Aditus
Wireless Access System

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Aditus Wireless Access System
Product Description

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1.0 INTRODUCTION

1.1 Wireless Local Loop Overview

The global demand for local access to the telephone network is significant and the required capital and time investment needed to complete a full deployment using wire lines are daunting. Hence, Wireless Local Loop (WLL) technology and systems were developed to supply a more efficient solution to providing network access. They promise a better use of capital and a much faster deployment than traditional copper lines.

WLL systems may be defined as wireless systems designed to provide users primary access to the Public Switched Telephone Network (PSTN). Various technologies can provide wireless access to the PSTN, including such technologies as cellular, PCS, wireless PBXs (such as DECT and PHS), and microwave. Adicom Wireless, Inc. also provides a WLL solution. Adicom's WLL system utilizes a Code Division Multiple Access (CDMA) based technology specifically designed to deliver high quality telecommunications services to subscribers around the world.

In order to deploy WLL services, radio Base Stations and their links to the Central Office switching must be constructed in a manner that provides the necessary geographic coverage and capacity required by the network. Telephone service is then immediately available to all potential customers within range of the radio Base Station, thus eliminating the need to wire the subscriber access. WLL technology intrinsically offers flexibility to meet varying levels of penetration and subscriber growth rates. Since the subscriber locations are fixed, the initial coverage of radio Base Stations only need to provide services to areas where the immediate demand for service is apparent.

1.1.1 Advantages of Wireless Local Loop

Compared to the deployment of copper wires for the subscriber access infrastructure, WLL technology offers a number of key advantages:

Faster Deployment

Successful WLL systems can be deployed in weeks as compared to months or years needed for the deployment of aerial or underground copper wire. Faster deployment can mean quicker connections to subscribers and accelerated service provider revenues resulting in an earlier payback of the operators' capital investment. The rapid rate of deployment can create an advantage with respect to competitive services, accelerate the pace of regional economic growth, and provide a political benefit as a tangible evidence of substantive progress in the development of needed infrastructure.

Reduced Construction Costs

The deployment of WLL technology eliminates the majority of the civil engineering construction needed to place copper wires. This translates into less traffic disruption and reduced traffic jams on roads dug to lay down the copper. Furthermore, less equipment is required throughout residential and business locales in order to provision the subscriber access.

Lower Recurring Network Maintenance, Management and Operating Costs

Wireless equipment is less failure-prone than copper wire and is less vulnerable to sabotage, theft, or damage due to environmental conditions. In some WLL designs, including Adicom's WLL Systems, network management, fault analysis and system reconfiguration can be conducted from a centralized administrative support location. The overall result is reduced lifetime network cost.

Lower Network Extensions Costs

Once the WLL infrastructure (the network of radio Base Stations and the interface to the telephone network) is in place, each incremental subscriber can be installed at very little cost. Some WLL systems, including Adicom's systems, are designed to be modular and scaleable to allow the pace of network deployment to closely match demand—minimizing the costs associated with an underutilized plant. WLL systems are flexible enough to meet varying levels of penetration and rates of growth. In addition, non-paying subscribers can be easily removed from the subscriber base without wasting copper investment.

1.2 Technology Overview

Most commercially available WLL systems utilize wireless technologies developed primarily for digital mobile cellular or PCS applications. Adicom believes that the fixed nature of WLL systems do not require the added complexity of mobile cellular technologies. Furthermore, the limited distance coverage of PCS technologies does not make it cost-effective for typical WLL network requirements. Adicom's technology strategy has been to develop and implement a ground-up design optimized for WLL applications. By reducing the complexity of the system and enhancing the features supported by WLL (e.g. data capability and higher audio quality), a more reliable, cost-effective, and highly efficient system was developed.

Adicom selected CDMA as the technology of choice. CDMA offers many advantages for the WLL application:

- Higher capacity and higher spectral efficiency especially for fixed applications—a feature well recognized by many service providers worldwide.
- Secure by design and suitable for wireless communications—an important feature for subscriber access systems demanded by both service providers and subscribers.
- Robust technology capable of surviving jamming from narrow-band interfering sources—a feature needed to ensure the quality of the network.
- Reduced frequency-planning efforts to eliminate one major concern and lower expenses for building out WLL based networks.
- Provides both easy migration and evolution paths from narrow band to broadband services

Traditional CDMA, on the other hand, is a mobile-focused technology, normally associated with higher costs and complex operating procedures. Adicom's patented A-CDMA™ technology reduces the complexity and optimizes the system design for WLL. This reduces the cost of Adicom's products to levels unmatched by traditional mobile standards.

