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BASE TRANSCEIVER STATION

1.1 OVERVIEW

The Base Transceiver Station (BTS) consists of a single rack or cabinet that houses the necessary elements for a point to multi-point RF communication network. A single BTS may contain 1 or 2 Radio Base Units (RBUs). Each RBU contains all necessary Transmit/Receive equipment required for the operation of a single sector or cell. A modular design provides for multiple co-located BTSs.

The architecture of the system is flexible, and can accommodate small or large numbers of subscribers. It can also be adapted for use in rural, suburban, and urban environments.

1.1.1 INTRODUCTION

The Eagle Telephonics, Inc. AirLink 8000 system is a WLL Specific system based on digital radio technology. Specifically, it employs direct sequence, spread spectrum based, Synchronous CDMA (S-CDMA) techniques over the air link to provide local access to subscribers. It offers very high quality, highly reliable service at costs that are very competitive with the wireline solutions. The system has very high spectral efficiency and thus can provide wireline quality service with limited available bandwidth. Its large dynamic range allows it to be deployable in virtually all environments, meeting specific needs of dense urban, suburban, and rural communities in an economical way.

Some of the key attributes of the system are:

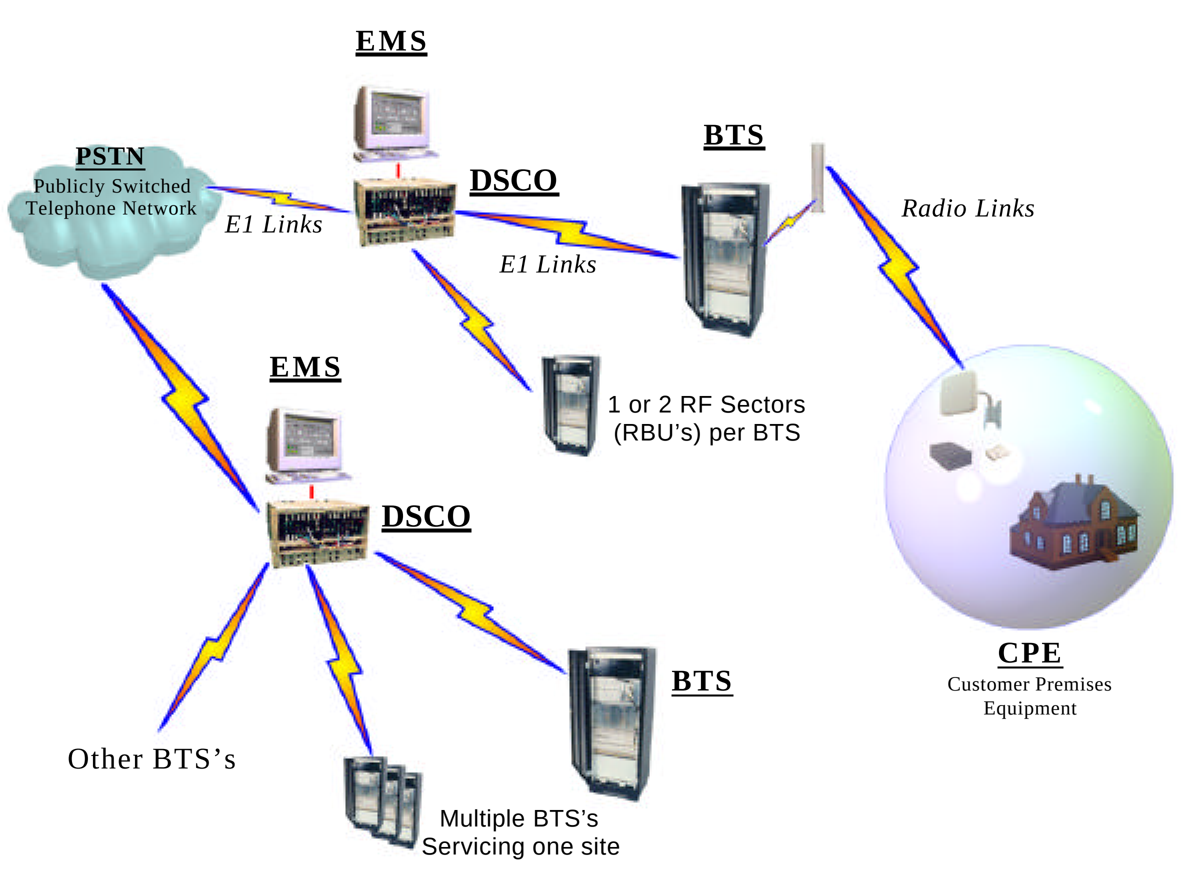
-- Wireline voice quality delivered at 32 or 64 kbps.
-- High throughput for data and fax applications with 32 or 64 kbps throughput.
-- High service reliability with good tolerance for noise and ingress.
-- Secure airlink that is virtually impossible to break into or eavesdrop.
-- CLASS services are supported.
-- Enhanced services like priority/emergency calling - both inbound and outbound.
-- Full switching services available.

For the network operator, the system provides several benefits:

-- Advanced graphical operator interface.
-- Equipment cost per access line is low and very competitive with average wireline costs.
-- In typical deployments, over 70% of the per line equipment cost is on the subscriber end; thus most of the investment needs to be made only when signing up paying customers.
-- Quick and easy installation and provisioning process.
-- Low maintenance costs reduce the life cycle costs and total cost of ownership.
-- Theft deterrent system (stolen or misused equipment will not operate). With properly implemented procedures, even installation/maintenance staff cannot beat the system.
-- Ability to provide high quality digital data services at 64 to 256 kbps and beyond increases the appeal to business and discriminating customers and provides opportunities for premium revenue producing services.
-- Economically viable over a wide range of subscriber densities and hence can be used for stand alone as well as overlay networks. It can also easily grow with the subscriber population.
-- The system will grow with customer needs and be able to provide higher bandwidth data/video services.

1.1.2 GENERAL ELEMENTS

The diagram below depicts the elements of the system.



As depicted, there are four main elements of the system:

- -- The Digital Switching Central Office (DSCO) connects the system to the rest of the public network.
- -- The Base Transceiver Station (BTS), which each may include the electronics for 1 or 2 RF sectors (Radio Base Units, or RBUs), controls and aggregates large numbers of radio links.
- -- The Customer Premises Equipment (CPE) provides the subscriber end of the radio link and provides the standard wireline interface to the customers telephony equipment
- -- The Eagle Management Suites (EMS) Software, which provide control to the overall system.

The Eagle Management Suites (EMS) provides the Operations, Administration, Maintenance, and Provisioning (OAM&P) functions and EMS also provides programming control of the DSCO, Collection of the subscribers call records (CDR) and contains the Eagle Billing Suite (EBS) for real-time billing of the subscriber base.

Some of the distinguishing characteristics of the system include:

-- Full duplex Synchronous Code Division Multiple Access (S-CDMA) operation that provides higher user capacity than competing technologies and systems:

1) Three to five times capacity advantage over conventional asynchronous CDMA technologies

2) Three to seven times capacity advantage over Time Division Multiple Access (TDMA) technology

-- Modular system design allows service providers to incrementally deploy wireless service, increasing user densities and capital expenditures while initiating revenue recovery

-- State of the art custom ASICs for improving reliability and packaging, and for lowering the system power requirements and overall cost

-- Complete system redundancy and hot swap capability for all central equipment provides for high reliability

-- Real time Call Record Collection.

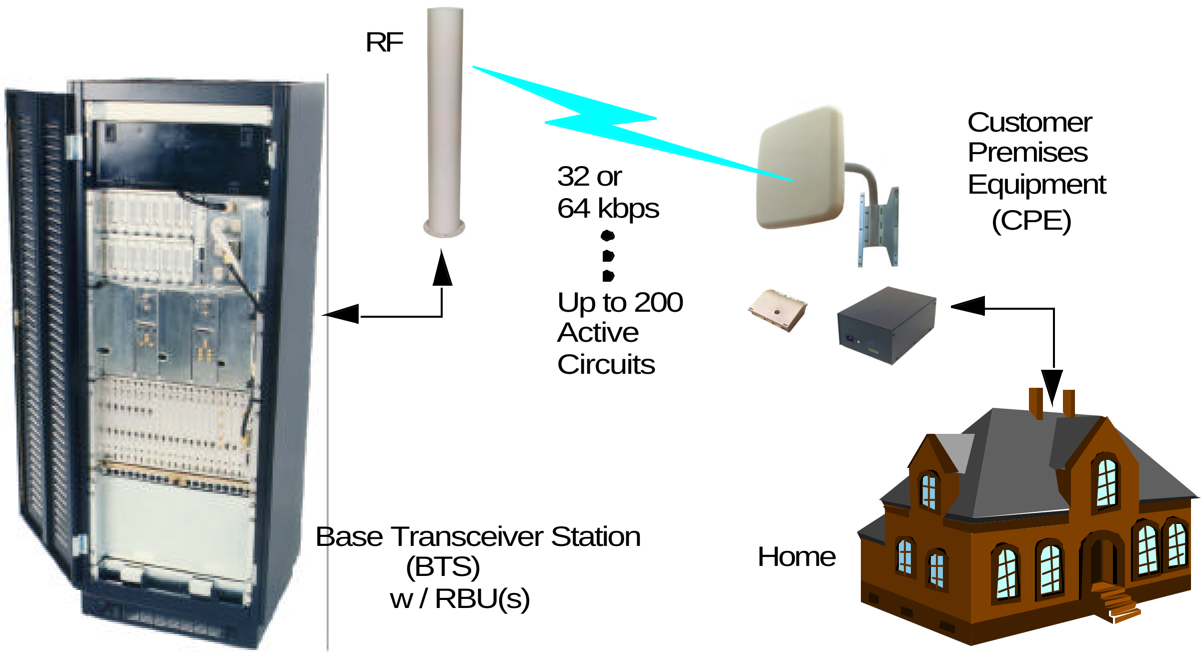
-- Monthly Invoices to the Subscriber Base

-- On-line Subscriber status with the ability to change Customer features.

