Requirements Document

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AI Traffic Forecast

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Section 1 Introduction

1.1 Purpose and scope

The product is envisioned to help common & country product managers, service managers, solution managers, business managers for mobile services, network & RAN engineers as well as country specific operational teams such as sales and marketing take informed decisions to optimize operations and improve user experience through network planning, marketing and sales using accurate and reliable forecasts for data usage and user volumes.

The AI Traffic forecast product would provide accurate total data usage and subscriber count monthly forecasts for 36 months in future across multiple hierarchical levels of municipality, product type, subscription type, technology type and spectrum band.

The current scope of product excludes un-classified product categories or un-identified users (contributing to <X% of total data usage during 2023).

The forecasts would be accompanied by confidence intervals that would help the users take informed decisions in an uncertain future.

The forecasts do not account for sudden changes in sales strategy or major deviations in market sentiments in the short term. However, the forecasts are expected to learn the changes in trend during regular refresh cycles.

1.2 Definitions, acronyms, and abbreviations

Provide the definitions of all terms, acronyms and abbreviations that you have used in the document. As a suggestion, you could use a table. Do not forget to specify here how you refer to each requirement (identity).

If you have any domain specific terms or domain descriptions please add them here.

Acronyms & Abbreviations	Definition
AI	Artificial intelligence
RAN	Radio access network
MAPE	Mean absolute percentage error
System 1 (name hidden owing to data privacy control)	Internal system capturing historical data usage data

System 2 (name hidden owing to data privacy control)	Internal system capturing historical subscriber details
System 3 (name hidden owing to data privacy control)	Internal system capturing historical competitor details
System 4 (name hidden owing to data privacy control)	Internal system capturing historical pricing and revenue details
System 5 (name hidden owing to data privacy control)	Internal system capturing historical country level macro-economic data
System 6 (name hidden owing to data privacy control)	Internal system capturing historical infrastructure data

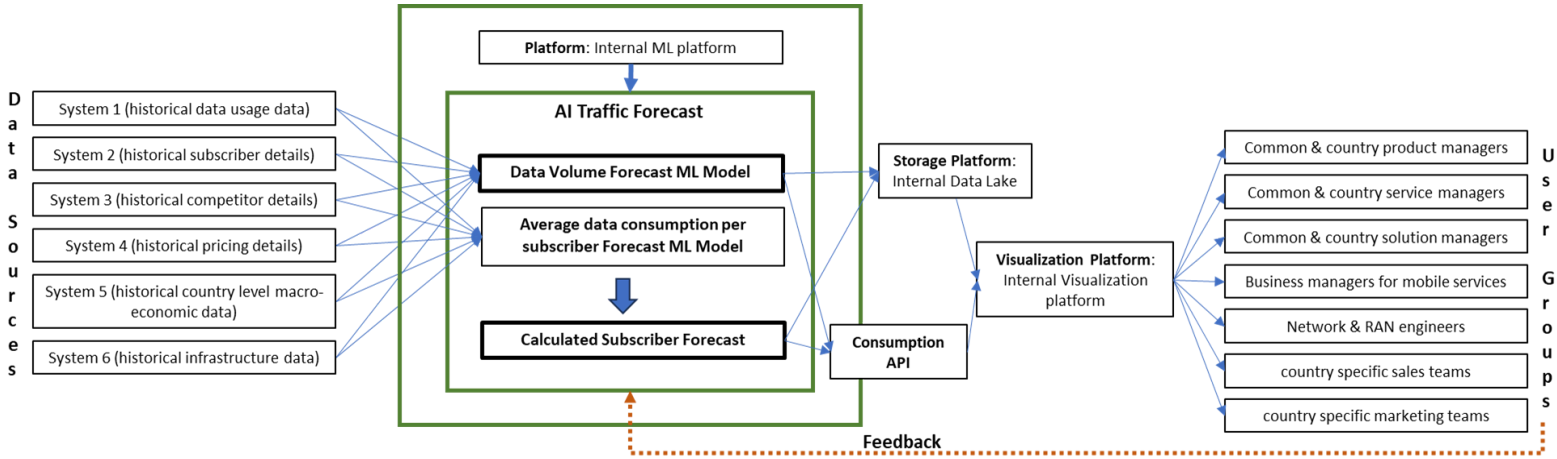
1.3 Overview

The document provides a detailed overview of requirement gathering and prioritization exercise done for AI traffic Forecast product starting with stakeholder and data source identification.

