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# KPI Report Creation and Automated Data Flow to Power BI Platform

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## Abstract


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One of Nokia's primary services is the 5G network services. The performance and capability of 5G software packages are measured as key performance indicator values. The Nokia Field Verification department has several teams working on 5G testing. These teams use different ways to create reports to show the results of their testing. The process of creating reports currently requires manual work and is impractical. The reporting process needs updating.

This thesis introduces the new Power BI report for showing data from 5G testing and automated data flow to that report. The project's primary objective was to unify the way of the reporting process among teams. For teams to switch to this new reporting process, the Power BI report must be adaptable and fit every team's purposes.

The development process was split into two parts. First, the automation was implemented. After successfully transferring data automatically to Power BI the report creation was started. The test data needed some editing for the report purposes, and this was done during the implementation process of the project.


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Keywords: KPI, Power BI, Power Automate, 5G, base station, network


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5G verkkopalvelut ovat yksi Nokian tärkeimmistä palveluista. 5G ohjelmistopakettien suorituskykyä mitataan Key Performance Indikaattorien (KPI) avulla. Tällä hetkellä moni KPI datan parissa työskentelevä tiimi käyttää omaa tapaansa luoda 5G testauksen tuloksista raportteja. Raportin luominen vaatii manuaalista työtä, eikä nykyinen tapa ole käytännöllinen, ja vaatii siksi päivittämistä.

Tässä opinnäytetyössä esitellään uusi Power BI raportti testitulosten esittämiseksi, ja kuinka testauksesta saatu data voidaan siirtää automaattisesti Power BI alustalle. Työn päätarkoituksena oli yhtenäistää raportointiprosessi samanlaiseksi tiimien välillä. KPI tulokset esittävän Power BI -raportin on oltava mukautuva ja sopia jokaisen tiimin tarkoitukseen, joka mahdollistaa sen, että kaikki tiimit siirtyvät käyttämään uutta raportointiprosessia.

Kehitysprosessi jaettiin kahteen osaan. Datan automaattinen vienti Power BI alustalle toteutettiin ensimmäiseksi. Tämän jälkeen luotiin raportti, jossa data esitetään graafisessa muodossa. Data vaati muokkausta raporttia varten, joten muokkauksia tehtiin koko projektin kehittämisprosessin ajan.

# Contents

## List of Abbreviations

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| KPI: | Key Performance Indicator |
| gNB: | gNodeB |
| eNB: | eNodeB |
| JSON: | JavaScript Object Notation |
| BTS: | Base station transceiver |
| RAN: | Radio access network |
| NSA: | Non-Standalone |
| SA: | Standalone |
| Hz: | Hertz |
| MHz: | Megahertz |
| GHz: | Gigahertz |
| SQL: | Structured Query Language |
| DAX: | Data Analysis Expressions |
| BI: | Business Intelligence |
| MIMO: | Multiple Input, Multiple Output |

# 1 Introduction

In 5G Field Verification, Key Performance Indicators KPIs are measurement results of 5G testing and evaluate the network performance. These measurements are obtained through test drives in a field environment. The test environment is the geographical area formed by signals transmitted from base station cells. The current project focuses on test drives in the field, but 5G could also be tested in a lab environment. Comparing the current test results to previous results of similar test drives provides a good understanding of the current state of the software package being tested. Comparison between test drives could be done for example in software, base station, or at a cell level.

KPI data is displayed as numeric values, generated through calculations based on counters. Counters are variables in the code of the network software, that increase when a defined event happens. KPI indicators can exist in many thousands so presenting this big amount of numeric data for managers and customers is unnecessary and ineffective. The ideal way for presenting the network performance as KPI data is a compressed but still informative format. That could be done for example with different visualizations and by filtering the KPI data to show only the most important KPIs. KPI data is collected from base stations during test drives and converted to KPI indicators through calculations.

Currently, many teams in Nokia working with 5G testing are using their way to create reports for showing 5G testing results as KPI values. Report creation is a manual process, and this current way is impractical and requires updating. If the reporting process is implemented as automated as it can be, time and effort can be saved.

This document introduces the creation of a Power BI report that shows the most important KPI data values in a visual format. Also, the automated data conversion from the KPI tool to this Power BI report is presented. The automation process is a temporary solution because the tool producing the KPI indicator results is going through changes. A more sustainable solution will be available in the spring of

2024. This document aims to answer questions of why, what, and how the automation and the KPI data visualization were carried out at this stage. The paper discusses the programs used in this project and the fundamental concepts related to 5G testing.

First, the paper discusses the project idea and the background, followed by the planning section. The project implementation including the automation process, report creation, and visualization will be examined in detail. Finally, the result of the project is presented at the end of the document and future ideas are discussed.

# 2 Problem and Methods

There are many thousands of KPIs, so how should the results of 5G network testing be presented to management in a short and informative format? Since the network is wide and complex, various teams work with KPI data and create reports of the results in their own way.

This section introduces the reasons behind the current project. First, the current and impractical ways of creating KPI reports are presented. Following that is discussed about, how the new KPI report automatic data transfer and visualization is planned to be implemented in the Power BI platform.

## 2.1 Problem

Figure 1 illustrates the entire KPI reporting process, beginning from a base station (BTS) to a .csv format. Currently, every test team has its own way of creating KPI reports. Most teams use Excel for analyzing and reporting. Also, PowerPoint is used for creating result reports that include pictures of Excel tables. These reports lacked a common framework or structure. As a result, there are many kinds of reports depending on the team in question.

The project's goal was to replace Excel and PowerPoint reports with one common Power BI report. The reason for this was to better utilize the data visualization capabilities of Power BI. It is also very slow to make PowerPoint documents by first making Excel tables and then pasting pictures from Excel to PowerPoint. This reporting is done with every software package tested so it takes a lot of time and needs effort. Reporting could be done in a more time-saving and efficient way with a common report template for all teams.

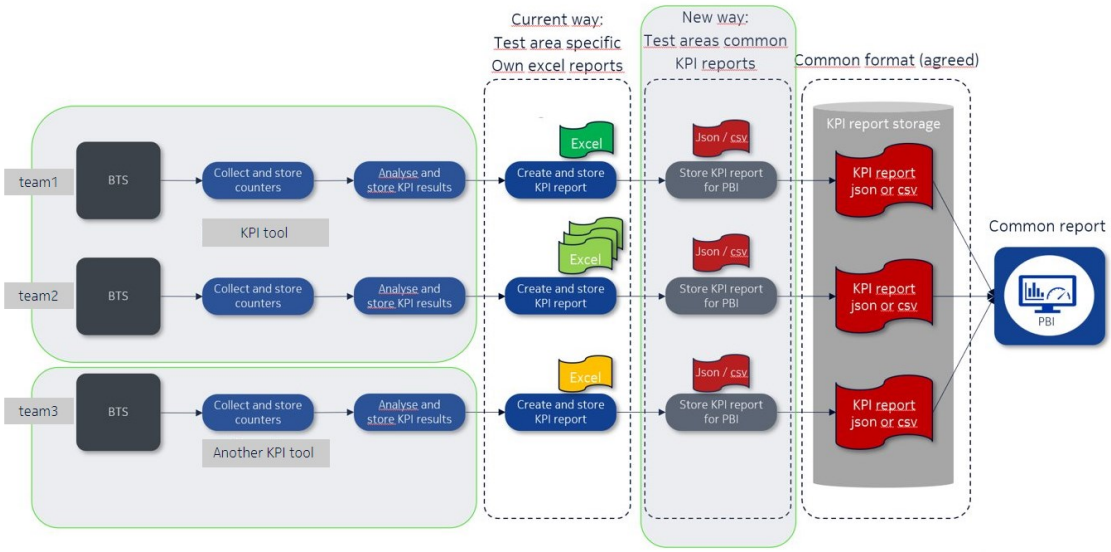



Figure 1. The process of the current way of reporting and the new way of reporting with Power BI.

The idea for a common KPI report for all teams was raised already about a year ago. There was one simple Power BI report, but it was never adopted for wider use due to its very limited features. Getting data to the report needed manual work and involved exporting KPI data as .json or .csv format from the KPI tool and transferring it to a shared network drive. Then one Power BI specialist had to combine this new data with the Power BI report. This method was inefficient and required improving actions.

The idea of a new unified reporting method with Power BI was considered highly important, leading to implementing the report as a bachelor's thesis.

## 2.2 Goals

The primary objective of the project was to automate the KPI data transformation to Power BI and generate an informative summary with visuals representing the network testing results. The report should be in such a format that the teams working with the KPI data can use it to show the results of 5G testing to the management and customers. A visual presentation about KPI indicators is useful especially when comparing changes over time. Visual information is easier to interpret than numerical data presented in a table. A quick look at visually presented data can already give some idea of how the network performance is improved. The end-users are busy managers who do not have the interest or time to fall deep into the results, so this informative visual concept is an important factor.

