MINI-LINK BAS
Technical Description

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MINI-LINK BAS

Technical Description

Foreword

The customer documentation includes all information and documents necessary for a basic knowledge of Ericsson systems.

The above said documentation has its own code number and release; the latter is subject to changes whenever eventual updates may occur.

The customer documentation is subdivided into the following manuals:

- AT Installation Manual
- Installation Manual
- Operation and Maintenance Manual
- Planning and Engineering Manual
- Product Catalogue
- Technical Description

The purpose of this description is to support the reader with detailed information on the product from technical and functional points of view.

It supplies all information necessary to understand equipment operation and technical characteristics. This document is addressed to the network planner and operation personnel who will find the information they are interested in.

Use of any trademark in this document is not intended in any way to infringe on the rights of the trademark holder.

Preface

For more information, please refer to the MINI-LINK BAS Product Catalogue.

You may also contact your Ericsson representative or the area sales manager for your country at:

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Please contact your Ericsson representative for latest details and data.

The specifications or configuration contained in this document are subject to change without notice due to continuous design improvement.

If there is any conflict between this document and Compliance statements, the latter will supersede this document.

Please refer to the *"Information Revision"* document for details about the updating level of the present description.

The MINI-LINK BAS and the relative Customer documentation have been designed and developed by:

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Introduction

1.1 General Information

The new fields for application of microwave radio links introduce more demanding functional requirements as well as stricter requirements on operational performance. The transmission quality in terms of acceptable bit error ratio, availability, and so on is improved, as well as the spectral characteristics in order to permit effective utilization of the available bandwidth.

The scope of requirements in the form of directives, standards and recommendations issued by national and international organizations is constantly widening.

The MINI-LINK BAS meets these requirements. Performance data meets or surpasses the detailed requirements specified for this type of equipment.

1.2 Manual Structure

The *Technical Description* was prepared in order to satisfy the customer's need for information on the technical features of his equipment; it is composed of the following parts:

Contents

It includes the general contents of the chapters.

Introduction

It consists of this section that describes in short the contents of the various parts composing the description and the list of acronyms and abbreviations.

Chapters

They supply all information necessary to understand equipment operation and technical characteristics. These are addressed to the network planner and operation personnel who will find the information they are interested in.

1.3 General Overview

The MINI-LINK BAS -*Broadband Access System*- product family is member of Ericsson’s large and powerful product line for telecommunication. The combined expertise of Ericsson, covering switching, cellular technology, radio and networking, means excellence in turnkey project management.

It is more than just an Asynchronous Transfer Mode (ATM) cross-connect featured by a *point-to-multipoint microwave radio*. It is a complete system, including hardware, software, experience and competence. The MINI-LINK BAS integrates fully with existing telecom access networks, adding new levels of flexibility. It has proved to be a reliable communication medium, a highly competitive alternative to copper and fibre cable.

The MINI-LINK BAS is a natural step in Ericsson's product development program, in response to new requirements from a growing market and is based on more than 20 years’ experience of microwave links.

Ericsson designers and engineers remain vigilant, seeking new technology and developments to keep MINI-LINK BAS at the forefront of microwave communications. Advanced Technology, constant product development of powerful functions, operational reliability and quality have resulted in the MINI-LINK BAS.

MINI-LINK BAS is a product for point-to-multipoint and point-to-point connections, carrying multimedia traffic services and is designed primarily to meet increased demands for more efficient transmission systems in access networks.

1.3.1 Opportunities

The worldwide deregulation of the local loop market, the emergence of new wireless technologies, and an increased demand for new services, has created a great market opportunity for existing and new competitive access service providers.

Small and medium sized businesses have an increasing demand for data oriented services such as high-speed Internet/Intranet access, LAN-LAN interconnect, Internet Protocol (IP) services and T1/E1 leased line connections.

MINI-LINK BAS offers the possibility to satisfy these needs, providing the medium for convergence between telecommunication, and datacom/ Information Technology (IT) systems.

Ericsson experience in building world class radio products coupled with clear market drivers such as Local Multipoint Distribution System (LMDS), has lead Ericsson to define and develop our next generation ATM based digital microwave radio systems, for broadband radio access. The system is initially targeted for the business community supporting a large range of multimedia services.

A well designed wireless broadband access system, enables operators to provide rapid, cost efficient, flexible and reliable broadband access, without the need of a cost prohibitive and complex fiber access infrastructure. The system is efficient in both areas with high and low/medium penetration since the system is featured by a scaleable "pay as you grow" architecture.

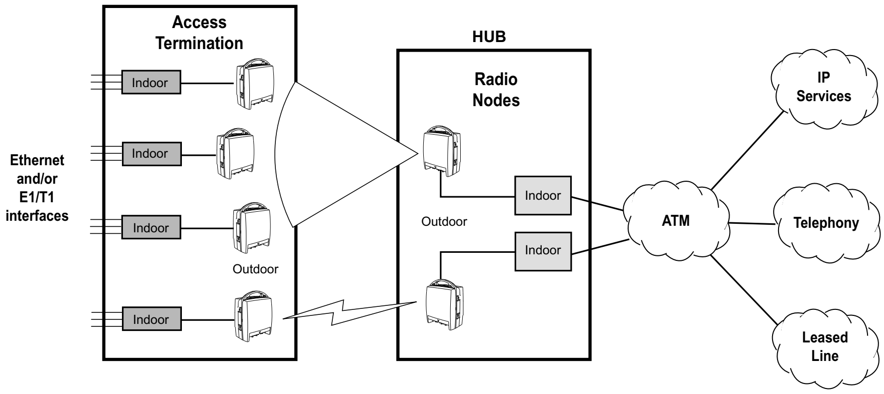

Figure 1-1 General Applications for the BAS

1.3.2 Product Benefits

The MINI-LINK BAS offers, to name a few, the following features:

- true Fast Dynamic Capacity Allocation (F-DCA) for data services;
- port-to-port, intra-Hub, Local Area Network (LAN) and Private Branch Exchange (PBX) interconnections without the use of core resources;
- symmetrical broadband air-interface, independent in both directions;
- cost-efficient scaleable broadband access solutions (pay as you grow);
- rapid deployment and provisioning;
- reduced dependence on existing facilities;
- integration/convergence of different types of services such as IP traffic and telephony traffic.

The radio design is based on the same platform that is being developed for the immensely successful and reliable MINI-LINK family, deployed in more than 100 countries.

This digital microwave family has shown exceptional reliability with actual Mean Time Between Failures (MTBF) figures exceeding 30 years, thanks to a quality oriented high volume production, with a current production capacity exceeding 100,000 units per year. In the MINI-LINK BAS the new multi-chip module improves the reliability and simplifies production even further.

- The design is compact and integrated. The radio and antenna form an integrated outdoor part;
- clean-cut concept; the outdoor part holds all frequency-dependent units and the indoor part holds all traffic management units;
- single coaxial cable interconnection between outdoor and indoor parts;
- software-aided Access Terminal (AT) configuration and setup;
- centralized operation and maintenance system by means of the EM (Element Manager);
- high system gain and spectrum utilization with an advanced modulation process and coding;
- high MTBF figures of 20–30 years.

1.4 Terminology

AAL	ATM Adaptation Layer
ACT	AT Craft Tool
ANSI	American National Standards Institute
API	Application Programming Interface
ASK	Amplitude Shift Keying
AT	Access Terminal
AT	Access Termination
ATM	Asynchronous Transfer Mode
ATPC	Automatic Transmit Power Control
BAS	Broadband Access System
BBER	Background Block Error Ratio
C-AAS	Concentration Shelf
CB	Channel Bank
CBR	Constant Bit Rate
CE	Circuit Emulation
CE-AAS	Circuit Emulation Shelf
CE Board	Network side Circuit Emulation card
CEPT	Conference on European Post and Telegraph
CP	Control Processor
CPE	Customer Premise Equipment
C-QPSK	Constant envelope offset Quadrature Phase Shift Keying
CRC	Cyclic Redundancy Check
DP	Device Processor
EBER	Excessive Bit Error Ratio
EIA	Electronic Industries Association
EM	Element Manager
ESR	Error Second Ratio
ET	Exchange Terminal
ETSI	European Telecommunication Standard Institute
FAS	Frame Alignment Signal

FAW	Frame Alignment Word
FEC	Forward Error Correction
FCC	Federal Communication Commission
FCS	Frame Checking Sequence
F-DCA	Fast Dynamic Capacity Allocation
FDD	Frequency Division Duplex
FlexNU	Flexible Network Unit
FPROM	Flash Programmable Read Only Memory
GUI	Graphical User Interface
HH	Hardware Handler
HP-OV	Hewlett Packard OpenView
HTTP	Hyper Text Transport Protocol
ICS	Internal Communication System
IEC	International Electrotechnical Commission
IF	Intermediate Frequency
IP	Internet Protocol
IRCC	Internally Radio Communication Channel
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IT	Information Technology
ITU	International Telecommunications Union
LAN	Local Area Network
LLC	Logical Link Control
LMDS	Local Multipoint Distribution System
LOS	Line-of-Sight
MAC	Media Access Control
MCM	Multi-Chip Module
MIB	Managed Information Base
MMIC	Microwave Monolithic Integrated Circuit
MRI	Managed Resource Interface
MRS	Managed Resource Server
MS	Management System
MTBF	Mean Time Between Failures

NCU	Node Control Unit
NE	Network Element
NNM	Network Node Manager
NU	Network Unit
ODU	Outdoor Unit
OTP	Open Telecom Platform
OSI	Open Systems Interconnection
PABX	Private Automatic Branch Exchange
PBA	Printed Board Assembly
PBX	Private Branch Exchange
PDH	Plesiochronous Digital Hierarchy
PDU	Power Distribution Unit
PID	Process Identification Number
PLL	Phase Locked Loop
PMP	Point to Multi Point
POTS	Plain Old Telephone Service
POU	Power Unit
PRC	Primary Reference Clock
PSTN	Public Switching Telephone Network
PSU	Power Supply Unit
PVC	Permanent Virtual Circuit
QoS	Quality of Service
R-AAS	Radio Shelf (Radio ATM Access Subrack)
RAI	Remote Alarm Indication
RC	Radio Control channel
RCL	Radio Control Loop
RDI	Remote Defect Indication
RF	Radio Frequency
RN	Radio Node
RAU	Radio Unit
RSSI	Received Signal Strength Indication
RTD	Round Trip Delay
SC	Service Configuration

SDH	Synchronous Digital Hierarchy
SESR	Severely Error Second Ratio
SN	System Node
SNI	Service Network Interface
SONET	Synchronous Optical Network
STA	Spanning Tree Algorithm
SU	Service Unit (AT side)
TDM	Time Division Multiplex
TDMA	Time Division Multiple Access
TMN	Telecommunication Management Network
UAT	Unavailability
UBR	Unspecified Bit Rate
UDT	Unstructured Data Transfer
UF	Uplink Efficiency
UNI	User Network Interface
VC	Virtual Channel
VCO	Voltage Control Oscillator
VCTCXO	Voltage Controlled Temperature Compesated Crystal Oscillator
VoIP	Voice over Internet Protocol
VP	Virtual Path
WAN	Wide Area Network
WBAS	Wireless Broadband Access System

2

System Description

2.1 Overview

The MINI-LINK BAS integrates ATM transport and microwave broadband technologies. This permits the system to efficiently use the carrier bandwidth to support a wide range of medium to high-speed services. It is a complete end-to-end solution from customer service terminals, to IP/ATM/PSTN backbone equipment and management systems. It assures the quality, availability and security that Ericsson customers have come to depend on for over a century.

The MINI-LINK BAS consists of customer located Access Terminations (ATs), communicating with Radio Nodes (RNs).

User traffic is either transported to the customer premises through a dedicated point-to-point connection, for longer radio reach, or in a point-to-multipoint configuration. The latter provides an efficient use of available spectrum sharing the air interface capacity among many customers and allowing the use of statistical multiplexing over the radio interface.

The system communicates with ATM and PSTN backbones via a variety of standard interfaces, from E1/T1 to OC-3/STM-1, 155 Mbps.

ATs support a wide variety of services, from PBX interconnections to LAN to LAN interconnect and Internet access over different types of interfaces such as E1/T1 and Ethernet 10/100BaseT.

The customer located ATs are designed with “hot plug-in” service interface boards for different service requirements. So new services are easily added without any impact on other services. ATs are also designed with remote program capability so that settings can be changed without the need for a visit from a service engineer at the customer premises.

The MINI-LINK BAS utilises a Constant envelope offset-Quadrature Phase Shift Keying/Time Division Multiple Access/Frequency Division Duplex (C-QPSK/TDMA/FDD) scheme.

C-QPSK is a robust modulation scheme that delivers exceptional Carrier to Interference (C/I) performance and a healthy link budget that is required in a fully built out system.

The TDM/TDMA solution allows to efficiently support the fast dynamics in bursty packet switched data networks (IP traffic) via statistical multiplexing and F-DCA. This results in a very compact and cost effective solution.

The MINI-LINK BAS uses applicable frequency spectrum such as:

- 24.5-26.5 GHz band in Europe
- 27.5-28.35 GHz in the US LMDS “A” band
- 31.0-31.30 GHz in the US LMDS “B” band

MINI-LINK BAS supports 28 MHz Channelling achieving a capacity over the air interface of 37.5 Mbps in both directions.

The MINI-LINK BAS follows a cellular deployment structure where multiple cells support a footprint over a geographical area. Each cell is comprised of a Hub with multiple RNs equipped with sector/directional antennas for point-to-multipoint and point-to-point connections.

The ATs require a Line-of-Sight (LOS) path toward the Hub and can be located anywhere within the sector coverage area, typically up to 6 km for point-to-multipoint access; up to 10 km for point-to-point access; the actual distance depends on the operating frequency and rain zone.

2.2 System Components

The MINI-LINK BAS consists of the following components:

1. AT
   - In Door Unit (IDU): FlexNU
   - Out Door Unit (ODU): Radio and antenna
2. RNs
   - Indoor NCU
   - ODU: Radio and antenna
3. C-AAS
4. Control and management
   - CP
   - EM

RNs are housed in R-AAS. A Radio Hub site can contain one or more RNs plugged into one or more R-AASs. The multiple shelves can be co-located or remote from each other.

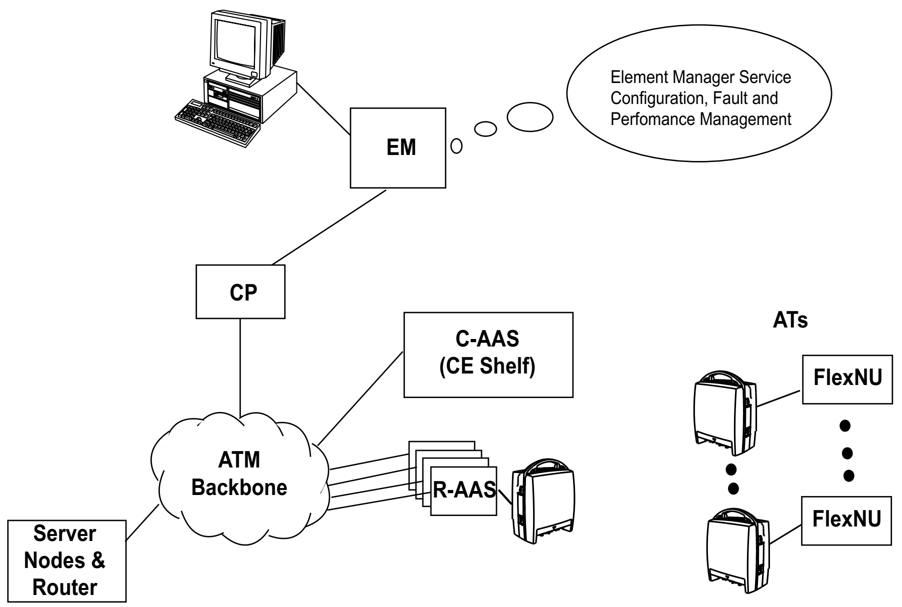

Figure 2-1 MINI-LINK BAS Generic Network

2.2.1 AT

AT is composed by:

- IDU: FlexNU
- ODU: Radio and the antenna

AT is located at the edge of the network close to the subscriber providing an interface between the MINI-LINK BAS network and the subscriber equipment.

Each AT is assigned to a RN and receives downlink, broadcast traffic from that RN using the TDM scheme. AT transmits uplink traffic to the RN in a TDMA fashion sharing the total RN capacity, 37.5 Mbps, with the ATs.

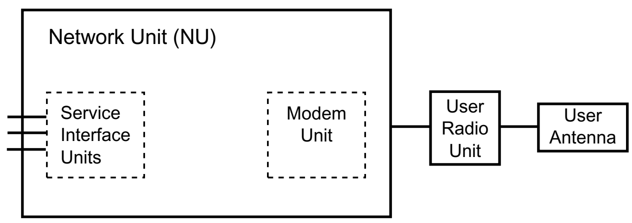

Figure 2-2 AT Block Diagram

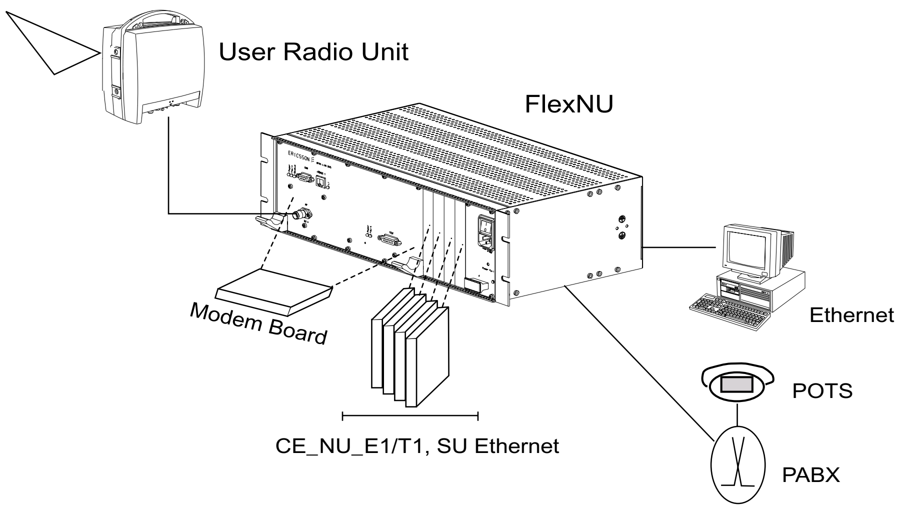

Figure 2-3 AT

2.2.1.1 FlexNU

FlexNU is the indoor part of the AT. It is connected to the ODU with an IF coaxial cable, as shown in the Figure 2-3.

The FlexNU, which can house Modem board and Service Units (SUs), features an active backplane on which the Media Access Control (MAC) functionality is implemented.

FlexNU supports different types of services at each subscriber node by means of SU boards. Two types of SUs are currently available:

- CE-SU E1/T1 with 2 interfaces per board
- 10/100BaseT-SU with 2 interfaces per board

Up to four SUs can be inserted as plug-in modules in the FlexNU. This gives the FlexNU service flexibility and upgrade capability. In addition to the plug-in SUs, the FlexNU is equipped with a power supply unit, 110/220 Vac, and a built-in Ethernet 10BaseT interface usable for maintenance operations.

2.2.1.2 ODU

The ODU consists of a Radio and a directional antenna ”Low Profile” parabolic type, 0.20 m., integrated within its casing.

Optionally an integrated 0.60 m antenna is available.

2.2.1.3 ACT

The AT Craft Tool (ACT) is a software application that resides in the AT. By means of an external notebook, working in VT-100 emulation, the ACT is used for local maintenance of the AT. The connectivity is provided by a RS232 interface available on the FlexNU front plate.

The installation or maintenance personnel can read or set configurable parameters locally within the AT, for example the radio frequency, the AT and RN identification numbers.

Via ACT it is possible to execute local software download and download swap command can be independently executed.

2.2.2 RN

The Radio Node (RN) consists of an ODU and an IDU. The ODU is made of a Radio and a Node Antenna. The Node Antenna is either a directional antenna for point-to-point applications or a sector antenna for point-to-multipoint applications.

A RN, equipped with a sector antenna, creates a sector carrier that typically covers an area up to 6 km in radius. Multiple sector carriers can be used to increase the capacity within a sector and multiple sectors can be used to cover a complete cell area of a Radio Hub.

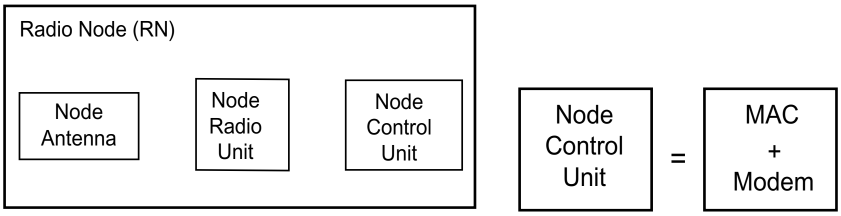

Figure 2-4 RN Block Diagram

The Node Antenna and the Radio are encased in a weatherproof outdoor mounted casing. The Radio is highly integrated and connected to the IDU via an Intermediate Frequency (IF) coaxial cable.

The microwave parts incorporate Ericsson's unique Microwave Monolithic Integrated Circuit (MMIC) technology that supports integration of a complete receiver and transmitter into a single multi-chip module, thus reducing the size of the ODU (see Figure 2-5). MMIC technology also guarantees extremely high reliability and is suitable for high-volume production.

The IDU is the NCU of the RN and it consists of Modem and MAC board sandwiched in a single plug-in unit.

The Modem board provides the IF interface towards the outdoor mounted radio and contains all modulating/demodulating functions. The Modem is also in charge to maintain the radio links, providing control loops for frequency, timing and transmitter power.

MAC functionality rules the traffic demands toward and from the ATs. MAC is based on very fast protocol and scheduling mechanism that grant capacity request in less than 1 msec.

The F-DCA feature of the MAC protocol affords very high statistical gain so that Radio capacity is used in a very efficient way.

The MAC board connects to the ATM bus on the backplane of the R-AAS.

The downering cell rate managed by a RN is 78000 cells/s. This is a net capacity in downlink and a gross capacity in the uplink.

In order to calculate the net capacity in uplink it must consider the overhead, which is necessary to handle traffic queues status in each AT. The overhead depends on the number of ATs per RN and on the polling period.

In the following table the capacity reduction is given for a default-polling period, 80 slots, versus the number of ATs per RN. The Uplink Efficiency (UF) varies from 0.96 to 0.75.

The throughput at the application level, both CE and Ethernet will decrease because of the ATM and AAL1, AAL5 overhead.

Moreover some capacity is allocated for control purpose and Physical Layer preservation. In the table are reported the max number of unstructured E1/T1 connections versus the number of ATs.

ATs/RN	UF (%)	E1/RN	T1/RN
1 to 8	0.96	14	18
9 to 16	0.93	13	18
17 to 24	0.90	13	18
25 to 32	0.87	13	17
33 to 40	0.84	13	17
41 to 48	0.81	12	17
49 to 56	0.78	12	16
57 to 64	0.75	12	16

2.2.2.1 R-AAS

The R-AAS is an indoor mounted subrack that can accommodate up to six plug-in NCUs (Modem + MAC). Each NCU is connected to an ODU, which is dedicated to a RN in a sector.

R-AAS can also house ET and CE-SNI boards. ET boards provide Wide Area Network (WAN) connectivity towards ATM backbone, IP router, C-AAS. CE-SNI boards provide connectivity towards PSTN.

R-AAS provides a total of 17 board slots, which are distributed according to the following scheme.

- Slot 1: ET board, any type 155, 45 or 34 Mbps
  An ET board shall be always present for Cellbus arbitration.
- Slot 2, 3: 2 CE-boards
- Slot 4, 5: 1 NCU or 2 CE-boards
- Slot 6, 7: 1 NCU or 2 CE-boards
- Slot 8, 9: 1 NCU or 2 CE-boards
- Slot 10, 11: 1 NCU
- Slot 12, 13: 1 NCU
- Slot 14, 15: 1 NCU
- Slot 16: POU
- Slot 17: POU

Depending on the configuration, a R-AAS can host up to 6 RNs, or up to 8 CE-boards that can terminate 32 E1/T1 interface connections.

R-AAS can support different configurations:

Number of RNs	Number of CE boards	Number of E1/T1 interfaces
6	2	8
5	4	16
4	6	24
3, 2, 1	8	32

In principle, a fully equipped R-AAS with 6 RNs, could cover up to 6 * 64 = 384 ATs. However, in order to optimise the overall performance of the system, it is recommended not to exceed 128 ATs per R-AAS.

The R-AAS backplane can handle up to 530 Mbps, providing cross-connect functionality between ATs covered by RNs inserted into the same R-AAS.

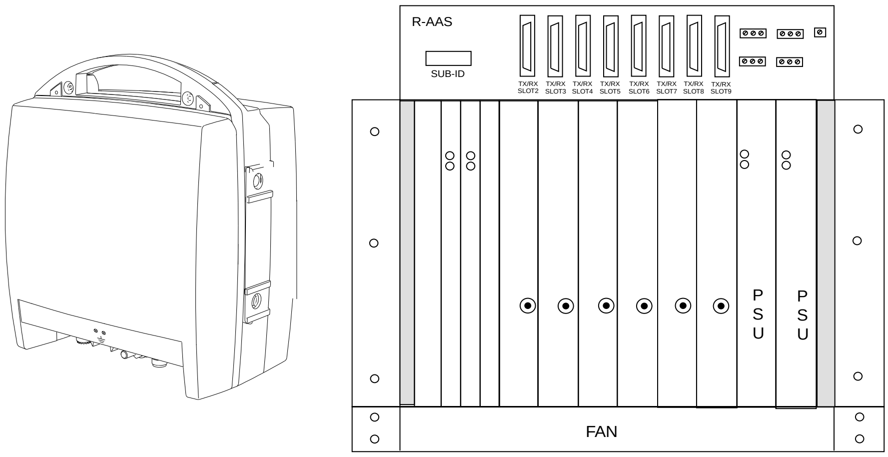

Figure 2-5 ODU and the R-AAS

R-AAS provides an ATM cross-connection capability through a distributed bus architecture named Cellbus. Each NCU, ET, CE-SNI boards access the bus through a CUBIT-PRO device.

ET board in slot 1 will acts as bus arbiter.

The traffic from the NCU/RNs is cross connected on the Cellbus to allowing very flexible interconnection between two ATs in a RN.

ATs can be connected not only to the backbone networks but also among them:

- ATs in a RN (User to User connection)
- From one RN to another RN (User to User connection)

- From a RN to a ATM switch, through an ET155 interface board; OC-3/ STM-1 (User to Service connection)
- From a RN to a PSTN switch, through a CE-SNI E1/T1 interface board (User to Service connection)

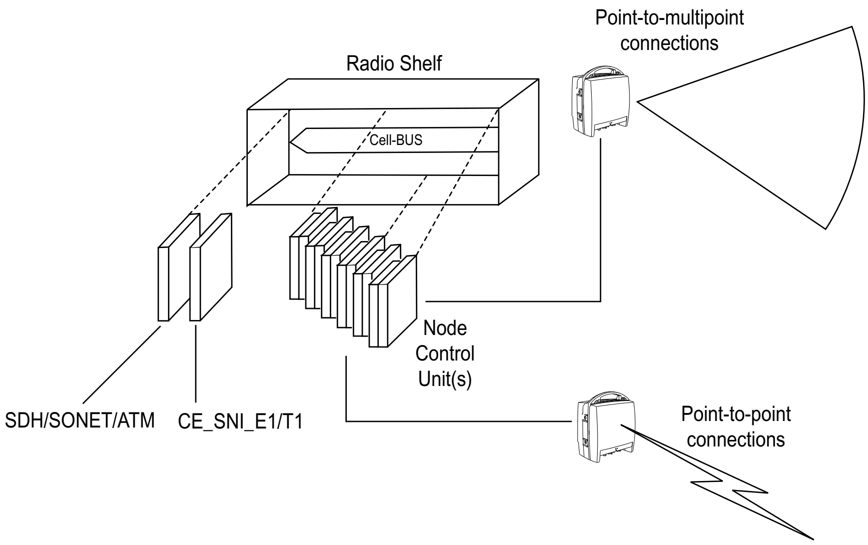

Figure 2-6 R-AAS

The interfaces at the customer premises, in our case at the ATs, are referred as User interfaces, whereas interfaces toward backbone network are referred as Service interfaces.

Subscriber traffic can be connected in a User to Service connection, from the subscriber to the backbone network, or from User to User.

For User to Service connections, CE traffic from various RN, can be terminated in the R-AAS using the CE-SNI (E1/T1) board. As an alternative it can be connected through an ET155 to an ATM network and then terminated in an external C-AAS (CE Shelf) using CE-SNI (E1/T1) boards or in other equipment supporting standard CE termination functions.

Data traffic related to an AT Ethernet interface, similarly, can be connected in a User to Service connection from the RNs through an ET155 to an ATM switch. For User to User connections (data or CE), the R-AAS provides a through path from RN to RN.

2.2.2.2 ODU

ODU contains Node Antenna and Radio. The ODU is connected to the NCU through a coaxial cable.

The Node Antenna used for point-to-multipoint applications is sector antenna, highly directive in elevation. For point-to-point applications the antenna that is used is a directive ”Low Profile” parabolic type antenna.

2.2.3 C-AAS

C-AAS is aimed to host CE terminations towards PSTN. C-AAS is mostly equipped with CE-SNI boards.

The C-AAS has 19 board slots which usage is report below:

Slot 1: ET boards

Slots 2-17: CE boards or ET boards

Slots 18-19: Two redundant power supplies, operating in load sharing mode

The ET board, in slot 1, shall be always present as performs Cellbus arbitration. Typical configuration foresees one ET board, for connection toward R-AAS or backbone network and up to 16 CE-SNI boards for connection toward PSTN.

Other configurations, with a greater number of ET boards, are allowed.

The C-AAS provides an ATM cross-connect functionality through Cellbus, as in R-AAS.

2.2.4 Control and Management

2.2.4.1 CP

The CP constitutes the agent that carries out all of the EM User commands, acts as the repository for the system database, and oversees control of the overall system. It is a UNIX based shelf mounted processor. CP can be either co-located with the R-AAS, C-AAS or at a remote location.

The CP is physically connected through a SDH/SONET link at OC-3/STM-1 Rate. The ATM switch multiplexes the CP control message traffic and subscriber traffic together for interfacing to the ET155 boards.
It is possible to connect the CP either to each C-AAS (CE Shelf) or R-AAS shelf using ATM connection or directly to ET in slot 1.

