Rural Network Planning

Case Study

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1. INTRODUCTION

The objective of this case study is to illustrate the application of digital equipment in a rural area. Equipment to be used is digital exchange with remote subscriber stages and subscriber multiplexors, digital cable and radio systems one channel subscriber radio and eight channel subscriber carrier equipment.

2. STUDIED AREA

The area is 3500 km^2 with a population of 175.000 inhabitants (see Figure 3). City A is the region centre with 50.000 inhabitants. Other locations of importance in this concept are smaller cities, towns and villages, some of them located in the southern mountainous part of the region. The main part of the population, however, lives in the valley which runs through the area from east to west.

3. EXISTING NETWORK

The telephone service is today mainly provided in larger towns and cities in the valley. An automatic combined primary and local exchange is located in the region centre A (see Figure 4). This exchange is connected to the long distance network, using FDM transmission on radio link. Another automatic local exchange is located in city E2. Subscribers in other town and villages are connected to manual exchanges.

In most cases, loaded pair cables are used for transmission between exchanges. The pupin distance is 1800 m. Between E2 and E4, open wires are used.

Two locations are connected using one channel analogue radio. In A, antennae are mounted on radio link towers used for LD connections. In B1 and D1, the connection to the radio link is shown in Figure 1. Between the manual exchange and the radio link termination, open wire is used.

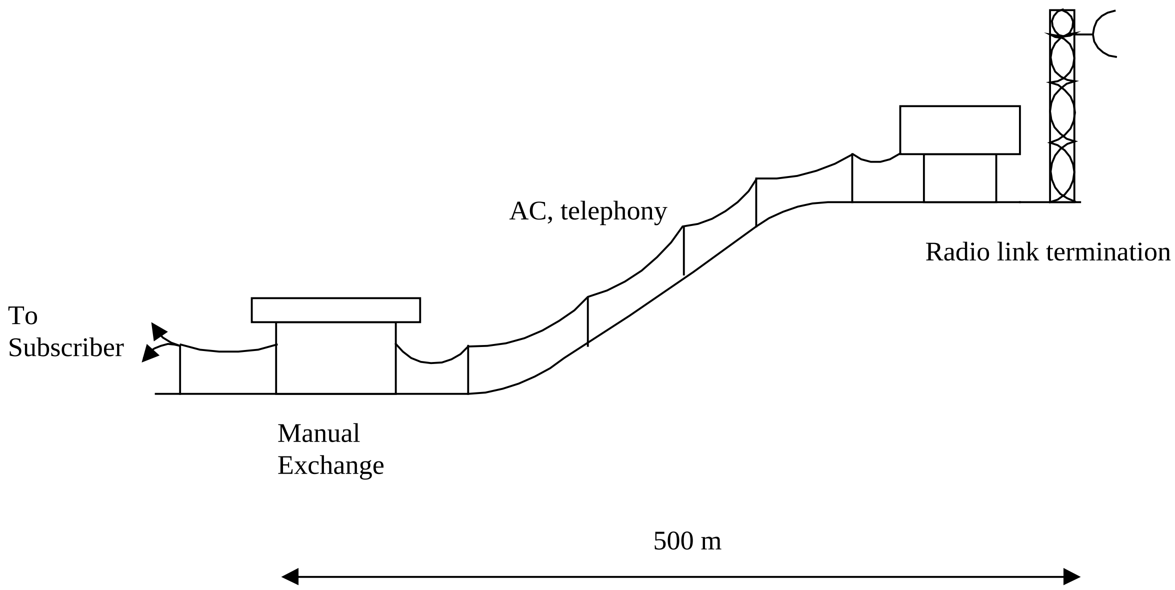


Figure 1 - Connections to radio link in locations B1 and D1

4. NETWORK TO BE PLANNED

The need of telephone service in the area has increased rapidly, and the future requirement is expected to be more than doubled during ten years (see Figure 5). It has been decided to plan an integrated digital network for extension of the network capacity. It was also decided to replace the existing manual exchanges with new digital equipment. The existing automatic exchanges will not be extended.

Measurements of cross talk in existing cables showed that they can be used for transmission of 2 Mb PCM signals. Existing pole lines can also be used for new cables.

The existing masts in A, B1 and D1 can be used for new digital radio systems. Buildings for radio and power equipment in B1 and D1 can also be used for new equipment. Digital multiplexors 2/8 or 8/34 Mb/s are not possible to room in the cabinet for RSS 128 or RSM. Existing houses for manual exchanges are not possible to utilise for new equipment.

