Nokia Remote Tool
— A Case Study of Nokia Corporation

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Business Information Technology
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Laurea University of Applied Sciences **Abstract**

Business Information Technology

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The target of this thesis is to address the common pain points in remote work by utilizing the Network as Code concept. The thesis was conducted in collaboration with Nokia Corporation, following the Design Sprint method, which included a five-day Sprint week.

The concept developed is called Nokia Remote Tool, designed specifically for remote workers. The application enhances the user's internet connection and provides the option to boost the connection during critical tasks. The connection is optimized and analyzed in real time, ensuring the best possible performance throughout the remote work.

The theoretical framework introduces the key concepts and technologies behind the Nokia Remote Tool. The technologies that form the foundation of the application include the Network as Code platform, 5G networks, Quality of Service (QoS) and Quality of Service on Demand (QoD) functionalities, SDK (Software Development Kit), APIs (Application Programming Interfaces), and eSIM (the Embedded SIM).

Various development methods were used during the design process. Ideation was conducted through brainstorming sessions within the team. Benchmarking helped clarify the key features of the application. A survey was conducted to gather research data, providing a comprehensive understanding of user's needs. The creation of a persona offered concrete representations of potential user challenges. A prototype was developed to illustrate the application interface and its main functionalities.

The research results and feedback revealed the need for improved internet connectivity in remote work. Nokia Remote Tool addresses many of these challenges, enhancing user satisfaction and productivity in remote work environments. This offers significant value not only to companies but also to Nokia Corporation and network providers. Additionally, the solution opens up future scope, paving the way for innovative features and services that can benefit all stakeholders involved.

Keywords: Design Sprint, Nokia, Remote work, 5G, Network as Code

Contents

1 Introduction

The thesis was conducted in collaboration with Nokia Corporation to address a challenge related to utilizing Network as Code. Remote work has become increasingly common in recent years, evolving into an essential part of many companies' and employees' workflows. Remote workers need reliable internet access wherever they work, whether it is at home, a summer cottage, or a public space. In these cases, mobile networks, such as 5G, are commonly used. This thesis aims to enhance the reliability of employees' internet connections for critical work tasks through a computer-based application. The solution focuses on improving 5G network performance by utilizing technologies such as Network as Code and Quality of Service.

The benefit to Nokia Corporation would be an enhanced position in the digital industry and strengthened Network as Code offering. By collaborating with operators, the remote tool app provides increased visibility while offering organizations a reliable internet connection for remote work. As a result, Nokia Corporation gains recognition and credibility in the industry.

The knowledge base of this thesis includes information on relevant topics such as 5G, eSIM, Network as Code, Software Development Kits (SDKs), and Quality of Service (QoS). These areas were comprehensively explored, including their potential and existing solutions. The decision to focus on remote work was driven by its growing significance and the team's firsthand experiences. Additional insights into remote work were gathered through a survey targeting remote workers.

The thesis employed the Design Sprint methodology, incorporating various methods. Benchmarking provided insights into existing solutions, enabling comparisons to refine the proposed solution. Further, data was collected through a survey exploring the number of remote workdays, working habits, and network-related challenges. A persona was also created using survey data to represent the end user, which helped illustrate the solution's benefits and was incorporated into the pitch to emphasize the value of the solution.

The upcoming chapters were organized as follows, the project background, including an introduction to Nokia Corporation and the Design Sprint process in collaboration with them. The theoretical framework covers the technologies behind the Nokia Remote Tool and the role of remote work. The development methods chapter outlines the methods used, providing insights from the remote worker survey. The Nokia Remote Tool concept chapter provides an in-depth look at the prototype, feedback received, and its benefits. The thesis concludes with a summary and explores the future potential of the Nokia Remote Tool. This report was

written with the assistance of the artificial intelligence tool ChatGPT, which was used to verify the spelling and improve the overall flow of the text.

2 Project background

The project was conducted in collaboration with Nokia Corporation, which served as both the client and the focal point of the thesis. Nokia posed a challenge to develop an application or service in any field utilizing the concept of Network as Code. The specific topic addressed in this project is the development of Nokia Remote Tool designed for remote workers.

2.1 Nokia Corporation

Nokia Corporation is a Finnish multinational telecommunications company specializing in information technology and consumer electronics. With a history spanning over 155 years, Nokia has played a significant role in the development of the digital world and continues to be an influential force in the industry today. The company emphasizes sustainability and digital inclusion, striving to create value for businesses, society, and the environment. (Nokia 2023a.)

Nokia operates in over 130 countries globally, with its headquarters located in Espoo, Finland. The company employs approximately 86,700 individuals worldwide, with over one-third of its workforce based in Europe. In 2023, Nokia reported net sales totaling 22.3 billion euros. (Nokia 2023b, 5.)

Nokia Bell Labs is a globally recognized research and scientific development organization that has pioneered numerous technological innovations in communication and networking systems. Established in 1925, Bell Labs has a rich history of advancing telecommunications, including the invention of the transistor, the development of information theory, and the creation of key technologies underpinning modern networking. Today, it continues to lead cutting-edge research in areas such as 5G networks, artificial intelligence and quantum technologies, maintaining its reputation as a cornerstone of innovation in the tech industry. (Nokia Bell Labs 2024.)

2.2 Design Sprint Method and Cooperation

The Design Sprint thesis was conducted following the Design Sprint method (Knapp & Zeratsky 2024). Laurea UAS facilitated the Design Sprint process, and the functional part of the thesis was carried out by the team during the Design Sprint week for the customer Nokia.

Design Sprint is a design process created by Jake Knapp that aims to build and test a prototype by a team during the Design Sprint week. The main idea behind the Design Sprint is to efficiently create a solution for a challenge in just five days. The team follows the pre-scheduled, day-by-day process that leads to a testable prototype. The sprint includes five phases: problem mapping, solution sketching, deciding, prototyping and testing. Design Sprint is an efficient method applicable to many different design processes. The approach saves time and provides an opportunity to test a solution for a customer before investing significant resources into it. (Knapp & Zeratsky 2024.)

A month before the Design Sprint week, the team met with Nokia to discuss the Design Thinking challenge and to get to know each other. The team conducted background research on the key concepts related to the digital service process and decided on teamwork methods. As in Knapp's Design Sprint Method (Knapp & Zeratsky 2024), the design process was conducted in a five-day sprint. Laurea UAS's Sprint week schedule differed from Knapp's Design Sprint method in the final days. Instead of testing, Friday included a pitching session for the customer.

The sprint started on Monday with an immersion in ideation for the solution. Through a sparring session with Nokia representatives, the main scope of the idea was defined and a vision for the solution was formed. On Tuesday, the team conducted benchmarking and refined the details of the concept's functionality. The research began by creating and sending a survey to the test participants. Wednesday involved analyzing the survey data and designing the prototype. The sparring session with Nokia provided an even clearer vision of the idea's technical feasibility. On Thursday, the prototype was finalized, and the team rehearsed the pitch for Friday. On the last day of the Sprint week, the team presented the concept and prototype to Nokia in a pitching event.

The teamwork during the Sprint took place in remote sessions via Microsoft Teams. Ideation was conducted collaboratively in several sessions. The team utilized various teamwork and design tools to help work efficiently in a remote setting. The Miro platform was used for ideation and process framing, the prototype was created in Figma, and the survey was designed with Microsoft Forms. Other tools used included Canva, WhatsApp and Microsoft Word and Excel. To work efficiently within the limited time, the team was divided for benchmarking, prototyping and survey analysis phases. The final version of the prototype was created after several iterations and feedback sessions involving the entire team.

After the Sprint week, the team conducted prototype testing and began writing the thesis. The prototype was finalized after incorporating feedback from testing. The writing of the thesis was divided among the team members. The team received valuable feedback during

the opposing session from fellow students, as well as from the thesis advisors. The thesis report was written over a period of four weeks.

3 Theoretical Framework for Nokia Remote Tool

Theoretical framework introduces the key concepts and technologies essential to the functionality of the Nokia Remote Tool. The application leverages cutting-edge technologies such as the Network as Code platform, 5G networks, QoS and QoD functionalities, Software Development Kits (SDKs) and APIs, as well as eSIM technology to address the challenges associated with remote work. These technologies form the foundation of the application, enabling seamless connectivity, real-time network optimization, and secure communication for users. The framework also examines the growing significance of remote work and the associated challenges from the perspective of the application's ideation. The following chapter explores these elements in detail, illustrating how they collectively support the application's functionality and provide solutions to the demands of modern remote work.

3.1 Network as Code

Nokia's Network as Code platform connects networks, software developers, and system integrators, creating a unified ecosystem that facilitates the use of applications across different networks. The platform aims to simplify network management by removing complexities and providing developer-friendly interfaces. These interfaces allow developers to build and deploy applications effortlessly without needing to delve into the technical details of the networks. (Nokia 2024a.)

Figure 1 demonstrates how the Network as Code platform acts as a unifying element between application developers and communication service providers. It provides developers with tools and interfaces to connect applications with the network, facilitating the utilization of complex network features.

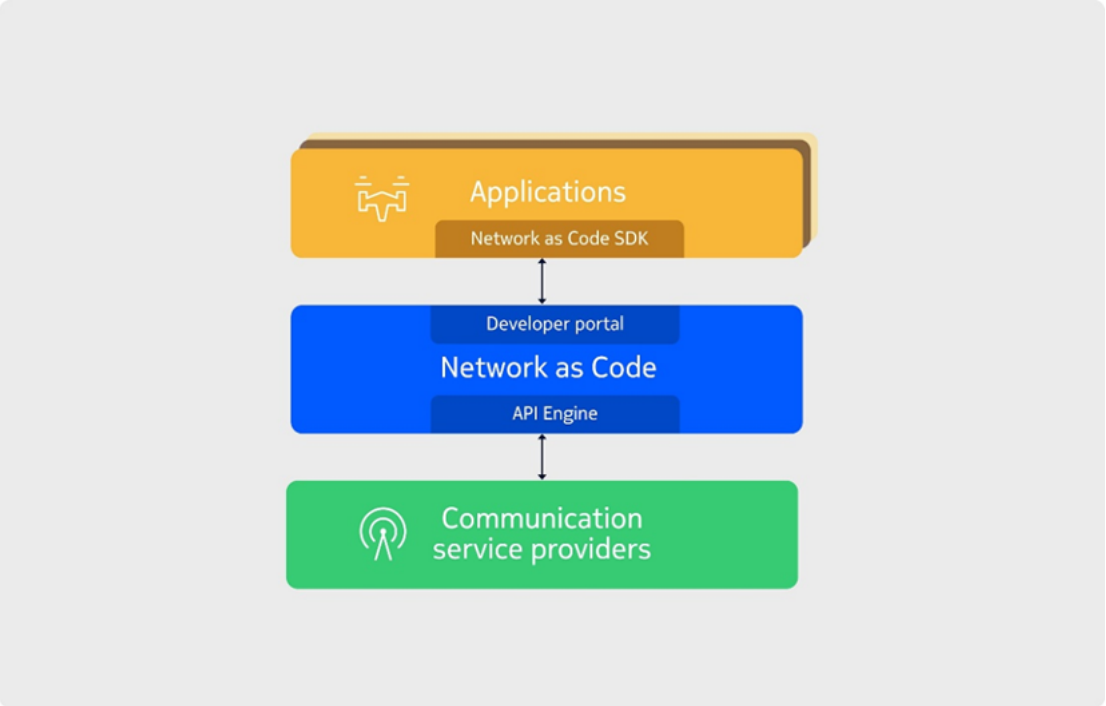

Figure 1: The structure of Nokia's Network as Code platform, which connects applications, the developer portal, and APIs to communication service providers (Nokia 2024a)

There are significant advantages to network APIs, as they provide service providers with opportunities to generate revenue through various business models, such as revenue-sharing, subscription, or usage-based pricing strategies (Nokia 2024b). According to GSMA (2023), this creates new business opportunities that can enhance the competitiveness of service providers. Cultivating innovative revenue streams is indispensable for all members of the ecosystem. Nokia is committed to enabling diverse monetization models, ensuring the platform facilitates seamless and flexible value exchange between different parties.