One CP can control a number of shelves, C-AAS (CE Shelf) and R-AAS, and their subtended equipment, that are radios and ATs.

2.2.4.2 EM

The EM operates on a standalone UNIX based workstation. The EM interfaces to the CP using a 10BaseT connection. One EM can manage shelves controlled by several CPs.

The EM can be co-located or remote from the CP that it manages.

2.3 Configuration Limits

MINI-LINK BAS components have the following configuration limits:

- EM can support to 10 CPs.
- 1 CP can control up to 128 ATs and support up to 30 SNs.
- 1 RN supports up to 64 ATs.
- 1 AT supports up to 4 Ethernet SUs or CE SUs.

2.4 System Interfaces

The system includes several primary physical interfaces.

2.4.1 Intra-System Interfaces

ET155 ATM

- 155 Mbps, IR, SONET STS-3c (Bellcore GR-253-CORE)/ S1.1 SDH STM-1 (ITU-T G.957)
- Full duplex
- Single mode optical interfaces

Radio Interface

- Channel spacing: 28 MHz
- Air capacity: 37.5 Mbps gross bit rate, full duplex using C-QPSK modulation scheme
- Frequency bands:
  - ETSI 26 GHz
  - LMDS A 28GHz
  - LMDS B 31 GHz

Note: The formal Type Approved certification has been obtained for the given frequencies.
There are also other frequencies that have been introduced, apply to the local Business Manager for more information.

- Duplex distance:
  - 1008 GHz for ETSI

– 420 MHz for LMDS

ET34/45 ATM

- E3/T3, 34/45 Mbps
- Full duplex
- Electrical interface
- DS3 direct and PLCP mapping available

2.4.2 Customer Service Interfaces

10BaseT/100BaseT Ethernet

- IEEE 802.3/Ethernet, 10/100 Mbps
- Half duplex and full duplex
- Electrical interface with Multiprotocol over ATM Adaptation Layer 5 encapsulation (RFC 1483)

Note: This functionality minimizes the system impact on supporting LANs.

2xDS1 – CE_NU_T1 SU

- ITU G.703/704
- TDM
- 1.544 Mbps
- Full duplex
- Electrical interface
- Unstructured CE service, synchronous and plesiochronous

2xE1 - CE_NU_E1 SU

- ITU G.703/704
- TDM
- 2.048 Mbps
- Full duplex
- Electrical interface
- Unstructured CE service, synchronous and plesiochronous

10BaseT NU built-in

- IEEE 802.3/Ethernet

- 10 Mbps
- Half duplex
- Electrical interface with Multiprotocol Over ATM Adaptation Layer 5 encapsulation (RFC 1483)
- Operation and Maintenance access only

2.4.3 Local Exchange/ISP Interfaces

ET155 ATM

- 155 Mbps, IR, SONET STS-3c (Bellcore GR-253-CORE)/ S1.1 SDH STM1 (ITU-T G.957)
- Full duplex
- Single/multi mode optical interfaces

ET34/45 ATM

- E3/T3, 34/45 Mbps
- Full duplex
- Electrical interface
- DS3 direct and PLCP mapping available

4xDS1 - CE_SNI_T1

- ITU G.703/704
- TDM
- 1.544 Mbps
- Full duplex
- Electrical interface, unstructured CE service, synchronous and plesiochronous

4xE1 - CE_SNI_E1

- ITU G.703/704
- TDM
- 2.048 Mbps
- Full duplex
- Electrical interface, unstructured CE service, synchronous and plesiochronous

3

Network Architecture

3.1 Introduction

MINI-LINK BAS is a scaleable system that allows building up access networks ranging from very small to very large configuration.

MINI-LINK BAS network can be tailored to very different scenarios in terms of subscribers or traffic density.

This chapter describes basic configurations and the rules to build large configurations. Network synchronisation options are described. Remote and local connection of Control and Management components, CP and EM, are described as well.

Last some typical network applications are shown in Paragraph 3.5.

3.2 SN

The basic MINI-LINK BAS network is constitued by a single R-AAS and its served access terminals.

This basic network supports all services and can be connected both to an ATM backbone network and a PSTN network through STM-1, E1, T1, E3, DS3 interfaces.

A large access network can be made of several basic networks, according to a cellular deployment. In a MINI-LINK BAS network, geographically spread, the use of ET1/T1 links for connection of R-AAS to the PSTN would be quite expensive because of the high number of links and their length.

MINI-LINK BAS provides an effective solution by the use of a C-AAS close to the PSTN. Traffic collected from the R-AASs can be transported toward the C-AASs through a few high capacities STM-1 connections.

This will result in a very cost-effective solution.

The R-AAS and the C-AAS are named, in the Control and Management perspective, SNs. SNs can be connected to CP and EM either in local or in remote mode.

3.2.1 SN R-AAS Stand-alone

This is the basic MINI-LINK BAS configuration made of only one R-AAS.

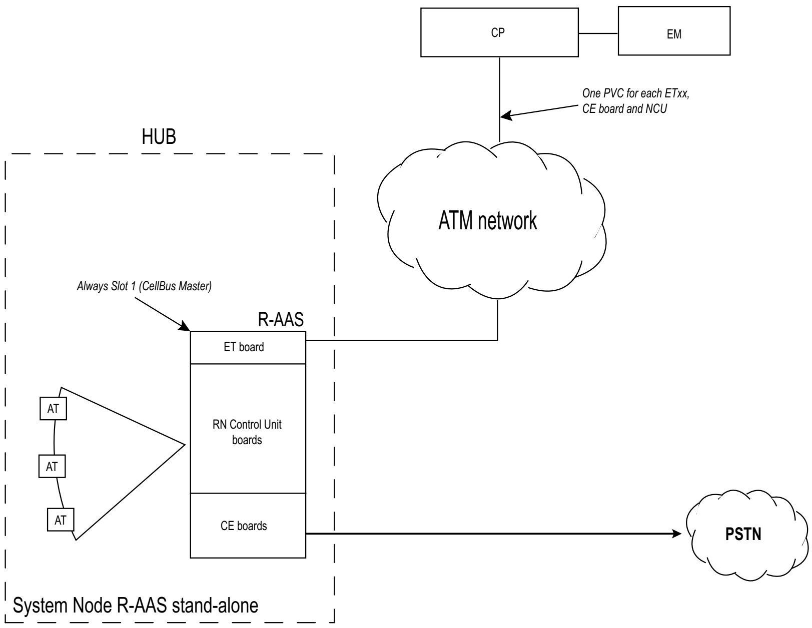

Figure 3–1 SN R-AAS Stand-alone

The R-AAS is directly connected to the backbone networks, both ATM and PSTN. CE boards and ET boards can be mixed in a rather free way in the subrack.

This is the typical SN architecture where mainly data traffic is handled and only few CE E1/T1 connections are terminated.

In the Figure 3–1 the R-AAS is remotely connected to the CP, through the backbone ATM network. The local CP connection is supported as well.

3.2.2 SN C-AAS

The C-AAS SN addresses a specific functionality in a MINI-LINK BAS network: the termination high number of CE emulation connections.

The typical application is therefore in large MINI-LINK BAS networks where several SN R-AAS are present and a high number of CE connections are transported and terminated within the system.

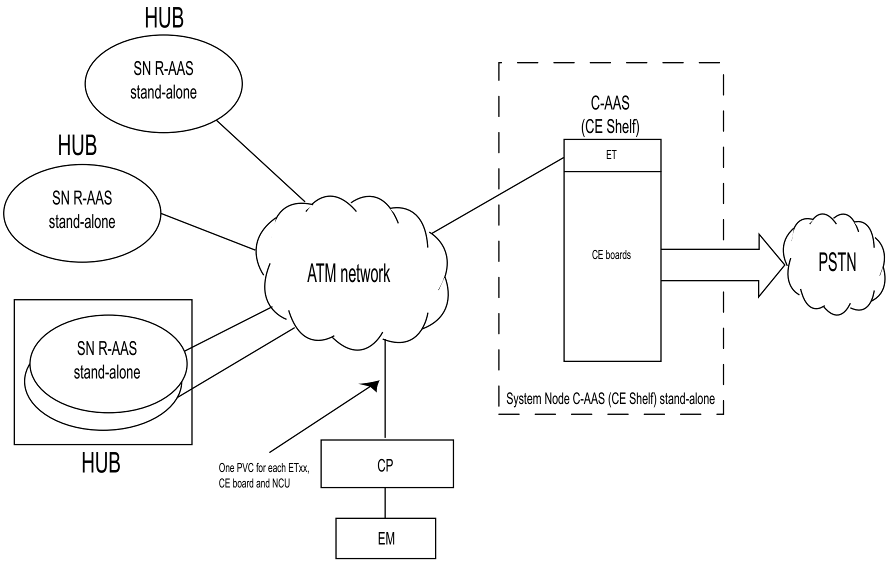

Figure 3–2 SN C-AAS Stand-Alone

When a large number of E1/T1 connections is terminated within the system, due to the R-AAS limitations and capacity availability, proper C-AAS has to be used. All CE traffic coming from each R-AAS can be terminated in one or a set of C-AAS.

Theoretically, in principle the C-AAS has 16 slots available to host CE boards for CE traffic collection from the R-AAS through the backbone ATM network. In practice, the bandwidth budget has to be analysed when defining the actual structure of this SN.

In fact, the C-AAS has here to terminated the CBR (typically E1/T1) traffic. The ET link capacity and the number of CE boards, in terms of E1/T1 ports, constitute the bottleneck of such a configuration.

Moreover, it must be noted that the intermediate configurations are possible. In fact, as the CE boards can be hosted both into the R-AAS and into the C-AAS, additional PSTN links could be obtained using available slots in the R-AAS directly.

This configuration is well suited when the physical connection points with the PSTN are co-located with the C-AAS, while the R-AAS is remote.

The C-AAS is basically equipped with CE boards and one ET board connected to the ATM backbone, in slot 1.

3.2.3 Generic MINI-LINK BAS Network

The generic MINI-LINK BAS network is made of several SN.

Each SN can be seen as a totally independent, tree-structured sub-network, having the direct access to each backbone network and offering end-user services.

The SNs are mutually independent, that is, there is no traffic crossing the SN boundaries toward another SN without passing through the backbone network. Each CP can manage a number of different System Nodes (SNs). The numbers of SNs each CP can manage is mainly dependent on the total number of ATs.

A single EM can manage up to 10 CPs. In the management perspective the CP is the agent whilst the EM is the manager. The sub-network controlled by the CP is therefore referred as NE.

A single CP can control up to 30 SNs. However, in order to optimise the control architecture performance, it is recommended not to exceed 128 ATs per CP; therefore, the real number of CP to be deployed strictly depends on the topology of each SN, and less than 30 SNs could be actually allowed under the same CP.

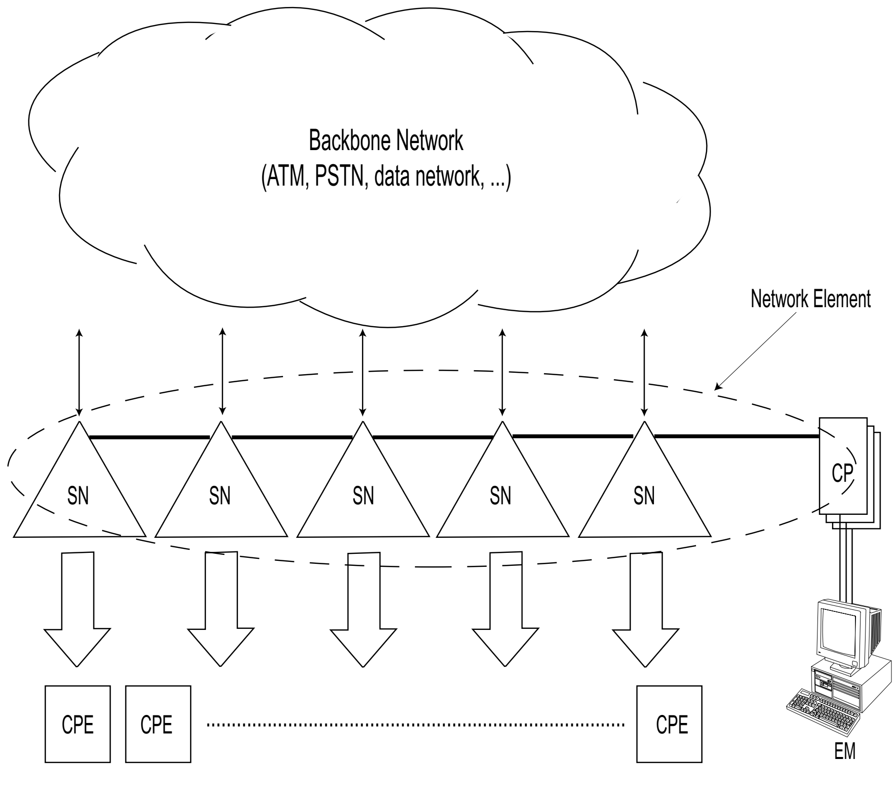

Figure 3–3 Generic MINI-LINK BAS Network

3.2.4 SN connection to CP and EM

The CP is equipped with ATM interface at STM-1 line rate, therefore can be connected to SNs through ATM virtual connections, is either a remote or local mode.

In the remote connection mode, the CP is connected to the ATM backbone network and virtual connection are set up in the ATM network to reach SN, as shown in the Figure 3–4.

CP can be locally connected to a SN as well. In such a case the CP is directly connected through an optical fibre to the ET 155 board housed in the slot 1 of shelves, either R-AAS or C-AAS.

The ET 155 board exploited for CP local connection is no longer available for traffic.

Only one SN can be managed by the CP local mode because of the uniqueness of the physical interface.

CPs are connected to EM through an Ethernet interface on an Ethernet LAN. External device performing Ethernet bridging are needed in case the EM is remotely located respect the CP.

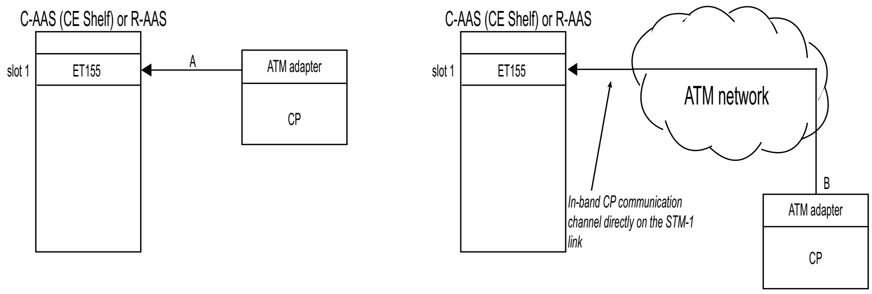

Figure 3–4 CP-SN Connection through ATM Network

Up to 10 CPs can be managed by an EM. An estimated bandwidth of 128 kbps per CP is needed.

3.2.5 Examples of an Overall Network

The following diagrams show some different network applications for the MINI-LINK BAS.

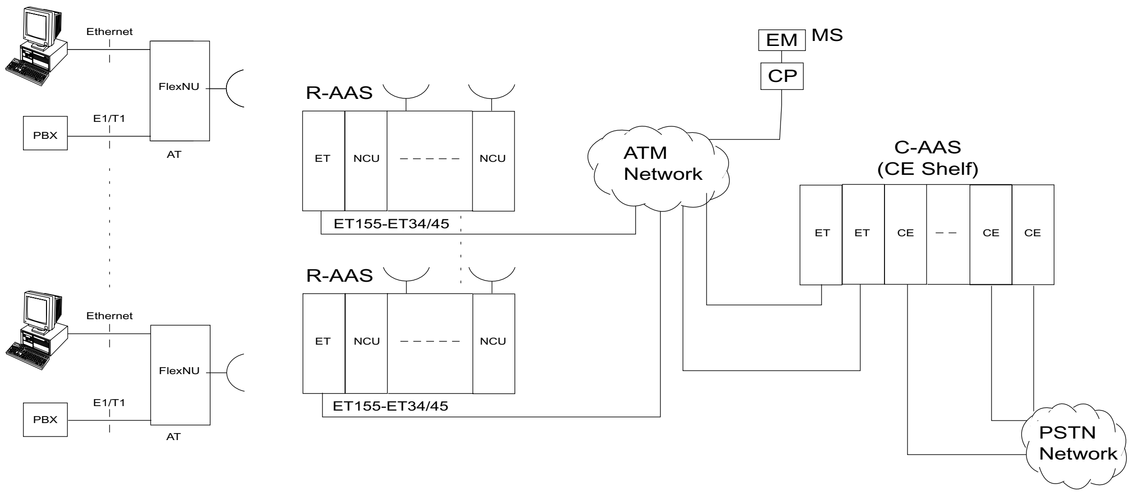

Figure 3-5 Network Example with R-AAS and C-AAS

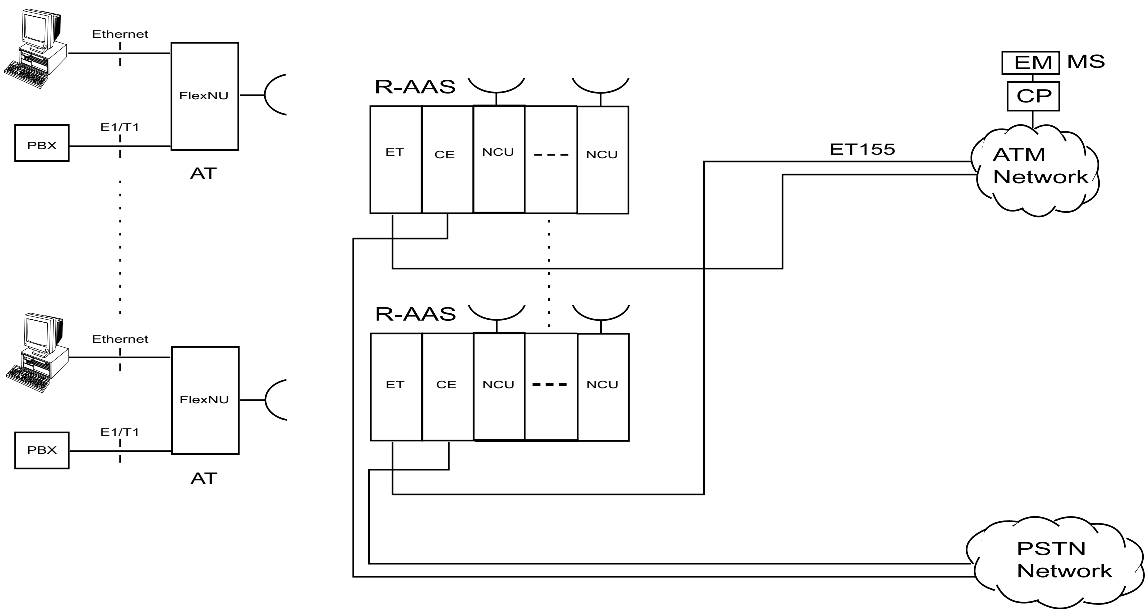

Figure 3-6 Network Example with R-AAS

3.3 System Synchronisation

MINI-LINK BAS access network needs to be synchronized to the backbone networks in order to interoperate correctly with them. Interoperation with a PSTN is strictly related to the services provided which imply isochronous operations and timing transparency from the Local Exchange till Customer Premises Equipments (CPEs).

Even the SDH/ATM backbone network requires synchronous operation, at least at link level. The timing of PSTN and SDH/ATM backbone derive from a Primary Reference Clock (PRC) – eventually this PRC clock could be unique.

In order to face different network scenarios the system allows the choice of any port in the system – both PDH synchronous and SDH – for synchronization purpose. In principle, because of the synchronous CES support, the best choice is to use synchronous PDH references as isochronous operation where the PSTN network is inherently assured.

The use of SDH ports for synchronization is also a suitable choice since once timing of SDH network and PSTN network are traceable to the same PRC. If it is not the case and the two networks are traceable to separate PRC, byte slips would be experienced for the PDH service, which rate is anyway limited to less than 1 slip every 72 days.

Slips are not due to the system behaviour but are due to the plesiochronous operation of the backbone networks.

Asynchronous PDH ports are not suitable for network synchronization and their use is not allowed for synchronization purpose.

The lack of a network reference will make the system operate in the free running mode: the port selected for synchronization will keep synchronizing the system exploiting the on board internal reference, that features a Stratum 4 clock accuracy, that is better than 32 ppm.

The port selected for synchronization is monitored against failures, synchronization specific alarms are reported to the operator to allow manual recovery of the failure. Guidelines and procedures are given in the proper section of the user documentation.

The system does not foresee any dedicated port for network synchronization from office clock distributors.

3.4 Traffic Routing

MINI-LINK BAS, as any access network, allows the set-up of traffic connection from the customer, User interface, to the backbone networks, Service interface.

Due to a cross connection capability in R-AAS, C-AAS, AT-to-AT connections are allowed without resorting to the backbone network.

Internal traffic is generated, whenever AT-to-AT connections are established within a sector, without exploiting R-AAS resources, or within a single R-AAS domain, without exploiting ATM Network resources.

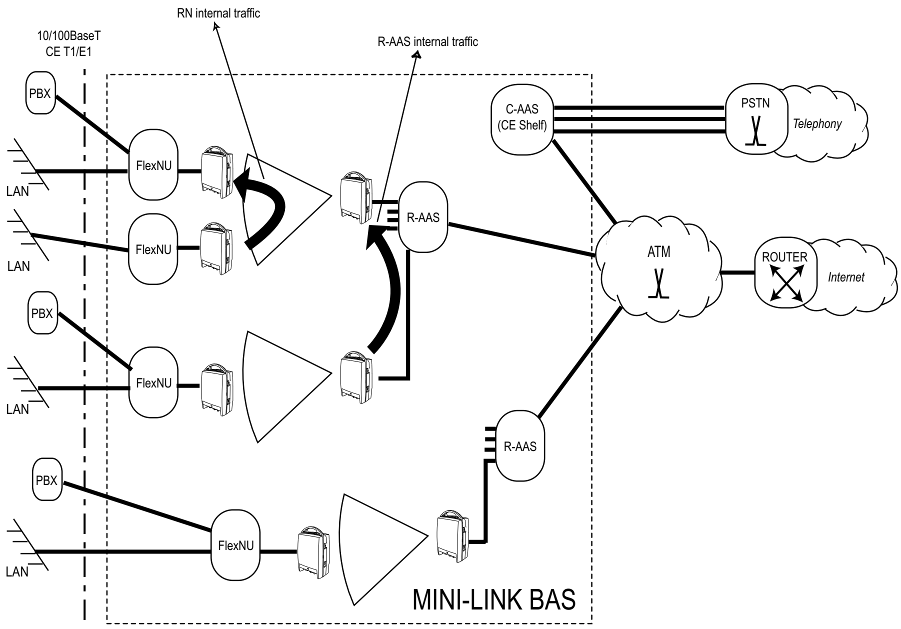

Figure 3–7 MINI-LINK BAS with AT-to-AT Connections

3.5 Typical Network Applications

Due to its flexible ATM based platform and its F-DCA technology, is a highly competitive solution for delivering services in the access network.

Traditional telephony service can be supported by the MINI-LINK BAS as shown in Figure 3-8. Typically, small and medium businesses have a PBX that uses either analogue or digital lines. A digital PBX that uses E1/T1 trunks can interface directly to the CE-SU (E1/T1) AT interfaces. In order to support analogue telephony services, the operator can augment the AT functionality with a Channel Bank (CB).

ATM PVC links the AT's E1/T1 interface to a CE-SNI E1/T1 interface in the R-AAS or in a C-AAS, which in its turn is connected to the PSTN. Note that the MINI-LINK BAS can also support an intra-Hub port-to-port connection, depicted in Hub 1 in the diagram. For local leased line interconnection applications this can reduce the load on the ATM mux/switch and other associated central office equipment.

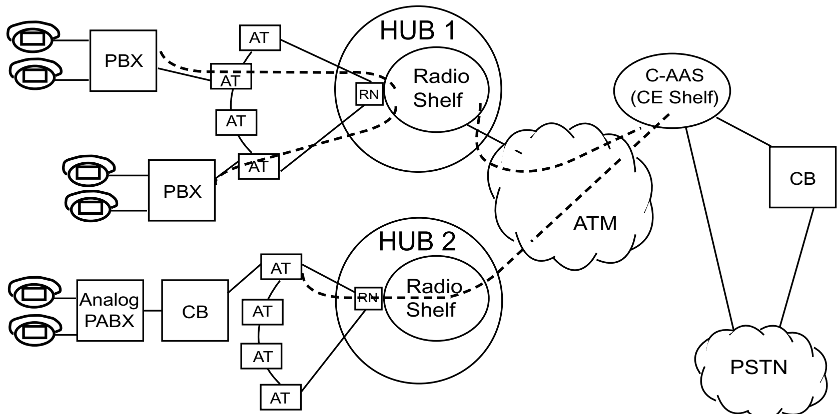

Figure 3-8 System Deployed for Telephony (PBX-PSTN, PBX-PBX)

An alternative solution to the conventional voice transportation is offered by the Voice over IP (VoIP) technology. An example of how the MINI-LINK BAS can support VoIP is shown in Figure 3-9. In such a scenario the subscriber's IP packets, containing telephony information, interface with the MINI-LINK BAS through an AT's 10BaseT interface and are then carried along with other IP services. To support VoIP services, the operating company or subscriber must use an external VoIP gateway.

This solution gives the subscriber and operating company the option to select between traditional voice or datacom and VoIP services converged according to their needs.

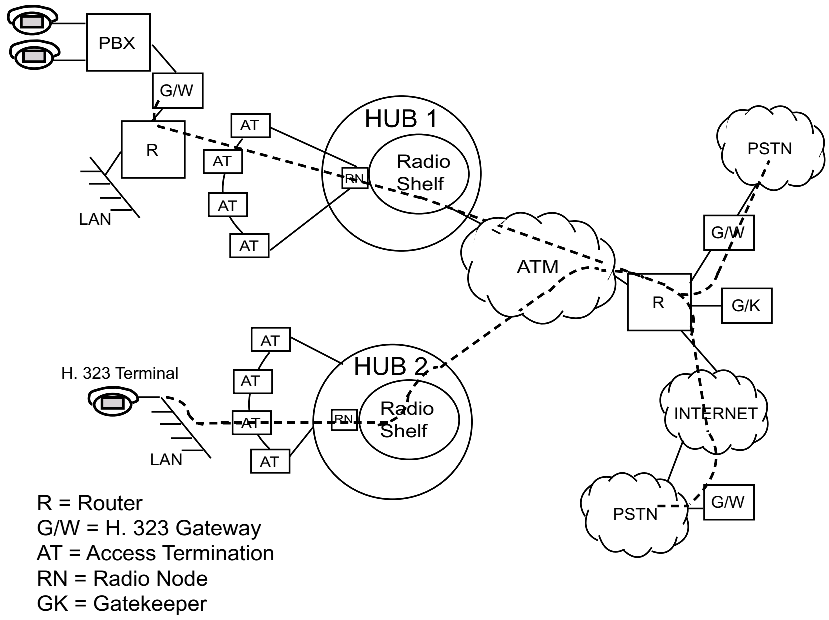

Figure 3-9 System Deployed for IP Telephony (PBX-PSTN, PBX-H.323 terminal)

Subscriber's datacom traffic is bridged at Ethernet interface to provide a demarcation point between the CPE LAN and the public network.

Typically a router can provide the operator with many options for multiple ISP access, billing and security for Internet and Intranet solutions.

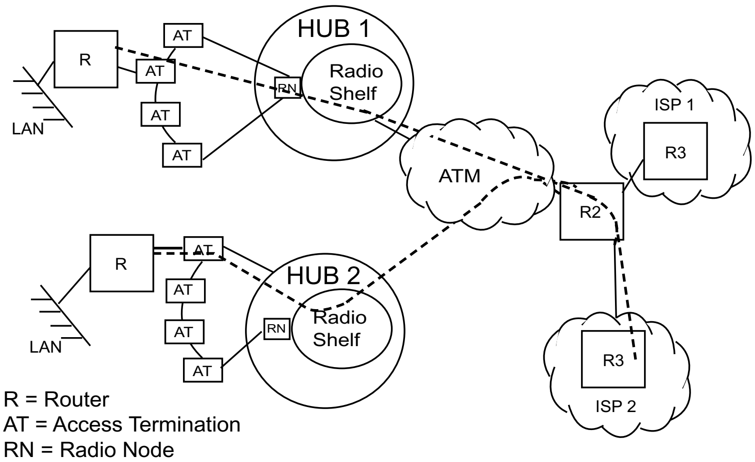

Figure 3-10 System Deployed for Data Traffic and Multiple IP Selection

4

End-User Services

4.1 Introduction

Small and medium sized offices require support for data and telephony traffic interconnection. Data traffic can be either between the end-user LANs or between a LAN and the Internet.

In a similar way the telephony traffic can be either between end-user PBXs or between a PBX and the PSTN.

These different interconnection cases are shown in Figure 4-1.

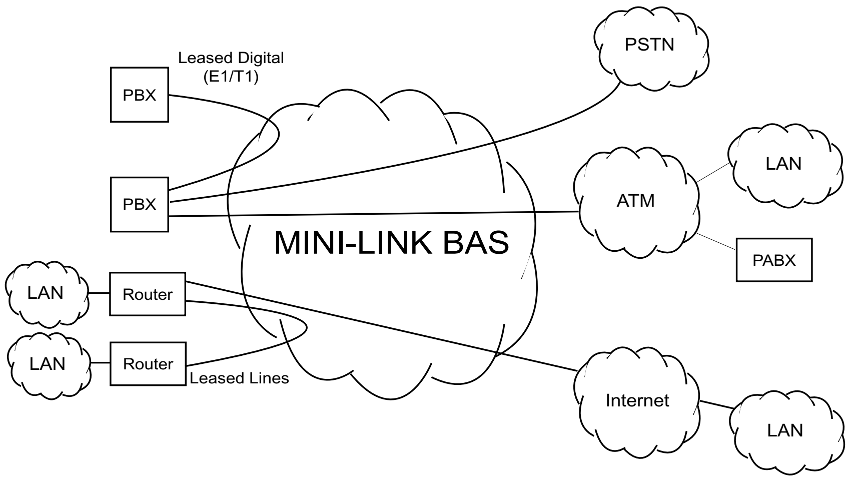

Figure 4-1 Different Traffic Interconnections Needs

Traditionally the services described above have been offered to the end-users as leased lines based on the telephony network infrastructure with a permanently allocated capacity and a granularity of 64 Kbps.

