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Designing Business Model for Precise GNSS Positioning Correction service FINPOS

Case: National Land Survey of Finland

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The purpose of this thesis was to find ways for opening Precise Positioning FINPOS RTK-service and FinnRef GNSS CORS Network Data to all so that everyone can benefit from the openness of FINPOS services. National Land Survey of Finland (NLS) is a government agency responsible of Finland's cadastral surveys, maintaining information about properties and dwellings, handle registrations of title and mortgages, produce map data and promote the research of spatial data. Part of FINPOS services were still closed from the public. The need for full-service openness had reached a significant demand from the public, private and global sector. New business model for FINPOS services was required to open the services to all.

Existing knowledge was used to gain better understanding of how a new business model can be designed. Business Model Canvas tool was selected to help design the FINPOS business model. Current State Analyses of GNSS Positioning service market in Finland and globally were also carried out.

The outcome of this thesis was a New Business Model design for NLS FINPOS services stating the biggest possible added values as a proposal for everyone; GNSS RTK positioning service for free and FinnRef GNSS CORS Network data for a fee for every positioning service provider to secure the quality and availability of FinnRef data. The data having a fee makes it possible to produce free precise positioning for Finnish tax payers with the same quality and availability as for all other positioning service providers for other use cases like autonomous vehicles. The outcome of the analyses was presented as a business proposal to the key stakeholders in National Land Survey of Finland.

Keywords	GNSS, RTK, CORS, Business Model Canvas

Contents

Introduction

1.1 Overview

National Land Survey of Finland has a Positioning correction Service FINPOS maintained and developed with Finnish tax money originally for maintaining coordinate reference systems. NLS has been developing FINPOS and FinnRef, Finland's GNSS (Global Navigation Satellite Systems) CORS (Continuously Operated Reference Network) network in order to use FINPOS on its own production in 2019 (NLS, 2019). FINPOS openness question is still open regarding the RTK (Real Time Kinematic) positioning service and CORS data for public, private and global sector. NLS needs a plan how to make a market entry so that everyone wins; NLS, government, municipalities, global companies, private sector and citizens.

1.2 Key terms

PNT	Positioning, Navigation and Timing
CSA	Current State Analyses
SLA	Service Level Agreement
RTK	Real Time Kinematic
PPP	Precise Point Positioning
CORS	Continuously Operated Reference Station
FinnRef	National CORS operated by NLS
Trimnet	Geotrim Oy CORS network
SMARTNet	HxGN SmartNet CORS network
FINPOS	National Positioning service
GNSmart	Geo++'s GNSmart software
NLS	National Land Survey of Finland
FGI	Finnish Geospatial Research Institute
GNSS	Global Navigation Satellite System
GPS	USA's Global Positioning System
GLONASS	Russian Global Positioning System
Galileo	EU's Global Positioning System
BeiDou	China's Global Positioning System
EUREF	Regional Reference Frame Sub-Commission for Europe

EPN	EUREF Permanent GNSS Network
IGS	International GNSS Service
UTC	Coordinated Universal Time

1.3 Positioning correction services in Finland

Finland has two private Positioning service providers operating at cm level accuracy: Geotrim Oy's Trimnet and HxGN Geosystems Finland's SMARTNet. Both services are based on more than 100 COR Stations covering Finland, in which data their RTK positioning services are based and sold to customers like NLS. These systems allow measuring cm level accurate coordinates in EUREF-FIN coordinate system in Finland. National Land Survey has defined E2 class EUREF-FIN coordinates to their COR Stations to be used in a Positioning system. NLS has built its own Positioning system called FINPOS, which data is based on FinnRef CORS network, which stations has E1 EUREF-FIN class coordinates defined by NLS FGI. EUREF-FIN E1 class stand for highest order reference coordinates system, FinnRef. It is a base for all other coordinates and its systems in Finland. E2 classification is for positioning systems COR Stations (JHS184, 2019). FINPOS can produce RTK positioning service as well as other positioning methods.

Globally there are also many different kind positioning correction systems available that can produce cm level accuracy positioning in a global WGS84 coordinate system, but not necessary in local EUREF-FIN coordinate system, where for example all Finnish maps are. These are many global positioning services: Omnistar, RTX, Starfix/Seastar, Atlas, Starfire, C-Nav, Veripos, and Terrastar. New similar services are also arriving from Sapcorda and GMV aiming to produce global positioning servicesfor autonomous vehicles. These new companies most likely require local CORS data in order to be able to produce positioning corrections for example in Finland. EU's Galileo High Accuracy Service is also planned to be opened in 2020 for EU member states providing 20 cm accuracy everywhere in Europe.

To open FinnRef CORS data would open new business opportunities in Finland and bring competition for positioning markets. Land surveying, Agriculture and Intelligent transportation (autonomous vehicles) are expecting FinnRef CORS data to get opened. For example, all above global companies could add FinnRef CORS data in to their positioning services to operate in high precision in Finland. In order to start a Safety-of-Life

service for example for autonomous vehicles, high SLA contracts should be required from the CORS data providers as well as from the positioning service providers.

1.4 Case company NLS and service FINPOS

National Land Survey of Finland (NLS) is a government agency responsible of Finland's cadastral surveys, maintaining information about properties and dwellings, handle registrations of title and mortgages, produce map data and promote the research of spatial data (Maanmittauslaitos.fi, 2019).

Global Navigation Satellite System (GNSS) which includes GPS, GLONASS, Galileo and BeiDou Global Positioning Systems is used by National Land Survey of Finland (NLS) to ease legal cadastral surveys, property parcelling's and mappings etc. To be able to fulfil all these tasks NLS has been buying Positioning service from private sector since 2003to produce precise coordinates.

National Land Surveys Centre for ICT Services is responsible of FINPOS services and FinnRef CORS network operations, including maintenance and development.

FinnRef CORS network was renewed in 2014 by Finnish Geodetic Institute. First positioning service was also launched on top of FinnRef CORS data. Positioning Service was based on CORS data from 20 FinnRef stations producing RTK-, DGNSS and RINEX services for everyone. RTK service was closed in 2015 when FGI merged with NLS.

In 2015 NLS started a project to investigate possibility to use FinnRef's data and Positioning service in NLS's production instead of buying the service from the private sector.

In year 2016 NLS decided to start a development project for FinnRef-network so that it would become dense enough for NLS production needs before summer 2019 to fulfil lower than 10cm vertical and 20cm horizontal accuracy needs for land surveying production works.

During project's building years 2017-2018 NLS had built nearly 30 new stations all around Finland and made data exchange deals with Estonia, Sweden and Norway for usage of their stations near the Finnish boarder. By the end of 2018 total amount of stations in Positioning Service was almost 65 stations.

In early 2019 Positioning service got an update to GNSmart 2, positioning service software by Geo++. Most waited update features where Galileo and BeiDou satellite constellation corrections to produce the expected accuracy less than 10cm in Finland with current station density. This GNSmart 2.0 update was first supposed to be released in 2015 but got finally released in late 2018, mostly due to late operative start of Galileo and BeiDou satellite systems.

2019 RTK positioning service and RAW COR Station data are still closed from the public, private and global sector because GNSmart 2 is still under development. Vision is that RTK positioning service will be free for everyone and FinnRef CORS data will be opened. Current Business model offers very low value for all regarding its full potential. Service development is ongoing and is expected to be finished by the end of summer 2020. By then service is also expected to be ready to be opened for NLS production, public, private and global sector as well for all citizens.

2 Research Design

2.1 Business Problem, Objective and Outcome

The known world we have been living is currently evolving rapidly. Everything is digitalizing and old school methods are continuously stepped over. This can be seen also in the land surveying industry. Coordinates are getting more accurate every day as well as the speed and methods of getting precise coordinates. Overall GNSS market is changing and the biggest markets are in the navigation and location-based services. Land surveying is slowly becoming one of the minority segments in overall GNSS market (GSA, 2017).

Europe and China have been building their own satellite navigation system constellations for years now and both are finally almost in full operational use. These two constellations and the old ones; GPS and GLONASS are really changing the positioning methods. Using all four constellations at the same time adds positioning satellites to the sky basically four times more than just traditional GPS. This means the speed, accuracy, window of opportunity and harsh conditions are all now totally different than before, when making

GPS measurements. From 10m accuracy now to less than 1cm means that the GNSS market is getting constantly new areas to expand its usage, the biggest trending by far now is autonomous vehicles and precision timing, in which all of the world's biggest companies like Google, Amazon, Tesla, Uber, Apple etc. are all now competing to get the world's first autonomously driving vehicle (Welch and Behrmann, 2018). The whole GNSS industry will be growing extensively in the future. For instance, autonomous driving can and probably will change the whole car industry and all the logistic transportations on the ground, sea and air. The need for designing the future Business Model of NLS Positioning services is now higher than ever.

As an overall current highest precision RTK-based services are getting global competitors. Worldwide GNSS ecosystem is changing and the need for high precision positioning is growing. Future technologies like PPP (Precise Point Positioning) and SSR (State Space Representation) needs ground stations, but significantly less, average mean could be around 5 times less than with RTK. Therefore, also Finnish GNSS markets will change drastically in the next 5-10 years once PPP/SSR will get more developed. Positioning services may also become safety critical mass market services for mobile phones, autonomous vehicles and intelligent transport systems where precise Positioning, Navigation and Timing (PNT) are needed.

As there is a high need to open services to global, public and private sector. Therefore, the objective of this thesis is to design a new business model for NLS Positioning services that benefits all. Future needs to be considered in such way that a proposal for the new business model can be presented to the NLS stakeholders to make an easy decision about the openness of FINPOS services.

Outcome of the thesis is therefore to have new business model for Positioning service that benefits all; NLS, public, private and global sector as well as the citizens of Finland.

2.2 Design

Research design is based on following flow chart (figure 1).

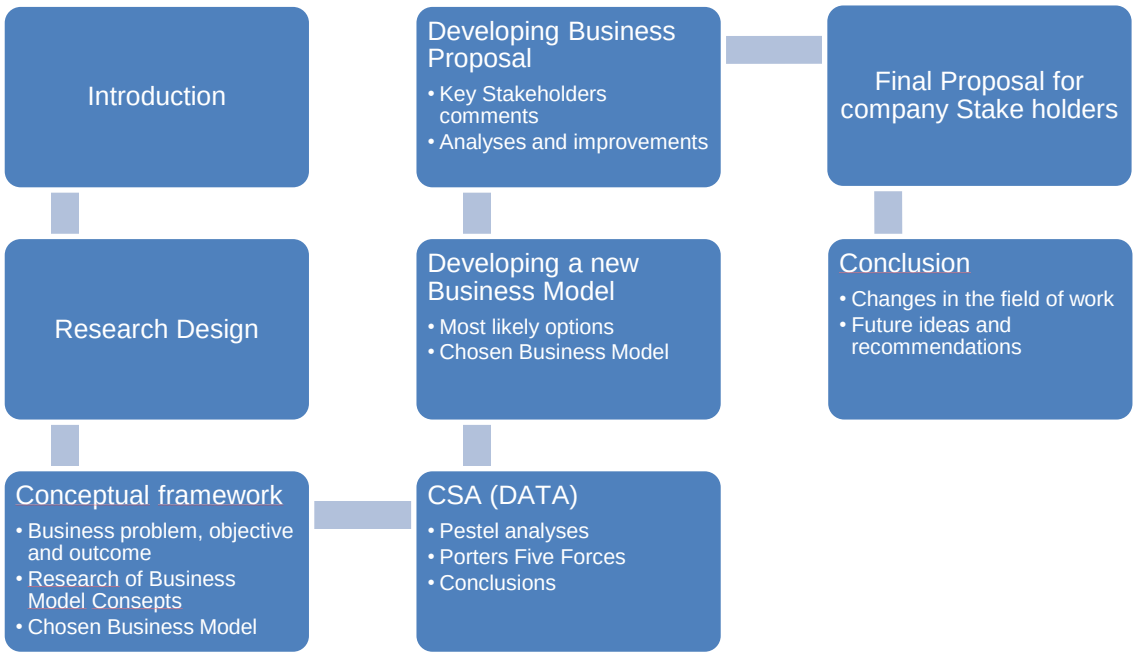

Figure 1: Flow chart for Research Design

For this thesis to be scientifically valid, all literature sources and solutions presented in the work must be scientifically proven. This part creates the conceptual framework for this work. Therefore, only academic journals and well-known concepts are used to work as source of choosing the method; how to create a business model.

