NRK MA-3616-23E

Contract for Live/Live-to-VOD Origin

SSA-L – Appendix 1

Customer requirements specification

[Supplier name]

[Supplier logo]

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Attachments

Attachment 1-1: NRK Vendor Security Requirements

1 INTRODUCTION

1.1 ABOUT THIS APPENDIX

This Appendix describes the scope of the agreement and describes the Customer's needs and requirements for the service, which includes a new Live/Live-to-VOD origin service including options, of which the Customer refers to as the “service” or the “solution “, or both in this Appendix. The service is defined as the technological solution that defines the system, architecture, infrastructure, hardware and software inclusive of services (operations, support, documentation etc.) that supplier will provide.

The needs and requirements must be answered in subsequent appendices as indicated, where an overall description of the service and solution must be provided as well as a detailed description of how the Customer’s objectives, needs and requirements will be fulfilled.

This Appendix contains a combination of textual descriptions of objectives, needs, cases, user stories and terms as well as tabular listing of specifications and technical as well as service requirements.

The specified needs and requirements must be understood based on descriptions of the background, as well as the Customer's purpose and needs in chapters 2 and 3. By answering and describing how the requirements are met in the offered service and solution, the Supplier is expected to present its best proposed solution that fulfils the objectives in a best possible manner.

For practical purposes “the Customer” may also be referred to as “NRK”.

Any reference to “clause” refers to a section in the General Contract Terms (SSA-L). NRK advises the Supplier to read the SSA-L agreement thoroughly.

1.2 EXPLANATION TO THE REQUIREMENTS SPECIFICATION

The requirement specification table as used in this appendix consists of the columns shown in Figure 1 below. Light grey shaded columns in Appendix 2 only and to be filled out by the Supplier.

#	Requirement	Requirement fulfilment					The Supplier Solution Description
		STD	PART	FUT	DEV	NOT	

Figure 1: Columns in Appendix 2 Attachment 2.1 Supplier's solution description

#: Requirement ID - Consecutive numbering of needs/requirements within each section.

Requirement description: Textual description of the need/requirement.

Requirement fulfilment (STD/PART/FUT/DEV/NOT): Where requirement tables are used the Supplier must answer each requirement with a confirmation by marking an “X” in the relevant column(s) under the heading “Requirement fulfilment”.

- **STD**: the requirement is fulfilled through default standard functionality “preconfigured out of the box”.
- **PART**: the requirement is partially fulfilled. The Supplier shall describe which part of the solution is fulfilled and what is not fulfilled.
- **FUT**: the requirement is fulfilled through future releases. Future releases refer to versions that are released after the service and solution is put into operation for the Customer. The Supplier must comment on the estimated time for when this feature will be available to the Customer.

- **DEV**: the requirement is fulfilled through custom development (changes to the source code of the standard solution or custom extensions/add-ons to the standard solution). Or if the Supplier does not fulfil the requirement as intended by the Customer's requirement description, but the Supplier has another solution, the Supplier must put a mark in the "D"-column and describe the workaround solution in the "Description"-column.
- **NOT**: the requirement is **not** fulfilled.

The Supplier's Solution **Description:** The Supplier's detailed description of *how* the need/requirement is fulfilled. This includes parts of the requirements which are not fulfilled according to the applied fulfilment code. Please also refer to section 1.3 below.

1.3 INSTRUCTIONS FOR COMPLETING APPENDIX 2

The Supplier is required to document the degree of fulfilment of and compliance with the specified objectives, needs and requirements in Appendix 1 by completing the corresponding Appendix 2 Supplier's solution description.

In Appendix 2 the Supplier shall:

- Provide a high-level solution overview, cf. chapter 4.
- Document fulfilment of cases and user stories, cf. sections 5.2 through 5.3.
- Document fulfilment of requirements as specified in chapter 6 through 8.

The Supplier must in Appendix 2, provide for each case, user story and requirement, an exhaustive elaboration of how the Solution addresses the Customer's needs and requirements. The Supplier is encouraged to add illustrations and screenshots whenever this may help the Customer to a better understanding of how the Solution addresses the requirement. References to general materials such as sales and/or product brochures, product magazines and web content is not sufficient. Any relevant supplementary information may be provided as attachment(s) to Appendix 2 with clear and unambiguous reference.

If the column "The Supplier's Solution Description" in the opinion of the Supplier does not contain sufficient space for text and possible illustrations for certain requirements the description may be included under each requirements table with clear and unambiguous reference to the applicable requirement number.

Although alternative proposals are not allowed as such, this does not prevent the Customer from accepting a fulfilment of individual requirements that are not necessarily "according to the letter of the requirement" if the Customer has justified (in Appx. 2 chapter 4) this in terms of increased performance, value, efficiency, safety, gain etc., or reduced risk and cost. Similarly, if the Supplier considers certain requirements to be particularly complex or cost-driving the Supplier may justify this and propose and describe an alternative fulfilment.

It is the responsibility of the Supplier to ensure that all requirements are sufficiently addressed. If requirements are left unanswered, uncommented, or replied with 'to be negotiated' – they are to be considered as unfulfilled.

Any limitations, demarcations, assumptions, or deviations must be clearly described in connection with the individual goal/need/requirement in Appendix 2 order to be invoked.

1.4 INSTRUCTIONS FOR COMPLETING OTHER APPENDICES

ID	Instructions
1	The Supplier shall in Appendix 3, in accordance with the structure and instructions provided in the Appendix, describe their overall project- and progress plan for the delivery of the Solution, based on the Supplier's applied project methodology.
2	The Supplier shall in Appendix 4, in accordance with the structure and instructions provided in the Appendix, describe their offered service level with standardized compensations.
3	In Appendix 5, the Supplier shall, in accordance with the structure and instructions provided in the Appendix, describe its organization, staff and interaction with the Customer as instructed.
4	The Supplier shall specify prices and the principles for pricing in Appendix 6.
5	If the Supplier has any reservations to the general terms in the Agreement these shall be set forth in Appendix 7, except for cases where the General Contract Terms refer to other documents.
6.	Any terms related for the Customer access to and use of third party should be included in Appendix 9.

1.5 GLOSSARY

Marienlyst: NRK HQ, main office located in Oslo.

NRK: the Customer.

NRK TV: Branded name for the TV streaming service of NRK which includes both live, linear channels, recordings and on-demand content. The service is available on multiple user devices such as smart TVs, set-top-boxes, mobile devices, and desktops. The NRK TV service is not to be confused with the broadcast linear channels, although they are available in the NRK TV service.

NRK Radio: Branded name for the radio streaming service of NRK which includes both live, linear channels, recordings and on demand content. The service is available on multiple user devices such as mobile devices and desktops. The linear channels are also available on third party platforms such as TuneIn, Sonos etc. The NRK Radio service is not to be confused with the broadcast linear channels, although they are available in the NRK radio service.

NRK.no: The main webpage for the article-based offerings of NRK.

Compliance recording: NRK is legally obliged to continuously deliver recordings of everything which has been aired on all planned channels (https://www.nb.no/en/legal-deposit/).

Primary channels: Channels with very high up-time (cf. Appendix 4) and redundancy requirements (cf. Appendix 1). E.g., NRK1 and NRK P1.

Secondary channels: Channels with lower up-time and redundancy requirements than the primary channels. E.g., NRK2, NRK Super, NRK Sport.

Pop-up channels: Channels that do not have a 24/7 transmission, and mostly for publishing news and sports events.

Gray-out: Substitute video frames with an image for a given time frame or replace sound from a radio stream for a given time frame. Typically used when some sensitive information has been aired erroneously.

VOD: Video on Demand.

Slow TV: Term used for a genre of "marathon" television coverage of an ordinary event (e.g., a train journey) in its complete length.

End-user platform support: WEB, Android, Android TV, Chromecast, Apple iOS, Apple TVOS, STB, Samsung Tizen, LG WebOS, PlayStation 4/5. More details: https://info.nrk.no/tv/?/stotte-nrktv

Live Progressive Download: System needed to support live distribution for internet connected radios.

The service: New Live/Live-to-VOD origin service including options, of which the Customer refers to as the "service" or the "solution ", or both in this Appendix. The service is defined as the technological solution that defines the system, architecture, infrastructure, hardware and software inclusive of services (operations, support, documentation etc.) that supplier will provide.

2 BACKGROUND AND PURPOSE

2.1 BACKGROUND

NRK's current streaming origin solution, for both live, live-to-VOD and on-demand, has reached its end-of-life and needs to be replaced and modernized. Like many other broadcasters, NRK has experienced a shift from the traditional linear way of consuming media content over the past few years. The end-users changing habits can be seen in a shift from linear consumption on big screens (TVs) to streaming of content on both big screens and mobile terminals.

This procurement covers the streaming origin solution for live and live-to-VOD. NRK has recently acquired a solution for on-demand origin service. Nevertheless, we ask for this as an option in this contract. It is expected that implementation of a new origin contributes to NRK's efforts to reach its strategic objectives. In the long-term strategy for 2021-2024, NRK states three strategic objectives shown in Figure 2 below.