1.3 The Adicom Advantage

In a market with tremendous growth potential, several well-established telecommunications equipment manufacturers, as well as new startup companies have targeted WLL and developed WLL products. However, the majority of these products have proved to be problematic or unsuitable for the WLL market. Both, the lack of contract awards and the poor performance of these systems under field conditions have demonstrated this. This is often because the manufacturers failed to recognize one or both of the fundamental WLL requirements: 1) The product has to be cost-effective compared with wireline alternatives, and 2) the product has to support services and with quality that are equal or better than the wireline alternatives.

Adicom's approach to WLL is different from other competing systems and solutions. Our WLL systems provides:

- Most cost effective solution based on Adicom's exclusive patented A-CDMA™ technology, developed specifically for fixed wireless access systems and is not adapted from cellular and/or PCS technologies, realized all WLL advantages described in previous sections.

- A seamless connection to existing networks similar to any Digital Loop Carrier (DLC) system utilizing existing embedded support systems and providing services available on the PSTN transparently to subscribers, without compromising quality.

- Standard interfaces to switching systems and off-the-shelf user terminals (e.g. standard telephone sets, fax machines, and data modems).

- Most flexible architecture, adaptable to different network architectures and implementation scenarios.

- Capability of operating in a wide range of operating frequencies. A cost-effective, power-efficient radio system using Adicom's own Amptenna™ design (patent pending) allowing for excellent coverage of services.

2.0 ADITUS WIRELESS ACCESS SYSTEM

2.1 System Overview

The Aditus System is a Wireless Local Loop (WLL) product. It provides a very efficient wireless access between a subscriber and the Public Switched Telephone Network (PSTN) switch, meeting or exceeding all the features that are available from a wireline system.

The Aditus system consists of three elements:

- A Base Station (BS) that can be connected directly to the Central Office (CO) switch or connected remotely over landlines, radio or optical fiber links. The Base Station also supports a variety of analog and digital network interfaces.

- A Remote Access Unit (RAU) that extends service for up to 32 subscribers using standard telephones, faxes and modems connected via standard RJ11 phone jacks.

- A Network Management System (NMS) which controls and monitors all Base Stations, RAUs, air interfaces and subscriber wire drops.

Around the location where one or more Base Stations are installed subscribers within a "cell" are served through a group of RAUs. Between the Base Station and the RAU radio signals are transmitted using Adicom's proprietary A-CDMA™ common air interface. Each cell can be extended to a 15-km radius or larger, depending upon some network considerations. The system operates on a Time Division Duplex (TDD) basis, which provides full duplex operation on a single Radio Frequency (RF) channel. An Aditus system network is made of one or more such cells, controlled by a single NMS.

2.2 Key Features

2.2.1 High Deployment Flexibility

The Aditus system is extremely flexible to meet a wide variety of market needs, whether urban, suburban, or rural deployments with different network requirements.

- Modular expandability with small quantity of equipment for low capacity initial deployment, gradually expand to large capacity systems.
- A variety of switch interfaces are supported i.e. V5.2, CAS, Loopstart, GR303, 2W analog etc.
- Base Stations can be co-located with the switch, or remote from the Central Office. Additionally, multiple Base Stations can be placed at the same cell site.
- RAU's support all Customer premises equipment that support RJ-11 interface, such as standard telephone set, fax machine, and computer modems.
- Optional AC/DC power.
- RAUs have very flexible mounting options, outdoor, on a wall, pole, rooftop, tower or any convenient structure with an Adicom mounting bracket.
- Back-up RAU batteries are available, that provides up to 4-hour talk time.

2.2.2 Flexible Transmission Rates

An industry leading feature, the flexible transmission rate allows optional subscriber provision at different service levels, thus provides optimal balance between service availability and quality, data speed, and system capacity. The subscriber ports are configurable to any rate by the operator, through the NMS.

- Standard configuration with 32 Kbps vocoder rate provides toll-quality voice, Group III fax and high speed data.
- System also offers a capacity enhancing 16 kbps service rate with superior voice quality and group III fax capability
- A premium 64 kbps rate for fast data applications.

2.2.3 High Quality Service

- The Aditus system provides a transparent wireless access to the PSTN such that the dial tone and all the supplementary services are offered to the subscribers from the switch. No new numbering plan is required.

- Supports fax services with data speeds of up to 14.4 Kbps.
- At 64 kbps the system supports V.90 data transmissions up to 56kbps modems.

