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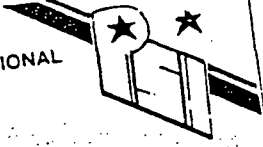
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List of all weapons in Comm.

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TO: OMM McCLANE

10-5-85

FROM: CURTIS BAYLOR

RE: COMMUNICATIONS REPORT

OUTLINE

I. TRUNKING VS. CELLULAR SYSTEMS

II. AMATEUR RADIO COMMUNICATIONS

III. IMPORTANCE OF ANTENNAS

IV. REPEATER VS. POINT TO POINT COMMUNICATIONS

IMITATION
TWO TALKING
CELLULAR REPEATER

V. REPEATER LOCATIONS IN DENVER METROPOLITAN AREA

VI. SATELLITES & TELEPHONE COMMUNICATIONS NETWORK

VII. SUBAUDIBLE MODULATION

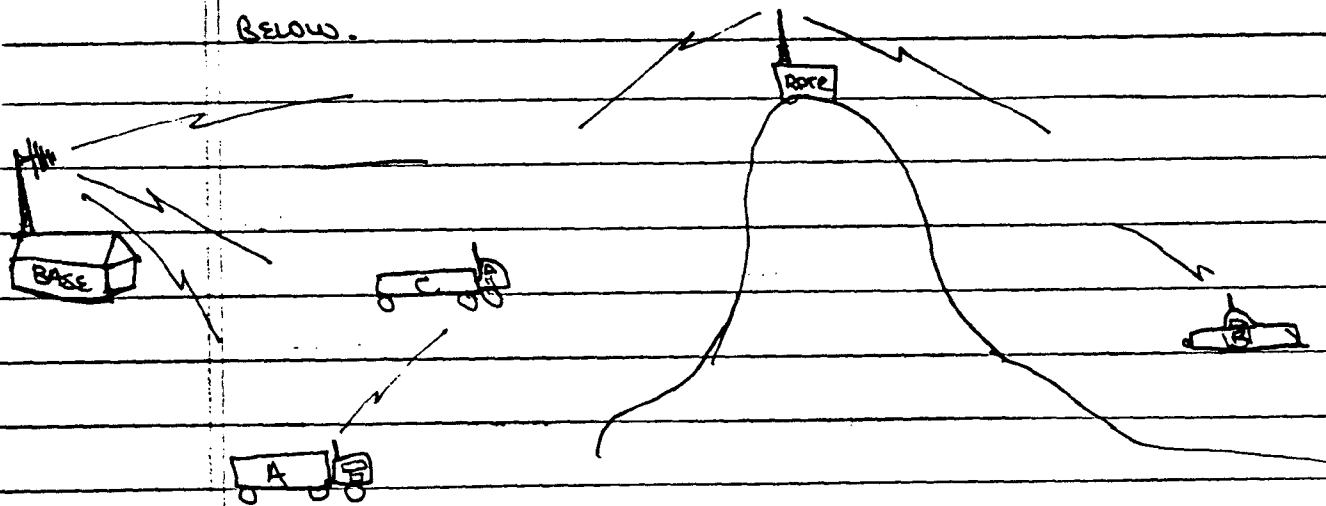
IV. REPEATER VS. POINT TO POINT COMMUNICATIONS

POINT TO POINT COMMUNICATIONS IS AN EFFECTIVE USE OF ~~THE~~ TWO-WAY RADIO SYSTEMS FOR LINE OF SIGHT COMMUNICATIONS. THIS TYPE OF COMMUNICATIONS IS USED IN CITIZENS BAND (CB) (27 MHz) AND IS USUALLY A PART OF BUSINESS/POLICE/FIRE COMMUNICATIONS SYSTEMS. UHF AND 800 (450 MHz AND ABOVE; 800 - 950 MHz) ARE PREFERRED FREQUENCIES FOR POINT-TO-POINT COMMUNICATIONS BECAUSE IT IS IN WIDE OPEN SPACES BECAUSE IT IS THE NATURE OF RADIO WAVES AT IN THE UHF RANGE TO BENT SLIGHTLY WITH THE EARTH'S SURFACE AND WILL EXTEND COVERAGE TO JUST BEYOND THE HORIZON. LOW BAND (30 MHz TO 50 MHz) IS A FAVORITE IN COASTAL AREAS AND OVER MUDDY, CLAY TYPE TERRAIN BECAUSE AT THESE LOW BAND FREQUENCIES RADIO WAVES TRAVEL VERY WELL ALONG THE SURFACE OF THE EARTH'S SURFACE OVER WATER AND MOIST TERRAIN.

