About remote area connectivity problems, use cases and solutions

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Researchers from the university of Oulu have studied (Internet) connectivity problems and their impact to people's daily life, work and business in the northern Finland and especially its remote areas. By definition, the remote area means "edge, periphery, hinterland". In this report it means remote areas that suffer Internet connectivity problems. In that sense, it could also include areas inside cities. Information has been collected with a questionnaire and interviews. The research is a part of Arctic 5G Test Networks project that is a joint effort with the Luleå technical university and funded by the EU Interreg Nord program, Lapin Liitto (FI) and region Norbotten (SE).

This report contains main observations. In table 1 at the end, we have listed typical connectivity use cases that naturally cannot be executed properly if connectivity fails or is too limited. Table 2 includes potential connectivity technologies that are used now or in near future. Finally, a few results from questionnaire are shown after the tables.

Properly working (data rate, availability) Internet and voice connectivity is a basis of digital society, and these services should be available for all the people. This will has been expressed in many strategies or even in laws, like in Finland where the law about the services of electronic communications[1,2] sets so called generic data rate as 3.5 Mbits per second (Mbps) at the moment. Connectivity services should be available at comparative prices to urban areas to reduce the digital divide and keeping remote areas attractive places.

The will is not yet realized: operators' coverage maps are not necessary describing achievable data rates and mobile systems are suffering capacity problems in some areas. This can be seen, e.g., when pupils return to home in residential areas and start using Internet, then the connectivity quality drops. This could even prevent some Internet activities, even important ones. More capable and stable fibre is not always available or could be too expensive. In Finland, the fibre status offered by Traficom's Monitori service[3] clearly demonstrates coverage problems related to remote areas.

Besides homes and working places problems occur also in highways. Locals know these places, but visitors do not. This could be a safety problem since emergency calls and operation of safety authorities may be cumbersome. In some countries, the roadside coverage may be included into frequency permissions (of mobile network operators MNOs) but control has been weak though some light has been seen. Traficom (communications authority in Finland) asked[4] (autumn 2021) MNOs to fix coverage in some roads in Finnish Lapland, but these are not the only problematic places.

[1] https://finlex.fi/fi/laki/ajantasa/2014/20140917?search%5Btype%5D=pika&search%5Bpika%5D=s%C3%A4hk%C3%B6inen%20viestint%C3%A4#O3L7P55

[2] https://finlex.fi/fi/laki/alkup/2021/20210888

[3] https://eservices.traficom.fi/monitori/area

[4] https://www.traficom.fi/sites/default/files/media/regulation/P%C3%A4%C3%A4t%C3%B6s_matkaviestinverkkojen_tiepeittovelvoitteiden_toteutumisesta_saamelaisalueen_pohjoisosissa.pdf. Decision Dnro TRAFICOM/1067/11.02.02/2021

Connectivity problems occur also in wilderness areas where people move for work and leisure. Improved connectivity would affect safety. Societies should discuss what level of connectivity is needed in these areas. Low data rate services would allow 112-calls and 112-messages, sms-messaging to home and between friends, use of various dog and reindeer tracking devices and text based weather reports that are valuable services for these areas. Providing coverage is not necessarily an easy task due to lack of power grid, roads and so on. Cooperation between MNOs could be a key for this.

Wireless communication networks are depending on power grid and fibre used to power and connect base stations. In some case these are not doubled, i.e., these is just one source available making such places vulnerable to faults. In some cases, international cooperation would be needed to organize this doubling in a sensible way.

In some places, people living in areas that suffer from badly working wireless connectivity have been activated. They have formed so called fibre cooperatives to get fibre in the village. If the regulation would allow, also wireless cooperatives would be possible. Together with (local) national roaming this offers new tools to build ubiquitous coverage. Basically, now evolving private network concept is the first step in this path.

Besides operators, also people should be active. In some cases, an additional gadget might be needed such as an indoor modem that has much better antennae than the smart phone has. That could offer much better connectivity and offers mobile WiFi at home or work. Closely related is ICT related education. People should be made aware what devices could offer help in their situation (same solution is not working everywhere). Good leaflets should not need much finance.

As a summary, remote area connectivity problems are rather common causing problems to the people in their daily-life, work and business. Today's commercial model has not generated equal Internet connections (not even voice connections) to all citizens, and fast change its not foreseen. Investment (of 5G now) are concentrating on areas that have high population density where investments can be redeemed fast, such as skiing and other holiday centres. Furthermore, proper performance indicators should be pondered since the signal power or potential maximum data rate used in the coverage maps are not indicating the real performance. Minimum (and average) data rate and availability (24/7) would be better metrics. Consequently, a lot has to be done in this sector concerning business ideas, regulation, financing and adopting technology such that properly functioning Internet connectivity could be offered also in remote areas in reasonable price both for users and operators. This should be done sooner than later.

The questionnaire was open in the project's web page 2019 – (early) 2022. It was about Internet connectivity problems at home and work in northern areas. It was advertised through various channels like municipalities, various (business) organizations and University of Arctic. Answers were mainly from Finland, Sweden and Russia. According to the results, Internet connectivity problems occur often 35% and randomly 25% of responders. The interviews were made in the municipalities of Enontekiö, Kittilä, Pelkosenniemi and Kemijärvi, whose staff from various positions were met. We got 325 responds to the questionnaire and made 20 interviews. The results in both were similar. We will report findings in more detail in scientific publications.

