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Financial model development for the investment in a Performance Management system

The case of Ericsson Network IQ

Master of Science Thesis

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Abstract

This Master's thesis has been commissioned by Ericsson AB. It revolves around a Performance Management (PM) system named Ericsson Network IQ (ENIQ). ENIQ enables telecommunications operators to manage availability, capacity and quality of their network services by collecting performance data and presenting the data in reports.

The overall objective of this thesis is to generate a financial model for the investment in the technology package that is Ericsson's 2G version of its performance management product, ENIQ. The segment of operators considered in the report already have an ENIQ system in place to manage the performance of their 3G networks and have their 2G networks managed by the Network Statistics (NWS) system[1]. Faced with Ericsson's resolution to phase out NWS in 2013, this customer segment must make a decision to either migrate to an all-ENIQ solution to manage both their 2G and 3G networks' performances or to invest in a competing PM solution to manage their 2G network performance. The model thus aims to strengthen incentives for operators to invest in ENIQ to manage their 2G network performance.

The thesis' result is a spreadsheet model, conceptually visualised below, that facilitates a valuation of the investment in ENIQ. The model considers the operational and capital expenditure savings incurred by the operator when opting for the ENIQ solution, while taking into account what the system's Total Cost of Ownership[2] will be.
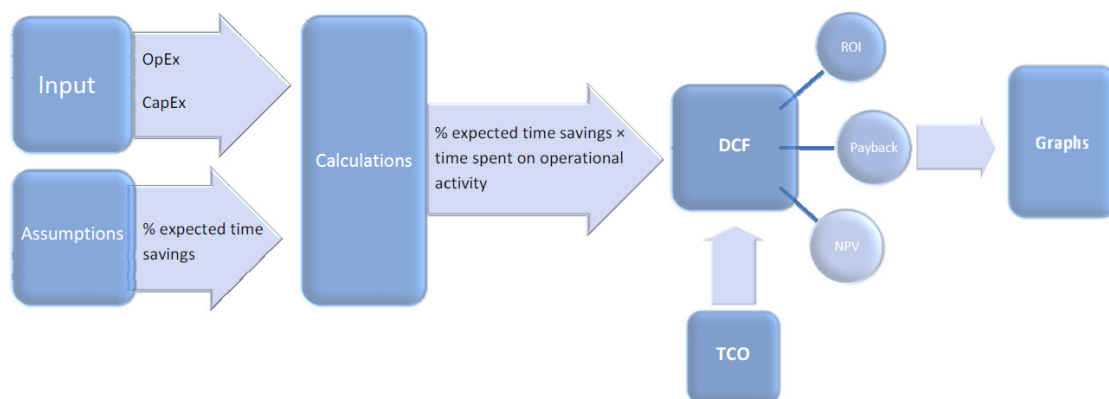
The ENIQ investment valuation model

The model calculates the Return on Investment (ROI), Payback and Net Present Value (NPV) of the investment in ENIQ. It thus provides Ericsson with an easy-to-use financial case tool that can be used in both externally (in sales efforts to provide customers with concrete incentives to invest in the ENIQ technology) and internally (in strategic pricing efforts to see what system price gives the operator reasonable return and gives Ericsson reasonable profit margins). A real case study performed on an operator showed that an investment cost of €465,000 in the ENIQ system had a NPV €1,018,000 (corresponding to a return on investment of 219% and a payback period of 19 months) – indeed a compelling financial case for an investment in ENIQ.

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[1] Ericsson's legacy PM system.
[2] Please refer to the Glossary in Appendix A for a precise definition of TCO

Contents

1 Introduction

This Master's thesis has been performed in consultation with Ericsson AB, Operational Support Systems (OSS) Sales Division. The following introduction will dedicate three brief paragraphs to introduce the company and the business area within Ericsson that the thesis was carried out for, before turning to the introduction of the thesis' specific topic.

1.1 The Commissioner – Ericsson OSS

Ericsson is a leading telecommunications[3] equipment and related services provider for mobile and fixed network operators all over the globe. As one of the few companies in the world to offer end-to-end solutions for major mobile communication standards, its origins can be traced back to 1876. Almost half of all the world's mobile calls made pass through the Ericsson systems, facilitated by networks built with Ericsson equipment that have been deployed in more than 175 countries worldwide.

The business area OSS[4] within Ericsson operates in the telecom software market and provides their main customers (telecom operators) with service delivery platforms and systems for real time charging, customer care and billing. The area also comprises service fulfilment, service assurance and network management systems. Ericsson is ranked as one of three industry leaders within network management systems and offers a powerful OSS solution, the OSS-Radio Core product (OSS-RC), which allows its telecom operator customers to efficiently manage multiple networks from one distinct platform.

This report revolves around a complementary solution to the OSS-RC; a performance management system which enables telecom operators to manage availability, capacity and quality of their network services by collecting performance data and presenting the data in reports. With this in mind, the introduction will now turn towards providing a fuller background to the specific issues attended to within this thesis.

1.2 Background

Set against the backdrop of a deep and truly global financial crisis, with its all encompassing effects, the telecom giant Ericsson is currently facing a growing number of challenges both on the strategic and operational fronts. A heightened and more aggressive competitive environment coupled with an increasing level of consolidation and restructuring of the traditional telecom industry is placing increasing demands on Ericsson to deliver – both effectively and more cost-efficiently than ever before.

Turning toward the demand-side of the contextual equation, a number of Ericsson's customers naturally also currently command an intense focus on cost reduction schemes. Ericsson's acute sensitivity to this is exemplified by the following statements dedicated to their telecom operator customers:

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[3] Telecommunications will hereafter be termed telecom
[4] OSS stands for Operational Support Systems which effectively is the software used to provision, bill, manage and inventory networked products and services. For definitions of this and other terms used throughout the report, please refer to the Glossary in Appendix A.

"Times are tough. You're under pressure to improve you figures. In today's economic climate, everyone is. It boils down to getting the most out of capital investments and operating costs, and generating revenue. It's not rocket science. It's telecom." (Ericsson, 2010)

As a result of this fierce competitive environment and general rationalisation focus, telecom operators' general inclination towards investments is one relatively subdued and cautious. Yet it is precisely the proposition to make an investment that this report aims to evaluate, reducing the level of abstraction from the contextual to a concrete case. By exploring the rationale and motives that drive and influence investment decisions in telecom and information technology, this report aims to build a compelling financial model for the investment in a performance management (PM) system supplied by Ericsson.

More specifically, this report will revolve around creating a financial model that will create a way for Ericsson to value the cost savings that its customers will incur when investing in the abovementioned Ericsson product - from the customer's perspective. The product in question is a technology package[5] which enables Ericsson's Network IQ (ENIQ), a PM platform, to manage performance across 2G networks. The financial model will model the value of the incremental investment (i.e. model the difference) between having Ericsson's legacy PM system Network Statistics (NWS) in place as compared to the new ENIQ system under consideration. The two systems each generate different operational efficiencies for telecom operators in day-to-day activities; it is the difference between these measures that, when quantified, will drive cost savings that will be used to value the investment.

1.3 The Case

In order to create a financial model for the investment in the 2G ENIQ technology package, the scope of the report must be narrowed down by selecting a specific set of telecom operators – as specific customer segment, to which the model can be tailored. The customer segment studied in the report is a set of operators which have already invested in the ENIQ product to manage their 3G networks, and also has Ericsson's legacy PM system, the so-called Network Statistics (NWS) PM system in place today to monitor their 2G networks.

Why these customers are facing the investment decision to buy into the ENIQ offering for their 2G networks stems from Ericsson's strategy to progressively phase out NWS by 2013. Ericsson is shutting down the support and upgrade services provided to operators, which effectively incapacitates the system – leaving operators with no choice but to consider an investment in a new PM system for their 2G network. The fundamental question for the operator therefore becomes whether or not to invest in the 2G tech-pack for ENIQ - or to opt for a competing solution.

The phase-out of NWS will be performed in order for Ericsson to implement its strategy to make the ENIQ solution its main long-term offering when it comes to PM systems. NWS has

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[5] A technology package (also referred to as a tech-pack) is defined as a set of configuration instructions that dictate how ENIQ-software is to handle incoming measurement data from the network node type in question. The technology package in question t hus dictates how the PM system should handle data from 2G network elements (a more detailed product description will follow in Chapter 3).

historically proven to be a problem product in terms of reliability and has not delivered on Ericsson's, or indeed the operators', performance expectations. The consequences for Ericsson are that customer satisfaction is not delivered and massive service costs are incurred internally, which arise due to having to take care of the problems operators face when operating the system. These problems tend to surface because of the NWS' poor design and functionality, together with its emergent incapacity to handle growing volumes of data present in today's more complex and dynamic network architectures.

The need to address the situation is critical for Ericsson in two primary dimensions. Maintaining the NWS system has observably proved to be more time and resource consuming (and thus more cost-driving) than desired in proportion to the extent to which the system has been revenue generating. Recent developments in terms of rapidly increasing network complexity and more volatile dynamics has also been a compelling issue for Ericsson to approach and offer a solution to. Ericsson typically prides itself in being able to manage and maintain long-term relationships with its customers – and these relationships require that Ericsson delivers on offerings promises and also proactively seeks to satisfy operators' evolving demands. ENIQ is referred to as the solution developed in order to meet demands for solutions to handle rising complexity in networks.

To summarise, therefore, operators are facing a situation where they are forced to decide on whether or not they wish to invest in the 2G technology package for ENIQ or opt for a competing PM solution to manage their 2G networks upon the planned and announced end-of-life for NWS in 2013.

As mentioned above, the ENIQ 2G tech-pack promises to deliver where NWS has failed and also provide a platform of opportunities for the demanding operators to handle the future's challenges. For the set of operators that might require higher performing PM systems for their 2G networks because of future expectation or simply because of dissatisfaction, they might be more open to the concept of having to make an investment decision in a new PM system solution.

However, the consequences of Ericsson's following through on this strategy could adversely affect its relationship with the categories of operators recently having made an investment in NWS for their 2G networks or indeed those who have not experienced trouble with it. From their perspective, where the perceived benefits of the ENIQ solution do not resonate as clearly, Ericsson's strategy could be categorised as one rather hostile and their stance in sales negotiations difficult to perturb.

A financial model that allows Ericsson to value an investment in the 2G technology package, as seen from the telecom operators' perspectives would be a powerful persuasive tool in sales efforts considering the case. The forward-looking and opportunity-exploitive customers could, by being presented with tangible figures on what the value of the investment is by a model, be more thoroughly convinced to follow through on the investment. The customers not directly being able to value the ENIQ 2G system intangibly might likewise reduce their opposition should they see figures proving the investment to be lucrative. Ericsson thereby gains more credibility by being able to quantify the investment.

The financial model is also important internally; it has been a requested competence to develop within the OSS Sales Division as a step in efforts to become more business-oriented and financially driven. Typically, the sales teams have relied both on the strength of their relationships and experiential knowledge of the market as a basis for new sales opportunities. In selling the ENIQ 2G technology package, focus has been placed on highlighting its benefits in a qualitative way. Yet, the dimension of quantifying the benefits accrued when making an investment in the product has been one not prioritised or systematised in operation. The model's inherent generic qualities and the general approach to financial modelling can be seen to have strong elements of genericity which lends itself well to a first step in developing a competence and culture of financial modelling at Ericsson OSS Sales. With the making of the financial model in this thesis and the process of doing so documented, Ericsson OSS can thus integrate the process of financial model building as a step towards fulfilling its internal objective of becoming more business driven.

The financial model is also a step, as mentioned, for Ericsson itself to become more financially driven and aware of the actual value of their products for their customers. Historically, Ericsson follows pricing guides set by the headquarters which are expected to be followed. However, in many cases, deviations from this guide are necessary and permitted due to market specific requirements and to maintain good customer relationships by individual regional market units across the world. At times, systems are just given away. With the financial model in place, the market units could more tangibly appreciate the value that the investment in the product will offer their customer – and will thus also give them a financial case upon which to leverage benefit back to Ericsson. The market units can, by appreciating the value of the investment quantified in dollar terms, more reasonably price the product they are selling when this can be placed in proportion to the money their clients are expected to make from the investment in it. Thus, the financial model will thus also contribute to more proportional and just pricing of Ericsson's products.

With the above background information having been provided, the thesis' purpose can be formulated below.

1.4 Purpose

The overall objective of this thesis is to generate a financial model for the investment in the technology package that is Ericsson's 2G version of its performance management product, ENIQ. The financial model's purpose in turn, is three fold:

- Provide Ericsson with a tool with which to build a financial case that complements the existing business case for the ENIQ offering.
- Provide Ericsson's customers, telecom operators, with a way to evaluate the investment financially.
- Provide Ericsson with a pricing tool to be used within the organisation, since the model should allow for alternative prices to be entered into the model.

1.5 Research Question

The objective of the report can be formulated into the following research questions:

- How can an investment in the ENIQ 2 G tech-pack be modelled financially?

And also,

- How can the resulting model be implemented by Ericsson in day-to-day operations?

In addressing and subsequently answering the above questions, the study will provide Ericsson with a tool for quantifying the value of the investment from the customer's point of view. Financial modelling has, as mentioned earlier, been a requested competence within the OSS division in its efforts to become more business-oriented. By providing Ericsson OSS Sales with an easy-to-use and understand tool with generic qualities (so that it can be used in other sales instances than the one studied in this thesis), employees can tangibly change their way of implementing their sales strategy in day-to-day operations.

The virtue a financial model at hand can be considered dual. Not only does it present Ericsson with the ability to increase its pricing accuracy and thereby charge its customers accordingly; it will also serve as a vehicle to be used when creating the incentive structure for prospective customers to invest in the ENIQ tech-pack. The latter aspect gains particular relevance given the impending challenge that Ericsson faces when it is to motivate the current installed base of customers to invest in the ENIQ tech-pack. In this context, the ability to quantify benefits of the investment is indeed a powerful vehicle since it will enable Ericsson to prove the value for the customer in a more precise manner and thereby enhance measurability as well as the credibility surrounding the investment project at hand.

1.6 Limitations

The process of building a financial model is coupled with a high degree of uncertainty as to what parameters to include in the model and how these interact. In order to reduce complexity and to avoid redundancy of variables, there is an evident need to restrict the scope of model application to a relevant target group of Ericsson's customers. The financial model generated in this study will be targeted to applications on customers already having invested in ENIQ for 3G. This customer group will, due to the forthcoming termination of the NWS system currently in use, be faced with the choice between investing in the ENIQ tech-pack for 2G or standing with a non-operating system as the NWS is taken out of service in 2013.

2 ENIQ Product Description

The following chapter is dedicated towards providing the reader with a more detailed description of the ENIQ product, as well as a comparison between ENIQ and NWS. Thus, the understanding of the architectural design and functionality differences between the two products will allow for an easier subsequent understanding of what drives the differences in operational efficiencies between the two systems for the operators.

The product in question for this report is the Ericsson Network IQ (or, for short, ENIQ) and is based on the product DC5000 initially developed by the company Distocraft that Ericsson acquired in August 2006. The ENIQ offering has the long term objective to be the preferred

PM (Performance Management) solution in all Ericsson offerings and will replace the legacy PM system embedded within the OSS-RC, NWS.

ENIQ is Ericsson's answer to a high-end performance management application for multi-vendor, multi-technology environments. This essentially implies that it is compatible with network equipment from a multitude of vendors (for e.g. Nokia or Huawei) and is capable of collecting universal types of data from all types of network elements. It collects and processes data for use in performance reporting, resource planning and service assurance. ENIQ provides telecom operators with a network management data warehouse foundation for integrated fault management, configuration management and event based statistics. It also provides telecom operators with functionality enabling historical and statistical trend analysis (it is hence not a real-time monitoring tool). Ericsson labels the product as a "strategic enabler" that is flexible by design, and cost-efficient as well as effective in operation – it promises to increase and enhance the performance of telecommunication operators' network assets.

2.1 ENIQ Architecture

The product is essentially built using three main components: a platform, technology packages and reports. These components will be elaborated on below and a description of the Sybase IQ data warehouse foundation will also be provided. Many of the perceived benefits with the ENIQ solution can be traced back to its architectural build-up and it is therefore an important area to highlight for the reader.

2.1.1 The Platform

ENIQ is built upon a software platform that is independent of data contents and is therefore open to multiple vendor data streams. This is the basis for its multi-technology and multi-vendor capacities. However, as of the present moment, these capacities rely on the development of customer specific technology packages. The building of these is currently provided as an Ericsson service by GSDC (Global Services Delivery Centres[6]). Ericsson is underway with creating off-the-shelf multi-vendor technology packages (MVTP) to ease ordering and some of these have been available to the market since fall 2009. According to Ericsson documentation, the availability and development of such MVTP's as off-the-shelf products will depend on anticipated volume and market requirements.

2.1.2 The Technology Packages

A technology package is defined as a set of configuration instructions that dictate how ENIQ-software is to handle incoming measurement data from the network node type in question. The ENIQ solution involves combining a set of modular technology packages that satisfy the client's requirements and enables collection of PM data from a vast array of network sources. The modular technology packages are each designed specifically for varying types of network element types. The modular technology packages are also the reason for ENIQ's multi-vendor capabilities – ENIQ is currently in operation in both Ericsson and Nokia Siemens network

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[6] In the case of ENIQ specific technology-packages, development and support is offered mainly by the GSDC located in Finland.

environments. In fact, this report focuses on one specific technology package – the technology package that enables ENIQ to collect PM data from 2G network elements. The clients targeted have, as previously mentioned, already purchased and installed the ENIQ solution to manage their performance on 3G networks.

2.1.3 The Reports

The performance management system generates reports on performance to PM system users working in a so-called Business Objects (BO) reporting environment. The full client BO suite is accessed via a windows or web application server. This allows for end-to-end visibility for PM users accessing reports or queries from the system, all on standard web-based tools. Daily administration of the system is also performed via the web-based Graphical User Interface (GUI) by the system administrator.

2.1.4 The Database - Sybase IQ

One of ENIQ's strongest selling points is its state-of-the-art relational database; that is the reason for stating earlier that ENIQ provides telecom operators with a data warehouse foundation for integrated fault management, configuration and performance management solutions. The Sybase IQ database is essentially a high-performance decision support server designed specifically for data warehousing. It is considered optimal for loading data in bulk because of its fast and incremental loading capabilities. It is also optimal in handling analytical queries intelligently. The database also aggregates, counts and is able to compare data quickly and also allows for parallel processing which is an optimal solution for the multi-user environments that telecom operators have.

Many of these benefits can be ascribed to the fact that the Sybase IQ solution stores the data collected in column indexes, as opposed to many traditional solutions where a row-based architecture is predominant. For example, this column-based architecture dramatically reduces input to output disk usage when processing a query; a comparison between the row-based Oracle solution and ENIQ shows that while ENIQ only had to access 100Mb of data to handle the query, Oracle's solution had to run through 8Gb – and therefore had significantly longer query handling times. The Sybase IQ's column based architecture is also especially well adapted to handling business intelligence queries that require thousands of rows to be processed, while perhaps only requiring a few columns to be accessed.

Its architectural build-up furthermore enables the entire database and its indexing to be stored in less space than raw data – and considering that data storage costs are significant cost drivers for operators, this is an important feature. Moreover, the hardware requirements when using the Sybase IQ solution are typically cheaper than traditional counterparts.

2.2 ENIQ Expectations

The ENIQ offering is expected to perform exceptionally well along a multitude of dimensions. The following passage will put forward some of the benefits that can be ascribed to the ENIQ solution. The ENIQ business case that Ericsson uses commercially is primarily built upon these ENIQ qualities – and hence a description of them is therefore essential to

give the reader insights that aid in an understanding of what expectations Ericsson has for the product.

As mentioned earlier, ENIQ is expected to be synchronised with all network equipment – regardless of the network element it is managing – and therefore it is expected to be able to fully support and perform in multi-technology and multi-vendor environments. It has the full capabilities to incorporate completely new types of nodes as they are developed and entered into the network. Therefore, when operators integrate new types of technologies, ENIQ promises to adapt efficiently and reduce the lead times to incorporate new elements. The operators' demands on a PM system that can deal with recent developments wherein network architectures have become more complex are thus answered.

ENIQ promises to deliver on scalability and flexibility further – in terms of being a fully scalable and customisable in the dimensions of size. One ENIQ can for example be deployed to monitor performance across multiple OSS's – with the added benefits of having one centralised database for historical data – and with the pay-as-you-grow solution, additional capacity can be bought upon demand.

Flexibility is also enhanced across other dimensions, most notably that of performance. ENIQ, with its Sybase IQ data warehouse concept, processes queries faster and correlates data more intelligently because of its unique column based structure. It also handles object aggregations more efficiently since these are relocated to be handled by the Universe, releasing aggregation load on the Sybase, where aggregation was performed previously. ENIQ PM Statistics also have the potential to be combined with Configuration Management data, Event Based Statistics or Fault Management data and statistics – thus providing more holistic perspectives on how the network is performing.

Furthermore, ENIQ promises to deliver on ease of maintenance and administration, thus reducing operators' operating expenses. This will be achieved through fast and secure deployment from Ericsson, enabled by efficient tools such as commercial off-the-shelf, rapidly developed multi-vendor, multi-technology technology packages and support. The user friendliness and assumed client familiarity with a standard web portal interface also eases use and maintenance. The database tools are simple, fast and unified, enhancing administrative efficiency. They allow for easy KPI modification without hard-coding and re-configuration[7], and allow for simple creation of ad-hoc reports that are generated in seconds rather than in minutes. Additionally, the status overview functionality eases identification of problems and provides a bird's-eye perspective on the network quickly.

Lastly, the overall total cost of ownership of the ENIQ solution aims to be optimal compared to similar solutions. The costs for investment in the hardware are relatively low, the Sybase IQ technology uses less disk storage (data storage drives costs for operators) and since ENIQ is a stand-alone solution on a separate server, savings can be made when costly backup

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[7] This is due to the fact that the KPI's are defined on the reporting level and the formulae used to generate them are transparent and easily accessible by the client users.

solutions can be removed from operations. The last fact that ENIQ runs on a separate server also contributes significantly in enhancing security for the operator. The critical PM application can then theoretically continue to function even if the OSS is down while simultaneously freeing up capacity on the master server which can then be re-used for network growth and functional improvements. ENIQ is also expected to not only reduce upgrade times – but also reduce data losses when upgrades are performed.

