REPUBLIC OF SOUTH AFRICA

REPUBLIEK VAN SUID-AFRIKA

Government Gazette
Staatskoerant

Vol. 411 PRETORIA, 13 SEPTEMBER 1999 No. 20471

GENERAL NOTICE

NOTICE 2108 OF 1999

SOUTH AFRICAN TELECOMMUNICATIONS REGULATORY AUTHORITY

NOTICE IN TERMS OF SECTION 27 OF THE TELECOMMUNICATIONS ACT (ACT 103 OF 1996) INVITING REPRESENTATIONS WITH REGARD TO THE FEASIBILITY OF THE PROVISION OF A THIRD PARTY PROVIDING RADIO TRUNKING SERVICE TO PUBLIC SAFETY SERVICES IN SOUTH AFRICA.

1. The South African Telecommunications Regulatory Authority ("the Authority") hereby gives notice and invites representations on the Feasibility of licensing a Third Party Operator to provide Radio Trunking services to Emergency and Municipal services.

2. The purpose of this document is to seek views from interested parties on the assumptions and recommendations made in developing the information contained in this document by ***Friday, 29 October 1999 not later than 16h00.***

3. Persons submitting written representations are further invited to indicate whether they are requesting an opportunity to make oral representations and the estimated duration therefore, which duration shall not exceed one hour.

4. Written representations will be made publicly available except where respondents indicate that their responses or parts thereof are confidential. Respondents are requested to separate any confidential material into a clearly marked confidential annex. Unconditional permission to use such confidential material will be assumed unless the author expressly states otherwise. Any copyright attached to responses will be assumed to have been relinquished unless it is expressly reserved.

5. It would be helpful if five hard copies of all written representations are submitted and an electronic version thereof, either on disk or e-mail, would be appreciated.

6. Written representations may be posted or hand delivered for the attention:

The Project Manager
Public Safety Trunking
Private Bag X1
Marlboro
2063

or

SATRA Block A
Pinmill Farm
164 Katherine Street
Sandton
Gauteng Province

7. All comments and queries regarding this document and the Third Party Emergency and Municipal Radio Trunking Services should be addressed to Mr Peter Zimri.

Tel	011-321 8404
Fax	011-321 8538
Email	zimpe@satra.gov.za

8. THE CONSULTATION DOCUMENT

8.1 The consultation document outline a feasibility study into a possible Third Party Operator providing radio communications for Emergency and Municipal Services in South Africa. The views, conclusions and recommendations, which follow, are not to be regarded as SATRA's final views.

8.2 The information in this document after it has been validated through consultation with interested parties will form a major input for this project. The aim of the consultation is to move this project into the next phase in which a proposed solution will be defined.

9. REQUEST FOR COMMENTS

Comments are invited on all aspects of this discussion document. In particular views are sought on the questions contained in the consultation document.

MAEPA, PrEng, PE
CHAIRPERSON - SATRA

PUBLIC SAFETY RADIO TRUNKING TELECOMMUNICATIONS IN SOUTH AFRICA

A CONSULTATIVE DOCUMENT ISSUED BY THE SATRA (SOUTH AFRICAN TELECOMMUNICATIONS REGULATORY AUTHORITY)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

APCO25	Association of Public-Safety Communications Officials
ETSI	European Telecommunications Standards Institute
GSM	Global System for Mobile Communications
ITU	International Telecommunications Union
NMT	Nordic Mobile Telephone
PAMR	Public Access Mobile Radio
PMR	Professional (Private) Mobile Radio
RFI	Request for Information
SATRA	South African Telecommunications Regulatory Authority
SAPS	South African Police Service
TETRA	Terrestrial Trunked Radio
UMTS	Universal Mobile Telecommunications System

LIST OF APPENDIXES

1. EXECUTIVE SUMMARY

This public discussion document will ask many questions of the South African public in an effort to ensure national input is provided to SATRA as we seek to use a particular band of the frequency spectrum for the purposes for which it was allocated. This is the band under SABRE-1 allocated to public safety and security trunking. Sections 28 and 29 of the Telecommunications Act of 1996 places this responsibility squarely in the hands of SATRA.

For many years now the police, ambulance, and the fire protection services in cities and towns across South Africa have been unable to seamlessly communicate with one another over the air. This has been particularly problematic during emergencies. These are areas that traditionally have been populated by the white citizens of the country. The rest of the populated areas did not, and still, by and large, do not have similar services.

With the arrival of democracy, many of the White areas have taken on the "Greater City" description as the previously Black areas have been made part of the White areas. Thus we have Greater Cape Town, Greater Pretoria, Greater Johannesburg, and on and on.

The purpose of this Discussion Document is to seek answers from the public in addressing the issue of regulating this sector so as to speed delivery of safety and security communications to these Grater Cities and, in particular, the rural areas that under the new dispensation now have such new public service facilities as clinics and hospitals, many now with ambulances. At the same time, the results of the Discussion Document will address how best to speedily relieve the problems that the former White cities are experiencing with respect to inability for public safety services to communicate effectively.

Question: Should SATRA change the current state of affairs in access to public safety and security communications?

It is also not lost on the Authority that Government, in order to meet all its obligations to the citizenry, does not have the resources to build nation-wide safety and security telecommunications networks at a time in which the environment in the country needs to be made conducive for investment, job.creation, and improvement in the quality of life of all the people.

In order to better understand the possibilities for tackling the issue of poor safety and security telecommunications in the country, the Authority undertook a study project. The bulk of this Discussion Document is built around the Final Report of the Authority's consultants, Omnitele, of Helsinki, Finland.

The main objective of the project 'Third Party Emergency and Municipal Services Radio Trunking Feasibility Study' was to investigate the commercial opportunities for Public Safety trunking radio in South Africa and to estimate the number of licences that can be issued to public trunking radio operators and allow each licensee to have viable commercial prospects.

The basis for this commercial opportunity stems from the fact that rural Kgabalatsane, North West Province, stands no chance at raising funds to build a safety and security telecommunications network, but Cape Town possibly can with national Treasury support and the expertise already resident in the city. Thus to continue as has been done in the past would imply that Kgabalatsane never would be able to dispatch to its new schools any of the new ambulances at its new clinic. That would perpetuate the imbalances of the past.

Question: Should SATRA act to change this imbalance and thereby provide a new type of business opportunity for the economic empowerment of the historically disadvantaged?

In addition, the basis of this commercial opportunity stems from the fact that the operations use the frequency spectrum. The frequency spectrum is found by the Authority to have been assigned inequitably with respect to its use for commercial purposes by the historically disadvantaged. Therefore such a commercial opportunity would provide further opportunities for the economic empowerment of the historically disadvantaged while serving a huge public need for safety and security communications, including to areas where they live, often not by choice.

Currently, the level of radio communication technology in South Africa, especially in the historically disadvantaged areas, is low. Equipment and systems are old and the coverage provided has many shortcomings. In spite of this fact, there are excellent overlapping radio networks in some areas, owned and operated by a variety of organisations. A radio network that would enable country-wide communication within and between different public safety organisations and municipal authorities would make operations more effective and be of real benefit to the citizens of South Africa. Combining the user organisations into a single network would result in economies of scale and cost savings in both network investment and in operational expenses. Furthermore, a combined network would allow the efficient use of the scarce spectrum resource.

In South Africa, commercial possibilities for a single nation-wide Public Safety radio network exist. A nation-wide network is viable in the commercial sense with technology platforms that enable thin, low capacity networks in rural and suburban areas, with large coverage provided by a reasonably low total number of radio sites.

Reliability of the network performance values has a significant importance on the total network investment and operational costs (related directly to the number of base stations required). This is emphasised in a large country such as South Africa.

A network with cellular-type coverage naturally has better commercial prospects when the investment and operational expenses are 40% lower. Such a network would, however, provide effective radio communication services in those areas where it is most urgently needed, i.e. in the historically disadvantaged areas.

The width of the given frequency allocation will have a major impact on the commercial possibilities open to a radio network operator. This study showed that 2*3 MHz is a sufficient allocation, especially if the subscriber base is low.

Decisions on how to proceed with the Public Safety trunking radio network issue in South Africa should be made without undue delay.

Question: Do you agree? If you do, when do you want such a network to be operational? If you do not, what is your basis?

There are two major options for the provision of nation-wide Public Safety trunking radio services: a privately-funded option and a state-funded option. As a result of this feasibility study Omnitele recommends that the privately-funded option be pursued by announcing a licensing procedure for a single nation-wide Public Safety trunked radio network.

2. INTRODUCTION

2.1. PROJECT BACKGROUND

SATRA has conducted a frequency band replanning exercise known as Project SABRE (South African Band Replanning Exercise), the outcome of which was the allocation of the 407,625 – 413/417.625–423 MHz frequency band for use by Government and Public Safety trunking networks.

This band is designated for use in mobile communications by organisations involved in ensuring public safety, including police, fire, ambulance and traffic law enforcement services and other personnel employed by Government-funded local and regional authorities such as municipalities and provincial authorities.

SATRA is now investigating the feasibility of issuing a national licence or licences for a trunked radio network or networks. Such networks would be aimed at serving the needs of Public Safety and other critical second- and third-tier Government services. It is also SATRA's wish that the network be implemented and operated by a private operator using venture capital.

In general, the benefits of a nation-wide trunking radio network which combines the different public safety and municipal organisations into a common single network are significant. At this moment, the level of radio communication equipment in South Africa is low, especially in the historically disadvantaged areas. Although in general equipment and systems are old and the coverage provided has shortcomings, in some areas there are excellent overlapping radio networks owned and operated by different organisations. A network that would enable the communication within and between the different public safety and municipal organisations, especially in situations of catastrophe, would make operations more effective and would be of benefit to those that these organisations serve, i.e. the citizens of South Africa.

Additionally, combining the user organisations under a single network would obviously result in economies of scale and cost savings in both network investment and in operational expenses. Also, a combined network means frequency efficiency and would therefore allow the effective utilisation of the scarce natural resource, i.e. spectrum.

2.2. OBJECTIVES AND SCOPE

The main objective of the project 'Third Party Emergency and Municipal Services Radio Trunking Feasibility Study' is to investigate the business opportunities in Public Safety Trunking in South Africa and make an estimate of the number of public trunking operators that can be licensed with the prospect of them being able to run viable businesses.

To achieve the main objective it was necessary to estimate the size of the market. This required an assessment of the probable number of subscribers and an estimate of both traffic demand and the volume of capital used for providing services.

This project also included an evaluation of the different standards available for Public Trunking, and an argued recommendation on how the standards issue should be handled within the licensing procedure.

2.3. APPROACH AND METHODOLOGY

The feasibility study was carried out in five major phases:

Phase 1 - Review of existing information

Information available about existing PMR (Private Mobile Radio) and PAMR (Public Access Mobile Radio) users in South Africa was collected in discussions with SATRA and CSIR and studying the SABRE 1 reports, and issue 17983 of the Government Gazette.

Phase 2 - Market study

The present status of PMR/PAMR and the potential trunking radio market, primarily in the public sector, was analysed based on:

- information received from SATRA,
- questionnaires sent to existing and potential PMR and PAMR users in the public sector, and
- interviews conducted with major potential public trunking radio user groups and operators

The main part of the market study was carried out as a *statistical user survey* by sending a questionnaire to potential public safety network customers i.e. to current PMR users in the public sector. The questionnaire consisted of enquires about the current situation; the status of systems currently in use, the extent of traffic, the busy hour profile, problem areas and possible future changes. User intentions as regards migration to a possible new public safety network were also queried as were price sensitivity and the relative importance of the various PMR services.

As support for the statistical user survey, interviews were conducted with the biggest user groups (e.g. SAPS) and customers primarily from the public sector. This was done in order to obtain a clearer view of the market and to see 'which way the winds are blowing' in the field.

PMR operator candidates were also interviewed in order to obtain their view of the evolution of the public sector PAMR markets, the possible business opportunities, viable network coverage, operational expenses and organisational requirements for operators, and other questions that contributed to the business analysis.

A total of 37 organisations contributed to the user survey. All the returned questionnaires received by Omnitele prior to 16.4.1999 were included in the statistics analysed in this report. The list of organisations that contributed to the user survey is given in Appendix 1 and the list of organisations interviewed is given in Appendix 2. The questionnaire used is reproduced in Appendix 3. The results of the market study are presented in Chapter 4.

Phase 3 Analysis of the public trunking radio operator business in South Africa

In the business analysis a scenario approach was adopted using a predefined study framework. Two major scenarios was selected for this study:

1) Nation-wide licence scenario

In this scenario, business opportunities were analysed for networks providing indoor coverage in urban/suburban areas for cellular type terminals and outdoor coverage in rural areas for handheld terminals

2) Cellular type coverage scenario

In this scenario, the business possibilities for a network that covers an area comparable to that covered by current cellular networks (see Appendix 6) were evaluated.

Both scenarios were analysed using different technology options, market projections and frequency allocations.

The analyses were based on information obtained by:

- questionnaires sent to the existing PMR and PAMR operators,
- questionnaires sent to the major PMR vendors,
- interviews conducted with major potential public trunking radio user groups and operators,
- interviews with major PMR vendors, and
- Omnitele's earlier experience of PAMR, PMR and cellular networks and their operation.

A detailed framework for the business analysis is described in Chapter 5 and the business analysis and its results are presented in Chapter 6

Phase 4 - Licensing requirements

It will be SATRA's responsibility to specify the licensing requirements for public trunking networks. To assist in the licensing process, the project team will considered the different possibilities for the terms of licensing public trunking networks in South Africa with SATRA representatives, and also discussed licensing practice in public safety and civil public trunking in other countries. In addition, an argued recommendation is given on how the standards issue should be handled in the licensing procedure. The major digital PAMR/PMR standards are presented in Chapter 3 of this report.

Phase 5 Final Reporting

The results of the project were collected into this Draft Final Report and will also be presented at a public conference organised by SATRA for the project stakeholders. Once comments have been received from SATRA, the Draft Final Report will be completed.

3. PMR TRUNKING TECHNOLOGIES

Trunking is a technique that allows many independent (both private and public) organisations to use the same physical network whilst giving each user group the impression that the network is exclusively their own. This arrangement guarantees effective frequency usage and should allow lower total investment costs (depending of course on the development of the market and prices).

3.1. TETRA

General

TETRA, "Terrestrial Trunked Radio", is a European standard for a mobile radio network system aimed at professional users. The first TETRA systems have been in operation since 1997. TETRA is a standardised, non-proprietary trunking radio system. The TETRA standard specifies a number of interfaces such as the Radio Air Interface, an Inter System Interface, a Line Station Interface and a Terminal Equipment Interface. User organisations are therefore able to acquire mobile terminals from competing manufacturers, which should guarantee lower costs and a wider selection of equipment. Additionally, the Inter System Interface (ISI) makes it possible to interconnect TETRA systems produced by different manufacturers. This should enable competition between system manufacturers in large networks.

TETRA is based on digital technology and therefore provides good quality for both voice and sophisticated data services. Security of calls from terminal to terminal can be guaranteed by using ciphering in both the radio and the fixed part of calls.

TETRA supports both common and advanced professional radio communication features such as group calls, speech/data, facsimile, file transfer, access to databases, message handling, vehicle location services, fleet management, etc.

In TETRA networks, coverage areas can be adjusted from a single city to several cities and rural areas and even to other countries because of the roaming capability provided by the system.

TETRA standardisation situation

TETRA standardisation has been an ongoing process since 1989 and the process still continues. The main parts of the standard passed through the public enquiry process before 1997 and thus obtained the status of ETS (an ETSI standard). The main subjects on which the EP TETRA (ETSI Project) is currently working are the maintenance of the air- (radio) interface, the ISI (Inter System Interface), Direct Mode, Security and an ISDN gateway for circuit-switched data.

The basic services in the ISI interface were finalised during 1998 and are now going through the public enquiry process (individual call, group call, short data and mobility management). The general solution for Part 6 that will specify the mapping of user information between two systems is still open and under development.

The basic part of the Direct Mode standard specifying normal- and single-frequency repeater functioning is presently going through the public enquiry process. Current work concerns the second edition of the Security standard.

In general, standardisation of the basic TETRA services, i.e. services that will satisfy the majority of the users, is well stabilised. The standards do not prohibit the implementation of basic TETRA systems. Also, the terminal and network interface is stable, allowing the use of terminals produced by different manufacturers in TETRA networks.

TETRA vendors and projects

The TETRA standard has been selected for public safety in Finland (VIRVE), Belgium (Astrid), Sweden (RAPS), United Kingdom (PSRCP), Jersey, the Netherlands (C2000), Germany (BOS), Italy (Carabinieri), Austria (Adonis), Denmark (TeleD), New Zealand and Gibraltar.

Table 1 lists the current TETRA infrastructure and terminal vendors.

	Infrastructure	Terminals
Motorola	X	X
Nokia	X	X
Rohde & Schwartz	X	
Italtel		X
Marconi	X	X

Simoco	X	X
Frequentis	X	
Tait	X	X
DeTeWe		X
Kenwood		X
Maxon		X
Alcatel	X	X
Cleartone		X
ICOM		X

Table 1. TETRA system and terminal vendors (Source Tetra News)

3.2. TETRAPOL

General

Tetrapol is a land mobile radio system which has been developed to provide digital narrow-band voice, messaging and data services for public safety organisations. The first Tetrapol systems have now been operational in the field for 5 years.

Tetrapol specifications determine the operation of the system in several interfaces, such as the Radio Air Interface, the Line Connected Terminal Interface, the Inter System Interface, and the User Data Terminal Radio Terminal or Line Connected Terminal Interface. In contrast to the e.g. TETRA specifications, the Base Station and Radio Switch Interface has also been specified. Standard open interfaces ensure interoperability between equipment produced by different infrastructure suppliers, thus giving the operator the freedom to select between a number of manufacturers.

Tetrapol is based on digital technology and thus provides good quality in voice service and sophisticated data applications. Basic services supported include e.g. group calls, multiparty calls and talk groups. Supplementary services supported are e.g. call forwarding, call waiting, call barring etc. Both circuit and packet data is supported as well as short messages. The security of communications can be assured by using end-to-end encryption. Other security features include e.g. mutual authentication, secured key management, terminal disabling and login/logout procedures.

The Tetrapol system has two main modes of operation: network mode and direct mode. Tetrapol terminals also have a so-called dual watch mechanism. This means that even in direct mode the terminal can still monitor the control channel of the BS to detect incoming calls when it is within the area covered by the network. Tetrapol also supports simulcast operation.

Due to the narrow bandwidth and robust modulation scheme Tetrapol can provide slightly better sensitivity figures leading to a bigger maximum allowable path loss and hence larger cell coverage areas than e.g. TETRA. This could be an advantage in areas where the capacity requirements for the network are small. One drawback of the narrow channel bandwidth is slower user data rates, for voice the net rate is 6 kbit/s and for data it is 3.3 kbit/s and 4.6 kbit/s. The gross data rate over the air interface is 8 kbit/s.

The coverage of a Tetrapol system can be limited to a certain area or can include the whole country. Coverage is the same for both voice and data services. System specifications support evolution from existing analogue systems to Tetrapol. The standardised Inter System Interface enables cooperation between different Tetrapol systems or, in the future, also between Tetrapol and e.g. TETRA or GSM.

Promotion of Tetrapol

The Tetrapol Forum has been created to promote Tetrapol technology, to ensure multi-sourcing and to exchange experiences. The Forum maintains publicly-available specifications for Tetrapol. It is also responsible for accepting the standards and these are freely available from the Forum. While most parts of the specifications have been already accepted, development work to include new features into the standard is continuously being carried out. The Tetrapol Forum has applied for PAS status for its specifications from ETSI, but that has been rejected. The Tetrapol specifications have been recognised by the ITU.

Tetrapol vendors and projects

Tetrapol has been selected for public safety in: France (ACROPOL, RUBIS), Switzerland (POLYCOM), Romania (PHOENIX), Spain (LEGACOM, NEXUS), Czech Republic (PEGAS), Thailand (ROYAL THAI POLICE), Mexico (Ministry of Interior), Taiwan (TAIWAN CG) and Singapore (the Ministry of Home Affairs).

Table 2 lists the current vendors of Tetrapol infrastructure and terminals.

	Infrastructure	Terminals
AEG Mobile Com.	X	X
Atmel		X
CS Telecom	X	
Daimler-Chrystel Aerospace	X	X
Dassault Electronique	X	X
Grundic Plettac		X
Matra	X	X
Maxon		X
Mier	X	
MRS		X
Nortel		X
Plessey SA		X
RCD		X
Sagem		X
Schlumberger		X
Siemens	X	X
Sonic		X
Swissphone		X

Tecsi		X
Velec	X	

Table 2. TETRAPOL system and terminal vendors (Source: Tetrapol Forum)

3.3. APCO25

General

APCO25 is a public safety communications project carried out in co-operation with the Association of Public-Safety Communications Officials – International, Inc. (APCO International) and the National Association of State Telecommunications Directors (NASTD) in the United States of America. The National Telecommunications and Information Administration (NTIA), National Communications System (NCS) and the Department of Defense (DoD) also participate in the work of the steering committee of APCO25. APCO25 brings together representatives from several local, state and federal government agencies in USA. The steering committee has also encouraged international safety organisations to participate in the project.

The objectives of the project are to offer direct interoperability for effective, efficient and reliable intra-agency and inter-agency communications, to support multiple sourcing in order to ensure competition among vendors through Open System Architecture, to improve spectrum efficiency and to enhance functionality and provide user-friendly equipment with capabilities focused on public safety. One of the basic requirements for the project was backward compatibility with existing analogue systems.

To ensure competition between equipment suppliers, open interfaces were standardised. These include e.g. a Common Air Interface, an Inter-System Interface, and a Data Port Interface.

The standard has been developed using an open process. A set of basic requirements was established and proposed technologies were evaluated against them in open and independent tests.

APCO25 is a digital system supporting integrated voice and data communications. The services supported by APCO25 include individual and group calls, call restrictions, short data, end-to-end encryption and direct mode operation.

APCO25 standardisation situation

The original APCO25 standards were approved in 1995. Since then, work has continued to develop Phase II and Phase III standards. The steering committee of APCO25 has also engaged in some cooperation with the ETSI/TETRA standardisation project, including e.g. the free and open interchange of documents. The APCO25 standards are also in the process of being approved by the ITU.

