# OSS Architecture

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When building an IT architecture for a greenfield or existing telecom operator, it is essential to have a template of which IT systems should exist, how data and functions should be partitioned between these, and how the systems should be integrated. For OSS, Telenor has developed such a template in what is called the CONTEST OSS Reference Architecture.

## Terminology

OSS stands for Operation Support Systems. In this paper, the expression is used to denote computer systems that are used to manage a telecommunication network. In the section on the CONTEST organisation, you will find some text on the relationships to other business domains. CONTEST stands for Common Technology and Strategy within Telenor.

OpCo stands for Operation Company. The Telenor corporation consists of several OpCos. There may be one or more OpCos in one country. This also complies with the way ITU (the International Telecommunication Union) assigns ITU Carrier Codes.

The CONTEST OSS Reference Architecture has been used extensively in Merger and Acquisition projects. And it is a good tool for analysis and comparison of OSSes in various OpCos.

Use of OSS by third parties, such as installation companies, customers, collaborating operators and outsourcing of network planning, is not elaborated. Also, outside access to internal systems is not considered. Management of IT systems, to the degree that they differ from management of telecom systems management, is not covered by this study. The study has been extended with additional studies, such as transition to broadband and all-IP, that is not covered by this paper.

## Use of the Architecture

This paper is mainly an extract from the report found in the CONTEST report. CONTEST has identified the following possible usages of the CONTEST OSS Reference Architecture:

1 Identify missing data and functions in current IT systems;
2 Categorisation and analysis of existing systems;
3 Categorisation and analysis of proposed future systems;
4 Identify and delimit systems by data to be contained in them;
5 Define data flows between systems;
6 Provide a common terminology for comparing and discussing system solutions;
7 Provide an idealistic goal for systems development;
8 Do pragmatic adjustments to existing practice;
9 Consider interactions with BSS;
10 Provide a starting point for more detailed designs;
11 Provide a goal for the development of an evolution plan;
12 Provide a background for a migration plan;
13 Contribute to a methodology for systems and interaction planning;
14 Provide a comparison with other frameworks;
15 Assist in analysing maturity of existing IT portfolio.

## Comparison with Other Frameworks

The most famous IT frameworks for the OSS domains currently come from the TeleManagement Forum. The entire set is called NGOSS, Next Generation Operation Support Systems. NGOSS has three parts:

- eTOM – extended Telecommunications Operation Map;
- SID – Shared Information and Data model;
- TAM – Telecom Application Map.

eTOM defines a hierarchy of processes for managing any business. The processes and their decomposition define manual or automatized work. And they are independent of what is managed. Therefore, we believe that eTOM serves to mislead analysts, IT designers and users. In particular eTOM misleads the IT designers to design IT systems like when they are designing manual organisation of work, rather than focusing on data design, as is what they should. eTOM is even bad for the design of manual work, as it leads to programming of the humans, rather than making them responsible decision makers for a domain. eTOM is organised in layers and columns that may lead to an unnecessary split of work. And most importantly; only the leaf nodes of the process decomposition should be used in the final design, if any. Most of eTOM is about abstract processes that should appear nowhere.


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SID is organised into the same process domains as eTOM. This means that it is split into parts that do not provide a good overview. SID is intended to define both information and data. Only the information, ie. conceptual part, is defined so far. Data designs are missing. This means that SID does not contain a serious design of data classes, name bindings and syntax. This may typically mislead implementers to think that the conceptual design should be used as data design, and two implementations of the same specification may not be compatible.

The TAM framework uses the same layering as eTOM. This misleads the designers to think that each application has to fall into a layer. In reality, a good design is typically to merge data from different layers into one IT system.

From the above short argumentation, we see that the basic reasoning behind NGOSS is wrong. Therefore, Telenor has developed the CONTEST OSS Reference Architecture to serve the purposes listed in the first section, Use of the architecture.

