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Introduction

This report describes the experiences gained from a pilot project for a common digital radio network for the Norwegian emergency services. The Public Safety Radio Project within the Ministry of Justice and the Police is the project owner. Tor Helge Lyngstøl is the Project Director.

The pilot project started early 2000 and an approach to the market was done in the spring. A TETRA digital radio system was established in the Trondheim region in the autumn 2000. This system was operational until June 2003. The following parties were involved in the project:

- Ministry of Justice and the Police
- The Defence Logistics Organisation
- Sør-Trøndelag Police district
- The fire departments of Trondheim, Klæbu, Malvik and Melhus
- The health sector represented by the county health service of Sør-Trøndelag and the municipal health services of Trondheim, Klæbu, Malvik and Melhus. St. Olav's Hospital
- Telenor

The public safety organisations involved are organised differently and during the Pilot Project there has also been organisational changes. Managing organisational challenges has thus been an important part of the Pilot Project.

The Pilot Project objective was to evaluate technical, financial and organisational issues associated with the proposed project for the establishment of a shared digital network for the emergency services - the Public Safety Radio Project. The experience gained from the pilot project is very valuable with respect to the establishment of a potential new, shared network. This report is based on experiences from the involved parties and feedback throughout the project period.

The target groups of this report are Norwegian and foreign users and suppliers of shared emergency networks as well as public agencies responsible for emergency preparedness and planning.

The report has four attachments; a technical addendum and reports from the three emergency agencies on experiences from the pilot period

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Project Director

Contents:

1 Abstract

This report describes the experiences gained from a pilot project for a common digital radio network for the emergency services, which was established in the Trondheim region between September 2000 and June 2003. This report is intended for both Norwegian and foreign users, suppliers of emergency service networks, as well as for public bodies responsible for emergency preparedness and planning.

The pilot's aim was to evaluate the technical, financial and organisational issues associated with the proposed project for the establishment of a shared digital network for the emergency services - the Emergency Network Project. The Ministry of Justice and the Police, who managed the project, awarded a contract to Telenor Mobil after an open tender for the establishment of a pilot network based on the TETRA standard.

In general terms, the pilot demonstrated that:

- TETRA satisfies the emergency services' most important requirements for radio communication, both within individual agencies and between different agencies. The technology is mature enough for operational use
- Active participation in the project by all of the emergency services is crucial for success
- A common network can provide a stable and secure baseline functionality for all services whilst also supporting additional agency specific requirements
- Having the same organisation responsible for both rollout and ongoing operation of the network was a success.

Ch. 4 examines the experiences of the pilot in detail. These include themes such as:

- 'Our emergency agency' can work together with 'the two other agencies'– we do not need to own our own network
- The establishment of a shared emergency network requires active participation by 'our agency'
- It is an effective alternative to today's network that has been proven during real incidents
- Local implementation requires a manageable organisation, clear lines of responsibility and a considerable resource commitment from the emergency services, both on their own and co-operatively
- The clear differences between the three emergency services must be taken into account
- A shared digital system provides greater efficiency for emergency services when carrying out tasks that require radio communication
- The users are getting more and more confident with 'the digital working day'
- More and more suitable terminals are being launched in the market
- Standard solutions give a low risk but have a lower acceptance from the users
- Tailor-made solutions are more risky and expensive but are better accepted by the users.

In addition to a frank description of the various experiences, the report also includes a joint evaluation of the pilot. The evaluation has been carried out by the Project Director of the Public Safety Radio Project, who was also responsible for the establishment and implementation of the pilot.

2 Background

2.1 Why a Pilot?

In 1995 the Ministry of Justice and the Police, the Ministry of Local Government and Regional Development (KRD) and the Ministry of Social Affairs and Health (SHD) joined together in a formal partnership to carry out a preliminary study that was called 'Common Radio Network For The Emergency Service'. This study concluded that the radio systems in the fire departments, the police and the health services could no longer meet the requirements for an up-to-date and reliable communication system. The following recommendations were given:

1. A common digital radio system for the emergency services and emergency preparedness agencies should be further investigated.
2. The investigation should be based on the use of the European TETRA standard.

A project team was established with responsibility for the work leading up to a final decision on the possible implementation of a national TETRA system. Furthermore, it was decided to implement a pilot project. The reason for the pilot project was as follows:

> "To ensure a high quality evaluation of technical, economic and organisational issues. The organisational challenges of the TETRA-project are huge. Hence, it is vital that the users are actively involved during the pilot period, and that the pilot network should be the means of ensuring active participation."

TETRA technology was tested in the pilot because, at the outset, there was broad agreement that this was the most suitable technology for an emergency network. It was taken for granted that the subsequent national network would be based on TETRA . Later, in 2003, it was decided that a tender for the rollout of a national network should be technology neutral.

One aspect of the pilot has been to test the functionality necessary for an emergency network – irrespective of whether the technology is called TETRA or something else. Furthermore, the evaluation of organisational structures for inter-agency working was central to the pilot. Hence, the experiences from the pilot are applicable to whatever kind of technology is eventually selected for the new emergency network.

2.2 The Objectives and Organisation of the Pilot

2.2.1 Participants in the Pilot

The pilot project was carried out as a partnership project between the Government, represented by The Norwegian Ministry of Justice and the Police/ The Rescue and Emergency Planning Department (JD/RBA), and Telenor Mobil AS (TnM), of which TnM and its sub-contractors contributed the largest share of the overall cost. TnM was chosen on the basis of an open request for tenders in which TnM and Stento ASA (now named Zenitel Norway ASA) participated. Motorola was the infrastructure supplier in Stentos' tender while Nokia was the infrastructure supplier in the TnM tender. In November 2000, a partnership agreement was established

between JD/RBA and TnM, who as the prime contractor was also responsible for its subcontractors. JD/RBA represented all the public participants in the project:

- JD/RBA
- Norwegian Defence Communications & Information Services Agency (FLO/IKT)
- JD/ Trondheim Police District (merged into Sør-Trøndelag Police District during the pilot)
- KRD/ The fire departments of Trondheim, Klæbu, Malvik and Melhus
- SHD/ The health sector represented by the county health service of Sør-Trøndelag and the municipal health services of Trondheim, Klæbu, Malvik and Melhus. During the pilot the health service was reorganised and so St. Olav's Hospital also became a partner for the last part of the project.

Later Ørlandet Air Force base, the Norwegian Red Cross and Trondheim Electricity Board also participated.

JD/RBA represented the public agencies. In terms of the internal organisation on the JD/RBA side, existing line management structures were used for its own subsidiary organisations (e.g. the Police) whereas special agreements with the other emergency services were established.

2.2.2 The Objectives of the Pilot

The following objectives were set at the start of the pilot:

- To demonstrate TETRA to the public safety agencies in Norway
- To test new functionality and its applicability to the users
- To gain experience on the organisation, administration, specification and operation of a nationwide shared system
- To make use of the experience gained from the establishment of the pilot as the basis of a recommendation to the authorities for further work on TETRA as a shared radio network for emergency preparedness and emergency services
- To create a common understanding of what is involved with an emergency network and its associated support systems
- To gain experience of the migration from the old radio systems to a new common system.

The following resource commitment was expected from the partners:

- Participation in the work to demonstrate TETRA to the emergency services in Norway
- Preparation of co-operation plans/projects
- To evaluate methods for test and coverage investigations
- To promote TETRA internally in their own agencies and organisations.

2.2.3 Telenor's Contribution

TnM contributed the following:

- Establishment of the pilot network
- Operation of the network
- Control room solutions in all three emergency services
- Consultant support to the emergency services and FLO/IKT as the project manager.

TnM's most important partners/subcontractors were:

- Nokia: TETRA equipment/software, training, support and consultancy services
- Telenor Connect: Control room solutions, training, technical support and applications
- Telenor Networks: Sites, communication, supervision and field operation
- Locus: mapping and fleetmapping solutions, training and support
- Racom: Voice logging solutions
- Mikom: Repeater equipment for tunnels.

2.2.4 Selecting the Pilot Location

The region of Trondheim was selected as the location of the pilot for several reasons:

- The topography is varied and representative of the whole country
- It was desirable to include a major city with 110, 112 and 113 control rooms
- Local interest was expressed, and there was a desire to be close to the Norwegian Technical Scientific University (NTNU) environment.

2.3 The Purpose of this Report

This report covers the period from the beginning of the pilot on 5 September 2000 until the end of the project on 15 June 2003.
The target groups are end-users, administrators, operational personnel and leaders in the emergency services, other potential users, decision makers, suppliers of a future shared emergency network in Norway as well as public agencies responsible for emergency preparedness and planning. This report will also be made accessible to the Norwegian media as well as to foreign user groups. The purpose of this report is divided into threefold:

1. To describe what has been done in the pilot
2. To describe the most important experiences from the pilot process
3. To present the Emergency Network Project's evaluations of the pilot experiences with respect to the rollout of a national emergency network.

3 The Organisation and Activities

The pilot was initially planned to finish in June 2002, with the option of extending it until December 2002. After taking up this option, and then in the light of the experiences up to the autumn of 2002, a decision was made to negotiate a further six months' extension up to June 2003. This final extension was based on a new organisational structure and entirely financed from the JD's budget.

3.1 The Organisation

3.1.1 The First Agreement Period: September 2000 - December 2002

The pilot project was supervised by a steering group, which consisted of representatives from both public and commercial parties. This type of organisation, consisting of groups of both users and suppliers, was used at all levels of the project. **Figure 3.1** shows the organisational chart of the project. FLO/IKT, who managed the project on behalf of JD/RBA, divided the project into five main activities or sub-projects. Each sub-project and a common project group (not shown in this chart) had representatives from each agency, the supplier and FLO/IKT. The purpose of this way of working was to ensure close co-operation and to make use of all resources with the necessary expertise to carry out of the project.

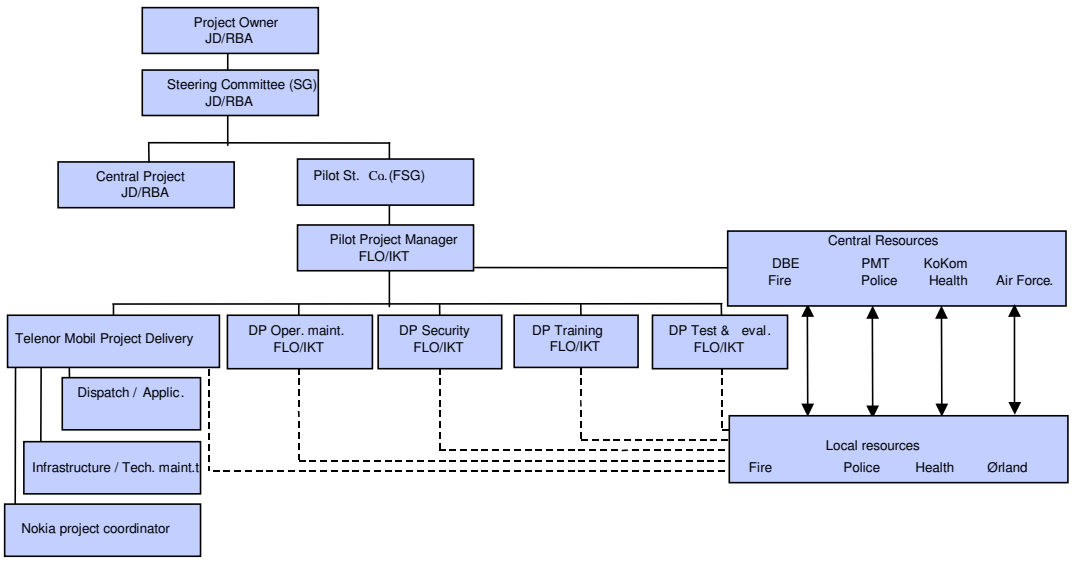

Figure 3.1: Summary of the Project Organisation in the First Contract Period

3.1.1.1 Roles

The pilot's project manager planned and supervised the project via the five sub-projects. The project director received issues and status from the sub-projects and user representatives, which either was dealt with in a 'common project group' or

passed up to the Steering Group to be dealt with. The common project group was established as a forum for co-operation but was not part of the formal organisation. The sub-project managers organised, planned and carried out activities in their own areas with participation from all parties. The exception was the sub-project of Telenor Mobil, which was responsible for project delivery, where the suppliers carried out all the technical work on the network, installation and network operation, whilst the users and supplier cooperated on control room solutions and applications. FLO/IKT was responsible for the operational management of the network.