AD 11-16-85

ADEQUATE
LINE OF SIGHT COMMUNICATIONS IS VERY GOOD IN AREAS WHERE THERE
ARE NO OBSTRUCTIONS (I.E. MOUNTAINS, TALL BUILDINGS) ~~TO~~ IN AREAS WHERE
THESE OBSTRUCTIONS PRESENT A PROBLEM REPEATERS MAY BE USED.

THE BASIC OVERVIEW OF REPEATERS: THE BASIC REPEATER
SYSTEM CONSISTS OF MOBILES, BASE STATION, REPEATER, AS ILLUSTRATED
BELOW.



~~THE SYSTEM USES TWO CHANNELS, CHANNEL 1: TX 456.625 MHz~~
~~CHANNEL 2: TX 451.625 MHz~~

~~THE SYSTEM USES TWO CHANNELS~~
TYPICALLY,
THE SYSTEM USES TWO(2) CHANNELS. THE TWO-WAY RADIOS USED BY THE
BASE STATION AND THE VEHICLES (MOBILES) WILL HAVE THE CHANNELS ARRANGED
AS FOLLOWS: CHANNEL 1: TX → 456.625 MHz Rx → 451.625

SUB TONES

CHANNEL 2: TX → 451.625 MHz Rx → 456.625

DIGITAL

THE REPEATER WILL BE ARRANGED: TX → 451.625 Rx → 456.625

TALK TO

EACH OTHER

~~THE BASE STATION WILL TRANSMIT~~

TYPICAL COMMUNICATIONS WILL PROCEED IN THE FOLLOWING MANNER:

(1) IN ORDER FOR THE BASE TO COMMUNICATE WITH MOBILE B, THE BASE
MUST USE CHANNEL 1. USING CHANNEL 1, THE BASE WILL TRANSMIT ON
456.625 MHz (456.625 MHz) IS THE FREQUENCY ON WHICH THE

REPEATER RECEIVES THE REPEATER HAVING RECEIVED THIS COMMUNICATION FROM THE BASE, AUTOMATICALLY TRANSMITS THIS COMMUNICATION ON 451.625MHz. THE COMMUNICATION IS THEN RECEIVED BY MOBILE B ON THIS FREQUENCY (451.625MHz). THERE

(2) IN ORDER FOR BASE TO TALK TO MOBILE A OR MOBILE C AND FOR MOBILE A TO TALK TO MOBILE C, CHANNEL TWO MAY BE USED IF IT IS PREFERABLE TO USE W. IT IS PREFERABLE TO USE CHANNEL 2 FOR "LINE OF SIGHT" COMMUNICATIONS AS THIS DOES NOT TIE UP THE REPEATER, AND ALLOWS ITS USE THEREBY KEEPING IT FREE FOR USE WHEN NECESSARY.

CHANNEL 1 IS USUALLY REFERRED TO AS THE REPEATER CHANNEL. CHANNEL 2 IS NORMALLY CALLED "SIMPLEX" OR "TALK AROUND."

TYPICALLY, REPEATER OPERATION INVOLVES MANAGEMENT AND CO-ORDINATION OF A COMMUNICATION SYSTEM. THE COST OF THE REPEATER ITSELF, INSTALLATION OF REPEATER AND TRANSMITTING TOWER, RENT OR PURCHASE OF LAND/SPACE ON MOUNTAIN TOP OR ATOP A TALL BUILDING(S) DICTATES LICENSING AND OPERATION AS A "COMMON CARRIER" RADIO COMMON CARRIER (RCC).

