acceleration of knowledge production* with the emergence of knowledge-based communities, i.e. "networks of individuals striving, first and foremost, to produce and circulate new knowledge".
2. *The rise of intangible capital at macroeconomic level*, basically the human capital, meaning that the decisive ability is "to create new knowledge and ideas and incorporate them in equipment and people".
3. *Growing speed of innovation* including both formal and layman environments in the efforts, while innovation comes close to being the sole means to survive and prosper in highly competitive and globalized economies.
4. *The revolution in instruments of knowledge* where technologies for knowledge and information production and dissemination, among other capacities offer remote access, enormous quantities of information and, enhancement of creative interaction.

According to David and Foray the distinction frequently drawn between information society "haves" and "have-nots" is overly simplified. The issue is not about a "digital divide" that can and should be overcome by providing universal access:

"[T]he more difficult and in a sense more fundamental problems are not simply those of providing greater technological access to information streams. Rather, they involve furnishing people with the cognitive capacities and intellectual frameworks than enable humans to interpret, select and utilise information in ways that augment their capabilities to control and enhance the material circumstances and qualities of their existence." (David & Foray 2002, p. 10)

Besides comparing with already achieved successes, the issue can be addressed via collecting experience from societies and nations that are engaged in processes for inclusion. Mongolia's path towards the knowledge society was investigated by Johnson et al (2005). This study is of interest for N4C as nomadism and remote locations are shared factors of Mongolia, the Swedish test site and the SNC architecture's target population. Building also on original studies in the African continent, the analysis of Johnson et al emphasises the "four pillars of the knowledge society" (Johnson et al 2005, p. 217);

1. *ICT and connectivity*: The backbone of a knowledge society is a well developed, well-maintained and affordable information infrastructure that allows access to, and manipulation of the digital economy;

2. *Usable content*: The information available should be affordable, available, timely, relevant, readily assimilated, and in a language users can understand.
3. *Infrastructure and deliverability*: The new digital or dematerialized economy is underpinned by a materialized and top-heavy infrastructure comprised of airports, railways, roads, trucks, warehouses and physical addresses of people. A dematerialized economy without a physical infrastructure is of little use and can even create unmet expectations.
4. *Human intellectual capability*: The development of human capital facilitates development and economic growth. A knowledge society needs people who can create as well as utilize knowledge to ensure not only sustainability, but also prosperity.

None of the above authors explicitly address gender or any aspect of social identity. This is a problem. Gender is a major factor for social organization in nations affluent as well as marginal in terms of knowledge society traits. There is concern for women's conditions, not obviously proceeding towards the better. In a report published by Orbicom, the International Network of UNESCO Chairs in Communication, Huyer and Hafkin summarize the situation:

“Worldwide the capacity of women to engage in the knowledge society is grossly under-developed and under-utilized. Women are at risk of becoming increasingly marginalized in the knowledge society, where much more than access to and use of information technology is at stake. In the knowledge society women need access not only to new technologies but also to education, entrepreneurship and employment opportunities, and the ability to participate fully in knowledge-based activities.” (Huyer & Hafkin 2007, p. 2)

Sweden, gained a high ranking in Richard Florida's creative class index (Florida 2002). This indicates that Sweden is one of the very top nations in terms of the share of the population working in knowledge production and processing. In this advanced setting the issues suggested by Huyer and Hafkin emerge in such as the distribution of public funding to innovations development and actions for creating competitive knowledge economies in the country's different regions. Women make a small share of the recipients of public funding both as employees in knowledge organizations and as business owners. Likewise the branches dominated by women are minor recipients even where they represent sectors that are expected to be important for competitiveness in the knowledge society. (Lindberg et al 2010, Pettersson 2007) In other socio-economic settings it is noted for instance how in practice development aid in local communities delivers ICT access to men only, with the effect that the comparative power of women in the communities decrease, perhaps from levels that are already alarmingly low. Thus the “aid” puts women at increased risk of ill health and economic exploitation. This is why an organisation such as Bangalore based organization IT for Change makes explicit efforts to make ICT available to women in village programs, through making sure that a PC when handed over to villagers, is put in places which women have access to without social or other risks, and through following this up via continuous contacts and activities that are meaningful to the women. (<http://www.itforchange.net/>) In sum gender theorists, posit that there is no automatically emancipating power in the progress of the Knowledge (or Information) Society. The sense is captured by Indian computer scientist and equal access activist Anita Gurusurthy, founding member of IT for Change:

“New paradigms do reproduce old hegemonies and thus there are undoubtedly many mutations to old hegemonies that can keep feminists busy, agitated and as overworked

today as in our industrial age preoccupations. The IS [Information Society] paradigm does sit over existing structures of power.....” (Gurumurthy 2006, p. 2)

Again, it is important to see the critique in its context – which is the search for and activities to create emancipating opportunities. To the degree that knowledge society inclusion and involvement in frontline technology development are crucial factors for the competitiveness of nations, regions and companies – something which at present is largely taken for granted – it would be strange if specifically women or rural communities could not enjoy the same benefits. Putting up hypotheses saying they essentially cannot, would necessarily include a view on either technology or gender and cultural location, perhaps all, as possessing some sort of magic quality. Thus, from a scientific point of view old hegemonies and old values, are input variables among others, in the negotiations that take place when ICT is developed and implemented and knowledge society processes evolve.

Plurality as ideal¹

A main target from the early gender studies and feminist critique of science has been the practice to search for singular forces and simple explanations to complex problems. This drive is symbolized by the idea about ‘the great unification theory’. “In the realm of theoretical physics”, feminist and theoretical physicist Evelyn Fox Keller argued, “the modern physicist searches for the laws of nature; he seeks communion with the nexus of authority to which material nature is subservient.” (Keller, 1985, p. 30) In *A feeling for the organism: The life and work of Barbara McClintock*, Keller (1984) showed McClintock’s attention to details that



at a first glance would have been possible to overlook as just random deviances, and the advancements of molecular biology that this attitude fostered.

Figure 6. From left: Elwyn Davies coding in candle light 2006, at the test base in Kutjaure East. In centre Anders Lindgren, main author of PROPHET, right Samo Grašič, author of the first PROPHET implementation. Photo: Mattias Ek

In gender studies the conclusion that plurality in subjects as well as interpretation is simultaneously both necessary for sustainable knowledge development and the only route for women’s gaining genuine access to research and development, echoes throughout disciplines and time. In Mörtberg’s account, transdisciplinary meetings such as happens in systems design and, methodologies as participatory design and the Scandinavian tradition of user involvement, are means for sowing small seeds for reformulation of techno-science. The rationale is as follows (Mörtberg 2003):

- In the design situation, problem solving implies that a practice or use situation is translated into a system or product.

¹ The section Plurality as ideal and the following section build in part on articles by Udén (2009, 2010)

- The translation engages several steps of abstraction.
- With reference to Donna Haraway, Mörtberg suggests that the finished product or system thus, can be regarded as a set of *frozen stories*.