Note: See the Eagle Telephonics, Inc. Support Manual for complete details the Eagle Management Suites for the operation and description for the Software.

1.2 GENERAL DESCRIPTION

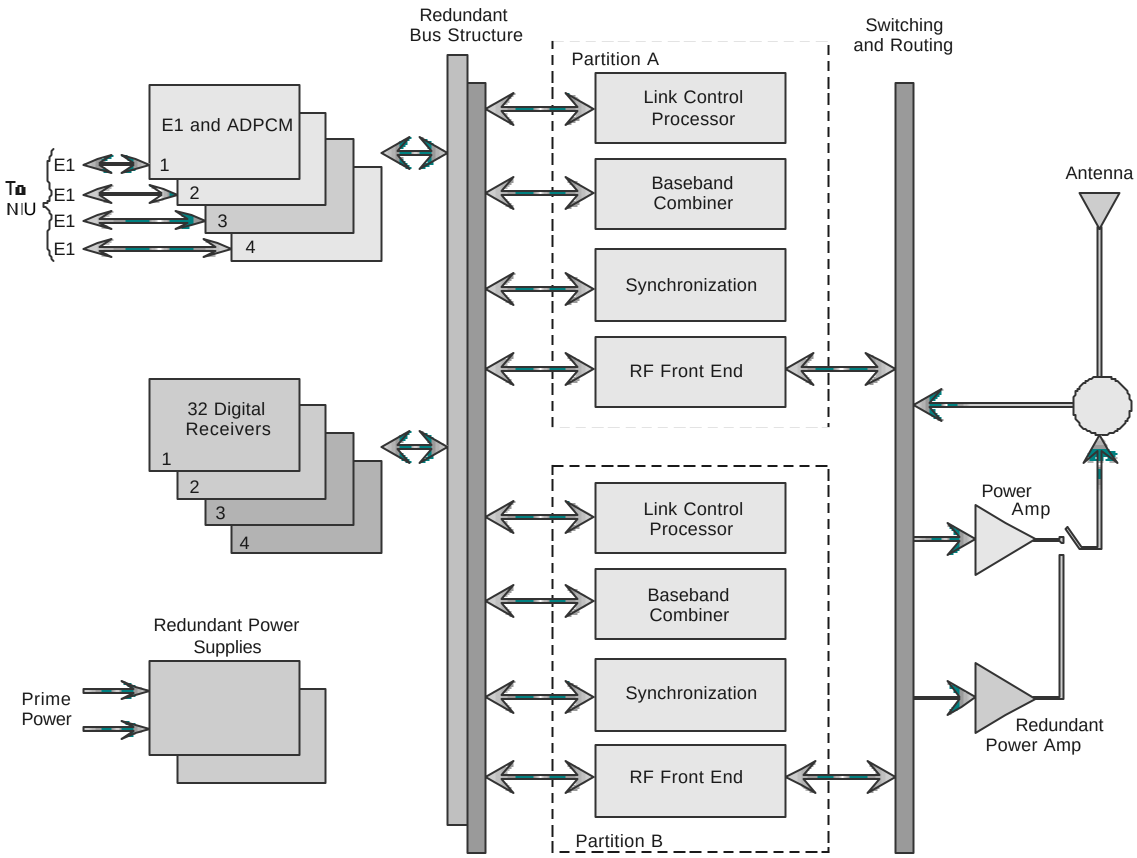
The AirLink 8000 system Base Transceiver Station is described in this section. The design philosophy has been to use advanced technology in order to create a point to multi-point system with high bandwidth efficiency, and comparatively large range. Attention has been paid to expandability of future services and requirements, high reliability, service security, fraud prevention, emergency services, and many other features.



The following information entails the workings of the BTS in conjunction with the CPE. Antenna characteristics are matched to the CPE along with controls signals.

See the CPE Overview for a more complete description of the CPE.

1.2.1 BLOCK DIAGRAM OF THE BTS



Multiple RBUs may be co-located to configure local cells or scattered to form multiple cells. Two RBUs can be located in each Base Transceiver Station Cabinet. Each RBU uses a separate RF transmitter and receiver front end but may share a single omni antenna with other RBUs or use a dedicated antenna.

An RBU is configurable such that it is capable of operation in a contiguous cell deployment wherein the operation of any one cell does not prohibit the operation of any adjacent cells.

The modular nature of the RBU accommodates a combination of redundant and high reliability hardware to provide the necessary resiliency to provide a high MTBF. The RBU interfaces with the DSCO via one to four E1 connections. An Operation, Administration, Maintenance, and Provisioning (OAM&P) interface is provided for each RBU, but the standard OAM&P interface is to the DSCO.

The RBU connects to the Network Interface Unit (DSCO) which is the Eagle Telephonics, Inc. DSCO, via multiple E1 type connections. 75-ohm BNC or 120 ohm dB connector interfaces are available. Optional Forward Earthing is available on both interfaces.

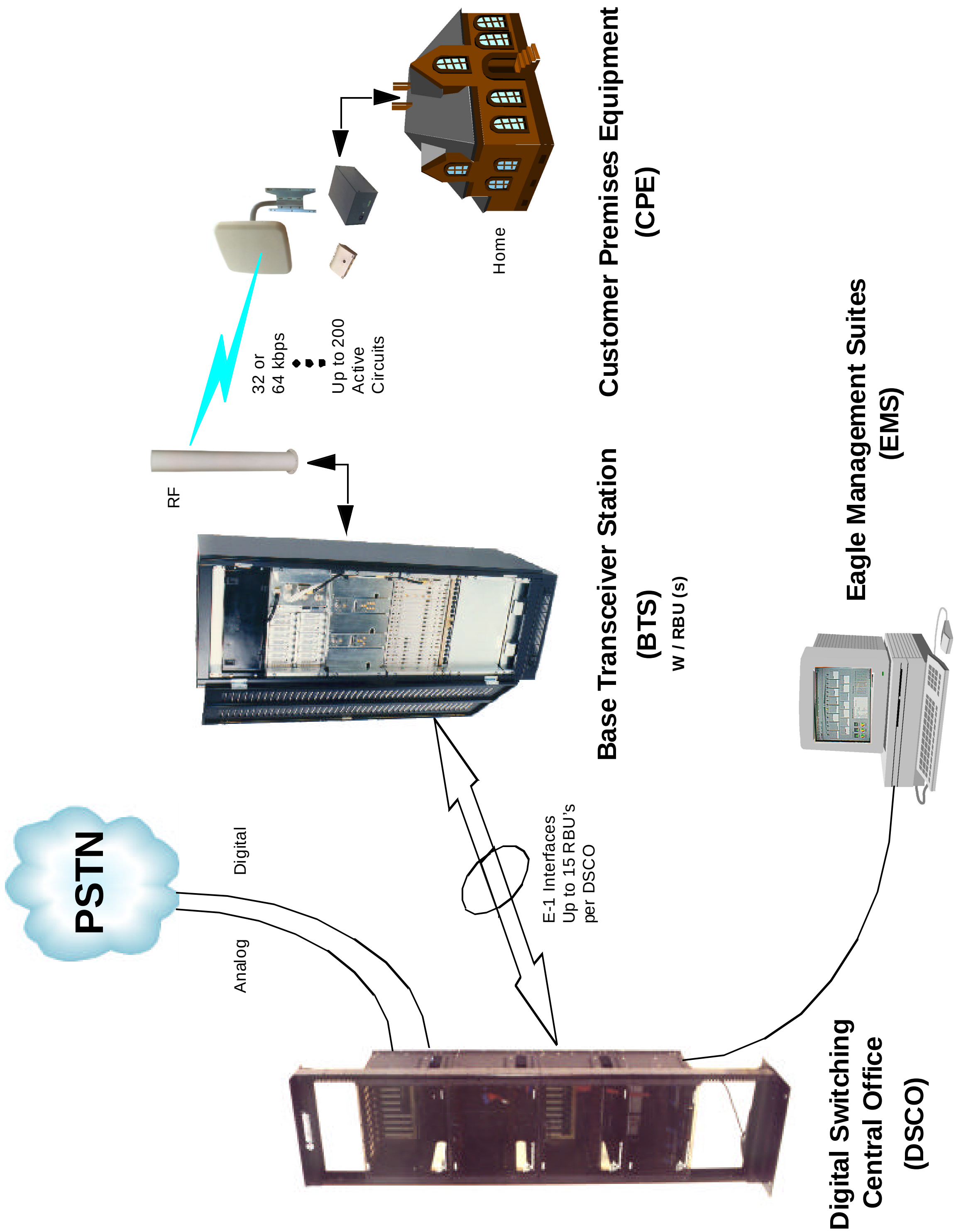
This E1 connection may be implemented via various interface links such as wire, optical fiber, or microwave radio.

All external signal cables and field replaceable modules are accessible from the front of the Base Transceiver Station, with the exception of the antenna cables, which are accessible from the top of the Base Transceiver Station.

