APPENDIX D

INFRASTRUCTURE

Contents

1 INFRASTRUCTURE OVERVIEW

The Infrastructure section is responsible for project planning, advisory services, procurement, configurations, automation, development and operation of:

- 2260 virtual and approximately 600 physical servers
- NRKs storage platform (covering the entire NRK). Involves approximately 35PB, close to 50 storage systems at around 20 different locations), all hardware operation, OS operations for Windows servers, and backup.
- Facilitation for monitoring of windows servers and applications and automation of operational tasks (SCOM, OMS, Powershell, SquaredUp).
- Microsoft services for Active Directory (3 AD domains), DNS, DHCP, ADFS, group policy. Terminal servers for user applications, remote access for external operators, configuration of AD etc.
- Configuration management (ConfigManager), software deployment, tactical and operational IT security, patching and antivirus on Windows servers (SCEP)
- Communication tools:
    - Skype for Business
    - Hybrid Exchange solution
- Phone system (Skype for business) and monitoring (Prognosis)
- Skype meeting room equipment, access control systems, visitor system (Visitor), and video monitoring of NRK premises
- Server on call support ("Servervakt") for production- and broadcasting critical services defined in the service catalog with 1 hour response time, evening, night and weekends. Total of 6 people.

2 SERVICES AND CUSTOMERS

The Infrastructure section performs several different services, which will be described in further detail in this chapter. The services they provide have (for this RFI) been divided in the following categories:

- Server and storage
- Active Directory (AD)
- System operation
- Monitoring

The number of server configurations and decommissions in 2016 and 2017 are given in the table below, and provide an indication of the volume of the services.

Task	2016	2017
Server installations and configurations	790	745
Server decommissioning	616	377

Table 1 - Server configuration and decomissionins

Total changes in NRK in 2017:

Type of change	2016	2017
Major change	173	111
Time critical change	14	34
Standard change	686	182
Patching all servers		Once every month

Table 2 - Changes

2.1 Server and storage

2.1.1 Project planning and advisory

The Server and Storage group performs various project planning and advisory services, such as:

- Ensures correct solution specification (requirements specification) so that systems are not under- or over dimensioned, and are adapted to the existing systems portfolio in NRK. Standardized components are important (2-vendor strategy).
- Help IT contacts with solutions at the regional and branch offices
- Assists in “special” projects that require “special” solutions
- When other IT communities in NRK need IT solutions, they approach the Server and Storage group for suggestions and guidance

2.1.2 Procurement

The Server and Storage group assists the Procurement department with procurement of new equipment.

- Execution of mini tenders, requirements specification, production of tender documents and interaction with the Procurement department in NRK
- Procurement of all sorts of equipment within data center, storage etc. (except for network)
- Participation in larger procurement projects, frame agreements etc.
- Vendor- and contract management

2.1.3 Installation

The Server and Storage group performs installation of new infrastructure.

- Regional offices: Coordination between local NRK contacts and vendors for installation and commissioning. Coordination with Network in Oslo and local NRK contacts for correct configuration etc.
- Pickup at the goods central, unpacking, installation in racks, cabling, OS installation, patching, network setup
- Installations are ordered by customers through HP Service Manager

2.1.4 Operations and customization

The Server and Storage group performs various Basic Operations (BO) and Data Center (DC) services:

- Basic operations of Windows Server OS in different versions from 2003 and later. Hereunder different roles, primarily file server. Hereunder driver patching, firmware/bios updates and troubleshooting.
- Hardware operation of servers and storage. Replacement of defective parts.
- Backup (Veritas Netbackup and BackupExec), operation, installation, setup and patching
- IBM Tape robot, operation, installation of tape, decommissioning of tape
- VMWare operation. Installation of vSphere products, updates, patching
- Fibrechannel network. Installation, configuration, operation, updates, patching of Brocade FC network
- Block storage, installation, setup, disk provisioning, troubleshooting, integration with VMWare etc. (Hitatchi VSP-G, EMC VNX, EMC VMAX, Dell Compellent, Dell MD). Static setup, minimal changes.
- Dell EMC Isilon (NAS storage): installation, setup, provisioning, integration with AD, allocation of access rights. Much more dynamic environment, with lots of changes.
- Hardware monitoring of servers and storage components.

- Data room (DS1, DS2, Tape room, Backup room); Installation of racks, power rails, ordering installation of electricity from Electro, governing cooling with Facility Services/Real Estate ("Eiendom"), tidying etc.
- Use a significant amount of time on legacy storage systems, servers and OS's that demands careful operation in order to be kept alive. This hardware cannot be decommissioned until the system owner uses resources on modernizing applications so that they can run on modern hardware (VM's/cloud etc.).

2.1.5 Decommissioning

Server and Storage is responsible for all decommissioning (phasing out) of infrastructure:

- Phasing out involves "the opposite of installation"
- Making sure AD, System Center, IP database, hardware monitoring etc. is phasing out correctly.
- Contact with other areas to collect input for further development of platforms
- Leveraging the contacts in the organization. The employees have been in the organization a long time, and know who to contact

2.2 AD group

The AD group is responsible for operations, maintenance and development of:

- Microsoft Active Directory-services (AD (Active Directory), DNS (Domain Name System), DHCP (Dynamic Host Configuration Protocol), ADFS (Active Directory Federation Services), LAPS (Local Administrator Password))
-
- Email: operation and maintenance of mailboxes, shared mailboxes, public folders, meeting rooms etc., transport rules (Microsoft Exchange-Online (Office 365)).
- Email security maintenance: EOP and ATP (Exchange Online protection, Advanced Threat Protection)
- Exchange – internal installation because of ADFS, email-relay (unauthenticated, from a system without a mailbox, notifications…), administration and configuration of AD-elements, etc.
- Terminal server service, applications (client software) run on terminal server, systems administration, vendor access (external operators)
- Azure AD Connect, synchronization of AD-info with Azure
- Maintenance of script for license allocation ("Lisenstildelingsscriptet")
- Participation in projects that need AD-integration, email (e.g. Workplace, Economy-project (Agresso), etc.)

2.3 System operation group

The System operation group is responsible for the configuration database for Windows servers, server antivirus, and designing and planning patching on servers. They also performs various Application Operations (AO) Services.

2.3.1 Config manager

- Systems maintenance/design/architecture
- Operation of server topology
- Areas of use:
    - Monthly patching of all servers
    - Timed patching based on defined service windows for production systems
    - Deployment of software updates for servers
    - Server management
        - Inventory system - statistics
        - Baselining – making sure servers have as similar configuration as possible.
    - "Rapid deployment" of patches after installation of server.
    - Ability to handle “critical PCs” to achieve predictable service windows
        - Handles servers today, but was used for clients before
    - Web reports - providing statistics for internal and external operation resources, system owners and license reporting.
    - Software deployment for servers (may apply for client OS /mobile components)
    - Contribute with OS (operations) competence towards the operating environments

2.3.2 Server patching

Various services related to server patching:

- Logistics, design and customization of patching for NRK’s production and decommissioning solutions.
- Integration with service catalogue (Tjenestekatalog) for service windows.
- Assistance to internal and external operating groups.
- Contribute with OS (operations) competence towards the operating environments
- Facilitate optimized operation of production systems and the Windows server platform.

2.3.3 Skype for business

- NRK’s Chat/Telephony solution for employees (voice and video conference).
- System maintenance, architecture/design
- Operation of server portfolio
- Advanced troubleshooting and integration with Avaya telephony service solution (External vendor)
- Operation of Skype meetings

- Chatrom for "Breaking News"
- Technical consulting in designing Skype meetings

2.3.4 Prognosis

AO of the Prognosis application, which is used for monitoring of telephony and Skype services.

- Monitoring, statistics and troubleshooting.
- Monitoring of Avaya telephony systems and Skype for Business.

2.3.5 Operating the servers for monitoring of the NRK-building

BO and DC of servers for monitoring of the NRK premises.

- Server operations for DVM-video monitoring
- Server operations for EBI access control
- Contact point towards external vendors with regards to monitoring cameras (from an IT point of view).

2.3.6 Tansa: language proofing system for journalists

Language proofing, spelling and grammar checking system. Implemented as a service in Polopoly and ENPS. Operations of servers and application on servers/clients, configurations, bug fixing.

2.4 Monitoring group

The monitoring group delivers monitoring and automation to the enterprise.

2.4.1 Monitoring

The main responsibility of the Monitoring group, is delivering monitoring as a service for the enterprise.