2.2.4 Network Enhancer

The Busy Hour Network Enhancer is a software feature innovated by Adicom based on Aditus system's industry-leading variable rate capability. This feature allows operator to expand the network capacity during "busy hour" or other capacity bottlenecks without adding equipment hardware. For a capacity-limiting network, if channel blocking during busy hours or due to unexpected traffic surge is a key concern of the operator or customers, this feature provides an economic way to leverage existing network resource to partially or completely solve the capacity bottleneck problem. For operators who face tough decisions to choose between high capacity and high service quality but with a very limited capital budget, this feature provides an alternative way for operator to reach a customized, optimal balance between these two requirements. The most important benefit brought by this feature for operator and subscriber is to "not lose that call" when a call attempt is made while the network load is reaching its capacity limit.

When this feature is activated, the network will ratchet down the transmission rate of the 64kbps channels to 32kbps, and that of 32kbps channels to 16kbps, thus "create" more abundant channels for subscriber traffic. Depending on subscriber configuration mix, this feature would provide up to 75% extra capacity during a capacity jamming period.

The Busy Hour Network Enhancer feature can be activated under two conditions:

1. During Busy Hour: A pre-determined time period during the day is entered on the NMS and the transmission rate reduction only occurs during this period.

2. At High Capacity Load: A pre-determined load threshold (as percentage of the maximum capacity) is entered on the NMS. Transmission rate reduction occurs whenever (except during the busy hour) the system capacity traffic load reaches this threshold.

The operator has complete flexibility in determining the activation thresholds. Besides, any given subscriber port can be configured to not participate in this feature even when it is activated, i.e., keep the same pre-configured transmission rate throughout the day. Operator also has full authority to determine how to charge subscribers should they are configured differently.

2.2.5 Frequency Flexibility

As an industry leader in providing operator with maximum flexibility in selecting operating band, Adicom implemented unique radio architecture and manufacturing processes to accommodate customer's needs in frequency selection. Once customer selects and orders a specific frequency band, Adicom engineers generate a special "frequency kit" that will tailor the radio frequency to this specific requirement. The Aditus system will be manufactured and equipped with this kit prior to system testing and burn-in.

- System is factory configurable to operate on several different frequency bands from 370 MHz to 3600 MHz[1]

- Operating frequency bands can be of any given width ranging between one and multiple CDMA carriers. Multiple carriers do not have to be on a contiguous band. The system is capable of tuning the central frequencies with fine resolution. This resolution is 62.5 kHz for the Aditus radio. Once the exact operating range is available, Adicom will apply its frequency allocation algorithm to determine central frequencies for each carrier.

- Adicom's custom designed sectorized antennas provide 360^0 coverage with complete frequency reuse in each sector. This increases flexibility of network design and deployment to meet realities of non-uniform subscriber distribution.

2.2.6 Large Coverage

Base Station cell ranges up to 15 km under near line-of-light conditions for the 1.9GHz frequency band, and even larger coverage for lower frequency bands. Large coverage allows operator to serve more subscribers in low population density regions and provides better economic returns.

2.2.7 Network Management System (NMS)

- Full featured Operation, Administration, Maintenance and Provisioning (OAM&P) capabilities