1.2.2 OVERALL SYSTEM

For purposes of understanding the placement of the BTS in the AirLink 8000 system, the following diagram shows all of the elements of the Eagle AirLink 8000 system:

The four main elements are the BTS, CPE, DSCO and EMS:



1.3 Hardware Description.

There are three primary subsystems in the Eagle Telephonics, Inc.'s AirLink 8000 system — the Eagle Telephonics, Inc. Digital Switching Central Office (DSCO), Base Transceiver Station (BTS), and Customer Premises Equipment (CPE). The CPE itself has three primary components — the Subscriber Unit (SU), the Network Termination Unit (NTU), and the Uninterruptible Power Supply (UPS). The DSCO and the BTS share the Eagle Management Suites (EMS) for all OAM&P functions, central office control and subscriber programming. The DSCO connects to the public telephone network via analog or digital trunks. The BTS connects to the DSCO using E1 trunks and to its master antenna using a coaxial cable. The SU communicates with the BTS via the radio interface. At the customer premises the NTU serves as the connection point between the SU and the subscriber's standard telephony termination point, and the UPS interfaces to the subscribers primary power using a standard cable. Further details are presented below along with appropriate diagrams.

1.3.1 Digital Switching Central Office

The Digital Switching Central Office (DSCO) is the system's interface to the public network. Its primary purpose is to provide the specific protocols and signaling that are required by the public network. These protocols can vary by the country as well as by the customer and even by the connecting point in the network.

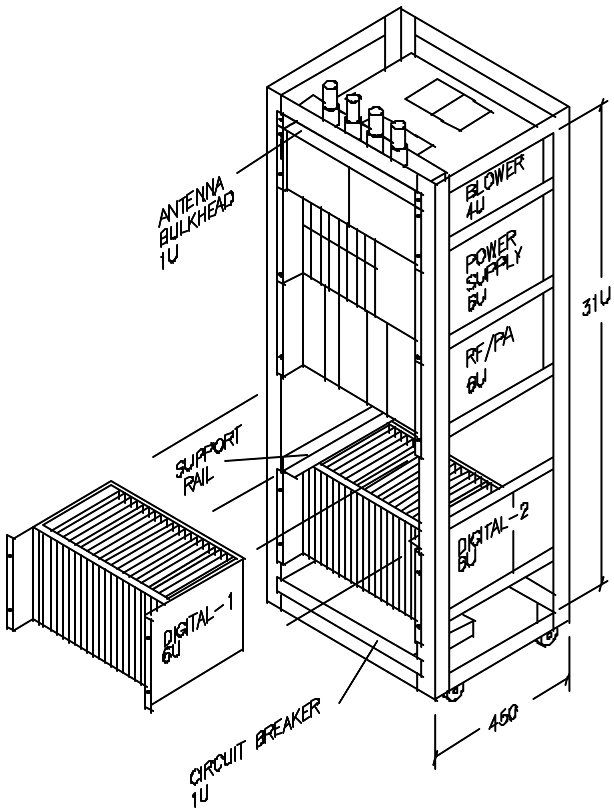
The DSCO can connect to a maximum of 15 RBUs using 1 to 4 E1 connections per RBU with 4 E1s needed for a fully populated RBU. In addition, each DSCO may be configured for a maximum of 10,000 subscribers. Time Slot 16 on each E1 trunk is used for passing control information between the DSCO and the attached RBUs as well as for passing information to and from the controlling EMS. Specific functions provided by the DSCO include:

-- Provisioning of dialtone to the Subscriber Units
-- Set up and tear down of voice and data calls
-- Billing system interface
-- Call priority management (drop least priority when all channels are used)
-- Channel reassignment for calls in progress
-- Detection of hook flash to enable POTS+ calling features
-- 32 to 64 kbps rate change initialization
-- Pay phone capability (12/16 kHz tone detection, line reversal)
-- Priority and emergency number calling
-- Accommodation of country specific signaling interfaces such as E&M, R2, R2 variants, V5.1, V5.2, C7, and C7 variants
-- System modularity: analog/digital options for both line side and trunk side
-- Full redundancy and hot swap for all circuit cards

Note: See the Eagle Telephonics, Inc. Installation and Maintenance Manual (IMM) for complete details of operation and description for the DSCO.

1.3.2 Base Transceiver Station

The BTS consists of a standard front access 19” telephony equipment rack (31U high), populated with up to four equipment subracks. The subracks provide all the functionality required to interface to the DSCO and may include the electronics for 1 or 2 Radio Base Units (RBUs) which provide radio communication to all CPE within a cell or sector. The RBUs are connected to external antennas that communicate with the SUs.



Base Transceiver Station - Mechanical

1.3.3 Base Transceiver Station - Mechanical

The antennas can be located up to 100 meters from the BTS using a 50 W coaxial cable. The antenna location is chosen to optimize transmission characteristics to the served SUs (principally line of sight). The RBU is fully redundant and all field replaceable units are hot-swappable. RBU accepts 48 or 60 VDC power with 15% tolerance.

1.3.4 Eagle Management Suite

The EMS is a personal computer based platform that is used to provide all the Operations, Administration, Maintenance, and Provisioning (OAM&P) control for the system. The EMS is hosted on a Windows NT® compatible PC platform and uses a Graphical User Interface (GUI) to facilitate operator inputs and report system information. Functions managed by the EMS include initiation, control, and data logging of all system wide tests, alarm reporting, operator entry of system parameters, and entry and maintenance of subscriber information such as priority, ID, and phone number. The EMS also acts as the administration terminal for system configuration and reporting.

1.3.5 Customer Premises Equipment

The Customer Premises Equipment consists of three separate hardware units — the Subscriber Unit (SU), the Network Termination Unit (NTU) and the Uninterruptible Power Supply (UPS). All of the CPE units are located at or near the end user’s location. A typical installation would find the SU located on an exterior wall or rooftop to enable wireless communication with the RBU antenna, the NTU mounted at a ground accessible exterior point on the customer building, and the UPS located within the building.

1.4 EVOLUTION

The present system is targeted to meet the needs of a vast majority of business and residential customers, particularly in the countries/regions with inadequate telecommunications infrastructure. Its features and functions will serve the needs of discerning consumers desiring a high quality service that includes data in addition to voice. Such consumers include middle/upper income residential customers as well as small businesses throughout the world.

With its inherent broadband orientation, the system has a strong appeal in competitive access markets. The system will evolve to provide broadband data services (beyond ISDN basic rate) to further enhance its appeal to business customers. It is also well positioned to serve the need for specialized overlay networks that may be geographically dispersed in a metro area.

To further improve the economics of deployment, additional multi-line subscriber units are planned to serve the needs of subscribers in close geographical proximity. A 32-line unit is slated for the near future.

1.5 SUMMARY

Rapid advances in digital radio technologies have made high quality telecommunications services feasible and economical using radio instead of wireline. Radio offers advantages over wireline deployment in the areas of lower initial cost, lower maintenance costs, and rapid deployment and is thus increasingly becoming the medium of choice for operators looking to rapidly expand their networks.

The Eagle Telephonics, Inc. AirLink 8000 is a custom designed fixed wireless system using leading edge CDMA technology. It provides wireline quality at an initial cost that is very competitive with wireline solutions. Advances in digital radio technology and increasing volumes virtually ensure that it will be the technology of choice for most fixed telecommunications applications.

By providing voice at 32 Kbps and data at 64 Kbps, the system meets or exceeds the quality and performance of wireline systems. Adjustable dynamic range of a cell from 100m to over 30 km enables the system to be deployed in a variety of situations ranging from dense urban to sparse rural. It further enables the system to be deployed as the primary network infrastructure or as an overlay network for specialized services or for select user communities. The security and reliability of the CDMA technology ensures privacy, theft deterrence, and noise/interference immunity.

In the not too distant a future, digital radio technology will be able to provide seamlessly integrated, economic, high quality, feature rich service to every user - fixed and mobile. Building a wireless infrastructure for fixed services is a necessary first step in realizing such a goal and minimizing the risk of leaving behind stranded, non-upgradable assets.

