Direktoratet for samfunnssikkerhet og beredskap

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Next Generation Nødnett in commercial mobile networks

List of questions

Enclosure 1 to the Request for information (RFI) to the commercial mobile operators with their own nationwide radio network

Content

1 Introduction

DSB are studying how a "Next Generation Nødnett" (NGN) may be implemented based upon the commercial mobile networks, which raises some strategic, commercial and technical issues that must be addressed. In this enclosure, the mobile operators are invited to share their opinion on how their networks and operational activities may be organised in the future to facilitate the mobile networks being able to handle a communications solution that is critical to society and with stringent requirements relating to robustness, security and functionality.

The questions in this document are categorised as follows:

- Commercial and contractual arrangements:
  NGN in commercial mobile networks will entail an important paradigm shift, both for the State and for the operator(s) assigned the responsibility of supporting NGN; how may we establish commercial and operational terms and conditions that are appropriate both for the operator(s) and the State, and that will benefit the society as a whole in the form of more robust mobile services?
- Technology:
  It is assumed that NGN will be based on LTE and subsequent mobile standards from 3GPP.
- Network models:
  Should NGN be based on access via one or more mobile networks? Should a dedicated core network be established for NGN and if so, who should own this core network?
- Functionality:
  NGN requires specific functions such as priority, group calls, direct communication between terminals, and air-ground-air coverage.
- Coverage:
  NGN must be available where incidents occur and where the emergency services are active
- Robustness:
  NGN must be robust in demanding situations; i.e. in situations where emergency communication will often be required
- Security:
  NGN shall serve functions that are critical to society and must be secured against dedicated attacks from the inside as well as the outside
- Opportunities for cost optimisation through re-use from Nødnett:
  It is in the interest of the State that investments in Nødnett be re-used to the extent that this will be beneficial

The operator is requested to reply as indicated to each question below. Please refer to any additional documents in the relevant replies and include these documents in the RFI's *Enclosure 2 Additional information*.

NOTE: The operator is requested to reply to the questions of this document based only on LTE and more recent 3GPP standards; i.e. not GSM nor UMTS.

2 Commercial and contractual arrangements

The current TETRA-based Nødnett is owned by the State. Daily operations are handled by a commercial party, who is also responsible for the development. More than 90 % of the radio equipment is located in infrastructure not owned by the State. A considerable number of transmission lines are leased in the market, even though most of the access lines between base stations are realised with radio lines owned by the State. The users pay for the external operating expenses through subscription agreements, but the State does not invoice the users for the capital expenditures associated with Nødnett. The user payments are based on a fixed price model where the users are placed in price brackets based on the assumed usage.

Realisation of NGN in commercial networks will require a different business model, based on the principle that NGN will mainly entail a procurement of services based on an infrastructure that already is in place to a large extent and that is shared with the existing customers of the operators. Such a solution will not require dedicated radio frequencies, transmission lines or base stations. Operations and field services will also be handled by the personnel already working for the operator(s). A core network and functionality associated with NGN-specific telecommunications services may be realised in various different ways, with or without any state ownership, but this is not expected to constitute a significant cost driver. Such extensive use of the operators' existing infrastructure may indicate that a solution based on commercial networks will be considerably less costly for the State than the current dedicated TETRA network. At the same time, it must be assumed that the realisation of such a solution will require additional investments, in particular in terms of robustness measures. However, depending on the solution, these investments may benefit the whole society in the form of more robust services for all users of mobile networks.

a) It is very important that the State obtains a realistic picture of what expenses the State may incur due to NGN, while also gaining an understanding of the complexity and risks associated with the commercial agreements that must be established. Thus, the operator is requested to provide general assessments and recommendations concerning the issues described above (supported by further details provided later on in the reply), in particular with respect to the cost picture and potential business models for NGN. The operator is also requested to address what they consider to be the most important commercial challenges associated with the realisation of NGN in his mobile network.

The operator's reply:

[Text]

b) In the press release 212/17 (8 December 2017) from the Ministry of Transport and Communications, it is stated that the needs of users who are important to societal functions may be safeguarded through a combination of requirements imposed by the authorities and commercial procurements. The operator is requested to state his viewpoints on this matter.

The operator's reply:

[Text]

c) The supposedly most costly measures to be implemented in order to safeguard the needs associated with NGN, in particular concerning robustness, will also benefit the other mobile customers of the operator. Such measures may be considered an acceleration of measures that the operator will have to allow for in any case, in order to meet future demands from regular mobile customers, new services, as well as more demanding customer groups expecting a higher degree of service availability than can be provided by the current networks. In the opinion of the operator, to what extent should the State cover the expenses associated with such measures?

The operator's reply:

[Text]

d) The operator is requested to provide a general assessment of potential contract models for NGN, e.g. whether the operator recommends a main provider agreement ("turnkey", ref. FirstNet/USA), or a model with several smaller contracts (ref. ESN/UK). The operator is also requested to indicate what they consider to be an appropriate term for such contracts (ref. turnkey contract with a duration of 25 years for FirstNet/USA, compared with a set of contracts with a far shorter duration for ESN/UK).

The operator's reply:

[Text]

e) Experience from other countries shows that it may take a very long time from when the planning of a broadband solution for emergency and preparedness usage is initiated, until the solution has been implemented. It seems, for example, that this process will take at least 10 years for both FirstNet/USA and ESN/UK). Thus, it is important for the State to facilitate phase-out of Nødnett well in advance. In this context, the operator is requested to evaluate when they will be able to offer an NGN solution of at least the same level as Nødnett as regards robustness, coverage, security and functionality, including critical group communication for voice. Please consider this reply in light of more detailed questions further down in this enclosure.