Once the model of building the business model is figured out, work can focus on collecting data to create the business model. Data collection plan can be found below (table 1). First round of data will be based on Current State Analyses (CSA) (data1). CSA will be produced of using the world's most commonly used strategic analysis tools; PESTEL and Porters Five Forces to create environmental and market attractiveness analyses.

Table 1: Data collection plan

Data 1	Current State Analyses	PESTEL && Porters Five Forces Analyses, work experience and insights	Spring 2019
Data 2	Key Stake Holder comments of proposal	By discussion or written text	Autumn 2019
Data 3	Decisions of Proposal	Stakeholders decision	Autumn 2019

After CSA the work will continue developing an executive proposal draft for company stakeholders. This section focuses on how building the business model can be done using the chosen method. What customer segments there are and what are the most attractive business models to choose from, their differences and impacts to other competitors. To choose the best business model, work must compere what are the biggest insights and added value proposals risen from the CSA. Based on analysed results, chosen final business model is to be presented for the company stakeholders.

In order to get valuable data to further improve the proposal to be as most attractive as possible and well grounded. Proposal will be given to key stakeholder to get comments and improvements. These stakeholder comments (data2) are to be analysed and adjusted to the final executive proposal for the company stakeholders.

Final chapter of this work will be the evaluation and conclusions (data3) of the final proposal. Also, there will be thoughts about the changes in the field of work and its future.

3 Conceptual Framework

In order to determine the method of designing the business model for this thesis, several articles have been read to know the most used business concepts for generating a business model.

Business is changing so drastically that a new business model needs to be created. Business is already there but changes to the business is go into be so big, that it is necessary to design a new business model for the new business in order to fully understand NLS's own needs, governmental, municipally, private sector, global and citizen needs. Therefore, it is needed have a proper current state analyses (CSA) of current

GNSS positioning services market competition and how it could change after NLS possible decisions. In order to innovate and develop the new business model for the Positioning service, a suitable way or tool to create the business model is needed.

3.1 Business models

What is a business model? Alexander Osterwalder wrote in his blog in 2005: “A business model is nothing else than a representation of how an organization makes (or intends to make) money” (Osterwalder, 2010). Since then the idea of business model has changed a bit. In Alexander Osterwalder’s and Yves Pigneur’s book Business Model Generation, Business model is defined in short as: “A business model describes the rationale of how an organization creates, delivers and captures value”. In the book this has been nicely described through in 9 building blocks. These blocks binded together creates the "business model canvas" (Osterwalder and Pigneur, 2013).

This is indeed is the core idea what this case also tends to achieve and therefore this could be the method designing the business model. To be sure, we must compare Osterwalder’s Business Model Canvas to a traditional Business Plan. Short review is done as followed.

Business plan in its simplest form is a description of the business goals and how to get there. Plan is about executive summary, company overview, information about the products, marketing plan, major milestones, company resources and a financial plan (Berry, 2019).

The traditional Finnish way of describing the business or its business model used to be a business plan but indeed this is not the most convenient and practical for innovating new business models quickly on time to time based on collected data and insights from the industry. Therefore, traditional business plan is not the case to plan a business model continuously over periods of time, and neither it should not be used in this work.

Business Model Canvas is widely used innovative business model generation tool, that was first introduced in the article The Business Model Ontology: A Proposition in a Design Science Approach in 2004 (Osterwalder, 2004) and reintroduced in 2005 as best known as a business model canvas by Alexander Osterwalder.

Concept tool separates the biggest key factors (nine as a total) of modelling new business model and adds them all in line on a canvas table. Canvas is very self-explaining, and therefore is easy to fill with the needed factors. All factors are most commonly used and thought when designing a business model. Therefore, the canvas is fast to full fill regarding any new idea and aligning all key factors easily on one page to evaluate if the model is successful or not.

Conclusion of these two sources, decided concept for business model is to be Business model canvas by Alexander Osterwalder. Business model canvas is an exceptional tool to design a business model.

3.2 Business Model Canvas

Business Model Canvas has a very simple idea as concept; simplify the talk of business model innovations into a shared language that is intuitively understandable, but not too oversimplified. Osterwalder and Piqneur believes that business model can be divided in 9 building blocks that covers the main areas of business. These areas are: customers, offer, infrastructure, and financial viability (Osterwalder and Pigneur, 2013).

The 9 Building Blocks:

1. Customer Segments
2. Value Propositions
3. Channels
4. Customer Relationship
5. Revenue Streams
6. Key Resources
7. Key Activities
8. Key Partnerships
9. Cost Structure

Business Model canvas is presented below in the figure 2. In order to understand better how to canvas really work, we will go thru The 9 Building Blocks in detail.

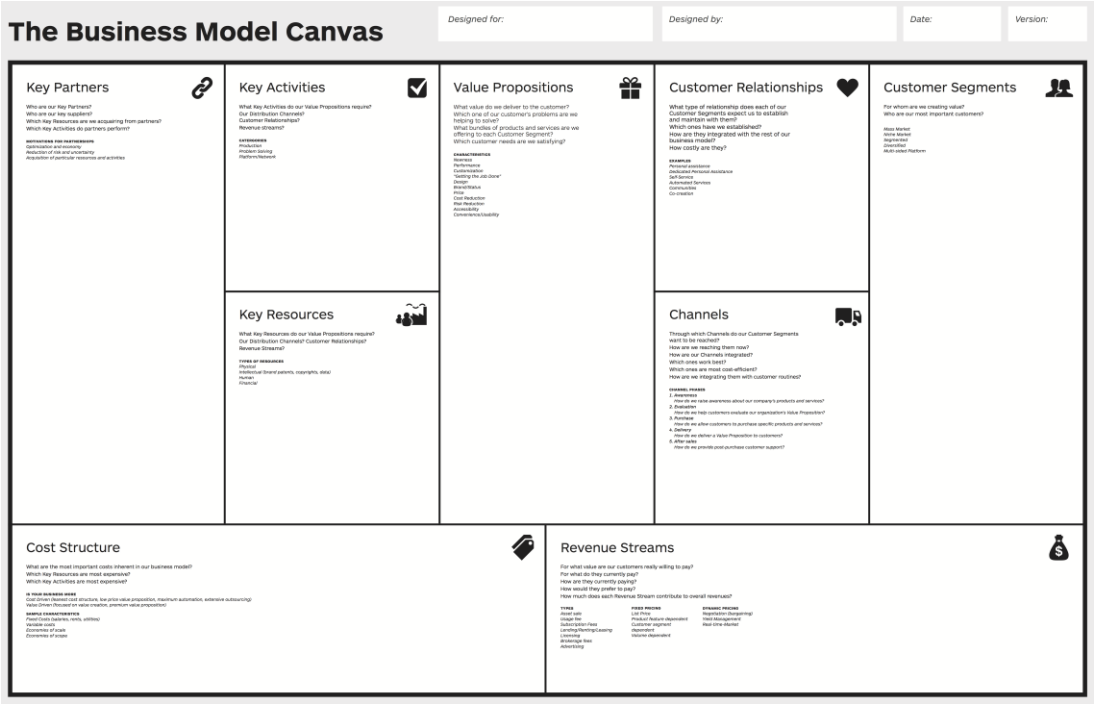

Figure 2: The Business Model Canvas (Osterwalder, A. and Pigneur, Y, 2013)

3.2.1 Customer Segments

“For whom are we creating value?”, “Who are our most important customers?” These are the key questions Customer Segments (Osterwalder, A. and Pigneur, Y, 2013) try to answer. According to Osterwalder, Customer Segments can be divided to multiple groups depending whether the customers’ needs are different than others or if they are reached through different Distribution channels. Customers can also need different kind of relationships, like company’s vs citizens. There can also be different kind of profitability’s which separates the customers.

Osterwalder gives a few examples on how segments can be divided in general: Mass market, that focuses only on massive groups that require similar added value, like citizens that require cars. Niche market, that focuses only on specific customer segments, maybe even just one big customer, like certain car parts manufacturer. Segmented customers mean, that the value proposition is slightly different but for different customer segment, for example 100 000€, 50 000€ or 20 000€ car. All cars all sold to people, but the customers require different kind of service and quality and therefore value proposition. Diversified segments mean that business model can be diversified to totally different

needs and problems using the tools or parts that the company uses. For example, Amazon that sells cloud services, also sells processing power from the same IT infrastructure.
Multi-sided platforms (or multi-sided markets) needs multiple segments to work as a business model. For example, commercial tv-channel, that needs a large distribution channel and audience. It also needs to attract lots of advertisers in order to finance itself. Whiteout the other, the business model cannot success (Osterwalder, A. and Pigneur, Y, 2013).

3.2.2 Value Proposition

“What value do we deliver to the customer?”, “Which one of our customer’s problems are we helping to solve?”, Which customer needs are we satisfying?”, What bundles of products and services are we offering to each Customer Segment?” – These are the questions Osterwalder presents us to question on describing the Value proposition. In other words, Value Proposition building block describes how we help the customer segment providing the added value serving products or services and the customer decides to choose this before the other. Added value can be quantitate like price, risk reduction, speed of service and performance or qualitative like design, brand and customer experience (Osterwalder, A. and Pigneur, Y, 2013). Osterwalder gives several examples:

Newness, like the mobile phones which brings new set features every year. Performance, like computers that got faster every year or service that performed better giving more value for the customer. Customization, tailoring services or products for specific customers. Getting the job done, is like buying a sub service in order to get the main service to work continuously without worrying of the sub service. Design, hard to measure, but in fashion, a decisive way to offer more value. Brand/Status, customers get more value for them self’s, like high cost car can mean good wealth or using a certain product brand can tell others what the customer is into. Price, a lower price is usually the best way to get more attraction, but it may also mean that the quality isn’t the best. Usually price quality ratio is the best way to great the value proposition. Same applies to cost reduction, a very easy way to create more value when customer is buying the same product or service. This also applies to risk reduction; everyone wants to lower their risks and get more value. Accessibility, if the service or products are not available when the customer needs them, the value is not good, and customer will most likely get another one. Convenience/Usability, best example is probably Apple, how it has created value of

creating a work flow on every service and product so easy and short that the Convenience and its usability has given superior value compered to others (Osterwalder and Pigneur, 2013).

3.2.3 Channels

“Through which Channels do our Customer Segments want to be reached?”, “How are we reaching them now?”, “how are our Channels integrated?”, “Which ones work best?”, “Which ones are most cost-efficient?” and “How are we integrating them with customer routines?” are the questions on how Osterwalder describes the customer communication and reaching Channels for value proposition.

Channels is the key way on marketing or creating awareness of services and products, helping customers to evaluate and understand your value proposition. It is also the way the customers can buy the services and products and providing support.

Osterwalder divided the channels in five phases which all can be behind your own or your partners channel, as direct or indirect channel type, as shown below in table 2. Choosing the right channels can optimise your resources on reaching the customers (Osterwalder and Pigneur, 2013).