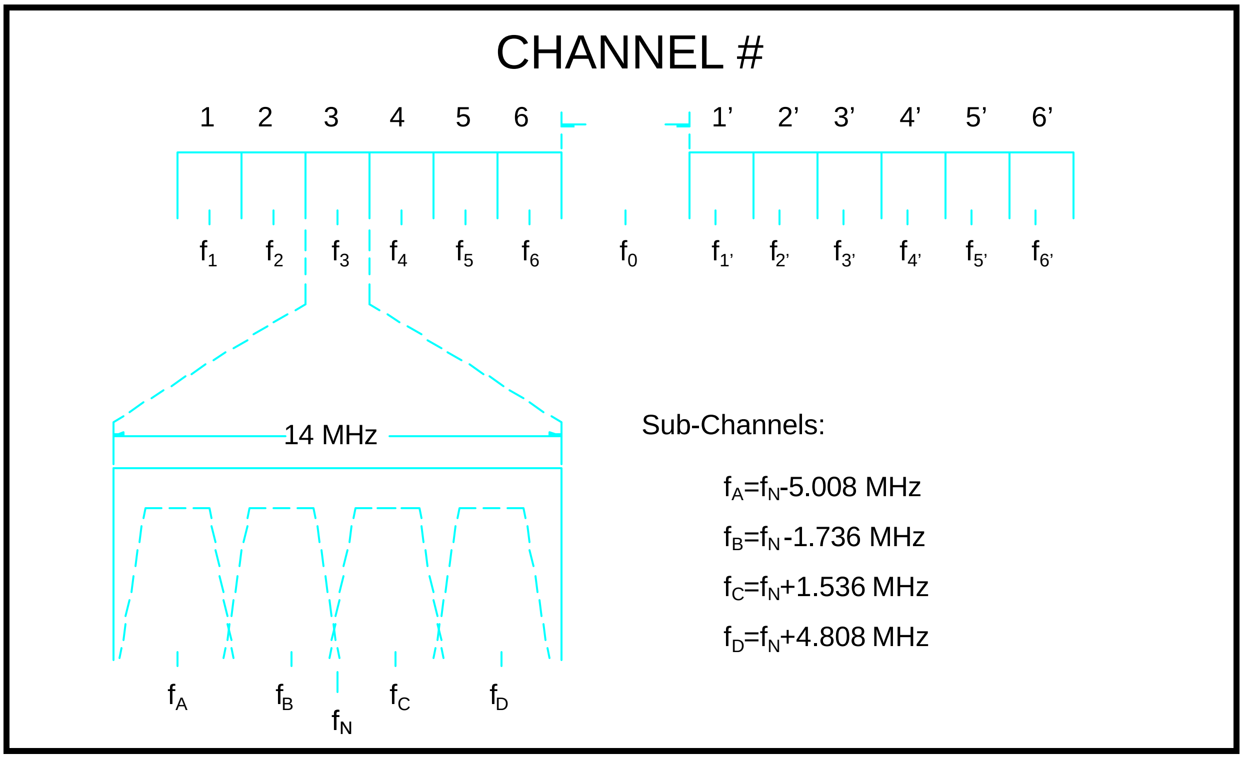
1.6 RADIO FREQUENCY DETAILS

1.6.1 Radio Link

Some of the important characteristics of a radio access link are — the spectrum used, frequencies of operation, spectral efficiency, multiple access protocol, dynamic range, and traffic carrying capacity. These aspects are discussed in detail below for AirLink 8000.

1.6.2 Spectrum & Frequencies

As mentioned earlier, AirLink 8000 is a CDMA system. It requires a separate 2.72 MHz (3.5 MHz including guardbands) channel in each direction separated by either 100MHz, 119 MHz, or 175 MHz of bandwidth, depending on the band of operation. The system will operate in one of four 3.5 MHz sub-channel pairs in one of the 14 MHz channel pairs as allocated by ITU-R 283-5, and shown below.



Currently available spectrum of operation is 2.1 - 2.3 GHz and 2.5 - 2.7 GHz (per ITU-R 283-5), 3.4 – 3.7 GHz (per CEPT REC. 1403-E, ANNEX B), and 2.0 – 2.3 GHz (per ETSI DE/TM 04031).

1.6.3 RBU Capacity & Spectral Efficiency

One RBU can support 128 simultaneous 34 Kbps channels using the 2.72 MHz bandwidth giving it a spectral efficiency of 1.6 bits/Hz. Of this total capacity, 9 channels are used by the system and an additional 2 Kbps per channel is system overhead. Thus the effective traffic carrying capacity is 119 channels at 32 kbps. In order to further assure continued operations under less than ideal environmental conditions, the system is conservatively rated for 100 channels at 32 Kbps.

The spectral efficiency of the system is 3 to 5 times that of competitive CDMA systems primarily because this system employs bi-directional Synchronous CDMA (S-CDMA). Competing systems, including those based on IS-95 are asynchronous or at best synchronous only in one direction. The bi-directional synchronicity permits this system to use near orthogonal codes and gain maximum possible data carrying capacity. As designed, the system is code limited unlike most other CDMA systems that are noise or interference limited.

1.6.4 Power Control

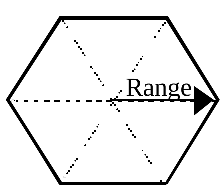
Radio emissions lose energy as they travel in air over long distances. In order to ensure that the received signal energy from a distant subscriber is not completely overwhelmed by that of a near subscriber, the RBU controls the power level of the subscriber unit. In this system, only the reverse channel power (from SU to the RBU) is controlled by the RBU. This power control is primarily established at SU initialization. Subsequent power adjustments are likely to be infrequent and mostly in response to transient environmental conditions. The closed loop power control is implemented by comparing against a desired power level and making incremental adjustments until the desired level is achieved.

The forward channel power control is not needed since each SU receives its entire signal at only one level. The RBU merely to ensures that the received signal strength by the farthest SU is sufficient for its application.

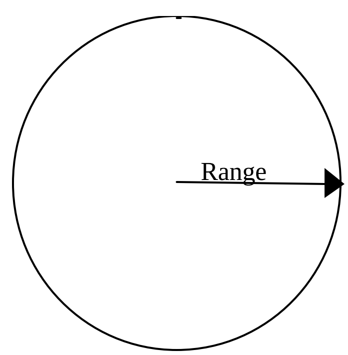
The nominal average power in both directions is 14dbm.

1.6.5 Range

The range of an RBU is nominally determined by the farthest SU that can be served by the RBU. This implies that the range is determined by the farthest SU that has a received signal strength that is large enough to keep the bit error rate below the acceptable threshold. This system is nominally designed to serve an SU at a distance of 10 km from the base station antenna with a bit error rate of less than 1x10 -6. Given good line of sight and environmental conditions, this range could be further extended up to 30 km or more.



Typical Urban/Suburban Deployment
Typical Range: 100m to 10 km.



Typical Rural Deployment
Typical Range: 10 to 30 km.

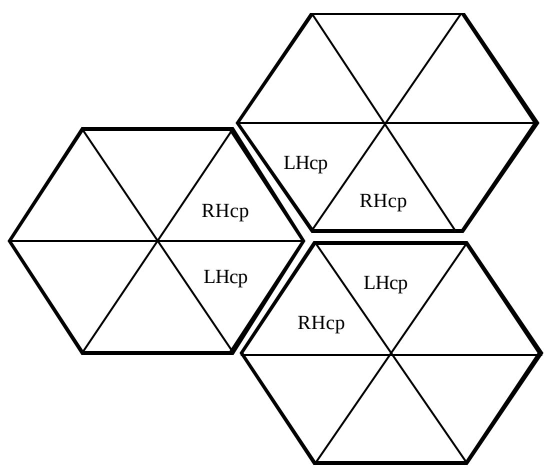
It is not always desirable to have an extended range. In a dense urban or even a suburban setting, one needs to deploy the system in a cellular architecture as depicted below. To reduce interference between sectors and between cells in such a deployment, one needs to limit the range of an RBU - overall as well as selectively in specific directions. Such range control may be accomplished using directional master antenna at the RBU as well by controlling overall RBU power.

This system has been designed with a dynamic range control of 100m to 30 km. Hence in a dense urban setting with need for pico-cell deployment, the RBU range can be pulled back to as low as 100m. In an overlay network with scattered users or in a semi-rural setting the range may be extended to 30 km and beyond. Of course the actual range that can be realized depends on site specific conditions.

1.6.6 System Capacity

As mentioned before, the system is rated to provide at least 100 simultaneously active 32kbps channels using 3.5 MHz bandwidth in each direction. Traffic engineering based on the nature, distribution, holding time and other parameters would determine the number and type of subscribers that can be put on a single RBU.

Traditional cellular deployment involving sectors, cells, and multiple frequency pairs is the most pragmatic approach to increase capacity in presence of limited spectrum availability. A typical 6 sector cell layout is depicted below with reverse circular polarity.



Six sector hexagonal cell layout with reverse circular polarity in adjacent sector

There are three main parameters to consider when designing the cellular layout — range of each cell, number of sectors in each cell, and the frequency reuse pattern (in adjacent sectors and cells). If a number of frequency pairs are available, it is best to use different frequencies in adjacent sectors to minimize co-channel interference. However, unlike the analog and TDMA systems, the system does function with minimal capacity loss even with one frequency pair. In any situation, additional frequency pairs will increase the overall traffic carrying capacity of the system.

The number of sectors is a function of traffic to be carried, actual distribution of traffic, and the antenna availability and cost. To reduce adjacent sector interference reverse circular polarization is recommended with adjacent sector antennas having alternating Right Hand (RHcp) and Left Hand (LHcp) circular polarity. This alternating circular polarity provides an additional 6 dB separation, thereby decreasing adjacent sector interference. For uniformly distributed traffic, a 6 sector approach is recommended as antennas are relatively common for the 60º beam width. However, the number of sectors is not a fixed number as the system can accommodate different number of sectors as needed.

The range of each cell is a function of traffic distribution. The system is designed so that the RBU power can be adjusted to control the nominal cell/sector range from 100m to 30 km. Of course the maximum cell size is dependent on prevailing topography and other environmental conditions and acceptable bit error rate.

This system is likely to suffer minimal capacity degradation under a single frequency reuse pattern for the following reasons:

-- The directional antennas and fixed application provide the flexibility to setup the RBU and SU antennas so as to minimize interference, something that cannot be achieved with systems using omni SU antennas. An SU is more likely to suffer interference from an adjacent cell rather than an adjacent sector.
-- Alternating reverse antenna polarity reduces adjacent sector interference along common boundaries.
-- Synchronous CDMA inherently reduces interference effects by rejecting signals outside the time slot (chip boundary). This effect is further enhanced by randomization of the P/N codes.
-- The ability to adjust the RBU power to meet the needs of the cell size without sacrificing capacity reduces interference from adjacent cells.
-- The system is code limited, not noise or interference limited. Hence there is a buffer for additional interference from adjacent sectors without degrading the capacity.

