



**UNIVERSIDAD TÉCNICA DEL NORTE**

**FACULTAD DE INGENIERÍA EN CIENCIAS APLICADAS  
CARRERA DE INGENIERÍA ELECTRÓNICA Y REDES DE  
COMUNICACIÓN**

# **Technical Brief**

**Project Name: DESIGN OF THE NETWORK OF RADIO COMMUNICATIONS TO TRUNKED CONNECTION OF THE INTEGRATED SECURITY SYSTEM CITIZEN OF ECUADOR NATIONAL GOVERNMENT IN IMBABURA PROVINCE.**

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## **1. Introduction**

The report describes the process that was realized for the development of research design called Network Interconnection Trunked Radio for the Integrated System of Public Safety of Ecuador Government, in Imbabura province , here you can show the steps more relevant to the execution of the same.

## **2. Abstract**

The present document indicates the processes followed in the preparation of the thesis project, which consists of five chapters are indicated. Each describes the techniques used in the course of the design developed trunked network, to which was realized a study of the current state of the network took place in Imbabura province, the current regulations of trucking systems studied in Ecuador, also made

an analysis of current and future areas of the trunked network coverage, to this determine the geographical elevations higher elevations where located the repeaters to the proposed design.

The project born from the need to interconnect to Imbabura province to Trunked Network of Ecuador Integrated System of Public Safety of the Government , mainly meddling to the National Police is handling this trunk system also will solve the drawbacks that currently has this trunked network.

To start the execution of the study of the characteristics, architecture and operation of the existing network of communications for the National Police did this together with the analysis of the geographical location where you want to provide coverage, as this was presented current techniques and

geographic features inside the province to the location of the remote repeaters, network designed based on these parameters was subjected to simulation tests by Radio Mobile software, here are able to determine their feasibility and proposed range.

The execution of cost-benefit analysis gives accurate idea of what is the economic value for the installation and operation of the Trunked Network, furthermore with this analysis will arrive to determine how beneficial it is for society the raised project.

In this manner you get to design the network with four new remote sites trunked network in the province of Imbabura, located in strategic places of the province, in the northeast the repeater Habra, in northeast Cabras repeater on southwestern Tabacoloma repeater and in the southeast the repeater Cerro Blanco,

these new repeaters provide coverage to rural areas where police members perform their job without the necessary tools. These sites are interconnected by a microwave system occupying the frequency of 5 GHz for the trunked repeater equipment manufacturer Motorola for standardization nationwide network that uses frequencies of 800 MHz is used to your diffusion.

Its include a diagram of detailed engineering, where the links for the transmission of information will be illustrated, the same way the equipment used, the simulation results of network coverage, use of AC and DC power is detailed together with is included climate control with which the telecommunications room count in each repeater.

Next, describe the following chapters of research and development to the proposed project.

### **3. Body work**

#### **3.1. Chapter I: Analysis of the present architecture of the network and fundamentals of trunked Radio.**

In this chapter realize and analyze of the present architecture of network and basic concepts of trunked radio, a study of the characteristics, architecture and operation of the existing network of communications for the National Police were performed and a study of technology and existing trunked radio regulatory matters in the country on trunked systems to operation.

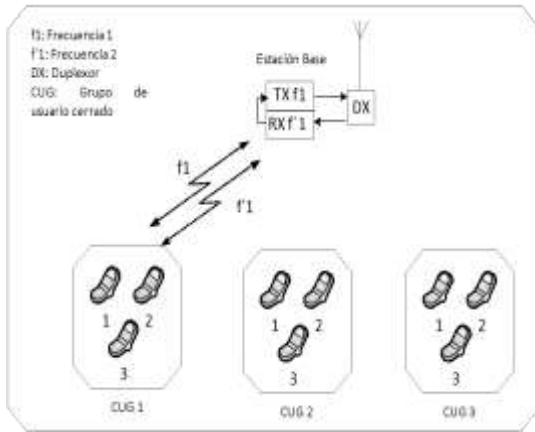
##### **3.1.1. Present architecture of network**

National Police in Ecuador currently has a radio communication system based on the SmartZone technology, for version 4.1, developed by

the manufacturer Motorola, whose operating range is 800 MHz. This system has the characteristic of support traffic services analog and digital voice, has several remote sites nationwide repetition, these sites are configured to work in wide area type and linked via microwave links with the Master Controller located on the national Communications .

##### **3.1.2. System of tracking radio**

In these systems, the traffic generated by a group of mobile users are offered a set of multiple channels, this allows the assignment of frequencies to users not rigid but dynamic. A channel is only allocated when there is demand, allowing minimize idle time, because each user occupies the channel only talk time when this concludes the channel automatically is released, returning to the reserve in order to be assigned to another user, as show in the following figure:



**Figure 1.** Trunk system for user group.

### 3.2. Chapter II: Analysis of the geographical location and design requirements.

It was investigated the places where we want to provide coverage, as this current techniques and geographic characteristics presented within the province for the location of the relay.