Nokia seeks to simplify the programming of cloud-based 5G networks for demanding applications. For example, live HD video streaming may require enhanced bandwidth, while remote control systems necessitate low latency. This programmability helps mobile operators generate revenue from new software-based networks. Nokia collaborates with mobile operators and developers to leverage the diverse and advanced capabilities of 5G technologies and continually strives to enhance the Network as Code platform. (GSMA 2023.)

3.2 Opportunities of 5G Networks

Fifth-generation mobile networks (5G) represent a significant advancement in mobile communication technologies, offering substantially faster data transfer rates and lower latency compared to 4G networks. These improvements enable the deployment of advanced

services, such as telemedicine and virtual reality, in wireless environments where performance and reliability are critical. (Penttinen, 2019, chap. 1.)

One of the most significant new features of 5G is network slicing, which allows the creation of multiple logical networks on a single physical infrastructure. Each slice can have its own performance requirements and Service Level Agreements (SLAs), providing a flexible approach to resource management and dynamic optimization. This is especially important for supporting industrial applications and critical communication systems where reliability and resource efficiency are essential. (Ghosh, Ratasuk & Rost 2019, 84-91.)

Cloud edge is a distributed computing model that processes data as close to its source as possible, rather than sending all information to a centralized cloud server. This approach reduces latency and enhances performance, which is especially important in real-time applications (Infinity Technology Solutions 2024). Cloud edge plays a vital role in this context by enabling local data processing and reducing latency, thus enhancing the overall user experience. Our proposed remote work solution for Nokia utilizes the capacity and low latency of 5G, which can be critical for the implementation.

The advantages of 5G in terms of device capacity are also significant; it can support a large number of devices simultaneously, which is a critical feature for the Internet of Things (IoT). In IoT environments, many devices, such as sensors and industrial machines, communicate autonomously and exchange vast amounts of data. The integration of edge computing further optimizes this process by allowing real-time data analysis and decision-making, making 5G ideal for data-rich environments. (Dangi & Lalwani 2023.)

3.3 QoS and QoD

QoS (Quality of Service) is a set of techniques that help manage network traffic and improve its performance. It allows important services, such as calls and video streaming, to be prioritized on the network, making connections more reliable and faster. QoS uses methods such as traffic classification and queuing to reduce congestion and latency, enhancing user experience while allowing network administrators to allocate bandwidth more effectively. (Netify 2024.)

Figure 2 illustrates how Quality of Service (QoS) affects bandwidth allocation. The top part shows bandwidth distribution without QoS, where different types of traffic compete, causing congestion. The bottom part shows bandwidth with QoS applied, where essential services receive priority, leading to more stable performance.

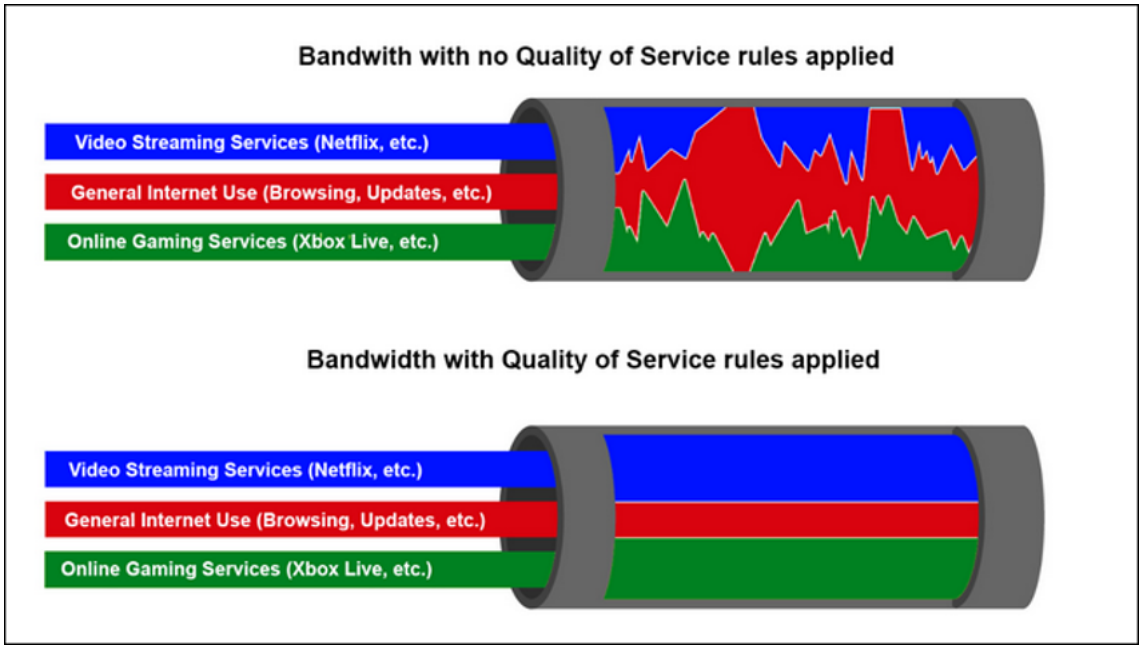

Figure 2: Bandwidth Distribution with QoS compared to without QoS (Vas Experts 2023)

Quality of Service on Demand (QoD) is a feature that utilizes QoS techniques to create prioritized connections between mobile devices and internet services. With QoD, bandwidth and latency can be managed for each device, meaning that the network can adapt to user needs in real-time, improving the reliability and efficiency of connections. (Nokia 2024c.)

As network slicing divides the network into separate parts, QoS prioritizes traffic and ensures that essential applications, such as video streaming, receive the resources they need (ITPro Today 2023). QoD manages and optimizes this process in real-time, ensuring that user needs are met quickly and effectively (Nokia 2024c).

3.4 SDK and APIs

The SDK (Software Development Kit) and its APIs (Application Programming Interfaces) for connecting our application to network interfaces are key factors in effectively utilizing 5G technology and QoS/QoD functionalities. SDKs provide developers with APIs, tools, and libraries to build applications that leverage mobile network features, such as analytics and Quality of Service on Demand functionalities. (Nokia 2024d.)

Network Insights is an API within the SDK that provides real-time information on network status and congestion across different areas, helping applications respond proactively to potential performance issues. This technology leverages the new NWDAF function in 5G networks, enabling the secure use of core network data and simplifying data collection. In this way, organizations can better assess network changes and make decisions that enhance customer experience. (Nokia 2024e.)

Quality of Service on Demand has a dedicated API that enables dynamic adjustment of network service quality (QoS) based on needs (Nokia 2024d). Through this API, Nokia Remote Tool can optimize the connection quality, such as improving bandwidth, reducing latency, or ensuring more reliable connectivity, according to the user's needs.

3.5 SDK from a Remote Tool Perspective

Network analytics APIs play a crucial role in the application's functionality by enabling real-time monitoring of the network state. For example, congestion level monitoring can be implemented using either polling or webhook subscriptions. In the polling method, the application requests information about the network state and receives immediate responses on congestion levels. This ensures access to current information on the network's operation. (Nokia 2024f.)

With a webhook subscription, the application can automatically receive notifications about changes in congestion levels, keeping users informed of network status changes without active inquiries. When the application’s analytics detect network congestion, it can display a pop-up notification with a "boost" button. The user can press this button to optimize their connection, allowing proactive responses to change in network conditions.

QoD API is a key feature that enhances user experience. When the user presses the "boost" button, the application creates a QoD session that specifies the necessary service quality profiles (QoS). This process begins when the QoD session is in the REQUESTED state and changes to AVAILABLE once the network has allocated resources. (Nokia 2024g.) QoD sessions prioritize network connections, improving bandwidth and reducing latency, especially in congested areas.

When the user no longer requires enhanced connectivity, the QoD session can be disabled automatically after a predefined period or manually. At this point, the application releases network resources, transitioning the QoD session from the AVAILABLE state to the UNAVAILABLE state. This process ensures efficient use of network resources, freeing them up for other purposes. Users receive a notification when sessions end, confirming that their connection is reverted to standard service quality.

3.6 eSIM

The Embedded SIM (eSIM) is an integrated chip within mobile devices, functioning with equivalent capabilities to traditional physical SIM cards. Configured remotely, the eSIM enables over-the-air (OTA) management, allowing mobile devices to seamlessly connect to cellular networks. eSIM technology is widely available in consumer devices such as smartphones, tablets, and laptops. (Thales 2024.)

The adoption of eSIM technology presents multiple benefits. For users, eSIM facilitates immediate device activation upon powering on, downsizing the need for a physical SIM card. It also offers the flexibility to select local prepaid numbers when traveling, potentially reducing roaming costs. For mobile operators, eSIM expands the range of compatible consumer devices, thereby broadening the market for mobile network access. (Thales 2024.)

eSIM-compatible devices also provide a more secure option for internet connections, as they enable users to avoid dangerous public Wi-Fi networks that can expose them to cybersecurity threats. For this reason, eSIM is an ideal choice for professionals who require both reliable and secure connectivity, particularly in environments where the quality and security of connections are of paramount importance. eSIM technology not only enhances usability but also supports professionals in their daily work by facilitating more flexible and secure operations. (Voye Global 2024.)

The selected technology to enable 5G connectivity on end-user computing devices is the Embedded SIM (eSIM). In cases where eSIM is unavailable, a standard physical SIM card may alternatively be used to provide connectivity.

3.7 Remote Work

The practice of working from home has a history spanning nearly three decades, although it was significantly normalized by the global COVID-19 pandemic. The pandemic and subsequent government-imposed lockdowns in 2020 compelled many organizations to rapidly transition to remote work. The effectiveness of this model, however, varies based on the unique circumstances of each organization. Post-pandemic workplace trends have influenced industries in diverse ways, underscoring the varied challenges and opportunities inherent in adopting remote work practices. (Alain 2024.)

Unreliable internet connectivity represents a critical challenge in remote work. This issue can negatively affect essential aspects of communication, particularly during video calls. Such disruptions often result in problems like frozen screens, audio delays, or interruptions, undermining effective collaboration. (CloudTask 2024.)

The team selected remote workers as the target group due to the increasing prevalence and popularity of working from home, along with the associated challenges. Additionally, the team's personal experiences with remote work influenced this decision. In response to these challenges, the team identified an opportunity to innovate by leveraging the concept of Network as Code to address the commonly encountered pain points of remote work.

4 Development Methods

Among the development methods, the team utilized brainstorming and benchmarking. Benchmarking was employed to analyze and compare similar concepts already available in the market. Additionally, a survey was conducted to gather research data, providing a more comprehensive understanding of customer needs. The creation of a persona offered concrete representations of potential customer challenges and generated valuable insights into possible solutions. Collectively, these methods informed the development of a prototype that aligned with the perspectives and requirements of potential users.

