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CDMA based secure cellular communication via satellite link

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Abstract: *A CDMA based Range Communication system via Satellite link is chosen to link the Base Station Transceiver (**BTS**) and Base Station Controller (BSC), which is essential to overcome the Communication problems especially during natural disasters like flood, cyclone, tsunami etc, during which, the BTS is the most vulnerable to damage interrupting the BTS-BSC link. In this case, a quick restoration of the BTS and BSC link is required for voice communication among Disaster Management/ Emergency Rescue teams etc, where satellite link is the only way to overcome these problems. The size of BTS can be micro with limited coverage area plugged to a portable satellite terminal like GSAT-12 terminal, for an instant restoration of the communication link. The advantage is small ground terminal size, high capacity enabling more number of CDMA voice channels per carrier. The CDMA based Secured Range Communication System via Satellite link provides voice services over commercially available cheaper mobile handsets in the areas which are otherwise not feasible by terrestrial link.*

Key words: CDMA, cellular network, BTS, BSC, Matrix eternity, Matrix SETU VGFX, 8 Port D-link, IDIR

1. Introduction:

It's been a revolutionary change and growth in telecommunication industry. The cellular technology has reformed the way people interact with each other. In this technology we are using BTS and BSC which is linked through satellite making strong communication during

natural disasters .The wired telecommunication systems used previously are affected to the natural disasters and causes breakage in telecommunication link.To overcome the drawbacks in the above system, The CDMA based Cellular Communication System is proposed, which has inherent security features and the Subscriber units can be very compact, which are generally and commercially available in the market. Also the system is proposed to be in compact farm factor with easy deployment feature for use during any disaster and Emergency Situation management times with a Satellite link interface.

The generally available CDMA based Cellular Communication System in the market has BTS and BSC which are geographically located away and connected by an ABIS interface. The ABIS interface or connectivity is the most vulnerable link which may prone to damage during any natural disaster times. Hence, a CDMA based Cellular Communication System been chosen such a way that the BTS and BSC are integrated in a compact unit which eases portability and fast deployment. Also the system is proposed to integrate with the Satellite link to connect to a remote hub with PSTN connectivity.

2. The General CDMA Cellular System

The general set up of a CDMA network involves either a Line Of Sight Microwave Link or a Fiber Optic Link between Base station Transceiver (BTS) and Base station controller (BSC) as shown in figure 1.

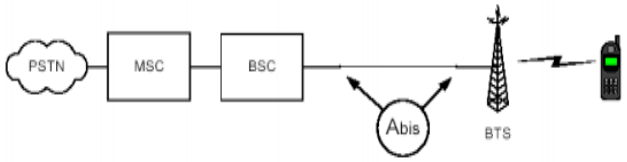


Fig 2.1: Direct link between BTS and BSC

Here, PSTN stands for Public Switch Telephone Network, MSC meant for Mobile Switching Centre, BSC meant for Base Station Controller, BTS stands for Base Station Transceiver

2.1: Base Station Transceiver:

A BTS is equipment that facilitates wireless communication between user equipment (UE) and a network. BTS is also referred to as the Radio Base Station (RBS), node B (in 3G Networks), eNB - evolved node B (LTE standard) or, simply, the Base Station (BS).

Fig 2.1.1: BTS

The BTS consists of equipment for encrypting and decrypting communications, spectrum filtering tools (band pass filters) etc.

A BTS is usually composed of transceiver, power amplifier, combiner, multiplexer, antenna, and alarm extension system and control function.

2.2 Base Station Controller:

The Base Station Controller (BSC) provides, classically, the intelligence behind BTS. Base station controller has several base station transceivers under its control. It handles allocation of radio channels, receives measurements from the mobiles and controls handoff from BTS to BTS.

Fig 2.2.1: BSC

The BSC is undoubtedly the most robust element in the BSS as it is not only a BTS controller but for some vendors a full switching centre as well as an SS7 node with connections to the MSC and serving GPRS support node(SGSN).

3. CDMA based cellular network

In CDMA based cellular network all the radio cells share the same frequency bands and users can transmit simultaneously .In other cellular techniques transmissions from one user causes interference to other users, the more users are in the system and the higher power they transmit, the more interference they generate to one another where as in CDMA based network interference is typically limited.