The operator's reply:

[Text]

3 Technology

a) DSB assumes that NGN must be based on LTE and more recent standards from 3GPP. This is in part because this appears to be the technology preferred by the operators, and in part because this technology supports or will support properties that will be of particular importance for a public safety radio network. The operator is requested to provide a schedule for when the various LTE versions will be supported across the entire mobile infrastructure of the operator, both geographically and in the various subsystems (i.e. radio and core networks).

The operator's reply:

3GPP Release #	*11*	*12*	*13*	*14*	*15*	*16*
Scheduled availability in the operator's entire network (Hx/20yy[1])						

b) DSB envisions that NGN will be based on access to all frequencies used by the operators for their LTE networks, and assumes that functionality will be made available everywhere in the network, regardless of the frequency. DSB are of the opinion that there are security challenges associated with use of the type of WiFi solutions that the operators appear to be marketing, for example as a method to improve the indoor coverage. The operator is requested to comment on what the indoor coverage for NGN will be without use of such WiFi solutions, as well as provide an evaluation of security consequences if WiFi were to become part of the solution.

The operator's reply:

[Text]

c) If NGN is implement in commercial mobile networks, this will probably become the solution used for very many years to come. It is therefore preferable to gain an understanding of how the operator envisions that the networks will develop over the short and long term. Thus, the operator is requested to provide a description of his infrastructure, and how this will be developed over the coming 5-10 years:

- General architecture in the base station network, the core network, service platforms and administrative support systems for handling of subscriptions
- Structure of the transmission network – both the transport network and the access network – as well as what capacity providers dominate in this network
- Mechanisms for robustness, e.g. redundancy, in use in the operator's network
- Any geographical variations in the network structure (city, densely populated areas, sparsely populated areas, unpopulated areas, ocean areas close to the coast)
- Core network architecture, incl. the operator's plans for introduction of network slicing, as well as the operator's evaluation of security challenges associated with such solutions
- Any other issues that the operator would like to address

The operator's reply:

[Text]

[1] Hx/20yy: X half of year 20yy

4 Network models

There is a need to assess various network models and associated business models for NGN in commercial mobile networks. The following are among the issues that must be assessed:

- Should NGN be based on use of the radio network of one of the operators, or the radio networks of several operators?
- What business models will be the most appropriate, in terms of ownership, contractual relationships, definition of roles and responsibilities, etc.?

In the following chapters, DSB would like the operator to provide his assessment of these key issues.

4.1 NGN in one commercial mobile network

Selecting only one of the commercial mobile networks as the carrier of NGN seems to entail the following advantages:

- The responsibility for the services will be clearly defined
- The infrastructure will be uniform with regard to equipment, LTE releases, etc. This will reduce/eliminate any interoperability issues linked to the functionality and properties of the services.
- Necessary investments to fulfil the requirements related to NGN will be limited to only one network

At the same time, such a solution does entail certain challenges:

- This will distort competition vis-á-vis the other operators, in particular if implementation of NGN requires the State to contribute major investments in the selected network
- NGN will be dependent upon the quality, robustness and services of only one network
- The risk of long-term lock-in to one operator; i.e. the expenses incurred by the State in the event of a change in radio network operator at a later date, for example, will be considerable

a) The operator is requested to provide his evaluations and recommendations regarding the above. The operator is in particular requested to describe what challenges are envisioned if only one commercial mobile network is selected as the carrier for NGN, as well as how such challenges may possibly be resolved in commercial or regulatory terms.

The operator's reply:

[Text]

b) The operator is requested to evaluate the advantages and disadvantages of having a dedicated core network, or parts of a core network (e.g. HSS, P-GW, PCRF), for NGN in such a solution (physically or logically), in particular with regard to security, robustness and introduction or customisation of services.

The operator's reply:

[Text]

c) The operator is requested to evaluate whether or not a dedicated core network should be owned by the State, or be procured as a service from the operator, alternatively procured as a service from an external service provider (as in the case of ESN/UK).

The operator's reply:

[Text]

4.2 NGN based on access to several commercial mobile networks

It will be possible to establish an NGN solution utilising several commercial mobile networks based on national roaming, for example. Use of such a solution seems to avoid some of the challenges associated with implementation of NGN on the basis of only one mobile network:

- Effects that will distort competition may be avoided by distributing costly measures across all networks that are involved in the solution
- The total mobile infrastructure in the country may be utilised, which in principle appears to allow for a solution that will result in higher service availability than if being dependent upon only one mobile network

At the same time, this solution does entail certain other challenges:

- The division of responsibilities in the delivery chain will be more complicated and difficult to follow
- The different networks may have different properties due to different providers, different service versions, etc., which may render it more difficult to offer uniform services and functions across the different networks
- The operational situation will involve several parties, who will also be competitors
- The commercial agreements between the authorities and operators will be more complex
- Depending on the division of responsibilities and contractual terms and conditions, it may be necessary to implement the same costly measures in several networks

a) The operator is requested to provide his evaluations and recommendations regarding the above. The operator is in particular requested to describe what challenges are envisioned in case of establishment of a solution that will depend upon more than one commercial mobile network, as well as how such challenges could possibly be resolved.

The operator's reply:

[Text]

b) DSB envisions that a solution based on national roaming in several networks may be based on the same type of interfaces that is normally used for international roaming; i.e. S8. The operator is also requested to evaluate whether or not any other types of interfaces with associated functionality (e.g. for handover between networks) may be appropriate, e.g. Multi-Operator Core Network (MOCN).