To summarise, the ENIQ offering's main benefits are visualised in figure 1 below.

Future-proof, scalable solution

Multivendor and multi-technology solution

Based on proven technology acquired from Distrocraft

Intelligent Data Correlation Capacities

Long retention periods for data

Efficient query performance

Centralised, stand-alone PM application improves security and releases capacity

Fast upgrades and minimised loss of data

Figure 1 The ENIQ offering's main benefits

2.3 ENIQ Challenges

Just as the ENIQ offering has strengths, it also has a number of weaknesses and challenges to overcome. Much of the following material on its drawbacks stem from market feedback documented internally within Ericsson.

Although one of ENIQ's strengths is the fact that its reports are customisable, it is precisely this which users have found to take unnecessary amounts of time (even though the expectations are that they should be delivered efficiently) and their quality varying. The lack of variety in pre-defined reports in the off-the-shelf technology packages has been voiced as a drawback when implementing the ENIQ solution. The system's ability to handle prompts has also been remarked on and is considered too slow, although attempts to remedy this have been made in recent upgrade efforts. Also, the operators have voiced the need to be able to monitor precisely how the data is loaded into ENIQ from specific NE's – they are not only concerned with the fact that data *is* loaded, but also how the underlying process of *how* it is loaded is progressing. Additionally, new report features relating to bottleneck identification and possible problems in the networks have been requested.

It is worth noting that Ericsson continually communicates with its customers and integrates solutions in its upgrades to meet changing requirements and remedy faults within the system – that is one contributing reason as to why and how Ericsson receives information from the users on challenges with their product.

2.4 Differences between ENIQ and NWS

The ensuing section is dedicated towards providing the reader with an overview over the differences in functionality and architecture between the ENIQ solution and its legacy counterpart NWS.

2.4.1 Design Differences between NWS and ENIQ

	SDM	ENIQ
Capacity	15,000 cells	30,000 cells
Database	Sybase ASE	Sybase IQ (Unified)
Control Engine	Script Based	Java Based
Solutions for Subnetwork/NE types	Dedicated per sub-network/NE type	Unified
Monitoring Capabilities	Limited	Web-based monitoring GUI
BusinessObjects interfaces (reporting)	Default interface	Web portal

Table 1 Design differences between NWS and ENIQ

Table 1 above illustrates the most important fundamental design differences between the NWS and the ENIQ solution. Firstly, their database structures differ in that NWS is built on Sybase ASE– while ENIQ is built on the Sybase IQ, and has all the benefits associated with a unified data warehouse solution (these benefits are more elaborately detailed in the description of the Sybase IQ). Moreover, the NWS' Statistical Data Mart (SDM) control engine is SQL script based which requires manual modification to scripts upon each new release of the SDM. ENIQ's control engine meanwhile, is java based and only requires configuration (i.e. the implementation of new technology packages) upon every new release. As for the solutions per subnetwork/network element, the SDM has different solutions while ENIQ is a unified solution for all. ENIQ can also handle data from up to 30,000 cells in a network; double the amount that the NWS can. The ENIQ solution is stand-alone and centralised, while the Statistical Data Mart (SDM) that handles statistics in NWS is embedded within the OSS-RC and runs on its capacity. ENIQ thus has the added advantage that it releases capacity from the CPU allowing for it to run more efficiently than having to house the SDM. Also, the interface that the system administrators and end users face is web-based in the case of ENIQ – while it is set to the default Business Object interface with the SDM.

2.4.2 Functional Differences

There are a number of functional differences between ENIQ and NWS, which are compiled in table 2 below. These pertain to their database schemas, time and object aggregation methods, their absolute value counters and the way in which they handle the so-called busy hour data and also how they delete data. Furthermore, they differ in the way they offer recovery of Report Output Period (ROP) files and the way they can be used to generate performance Statistical Alarms.

	NWS	ENIQ
Database Schema	Different Databases per system and each has its own schema	Unified database and schema
Time Aggregation Strategy	Data is aggregated automatically in order to minimise size of database. Counter data is kept only for days, while aggregated data is kept longer.	All counter data and multi-vendor Key Performance Indicators (KPI's) are aggregated only on a day-to-day basis. The data warehouse strategy allows raw counter data to be kept for months and daily aggregations for as long as required. All other aggregations done upon request from end user.
Object Aggregation	Aggregations and calculated counters stored in the database	No aggregations or calculated counters stored in database; all handled upon request in the BO reporting environment
Absolute Value Counter	Hardcoded procedure for converting absolute value counters into calculated values	Absolute value counters are stored in raw data tables and calculated once a day using formulae defined in the technology packages
Busy Hour Statistics Handling	Two ways to handle busy hour statistics: Sliding window and time consistent peak hour. The sliding window calculates the hourly statistics every 15 minutes – thus generating 96 possible busy hours in a day. In time of the time consistent peak hour, the end user accesses the interface to select a time period and the SDM normalises the busy hours to choose a time consistent busy hour. From that point on, that hour is configured to save busy hour information.	The busy hour is defined per busy hour type by technology packages and is calculated on an absolute hour boundary which allows for 24 hour days. It is also possible to customise Busy Hour Support for different types of traffic in addition to traditional voice traffic busy hour (IP, SMS, MMS traffic can also be monitored).
Data Deletion	Since time aggregated data is stored in the same tables as the raw data, the deletion routines are forced to regularly scan the tables to find data to delete because it has passed its retention period	Raw and day level aggregated data is stored in separate tables. When the data partition that stores the table then passes its retention period it is simply deleted. This is the partition management functionality embedded within the Sybase IQ.
Performance Statistical Alarms	Limited types of counters in database can be defined to trigger alarms by hard-coding alarm definitions. Two types of alarms can be generated: Static or floating threshold. Limited, hard coded formulae and operands to calculate and define alarm thresholds	All counters supported to generate alarms. The PM Alarm Module in ENIQ uses templates to generate alarms. Six types of alarms are fully supported: Static threshold, deviation from a trend, derivative, number of occurrences within a period and number of continuous occurrences. The full calculation capacity within the BO can be used
Reporting Differences	Pre-defined, optional report packages containing BO universes and BO reports built on pre-defined KPI's. Accessed using the standard BO user interface.	Customer-specific reports embedded within a technology package containing BO linked universes. Upgrades of the technology package are easier therefore. Accessed using the full BO web interface.
Recovery of Files	Handled differently according to which NE data stems from and no automatic recovery function for some NE's and no manual recovery for certain types of NE's	Efficient and automatic recovery for all NE's.

Table 2 - Functional Differences between NWS and ENIQ

2.4.3 Performance Differences

The differences between the two performance managers ENIQ and NWS incur implications in their relative performances. ENIQ is observably faster in generating reports and does make data accessible in shorter amounts of time. This is because in ENIQ, data is loaded as it arrives and is then made available to be included in reports. In contrast, it could take up to three hours before data was made available in NWS because it was required to wait for all node data in order to perform all aggregation prior to being included in reports. The ENIQ solution allows access even to the raw data before any aggregation is done as well. ENIQ is also capable of handling a larger amount of Business Object users (PM end users) and can handle larger, more analytically deep queries where intelligent correlation between data is required. The queries made in ENIQ can span over significantly longer periods of time and include larger parts of the network as compared to those made in NWS.

2.4.4 Disclaimer

The above ENIQ product description, and brief overview of functional and architectural differences between NWS and ENIQ are those deemed relevant in order to provide sufficient understanding and to subsequently follow the lines of reasoning developed in later stages of the report. A complete understanding of the advanced technical differences and general characteristics of network management was not intended to be provided, since the report's priority has been on developing the financial case for the product – and not generating a complete technical understanding of its functionality and architecture. Only aspects relevant to the scope of the project and to provide a basic understanding have thus been presented.

2.5 ENIQ deployment and sales strategy

To date, approximately 300 ENIQ systems have been deployed across the world. As previously mentioned, ENIQ will be the only long-term PM solution fully supported by Ericsson from 2013. This effectively means that operators currently using the NWS solution for PM will be forced to review their options and either migrate to ENIQ or invest in a competing solution from another vendor.

The ENIQ offering intends to replace the OSS RC's embedded legacy PM application, NWS, which is currently deployed to approximately 600 customers worldwide. Approximately 100 of these customers already have ENIQ for their 3G networks. Ericsson has announced the termination of support service for the NWS in November 2009. Support will be terminated completely in 2013, effectively forcing NWS customers to seek an alternative solution in order to receive necessary support and upgrade services.

Purchasing ENIQ involves an investment in new hardware and in licenses for the software and Sybase IQ database. It is a pay-as-you-grow and scalable solution, which means that should the operator's requirements change upon expansion of its network, more licenses and associated hardware can be purchased as time progresses. This scalability and flexibility towards changing conditions is favourable since it does not limit the operator and does not force it to purchase excess capacity in anticipation of rising requirements. Hardware and software requirements are dimensioned by Ericsson depending on the client's existing network and expansion plans.

Ericsson does not offer its current NWS clients the possibility to define the migration from the soon-to-be-shut-down NWS to ENIQ, but rather aims to implement a strategy wherein ENIQ is sold as a completely new solution and therefore also aims to generate new sales. The stand-alone PM application is to be sold as Project Sales together with the local Ericsson SI-organisation[8]. This is due to the fact that the migration from NWS to ENIQ requires a diversity of Ericsson services relating to OSS Analysis and Planning, PM Integration and Adaptation. These preparations are essential in order to secure a smooth transition from NWS to ENIQ and involve collection of historical data, adaptation of reports and adaptation efforts to fit the existing PM tools in use into the new database interface. Also worth noting is that the support service offered by Ericsson to its customers will be in the form of so-called Solution Management.[9] Ericsson promises to deliver fast and secure deployment of ENIQ with commercial off-the-shelf support tools for Ericsson equipment and multi-vendor, multi-technology technology packages and support when needed.

It is important to note, however, that although official pricing guides have been developed to strategically aid sales efforts globally, Ericsson acknowledges the fact that the locally dispersed market units should be given the freedom to offer appropriate discounts to existing NWS clients based on their intimate knowledge of the customer, the geographical market and associated sales climate. For example customers that recently upgraded their NWS, Statistical Data Mart (SDM) to SDM-I (which offers basically the same functionality as ENIQ) may be given special consideration when required to migrate to ENIQ.

2.5.1 Customer Segment Studied

To review, the ENIQ customers focused on in this report is a segment of approximately 100 customers from the installed base: those who have purchased licenses for ENIQ on their 3G networks and currently have NWS for their 2G networks. These customers will be compelled to migrate to ENIQ – and do so by purchasing the 2G technology package that allows for data streams from their 2G networks to flow into their ENIQ system. They already have much of the necessary hardware (although some customers may require to add hardware capacity depending on their individual set ups) and simply have to invest in the 2G technology package, associated licenses and integration services.

However, the strategy wherein the NWS is effectively shut down is not friction-free. Customers that are happy with the NWS today, who do not plan future expansions of their 2G networks, and generally enjoy relatively static networks do indeed pose a challenge for Ericsson when approached with the 2G ENIQ offering. There does indeed exist a risk that they might not fully be able to appreciate the benefits that an investment in ENIQ might bring in light of their requirements. Yet, since the customers considered in the report already have experience in working with ENIQ in their 3G networks and can appreciate the intangible benefits (which do not lend themselves to be quantified readily) that the system can offer, approaching them on the grounds of tangible and indeed quantifiable benefits that the

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[8] SI stands for System Integration
[9] Solution Management (SM) is Ericsson's response to operators' needs to run increasingly complex and customised networks efficiently and securely. SM supports these needs by offering dedicated expertise to support and develop integrated solutions, as well as process and component management.

investment can bring might be a more viable strategy. The business case tool – the financial model on the investment in the 2G ENIQ technology package that has been developed in this report – aims to do precisely this and thus further strengthen the business case for ENIQ for this select group of customers.

3 Methodology

A thorough account of the method that was followed in order to generate this report is given below. According to Lantz (2007) it should theoretically be possible to repeat the underlying process allowing for the generation of this thesis by following the description of the method provided. Patel and Davidson (2003) put forward another element relating to the purpose of providing an exhaustive description of the method undertaken – and that is that it gives the reader a chance to evaluate the validity of the results.

The account of the methodology has been structured in the following manner: It begins with a descriptive passage of how the report has been structured in order to provide the reader with guidance. After that, the general methodological approach undertaken is presented, followed by a description of the fundamental research process and its direction. As this thesis ultimately aims to produce a financial model as a deliverable, the model development process is accounted for in more detail and is given its own section within the account of the method. Subsequently, the data collection methodology is accounted for. A special section is dedicated to an account of actually building the spreadsheet model in Excel and the process followed to collect the necessary data to be inserted in the model. The empirical study was performed in order for this data collection to be performed, and is therefore presented in conjunction with that section also. How the thesis' primary results will be presented and documented will thereafter be described.

3.1 Report Structure

The following passage aims to provide the reader with a guide to the report's different sections and to provide the logic as to how it has been structured.
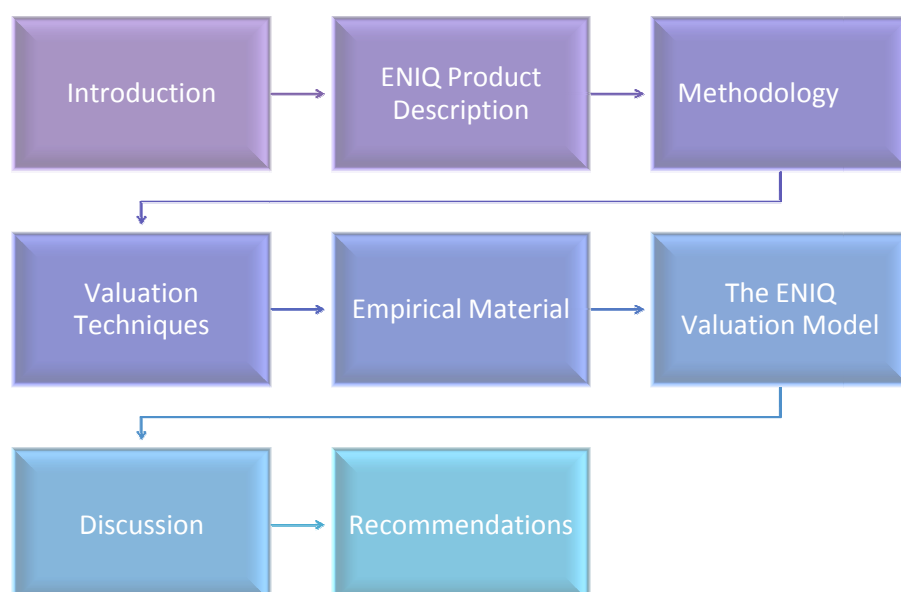

Figure 2 An overview of the report's chapters

An overview of the report's chapters is illustrated in figure 2 above. The introduction in Chapter 1 aims to provide necessary background to the reader and also states the objectives, research question and limitations of the thesis. The ensuing section on the methodology (Chapter 3) accounts for how the research process was structured and describes the processes that allowed for the generation of the results. It also motivates the methodological choices and evaluates the validity and reliability of the study. The next chapter (Chapter 4) presents the theoretical study conducted on valuation techniques derived from literature. Chapter 5 provides a report on the empirical material collected from the study. The following chapter 6 is effectively an analysis that relays and motivates how the valuation techniques have been united with the empirical data collected and presents the results of the analysis: the ENIQ Valuation Model. Here the value of the investment based on real case study figures is also presented. The results, method and entire research process is then discussed in Chapter 7. Closing recommendations and future areas for research are proposed, finalising the report in Chapter 8.

3.2   Methodological Approach

Researchers typically work towards uniting empirical material with its theoretical counterpart – and so is duly the case even within this thesis. Three main methodological approaches exist that convey real knowledge and that unite the empirical with the theoretical: the deductive, inductive and abductive approaches. Patel and Davidson (2003) assert that a deductive approach tests already existing theory on specific phenomena. Objectivity is strengthened, according to the authors, due to the fact that the researcher(s)'s own values and subjectivity are not able to affect results since the research's inception lies in established theory. Induction is per definition the opposite of deduction and implies that the researcher builds and formulates theory based on empirical data collection. The researcher then fulfils the objective of generating new theory founded upon studied phenomena. An inductive approach is subject to the researcher's own values and inherent subjectivity – thereby weakening this type of research's objectivity.

When an abductive approach is undertaken on the other hand, existing theory facilitates understanding of a phenomenon, while simultaneously allowing for the generation of new theory and perceptions alongside the path of research followed. Discoveries or ideas are thus often generated as research is conducted. According to Svensson and Starrin (1996), this switching between observation and ideas, between the parts and the produced whole, is what defines abduction. This latter statement justly defines elements pertaining to this report, and the research activity which underlies its generation, and therefore it is concluded that an abductive approach has been adopted.

3.3   The Research Direction

An explanation of how data shall be generated, processed and subsequently analysed describes the general direction of research undertaken. Two primary directions of research can be undertaken; either quantitative or qualitative. However, all research cannot be classified as distinctly one or the other due to the general presence of both qualitative and quantitative directions within a single research project. The direction of the research is dependent and

driven by the purpose of the actual research conducted. If raw data is collected and processed only employing statistical methods, the research conducted can be assumed to be quantitative in nature and is most likely used to test hypotheses. If the purpose is rather to understand and interpret a specific phenomenon, Patel and Davidson (2003) state that qualitative research is being conducted. Since the purpose of this report is generate an understanding of what drives the value of an investment decision in Ericsson's Network IQ and to then subsequently quantify the value of this investment by generating a financial tool, the research conducted is to a greater extent qualitative rather than quantitative.

3.4 The Research Process

The following section will provide a brief overview of the general research process undertaken and also present the model development process that guided the project in practice.
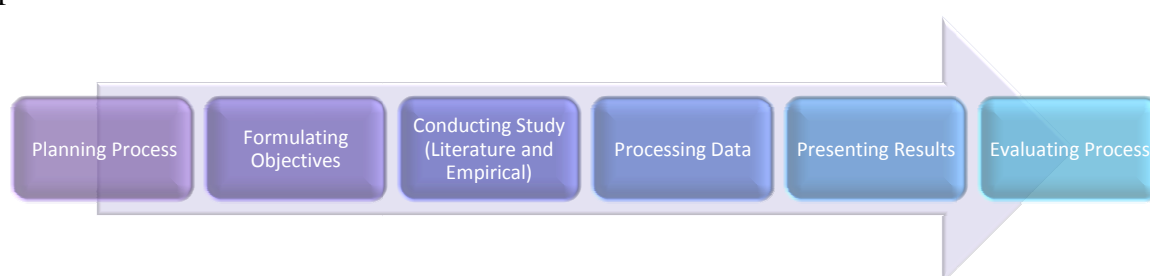

Figure 3 The general research process visualised. The main stages are illustrated distinctively in a linear process, although elements of iteration were present

The research process undertaken is illustrated in figure 3. The figure demonstrates how the project has been split up into broad phases; the different phases have not followed a strict order, the process has rather been iterative in nature. Evaluation and repositioning of the different elements of the report was conducted continuously throughout the enquiry. New results were generated recurrently and subsequently integrated into the report. It is worth noting that reports of progress and any changes in direction were continually reported to both supervisors at Ericsson (Thomas Wallström, Sales Manager for the Nordic region and the Baltic States) and at Chalmers (Joakim Björkdahl), as well as the head of Ericsson's OSS division (Johan Axelsson, Head of OSS) in order to receive constructive criticism and valuable input.

A preliminary time management plan for the project was developed early on, key milestones were clarified and areas of responsibility were assigned within the research team. Relevant literature, corporate brochures and documentation relating to the product was studied in order to aid the narrowing down of the scope in the initial phases. Discussions with key persons within Ericsson (Thomas Wallström, Johan Axelsson and Sales Manager Gillian Leetch) also contributed significantly towards the formulation of a concise, manageable scope and a segmentation of the customers. Ericsson provided us with the opportunity to receive introductory training sessions relating to the area of OSS, Performance Management, their business case build-up methodology and more in-depth sessions relating directly to the product at hand - the Ericsson Network IQ (ENIQ). Theory on investment valuation techniques was studied in parallel with this.

In order to fulfil the purpose formulated an empirical investigation was conducted. Interviews were held with key persons within Ericsson and with customers fulfilling the requirement of the segment chosen for study. Data collected was processed and analysed – data essential for the development of the financial model proposed. Thereafter, this processed data was used as input in the financial model, developed according to recommended procedures on general business modelling which will be elaborated on in more detail below based on Friend and Tennant's guidelines (2001). The last phase of the research process involves evaluating both the research process as a whole and also the report and the quality, validity and reliability of its results and suggestions for further development and research.

3.5 The Business Modelling Process

The following passage is dedicated towards describing the business modelling process undertaken to generate the results of this thesis: the financial model.