MINI-LINK BAS offers both permanent capacity allocation for PBX interconnectivity and the possibility to offer better performances for data traffic exploiting statistical multiplexing and bandwidth allocation not constrained by the 64 Kbps granularity. Statistical multiplexing at the air interface is obtained via the F-DCA feature offered by the MAC at the air interface, see Chapter 5.

10/100 Base-T Ethernet interfaces at the NU, named FlexNU, are offered for data communication. E1 and T1 interfaces are available for PBX interconnectivity. Up to 4 SUs can be installed in a FlexNU.

Each FlexNU offers 2 interfaces. In addition, a 10 Base-T Ethernet interface is available in the FlexNU mainly for OAM purposes, but can also be used for support of pure best effort data traffic.

4.2 Data Communication

Enterprise data equipment with Ethernet interfaces connects directly to MINI-LINK BAS FlexNU Ethernet interfaces. Typical data equipment represents routers and layers 2/3 switches.

The FlexNU encapsulates Ethernet frames in ATM cells, in agreement with RFC1483.

Data services are offered using a UBR best effort service category. As an option, connection admission control, always executed in case of CBR connections, can also be activated for data UBR connections.

The option is selectable on SN basis.

The best effort service category allows the maximum utilisation of the air interface bandwidth. The MAC protocol serves on a fair basis the traffic offered by the different ATs. The minimum guaranteed bandwidth per end user is controlled dimensioning the number of ATs planned in the sector and the number of Ethernet interfaces active per AT.

A reduction of the air interface capacity is programmable by the EM. This control of the allocated sector capacity allows to balance the load on the different sectors with the aim to prevent the allocation of an excessive bandwidth to ATs located in not fully deployed sectors. This plain best effort service is the only service available for the built-in Ethernet interface.

On the Ethernet SUs an additional traffic management function is available: the peak cell rate shaping of the traffic at each Ethernet interface. This allows the control of the maximum additional best effort bandwidth that an end-user can access in addition to the minimum guaranteed. The peak cell rate value can be set using the EM.

The option of activating connection admission control allows the provision of a guaranteed bandwidth to each end-user exceeding the minimum allowed by the specific sector configuration. In this case statistical multiplexing is not used at the air interface. Connection admission control is executed by the system to control the bandwidth availability when a new connection is reserved.

In the downstream direction the MINI-LINK BAS supports differentiation between CBR and UBR traffic flows. Shaping or minimum guaranteed bandwidth has to be provided by the NE sending traffic towards the system. Therefore, when the minimum guaranteed bandwidth is desired suitable ATM service categories like UBR + have to be used in the ATM backbone network.

4.2.1 Ethernet Frames Encapsulation According to RFC 1483

The Ethernet frames received at the Ethernet 10/100 BaseT interface of the NU are encapsulated in ATM cells according to RFC 1483.

The protocol stack for data traffic handling is shown in Figure 4-2. In the figure it is assumed that the data flow is directed to an external router where the IP protocol is processed. Note, however, that the MINI-LINK BAS acts as a totally transparent system to the different protocols running above the Ethernet layer protocol. Therefore data transport is not limited to the IP protocol.

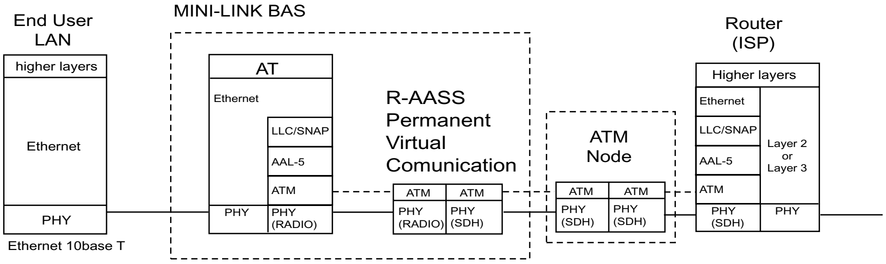

Figure 4-2. Protocol Stack Model for Ethernet Frames in MINI-LINK BAS

The connection through the MINI-LINK BAS is set via the EM as a UBR PVC through the whole MINI-LINK BAS, shown as a dotted line in Figure 4-2.

In that case local frames sent to local LAN MAC addresses are filtered but not forwarded to the air interface. All broadcast/multicast messages are passed over the bridge.

Note: FlexNU does not support the Spanning Tree Algorithm (STA).

The Ethernet SU transceiver provides an auto-sensing 10/100 Base-T interface, both half or full duplex, and complies with both IEEE 802.3 and Ethernet frame formats.

The encapsulation of the IEEE 802.3/Ethernet frames is in agreement with RFC 1483 and RFC 2684. The encapsulation for the case of an Ethernet frame is shown in Figure 4-3.

The Logical Link Control (LLC) or the VC multiplexing option and the Frame Checking Sequence (FCS) presence are selectable by EM on per connection basis.

In the LLC multiplexing option the LLC and SNAP fields are inserted to identify the type of bridged protocol data unit. In the VC multiplexing these fields are not required, as indicated in the figure, as the protocol data unit type is associated to a specific VC. This option allows therefore to decrease the encapsulation overhead and is recommended whenever supported by the equipment terminating the RFC1483 protocol, such as the external router shown in the Figure 4-2.

The ATM Adaptation Layer 5 (AAL5) is used to segment the frames in cells and insert also an FCS field additional to the one available in the Ethernet frames. The Ethernet FCS field can therefore be omitted in the encapsulated frame to save bandwidth. In this case it is reinserted when the Ethernet frame is rebuilt. The presence of the FCS field can be set by the EM.

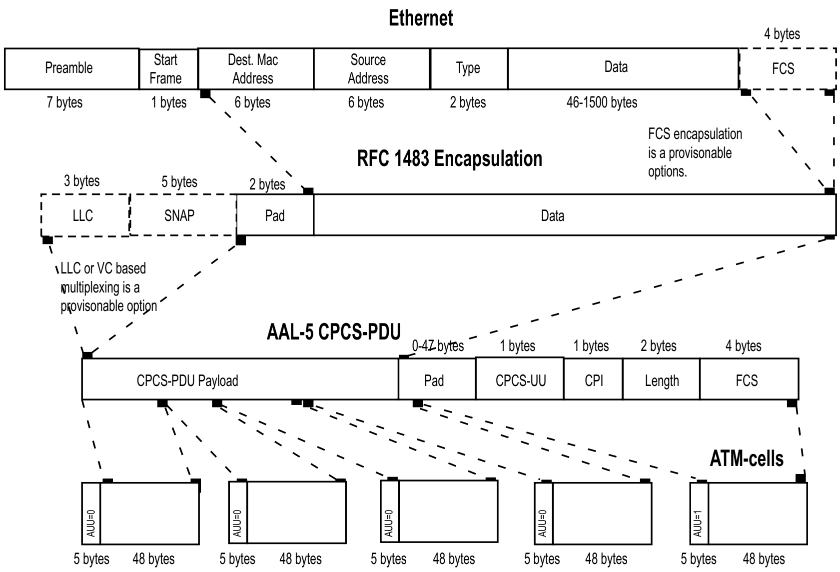

Figure 4-3. Ethernet Frame Encapsulation on ATM in the AT

4.3 CE Services

MINI-LINK BAS system supports Synchronous and plesiochronus, unstructured E1/T1 service. Unstructured service can be used to support any framed or unframed E1/T1 structure.

Unstructured CE end-user services are provided in MINI-LINK BAS through the E1 and T1 interfaces at the NU.

CE Services are supported via ATM PVCs. In the CE case, however, a CBR service category is used to ensure low cell loss ratio, low cell delay and low cell delay variation.

The mapping of the CE services in ATM cells is done in MINI-LINK BAS according to the ATM forum CE service inter-operability Specification (AF-VTOA-0078.000), ITU-363 and ETSI ETS 300 363.

The unstructured circuit transport allows transport of any framed or unframed E1/ T1 services over MINI-LINK BAS. It does not however enable the operating company to monitor the performance of the framed E1/T1 services. Data traffic and embedded facilities, signalling and maintenance information, are transparently transported.

Bits of E1/T1 interfaces are mapped into ATM cell payload using the AAL-1/Unstructured Data Transfer (UDT) mode adaptation layer.

The synchronous or plesiochronous modes of operation are selectable per port basis via the EM.

Synchronous mode applies when the E1/T1 interfaces connected by the CE connection are synchronised to a common primary reference clock used also by the MINI-LINK BAS.

Plesiochronous mode is used when:

- the E1/T1 interfaces connected by the CE connection are not synchronised to the same primary reference clock,

or

- if they use a common clock different from the one adopted by the MINI-LINK BAS, for example, a Private Automatic Branch Exchange (PABX) connected to a Plain Old Telephone Service (POTS) carrier not providing the reference clock to the MINI-LINK BAS.

In the plesiochronous case the receiving CE function rebuild the originating clock from the receiving cell interarrival timing. The protocol stack for the transparent transport of E1/T1 bit stream is shown in Figure 4-4.

Note that the AAL-1 protocol originated by a FlexNU can be terminated either in a CE board housed in the MINI-LINK BAS, R-AAS or CE-AAS, or in any external CE equipment compliant with the CE service inter-operability Specification or ATMF ITU/ETSI relevant standards.

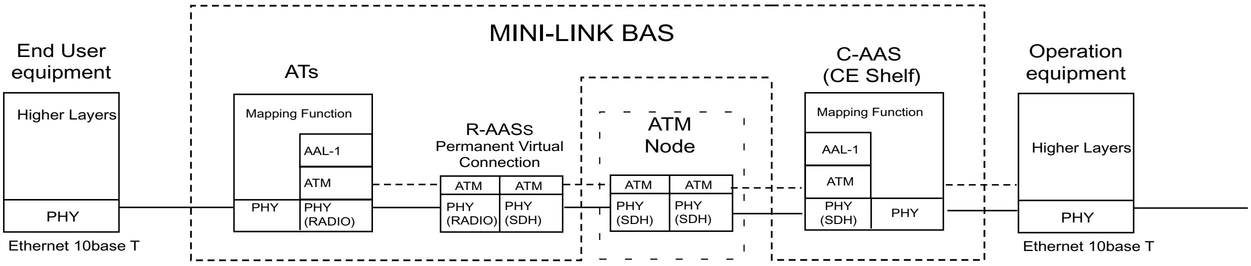

Figure 4-4. OSI Model for Transparent Transport of E1/T1 Data in MINI-LINK BAS

The delay on CE traffic is due mainly to four contributions:

- ATM packetization delay
- MAC delay
- Transport delay
- Cell delay variation compensation delay

The ATM packetization delay is related to the time needed to fill one ATM cell with the CE data. In the E1 and T1 case this value is equal to 183 and 244 µs respectively.

The MAC layer in the MINI-LINK BAS introduces a delay of the order of 1 ms. The transport of cells over the air is of the order of 0.1 ms depending on the actual location. Its contribution to the total delay is therefore insignificant.

The Cell Delay Variation compensation delay is inserted at the receiving side to guarantee that there are not octet starvations in rebuilding the E1/T1 signal due to high cell delay variation. Typical values are of the order of 2 ms.

The delay for unstructured CE traffic is therefore of the order of 3 ms.

5

Physical and MAC Layers

5.1 Introduction

In this chapter it will be presented a brief treatment of the implementation of the Open Systems Interconnection (OSI) layers, which are the Physical layer, LLC and MAC layers, in the MINI-LINK BAS.

The following figure provides a description of the terms used in a radio fixed or mobile link.

Physical layer handles the conversion between a digital stream and a Radio Frequency (RF) signal, providing the following functions:

- Media control loops
- C-QPSK Modulation in both uplink and downlink
- Automatic Transmit Power Control (ATPC) in uplink direction, to prevent the ATs to create unnecessary interference to other MINI-LINK BAS Cells and limit dynamic range requirements in RN receiver.

In particular in this chapter it will be considered the Physical Air Interface, whereas the aspects regarding the Users, Service Network and Internal interfaces are described in the relative sections.

- LLC layer creates the information frame structure to be transported by the link. The LLC provides the following functions;
- Downlink Frame Alignment Signal (FAS)
- Scrambling
- Forward Error Correction (FEC)
- Error control, by Cyclic Redundancy Check (CRC)
- Performance monitoring

Finally the MAC layer handles the access to the physical medium providing the following functions:

- TDMA Access
- Handling request and permits to access the shared medium
- Signing-on of new ATs
- Ranging of the new ATs to compensate for propagation delay
- Addressing of ATs

Following the OSI stack, which describes the general structure of a communication system, we can define the overall architecture of the MINI-LINK BAS as depicted in the Figure 5-1.

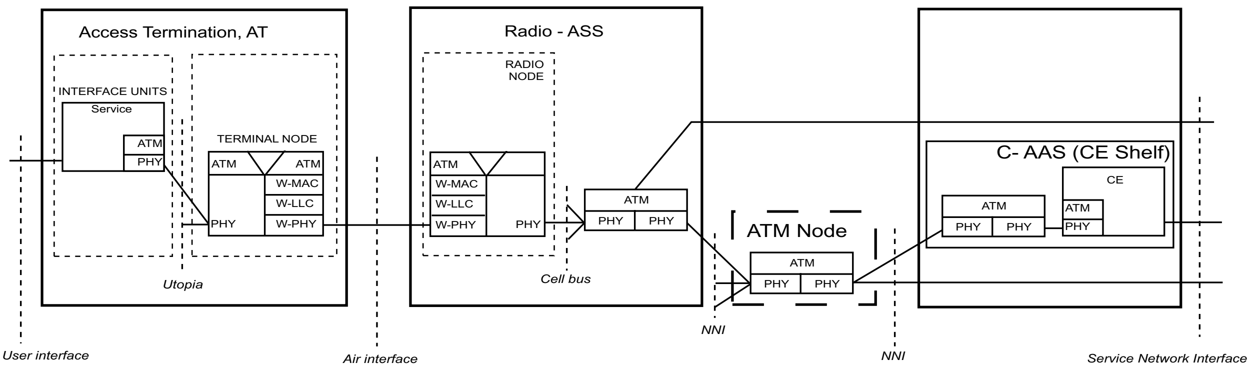

Figure 5-1 Generic MINI-LINK BAS System Model

5.2 Physical Layer

The service offered by the physical layer is to transfer bits or bit groups. The protocols of this level manage the link through the physical media, in the most effective way in terms of channel allocation, channel bandwidth usage and transmission robustness.

Facilities are implemented in the Physical Layer in order to allow PMP operations by controlling physical parameters like carrier amplitude, carrier frequency, symbol clock phase and modulation index.

The most important functionality handled by this level is implemented in two specific blocks: the radio and modem units.

Functional schemes for the radio and for the modem units are depicted in the Figure 5-2 and Figure 5-3.

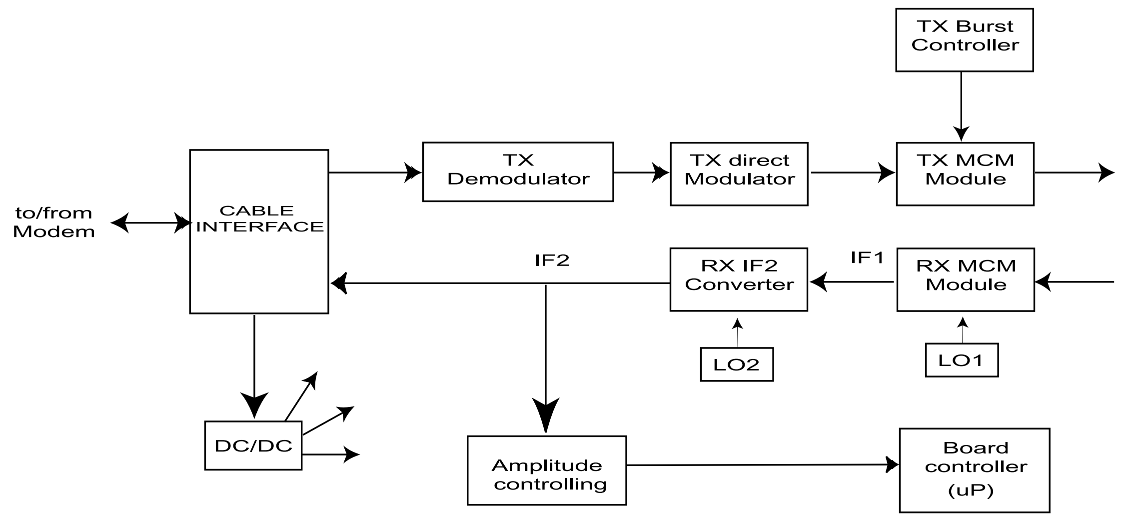

Figure 5-2 Radio Board Functional Block Diagram

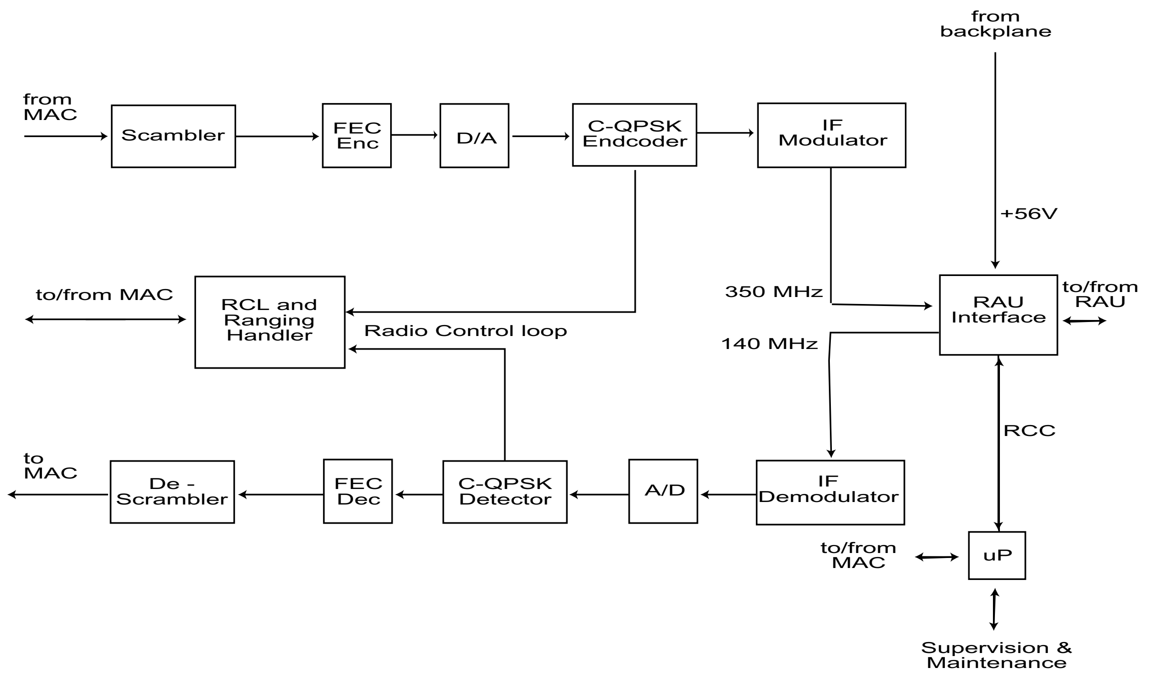

Figure 5-3 Modem Board Functional Block Diagram

5.2.1 Media Control Loops

Media control loops are needed to control transmission parameters of Terminals and RN in order to make a proper working of PMP transmission scheme.

PMP synchronisation encompasses carrier amplitude and frequency control, symbol clock phase and modulation index control. These control loops are used to compensate the effects of the real components and of the radio propagation.

The above controls are distinguished in local internal loop and in remote radio loop. The local loops are confined to the Node whereas radio loops encompass node and terminals while the others are the radio controls loop. These are:

- Carrier Amplitude
  - Local Loop in Down-Link
  - Local/Remote loop in Up-Link
- Carrier Frequency
  - Only internal Local Loop, at the AT side
- Modulation Index
  - Local/Remote loop in Down-Link
  - Local/Remote loop in Up-Link
- Clock Phase
  - Only internal Local Loop in Up-Link

The internal and radio loops share the same error detectors. The error corrections are either performed internally in the demodulator for the internal control loops or performed in the remote radio and modulator for the radio control loops.

The action of internal control loops is faster than of the remote, with the only exception of the amplitude control loop; they act directly on the received bit stream, whereas the radio control loops act at the remote transmission side and their time response depends on the loop bandwidth.

In order to implement the radio control loops, a logical channel within the physical radio channel is provided to send back through the air interface the error information to the terminals.

Symbol clock phase and modulation index control are strictly related to the modulation and demodulation processes and are following described.

5.2.1.1 Amplitude Control Loop

Amplitude control is necessary in down or uplink direction in order to have a constant signal at the input of the demodulator passing from a TDMA slot to the adjacent one. In fact in the uplink direction there are the contributions of the different terminals served by the RN.

Therefore for proper operation the received power level from each terminal shall be equalised. This is accomplished by the amplitude control loop: in the RN the amplitude is measured and an error signal is send back to the terminal in order to adjust output power until error is within a proper threshold.

The RAU in the node transmits at a fixed output power level whereas the RAUs of terminals change dynamically their output power in such a way that the signal at the input of the modem in the node holds nominally equal amplitude from all the ATs.
In order to control carrier amplitude a facility is provided to measure the amplitude of the received signal referred to Received Signal Strength Indication (RSSI).

The information concerning the error relevant to the amplitude is evaluated in the node modem exploiting also the RSSI information coming from radio.

The transmitted power is fine-tunable in the terminal radio only. The RN sends, via Internal Radio Control Channel (IRCC) interface, the peak value of the received signal to the modem, where this value is compared with a reference amplitude, to guarantee the required signal to noise ratio for each AT in uplink direction. The result of the comparison is a byte, which represents the amplitude error.

5.2.1.2 Frequency Control Loop

The carrier frequency of all terminals in uplink direction must be controlled too, in order to be compliant with the frequency stability requirements.

In the RAU, both the transmitter and the receiver are locked to the same reference frequency, this is generated from an internal reference supplied by a Voltage Controlled Temperature Compensated Crystal Oscillator (VCTCXO).

Synchronisation of carrier frequency of terminals is accomplished using the Node carrier frequency as a reference. The RN carrier frequency is locked to a fixed IF reference inside the NCU.

In the ATs the nominal reference frequency is the carrier frequency from the RN; the frequency lock is performed in the NU, calculating the carrier residue with respect to the RN-NCU main reference frequency, in the Rx direction.

5.2.1.3 Modulation Index RCL, Uplink and Downlink

The purpose of this loop is to ensure that the error in the modulation process of the physical carrier remains within acceptable limits, regarding both spectral emission requirements and receiver performance degradations.

The control is implemented by estimating the average error in a phase increase of the modulated carrier, inside the demodulator, and sending a correction message to the corresponding transmitter by means of a RCL message over the air-interface.

The RN modulation index compensation uses a subset of the active terminals to receive the feedback.

5.2.1.4 Clock Phase RCL, Uplink only

The purpose of this loop is to control the symbol frequency of each terminal in transmission, in order to have the two clock phases aligned as much as possible. In this way the node receiver can sample the received signal at the lowest possible frequency ensuring best perfomance.

The control is implemented by estimating the clock phase error in the RN demodulator on AT-basis and transmitting the AT self-correction information through an RCL message over the air-interface.

5.2.2 Radio Link Adaptation

Radio link adaptation is needed to adapt data stream from base band to the characteristics of the medium. The main processing is physical parameter setting and frequency conversion.

A frequency conversion is then necessary in order to take the signal from a fixed IF to the proper microwave frequency and viceversa, in order to allocate the signal in the requested band.

On the modulation side, the input signal is filtered and up-converted to 350 MHz using a Voltage Control Oscillator (VCO) locked to the reference oscillator.

The IF signal is then amplified and put towards the RAU interface. The incoming signal from RAU towards the demodulator is at 140 MHz. It is amplified and demodulated down to base-band to extract its in-phase and quadrature components.

It is possible to loop back the modulator output into the demodulator input using a local shift oscillator that carries the 350 MHz signal down-to 140 MHz.

Operation and administration signal needed to the RAU board processor are sent via radio control interface by means of an Amplitude Shift Keying (ASK) modulator at 6.5 MHz. Data provided by RAU processor to modem is decoded by a ASK demodulator working at 4.5 MHz.

5.2.3 Modulation

The adopted modulation technique is called Constant envelope Quaternary Phase Shift Keying (C-QPSK).

In the C-QPSK modulation the complex envelope is always on the Unit circle and its average position in the decision instants is centred in one of the eight points.

The C-QPSK modulated signal is generated by setting the control voltage of a VCO, according to the bits stream to be modulated.

The bits stream at the modulator input generates a voltage level, which depends on the value of the modulation index, mod_index_Tx.

The modulation index signal in the transmission, mod_index_Tx, is extracted by the remote demodulator and feedback to the modulator by Mod Index radio control loop.

5.3 RAUs

The MINI-LINK BAS comprises the following radio models referred to the indicated frequency bands:

- 24.5 - 26.5, ETSI 26 GHz
- 27.5 - 28.35, LMDS "A" 28 GHz
- 31.0 – 31.30, LMDS "B" 31 GHz

They are available for different frequency channel arrangements, according to the Federal Communication Commission (FCC), ITU-R and Conference on European Post and Telegraph (CEPT) recommendations.

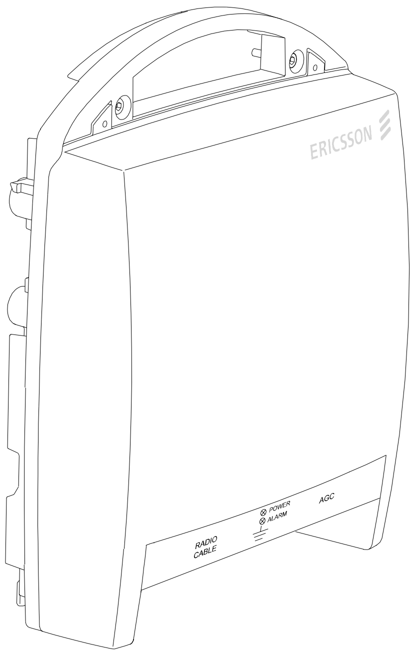

Figure 5-4 RAU

The RAU is a waterproof box, with a handle for lifting and hoisting. It fits on the back of the integrated antenna unit, where it is connected to the RF-port. Physically, a printed board assembly, RF Multi-Chip Modules (MCMs) and branching filters, constitute the MINI-LINK BAS RAU.

The printed board assembly includes external interfaces towards the indoor parts. This interface is featured by a 50 Ohm N-type connector. A connector for RF-input level measurements and a set of LEDs are accessible from the outside of the RAU.

The MCMs consist of a mechanical assembly, containing the MMICs, which perform the RF conversion. The branching filters provide the waveguide interfaces towards the antenna and are mounted between the waterproof box and the printed board assembly.

5.3.1 Block Diagram

The following main functions are included in the RAU, as shown in Figure 5-5:

- Cable interface with lightning protection
- Transmitting IF signal processing
- Receiving IF signal processing
- Supervision and control
- Tx ON/OFF circuit to transmit in burst condition

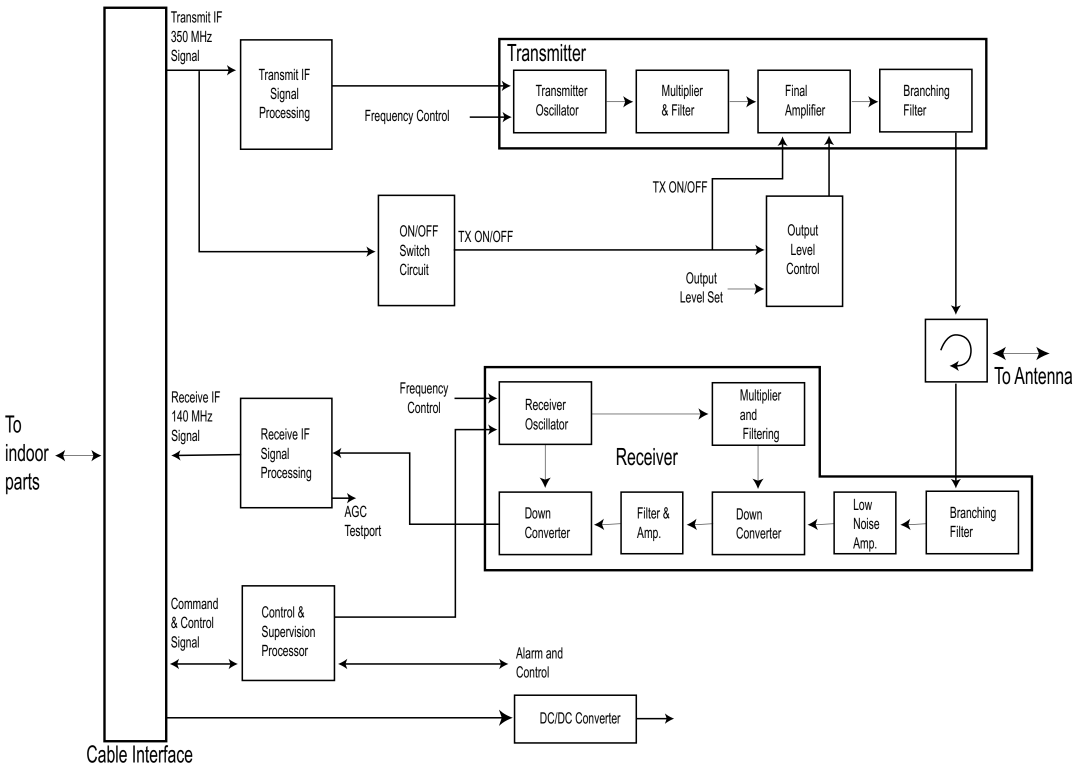

Figure 5-5 General RAU Block Diagram

Cable Interface

The incoming composite signals from the indoor units, that are, the transmitting IF signal, command and control signal and DC, are demultiplexed in the cable interface and forwarded for further processing:

- Transmitting IF signal: modulated signal with a nominal frequency of 350 MHz
- The command and control signal from modem to RAU: an ASK modulated signal with a nominal frequency of 6.5 MHz;

- The DC feed for the overall RAU.

Similarly, the outgoing signals are multiplexed in the cable interface: receiving IF signal and command and control signal downlink.

- The nominal frequency of the receiving IF signal is 140 MHz.
- The command and control signal from RAU to modem is an ASK modulated signal with a nominal frequency of 4.5 MHz.