All teams are not yet using that internal KPI tool for collecting KPI data. One longer-term goal is to demonstrate that this new report in Power BI is practical for showing the test results so that the teams start to use the KPI tool more in their testing. As a result, teams can disregard all other analyzing and reporting tools that they are using. KPI tool for analyzing KPI results and Power BI for showing the most important results should be enough. This will simplify the process and reduce the use of many different programs. Ultimately the amount of work will be reduced because there are fewer programs to maintain, and this will also simplify the process of teaching new employees. That will also provide a financial gain when time becomes available for other important tasks.

## 2.3 Planning and Methods

The automation process was planned to be implemented with Power Automate. Power Automate offers automated action that completes a data refresh in the Power BI workspace when a file is added to a SharePoint folder.

At this stage, the export will still need a little manual work. The user must export the file and transfer it to the SharePoint folder. In the future, the functionality will

be changed so that the data is stored in the KPI tool, and the user only specifies which results will be shown in the KPI report. The desire is that Power BI uses the KPI tool's database directly as a data source. This new feature is now under development by Nokia's KPI tool specialists.

The decision to use Power BI for the report was predetermined because Power BI was widely used in Nokia. Other business intelligence (BI) options would be, for example, Tableau or Looker, but since Power BI was commonly used in the company it was a clear choice.

The project was planned to be implemented in smaller phases. First, the KPI report will be created from one team's point of view and then the working version of the report will be expanded to other team's purposes as well. Other departments are also working with KPI data, and they might be also interested in this way of reporting. The plan is that the report will be expanded to not only meet the other teams' purposes but other department purposes as well. Different departments will have their own pages in the report.

The report will contain pages including different visual models and tables that could be filtered. The purpose of the KPI report is to replace the PowerPoint reports so the contents should be quite similar. The report will be built based on those old PowerPoint reports. The PowerPoint reports contain pictures of Excel tables and graphs so the visuals and tables of the Power BI report should give the same and even better picture of the reported test drives. The KPI report will be added as a part of the bigger Power BI dashboard as one section.

# 3 Related Research and Background Study

To understand the purpose of the KPI report it is essential to know what KPI indicators are. A basic understanding of 5G technology and how it is tested is also necessary. This section briefly introduces the most important platforms used in the project.

## 3.1 5G network

The 5G cellular network is the fifth generation of wireless technology. 5G is the successor of 4G technology and the deployment started in 2019. [1]

5G is a radio access network (RAN), which provides a wireless connection between the core network and device. Radio antennas transmit and receive signals to all kinds of wireless devices. Base station transceivers (BTS) consist of radio equipment, an antenna, and signal-processing software. BTS is divided into cells that point in different directions covering a defined geographical area of the network. 5G wireless devices are connected to the Internet through radio waves that come through a base station and antenna in the cell. New 5G antennas use a technology known as multiple input, multiple output, (MIMO) which enables multiple receivers and transmitters to transfer more data at the same time. [2] Figure 2 illustrates the advantages of the 5G network.

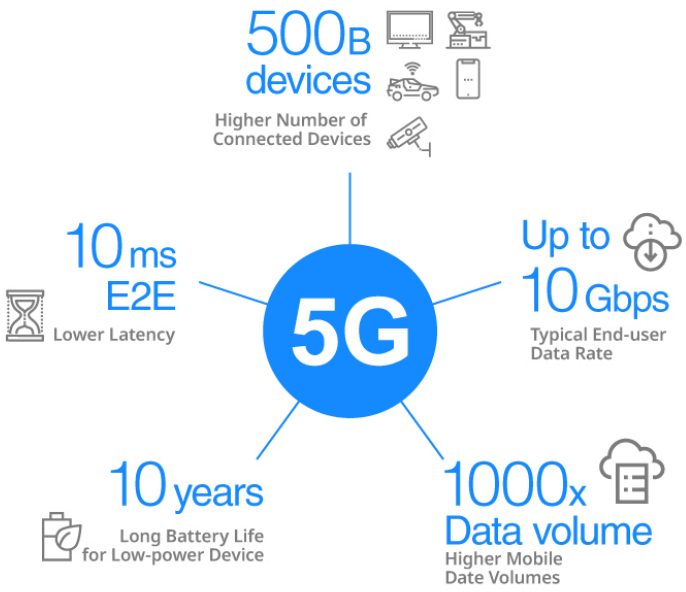



Figure 2. Advantages of the 5G network. [3]

The 5G network can do higher speeds up to 10 gigabits per second. Compared to previous generations 5G provides a much higher throughput and carries more

bits of data per watt of energy. One advantage of 5G technologies is reduced latency which is the delay between sending a signal and receiving a response. 5G allows more devices to be connected, which improves the quality of Internet services. Due to this improving quality, it is expected that the 5G networks will be used increasingly. [2]

Depending on the network application, 5G uses different spectrum frequency ranges. These ranges include low, medium, and high bands. Lower frequencies can cover longer distances, while higher frequencies offer greater data throughput and capacity. Frequencies are informed as hertz which is a frequency unit in the International System of Units. It is equivalent to one cycle/event per second. The expression in SI-based units is s-1 which means that one hertz is the reciprocal of one second. One MHz is 1 000 000 hertz and one GHz is 1 000 000 000 hertz. [4] Low-band frequencies range between 450MHz to less than 1GHz. Mid-band frequencies range between 1GHz and 6GHz. High-band frequencies range between 24GHz and higher. [2]

An essential part of 5G technology is millimeter wave which offers a high-performance network by providing very high speed and wide bandwidth. It’s a far less used spectrum but there is an increasing trend in utilizing it more. [5]

### 3.1.1 5G Network Testing in Field Verification

To ensure and improve 5G network advantages the network software packages need to be tested. Testing is done in the field environment, meaning that there are base stations that form a 5G network in a particular geographical area.

Testing is done with phones that are compatible with 5G technology. Today many new phones are 5G capable. Phones could be either NSA or SA capable. Non-Standalone (NSA) network consists of 4G and 5G wireless side and have either 4G or 5G core network. A standalone network (SA) only uses a 5G core network. [6]

The number of phones in the test depends on what network feature is tested. An increasing number of users in a network increases load and often leads to worse performance. The performance should stay as high as possible, even if the network is burdened with many users. Testing could be done for example by changing configuration parameter values or enabling and disabling features.

Testing results in different KPI values that measure different 5G network performance areas. The test drive results can be compared to previous similar tests. As a result of the comparison, one will get an idea of which direction the network has changed and whether there is something that needs to be fixed. Comparison between drives could be in software, base station, radio, or cell level.

After getting results from test drives the data will be analyzed by testers. A correction request is made if tests prove that the software has problems. With correction requests are provided logs from test drives so developers can get a good understanding of where the problem is and what needs to be changed. After the correction is made the software comes back for further testing.

### 3.1.2 KPI Data

KPI is an abbreviation for the words Key Performance Indicator. KPI is a performance measurement and indicator of the intended result. KPIs are general indicators of performance that focus on critical aspects of outcomes or outputs. [7]

In Nokia 5G Field Verification KPIs evaluate the success of the 5G network. Many different KPI values represent different parts of the 5G network.

In the KPI report, KPI indicators are divided into categories. The categories are [8]:

- Availability: Measure the network availability to be accessible for wireless network activity.

- Accessibility: Measure how users succeed in accessing the wireless network.

- Retainability: Measure the 5G network capacity to hold and provide the network service promised to users. It describes the stability of the network sessions.

- Mobility: Measure session continuity during mobility. Enables access while the end-user is on the move.

- Throughput / Usage: Measures the amount of data sent and received by the network.

- Integrity: Measure the quality of the session by throughput and latency.

- Carrier aggregation CA: Measures the network's ability to combine the capacities of different radio cells operating at separate frequency bands.

- Voice over new radio VoNR: Measures how voice is leveraged using the 5G Core functions and IMS, while the 5G use cases are delivered by the NR and the 5G Core.

For each test case category, there is a set of high-level KPIs defined. Other KPIs are monitored as well, which provides additional information but a set of KPIs is selected to define the PASS-FAILL criteria.

Because there are so many KPIs, only a limited, manageable number is maintainable for regular use. If there is a need to always check too many KPIs with each test drive it can be time- and resource-consuming. [7]

To make conclusions based on KPI indicators, it is necessary to have data over a long period of time. A large sample size is required to reduce the impact of

drive-specific variables. Therefore, KPIs should be designed to be used on every test drive. [7]

Categories mentioned above include different KPI indicators which are calculated with expressions consisting of different counters. Counters are numeric values that provide information about network performance. Counters are variables in network software's code. Variable value increases every time a defined event happens. Most of the counters are expressed as percentages. For example, KPI can tell how many attempts to download a big file were successful. A KPI is calculated based on successful and failed attempts. So, if the aim was to know the KPI for downloading a big file it would be successful downloads divided by all the attempts to download the file.