Define the fundamental business question

Identify the key input variables that determine the outputs

Build spreadsheet model and collect data

Document and present findings

Post-project review and apply lessons learned to future projects
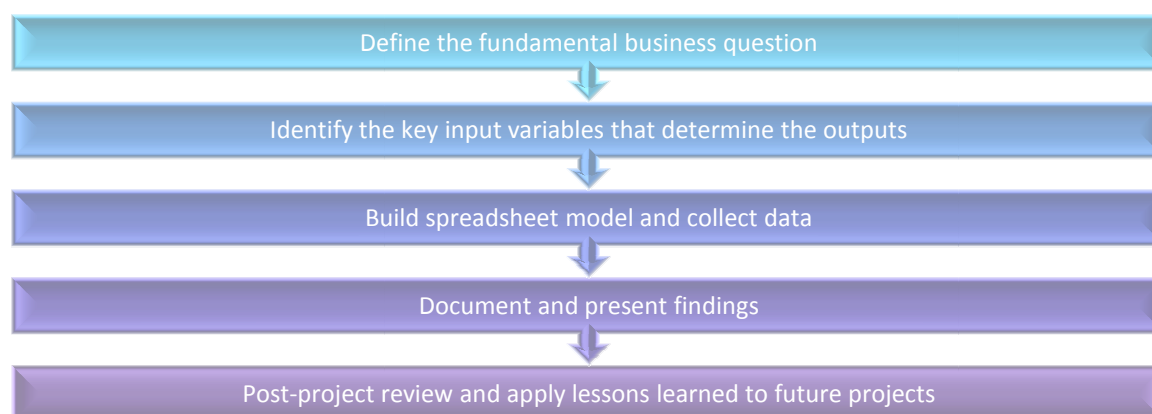
Figure 4 The business modelling process, adapted from Friend and Tennant (2001)

3.5.1 Defining the fundamental business question

The above model development process (see figure 4) illustrates the general stages that were carried out in order to build the financial model of the investment in the 2G technology package for ENIQ. As the figure dictates, the process was initiated by defining the fundamental business question that is driving the enquiry. In this case, the issue at hand was that Ericsson whether or not it was possible to generate a business tool that effectively modelled the financial investment decision associated with a migration from NWS to the ENIQ 2G technology package, in order to ultimately strengthen the existing ENIQ business case. The underlying business question that was to be answered was therefore: *Does an investment in the ENIQ technology package increase operational efficiency compared to employing NWS - and therefore also, is it financially favourable for Ericsson's customers to undertake an investment in the ENIQ 2G technology package and abandon the legacy system NWS?*

3.5.2 Defining Model Outputs

From this point on, when the fundamental business question had been defined, every remaining stage of the process was driven by finding an answer to it. The natural step following the establishment of the business question was to define the necessary outputs of the model. In order to determine if an investment is favourable or not a number of financial

methods can be employed. It was here that the theoretical study conducted came into direct use. A number of alternative output measures were discussed, based on investment valuation techniques and theory, both within the research group internally and outwardly, with Ericsson. The outputs deemed most useful following the discussions held were the payback period, the net present value and the return on investment that clients obtained from having made the investment in the 2G technology package. These were the outputs most easily understood and communicated from Ericsson's perspective when dealing with potential investing clients – and indeed also fulfilled the criteria of being able to answer the business question satisfactorily. The techniques are individually accounted for and further theoretical motivation as to their suitability is provided, as mentioned before, given in chapter 4 – Valuation Techniques.

3.5.3 Defining Model Inputs and Model Logic

The next step, once the outputs were identified, was to specify the necessary input variables required in order to generate these outputs and develop the logical arguments that explain the dependencies between the inputs and related outputs (Friend and Tennant, 2001). How were the values return on investment, net present value and payback period for the investment to be derived? Since the model was to provide an indication as to whether *operational efficiency* was enhanced should the client telecom operator migrate from NWS and use ENIQ 2G instead, the model should intend to represent what effects the migration had had on the profit margin that the telecom operator would have before and after an installation of the 2G technology package[10].

In order to generate the required input variables, the empirical study was performed. The empirical study is described in more methodological detail in Chapter 3.4, and its results accounted for in Chapter 5 – Empirical Study. It essentially involved an in depth case study of one operator and a number of interviews with key individuals within Ericsson to uncover cost driving activities that change from the one system to the other as well as a documentation study on product information and to validate a draft of the model. A general set of input parameters was presented to firstly Jesper Hök, based on the researchers' general understanding of ENIQ vs. NWS systemic differences and after a discussion-based interview, the list of presented parameters was revised: some parameters were eliminated and others were added. The same procedure was performed during the case study interviews held with the telecom operator that had made the investment. Thus, the relevant input parameters were established and the input logic was developed. The logic was then duly validated and tested during the consultation with Marian Delinkov.

3.5.4 Building the Model and Collecting Data

Figure 5 below is provided in order to remind the reader what stage of the business modelling process the passage pertains to, namely the building of the spreadsheet model and the data collection stages. These processes were conducted in parallel, as can be seen in the Gantt chart drawn up in the project planning stages (Appendix B). These two stages can be further

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[10] Operational efficiency is generally measured in terms of profit margin, where profit margin is defined as the percentage of net profit after taxes as compared to revenue. (Investor Words, 2010)

broken down into specific spreadsheet model building process and the empirical study that allows for data collection, as visualised below.
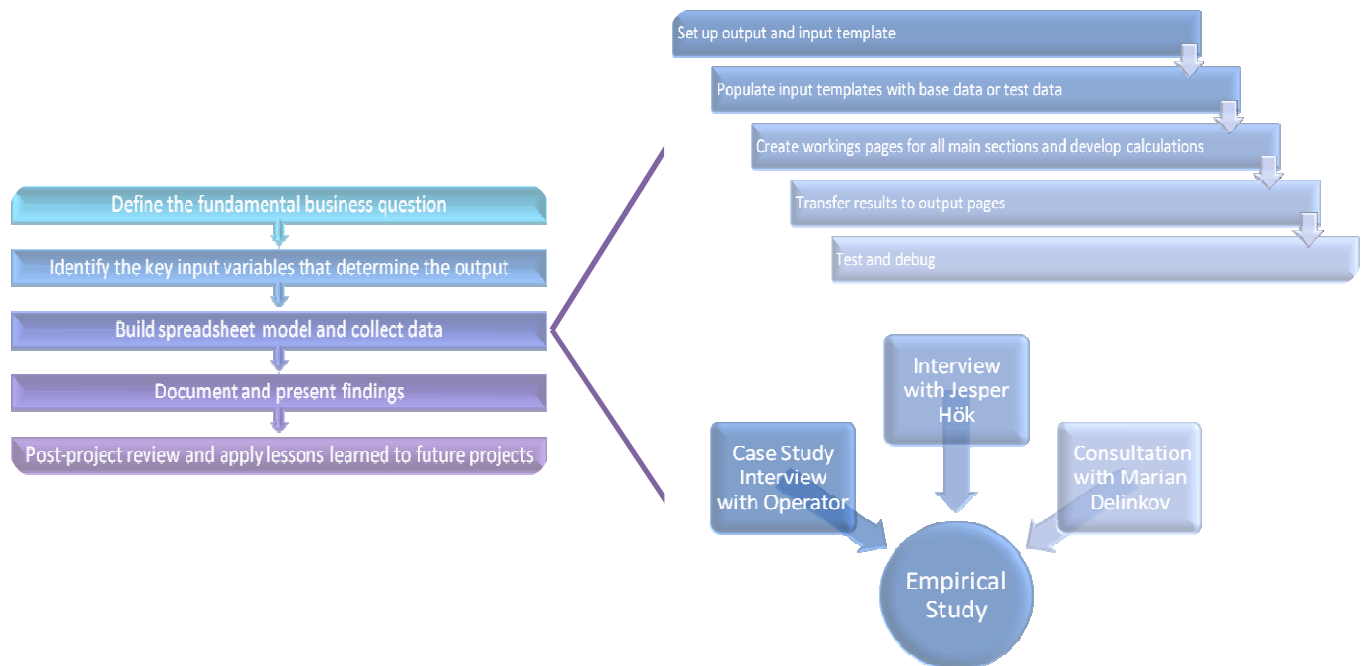
Figure 5 Visualisation of the third stage in the Model Building Process split up into the process for building of the spreadsheet model in Excel and the Empirical Study to collect data and validate the model

Model Building

Following guidelines drawn up by Friend and Tennant (2001), the model construction stage was made more manageable and efficient by structuring it in individual stages – thus breaking down the undertaking into clearly defined sub-tasks. The process can be mapped out as illustrated in figure 6 below.
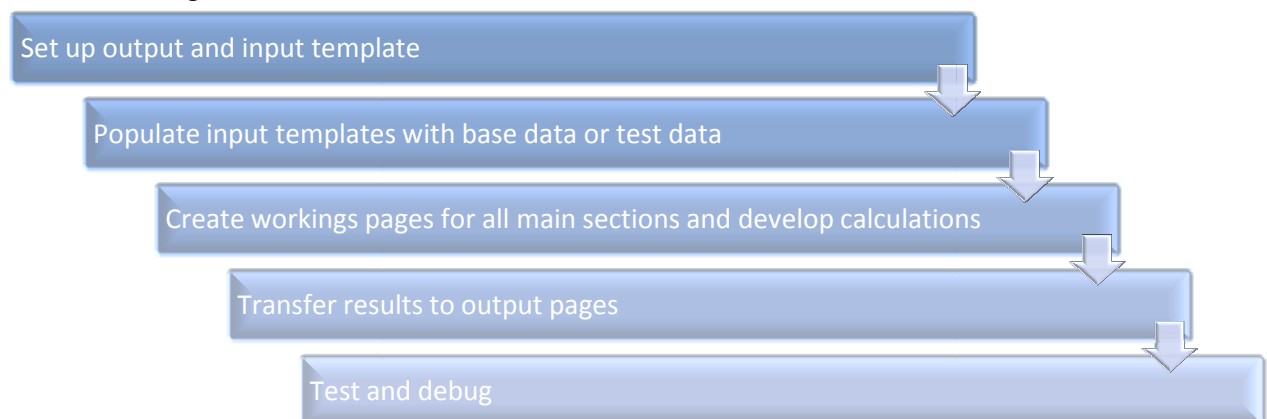
Figure 6 Model Building Process, adapted from Friend and Tennant (2001)

Basic input and output templates were set up on the outset, developed from the understanding gained of the already determined in- and outputs. Input templates were subsequently populated with test data that was purely fictional yet not unrealistic. The reason for doing so was to allow the model development process to continue despite the initial absence of real

case data. This enabled the model builders to assess the effectiveness and accuracy of the work conducted to develop the model (Friend and Tennant, 2001). Subsequently, the workings pages and associated calculations were developed in greater detail. The bulk of the model building process is dedicated to this stage – separate sheets were created for each of the main classes of calculations and their structures were individually outlined to include necessary coding and formulae.

Once this was done, attention turned towards transferring the results from the workings pages directly to the output template. If any changes or modifications in the outputs generated from the model were found to be of importance, they were then duly incorporated into the output templates, and any further input requirements discovered were also incorporated. Once all calculations, formulae and coding were finalised, the model was tested and tried for any bugs. The model was thus revised and its technical accuracy and logical soundness evaluated and validated (as mentioned, also externally validated by Marian Delinkov). Naturally, any fault, whether technical or conceptual, was corrected and necessary changes incorporated until the modellers saw it fit to be presented to the users and made available for them to test it.

Since the model is developed for Ericsson Sales representatives as a business case tool, simplicity and user friendliness was key when developing the interface. A user guide was also developed in order to aid future use of the model and provide more elaborate understanding of the workings of the model. All assumptions were clearly stated and the user is expected to only modify the input pages, where all required input data is clearly explained and communicated. The output pages can then be referenced for results, both quantitative and graphical. The financial model in its entirety is presented under the results (Chapter 6) section in greater detail.

These stages described above were followed in a primarily linear fashion, although it did contain an element of iteration. As soon as the workings were completed for example, the results were transferred to the output pages. If new outputs were developed these were then incorporated back into the output template immediately as work progressed. This iterative process nature allowed new, unforeseen issues to be taken into account. Similarly, any changes or discrepancies discovered in the last stage of the model building process, the testing and debugging stage, were remedied and appropriate corrective actions were implemented back in the input and output templates and relevant workings sheets.

Data collection – The Empirical Study
The empirical study performed aimed to facilitate data collection. The report is based on both primary and secondary data. A primary data source is described by Bell (2006) as eye witness accounts and first person reports where proximity to the source of information is given great importance. A secondary source is on the other hand, an interpretation of primary data according to Patel and Davidson (2003). Primary data has been collected throughout the project from interviews (in person and conference calls) and this has been used to shape an understanding of what operators, end-users and system administrators, Ericsson employees and others value in terms of cost-savings and benefits related to the ENIQ product. Secondary data has also been used as a source of information; material used in presentations as well as

documentation concerning the product and the strategy of its deployment have been studied, for example.

Figure 7 below illustrates the main elements of the empirical study conducted. An interview was held with Strategic Product Manager for ENIQ, Jesper Hök. A case study interview was performed with a technologically competent operator who has invested in the 2G technology package for ENIQ and has previously had NWS in operation. Lastly, a consultation with Marian Delinkov was undertaken. These elements will be described in greater detail in the ensuing passages.
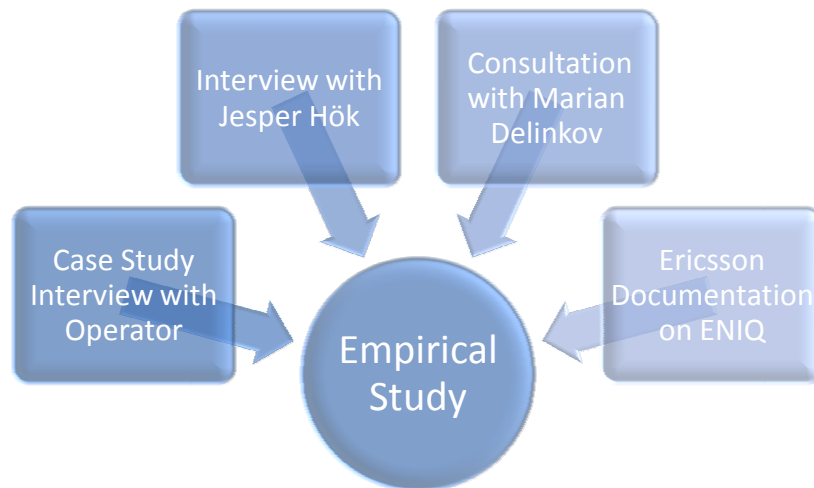
Figure 7 The Empirical Study performed visualised with its four main elements: the case study, the interviews with Hök and Delinkov along with the empirical documentation study

Sources of data

The data collected in this study stems from interviews, one case study and internal Ericsson documentation. The empirical material collected on the product ENIQ that resulted in the chapter 2. ENIQ Product Description was all recovered from internal Ericsson documentation, and is not referenced since access to the original documentation will not be granted. The re-publication of the material in this thesis is however warranted and approved by the commissioner since it is essential information to relay to the reader.

According to Lantz (2007), a good methodological practice to collect qualitative data is conducting interviews – explaining why this method was employed as a primary source of data. The technique of interviewing was also how information was collected from the case study with the telecom operator. Interviews are appropriate in the given setting, especially considering that the interviewees can easily be allowed to express their experiences with ENIQ and the legacy NWS in a qualitative manner by discussing the impact of the migration from NWS to ENIQ in their own words.

The interviewees contributed with their views on which parameters were of importance, from an operational impact, which were then interpreted and integrated into the model generation. Employing the survey as a method to collect data may have allowed for more data to be collected in absolute terms and allowed for statistical analysis techniques to be employed in order to classify and generalise the relevancy of parameters for the model. However, the

survey only allows for the collection of viewpoints on predefined parameters, since the questions are formulated in advanced and standardised – and therefore inherently lacks the required flexibility and adaptability to unique situations. Since the qualitative element of the research conducted wished to allow for both Ericsson's customers and key stakeholders within the firm to impact which parameters to be included in the model and grasp the reasoning behind their decisions, the survey method was not chosen to be used in the investigation. It is important, however, to be aware of the limitations associated with interviewing; the fact that it is time consuming and costly (especially in cases where travelling is required), does limit the number of interviews and interviewees included in the study. This, in turn, also influences the types of conclusions that may be drawn and restricts their elements of generalisability.

Interview Design
The following section will address how the interviews were structured and how the interview guide was developed and evaluated.

The character of the report's purpose, how the problem is formulated and which types of conclusions the report aims to draw are decisive factors to consider when structuring the interview, according to Lantz (2007). However, since the interviews conducted aimed to provide necessary information on the parameters for the model, their purpose can also be said to describe and deepen the understanding of a phenomenon (the migration process from NWS to ENIQ) – and for that an open, directed interview should be employed. Lantz (2007) motivates this reasoning by relaying how an open, directed interview allows the interviewee an opportunity to individually classify and relate to the concepts and also contextualise them as he/she might deem appropriate. Had a more structured technique of interviewing been applied, the interviewer and his/her predefined notions of the concepts would have determined their associated context; for this report, that would not have been an appropriate way of approaching the problem of establishing relevant parameters. Lantz (2007) points to the fact that an open interview allows the interviewees subjective perception of the concepts and their contexts to come forward and thus also allows the interviewer to understand the concepts and phenomenon from the interviewee's perspective.

In order to heighten the quality of the interviews, a pilot interview was set up with the strategic product manager of ENIQ, Jesper Hök. The pilot interview had two purposes: one, to provide deeper understanding of the research area and how the performance management system is used and two, to develop the interview guide further. The interview was, as all interviews performed in the study, held by both the authors (one of the authors actively interviewing, while the other took notes and held a more passive interviewing role) and the interview session was recorded using a digital audio device. Moreover, as mentioned, written notes were also taken by one of the interviewers to serve as a complement and a security measure should the recording equipment for any reason falter during the course of the interview. The pilot interview did result in changes of the interview template and contributed significantly towards a heightened understanding of the process and the effects of migrating from NWS to ENIQ.

Interviewees

The following section aims to introduce and provide a brief presentation of the interviewees consulted in the empirical study.

The first person to be interviewed was **Jesper Hök**, Strategic Product Manager working within Ericsson's BNET division (Business Unit Networks). Jesper Hök has been with Ericsson for over 10 years, and has a background within Applied Physics and is has held his position at Ericsson since 2002. The interview aimed to result in the identification of relevant parameters that were to be included as input in the model.

The business case study interview performed with one of Ericsson's customer companies[11] having made the investment in the 2G tech-pack for ENIQ and who had experience of NWS. The interviewed organisation is a **telecom operator** with a lean and efficient organisational approach employing approximately 1,000 people. The operator values its strong focus on technology and competence with around 50 percent of the organisation being technically dedicated. Its differentiating value proposition lies in its efforts to maintain high quality customer service with short response times. It also uses aggressive marketing techniques which, coupled with successful, high quality services has allowed the operator in question to expand and take market shares where only two main competitors otherwise are in operation. The operator expresses that its technology strategy has basically been to focus on commercial tools and systems with proven performance and guaranteed support, and has opted to manage its networks exclusively with Ericsson equipment and associated systems. The interview with the operator resulted in further refinement and validation of input parameters developed initially together with Jesper Hök and also duly allowed for the collection of case specific data.

Lastly, **Marian Delinkov** from the Global Service Delivery Centre (GSDC) in Gothenburg was interviewed. Marian Delinkov was presented with a draft of the model upon preliminary completion in late December 2009. Marian Delinkov has extensive experience of delivering installation projects to Ericsson's customers and has performed such deliveries for the ENIQ product. Marian Delinkov's input and feedback generated a number of new input parameters. Also, this review, considering Delinkov's professional experience, further strengthened the validity of the model and its logical soundness in modelling the investment.

Interview Execution

How well an interview session is executed influences the reliability and validity of the results that are generated and the extent to which the audience is able to critically evaluate these in the same dimensions, according to Lantz (2007). The following section will relay important information which pertains to how the interviews were executed in this study.

At the beginning of an interview session, the purpose and structure of the interview was clearly communicated to the interviewees, as well as how the interview's results aimed to contribute to the overall research and report – and also pointed out the potential benefits of the

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[11] As a reminder, a NDA agreement was negotiated which restricts the ability to disclose any information that can make it possible to identify the telecom operator in question. This measure was taken in order for the operator to be assured enough to disclose sensitive financial information.

model for the client company to validate their own investment decision. The interviewer also explained the fact that the data collected will be published in the report and that the interviewee(s)'s position(s) in the employing firm will be disclosed. However, since the financial model generated incorporates certain strategically important information, from both Ericsson's and the customer company's perspective, an oral non-disclosure agreement was negotiated. This does not significantly affect the research as such, the significance of the results does not lie in the disclosure of sensitive information – in fact, the reassurance that the customer company will be protected can strengthen the motivation for them to disclose accurate information. Further interview formalities were then run through with the interviewee(s); they were asked permission from to be recorded and they were informed that they would have the right to comment and request alterations should their answers have misunderstood. Since the interview was designed to be open, the areas of interest were highlighted by main questions coupled with more guiding questions should the interviewee require that the issues should be elaborated on. Posing leading questions was avoided so as not to adversely affect the validity of the result, since leading questions involve posing questions in a manner wherein the interviewer's own biased interpretations of the issue at hand are allowed to influence the interviewee.

3.5.5 Document and Present Findings

The following passage is dedicated towards describing the method followed to generate documentation and presentation material on the findings, and figure 8 below is a reminder of where in the Model Building Process the stage is situated.
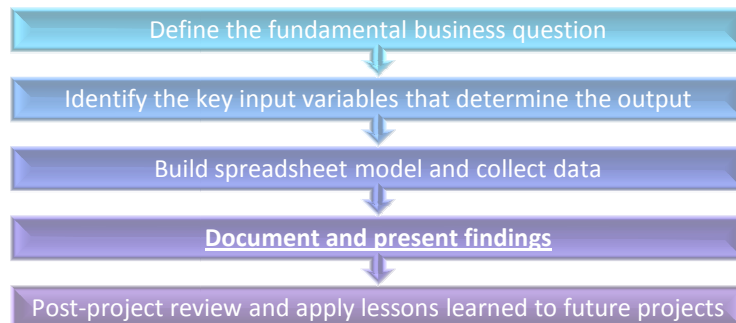
Figure 8 The Model Building Process

The penultimate stage of the model development process involves documenting and presenting the findings: the resulting financial model of the investment in the 2G technology package for ENIQ. The necessary documentation (the user manual and detailed description of the model build up is presented in chapter 6 – Results) was made available organisation wide and announced on the intranet and KnowledgeBase (the internal knowledge database for sharing and creation of knowledge internally within Ericsson). This enables the geographically dispersed users of the business tools across the international market units to access the model and acquire necessary information. The model was also presented to the main project owner: Johan Axelsson in a seminar based presentation

3.5.6 Post-project review and apply lessons learned to future projects

Upon the project's completion at Ericsson, a general review session was held internally within the research group and with the project's supervisor at Chalmers, Joakim Björkdahl. Overall

criticism and feedback was voiced and possible areas for improvement were discussed – both generally on the research process and on the report in specific. The lessons learned and post project review contributed to a small extent also to the concluding remarks and future areas of research in the report.