In addition to the above, the cable interface includes an over-voltage protection circuit.

The transmitted IF signal is also used as control signal for the Tx on/off circuit.

Transmitting IF Signal Processing

The transmitting IF signal is amplified, limited and demodulated. The demodulated signal is amplified and passed, via a buffer amplifier, to the microwave transmitter for modulation on to the RF carrier. The input amplifier is automatically gain-controlled so that no compensation is required due to the cable length between indoor and outdoor equipment. The level is used to generate an alarm, indicating that the transmitting IF signal level is too low due to excessive cable losses.

Receiving IF Signal Processing

140 MHz receiving IF signal from the microwave receiver is amplified and fed to the cable interface. Additionally, a portion of the signal is fed to a calibrated detector to provide an accurate receiver input level measurement. The measured level is accessible either as an analogue voltage at the receive signal level test port or as a straight forward measure, in dBm, through the operation and maintenance system.

Control and Supervision Processor

The RAU houses the processor for control and supervision. The main functions of this processor are:

- Alarm collection

  Collected alarms and status signals from the RAU are sent to the indoor processor. Summary status signals are visualised by LEDs on the RAU

- Command handling

  Commands from the indoor units are executed. These commands include transmitter activation and deactivation, channel frequency settings, output power settings and RF-loop activation/deactivation

- RAU control

  In addition to above, the processor controls the RAU’s internal processes and loops.

DC/DC Converter

The DC/DC converter provides stable voltages for the microwave sub-units as well as for the radio interface unit.

Transmitter Oscillator

The frequency of the transmitter is controlled in a Phase Locked Loop (PLL), a sample of the VCO signal is fed to a divider and further on to a programmable phase detector. The error signal is controlled by the integrated control and supervision system through a serial bus. An unlocked VCO loop generates a transmitter frequency alarm.

Multiplying and Filtering

The VCO signal is amplified, frequency multiplied and filtered.

Final Amplifier

The transmitter output power is controlled by adjusting the gain of the final amplifier. The output power is set in steps through the operation and maintenance system (EM). The transmitter can be turned on or off by switching the final amplifier.

Power Detector

The transmitted output power it's checked for supervision, output power alarm.

RF Loop

An attenuated replica of the transmission signal is mixed with a shift oscillator signal and is fed into the receiver for test purposes.

Branching Filter

On the transmitting side, the signal is fed to the antenna via a branching filter and a circulator. On the receiving side, the circulator feeds the received signal to an input branching filter.

Receiver

The received signal is fed from the input branching filter into a low noise amplifier and a down-converter to a first IF step. After bandpass filtering and amplification, the signal is down-converted to the second IF of 140 MHz.

Receiver Oscillator, Multiplier and Filter

LO signals for the two down-conversions are generated in the same way as for the transmitted signal. A frequency control signal from the indoor parts (AFC) is fed to the receiver oscillator via the control and supervision processor.

A double superheterodyne receiver with a high first IF, is implemented enabling frequency selection over a wide frequency band, with an excellent receiver of spurious and image rejection.

5.3.1.1 Transmitter On/Off Switch

While the RN RAU transmits in a continuous way, due to the TDMA structure adopted in uplink, the AT RAU transmits in a burst way, so it’s necessary to switch on the NU transmitter only during the time-slots assigned for transmission.

5.4 LLC Layer

The LLC is a sublevel of the data link layer and its main task is to determine the structure of the information frame and provide a transmission error control and a robustness of the transmission link in part by a scrambling function.

5.4.1 TDMA/TDM Framing

TDMA technique which foresees the access to the shared medium is done in different time intervals called timeslots.

TDMA refers to the uplink radio channel and TDM to the downlink radio channel. In uplink direction the access has to be managed because of the concurrent requests from terminals, whereas in the downlink direction there is no contention that data streams come from a backbone network.

Up and downlink are separated in frequency, according to the FDD. In MINI-LINK BAS, the delay between transmission and reception can be of few timeslots.

The MINI-LINK BAS is a FDD system with a full flexibility of instantaneous capacity allocation in the up and downlink per AT and connection.

5.4.1.1 Downlink TDM Frame

In the following figure the structure of the downlink TDM frame, together with the slot format, is depicted.

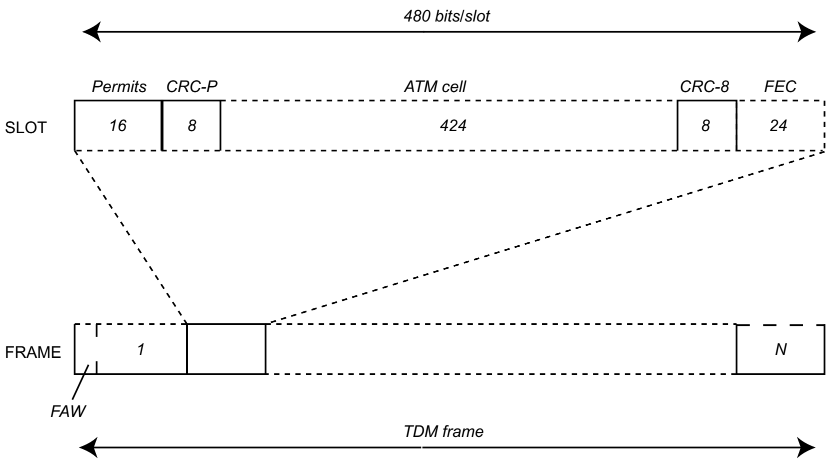

Figure 5-6 Downlink TDM Frame

The downlink TDM frame is made of several timeslot, where the number of slots can be set to 80 or 128 (default value). The ATM cell is carried together with the permit field, needed in the MAC protocol, in the TDM slot structure.

The permit field is checked by a CRC-8, named CRC-P, and discarded if errors are detected. The whole information, included permits, CRC-P and the complete ATM cell, is error checked by a CRC-8. This code is used to allow fault handling and performance monitoring, the CRC-8 errors are counted per NU.

Furthermore 24 bits are dedicated to the FEC function. The actual way, according to which FEC bits are processed, is explained in the physical layer relevant section.

The frame length must be chosen together with the MAC polling period as depicted in the following table, where the time duration of the frame is reported too.

MAC Polling Period	Downlink TDM Frame
20 Slots	80 Slots (1ms)
32 Slots (Default)	128 Slots (1.6ms)
80 Slots	80 Slots (1ms)

The polling of all NUs is done in consecutive slots, which means that 64 NUs are polled in 8 slots. The above-mentioned length of radio frame will give a period time of 1-2 ms.

The Frame Alignment Word (FAW) is used for frame synchronisation. It is composed by the first group of polling permits plus the correspondent CRC-P code.

5.4.1.2 Uplink TDMA Frame

The uplink TDMA frame has basically the same structure of the downlink TDM frame. It is made of several timeslots, where the number of slots can be set to 80 or 128 (default value), each timeslot is 480 bits wide.

There are different kinds of slots in order to support MAC protocol and ATM cell transport. Structure of timeslots is depicted in Figure 5-7.

Some fields of timeslot structure are common to all kind of timeslots, name guard and preamble fields.

A guard is made up of 10 bits and is inserted at the beginning of the upstream slot respectively. Guards are meant to reserve time to the terminal transmitter for switching on/off.

A preamble is made of 20 bits and is inserted at the slot beginning. It is meant to allow the RN receiver to get carrier phase locking in order to demodulate properly the useful part of the timeslot.

Guard, preamble and FECs bits are added by the modem in the NU when building up the upstream slots and are terminated in the NCU of the RN.

Control timeslots are used in the MAC protocol for carrying queues status (requests) from terminals to the RN. Control timeslots are made of 8 minislots, which are 60 bits wide.

Requests in minislots are checked by a CRC-4 and if errors occur the request is discarded.

Ranging slot has a specific format as it is used in the ranging procedure. Terminal identity and unique word are functional for the ranging procedure while a CRC-16 is foreseen for ranging information validation.

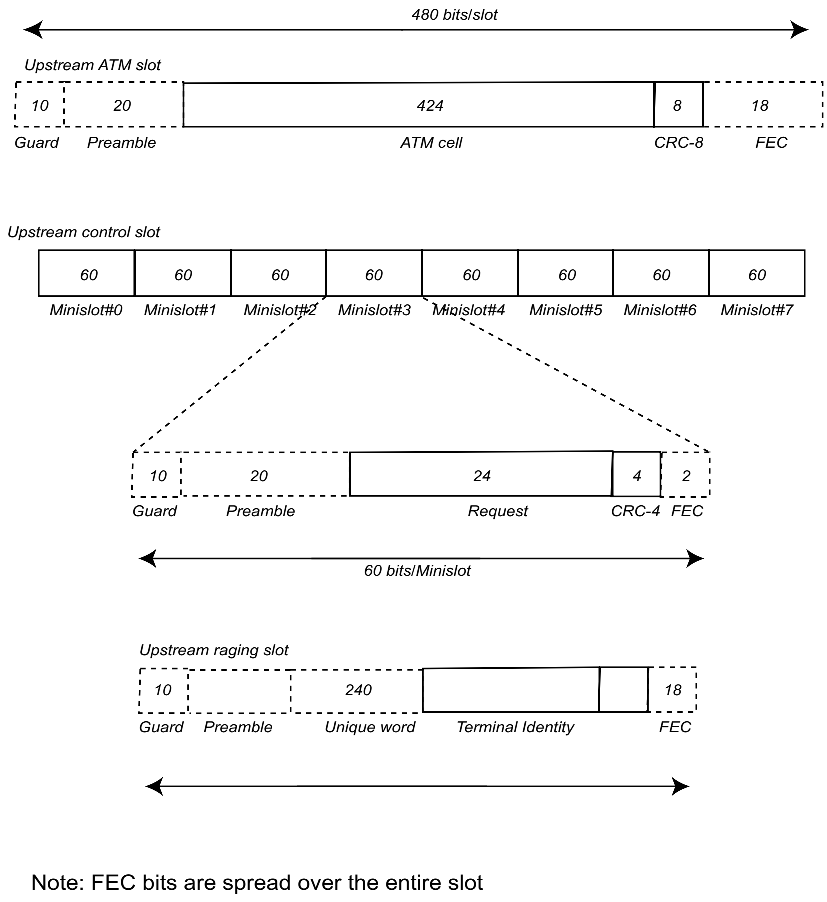

Figure 5-7 Uplink TDMA Slot Structure

5.4.2 Frame Alignment

Frame alignment for the radio frame is performed by using the first group polling permit plus the CRC-P as a FAW.

Frame recovery is achieved in the NU by detecting the FAW. This unique pattern marks the beginning of each radio frame. Two consecutive FAWs will be far apart as many bits as specified by the frame format.

When FAW is detected for three consecutive times, the receiver in NU can be assumed as aligned with the transmitting RN. If FAW is not detected in the expected position for four consecutive times, then the receiver in NU can be considered to have lost the frame alignment to the transmitting NCU and consequently a loss of sync is issued.

5.4.3 Scrambling

Data stream received from the MAC layer is scrambled in order to guarantee the right shape in output spectrum, to provide enough transition for clock recovery purposes, to support security of data.

Scrambler is synchronous with the TDMA/TDM frames; at the beginning of a TDMA/TDM frame the scrambler register is preset to a known value. This value can be either all “1”s fixed or derived from the RN identity, 20 ASCII characters.

In the RN the slots received from the MAC unit are scrambled, FEC encoded and input to the modulator. The data stream is then converted to analogue signal, frequency up-converted and sent towards the outdoor RAU.

The signals coming from the outdoor RAU are frequency down-converted and in the demodulation process translated to a digital data stream, then FEC is decoded, descrambled and sent to the MAC unit.

FAW, guard and preamble are not scrambled.

5.4.4 FEC

Error performance is a major issue for wireless ATM systems. Two main error sources are expected:

- Errors due to propagation anomalies, mainly rain outage
- Errors due to presence of unwanted signals
- Errors due to interference from neighbouring cells

FEC capability is foreseen in the physical layer to improve robustness to transmission impairments.

FEC bits are inserted in each timeslot in addition to the original MAC packet data stream. The FEC bits are spread unevenly over the slots in such a way to better protect information fields related to the MAC protocol than the payload.

FEC is able to correct one error in the protected field. As demodulation process cause double adjacent errors, fields covered by FEC are bit interleaved and two FEC coded are actually acting in order to ensure that the double adjacent errors generated by the demodulation process will result in one error in a field covered by the FEC.

5.4.5 Performance Monitoring

Facilities are foreseen in order to support the quality performance monitoring in the LLC layer.

Evaluation of performance are mainly based on the mismatch detected on the byte referred as CRC-8, as this byte is meant to detect errors in a complete TDMA/TDM slot encompassing then both ATM cell and permit field.

The performance parameters are evaluated per NU both in uplink and downlink, as there are different physical links for each NU.

In order to do this in the uplink the RN has to take in account the transmitting NU whereas in the downlink the NU can monitor all TDM slots.

Performance events provided for the ATM layers are:

- Cell error ratio
- Cell loss Ratio
- UBR discarded cells
- CBR discarded cells

Performance events provided for the physical layer are:

- Unavailability/Availability Time (UAT/AT)
- Errored Second Ratio (ESR)
- Severely Errored Second Ratio (SESR)
- Background Block Error Ratio (BBER)

In order to evaluate the above Performance Events following parameters are counted:

- Number of received TDMA/TDM slots
- Number of CRC-8 errors on uplink, calculated over the complete TDMA slot, or missing TDMA slots, for measurement on physical layer

- Number of received correct TDMA slots
- Number of received TDMA slots
- Number of CRC-8 errors on downlink, calculated over permit, CRC-P and the ATM cell

Some additional performance parameters not foreseen by ITU standards are evaluated:

- Received RF power, max – min - average
- Output nominal RF power, max – min - average

Further details on performance monitoring can be found in the relevant section.

5.5 MAC Layer

A fundamental feature for MINI-LINK BAS is an efficient MAC protocol. An F-DCA is the key to handle burst traffic.

The medium access algorithm in the MINI-LINK BAS is optimised to handle burst data traffic but efficiently handles also CBR and CE Services.

The MAC protocol is accomplished by the MAC functions in the Node and Terminal. The MAC function in the node acts as master whereas MAC function in the terminal acts as slave.

The master MAC in the node polls each terminal about the status of the queues that correspond to request for access the shared medium by the NUs.

Depending on these terminals requests the master MAC will assign permits to transmit in uplink direction to the different terminals. The slave MAC functions in the terminals analyse the incoming permits and take the correct action depending on type of permit.

The general idea is that no terminal is allowed to send data in uplink direction, unless it has received an explicit permission to do so from the master MAC in the node, see Figure 5-8.

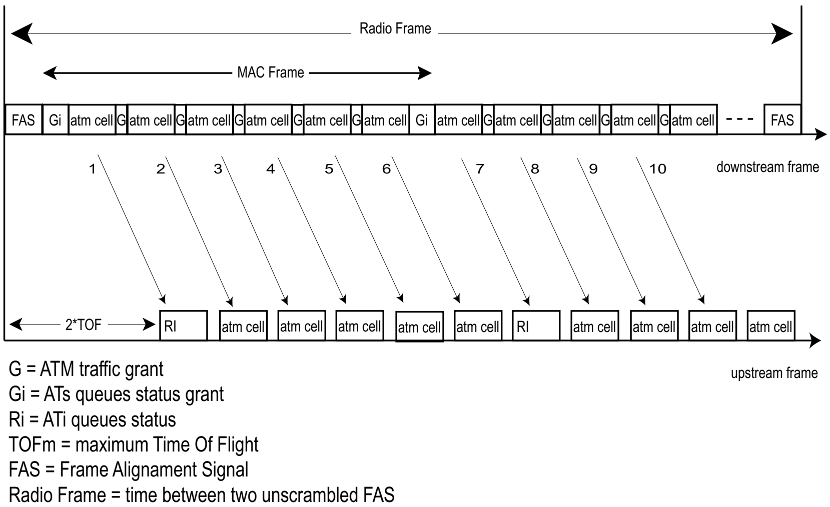

Figure 5-8 Up-Stream and Down-Stream Frames

1. The master MAC in the node issues different types of permits for different functions.
2. ATM permit: the specified NU is allowed to send one ATM cell, CBR or UBR.
3. Polling permit: a group of 8 of NUs is allowed to send requests toward the Node.

4. Ranging permit: the specified NU is requested to sign on.
5. Blanking permit: this corresponds to nothing being sent upstream.

When allowed by the above types of permits, a NU will send a slot back to the node. This slot can be of 3 types:

- ATM slot: includes one ATM cell from the NU. If no ATM traffic cell is available, an idle cell will be sent.
- Control minislot includes queues status in the NU.
- Ranging slot: the modem will use this slot to measure distance and power of the NU.

The structure of the permit field is depicted in Figure 5-9.

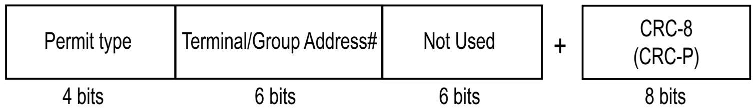

Figure 5-9 Downlink Permit Field Plus CRC-8

The permit field allows different permit types and has a capability to address up to 64 NUs and for each NU can specify 64 lines, VC connections.

In the permit field is also foreseen a CRC-8 aimed to check for error and validate the information. In case of errors detection the permit is deemed invalid and discarded.

In the following table the different types of permit are reported together with a description of the usage and the addressing capability.

Permit Description	Terminal/Group Address field (6 bits in hex)
CBR Polled	Terminal Address
UBR	Terminal Address
Ranging	Terminal Address
Request Polling	Group Address

Terminal identification is done through the terminal address for which 6 bits are provided. Therefore up to 64 terminals can be addressed. Terminals are grouped in pools of 8 in order to minimise the bandwidth usage in the polling procedure. A terminal group is identified through the 3 most significant bits of the Terminal address.

In the following figure the structure of the request field (minislot) is reported. The request fields are sent from terminals to the node in answer to node polling.

CBR request	Not Used	Not Used	UBR request	+	CRC-4
4 bits	6 bits	6 bits	6 bits		8 bits

Figure 5-10 Request Field, Minislot

The request field contains the present buffer status of the addressed NU in terms of the number of ATM cells that are in each buffer at the polling instant. The maximum request value for each queue is 63, together with the polling rate, that limits the maximum achievable data rate for a terminal.

Three values of the polling cycle are possible. For each of these cycles the possible maximum bit rate is calculated for an AT which is always authorised to transmit its cells, capability which is not an effective band, for more information see table at paragraph 5.4.1.1.

5.5.1 Sign-On

The sign-on procedure is aimed to bring a terminal into service. Sign-on could be required either for a new terminal to be brought into service, initial sign-on, or for a terminal that lost contact with node because of a failure occurrence. Initial sign-on is always initiated by command from the CP.

A unique number or string, called terminal identity, is associated to each terminal. The terminal identity is set by an ACT during installation and is stored in non-volatile memory.

The terminal identity must also be set in the CP from EM in order to make the sign on successful.

The sign-on procedure foresees two sub procedures to be accomplished, namely the distance ranging and the power ranging. After the completion of the distance and power ranging a little time is required to allow control loops to get lock condition before the sign-on procedure is assumed to be completed.

5.5.2 Distance Ranging

Distance ranging is made when a NU has to be signed on. The purpose of this procedure is to measure the distance to the new NU, and then to adjust the delay to a desired value.

In fact all NUs are to be located virtually at the same distance, measured in delay time, from the RN. This delay is fixed to a reference value, the maximum Round Trip Delay (RTD), and is calculated between the moment at which a data permits are emitted from the node to the moment at which the corresponding slot is received. This adjustment is done setting a programmable delay in the modem at the considered NU.

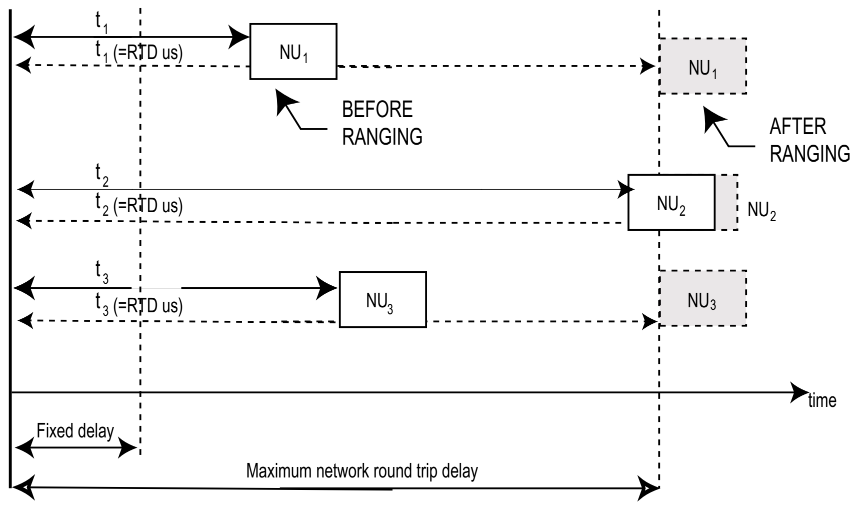

Figure 5-11 Distance Ranging Procedures

5.5.3 Radio Bandwidth Limitation

In multi access systems, performances are related to the number of ATs connected to the same RN, in terms of throughput. In order to make the system have nearly the same performances, as the number of served terminals changes, a limitation of the air capacity is provided.

This functionality performed by the MAC can reduce the user bit rate on the radio link, by inserting idle cells in slots that could carry traffic cells. The percentage of not used slots is configurable from CP-EM.

5.6 Processing Flow

An overall scheme of the composition both of the downlink and uplink streams is depicted respectively in the Figure 5-12 and Figure 5-13.

5.6.1 Downlink Processing Flow

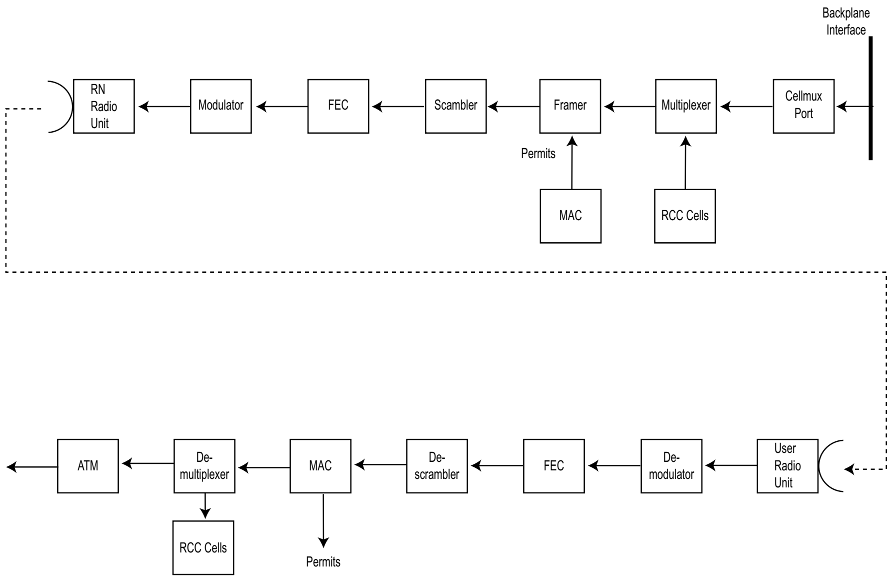

Figure 5-12 Block Diagram for the Downlink Stream

In Figure 5-12 the processing flow in the downlink direction is described.

ATM traffic cells are multiplexed with the ATM cells which transport the RC information, for modem to modem communication.

ATM cells received from the cellbus interface are buffered until they can be placed in their proper position in the downlink frame.

There is a separate buffer for system control cells, and these will have the highest priority in the downstream path.

If no traffic cell is available when required by the generated frame, an idle cell will be internally generated and put in that position.

In a second step ATM cells are inserted in the slots of the TDM frame together with MAC permits by the MAC function.

The framer block builds the proprietary TDM frame.

CRC error check fields are added to the downstream signal to allow for fault handling and performance monitoring.

Finally the TDM Framed data is first scrambled, FEC encoded, in order to increase transmission robustness, and then modulated.

On the AT side the received data stream is extract realizing the same operation of the ANT transmission side, but in the reverse order, moreover data stream is monitored for Excessive Bit Error Ratio (EBER) after FEC decoding.

When the data stream is descrambled, the MAC extracts the MAC information and the RC cells and demultiplexing block, the traffic signal, ATM cells, is available.

At last data is delivered to the ATM handler for ATM layer processing.

5.6.2 Uplink Processing Flow

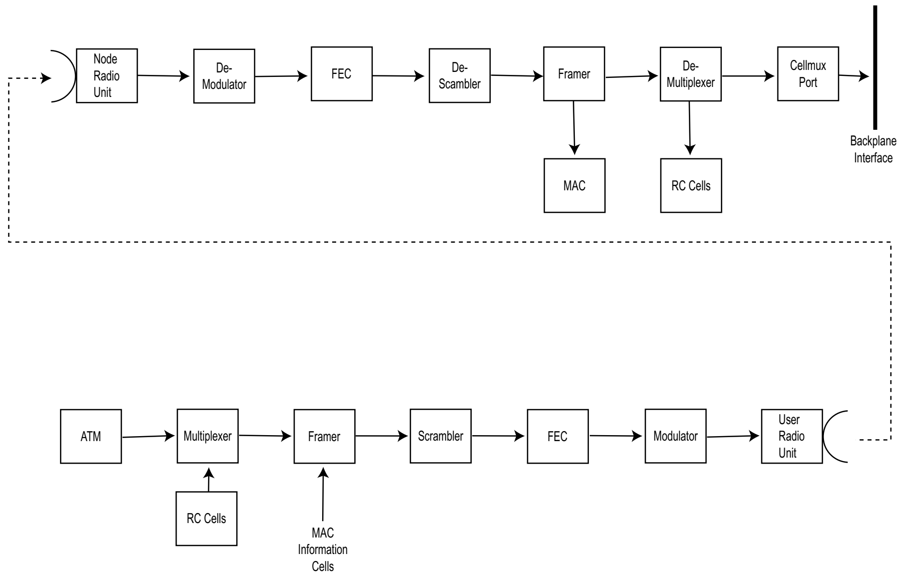

Figure 5-13 Block Diagram for the Uplink Stream

In the figure above the building up of the uplink flow is described in terms of functional blocks.

The incoming flows of ATM cells are stored in two buffers depending on the class of service and are multiplexed with the Control cells, which are queued in a separate buffer and have the highest priority, so they are inserted in the outgoing frame as soon as possible.

As allowed by sent downlink permits, ATM cells are inserted in the available TDMA timeslots and sent upstream by the NU.

Depending on the type of permits, traffic cells or minislots are inserted. Minislots contain the requests to transmit contract based on traffic and buffer filling level.

Then ATM traffic is first scrambled, FEC encoded and modulated. On the RN side the received stream is demodulated and checked for header errors, corrupted cells are discarded.

After the FEC decoding an EBER function is provided to detect if the bit errors exceed a certain threshold, that is if the radio link quality from the NU is unacceptable.

Then CRC over the whole ATM cell, including the payload is checked and used for fault handling and performance monitoring. In case a MAC control cell with requests is received, the request information, after error checking, is sent to the MAC function.

The demultiplexer distinguishes between the ATM traffic cells and the RC control cells passing the ATM traffic cells on to the cellmux port and to the backplane interface.

The RC is using ATM cells in uplink direction, as well as in downlink. When these upstream cells, which have a specific VPI/VCI value, arrive to the deframer, they are routed to a port, which is connected to the modem.

To identify from which terminal a slot is coming and what kind of data it contains, the RC uses information on terminal address and slot content from the MAC function.

5.6.3 RC Cells Insertion

The RC is an internal channel for AT-node communication. VC connections are dedicated to this purpose.

The frame format of the RC packets is depicted in Figure 5-14. A field address is foreseen in order to address the relevant terminal.

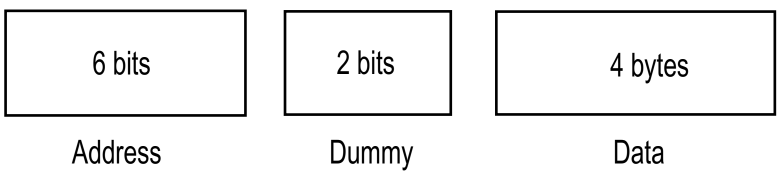

Figure 5-14 RC Frame Format

Radio Control channel (RC) packets are mapped into ATM cells as depicted in Figure 5-15. Field address is mapped in the VPI field that uniquely identifies the addressed terminal. A specific VCI value has been adopted for these cells.

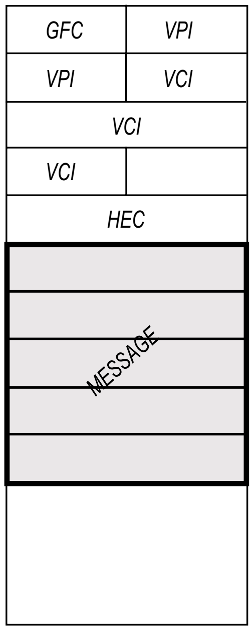

Figure 5-15 RC Communication Cells

6

Management and Control

6.1 Introduction

Management and control are the basic features required to MS in order to allow operators to supervise their network. The following terms are used:

- The management of a NE implies the possibility for an operator to have visibility on the current system status and suitable tools for modifying configurable parameters. The system status is either displayed autonomously by the network element, or it is a result of an explicit operator request. On the other hand, the NE may provide some default or rule-based configuration to specific parameters, or the operator may manually reconfigure them.
- The control of a NE is the implementation of self-recovering tools, able to handle routine tasks, such as alarming the operator, recovering after a power break, upgrading software, coordinating the set-up of cross connections based on system topology information.

Management and control are often so correlated, that this chapter normally treats them together as a single item, under the general term of “management”. When reading this chapter, however, it will be easy for the reader to identify the two concepts.

The MINI-LINK BAS is managed by means of an EM. The EM communicates with the MINI-LINK BAS control system. The control system consists of a CP, one or more Device Processors (DP) and their related software. The following paragraphs describe the usage of EM and CP and correlation to the rest of the system.

6.2 Management System

This section gives an overview of the control architecture, which the management system is based upon; information about the possible interfaces towards higher level systems is available in Paragraph 6.5.1.

Figure 6-1 gives a general overview of the connections between the various parts of the network; this figure is used as a reference throughout this chapter.