APCO25 vendors and projects

APCO25 has been selected by e.g. the State Police of New Hampshire, the City of Cleveland, the State of Michigan and the State of Florida. Outside the USA, APCO25 has been selected by e.g. the Zurich Police and the Austrian Federal Police.

Table 3 lists the current APCO25 infrastructure and terminal vendors.

	Infrastructure	Terminals
Motorola	X	X
Stanlite Pacific Ltd.	X	
E.F. Johnson Co.		X
BK Radio Inc.		X
Transcrypt International		X

Table 3. APCO25 system and terminal vendors (Source Motorola)

3.4. OTHER TECHNOLOGIES

TETRA, TETRAPOL and APCO25 are the most widely-known digital trunking technologies based on an "open standard". There are also GSM-based, proprietary and analogue solutions available for trunked radio.

A large number of proprietary systems (iDEN, EDACS etc) are used all over the world. Proprietary systems are not based on an open standard and users are therefore dependent on a single supplier, which could become expensive and/or unreliable in the future.

GSM –based systems

A large number of system vendors are offering PMR features either as stand-alone networks or overlaid on commercial GSM networks. One example of this is Ericsson's GSM Pro system which provides group calls, priorities, fleet management and other typical PMR features. In addition, robust user terminals operating in both normal GSM mode and PMR mode will become available. Such features will certainly attract civil sector PMR users such as transport and service companies who are not willing to invest in their own networks. There are however several reasons why GSM-based systems cannot be used for the South African Public Safety network:

- GSM call setup is far too slow for use in public safety applications,
- there is no direct mode available between terminals operating without network coverage, and
- bursty PMR traffic cannot be efficiently incorporated into GSM networks that are already carrying a large amount of cellular-type individual traffic. Disaster situations would lead to a larger number of cleared individual calls based on priorities and network performance for all users would therefore be significantly degraded.

Analogue systems

In general, existing analogue PMR products are 20-50% cheaper than digital products. This is because the technologies are at different phases of their maturity. The digital PMR market is still young, volumes are quite low and price levels have not really started to fall. These considerations apply to both the terminals and to the network infrastructure. Prices for network infrastructure vary greatly from supplier to supplier.

In existing analogue systems, the operational and maintenance costs are extremely low. This applies in particular to systems that have a low frequency of equipment failure. Annual operational and maintenance expenses can be very low, as proved by the user survey. While such systems normally provide users with basic voice services, they can only transmit data at relatively slow rates.

Small analogue PMR networks can, at present, be set up at a total cost which is just 30% of the cost of a small digital system. On the other hand, security, rapid data transfer and supplementary services are not normally available in these systems.

When the cost of large new analogue and digital systems are compared, analogue technology is, at the moment, cheaper for systems that require large coverage but low capacity. If high capacity is required, digital technology is more cost-effective. Also, digital technologies are more frequency-effective than most of the analogue systems now available and they offer high security, something which an analogue PMR system cannot provide.

3.5. COMPARISON OF THE SELECTED DIGITAL TECHNOLOGIES

The TETRA, Tetrapol and APCO25 products currently available commercially all operate in the public safety band below 400 MHz (380-400 MHz) or in the civil bands above 400 MHz (410-430 MHz). The SABRE frequency band plan poses no major problems for use of any of these technologies, yet the products for band for 407,625 – 410/ 417,625 –420 are not off the shelf products, where as those for the band 410 – 413/420 – 423 are.

The definition of an open standard is slightly questionable. TETRA standard has been created by ETSI in an open forum with a large number of system and terminal vendors as well as operators and public safety representatives participating in the work. Being an ETSI standard guarantees fair and reasonable IPR terms for all vendors designing and manufacturing TETRA equipment. TETRA can therefore be considered more open for competition than Tetrapol and APCO25.

Tetrapol is actually a specification mainly created by Matra Nortel Communications. The Tetrapol Forum has been set up afterwards to maintain specifications, to promote Tetrapol technology and to find multi-sourcing for Tetrapol equipment. Tetrapol equipment developed by Matra Nortel Communications are being distributed on different brand names by several other system vendors such as Siemens and AEG, thus making the vendor list larger than it actually is. There are, however, no restrictions for other vendors to acquire the specifications and Intellectual Property Rights for development and sales of infrastructure and terminals.

Additionally APCO25 is a standard mainly created based on Motorola proprietary solution, thus the APCO25 standard lacks the influence of other PMR vendors. This has then resulted to low vendor pool as shown in Table 3.

All three technologies provide the basic features required by most public safety user groups. However, there may be some features that are to the utmost importance for some major user groups. These features must be clearly specified by the user groups and the true availability of such features must be made commercially binding by the system vendors.

Network terminals represent a significant portion of the total investment. Terminals were not evaluated in detail in this study but no large differences in price or features were found at the moment. Nevertheless, only large vendor pool for the terminal equipment and truly open standard will guarantee terminal price competition and thus low prices for the users. Therefore in the future the terminal price differences may be much larger than at the moment, and this difference can be anticipated to be in favour of TETRA.

It can be concluded that all the above-mentioned technologies are well suited to the South African situation from the overall technology point of view and that the technology choice should be based on more detailed user/operational requirements and commercial considerations.

4. MARKET STUDY

4.1. METHODOLOGY

The market study described in this chapter is based on several independent evaluations. These are:

- Background information provided by SATRA and CSIR
- Interviews with major public safety user groups
- A statistical analysis of 37 completed questionnaires,
- Benchmarking against other countries,
- Omnitele's experience of similar projects.

The methodology is shown in Figure 1.

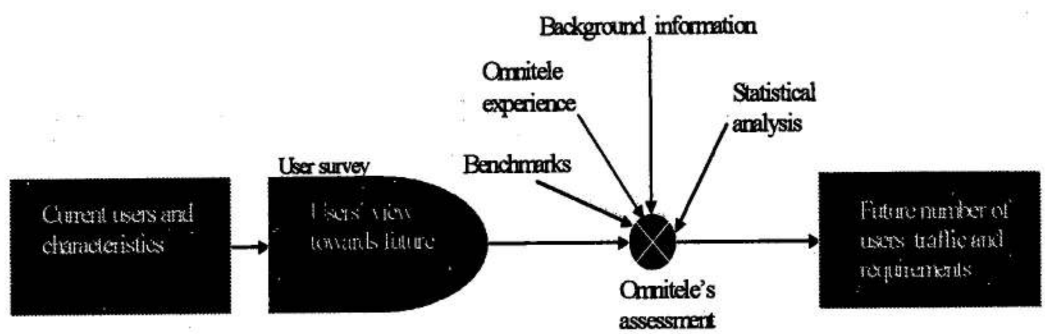


Figure 1. Methodology

4.2. GENERAL

In general, the PMR and PAMR market is divided into a number of sectors. The most commonly used segmentation is shown in Table 4. Because the focus of this study is on third-party emergency and municipal services, the market analysis conducted focused primarily on Sectors 4. Non-emergency authority *(government department, counties, communities, etc.)*, and 5. Public safety & public security *(police, fire & rescue, para-military, customs, ambulance, etc.)*.

1. **Transport** *(airline, port, airport, air-freight, road transport, river transport, taxi, bus, railway, etc.)*
2. **Utility** *(gas, electricity, power, water, oil, etc.)*
3. **Industry** *(paper, metal, construction, manufacturing plant, medicin/health, IT/telecommunications, etc.)*
4. **Non-emergency authority** *(government department, counties, communities, etc.)*
5. **Public safety & public security** *(police, fire & rescue, para-military, customs, ambulance, etc.)*
6. **Services** *(security, telecom operator, customer services, maintenance, etc.)*
7. **Other**

Table 4. PMR/PAMR Market segmentation

4.3. EVOLUTION OF THE PUBLIC SAFETY PMR MARKET

Market size and segmentation

It was not possible to decide on the exact number of current public safety and municipal radio users. Based on the information that was collected, Omnitele estimates the current total of Public Safety radio users to be 195,000. The relative sizes of the different public sector user segments are shown in Figure 2.

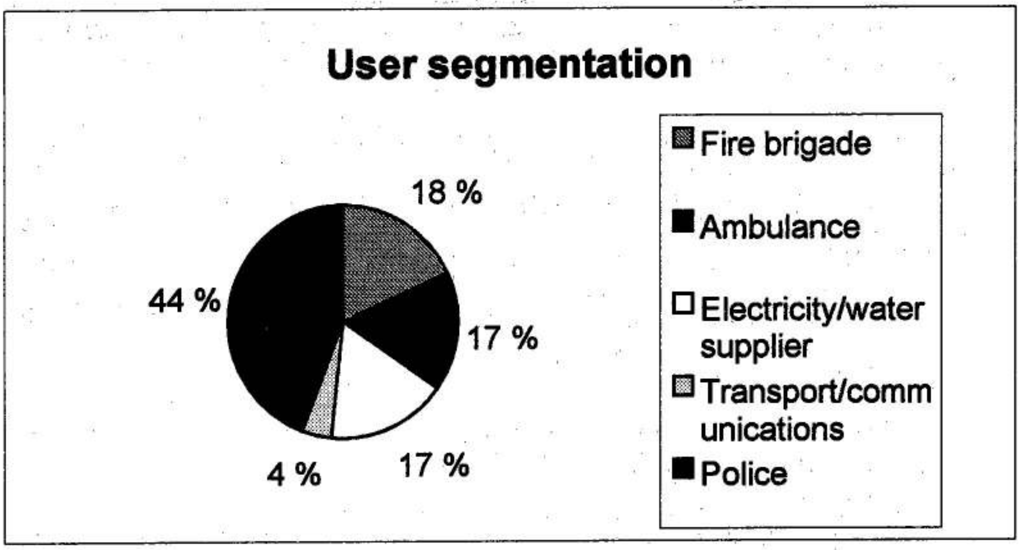


Figure 2. Current public safety user segmentation

The results of the user survey indicate that 15% growth in the number of users during the next ten years can be expected.

Equipment base

Of current users, 80% use PMR networks that are owned and operated by user organisations. The use of cellular phones for operations involving public safety is minimal, as is the traffic volume.

The lifetime of PMR equipment is high. Figure 3 shows the age distribution of the equipment in South African public safety networks. Users estimated that they will be using the current networks for an average of 5.5 more years, although in some cases major upgrades are required.

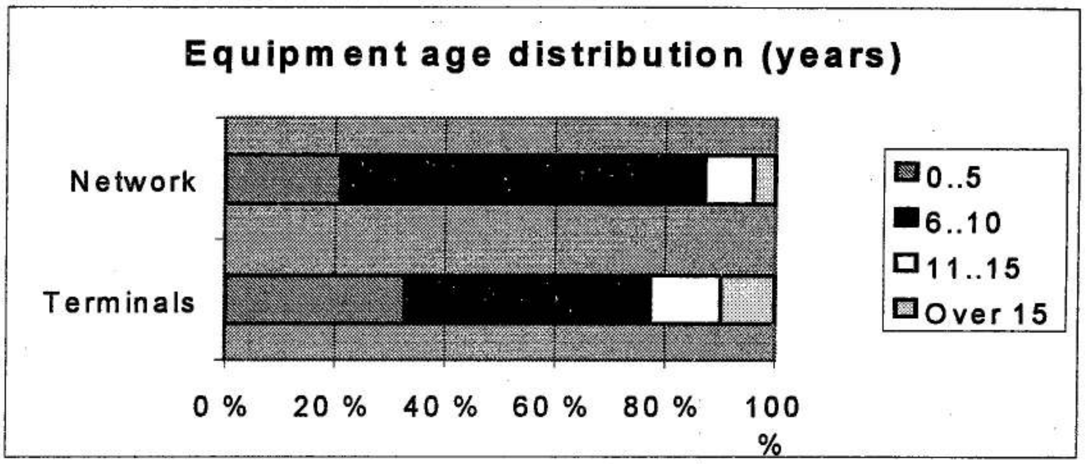


Figure 3. Age distribution of current equipment

Traffic

A surprisingly large portion (24%) of the total traffic is data, mostly for telemetry and vehicle tracking. Both of these applications do not require high data throughput from the network. The transfer of images and large files does not, in practice, take place.

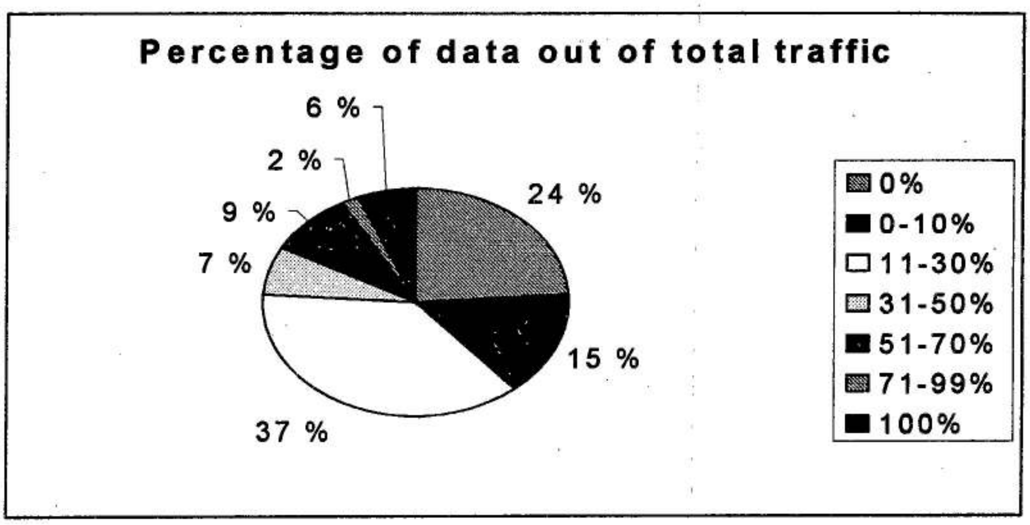


Figure 4. Percentage of data traffic out of total traffic

As to be expected in the case of public safety, the most common mode of communication via PMR is open channel group calls. According to the survey, more than 92% of traffic is group or open channel communication.

The amount of traffic per PMR user per day is, on average, 26.3 minutes. According to the survey, the amount of traffic will increase by 19 per cent over the next 10 years. The forecast of a higher increase in traffic than in the number of users can be explained by the fact that increasing cooperation between the public safety authorities is expected.

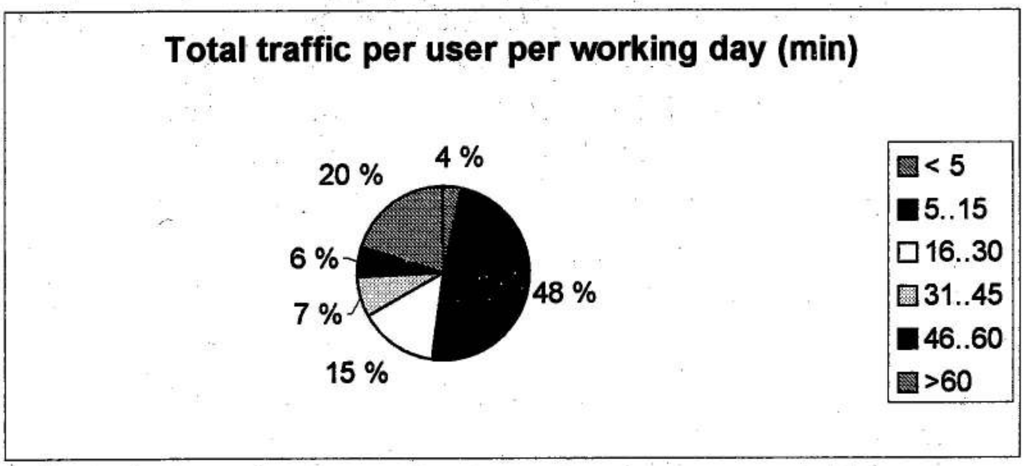


Figure 5. Total traffic per user per working day

The survey highlighted the fact that there is no clearly-defined busy hour in public safety use. A high traffic load is generated during the 06:00-09:00 and 17:00-23:00 periods, as well as during 00:30-02:30. Based on previous experience it can be assumed that 80% of the total traffic is generated during the 11 busiest hours and that therefore peak traffic is 80% of 26min/(11h*60min) = 31mErl per user. This figure is used later in this study when handling matters connected with network capacity.

Coverage and problem areas

As shown in Figure 6, the most common coverage requirement is the municipal area. Requirements for national roaming are minimal.

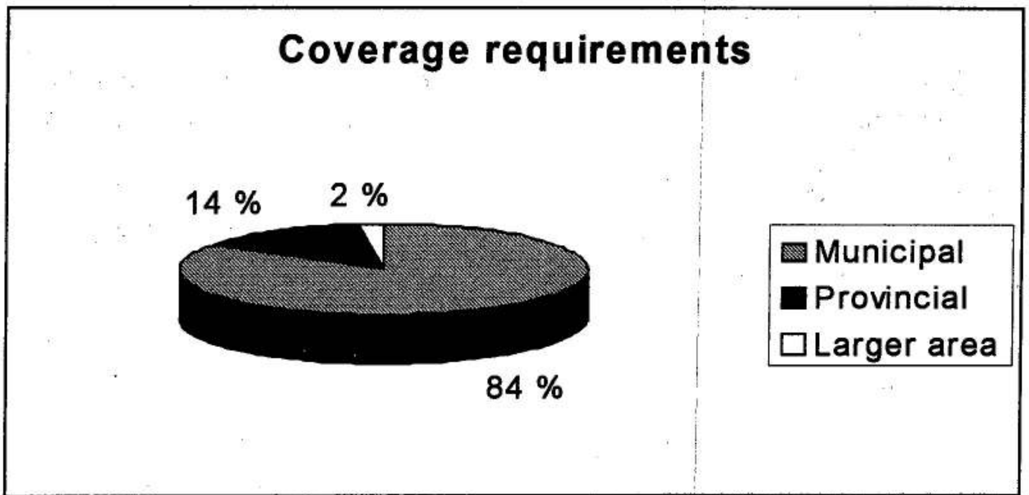


Figure 6. Network Coverage requirements

The coverage of existing systems was the most-frequently stated cause of problems. All-in-all, 38 per cent of users had problems with coverage. The most widely stated coverage problems were network performance at municipality boundaries and indoor coverage with handheld terminals.

Other problems mentioned were, for example:

- old technology,
- maintenance of remote sites, and
- the inadequate quality of leased link services.

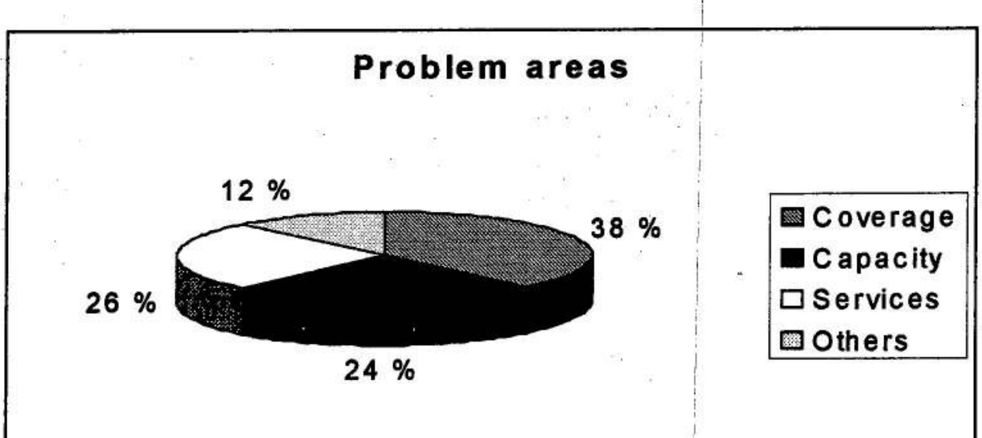


Figure 7. Problem areas in current network use

Investment cost and operational expenses

The average investment cost and operational expenses per user were estimated as being rather low, as shown in Figure 8 and Figure 9. According to the user survey:

- The total average investment in network infrastructure and terminals is ZAR 7365 per user
- The annual operational expenses (including manpower, transmission, maintenance etc) are ZAR 687 per user

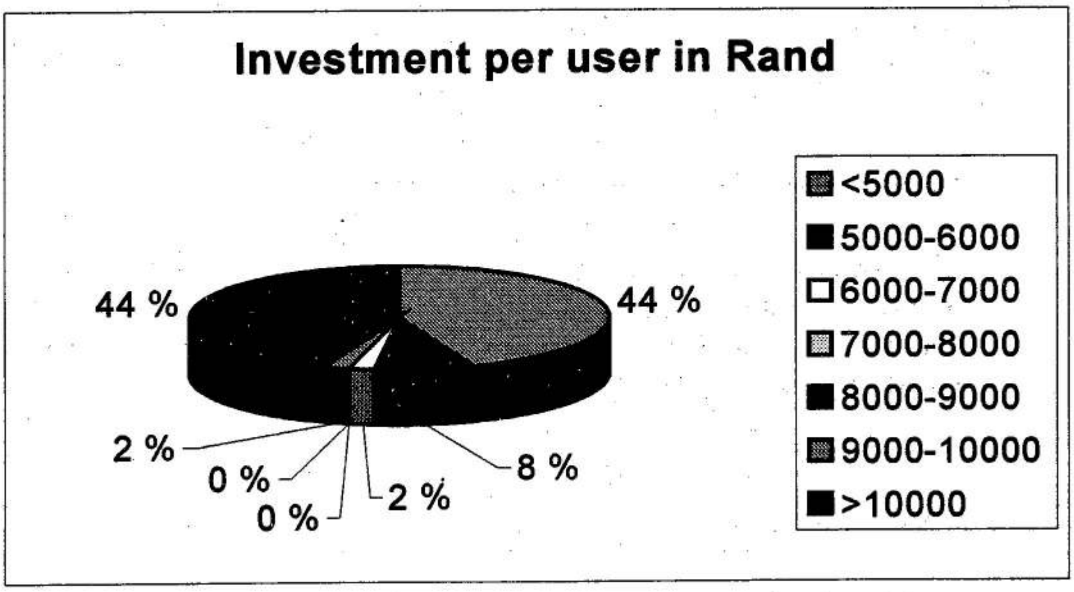


Figure 8. Average network and terminal investment per user

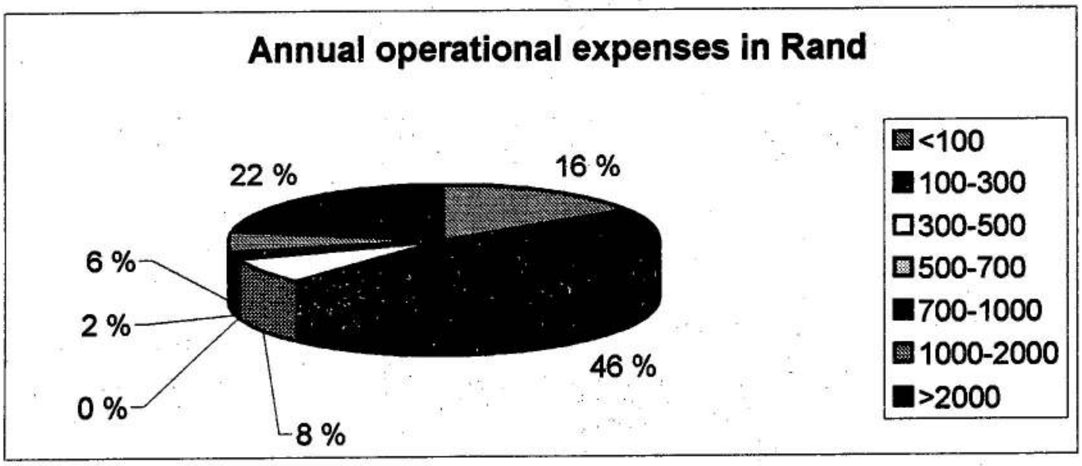


Figure 9. Annual operational costs per user

Cellular services

According to the survey, the usage of cellular services is limited to management functions and backup personnel. Cellular terminals and subscriptions are seen as far too expensive and inefficient for use in public safety work. On the other hand, cellular coverage seems to be sufficient for most users.