3.6 Validity and Reliability

Since this report is based on qualitative studies, issues related to validity and reliability might occur (Davidsson och Patel 2003). A disadvantage with recording interviews could be that the interviewee might feel uncomfortable (Trost 1997). However, interviews conducted in the study were recorded in order to minimise the risk of potential validity distortions due to the interviewers' inability to capture all potentially valuable information given and in order to give the interviewers more freedom to interact with the interviewees. All interviews were also documented carefully in written notes to serve as a compliment and insurance should the recording equipment falter. An issue of validity can be whether this study is generalised since just one customer was consulted in the study (Bryman 2004). A more detailed account for this and other potential validity issues pertaining to the model generated can be found in chapter 6 of this report.

4 Valuation Techniques

There is a wide range of measures to be employed for valuing investments or other cash flow generating entities; some of which can be used in many various instances and others which are more specific. In the following chapter, a number of common investment valuation techniques will be presented and discussed together with their respective drawbacks and benefits in order to formulate a theoretical backdrop on which to base the decision of techniques relevant to utilise when valuing the investment in ENIQ. The modelling and valuation considerations specific to the ENIQ tech-pack investment will be discussed in the results chapter of this report order to enable an identification of the valuation methods to be used in the financial spreadsheet model developed in this study.

4.1 Some General Considerations about Valuation

An equivalent to making a sound investment is logically to not pay for more an asset than it is worth. The size of a financial investment should be based on the expected cash flow that the investment asset is supposed to generate and conceptions of this value have to be backed up by reality. There are many different financial valuation techniques developed to relate the value of an investment to the expected growth and size of these investments; some of them will be presented in the subsequent sections. This introductory section intends to shed some light on a number of general reflections on investment valuation

4.1.1 Objectivity Considerations

The concept of valuation is neither a science nor an objective quest for a true value (Damodaran 2002). Valuation models may be ever so quantitative in nature; nevertheless, its inputs will always leave plenty of freedom for subjective elements to bias the final value produced by the model. There are a few approaches to reduce model bias prior to embarking on a new valuation. The first solution is to simply avoid taking any positions on the value of

an investment prior to the completion of the valuation (Damodaran 2002). Refraining from deciding whether the investment is sound or not prior to the valuation itself reduces the risk of making a biased analysis considerably. A second solution is simply to minimise the interest or stake in the valued entity, which is important in order to avoid making a valuation biased by personal interests (Damodaran 2002).

4.1.2 The Role of Time

The value of an investment is contingent on both macroeconomic and firm-specific information, and it is reasonable to assume that the conception of an investment value will change as new information is unveiled. Hence, taking advantage of the benefit of hindsight, it is important to adjust estimates in valuations accordingly as soon as new information affecting the model input is made available (Blackstaff 1998).

4.1.3 Valuation Accuracy

Not even the most meticulous valuation model will produce final numbers without any elements of uncertainty since these are tainted with the set of assumptions made about future development of the company and its operations as well as about the general economy. Hence, it is not realistic to expect unconditional certainty of the final value since it is heavily dependent on estimates of future cash flows and discount rates, and a sufficient margin of error should therefore be allowed for when making valuations. (Damodaran 2002)

4.1.4 The Principle of Parsimony

In many cases of financial modelling, it is mistakenly assumed that bringing in more input factors should make the model more accurate in estimating the true value (Blackstaff 1998). However, as the number of variables in the model increases, the room for potential input errors will increase proportionally. The essential insight needed in this case is that no more inputs than are actually needed should be used to value an investment, which normally is referred to as the *principle of parsimony*. It is important to realise that here exists a trade-off between making the model input more detailed and the cost of error and estimation with providing this level of detail (Damodaran 2002). In addition, it is essential to emphasise that it is not the model itself but the practitioner that makes the valuation. In other words, it is the analyst's task to separate the important inputs from the redundant ones, which is nearly as important as the decision as to which valuation techniques should be used (Damodaran 2002).

4.2 Net Present Value

Net present value (NPV) is a standard approach for assessing long-term projects, where the time value of money is used to gauge performance over a specified period of time. Put simply, NPV can be seen as an indicator of how much value the investment in question adds to the firm; if the NPV is positive, the project will yield a capital inflow, and if the NPV is negative, the project will generate a cash outflow over the specified period of time.

4.2.1 Inputs and Calculation

The NPV (occasionally referred to as *net present worth*) is essentially defined as the aggregated present value of a time series of cash flows less the initial investment cost

(Brealey and Myers 2007). The present value of an investment to occur in t years away can be defined as follows:

$$\text{Present value} = \frac{\text{Future value after t periods}}{(1 + r)^t}$$

where r is the interest rate employed, which normally is referred to as the *discount rate,* while the ratio $1/(1 - r)^t$ generally is termed the *discount factor*. The discount rate being used to compute NPV is indeed a key input in the sense that the NPV value exhibits a rather high degree of sensitivity to a few percentages change of the discount rate used. The discount rate is normally visualised as the rate of return offered by comparable investment alternatives, and is usually known as the opportunity cost of capital – the return given up by investing in the project, for which a common proxy is to use the return of an alternative venture such as a bank deposit. A related concept to use as discount factor is the firm's investment rate, which can be described as the average rate of return for the firm's investments. The reinvestment rate proxy is best suited for analysing projects in capital constrained environments.

Under normal circumstances, it is common to use a firm's weighted average cost of capital (WACC) as discount factor. Some critics, however, argue that the discount factor ought to reflect the higher uncertainty pertaining to forecasting cash flows taking place in increasingly distant periods of time. In order to alleviate this problem, an alternative approach is to use a variable discount rate which is adjusted to increase incrementally over time in order to reflect the yield curve premium that is incurred for longer term debt (Barker 2001). This way of discounting guaranteed cash flows differently as compared to cash flows at risk is a theoretically appealing methodology which however is very seldom applied in practice since it is very difficult to carry out in practice (Barker 2000). For professional investors there is normally a target set up for the returns to be achieved by their investment funds; in these cases it is optimal to set this rate as the discount rate for the project. This method also enables a comparison between the actual profitability of the project and the targeted rate of return (S. Barker 2000). An alternative to reflect risk in the discounting factor is to correct the cash flows for risk directly using the *risk-adjusted NPV* (rNPV, sometimes referred to as *expected NPV* or eNPV), where each cash flow is multiplied by the probability of its occurrence. This is for instance a standard procedure in the drug development industry where success rates are easily accessible.

The selection of the discount rate for a project is to some extent also contingent on the context in which it will be used. For the purpose of determining whether an investment is value adding to a company or not, the use of the firm's weighed average cost of capital is normally recommended. If, on the other hand, the intent of the model is to choose between alternatives with the purpose of maximising the firm value, using the reinvestment rate proxy is normally a better alternative. (Barker 2000)

Since the calculation of present value requires discounting of the future value of a future value, the method of calculating NPV is normally referred to as *discounted cash-flow* (DCF) analysis. To finally obtain the NPV of an investment, all cash inflows and outflows are discounted back to their present values and are subsequently summed up. In essence, the

inputs needed to compute an NPV are all cash inflows and outflows generated by the investment over a period of time as well as the initial investment cost and the discount rate to be used for the investment in question. These cash inflows and outflows are discounted and summarised to determine the present value, from which the initial investment finally is subtracted. The net present value of a project can hence be stated according to:

$$NPV = \text{Present value} - \text{Required investment}$$

Here, an investment is normally deemed as value adding if its return exceeds the opportunity cost of capital which is equivalent to a positive NPV of a project bearing appropriate levels of risk. This may however not be a direct sign that the firm should undertake the project since NPV at cost of capital might not account for opportunity costs; that is, other investment opportunities. Hence, in a choice between two mutually exclusive investments, [12] the one with the higher NPV should be selected (Damodaran 2002).

4.2.2 Common Problems with NPV

There are a few general pitfalls pertaining to the use of NPV in capital budgeting. One common difficulty is when the net cash flow happens to be negative towards the end of the project which incurs debt on the company, implying that a high discount rate as opposed to "normal" investment cases is not conservative but rather too optimistic to the NPV of the project (Barker 2001). This can normally be overcome through including provisions for financing losses explicitly after the initial investment takes place, as a means for incorporating the cost pertaining to such losses. (Ross and Westerfield 2008)

Another pitfall pertains to the above mentioned method of adjusting for risk through adding a risk premium to the discount rate, which loses reasonability due to the previously discussed problem. This approach may seem sensible in many cases, but when cash flows are negative late in a project, resulting from risk increases that have incurred losses, a discount rate increase will reduce the impact of such losses and yield a higher NPV which hence results in an adverse impact on the true financial cost. (Barker 2000)

Yet another issue is that it may be tempting to conclude that NPV-negative projects should be rejected. A more correct stance is to look at the project with respect to its opportunity costs; hence, a project with NPV below zero should not be immediately rejected since firms at some occasions may need to take on NPV-negative projects if refraining from doing so results in more value destruction. (Barker 2001)

4.3 The Payback Period Method

The payback method is one of the most commonly used alternatives to NPV. In essence, the payback period measures the time it will take for a firm to cover the investment in question.

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[12] In financial economics, two mutually exclusive projects A and B are referred to as mutually exclusive if you can accept A or you can accept B or you can reject both of them, but both projects cannot be accepted simultaneously. (Ross and Westerfield 2008)

4.3.1 Inputs and Calculation

The payback period method is fairly straightforward; the size of the initial investment is identified and the subsequent cash flows generated from the investment assets are accumulated incrementally. When the sum of the initial cost and the aggregated cash flows is zero, the payback period is reached. The *payback period rule* resting on this approach for making investment decisions pertains to determining a cut-off date of t years. Accordingly, all investment projects with a payback period of t years or less are accepted and the remaining projects are rejected (Ross and Westerfield 2008).

4.3.2 Common Problems with the Payback Method

There are at least three different problems usually materialising in the use of payback. The first one pertains to the fact that different projects with the same payback period may not be as equally attractive as it appears at first sight. For an investment where the large cash flows occur at an early stage, its NPV should logically be higher. Nevertheless, the project is equally valued in terms of payback as another project where the cash flow comes later in the same payback period. Hence, one drawback with the simplicity of the payback period is that it does not take into consideration the timing of the cash flows. In this sense, this method can be regarded as inferior to NPV since the latter has the advantage of discounting the cash flows. (Brealey and Myers 2007)

Another common pitfall with the payback period is that it disregards cash flows occurring after the payback period. Hence, given the short-term focus of this method, many long-term value adding projects are likely to be rejected. The NPV method does not suffer from this shortcoming given that it takes into consideration all the cash flows pertaining to the project. (Ross and Westerfield 2008)

A third problem common to the use of payback is the arbitrary standard for specifying the payback period. As for the discount rate used in the NPV model, there are a set of standardised approaches to deploy as proxies for the discount rate; whether it be the risk-free rate for a riskless investment or the cost of capital for a firm. However, there is no equivalent guide for choosing the cut-off date in the payback period rule, which makes the choice of rule slightly arbitrary. (Ross and Westerfield 2008)

In summary, the payback period method can be deemed to be conceptually wrong in that it differs from the NPV model (Ross and Westerfield 2008). Nonetheless, due to its ease of use and its characteristic of yielding managerial feedback whether the investment appraisal was accurate immediately after the cut-off period (as opposed to NPV where it may take long before a decision can be evaluated). These features make payback a desirable vehicle for screening the multitude of investment alternatives that managers face continually.

4.4 The Discounted Payback Period Method

As a response to the drawbacks identified in the payback period, some practitioners have turned to using a variant of this approach; the *discounted payback period method.*

4.4.1 Inputs and Calculation

The main difference here is that cash flows are discounted to their present value using a relevant discounting factor, prior to calculating the payback period. As long as the cash flows and the discount rate remain positive, the payback period will never be shorter than the discounted payback period given the reductive effect that discounting has on cash flow.

4.4.2 Common Problems with the Discounted Payback Method

Even though the discounting payback method appears to get rid of a fundamental flaw of the ordinary payback period, it still exhibits some of the main weaknesses of the payback period. The discounted payback period still requires the user to define an arbitrary cut-off value. It also disregards all cash flows occurring post the payback period specified. Further, the adding of complexity as incurred through discounting the cash flows may have removed the attractive feature of simplicity that the original payback had above the NPV method. Hence, although the discounted payback period has a lot in common with NPV, it has been classified as a poor compromise between payback period and NPV by many practitioners (Ross and Westerfield 2008).

4.5 The Average Accounting Return Method

Another popular model for capital budgeting is the average accounting return (AAR) model. Like the payback period method, AAR does not take into consideration the time value of money and the measure is essentially the net income as a percentage of the investment value.

4.5.1 Inputs and Calculation

The AAR is calculated as the average project earnings after depreciation and taxes (that is, the net income of the project) divided by the average book value of the investment over its life cycle. The first step in this computation is to determine the average net income over the life time of the investment, which is done by simply adding up the values for each year and treating these equally notwithstanding in which year they occur. Next step involves to calculate the average investment value (where depreciation is taken into consideration) over the period specified. The AAR can then be calculated according to the following formula:

$$\text{AAR} = \frac{\text{Average net income}}{\text{Average investment}}$$

This measure is then assessed against a preset minimum, target AAR in order to estimate whether the project is desirable or not.

4.5.2 Common Problems with AAR

The most fundamental flaw of ARR is the character of its input; both the net income and the book value of an investment are accounting items and are hence subject to different kinds of arbitrariness. This applies in the sense that some cash flows (such as cost of property) are depreciated, whereas others (such as maintenance) are expensed under current accounting standards. (Ross and Westerfield 2008) The decision whether to expense or depreciate a cash flow involves some extent of judgement and hence both of the model inputs are subject to the uncertainty pertaining to the accountant's judgement.

Another weakness of the model is the fact that it does not take into account the time value of money, which puts it at a disadvantage to NPV that is reduced as positive cash flows are delayed (Caplan 2008). Further, like the payback period, the AAR requires an arbitrary approach in order to determine a reasonable benchmark for the rate of return.

To its defence, the AAR is just like the payback period simple to employ; it is easy to compute and the inputs are readily available from the firm's financial statements. Additionally, shareholders and the overall market generally focus a lot of attention on the profitability of a firm, which may tempt managers to select projects that are profitable over the next few years; a case where AAR comes particularly handy (Ross and Westerfield 2008).

4.6 Return on Investment

Another technique commonly used in capital budgeting is Return on Investment (ROI). This is fundamentally a performance measure employed to assess the efficiency of an investment, and is very popular among practitioners due to its versatility and simplicity.

4.6.1 Inputs and Calculation

In order to calculate ROI, the benefit of an investment is divided by the cost of the investment, which can be expressed as:

$$ROI = \frac{Gain\ from\ investment - Cost\ of\ investment}{Cost\ of\ investment}$$

Normally, the ROI is expressed over a single period, but it can also be calculated as an average over multiple periods. When computing ROI over multiple periods it is important to take into consideration the time value of money. Hence, to obtain the ROI of an investment which generates cash flows over several years, each cash flow has to be discounted before it is divided by the present value of the funds invested in the project.

Another variant to compute ROI is to express it as a logarithm of the gain from the investment over the cost of investment, that is:

$$ROI_{log} = \ln\left(\frac{Gain\ from\ investment}{Cost\ of\ investment}\right)$$

This ratio is normally referred to as the *logarithmic return* or the *continuously compounded return.* The use of a logarithmic scale is mainly for mathematical purposes since it facilitates calculations and manipulations of interest rate formulae (Frykman and Tolleryd 2003).

As mentioned, the ROI can also be expressed in an average form in case the cash flows of the investment occur over multiple periods. ROI in average form is normally expressed as an annual average, and can be expressed in two forms; *geometric average* or *arithmetic average*. The arithmetic average over n periods is stated as follows:

$$\overline{ROI}_{arithmetic} = \frac{1}{n}(ROI_1 + \cdots + ROI_n)$$

whereas the geometric average (also known as the *time-weighted rate of return)* over n periods can be written as:

$$\overline{\text{ROI}}_{\text{geometric}} = \prod_{i=1}^{n} \left[(1 + \text{ROI}_i)^{1/n} \right] - 1$$

The choice between arithmetic and geometric average will essentially be based on the return characteristics of the underlying asset, and it is likely to differ from case to case which of these methods is the best suited. Normally, if returns are uncorrelated over time, conventional wisdom argues that the arithmetic average is the best unbiased estimate of the true return (Damodaran 2002). For some asset classes, for example when it comes to stock price returns, empirical evidence has shown that returns exhibit negative correlation, which implies that the arithmetic return is likely to overstate the size of the return (Damodaran 2002).

4.6.2 Common Problems with ROI

The most noteworthy flaws of the ROI approach are attributable to the freedom with which this measure can be modified to suit the situation. This applies both with respect to what should be included in terms of returns and costs, and as to the multitude of definitions of these measures. Hence, the flexibility has a downside in the sense that it can be manipulated to best suit the purposes of the user. It is therefore essential that the user has a perfect understanding of the inputs and methods used to obtain the ROI in order for the method to be useful in practice.

4.7 Internal Rate of Return

The internal rate of return (IRR) is generally deemed to be the primary alternative to the NPV method (Ross and Westerfield 2008). The essence of the model is that it provides a measure of the performance of a project that is independent of the interest rate of the capital market.

4.7.1 Inputs and Calculation

The IRR approach focuses on investigating whether the return of the project exceeds the opportunity cost of capital. The logic of the method is to determine what discount rate to be utilised in order to make the NPV of a project equal to zero, which is conducted through a trial-and-error procedure. The IRR of the project is then simply the discount rate yielding an NPV equal to zero. To compute the IRR, all that is needed is to know the expected cash flows of the project and the value of the initial investment. The rule governing the decision making around an investment valued using the IRR approach is then to accept the project if the IRR is greater than the discount value, and to reject the project if the IRR is below the discount rate. Expressed algebraically, IRR is the unknown variable in the following equation:

$$0 = -C_0 + \frac{C_1}{1 + \text{IRR}} + \cdots + \frac{C_n}{(1 + \text{IRR})^n}$$

where C_0 is the initial investment and C_n the cash flow occurring in period n. It follows that for discount rates below the IRR, NPV is positive, and conversely; for discount rates above the IRR, NPV is negative. Hence, the rule governing IRR coincides perfectly with the NPV

logic. The methods are not always as perfectly correlated though, as several flaws of IRR tend to materialise in more complex valuation situations.

4.7.2 Common Problems with IRR

The IRR approach has several pitfalls that make the method prone to ambiguity and erroneous values. One of these cases is the consideration whether the project is an *investing* or a *financing* type project. The investing type of project is the norm when it comes to computing the IRR, but normal rules for IRR do not apply for financing type projects. For a financing type project, NPV is positively related to the discount rate, which is the reverse to the standard IRR criterion due to the fact that an investment in the project in these cases are seen as substitute for borrowing rather than for lending as in the normal case. The problem is particularly common in the case where positive cash flows occur before the cash outflows. (Ross and Westerfield 2008)

Another problem with the IRR emerges when multiple rates of return solve the IRR equation. This is common in projects which are subject to so-called flip-flops, where the project's cash flow experiences two changes of sign which is commonly the case for an investment requiring follow-up capital injections. (Brealey and Myers 2007) In such a case the NPV rule can be relied upon since it always provides correct values in the case of multiple changes in the signs of cash flows (Ross and Westerfield 2008). Another way to alleviate this problem is to employ the *modified IRR* (MIRR) approach, where multiple IRR are handled by combining cash flows until only one change of sign remains (Ross and Westerfield 2008).

A third problem common to the IRR approach is a case specific to mutually exclusive projects; that is, where a firm has two projects to choose between and it can only undertake one of them. One of the projects has a higher IRR than the other, but the other project exhibits a higher NPV. Hence, the IRR method is prone to mistakenly favour a project with a higher percentage return but yet a lower NPV. It should be noted that a high IRR is not itself a goal; the ultimate objective for all firms is rather to enhance the firm value. This target is achieved by choosing investments that generate good returns for a sustained period. These projects normally yield higher NPVs than projects which earn high percentage returns but only last for a short period of time (Brealey and Myers 2007).

4.8 Cash Flow Return on Investment

The cash flow return on investment (CFROI) was originally designed by the Boston Consulting Group and is most commonly used to express a company's future or current ability to generate free cash flow; it can however also be applied to value an investment.

4.8.1 Inputs and Calculation

The CFROI can be envisaged as a weighted average IRR on investments and should ideally be compared to the cost of capital or against the real industry rate of return in order to assess the quality of these investments (Frykman and Tolleryd 2003). The calculation of CFROI is performed using four inputs. One is gross investment (obtained by adding back depreciation and inflation adjustments to the book value of the asset valued), and the second is the gross cash flow earned on that asset in the current year. The third variable is the expected earning

life of the investment as estimated at the time of the original investment and the final input is the expected salvage value of the investment asset at the end of its life; that is, the portion of the asset that is not subject to depreciation (Damodaran 2002). The CFROI of an investment is basically the IRR of these cash flows and can be expressed as follows:

$$\text{CFROI} = \frac{\text{Gross cash flow} - \text{Economic depreciation}}{\text{Gross investment}}$$

Conceptually, CRFROI is similar to ROI in the sense that they are both measures of an investment's rate of return over a single period. In effect, CFROI can essentially be pictured as a cash-based return on investment given that it represents the cash flow (which can be conceptualised as annual returns) divided by the invested capital (Barker 2001). With respect to the limitations of accounting information, neither the ROE nor the CFROI can however e regarded as reliable methods for estimating IRR (Damodaran 2002).

4.8.2 Common Problems with CFROI
One of the disadvantages of the CFROI is that the calculation of this measure tends to be rather complicated in practice. Further, although the model can be tailored to allow for variable future cash flows, it is still fraught with the difficulty of making accurate forecasts (Barker 2001).

4.9 Real Options Valuation
The real options approach to valuation is a relatively recent addition to accepted valuation methodologies but has nevertheless become a popular alternative to traditional NPV valuation. It is essentially based on application of the theory of financial option pricing to real investment decisions and it differs from other valuation techniques in that it takes into consideration the value of having an opportunity to take advantage of an uncertain future outcome.