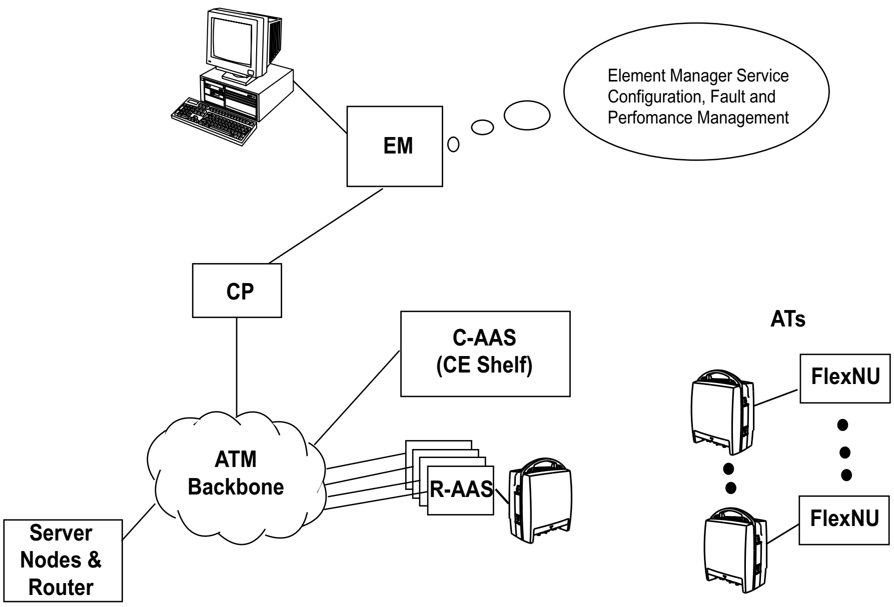

Figure 6-1 Management System Architecture

The EM commonly is located in a maintenance centre and communicates with one or more remote CPs. The CP communicates with the subtended SNs and AT device/nodes and stores in a database all the system’s persistent data (for example, configuration data, alarm logs).

The communications protocol between the EM and the NE is proprietary. A Simple Network Management Protocol (SNMP) version 1 interface, using User Datagram Protocol/Internet Protocol (UDP/IP) over an IEEE 802.3, 10Base2 or 10BaseT, is also supported. TCP/IP, File Transfer Protocol (FTP) and Telnet are used for file transfers, for backup and restoration of the database, software releases, and so on.

If the CP is remote from the EM LAN, the operating company must provide a Metropolitan Area Network/Wide Area Network (MAN/WAN) connection for interconnecting the two. The estimated minimum bandwidth that is needed on the link between EM and CP is 128 Kbps, for a single CP with a single EM user.

6.3 Control Architecture

By the term control architecture it is here meant the hierarchy of intelligent system features that cooperate in order to allow the operator to get information about the overall network condition and to possibly modify some configuration parameters.

6.3.1 Hierarchy

The EM is the access point for operators wanting to manage the MINI-LINK BAS. The EM is connected to the CP, which can be considered as the heart of the management system. The CP, in turn, communicates with a number of system elements of different types:

- C-AAS (CE Shelf)
- R-AAS (Radio Shelf)
- AT

From the EM point of view, the complete set made up of the CP and all controlled equipment and shelves is referenced to as NE. In this perspective the EM manages a number of NEs.

The CP is essential for the management of the system, and it is connected to the MINI-LINK BAS through the ATM network.

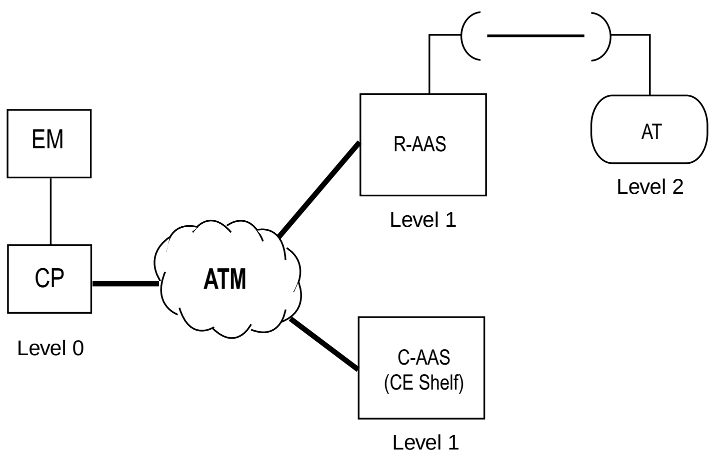

Figure 6-2 Control Architecture Levels

6.3.2 Board Relay

The board relays are based on channel relaying, with a physical connection per shelf (1 channel per shelf).

This approach is called board relay and actually means that each DP behaves as soft relay toward other DPs (lower in the hierarchy) to exchange control signalling messages without physical connections with the CP.

In Figure 6–3, a simple network configuration is shown and the board relay steps are indicated. As it can be easily verified, the CP needs no more than one board relay step to distribute control messages to each DP within the system.

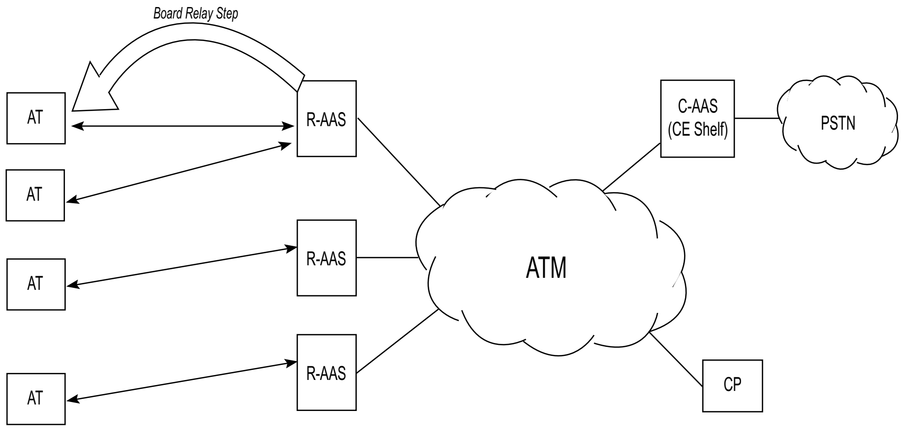

Figure 6–3 Board Relay Steps: Correct Configuration

6.3.3 ICS/ATM Connection Rules

The communication between the CP and the DP is realised through the ATM network, using an Internal Communication System (ICS) mapped onto ATM cells.

The rules to connect each SN to the ATM switch, with an ATM connection using VBR service, are distinguished in:

- Configuration requirements
- Interface requirements

6.3.3.1 Configuration Requirements

The configuration data required for the ICS/ATM connections are:

- Peak cell rate: 1 cell/2 ms = 500 cells/sec

- Max Burst Size: 30 cells
- Sustainable cell rate: 1 cell/5 ms = 200 cells/sec
- Cell Delay Variation Tolerance: 2ms

6.3.3.2 Interface Requirements

Two types of interfaces, see Figure 6-4, for the control signalling are present in the configurations with the CP remotely located.

- I1 Interface, between CP and ATM switch;
- I2 Interface, between SNs stand-alone and ATM switch.

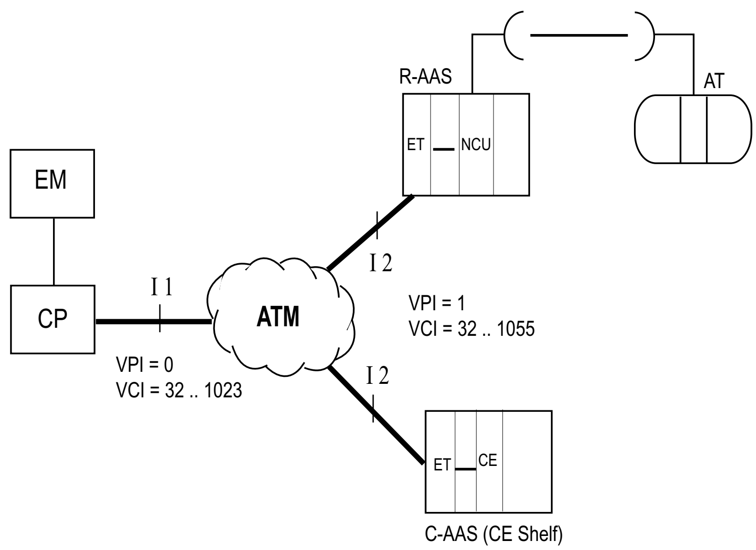

Figure 6-4 I1 and I2 Interfaces

I1 Interface

The basic assumptions are:

- VP = 0 out from the ATM adapter
- Maximum number of C-AASs (CE Shelves) is 30 (Subrack number = 2-31; Subrack number = 0 means ‘itself’, Subrack number = 1 means ‘CP’)
- Maximum number of R-AASs (Radio Shelves) is 224 (Subrack number =32-255).

The values of each board (subrack number and slot) are stored in the configuration file. The association between the board and the VPI/VCI information is performed with a process running on the CP, using the following algorithm:

- VCI = Subrack number *18 + Slot – 5;
  when 2 <= Unit <= 31 (C-AASs (CE Shelves))
- VCI = Subrack number *17 + Slot + 27;
  when 32 <= Unit <= 255 (R-AASs (Radio Shelves)).

For example to address a board in slot 2 of the C-AAS (CE shelf) number 17, the VPI/VCI output from the CP are:

- VPI = 0
- VCI = 17 * 18 + 2 – 5 = 303

If there is a board in slot 4 of the R-AAS (Radio Shelf) number 42, the VPI/VCI output from the CP are:

- VPI = 0
- VCI = 17 * 42 + 4 +27 = 745

I2 Interface

The basic assumptions are:

- VP = 1 as SN input;
- The VCI range is 32-1055 ([0-31] reserved for ATM to be compliant with the standards) and it depends only on the board position, that is, it does not depend from the Subrack number of the shelf the board belongs to.
- DP boards can be reached maximum on two levels of shelves downstream (board relay function).

The ATM switch within the network must perform the VP/VC switching between the two interfaces in both directions.
Both these interfaces shall not be changed to support the board relay functionality.

Each board has an own VPI, VCI depending only on its position in the shelf, that is, the same couples are used within any shelf.

Note: The software allows up to 32 different VCIs within each shelf, but only the first 17 VCI values are used, so far each shelf contains maximum 19 slots, that is, 17 boards plus two, maximum, power boards.

For any subrack C-AAS (CE Shelf) and R-AASs (Radio shelves) at first level, directly connected to the ATM switch, the rule is following:

- VPI=1
- VCI= 31+ Slot

For example to address a board in slot 2 of the C-AAS (CE Shelf) number 17, the VPI/VCI output from the CP is:

- VPI = 1

- VCI = 31 + 2 = 33

To address a board in slot 4 of the R-AAS number 42, the VPI/VCI output from the CP is:

- VPI = 1
- VCI = 31 + 4 = 35

In case of local CP configurations the ICS connections are automatically set by the CP and by the ET located in slot 1 of the first level shelf.

6.4 EM

The functionality of the EM is implemented by means of a number of applications, each handling a specific management area. Some applications also provide GUI, through which an operator can manage resources in the NEs.

Applications are based on the OTP and HP-OV NNM platforms. These are widely used platforms for telecom application, also providing support for fault, configuration and performance management.

In general, the EM software may be seen as layered in three levels. This architecture allows the system to be very flexible: modules at a given level require functionality to modules at the level below it. This also allows adding new applications on top of the current architecture without changing the lower layers.

Figure 6-5 depicts the internal software architecture of the EM.

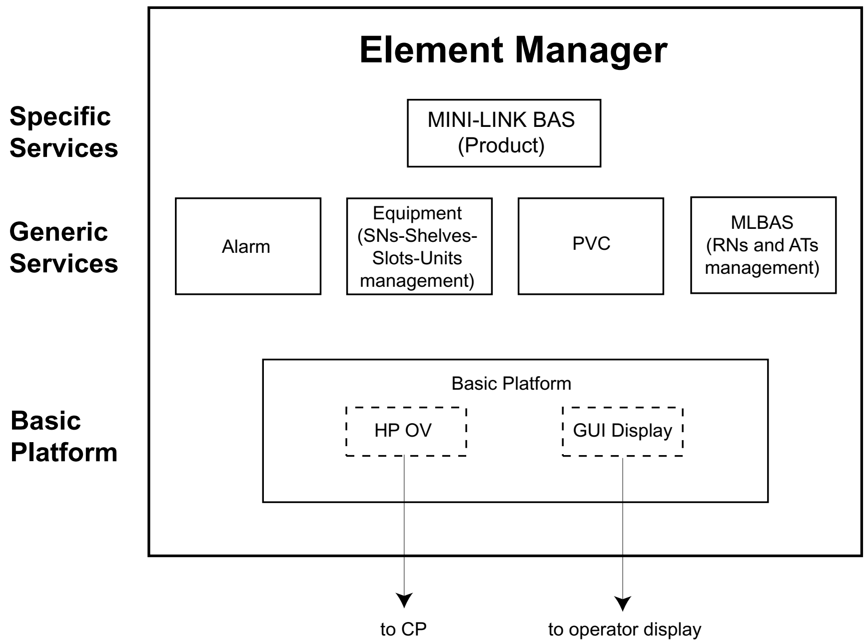

Figure 6-5 EM Software Architecture

6.4.1 Basic Platform

The EM uses commercially available software as a basis on top of which its own applications are added. The management software platform used is HP-OV NNM.

HP-OV provides an interface to other applications and modules through a specific Application Programming Interface (API), based on the C language, which allows the access to all the services provided by this interface.

Upon start-up, the EM is invoked by HP-OV, which is the first to run on the management computer. The basic platform is then started, all needed resources are initialised and reserved.

The basic platform then loads a file listing the applications to be invoked and starts each of them in turn, according to the information found in the application configuration file.

When an application is started, it sends a subscription message to the basic platform that stores the Process Identification Number (PID) of the process itself and enters it into the list of subscribed processes.

The applications are written in Erlang language while the HP-OV API is based on C. The Erlang to C interface is handled by the basic platform and is hidden from the applications. In this way, the applications are independent from the C based GUI software and the HP-OV C API.

The basic platform, that accesses HP-OV in order to prepare, send and receive the messages, also accesses the GUI software to display information on the operator’s terminal.

It uses the Erlang message passing facility to forward events to the applications. Events are information messages handled by the basic platform, for example, a trap alarm received from a remote equipment or menu option selections by the operator. All the events are passed then to all subscribed applications. The basic platform has the responsibility of the applications to respond to events they are interested in or to ignore them.

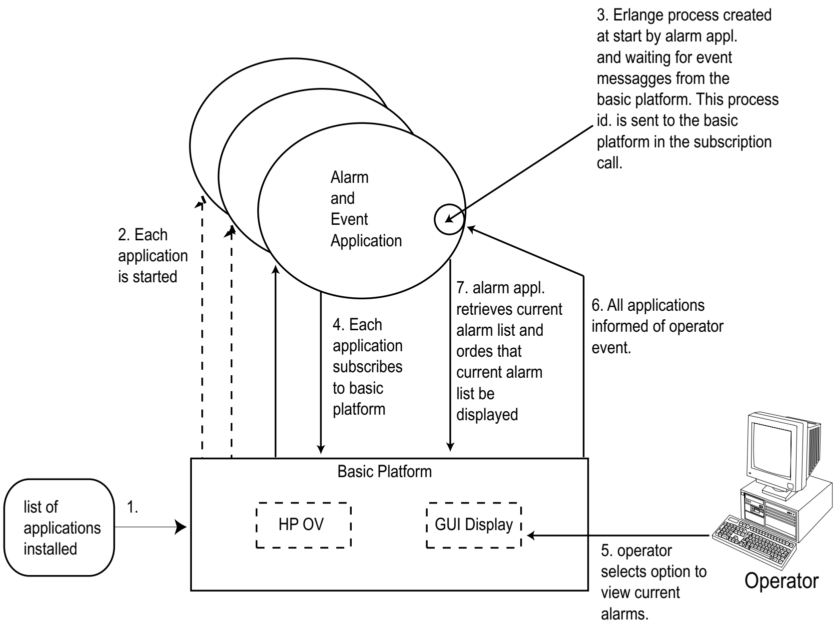

Figure 6-6 Basic Platform

Figure 6-6 is an example clarifies how the basic platform architecture works.

1. Upon start-up, the basic platform reads a file listing the applications that have to be started installed.

2. The basic platform starts the applications listed in the above mentioned file.

3. All applications initialise an internal Erlang process whose purpose, which is to receive event messages from the basic platform.

4. The application sends a subscription message to the basic platform, carrying the PID of the process to which all event messages have to be sent by the basic platform.

5. Now suppose that, once the system is up and running and therefore all applications have been correctly started, the operator selects a menu option, requiring the system to display the list of current alarms. The request is intercepted by the basic platform that converts it to an event message.

6. The event message containing the operator request is forwarded to all applications, but only those that are interested in the event will manage it.

7. The alarm application retrieves the list of alarms and asks the basic platform to display them onto the screen.

6.4.2 Generic Services

Generic Services layer consists of three distinct subsystems that offer an API to the third level applications.

The functionality offered by this layer that is common to all types of systems managed by the third layer, specific services. The subsystems making up the generic services layer are:

- EM Event Handler
- EM Equipment Handler
- EM Generic Services

EMEV, Alarm and Event Handling

This subsystem handles alarms and events. It includes functionalities for:

- Event reporting
- Event logging
- Event reporting and logging criteria
- Alarm reporting
- Alarm severity assignment
- Alarm summary
- Alarm logging

EMEQ, Equipment Handling

The configuration information in the MINI-LINK BAS is stored in a Management Information Base (MIB). A generic, basic configuration is loaded in the MIB during installation from software configuration files. Any boards or other equipment that are inserted into the system, are automatically detected and displayed by the EM.

The EM provides the following functions to the operator:

- Add and remove subracks and boards
- List system nodes, a system node includes all the elements subtended by a common SNI, subracks, slots and boards. Both overview and detailed information are provided

The EM display provides a graphical representation of the subrack with board front panels, interconnections between subracks and detailed information about the:

- System node, including name and location
- Subrack, including name, location and alarm status
- Slot, including board identity, management and alarm status

- Board, including type, HW/SW identity, operational and alarm status
- Port, including port identity, administrative status, operational status and usage

The EM entries allow the user to:

- Modify system nodes, subracks, slots, boards and ports
- Manage and unmanage slots
- Lock and unlock boards
- Sign-on and sign-off ATS
- Activate and deactivate boards and ports
- Add, remove and modify RN configurations including:
  - RN identity
  - AT identity
  - Transmit/ receive frequency
  - Output power
  - Alarm threshold

Provisioning of equipment:

- Inventory of installed equipment
- Modification of equipment attributes, such as names and labels
- Create or delete equipment
- Capacity activation or deactivation

EMGS, Generic Service Support

The access user port table is used to represent NU internal ATM connection end points for Ethernet datacom or CE traffic.

The access service port table contains entries for a bi-directional ET155/DS3/E3/E1/T1 port in the R-AAS or C-AAS. These ports represent end points for ATM connections.

Entries in the generic table describe NUs. Entries in this table are created by the operator as part of the procedure.

The customer identity table contains a subset of the information in generic table indexed by the customer ID, giving a fast way to obtain the system node, subrack, and position given an NU identifier.

Entries in the cross connect table represent PVC connections between a user port and a service port, ATM switch interface or ATM service node interface. Entries in this table are created by the operator in order to set up a PVC.

The functionality of the table is following:

- Create VP cross connection
- Delete VP cross connection
- Activate VP cross connection
- Deactivate VP cross connection
- Create VC cross connection
- Delete VC cross connection
- Activate VC cross connection
- Deactivate VC cross connection

6.4.3 Specific Services

The specific services layer contains all service and system specific applications that manage equipment, for example MINI-LINK BAS, and services, for example telephony.

These subsystems make use of the functionality provided by layer 2 generic services which in their turn base themselves on the basic platform.

6.5 CP

The functionality of the CP is implemented by means of a number of applications, each handling a specific task. The CP software Erlang language running on the OTP which in its turn runs on the Solaris operating system. The CP hardware is basically a Force Sparc station.

Figure 6-7 and Figure 6-8 depict the internal software architecture of the CP.

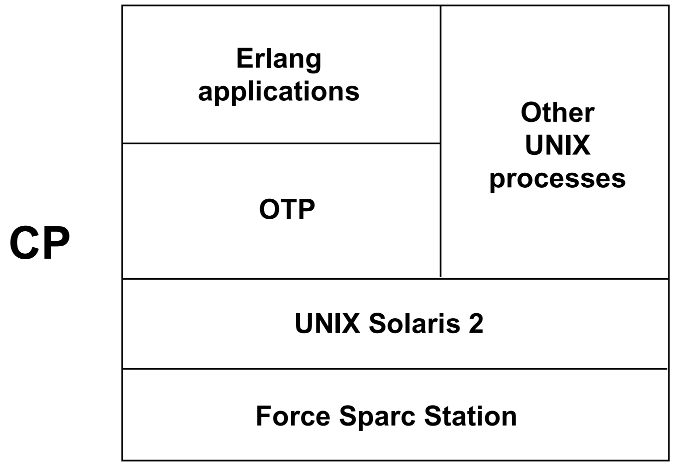

Figure 6-7 CP Software Architecture, Structural View

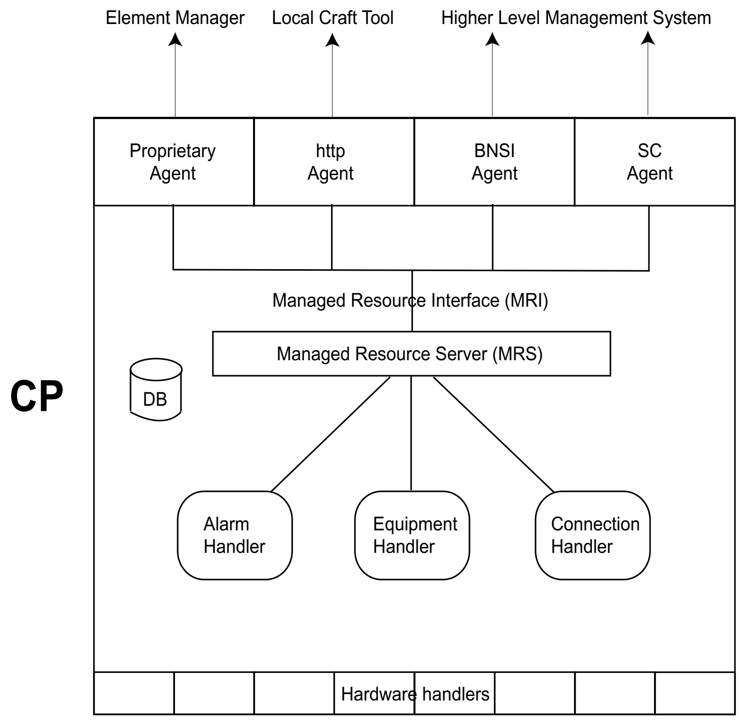

Figure 6-8 CP Software Architecture, Functional View

Note: The HTTP agent port is prepared for the connection to a Local Craft Tool, not included in the current release.

As the EM, the CP software may be seen as layered in at least three functional levels (Figure 6-8).

Nevertheless, EM and CP layers are conceptually different, because in the EM, each layer provides services to the layer that is immediately above it, whilst in the CP, each layer may be seen either as an interface or a feature handler.

6.5.1 Interface Handlers

The boxes in Figure 6-8 represent the interfaces towards management system; these are the ways through which operator can access information by the CP. The software modules driving the interfaces are called “agents”. Four agents are available:

- Proprietary agent
  this is used to manage the computer and telecommunication networks.
- HTTP agent
  HTTP is the protocol normally used on the Internet. See Note in Paragraph 6.5.
- BNSI agent
  BNSI is the interface towards a higher-level management system called “Ericsson Network Surveillance” that primarily provides operators with the alarm situation of the network. It does not handle configuration information, just alarms at network level.
- SC agent
  Interface towards higher level management systems.

6.5.2 Main Applications

The CP software architecture uses a small set of applications as the core of the software itself. The main applications can be subdivided into two groups:

- General applications
- Specific applications

The general applications deal with the equipment at a high level.

These applications have not to worry about the specific way a piece of equipment performs an action, just as an example, the reader may think of the establishment of a connection.

The applications consider all equipment in the network in the same way, regardless of their peculiarities. Specific applications, on the other hand, handle system-specific tasks, in our case MINI-LINK BAS specific tasks.

The general applications are:

- Connection handler
- Equipment handler
- Alarm handler

6.5.2.1 Connection Handler

The connection handler is responsible for coordinating the setting up of cross connections. It is also responsible for the re-establishment of cross connections after failures and performing audits to ensure that the hardware state corresponds to the internal software status.

The connection handler contains a database for all the reserved and established cross connections. It also stores private data for each hardware handler involved in cross connections. By letting the connection handler store this data and perform the necessary transaction handling, data consistency is ensured.

6.5.2.2 Equipment Handler

The equipment handler provides a common interface for the management of basic features that are applicable to all equipment in the network. It also provides functions to insert and delete hardware in the system. The Equipment Handler may be seen as made up of several blocks:

- Configuration Manager
  the startup configuration data of the system is read from configuration files at system start. The configuration manager provides an interface for the retrieval of this data.
  Typical information items that are handled by this module are site specific data, such as information about the circuit boards, their hardware and software identifiers, topology and the PVC in the system.

- Hardware Status
  the equipment handler maintains a database containing data for all boards, sub-racks and slots in the system. The equipment handler also keeps a database of all the units in the system and their administrative states. The administrative states of boards and ATM interfaces are changed as needed via the EM.

- Resource Collector
  the resource collector provides an interface towards the hardware handlers to create and manage the different transmission interfaces in the system. It also provides inventory functions for topology.

  The resource collector keeps a database of all the transmission interfaces in the system and their interconnection. Such a database together with the equipment database represents the actual configuration of the system in terms of subracks, slots, boards, and interfaces.

- Software Upgrade
  this is the process responsible for upgrading the software on Device Processors. It reads a text file defining load modules to be downloaded on different boards.

  The software upgrade function is activated through Unix scripts residing on the CP.

6.5.2.3 Alarm Handler

The alarm handler provides alarm and event reporting functions. It maintains a table holding information about all events and alarms that can be notified by the system. Alarms and events have a set of associated properties that define the actions to be taken when they occur, for example whether it should be logged, where it should be sent to and so on.

The alarm handler also keeps a log of the most recent events and a summary of all active alarms.

6.5.3 HH (Device Handlers)

HHs provide the interface between the main applications and the DP running on the various pieces of hardware in the network, in order to perform the actions required by the applications themselves.

HHs are also responsible for the detection and notification of failures to the alarm handler. HHs are also called device handlers.

The main configuration activity HHs are involved in is the setup of cross connections. These modules do not maintain information (in a database or in any other form) about the cross connections, but let the connection handler do this for them. This allows having just one central point where information is stored, and inconsistencies are avoided.

HHs also use the resource collector database, a part of the equipment handler application, to store configuration data of the hardware they interface to. This contributes to avoid the risk of database inconsistencies.

The resource collector provides HHs with a function that allows these latter to verify whether new connections are allowed or not. This of course takes into consideration the operational and administrative states of both the ATM interfaces and the involved boards.

There is no direct interface among HHs.

Examples of HHs are:

- ET
- Cellmux
- MINI-LINK BAS, RN and AT
- CE units

6.5.4 MRS & MRI

The interface towards the EM is handled by the Managed Resource Interface (MRI), which is a generic Erlang language based interface between the Managed Resource Server (MRS) on one side and the management interfaces on the other side (Figure 6-8).

The MRS acts as a sort of “dispatcher”, by forwarding the requests coming from the EM to the appropriate main application or the HH.

MRS does not know anything about the configuration parameters of the equipment in the network, nor their values: it only knows which are the currently “managed objects” and how to have access to them, what HHs is involved and what is the relevant instance, that is which shelf or board.

6.6 Equipment Management

6.6.1 Equipment Hardware Configuration

A piece of equipment, sometimes also referenced to as “system element”, is considered as a sub-network element connecting a number of user network interfaces to one or more service network interfaces. In principle, the hardware configuration can be done beforehand or during system operation. This involves the definition of:

- Subrack type
- Board type
- Slot type
- Links between subracks, that is topological information
- Links towards external equipment

The topological information is used for the definition of the path from a service network interface to a user network interface (connection handling) and the definition of the equipment supervision startegy and hierarchy.

6.6.2 Equipment Software Configuration

Software consistency is assured by the system according to the general principle by which software versions are not released on a sub system basis, but on a system level. This means that when a new software version is defined, this includes the software for all boards or interfaces in the system, so that they are always aligned.

Patches are neither provided nor supported at all, because they might create software consistency problems and increase maintenance costs and the overall system complexity. In addition, patches might lead operators into confusion because similar interfaces may behave differently according to the software versions or patches they are currently using.

The software consistency is likewise maintained after an upgrade by downloading all boards in the system. The software download procedure is done as a background process on a board type basis, not on a single board basis, which makes the procedure simple and does not affect the traffic.

During software download the board functions are not affected until the board has to switch to the newly downloaded version, a restart is required.

Each slot can be configured to accept a specific board, or it can be configured to be plug-and-play and to accept any inserted board.

If the download is unsuccessful, the system can be downgraded to the previous version without need of an additional download. The terminals will rollback automatically to the previous software version if it is not possible to re-establish the contact with the CP, the rollback of the other boards must instead be ordered through specific commands from the CP.

The management hierarchy and protocol determine whether a board can be inserted, detected and configured in a certain position that board, otherwise, lits a red light.

Software download is also possible locally through the ACT. By use of this tool it is possible to download a new software version onto an AT.

6.6.3 Equipment Supervisioning

When a position, that is a slot, is put into the managed state, the slot type become supervised.

Slots, that are defined to hold DPs, are supervised directly by the CP. The management system starts scanning the network for scanning the units.

If a board is detected, the system verifies whether the hardware identity, that is the actual board type, and hardware revision are as expected. If this is the case, the software identity and software revision are then checked; if these do not match, an automatic software download procedure is started.

When all these operations come to the end, the corresponding HHs are informed of the new board, which is now ready for operation because both hardware and software have been checked. Once HHs finish their work, they inform the Connection Handler, which in turn will then set-up preconfigured cross connections over this hardware.

If the above mentioned scan fails for a number of times, the board is considered as removed, and is reported as such to the HHs. Again, the connection handler is informed; the cross connections using this hardware unit are established as well, but they are set to the disabled state.