RADIO COMMON CARRIERS ARE PROPERLY LICENSED PERSON(S) WHO SELL A RADIO COMMUNICATION SERVICE TO INTERESTED PARTIES. THE SERVICE IN THIS INSTANCE, IS THE USE OF THE REPEATER FOR A MONTHLY FEE, THIS USE OF THE REPEATER

BY VARIOUS CUSTOMERS USUALLY INVOLVES THE USE OF SUBTONES, FOR THE CONVENIENCE OF CUSTOMERS AND POSSIBLE METHOD OF DISCONNECTION WHEN PAYMENT IS NOT MADE. SUBTONES WILL BE DISCUSSED FURTHER LATER ON IN THIS REPORT.

I. TRUNKING VS. CELLULAR COMMUNICATION SYSTEMS

~~IN RESPONSE TO THE~~

AS ~~SYSTEMS~~ PRESENTLY USED RADIO SPECTRUM BECAME MORE AND MORE CROWDED THE TRUNKING AND CELLULAR SYSTEMS HAVE ~~BECOME~~ BECOME POPULAR BECAUSE OF INCREASED ACCESS TIME. STATISTICALLY, THE REGULAR REPEATER SYSTEM AFFORDS A USER APPROXIMATELY 50% ACCESS TO THE SYSTEM (I.E. ~~50% OF THE TIME HE HAS A NEED TO USE THE SYSTEM~~ ^{AS A USER} 50% OF THE TIME ~~HE~~ THE REPEATER WILL BE FREE FOR USE)

THE ADVENT OF TRUNKING SYSTEMS INCREASES ACCESS TIME TO APPROXIMATELY 80% TO 90%. THE CELLULAR SYSTEM HAS BEEN

REPORTED TO AFFORD A USER POSSIBLE 99% ACCESS TIME TO THE SYSTEM. THESE SYSTEMS ARE ALSO PREFERRED BY ~~BUSINESS~~ PEOPLE,

~~THE NATURE OF WHOSE BUSINESS IS SENSITIVE (REAL ESTATE AGENTS, TRUNKING POLICE, FIRE, AMBULANCE SERVICES) BECAUSE OF THE ADDITIONAL MAJOR SECURITY IT PROVIDES.~~

THERE ARE THREE ~~BASE~~ TYPES OF TRUNKING SYSTEMS:

~~THEIR BASE OPERATION IS MANUFACTURED BY~~ MANUFACTURED BY GENERAL ELECTRIC, MOTOROLA, E.F. JOHNSON. THERE ARE A FEW SYSTEMS IN OPERATION MANUFACTURED BY RCA. HOWEVER, RCA IS NO LONGER IN THE TWO-WAY RADIO BUSINESS. EVEN THOUGH ITS ASSETS SEEMED TO HAVE BEEN TAKEN OVER BY TACTEL, PARTS ARE EXTREMELY DIFFICULT TO LOCATE AT THIS TIME. (TACTEL WILL NOT GUARANTEE ANY TIME SCHEDULE ON DELIVERY OF PARTS;

TACTEL ~~TELES~~ ^{GIVES} ITS CUSTOMERS ONE MONTH TO A YEAR ON DELIVERY OF PARTS AS ITS STANDARD OPERATING PROCEDURE.

~~AP~~ THE THREE MAJOR TRUNKING SYSTEMS OPERATES BASICALLY

~~THE~~ - EACH SYSTEM USES FIVE REPEATERS;

THE DIFFERENCE IS IN THE METHOD OF CONTROL FOR EACH SYSTEM.

GENERAL ELECTRIC USES MICROPROCESSORS IN THE RADIOS WHICH DIGITALLY COMMUNICATE WITH THE SYSTEMS FIVE REPEATERS.

MOTOROLA USES A CENTRAL PROCESSING UNIT (CPU) TO CONTROL THE SYSTEM AND EMPLOYS THE USE OF ONE OF THE FIVE REPEATERS TO PROVIDE A CONSTANT "TRAIN" OF DATA FLOWING TO RADIOS USING THE SYSTEM.

E.F. JOHNSON USES FIVE CENTRAL PROCESSING UNITS: ONE FOR EACH REPEATER, TO CONTROL THE SYSTEM.