The operator's reply:

[Text]

c) The operator is requested to describe opportunities for optimisation of change of networks in a solution with national roaming (S8 or MOCN, respectively), in order to minimise the time needed to reselect and connect to a new network, for example, as well as opportunities for preferencing a network. The operator is furthermore requested to describe to what extent such optimisation mechanisms will affect the battery life in the terminals.

The operator's reply:

[Text]

d) In light of the reply to the two preceding points, the operator is requested to evaluate what they consider to be the best solution for an NGN that is based on access to several commercial mobile networks. The operator is in particular requested to address the following issues:

- To what extent will the functions of terminals and applications be affected by what network is used by the user?
- To what extent will there be interoperability problems associated with services across the networks if different networks are used by the various users, e.g. during group calls, and how may such challenges be resolved?
- To what extent will a solution based upon more than one mobile network affect security issues (cf. Chapter 8)?
- How will the priority mechanisms (see Chapter 5.2 below) be safeguarded for NGN users across different networks? Does the 3GPP standard support these priority mechanisms during roaming in other networks?
- How may users be transferred to another network, manually or automatically, if such transfer should be appropriate?
- Will it be feasible with a solution where users may roam in other networks even though key core network nodes such as HSS or P-GW in the home network are not available?

The operator's reply:

[Text]

e) The operator is requested to provide an evaluation of whether or not the operator will be able to assume the overall commercial and operational ("turnkey") responsibility for NGN based on this solution if such a solution is selected, and thus also be responsible for the deliveries from the other operators included in the solution. The operator is in particular requested to indicate what prerequisites must be fulfilled in order to assume such a turnkey responsibility. The operator is also requested to evaluate any alternative business models for a solution where NGN is based on access to several mobile networks.

The operator's reply:

[Text]

f) The operator is requested to evaluate to what extent a solution based on access to several mobile networks will require that a separate core network be established either logically or physically for NGN, including what network nodes must be established in that case.

The operator's reply:

[Text]

g) The operator is requested to evaluate whether or not a dedicated core network should be owned by the State in case of a solution based upon access to several mobile networks, or be procured as a service from the operator (as in the case of FirstNet/USA), alternatively procured as a service from an external service provider. Please make an assessment of advantages and disadvantages.

The operator's reply:

[Text]

h) The operator is requested to evaluate to what extent use of national roaming for NGN will render the technical solution more complicated compared to use of only one mobile network, as well as describe what kind of additional expenses may be incurred as a consequence of this.

The operator's reply:

[Text]

i) The operator is requested to describe commercial consequences for a solution based on national roaming, rather than a solution where NGN is based on only one mobile network.

The operator's reply:

[Text]

j) The operator is requested to evaluate whether there are any mechanisms other than national roaming, e.g. use of multi-SIM and any underlying systems, that may be relevant alternatives if NGN is to be based on several mobile networks.

The operator's reply:

[Text]

5 Functionality

5.1 Telecommunications services and special functions for emergency and preparedness

The current TETRA-based Nødnett offers telecommunications services such as the following (see also www.nodnett.no):

- "Push-to-talk", both point-to-point and point-to-multipoint (talk groups)
- Telephony (both internally within Nødnett and towards public networks)
- Message service (Short Data Service, both directly between endpoints and with store&forward)
- Packet switched data, up to 13 kbps in both directions

In addition, the current Nødnett provides services such as:

- Local autonomy (i.e. communication via local base stations, if other infrastructure should become unavailable)
- Direct communication between terminals
- Access to the network via gateway terminals
- Air-ground-air communication to helicopters, for example
- TETRA Inter System Interface (ISI) between the Norwegian and the Swedish public safety radio networks, as well as between the Norwegian and Finnish networks

This portfolio of functions and services must be provided, expanded upon and further developed in NGN.

a) The current Nødnett offers packet data services with low speed, well suited for machine-to-machine communication, SCADA, etc. There is, however, an increasing demand for more advanced and capacity-demanding data services in line with what is available in the commercial mobile networks, e.g. for transfer of live images, access to databases from the field, file transfers, etc. Thus, NGN must be able to offer broadband data with better availability and robustness than what the users currently have access to as regular subscribers in the commercial mobile networks. A secure and robust broadband solution should be introduced in parallel with Nødnett, and it should be possible to further develop the solution over time to facilitate gradual transfer of all Nødnett services.

The operator is requested to describe what data speeds may be offered in general to the individual users in the operator's network over the coming 1-5 years, and in particular state what assumptions have been made regarding the number of simultaneous users in the optimum sections of the radio cell's coverage area as well as towards the cell border, respectively. The operator is also requested to detail how the available data speed will vary geographically.

The operator's reply:

[Text]

b) 3GPP has defined a number of services for LTE that are especially useful for emergency services, and these correspond to several of the services offered in the current Nødnett:

- *Evolved Multimedia Broadcast Multicast Services* (eMBMS), which may help ensure efficient utilisation of the capacity in the radio network in connection with group communication
- *Proximity Services* (ProSe), which may facilitate direct communication between user terminals, for example
- *Isolated E-UTRAN Operation for Public Safety* (IOPS), which may facilitate use of the coverage from a single base station or a group of base stations in situations where the rest of the infrastructure is accessible
- Group communication services in LTE for "*mission critical push-to-talk*" (MCPTT) for voice, and correspondingly for data (MCData) and video (MCVideo); i.e. group communication services with a security / functionality / robustness level corresponding to what is required for emergency services and preparedness agencies (i.e. not internet-based services without QoS, etc.)

The operator is requested to indicate when these services may be made available for use across the entire network of the operator (all frequencies and all geographical areas). The operator is requested to distinguish between services provided by themselves, and services that will be provided by external service providers (e.g. the State) with servers that will be connected to the operator's network via relevant interfaces.