The customers are NRK internal system administrators, managers and the Operations Bridge (Bifrost). Each group of system administrators receive their own tailored and focused dashboards based on the system ownership described in the service catalogue. In addition to standard monitoring (Management Packs) delivered by Microsoft, the Monitoring group have created custom Management Packs for NRK in-house applications in cooperation with the application administrators/developers.

Automation in Powershell is utilized to enrich alerts with Service Catalogue data and do automatic alert handling.

The monitoring platform is setup as a highly available service with servers in our disaster site in addition to the main site.

The platform is delivered using:

- System Center Operations Manager
    - Agents deployed: 2000 Windows Servers
    - Managements Packs: 300 total (50 developed by NRK)
- Squared Up (primary dashboard front end)
    - 100 dashboards (all NRK made)

- Custom Powershell scripts:
    - Alert management: tag service catalogue information and set resolution states based on set of rules.
    - Agent maintenance automation: Repair SCOM agents and remove agents that is removed from the CMDB.
- Custom CMDB (Sources: AD, HP SM, VMware, Salt stack, SCCM)
    - 25 Powershell scripts for data synchronization to a SQL database
    - Contains about 50 SQL-views and 30 Stored Procedures
- HP Connect-IT for integration with HP Service Manager (Service Catalogue/CMDB)
- Microsoft Operations Management Suite (Log Analytics and Change Tracking, integrated with Squared Up for displaying OMS-/change tracking-data in dashboards)

An overview of the monitoring platform is given in the figure below:

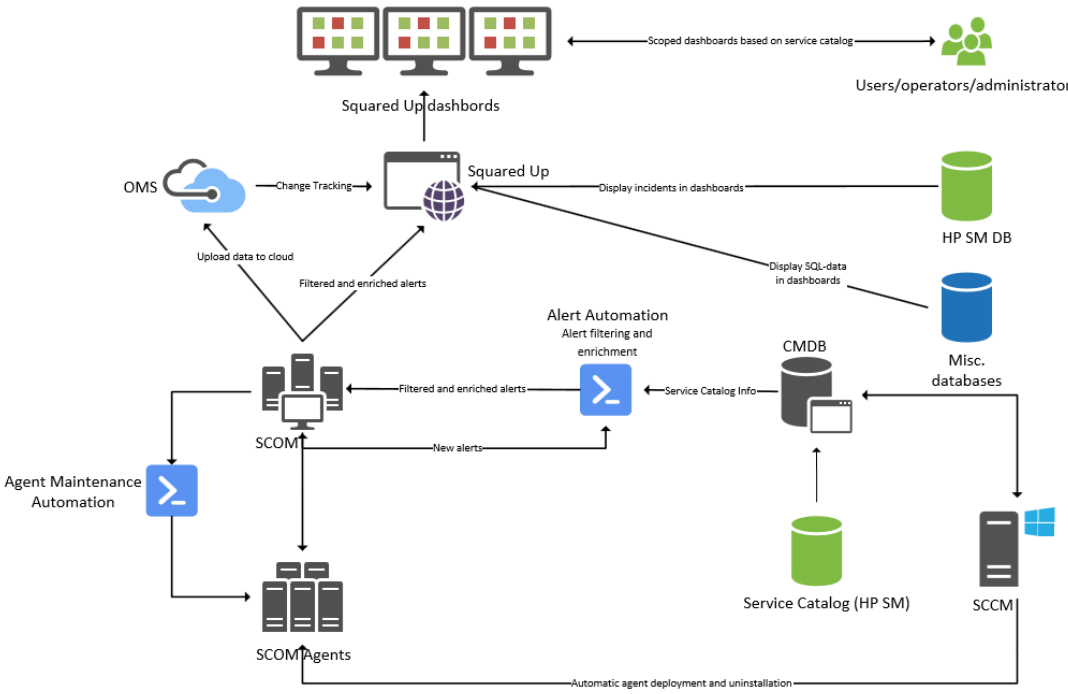

Figure 1 – Monitoring platform

The Monitoring group performs the following tasks:

- Operations/development of System Center Operations Manager in entire life cycle
- Operations/development of Squared Up (Visualization platform for SCOM etc.)

    - HTML5-dashboards customized for each operating environment
    - HTML5-dashboards for services and for specific object types
- Operations/development of integrations between SCOM and Squared Up/OMS/HP SM/CMDB/Others
- Tuning of alert flow from of off-the-shelf (windows/sql etc.) and custom NRK management packs.
- OMS: Operations Management Suite
    - Utilizes Change Tracking and Log Analytics.
- Development of monitoring (Management Packs) of internal applications and systems.
- Cooperation with Operations Bridge (Bifrost) for improvement of dashboards and alert tuning.
- Documentation and source code lifecycle management.

2.4.2 Automation

Various tasks related to automation in different contexts:

- Competence in Powershell (primary) and ASP.net/C# (Web frontend), for automating the section's tasks and other operating environments i NRK.

- Datamining/Ad hoc-scripting («on demand») for various environments in NRK

Automation developed by the monitoring team:

1. DataHub (Custom CMDB): As described in section 2.4.1.

2. Integration of Service Manger (HP) and System Center Configuration Manager to drive the automatic server-patching. Based on powershell scripts synchronizing collections in SCCM with data from the service catalogue in HP SM.

3. SCOM automation: As described in section 2.4.1.

4. User automation:

   Automation of the lifecycle of user accounts and related resources, based on data from the HR System.

   The main user automation engine is developed in Powershell. The web front end is a web application developed in ASP.net (C#). Both the main engine and the web application is built on top of a MS SQL database.

   Components:

- The user automation engine (Powershell):
  Receives job files (JSON) from the Service Platform (HR-System), and updates properties for existing user account in Active Directory if necessary. If the AD account does not exist, the job will be evaluated against a set of rules. If the job satisfies the requirements, the user will be created and all necessary resources will be provisioned. Disables accounts when employment expires for a user.

- WEB Application (ASP.net application running on IIS 10):

  Most functionality of this web application is used by the helpdesk (2300 and Servicetorget) like:
  - Reactivate users in quarantine (In some circumstances, e.g. outside normal working hours, the user need to reactivate the account. Then the helpdesk may use this web form to temporary reactivate users without go through the HR-System).
  - Get user status (e.g. checking why an account is not created according to the rules for provisioning)
  - Change Office 365 license type for users
  - Display logs, reports and statistic
  - Change configuration (Thresholds, folder paths, server names, URLs, e-mail templates, field mappings)

- MS SQL database: consisting of 20 tables, 40 views and some stored procedures.

- Integrations:

  - HP Service Manager (for creating incidents)
  - Exchange Online and Exchange On Premises (Hybrid) (Provisioning mailboxes, and inform users and managers)
  - AD and Azure AD (Provisioning/deprovisioning AD-accounts, enabling Multi Factor authentication for users in Azure AD)
  - Skype for Business
  - File servers (home directories)
  - SQL server (logging, creating/updating jobs)
  - Service Platform (send update messages (REST) back to HR-system with changes in the AD-properties: e-mail address, telephone number and samaccountname)

The Monitoring group performs the following tasks:

- Developing new functionality.
- Perform configuration changes when necessary
- Documentation
- 3rd line support and operations:
  - Check monitoring status in tailored dashboard and fix errors when it occurs
  - Advanced log analyses
- Cooperation with the Service Platform team and the HR-system team.

The figure below gives an overview of the User Automation:

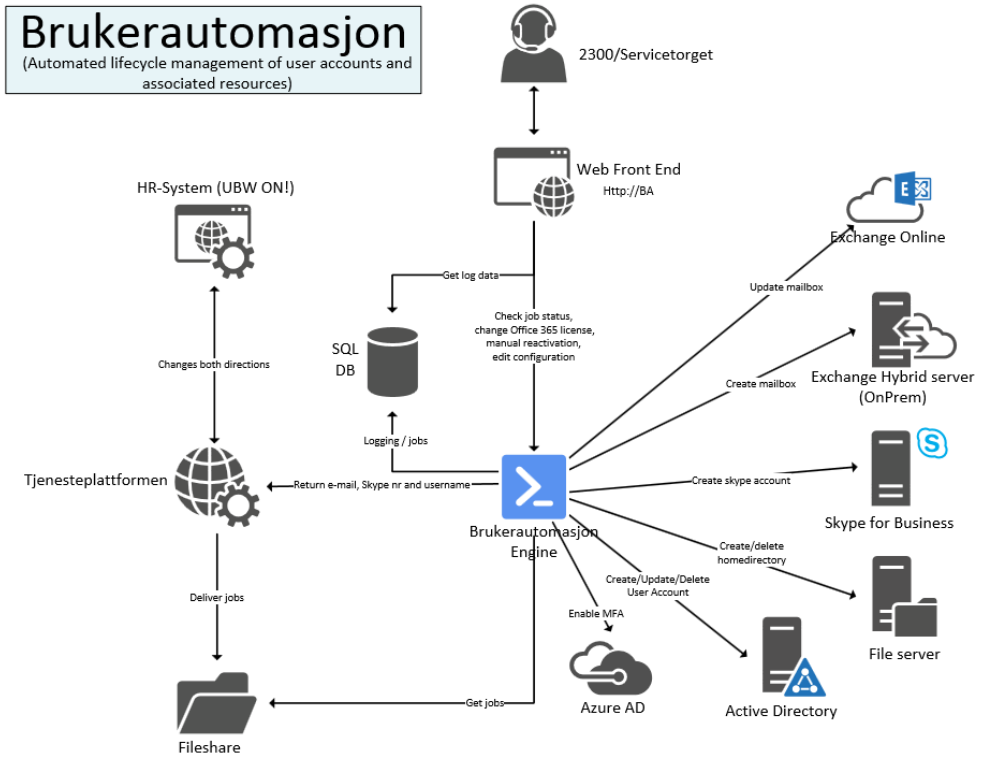

Figure 2 – User automation

2.4.3 Ad hoc

The Monitoring group also performs various tasks on an Ad hoc basis. This includes, but is not necessarily limited to, consulting, crisis management, troubleshooting and problem solving. The services are based on insight acquired from lengthy experience with NRK and various internal IT-systems.

3 STRATEGY

The Infrastructure section does not have a clearly mandated strategy, but works according to a set of guiding principles:

- **Virtualization**: Virtualization is preferred over physical servers
- **Industry standard**: Industry standards, standard systems and components are to be followed whenever possible
- **Best practice**: The Infrastructure section should strive to work according to established best practice in their field.

- Requirements for IT-systems used at NRK (v3.0).
    - See Attachment D.1 to this Appendix.

Furthermore, the Infrastructure section works according to a two-vendor strategy in order to ensure competition.

4 PROJECTS

The Infrastructure section is currently conducting several projects, and more are planned. In this chapter, all major projects affecting the Infrastructure section are described, including lifecycle management (lifecycle management is carried out as projects in the Infrastructure section).

4.1 Server and storage

4.1.1 Backup project

4.1.1.1 Background and purpose

The purpose of backup project is to enter into a service contract with one financially solid and otherwise competent contractor for backup solutions and related services in order to provide NRK with a simplified, robust and future proof solution that can grow flexibly over time, reduce risk, cost and restore times.

The new solution will be the backup solution for both general IT and media production. Hence NRK has particularly encouraged suppliers/manufacturers of backup systems and services with extensive experience and multiple relevant references to request for participation.

NRK aims to enter into a service contract for a backup infrastructure with a more extensive and unified backup strategy based on standard backup technology. The new backup solution shall provide NRK with a solid and efficient foundation for backup of data in both media production and traditional administrative IT-storage.

The following list defines the purpose of the procurement into more detail, with no specific order of priority:

- Simplification of management and administration
- Automated services and processes; e.g. tiering, automatic procedures of the backup system, failover of defective components etc.
- Reduction of risk, backup restore times and cost.
- Detailed reports and analytics
- Simple scaling of performance and capacity
- Increased support for backup targets; Local, private cloud, public cloud.
- Increased security in the form of high redundancy and backup

- Easy monitoring of resource usage -both capacity and performance
- Improved economy

4.1.1.2 Scope of procurement

The current backup systems at NRK are mainly configured for administrative IT, and does not cover active media production data (audio, video, graphics etc.). Only a few critical selected areas of video/audio production storage have been part of the same backup solution as for administrative IT. With this agreement NRK aims to establish a backup solution and strategy for all storage.
In 2016/2017 NRK acquired, modernized and migrated most of the old storage systems, standardizing all file based NAS storage on Dell EMC Isilon and ECS (Elastic Cloud Storage). NRK considers this as the second phase of a storage transformation process and as a golden opportunity to improve and modernize the data backup strategy.

NRKs television- and radio archive is managed separately with automated archiving and backup routines, and is currently not part of the scope for this agreement.

The new backup solution service will therefore include:

- Service operations, maintenance and monitoring
- End user support for Customer
- Any additional extension of the backup solution
- Consultancy and consulting services related to the backup solution

This procurement is supposed to cover all backup needs at NRK. Hence a solution with standardized interfaces and protocols, that can deliver the most comprehensive and simple solution while still being able to cover the specified needs is considered a strong contender.

NRK acknowledges and appreciates that the systems covering this market may have different approaches and may solve the functional challenges in different ways, and that the best approach to solving NRK's backup needs might be a mix of different systems in a modular and integrated system.

NRK expects to enter into a long-term contract, as the solution is expected to have a minimum lifetime of 5-7 years.

The scope of the procurement is based on the current needs, organisational structure and offices, and may be subject to change or adjustments as e.g. new services should be subject to be included in the service and changes in NRK’s organisational structure that may affect the agreement should occur.

4.1.1.3 Time schedule

The time schedule that has been communicated to the qualified Vendors in the backup project is presented in the table below.

Contractual dates	Tentative timeline
Signing of Contract	12. April 2018

Detailed project plan delivered to NRK	20. April 2018
Installation main office	May – June 2018
Installation regional offices	May – August 2018
Approval main office	Q3 2018
Approval regional offices	Q3 2018
Final approval entire solution	End of Q3 2018

Table 3 - Backup project – Tentative time schedule

4.1.1.4 Dependencies to the sourcing project

The backup project was initiated before the Sourcing project was started. In the initiating phase of the sourcing project, NRK considered to halt the backup project and include it in the larger backup-project. However, NRK concluded that the need for a backup solution was very high, and that the risk of waiting for the sourcing project was too high. Thus, the backup project is run according to its original plan.

4.1.2 Data migration from Windows fileservers to NAS

Migration of data from Windows Fileservers to NAS, which involves consolidation of many areas, preparation of new workflows during the transfer/move (requires a lot of effort and coordination across the organization). Many of the involved departments/areas are very critical for the production, thus for NRK to appear on TV, radio and online. The project will run through the majority of 2018.

2 persons half time. Finish by the end off 2018.

4.1.3 Phasing out Windows Server 2003 and 2008

There is an ongoing project for decommissioning Windows Server 2003 and 2008. This project has been going on for a very long time, as the vendors of broadcasting systems don't prioritize such updates, and the OS updates are dependent on updates to the software that runs on top. The goal is to migrate as many applications as possible to modern infrastructure (VMWare), or to modern hardware running newer versions of Windows Server.

No dedicated resources and no set timeline for ending the project.

4.1.4 Phasing out old hardware, servers and storage

Moving old systems to virtual servers. Takes a lot of time because they run old broadcasting-systems that are not updated to be able to run on modern infrastructure.

Running tasks. No dedicated resources.

4.1.5 Automation of server installation

A proof of concept (POC) for automation of server installations was completed three years ago. The project has been put on hold due to a lack of funding.

4.1.6 IP Adress Management (IPAM)

This project conducts an assessment of the possibilities regarding automation of the IP database. Currently using free software.

4.1.7 Access control on NAS via AD

Automation of access control in AD.

4.2 AD group

4.2.1 Two-factor authentication MFA

A two-factor authentication solution for NRK is being implemented by the user automation group in cooperation with 2300 (Service Desk). The project consists of 4 people plus participants from Service Desk, and will finish by the end of January of 2018.

4.2.2 Upgrade domain controllers to 2016

Upgrade Domain controllers (DCs) to 2016 in all domains. The domain in the disaster site is ready, working with the main domain. The project consists of two persons, and will be finished in April 2018.

4.2.3 Set up new licensing server for RDP to 2016

Upgrade Remote Desktop Software licencing server to 2016 when all Domain controllers (DCs) are upgraded. The project consists of one person, and will be finished in April 2018.

4.2.4 New terminal servers (2016) for administration of AD

RDP (Remote Desktop Protocol) server is finished, but terminal server licences for 2016 are missing. The project consists of one person, and will be finished in April 2018.

4.2.5 Upgrade of Exhange to 2016

Upgrade of Exhange hybrid on-prem to 2016. The project is currently being planned, and a suggested design has been quality assured by an external expert by the end of january 2018. The project consists of three people, and is planned to be finished by the end of Q1 2018.

4.2.6 Convert distribution groups from AD to Office 365

Convert distribution groups and move them to Office 365. The project is being conducted in conjunction with the upgrade to Exchange 2016.