In short, Mörtberg finds that, in the concrete technology making, each step that leads to one story or another being materialized in artefacts and systems needs to have the capacity, to account for heterogeneity and situatedness. (Mörtberg 2003) The concepts of language and stories have been found to be effective tools for verbalizing how norms and practices affect supposedly objective research and development processes and their results. In gender studies overall, language and the processes of social construction behind intelligibility are regarded as fundamental for humans, for better as much as for worse. None the less, because of what science and technology is about, attention to language only cannot be the sole component of analysis. This has been long felt in gender and technology studies. Thus, already in the early 1990's Keller highlighted that "Whatever force [language] may have, that force can, after all, only be exerted on language-speaking subjects" (Keller 1992, p. 33). She found the core capacity of science being in its relations with the material world beyond language:

"What distinguishes it [science] from other successful institutions and practices is precisely its disciplined interaction with the material constraints and opportunities supplied by that which, for a lack of a better word, I still call "nature"." (ibid, p. 5)

At the time of writing Keller had to express caution when using the word *nature*. This was during the heydays of indulgence in social construction of reality, at the same time as the critique was harsh, against how much naturalized repression lay in the nature concept. After many years when the term has been almost programmatically questioned, in gender studies as in the scholarly community at large, the 21st century sees its revival. Gender studies and feminist theory are often regarded as some of the most far going strongholds for a vulgar social constructivism. However, from feminist and gender studies debates it is clear that in the eyes of a fair share of scholars in this area, advancements have suffered more than served from 'post modernism', 'social constructionism' or should we say lack of stable frames for addressing materiality.

An active matter and the human experience

"Language has been granted too much power" (Barad 2003, p. 801). The words are from *Posthumanist performativity: Toward and understanding of how matter comes to matter* physicist and feminist philosopher Karen Barad. The article displays the general dilemma: a need for access to relevant language for fostering relevant research, and a feeling that getting to this is hindered by a dominant intellectual trend. Barad (2003, 2007) names the academic route as being at fault in 'representationalism' referring to the belief that we have access to representations while not to that which they represent, while Norris (1999) speaks of 'the strong programme'. Another commonly used term is 'postmodernism'. Writes Barad: "The belief that nature is mute and immutable and that all prospects for significance and change reside in culture is a re inscription of the nature/culture dualism that feminists have actively contested." (Barad 2003, p. 827) Barad relates to Niels Bohr for her methodology and puts forth the notion that phenomena are the primary epistemological units; "relations without pre-existing relata" (as defined e.g. in Barad 2003, p. 815). Thus her methodology validates *becoming* rather than 'being' or even 'doing'. A main point is the issue, of whom or what are involved in the processes of becoming.

“Crucial to understanding the workings of power is an understanding of the nature of power in the fullness of its materiality. To restrict power’s productivity to the limited domains of the social, for example, or to figure matter as merely an end product rather than an active factor in further materializations is to cheat matter out of the fullness of its capacity.” (Barad 2007, p. 66)

Interaction cannot take place between one active part and one that is dumb. Where Donna Haraway has made us reflect upon the possibility of animals and machines not only having agency but co-construct the agency we possess as humans, Keller has indicated matter and energy as co-agents and Barad’s emphasis on the agency of *all* relata composing phenomena explicitly brings those functions in. This opens up for arenas in technology making and engineering that have largely been unnoticed in gender and technology studies.

The turn in feminist and gender studies, towards counting with nature and with power beyond language, has taken place in correspondence with similar re-orientation overall in academy, society and the arts; “new realisms”. The success of Daniel Kehlmann’s novel *Die Vermessung der Welt* (2005), about Alexander von Humboldt on the one hand, and Carl Friedrich Gauss on the other, is an expression of the wide interest this type of issues currently gain.



Kehlmann lets especially Humboldt as a traveller setting out to take measures of the world, struggle with nature and the physical conditions of the planet. Gauss stays at home but in this novel, he too develops his observations of mathematics in a location of not always so pleasant weather (and the reality of the earth as a curved surface, not flat paper). The broad come-back of material interaction to the common understanding of the world and how we gain knowledge within the world, includes accounting for the human organism as location for knowledge production. The typical concentration of gender studies in this stream is, if compared to for instance Kehlmann’s writing, perhaps more situated in *establishing loyalty with the excluded*, which comes from experiences of women’s exclusion in person from science and technology.



Figures 7 and 8. From the Kočevje region, Slovenia. The village *Dolenja Topla Reber* 1937 and 1992. <http://www.kocevje.si>

The N4C ambitions

The Department of Human Work Sciences at LTU¹ has a tradition since the 1970's, of co-operating with local actors in community and small business, as well as heavy industry in work place and technology development. None the less, from a gender equality and ethnic minority perspective Udén (2000, 2002) found that the technical research and development at LTU to a very small degree was involved in women's work place development and minority group's concerns. Concurrently with the research at the Human Work Sciences, grass root activities developed in the region surrounding Luleå, in relation to a growing concern with gender equality. In the Sirges Sámi Village², the issue was raised in several activities starting from about the 1990's. The project *Woman in the Sámi Village* (KIS) was run by Sirges Sámi Village as an EU Objective 1 funded project 2002-2003. With 400 members, Sirges is the largest Sámi Village on Swedish territory. The main location of Sirges' members is Jokkmokk municipality.



Figure 9. Working as LTU's field test manager in N4C, reindeer herder Fritz-Åke Kuoljok has brought equipment and N4C scientists to remote locations in the Swedish field tests. This picture is from the winter test with Samo Grašič in January 2011.

Executive manager was Susanne Spik, reindeer herder and member of Sirges. The aim of KIS was to develop reindeer herding practices and to lay the foundations for a larger influence from women's part, in the management of the Sámi village. For assistance in mapping and analysing social and technical circumstances in reindeer herding from a gender perspective, LTU was contacted and Maria Udén at the Department of Human Work Sciences developed an associated research project to work with KIS. *New Possibilities for Women in Reindeer Herding* (NMKR) was initiated with funding from Vinnova and EU Objective 1 and was able to follow KIS from the start. The KIS-NMKR interaction built on ethnographic methods including a participation and action research scope such as, counselling, seminars, strategy building and analysis.

SNC – a nomadic network architecture is suggested³

In the spring of 2002 Avri Doria, at the time guest researcher at LTU, presented an idea for how to establish Internet connectivity to suite the conditions of reindeer herding to the KIS-NMKR partners. This idea came to be called Sámi Network Connectivity (SNC). A solution to serve Sirges has to address topographic circumstances (mountainous area), the fact that major parts of the Sirges territory is protected and should be preserved (which puts constraints

¹ The Department of Human Work Sciences has a new name from 2011, *Department of Business Administration, Technology and Social Sciences*

² A Sámi Village, also known as grazing community, is a specific type of co-operative installed by the Swedish state, for organizing the rights to reindeer grazing in the Swedish territory. The reindeer are however owned by individuals, who need being members for having husbandry rights.