The operator's reply:

Relevant functions in LTE:	*Scheduled availability in the operator's entire network (Hx/20yy)*	*3GPP Release # the functions will be according to*
eMBMS		
ProSe		
IOPS		
MCPTT (produced internally vs via external service provider, respectively)		
MCData (produced internally vs via external service provider, respectively)		
MCVideo (produced internally vs via external service provider, respectively)		

c) Will the network functions addressed in the preceding point require investments in the operator's network, and if so, is the operator able to estimate what this will entail in terms of initial and running costs for the operator?

The operator's reply:

[Text]

d) The alternative solutions considered by DSB include use of several commercial radio networks to carry NGN. This will entail that users who communicate with each other, in the same group call, for example, may be using different networks.

The operator is requested to describe whether or not the 3GPP functions and services listed in point b) over may function across different networks belonging to different operators, and what challenges and limitations may be associated with this.

The operator's reply:

[Text]

e) In case of major incidents, there may be many participants in the same talk group, perhaps more than 100, within a small area covered by only one base station. With eMBMS, the participants will have simultaneous access to a shared radio channel, but without eMBMS, a connection must be established for each individual participant. The operator is requested to describe how long it will take to establish such a connection, and estimate how many connections may be established over the course of 400 ms, for example (a target figure for the time needed to establish a group call in Nødnett).

The operator's reply:

[Text]

f) The operator is requested to describe what challenges may be associated with the use of eMBMS, for example whether or not eMBMS must be set up manually in each individual case, etc.

The operator's reply:

[Text]

g) The majority of the functions described above will require support in both terminals and network. The operator is requested to evaluate whether or not there will be terminals available in the market that will support each of these functions by the time these functions become available in the operator's infrastructure.

The operator's reply:

[Text]

5.2 Priority

The current Nødnett is a separate network dedicated to communication between emergency and preparedness users with associated equipment and control rooms. This entails that the available capacity in Nødnett at any given time is not affected by the traffic in the commercial telecommunications networks. When NGN is established as part of the commercial mobile infrastructure, the emergency services will have to compete with other customers for the available capacity in these networks. This may entail a challenge, in particular in case of incidents where there is a lot of communication to/from many users from the emergency services within a limited area, at the same time as there is heavy traffic from regular users within this same area. One way to resolve this challenge is to make use of the priority mechanisms that are available in the LTE standard and grant the emergency services a higher priority than communication from other users.

a) The operator is requested to indicate when the QoS mechanisms specified by 3GPP, *QoS Class Identifier* (QCI, with relevant levels) and *Allocation and Retention Priority* (ARP), are scheduled for use in the operator's network. The operator is requested to specify whether or not the availability of these functions will depend on whether customers request this, alternatively that these become the object of regulatory orders.

The operator's reply:

	Scheduled availability in the operator's network (Hx/20yy)	*3GPP Release # the function will be according to*
QoS Class Identifier (QCI), relevant levels		
Allocation and Retention Priority (ARP)		
Any other relevant QoS mechanisms (please specify)		

b) The operator is requested to comment on whether or not the access control mechanism *Access Class Barring* (ACB) will be relevant for use for NGN users. The operator is also requested to describe whether or not any other mechanisms may be relevant, for example *Extended Access Barring* (EAB) and *Service Specific Access Control* (SSAC). The operator is requested to indicate when the relevant mechanisms are planned to become available in the operator's network.

The operator's reply:

	Scheduled availability in the operator's network (Hx/20yy)	*3GPP Release # the function will be according to*
Access Class Barring (ACB)		
Extended Access Barring (EAB)		
Service Specific Access Control (SSAC)		

c) The operator is requested to describe how the emergency services may be granted special priority in the operator's network, possibly using the mechanisms mentioned in this chapter. In this context, the operator is requested to describe any challenges and limitations associated with granting the emergency services such priority ahead of other users, and whether any of these mechanisms are unsuitable for use with NGN. As part of such a solution, the operator is also requested to describe whether priority for the emergency services will be handled automatically or manually, where the latter entails that the emergency services may be granted priority in connection with specific incidents within specific areas, but otherwise have a priority that is different from or the same as for other users.

The operator's reply:

[Text]

d) The alternative solutions considered by DSB include use of several commercial radio networks to carry NGN. This will entail that users who communicate with each other, e.g. in the same group call, may be using different networks.

The operator is requested to describe how the 3GPP mechanisms described in a) and b) will be implemented in the operator's network, as well as provide an evaluation of to what extent the mechanisms may be implemented in a different manner in other operators' networks and whether or not there may be a need for national coordination, alternatively a clarification in the 3GPP standards, regarding this issue. The operator is also requested to evaluate whether or not the mechanisms in a) and b) above may function across different networks belonging to different operators, and what challenges and limitations may be associated with this. The operator is also requested to describe how the solution(s) described in c) above may function across different networks.

The operator's reply:

[Text]

e) The operator is requested to describe what mechanisms may be used to ensure that calls from regular users to the emergency numbers (110, 112 and 113, respectively) may be routed through even if the traffic from the emergency services is granted priority.

The operator's reply:

[Text]

f) The current priority subscription, which grants users priority for 2G and 3G voice communication, is dimensioned for 10-15,000 users. In NGN, the number of users with a need for priority may be considerably higher than what is the case with the current Nødnett, in particular if the users from the Armed Forces are included. Does the operator foresee any technical or commercial challenges associated with offering priority for 4G voice and data to 100,000 users, for example? Should prioritisation be situation-specific, and possibly depend on what application is used, or may prioritisation be defined statically?