Both central and local user representatives organised and coordinated the pilot activities within their organisations. As well as giving input from their own agency, these representatives also made sure that proposed solutions and documents from the project manager and the suppliers were dealt with within each agency.

3.1.1.2 Resourcing

Each of the parties in the pilot was responsible for the resourcing of their own participants. The number of people and the level of competence was decided and funded by each of the parties themselves:

- The Project Management: A project manager plus about three people from FLO/IKT working part-time
- Sub-project Telenor Mobil as project suppler: Three to four people fulltime and 30-40 people working part-time (including sub-contractors)
- Sub-projects led by FLO/IKT: Four to five people working part-time (including user representatives and TnM)
- Police: A core group of two to three people working part-time from the Sør-Trøndelag Police District. One person working part-time from PMT West Norway as a central representative
- Fire: One coordinator and contact person from the 110-call centre in Trondheim and representatives from the fire departments of four municipalities working part-time. One central representative with deputy from DSB working part-time
- Health: One coordinator and contact person for the core group with four to five people attached to the ambulance service and emergency medical unit at AMK, St. Olav Hospital, working part-time. One central representative, with a deputy from the advisory body, KoKom, working part-time.

Several people held a multiple roles and participated on a part-time basis in several sub-projects. Staff from FLO/IKT, TnM and the users' central representatives in the project were not based permanently in Trondheim.

3.1.1.3 Other Participants

In addition to the fire, health and police agencies, the Air Force, stationed at Ørland Air Base, the local unit of the Norwegian Red Cross (RK) and Trondheim Electricity Board (TEV) also participated with the users in the pilot. These were briefed and represented through their participation in the common project group.
Limited participation for parties that were not signatories to the agreement with JD/RBA was also possible. Suppliers and agencies that wished to try out applications, conduct tests or participate in some of the project activities needed to seek approval.

3.1.2 Extended Agreement: January-June 2003

In the spring of 2002, the Steering Group for the main project decided to work towards a financial basis for a half-year extension of the pilot from the year-end 2002/2003. At the same time a decision was made to go forward with a re-organisation of the pilot.
Many of the tasks from the initial stage of the pilot were completed before the start of the final contract extension. Two major changes were made in the organisation:

- The user role and the supplier role were separated so that now only the users were represented in the new Steering Group. The Emergency Network Project paid TnM and FLO/IKT directly for their provision of service during this period
- The Emergency Network Project, represented by JD/RBA, established and financed their own project management as well as part time project managers within the three services.

The new organisation is shown in the organisational chart in Figure 3.2. The project manager was based in Trondheim. The Emergency Services' local project managers were each agencies' only contact point with the pilot's project management. They were responsible for providing information and the co-ordination of suitable agency resources in the pilot. The Emergency Services' project managers participated in the planning and carrying out of activities, in relation to the agreed targets set for the extension of the pilot.

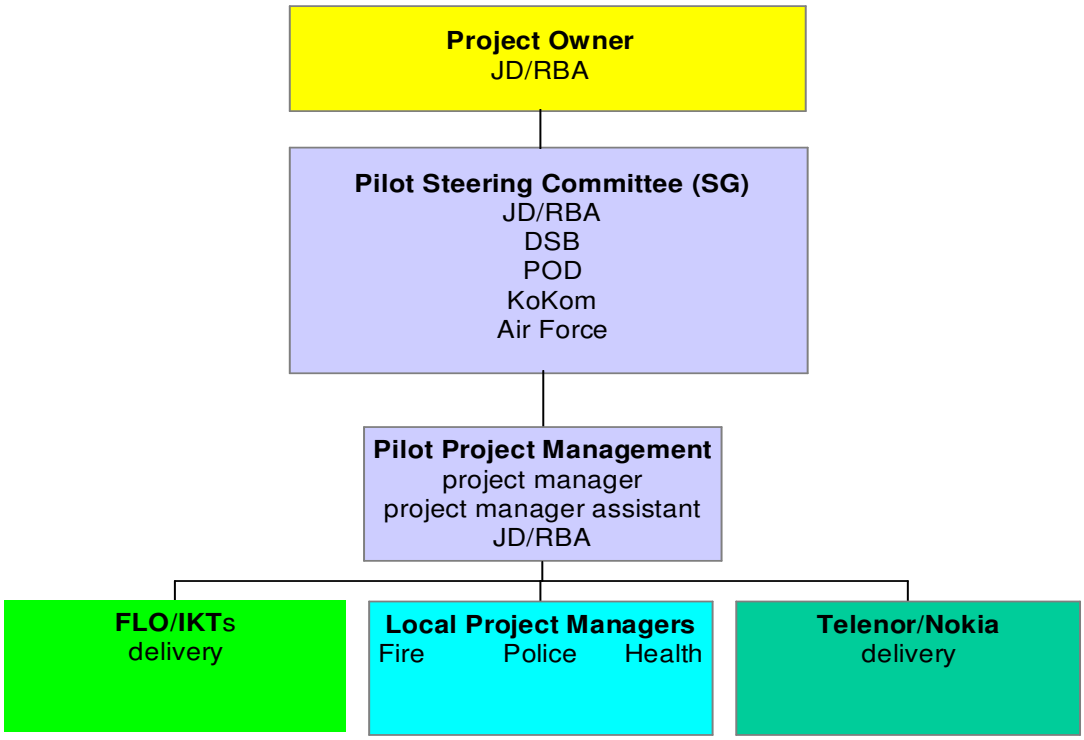

Figure3. 2: Organisation Of The Pilot During The Extended Contract- Spring 2003

For the extended pilot period (first half of 2003) TnM and FLO/IKT changed roles from being co-operating partners to becoming suppliers, based on commercial contracts. Users in the new organisation were the three emergency services, the Air Force/Ørlandet, Red Cross and TEV.

New objectives were agreed by all parties, for the first half of 2003:

- All three emergency services would use the pilot network for speech and data for the agreed periods of time for each agency
- Communication between all three services would be tested out through exercises and under the real incidents that were expected to arise
- The vulnerability, coverage, capacity and possibilities for operational management of the TETRA system would be tested.
- New terminals and accessories from several different distributors would be tested technically and operationally.
- The experiences associated with the goals, both common and agency specific, would be documented.

In addition to these common aims there was agreement on individual goals for each service concerning the testing of specific solutions and equipment.

3.2 Activities

Figure 3.3 shows the main activities that were carried out, in each quarter, for the whole pilot period from 2000 until 2003. 'bhp' in the figure means fire, health and police. The numbered activities comprise:

1. Coverage testing - a car with measuring-equipment was regularly driven through the same test routes during the period.
2. Police - integration between the police's control room console, PABX, analogue radio and the pilot network. The work was carried out through a cycle of installation, test, changes, training and use of several versions or alternatives.
3. Fire - integration and installation of the Fire Service FAS-TETRA control room application and fixed mobile radio. The work was conducted through a cycle of installation, test, changes, training and use of several versions or alternatives.
4. Health - installation of a PC-based telephone solution, operator interface with the pilot and integration with the AMK-Trondheim control room and the pilot. The work was conducted through a cycle of installation, test, changes, training and use (for a short time – a few weeks) of several versions or alternatives.

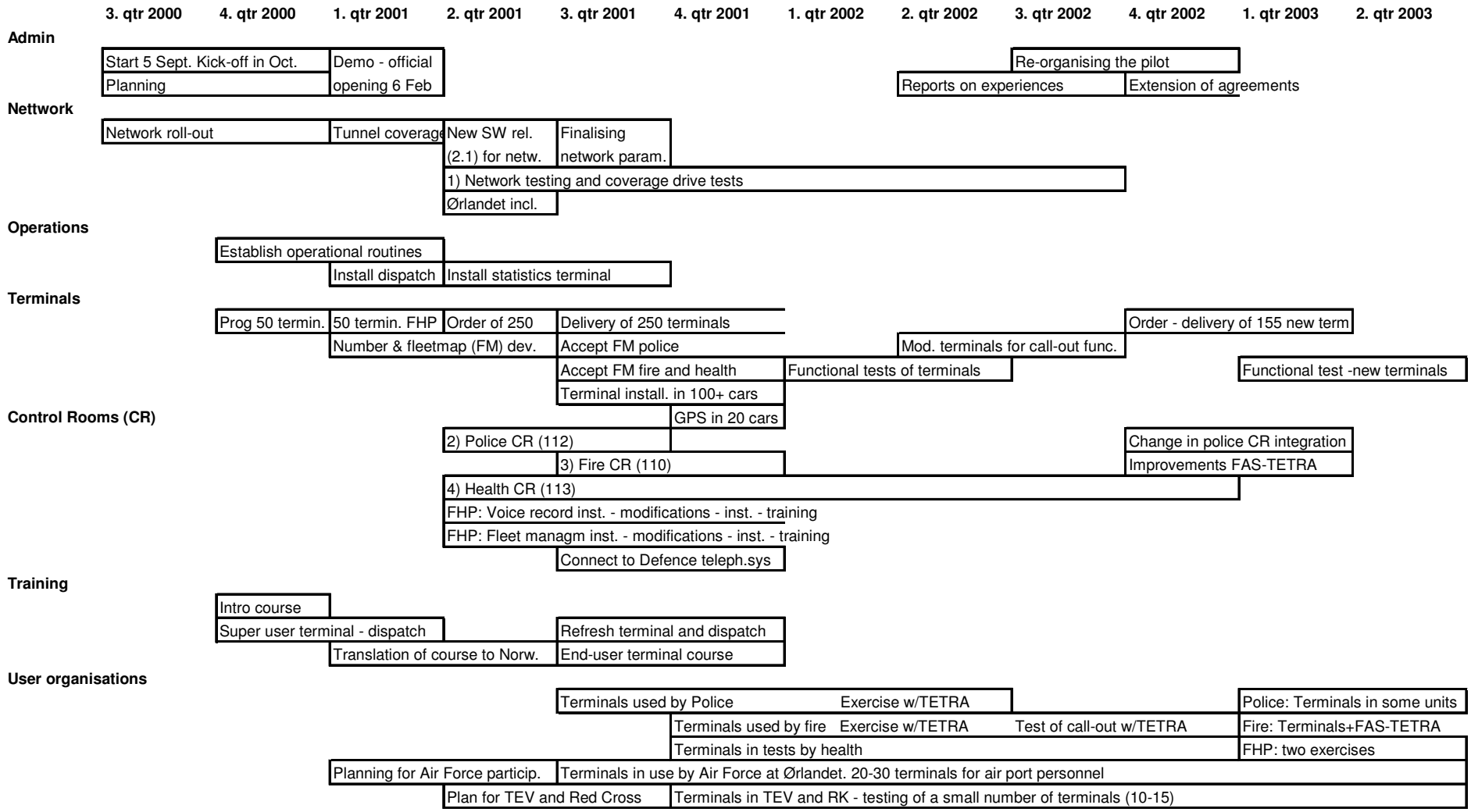

Figure 3.3: Status of Main Activities Carried out by Quarte

3.3 Use of the Pilot

The experiences described in Chapter 4 are from the use of the pilot network by the emergency services. Different services and applications in the network were exercised by carrying out daily tasks specific to the emergency services. Some services and applications were tested for short periods of time or during exercises, while others were in constant use over several months.