## Data Orientation

We define an IT system to be a set of data that are enforced as a consistent whole. Hence, we start all work on IT architecture with identifying and designing data. An IT system appears as a vertical or horizontal partitioning of the data. A vertical partition is a set of data classes, eg. of columns/attributes. A horizontal partition is a set of data instances, eg. of rows/record instances.

The partitioning is made such that the enforcement of data can be carried out within the border of one system and does not need to go across several systems. In order to create a design that allows for this, we have to identify all functional dependencies between data and partition data such that each function appears within one system only.

The partitioning of data does not mean that one data type appears in one system only. Objects with their Identifiers will be shared between systems. And for two systems to be able to communicate, they have to share the same definition of the corresponding object classes and of identifier definitions. If two systems do not share the same definitions and instances of identifiers, they will not be able to communicate.

From the previous paragraph, it follows that design of identifiers is at the heart of IT architecture development. To identify systems and interactions makes no sense if the communicated data are not harmonised. Hence, data quality comes before implementation of an IT architecture. But the interactions according to the architecture may also help ensure quality of the data.

The reader should note that work on data quality and data harmonisation is not just about studying and picking what exists. The IT architect will have to base his IT architecture design on design and redesign of data, such that they become efficient and meaningful for their intended use. Design of data is a huge topic that will not be covered in this paper.

Also, rather than talking about data classes, in this paper we talk about data subjects. A data subject is a set of functionally dependent data classes. A data subject could then in principle have been handled as one system, since consistency enforcement needs only take place within a data subject. However, a user may want to access data from several data subjects simultaneously to carry out a piece of work. Therefore, several data subjects are grouped into one system, such that a user may normally only need to access one system to carry out a certain task.

## The CONTEST Organisation

Telenor has organised its work on a Common Technology Strategy for the Telenor Mobile Operations World Wide into the CONTEST programme. CONTEST is organised as shown in Figure 1.

The CONTEST Work Group organisation defines the scope of the OSS Reference Architecture. We are aware that there is no universally agreed definition of the following terms, and often they are used interchangeably. The reader should note that CONTEST uses these terms and others for separate non-overlapping but related domains:

- OSS – Operation Support Systems
- BSS – Business Support Systems
- ERP – Enterprise Resource Planning

The contents of OSS will be defined by what it contains. The other terms will be left undefined.

## Systems Plan

Within the OSS domain, we have identified a need for fourteen different kinds of systems for a telecom mobile operator.

Most of the systems represent a vertical partition of data. This is not the case for the replication of data between the Logical Network Inventory system and the Network Element Management (NEM) systems. The existence of the NEMs is primarily due to the

