Wireless Service Provider Solutions

# BSS Overview

PE/DCL/DD/0001 14.10/EN Standard December 2003
411–9001–001

NORTEL NETWORKS™

Wireless Service Provider Solutions

# BSS Overview

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# PUBLICATION HISTORY

## System release: GSM/BSS V14.3

### December 2003

Issue 14.10/EN Standard

### November 2003

Issue 14.09/EN Preliminary

Updated according to the following features:

- 20470: S8000 ind/out up to 3S888 / H2D (1 or 2) + H4D with PA (CMCC)
- 24915: S12000 ind/out up to 2S666 / D (1 or 2) + H2D (1 or 2) with HePA/PA (Microcell)
- 25043: S12000 ind/outd up to 3S666 / D (1 or 2) + H2D (1 or 2) with PA (Microcell)
- 20468: S8000 ind/out up to 2 S666 / D(1 or 2) + H2D(1 or 2) with PA (CUTC, CMCC, Microcell)
- 25044: S12000 ind/out up to 3S121212 / H2D (1 or 2) + H4D (1 or 2) with PA (Cingular)
- 23849: S12000 1800/T1
- 24963: S12000 850/E1
- 24964: S12000 1900/E1

### August 2003

Issue 14.08/EN Preliminary

Updated to include S8003 Indoor BTS, feature 24389

### April 2003

Issue 14.07/EN Preliminary

Update according GIPS introduction (Chapter 3)

### January 2003

Issue 14.05/EN Preliminary

 

Minor editorial update

### December 2002

Issue 14.03/EN Preliminary

Update for V14.3 system release

 

## System release: GSM/BSS V13

### November 2002

Issue 13.08/EN Standard

The following changes were made throughout the document:

- modify emergency calls description
- add S12000 BTS hardware structure
- update BTS input voltages table
- update Regulatory information to include S12000 BTS

### August 2002

Issue 13.07/EN Standard

Minor editorial update

Issue 13.06/EN Preliminary

Update after internal review

### April 2002

Issue 13.05/EN Draft

Update chapter 3.3

Introduction of T3 and Sun Blade, Chapter 7

### March 2002

Issue 13.04/EN Standard

Update according to CR Q00181312 and SR NW12052

### November 2001

Issue 13.03/EN Standard

Introduction of RACE, Chapter 7

### July 2001

Issue 13.02/EN Preliminary

Modifications for V13.1A system release:

- new battery cabinet; Chapter 3
- polarity battery cabinet; Chapter 3
- BSC 6000 and 12000; Chapter 4

## November 2000

Issue 13.01/EN Preliminary

Modification for V13.0 system release

 

## System release: GSM/BSS V12

### September 2000

Issue 12.07/EN Standard

Update after internal review.

### July 2000

Issue 12.06/EN Draft

S8006 BTS: Introduction, Chapter 3

EMC of e–cell: Chapter 1

### June 2000

Issue 12.05/EN Preliminary

Minor editorial update

### November 1999

Issue 12.04/EN Standard

Minor editorial update

### November 1999

Issue 12.03/EN Standard

Modification for V12 system realease

- S8000 Outdoor: Introduction of the climatic system with “LN” (Low Noise) DACS (Chapter 3)
- S8002 Outdoor: add a picture of the BTS with the right opening door on (Chapter 3)
- Introduction of the e–cell BTS (Chapter 3)
- S2000 H/L: Introduction of an extension unit (“EP” type) connected to the base unit (”FP” or “EP” type) (Chapter 3)

## June 1999

Issue 12.02/EN Draft

Update after internal review.

## May 1999

Issue 12.01/EN Preliminary

- Update for the V12 release according to the “V12 Functional Notes Status”, PE/SYS/DPL/D013 V01.04/EN
- CM 888, TF 889: Concentric cells, chapter 3.
- TF184: Extended CCCH, chapter 9.
- TF995: Cell tiering, chapter 3.
- TF875: Dual Band Cells management, chapter 3.
- New products: S8002 BTS, S2000H/L “EP” BTS”, chapter 4.
- Regulatory information, chapter 2.
- OMC–R Chapter, chapter 8.

Former versions document obsolete BSS system versions. Therefore, the publication history is not applicable.

 

# ABOUT THIS DOCUMENT

This document briefly describes all cellular network elements, and how each part communicates with the others.

## Applicability

This document applies to the V14.3 BSS system release.

## Audience

This document is intended for operations, maintenance, and other personnel who want to gain an overview of the GSM System.

## Prerequisites

< 00 > : BSS Product Documentation Overview

It is recommended that the readers also become familiar with the following documents:

< 03 > : S4000/S4000C Indoor BTS Reference Manual

< 23 > : S4000 Outdoor BTS Reference Manual

< 35 > : S2000 H/L BTS Reference Manual

< 43 > : S4000 Smart BTS Reference Manual

< 53 > : S2000/S2000E BTS Reference Manual

< 63 > : S8000/S8002/S8003/S8006 BTS Reference Manual

< 92 > : e–cell BTS Reference Manual

< 126 > : BSC/TCU e3 Reference Manual

< 127 > : RACE – Reference and User Manual

< 142 > : S12000 BTS Reference Manual

The glossary is presented in the document < 00 >.

## Related Documents

The NTPs listed in the paragraph above are quoted in the document.

## How this document is organized

This document is divided into sections. Each section is dedicated to one element of the system and gives a general description of its structure and function.

After a general presentation of a cellular network, the services provided by this new concept in telecommunications are described in Chapter 2.

The cellular subsystem is divided into three subsystems: the Base Station Subsystem (BSS), the Network Subsystem (NSS), and the Operations and Maintenance Subsystem (OMS).

The BSS is described in Chapter 3 for the BTS, Chapter 4 for the BSC, and Chapter 5 for the TCU.

The MSC and VLR are described in Chapter 6.

The Operations & Maintenance of the BSS are centralized on OMC–R machines. An OMC–R is described in Chapter 7.

The standardized interfaces that enable the main components of a cellular network to communicate are described in Chapter 8.

 

## Vocabulary conventions

The following table gives the generic terms used in all the reference manuals.

| PCM | | |
|---|---|---|
| External PCM | **E1 PCM** (32 TSs) | **T1 PCM** (24 TSs) |
| external PCM rate | rate: 2.048 Mbit/s | rate: 1.536 Mbit/s |
| speech coding law | A–law speech coding | μ–law speech coding |
| coding type | HDB3 coding type | AMI or B8ZS coding types |
| PCM link | HDB3 PCM link | AMI or B8ZS PCM link |
| cyclic redundancy code CRC | cyclic redundancy code CRC4 | cyclic redundancy code CRC6 |
| impedance matching value | 75 Ω line impedance (coaxial cable)<br>120 Ω line impedance (twisted pair) | 100 Ω line impedance (coaxial cable) |
| submultiframe | 1 ms submultiframe | 0.75 ms submultiframe |
| multiframe | 16–frame–multiframe (2 ms) | 12– or 24–frame–multiframe (1.5 or 3 ms) |
| **BOARDS** | | |
| DTI board | E1 DTI board | T1 DTI board |
| CSW2 board | E1 CSW2 board | T1 CSW2 board |

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# 1 OVERVIEW

## 1.1 Functional overview

The system is a versatile, open–ended digital radiotelephone system. It reduces installation costs and network operating costs, especially transmission costs.

This mobile radiotelephone system includes the following subsystems (*Figure 1–1*), as specified in the technical recommendations:

- Base Station Subsystem (BSS)
- Network and Switching Subsystem (NSS)
- Operations and Maintenance Subsystem (OSS)

The rapid rise in traffic handling requirements for this type of system has led to the development of a micro–cellular layer in urban areas. Two layers work together to increase traffic handling capacity and improve coverage, especially inside buildings.

The two layers making up a micro–cellular network are as follows:

- macro–cellular
- micro–cellular

### 1.1.1 Base station subsystem (BSS)

The base station subsystem, or radio subsystem, provides the distribution function of the communication network. It includes Base Transceiver Stations (BTS) that provides the radio link with mobile subscribers.

BTSs are controlled by a Base Station Controller (BSC), which also controls remote TransCoder Units (TCU). These units enable users to reduce the number, and thus the cost, of PCM (Pulse Code Modulation) links needed between BSS and NSS. As required by the system, the BSS has a standard interface so it can be connected to different types of switching centers.

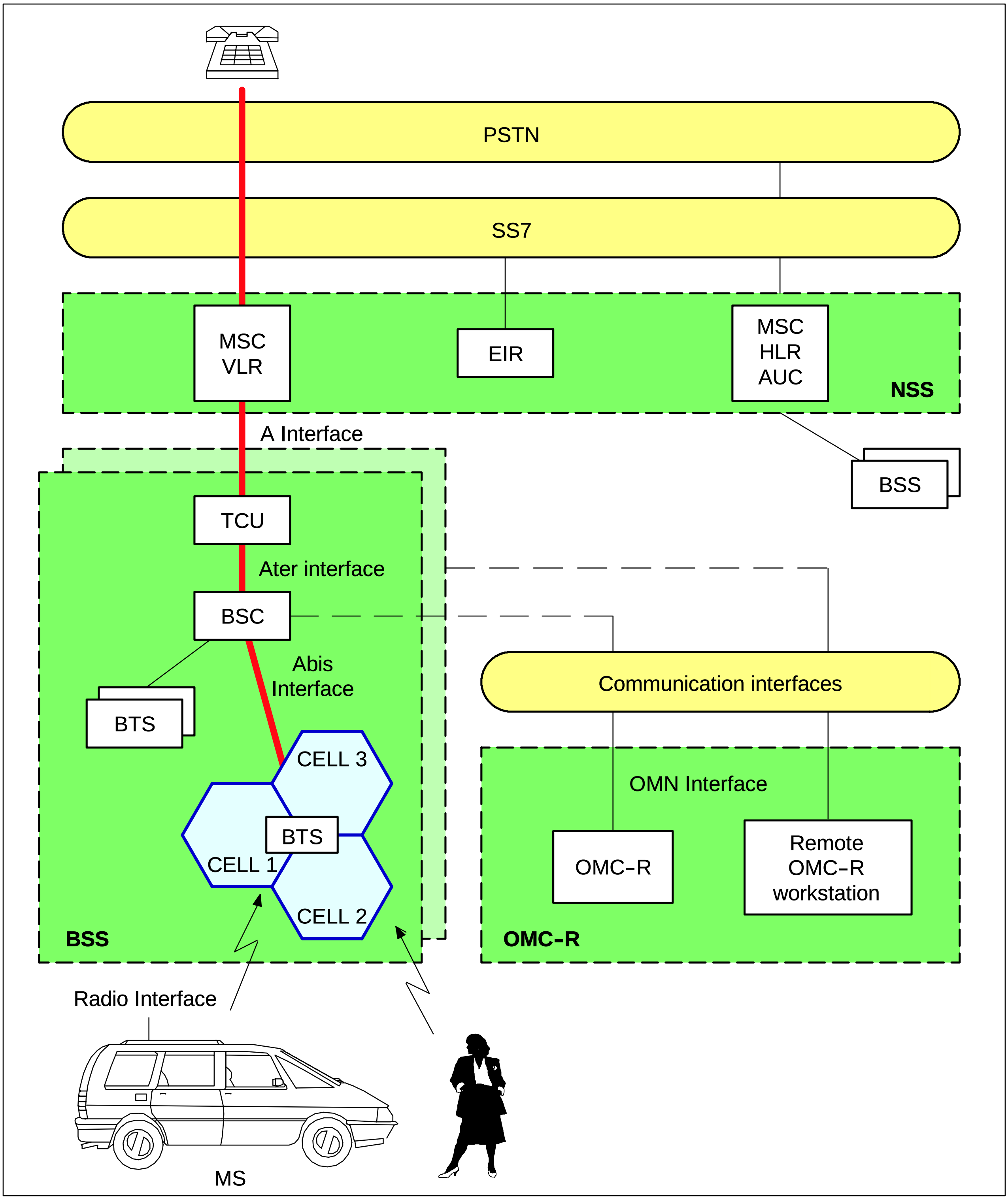



**Figure 1-1 Functional presentation of the GSM system**

#### 1.1.1.1 Site definition

A site is the area controlled by a BCF (Base Common Functions). A BCF can control up to three BTS cabinets (one base cabinet and two extensions).

There are two types of sites:

- single–cell
- multi–cell

A single–cell site is composed of one BCF and one or more TRXs or DRXs.

A multi–cell site is composed of two or three sectors that each correspond to a cell. The BCF contains the equipment common to all site sectors. One or more TRXs or DRXs are dedicated to each sector.

Both types of sites are shown in *Figure 1–2*.

### 1.1.2 Network and switching subsystem (NSS)

The network subsystem handles all switching and routing functions. Mobile–oriented communication networks require a mobile station to be located before a call may be routed and set up.

The Mobile services Switching Center (MSC) is responsible for switching and routing. Reference data, specific to each subscriber, is stored in a database that is distributed among Home Location Registers (HLR). To minimize access to the HLR, the MSC uses a Visitor Location Register (VLR), which contains working data for subscribers moving around its coverage area. Network security and access controls are provided by the AUthentication Center (AUC) and by the Equipment Identity Register (EIR).

### 1.1.3 Operations subsystem (OSS)

The operations and support subsystem contains two parts: the Radio Operations and Maintenance Center (OMC–R) and the Switching Operations and Maintenance Center (OMC–S).

### 1.1.4 Terrestrial links between entities

The components of the cellular network infrastructure are linked together by PCM links on the Abis (BTS–BSC), Ater (BSC–TCU), and A (TCU–MSC) interfaces.

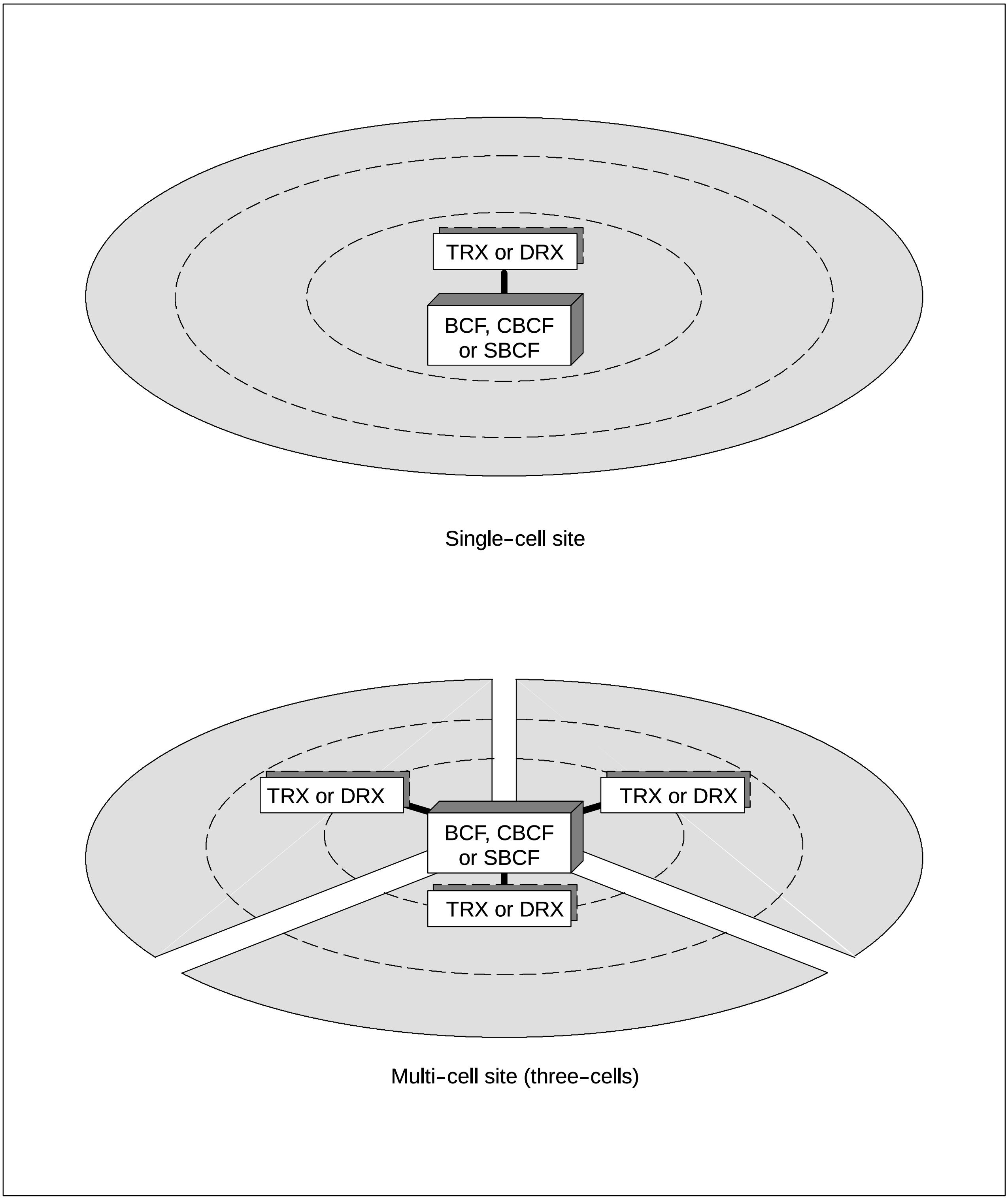



**Figure 1–2 Single–cell and multi–cell sites**

### 1.1.4.1 E1 PCM links

The general features are as follows:

- The E1 PCM bit rate is 2.048 Mbit/s carrying 32 time slots at 64kbit/s. Time slot 0 is used for synchronization only.
- The speech coding follows the A–law.
- The coding type is HDB3.
- The cyclic redundancy code is CRC4, used for external and internal links.
- Line impedance can be at 75 ohms or 120 ohms.
- A transmission/reception line interface handles communication between external and internal E1 PCM links.
- The cellular system components use PCM E1 links or internal PCMs.

### 1.1.4.2 T1 PCM links

The general features are as follows:

- The T1 PCM bit rate is 1.544 Mbit/s (24 time slots at 64 kbit/s plus one kilobyte for synchronization, which is distributed along the multiframe).
- The speech coding follows the μ law.
- The coding types are AMI or B8ZS.
- The cyclic redundancy code is CRC6, used for external links only.
- Line adjustment is fixed to 100 ohms.
- A transmission/reception line interface handles communication between external T1 type PCM at 1.544 Mbit/s and internal type PCM links at 2.048 Mbit/s. Unused time slots on the internal links are ignored for transmission, and are set to FF (hexadecimal value) in reception.

*Table 1–1* shows the correspondence between the E1 internal PCM TSs and the T1 external PCM TSs.

| E1 internal PCM | T1 external PCM |
|---|---|
| 0 | |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | |
| 5 | 4 |
| 6 | 5 |
| 7 | 6 |
| 8 | |
| 9 | 7 |
| 10 | 8 |
| 11 | 9 |
| 12 | |
| 13 | 10 |
| 14 | 11 |
| 15 | 12 |
| 16 | |
| 17 | 13 |
| 18 | 14 |
| 19 | 15 |
| 20 | |
| 21 | 16 |
| 22 | 17 |
| 23 | 18 |
| 24 | |
| 25 | 19 |
| 26 | 20 |
| 27 | 21 |
| 28 | |
| 29 | 22 |
| 30 | 23 |
| 31 | 24 |

**Table 1–1 Correspondence between the E1 internal PCM TS and the T1 external PCM TS**

### 1.1.5 Interfaces

Modules that make up the cellular network are linked to one another through the following interfaces (see *Figure 1–3*):

- Radio interface, also called Um or Air interface
- Abis interface
- Ater interface
- A interface
- OMN (Operations and Maintenance Network) interface
- MAP (Mobile Application Part) interface
- PSTN/PSPDN (Public Switched Telephone Network/Public Switched Packet Data Network) interface

#### 1.1.5.1 Radio interface

The radio interface provides communication between the mobile station and the BTS for speech and data. The signaling protocol is based on the LAPDm layer 2.

#### 1.1.5.2 Abis interface

The Abis interface provides communication between the BTS and the BSC for radio traffic management and base station operations and maintenance using the LAPD protocol.

#### 1.1.5.3 Ater interface

The Ater interface provides communication between the BSC and the TCU for traffic management using the LAPD protocol CCITT No. 7 signaling protocol and X.25 protocols are also used but remain transparent for the TCU.

#### 1.1.5.4 A interface

The A interface provides communication between the TCU and the MSC for traffic management using the CCITT No. 7 signaling protocol and the system defined BSSAP (BSS Application Part) protocol.

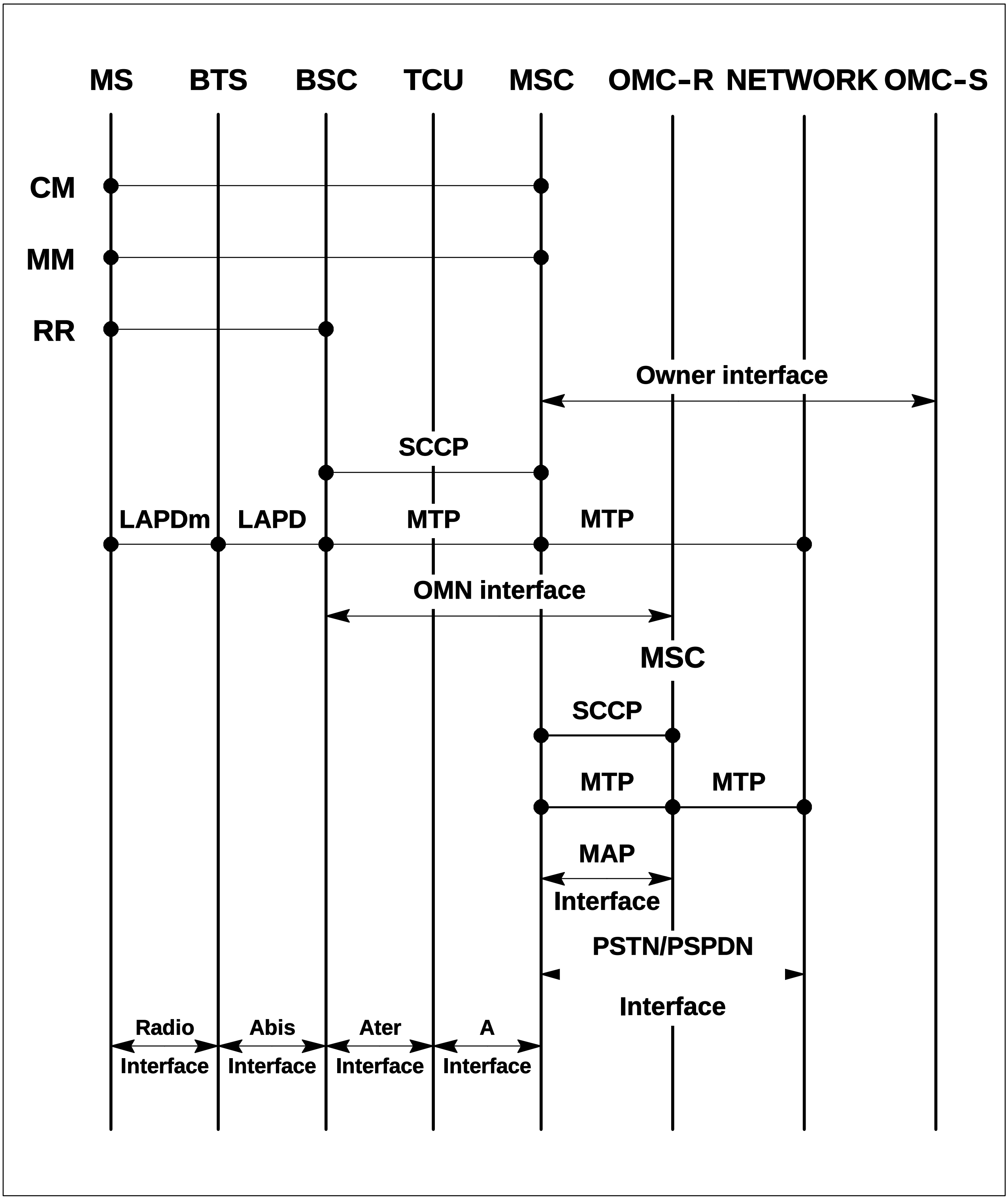



**Figure 1-3** **Radio cellular system interfaces**

#### 1.1.5.5 OMN interface

The OMN interface provides communication between the BSC 2G and the OMC–R using a X.25 no–type data transmission network for radio subsystem centralized operations.

The OMN interface provides communication between the BSC e3 and the OMC–R using Ethernet links for radio subsystem centralized operations.

#### 1.1.5.6 MAP interface

The MAP interface provides communication between NSS various units, using the CCITT No. 7 signaling protocol and the MAP protocol. Communication between the MSC and database enables mobile station mobility monitoring.

#### 1.1.5.7 PSTN/PSPDN interface

The PSTN/PSPDN interface enables the MSC to be connected to public speech or data networks via PCM (Pulse Code Modulation) links, according to the CCITT No.7 signaling protocol and the TUP (Telephone User Part) and ISUP (ISDN User Part) protocols used by public networks.

### 1.1.6 BSS defense and reconfiguration

To protect the BSS, in case of PCM faults on the Abis, Ater or A interface or of BSS component fault, the BSC runs some defense procedures, and BTSs and TCUs reconfiguration if necessary. Meanwhile the BSC sends to the OMC all the EVENT REPORT messages, which are provided by the BTSs, so as to describe the events such as fault beginning, fault end, status change and transient event.

All the protective mechanisms are supported through a duplex mode which minimizes any service break in case of active chain switch in the BSC and allows maintenance activities on radio resources.

## 1.2 Physical overview

The flexibility of the cellular system enables the operator to easily increase the equipment capacity according to traffic needs. The number of links needed to connect the system units depends on the amount of traffic that must be handled. The system physical architecture is shown in *Figure 1–4.*

### 1.2.1 BTS

The BTS contains a base cabinet and one or more extension cabinets depending on the BTS type. The number of extension cabinets depends on the number of radio channels to be supported and on the site structure (single or multi–cellular site). The same flexibility applies to TCU inside each cabinet.

### 1.2.2 BSC 2G

The BSC includes a control cabinet and an equipment cabinet. The amount of constituent modules in each cabinet depends on the number of PCM links to be managed. There are several types of BSC, depending on the amount of traffic to be managed.

### 1.2.3 TCU 2G

A TCU cabinet contains four shelves. Each shelf manages four PCM links from the MSC and one from the BSC. The number of shelves depends on the number of required PCM links to connect the BSC to the MSC.

### 1.2.4 BSC e3

The BSC e3 houses a BSC e3 frame and an SAI (Service Area Interface) frame. The BSC e3 frame houses two dual–shelf:

- the control node

  The amount of constituent redundancy modules in the control node depends on the amount of traffic to be managed.

- the interface node

  The amount of constituent redundancy modules in the interface node depends on the number of PCM links to be managed.

### 1.2.5 TCU e3

The TCU e3 cabinet houses a TCU e3 frame and an SAI frame. The TCU e3 frame houses two dual–shelf. Each of them contains:

- a transcoder node

  The amount of constituent redundancy modules in the transcoder node depends on the amount of the number of PCM links to be managed.

### 1.2.6 HPRF module (S2000H BTS)

The High Power Radio Frequency module (HPRF module) houses the RF coupling system of the S2000H BTS.

### 1.2.7 Splice box (S2000H BTS)

In the star configuration the HPRF modules are linked to a splice box via an external DC/DATA cable and the splice box is linked to the Base unit via a short external DC/DATA cable.

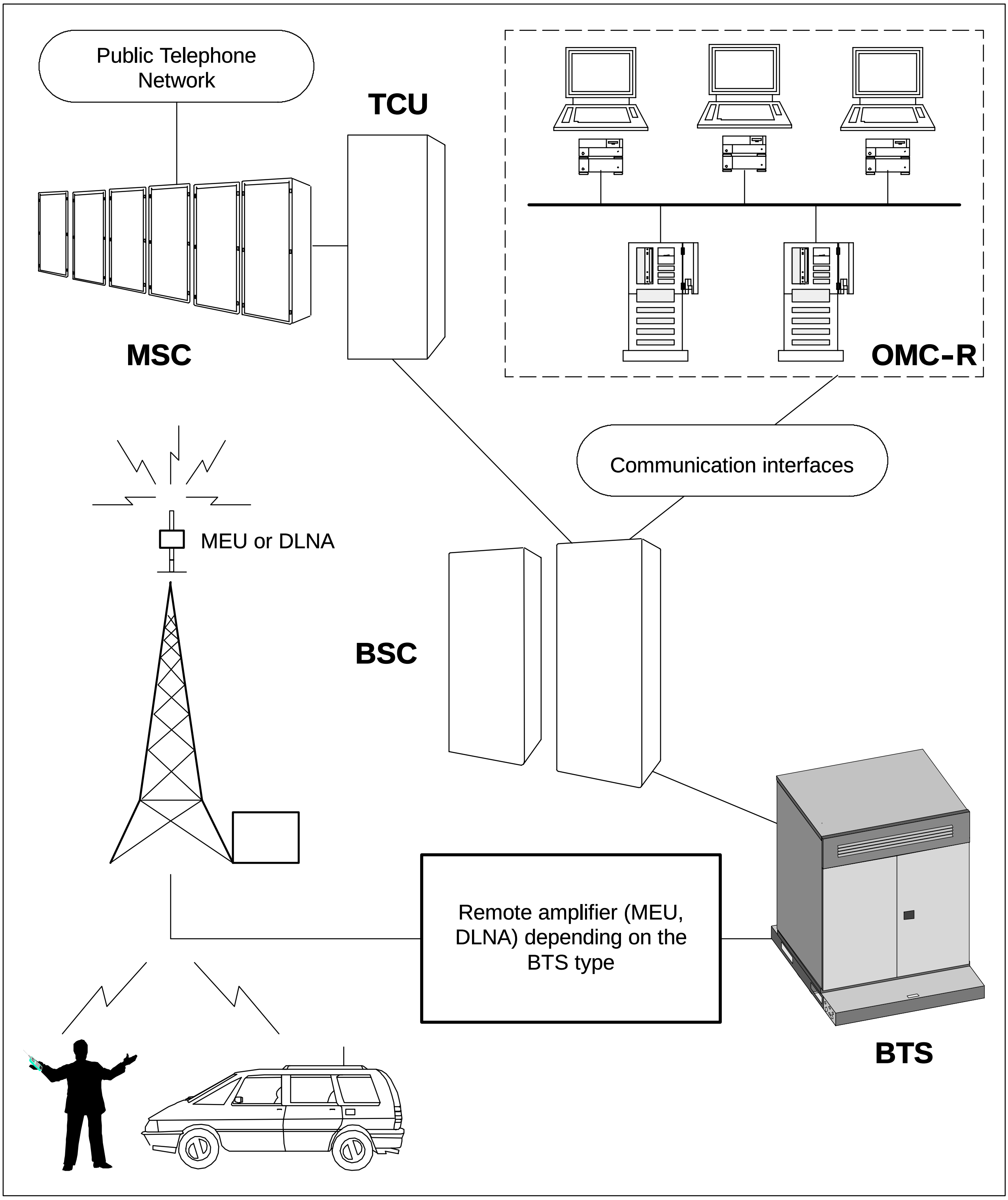



**Figure 1–4 The cellular system presentation**

### 1.2.8 MEU, DLNA (S4000 Indoor BTS)

The MEU (GSM 1800) and DLNA (GSM 900/1800) are both housed in a unit fixed on a mast, installed close to the antenna, at less than 5 meters (16 feet 5 inches). They equip S4000 Indoor BTS only.

### 1.2.9 MEU (S4000 Smart BTS)

The MEU (GSM 1900) contains an antenna facet (also called Smart BTS Antenna Module = SAM).

It also contains electronics (Power Amplifier/Low Noise Amplifier) that have four columns of radiating elements. Therefore, three facets form a tri–sectored base station site.

### 1.2.10 Battery & Interface Module (S2000H/L BTSs)

The battery & interface module is an additional package available as an option. It provides power backup and includes primary lightning protection and bare wire termination for the AC and PCM inputs.

### 1.2.11 Lightning protection and distribution box (S4000 Smart BTS)

It includes a lightning protection and distribution system for the S4000 Smart BTS available in GSM 1900 frequency bands only. The lightning protection box has been designed to connect the masthead and the cabinet.

### 1.2.12 BCF cabinet (S8000 Indoor BTS)

Base Common Functions boards are in a separate BCF Cabinet solely for the S8000 Indoor BTS.

### 1.2.13 MSC

The MSC/HLR/VLR units include several cabinets. Their equipment units vary according to the amount of traffic to be handled.

### 1.2.14 OMC–R

The OMC–R includes workstations, database servers, and computer peripheral equipment units (disks, printers, etc.). Their number depends on the amount of traffic to be monitored.

### 1.2.15 OMC–S

The OMC–S constituents are computer display units that handle operations and maintenance of the Network and Switching Subsystem (NSS).

# 1.3 Regulatory information

## 1.3.1 Specific regulatory information

### 1.3.1.1 United States of America

The products comply with Part 68 of the FCC rules. On the equipment is a label that contains, among other information, the FCC registration. If requested, this information must be provided to the telephone company.

Each product uses the following standard connections and codes:

| | | | |
|---|---|---|---|
| S4000 Indoor BTS | USOC CODE<br>Service Order Code<br>Facility Interface Code | :<br>:<br>: | TBD<br>6.OP<br>04DU9–BN, 04DU9–DN, 04DU9–1KN, 04DU9–1SN |
| S2000 Outdoor BTS<br>S4000 Outdor BTS<br>S4000 Smart BTS | USOC CODE<br>Service Order Code<br>Facility Interface Code | :<br>:<br>: | RJ–48C<br>6.OF<br>04DU9–BN,04DU9–DN,04DU9–1KN,04DU9–1SN |
| TCU e3 | USOC CODE<br>Service Order Code<br>Facility Interface Code: | :<br>: | TBD<br>TBD<br>TBD |
| BSC e3 | USOC CODE<br>Service Order Code<br>Facility Interface Code: | :<br>: | TBD<br>TBD<br>TBD |
| S2000 H/L BTS | USOC CODE<br>Service Order Code<br>Facility Interface Code: | :<br>: | TBD<br>6.OF<br>04DU9–BN,04DU9–DN,04DU9–1KN,04DU9–1SN |
| S2000 Indoor BTS | USOC CODE<br>Service Order Code<br>Facility Interface Code: | :<br>: | TBD<br>6.OP<br>04DU9–BN,04DU9–DN,04DU9–1KN,04DU9–1SN |
| S8000 Outdoor BTS | USOC CODE<br>Service Order Code<br>Facility Interface Code: | :<br>: | RJ–48H<br>6.OF<br>04DU9–BN,04DU9–DN,04DU9–1KN,04DU9–1SN |

**Table 1–2 Regulatory information**

If the equipment causes harm to the telephone network, the telephone company will notify the customer in advance that temporary discontinuance of service may be required. But if advanced notice is not practical, the telephone company will notify the customer as soon as possible. Also the customer will be advised of his right to file a complaint with the FCC if he believes it is necessary.

The telephone company may make changes in its facilities, equipment, operations or procedures that could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for the customer to make necessary modifications to maintain uninterrupted service.

No repairs can be performed by the user. If the customer experiences trouble with this equipment and for repair and warranty information, he will contact:

NORTEL NETWORKS
400 North Industrial
Richardson, Texas 75081
U.S.A
Tel (972) 684–1000

If the equipment is causing harm to the telephone network, the telephone company may request that the customer disconnects the equipment until the problem is resolved.

This equipment cannot be used on public coin phone service provided by the telephone company. Connection to party line service is subject to state tariffs. Contact the state public utility commission, public service commission or corporation commission for information.

### 1.3.1.2 Canada

**“NOTICE**: The Industry Canada Label identifies certified equipment. This certification means that the equipment meets telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document(s). The Department does not guarantee the equipment will operate to the user’s satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation in service in some situations.

Repairs to certified equipment should be coordinated by representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

**Caution:** Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.”

### 1.3.2 Human exposure to radio frequency electromagnetic fields

#### 1.3.2.1 United States of America and Canada

Regulatory bodies in the US, Federal Communications Commission (FCC), and Canada, Health and Welfare, are imposing EMR limits. FCC's OET Bulletin #65 addresses calculation and measurement procedures to determine compliance with the FCC limits which includes the 800 MHz cellular and 1.9 GHz bands. The equipment and its associated deployment must comply with NCRP Report No.86, "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields". This standard is largely based on the limits and test methods outlined in IEEE C95.1–1982 and C95.3–1982 respectively.

This requirement officially takes effect Jan.1/97, but should apply to all known sites since existing facilities are not exempt or grandfathered from the new rules.

The FCC has determined that certain sites will require "Environmental Evaluations" in order to show compliance to the standards. Adhering to these guidelines can ensure compliance to the standard, and therefore can be the basis for the Environmental Evaluation. Please note that some installations do not require such an evaluation, exceptions are noted further in this document, but adherence to these guidelines are still recommended to promote safety. Environmental Evaluations are kept on hand, as opposed to filed with the FCC, unless it is requested by them for substantiation.

Where NORTEL NETWORKS is responsible for installing or engineering base stations the person in charge should be aware of and have access to documentation for making an Environmental Evaluation. Also, NORTEL NETWORKS will need to provide assurances to the FCC that Environmental Evaluations have been conducted for each radio station that uses our Experimental Radio License, or STA, where the station transmits at 100 Watt ERP or more.

The objective of the Environmental Evaluation is to ensure that human exposure to RF energy does not go beyond the maximum permissible levels stated in NCRP No.86. Therefore certain sites do not require an evaluation by nature of its design. It could be that the antennas are placed high enough thereby resulting in extremely low RF fields by the time it reaches areas that would be accessible to people. Environmental evaluations are required for broadband GSM 1900, Part 24 Subpart E:

- non–rooftop antennas: height of radiation center < 10 m above ground level and total power of all channels > 2000 W ERP (3280 W EIRP)
- rooftop antennas: total power of all channels > 2000 W ERP (3280 W EIRP)

An environmental evaluation must be prepared, regardless of the above conditions, should the site be located in any one of the areas mentioned below:

- Wilderness Area
- Wildlife Preserve
- Endangered Species Area
- Historical Site
- Indian Religious site
- Flood Plain (100 yrs)
- Wetlands
- High intensity lights in residential neighborhoods

RF energy from other people's equipment must be considered when sharing antenna sites. The total RF must be within the limits for exposure. All parties sharing that site are accountable unless the RF energy from their system contributes less than 1% of the total energy. Therefore, when deploying at a shared site, it is recommended that measurements are made at that site prior to its acquisition.

If an Environmental Evaluation shows that the EMR limits are exceeded, then an Environmental Assessment must be made and filed with the FCC that justifies why the limits in this case can be exceeded. The FCC would then review this Assessment and make a judgement whether or not its acceptable.

Safe distance formulae for base stations.

| Limits | Uncontrolled | Controlled |
|---|---|---|
| Frequency band | r [ meters ] | r [ meters ] |
| GSM 1900 | $r = 0.228 \sqrt{ERP}$ | $r = 0.102 \sqrt{ERP}$ |

Uncontrolled refers to situations where individuals are either unaware or not in control of their exposure to the electromagnetic fields in question. This typically pertains to the general public.

Controlled refers to situations where individuals are aware and in control of their exposure to the electromagnetic fields in question. This typically pertains to trained staff that are in contact with these fields as a result of their employment.

If it is important for trained personnel to gain access to an area which exceeds the controlled limits, access can still be allowed given the following conditions:

- Mount appropriate warning signs to make sure they are cognizant of the danger and can therefore take any of the following steps to minimize exposure. An example of such a sign is as follows:

  This equipment emits electromagnetic radiation. You should not come into contact with this equipment while it is being operated."
- Use RF shielding
- Turn off or reduce the transmit power
- Control time of exposure. The controlled limits are averaged over 6 minutes, therefore one could reduce their exposure by almost 50% if working in proximity for only 3 minutes at a time.
- RF protective clothing could reduce power density levels by as much as 10dB.

For more complete Antenna Siting Guidelines, please refer to the document SI–EMR–R01.0.

#### 1.3.2.2 Europe

No European legislation is in place regarding Maximum Permissible Exposure to electromagnetic fields. Nevertheless, there is a project which reference is ENV 50166.

Guidelines outlined above for America and Canada can be retained, in so far as they are very close to the European project. For further information, please contact your NORTEL NETWORKS representative.

### 1.3.3 Electro–magnetic compatibility (EMC)

#### 1.3.3.1 United States of America and Canada

**GSM 1900 products**

GSM 1900 products are classified under two categories:

- Class A devices: S2000/S2000E Indoor, S4000/S4000C Indoor, S4000 Outdoor, S4000 Smart, BSC/TCU 2G, BSC/TCU e3
- Class B devices: S12000 Indoor, S12000 Outdoor, S2000E Outdoor, S8000 Outdoor, S2000H, S2000L.

For a Class A digital Device

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial environment. If this equipment is used in a residential area, it may cause harmful interference that you must fix at your own expenses.

For a Class B digital Device

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**For all BTSs only:**

This Base Station has been evaluated under IEEE C95.1 requirements, regarding safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300 GHz. The leakage fields and equivalent power densities are orders of magnitude less than the maximum permissible exposures (MPEs) given in the IEEE safety guidelines.

#### 1.3.3.2 Europe and others

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference.

The EMC requirements have been selected to ensure an adequate level of compatibility for apparatus at residential, commercial, and light industrial environments. The levels however, do not cover extreme cases which may occur in any location but with low probability of occurrence. In particular, it may not cover those cases where a potential source of interference which is producing individually repeated transient phenomena, or a continuous phenomena, is permanently present, e.g. a radar or broadcast site in the near vicinity. In such a case it may be necessary to either limit the source of interference, or use special protection applied, to the interfered part, or both.

Compliance of radio communications equipment to the EMC requirements does not signify compliance to any requirement related to the use of the equipment (i.e. licensing requirements).

These products are compliant with the relevant parts of the following specifications:

| **S2000/S2000E Indoor /S2000E Outdoor BTS** | **S2000H/L/S8002 BTS** |
|---|---|
| 89/336/EEC (EMC directive) | 89/336/EEC (EMC directive) |
| ETS 300 342 – 2 nov 1994 | p ETS 300 342 – 3 may 1997 |
| GSM 11.20 | GSM 11.21 |
| **e–cell** | |
| 89/336/EEC (EMC directive) | |
| EN 61000–4–6 | |
| EN 61000–4–11 | |
| **S4000/S4000C Indoor BTS** | **S4000 Outdoor BTS** |
| 89/336/EEC (EMC directive) | 89/336/EEC (EMC directive) |
| ETS 300 342 – 2 NOV 1994 | ETS 300 342 – 2 NOV 1994 |
| GSM 11.20 | GSM 11.20 |
| **S8000 Indoor BTS** | **S8000 Outdoor BTS** |
| 89/336/EEC (EMC directive) | 89/336/EEC (EMC directive) |
| p ETS 300 342 – 3 MAY 1997 | p ETS 300 342 – 3 MAY 1997 |
| GSM 11.21 | GSM 11.20 |
| **S12000 Indoor BTS** | **S12000 Outdoor BTS** |
| 89/336/EEC (EMC directive) | 89/336/EEC (EMC directive) |
| p ETS 300 342 – 3 MAY 1997 | p ETS 300 342 – 3 MAY 1997 |
| GSM 11.21 | GSM 11.20 |

| BSC e3 | TCU e3 |
| --- | --- |
| 89/336/EEC (EMC directive) | 89/336/EEC (EMC directive) |
| EN 300 386 V1.2.1 | ETS 300 342 – 2 NOV 1994 |

**Table 1–3 Specifications**

### 1.3.4 Operating conditions

#### 1.3.4.1 For all countries

EMC compliance of the product is based on the following operating conditions (called normal operation):

- doors closed and/or cover in place
- external cables of the same type as specified by NORTEL NETWORKS
- no modification of any mechanical or electrical characteristics of the product

Any change or modification made to the product without written approval from NORTEL NETWORKS does not engage NORTEL NETWORKS’ responsibility any more.

### 1.3.5 Cable specifications

#### 1.3.5.1 For all countries

The compliance to EMC requirements in force (89/336/EEC) has been verified using cables as specified by NORTEL NETWORKS. The continuing compliance of the product relied upon the correct cabling scheme, as specified by NORTEL NETWORKS.

Refer to the installation guide for details on cable specifications.

### 1.3.6 PCM requirements

#### 1.3.6.1 United States of America

This equipment complies with Part 68 of the FCC rules. The equipment label contains, among other information, the FCC registration number for this equipment. Upon request of the telephone company, you should provide the FCC registration number of the equipment which is connected to your T1 line.

No repairs can be performed by the user. If trouble is experienced with this equipment, please contact your NORTEL NETWORKS representative office. If the trouble is causing harm to the public network, the telephone company may request you remove the equipment from the network until the problem is resolved.

### 1.3.6.2 Canada

This equipment has been certified by the Industry Canada under CS03 requirements. The equipment label shows the certification number. This certification means that the equipment meets telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal equipment technical requirements document(s). The department dose not guarantee the equipment will operate to the user’s satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The customer should be aware that compliance with the above conditions may not prevent degradation in service in some situations.

Repairs to certified equipment should be coordinated by representative designated by the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connection of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

### 1.3.6.3 Europe

Compliance of the product to European PCM requirements has been verified against standards CTR 12 and TBR 13. They cover essential requirements (directive 91/263/EEC) for the physical and electrical characteristics of the terminal equipment interface, unstructured leased lines (U2048S) and structured leased lines (D2048S).

Conformance to these requirements does not guarantee end–to–end interoperability.

Conformance to these requirements does not guarantee user safety or safety of employees of public telecommunications networks operators, in so far as these requirements are covered by the Low Voltage Directive 73/23/EEC.

## 1.3.7 Radio approval

### 1.3.7.1 United States of America

***For all BTSs only:***

This equipment complies with Part 24 Subpart E of the FCC rules. The equipment label contains, among other information, the transmitter (TX) FCC registration number for this equipment. Upon request of the telephone company, you should provide the TX FCC registration number of the equipment.

Compliance of radio communications equipment to the FCC Part 24 Subpart E requirements does not signify compliance to any requirement related to the use of the equipment (i.e. licensing requirements).

### 1.3.7.2 Canada

***For all BTSs only:***

This equipment complies with RSS 133 of the DOC rules. The equipment label contains, among other information, the DOC registration number for this equipment. Upon request of the telephone company, you should provide the DOC registration number of the equipment.

Compliance of radio communications equipment to the DOC RSS 133 requirements does not signify compliance to any requirement related to the use of the equipment (i.e. licensing requirements).

### 1.3.7.3 Europe and others

There is a specific radio approval procedure for each country. It is not possible to list all the applicable approvals, since they will be dependant on markets and products. Please contact your local NORTEL NETWORKS representative for more information.

### 1.3.8 Product labeling

#### 1.3.8.1 United States of America

To indicate compliance with FCC requirements, this device bears the following statement in a conspicuous location on the device:

- This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
  - (1) This device may not cause harmful interference
  - (2) This device must accept any interference received, including interference that may cause undesired operation.
- TX FCC ID: (FCC Part 24 compliance)
- FCC ID: Complies with part 68, FCC rules
- Manufacturer's name
- Model Number
- Equipment designation: Example = S8000 Outdoor BTS GSM 1900

The label may be located inside or outside the product, provided that the user and/or maintenance people will have the information when working on the product.

#### 1.3.8.2 Canada

To indicate compliance with the Canadian Standards, the device bears a label stating that the unit complies with all conditions set out in the special permission. Suggested text for the notice indicating compliance with this Standard:

- This Class (*) digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
- CANADA ID: (RSS 133 compliance)
- CANADA ID: (CS03 compliance)
- Manufacturer's name
- Model Number
- Equipment designation: Example = S8000 Outdoor BTS GSM 1900

(*) has to be replaced by A or B depending on the product, as following:

- Class A devices: S2000 Indoor, S2000E Indoor, S4000/S4000C Indoor, S4000 Outdoor, S4000 Smart, BSC 6000, BSC 12000, TCU
- Class B devices: S2000E Outdoor, S8000 Outdoor, S2000H, S2000L.

The label may be located inside or outside the product, provided that the user and/or maintenance people will have the information when working on the product.

#### 1.3.8.3 Europe and others

To indicate compliance with the European Directives (EMC, Low Voltage, Terminal), this device bears the following label in a conspicuous location on the device:

- CE 0188 X
- Manufacturer’s name
- Model Number
- Equipment designation: Example = S8000 Outdoor BTS GSM 1800
- Any labelling requirement specific to a market (e.g. Type Approval)

The label may be located inside or outside the product, provided that the user and/or maintenance people will have the information when working on the product.

# 2 SERVICES

## 2.1 User services

The system for mobile communications will begin a new era in radiocommunication services for telephone users. It offers services in the following fields:

- teleservices
- supplementary services
- bearer services

The system's modularity enables the operator to meet future user requirements by incorporating new service options within existing modules.

### 2.1.1 Teleservices

Teleservices offered by the system are full end–to–end services, including terminal capabilities, and are designed to meet user needs in the communication field. The following services are provided:

- Standard telephone services enable mobile subscribers to communicate with other users of telephone networks, whether fixed or mobile.
- Emergency call services enable any mobile or fixed user to call emergency services from the mobile network. These calls take priority over all other calls.
- Short message services enable any mobile or fixed user to send tens of bytes long alphanumeric messages to another user.
- Teleservices, such as fax, telex or videotex, will be provided in the future and are only listed in this document. They will be more detailed when introduced.

#### 2.1.1.1 Telephony

The cellular system offers great advantages in speech transmission over other systems currently in use. Whether sent or received by a mobile subscriber, calls have a high speech quality level.