3.3.1 Fire

2001-2003: The fire departments of Trondheim, Melhus, Malvik and Klæbu used terminals in the pilot network for nearly two years, from October 2001 until June 2003[1]. Both speech services and status messages were used. During the same period the FAS-TETRA was used, with interruptions caused by instability and during upgrades to the network. The 110-call centre also used a standard Nokia TETRA dispatcher and voice recorder during this period.

2003: Klæbu and Malvik used the pilot network for call-out of part-time personnel during the final contract extension from January to June 2003. In Melhus only the part-time personnel at Lundamo fire station used this system. The other departments could not use the system because of limitations in FAS-TETRA in relation to the organisation of the fire departments.

Testing, events and exercises: The mapping and fleetmapping application was infrequently used, as too few cars in the emergency service were equipped with the system. The electronic map at the 110-call centre was used as a mapping display from the autumn of 2001 until 2003. The 'Hazardous Loads' application was used for the exercise on 15 May 2003. The fire service also used the pilot network during:

- A joint exercise with the Trondheim fire department on 21 February 2002
- The city fire on 7 December 2002
- A joint exercise with the emergency services, the Civil Defence and the Norwegian State's representative in the county of Sør-Trøndelag on 15 May 2003

3.3.2 Health service

2002-2003: AMK at St. Olav's hospital; the ambulances and the doctor's vehicles in Trondheim and Melhus used the mapping and fleetmap application in the pilot network from February 2002 until June 2003. The application was used by AMK in order to monitor the vehicles' positions and to send text messages (tasks) to the vehicles. The vehicles were able to acknowledge receipt of the messages from their own display. Some vehicles also had a large colour display and electronic map installed. The health service did not use voice services.

Testing, events and exercises: In addition to the use of the mapping and fleet map application, several units within the health service had different systems in trial use and testing. Speech services were thoroughly tested over a period of several weeks during the spring of 2002, after the issue of a light terminal to ambulance personnel. Different terminals with voice and text functionality were also tested. In the 113 call-centre were computer-based solutions for reception and handling of phone and radio

[1] See technical appendix for more information

calls from the public and health personnel; these were tested on several occasions during the period of spring 2001 until the autumn 2002. An application for transferring ECG-data was tested during 2002 and 2003.

3.3.3 Police

2001-2003: When the police were given a light and small terminal, which looked like a mobile phone, the undercover unit in Trondheim made use of the pilot network. The calls within this group were not connected to the police's analogue radio network or the 112-call centre.

2001-2002: In September 2001 the Trondheim Police Administration Unit began using the pilot network. All units replaced their analogue radios with TETRA terminals for speech services (the traffic police and local police did not participate in the pilot). Vehicles were fitted with both analogue and TETRA terminals. From the control room the operators could direct and participate in the traffic from existing control consoles and from the standard Nokia dispatcher. As of January 2002 the police administration unit was reorganised and expanded to cover the whole of Sør-Trøndelag County. It was then necessary to interface the analogue radio to one of the police TETRA talkgroups. In May 2002 the police decided to suspend the use of the pilot network because this interface gave poor speech quality and dropped out on a few occasions.

2003: From February until June 2003 most of the police force in Trondheim were using the pilot network again. New terminals were used and several changes had been made to the interface between the police's analogue radio network and the pilot network.

Testing, events and exercises: The mapping and fleet mapping application was tested during the winter of 2001 to 2002. The Sør-Trøndelag Police Administration Unit conducted an exercise on 13 February 2002 and participated in the joint exercise on 15 May 2003. In 2003 the police also set up a repeater and gateway-terminal for test use.

4 Experiences

4.1 Responsibility, Organisation and Planning

Based on the earlier description of the organisational structure of the pilot in Chapter 3.1, this section covers experiences and evaluations. Several of the main objectives of the pilot were associated with the desire to gain experience of organisational issues (see 2.2.2). The following sections show how this was achieved in the pilot.

4.1.1 First Contract Period

4.1.1.1 Contracts and Agreements

In order to secure the contracts to establish the pilot, an invitation to the market for commercial organisations to pay for and build the pilot was carried out. As the basis for this market invitation, central representatives from the emergency services participated in the production of a specification for the pilot project. By the time the contract between JD and TnM was signed, many of the requirements in the

specification were omitted. This is because the specification contained some detailed and expensive requirements.

The local participants in the pilot were not informed about these omissions until later on. Before this was clarified, there were several disagreements between the suppliers and the users about their understanding of the requirements that the supplier should fulfil.

The contract between the JD and TnM was not a normal purchase agreement, as TnM were substantially funding the project without payment from the JD. Through the contract the JD committed itself to arranging the organisation and execution of the pilot. The contract included a framework agreement for the purchase of all of the terminals for the pilot. After all parties were fully informed of the scope of the partnership agreement, the subsequent problems that were raised between the parties had more to do with the organisation of the pilot and responsibility for implementation than the scope of the contract itself.

The rest of the agreements for the establishment of the pilot between the JD and other public bodies worked without any particular problems.

4.1.1.2 Project Organisation

Experiences from the project organisation:

- Local representatives from the agencies were instrumental in creating trust between the project and the agencies. They also helped motivate the end-users
- Fire, health service, police and the project management team found that there was a need for greater resources from their own organisations in order to properly contribute to and progress the project. The agencies had to give preference to their own 'day to day' tasks, but had asked that the people involved in the project were freed from their existing work commitments within their own organisation
- The internal agency project groups worked best where they had a combination of personnel with operational and technical expertise
- There was some duplication of effort as well as a lot of administrative work because all of the agencies participated in the planning and testing of all the joint solutions. Instead, one agency could have carried out preliminary testing and development before their experiences and the solution were passed onto the other two services for further testing
- Individual parties experienced to some extent that responsibilities and roles were not clearly defined in the pilot organisation, especially in the pilot's start-up. It was also partly unclear what responsibility the agency participants held higher up in the project, and to whom the project should contact regarding the emergency services' existing network and control room solutions. The links between local and central representatives had to be (re)established for the project
- It took a long while to establish common understandings and expectations in the pilot. Large joint progress meetings contributed to the establishment of responsibility and agreement on issues, but the efficiency of the meetings was too low

- It was effective and problem free for telcom operators (Telenor Mobil and the National Defence's digital network) to include the operation of the pilot within the normal day to day operation of their own telecom networks
- Some conclusions reached about the level of customer care (user support and more) were unfounded because they were based upon a limited amount of operational use of the network
- Planning and introduction of solutions that encroached on the core activities of the agencies, needed engagement from a wide user group, and took a lot of time. Examples of this are number plans and fleetmapping as well as logistics for terminal equipment.

4.1.1.3 Plans and Budgets

A high level project plan and activities for every sub-project were created. Only some installation activities were fixed. For all the other activities the parties had to agree on and plan jointly. The project leader's priority was to get operational use of the pilot network. During the planning process the users called for the need for the whole solution to be in place before the pilot could be taken into operational use. This led to the planning and carrying out of many parallel activities (see Figure 3.3 in Chapter 3.2, from the second and third quarter of 2001), which again put great strain on the limited resources in the project.

The project director did not have access to or control over each of the parties' budgets, which all in all amounted to a substantially greater sum than the common budget of the project, and caused problems for him. A suggestion for the common project budget was given from the project leader to the pilot Steering Group. For 2000 and 2001 this was almost exclusively the only means for purchasing terminals. Unforeseen expenses[2] and the terminal purchase needed extra contributions from the police, the National Defence and St. Olav's Hospital. Clarifications concerning the extra contributions took a lot of time. For 2002 the entire budget was granted from the JD/RBA in April.

Uncertainties in the plans were not adequately described, and this created unrealistic expectations among all involved parties. With many activities running in parallel, it was difficult to maintain a clear overview and to focus the effort. The demarcation between the existing capital and operational budgets of the emergency services was not good enough and this led to uncertainty in the project's budget.

4.1.1.4 Progress

Progress was monitored by the sub-project leaders, who then reported the status to the project manager. The project director carried out instructions from the Steering Group. During meetings together with the 'joint project group', status on all areas was presented and conclusions from the discussions were written down in a list of actions.

In the project plan from November 2000, operational use of the network by the three emergency services was planned to start in the summer of 2001. As can be seen from

[2] Among other things: necessary changes to the emergency service's control room PABXs and the purchase of public telephone number series for connecting radios to the public phone network.

the activity chart in Chapter 3.2, long delays occurred relative to this first plan. Later plans were also subject to long delays. The reasons for the delays in the project were:

- The introduction and usage of radio and control room solutions was very challenging. None of the parties had sufficient insight and experience to deal with them
- Fewer resources were available than planned for to carry out the project (initially it was planned that all sub-projects would be manned with participants from all parties - see paragraph 3.1.1.2)
- The users had little competence on digital networks and limited opportunity to see the consequences of using a common digital radio system in parallel with the analogue
- No direct (economic) penalties for the parties for delays. The contracts did not specify measurable targets for contribution of effort or the extent of responsibility of any of the parties
- The model for organising and managing the pilot. The working structure for collaboration in the pilot did not give the project manager control or approval of different activities
- Limited budgets and, in part, uncertainty of funding.

Joint meetings and a joint list of actions for the project put pressure on the participants to follow up and stick to deadlines. However, there was still plenty of room for misunderstandings, misjudgements and generally parties giving the project less priority compared to their other commitments.

4.1.1.5 Reporting

The project manager briefed the pilot Steering Group at their formal meetings and also progress updates outside of the meetings. The achievement of goals, organisation and resourcing, progress, public relations and budget tracking were also reported to the Steering Group.

Within the project, the sub-project managers and the user representatives reported to the project manager. Telenor Mobil's sub-project manager worked with, and reported to, both the project management and directly to the users, according to the partnership agreement.

Operational problems were reported by the users in relation to customer support, as described in Section 4.9.

The user experiences were captured in both individual and joint reports. The JD/Emergency Network Project also carried out polls and user interviews.