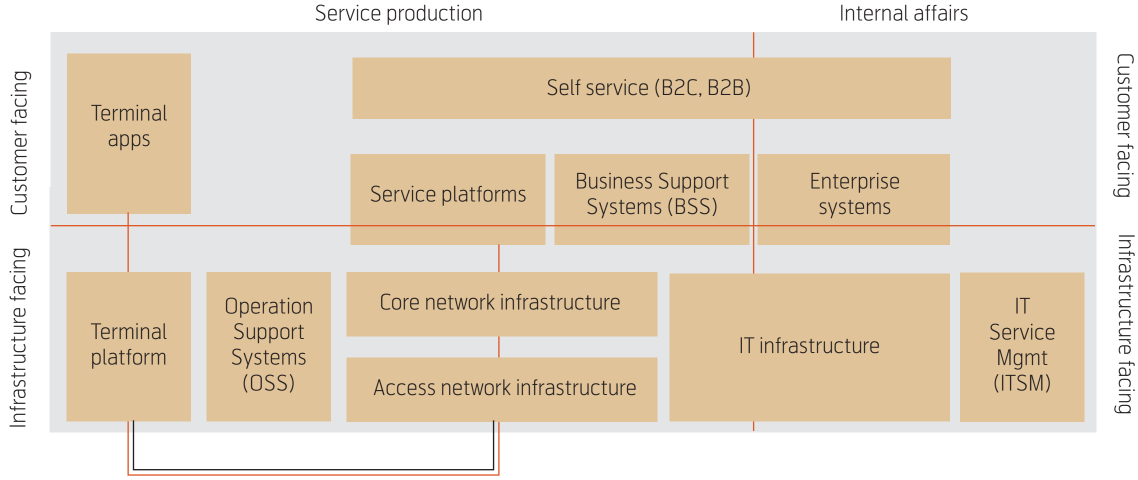


*Figure 1 CONTEST organisation of Work Groups*

control of these by the Network Element vendors; this shows a pragmatic aspect of the OSS Reference Architecture. The architecture is idealistic, but takes reality into consideration.

However, it is important to note that the systems plan is a plan for systems within a telecom operator. It is not a portfolio plan for a software package vendor. How a vendor chooses to organise its packages is a totally different topic from how a telecom operator wants to organise its systems. These two very different topics should never be confused, but unfortunately they often are when a vendor presents its solution.