6.6.4 Equipment Errors and Error Handling

On all boards, the equipment application handles the software and hardware supervisioning.

Apart from this software based supervision, the hardware processor has a watchdog as well, in orderd that if the software supervision process does not update the watchdog circuitry, a processor restart is initiated, cold restart.

6.6.5 Equipment Audit

At a hot start, the equipment is checked, trying to avoid traffic disturbance as much as possible, while a hardware self-test is performed at board restart and cold restart. At hot restart, the equipment configuration is also checked and updated.

6.7 Connection Management

6.7.1 Connection Configuration

The connection handler is responsible for the setup of cross connections in the system and for the coordination of all related activities carried out by the HHs. The following four operations can be performed when dealing with cross connections, as shown in Figure 6-9:

- Reserve
  the needed resources for the cross connection are reserved, so that they are allocated to the connection itself, even if this has not yet been established.
- Connect
  the previously reserved resources are used for the establishment of the connection.
- Disconnect
  the connection is removed, but the resources are retained.
- Release
  the resources for a connection are freed.

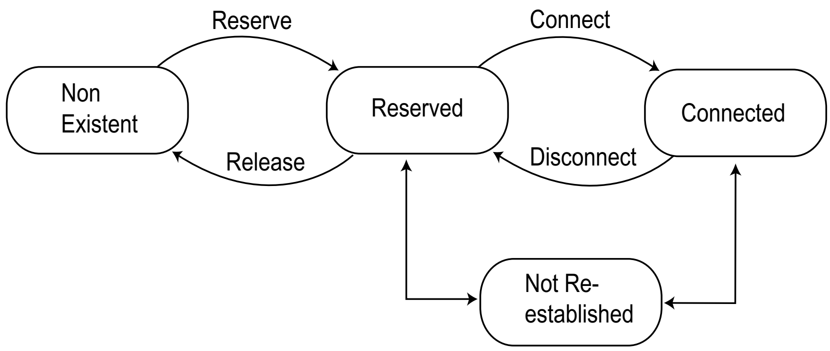

Figure 6-9 Cross Connection Activities

The connection handler receives requests to perform these actions from the MRS, which in turn is requested to do so by the EM.

The connection handler communicates with all involved subsystems (HHs) in order to set up a given cross connection. Thus, for example, when setting up a connection from the ET to an AT in the MINI-LINK BAS, the connection handler will have to communicate with the cellmux and HHs.

All information about cross connections is stored in a database maintained by the connection handler.

In order to maintain consistency, the processes, which control the logical units, retain no information about cross connections. If should they need details about cross connection, they have to explicitly ask the connection handler.

The connection handler also stores a list of dependencies for each cross connection. It is a list of the circuit boards through which the cross connection passes. This list is stored in order to allow re-establishment of cross connections after hardware or software failures. In case of hardware failure or ATM level alarm, the list is also used to point out which cross connections are affected by the alarm itself.

6.7.2 Cross Connection Re establishment

Cross-connection re establishment is needed when the contact with one or more boards has been re established after it was lost before.

This procedure consists of the following steps:

- Find out the boards for which the contact has been established again.
- Retrieve, from the connection handler database, the list of cross connections that are affected by these boards.
- Start an audit for all affected boards. This means assuring that the correct cross connections are set-up and all others are removed.

In both cold and hot restart there may be connections, which cannot be re-established. For example, the connections may use interfaces or circuit boards which have been removed or which have failed. These connections are retained in the connection handler database but are marked as “not re established”, as shown in Figure 6-9. These connections will thus not just disappear but will be visible through the management system as having their operational state set to disabled.

6.7.3 Connection Supervision

The cross connection supervision is essentially based on the relation between cross connections and the related resources. Fault management on any resource used by a cross connection, typically boards, interfaces and physical links, will result in alarms on such a resource and in a consequent change in operational state of the affected cross connections.

Therefore the cross connections supervision is essentially based on the fault management procedures for the resources used by such a cross connection.

6.8 Alarm and Event Management

The alarm and event handling is performed by the HHs.

This means that alarm and event filtering is done as close to the alarm originating point as possible, so as to avoid overloading of the system with internal traffic. This also contributes to reduce the complexity of the management structure because some alarm suppression activities are already performed at a lower level.

6.8.1 Alarm Correlation

The alarm or event notification is managed by the corresponding HH instance, the one managing the logical unit that originated the alarm/event, which filters it according to predefined criteria and by taking into consideration the actual alarm situation of the unit itself. This activity, that does not involve other HHs than the one originating the alarm, is called local alarm correlation.

When it comes to the correlation among alarms coming from different HHs, it is the alarm handler that takes decisions, by using an alarm correlation file.

6.8.2 Alarm Suppression

During system restarts the alarms and events are not forwarded to the management system until the restart has been properly carried out, to avoid spending time on sending and handling alarms and events that are of no use to the operator. After the restart is finished, the alarm notification function is enabled.

It is also possible for the operator to mark an alarm as no-trap, that means that even if the alarm occurs, no notification will be sent to the management system.

6.8.3 Active Alarm List

The alarm handler is responsible for keeping a list of active alarms. This list is updated by the other applications; alarms are also cleared by the sender. In other words, the alarm handler maintains the list, but it does not perform any polling activity: it is the responsibility of the other applications to ask the alarm handler to add a new record to the list or to remove an existing one, called alarm clearance.

At the restart, the active alarm list is cleared. Thus, the active alarm list contains only outstanding alarms.

6.8.4 Alarm and Event Log

The alarm and event log contains all alarms and events occurred in the system, together with the time and date indication of when they have been received. The alarm and event log has a limited size and wraps around after a certain number of alarms and events.

Alarms and events can be marked as not logged via the EM. This means that the relevant notification will not be logged. Furthermore, the operator can filter the alarm list by use of several criteria: severity, occurrence time, and so on.

Alarm records contain the following information:

- Alarm identifier
  A unique identification number for this alarm
- Alarm name
  The name of the alarm, for example, power failure and loss of signal
- Alarmed object
  Object that issued the alarm, for example, a circuit board and a subrack
- Alarm type
  Alarm class the alarm belongs to communications, quality of service, processing, equipment, environmental
- Alarm severity
  One of the standard alarm severity levels: critical, major, minor, warning
- Alarm occurrence date and time
- Alarm information
  Additional information about the alarm

6.8.5 Alarm Severity

The severity of an alarm can be defined through the EM. The alarm severity assignment function supports the assignment and modification of the alarm severity associated with an alarm reported by an object.

The alarm severity levels correspond to those used by the standards for Telecommunication Management Network (TMN): critical, major, minor, warning, indeterminate and cleared.

When an alarm notification is issued with the severity field set to cleared, it is removed from the current alarm list, but remains in the “historical” log. Changing alarm severity only affects new alarms, not alarms that were already entered into the alarm list.

6.9 Performance Management

The performance management values are today captured by the EM after performance monitoring has been started.

Performance data is available at the physical layer for the connections between AT and the relevant RNs.

HP-OV is used to gather the counter values for presentation to the operator. HP-OV includes functionality to perform thresholding and event notification.

6.10 Database Management

6.10.1 Persistent Data

To avoid the data become inconsistent, all persitent data on cross connections is stored by the connection handler; at cold restart this latter removes all system internal connection data and keeps only the end-points to be sure that no-one takes any consideration to the earlier set-up. For the same reasons, the equipment handler stores all equipment configuration persistent data, and all alarm persistent data is stored by the alarm hander.

If any database changes have been done, while upgrading the system from one version to another, a specific database upgrade procedure is to be initiated by performing the following steps:

- Stop the system in a controlled manner (as so to synchronise the database).
- Start the database upgrade procedure.
- Upon procedure successful termination, install the upgraded database and the new system software.
- Initiate a hot or a cold start of the system, depending on the level and amount of changes.

6.10.2 Backup and Restore

Since the system hard disk and other unreliable hardware may fail, a database backup procedure can be manually ordered by the operator.

The database will be frozen before the backup.

Backed-up databases can be restored in case of need. This will of course require the system to be stopped and restarted, according to the following steps:

- Stop the system in a controlled manner.
- Restore the previously backup database.
- Upon successful restoration, initiate a hot restart of the system.

6.10.3 Atomicity of Transactions

The atomicity of transactions is ensured by having only one interface for writing data, only one entity for handling a database table, no dependencies between data records, and other security and database maintenance features.

6.11 Internal Communication

This section describes the communication structure used for the management of the MINI-LINK BAS. Several communication levels exist in the system to each of them is dedicated a separate subsection.

6.11.1 Communication between EM and CP

The communication between EM and CP is done using a proprietary protocol over TCP/IP. A normal Ethernet connection is provided between EM and CP.

The protocol is based upon a manager-agent approach, where the manager asks the agent about specific information items. It is the responsibility of the agent to find such an information and to present it to the manager. In our case, the EM makes the role of the manager and the CP represents the agent.

The protocol requires the manager and the agent to share the information structure of the objects they want to handle; this is called Managed Information Base (MIB).

6.11.2 Communication between CP and DP

The communication between CP and DPs is controlled by the ICS. The ICS provides facilities for link supervision, message acknowledgement, message retransmission, Erlang interface, and so on.

The ICS protocol between CP and DPs is ICS over ATM (ICS/ATM), as shown in Figure 6-10. The ICS messages are mapped into ATM cells by using the AAL5.

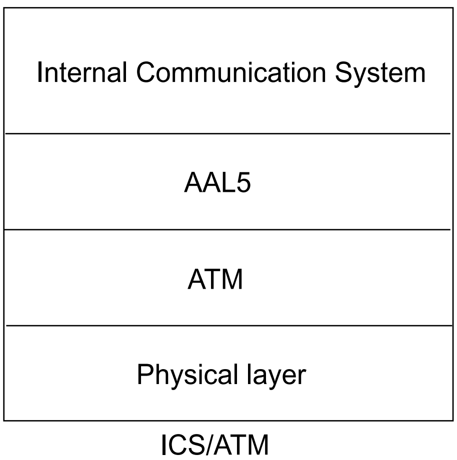

Figure 6-10 ICS over ATM.

The characteristics of the ICS/ATM connections are described at Paragraph 6.3.3.

Where the DPs loosing contact with the CP will keep their configuration and traffic will continue flowing without modifications. When contact is back, the *audit* procedure assures the correctness of the configuration, without affecting the traffic.

6.12 Recovery Procedures

There are three system startup modes:

- Initial start
- Cold restart
- Hot restart

6.12.1 Initial Start

An initial start is used the first time the system is started, or if a completely new configuration is to be managed. The main actions performed at initial start are:

1. Restart all boards in the system using a cold restart;
2. Restart all CP software modules;
3. All database tables are cleared;
4. The current configuration is read from the configuration files;
5. The event log is emptied;
6. The alarm log is reset.

The configuration data is used to find all preconfigured boards and to set-up preconfigured cross connections. The system remains in this state until all expected boards have been searched and found or timed-out. During this time all attempts to manipulate boards or cross connections will be rejected.

6.12.2 Cold Restart

Cold restart may be applied to one board or to the complete system. Cold restart also involves the system hardware, that is traffic is interrupted.

6.12.2.1 System Cold Restart

A cold start is initiated the first time a system is started, or the system has failed a hot restart. When the system is cold restarted:

- All CP and board software is restarted as well as all board software.
- Process and board configuration data is cleared.
- The configuration is read from the database.

- The CP then uses the configuration data contained in the current database to define the boards configuration, according to their state before the cold restart.
- The connection handler establishes all permanent cross-connections that existed before the cold restart.
- The event log is maintained, not cleared.
- The alarm log is reset to only hold active alarms.

Until this process has been completed, the system remains in the cold restart state, and all attempts to manipulate boards or cross-connections will be rejected.

6.12.2.2 Board Cold Restart

Board cold restart is initiated, for example, when a board is removed and re-inserted or when a power failure has occurred.

Boards that do not come in properly, that is they restart many times without reaching a consistent state, are automatically set to the unmanaged state by the equipment handler to avoid control system overload.

6.12.3 Hot Restart

Hot restart is applied to a part of the CP software or the complete CP software. Hot restart does not involve the system hardware, that is traffic is left unaffected. A hot restart is initiated when any major software process or module has failed. When this happens:

- Process and configuration data is kept, but an audit procedure takes place in order to enforce that the boards and cross connections in the system are consistent with data known by the CP.
- The event log is kept.
- The alarm log is reset to only hold active alarms.

Until this process has been finished any attempt to manipulate boards or cross connections will be rejected.

Hot restart of a single CP software module is also called a running restart. Such minor restarts will not prevent the manipulation of boards or cross connections more than for a very short time.

If a CP software module recognise the occurrence of a serious problem, the following steps are envisaged:

- The software module will first try to recover using a “local” hot restart, only involving itself.

- If this fails a number of times, a hot restart of the complete CP system will be attempted.
- If this in turn fails, a cold restart of the complete CP system will be tried.
- If this also fails a number of times, more than 10 times an hour, the system will shutdown.

The hot restart of a HH does normally not affect other HHs, but the hot restart of a common function, for example equipment, alarm, and connection handlers, will cause the hot restart of all CP software.

7

ATM Transport and Multiplexing

7.1 Introduction

ATM is the transport technique used in MINI-LINK BAS.

ATM transport guarantees the efficient delivery of services with totally different QoS requirements, such as data and telephony services. This is obtained by deploying the flexibility of ATM virtual connections and service categories.

The system exploits the fine bandwidth granularity and the statistical multiplexing capability of ATM.

ATM transport along the system involves the following functionality:

- Cross-connection of VCCs
- Connection admission control for ensuring proper utilisation of resources
- Prioritisation of real-time traffic for low transfer delay and jitter
- Extensive buffering of non real-time traffic
- Fault management

7.2 Virtual Connections

ATM transport is accomplished by setting up virtual connections along the system. The equipment supports point-to-point permanent VCCs.

VCCs can be established between:

- A user port and a service port;
- A user port and a service-user port;
- Two user ports;
- A service-user port and a service port.

Service ports and service-user ports are ports toward a SN or a single Service Node, such as a one-armed router. They are located on any type of shelf, regardless of whether it is a R-AAS or a C-AAS (CE Shelf), but they are never to be located on ATs.

User ports are ports toward the customer premises network and are always located on ATs.

The difference between service ports and service-user ports consists in the fact that the latter can have connections towards a service port, while connections between two service ports are not allowed. Thus, for example, the port used to connect the system with a one-armed router must be qualified as service-user port if connections must be possible both between the router and the users and between the router and a service network (connected via a service port). Otherwise, if only connections between the router and the users are necessary, the corresponding port can be indifferently qualified as a service port or as a service-user port.

As another example, the E1/T1 ports of a C-AAS (CE Shelf) must be qualified as service-user ports as to enable the possibility to establish connections between them and the service port, ET, used to connect the same C-AAS (CE Shelf) with the ATM network/switch.

The setting up of a VCC is a straightforward. The operator is merely required to specify the two ports which are intended to be connected. The system automatically establishes all the VC links necessary to obtain the connection.

VCC between two user ports can be set up without consuming resources in the ATM network or switch. This is enabled by the fact that the R-AAS has full VC cross-connection capabilities. This same characteristic is shared also by the C-AAS (CE Shelf).

7.2.1 VP/VC Connection Plan

The system uses point-to-point Virtual Channel (VC) connections, but it is ready in all its parts to support Virtual Path (VP) connections.

VP connections are unused just because the available user ports, Ethernet 10/100BaseT and E1/T1 for CE, are always associated with VC end-points. When ATM user ports, such as the ATM 25.6 Mbps, will be introduced, they will be usable for both VC and VP connections crossing the boundary between the system and the customer premises network.

Beside the normal usage for traffic transport, VC connections are also used as internal communication channels among different parts of the system.

This aspect is entirely invisible to the operator, except these connections required by the CP reached through an ATM switch or network. In such cases, the operator is required to set up appropriate connections through the ATM switch or network, see Chapter 6.

7.2.2 Use of VPI/VCI Values

In order to simplify the service provisioning process, the system automatically selects the VPI/VCI values used over all its internal interfaces, while it lets the operator choose the VPI/VCI values where they have relevance outside of the system boundaries.

As an example, when a connection is established between an Ethernet user port and an ATM service port, the only VPI/VCI value the operator is requested to specify is the one used at the ATM service port.

Given the types of user ports currently supported, the manual selection of VPI/VCI values by the operator is only necessary at ET, service or service-user, ports. Such as selection is subject to constraints on the supported VPI and VCI ranges.

However, as indicated in the following table, the operator can chose one out of many possible different configurations.

Configured mode	Configured VCI max	Max allowed VPI	Max possible number of VCCs at the ET port
NNI	255	4095	28160 in 110 VPIs
	511		28160 in 55 VPIs
	767		27648 in 36 VPIs
	1023		27648 in 27 VPIs
	1279		28160 in 22 VPIs
	1535		27648 in 18 VPIs
	1791		26880 in 15 VPIs
	2047		26624 in 13 VPIs
	3583		25088 in 7 VPIs
	4607		27648 in 6 VPIs
	6655		26624 in 4 VPIs
	9215		27648 in 3 VPIs
	16383		16384 in 1 VPI
UNI	255	255	30976 in 121 VPIs
	511		30720 in 60 VPIs
	767		30720 in 40 VPIs
	1023		30720 in 30 VPIs
	1279		30720 in 24 VPIs
	1535		30720 in 20 VPIs
	2047		30720 in 15 VPIs
	3071		30720 in 10 VPIs
	4095		28672 in 7 VPIs
	7679		30720 in 4 VPIs
	14335		28672 in 2 VPIs
	16383		16384 in 1 VPI

Within those constraints, the operator has full freedom to choose any combination of VPI and VCI values, thus enabling the use VPI values in accordance to one of the policies.

For example, the operator may decide to use the same VPI for all the connections that must extend over the ATM network towards the same destination node, so that they can be cross-connected as a single VPC.

7.3 Service Categories

Two ATM service categories are supported throughout the system, each one associated with specific QoS guarantees:

- CBR, which grants low cell transfer delay, cell delay variation and cell loss ratio to services whose traffic profile has a well specified maximum bandwidth (expressed in terms of peak cell rate)
- UBR, which grants best effort handling to bursty, non-delay sensitive services

CBR connections are intended to be used for services with stringent transport delay constraints, such as the VCCs used in support of CE services. In most of the cases, these services have also very stringent requirements in terms of cell loss ratio, given the impossibility to accommodate retransmissions.

UBR connections are intended to be used for data services, with limited sensitivity to delay and with the capability to tolerate or recuperate from losses. Typically, these services have a bursty nature and the use of statistical multiplexing can facilitate the appropriate utilization of transmission resources.

The combination of CBR and UBR connections has the potential to enable a very effective use of transmission resources.

7.3.1 Connection Admission Control

Whenever a CBR connection is set up, the system implicitly undertake the commitment to grant the corresponding QoS guarantees. Therefore, prior of confirming the establishment of a CBR connection, the system verifies whether appropriate resources are available throughout all its involved parts. If this is not the case, the connection establishment is rejected.

The establishment of UBR connections is or is not submitted to verification on resources depending on how the system has been configured.

If the operator has decided to support data services with a best effort approach (with or without a minimum bandwidth gurantee), then no verifications on resources are made at connection establishment, that is, the establishment of a connection is never rejected for a lack of resources. Conversely, if the operator has decided to support data services with a circuit-like approach, that is by providing a constant guarantee for a specific amount of maximum bandwidth, then the establishment of a new connection is possible only if the corresponding amount of bandwidth is actually available throughout all the parts of the system.

7.4 R-AAS and C-AAS (CE Shelf)

As already mentioned, both the R-AAS (Radio Shelf) and the C-AAS (CE Shelf) have full ATM VC cross-connection capabilities.

In terms of internal architecture, both shelves are identical and are classified as ATM shared bus cross-connections with pure egress queuing.

The backplane capacity is as high as 2062500 ATM cells per second, that is, 875 Mbps at the ATM layer. Given the pure egress queuing structure, the cross-connect should be operated in non-blocking configurations, that is, the aggregate traffic received at ingress ports should never exceed the backplane capacity.

The following table lists the maximum traffic, which is presented at an ingress port of the cross-connection depending on the type of boards installed.

Units	Maximum traffic
ET STM-1/STS-3c	353207 cells/s
ET DS3 PLCP	96000 cells/s
ET DS3 DM	104268 cells/s
ET E3	80000 cells/s
CE 4xT1	16425 cells/s
CE 4xE1	21787 cells/s
NCU	77222 cells/s (This is the absolute maximum, which occurs when no more than 8 ATs are served and the polling period is fixed to 1 ms).

Extensive queues for UBR traffic are available at all the ports where congestion may occur. These are:

- The egress port of ET boards
- The egress port of NCU boards

In the first case, the UBR queuing capability is for 16K cells and supports packet level discard policies (EPD and PPD).

In the second case, the UBR queuing capability is for 8K cells.

7.5 FlexNU

The FlexNU uses ATM multiplexing techniques to handle properly the traffic associated with all its ports.

Both for Ethernet and CE ports, the conversion from and into ATM occurs within the corresponding Service Units. Therefore, the demultiplexing of downstream traffic towards different SUs and the multiplexing of upstream traffic from different SUs is performed at the ATM layer.

For this purpose, the FlexNU uses a UTOPIA-like backplane, whose capacity exceeds the aggregate throughput, which can be transmitted and received over the radio interface.

7.6 ATM Fault Management

The MINI-LINK BAS supports the ATM fault management and F4/F5 flows handling in the following way:

- VC-AIS cells are detected and VC-RDI OAM cells are generated by the Ethernet port at FlexNU side according to I.610.
  No notification of the VC-AIS/VC-RDI status is sent to the management system.
- VC-AIS/VC-RDI cells are not detected or generated by the CE ports, both at FlexNU and SNI side.
  In case of VC-AIS status of the VCC an AAL1, starvation condition occurs on the CE boards and an alarm is sent to the management system
- VP-AIS/VP-RDI cells are handled by the system but VP-AIS/VP-RDI status is left only when the state time-out is expired due to missing reception of VP-AIS/VP-RDI OAM cells. The status is not left if end-user cells are carried across the failed VPC.
- VC-AIS cells generation is not supported by the MAC board.
- ATM loops and continuity check is not supported by the system.

8

Equipment Practice and Power

8.1 Introduction

The present Chapter describes the mechanical parts that compose MINI-LINK BAS. These are:

- Hub site
- AT site;
- Core ATM – C-AAS (CE Shelf)
- Control and Management
- PDU
- Cabinets

8.2 Hub Site

The Hub site is composed by the following parts:

- R-AAS
- RAU
- Node Antenna

8.2.1 R-AAS, Radio-ATM Access Shelf

The R-AAS (Radio Shelf) is the shelf which houses the ATM interface toward the ATM network and the NCUs that drive the outdoor Radios.

The R-AAS has front-access connection field with connectors for external alarm and power. The connections to the ET and to the NCUs are via front connectors.

Slot 1 of the front access of R-AAS is dedicated for the ET board, used to connect the shelf to the external network. Slots 2 and 3 are for CE plug-in units. Slots 4-5, 6-7 and 8-9 can each of accommodate either two CE plug-in units or NCU plug-in unit. Slots 10, 12 and 14 can accommodate only a NCU plug-in unit each, while positions 16 and 17 are dedicated for the dual redundant power plug-in units.

The R-AAS is only available in front access version with duplicated, redundant, PSU’s.

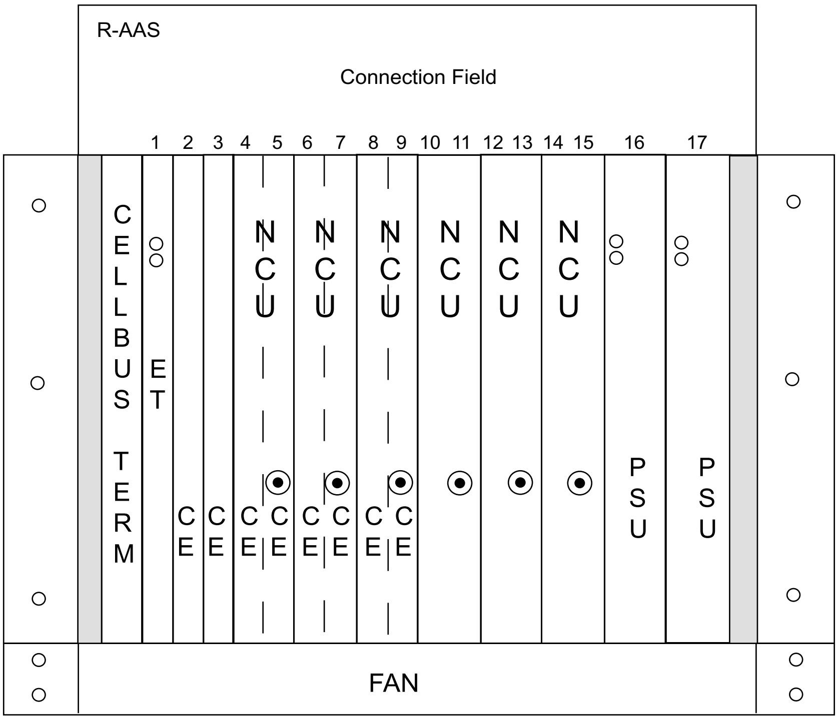

Figure 8-1 R-AAS with Redundant Power

8.2.1.1 PSU

The function of the PSU is the conversion of central office –48 V system voltage into 5,15 V and 3,4 V supply voltages and 1,5 V reference voltage required by the other plug-in units in the R-AAS (Radio Shelf), and a +56 V supply voltage required by the outdoor radios and supplied via the coaxial cable connecting, NCU to RAU.

The board is designed for 2-wire or 3-wire distribution, 48 V return is separated from signal reference ground. Input voltage range: -38,0 V to –60 V. The PSU also provides inputs for alarm signals from an external fan unit and an external alarm contact.

The PSU has two front panel LEDs. When the input voltage exceeds 35 V, one of the LED’s is lit. The red LED is lit when any of the output voltages is below it’s lower tolerance limit, otherwise the green LED is lit. When the PSU is powered up both LEDs are lit for approx. 1 s, regardless of the output voltages. Maximum output power:

- Shelf boards: 150 W
- Outdoor radios: 150 W

8.2.1.2 Fan Unit

The fan unit, equipped in the R-AAS below the card cage, is the same module used in the C-AAS (CE Shelf) rear access version, see paragraph 8.4.5 for more information.

8.2.2 RAU

The RAU has a waterproof casing, with a handle for lifting and hoisting. It fits on the back of the integrated antenna unit, where it is connected to its RF-port.

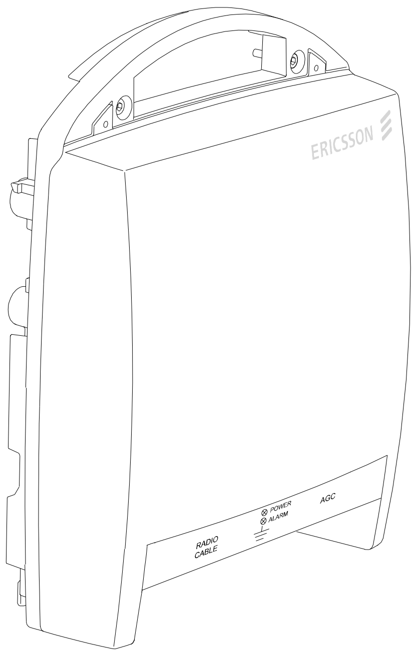

Figure 8-2 RAU

RAU dimensions are 260x321x97 (WxHxD), with a weight of 7 kg.

The RAU has two connectors on the bottom:

- N-female connector for the coax cable carrying DC supply and I/F signals from NCU/AT;
- An alignment port used for RAU installation used for ATs or in point-to-point configuration only.

The RF port is a 154 IEC-UBR260 waveguide.

The radio can be fitted either directly on the antenna or separately and the connection to indoor units is through a single coaxial cable.

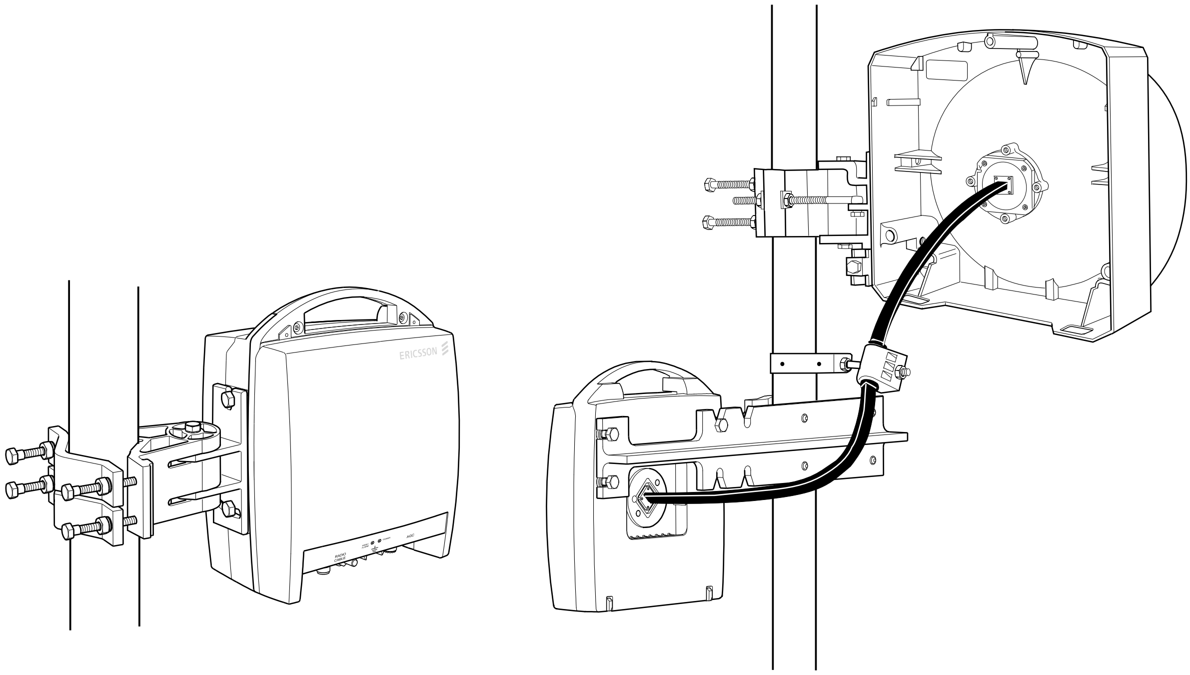

Figure 8-3 RAU Fitted Directly and Separately to the Antenna

8.2.3 Antenna

Two types of antenna are available: one for the RN to Multi AT Connection, Point-to-Multipoint, and the other for RN to single AT Connection, Point-to-Point.