³ The process is described also by Lindberg & Udén (2010) and Udén & Doria (2007).

on installing fixed infrastructure like antenna towers) and the semi-nomadic nature of reindeer herding. Also, the cost need be affordable, including the maintenance cost. Doria's approach to meet these requirements was based on the concept of Delay Tolerant Networks, built into an Opportunistic Routing system using a mix of 802.11 hotspots and mobile relays, and building the idea around off-the-shelf equipment. In this context, the latter refers to normal products that are available at retail prices and which are subject to competition and therefore sold at affordable prices. Developing this architecture as direct response to the Sirges herders' situation, made that their conditions became a template for one of the first DTN architectures suggested for the Internet Research Task Force. In short, the idea of the SNC architecture was to build Delay Tolerant Networking capacity into an Opportunistic Routing system using a mix of wireless access hotspots and mobile relays. As the community continuously relocates, the system need be composed of affordable, durable and handy hardware, so that it can be taken along and set up depending on where people are. The SNC architecture requires that within such a set up, the mobile relays periodically travel between camps and huts on the one hand, and meeting at points on the other, where data bundles can be exchanged. Finally, at least one mobile relay need reach a location where a gateway to the Internet is prepared. To a degree this resembles a peer-to-peer system. The DTN component is the key to the functionality. It so to speak "preserves" the communication through interruptions in time and space, where TCP/IP would close down. (Cerf et al 2002, Doria & Udén 2007, Lindgren & Doria 2007) As the SNC proposition was accepted by the KIS project workers and in next step by Sirges' village board, phase 0 of SNC was started – development of the architecture and high level design and the production of project plans and fundraising. A necessary step was thus to describe the socio-economic situation and the hypotheses regarding effects of SNC, which would motivate funding, and research and development in order to realize the idea. This document prepared by Maria Udén, *Social Impact*, has not been published but has circulated among research groups from 2002. From January 2004, LTU was granted funding for SNC from Vinnova's program New Communication Networks. In this setting, the development of the PROPHET routing algorithm and protocol took place.⁴ PROPHET describes the routine for sending messages in a dynamic system, where nodes move geographically but social patterns will make certain meetings between nodes more probable than others and which uses this probability to calculate the best way to send each bundle or message to its destination. Several aspects of N4C continue to build on PROPHET.⁵ The setting of the KIS-NMKR partnership, at this stage added to by staff of the Sámi Educational Centre in Jokkmokk, was brought into SNC via its research plan, and through Sirges members and other local people being appointed to the project's Reference Committee. Maria Udén and the gender and technology studies at LTU remained as lead also for the high-tech SNC project. At this time, Fritz-Åke Kuoljok was daily manager for the Same Net portal with facilities in the Sámi Educational Centre in Jokkmokk. From this position he and his colleagues supported the process. In June 2005 Mr. Kuoljok and the Sámi Educational Centre, was the local host in Jokkmokk when Vint Cerf visited SNC for a three day meeting. Finally, during this period, together with her KIS co-worker Karin Kuoljok, Susanne Spik established the company Tannak.⁶

Tests with Communication Platform Sirges 2006

In May 2006 the Swedish Sámi Parliament approved funding from EU Objective 1 to Sirges, for the Communication Platform Sirges project. This enabled technology transfer between the

⁴ PROPHET is short for "probabilistic routing protocol using history of encounters and transitivity".

⁵ Version of the PROPHET routing protocol in time of writing, see Lindgren et al 2010.

⁶ As Kuoljok is a usual name only in a limited area of Sweden, it is called for to clarify that Fritz-Åke Kuoljok and Karin Kuoljok are not family.

university and the Sámi Village. An on site test was performed in cooperation between SNC and Sirges in August 2006. The on site test was located to Sirges' summer territory in Padjelanta National Park. Four bases with were put up in four of the Sámi summer camps (Vastenjaure, Sallohaure and Kutjaure East and West). The tests were successful, showing that DTN and specifically the SNC architecture can bring useful applications to an area such as the Sirges summer land. Using first rudimentary versions of implementations and applications the team sent and received email and published information on the World Wide Web, and accessed cached web pages. Also, they gathered a crew some of which continued into N4C. Through the co-operating projects and through the help of additional volunteers skillful professionals of both genders introduced high-quality practices and kept up the level of the achievements. Without space to here list all people involved, there is reason to mention at least a few by name. This is because the details of the process will otherwise remain abstract. A member of the IETF Internet Architectural Board, Mr. Elwyn Davies from U.K. was a volunteer in the 2006 tests and later a driving force in the formation of N4C. Project leader Annika Sällström at the Center for Distance Spanning Technologies in Luleå developed a partnership for extending the SNC idea to the North Calotte region of EU. This gave resources for the summer 2006 and further DTN testing in the winter 2007, and established the connections with Norut, now a partner in N4C. The young generation of up and coming professionals was likewise crucial. LTU M.Sc students in computer science Mattias Ek and Jan Lindblom worked for Communication Platform Sirges and set up the test bed including arranging a link to the internet thanks to a local supplier. Exchange student Samo Grašič from University of Ljubljana made the implementation of the central innovation, the PRoPHET algorithm and as mentioned elsewhere, received support for this work from volunteer input from Slovenia. By 2008, through joining N4C as LTU staff, Samo Grašič had become a co-author of the PRoPHET experimental draft (a suggestion for internet standards).



Figure 10. Vint Cerf participated in the SNC meeting in Jokkmokk 2005. At left Karin Kuoljok, co-owner of N4C beneficiary Tannak. Photo: Elwyn Davies

Last but not least, it is reasonable to say that the interest paid by Dr. Vinton G. Cerf to the Luleå-Jokkmokk process of DTN projects and development has both inspired project members, and offered credibility in contacts with new contacts, including with staff at authorities and public funds. At least, where there is awareness of the concrete processes at global level which has lead to the present status of ICT regimes. Already the first discussions between Doria and the group preparing the first DTN internet draft mentioned the Sámi reindeer nomadic setting and architectural idea of SNC (Cerf et al 2002). Vint Cerf was a member of the Sámi Network Connectivity Advisory Board 2004-2006; he was involved in the preparations of research plans that lead first to Vinnova funded SNC+1 in 2007 and then N4C. For N4C he has been a member of the Technical Advisory Board.

A nomadic architecture and the three tier hypothesis

Reindeer husbandry exists all around the Arctic, and traditionally in particular in the Eurasian continent. There are several indigenous peoples to whom reindeer husbandry is central. One of them is the Sámi. Among the different Sámi populations are groups of semi nomadic reindeer herders who move with the reindeer according to a yearly cycle that makes optimal use of grazing in relation to the other variations that occur with the seasons. In Scandinavia a core group of professional herders only, is nowadays able to follow the herds throughout the year. Schooling, the need for additional incomes, and the general duties of citizenship, makes a combination with stationary living necessary for most members of the community.

Nevertheless, when possible, additional family and community members join. The Sirges herders may move their herds between locations 400 km apart during one year. The grazing is naturally best where there is few people and minimal if any infra structure. In combination with the lack of commercial potentials in the remote areas, the effect for the herders is that their access to ICT, such as cell phone coverage, is patchy. In the summer land, being mountainous nature preserves, the access is particularly problematic. In many sites and traditional camps, not even reception of radio broadcasts can be expected. Commercially available satellite communications are expensive and at this northern latitude in reality only available in certain camps. (Beach 2001, Udén 2007)

Technology, culture and jobs

The initiative to involve technology development in the Sirges-LTU cooperation, together with the added value from the SNC architecture launched by Doria in 2002, represents a complex hypothesis about the sustainable development of a community or culture, and about power relations and emancipation within a group or society. Put into ICT language this can be expressed as the hypothesis being built from several *tiers*. In short the different levels can be expressed as:

- Technology and culture co-create each other
- Technical development means more than its results
- Generating business and jobs

When the different tiers are approached with gender equality and the inclusion of women in mind, it is a step towards informing a wider set of values in technical research and development. All three points can be recognized from virtually any discussion on innovations, science and technology. Yet, there are always details that occur differently in each context. The view that technical development or rather *the implementation of innovations*, as much as being instrumental for a society eventually will effect its values, practices and organization occurs in uncountable research studies and guides political discourse in established parties as well as in grass root and protest movements. Besides opening up a world of communication opportunities to its users, the internet and www offer enormous databases that help us overcome some of the information limitations earlier generations lived with and, strived to overcome.⁷ In the SNC-N4C process we have assumed that ICT have potential to resolve tensions that reindeer husbandry households live with today.⁸ These conflicts can be understood as occurring as result from the different ways to organize time and space that rein in the nature based reindeer nomadism as compared to the majority society's calendar and

⁷ Among the many publications pursuing analysis along this line see for instance Castells (2004), David and Foray (2002), Haraway (1997).