- Configuration and performance management

- Subscriber services provisioning

- Fault management

- User friendly GUI interface

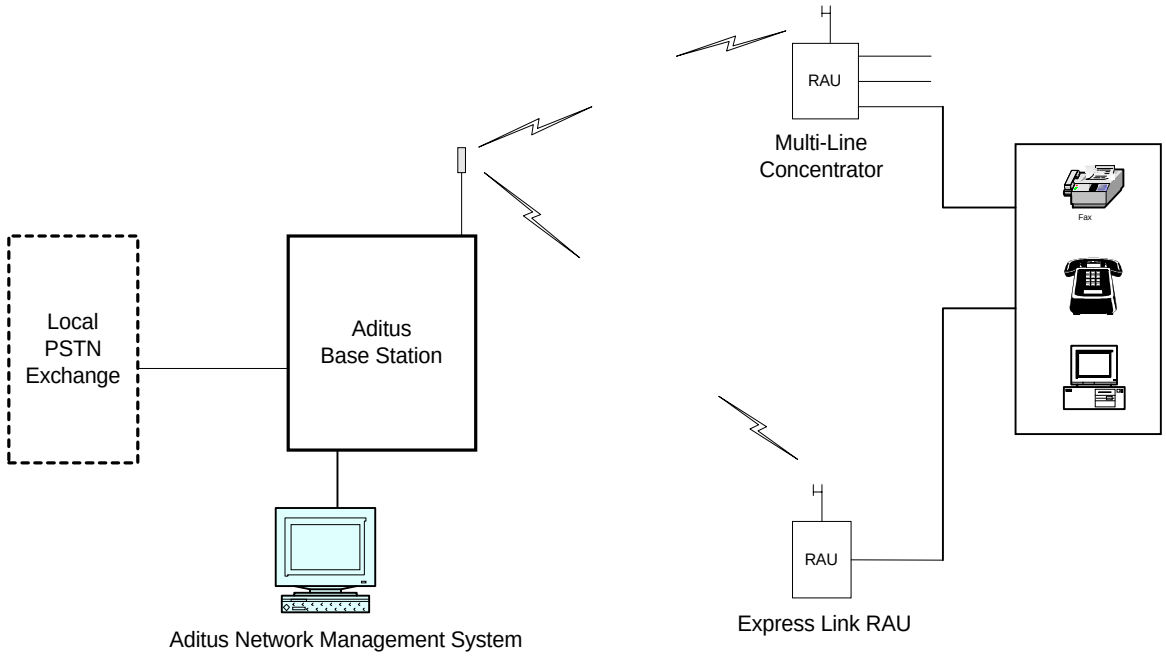
- PC/NT platform based NMS

[1] Different frequency bands may require different manufacturing lead time. Please consult your Adicom sales personnel on availability for specific frequency band.

2.3 System Architecture

The architecture for the Aditus system conforms to the principles for Universal Personal Telecommunications (UPT) as defined in International Telecommunications Union (ITU) and North American (T1P1) standards bodies. This provides seamless integration with existing and future telecommunications networks. However, since the Aditus system does not support handoff capability, UPT features related to mobility are not included here. The deployment of the Aditus system is not dependent on the availability of any advanced network features (such as the Intelligent Network (IN) architecture) required to support user and terminal mobility. Figure 2-1 shows the system architecture for the Aditus system.

Figure 2-1 Aditus Wireless Access System Block Diagram



2.3.1 Base Station

The Base Station provides a highly reliable interface between the PSTN and the subscriber equipment. Modular expansion and scalability have been emphasized in order to optimize cost-effectiveness for both large and small network configurations.

The principle functions of the Base Station are:

- Central control of the Aditus system, which provides the interface to the NMS. The NMS controls the operation, administration, maintenance, and provisioning of the Base Station and RAU equipment.
- Call processing for supporting outgoing and incoming calls between subscribers and PSTN.
- Network interface between the Central Office Switch and the Aditus system to support signaling and bearer channels to the Local Exchange.
- Signal processing which provides the CODEC functions (compression and decompression) and the MODEM functions (spreading and de-spreading).
- Radio Frequency (RF) transmission and receiver functions for the air interface, including an innovative and flexible distributed antenna system.

2.3.2 Remote Access Unit

The RAU is a telecommunication unit that connects subscriber telephones through a wireless link to the Aditus Base Station. The RAU is located on the customer (or user) site and is installed in a ruggedized outdoor enclosure mounted on a roof or outside wall. Each RAU is installed with a directional antenna.

2.3.3 Network Management System

Aditus NMS is a proprietary network management system installed on a Personnel Computer (PC) configured as an NT Server. It operates on an HP OpenView platform that provides a telecommunications service provider with Operations, Administration, Maintenance and Provisioning (OAM&P) functions for a network of Adicom's WLL, and uses Simple Network Management Protocol (SNMP) protocol.

2.3.4 Other Equipment

2.3.4.1 Standard Customer Premises Equipment

The Aditus RAU connects to all standard subscriber equipment such as, voice-band data/fax modems that correspond to Terminal Equipment Type 2 (TE2) standards that represent non-ISDN terminal equipment. The TE2 units connect to the RAU via a standard RJ11 interface. This equipment is purchased and installed by the end-user and it is not part of the Aditus system.

2.3.4.2 PSTN Exchange

The Local PSTN Exchange represents the existing network infrastructure that provides public or private switched services to wireline user terminals. These switched services support traditional voice and voice-band data. The Aditus system provides a transparent interface to the PSTN. Subscribers receive dial tones and all the service features including supplementary services from the PSTN. This is very similar to having a wire line phone.

2.4 System Interfaces

2.4.1 Central Office Switch Interface

The Aditus system supports and can be integrated with different switch architectures, both analog and digital. Its network interface is modular and can be easily customized to meet switch requirements with respect to bearer channels and signaling links. The Aditus system appears simply as another element of the network.

The Aditus system can be interfaced with most of the networks in use throughout the world. In order to achieve seamless inter-working between the Aditus system and the existing network, the system is configurable to adapt to most access protocols. An T1 or E1 CAS (Channel Associated Signaling), or a 2-wire analog non-concentrated connection will support each country's line-side protocol. The Aditus system can also be configured with a V5.2 concentrated E1, or GR-303 concentrated T1 interface.