Table 2: Channels and their phases

Channel Types:	Channel Phases:
Direct - Sales force - Web sales Indirect - Own stores - Partner stores - Wholesaler	1. Awareness 2. Evolution 3. Purchase 4. Delivery 5. After sales

3.2.4 Customer Relationships

“What type of relationship does each of our Customer Segments expect us to establish and maintain with them?”, “Which ones have we established?”, “How costly are they?” and “How are they integrated with the rest of our business model?” is how Osterwalder questions and describes the types of Customer Relationships in different customer segments.

Osterwalder divides Customer Relationships into six different segments: Personal assistance, which is based on human interaction thru face to face, phone call, email or by other ways. Dedicated personal assistance, is solely dedicated person to help customer at the best possible way as agreed, like private banker or key account managers who maintain solely the customer relationship with the customer. Self-service is where service provider has no direct interaction with the customer meaning customer can handle everything by themselves. Automated services, which can mean automated tailored services for individuals or groups by their unique information. Good example is targeted marketing for individuals at internet, where customer gets advertisements depending on its search behaviours and interests. Communities are like chat forums where customers can share their insights and tips on how to get more value out of the service or product. Co-creation, like Amazon askes customers give and write reviews to the products to share awareness of the product and give experience-based value for the other customers to more easily buy the product (Osterwalder and Pigneur, 2013).

3.2.5 Revenue Streams

“For what value are our customers really willing to pay?”, “For what do they currently pay?”, “How are they currently paying?”, “How would they prefer to pay?” and “How much does each Revenue Stream contribute to overall revenues?” are how Osterwalder questions and describes how company gets its cash Revenues Streams for each customer segments, earnings left after all costs. There are two types of revenues: one-time payments and recurring payments. One-time payment can be one car for example or a recurring a yearly post-purchase maintenance service for the car or a recurring cleaning service (Osterwalder and Pigneur, 2013).

Osterwalder presents several possibilities creating Revenue Streams: Asset sale, meaning a product like a book or a car. Usage fee, for example electricity fee or car rental fee for several minutes, hours, days or even years. The more there is usage the more the fee is. The Subscription fees are exact fees of certain collection of assets for certain period like Spotify or Netflix. Lending/Renting/Leasing are for assets for a fixed period for a fixed fee. Honestly all these sounds the same but are still diverse. Licensing is when one's intellectual property rights are licensed for a fee, meaning one can for a fee use your design or technological patent for its own product. Brokerage fees, when a third party sells your or someone else's product it takes a cut from the actual price for itself, like a real estate agent when they sell your house. Advertising creates fees from advertising someone's products, services or brand. For example, media industry when they advertise products and services in order to get revenue for themselves to produce or sell the media. Pricing mechanism is dived in two: Fixed Menu Pricing and Dynamic Pricing (Osterwalder and Pigneur, 2013):

Fixed Menu Pricing

- List price
- Product feature dependent
- Customer segment dependent
- Volume dependent

Dynamic Pricing

- Negotiation (bargaining)
- Yield management
- Real-time-market
- Auctions

3.2.6 Key Resources

"What Key Resources do our Value Propositions require?", "Our Distribution Channels?", "Customer Relationships?" and "Revenue Streams?" are how Osterwalder questions and describes Key Resources that are needed for the business model to work. Osterwalder divides Key resources in four categories; Physical, Intellectual, Human and Financial and they can all be owned or leased or got from partners (Osterwalder and Pigneur, 2013).

According to Osterwalder, Physical Key Resources are everything which are physical, as an assets, houses, machines and systems. Intellectual resources are patents, copyrights, confidential or secret knowledge, brands, partnerships and customer databases. Human key resources are still needed almost in every business. They are most needed in creative and knowledge-based businesses. Financial, most of the business require financial support and/or financial guarantees. For example, to produce massive number of products for buyer, company must take a loan to get all needed parts or materials to be able to compile the product for customer before getting payed (Osterwalder and Pigneur, 2013).

3.2.7 Key Activities

“What Key Activities do our Value Propositions require?”, “Our Distribution Channels?”, “Customer Relationships?” and “Revenue Streams?” are how Osterwalder questions what the companies most important key activities are required for the business model to work accordingly. There can be many kinds of key activities, for example, National Land Surveys key activities are for example land surveying and cadastral works.

Osterwalder separates key activities in following three categories. Production, starting from designing the product, then making and delivering it. Problem solution is all about consulting new solutions to existing problems for individual customers. Platform/Network, for example huuto.net, is an auction site where anyone can action its products. This kind of platform business model requires constant platform development. Same goes with a networking and brand business models, they constantly need development keeping the status as brand (Osterwalder and Pigneur, 2013).

3.2.8 Key Partnerships

“Who are our Key Partners?”, “Who are our key suppliers?”, “Which Key Resources are we acquiring from partners?” and “Which Key Activities do partners perform?” are how Osterwalder questions who most important partners and suppliers are enabling the business model to work. Partnering someone may be due to reducing risks, or optimising business model or just by acquiring resources. Osterwalder divides partnerships in four:

1. Strategic alliances between non-competitors
2. Coopetition, strategic partnerships between competitor

3. Joint ventures to develop new businesses
4. Buyer-supplier relationships to assure reliable supplies

Osterwalder explains three different motivations for them: Optimization and economy of scale, mostly optimization happens only when company wants to reduce its costs by outsourcing part or most of its production or activities. Reduction of risk and uncertainty is a place for partnership where one wants to reduce risk and uncertainty by cocreating something like Osterwalder's example, Blue-Ray, which all biggest electronic companies of the world developed it instead of everyone developing their own technologies. Acquisition of resources and activities. Licensing a product or activity can be very cost saving, like Osterwalder's example, mobile handset, where one just buy the licence to use the technology instead of developing it from the scratch (Osterwalder and Pigneur, 2013).

3.2.9 Cost Structure

"What are the most important costs inherent in our business model?", Which Key Resources are most expensive?" and "Which Key Activities are most expensive?" are how Osterwalder questions what are the companies most important cost to run the business model. Everything creates costs, all our working hours like Osterwalder's describes: "Creating and delivering value, maintaining Customer Relationships, and generating revenue all incur costs." These costs can be the most important costs defining The nine building blocks of the Business Model Canvas.

Most of the business models follow either cost driven or value driven business model or are somewhere in the middle. Cost-driven, is a model where almost every cost is as small as possible. Value-driven instead is all about focusing on creating more value, or Premium value and not by minimizing the price regarding the end value. Example could be given from a luxury hotel, where everything is luxury and may even be high priced, but so are the customers willing to pay for the added value as well, as Osterwalder explains.

Costs structures can vary differently. Fixed costs are the ones that come from materials and human resources like salaries for example. Variable costs vary when for example service gets more volume and therefore the costs get bigger as well. Osterwalder gives an example of music festival where the costs change when more people need to be serviced. Economies of scale, the bigger volumes of parts, or materials company buys,

the bigger discount it may get from the product and then business model can bring more outputs. Economies of scope, where operations can be having bigger scope and therefore multiple products can receive the same distribution channels or marketing channels and gain advantage (Osterwalder and Pigneur, 2013). All these 9 Building Blocks binds the Business Model Canvas into a nice and easy tool.

3.3 Strategic analyses tools for CSA; PESTEL and Porters Five Forces

For this business case, two of the most commonly known strategic analyses tools; PESTEL and Porters Five Forces analysis tools are used to create the CSA analysis.

PESTEL analysis is a Contingency Planning Tool, it is all about determining all the relevant factors in Local/National/Global market that effects on subject externally on macro-environment. After evaluating how the external factors effect on the subject, we can learn insights and trends. After evaluation/analysis we can develop appropriate strategy to our goals and visions. PESTEL analysis identifies the six key environmental elements that effects business externally (Johnson, Scholes and Whittington, 2015):

Political - Government influence, Tax or Duty, Regulation
Economic - Performance, Demand / Supply, Interest rate, Direct investment, Growth
Social - Has a unique mind set, Lifestyle changes, Preferences, “Customer segments”
Technological - R&D, Competing Technologies, Data transfers
Ecological - “Green effect”, Recycle, Longer lifespan
Legal - Legislations, Labor law, food safety law

Porter’s Five Forces Model of Competition Analysis is about what kind is the current Market Structure or Industry analysis where our vision lies. Dynamics, where the industry is going. Analysis goal is to determine how attractive the market is and how to exploit the different forces on perfect timing (Johnson, Scholes and Whittington, 2015). Five forces model consists of:

1. Competitive rivalry
2. Threat of new entry / competitors
3. The threat of substitute products
4. The bargaining power of byers / customers
5. The bargaining power of suppliers

4 Current State Analysis

4.1 Need for new Business Model

Future is not all about developing Positioning service only for the NLS production. Positioning is constantly used in all around us, but high precision accuracy positioning is now coming faster than ever to global markets. GNSS industry is growing rapidly, GNSS chips are soon in every mobile phone, vehicles, maritime and airplanes.

GSA's (European GNSS Agency) last GNSS market report was released in 10th of May 2017. Figure 3 below describes GSA's global estimate of future revenues in GNSS receivers and augmentation services. Estimation for Added-value services growth seems to be quite linear.

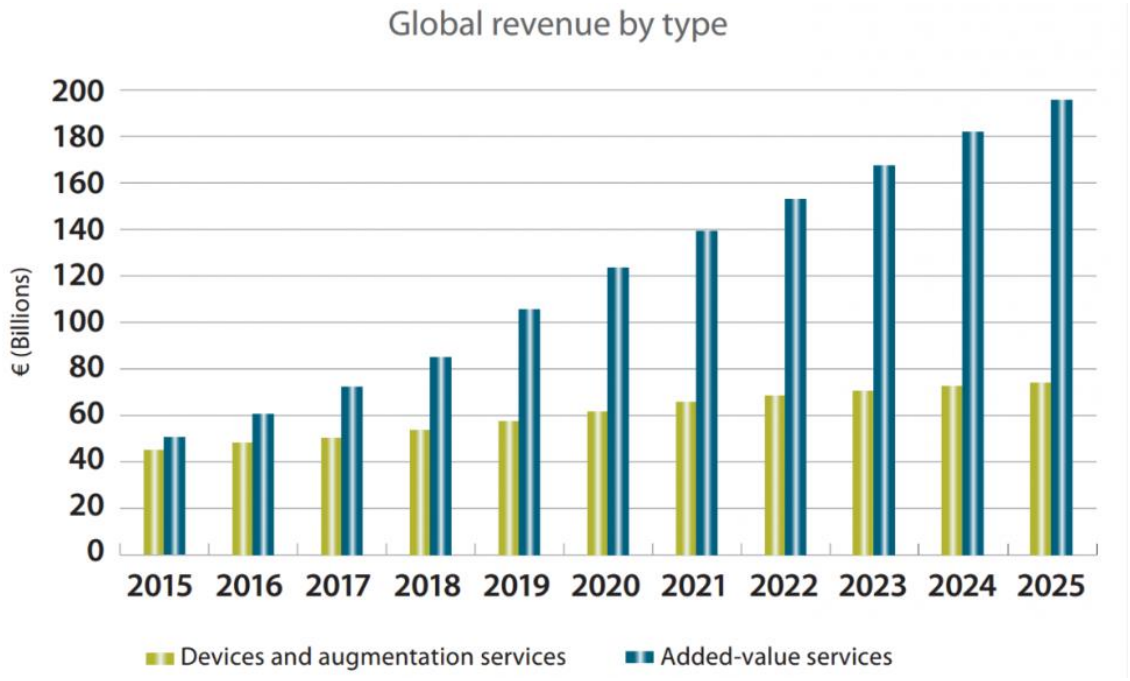

Figure 3: GSA GNSS Market Report 2017 (gsa.europa.eu, 2017)

More precisely, below in figure 4 Location Based Services (LBS) and Road produces a total of 93.4% of cumulative Revenue in GNSS market and surveying is only 2.6% of the total market. Land surveying was the primary reason why NLS started to further develop FinnRef-network. Numbers indeed indicates what will be the true need for GNSS in 2020-2025, it surely won't be NLS's need only for RTK from national or global point of view.