4.4. VIEWS ON THE FUTURE TRUNKING RADIO NETWORK

Demand for the future network

Figure 10 shows the views of the user organisations about migrating to the new network.

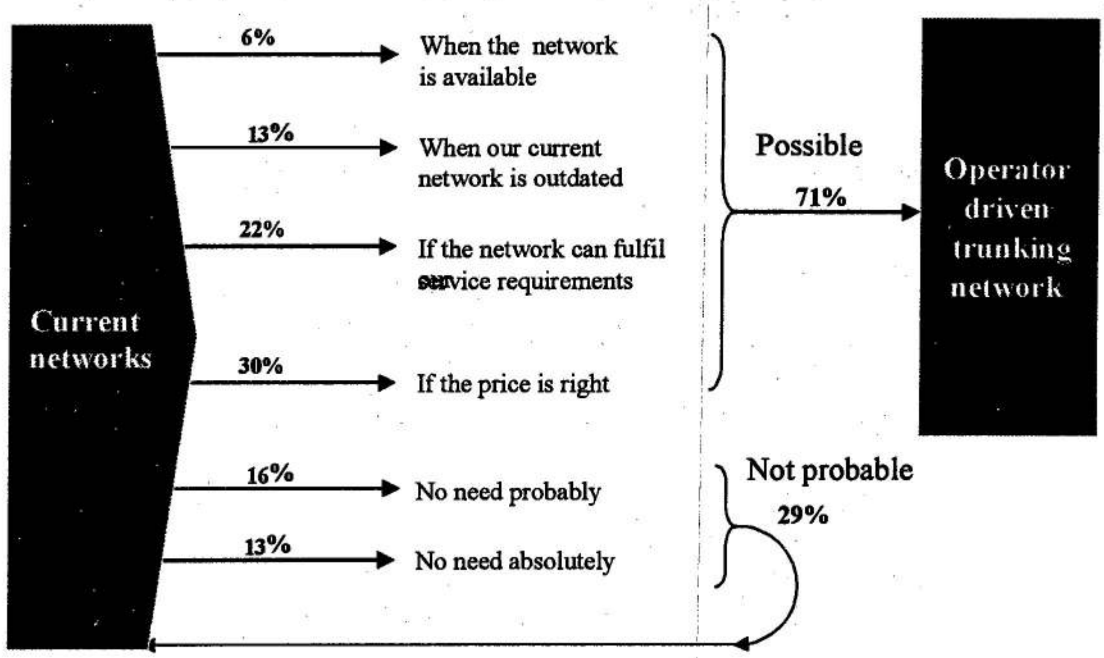


Figure 10. Conditions for joining the new network

Interest in the new network is clearly related to the associated costs. The usual reasons for not willing to join the network are the satisfactory operation of an existing network and the capital already spent as well as the common belief that the costs of such a future network will be very high.

Coverage and service requirements for the future network

Coverage requirements for the new network are the same as those for present networks. Although some major user groups such as SAPS and ESKOM expect almost 100% area coverage, the operational coverage requirements are regional and wide-area roaming is not seen as being important. Service and functionality requirements are shown in Figure 11. Additional requirements given by the users were, for example:

- voice logging and recording capabilities,
- automatic location services on demand or on a periodic basis,
- user-friendliness, and
- video transmission.

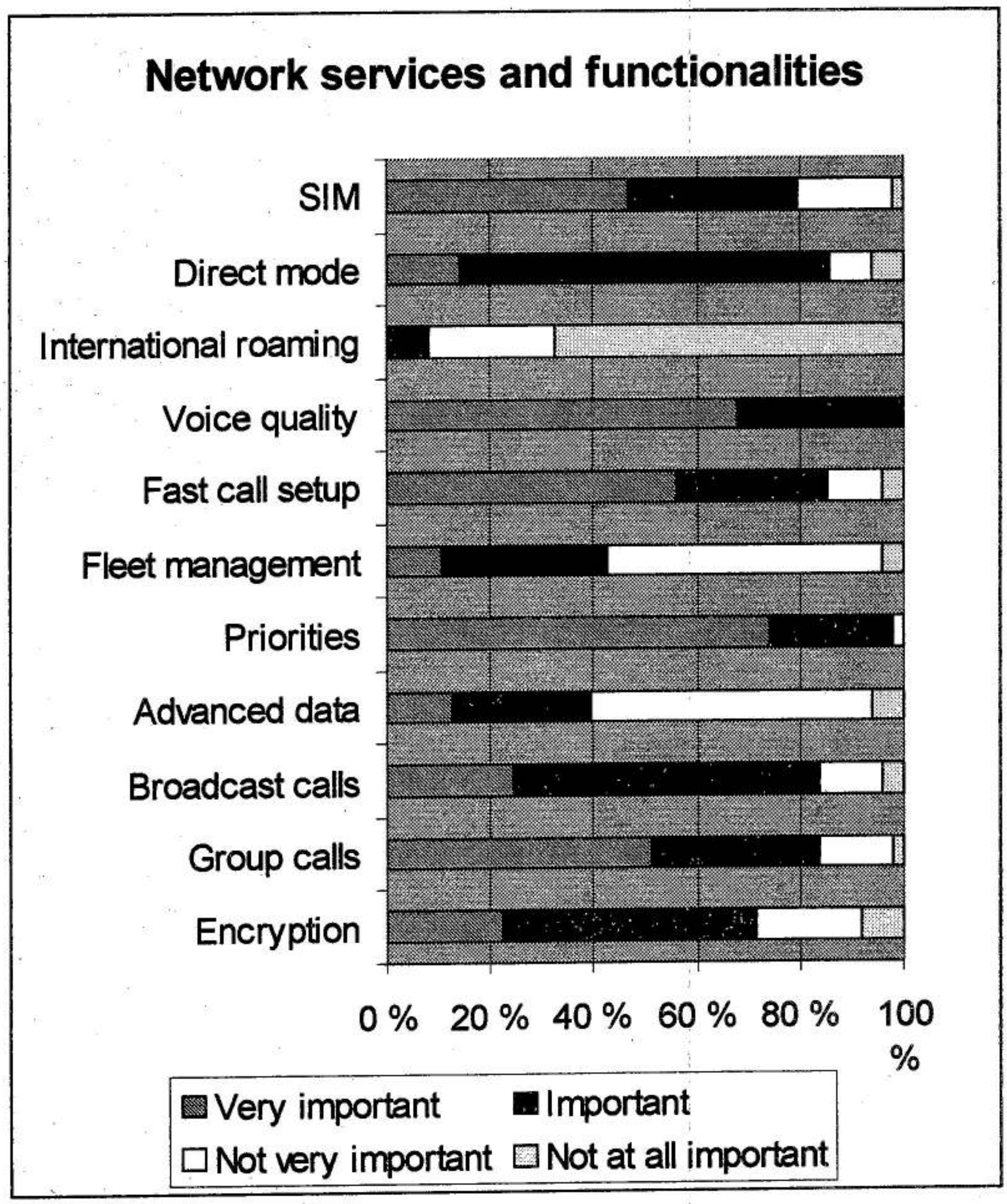


Figure 11. Service and functionality requirements

Annual costs and terminal investments in the future network

The distribution of answers concerning the acceptable annual cost per user is shown in Figure 12. The average acceptable annual cost is ZAR 786. This annual cost covers all fees paid to the third-party operator including airtime fees, user administration fees and support fees as well as all network-related costs.

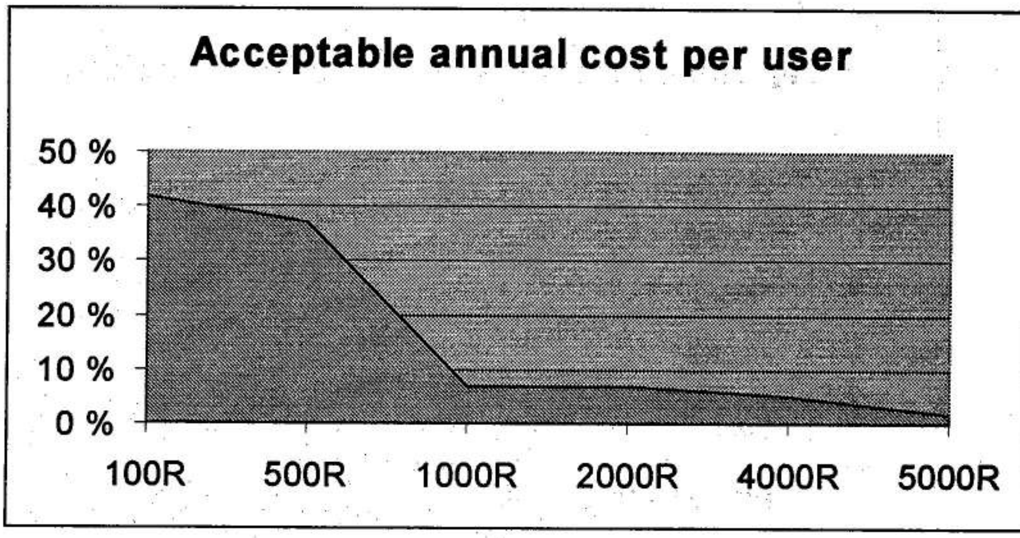


Figure 12. Acceptable annual cost per user

The average acceptable price of a normal user terminal is ZAR 2694 and that of an advanced user terminal with data capabilities is ZAR 4270. These figures are approximately 50% of the prices currently being offered in the market. SAPS, the biggest user group, indicated a willingness to respond favourably to a price which is 75% of the price currently being offered.

Selected comments from the user survey

In general, trunked systems are assumed to be impractical and not cost-effective in rural areas. Some major user groups also believe that purchased services are more expensive than the operation of existing networks.

The municipalities are responsible for public safety and do not trust that a commercial third party operator will be able to provide services at the required high level of reliability. The question is where legal responsibility falls in cases of failure or poor performance of the radio network.

SAPS sees the control and administration of a common network as a problem in unexpected emergency situations when fast reaction is required. User priorities in multi-incident situations are also a matter of concern. SAPS has a sufficient number of interlinking positions if the new network is created for local authority services only.

The Metropolitan Councils preferred the establishment of localised networks for cost reasons, with licenses being issued separately to each council.

4.5. Conclusions of the Market Study

The largest potential single user group is SAPS. The answers given by SAPS were therefore given the highest weight when averaging, but it should be noted that there was no significant difference between the answers given by SAPS and the answers given by others.

Based on the existing figure of 195,000 public sector PMR radio users, 15% expected growth during the next ten years and approximately 70% willingness to join the new network, it can be projected that the size of the commercially-generated market in 2010 will be approximately 157,000 users.

Nevertheless, since the Public Sector is subject to political control, a ministry-level decision to direct services to a single network would result in the total market size of the Public Safety and Municipal Sector being an estimated 225,000 users (existing public sector PMR base with 15 % growth) in 2010. Both these figures (157,000 and 225,000) are used in the business analysis described in Chapter 5, Framework for the business analysis.

The analysis shows that the new network's potential user base is not really willing to pay a realistic price for the service it will provide. As the commercial evaluation will later show, the figure of ZAR 786 is far too low a level of revenue to cover the total expenses incurred by the network operator.

There is already a significant quantity of fairly new network infrastructure in South Africa. Migration to the new network cannot therefore be very rapid and must be carefully planned in advance.

From the operational point of view, the nature of public safety usage eases the traffic load and congestion in the network due to the lack of clear busy hours, such as occur in the civil and cellular sector. On the other hand, the network operator must be able to cope with the requirement for rapid capacity enhancement in major disaster situations where all the public safety entities will be operating in a small area at the same time. The importance of good coverage must be emphasised in both network dimensioning and in further planning. The service requirements of the potential user groups can be met perfectly by employing the trunking radio systems evaluated in this study (TETRA, TETRAPOL and APCO25).

5. FRAMEWORK FOR THE BUSINESS ANALYSIS

5.1. GENERAL

The main objective of this project was to analyse the feasibility of commercially operated PAMR network for public safety and municipality uses. To be able to do the analysis, a framework describing the market, time frame, network dimensioning, network cost structure etc. is needed. This framework is described in the following sections.

5.2. THE SCENARIOS

The study uses a scenario approach. Two main scenarios are specified for this feasibility study:

1. **Nation-wide licence scenario**

   In this scenario business opportunities are analysed for networks providing indoor coverage in urban/suburban areas for cellular type terminals and outdoor coverage in rural areas for handheld terminals

   This scenario is analysed with three technology options; TETRA, Tetrapol and APCO25, three different market projections; low, medium and high and two different frequency allocation: 2* 5, 375 MHz and 2*3 MHz

2. **Cellular type coverage scenario**

   In this scenario the business possibilities for a network that covers area comparable to current cellular networks (presented in Appendix 6) are evaluated. Also this scenario is analysed for three technology options TETRA, Tetrapol and APCO25 in two different market situations and for two different frequency allocation.

5.3. THE MARKET

The number of subscribers used in the business analysis of scenarios is derived from the Chapter 4, Market Analysis. These projections are shown in Figure 13. For the sensitivity analysis and in order to find out the profitability level for different scenarios also so called 'Maximum projection' is generated. This projection has no statistical back round but it could be anticipated to include Public Safety type users outside the public sector, such as utilities, (electricity, water) and privately owned security companies.

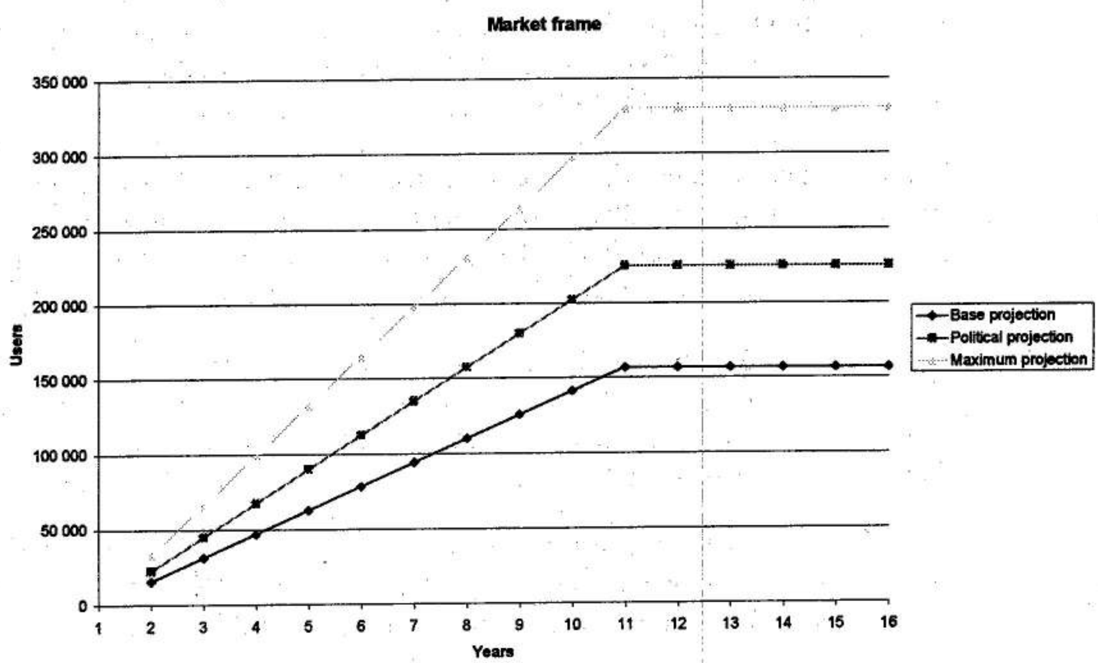


Figure 13. Market projection

5.4. THE TIME FRAME FOR THE STUDY

The timeframe selected for this study is the period from 2000 to 2009. The total investment is completed during this period in all the scenarios studied. Operational costs as well as sales revenues are studied for the same period, but are also continued up to 2014 to obtain further information about the development of the profitability of operations from the operator's perspective, and also to establish the development of user costs from the users' perspective.

5.5. FREQUENCY ALLOCATION

SATRA has conducted a frequency band replanning exercise, known as Project SABRE (South African Band Replanning Exercise) the outcome of which was the allocation of the frequency band for Government and Public Safety trunking networks in the band of 407,625 – 413/ 417.625 –423 MHz.

The band is designated as being used for mobile communications by organisations involved in ensuring public safety, including police, fire, ambulance and traffic law enforcement services and other personnel employed by Government-funded local and regional authorities such as municipalities and provincial authorities.

The band 407.625 – 410/417.625 –410 is currently used by SAPS, who may continue to use the band band for mobile communications. The band 410-413/42020-423 MHz is currently used for single frequency links, which will be migrated as soon as possible.

Since the possibility to use the SAPS's current allocation for the benefit of a common Public Safety network is unclear, the business analysis is conducted with two possible frequency allocation scenarios: 2 * 5,375 MHz and 2 * 3 MHz.

5.6. RADIO NETWORK DIMENSIONING

General

Radio network dimensioning results in the number of base station sites required for coverage only. Switching, transmission and network management factors as well as additional radio infrastructure due to capacity requirements are described in Chapter 5.7.

Radio network dimensioning of the South African public safety network is based on Omnitele's experience, TETRA Designer's Guide ETR300-1 document and assessment of the information provided by system suppliers of Tetrapol and APCO25:

- APCO25: Motorola information available only; therefore the reliability of the information is questionable
- Tetrapol: Only Siemens provided information related to network dimensioning. Matra Nortel Communications refused to provide any information specific to the South African case before a Request for Quotation is submitted. However, the Siemens S-Pro system is designed by Matra Nortel Communications and it can be assumed that the system performance is completely similar.

Detailed radio planning with digital maps and propagation prediction would be required to achieve a more reliable number of base stations. Within the scope of this study the following simplified, but well field-proven method is used:

- Planning assumptions concerning coverage requirements and probabilities as well as practical base station configurations in South Africa are set.

- Radio link budgets for different technologies provide the maximum path loss for vehicle mounted and handheld user terminals in rural and urban/suburban environments.

- Average cell radii in these environments are calculated from the maximum path loss by the Okumura-Hata formula.

- Effective cell footprint is calculated from the cell radii and the number of base stations required is achieved by dividing the size of the area by the effective cell footprint

Planning Assumptions

The network infrastructure of the South African public safety network is dimensioned for two different coverage scenarios:

1. Nation-wide coverage

2. Specified coverage comparable to current cellular networks (approximately 200000km^2). Most of the urban/suburban areas as well as main roads are included.

In both analysed scenarios the following planning assumptions are used:

- 20% coverage overlap is required to ensure good performance at base station cell borders

- Average base station antenna height is 50m

- Base station antenna gain is 10 dBi with an omnidirectional antenna pattern

- Diversity reception is assumed if it is possible in the system

In this study the description of urban/suburban refers to areas characterised by high population density and significant amount of buildings, which require indoor coverage. Without detailed radio planning and more specific coverage requirements it is very difficult to detemine the actual size of urban/suburban areas in both scenarios. The assumptions are given in Table 5 below.

	Nation-wide coverage of 1184825 km²	Specified coverage of approx 200000 km²
Urban/suburban	50000 km²	40000 km²
Rural/open	1134825 km²	160000 km²

Table 5. Area type distribution

Urban/suburban areas:

Indoor coverage for handheld user terminals is required with a 90% location probability. 20dB planning margin is used to compensate slow fading and indoor penetration loss. -8 dB area type correction is applied to the Okumura-Hata propagation prediction formula. This correction is suitable for densely populated areas such as Gauteng, where relatively small blocks of dense urban areas are surrounded by highways and suburban and industrial areas. Building penetration loss is also substantial because of high use of metal and glass in modern buildings.

Rural areas:

Outdoor coverage for vehicle mounted user terminals is required with a 95% location probability. 7dB planning margin is used to compensate slow fading. -15 dB area type correction is applied to the Okumura-Hata propagation prediction formula.

Radio Link Budgets

Radio link budgets for TETRA, APCO25 and Tetrapol are given in Appendix 5. The TETRA link budget is based on TETRA Designer's Guide ETR300-1, representing the minimum performance requirements of the standard. In addition, a TETRA link budget representing industry values is given and analysed in the chapter on the sensitivity of dimensioning. The lowest maximum path loss represents link balance and is therefore used in the cell radius calculation.