The Aditus system also supports standard Central Office Terminal (COT) for applications that require remote analog interface setup.

2.4.2 Common Air Interface

The Air Interface is a proprietary interface based on Adicom's A-CDMA™ protocol, operating at the frequency band selected by the customer.

The transmitted power output depends on the propagation environment, range, number of active traffic channels and government regulations. The transmitted power is preset but can be adjusted to meet the range needs of the network's topology. Power output may range from higher transmitted power (28 dBm) for large cells to lower power for smaller cells.

2.5 Base Station Equipment

2.5.1 Base Station Equipment Shelf

The Base Station is enclosed in an equipment shelf as shown in the figure below. It is designed for mounting in a 19-inch Electronic Industry Association (EIA) open frame rack. The shelf can be equipped with one Central Processing Module (CPM), up to four Network Interface Modules (NIM) and up to 18 Base Station Signal Processing Modules (BSPM) depending upon configuration. There can be up to four Base Station Power Supplies, either AC or DC, used in each shelf, depending on the module loading.

All external connections are made from the back panel of the Base Station Equipment Shelf. There are 19 N-Type connectors located in the center of the back panel. These connectors are IF signal terminations for the Base Station Radio Frequency Modules (BRFMs) installed on the Antenna Arrays.

Figure 2-2 Aditus System Base Station

2.5.2 Aditus Base Station Modules

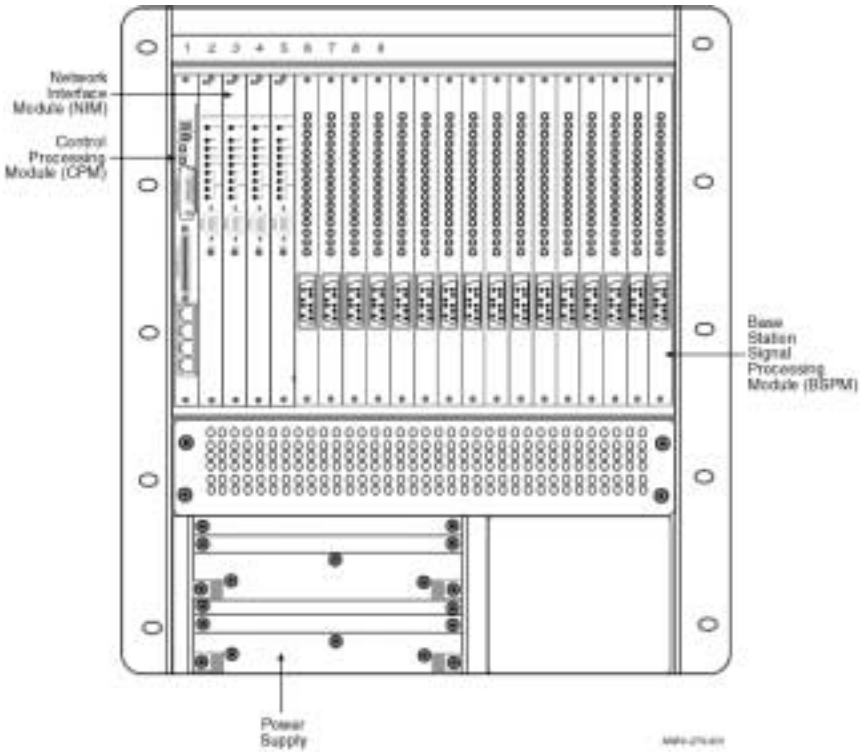
Central Processing Module

The Control Processing Module (CPM) provides a platform for all the call processing, system configuration, communication with the NMS, and fault management. One control processor card is installed in each Base Station.

Network Interface Module

The Network Interface Module (NIM) provides the Base Station with E1 or T1 primary rate digital network interfaces, transparently passing signaling bits from the PSTN. The system can be configured with up to four network interface cards per shelf. Each NIM provides four E1 or T1 ports with software selectable framing and line coding formats.

Figure 2-3 Base Station Equipment Shelf



The network interface module accepts AMI or HDB3 line coding, CAS, CCS, and CRC4 framing formats and a variety of US and international standards.

Base Station Synchronization Module

The Base Station Synchronization Module (BSM) provides timing information to the Base Station in order to synchronize all Base Stations and all RF channels to a Time Division Duplex (TDD) frame structure. This also provides bit synchronization for analog switch interfaces. The BSM consists of a Global Positioning System (GPS) receiver, antenna unit and antenna cable.