Geographic obstacles reduce, in some cases, the possibility of direct radio link connections.

Radio link repeaters must be used in such cases. It is also assumed that radio link masts and antennae can be located close to remote subscriber stages and subscriber multiplexors (see Figure 2).

All villages, as well as locations B1 and D1, have AC power for feeding of electronic switching and transmission equipment. If radio equipment is located in other positions, power has to be generated locally. It is possible to power feed radio link from RSS and RSM.

Total traffic per subscriber is 0.05 Erl. The congestion on the route to RSS should not be higher than 1 %. If a RSS with more than 128 subscribers is connected to an exchange via 2 Mb/s digital line system, it is advisable to double the system for security reasons.

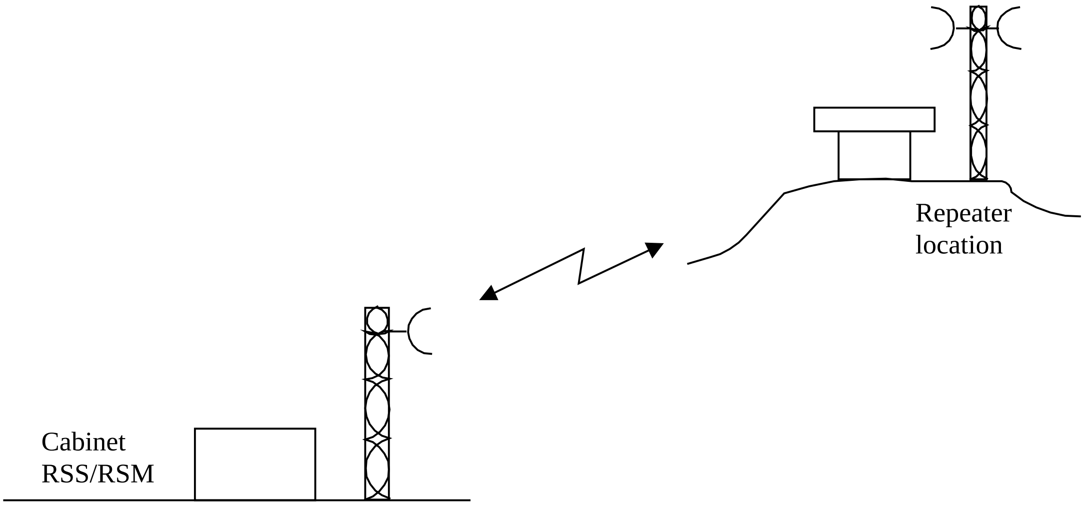


Figure 2

Cabinet mounted RSS or RSM connected to radio equipment

5. EXERCISE

For the whole network:

- decide location(s) of digital exchange(s);

For each network branch extended from A:

- decide location(s) and capacity of remote subscriber switch(es), RSS;
- decide location(s) and capacity of remote subscriber multiplexor(s), RSM;
- decide type and capacity of subscriber distribution network (physical, 1 ch radio or 8 ch carrier);
- decide type and capacity of transmission between digital exchange, RSS and RSM.

The network solution shall satisfy technical requirements listed in appendix, and a low cost shall be aimed at.