Base Station Cell Radii

The average base station cell radius can be approximated from the Okumura-Hata equation for suburban/urban areas:

$$\text{Path loss [dB]} = 69.55+26.16\log f - 13.82\log h_b - [(1.1\log f-0.7)*h_m-(1.56*\log f-0.8)]+[44.9-6.55*\log h_b]*\log d + k_c$$

- Frequency f = 415 MHz
- Effective base station antenna height h_b = 50m and mobile height h_m = 1.5m
- Area type correction factor k_c = -8 for urban/suburban areas and -15 for rural areas

The cell radii d [km] can be solved from the equation and are presented in the Table 6 below.

	TETRA	TETRAPOL	APCO25
Maximum path loss in rural areas including the 7dB planning margin	144 dB	150 dB	157,8 dB
Average cell radius in rural areas	20,7 km	31,1 km	53,0 km
Maximum path loss in urban/suburban areas including the 20dB planning margin	122 dB	128 dB	131,3 dB
Average cell radius in urban/suburban areas	2,9 km	4,3 km	5,4 km

Table 6. Maximum path loss and cell radii to be used in network dimensioning

Number of Base Stations Required

The number of base stations required is calculated by dividing the area sizes from Table 5 by the corresponding effective base station footprint, taking the coverage overlap into account.

	TETRA	TETRAPOL	APCO25
Rural area base stations	1056	466	161
Urban/suburban area base stations	2427	1071	683
Total number of base stations	**3483**	**1537**	**844**

Table 7. Number of base stations required for nation-wide coverage

	TETRA	TETRAPOL	APCO25
Rural area base stations	149	66	23
Urban/suburban area base stations	1942	857	546
Total number of base stations	**2091**	**923**	**569**

Table 8. Number of base stations required for cellular type coverage

Sensitivity of Dimensioning

The effect of changes in some planning assumptions on the total number of base stations in the nation-wide coverage scenario is evaluated for some example cases. It is not practical and not within the scope of this study to evaluate all possible variations in the assumptions.

Area type distribution

It is very difficult to approximate the exact proportion of rural and urban/suburban terrain. The following graph illustrates the effect of 2% and 6% urban/suburban terrain proportion compared to the 4.4% used in the dimensioning.

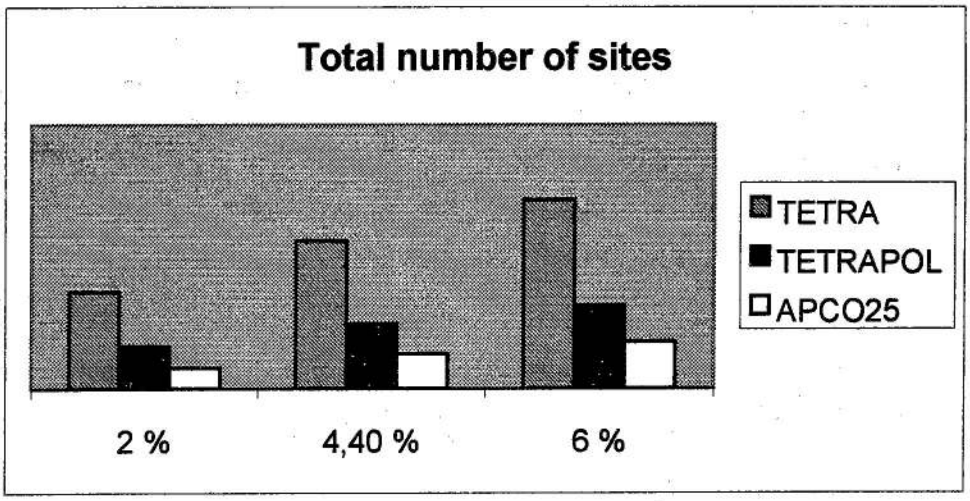


Figure 14. The effect of terrain proportion

Due to the significant effect of changes in the area type distribution indoor coverage requirements of the user groups should be carefully evaluated when preparing more detailed radio plans. Implementation of indoor coverage in urban/suburban areas is very expensive.

Average cell radius depending on area type

Propagation model area type correction k_c=–5 dB is generally recommended for urban areas, practically downtown areas of Johannesburg, Cape Town or Durban. The effect of applying this correction factor to all urban/suburban areas is depicted in Figure 15.

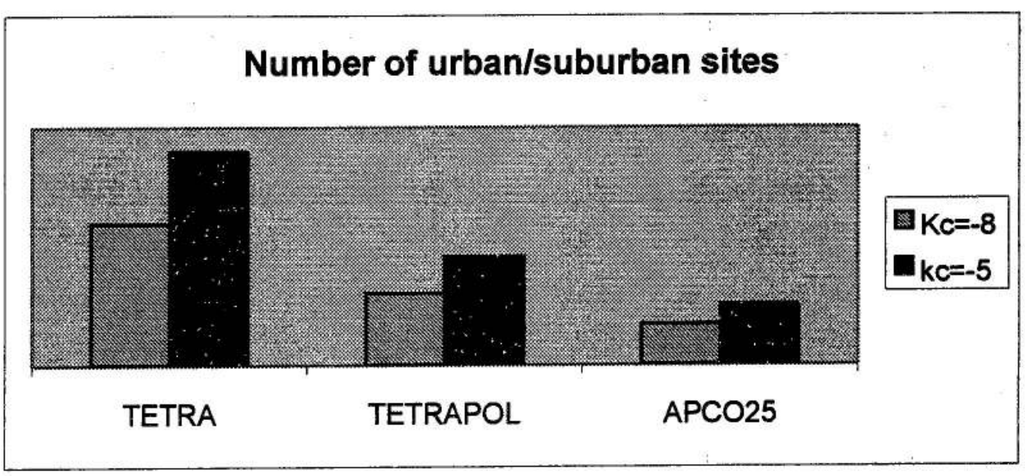


Figure 15. The effect of applying correction factor to all urban/suburban areas

Coverage overlap

Public safety services require a very high grade of service and network availability. Effect of the reduction of coverage overlap from 20% to 10% is shown in Figure 16.

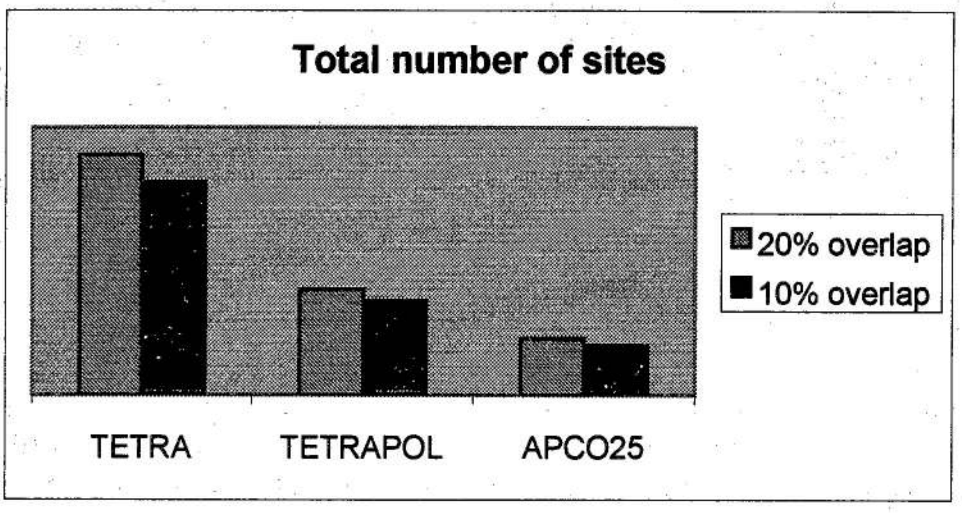


Figure 16. Effect of the reduction of coverage overlap

20% overlap is used in the dimensioning for the business analysis because the cost increase is not very significant compared to the benefits in performance.

Average antenna height

Average antenna height of 50m is practical when taking the existing South African radio mast infrastructure into account. Availability of high sites in the mountain areas will reduce the number of sites required in rural areas. However, the effect on the total number of sites will be compensated by a higher number of urban sites required due to special coverage requirements (underground, high penetration indoor etc) and in some cases a lower average antenna height. As an example the change of average antenna height from 50m to 30m is demonstrated in Figure 17 below.

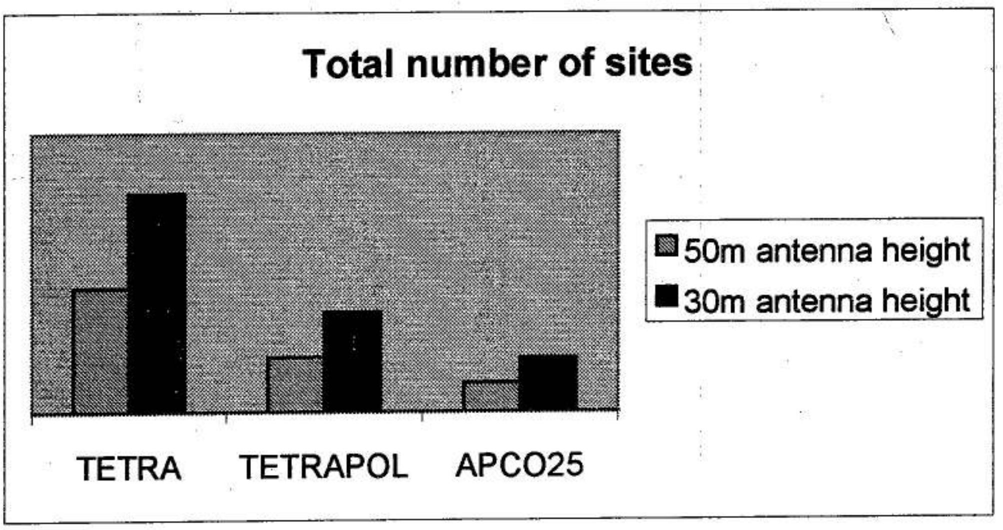


Figure 17. The effect of the change of average antenna height from 50m to 30m

The graph shows clearly the importance of good high sites. Detailed radio planning should take all existing radio masts into consideration when selecting a site from the candidates. Naturally total network costs including site construction and transmission costs have to be taken into account equally when selecting the optimal sites.

TETRA planning case based on industry values

It is very difficult to verify the actual values for factors such as diversity gain or body proximity loss affecting handheld performance, but these values are equal for all different technologies.

TETRA standard specification values were used in the dimensioning, but an additional planning can be made with industry values, i.e. performance values that are given by TETRA system vendor. This latter approach is in line with the approach used with Tetrapol and APCO25 where all the performance values are derived form the documentation given by the system vendors.

	TETRA industry values
Maximum path loss in rural areas including the 7dB planning margin	148 dB
Average cell radius in rural areas	27,2 km
Maximum path loss in urban/suburban areas including the 20dB planning margin	126 dB

Average cell radius in urban/suburban areas	3,8 km

Table 9. Maximum path loss and cell radii based on TETRA industry values

	Nation-wide coverage	Cellular-type coverage
Rural area base stations	612	86
Urban/suburban area base stations	1407	1125
Total number of base stations	**2019**	**1211**

Table 10. Number of TETRA sites required for nation-wide and cellular-type coverage scenarios (based on industry values)

As a conclusion, the 4dB increase in the link budget performance decreases the number of sites required by 40%.

The increased performance is a result of better design of the radio frequency system components. Commercially binding performance values should be required in the vendor selection process in order to get completely comparable and reliable results.

5.7. THE COST STRUCTURE

Investments

Base Stations and capacity dimensioning

In all terrestrial radio networks the most important cost factor is the number of base station sites. The radio network part of such networks normally represent between 40 and 80% of the total investment. In this way the requirement for radio coverage is the basis for business possibilities.

In all the scenarios studied the number of sites is derived based on the coverage and capacity requirement. This analysis is based on the average site footprint size for different coverage criteria in urban and rural environments.

The base station investment comprises the following components: Basic infra (cabins, power, etc.), towers, antennas, cables and connectors, and system specific (TETRA, Tetrapol, APCO25) equipment. A more detailed list of base station components is given in Appendix7.

For each scenario studied, the number of average carriers per site and the needed additional number of sites due to capacity requirements and narrow frequency allocation is calculated separately. This calculation is based on the allocated frequency band, estimated re-use factor (20 for all technologies analysed), estimated average traffic per busy hour per subscriber (0,031 Erl) and allowed blocking factor (1% for public safety).

The total base station investment depends on whether the site can be built on an existing tower and cabin or whether a new tower and cabin need to be constructed. On average, the investment needed for a new site is twice as much as the investment required in an existing site. For this reason, in the business calculations sites are divided into two categories - new own sites and old leased sites - and the investments required for these categories are evaluated separately. In all the scenarios it has been assumed that the percentage of own new sites is 40% and old leased sites is 60%.

Switching, Operation and Maintenance and Customer Care

Manufactures that provide PAMR/PMR network infrastructure have based their solutions on different architectures. Some of them have selected centralised structures with high capacity switching nodes while others have based their network on decentralised architecture.

According to our experience with similar projects, the size of the total investment is not significantly dependent on the network architecture chosen. The business model does not therefore specify the number of switching nodes or network architecture as such. Switching equipment investment is evaluated on the basis of the number of carrier units. The same rule is applied to the operational and maintenance investment. The switching investment includes gateways to the PSTN.

In customer care and billing systems the initial investment is not directly dependent on network size but primarily related to flexibility requirements of the system as well as the size of the subscriber base. The customer care and billing system investment is therefore divided into the initial investment and investment per subscriber. The initial investment is assumed to be reasonably high due to the large service supply in PAMR networks as well as due to the need to differentiate the system from cellular services.

Subscriber equipment

This evaluation does not include subscriber equipment, i.e. radio terminals and dispatching units. We presume that the customer meets the investment cost and expenses related to radio terminals and dispatching.

Network set up

The investment required for network set-up is not separated out in the business calculation model. Set-up costs are added to each network component as a specified value (base stations) or percentage of the investment (switching). This percentage varies from 10 to 20%. Network set-up costs include planning, construction of the basic infrastructure, installation, commissioning, and network integration.

Operation and Maintenance

Base Stations

Once again, base station sites are separated into two categories: new sites and old sites. On new sites the operational expenses are low as the infra equipment is owned by the operator. On old sites, operational expenses include the costs of leasing the antenna site and cabin. The same average values are used in all the basic scenarios.

The effects of the redundancy requirements on operational costs are studied in the sensitivity analysis of the scenarios.

Since no network architecture has been specified, the transmission costs between switching points and location leases for the switching points are included in the operational costs of the base stations.

Network Maintenance

Maintenance costs are calculated per site for the whole system specific infrastructure. These expenses include the chain from the base station to the switching point and include repairs and testing of equipment.

Software maintenance costs are included to the system specific investment. This includes software maintenance as well as software updates.

Others

Billing and customer care costs are evaluated as an annual cost per subscriber.

Marketing costs are evaluated based on new subscribers connected to the network. Service delivery costs are included in marketing expenses. In all cases marketing costs are set to the same value as the activation fee.

Personnel expenses include only the cost of administrative and managing personnel. This is because the planning, construction and maintenance costs are taken into account when calculating the cost of investments and operation.

Sales Revenues

In all the models sales revenues consist of two basic components: an activation fee and an average fixed monthly fee. No revenues from sales of handsets are assumed. The settlement for calls coming from the PSTN is subtracted from the interconnection costs and is thus not seen as revenue.

Services or feature charges as well as usage changes are included in the average fixed monthly fee. As a starting point ZAR 400 revenue per subscriber per month is used in each basic scenario analysis. This value is then modified in the sensitivity analysis.

Financing and Depreciation Presumptions

For the Net Profit and Net Cash Flow analysis, financing is assumed to be in the form of loans. In all the scenarios analysed it is presumed that the operator needs outside finance for 100% of the negative cash flow. The interest rate is set at 15%. The loan repayment time is set to 10 years.

The network depreciation lifetime is set at 15 years. This relatively high figure is chosen in view of the history of PMR, in which equipment lifetime has traditionally been in the range 15 to 25 years.

Values used

Table 11 lists items used in the economic evaluations. The values of these items are modified in different scenarios due to the size (number of sites) of the network.

Network components	
Number of cells	3 483
Sectors/site	1
Number of sites	3 483
Average number of carriers/cell	1,25
Total number of TRXs	4353,75
Investment prices (infra + set up)	
Base Stations investement to leased site	438 200 ZAR
Base Station investment to own new site	818 200 ZAR
Average investment/Base Station Site	590 200 ZAR
Average investment/cell	590 200 ZAR
Added carrirer unit	130 000 ZAR
Switching (infra+ set up)/carrier unit	75 000 ZAR
O&M (infra + set up)/carrier unit	10 000 ZAR
Billing and customer care/subscriber	50 ZAR
Billing and customer care setup	15 000 000 ZAR
Operation and Maintenance	
Operation; own base stations; transmission, eases/year/site	24 000 ZAR
Operation; leased base stations; transmission, leases/year/site	48 000 ZAR
Average oparation expenses/site/year	38 400 ZAR
Maintenance/site (BTS, controller, switching,repairs, test equipments)/ye	10 000 ZAR
Billing and customer care/year/subscriber (=user, not a company)	50 ZAR
Marketing expenses/subscriber	500 ZAR
Average administrative personal expences/year/person	400 000 ZAR
Interconnection fee/minute	0,30 ZAR
Termination in Fixed network (% of total traffic)	5 %
Termination from Fixed network (% of total traffic)	5 %
Financing	
Required outside financing of annual negative cash flow	100 %
Interest rate	15 %
Depreciation life, years	15
Loan repayment plan/year	10 %
Subscriber charges	
Activation fee	500 ZAR
Fixed (Average) Monthly fee	400 ZAR
Average traffic/subrcriber/day	0,0
Usage charge/minute(average)	0,0 ZAR

Table 11. Example of items and values used in the economic evaluations

5.8. MODEL FOR ECONOMICAL EVALUATION

The business model used in the study is a generic PMR business model generated by Omnitele. The model consists of the following components:

- Subscriber forecast
- Investments
- Operational expenses

- Sales revenues
- Financing and Depreciation
- Revenue and Expenditure schedule
- Income Statement.

Values used to evaluate investment levels and operating costs are derived from the interviews conducted during the project as well as from the earlier PAMR, analogue trunking and cellular network projects conducted by Omnitele.

The indicative system equipment price information was asked from vendors with RFI (Request for Information) process, the RFI is presented in Appendix 4. The information was received from the following vendors:

- TETRA: Motorola, Nokia Telecommunications, Simoco International and Marconi Communications
- APCO25: Motorola information available only; therefore the reliability of the information may be questionable
- Tetrapol: Only Siemens provided information related to equipment pricing.

The indicative operational expenses were asked from vendors with RFI (Request for Information) process, the RFI is presented in Appendix 4. The information was received only from Transtel Mobile Ltd. and Grintek Electronics System Ltd.

Operational expenses are thus mainly based on Omnitele's projects for a variety of mobile operators including PAMR. The information obtained by interviewing operator candidates in South Africa was used to verify these values.

In each scenario the operator revenue per subscriber per month is set to a fixed value, ZAR 400. This value was selected based on earlier studies made by Omnitele for large PAMR networks.

5.9. INDICATORS USED

The economics of the scenarios are evaluated and described using following indicators:

1) cumulative investment for 10 years,

2) annual operating expenses for the tenth year,

3) cumulative operating expenses for 10 years,

4) annual cash flow (sales revenues less total expenditure) including financing costs,

5) cumulative cash flow including financing costs,

6) NPV (Net Present Value) of the annual cash flow including financing expenses for 15 years (2000–2014), discount rate 15%,

7) IRR (Internal Rate of Return) on the annual cash flow for 10 years (time scale 2000-2009) and 15 years (2000-2014). The rate of return calculated by the IRR is the interest rate corresponding to a zero net present value,

8) Break-even year for cumulative cash flow including financing costs,

9) First year for positive net profit. (net profit = net sales revenue less operating costs, network depreciation and financing costs)

Since by default the PAMR business requires major long-term investments in a sensitive environment, relatively moderate criteria are used to judge the cases studied. The main criteria are based on the IRR. If IRR>20% for 10 years and IRR> 30% for 15 years of operation, the case is judged to have business possibilities.

6. BUSINESS EVALUATION

6.1. GENERAL

In this chapter the business opportunities digital Public Safety Network in South Africa is evaluated. The study uses a scenario approach as well as the framework specified in the Chapter 5. The scenarios selected are as follows:

1. **Single licence for nation-wide network**

   In this scenario business opportunities are analysed for networks providing indoor coverage in urban/suburban areas for cellular type terminals and outdoor coverage in rural areas for handheld terminals

   This scenario is analysed with

   - three technology options; TETRA, Tetrapol and APCO25.
   - three different market projections; low, medium and high
   - two different frequency allocation: 2* 5, 375 MHz and 2*3 MHz

2. **Single licence for cellular type coverage network**

   In this scenario the business possibilities for a network that covers area comparable to current cellular networks (presented in Appendix 6) are evaluated. Also this scenario is analysed for three technology options TETRA, Tetrapol and APCO25 in two different market situations and for two different frequency allocation.

6.2. EVALUATION OF THE SINGLE NATION WIDE LICENCE SITUATION

Presumptions

This case study presumes that in South Africa a single Public Safety network licence is issued. The network will eventually provide indoor coverage for cellular type terminals on all urban areas and nation-wide outdoor coverage for handheld terminals.

The commercial subscriber base prediction presented in Chapters 4.5 and 5.3 is used here as a starting point for the business evaluation. The total number of subscribers grows from 15 700 (year 2000) to 157 000 (year 2009). A sensitivity analysis is performed for this scenario both with Political projection (growth up to 225 000 subscribers) and Maximum projection (growth up to 330 000 subscribers) presented in Chapter 5.3. The monthly revenue per subscriber is assumed to be ZAR 400.

The network dimensioning is based on the framework for the business analysis presented in detail in Chapter 5. The required number of sites and carriers for different technologies when 2*5, 375 MHz is allocated for a single national Public Safety network are given in Table 12. The high number of sites is mainly due to the good indoor coverage provided in urban areas. It is estimated that 40% of the sites require investment in new tower and cabin infrastructure, the rest of the sites (60%) are leased e.g. from other operator.