Problems relating to transmission in urban areas where density of traffic is high have led the system to select a sophisticated technology called "narrow band TDMA with frequency hopping", which provides the highest quality of service a user can expect and offers the following features:

- provides a perfect listening quality whether the mobile station is in motion or halted
- solves the problem of radio fading
- eliminates noise on radio waves
- greatly reduces interference between two mobile terminals when they are located close to each other

Considerable effort has been made to preserve users' privacy. Digitized and ciphered transmission of speech prevents call ease dropping. Except during call setup, the IMSI (International Mobile Subscriber Identity) is always transmitted in cipher mode so that unauthorized people can not locate the mobile station and calls are protected from unwanted listeners.

This cellular system, which has been approved by a large number of countries, increases convenience offered to the traveling subscriber by ensuring that every call is made without being interrupted as long as it is within the PLMN (Public Land Mobile Network) corresponding to the subscription area. Although rates may differ from country to country, it enables a mobile station to send or receive calls, even when outside its home area.

Using a mobile terminal is similar to using a telephone from the fixed network in the following ways:

- Dialing of called party numbers is direct and followed by their authentication.
- The same tones are used to inform the user when the called party is absent or its line is busy. These signals are usually generated by the mobile telephone. Mobile terminal manufacturers must make these signals sound friendly.

Mobile originating calls and mobile terminating calls can be established.

### Mobile originating calls

When a subscriber picks up a mobile telephone, a signaling exchange is initiated between the mobile station and the PLMN.

Steps of the call setup procedure are as follows:

- The mobile station makes a random access setup request to the base station controller (BSC) via the BTS.
- According to radio resource availability, the BSC allocates a signaling channel (SDCCH) to the mobile station.
- The BSC establishes a connection between the mobile station and the MSC.
- The mobile station acknowledges the connection and sends a setup request to the MSC.
- The MSC performs a subscriber's authentication procedure (see Paragraph 2.2.2).
- If the procedure is successful, the MSC requests to switch to cipher mode.
- The mobile station sends the entire call setup request to the MSC (subscriber's number, requested service, etc.).
- The BSC allocates a traffic channel (TCH) and releases the signaling channel (SDCCH).
- The MSC may then route the call to the fixed network (PSTN) user.

#### Mobile terminating calls

When a user attempts to make a call to a mobile station, the following procedures are started:

- The PSTN switch recognizes the called party's number as a mobile subscriber and routes the call to a specialized server, the GMSC (Gateway Mobile services Switching Center), which looks for the mobile station roaming number (MSRN).
- The GMSC sends a roaming number request to the mobile subscriber's home database (HLR – Home Location Register).
- The HLR requests from the mobile subscriber's visitor database (VLR – Visitor Location Register) a specific roaming number to be dedicated to the call.
- The VLR allocates a roaming number and transmits it to the GMSC via the HLR.
- The GMSC routes the call to the mobile subscriber's host MSC.
- The MSC identifies the subscriber by the roaming number and checks its VLR for the list of cells in which the mobile station should be located.
- The MSC begins a paging procedure in the areas where the mobile station should be located (see Paragraph 2.2.1.3) via base station controllers (BSC) and base transceiver stations (BTS).
- The mobile station is advised that it is being searched for and begins a call setup procedure, as described above.
- The MSC may then route the call to the mobile station.

### 2.1.1.2 Emergency calls

The cellular system offers an emergency call telephone service available to all subscribers that enables them to make a call to a centralized emergency service by using a short code (112 or 911) or by pressing a single key on the mobile terminal. Calls are routed to the nearest emergency station.

Enhanced 911 (E911), through the network nodes Serving Mobile Location Center (SMLC) and Gateway Mobile Location Center (GMLC), allows the network to ascertain the location of the mobile station with great accuracy. This information is then transferred to the Public Safety Answering Point (PSAP).

The emergency call setup procedure is similar to the normal call setup procedure (see above) and only differs in that the MSC does not perform the authentication procedure, thus allowing mobile network non–subscribers to make emergency calls from a mobile telephone. The MSC gives first priority to this type of call.

### 2.1.1.3 Voice mail

If the called mobile does not reply or if the calling line–connected or cellular network subscriber prefers to leave a message in the GSM subscriber's mailbox, the system stores the called subsriber's messages that can be consulted at any future time either by dialing a pin code from the subscriber's mobile station or via a line–connected telephone set.

#### 2.1.1.4 Short message services

The cellular system enables users to transmit and receive short messages. These services are used by stealing SACCH (Slow Associated Control CHannel) blocks usually reserved for signaling. They are as follows:

- the mobile terminating/point–to–point short message service (SMS–MT/PP) for reception by a mobile subscriber
- the mobile originating/point–to–point short message service (SMS–MO/PP) for transmission by a mobile subscriber
- the cell broadcast short message service (SMS–CB) that enables general messages (such as road traffic information) to be broadcast among all subscribers roaming within a given geographical area at regular intervals

Short message services offered to mobile subscribers are better than conventional services offered to alphanumeric pagers since the mobile station acknowledges reception of the message. Therefore, the system can advise the sender that the message has been received or keep it in case of delivery failure and repeat it as needed. Mobile stations can store the last received messages in a nonvolatile memory.

#### 2.1.1.5 Fax and telex services

The cellular system offers a fax service to mobile subscribers in both directions. No choice has been made in the technology yet, but in all cases, a server will be integrated.

Other services include telex and vocal message services. They should be made available in the future.

### 2.1.2 Supplementary services

When subscribing to the mobile network, users may choose among services that add up to the conveniences of basic radiocommunication services.These services (only the first three are currently available) include the following:

- calling line identification
- call transfer
- call wait
- call hold
- conference call
- closed user group
- charge–related services
- user–to–user signaling
- call barring

#### 2.1.2.1 Call line identification

A mobile subscriber may request to get the number of a party when calling it or when the party tries to call. Users may request that their numbers not be communicated to a party when they try to call or when the party tries to call them. If anonymous or malicious calls are received by mobile subscribers, they may request the system to give them the calling party's number by pressing a key on the mobile terminal.

#### 2.1.2.2 Call transfer

When a call is sent to a mobile station, it may be forwarded to another fixed or mobile network subscriber's number chosen by the mobile subscriber. When subscribing, the user may ask for this service to be provided and indicates which forwarding number will be used. This number and the service activation period may be changed by the subscriber at any time.

The system enables a call to a mobile station to be rerouted once under the following conditions:

- unconditionally. When the mobile subscriber is unable to receive the call, it is forwarded to pre–chosen number.
- if the subscriber's line is busy
- if the call is not answered
- if the radio subsystem is congested
- if the paging message is not answered
- if the mobile subscriber is not registered within the searched zone
- during the call, rerouting may be performed from the mobile terminal.

A call transfer, whenever unconditional or due to non–registration, is handled by the HLR. Other call transfers are controlled by the MSC/VLR.

#### 2.1.2.3 Call wait

If a call is received by a mobile station while its line is busy, it may be put into a waiting state until the mobile subscriber is ready to take it. Users are warned by a visual or audible signal that a call is waiting.

#### 2.1.2.4 Call hold

Conversely, the mobile subscriber may put the first party on hold, take the call from the other party, and return to the first one later.

#### 2.1.2.5 Conference call

The conference service allows users to handle calls among three people is being planned. This service enables the mobile subscriber to talk to two other users simultaneously.

#### 2.1.2.6 Closed user group

Subscribers to the mobile network may choose to make a subscription restricted to a group of users. In this case, calls to and from subscribers of the group are limited to the group itself and registration fees are smaller.

#### 2.1.2.7 Charge-related services

Two services are provided:

- A mobile subscriber may be notified of the amount of charges to be paid for a call (calls to this service are free of charge).
- A mobile subscriber may call another subscriber, who will be charged for the call (call collect).

#### 2.1.2.8 User-to-user signaling

This service enables the transfer of a limited amount of information between a mobile user and another mobile or ISDN (Integrated Services Digital Network) subscriber during a call, or upon call setup or release. For example, it may be used during a call to convey a short message that is visualized on the mobile terminal display or on the ISDN station display.

#### 2.1.2.9 Call barring

When subscribing to the mobile network, users may specify call restrictions. It is possible to bar the following:

- all outgoing calls
- outgoing international calls
- outgoing international calls, except those to some countries (for example, all countries members of the European Conference of Postal and Telecommunications Administrations (CEPT))
- outgoing international calls, except those towards the home PLMN country
- outgoing calls, if the mobile station is outside its home PLMN country
- all incoming calls
- incoming calls, if the mobile station is outside its home PLMN country

## 2.1.3 Bearer services

These services enable the mobile subscriber to send data in the following modes:

- circuit
- PAD (Packet Assembly/Disassembly)
- packet

Full–rate, transparent and non–transparent data channels are supported. The alternate speech/data transmission service may also be used.

### 2.1.3.1 Circuit mode transmission

This service is used to send data in synchronous or asynchronous duplex circuit mode to the PSTN or the ISDN.

Transmission rate in asynchronous mode may be 600 bit/s, 1200 bit/s, 2400 bit/s, 4800 bit/s or 9600 bit/s.

Transmission rate in synchronous mode may be 1200 bit/s, 2400 bit/s, 4800 bit/s, or 9600 bit/s.

### 2.1.3.2 PAD mode transmission

This service enables a mobile station to gain access to a PAD facility in asynchronous mode at a transmission rate of 600 bit/s, 1200 bit/s, 2400 bit/s, 4800 bit/s, or 9600 bit/s.

### 2.1.3.3 Packet mode transmission

This service, which will be effective in a future version, enables a mobile station to send packets of data in synchronous duplex mode, at a transmission rate of 2400 bit/s, 4800 bit/s, or 9600 bit/s.

## 2.2 Network internal services

Call routing and follow-up services are transparent to users, but they initiate complex procedures to do the following:

- locate mobile subscribers. Due to its cellular design, the system must be able to locate a mobile station at any time, so calls may be routed to it.
- authenticate mobile subscribers. Each time a procedure, such as call routing or location updating, is initiated between a mobile station and the network, a subscriber’s authentication procedure is performed to prevent fraudulent connections to the network.
- maintain communications. When a call is setup between a mobile subscriber and its called party, the system must maintain the communication according to the mobile station moves through power control and handover procedures.

### 2.2.1 Locating

The network must be able to locate any mobile station so it can route calls to it. Given the cellular design, two types of procedure may be initiated:

- the location updating/registration procedure
- the paging procedure

Both procedures are used simultaneously to locate the mobile station as precisely as possible.

#### 2.2.1.1 Cell selection

Cells are put into geographic groups, and their number in a group is determined by the amount of traffic to be handled and by their range. A group of cells is called a location area. In case of dual band network, a location area is made up of both 900 and 1800 frequency bands.

The cellular system requires mobile stations to know which cell they are moving in at any time, so as to be registered by the mobile services switching center (MSC) that controls the location area.

When the mobile station moves from one location area to another, a procedure is initiated between the mobile station and the network that requires the mobile services switching center (MSC), via the base station subsystem (BSS), to update the mobile new position to the visitor database (VLR).

If a call is to be routed to the mobile station, the MSC gets its location area from data stored in the VLR. It then begins a paging procedure, via the BSS, in all cells that belong to the specified location area. The mobile station picks up the message and begins a call setup procedure with the MSC via the BSS.

Base transceiver stations (BTS) broadcast general information about their identity on the BCCH (Broadcast Control CHannel). Mobile stations continuously monitor that channel and know the location area to which the cell belongs.

When the mobile station does not handle any communication, the portable terminal is put into a “sleeping” state for economy purposes. However, it still listens periodically to the BCCH carrier to be ready to receive a call.

#### 2.2.1.2 Location updating/registration

When a mobile station moves into another cell, it first checks if the new cell belongs to the same location area. If it does, no procedure is initiated. If it does not, the mobile station must register itself to the new location area. Depending on whether the new location area is controlled by the same MSC or by a different one, a location updating or a registration procedure is performed. Both procedures are performed the same way. *Figure 2-1* shows the progress of a registration procedure:

- BTS1 sends a broadcast channel (1) and the mobile station (MS) moves (2).
- BTS2 sends a broadcast channel and the MS detects a location area change (3).
- MS makes a random access setup request to the base station controller (BSC2) that, according to radio resource availability, allocates a signaling channel (SDCCH) to the mobile station.
- BSC2 establishes a connection between the mobile station and the mobile services switching center (MSC2) that controls the new location area.
- MS makes a location updating request to MSC2 via BSC2 and BTS2 by indicating its IMSI (International Mobile Subscriber Identity).
- MSC2 consults its visitor location register (VLR2) to establish whether the mobile station comes from a location area controlled by itself or by a different MSC (4).

If MSC2 controls the former location area, it performs out an authentication procedure (see paragraph entitled “AUTHENTICATION”) and, if it is successful, updates the mobile new location data into its visitor database (VLR). This is the end of the location updating procedure.

Otherwise, MSC2 initiates a registration procedure:

- It asks the HLR for the subscriber’s information and authentication data (5) and begins an authentication procedure.
- If it is successful, MSC2 enters the mobile station new location data into VLR2 (6) and informs the HLR that it is now controlling the mobile station (7).
- The HLR stores the identity of the MSC/VLR, which now controls the mobile station and informs VLR1 that it can remove all mobile station information from its database (8).

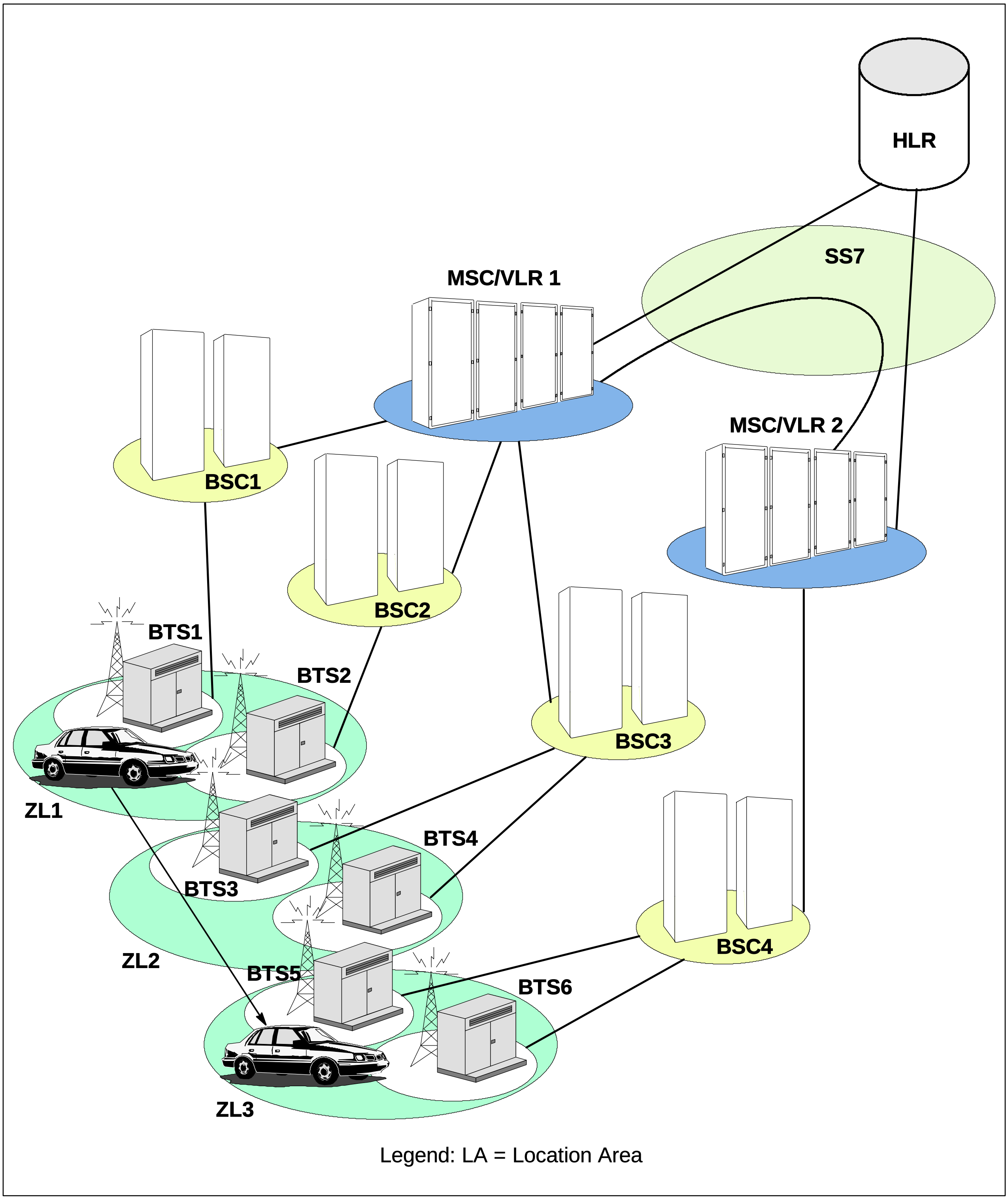



**Figure 2–1 Registration**

#### 2.2.1.3 Paging

When a user attempts to call a mobile subscriber, the call is handled by the MSC, which controls the location area the mobile station is in and a paging procedure is begun (see *Figure 2–2*):

- A call to the fixed network is switched to the mobile services switching center (MSC) (1), which searches its VLR for the location area the mobile station is in (2).
- The MSC sends instructions to the BTS via one or several BSC to page the mobile station in all cells within the location area (3).
- The BTS send a signal to every cell they control that informs the mobile station that it is being called. The mobile station receives the request from BTS2 (4),(5).
- When the mobile station picks up the message, it performs a call setup procedure, as described in paragraph entitled “Mobile terminating calls”.
- When the path is setup, the MSC routes the call to the mobile station.

### 2.2.2 Authentication

The authentication procedure prevents unauthorized access to the network. Each time a connection is attempted, the mobile subscriber undergoes an authentication procedure to check the IMSI (International Mobile Subscriber Identity). Each IMSI is associated with a secret key (Ki). This key is stored in the HLR and in a special module inside the mobile terminal, the SIM (Subscriber Identity Module), and is never transmitted on radio waves. The mobile equipment identity number (IMEI) is used to ensure that the mobile station is not faulty or stolen. If it is faulty or stolen, the attempt to establish a connection is rejected. Confidentiality is also increased by replacing the IMSI with a temporary mobile subscriber identity (TMSI) number which is frequently changed.

The home location register (HLR) hosts an authentication central unit (AUC) that stores the subscriber’s IMSI and secret key. Using the IMSI and the secret key, the AUC processes an algorithm that produces triplets composed of the following:

- a random number (RAND)
- a signed answer (SRES) for signed result
- a cipher key (Kc)

Upon each HLR request, the AUC generates authentication triplets. The HLR sends some of these triplets to the VLR that requests them. One triplet per authentication procedure is used. When its stock is exhausted, the VLR makes a new request to the HLR.

During an authentication procedure, the VLR transmits a random number (RAND) to the mobile terminal . The mobile terminal uses this number, together with the secret key (Ki) stored in the SIM, to generate a signed response (SRES) and sends it to the VLR, which compares it to the one supplied by the HLR. If they are identical, the connection may be established between the mobile station and the network. If they are not, the connection is immediately rejected.

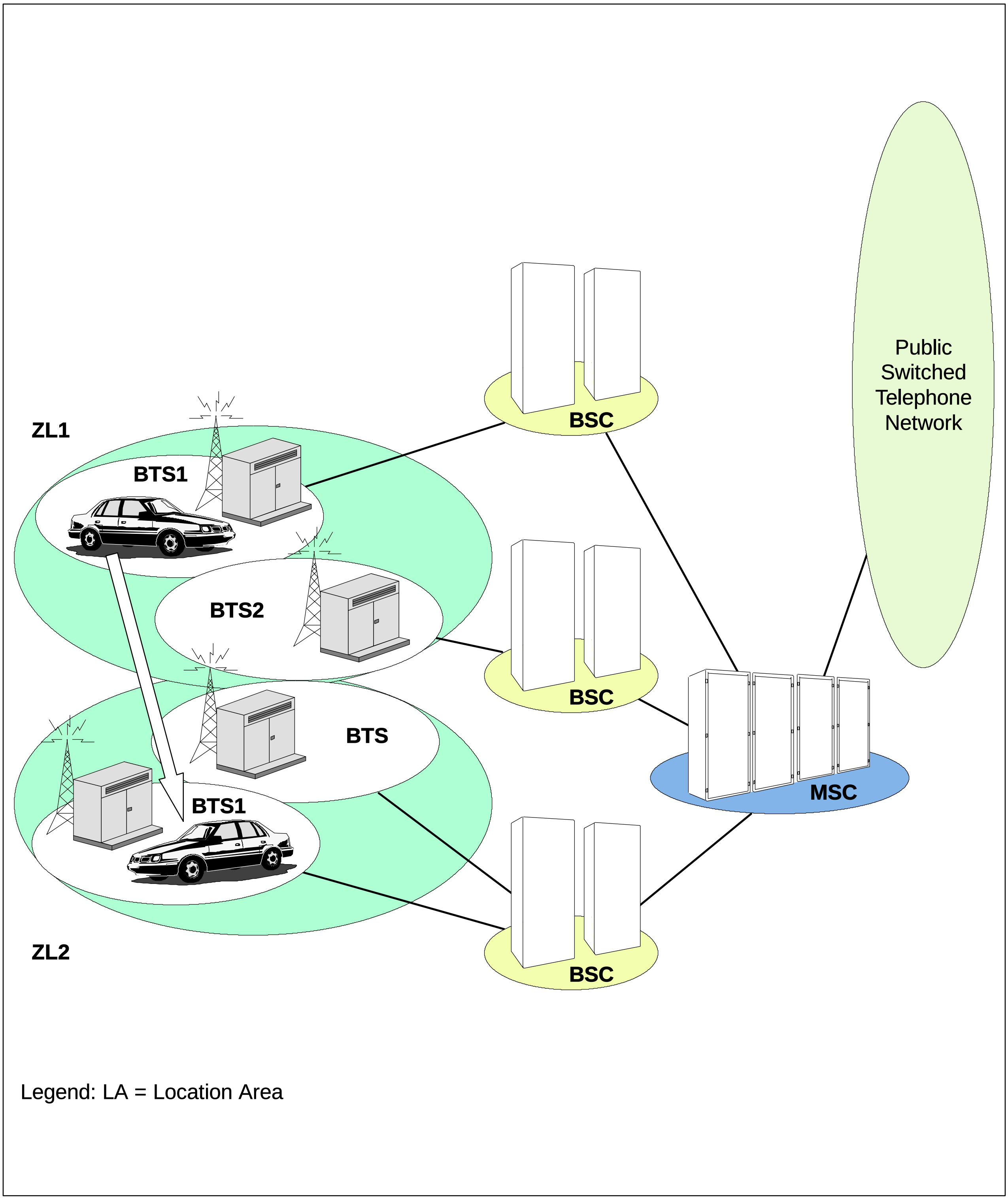



**Figure 2–2 Paging**

### 2.2.3 Communication supervision

The system must maintain communication with a mobile subscriber when moving in a cell or between two cells. The call is maintained by the network according to the transmission quality and the amount of traffic handled by the cells. Mobile and base stations regularly perform radio transmission measurements.

The radio measurement processing is performed by the BTS. It ensures that the network and the mobiles can communicate with each other with minimum interference, at the lowest possible transmission power and with the best transmission quality. The mobile takes measurements in the downlink direction (BTS → MS) and the BTS in the uplink direction (MS → BTS).

The BTS averages these measurements for each connection. The averaged measurements are then used as the basis for a decision making process for the following:

- power control
- call clearing
- inter–cell handover
- intra–cell handover

These decisions are made by comparing the measurements with a series of O&M–defined thresholds.

The power control and the handover procedures may be initiated.

When transmission quality from MS to BTS decreases, the BTS asks the mobile station to increase transmission power. If transmission by the mobile was already at maximum strength, or if transmission from the BTS to MS is considered too weak, the BSC performs a communication handover.

Power control and handover algorithms are performed, whatever channel is used by the mobile station (traffic channel TCH or dedicated signaling channel SDCCH). When it receives an external handover command, a BSC does not check the state of the requested resource (TCH or SDCCH).

#### 2.2.3.1 Cell types

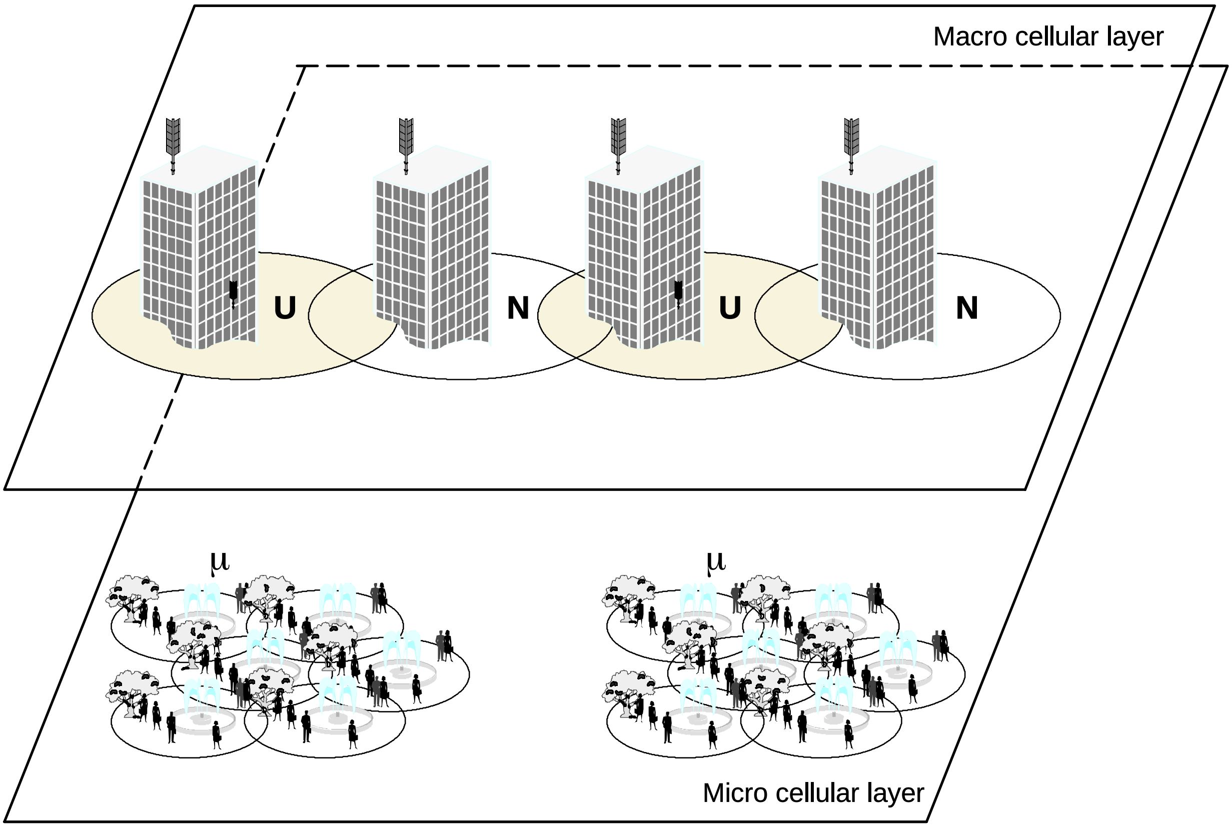
The communications are processed according to the cell configuration:

- Standard cells

  A standard cell is defined by a 35 km (22 miles) radio coverage radius.

- Umbrella cells and microcells

  To increase radio coverage in an uneven or urban area (dense traffic and inside coverage), it is necessary to implement a multi–layer system. Standard cells and other umbrella cells are spread over a macrocellular layer. Each umbrella cell (roof antenna) covers a set of smaller cells (indoor antenna) spread over the microcellular layer (see *Figure 2–3*).




Legend:

N : Normal cell
U : Umbrella cell
μ : Micro–cell

**Figure 2–3 Cellular network presentation**

- Concentric cells

  A cell divided into two areas, an inner and an outer one, forms a set of two cells appointed as concentric cells. This configuration decreases the BSC load by reducing the number of intracell handovers (see *Figure 2–4*).

- Extended cells

  When a standard cell proves to be insufficient to cover an area which traffic does not require the addition of a BTS, the “ extended cell ” mode allows to increase the maximum range up to 90 km (56 miles). Note that standard and extended cells can share the same site.

  The TRXs belonging to the same extended cell must be configured in extended mode. The diversity function is not available in extended cell mode. Only the frame processor (FP) with MNU (MaNagement Unit) and DCU (Dual Channel Unit) boards can process the extended cell mode.

- Split cells

  The split cell strategy consists in dividing one cell into several sectors so that there are several BTSs in one site. Split cells are also called multi–BTS sites. Split cells allow an operator to modify the site configuration or increase site capacities without the requirement of adding specific cables, cabinets, and interfaces.

  A split cell is viewed as a single site from the OMC–R graphical fault display.

  For installation purposes, two BTSs in a split cell are treated separately and each has its own power supply. However, one AC box supplies both BTSs.

  BTSs in a split cell configuration are connected using the drop and insert celltiering configuration to save transmission costs.

- Cell tiering

  A tiered cell is a cell where all TDMAs are not organized according to the same reuse pattern.

  Today, TCH resource allocation is made randomly. This does not optimize the “worst case” situations which determine the acceptable grade of service, and in particular the maximum load which can be accepted on a network when fractional reuse applies.

  Tiering is a technique to organize the TCH allocation to minimize the worst cases.

#### 2.2.3.2 Dual band configuration

The dual band configuration is for an operator the possibility to manage both 900 and 1800 BTSs within the same network or same cell. The two frequency bands may share the same geographical area (see *Figure 2–5*) or may be organized hierarchically (macro and micro–cell layers) (see *Figure 2–6*). Only multiband mobiles are able to select any band within the network.

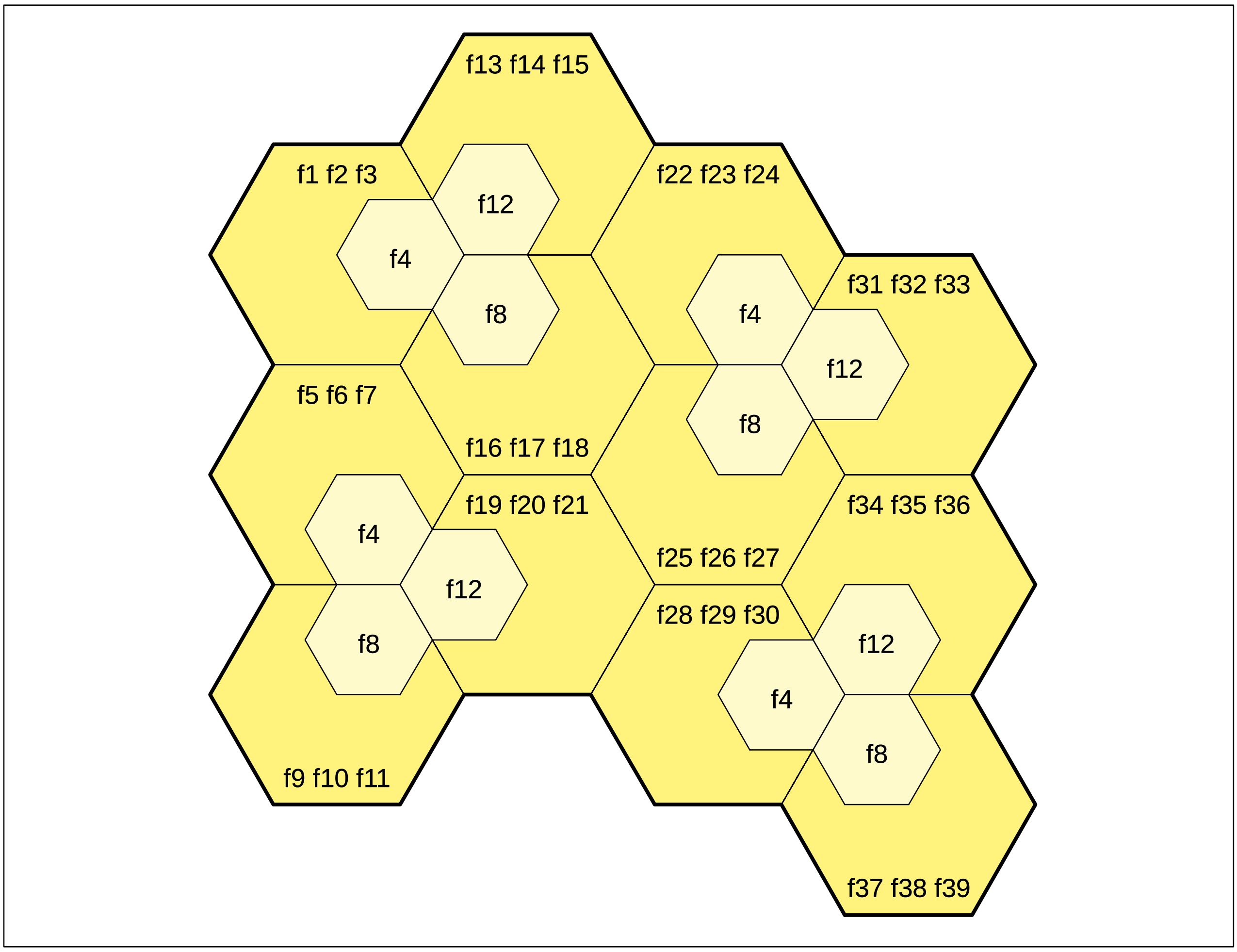



**Figure 2-4 Concentric-cell network**

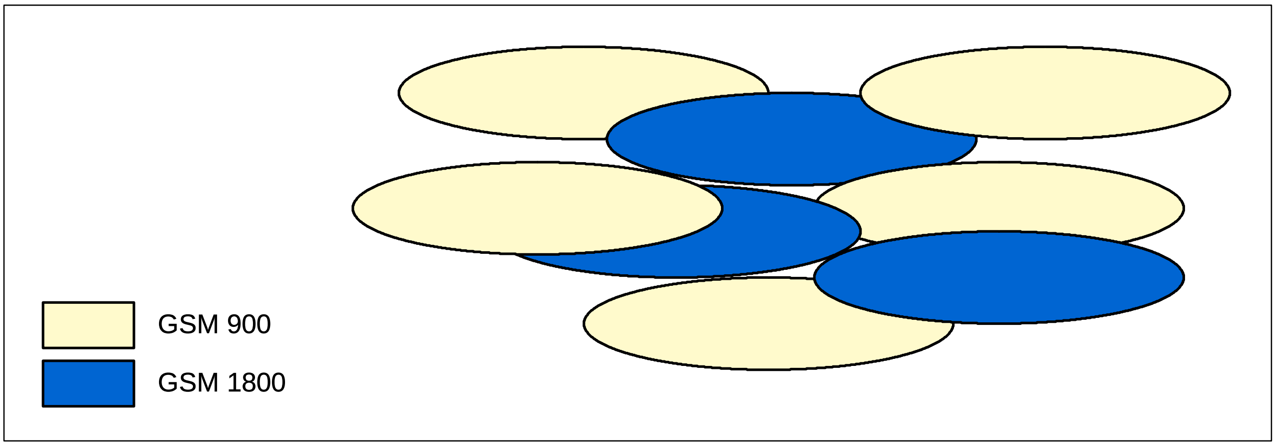



**Figure 2-5 Dual band configuration (example 1)**

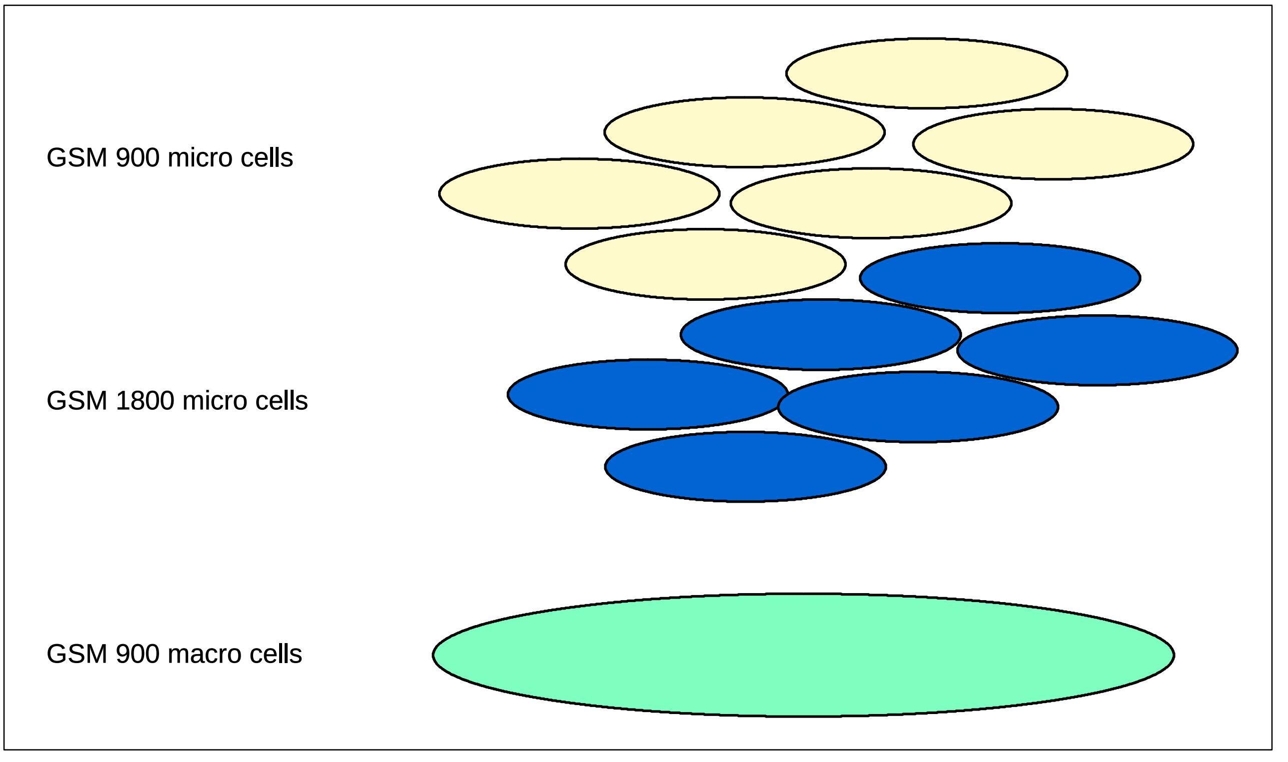



**Figure 2–6 Dual band configuration (example 2)**

2.2.3.3 Power control

The BSS supports dynamic power control in both directions and static power control in the downlink direction. Power control procedures are performed by the BSC. The system requires dynamic power control to be performed at MS level (uplink), while dynamic power control at BTS level (downlink) is optional.

**Dynamic power control**

Dynamic power control is handled by the BSS to optimize mobile station (MS) and base station (BTS) transmission power.

MS and BTS transmission levels are determined by analysis of strength and quality measurements collected in both directions. Power control criteria are set by the operator and processed at the OMC–R. The more accurate adjustment step is 2 dB. Information about call supervision is managed by the BSC in duplex mode.

**Static power control**

The BTS transmission power may be adjusted on–line from the OMC–R either by 2 dB steps within a 12 dB range or directly to the required value.

#### 2.2.3.4 Handover

When a call is in progress, the mobile station measures the quality of the signal received from its cell, as well as from neighbouring cells for which the received level is acceptable and on the BCCH of which it was able to synchronize itself and recognize the cell BSIC (Base Station Identity Code). Measurements are sent to the BTS, which measures the reception level and quality.

If transmission is at full strength and service quality is too low, or if the BTS and the MS are too far apart, the BSC may perform a handover procedure, either inside the same cell or with the first cell from a list of preferred order cells table to support the call.

In the case of a poor uplink transmission (MS–BTS), the BSC may request that the mobile increase its transmitted power.

The BSS supports intra–cell and inter–cell handovers. Inter–cell handovers may be either intra–BSC handovers (both cells belong to sites that are controlled by the same BSC), inter–BSC handovers (each site is controlled by a different BSC that may be controlled by a different MSC), or inter cellular layers (see *Figure 2–8*).

Handover algorithms play an important role in cellular planning. All parameters (neighbouring cell list, maximum power to be used in a cell, maximum distance to a cell, handover margin, power budget in use, level/quality/interference thresholds, average computing laws) are set from the OMC–R. Most of them may be dynamically updated by the operator.

There are several types of handovers described below and also summarized in *Table 2–1*.

- Handover on power budget criteria

  The power budget criteria is a powerful way to restrict a mobile station within an area where the path loss is minimized. Therefore, interference level and transmission power may be minimized too.

  In a heavy traffic area, most of the handovers should fall into this category.

- Handover on degradation criteria

  Signal strength and quality, interference level, and the distance between the BTS and the MS (call clearing) provide another way to handover a communication when the power budget criteria cannot be used.

  The BSC classifies the cells that are able to maintain a call. When it determines, from information sent by the BTS, that the quality of the call becomes too low, it begins a handover procedure.

- Handover on capture criteria

  This algorithm is based on the assumption that if a mobile in a cell (macro all or micro–cell) receives a strong and stable signal from a neighbouring cell (micro or macro cell), it can be safely evacuated towards the new cell, according to the “capture” criterion.

- Forced handover

  A forced handover occurs to free resources in a congested cell. When the serving cell is close to saturation, a handover is forced to a cell that is not loaded.

- Directed retry

  A directed retry is a load management feature that ensures that a call is not rejected when a traffic channel is not available in the current cell, by allocating a traffic channel in a neighbouring cell.

  The following two modes of directed retries are supported:

  - the call hands off from a cell to its umbrella cell
  - the call hands off from the current cell to the ”best” cell among the neighboring cells

- Early handover

  A early handover provides increased reactivity in detecting handover needs, which can avoid dropped calls in some cases. An early handover decision is based on a limited number of measurements and can occur at call setup, when a neighboring cell appears, or on a new connection following a handover.

  The algorithm used to trigger an early handover also prevents ping–pong handovers, which can occur when a mobile is transferred from one cell to another and back again in a short time. Such a handover occurs when a mobile in Cell A crosses an intersection, the center of which is covered by Cell B.

| CURRENT CELL \ NEIGHBOUR CELL | NORMAL OR EXTENDED CELL | MACRO–CELL | MICRO–CELL |
|---|---|---|---|
| NORMAL OR EXTENDED CELL | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. |
| MACRO–CELL | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. | Capture (minimum field level), directed retry, forced handover, early handover. |
| MICRO–CELL | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. | Signal quality, signal strength, distance, directed retry, forced handover, early handover. | Signal quality, signal strength, distance, power bugdet, directed retry, forced handover, early handover. |

**Table 2–1 Summary of call transfer criteria**

#### Intra–cell handover

The intra–cell handover supported by the BSS is triggered mainly when a channel experiences poor quality. In case of SDCCH channel, the intra–cell handover is controlled by OMC–R flag. Measurements of interference levels on idle channels are used to select a new channel within the cell. Intra–cell handovers are given priority over inter–cell handovers.

Concerning the concentric cells, this procedure corresponds to call transfers between inner and outer areas (see *Figure 2–4*). In a concentric cell, each transmitter is dedicated to one of these two areas to which different frequencies are allocated.

Any handover or any initial posting in a concentric cell is completed first towards the outer area. Inter–area transfers only allow the MS to roam from one area to the other of the same cell. In case of bad radio conditions, a standard inter–cellular transfer occurs from the inner area of a concentric cell towards another cell.

#### Frequency reuse in a concentric cell structure

*Figure 2–7* shows a network composed of four tri–sectorial BTSs each with four monomode transmitters per cell. Four frequencies are available for each cell and consequently 48 frequencies are necessary in a usual situation. In *Figure 2–4,* the concentric cell structure, whose inner areas frequencies are reused in the whole network, only monopolizes 39 frequencies ((12*3)+3=39) namely nine frequencies saved.

Advantages for the operator:

- In *Figure 2–7,* the operator uses 48 frequencies which requires a bandwidth of 9.6 MHz (48 * 200 kHz).
- In *Figure 2–4***,** the bandwidth required is lowered to 7.8 MHz for 39 frequencies (39 * 200 kHz).

#### Inter–cell handover within the same MSC

This type of procedure is initiated after the BSC decides to handover the call to another cell.

The procedure described below relates to a target cell that is controlled by the same BSC (see *Figure 2–8)*:

- A call is in progress between the mobile subscriber (MS) and another user. It is controlled by BTS1.
- The mobile station moves to another cell.
- The BSC1 decides to hand over the call and allocates a traffic channel (TCH) to the target BTS (BTS2).
- The BSC1 sends the cipher key (Kc), the channel to be used, and the frequency hopping sequence to BTS2 and requests the mobile station to connect to BTS2 by sending a handover request to MS via BTS1, which indicates the identity of the target cell.
- The mobile station sends a random access setup request to BTS2 to establish a connection.
- BTS2 informs the BSC1 that the connection has been successfully established and the BSC1 switches the call to the new cell via BTS2.
- The BSC1 sends a message to the MSC1, which informs it of the transfer and releases BTS1 radio resources.

Depending on where the BTS are located, two cases may arise:

- If both BTS are in the same radio location, they use the same time base. The mobile station undergoes a synchronous handover.
- If the target BTS is in a different radio location, it is not synchronized with the initial BTS. The BSC informs the target BTS that the mobile station must be synchronized and, when the connection is established, the target BTS synchronizes the mobile station using the timing advance signal.

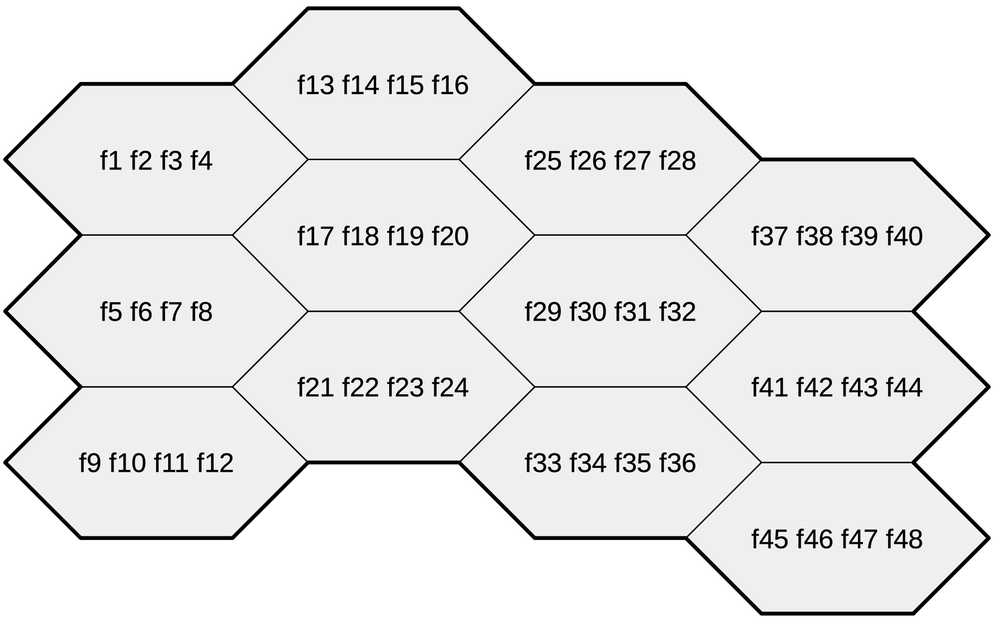



**Figure 2-7 Non concentric-cell network**

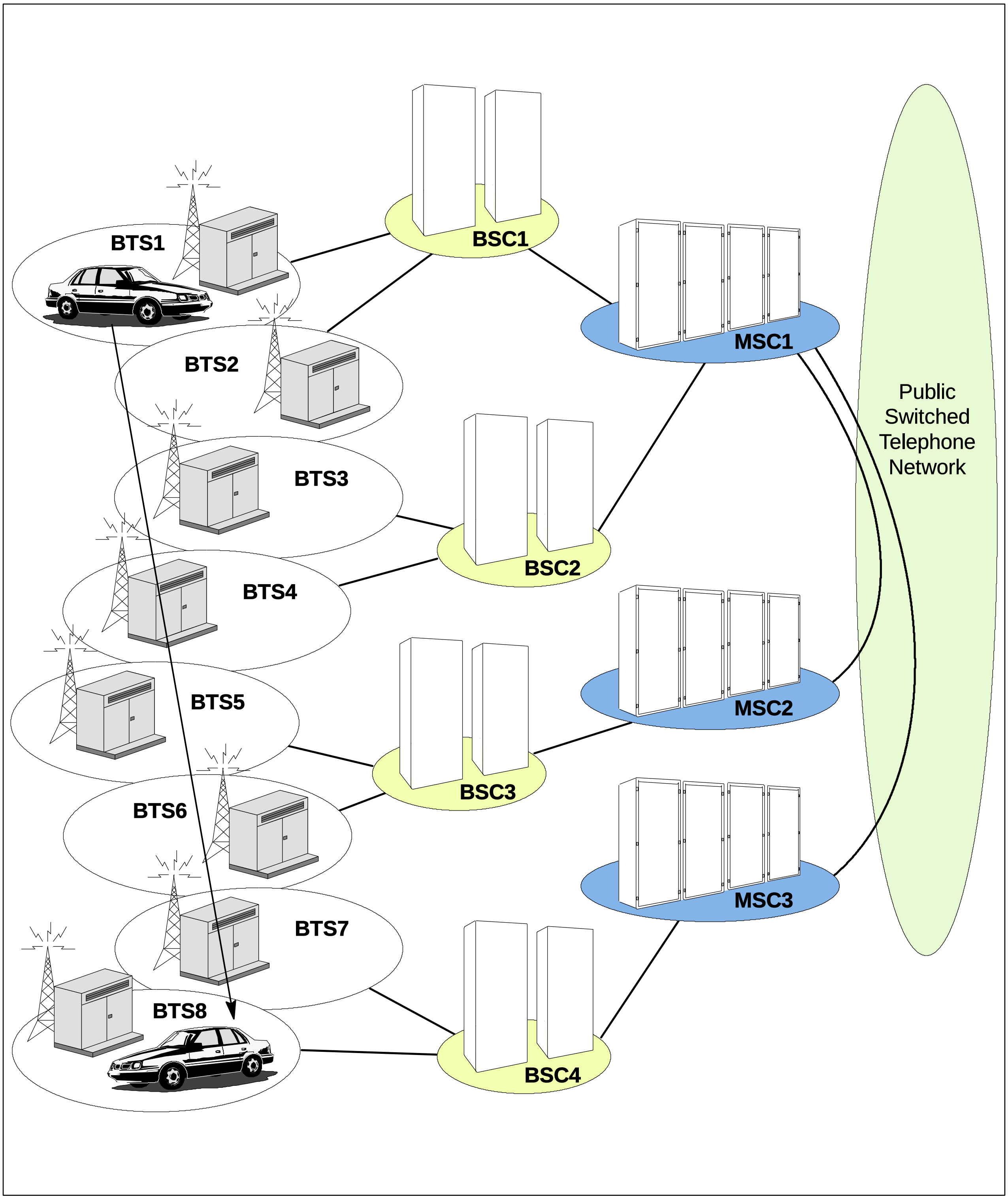



**Figure 2-8** **Handover procedures**

### Inter–MSC handovers

The procedure is the same as the one described in "Inter–cell handovers within the same MSC" paragraph until the initial MSC (MSC1) detects that the target cell is controlled by another MSC (MSC2, see *Figure 2–8*):

- MSC1 sends a channel allocation request to MSC2 and indicates the identity of the target cell.
- MSC2 makes a channel allocation request to the BSC3 that controls the target cell (BTS5).
- BSC3 selects and activates radio resources and informs MSC2.
- MSC2 informs MSC1, which informs BSC2 that the procedure has been performed.
- BSC2 transmits the handover request to the mobile station via BTS4.
- The mobile station attempts to connect to BSC3 via BTS5 (see "Inter–cell handovers within the same MSC").
- When the connection is established, MSC1 switches the call to the mobile station via MSC2, BSC3, and BTS5.
- MSC1 informs BSC2 that it can release all radio resources used.
- MSC2 keeps control of the call and stores all resource information.