The GPS receiver synchronizes its on-board clock to UTC (Universal Coordinated Time) and provides an RS422 output of 1 PPS. The GPS unit is a weatherproof dish approximately 15 cm in diameter mounted outdoors with a clear view of the sky. Each Base Station must have one GPS receiver.

Aditus Radio Link Modules

The Aditus Radio Link consists of two modules: Base Station Signal Processing Module (BSPM) and Base Station Radio Frequency Module (BRFM), each is described in detail below:

Base Station Signal Processing Module

The Base Station Signal Processing Module (BSPM) functions as the interface between the NIM and the BRFM, handles the digital signal processing of all traffic channels, executes the air-interface protocol between the Base Station and the RAU, and configures various parameters on the BRFM.

The BSPM is connected to the NIMs through the TDM bus interface. In the transmit path, the BSPM receives 64 kbps digitized PCM voice-band signals from the NIMs and then transcodes these to 64 PCM, 32 or 16 kbps ADPCM. The Aditus CDMA Engines (or ACE™, the core processing chip) spreads and encodes the data into separate I & Q data streams which are combined into single I & Q streams by the Intermediate Frequency (IF) Section before being sent to the BRFM. The process is reversed in the receive path.

The BSPM performs modulation, demodulation and conversion to the IF. The IF signal is sharply filtered to reject adjacent channel interference and fed to the demodulator. An AGC circuit maintains the signal level at the demodulator input over a wide range of input power levels.

Each BSPM is associated with an externally mounted BRFM. Up to eighteen BSPMs can be installed in a single chassis. The capacity of each type of BSPM is illustrated in the following table:

	BSPM Channels
All 64 kbps	3
All 32 kbps	6
All 16 kbps	12
Mixed Rates	Yes

Base Station Radio Frequency Module (BRFM)

The Base Station Radio Frequency Module (BRFM) is a small module that mounts onto the antenna. It contains the low noise amplifier (LNA), power amplifier (PA), diversity/TDD switch, and band-pass filters. The TDD switch controls the path between the receiver and the transmitter. The LNA amplifies the receiver signal high enough to compensate for antenna cable loss. The PA boosts the transmitted signal up to +30 dBm. The various band-pass filters isolate unwanted signals from entering or leaving the antenna.

Each BRFM is connected to a specific BSPM (one-to-one ratio) through a single IF coaxial cable. DC power and the control signals are passed up to the BRFM from the BSPM through the coax cable along with the IF signal.

Analog Interface Module (AIM)

The Analog Interface Module (AIM) provides an analog interface between a base station and an analog switch for up to 32 telephones. AIM boards are housed in a specially designed AIM chassis, which is installed at the same location with the Base Station and has a similar size. Each AIM chassis can house up to 21 AIM boards. A typical Base Station interfacing with an analog switch requires one AIM chassis equipped with certain number of AIM boards, depending on number of subscribers it serves.

The bearer channels (voice, fax, or modem) are brought into the AIM by analog 2-wire Tip and Ring lines, converted to/from 64Kbps digital PCM data and routed to/from the TDM bus, to which the AIM interfaces internal to the Base Station. All provisioning, configuration, and operations are managed by the CPM, which communicates to the AIM microprocessor over the TDM bus.

2.5.3 Base Station Antenna

Distributed Power and Antenna Configuration

In most multiple-access communication systems it is necessary to transmit and receive signals on separate RF carriers. Typically, this is done by modulating and amplifying the RF carriers separately and then combining them before final amplification and application to the antenna. Broadband power amplification is expensive at RF and microwave frequencies, especially when required to meet significant linearity specifications.

A distributed antenna approach, which is adopted by the Aditus system, provides a number of advantages by distributing the power amplification among several low power, low cost amplifiers.

This distributed transmission design architecture protects the network so that the failure of a BSPM will reduce the system capacity by only one single RF carrier associated with four bearer channels, without impacting the rest of the system.

Distributed Antenna Design Description

Several BSPMs are connected to the antenna assembly through individual coaxial cables. IF signal is transmitted over the cable and the cable loss is low. This allows for the use of less expensive cables. DC power, control signaling, and a synthesizer reference signal are also multiplexed on the cable.

The antenna array shown in following figure consists of four radiating elements. When a BRFM is mounted on the back of the antenna array as illustrated, it is connected to one of the four radiating elements with a short coaxial cable. Up to four BRFMs can be mounted on a single antenna array.