Basically, the network is built up in 5 years, in the last 5 years of the study construction consists in the main of capacity additions in the form of adding new carrier units to sites that are already in use.

Network components	TETRA	Tetrapol	APCO25
Number of sites	3 483	1 537	844
Average number of carriers/cell	1,25	8	12
Total number of TRXs	4 354	12 296	10 128

Table 12. Site data, nation wide scenario

Network investments

The cumulative investments as well as the relative size of the investment solutions in each network component for nation wide networks based on different technologies are presented in Figure 18. Additionally, Figure 19 shows the annual distribution of the investment. The big differences in the total size of the investment is originated from significant difference in the needed number of radio sites, see Table 12. Additionally, the large up front investment required by TETRA is a consequence of the TDMA technology employed, which provides large capacity already in coverage building phase, where as with the FDMA technology the capacity can be added later on when it is needed.

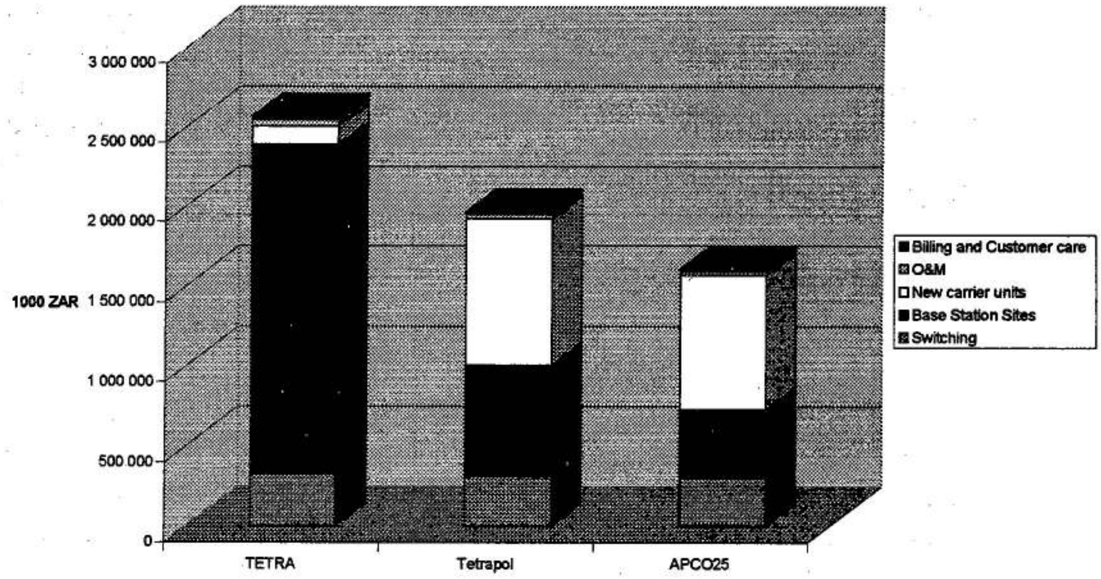


Figure 18. The size and the distribution of the investments, nation wide scenario

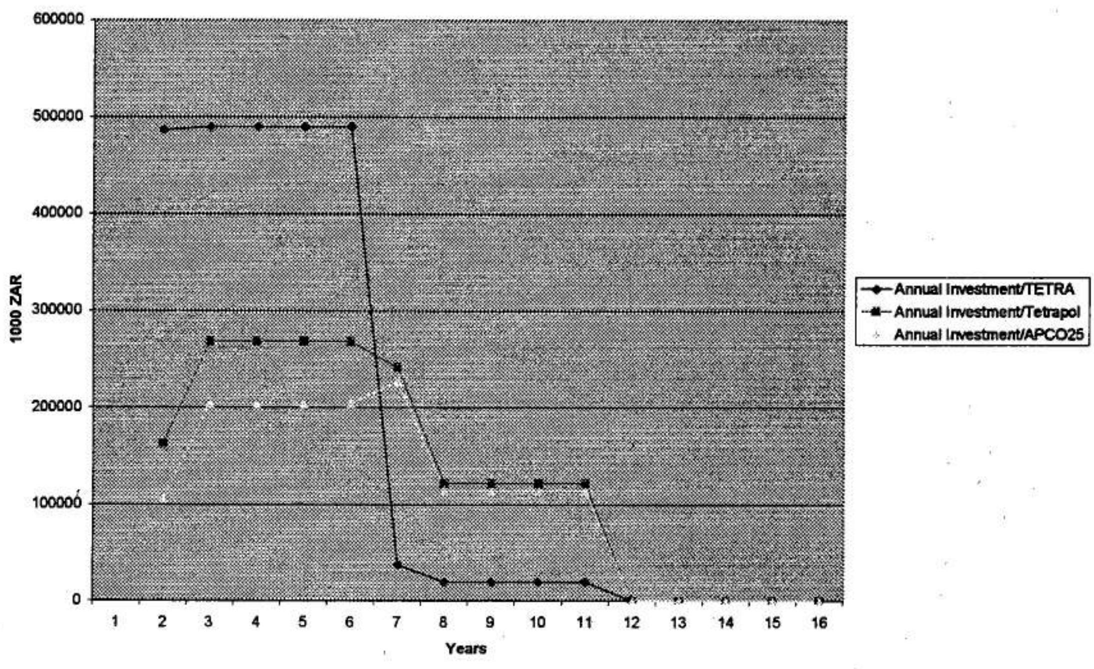


Figure 19. Annual distribution of investments for different technologies, nation wide scenario

Operational expenses

Figure 20 shows annual operating expenses for nation wide networks for different technologies and Figure 21 shows the cumulative operational expenses as well as how the operating expenses are distributed between the different network functions.

The differences here again can be explained with same arguments as was done with the investments i.e. the number of required sites.

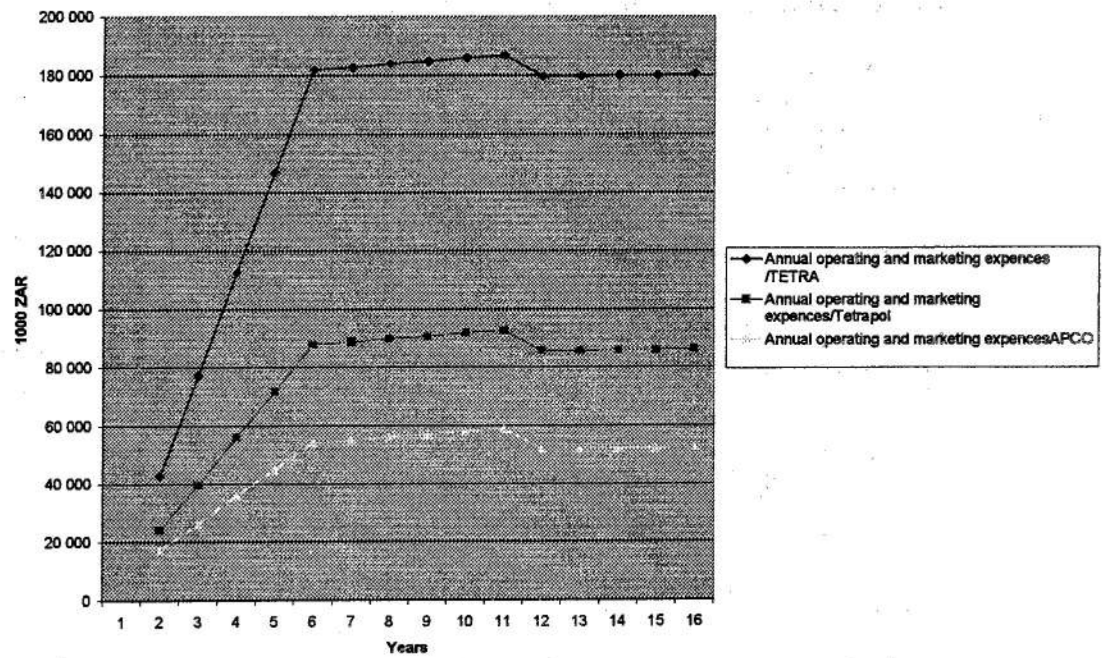


Figure 20. Annual Operating Expenses

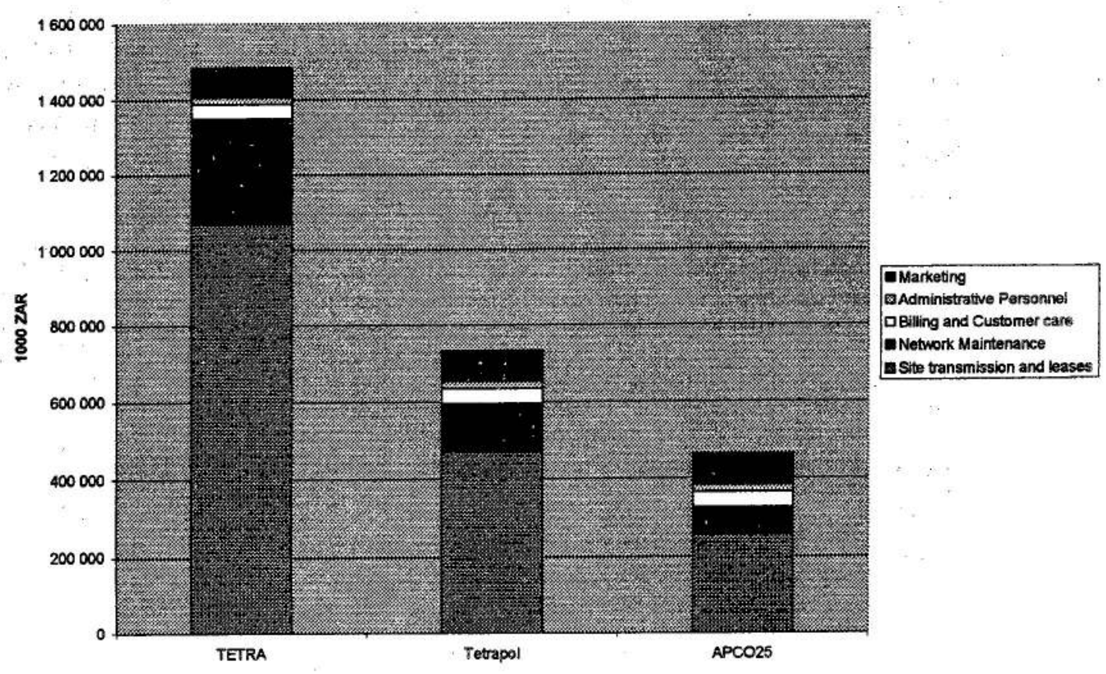


Figure 21. Distribution of operational expenses

Cash flow, Break even and IRR

Figure 22 shows the Cumulative Cash flow curves for nation wide networks with different technologies. It can be seen that with the low number of sites required by APCO25 technology and the prices given for the mentioned technology the business case shows out to be viable. Even with large nation wide network and low subscriber base, break even is reached on 6th year.

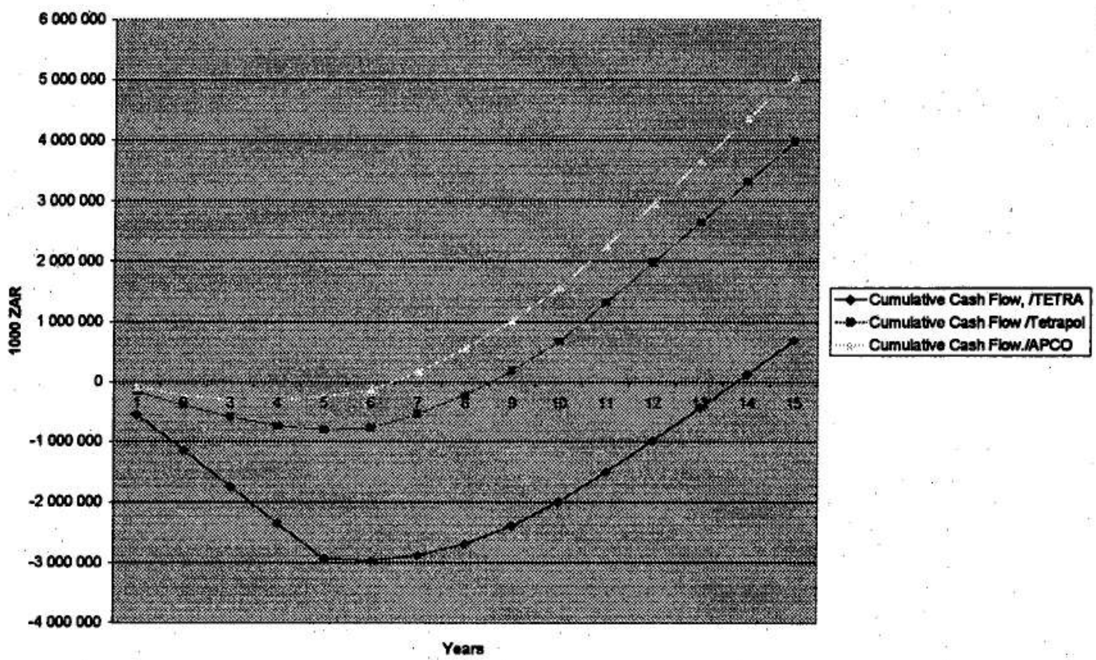


Figure 22. Cumulative Cash Flow

In Table 13 the result and indicators are collected for the basic scenario 1. Both with Tetrapol and APCO technologies the nation wide scenario is reasonable in business sense. For TETRA such a large network with low subscriber base the required investment is far too high in order to result to viable business case. Nevertheless this picture changes quite remarkably when the market projection is altered, as is shown seen in the following chapter.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 561 782 850 ZAR	1 961 314 400 ZAR	1 604 674 800 ZAR
Annual operating expenses, 10th year	186 684 700 ZAR	92 498 300 ZAR	58 957 100 ZAR
Cumulative operating expenses, 10 years	1 485 567 600 ZAR	732 076 400 ZAR	463 746 800 ZAR
NPV cash flow excl.financ., 15 years	-347 650 227 ZAR	677 927 009 ZAR	1 046 589 440 ZAR
IRR, 10 years	-2 %	20 %	43 %
IRR, 15 years	11 %	30 %	49 %
Year for break even	14	9	6
First year for positive net profit	8	1	1

Table 13. Summary table

Sensitivity analysis

The most significant uncertainty for all the scenarios studied in this feasibility study is the market development. There are also other factors such as the frequency allocation, the estimated size of the urban are or performance values which have a major effect on the result. Additionally, the regulatory environment, e.g. operator's the right to supply the backbone transmission, can influence to the outcome of the study.

The Table 14 shows the effects of changes in subscriber base and the frequency allocation network on needed radio network components. It can be noticed that the growth in subscriber base causes major equipment additions for Tetrapol and APCO25 networks, where as changes are minor for TETRA. Additionally, the narrowed frequency allocation (2* 3 MHz) with large subscriber base results to need for additional sites for Tetrapol and APCO25 networks.

Frequency allocation: 2* 5,375 MHz						
No of subscribers	TETRA sites	Carriers	Tetrapol sites	Carriers	APCO sites	Carriers
157 000	3483	1,25	1537	8	844	12
225 000	3483	1,5	1537	10	844	16
330 000	3483	1,75	1537	13	844	21
Frequency allocation: 2* 3 MHz						
No of subscribers	TETRA sites	Carriers	Tetrapol sites	Carriers	APCO sites	Carriers
157 000	3483	1,25	1537	8	844	12
225 000	3483	1,5	1537	10	1200	12
330 000	3483	1,75	1750	12	1750	12

Table 14. The influence of subscriber base and the frequency allocation on radio network components

The Table 15 shows the influence of changing the amount of urban/suburban area from 4,4,% used in basic calculations to 1% on the total number of required sites.

Network components	TETRA 4,4 %	TETRA 1 %	Tetrapol 4,4%	Tetrapol 1%	APCO 4,4,%	APCO 1%
Urban/Suburban sites	2 427	575	1 071	254	683	162
Rural sites	1056	1 091	466	481,00	161	166
Total number of sites	3 483	1 666	1 537	735	844	328

Table 15. The influence of estimated amount of urban area

The Table 16 below shows the influence of the source of performance values. The table compares the required number of base stations when the industry values, i.e. performance values that are given by TETRA system vendor are used to those when TETRA standard specification values are used when dimensioning the networks. For Tetrapol and APCO25 only industry values were available and are thus used throughout the study.

Network components	TETRA standard	TETRA industry value
Urban/Suburban sites	2427	612
Rural sites	1056	1 407
Total number of sites	3483	1 666

Table 16. The influence of the source of the performance values

The influence of these different variables are analysed in the following sensitivity studies:

- Sensitivity study 1. The base projection is changed to the political projection and the frequency allocation is kept unaltered (2* 5, 375 MHz)
- Sensitivity Study 2. The political projection is changed to the maximum projection and the frequency allocation is kept unaltered (2* 5, 375 MHz)
- Sensitivity study 3. The frequency allocation is changed from 2* 5, 375 MHz to 2*3MHz and maximum projection is used as a subscriber base.
- Sensitivity study 4. Instead of leasing the transmission from outside partner the transmission is implemented with own infra, i.e. microwave links. The frequency allocation is kept as 2*3MHz and maximum projection is used as a subscriber base.
- Sensitivity study 5. The urban/suburban area is assumed to be 1% instead of 4,4 % as was anticipated in all the other studies. The frequency allocation is kept as 2*3MHz and maximum projection is used as a subscriber base.
- Sensitivity study 6. The base projection is used as a market projection and the frequency allocation is kept unaltered (2* 5, 375 MHz) as in the basic scenario. But, instead of using TETRA standard specification values in the dimensioning, the planning is made with industry values, i.e. performance values that are given by TETRA system vendor.

Results of the Sensitivity analysis

Sensitivity study 1 and 2

When the base projection is changed to the political projection and futher more to the maximum projection whilst keeping the frequency allocation unaltered (2* 5, 375 MHz), we can see from Table 17 and Table 18 that the size of the investment is different networks are getting close to each other. This is because only minor equipment additions is needed to the TETRA network whereas a large number of carriers are added to Tetrapol and APCO25 networks.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 752 394 100 ZAR	2 309 002 400 ZAR	2 019 946 800 ZAR
Annual operating expenses, 10th year	193 314 700 ZAR	99 128 300 ZAR	65 587 100 ZAR
Cumulative operating expenses, 10 years	1 536 567 600 ZAR	783 076 400 ZAR	514 746 800 ZAR
NPV cash flow excl.financ., 15 years	462 000 477 ZAR	1 415 612 513 ZAR	1 753 311 124 ZAR
IRR, 10 years	10 %	38 %	66 %
IRR, 15 years	20 %	45 %	70 %
Year for break even	10	7	5
First year for positive net profit	5	1	1

Table 17. Sensitivity Study 1, Summary table with 225 000 subscribers

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 944 855 350 ZAR	2 830 684 400 ZAR	2 540 036 800 ZAR
Annual operating expenses, 10th year	203 552 200 ZAR	109 365 800 ZAR	75 824 600 ZAR
Cumulative operating expenses, 10 years	1 615 317 600 ZAR	861 826 400 ZAR	593 496 800 ZAR
NPV cash flow excl.financ., 15 years	1 758 866 156 ZAR	2 561 644 685 ZAR	2 900 072 676 ZAR
IRR, 10 years	25 %	65 %	118 %
IRR, 15 years	32 %	68 %	119 %
Year for break even	8	5	3
First year for positive net profit	2	1	1

Table 18. Sensitivity Study 2, Summary table with 330 000 subscribers

Sensitivity study 3

When the projection is kept as maximum and the frequency allocation is altered from 2* 5, 375 MHz to 2*3MHz, we can see from the Table 19 that the size of the Tetrapol as well as APCO25 network investment is now larger that of TETRA network. This is caused by new sites needed for Tetrapol and APCO networks. Nevertheless due to in total still larger number of sites in TETRA network, the operational expenses are smaller in Tetrapol and APCO networks. Therefore the business case shows out to be more viable with Tetrapol and APCO networks.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 944 855 350 ZAR	3 022 600 000 ZAR	3 311 350 000 ZAR
Annual operating expenses, 10th year	203 552 200 ZAR	119 675 000 ZAR	119 675 000 ZAR
Cumulative operating expenses, 10 years	1 615 317 600 ZAR	944 300 000 ZAR	944 300 000 ZAR
NPV cash flow excl.financ., 15 years	1 758 866 156 ZAR	2 407 598 567 ZAR	2 254 875 110 ZAR
IRR, 10 years	25 %	54 %	45 %
IRR, 15 years	32 %	58 %	51 %
Year for break even	8	6	6
First year for positive net profit	2	1	4

Table 19 Sensitivity analysis 3, frequency allocation 2* 3MHz

Sensitivity study 4

In this sensitivity study the transmission to the sites is implemented with own infra instead of leasing it from outside partner and other condition are kept as in sensitivity study 3. W can see from the Table 20 that no big changes in business results is caused with this alteration. Nevertheless the operational expenses drop now about 50%. With a clever financing of the up front investment required by the microwave link investment the operator naturally can benefit remarkably of being able to decide the way in which transmission is realised. This does not however show in the calculation because basic assumptions of 10 year pay back time and 15% interest rate is used through out the study.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	3 362 815 350 ZAR	3 232 600 000 ZAR	3 521 350 000 ZAR
Annual operating expenses, 10th year	133 892 200 ZAR	84 675 000 ZAR	84 675 000 ZAR
Cumulative operating expenses, 10 years	1 058 037 600 ZAR	664 300 000 ZAR	664 300 000 ZAR
NPV cash flow excl.financ., 15 years	1 779 630 998 ZAR	2 418 031 663 ZAR	2 265 308 206 ZAR
IRR, 10 years	24 %	48 %	42 %
IRR, 15 years	31 %	53 %	48 %
Year for break even	8	6	7
First year for positive net profit	2	1	1

Table 20. Sensitivity study 4, the influence of owning the transmission equipment

Sensitivity study 5

In this sensitivity study the urban/suburban area is assumed to be 1% instead of 4,4 % as was anticipated in all the other studies. The frequency allocation is kept as 2*3MHz and maximum projection is used as a subscriber base. The dimensioning results of this study are shown in Table 21 and the result of the business analysis in Table 22. As seen all the network scenarios with different technologies are now profitable and, due to its frequency efficiency TETRA network is now the most profitable network.