When a mobile station that has already been handed over from MSC1 to MSC2 leaves the area controlled by MSC2, a new handover procedure must be started. This new procedure is similar to the one described above and depends on the MSC to which the new target cell belongs.

One of the following occurs:

- Control returns to MSC1.
- A handover procedure is performed that which gives control of the call to a third MSC (MSC3).

When the call is completed, the mobile station performs a location updating or a registration procedure as required (see "Location updating").

### Dual–band handover

When a multiband mobile moves within a dual band network, the handover options are the following:

- The origin and target cells belong to the same frequency band (GSM 900 or 1800).
- The origin and target cells belong to different frequency bands (GSM 900 or 1800).

# 3 BTS

## 3.1 Introduction

There are different types of Base Transceiver Stations (BTSs):

- The S2000 and S2000E Indoor BTSs are designed for installations inside a building (see *Figure 3–1* and *Figure 3–2*).
- The S2000E Outdoor BTS is designed for installations essentially outside a building (see *Figure 3–3*).
- The S2000H “FP” and S2000L “FP” BTSs are designed for installations outside as well as inside a building (see *Figure 3–4* and *Figure 3–5*).
- The S2000H “EP” and S2000L “EP” BTSs are designed for installations outside as well as inside a building (see *Figure 3–6* and *Figure 3–7*).
- The e–cell is designed for installations outside as well as inside a building (see *Figure 3–8* and *Figure 3–9*).
- The S4000 Indoor and S4000C BTS are for installations inside a building (see *Figure 3–10* and *Figure 3–11*).
- The S4000 Outdoor and Smart BTS are designed for installations essentially outside or inside a building (see *Figure 3–12*).
- The S8000 Indoor BTS is designed for installations inside a building (see *Figure 3–13* and *Figure 3–14*).
- The S8000 Outdoor BTS is designed for installations outside a building (see *Figure 3–15* and *Figure 3–16*).
- The S8002 Outdoor BTS is initially dedicated to the Railway Market for installations outside or inside a building (see *Figure 3–17* and *Figure 3–18*)
- The S8003 indoor BTS is designed for installations inside the building (see *Figure 3–19* and *Figure 3–48*)
- The S8006 BTS is designed for installations outside a building (see *Figure 3–20*)
- The S12000 Outdoor BTS is designed for installations outside a building (see *Figure 3–21*)
- The S12000 Indoor BTS is designed for installations outside a building

All BTSs are supported by both BSCs 2G and BSCs e3.

For a list of BTS product reference manuals, refer to the chapter “About this document”.

### 3.1.1 BTS scope and purpose

The BTS provides the interface between the fixed network and the mobile stations.

Communication with mobile stations is enabled by a radio interface, also called the Um interface.

The Radio interface carries signaling and speech/data channels between the base station (BTS) and the mobile stations (MS).

Communication with the fixed network is enabled via a second wire interface called the Abis interface. The Abis interface connects the BTS to its Base Station Controller (BSC). The transmission of signaling, speech, and data channels is performed by means of PCM links.

The BTS configures its equipment and establishes, maintains, and clears calls to and from mobile stations as directed by the BSC.

The BTS organizes and manages radioelectric resources, supervises its own equipment, and conducts stand–alone defence actions when required.

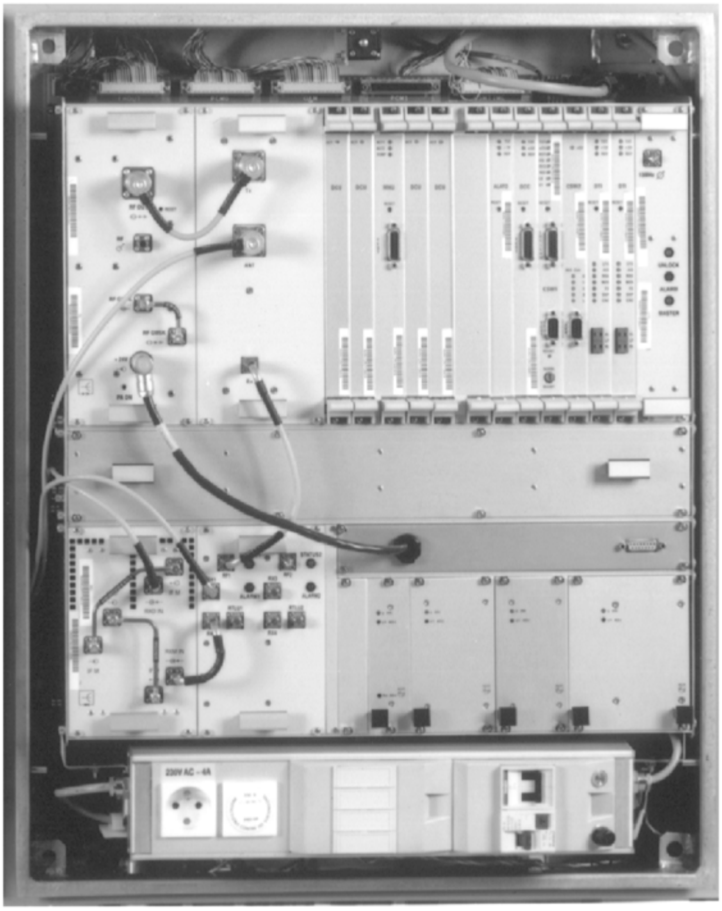


**Figure 3–1 S2000 BTS (inside view)**

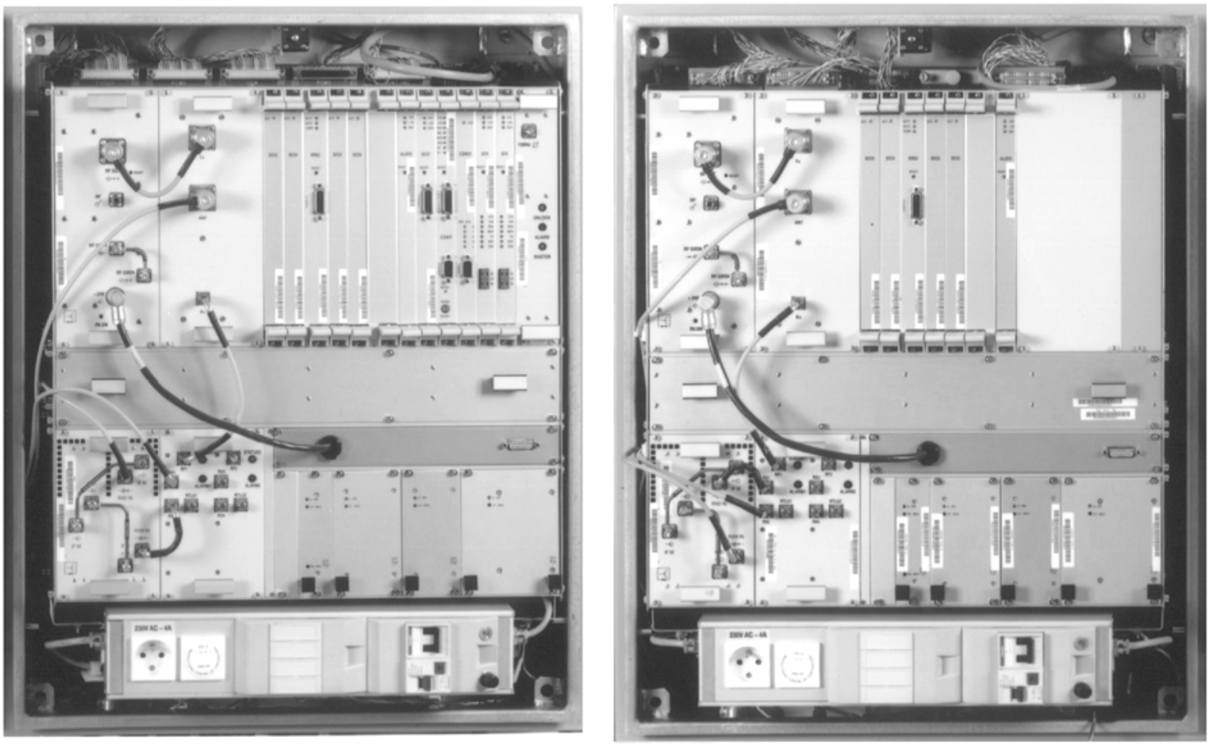


**Figure 3–2 S2000E Indoor BTS: Base and extension cabinets (inside view)**

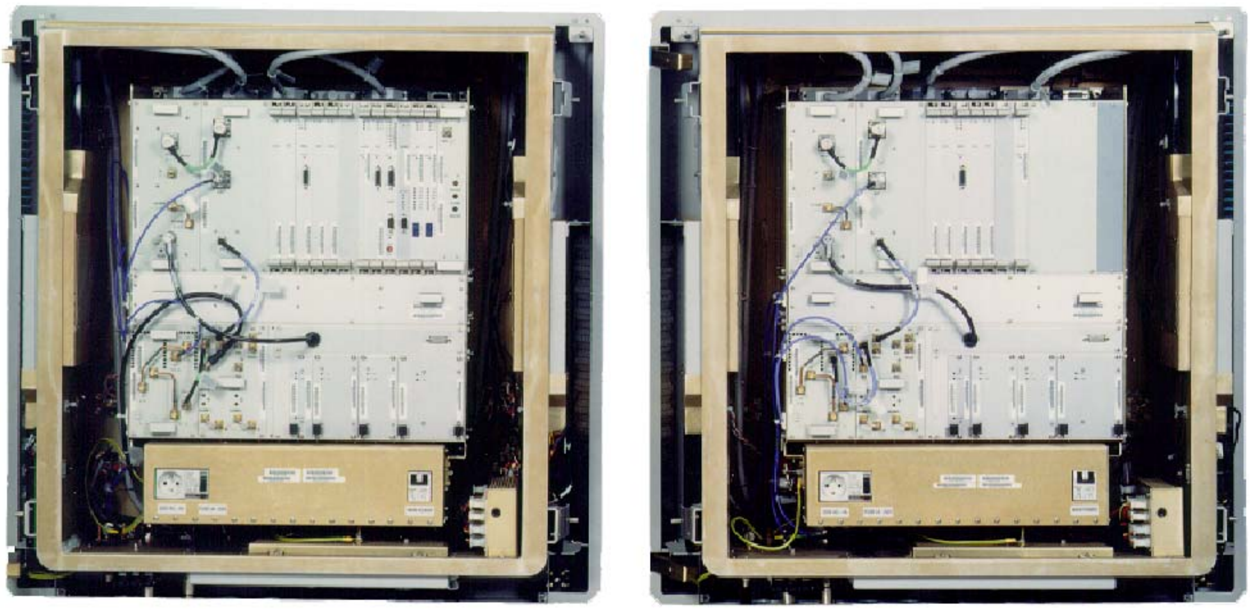


**Figure 3–3 S2000E Outdoor BTS: Base and extension cabinets (inside view)**


**Figure 3–4 S2000H “FP” BTS: Base unit and HPRF modules**

**Figure 3–5 S2000L"FP" BTS: Base unit**

**Figure 3–6 S2000H “EP” BTS: Base unit and HPRF module**

**Figure 3–7 S2000L “EP” BTS: Base or extension unit**

**Figure 3–8 e–cell: Standard base or extension unit**

**Figure 3–9 e–cell: Base or extension unit with battery pack and integrated antenna**

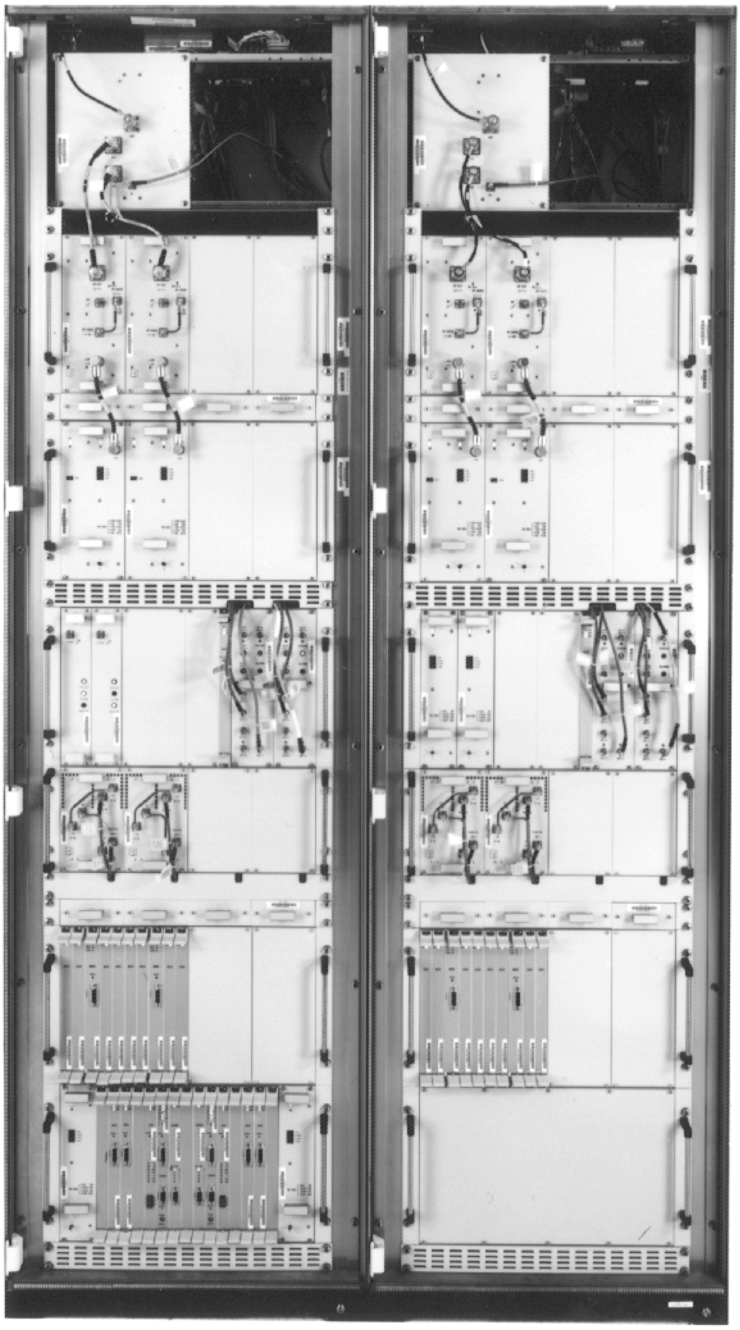


**Figure 3–10 S4000 Indoor BTS: Base cabinet**

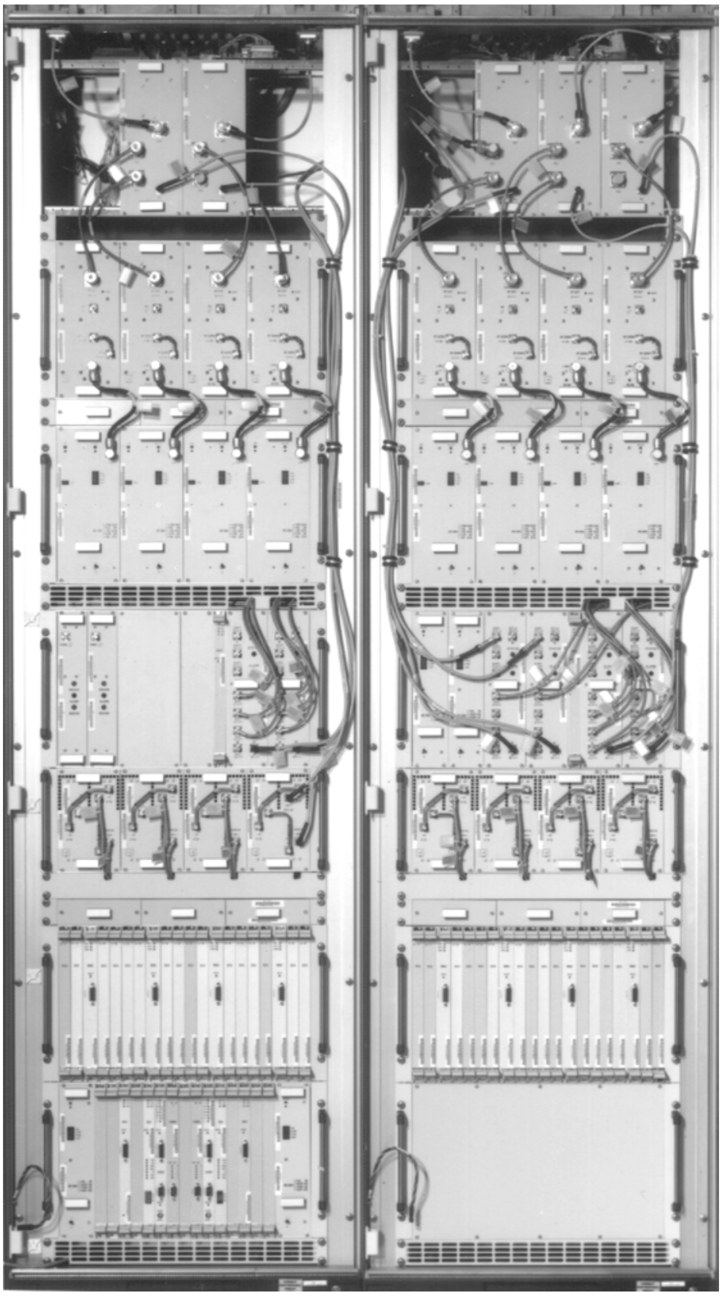


**Figure 3-11 S4000C Indoor BTS: Base cabinet**

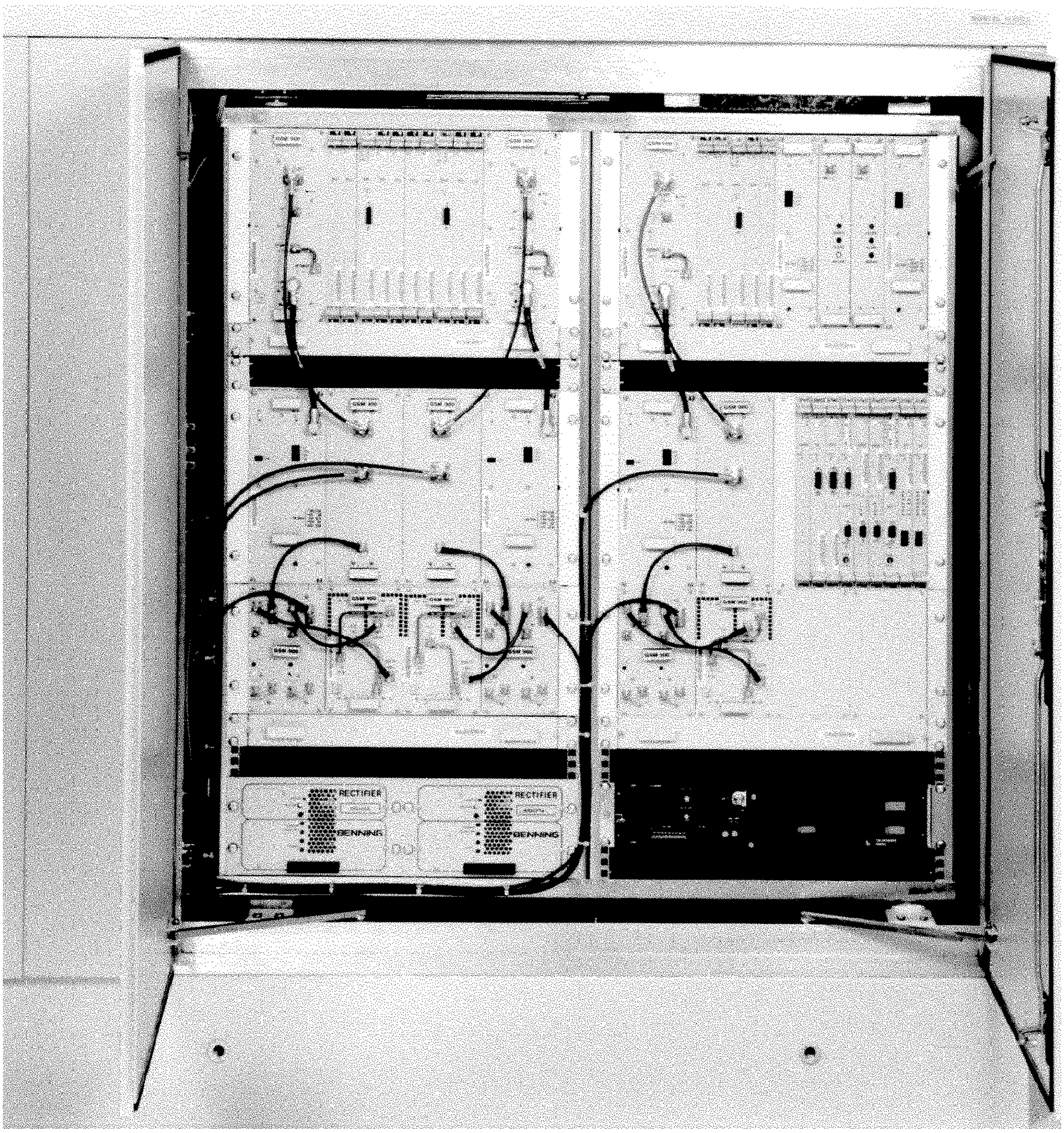



**Figure 3–12 S4000 Outdoor BTS: Base cabinet**

**Figure 3-13 S8000 Indoor BTS: Base cabinet and BCF cabinet**


**Figure 3–14 S8000 Indoor BTS: Base cabinet with CBCF module**

**Figure 3–15 S8000 Outdoor BTS : Base cabinet (with BCF)**

**Figure 3–16 S8000 Outdoor BTS : Base cabinet (with CBCF)**


**Figure 3–17 S8002 Outdoor BTS: Base cabinet with left door**

**Figure 3-18 S8002 Outdoor BTS: Base cabinet with right door**

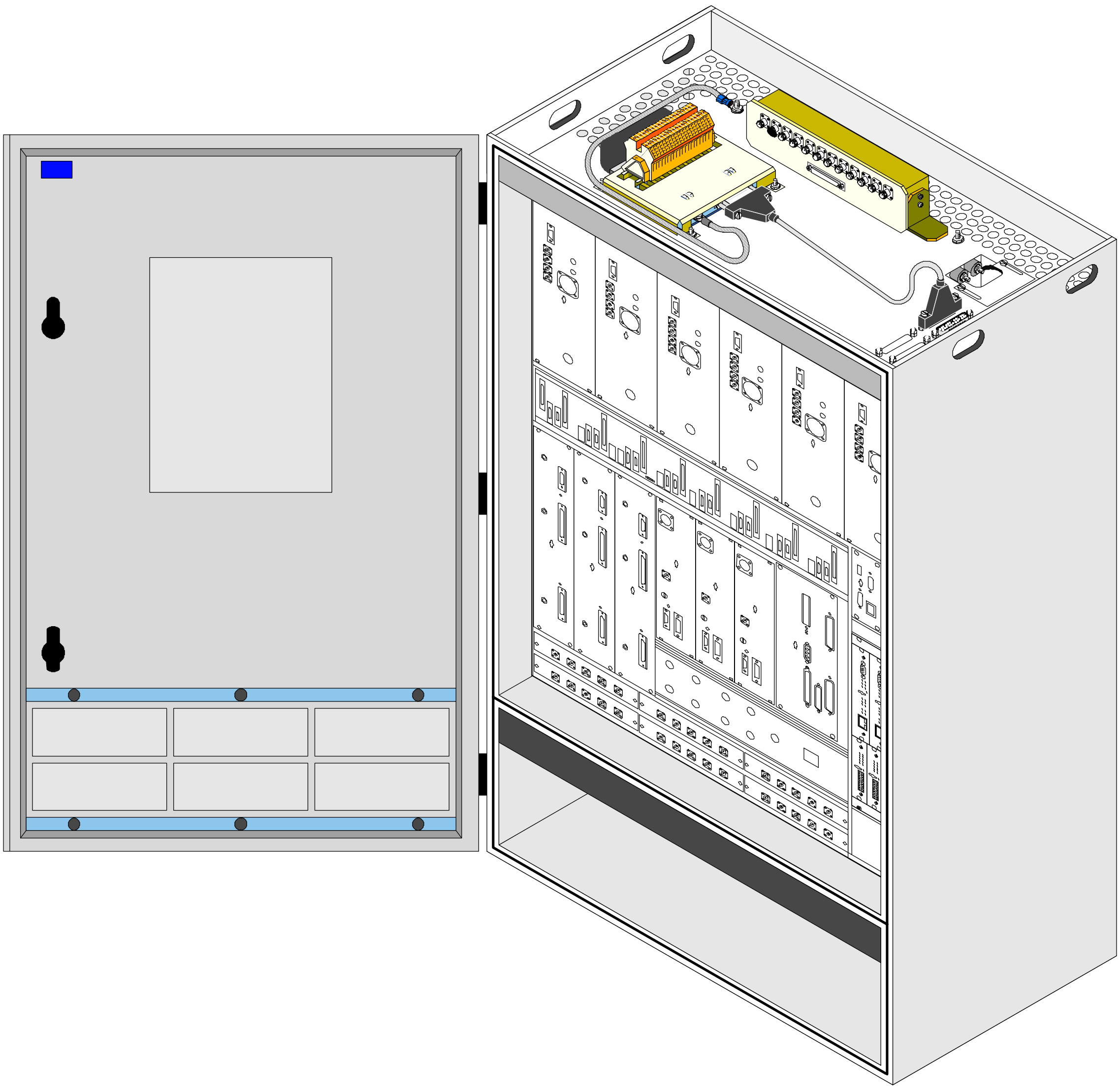


**Figure 3–19 S8003 BTS**

**Figure 3–20 S8006 BTS**

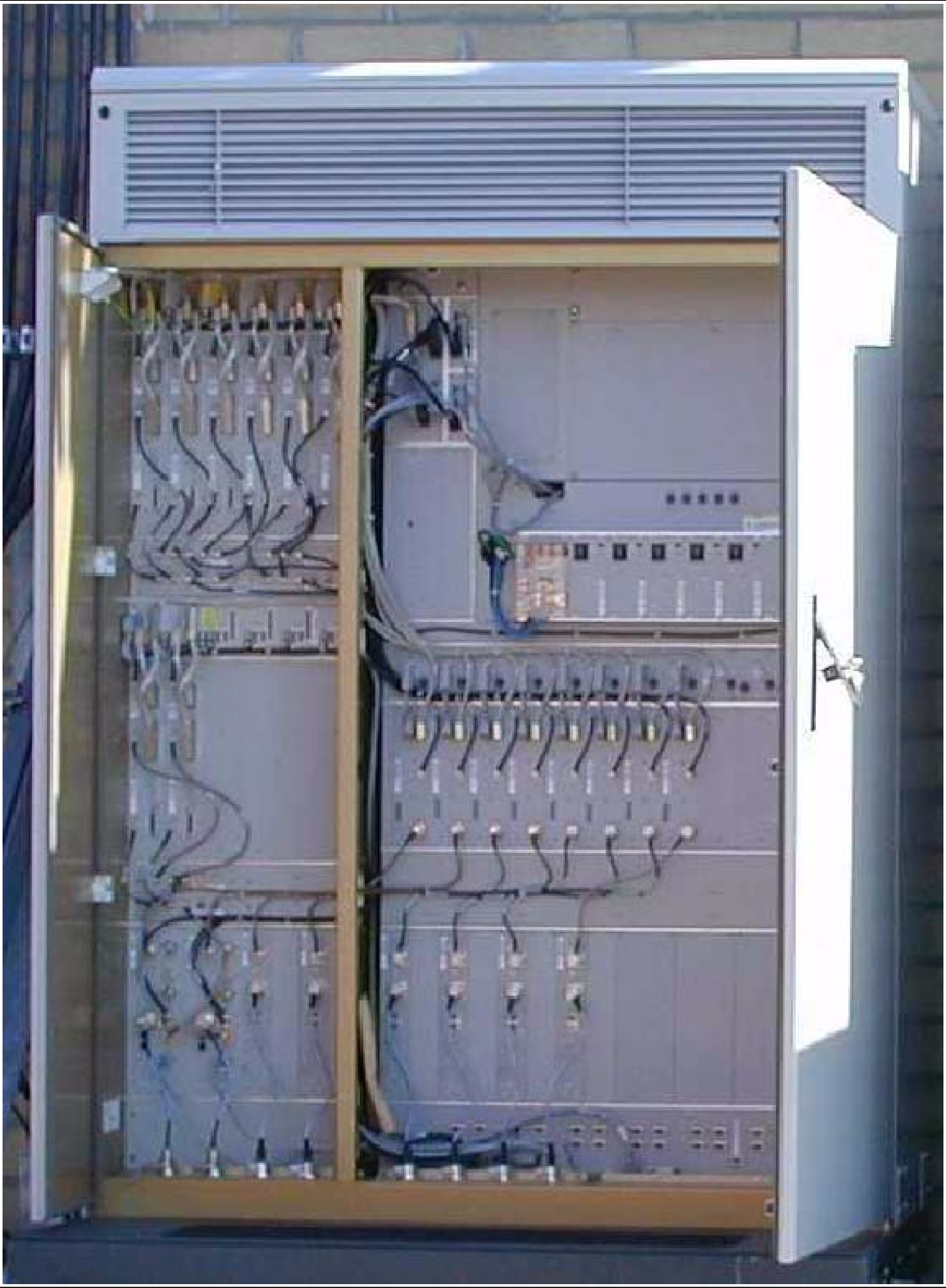


**Figure 3-21 S12000 outdoor BTS**

### 3.1.2 BTS location

BTSs are connected to their controller (BSC) in one of the following configurations, each shown in *Figure 3–22:*

- star
- chain
- loop “drop and insert”

The loop configuration provides a more reliable connection between the BTS and the BSC. It also reduces the number of necessary PCM links on the Abis interface and allows redundancy such that a faulty PCM does not cut off the BTS.

BTSs transmit to geographic sectors. Individual sectors are called cells.

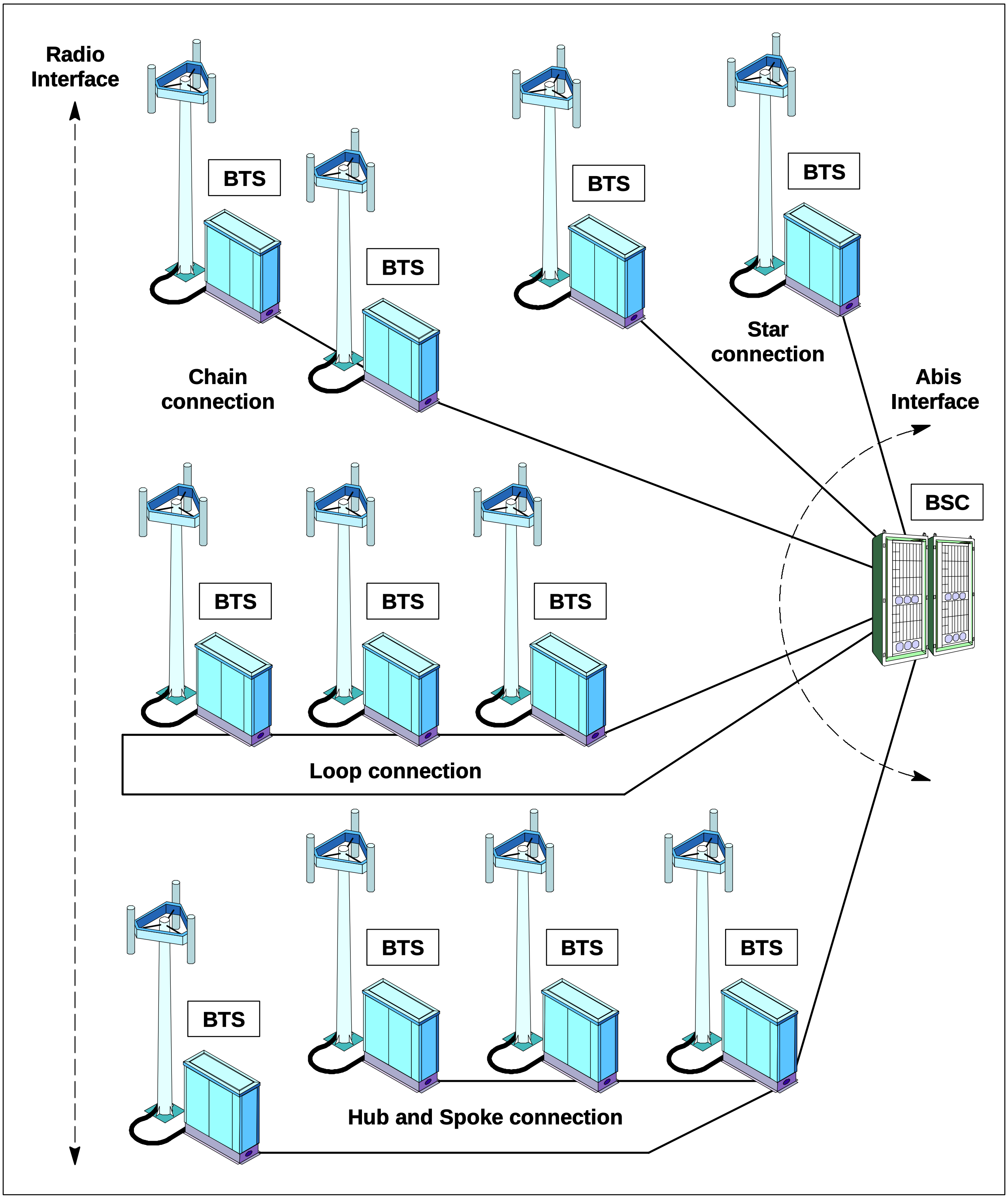



**Figure 3-22 Examples of BTS connections**

## 3.2 BTS hardware structure

The Base Transceiver Station (BTS) contains a base cabinet. According to the BTS type, it may be connected to one or more extension cabinets, according to the radio site configuration requirements.

### 3.2.1 S2000/S2000E BTS

The S2000E Indoor BTS is unavailable in GSM 1900.

#### 3.2.1.1 Hardware description

The S2000 BTS and S2000E Indoor BTS are designed to be mounted on an inside wall. The S2000E Outdoor BTS can be mounted on an outside wall, tower or mast and satisfies standard external weather and dust proofing standards.

The rack is easy to transport and is divided into two parts:

- a fixed part contains the different shelves and power distribution panel
- a removable part or door

The shelves contain modules, most of which standard BTS elements. The cover is removed to provide front facing access. External cables are connected on the underside of the cabinet. A base plate protects and hides the external connections.

The cover is locked on the side. A special tool is required to unlock the cover. An alarm is generated by the door contact when the cover is removed.

The S2000E BTSs are extensible.

The base and extension cabinets contain the following common elements (see *Figure 3–23* and *Figure 3–24*):

- one receiver (RX)
- one transmitter (TX)
- one duplexer
- one frame processor (FP = MNU + 4 DCUs) or enhanced frame processor (FP = AMNU + DCU4)
- one alarm management board (ALATO)
- one splitter (RX–Splitter)
- the power supplies
- the AC distribution panel
- the fan unit

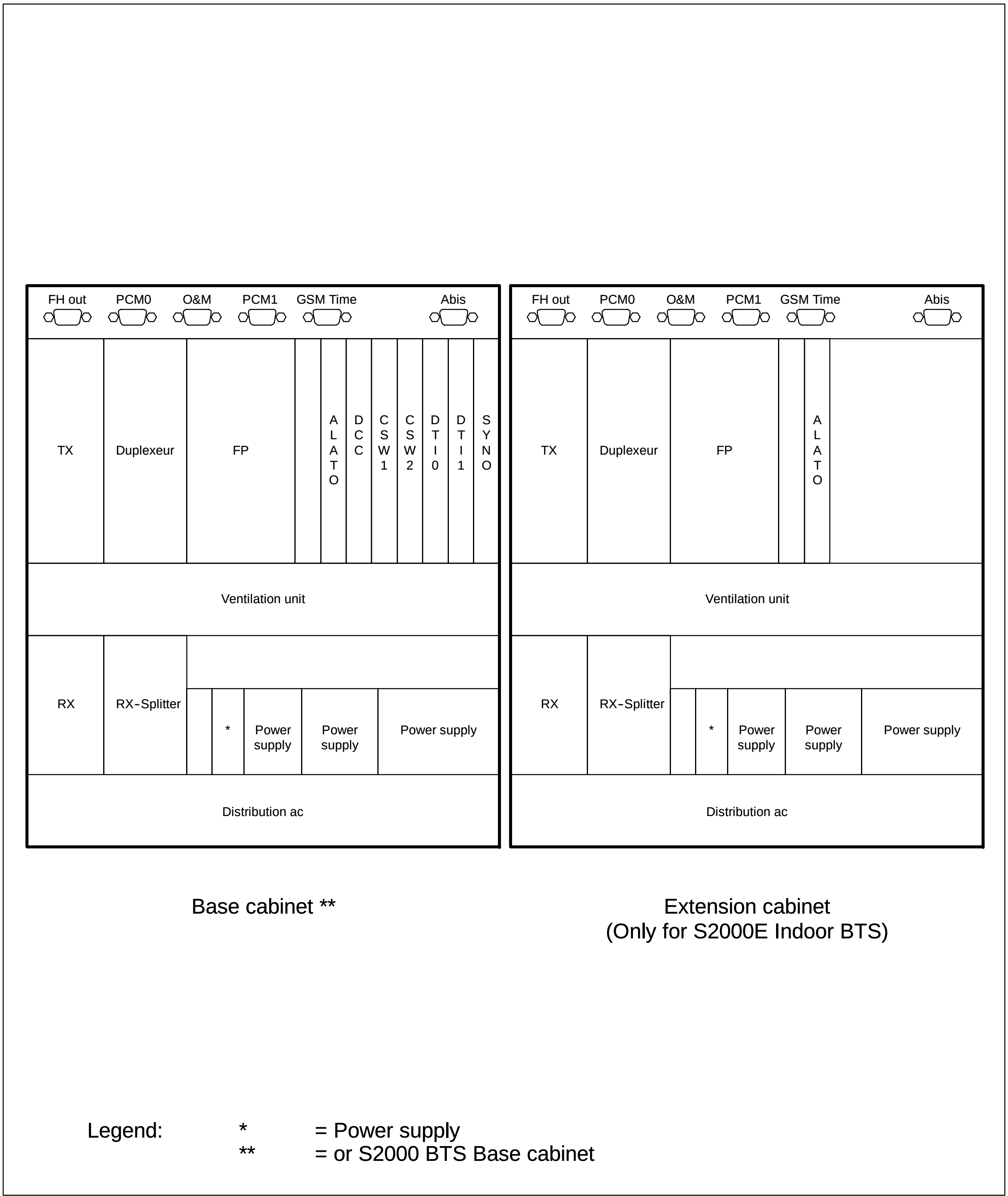
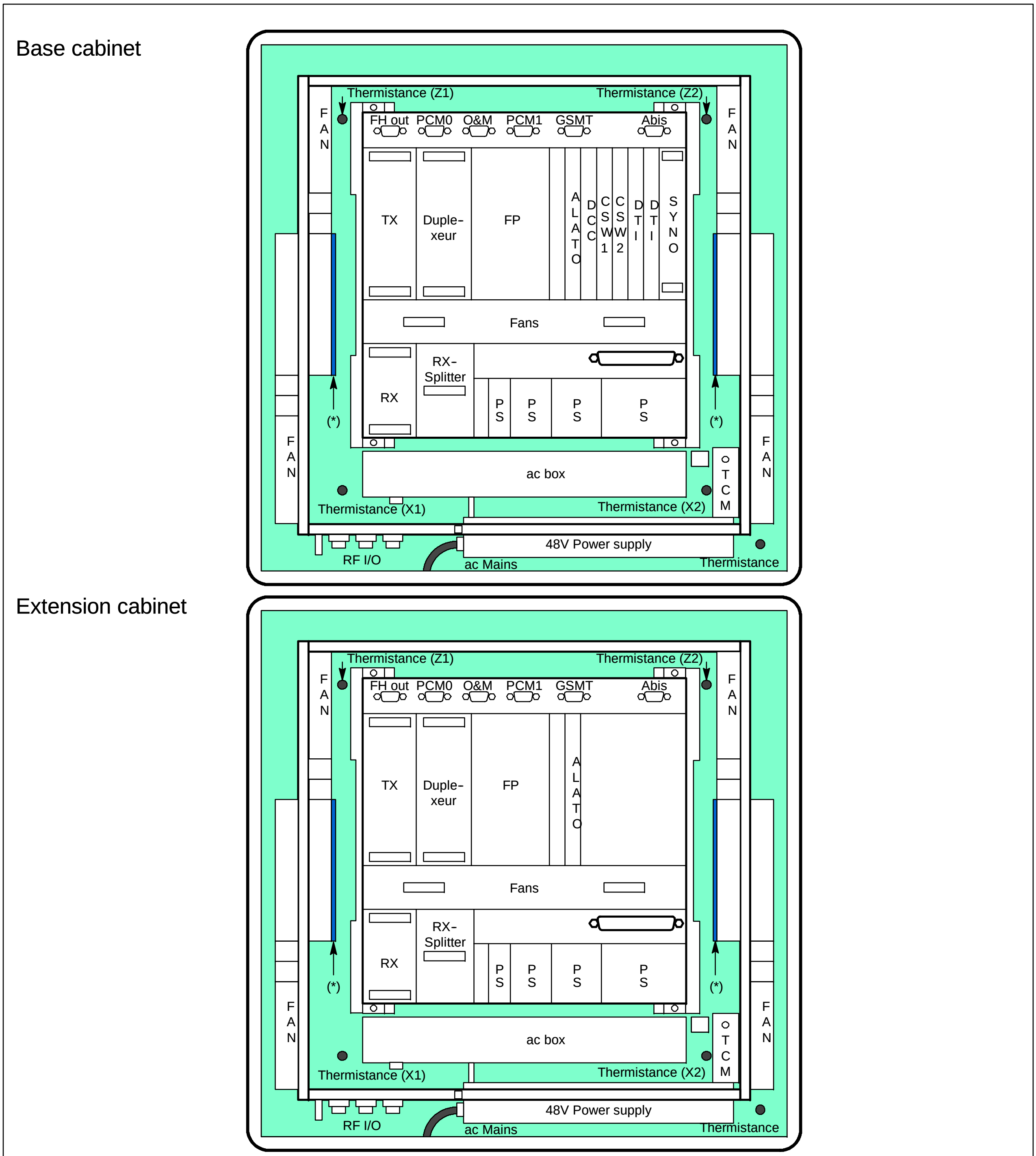



**Figure 3-23 S2000E Indoor BTS: Base and extension cabinets front panels**




Legend: PS: Power supply TCM: Temperature Control Module
(*): OEM (Optional Equipment) for GSM 1900 frequency bands

**Figure 3-24 S2000E Outdoor BTS: Base and extension cabinets front panels**

The base cabinet also contains the following specific elements:

- one control unit (CSW1)
- one switching unit (CSW2)
- two dual trunk interface units (DTI)
- one signaling channel concentrator (DCC)
- one synchronization unit (SYNO)

The S2000E Outdoor BTS cabinets also contains the following specific elements:

- four fans
- two heaters
- one Temperature Control Module (TCM)

#### 3.2.1.2 Physical characteristics

| | **S2000 Indoor** | **S2000E Indoor (*)** | **S2000E Outdoor** |
|---|---|---|---|
| **Height** | Cabinet: 775 mm (30.5 in.)<br>Cover: 100 mm (3.9 in.) | Cabinet: 775 mm (30.5 in.)<br>Cover: 100 mm (3.9 in.) | 950 mm (37.4 in.) |
| **Width** | 625 mm (24.6 in.) | 625 mm (24.6 in.) | 950 mm (37.4 in.) |
| **Depth** | 280 mm (11 in.) | 280 mm (11 in.) | 320 mm (12.6 in.) |
| **Weight** | < 55 Kg (121 lb) | < 55 Kg (121 lb) | < 88 Kg (194 lb) |

(*): except for GSM 1900 frequency band.

**Figure 3–25 S2000/S2000E: Dimensions and weight**

**Cooling**

- forced air on one level
- maximum generated noise less than 55 dB

## 3.2.2 S2000H/S2000L BTS

### 3.2.2.1 Hardware Description

The S2000H and S2000L BTSs are designed to be mounted outdoor or indoor on a pole, wall, or antenna mast.

The standard S2000H BTS contains:

- a base unit (type “EP” or “FP”)
- an extension unit (type “EP” only)
- one or two HPRF modules (High Power Radio Frequency).

  For a description of the HPRF module refer to paragraph 3.5.

The standard S2000H BTS contains:

- a base unit (type “EP” or “FP”)
- an extension unit (type “EP” only)

The standard S2000L BTS is made up of only one package: the base unit. In case of “EP” type, an extension unit may be connected to the base unit.

These light BTSs are easy to transport and handle by a single person. They can be installed in parts:

- the mounting plate
- the sunshield cover
- two fixed parts that contain the core modules

The core modules are not accessible but the front cover may be pull down and provides front facing access to connectors. External cables are connected on the underside of the cabinets. The sunshield cover protects the BTS and is lockable on the front side.

The Battery and Interface module is an additional package available as an option to provide battery backup.