4.1 Brainstorming

Brainstorming is a common practice in design thinking, where judgment and criticism are set aside to encourage the free flow of ideas. It is often an unstructured and intuitive process. (Straker & Wrigley 2023, 13.) However, the most successful outcomes are usually achieved through guided sessions. Techniques such as asking questions and role-playing different scenarios can help inspire creative and unconventional solutions. (Miro 2024.) During brainstorming sessions, participants explore both the problem and potential solutions simultaneously, which directly influences the design thinking process (Straker & Wrigley 2023, 15).

Brainstorming usually occurs in group settings, where individuals collaborate to generate ideas and creatively solve problems. It can also be beneficial for individuals seeking to explore new solutions to a problem. Taking time to work alone and writing down potential solutions is an effective way to brainstorm individually. By focusing on a specific problem, you can come up with multiple creative approaches to finding a solution. (Miro 2024.)

It is not only valuable for problem-solving but also helps team members gain insight into each other’s thought processes. It provides an opportunity for individuals to better understand each other’s strengths and weaknesses. Additionally, it encourages a more inclusive team environment and strengthens collaboration among team members. By creating an open space where everyone is encouraged to propose ideas, brainstorming helps draw out diverse perspectives, which can lead to innovative solutions that might not have been considered otherwise. (Miro 2024.)

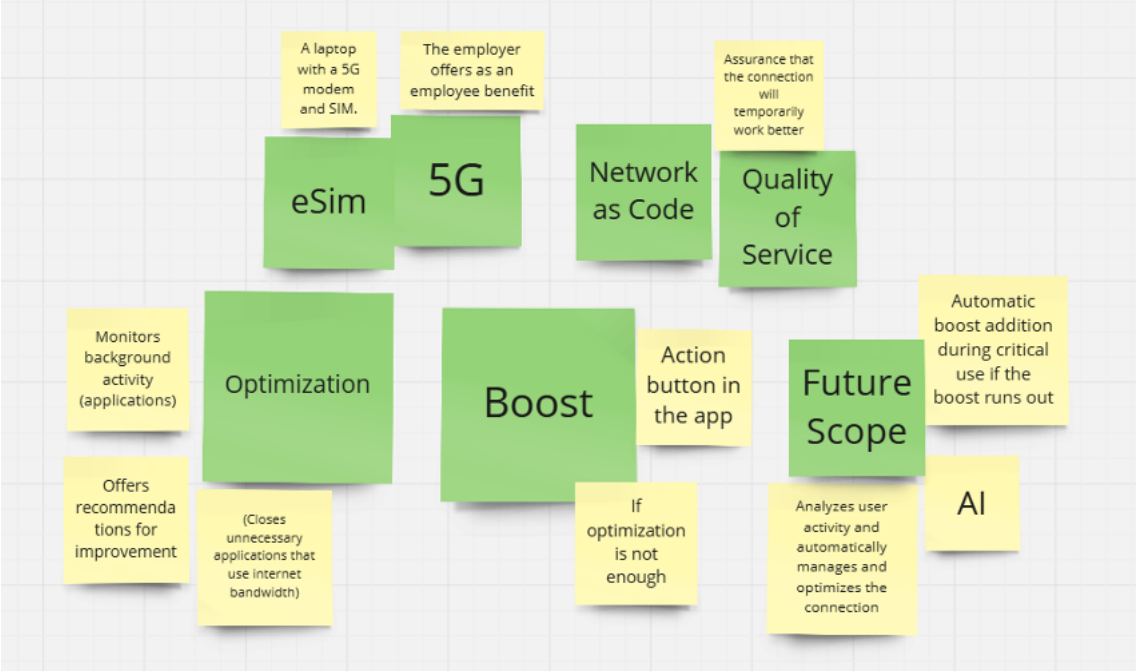

Figure 3: Collaborative brainstorming on sticky notes in Miro

During the sprint week, the team collaborated on a Miro board to generate ideas, discuss potential solutions, and document them. The ideas were then organized into categories for better clarity. This collaborative brainstorming process resulted in refined concepts and the development of a final solution.

4.2 Benchmarking

Benchmarking is a method aimed at finding ideas and solutions for similar factors from other organizations. Benchmarking examines how other entities function and succeed, with a goal of learning from them. It is important to identify a clear topic or focus for the benchmarking process. Information gathering can involve, for example, internet searches or site visits. After benchmarking, the results are analyzed and compared to one's own operations. Useful ideas can then be applied to one's own activities. (Ojasalo, Moilanen & Ritalahti 2015, 186.)

For benchmarking, the main selected topic was the internet connection boost feature. Since the boost feature is not a commonly available service on the market, we found it interesting to benchmark the few available services and compare them to our solution. Two operators, Elisa and Telia, offer internet connection boost services (Elisa 2024; Telia 2024). Operator Elisa offers an internet connection boost called Turbonappi for Finnish corporate customers (Elisa 2024). In Norway, operator Telia provides a data boost service for both corporate and private customers (Telia 2024). A comparison was made between these two companies and Nokia Remote Tool. The features compared included the boost time options and costs, boost

speed and speed assurance and boost ordering and notifications. The comparison between the benchmarked services and Nokia Remote Tool is compiled in Table 1.

Table 1: Comparison between the benchmarked services and Nokia Remote Tool

TOPICS	ELISA TURBONAPPI	TELIA DATA BOOST	NOKIA REMOTE TOOL
USERS	Corporate customers	Corporate and private customers in Norway	Corporate customers and remote workers
BOOST TIME OPTIONS	Day, week or month	1, 3 or 12 hours	Required time for the work task
COSTS	1,99 € / 24 h 9,99 € / week 19,99 € / month Paid by employer or employee.	19 NOK / 1 hour 39 NOK / 3 hours 99 NOK / 12 hours	Basic fee + boost fee by usage. Paid by employer.
BOOST SPEED	1000 Mbit/s / day 600 Mbit/s / week 300 Mbit/s / month	-	Quality-assured speed for specific app, max. 1000 Mbit/s. Basic speed 300 Mbit/s.
SPEED ASSURANCE	Not guaranteed. The device, location and network load affect.	-	Increases through network optimization
BOOST ORDERING	Via Elisa's website without logging in. Activates immediately.	Via the application or Telia's website after logging in. Activates immediately.	Via boost button or the application. Activates immediately or at the scheduled time.
NOTIFICATIONS	SMS notification when activating the service, one hour before the boost time is ending and when the subscription ends.	Notification when boost time is ending	Automatic pop-up window when boost is needed and boost time is ending.

Elisa and Telia offer three different boost time options (Elisa 2024; Telia 2024). Elisa's Turbonappi provides three fixed options: day, week or month (Elisa 2024). Telia offers shorter periods, limited to one, three or twelve hours (Telia 2024). For both services, the prices are fixed based on the boost duration (Elisa 2024; Telia 2024). Since Nokia Remote Tool is

designed for remote work and the boost feature is an additional service paid for by the employers, the boost time is defined based on the work task duration. As remote work tasks vary, flexibility in boost time options is necessary. This flexibility also helps to avoid unnecessary boost usage and extra costs for the employers.

A comparison of boost speed and speed assurance was made between Elisa's Turbonappi and Nokia Remote Tool, as there was no available information about these options for Telia's Data Boost service. Turbonappi's boost speed is determined by the selected boost duration. The shortest 24-hour boost period offers the fastest boost speed 1000 Mbit/s, while the longest boost period provides a speed of only 300 Mbit/s. (Elisa 2024.) Nokia Remote tool offers a basic connection speed of 300 Mbit/s and a faster boost speed, with a maximum of 1000 Mbit/s. The boost speed is activated only when the internet connection is deemed too slow for the required work task. This flexibility between different connection speeds ensures that a suitable speed is always available for specific tasks, thereby supporting efficient workflow.

Elisa's Turbonappi boost speed is affected by factors such as the device in use, location and network load, meaning it is not guaranteed to reach the maximum boost speed (Elisa 2024). In Nokia Remote Tool, network optimization plays a significant role in speed assurance, which could provide better performance compared to Turbonappi.

Elisa has made the ordering of the boost service easy, allowing it to be done directly via the website without requiring login (Elisa 2024). In contrast, Telia requires users to log in before ordering the boost via the website or mobile application (Telia 2024). In Nokia Remote Tool, boost activation can occur directly by pressing the pop-up boost button or through the application. Since the application is installed on the user's laptop, no login is required to activate the boost. Both Elisa's and Telia's boost services activate immediately after the order is completed (Elisa 2024; Telia 2024). In Nokia Remote Tool, the activation can happen either immediately or at a scheduled time, depending on the use case.

Both Elisa and Telia send a notification when the boost time is nearing its end, with Elisa notifying exactly one hour before (Elisa 2024; Telia 2024). Elisa also sends notifications about service activation and deactivation (Elisa 2024). Nokia Remote Tool notifies the user when the network connection is too slow and the boost is needed, through an automatic pop-up window with a boost button. Additionally, a notification appears when the boost time is about to end.

Benchmarking helped to clarify the most important key features of Nokia Remote Tool. Based on the comparison, the most beneficial features for Nokia Remote Tool are its flexibility in boost time, cost-efficiency from the employer's point of view, automated network optimization and efficient functionality.

4.3 Survey

Surveys are among the most commonly utilized methods for data collection, enabling the efficient gathering of substantial information from a large population. Due to this capacity, surveys are both effective and relatively quick to implement. The data obtained through surveys is also readily amenable to statistical analysis. Surveys can be administered through various modes, including questionnaires, online platforms, telephone interviews, or face-to-face interactions. Depending on the survey format, responses may be recorded directly by the interviewer or completed by the participants themselves. (Ojasalo et al. 2015, 121.)

It is essential to provide sufficient background information to ensure the reliability of survey results. Survey questions should be designed to be as clear and straightforward as possible, minimizing potential challenges for respondents and enhancing the accuracy of their responses. (Ojasalo et al. 2015, 122.)

The survey aimed to gather detailed information to inform the development of the Nokia Remote Tool. Insights provided by respondents supported the team in making modifications to the application and identifying areas for further improvement. A total of 33 responses were obtained, offering valuable data for this process. The questions posed are presented in Appendix 1.

Figure 4 demonstrates that 81% of respondents work remotely at least one week per month, while only 19% reported working remotely fewer than five days per month. These findings indicate that the survey successfully targeted the intended user group.