I AM MOST FAMILIAR WITH THE GENERAL ELECTRIC MARCV SYSTEM AND WILL ATTEMPT TO EXPLAIN IT BELOW.

THE G.E. MARCV SYSTEM EMPLOYS THE USE OF FIVE REPEATERS. EACH REPEATER USES TWO FREQUENCIES: ONE FOR TRANSMIT AND ONE FOR RECEIVE; THUS THE SYSTEM USES TEN (10) FREQUENCIES (FIVE PAIRS). THIS SYSTEM EMPLOYS THE FOLLOWING TONES IN THE AUDIBLE FREQ. RANGE. THE MICRO-PROCESSOR CONTROLLED MOBILE RADIOS IN THE

~~THE MARCV SYSTEM ARE CONTA~~
ASSIGNED

BUSY TONE → TONE SENT TO INDICATE REPEATER IS ALREADY IN USE

~~COLLECTION TONE → TONE SENT~~ ASSIGNED TO ALL RADIOS

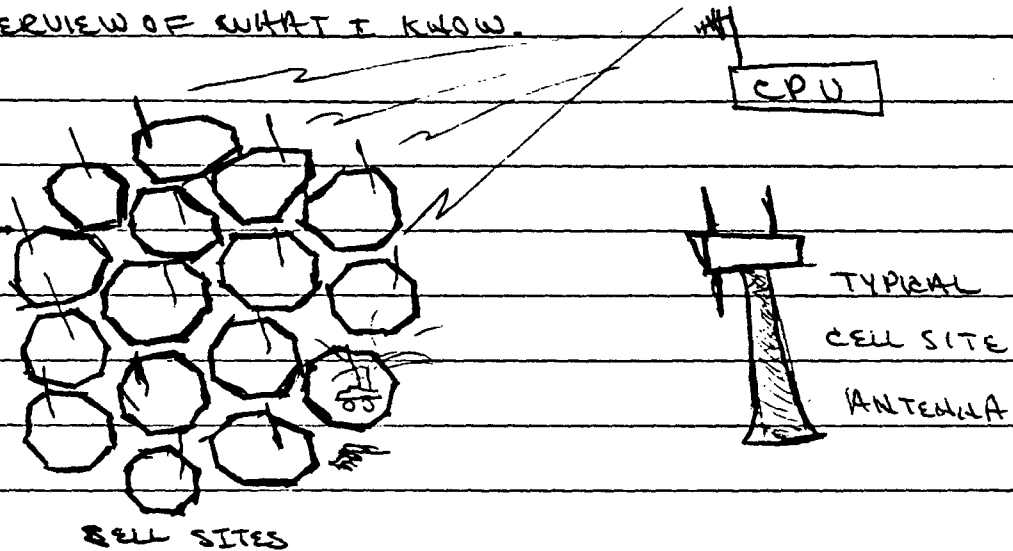
ACQUISITION TONE → TONE ASSIGNED TO LOCK A SPECIFIC REPEATER AND MOBILE IN COMMUNICATION

COLLECTION TONE → TONE ASSIGNED TO ALL RADIOS IN A SPECIFIC CUSTOMER'S FLEET

GROUP TONE → TONE ASSIGNED TO SPECIFIC GROUPS WITHIN A CUSTOMER'S FLEET (I.E. A TONE FOR OWNER; A DIFFERENT TONE FOR ALL SUPERVISORS, A DIFFERENT TONE FOR

TELEPHONES
CELLULAR PHONES

MY INFORMATION ON THE CELLULAR SYSTEM IS SKETCHY. BELOW IS AN OVERVIEW OF WHAT I KNOW.



THE FEDERAL COMMUNICATIONS COMMISSION (FCC) ALLOWS 666 CHANNELS IN EACH METROPOLITAN AREA FOR CELLULAR TELEPHONE OPERATION: 333 CHANNELS FOR HARD LINE (TELEPHONE WIRE) OPERATION AND 333 CHANNELS FOR MICROWAVE OPERATION. IN THE DENVER AREA THE HARD LINE CHANNELS ARE OPERATED BY NEW VECTOR (REALLY MOUNTAIN BELL) AND THE 333 MICROWAVE CHANNELS ARE OPERATED BY MCI (I'M NOT SURE WHETHER MCI'S SYSTEM IS ON LINE OR NOT YET, IT HAS BEEN SAID THAT MCI'S CELLULAR TELEPHONE SYSTEM SHOULD BE ON LINE BY THE END OF 1985).