Several parts of the BTS are described below (see *Figure 3–26* to *Figure 3–31*):

- a main part that contains the following elements:
  - two DRXs
  - one SBCF (base unit) or one SALCO (extension unit)
  - one main PSU
- an I/O connector field (only for “FP” type BTS)
- an I&C interface (Installation and Commissioning for base unit only) that contains:
  - one keypad
  - one display
  - three icons (LED)
- an HPRF Power Supply module for the S2000H BTS that may contain:
  - two (dual) VGA/Splitters
  - one secondary PSU for HPRF module powering
  - one MEU–protection PCB
- an LPRF module (Low Power Radio Frequency) for the S2000L BTS that may contain the following elements:
  - two LPAs
  - two LNAs
  - two duplexers

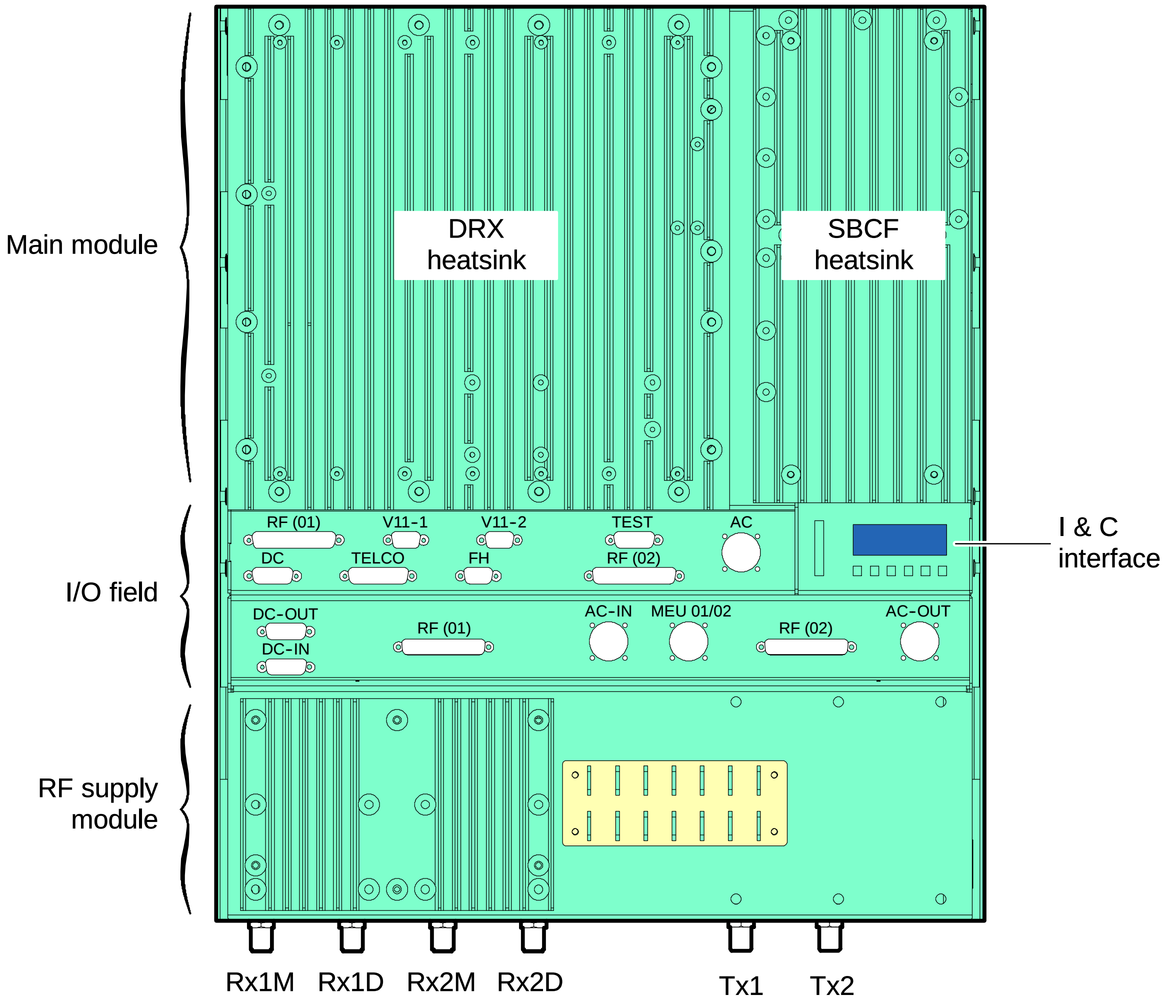



**Figure 3-26 S2000H "FP" BTS: Base unit**

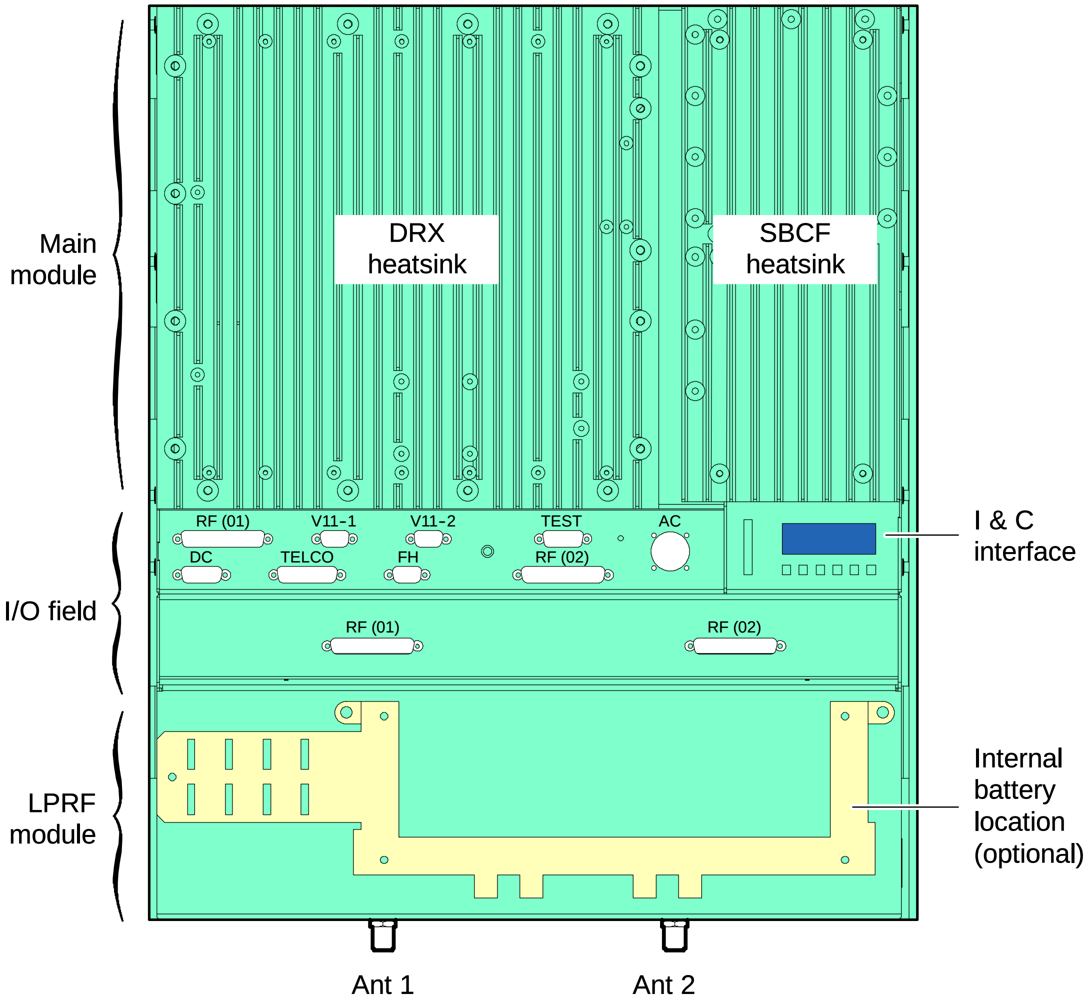
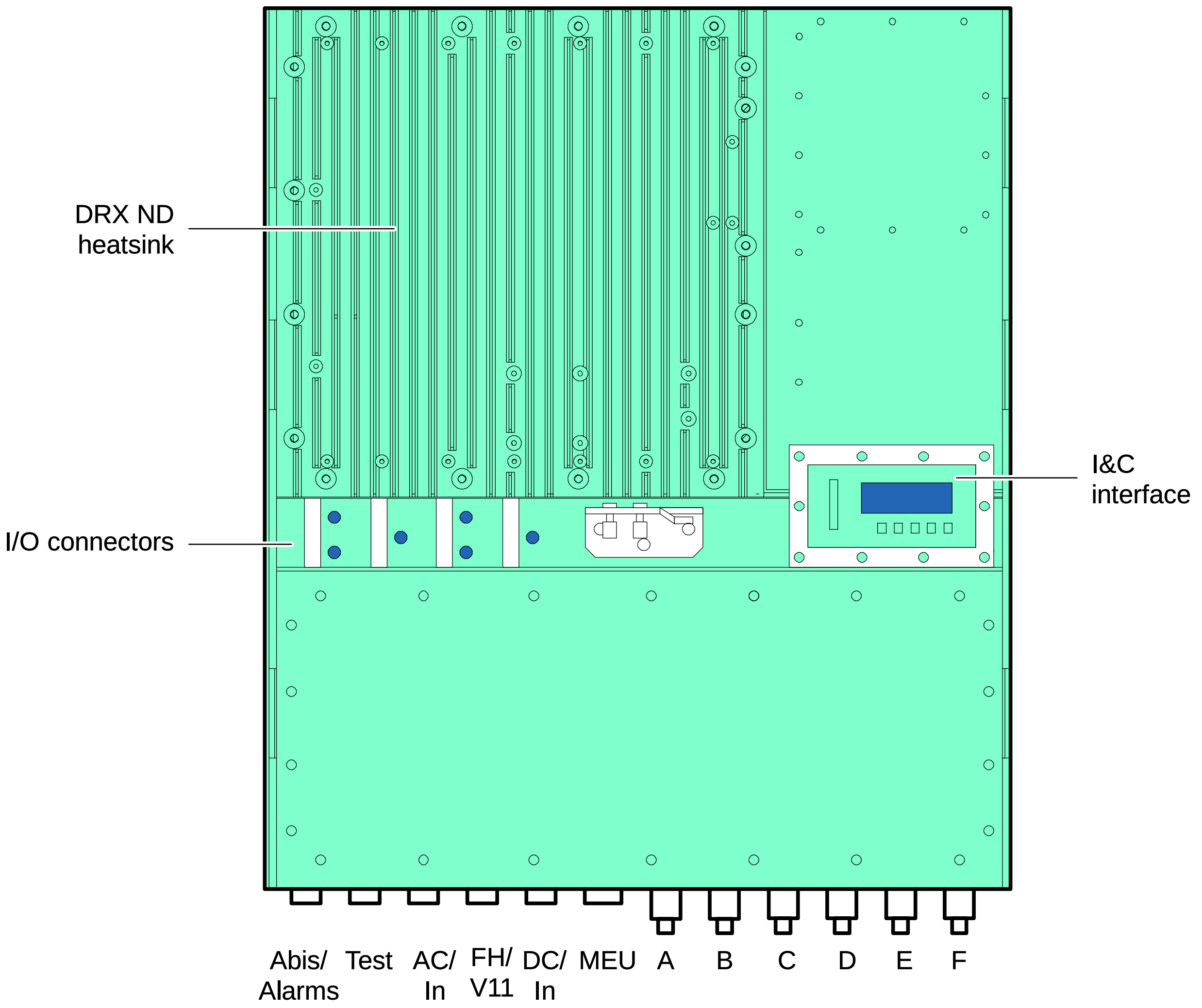
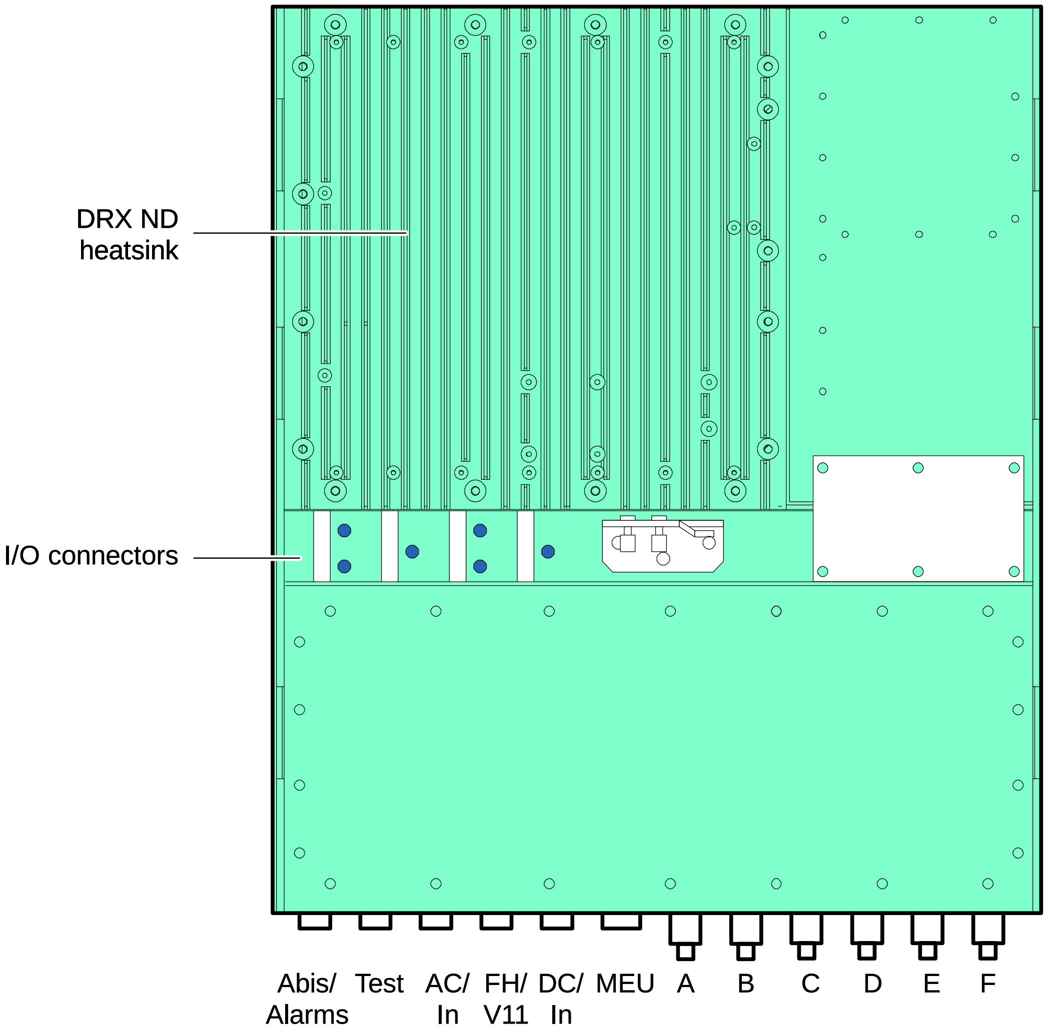



**Figure 3-27 S2000L "FP" BTS: Base unit**




| | | Connectors | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F |
| Configurations | O1/O1E | RxM | RxD | Unused | Unused | Tx | Unused |
| | O2 | RxM0/RxD1 | Unused | Unused | RxM1/RxD0 | Tx0 | Tx1 |
| | S11 | RxM0 | RxD0 | RxD1 | RxM1 | Tx0 | Tx1 |

**Figure 3-28 S2000H “EP” BTS: Base unit**




| | | Connectors | | | | | |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F |
| Configurations | O4/S22 | RxM0/RxD1 | Unused | Unused | RxM1/RxD0 | Tx0 | Tx1 |

**Figure 3-29 S2000H "EP" BTS: Extension unit**

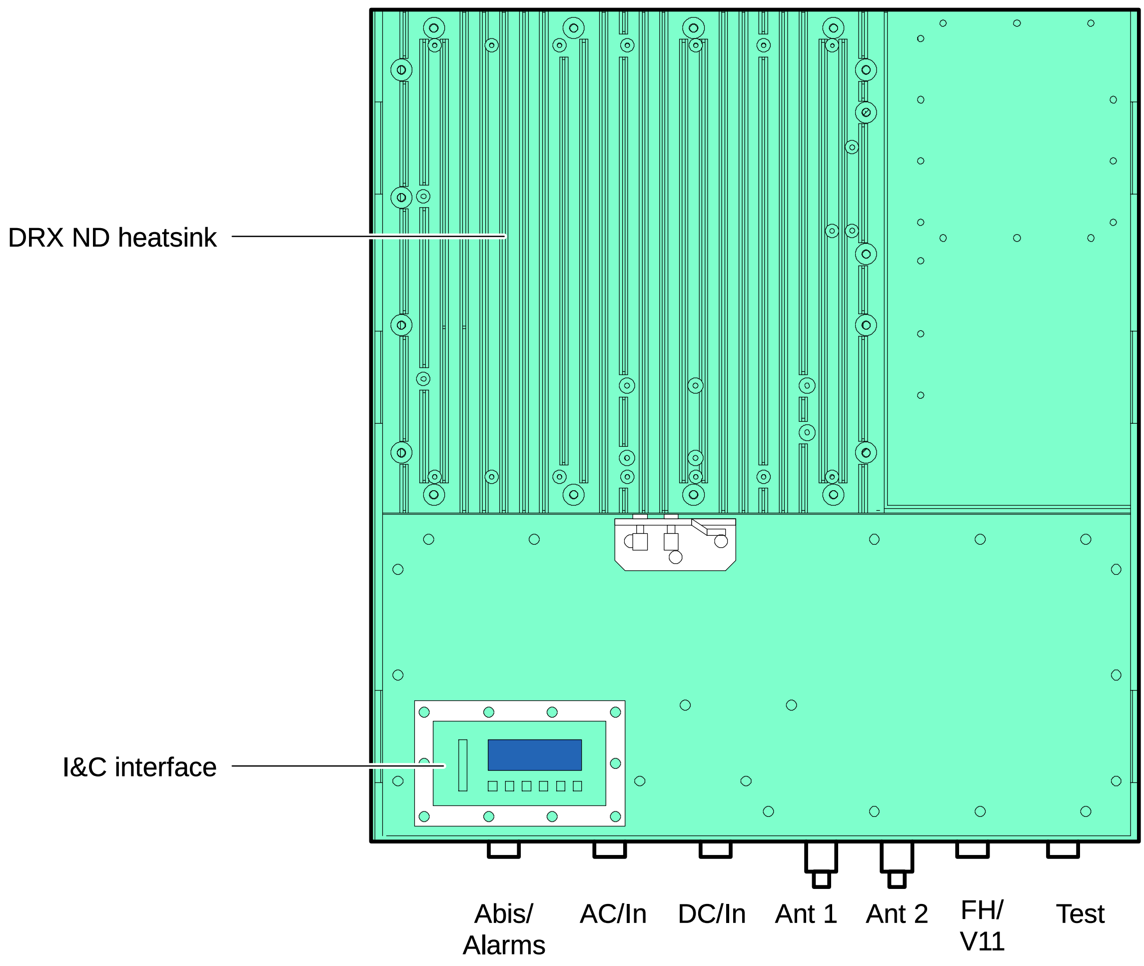



**Figure 3–30 S2000L “EP” BTS: Base unit**

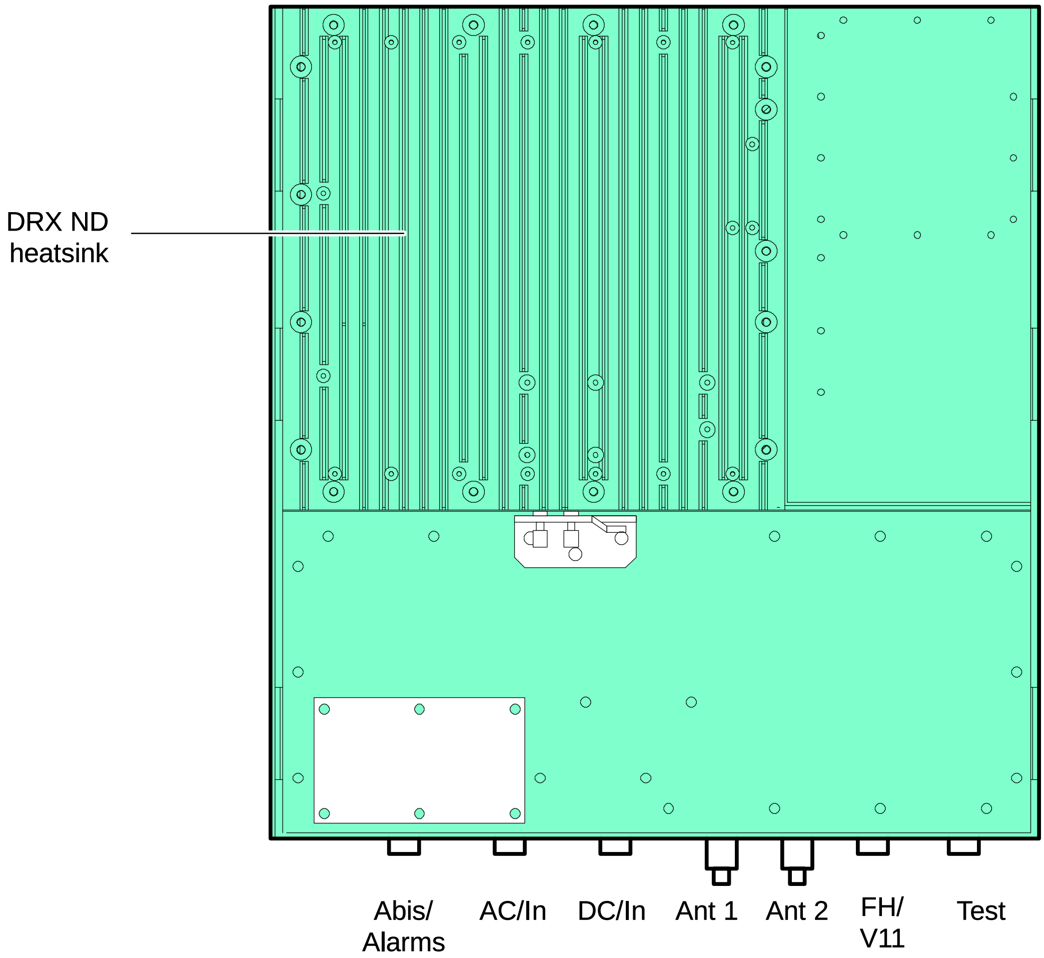



**Figure 3-31 S2000L “EP” BTS: Extension unit**

### 3.2.2.2 Physical Characteristics

- The dimensions and weight of the battery and interface module are:
  - height : 408 mm (16.1 in.)
  - depth : 238 mm (9.4 in.)
  - width : 317 mm (12.5 in)
  - weight: 14 kg (31 lb)

| | S2000H 'FP' | S2000H 'EP' | HPRF 'FP' | | HPRF 'EP' | S20000L 'FP' | | S2000L 'EP' |
|---|---|---|---|---|---|---|---|---|
| | | | 900/1800 | 1900 | | STANDARD | PROTECTED | |
| Height | 740 mm (29.1 in.) | 740 mm 29.1 in.) | 740 mm (29.1 in.) | 790 mm (31.1 in.) | 740 mm (29.1 in.) | 650 mm (25.6 in.) | 740 mm (29.1 in.) | 650 mm (25.6 in.) |
| Width | 542 mm (21.3 in.) | 542 mm (21.3 in.) | 273 mm (10.7 in.) | 273 mm (10.7 in.) | 273 mm (10.7 in.) | 540 mm (21.3 in.) | 540 mm (21.3 in.) | 540 mm (21.3 in.) |
| Depth | 197 mm (7.6 in.) | 197 mm (7.6 in.) | 329 mm (13 in.) | 329 mm (13 in.) | 329 mm (13 in.) | 200 mm (7.9 in.) | 200 mm (7.9 in.) | 200 mm (7.9 in.) |
| Maximum weight of unit | 34 kg (75 lb) | 32 kg (71 lb) | 20 kg (44.1 lb) | 20 kg (44.1 lb) | 20 kg (44.1 lb) | 31.4 kg (69.2 lb) | 31.4 kg (69.2 lb) | 31 kg (68.4 lb) |
| Maximum weight of cosmetic part | 14 kg (31 lb) | 12 kg (26 lb) | 9 kg (20 lb) | 10 kg (22 lb) | 7 kg (15 lb) | 10 kg (22.1 lb) | 14 kg (30.9 lb) | 8 kg (18 lb) |
| Total | 48 kg (106 lb) | 44 kg (97 lb) | 29 kg (64.1 lb) | 30 kg (66.1 lb) | 27 kg (59.1 lb) | 41.4 kg (91.3 lb) | 45.4 kg (100.1 lb) | 39 kg (86.4 lb) |

**Table 3–1 S2000H/L BTS: Dimensions and weight**

### 3.2.2.3 Cooling

- Natural convection cooling over heatsink fins (no fans)
- Sunshielding

## 3.2.3 e–cell

### 3.2.3.1 Hardware description

The base unit and the optional extension unit (see *Figure 3–32*) are designed to be mounted outdoor or indoor on a wall or pole. It is fixed on a wall or a pole using a fixation kit.

The base or extension unit is equipped with:

- a radio cabinet
- an installation kit equipped with:
  - an interconnection box, used mainly for connecting the boxes of the operator and the signal cable of the radio cabinet, the following cables:
    - an ac or dc power cable
    - an external alarm
    - an external MIC cable for the base unit only
    - an inter–unit cable (if extension cabinet is used)
  - optional equipment:
    - a PSU module. Its main function is to convert the ac current, which comes from the ac box of the operator in a dc current (–48 V dc.), to the radio cabinet.
    - a battery module, only if the PSU module is used. In case of current loss in the base or extension unit, this module supplies power for approximately 15 minutes.
    - a ground bar, which is mainly used for installing a common ground between the base unit and the extension unit

These light units are easy to transport and handle by a single person. The radio cabinet take out the installation kit easily in order to accede to the internal modules. The external cables are connected to the radio cabinet from the bottom of the base unit or extension unit via the interconnection box.

Optional equipment:

- An integrated antenna positionned on the front of the radio cabinet and fixed on the top of this one.
- An RF lightning protector, for an external antenna, which is connected on the antenna connector which is located on the top of the radio cabinet.

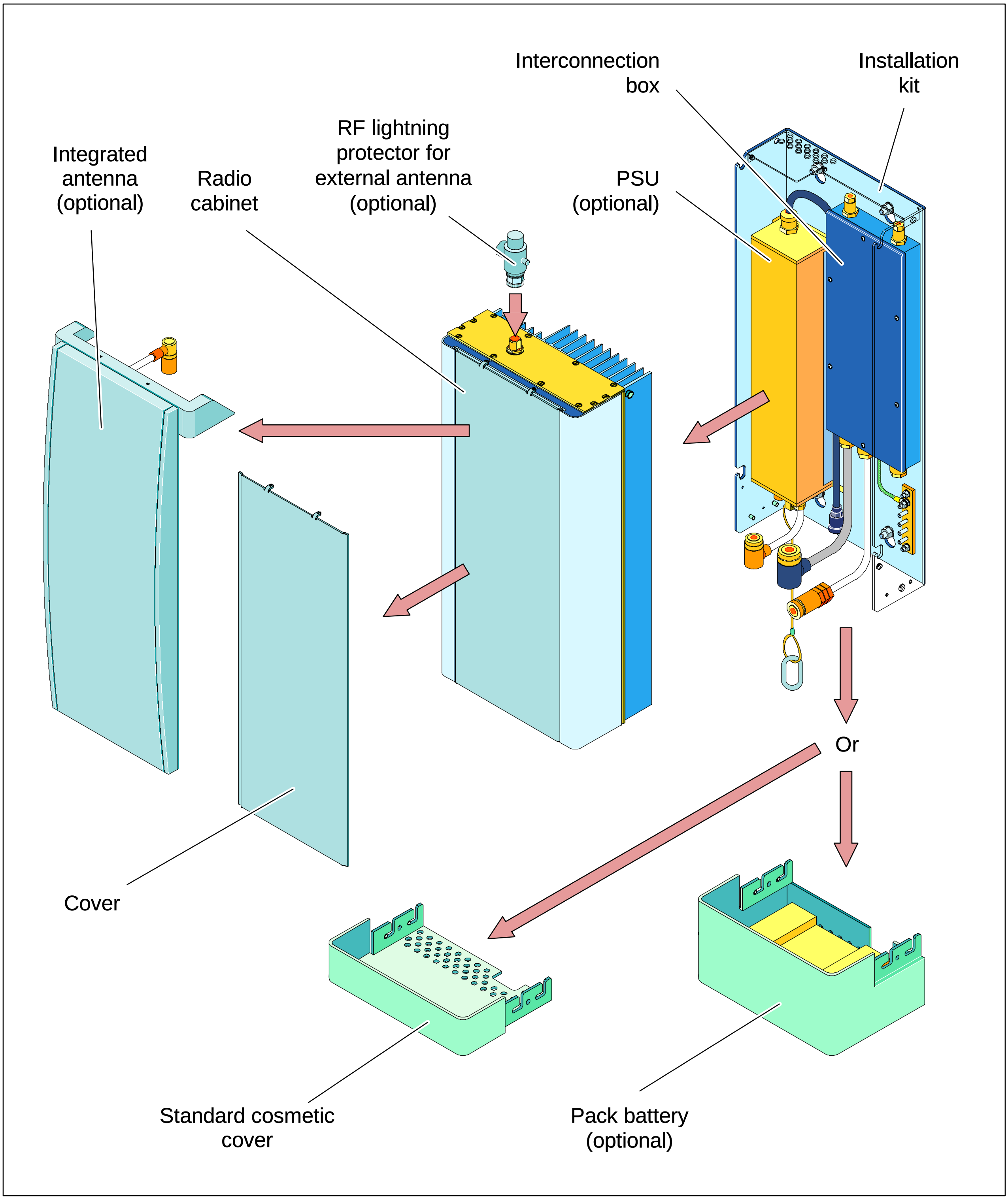



**Figure 3–32 e–cell part assembly**

### 3.2.3.2 Physical characteristics

| Equipment | Dimensions (HxWxD) | | Maximum weight | |
|---|---|---|---|---|
| | cm | inches | kg | lb |
| **Radio cabinet** | 55.5 x 26 x 15 | 21.8 x 10.2 x 5.9 | 17 | 33.5 |
| **Installation kit alone** | 60.65 x 26 x 9.75 | 23.9 x 10.2 x 3.8 | 4 | 8.8 |
| **Battery pack** | 13.25 x 26 x 17.45 | 5.2 x 10.2 x 6.9 | 5.4 | 11.9 |
| **PSU** | 40 x 10.2 x 7.4 | 15.7 x 4.0 x 2.9 | 4.45 | 9.8 |
| **Installation kit without battery pack and with standard cosmetic** | 62.15 x 26 x 17.45 | 24.5 x 10.2 x 6.9 | – | – |
| **Installation kit with battery pack and PSU** | 69.05 x 26 x 17.45 | 27.2 x 10.2 x 6.9 | 13.85 | 30.5 |
| **Radio cabinet + installation kit without battery pack and with standard cosmetic** | 62.2 x 26 x 19.2 | 24.5 x 10.2 x 7.6 | – | – |
| **Radio cabinet + installation kit with battery pack and PSU** | 69.1 x 26 x 19.2 | 27.2 x 10.2 x 7.6 | 30.85 | 68 |
| **Integrated antenna** | 59.5 x 26 x 4.0 | 23.42 x 10.2 x 1.57 | – | – |

**Table 3–2 e–cell: Dimensions and weight**

### 3.2.3.3 Cooling

The primary path for the removal of heat from the cabinet is through the vertical flow of natural convection cooling air over the fins of the external heatsinks on the front and rear surfaces.

## 3.2.4 S4000 Indoor and S4000C BTS hardware overview

### 3.2.4.1 Hardware description

The cabinet has a compact metal frame fitted with two lifting rings and contains removable shelves that hold equipment. All cabinets have the same physical structure.

The S4000 Indoor BTS comes as a base cabinet connected to one or more extension cabinets.

The S4000C BTS comes as a base cabinet connected to one extension cabinet.

BTS modules that provide radio and digital processing functions may be plugged into the shelves that fit them. Their number is variable and depends on the radio site configuration. All equipment units and connections are accessible from the front, so cabinets may be installed back to back. Shelves are plugged into the cabinets, making rear wiring inside the cabinets easily accessible by unplugging them. External connections are implemented from the top of the cabinets, so false floors are not needed (see *Figure 3–33* to *Figure 3–36*).

The following equipment are common to the base and extension cabinets:

- a transmission coupler
- the transmitters (TX)
- the TRX power supply units (PS/A)
- the receivers (RX)
- the reception couplers (RX–splitter)
- the reception diversity couplers (RX–splitter diversity)
- the frame processors (FP = MNU + 4 DCUs or AMNU + DCU4)
- two common power supply units (PS/B)
- one alarm management board (ALAT)
- two fan units

The BCF unit, which is unique in the BTS, is installed in the base cabinet and includes the following modules (see *Figure 3–33*):

- two synchronization boards (SYN)
- two processor boards (CSW1)
- two switching matrix boards (CSW2)
- the digital trunk interface boards (DTI)
- the data channel concentrator boards (DCC)

The 75 Ω kit box located at the top of main cabinet is necessary for GSM 900/1800 configurations working with 75 Ω impedance. It ensures the adaptation from the 120 Ω impedance of the DTI boards to the 75 Ω impedance of the external PCMs.

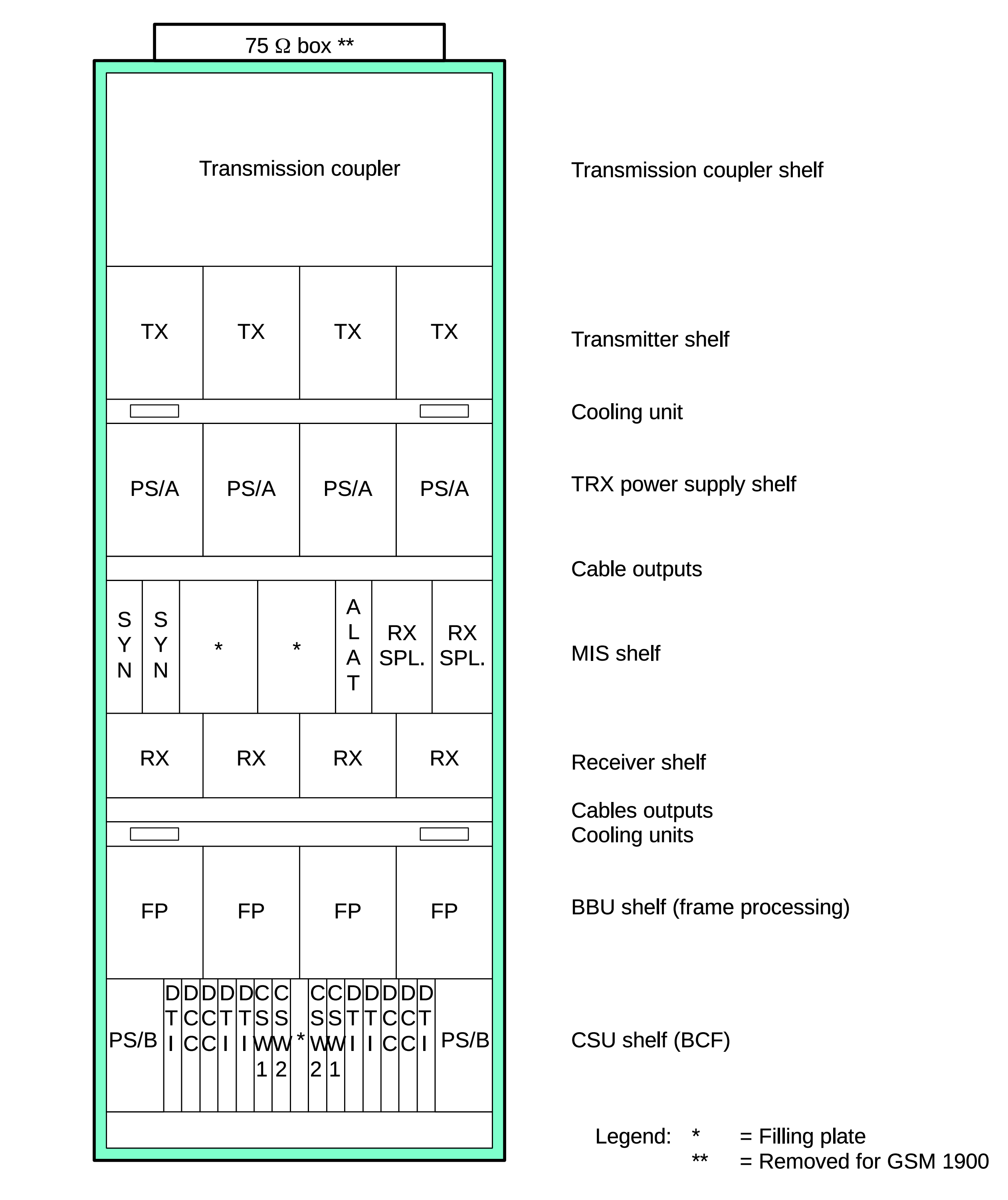



**Figure 3–33 S4000 Indoor BTS: Base cabinet (fully equipped with diversity)**

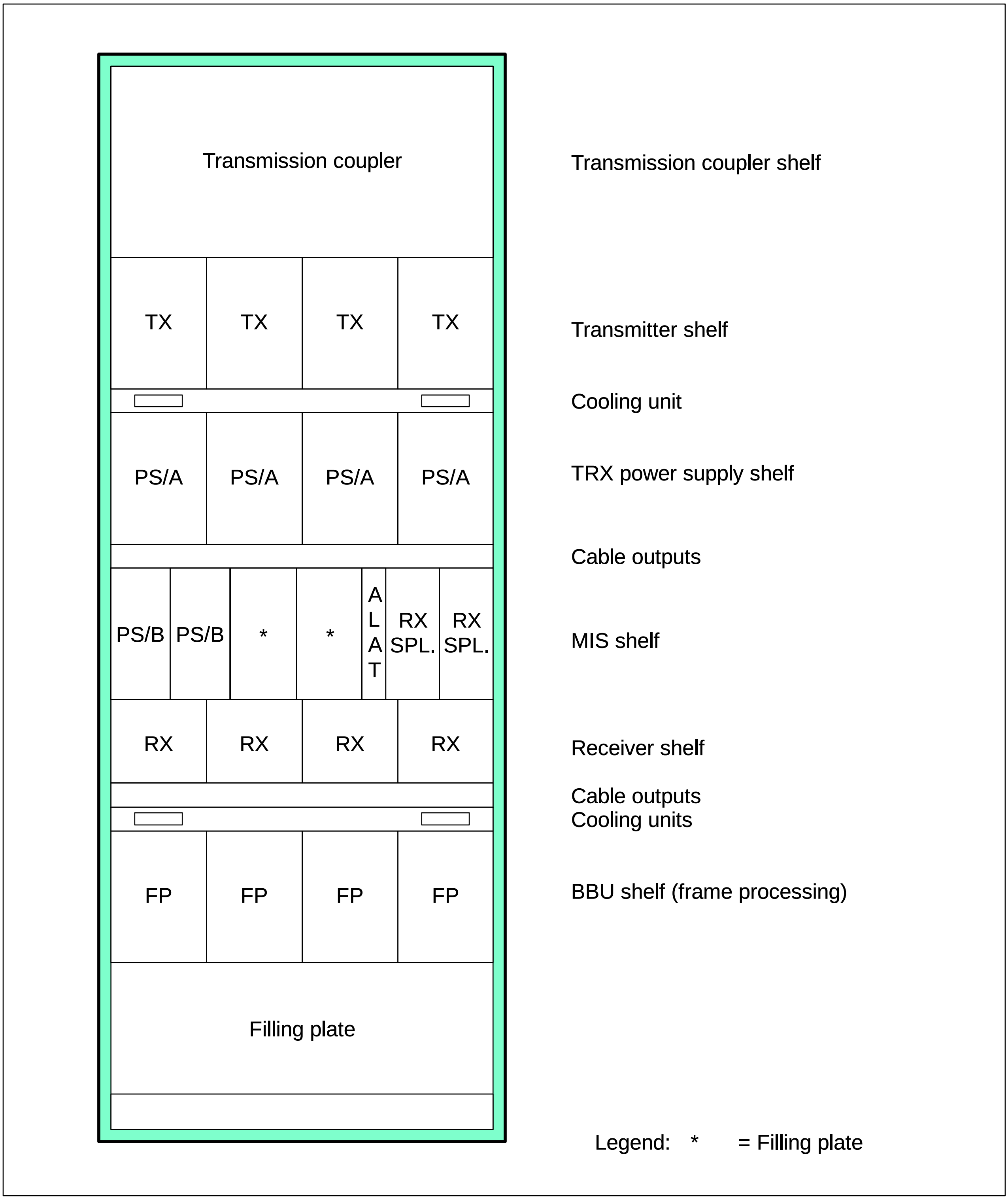



**Figure 3–34 S4000 Indoor BTS: Extension cabinet (fully equipped with diversity)**

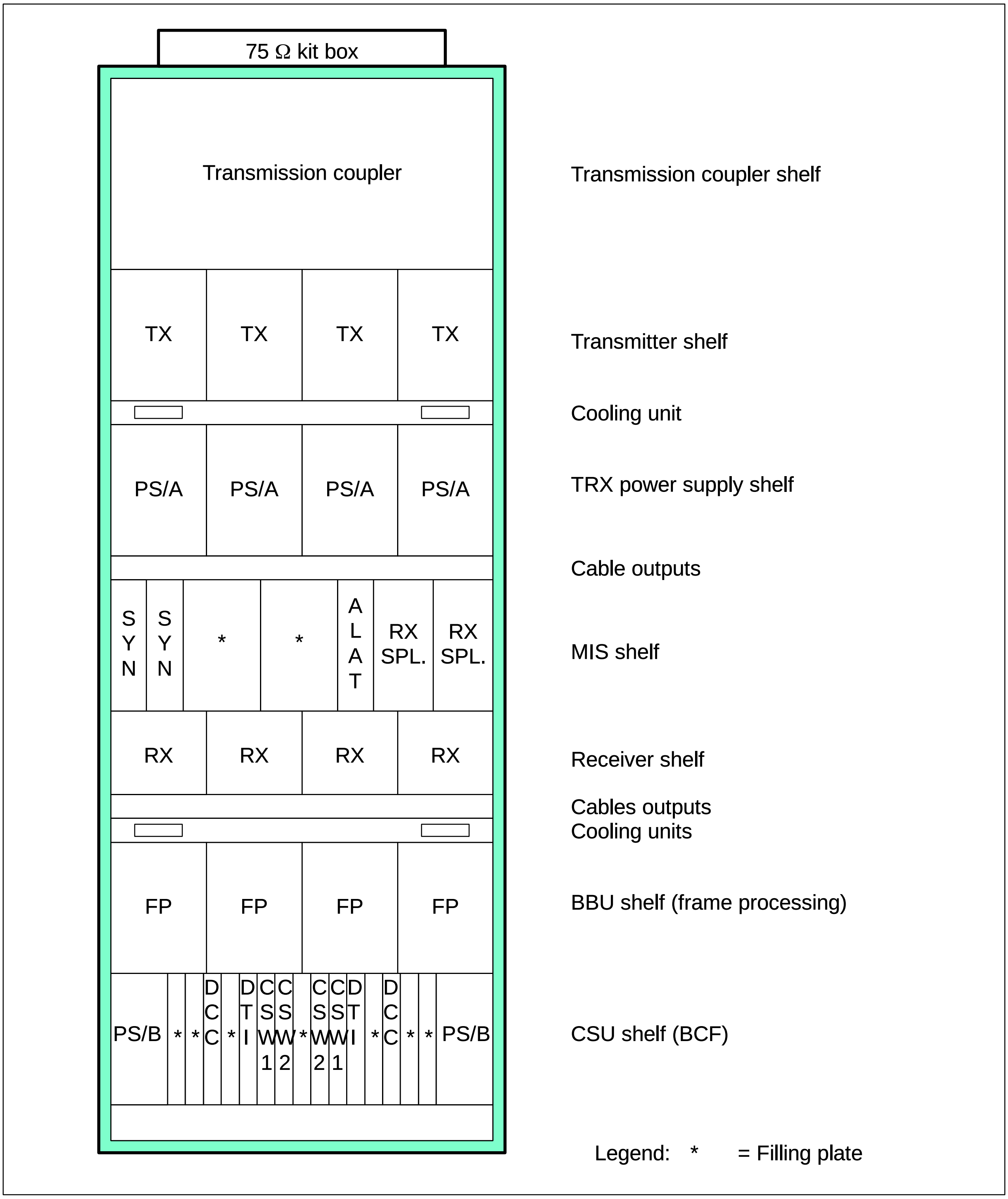



**Figure 3-35 S4000C BTS: Base cabinet (2S323 configuration)**

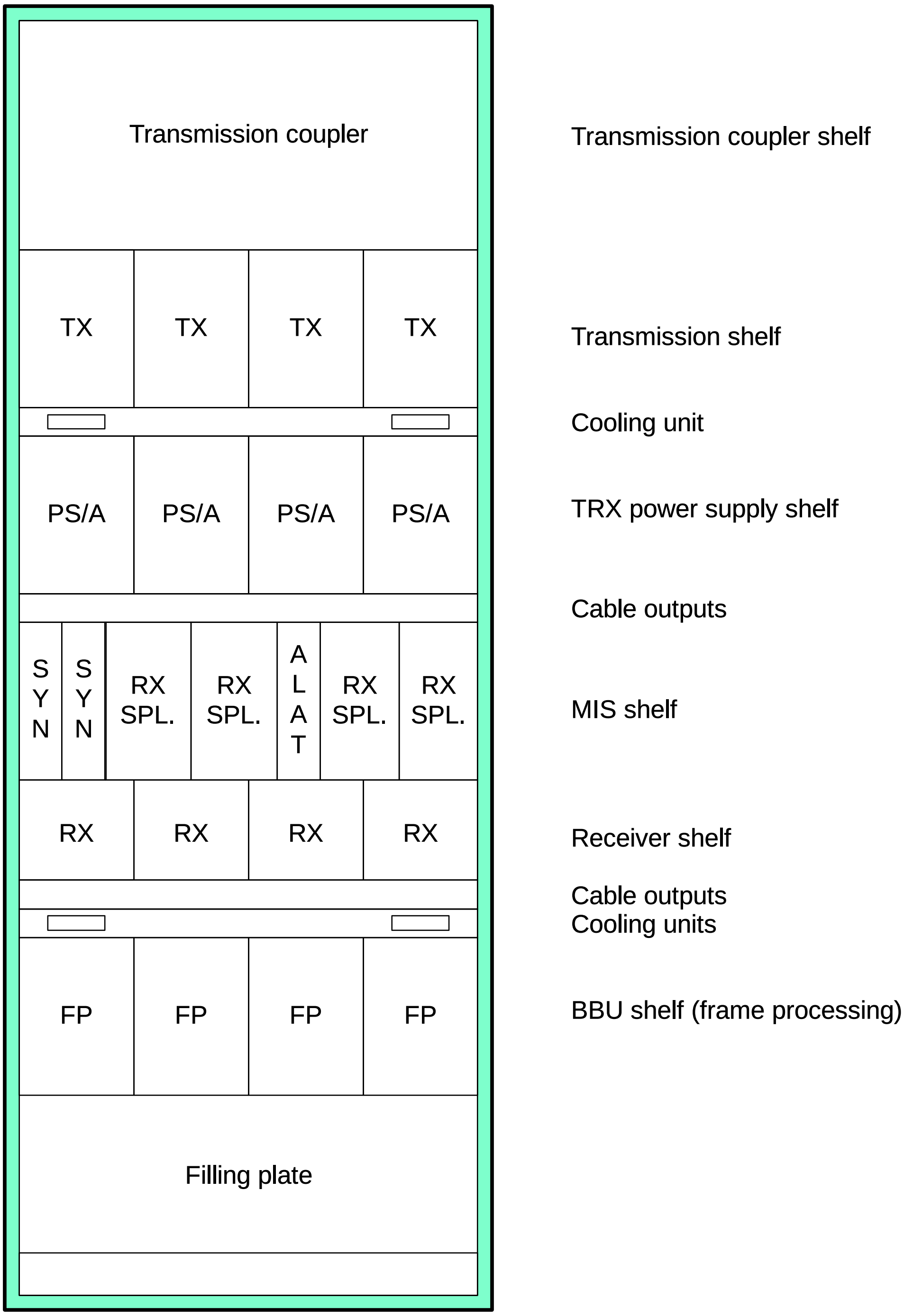



**Figure 3-36 S4000C BTS: Extension cabinet (2S323 configuration)**

#### 3.2.4.2 Physical characteristics

**Dimensions**

- width: 60 cm (23.6 in.)
- width: 30 cm (11.8 in)
- height: 220 cm (86.6 in)

**Weight**

- less than 250 kg (551 lb) for S4000 Indoor BTS
- less than 300 kg (661 lb) for S4000C BTS

**Cooling**

- forced on two levels
- generated noise is less than 65 dBA

### 3.2.5 S4000 Outdoor BTS

#### 3.2.5.1 Hardware description

The cabinet is made of extruded aluminium with double–layer side and rear walls, roof and doors. The cabinet is protected against dust and water intrusion. All cabinets have the same physical structure (see *Figure 3–37*).

Thermal management of the internal equipment is provided by the combination of the double–layer design, an additional heat exchanger placed on the back of the cabinet, and forced air cooling, including fans positioned below the enclosure roof and between the equipment.

The outside of the cabinets is painted with polyester coat material, which has a normal life expectancy of 30 years. The enclosure is manufactured so it has no protrusions that may catch passers–by or snag clothes. Sharp corners and edges are avoided by the fabrication technique that reduces welding to a minimum and uses folding techniques.

