Rural ICT Testbed - #fulltäckning

Quantitative Evaluation Measures

–

a summary
DOCUMENT HISTORY

v 0.1 Document structure created 2019-09-12
v 0.5 Contributions for added 2019-09-17
v 0.7 Contributions for added 2019-09-22
v 0.9 final draft 2019-09-27
v 1.0 First version for delivery 2019-09-29

CONTRIBUTORS

Jaap van de Beek Luleå University of Technology
Cecilia Reje Federation of Swedish Farmers (LRF)

EDITED BY

Jaap van de Beek Luleå University of Technology
## CONTENTS

1. Introduction ........................................... 4
2. The User perspective of rural hotspots – Interviews ... 5
3. A new index that measures inequality ............... 6
4. Summary .................................................. 9
1 INTRODUCTION

#fulltäckning aims to improve aerial coverage in rural regions in Sweden. In an earlier project report we have described the various pilots that have been developed, implemented, and tested by the project. This report now collects the evaluation efforts of #fulltäckning towards the end of the project’s Stage 2. It describes the experiences from some of these pilot hotspots, developed and tested by the project (Section 2).

The project has also been working conceptually with new ways to measure the digital rural/urban divide. As part of this work, this report presents a new index, developed by the project, by which digital inequality of cellular coverage can be measured and compared (Section 3).

We present conclusions of this work in Section 4.
2 THE USER PERSPECTIVE OF RURAL HOTSPOTS — INTERVIEWS

We have conducted qualitative interviews with Carl Henry Lundström and Lotta Folkesson during August 2020, about how they experience the pilot trials from a user perspective. The other two pilots, Ida Oderstål and Ulf Hannu, have not been possible to evaluate because Ulf Hannu has not tested the solution he had been offered and Ida Oderstål has not been possible to obtain.

The following is a brief summary of the interview results.

**Carl-Henry Lundström**, runs a service company in forestry in Glommersträsk, Norrbotten. He has previously experienced problems with connection in the forest when he performs the work for various forest companies. Through #fullcoverage, he has been able to test a SIM card with roaming.

In the interview, Carl-Henry describes that he feels that his mobile connection has become much better with the new solution and that the costs are the same as before. Now he can move more freely in the forest without losing the connection as often, as the SIM card allows him to connect to the particular network that is available in a given location. Above all, he has saved a lot of time because he can access maps and other material via Google Drive via his iPad at work in the woods, instead of having to print out all the documentation the night before. He also describes that downloads are carried out faster than before. Overall, Carl-Henry is satisfied with the test and he believes that it has saved a lot of time and streamlined the work in the company.

**Lotta Folkesson**, together with her husband, runs a company in forestry and horse operations in Vännäs, Västerbotten. The farm has previously had problems with the coverage on the farm coming and going. Through #fullcoverage, she has been able to test a SIM-card with roaming and a repeater.

Lotta Folkesson describes in the interview that the connection offered via Telia has been better distributed over the farm through the repeater and that their staff can carry out WiFi calls from more buildings. However, Telia’s network does not work well on certain days and Lotta’s assessment is that at these times the repeater solution does not help. In connection with the pilot, she has also had to test a SIM card with roaming, but has chosen to end the experiment because the farm was located exactly between two operators, and thus did not work well. Lotta Folkesson believes that the pilot would have been more successful if it was not dependent on Telia’s unstable mobile network but should also have investigated other solutions.
3 A NEW INDEX THAT MEASURES INEQUALITY

The government's target for mobile coverage in Sweden has been specified for the first time in the most recent Broadband Goals. For the first time, a target for mobile coverage is specified for 2023. This target, however, is insufficient and unclear. While the digital gap between urban and rural areas is increasing, the government's vision is partly inadequate, as it does not include the sparsely populated areas, beyond people's movement patterns, and partly unclear because it does not define what is actually good mobile coverage and is therefore difficult to quantify. Within the framework of the project #fulltäckning, we have developed an index that shows how mobile coverage is distributed between urban and rural areas, the Cellular Coverage Inequality Index (CCI). The index can measure the size of the digital gap and be used to show changes over time or to compare between countries. We hope that the index will be used as a tool to reduce the digital gap and contribute to political and technical solutions benefiting the countryside.