4.9.1 Inputs and Calculation
As opposed to standard techniques such as NPV, the real options approach incorporates the uncertainty that characterises the future development of the inputs determining the value of a project where other valuation techniques focus on the most likely outcomes, in addition to taking into account the flexibility of management to react to the development of these inputs. The primary parameters used to value the project in the real options approach are the starting value of the project and its uncertainty which is normally modelled by the volatility of the project NPV (Barker 2001). The ability of management to react to changes in value is normally modelled as four different options. These are the *option to expand, the option to abandon, the timing option* and *flexible production facilities*.

In the first of these cases, the *option to expand*, it is assumed that an NPV analysis fails to identify a hidden source of value. If the average forecast produces a negative NPV, the option to expand may reverse the case since a manager may be willing to expand the investment in case the optimistic case turns out to be correct.

The second case, the *option to abandon*, rests on the opportunity of a manger to abandon an existing project. Here, a negative NPV project may turn positive due to an analogy similar to the one governing the option to expand. This way, the NPV of the project is considerably changed since the conservative cash flow as predicted in the pessimistic case will not be allowed to continue into perpetuity but will be abandoned midstream as the cost overruns become apparent.

The third option case is termed the *timing option,* and concerns the trade-off between value loss caused by delayed cash flows and the ability to pick up valuable information as time goes by. The approach applies for cases where an owner of a project may not want to invest in the prevailing market conditions but may want to invest in the future should the drivers of inputs on which the project NPV is contingent change.

A fourth real option case is the *flexible product facility option,* which essentially serves as an option to switch between two production or service facilities. The option to switch applies in the case where manufacturing has built-in flexibility to vary its output mix to match fluctuations in demand.

4.9.2 Common Problems with Real Options Valuation

The main flaws of the real options analysis arises due to the dissimilarities between real options and financial options for which the options approach was originally developed. One main contrast between these two types of option is that the underlying asset of the real option is not tradable, which results in difficulties to determine the spot price and the volatility of the underlying asset which are key to determine the option price. Further, the uncertainty as to managers' future actions adds more complexity to the valuation (Campbell 1999).

As mentioned one drawback of real options valuation is that the real option itself is not tradable. In addition, some real options are proprietary (exclusive to one firm) whereas others are shared (exercisable by many parties). Accordingly, a project may have a set of embedded real options that are mutually exclusive which complicates matters considerably when it comes to work out a reasonable real options based decision (Barker 2001).

Besides the underlying complexity pertaining to computing option values, the real option approach puts high requirements on data accessibility. Cases characterised with a high degree of uncertainty involve probabilities that must be obtained from historical data, which may not always be equivalent to future probabilities. The inherently uncertain future development of a project as determined by demand and other external factors is one of the reasons why real options become very difficult to value (Barker 2001).

5 Empirical Study

The following passages will present information from interview sessions with Strategic Product Manager Jesper Hök and the client operator (constituting the case study) as well as the information collected in the consultation with Solution Architect Marian Delinkov on model validity.

The first two interviews, with Jesper Hök and the PM user and System Administrator from the studied operator, had one common aim: to refine the input parameters pertaining to quantifiable measures of operational activities that would be affected upon a migration from NWS to ENIQ. The identification and refinement of these parameters was paramount in order to avoid redundancy of input parameters and also to assure their feasibility and relevancy with respect to reality. The first refinement with Jesper Hök cut suggested parameters from 40 till 20 and the representatives from the operator further refined these twenty to a total of 9 that were to be included in the model. The parameters will be presented in greater detail in the ensuing sections. The case study interview with the operator representatives also aimed to collect customer specific input on these parameters to provide the thesis with a referential case on which the workings of the model could be based upon. The results of the case study figures are given in the results section of the report, where the value of the investment is presented for the specific operator studied.

The last interview with Marian Delinkov, Solution Architect at the GSDC in Gothenburg, served to validate the model's technical and logical feasibility. Marian Delinkov aimed to bring forward any aspect which had not been taken into account by the model. One aspect pertaining to investments in hardware was identified as having the potential to generate a cost capital expenditure saving for the operator should it choose to invest in ENIQ, and thus duly incorporated into the model. The interviews in their entirety are accounted for in fuller detail below.

5.1 Interview with Jesper Hök

The first interview session held was with Strategic Product Manager for ENIQ, Jesper Hök. The interview followed the interview guide that is shown in Appendix C. The interview aimed to contribute towards the refinement of the parameters to be used in the financial model by deepening the understanding of the phenomenon of migrating from NWS to ENIQ, and how an ENIQ investment influences operators' operational expenditure from Hök's expert perspective, to represent Ericsson's position.

The interview thus generated perspectives on performance management in general and more importantly, how the two systems (NWS and ENIQ) influence operators' day-to-day activities when working with them. The most important result of this interview was a refinement of parameters Hök was presented with. This list of parameters was generated by the authors and consisted of parameters that were identified to have the potential to change from a migration from NWS to ENIQ. Together with Jesper Hök, a multitude of parameters were dismissed as worth considering, while 20 were identified as potentially being able to be more efficiently executed by operators with ENIQ. These are presented below. The ensuing passages are dedicated towards relaying the information conveyed during the interview concerning the PM system ENIQ.

System Administrator Activities	PM user Activities
Backup storage activities	Monitoring & planning capacity
Cause of problem diagnosis	Troubleshooting
Troubleshooting	Optimising network activities

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Deciding and implementing corrective action	Network planning
Reporting on exceptions and outages	Network resource optimisation & balancing
Sharing info and control at shift changes	Time spent on analysis
Communicating across 2G/3G/CN departments	Time to access latest data
Index building and tuning	Time spent on validating network features
Time spent on adapting raw data to PM users' own requirements	Time spent on validating quality
	Time spent on waiting for Sys admin to adapt raw data to PM users' own requirements
	Interpreting KPIs across different domains (synergy effects)
	Waiting for statistical report generation
	Handling of business intelligence queries
	Busy hour handling
	Configuration of nodes (adding new nodes to NW)
	Cause of problem diagnosis
	Monitoring & planning capacity

Table 3 input parameters, as identified together with Jesper Hök

Hök (2009) contextualised the area of PM, by providing relevant historical aspects concerning the evolution of telecom and the industry's convergence with IT. A decade ago, networks were relatively simple to manage; the mobile networks were predominantly used by business users and the variety of mobile devices was relatively limited. Demands on today's networks have increased dramatically – with a multitude of new customers that require heightened availability both geographically and in terms of new services. Operators must take heed to the customer to a larger extent when introducing new services, placing heightened demands on them as service providers to understand what the customer wants.

A PM system will allow the operator to receive feedback on investment in the procurement of new services and monitor customer uptake and how they use services provided. It can therefore be viewed as a feedback tool on the operators' investments. ENIQ provides a basic and fundamentally necessary function in network management – reflecting the Ericsson viewpoint that PM is a necessity and not an area to be compromised with.

The next aspect that surfaced pertained to the operator's own operational efficiencies and created an understanding of the fundamental cost drivers in operators' day-to-day activities. The comparative study of how operational expenditures for operators previously running the NWS solution changed upon the investment in the 2G ENIQ technology package will provide valuable insights to how ENIQ aids in improving operational efficiency, according to Hök (2009).

Telecom operators' operational expenditures are typically built on the set of costs related to transmission, floor space rental (from real estate owners for the aerial antennae), power, Operations and Maintenance staff costs and Spares, Support and Rental from third party providers. Operators typically own base stations and network equipment and rent the transmission links from other firms. The issue then is how a PM system can contribute to reducing these operational expenditures according to Hök (2009). The ENIQ solution

primarily and most obviously affects how efficiently the O&M staff works. Even though the system can probably and more indirectly also be traced to increased revenue streams because of its capacity to proactively manage the networks and heighten network performance and subsequent customer satisfaction and retention, this link, according to Hök (2009), is impossible to establish concretely in practice.

Turning to the activities that O&M staff perform, they typically manage the networks 24 hours a day, seven days a week. Fault management monitoring staff monitor, define and solve alarms constantly. Alarm definition is a central activity and this is due to the fact that alarms are generated only once they are defined, that is to say, that the problem has had to have happened before the fact in order for it to generate an alarm in the system. If the problem has never been encountered before, it cannot generate an alarm. Many of these new problems cannot be identified unless rigorous statistical analysis is performed continuously, highlighting the importance of the PM function. The more efficiently that statistics can be handled and alarms proactively defined once risk areas are identified, the more operational efficiency is enhanced since fewer costs are incurred downstream in the organisation driven by having to send trouble tickets across departments.

The query process and report generation for PM data which end users access continually throughout the day is also sped up with ENIQ according to Hök (2009), since it requires less computer processing capacity and provides the user with a unified overview which removes the requirement for the end user to define and co-ordinate PM data and KPI, which was the case with NWS.

The reduced complexity involved in configuring and maintaining the ENIQ system for the client operator organisation directly also translates into reduced operational expenses. System administrator activity can generally be directly correlated to the cost of maintaining a PM system (Hök 2009). For NWS, an external IT system had to be put in place in order to actually manage the PM system– increasing complexity for the system administrator having to manage a multitude of different systems. The external system then monitors whether or not data is flowing into the NWS as it should. In contrast, the ENIQ solution not only monitors the network performance, but also provides information on its own performance. This is a daily monitoring activity that the system administrator engages in. Previously, the system administrator had to "hack" into the NWS system with open SQL, but now this information can be accessed easily through the AdminUI. Likewise, the system administrator would not have to delete old data in the ENIQ manually with scripts since the ENIQ solution has an automatic deletion function, saving the administrator time and releasing activity for more value adding activity.

To summarise, therefore, Jesper Hök contributed to the project by providing an understanding of what drives operator's operational expenses and how ENIQ, by releasing time for system administrators and PM users that can be used for value adding activity, can contribute in reducing these expenses. These related to improvement in fault management techniques, troubleshooting, problem and alarm identification, as well as improvements in system maintenance activity.

5.2 Case Study Interview with Telecom Operator

The passage begins by providing a brief introduction to the telecom operator and the interviewees within its organisation before turning to a presentation of the empirical material.

The studied organisation is a telecom operator with a lean and efficient organisational approach employing approximately 1,000 people. The operator values its strong focus on technology and competence with around 50 percent of the organisation being technically dedicated. Its differentiating value proposition lies in its efforts to maintain high quality customer service with short response times. It also uses aggressive marketing techniques which, coupled with successful, high quality services has allowed the operator in question to expand and take market shares where only two main competitors otherwise are in operation. The operator expresses that its technology strategy has basically been to focus on commercial tools and systems with proven performance and guaranteed support, and has opted to manage its networks exclusively with Ericsson equipment and associated systems.

As a reminder as to who was interviewed, the interviewed operator representatives were one PM system user and the system administrator that have intimate knowledge and experience relating to the migration in 2007 from NWS to ENIQ on their 2G network. The interview began by asking for view on a general level concerning PM and PM systems, and then funnelled down into more detailed questions on PM user and system administrator activities and how these have changed when working with ENIQ as compared to how it was with NWS. The full interview guide can be accessed in Appendix C.

The telecom operator enforces that they are faced with managing increasingly complex and indeed dynamic network environments. For example, monitoring performance on a 3G network generates 5-10 times as many statistics as compared to those generated in 2G GSM networks. At the same time, the operators' service level management is facing increased pressures to be able to monitor provided services from end-to-end to a greater extent. It is no longer acceptable to, as a service provider, simply deliver the service – it is becoming more and more important to also be aware and optimise that delivery. The complexity of the network environment is also generally rising, due to the fact that their network environments contain a vast array of network elements – provided by a multitude of different vendors. Their decision to focus on becoming "all Ericsson", i.e. having only Ericsson as their main vendor, was driven by the need to reduce complexity as much as possible. All of the mentioned realities present in the telecom operators' world create demands for more holistic, end-to-end performance management.

The operator expresses its general view on performance management as vital for its survival. PM systems are stated to be invaluable and central to operations. For example, it would, from the perspective of network planning and management, make any network expansion impossible should they not have a PM system in place (a technically oriented benefit). The PM system also delivers valuable information to the technical department management on the technical unit's performance and effectiveness (a more business-oriented benefit). Thus, the value of a PM system is two-fold – it is looked upon as an opportunity to meet both operational and business challenges. The operator expresses the view that the main selling

point of ENIQ, from its perspective, is not necessarily only its capacity to reduce operational expenses. Instead, it is the aforementioned opportunities that it enables the operator to take advantage of that makes it valuable.

The operator representatives elaborate further on these two topics, revealing examples where operational challenges have been overcome and operational cost efficiency has been increased as a direct result of network performance management efforts. Here, the PM user explicitly states that the operator's requirement is to make work more efficient in every aspect. The PM system is relied on to generate reports on network infrastructure effectiveness accurately and to troubleshoot problems as efficiently as possible. The PM system allows for the identification of network problems – and therefore also allows for the operator to find solutions to them, and although this is a reactive approach, it is inevitable and necessary in day-to-day operations.

One business challenge the operator faces is unifying the cost reduction efforts (continual efforts to maintain their lean approach) while increasing performance and strengthening their competitiveness. The experience of the ENIQ solution has been that it releases time for both handling of the system itself and for overall network management activities. The PM system can therefore also be seen as a driver for effectively managing the IT talent and competence within the organisation to maximise benefit to the firm (by performing more value adding activity). However, the operator stressed the point that although ENIQ implementation has released time, it is difficult to pinpoint exactly how much time it has released since there are many complexities and variables that also could have contributed to the change.

Turning to system administrator specific experiences, the main areas of interest during the discussion pertained to database configuration, aggregation, raw data handling & deletion and managing upgrade activity.

The system administrator relays that the NWS solution required little configuration as storage and aggregation times had already been rigorously pre-defined by Ericsson. Working with NWS was rather focused on specifying what data contents to store. In ENIQ, however, the configuration rules are experienced much freer since they allow for more complex equations when defining and handling busy hours for example. Two weaknesses with ENIQ were put forward in conjunction with this topic. The busy hour handling was showcased in a sliding window in the NWS and time and object level aggregation was performed – yet with ENIQ, only a fixed window is used and only time level aggregation is used. This limitation in functionality is a relative weakness and adds elements of frustration to day-to-day activities.

As for data retention periods in ENIQ compared to NWS, they are dramatically increased. The operator is now able to store data for three months in contrast to just 30 hours with ENIQ. This has opened up for the possibility to compare daily, raw data collected from years back with ENIQ, since aggregation is no longer performed. The system administrator conveys that storage time and speed are remarkably improved with ENIQ and that the problems associated with NWS taking CPU capacity from the underlying OSS-RC have been completely eliminated with the ENIQ solution which operates on its own server.

Data deletion was never an activity that the interviewed operator dedicated time towards in either ENIQ or NWS. However, the system administrator is aware of the increased efficiency of the deletion mechanism in ENIQ relative to NWS. Upgrades on the other hand, commanded massive amounts of time with NWS due to the problems incurred as a direct result of the upgrades, whether planned or emergency related. Data was lost and could not be retrieved, so information was lost which has significant impact on the monthly figures used in all parts of network management. Although ENIQ also requires time for upgrades, as does any system, lost data can automatically be retrieved. The system administrator stresses the importance of this functionality and labels the ENIQ upgrade handling process as one of its strongest selling points.

The last part of the interview session resulted in PM user experiences of working with ENIQ relative to NWS. They revolved around the user interface, the system's ability to intelligently monitor KPI's and deliver reports. The reporting environment and the user interface was deemed outstanding, with an ease and simplicity that facilitates more efficient daily monitoring and releases time for network planning activities. One issue that surfaced immediately was the ENIQ system's incapacity to handle prompts, which essentially enables filtering of data according to for example time resolution. Instead of prompting the system for specific reports, day level reports are generated automatically and all dimensions are reported on. This means that it takes time to switch between reports and run through them all in order to locate the requested ones.

Additionally, the issue of speed of report generation was brought up. Even though the Sybase IQ database is known by end users to be faster, it does not translate into faster report generation from the user experience perspective. Time is spent on waiting for reports – and in fact, more time is spent on this with ENIQ than with NWS. This is due to the data warehousing function with data retention masses so large that it takes minutes to retrieve data. Report generation was faster with NWS due to the object level aggregation it performed. The PM user also highlighted the fact that although ENIQ, with all its features and functionality, might be superior to NWS; the problem at Ericsson is truly understanding that network management relies on the quality of data that is fed into the system by the underlying OSS. ENIQ can only be as good as its source data is the general message, and that source data can vary in quality. All the faults in the OSS are reflected into the ENIQ solution. The operator has had to rely on an external solution that configures network elements and ensures that activated counters from which data is to be collected really relay information to the OSS.

The interview ended in a discussion wherein the suggested input parameters of the model (see table 4 below) that were generated in the interview with Strategic Product Manager for ENIQ, Jesper Hök, were debated on.

System Administrator Activities	PM user Activities
Backup storage activities	Monitoring & planning capacity
Cause of problem diagnosis	Troubleshooting
Troubleshooting	Optimising network activities
Deciding and implementing corrective action	Network planning
Reporting on exceptions and outages	Network resource optimisation & balancing

Sharing info and control at shift changes	Time spent on analysis
Communicating across 2G/3G/CN departments	Time to access latest data
Index building and tuning	Time spent on validating network features
Time spent on adapting raw data to PM users' own requirements	Time spent on validating quality
	Time spent on waiting for Sys admin to adapt raw data to PM users' own requirements
	Interpreting KPIs across different domains (synergy effects)
	Waiting for statistical report generation
	Handling of business intelligence queries
	Busy hour handling
	Configuration of nodes (adding new nodes to NW)
	Cause of problem diagnosis
	Monitoring & planning capacity

Table 4 Suggested input parameters

The operator was asked to assess their relevancy for performance management activities based much upon the previous part of the discussion. A number of parameters were eliminated due to redundancy and because they represented a level of detail that was not quantifiable. Only the time spent on main activities that the system administrator and PM user performed were left for consideration for valuation. The input parameters generated from the empirical study are visualised in table 5 below and constitute the main empirical material collected for input into the model.

System Administrator Activities	PM user Activities
Cause of Problem Diagnosis	Monitoring & planning capacity
Troubleshooting	Troubleshooting
Deciding and Implementing Corrective Action	Network planning
Communicating across 2G/3G/CN departments	Waiting for statistical report generation

Table 5 Main activities identified

5.3 Consultation with Marian Delinkov

The third and last empirical element of the study pertained to receiving feedback on a draft of the model with GSDC employee Marian Delinkov. The session aimed to validate the logic of the model and identify key weaknesses or fundamental parameters that might have been omitted in the model building process.

The fundamental input that the session generated, and which was subsequently integrated into the model logic, pertained to the relationship between an implementation of ENIQ on the underlying OSS from which it collects data. The architectural build-up of the NWS is such that it is embedded in the OSS-RC, while ENIQ is a stand-alone system that runs on its own server. As Delinkov pointed out, an investment in the ENIQ system effectively releases capacity of the OSS-RC to handle data flowing in from 15,000 cells that the NWS would otherwise have taken up. This means that if the operator had planned an expansion of less than 15,000 cells in time proximity to an investment in ENIQ, the operator is not required to make an investment in a complementary OSS-RC system – which is a considerable saving that should be modelled (Delinkov 2009). This was duly incorporated in the model. The

overall Delinkov contribution served to validate the logical soundness of the model and its practical feasibility.

6 Result: the ENIQ Valuation Model

In the following chapter, a concise description is given of the model generated to assess the value of the ENIQ investment for Ericsson's customers. The rationale behind the model's structure and its specific features is a synthesis of the theoretical and empirical considerations that have been presented in the preceding chapters. This chapter goes through the structure of the model and how it is to be used as well as discusses its qualities and limitations. It also provides an identification and motivation of the most suitable valuation methods to be used. In the subsequent discussion, an account will be given of a number of intangible benefits that have been identified but not included in the model.

The model can be visualised below in figure 9. The model essentially takes capital and operational expenditure savings into consideration incurred when moving from the NWS to ENIQ and rests on a set of assumptions that will be presented more thoroughly below. The operational expenditure savings incurred stem from increased operational efficiency due to more efficient execution of 8 central activities identified through the empirical study (please refer to table 5 on the preceding page for an explicit account of these variables). These cost savings generated annually are discounted for over the economic lifetime of the ENIQ product and result in ROI, NPV and Payback values for the investment at hand. Now, the section will turn towards more fully presenting the results and the logic behind the model.
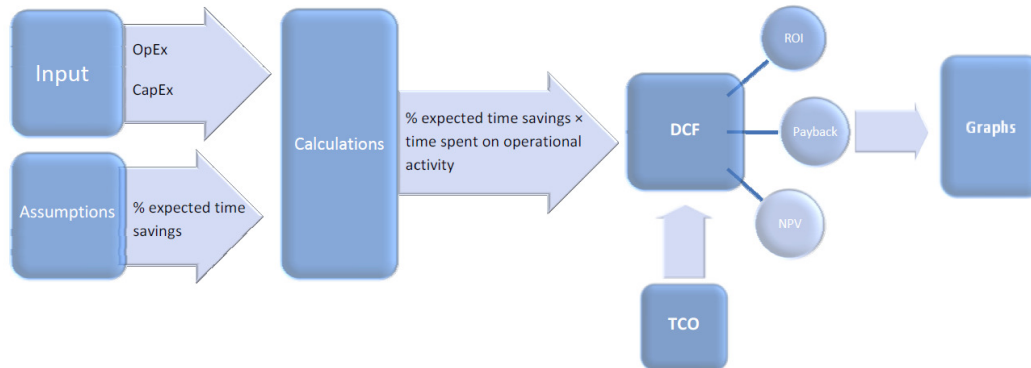
Figure 9 The model visualised

6.1 The Purpose of the Model

In the section below, a description will be provided of the purpose of modelling the ENIQ investment and what value it presents to Ericsson, along with the specific requirements which are put on the design and content of the model in order for these goals to be fulfilled. These very features and requirements will subsequently be used to form the framework on which the ENIQ model is built.