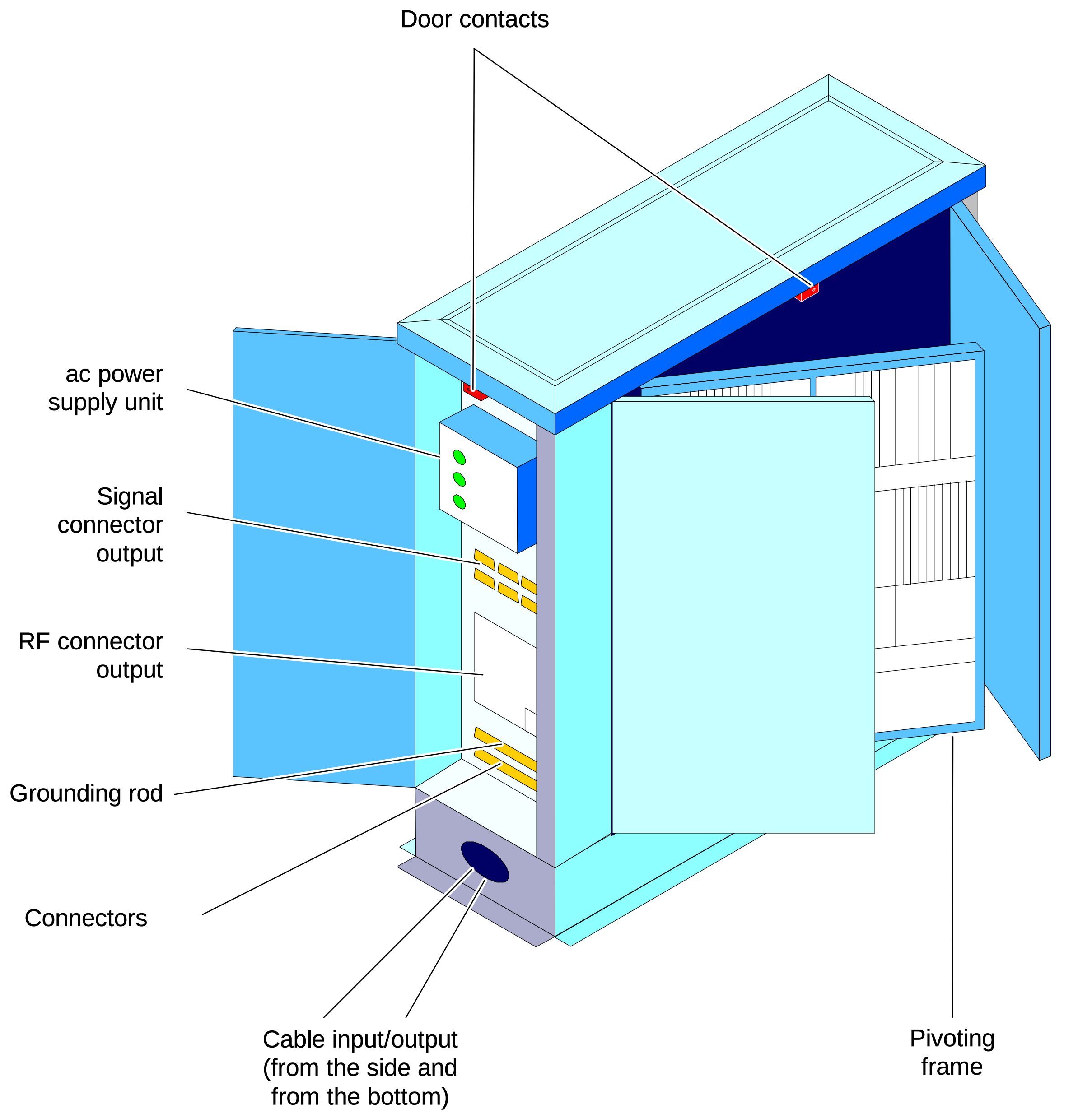



**Figure 3-37 S4000 Outdoor BTS: Overall view**

The cabinet is made of two main parts. The equipment compartment houses a 19” mounting swing frame that supports the radio modules and additional equipment such as power rectifiers. The swing frame enables very convenient access of back panels, heat exchanger, and batteries during maintenance and installation. The two main doors of the equipment compartment have locks that hold them open in 90° or 135° angles. On the left side of the cabinet is a power distribution box and switch and external RF/PCM connections compartment that opens from the right side. All external connections use two large holes located in the bottom of the compartment.

The following equipment units are common to the base or extension cabinets (see *Figure 3–38* and *Figure 3–39*) are:

- the transmitters (TX)
- the duplexers
- the TRX power supplies (PS/A)
- the receivers (RX)
- the receiver couplers (RX–splitter)
- the frame processors (FP = MNU + 4 DCUs or AMNU + DCU4)
- one fan unit
- two 48 V/25 A power rectifiers

The BCF unit, which is unique in the BTS, is installed in the base cabinet and includes the following modules (see *Figure 3–38*):

- two synchronization boards (SYNO)
- two processor boards (CSW1)
- two switching matrix boards (CSW2)
- the digital trunk interface boards (DTI)
- the data channel concentrator boards (DCC)
- one alarm management board (ALATO)
- two common power supply units (PS/B)

Optional equipment:

The base and extension cabinets can be equipped with an optional equipment complying with PCM links at 2 Mbit/s.

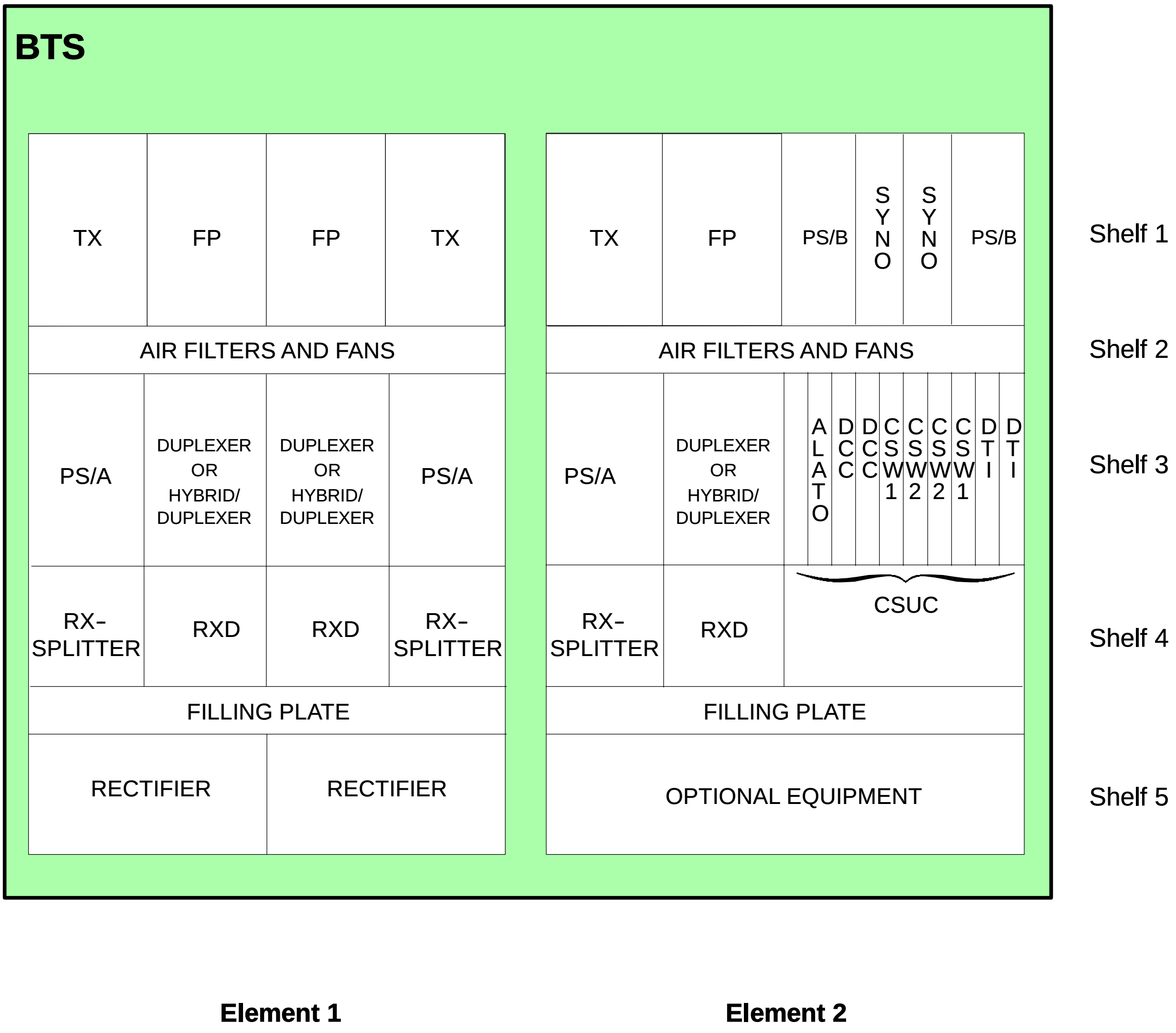



**Figure 3-38 S4000 Outdoor BTS: Base cabinet**

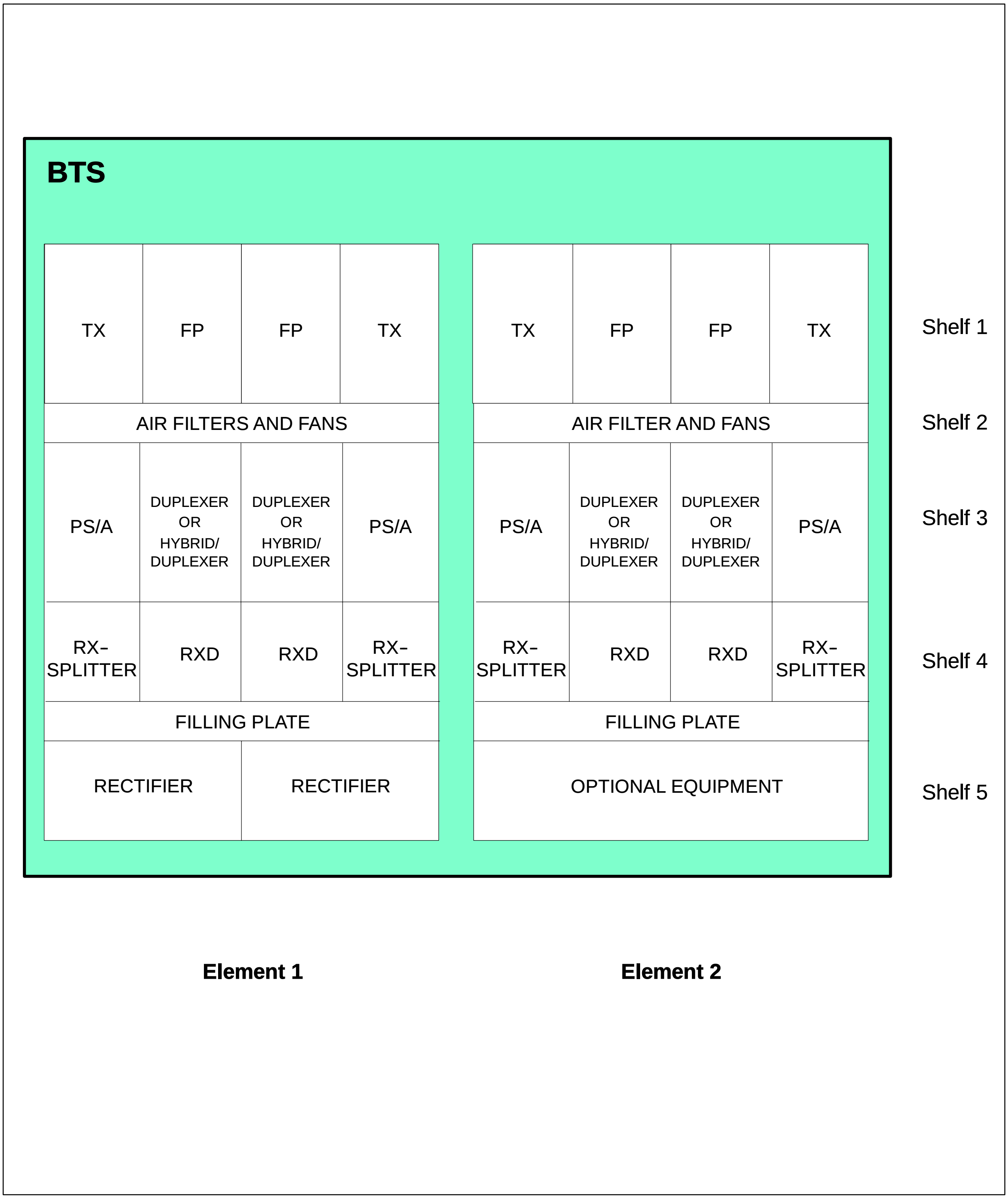



**Figure 3-39 S4000 Outdoor BTS: Extension cabinet**

### 3.2.5.2 Physical characteristics

**Dimensions**

- width: 150 cm (59 in.)
- depth: 50 cm (19.7 in.)
- height: 135 cm + 20 cm (plinth) (53.1 in. + 7.9 in.)

**Weight**

- empty cabinet: 303 kg (668 lb)
- fully equipped without batteries: base cabinet: 392 kg (864 lb)
  extension cabinet: 398 kg (878 lb)
- fully equipped with batteries: base cabinet: 480 kg (1058 lb)
  extension cabinet: 486 kg (1072 lb)

**Cooling**

- forced on a level
- generated noise is less than 65 dBA per cabinet at 1 m (3 ft 4 in.).

### 3.2.5.3 Electrical characteristics

**Backup Power Supply**

- a battery set enables a minimum backup time of:
  - 1h 20 mm: for three TRX working at maximum power
  - 4h 40 mm: software preservation (no transmission)
- average life time: four years
- weight: 87.2 kg (192 lb)
  21.8 kg (48 lb) per battery

## 3.2.6 S4000 Smart BTS

### 3.2.6.1 Hardware description

Note that the S4000 Smart BTS is available in GSM 1900 frequency bands only.

An S4000 Smart BTS contains a base cabinet, with possibly an extension cabinet, and a masthead that can be integrated facets or Masthead Electronic Units. All S4000 Smart BTS components are connected with cables. The length of the cable from the cabinet to the masthead equipment can be of up to 75 meters (about 166 feet).

When higher capacity S4000 Smart BTS products become available in future releases, it will be possible to upgrade an existing S4000 Smart BTS by adding or replacing shelves and adding new equipment cabinets as needed.

All PCS 1900 equipment conforms to US regulations and are designed to operate in North America. The components of the S4000 Smart BTS are described below.

### 3.2.6.2 Smart BTS Outdoor cabinets

The physical structure of the cabinet used for S4000 Smart BTS is the same as for the S4000 Outdoor BTS and is resistant to firearms misuse.

The following equipment units are common to the base or extension cabinets (see *Figure 3–40*).

- the transmitters (TX), which include D–type power supplies
- the frame processors (FP = MNU + 4DCUs or AMNU + DCU4)
- the C–type power supplies
- the receivers (RX)
- the frame receiver couplers (RX–splitter)
- the fan units
- the Digital Beam Formers (DBF)
- the power rectifiers (PR1 to PR5)

The BCF unit remains unchanged. A Radio Link Equipment and backup batteries may be added as an option. Power is supplied to the masthead equipment by a DC distribution box installed in the base cabinet. Configuration using two–branch digital beamforming is obtained by suppressing the DBF modules, terminating unused RF ports, and downloading appropriate software into the DCU modules.

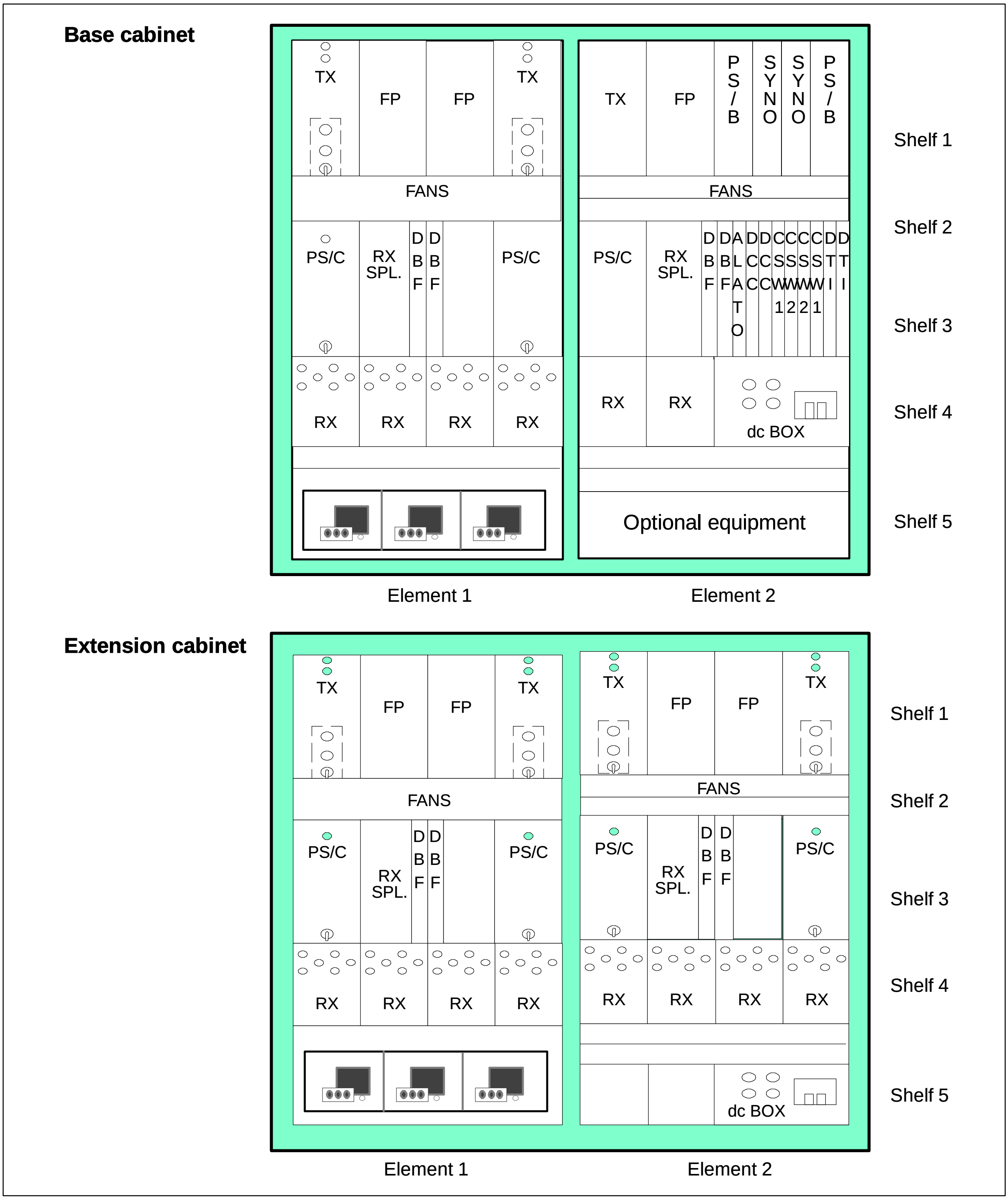



**Figure 3-40 S4000 Smart BTS: Base and extension cabinets**

### 3.2.6.3 S4000 Smart BTS Antenna Facets

An S4000 Smart BTS antenna (see *Figure 3–41*) appears as a plastic radome that is a weatherproof but breathing enclosure. It contains mechanical and structural items and appropriate internal wiring. It is designed to withstand the effects of wind speeds of up to 50 m/s (160 ft/s), minimize the effects of solar radiation, and an efficiently cool the High Power Amplifiers modules by natural convection.

The standard color is dolphin grey, but any color is available for special orders. Equipment is provided for attachment to various structures via an intermediate pole (about 12 cm, or 4.5 in., in diameter) and a standard mounting bracket. This enables mounting of three facets in a group on top, around lattice or monopole towers, or separated around the parapet or roof edge of a building. The constraints for positioning smart antennas are the same for conventional antennas.

A facet includes two side mounts providing mechanical downtilt, and one additional mount at the top of the facet to control and lock elevation adjustments. Azimuth adjustments can be made within ± 60° and elevation adjustments within ± 3°,with a roll accuracy of ± 0.5° in each case. The mechanical downtilt is given relative to a reference plane. An electrical downtilt can be made by 2.5° steps in a ± 10° range (with a 0.5 dB gain loss beyond ± 5°).

Fixing points that accept various types of camera brackets are provided for alignment purposes. Cable connectors are grouped at the bottom of the facet for easy installation.

The connection to the cabinet contains several RF cables (four transmit and four receive), a set of twisted pairs of serial data cables, and dc cables (four 30 V and 8 V power suppliers to and from the cabinet) enclosed behind an armored sheath. All equipment is protected against lightning, and the connectors interface contains quarter wave stubs for lightning protection of the RF cables.

Facets have been designed so that no special heavy equipment is necessary for installation apart from conventional rigging equipment (winches, pulleys, etc). Facets also offer the same degree of protection against impact as those that may occur during installation. All mountings are constructed from noncorrosive materials.

**Figure 3-41 S4000 Smart BTS: Antenna integrated facets**

### 3.2.6.4 Physical characteristics

**Dimensions**

- same as those for the S4000 Outdoor BTS

**Weight**

- empty cabinet: about 300 kg (661 lb)
- fully equipped without batteries: about 400 kg (about 882 lb) (for base and extension cabinets)
- fully equipped with batteries: about 500 kg (1102 lb)

**Cooling**

- same as for the S4000 Outdoor BTS

### 3.2.6.5 Backup Power Supply

Minimum of 40 minutes backup time for all configurations, with a self–preservation period of two hours (vital software is preserved).

### 3.2.6.6 Facet characteristics

**Dimensions**

- height ≤ 1.9 m (6 ft 4 in.)
- width ≤ 0.85 m (2 ft 10 in.)
- depth ≤ 0.30 m (1 ft)

**Weight**

- about 85 kg (187 lb) (to be reduced in later releases)

### 3.2.7 S8000 Indoor BTS

#### 3.2.7.1 Hardware description

The base cabinet and the extension cabinet have the same physical structure.

The cabinet frame is metallic. Equipment is accessed from the front of the cabinets and the cabling is achieved from the tops of the cabinets.

There are two types of cabinets:

- base cabinet, which contains the boards for the power supplies and radio processing units.
- BCF cabinet, which provides radio site functions, can be wall–mounted or installed on a plinth. The BCF cabinet is not required when the base cabinet contains a CBCF module.

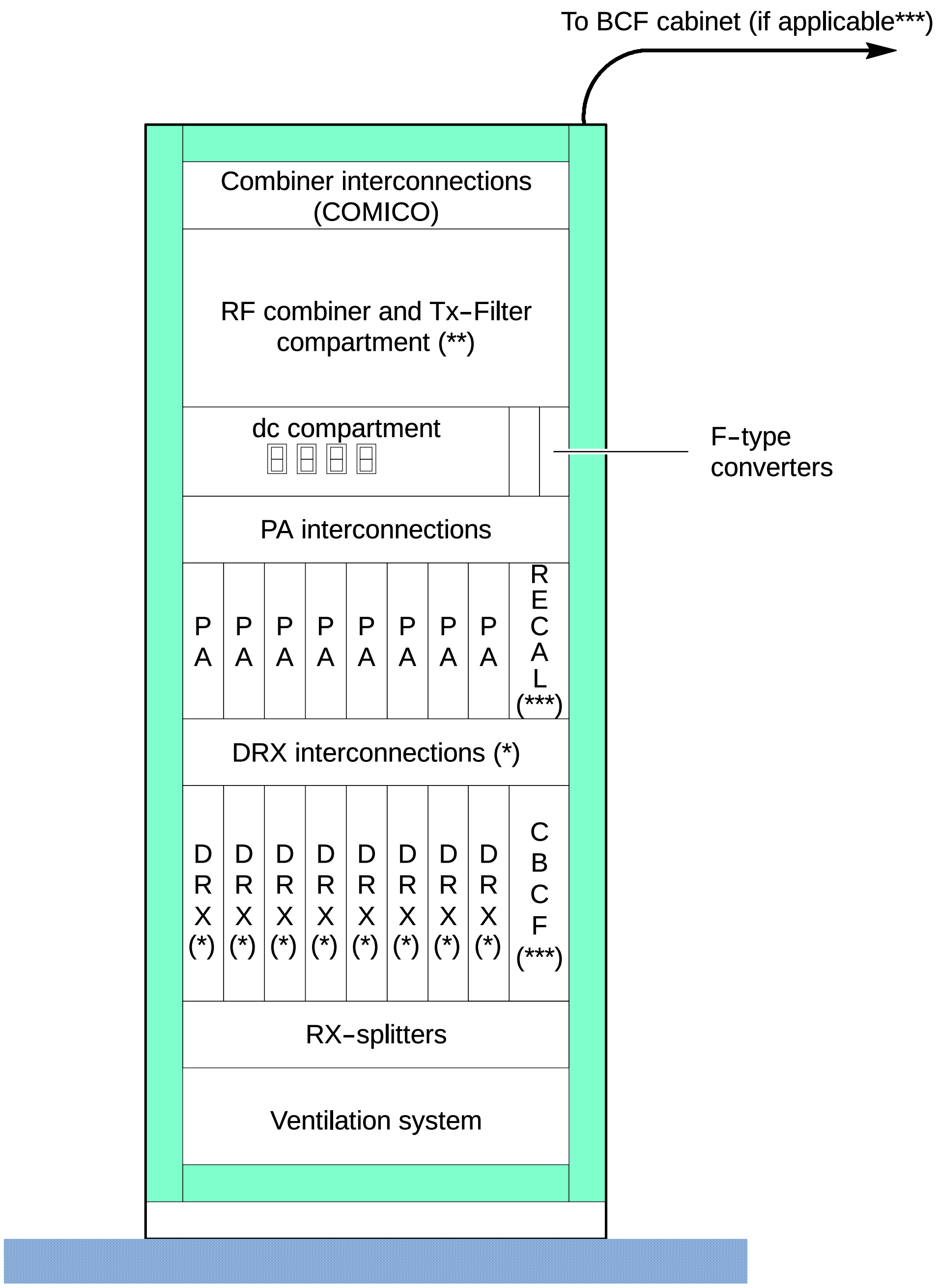
**Base cabinet**

The base cabinet includes the following maximum number of components (see *Figure 3–42*):

- eight DRXs (or e–DRXs)
- eight Power Amplifiers (PA)
- the following combinations of RF combiner modules and Tx–Filter modules:
  - six RF combiners of duplexer–only type (D) or of two–way hybrid type (H2D)
  - four RF combiners (D) and four Tx–Filter modules each with an optional VSWR meter
  - three RF combiners of four–way hybrid (H4D) type

**Note:** Depending on the coupling system used, an RF–combiner can contain a duplexer, an H2D on H4D transmitter coupler, an LNA splitter, and a VSWR meter.

- six RX–Splitters
- one CBCF module ( used only if there is no BCF cabinet)
- one of the following alarm management units:
  - ALCO, used with the BCF cabinet, or
  - RECAL, used with the CBCF Module




Note: (*) DRX or e-DRX.
(**) The Tx-Filter module is optional.

(***) When the BCF cabinet is used:
- the ALCO board replaces the RECAL board
- a filling plate replaces the CBCF module.

**Figure 3-42 S8000 Indoor BTS: Base cabinet inside view**

**BCF cabinet**

The BCF cabinet includes the following boards (see *Figure 3–43*):

- two Control and SWitching Modules (CSWM)
- four Data Signaling Concentrators (DSC)
- three PCM interface units (PCMI)
- two Gateway units (GTW)
- two Synchronization units (SYNC)
- three DC/AC rectifiers (5 V/12 A)
- one Controller board (PSCMD)

### 3.2.7.2 Physical characteristics

**Base cabinet dimensions**

- height: 170 cm (67 in.)
- width: 75 cm (29.5 in.)
- depth: 45 cm (17.7 in.)

**Base cabinet weight**

The weight of the empty base cabinet, that is, without boards and ventilation units, is 140 kg (308 lb.). The fully equipped cabinet does not exceed 250 kg (551 lb).

The CBCF module weighs 3.75 kg (8.30 lb).

**BCF cabinet dimensions**

- height: 40 cm (15.7 in.)
- width: 60 cm (23.6 in.)
- depth: 37 cm (14.6 in.)

**BCF cabinet weight**

The BCF cabinet weighs less than 30 kg (66 lb).

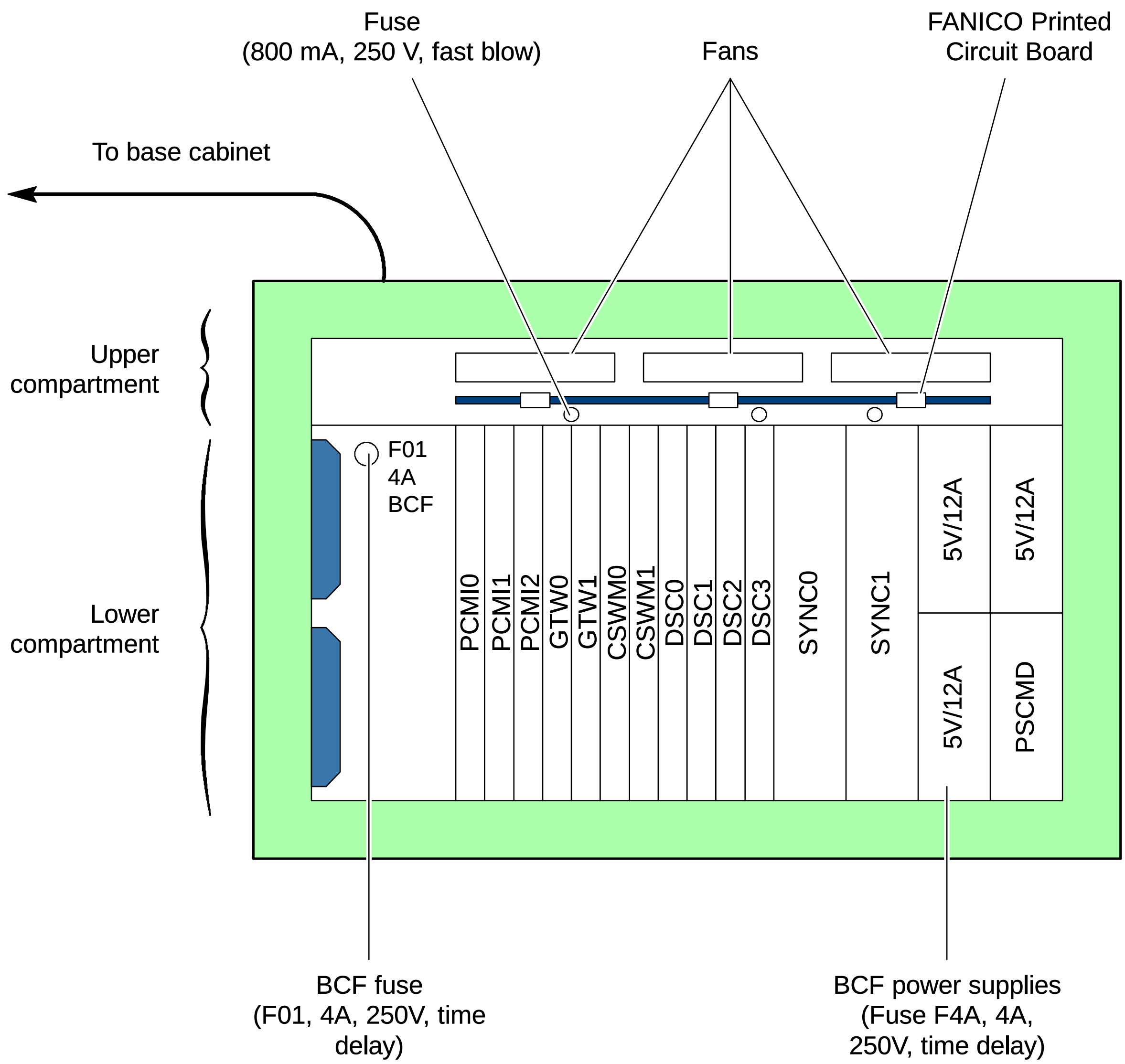



**Figure 3-43 S8000 Indoor BTS: BCF cabinet layout**

## 3.2.8 S8000 Outdoor BTS

### 3.2.8.1 Hardware description

The base cabinet (see *Figure 3–44* and *Figure 3–45*) and the extension cabinet (see *Figure 3–46*) have the same physical structure.

They come as a compact metallic structure. Equipment is accessed from the front of the cabinets and all the cables enter through the base of the cabinet (cabinets can be installed on a plinth for ease of cabling reasons).

The cabinet is divided into two separate compartments (see *Figure 3–44* to *Figure 3–46):*

- The top compartment contains the climatic system and internal batteries.

  Three types of climatic system are available:

  - climatic system with two ACUs (Air Cooling Unit)
  - climatic system with one DACS (Direct Ambient Cooling System)
  - climatic system with one “LN” (Low Noise) DACS (Direct Ambient Cooling System)

- The main compartment accommodates the plug–in radio, digital processing and power supply units. The number of units varies according to the configuration. In a fully loaded configuration the cabinet contains the following elements:

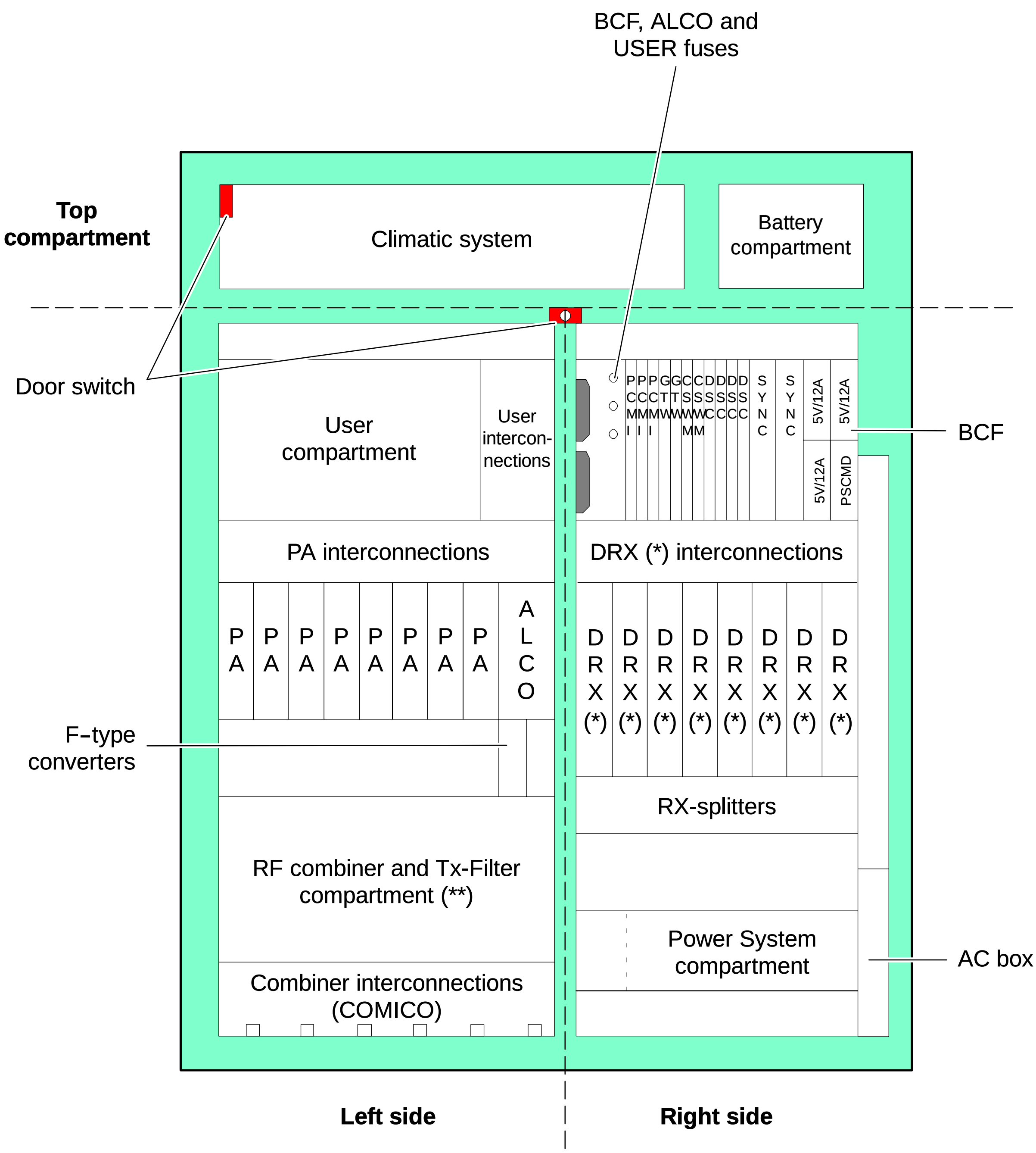
  - eight DRXs (or e–DRXs)
  - eight Power Amplifiers (PA)
  - two Control and Switching modules (CSWM)
  - one alarm management unit
    - ALCO, used with the BCF unit
    - RECAL, used with the CBCF Module

- The following combinations of RF combiner modules and Tx–Filter modules:

  - six RF combiners of duplexer–only type (D) or of two–way hybrid type (H2D)
  - four RF combiners (D) and four Tx–Filter modules each with an optional VSWR meter
  - three RF combiners of four–way hybrid (H4D) type

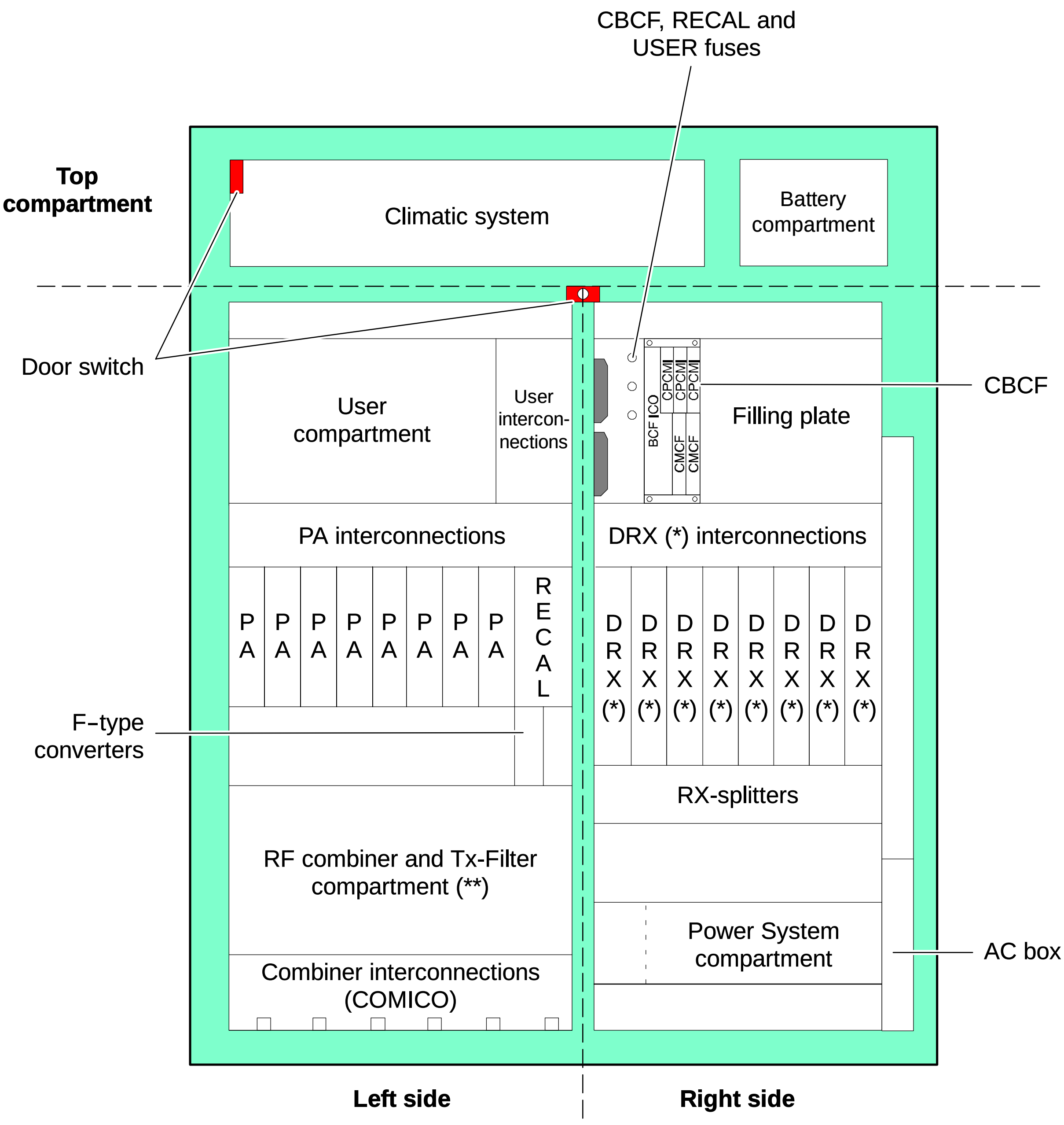
**Note:** Depending on the coupling system used, an RF combiner can contain a duplexer, an H2D on H4D transmitter coupler, an LNA splitter, and a VSWR meter.




Note: (*) DRX or e-DRX.
(**) The Tx-Filter module is optional.

**Figure 3-44 S8000 Outdoor BTS: Base cabinet layout (with BCF unit)**




Note: (*) DRX or e-DRX.
(**) The Tx-Filter module is optional.

**Figure 3-45 S8000 Outdoor BTS: Base cabinet layout (with CBCF Module)**

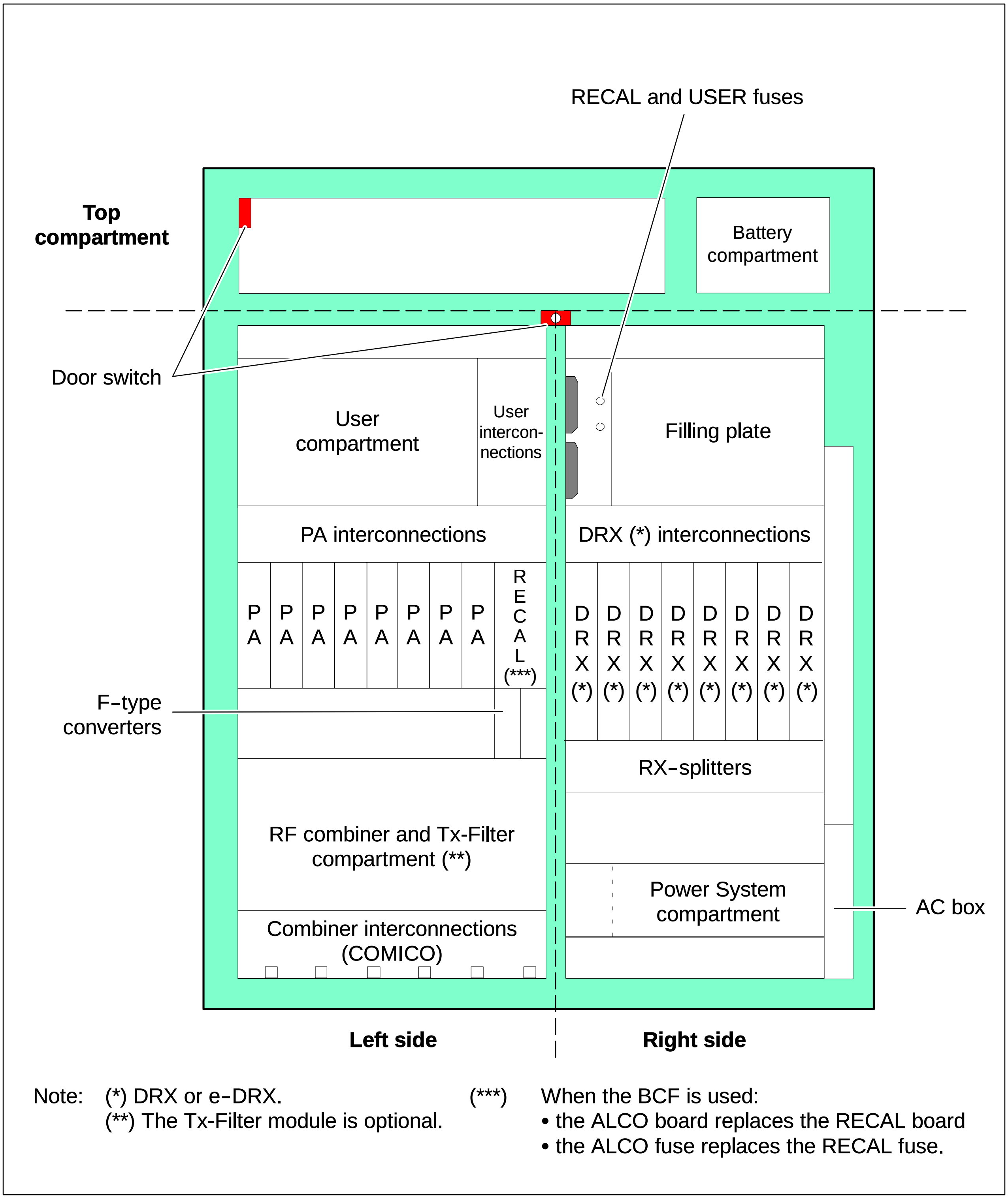



**Figure 3-46 S8000 Outdoor BTS: Extension cabinet layout**

- six RX–Splitter
- one power system including:
  - an ac mains box, a Power Controller Unit (PCU), a set of 600 W or 680 W rectifier units (SRU) and a set of batteries or
  - an ac mains box, a Controller Module, a set of 500W Rectifiers, a Distribution Module and a set of batteries or
  - an ac box / GIPS and a GIPS module (GSM Integrated Power System)

The following boards equip the base cabinet only:

- BCF Unit boards:
  - two Gateway unit (GTW)
  - four Data Signaling Concentrators (DSC)
  - three PCM interface units (PCMI)
  - two Synchronization units (SYNC)
  - three DC/DC converters (5 V/12 A)
  - one converter control board (PSCMD)
- CBCF Module boards:
  - three compact PCM interface (CPCMI)
  - two compact Main Common Function (CMCF)
  - one CBCF interconnection (BCFICO)

### 3.2.8.2 Physical characteristics

#### Dimensions

- height: 160 cm (63 in.)
- width: 135 cm (53 in.)
- depth: 65 cm (26 in.)

#### Weight

The weight of the cabinet when empty (without battery, fan units or boards) is 164 kg (321.5 lb).

A fully equipped cabinet can weigh up to 480 kg (1056 lbs) with ACU unit or 440 kg (968 lb) with DACS unit.

This weight does not include the plinth.

The CBCF module weighs 3.75 kg (8.30 lb).

#### Plinth

The S8000 Outdoor BTS can be installed on a plinth providing cable runways and primary external alarm and Abis interface protection. The characteristics are:

- height: 15 cm (6 in.)
- width: 135 cm (53 in.)
- depth: 112 cm (44 in.)
- weight : 48.5 kg (107 lb)

### 3.2.9 S8002 Outdoor BTS

#### 3.2.9.1 Hardware description

The cabinet (see *Figure 3–47)* is initially dedicated to the railway market for outdoor environments. It can be installed in indoor environments. The BTS has one base cabinet that includes a CBCF and two DRXs providing coverage to one cell.

It comes as a compact metallic structure and is accessed from the front of the cabinet. All the cables enter through the base of the cabinet (cabinet can be installed on a plinth for ease of cabling reasons).

The cabinet is divided into two separate compartments:

- The top compartment contains the Compact Direct Ambient Cooling System (CDACS).
- The main compartment accommodates:
  - three rectifier blocks
  - a User ICO and Power ICO compartment
  - two RX–splitter modules
  - a two–module RF combiner
  - up to two Power Amplifiers (PA)
  - two Driver Receiver units (DRXs or –DRXs)
  - a CBCF identical to the one of the S8000 BTS
    The following boards equip the CBCF Module:
    - three compact PCM interface (CPCMI)
    - two compact Main Common Function (CMCF)
    - one CBCF interconnection (BCFICO)
  - one C–PA–ICO (power amplifier interconnection)
  - a MAIN–ICO (interconnection board)
  - four batteries
  - a RECAL board
  - a C–ACMAIN module

### 3.2.9.2 Physical characteristics

**Dimensions**

- height: 140 cm (55.1 in.)
- width: 100 cm (39.4 in.)
- depth: 54 cm (21.6 in.)

**Weight**

The weight of the cabinet when empty, that is, without its battery, is 240 kg (529 lb).

A fully equipped cabinet can weigh up to 300 kg (662 lb).

**Plinth**

The S8002 Outdoor BTS can be installed on a plinth providing cable runways. The characteristic of the plinth are:

- height: 10 cm (4 in.)
- weight: 20 kg (44 lb)

**Batteries**

Four sealed lead batteries in series provide backup for a minimum of two hours. When the battery is discharging (no mains), we reach a first threshold level, where a part of the loads is disconnected. If the battery continues to discharge, when the second threshold is reached, all remaining loads are switched off.

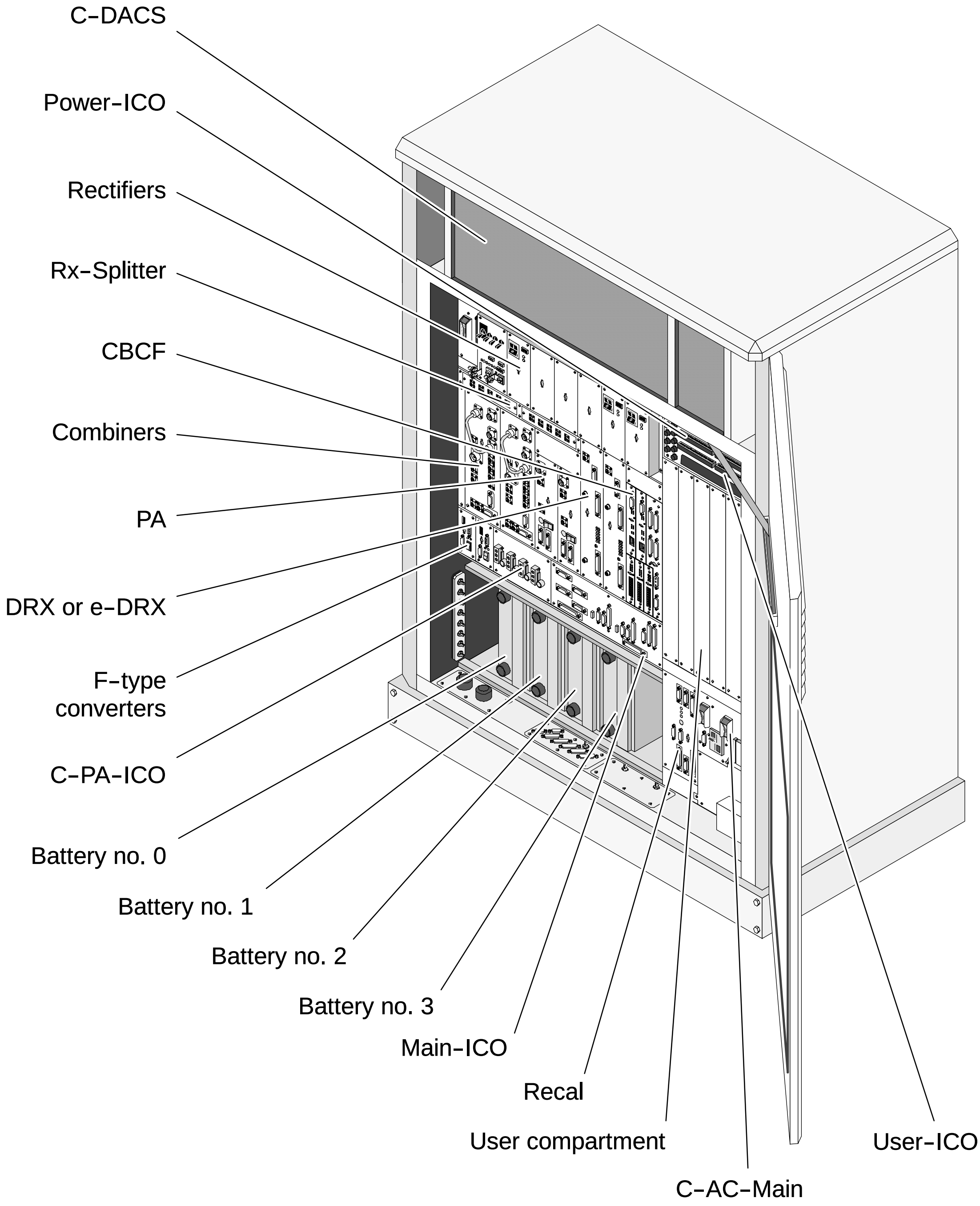



**Figure 3–47 S8002 Outdoor BTS: Cabinet layout**

### 3.2.10 S8003 BTS

#### 3.2.10.1 Hardware description

The cabinet (see *Figure 3–48)* is designed for indoor installations. The BTS has only one base cabinet which includes a CBCF and three DRXs.