The RAU is fitted directly to this antenna by default; the separate installation is possible through a flexible waveguide connected to the RAU.

8.2.3.1 Antenna for Point-to-Multipoint Connection

The antenna for point-to-multipoint connection is a sector antenna, highly directive in elevation. It is made of aluminium, and has an integrated radome. It is available in horizontal or vertical polarisation.

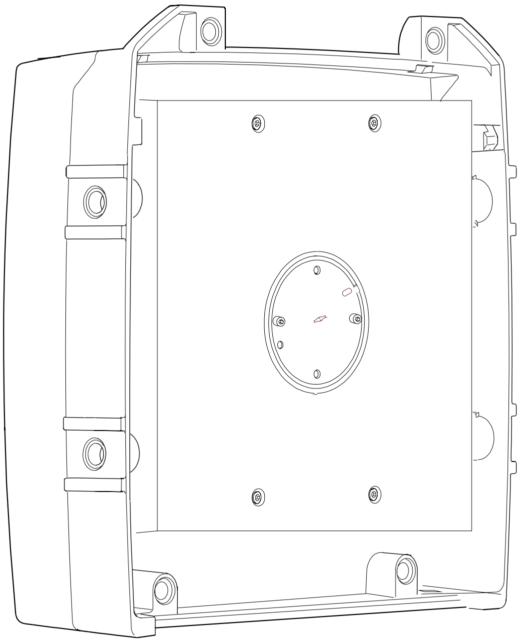

Figure 8-4 Point-to-Multipoint Antenna

8.2.3.2 Antenna for Point-to-Point Connection

The standard compact antenna module, for point-to-point connections, is a 0.24 m high performance compact antenna of reflector type. It has an integrated radome and it is made of aluminium, painted in light grey.

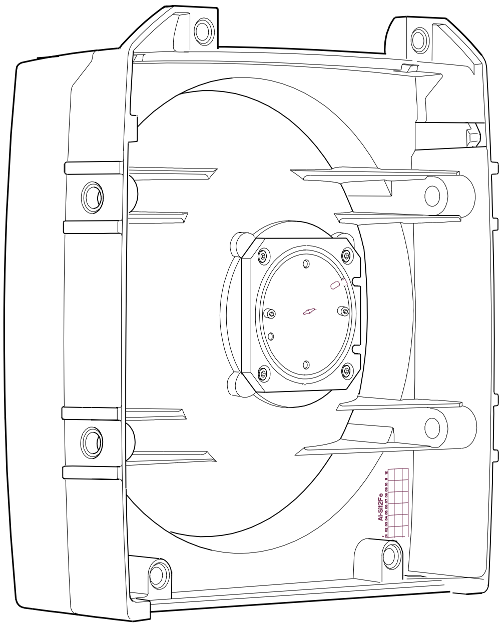

Figure 8-5 Standard Compact Directive Antenna

A 0.60 m integrated directive high performance antenna is also available.

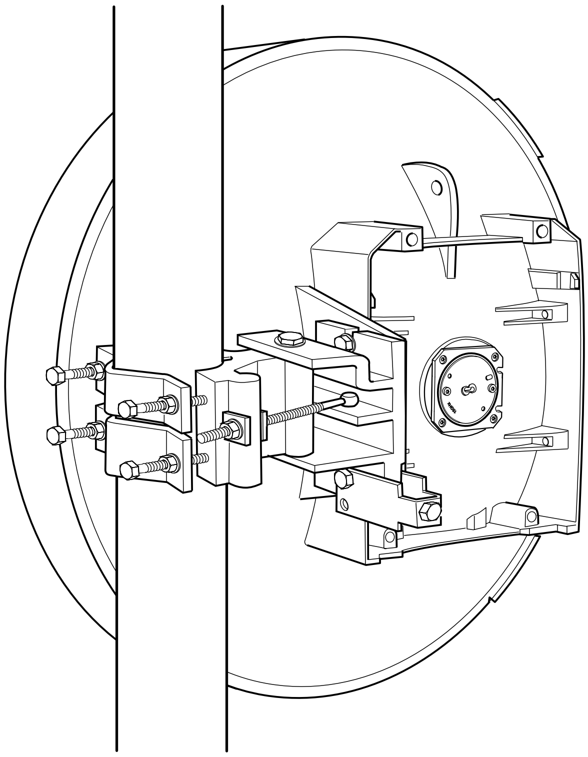

Figure 8-6 0.60 m Integrated Standard Directive Antenna

8.3 AT Site

The AT site provides the interface between the radio network distribution and the subscriber. Every AT is composed by indoor and outdoor parts:

- FlexNU, indoor
- RAU and the Antenna, outdoor

8.3.1 FlexNU

A 19” shelf composes the AT indoor unit, named FlexNU, EMC shielded for compact PCI.

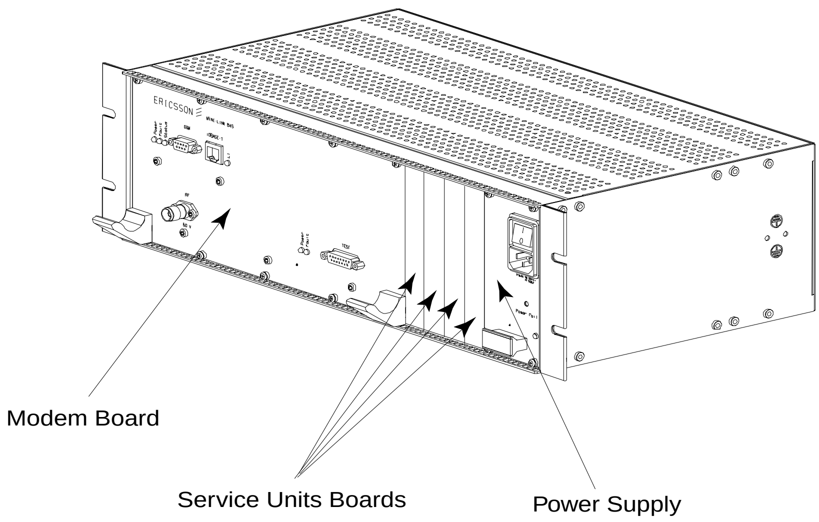

Figure 8-7 The FlexNU Indoor Unit

Dimensions according to IEC 60 297 are:

- Height = 3U (132.5 mm)
- Width = 84T (448.6 mm)
- Depth = 240 mm

Top and bottom covers, fully perforated, are made of pre-galvanised steel sheets. Front panel materials are stainless or aluminium, with EMC gaskets, eject handles and ESD pins in accordance to compact PCI standards.

Connection from the FlexNU to the outdoor radio is via a coaxial cable that is connected to the TNC connector at the front. The service 10BaseT Ethernet connection is made through an Ethernet RJ 45 connector.

Up to four SUs can be accommodated in a FlexNU. SUs comprise dual 10BaseT/100BaseT Ethernet interfaces with RJ 45 connectors and dual E1/T1 interfaces also with RJ 45 connectors.

The FlexNU is supplied by 110-220 Vac 50/60 Hz . The power consumption of one AT, including the outdoor radio, is 70 W. The FlexNU can be mounted in 19” cabinets according to ANSI/EIA-310-D and IEC 60 297.

8.3.2 RAU

The RAU used is the same as in Hub site. For more information please refer to paragraph 8.2.2.

8.3.3 Antenna

The type of antennas used in the AT site are point-to-point, for more information refer to the paragraph 8.2.3.2.

8.4 Core ATM – C-AAS (CE Shelf)

The C-AAS (CE Shelf) is an ATM multiplexer that is specialised for CE. It can be used as the primary interface for providing E1/T1 connections to the PSTN or as a supplementary interface (supplementary to CE-SNI interfaces housed in the R-AAS).

This shelf is designed according to International Electrotechnical Commission (IEC) standards. It fit in racks and cabinets designed according to Electronic Industries Association (EIA), American National Standard Institute (ANSI) or European Telecommunication Standardization Institute (ETSI) standards and practices. Both front access and rear access shelves are available, respectively illustrated in Figure 8-8 and Figure 8-9.

The C-AAS (CE Shelf) has 19 board slots. Slot 1 of the C-AAS (CE Shelf) is dedicated for the ET to connect the shelf to the external network. Slots 2-17 are used for CE boards, or other ET.

Finally position 18 and 19 are dedicated for redundant power board POUs.

It is possible to use the different ET board types, ET155 Optical, and ET34/45, freely in the C-AAS (CE Shelf).

8.4.1 Front Access Shelf

The front access C-AAS (CE Shelf) has front accessible connection field, for external alarm and power connections, below the card cage. The connections to both ET's and CE's are via front connectors.

The Printed Board Assembly (PBA) dimensions are 265 x 175 mm (HxD). A fan unit is placed above the card cage. The shelf has an EMI shielded card cage, the plug-in units have shielded front panels.

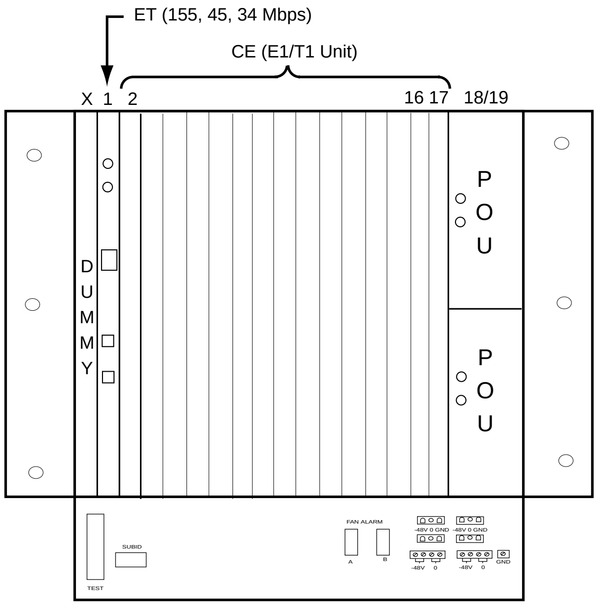

Figure 8-8 C-AAS (CE Shelf) Front Access Type

8.4.2 Rear Access Shelf

The rear access shelf is based on the same equipment practice as front access. The main differences are the rear accessible connection field, the champ connectors, instead of SubD, connectors and the fan unit placed below the card cage.

Fire enclosure bottom requirements according to IEC 60950/UL 1950 are fulfilled on each rear access shelf.

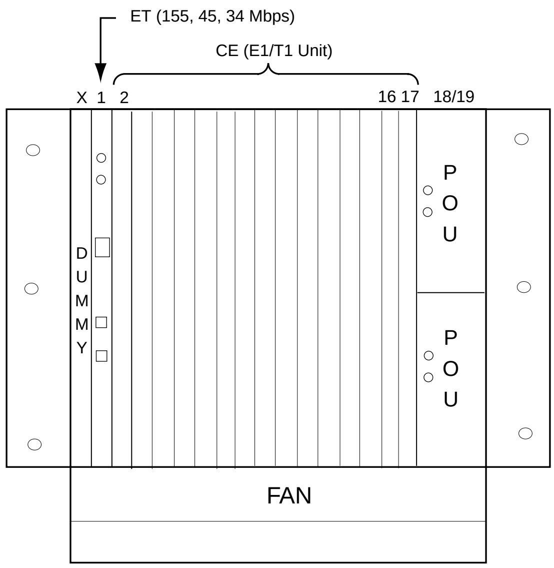

Figure 8-9 C-AAS (CE Shelf) Rear Access Type

8.4.3 POU

The function of these POUs is conversion of central office –48 V system voltage into 5,15 V supply voltage and 1,5 V reference voltage required by the other plug in units in the C-AAS (CE Shelf).

The boards are designed for 2-wire or 3-wire distribution, 48 V return is separated from signal reference ground, and the input voltage range is -38,0 V to –60 V. This POU also provides inputs for alarm signals from an external fan unit.

The POU has two front panels LEDs. When the input voltage exceeds 35 V, one of the LED's is lit. The red LED is lit when any of the output voltages is below its lower tolerance limit, otherwise the green one is lit. When the POU is powered up both LEDs are lit for approx. 1 s, regardless of the output voltages.

The POU has alarms for loss of one input feeder or loss of output voltages for the possible faulty POU.
Maximum output power is 120 W.

8.4.4 Fan Unit for Front Access AAS

A fan unit is mounted directly above the front accessible C-AAS (CE Shelf) as a plug-in unit with the same characteristics delivered together with the shelf.

The fan unit has a mounting plate which carries all functionality (the fan motors, the control board with all connectors and the internal wiring).

This mounting plate is combined with a covering and a front panel to form the complete unit. The dimensions excluding mounting mechanics are 50x210x450 mm, HxDxW.

The fan unit is temperature regulated, meaning that rotational speed is low for normal temperatures but increases at high temperature of the air stream.

This regulation is present in order to increase life time as well as to lower sound level, contamination and power consumption. The fan unit has two types of alarms, A & B.

The A alarm is activated by the following conditions:

- Temperature exceeds 65°C.
- There is no input voltage. Threshold voltage for this alarm is 37 V +/-2 V.
- All fan motors are faulty.

The B alarm is to be activated by the following conditions:

- Temperature exceeds 55°C.

- Cabling faults (supervision cable unplugged, in this case receiving of A-alarm is not possible).
- One fan motor faults.
- Controller faults.

Noise level measured 1m from front panel is 35-50 dB (A) depending on air temperature.

If the front access shelf is powered from two redundant –48 V feeders, the power connection board is used for connecting the fan unit. The power connection board has two –48 V inputs and one –48 V output.

8.4.5 Fan Unit for Rear Access AAS

This fan unit is plugged into the rear access C-AAS (CE Shelf) using one 9 pins DSUB connector for both duplicated –48 V power and alarm. It has the same characteristics as front access fan unit.

The fan unit has two types of alarms, A & B.

The A alarm is activated by the following conditions:

- Temperature exceeds 70°C.
- There is no input voltage. Threshold voltage for this alarm is 37 V +/-2 V.
- All fan motors are faulty.

The B alarm is to be activated by the following conditions:

- Temperature exceeds 65°C.
- Connection fault
  (FU unplugged, in this case receiving of A-alarm is not possible).
- One fan motor faults.
- Controller faults.

8.5 Control and Management

The EM and the CP compose the control and management section.

8.5.1 EM

The MINI-LINK BAS is managed by means of a MS comprising of an EM.

The functionality of the EM is implemented by means of a number of applications, each handling a specific management area.

The applications provide graphical user interfaces, through which an operator can manage resources in the NEs.

The EM is supported by a workstation, shown in Figure 8-10, composed by a keyboard and a screen. Three types of stations and screens are available for different standard configurations.

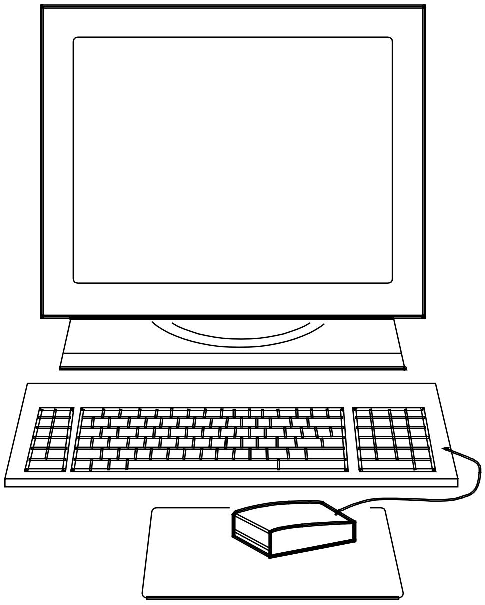

Figure 8-10 EM Workstation

8.5.2 CP

The CP consists of a CPU board, an hard disk, -48 V POU and an ATM adapter board(s). The CPU offers functionality similar to a Sparc Station.

The CP shelf dimensions are 176x450x270 mm, HxWxD.

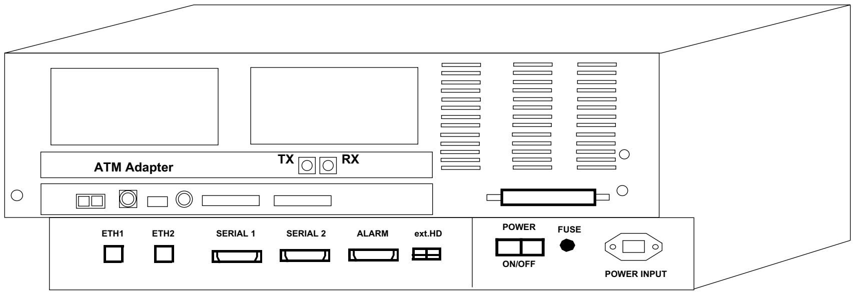

Figure 8-11 CP Shelf-Front View.

8.6 PDU

The PDU is an optional unit required if “high Ohmic” –48 V distribution is not available. The PDU branches one incoming –48 V distribution cable into 5 or 10 outgoing cables and converts a possibly “low Ohmic” electrical interface in to a “high Ohmic” interface.

Each output is protected by a 10A automatic circuit breaker.

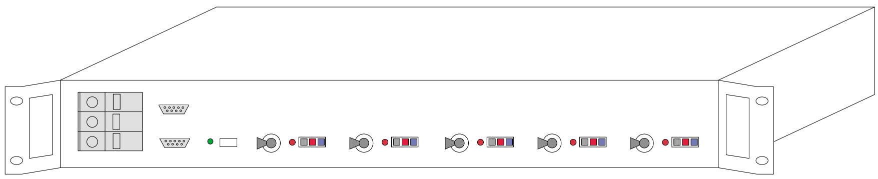

Figure 8-12 5 Outputs PDU Version

8.7 Cabinets/Racks

MINI-LINK BAS shelves are easily assembled in Ericsson cabinets BYB 501 and BYB 502, as well as in a range of standard cabinets.

The following paragraphs describe Ericsson products and typical configurations.

8.7.1 Front Access Central Office

The shelf mounting mechanics can be chosen for various types of rack and cabinets. The front access shelves, require a minimum cross-section aperture of 450x280 mm, WxD. The rear access shelves, requires 450x305 mm, WxD. Rear access shelves are not possible to locate in single depth ETSI standard cabinets.

Since front access C-AAS (CE Shelf) do not fulfil requirements on fire enclosure bottom according to IEC 60 950/UL 1950, cabinets/racks including fire enclosure bottom shall be used. In a partly equipped rack/cabinet, the shelves shall be mounted from the bottom upwards.

The rear access C-AAS (CE Shelf) and the R-AAS (Radio Shelf) are equipped with a fan unit that also acts as a fire enclosure bottom.

Ericsson standard cabinets for central office equipment that are recommended for housing of MINI-LINK BAS can be placed in single rows, back-to-back or back-to-wall.

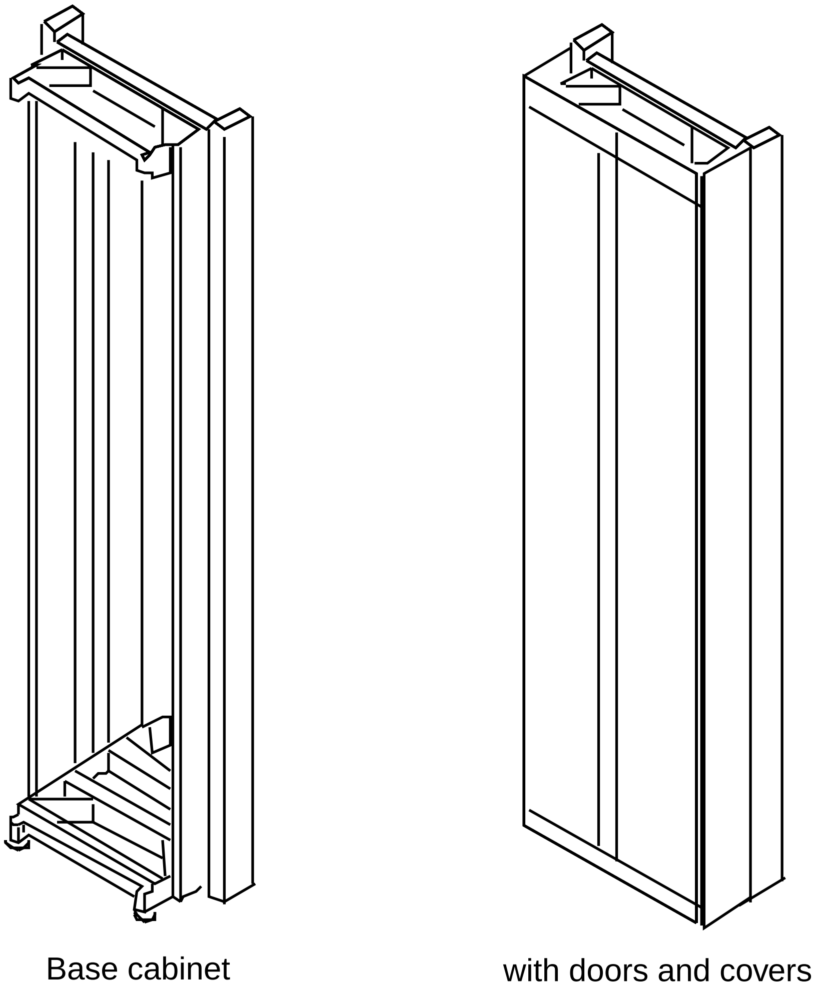

Figure 8-13 BYB 501 Cabinet

For the AT site or for the Hub site, if only the R-AAS shelf is present, the cabinet BYB 502 can be used.

BYB 502 standard dimensions are 400x600x400 mm, HxWxD. Up to five cabinets can be stacked and bolted together on a mounting base, height = 85 mm, and with a cover plate, height = 15 mm. In the Figure 8-14, for example, two cabinets are stacked and bolted together.

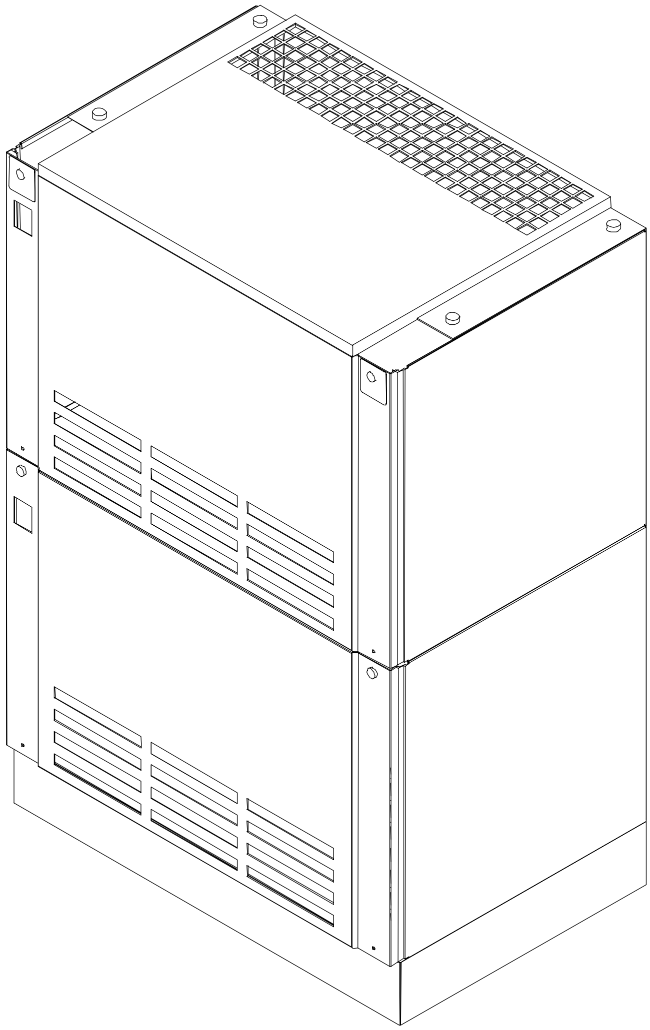

Figure 8-14 BYB 502 Cabinets

MINI-LINK BAS with front accessible shelves can be deployed in various cabinets and racks. Same possible configurations are shown below.

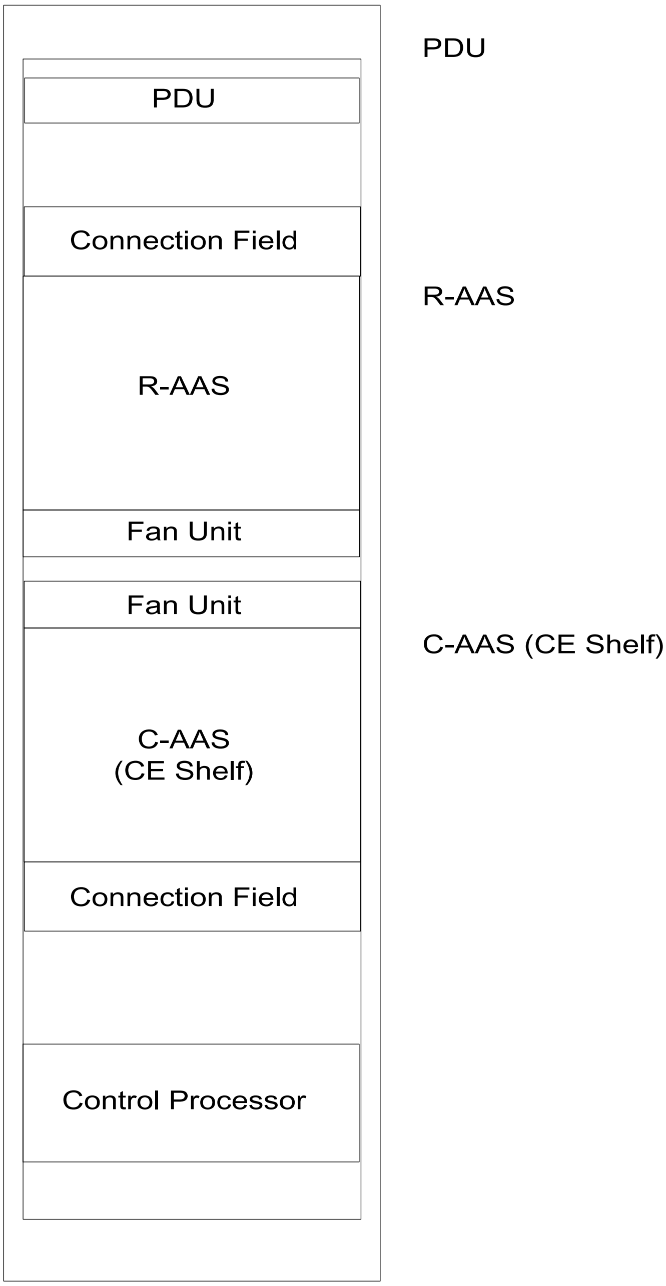

Figure 8-15 Central Office in Cabinet BYB 501

8.7.2 Rear Access Central Office

The rear access shelves are primarily intended to be mounted in ANSI/EIA-310 compliant 19" or 23" equipment frames. Those types of racks are not included in the MINI-LINK BAS.

The rear access system will be delivered on a shelf level. MINI-LINK BAS with rear access shelves must be deployed in racks accessible from the back, a possible configuration in 7’ racks, 19" or 23", is shown below.

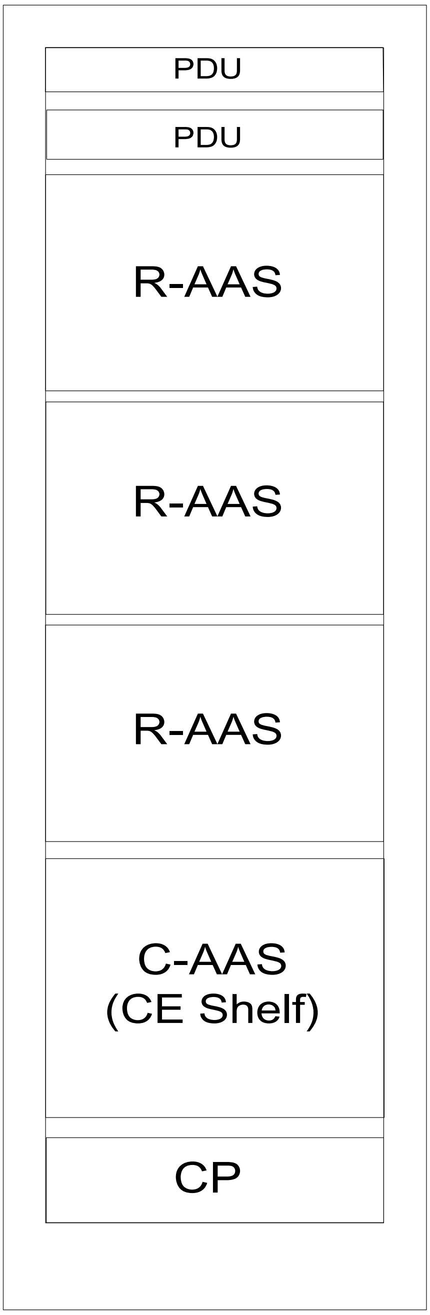

Figure 8-16 Typical US Central Office

9

O&M Facilities

9.1 Introduction

The MS, that performs the integrated control and supervision in all MINI-LINK BAS units by means of the EM and the CP, continuously monitors the transmission quality and alarm status.

The information is fed to the supervision channels, which are extended throughout the MINI-LINK BAS equipment.

Communication with this integrated control and supervision system is carried out by means of a Unix workstation along with suitable software.