Examples of a few KPI indicators are provided below:

5G cell availability ratio KPI shows the ratio of time in which services in a cell are available for end users. It is expressed as a percentage value. The KPI belongs to the network accessibility category.

5G SA NG-based handover total success ratio on the target cell KPI shows the SA NG-based handover total success ratio on the target cell. It covers the preparation and execution phases. In this context handover means the process of transferring an ongoing network session from one channel to another channel. KPI belongs to the mobility category and is expressed as a percentage value.

E-UTRAN Cell Availability Ratio shows the ratio of services in a cell being available for end users. It is part of the usage category and is expressed as a percentage value.

Functions used for calculating KPIs can be updated. Whenever there is an update, a letter is added at the end of the KPI number. Sometimes the update can be significant, leading to a major change in the calculation of the KPI. The

KPI values calculated with the earlier formula compared to those which are calculated with the new formula can be very different.

Formula changes must be considered when interpreting results. Big differences in KPI indicator value may indicate that the network performance is increased or decreased in that KPI's view, but it can be also due to formula change. Therefore, it is necessary to track any changes made to the KPI formulas. In some cases, if the change is minor and the calculation method is not changed significantly it may be okay to compare KPIs produced by different formula versions.

## 3.2 Microsoft Power BI and Other Data Visualization Tools

Data visualization and analytics tools are for organizations and businesses to comprehend large amounts of data. These tools help users to identify trends, patterns, and insights that inform decision-making. [9]

When choosing the best BI solution for an organization, there are several important factors to consider. These include cost, features, integration and customization options, and complexity. Platforms have differences in those factors and organizations need to choose which ones are the most important for their specific use. [9] For example, an organization might be willing to pay more for a platform that offers better visualization models for their specific purpose or use a Microsoft-based platform because of easy integration even if that platform offers less customization capabilities. Nokia is using Microsoft Office tools widely, so Microsoft Power BI was a natural choice. When choosing a BI platform, it is needed to consider how the data automation process will be implemented on that platform. In this project, Microsoft Power BI is used as a BI platform and Microsoft Power Automate does automated data refresh automatically to the Power BI report.

Power BI is a cloud-based data visualization service developed by Microsoft. It mainly focuses on business intelligence. Power BI consists of software services, apps, and connectors that communicate together to turn different data sources

into visualizations. Power BI has an online, a mobile, and a desktop version. [10] This project was developed on the desktop platform. After the project was finished, it was shared with the Power BI online service and included as a part of a bigger Power BI dashboard.

Power BI workspace storage limits depend on whether the workspace is in shared or Premium capacity. The workspace where this project is in premium capacity so there's a limit of 100TB and no per-user storage limit and it costs 18,70 € per/user/month. [11]

A dataset is imported or connected to the Power BI platform and can be used to build reports and dashboards. Each dataset represents a single source of data for example an Excel file, SQL server, Azure SQL database, or OneDrive. Pages consisting of visualizations, text, and graphics are called reports. [12] Power BI offers many ways to visualize data. Examples of visualization types are pie, card, column chart, and table. [10]

Tableau is an alternative data visualization tool to Power BI. It costs about 66 €/month and offers more data visualization customizations and data modeling capabilities compared to Power BI. Compared to Tableau, Power BI is considered more accessible for beginners due to its drag-and-drop functionality. Tableau is known for handling large datasets and complex data sources. [13]

Qlik Sense is an application development and data visualization management tool. It promises functionality even with large and complex data sets and easy use while no visualization or analyzing experience is needed. Qlik Sense could be a better option for businesses that are looking for a flexible and customizable platform and require more advanced data and visualization capabilities. [14]

Google's Looker studio is also an alternative to the previously mentioned Tableau and Qlik Sense data analyzing and visualization tools. Google Looker is part of the Google Cloud ecosystem and integrates well with other Google Cloud services. For that reason, Google Looker would be an easy option for

organizations already invested in Google's infrastructure. Google Looker is known for its easy usability and user-friendly interface. Looker Studio can run scheduled data refresh actions such as Power BI. [15]

### 3.2.1 Data Analysis Expressions Library

Sometimes data coming straight from the data source does not offer all the needed information for the report purposes. Then there is a need to apply simple math, calculate percentages, or compare data over time. Developing more complex formulas enables one to extend the analyses and illustrate the insights. [10]

Data Analysis Expressions (DAX) library consists of functions and operations that can be combined and used to extend data models and create metrics in Power BI dashboards. [10] It can be also used in Analysis Service and Excel Power Pivot. DAX expressions contain functions, operations, and values that perform intelligence calculations and queries for information that is related to them. [16] DAX is a formula language, not a programming language. DAX formulas resemble Excel formulas and even have many same functions such as SUM and DATE. But unlike Excel, DAX functions are meant to work with relational data. [17]

DAX can be used to create Calculated columns and Measures. [17] In this project, DAX is used for creating new columns based on existing columns, color formatting columns, and getting selected values from the slicer. Next, the paper shows a few examples from this project of how DAX can be used in measures and calculated columns.

A calculated column is a column that can be combined with an already existing table and contains the expression that defines the DAX function which creates the values. DAX function calculates the value of each row based on the input formula. [17]

FORMAT function can be used to display a value in a particular way [10]. Figure 3 shows an example of a calculated column that creates a new column “Month Group” based on the date when the test drive is started. FORMAT changes the “Month Group” information into a given format which in this case is “month – year”.

```
month group = FORMAT('Data_5G'[report_data.start_date_current], "mm/yyyy")
```

Figure 3. DAX function for creating a calculated column “Month group”.

Another example in Figure 4 of a calculated column is the “id and name” column which consists of the id field and the KPI name field values combined. This calculated column makes reading the report easier and faster by combining two important columns.

```
id and name = Data_5G[kpi_list.kpi_id] & " " & Data_5G[KPI name]
```

Figure 4. Calculated column for combining KPIs id and name.

Measures are calculations used in data analysis written with DAX. Measures can include sums, averages, minimum or maximum values, or counts. Unlike calculated columns, measures only appear in the report view, not in the data view. This means that measures only affect the visuals, not the data itself. [17]

The CALCULATE function enables applying a range of filters to a measure that can then be applied to the visualizations in the dashboard [17]. IF function checks whether the applied conditions are true or not. The ISFILTERED function is for checking if the given data column is filtered in the dashboard. The ALLSELECTED function in DAX is for not using any filters the user has applied [17]. Figure 5 shows an example of a measure that ensures that visuals do not show any data until at least one test drive is selected. To show data in the report visuals the user must select at least one test drive from the slicer that contains all the available test drives in the KPI report.

```
if no selection 5G data =
CALCULATE ( IF ( ISFILTERED ( Data_5G[report_data.comment] ), 1, 0 ), ALLSELECTED ( Data_5G ) )
```

Figure 5. Measure to ensure that if test drives are not selected visuals do not show any data.

### 3.2.2 Conditional Formatting in Power BI

Power BI tables and matrixes can be customized with conditional formatting. Conditional formatting includes cell background and font colors, gradients, web URLs, data bars, and KPI icons. Formatting is based on numeric field values. [18]

Color formatting can be used for example to perform the negative or positive change of the KPI value, for example, marking positive change with green and negative change with red. However, this is not used currently in the report because red and green color are quite dramatic ways to express the change. Numerous factors can affect this KPI value change, for example, formula changes, problems with phones, weather conditions, or software bugs. The KPI change to a red negative direction is not always due to software factors. That's also why there cannot be a predefined pass or fail value for each KPI. Testers must check what's the reason behind the change and if that change is considered an okay change.

### 3.2.3 Groups and Bookmarks

In Power BI Desktop grouping is a way to bind together visuals such as charts, buttons, and shapes. Grouping works in the same way as in PowerPoint enabling treating the group as a single object. Resizing, moving, and dragging is easier with groups. [19]

Bookmarks capture the current state of the report page. They save the current slicers and filters, sort order, etc. Bookmarks can be used in many cases for example to keep track of the progress in creating reports. [20]

In this project groups and bookmarks are used to create popup windows and change the page contents. Opening and closing popups and page content

changes are managed by a button press. Each report state is saved as a bookmark. Figure 6 is one example of element grouping and using bookmarks. Each KPI category has its group which binds all the visuals and elements inside that group together. Category visibility is controlled with bookmarks in a way, that when the category's button is clicked it changes the group's visibility, so that only the selected category's group elements are visible, and others are hidden.


Figure 6. KPI categories consist of elements that are bounded as a group and controlled with bookmarks that define group visibility.

The report's different views containing 5G and 4G KPI results from delivery and benchmark drives are implemented with groups and bookmarks. All views include the same functionality except KPIs are different, and data is coming from different sources.