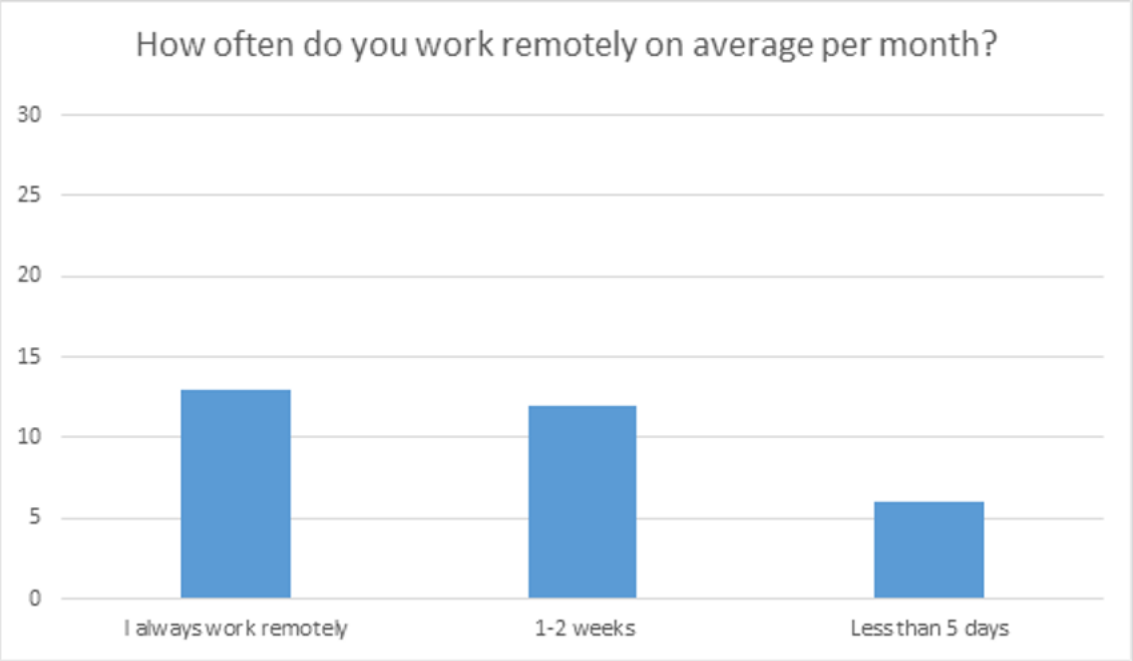

Figure 4: Remote workers based on responses

The primary objective of Nokia Remote Tool is to assist remote workers in securing a reliable network connection, particularly during video calls. The questions presented in Figure 5 were designed to determine the frequency of video call usage among respondents. The results aligned with the team's expectation of frequent video call use, as 77% of respondents reported using video calls daily. In contrast, only 10% indicated using video calls a few times per month, and 13% reported occasional usage.

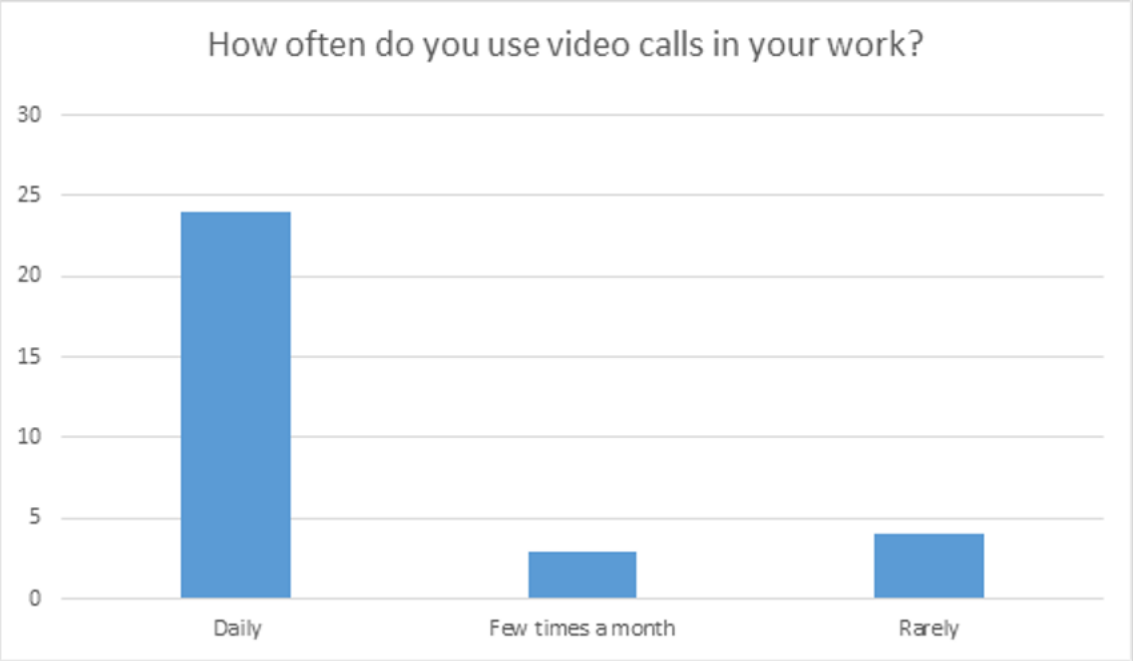

Figure 5: Use of video calls in remote work

The purpose of developing a prototype for the Nokia Remote Tool was to gain insights into the primary challenges encountered during a remote workday. To gather this information, respondents were asked how frequently they experience network connectivity issues. As shown in Figure 6, 48% of respondents reported encountering connection issues monthly, while 29% reported experiencing them weekly.

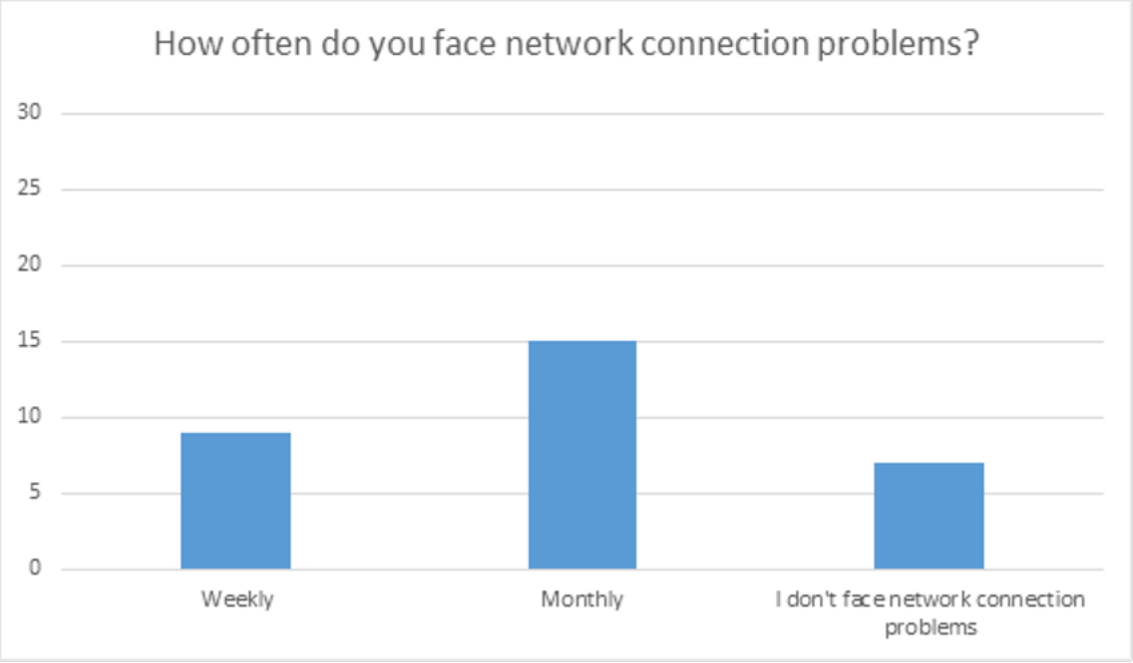

Figure 6: Frequency of network connectivity issues

At a more granular level, the team aimed to identify the specific types of challenges respondents encounter during the workday. As illustrated in the following figure (Figure 7), connectivity issues during video calls were the most prevalent, reported by 36% of respondents. Additionally, 23% of respondents indicated experiencing disconnections, while another 23% reported network slowdowns.

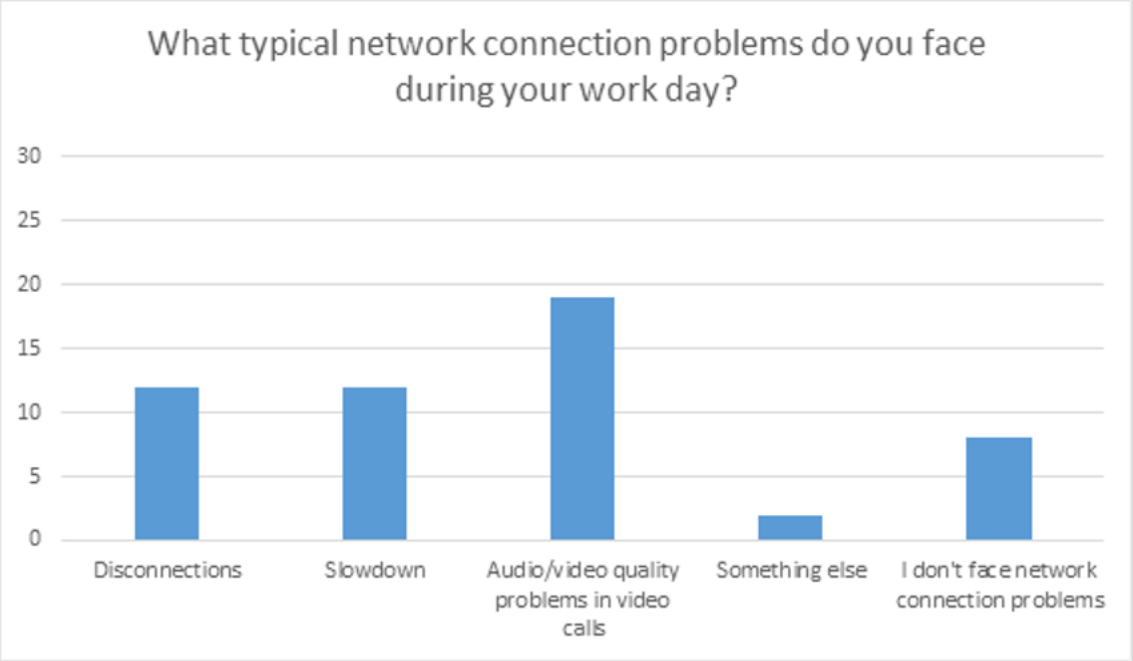

Figure 7: Various types of connectivity issues

Figure 8 illustrates that 71% of respondents believe network connection issues significantly impact work efficiency, while 26% indicated a minor impact. Only one respondent stated that such issues do not affect work efficiency. These responses highlight the potential need for a network-boosting tool.

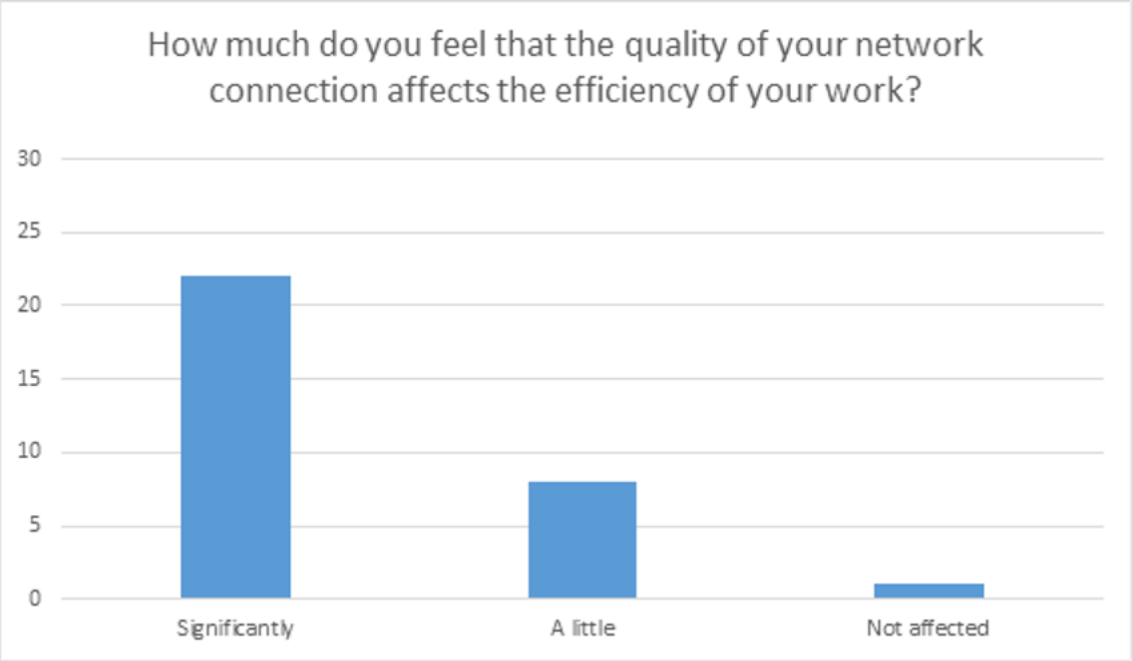

Figure 8: Impact of network connection issues on work efficiency

It was essential to understand the respondents' expectations regarding the tool. Among the respondents (Figure 9), 32% indicated a preference for receiving alerts prior to connection disruptions, while an equal proportion (32%) expressed a desire for automated prioritization of critical applications. Additionally, 18% favored the inclusion of simple action buttons. These responses guided the team in determining the priority functionalities for the tool.