In the system each transmitter uses a unique spreading code to generate the transmitted signal. The intended receiver reproduces the same spreading code used by the transmitter and recovers the desired signal. Cross-correlation of different spreading codes ideally zero, so that the desired signal can be recovered and interfering signals can be removed at the receiver. In CDMA power control is originally used to solve **near-far** problems in the uplink of the cellular CDMA networks, where homogeneous traffic is supported.

4. Proposed system

The configuration of Cellular based system shown below is commissioned to meet the secured voice communication requirements with commercially available sleek mobile handsets and to evaluate the system performance.

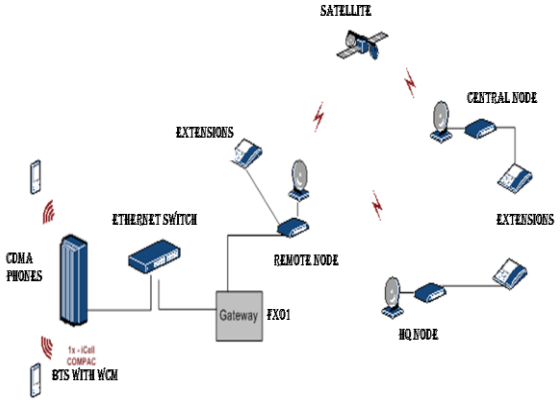


Fig 4.1: CDMA Cellular System with Satellite link connectivity via Gateway

The Base Station is a compact/ portable outdoor weatherproof unit with easy installation and having integrated features of Core Network and Radio Access Network functionalities.

It is a portable system with terrestrial connectivity for localized operations and by Satellite communication link for external connectivity.

Tested with antenna mast height of about 16 feet and obtained Radio Range of 2 Kms radius with 10W RF output power.

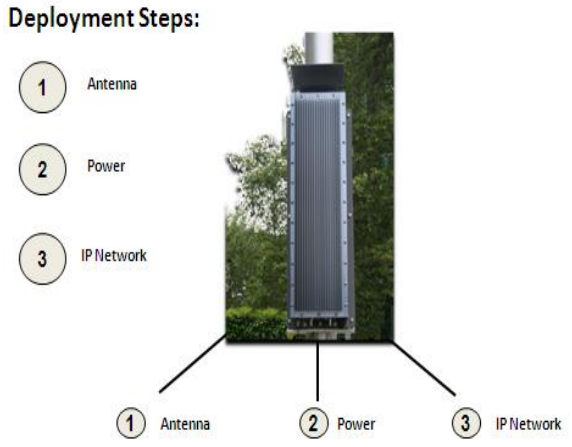


Fig 4.2: Portable BTS

5. Technical specifications of the BTS:

5.1: ***Capacity / Performance***

Configurations: 1FA/1S (Omni or directional sector)

RF Output Power: Up to 10 W at antenna port

Channel Elements: 64 Forward / 32 Reverse

Packet Data Rate (Peak Burst) : 153.6 Kbps Fwd/153.6 Kbps Rev

5.2: Frequency Bands

Band Class 0: Tx: 869–894 MHz | Rx: 824–849 MHz

Band Class 1: Tx: 1930–1990 MHz | Rx: 1850–1910 MHz

Band Class 5, Block A : Tx: 462.5–467.5 MHz Rx: 452.5–457.5 MHz

5.3: Protocol Support

Signaling: IOS/IP or SIP interface

Voice Traffic: RTP/IP

Packet Data: GRE/IP

OA&M Interface : SNMP v2c

5.4: Interfaces Hardware

Antenna Connectors: N-type female

Dimensions: 725 mm H × 220 mm W x 182 mm D(28.5 x 8.7 x 7.1 in.)

Weight : 20 kilograms

Input Voltage : -48 VDC

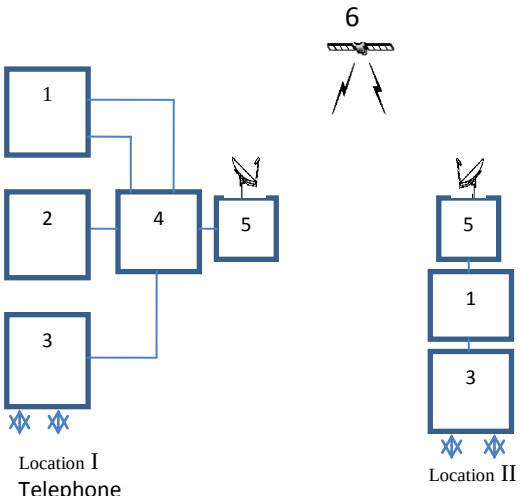
Power Consumption : 100 W

Here the satellite is chosen to link the BTS and BSC, during natural disasters like flood, cyclone, tsunami, since the BTS is most vulnerable to damage interrupting the BTS-BSC link. In this case, a quick restoration of the BTS and BSC link is required, where satellite link is only feasible. However the large satellite RF terminal size and its deployment time limits the feasibility of the satellite link for a macro BTS (bigger capacity), having large coverage area.