The combined effect of all these factors is that the system can be used in a multi-sectored cellular architecture with just one frequency pair to provide exceptionally high traffic carrying capacity. The following table illustrates different scenarios for load carrying capacity of a single RBU system. The Load Density column indicates the traffic that could be carried with cells sectorized as indicated with one RBU per sector per cell.

Scenario	Cell Radius	Sectors	Area/Sector	Capacity	Load Density
Metro	100m	6 (60º)	0.00433 km^2	100 Erlangs	23,000 Erlangs/km^2
Urban	500m	6 (60º)	0.10823 km^2	100 Erlangs	920 Erlangs/km^2
Suburban	1 km	6 (60º)	0.433 km^2	100 Erlangs	230 Erlangs/km^2
Rural	10 km	1 (omni)	314.16 km^2	100 Erlangs	0.32 Erlangs/km^2

The actual number of subscribers per RBU is limited to 2,500. Thus in the limit, the system could serve a subscriber density of 460,000 per km2 (which should be more than sufficient for even the most densely populated cities). In the more common urban scenarios with a cell radius of 500m and with a relatively high traffic load of 0.1 Erlangs per subscriber (for a total of 1,000 subscribers per RBU), the system can serve a subscriber density of 9,200 subscribers per km2.

All of the numbers stated above are for single frequency re-use. Higher traffic densities can be served with multiple frequency pairs. Thus the system has sufficient margins to serve high subscriber densities even when the traffic carrying capacity is somewhat degraded due to adverse environmental conditions.

1.6.7 Call Processing

When an SU detects an off-hook (the user has picked up the phone), it will transmit an outgoing call request on one of the 6 reverse synchronous side channels in a Slotted ALOHA fashion. The side channel is chosen at random. The RBU will process this request and, providing an active channel is available, send an outgoing call reply to the SU which contains the active channel codes (both forward and reverse). In the meantime, the RBU will begin to transmit forward side channel data on the newly activated channel and at a given time, begin to transmit the active call data. The SU, which is listening to the forward side channel, will receive the active channel assignment and switch at a superframe boundary to the active codes. It will begin to receive the side channel data and then the active call data.

When an incoming call is received by the DSCO for one of the SUs in the local loop, the RBU will be notified. The RBU will first check to see if the intended SU is busy. If not, the RBU will send a message to the SU on the forward side channel that contains the active channel codes. The process then continues the same as the outgoing call processing discussed above.

If all channels are busy and the DSCO receives an incoming call for a non-busy subscriber, it provides a subscriber busy tone to the caller unless the called SU has priority inbound access (like a hospital, fire station, or police), in which case the DSCO will instruct the RBU to drop the least priority call to free up a channel for the called SU. Similarly, if an SU initiates request for service and no traffic channels are open, then the RBU provides the dial tone on a side channel and receives the dialed number. If the dialed number is an emergency number then the RBU drops a least priority call to free up a traffic channel and connect it to the SU. If the called number is not an emergency number then the SU is provided a “softbusy” tone indicating a “wait for service” condition.

1.6.8 OAM&P

Eagle Management Suite discussed earlier provides Operations, Administration, Maintenance, and Provisioning (OAM&P) functions. It is a software module that needs a Pentium II / 266MHz PC or better running Windows NT® with English language interface. It can be on dedicated hardware or co-resident with a compatible hardware platform running the Administration Terminal (AT) for the DSCO. The EMS can communicate with the DSCO using an RS232 interface or a LAN connection (like Arcnet or Ethernet) and can also be connected to an RBU using an RS232 connection.

1.7 OPERATIONS

Equipment Activation/Deactivation - All AirLink 8000 equipment components may be activated and deactivated. This is used variously in the provisioning and maintenance of the system as well as for security purposes (compromise/theft of equipment) or a change of over the air frequency planning.

Failure Detection - Failures are automatically reported to the EMS. The information is then reported, logged, and displayed according to operator defined parameters.

Status Display - A permanent Status Display window is provided as a part of the main screen of the operator console. The specific components for which status is reported are configurable by the operator.

Operator Interface - The Man Machine Interface (MMI) for the EMS system is hosted on a PC with a minimum configuration as described in the table below. The EMS platform uses a Graphical User Interface (GUI) that is achieved in part by the inherent “look and feel” of the Windows® architecture and complimented by other features specific to the OAM&P requirements of the AirLink 8000 system. The interface allows for either keyboard or mouse inputs and provides the operator with Status Display windows for selected equipment as well as an Operator Console that displays a wide range of information based on user selectable data filters. Included in the data filtering options will be options such as the displaying of system alarms on the basis of Type of alarm, Source of alarm, or Category of alarm.

Attribute	Processor	Operating System	Mass Storage	RAM	Monitor	Resolution
Requirement	Pentium II	Windows NT®	2 GB	64 MB	17” VGA	1024x768

Minimum EMS Host Platform Configuration

1.8 ADMINISTRATION

Security **-** System security is defined as the access protection afforded the AirLink 8000 subsystems. The System Log and Activity Reports discussed below contribute to system security but are not specific to security concerns. To simplify the administration process, all access procedures may be disabled by the service provider.

-- **RBU Access -** Three levels of operators are supported: System Administrator, System Manager, and Technician. Each class of operator has a range of defined access within the EMS and is uniquely identified by a combination of User ID and Personal Identification Number (PIN). As an added measure of protection, the EMS is capable of verifying user ID input by an external swipe card device.

1) A *System Administrator* is the only Operator able to perform all functions within the control of the EMS. Functions unique to an administrator are creation, modification, and deletion of other AirLink 8000 operators.

2) A *System Manager* has the ability to perform those functions required for daily operations and installation of subscriber equipment. A System manager may add Technicians to the system, provision users, and perform Operations functions.

3) Technician access is limited to actions associated with the installation and maintenance of the RBU and CPE.

-- **Subscriber Unit Access -** The SU is sealed with a lead seal at the time of installation in order to detect tampering of the unit. Additionally, an alarm is raised at the EMS console upon detection of possible theft of services or movement of the SU.

Activity Reports **-** The actions performed by the System Administrator, System Manager or Technician are logged to disk on the EMS terminal. The level of detail in the activity log is configurable by a System Administrator to allow for management of the disk space resources. The data logged to disk allows for reports to be generated for a class of operators over a given period of time. The System Administrator is responsible for periodic backup of the activity log using standard system functions.

System Log **-** The System Log records all system activity and is maintained in non-volatile memory in the EMS platform. Included in the System Log are faults, alarms, configuration commands, provisioning requests, and call activity. The level of detail within each area is configurable by the System Administrator.

The EMS also provides facilities for interrogating the System Log to select and display events in a straightforward manner. This includes facilities such as analysis of faults, reports on call activity for the system of a select group of lines, examinations of commands invoked by a particular operator, etc.

Subscriber Call Data **-** The EMS maintains subscriber call information similar to that used in typical Call Detail Record (CDR) accounting. This information includes caller ID, called party ID, call origination and termination times, call priority, and other lower level information used in calculating system performance statistics.

1.9 MAINTENANCE

Test and Diagnostics - The Test and Diagnostics functions are contained within the Built-In-Test (BIT) capabilities of the system. Inherent hardware and software tests exist within the AirLink 8000 equipment down to the level of a Field Replaceable Unit (FRU) and are designed to detect and isolate non-functional FRUs as rapidly as possible. At a minimum, the internal hardware tests for each FRU are able to indicate the operational status at power-on and upon request from the monitoring unit. More detailed software tests reside both internally and externally to the various FRUs and are used to further evaluate their operational status. Application of BIT is dependent on the current state or mode of the FRU(s). The three state conditions are defined as follows:

> **Initialization State.** This state is defined by a cold start or power-on reset on the FRU. BIT is always applied immediately with the results of the test used by software to determine the follow-on state. A successful initialization BIT transitions the FRU to an in-service state and an unsuccessful BIT transitions it to an out of service state.
>
> **Online State.** This state defines the FRU as active and in-service. The FRU may be continually monitored or polled for status while in the online state. Limited BIT routines may be applied periodically whenever the FRU is idle or as a part of routine testing such that it does not interfere with active users.
>
> **Offline state.** This state defines the FRU as out of service. BIT can be applied at anytime under control of the EMS software or System Operator as defined above.

RBU BIT - The RBU Built In Tests are the basic set of tests that are used to determine that the system may be brought into service and for detecting and isolating faults once the system has transitioned to an in-service operational configuration. During the initialization state, BIT is performed on the partitioned (Dual Redundancy) FRUs first. All FRUs associated with the partition must successfully complete the scripted BIT routines to allow the partition to transition to an in-service state. To complete the initialization state, the designated online Link Control Processor (LCP) ensures that BIT is performed on all the remaining FRUs. In the case of select FRUs not passing the initialization BIT but where limited operational status may still be achieved, the operator is presented with the option of proceeding to a degraded in-service mode.

SU BIT - The BIT for the SU is applied at SU initialization or upon request by the RBU (EMS). The SU is originally initialized during the provisioning of the unit at the customer location. Once installation has proceeded to the point of applying power to the SU, the SU BIT will verify the CCA (modem, RFFE, subscriber interface) operational status as well as that of the power supply (including battery backup) prior to entering an online state. Once link availability is established, the results of the installation and BIT are reported to the RBU and the SU is transitioned to an in-service state. Once the operational state is obtained, the SU continuously monitors the forward channel bit error rate and the status of the primary power, making this information available to the EMS on demand.

In addition to the unit specific tests for both the RBU and the SU, the EMS is able to command the initiation of system level BIT activities involving both the RBU and the SU. These include various RF and digital loopbacks, a make/break dial tone test, a telephone (or X.21 DTE) present test, and the monitoring of an extensive list of link performance data (Error Free Seconds, Bit Error Rate, etc.).