4.2.7 Upgrade Azure AD Connect

Microsoft Azure AD Connect is being upgraded to the 2016 version. The upgrade is not considered urgent, and the work has therefore not started (as of January 2018).

4.2.8 Password policy

The AD Group have submitted their suggestions, tested the new policy and handed it over to the Security team. The work is almost done, and the new policy is planned to be taken into use the 5st of February 2018.

4.2.9 Domain-based Message Authentication, Reporting, and Conformance (DMARC) - email signing

The objective of the project is to reduce spam/phising that is being sent from @nrk.no adresses. The project will examine and ensure that all email being sent from @nrk.no is being authenticated by either SPF or DKIM. The project has not yet gotten a confirmation that email sent from publikum@nrk.no is authenticated. As the project also needs to analyse newsletter emails that are sent out irregularily, it is hard to say exactly when the project will finish. However, the project has (conservatively) estimated that it will finish no later than the end of March 2018, but hopefully sooner. 1 person is working on the project.

4.3 System operation

4.3.1 Managing critical production-clients with ConfigManager

Prepare for the use of ConfigManager to patch production critical systems running on client-HW. The project consists of 2 people, and is planned to be finished in March 2018.

4.3.2 Upgrade server-baseline on all Windows servers with Powershell 5.1

The project team will design the solution, prepare and complete it. The project consists of 2 people, and will finish in April 2018.

4.3.3 Upgrade servers for building security

The project will upgrade the servers (new hardware) for the building security system, including designing the solution, and prepare and complete the replacement. The project is being conducted by 1 person, and finishes in march 2018.

4.4 Monitoring group

4.4.1 Upgrade from SCOM 2012R2 to SCOM 2016, including dashboard upgrades.

Side-by-side upgrade of SCOM Infrastructure. The project consists of 3 people, and finishes in Q1 2018

4.4.2 Development/implementation of new functionality in User automation

License-saving change in new user creation automation. The project consists of 1 person, and finishes in March 2018

4.4.3 Utilize Microsoft OMS (Operations Management Suite) in delivering operations data to administrators

The project aims to make use of solutions within OMS to make available OMS information in SquaredUp dashboards for administrators. The project consists of 3 persons. It starts in Q1 and is planned to finish in Q3 2018.

4.4.4 Monitoring of Broadcasting Workflows.

Participation in project that intends to set up a unified, cross-platform, monitoring of broadcasting workflows. The project will consist of 1 person, but no timeline has been decided yet.

4.4.5 End user access to local admin password on their laptops/clients.

Web portal that enables users to get passwords sent to them via SMS message.
The project consists of 1 person and finishes in Q1/Q2 2018.

5 SERVICE LEVELS

Services in the Service Catalogue are categorized according to the following four priority levels:

1. Services that are critical for broadcasting: problem solving starts as soon as notification of critical error is received. If critical errors happen after regular hours, it is handled by an employee on call-duty (maximum one hour from call is made to person on duty arrives).
2. Services that are critical for production: problem solving starts as soon as notification of critical error is received, as long as there is not already ongoing problem solving on a critical broadcasting error.
3. Support systems = third priority
4. Non-critical services = fourth priority

Service levels for the BO and DC infrastructure today is best effort. There are no set SLAs in NRK. The infrastructure has been built to a 99% uptime standard. And all the infrastructure is the same for all systems in NRK. There is no "special" infrastructure for the critical systems.

6 SPENDING AND BUDGET

This information will be disclosed at a later stage in the process.

7 EMPLOYEES

Responsibility (per resource/employee)	Association
AD-operations	Full time
AD-operations	Extern consultant
AD-operations	Extern consultant
Automation and monitoring operations	Full time
Automation and monitoring operations	Full time
Automation and monitoring operations	Extern consultant
Server and storage	Extern consultant
Server and storage	Full time
Server and storage	Full time
Server and storage	Full time
Server and storage	Full time
Server and storage	Full time
Server and storage, team leader	Full time
System configuration operations + systems operation	Full time
System configuration operations	Extern consultant
Section leader	Full time

Table 4 - Employees

External: Approximately 5 FTEs.

8 NECESSARY HARDWARE, SOFTWARE AND FACILITIES

8.1 Storage and network infrastructure

At NRK there are two major platforms for storage. One for file based storage, and one for block-based VMware and database related storage. Hence two different backup solutions for these two categories of storage, could be beneficial.

The main platform for file based (NAS) storage is Dell EMC Isilon, while the main platform for block storage is Hitachi VSP G Series.

In addition to NAS and SAN storage, NRK also has the object based private cloud storage solution Elastic Cloud Storage (ECS) from Dell EMC.

The Isilon system in Oslo main office Marienlyst has two storage pools of storage. One on the X nodes and one on the NL and HD nodes.

The reason for this is that there are different systems that needs different performance of storage.

X tier is called “mediaproduction” and it is about 2PB in size, the HD/NL tier is called “hdtier” and is about 6PB in size. The system is at about 65% capacity today, with addons of more hardware coming very soon.

The systems that have the highest performance needs that are connected to the “mediaproduction” tier are the editing clients and systems needing higher performance.
IP based video editing is the current production platform at the central Marienlyst site as well as regional offices, using Dell EMC Isilon network storage. This platform requires a high performance local area network with high bandwidth and low latency. This to get the best performance possible on the network. There are over 150 editing clients in NRK. These systems read and write directly to this tier of storage.

The lower performing systems like the radioarchive (about 3PB of storage) read and writes data directly to the "hdtier" storage. Many other SMB shares and NFS exports are also reading and writing data directly to this tier.

The Isilon system is automatically managed with tiering/smartpools, policies and quotas.
Each SMB share and NFS expoert has a quota and a tiering policy attached to it. So that it can't fill up the whole system. Today there is about 150 quotas on the main Isilon system.
The systems in NRK that use Isilon as part or only storage is for example DigAS, Origo, Programbank, PRF, Oda, Adobe Edit Anywhere, Vantage, Potion, Sigma and many other systems.

It is also used for many other purposes in NRK like general purpose shares.

Isilon will in 2018 be the main storage platform for all production in NRK. All editing, VFX work, audio editing, transcoding and so on will be done with Isilon as the main storage platform. This makes Isilon one of the most critical systems in NRKs production.

The ECS system is today 8PB and not in much use. NRK will during 2018 split this system into two systems of about 4PB each and geo-replicate the system. The ECS system will then be used as cloudpool for the Isilon system and as the lowest performing tier of storage.

On the Hitatchi systems there are two tiers on the G600 systems. With 150TB of flash on 650TB of spinning 7.2K drives. Today the systems are at about 50% usage each.

The fiber-channel network used for the SAN storage is Brocade based with two X6-4 datacenter switches as the core for the two fabrics in NRKs main office.

The same, in a smaller scale, is in effect for the branch and region offices.