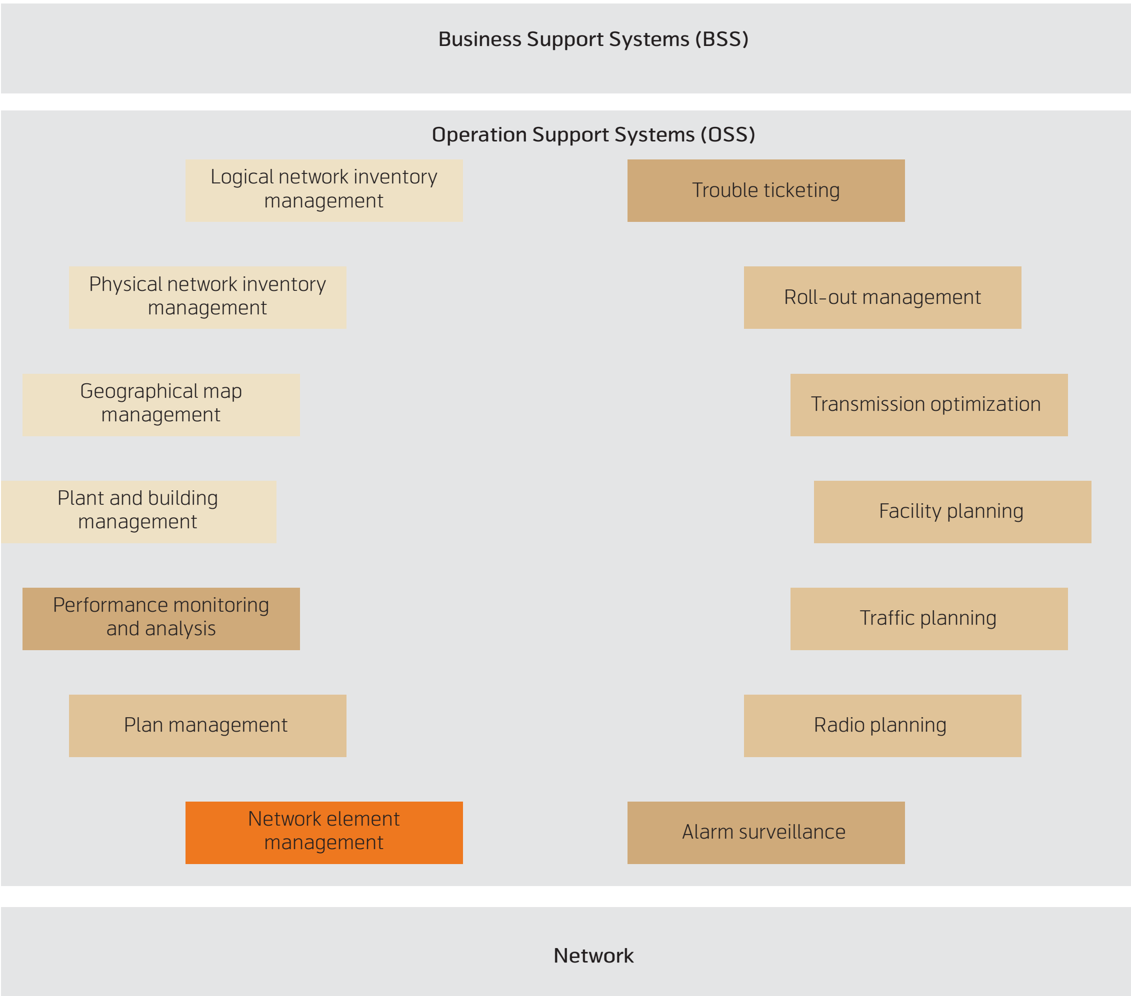


*Figure 2 Systems plan*


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Each system is identified as shown in the text that follows. The text only provides a short summary of the discussions carried out in the CONTEST report, earlier studies, and subsequent case studies.

The Logical network inventory management may manage the following data subjects:

- Countries and operators
- Cross-coupling sites and addresses
- Locations and positions
- Equipment and ports
- Equipment types and their parameter templates
- Trails and routings
- Physical links and terminations
- Network orders and work flows
- Network designs that are not yet implemented
- Replication of Network element information
- Asset management and reconciliation
- Installation contracts and brokering
- Parameters and attributes of network elements

The Logical network inventory management is a central resource for design, provisioning, ordering, construction, activation and analysis of the (logical) network. Also, work flows and brokering may be included in this system. The Logical network inventory management is also used for root-cause analysis of alarms.

The Physical network inventory management may manage the following data subjects:

- Nodes and co-ordinates
- Physical branches, series and legs
- Summary information on terminations
- Ducts and manholes
- Cable beds and placements
- Decided construction plans

The Physical network inventory management may be treated as a separate system. The data in the system may not be updated from Transmission optimisation, may not be considered during provisioning, and are not involved in activation and updating of information in the Network element managers.

The Geographical map management may manage the following data subjects:

- Geographical maps
- Information on sites and constructions

The geographical maps are used as background for presentation of logical and physical network resources and as a basis for network planning. The contents of the geographical maps is dependent on the various needs of the OpCos.

The Plant and building management may manage the following data subjects:

- Properties and their relations
- Buildings and their construction
- Contracts and suppliers
- Indication of batteries and energy support
- References to drawings and photos
- Key and building access

The Plant and building management system may be used for roll-out management, unless a separate system is acquired for this purpose.

The Network element management may manage the following data subjects:

- Network elements and network domain
- Trails and logical trail/connection termination points
- Assets in the network
- Events of all kinds of network resources

The primary role of Network element managers is to provide configuration data to the network elements. A network element management system may incorporate many function, like topology management (of the core network), parameter management (of network elements, like of the radio base stations), monitoring of alarms, monitoring of signaling, polling of performance data etc. Or, the various functions may be split on several specialized network element management systems.

The Alarm surveillance may manage the following data subjects:

- Alarms
- Correlation of alarms
- Filtering and distribution information
- Some network topology information
- Outages

Alarm surveillance may collect, filter, correlate and distribute alarms from the network. Typically, the alarms are received from Network element managers.

The Performance monitoring and analysis may manage the following data subjects:

- Performance, quality and traffic parameters
- Measurement jobs and schedules
- Filtering and distribution of information

- Service domains defined by product type, geography, customers or other
- Service instances defined by product instance and timing for end-to-end measurements
- Service level objectives/targets
- Measurement points (for traffic, delay etc.) located inside network elements
- Signalling monitoring
- Measurements from probes simulating user traffic

Performance monitoring and analysis is a centralized data warehouse of data about traffic and performance in the network. The Performance monitoring and analysis analyze the data for alarm, performance and service quality reasons.