#### 3.2.1. Analysis of geographical location

It was developed an analysis of the geographical locations where the National Police currently has drawbacks or no network coverage trunked radio, for this test signal

intensity was run at frequencies that police work currently using the spectrum analyzer was developed Aeroflex 3920 OPT 201, allowing you to specify the locations of the province to the northwest, northeast, southeast and southwest that have no network coverage.



**Figure 2.** Conexión de the Aeroflex 3920 OPT 201

#### 3.2.2. Design requirements

The design requirements were based on the technical standard for trunked systems issued by CONATEL by resolution 264-13-CONATEL-2000 trunked systems in Ecuador, inside this resolution is considered parameters such as technical characteristics of the system,

the channeling plan bands and the frequency plan.

### 3.3. Chapter III. Trunked Radio Design

The new design of the network trunked radio communication in Imbabura, based on the trunking system APCO25, implemented remote sites must be included with the architecture of the network, telecommunications equipment, power systems, radiation systems, calculations of the propagation and the services will offer by the designed network.

The repeater sites must have the same physical and technical characteristics, both in equipment and infrastructure for reasons of standardization, with the exception of transmission towers will depend on the link to design.

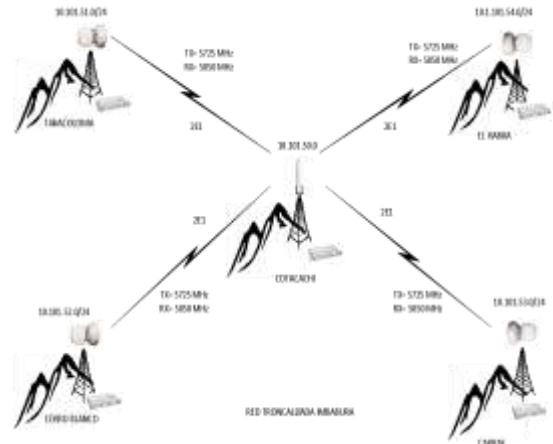


Figure 3. Design trunked radio to Imbabura.

### 3.4. Chapter IV: Testing Design

Once completed the system design by calculation simulation is made using radio Mobile software to verify the performance of the link for this provide quality coverage also the interpretation of the simulation of the link and the coverage the same.



**Figure 4. Coverage of trunking system in Imbabura**

### 3.5. Chapter V: Cost Analysis

The analysis cost benefit in the project made reference budget corresponds to equipment used in the design, and cost analysis for the implementation and operation. Regarding the benefits of this research have a qualitative value because they are not economic, but social, achieving better serve to the National Police and the institution in the same time mayor security to the society.

DESCRIPCIÓN	PRECIO TOTAL [USD]
Equipment Costs	1'667.278,00
Engineering Costs	33.345,56
Total Installation Costs	15.800,00
<b>TOTAL COST</b>	<b>1'716.423,56</b>

## 4. Conclusions

- The objectives raised in the proposed design, to provide coverage trunked network throughout the province of Imbabura with nationwide interconnection is done by increasing the four remote repeaters and the use of technology APCO 25 property Motorola maker.
- Using a free frequency to microwave links of the trunked network from remote locations, allows to the state to save money on frequency allocation, plus the efficient use of electronic radio in the country.
- The design of the trunked network presents links to great distance, so this does not cause problems to other systems operational dimensions must be done properly in technical and physical parameters of the equipment and infrastructure chosen.



- The remote repeaters network trunking located inside of the province it were interconnected to the main site located in the National Communications by microwave links that meet the objective of availability 99.999%, design through theoretical analysis.
- The use of informatics software in performing the trunked network design provided adequate support to the implementation of engineering in detail, values and results are through full satisfaction for compliance with the initial objective.
- Imbabura province has geography with great consideration elevations along its entire extension, for this reason the design of the network coverage was affected due to this crucial geographical problem in microwave systems.

## **5. Recommendations**

- Realizar una actualización del software del repetidor troncalizado que existe en la actualidad en Imbabura que es el de Cotacachi, para que pueda migrar a un nuevo protocolo como el APCO 25 con el cual se plantea el diseño actual.
- Realizar un software update trunked repeater that currently exists in Imbabura which is to Cotacachi, to can migrate to a new protocol as APCO 25 with which the current the present design.
- The raised design must have the characteristics of scalability properly without affecting the current network infrastructure, new repeaters must be incorporated correctly way into the system functionality, so the use of equipment from the same maker is recommended used in the today it is Motorola Inc., this is the objective to

arrive to the standardization and functionality of the services offered by the mentioned company,

- In the trunked network is essential dimension traffic to pursue within the network, for this the congestion parameter was used, calls that enter the system are not discarded, is on hold a certain time for a channel is assigned by the repeater, for it Erlang traffic, to assign the number of channels required so that calls are rejected not used. In the future is recommending dimension the number of users having the trunked network, this is with the finality to study the possibility of increasing the number of channels in the repetition sites.
- To the reference budget improvements in the investment project is recommended to do considering all the costs of acquisition of equipment, accessories, materials,

investment in technical personnel and costs of installation to the date realized.

- The trunked network is cataloged as a critical telecommunications system is therefore necessary that a preventive maintenance plan when implemented, with technical personnel capable that CNT EP has.

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