The operator's reply:

[Text]

g) How will the operator charge for prioritisation; establishment charge, fixed monthly price, price per actual usage (i.e. when the users are actually granted priority ahead of other mobile customers), for example? What external expenses (licence costs, etc.) may be incurred by the operator in case of the introduction of a prioritisation scheme?

The operator's reply:

[Text]

5.3 MCPTT across Nødnett and NGN

a) During a transitional phase, before Nødnett is phased out, it will be necessary to ensure users can participate in MCPTT talk groups that function across both NGN and Nødnett. The operator is requested to describe whether or not such interaction will depend on functionality only at the application layer, or whether functionality in the network will also be required. Please note that work is going on in 3GPP to establish functionality for such interaction between LTE and TETRA for Release 15.

The operator's reply:

[Text]

5.4 External interfaces

a) The operator is requested to describe what interfaces and associated mechanisms may be made available for customer administration and invoicing, in case it is determined that such functions should be handled by parties other than the operator (e.g. the State or the users themselves). The description should cover interfaces to obtain information for invoicing of the users, as well as interfaces to register and activate various services and service profiles for the individual users.

The operator's reply:

[Text]

5.5 End-to-end responsibility

a) Will the operator be able to assume end-to-end responsibility, where the operator is responsible for the function and performance of all relevant services across networks and user equipment, such as terminals, applications and potentially even equipment in the control rooms?

The operator's reply:

[Text]

6 Coverage

Nødnett is currently comprised of about 2,070 base stations. This entails coverage of 86 % of the mainland areas of Norway. Nødnett provides nearly full coverage along European, national and county roads as well as in cities and densely populated areas. In order to ensure better indoor coverage where the need is the greatest, uplift of signal strength is required in cities and towns and within a 5 km radius of all fire stations. As regards air-ground-air coverage, separate base stations have been established that provide nearly 100 % coverage at an altitude of 5,000 feet above the ground. There is also a total of 375 road and railway tunnels where separate facilities for Nødnett coverage have been installed or are scheduled for installation.

When NGN is to handle the voice traffic currently handled in Nødnett, the coverage must as a minimum be at the same level as for the current Nødnett, both outdoors and indoors.

a) The operator is requested to state the current coverage and the planned coverage for its network, as shown in the table below. The operator is requested to specify how the coverage has been defined, in terms of sensitivity threshold, propagation model, diffraction model, etc.

The operator's reply:

	2017/18 (now)						*2020*	*2022*
	Eastern Norway	*Southern Norway*	*Western Norway*	*Mid Norway*	*Northern Norway*	*The entire country*	*The entire country*	*The entire country*
Total number of base stations								
	Outdoor coverage							
Area coverage (%)								
	Indoor coverage							
Number of indoor facilities for LTE								
	Tunnel coverage							
Number of tunnels (road, railway) with coverage								
	Coverage in open waters *(typical coverage along the entire coast)*							
Nautical miles from the coast								

Eastern Norway: Comprised of the counties Akershus, Oslo, Vestfold, Østfold, Hedmark, Oppland, Buskerud, and Telemark
Southern Norway: Comprised of the counties Vest-Agder and Aust-Agder
Western Norway: Comprised of the counties Møre og Romsdal, Sogn og Fjordane, Hordaland, Rogaland
Mid Norway: Comprised of the counties Sør-Trøndelag and Nord-Trøndelag
Northern Norway: Comprised of the counties Nordland, Troms and Finnmark

b) The size of the radio cells and thus the LTE coverage depends on the volume of traffic within the individual radio cells. The operator is requested to describe how the coverage stated in the above table will be affected by an incident towards the radio cell border where a certain number of emergency services users, assume 20 (twenty) as an example, use the same radio cell, and everyone is listening to (i) an MCPTT conversation as a first case and (ii) an MCVideo conversation as a second case, respectively, without the network having support for eMBMS. For the MCPTT conversation, it may be assumed that a downstream data stream of 20 kbps must be established per user, and for MCVideo, 768 kbps per user. The operator is requested to describe appropriate measures that may be implemented in order to resolve any challenges associated with the communication quality in such a situation.

The operator's reply:

[Text]

c) The current Nødnett has six transportable base stations at its disposal in order to facilitate handling of incidents in areas that have no permanent coverage from the radio network, or areas that are affected by coverage outage. These base stations have their own power supply and are equipped with a satellite link to facilitate communication to/from areas without any functioning infrastructure. An agreement has been established regarding helicopter transport of the base stations when required, or they may be transported by car.

The operator is requested to state the number of transportable base stations in the possession of the operator, where these are located in the country, the time needed to render these available and operative at an arbitrary incident site, type of connection to the operator's network, size (from "backpack size" to container solution) and transportation methods.

The operator's reply:

	Eastern Norway	*Southern Norway*	*Western Norway*	*Mid Norway*	*Northern Norway*
Number of transportable base stations and their regular locations					
Time needed to render a station operative at an incident site					
What are the base stations equipped with (battery/generator)?					
Transmission link to the operator's network (satellite or other)					
Size and transportation methods					

d) The operator is requested to describe how often transportable base stations are currently used, and in what situations they are typically used.

The operator's reply:

[Text]

e) Nødnett has a special solution to facilitate TETRA coverage for airborne vessels, primarily helicopters. Nødnett has approx. 90 base stations dedicated to airspace coverage. These base stations are only available to aircrafts and use separate frequencies to avoid interference with the terrestrial network. In addition, Nødnett has mechanisms that allow the aircrafts to use the regular base stations when they land or take off, or when they fly close to the ground. The operator is requested to describe how a corresponding solution for LTE coverage for airborne vessels may be established in the operator's network, including whether or not this should be handled by allocating separate frequencies for this very purpose.