Figure 3 : RURAL AREA

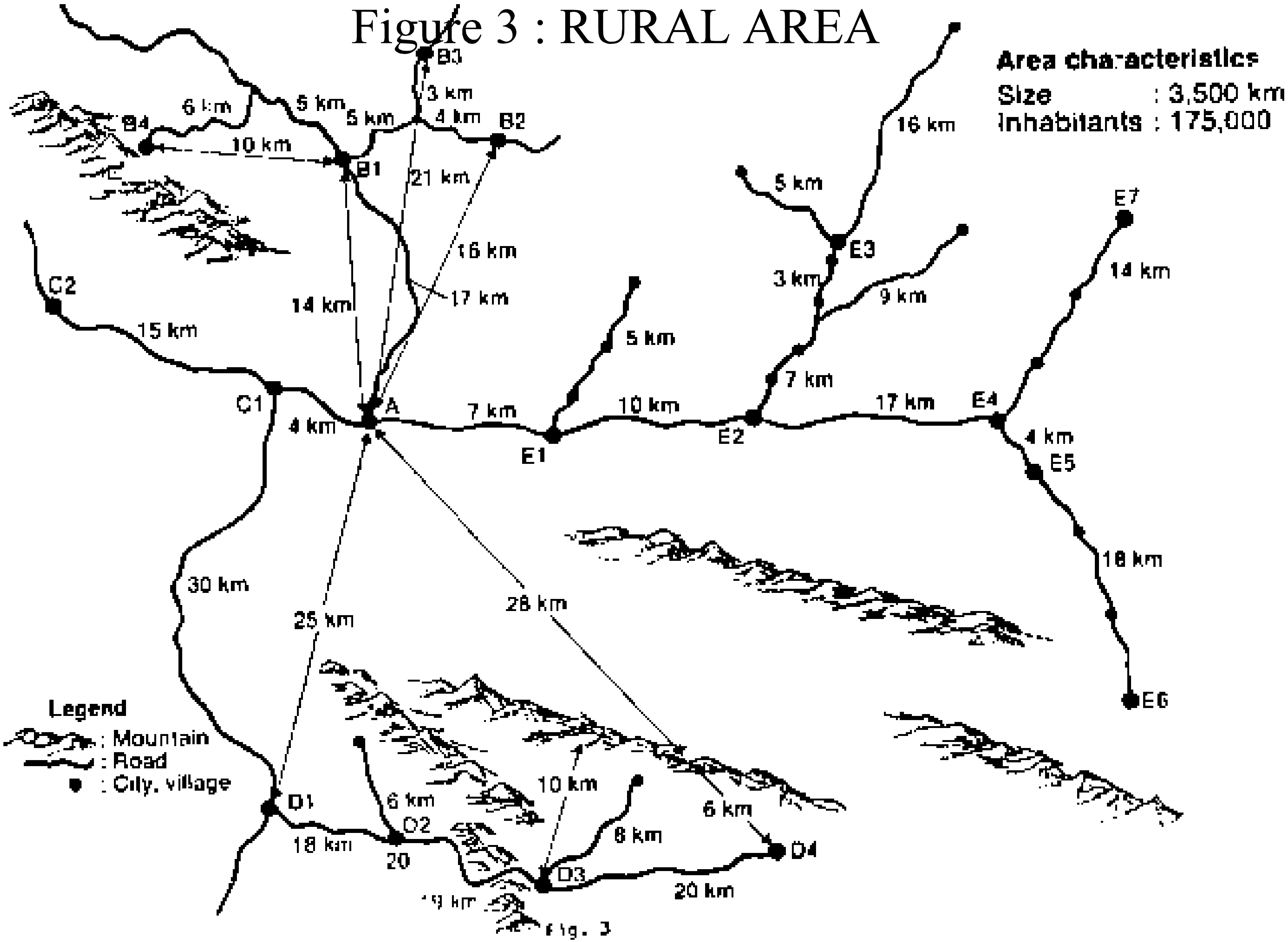


Figure 4 : Existing network

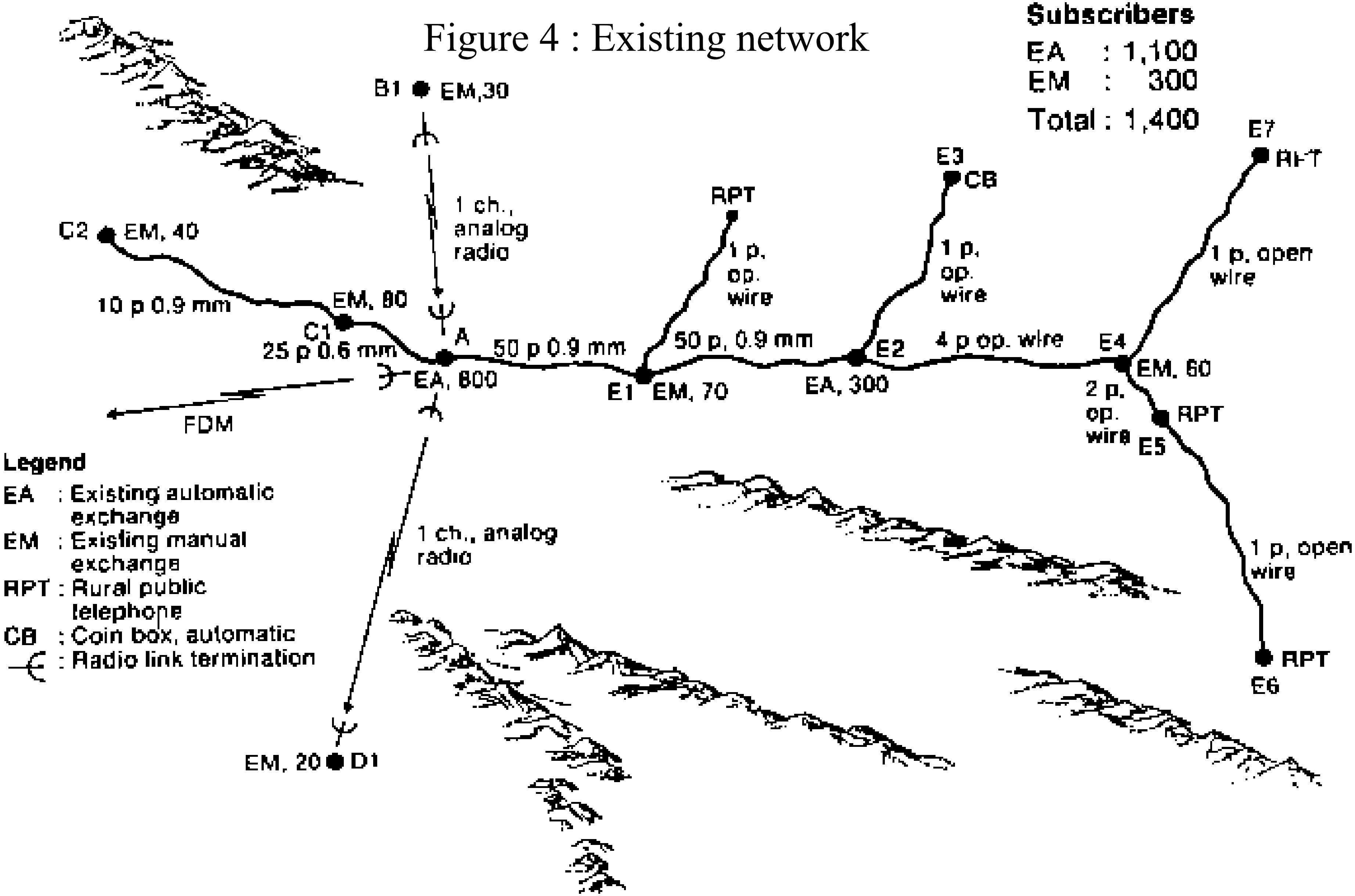