Frequency allocation: 2* 3 MHz						
No of subscribers	TETRA sites	Carriers	Tetrapol sites	Carriers	APCO sites	Carriers
330 000	1666	3,25	1750	12	1750	12

Table 21. Sensitivity study 5, site data

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	1 962 310 700 ZAR	3 022 600 000 ZAR	3 311 350 000 ZAR
Annual operating expenses, 10th year	115 609 400 ZAR	119 675 000 ZAR	119 675 000 ZAR
Cumulative operating expenses, 10 years	911 775 200 ZAR	944 300 000 ZAR	944 300 000 ZAR
NPV cash flow excl.financ., 15 years	2 849 424 957 ZAR	2 407 598 567 ZAR	2 254 875 110 ZAR
IRR, 10 years	66 %	54 %	45 %
IRR, 15 years	69 %	58 %	51 %
Year for break even	5	6	6
First year for positive net profit	1	1	1

Table 22. The influence of the size of urban/suburban area

Question: The type of investment figures indicated in the various Summary Tables above, and below, can either come from taxes through the fiscus, or from the private sector. Where should they come from?

Sensitivity study 6

In this final sensitivity study the base projection is used as a market projection and the frequency allocation is kept unaltered (2* 5, 375 MHz) as in the basic scenario. But, instead of using TETRA standard specification values in the dimensioning, the planning is made with industry values, i.e. performance values that are given by TETRA system vendor. The dimensioning results are already shown in Table 16 and the result of the business analysis are depicted in Figures 23- 25. As seen the source of the performance values has major effect to total result of the study. TETRA and Tetrapol are now in business sense on the same level, where as APCO25 is the most cost effective. This naturally applies only if the vendor specific performance values can be proven reliable in the field tests. Note, that for Tetrapol and APCO25 only industry values were available and are thus used throughout the study.

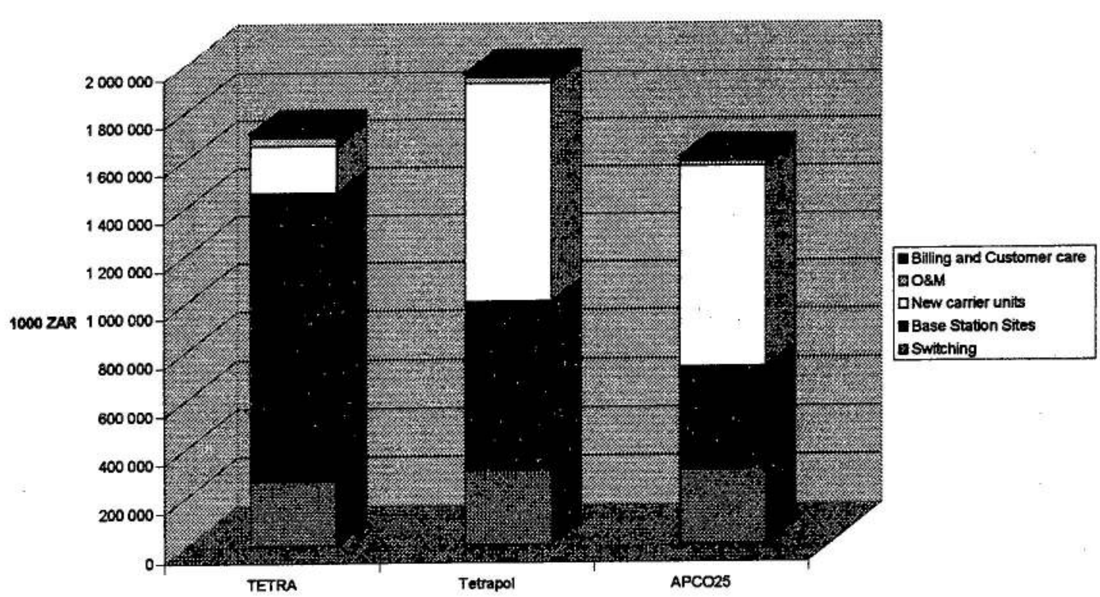


Figure 23. Sensitivity study 6. The size and the distribution of the investments

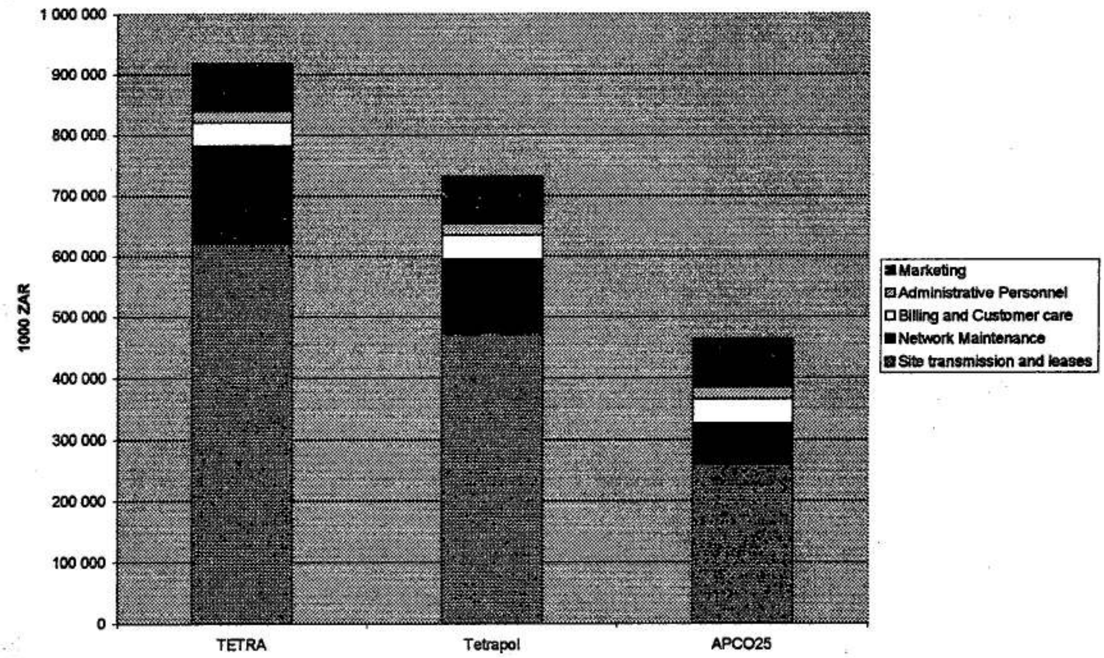


Figure 24. Sensitivity study 6. The size and the distribution of the operational expenses

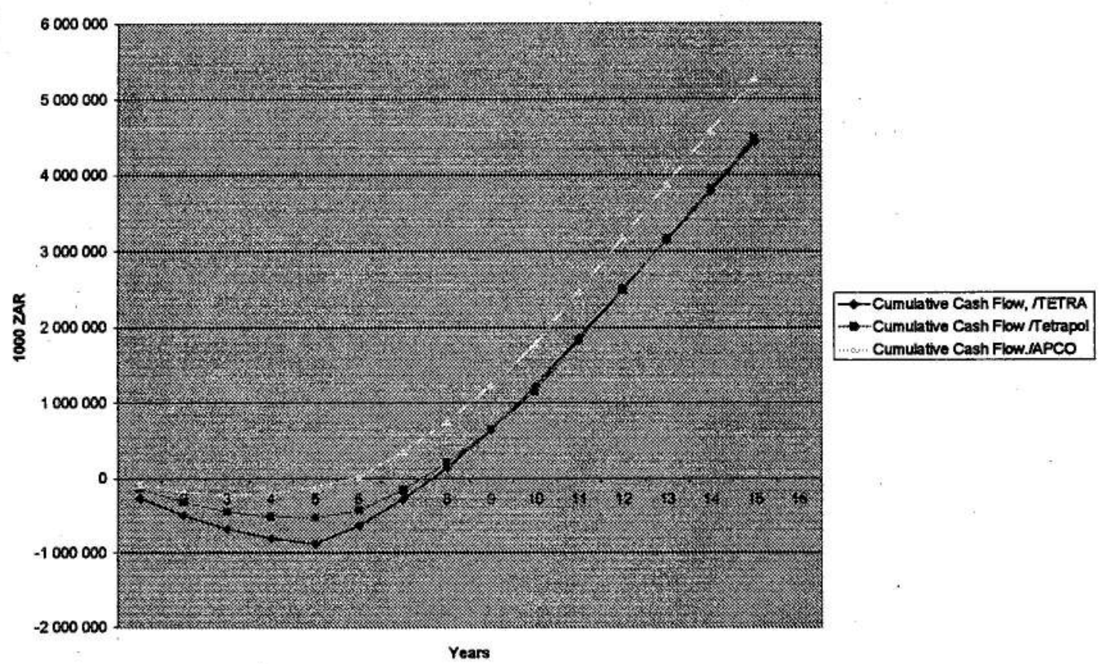


Figure 25. Sensitivity study 6. The cash flow analysis

6.3. EVALUATION OF THE CELLULAR TYPE NETWORK SITUATION

Presumptions

This case study presumes that in South Africa a single Public Safety network licence is issued. The network will eventually provide indoor coverage for cellular type terminals in all urban and suburban areas and to minor rural areas, as depicted in Appendix6.

The base subscriber projection presented in Chapters 4.5 and 5.3 is used also here as a starting point for the business evaluation. The total number of subscribers grows from 15 700 (year 2000) to 157 000 (year 2009). A sensitivity analysis is performed for this scenario Maximum projection (growth up to 330 000 subscribers).

The network dimensioning is based on the framework for the business analysis presented in detail in Chapter 5. The required number of sites and carriers for different technologies when 2*5, 375 MHz and respectively 2*3 MHz is allocated for a single national Public Safety network are given in Table 23. In the analysis it is estimated that 40% of the sites require investment in new tower and cabin infrastructure, the rest of the sites (60%) are leased e.g. from other operator.

Basically, the network is built up in 5 years, in the last 5 years of the study construction consists in the main of capacity additions in the form of adding new carrier units to sites that are already in use.

Frequency allocation: 2* 5,375 MHz						
No of subscribers	TETRA sites	Carriers	Tetrapol sites	Carriers	APCO sites	Carriers
157 000	2091	2	923	11	569	16
225 000	2091	2,25	923	15	569	21
330 000	2091	2,5	923	19	800	21
Frequency allocation: 2* 3 MHz						
No of subscribers	TETRA sites	Carriers	Tetrapol sites	Carriers	APCO sites	Carriers
157 000	2091	2	923	11	830	12
225 000	2091	2,25	1200	10	1200	12
330 000	2091	2,5	1750	12	1750	12

Table 23. Site data, cellular type network

Network investments

The cumulative investments as well as the relative size of the investment solutions in each network component for cellular type networks based on different technologies are presented in Figure 26. As in nation wide networks also with networks where the coverage is narrower and the subscriber base is low, there are big differences in the total size of the investment for different technology options. And this is originated from significant difference in the needed number of radio sites, as shown in Table 23.

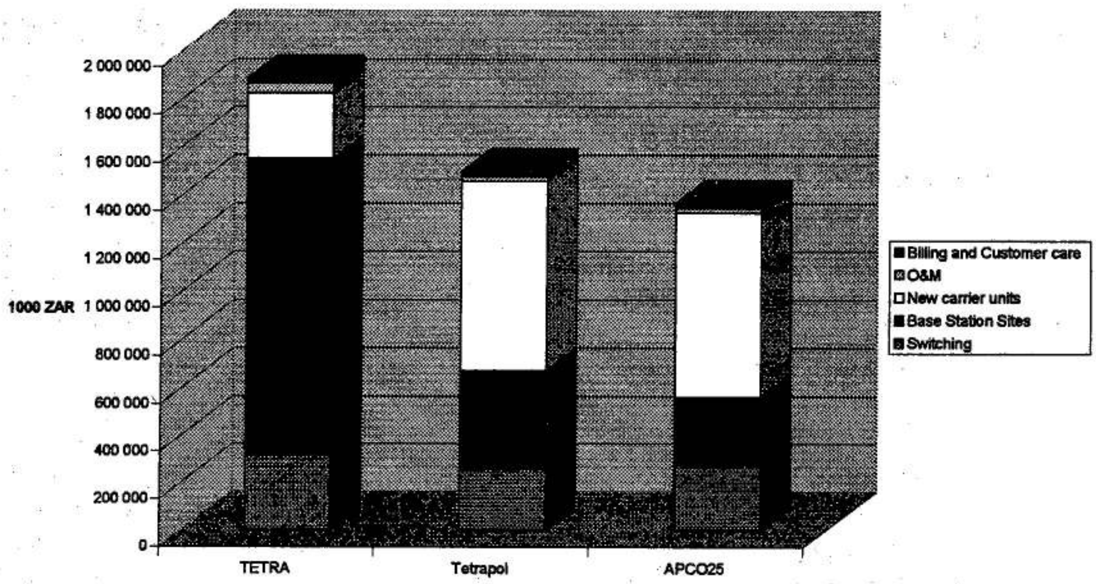


Figure 26. The size and the distribution of the investments, cellular type network

Operational expenses

Figure 27 shows the cumulative operational expenses as well as how the operating expenses are distributed between the different network functions. Here again the reasons for remarkable differences derives from the amount of sites needed.

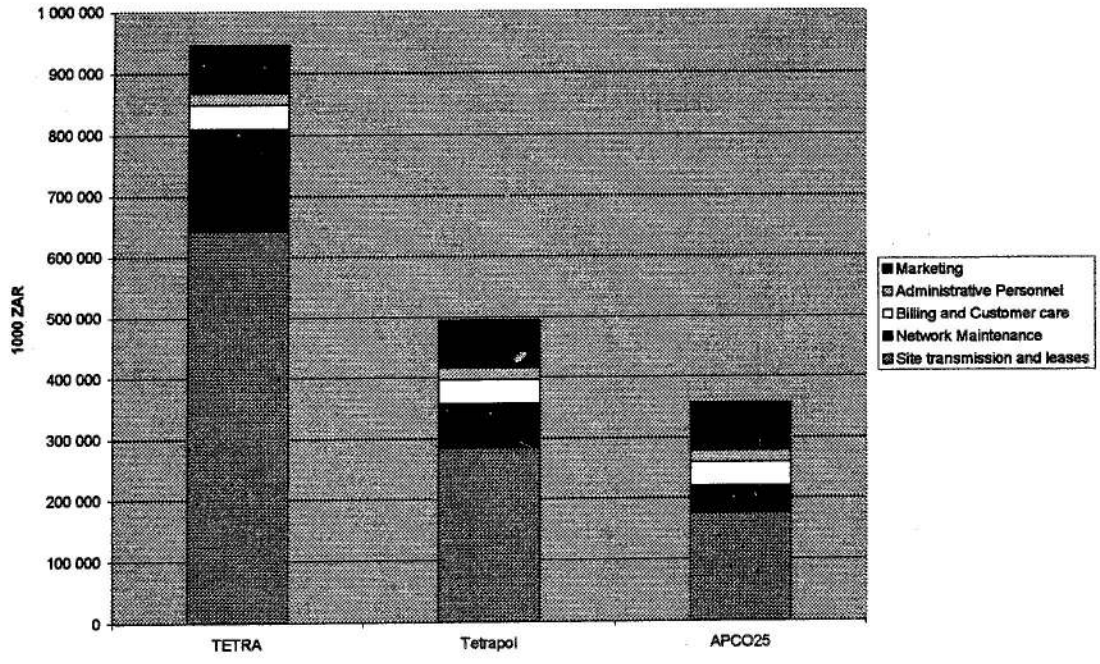


Figure 27. Distribution of operational expenses, cellular type networks

Cash flow, Break even and IRR

Figure 22 shows the Cumulative Cash flow curves for cellular type networks with different technologies. It can be seen now that all the different technology scenarios show out to be somewhat viable. Even with low subscriber base, break even is reached between 5th and 10th year.

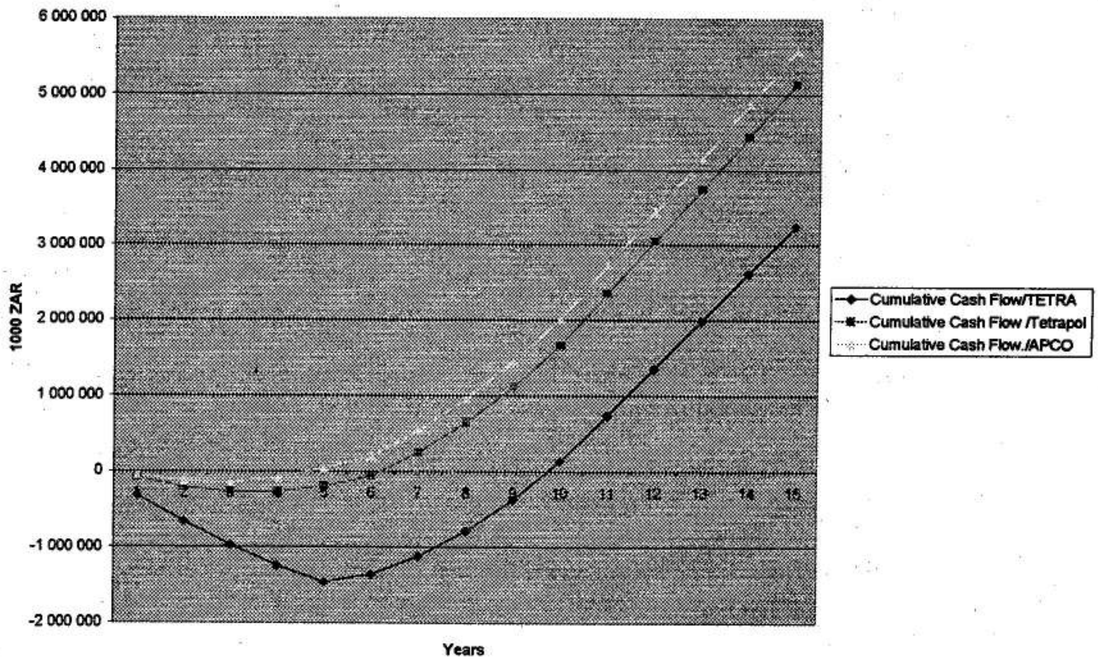


Figure 28. Cumulative Cash Flow, cellular type networks

In Table 24 the result and indicators are collected for the basic scenario 2. Both with Tetrapol and APCO technologies the network with cellular type coverage scenarios are good in business sense. For TETRA the scenario with the base subscriber projection is not very good but is reasonable viable in business sense. Nevertheless, this picture again changes quite remarkably when the market projection and the frequency allocation is altered, as is shown in the following chapters.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	1 884 258 200 ZAR	1 497 065 600 ZAR	1 366 941 800 ZAR
Annual operating expenses, 10th year	119 311 900 ZAR	62 780 700 ZAR	45 647 100 ZAR
Cumulative operating expenses, 10 years	946 585 200 ZAR	494 335 600 ZAR	357 266 800 ZAR
NPV cash flow excl.financ., 15 years	453 371 168 ZAR	1 081 221 716 ZAR	1 244 083 665 ZAR
IRR, 10 years	13 %	46 %	69 %
IRR, 15 years	23 %	51 %	72 %
Year for break even	10	6	5
First year for positive net profit	4	1	1

Table 24. Summary table, cellular type network

Sensitivity analysis

As shown in the sensitivity analysis for the nation wide network, there are a number of uncertainty factors that have a major effect on the results of the business analyses. The influence of two different variables are analysed in the following sensitivity studies:

- Sensitivity Study 1. First the monthly revenue per subscriber is changed to ZAR 300, then also the subscriber base is lowered so that after 10 years there are only 100 000 subscribers in the network. The frequency allocation is kept unaltered (2* 5, 375 MHz)

- Sensitivity Study 2. The political projection is changed to the maximum projection and the frequency allocation is kept unaltered (2* 5, 375 MHz)

- Sensitivity study 3. The frequency allocation is changed from 2* 5, 375 MHz to 2*3MHz and maximum projection is used as a subscriber base.

Results of the Sensitivity analysis

Sensitivity study 1

The results of changing the monthly revenue per subscriber to ZAR 300 is depicted in Figure 29 and the results of lowering also the subscriber base to 100 000 subscribers in Figure 30. As we can see, the operator prospective is extremely sensitive, now none of the options studied has good profitability.