1.4 Goals of the product (goal level requirements)

Goal_1: Forecast capacity across different geographical zones
Goal_2: Highlight areas with mis-managed capacity utilization for sales and marketing functions as well as network operational teams
Goal_3: Forecast models should have a MAPE <15%

1.5 Context diagram for the system (please insert the context diagram here)



Section 2 Stakeholder Identification and analysis (see lecture 2 about Elicitation)

This section lists the stakeholders for the system you are developing. List the stakeholders here, describe them briefly and categorize them according to the groups of interest or importance.

Stakeholder	Description	Category	Score (0-5) (higher is better)
Common & country product managers	Product managers own the roadmap for different product portfolios. These are key potential stakeholders that may use forecasts to analyze growth and take strategic product decisions	Internal stakeholder who can also provide value from experience as well as strategic direction. Provide influence.	Expertise: 5 Influence: 5 Behavioral: 2
Common & country service managers	Service managers own the service metrics and ensure consistent user experience. These are potential stakeholders who would use forecasts to analyze performance of respective domains and plan to minimize any significant deviations in customer experience due to overcrowding and over capacity utilization	Internal stakeholder who can also provide value from customer/market understanding as well as strategic direction. Provide influence. Also potential collaborators.	Expertise: 4 Influence: 5 Behavioral: 5
Common & country solution managers	Solution managers own multiple epic portfolios for different product areas. These are potential stakeholders who would use forecasts to analyze performance of respective initiatives and plan for strategic growth.	Internal stakeholder who can also provide value from domain expertise as well as strategic inputs. Provide influence.	Expertise: 4 Influence: 2 Behavioral: 3
Common & country business managers for mobile services	Business managers own a portfolio of mobile services for different products and geographical areas. These are potential stakeholders who would use forecasts to analyze performance of respective portfolio and plan for strategic growth.	Internal stakeholder who can also provide value from domain expertise as well as business processes. Provide influence.	Expertise: 3 Influence: 5 Behavioral: 4
Network & RAN engineers	Network & RAN engineers continuously monitor low level network performance metrics and ensure consistent user experience. These are potential stakeholders who would use forecasts to analyze performance and plan to minimize any significant deviations in customer experience due to overcrowding and over capacity utilization	Internal stakeholder who can also provide value from technical expertise and common practices that influence observed data	Expertise: 4 Influence: 0 Behavioral: 0

Country specific sales team	Sales teams own a portfolio of products and services for different geographical areas. These are potential stakeholders who would use forecasts to analyze performance of respective portfolio and plan for strategic growth within their respective domains to improve growth.	Internal stakeholder who can also provide value from customer/market understanding as well as strategic direction through planned strategies. Provide influence. Also potential collaborators.	Expertise: 3 Influence: 2 Behavioral: 5
Country specific marketing team	Marketing teams own a portfolio of marketing initiatives (brand and action campaigns) for different geographical areas. These are potential stakeholders who would use forecasts to analyze unused capacity and plan for strategic growth.	Internal stakeholder who can also provide value from customer/market understanding as well as strategic direction through planned strategies. Provide influence. Also potential collaborators.	Expertise: 1 Influence: 1 Behavioral: 4

Data Source	**Description**	**Category**	**Score (0-5)** (higher is better)
System 1	Internal system capturing historical data usage data	Low cost, easy to access and high data availability system that provide accurate data	Cost: 5 Easy of access: 5 Availability: 5 Accuracy: 5 Opportunity cost: 5
System 2	Internal system capturing historical subscriber details	Low cost, easy to access and medium data availability system that provide accurate data	Cost: 5 Easy of access: 4 Availability: 4 Accuracy: 5 Opportunity cost: 5
System 3	Internal system capturing historical competitor details	low data availability system that comes with high opportunity cost	Cost: 2 Easy of access: 2 Availability: 1 Accuracy: 2 Opportunity cost: 5
System 4	Internal system capturing historical pricing and revenue details	Low cost, easy to access and high data availability system that provides medium accurate data	Cost: 5 Easy of access: 1 Availability: 5 Accuracy: 3 Opportunity cost: 2
System 5	Internal system capturing historical country level macro-economic data	high cost and low data availability system that comes with high opportunity cost	Cost: 2 Easy of access: 3 Availability: 2

			Accuracy: 1 Opportunity cost: 5
System 6	Internal system capturing historical infrastructure data	Low cost, easy to access and high data availability system that provide low accuracy data	Cost: 5 Easy of access: 5 Availability: 5 Accuracy: 3 Opportunity cost: 3

Section 3 Requirements Elicitation Techniques

Since the product is a ML model, no mock-ups or visual prototypes were discussed during any of the requirement elicitation sessions.