The operator's reply:

[Text]

f) The Tunnel Safety Regulations (see https://lovdata.no (in Norwegian)) have provisions relating to emergency power and redundant systems to ensure safety equipment will function for as long as possible in case of incidents in tunnels. Requirements have also been stipulated in these Regulations relating to the fire resistance of equipment: «*The fire resistance level in all tunnel equipment shall take into account the technological possibilities and aim at maintaining the necessary safety functions in case of fire*». In practical terms, this entails that the current Nødnett must use two-sided feeding of each leaky cable segment, where each unit must be able to feed the entire segment. The operator is requested to describe the consequences of this for his tunnel installations, as well as estimate the associated expenses.

The operator's reply:

[Text]

7 Robustness

Nødnett has stringent requirements relating to availability and must function in the most demanding of situations. It is under difficult conditions, such as crises, catastrophes and extreme weather situations, that it is most important for the emergency services to have access to good communications solutions. Nødnett has been developed specifically for this purpose. The TETRA technology used in Nødnett includes a number of mechanisms that enhance robustness, including local autonomy and direct communication between terminals. In addition, all base stations have backup power for minimum 8 hours. Approx. 8 % of the base stations have 20 hours of backup power, while 15 % have minimum 48 hours, and DSB are evaluating how to increase this even further. No corresponding backup power requirements have yet been established for the transmission nodes used in Nødnett. However, a ring structure design has been used for the transmission to the base stations. This provides better protection against transmission outages as a consequence of power failure, line breaks or other events.

7.1 Robust systems

a) The operator is requested to describe what robustness solutions have been established to ensure high service availability. The operator is requested to describe such solutions in general and for the following areas in particular:

- The base stations
- The access part of the transmission network out to the base stations
- The transport part of the transmission network
- The core network
- The operational support systems

Please note that some of these areas will be addressed specifically in subsequent questions.

The operator's reply:

[Text]

b) The operator is requested to indicate what network elements or other components in the operator's infrastructure are especially critical, and will have an impact on large, geographical areas or a high number of users in case of a failure. The operator is requested to describe any measures that have been established to safeguard the robustness of these elements/components, alternatively what additional measures may be implemented.

The operator's reply:

[Text]

c) It is a goal for Nødnett to maintain a service availability of 99.95 %, including planned downtime, where service availability shall be understood to mean that a user located within Nødnett's coverage area will have access to the services in Nødnett with a probability of 99.95 %. The operator is requested to state the corresponding service availability figure for his network, with and without planned downtime, respectively. In addition, the operator is requested to specify what parts of the network, alternatively what network nodes, are the most important sources of service outages from the perspective of the user.

The operator's reply:

[Text]

d) In order to gain a better understanding of the robustness of the operator's infrastructure, and any typical risk areas, the operator is requested to list the most serious service outages in his infrastructure over the course of the last three years; i.e. outages that have affected a large geographical area (due to power outage, transmission breaks, etc.) or have resulted in outage of individual services such as SMS, voice or data (due to SW/HW/configuration faults in key network elements, etc.). The operator is also requested to indicate the cause of the incidents, where the fault occurred (e.g. the base stations, the transmission network, the core network, the operation and maintenance organisation) and the total downtime as a consequence of the incident.

The operator's reply:

Incident	*Cause*	*Location of vulnerability*		*Total downtime*
		Geographical area (county)	*In the network structure (e.g. core network, radio network, transmission)*	

e) The operator is requested to list the most common causes of service outages in the operator's infrastructure and an indication of the scope of these (estimated percentage of the total number of outages over the last 3 years).

The operator's reply:

Causes of service outages:	*Scope*
Power outage	
Transmission break	
Operator error (planned work)	
Error in software	
Faulty hardware	
Physical load (fire, vandalism, collapse of building, etc.)	
Other (indicate cause)	

f) The operator is requested to indicate whether there are any special areas in the country that are particularly exposed to service outages, and what are the causes of this.

The operator's reply:

[Text]

g) In light of the incidents described above, the operator is requested to indicate any special measures that are planned for implementation on the short and long term to eliminate the various vulnerabilities.

The operator's reply:

[Text]

h) Currently, all base stations in Nødnett have minimum 8 hours of backup power. Approx. 8 % of the base stations have 20 hours of backup power, while 15 % have minimum 48 hours, and DSB are evaluating how to increase this backup power capacity even further.

The operator is requested to indicate the backup power solutions (generator, battery, etc.) and the backup power capacity currently established in the operator's network.

The operator's reply:

Network element[1]	*Backup power solution*	*Share of equipment fitted with backup power solution*	*Duration of backup power capacity when in use*
The base stations			
The nodes in the access part of the transmission out to the base stations			
The transmission nodes in the transport network			
The core network nodes			
The operational support systems			

1) If there are different categories or different levels for what backup power capacity has been established for each of above elements, the operator is asked to indicate the requested information for all the different categories.

i) The ability to function in the event of a power outage is a very important property of NGN, and it is assumed that NGN's ability to provide services during power outages should be at least on level with Nødnett as achieved with its current backup power capacity and transmission ring topology in the radio network. It should, furthermore, be a goal to increase this level even further over time. However, backup power is costly, and DSB are of the opinion that significant investments may be required in the commercial mobile networks (the radio and transmission networks, respectively) in order to achieve this. The operator is requested to describe alternative measures and associated expenses for an increase in the resistance against power outages, for example by increasing the backup power in all base stations and transmission nodes, or by increasing the backup power more selectively (with or without the assumption of national roaming), etc. The operator is also requested to recommend the best strategy. The reply should preferably include a reference to previous work related to 1) implementation of the backup power decision («Reservestrømvedtaket», which is valid for 2014 - 2022), and 2) the «Forsterket ekom» program to increase the backup power.