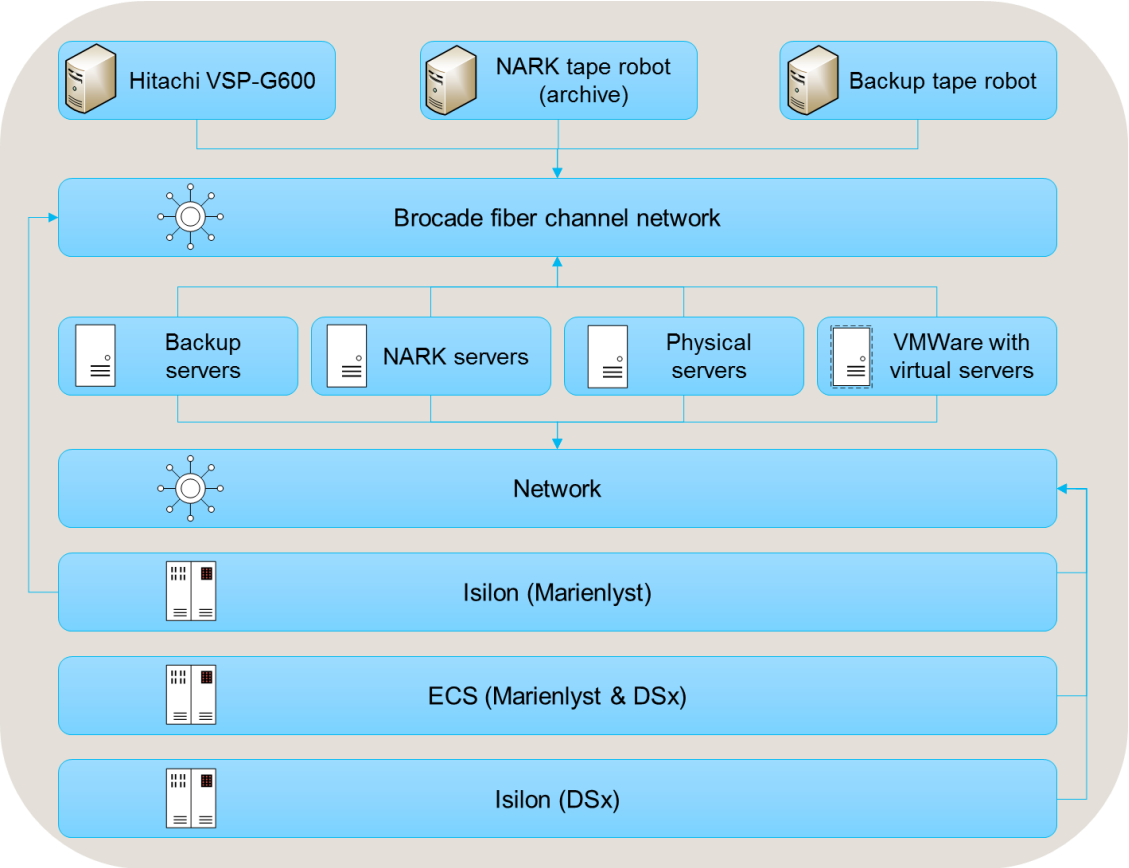

Figure 3 - The components in the storage and network infrastructure

Example of workflows in Figure 3 are described below.

Example 1, TV Studio Production:

- A production inputs material from a camera to an editing station, these files are stored over the network to the Isilon system
- The material is edited and is put into the different systems (running on both virtual and physical servers) with metadata attached to it. This step also includes transcoding the file. Systems that is included here is metadatabank, PRF, PI, Omnibus G3, Vantage, Adobe Premiere and more
- The file is now ready for airing, the media asset management system will now put the file into the NARK TV archive. This file is then stored on a cached area for the DIVA system for a period of usually 2 weeks on the Isilon, after this time the files is transferred to the NARK taperobot
- During this period, the area this data is stored in is taken backup off through the backup servers, data is transferred using NDMP over the fiber channel network to the backup taperobot
- When the file is ready to be aired or published to the web, a user can order this file through, for example, Potion. Then several systems will get this file from NARK, transcode it to several formats and publish it to NRK's CDN network. The files will then be available for a set period of time on the web. When the set time period has passed, the files will be deleted from the CDN network

Example 2, Radio studio production:

- A radio studio broadcast is completed and has been recorded in the DIGAS system. This file is the transcoded to correct format. Metadata is added about the system in different systems.
- The transcoded file is then put into the radio archive system, the storage for the radio archive is Isilon
- Today, the radio archive has no backup or replication
- When the file is ready to be aired or published to the web, a user can order this file through, for example, Potion. Then, several systems will get this file from NARK, transcode it to several formats and publish it to NRK's CDN network. The files will then be available for a set period of time on the web. When the set time period has passed, the files will be deleted from the CDN network

Example 3, Data tiering on Isilon:

- After a set period of time, a file in a folder will be moved from X tier on Isilon to the HD tier. This time is set by a policy on the Isilon system on a folder basis
- After even a longer time, the data will be moved from the Isilon HD system tier to the ECS system. There is a stubb file left on the Isilon system so that the user or the system using that file will not know that the file has been moved

8.1.1 Current Backup Solution

As mentioned earlier, there is an ongoing a process for procuring a new backup solution. This section briefly describes the current backup solution.

As part of the current solution, NRK has an IBM 3584 robot. IBM has given an end of life notice on the robot.

Data from the current backup solution will not be transferred to new solution and is not part of the scope of the backup project. The data will be left where it is and the solution will be scaled down as the retention times are reached. All operations will be handled by NRK.

8.1.2 Office/site categories

This is an overview of the total storage capacity for the different office/site categories.

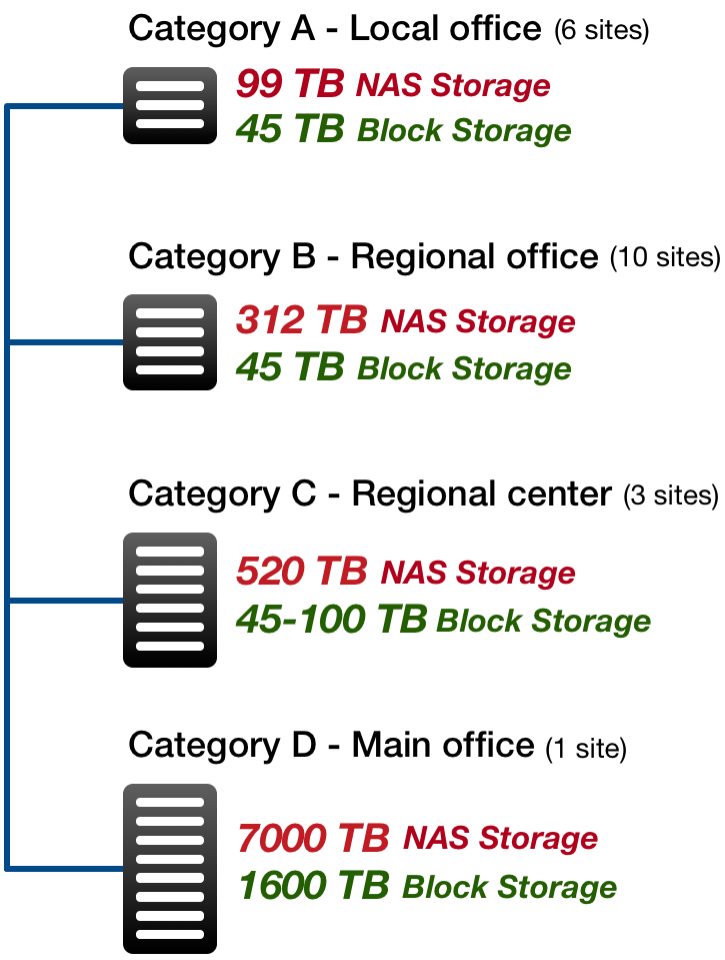

Figure 4 - The total storage capacity for the different office/site categories

8.1.3 Dell EMC Isilon

NRK has standardized on using Dell-EMC Isilon for NAS storage on all locations.

- For the local offices, a 4-node setup with X210 nodes is used. They are all connected with dual 10Gb Ethernet frontend. 2 GB/s total bandwidth
- For the regional offices, a 4-node setup with X410 nodes is used. They are all connected with dual 10Gb Ethernet frontend. 5.6 GB/s total bandwidth
- For the large regional centres, a 6-node setup with X410 nodes is used. They are all connected with dual 10Gb Ethernet frontend. 8.6 GB/s total bandwidth
- For the DR site, a 4-node setup with NL410 nodes is used. They are all connected with dual 10Gb Ethernet frontend.
- For the Oslo main site, there is a totally different setup with about 50 nodes of different types. They are still being setup and will by the end of 2017 all be connected with dual 10Gb Ethernet frontend. 23.8 GB/s total bandwidth.