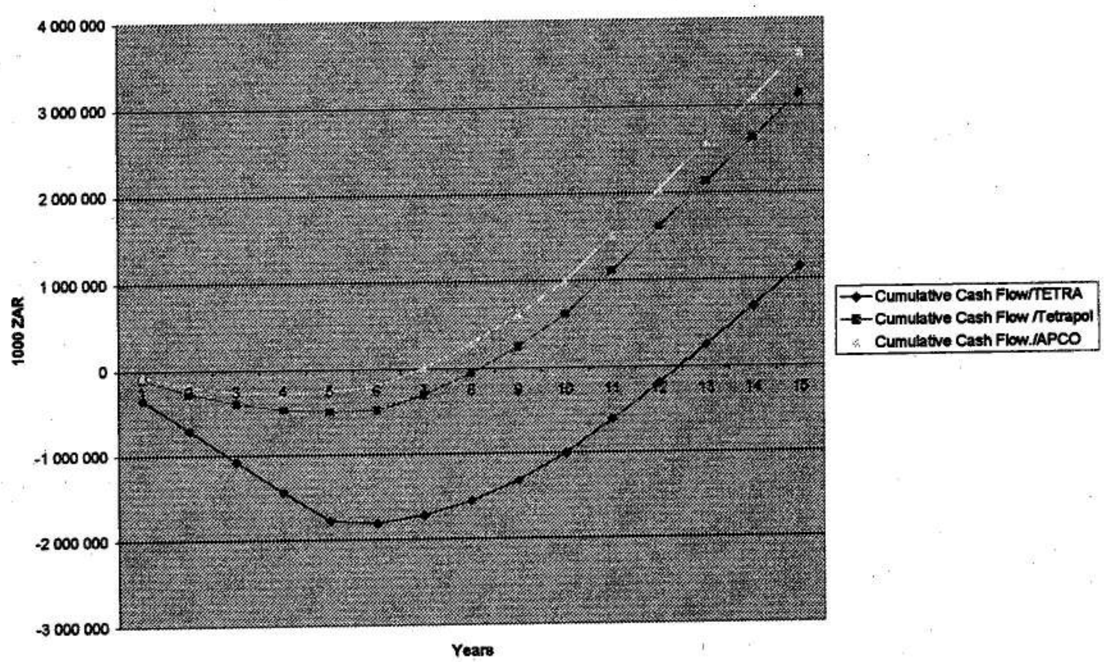


Figure 29. Sensitivity Study 1, monthly revenue ZAR 300

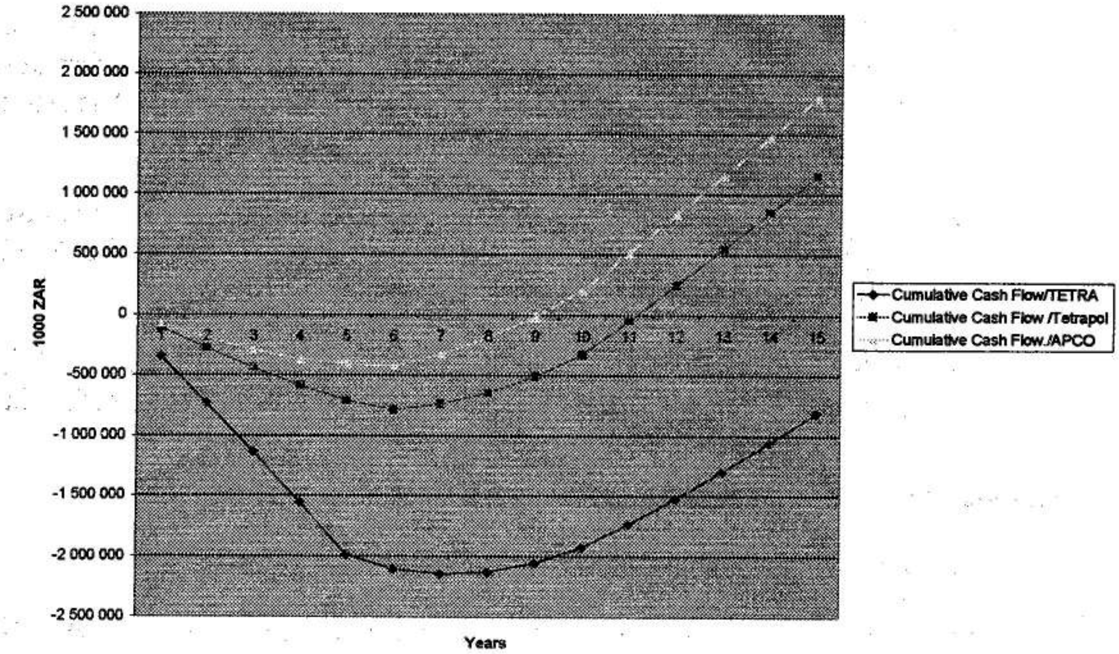


Figure 30. Sensitivity study 1, subscriber base 100 000, revenue ZAR 300

Sensitivity study 2

When the base projection is changed to the maximum projection whilst keeping the frequency allocation unaltered (2* 5, 375 MHz), we can see from Table 25 that the size of the investment in different networks are getting close to each other. The size of the Tetrapol as well as APCO25 network investment is now larger than that of TETRA network. This is because only minor equipment additions due to the larger subscriber base is needed to the TETRA network whereas a large number of carriers are added to Tetrapol and carriers and sites to APCO25 networks.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 117 690 700 ZAR	2 332 723 600 ZAR	2 409 260 000 ZAR
Annual operating expenses, 10th year	136 179 400 ZAR	79 648 200 ZAR	73 695 000 ZAR
Cumulative operating expenses, 10 years	1 076 335 200 ZAR	624 085 600 ZAR	576 460 000 ZAR
NPV cash flow excl.financ., 15 years	2 628 445 581 ZAR	2 980 384 648 ZAR	2 974 160 650 ZAR
IRR, 10 years	52 %	135 %	137 %
IRR, 15 years	55 %	136 %	138 %
Year for break even	5	3	3
First year for positive net profit	1	1	1

Table 25. Sensitivity Study 2, Summary table with 330 000 subscribers

Sensitivity study 3

When the projection is kept as maximum and the frequency allocation is altered from 2* 5, 375 MHz to 2*3MHz, we can see from the Table 26 that the size of the Tetrapol as well as APCO25 network investment is now much larger that of TETRA network. As Figure 31 depicts all the network scenarios are very viable and their profitability is on the same level. This is further explained with that show the investments and operational expenses of the different technology networks.

Summary table	TETRA	Tetrapol	APCO25
Cumulative investment, 10 years	2 117 690 700 ZAR	3 022 600 000 ZAR	3 311 350 000 ZAR
Annual operating expenses, 10th year	136 179 400 ZAR	119 675 000 ZAR	119 675 000 ZAR
Cumulative operating expenses, 10 years	1 076 335 200 ZAR	944 300 000 ZAR	944 300 000 ZAR
NPV cash flow excl.financ., 15 years	2 628 445 581 ZAR	2 407 598 567 ZAR	2 254 875 110 ZAR
IRR, 10 years	52 %	54 %	45 %
IRR, 15 years	55 %	58 %	51 %
Year for break even	5	6	6
First year for positive net profit	1	1	1

Table 26 Sensitivity analysis 3, frequency allocation 2* 3MHz

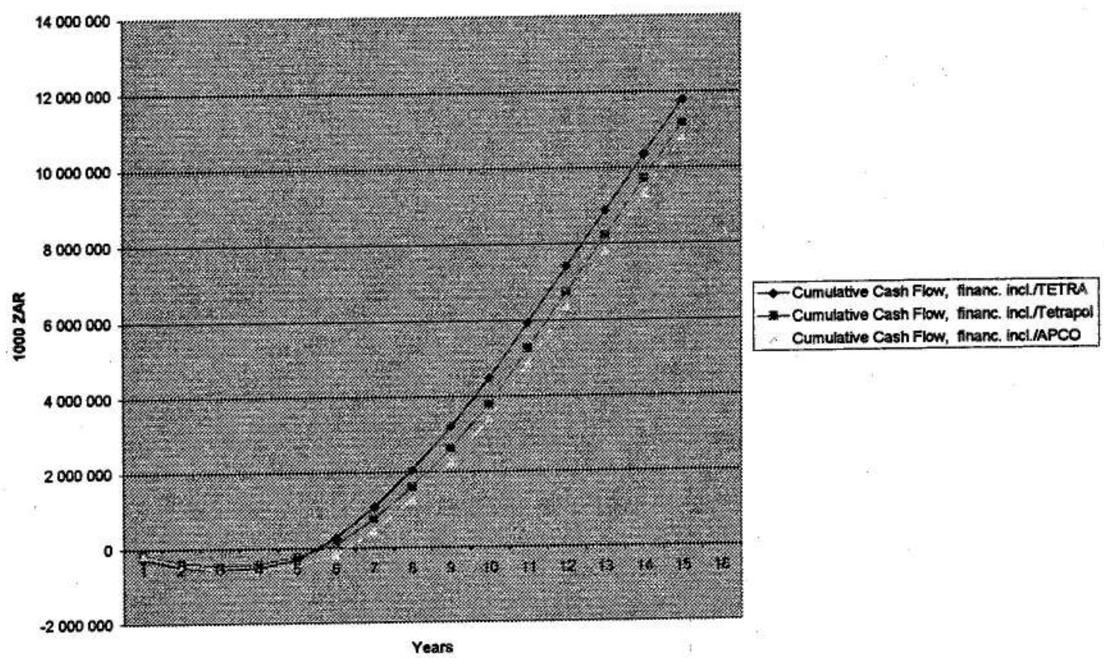


Figure 31. Sensitivity study 2, Cumulative Cash Flow

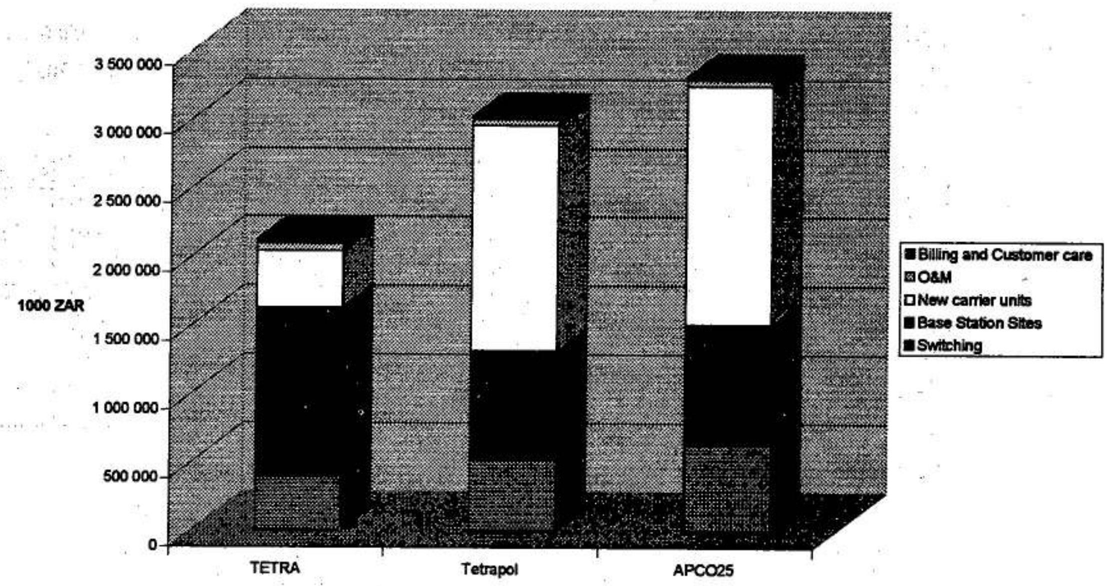


Figure 32. Sensitivity study 2, network investments, in total

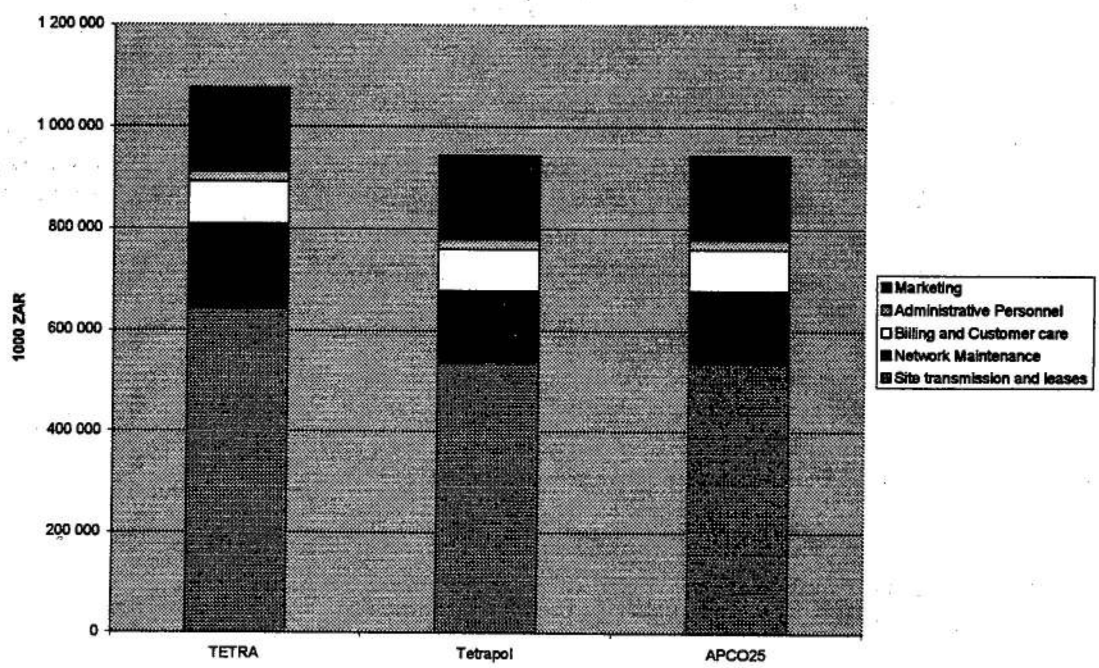


Figure 33. Sensitivity study 2, operational expenses in 15 years

6.4. CONCLUSIONS

With healthy subscriber growth and reasonable monthly revenue per subscriber the both analysed scenarios are viable. Nevertheless it is obvious that there is no room or business possibilities for two Public Safety radio network in South Africa.

Single nation wide network is viable in business sense with technology platforms that enable thin networks on rural areas with low capacity and large coverage provided with reasonable low total number of sites.

Single network with cellular type of coverage has naturally better business prospective with 40% lover investment and operational expenses. Yet it does not provide the effective radio communication services in those areas that they are most urgently needed, i.e. on historically disadvantaged areas.

The width of the given frequency allocation has a major impact to the business possibilities of a radio network operator. The analysis showed that 2*3 MHz is sufficient allocation to all of the technologies if the subscriber base is low. With high subscriber growth the business prospective of Tetrapol and APCO25 systems were much worse with narrow allocation compared to wide allocation (2*5,375). For TETRA systems the allocation had no effect to the business prospective.

Even though the results showed remarkable differences between different technologies in part of the analysis, this may not be the final truth. When analysing the cost comparison results of different technology platforms we should keep in mind that the prices given were indicative. For APCO25 and Tetrapol the price indication came from one source only whereas for TETRA the price indication, coming from 4 sources, is more reliable. Furthermore the source of the performance values for Tetrapol and APCO25 was the respective system vendors thus resulting to wide link budget and low number of sites. Whereas for TETRA the values used were minimum requirement values from the standard and thus not resulting to widest possible link budget but to that one that every TETRA supplier has to fulfil. This obviously influenced the results as was shown in a sensitivity analysis.

7. CONCLUSION AND RECOMMENDATION

7.1. THE MARKET

At present the level of radio communication technology in South Africa, especially in the historically disadvantaged areas, is low. Equipment and systems are generally old and the coverage provided suffers from a number of shortcomings. On the other hand, there are excellent, overlapping radio networks owned and operated by different organisations in some areas.

The market research conducted as part of this study did not give precise figures for the size of the public safety market in South Africa. Based on the information available, the total number of PMR users in the public safety sector is currently estimated to be 195,000. SAPS is the largest individual group, contributing some 44% of this figure.

Growth in the user base was estimated to be 15% over the next ten years, which would result in there being 225,000 PMR users in the Public Safety sector in 2010. South Africa has a large number of privately-organised safety services such as ambulance and security services. Also, the whole utility sector would be a potential user of a trunked radio network providing services suitable for use by the public safety sector. Adding these users to the potential user base of the public safety network would make even the nation-wide Public Safety network scenario viable.

The market study showed that Public Safety user organisations were ready to pay only very low annual amounts (< ZAR 1000) for radio communication provided by a third party. Only very few (< 5%) organisations were ready to pay the annual amounts that are actually needed (ZAR 4000 – 5000) to make the provision of such services attractive to potential operators. This is most probably due to the low operational expenses associated with existing networks. It should be noted that many organisations had major difficulties in calculating the level of operational expenses in existing networks and there is a widespread tendency to not take all the costs into account.

7.2. PMR TECHNOLOGIES

TETRA, Tetrapol and APCO25 are the most widely-known digital trunking radio technologies based on an open standard. The definition of an open standard is however slightly questionable. TETRA standard has been created by ETSI in an open forum with a large number of system and terminal vendors as well as operators and public safety representatives participating in the work. ETSI standard guarantees fair and reasonable IPR terms for all vendors designing and manufacturing TETRA equipment. Tetrapol is actually a specification mainly created by Matra Nortel Communications. The Tetrapol Forum has been set up afterwards to maintain specifications, to promote Tetrapol technology and to find multi-sourcing for Tetrapol equipment. APCO25 is a standard mainly created based on Motorola proprietary solution, thus also the APCO25 standard lacks the influence of other PMR vendors. TETRA can therefore be considered more open for competition than Tetrapol and APCO25.

GSM-based, proprietary and analogue solutions are also available for trunking radio. Proprietary systems, i.e. those not based on an open standard mean that users are dependent on a single supplier, which might become expensive and/or prove to be unreliable in the future.

If the cost of large new analogue and digital systems is compared, analogue technology is, at the moment, cheaper for systems that require large coverage but low capacity. When high capacity is required, digital technology is more cost-effective. A similar principle also applies when comparing TDMA-based (TETRA) and FDMA-based (Tetrapol and APCO25) access technologies: networks requiring a wide coverage area are viable in a commercial sense with technology platforms that enable low capacity networks in rural areas and wide coverage implemented by using only a low number of sites.

The commercial TETRA, Tetrapol and APCO25 products currently available all operate in the public safety band below 400 MHz (380-400 MHz) or in the civil bands above 400 MHz (410-430 MHz). The SABRE band plan poses no major problems for use of any of the technologies, but while products for the frequency band 407,625 – 410/417.625 – 420 MHz are not off-the-shelf products, those operating in the frequency band 410 – 413/ 420 –423 MHz are.

Network terminals represent a significant portion of the total investment. Terminals were not evaluated in detail in this study but no large differences in price or features were found at the moment. Nevertheless, only large vendor pool for the terminal equipment and truly open standard will guarantee terminal price competition and thus low prices for the users.

It can be concluded that all the above-mentioned technologies are well suited to the South African situation from the overall technology point of view and that the technology choice should be based on more detailed user/operational requirements and commercial considerations.

Question: SATRA has generally been technology-neutral, preferring instead functionality of the purpose of the service, its affordability, wide reach to the public, and a recognition that the one who has to come up with the investment can be expected to use their funds wisely, and that it is the role of SATRA to ensure the terms and conditions of the license ensure meeting the public need. Do you agree? If not, why?

7.3. FEASIBILITY OF A THIRD-PARTY PUBLIC SAFETY AND MUNICIPAL TRUNKING RADIO NETWORK

There is no commercial possibility of establishing two Public Safety radio networks in South Africa. With a healthy growth in subscribers and a reasonable monthly revenue per subscriber, a single, nation-wide third-party public safety and municipal trunking radio network is a feasible proposition.

Question: Do you agree with the conclusion of our consultants? If not, why not?

A single nation-wide network is viable in the commercial sense with technology platforms that enable thin, low capacity networks in rural and suburban areas and large coverage provided using a reasonably low total number of sites. With subscriber growth that reaches 157,000 in ten years and with monthly revenue of ZAR 400 per subscriber, an operator that has built a nation-wide network with reasonable low number sites has good business prospects.

A single network with cellular-type coverage naturally has better commercial prospects as the investment and operational expenses required are 40% lower. Such a network would not however provide effective radio communication services in the areas where such services are most urgently needed, i.e. in the historically disadvantaged areas.

The width of the given frequency allocation has a major impact on the commercial possibilities open to the operator of a radio network. The analysis showed that 2*3 MHz is an adequate allocation for all the three technologies if the subscriber base is low. With high subscriber growth the commercial prospects of Tetrapol and APCO25 systems were much worse with a narrow frequency allocation than with a wide frequency allocation (2*5,375). In the case of TETRA systems, the frequency allocation had no effect on the commercial prospects.

7.4. RECOMMENDATIONS

The decision on how to proceed with the Public Safety trunking radio network in South Africa should be made without delay. If this does not happen, Public Safety organisations will continue to purchase networks for their own exclusive use and thus make any later decision to migrate to a joint network rather more difficult.

In general, there are two major options for the provision of nation-wide Public Safety trunking radio services:

1) **The privately-funded option**

2) **The state-funded option**

As a result of this feasibility study, Omnitele recommends that the privately-funded option be pursued. If this option does not turn out to be commercially viable after the licence tendering process has been carried out, we recommend that the state-funded option be adopted. In the latter case, only public sector users should be allowed to join the network. Any mixture of privately-funded and state-funded networks may lead to subsidy problems, especially if privately owned companies are allowed to purchase services.

Privately-funded option

The licensing procedure for a single, nation-wide Public Safety network should be started immediately. A Technical Board, consisting of representatives of all major user groups, should be established as soon as possible. The board should have a strong leader independent of the user groups as well as government level support on its decisions. The task of the board is to create a technical/functional specification for the network, including but not limited to:

- detailed coverage requirements,
- coverage roll-out requirements,
- service roll-out and QoS requirements,
- redundancy requirements,
- interconnection requirements, and
- security requirements

Additionally the requirements of the United NationsTampere convention of 1998 (ICET-98) should be included into the requirement specification for the service.

The selection of the technology platform/standard should be left open to the operator candidates. A solution consisting of several technologies (for example digital trunking in populated areas and conventional two-way radio with good interworking functions in rural areas) should be allowed. It should be required that the licence proposal documentation gives a detailed description of the technology solution upon which the network will be based. In order to secure the QoS and security requirements of the Public Safety sector, it should be a requirement that the method employed to meet all the technical/functional requirements is guaranteed. The process should have government level support in order to ensure that all user groups will migrate into the new network if the technical/functional as well as economical requirements are met by the selected operator candidate. This government level support can best be accomplished by setting up a Management Board that will comprise persons from the stakeholder ministries that has power to assure the migration if requirements are fulfilled. The task of the Management Board would be to accept the technical/functional requirements specified by the Technical Board and to set the framework for the Public Safety Network initiative.

The operator should be allowed to use their own transmission backbone network and should also be allowed to market services to all potential PMR/PAMR user groups.

Question: If privately funded, should all or some organisations be permitted to use the network? For example, public utilities such as electricity for their dispatch communications needs? If not, why not?

State-funded option

If the privately-funded operation does not result in reaching the required goal, we recommend proceeding with the state-funded option. Europe has a number of Public Safety network projects that are all organised differently. Omnitele is willing to discuss the organisational aspects of these projects and also how these models would suit South Africa.

Question: If state-funded, who should run the network, the state or the private sector under a management agreement? State reasons for your answer.