## 3.3 SharePoint and Other Data Storage Tools

SharePoint is Microsoft's web-based platform where users can store, share, organize, and access information from any device. In this project, SharePoint was used to store the KPI data exported from the KPI tool. As a Microsoft product, Power BI is well integrated with other Microsoft products and that makes it easier to use in environments that use these tools.

SharePoint is not the only option for storing the KPI data files. Data could also be stored for example in Azure SQL database. It offers native JSON functions that enable the dataset to parse JSON data using SQL queries. JSON documents can be stored in an SQL server or database and JSON data can be queried from a NoSQL database [21]. Azure SQL database would be the best option if the JSON data file size was big. The file size is now a maximum of 350kb, so big file sizes are not involved. It was decided that for this temporary way of storing data, SharePoint is enough. The best option is to store data in the KPI tool where it is

also collected. That reduces the need for exporting data from the KPI tool to another data storage.

Power BI workspace located in the SharePoint folder can be opened on the Power BI desktop. When the report is edited and saved, updates are also added to the SharePoint report. Updates are automatically added to the Power BI online report because Power BI online gets the report from SharePoint.

## 3.4 Power Automate and Corresponding Automation Platforms

Automation Platforms are services that enable the user to connect applications and automate workflows. [23]

Microsoft's cloud-based app Power Automate allows users to create and automate tasks across multiple applications. Automated tasks help to save time and therefore improve productivity and make work much more effective. Automated actions in Power Automate are called Flows. In Power Automate one can see the history of the flow runs and the average run duration. [22]

Power Automate was chosen to do automated data refreshes to the report since the company is using Microsoft tools widely. One of the best features of Power Automate is that it requires no coding knowledge so anyone can create and manage the workflows. [23]

There are also many other task automation platforms such as Zapier, Automation Anywhere, and Laserfiche. The platform used in this project requires integration with Power BI. That limits some automation software from consideration. Automation Anywhere and Laserfiche both offer connectors for Power BI. Both seemed to require at least some knowledge of coding and were much more complicated to even get the information on how to get started.

Power BI has a feature that, by default, updates information from SharePoint or OneDrive on an hourly basis. SharePoint and Power BI are both in the cloud,

Power BI can import the data files to the Power BI workspace directly. The connection between SharePoint and Power BI is done once every hour. [24] If one refresh per hour is enough, the use of Power Automate is not mandatory. Sometimes schedules could be tight and there can be a need to get the new data to the report immediately. For that reason, Power Automate was needed so the data refresh is always made after new data is added. Following that the report is automatically up to date in a few minutes after new data is added.

## 3.5 JSON Data

JSON represents structured data based on JavaScript object syntax. JSON stands for JavaScript Object Notation. It is for storing and transporting data written in text format. [25]

Commonly JSON is used for transmitting data in web applications. JSON can be used independently from JavaScript and many programming platforms can read and generate JSON. [25]

An example of JSON data in the project is presented in Chapter 5.1 “Data Format” in Figure 8.

## 3.6 Agile Methods

A common goal of different agile methods is enabling teams to respond to change more rapidly. Changes can be costly to accommodate later in the project so the ability to respond rapidly to change reduces project costs and risks. [26]

Agile project management is an approach to managing software development projects consisting of sprints and iterations. Agile project management is a

useful way of tracking the development process and monitoring the success of the project. [26]

Agile project management increases development speed and expands collaboration between customers and developers and inside the project's development team. This is done by breaking down large projects into more manageable tasks, which are completed in short iterations called sprints. [26]

In this project, agile methods were useful for keeping track of completed tasks and tasks that still need to be done. Trello was used for task management and Microsoft Teams calendar for sprint management.

# 4 Design and Planning

The project started by getting to know the old way of transferring the data and reporting the KPI results. After that, the plan was to implement the data automation process to the report and then continue to create the report template in Power BI. It was known that JSON data from the KPI tool would need editing for this project's purposes.

## 4.1 Choosing Techniques

At first, the idea was to use GitHub for the automation, but it was quickly discovered that Power BI does not yet support GitHub as a data connection. Using GitHub for pushing new data would require implementing an automated pull action with a scheduled script or script that can detect the new changes pushed to GitHub. That seemed a lot more complicated than utilizing the existing automation task in Power Automate between SharePoint and Power BI.

Power BI has competitive platforms that could be used to create KPI data reports. For example, the previously mentioned Tableau could be also an option, but Power BI was used commonly in the company. Because it is widely used in the

company, it means that many people know how to use it. This saves time when employees do not have to learn how to use a new application.

Power BI offers a feature that by default updates information from SharePoint or OneDrive on an hourly basis. [24] That could be too slow if there is a need to get the new data immediately to be shown in the report. Because of the slowness, automated data refresh in the report was planned to be done with Power Automate. That is an immediate action and takes only a few minutes depending on the size of the new data.

## 4.2 Consulting Colleagues

Consulting colleagues was needed during the project's implementation because the architecture behind the KPI tool is so complex. First, there was an idea to implement a button to the KPI tool user interface and code the action to export the result files to the SharePoint folder in JSON format. That would be quite a simple action to implement because there was already a feature that exported the results to a local PC in JSON format with a button press. The need would be to create a new button that works just like the other, but the export destination should be defined in the SharePoint folder. The rest of the data transfer process happens with the help of Power Automate.

This idea was quite soon abandoned during the planning and implementing process because the new button that exports the drives to SharePoint would be only a temporary solution. The KPI tool is going through some bigger changes and there will be a feature to mark the drives that are wanted to show in the report. Marking the drives to be reported can be done with some checkbox choice or button press like first was planned. That final solution will be decided by the KPI tool developers. The biggest change for plans was that SharePoint would be unnecessary for data storage after those new features are published in the KPI tool.

The JSON KPI data was missing some important data fields for the KPI report. The missing data information existed in the KPI tool but only needed to be added to the structure of the result JSON file. During the project, many meetings took place with the KPI tool developers discussing how and what data needed to be included in the JSON file metadata section.

## 4.3 Agile Methods During Project Implementation

Agile methods are project management actions that prioritize continuous improvement and divide projects into smaller phases. [26] Trello is a project management tool, and it was used during this project. The project consists of two bigger phases: data flow automation and KPI report creation. In Trello, both phases were represented by a list consisting of cards. Each card was a task that needed to be done in that phase. The first phase of this project contained the data automation implementation. The second phase focused on report creation in Power BI.

The data edition was slowly phased during the project because it needed contributions from other professionals. The report was also tested continuously during the project implementation. If professionals using the report noticed a mistake or came up with a good idea it was taken into notice. Finally, when the KPI report was finalized, feedback and a few questions were asked from professionals using the KPI tool in the future. Data edition and testing also had their own lists in the Trello board and contained tasks related to them.

Figure 7 is from the Trello board of the project. The project was still in progress when the picture was taken. Tasks that are not done yet were marked as red, tasks currently under implementation were orange and tasks completed were marked as green. Tasks were sorted in priority order so that the most important task was uppermost. Two phases of the project were marked as numbers in front of the title. Sprints were managed in the Teams calendar where also was marked all the project meetings. The total project contained four sprints. The meetings with the product owner, who was also the instructor of the project, defined the

length of the sprints. Meetings included going through the new changes and creating new tasks about features that still need to be implemented in the report.