⁸ The hypotheses were described in Udén (2002) and have been developed in several documents and by different authors.

clock driven steady settlements way of life. (Beach 2001, Jernsletten & Klokov 2002, Nutti 2010, Udén 2007, Ulvevadet & Klokov 2004) When writing about socio-economic aspects of N4C it is sometimes tiring to repeat technical details, and the technical details are sometimes apprehended by readers, as a burden to the text. But the hypothesis about relations between culture and technology remains very abstract if there is not at least the possibility to look at the details of the technical design brought to N4C from SNC. As the concrete technical design adds momentum, binding long term and short term goals together with theory driven strategies, it is called for to first describe its composition and put this composition in relation to its target use situation. The issue can also be seen from a more narrow economic view. Speaking of cultures is not necessary to frame the basis of the ambitions expressed through the N4C project. The main costs in reindeer industry in Scandinavia today are connected to mechanical equipment, transport and constructions, snow mobiles, motorbikes, cars, helicopters. (Jernsletten & Klokov 2002, p.5) Travel makes up a major part of the costs, so that, reducing the need to travel is attractive. Moreover, working with technical development contains something more than the immediate results in form of systems and products. When the SNC process had just started it could not be taken for granted that the architecture was possible to realize. Would then, from a local perspective, working with the computer scientists and networking experts, be wasted? The view in the gender studies at LTU, has been that, the singular product has little significance overall. At a first glance this view can appear incompatible with the emphasis on need for well adjusted technology which has driven N4C. However, as the art of risk management teaches us, there is the possibility that the conditions changes, in such a way that yet other technology is needed. Getting hold of one particular technical solution can mean everything but, it can also mean nothing. From this perspective, the actual goal is not gaining access to technology but, to effective research and development environments. (See for example Directorate-General 2007, DG Enterprise and Industry 2009)

GROWTH POTENTIAL

Local and national potentials for new or strengthened enterprises in relatively short time span include:

- Increased economic outcome for reindeer herders as result of modernization of herding methods made possible through robust connectivity.
- Commercialization and production of software and hardware technology for an emerging type of connectivity in existing and new enterprises of various sizes.
- Commercialization of applications developed in parallel such as reindeer tracking system.

Figure 11. Expectations on growth potential, from the SNC application 2003 developed by Avri Doria and Maria Udén with Anders Östman, Per Gunningberg and Björn Pehrson

The economic outcomes of research and development normally contains expectations both referring directly to the defined projects and, to what can be called “spill-over effects”. (Brulin & Svensson 2011) Working with Delay Tolerant Networking as an emerging network paradigm, planned effects can be as described while spill-over effects can hypothetically emerge just from the advanced level that some of the actors have, when they meet the “new” environment of say a Sámi village. In the application to Vinnova 2003, which resulted in grants for the three year project SNC, the idea was expressed as in figure 11. In these formulations the border between the factors of knowledge society inclusion discussed in the

section above and the more defined level of results related are present as one. In concrete terms it is a question of generating jobs and business incomes.

Gender equality and project ambitions

In the concrete case of Sirges we find a limitation of ICT accessibility that relates to sustainability of the semi nomadic culture; if effectively available only in the winter home, the potential of is lost. The competitiveness of reindeer nomadism as life choice weakens. With this possibility in mind, the view that ICT make time and place irrelevant is widely spread and promoted world wide is more than a paradox; it is irony. Correspondingly the importance seems all the stronger, of technical ideas and products such as the SNC architecture and the PROPHET algorithm. However, neither the process of development nor implementation of technology is innocent in terms of the power relations and identities it evokes and, makes possible or suppress. As much as there is potential for empowerment and emancipation, there is risk that already marginalized groups come out even more socially vulnerable when all is said and done.⁹ A measure that has been intrinsic in the design of the N4C predecessors in the Swedish location has been to explicitly stage the activities as part of equal opportunities strivings, and as having an aim to make it possible for families to live in the remote locations. Women and men participating can thus easily identify the test arena as family friendly rather than “boot camp”, and certain competition that otherwise may estrange the test group from the “usual” citizen, is not encouraged to develop.

Where social practices or legislation already challenge women, it is important that both women and men in a sensible manner are included throughout. Likewise, it can be argued that for women’s broader inclusion in the knowledge society or say, in innovations systems, focusing on single positions is not enough. For instance, women becoming engineers need be complemented with women as patrons of technology development. Studies of science and technology reveal technological competence and influence as distributed rather than concentrated on certain positions: dependent on all of brotherhood and specialization and stratification. (Udén 2003)¹⁰ This conclusion is largely self-evident in policy and management studies. Yet, it deserves being mentioned here as it is less emphasised in studies of gender and minorities in science and technology. In sum, a hypothesis motivating the LTU Gender and Innovation Division’s efforts has been that the SNC-N4C process strengthens inclusion and women’s possibilities through the diverse roles of both women and men involved. The women as well as men involved have been both locals/laymen as well as technical experts and scientists. From a gender equality perspective, it is important to prepare for both planned and spill-over opportunities reaching both women and men. One measure is to keep communications channels open with groups of women as well as men and to create environments where women as well as men are comfortable.

⁹ Among reports and studies dealing with this dilemma see for instance Directorate-General (2008), Prasad. & Sreedevi (2007), Vehviläinen (2009)

¹⁰ See also Mörtberg (2003) and Gunnarsson (2007) suggesting interactive research as a platform for inclusion of women and gender equality.

Socio-economic aspects

The technical results achieved in N4C are overall at a stage just before being made available for regular use. Some results are indeed already being commercially exploited, others are of theoretical value or at a pre-standards level contribute to the development of the internet, while yet other are incorporated in competence and services offered at consultant basis. Fransson (2010) describes business, deployment and implementation status of the different results.¹ Yet, even results that have reached a market have hardly made an impact in social patterns yet. Thus, from a wider socio-economic angle, even the technically most encouraging results are still tricky to assess. Much remains embedded in ambitions and future plans. Nevertheless, in a few details, data can be retrieved already from N4C. Obviously, the issue of women's participation needs be assessed and at least with respect to the women directly involved certain conclusions can be drawn. Furthermore, making an offer to FIRE for a sustainable test bed is a result expected from N4C at the project end. Consequently, this is a detail which can instantly be assessed.