Question: If state-funded, who should own the network, the municipalities and local governments or the central government? State reasons for your answer.

Appendix 1

LIST OF ORGANISATIONS THAT CONTRIBUTED TO THE USER SURVEY

NST Town Council
Town Council of Orkney
Eastvaal District Council
Blaauwberg Municipality
Oostenberg Municipality
Wolmaransstad Municipality
Ceres Municipality
Heidelberg Town Council
Porterville Municipality
Komatipoort Municipality
Alberton Town Council
SAPS
Overberg District Council
Eskom
Western Cape Provincial Administration
Borough of Dolphin Coast
Ladybrand Municipality
City of Tygerberg
Piet Retief Local Council
Hermanus Municipality
Municipality of Caledon
Stellenbosch Municipality
Richmond Municipality
SAMRUG
City of East London
Upington Municipality
Bethlehem TLC
Municipality of Wolseley
Greater Louis Trichardt TLC
District Council Beaufort West
Borough of Richards Bay
Municipality Danielskuil
TLC Potgietersrus
Villiersdorp Municipality
Vryburg Municipality
Graaff-Reinet TLC
Wellington Municipality

Appendix 2

LIST OF INTERVIEWED ORGANISATIONS

CSIR
SAPS (in Pretoria and Cape Town)
SANDF
Ceres Municipality
Fleetcall
Vodacom
NIA
ESKOM
MTN
TELKOM
SAMRUG
CAPE METRO

Appendix 3

1. Type of organisation:

1.1. What is the user segment of your organisation?

☐ Police ☐ Fire brigade ☐ Ambulance / rescue service

☐ Electricity / water supplier ☐ Transport / communications ☐ Other, please specify below

____

____

1.2. What means of radio communication are used in your organisation presently ?

A. ☐ Your privately owned and operated radio network (PMR) where no other users are allowed

B. ☐ PMR radio network owned and operated by some other organisation

C. ☐ Your privately owned and operated PMR radio network where also other users outside your organisation are allowed

D. ☐ Fleetcall, Q-Trunk, One-to-one or other public radio trunking networks

E. ☐ Only cellular mobile phones; **if yes please move on to section 3**

____

____

Appendix 3

2. Use of the PMR network

Present situation:

2.1. Number of PMR users in your organisation:______________(exact figure)

☐ 1 – 40 ☐ 41 – 100 ☐ 101 – 200 ☐ > 200

2.2. Number of PMR base stations used by your organisation:______________(exact figure)

☐ 0 ☐ 1 – 2 ☐ 3 – 8 ☐ > 8

2.3. Frequency range of the network:

☐ 80 MHz ☐ 160 MHz ☐ 400 MHz ☐ 900 MHz

2.4. How old are your PMR user terminals in average?____________________________

☐ 0 – 5 years ☐ 6 – 10 years ☐ 11 - 15 years ☐ > 15 years

2.5. How old is the network (base stations)?________________________

☐ 0 – 5 years ☐ 6 – 10 years ☐ 11 - 15 years ☐ > 15 years

2.6. Technology used (description of possible standard and vendor of the network):

____

____

2.7. What is the total amount of traffic (voice and data combined) per user per working day ?

☐ < 5 min ☐ 5 – 15 min ☐ 16 – 30 min ☐ 31 – 45 min
☐ 46 – 60 min ☐ > 60 min

2.8. What percentage of the total network capacity is in use during the busiest hour of a day?

☐ 100% ☐ 80% ☐ 60 % ☐ < 50 %

2.9. When is the busiest hour of radio use in your organisation ?

Appendix 3

☐ 7.00 – 9.00 ☐ 9.00 - 12. 00 ☐ 12.00 - 15.00 ☐ 15.0 - 17.00
☐ There is no busiest hour

2.10. Type of voice traffic in your network ?

☐ Mostly open channel group traffic where everybody hears each other

☐ Mostly individual calls

☐ 50 % group traffic, 50 % individual calls

☐ Other, please specify below

____

____

2.11. How high is the percentage of data traffic and what is data used for ?

☐ 0 % ☐ 0,1 – 10 % ☐ 11 – 30 % ☐ 31 - 50 %
☐ 51 – 70 % ☐ 71 – 99 % ☐ 100 %

____

____

2.12. What is the coverage area of the network ? Please sketch the approximate coverage of your network on a map.

☐ Surroundings of the company

☐ Local area (town, municipality); please specify below which one

☐ Province; please specify below which one

☐ Larger part of the country; please specify below

____

____

____

2.13. What is your total investment per user for both the network and the user terminals ?

☐ < 5000 R ☐ 5001 – 6000 R ☐ 6001 – 7000 R ☐ 7001 – 8000 R

Appendix 3

☐ 8001 – 9000 R ☐ 9001 - 10 000 R ☐ > 10 000 R

____

____

2.14. What are your combined annual operational costs per user, including manpower, transmission, site rent and maintenance etc ?

☐ < 100 R/year ☐ 100 – 300 R/year ☐ 300 – 500 R/year ☐ 500 – 700 R/year
☐ 700 – 1000 R/year ☐ 1000 – 2 000 R/year ☐ > 2 000 R/year

____

____

2.15. What are the most important problems encountered in the present network ?

☐ Coverage is insufficient (indoor/outdoor)

☐ Capacity is insufficient during the busiest hour

☐ Network services are insufficient to the needs of your organisation

☐ Other, please specify below

____

____

2.16. Estimation on how many years you are going to use the present network?

☐ 0 - 1 years ☐ 1 - 3 years ☐ 3 - 7 years ☐ > 7 years

Appendix 3

Future:

2.17. Estimation of the number of PMR user terminals in your organisation after 10 years ?

☐ Has increased 10% ☐ Has increased 20% ☐ Has increased 25 – 50% ☐ Has increased >50%

☐ Has decreased 10% ☐ Has decreased 20% ☐ Has decreased 25 – 50% ☐ Has decreased >50%

☐ No major changes

2.18. Estimation of the number of PMR users in your organisation after 10 years ?

☐ Has increased 10% ☐ Has increased 20% ☐ Has increased 25 – 50% ☐ Has increased >50%

☐ Has decreased 10% ☐ Has decreased 20% ☐ Has decreased 25 – 50% ☐ Has decreased >50%

☐ No major changes

2.19. Estimation of the total amount of traffic after 5 years ?:

☐ Has increased 10% ☐ Has increased 20% ☐ Has increased 25 – 50% ☐ Has increased >50%

☐ Has decreased 10% ☐ Has decreased 20% ☐ Has decreased 25 – 50% ☐ Has decreased >50%

☐ No major changes

Appendix 3

2.20. Estimation of the total amount of traffic after 10 years ?:

☐ Has increased 10%
☐ Has increased 20%
☐ Has increased 25 – 50%
☐ Has increased >50%
☐ Has decreased 10%
☐ Has decreased 20%
☐ Has decreased 25 – 50%
☐ Has decreased >50%
☐ No major changes

2.21. Estimation of the percentage of data traffic of your total traffic in 5 years ?

☐ 0 %
☐ 0,1 – 10 %
☐ 11 – 30 %
☐ 31 - 50 %
☐ 51 – 70 %
☐ 71 – 99 %
☐ 100 %

2.22. Estimation of the percentage of data traffic of your total traffic in 10 years ?

☐ 0 %
☐ 0,1 – 10 %
☐ 11 – 30 %
☐ 31 - 50 %
☐ 51 – 70 %
☐ 71 – 99 %
☐ 100 %

Appendix 3

3. Use of cellular mobile phones

3.1. Number of cellular mobile phones in your organisation

☐ 1 – 10 ☐ 11 – 50 ☐ 51 – 200
☐ 201 – 1000 ☐ 1001 – 5000 ☐ > 5000

3.2. Check the options that describe your organisation:

☐ Cellular mobile phones will replace a part of PMR terminals in your organisation

☐ Cellular mobile phones will be replaced by PMR terminals in your organisation

☐ Cellular mobile phones have replaced PMR terminals in your organisation

____

____

____

____

4. Future radio trunking network

4.1. How would your organisation react if there was one or several operator driven radio trunking networks dedicated for Public Safety available in your area ?

☐ You might use the new network when the present system becomes outdated
☐ You might use the new network as soon as the service is available
☐ You might use the new network if it provides the coverage and services you require
☐ You might use the new network if the associated costs are not too high
☐ You would probably not use the new network; please describe below why

☐ You would certainly not use the new network; please describe below why

____

____

____

____

Appendix 3

4.2. What would be the minimum requirements for using the new network ?

A) Coverage

- ☐ Local (town, municipality); describe below which one(s)
- ☐ Regional (province); describe below which one(s)
- ☐ Larger part of the country; describe below
- ☐ All populated areas and main roads
- ☐ Whole country including rural areas

____

____

____

*B) The total annual cost per subscriber may not be higher than:*____________

☐ 500 R	☐ 1000 R	☐ 2000 R	☐ 4000 R
☐ 5000 R	☐ 6000 R	☐ 7000 R	☐ 8000 R

*C) The price of a user terminal may not be higher than:*____________

☐ 1000 R	☐ 2000 R	☐ 3000 R	☐ 4000 R
☐ 5000 R	☐ 6000 R	☐ 7000 R	☐ 8000 R

*D) The price of an advanced user terminals with data capabilities may not be higher than:*____________

☐ 2000 R	☐ 4000 R	☐ 6000 R	☐ 8000 R
☐ 10 000 R	☐ 12 000 R	☐ 14 000 R	☐ 16 000 R

*E) How many users from your organisation would use the new network:*____________***(exact figure)***

☐ 1 – 40	☐ 41 – 100	☐ 101 – 200	☐ > 200

F) When would the majority of the users in your organisation start using the new network:

☐ year 2001	☐ 2002 – 2004	☐ 2005 – 2009	☐ after 2010

____

____

____

Appendix 3

4.3. How important would the following services be in the new network ?

1) Encryption of voice and data

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

2) Group calls

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

3) Broadcast –type services of voice and data to all members of specified group(s)

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

4) Advanced data services (high speed)

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

5) Priorities to provide 100% availability for important use

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

6) Advanced fleet management services (dynamic group establishment etc)

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

7) Fast call establishment (< 1 s)

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

8) High voice quality

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

9) Roaming in neighbouring countries

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

10) Direct communication between user terminals without network access

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

11) Subscriber identity module (SIM)

☐ Very important ☐ Important ☐ Not very important ☐ Not at all important

4.4. Describe new services that would be important in the new network:

____

____

____

Appendix 3

4.5. How much money has been annually allocated during the past five years in your organisation for radio communications and how do you foresee the changes during the next five years ?

____

____

Any other comments on the topic of a new Public Safety radio trunking network ?

____

____

____

____

____

____

____

Information of organisation:

Name and address of the organisation: ________________________________

____

____

Contact person: ________________________________

Telephone: ________________ Fax: ________________

Appendix 4

Public Safety Radio Trunking Network

1 Supported standards and systems

Please specify the standards/systems your company is supporting. In case your company supports several different standards/systems, there should be a separate answer to all the questions in this RFI. Please keep in mind that digital technology in the frequency range of 407-423 MHz, as allocated by SATRA in the SABRE band replan, is required.

Please specify the other manufacturers supporting the standard/system you specified.

Please list the references you have for each standard/system you specified.

2 Budgetary price for the South African Public Safety network

Two scenarios for the South African Public Safety network should be evaluated:

1) Nationwide coverage with 230 000 subscribers
2) Coverage according to the attached map (APPENDIX 4) with 180 000 subscribers

The following planning requirements are to be used in both scenarios:

- The plan is for budgetary purposes only; detailed radio planning is not required
- Frequency range 407 - 423 MHz
- The number of subscribers is distributed throughout the area according to the population density
- Busy hour traffic per subscriber: 20 mErl including both voice and data
- Base station configuration: Single BTS per site, 10dBi omnidirectional antenna pattern, average antenna height 50m above ground level
- Urban/suburban areas: 90% indoor coverage probability for a hand-portable mobile unit
- Rural areas: 95% outdoor coverage probability for a vehicle mounted unit

Appendix 4

Please fill out the attached budgetary price and service information forms (APPENDIXES 1-3) separately for each standard/system you specified in 1. All prices must be given in South African Rand (ZAR) VAT 0%.

In addition to the price of the network in both scenarios, please provide the following information:

- Radio link budget (uplink and downlink) used in the dimensioning of the network

Appendix 4

Base stations	Total price of base stations in the nationwide network for 230 000 subscribers	Total price of base stations in the specified network for 180 000 subscribers	Number of base stations in the nationwide network for 230 000 subscribers	Number of base stations in the specified network for 180 000 subscribers	Unit price of a base station in the nationwide network for 230 000 subscribers	Unit price of a base station in the specified network for 180 000 subscribers
Single carrier/cell						
Single carrier with receiver diversity						
2 carriers/cell						
2 carriers/cell with receiver diversity						
3 carriers/cell						
3 carriers/cell with receiver diversity						
n carriers/cell (please specify n)						
n carriers/cell with receiver diversity						

Please note that one carrier = four TDMA channels - FDMA to be adjusted accordingly

Other investments	Total price in the nationwide network for 230 000 subscribers	Total price in the specified network for 180 000 subscribers
Switching (sw+infra+implementation expenses)*		
Network management (sw+infra+implementation expenses)*		
Billing (sw+infra+implementation expenses)*		
Transmission (sw+infra+implementation expenses)*		

* Busy hour traffic 20mErl/subscriber, containing the services listed in the service implementation sheet (APPENDIX 2)

Total price of network infrastructure	Nationwide network for 230 000 subscribers	Specified network for 180 000 subscribers

Appendix 5

Table 1: Radio link budget for TETRA representing the minimum performance values (Source: TETRA designers guide ETR300-1 and Omnitele experience)

	Base station to vehicle mounted	Vehicle mounted to base station	Base station to handheld	Handheld to base station
TX power (dBm)	44	40	44	30
Tx cable & combiner loss (dB)	6	2	6	0
Tx antenna gain (dB)	10	2	10	-2,5
Peak EIRP (dBm)	48	40	48	27,5
Rx antenna gain (dB)	2	10	-9	10
Rx cable loss (dB)	2	2	0	2
Diversity gain (dB)	0	3	0	3
Rx sensitivity (dBm)	-103	-106	-103	-106
Maximum path loss (dB)	151	157	142	144,5

Table 2: Radio link budget for TETRA representing industry values (Source: Vendor information and Omnitele experience)

	Base station to vehicle mounted	Vehicle mounted to base station	Base station to handheld	Handheld to base station
TX power (dBm)	48	40	48	30
Tx cable & combiner loss (dB)	6	2	6	0
Tx antenna gain (dB)	10	2	10	-2,5
Peak EIRP (dBm)	52	40	52	27,5
Rx antenna gain (dB)	2	10	-9	10
Rx cable loss (dB)	2	2	0	2
Diversity gain (dB)	0	3	0	3
Rx sensitivity (dBm)	-103	-109	-103	-109
Maximum path loss (dB)	155	160	146	147,5

Appendix 5

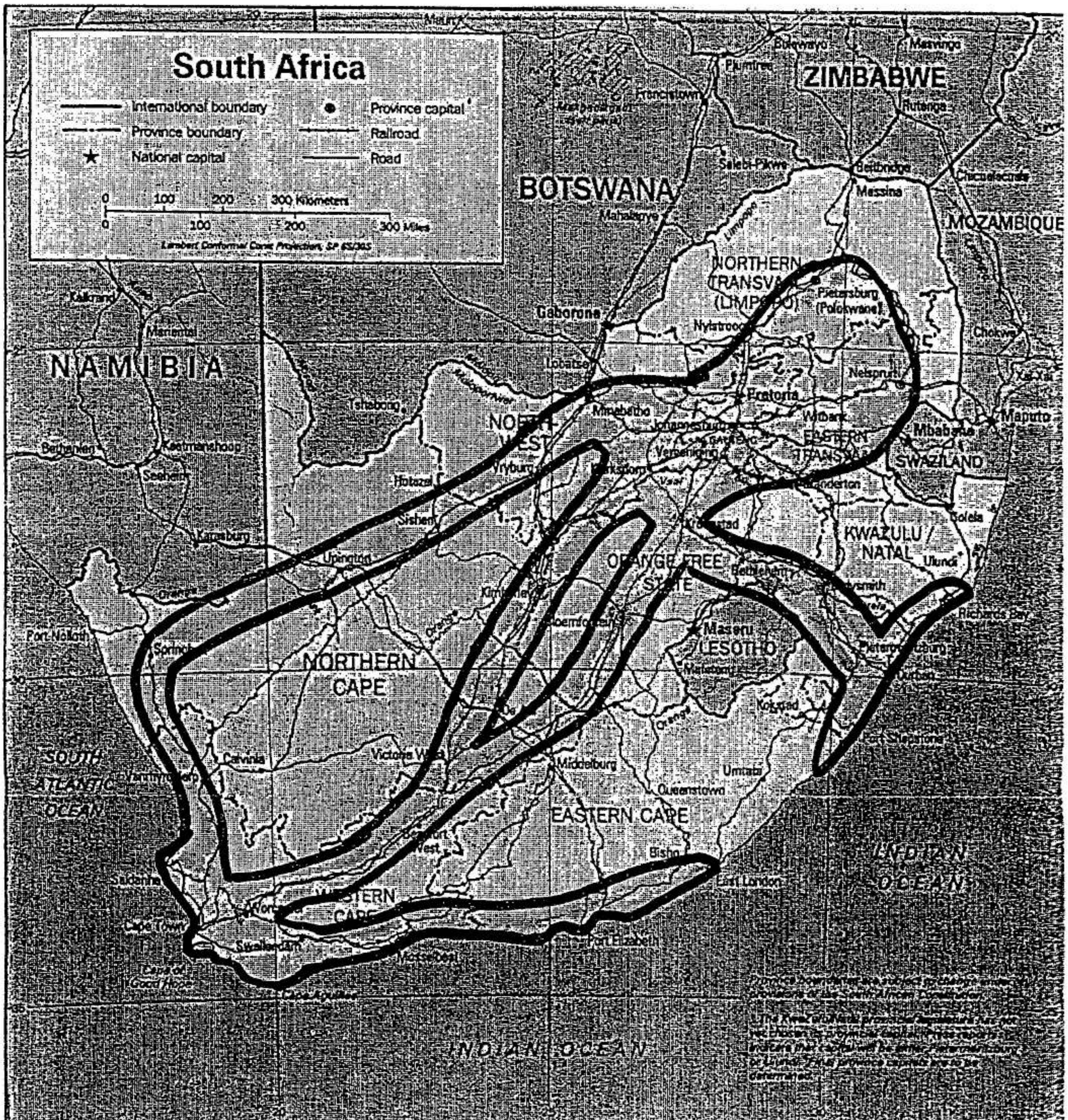
Table 3: Radio link budget for TETRAPOL (Source: Siemens and Omnitele experience)

	Base station to vehicle mounted	Vehicle mounted to base station	Base station to handheld	Handheld to base station
TX power (dBm)	43	40	43	33
Tx cable & combiner loss (dB)	7	2	7	0
Tx antenna gain (dB)	10	2	10	-2,5
Peak EIRP (dBm)	46	40	46	30,5
Rx antenna gain (dB)	2	10	-9	10
Rx cable loss (dB)	2	2	0	2
Diversity gain (dB)	0	3	0	3
Rx sensitivity (dBm)	-111	-113	-111	-113
Maximum path loss (dB)	157	164	148	154,5

Table 4: Radio link budget for APCO25 (Source: Motorola)

	Base station to vehicle mounted	Vehicle mounted to base station	Base station to handheld	Handheld to base station
TX power (dBm)	50,4	44	50,4	36
Tx cable & combiner loss (dB)	9,5	1	9,5	0
Tx antenna gain (dB)	10	4	10	-2,5
Peak EIRP (dBm)	50,9	47	50,9	33,5
Rx antenna gain (dB)	4	10	-9	10
Rx cable loss (dB)	1	2	0	2
Diversity gain (dB)	0	0	0	0
Rx sensitivity (dBm)	-112,3	-109,8	-111,4	-109,8
Maximum path loss (dB)	167,2	164,8	153,3	151,3

Appendix 6



Base 802358 (R01345) 6-9

Appendix 7

Base Station to old sites			**ZAR**
Basic Infra	**number**	**unit price**	**sum**
Land		30 000	0
Road		25 000	0
Cabin		20 000	0
Power	1	10 000	10 000
Elect. cabelling		200 000	0
Air conditioning		5 000	0
Sum			***10 000***
Towers	**number**	**unit price**	**sum**
50m (containing set up)		100 000	***0***
Antennas	**number**	**unit price**	**sum**
Omni	0	3 000	0
Panel	6	2 000	12 000
Antennas, sum	***6***		***12 000***
Cables and connectors	**number**	**unit price**	**sum**
Length of the cable	70		
Cables	420	30	12 600
Connectors	24	150	3 600
Cables and connectors, sum			***16 200***
System-specific equipment			
BTS	**number**	**unit price**	**sum**
BTS, 1 trx	0	320 000	0
BTS, 1 trx, omni, devided in to three sectors(diver	1	340 000	340 000
BTS 1+1+1			0
BTS, sum	***1***		***340 000***
Base Station extras	**number**	**unit price**	**sum**
Tower amplifier	0		0
Transmission boosters	0		0
Extras, sum	***0***		***0***
Others			
System spesific transmission equipment to BTS	1	20 000	***20 000***
Links	0	120 000	***0***
Investiment/Base Station			***398 200***
Planning, Acquisition, Building and Commissioning			
Planning	1	15 000	***15 000***
Site acquisition	1	10 000	***10 000***
Installation and commissioning	1	15 000	***15 000***
Works/Base station			***40 000***
Total investiment/Base Station, ZAR			***438 200***

CONTENTS

Printed by and obtainable from the Government Printer, Bosman Street, Private Bag X85, Pretoria, 0001
Tel: (012) 334-4507, 334-4511, 334-4509, 334-4515
Gedruk deur en verkrygbaar by die Staatsdrukker, Bosmanstraat, Privaat Sak X85, Pretoria, 0001
Tel: (012) 334-4507, 334-4511, 334-4509, 334-4515

20471—1