To overcome the limitation, a micro/pico BTS with limited coverage area plugged to a portable satellite terminal like GSAT-12 terminal can be used for an instant restoration of the communication link. Keeping apart the satellite visibility, the present system provides voice services over commercially available cheaper mobile handsets in the areas which are otherwise not feasible by terrestrial link.

This network can independently co-exist with other CDMA cellular networks and can extend connectivity to PSTN and other CDMA cellular networks with software upgrade.

6. **The proposed configuration is shown below:**



1) Matrix Eternity 4) 8 Port D-link
2) CDMA COMPAC 5) IDIR
3) Matrix SETU 6) Satellite Terminal

Fig6.1: Block diagram of CDMA based cellular communication system

The Cellular Communication System is interfaced with LOCATION 1 Telephone Exchange through Primary Rate Interface (PRI), so as to enable the calls between Mobile Subscriber Units and Landline Telephones.

The dial plan for the CDMA mobile users is as follows

Step 1: Each CDMA mobile phone is assigned a four-digit number of 9 series, Eg: 9001, 9002

Step 2: Calls among the CDMA mobile phones should take place by dialing respective four digit numbers

Step 3: Any Existing IP-PBX user should also be able to call the CDMA mobile phone with the given four-digit number of each CDMA phone in single step and vice versa

Step 4: External calls to PSTN /PLMN from the CDMA mobile phone should follow the same procedure as of IP-PBX users. The IP-PBX users will dial the PSTN or PLMN subscriber by prefixing zero (for example If the PLMN subscriber is 9*******788, the CDMA mobile user should able to access this number by dialing 09*******788).

Step 5: Any PSTN/PLMN subscriber can call to CDMA mobile user say XXXX by dialing on a PSTN number 0862322XXXX.