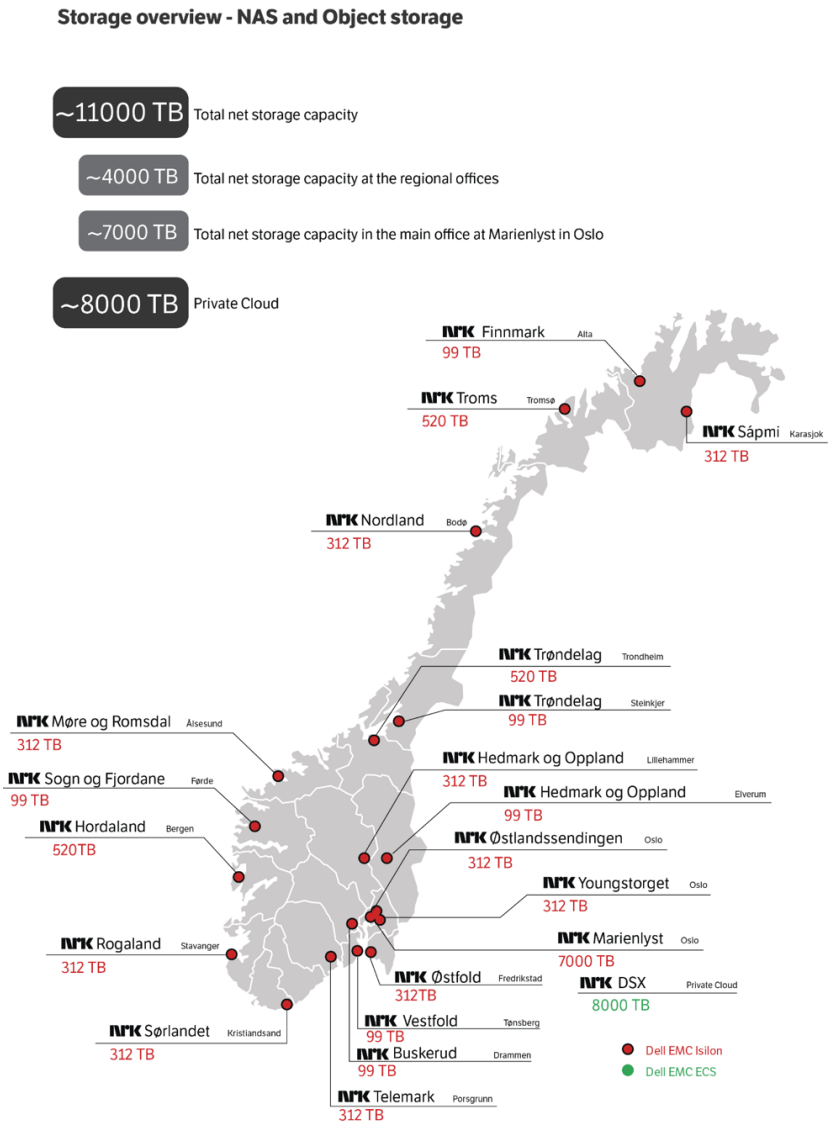

Figure 5 - NAS storage on all locations

8.1.4 ECS (Elastic Cloud Storage)

The ECS is not going to be used as a backup target, and is not part of the scope of the backup project. It is primarily being used as a cold data cloud tier (Cloud Pools) for Isilon, and it will be geo-replicated. Once files are untouched for a set period of time on the Isilon NAS, it is tiered to the ECS.

8.1.5 Archiving clarification

NRK experiences that some storage and backup vendors define cold storage and archiving as the same. Archiving for NRK is structured data with custom metadata attached. For most media/broadcast companies, cold storage is not considered an archive. NRK also considers archive and backup as two separate processes.

8.1.6 Disaster Recovery

Disaster recovery is currently covered by NRK. For the Dell EMC Isilon clusters, the most critical data will be replicated using SyncIQ. For servers and databases, this is handled by the tools managing the different systems. This is part of NRK´s total data storage and backup strategy, and was held outside the scope of the backup project.

8.1.7 VMWare

NRK have VMWare installations at all locations outlined in the storage overview map. NRK use the same version of VMWare on all locations. NRK run all kind of systems and workloads in our virtual environment. But there are not many IO intensive workloads.

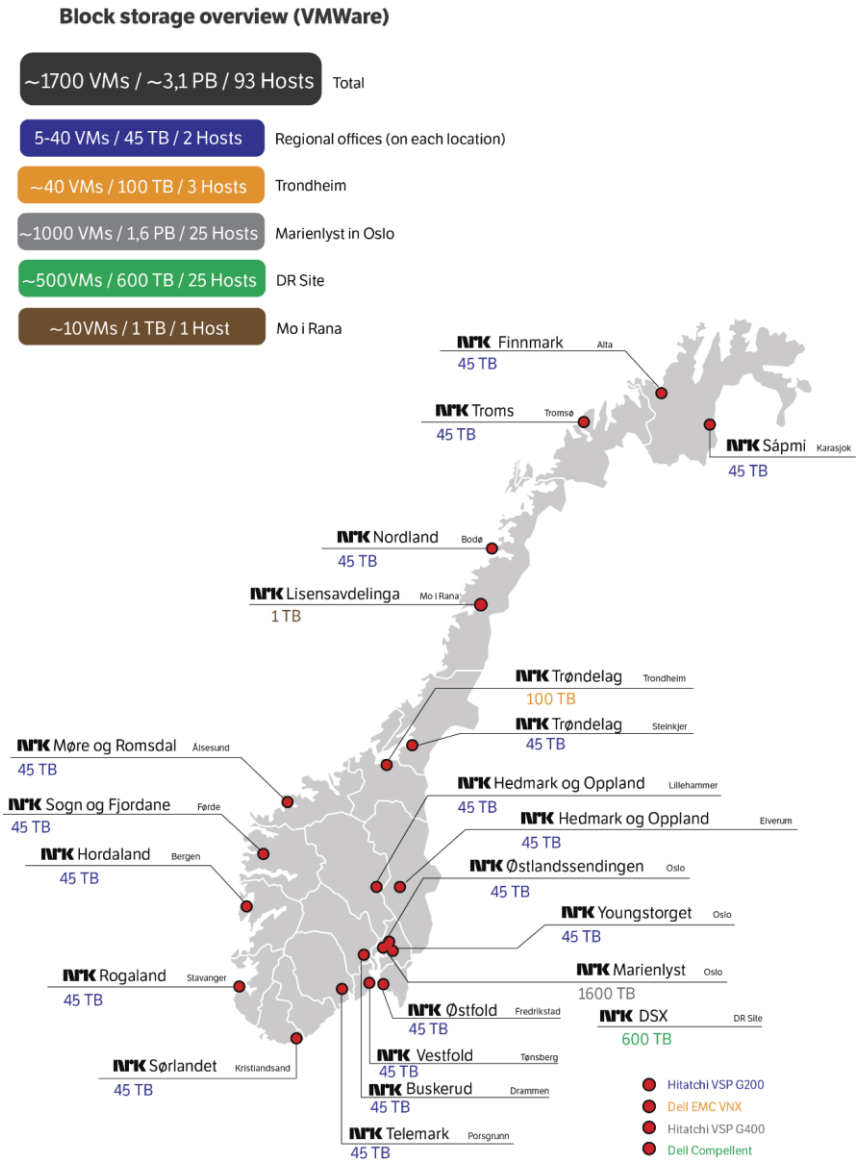

Figure 6 - VMWare installations at all local storage overview map

8.1.7.1 Local offices

Each branch office has its own VMWare installation. This consists of 2x HPE DL360Gen9 servers with fibre channel direct attached HDS VSP G200 storage. Each host has dual 10Gb network in use, but has more 1Gb and 10Gb NICs not in use.

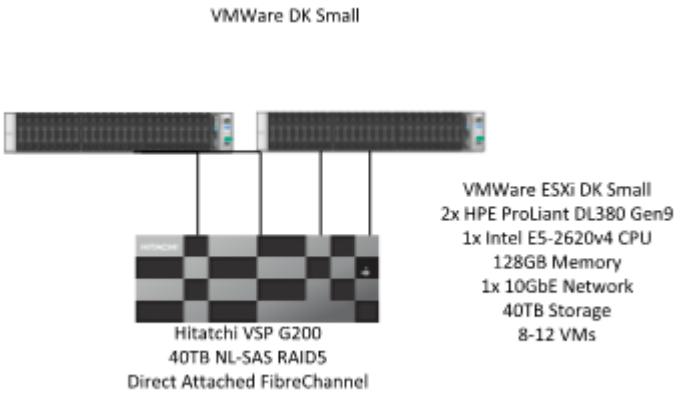

Figure 7 – VMWare DK Small

8.1.7.2 Regional offices and regional centres

Each regional office has its own VMWare installation. This consists of 2x HPE DL360Gen9 servers with fibre channel direct attached HDS VSP G200 storage. Each host has dual 10Gb network in use, but has more 1Gb and 10Gb NICs not in use. Figure 8 shows the VMWare installation at the largest regional offices and the regional centres.

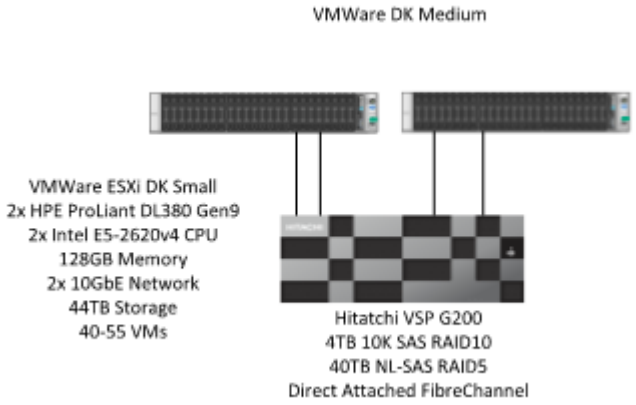

Figure 8 - VMWare DK Medium

8.1.7.3 Trondheim (Tyholt)

The Trondheim office, being the biggest regional office, has its own VMWare installation. This consists of 3x Dell R720 servers with fibre channel EMC VNX storage connected through dual Brocade fabrics. Each host has dual 10Gb network in use.