Base Station Antenna Array Characteristics:

	3 Sector	4 Sector
Gain	10 dBi	10 dBi
Horizontal beam width	60° at 3 dB	45° at 3 dB
Horizontal side-lobes	-28 dB	-28 dB
Front-to-back	-28 dB	-28 dB

Figure 2-4 Adicom Amptenna™

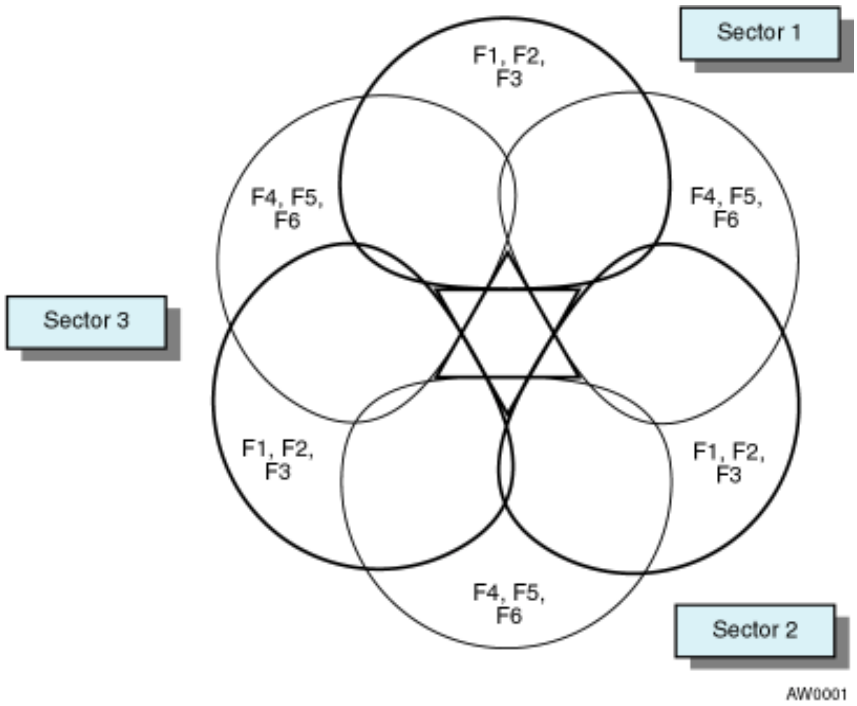
Adicom Amptenna Front View

Base Station Antenna Architecture

The architecture for the antenna system determines how the cell may be sectored. The Aditus system is configured as a three- or four- sector system. This arrangement allows the operator to maximize area coverage, adapt to varying population clusters, reduces co-channel interference and minimizes loss of service due to the distributed characteristic of this design.

Figure below shows a three-sector system. For example, if the operator is using 10MHz of bandwidth deployed with only Aditus radios, three RF carriers are used with each antenna array. The first set of patterns is outlined with thick boundaries. F1, F2, F3 are three carriers, 1.67 MHz each, used on the three antenna panels in the first antenna set. For the second set of antennas (three panels staggered on top of the first set and directed 60 degrees off the first set), three more carriers, F4, F5, and F6, are used. This staggering technique provides for interference protection among adjacent sectors, as well as additional coverage and capacity between sectors.

Figure 2-5 Typical 3-Sector Cell Arrangement



2.6 Remote Access Unit

Adicom Wireless provides Remote Access Units (RAU). The ***Aditus Multi-Line Concentrator*** family consists of: the Aditus Wireless Pedestal, a multi-line outdoor system; and the Aditus In-Building Concentrator, a multi-line indoor system (future release). The ***Aditus Express Link RAU*** family consist of the 2-Line and single line (future release) RAUs. The Aditus RAU systems are telecommunication units designed to connect subscriber telephones through a wireless link to the Aditus Base Station which, in turn, connects to the telephone network.

2.6.1 Aditus Multi-line Concentrator Overview

The multi-line concentrator RAU system is designed as an outdoor unit that support up to 16 or 32 subscriber lines. The outdoor installation is implement in a ruggedized enclosure for pole or wall mounting. A battery compartment is built into the watertight housing for safety and protection. The RAU is connected to a directional antenna through a RF coaxial cable and a multi-pair analog cable connects the RAU to a standard analog telephone punch block for the subscriber line termination. Local 110V or 220V AC utility lines supply power to the RAU through a 16 gauge, three-wire cable. Figure 2-6 shows the outdoor enclosure. The RAU consists of four functional blocks enclosed in a weather tight housing:

- Line Interface
- Customer Signal Processor
- Customer RF Module (CRFM)
- Power Supply

Figure 2-6 Multi-line Concentrator RAU (outdoor)

2.6.2 Aditus Multi-line Concentrator Models

The following sections describe these modules and functions.