Therefore, there is a great need to create a new need business model for NLS's Positioning correction service over FinnRef-network. Possibilities are endless when we consider all the end services and products that can have added value from the Positioning correction service and the FinnRef-network that produces the data. And since the service is run by government agency, the entire service and data should to be available for everyone's usage, freely or with low pricing (gsa.europa.eu, 2017).

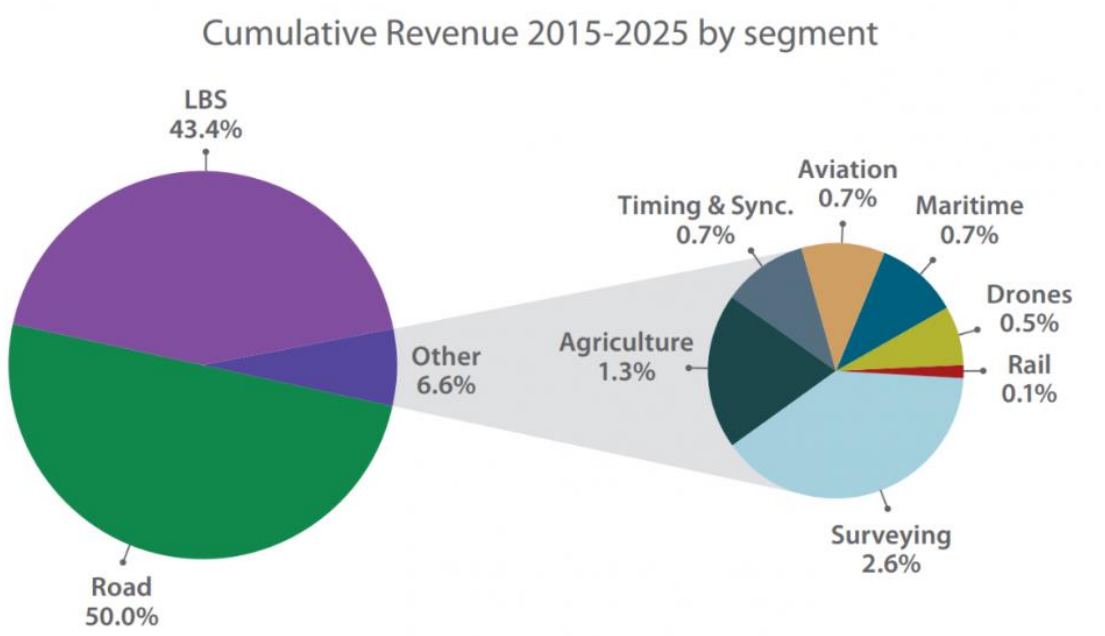

Figure 4: GSA Market Report 2017 (gsa.europa.eu, 2017).

Based on the current insights what future brings, it is best to have proper PESTEL analyses since the highest seen effectiveness is seen to come from political and technological point of view. Porters Five Forces analysis is also chosen to understand the future possibilities and risks as well as forces effecting the future market since the entire market is expected to change rapidly.

4.2 Strategic / Competitive Analysis

Following sections covers the two most used Strategic or competitive analyses of the Positioning service market in Finland.

4.2.1 PESTEL Analysis

The following analysis are mainly based on internal observations and insights.

Political

Ministry of Transport and Communications released a National Intelligent Transport Strategy in 05/2009 (Lvm.fi, 2019), saying that there is a high need for the GNSS reference data to produce Positioning service for Finland. Indeed, Finland will need a Positioning service for Intelligent Transportation Systems (ITS), but surely it cannot be only done by Finland and global providers are needed. ITS will need to move across the country's borders and NLS is not meant operate outside of Finland that extensively. What is needed, is a standardized augmented Positioning service multicasted from satellites. But for Satellites to produce positioning accurate corrections to calculate all the error models in Finland, GNSS ground stations are needed, meaning CORS and in Finland for example the national FinnRef network. Every country has its own coordinates system or even many. All these systems must have link to a global coordinate system or at least to local like European. Stations of FinnRef network are linked to EUREF and IGS in order to coordinates to sync together seamless and safely.

Ministry of Agriculture and Forestry started Spatial Information Policy Report in 2016 and it was handed for evaluation to the parliament of Finland in spring 2018 (Karlsson, 2018). Policy report is publicly available, and it includes attachment proposal for urgent tasks to be done. One of the tasks was to compile a plan how Positioning correction service can be opened in large scale usage for everyone in Finland for any purpose, especially for navigation, autonomous vehicles, logistics and for practical measurements like land surveying. This report is expected to have a major impact on Finland's GNSS sector, on public and private sector. From internal point of view, these actions would be more than welcome, since it would make NLS even more important for the citizens and authorities. These decisions could also grant NLS more funding to provide more accurate positioning for every purpose. This report may in its best result start an act of law to protect Positioning corrections service for all purposes. If law would be legislated, private sector could not have any bargaining power against FINPOS. Law would impact also in the private sector regarding the business, but mainly on the less accurate services, which are not private sectors key focus.

Ministry of Agriculture and Forestry Spatial Information Policy Report was released in May 2018 stating, “A plan will be formulated on how the FinnRef positioning correction service can be … introduced in extensive and open public use when developing and using future positioning and logistics services – including autonomous transport.” (Karlsson, 2018). It is still expected that the plan will come out from the ministry and it most likely needs some pushing from the NLS. As the report states, the “Legislative reforms will be carried out to ensure progress”. Basically, this statement is the key for success to get proper funding and legislation behind FINPOS to operate and serve everyone.

Ministry of Transport and Communications released in December 2017 Strategic program for Satellite Navigation Systems effective use in Finland for years 2017-2020 (Miettinen, Öörni and Lehtilä, 2017). FinnRef-network and Positioning correction service has been mentioned several times in the strategy. There are notes regarding GNSS unintended and intended interference in Finland and harnessing FinnRef-network to monitor these events regarding positioning and navigation. Strategy also implies that FinnRef-network can be used for government critical services like defense forces, security sector, taxing and timing services. FinnRef CORS data can also be used in research purposes. Program also noted that FinnRef network could be used as a part of Galileo PPP-service. Land surveying is not forgotten in strategy, it is highly noted also as a part of European GNSS network, in which usage EU’s Inspire Directive obligates. Positioning correction service is also part of Arctic navigation challenge, meaning that FinnRef-stations have been built in above Arctic Circle to provide a testing ground for using PPP/SSR/RTK solution-based navigation in automatic vehicles. FinnRef-network may also be harnessed to provide time synchronization services to provide international UTC-time in Finland in such services that requires by law tracking ability to UTC-time (Miettinen, Öörni and Lehtilä, 2017). There will also be an official information report of how Positioning correction service can be used to provide free open service for everyone like in the Spatial Information Policy Report. These both reports are expected to create a law behind positioning correction service and for the data coming from FinnRef-network.

European commission has made an implementing decision 2nd of March 2018 to change Galileo Commercial Service to partly free, meaning EU’s Galileo will offer in its E6 signal free High Accuracy correction service for EU member states (Eur-lex.europa.eu, 2018). The correction service will not be developed by Galileo program, but the service will be provided by an external service provider using the Galileo E6 Signal from every Galileo satellite making the correction service highly available even in harsh conditions in every

EU state and possibly in all around the world as well. Service will be provided by using PPP technology in order to provide promised 20cm accuracy. Since the service provider will be outsourced, to provide less at least 20cm accuracy service may very well need decent amount of ground GNSS CORS. In order to use the best stations, therefore it is very likely that EU member states GNSS reference stations will be used to the High Accuracy Service (HAS) or EU could as well build its own stations. If FinnRef network data will be used for Galileo High Accuracy service, it means that the station network may become part of EU's critical infrastructure and therefore it is very important that Finland legislates properly to secure FinnRef Positioning correction service and its stations.

EU's Inspire Directive was legislated in 2007 and in 2014 was published as a technical guideline for the Coordinate Reference Systems - such as FinnRef-network (Inspire.ec.europa.eu, 2014). Network is the only GNSS station network in Finland that full fills the requirements of the Inspire Directive and EUREF Permanent GNSS Network and therefore FinnRef could be a part of future Galileo HAS.

Directive 2007/2/EC Article 17: "1. Each Member State shall adopt measures for the sharing of spatial data sets and services between its public authorities referred to in point (9)(a) and (b) of Article 3. Those measures shall enable those public authorities to gain access to spatial data sets and services, and to exchange and use those sets and services, for the purposes of public tasks that may have an impact on the environment."

As the directive states, Positioning correction service must be given to all public authorities that needs to use the data provided by FinnRef network. This is also very important factor of stating why FinnRef-data should be opened for everyone.

Large GNSS interference event occurred in Lapland 6.11.2018 (Leisti, 2018). ANS Finland gave a warning of GPS interference effecting almost entire Lapland in Finland, also Norway. Event started the same day as NATO's Trident Junction exercise at Barents Sea. Norway expressed that they had proofs that Russia was behind GPS jamming. If such large-scale interference would occur in Finland, FinnRef-network could be possible detector for this kind of event, but only if the jamming source would come from the sky to the ground. This would then jam the FinnRef-stations as well and be detected. If jamming signal would come from the ground and far away from Finnish borders. Signal would not be seen very easily on the ground in Finland, meaning in FinnRef-stations,

because the jamming signal would most likely then be very much beam like (satellite antenna etc.) therefore hills on the ground would most likely block the signal from reaching to FinnRef-stations. This kind of jamming would of course effect on the Finnish air space effecting the airplanes, especially civil airplanes. Detection of air jamming can only be done at very high at the air, like on an airplane or very high radio and tv antenna masts. So only wide interference events origination from sky can be seen with the FinnRef-stations. There are two kinds of interference: unintentional and intentional interference. Everything is unintentional until proven else. FinnRef could then also be used to recognise if any space weather activities effecting GNSS in Finland. This will most likely also increase FinnRef's attractiveness.

Economic

What creates demand for the service relating economics or demographics? According to Ministry of Finance Finland's economic is currently rising slowly, which affects to everything that is build or renewed in national infrastructure and this reflects directly to the need of Positioning service (Ministry of Finance, 2017). Currently there are only two competitors providing Positioning service and this clearly creates high prices for the service. Because of the high cost many small businesses won't have a change on the market. This matter is also noted in governmental level, most of the smaller government agencies has a lot of usable GNSS-rovers but not enough licenses to use them with Positioning correction service.

Social

Pokémon Go brought enhanced reality in 2016, game functions on smart phones and uses GNSS to track your movement on map in real time (Knapp, 2018). By moving to different locations, you were able to find new Pokémon's and fight each other player. This game was one the first enhanced reality games that really got huge popularity on smart phones. These kind of games and augmented reality apps could start to pop up even more, creating higher demand for positioning accuracy for smartphones or other gadgets.

Google has introduced that it opens RAW GNSS measurements to smartphones and this may walk hand in hand with megatrend apps creating huge demand for the Positioning services once the smart phones can truly be enhanced by using positioning correction systems (Malkos, 2016).

Social encounter may get bigger with people when more and more start to use autonomous public transports. People will hopefully give up car ownerships and this may lead to more social encounters on public transports. Of course, most probably people will just keep their eyes on their phone even more then, but it is a possibility and it will define how the public transports are designed.