Radio planning may manage the following data subjects:

- Plans and their (base) stations
- Location and radio coverage
- Antennas, direction and power
- Frequency allocations
- Cell identifiers
- Neighbour cells and handover parameters
- Topology

Radio planning may cover both coverage and frequency planning. Also, Radio planning may cover several radio technologies, such as 2G, 3G and WiMax, and use different models for these.

Roll-out management may manage the following data subjects:

- Plans, sites and their overall relationships
- Vendors, contractors and contracts
- Resources required
- Drawings and maps
- Coverage and importance
- Timing and sequences

The Roll-out management function is considered necessary when having a high rate of change in the network, as the typical situation is for a greenfield operator. Therefore, we suggest that Roll-out management is given high priority in the systems plan for such operators, either as a separate system or by other means.

Facility planning may cover the following data subjects:

- Plans and their coverage
- Housing, property, energy supply, air conditioning, equipment, racks and other components
- Work force, contracts and timing
- Available product types and price lists
- Product usage and costs
- Customer and usage prognosis
- Investment costs
- Operational costs
- Income per station
- Strategic value
- Income prognosis
- Investment analysis

Facility planning covers the basic engineering activity of designing the network and finding all components that should be put in place for a geographical area. Facility planning incorporates calculation of costs of a plan or of alternative plans, and to do investment analysis of the same.

Transmission optimization may cover the following data subjects:

- Use of other operators' network
- Design of multiplex hierarchy
- Placement of routers and other nodes
- Optimal routing of connections
- Planning of reserves

Transmission optimization is about optimal design of the transmission network. Diverse routing is one aspect of the transmission optimization.

Traffic planning covers the following data subjects:

- Routing tables and traffic routing
- Traffic prognosis and congestion
- Quality requirements, availability and throughput
- Alternative traffic routing
- Number capacity and overall usage of the capacity
- Disposition of emergency numbers

Traffic planning is about traffic routing, ie. design of the tables that are used to direct the traffic. The routing will take place over transmission resources that are already designed in Transmission optimization, and expected traffic load is a design parameter for Transmission optimization. However, Traffic planning takes place on given transmission resources. Traffic planning should support direct update of routing tables in routers and act as an umbrella routing management system.

The Trouble ticketing system may manage the following data subjects:

- Customer faults
- Network faults
- Work flow including aspects of workforce assignment


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Trouble ticketing covers both customer reported trouble and network faults. However, if order management in the Logical network inventory management is generic and covers work flows, it should be capable of covering the network part of Trouble ticketing.

The Plan (portfolio) management may manage the following data subjects:

- Plan identifiers, timing and short description
- Overall costs
- References to plan documents of any type
- References to contracts on planning
- References to updates and status in inventories

The Plan management also keeps track of Roll-out plans and plans in the inventories, but the details of the roll-out should be kept track of in the Logical network inventory management. Plan management keeps track of the plan, while Roll-out management keeps track of the elements in the implementation of one or more plans; hence, their contents is very different. Also, if the planning is outsourced, the plans may only appear in external tools or applications.

The reader should note that Number planning is not covered in the above list of systems. Furthermore, Radio Access Network management may be separated from the Logical Network Management system. Service Monitoring may be added to the list of systems, while Customer Experience monitoring may be deferred to Business Support Systems, where Number planning may belong, as well. However, there is nothing fundamental in the distinction between OSS and BSS.

## Interworking Plan

In the Interworking plan, we will distinguish the data flows as shown in Figure 3.

The reader should note that manual interworking is not shown. This means that for example manual update of the inventories based on output from the network planning tools, like Radio planning, Roll-out management, and Transmission optimization, are not shown. Copy and paste are counted as manual interworking. A Reference is a click at an identifier in one system that takes you to the referenced object in another system.

*Alarm surveillance – Logical network inventory management:* Topological root-cause analysis is a function primarily of the Logical network inventory management. A selected set of alarms are transferred from Alarm surveillance, and the function finds common resources that may contain the root cause of the alarms. If wanted, the identified common resources from the Logical network inventory management may be fed into a similar function in the Physical network inventory management to find the common physical resources.