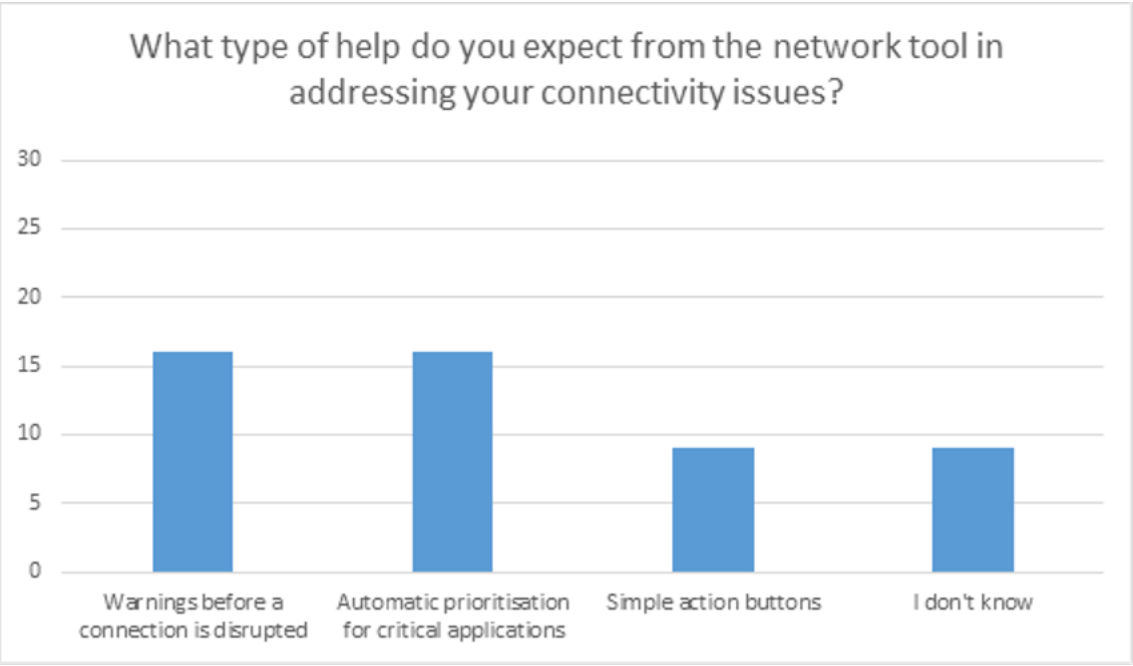

Figure 9: Expectations for the tool

The survey results indicate a potential market for this concept, as a majority of remote workers experience network connectivity issues that are likely to have a negative impact on their work. Based on these findings, the team was able to gather sufficient information to proceed with the development of the Nokia Remote Tool.

4.4 Persona

Personas are not real people, but they represent groups of users, including their motivations and behaviors. They offer insights into how users think, behave, and what they aim to accomplish. As a tool for ideation, personas help to gain an understanding of users' goals within a specific context. (Cooper, Reimann, Cronin & Noessel 2014, 62.)

For each primary persona, the design process begins with a thorough analysis of persona data and functional requirements. Priorities are established based on their specific goals, behaviors, and patterns of interaction with others across various contexts. (Cooper et al. 2014, 26.)

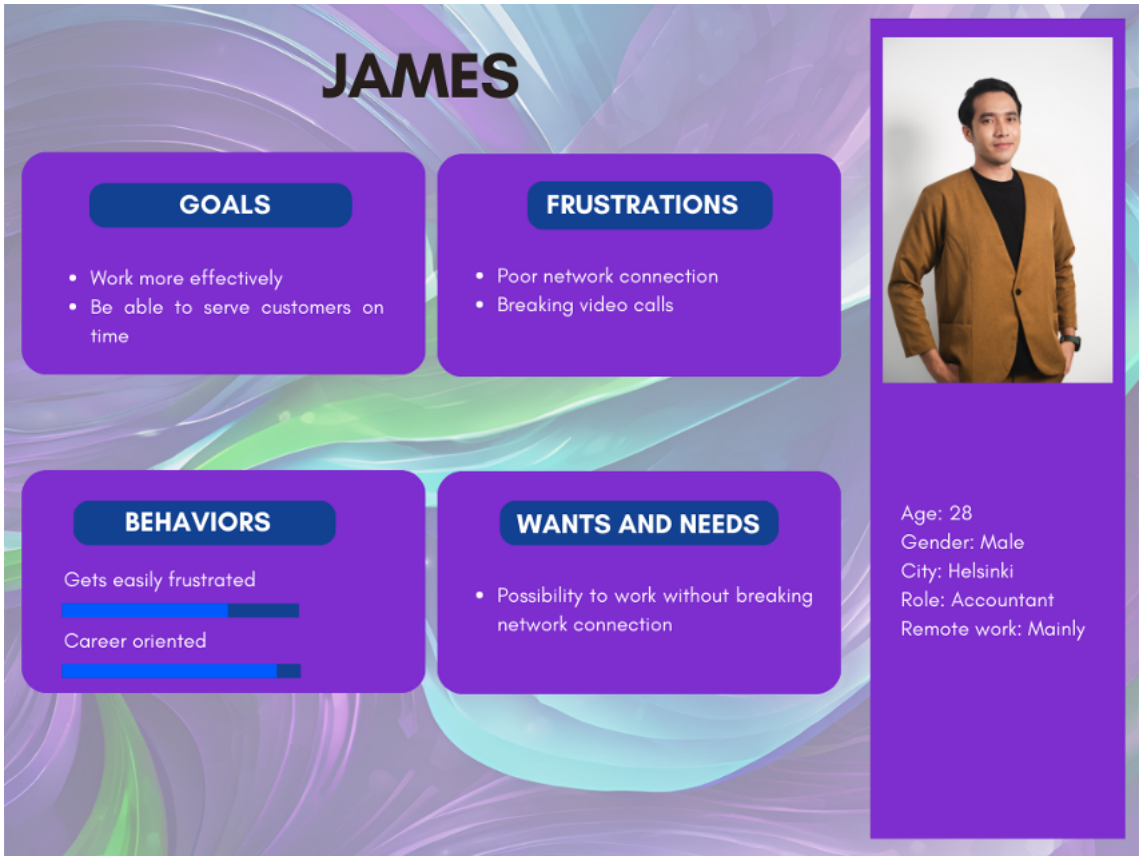

Figure 10: Persona

As part of the Sprint week, the team developed a persona to represent a potential user of the digital product. The persona is a remote worker who frequently encounters frustration due to

poor network connectivity and video call disruptions. His primary goal is to work efficiently and meet customer needs on time. He is career-oriented and becomes easily frustrated when technology fails to meet his expectations. The creation of this persona was informed by survey responses from individuals working remotely.

This persona was prominently featured in the Sprint week pitch, where the team introduced the Nokia Remote Tool through a scenario illustrating the persona's experience of encountering internet connectivity issues during a meeting. The solution enabled him to boost his connection via a pop-up interface, allowing him to continue the video call seamlessly and with satisfaction. This scenario was selected to emphasize a common challenge faced by remote workers and to demonstrate the practical benefits of the proposed solution.

5 Nokia Remote Tool Concept

During the development phase in Sprint week, the team created a concept called Nokia Remote Tool. This application enhances the user’s internet connection by optimizing and analyzing its performance. It is designed specifically for people who work remotely. Employers order the service and provide employees with devices equipped with a SIM card or eSIM with 5G connectivity. The main features of the application include a boost feature, as well as optimization and analysis of the user’s internet connection. These features leverage Network as Code and 5G technologies such as network slicing, Quality of Service and Quality of Service on Demand. The application addresses common pain points in remote work, as identified in our survey, including unreliable internet connections, dropped video calls and slow internet speeds.

5.1 Prototype Overview

Once the concept was clarified, the team built a protype to demonstrate the basic functional idea of the concept. A prototype is a visual demonstration of the product. It is beneficial in communication between designers and customers, as it helps to explain the concept’s visual appearance and functionality. (Saariluoma et al. 2010, 133.)

This prototype overview demonstrates the core functions of the application, with a focus on boosting connection. The automatic boost suggestion is illustrated in the video meeting context. Following that, the application interface is reviewed, and the three main functions, Boost Settings, Optimization and Analytics, are explained.

5.1.1 Application Installed on the Device

Nokia Remote Tool is an application that must be installed on the user's device. Figure 11 shows the application installed on the laptop, with its icon on the desktop serving as a shortcut to the application interface.

Figure 11: Application icon on the desktop

Since the application utilizes 5G connection features for operation, the device must have a SIM card or eSIM installed, and 5G connection provided by the selected operator. The employer provides the user with the required device, with Nokia Remote Tool installed on it. The application is connected to the employer's IT department, which receives analytics on connection usage and decides on requests for additional boost time. This will be explained in more detail in chapter 5.1.3.

5.1.2 Boosting During a Video Call Meeting

Since the survey revealed that unreliable internet connections during video calls were a common challenge among remote workers, the application's boost feature is presented in the video call context. Figure 12 demonstrates the user's view during a video call. If the network connection is too weak, the user is notified of that via a pop-up on the screen. From the pop-up, the user can choose to activate the boost option immediately or access the boost settings. Alternatively, if the user doesn't want to decide about the boost option, they can close or minimize the pop-up window by clicking the options in the top-right corner. This ensures that the pop-up window does not disturb the user during the meeting.