Figure 5 : Subscriber forecast

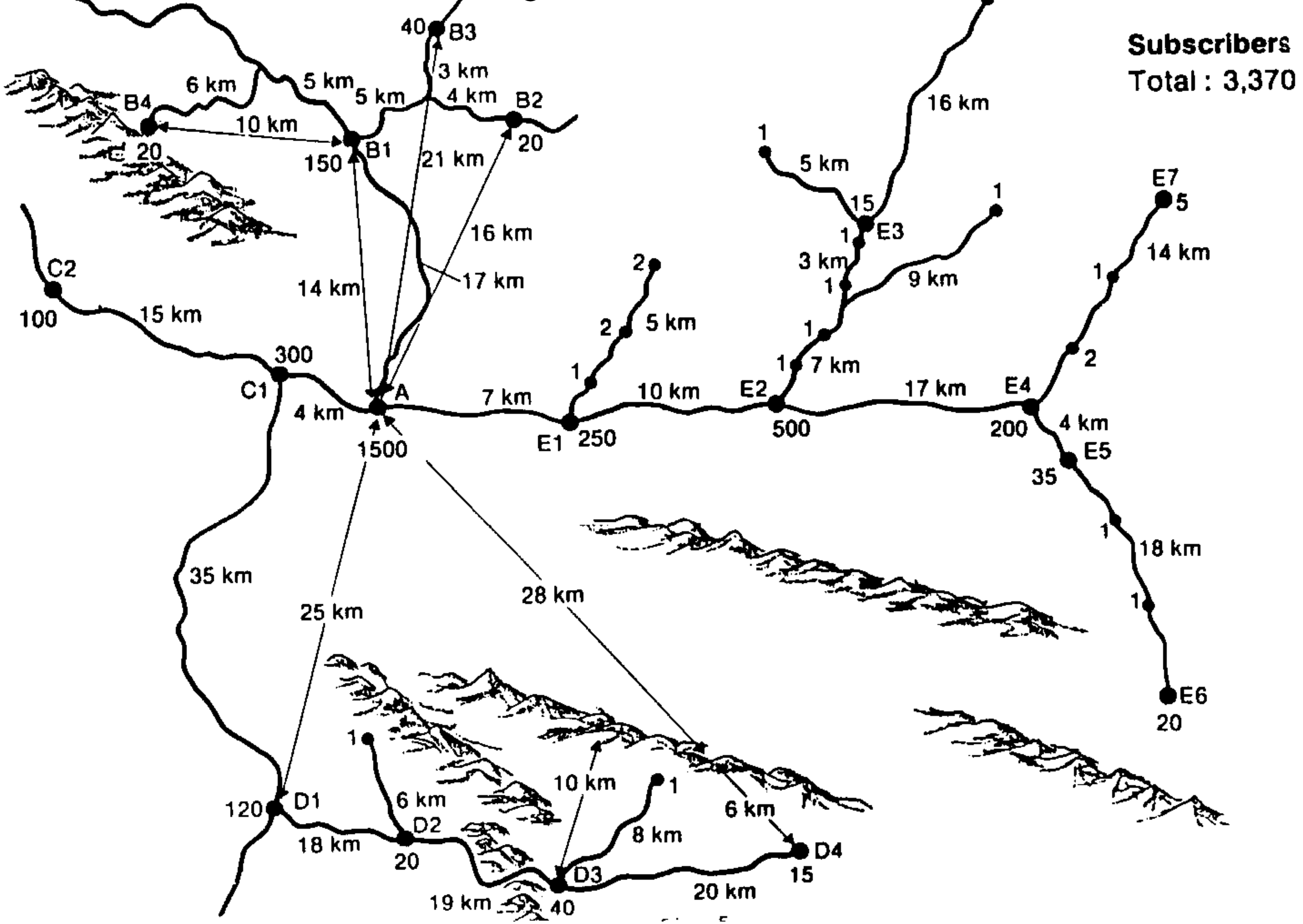


Figure 6 : CONNECTIONS TO DIGITAL EXCHANGE

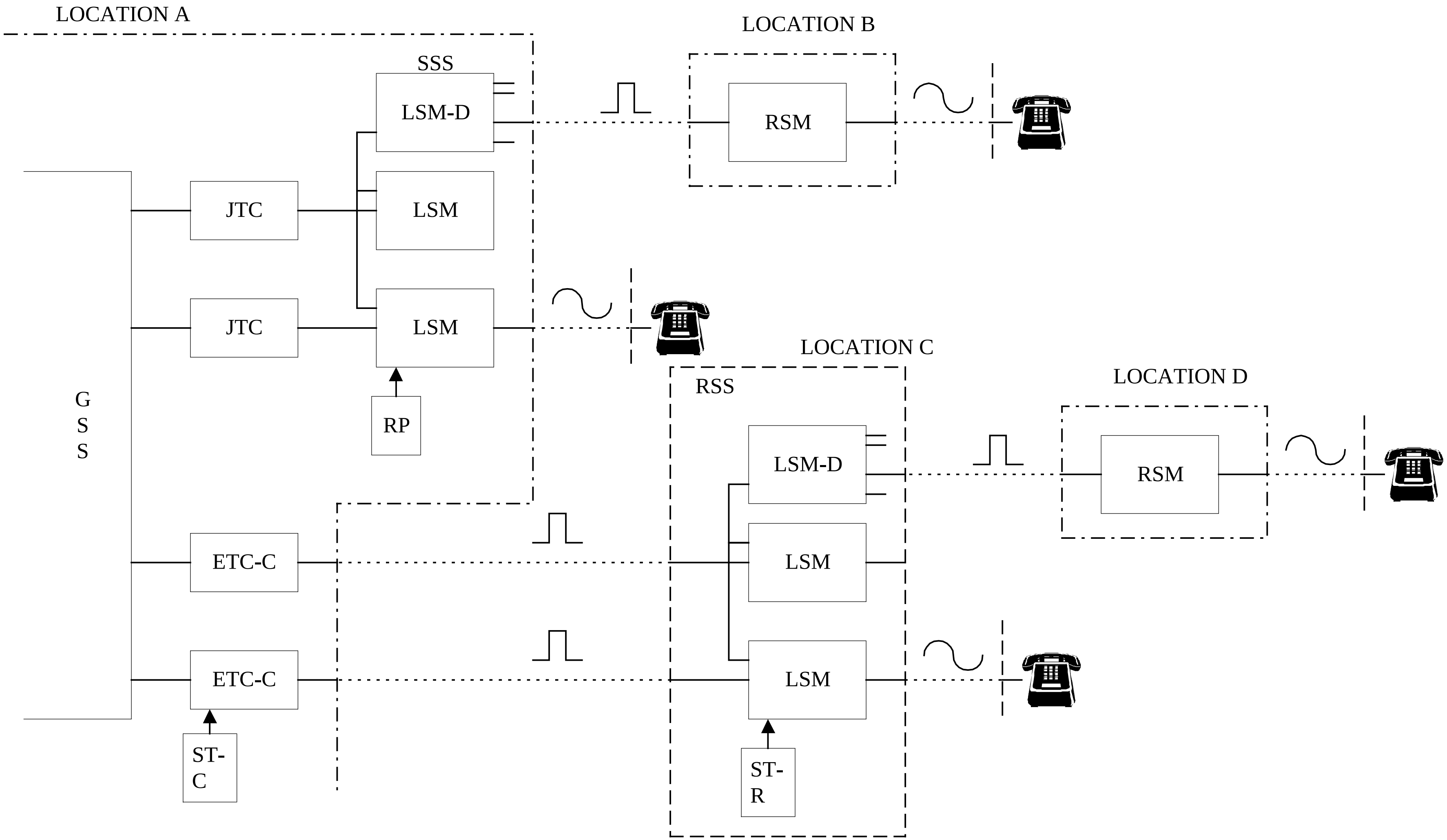