4.1.2 Extended Contract Period

4.1.2.1 Need for Reorganisation

The background for reorganisation was:

- Some of the activities needed to bring agencies into operational use of the pilot network were delayed
- Lines of responsibility and roles had shown themselves to be unclear. Together with limited visibility of each other's agreements this created many discussions about who was responsible for the problems that arose

- The pilot management did not take the necessary initiatives in order to reach the goals within the agreed time frame of the pilot
- There was a need for closer contact between the project manager and the local contact personnel in agencies
- The local contact personnel were not freed from their existing workload. This made it difficult to carry out the tasks that had to be done by the local agencies.

4.1.2.2 Agreements

When the pilot was extended, the project was reorganised and the existing agreements were therefore changed. The JD signed commercial contracts with TnM and FLO/IKT for the provision of services. These agreements worked very satisfactorily.

Agreements with other public bodies were extended and supplemented with financial contributions from the JD. These agreements have been clearly understood.[3]

4.1.2.3 Organisation

At the start of the extension of the pilot, the Emergency Network Project arranged a meeting for suppliers and users to discuss the new agreements. This set the basis for joint expectations concerning the goals and implementation of the extension. It also brought clarity to the understanding of the distribution of responsibility between the different parties.

The meeting worked hard to avoid the problems that had occurred earlier in the first pilot period because of differing expectations and unclear lines of responsibility.

The formation of a local core group that was very close to the decision makers gave clear lines of command in the pilot project. The establishment of responsible part-time resources in the agencies gave a more effective way of progressing the project than had been the case during the first period.

Follow-up meetings and technical clarifications between the users and distributors are necessary, but the experience from the pilot is that the users need more frequent meetings with the project management than with the suppliers.

4.1.2.4 Plans and Budgets

The steering document was used as the starting point for creating the work plan. This work plan included all activities that would be carried out during the period of the extension, together with clearly defined responsibilities and deadlines. This worked well and gave a clear and agreed approach to what should be done.

The pilot had a budget of 17 million NOK for the 2003 extension; the accounts for the pilot project up to January 2004 are in line with this budget. The charges for

[3] The extension agreement with the municipalities (fire departments) of Melhus and Malvik was not signed because these municipalities requested compensation when they returned to the analogue network. Still, the municipalities participated in the pilot in the same way as the others. At the end of the pilot the emergency network project and the DBE shared the expenses for the start-up of analogue networks after the pilot was ended.

frequency licences and de-installation of terminals were not on the budget, but were covered by the contingency that had been agreed.

4.1.2.5 Progress and Reporting

The agencies' local project managers acted as the point of contact with the pilot's project management for their agency during the extension. Weekly meetings were used to exchange information with users. The suppliers reported directly to the project manager. Progress was monitored through time schedules that were made at the same meetings.

The agencies produced reports on the two joint exercises as well as a report about the experiences of the extension in general.

4.2 Terminal Equipment

The pilot has emphasised the services' need for high quality user equipment, both in terms of terminals and accessories. Each agency has different requirements, both when it comes to functionality and operational use, but there seems to be a greater difference between the agencies when it comes to their functional requirements.

The majority of the terminals used in the pilot were first generation equipment[4], which of course implies some weaknesses, lack of functionality and user friendliness etc. At the start-up of the pilot, when terminals were to be chosen, the JD had limited funds at their disposal. In order to be able to procure the required number of terminals, Nokia was chosen as the supplier. This decision was influenced both by the technical evaluations and the price of the current models. During the last six months of the pilot, second-generation terminals from three different producers; Motorola, Sepura and Nokia were used.

There was quite a lot of dissatisfaction with the first generation terminals, but the second-generation terminals were much improved and the feedback was positive. There is still a lot of work to do, especially with regard to call-out functionality and robust accessories. Call-out functionality was not included in the original offer from TnM/Nokia. Nevertheless, the suppliers took the initiative to implement this requirement.

Set-up and introduction of terminals with the users in the pilot also demonstrated that great emphasis is put on the size of the terminal equipment, weight, design, battery capacity, display size and easily readable text, key design, keylock, visual and audible alerts, robust connections to audio accessories, practical carrying equipment etc. The users see audio accessories, carrying equipment, batteries, chargers and antennas as integrated parts of an operational terminal.

General experiences:

- Several terminal models (and the network) have functions that are not relevant for all users. This makes the terminals unnecessarily complicated
- The suppliers/producers had a limited range of accessories. This improved when the range got bigger

[4] At the start-up of the pilot, first generation equipment from Nokia was used.

- There is a need for reserves of terminals and accessories
- Feedback concerning terminal size, weight, display, keys, twist-keys, antennas and such varies from person to person, but generally the equipment is not robust enough
- Car installations must take into consideration covert use and HMS-rules.

4.3 Speech and Data Services

4.3.1 Speech

4.3.1.1 Speech Quality

Background noise is filtered out very effectively when transmitting. Speech in the pilot was clear and comprehensible. With car installations there were sometimes problems with echo/feedback when several terminals were used at the same time. It is important that volume control is easy to use and easy to access.

4.3.1.2 Safety alarms

Safety alarms had the highest priority in the network. This is a function that is not available in most analogue networks although the health service has it in its HE-network.

Safety alarm was implemented in the pilot in a different way for each agency, depending upon the emergency call destination. Possible destinations might be a control room, members of a group or units in the vicinity. This was not a technical challenge in the pilot but it was a challenge to establish operational routines for emergency call handling to match the lines of command and responsibility.

4.3.1.3 Group communication

Group communication was the most used service in the pilot. Within the police force almost all communication was done using a single group, but some units used other groups. During actions other groups were also used. The fire service used one group for every municipality.

These groups offered a good replacement for the emergency services' different analogue channels. The users also experienced that when several simultaneous actions were ongoing, it was practical to divide traffic into separate groups, something which earlier had not been possible to the same extent.

In the pilot the users had the opportunity to use dynamic groups, which included late entry, individual group priority and broadcast (one way speech) operation. Another function which, could be useful for leaders/local commanders at an incident, is the possibility to follow several groups simultaneously (simultaneous listening/scanning).

4.3.1.4 Individual Calls

The police force only used individual calls to a small extent and then mostly in semi-duplex. The control room sometimes used individual calls in order to communicate directly with individuals. The police experienced some breaks in individual calls and there were also occasions when only parts of the messages came through.

The fire department also used this service and found that such calls are suitable for use during incidents in order not to disturb everyone.

This service was also used, in duplex, to replace some of the GSM mobile phone use. This was first and foremost for users that had a different work place from where the 11x call centres were situated.

The problem with individual calls is that they use more network capacity, irrespective of the technology. Extensive use of individual calls leads to an increased requirement for network capacity, which in turn leads to an increased network cost. However the pilot network had sufficient capacity.

4.3.1.5 Telephony Calls

On their earlier analogue networks, the fire and police services were not able to make telephone calls directly from their terminals. The health service had this opportunity in its HE-network, but the speech is carried over an open network.

The police found that on terminals without full duplex functionality it was impossible to use this function. When terminals with full duplex were made available, both the fire service and the police benefited from the use of telephony calls.

4.3.1.6 Calls to Different Radio Networks

Within all the emergency services there was a need to be able to call different radio networks both within their own agency and to other user groups. The traffic police, the fire service in many municipalities associated with the 110 call centre in Sør-Trøndelag, helicopters of the Norwegian Air Ambulance Service, fire-ground radio and Norwegian People's Aid are examples of users without direct access to the pilot network during the pilot period.

Solutions for connecting the pilot network to other radio networks:

Fire FAS-TETRA

FAS-TETRA could provide a conference bridge between the pilot network and all analogue networks attached to the 110-control room (the networks of the different fire departments in different municipalities). This function was tested, but was rarely or never used because the fire department rarely uses radio to communicate between different municipalities.

Police MD110CA-TETRA

The pilot network covered only four municipalities in the county of Sør-Trøndelag. After the expansion of the Sør-Trøndelag Police Region , the police in Trondheim had to have good radio communication with all police force personnel in the county. Several technical solutions for interconnection of analogue channels and groups in the pilot network were established. The solutions were based on permanent circuits between the police's analogue equipment and the pilot network. It was found initially that the speech quality and stability were unsatisfactory. After repeated rounds of changes and tests were carried out, it was acceptable. The problems were due partly to confusion about the responsibility for the operation of MD110CA, and partly because the company that had the support responsibility for MD110CA went

bankrupt. Hence, procedures and operational responsibilities were not handled quickly enough. See Section 4.5.2.3 for further information.

Health
The health service had no experience of such interconnection as they never used the pilot for voice services.

'Back-to-back'-solution
The solution consisted of two terminals connected 'back-to-back'. Terminal 1 was a TETRA terminal, whilst terminal 2 was an analogue radio. A group in the pilot network was thus connected permanently to one of the emergency services' common rescue channels. The solution was tested in the joint exercise on 15 May 2003, see Section 4.11.3.

4.3.2 Status and Text Messaging

The fire service introduced the use of status messaging for routine reporting from the cars into the 110 call centre. They found that the use of status messaging and the automatic registration of these lead to a more efficient and reliable implementation of the tasks at the 110 call centre. Introducing this system reduced the amount of speech traffic.

The health service uses status messaging extensively in its analogue network. The same type of status messaging is transferable to the pilot network, either as a service from the terminals or by using the map and fleetmapping application. The feedback from the health service is that this works well.

The health service also used text messages to a certain extent and discovered that in some cases it is a benefit to use text instead of speech.

The police configured the radios with four pre-defined status messages for reporting into their control room. As these were not used, the police instead chose to broadcast a short speech message (as an 'verbal status') to a common group. The advantage of using this within a common group is that everyone is updated - without having to read a text message from the terminal display.

4.3.3 Call-Out

Call-out is an important function both within the fire and health services. In the fire service the radios will replace the pagers that are presently used for calling out part-time personnel. The health service was not able to adapt its way of working and so did not use the pilot for call-out.

4.3.3.1 Functionality and Specific Requirements

The fire service defined the following requirements for call-out: *The alarm must be sent from the 110-call centre out to the radio. The recipient of the alarm acknowledges receipt and whether he/she can attend or not. It must be possible to pre-program duty lists such that one can send an alarm to a selected group without having to check the duty lists manually. It must be possible for each municipality to program the duty list.*

4.3.3.2 Call-out of Part-time Fire Personnel

Call-out of part-time personnel is the most important function for the fire service. There is presently in the order of 10 000 part-time fire men in Norway, who are alerted by pager, over the fire service's analogue network.

During the pilot extension, the call-out of part-time personnel over the pilot network was tested. When call-out was implemented on the pilot network, the personnel carried TETRA terminals through which they received the alarm. Klæbu and Malvik were both alerted only via TETRA throughout the whole testing period. In Melhus only the personnel at Lundamo fire station were alerted via the pilot network because of limitations in the FAS and the organisation of the fire service (see 4.3.3.2.1).

The fire service see great advantages with call-out via TETRA, where the greatest benefit is the possibility for the personnel to confirm if they will arrive or not. In addition there is the financial aspect; one cannot maintain a separate analogue network for call-out. Neither are there presently any commercial networks that offer an equivalent service.

4.3.3.2.1 Tools for Local Group Administration

Several municipalities have a complex solution for the call-out of the fire service. Out of the participating municipalities in the pilot, Melhus offered the greatest challenges, and may be an example for those demands that will be put forward by other municipalities with a similar organisation.