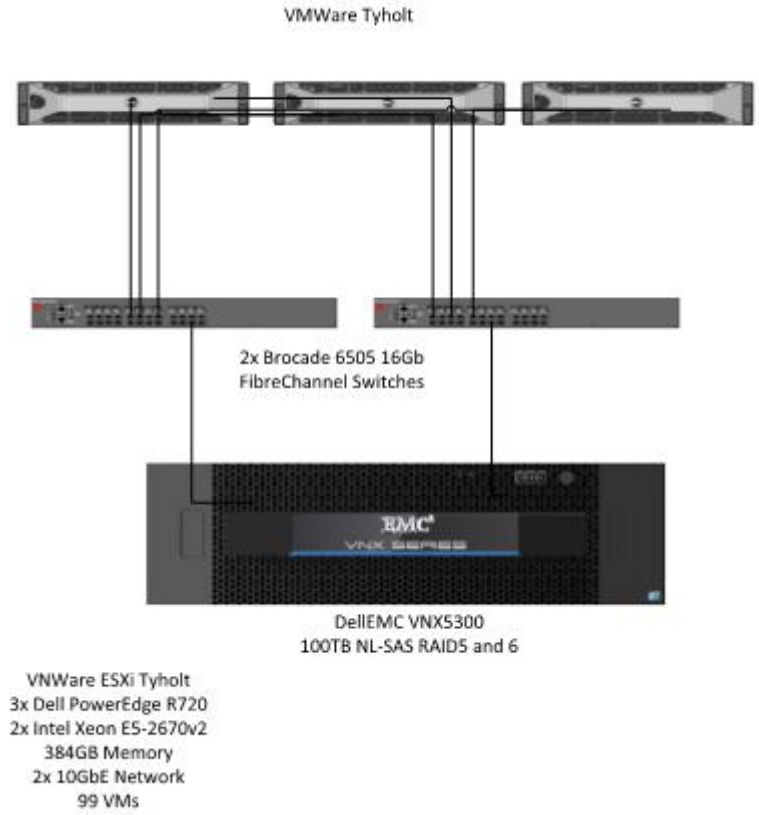

Figure 9 - VMWare Tyholt

8.1.7.4 Disaster recovery site (DSx)

The DR site for NRK has a VMWare installation consisting of 25x Dell M620 blades with fibre channel attached Dell Compellent SC8000 storage connected through dual Brocade fabrics. This site consists of several Clusteres. One for Linux VMs (12 hosts), one for Windows VMs (6 hosts) and one for SQL VMs (2 hosts). Each host has four 10Gb network in use. This site is used for DR for some systems, but mostly is used for test, stage, preprod and development.

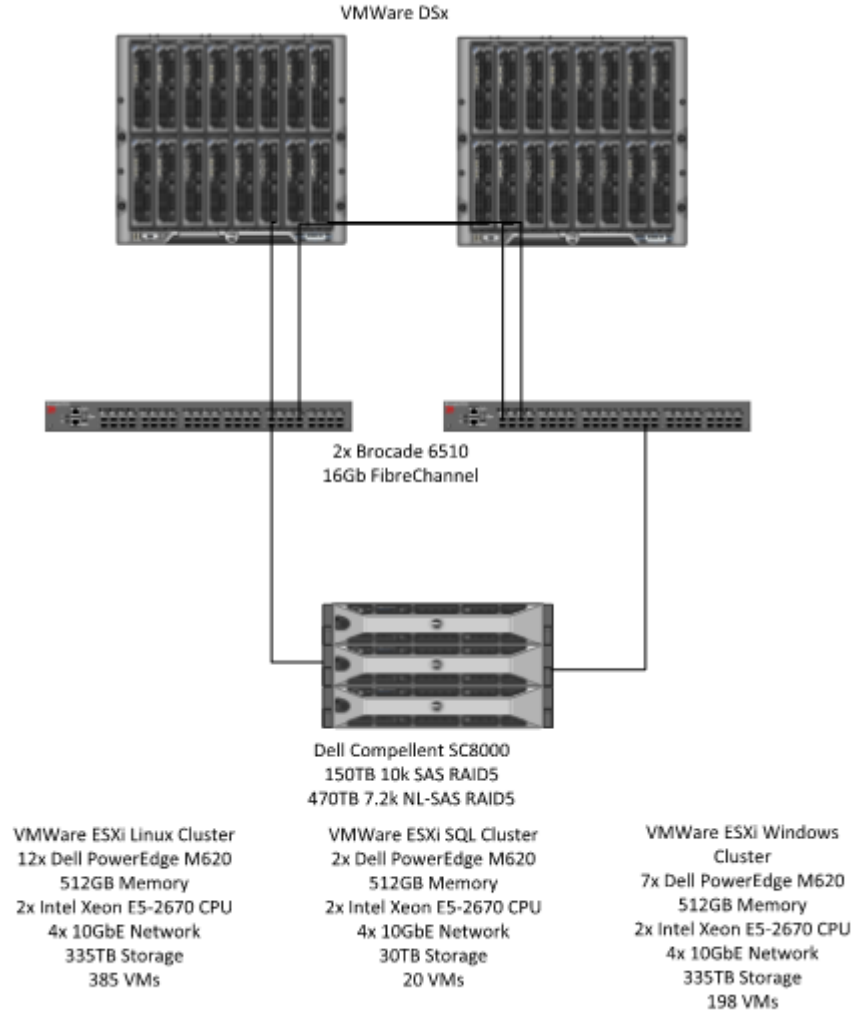

Figure 10 - VMWare – DSx

8.1.7.5 Marienlyst

NRKs main site has a VMWare installation consisting of 25x HPE DL380Gen9 servers with fibre channel attached HDS VSP G600 storage connected through dual Brocade fabrics. This site consists of several Clusters. One for Linux VMs (11 hosts), one for Windows VMs (11 hosts) and one for SQL VMs (3 hosts). Each host has four 10Gb network in use, but has more NIC available for future use.

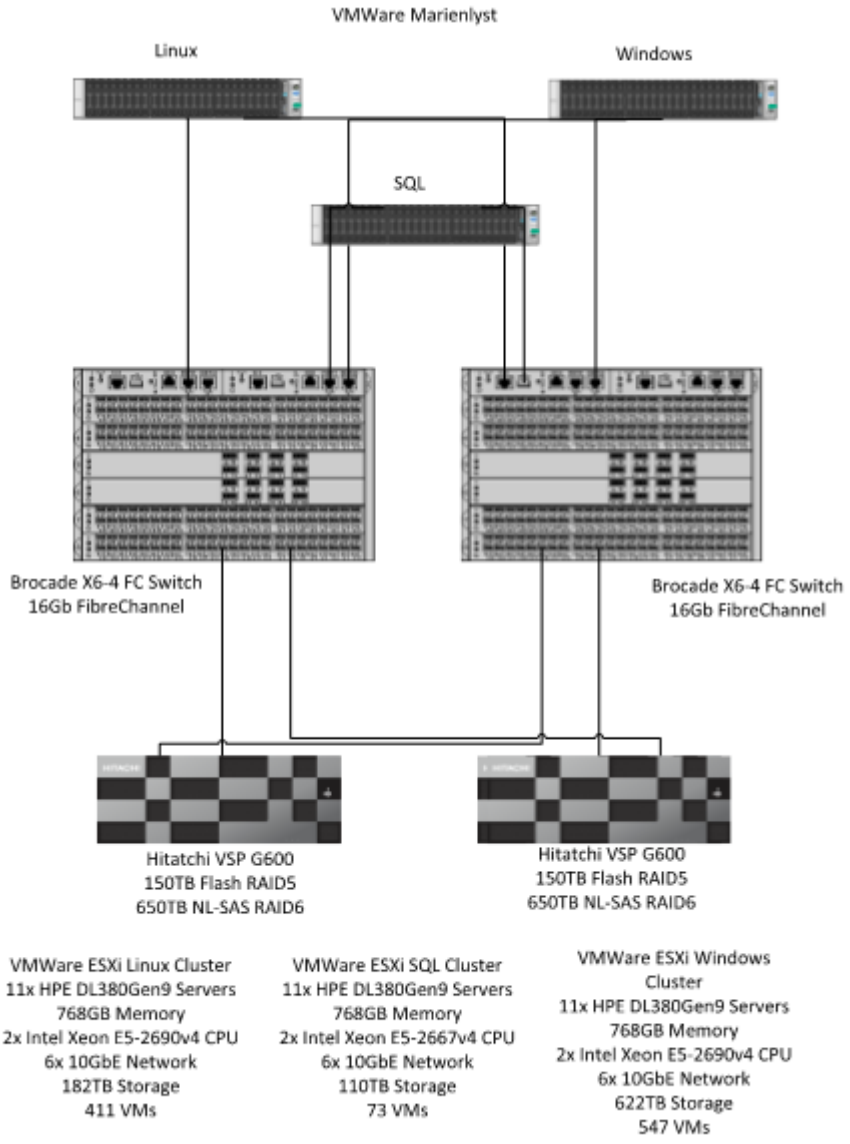

Figure 11 - VMWare Marienlyst

8.1.8 Servers – Windows and Linux

NRK are using a mix of most versions of Windows Server. For the Linux NRK mainly use Ubuntu, some Red Hat, CentOS and a few other distros.