Test beds as an opportunity

One aim of N4C is that after the project has finished, at least one of the two test beds built for the purposes of the project shall be offered to the federation of test beds which in turn is a goal for the FIRE initiative to create. Looking back at the pre N4C history, this was not a goal in the first instance but the possibility of creating a test bed in the Jokkmokk area emerged as an associated idea shortly after the technical idea was taken on. The test bed industry was favoured in the Swedish national policies as well as the regional policy of Norrbotten County where both Jokkmokk and Luleå (site of LTU) are situated. Additionally, on the occasion of the SNC meeting in Jokkmokk 2005, Vint Cerf wrote an official note to the Swedish Sámi Parliament information office. Here, he mentioned a need for DTN testing in connection to NASA needs. (Cerf 2005) Two major project applications were developed, for projects to run in parallel with SNC and prepare the local community in Jokkmokk for making business out of the new ICT and the process of technology development. One was the *Nomadic Com Lab* application aimed at test bed activities using SNC as "customer", which was submitted to the EU Structural Funds Objective 1. The team was not successful with these applications but had reasons to hold on to the ideas of test bed development (and education for local community members in making use of new ICT options, which was the content of the other application).

For N4C Fransson (2010) has developed a three level strategy for governing models of test beds:

- Level 1: A research test bed platform on similar level as during the N4C FP7 project
- Level 2: A small scale test bed for present research partners and for a few new clients
- Level 3: A large scale federated test beds in collaboration with FIRE network

In the N4C offer to the FIRE federation, the Slovenian test bed will be offered as level 3 (or as level 2 with near development to level 3). The Slovenian test bed will be run by the N4C

¹ The results are presented in the Deliverables of N4C, made available by the project partners and www.n4c.eu and the Coordinator www.ltu.se. Power Lake AB in Stockholm has developed business plans and exploitation plans for several products and services for the partners. The EU Leonardo da Vinci Transfer of Innovation project (2010-2012) develops an e-learning course for making the open source results not only available but accessible in real terms. Coordinator is Maria Udén, Luleå University of Technology.

partner MEIS, which is a company that already sells services that require a high level of technical and organizational preciseness in the customer relation. The Swedish test bed however, will not be included as a level 3 offer but will continue rather as a level 1 test bed, with nearest probable development being towards level 2. There is not yet a commercially viable technical and management standard to make a stable offer of the type expected for the integration with the European Commission plans for federation. This standard would require services where the technical and procedural specifications and performance is guaranteed by the test bed owner. This fact does not say no activities will continue or that such a capacity will not be developed. It is very likely that at least one or two partners will continue traveling to the Jokkmokk mountains already a few months after the N4C end. The Swedish test bed not being base for an offer to federation points however, to some of the complications in terms of knowledge society inclusion and, these complications bring back the issue of knowledge society inclusion, or the building of a knowledge economy. For the herding community, ICT is not available where needed. This puts restraints on the development of the herding industry and hampers genuine integration of knowledge society practices in the indigenous community overall. (Udén forthcoming) The overall situation thus supports the appreciation of Johnson and co-writers (2005) that is: physical access is step one to prepare for inclusion. In relation to the test bed development, the situation reverses. The decisive access is that to a certain type of organizational and technical expertise, which is what David & Foray (2002) places as the first step towards genuine inclusion. At least in the immediate perspective the Lapland test bed is not ready to be run as an autonomous high tech business. On the other hand, the interest from research teams and groups in the forefront among the creative class (Florida 2004) to do testing and related activities in the area has been proven during the time of N4C and before in SNC.

From the preparation and execution processes that have been, it seems as some teams will rather prefer not to include a local test host in the technical details. For such a situation the business for the local community comes from specialized services that connect to tourist industry like eco tourism, cultural tourism and other specialized high quality alternatives. Besides testing, tourism is one of the favoured industries in regional as well as national policies. If the primary sign of a knowledge economy is “networks of individuals striving, first and foremost, to produce and circulate new knowledge”, it is none the less necessary to acknowledge that in terms of test beds as an advanced knowledge society business this quality has not been reached until the effort was run on European level. Likewise, the idea has been realized at the EU level that products and business can be developed in association to the knowledge process, and that this should happen in several separate companies. Technology transfer, one of the original reasons for on site tests, has taken place as DTN, which was known by few actors in the consortium, is now mastered at the level of independent system integration by the project’s participating technical institutes in both northernmost, south and east Europe. At the same time, these institutes have had a crucial role in making the research results accessible for a wider audience through demos, summaries and instructions produced throughout the project. (See for instance Freitas et al 2011) Thus, looking further in to future possibilities, they may show to having been instrumental for reaching the final target end users in remote areas, including the Lapland reindeer herders.

Women in technology, women in the knowledge society

As shown by Wamala (2011) N4C has had a gender mix which is reasonably favorable in comparison to an average or statistical level appraisal of gender distribution in relevant sectors. Pondering on this state, it is the detailed level of the process that can offer vital new knowledge in terms of issues such as women and technology and the inclusion of women in

the knowledge society. The case can draw the attention to aspects that may underpin processes that are visible but not fully possible to understand at statistical or aggregated level. The test bed theme offers such possibilities. In relation to the test beds it becomes concrete, how one aspect of gender equality (or inequality) can influence outcomes in quite other situations. One might say that this thread starts from the rights to use land and water in the grazing areas. The very large areas crossed by the herds of the mountain Sámi and their reindeer are not owned by the reindeer herders. Based on ancient rights and modern legislation, each village (grazing community) and its members, has the right to let reindeer graze and pass over a specified territory but in legal terms the land is owned by private owners. These owners can be either persons or companies (including large forestry companies). In the case of the nature protected areas the owner is the state. The rights to travel and stay in the areas is not something that each Sámi person has, it rests on status. It is the “Class one”, so called “active” reindeer herder who enjoys this legal right. Other Sámi or community members enjoy the possibility to the degree that it is acknowledged by the Class one herders. This is an aspect of relevance for N4C as not just any community member has the mandate to invite test teams to either the Padjelanta national park where the N4C summer tests have taken place or the privately owned areas where winter tests of reindeer tracking equipment have taken place. Considering that the majority of Class 1 herders are men this fact implies that significantly more men than women enjoy the opportunity to take the initiative to the type of tests that have been organized within N4C. About seventy five per cent of the Class 1 herders are men. Women’s marginal position is connected to legislation in combination with practice among the industry as well as the authorities that control it, and in the communities’, and herding groups’ interpretations of the legal frames. (Amft 2000, Udén 2002, forthcoming, Ulvevadet & Klovov 2004) However, in N4C the Class one reindeer herders most effectively involved have been women. These are the Tannak owners Susanne Spik and Karin Kuoljok.

Comparing the N4C case to the concerns expressed regarding gender equality in the ICT area, it is noteworthy that women have from start been deeply involved in furthering the process itself. Women have also gained employment and business opportunities, along the way of the research and development process. Gender equality and affirmative action for women have been explicit main goals in a minority of the projects that have made this possible. Yet, as shown by Lindberg & Udén (2010) affirmative action was the ticket for getting in. Alas, has the innovative alliance brought change? The continuous ethnographic efforts accompanying the SNC-N4C efforts, render the possibility to somewhat reflect upon the issue. At a first



glance it appears a very great win that women, even indigenous women from a traditional semi nomadic community participate in FP7 research and development.²

Figure 12. Paulo Freitas, Instituto Pedro Nunes showing a demo of the integrated N4C system for Head of Unit Mr. Per Blixt in the Barcelona FIRE meeting 2010. At left Barbro Fransson, Power Lake AB, leader of Business model development in N4C

² Some more details regarding women’s involvement are described in Udén (*forthcoming*) which is also the publication where the discussion about knowledge society inclusion was first developed.