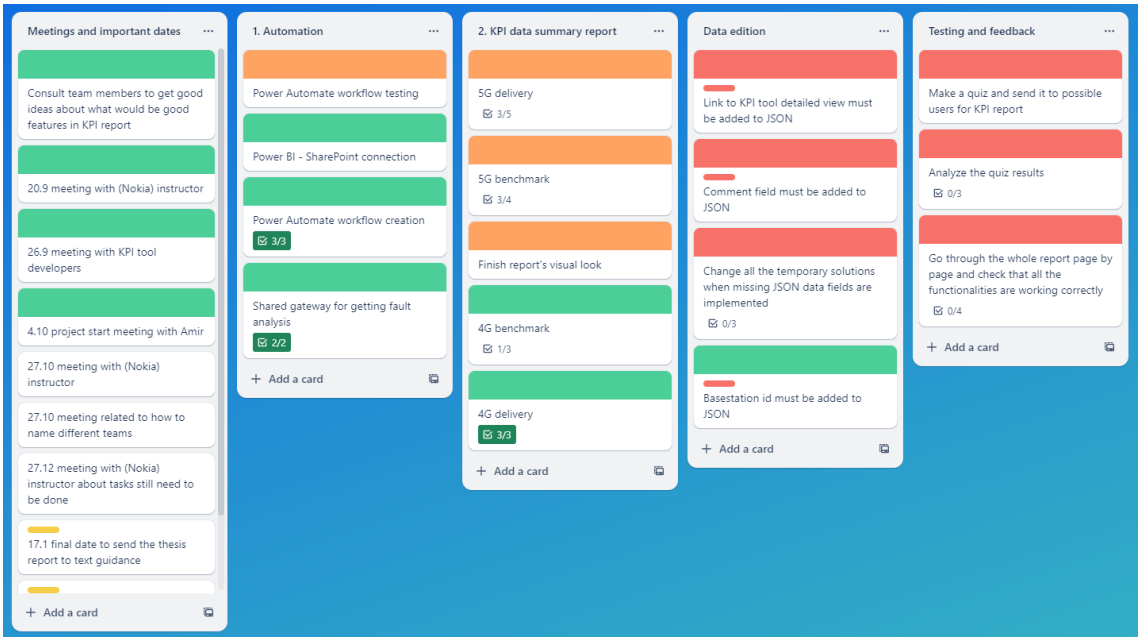
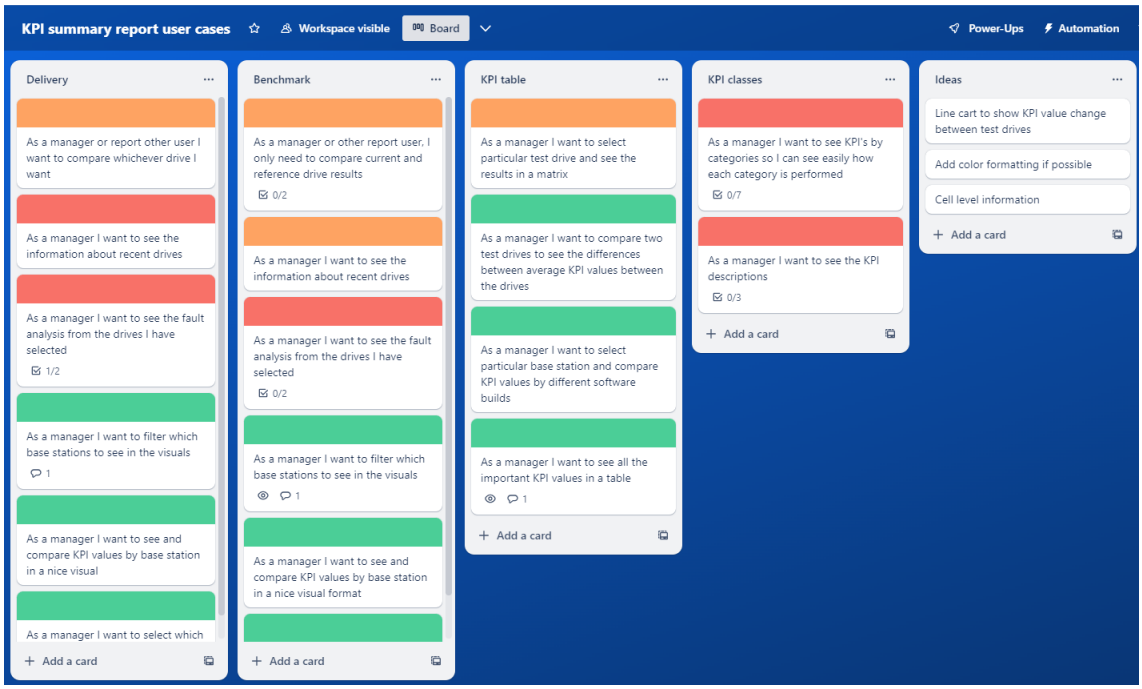



Figure 7. Project board in Trello project management tool. Green means that the task is done, orange is the task still in progress, and red tasks have not started yet.

This agile method of handling the project was a good way to approach it. Dividing the whole project into smaller parts helped to understand which tasks needed more attention, and what pace the project was progressing. Time management and calendar events were in Microsoft Outlook and Teams.

KPI report user cases were also created in the Trello board. This board was used only in the KPI report creation phase of the project. The cases were divided into four lists where three represented a bigger set in the report and the fourth one consisted of ideas set up during the implementation process. The Trello user case board is shown in Figure 8.




(Figure 8). KPI report's use cases in Trello board.

The use cases were created based on ideas that came from the Thesis instructor and other professionals working with KPI data in Nokia. Keeping track of use cases was only a private project management tool and was not shared with anyone. This was a good way to keep track of the upcoming ideas and requests from KPI professionals.

# 5 Project Implementation

The project implementation was separated into two stages. The project started by implementing the automation functionality between the SharePoint folder and the Power BI workspace. After that, the report was created in Power BI. JSON data from drives needed editing during the project when new ideas about useful features came out. Finally, the KPI report functionality was tested, and feedback was asked.

## 5.1 Data Format

KPI tool provides data in .json or .csv format. The decision was to use JSON data because it was found more readable and simpler to transform to Power BI.

JSON represents structured data based on JavaScript object syntax. It is text-based and easy to read and write. [25] In this project, the JSON was structured as shown in Figure 9.

```
{
  "report_data": {
    "report_date":
    "report_name":
    "hw":
    "source":
    "start_date_reference":
    "end_date_reference":
    "start_date_current":
    "end_date_current":
    "duration_reference":
    "duration_current":
    "test_case":
    "activity_type":
    "feature":
    "feature_status":
    "sw_release_reference":
    "sw_release_current":
    "sw_build_reference":
    "sw_build_current":
    "comment":
    "test_results":
  },
  "kpi_list": [
    {
      "kpi_id":
      "kpi_name":
      "kpi_class":
      "unit":
      "network": {
        "reference":
        "current":
      },
      "bts_list": [
        {
          "bts_name":
          "bts_id":
          "bts": {
            "reference":
            "current":
          }
        }
      ]
    },
    {
      "kpi_id":
```

Figure 9. KPI data's JSON structure.

Metadata information in this JSON data is under “report_data” which contains information about the test drive like the software build that was used and the start- and end-time for the drive. Every test drive contains a list of KPIs, and the contents of the list define the template that is used to export that data. In JSON data the KPIs are stored in the “kpi_list”. That list contains information about each KPI value such as name and id. The list also contains another list “bts_list” that provides KPI values from current and reference build from every base station. Reference build is a previously completed similar kind of drive and the current drive KPI values should be at the same level or better.

The template that can be selected in the KPI tool defines what KPI values are in the JSON data. The KPI report uses a template consisting of about 200 KPI values. Some of those KPIs are more important than others and can be critical when defining if the software tests pass or fail the requirements.

### 5.1.1 Data Edition

For the KPI report some important data fields were missing in the KPI JSON file. The KPI tool was collecting all the missing data, but the result JSON was missing that information.

During the development process of the project, there was a need to create temporary solutions when some important data fields were still not in the result JSON. For example, there needed to be more unique names for drives than the “report name” which was the JSON file’s filename and its usual software build number. Before the JSON got the drive name field it was needed to manually edit the exported JSON to add the drive name. There could be many drives with the same name because one software build is often used in many different test drives and that would cause problems because then it is not possible to separate the drives from each other.

There was a request that the drives in the report should be linked to each test drive in the KPI tool. That's because the KPI tool provides much more detailed information about the drives than the KPI report can afford. For example, cell-level data might be needed to investigate possible negative changes. If there is a need to check something on a more detailed level the link is a quick way to access the information. This was also one field that JSON did not contain by default.

The team information was missing in the JSON. That was needed for filtering a particular team's drives from all the data. Before JSON had only department-level information but a department consists of many teams, so team information is a useful way to filter the data into smaller sections. The teams within the departments work with different areas of 5G and KPIs.

For test drives that test some feature a reference drive is needed. This means that there is always a drive with the tested feature switched on, and in the reference drive feature is off. In JSON data that reference information was missing. The field existed, but it did not contain any data. This data was needed for the report to compare the correct drives to each other.

The JSON data contained some fields that are not used in the KPI report but could be used for other purposes.

## 5.2 Different Data Sources and Report Structure

All the data presented in the report is in JSON format. Test drives can be either 4G or 5G drives which is why the drive results are separated into two folders: the 4G drives and the 5G drives folders. The separation was made because 4G and 5G drives have different KPIs, and there is no need to compare 4G and 5G drives with each other.

The report contains four different tabs: 5G delivery KPIs, 4G delivery KPIs, 5G benchmark KPIs, and 4G benchmark KPIs. Delivery software is software

packages that are tested and delivered to the customer. Benchmark drives could be, for example, feature test drives or other tests that are not delivered to customers. The separation between delivery and benchmark drives was made because comparing just two drives without a good understanding of the purpose of the drive could provide a wrong idea of software package performance.

As mentioned earlier, several departments work with KPI data and need to create result reports about the test drives. The new KPI report consists of three separate pages, each one dedicated to a specific department. That is because each department is interested in different KPIs and uses a slightly different way of collecting data. The ultimate goal is to unify all departments to use the KPI tool for collecting and the KPI report for reporting. At this stage, different pages were still needed.