The operator's reply:

[Text]

j) DSB are considering solutions for NGN based on national roaming in several mobile networks, in order to increase the total robustness of NGN. DSB are aware, however, that some of the current infrastructure is shared by several operators. This includes parts of the transport network and some physical locations. Increased robustness cannot be achieved for such common elements even if it is decided that NGN should be based on multiple mobile networks. For the purpose of achieving an understanding of the scope of such common vulnerabilities in the assessment of NGN models, the operator is requested to provide a general evaluation of the scope of common elements between the mobile operators at the physical and logical level for the different parts of the infrastructure as designated in the table below, today and in the years to come.

The operator's reply:

	Scope of common elements between the mobile operators (physical and logical level)
Transmission nodes in the radio/access network	
Transmission nodes in the transport network	
Physical core network locations, as well as any shared use of backup power	
Physical base station locations, as well as any shared use of backup power	

k) DSB wish to assess the opportunities for achieving robust solutions in a cost-effective manner. Thus, DSB request that the operator evaluates the possibility of establishing a logical set of extra robust "umbrella base stations" that may provide continuous coverage in all or parts of the operator's network, and that may ensure that the emergency services will be able to communicate even in case of outages in other parts of the radio network. In the event of such a solution, it may be envisioned that the investment needs may be reduced by primarily focusing on the umbrella base stations.

The operator's reply:

[Text]

l) In DSB's understanding the operators' radio networks are based on transmission networks in a star structure out to the base stations. DSB are of the opinion that this is a less robust solution, and has therefore decided on ring structures for connection of the base stations in the current Nødnett. The operator is requested to describe how the robustness may be increased for the transmission network out to the base stations in his network, as well as provide an estimate of the cost of such measures.

The operator's reply:

[Text]

7.2 Robust operations

a) The operator is requested to provide a description of his operational support systems for the various parts of the operator's infrastructure. The operator is specifically requested to detail solutions to ensure robustness in these systems, including redundant systems and redundant operations locations.

The operator's reply:

[Text]

b) The operator is requested to provide a description of his operations organisation, included staffing levels and locations. The operator is also requested to describe his duty schemes and the scope of any stand-by/on-call duty schemes and associated response times.

The operator's reply:

[Text]

c) The operator is requested to provide information on to what extent and how subcontractors are incorporated into the operator's operations organisation. The operator is in particular requested to indicate the following:

- Any outsourcing of operating assignments to external companies, in terms of first and second line support or upgrade of HW and SW in the network, for example, and what parts of the infrastructure are operated by such companies, if any
- Whether or not any third line support; i.e. support from equipment suppliers, is provided from Norway or from abroad, and if so, which countries, for the different elements in the operator's network
- To what extent configuration changes and software updates in the network are handled via remote access

The operator's reply:

	First line support (internal / external supplier, use of remote access)	*Second line support (internal / external supplier, use of remote access)*	*Third line support (from Norway / from abroad, use of remote access)*
Radio network			
Transmission network			
Core network			
Operational support systems			

d) The operator is requested to state typical response times in case of faults in the different parts of the infrastructure.

The operator's reply:

	Typical time lapsed from fault is discovered until fault correction is initiated	*Typical time lapsed from fault correction is initiated until the fault has been corrected (temporarily or permanently)*
Fault in the base stations		
Fault in the transmission network		
Fault in the core network		
Fault in operational support systems		

e) The operator is requested to provide a description of the routines and systems for handling of crises and emergency response, including how his organisation and relevant subcontractors are mobilised.

The operator's reply:

[Text]

f) The operator is requested to provide a description of his routines for planned work, including time of day/night and notification of customers.

The operator's reply:

[Text]

g) The operator is requested to provide information on his solutions for handling of spare parts, including whether or not the operator has his own spare parts inventory, the geographical location of the operator's and/or equipment supplier's spare parts inventories, as well as the response times for replacement of faulty hardware.

The operator's reply:

	Owner of spare parts inventory (operator/supplier)	*Geographical location(s) for spare parts inventory(ies)*	*Replacement time for faulty hardware*
Base station equipment			
Transmission equipment			
Core network equipment			
Operational support systems			
Location-specific equipment (cables, generator parts, etc.)			

h) The operator is requested to describe what adaptations may be required in terms of how the network is operated if the network were to carry NGN, as well as describe what kind of expenses may be incurred.

The operator's reply:

[Text]

8 Security

Security is of particular importance for Nødnett as functions critical to society depend on this infrastructure. Nødnett is used only by the emergency services and other authorised users. The current Nødnett is secured in several different ways, including by encryption of the air interface, end-to-end encryption of voice traffic, very restricted and controlled access to Nødnett from other networks, security clearance for operations personnel,

and by the TETRA network being a self-contained, almost closed network without any commercial users. The operators' replies may contain classified information. If so, please contact DSB directly to ensure information may be received, handled and stored properly, see the administrative section of the request for information.

8.1 General

a) The operator is requested to describe his security organisation, including organisation, competence and mandate.

The operator's reply:

[Text]

b) The operator is requested to describe his systems and solutions for preventive security work, including monitoring of security in the physical and logical infrastructure.

The operator's reply:

[Text]

c) Nødnett is subject to Norway's Security Act ("Sikkerhetsloven"). The operator is requested to specify to what extent the Security Act has any impact on the operator's current activities and what measures the operator must establish in order to fully comply with requirements of the Security Act, the Object Security Regulations ("objektsikkerhetsforskriften") and associated requirements in the electronic communications legislations.