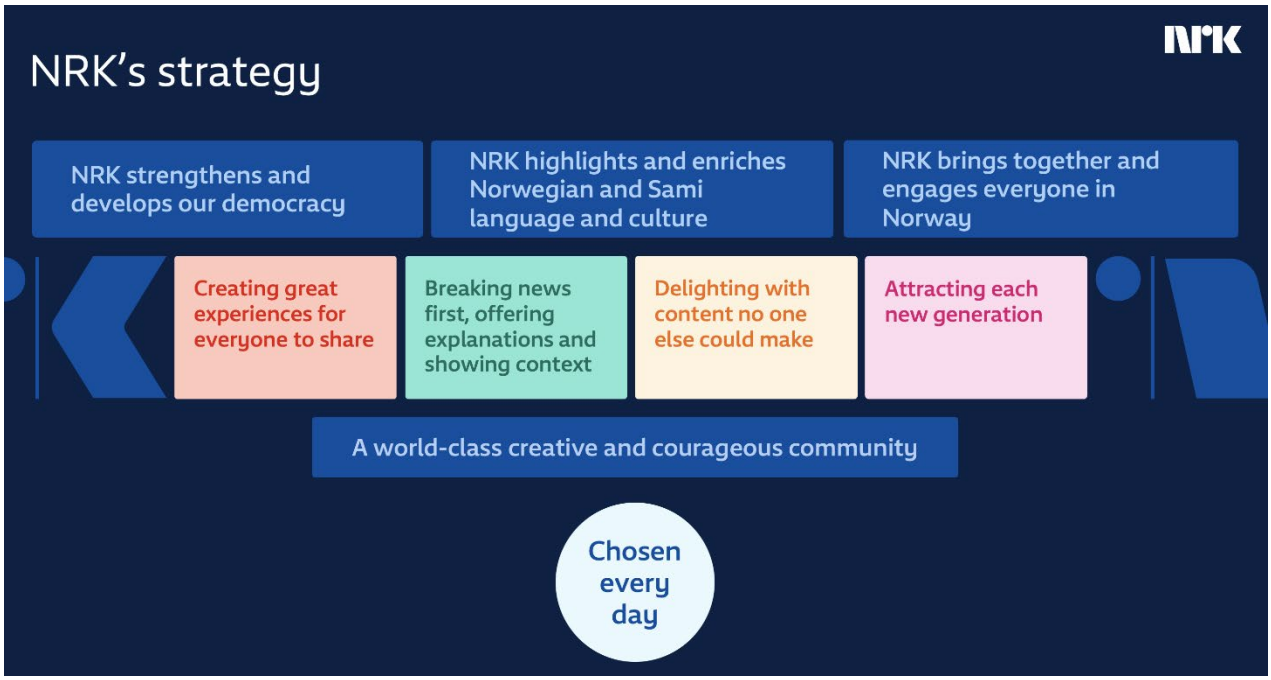


Figure 2: NRK's three strategic objectives in the long-term strategy for 2021-2024

NRK's long-term strategy is based on NRK's role in the Norwegian society, as formulated both through the statutes approved by the Ministry of Culture and through the NRK placard set by the Parliament. Some of the highlights include:

a) NRK shall ensure that content and services can be used by everyone regardless of sight, hearing and other cognitive or physical skills.

b) NRK has a special emergency response responsibility and will thus facilitate that the government reaches the entire population with information in the event of national crises and disasters.

c) NRK shall strengthen the Norwegian and Sami languages, culture and identity.

2.2 MAIN OBJECTIVES

NRK prefers that the new origin is an "off-the-shelf" solution that can be implemented and go live in a short timeframe, with no development or components custom to NRK.

NRK wants a flexible and modern origin solution which enables NRK to cater for end users' expectations in a highly competitive and evolving market. A relevant example of this would be the introduction of higher quality content like Ultra High Definition (UHD) and High Dynamic Range (HDR). The Supplier should continuously develop the service based on its own initiatives (cf. SSA-L Appendix 7, clause 2.1) to continuously deliver a "state-of-the-art" origin solution for the streaming market.

The solution and service should enable NRK to deliver flawless experience to the audience and cater for good accessibility services across multiple end-user platforms.

NRK believes that focus on the following will be imperative to reach the main objectives in this procurement:

2.2.1 CONTINUOUS TECHNOLOGICAL RENEWAL AND MODERNIZATION

Modern software development and operations methodologies

Examples include infrastructure as code, version-controlled configuration, continuous integration/delivery and automatic deployment of both servers and software.

API-driven

Integration and "development-friendly". Use modern API-interfaces and other modern techniques to integrate applications***.***

Time to market

Off-the-shelf solution, time to market, continuously delivery of functionality according to industry standards and end-users' expectations.

The supplier keeps up to date on the latest technical developments and standards within its field as well as security related updates and actively notifies NRK of new trends.

2.2.2 SERVICE AVAILABILITY

Secure, high availability design to achieve redundancy and resilience

High availability design with multiple parallel streams from more than one location (geo redundance) will be important to secure NRKs responsibilities as a public broadcaster.

Robust, reliable, and secure storage strategy with a clear plan of recovering data in the event of a failure.

Quality

High technological quality. Higher degree of flexibility to meet current and future technical standards and formats to achieve NRK's long-term strategy.

The supplier bears total responsibility for the total origin solution to sustain the agreed service level.

The Supplier assists actively NRK to ensure the best possible quality, availability, reliability, capacity, and sustainability for NRK and its audience.

3 SCOPE OF PROCUREMENT

The Customer intend to procure an off-the-shelf new live and live-to-VOD origin solution as a service. This chapter covers the high-level overview of what the Customer seeks to procure. The requirements of the service follow in chapter 5 through chapter 8.

The following deliveries are included in the service:

1. Delivery and further development of the origin software
2. Support 24/7
3. Operation of the service and further development of the origin solution (cf. section 3.1)
4. Operation of infrastructure (for the origin solution)
5. Implementation with NRK

If the Supplier itself does not deliver all deliveries, NRK has a clear expectation that the Supplier itself performs delivery 2 and 3 and that the manufacturer/supplier of the software will enter as a subcontractor for delivery 1 and 2.

Operation of the environments must take place at a data centre operated by the Supplier or a subcontractor/third party or a combination. It is highly preferable that the data centres (delivery 4) are geographically located in the EEA area, preferably in Northern or Western Europe. There are high demands placed on uptime, security and backup for the whole service (cf. Appendix 4 and this Appendix 1) (all deliveries) and NRK expects the Supplier to take responsibility for the whole service – end to end – also with regards to guaranteed uptime.

The Customer expects the Supplier to be transparent on how the delivered service will be set up, what components and building blocks that will be offered, which geographical locations and datacentres / runtime environments in use, network connectivity: POPs in use, network routes, connectivity providers from both the Customers content sources and towards the Customer's CDN partners and how the whole delivered solution will be protected from physical and online threats, cf. Ch 4.

The Supplier must assist in establishing and setting up the service (delivery 5) and provide operation and service desk 24/7/365 and otherwise be able to provide consultancy assistance if required.

It is important for NRK to be able to get the service up and running quickly and implementation time is important for the Customer. The Supplier should prioritize setting up a fully functional staging environment to enable the Customer to start implementing and testing as soon as possible.

As the listed areas below involve different teams at NRK, it is beneficial to the Customer if all teams can start implementing in parallel.

The Customer does not see the need for specific iterations during the delivery but if the Supplier plans for iterations, they should be aligned with the Customer's following priority.

During implementation NRKs priority will be in the following order:

a) **Live**

b) **Compliance recording**

c) **Live-to-VOD**

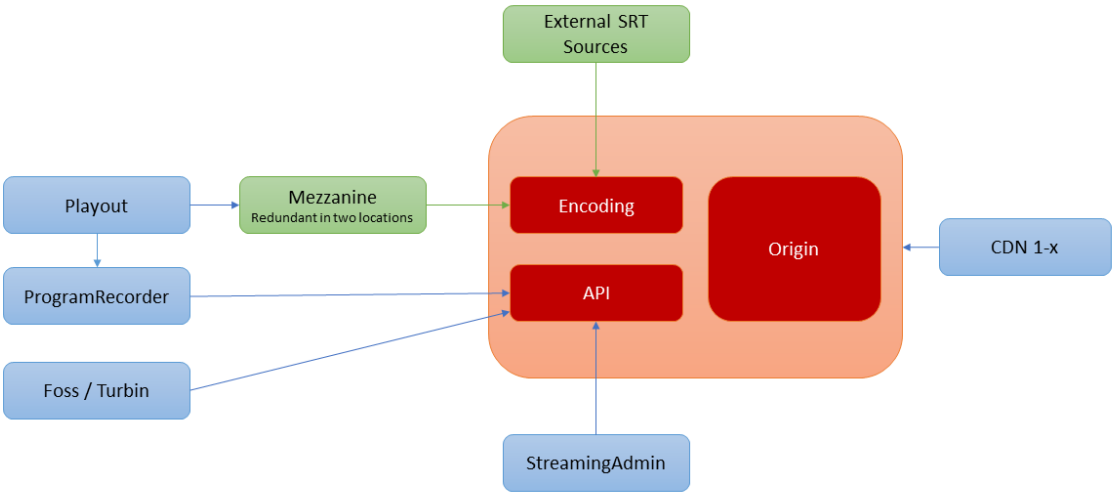
3.1 TECHNICAL SCOPE

The high-level scope for this procurement is illustrated in the figure below **coloured in red**. The figure includes the origin solution, but also other components in the value-chain to give a full picture.

The Supplier's proposed solution could differ from the illustration, however in areas where NRK has very bespoke needs or expects changing business or user requirements, a separate system or integration is preferred to an "all-in-one" solution. Likewise, the integration between new and existing systems where the business logic or domain is important and may change due to changing business flows or

requirements, NRK wants to own or be a part of the system-integration, see 3.3 and 6.5 for more information.