One leading woman in N4C was Barbro Fransson, the owner of Power Lake AB. With long experience from projects with the European Commission and broadband actions, her role was crucial in building the consortium and writing the successful application for N4C. This starting point clearly positions her as one of the creative class. Nevertheless, PLAB is situated in Stockholm. We can look to the more remote areas. The first three women involved in the process that made N4C were the current N4C project manager, and the owners of Tannak AB. The project manager started as an engineer and PhD at a technical university. Via her role in N4C she has gained prestige and the control of a considerable budget (as the coordinator was the largest partner). The Tannak owners started out as reindeer herders. This means that they were women in a male dominated profession with the highest status possible in the indigenous Sámi society. Starting their company and furthering the SNC-N4C process, they have again stepped into a statistically male dominated, symbolically masculine environment of technical research and development. As owners of a technology dense SME start-up they combine all these male dominated worlds; reindeer husbandry and technology R&D. All women in the community where the SNC-N4C process started have not been directly affected by the process but, those who have been can distribute some of the good that comes out of it in accordance with their own judgements and aims. And again, this is a capacity the Tannak owners already have in the authority of their full reindeer herder rights. As mentioned above, this particular authority is what gives the research team access to the herding locations and the real life tests. As project partners they can offer and decide about resources of tangible value for the research process and its profile among other technical research efforts. It is not obvious how this should be interpreted. A main knowledge society feature is the growing speed of innovation that includes both formal and layman environments as innovation. In the highly competitive global economy, taking active part in innovation would be close to the sole means to survive and prosper. (David and Foray 2002) Yet, what is the alternative? If not all women need be involved in FP7, what does it mean if none are? Not being ruled out in the fierce competition but, simply to defend the place one has, may be an acceptable reward.

Methodology in N4C and current discourse

In total N4C has carried out six test cycles in remote areas (three sets of summer and three sets of winter season tests.) In such work, a test team is exposed to conditions that computer scientists and systems developers do not usually have to deal with. In networks created in conventional built environments, several groups of technicians and engineers have, so to speak, already paved the way for the ICT professionals. Civil engineers, construction engineers, builders and architects organise our sheltered, built environments. Here, such as weather, wind and wild animals do not disturb. Electric power is provided by “someone else”. You just plug in. In field tests, a team must accomplish so much more on its own. If a piece of equipment is placed in nature, nature’s forces, fractions and creatures will respond. When walls, doors, ventilation, heating, climate systems, and last but not least janitors and cleaners are not around, many more details require planning, attention and correction along the way. Condensation damages the circuits. Birds pick on the casings. Trees and leaves grow and change the line of sight¹.

Solar panels and windmills – nature and technology

The organization of power supply makes a vivid example of battles with material reality that the different teams needed to solve, each with respect to location and time of each test. For instance, the LTU test team with two PhD students, Samo Grašič and John Näslund and LTU’s local test manager Fritz-Åke Kuoljok have built and organized DTN networks, and installed updated versions of applications in remote settings in Lapland all six seasons. Solar panels were used as power source by several N4C teams during their respective field experiments. Fairly manageable panels that can be readily transported to the field are available. However, this does not help, that the solar capacity that is accessible, is limited by the Arctic Circle, where the LTU team carried out their tests. This fact together with the interest in experimentation as such, and paired perhaps with normal curiosity, made that the LTU team, early on decided to try out small windmills besides the solar panel. During the summer 2010 this showed to be a wise decision. The weather was rainy and, when the rain did not fall clouds covered the sky. Accordingly, the solar panels hardly produced any electricity. This was summer. Then we have the winter conditions. Both solar panels and windmill has been used during winter tests as well as summer tests. As the tests in Sweden have taken place above or slightly below the Arctic Circle, the sun does not rise above the horizon very much during the winter season. One would expect that the windmill is a more dependable source.

However, in LTU’s winter tests 2011 a windmill burnt out from overheating in a storm, then virtually exploded in the cold. It is well established that incidents like this happen, even in laboratory work. It is less usual it is brought into the open. In feminist and gender studies critique of this manner of hiding what does not fit has been an important theme. Yet, in many cases it is probably quite relevant to not make an issue of misfortunes. Learning to master the material opportunities and constraints can be needed for creative thinking or innovative ideas come to their full right, just as it is in the arts. In N4C, openly discussing unexpected situations is however methodologically relevant. Through meeting around the realistic use situation, team members learn about the template area’s conditions on the one hand, and about the fundamentals for transcending the limitations of the present ICT technology on the other.

¹ This has been accounted for in the N4C Deliverable 8.3 *Test bed development* (Udén et al 2009).

Being exposed to the template situation even challenges some of the most fundamental concepts.

The story about the exploding windmill contains an interesting contradiction as eventually it became a solar panel that made the last winter test possible, despite of the very short days in the northern latitudes during winter. But in summer, when there supposedly is light twenty four hours a day because of the midnight sun, it was the windmill that saved the day. Moreover, we can here remind ourselves about the N4C strategy. Using off-the-shelf equipment is one constituent in the original SNC architecture which was brought further to the N4C technical paradigm. As in the template area (the grazing communities of Jokkmokk) power is not supplied, the equipment needed for actually running a network includes solutions for power supply. It became part of the cultural diversity aspect of the project that the different staff members meet and learn together, and with community members and local business owners. In the discussions within the LTU team Fritz-Åke Kuoljok, the LTU field test manager, commented the exploded wind mill with the remark that it is good that it is made known how “normal” equipment does not always work in the conditions he and other reindeer herders live in. He meant that from a local point of view, it is often difficult to explain and motivate that technology choices are not always as straight forward as they may seem. The off-the-shelf strategy is consequently challenged. Not in all aspects but, it is clear it should not be a normative restriction in the system design. Samo Grašič, the PhD student responsible for the set up where the windmill broke includes the experiences from working in field in theoretical considerations with support from among other the works of Bruno Latour. Nevertheless, on another level, he obviously regrets the loss of equipment.

A discussion relevant to this theme took place in connection to the project start in 2008, with N4C Technical Advisory Board member Jacqueline Morris from Trinidad and Tobago. Dr. Morris told about the combination of humidity and salt that people in her part of the world need to constantly take into account. This is another form of firm message from nature than cold where the “mainstream” template does not serve well enough, and that require yet other considerations in technology design. For instance, her experience was that not even preparing special rooms to safeguard electronic equipment helped very long against the corrosion that hits metals in an atmosphere that combines humidity and salt. Variations in material cultures may be that people learn to handle, to the degree it is at all possible, the same systems and equipment or, that variations in the technologies offer choices that are actually made for different places and ways of living. For instance, how is a router best designed for nomadic communities? This has been a question for the N4C team from Intel and Trinity College