## 5.3 Automation Process

This section introduces how the data flow to the report is implemented at this stage. Data flow to the report is going to change and be fully automated when data storage is moved to the KPI tools database. For now, the process is not fully automated because the user needs to export the file from the KPI tool to the 5G or 4G folder in the SharePoint folder. The basic idea of the KPI report automation process is represented in Figure 10.

The process consists of three steps:

1) Press the “Export” button in the KPI tool and move the file to the SharePoint folder.

2) Power Automates automated action detects new files in the folder and refreshes the data in the Power BI workspace.

3) Power Automates automated action sends an email about new changes in the SharePoint folder.

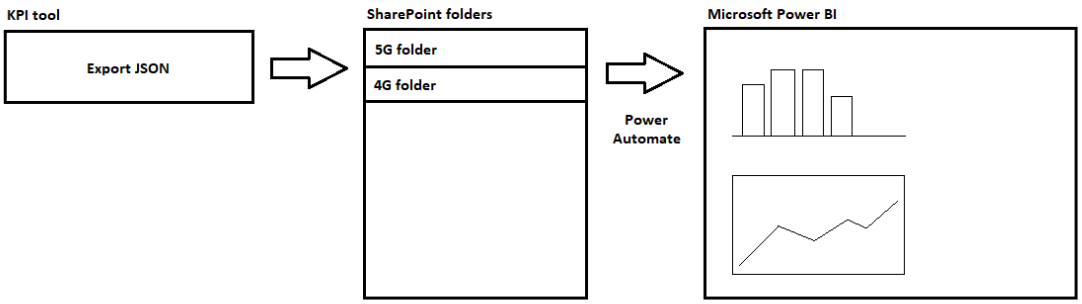



Figure 10. Automation process from KPI tool to Power BI workspace.

The user must first export the test drive result JSON file and transfer it to the specified SharePoint folder. Then Power Automate notices that there are changes in the folder and refreshes the KPI report dataset. After the refresh, the new data is shown in the Power BI report visuals. The time that this refresh process takes depends on the size of the added data. Usually, it takes about two and a half minutes to complete.

### 5.3.1 Exporting Data to SharePoint

The KPI tool is an internal tool for analyzing and reporting KPI data. In the KPI tool, the KPI data can be compared with graphs and visuals. Comparison can be done for example on release, software, base station, or cell level.

On the KPI tool side, the user must select the drive that wants to be exported to the KPI report and which data template to use. The KPI tool has many different templates to choose from to be exported. The templates vary in which KPI indicators are provided.

Test drives result in hundreds of KPI indicators but the template that this project uses contains about 200 KPIs. Different templates can be used in the report if the metadata section fields have the same structure. That is because metadata is represented as columns in the data and if metadata contains new columns Power BI doesn’t recognize that there is a new column in the data structure.

Row count can be different and will be if results are exported by using a different template. In the JSON structure that the KPI tool provides, data from base stations is presented inside a list. List values are presented as rows so there can be different amounts of KPIs among reported drives.

The KPI data can be exported from the KPI tool in .json or .csv format.

### 5.3.2 SharePoint and Power BI Integration with Power Automate

Microsoft Power Automate is an automation platform that can do repetitive tasks. [22] In this project, new data updating to the report from the SharePoint folder to Power BI was done with Power Automate.

Figure 11 represents the Power Automate process which includes three automated steps. The first step is when a new file exported from the KPI tool to the SharePoint folder is detected. That causes a dataset refresh which means that the defined dataset in the KPI Power BI workspace is updated with the new data. Power Automate offers ways to inform about new data in the SharePoint

folder. Information could be done for example via email, Microsoft Teams message, or an SMS text message.

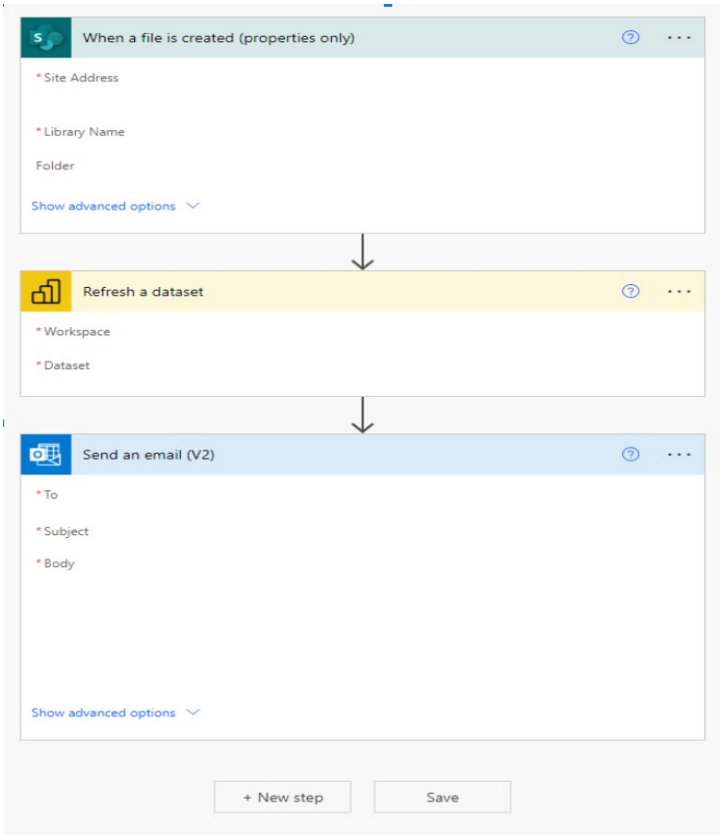



Figure 11. Power Automate view when creating automated data refreshes in the KPI workspace when a new file is added to the SharePoint folder.

This automated action requires a data connection between Power BI and the SharePoint folder. This connection can be created in Power BI by setting the link to the SharePoint folder where the KPI data files are located.

## 5.4 KPI Report in Power BI Platform

The idea of the KPI report is to show the network performance state measured by the KPIs in a simple and readable format. This is done with different visuals, tables, and matrixes.

### 5.4.1 Power BI Visualizations

Visualizations can give a good understanding of the data with a quick look. It is much harder to detect changes from data containing only text. Power BI was chosen as the best option to visualize the KPI data. In Power BI, data can be visualized with many different visualizations. In this project, Power BI visualizations such as matrices, column charts, tables, and slicers.

A stacked column chart is a basic type of chart that allows the comparison between two categories. X-axis values represent the individual entry for the category. The y-axis is for values against each type of category in the x-axis. [27] Figure 12 is an example of a stacked column chart in the KPI report.

The visual in Figure 12 shows a particular KPI value from a selected base station by all selected drives. 5G base stations are expressed as gNodeB (gNB) and 4G base stations as eNodeB (eNB). In Figure 12 the y-axis shows the ratio of the number of abnormally released QoS flow (5QI flows) attempts initiated by gNB to the total number of QoS flow release attempts.

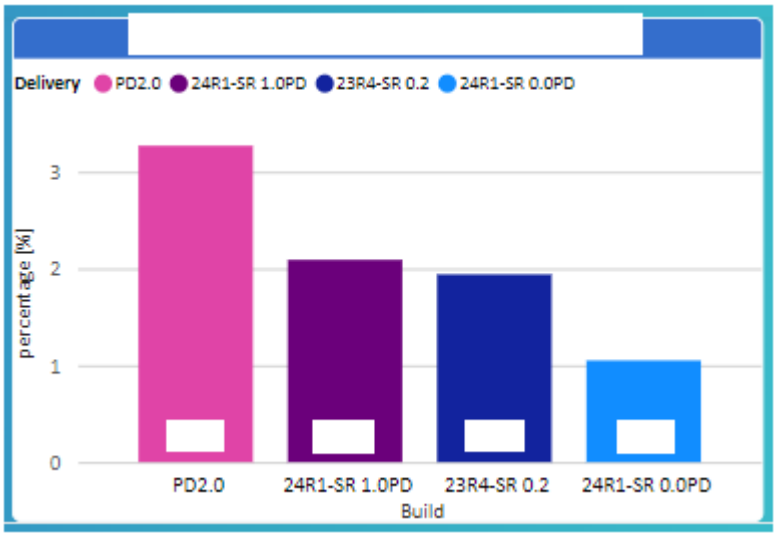



Figure 12. Stacked column charts represent KPI values by drives.

A line chart consists of many data points connected by straight lines. [28] The KPI report line chart, shown in Figure 13, is used to show the KPI indicator change

over time. The y-axis contains the selected KPI value, and the x-axis represents time. Each data point is from a different test drive. A line chart can be useful especially when it is desired to see trends about how value is changed during a long period of time.