Technological

New satellite constellations, Galileo (GNSS) by European Union is expected to be operational in 2020 (Gsa.europa.eu, 2019) and BeiDou (GNSS) by China is expected to be operational in 2020 (En.beidou.gov.cn, 2019). Both new Global Navigation Satellite Systems will enhance satellite geometry over Finland meaning that GNSS-rovers on ground will be able see more GNSS-satellites on sky. The more satellites there are, the better the satellite geometry is and therefore the better positioning accuracy will be for the GNSS-rovers. There are expectations that, since today the density of ground stations network has been about 100 stations in Finland per operator and when Galileo and BeiDou are fully operable, the required ground station density could drop to drop down to 50 or less stations from 100 in a coverage area like Finland.

State Space Representation (SSR) is a technological solution to provide high accuracy correction service via broadcast instead of unicast service model. This technology answers to the need to give the accuracy needed for masses like autonomous vehicles and smartphones. Technology has been chosen for the Japans Quasi-Zenith Satellite System (QZSS) (Geopp.de, 2015).

Other global GNSS service providers are also bringing their own services to the market. Sapcorda Services GmbH was established in 2017 by Geo++, Ublox, Mitsubishi Electronic and Bosch. Sapcorda will bring its own GNSS corrections to the market by geostationary satellites and via mobile networks. Target end customers are autonomous vehicles and embedded systems. Sapcorda will also be using a Geo++ method called State Space Representation (SSR). It is a mix of PPP and RTK which requires GNSS ground stations, like FinnRef in order to produce High Accuracy Positioning. Sapcorda states that SSR is the only possible technology to produce high enough accuracy and convergence time for autonomous cars (Boyd, 2017) to rely position safely enough.

Google has been providing RAW GNSS measurements since Android N (7.0) version to smartphones. This allows smartphones to use Positioning correction service on the Android smart phones to have even more precise positioning (Malkos, 2016). Free Positioning services may become hardcoded to the smartphones and this could create massive need for producing the service for masses. There are already positioning service apps for smartphones that previously used external antennas but now with no need external antennas the service may also get massive attractiveness and demand for available and free Positioning services.

Mobile phone chip manufacturer Broadcom announced in 2017 that it will bring new GNSS chip to the consumer markets that will enable 30cm accuracy positioning (Murfin, 2017). This will likely have a major impact on the future GNSS ecosystem when almost any device can have embedded GNSS receivers capable of high accuracy with low price.

Autonomous vehicles; cars, transportation and logistics on ground, air and maritime is expected to be very safety relevant and all positioning solutions based on it are expected to have a continuously augmented services providing the positioning service, since the services are about safety-of-life. This is clearly a new market area for PPP providers and there will also be a high need for local country level GNSS CORS data providers, and what could be any better than a governmental level data provider like NLS with its FinnRef-stations data.

Ecological

Possibility to recycle GNSS rovers if Positioning service licences were to be free or much cheaper. Low cost antennas to smart phones. To be able to use positioning service in different environments, rovers need to have almost perfect line of sight to the satellites. This creates a problem in very dense urban areas with high buildings.

Intelligent Transport Systems will also use Positioning services as one of the tools to stay on the road and parking. Biggest change will hopefully be the time when people start to use more even only automated transportation systems instead of privately-owned cars to move more efficiently and ecologically.

Agriculture also relies on Positioning service that allows them to sow seeds with cm-accuracy. Intensive farming can also have severe side effects like for example in the north America where grounds are so “used” that they have started to disappear as a soil

erosion (Grey, 2019). There are beneficial sides with this but also consequences. Agriculture 4.0; digitalized with IOT (Internet of Things), Big Data and precision agriculture with automated machines on the fields of agriculture (Proagrica, 2018). This change will change the agriculture even more intensive farming or as positive side there could be a way where machine learns when the ground is used enough to give it a rest.

In order to be as ecological as possible, all future positioning systems should also support older versions of positioning so that the older GNSS rovers could also be used in the field where the speed is no longer the case for production. This way we would not always need to get the newest product.

Legal

Spatial information report may be used for spatial law. EU may have something to say also for the ITS and how it will be dealt with in EU countries. There is also a threat that if NLS enters private sector with the positioning service, matter may go to market court, since government is not allowed to compete with private sector.

General Data Protection Regulation (GDPR) brings a new set of rules to the data protection in Europe. All location-based data that can be linked to an IP-address is someone's personal data by GDPR (Tietosuojavaltuutetun toimisto, 2019). These data rules must be taken seriously when operating a positioning service in Government level.

Conclusion made by using Pestel analysis

Analysis of the current status of possible future scenarios are shown below on table 3. There is a possibility that smartphones become a megatrend in Positioning correction service, meaning that smartphones use Positioning correction service for most accurate positioning available in every possibly position based application or games like Pokémon Go.

The biggest and clearest opportunity of all factors is Galileo and BeiDou becoming operational allowing anyone to create GNSS-network with just near to 50 stations covering entire Finland. This is a chance for Finland to change its course to become National GNSS CORS data provider and Positioning system service provider. By to today investment in ground station network has been so big that only to operators exists, Geotrim and HxGN Geosystems. This market situation has kept service pricing very high. Over

the years NLS has paid several times more than what it would have paid if it would have maintained the network by itself providing positioning service for everyone.

Without a proper legislation, NLS to enter private sector offering free GNSS-network data and even RTK-based Position correction service may become very difficult to enter the market without getting prosecuted to market court. Currently there are ongoing a few legislations attempts that may bring the needed legislation regarding free Positioning service and open CORS data as well. See table 3 below.

Table 3 gives a conclusion from internal point of view for the PESTEL analyses if NLS would pursue to build national GNSS infrastructure and open its CORS data and RTK-positioning service and what are the key external opportunities and threats.

Table 3: PESTEL opportunities and threats

	External Opportunities	**External Threats**
Political	Report on spatial data policy by Ministry of Agriculture and Forestry will create a plan to legislate openness of CORS data and RTK positioning service for everyone.	There will be no legislation or funding gets cuts. Ministry changes its key goals.
Economic	Stable funding, more business opportunities, more jobs	Lack of demographics, smaller budgets for infrastructure or NLS, No competition -> high priced service for NLS and other government agencies
Social	Trendy apps and games for smartphones.	Ethics like GDPR.
Technological	Galileo and Galileo HAS, BeiDou, PPP, smaller density CORS network, Intelligent Transport Automation, Agriculture	PPP will get so good that RTK will no longer be needed.
Ecological	Cheap or even free licenses could great demand for recycled rovers. ITS with less pollution.	Automation goes too far and over uses our resources.
Legal	Law should be required behind the data openness and Precise positioning for everyone	Private sector will sue NLS on entering private sector without a law behind.

As a whole from everyone's point of view, the biggest opportunity to gain added value would be to take advantage of the current need for positioning service and CORS data

and to get legislations or decisions for FINPOS services to have final blessing to open RTK service and FinnRef CORS network data.

4.2.2 Porter's Five Forces Model of Competition Analysis

The following analysis are mainly based on internal observations and insights.

Competitive rivalry

Currently there are only two real competitors in Finland offering RTK-based measurements from Positioning service; Geotrim and HxGN Geosystems. Both have a about a 100 permanent GNSS COR Stations. Geotrim finished their Trimnet-network in 2005. HxGN Smartnet arrived in the market 2012. In 2013 former Finnish Geodetic Research Institute FGI renewed its 20 station GNSS reference network FinnRef. This network works as a foundation to EUREF-FIN coordinate system. In 2015 FGI and NLS merged as one and NLS gained access to FGI's Positioning service. NLS's FINPOS on top of FinnRef is expected to start acting as competitive rival in the Finnish GNSS market, but only in accuracy level of 10cm. Smartnet and Trimnet both operate at 1cm level accuracy and are fee-based services. FINPOS positioning service is expected to be free for everyone. It might be that, once FINPOS would open its CORS data for anyone for a fee or free the others might follow creating a new competition, but FinnRef's COR Stations are geodetic quality and follows the EUREF and IGS requirements whereas the Smartnet or Trimble stations are not geodetic level, and this could be competitive advantage against the others.

There are zero competitors regarding CORS data, for a fee or free. This can very well be the future market, because it is estimated that in the future Global PPP or PPP+RTK positioning solutions may replace only RTK solutions by convergence time and in accuracy. Both solutions require some COR Stations. It is estimated that the need is close to 200km density station network or even denser, roughly 20 stations in entire Finland.

Threat of new entry / competitors

Galileo High Accuracy Service (HAS) will bring free less than 20cm positioning accuracy in normal operating conditions (De Ingenieur, 2018). HAS will be based on Galileo´s satellites Precise Point Positioning (PPP) service broadcasted by Galileo E6 Signal (Gssc.esa.int, 2014). NLS demand for accuracy is less than 10cm so therefore Galileo´s HAS will not be a competitor but more as an enabler for ministry to legislate FINPOS as

free service for all. Also, the convergence time meaning solution time for first fix will not be enough for NLS at this moment. Indeed, HAS will be a developing threat for RTK-positioning.

There are also many other PPP servicer that might be interested of producing correction service in Finland. But these providers have not been very successful marketing their services in Finland. At least their markets have been very small and the value still very poor. In the future when PPP gets even better and faster, their market share may start growing rabidly once its convergence time will get close to RTK positioning. PPP is said to come to autonomous vehicles, but it is yet know in what way, at least the service integrity must get very high to produce safety-of-life kind service like EGNOS correction service for airplanes (Gsa.europa.eu, 2019).

As already mentioned in the technological part, Sapcorda (Joint company by Geo++, Mitsubishi and Boch) is building a positioning service for Europe - that as they say - will be essential for enabling the future of autonomous vehicles such as UAVs, trucks, and cars. Visio: Sapcorda aims to enable the safe use and proliferation of autonomous vehicles and devices in our everyday lives. Mission: Sapcorda is building a GNSS Multi-Augmentation System that is essential for the future of autonomous vehicles (Sapcorda, 2019). Sapcorda will not be threat for FINPOS but is seen as partner in the future by using NLS GNSS data to produce Sapcorda positioning service over Finland.

Topcon is one of the biggest RTK-rover manufacturers and among the four biggest Positioning correction service providers globally (Topnetlive.com, 2019). Topcon has no own RTK based positioning service at Finland. For Topcon, investing in 100 permanent stations would be very big and risky for market entry. But if they could partner with one station network owner in Finland, their barrier for entry would get significantly smaller. Topcon could very easily be a future partner of NLS by using FINPOS data to produce their own service in Finland. This would also mean that Topcon could start selling their own RTK-rovers bundled with their own positioning correction service. This would be the biggest change in RTK positioning field in Finland. Prices would most likely get smaller for everyone as would Positioning correction services. This would benefit everyone except the current two private sector parties, but competition would then also be healthier.

NLS densified its 20 COR Station network to almost 50 reference stations by the end of 2019. In 2020 this amount of ground stations should be enough to produce Positioning

service as good as today ‘s services with a 100 ground stations. NLS is waiting legislations regarding to open RTK-service for public use.

If NLS opens all the GNSS CORS stations data to everyone for fee or free. This could lead to a situation where everyone interested enough could start their own Positioning service in Finland using the National GNSS reference network, FinnRef. This could start a new technological leap in positioning and especially in autonomous vehicles and could create new businesses and open new jobs for Finland. There is also a possibility that private sector wouldn’t have to maintain their CORS anymore by changing to national CORS allowing them to make savings. FinnRef’s data should be accessible for a fee because then it would secure the FinnRef’s development and maintenance regarding the public funding and risky political behaviours. This could be a win-win situation for everyone; governmental authorities could get its own CORS network and private sector would get an access to a reference network with less costs regarding its own CORS network development and maintenance.