Details for each system are described in 3.2 (green items) and 3.3 (blue items). Requirements to the scope is further detailed in chapter 6.



3.2 AUDIO AND VIDEO INPUT

The solution must at least handle the formats delivered by the Mezzanine system. In addition to the agreed number of channels, the system should handle the proposed resilience model (See 6.2.1). For details on Mezzanine formats and external SRT, see 6.1.1 and 6.1.3.

3.3 SYSTEMS AND INTEGRATIONS

NRK would ideally integrate with the origin solution using APIs for all needs.

This is the main principle, but NRK may consider counterarguments and suggestions to why and where this may not apply or be solved differently.

The following sections describe the internal applications/systems which have direct integration with the existing origin system.

The new solution would need to solve the same needs, but not necessarily in the same way. NRK expects the Supplier to assist in finding the best possible solution to cover all existing needs.

NRK has a strong developer community, and especially in areas where NRK has very bespoke needs or expects frequent changing business or user requirements, there is a policy of (co)developing and owning these integration-services or -modules in-house rather than asking the involved vendors to deliver a bespoke integration on their own. This is based on prior experience where the most complicated and difficult part of many integrations are not the technical implementation or development, but the business and data model impedance and the need to be able to adjust and adapt the mapping and logic over time.

If a feature is missing or inadequate, NRK would prefer that work and effort is put into providing proper, public APIs if needed and incorporating the feature as part of the standard product/solution. See chapter 6.5 for API requirements.

3.3.1 FOSS / TURBIN

Foss is a tool used to schedule live streams. An example of this would be an ongoing press conference.

Turbin is a tool which can create shorter clips from an ongoing live stream which then can be made available in articles to the end-user. An example would be the last two minutes of a ski race.

The output of both these processes is an asset with a fixed start and end with resulting HLS/DASH manifests which can be viewed and linked to metadata for further embedding in news articles.

3.3.2 PROGRAMRECORDER

ProgramRecorder has two main features.

1. Listen to events from the playout system and record live programs so that they will be available as Live-to-VOD until an adaptive bit rate set (ABR)has been produced and made available On-Demand. Today NRK asks for the deletion of the Live-to-VOD asset once the On-Demand ABR set has been produced and distributed.
2. Schedule continuous one-hour recordings on a set of predefined live channels where NRK is required by law to store and forward these recordings to the Norwegian National Library. (https://www.nb.no/en/legal-deposit/). Today's implementation is done by downloading the recording after it has ended using the assets HLS filtered by bandwidth low and high parameters to specifically download one quality (as of today resolution height of 720). After the asset has been downloaded NRK sends a request to delete the asset from the origin system.

3.3.3 STREAMINGADMIN

StreamingAdmin has two main features.

1. GUI to edit metadata for any given live channel in NRK, including streaming URLs. Currently streaming URLs is built by calling an API at the origin service.
2. GUI to edit metadata for any supported client in NRK, like supported resolution, startup resolution, supported formats and CDNs.

3.3.4 CDN 1-X

NRK uses a multi-CDN setup to handle a high number of users. The CDNs will need to integrate to the Origin service in order to fetch content as described in Ch. 6.4. Currently NRK has 3 CDN vendors.

3.3.5 PLAYOUT

The playout system is used for linear broadcast for TV and Radio. This system will not integrate to this Origin solution directly.

3.3.5.1 LINEAR TV CHANNEL STRUCTURE

NRK broadcasts its programs on the linear channels NRK1, NRK2, and NRK3/NRK Super. In addition, we have six streaming/off-loading channels. For streaming NRK3 and NRK Super is split into two different sources.

NRK 1 is the most popular TV channel in Norway. The market share is about 30 %. The content offered by NRK1 is varied and broad and is intended to give Norwegian people shared understanding and great experiences across news, sport, drama, entertainment, and documentaries. Flexible control of program length and scheduling for handling live programming and breaking news situations (last-second changes) is of high importance for NRK1, which is an important news source for people in Norway on major events. NRK1 has a special mission in being a tv channel for government information in case of emergencies.

During weekdays the regional offices have their own live news broadcasts. Currently, there are 10 regional offices transmitting at 19:45-20:00 and 22:55-23:00.

NRK 2 offers news, debate programs, documentaries, analyses, and cultural programs. Primarily preprogramed playlists, however, when major news events occur, it often takes the role as an offloading-channel for NRK1, and this requires a high degree of flexibility.

NRK 3 offers movies, comedy, lifestyle, and music for a younger audience. Usually broadcasts between 19:30 and 04:00.

NRK Super is the children's channel. Usually broadcasts between 04:00 and 19:30.

NRK Tegnspråk is the channel for hearing impaired audience.

NRK 4-9 is the internal names for NRKs streaming/off-loading channels. They are available only in the NRK TV app and are shown only as event-based transmissions, not discrete channels. Primarily used for live sport and news events.

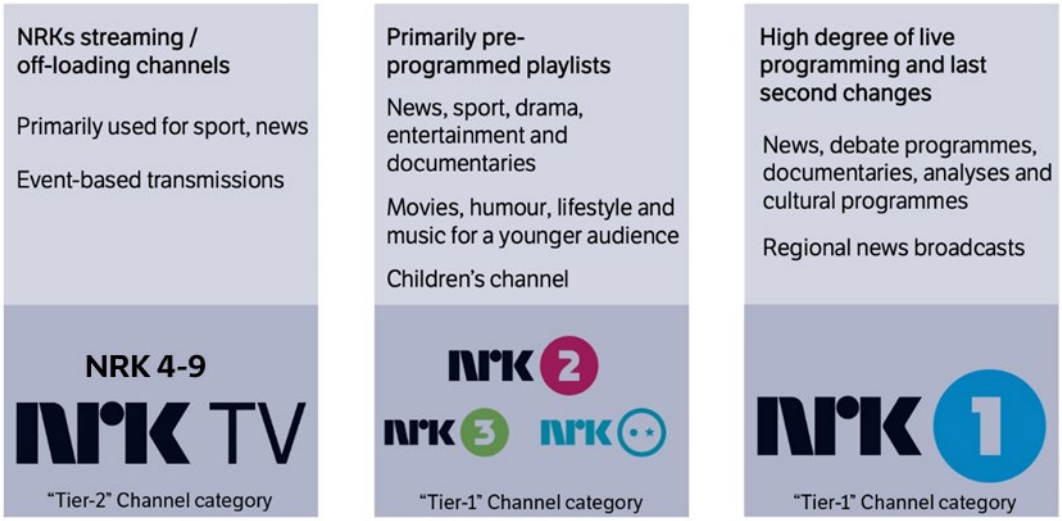


Figure 6: Linear Channel Structure

Complete channels list, see 6.1.2.

3.3.5.2 LINEAR RADIO CHANNEL STRUCTURE

NRK P1 is by far the largest radio channel and has a market share of 37%. NRK P1 has a special mission in being a radio channel for government information in case of emergencies. NRK P1 contains the 15 regional channels that transmit 06-09 and 14-17 on weekdays. NRK P1 transmits regional news bulletins at fixed points in time, now mostly 03-02 minutes over the hour during the day (currently 10:03- 12:03). NRK Stor-Oslo transmit P1 when regional channel is not in transmission.

Complete channels list, see 6.1.2.

3.4 OPTIONS

The Supplier is asked to include the following options into this contract. More details of each option are described in Ch. 8.

No	Short description
A	STREAMING ORIGIN – ON-DEMAND NRK has recently acquired a new streaming Origin solution for On-Demand content. When this agreement expires or is terminated, NRK may find it beneficial to include On-Demand Origin functionality into this agreement and expand the scope. More details in Ch. 8.1.
B	SERVICE SCALABILITY

No	Short description
	NRK has several TV, Radio and Pop-up channels as well as SRT sources as described in Ch. 6.1.2 and Ch. 6.1.3. This number may change during the contract period. More details in Ch. 8.2.
C	SUPPLIER'S OPTIONS – EXISTING FEATURES During the contract period, NRK may wish to use existing features in the product. Examples of such features are described in Ch. 6.8 and Ch. 8.3.
D	INSOURCING OF INFRASTRUCTURE OPERATIONS (OPTION) NRK is in the process of establishing data centers in Oslo and Trondheim and reserves the right to insource parts of the service if this should prove necessary or appropriate. More details in ch. 8.4.

3.5 BUSINESS NOT IN SCOPE

Early 2022 NRK published a RFI for a complete distribution platform. This RFP is just a part of the total RFI, hence the following services are not part of this procurement:

- Mezzanine source system
- CDN services
- CDN selection service
- DVB services
- End-user players / native players

4 SUPPLIER HIGH-LEVEL SOLUTION OVERVIEW

The Supplier shall provide a comprehensive high-level overview of their Solution and service based on the objectives and needs described in chapter 2 and 3 and the accompanying cases, user stories and requirements in the following chapters. A high-level technical description/illustration of the Solution should be included as well as an overview of the parties in entire value chain.

The Supplier must provide clear and unambiguous statements about which of the Customer needs and requirements they do not support or cannot deliver.

The documentation should emphasize:

a) **Performance**: How the offered Solution contributes to achieving the main objectives of this procurement (see 2.2). Please make unambiguous references to the relevant sections in Appendix 2 that contribute to the achievement of the Customer's objectives.

b) **Risk**: How the Supplier will help the Customer to reduce principal risk related to this Solution. Both in establishing the service and running it. Please make unambiguous references to the relevant sections in Appendix 2 where the offered measures provide effect.

c) **Additional Value**: How the Supplier can offer additional value to the Customer in addition to the listed requirements and relative to competing Suppliers. Please make unambiguous references to the relevant sections in Appendix 2 that show how the offered Solution provides added value and better goal achievement for the Customer.