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dtnuser@n4crouter-5:/var/log/dtn$ dtnd-control
unknown operation
dtnd-control [-port port] stop|check|logrotate|bundle_stats|daemon_stats
|reset_stats|route_dump|link_dump|bundle_list|registration_list|gettimeofday
|[-id id] bundle_info
|[-id id] bundle_del
|[-id id] bundle_dump
|[-id id] bundle_expire
dtnuser@n4crouter-5:/var/log/dtn$

```

Figure 12 “HELP OPTION ON DTND-CONTROL”. From an instruction on how to build a “Village router” for DTN by Meehan & Hartnett (2011) p. 22

Combining theoretical and practical experience of nature

Even though mainstream ICT development addresses urban and built environments, working in wilderness and remote areas is obviously not an unknown situation. Putting up WiMAX in remote areas, Albentia has already been mentioned as one of the companies representing such experience in N4C. (See the Introduction section). The lead of Work Package 8 “Tests and validation in remote test beds”, the Slovenian company MEIS is another representative for this type of experience. MEIS delivers, as its normal business, meteorological and pollution data to customers, together with projections and early warning systems based on their own simulation models. In the context of N4C this has meant that there is a scientifically advanced partner for which taking account of the natural environment, and to which working with weather, wind, flora and fauna is the normal procedure. This experience is different both from the mainstream ICT developers’ and from the layman’s or end user’s. This is because the interaction between advanced technology and nature explicitly is its content. It is unlikely that the project results would have developed quite as has been the case without this type of competence in the team. Returning to the steps suggested by Mörtberg (2003) we see how the design situation in N4C periodically has moved from the laboratory and desk to the situation in which the system shall function. Starting from abstractions (of the Delay Tolerant Networking functionalities, the PROPHET protocol, air interfaces and other ingoing technology) the practical experiences lead to changes in these abstractions

The Old Library in Dublin

Feminist and gender studies argue that it is a common mistake to take the majority or mainstream society as given; a neutral and transparent “culture of no culture”. (Traweek 1992) If this is done, important information is lost, that can be used in the knowledge process. To avoid this mistake, we need getting a grip of the conditions that so to speak meets the reality of the reindeer herders, wildlife surveillance staff and other people who regularly spend their time in unsettled areas. One of the partners in N4C was the distinguished Trinity College of Dublin, Ireland. Its full name being The Provost Fellows and Scholars of the College of the Holy and Undivided Trinity of Queen Elisabeth Near Dublin, this higher education and research institution counts its history back to 1592. One of the most fascinating experiences of visiting Trinity College is the Old library and above all its Long room. The library was built 1712-1732. Its main room, known as the long room was expanded in 1860, through the construction of barrel-vaulted ceiling and upper gallery bookcases.² This created the intriguing interior that fascinates its visitors since. Our guide to the Old Library Dr. Stephen Farrell, likewise the leader of the TCD team in N4C, shared with us some of the impact this construction has had on culture and education. This includes a treat for science fiction fans. The Old Library long room inspired the Jedi Archives image in the Star Wars episode *Attack of the Clones*. A library is a familiar environment to most of us who are fostered in the modern education system. The buildings and environments that has formed our material experiences come from a tradition of protecting and preserving books and, first of all *paper*.

² The data are fetched from the information of Trinity College’s own web site <http://www.bookofkells.ie/old-library/>.

Figure 13. *The Jedi Archives*. Picture from the George Lucas film *Attack of the clones*. Accessed from Wookieepedia 2011-03-17 http://starwars.wikia.com/wiki/Jedi_Archives



For this, a stable temperature is essential. Furthermore, for reading what is said in the books and documents, we need light. The buildings we create to fit the composition of, and end user access to paper sheets and books have through the centuries been served with heating

and light through different technologies which today prepare for highly efficient ICT. When we are confronted with nature again, the basic limitation of resources and the unpredictability of conditions in the N4C test beds, it gets explicit how this heritage is reflected in taken for granted features of ICT design. Most people in N4C are much better prepared to work in offices than in field. Yet, at an individual level, the diversity aspect that goes in to a project such as N4C negates simple stereotypes. For instance, a “white male middle class” engineer working at a multi national high tech giant may well have grown up on a farm, which hardly is a type of place devoted to the preservation of documents. He may then carry experience, ways of thinking and practices that mirror what field work and design for remote areas require from people and technical thinking. Experience as identity is multi faceted.

Experimentation in FP7 and the N4C project

While computers once offered simulation as a “more effective” means to pursue most any type of research, and computer networks came to increase the capacity for simulations even more, it is today widely understood that simulating computer networks has its limitations in terms of validity. In FP7 ICT, resources are explicitly made available for actual experimentation and also, for contributing to a future test bed federation which is envisioned as a tool for European competitiveness and drive in future internet development.

“FIRE has two related dimensions: on one hand, promoting experimentally-driven long-term, visionary research on new paradigms and networking concepts and architectures for the future Internet; on the other hand, building a large-scale experimentation facility supporting both medium- and long-term research on networks and services by gradually federating existing and new testbeds for emerging or future Internet technologies.”
(Gavras et al 2007)

In FIRE experimentation is a matter of discussion, including the yet very open question of what experimentation with the internet is all about. In November 2009, representing the support action FIREworks Professor Alostinioti identified the scope of experimentally driven research in five steps (Alostinioti 2009):

1. Experimentation as a methodology to achieve concrete results: where, how, when?
2. The experimentation facilities as a service offered to R&D
3. What are the metrics relevant to experimentation?

4. The impact to standardization

5. Large scale experimentation: requirements and limitations

The question of the meeting was fundamental: What does it mean to conduct experimentally driven research? The first issue is what experimentation is for. Alostinioti argued that experimentation is a mandatory step in the validation of new ideas. In the efforts to identify the role of experimentation in ICT development and, in the shaping of the future internet, the fundamental questions asked in gender and technology studies can be recognized. What is the purpose? Who is it for? What factors are we dealing with, and how do we find the ways in which we can successfully interact with these forces? Speaking with Barad, the question would be how we create phenomenon, where we can place ourselves and intra-act with matter, machines and nature in experimental situations. The open mindedness in FIRE and FIA resonates well with the open ended explorations many feminist and gender studies researchers in the ICT area, tend to favour. (See for instance Elovaara et al 2010)

As showed in the several deliverables presented by the N4C consortium, consistent results and working prototypes have been successfully developed throughout the project. For instance, the work package “System integration” has independently produced a platform and instructions for the integration of components to an N4C DTN network. Yet, a strong feature of N4C is also its experimental character. In the basic sense what makes the N4C approach experimental in terms of internet research is that, we have worked with different routing schemes and implementations in such as system integration, real life tests and applications. In the first assessment of FIRE projects the assigned group of experts (the so called Wise men) noted that N4C was a project which indeed carried out experiments.³ In many cases, ICT research processes have tended to be directed towards proving, or validating, a solution which is so to speak given in advance. There are reasons as to why experimentation is demanding. First of all, it is not a straight forward process to develop routines where the input is varied.



Another obstacle could be the way in which difference and variety is appraised.

Figure 14. In a boat on the Lule River August 2008. John Näslund, LTU catching a signal, establishing communication with the internet.

A suggestion as to why experimentation has been profound in N4C could be the combination of the gender studies ethos where variety is an ideal with the spiral development model which was suggested by Stephen Farrell from partner Trinity College in Dublin, during the N4C technical kick-off meeting 2008 . The emphasis on diversity which has been developed in feminist science and technology studies makes that encompassing several strategies acting alongside each other in a project, does not become a failure. The spiral development model

³ The Wise men group are Scott Kirkpatrick, Jerker Wilander, Jacques Magen, Dirk Trossen. Their assessments have been presented in internal reports for FIRE and internal meetings.

was endorsed by the consortium. Together with the definition of the concept this endorsement was made official as follows: “The project intends to employ a spiral development model whereby successive refinements are made to the novel components in the light of experiences during earlier testing phases.” (Božnar et al 2008, pp. 9-10)