The index combines two maps of a region, illustrated in Figure 1. The left-hand Figure illustrates for each location on the map a measure for how "rural" this location is. In Sweden such a measure has been developed a decade ago by Glesbygdsverket, later Tillväxtanalys. The measure of rurality of a location is defined by a weighted sum of distances to nearby centres of service, "tätorter". The left-hand figure illustrates the urban centres in Sweden with populations larger than 3000 inhabitants.

The second map is provided by the Swedish regulator each year and provide for each location in Sweden a flag (yes/no) whether there is a 30 Mbit/s coverage provided by at least one of the cellular operators in this location.

The index combines these two data sets similar to the well-established Lorentz curve and Gini-index in economics. First, all locations in the regions are ordered according to the degree of ruralness (from the left-hand figure and dataset). Starting with the most rural locations and starting drawing a curve in the lower-left corner of a graph-axis, we move the curve in step upwards, if this location has coverage according to the second data-set, and one step to the right, if it does not. We then proceed to the next-but-most rural locations and draw a similar step of the curve. We proceed in this way until all locations have been contributing to the curve and we end up with the most urban location in the region, and finish the curve somewhere in the upper right of the figure, See Figure 2. The axis are then normalized and scaled to represent values between 0 and 1. The resulting curve indicates how coverage is distributed over all locations in a region — rural locations to the left and urban location to the right.

The CCI index is then defined as twice the area between the main diagonal of the graph and the curve, see Figure 2. In a region where cellular coverage is equally distributed over a region this CCI index is close to 0. In a region, where cellular coverage is found in the most urban parts only, this index is close to 1.
Figure 2: Concept of the CCI-index illustrated for the region of Norrbotten. The red curves illustrate the coverage inequality distribution for various reception-strength of 30Mbit/s data rates, and the blue curves for 10 Mbit/s, respectively. The colored region illustrates the area that defines the CCI-index for one of the 10 Mbit/s reception levels.

Figure 3: Inequality-curves for Sweden, 10Mbit/s (blue) and 30Mbit/s (red). The left-hand figure shows the situation in 2015 – the right-hand figures shows the situation in 2018.

The CCI-index can be used to compare various regions in terms of areal equality. Alternatively, the development of cellular coverage in a region over time can be monitored using the CCI-index. Figure 3 illustrates for instance the inequality curves for Sweden for 2015 and for 2018.

In Figure 4, The CCI-index along with the percentage of areal coverage for Sweden are indicated for the years 2013-2019. The desired direction of development is towards the lower-right corner: a high percent of coverage with a low CCI-index indicating an "equal" deployment distribution over rural and urban regions. For two of the points in Figure 4 (labelled 2019), Figure 5 shows the respective coverage maps these points have been based on.
Figure 4: A graph that illustrates how coverage and equality-of-coverage develops over time (2013-2019). The blue curve shows the trajectory for 10 Mbit/s, and the red curve for 30 Mbit/s.

Figure 5: Coverage in Sweden in 2019. 10 Mbits/s (left) and 30 Mbit/s (right).
4 SUMMARY

As part of the project #fulltäckning, evaluation of cellular coverage improvements have been assessed in two ways. First, we have performed a qualitative evaluation through interviews with two of the pilot hotspots that we have helped with new extension techniques. These interviews show that improvement on a small scale can have a large impact for businesses and individual end consumers. Second, in a conceptual approach, we have developed a new index that measures the rural/urban divide in cellular coverage. This index can be used to compare various regions in terms of deployment equality, it can be used to compare the cellular status in a single region at various points in time and hence monitor the development in terms of rural/urban equality, and finally it can be used by regulatory bodies to set lower bounds and minimum requirements to planned deployments.