3.1 Elicitation Technique 1: Interviews:

To kick start the process interviews were done with representatives across the stakeholder groups. These interviews were kept unstructured to capture issues and current processes in detail, helping us formulate requirements. Each interview was done 1x1 within a 30 min slot either virtually or in-person when possible. The following set of requirements were formulated based on these sessions:

1. Goal_1: Subscriber and data forecast are required not only at country level but also for each geographical zone/municipality.
2. Goal_2: Data forecast combined with installed capacity can help teams identify areas with additional capacity as well as areas with need of additional capacity.
3. Current planning is done ad-hoc using simple linear regression based models coupled with intuitions that often suffer from lower accuracy and are difficult to reconcile.

3.2 Elicitation Technique 2: Brainstorming:

Post initial discussions and literature review we did a whiteboard brainstorming session to identify potential solutions and factors associated with forecasting subscriber and data growth. The session was conducted with a key set of stakeholder representations selected from the pool to form a focus group.
The following list captures key outcomes:

1. Forecast split across customer type, subscription type as well as technology type would add value and help multiple other use-cases
2. Goal_3: To help teams with operational team plan sales, marketing campaigns or capacity a MAPE<=15% would be sufficient.
3. Identified System 1-6 as key sources that can help capture factors impacting subscriber and data growth.
4. Owing to data privacy and quality issues with multiple data sources, it may be difficult to source all the data in the first stage itself.

A separate brainstorming session with Data Science practice helped identify different modeling methodologies and workflows that can be explored to help design the solution.

3.3 Elicitation Technique 3 : Requirements Workshop:

Post multiple discussions and inputs from the community we consolidated the list of requirements to plan for the product roadmap. The findings and initial draft of the roadmap was discussed with the focus group to gain consensus as well as chalk out the intricate details for the plan and resolve prioritization conflicts.
This exercise was instrumental in helping us identify top priorities as well as plan deliverables/release cycles.
The following lists some of the key decisions made during the workshop.

1. A monthly forecast spanning across 3 years in future would be required to provide sufficient time to teams for planning and relevant actions.
2. First product cycle would include factors only from data sources 1,2 and 6.
3. Second release would include factors using data source 3.
4. Future releases post version 2 would depend on feedback, adoption and accuracy levels

Section 4 System Requirements

To capture requirements following techniques were used:

1. Data model : Illustrated below in section 4.3. Owing to data privacy issues the actual data columns have been hidden.
2. Data dictionary : Owing to data privacy issues it was difficult to provide any specific details
3. Feature requirements See individual Functional Product Level Requirements.
4. Vivid Scenario: This technique was used to capture different scenarios where the model would exclude/include in prediction. eg.

Maintenance of 4G Tower for in Municipality X: During the week 24, tower XXX in municipality X was shut down and traffic was rerouted to nearby 3G towers. This led to a major jump in data consumed on 3G in municipality X and a consequent drop in 4G data consumption. Since this is a short term event, the model does not learn the behavior and excludes sudden changes in 3G/4G data consumption for municipality X.

Summer season: Every year Swedish residents move from metropolitan cities such as Stockholm to smaller towns and remote geographical areas during the months July and August. Since this trend is observed across all years, the model learns the seasonal behavior and forecasts lower data consumption during July and August for big cities while higher data consumption for rural and otherwise sparsely populated geographical zones.

5. Context diagram: See section 1.5

4.1 Domain Level Requirements

DL1: Model should account for seasonal changes in data consumption trends across municipalities and other geographical zones. eg. major subscribers move to rural/semi-urban municipalities during the summer season.

DL2:Model should adapt to changes in sales strategy and learn the growth cycle of different products over time within 3 months of major changes. While 3G is being phased out, 4G is saturated and 5G is showing growing adoption.

DL3: Model should account for capacity changes and maintenance plans across different geographical zones. Short term changes spanning less than 1 month can be excluded, however long term changes to capacity should be identified and included as part of the prediction.