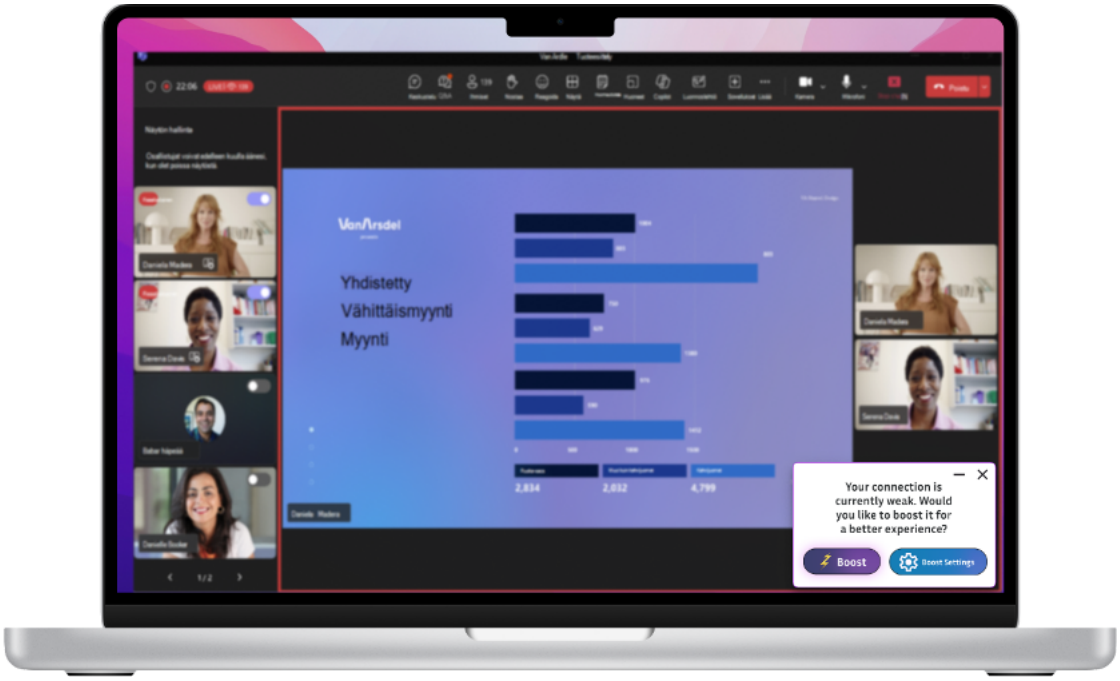

Figure 12: Pop-up window with notification

The pop-up window appears when the Nokia Remote Tool detects a poor internet connection. The application runs in the background while the user completes tasks, analyzing the connection in real time and enabling automatic notifications when the resource, in this case, the video call application, requires more bandwidth to function properly. The technical details of the pop-up feature are described in more detail in chapter 3.5.

When the user clicks the Boost button (Figure 12), the pop-up window will display the message “Boost activated!” along with the “Stop Boost” button (Figure 13). After a few moments, the pop-up will automatically minimize into a small icon, as shown in Figure 14.

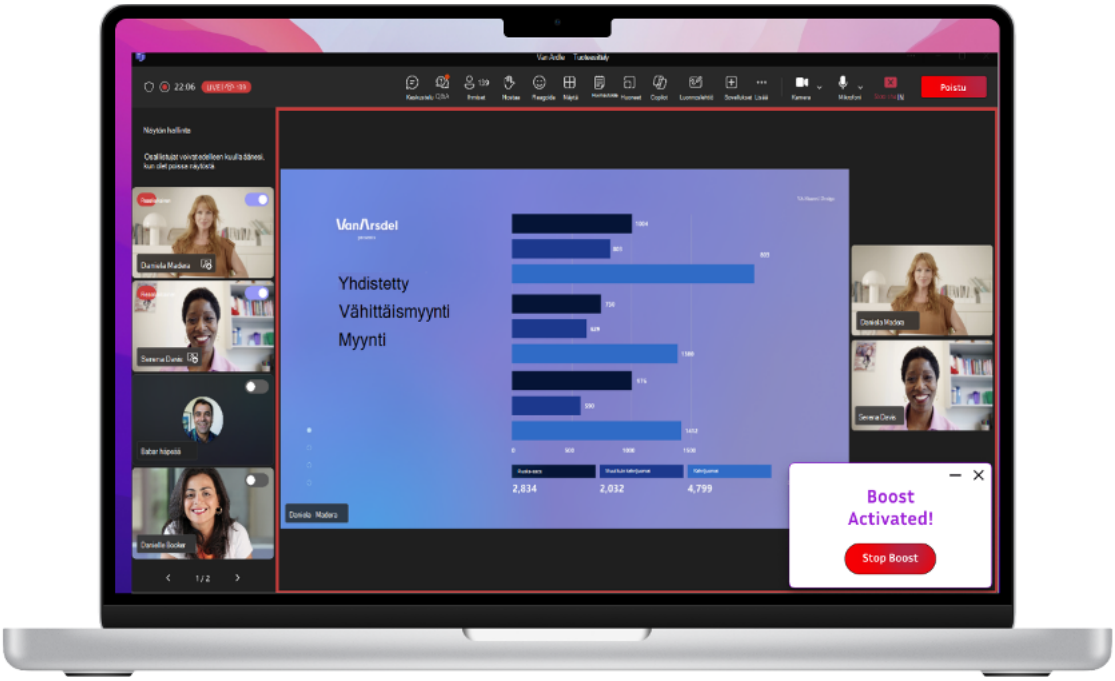

Figure 13: Pop-up window with boost activation enabled

The boost speed is defined by the needs of the application. Nokia Remote Tool offers a basic connection speed of 300 Mbit/s, and a maximum boost speed of 1000 Mbit/s. Quality of Service on Demand allows the adjustment of the boost speed in real time by analyzing the required connection speed, as described in chapter 3.3.

When the boost is activated, the boost time window will remain visible as a smaller icon with a flash figure in the bottom-right corner (Figure 14). This reduced icon ensures that the boosting information doesn’t disrupt the user experience, while still providing easy access to boost time details if needed.

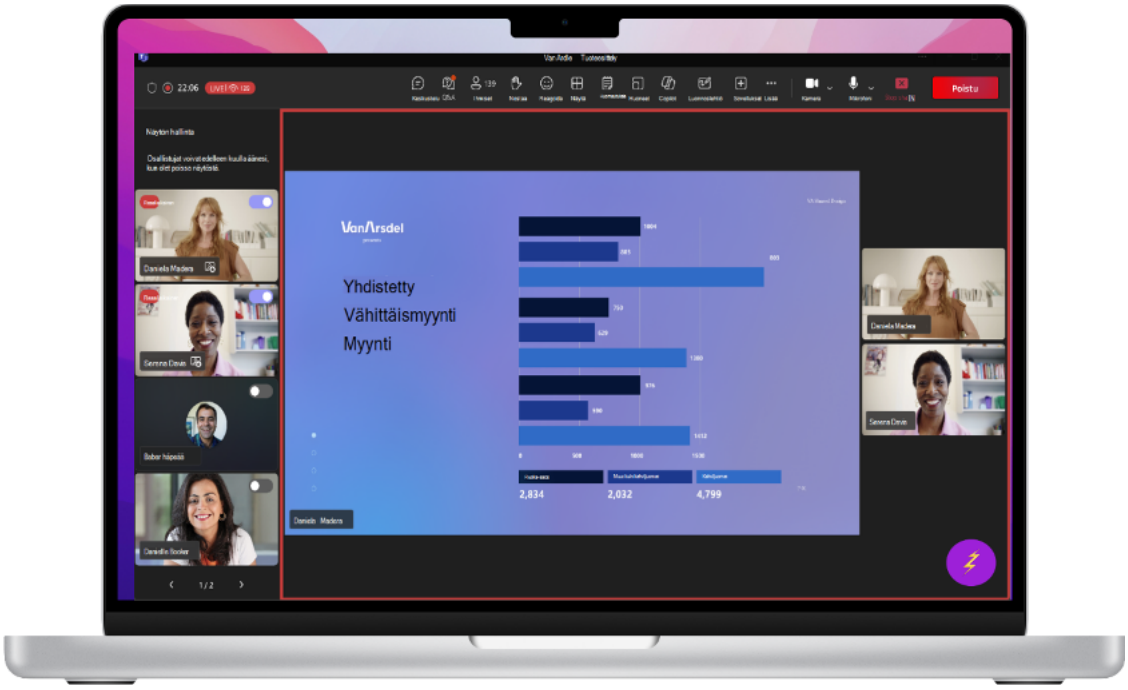

Figure 14: Minimizes boost window displayed as an icon

When the user clicks the boost icon (Figure 14), the boost time information will appear (Figure 15). If the boost session has a defined time, this will show both the time used and the remaining boost time. The user can minimize the pop-up window and continue the session (Figure 14). Alternatively, they can manually end the boost before it expires automatically, or they can access the boost settings.

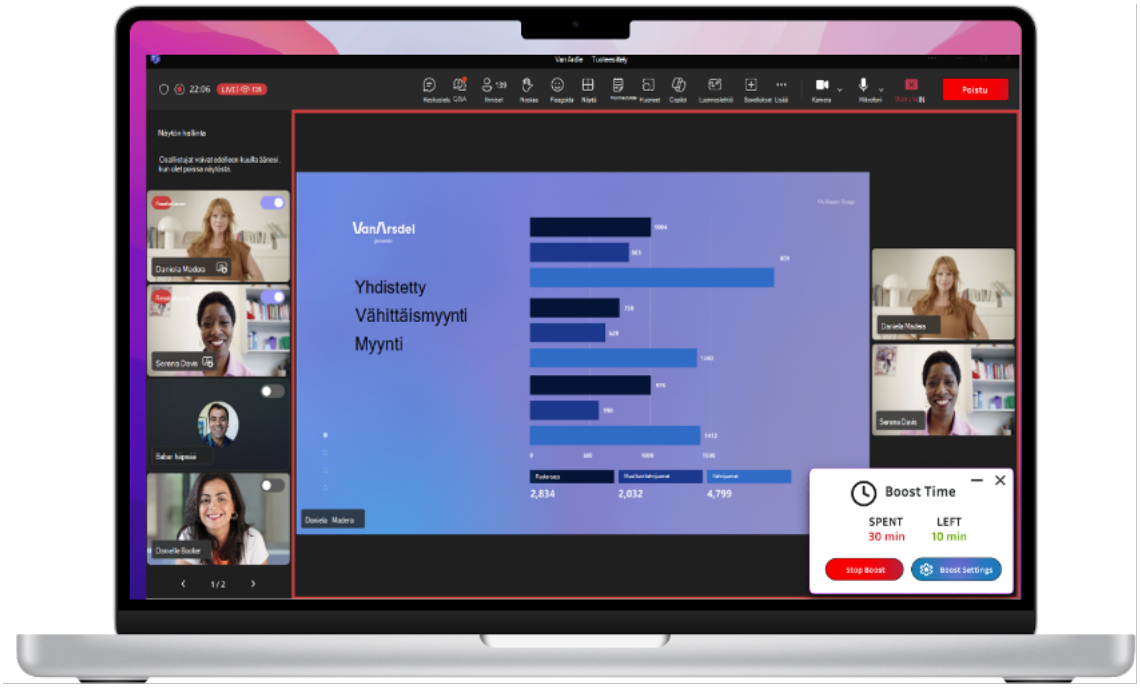

Figure 15: Pop-up window showing boost time details

If the session has a defined boost time, the boost icon will notify the user as the boost time nears its end (Figure 16). Notifications will appear, for example, 10, 5 and 1 minute(s) before the boost expires. The design of the notification window is simple yet clear, with the remaining time clearly visible without interrupting the user too much.