Many other countries have national network infrastructure, like Sweden and Norway for instance. In Sweden every service provider pays a fee to use national infrastructure and therefore the infrastructure is one of the best in the world working as the most attractive business model for every country. This business model would give everyone the ability to enter as a Positioning service provider in Finland using the National GNSS network, FinnRef. Healthy competition against oligopoly would lower the Positioning service fees as well as the rover’s prices or vice versa, the prices of rovers could get higher since the service price may no longer balance the lower rover price. This could impact as a whole getting a better national infrastructure. Every constructor could get high precision GNSS measurement tools with a reasonable price to build roads, plumping, buildings etc. creating more contractors, more jobs and of course cheaper government funded infrastructure.

The threat of substitute products

From government point of view, there really isn’t any substitute products of producing reference networks in Finland. Of course, there can be multiple Positioning services. One substitute product could be EU’s Galileo HAS and EGNOS service. Future may bring advanced PPP (Precise Point Positioning), this way of calculating position is becoming more likely to be released in Finland because and for PPP work properly 20-25 CORS stations are still needed to remove the error of the constant ground lift and movement.

For calculating a model to predict this movement, we still need a reference network. Nordic countries are in co-operation to solve these models, but who knows when this will get finished (Maanmittauslaitos.fi, 2019).

The bargaining power of byers / customers

Currently both public and private sector acts as a buyer for the two only Positioning service provider. Also, currently buyer is very likely to use service provider's product family because they tend to work best with each other with few exceptions on the market. NLS currently has about 400 rovers and this is a very important factor to note. This be a challenge for the development of NLS own Positioning service since the service is still not ready for production and NLS is forced to buy Positioning service outside to secure production as long as its own service is not ready. NLS has been using its own current positioning service only for testing and scientific use. When Galileo and BeiDou became operational, NLS's positioning service software was not ready and still isn't able to solve corrections to all constellations. Because of this NLS has decided to start testing all other software's as well to produce its own positioning service. It is known that other vendors are not either fully ready and that there is still development to be done.

Basically in a bidding, government agency should almost always – for NLS in RTK rover biddings price weight has been about 35% - choose the cheapest one producing the best value for price, but NLS could try to reason with a reasonable arguments that points out the best Positioning service for NLS's rovers, creating a leverage to buyer, but of course the service provider could rise its price to sky high it the other Positioning services would be significantly worse with the buyers rovers. This is also very important factor why Finland's GNSS markets should have several positioning services instead of only two.

Today's positioning service and rovers go hand in hand and currently there are only two bidders for the Positioning services for NLS rovers. This situation could be changed when there could be multiple service providers, and each would work almost equally or would have some added value to specific vendors. This would also allow more rover competitors to the market and probably lower the rover pricing for everyone as well as the positioning service price.

The bargaining power of suppliers

Probably the only bargaining power currently against NLS from the suppliers would be to prosecute NLS to the market court if NLS decides to compete with private sector without a law. Also, suppliers could use this threat of entry as a bargaining power for future rover sales and for the NLS's ongoing need for full scale Positioning service. For past few years, NLS has managed to buy Positioning service always with a lower price with a bargaining threat that NLS builds its own full-scale network for Positioning service and this has clearly caused supplier to drop its pricing. This strategy also has a risk that if NLS would decide not to expand its network reasonable quick, who is to say why supplier wouldn't raise its Positioning service pricing back to what it was if there wouldn't be a threat anymore. So strategically NLS should continue to develop the network in order to keep the pricing reasonable low as long as it gets its own service to operational.

Bargaining power of the suppliers in the future will most definitely be about added value compared to service costs. This is where NLS will most likely never compete, because customer service is always very expensive and NLS will never sell any rovers and therefore there really isn't a need to have own customer service, since most of the cases the customers reaches are about how to setup a RTK-rover and this clearly is not the case for NLS, since it cannot ever handle all the GNSS market's rovers – only to give general guidance.

Conclusion made by using Porters Five Forces model

Current Positioning service market is very oligopoly having only two rivals with providing high precision GNSS RTK-based services. There is rivalry and both competitors are making profits and growing. Their products are very similar but uses a bit different method, therefore if you buy service from Geotrim it is very likely that you also buy the rover from them as well and same for HxGN. Same product families are always tweaked the best for themselves. Unfortunately, the best available rovers on the market at this time isn't from either of our possible service provider. See table 4 and 5 below.

Threat of entry is very low for the next years until 2020, when Galileo and BeiDou comes operational, after then needed investment for the network drops to 30-50% of current setup. This will create more attractiveness to the market for possible new entrants.

Currently there are no relative substitute products RTK-market to produce needed accuracy except PPP or PPP+RTK that may create any even large attractiveness soon if the

technology develops to be faster, more accurate and very reliable. See table 4 and 5 below.

Buyers don’t really have any bargaining power currently on the market since there are only two suppliers. NLS has gained a power to bargain with its massive number of RTK-rovers and with a threat of building its own Positioning service as a fear of opening the service to the public. This has significantly dropped the current service price for NLS, even so much that building own service may not be advised, but what would happen if the threat wouldn’t be there anymore? See table 4 and 5 below.

Suppliers bargaining powers have been diminishing since the threat of NLS’s own Positioning service. In order to keep this threat, it is advisable that NLS continues to build at least few stations per year to maintain current threat keeping the Positioning service price as low as possible for itself until NLS has built enough stations to produce Positioning service for itself. There is no competition on the CORS data, and demand for this kind of service is rising and may even be the most important future business model by offering CORS data for a fee. There are also no competitors on 10cm level accuracy regarding NLS plans to start offering service, only the future PPP and PPP+RTK service providers, for who NLS plans to provide data for example of the usage of autonomous vehicles. See table 4 and 5 below.

Table 4 gives a conclusion from internal point of view for the Five Forces analyses if NLS would pursue to open national GNSS RAW COR Station data for a fee and Positioning correction service (RTK) for free, and how the market could be in 2020 and 2025. All forces and are ranked by low, medium or high informing the attractiveness with a short explanation.

Table 4: Conclusion if NLS decides to open FinnRef CORS data for a fee

FORCE	CURRENT SITUATION	NEAR FUTURE 2020	FUTURE 2025
Rivalry among competitors	**Low:** No competitors.	**Medium:** No competitors but if NLS opens CORS data, others may follow.	**High:** Others have followed to create business model like Sweden and Norway were everyone shares data, and everyone benefits.
Threat of new competitors	**Low:** No competitors.	**High:** Once NLS opens CORS data, others are forced to follow	**High:** Anyone can build more stations and act as competitor and get existing data from others with a small investment
The bargaining power of customers	**Low:** No competitors no bargaining power for customers	**Medium:** Others will join the business model and creates better bargaining power for the customers	**Medium:** There may be new rivals to lower the pricing. Prices are expected to be high anyway, because of a must need for the service.
The bargaining power of suppliers	**High:** No competitors, best way is to make long contract to not leave space for possible new competitors	**Medium:** There may start to come more rivals to benefit of the business model once opened	**Low:** Most likely other competitors
The threat of substitute products	**Low**. If no one offers data, oligopoly exists.	**Medium:** Private CORS can be used	**Medium:** Other enterers will start densifying their networks
Barrier to Enter	**High:** Private sector will keep its oligopoly instead of letting anyone to enter without investing to own infrastructure	**Low:** Only if NLS opens data for everyone, then others must follow.	**Low:** Low barrier since only small investments are required
Barrier to Exit	**High:** No one to exit	**Medium:** Long period contracts and SLA's prevent exit	**low:** PPP will work so well that data providers are less needed.

Table 5 gives a conclusion from internal point of view for the Five Forces analyses if NLS would pursue to open national RTK Positioning service on top of the FinnRef-data and how the market could be in 2020 and 2025. All forces are ranked by low, medium or high informing the attractiveness with a short explanation.

Table 5: Conclusion if NLS decides to open RTK Positioning service for free

FORCE	CURRENT SITUATION	NEAR FUTURE 2020	FUTURE 2025
Rivalry among competitors	**Low:** Oligopoly, no huge need to compete except of the big clients like NLS. High pricing.	**High:** More competitors with Positioning service when everyone can buy network data from NLS and produce their own services (if data gets open). A lot of lower fixed prices for Positioning service and rovers when entering market for service providers is significantly low	**High:** Even lower fixed prices for Positioning service and rovers when entering market as a service provider is significantly low. Outcome: More contractors, jobs and better infrastructure. Biggest rivalry will be regarding the positioning calculation software and their combination with RTK-rovers to produce best high valued service and customer service.
Threat of new competitors	**Low:** because of high entry barrier. Investments are very big.	**Medium:** NLS has entered the market. New competitors arrive may arrive when needed investment for the infrastructure lies only in cloud service using FinnRef's RAW CORS station data to produce Positioning service for very reasonable fee.	**High:** New competitors arrive in many when needed investment for the infrastructure lies only in cloud service using FinnRef's RAW CORS station data. PPP/PPP+RTK service providers exists in Finland and globally to produce expected 10-20cm accuracy.
The threat of substitute products	**Low:** No true substitute products available to comparison. EU's free EGNOS Positioning service providing accuracy of 3 meters	**Low**: PPP/PPP+RTK positioning will start to get more attractiveness.	**Medium/High:** PPP/PPP+RTK may be very attractive and be the main service for automated vehicles. Free Galileo HAS (PPP)
The bargaining power of customers	**Low:** Customers can bargain with a threat to enter market producing own service or with a high number of RKT rovers. Not high for anyone else.	**Medium:** There may be multiple service operators and therefore customer's power to bargain gets higher.	**High:** There will be multiple service operators and therefore customer's power to bargain gets higher.
The bargaining power of suppliers	**High:** Best value for costs and for certain RTK rovers can produce power except for big buyers.	**Medium:** Unique and best performance or value of service survives the best. Healthier competition when new RTK rovers can come to the market.	**Low:** Unique and best performance or value of service survives the best. Healthy competition.

Barrier to Enter	**High:** For NLS, legislation is required for Positioning service. High investments and high risk.	**Medium:** Very small investments for cloud-based Positioning services using FinnRef data. Still high risk to produce own service with own RTK rovers.	**Low:** Very small investments for cloud-based Positioning services using FinnRef data.
Barrier to Exit	**High:** Investments have been high and there are SLA's for the current clients	**Medium:** Depend on given SLA's. Very small investments for cloud-based Positioning services using FinnRef data. Easy exit if only using FinnRef-data and no other investments.	**Low:** Depend on given SLA's. Very small investments for cloud-based Positioning services using FinnRef data.

As a whole, markets would change drastically in the next coming years, but the change is inevitable and therefore reasoned and even guided for a private sector. Markets would get much healthier when there could be true competition regarding the positioning service and RTK rover sales. Everyone would benefit from this.

NLS should open its CORS data for a fee or free to possible service providers and indeed open a free RTK positioning service for everyone with an accuracy of less than 10cm in Finland. Opening the data would give Finland technological leap to give possibility to bring automated vehicles to Finland for testing purposes at first and in the future even for productive usage. Open data creates always more value than closed.

4.3 Conclusion

GNSS Positioning service provider market is an attractive market for everyone who acts as big Positioning service provider and RTK rover buyer and of course for those who sells RTK rovers. Barrier to entry is big, because of the investment required in CORS network. If Government decides to open CORS network data, then the barrier of entry would get extremely low in Finland. This would mean that by buying data from NLS a service provider could get a 50 stations network. This could be significant for PPP+RTK service providers. To produce 100 station network in Finland only 50 stations would be needed to gain same amount of stations as the rest of the Finnish rivals. Question is how to get win-win situation for multiple networks and multiple maintain costs. Answer is simple, there should be only one network, a shared model, a win-win for all. In the future this could become a game changer, if other Positioning correction service providers would start buying CORS data from NLS. CORS data could produce revenues from possible

other Positioning service operators to develop and maintain FinnRef and FINPOS – secured from the government funding cuts and political changes.