Please provide a response in Appendix 2, section 4.

5 FUNCTIONAL/USER REQUIREMENTS

This chapter describes roles, a selection of “every-day” case examples, and user stories to exemplify functional requirements and deliveries from the perspective of a live streaming origin.

NRK believes that the Suppliers are best suited to suggest the best solutions to meet our requirements, therefor we have described case examples and user stories for the Supplier to answer.

The phrased and simplified user stories begin with a role, e.g. “As an end user …”. The wording of a user story cannot be considered literally exhaustive, they are only meant to exemplify functional requirements in a richer context.

5.1 ROLES

5.1.1 END USER

The end user is a consumer of content on NRK TV, NRK Radio and nrk.no.

5.1.2 PLANNER

These are people with the full-time role of handling schedule planning, but the responsibility is divided between several different other roles – depending on time scale.

5.1.3 BROADCASTER

The Customer, NRK, is a national broadcaster.

5.2 CASE EXAMPLES

This chapter contains a selection of “every-day” cases. They describe the level of functionality for the origin solution. These are typical scenarios and help to illustrate and explain the overall workflow.

They do, however, **not** say **how** the tasks are to be solved with a new system but are descriptions of the functions needed.

The Supplier will under section 5.3 below be asked to describe how the offered solution would solve the scenarios below.

5.2.1 REGIONAL CHANNELS

NRK has regional offices all over Norway. These regional offices have their own radio and/or television broadcasts and have daily broadcasts at set times. Outside of the scheduled regional specific broadcasts, NRK's main channels for radio and TV, P1 and NRK1 respectively, are broadcasted on the channels. Currently, there are 10 television broadcasts and 15 radio broadcasts coming from regional offices.

The signal to the new origin service will come from the Mezzanine system, regardless of whether it is a main channel or a regional channel. The stream from Mezzanine for a regional channel will have content from the main channel (NRK P1 / NRK1) during the periods when there is no broadcast from the relevant regional office.

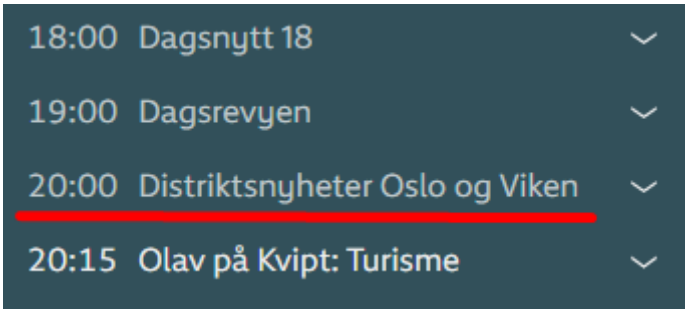


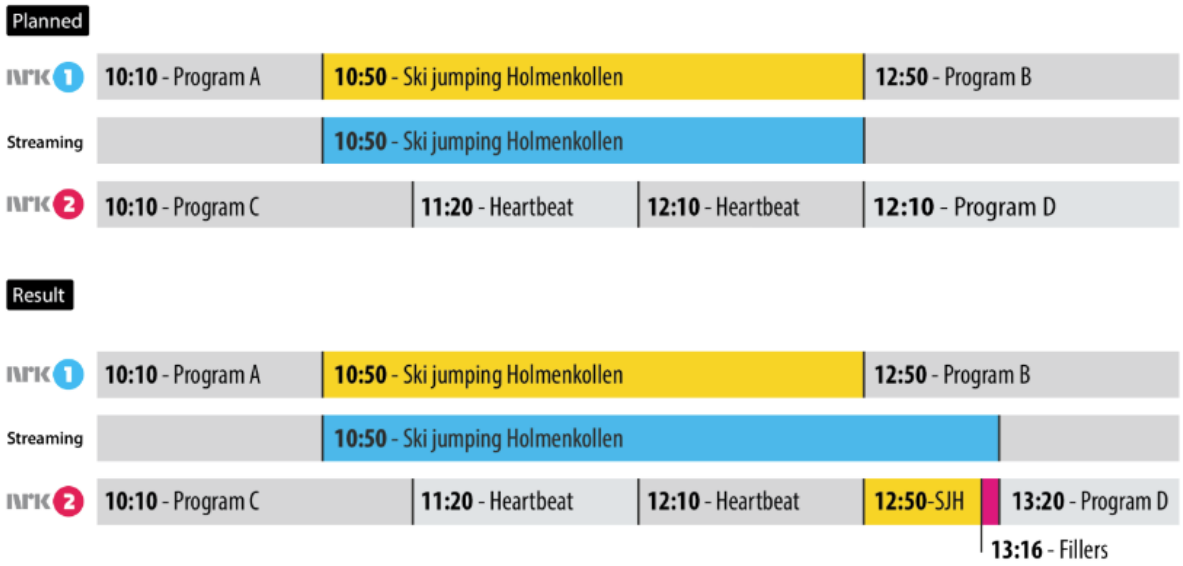
Figure 7: Program guide showing a time slot for a regional channel transmission (underlined in red).

Today, NRK's players use their own URLs for the regional channels, based on the user's choice. A user who has chosen "*NRK1 Oslo and Viken"* will get a URL pointing to "*NRK1 Oslo and Viken"*, while a user who has chosen "*NRK1 Buskerud"* will get a different URL pointing to this stream. The streams for the regional office are thus in use around the clock – even when the broadcast is from on the main channel.

5.2.2 SKI JUMP INTERRUPTED BY FOG

NRK has the rights for a ski-jump event from the venue **Holmenkollen** in Oslo. The event is planned on NRK1 from 10:50 to 13:00 (see figure below), and this is the slot the program is given in the transmission schedule in NRKs internal planning system.

The event is also planned on one of the streaming channels, so that end-users don't need to jump to a new stream to watch the end of the ski jump event.



Based on prior experience, this is a typical open-end event, where there are several circumstances (like the weather) that may affect the competition and thus the impact actual end-time. Today the forecast warns of fog, not uncommon at the venue, and this will typically result in delays for events like ski jump.

During the competition, and if possible, well in advance of the next program, the planner will look for a way of extending the transmission either on the same channel or any of the other main channels. The program following the ski jump competition on NRK1 should preferably not be moved, so the operator makes space on NRK2 for the continuity of the original program and moves the rest of the schedule on NRK2 accordingly.

Normally the users watching the event online will get a link to the transmission on the streaming channel. When the user starts watching the end time will be 13:00, but during the transmission the end time of the stream will be moved to 13:20. Today the extension of the transmission will not cause any interruption visible to the viewers watching the stream.

5.2.3 POP-UP CHANNELS

NRK has several pop-up channels that are mainly used to publish news and sports on NRK.no. These channels do not have a 24/7 transmission, but a planner can go to the Foss system and schedule a transmission for a given time and channel. Foss will publish metadata for the given transmission to NRKs API for playback, such as geolocation, usage rights, title, images, and description.

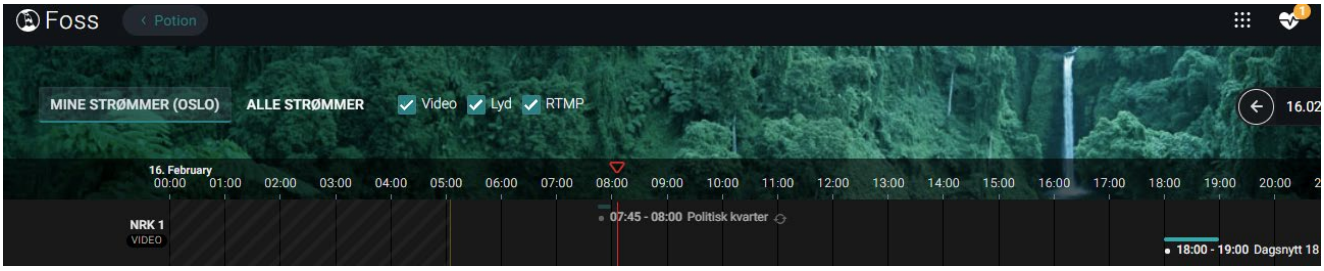


Figure 8: Foss screen shot showing two planned transmissions.

As for the regional channels, the pop-up channels will also receive a signal via the Mezzanine system. When the journalist has not ordered the routing of a signal into the given pop-up channel, there will be a poster. The Mezzanine system will thus have a signal 24/7, even though there is no scheduled broadcast.

5.2.4 AUDIO SUPPORT FOR THIRD PARTY PLATFORMS

In addition to HLS and Dash, NRK delivers all radio streams using IceCast. These streams are delivered using progressive download. The format is currently MP3 and AAC, both in two qualities. The complete list of URLs is available on https://lyd.nrk.no. The system also delivers playlists in m3u and xspf formats. Examples of platforms are Sonos, internet connected radios and TuneIn.

Today our IceCast setup has an integration with an internal NRK system to update metadata about current and next song on the channel.

Currently NRK is looking into securing the streams on the source using authentication. The reason for this is to better control the access to the streams.

5.2.5 GRAY-OUT OF A SENSITIVE INFORMATION WHICH HAS ERRONEOUSLY BEEN AIRED ON NRK1

Sensitive information (e.g a social security number, credit card details) has been shown in a live news transmission on NRK1. All regional channels are airing the same transmission (see 5.2.1).