6.1.1 The Valuation Model as a Marketing Tool

As put forward in the objective of this report, the ultimate goal for the ENIQ valuation model to fulfil is to provide Ericsson with a powerful tool when motivating customers to undergo the forced migration to ENIQ. The ability to prove the economic benefit of the new PM system

through quantifying the savings that ENIQ creates for the customer will in turn enable Ericsson to determine the license fee to be paid by the client since it becomes easier to motivate each dollar charged if it can be supported by pecuniary factors. This is particularly important given the state as discussed, where Ericsson has been coerced to give the product away for a symbolic price due to its inability to prove its economic value to the customer. Accordingly, the ENIQ valuation model will serve as a marketing tool to be used for Ericsson; not only will it help winning the confidence with sceptical customers that normally would not be persuaded by the qualitative values of ENIQ alone, but it will also (provided that it proves a sizeably positive economic value) allow for Ericsson to charge a higher price from its customers.

6.1.2 Model Genericity

The second important feature of the valuation model is for it to have generic qualities in order to enable Ericsson to adjust the model to be used for other products than ENIQ. A generic financial model applicable to products specific to OSS is sought for by management in order to enable a pricing system based on real economic benefit rather than historical prices and intuition as is currently the state. Hence, an important element of the model is to make it as standardised as possible in order to enable for flexibility for the model to be used with other products after some extent of modification to the existing model.

6.1.3 Model Requirements

To fulfil the requirement on the model to be generic in nature, a strict conformity to the principle of parsimony ought to be followed; that is keeping the level of detail as low as possible. Here, this will not only be for reasons of avoiding occurrence of redundancy but also in order to make the model as simple to replicate as possible for other types of investments.

Another important quality of the model is ease of use. Since the model should be applicable for employees at Ericsson's local market units, its user-friendliness in terms of the ease with which the inputs for a specific customer can be inserted and the ease of interpreting and understanding the model's output is fundamental to its value as a business tool. Also, in order to allow for the opportunity of the model to be adjusted for applications with other products, it is important that the model comes along with a specification of how to modify the model. While it is not necessary for the user to have a complete grasp of the entire model's workings, it is essential that the user knows how to perform the adjustment of the model without distorting its mechanism. The user-friendliness becomes yet another reason to keep the number of inputs low in order to reduce the level of complexity and thereby enhance the user's ease in understanding the model.

6.2 Choice of Valuation Techniques

As the main objective of this model development is to generate a value for the ENIQ tech-pack investment, the valuation technique used is at the centre of the process. A number of aspects have to be taken into consideration when selecting methods for the modelling process; a goal for the technique to fulfil is computational simplicity; the inputs required should be compatible with the inputs available and at the same time the values obtained should be sufficiently familiar for Ericsson and its customers to interpret. As presented in the theoretical

framework in chapter 4, there exists a multitude of financial valuation techniques to be used when valuing an investment.

The requirements specific to the study and the fact that the user has a non-financial background, makes the ease of interpretation a main argument in the selection process for financial models to be used in this study. Set against the backdrop of the character of the cash flows incurred, and while also taking into consideration the user requirements, the models selected to model the ENIQ investment are NPV, ROI and the payback period method.

NPV was selected as a method partly based on its prominence for applications in many areas; the NPV method is arguably among the most frequently used and accepted methods and is widely recognised in most business contexts. Thus, the requirement of the model to be easy for the user to interpret is readily fulfilled, at the same time as the computation of NPV is fairly straightforward and easy to implement. Further, the weak points of the NPV model such as its flaws in computing values for negative cash flow cases or NPV-negative investments were not applicable to the specific case of ENIQ. Nor is it applicable to the general type of product offerings provided by Ericsson OSS.

The payback period is another method chosen widely based on its popularity and broad recognition as an all-encompassing valuation tool. In particular, this is a methodology commonly used by Ericsson which makes it particularly valuable in this case. The main flaws of the payback period were no major concerns, since neither the issues pertaining to the timing of cash flows, nor cash flows occurring after the payback apply for the ENIQ investment.

The ROI method is yet another well-known technique for investment valuation and is attractive in this case since it relates the money invested to the proceeds from the ENIQ investment. The ROI used in this case is calculated as the present value of the total investment (that is, NPV) over the present value of the investment made (total cost of ownership). Importantly, the common pitfalls with this method were not applicable since the ENIQ investment does not involve the case of mutually exclusive projects. Further, ROI is also benefited from its ease of use and applicability for Ericsson and its customers as it is a broadly applied measure which will bring about little difficulties of interpretation.

Another technique that might have been relevant to include in the model is the IRR; it is an appealing method in the sense that it measures the rate of return generated annually. Nevertheless, the method has been criticised broadly for exhibiting many flaws that makes it inferior to NPV (which in many senses can be seen as a close substitute) in most respects. Additionally, from Ericsson's and its customers' perspective, the notion of an NPV can be argued to be easier to conceptualise which advocates NPV to IRR, since it yields an absolute rather than relative value of the investment.

Further, a common practice of valuing telecom and IT investment is to make use of an options based approach to valuation. However, the ENIQ investment as such cannot easily be modelled as a set of different outcomes, and even though this had been the case, the respective probabilities of these outcomes would have been difficult to determine. Coupled

with the relatively technical approach that the options based approach entails, the case tells against the use of this valuation technique in the ENIQ case.

Given that the intent of the model is to motivate a switch from NWS to ENIQ, it is rational to assume an "incremental" approach to valuation. Thus, no costs other than the ones that differ between ENIQ and NWS will be implemented in the model, and each cost and benefit considered in the model should thus be seen as a "difference" with ENIQ in comparison to NWS.

6.3 Delimitations of the Model

A financial case is supposed to aid in decision making and it is not in itself a decision maker. The financial model for ENIQ should be seen as a part of a larger business case; that is, the model is not intended to cover all benefits but rather indicate the size of these values of the ENIQ investment that are possible to quantify with reasonable accuracy. Since many of the benefits of ENIQ are intangible in nature, and since many of these soft benefits are difficult to harden, the model will not capture the full value of the investment to the customer. Hence, everything else equal, it can be assumed that the customer is likely to exhibit more benefits than these quantified in the financial model presented in this study since the model incorporates all costs of ownership. For the model to be presented in the following section, main focus has been on how the functionalities of ENIQ translate into efficiency improvements as reductions in non-value adding activities among each of the two categories of ENIQ using employees. Hence, only cost savings have been included in the model, whereas potential revenue increases (due to their highly uncertain and complex nature) are confined to being discussed in the subsequent chapter.

6.4 The ENIQ Valuation Model

In the following section, the ENIQ valuation model will be presented in its entirety; first, a detailed account will be given for the process followed to select the relevant inputs of the model, followed by a description of how these variables have been defined to interact in order to generate the output of the model: the customer value of the ENIQ tech-pack investment.

6.4.1 Model Input Definition

Drawing on the information obtained from the empirical study on an existing customer having already invested in the ENIQ tech-pack, the set of inputs identified with support from the strategic product manager Jesper Hök were revised prior to modelling (refer to Appendix B for these variables). Not all of the variables identified where subject to change upon migration from ENIQ to NWS, and some of these could accordingly be eliminated in order to avoid input redundancy (the variables which were kept in the final model are also underscored in Appendix B). The final result after revision from the customer was a set of four non-value adding activities each for the PM user and the system administrator, comprising of eight variables in total. The activities are presented below in table 6. The activities were expressed as the percentage of time spent of an employee per day spent on each activity, and were obtained both post and prior to the implementation of ENIQ in order to enable a percentage change of time spent to be plugged into the model.

System Administrator Activities	PM user Activities
Cause of Problem Diagnosis	Monitoring & planning capacity
Troubleshooting	Troubleshooting
Deciding and Implementing Corrective Action	Network planning
Communicating across 2G/3G/CN departments	Waiting for statistical report generation

Table 6 Main activities identified

After a revision and discussion of the draft model with GSDC employee Marian Delinkov, additional aspects pertaining to the ENIQ investment could be identified. Delinkov brought up the case for customers facing capacity constraints. Given that one OSS-RC has capacity to handle no more than 15,000 cells, a planned expansion of the net in the near future would entail the need for purchasing one new OSS-RC for each set of 15,000 cells in excess of current capacity if NWS were retained. For a customer migrating to ENIQ, this problem does however not occur since ENIQ has the capacity to handle the double amount of cells and since the customer at the purchase of ENIQ will dimension the number of tech-packs used so as to cover up for capacity expansion needs occurring over the expected lifetime of ENIQ. Accordingly, the cost of installing a set of OSS-RC due to capacity constraints is implemented in the ENIQ valuation model as a possible opportunity cost of installing ENIQ.

6.4.2 Assumptions

One basic assumption that was made at this point was that the revenue streams generated before and after the investment in the technology package were unchanged. The reasoning for this decision is presented below. Making assumptions and approximating the value of how much a performance management system (which, with gross simplification, essentially just monitors performance) directly influences revenue was dismissed as an option. The grounds for that decision lie in the fact that it is unfeasible in practice to investigate, with any certainty, the link between the use of PM systems and revenue – and equally unfeasible to argue, with any certainty, that the value of the PM system lies in its capacity to directly drive increases in revenue. The practical, organisational complexity involved in firstly establishing that link is almost insurmountable; furthermore, fixing a percentage to any variation in the revenue (that might have been caused by a change in the PM system) would in any case be so unsystematic in its determination that it would be of no value. The principle of garbage-in garbage-out naturally plagues all modelling efforts, yet efforts where it is so blatantly apparent that the variable is not able to be approximated with any, however small, amount of certainty does not lend itself to further consideration. Therefore, efforts to establish possible linkages between improved organisational performance and subsequent increases in revenue was abandoned as an option worth investigating – and any potential or realised changes in revenue due to an investment in ENIQ 2G was therefore also dismissed as an input variable.

The cost savings, on the other hand, lends itself more suitably towards investigation. There are two basic logical factors influencing the value of the investment in terms of how it influences the operator's profit; namely how a migration from NWS to ENIQ 2G affects the cost driving elements or the revenue generating parts of profit[13] for the telecommunications operator. Since, following the previous line of reasoning, revenues are assumed constant over

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[13] Net profit margin is defined as the difference between total revenues and total costs, after tax.

the investment period[14] – the factor that is of interest to study is the operator's costs, with a main focus on its operating costs - although its capital expenditure indeed also does change (and will be accounted for). The operational costs are those which then cover the non-revenue parts of the profit and loss account (Friend and Tennant, 2001). Investing in the performance management system ENIQ is assumed to release time for both system administrators and users because of its improved functionality and enhanced features. A reduction of time spent on non-value adding activities is viewed to enable time to be spent on activity that instead does generate value directly. The focus for the financial model developed was then to generate input parameters that aptly reflected categories of operating costs that changed when using ENIQ as compared to NWS. The full set of costs that contribute to the cost base that an operator has is not important to develop in any further detail in light of this. Elaborating further, this essentially means that the model aims to compare how the operator's operating expenditure changed when a migration from NWS to ENIQ was performed, considering only the costs that effectively do change.

Given that the model should incorporate the improvement in terms of benefits from installing the ENIQ-tech pack, it will be assumed that the annual maintenance costs such as annual cost for upgrades for the two systems (ENIQ and NWS) are equal. Since Ericsson OSS is the unit in charge of deciding on this cost, it has been possible to verify that this one assumption is a justifiable one since the annual maintenance cost (although it may fluctuate due to customer specific qualities and unexpected events) is very likely to be kept at the same level after migrating to ENIQ.

As discussed in connection with general modelling considerations, the impact of time may in certain respects affect model assumptions over time due to market changes or customer specific events occurring over the course of the investment lifetime. For practical reasons and given the difficulty in identifying and quantifying the potential changes to take place that may affect the expected revenues and costs of installing ENIQ, it has been assumed that the benefits of installing the system will remain consistent over time. As earlier pointed out, however, there is still a possibility for Ericsson to adjust specific model inputs should special events or market changes occur that will affect the inputs of the model.

Another assumption pertains to the inputs accounting for potentially planned network expansions. For reasons of minimising model complexity, it has been assumed that a customer is not likely to expand the number of cells in their networks more than once. While it may be tempting to believe that the model would gain from allowing the customer input to include expansions at more than one occasion, reality favours the assumption that planned expansions over a period corresponding to the lifetime of a PM system will not occur more than once. The likeliness of the customer increasing network capacity incrementally is rather small, and it is reasonable to assume that although the customer may expand over a couple of years, the

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[14] Since no changes are assumed in terms of revenue, no automatic change in the underlying costs will be generated. There generally exists a dependence relationship between revenues and the set of underlying costs – hence the need to (in general) identify each dependency relationship between revenue and each individual cost and also what drives the cost assumption (Friend and Tennant, 2001).

purchase cost of new OSS-RC systems, based on historical cases, is likely to be incurred at one occasion.

One more aspect to be taken into consideration is the fact that some customers may recently have undergone the installation of NWS for 2G; this may be the case for emerging market operators which is currently the customer segment experiencing the most expansive development of the 2G network at the moment. Had this been the case, it may be that the customer is still making large write-offs on the NWS investment. Such a case is likely to incur scepticism for making an investment in a new PM system. However, the investment in an old system is already a sunk cost, in that it can under no circumstances be recovered even though NWS had been retained. Furthermore, in the case considered, comprising of a limited set of Ericsson's installed base of customers (that is, customers that have already installed ENIQ for 3G) no customer has been identified to have made an installation of a new NWS system in the last few years. With this in mind, we set the model to assume that no large write-offs are being made on old PM systems for the customers which the model intends to address.

Yet another assumption concerns potential training costs; as with any new organisational change, the introduction of a brand new system ought to require training and this is normally associated with some sort of expenses incurred both by absence from normal working hours and by the competency needed to appoint when educating staff in how to use the new system. The ENIQ tech-pack is however a slightly different case; since the customer base for which the model is intended already has installed the same system for its 3G network, the competency is already in the organisation; in essence, the staff currently working with NWS at these firms are normally the same people being in charge of the 3G system and accordingly the users which are to use the ENIQ tech-pack for 2G are already familiar with the new system. Set against this background, it will be assumed in the model that no training costs will be incurred upon the installation of the ENIQ tech-pack.

As discussed in the preceding theoretical chapter, there are many approaches to estimating the discount rate to be used when discounting cash flows. In the ENIQ valuation model, the discount rate used is set to the operator's cost of capital. The cost of capital, or the WACC, is conventional to apply for investments taking place under normal circumstances, and is particularly suitable for determining whether an investment is value adding to a company or not, such as for the case of ENIQ. The WACC used is a flat rate, implying that the model does not take into consideration any potential changes in cost of capital over time. Such a variable discount rate would be difficult to estimate in practice, and applying a flexible figure would most likely not add any value to the model. Nor would it be sensible to handle a discount rate building on the expected probability of each cash flow; it would be hazardous to deal with the probabilities of different outcomes given the difficulty in identifying different scenarios and estimating their respective likelihoods for a case such as ENIQ.

Cost savings used in the model are also suited for internal comparisons; they are difficult to compare inter-organisationally since variations in operational and financial structures can be so large that comparisons across firms tend to lack meaningful value. However, since the modelling process aims to compare before and after states (i.e. firm specific states with the

legacy NWS as compared to the same firm's state after having undertaken the investment in the 2G technology package), it was deemed as an appropriate and indeed useful measure from which NPV, ROI and PP could be derived.

6.4.3 The Model – A Schematic Overview

Below is a schematic illustration of how the model is structured. Each blue box represents one of the six functional Excel sheets while arrows model how the information flows through the model. How these exact interrelations are designed and what is comprised within each sheet is described in the next section.
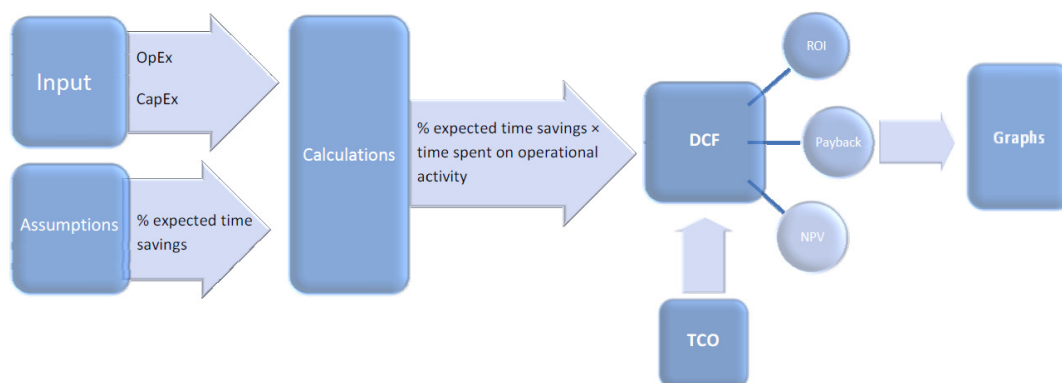
Figure 10 Schematic overview of the ENIQ valuation model

6.4.4 The Logic of the Model

For the logic of the model to be as clear and as easy to follow as possible for the user, attention has been given to build the model framework so as to allow for the user to quickly get a good overview of its structure. To enable this, the model has been designed so as to keep the number of worksheets at a minimum and at the same time structure the contents in these sheets in a way that is as natural as possible to the user to apply and to navigate through. The ENIQ valuation model is structured as seven separate worksheets; *Front, DCF, Graphs, TCO, Calculations, Assumptions* and *Input*.

Figure 11 Front Sheet

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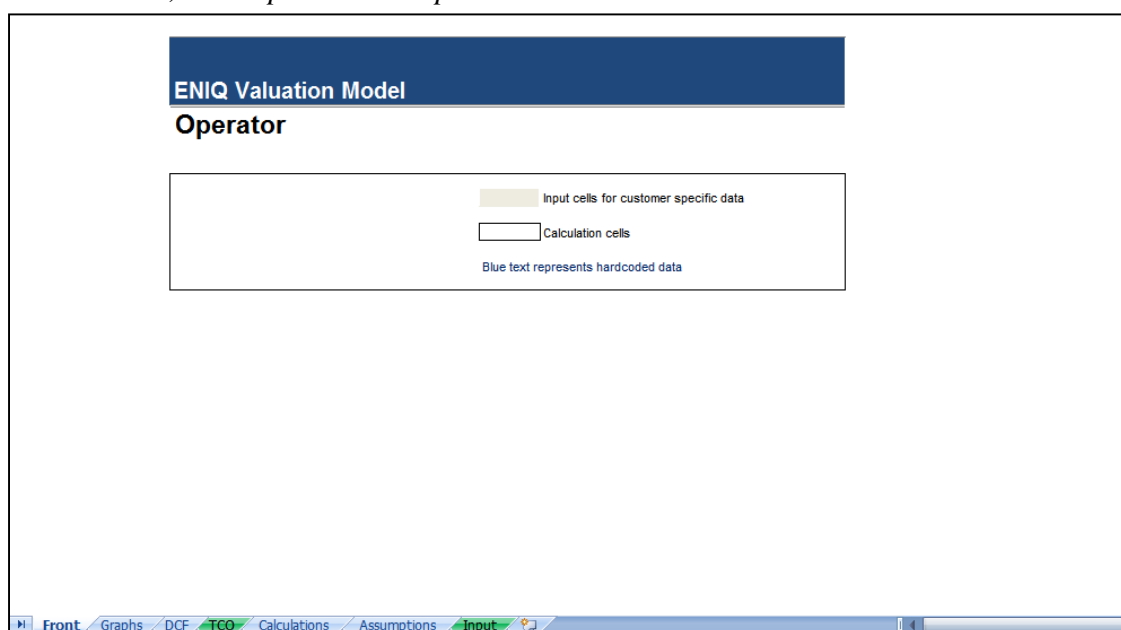The **Front sheet**, which has no functional role in the model, is displayed in figure 11 above. The sheet is intended to be the first screen that the user sees when opening the model, and provides an explanation of the colour coding that is used throughout the model in order for the user to easier understand the character of each cell. Specifically, light grey shading has been used on the cells intended for inputs, whereas cells that are fixed calculation cells are transparent. Further, in order for it to become easier to discern between data which is hardcoded and data which is calculations or simply refer to other cells, the cells containing hardcoded data is presented in blue font whereas remaining figures are written in plain black. This practice of colour coding cells does not only make the model less prone to distortions due to that the user puts in data in the wrong cells, but it also provides a way to readily gain an overview of the nature of each cell. As displayed in figure 11 above, certain worksheet tabs have also been coloured in green to signal that the worksheet in question contains input cells, whereas the blue tabs denote sheets containing only output data.

The remaining sheets are placed in "reverse" order. That is, the input sheet is placed lastly whereas the output is presented in the beginning of the workbook. This may at first glance seem irrational, but in bearing in mind the intent of the model, namely for it to be used as a selling tool to be used on customers, it is natural to display the sheets of highest interest, the output sheets, first in the workbook. For pedagogical reasons, the remaining parts of this section will go in reverse order and therefore start with the last sheet, the Input sheet.

The **Input sheet** is one of two worksheets (together with the TCO sheet) which are to be manipulated by the user – that is, the only two sheets where customer specific data is to be plugged in. Confining the number of sheets which the user is supposed to manipulate will limit the probability of the user to accidentally distort the model at the same time as it simplifies the process of plugging in customer specific data as well as limits the risk of forgetting to insert all data required. Figure 12 below provides a snapshot of the input sheet. The worksheet has been divided into five separate groups, where the first one concerns general staffing data of the customer in question, including the number of PM end users and system administrators employed as well their total annual cost. Additionally, since the daily activities of a PM end user include tasks other than working with PM, the percentage of PM user time spent on ENIQ is included in the input sheet. Further, the non-value adding activities that have been identified to be affected upon installation of ENIQ make up one the second and third sections, one each for the PM user and the system administrator categories of employees, respectively.

The fourth input section is designed to take into account the opportunity cost of installing ENIQ prior to a planned expansion. Here, the current cell capacity as well as potentially planned expansions and when these are to take place are inserted, along with the cost of installing a new OSS-RC, are plugged into the model. This data enables the model to identify whether installations of new OSS-RCs will be necessary (in the case of retention of NWS) and to implement this alternative costs accordingly.

The last section of the input sheet takes into account the expected lifetime of ENIQ as well as the cost of capital of the customer in question.

Figure 12 Input Sheet

The worksheet following next in the logical order after the input sheet is the **Assumptions sheet,** of which a snapshot is displayed in figure 13 below. Here, the changes in non-value adding activities as derived from the business case conducted on one of Ericsson's customers are inserted. The data in this worksheet is not subject to changes made by the user but flows directly into the model's calculation sheets.

Figure 13 Assumptions Sheet

The calculations wherein the assumptions and the input data are processed is the **Calculation sheet,** which is pictured in figure 14 below**.** Here, the change in time spent on non-value adding activities specific for the customer in question is calculated for both system administrators and PM users, by using the assumed changes obtained from the assumptions sheet to compute the total efficiency savings based on the customer specific data plugged into the input sheet. As the total efficiency improvement is calculated, the total effect taking into consideration the number of employees of each category and their annual cost can be identified, which adds up to total efficiency savings that subsequently will flow into the model as annual benefits from installing ENIQ.

Calculations

System administrator activities	% time spent before ENIQ	hours/person/day	% change in time	hours/person/day	change in hours
Cause of problem diagnosis	20%	1.60	(50)%	0.80	(0.80)
Troubleshooting	20%	1.60	(50)%	0.80	(0.80)
Deciding and implementing corrective action	20%	1.60	(50)%	0.80	(0.80)
Communicating across 2G/3G/CN departments	30%	2.40	33%	3.20	0.80
Other	10%	0.80	0%	0.80	0.00
Total	**100%**	**8.00**		**6.40**	**(1.60)**
Total efficiency improvement	**20%**				

PM user activities	% time spent before ENIQ	hours/person/day	% change in time	hours/person/day	change in hours
Monitoring & planning capacity	10%	0.80	(50)%	0.40	(0.40)
Troubleshooting	10%	0.80	(50)%	0.40	(0.40)
Network planning	10%	0.80	(50)%	0.40	(0.40)
Waiting for statistical report generation	40%	3.20	(25)%	2.40	(0.80)
Other	30%	2.40	0%	2.40	0.00
Total	**100%**	**8.00**		**6.00**	**(0.80)**
Total efficiency improvement	**10%**				

Efficiency improvement

System administrator
Efficiency improvement	20%
Number of employees	2
Cost per employee	€55,000
Efficiency savings	**€22,000**

PM user
Efficiency improvement	10%
Number of employees	20
Cost per employee	€55,000
Efficiency savings	**€110,000**

Figure 14 Calculation Sheet

The next sheet is the **TCO sheet,** wherein the total cost of ownership is calculated for the system to be installed. As displayed in figure 15 below, the TCO sheet takes into account the upfront purchase cost for the customer as well as the cost of implementing the system. The former is based on Ericsson's own prices and, as will be further discussed later, this component is a key variable in defining the value of the model to Ericsson in that it provides it with the flexibility of adjusting the purchase price so as to yield an attractive investment value to the customer. The upfront purchase price is broken down into three components in accordance with Ericsson's conventional pricing system: license fee, hardware cost and software cost. Each of these three inputs is based on total freedom and their respective sizes are therefore a decision entirely made at Ericsson's discretion. As for the implementation costs, the total charge is based on the size of the system as well as geographical and customer specific factors and is also set by Ericsson itself according to an experience based estimation of the number of hours required for the implementation.

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Figure 15 TCO Sheet

Following the TCO sheet is the **DCF sheet,** the design of which is displayed in figure 16 below. This can readily be considered as the key sheet of the model since it is where inputs from the TCO sheet and calculations of reductions in non-value adding activities are synthesised into yielding the value of the investment for the customer studied. As displayed below, the model is designed so as to replicate a discounted cash flow which is to capture all of the above mentioned costs and benefits pertaining to an investment in the ENIQ tech-pack for 2G. The model has been tailored to be adjustable for the expected lifetime of ENIQ, which implies that the number of years for which the NPV is computed is flexible. The number of years to be included in the NPV, along with the year of investment in ENIQ, flow from the input sheet, and the model automatically uses this information to decide the length of the discounted cash flow period. Specifically, it allows for an NPV for up to 20 years of lifetime, which is very conservative and can thus be used for applications on customers of all types of time perspectives. The NPV of each type of cash flow will, as displayed below, always show up on the rightmost hand of the cash flow series, notwithstanding the length of the period used. Neither of these adjustments requires user assistance, the only inputs needed to produce a year-specific cash flow over the period desired are the lifetime of ENIQ and the year of investment via the input sheet.

As seen below, the cash flows are divided into two categories: total cost of ownership and benefits of ENIQ vs. NWS. The former are the front-up purchase costs and implementation costs which flow in from the TCO sheet. These costs are one-off charges and will thus appear in the year of implementation only. The section illustrating the benefits displays positive cash flows which are obtained directly from the computations of efficiency savings in the calculation sheet, and expressed both for the system administrating staff and the PM end user employees. These are yearly savings and will thus, in accordance with the assumptions set out above, be incurred during each year of the expected lifetime of ENIQ. Another input in the benefit section is the opportunity cost of avoiding to buy a new OSS-RC. This field is sensitive to planned expansions in which the new number of cells will exceed the current capacity of the customer in question. Here, the model is responsive to the year in which the customer plans to make the potential expansion, and also to the number of new OSS-RC that will have to be installed in order to meet the capacity gap created. Each cell in the "Avoidance to buy new OSS-RC" field is designed as a conditionality upon the event of an planned

expansion taking place in that year, and an additional conditionality which automatically decides how many OSS-RCs will be needed to cover the capacity gap. If the conditionality is true, the model inserts the cost of purchasing new OSS-RCs accordingly. The model is designed to handle no more than a requirement of ten new OSS-RC's, which is based on historical and conventional purchase volumes and is a conservative figure which accordingly runs little risk of underestimating the purchase cost.

The net cash flow section is simply the aggregated benefits and costs for each year of the cash flow period, where the rightmost figure in the sheet displays the NPV and thus the value of all cash flows incurred in each category. This is expressed as the value of the investment, along with the ROI and Payback period in the summary analysis at the bottom of the sheet.

DCF Valuation												
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	10-year NPV
Total cost of ownership												
Licence fee	€(100,000)											€(100,000)
Hardware	€(50,000)											€(50,000)
Software	€(30,000)											€(30,000)
Upfront purchase cost	€(180,000)											€(180,000)
Manhour cost for implementation	€(60,000)											€(60,000)
Total cost of ownership	€(240,000)											€(240,000)
Benefits of ENIQ vs. NWS												
System Administrator efficiency improvements	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€22,000	€157,180
PM User efficiency improvements	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€110,000	€785,902
Efficiency savings	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€132,000	€943,083
Avoidance to buy new OSS-RC						€60,000						€37,255
Total benefits	€132,000	€132,000	€132,000	€132,000	€132,000	€192,000	€132,000	€132,000	€132,000	€132,000	€132,000	€980,338
Net cash flows												
Total benefits		€132,000	€132,000	€132,000	€132,000	€192,000	€132,000	€132,000	€132,000	€132,000	€132,000	€980,338
Total cost of ownership	€(240,000)											€(240,000)
Net cash flows	€(240,000)	€132,000	€132,000	€132,000	€132,000	€192,000	€132,000	€132,000	€132,000	€132,000	€132,000	€740,338
ENIQ Valuation summary												
Net present value of ENIQ investment			€740,338									
Return on investment			308%									
Payback period (months)			22									

Figure 16 DCF Sheet

The final sheet in the model, which provides no new information but an illustration of the results displayed in the DCF sheet. This is the **Graph sheet,** illustrated in figure 17 below, in which the cash flows and the investment vs. return are plotted. This aims to allow for the user to visualise the different cash flows incurred by the ENIQ investment as well as the money returned in relation to the amount invested, and are upon request by Ericsson valuable tools for use in presentations or in discussions with customers.
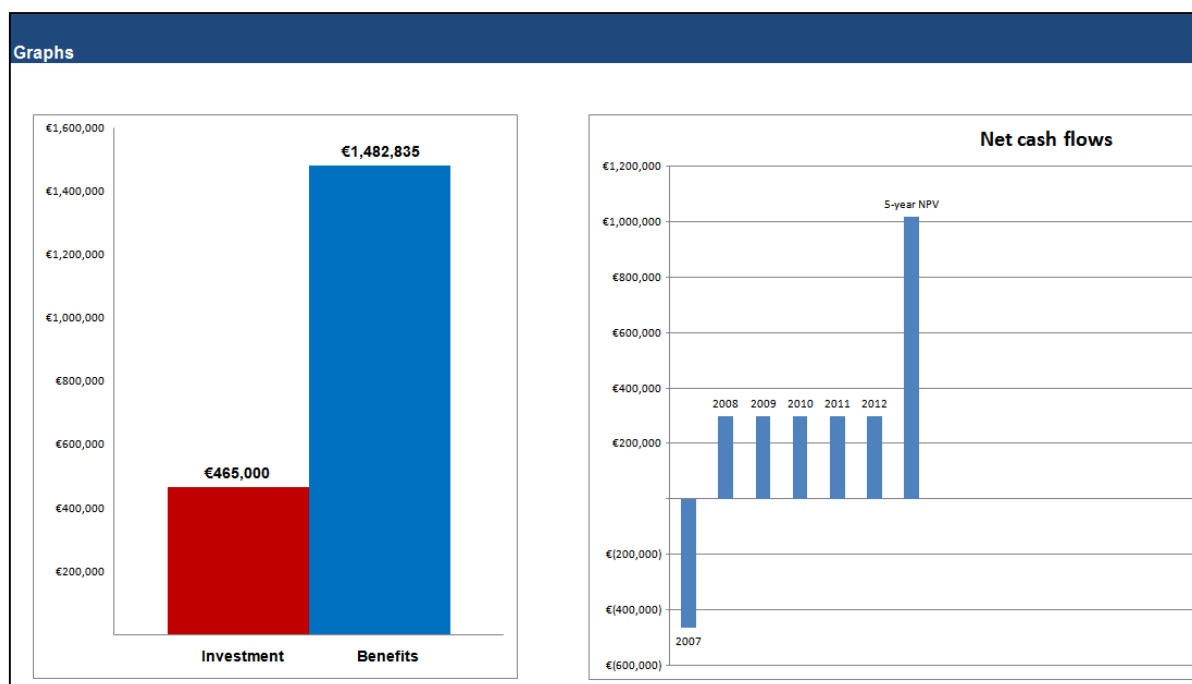
Figure 17 Graph Sheet

6.5 Validity and Generic Qualities

For a financial case such as the ENIQ tech-pack for 2G investment, certain issues of model validity may arise. This may stem from the uncertainty inherent in assumptions as well as from differences in the context in which it is applied. In order to minimise the threats to validity, a rigorous process (which is accounted for in detail under the methodology description of this report) has been followed throughout the study. As for the financial modelling procedure, focus has been on keeping the influence of bias as low as possible through avoiding some of the most usual sources of lacking accuracy in valuation.

In particular, the level of detail has been kept as low as possible; many categories of inputs were considered prior to reaching what is the final version of the model. However, in order to avoid redundancy only a few of these; namely, the input variables for which there were reasonable estimates and economic significance were retained in the model. As for the general structure of the model, persons in the OSS organisation were consulted in order to bring in new aspects to the process, which added some valuable inputs that would otherwise have been left unconsidered. Additionally, the inputs defined together with people from Ericsson were subject to review and revision by the operator studied which adds to the internal validity of the model.

Regarding bias pertaining to subjectivity the model can be argued to be built independently of Ericsson in the sense that it has not been put together by an Ericsson employee, which reduces the impact of bias arising from the modeller having a personal interest in the valued entity. Further, all model input has been based on real time data in order to avoid the influence of distortions due to data changes occurring over time. Another aspect to take into consideration when discussing validity is the fact that not even the best model can produce final values free from any elements of bias, no matter how accurate the process followed to generate the model. Hence, the investment value produced by the model is not to be taken as a guarantee,

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but rather as an indication. Also, it should be emphasised that the financial model is only part of an entire business case; many of the benefits of ENIQ are soft in nature or impossible to model numerically, which ceteris paribus suggests that the actual value of the ENIQ investment ought to go beyond the financial value produced by the model.

Another aspect that may give rise to issues of validity is the fact that the model data for estimated reductions in non-value adding activities is conducted using one customer. From a generality point of view, it may not be optimal to base results on one case. Nevertheless, the case investigated was the only live case of a customer with the ENIQ tech-pack up and running, which leaves no other option for a study of the value of this investment. The activity breakdown of an operator is furthermore rather standardised in nature given the specific set of requirements the PM system puts on its user, and operators can hence readily be assumed to exhibit little difference in terms of time spent. Hence, the customer studied should be seen as fairly representative; in particular given its reputation for being in the forefront of technical knowledge among Ericsson's installed base. Furthermore, given the scarcity of available live cases, additional effort was put into verifying the definition of inputs with the customer both prior to and after the interviews, and data was cross-checked by several persons in the organisation.

Part of the value in the model lies in its generic qualities; it is a tool for also assessing the operational benefits for cases other than the ENIQ tech-pack investment. A modification to fit a new context will naturally demand some adjustments to the model, which requires the user to conceptualise the respective costs and benefits for the new product and subsequently integrate these features in the model. While the total cost of ownership is likely to be structured according to the Ericsson standard following the same breakdown (with potential additions of annual service costs should they differ from the ENIQ investment in that they are not the same before as after the investment), the benefits are likely to have a somewhat different breakdown. Part of the model focuses on operational savings in terms of reduction in non-value adding activities, which are likely to differ from product to product and hence will require some adjustment. Given that the product range offered by Ericsson OSS shares the same characteristics in that it adds functionalities or streamlines processes, the activity based focus will likely be suitable for other products. Additionally, the model is constructed so as to allow for other benefits, such as in the example of ENIQ where the customer can avoid the cost of installing new OSS-RC systems, to easily be added and included in the discounted cash flow analysis.

6.6 Valuation Results

Since an indirect goal with the creation of the financial model developed in this study is to prove a positive value for the investment in the ENIQ tech-pack for 2G, it is interesting to shed some light on the results obtained from the customer reference case conducted. The customer studied made an investment in ENIQ in December 2007, with an expected lifetime for the system of five years. It employs two administrators system and 100 PM users, each with a total annual cost of €55,000. Since the operator is a developed market customer, no major network expansions were expected to take place within the five years following the investment, and thus no opportunity cost for the avoidance of installing a new OSS-RC was

implemented when computing the investment value for this customer. With the expected benefits occurring over the five year lifetime of ENIQ and with the investment cost charged by Ericsson totalling €465,000, an expected NPV of €1,018,000 (corresponding to a ROI of 219% and a payback period of 19 months) was obtained for this customer's investment.

Certain aspects regarding the uncertainty pertaining to the estimated cost of capital used as discounting factor can arise in discussions of model validity. To eliminate the occurrence of fatally erroneous conclusions as to the model's validity as a proof of the ENIQ investment value due to this very fact, a sensitivity analysis with the cost of capital as variable factor was performed on the operator studied. Allowing for the discount factor (which for the operator studied was set to 8%) to vary between 5% and 15% (both well beyond the respective lower and upper confines for what is reasonable to use as cost of capital for a mature firm). This resulted in a range of NPV between €1,118,000 (corresponding to a ROI of 240%) and €828,000 (equivalent to a ROI of 178%), respectively. Hence, issues related to the choice of cost of capital cannot be argued to change the conclusions as to whether or not the model produced a positive investment value for the ENIQ tech-pack.

Another measure of investment value which lends itself to be easily communicated to customers is the cost savings incurred by the investment in ENIQ (that is, the undiscounted positive cash flows generated). For the customer studied, annual cost savings would total €297,000, which is equivalent to accrued cost savings of €1,485,000 over the estimated five-year life time of ENIQ.

In conclusion therefore, the purchase of ENIQ for the customer in question was indeed a profitable decision (even when only taking operational efficiency savings into consideration). For Ericsson OSS, this is indeed an important result since it proves the model's potential to become a value-adding tool in its set of marketing products for the forthcoming sales pitch to its installed base of customers.

7 Discussion

In the following chapter, a discussion of the various intangible benefits of ENIQ that are not mirrored by the financial model will be provided along with an account for the model's specific value as a business case tool for Ericsson. The chapter is followed by specific recommendations and conclusions as to how Ericsson may use the model going forward.

Given the highly intangible character of the investment in a performance management system, many benefits expected to emerge following the migration to ENIQ cannot be taken on consideration wholly in the financial modelling case. Other soft benefits will have to be taken with no consideration in the model, which follows from the complexity that pertains to hardening certain types of soft benefits. Nevertheless, it is interesting to bring forward not only the returns delivered directly but also these enabling factors that facilitate other business goals to be fulfilled. Below, some arguments beyond the scope of the financial model will be discussed briefly.

One feature essential to ENIQ that incurs benefits which due to their intangible character had to be omitted from the model is the data recovery function of ENIQ. As compared to NWS, downtime due to upgrades will not incur large laps of data to be lost; instead, data is always retained by means of the recovery function in ENIQ. As a consequence, the ENIQ user will not exhibit large statistical distortions that were the case for NWS. Specifically, one of the core functions of a PM system pertains to providing statistics for the operator to adapt capacity to network activity and thereby avoid capacity constraints incurring revenue losses, and the data recovery function provided by ENIQ can accordingly be considered a paramount need to a sophisticated PM system.

As expressed by employees of the operator consulted in this study, the cost reduction value of ENIQ is not the main selling point; this is rather the opportunities provided by the system. The detailed scope on the operator's performance enabled by ENIQ is in itself a vehicle which indirectly will improve the company image and provide better service to customers if measures are taken to adjust network performance accordingly. In this sense, ENIQ can be seen as an enabling investment; an essential foundation which enables for the customer's other organisational goals to be fulfilled. The difficulty in modelling avoidance of revenue losses pertains to the complexity of hardening soft benefits where so many different aspects of a system have to be taken into consideration that the input data relies too much on assumptions to produce sufficiently reliable output.

Although the ENIQ valuation model output essentially illustrates the economic value of the operational efficiency savings that the investment brings to the customer, the main purpose of its existence is for it to be a valuable marketing tool for Ericsson. The ability to demonstrate a positive-NPV investment to the customer draws on the advantage of using the power of numbers. It should be stressed that the financial model provides a case for the ENIQ tech-pack investment, but it is not a complete base on which to make an investment decision. The financial model should be seen for what it is; namely as a part of a wider business case, which is a set comprised of all arguments for and against the proposed investment. The financial model includes only what has been possible to quantify in numerical terms of cost and benefits, whereas the entire business case comprises of other soft factors such as these discussed above.

The case for ENIQ can in many respects be considered an enabling investment in the sense that it is not primarily the immediate and quantifiable benefits incurred from operational cost savings that constitute the core of the investment value. In the competitive environment of today's telecom market, with customer loyalty resting firmly on price and satisfaction with the quality of services, it is a cardinal virtue for the operator to retain its installed base. The functionality of ENIQ plays to business goals that readily can be attributable to most operators; a view to optimising the availability of the system and thereby the customer satisfaction in order to maximise revenue streams and customer retention.

For Ericsson, an inherent value in quantifying operational savings through the ENIQ model is the ability it provides to model the sensitivity to price adjustments; Ericsson can readily use the model as a tool for sensitivity analyses with respect to the responsiveness of the customer

value to changes in price. This enables Ericsson to set prices that appeal to the customers' requirements on return as well as to Ericsson's targeted revenues from selling the system.

As targeted, the model is generic in the sense that it can be adjusted to be used with other products than ENIQ. Since Ericsson OSS does not have a history of using financial modelling in its pricing process, the ENIQ model provides a valuable addition to its set of marketing and pricing tools. The former fashion of setting prices based solely on intuition and historical prices will most likely gain from being backed up by the power of numerical evidence of improvement. This very fact is further emphasised by Ericsson OSS employees which themselves have communicated that a more accurate approach to pricing is something that has been missing in the process of selling new products to customers which as a rule are reluctant to buying into systems without proven and sizeable benefits. It is our belief that the ENIQ valuation model will prove a useful tool in Ericsson's forthcoming mission of pitching the ENIQ tech-pack for the customers concerned, and it will most likely prove valuable to Ericsson OSS should it decide to utilise its numeric qualities and integrate the model into its general selling process.

8 Recommendations

As set out in the objective of this report, the aim of the study is to model the value of the benefits derived from investing in the ENIQ tech-pack for 2G. The financial model presented in this report identifies the operational cost savings that can be expected to follow a migration to ENIQ. Conventionally, investment decisions are not taken on consideration of the financial case only; in essence, the model is a tool for Ericsson to be used when proving the value of ENIQ to its customers. The model should optimally constitute part of a complete business case which sets out all the arguments for the investment, emphasising ENIQ's potential as an enabling investment comprising additional but intangible values that are beyond the scope of a financial model to measure.

As a result of these insights, a number of more general recommendations will be put forward below pertaining to both the use of the model in practice and to the practice of systematically integrating financial modelling in the OSS division's overall selling strategy. Ericsson OSS has identified the need to become more business-oriented and is undergoing a reorganisation that will support a more integrated business approach in operations. The financial modelling process outlined in this thesis and its generic qualities have implications in the following dimensions; Ericsson has the possibility:

- To utilise the financial model as a complement to the set of qualitative arguments used to convince customers to invest in ENIQ. It draws on the power of numbers, and is an indicator to be used when convincing the customer that an investment in the ENIQ tech-pack for 2G is a course of action that makes financial sense. The ENIQ valuation model allows Ericsson to assume a pragmatic approach to pricing, focusing on customer value when setting the final price to its clients.

- To use the model as Ericsson sees fit. The model is versatile in its delivery of the value of the investment and Ericsson thereby controls the flexibility in how this value

is communicated outwardly to the customer. An alternative measure to the ROI, Payback and NPV of the investment that could be presented to the customer is the annual cost savings (disregarding the time value of money, i.e. the discount rate). Annual cost savings could further be presented cumulatively over the lifetime of the investment, annually or set relative to the annual license fee to get the perspective of savings vs. costs of the investment. Providing alternative perspectives and measures might be more understandable for some operators – and the model duly allows for such alternative figures to be extracted from it. The model's versatility is built-in and should be exploited to the maximum to ease and tailor communication with operators.

- To draw on the model's generic qualities and integrate the financial model as a tool in the pricing of other products in order to rationalise its process into relying on factors other than historical pricing and intuition.

- To assume a more pull-based stance towards launching new products. Now, Ericsson OSS faces resistance due to that the ENIQ tech-pack for 2G builds on forcing rather than compelling customers to buy into the product. The use of a financial model can help Ericsson prevent customer animosity towards new investments. This could potentially help Ericsson OSS enhance its reputation as a solid counterparty in a market where aggressive competitors consistently seek to seize new market shares. To look into how this could be conducted is beyond the scope of this report; however, it may be an interesting avenue for further research to explore.

9   Bibliography

Barker, Richard. *Determining value - Valuation Models and Financial Statements.* London: Pearson Education, 2001.

Barker, Samuel. *Perils of the Internal Rate of Return.* 2000. http://hspm.sph.sc.edu/COURSES/ECON/invest/invest.html (accessed January 14, 2010).

Bell, Judith. *Introduktion till forskningsmetodik.* Lund: Studentlitteratur, 2006.

Blackstaff, Michael. *Finance For IT Decision Makers.* London: Springer-Verlag, 1998.

Brealey, Richard, and Steward Myers. *Fundamentals of Corporate Fiance.* New York: McGraw-Hill, 2007.

Bryman, Alan. *Social Research Methods. 2. uppl. .* Oxford: Oxford University Press, 2004.

Campbell, Harvey. *Identifying Real Options.* 30 12 1999. http://faculty.fuqua.duke.edu/~charvey/Teaching/BA456_2002/Identifying_real_options.htm (accessed January 15, 2010).

Caplan, Dennis. *Oregon State University.* 2008. http://classes.bus.oregonstate.edu/spring-06/ba422/Management%20Accounting%20Chapter%2019.htm (accessed January 14, 2010).

Damodaran, Aswath. *Investment Valuation - Tools and Techniques for Determining the Value of Any Asset.* New York: John Wiley & Sons, 2002.

Davidsson, and Patel. *Forskningsmetodikens grunder.* Lund: Studentlitteratur, 2003.

Delinkov, Marian, interview by Johanna Miller and Jessica Grundsell. *Solution Architect* (23 12 2009).

Friend, Graham, and John Tennant. *Guide to Business Modelling.* London: The Economist in association with Profile Book Ltd., 2001.

Frykman, David, and Jakob Tolleryd. *Corporate Valuation - an easy guide to measuring value.* London: Pearson Education, 2003.

Gartner. *Gartner Glossary.* 2010. http://www.gartner.com/6_help/glossary/GlossaryT.jsp (accessed 01 04, 2010).

Hök, Jesper, interview by Jessica Grundsell and Johanna Miler. *Strategic Product Manager* (19 10 2009).

"Investor Words." 2010. http://www.investorwords.com/3885/profit_margin.html (accessed 01 04, 2010).

Lantz, Annika. *Intervjumetodik.* Lund: Studentlitteratur, 2007.

"Network Dictionary." 2010. http://www.networkdictionary.com/hardware/c.php (accessed 01 10, 2010).

Operator, interview by Jessica Grundsell and Johanna Miller. (17 11 2009).

Patel, Runa, and Bo Davidson. *Forskningsmetodikens grunder.* Lund: Studentlitteratur, 2003.

Ross, Stephen, and Randolph Westerfield. *Modern Financial Management.* New York: McGraw-Hill, 2008.

Svensson, Per Gunnar, and Bengt Starrin. *Kvalitativa studier i teori och praktik.* Lund: Studentlitteratur, 1996.

Trost, Jan. *Kvalitativa intervjuer.* Lund: Studentlitteratur, 1997.

Appendix A: Glossary

The following glossary aims to provide definitions and explanations of terminology used in the report[15].

2G
2G is short for "second generation" wireless communication technology over digital cellular networks. (Gartner 2010)

3G
The term used to refer to the next generation of wireless communications technology. 3G aims to provide universal, high-speed (up to four megabits per second), high-bandwidth wireless services supporting a variety of advanced applications. (Gartner 2010)

Aggregation (see Aggregator)

Aggregator
Content aggregators aggregate information and match it to user preferences. These preferences may be declared actively (that is, if the user explicitly specifies them) or passively (for example, the software discerns preferences from patterns of user behaviour or interest). (Gartner 2010)

Alarm
An indication of a fault, that is, an abnormal status of equipment or a function in a supervised managed element.

Business Objects
Application used for generating provided reports, and for modifying and creating new reports. Also the name of the suite of applications that consists of the report generator, Designer, Supervisor and Broadcast Agent.

Busy hour
In a communications system, the sliding 60-minute period during which occurs the maximum total traffic load in a given 24-hour period. The busy hour is determined by fitting a horizontal line segment equivalent to one hour under the traffic load curve about the peak load point. If the service time interval is less than 60 minutes, the busy hour is the 60-minute interval that contains the service time interval. In cases where more than one busy hour occurs in a 24-hour period, i.e., when saturation occurs, the busy hour or hours most applicable to the particular situation are used.

Cell
The area of radio coverage locally defined, as seen by the Mobile Station, and uniquely defined, as seen by the network.

Churn
When subscribers change to other network operators.

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[15] Unless otherwise specified, the definitions have been retrieved from internal, classified Ericsson documentation which cannot be referenced.

Configuration management (CM)
The process of managing the configuration of enterprise software or system components (such as PCs, networks or applications) to achieve benefits such as increased efficiency or interoperability. Historically, maintaining configuration consistency across an infrastructure has largely been a process-driven endeavour using point tools to automate change across the silos of the infrastructure. Configuration management products oriented to desktop PCs, mobile devices and servers have added an important technology component to facilitate just-in-time configuration. (Gartner 2010)

Counter
In general, a counter is a device which counts (and may display) the number of times a particular event or process has occurred often in relationship to a clock. (Network Dictionary 2010)

Central Processing Unit (CPU)
The component of a computer system that controls the interpretation and execution of instructions. The CPU of a PC consists of a single microprocessor, while the CPU of a more powerful mainframe consists of multiple processing devices, and in some cases, hundreds of them. The term "processor" is often used to refer to a CPU. (Gartner 2010)

Data warehouse
A storage architecture designed to hold data extracted from transaction systems, operational data stores (ODSs) and external sources. The warehouse then combines that data in an aggregate, summary form suitable for enterprise wide data analysis and reporting for predefined business needs. The five components of a data warehouse are: Production data sources, Data extraction and conversion, The data warehouse database management system (DBMS), Data warehouse administration and Business intelligence tools. (Gartner 2010)

Element
Object in the network, providing resources in the form of points available for connections, for instance a switch or a router.

Ericsson Network IQ (ENIQ)
PM system providing service-aware and network-performance management with statistical trend analysis, by service or subscriber, and problem-management alarms for proactive problem indication

Extract, transform, and load (ETL)
Tools for extracting data and its metadata from one data store, transforming the record structure and content of this data, and loading the transformed data to another data store. These tools are sometimes referred to as extraction/transformation/transport or ETT technology. (Gartner 2010)

Equipment
Used in two senses: Real equipment or the managed object for real equipment. Equipment is a physical component of a NE.

Event
Events can be external or internal. Messages about events can be adapted (converted) to alarms that are processed by the Fault Management functions.

Fault Management
Online diagnostics that detect faults in real time, prevent contamination into other areas and attempt to retry operations (Gartner 2010). Fault Management is one part of the TMN (Telecommunications Management Network). Other parts are CM (Configuration Management) and PM (Performance Management).

Fault Manager
The OSS application which handles all alarms occurring within a telecommunication network.

Global System for Mobile Communications (GSM)
The dominant digital cellular technology for mobile telephone networks in Europe. GSM (formerly called "Groupe Speciale Mobile") utilises the 905-915 MHz and 950-960 MHz reserved spectrum to provide roaming capability across 18 countries in Europe. GSM 1900, the North American version of GSM, allows the standard to be used in the 1,900 MHz frequency band, which the U.S. Federal Communications Commission and Industry Canada have allocated for personal communication services (PCS). GSM is also the name of the European Telecommunications Standards Institute technical committee responsible for the developing the standard. (Gartner 2010)

Index
An index allows a set of table rows matching some criterion to be quickly located.

Key Performance Indicator (KPI)
A high-level measure of system output, traffic or other usage, simplified for gathering and review on a weekly, monthly or quarterly basis. Typical examples are bandwidth availability, transactions per second and calls per user. KPIs are often combined with cost measures (such as cost per transaction or cost per user) to build key system operating metrics.

Monitoring Tool
Provides the network operator with a flexible and efficient tool for the collection and handling of network statistical data for elements in the IP network. The Performance Management Systems are provided with a single, uniform and stable standard interface for all statistical data collection by PMT. This gives a less complex solution for statistical data collection in an IP environment and cuts costs for integration of new NEs.

Network Element (NE)
A NE provides telecommunications and support functions, and is managed by a telecommunications operations system. NE is a manageable logical entity uniting one or more physical devices. This allows distributed devices to be managed in a unified way using one management system.

Network Management
Supervision of other telecommunication management systems (Element Managers)

Network Management System (NMS)
A combination of hardware and software used to monitor and administer a network.

Network Statistics (NWS) The OSS-RC Performance Management application. It receives and stores counters from the managed NE's and generates statistical reports.

Network Statistics Analyzer
Used for generating reports on the statistical data collected from NE's by NWS. These reports are used to analyse the behaviour and performance of the radio and core network in order to fine tune the network.

Network Statistics Analyzer GSM (NWS-AG)
Part of the performance management solution called Network Statistics (NWS). NWS-AG provides a number of pre-defined reports that support the operator in analysing the behaviour and the performance of the GSM network.

Operational Support System (OSS)
Software used to provision, bill, manage and inventory networked products and services

OSS-Radio Core (OSS-RC)
An Ericsson OSS solution that allows telecom operator customers to efficiently manage multiple networks from one distinct platform.

Partitioning
The division of a database into parts.

Performance Management (PM)
Performance management is the combination of management methodologies, metrics and IT (applications, tools and infrastructure) that enable users to define, monitor and optimise results and outcomes to achieve personal or departmental objectives while enabling alignment with strategic objectives across multiple organisational levels (personal, process, group, departmental, corporate or business ecosystem). (Gartner 2010)

Performance Monitoring Administration (PMA)
Performance Monitoring Administration provides support for setting up collection of statistics.

Performance Management System (PM system)
Performance management system collects and analyses network performance information to ensure availability, capacity and quality of services.

Performance Management, Traffic Recording (PMR)
The PMR application unit provides the user with a tool for detailed observation of radio network performance. The observed performance is related to traffic behaviour, such as setup of connections, handover operations and disconnection operations.

Performance Management Traffic Recording, Analyzer
Provides the operator with the universe and a number of predefined reports. These reports will support the operator in analysing the behaviour and the performance of the radio network. The reports are based on data collected from the network and stored in the PMR database. The reports are created and presented using the BusinessObjects (BO) reporter module.

Platform Independent
A term describing software that can run on a variety of hardware platforms or software architectures. Platform-independent software can be used in many different environments, requiring less planning and translation across an enterprise. For example, the Java

programming language was designed to run on multiple types of hardware and multiple operating systems. (Gartner 2010)

Prompts
A message from a computer that gives instructions to the user. (Gartner 2010)

Query
A precise request for information retrieval with database and information systems

Real-Time Performance Monitoring
Provides the radio network optimizer and the troubleshooter with a presentation of quality and traffic monitors in real-time.

Relational Database Management System
A database management system (DBMS) that incorporates the relational data model, normally including a Structured Query Language (SQL) application programming interface. It is a DBMS in which the database is organised and accessed according to the relationships between data items. In a relational database, relationships between data items are expressed by means of tables. Interdependencies among these tables are expressed by data values rather than by pointers. This allows a high degree of data independence. (Gartner 2010)

Report
A report is a textual or graphical presentation of a selected part a Performance Management recording.

Report Generator Business Objects
A flexible web-based statistical report generator. Business Objects is a powerful tool for creating, modifying and running reports on an Internet environment. It also provides a full support for exporting any data, tables or charts into Microsoft office applications, which provides the possibility to compile statistics with other sources.

Report Level
At this level it is possible to present all reports except those which are unique for the Expert Level.

Report Output Period
For each active Performance Monitoring on a NE, an attempt to collect a PM Data file (ROP File) will be made. Result files are fetched automatically every ROP (15 minutes), from the NEs, for active Statistics and other information and stored in a corresponding Performance Management Directory.

Resolution
Specifies the length of the time period for which a measurement value is calculated.

Statistical Data Mart (SDM)
SDM is a data model that is designed for the fast retrieval of performance data. SDM stores the data in the database for the users of OSS. The SDM application is reachable from other OSS applications through an SQL interface and can, for example, be used as a basis for decisions to optimise the network.

Structured Query Language (SQL)
A relational data language that provides a consistent, English-keyword-oriented set of facilities for data querying, definition, manipulation and control. It is a programmed interface to relational database management systems (RDBMSs). (Gartner 2010)

SubNetwork
A SubNetwork is a logical collection of Network Objects.

System Management
Any of a number of "housekeeping" activities intended to maintain or correct the operation of a computer system. Included are such routine but critical processes as hardware diagnostics, software distribution, backup and recovery, file and disk integrity checking, and virus scanning. (Gartner 2010)

System Administrator
A system administrator, systems administrator, or sysadmin, is a person employed to maintain and operate a computer system and/or network.

System Integration (SI)
The process of creating a complex information system. This process may include designing or building a customised architecture or application, and integrating it with new or legacy hardware, packaged and custom software, and communications. Most enterprises rely on an external contractor for program management of most or all phases of system development (see system integrator). (Gartner 2010)

System integrator
An organisation or an individual that performs system integration. Major system integration projects often require the assistance of a specialty firm that has the resources and expertise to manage a project plan that could last over several months or even years. This external vendor generally assumes a high degree of the project's risks. (Gartner 2010)

Total Cost of Ownership (TCO)
TCO is a comprehensive assessment of information technology (IT) or other costs across enterprise boundaries over time. For IT, TCO includes hardware and software acquisition, management and support, communications, end-user expenses, and the opportunity cost of downtime, training and other productivity losses. (Gartner 2010)

Technology Package (tech-pack)
A set of configuration instructions that dictate how ENIQ-software is to handle incoming measurement data from the network node type in question
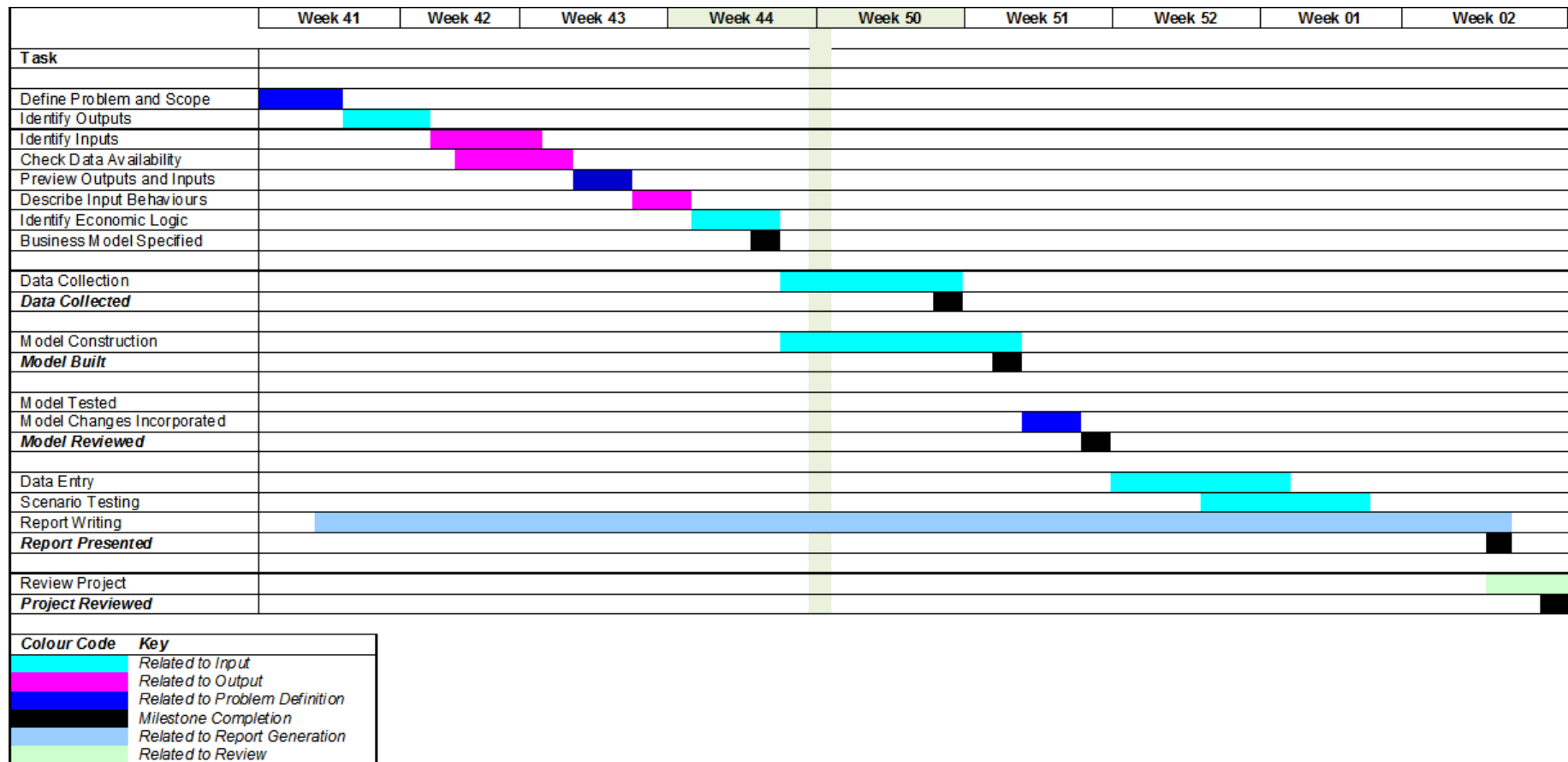
Universe
This is a concept used in the tools BusinessObjects/WebIntelligence. A universe is the semantic layer that isolates the end user from the technical issues of the database structure. It lets you work with data in terms you can easily understand.

Update
An update operation applies a planned configuration to the network.

Appendix B: Gantt Chart

Task	Week 41	Week 42	Week 43	Week 44	Week 50	Week 51	Week 52	Week 01	Week 02
Define Problem and Scope	██								
Identify Outputs		░░							
Identify Inputs		▓▓							
Check Data Availability		▓▓	▓						
Preview Outputs and Inputs			██						
Describe Input Behaviours				▓▓					
Identify Economic Logic				░░					
Business Model Specified				■					
Data Collection				░░	░░				
Data Collected					■				
Model Construction				░░	░░░				
Model Built					■				
Model Tested									
Model Changes Incorporated						██			
Model Reviewed						■			
Data Entry							░░		
Scenario Testing							░░	░	
Report Writing		▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒▒							▒
Report Presented									■
Review Project									▒
Project Reviewed									■

Colour Code	Key
░░	*Related to Input*
▓▓	*Related to Output*
██	*Related to Problem Definition*
■■	*Milestone Completion*
▒▒	*Related to Report Generation*
▒▒	*Related to Review*

Note that due to space limit the chart has been truncated between week 44 and 50; this period is however a period of only data collection, model construction and report writing as is the following week.

Appendix C: Interview Questions

General

Do you consider a PM system as an opportunity or a necessity?

How important is performance management for you?

What is the role of PM in your organisation – and how do you value its role in your overall network management?

What elements do you consider essential for a PM system?

ENIQ Specific

What are the overall experiences from the implementation of ENIQ?

Have you experienced that the installation of ENIQ has released time/capacity for other activities?

What have been the drawbacks of implementing ENIQ?

What operational and organisational factors have been affected by ENIQ?

Have alternative solutions to ENIQ been considered?

What are the major benefits of ENIQ as compared to NWS?

Are you planning to expand the use of ENIQ in the near future?

Have you experienced increasing complexity in your networks (e.g. customers requesting services at obscure times, places, more frequent update requirements, using different phone models)? How do you handle the increasing complexity and dynamic nature of your network? How does this affect the need for and character of PM?

Do you currently use ENIQ in FM (fault management). If so, how?

What potential do you see in developing ENIQ as a complement to your current FM tools?

How do you estimated the effect of downtime on revenues, customer retention and churn? In this respect, what can ENIQ contribute in terms of customer satisfaction?

Do you consider using ENIQ as a superordinate PM system for multiple OSS?

What are the actions implemented for busy hour handling? Have you seen any direct links between levels of churn and customer uptake with using ENIQ?

How do you handle busty hour support with ENIQ as compared to NWS?

How do you value the flexibility of ENIQ to combine statistics with data from other sources (e.g. data from other vendors, command printouts, manually collected data)?

Have you experienced that ENIQ releases time for value adding activities? Have any of these activities been identified that contribute to increasing revenue streams and how?

System administrator

How did you previously work to configure the database (setting rules for aggregating data) with NWS and how do you work with it using ENIQ? What is the effect of these differences?

How did you previously work with rules for generating reports with NWS and how do you work with it using ENIQ? What is the effect of these differences?

To what extent did you experience unreliability of NWS loading data from the OSS when a connection to the network was down (using open SQL)? How do you find the search for missing data with ENIQ compared to NWS? How do you value of the automatic recovery function in this context?

Do you experience a difference in working with raw data in ENIQ as compared to NWS?

How does your organisation handle the deletion of old data in ENIQ as compared to NWS?

PM user

What is your experience of working with the Admin UI (user interface) in ENIQ? How is it compared to the previous interface used in NWS? Do you experience a difference in working with raw data in NWS as compared to ENIQ?

How is the speed of data requests for ENIQ as compared to NWS? How large a difference in time for these requests have you experienced?

How do you value ENIQ's ability to monitor KPIs as compared to NWS?