The municipality of Melhus has five fire stations and with different duty patterns at each station. FAS, which is situated at the 110 call centre in Trondheim, has limitations when it comes to pre-programming duty lists. Within the municipalities and at the different stations, people change duties and duty groups all the time, and it is too much work for the operators at the 110 call centre to supervise the municipality duty lists. In today's analogue network an alert is sent from the 110-call centre to an 'AKU-B'-unit in the municipality of Melhus. This unit is programmed with internal duty lists by the municipality's fire chief, and alerts the personnel on the different stations according to these lists.

A similar solution is needed in a future national emergency network. The fire service thinks that applications must be developed for call-out group handling, which take into account the local group administration and a local back-up solution for call-out.

4.3.3.3 Control Room Functionality

In municipalities with part-time personnel the concepts of full alert and group alert is used today. Full alert includes all part-time personnel in the municipality; group alert is used when only part of the force is needed. The operator should be able to choose a group call-out without having to choose between many groups. This selection should be pre-programmed by the municipality in question.

FAS is the application used in the 110-Control Room to call out part-time personnel, see also Section 4.3.1.6.

4.3.3.4 Terminal Functionality

When the terminal receives a call-out alert, the sound level and the sound quality must comply with the requirements that are described in the manual on technical equipment for call-out in municipal fire departments (HR.1052) published by the DBE. In Section 8 it says, among other things, "(…) *for pagers and portable terminal equipment it is recommended that the specifications of the SFT/DBE concerning technical strength, EX-protection, water tightness, sound quality etc, is used as a basis when purchasing.*"

When the terminal receives an alert, two choices must appear in the display; 'received' and 'reject'. When the recipient selects one of these choices, a status message must automatically be sent to the 110-Control Room, which in its turn will provide the operator with a summary of those who can attend to the scene of the incident. Using the pilot gave a better overview of the resources than with the present system, and the officers on duty got the opportunity to plan the mission at an earlier stage.

The users experienced that the terminals in the pilot were not satisfactory in terms of the volume of the alert tone, frequency and duration, as well as lack of a vibrating alert.

4.3.4 Inter-Agency Communication

Inter-agency communication may be useful for:

- Exchange of information during a joint operation whilst heading towards an incident
- Mutual access to the other agencies' vehicle positioning
- Coordination of preparedness at major events
- Making use of joint groups for group communication and individual calls.

First and foremost, the emergency services gained experience of inter-agency communication in the pilot network through exercises. During preparations for the exercises and as a result of the exercises, the three agencies established simplified common communication procedures based on the current emergency services' procedures. Modified and simplified routines were made for terminal users and operators in the control room.

The most important experiences for the agencies from the joint exercises were:

- When returning to working groups within the individual service, routines must be established for when and how the service leaders communicate
- The individual services use their own talk-groups for internal communication at the scene of accident – as before
- The guidelines for collaboration between the agencies using radio communication can largely be followed
- During calls where several services cooperate, it is important that one uses terms in clear text, such as Fire service leader, Incident leader, Trondheim car 2 etc
- The police must manage which joint group should be used from time to time
- It is beneficial to name the groups in accordance with their intended use. There is some disagreement between the agencies and within the health service about the necessity of using both rescue and collaboration groups

- It is an advantage to distinguish between communication for use within all the agencies and communication used for management at the scene of accident
- It is important that all know who is the addressee and the sender of transmissions because the use of call-signs on the agency's service units gives room for misunderstanding. There is a need to inform both the addressee and the sender of the message with clear text
- Listening to several groups on the dispatcher will become a challenge in the future. Control room solutions should make it possible to split the audio and quickly be able to listen to a particular group. It must be possible to quickly change selections during an incident in order to avoid the mixing of audio.

4.3.5 Direct Mode

Direct mode was not used much operationally. Where there was radio coverage from the network, the users saw it as an advantage to use the network, so as to receive common messages and to be contactable by others at work.

4.4 Security

There was not much reported experience of security in the pilot. Nevertheless the project gave a general impression of how stable and protected access to a digital network is.

4.4.1 Service Security

The police consider communication as the most important protection equipment for their officers when out on missions. These users, and users within the fire and health services, therefore have stringent requirements for stability and security in all situations. No reports about holes in coverage (see Section 4.7) could be traced back to TETRA network problems. No other events occurred where the users experienced that the services over the radio interface were unstable or inaccessible.

Still the users experienced that the network stabilityw as worse than the network availability reported by the system showed. This might be caused by the terminals, the incorrect use of them, or the emergency services' equipment at the control rooms and so on. Users reported audio breaks and problems with stability for services that were delivered via the fixed network to control rooms, and for some applications. The control rooms belonging to the fire service, and in part for the health service, lost contact, on many occasions, with the network via these applications. In the case of the fire service this led to relatively long periods of unavailability of the applications, but they were still able to use the pilot network directly. The police also experienced instability from time to time related to the interface between the control room and the analogue channels associated with TETRA. The police and fire service also had problems with stability and functionality of their mapping and fleetmapping application.

The experiences show that it is necessary to test new solutions in combination with existing systems. Effective failure alarms must also be implemented on all critical components.

4.4.2 Information security

Users in all emergency services valued highly that conversations in the pilot network were difficult to eavesdrop (listen in):

- For the police in Trondheim it was noticeable that outsiders could no longer listen to the police's conversations on radio. Those in the media and the public who had 'police scanners' were no longer informed about police missions
- The fire service also found it beneficial that they could communicate on the radio without fear of being quoted in the media. The security of being able to set up a private individual call was also positive
- The health service said: "The TETRA system will, in our opinion, provide almost full confidentiality and thereby safeguard all health information against eavesdroppers".

The pilot was set up as a 'digital island' with the need to be able to connect to analogue networks in neighbouring areas and emergency services. Where a digital communication group was connected to an analogue channel, listening in on traffic was possible in the same way as for existing insecure analogue channels. This insecurity has to be weighed against the functional benefit of such connections.

Access to information about the central elements of the network was effectively protected. This also applied to other sensitive information. During the time of the project it was experienced that it was time-consuming to apply the letter of the law and to establish practical routines that provide necessary security and trust for the exchange of sensitive information between public participants and private organisations. The number of participants and the need for distributed access to sensitive information also influenced the extent of this work in the pilot.

Because of the lack of resources of the participants, it was not possible to introduce administrative or technical systems for the encryption of traffic in the pilot network. Dialogue was initiated with the National Security Authority (NSM) in order to look at the requirements and possibilities for a joint solution.

4.4.3 Security of Personnel

The emergency service personnel were protected by a network that handled service and information security well. Moreover, the end-users that their personal safety was improved because the terminals used in the pilot had specific alert keys to trigger emergency calls (see Section 4.3.1.2).

4.5 Control Rooms

The emergency services' control rooms used in the pilot were the fire service's 110 call centre in Trondheim, the health service's AMK call centre at St. Olav's Hospital and the police control room for the county of Sør-Trøndelag. Radio operation in the pilot network required the installation of new applications and solutions with interfaces to several existing IT, radio and telephone systems. The relevant experiences beyond those specific to the supplier and the local solutions are described here.

A general finding is that suppliers and the project management (responsible for progress) must have regard to, and an understanding of, the very high requirements for security and stability that the control rooms have.

4.5.1 Standard Dispatcher

A standard dispatcher, developed by the network supplier, is intended to be used to manage and get an overview of the radio resources. In the pilot a standard Nokia dispatcher was installed into each of the control rooms (later a second one was installed in the Sør-Trøndelag 110 control). Such a standard dispatcher, which is intended for all types of users (such as emergency services, defence units, industry, transport agencies etc), has a very good choice of general network functions, but has no emergency services specific functionality.
The experiences are as follows:

- The user must be taught and trained in the use of this application specifically. Several operators found that they could not use the dispatcher often enough in order to remain familiar with it, and so were not be able to use it safely and efficiently. This was due to the fact that operators could use alternative applications (see 4.5.2) for the most used functions
- Such an application typically has a lot of options and it was therefore difficult for the pilot users to get an overview
- The application had to be physically situated next to the existing systems in the control rooms. Generally, it was difficult to get enough room for the new equipment in the three control rooms
- The standard dispatcher used in the pilot was stable and did not have any serious problems.

4.5.2 Specific Solutions for the Agencies for Radio and Telephone Operation

Experiences with the specific solutions, for instance telephone calls from the emergency network, call-out and so on, are described in paragraph 4.3.

4.5.2.1 Fire

FAS was further developed and connected to the pilot network in FAS-TETRA. The experiences from the development and the use of FAS-TETRA in the pilot are as follows:

- It was complex and time-consuming to add new functions and an interface to FAS. It was especially difficult to test and find bugs in the application when it was in use at an operational 110-control room
- The conventions and symbols used in user interface were not retained when new functionality was added. The users had to learn a 'new' application
- It was very difficult to troubleshoot the application that had many interfaces and adjacent systems. In the pilot it took a long time before the application was stable with respect to the pilot network.

4.5.2.2 Health Service

Integration between the pilot network and the AMK call centre was intended to be carried out by the adaptation and development of a PC-based interface. The intention was to give the operators in the AMK control room a single system, with both radio and telephony, for them to carry out their duties with. A variety of systems and system versions were developed and tested in the pilot but they weren't stable enough to put in to operative usage. The experiences are as follows:

- Integrated PC-based solutions for existing as well as new systems in a control room, are difficult to develop. Work on specifications, developing, testing,

training and operational trials require a great deal of resources from both the supplier and the users, and are expensive and time consuming
- Close cooperation between user and developer can deliver user friendly and efficient solutions for existing as well as new tasks in the AMK.

4.5.2.3 Police

The police installed a solution whereby the pilot network was connected to an existing control panel, serving phone and radio communication that gave access to the basic speech services in the pilot network. All police districts, with the exception of Oslo, have the same control panel. The experiences are as follows:

- Installation was quick and the users needed minimal training to be able to use the solution
- Interconnection with the digital pilot network needed some expansion of capacity and upgrades to the police's existing radio and phone system. No one supplier or user had expertise on both systems and so it took a long time to assess which changes were necessary
- The police found that the solution suffered from unstable connections and poor speech quality. Because of divided and unclear system responsibilities, scattered expertise, few resources to be able to gather detailed error reports and troubleshooting across the system interfaces, it took a long time to find the reasons for the failures and correct them.

4.5.2.4 Voice Recording

Voice recording/logging equipment was installed relatively quickly and easily. All group calls where the control rooms participated (actively or passively) were logged, whilst individual calls, in which the call centres did not participate, were not. The voice recording solutions did not fulfil all the agencies requirements, but were good enough for the pilot.
The users found that the installation and set-up of agency type logging of group calls in the pilot and analogue network, needed a detailed specification. The supplier and the user had, jointly, to go through a lot of alternatives before the set-up of the voice logging was correct. With some of the new voice loggers there was also a need for training, new procedures and some new equipment and software for playback.

4.6 Applications - Mobile

4.6.1 Hazardous Loads

Hazardous loads are classified as substances that are potentially hazardous in terms of being easily ignitable, explosive, poisonous, or dangerous in other ways. In this context the term is used in relation to an application includes a database that contains information about these substances. Rescue personnel and especially fire crews need this.

In the pilot the aim was to test an application to allow database lookup from the control room and then to send the result to a printer in one fire engine in every municipality except Klæbu. Early in the pilot it was decided to use a Swedish database, which contained 6500 substances. The installation was delayed, so it was only tested in one vehicle in the Trondheim fire department. The system was used during the last joint exercise on 15 May 2003.