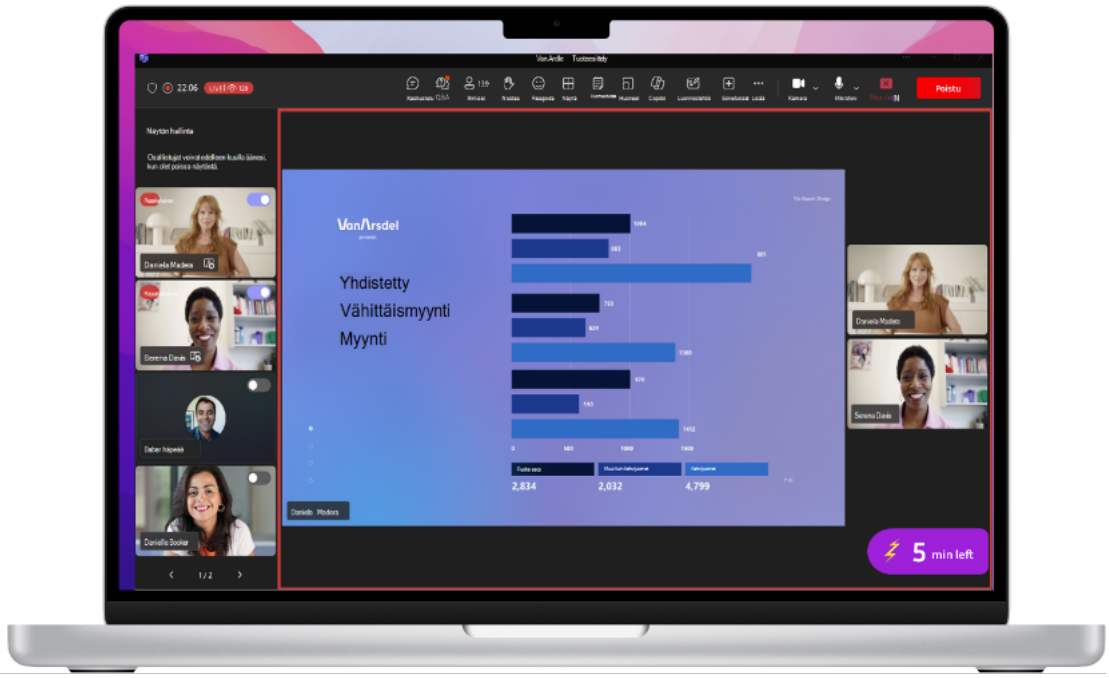

Figure 16: Boost icon with notification of remaining boost time

The user can add more boost time from the boost settings, which can be accessed directly from the boost pop-up window, as shown in Figure 15. When the boost ends, the connection speed is reverted to the basic speed of 300 Mbit/s.

5.1.3 Boost Settings

Figure 17 demonstrates the interface of the Nokia Remote Tool application with The Boost page open. The navigation bar includes direct links to the Boost, Optimization and Analytics pages. Additionally, application settings and language options can be accessed directly via specific icons in the top-right corner of the navigation bar.

Additionally, along with the automatic boost suggestions, the user can manually boost the connection themselves. If the user wants to ensure a fast connection for a specific task, they can activate the boost directly from the Boost page. The user can select one or more resources to boost and set the desired duration for the boost. The boost will start immediately once the user presses the Boost button.

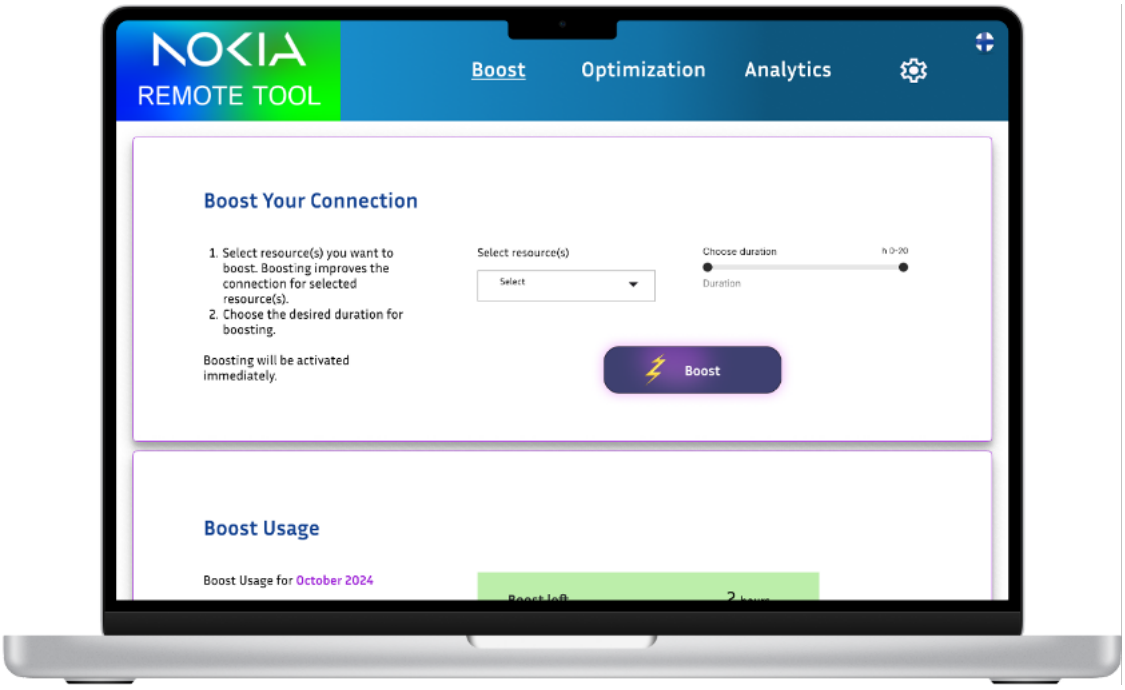

Figure 17: Boost activation settings

The boost activation requires that the user has sufficient boost time remaining. Employers define the amount of boost time each employee is allowed per month. In the application (Figure 18), the user can view how much boost time they have remaining and how much they have already used.

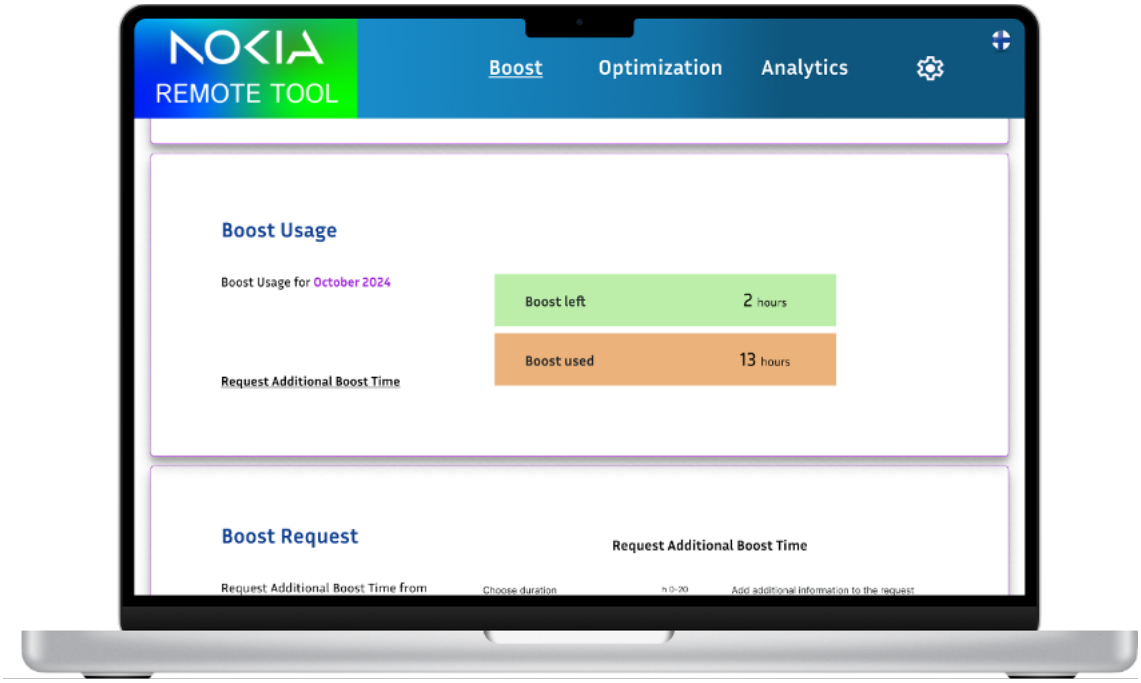

Figure 18: Boost usage information

The Boost Request section offers the user the option to request additional boost time (Figure 19). This is particularly useful when the user is running low on boost time and has an important work task ahead that requires a reliable connection. The user can request more boost time by selecting the desired duration, adding relevant details such as information about the work task, and submitting the request to the company's IT department (Figure 19).

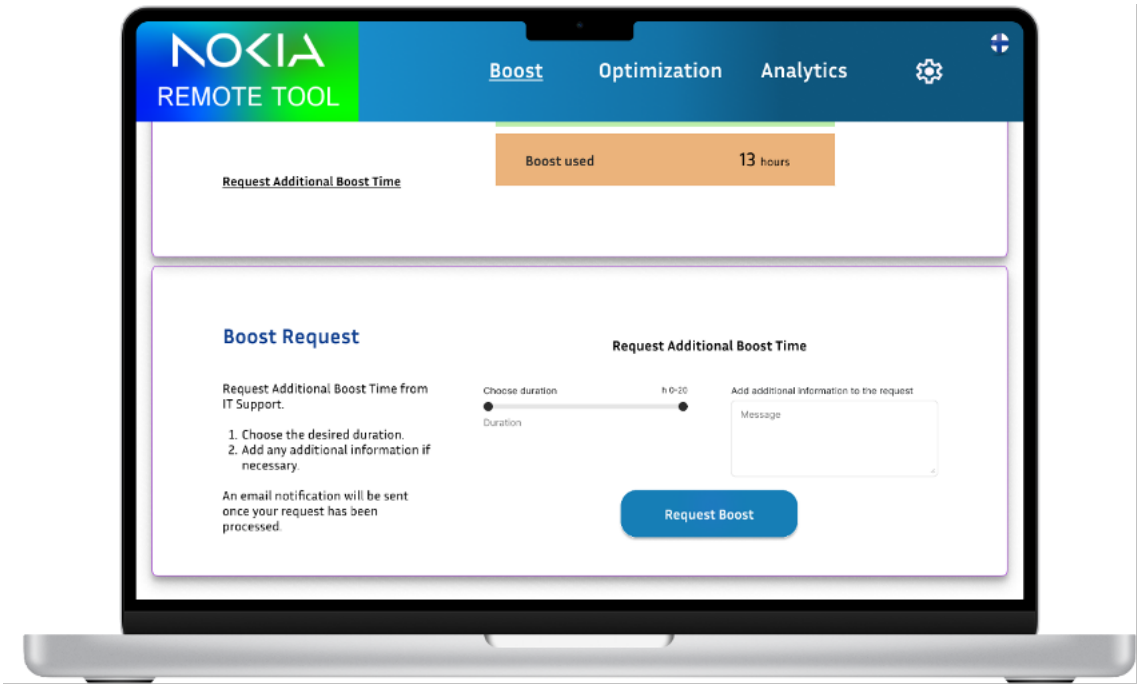

Figure 19: Boost request

The company's IT department will decide whether to grant additional boost time to the employee. The decision can be made with the help of analytics on the employee's boost usage, as displayed by the application. An email notification will be sent to the user once the boost request has been processed.

5.1.4 Optimization and Analytics

In addition to the boost feature, the application continuously optimizes and analyzes the internet connection. Optimization provides suggestions for improving the connection, such as recommending the user to turn off the applications that consume a large amount of bandwidth and slow down critical processes. Figure 20 demonstrates the optimization view with an optimization suggestion displayed in the upper-right corner.