AN ELECTRONIC IDENTIFICATION IS "BURNED" INTO A/THE MICRO-PROCESSOR IN THE RADIO. THIS ~~IS~~ WHENEVER THE PUSH-TO-TALK BUTTON IS DEPRESSED, HANDSET REMOVED, VSW (HANDS-FREE ~~VOICE~~ VOICE OPERATED MIC) OPERATED. THIS ELECTRONIC IDENTIFICATION IS THE FIRST THING TRANSMITTED BY THE RADIO. THE ~~CELL~~

THE ~~CELL SYSTEMS~~ CELLULAR TELEPHONE SYSTEM IS CO-ORDINATED BY A CENTRAL PROCESSING UNIT (CPU). THIS CPU RECEIVES ALL TRANSMISSIONS ~~AND~~ FROM MOBILES AND CELL SITES IN THE SYSTEM, CO-ORDINATES "VOTING" AND ~~HAND~~ TRANSFERS FROM ONE CELL SITE TO THE NEXT. EACH CELL SITE OPERATES ON A DIFFERENT PAIR OF FREQUENCIES (ONE FOR TRANSMIT, ONE FOR RECEIVE) THUS THE USE OF 333 CHANNELS. THE COVERAGE AREA OF EACH CELL SITE IN THE DENVER AREA IS APPROXIMATELY EIGHT (8) MILES.

WHEN ~~THE~~ A PERSON USING A CELLULAR PHONE WISHES LIFTING THE TO PLACE A CALL, ~~AND THE~~ ~~THE~~ HANDSET FROM THE CONTROL HEAD IN THE VEHICLE, THE ELECTRONIC ~~ID~~ IDENTIFICATION IS IMMEDIATELY TRANSMITTED. THIS ELECTRONIC ID IS RECEIVED BY THE CPU AND CHECKED TO SEE IF IT IS A MEMBER OF THE SYSTEM. IF THIS ELECTRONIC ID IS NOT A MEMBER OF THIS SYSTEM AN OPERATOR WILL INTERRUPT THE CALL AND TAKE THE CALLER'S ~~NAME OR~~ MAJOR CREDIT CARD NUMBER AND ~~CON~~ PERMIT COMPLETION OF THE CALL FOLLOWING VERIFICATION. IF THE ELECTRONIC I.D. IS VERIFIED AS A PAID-UP MEMBER OF THE SYSTEM, ~~THE CPU WILL INTERROGATE ALL CELL SITES.~~ THIS THE FOLLOWING PROCEDURE WILL OCCUR: THE CPU INTERROGATES THE CELL SITES ~~REQUESTING~~ AS TO WHICH CELL SITES HAVE RECEIVED A TRANSMISSION FROM THAT PARTICULAR ELECTRONIC ID AND HOW STRONG IS THE SIGNAL. THE CELL SITES THEN DIGITALLY REPORT THIS INFORMATION TO THE CPU WHICH IN TURN ASSIGNS THE TRANSMISSION TO THE CELL SITE RECEIVING THE STRONGEST SIGNAL; THIS IS CALLED "VOTING."

IF THE SIGNAL DECREASES BELOW A PRE-SET LEVEL

THE CELL SITE REPORTS THIS INFORMATION TO THE CPU AND THE "VOTING" PROCESS REPEATS

CONCLUSION

THE CELLULAR TELEPHONE SYSTEM IS BY FAR ~~FM~~ MORE ADVANCED THAN TRUNKING AND PRODUCES MUCH CLEARER AUDIO. IN FACT A RADIO TRANSMISSION FROM A CELLULAR PHONE SOUNDS EXACTLY LIKE THE TELEPHONE; WHEREAS ~~THE~~ TRUNKING SYSTEM COMMUNICATIONS SOUND LIKE REGULAR TWO WAY RADIO. HOWEVER I THINK THAT THE TRUNKING IS THE MORE SECURE OF THE TWO SYSTEMS.