The fire service felt that the application worked well inside the call centre, but there was some instability in the connection to the printer in the vehicle. The service looks forward to be able to interrogate the database directly from a terminal and get first-hand, information such as the names of substances and security zones shown as text on the terminal.

4.6.2 Map and Fleetmapping Application

The map and fleetmapping application was installed into 20 vehicles; seven in the police, four in the fire service and nine in the health service. The installation included equipment for satellite positioning in the cars (GPS) and a PC with electronic maps in the control rooms. The geographical position of the vehicles could be followed on the map in the control rooms. The application could also transmit text messages between the vehicles and the control rooms. Screen-based maps in the cars were also purchased for some of the vehicles in the health service.

The ability to view vehicles from other agencies on the map was not used.

The AMK control room has an application that logs all messages that are received (AMIS). This application is also used when sending text messages via the TETRA terminal to vehicles. This is especially important for patient information.

It was important for the health service to test and document the use of secure and prioritised data communication through the pilot. They have had positive experiences with message transmission, map and fleetmapping, and they found that during the pilot period much of the speech communication was replaced by text messages.

The police found it hard to use the application operationally since only seven out of about 70 vehicles had the system. The distributor also had to correct some initial technical problems, while the fire service had great problems with the installation of their application in one of their four cars (Melhus).

The agencies experienced a problem with the radio, which was used to send positioning updates to the control room, because it could not be used for speech services at the same time. This function is available in a newer version of the supplier's software.

4.6.3 Transferring ECG-data

The requirement for transferring ECG-data over a radio network is clearly needed and it has previously been tried over the GSM-network.

The health service tested the transferring of ECG-data in the pilot between ambulance units and the AMK control room. The solution in the pilot was based on an application originally developed by the Health Service Unit in Trondheim that used the GSM-system as the bearer. The transfer of data between mobile units and the AMK call centre used a stationary mobile terminal, where analogue signals were sent directly into the microphone on the terminal that was connected to the AMK. A modem connected to a computer with specially developed software, turned the analogue signal back into ECG-signals.

The aim was to give early treatment to patients and to give the ambulance personnel the opportunity to get advice from specialists at the hospital. The results were not satisfactory due to several factors. The data was not continually transmitted via a data interface, but as a sampled file via microphone (speech) to the AMK control room. There were technical problems found with the terminal connection between the AMK control room's modem and the software, also the connection in the ambulance added noise. The transmission was unstable and there were only a few successful tests conducted with the pilot network as the bearer. Among many things, this may be due to TETRA using a different speech coder than GSM.

In the pilot a simple technical solution was used which limits the number of units that can be connected. A future solution must be based on communication directly into the infrastructure of the network.

As mentioned, GSM could be an alternative data bearer to the emergency network, but the health service states in its report that the requirements for availability and response time are critical factors, which are not adequately addressed in the present GSM network.

4.7 Radio Coverage

The emergency services, TEV, RK and the Air Force tested and used terminals in the pilot network over a period of almost two and a half years. The shared network provided continuous radio coverage across a large geographical area as shown in the coverage map in appendix [V1]. Users found that radio coverage within the central pilot area was good. No significant areas without radio coverage were discovered. The fire service and the police reported that the radio coverage within the core area of the pilot network in Trondheim was better than their present analogue network, especially indoors. The health service's analogue radio network has radio coverage similar to that of the pilot network.

The users reported worse radio coverage from the pilot network than from the existing analogue networks in Melhus. This might be due to the fact that part of Melhus is on the edge of the pilot coverage area and therefore had less overlapping coverage than other areas with more radio use. With the rollout of a national network, when a countrywide network is installed, there will be no such edge zones.

The pilot users reported places with no radio coverage (coverage holes) in areas where there was normally coverage. There were not many such reports and only a few of them contained enough information for it to be possible to investigate at the actual time and place. The faults that were checked for in these incidents were (if possible) the following:

- Switch, relevant base stations and connection – configuration and physical components
- The terminal(s) – configuration and physical components
- Occasional noise or screening
- Users' operation of the terminal(s)
- Multipath problems[5]

[5] Obstructions like mountains or buildings make the signals reflect so that several versions of the same signal in different phases reach the receiver. This gives inter-symbol interference and thereby multipath problems.

Besides the 28 base stations that provided permanent radio coverage, RF-repeaters and gateway-terminals were also installed and tested in the pilot.

The RF-repeaters were installed to provide better radio coverage inside tunnels. Different antenna solutions and fixed connections to the pilot network were used, dependent on the length and position of the tunnels. The users reported some communication breaks at the tunnel entrances. The breaks could be explained as a result of technical limitations in the network, which do not exist in the newer versions.

The gateway-terminals, which were tested in the pilot, will typically be installed like an ordinary radio in incident response vehicles. The gateway-terminal can be placed so that it can convey conversations in direct mode from one or several terminals outside the radio coverage of the network onto users who are on the network. Outdoors the range is about one to two kilometres.

4.8 Tests

A series of technical and practical tests were conducted in the pilot. This chapter describes the general experiences from the tests.

4.8.1 Radio Functionality Tests

The tests showed that the radios offered for a relatively recent standard like TETRA are substantially improved after a couple of years. Both user friendliness and functionality were constantly improved during the time span of the pilot. The tests also showed that it takes time for the suppliers to agree on common interpretations of the standard and thereby develop radios that are fully interoperable with each other's networks.

Special conditions related to the use of terminals in direct mode were also tested. Tests were carried out with gateway terminals that can connect calls from terminals in direct mode to terminals on the network. Such tests provide useful information about how new functions and capacities may be used.

4.8.2 Coverage Tests – Multipath

In the pilot it was found difficult to find suitable measurement parameters and that it is technically complicated to carry out testing of radio coverage and multipath. On this basis the tests involved the expertise of many parties: The network supplier, the network operator, The Post and Telecommunications Authority, departments within the emergency services and the National Defence, experts from abroad and expertise from Norwegian scientific environments. Such cooperation gave good results in the pilot.

4.8.3 EMC-Tests

Comprehensive tests of Electromagnetic Compatibility (EMC) were carried out; EMC is the ability of electronic devices to influence and change the mode of operation of other devices. In the pilot this included the influence on medical-technical equipment as a result of electromagnetic radiation from the terminals in the pilot. In this area there are no established test routines with defined limits that can provide a formal certification. Laboratory measures and practical tests were therefore

combined and conducted by the National Defence in collaboration with leading Norwegian expertise in the field of medical technology. The results were such that a formal certification could be recommended for the use of the terminals in hospitals and in ambulances in the pilot.

It was claimed that digital radio systems could be affected by the radiation from strobe lights on vehicles responding to an incident. This claim was tested, but no harmful effect was found.

4.8.4 Emergency Control Rooms

The applications that were tested in the emergency control rooms are mentioned in Sections 4.3, 4.5 and 4.6. The majority of these applications were either developed or improved for the pilot. Functions and interfaces were tested, and integrated tests were carried out in order to evaluate the usage of these applications in the emergency control rooms. The functionality tests demand great resources as they include several people and large parts of the system. Several different test scenarios have to be developed and carried out in order to evaluate an application.

A common theme from the tests is that active participation by the users is necessary. External work on an emergency control room needs a thorough planning process in advance of the implementation, so that there is no disruption.

4.8.5 Call-out of Rescue Helicopters

The Air Defence participated in the pilot from the spring of 2001 onwards. In the autumn of 2002 the Air Defence's 330-squadron, the rescue service's helicopter on Ørlandet, decided to test the call-out procedures of the helicopter crew via the pilot network. This meant that the Main Rescue Control Room for the south of Norway (HRS-S) had to have access to the pilot network. A simple solution with a fixed line between the pilot network and the HRS-S was set up at the end of the year 2002. For the rescue service at Ørlandet it was an advantage use the same network for call-out as the health service since they cooperate closely.

4.8.6 Third Party Tests

4.8.6.1 Police/SINTEF Coverage Test

The police, represented by the Police Equipment Service (PMT), requested their own user-initiated technical evaluation of the radio coverage in the pilot. PMT contracted SINTEF to carry out the work. SINTEF were authorised to conduct third party tests in the pilot network and the tests were carried out in June 2003. At the moment it is not known when a final report will be available.

4.8.6.2 Health/IHM Paramedics Call Centre

The health service tried, during the extension, to initiate third party tests together with the engineering company Hardy Mortensen (IHM) at an LV-central in the pilot area. However, because of a number of reasons it was not possible to carry these out. The health service hoped that the tests would clarify whether it was possible to use similar user interfaces to the HE network for alarm calls and communication in the TETRA network. In the future, the agencies will have equipment in control rooms

and in vehicles that are not delivered by the network supplier. The experience from the pilot was that it could be challenging to adapt the user interfaces.

In the pilot, the health service was concerned about whether equipment in control rooms and in vehicles that is not produced by the network supplier, could be used in a future shared digital network. Through third party tests with IHM it would be clarified whether it was possible to have a user interface in the TETRA-network that was equivalent to the HE-network, for alarming and communication. For different reasons it was not possible to carry out these tests.

4.8.6.3 'FieldCare' from SINTEF Speech and Data

SINTEF Speech and Data applied in April 2002 for permission to conduct independent tests in the pilot network. Their application, with support from the health service, was approved in May 2002. SINTEF Speech and Data wanted to carry out tests with their 'FieldCare' product, using the pilot network for communication between the scene of accident and the hospital, or similar. The tests were not carried out, because SINTEF terminated the activity.

4.9 Customer Service

Customer service is defined as contact between suppliers and users in relation to the operational use of the network. In the pilot this included user support (logging of enquiries, defining and solving problems) and notifying users.

During the first pilot period, the FLO/IKT had the responsibility for customer service including:

- Meetings with the local user forum including the agencies, the Air Force, Trondheim Electricity Board, Trondheim Red Cross, the FLO/IKT and, when needed, invited suppliers
- 24 hour telephone response, reception of written fault reports and exchange of faulty terminal equipment
- Notifying users about planned work and service disruptions or network failures (alerts).

For the last six months of the pilot Telenor Connect took over customer relations. The arrangements for telephone contact and sending written enquiries was retained. A user support function was established which had a system overview and first line expertise on applications, mobile and portable equipment. Information about service outages was still redirected to the respective agencies, with an explanation of the impact of these outages on each agency's operations.

The following types of inquiries were sent to customer relations:

- Damage to terminal equipment
- Use of terminal equipment and dispatcher
- Unstable terminals (turning themselves off, failing to locate the network etc)
- Coverage problems in areas which supposedly have coverage
- Application instability in the emergency control rooms.

As noted in Chapter 3.3, there was limited use of the pilot network. Consequently Customer Services had a light workload and for periods of time they did not receive any enquiries at all. No enquires were received that necessitated urgent and

immediate repair. Several direct inquiries to Telenor Connect's service centre were made, which did not go via the normal error reporting or registration.

The customer service worked well in general, however the service was improved in the last phase when the users could contact the service provider directly in case of problems. In any case it seemed as if the routines related to handling of fault reporting and planned outage time were not fully clear to everybody.