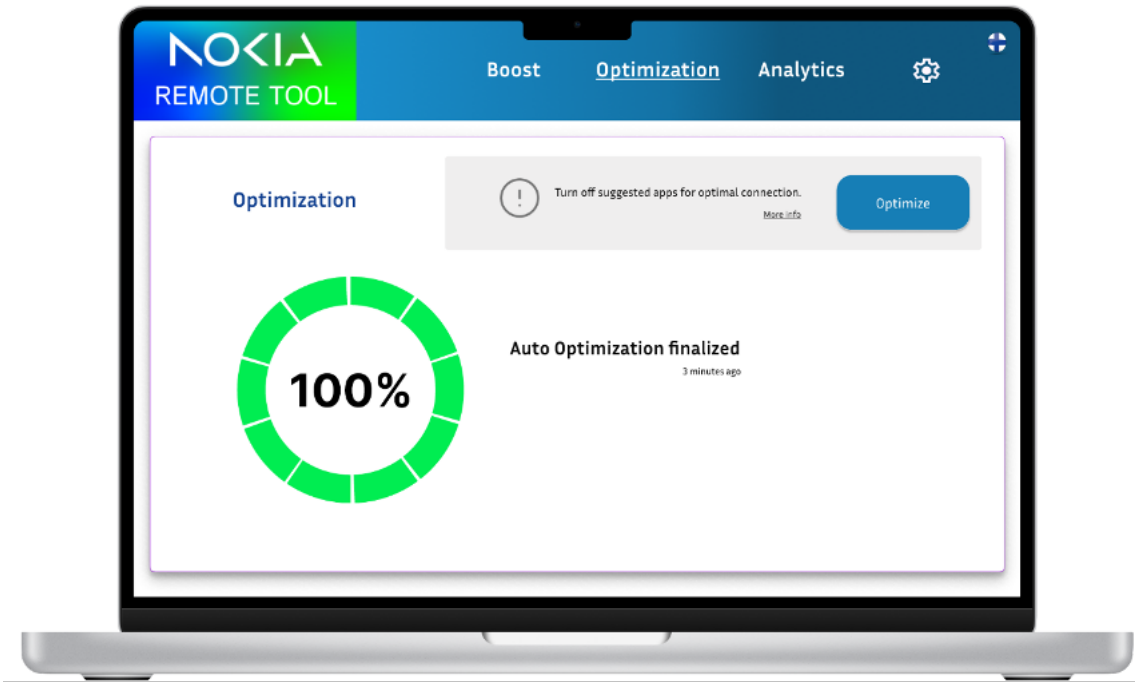

Figure 20: Optimization view with an optimization suggestion

If the user wants to view a list of the applications the optimization suggestion refers to, they can click the “More info” text link. When the user clicks the Optimize button (Figure 20), the applications will be closed automatically, and optimization will take place. Figure 21 demonstrates the view after the optimization is complete.

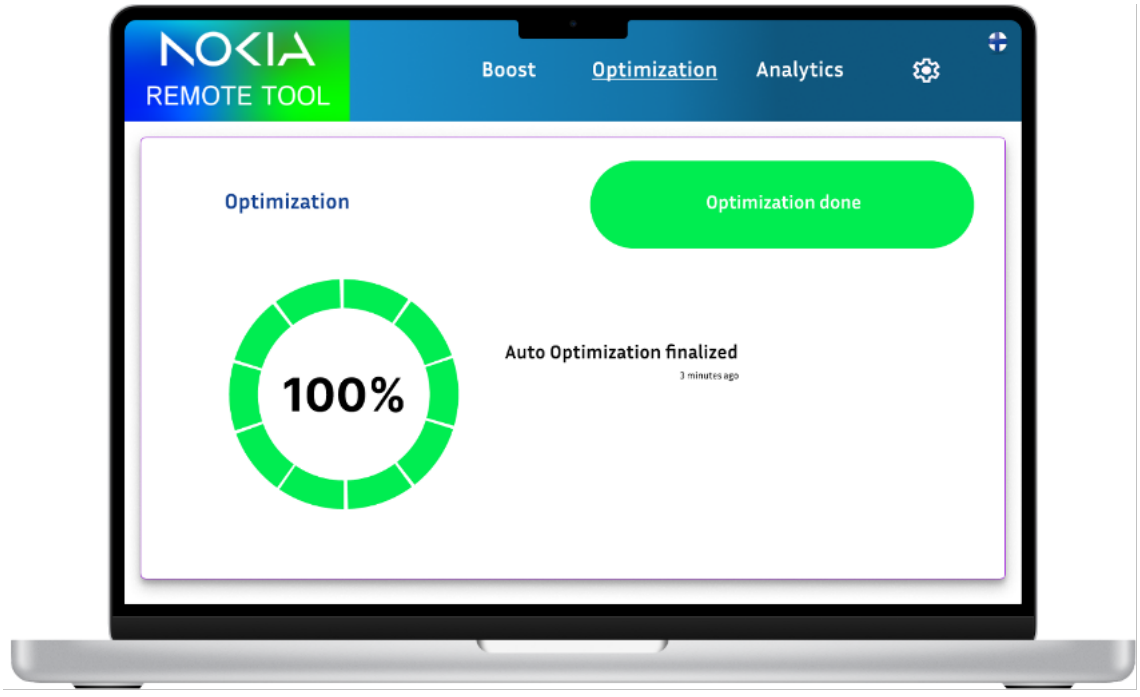

Figure 21: Optimization view with optimization completed notification

Network optimization ensures an efficient workflow and enhances the user experience. Automated optimization requires no effort from the user to maintain an optimized connection, while the optimization suggestions provide an opportunity to control operations that may be important for the user. Network optimization is achieved through techniques such as network slicing, Quality of Service and Quality of Service on Demand, as described in chapter 3.2. and 3.3.

From the Analytics page, the user can view various analyses of the internet connection usage gathered by the application. Figure 22 demonstrates bandwidth usage of each application over a specific time.

Figure 22: Analytics of bandwidth usage by applications

The analytics section provides a comprehensive and detailed overview of, for example, connection usage by the applications, as well as analytics on data downloads and boost usage. This information would also be available to the company's IT department via their application interface. This could be particularly beneficial, for instance, in cases where the need for a boost in usage by employees needs to be evaluated. This way, analytic information helps the company control the use of the service in a cost-efficient manner.

5.2 Prototype Feedback

After the Sprint week, the prototype was converted into a clickable version to make it easier to use during the testing phase. The testing was conducted by potential end users of the

application. Some changes were made after the testing based on feedback received from these potential end users.

The feedback on the prototype was mostly positive. It was seen as simple and clear, with important actions easily visible. The notifications on the video call screens were considered informative, and it was easy to navigate to the application settings from the boost pop-up window and the application icon on the desktop after the boost session.

Based on the feedback, pop-up notifications were slightly improved. The pop-up now automatically minimizes into a smaller icon (Figure 14), which was added to ensure a better user experience during video calls. Additionally, a notification about the remaining boost time was added to the icon to alert the user when the remaining time is nearing its end (Figure 16).

The application interface received positive feedback, especially regarding the navigation between pages and the boosting selection process. The action buttons were visually appealing and easy to understand. Based on the feedback, the information texts were added to the boost activation settings and boost request sections (Figures 17 and 19), making the process even more informative for the user. Additionally, some minor updates were made to the interface, including the addition of an icon with language options in the banner and a time display in the Boost usage information.

The testing revealed a need for an interactive guide or shortcut icons that explain the function of each feature for first-time users of the application. This could be included in the final version of the application.

5.3 Benefits of the Nokia Remote Tool

The development of the Nokia Remote Tool provided multiple advantages. For Nokia, the solution leverages partnerships with operators and businesses, enhancing service offerings and contributing to increased market share. Innovations such as Network as Code enable the creation of new revenue streams and foster technological advancements, solidifying Nokia's position as an industry leader.

From a customer perspective, the solution offers the ability to purchase additional bandwidth or enhanced connectivity tailored to specific needs. This approach not only creates new revenue opportunities for network providers but also enhances customer satisfaction by helping to fulfill individualized connectivity requirements.

The Nokia Remote Tool also benefits organizations by enhancing employee efficiency through seamless connectivity, thereby minimizing disruptions that could otherwise lead to significant operational challenges. By reducing downtime and interruptions, companies can achieve

substantial cost savings and focus on growth and innovation rather than resolving connectivity issues. End users benefit from streamlined workflows free from internet-related disruptions, reduced stress during critical meetings, and an overall improvement in job satisfaction.

6 Conclusions and Future Scope

The research conducted for the Design Sprint process and the thesis has revealed that remote workers often face issues such as weakened connections and interruptions, which negatively affect work continuity and productivity. The Nokia Remote Tool application addresses these challenges by improving network quality and optimizing connections in real-time, reducing interruptions and enhancing efficiency.

For Nokia Corporation, this solution provides value by improving the company's ability to offer innovative solutions for remote work, thereby increasing its competitiveness in the global market. Additionally, it opens new opportunities for collaboration with operators and other stakeholders, creating new business models and opportunities for delivering customer value. As a result, Nokia Remote Tool also supports Nokia Corporation's strategic objectives.

The solution also offers good opportunities for further development, particularly in leveraging artificial intelligence. Currently, network optimization in the Nokia Remote Tool relies on predefined algorithms that make adjustments according to set rules. However, with AI, network optimization could become more real-time and adaptive, automatically adjusting to the needs of users and applications without requiring manual intervention. This would improve the overall efficiency of remote work and the network’s ability to respond to changing conditions.

AI could also enhance the security of the Nokia Remote Tool by continuously monitoring network traffic for anomalies and suspicious behavior. It could automatically detect threats, such as malicious traffic, and trigger immediate security measures, such as strengthening encryption or securing connections. This would increase the security of remote work environments, particularly by protecting users and devices from potential cyberattacks, while also improving the reliability of the network.

Additionally, AI could enable adaptive toolsets that automatically adjust resources based on the user’s specific needs. In a remote work setting, AI could analyze the user’s tasks and dynamically optimize network resources, ensuring that the most suitable tools and connections are available for each task. This would increase the flexibility and efficiency of remote work, as the network and tools would adjust seamlessly in real time to the evolving needs of the user and applications.

In the future, tools like the Nokia Remote Tool could play a crucial role in the development and advancement of remote work environment management. It could offer significant opportunities that might make remote work more flexible and productive. This thesis has highlighted how advanced technologies could provide solutions to current workplace challenges and lay the foundation for innovative future practices that would benefit both end users and Nokia Corporation.

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This report was written with the assistance of the artificial intelligence tool ChatGPT, which was used to verify the spelling and improve the overall flow of the text.

Figures

Tables

Appendices

Appendix 1: Survey questions

1. Ikä
2. Millä alalla työskentelet?
3. Mikä on työtehtäväsi?
4. Kuinka paljon teet etätöitä keskimäärin kuukaudessa?
5. Missä teet etätöitä?
6. Kuinka usein käytät videopuheluita työssäsi?
7. Mitä tyypillisiä yhteysongelmia kohtaat työpäiväsi aikana?
8. Kuinka usein kohtaat yhteysongelmia?
9. Mitkä työtehtävät vaativat kohdallasi varmimman verkkoyhteyden? (Esimerkiksi videopuhelut, tiedostojen lataus).
10. Kuinka paljon koet, että verkkoyhteyden laatu vaikuttaa työn tehokkuuteen?
11. Kuvaile etätyötilannetta, jossa verkkoyhteys on aiheuttanut haasteita tai hidasteita työtekoon. Mitä olet tehnyt vikatilanteessa?
12. Minkälaista apua odotat verkkotyökalulta yhteysongelmien korjaamiseen?
13. Mitkä ovat tärkeimmät teknologiat ja työkalut, joita käytät säännöllisesti etätyössäsi?
14. Toivoisitko, että työnantaja tarjoaisi yhteyden boostausta?
15. Millaisissa tilanteissa yhteyden boostauksesta voisi olla hyötyä?