4.2 Functional Product Level Requirements

PR1: Forecast ML model runs each month to forecast values for subscriber count and data consumption for the 30th Month in future.

PR2: Model refresh or update occurs every X months to ensure unforeseen changes in market conditions are accounted for.

PR3: Model should forecast subscriber count and data consumption for each combination of dimensions.

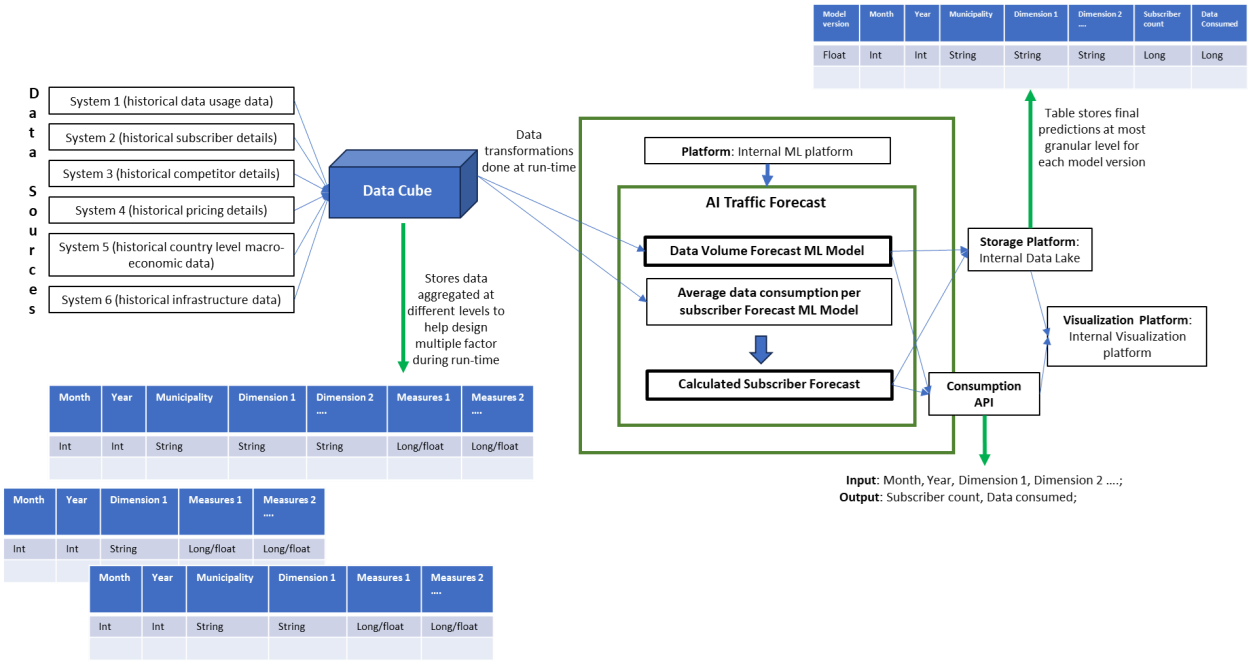
PR4: Model should forecast subscriber count and data consumption for each municipality.

PR5: Forecasts should be accompanied by respective confidence intervals to ensure ease of use and reliability.

4.3 Data Requirements

Owing to data privacy issues the actual data columns have been hidden.

The tables represent views/tables with relational data model.



DR1: Data cube contains measures aggregated at multiple levels of dimensions. The levels should cover all possible permutations of different dimensions for each month eg. all measures aggregated for each municipality for each month, all measures aggregated for each municipality and categories of dimension 1 for each month.

DR2: Values of month, year along with combination of dimensions in specified order needs to be passed to API to get predicted subscriber count and data consumed predictions in return.

DR3: Prediction data is stored in a table using a rational data model with prediction values for each month and combination of dimensions to most granular level eg. predicted subscriber count for May 2025, Stockholm municipality, dimension 1 = X, dimension 2= X2 …

4.4 Product Quality Requirements

Here you specify your quality requirements (also called non-functional requirements). You are expected to write requirements about a minimum of 5 quality aspects (e.g. performance, usability etc..)

QR1: Correctness: Model performance statistics such as MAPE are monitored every month to ensure SLA of overall MAPE <=15% is met.

QR2: Usability: 80% of users shall find the visualization forecast dashboard easy to use. 60% shall recommend the dashboard to others.