The following issues states areas that must be considered when establishing a new national emergency network:

- The users have to be motivated in order to use customer services
- Customer services and the network operator's staff that have the network overview depend upon on each other
- Customer services must be carried out so that the users are supplied with the latest information on an ongoing basis. A solution for a problem that is solved for one user must also be given to other users
- Customer services should, as far as possible, have expertise on the local conditions
- Customer services must have expertise and agreements with the system suppliers for all systems in use.
- Customer services need agreed routines with the users for receiving and dealing with inquiries
- Customer services must have a professional tool for issue management
- Notifying users in a common emergency network need agreed routines between customer services and users. Redundant channels for notification must be established
- Equipment maintenance in each of the user organisations can be based on agreements directly between each user organisation and the respective suppliers, so that local arrangements are maintained. The ownership and guarantee of purchased equipment must be attributed to the correct department.

There are no findings concerning the size of the customer services function in the pilot.

4.10 Training

Experiences of the training activities in the pilot can be summarised as follows: Delivering the right type of course – to the right participants – at the right time is essential. In addition, the pilot showed how difficult it is to estimate the required resources and to agree on priorities for the limited common resources that were available.
The experiences are in brief:

- Coordinating courses and carrying out joint training proved to be an efficient use of resources and gave good results in the pilot. In this way the agencies can learn from one another. Joint courses need the same progress in the introduction phase of the system.
- The user organisations have to describe their requirements for training based on the suppliers' courses/system descriptions. The users must prioritise their needs

- It is useful to develop course profiles for different user groups. In order for the course profiles to be correct, those who take part in the work need to have knowledge of all the user groups' tasks, in addition to a basic insight about the systems that the training will be given on
- For some user groups it might be necessary to arrange courses in how to use equipment they will not use themselves, but which they need to understand when in communication with others
- The pilot's training model was based on the training of super users from each service, who were then responsible for training end users, and it worked well. Super users should have time set aside for them to maintain their skills, and to gain experience from the use of the system
- A general introduction into the pilot network was useful. There was a need to establish a new terminology and to relate this to the terminology for existing systems
- All training courses must include any possible new routines and procedures needed for the use of the system within the respective organisation
- Quick practical follow-ups of theoretical courses had to be done in order for the users to gain trust in and to master the systems on their own
- In all courses, the equipment that is used should be identical to that which the users will eventually be equipped
- Courses given by Norwegian instructors and written material in Norwegian gave the best results for the course participants
- It was necessary to clarify questions about copyright so as to be able to adapt, split, translate and copy documentation from suppliers
- In the pilot it was found that courses for personnel working shifts needed very good planning and predictability
- The need for revision was covered by specially adapted revision courses, exercises and short briefings given at weekly gatherings
- The suppliers' personnel must have relevant expertise, both in relation to the systems and to the way that the emergency services use it. Training of the suppliers' personnel can in part be run simultaneously with the user training in the pilot.

4.11 Exercises and Real Incidents

4.11.1 Emergency Service Exercises, February 2002

Two emergency service exercises were carried out in 2002:

- The police on 13 February 2002
- Trondheim fire department on 21 February 2002.

The exercises were found to be useful at identifying any lack of user knowledge about equipment, group set-ups and routines both within the control rooms and the units. The exercises were therefore an effective means of both specifying and evaluating training, routines, number plans, group structure, the use of advanced services and terminal equipment requirements.

4.11.2 Joint Emergency Service Exercise 8 April 2003

The first joint exercise was carried out on 8 April 2003, and was a desktop exercise. The project wanted to focus on procedures and routines in connection with network

and group handling from the control rooms, in order to discover errors and omissions when the same communication network is used across the agencies.

There was a widespread opinion among the parties involved in the pilot that a shared emergency network offered a new opportunity for communication between the agencies. The greatest benefit is in the ability to communicate with one another on the way to the scene of an incident.

Critical phases:
Two critical phases were identified from the point when a 11x emergency call is received to when all the agencies' vehicles have arrived on the scene of the accident:

1. 'Alert phase': How do you ensure that everyone goes into the same joint group?
2. 'Arrival phase': When and how do you get resources into their own work groups?

The services' most important experiences from this exercise are related to the development and definition of routines for when and how the leaders and users communicate, both within the agency and between different agencies. The experiences are set out in Section 4.3.4.

4.11.3 Joint Emergency Service Exercise 15 May 2003

The second joint exercise was held on 15 May 2003 in Muruvika outside of Malvik. This exercise was carried out jointly by the emergency services, the Civil Defence, the Norwegian State's representative in the county of Sør-Trøndelag and the TETRA pilot project, with the purpose of looking at the ability to handle a crisis in the municipality of Malvik. During the exercise the TETRA system was used on land, in the air and off shore. More than 100 people from the fire service, the police, the health service, the Civil Defence, the Norwegian Air Ambulance Service, fire service boats and the municipality were involved.

The exercise was built around a 'Hazardous load'-scenario where a tanker collided with a car and turned over, causing a leak from the tanks. No one knew what load the tanker was carrying. People that were sat in their cars were exposed to the gas leaking from the tanker, and a school class on a field trip was within the immediate range of where they could be affected by the gas.

The services wrote in their reports that this exercise to a large extent confirmed their earlier experiences from the desk-top exercise on 8 April. The exercise illustrated well the need for a mobile network adapted to the emergency services needs together and good common communication routines. The work carried out within the services was more effective because all the services got the same information at the same time. The first people arriving at the scene of the accident optimised and directed the resources that were on their way to the scene.

The Directorate for Civil Protection and Emergency Planning specially emphasised the positive experiences with the communication aspects of the exercise. The exercise director confirmed this in the subsequent briefing, where he claimed that

this was the first municipal exercise he had conducted without having received any complaints about the communications.

4.11.4 Real Incidents

City Fire 7 December 2002

On the 7 December 2002 around 10.35am, a fired started in a restaurant in Nordre Gate in Trondheim, which resulted in a whole block of the wooden buildings in the city centre burning down. A large number of police units and fire service personnel from both Trondheim and neighbouring municipalities were called out.

At this point in time the police were not using of TETRA operationally, but the fire service got much useful experience through the fire service's use of the network on that day. The DBE mentions in their inquiry report [27]: *"The new radio communication network (TETRA), which is currently being tested by the emergency services in the region of Trondheim, was used by the fire department during the fire. TETRA as a radio system functioned satisfactory during the fire, such that it was able to maintain communication with good speech quality and operational security for the whole of the incident."*

The fire department regrets that during the incident it did not set up several groups in order to limit the traffic in the joint group. At the same time there was also a leak in a water pipe, a fire in a car workshop, as well as three chimney fires. The reason for not using more groups was that there was only one operator on duty at the 110-control room.

During the city fire there was a power failure at the fire department in Trondheim. The automatic emergency power supply kicked in and the 110-call centre equipped with TETRA was not affected by the failure.

The fire department states that: "There have not been many actual events where inter-service communication has genuinely been put to the test. However the big city fire on 7 December 2002 showed how great the need is for this. The fire service was the only service that used TETRA, which, by the way, worked excellently, and the fire chief wasted a lot of time in walking around and searching for people from the other agencies that he needed to talk with."

5 The Emergency Network Project's Evaluation

5.1 General Expectations

The reasons for the implementation of the pilot were stated as:

"To ensure a high quality evaluation of technical, economic and organisational issues. The organisational challenges of the TETRA-project are huge. Hence, it is vital that the users are actively involved during the pilot period, and that the pilot network should be the means of ensuring active participation."

The general findings, at the end of the pilot, can be summarised as:
Technical and functional experiences:

- The TETRA technology that was used in the pilot has been developed in order to meet the emergency services requirements for radio communication. The pilot confirmed that, in the main, the technology works as expected and is mature enough for operational use today
- A common digital radio network for fire, police and health agencies will substantially increase the quality of their essential communications, within each agency and between different agencies.
- The significance of communications that cannot be listened in to and the increased security for servicemen and the general public, was confirmed
- Similar basic functionality for all agencies gives a platform that supports common solutions
- The additional functionality that each service needs, is available or can be developed.

Organisational experiences

- Coordination of common solutions for the three agencies needs to show respect for, and understanding of, each agency's special requirements. At the same time the benefits of common solutions should be emphasised
- The agencies' active participation is a crucial factor for success. Each agency needs their own people that are able to concentrate on the project and develop good personal relations with their opposite numbers in the other agencies. The agencies need to give priority to these dedicated personnel and support them by effective internal communication.
- Common and realistic expectations about what will be achieved are a critical success factor must be developed by the agencies
- A single supplier of a shared communication systems for the agencies must have total responsibility for delivery and effective control of its subcontractors.

Consequences for Funding and Procurement
A future rollout of a common national network will have the following consequences:

- Gains that exceed what each service can achieve alone
- An open standard that encourages competition between the suppliers
- A common operational solution that is more economical than the operation of agency specific networks.

5.2 Expectations For New Communications

In Section 5.2 to 5.7 the focus is on national rollout. There is a distinction between 'the first agreement period' (September 2000-Desember 2002) and the 'extension' (January-July 2003).

A common understanding between all parties about the goals for the project and realistic expectations as to what would be attempted during the pilot, proved to be very important. This experience will be transferable when a new emergency network is rolled out, tested, validated and put into use. The pilot project set challenging goals compared to similar projects as it aimed to use the network operationally.

Most pilot projects are only used for testing and generally trying out. It is therefore a positive sign that all three emergency services gained operational experience of the TETRA network for different amounts of time – partly as a speech network and partly for data transmission.

5.3 Organisation of the Roll-out

5.3.1 Simple Organisation of Local Responsibility

The structure of the pilot organisation during the first agreement period was complex and the follow-up of problems reflected this. Lines of responsibility and authority were unclear, and most of the important decisions about the progress or scope of the pilot were taken by organisations or people from the central authority in the pilot organisation. Furthermore, the project manager for the pilot was stationed in Oslo and the central resource personnel from the agencies were based in Bergen.

During the pilot extension the project director was stationed in Trondheim, and local project management in each agency in Trondheim was established by the secondment of resources. Most of the questions about scope and progress were dealt with on a local basis, between the project manager and the local agency project managers. The steering document that was the basis for the extension was developed in cooperation with the Steering Group (with representatives of the agencies and from the JD Central Office) and the local representatives.

With the national rollout, the agencies will have a number of tasks imposed on them, which can only be carried out locally. Therefore, in good time before the rollout begins, high-level guidelines must therefore be developed and communicated to the local units, which will be taking up and using the new network. These guidelines must clarify responsibilities and roles. Collaboration between the agencies should be organised locally and also between the agencies and the central body that has responsibility for the rollout (the developer), which makes it easier to make decisions on a local basis.

5.3.2 Internal Organisation within the Agencies

The organisation inside each agency in relation to the rollout must be carefully thought out. The Agency's local representatives that are responsible for rollout need to be aware of any internal agency guidelines and must be authorised to take the local decisions.

For the fire service, which is organised on a municipal level, a different solution must be agreed on. This is because the police and health regions (which each include several municipalities) will probably be the minimum sized units of rollout, and the rollout organisation cannot negotiate directly with all the municipalities in the land.

A logical solution could be to use the fire service's control rooms as the point of contact with the municipalities, as was the case with the 110-call centre in Trondheim in the pilot. The number and location of the fire service's control mainly follows the police regions. Furthermore it seems natural that the Directorate for Civil Protection and Emergency Planning (DSB) will be the main body for the fire service to relate to during the rollout, as this is a natural development of the role of the DSB, both in the pilot and in the planning of a country-wide emergency network.