IN THE CELLULAR PHONE SYSTEM ALTHOUGH THE FREQUENCY CHANGES EACH TIME THE CPU SWITCHES THE CELL SITE ASSIGNMENT, IT IS POSSIBLE (WITH ~~THE~~ A ~~SEE~~ COMMUNICATIONS MONITOR) TO ~~HEAR~~ MONITOR THE TRANSMISSION ~~FOR~~ AS THE VEHICLE TRAVELS EIGHT (8) MILES. IF THE CELLULAR SYSTEM FREQUENCIES ARE KNOWN IT IS POSSIBLE TO SCAN THESE FREQUENCIES AND CONTINUE TO MONITOR THE TRANSMISSION.

IN THE TRUNKING SYSTEM ALTHOUGH THERE ARE A ^{MUCH} SMALLER NUMBER OF POSSIBLE FREQUENCIES, AND ONCE A REPEATER HAS BEEN LOCKED ON TO A MOBILE FOR TRANSMISSION THAT SAME REPEATER REMAINS IN USE FOR THE ENTIRE TRANSMISSION. THE TRANSMISSION CAN ONLY BE RECEIVED BY THOSE RADIOS THAT HAVE BEEN PROGRAMMED WITH THE SELECTED COLLECTION TONE AND GROUP TONE. THESE TONES CAN ONLY BE PROGRAMMED INTO THE RADIO BY A TECHNICIAN AND INFORMATION REGARDING THESE TONES, GENERALLY SPEAKING, IS NOT PUBLIC INFORMATION

M McCLANE

10-5-85

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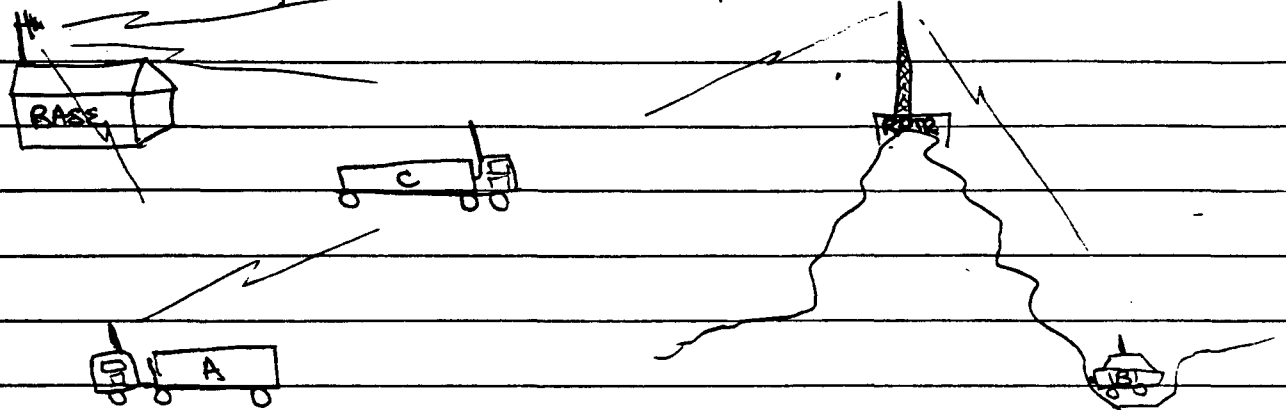
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LINE OF SIGHT COMMUNICATIONS IS ADEQUATE IN AREAS WHERE THERE ARE NO OBSTRUCTIONS (I.E. MOUNTAINS, TALL BUILDINGS). IN AREAS WHERE THESE OBSTRUCTIONS PRESENT A PROBLEM, REPEATERS MAY BE USED.

1-16-90

THE BASIC OVERVIEW OF REPEATERS: THE BASIC REPEATER SYSTEM

CONSISTS OF MOBILES, BASE STATION, REPEATER SITE; AS ILLUSTRATED BELOW.