8.1.9 Physical servers

NRK has about 700 physical servers with different OS versions. Backup is only done on a handful of these servers today. The physical servers backed up of today is via installed agents. These servers mostly consist of Oracle servers, Sharepoint, Windows File Servers, SQL servers, MySQL servers.

NRK does not take backup of all physical servers today and will not do that in the future. NRK does about 10% backup today and don't think this will increase in the future. The plan is to get even more virtualized.

8.1.10 Databases – Microsoft SQL, Oracle, MySQL

For databases, a mix of Microsoft SQL is used. In addition, multiple versions of both Oracle and MySQL are used.

Database backups are handled in close cooperation with the respective database administrators and owners. Below NRK describe how NRK handle the different databases with the current backup system.

- MySQL is dumped to a central repository that is backed up. The repository is hosted on a VMWare server, and the current size is about 1 TB.
- MSSQL is dumped to a central repository that is backed up. The repository is hosted on the Isilon NAS and is backed up using NDMP. The current size is about 2 TB.
- Oracle is backed up using agents in Veritas NetBackup. Oracle runs on physical servers. The current size is about 3 TB.

8.1.10.1 Change rate

NRK do not have detailed statistics for change rate in our current environment, but a daily change rate guesstimate would be somewhere between 2-5%.

8.2 NAS media production data properties

To give you an idea of the number of files, file sizes and file types stored in the media production environments on the NAS storage, NRK have gathered some statistics for each office category.

8.2.1 Top file types

Video (large file size)	
MXF	Material Exchange Format (video)
MOV	QuickTime Movie
MP4	MPEG4 Video format
MTS	MPEG Transport Stream (MPEG2 or MPEG4)

Audio (small to medium file size)	
WAV	Waveform Audio File Format

AIFF	Audio Interchange File Format
MP3	MPEG-2 Audio Layer III
OMF	Open Media Framework Interchange
Still image (small-medium file size)	
JPEG	Still image
PNG	Still image
CR2	Canon Raw photo format
PSD	Adobe Photoshop
EXR	High dynamic range still image format
DPX	Kodak raster image format (uncompressed)
Application project file format (small file size)	
PPROJ	Adobe Premiere Pro project file
AE	Adobe After Effects
Cache files (small files)	
MCDB	Adobe Media Cache Database
IMS	Adobe Premiere Pro file properties cache
MXFINDEX	Adobe MXF video index cache
PRMDC2	Adobe Premiere Pro project file cache
PEK	Adobe Audio Peak File cache
CFA	Adobe Conformed Audio File cache
Metadata (small files)	
XML	Extensible Markup Language (metadata)
XMP	Adobe's Extensible Metadata Platform

Table 5 - Top file types

8.2.2 Number of files and file sizes for media production data

The number of files and file sizes vary between different offices. Below is an excerpt for each office category. For details about each office, see attachment 2.

The main reason why NRK see a large number of small files in certain offices for both unstructured media production data and mam production data, is because some offices store Adobe cache files directly on the NAS. Hence it will be important for us to be able to exclude certain directory paths and/or file types, to make sure small cache files etc. don't inhibit or slow down the backup process of important data.

8.2.2.1 Category A – Local Office – October 1st. 2017

NRK FINNMARK - Alta

~5 TB	
UNSTRUCTURED MEDIA PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	87 031
8 KiB to 128 KiB	11 725
128 KiB to 1 MiB	43 791
1 MiB - 10 MiB	229 722
10 MiB - 100 MiB	66 773
100 MiB to 1 GiB	34 204
1 GiB to 10 GiB	6 221
10 GiB to 100 GiB	635
100 GiB to 1 TiB	3
Total file count	**480 105**

N/A	
MAM PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	0
8 KiB to 128 KiB	0
128 KiB to 1 MiB	0
1 MiB - 10 MiB	0
10 MiB - 100 MiB	0
100 MiB to 1 GiB	0
1 GiB to 10 GiB	0
10 GiB to 100 GiB	0
100 GiB to 1 TiB	0
Total file count	**0**

Figure 12 – NRK Finnmark - Alta

Note: Local offices are not yet managed by the MAM system.

8.2.2.2 Category B – Regional office – October 1st. 2017

NRK ROGALAND - Stavanger

~2 TB	
UNSTRUCTURED MEDIA PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	692
8 KiB to 128 KiB	324
128 KiB to 1 MiB	28
1 MiB - 10 MiB	1 033
10 MiB - 100 MiB	1 961
100 MiB to 1 GiB	269
1 GiB to 10 GiB	30
10 GiB to 100 GiB	19
100 GiB to 1 TiB	6
Total file count	**4 362**

~18 TB	
MAM PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	16 676
8 KiB to 128 KiB	12 074
128 KiB to 1 MiB	16 955
1 MiB - 10 MiB	31 668
10 MiB - 100 MiB	31 150
100 MiB to 1 GiB	14 815
1 GiB to 10 GiB	3 216
10 GiB to 100 GiB	126
100 GiB to 1 TiB	7
Total file count	**126 687**

Figure 13 - NRK Rogaland - Stavanger

8.2.2.3 Category C – Regional Centre – October 1st. 2017

NRK TRØNDELAG - Tyholt

~150 TB	
UNSTRUCTURED MEDIA PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	469 379
8 KiB to 128 KiB	197 767
128 KiB to 1 MiB	78 699
1 MiB - 10 MiB	497 298
10 MiB - 100 MiB	237 676
100 MiB to 1 GiB	59 234
1 GiB to 10 GiB	24 646
10 GiB to 100 GiB	1 760
100 GiB to 1 TiB	151
Total file count	**1 566 610**

~17 TB	
MAM PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	94 779
8 KiB to 128 KiB	29 064
128 KiB to 1 MiB	3 133
1 MiB - 10 MiB	21 356
10 MiB - 100 MiB	18 822
100 MiB to 1 GiB	15 051
1 GiB to 10 GiB	2 676
10 GiB to 100 GiB	217
100 GiB to 1 TiB	4
Total file count	**185 102**

Figure 14 - NRK Trøndelag - Tyholt

8.2.2.4 Category D – Main Office – October 1st. 2017

NRK MARIENLYST - Oslo

~800 TB	
UNSTRUCTURED MEDIA PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	2 290 087
8 KiB to 128 KiB	829 109
128 KiB to 1 MiB	656 302
1 MiB - 10 MiB	2 850 711
10 MiB - 100 MiB	685 525
100 MiB to 1 GiB	488 142
1 GiB to 10 GiB	239 121
10 GiB to 100 GiB	9 289
100 GiB to 1 TiB	293
Total file count	**8 048 579**

~400 TB	
MAM PRODUCTION DATA	
File size	*File count*
0 KiB to 8 KiB	0
8 KiB to 128 KiB	6
128 KiB to 1 MiB	5
1 MiB - 10 MiB	230
10 MiB - 100 MiB	8 583
100 MiB to 1 GiB	35 732
1 GiB to 10 GiB	15 265
10 GiB to 100 GiB	9 036
100 GiB to 1 TiB	107
Total file count	**68 964**

Figure 15 - NRK Marienlyst - Oslo

Note: NRK does not have detailed statistics for the MAM production data at Main Office (Marienlyst)

9 ATTACHMENTS

Attachment	Description
Attachment D.1 - IT-requirements for NRK version 3.0	A list of current IT requirements. Please note that these requirements are formulated in light of the Operations being conducted in-house, and that some of the requirements thus may change/become irrelevant if the operations are outsourced. These requirements have been used in previous RFP processes regarding infrastructure services. Please note that these requirements are NOT to be answered during this RFI process.

Table 6 - Attachments