5.4 Terminal Equipment

5.4.1 Verification System

It was confirmed in the pilot that not all functionality worked properly between terminals from different suppliers. Therefore with a national rollout it is necessary to have a coordinated verification program for terminals so that they can be authorised before being used on the network. Additionally each agency must decide on which terminals they consider suitable for use within their agency. The health service would like to keep the present verification system that is used for terminals in the health service's current radio network.

5.4.2 Accessories

Speech accessories are a very important to the user of terminals in an emergency network. A terminal is therefore not regarded as acceptable for use before the accessories are certified. The agencies impose strict but different requirements for accessories that are used daily.

The accessories that were delivered for the portable terminals in the pilot were of a relatively light construction and not suitable for operational use. The requirements for original, robust and customised accessories must therefore be given considerable focus in a national network.

5.4.3 Programming

The users' requirements for the terminals must be clearly defined and shared with the terminal suppliers. Based on these requirements, a procedure to ensure optimal programming of the terminals must be developed. Trying and failing in different rollout areas is not acceptable.

5.4.4 Purchase

Purchase and distribution of terminals should be handled by each agency respectively on the basis of assigned means and frame agreements for purchase and service.

5.5 Terminal Functionality

5.5.1 General

First generation TETRA terminals from Nokia were initially used in the pilot. Later on second-generation terminals from Nokia, Motorola and Sepura were used. As a speech network the terminals were first and foremost used for group communication (fire and police). Status and text messaging was used to a large extent, especially by the fire and health services. Safety alarm was also used. As the basis for the evaluation of terminals during a national rollout, there have been attempts to test different types of functionality (Individual calls, telephone calls, calls over different networks and direct mode[6]).

5.5.2 Call-out

Call-out out of duty personnel from the fire and health services happens today using the agencies' own networks. One aim of the pilot was to develop and integrate this functionality into the digital radio network with the possibility to return calls. The fire service got a customised solution that was taken into use. These experiences have given a good basis for the requirements for functionality and coverage for call-out.

5.6 Migration to a New Network

5.6.1 Interconnection between the New and the Old Networks

During the rollout of the new emergency network, there is a need for interconnection with other communication networks. These must be stable and provide the necessary functionality and flexibility. Such connections were demonstrated in the pilot network, and the problems that were experienced have been documented. In the rollout phase of the common digital emergency network there must be corresponding connections, as in the pilot. Such connections are especially important for communication in border areas between the new national network and the old networks.

5.6.2 Specific Experiences of the Police

In the pilot the police had a need for a permanent connection between the pilot network and their own VHF-network, since only parts of the police region were participating in the pilot. It proved to be a great technical and organisational challenge to get this connection established with the adequate stability. Shortly before the end of the pilot the police in Sør-Trøndelag verified the connection on a technical basis. However, it was not quality tested operationally. Before such a connection can be regarded as stable, it must have been in operative use for a certain period of time. If a corresponding solution is required in a national network, then stability testing must be conducted in the first area where the network is developed and verified before it is used in additional areas.

During the rollout in Finland a different solution was chosen. No connections between old and new networks were established. In the transitional period the

[6] Direct calls between two radios without contact with the network.

personnel was obliged to listen to the analogue network at the same time as they used the new one. This is also an option that should be considered in Norway.

5.6.3 Eavesdropping of Network During the Migration Period

When a digital network that is protected against eavesdropping (or 'tapping') is connected to the analogue network, the conversations both on the digital and analogue radios are open and in danger of being listened in to (eavesdropped or 'tapped') from the analogue side. To prevent the unintentional distribution of sensitive personal information, and in order to increase the security for the operational agency staff, it is important that the networks are connected together for as short a time as possible.

5.6.4 Local Technical Expertise

In order to get the pilot network functioning at its best, it was necessary for the agencies to have technical expertise available for their existing solutions. This is probably due to the fact that many of the solutions in the agency control rooms were bespoke (or 'tailor-made'), as mentioned in Section 5.7. Both the police and the health service had in-house technical resource personnel whilst the fire service did not. At a national rollout it must therefore be made clear what kind of expertise will be required in the local agencies for the rollout.

5.7 Use of New Network

5.7.1 Radio Coverage

The testing out of how good the radio coverage should be in the pilot area was not a preconceived topic for the pilot tests. The network was established with a coverage level that was thought to be satisfactory. This was confirmed by the users experiences. At the same time it is clear that the users in the pilot were very preoccupied with coverage as they thought it to be an important success factor for a new radio communication network. Comprehensive radio planning and thorough coverage testing is needed in each rollout region before the network is approved. This process therefore becomes very important in order to ensure that new users have a positive attitude towards the new emergency network.

5.7.2 Network Stability

The users' experience of stability in the network is not only dependent on coverage, but also on the interaction between the network, agency control room equipment and the terminals. The Users' opinion of network stability was not measured in the pilot. With a national rollout the network stability must, from the user's point of view, be proved on the basis of agreed tests. Telenor Mobil's measurements showed that the network had very high availability (over 99%).

5.7.3 Security

Special security initiatives were not tested out in the pilot. There was no specific air interface encryption (the connection between the terminals and the network). Basic protection against eavesdropping (e.g using a scanner) was provided by the characteristics of the TETRA standard. A common security level in the network must be established for the national rollout, and security work must be organised.

5.7.4 Operation of the Network

Telenor Mobil, the supplier in the pilot, included the running of the emergency network into its existing commercial support operation. This made for effective operation of the pilot network and the users did not experience any problems with the operation of the network. It will probably be similar if the operation of a national emergency network is integrated into an existing commercial support organisation.

5.7.5 Training

In the pilot, a two level training format was used: The supplier trained super users in the agencies, who thereafter trained and gave instructions to the end users. This mainly worked well, but there was also evidence that when too much time elapsed between the training session and the first actual use of the network some of the training was forgotten. At the national rollout there should therefore be a short period between the training session and first use of the network.

5.7.6 Applications

In the pilot the emergency services got experience in using the following applications: Mapping and fleetmapping, hazardous load-database and transfer of ECG-data. There is no doubt that these and other applications will be very important for the overall usefulness of a new network. Independent of which applications are part of the rollout, it is very important the applications are considered when selecting terminals and equipment for the control rooms.

5.7.7 Customer Services

Experiences from the pilot show that the agencies want as few points of contact towards the distributor as possible. The agencies want a single point of contact towards the supplier, with the responsibility for user support on all types of equipment. The agencies want to do the first line user support service themselves.

5.7.8 Efficiency Measures

Thorough analysis of the potential for more efficiency within the agencies with regard to a new emergency network requires more extensive use, for a longer time, than was the case in the pilot. Still, in two areas the benefits for efficiency are obvious from the pilot experiences:

1. More targeted calling-in of duty personnel within the fire service, via a new system for call-out
2. Less use of resources for speech communication at the AMK call centre when using text messaging for the mapping and Fleetmap application.

5.7.9 Interaction between the Agencies

Improved interaction between the agencies on their way to, and on the scene of an accident is an important goal for a new common radio network for the emergency services. The pilot gave valuable experience of this through realistic exercises. It was found that routines already in force in such situations needed to be further developed and reflected in the agencies regulations. The agencies must clarify between themselves which of them are responsible for the follow-up work in this area.

5.8 Standard Solutions or 'tailor-made'

The critical section at the rollout of the pilot was the equipment at the control room. In the main, special solutions were developed in conjunction with extensive user participation. This was technically complicated, and the amount of time spent was grossly underestimated. Much of the development work was unfinished when the pilot was ended.

At the national rollout, a standard solution for the emergency control rooms should be made a priority, which is adapted to the needs of each agency. Today there is a healthy market for thoroughly tested standard products in this area.

6 References and appendix

6.1 Definitions and explanations

Definitions, explanations of words and abbreviations

Abbreviation	Description
AKU-B	Alarm and control equipment - fire. Alarm communication unit, which directs and supervises the base stations in the analogue radio networks for fire agency. FAS is linked to AKU-B.
AMK	Emergency control room for medical emergencies, i.e. the health service's control room receiving emergency calls and communicating with the medical resources using Health's radio network
Base station	Radio transmitter/receiver at fixed site in (TETRA) communication network
Call centre	A system of users and applications for dealing with telephone calls
DBE	The department of fire and electricity safety. Integrated into DSB from 1 September 2003
Direct mode	See DMO
Dispatch	The dispatch provides access to network services and control of the communication resources. Thereby a user of the dispatch can communicate with medical/fire/police units and dispatch such units to an incident.
DMO	Direct Mode Operation – setting up calls between two or more terminals without using the network. The terminals must be close enough for direct radio contact.
DSB	(See DBE) The Directorate for Civil Protection and Emergency Planning
Duplex	Simultaneously listen and talk, i.e. like in a telephone
EKG	Electrocardiogram – measures the electrical activity of the heart
EMC	Electromagnetic Compatibility
FAS	Application for receiving phone calls from the public, radio communication with associated fire departments, setting up radio-radio conferences and radio-phone conferences, registration of descriptions of events and call-out of personnel.
FM – Fleet map	Configuration of a user organisation's virtual network in a physical TETRA network. The set-up consists of, among other things, talk groups, terminals, user rights, network service priorities and a number plan
FLO/IKT	Norwegian Defence Communications & Information Services Agency (formerly FTD)
Gateway	Component, which is placed on the border between an area with radio coverage from a network, and an area without fixed radio coverage. Might be a radio connecting networks on different frequencies, e.g. TETRA and VHF. No interference because of different frequencies
GSM	Global System for Mobile Communication

HE	The health service's radio network – Country-wide communication system established by Norwegian Board of Health for medical emergency communication
Inter-Symbol Interference (ISI)	A form of interference that occurs when echoes of a radio-signal interfere with the original signal. ISI can reduce the quality of radio network services.
IP	Internet protocol
JD/RBA	The Norwegian Ministry of Justice and the Police/ The Rescue and Emergency Planning Department
KoKom	National Centre on Emergency Health-Care Communication
Mobile applications	Computer software that sends or receives data over the TETRA pilot network. Recipient/sender might be a TETRA terminal, a TETRA terminal connected to a PC, a server connected to TETRA switch, etc.
PABX	Private Access Branch Exchange. Telephone central connected to the public telephone network (PSTN)
PMR	Private Mobile Radio
PMT	Police Materiel Services (from 2003 PDMT Police Material and Data Services)
PTT	Push To Talk
RBO	Radio operator transfer, used in the health service's radio network
RF-repeater	Radio frequency repeater - magnifies the radio signals between a base station and a terminal
RK	Norwegian Red Cross
SLA	Service level agreement
TETRA	*Terrestrial Trunked Radio – Distributor Independent ETSI-standard for mobile communication*
TEV	Trondheim Energiverk AS - Trondheim Electricity Company (grid operator)
TnM	Telenor Mobil AS

6.2 Appendix

No	Classific.	Description	Agency	Responsible
[1]	N/A	Technical addendum	JD	RJ
[2]		Police report on experiences from the extended pilot period - 2003	Police	Jan Klüver
[3]		Fire and rescue services report on experiences from the extended pilot period - 2003	Fire	Sissel Hunderi Stemland
[4]		Health services report on experiences from the extended pilot period - 2003	Health	Kirsten Mo Wiseth