This must be removed as soon as possible to minimize exposure to the public so that end user can't watch it in the buffer. The sensitive part of the transmission is "greyed-out" on the live transmission as well as in the recording used for Live-to-VOD.

Compliance recordings will not be affected by grey-out as this needs to contain what was originally aired.

5.3 USER STORIES

The following user stories are meant to give the Supplier an understanding of NRK's needs and current solutions to exemplify functional requirements. The Supplier is asked to describe, in written form and

with illustrations, how the solution will support the functionality requested and the use cases described below. Please provide this in Appendix 2.

Where we describe how the system works today does not mean that the system must work in the same way with the new origin solution. It is the functionality which is important not how it will be implemented.

5.3.1 AS AN END USER I WANT TO

Id	Requirement
5.3.1.1	Start a live stream at a specific time to be able to catch up *Today we have live channels with configurable hours of viewing buffer per channel. The clients can freely forward/rewind within this buffer. The buffers are configurable for each channel.*
5.3.1.2	Watch or listen to a live transmission, both when it is ongoing and as on-demand when the transmission has ended. *Today we have an EVENT manifest with a growing buffer while the program is being aired which transitions to a VOD manifest when the program is finished. After the program has finished the VOD manifest is cached in the CDN's as On-Demand.*
5.3.1.3	Listen to a live Radio transmission, both when it is ongoing and as on-demand when the transmission has ended. *Currently NRK does not utilize such functionality for Radio streaming.*
5.3.1.4	I want to be able to choose between different types of subtitles. *Today's solution does not support this. The current solution has burned in subtitles.*
5.3.1.5	I want to be able to forward and rewind and be able to see a video thumbnail preview to be able to catch up to a specific scene. *Today we have an I-frame playlist available for HLS. In addition, we have a WebVTT playlist with thumbnails. The thumbnails are available in the same resolutions as the video.*
5.3.1.6	I want to be able to view video content on all supported clients and platforms. *Today we do this by* *a) Filtering out I-frame playlist form HLS using query parameters* *b) Filter available qualities for different client based on bitrate by using query parameters* *c) Filter out subtitles from manifests so that these can be sideloaded for the clients which only supports this* *d) The rule for this filtering is done by StreamingAdmin*
5.3.1.7	I want high quality from the beginning so that I don't see a low-resolution video at the start. *Today we do this by sorting the manifest so that the preferred initial quality is at the top.*

Id	Requirement
5.3.1.8	I want to be able to listen to radio content on all supported clients and platforms. *Today we do this by* *a) Filter available qualities for different client based on bitrate by using query parameters.* *b) Supply streaming URLs for a progressive distribution format via IceCast.* The rule for this filtering is done by StreamingAdmin.
5.3.1.9	I want high quality from the beginning so that I don't listen to a low-quality at the start in a radio stream. *Today we do this by sorting the manifest so that the preferred initial quality is at the top.*

5.3.2 AS A PLANNER I WANT TO

Id	Requirement
5.3.2.1	Be able to adjust the duration of a live transmission. *Today's live-to-VOD solution supports this seamlessly without the user noticing that the stream duration is changed.*
5.3.2.2	Be able to add gray-out (see 1.5) in a live transmission so that content which has been aired erroneously will be unavailable for new end users. *Today we need to contact the origin supplier. They copy in a reference to a poster in the manifest without changing the timeline in the manifest.* One of today's challenges in NRK is that because the same content is aired on NRK1 or NRK P1 and potentially many regional channels this operation needs to be done several times. We therefore want to be able to do this via an API to be able to automate it. Please refer to the case 5.2.5 above.
5.3.2.3	Control which geo-location content is available in so that we comply with content rights. Today most live channels are geo-blocked to Norway. At the same time, we record transmissions for live-to-VOD from the same channel, where the geo-block can potentially be different. The live-to-VOD recordings-geo-block can also be changed retrospectively.
5.3.2.4	Configure a longer viewing buffer on a pop-up channel for a Slow TV production. One of the challenges today is that this impacts the overall origin system stability and performance.

5.3.3 AS A BROADCASTER WE ARE

Id	Requirement
5.3.3.1	Legally obliged to continuously deliver recordings of everything which has actually been aired on all planned channels (https://www.nb.no/en/legal-deposit/). *Today this is done by scheduling one-hour continuous recordings. These recordings are done on a buffer which is different from the viewing buffers so that potential gray-outs are not applied. These recording buffers are configured per channel with 5 hours which is longer than the viewing buffers.* After the recordings are downloaded and shipped to the National Library they are deleted at the Origin.

6 TECHNICAL REQUIREMENTS

This chapter contains the technical requirements that NRK wants from an Origin-service. Initially, we explain the video and audio sources, as well as examples of how these sources are structured. NRK also lists all TV and Radio channels that are available from the Mezzanine system, which are expected to be delivered in the offered solution. Furthermore, the requirements for the offered solution, linked to the system drawing in 3.1, are listed.

All TV and radio channels will broadcast 24/7, but the popup-channels will only be used some hours each day. The number of simultaneously usage of popup-channels will vary.

6.1 BACKGROUND

6.1.1 MEZZANINE SYSTEM

The Mezzanine System will be the primary source for the origin service. The distribution format available in NRKs Mezzanine system has the characteristics shown in tables below.

The Mezzanine will be available from two different locations in the Oslo-area offering multicast streams. The source on these two locations is not guaranteed to be in sync but should be handled as equal.

Detailed list of inputs and outputs for the for the Mezzanine System:

Radio Channels:

TS ID: 101

ServiceName: NRK P1 Stor-Oslo

Multicast: 239.xxx.xxx.xxx

Port: 5004

Protocol: RTP / UDP

Content	PID	Description	Format	Bit rate
PMT	100			

Audio 1	201	Stereo	HE-AAC v1	64 kbps
Audio 2	202	Stereo	HE-AAC v1	128 kbps
Audio 3	203	Stereo	HE-AAC v2	24 kbps
Audio 4	204	Stereo	AAC-LC	128 kbps
Audio 5	205	Stereo	MP3	32 kbps
Audio 6	206	Stereo	MP3	96 kbps
Audio 7	207	Stereo	MP3	192 kbps

Table 1: Example Radio channel

TV-Channels:

TS ID: 1

ServiceName: NRK1

Multicast: 239.xxx.xxx.xxx

Port: 5004

Protocol: RTP / UDP

Content	**PID**	**Description**	**Format**	**Bit rate**
PMT	100			
Video	101	CBR	H.264/AVC, High10@Level4.2 50fps	35 Mbps
Audio 1	201	Stereo	AAC-LC	160 kbps
Audio 2	202	Stereo	HE-AAC v1	64 kbps
Audio 3	203	Multichannel	Dolby Digital AC3	448 kbps
Audio 4	204	Stereo / Audio description	AAC-LC	160 kbps
TTML Subtitling 1	301	Normal	EBU-TT-D	
TTML Subtitling 2	302	Hard-of-Hearing	EBU-TT-D	

Table 2: Example TV Channel with H.264 video

TS ID: 2

ServiceName: NRKTV7

Multicast: 239.xxx.xxx.xxx

Port: 5004

Protocol: RTP / UDP

Content	PID	Description	Format	Bit rate
PMT	100			

TS ID: 2 **ServiceName: NRKTV7** **Multicast: 239.xxx.xxx.xxx** **Port: 5004** **Protocol: RTP / UDP**				
Content	PID	Description	Format	Bit rate
Video	101	CBR	H.265/HEVC, Main442-10@Level5.1 50fps	35 Mbps
Audio 1	201	Stereo	AAC-LC	160 kbps
Audio 2	202	Stereo	HE-AAC v1	64 kbps
Audio 3	203	Multichannel	Dolby Digital AC3	448 kbps
Audio 4	204	Stereo / Audio description	AAC-LC	160 kbps
TTML Subtitling 1	301	Normal	EBU-TT-D	
TTML Subtitling 2	302	Hard-of-Hearing	EBU-TT-D	

Table 3: Example TV Channel with H.265 video

6.1.2 MEZZANINE SOURCES

The table below gives a complete list of NRKs channels, available via the Mezzanine system. The column "Category" refers to the terms found in the glossary (Ch. 1.5).

Channel Name	Type	Category
NRK1 Oslo og Viken	TV	Primary
NRK1 Innlandet	TV	Secondary
NRK1 Møre og Romsdal	TV	Secondary
NRK1 Nordland	TV	Secondary
NRK1 Nordnytt	TV	Secondary
NRK1 Rogaland	TV	Secondary
NRK1 Sørlandet	TV	Secondary
NRK1 Trøndelag	TV	Secondary
NRK1 Vestfolg og Telemark	TV	Secondary
NRK1 Vestlandsrevyen	TV	Secondary
NRK2	TV	Primary
NRK3	TV	Secondary
NRK Super	TV	Secondary
NRK Tegnspråk	TV	Secondary
NRKTV4	TV	Secondary
NRKTV5	TV	Secondary
NRKTV6	TV	Secondary

Channel Name	Type	Category
NRKTV7	TV	Secondary
NRKTV8	TV	Secondary
NRKTV9	TV	Secondary
PopUp 1 - 10	TV	Secondary
NRK P1 Stor-Oslo	Radio	Primary
NRK P1 Buskerud	Radio	Secondary
NRK P1 Finnmark	Radio	Secondary
NRK P1 Hordaland	Radio	Secondary
NRK P1 Innlandet	Radio	Secondary
NRK P1 Møre og Romsdal	Radio	Secondary
NRK P1 Nordland	Radio	Secondary
NRK P1 Rogaland	Radio	Secondary
NRK P1 Sogn og Fjordane	Radio	Secondary
NRK P1 Sørlandet	Radio	Secondary
NRK P1 Telemark	Radio	Secondary
NRK P1 Troms	Radio	Secondary
NRK P1 Trøndelag	Radio	Secondary
NRK P1 Vestfold	Radio	Secondary
NRK P1 Østfold	Radio	Secondary
NRK P2	Radio	Primary
NRK P3	Radio	Primary
NRK Sapmi	Radio	Secondary
NRK Sport	Radio	Secondary
NRK Super	Radio	Secondary
NRK P3X	Radio	Secondary
NRK Urørt	Radio	Secondary
NRK P1+	Radio	Secondary
NRK P13	Radio	Secondary
NRK Nyheter	Radio	Primary
NRK MP3	Radio	Secondary
NRK Klassisk	Radio	Secondary
NRK Jazz	Radio	Secondary
NRK Folkemusikk	Radio	Secondary
PopUp 1- 5	Radio	Secondary

Totally 30 TV channels and 34 Radio channels.