Visualised Forecast should be easy to understand and be displayed in units commonly used. eg. GB/TB of data consumed per month or X hundred thousand subscribers

QR3: Interoperability: Model should be built using kubeFlow pipeline to ensure easy transition to any system for processing. eg. GCP, AWS, Azure cloud or on-prem data center.

QR4: Integrity: Only internal infrastructure should be used in development to ensure high levels of security and data privacy protocols are followed.

QR5:Portability & Maintainability: Model refresh and update should not take more than 1 sprint cycle.

Code should follow kubeflow pipeline structure laid out as part of best practices for data science development. All functions should be modular and parameterized to ensure easy portability.

QR6: Usability: Forecast visualization should load within 20 seconds and handle a load of at least 10 concurrent users at peak usage.

Section 5 Requirements prioritization

We started with the 100-dollar test to estimate the top of mind and contrasting views among stakeholders. The prioritization exercise was done with representatives within the focus group only. Also to note the stakeholder groups may not be equally distributed. The following table represents average score from each of the stakeholder groups:

	Stakeholder Group						
Requirement	Common & country product managers	Common & country service managers	Common & country solution managers	Common & country business managers for mobile services	Network & RAN engineers	Country specific sales team	Country specific marketing team
DL1	35	15	20	30	10	25	30
DL2	20	25	20	25	20	25	25
DL3	5	15	20	15	30		
PR1	10						
PR2							
PR3		10	10	15		20	20
PR4	10	15	15		15		
PR5	10	10	5	5		5	5
DR1							
DR2					10	5	5
DR3					5		
QR1	5	5	10	10	10	20	15
QR2	5	5	5				
QR3							
QR4							
QR5							
QR6							

Since some of the requirements are correlated we found this exercise could have been optimized by grouping some of the dependent requirements. We also found the stakeholder prioritization to be biased towards the business outcome and output as opposed to prioritizing any of the platform/data related requirements that may be crucial to the success of the product.

To simplify the prioritization we clustered the requirements into groups (Numerical Assignment) and did a self ranking exercise based on the delivery version to be presented to stakeholders for approval. Since the ranked release version was influenced by the 100-dollar prioritization exercise, it was well received by the focus group. However, I found the group to lay more focus on v1 and v2 deliveries as opposed to reviewing all versions since later releases might be far in future and other feature requirements may be identified based on the feedback and adoption.

Requirement	Group	Ranked Release Version
DL1	Critical	v1
DL2	Critical	v1
DL3	Standard	v2
PR1	Standard	v1
PR2	Optional	v2
PR3	Standard	v2
PR4	Critical	v1
PR5	Standard	v1
DR1	Critical	v1
DR2	Critical	v1
DR3	Critical	v1
QR1	Standard	v2-3
QR2	Standard	v1
QR3	Standard	v2
QR4	Critical	v1
QR5	Optional	v4
QR6	Optional	v4

Section 6 Policy and Regulation Requirements

1. Any combinations with less than 5 subscribers are anonymised even after aggregation
2. QR4: Integrity: Only internal infrastructure should be used in development to ensure high levels of security and data privacy protocols are followed.

Section 7 References

Document Number	Title	Date	Author/Owner
1.1	Data Dictionary for data source 1	16th April 2024	Data platform team
1.2	Data Dictionary for data source 2	16th April 2024	Data platform team
1.3	Data Dictionary for data source 3	17th April 2024	Data platform team
1.4	Data Dictionary for data source 4	17th April 2024	Data platform team
1.5	Data Dictionary for data source 5	17th April 2024	Data platform team
1.6	Data Dictionary for data source 6	17th April 2024	Data platform team
1.7	ML infrastructure and components	18th April 2024	Data Science platform team
1.8	Network planning and operational maintenance SOPs	28th April 2024	Network & RAN Team

Section 8 Document Revision History

Version	Date	Name	Description
v1.0	15th April 2024	Uday Jain	Added scope
v1.1	21st April 2024	Uday Jain	Added stakeholder and data source elicitation
v1.2	25th April 2024	Uday Jain	Added details for different elicitation techniques used
v1.3	5th May 2024	Uday Jain	Added system requirements and techniques used
v1.4	9th May 2024	Uday Jain	added results from requirement prioritization
v1.5	10th May 2024	Uday Jain	Added goal

Section 9 Appendices