The S8003 BTS is a compact metallic structure and is accessed from the front. All the cables enter through the top of the cabinet.

The cabinet is divided into two separate comparments. The lower compartment contains the internal cooling system.

The main compartment contains, in its maximum configuration, the following elements:

- one Compact Base Common Functions (CBCF), composed of:
  - three Compact PCM Interface boards (CPCMI)
  - two Compact Main Common Functions boards (CMCF)
  - one interconnection BCF ICO board
  - one CBCF interconnection Back Panel module (CBP)
- one REmote and Control ALarm board (RECAL)
- three TRXs, composed of:
  - three DRXs
  - three Power Amplifiers (PAs)
- RF–combiner modules, composed of:
  - D RF–combiners, each composed of:
    - one duplexer
    - one LNA–combiner module
    - one VSWR–combiner module (optional)

AND/OR

  - H2D RF–combiners (six maximum), each composed of:
    - one duplexer
    - one LNA–combiner module
    - one hybrid coupler
    - one VSWR–combiner module (optional)
- one COMbiner InterCOnnection panel (COMICO)
- up to two F–type converters (one is optional)

- one DC main panel:
  - one main breaker 50 A
  - 9 fuses.
- one ventilation rack, composed of:
  - four fans (one is optional)

### 3.2.10.2 Physical characteristics

**Dimensions**

- height: 115 cm ( 45.28 in.)
- width: 75 cm ( 29.53 in.)
- depth: 45 cm ( 17.72 in.)

**Weight**

A fully equipped cabinet can weigh up to 140 kg (308 lb).

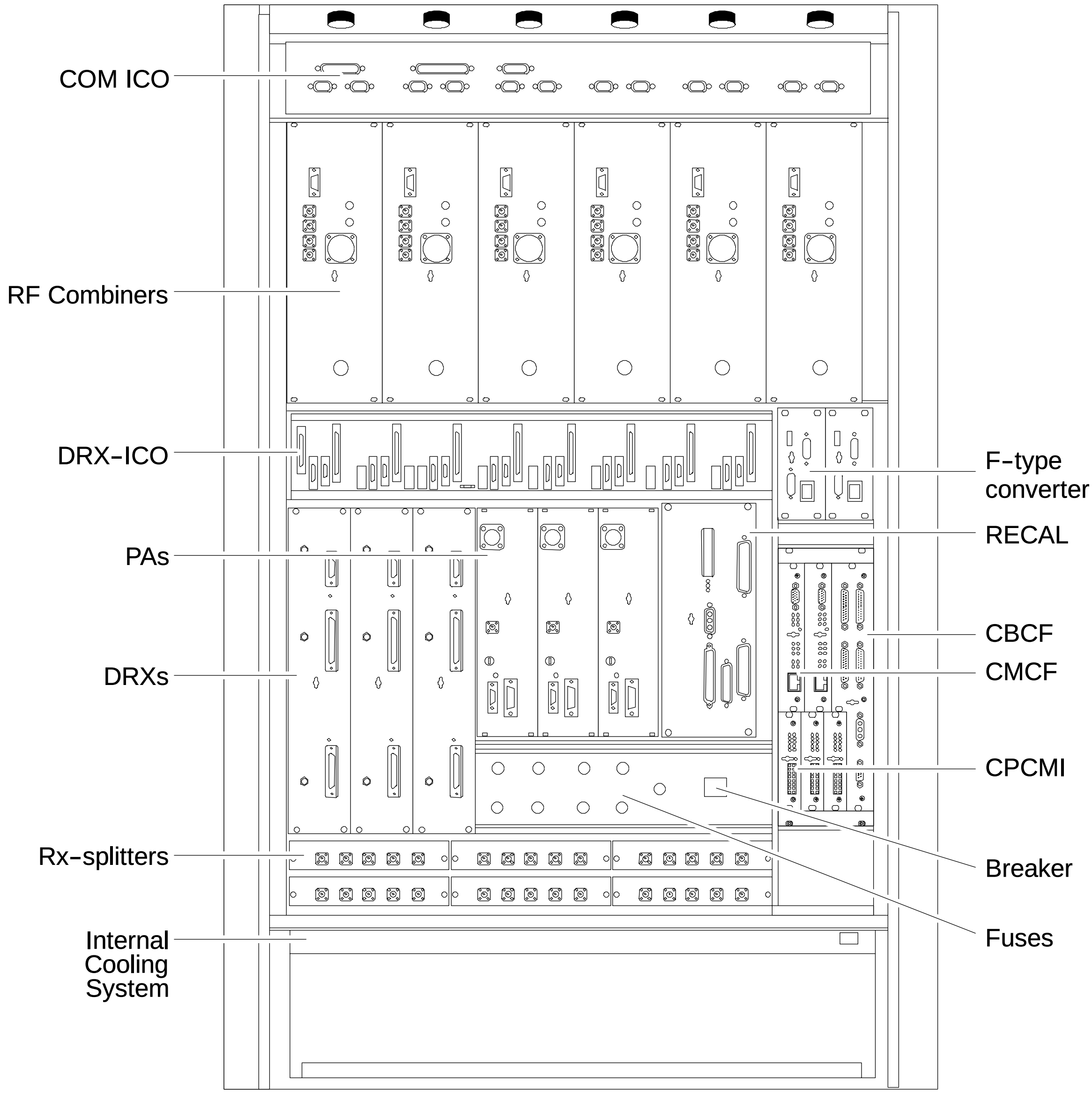



**Figure 3–48 S8003 BTS: cabinet layout**

## 3.2.11 S8006 BTS

### 3.2.11.1 Hardware description

The cabinet *(see Figure 3–49)* is dedicated for outdoor environments. The BTS has one base cabinet that includes a CBCF and six DRXs providing coverage to one cell.

It comes as a compact metallic structure and is accessed from the front of the cabinet. All the cables enter through the base of the cabinet (cabinet can be installed on a plinth for ease of cabling reasons).

The cabinet is divided into two separate compartments:

- The top compartment contains the Low Noise Street – Direct Ambient Cooling System (LNS–DACS).
- The main compartment accommodates:
  - one PA–INTERCO and one DRX–INTERCO compartment
  - six power amplifiers (PAs)
  - one remote control and alarm board (RECAL)
  - one compact BCF houses the following boards:
    - one compact PCM interface board (CPCMI)
    - one compact main common function board (CMCF)
    - one CBCF interconnection
  - six DRXs (or e–DRXs)
  - one AC box
  - one F–type converter
  - six RX–splitters
  - six RF–combiners
  - one dc–ICO compartment (dc interconnection)
  - one power system compartment (one PCU + five rectifiers)
  - one combiner interconnection module (COMICO)
  - one filter located in the doors

### 3.2.11.2 Physical characteristics

**Dimensions**

- height: 130 cm (51.8 in.)
- width: 135 cm (53.15 in.)
- depth: 55 cm (21.65 in.)

**Weight**

A fully equipped cabinet can weigh up to 300 kg (662 lb).

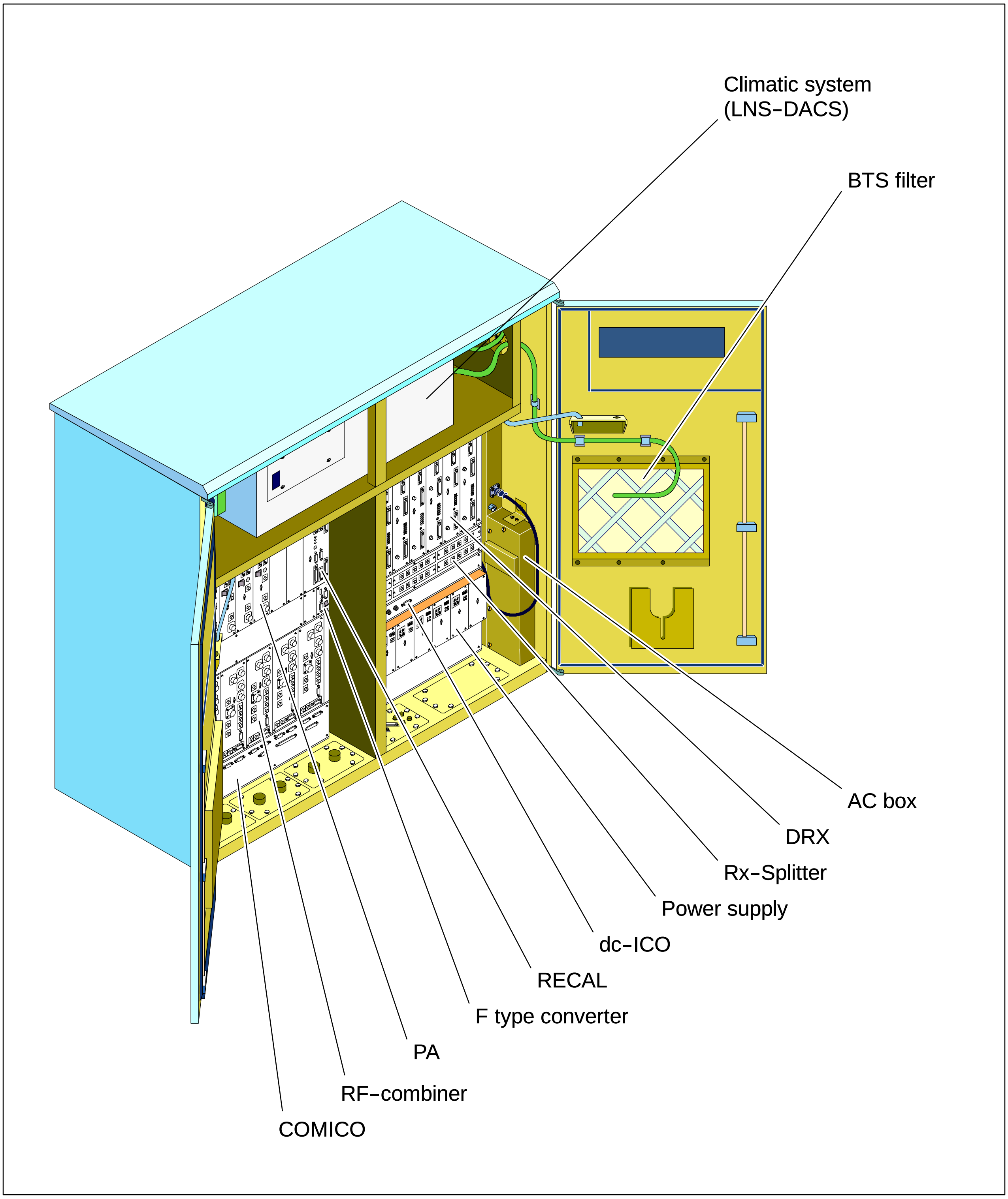



**Figure 3-49 S8006 BTS: cabinet layout**

## 3.2.12 S12000 Indoor BTS

### 3.2.12.1 Hardware description

The base cabinet and the extension cabinet have same physical structure.

They come as a compact metallic structure. Equipment is accessed from the front of the cabinets and all the cables enter at the top of the cabinet.

The cabinet is divided into separate compartments (see *Figure 3–50):*

- The cabinet top holds the ALPRO boards and the RF connectors
- The combiner interconnection (COM–ICO) compartment
- The RF combiner and Tx–Filter compartment accommodates the plug–in radio, digital processing and power supply units. The number of units varies according to the configuration. In a fully loaded configuration the cabinet contains the following elements:
  - 12 DRXs (or e–DRXs)
  - 12 Power Amplifiers (PA)
  - one alarm management unit
    - RECAL, connected to the external protection boards

The following combinations of RF combiner modules and Tx–Filter modules:

- 12 RF combiners of duplexer–only type (D) or of two–way hybrid type (H2D)
- 12 RF combiners (D) and Tx–Filter modules each with an optional VSWR meter
- six RF combiners of four–way hybrid (H4D) type

**Note:** Depending on the coupling system used, an RF combiner can contain a duplexer, an H2D on H4D transmitter coupler, an LNA splitter, and a VSWR meter.

- The dc compartment
- The F–type converters compartment contains two F–type converters
- The PA interconnection (PA–ICO) compartment
- The PA compartment contains up to 12 PAs
- The RECAL board
- The DRX interconnection (DRX–ICO) compartment
- The DRX compartment contains 12 DRXs
- The CBCF module
- The RX–splitter compartment contains up to eight RX–splitters
- The climatic compartment contains two fans and a board

### 3.2.12.2 Physical characteristics

**Base cabinet dimensions**

- height: 195 cm (76.8 in.)
- width: 91 cm (35.8 in.)
- depth: 45 cm (17.7 in.)

**Internal cooling system dimensions**

- height: 27.5 cm (10.8 in.)
- width: 77.6 cm (30.5 in.)
- depth: 44.5 cm (17.5 in.)

**Weight**

A fully equipped cabinet can weigh up to 160 kg (352 lb).

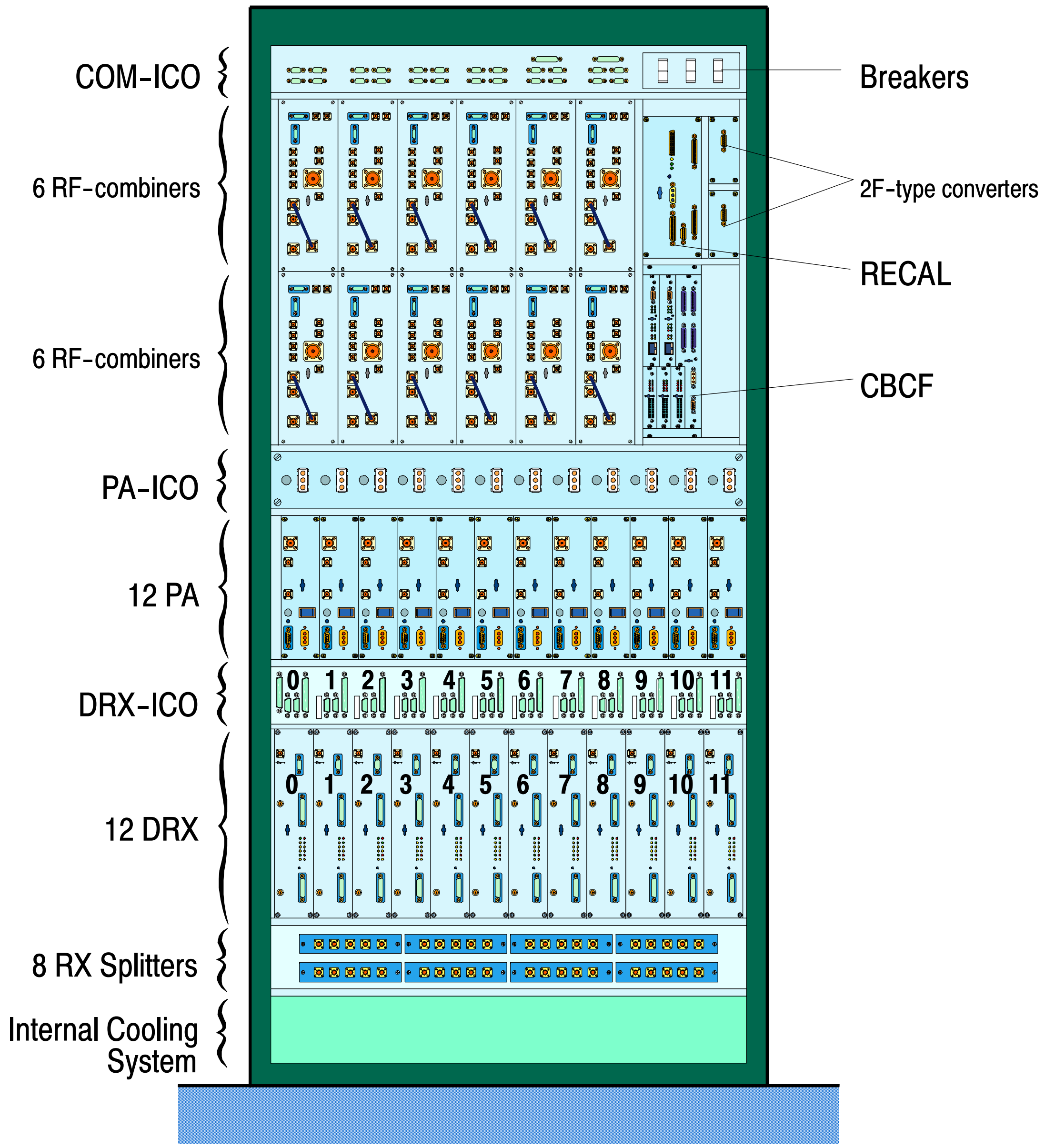



**Figure 3-50 S12000 Indoor BTS: Base cabinet inside view**

### 3.2.13 S12000 Outdoor BTS

#### 3.2.13.1 Hardware description

The base cabinet and the extension cabinet have the same physical structure.

The cabinets are a compact metallic structure. Equipment is accessed from the front of the cabinets and all the cables enter through the base of the cabinet (cabinets can be installed on a plinth for ease of cabling).

The cabinet is divided into separate compartments (see *Figure 3–51):*

- The top compartment contains the Direct Ambient Cooling System (DACS) and the batteries.
- The main compartment accomodates the plug–in radio, digital processing and power supply units. The number of units varies according to the configuration.
- In a fully loaded configuration the left compartment contains the following elements:
  - two DRX interconnection (DRX–ICOA and DRX–ICOB) modules
  - two DRX shelves that contain up to 12 DRXs
  - two RX splitter shelves that contain four RX splitters
  - RF combiner shelf that contains four RF combiner
- In a fully loaded configuration the right compartment contains the following elements:
  - the user rack and its interconnection module
  - the RECAL board
  - two F–type converters
  - the CBCF module
  - the power system rack that contains rectifiers and a PCU based system or a DCU based system (GIPS)
  - the PA interconnection (PA–ICO) module
  - the PA shelf that contains up to 12 PAs
  - the RF combiner shelf that contains eight RF combiners
  - the combiners interconnection (COM–ICO) module
  - the ac box

### 3.2.13.2 Physical characteristics

**Base cabinet dimensions**

- height: 191 cm (75.2 in.)
- width: 135 cm (53.1 in.)
- depth: 65 cm (25.6 in.)

**Plinth dimensions**

- height: 191 cm (75.2 in.)
- width: 80 cm (31.5 in.)
- depth: 65 cm (25.6 in.)

**Weight**

A fully equipped cabinet can weigh up to 180 kg (396 lb).

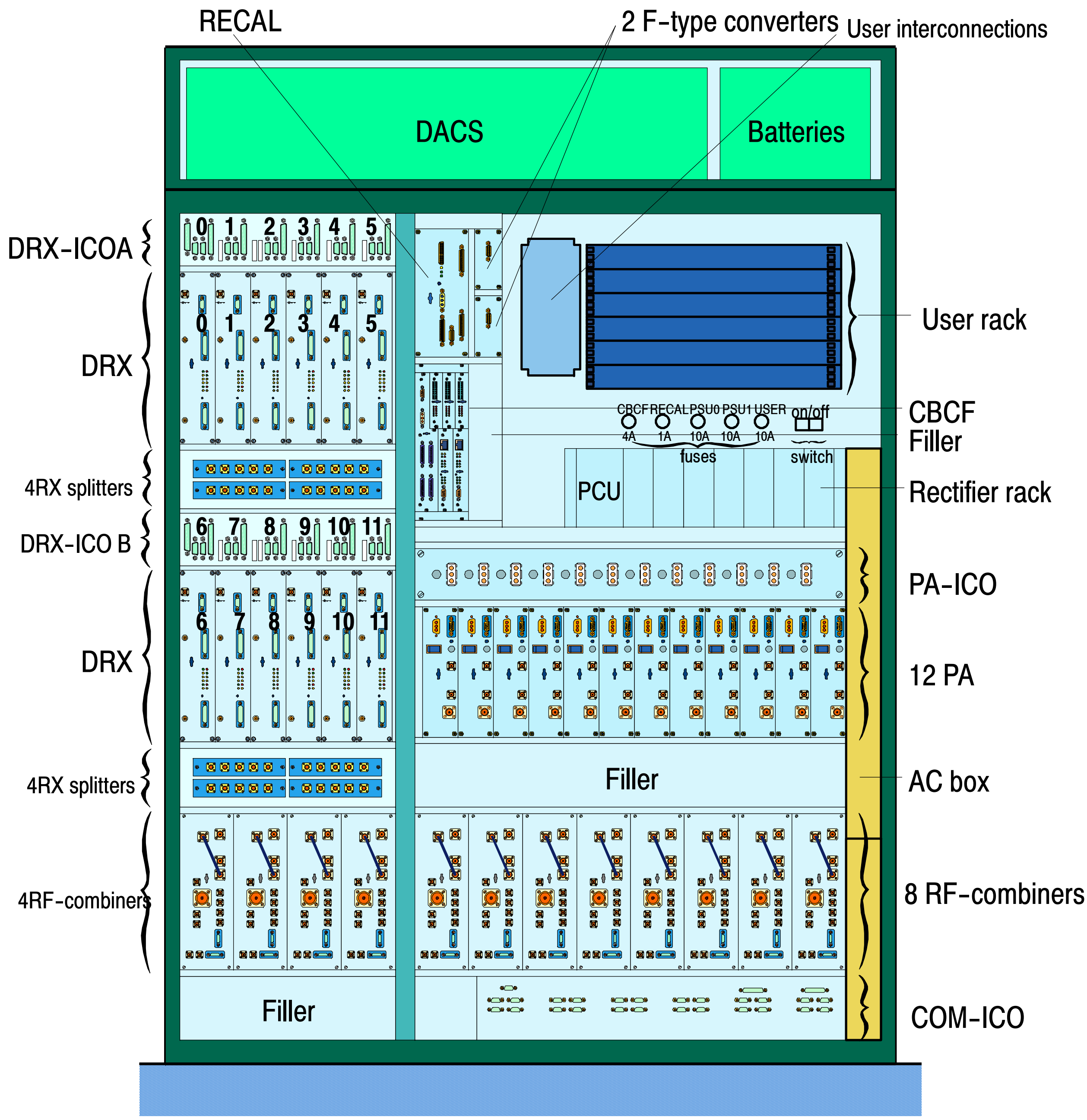



**Figure 3-51 S12000 Outdoor BTS: Base cabinet inside view**

## 3.3 Power supplies

The two following tables give the BTSs input voltages.

| | –48 V dc | Single phase 120 V ac | Single phase 220–240 V ac | Three–phase 230/400 V ac | Split phase 240 V ac |
|---|---|---|---|---|---|
| S2000 | | X | X | | |
| S2000E Indoor | | X | X | | |
| S2000E Outdoor | | X | X | | |
| S2000H “FP” and “EP” | | | X | | X |
| S2000L “FP” and “EP” | | X | X | | X |
| e–cell | X | X | X | | |
| S4000 Indoor | X | | | | |
| S4000C Indoor | X | | | | |
| S4000 Outdoor | | | X | | X |
| S4000 Smart | | | | | X |
| S8000 Indoor | X | | | | |
| S8000 Outdoor | | | X | X | X |
| S8002 Outdoor | | | X | X (dual–phase) | X |
| S8003 indoor | X | | | | |
| S8006 | | | X | | |
| S12000 Indoor | | | | | |
| S12 000 Outdoor | | | X | X | X |

**Table 3–3 BTS input voltages**

## 3.4 Battery cabinet

### 3.4.1 Battery cabinet (type 1)

The S8000 Outdoor BTS and the S12000 Outdoor BTS power autonomy depends on the configuration. This cabinet consists of four compartments, each containing four batteries (see *Figure 3–52*).

The characteristics of the cabinet are:

- height: 160 cm (63 in.)
- width: 80 cm (31.5 in.)
- depth: 66 cm (26 in.)
- weight: 90 kg (198 lb) without batteries

The cabinet is installed on a plinth. This plinth is identical to the plinth of the BTS base cabinet except the width (80 cm (31.5 in.)).

One battery cabinet is necessary for each BTS.

### 3.4.2 Battery cabinet (type 2 and type3)

This battery cabinet provides power autonomy for S8000 Outdoor/S8002 BTS and S12000 Outdoor BTS. It also consists of four compartments including four batteries (see *Figure 3–53* and *Figure 3–54*).

The physical characteristics are the same as type 1 battery cabinet.

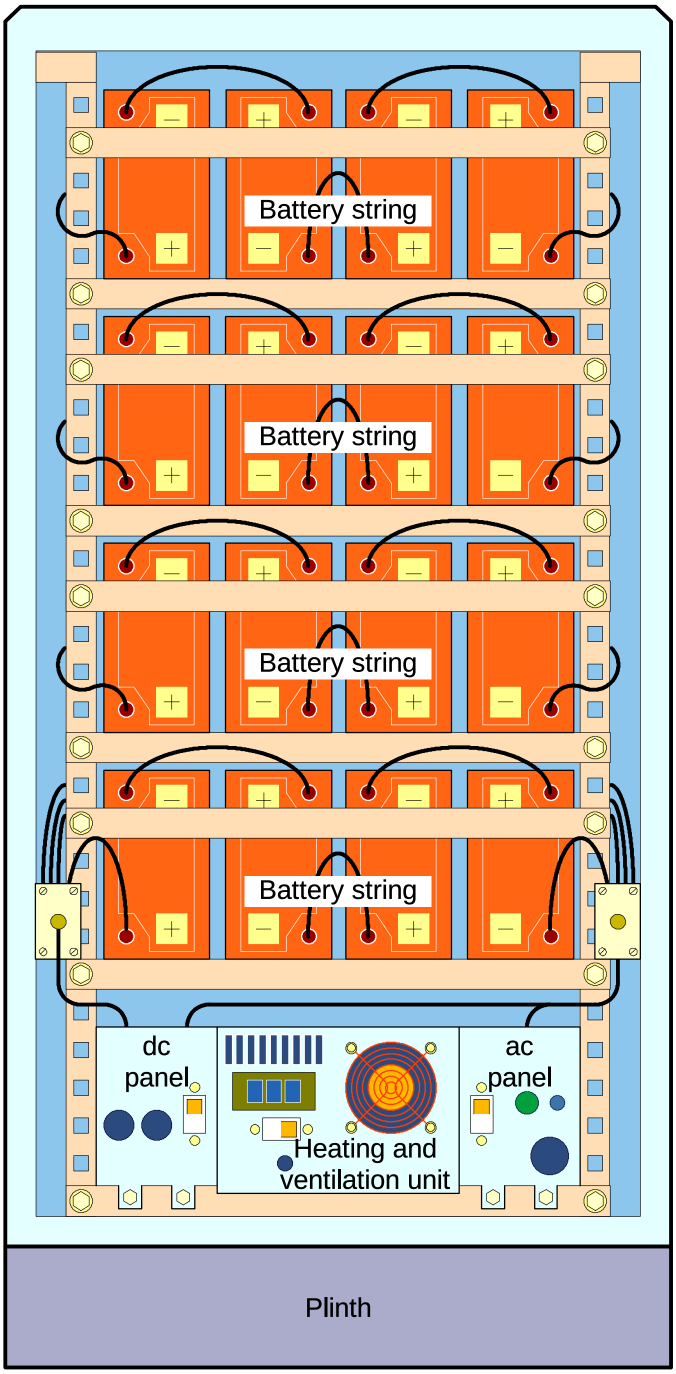



**Figure 3-52 Battery cabinet (type 1)**

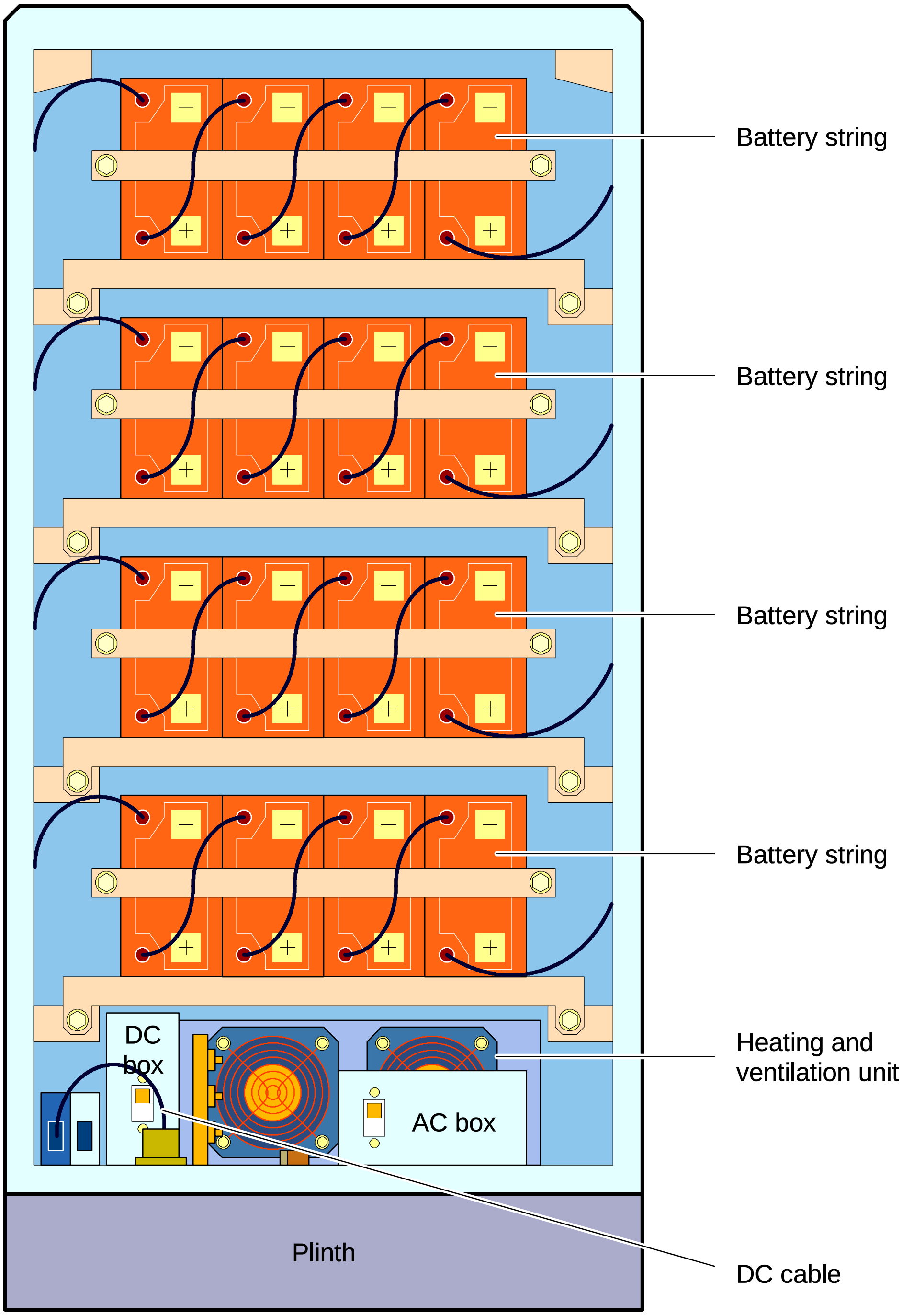



**Figure 3-53 Battery cabinet (type 2)**

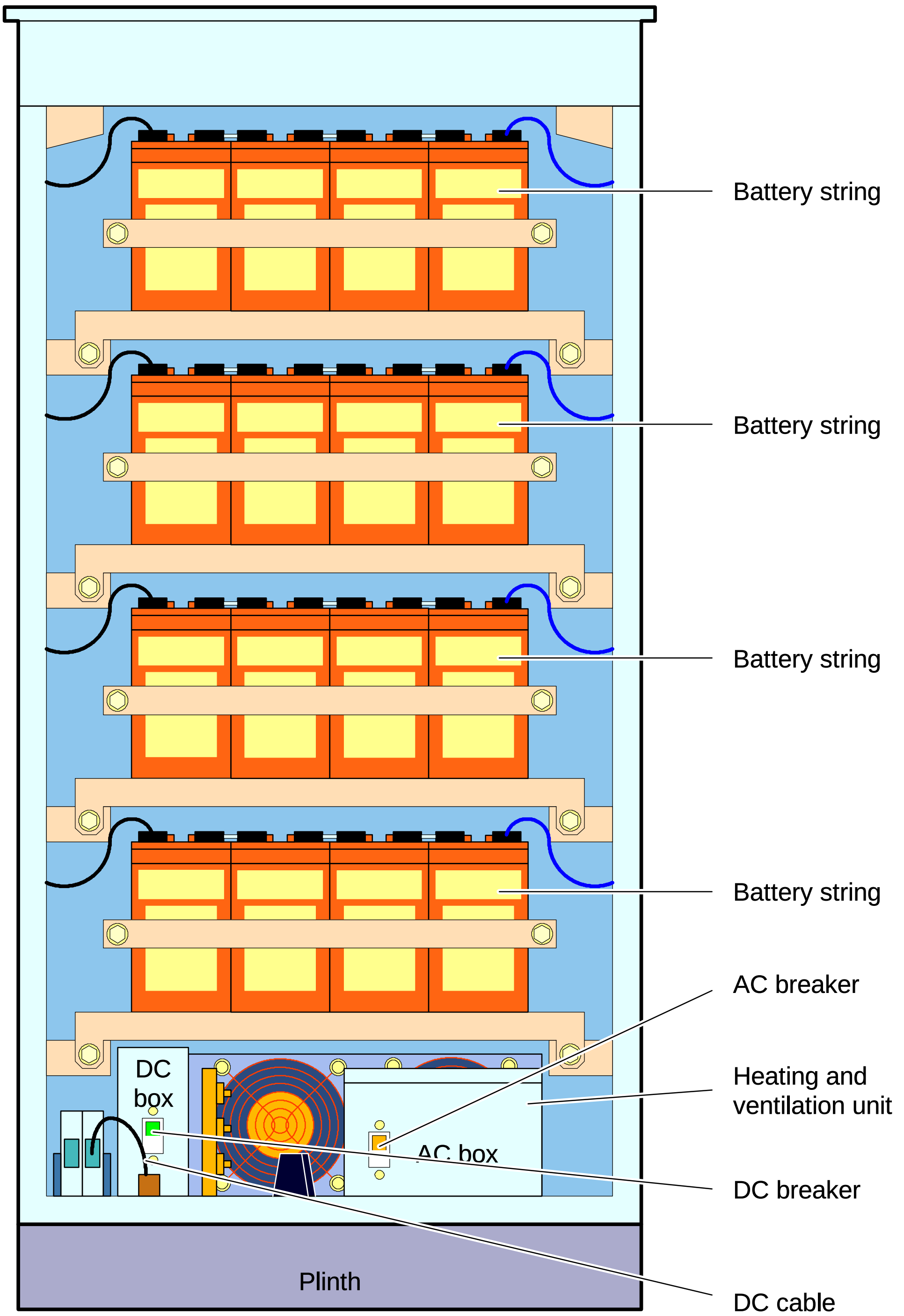



**Figure 3-54 Battery Cabinet (type 3)**

## 3.5 Remote power amplifier

Remotely connected amplifiers are designed to be installed outside, on a supporting wall or a mast. It must be located no more than 5 m (17 feet) from the antenna.

They are compatible with standard TRXs or DRXs and have lightning protectors.

### 3.5.1 The HPRF module (S2000H BTS)

#### 3.5.1.1 Hardware Description

The HPRF module houses the RF coupling system. It can be mounted either close to the Base Unit or remotely at the antenna masthead (see *Figure 3–55*).

The MEU may contain:

- one PA
- two LNAs
- one duplexer
- one RX filter
- one MEU–protection PCB

#### 3.5.1.2 Physical Characteristics

**Dimensions**

The HPRF module dimensions when equipped with basic components (mounting bracket, sunshield, cable cover, RF module, lightning protection) are as follows:

- Height: 740 mm (29.1 in.) or (790 mm (31.1 in.) for the “FP” 1900)
- Width: 273 mm (10.7 in.)
- Depth: 329 mm (13.0 in.)

**Weight**

- 20 kg (44.1 lb.)

#### 3.5.1.3 Electrical Characteristics

The HPRF module is supplied through the DC/DATA cable by the secondary PSU housed in the HPRF supply module of the S2000H Base Unit. The voltage is –48 V dc.

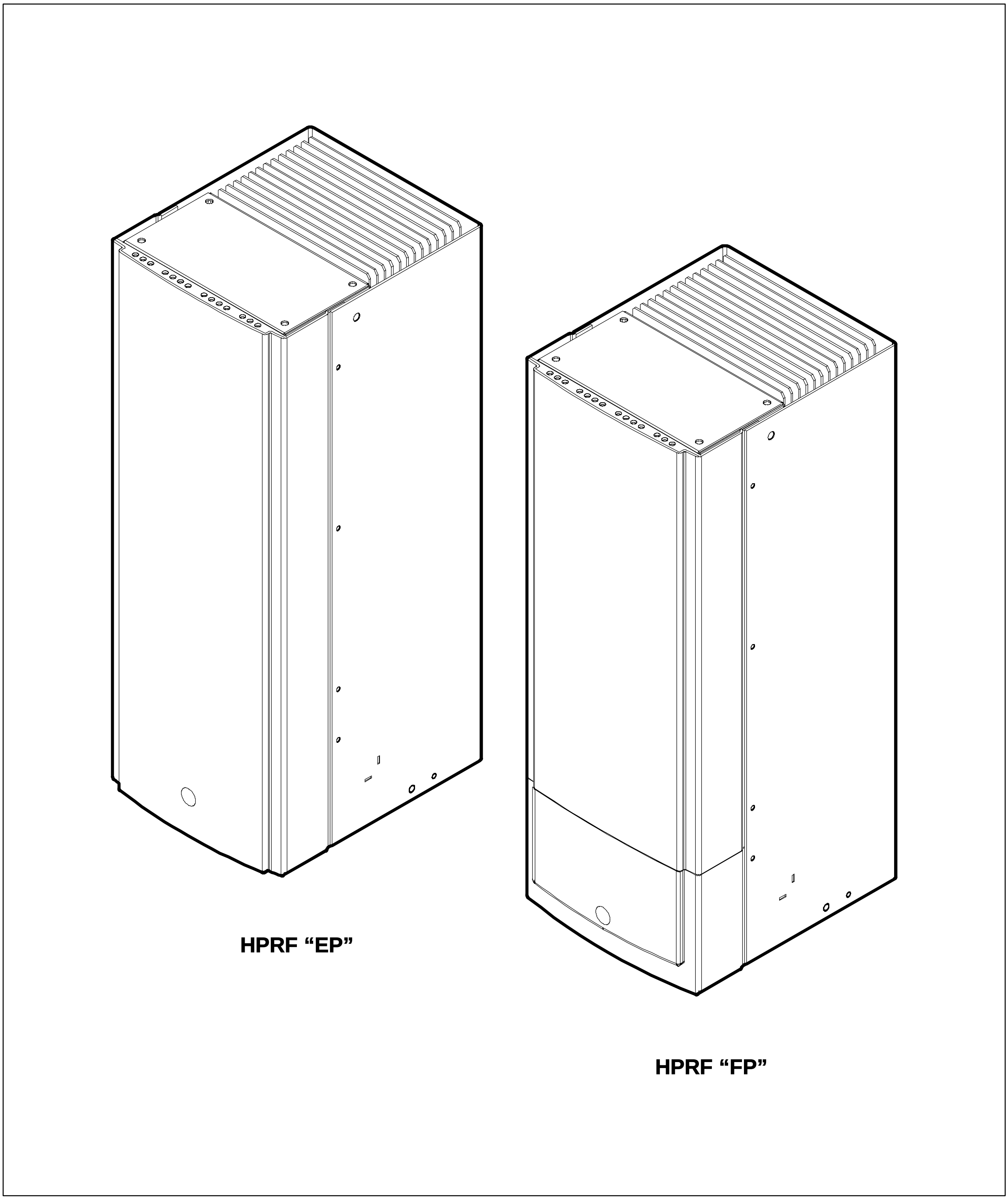



**Figure 3-55 HPRF module types**

## 3.5.2 The DLNA (S4000 Indoor BTS)

### 3.5.2.1 Hardware description

The DLNA contains one duplexer and one low noise amplifier (LNA).

In addition to the antenna socket, the DLNA also has a TX input from the BTS transmission coupling system and an RX output to the RX–splitter.

### 3.5.2.2 Physical characteristics

**Dimensions**

The DLNA dimensions are as follows:

- Width: 25 cm (9.8 in.)
- Depth: 20 cm (7.9 in.)
- Height: 35 cm (13.8 in.)

**Weight**

- 8 kg (17.6 lb.)

### 3.5.2.3 Electrical characteristics

The variable gain RX–splitter to which it is connected supplies the DLNA with power directly over the RX cable. In normal mode, the voltage is 12 V dc and the current is 200 mA (GSM 900) or 350 mA (GSM 1800). When a fault occurs, DLNA consumption increases or decreases. The RX–splitter considers a DLNA to be faulty when its consumption is upper than 350 mA (GSM 900) or 410 mA (GSM 1800), or lower than 50 mA (GSM 900) or 100 mA (GSM 1800).

## 3.5.3 The MEU (S4000 Indoor BTS)

### 3.5.3.1 Hardware description

The MEU contains the following (see *Figure 3–56*):

- one duplexer
- one two–way hybrid coupling system (H2D)
- two transmission power amplifiers (PA)
- one low–noise amplifier (LNA)

### 3.5.3.2 Physical characteristics

**Dimensions**

MEU dimensions are as follows:

- Width: 30.5 cm (12 in.)
- Depth: 25 cm (9.8 in.)
- Height: 50 cm (19.7 in.)

**Weight**

- less than 27 kg (59.5 lb.)

### 3.5.3.3 Electrical characteristics

A converter, supplied with 230 V ac, supplies the MEU power supply units with 48 V dc. The MEU are fed by PSU (Power Supply Unit). Each supplies two MEU (a main reception frequency MEU and its diversity frequency MEU) with ± 12 V dc and ± 24 V dc.


**Figure 3-56 Masthead electronic unit (MEU)**

## 3.5.4 The MEU (S4000 Smart BTS)

### 3.5.4.1 Hardware Description

The integrated facet equipment for smart BTS antennas provides coverage for three–sectored sites. Each facet covers a 120° sector and consists of an array of four antennas (four separated columns of radiating elements) with their associated MEU.

The MEU is integrated into a single unit which is protected by a plastic radome and may be located up to 100 meters (328 ft) from the Base Cabinet.

The MEU contains:

- four HPAs
- four DLNAs

### 3.5.4.2 Physical Characteristics

**Dimensions**

The HPRF Unit dimensions when equipped with basic components (mounting bracket, sunshield, cable cover, RF module, lightning protection) are as follows:

- Height: 1900 mm (6.2 ft)
- Width: 850 mm (2.8 ft)
- Depth: 300 mm (1 ft)

**Weight**

- 85 kg (187.4 lb)

### 3.5.4.3 Electrical Characteristics

The MEU is supplied with DC power (32 V or 10 V).

# 4 BSC

## 4.1 BSC e3

### 4.1.1 Introduction

**Features and functions**

The BSC e3 ensures the links between the radio sites of the radio sub–system BSS, and the network sub–system NSS. The BSC e3 manages all the radio resources of its base station (BTS) members. It does everything required to set up or reestablish calls and release previously secured resources, and perform specific call sustaining procedures (power control and handover management).

It also supervises the radio subsystem as a whole and is responsible for it. It performs operations and maintenance functions under central OMC–R management control.

The BSC e3 concentrates external PCM links, thus reducing the number of traffic channels used. These channels are transmitted via the TCU to the Mobile services Switching Center (MSC) to which the BSC e3 is connected.

To handle more sites, the BSC e3 also concentrates the LAPD signaling channels that are established with the BTS.

**Location**

The geographic position of the BSC e3 has little effect on its operating ability. However, the choice of an appropriate site enhances hardware performances, one of the main objectives of network operators being to reduce the number and length of PCM links used.

The high number of BTSs installed in urban areas and the short distance between them and the switching center means that the BSC should, when possible, be on the same premises as the MSC if the premises are well–suited for this type of equipment.

Fewer BTSs are installed in less densely populated areas, and the distance between them and the MSC may be much greater.

To optimize the use of PCM links, the BSC e3 should be between the switching center and the base station. The best possible BSC e3 location in terms of specific network constraints is chosen by the operator.

### 4.1.2 Hardware structure

#### Mechanical structure

The BSC e3 cabinet (see *Figure 4–1*) is composed of one frame assembly and one SAI (Service Area Interface) frame assembly.

The BSC e3 frame and each SAI frame are based on a PTE2000 architecture.

The basic mechanical elements of a BSC e3 frame consist of two dual–shelf assemblies which are based on a SPECTRUM architecture. Each of them accommodate up to thirty removable modules.

The modules are electrically–shielded metal boxes that have identical dimensions. Modules, cable connections, air–filter assemblies, and other maintenance items can be accessed from the front of the frame.

Retractable doors and cable–trough covers protect the cable runs and cable connections. The frame can be used with existing earthquake anchors and existing overhead or underfloor cabling systems.

The SAI is installed in the left hand side of the frame. It is an auxiliary frame which allows to connect the PCM E1/T1 cables between the BSC e3 frame and the other BSS products.

The BSC e3 cabinet are designed for indoor applications and are EMC compliant (no rack enclosure is necessary. EMC compliance is performed on each dual–shelf.)