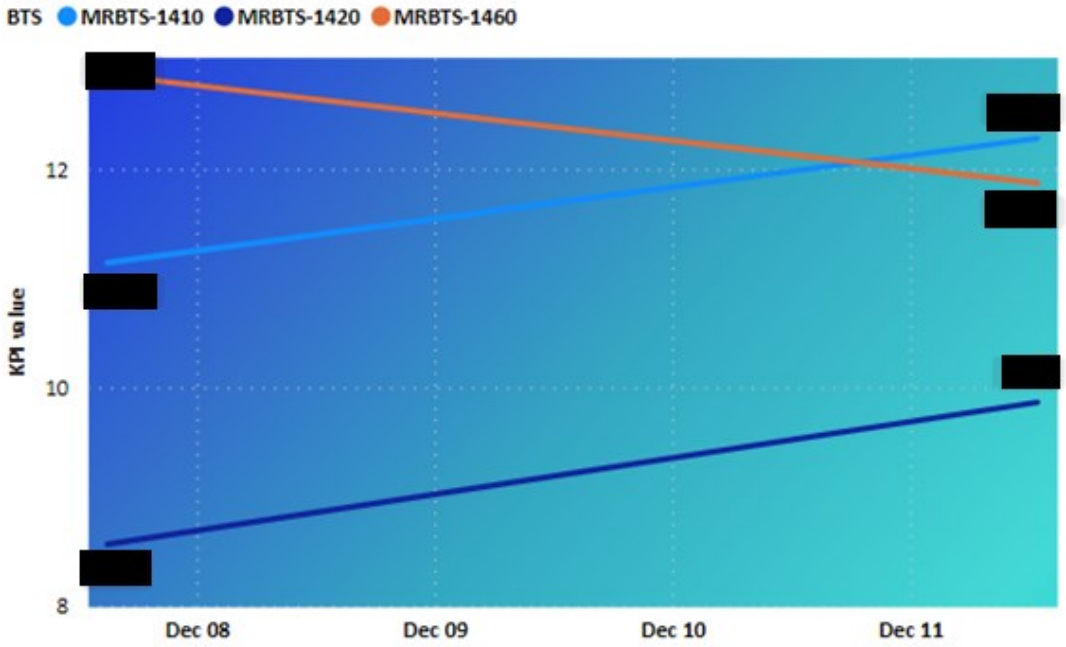



Figure 13. Line chart showing the change of KPI indicator value over time.

Figure 14 shows a clustered column chart where base stations are the clusters that can contain many test drives. Drives are marked in different colors and with a legend bar. The x-axis contains base stations, and the y-axis represents the KPI value. For showing data in this chart the user must select KPI builds, particular KPI, and all the base stations that are wanted to be shown in the visual. If one base station has much lower KPI values than the other, that can give a hint that there could be a problem within that base station configuration.

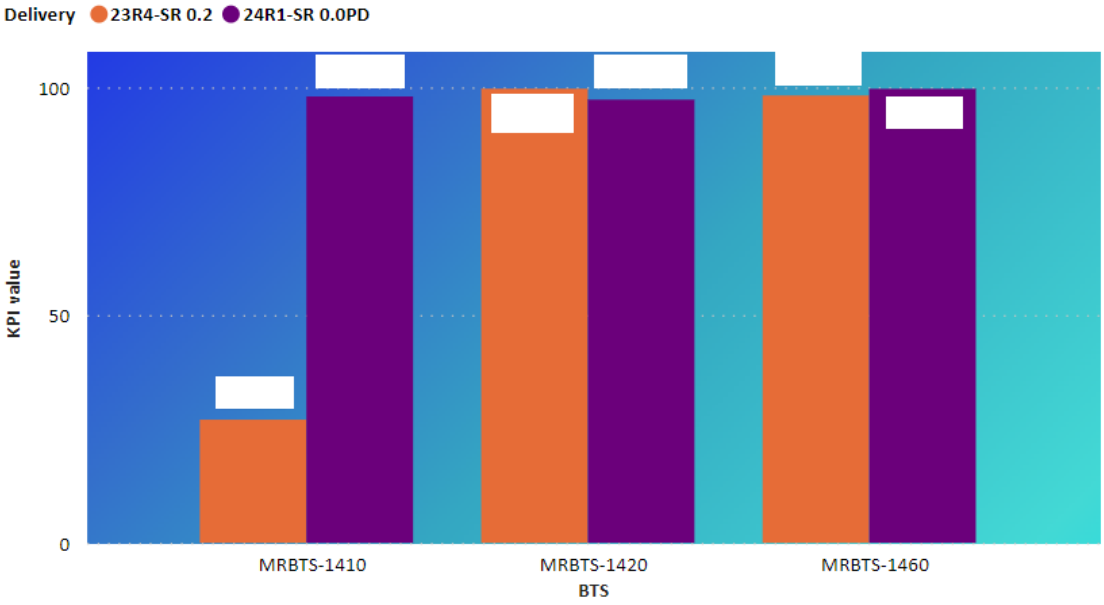



Figure 14. KPI value by base stations.

A matrix is a type of table visual that supports displaying data across multiple dimensions. It supports a stepped layout. [28] Figure 15 shows an example of a matrix visual. The steps are indicated as indentations.

In addition to the visual presentation of data, all KPI data from selected drives is presented in a matrix. The matrix row can be expanded by pressing the plus button before the row value and closed by pressing the minus value. Then by expanding the KPI, the KPI value and unit form each selected base station is shown.

| Delivery | 23R4-SR 0.2 | | 24R1-SR 0.0PD | |
|---|---|---|---|---|
| KPI | KPI value | Unit | KPI value | Unit |
| NR_5023b 5G Ratio of UE releases caused by X2 reset | | | | |
| MRBTS-1410 | | % | | % |
| MRBTS-1420 | | % | | % |
| MRBTS-1460 | | % | | % |
| MRBTS-1470 | | % | | % |

Figure 15. KPI data in Power BI Matrix.

Tables are grids that contain rows and columns containing data values. A table can contain headers and a row for total values. Tables are useful when comparing many values in the same category. [28]

In the report, the test drive details are shown in the table as illustrated in Figure 16. Details include delivery information such as drive name, start time for the drive, duration, build id, and a link to a more detailed view in the KPI tool.

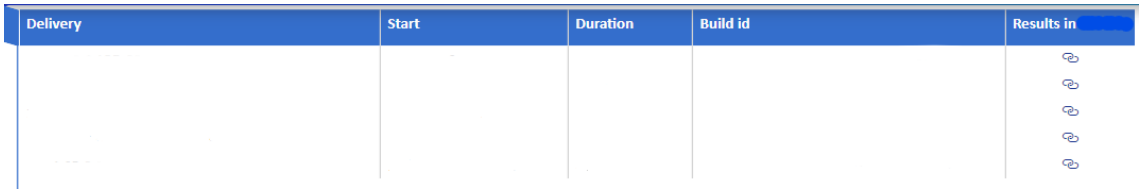



Figure 16. Table visual for presenting KPI test drive details.

When the amount of data is large it is useful to delimit it into smaller parts. Often the user is interested in just some part of the data such as particular team, year, or software build results. Then filtering the data is needed because it is impossible to look at visuals containing a huge amount of data.

Slicers are based on JSON data fields and filter the report data based on selected values. The report has slicers on every page for filtering the presented data. For the user, Power BI slicers are a way to control the data presented in the report visualizations. Slicers narrow the portion of the dataset that's shown in the report visualizations. [29]

Figure 17 contains slicers for selecting release, test drive name, team that has completed the test, and from which base station the KPI data is collected. Slicers can affect other slicers, for example by selecting the year 2023 releases, the test drive name slicer only shows drives from that year. By default, slicers affect all the other visualizations on that page but there is also an option for controlling which page visuals are affected by slicers [29].

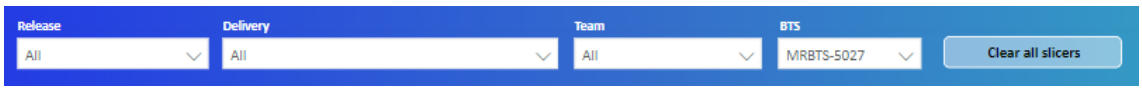



Figure 17. Slicers in the KPI report main page.

### 5.4.2 Correction Requests

A correction request is made by testers if the software has issues or faults. The information about the requests is in the internal reporting tool. In the KPI report, the aim is to show the requests related to each drive.

A connection between the reporting tool and Power BI needed to be implemented in the report to get information about the correction requests. The connection was done by an already existing API which provides a query for getting data from the reporting tool to Power BI. The interface allows retrieving data in JSON format.

Software builds could have correction requests, so in the report when filtering software, also the table consisting of correction requests is updated. The same correction request could be related to many software builds if the correction had not been made in the first build when the fault was discovered. Correction request state can be open, still in progress, or closed.

Getting the correction requests to the report from another internal tool required an on-premises data gateway. A gateway was needed because this internal tool where the correction requests locate are not in the cloud and the report is in the cloud. The on-premises data gateway acts as a bridge between those two.