FinnRef COR Stations network should be stated as a national critical infrastructure, which is maintained by National Land Survey of Finland. NLS should start building more stations, from 50 stations to nearly 100 stations in order to maintain best possible National Positioning system for all coordinate related measurements and Spatial data in Finland. Current 50 stations network is very vulnerable because of the density and future rising solar activity. If one station would get down, too big area would get affected at the service level. Basically 50 stations network is enough if only 25 stations would be enough, like for instance for PPP/PPP+RTK positioning, but NLS requires RTK for its production and therefore more stations should be built as soon as possible. This also means that the FinnRef networks CORS data attractiveness will not get higher for just RTK service providers. Gaining more stations would make a significant change.

Biggest added value would been seen to get when High accuracy RTK Positioning service is free for everyone and CORS data is offered for a fee. RTK is used in multiple sectors. One of the proposed added values could be so that when all is given the same accuracy, chances are that the value starts to produce even more value by starting new business, old processes could get more effective, more RTK rovers could be utilised, also older rover models for production work. This model could create possibly the biggest tax revenues to the government and gives the biggest savings to the government, cities and municipalities when they could make saving by using the free Positioning correction service which is enough for NLS and therefore for some others as well, at least for land surveying. Room is still left for machine guidance meaning 1cm level accuracy in which private sector operates its own Precise positioning services (RTK). Open CORS data would open the Positioning service provider markets for everyone, also for global service providers, like PPP/PPP+RTK correction providers which aims to offer Positioning service globally for automated vehicles and are relying in local CORS stations like national ones to provide local data to the global services. This is evidently the biggest seen added value of opening the data for service providers. By giving a price to the CORS data would also be seen to change the markets so that possible other CORS owners could start providing their data and therefore anyone could benefit from the existing CORS networks. It could also be possible that someday Finland would only have one CORS provider, NLS, because NLS is non-profit making governmental agency and therefore networks development and maintenance should be less expensive and there would also be

the benefit of having tax-based funding for the network and therefore other CORS providers would not have to keep their networks.

Therefore, it is stated that FinnRef CORS data should be opened for a fee and RTK positioning service for free for everyone.

5 Developing Business Model

As an outcome of the CSA, following possible scenarios are identified:

1. Precise positioning service RTK are free and RAW COR Station data is charged
2. Precise positioning service RTK and RAW COR Station data is free / open data policy
3. Precise positioning service RTK stay closed and RAW COR Station data is charged
4. Precise positioning service RTK stay closed and RAW COR Station data is free / open data policy
5. Precise positioning service RTK and RAW COR Station data stays closed

Only the first four options generate true added value and therefore the fifth scenario will not be a possible new business model to be proposed for the key stakeholders.

First four scenarios will be transformed into business model canvas as followed:

5.1 Free Positioning service RTK, RAW CORS data is charged

Precise correction services are free and RAW GNSS station data is charged with SLA's. In general, free Precise correction service could generate the highest added value for all sectors in public, private and globally – as stated in the Current State Analyses. Value proposition is seen as the best against other models. Biggest tax revenues and biggest possible CORS data revenues and biggest value proposition for everyone. The more effective Finland can become the more tax revenues it can get and therefore wealth for everyone. It should also be noted that Finnish tax payers should get benefit out from their tax money (investment), so therefore other global companies should be charged for using the national infrastructure for creating business for them self's. So therefore, a price for data should be given. Developing and maintenance of the Positioning correction and

CORS service would get a stable funding by getting fees from the CORS data and therefore service operations would get more stable and less risky for everyone to use the services. Better SLA's would also be possibility to secure RAW CORS data service.

Following canvas (table 6) presents the business model.

Table 6: Free Correction services, RAW CORS data and SLA's for data/services costs

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
Free less than 10cm accuracy RTK positioning service for everyone

CORS data for everyone = New Service providers*
Equal for everyone = same price for all service providers

Station Coworking = Rental agreements

Autonomous vehicles to Finland

Service Level Agreements (SLA's)

Green effect = responsibility, no more multiple stations near each other

*RTK and other correction services for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td>Customer Relationships
Public, Private and Global Sector and citizens</td>
<td rowspan="2">Customer Segments
Niche, Segmented and diversified market
NLS production
Public sector
Private sector
Global sector
Citizens
Autonomous vehicles</td>
</tr>
<tr>
<td>Key Resources
LAW or MMM's decision
Traficom and LVM
Financial
More personnel</td>
<td>Channels
NLS channels
Key partners
Customer service providers</td>
</tr>
<tr>
<td colspan="3">Cost Structure
Cost and Value driven
No profits = minimum costs
Continuous infrastructure costs
Depreciations of key equipment
Monitoring (24/7)
Redundancy
Salaries</td>
<td colspan="3">Revenue Streams
Partly tax funded
Station data streams
Coworking stations = Rental agreements
Service Level Agreements (SLA's)</td>
</tr>
</table>

5.2 Free positioning service RTK and CORS data free / Open Data policy

Precise positioning correction service RTK and CORS station data is free / Open Data policy. A ones utopia, as this (table 7) could be seen. Indeed, it is something that would be the best, but there are high risks why this should be avoided. As governmental agency, politics can have very big influence on NLS's decisions as can also the tax payers funding for NLS that is constantly being cut from the ministry. These kinds of risks

would create unintended attraction against NLS and its services and therefore CORS data should not be free. If data would be free the bring competitors without any investments to Finland and would create unequal position against other Positioning service providers.

Table 7: Free Correction services and data / Open Data Policy

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
Free less than 10cm accuracy RTK positioning service for everyone

RAW CORS data for everyone = New Service providers*
Less equal for everyone = Easy market entry for new service providers but possibly small gain for old providers

Station Coworking = Rental agreements

No SLA’s

*RTK and PPP/ PPP+RTK for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td rowspan="2">Customer Relationships
Public, Private and Global Sector and citizens</td>
<td rowspan="2">Customer Segments
Niche, Segmented and diversified
NLS production
Public sector
Private sector
Citizens</td>
</tr>
<tr>
<td>Key Resources
LAW
Traficom
LVM/MMM
Financial
Key personnel</td>
</tr>
<tr>
<td colspan="3">Cost Structure
Cost and Value driven
No profits = minimum costs
Continuous infrastructure costs
Depreciations of key equipment
Redundancy
Salaries</td>
<td colspan="3">Revenue Streams
No revenues
Tax funded</td>
</tr>
</table>

5.3 Positioning service RTK stay closed and CORS data is charged

Precise positioning correction services (RTK) stay closed and CORS station data is charged (table 8). Reasons why RAW CORS data being charged is already well explained before. A closed precise positioning correction service RTK would be a waste of resources that Finland already owns. There are hundreds of older RTK rovers that could be used if the licences would be free of notably cheaper. More money would go the global company’s where only these companies would get the benefit and not the ones who have already made the investments, government and tax payers. It should also be mentioned that NLS would only offer less than 10cm accuracy, not less than 1cm – which the private companies in Finland offer or the future other global companies therefore NLS would not compete against the local Positioning service providers. Better SLA’s would also be possibilities to secure RAW CORS data service.

Table 8: Closed Correction services, RAW COR Station data fees

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
RTK service for NLS only

CORS data for everyone = New Service providers*
Equal for service providers = same price for all service providers

Station Coworking = Rental agreements

Autonomous vehicles

Service Level Agreements (SLA’s)

Green effect = responsibility, no more multiple stations near each other

*RTK and PPP/ PPP+RTK for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td>Customer Relationships
Public and Private Sector and citizens</td>
<td rowspan="2">Customer Segments
Niche, Segmented and diversified
NLS production
Public sector
Private sector
Citizens
Autonomous vehicles</td>
</tr>
<tr>
<td>Key Resources
LAW
Traficom
LVM/MMM
Financial
More personnel</td>
<td>Channels
NLS channels
Key partners
Customer service providers</td>
</tr>
<tr>
<td colspan="3">Cost Structure
Cost and Value driven
No profits = minimum costs
Continuous infrastructure costs
Depreciations of key equipment
Monitoring (24/7)
Redundancy
Salaries</td>
<td colspan="3">Revenue Streams
Partly tax funded
Station data streams
Station Coworking = Rental agreements
Service Level Agreements (SLA’s)</td>
</tr>
</table>

5.4 Positioning service RTK stay closed and CORS data is free or Open Data

Precise positioning correction service RTK stay closed and RAW CORS station data is free/Open Data (table 9). Only positive thing to see here is that tax payers would get extra Positioning services but for what price? They would have invested already in, but the only gain would be to get service that costs. Risks are also high for the other service providers, because NLS could not give any better Service Level Agreement for them if the data would be free, so therefore this model has a very low value proposition.

Table 9: Closed correction services and CORS data is free

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
RTK service for NLS only

CORS data for everyone = New Service providers*
Equal for everyone = same price for all service providers

*RTK and PPP/ PPP+RTK for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td rowspan="2">Customer Relationships
Private and
Global Sector</td>
<td rowspan="2">Customer Segments
Niche, Segmented and diversified
NLS production
Private sector
Citizens</td>
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<td>Key Resources
LAW
Traficom
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Continuous infrastructure costs
Depreciations of key equipment
Monitoring (24/7)
Redundancy
Salaries</td>
<td colspan="2">Revenue Streams
Tax funded</td>
</tr>
</table>

5.5 Conclusions

Highest value proposition is identified to have on a Business Model, that is a free correction services and charged CORS data with SLA's. Lowest risk for everyone, no high political risks. Tax funding, staff, key equipment, service level are also secured at highest level. Chosen business model could also be the most equal to all private sector companies that offer the correction services.

6 Developing Business Proposal

Chosen business model for Developing Business Proposal was the first Model, were Precise Positioning correction services (RTK) is free and RAW GNSS COR station data is charged to be able to give Service Level Agreement's (SLA) to CORS data users.

6.1 Proposal for key stakeholder

Proposal for Executive Business Model Proposal for FINPOS

FINPOS RAW-data (CORS) service will open 01/2020

- Service will get fixed price per station stream and
- Dynamic pricing for SLA's regarding the CORS data distribution servers regarding the amount of resources required to produce and maintain agreed SLA.

Once NLS has stated that its Positioning correction service (RTK) is ready to be used in its own production, service can be opened. Estimation to open the service is after vigorous testing during the summer 2020.

Business Model Canvas presents the key factors of Value proposition and its requirements. All chosen key factors are explained in table 10 and in detail after it.

Table 10: Free Correction services, RAW CORS data and SLA's for data/services costs

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
Free less than 10cm accuracy RTK positioning service for everyone

CORS data for everyone = New Service providers*
Equal for everyone = same price for all service providers

Green effect = responsibility, no more multiple stations near each other or Station Coworking = Rental agreements

Service Level Agreements (SLA's)

Autonomous vehicles to Finland

*RTK and other correction services for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td>Customer Relationships
Public, Private and Global sector and citizens</td>
<td rowspan="2">Customer Segments
Mass, Niche and Segmented markets;
NLS production
Public sector
Private sector
Global
Citizens
Autonomous vehicles</td>
</tr>
<tr>
<td>Key Resources
FinnRef (E1 level) GNSS CORS Network

FinnRef data availability

LAW behind FinnRef and FINPOS

Traficom, important support partner

MMM and LVM, ministries support

Financial, yearly budget from Ministries and/or revenues from CORS data.