Figure 7 : DIGITAL RADIO LINKS AND LINE SYSTEMS

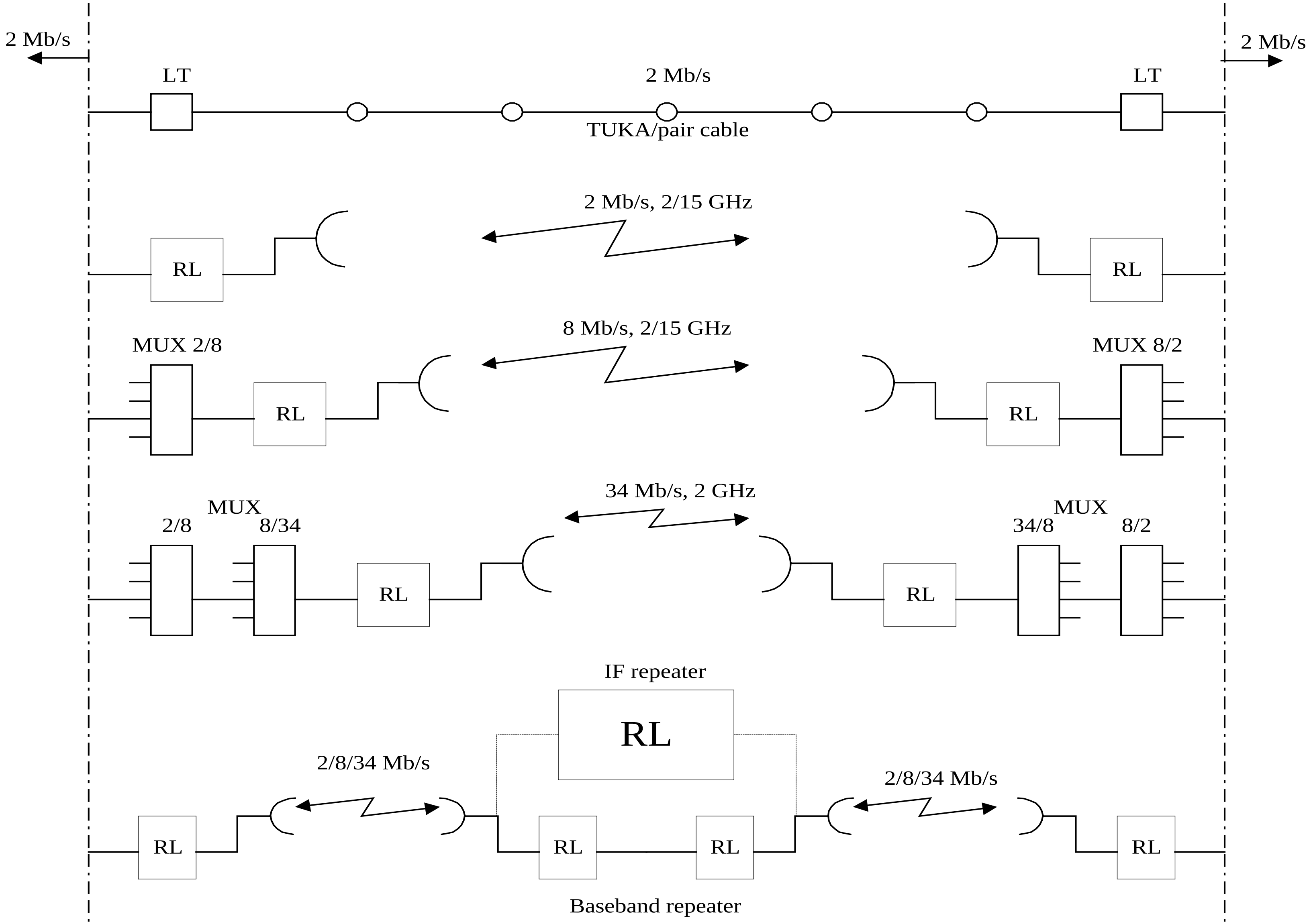
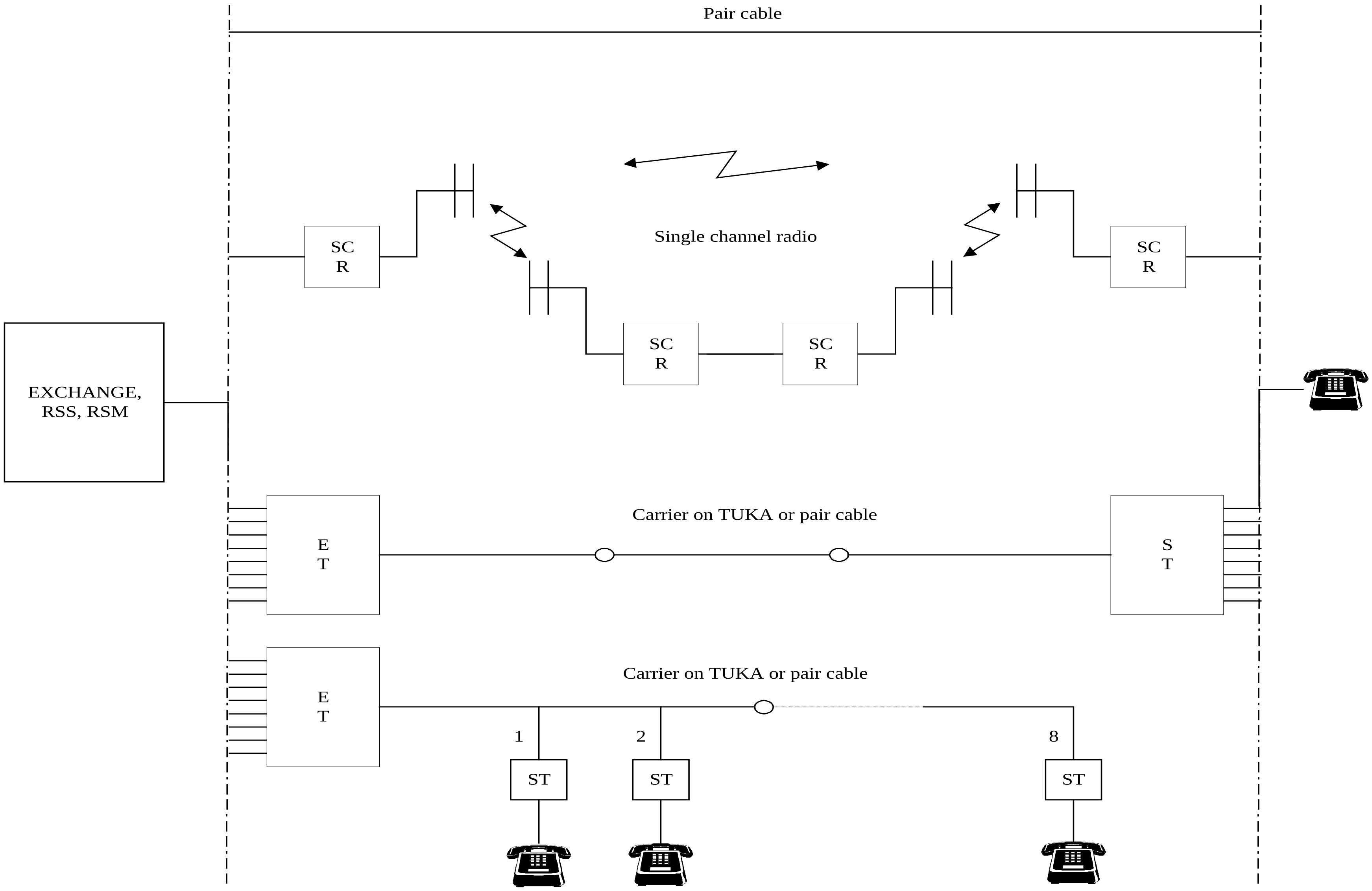


Figure 8 : TRANSMISSION, SUBSCRIBER NETWORK



APPENDIX 1

RELATIVE COSTS INTENDED FOR EXERCISE IN RURAL NETWORK PLANNING

1. DIGITAL EXCHANGE

Basic cost excl. accommodation	3000
Incremental cost for 128 subscriber lines excl. line circuits	70
Incremental cost for 4 RSM 2Mb/s inlets	100
Incremental cost for 1 RSS 2Mb/s inlets	10