TYPICALLY, THE SYSTEM USES TWO (2) CHANNELS. THE TWO-WAY RADIOS USED BY THE BASE STATION AND THE VEHICLES (MOBILES) WILL HAVE THE CHANNELS ARRANGED AS FOLLOWS:

CHANNEL 1: Tx → 456.625 MHz Rx → 451.625 MHz

CHANNEL 2: Tx → 451.625 MHz Rx → 456.625 MHz

THE REPEATER WILL BE ARRANGED: Tx → 451.625 MHz Rx → 456.625 MHz

TYPICAL COMMUNICATIONS WILL PROCEED IN THE FOLLOWING MANNER:

IN ORDER FOR THE BASE TO COMMUNICATE WITH MOBILE B, THE BASE MUST USE

CHANNEL 1. USING CHANNEL 1, THE BASE WILL TRANSMIT ON 456.625 MHz.

THIS (456.625 MHz) IS THE FREQUENCY ON WHICH THE REPEATER RECEIVES.

THE REPEATER HAVING RECEIVED THIS COMMUNICATION FROM THE BASE, AUTOMATICALLY

TRANSMITS THIS COMMUNICATION ON 451.625 MHz. THE COMMUNICATION IS THEN

RECEIVED BY MOBILE B ON THIS FREQUENCY (451.625 MHz).

MONEY HAS BEEN SENT AHEAD

DO NOT TALK ABOUT WHERE YOU COME FROM

REPEATER LOCATIONS IN DENVER METROPOLITAN AREA

THERE ARE THREE (3) LOCATIONS, THAT I AM AWARE OF, THAT ARE USED AS REPEATER SITES IN THE DENVER/METRO AREA:

LOOKOUT MOUNTAIN, GREEN MOUNTAIN, EL DORADO MOUNTAIN.

LOOKOUT MOUNTAIN

LOOKOUT MOUNTAIN IS A POPULAR SITE FOR REPEATER LOCATION. THE ARRAY OF ANTENNAS CAN BE SEEN FROM INTERSTATE 70 NEAR MORRISON RD.

LOCAL ALL OF THE TELEVISION STATIONS HAVE THEIR BROADCASTING ANTENNAS ON LOOKOUT MOUNTAIN. IF YOU LOOK AT THE TV ANTENNAS ON THE HOUSES IN DENVER YOU WILL SEE THAT THEY ALL POINT IN THE SAME DIRECTION: LOOKOUT MOUNTAIN. LOOK.

LOOKOUT MOUNTAIN HAS BEEN CLAIMED AS THE PROPERTY OF THE UNITED STATES FORESTRY DEPARTMENT, WHO HAS LEASED LAND TO VARIOUS GROUPS OF INDIVIDUALS WHO IN TURN HAVE BUILT HOUSES IN WHICH THEY HAVE REPEATERS.

RADIO CONTACT CORPORATION HAS REPEATER THEIR REPEATERS ATOP LOOKOUT MOUNTAIN. THEY ALSO LEASE SPACE TO: U.S. DRUG ENFORCEMENT AGENCY, FEDERAL BUREAU OF INVESTIGATION, SECRET SERVICE, AN AMATEUR RADIO GROUP, AS WELL AS OTHERS.

COMMUNICATION SERVICE COMPANY HAS THEIR REPEATER ATOP LOOKOUT MOUNTAIN WHERE ~~WANT~~ THEY PROVIDE REPEATER SERVICE FOR MANY OF THEIR CUSTOMERS. THEY ALSO SERVICE FEDERAL PROTECTION SERVICE ~~PT~~ WITHIN THE SYSTEM

THERE IS A GOVERNMENT AGENCY THAT HAS A FENCED IN REPEATER SITE ON LOOKOUT MOUNTAIN, BUT I DO NOT KNOW WHICH AGENCY IT IS.

GREEN MOUNTAIN & EL DORADO MOUNTAIN

I HAVE NOT BEEN TO GREEN OR EL DORADO MOUNTAIN, BUT I HOWEVER COMMUNICATION SERVICE COMPANY OPERATES REPEATERS ATOP BOTH THESE MOUNTAINS