Key personnel working with FINPOS.</td>
<td>Channels
NLS channels
Key partners
Customer service providers</td>
</tr>
<tr>
<td colspan="3">Cost Structure
Cost and Value driven
No profits = minimum costs
Continuous infrastructure costs
Depreciations of key equipment
Monitoring (24/7)
Redundancy
Salaries</td>
<td colspan="3">Revenue Streams
Partly tax funded
COR Station data streams
Coworking stations = Rental agreements
Service Level Agreements (SLA's)</td>
</tr>
</table>

Value Proposition

- Free less than 10cm accuracy RTK positioning service for everyone, this would benefit all of us potential users of RTK positioning, especially land surveying, forestry, agriculture, drones, research, small businesses.
- CORS data for everyone equals new RTK and PPP/PPP+RTK service providers to Finland for autonomous vehicles, transportation and logistics, land surveying, constructions, drones and other navigating vehicles in ground, maritime and air.
- Equal for everyone, price per service is always the same for all, whether the service provider is using CORS data or RTK positioning.
- Station Coworking or Rental agreements for other service providers that for example don't want to use NLS CORS receiver's data and wants to use its own GNSS receiver but still is able to use all the other CORS infrastructure components by getting synergy and saving costs.
- Service Level Agreements (SLA's), once there is a cost involved, service level agreements can be done. Services providers for example autonomous vehicles require this to provide safety-of-flight service. Coworking at CORS requires SLA's for telecommunications and maintenance for example.
- Autonomous vehicles to Finland, would not be possible to if Finland would not have GNSS CORS stations to provide for global augmented positioning service providers.
- Green effect, responsibility, coworking stations means no more multiple stations near each other. New area creates rental agreements.

Customer Segments

- Mass markets for global markets as end customers in autonomous driving thru partners positioning services.
- Niche market as NLS itself and Traficom as supplier-buyer.
- Segmented market as public sector; cities and municipalities, private construction companies, land surveying, drones, small businesses and Citizens. Almost endless possibilities in ground, maritime and air.

Customer Relationships

- Public relationships are the key enablers for the hole service to work. NLS for land surveying production, Research and reference frame maintenance and other for their usage.
- Private, other CORS owners in Finland to share CORS stations and inviting them to coworking in NLS stations or selling them CORS data.
- Global Sector, selling the CORS data for global positioning services with SLA.

Revenue Streams

- Partly tax funded, means semi funding would come from NLS or Ministry of Agriculture and Forestry to maintain FinnRef reference network and to produce services to all. This most likely will not cover everything as budgets are constantly being cut in public sector. Therefore, other revenues must be charted in order to secure FINPOS services for all.
- COR Station data streams should be charged - as they are in every other country as well - since they are national resources and others (global) should not be able to use them as free to produce new services in Finland unless they produce significant value for Finnish citizens. Free data would also cause unfair competition to Finland's private sector RTK service providers.
- Coworking stations or rental agreements in FINPOS stations would also create revenue streams by sharing the station infrastructure with other service providers who wants to bring their own GNSS receivers to the stations.
- Service Level Agreements (SLA's) can be given when service is charged, and this creates revenues and is vital for all other positioning service providers wanting to purchase NLS CORS data to their usage.

Key Partnerships

- Geo++ that produces the NLS Positioning service software GNSmart. Software is one of the four most used in the world.
- Javad, NLS's most used GNSS receiver and antenna supplier.
- Septentrio, GNSS receiver supplier.
- Local telecommunication providers for the COR Stations.

- Local telecommunication subcontractors to provide maintenance service with SLA's for telecommunications.
- Public authorities, key supporters to get FINPOS RTK positioning service opened for everyone and CORS data opened for global service providers.

Key Activities

- National Land Survey or Ministry of Agriculture and Forestry needs to make decisions or legislations or even a law regarding the Openness of NLS FINPOS RTK Positioning service and FinnRef CORS data. Decide a business model for FINPOS.
- FINPOS needs More stations to be able to provide RTK positioning for NLS production and others. More stations would secure FINPOS accuracy during regional station outages. RTK convergence time in under dense forest canopy is critical for productions performance.
- Positioning service software GNSmart development must get a proper first fully stable working release to function in Finland it to solve all GNSS satellite constellations for positioning corrections in order to get the performance expected of it.
- When operations get bigger, more personnel are needed.

Key Resources

- FinnRef (E1 level) GNSS CORS Network, without data Positioning services cannot work.
- Securing FinnRef data availability for GNSmart.
- LAW behind FinnRef and hopefully a new law to produce Precise positioning service (RTK) and CORS data openness. Law would secure FINPOS operations, maintenance and development.
- Traficom, important partner supporting FINPOS CORS openness and free Precise positioning in Finland.
- MMM and LVM, Ministries support for operational FINPOS.
- Financial, yearly budget from Ministries and/or revenues from CORS data.
- Key personnel working with FINPOS.

Channels

- Raising awareness thru NLS website, magazine and social media. Networking to GNSS people on various international GNSS events raises awareness globally.
- Key partners and supplier channels are great raising awareness when your infrastructure is the best there is and therefore you are the model example.

Cost Structure

- Cost and Value driven, meaning best possible secured infrastructure and GNSS components and data quality with lowest price.
- NLS is non-profit making government agency.
- Continuous infrastructure costs, CORS data high availability has costs.
- Depreciations of key equipment, all key equipment must be renewed when their life cycle comes to an end.
- Monitoring (24/7) may come to question when SLA requirements get very high, but it can also bring revenues.
- Redundancy, when operating at minimum staff and stations, redundant connections and servers secure operations at good level.
- More FINPOS (E2 level) CORS stations are needed.

6.2 Validation and comments

NLS key stakeholder agreed the proposed business model to be the best for all, but decision regarding the openness of FINPOS services will stay open for a while, because NLS will not make the decision directly by itself. All four business models presented in the developing phase and conclusions of this thesis have been delivered to Ministry of Agriculture and Forestry to decide the business model for FINPOS services.

Final Business Model Proposal from writer’s opinion would be as followed.

6.3 Final Business Model Proposal

Final Executive Business Model Proposal for FINPOS

FINPOS RAW-data (CORS) service will open 01/2020 (table 11).

- Service will get fixed price per station stream and
- Dynamic pricing for SLA's regarding the CORS data distribution servers regarding the amount of resources required to produce and maintain agreed SLA.

Once NLS has stated internally that its Positioning correction service (RTK) is ready to be used in its own production, service can be opened internally and then also for the everyone else for productive usage. Estimation for opening is after vigorous testing during summer, 08/2020.

Table 11: Free Correction services, RAW CORS data and SLA's for data/services costs

<table>
<tr>
<td rowspan="2">Key Partnerships
Geo++
Javad
Septentrio
Telco Operators
Telco subcontractors
Public authorities</td>
<td>Key Activities
Decisions (NLS and MMM) / Law
More stations
GNSMART</td>
<td rowspan="2">Value Proposition
Free less than 10cm accuracy RTK positioning service for everyone

CORS data for everyone = New Service providers*
Equal for everyone = same price for all service providers

Green effect = responsibility, no more multiple stations near each other or Station Coworking = Rental agreements

Service Level Agreements (SLA's)

Autonomous vehicles to Finland

*RTK and other correction services for mass markets like, land surveying, constructions, drones, autonomous & driving vehicles (ground, maritime and air)</td>
<td>Customer Relationships
Public, Private and Global sector and citizens</td>
<td rowspan="2">Customer Segments
Mass, Niche and Segmented markets;
NLS production
Public sector
Private sector
Citizens
Autonomous vehicles</td>
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<td>Key Resources
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FinnRef data availability

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<td colspan="3">Cost Structure
Cost and Value driven
No profits = minimum costs
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Monitoring (24/7)
Redundancy
Salaries</td>
<td colspan="3">Revenue Streams
Partly tax funded
COR Station data streams
Coworking stations = Rental agreements
Service Level Agreements (SLA's)</td>
</tr>
</table>

Backup Positioning service bought from private sector is also advised, since the current Positioning service software is still under development and not stable to produce corrections for NLS production and possibly everyone else.

Business Model Canvas presents the key factors of Value proposition and its requirements.

7 Conclusions and summary

7.1 Summary

NLS has made a significant investment on developing FinnRef GNSS CORS network and FINPOS positioning service.

To get the true value out of the services, a research and of Current Status Analyses where done to understand how at the best possible way all FINPOS services could be opened to all to. By these analyses results, it is proposed that FINPOS RTK positioning service would be opened for free for all and FinnRef GNSS CORS network data for a fee for all other positioning service providers working locally and globally to enhance positioning technologies development like for example for the autonomous vehicles. Technological advances should never be slowed down if all can benefit from them.

7.2 Outcome vs objective

As an overall, this thesis answers the question on how to benefit all by opening FINPOS services. Therefore, I would state that objective was met but indeed the outcome is still open when this thesis is left for evaluation. Personally, I truly hope that this thesis works as catalyst and as a definition why and how opening FINPOS services should be done for the stakeholders in National Land Survey and Ministry of Agriculture and Forestry.

7.3 Final words

Working with this project has opened clearly writers' eyes on how decisions can impact on everyone's lives and how hard they can be, but once there is enough data to reason all the expected statements, one can truly stand straight behind its own words.

I think this work was wonderful teaching and learning experience as total it would have been nice to even further build statements. Time is still all we got, and it should never be used lightly or too extensively unless it truly is one's passion.

Biggest thanks go to supporters at home and work who made it possible to find the time to write this thesis. Thank you Jonna, Lukas, Ari, Marko and Topi.

7.4 Changes in the field of work

PPP services are arising more rapidly than expected. Especially now when they are being developed for mass markets like autonomous vehicles.

Rising awareness of GNSS. GSA the European GNSS agency has been doing a lot of work growing the awareness of GNSS and its possibilities. Recently GSA published a GNSS market report stating how GNSS industry will expand vigorously in the future and that GNSS market is worth of billions of billions of euros and growing. Now or never, Finland should be as much involved as possible to gain a slice of this market share.

BeiDou, the Chines Satellite positioning system if finally getting a third generation in its satellites. The second generation is now known to have so bad defects that positioning service software's quality checks are continuously discarding second generations satellites because of its poor data quality. Therefore, FINPOS RTK is not yet function at its best possible performance because one satellite constellation is basically out of order. Ones this will get fixed with the new 3rd generation satellites, FINPOS is expected to work at its fullest potential regarding its number of FinnRef CORS stations network density producing the FINPOS RTK service corrections to everybody. But in the meantime, 3 constellations are still good enough to produce production once the GNSmart 2 get developed a bit further stable.

There are now over 40 corporations working on autonomous vehicles (CB Insights Research, 2019). Corporates like: Amazon, Apple, Aptiv, Audi, Baidu, BMW-Intel-Mobileye, Bosch, Cisco, Continental, DAF Daimler Iveco MAN Scania and Volvo, Didi with Uber, Ford, GM, Honda, Huawei, Hyundai, Jaguar and Land Rover, Magna, Microsoft, Nissan and Renault, Nvidia, Samsung, SoftBank, PSA Groupe, Tata Elixsi, Tesla, Toyota, Uber, Valeo, Volkswagen, Volvo, Waymo, Yutung and ZF. Big list of big automotive and others to solving autonomous driving. Progress will probably happen faster than expected and more PPP providers will come to the market to serve positioning service for future autonomous vehicles.

7.5 Future

Future is all about Internet and connected Things like IOT. Vehicles will get automated and drivers are no longer needed. Positioning will be everywhere because of human's passion to know always where we or our things are. Therefore, I humbly believe that positioning data should be available for everyone and the ones using it, for creating mass business, should be charged to gain tax revenues and to take care of national critical infrastructures providing the data. When the end services get bigger, Finnish tax payers should get the end products as added value for their lives, therefore basic positioning should always stay free of charge. Perhaps someday NLS could start charging royalties from the 3rd party positioning service providers selling future PPP licenses for example for autonomous vehicles used inside Finland based on FinnRef data. This could be future opportunity to gain new taxes from the future mass market PPP industry.

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