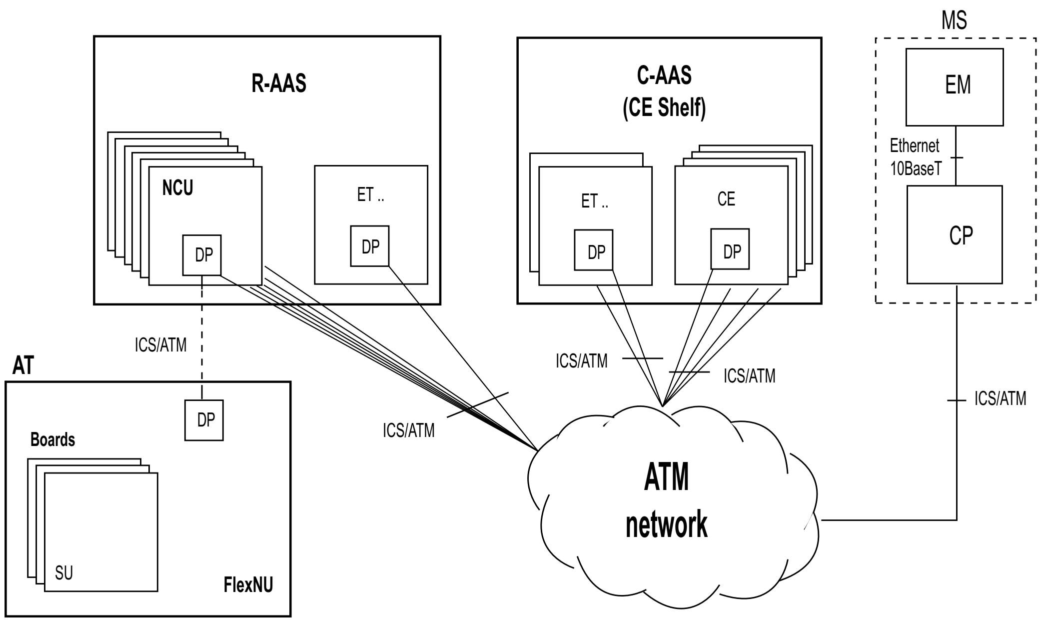

Figure 9-1 MINI-LINK BAS Control Architecture

9.1.1 Communication Channels

Operation and maintenance data between MINI-LINK BAS units are distributed via CP and DPs. The data connection between EM and CP is a 10BaseT Ethernet featured by a TCP/IP protocol.

Connections between the C-AAS (CE Shelf) and R-AASs (Radio Shelves) are performed through the ATM Network by means of optical links, SDH or SONET, with ICS/ATM protocol.

Connections between R-AASs and ATs are performed through the air interface, NCU+RAUs+ FlexNU, using the ICS/ATM protocol.

Note: Reference is made to the Chapter 6: Management and Control.

9.1.2 AT Setup

Initial configuration of the AT (AT setup) is required before bringing the terminal into service and it is performed locally through the ACT.

Differently, when the connection with the RN has been estabilished and the terminal has been signed on the configuration of AT parameters is possible only from the MS.

The ACT is a software tool displayed by a portable PC directly connected to the FlexNU, used for AT local setup, testing and fault management purpose. For more detailed information about ACT tool refer to the “ACT User Guide” of the AT installation manual.

9.2 Fault Detection

The following lists describe the main events and alarms graphically presented in the specific EM window fields.

9.2.1 Alarms

The first table shows the alarm name, the category, the severity and a short description. The category and severity columns are explained below.

Category:

The abbreviations in the Category column are the following:

- Comm = Communications
- Eq = Equipment
- Proc = Processing
- QoS = Quality of Service

Severity:

The alarm severity can be either critical, major, minor or warning. The severity can be changed in the alarm severity assignment window. The listed severities are the default values.

Name	Category	Severity	Description
aal1BufOverflow	Comm	Minor	Sent when buffer-overflow condition is detected.
aal1Starvation	Comm	Minor	Sent when buffer-underflow condition is detected.
atControlChannel	Eq	Major	No communication with modem processor.
atHwFailure	Eq	Major	General hw failure on an AT is detected.
boardMismatch	Eq	Minor	It is sent when the insertion of a circuit board that does not match the configured data for the slot has been detected. An alarm ceasing report, alarm severity cleared, will be sent when matching configuration data is set for the slot, when the configuration data is cleared for the slot.
boardRemovedAlarm	Eq	Major	The removal of a matching board from a slot has been detected or the contact towards the board has been lost. An alarm ceasing report, alarm severity cleared, will be sent when a board is inserted in the slot, or when the management status of the slot is set to unmanaged or when the ICS channel towards the board is re-established again.
boardUnrecognized	Eq	Minor	It is sent when the insertion of a circuit board in a slot has been detected, but the board ID is not recognisable, or not valid for this system. An alarm ceasing report, alarm severity cleared, will be sent when the board is removed.
bufferOverflow	QoS	Warning	It is sent when a buffer overflows for a while.
bufferUnderflow	QoS	Warning	It is sent when a buffer underflows for a while.
cellbusFailure	Comm	Major	It is sent when a Cellbus has a defect that is longer than 2.5+/-0.5 sec, cellbus clock missing.
communicationError	Eq	Major	It is sent when a slot is automatically unmanaged, the board is restarted unprovoked too many times.
disk_full	Proc	Minor	The filesystem on a disk in the CP is almost full.
downLoadLmFailed	Eq	Major	It is sent when the downloading of a new Load Module (LM) from CP to a DP fails.
dpSoftwareFailure	Proc	Critical	It is sent if the DP software fails. Internal exception occurs in an ET driver.
ethernetLossOfCarrier	Eq	Minor	It is sent if Ethernet port detects loss of carrier.
fanFailure	Eq	Major	It is sent when a fan failure has been detected in the subrack. This could be based on detection of over-temperature in the subrack. An alarm ceasing report, alarm severity cleared, will be sent when an indication that the fan is back in operation has been detected.
hardwareFailure	Eq	Critical	It is sent when a hardware failure occurs on a board. It is sent if the board fails the self-test.

Name	Category	Severity	Description
incorrectSwVersion	Eq	Major	It is sent when a board has been loaded with the incorrect version of software.
incorrectSwVersModem	Eq	Minor	The active LM in the Modem at Terminal side contains an incorrect SW version
incorrectSwVersRadio	Eq	Mnor	The active LM in the Radio at Terminal side contains an incorrect SW version
interfaceFailure	Eq	Warning	It is sent when a fault occurs while establishing a connection in the hardware, during commit phase or audit.
laserPower	Eq	Critical	It is sent when a failure of the laser power occurs on a optical ET board.
lof	Comm	Critical	It is sent when a loss of frame has been detected.
lop	Comm	Critical	It is sent when a loss of pointer has been detected.
los	Comm	Critical	It is sent when a loss of signal has been detected.
lossOfCellDelineation	Comm	Critical	It is sent when loss of cell delineation has been detected.
lossOfNetSync	Comm	Major	It is sent when the network synchronisation is lost. It is sent whenever critical alarms – for example, LOS, LOF and so on - are detected on a specific board - ET, CE - which is master for the network synchronisation.
lossOfRefClock	Eq	Major	It is sent when 8 kHz clock is lost.
macCbrOverflow	Eq	minor	It is sent when the CBR buffer is overflow.
macControlChannel	Comm	Critical	No communication with modem processor, at RN side.
macHwException	Eq	Major	Mac hardware internal fault
macIncorrSwVersModem	Eq	Minor	The active LM in the Modem at RN side contains an incorrect SW version
macIncorrSwVersRadio	Eq	Minor	The active LM in the Radio at RN side contains an incorrect SW version
macSignonFailed	Eq	minor	It is sent, when AT, which should be signed on, is lost.
macSwdlFromPassiveToModemInProgress	Eq	Minor	A background downloads from the MAC FPROM passive part towards the passive area of Modem in progress at RN side.
macSwdlFromPassiveToRadioInProgress	Eq	Minor	A background downloads from the MAC FPROM passive part towards the passive area of Radio in progress at RN side.
macSwdlFromActiveToModemInProgress	Eq	Minor	A background downloads from the MAC FPROM active part towards the passive area of Modem in progress at RN side.

macSwdlFromActiveToRadioInProgress	Eq	Minor	A background downloads from the MAC FPROM active part towards the passive area of Radio in progress at RN side.
macModemSwDownloadFailure	Eq	Major	The download from the MAC FPROM active or passive towards the passive area of Modem has failed at RN side.
macRadioSwDownloadFailure	Eq	Major	The download from the MAC FPROM active or passive towards the passive area of Radio has failed at RN side.
mcnWarning	Eq	Warning	The alarm is issued only after system restart in order to verify that the MCN channel is properly working.
modemControlChannel	Comm	Major	No communication with RAU processor. Alarm detected both at AT and RN sides.
modemEberUp	Comm	Major	The Eber received by the modem has exceeded the allowed limit. Alarm detected at RN side.
modemEberDown	Comm	Major	The Eber received by the modem has exceeded the allowed limit. Alarm detected at AT side.
modemHwException	Eq	Major	Hardware internal fault
modemLoftTdm	Eq	Major	AT modem has lost the downstream frame alignment
modemModInd	Eq	Minor	Unable to adjust modulation index
modemRauPow	Comm	Critical	RAU power supply failure
modemRxIFinUp	Comm	Major	Input level from RAU is too low. Alarm detected at RN side.
modemRxIFDown	Comm	Major	Input level from RAU is too low. Alarm detected at AT side.
msAis	Comm	Minor	It is sent when alarm indication signal is received for more than 2.5 sec on a multiplexer section.
msRdi	Comm	Minor	It is sent when remote defect indication is received for more than 2.5 sec on a multiplexer section.
pathAis	Comm	Minor	It is sent when alarm indication signal is received for more than 2.5 sec on a path.
pathRdi	Comm	Minor	It is sent when remote defect indication is received for more than 2.5 sec on a path.
powerFailure	Eq	Critical	It is sent when a power failure has been detected in the subrack. An alarm ceasing report, alarm severity cleared, will be sent when an indication that the power is back on has been detected.
powerLoss	Eq	Minor	It is sent when a power loss occurs at a board.
radioHighTemperature	Eq	Minor	Outdoor temperature above limit
radioRfOut	Comm	Major	RF output level to antenna to low.
radioRxFreq	Comm	Critical	Received frequency incorrect, Rx RF PLL unlocked

radioRxIfc	Comm	Critical	Received frequency incorrect, Rx IF PLL unlocked
radioTxFreq	Comm	Critical	Transmits frequency incorrect, Tx PLL unlocked
radioTxLevel	Eq	Minor	Unable to adjust radio output power level at AT side.
radioTxLos	Comm	Major	The IF input level from modem is too low.
rai	Comm	Minor	It is sent when a Remote Alarm Indication (RAI) has been detected.
startError	Eq	Major	It is sent when a start error condition has been entered or ceased on a circuit board.
subrackMismatch	Eq	Major	It is sent when the hw_id of a subrack does not match the configuration. The info field contains the actual hw_id.
suHwFailure	Eq	Major	Hardware failure on SU
suInitFailure	Eq	Major	Initialization of SU failed.
suMismatch	Eq	Major	A SU of wrong type has been inserted in a configured SU-slot.
suPowerFailure	Eq	Major	Power failure on a SU
suUnsupportedType	Eq	Minor	SU of a type, which is not supported, had been inserted.
suRemoved	Eq	Major	A SU has been removed.
swdlFromPassiveToModemInProgress	Eq	Minor	A background downloads from the FlexNU FPROM passive part towards the passive area of Modem is in progress at Terminal side.
swdlFromPassiveToRadioInProgress	Eq	Minor	A background downloads from the FlexNU FPROM passive part towards the passive area of Radio is in progress at Terminal side.
swdlFromActiveToModemInProgress	Eq	Minor	A background downloads from the FlexNU FPROM active part towards the passive area of Modem is in progress at Terminal side.
swdlFromActiveToRadioInProgress	Eq	Minor	A background downloads from the FlexNU FPROM active part towards the passive area of Radio is in progress at Terminal side.
swDownloadFailureRadio	Eq	Major	The download from the FlexNU FPROM active or passive towards the passive area of Radio has failed at Terminal side.
swDownloadFailureModem	Eq	Major	The download from the FlexNU FPROM active or passive towards the passive area of Modem has failed at Terminal side.
vpAis	Comm	Minor	It is sent when a VP AIS alarm occurs.
vpRdi	Comm	Minor	It is sent when a VP Remote Defect Indication (RDI) alarm occurs.

9.2.2 Events

The events that are not defined as alarms don’t have category or severity. When updating the event and alarm management window (by opening the event and alarm application) the events are logged in the event log.

Name	Description
alarmDisturbance	It is sent if alarm state changes frequently.
boardReplaced	It is sent when the insertion of a circuit board that matches the configured data for the slot, but not the serial number, has been detected.
cbrQueue	Full temporary buffer overflow.
selfTestFailedOnModem	Loop on modem does not work at RN side, that is, MAC or modem faulty.
selfTestFailedOnRadio	Loop on radio does not work at RN side, that is, radio is faulty, MAC and modem are working correctly.
selfTestOk	Loop on radio is working at RN side, that is, MAC, modem and radio have no faults.
signOnComplete	It is a notification that the sign on of an AT is completed.
softwareDownloadDone	It is sent when the software is downloaded.
softwareDownloadInProgress	Sent when the board software is being downloaded.
subrackCreated	It is sent when a new subrack has been created.
subrackDeleted	It is sent when a new subrack has been removed.
systemAudit	It is generated by the CP to notify that a CP starts or restart is ongoing.
systemNodeCreated	It is sent when a new SN is created.
systemNodeDeleted	It is sent when a new SN deleted.
systemUp	It is sent when the CP has initialised.

9.3 Test Loops

A set of physical loops is managed within the MINI-LINK BAS, focusing the segment between the RN and the AT. These loops are used with the system in off-line condition, because their use means traffic loss.

They are local loops only, RN side, they are defined by EM operator; AT side, from the operator during the installation phase, to verify the AT functionality using the ACT.

Generally the loop facilities are used to check the system after installation, or an RN and AT replacement following a failure. Both in case of traffic absence condition, for the entire RN or for the single AT.

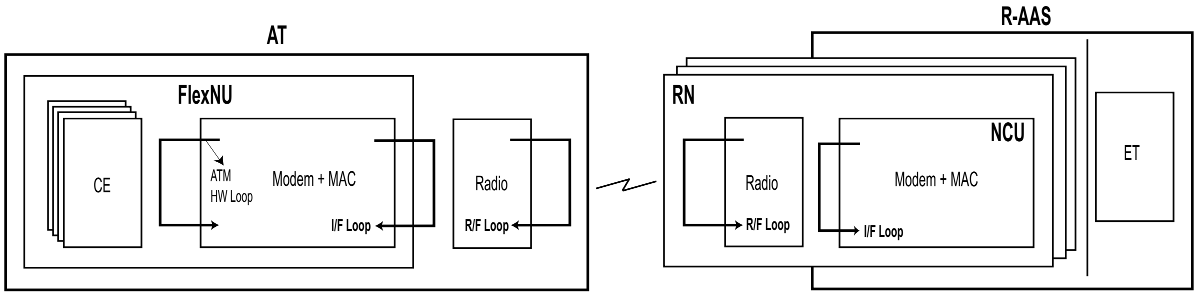

Figure 9-2 RN Near-End Loops and AT Near-End Loops

9.3.1 RN Near-End Loops

The RN near-end loops are used to find out if indoor or ODU, RN side, are faulty. The following near-end loop tests are available:

- I/F test loop
- R/F test loop

The I/F loop is used to verify if, at intermediate frequency level, indoor part, NCU, the RN is working correctly. The R/F loop is used to check if, at radio frequency level, outdoor part, RAU, the RN is working properly.

9.3.2 AT Near-End Loops

The Access Termination (AT) near-end loops are used to find out if IDU or ODU, AT side, are faulty. The following near-end loop tests are available:

- I/F test loop
- R/F test loop

The I/F loop is used to verify if, at IF level, FlexNU, the AT is working correctly. The R/F loop is used to check if, at radio frequency level, outdoor part RAU, the AT is working properly.

9.3.3 AT Far-End Loops

The AT Far-End loop is used to check the ATM UBR traffic signal in output from the AT.

This loop can be set from the EM.

9.4 Performance Monitoring

Transmission performance according to ITU-T G.826 and I.356 ATM is measured and logged. It specifies the error performance events, parameters and objectives for paths operating at bit rates at or above the primary rate.

The G.826 recommendation evaluates performance by measuring errors in blocks. These have been defined as a set of consecutive bits associated with the path. Each bit belongs to one only, block and consecutive bits may not be contiguous in time.

The performance parameters are evaluated per FlexNU both in uplink and downlink, as there are different physical links for each FlexNU.

In order to do this in the uplink the RN has to take in account the transmitting FlexNU whereas in the downlink the FlexNU can monitor all TDM slots.

Performance events provided for the ATM layers are:

- Cell Error ratio
- Cell Loss Ratio
- UBR Discarded Cells
- CBR Discarded Cells

Performance events, provided for the physical layer, are:

- UAT/AT: Unavailability/Availability time;
- ESR: Error Second Ratio;
- SESR: Severely Error Second Ratio;
- BBER: Background Block Error Ratio.

Some additional Performance parameters not foreseen by ITU standards are evaluated:

- Received RF power, Max, min., average
- Output nominal RF power, Max, min., average

9.4.1 Signals Monitoring

The RF signal is measured for monitoring of antenna alignment, path acceptance by means of check the actual RF levels, alarm generation, RF monitoring, long time RF measurement to discover slow degradation in system gain.

Acronym	Description
PRx min	Minimum received power
PRx max	Maximum received power
PRx average	Average received power
PTx min	Minimum output power
PTx max	Maximum output power
PTx average	Average output power

9.5 Unit Replacement

Replacement of a faulty unit, outdoor or indoor, is done on site.

When an indoor or an ODU has been replaced, the EM automatically provides the unit set up without any other operation by the maintenance staff.

The new unit must be of the same type of the replaced one, of course.

9.6 Local Supervision Interface

The local supervision consists of:

- LEDs on the indoor units, when present, for fault detection
- LEDs on the outdoor RAUs for fault detection

Hereafter are described the functions of every LED present in the MINI-LINK BAS.

Unit Name	LED	Colour	Status	Function
FlexNU	POWER	Green	On	Power on
	FAULT	Red	On	HW Fault or SW downloads on going or Restart on going (if Status LED is also On).
	STATUS	Yellow	On	FlexNU signed-off
			Blinking	Sign-on procedure on-going
			Off	Signed-on
	LI LED (10BaseT Connector)	Yellow	On	Port successfully connected (no meaning on PVC)
	Power (Modem)	Green	On	Power Modem On
	Fault (Modem)	Red	On	HW fault or missing connection with the radio (HDLC down) or No DownLink
CE-NU-E1/T1	Power	Green	On	Power on
	Fail	Red	On	HW fail or if LI1 and LI2 LED are ON too, the board is unmanaged
	LI1 / LI 2	Yellow	On	Unmanaged port
	LI1 / LI 2	Yellow	Slow Blinking (1 sec. rate)	Loss of signal
	LI1 / LI 2	Yellow	Fast Blinking	AAL-5 Starvation
		Blue	On	Board inserted but no active (ready to be removed)

Unit Name	LED	Colour	Status	Function
SU 10/100BaseT	Power	Green	On	Power on
	Fail	Red	On	HW fail or if LI1 and LI2 LED are ON too, the board is unmanaged
	LI 1	Yellow	On	Port successfully connected (no meaning on PVC)
	LI 2	Yellow	On	Port successfully connected (no meaning on PVC)
		Blue	On	Board inserted but no active (ready to be removed)
FlexNU, Power Supply	Power Fail	Red	On	Power Fault
POU	Power	Green	On	Power On
	Fault	Red	On	Power fail on POU (if the LED Power is ON too), or loss of input power (if only this LED is ON)
PSU	Power	Green	On	Power on
	Fault	Red	On	Power fail on PSU (if the LED Power is ON too), or loss of input power (if only this LED is ON)
ET, CE units	Power	Green	On	Power On
	Fault	Red	On	HW Fail or restart/SW download on going (no contact with CP)
NCU units	Power	Green	On	Power On
	Fault	Red	On	HW Fail or restart/SW download on going (no contact with CP)
	Power Modem	Green	On	Modem is powered On
	Fault Modem	Red	On	HW fault or missing connection with the radio (HDLC down)
CP	Run	Green	On	Power On

Unit Name	LED	Colour	Status	Function
CP (Slot PMC2)	Link	Green	On	Link on ATM interface
	Status	Yellow	Blinking	The status is OK
			Off	The status is not OK
RAU	Power	Green	On	RAU is power On
	Radio Alarm	Red	On	Alarm on the RAU

9.7 System Upgrade

A system upgrade procedure with minor service interruption is available.

The complete procedure to upgrade the system is described in Figure 9-3, covering also the case of CP and EM software upgrade. Depending on the modifications introduced by the new software baseline, some steps could be skipped, shown with a grey background.

Note: The system upgrade procedure described here is available in system revision R1C and therefore will be used in the upgrade from R1C to R1D. For upgrades from previous versions of the system, please refer to operation and maintenance manuals.

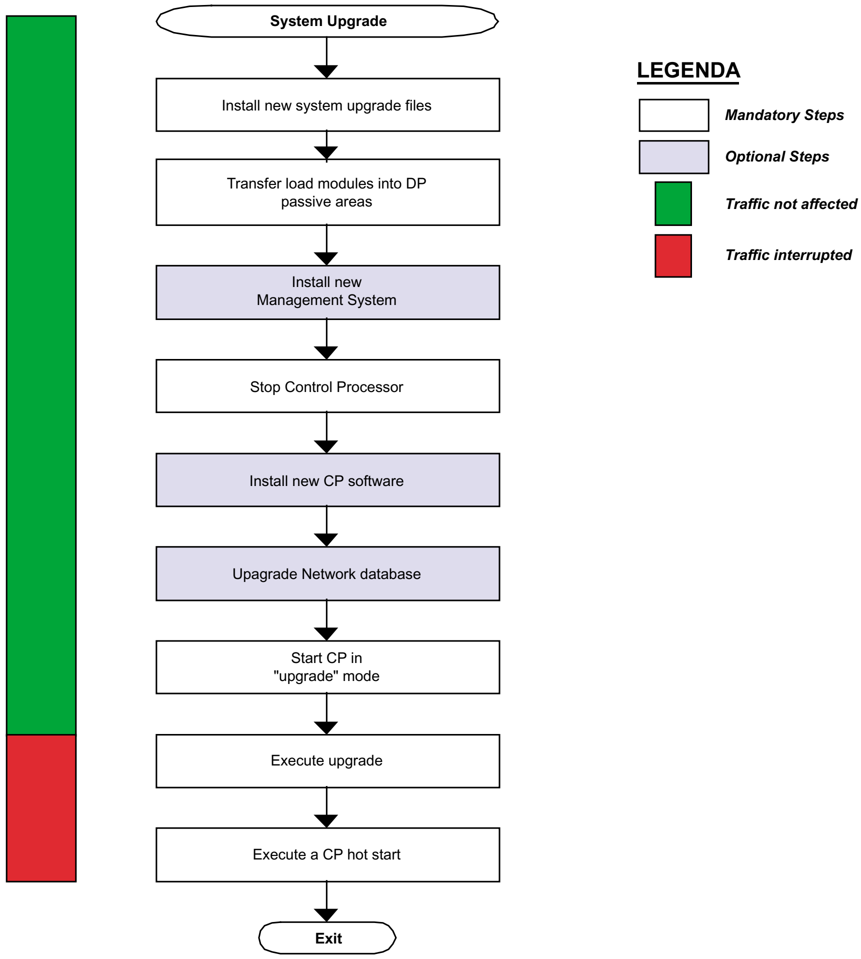

Figure 9-3 System Upgrade

In the following sub-sections, each step is described in detail.

9.7.1 Install SW Upgrade File

The new configuration files containing the new baseline and the new software files are installed in the CP file system.

9.7.2 Download Modules

Based on the HW-SW relationships contained in the baseline configuration files, the download procedure is started. The system will transfer on the passive memories of all the upgradable boards, DPs and BC, the loadmodule of the new baseline in order to prepare it for the upgrade.

After the load module has been downloaded the CRC-16 is verified; if the check fails, a retransmission is started.

9.7.3 Install New Management System

This operation is optional and implies an upgrade of the EM software. Backward compatibility for all the functions involving equipment handling and software upgrade is guaranteed.

9.7.4 Stop CP

The CP needs to be stopped.

From now on, no O&M actions on the system are possible. However, this doesn’t imply any traffic interruption.

9.7.5 Install New CP Software

Also this operation is optional and is executed only if the CP software itself is being updated.

9.7.6 Upgrade Network Database

If the new baseline implies software modifications impacting on the network database structure, a proper update is automatically executed to generate a database version with the structure required by the new software. The old database version is always saved in a back-up copy. All configuration data is maintained and adapted to the new database structure.

9.7.7 Start Control Processor in “Upgrade mode”

The software upgrade procedure requires that all the CP applications are not running. Only the equipment handling process is started. This operational mode of the CP is called “upgrade mode”.

9.7.8 Execute Upgrade

This step corresponds to what is usually referred as swap action. In other words, provided that the previous steps have been completed successfully, the system is now fully prepared for the activation of the new software modules. Each board has properly received the new load module (placed in the passive memory) and is waiting for a swap command.

The following actions are done in this step:

- Read of CP baseline configuration file.
- Ask each upgradeable to notify which load module (type and revision) is present on the passive and active memories.
- Execute the proper action, swap and download & swap, or no action.

The previous steps are needed to guarantee a robust behaviour of the procedure in any possible case. As the download of the load modules is an action totally independent from the swap, there is no possibility to guarantee that in the meantime the hardware/software configuration of the deployed network has not been change. For example, a hardware failure after the download step as described in Paragraph 9.7.2 could require the substitution of a board: in principle, the spare board could have a different software version not aligned with the new baseline, see the Note. Therefore, it is safe to check the load modules present on the passive and active memory of each upgradeable object immediately before executing the swap, and include also a new download, if needed.

Differently from all the previous steps, this operation is forcing a traffic interruption.

Note: The spare board could be even so new that it already has the load module corresponding to the new baseline in the active memory. This is the reason why this step could imply no action.

9.7.9 Restart Control Processor

After all the upgradeable boards have swapped the passive and active load modules, the CP must be restarted in order to re-establish the complete system functionality. In this phase, all the ATs are signed-on again, the network database is restored and the CP makes an audit procedure on all the network.

The time needed for this operation is very much depending on the number of ATs to be reconnected. The audit procedure time is in the range of 1-10 minutes.

At the end of the CP restart, the system functionality and the traffic are completely restored and the new baseline is installed.

9.7.10 Software Rollback

As each upgradeable object has two non-volatile memories, it is always possible to swap back to the previous load module without the need of executing again a complete SW upgrade procedure.

Note: The SW rollback procedure will be available from R1D to R1C in the next release.

Three cases are considered here:

1. The installation of the new SW baseline is completed successfully and all the connections have been re-established.
2. The installation of the new SW baseline implies problems in the radio connection that prevent all the ATs to be reconnected to the hosting radio node.
3. An intermediate situation between 1 and 2.

9.7.10.1 Case A

In this case, all the connections have been re-established and the CP has complete control of the network.

In order to rollback the SW baseline, a procedure similar to the SW upgrade must be executed, as shown in Figure 9-4. The difference with respect to the previous procedure, is that no transfer of load modules is executed, but directly an upgrade with the previous sw baseline as a target.

Note: As already mentioned in the introduction, the upgrade command is not related to any temporal relationship beween two SW versions, therefore it can be executed an upgrade command towards a previous SW baseline.

9.7.10.2 Case B

This case it the most critical one, as after the upgrade command, see Paragragh 9.7.8, no remote terminal is able to re-establish the connection. This would imply to send installation personnel to each remote site. The immediate consequence would be very long traffic interruption times and high costs.

In order to avoid these consequences, an autonomous capacity to rollback the SW load module is included in the AT-DP. The AT must be able to distinguish between a radio link outage due to external propagation conditions or to RN failures from sw related problems. Therefore, the main event needed to start the procedure for an automatic rollback is that the last operation executed before the rollback was a SW swap. Moreover, in order to avoid oscillations between the two sw load modules, the automatic rollback must be enable only after a new load module download and disable immediately after its execution. The AT automatic rollback procedure is depicted in Figure 9-5.

9.7.10.3 Case C

In theory this situation should never happen, as the same SW problem, if any, is expected to be experienced by all the ATs concurrently. In practice, however, a deployed network could contain ATs installed in different times with different hardware revisions. Even though backward compatibility within the R1 system is guaranteed, however the effect of a SW problem could not always be the same.

It’s not so easy to define a common strategy for all these situations. For example, if after a SW upgrade procedure 95% of the ATs have been reconnected, it will be very likely that the remaining 5% have made a SW rollback. It’s up to the operator’s strategy to decide if rollback the complete network including the 95% ATs already reconnected or to send maintenance personnel to the 5% remote sites to solve the problem.

Figure 9-4 System Downgrade

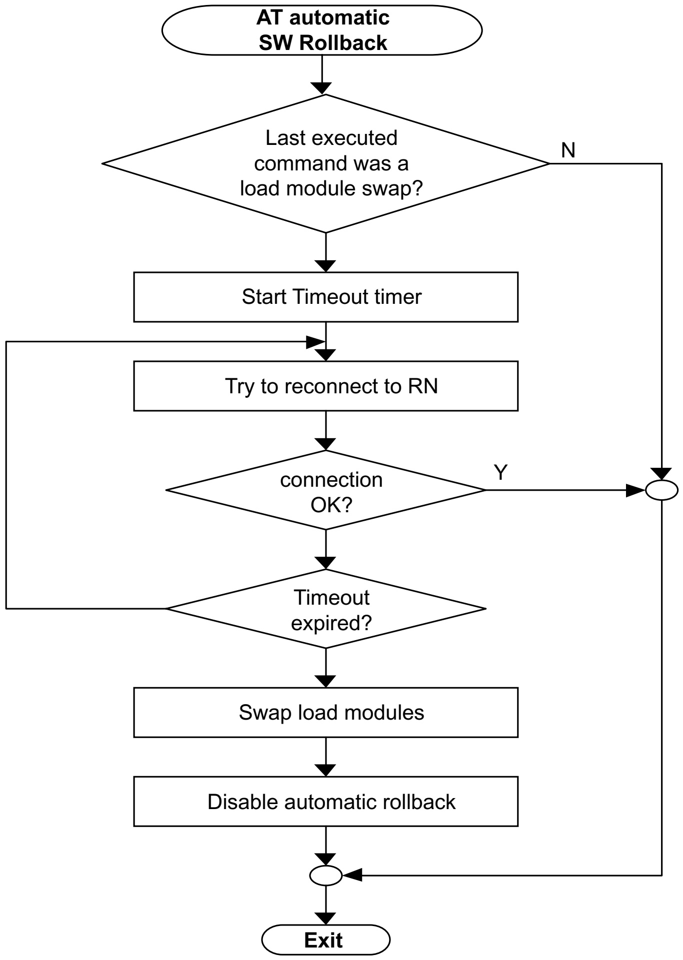

Figure 9-5 Automatic SW Rollback in the AT

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