Repair and Maintenance Requests - Repair and Maintenance requests are initiated in three different ways:

> 1) A subscriber reports an equipment or service problem
>
> 2) An error condition requiring service is detected at the EMS
>
> 3) A unit - BTS or SU - is scheduled for periodic maintenance, replacement or upgrade.

Once a request is established through one of these three means, a Work Order is generated, resulting in technician response. Some maintenance actions may be addressed through the over-the-air download of software (patches or upgrades) to the SU. This will be accomplished over an assigned 64 kb/s channel with the software contained in the user data fields of the message frames.

1.10 Provisioning and Configuration

Provisioning and configuration activities involve initial provisioning of a new AirLink 8000 system and modifications to an existing system configuration. They are discussed briefly to familiarize the reader with some of the key provisioning concepts. A complete explanation of the provisioning process is covered in the AirLink 8000 Provisioning Manual.

1.10.1 Initial System Provisioning

Initial system provisioning is the first ever deployment of the AirLink 8000 product into a given geographical service area and is in effect whenever a new DSCO is being deployed. All other provisioning activity (addition of BTSs or RBUs, CPE) will be considered modifications to the existing configuration. Once the architecture (number of RBUs, CPE, service mix, subscriber locations, etc.) for the system is determined and the BTS is physically installed and connected to the DSCO, the system installer (using the EMS interface) configures the Link Control Processor in the RBU to accommodate the particular scenario being provisioned. The LCP has the responsibility to coordinate and maintain all radio specific provisioning parameters. All AirLink 8000 systems are pre-configured for a generic installation. Site specific parameters are used to tailor this generic configuration to meet local requirements. Provisioning data is categorized as:

-- Radio characteristics
-- Service configuration - Telephony, Data service, payphone
-- Hardware configuration
-- Periodic functions
-- DSCO/EMS configuration information
-- Subscriber and CPE information

Once the EMS, DSCO, and BTS components are successfully installed, the provisioning data entered for the CPE is used to create a Work Order to initiate the physical installation of the CPE by a technician (the overall procedures are not discussed here). The Initial Boresight Alignment Tool (IBAT) is the key craft accessory used in the provisioning the CPE/SU. The IBAT is a hand held, battery powered device that provides two essential functions in the installation of the Subscriber Unit:

-- Transfers technician ID/Work Order Number information to the RBU to verify the authorized installation of the SU (provides SU and service theft protection).
-- Assists the technician in aligning the SU antenna in a direction that maximizes RF link performance with the RBU. The IBAT reads the received power levels for various adjustment positions attempted by the installer. It stores the various signal levels and, after a series of readings, indicates to the installer when he has returned to the position of maximum link margin.

1.10.2 Modifying System Configuration

All modification of the system configuration is done through the EMS and must occur without disruption or impact to the service of current users. The EMS interface allows for the addition or deletion of DSCOs, RBUs, and SUs. In the case of the SUs, additional modifications may be made to change the randomizing code (unique to a single cell or sector) or change the frequency of operation to another of the four sub-band frequencies within the same 14 MHz F.283-5 channel. The RBU is also capable of temporarily discontinuing service to an SU for equipment repair or other reasons.

The over the air commands to the SUs may be made either individually, group addressed to a subset of the deployed SUs, or to all SUs in a cell or sector. The code or frequency change procedures will utilize a secure key system to ensure that unauthorized RBUs or imitators cannot instruct a change. Additionally, before the final command for a change is sent out by the controlling RBU, the RBU requires each SU to acknowledge that it has received the new code or frequency details and that a change is imminent. This allows the genuine RBU to raise an alarm if it receives this acknowledgment unexpectedly from any SU.

1.11 GENERAL FUNCTIONS

1.11.2.1 Protocol between RBU and SU

Command and status communication between the RBU and SU is provided via overhead control bytes contained in the active channel frame or in a frame sent on a 32 kbps side channel.

1.11.2.2 Antenna

An antenna with an N-type female connector should be located as close to the Base Transceiver Station as possible. This antenna may be mounted on a tower, pole, building or suitable structure.

1.11.2.3 RF Cable

The length of the 50 Ohm coaxial RF cable from the Base Transceiver Station to the antenna is site specific and is recommended to be type LDF5-50A manufactured by Andrew (attenuation for 100m of type LDF5-50A cable is approximately 6 dB at 2 GHz and 10 dB at 4 GHz). An N-type male connector is specified for both ends.

1.11.2.4 Grounding

A chassis ground stud is provided for connecting the Base Transceiver Station to a required earth ground point provided by the installer. ESD protection of the Base Transceiver Station is provided through hardwired chassis connection to earth and a local ground strap attachment point. All grounding should be in accordance with local code.

1.11.2.5 Prime Power Interface

The Base Transceiver Station accepts a positive ground DC input voltage source 40.8 through 69 VDC.

Terminal screws located inside the back of the Circuit Breaker Assembly are available to connect prime power.

1.11.2.6 System Health Monitor Function

System health is periodically monitored and results are stored at the RBU. Where possible the RBU and SU detect faults and isolate them to the failing Field Replaceable Unit (FRU).

Request for/access to system health data

Requests for system health information come through the Network Element Management System (EMS) which is connected to the RBU via the common channel signaling interface to the DSCO. Also, health information and command BIT can be accessed through the maintenance terminal.

1.11.2.7 System Health Data Storage

Complete current system health status is stored in the RBU volatile memory. The status is updated continuously. Health status is retrieved by the EMS at intervals of approximately 10 minutes. The data is stored in non-volatile memory at the EMS for a period of a least 48 hours.

1.12 Built-in Test (BIT) Requirements

Built-in hardware and software tests exist down to the FRU level to attempt to identify non-functional FRUs as rapidly as possible. As a minimum the internal hardware tests for each FRU attempt to indicate its operational status at Power-On and upon request from the monitoring unit. The software tests reside both internally and externally to the FRU and attempt to confirm the functional status of the FRU. Application of BIT is dependent upon the current state or mode of the FRU(s). The three state conditions are described as follows:

1.12.1 Initialization State.

A cold start or power-on reset on the FRU forces this state. BIT is applied immediately with the results of the test used by software to determine the follow-on state. A successful BIT result forces a transition to an in-service state where as an unsuccessful BIT result forces a transition to the out of Service State.

1.12.2 On-line State.

This state defines the FRU as active and in-service. The FRU will be continually monitored or polled for status. BIT may be applied anytime a fault is suspected in the FRU. BIT may also be applied periodically whenever the FRU is idle as part of routine testing such that it does not interfere with active users.

1.12.3 Off-line State.

This state defines the FRU as out of service. BIT can be applied at anytime under control of the software or at the request of maintenance personnel.

1.13 RBU Built In Test (BIT)

The RBU BIT is the basic test for bringing the system into service and for attempting to detect and isolate problems once the system has achieved an operational configuration. During the Initialization State, in the case of an RBU configured for redundancy, BIT is performed on the active FRUs first. All FRUs associated with the partition must complete a successful test to allow the partition to transition to an in-service state. To complete the Initialization State the designated active Link Control Processor (LCP) ensures that BIT is performed on all the remaining FRUs.

The remaining FRUs consists of the N+1 redundant and non-redundant equipment such as:

-- Digital Receivers
-- E1 Framers
-- Baseband Combiner
-- Synchronization
-- RF Front End
-- Power Supplies
-- RF Power Amplifiers
-- Fans

Some of these tests are limited and may be as simple as polling the status of the FRU. The results of these tests are reported to the EMS prior to entering the on-line operational state. Once the operational state is obtained the normal on-line BIT runs periodically. The RBU periodically polls for operational status from the associated CPE.

1.14 CPE Built-in Test (BIT)

The BIT for the CPE is applied at SU initialization or upon request by the EMS. During initialization SU BIT attempts to verify SU operational status and power supply status including main and battery backup power source prior to entering an in-service state. Establishment of link availability completes the on-line operational state and test results are reported to the RBU. Once the operational state is obtained the CPE BIT continually monitors the power status and reports any changes to the RBU. The SU and the RBU monitor forward and reverse link estimated Bit Error Rate (BER) and make this information available to the EMS. Re-encode and compare (SER) is used on all active links in both directions. When an SU is not active it reports Symbol Error Rate (SER) for the forward side channel

1.15 Operation Administration Maintenance & Provisioning (OAM&P)

Functional areas on the EMS system fall into the four categories of Operations, Administration, Maintenance, and Provisioning (OAM&P). Commands in these categories and notifications from the target RBU system are performed and received from the EMS only.

1.15.1 Platform and User Interface

Network Element Management Software is provided to support basic OAM&P functionality.

The minimum required EMS platform is a Pentium II or greater PC running at least 266 MHz, with a minimum of 32 MB memory and a minimum of 300 MB free hard disk space. The video must be an SVGA Controller and at least a 1024 X 768 color monitor. The mouse must not be connected to a serial port making available two serial ports (three serial ports are required if EMS is to be operated remotely). This PC runs Windows 95 for software releases 1.X, Windows NT for 2.X and uses English as the interface language.

1.15.2 EMS/RBU Access

The OAM&P hardware platform supports attachment to the DSCO via a dedicated V.24 (RS232) port. The DSCO manages distribution of information to/from RBUs and the EMS/AT. The RBU has an additional V.24 (RS232) port for local connections when the RBU and DSCO are not co-located.