### 5.4.3 Visual Look of Report

The visual look of the report was improved during the project. The blue color was chosen as the main color of the report because Nokia as a company is often linked to blue. Inspiration for a visual look was also taken from Nokia’s different presentations and documents. The report uses different shapes of blue also containing some white and black borders and texts.

The theme is the same on every page of the report. Text font, table format, and dropdown menus are similar in the visual look. The Nokia logo is placed in the upper right corner.

The report background was created in Microsoft PowerPoint by using a gradient. PowerPoint was saved in picture format and imported to the Power BI as the report's background.

### 5.4.4 Project Outcome

The final report is located on the Power BI online platform as a part of the bigger Power BI dashboard. The report contains three pages, one page for each department working with KPIs.

Each page contains four tabs: 5G delivery, 4G delivery, 5G benchmark, and 4G benchmark. The separation into 5G and 4G tabs is because of different KPIs. Benchmark and delivery tabs are for clearness. Delivery tests are made to software that is delivered to customers. Benchmark tests are often feature drives or some baseline drives for the network. Although deliveries can sometimes be used as a reference drive to some other delivery or benchmark drive. Benchmark and delivery tabs differ only a little. Each tab has the same appearance and functionality. The only difference is that in benchmark tabs test drives can only be compared to their own reference drives.

Power Automate takes care of the automation process and transfers KPI data to the report when a new file is exported from the KPI tool to the SharePoint folder. Power BI report is automatically refreshed, and the new data can be seen in the visuals in a few minutes.

## 6 Test Process and Feedback

During the project implementation, professionals who will be using the report in the future were consulted. Those professionals are experts in 5G testing and working with KPI data analysis. They will be using the report daily and are the best people to consult since the purpose of this report is to help them in their

work. They know the best which kind of features and visuals are needed to include in the report.

The report was tested with different teams' test drives. Each team has preferred different templates that vary KPIs. The metadata section in the JSON has the same structure in all templates, but how the teams were using the fields might be very different. For example, it was discovered during the testing that the base station name field did not always contain the official base station id. Some teams were using it for id and others named their base stations differently. If the same base stations were not marked with the same id, the report functionality was not working correctly. That was because then grouping base stations by id was failing, and Power BI could not recognize that the name was referring to the same base station. The solution for this problem was that a new base station id field was added to JSON and that field was not modifiable. This kind of common practice about data format was needed to make for making the data suitable for KPI report purposes.

In the final phase of the project, a few questions about the KPI report were sent to a few people who will use the report in the future. The short form was made with Microsoft Forms and a link to the Power BI online report was provided with the form. The questions were of a type of choice or text, and some of the questions were mandatory. Because there were only a few answers the results are more qualitative than quantitative. If the group answering those questions had been bigger there would have been more variability and more improvement ideas. Received answers indicated that the new Power BI report is a good change for the reporting process and there is a willingness to abandon Excel and adopt the new way of reporting with Power BI.

The answers gave good ideas for implementing new features. To quote one response: "As KPI performance is dependent on radio type, bandwidth, and the number of UEs. It could be nice to have a short introduction for the raw data environment.", this is a good example of a useful feature that most likely will be implemented to the report.

# 7 Discussion

There were successes and challenges encountered during the project. The project results in a working Power BI report for showing and comparing 5G and 4G KPIs. Data automation to the report is a temporary solution for now because the KPI tool will have new features in the future that allow getting the KPI data straight from the KPI tool database.

## 7.1 Challenges

The biggest challenge in this project was to get a good understanding of what would be the best way to visualize the KPI data. That required getting familiar with the different Power BI visualization models and choosing the best option for showing the KPI data in as an informative and readable way as possible.

Small challenges during this project were in the automation process. Getting the correction requests from one internal tool required a shared data gateway. The on-premises data gateway acts as a bridge between on-premises data which is several Microsoft services and data that is not in the cloud. This required some internal actions to get it to work properly.

After learning the basics and understanding Power BI capabilities, the Power BI was quite simple to use and create reports. On the Internet, there are many tutorials and introductions related to Power BI and how one can use it to visualize the data. One feature that Power BI lacks is an option for default select nothing in the single select slicer. That would be a needed feature for showing all test drives by default but after the user has selected one base station it filters the page data. Also, in the Power BI matrix, it is impossible to not show the summary value in a row if the matrix is not expanded. For the purposes of this report, there was no need to show the summarized value and the value in the row that is not expanded might be quite misleading.

A large-scale company such as Nokia has teams and professionals for every different area. The KPI tool has its own development team and professionals who were included closely when implementing the project. During the project implementation, there was many times a need to get some new data fields to the result JSON file. Timetable challenges occurred when needed to wait for the KPI tool team to add the missing data fields.

## 7.2 Improvement Ideas

The fault management of the automatic data transferring could be improved in the future. The assumption is that the action should be successful but if not, the data is not transferred to the report by itself. Now if the data refresh from the data source to the report fails Microsoft sends a message about the failed action in Power Automate. The details about failed actions are shown in Power Automate. Reasons for the failure should be corrected before the automated action can transfer the data successfully in the report.

Version control was considered a less important part of the project, so it was decided that the SharePoint version control was enough for this project's purpose. The project’s template is not changing regularly so keeping track of versions is not an essential feature. SharePoint versioning can store, track, and restore the previous state of the file. Versioning creates a historical record of all changes. This record includes data/time and the name of the user who has made the change. The end user can delete, restore, and view versions. [30] Editing the report could be done by opening the Power BI report in SharePoint on the Power BI desktop and saving the changes.

Version control for data importing could be a useful feature. A user might accidentally add a wrong test drive to the report. In that case, it would be valuable that by pressing a button the user could undo the data export. Currently, if an accident happens and wrong data is added to the report, the user must manually delete the JSON data file from the SharePoint folder containing the report data.

## 7.3 Data Storage and Automation Process in Future

SharePoint is not the final and sustainable solution for storing data. The KPI tool is going through bigger changes in the spring of 2024 and after that, the data will be stored in the KPI tool. The KPI tool is already collecting the data, so it also stores the data but the feature for marking the reported drives is missing. The functionality changes so that the user only must mark which test drive results to show in the Power BI report and Power BI directly uses the KPI tool's data storage as a data source.

Those new features in the KPI tool reduce resources while data is stored in the same place where the data is collected. After new features in the KPI tool, SharePoint is an unnecessary step for reporting KPIs. That will free space from SharePoint and simplifies, even more, the reporting process when there is one tool less to use.

## 7.4 Future Goal

The future goal is to get this report into wide use so that all teams working with KPIs will use the same way of showing the test results. That requires that teams are willing to abandon the old ways and adapt to this new way of reporting with Power BI. That simplifies and unites the way of reporting the results between teams.

There is an idea to make a page for each team so that teams can modify their page if needed without destroying anything that some other team might still need. Also, soon the result JSON file coming from the KPI tool will contain cell-level KPI data. Now it has only base station-level data that contains data coming from cells in the base station. This cell-level data will give more detailed information about the network performance and help testers find the reason why some KPIs are changed in some direction. This cell-level data is already shown in the KPI tool and the KPI report in Power BI contains links to drive details, but it would be nice to present the data directly in Power BI. That cell-level information will be kept

separate from the official report. In addition, there will be another report that is the same as the official one but contains more detailed views and own pages for each team. That is because there is no need to get so deep into cell data when presenting results on a large scale. Cell information is only for testers to help to find the problem if there is one.

## 7.5 Conclusion

The idea of the project was to create a new KPI report in the Power BI platform and automate the data transfer from the KPI tool to Power BI. The project was done by the Nokia 5G Field Verification KPI team.

The automation part was implemented with Power Automate and SharePoint. Power Automate has an automatic action to detect new files in the SharePoint folder and add the new data to the Power BI workspace. The report was done from scratch based on earlier KPI reports made with Excel and PowerPoint. The report shows the most important KPI indicator values and how the values have changed compared to the previous test drives and over time. KPI indicators are a way to measure 5G and 4G software performance.

This project proves that Power BI is a good option for creating reports to compare key performance indicator values. With Power BI it is easy to create visual representations of the data and the end users can filter the data to be shown. There are also other quite similar platforms but not as established and well-known as Power BI.

The purpose of the project was to simplify and unify the way of reporting the KPI testing results. When management or others are interested in the software package performance, a link to the Power BI report can be provided. There is no more need for testers to produce Excel tables and charts, or PowerPoint presentations. The tester must only export the reported drives to SharePoint and the reporting process is done.

This new way of reporting will save testers' time. Also, time is saved when testers can forget some tools that were previously used for reporting, and there is no need to learn how to use those. It is also a lot easier for users to get an understanding of the network performance when the report is similar amongst all sources producing KPI reports. Of course, at first adopting a new reporting method may take a little time.

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