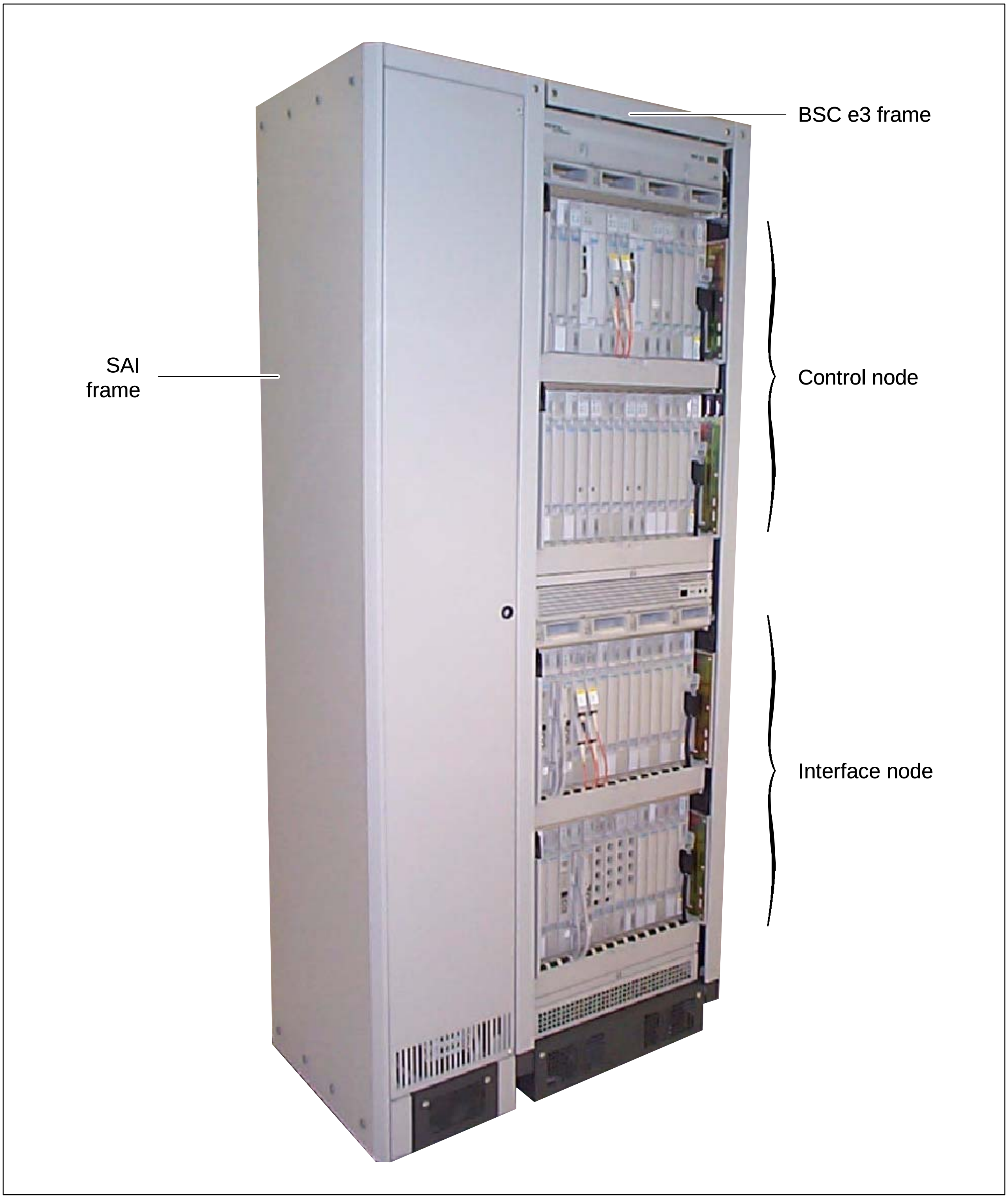



**Figure 4–1 BSC e3 cabinet: presentation**

## BSC e3 frame overview

The frame of the BSC e3 cabinet houses the following (see *Figure 4–2*):

- two dual–shelf

  The control node which houses the following modules:

  - **OMU:** Operation and Maintenance Unit
  - **TMU:** Traffic Management Unit
  - **MMS:** Mass Memory Storage
  - **ATM–SW:** ATM SWitch or CC1: Communication Controller 1
  - **SIM:** Shelf Interface Module
  - **FILLER** modules

  The interface node which houses the following modules:

  - **CEM:** Common Equipment Module
  - **ATM–RM:** ATM Resource Module
  - **8K–RM:** 8K Resource Module or SRT–RM: SubRaTe Resource Module
  - **LSA–RC:** Low Speed Access Ressource Complex

    Each of these modules housesthe following modules:

    – **IEM:** Interface Electronic Module

    – **TIM:** Termination Interface Module
  - **SIM:** Shelf Interface Module
  - **FILLER** modules

- four retractable doors on each dual–shelf

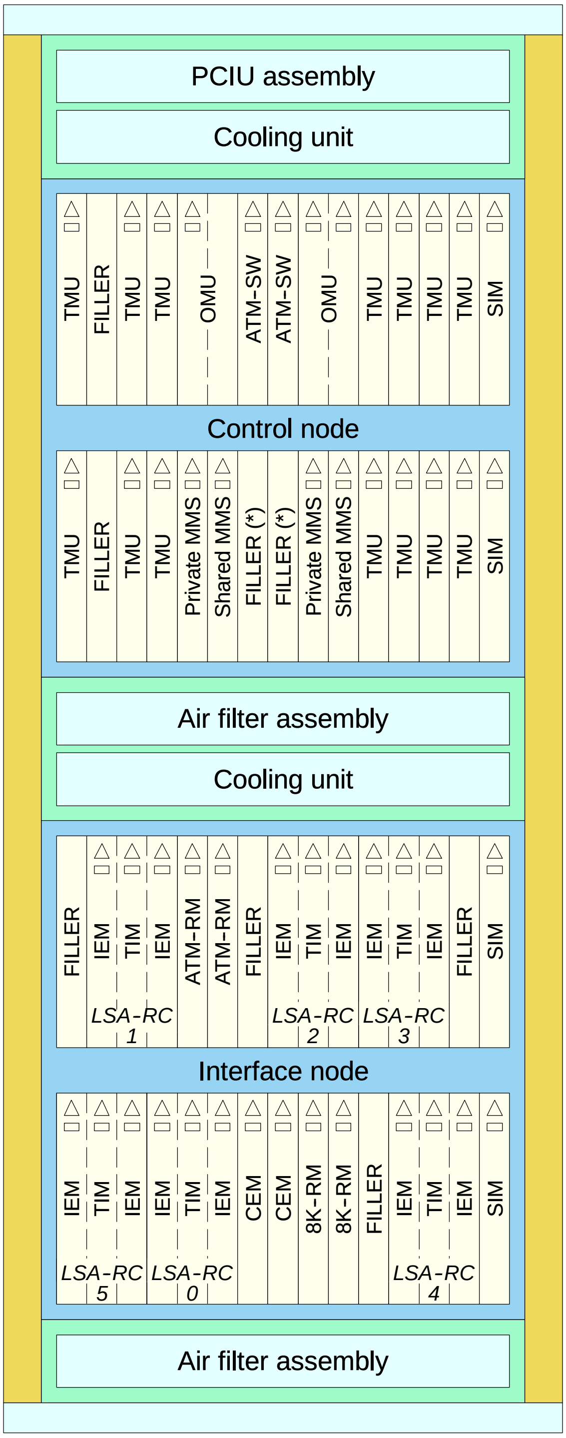
  Each door houses a transparent part to show both visual indicators (red and green LEDs) on each module.

- one PCIU (Power Cabling Interface Unit)

  The PCIU is mounted on the top of the BSC e3 frame. It accomodates the power cables from the operator boxes, the power and alarms cables to each dual–shelf. Different covers protect each cable and each connector. A frame summary indicator and a fan failure lamp are located on the cover.

- two air filter assemblies

  The air filter assemblies filter the air supply for each dual–shelf. One filter assembly is located in the middle of the frame and the other at the bottom of the frame.




(*) : Slots used during the replacement of a private MMS module.

**Figure 4-2 Frame of the BSC e3 cabinet: front view**

- two grill assemblies

  The upper grill assembly is located in the middle of the frame and the lower grill assembly at the bottom of the frame. They allow the air flow circulation.

- two cooling units

  One is located on the top and the other in the middle of the frame. Each cooling unit houses four fan units and provides mechanical ventilation for each dual-shelf.

## SAI frame overview

The SAI frame (see *Figure 4–3*) enclosures electronic equipments to interface the BSC e3 frame with the external PCM (E1/T1) cables to the:

- TCU e3 cabinet via the Ater interface
- BTS cabinets via the Abis interface

The SAI houses the following:

- up to six CTU modules (Cable Transition Unit). They provide the physical interface for:
  - up to 21 PCM E1 links
  - up to 28 PCM T1 links
- up to two optional HUBs

  They provide a physical interface between the OMC–R and both OMU modules.

  **Note:** an optional HUB can be installed inside or outside the SAI.

Each CTU module, in the SAI frame, houses:

- one backplane: CTB (Cable Transition Board)
- up to seven boards: CTMx (Cable Transition Module)

  Each of these is either a:

  - CTMC board for PCM E1 Coax, which permits connecting three PCM E1 links
  - CTMP board for PCM E1 twisted pair, which permits connecting three PCM E1 links
  - CTMD board for PCM T1 twisted pair; which permits connecting four PCM T1 links

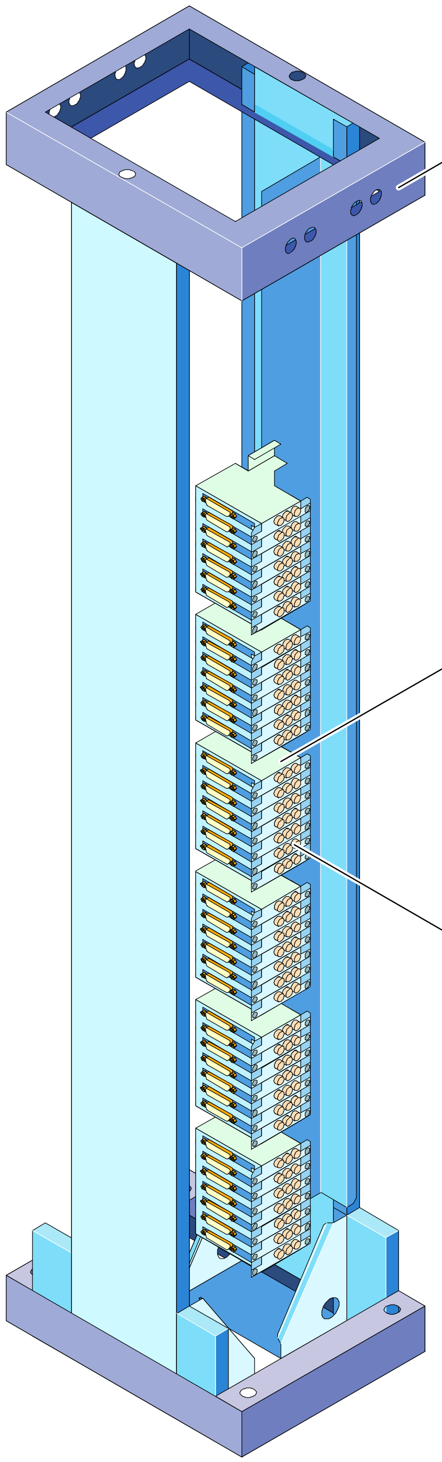



**Figure 4–3 SAI frame: hardware overview**

### 4.1.3 Physical characteristics

#### Dimensions

BSC e3 cabinet dimensions with cosmetic panels

- width: 960 mm (37.8 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

BSC e3 cabinet dimensions without cosmetic panels

- width: 900 mm (35.4 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

BSC e3 frame dimensions

- width: 600 mm (23.6 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

SAI frame dimensions without cosmetic panels

- width: 300 mm (11.8 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

#### Weight

- BSC e3 fully loaded (including cosmetic panels): 550 kg (1200 lb)
- BSC e3 frame only with all modules integrated: 400 kg (880 lb)
- BSC e3 frame only without any module: 220 kg (480 lb)
- SAI frame only with modules: 90 kg (200 lb)

#### Cooling

- forced air in each dual–shelf
- in case of risk of dust, the ventilation system must be equipped with a filter compliant with ETS 300 019–1–3. Maintenance must be periodically performed.
- the temperature gradient inside the premises must comply with the recommendation for operating conditions (refer to ETS 300 019–1–3).

### 4.1.4 Electrical characteristics

**Power Supply**

- rated voltage: –48 V dc
- minimum voltage: –40.5 V dc
- maximum voltage: –57 V dc

**Power consumption**

- maximum consumption (W): 2000 W approximately

## 4.2 BSC 6000 and 12000

### 4.2.1 Introduction

There are two types of BSCs: BSC 6000 and BSC 12000.

**BSC features and functions**

The BSC ensures the links between the radio sites of the radio sub–system BSS, and the network sub–system NSS. The BSC manages all the radio resources of its base station (BTS) members.

It does everything required to set up or reestablish calls and release previously secured resources, and perform specific call sustaining procedures (power control and handover management).

It also supervises the radio subsystem as a whole and is responsible for it. It performs operations and maintenance functions under central OMC–R management control.

The BSC concentrates external PCM links, thus reducing the number of traffic channels used. These channels are transmitted via the TCU to the Mobile services Switching Center (MSC) to which the BSC is connected.

To handle more sites, the BSC also concentrates the LAPD signaling channels that are established with the BTS.

**Location**

The geographic position of the BSC has little effect on its operating ability. However, the choice of an appropriate site enhances hardware performances, one of the main objectives of network operators being to reduce the number and length of PCM links used.

The high number of BTSs installed in urban areas and the short distance between them and the switching center means that the BSC should, when possible, be on the same premises as the MSC if the premises are well–suited for this type of equipment.

Fewer BTSs are installed in less densely populated areas, and the distance between them and the MSC may be much greater.

To optimize the use of PCM links, the BSC should be between the switching center and the base station. The best possible BSC location in terms of specific network constraints is chosen by the operator.

### 4.2.2 Hardware structure

The Base Station Controller (BSC) contains a control cabinet and an equipment cabinet (see *Figure 4–4*).

#### Hardware overview

Each cabinet has a compact metal frame fitted with four lifting rings and a chassis that supports the equipment units. The chassis contains racks that hold various units.

It may be pivoted on an axis, providing easy access to the rear of the boards and to the cabinet wiring. A metal door closes the cabinet.

By pivoting, the chassis enables maintenance of cabinets from the front, so the operator is free to install them back to back, reducing the area covered by BSC sites.

Since wiring can be done from the top of the cabinets, false floors are not necessarily required. Since cooling is forced inside the cabinets, the equipment will remain in good operating condition without site air–conditioning.

**Control Cabinet**

The control cabinet holds two identical shelf sets that contain the MPUA and MPUB processing chains:

- a power supply shelf with one power supply unit PSUC
- a PSUC cooling shelf
- a MPU processing shelf
- a MPU cooling shelf

Each fully equipped MPU processing shelf has the following boards:

- BSC 6000 (see *Figure 4–5*)
- BSC 12000 (see *Figure 4–6* and *Figure 4–7*)

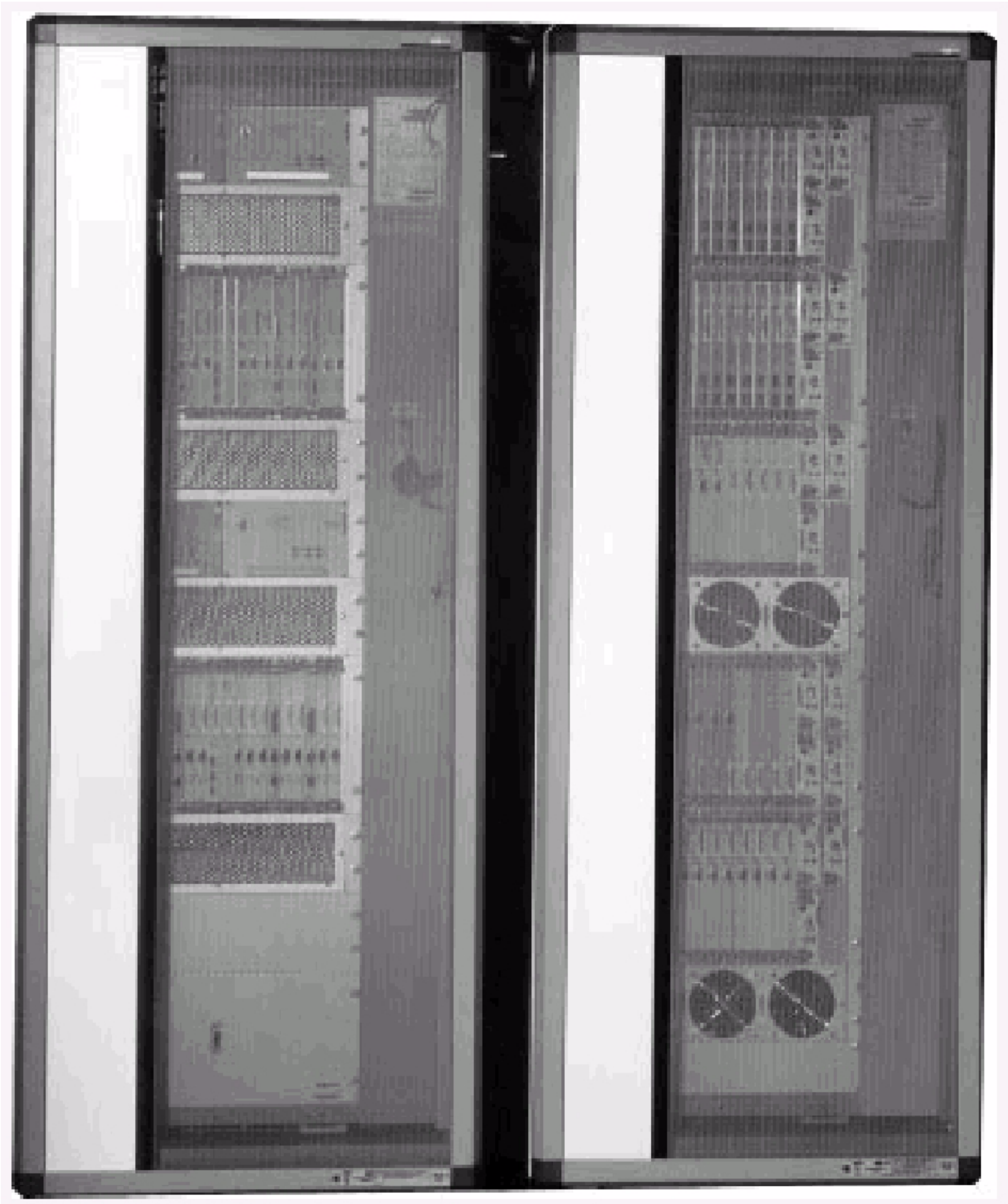
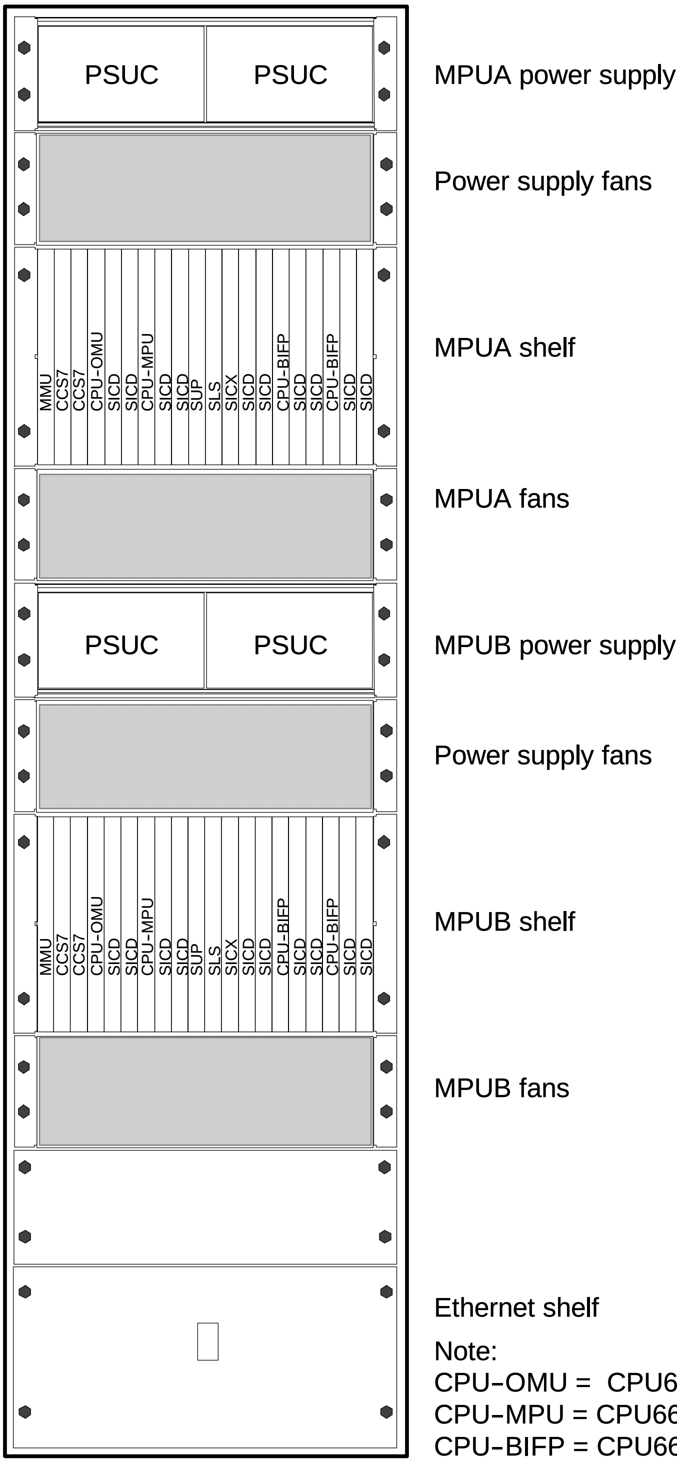


**Figure 4–4 BSC control and equipment cabinet**




Note:
CPU–OMU = CPU66SE
CPU–MPU = CPU66 or CPU120 without mixing
CPU–BIFP = CPU66 or CPU120 without mixing

**Figure 4–5 Fully equipped BSC 6000 control cabinet**

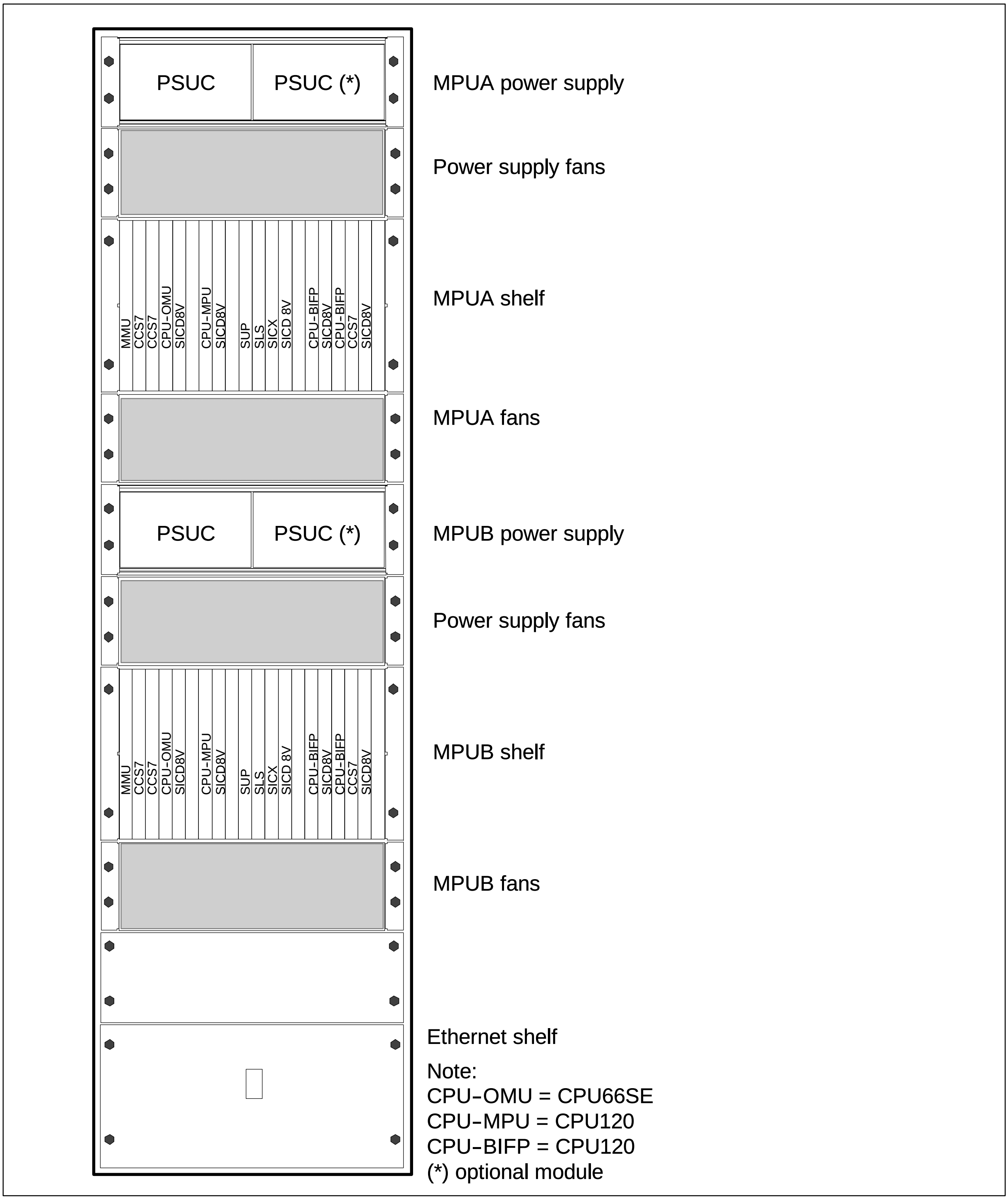



**Figure 4–6 Fully equipped BSC 12000 control cabinet**

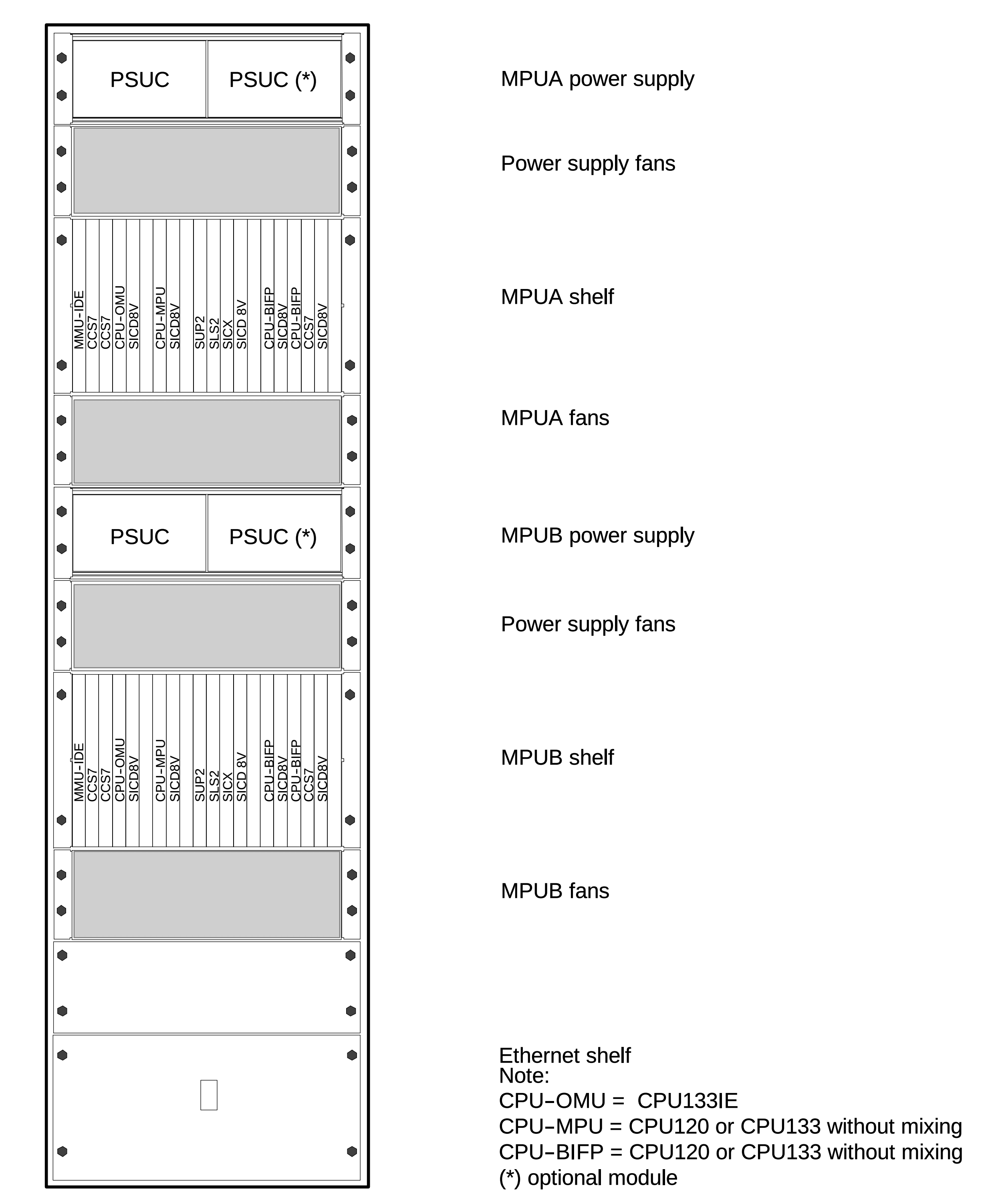



**Figure 4–7 Fully equipped BSC 12000 “HC” control cabinet**

Equipment Cabinet (BSC 6000 and BSC 12000)

The equipment cabinet contains the following units (see *Figure 4–8*):

- two EQPD shelves (upper racks) that contain the following:
  - 24 PCM link management boards (DDTI)
  - 6 power supply units (PSUE)
- an EQPI shelf (intermediate rack) that contains the following:
  - 1 alarm management board (ALA)
  - 2 transcoder signaling concentration boards (TSCB)
  - 10 rate converter boards (RCB)
  - 3 power supply units (PSUE)
- an SWG shelf (switching rack) that contains the following:
  - 2 switching control boards (SWC)
  - 4 switching boards (MSW)
  - 4 switching extension boards (SWE)
  - 2 equipment cabinet interface boards (ECI)
  - 4 power supply units (PSUE)
- an EQPT shelf (concentration rack) that contains the following:
  - 12 BTS signaling concentration boards (BSCB)
  - 3 power supply units (PSUE)
- two cooling units with three front fans

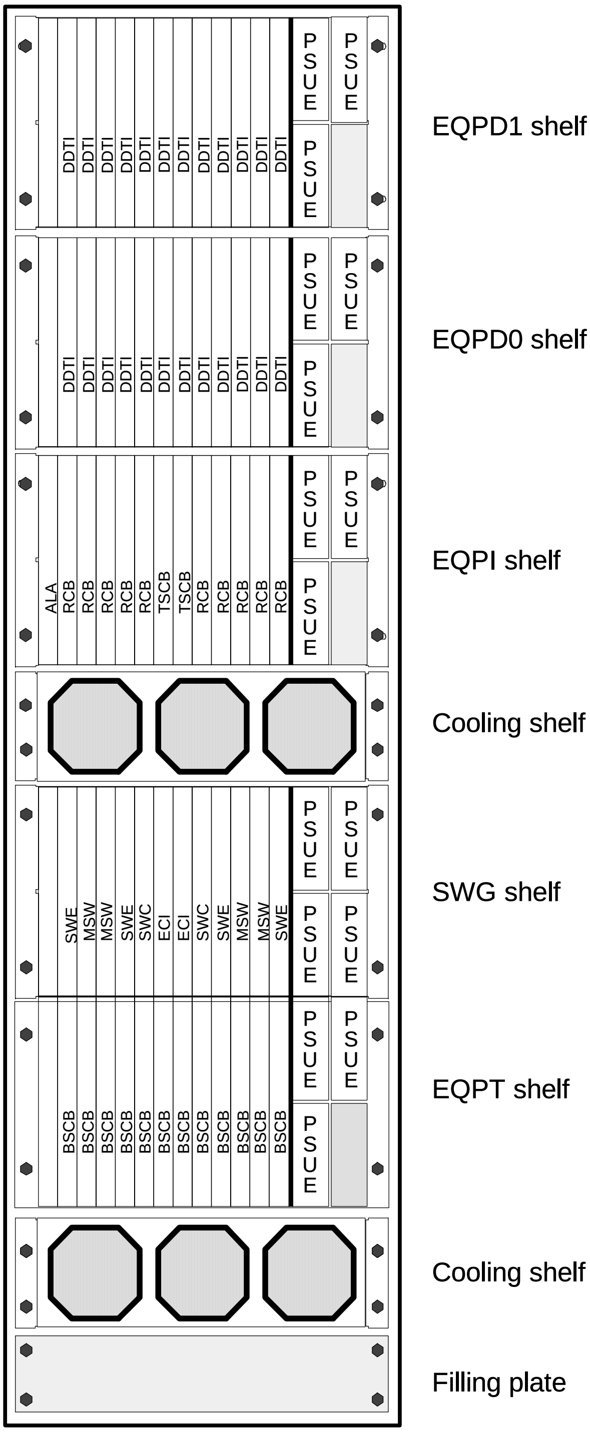



**Figure 4–8 Fully equipped BSC 6000, 12000, and 12000 “HC” equipment cabinet**

## 4.2.3 Physical characteristics

**Dimensions**

- width : 78 cm (30.7 in.)
- depth : 60 cm (23.6 in.)
- height : 200 cm (78.7 in.)

**Weight**

- less than 250 kg (551 lb)

**Air Cooling**

- control cabinet: forced on four levels
- equipment cabinet: forced on two levels

## 4.2.4 Electrical characteristics

**Power Supply**

- rated voltage: –48 V dc
- minimum voltage: –40.5 V dc
- maximum voltage: –57 V dc

**Power consumption**

| | | Control cabinet | Equipment cabinet |
|---|---|---|---|
| **BSC 6000** | With CPU 66SE and CPU 120 boards | 1064 W | 555 W |
| | Other cases | 1510 W | 555 W |
| **BSC 12000** | With CPU 66SE, CPU 120 and SICD8V | 1000 W | 555 W |

**Table 4–1 Cabinet power consumption**

# 5 TCU

## 5.1 TCU e3

### 5.1.1 Introduction

The TCU e3 are provided to reduce the number of PCM links required to convey radio speech and data channels between the BTS, BSC, and MSC.

#### 5.1.1.1 TCU e3 goals

Remote transcoders enable users to convey multiplexed radio channels at 8/16 kbit/s onto one 64 kbit/s PCM channel. Therefore, four full–rate channels may share one PCM time slot.

Multiplexing is performed within the BTS, reducing the number of PCM links needed on the Abis interface, which connects a BTS to a BSC.

The TCU e3 are operated by the BSC, but they should be located at the MSC site to reduce the PCM length between BSC and MSC.

For PCM optimization purposes, the BSC should be located at half the distance from the BTS they control. Using a smaller amount of PCM links means lower operating costs and helps minimize one of the main problems encountered by operators of mobile networks.

#### 5.1.1.2 TCU e3 location

TCU e3 are part of the base station subsystem (BSS). They are controlled by BSC e3 for alarm detection and maintenance purposes. A TCU e3 cabinet contains up to two transcoder nose that may be connected to different BSC.

Since several BSC may be linked to one MSC and several TCU e3 may be concentrated inside one piece of equipment, installing TCU e3 cabinets on MSC premises is a good choice.

### 5.1.2 TCU e3 hardware structure

#### 5.1.2.1 Mechanical structure

The TCU e3 cabinet (see *Figure 5–1*) is composed of one frame assembly and one SAI (Service Area Interface) frame assembly.

The TCU e3 frame and each SAI frame are based on a PTE2000 architecture.

The basic mechanical elements of a TCU e3 frame consists of two dual–shelf assemblies which are based on a SPECTRUM architecture. Each can accommodate up to thirty removable modules.

The modules are electrically–shielded metal boxes that have identical dimensions. Modules, cable connections, air–filter assemblies, and other maintenance items can be accessed from the front of the frame.

Retractable doors and cable–trough covers protect the cable runs and cable connections. The frame can be used with existing earthquake anchors and existing overhead or underfloor cabling systems.

The SAI is installed in the left hand side of the frame. It is an auxiliary frame for connecting the PCM E1/T1 cables between the TCU e3 frame and the other BSS products.

The TCU e3 cabinet is designed for indoor applications and is EMC compliant (no rack enclosure is necessary. EMC compliance is performed on each dual–shelf.)

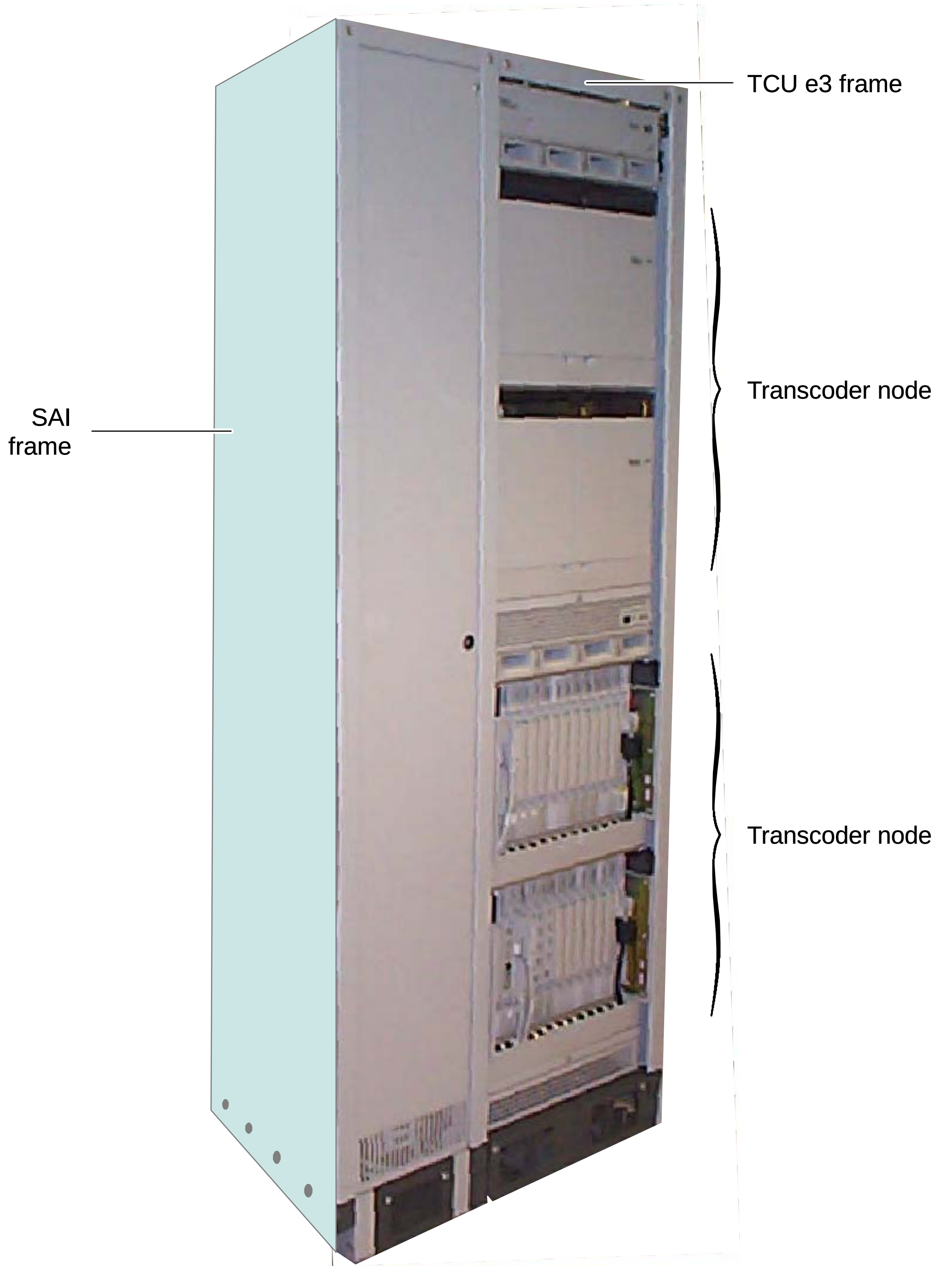



**Figure 5–1 TCU e3 cabinet presentation**

### 5.1.2.2 Hardware overview

### 5.1.2.3 TCU e3 frame overview

The frame of a TCU e3 (see *Figure 5-2*) cabinet houses the following:

- two dual-shelf

  Each dual-shelf corresponds to the transcoder node which houses the following modules:

  - **CEM:** Common Equipment Module
  - **TRM:** Transcoder Resource Module
  - **LSA-RC:** Low Speed Access Resource Complex

    These modules house the following modules:
    - **IEM:** Interface Electronic Module
    - **TIM:** Termination Interface Module
  - **SIM:** Shelf Interface Module
  - **FILLER** modules

- four retractable doors on each dual-shelf

  Each door houses a transparent part to show both visual indicators (red and green LEDs) on each module.

- one PCIU (Power Cabling Interface Unit)

  The PCIU is mounted on the top of the frame of the BSC e3 or the TCU e3 cabinet. It accommodates the power cables from the operator boxes, the power and alarms cables to each dual-shelf. Different covers protect each cable and each connector. A frame summary indicator and a fan failure lamp are located on the cover.

- two air filter assemblies

  The air filter assemblies filter the air supply for each dual-shelf. One filter assembly is located in the middle of the frame and the other at the bottom of the frame.

- two grill assemblies

  The upper grill assembly is located in the middle of the frame and the lower grill assembly at the bottom of the frame. They allow the air flow circulation.

- two cooling units

  One is located on the top and the other in the middle of the frame. Each cooling unit houses four fan units and provides mechanical ventilation for each dual-shelf.

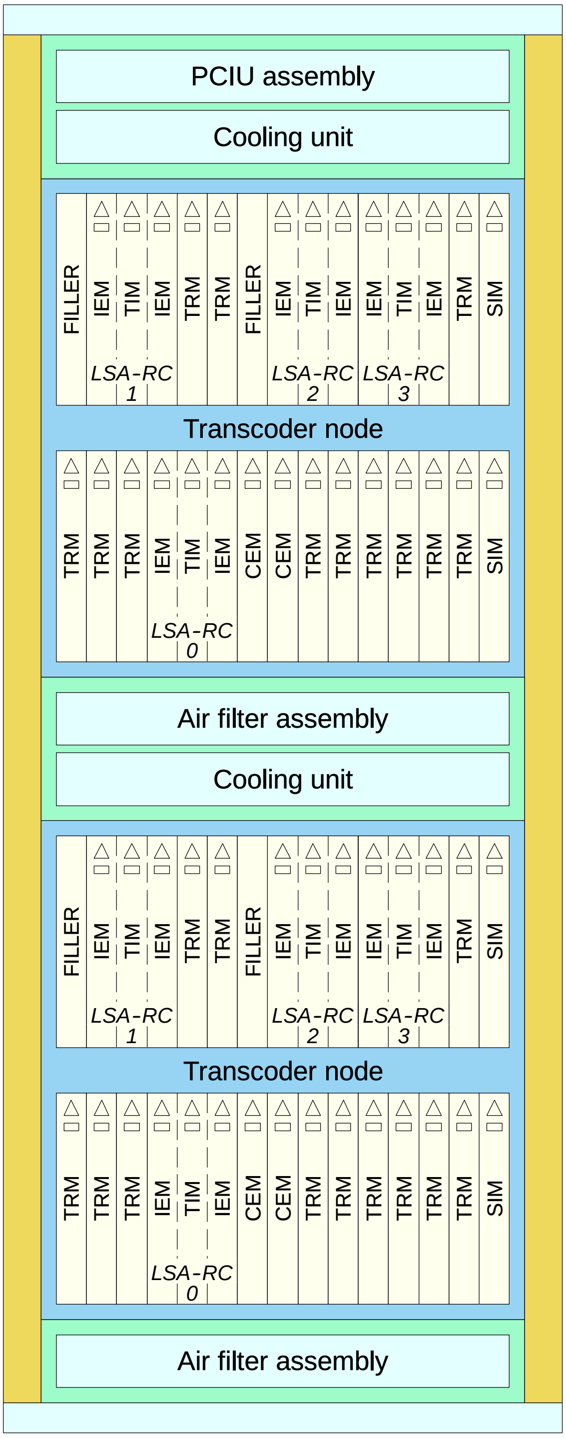



**Figure 5-2 Frame of the TCU e3 cabinet: front view**

#### 5.1.2.4 SAI frame overview

The SAI frame (see *Figure 5–3*) enclosures electronic equipments to interface the TCU e3 frame with the external PCM (E1/T1) cables to the:

- BSC e3 cabinet via the Ater interface
- MSC cabinet via the A interface

The SAI houses the following:

- up to eight CTU modules.

  They provide the physical interface for:

  - up to 21 PCM E1 links
  - up to 28 PCM T1 links

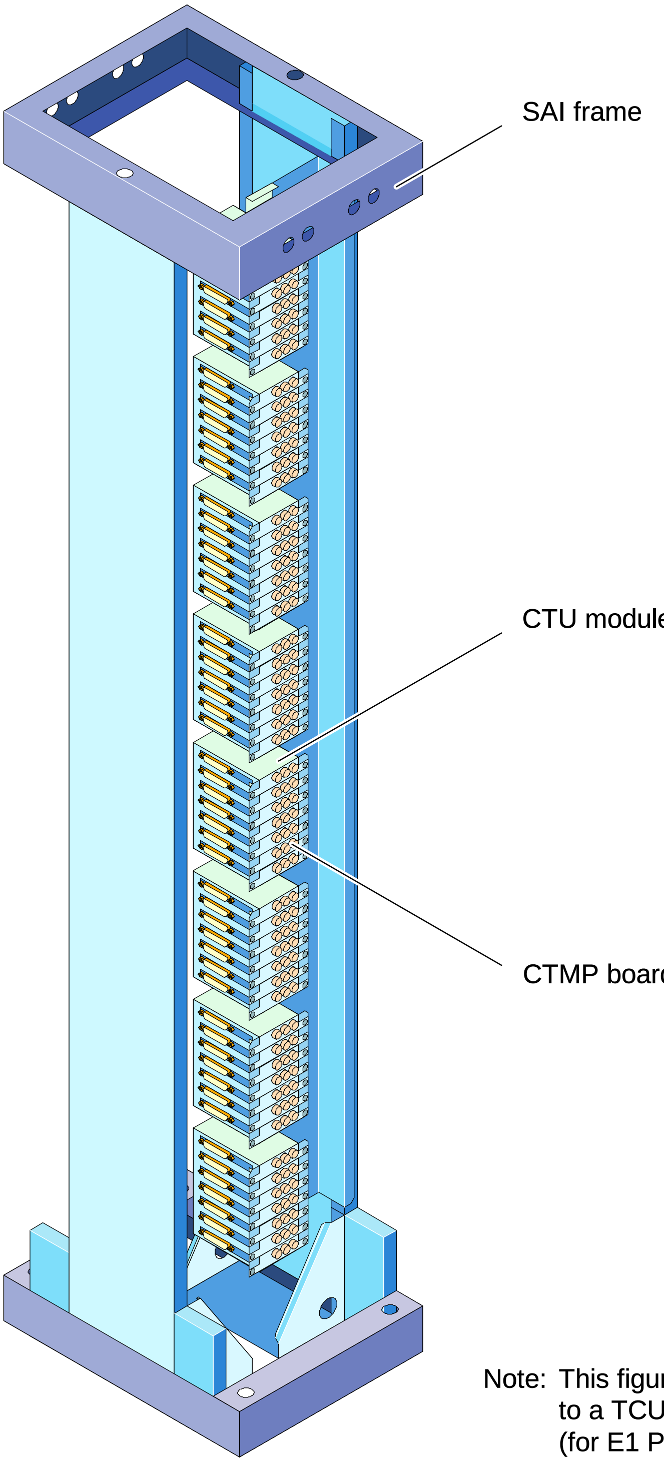
Each CTU module, in the SAI frame, houses:

- one backplane: CTB (Cable Transition Board)
- up to seven boards: CTMx (Cable Transition Module)

  Each of these is either a:

  - CTMC board for PCM E1 Coax, which permits connecting three PCM E1 links
  - CTMP board for PCM E1 twisted pair, which permits connecting three PCM E1 links
  - CTMD board for PCM T1 twisted pair, which permits connecting four PCM T1 links




Note: This figure shows a SAI frame dedicated to a TCUe3 cabinet with the CTMP board (for E1 PCM 120 Ω).

**Figure 5-3 SAI: hardware overview**

### 5.1.2.5 Physical characteristics

**Dimensions**

TCU e3 cabinet dimensions with cosmetic panels

- width: 960 mm (37.8 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

TCU e3 cabinet dimensions without cosmetic panels

- width: 900 mm (35.4 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

TCU e3 frame dimensions

- width: 600 mm (23.6 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

SAI frame dimensions without cosmetic panels

- width: 300 mm (11.8 in.)
- depth: 600 mm (23.6 in.)
- height: 2200 mm (86.6 in.)

**Weight**

- TCU e3 fully loaded (including cosmetic panels): 550 kg (1200 lb)
- TCU e3 frame only with all modules integrated: 400 kg (880 lb)
- TCU e3 frame only without any module: 220 kg (480 lb)
- SAI frame only with modules: 90 kg (200 lb)

**Cooling**

- forced air in each dual–shelf
- in case of risk of dust, the ventilation system must be equipped with a filter compliant with ETS 300 019–1–3 and maintenance which is periodically performed
- the temperature gradient inside the premises must comply with the recommendation for operating conditions (refer to ETS 300 019–1–3).

### 5.1.2.6 Electrical characteristics

**Power supply**

- rated voltage: –48 V dc
- minimum voltage: –40.5 V dc
- maximum voltage: –57 V dc

**Power consumption**

- Maximum consumption (W): 2000 W approximately

# 5.2 TCU 2G

## 5.2.1 Introduction

Transcoder units (TCUs) are provided to reduce the number of PCM links required to convey radio speech and data channels between the BTS, BSC, and MSC (see *Figure 5–4*).

### 5.2.1.1 TCU goals

Remote transcoders enable users to convey multiplexed radio channels at 16 kbit/s onto one 64 kbit/s PCM channel. Therefore, four full–rate channels may share one PCM time slot.

Multiplexing is performed within the BTS, reducing the number of PCM links needed on the Abis interface, which connects a BTS to a BSC.

The TCU are operated by the BSC, but they should be located at the MSC site to reduce the PCM length between BSC and MSC. For PCM optimization purposes, the BSC should be located at half the distance from the BTS they control.

Using a smaller amount of PCM links means lower operating costs and helps minimize one of the main problems encountered by operators of mobile networks.

### 5.2.1.2 TCU location

TCU are part of the base station subsystem (BSS). They are controlled by BSC for alarm detection and maintenance purposes.

Each TCU shelf includes one PCM link to the BSC and up to four PCM links to the MSC. A TCU cabinet contains up to four TCU that may be connected to different BSC.

Since several BSC may be linked to one MSC and several TCU may be concentrated inside one piece of equipment, installing TCU cabinets on MSC premises is a good choice.

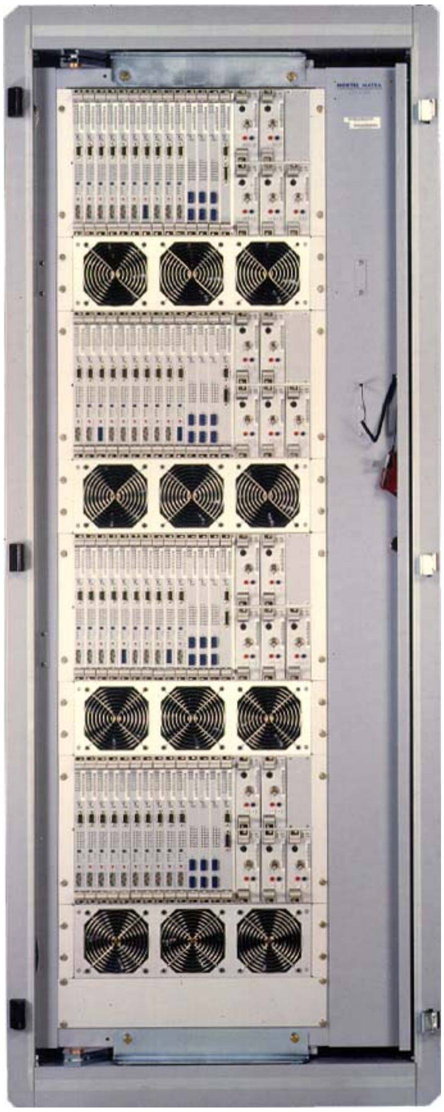


**Figure 5–4 Transcoder unit (TCU)**

## 5.2.2 TCU hardware structure

The transcoder unit (TCU) fits into a TCU shelf inside a cabinet that can hold four shelves. In this cabinet, each TCU shelf represents an independent entity (the four shelves may be connected to four different BSC).