The EMS and AT software supports a remote dial up connection through the EMS console using a software program such as © PC ANYWHERE 32.

1.15.3 Operations

Operations includes those areas of the EMS functionality that provide ongoing support activity for the system.

Specifically, these areas support:

-- Viewing the status of the equipment and interfaces to the Network Interface Unit (DSCO).
-- Activation / deactivation of the equipment
-- Detection of error conditions and attempted diagnosis of root cause
-- Interactive operator display

The AT also provides operations data and display of the following:

-- Status of trunks, Radio Interfaces, Subscribers
-- Statistics (Peg Counts)
-- Utilization Display
-- Activation / Deactivation of DSCO hardware
-- Administration
-- System Security
-- RBU Access

Three levels of operators are supported:

-- System Administrator
-- System Manager
-- Technician.

Each class of operator has a range of defined access within the EMS system and is uniquely identified by a combination of User ID and PIN

A System Administrator is the only operator able to perform all functions within the system. Functions unique to an administrator are creation, modification, and deletion of other operators.

A System Manager has the ability to perform those functions required for daily operations and installation of subscriber equipment (i.e. Technician functions). A System Manager may add Technicians to the system, provision users, and perform operations functions.

1.16 Tests and Diagnostics

The EMS may command tests to be performed on system equipment to support the operator diagnostic processes. The results of these tests are reported to the system console and update the status display of the equipment (if currently active). Only System Administrators or System Managers may perform tests and diagnostics.

Test results that indicate hardware faults prompt for a work order to be generated to correct the problem.

This equipment can then be tested interactively by the operator on inactive equipment and, to a limited degree, during active use.

1.16.1 Standard Testing

The following paragraphs list the standard tests

1.16.1.1 Make/Break Dialtone

The Network Element Management System is able to command an SU to initiate the looping of dialtone to the PSTN.

1.16.1.2 Data Loop-Back

The Network Element Management System is able to place an SU in loop-back mode to determine both the operation of transmission components and link quality (BER).

1.16.1.3 Telephone Present Test

The Network Element Management System is able to command an SU to initiate a test to detect the presence of a customer telephone.

1.16.1.4 RBU BIT

The Network Element Management System is able to command the RBU system to perform its built-in test and report the results.

1.16.1.5 SU BIT

The Network Element Management System is able to command an SU to perform its built-in test and report the results.

1.16.1.6 Status Poll

The Network Element Management System is able to request each SU to respond to a request for status.

1.16.1.7 Automatic Tests

All tests that may be performed manually may be automated with the use of scripts that may be executed on demand or periodically. Tests (manual or automatic) that interfere with the operation of SUs that are active are noted but not performed.

1.16.1.8 Performance Tests

Facilities for ongoing bit-error tests on the RBU-SU link and storage of results on the EMS are provided. From the EMS this stored data is available and can be utilized for such things as statistics gathering and plotting.

1.16.2 Monitoring Activities and Alarms

This section identifies the types of network and maintenance functions that can be monitored, detected and corrected by the AirLink 8000 software. The EMS receives unsolicited diagnostic information in event messages. Some events are interpreted as alarms and sound an audible alert.

Using the Diagnostics window functions, you can:

-- Clear Alarms
-- Request Equipment Status
-- Send Loopback Tests
-- Reboot an RBU
-- View RBU Properties
-- Diagnose Alarms
-- Resolve EMS/RBU Communications Failures
-- Resolve Rack Alarms
-- OVER TEMP
-- AIR MOVER
-- PWR SPPLY
-- RF-PA
-- PRM PWR1
-- PRM PWR2
-- Resolve RBU CCA Failures
-- Interpret Miscellaneous Alarm Events

The AirLink 8000 system software continually monitors the health of the system. If a noteworthy event occurs, the component that detects the event sends an event message to the EMS. The EMS displays the event in the Systems Events List in a Diagnostic window.

Events are diagnostic in nature and contain information specific to the condition being reported. The event includes a severity indicator.

The EMS system defines the following severity levels:

-- D=>Debug message
-- I=>Informational
-- A=>Audit
-- W=>Warning
-- E=>Error
-- F=>Fatal

An alarm is an event, generated by AirLink 8000 software that has a severity level of Error or Fatal. In addition to displaying the event, the EMS sounds an audible alarm that consists of a short tone repeated once every second. This alarm can be cleared from the EMS.

1.16.3 Monitoring CPE Activities

The following gives information on activities generated by the CPE.

1.16.3.1 Radio Base Unit Antenna system

The RBU is capable of operation with a family of omni or directional antennas to support a particular requirement (see table 3.2.1.6-1).

1.16.3.2 Base Transceiver Station

The Base Transceiver Station configuration is designed for deployment into an environment with marginal environmental control (e.g., shelter). The unit is completely modular allowing for the easy removal and replacement of the functional modules. Cable I/O is accessible from the front of the unit, except for the antenna cable, which is accessible from the top. All FRUs are hot swappable.

1.16.3.3 Controls and Indicators

Controls and indicators for the Radio Base Unit are located on the front panel of the unit. To the extent possible, a series of LED's starting from the power distribution module visually directs the operator from cabinet to drawer to failing replaceable module.

1.16.3.4 On/Off switch

A system power on/off switch (circuit breaker) is provided to protect a circuit overload condition and is configured to prevent accidental shut down.

1.16.3.5 Base Transceiver Station Alarms

The Base Transceiver Station has alarms indicating "critical" level conditions regarding the Radio Port equipment operation.

A Rack Alarm is provided that provides both contact closure and a red LED visual indication of any FRU failure. A receiving attention switch, latch and indicator are provided that causes a green LED to light and removes the rack alarm.

1.16.3.6 The Customer Premises Equipment (CPE)

The CPE consists of three major subsystems, the Subscriber Unit (SU), the Network Terminating Unit (NTU), and the Uninterruptable Power Supply (UPS). Each component is located in different areas of the installation site. The SU is mounted outside at a high point on the building or on a ridged pole. The NTU is located outside of the home/building on a wall at or near the point of entry of the UPS and subscriber cabling. The UPS is located inside the home/building near (within 6 feet) the point where prime source power is available.

1.16.3.7 Controls and Indicators

The only indicator on the CPE is the UPS power-on indicator. Controls and other indicators can be accessed wirelessly via the EMS or by the IBAT.

1.16.4 Cooling for the Base Transceiver Station

The Base Transceiver Station relies on forced convection air cooling i.e. fans, to exchange internally heated air with room air. A permanent type (may be cleaned and reused) air filer is provided. The air handlers are redundant, and are hot swappable. Air temperature monitoring indicate a high temperature condition due to a dirty air filter or other environmental conditions.

1.16.5 Radio Base Unit Enclosure

The Radio Base Unit is packaged in modular sub-racks, which are mounted in a standard 48.3 cm rack. The sub-racks are mounted in a 31U open rack with front and back doors and sides.

The RBU sub-rack (shelf) depth is no more than 412.24 mm. This sub-rack depth then allows the unit to fit into an optional cabinet of depth 450 mm.

Unit	Size	Weight	Dissipated Power
Base Transceiver Station Input voltage range –40 to 69 VDC.	48.3 cm x 56.8 cm x 159.1 cm 31 U (castor/leveling feet included in height).	From 158.8 kg to 209.6 kg, depending on configuration.	From 30 to 72 Amps 1224 to 2938 Watts See Note for configuration.
BTS sub-racks	Depth ≤ 41.2 cm	NA	NA
RBU Antenna (Omni 2.025 to 2.290 GHZ, type N female connector)	3.2 cm dia. x 96.5 cm long.	686 gm	NA
RBU Antenna (Omni 2.1 to 2.3 GHZ, type N female connector)	3.2 cm dia. x 92.1 cm long.	675 gm	NA
RBU Antenna (Omni 2.484 to 2.688 GHZ, type N female connector)	3.2 cm dia. x 92.1 cm long.	652 gm	NA
RBU Antenna (Omni 3.4 to 3.6 GHZ, type N female connector)	3.2 cm dia x 75.9 cm long.	637 gm	NA
RBU 90 Degree Sector Antenna (0 –5 Degree Adjustment)	98.85 cm x 11.43 cm x 5.92 cm + Downtilt Mounting Kit	2.25 kg	N/A

Minimum BTS Configuration is a single non-redundant system with 30 user channels.

Maximum BTS Configuration is dual redundant system with 200 user channels

Worst case current values are based on –40.8 VDC (48V –15% worst case)

1.16.6 Maintainability

The CPE is designed to provide up to 10 years MTBF. The Base Transceiver Station and DSCO are designed for long MTBF, and vary depending on operating conditions and configuration.