6.1.3 OTHER SRT SOURCES

Sometimes NRK need to stream sources that are not part of the regular Mezzanine Setup. The distribution format will have the same formats as above but might lack subtitles, some audio tracks or have other frame rates. NRK will need to encode two simultaneous SRT sources (video).

6.2 Solution Architecture

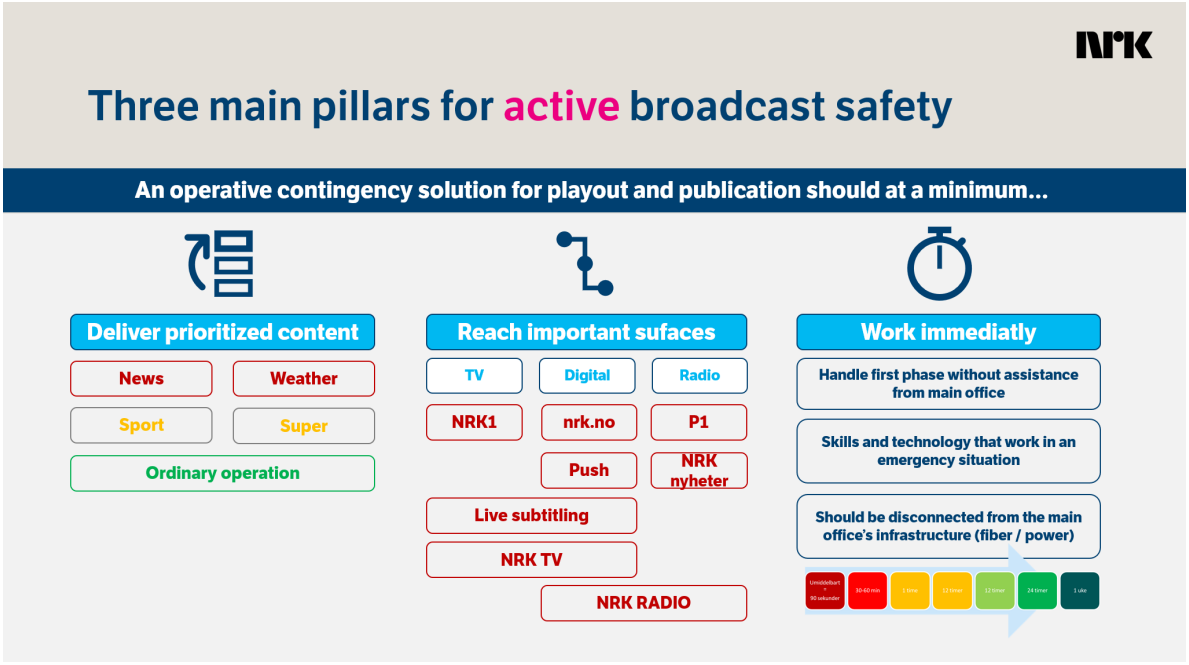
The Supplier shall provide a description on how their solution will comply with the different aspects of the architecture requirements listed under this chapter.

The purpose of the architecture requirements is to ensure that the new solution will support NRKs needs.

6.2.1 HIGH AVAILABILITY (HA) AND RESILIENCE

Very high service availability is imperative for NRK. Ref. table Mezzanine Sources in 6.1.2, the table column “Category” refers to the terms found in the glossary (section 1.5).

Primary channels should have redundancy level at 1:1 in both in network layer and related to encoder resources. For secondary channels the Customer expects a pool of minimum 2 extra encoders to be available as spares in case of encoder outage for a given secondary channel. The same applies to infrastructure such as network resources. These requirements should be applied for the production environment for all the different geolocation setups. As for a staging environment, these redundancy requirements do not apply.



Keeping in mind the different SLA and availability requirements for the primary channels and the streaming channels specified in chapter 6.1.2, please suggest, and discuss the following:

- The systems’ resilience strategies
- What type of outage, failure and emergency situations are mitigated with the different possible configurations (1:1, N:2, etc.)?
- Is there any added value or additional benefits in running all channels with same resilience/redundancy strategy.
- Site-redundancy for the origin service, where each channel is in sync between sites

- How non-planned maintenance and / or operational disruptions won't impact Customers audience

#	Requirement description
6.2.1.1	The Supplier shall describe their solution architecture and addressing the text above the table.
6.2.1.2	The solution must support operating on two physically separate sites (geo redundance).
6.2.1.3	The solution must provide redundancy and real-time content synchronization between all nodes on two separate physical sites.
6.2.1.4	The solution must provide redundancy and real-time content synchronization between two or more internal nodes on the same physical site. The default switch-over criteria should be TS_sync_loss as described in Priority 1.1 in ETSI ETR290 specification. The switch-over should be near seamless given that the quality of the input signal allows it.
6.2.1.5	The Supplier should be able to manually override the automatically failover functionality

6.2.2 SOFTWARE

The Customer prefers that the solution offered consists of off-the-shelf software based on modern software development and operations methodologies. The Customer expects the Supplier to continuously develop the service based on its own initiatives to deliver a "state-of-the-art" origin solution for the streaming market.

If there is a need to develop new functionality in order to meet NRK's requirements in this document, the functionality must also be made available to other customers. In the same way, if other customers order new functionality in the software, this will be made available to NRK.

Please describe versioning of the software and how the requirements above can be met.

6.2.3 INSTALLATION AND DEPLOYMENT STRATEGIES

Through its many internal development teams and in-house developed services, NRK has learned the huge benefits of automated deployments – both for reducing risk, documenting installation procedures, ensure repeatability, increase development and deployment speed - and ultimately making higher-quality services available for both users and viewers.

Please describe what deployment technologies and strategies used by the Supplier, including both initial installation and subsequent updates and upgrades, including configuration changes.

NRK would like the Supplier to contribute to end-to-end testing (including the Customers end-user experiences) of changes to reduce risk for regressions errors. This should be part of App. 5 Ch. 6.1 Collaboration Plan.

How do you plan to test updates and upgrades, and how will you handle deployments to avoid downtime?

6.2.4 STATEFUL AND STATELESS COMPONENTS, BACKUP

NRK expects automated deployment and provisioning. Please make sure that it is clearly stated what parts of the system hold local (and authoritative) state – i.e., what part of the system holds data that must survive a re-installation/re-deployment, and thus needs traditional backup.

Please describe suggested backup strategies (database backups, snapshots etc.) for the stateful instances, and any if any operational considerations must be taken (downtime, failover etc.) for backing up or restoring the system to a previous state.

Please state if there are parts of the system that has quorum requirements – i.e., if there are a minimum number of nodes that need to be healthy for a cluster to be available, and how this may affect deployment strategies and requirements.

6.2.5 LOCATION INDEPENDENT ARCHITECTURE

As stated in 2.2.1 NRKs HQ will be relocated. This means that the pickup-points for the Mezzanine signal might be relocated. For now, the two pickup-points will be available from two different locations in Oslo, in the future one of them might relocate to another city in Norway. Please describe any challenges this may pose.

6.2.6 SCALABILITY AND FLEXIBILITY

The Supplier is asked to describe how the Solution is scaled up or down and important limitations or dependencies. See also chapter 8.2 Service Scalability.

6.2.7 STAGING ENVIRONMENT

The Solution must be delivered with a staging-environment for testing changes, installation, patching and features before they are put into production. The staging-environment must consist of node(s) with feature-parity to the production environment, running at least two Mezzanine sources, both TV and radio, and one SRT source, e.g., NRK1 and P1, including progressive download for radio (see 5.2.4). The requirement for redundancy is stated in section 6.2.1 above. Please describe if the Supplier will be able to deliver a staging environment as described.

6.3 ENCODING

In order to make NRK's live streams available to the public, the delivered system must be able to encode the Mezzanine system's transport stream to an ABR format. The characteristics and requirement that NRK wants of such a component are summarized in the table below.