What follows are two tables. Table 1 contains typical use cases from questionnaire and interviews, that may be disturbed if connectivity fails. Table 2 contains connectivity solutions. After the tables are a few results from the questionnaire.
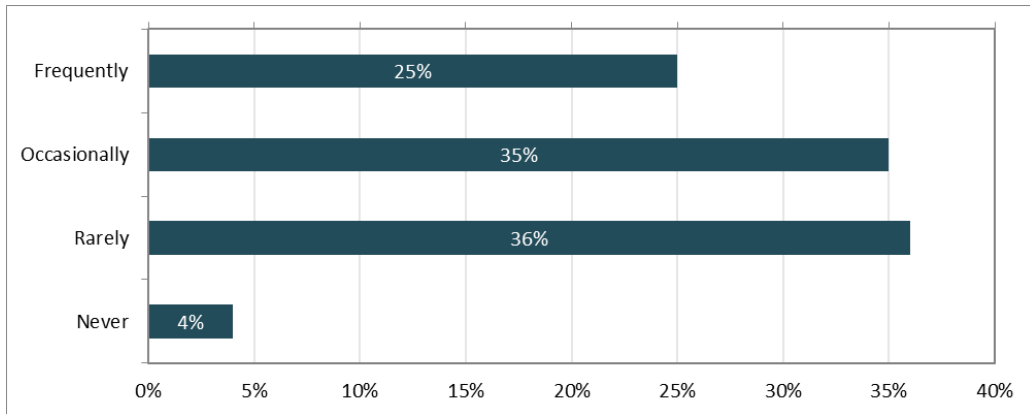
TABLE 1: USE CASES

|	USE CASES	EXAMPLES
EVERYDAY LIFE AT HOME	- connections with relatives and friends (e.g. calls, sms, Watchup, Wathcup-video, Facebook)	
	- bank and other Internet based services, Internet shopping	- food ordering
	- connectivity to healthcare and other similar in-person services	- remote services
	- smart-TV, video and streaming services (Netflix, …)	
	- Internet gaming	
STUDIES	- remote lectures	- temporary schools at reindeer roundup areas
or SCHOOL	- connectivity with teachers, study material in Internet	
WORK	- remote work	
	- workplace at home	- contacts with clients and partners; company home pages and Facebook pages, etc.
	- remote paying (devices)	- credit card readers do not work if connection is not working -> affects sales
	- logistic chain: entries, tracking	- entry problems in one end affect the whole chain
	- forestry, clearing snow from roads, , making skiing and other track, ….	- follow up, planning, information collection and sharing (e.g., to the public)
	- healthcare home visits: connections to data bases/registers	- patient safety may be jeopardized without these connections
	- wilderness: reindeer and dog tracking; location services; safety (112 service); connections to home, partners, work	- bad connections may affect victim localization and getting help on time
	- authorities	- bad connections affect operation
TRANSPORT	- unconnected services: work, free time	- phone and video meetings: brakes could be annoying (trains, cars, ferries)
	- safety	- accidents, availability of 112-service
FREE TIME	- cottage etc. fixed place: like everyday life at home	
	- off road or wilderness: dog tracking; location services; safety (112 service); connections to home, partners	

TABLE 2: CONNECTIVITY TECHNOLOGY

		PROS	CONS
FIBRE		- "unlimited" capacity	- not available everywhere - price might be high
FIXED WIRELESS ACCESS (FWA)	- Reserves capacity from the base station	- service provider installs	- quality (like data rate) depends on distance to the base station
WIRELESS	- smart phone	- carry with you	- base stations have limited capacity: once the demand increases quality drops (e.g., next to schools during day time)
	- modem (indoor or outdoor model) - modem with external directional antennae	- modem often have 10× better antennae than smart phones - could be 60× better than smart phone antennae	- needs good "visibility" to a base station; often placed high (more a restriction and a cons) - modem does not necessary work with external antennae like seller/manufacturer promises - antennae must be directed properly - losses in long antenna cables reduce benefits
LOCAL ACCESS e.g., at home or working place	- WiFi bring mobility at home		- WiFi limited coverage area - need for several WiFi routers - own WiFi for indoors and outdoors
	- 5G private network		- how many sim-cards are needed? - available for industry – is it available for private customers?
SATELLIITTI	- coming2022/23: Starlink, Oneweb, TeleSat	- ubiquitous, but needs sky visibility	- data rate and price still question marks (needs a satellite receiver and monthly plan) - when in your country? To whom? - a satellite receiver is quite big - long term availability unknown
About smart phones		- different smart phones have different sensitivity and cold resistance, even between models of one manufacturer. Unfortunately, information about these aspects is badly available. - price could be high	

Responds to the questionnaire

Question: What is the frequency of connectivity problems?

Question: the services you use (over internet) and which of them are affected by connection problems.
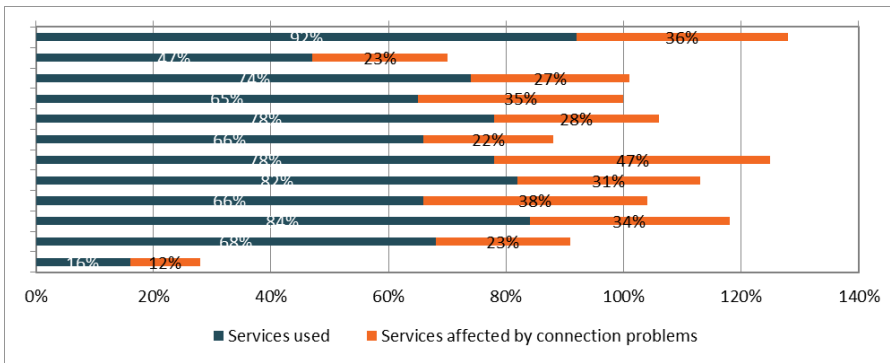
Searching Information
Health services
Shopping
Online learning
Governmental e-service
Communal services
Video services
Social media
Internet calls
Bank services
Travel and transportation services
Other, please specify