Line Interface

The Line Interface is a printed circuit board supporting up to 16-subscriber line interface ICs, or 32-subscriber line interface with 2 line interfaces, capable of emulating a direct connection to the telephone network. The line interface is controlled by the customer signal processor through a general Micro-Controller interface (i.e., all micro-controller bus signals are connected to the line interfaces allowing for future expansion). The main function of the line interface is to interface the user telephone lines to the customer signal processor.

To initiate and receive a call and to transmit voice or data, the customer signal processor firmware through the line interface hardware will perform the following functions:

- Detect a subscriber picking up the phone
- Connect subscribers to any available channel
- Ring the appropriate subscriber line
- Connect the incoming call channel to the appropriate subscriber line

In addition to receiving and transmitting calls, provisions are made for testing each subscriber line.

Customer Signal Processor

The customer signal processor performs CDMA and IF signal processing and controls all line interface functions and the interface to the CRFM.

It can accommodate four 32 kbps ADPCM or eight 16 kbps ADPCM traffic channels. The processor performs the following:

- Interface with a CRFM for receive and transmit of user signals as well as the configuration and control of the CRFM module
- Perform all the modem signal processing functions required for each of the CDMA channels
- Perform the protocol functions necessary for the establishment and termination of RAU connections
- Encode and decode speech

The processor performs modulation, demodulation and conversion to the IF. The IF signal is sharply filtered to reject adjacent channel interference and fed to the Quadrature Phase Shift Keying (QPSK) demodulator. An AGC circuit maintains the signal level at the demodulator input over a wide range of input power levels. The demodulator produces Q and I signal that are passed on to the processor for further demodulation. The processor controls the output power by programming the variable attenuators in the transmitter section of the CRFM.

Customer RF Module (CRFM)

The CRFM acts as a transceiver for the air-interface to transmit and receive radio signals to and from the Base Station interface. It contains the Low Noise Amplifier (LNA), Power Amplifier (PA), diversity/TDD switch, and band-pass filters. The diversity/TDD switch controls the path between the receiver and the transmitter. The LNA amplifies the received signal to overcome antenna cable loss. The PA boosts the transmitted signal up to 1 watt. The various band-pass filters isolate unwanted signals from entering or leaving the antenna.

The CRFM can be integral to the RAU, or if the distance between the antenna and the RAU is greater than 8 meters, it can be mounted externally with the RAU antenna, remotely from the RAU, to minimize the RF loss. When it is mounted remotely from the RAU, it will be connected to the RAU through a single IF coaxial cable with a maximum length of 100 meters, if the standard cable type is used. DC power and the control signals are passed up to the CRFM from the RAU through this cable along with the IF signals.

RAU Enclosure

The RAU outdoor enclosure is a ruggedized chassis used to house and power each RAU module. It is designed to be mounted outdoor on a wall, pole, etc. This enclosure has a weather-proof, heat-dissipating design that warrants normal RAU operation under severe environmental conditions. When outdoor enclosure is used, the CRFM is typically mounted inside the enclosure.

Battery Backup

Multi-line concentrator RAUs can have an optional, internal battery installed that is capable of 4-hour backup. This battery is a standard 12V 24 amp-hour sealed rechargeable lead-acid battery.

2.6.3 Directional Antenna

Flat panel type directional antenna is used with multi-line concentrator RAUs.

Flat Panel Antenna Characteristics:

Gain:	10 dBi
Horizontal beam width:	45° at 3 dB
Horizontal side-lobes:	-15 dB
Front-to-back:	-20 dB

2.6.4 Aditus Express Link RAU

The Aditus Express Link RAU is a telecommunications unit designed to connect subscriber telephones through a non-concentrated wireless link to the Aditus Base Station. Currently available model is a dual-line unit (RAU-2) that has two non-concentrated subscriber lines.

Besides 32kbps or 16kbps service similar to the concentrated units, each subscriber port can also be configured at 64kbps PCM that provides for faster data applications such as Internet access via a modem.

With its flexible capability, the Express Link RAU can be used for a variety of applications. Following are some examples:

- One RAU-2 serves a small office with one dedicated date line configured at 64kbps rate while the other configured at a lower rate primarily for voice service
- Provide telephone lines for a single or two adjacent offices or family residences
- RAU-2 installed to provide access to a pair of back-to-back street or in-building payphones
- One RAU-2 installed to provide ISP access port for an internet access network, configured at 64kbps, also provide voice service on the same line

Figure 2-7 Express Link Remote Access Unit