*Alarm surveillance – Performance monitoring and analysis:* The Network element managers will most often collect alarms from the network elements and route this information to the Alarm surveillance system. In some cases, the Alarm surveillance system may receive alarms directly from the network elements. Alarms may be communicated from the Alarm surveillance system to the Performance monitoring and analysis system to give a full picture of the status in the network. Also, parameters from Performance monitoring and analysis may be used to define filters in Alarm surveillance.

*Alarm surveillance – Trouble ticketing:* Alarms may initiate trouble tickets. If Alarm surveillance is handled by Performance monitoring and analysis, the update may take place from there.

*BSS – Logical network inventory management:* BSS may order access lines, eg. radio links, from the Logical network inventory management. The allocation and routing of trails may not be automated for a Mobile operator. The request may take place in real time.

*BSS – Trouble ticketing:* The Trouble ticketing may receive trouble tickets from the outside, eg. customer complaints from BSS. The information may be received in real time.

*Geographical map management – Logical network inventory management:* The Logical network inventory management may use maps from Geographical map management as backgrounds for making geographical or schematic presentations. This means that coordinates of cross-coupling sites must be stored in the Logical network inventory management.

*Geographical map management – Physical network inventory management:* The Physical network inventory management may use maps from Geographical map management as backgrounds for making geographical or schematic presentations. This means that

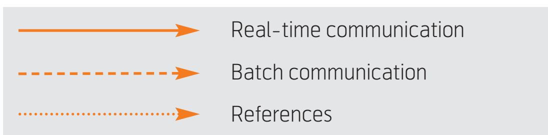


*Figure 3 Data flows*


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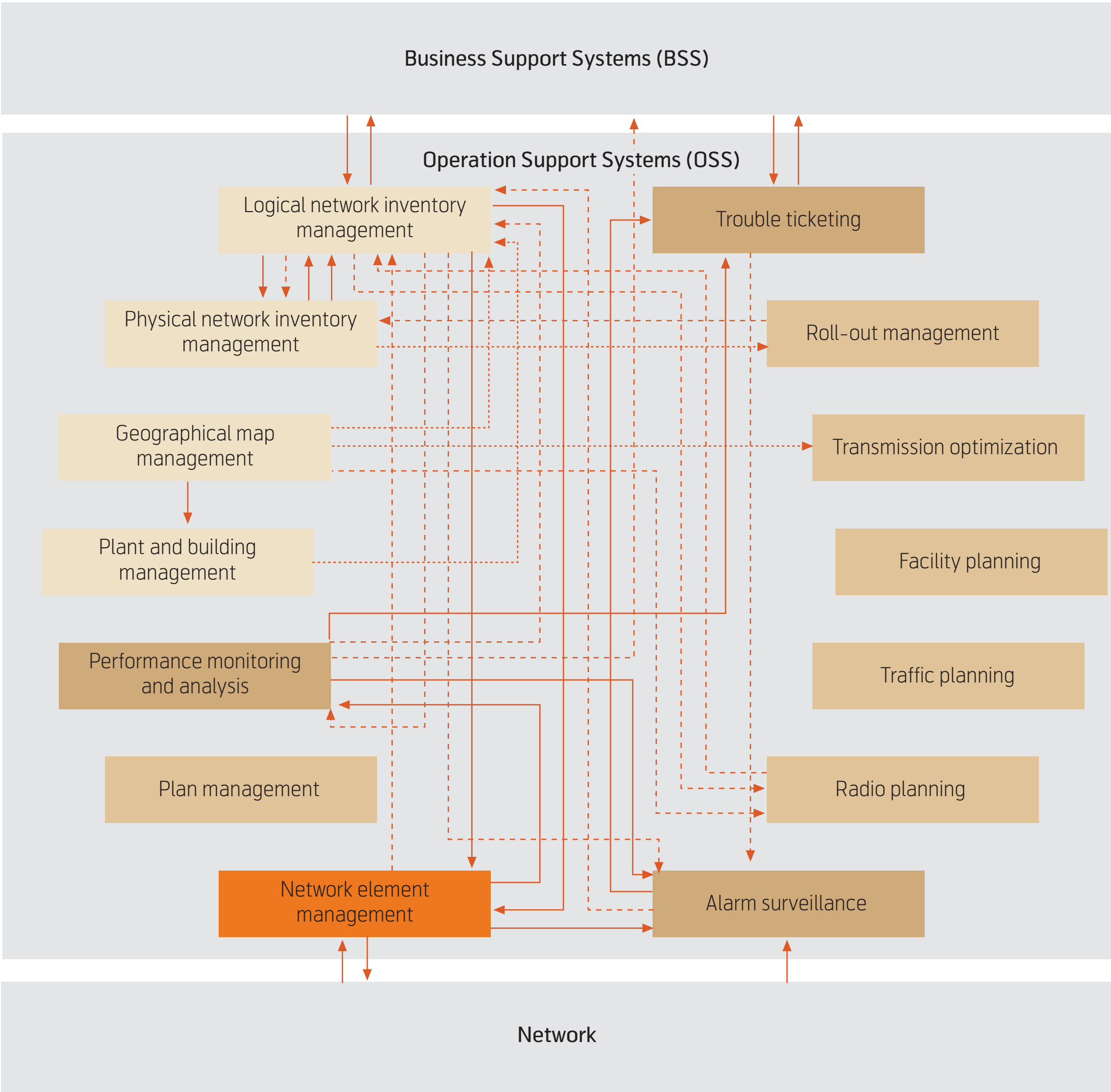