7. Result Analysis

Fig 7.1: Web browser based BTS status display page

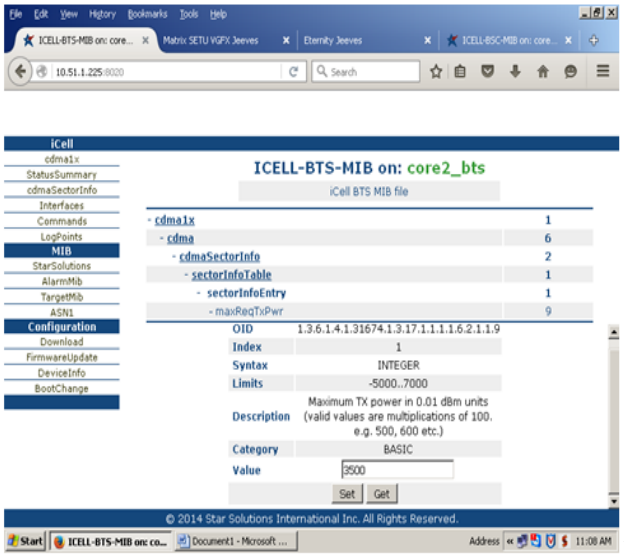


Fig 7.2: BTS transmitter power level configuration change page

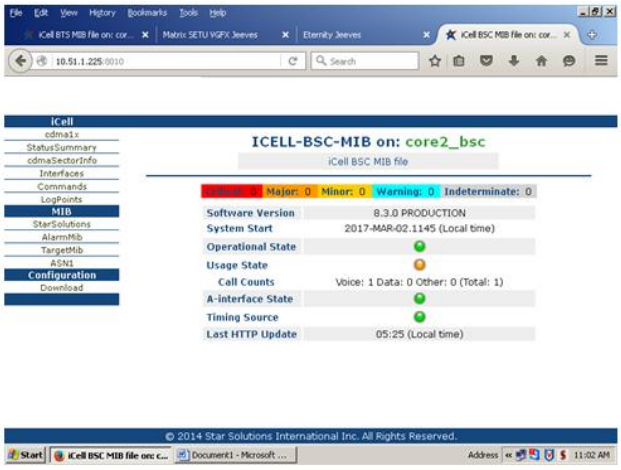


Fig 7.3: Web browser based BSC status display page

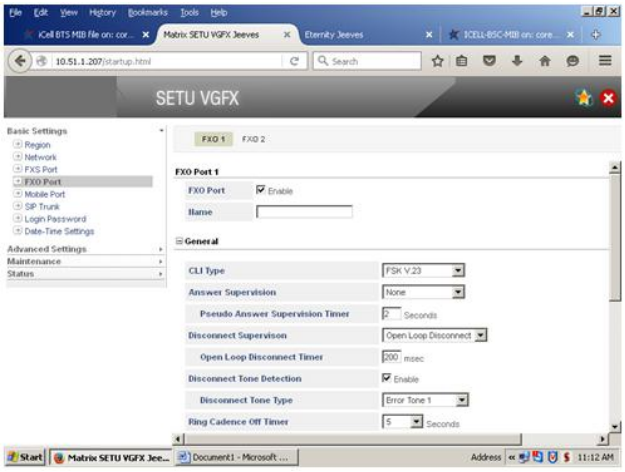


Fig 7.4: PSTN interface configuration page of telephony gateway unit

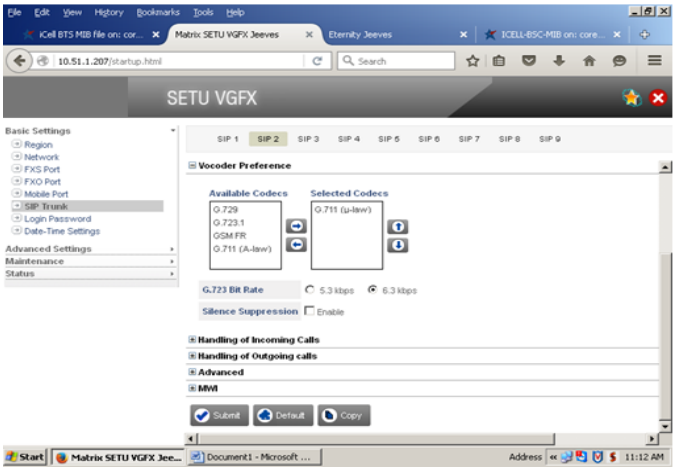


Fig 7.5: PSTN interface configuration page of telephony gateway unit

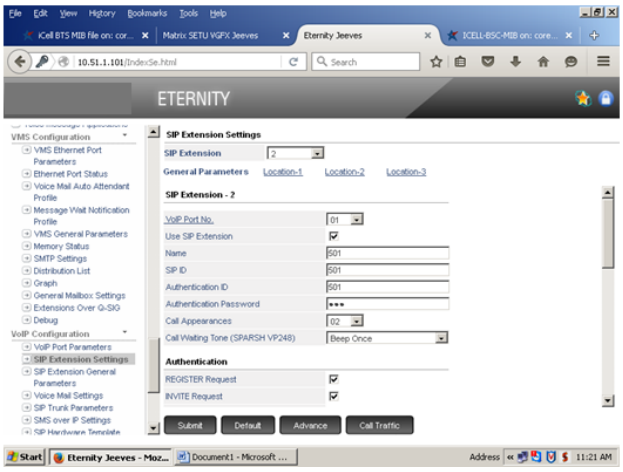


Fig 7.6: Configuration page of IP-PBX unit

8. Conclusion

The Communication/ telecom networks evolved from analog PSTN to digital ISDN, the wireless GSM/ CDMA and then the packet IP network. Superior voice quality, faster communication, better and more services and reduced communication cost are the fruits of these technological developments.

The project dealt with the Integration of two or more technology devices (CDMA Base Station, analog PSTN, Satellite Communication Terminals), which is a challenge by itself, as interoperability issues may arise if not configured properly as per the industry standard protocols, maintaining the toll-grade voice quality of the integrated/ interfaced networks.

The project is only to functionally evaluate the performance of the integrated/interfaced systems with a single site CDMA Base Station installed with a near Omni-directional antenna (8.5 dBi), which gave an area coverage of around 3 Km radius.

The project can be further expandable with multi-site networked CDMA Base Stations with highly directional antennas (15 dBi) for wide coverage area along with improvement in total system call handling capacity & soft handoff.

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