A shortcoming of an experimental approach with regards to technical variations may be that a higher level of technical difficulty consumes some of the resources that could have been spent optimizing the system for user friendliness or for interaction with intended end users. With roots in the Scandinavian tradition of interactive research, the N4C project, is based on the one hand on the technology being developed and experimented with and, on the other on people coming together who for different reasons are interested in communications challenges in remote areas. This combination is in line with FP7 ICT, through the Living Labs movement that gained momentum at the time when the N4C application was submitted. A Living Lab is envisioned as a unit where the use situation makes a laboratory when testing new products as networks, services, hardware and generally ICT arrangements and devices. The Living Lab can be such as a neighbourhood, individual users volunteering, or for instance projects of defined extension. (Ståhlbröst 2008) The idea is that the people and organizations that use the devices and services give input not only for validation and final fine-tuning but in the design processes as such. The situation created is in the ultimate case experimental that is, not set up as to validate one solution but to allow several set ups and let the test results define strategies for further steps. In more detail, this aspect is part of the technical development are covered in the early deliverables of work package three and obviously in reports from work package devoted to real life tests, work package eight. If the finished product is a set of “frozen stories”, it has also been part of the methodology developed to talk about the experiences that differentiate a bit differently than usual, as a way to keep a conversation going (“tell the stories”). As mentioned, in other aspects of our results we have strived more to finalized results. This is seen for instance in the final deliverable where application prototypes are presented (Grøttum et al 2011), and in the system integration results (Freitas et al 2011).⁴

⁴ Deliverables are available via www.n4c.eu , from the coordinator Luleå University of Technology www.ltu.se or responsible partner.

Conclusions

In itself, housing a future internet project in a gender studies environment is an experimental endeavour. This endeavour can be envisioned as trying out how applied engineering science fits with the gender and technology studies tradition and how they can mutually serve each other's development.

In the N4C technical strategy DTN and air-interface technologies serve to make creating a network and connecting to the internet possible. People's possibility to use the network, or "access" as the term goes, is taken care of through the attention to applications and services (e-mail, web, pod cast, and other). Finally, development of business models is initiated to make connectivity and access real (someone needs to run the network and provide the services). The project results prepare for setting up internet connectivity and to making use of ICT services feasible in regions and situations that do not fit to a conventional understanding of modern life. This means that they potentially can support cultural diversity. The project's motivating hypothesis that connectivity and access, promote social and economic prosperity includes complex relations and dynamics. According to the discourse on inclusion of new groups in the knowledge society, it is expected that if positive effects are to arise, this has to do with the capacities to make something out of connectivity and access. Eventually, in connection to a process such as N4C, it would also come from making something productive out of contacts and standings established within a European Union Framework Consortium. Even though European and global level experts have been included from start, the first research and development efforts that lead up to N4C, as a project addressing communications for people in remote and even wilderness areas, where in a formal sense carried out in a national and even local setting. It is therefore interesting that, reaching a pan European level through FP7 was needed for realization of goals that were expressed already within the national and regional frames.

The progress of women's situation in the knowledge society is indeed a concern where the N4C case can give an insiders' illustration. More commonly, themes of exclusion are highlighted in the gender studies field and in discussions about gender equality. The fact that indigenous women have been involved in leading positions in the N4C process adds an exclusive and eye-catching character to the case. Yet, it is not clear whether the history of the comparatively high and also high level involvement of women is to be understood as success or "status quo". Already before entering this particular process the women mainly involved in the central positions of the project, including the indigenous women, came from what in their respective contexts are high status male dominated positions. Throughout the process one could claim that several women involved in N4C have gained in seniority. However, this is not evidence of higher degrees of gender equality being gained. This is because gaining in seniority is just what is expected for a career. Yet again, failure in completing a career is a possibility and, as the world evolves, status quo is not the same as nothing being gained. In the competitions of the present times, being able to defend one's original position must be acknowledged as one form of a substantial outcome. Furthermore, when using details from the N4C case for looking a bit deeper into topics of identity and social status, focus falls on the interplay between participation in innovations processes and socio-economic status. One of the N4C features is the connection to Sámi semi nomadism. This does not mean the process has been "open" for any or all Sámi on an equal footing. The opportunity has been most evident for members of reindeer grazing communities in the Jokkmokk area. For people in this community to make use of the situation for instance to generate incomes and other resources from it, the opportunities have occurred based on their status with respect to

reindeer industry or in real terms, their official status as reindeer herders or relations to officially recognized herders. Few women in the herding communities have a full reindeer herder status.

To recapture the setting of N4C; in the beginning of the 21st century, the internet is increasingly used and commonly thought of as a provider of future solutions to needs in many fields of society and business. In the same instance the internet has become an increasingly strategic asset to nations and industry and, also for common people and citizens in their everyday life. It is repeatedly stated that, competitiveness requires further and renewed forms of ICT research, and exploitation of opportunities created by the internet and IP communications. At the same time, it is evident that continuing functionality requires continued attention. For instance, the increasing use puts strains to the infra structures that make the internet possible and, from a political point of view such as the internet's global reach and the distribution of access is an issue. Against this background, it is explainable that at the time N4C was initiated, there was an explicit open mindedness with regards to networking concepts and research methodology in the EU Commission and the units where research for ICT development is initiated and funded. These have been positive factors for finding common grounds between gender studies strategies and emerging ideas about research and development among ICT actors and policy makers.

Figure 13. Susanne Spik (standing) and Maria Udén taking a break during an inspection round walking between the camps Sallohaure and Kutjaure East during the DTN tests in August 2006. Photo: Karin Kuoljok.



Speaking in terms used within gender studies, one might say that in the work towards the N4C

results it has been accentuated how, the stories created and being materialized in the project's technical products adds to the options for diversity in a future internet. This has to do with the situation of on-site tests, far from the locations of universities and industry labs which has rendered much attention internally in the N4C work. This does not mean field work is the only work needed to realize the N4C vision of serving communications challenged communities. On the contrary, partners working totally in laboratory environments have been essential for formulating and packaging the achievements so that they eventually will be accessible for people outside the project group as such that is, for people accessing the technology and making it their own.

If interaction with “use situations” as much as “users”, is regarded as a means for tests and validation, the impact from the field tests on the research and development comes through. In line with the current discourse in philosophy of science, where nature and matter are seen as co-actors in knowledge development, the different test teams have, formulated accounts of the technical development that encompass the interaction with nature, matter and the surroundings during the tests (in many diverse aspects from topology and water systems, to

weather and wind and to animals and plants). This activity becomes a media for creating conversations about technical designs. With regards to the currently very profound interest for exactly these types of discussions within gender studies in science and engineering this, is encouraging with regards to future possibilities to combine gender studies with applied engineering. Furthermore, from a gender studies perspective it is also significant that the FIRE interest in research methodology resonates with the same interest within gender studies. Questions are asked about methodology, about how and why. Working within the FIRE initiative has thus provided a context for experimentation and building alternative technologies. It may also be that the ideals of gender studies, where diversity and multiple paths are favoured, have reinforced N4C to succeed as a FIRE project in terms of producing experimental routines in a branch where the proving of one concept per effort is perhaps a more familiar procedure. This statement is of course nothing but a hypothesis and furthermore one that would be quite complicated to even trial. Yet, in a time when there is positive interest within gender studies to get involved in science and in technology making, it is relevant to highlight possible common grounds. After all, if these common grounds exist is not a question of logics or of any other formal proof. It is a matter of identification in a social sense.

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