*Figure 4 Interworking plan*

coordinates of nodes and cable bends must be stored in the Physical network inventory management.

*Geographical map management – Plant and building management:* The Plant and building management may use maps from Geographical map management as backgrounds for making geographical or schematic presentations. This means that coordinates of sites must be stored in the Plant and building management.

*Geographical map management – Radio planning:* Information about the geographical topology in three dimensions needs to be downloaded to the Radio planning tool to decide radio coverage, radio link and placement of sites.

*Geographical map management – Transmission optimisation:* Geographical maps may be used as background information for presentation of transmission configurations.

*Logical network inventory management – Alarm surveillance:* See the full text under Alarm surveillance-Logical network inventory management.

*Logical network inventory management – BSS:* The Logical network inventory management may provide trail identifiers in an order, together with activation status and billing data to BSS. The information may be transferred in real time without direct action from a human user. Also, results from root-cause analysis may be transferred to BSS for information to the customer etc.

*Logical network inventory management – Network element management:* The long term vision is that all design of the network will take place in the Logical network inventory management.

Before doing network design in the Logical network inventory management, network planning may have taken place in Radio planning, Transmission optimi-


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sation, Facility planning and Traffic planning. Roll-out management may or may not have taken place before the update of the Logical network inventory management. All communication from the network planning systems to the network design in the Logical network inventory management may be manual. This does not prevent that a network designer copies data electronically from one system to the other, but data structures and identification may not be updated automatically through this operation.

*Logical network inventory management – Network element management:* All design and configuration of the network should ideally first take place in the Logical network inventory management and then be downloaded to the appropriate Network element managers. This update may take place in batch mode.

*Logical network inventory management – Physical network inventory management:* The two inventories may be rather disjoint, but the Physical network inventory management may contain cross-coupling sites and physical links that also appear in the Logical network inventory management. This copying may take place in batch mode. Results from root-cause analysis in the Logical network inventory management may be transferred to the Physical network inventory management for further processing.

*Logical network inventory management – Radio planning:* See text under Radio planning-Logical network inventory management.

*Network – Alarm surveillance:* Alarms may be received directly from network elements without being routed via any Network element manager.