#	Requirement description
6.3.1	The Supplier should be able to connect to two redundant source feeds for a given multicast live channel
6.3.2	Support both Single Program Transport Stream and Multi Program Transport Stream
6.3.3	Support Mpeg4 AVC (ISO/IEC 14496-10)
6.3.4	Support HEVC (ISO/IEC 23008-2)
6.3.5	Support live multicast mpeg2ts ABR as input as a range of PIDs on the same multicast group address
6.3.6	Support passthrough for audio sources as specified in table 1 above
6.3.7	Support mapping for video, audio (passthrough) and subtitling as specified in table 2 above
6.3.8	Support mapping for video, audio (passthrough) and subtitling as specified in table 3 above
6.3.9	Support SMPTE 2038 signaling
6.3.10	Support SCTE 35 signaling
6.3.11	Support Mezzanine signals of 25/50 fps with aspect of 16:9

#	Requirement description
6.3.12	Support reconfiguration of an encoder to a different frame rate setup
6.3.13	Support HDR color space/signaling in the solution, including HDR-to-SDR and SDR-to-HDR remapping. NRK has selected HLG as HDR format
6.3.14	Support other SRT Input with AVC/HEVC, 8/10bit, 4:2:2, 25/50 fps
6.3.15	Support other SRT Input with AVC/HEVC, 8/10bit, 4:2:2, 29.97/59.94 fps
6.3.16	Support other SRT Input with AVC/HEVC, 8/10bit, 4:2:2, 30/60 fps
6.3.17	Support encoding of AVC/H.264 to suggested (6.4.1#5) ABR ladder
6.3.18	Support encoding of HEVC/H.265 to suggested (6.4.1#5) ABR ladder
6.3.19	The visual/audio quality must be approved by NRK based on VMAF, PSNR and a subjective judgement. The Supplier must provide encoding samples and test results in a SAT
6.3.20	Support chunked encoding to enable low latency streaming
6.3.21	Support ETSI EN 300 468 to map content in Program Map Table (PMT) from the Mezzanine signal to the corresponding requirements for audio, video and data components such as subtitle, E.g. language description
6.3.22	Support VBR type encoding metadata, for HLS and for DASH
6.3.23	Support extracting EBU-TT-D for creation of subtitles for manifest files.
6.3.24	In case of network drops, packet drops, MPEG2ts errors, the solution must be capable to seamlessly replace missing input video with a blank stream or an image-based courtesy banner insertion until input is resumed
6.3.25	In case of network drops, packet drops, MPEG2ts errors, the solution must be capable to seamlessly replace missing input audio with silent audio tracks insertion in the same channel output configuration until input is resumed
6.3.26	In case of network drops, packet drops, MPEG2ts errors, the solution should be capable to seamlessly replace missing input subtitles tracks with blank subtitle tracks insertion until input is resumed

6.4 ORIGIN - PACKAGING AND MANIFESTS

The following chapters contain current functionalities and new requirements to be met in a new system.

6.4.1 GENERAL

#	Requirement description
6.4.1.1	The solution must provide a state-of-the-art IO model, handling ram cache, flash cache, and local storage as well as external storage in a flexible way. Details must be included in the solution description
6.4.1.2	The solution must generate and deliver manifest adaptations based on client capability and device class, so that any given device is served a manifest that contains ABR renditions matching (and not exceeding) its capabilities
6.4.1.3	Support HLS manifest creation specified in RFC8216 - HTTP Live Streaming
6.4.1.4	Support Mpeg DASH manifest creation specified in ISO/IEC 23009 rev. 1:2022 - MPEG-DASH

#	Requirement description
6.4.1.5	Please suggest suitable ABR ladder(s) for content ranging from 270p25 to 2160p50, SDR to HDR (HLG) including HLS (ver3 TS), HLS (CMAF) and Mpeg Dash, encoded in both AVC and HEVC. Explain why these ladder(s) would benefit NRKs delivery
6.4.1.6	Support configuration of video and audio mapping pr step in ABR ladder (e.g. high quality video mapped to high quality audio and low quality video mapped to low quality audio)
6.4.1.7	Support HLS v3 (TS) manifests (for end users with older players)
6.4.1.8	Support HLS v6 manifests (CMAF)
6.4.1.9	Support Dash manifests (CMAF)
6.4.1.10	Please suggest optimal segment lengths suitable for achieving a latency for the end user between 5 and 8 seconds. Explain why these configurations would benefit NRKs delivery, and possible solutions regarding NRKs challenges for older / low-end platforms. See Ch. 1.5: End-user platform support
6.4.1.11	Support configurable segment length pr. channel
6.4.1.12	Support HDR to be marked as HLG in manifests, E.g VIDEO_RANGE in HLS
6.4.1.13	Support filtering video resolutions in TV Channel manifests based on query parameter
6.4.1.14	Support filtering of audio qualities in a Radio Channel manifest based on query parameter
6.4.1.15	Support setting start video resolution in TV Channel manifests based on query parameter
6.4.1.16	Support filtering audio qualities in Radio Channel manifests based on query parameters
6.4.1.17	Support AES-128 encryption with fixed and dynamic key for HLS manifests according to the HLS specification
6.4.1.18	Support AES-128 encryption with fixed and dynamic key for DASH manifests according to the DASH specification
6.4.1.19	Support DASH Segment timeline mode
6.4.1.20	Support DASH Numbered template mode
6.4.1.21	The solution must meet or exceed the following per-unit performance requirements in absence of hardware bottlenecks: 100 channels; 10Gbps input processing; demux, package and encrypt JITp and JITe, 80Gbps egress (from memory).

6.4.2 SUBTITLES

Subtitles are an important tool to achieve the goals set in the statutes mentioned in section 2. NRK provides subtitles as EBU-TT-D in the Mezzanine system. These subtitles should be processed to appropriate format and referenced in the manifests produced.

#	Requirement description
6.4.2.1	Support normal subtitles (E.g. PID 301) in manifest
6.4.2.2	Support hard-of-hearing subtitles (e.g. PID 302) in manifest, marked with correct metadata, e.g. CHARACTERISTICS for HLS
6.4.2.3	Support multiple subtitle tracks, where the tracks are marked with metadata as specified in the manifest specification. Properties visible to end user should be configurable, e.g. NAME for HLS
6.4.2.4	Support configuring the egress subtitles with full styling, such as size, font, positioning, background color etc. based on subtitles in Mezzanine

#	Requirement description
6.4.2.5	Support WebVTT egress
6.4.2.6	Support IMSC1 egress

6.4.3 AUDIO TRACKS

As described in table 2 and 3 above in section 6.1.1, the Mezzanine system could provide multiple audio tracks for both normal audio and separate audio tracks for hard-of-hearing (e.g. PID 204).

#	Requirement description
6.4.3.1	Support multiple audio tracks, where the tracks are marked with metadata as specified in the manifest specification. Properties visible to end user should be configurable, e.g. NAME for HLS
6.4.3.2	Support mapping of hard-of-hearing audio tracks in the manifest with the appropriate metadata according to standards

6.4.4 THUMBNAILS

To help the end user to navigate in the stream, NRK wishes to provide thumbnails for the video timeline.

#	Requirement description
6.4.4.1	Support I-frame playlist (HLS trick play) in HLS manifests. It should be possible to remove the reference from the manifest using a query parameter
6.4.4.2	Support thumbnails playlist in Dash manifests (DASH trick mode Adaptation Sets). It should be possible to remove the reference from the manifest using a query parameter
6.4.4.3	Support a thumbnail playlist with timestamps aligned to the video stream

6.5 API

NRK has a strong developer community, and being able to create new workflows, automate operations and adjust integrations between in-house built software and third-party systems is an important principle for NRK.

We have seen a shift in the last years from commissioning bespoke integrations between third-party systems to making the glue-services in-house, and this has enabled us to deliver new and powerful integrations and workflows to our users and viewers.

NRK value well-defined, documented APIs with a high degree of functionality coverage, and has come to expect this as an essential part of any new system or software delivery.

Systems that NRK envision should be integrated via APIs provided in the procurement are described in Ch. 3.3.

#	Requirement description
6.5.1	The system must provide access to all needed functionality through public APIs.
6.5.2	The APIs must be thoroughly documented, and the API documentation shall be included as attachment to Appendix 2.
6.5.3	The data model in use by the API should be documented and include formal schema definitions.
6.5.4	Usage of the API must be covered by the **support** level agreements.
6.5.5	The API and documentation must be kept up to date when new features are added to the system so that requirements #1 and #2 are always fulfilled.

#	Requirement description
6.5.6	If the API is exposed through one or more HTTP REST-like endpoints, they should use proper HTTP methods and response codes (i.e. errors should be in the 400-500 range etc).
6.5.7	The API should be consistent on media format and return types – using correct Content-Type headers including character sets.
6.5.8	Access to the API should at a minimum be controlled by authorization and authentication mechanisms (E.g built-in/LDAP/Azure AD/OAuth/Tokens)
6.5.9	The concurrency control mechanism (locking, etags, row version or similar) in use by the system should also be available and in use by the API, enabling prevention or detection of the Lost Update Problem.

6.6 SECURITY

The Supplier shall demonstrate that processes are in place to minimize the risk of product/service-vulnerabilities and minimize the risk that professional or support services are exposing NRK to threats.

The Supplier shall review and complete Attachment 1-1: NRK Vendor Security Requirements.

#	Requirement description
6.6.1	The origin service should only be available for specified CDNs or IP-ranges
6.6.2	All traffic (media content and API) delivered by the Origin service must be secured via HTTPS.
6.6.3	The system should have audit logging of all configuration changes in the system.
6.6.4	The Supplier shall review and complete Attachment 1-1: NRK Vendor Security Requirements.

6.7 NETWORK

The Supplier must ensure that the solution support the following for ingress and egress.