The operator's reply:

[Text]

d) What processes and activities do the operator carry out to ensure the security requirements, including elements covered by the Security Act, are fulfilled? The operator is in particular requested to provide a description of how security-related functions and needs are safeguarded in connection with changes in the operator's infrastructure.

The operator's reply:

[Text]

e) The operator is requested to state the name of the suppliers of core network nodes, base stations, transmission equipment and operational support systems.

The operator's reply:

	Equipment type / category[1]	*Supplier(s) of equipment (OEM)*	*Supplier(s) of operations and maintenance services*		
			First line support	*Second line support*	*Third line support*
Base station equipment					
Transmission equipment					
Core network equipment					
Operational support systems					

1) Equipment type / category means sub-groups within the stated main categories, e.g. MME and HSS in the core network. Such information needs only be provided if the operator has different suppliers for this equipment.

f) The operator is requested to indicate whether any of the suppliers of operations and maintenance services in the preceding point provide their services from abroad, and if so, what country/countries, or use foreign personnel in Norway.

The operator's reply:

[Text]

g) The operator is requested to state the name of the main suppliers of construction services and indicate whether or not any of them provide their services from abroad, and if so, what country/countries, or use foreign personnel in Norway.

The operator's reply:

[Text]

h) How does the operator evaluate and handle the operational risks associated with the various types of suppliers, the countries they operate from, and the work they perform?

The operator's reply:

[Text]

i) The operator's main suppliers will generally have several subcontractor chains. How does the operator maintain overview and control of all the supplier chains?

The operator's reply:

[Text]

j) The operator is requested to provide a description of how national autonomy is currently handled, as well as what functions are handled outside of Norway and whether or not there are any plans for transfer of these functions to Norway.

The operator's reply:

[Text]

k) Will the operator be able to grant DSB access to the operator's security policies and manuals, if this should become relevant at some time in the future?

The operator's reply:

[Text]

8.2 Physical security

a) The operator is requested to describe how the physical nodes in the operator's network are secured physically (e.g. perimeter protection, access control, fire, flooding).

The operator's reply:

	Physical security
Base station equipment	
Transmission equipment	
HSS	
Other core network equipment	
Operational systems	
Customer management and invoicing systems	

b) The operator is requested to describe his systems and procedures for providing his own employees and suppliers access to locations and physical equipment in his infrastructure, as well as any plans for stricter enforcement. The operator is requested to describe any incidents of a serious nature over the course of the last three years due to breaches of or faults in these systems or procedures.

The operator's reply:

[Text]

c) The operator is requested to describe any measures that may be implemented to improve the physical security in the operator's infrastructure even further. The supplier is in particular requested to describe any additional measures that the operator believes will be necessary in order to carry NGN in his infrastructure.

The operator's reply:

[Text]

8.3 Logical security

a) The operator is requested to describe what solutions have been established to prevent unauthorised personnel from gaining access to the operator's infrastructure via external interfaces.

The operator's reply:

[Text]

b) The operator is requested to describe what solutions are used to prevent unauthorised personnel from gaining access to user communication or user data, including content data, location data and other meta data. In addition, the operator is requested to specify what solutions are used to safeguard the integrity of such data.

The operator's reply:

[Text]

c) The operator is requested to describe how access to networks, services and information/data is currently managed and controlled for both own employees, suppliers and others. The operator is requested to describe what tools, processes and personnel provide support for access control, for example network-based access control, segmentation/segregation of networks, authorisation of users, granting of rights and access, etc.

The operator's reply:

[Text]

d) The operator is requested to describe the security benefit of verifying the network's configurations vis-á-vis approved configurations, and the associated capability to restore normal conditions in case of incidents.

The operator's reply:

[Text]

e) The operator is requested to describe any measures that the operator considers necessary to improve the logical security to facilitate carrying NGN in the operator's infrastructure, as well as estimate the cost of such measures.

The operator's reply:

[Text]

f) The operator is requested to describe any incidents of a serious nature over the course of the last three years due to breaches of or faults in the logical security, including incidents linked to unauthorised access, compromises and attempts at compromises, denial-of-service attacks and fraud.

The operator's reply:

[Text]

9 Operational matters

In the current Nødnett, the emergency services are notified of scheduled work well in advance, and the emergency services may demand that the timing of scheduled work be altered if the consequences of the work (e.g. downtime or reduced capacity) will entail an unacceptable interruption for the emergency services due to a planned, major event. Corresponding requirements relating to any impact on the operations may be stipulated for NGN as well. There may also be a need to stipulate special requirements regarding handling of risks and preparedness in terms of the manner in which the operator handles operations, in addition to authorisation and handling of subcontractors, in particular foreign subcontractors.

a) The operator is requested to evaluate and describe the consequences of having to take NGN into consideration in terms of his operational flexibility.

The operator's reply:

[Text]

10 Opportunities for cost optimisation through re-use from Nødnett

a) The State has made considerable investments in the current Nødnett. The State owns about 140 base station locations, for example. Thus, it is desirable that as much as possible of these investments be re-used if NGN is to be established based on commercial mobile networks.

The operator is requested to make an evaluation of what parts of the current Nødnett and associated facilities may be re-used in a model where the operator carries NGN in his infrastructure. Examples of re-use include investments in tunnel facilities and infrastructure in areas where Nødnett has been granted dispensation for construction.

The operator's reply:

[Text]

b) The operator is requested to describe whether there are any other elements associated with the current Nødnett that may be re-used if NGN is to be implemented in his network.

The operator's reply:

[Text]