1.17 SPECIFICATIONS

1.17.1 Characteristics

Frequency Plan	Currently available: 2.1 -2.3 GHz, 2.5 - 2.7 GHz, 3.4 –3.7 GHz, and 2.0 – 2.3 GHz
Multiple Access Method	Bi-directional Synchronous Code Division Multiple Access
Modulation Scheme	128 level QAM/QPSK, differential encoding/decoding, Direct Sequence Spread Spectrum (DSSS)
Traffic Capacity	119 voice channels per 3.584 MHz carrier
Traffic Concentration	Operator definable, up to 25:1 concentration
Users/RBU Users/DSCO	2500 voice channels 10,000 (15 RBUs)
Nominal Power	14 dBm/channel in each direction; normally 35 dBm from RBU
Power Control	None from RBU to SU; Closed Loop for SU to RBU - 50 dB in steps of ±0.25 dB
SU Antenna RBU Antenna	18 dB_{ic} gain, 22° 3dB beamwidth Omni - RH_{cp} with 8 dB_{ic} max. gain or Sectored with 11-15 dB_{ic} gain
SU Receiver RBU Receiver	-114 dBm sensitivity, -50 dBm max. input sensitivity, 6dB noise figure -114 dBm sensitivity, -30 dBm max. input
Dial Tone Delay	Less than 0.5s under non-blocking conditions
Propagation Delay	RBU to SU under 6ms
Bit Error Rate	Less than 10^{-6} when received input power is more than -111 dBm
Security	Pseudo-random Noise encoding (2.72 Mc/s per user) with randomizing, Full encryption for over the air network control channels
Subscriber Services	32 kbps voice (ITU-T ADPCM) 64 kbps fax and modem (dynamic rate change from 32 kbps) 64 – 256 kbps data (ITU-T X.21 leased line service) ISDN BRI (2B+D) 32 kbps Payphone support (battery reversal, 12/16 kHz metering)
Priority Calling	Outbound (line side) for up to five pre-set emergency numbers Inbound (network side) for local fire, police, EMS, VIP, etc. Leased line service (permanent virtual circuits)

1.17.2 ENVIRONMENTALS

1.17.2.1 RBU and UPS (Indoor equipment)

Environment	**Requirement**
Temperature	-10º C to +55º C ambient air
Humidity	95% Relative humidity at 30º C, non-condensing
Air Pressure	70 to 106 Kpa
Shock	Basic shipping and handling shock
Cooling provisions	Forced air convection cooling, Fans & Filter (BTS)
Desiccants	None
Exposure	Must withstand UV radiation, water, dust, dirt, sand, etc.
EMC/EMI	per ETSI 300/339
Safety	UL and CE Mark
Coatings	Protection from humidity and corrosion

1.17.2.2 SU and NTU (Outdoor equipment)

Environment	**Requirement**
Temperature	-30º C to +55º C ambient temperature, derated for Altitude.
Weight	SU: 3.4kg max.; NTU: 340 gm; UPS: 6.8 kg
Humidity	100% RH, Condensing
Rain	150mm per hour
Ice Accumulation	10 mm on exposed surfaces
Air Pressure	70 to 106 Kpa
Wind Gusts	240 km/hr
Shock	Basic shipping and handling shock
Cooling provisions	Natural Convection Only, No Forced Air Cooling
Desiccants	No desiccants
Exposure	Must withstand UV radiation, water, dust, dirt, sand, etc.
EMC/EMI	Per ETS 300 339 as a guide
Safety	Designed to meet IEC En 60950
Coatings:	Protective coatings against humidity and corrosion

1.17.3 System Level Parameters

Method of Operation	Full duplex. Frequency pairs are used, one for the forward channel and the other for the reverse channel.
CDMA Method	Direct sequence spread spectrum (DSSS), forward and reverse channels
Spreading Rate	2.7 Mcps.
Forward Error Correction	Trellis coding and Viterbi decoding in both forward and reverse channels.
Frequency Plan	Four bands currently supported: 2.0 to 2.3 GHz as defined by ETSI DE/TM 04031 2.1 to 2.3 GHz as defined by ITU-R F.283-5 2.5 to 2.7 GHz as defined by ITU-R F.283-5 3.4 to 3.6 GHz as defined by CEPT Rec.1403-E
Frequency channels	In the currently supported plans, each band is divided into 14 MHz channel pairs. Each channel is divided into 4, 3.5 MHz sub-channels
Encryption	Forward and reverse channels. Voice and data signals: PN scrambling. Control signals: authentication encrypted.
Voice Compression	Voice mode only: A-law companding with ADPCM. A-law only for fax and modem (ADPCM bypassed). For less bandwidth efficient cases, voice mode can be used with A-law only, and no ADPCM compression.

1.17.4 Equipment Summary

Customer Premises Equipment (CPE)

Subscriber Unit (SU)	One piece enclosure includes antenna, RF circuitry, modem, telephone interface, and data interface.
Network Termination Unit (NTU)	Provides boundary between provider equipment and customer equipment.
Uninterruptible Power Supply (UPS)	Uninterruptible power supply maintains service during power outages.

Central Site Equipment

Radio Base Unit Antenna	Provides the aperture for transmission and reception of signals within one cell.
Radio Base Unit (RBU)	One rack of equipment that includes RF circuitry, modem, telephone interface, and data interface.
Network Interface Unit (DSCO)	Provides the interface from the PSTN to the RBU, controls PSTN protocols.

1.17.5 System Capacity (SYSTEM = single DSCO scenario)

Active Telephone Lines per RBU	100 active lines, up to 119 under ideal conditions (Note: telephone lines can optionally be data connections).
Maximum Lines per RBU	Up to 2500 with 25:1 concentration.
Maximum RBUs per DSCO (System)	Up to 15 (assumes no DSCO intra-calling. When intra-calling is used, more RBUs can be supported.)
Maximum Active Lines per System	Up to 1500.
Maximum Lines per System	10,000 lines.
RBUs per Cell	Variable depending on antenna, frequency, and PN code selection.

1.17.5.1 Interfaces

Network Interface Unit (DSCO)

PSTN Physical Interface	Twisted pair VF channel bank or E1 (75 or 120 ohm). Up to 1500 ports.
PSTN Protocol Interface	Flexible to accommodate all known CAS, and CCS protocols.
RBU Interface	1 to 4 E1 connections per RBU. The E1 signals can be relayed to accommodate remote RBUs. Up to 15 RBUs can be supported from a single DSCO.
Power Input	-48 VDC.

1.17.5.2 Radio Base Unit (RBU)

DSCO Interface	One to four E1 connections. The E1 signals can be relayed to accommodate remote RBUs.
Antenna	Coaxial cables of up to 100 meters connect the antennas. For space diversity, up to two antennas can be connected.
Power Input	48 VDC, or 60 VDC.

Customer Premises Equipment

Telephone Interface	One to eight telephone lines with independent telephone numbers using standard tip and ring signaling.
Pay Phone	One or two pay phones.
X.21 Data Interface	One or two standard DB15 connector.
Power Input	Universal AC Input.

1.17.5.3 Antennas

RBU Transmit and Receive Gain	8 dBi, max. Optional sectored antennas with increased gain.
SU Transmit and Receive Gain	18 dBi, max.
Polarization	Right Hand/Left Hand Circularly Polarized (RHCP/LHCP).

1.17.5.4 Transceivers

RBU Power Amplifier Output	+35 dBm nominal.
SU Power Amplifier Output	+14 dBm nominal.
Modulation	Quadriphase shift key (QPSK) data modulation with BPSK spreading.
Demodulation	Coherent.
User Data Rate per SU	Variable in real time to support single, dual and Quad line configurations. 32 kbps, 64 kbps, 96 kbps, 128 kbps.
Bit Error Rate (BER)	< 10-6.
Receiver Sensitivity	-114 dBm.
System Sensitivity	-111 dBm (Includes the effects of multi user interference)
Power Control	Reverse channel, 40 dB range.

1.17.5.5 Radio Base Unit

Reliability	25 years mean time to hardware stop (MTTHS).
Redundancy	Option for N+1 redundancy on all major components to ensure continued operation in the presence of a failure.
Space Diversity Option	A second antenna can be added to improve performance in a multipath environment through space diversity, when required.
Maintainability	All circuit cards are replaceable without interrupting system operation and with power on (Hot Swappable).
Operating Environment	-10 to +55 C, Indoor.
Size	One standard rack, 483 mm (19”) wide, 1300 mm high (27u), 450 mm deep.
Cooling	Forced air cooled.

1.17.5.6 Customer Premises Equipment (CPE)

Equipment Interfaces	SU can be configured to interface to the following: One to eight telephone lines Single or dual X.21 port One or two pay phones One telephone and one X.21
SU Reliability	10 years mean time between failure (MTBF)
SU and NTU Environment	-30 to +55 C, Outdoor. Environmentally sealed and UV resistant.
Power Supply Environment	-10 to +55 C, Indoor.

SU Size	41cm x 41cm x 8cm (16” x 16” x 3”).
NTU Size	12cm x 13cm x 6cm (4.75” x 5.25” x 2.5”).
Power Supply Size	19cm x 26cm x 12cm (7.5” x 10” x 4.75”).
Cooling	Natural Convection only.

1.17.5.7 Operations, Administration, Maintenance and Provisioning (OAM&P)

Human Interface	One computer terminal controls one DSCO and all connected RBUs up to 15.
Provisioning	The Control Terminal provides all necessary tools to provision the system, including adding, reconfiguring, and deleting users.
Monitoring	The Control Terminal allows monitoring of a wide variety of system parameters. System health and status, including data link quality, are recorded in each RBU every 10 min., and can be maintained for up to 48 hours. This data can be downloaded to the control terminal.
Fault Detection and Isolation	Full set of built in tests provided to isolate failures to the circuit board. All faults and performance degradation are reported to the control terminal. System tests, element test and circuit card self tests are provided. Tests are conducted automatically, but can be commanded from the control terminal.
Phone Tests	Make/Brake dial tone and loopback test capability are provided.
Maintenance	All equipment designed for ease of maintenance. RBU can be maintained without interrupting service.
Billing	Full billing data is available.
Unintended System Use	Extensive provisions to detect and defeat CPE equipment theft, service pirating, intrusion, etc.
Software upgrades	Upgrades can be downloaded to the DSCO, RBU and SU from the control terminal. SU downloads software over the air via the forward channel.
TMN	Growth path to TMN services, including Q interfaces.

NOTES: