# UTILIZING A MODERN NETWORK INFORMATION SYSTEM IN THE OPTIMIZATION OF NETWORK INVESTMENTS

Jussi VATILO
Trimble Navigation Ltd – Finland
jussi.vatilo@trimble.com

Harri SALMIVAARA
Electrosoft Oy – Finland
harri.salmivaara@electrosoft.fi

Tommi LÄHDEAHO
Elenia Oy – Finland
tommi.lahdeaho@elenia.fi

## *ABSTRACT*

*Network utilities in Finland are facing several challenges in the long-term development of the distribution networks, as the need for investments is growing due to the aging infrastructure and to legislative requirements. Investment budgets are limited and the utilities need to allocate the network investments wisely to meet the needs of the owners, the end customers and the regulator.*

*This paper presents how a modern network information system (NIS) complemented with an Enterprise Resource Planning (ERP) system can be a powerful tool in helping utilities to make effective and systematic investment decisions. Planning data produced by a modern NIS can be utilized in a novel way to provide an accurate and up-to-date view into the investment program of the network utility. The concept is demonstrated based on the experiences of Elenia Oy, Finland's second largest distribution company, where the new way of managing investments was piloted.*

## INTRODUCTION

Strategic planning of investments is at the core of utilities' business. The aim of utilities is to optimize their investments as well as possible from the economical, technical and reliability perspective. The network utilities in Finland have a regional monopoly and the Finnish regulator has defined a limit for reasonable profit adjusted on the basis of the capital committed to the network as well as on other parameters. The complexity of the regulatory model makes it difficult to assess the effects of the investments. A single investment can have an effect on the reliability, the operational costs, and the network value, which all have an impact on the allowed rate of return. Smartly allocated investments benefit both the owners of the utilities and the end customers. From the owners' perspective the effect of investments on the network value is maximized and the users of the electricity benefit from optimized improvements to the security of the supply and from reduced operational and maintenance costs. [1][2]

In Finland, the new Electricity Market Act drives utilities to increase the supply security of electricity by the year 2028, which means a significant increase in the investments [2]. Choosing and scheduling investments optimally is essential for the utilities now more than ever. On the other hand, planning the investments can be a very complex task with huge amount of data scattered across different IT systems in the utility.

Diverse IT environment is a challenge to the network investment management, especially for larger utilities. In Elenia, different parts of the organization used to have their own main system, which was used for managing one part of a project's life cycle. Planners worked with the network information system (NIS) to do the planning and with the Enterprise Resource Planning (ERP) system to manage internal work orders. Construction department used a work order management system for managing contracting and purchase orders, and another system for financial administration. Contractors also used the NIS for planning and documentation with a limited interface and user rights. The investment prioritization and optimization was done by collecting data manually from each system to yearly Microsoft Excel spreadsheets (see Figure 1).

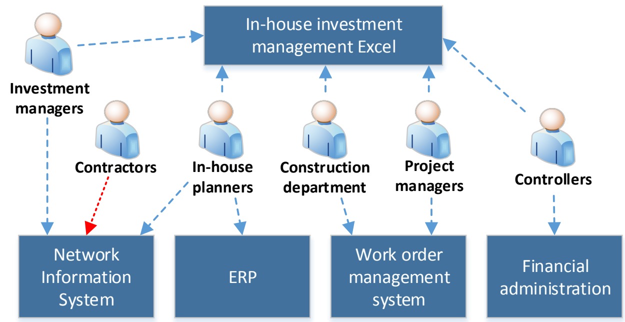


*Figure 1. Investment management related IT environment at Elenia prior to the change.*

The main problem with the approach was the difficulty of managing the investment program as a whole both from planning and follow-up perspective. Manual work led to inefficiency, as the users had to enter information to multiple systems, and it increased the chance for errors. The data was only as up-to-date as users manually kept it so special attention was needed to have accurate and reliable data for decision makers. Manual approach also limited the scope of investment management to only the biggest projects. Smaller projects had to be omitted even though they also have a significant contribution to the investment program.

In order to solve the problem, incorporating the investment management into the network information system was studied. Network information system is an essential planning tool for Elenia, like for almost every distribution network operator. In addition to holding utility's network asset data, the tools of a modern NIS automatically generate a vast amount of useful data during a plan's life cycle from the planning to the commissioning, which makes it an excellent platform for investment management. A NIS can also contain other tools that complement the investment management like reliability analysis to provide crucial data for selecting investment targets.

However, it was seen that the role of the NIS is focused on planning and investment management while other crucial business systems like the ERP system should be able to share data with the NIS through real-time or near real-time interfaces. With extensive interfaces, the network utility would be able to choose which software tools support their processes the best and integrate them to the investment management.

Elenia arrived to the conclusion that combination of NIS and ERP works the best for their processes. Planning and support for techno-economical decision making should be managed in the network information system, while the administrative and financial follow-up as well as procurement, contracting and project management of individual projects should be done in the ERP (see Figure 2).

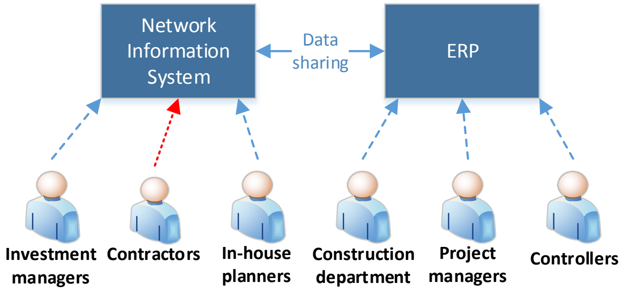


*Figure 2. Proposed new investment management IT environment*

## CONCEPTUAL MODEL

The conceptual model of the proposed investment management consists of key figures, which condense information about the network plans into concise numbers, and clear hierarchy, which aggregates key figures from individual plans to yearly programs and different project types.

### Key figures

Key concept of the proposed model is a key figure, which represents an investment criterion. A key figure can be economical (e.g. construction cost, impact to regulatory asset value), technical (e.g. impact to a reliability index, impact to losses) or derived key figure calculated from other key figures (e.g. efficiency of investments). Each key figures can have both estimated and realized values, which enables comparison between them when following up on the fulfilment of the investment program.

The key figure concept has to support the utility's planning process from preplanning to construction. The proposed approach models the planning process with a key figure life cycle. Estimated key figures coming from different sources and process stages have priorities, which define the significance of the value. For example, cost estimates calculated from construction plans with average unit prices supersede manual estimations (see Figure 3). The life cycle concept stores the historical values for analysis and accountability purposes. In the proposed model, key figure values can be taken automatically from the internal NIS database, imported through an interface from an external system or entered manually.

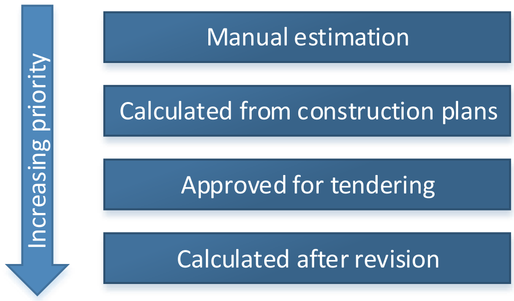


*Figure 3. Example of different key figure value sources*

### Project hierarchy

In the proposed model, investment hierarchy consists of three levels: project type, project and plan. On the top of the hierarchy are project types, which categorize same type of projects together (e.g. new customer connections, construction program). Projects represent bigger construction projects that typically last for several years. Projects are divided into plans, which contain the actual network plans. General plans contain a rough outline of the project and implementation plans contain detailed plans of execution (see Figure 4).


*Figure 4. Project hierarchy for a large three-year project*

Current yearly key figure values are inherited from the bottom up in the hierarchy. A project aggregates key figure values from its plans and a project type sums up key figures from its projects. With this approach, it is possible to follow the investment program from a yearly perspective or by desired categories. Figure 5 shows an example of a key figure of a project in different phases. Initially, the project has only rough estimates and the level of detail increases when the planning process goes forward.

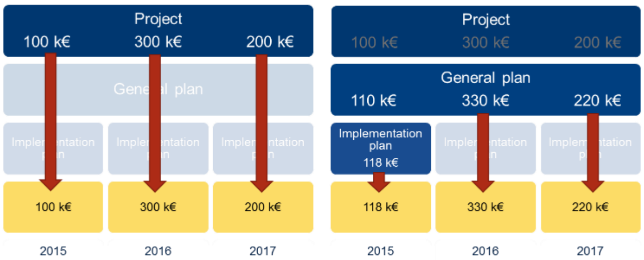


*Figure 5. Project in an early phase with only rough project estimates on the left and the same project with a general plan and an implementation plan for the 1st year on the right.*

## SYSTEM ARCHITECTURE

In the proposed system architecture, the investment management module is embedded in the NIS. The NIS provides a platform for integration with a web service interface, which external system clients can access, for adding and querying key figure values and workflow states (see Figure 6). When an external system is the initiator of the communication, it communicates with the NIS web service, which receives and processes the key figures, and stores new values to the NIS database. Recalculation of the project key figures and derived values is embedded into the interface logic. If the NIS needs to independently send data, similar client - web service architecture has to be implemented, although the same communication schema can be used.

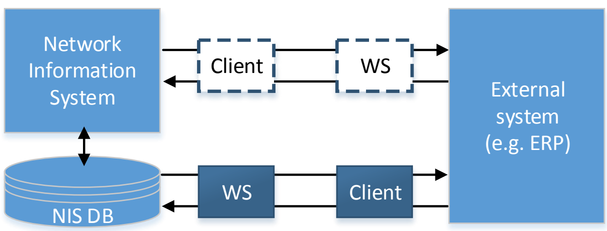


*Figure 6. Simplified web service based system architecture.*

The architecture makes it possible to integrate needed external systems to the NIS depending on what features are available in it and which key figures are of interest to the utility. The approach is modular giving the utility the possibility to complement any lacking capabilities with external software.

Web service can receive values at any time so the communication between systems can be made as real-time as needed based on the utility's requirements. For example, realized project costs could be updated daily from the ERP or construction cost estimates could be sent from the NIS immediately when they are calculated.

For the internal modules of the network information system, the investment management can gather and refine data from the NIS database to the key figures directly. For instance, construction planning module can calculate detailed cost estimates and the plan's effect to the network value to the database. This data is then summed up and updated to appropriate key figures of the network plan. Available data depends on the capabilities of the network information system. Figure 7 shows an example of the data flow from internal modules of a modern NIS and external systems to investment management.

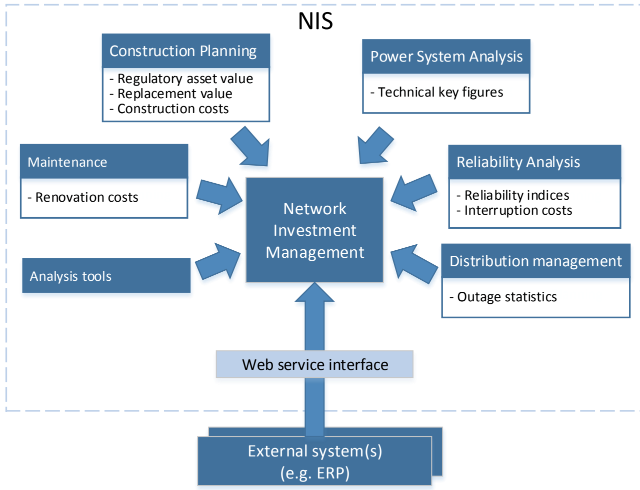


*Figure 7. Example of data flow to investment management*

## IMPLEMENTATION CASE STUDY

Elenia is the second largest network utility in Finland with more than 60 000 kilometres of LV and MV lines and over 400 000 end customers. Its yearly investment program consists of approximately 1000 projects and the utility invests roughly a hundred million euros per year to its network.

The proposed concept was implemented to Trimble NIS, the network information system used by Elenia, and to the ERP system provided by a different software vendor. The investment management tool was taken into use in three phases. The first version was installed in the spring of 2013. Full production use of the NIS part started in the beginning of 2014 and the NIS-ERP data sharing was taken into use in autumn 2014. The first experiences from the network investment management have been very positive. The whole investment program is now managed with the tool and it provides a framework for all planning activities.

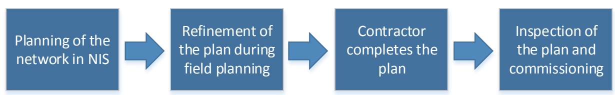


*Figure 8. Simplified plan workflow in Elenia*

In Elenia's planning process (see Figure 8), outsourcing plays a significant part. Much of the planning in Elenia is done by outside contractors using the NIS, which was an important factor to consider in the development, as well. Contractors were taken into account by hiding sensitive information such as price lists from their view and by performing all the necessary cost calculations in the background. Access to investment management view was restricted as well.

Now the NIS and ERP have clearly defined roles in Elenia's process. Planning, investment program management and network asset management are done with the NIS. The NIS is also the primary source of all estimated key figure values as well as the realized changes to the network value. The ERP's role is the detailed management of individual construction projects, and it is the source for the realized costs and cost estimates based on tenders. Figure 9 illustrates the tasks of each system and the data sharing between them at each stage of Elenia's planning process.

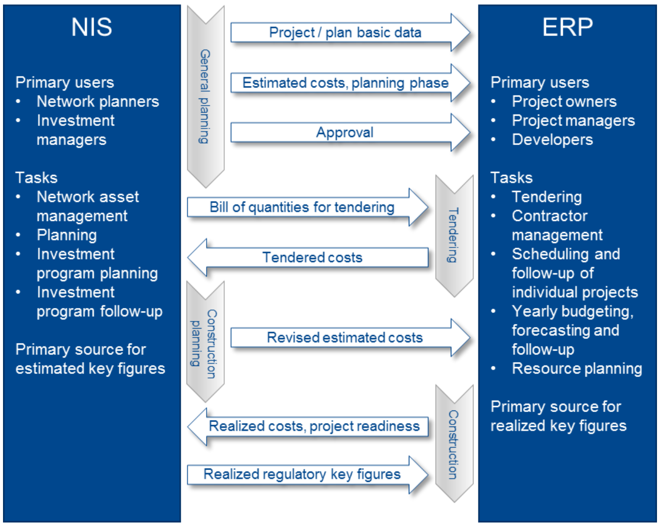


*Figure 9. The roles and data sharing of NIS and ERP in Elenia's planning process.*

With the integrated solution, the effort for the users to maintain data has reduced significantly, but still the most important benefit has been the up-to-date view into the investment project portfolio. Data needed in the decision making process is current and produced automatically as a part of the daily work. Automation has also made it possible to include every project instead of just the largest ones to the investment management. Thus the big picture is available and the effect of the investment program to the network value can be seen early on. Differing alternatives can be compared based on the investment criteria before the choice is made, which would not have been possible in the ERP as it only deals with the approved projects.

In the pilot phase, the network investment management was focused on the construction costs and the effects on the regulatory asset value (i.e. the present value of the network) and the replacement value. Other modules were omitted from the automated handling, but expansion possibilities are very appealing. Especially including reliability analysis and maintenance costs automatically can bring more added value to the prioritization of investments.

## CONCLUSIONS

This paper presented how investment management can be incorporated into a modern NIS and how the concept can take advantage of its advanced embedded features complemented with data shared by other systems through an interface. From Elenia's experiences, it is clear that it is essential to have a centralized investment management with automated integrations between the systems. The presented approach has given the utility a clear and concise picture into their project portfolio for the whole organization and a framework to smartly manage investments. The network utility can focus on choosing the right projects in order to be as cost-efficient and profitable as possible while also optimizing the benefit to the end customers.

## REFERENCES

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