*Network – Network element management:* See text under Network element management – Network.

*Network – Performance monitoring and analysis:* Performance monitoring and analysis may receive data directly from network elements without going through Network element managers.

*Network element management – Alarm surveillance:* Unfiltered alarms are received in real time from the Network element managers or directly from network elements.

*Network element management – Network:* See text under Network-Network element management.

*Network element management – Logical network inventory management:* See text under Logical network inventory management-Network element management.

*Network element management – Performance monitoring and analysis:* Performance monitoring and analysis receive results from measurements.

*Performance monitoring and analysis – Alarm surveillance:* Results from Performance monitoring and analysis may be used to set filtering parameters in Alarm surveillance, and Alarm surveillance may receive alarm-like events based on threshold-crossing events in Performance monitoring and analysis.

*Performance monitoring and analysis – BSS:* Performance data may be communicated to the BSS side for presentation or analysis purposes.

*Performance monitoring and analysis – Logical network inventory management:* See text under Logical network inventory management – Performance monitoring and analysis.

*Performance monitoring and analysis – Logical network inventory management:* See text under Logical network inventory management-Performance monitoring and analysis.

*Physical network inventory management – Logical network inventory management:* See text under Logical network inventory management-Physical network inventory management.

*Plant and building management – Logical network inventory management:* By clicking at the identifier of a cross-coupling site in the Logical network inventory management, the Plant and building management may show drawings and other information of the building. This may require implementation of single sign-on.

*Radio planning – Logical network inventory management:* All parameters from decided radio plans shall be uploaded from Radio planning to the Logical network inventory management as part of the network design. The upload may take place in batch mode initiated by a status setting on a decided Radio plan. Here some co-ordination of status settings in the Radio planning and Plant management could be made.

*Roll-out management – Logical network inventory management:* Data from Roll-out management may lead to updates of dates and status of logical network resources.

*Trouble ticketing – Alarm surveillance:* Trouble ticketing may report status of corrected faults back to Alarm surveillance for clearing of alarm suppressions.

*Trouble ticketing – BSS:* Trouble ticketing may send trouble tickets to the BSS side, installation companies or other operators.

*Other:* Performance monitoring and analysis may present information as overlays to geographical maps; this is not illustrated. Creation of prognosis and budgets are considered to be outside the scope of OSS, and are not shown. Also, collaboration with partners, such as other operators, installation companies and planning companies is not shown. Collaboration with other kinds of planning, such as with municipalities, water and energy suppliers are not shown. Communication with outside sources, such as ERP is not shown. Note also that data from Performance monitoring and analysis may be used in several of the planning activities, but this is not shown as an automatic interaction.

## Future Work

Further work items related to the CONTEST OSS Reference Architecture area may include:

- Further detailing of the architecture on network planning;
- Coordination of the architecture with BSS and ERP;
- Providing references to standards and relevant literature for each system domain;
- Evaluation of the reference architecture by the OpCos;
- Evaluation of the reference architecture against the solutions available from the OSS vendor community;
- Ongoing study of OSS architectural challenges related to management of IP traffic and dynamic establishment of connections, eg. over IP/MPLS;
- Study of relationship between OSS and IT-management (similarities and differences);
- Development of more detailed interworking plan for selected areas, eg. specifying data mastering, flow directions, interactions, and data subjects;
- Study of data structures for selected system domains within OSS;
- Develop RfIs/RfQs for selected system domains;
- Study the possibility to avoid horizontal partitioning in selected system domains;
- Establish target system plan for each OpCo;
- Establish evolution plan (transition from current systems and interfaces to planned systems and interfaces) for one or more OpCos.

## References

1 Meisingset, A. Introduction to Information Systems Architecture. *Telektronikk*, 94 (1), 3-11, 1998.

Note that CONTEST reports are not open for readers outside Telenor. Therefore, no reference is given to these, even if they give the reasoning behind this paper.

*For a presentation of Arve Meisingset, please turn to page 80.*


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