2. REMOTE SUBSCRIBER SWITCH RSS

Basic cost	≤ 128 subscriber	100
incl. accommodation	129 - 2048 subscr.	300
Incremental cost for 128 subscriber lines excl. line circuits		70
Incremental cost for 4 RSM 2Mb/s inlets		100

3. REMOTE SUBSCRIBER MULTIPLEXOR RSM

RSM for 30 subscribers incl. accommodation, exclusive line circuits	50

4. RADIO LINK

4.1 15 GHz MINI LINK FOR OUTDOOR INSTALLATION

		Capacity
	2Mb/s	8Mb/s
Terminal station	70	90
Repeater station	140	180

4.2 2 GHz NERA LINK FOR INDOOR INSTALLATION

			Capacity
	2Mb/s	8Mb/s	34Mb/s
Terminal	100	120	150
Repeater	160	200	250
Feeder and antenna	20		

5. RADIO LINK CONSTRUCTION

Mast central	80
Mast peripheral	40
Primary power	70
Accommodation	80
Civil work (roads)	150

6. <u>DIGITAL 2Mb/s LINE SYSTEM</u>

Repeater housing with:	1 repeater(s)	6
"	2 "	8
"	3 "	13
"	4 "	15
"	5 "	17

7. <u>DIGITAL MULTIPLEXOR</u>

Dig mux 2/8 Mb/s	25
Dig mux 8/34 Mb/s	35

8. <u>CABLES</u>

8.1 TUKA ON EXISTING POLE LINE

1 TUKA	7 per km
2 TUKA	11.5 per km
3 TUKA	16 per km

8.2 PAIR CABLE (0.5 mm) ON EXISTING POLE LINE

No. of pairs	Cost/km
10	12
30	17
50	23
100	38

8.3 PAIR CABLE (0.5 mm) BURIED IN THE GROUND

No. of pairs	Cost/km
10	56
30	61
50	66
100	80

9. <u>CONSTRUCTION OF NEW POLE LINE</u>

per km	20

10. <u>ONE-CHANNEL SUBSCRIBER RADIO LINK</u>

Terminal and antenna	10

11. <u>8-CHANNEL ANALOGUE SUBSCRIBER CARRIER</u>

Exchange terminal per 8 subscriber	16
Remote terminal per subscriber	2
Repeater	3

APPENDIX 2

SYSTEM CHARACTERISTICS TO BE USED IN EXERCISES IN RURAL NETWORK PLANNING

1. RADIO LINK

The maximum hop length of a radio link depends on may factors. For sake of simplicity, we assume here that the maximum hop lengthy for the 2 GHz link is 40 km, for the 15 GHz link is 20 km, and for the one-channel subscriber radio link 50 km.

The 2 GHz terminal is intended for indoor installation. A feeder is used to connect the terminal on the ground with the antenna on the mast.

The 15 GHz terminal is accommodated behind the antenna, forming one mechanical unit located on the mast. Thus, no extra cost for feeder and antenna is required.

2. DIGITAL 2Mb/s LINE SYSTEM

The maximum repeater distance for:

TUKA cable	2.2 km
Pair cable 0.5 mm	1.8 km

Each line system requires two pairs, one for each direction. Due to crosstalk restriction, only 50 % of the pairs can be used for digital transmission. The TUKA cable can be used for one line system. It is not possible to use open wire for digital transmission.

3. 8-CHANNEL ANALOGUE SUBSCRIBER CARRIER

This system comprises an exchange terminal (ET) for 8 subscribers and individual branching units, ST, for each subscriber. Using TUKA cable as transmission medium, the maximum distance between the ET and the most remote subscriber is 8 km. For longer distances, repeater has to be used. The repeater distance is then 8 km. One pair is used for the two directions. The TUKA cable could thus carry two systems. Metering pulses are not possible to be transmitted over the system. It is not possible to have subscriber carrier on open wire for crosstalk reasons. If pair-cable is used, all pairs may be utilised.

4. CABLE CHARACTERISTICS

Maximum attenuation and resistance in the local network, the voice frequency connection from the local exchange, RSS or RSM to a telephone set, are 8 dB and 1800 ohm.

	Attenuation/km	Resistance/km
0.5 mm pair cable	1.3 dB	270 ohm
1.0 mm open wire	0.5 dB	50 ohm