#	Requirement description
6.7.1	Network interface for Mezzanine pickup points should be SFP+ with single mode 10Gbase-LR
6.7.2	Support Unicast UDP/RTP (RFC3550) ingress
6.7.3	Support Multicast UDP/RTP (RFC1112) ingress
6.7.4	Support HTTP/2 Unicast TCP (RFC7540) egress

6.8 ADDITIONAL FEATURES / ROADMAP

NRK expects a Supplier that is forward leaning in relation to technological development in the streaming market and offers new standardized functionality when this may come, or existing functionality upon request by NRK.

If the Supplier already have support for these functionalities, please describe this in section 8.3 and address whether this is included in the base service or not.

The list below addresses support for several features NRK may need in the year(s) to come.

#	Requirement description
6.8.1	Support LL-HLS (Low Latency HTTP Live Streaming), as defined in the Low-Latency extensions in draft-pantos-hls-rfc8216bis (revision 7 and later)
6.8.2	Support Low-Latency DASH with CMAF (Common Media Application Format, as per DVB Bluebook A168, chapter 10.20 and following, and ISO/IEC 23000-22)
6.8.3	Support multi-platform DRM
6.8.4	Support AV1 codec
6.8.5	Support VVC codec
6.8.6	Support Dolby Atmos
6.8.7	Support MPEG-H audio
6.8.8	Support JPEG XS from Mezzanine system
6.8.9	Support Playlist Delta Updates
6.8.10	Please elaborate on other existing/upcoming relevant features.
6.8.11	Please elaborate on the pricing model for new features, how or if the scope of this agreement or the size of NRK's end users or NRK's market share in Norway will affect the price for new features. Specific price models to be inserted in Appendix 6, section 3.5.

7 SUPPORT / SERVICE AGREEMENT

7.1 SERVICE ORGANISATION

7.1.1 SERVICE DESK

The Supplier must have a Service Desk for NRK that is responsible for both incident handling and change management.

The Service Desk and the Customer should use the same ticket system to ensure that all cases and change requests are recorded and is available for both parties. See Ch 7.1.2

The Supplier must staff its Service Desk 24h/day and 7 days per week with personnel possessing knowledge and experience on the NRK deployment. NRK needs access to 24/7 telephone support described in Appendix 5, Ch 2.3.

NRK has high-profile events, such as the Eurovision Song Contest. These broadcasts reach large parts of Norway's population. At such events, NRK needs extra attention to our systems and services, so that NRK is sure that the event is delivered without errors. NRK informs the Supplier in advance on such occasions.

The Supplier must be able to offer 2nd and 3rd line of support personnel and describe time zones and working language.

In the event of incidents, NRK must be continuously informed based on the frequency detailed in the SLA agreement.

The Supplier shall describe their service- and operation organisation, including the service desk available for this Agreement in Appendix 2, considering requirements regarding service level in Appendix 4 and effective communication, collaboration, and escalation routines in Appendix 5.

7.1.2 TICKET SYSTEM

The reason for using a ticket system is to maintain an overview of all cases over time during the agreement period. Customer seeks the following characteristic and functions for the ticket system:

- Flexible and user-friendly
- Send and receive email to create and update issues
- Send email on all status changes of an issue
- Web User Interface
    - Full case handling of issues
    - List of all issues with status
- Single Sign-On Login via Azure AD

The Supplier shall describe their ticket system available for this Agreement in Appendix 2. How the ticket system is to be used shall be part of the collaboration plan, described in Appendix 5.

7.1.3 DAY-TO-DAY COMMUNICATION

NRK's preferred day-to-day communication platform is as of today Slack. NRK would prefer to create a joint Slack channel to engage / exchange information and ask questions. This channel should also be used for clarifying details regarding ongoing issues already registered in the mentioned ticket system or general collaboration.

The Supplier shall describe how he intend to implement the preferred day-to-day communication channels in Appendix 2, aligned with the proposed collaboration plan in Appendix 5.

7.2 OTHER ADMINISTRATIVE REQUIREMENTS

7.2.1 QUALITY ASSURANCE PROCESSES

The Supplier must perform the services in this Agreement in accordance with the relevant quality systems on which the Supplier or its subcontractors have been qualified to in the procurement of this Agreement. The qualification requirements were established suitable methods and/or systems to ensure to the quality of the deliveries (ISO9001, 2000-1 or equivalent), ensure adequate information security (ISO27001 or equivalent) and ensure adequate environmental management ISO14001/ EMAS/Miljøfyrtårn/ or equivalent).

If the Supplier has certified its systems, the Supplier undertakes to renew its 3rd party certified systems or standards in due time before it expires so that the certifications are maintained throughout the Agreement period. On request, the Supplier must present the license number on the certification.

The Supplier must report on how the routines are complied with, any deviations and corrective measures at contract follow-up meetings (see Appendix 5).

The Supplier shall describe how his quality systems will be used delivering the service in this Agreement in Appendix 2.

7.2.2 BUSINESS CONTINUITY PROCESS

The origin service is business-critical for the Customer, and the Customer foresee a long-term partnership with the Supplier for this service.

However, the broadcast industry may be subject to future changes; bankruptcy and merges may occur, the Supplier or its subcontractor may discontinue their solution/service etc, affecting the Supplier to deliver according to this Agreement.

Depending on which part in the delivery chain that may be affected, measures may imply inter alia

- Access to the source code of the origin solution
- Access to expertise for the origin solution is offered for a sufficient period of time
- A fulfilment of the obligations in the contract with an alternative origin system
- Parent or solidary guarantee for continued services/deliveries

In those circumstances where the Customer is entitled to have such arrangements put in place, the Party that obtain access to the source code shall have an expanded right of disposal that covers the right to use, copy, modify and develop the solution itself, or with the aid of a third party, to the extent necessary to achieve the purpose of the procurement.

The measures must last until NRK has obtained a new service.

Thus, the Supplier is required to suggest and describe in a binding manner in Appendix 2 appropriate measures that satisfactorily secures the Customer's interests according to which the Customer shall be notified if events above occur.

7.2.3 SUSTAINABILITY REPORTING

NRK has an ambition to take environmental considerations into account in all decisions. NRK will therefore be a driving force and contributor to a more climate- and environmentally friendly media production industry. By 2030, the aim is to reduce directly influenceable emissions by at least 50 per cent compared to the 2019 level. The aim is based on the principle that NRK prioritizes measures that result in real cuts from its own activities.

NRK's focus on sustainability is, among other things, anchored in the UN's Sustainable Development Goals, which is the world's joint work plan to eradicate poverty, fight inequality and stop climate change by 2030. NRK has several partners and suppliers that greatly influence NRK's environmental footprint, and it is therefore important for NRK to choose sustainable providers for IT services.

The Supplier should have access to the necessary technical insight and resources in order to assist the Customer in inquiries related to the environment and sustainability based on the content of the agreement for this origin services.

The Customer requires annual sustainability reporting on the delivered solution. The Supplier shall provide information about the Customer's total climate footprint and in cooperation with the Customer advise on measures related to the provided service that can contribute to reducing the climate footprint.

The Supplier shall describe how they are capable of serving the Customer as requested in Appendix 2.

7.2.4 DOCUMENTATION

The Supplier must document the technical environment, APIs and configuration descriptions and make the parts relevant for this service available to the Customer.

E.g., Technical overview, high level concepts, components.

Maintaining the documentation must be viewed as an ongoing task, to ensure that the documentation is always correct and complete. This activity shall be part of the service price.

7.2.5 LANGUAGE

All documentation must be in English or Norwegian.

7.2.6 TRAINING

If needed, the Supplier should offer relevant training on the functionality related to the services provided under this agreement.

The Supplier must indicate whether training is included as an activity in the project plan and if so, price this separately in Appendix 6.

8 OPTIONS

The Supplier shall describe the following options in Appendix 2 with prices in Appendix 6. There will be no obligation for the Customer to order any of the options below during the contract period.

8.1 STREAMING ORIGIN – ON-DEMAND

NRK has recently acquired a new streaming Origin solution for On-Demand content. The service is delivered by Global Connect, using ScalCast Origin from ScalStrm. This is a JIT-origin solution, with 400TB storage and approximately 5Gb/s egress, accessed by a multi-CDN solution. NRK ingests pre-encoded ABR-sets to the origin storage. In addition, the other requirements from Appendix 1 will apply. Please price the option with 99.95% SLA, cf. Appendix 4.

An extension of the scope will not be applicable until the existing On-Demand agreement expires or is terminated. The current agreement started February 28th 2023 and is valid for 2 years, with an annual extension.

8.2 SERVICE SCALABILITY

At the moment, NRK needs the number of channels as described in Ch. 6.1.2 and Ch. 6.1.3. In the future, however, the number of channels may change. New needs may include more or fewer channels or a change in the level of redundancy. Please describe how you will handle such a change. Please see Appendix 6 for the preferred pricing model for these options.

The supplier must also specify the delivery time from the Customer order until the channel/service is ready for use.

8.3 SUPPLIER'S OPTIONS – EXISTING FEATURES

Please specify available options below - including extensions, increased capacity, storage etc. If there are any, please also describe reservations or prerequisites. Each option shall be prised in Appendix 6.

Please also include descriptions of other related services that could be provided under this agreement. E.g., a general service catalogue. You may use an enclosed attachment as description and conditions related to these services.

8.4 INSOURCING OR MOVE OF INFRASTRUCTURE OPERATIONS

NRK is in the process of establishing data centers in Oslo and Trondheim and reserves the right to insource parts of the service or move the service if this should prove necessary or appropriate.

Please address how this may be solved in Appendix 2 and in Appendix 6 specify which parts of the costs of the service that will be affected if insourced cf. Appendix 6, section 3.4.