### 5.2.2.1 Hardware overview

The TCU cabinet has a compact metal frame fitted with four lifting rings. A chassis supports the equipment units. It may be pivoted on an axis to access the rear of the equipment units and to the cabinet wiring.

The chassis contains shelves hosting racks designed to hold various units. By pivoting, it enables maintenance of the TCU cabinets from the front, enabling the operator to install them back to back, reducing the area occupied. A metal door closes the cabinet.

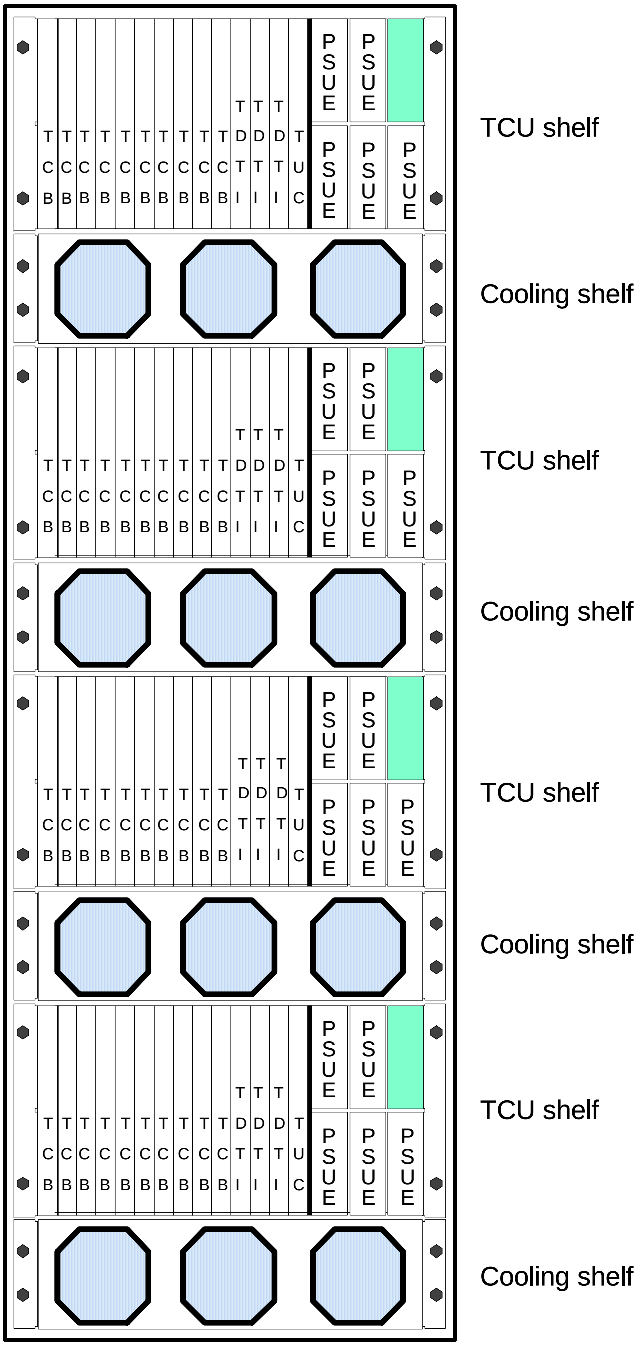
Wiring is done from the top or the bottom of the cabinets. In this case, false floors must be installed. Since cooling is forced through each shelf and converted to the top, the equipment will remain in good operating conditions without site air–conditioning.

The TCU shelf contains two racks:

- The upper rack has the following boards:
  - ten transcoder boards (TCB or TCB2). Although eight are required for the TCU to work at its nominal capacity, it can also work with less.
  - three PCM link management boards (TDTI)
  - a transcoder unit controller (TUC)
  - five power supply converters (5 V/12 A)
- The lower rack has a cooling unit that contains three front fans and an air detector.

*Figure 5–5* displays a TCU cabinet fitted with four TCU shelves.




**Note:** TCB board = TCB or TCB2.

**Figure 5–5 TCU cabinet (fully equipped)**

### 5.2.2.2 Physical characteristics

**Dimensions**

- width: 78 cm (30.7 in.)
- depth: 60 cm (23.6 in.)
- height: 200 cm (78.7 in.)

**Weight**

- less than 280 kg (617 lb)

**Cooling**

- forced air in each shelf (four levels)

### 5.2.2.3 Electrical characteristics

**Power supply**

- rated voltage: –48 V dc
- minimum voltage: –40.5 V dc
- maximum voltage: –57 V dc

**Power consumption**

| | TCB boards | TCB2 boards |
|---|---|---|
| TCU E1 | 730 W | 920 W |
| TCU T1 | 647 W | 725 W |

**Table 5–1 Board power consumption**

# 6 MSC

## 6.1 Introduction

The Mobile services Switching Center performs the interface between the mobile network and the public networks already established.

### 6.1.1 Mobile services switching center

The Mobile services Switching Center (MSC) performs all the switching functions needed for mobiles located in its geographical area. To perform its switching and call processing functions, the MSC must interact with other nodes in the network. For performance reasons, the MSC is often paired with a Visitor Location Register (VLR), and the MSC/VLR pair serves one or more location areas.

### 6.1.2 Visitor location register

The Visitor Location Register (VLR) is a database that holds information pertaining to Mobile Stations that are currently registered in the VLR serving area. For Mobile Stations that have currently roamed in a VLR area, the VLR maintains a local copy of some of the subscriber’s permanent data. As its name implies, the VLR is concerned only with the information pertaining to Mobile Stations that are currently visiting the VLR serving area.

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# 7 OMC–R ARCHITECTURE

## 7.1 Introduction

### 7.1.1 Purpose of the OMC–R

The OMC–R centralizes the operation and maintenance of the radio subsystems (BSS) that are connected to it. Each BSS consists of a Base Station Controller (BSC), a set of Transcoding Units (TCU) and several Base Transceiver Stations (BTS).

The operation and maintenance of the BSS and of the OMC–R are based on the following general functions:

- configuration, from the OMC–R, of the entities that make up the BSS
- observation of the operation of the BSSs and of the OMC–R, in order to analyse the performance of the system and detect any operational anomalies

These functions are provided by the operator's personnel, using an interactive software application.

### 7.1.2 Location of the OMC–R

The OMC–R is connected to a set of BSSs.

*Figure 7–1* shows the position of the OMC–R in the network.

Physically, the OMC–R is in a room that contains the equipment described in the "OMC–R physical architecture" chapter.

Furthermore, some of the OMC–R's interactive equipment (remote stations, RACE) can be located and used remotely to meet specific operating requirements such as operation and maintenance from BSS sites.

Remote ACcess Equipments (RACE) are portable PCs with web browsers, and are connected to the telephone network (PSTN) or to the Local Area Network (LAN). In order to carry out the maintenance and operation of the BSS, they use functions identical to those of the OMC–R, except for a few such as the security management functions.

The OMC–R is made up of two logical entities: a local manager and an agent (the MD–R). The two communicate via an internal Q3 interface, except for the notification management.

However, the Q3 can become external and enable the MD–R to communicate with a remote manager.

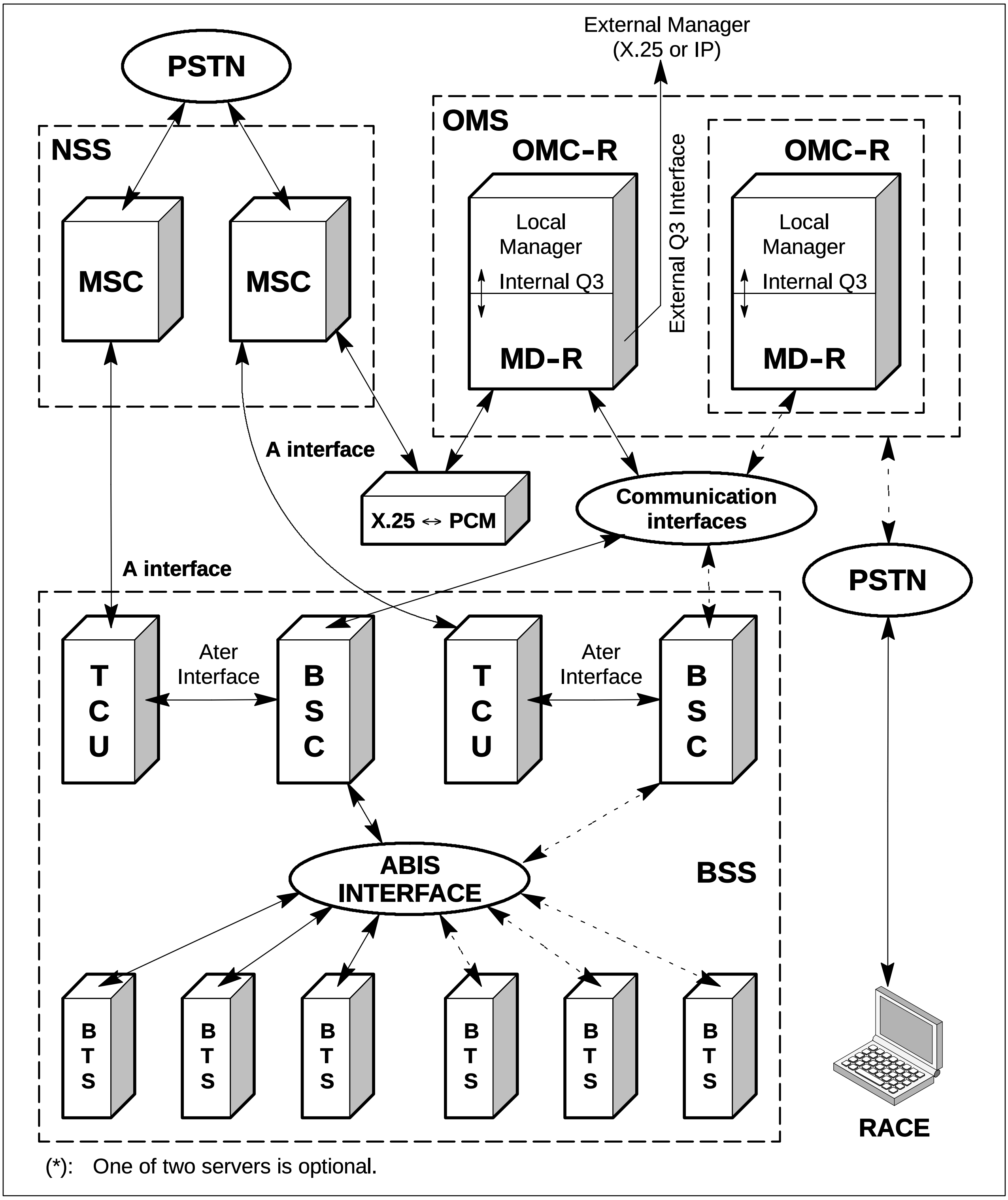


**Figure 7-1 Location of the OMC-R in the GSM network**

Furthermore, and on an optional basis, it is possible to have the OMC–R communicate with the BSSs without using the X25 PSTN via the MSC. and a hardware unit which transcribes the X.25 protocol onto the PCM links (DPN 100)

This possibility can be used when an X.25 network is not available.

## 7.2 OMC–R physical architecture

### 7.2.1 Principles

The OMC–R is based on a SUN client–server architecture that consists of three subsystems:

- server
- client workstations
- communication network that links the server and workstations

### 7.2.2 Abbreviations

| | |
|---|---|
| E4XXX: | Sun Ultra Enterprise series E4500 or E4000 |
| A5XXX: | Sun redundant StorEdge Disk array device:<br>the A5000–22 slots is referenced A5200 |
| T3: | Sun Disk Storage Array (disk array device) |
| Sun Blade: | Sun workstation |
| SC: | Standard capacity |
| HC: | High capacity |

### 7.2.3 Servers

The configuration server can be:

- the server E4XXX is connected to one A5XXX for mirroring purpose (V12)
- the server E4XXX is connected to two T3 for mirroring purpose (V13)
- the OMC–R active and passive servers E4XXX are connected to one A5XXX, the data being written on two internal A5XXX disks

The server is a server containing the mediation function and the manager function at once.

In a dual server configuration, the server is set up as a dual redundant system with two distinct machines. At any time, one server is active and the other is passive, and the data are updated on both servers.

There is one type of server Ultra Enterprise E4XXX.

For Ultra Enterprise E4XXX servers, data are stored and updated on one storage unit A5XXX. An A5XXX is connected to each server by optical channels.

### 7.2.4 Workstations

The workstations are installed on the OMC–R site (local stations) or on a remote site (remote stations). The remote stations are dedicated to an OMC–R or multi–OMC–R. In the second case, the remote stations can be linked to predetermined different OMC–R (but only to one at the same time at a given moment).

The MMI may also be operated on an X terminal connected to a workstation.

**RACE**

The RACE client communicates with the RACE server (hosted in an OMC–R station) through the PSTN. This OMC–R station (RACE server) is connected to the OMC–R LAN.

### 7.2.5 Servers/workstations communications

Servers and workstations communicate in two ways:

- local workstations, they are linked to server(s) by means of a local Ethernet network.
- remote workstations, they are linked at each site to a Local Area Network (LAN) using Ethernet. The LAN sites and the LAN servers are interconnected by means of a X.25 network and gateways (or routers) using TCP/IP–X.25.

The DNS feature allows a PLMN operator to manage dynamically all the IP addresses of his intranet including those attached to the OMC–R machines.

The NIS feature allows a PLMN operator to manage dynamically all UNIX users and user groups of his intranet including those attached to the OMC–R machines.

An asynchronous terminal server to the local network completes the system architecture. It supports modems to communicate with the RACE by means of the PSTN.

With the OMC–R, a workstation hosting the RACE server can be logically connected to a RACE client, after establishing a communication by means of the PSTN using a modem and the terminal server.

**Note:** The RACE server can only run on an OMC–R station which does not run any other application (PCUSN, SDO software) besides the OMC–R application.

The physical architecture of the OMC–R is shown in *Figure 7–2* (server E4XXX and A5XXX).

The physical architecture of the OMC–R is shown in *Figure 7–3* (line mode via terminal server).

 

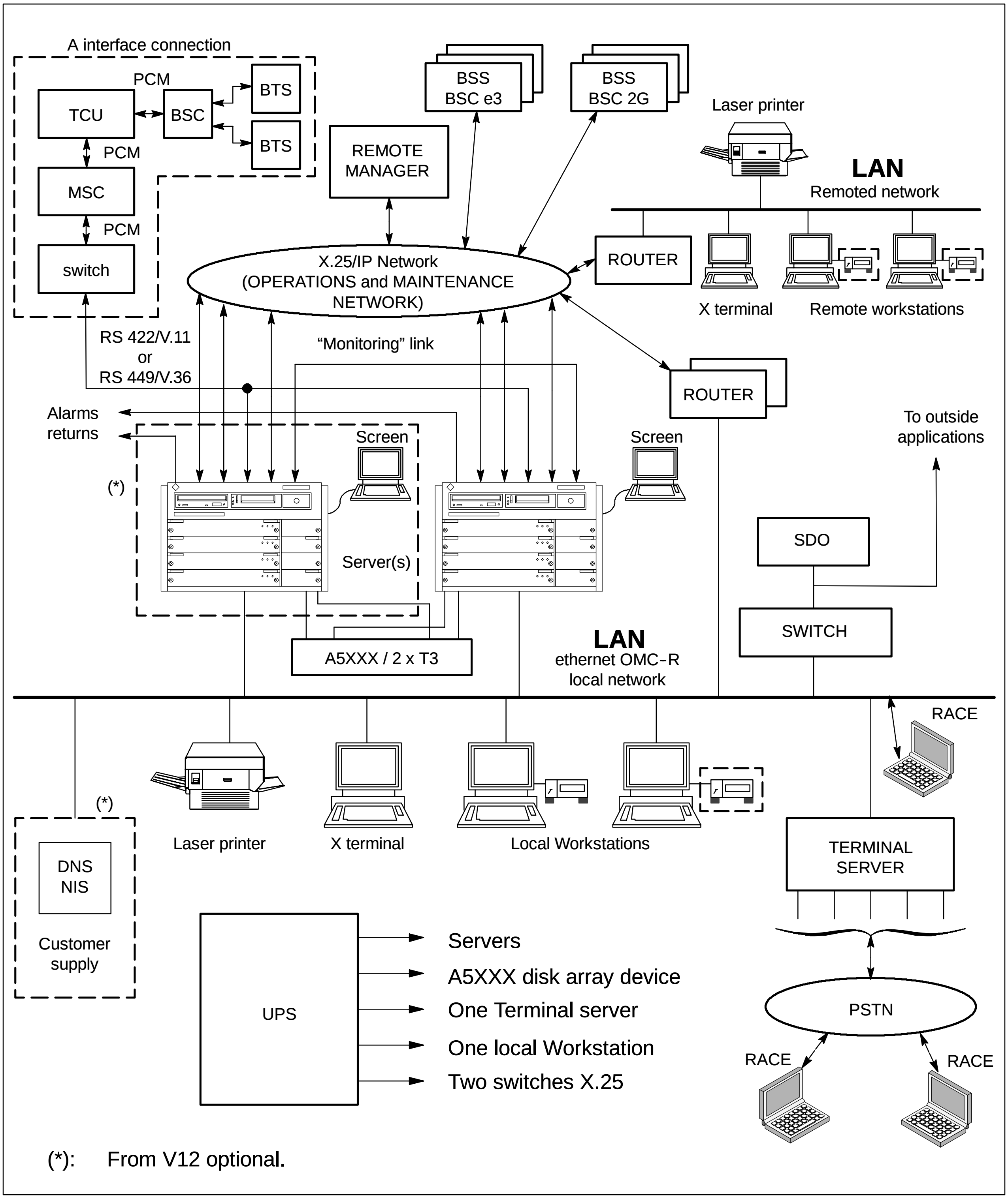


**Figure 7–2 Physical architecture of the OMC–R (Server E4XXX and A5XXX)**

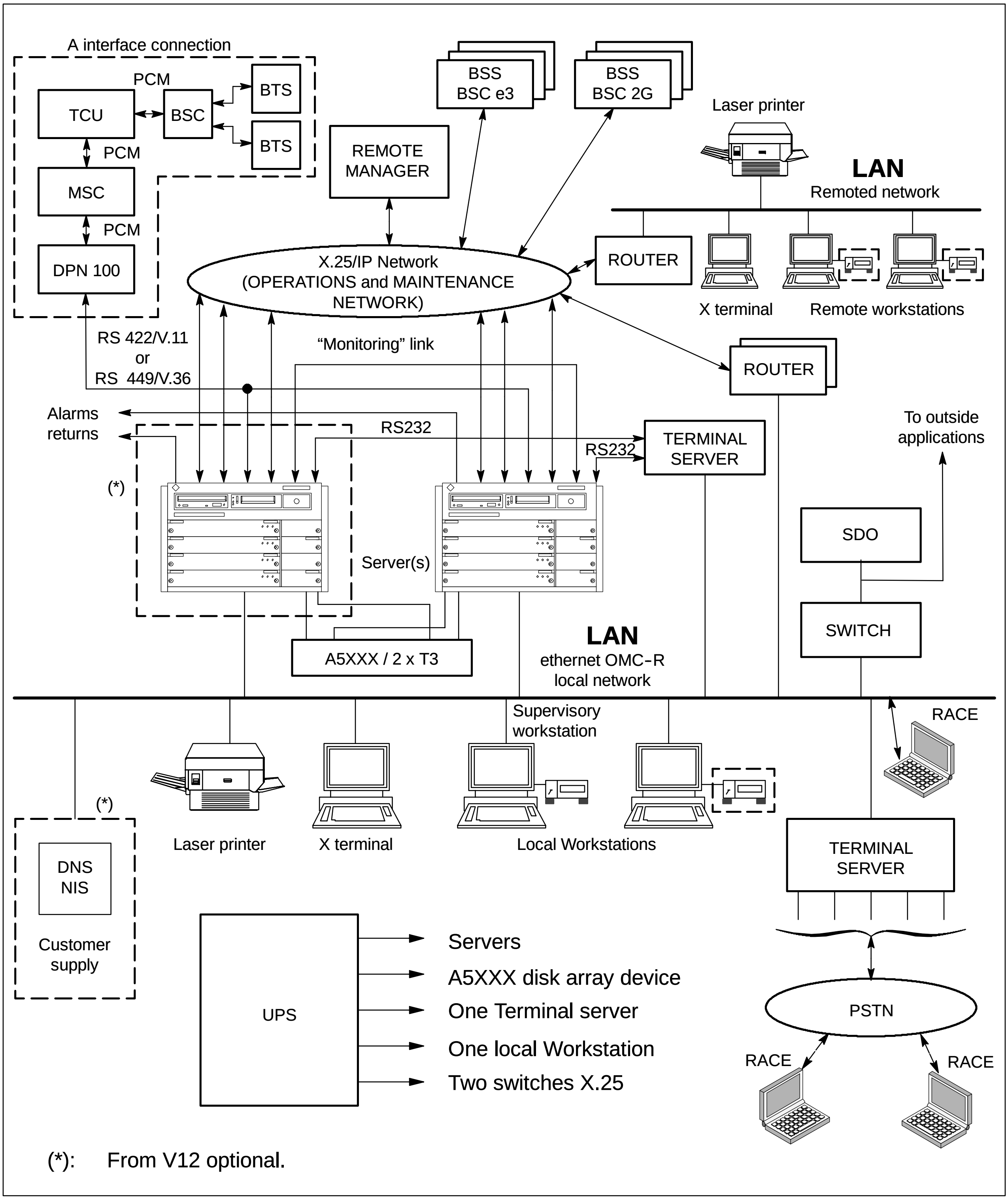


**Figure 7-3 Physical architecture of the OMC-R (Server E4XXX and A5XXX) remote operation in line mode via terminal server**

### 7.2.6 Introduction to the OMC–R physical entities

The OMC–R contains the following components:

- one server (from V12) or two servers
- two to 16 workstations or X terminals (maximum of 14 remote stations)
- zero to one asynchronous terminal server
- zero to five five modems
- routers, the number of which depends on the number of remote stations and their setup
- one or more OMC–R printer(s)
- zero or two alarm supervision boxes
- zero to five RACE (PC) client connections
- zero or one PC Firewall (Security PC)
- one 10 Base T hub or 100 Base T
- one or more X.25 switch(es)
- zero or one Uninterruptible Power Supply (UPS)
- an Ethernet switch
- zero or one OMC–R equipment rack

### 7.2.7 Environmental constraints

#### Nominal conditions

- temperature: +15 ºC to +35 ºC
- humidity: 20 % to 80 %
- temperature gradient: 10 ºC/hour

#### Exceptional conditions

- temperature: +10º C to +40 ºC
- humidity: 5 % to 80 %

#### Storage

- temperature: –20 ºC to +60 ºC
- humidity: 5 % to 95 %

### 7.2.8 Power supply

- GSM 900/1800: 220 – 240 V ac
- GSM 1900: 120 V ac or 240 V ac

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# 8 INTERFACES

## 8.1 Radio interface

### 8.1.1 Radio interface function

The radio interface provides call continuity between the fixed network and Mobile Stations (MS). The interface description covers the following:

- interface physical aspects (level 1)
- the LAPDm protocol (level 2)
- application–oriented protocols (level 3)

### 8.1.2 Radio level 1 characteristics

A set of frequencies is assigned to each cell. This set of frequencies may be used by others cells, if they are distant enough.

#### 8.1.2.1 Frequency aspect

The transmission is in duplex mode, with 200 kHz spacing between carriers and 9–dB protection on the adjacent channel. The binary rate is 270.833 kbit/s. The GMSK (Gaussian filtered Minimum Shift Keying) continuous phase modulation is used. To reduce the spectral signal response, the base train passes through a gaussian filter characterized by the product BxT = 0.3.

From mobile–to–BTS (uplink) frequency bands in megahertz are the following:

- in GSM 900:
  - 890 + n x 0.2 with $1 \leq n \leq 124$ (standard)
  - 880 + n x 0.2 with $1 \leq n \leq 174$ (E–GSM)
  - 876 + n x 0.2 with $1 \leq n \leq 19$ (R–GSM)
- in GSM 1800: 1710 + 0.2 x (n – 512) with $512 \leq n \leq 885$
- in GSM 1900: 1850 + 0.2 x (n – 512) with $512 \leq n \leq 810$

From BTS–to–mobile (downlink) frequency bands in megahertz are the following:

- in GSM 900:
  - 935 + n x 0.2 with $1 \leq n \leq 124$ (standard)
  - 925 + n x 0.2 with $1 \leq n \leq 174$ (E–GSM)
  - 921 + n x 0.2 with $1 \leq n \leq 19$ (R–GSM)
- in GSM 1800: 1805 + 0.2 x (n – 512) with $512 \leq n \leq 885$
- in GSM 1900: 1930 + 0.2 x (n – 512) with $512 \leq n \leq 810$

 

#### 8.1.2.2 Time aspect

Eight physical channels are multiplexed on each carrier; it is called a Time Division Multiple Access (TDMA) of eight time slots. A physical channel is made of the recurrence of the same time slot taken from successive frames (see *Figure 8–1*).

The prescribed time slot interval is 577 μs (15/26 ms); eight contiguous intervals form a TDMA frame (8 x 0.577 = 4.6 ms).

A multiframe contains 26 TDMA traffic frames (with associated control channels) or 51 TDMA frames from common and/or dedicated channels.

A superframe contains 26 x 51 TDMA frames (6.12 s).

A hyperframe contains 2048 superframes (3 h 28 m 53 s).

#### 8.1.2.3 Logical channel types

A logical channel uses a division of the time slots that make up one physical channel. This division depends on the logical channel type (more than one logical channel may share a same physical channel).

There are two types of logical channels:

- signaling control channels (CCH), which are subdivided into two groups based on whether they can be used by all the mobile stations (common channels) or by one mobile station (dedicated channels)
- traffic channels (TCH), which convey user data (coded speech at 13 kbit/s or data)

**Common signaling channels**

- The Broadcast Control CHannel (BCCH) is a unidirectional fixed frequency channel occupying time slot 0. It is used to broadcast system cell and neighboring cell information to mobile stations.
- The Cell Broadcast CHannel (CBCH) is a unidirectional channel and takes the place of SDCCH No. 2 in all cases. It can be combined with either a SDCCH/8 (“CBCH”) or BCCH + SDCCH/4 (“CBCH combined”).
- the Common Control CHannel (CCCH) includes the following:
  - the unidirectional Random Access CHannel (RACH) used by mobile stations to access to the cell (uplink)
  - the unidirectional Paging CHannel (PCH) used by the network to page mobile stations (downlink)
  - the undirectional Associated Grant CHannel (AGCH) used by the network to assign a dedicated channel to a mobile station to set up calls (downlink)
- In cells where MS signaling is high, one CCCH channel is not sufficient. Then additional CCCH channels or an extended CCCH (ECCCH) manages cells of more than six TRXs capacity.

 

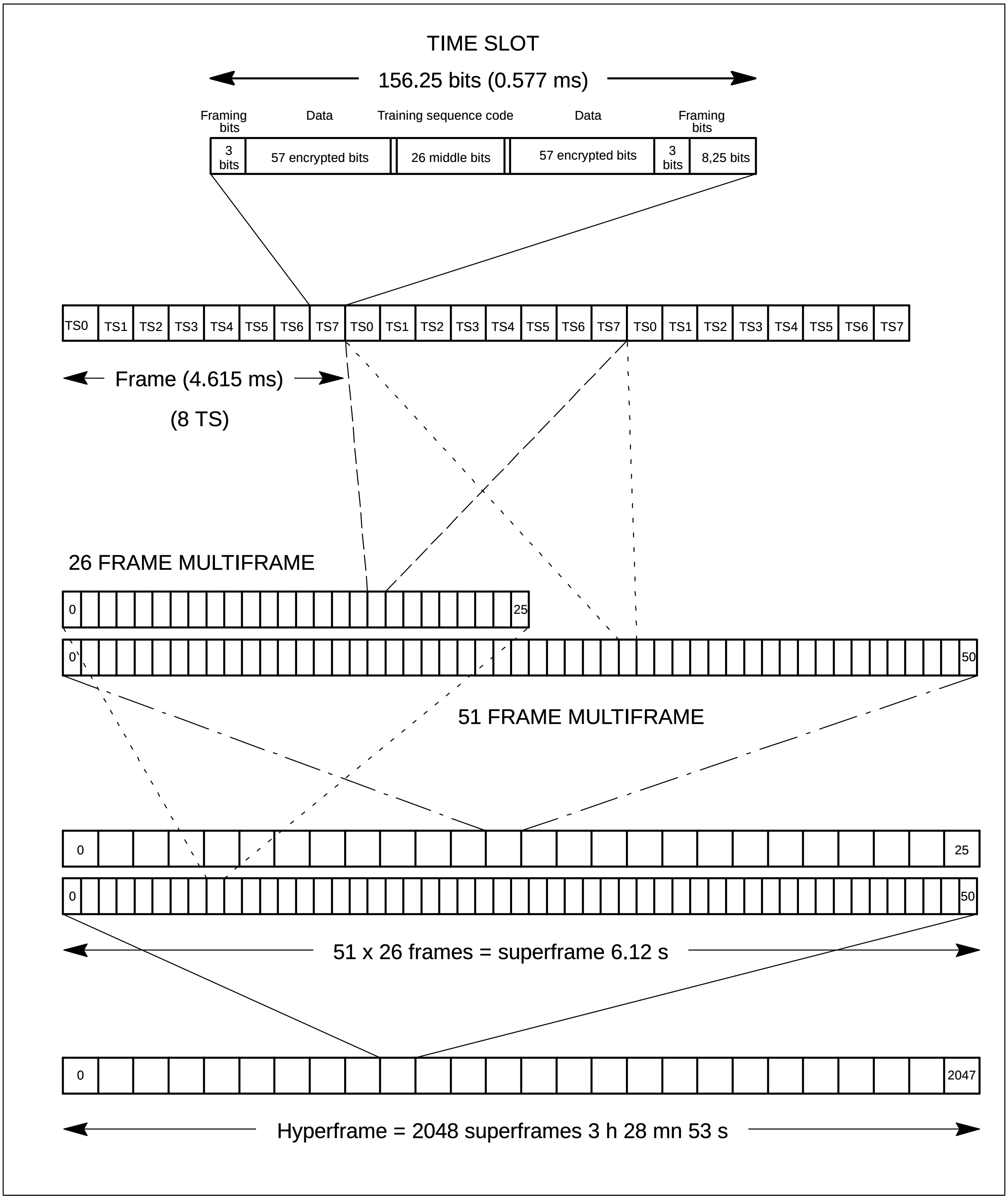


**Figure 8–1 TS, frame, multiframe, superframe, hyperframe**

- the unidirectional Frequency CHannel (FCCH) is used for frequency synchronization of mobile stations (downlink)
- the unidirectional Synchronization CHannel (SCH) which contains information for synchronizing mobile stations (short frame number) and the cell identity (BSIC) (downlink)

#### Dedicated signaling channels

These bidirectional dedicated channels used at fixed or variable frequencies are of two types:

- Stand–alone Dedicated Control CHannels (SDCCH), which are temporarily assigned while the call is being set up
- Associated Control CHannels (ACCH), which include the following:
  - the SACCH, which is used to exchange the system information needed to maintain calls (measurements, power, timing advance. They are always combined with a TCH or SDCCH.
  - the FACCH, which is created by preempting the timing pulse normally used by a TCH channel. They are used to exchange signaling information instantaneously during an ongoing call

#### Traffic channels

These bidirectional dedicated channels used at fixed or variable frequencies are of two types:

- Full–rate traffic channels (TCH/F) support either a voice or a data channel. There are different types of TCH/F:
  - TCH/F 9.6 : 9600 bit/s
  - TCH/F 4.8 : 4800 bit/s
  - TCH/F 2.4 : 2400 bit/s
  - TCH/F 1.2 : 1200 bit/s
  - TCH/F 1.2/75 : 1200/75 bit/s
  - TCH/F 0.6 : 600 bit/s

  The format of TCH/F frames depends on the mode (transparent or non–transparent).
- Half–rate traffic channels (TCH/H) support two voice or data channels.

 

#### 8.1.2.4 Burst bit patterns

A burst is the actual content of one time slot. It contains bits of information sent over a radio channel. There are five kinds of bursts (see *Figure 8–2)*:

- normal
- frequency correction
- synchronization
- dummy
- access

Normal bursts transmit the logical FACCH, BCCH, PCH, AGCH, SDCCH, and SACCH channel and TCH voice channel data bits.

Frequency correction bursts transmit a pattern of bits over the logical FCCH channel. The Mobile Station (MS) uses them for call frequency correction.

Synchronization bursts transmit logical SCH channel data bits.

Dummy bursts transmit redundant bits to maintain radio transmission continuity. They have the same pattern as the normal bursts.

Access bursts allow mobile stations to gain access to the cell and include the following:

- random access bursts RACH for first–time cell access
- handover bursts for cell changeover purposes

#### 8.1.2.5 Logical channel multiplexing

There are five ways to combine logical channels onto physical channels:

- TCH/F + SACCH (+ FACCH): it is a full–rate traffic channel plus its associated channels (see *Figure 8–3*)
- TCH/H + SACCH (+ FACCH): it is a half–rate traffic channel plus its associated channels (not supported by the BTS) (see *Figure 8–3*)
- BCCH + SCH + FCCH + CCCH: it is an uncombined BCCH channel plus its common channels (see *Figure 8–4*)
- BCCH + SCH + FCCH + CCCH + 4 x (SACCH + SDCCH): it is a combined BCCH channel, same as above except that four dedicated signaling channels are added (see *Figure 8–5*)
- 8 x (SACCH + SDCCH): it is a channel that can support eight dedicated signaling channels (see *Figure 8–6*)

 

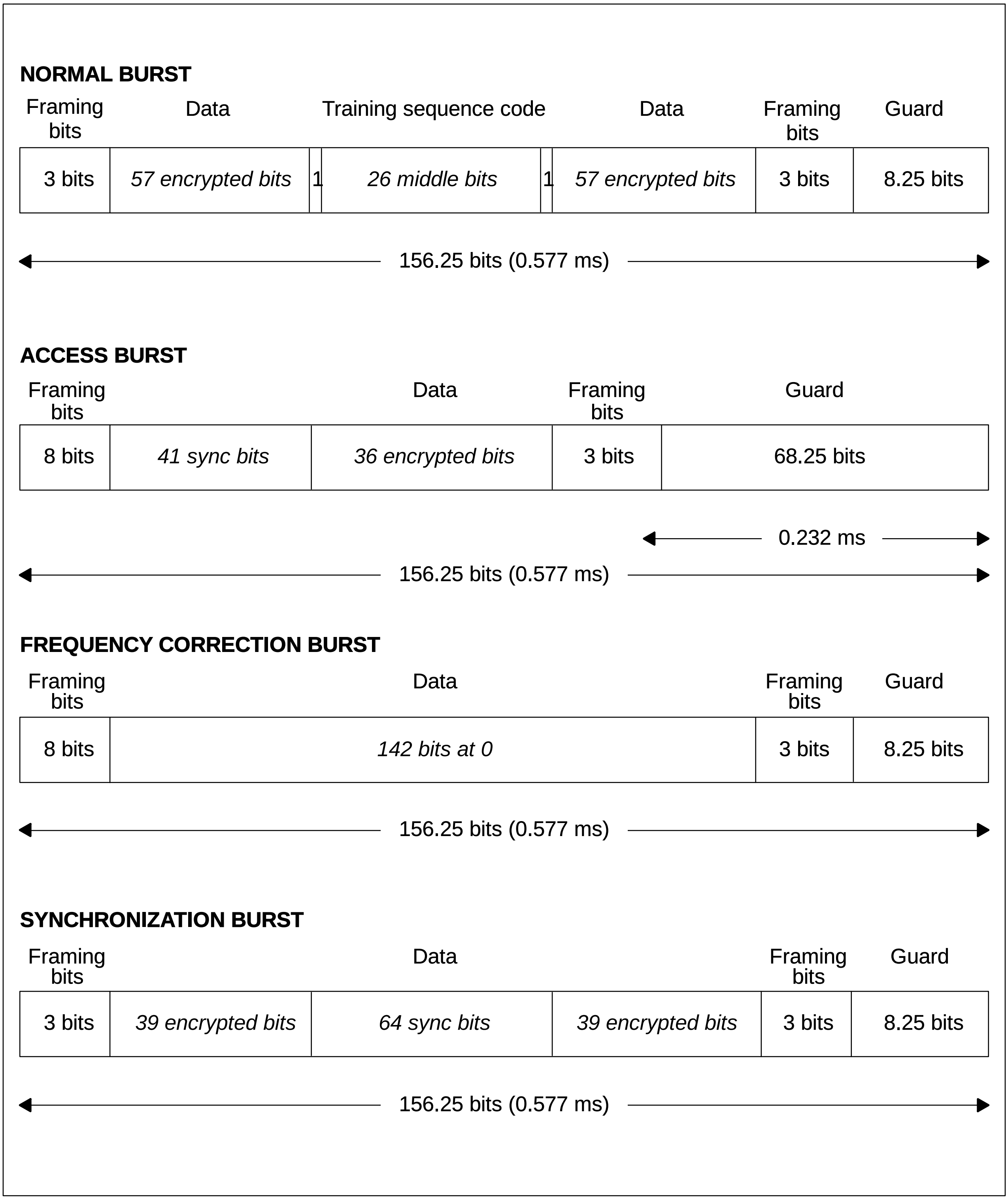


**Figure 8-2 Burst bit patterns**

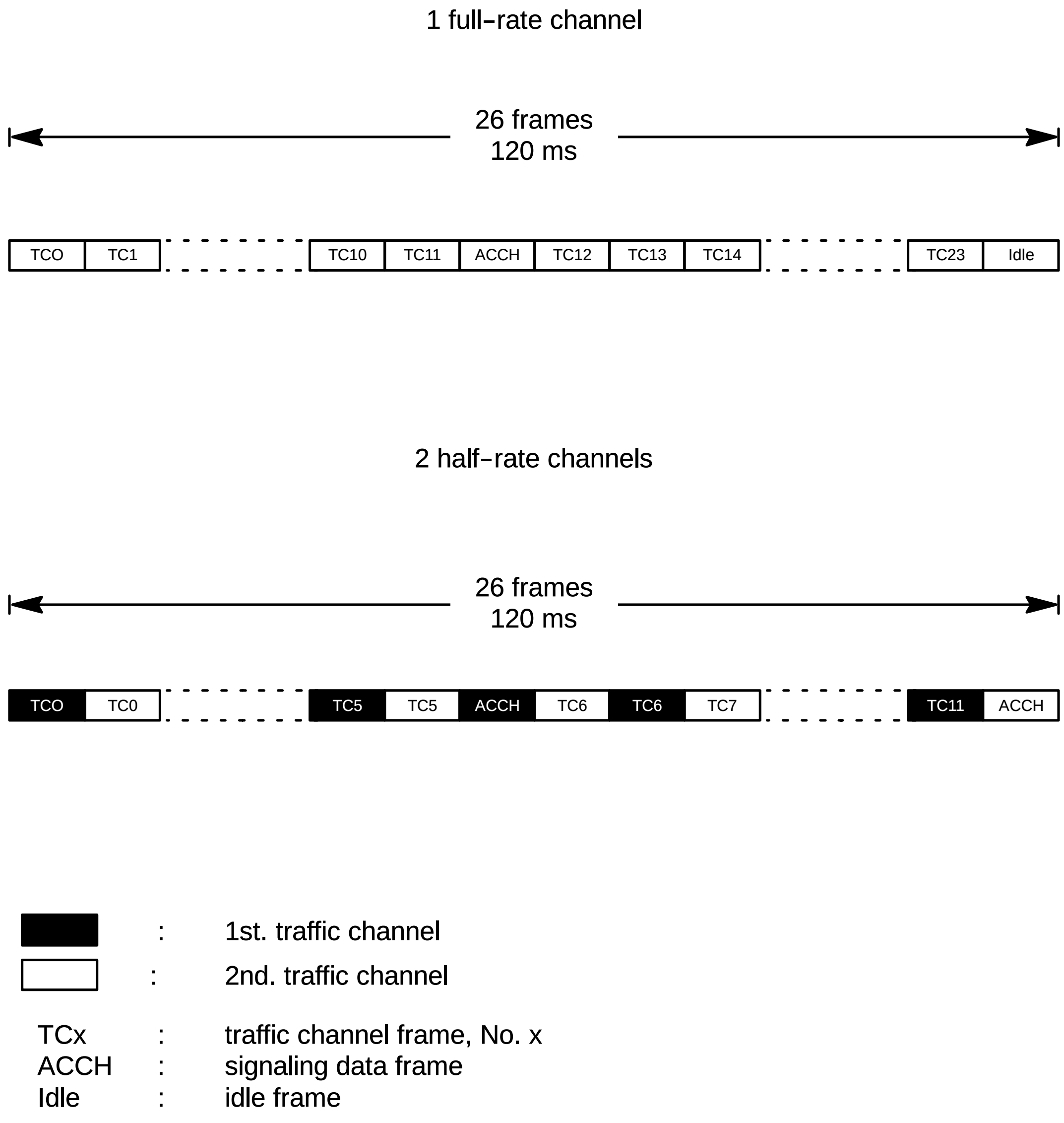


**Figure 8-3 Logical channel multiplexing onto full- and half-rate channels**

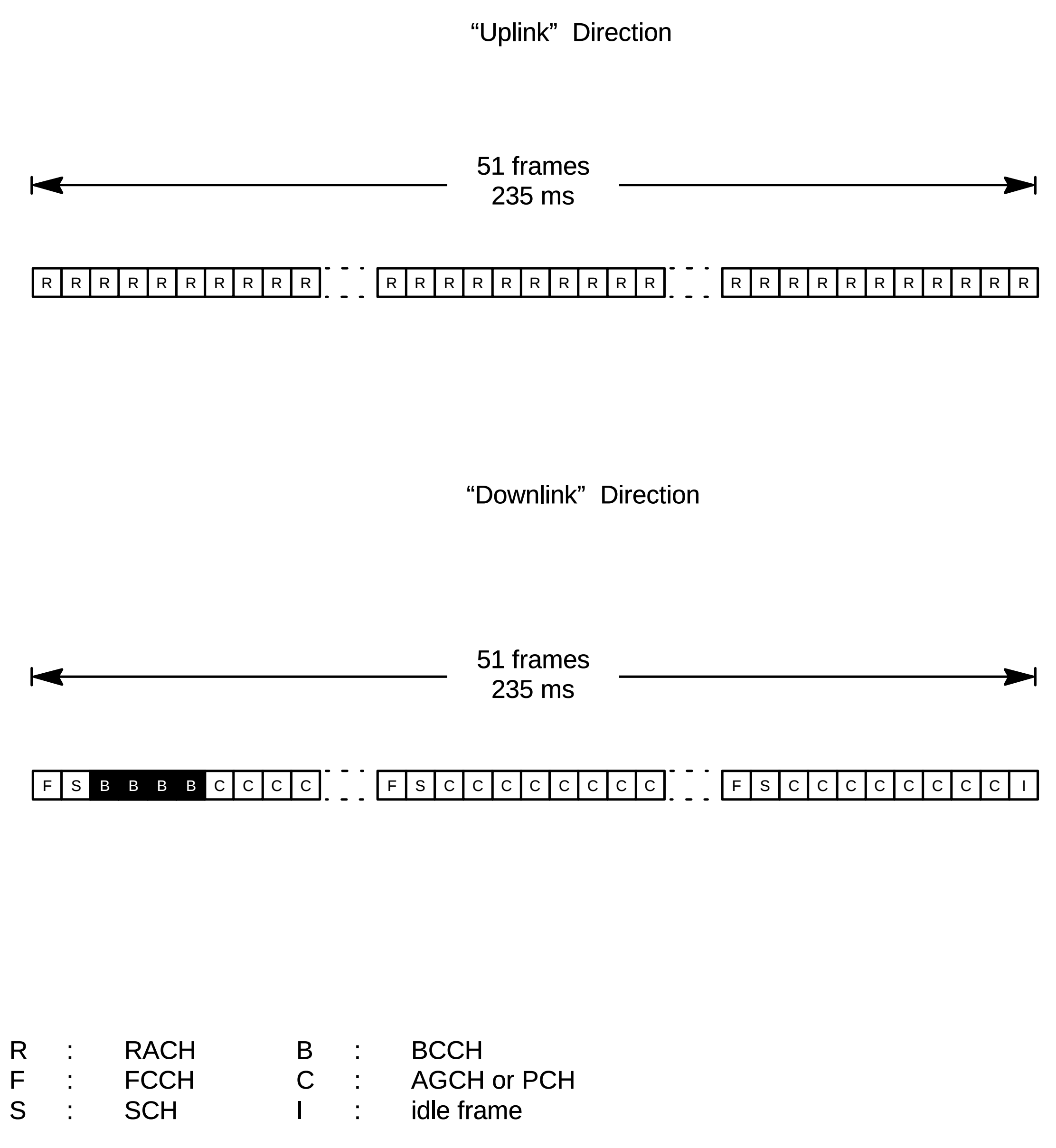


**Figure 8-4 Logical channel multiplexing onto a non-combined BCCH channel**

 

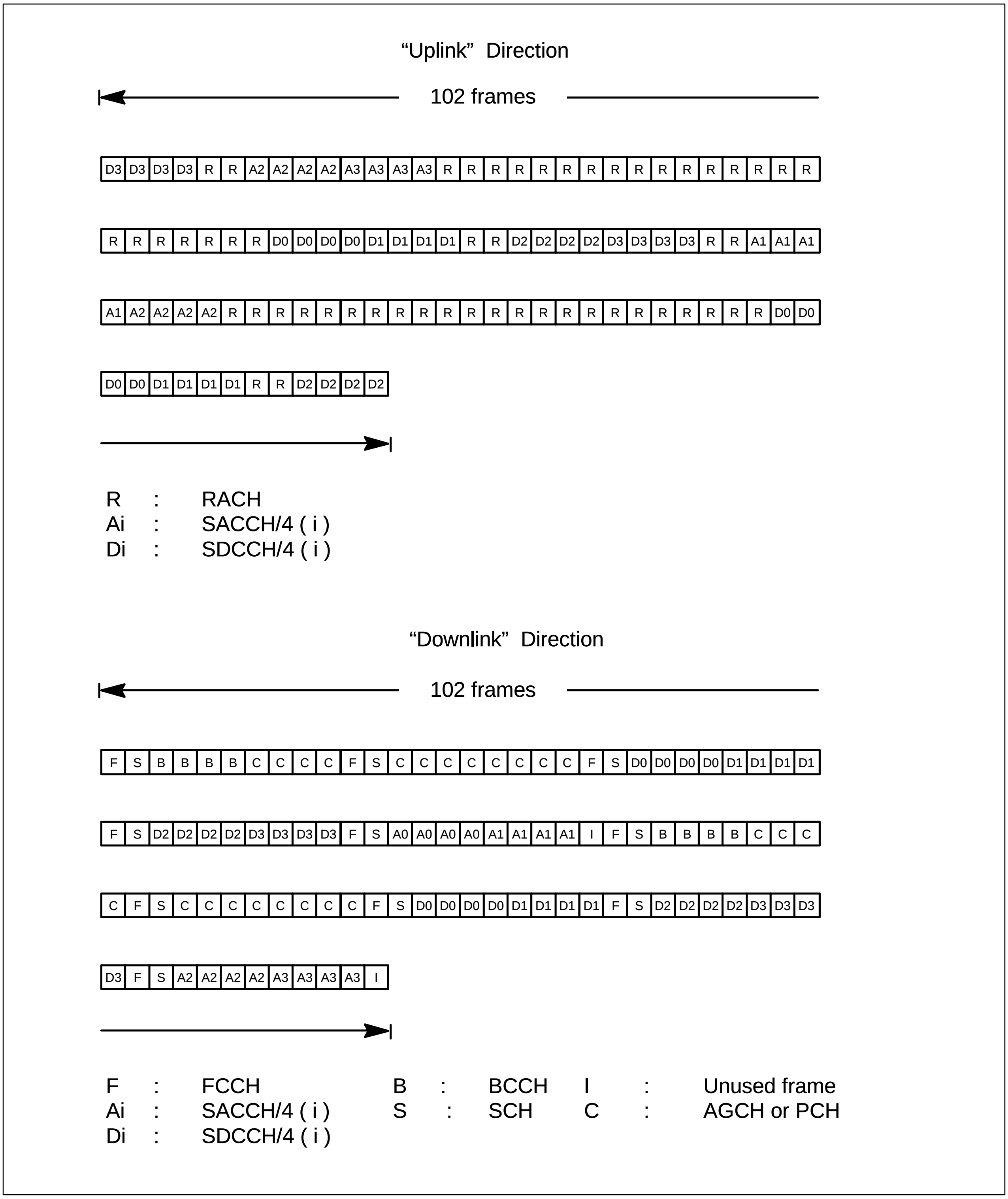


**Figure 8-5 Logical channel multiplexing onto a combined BCCH channel**

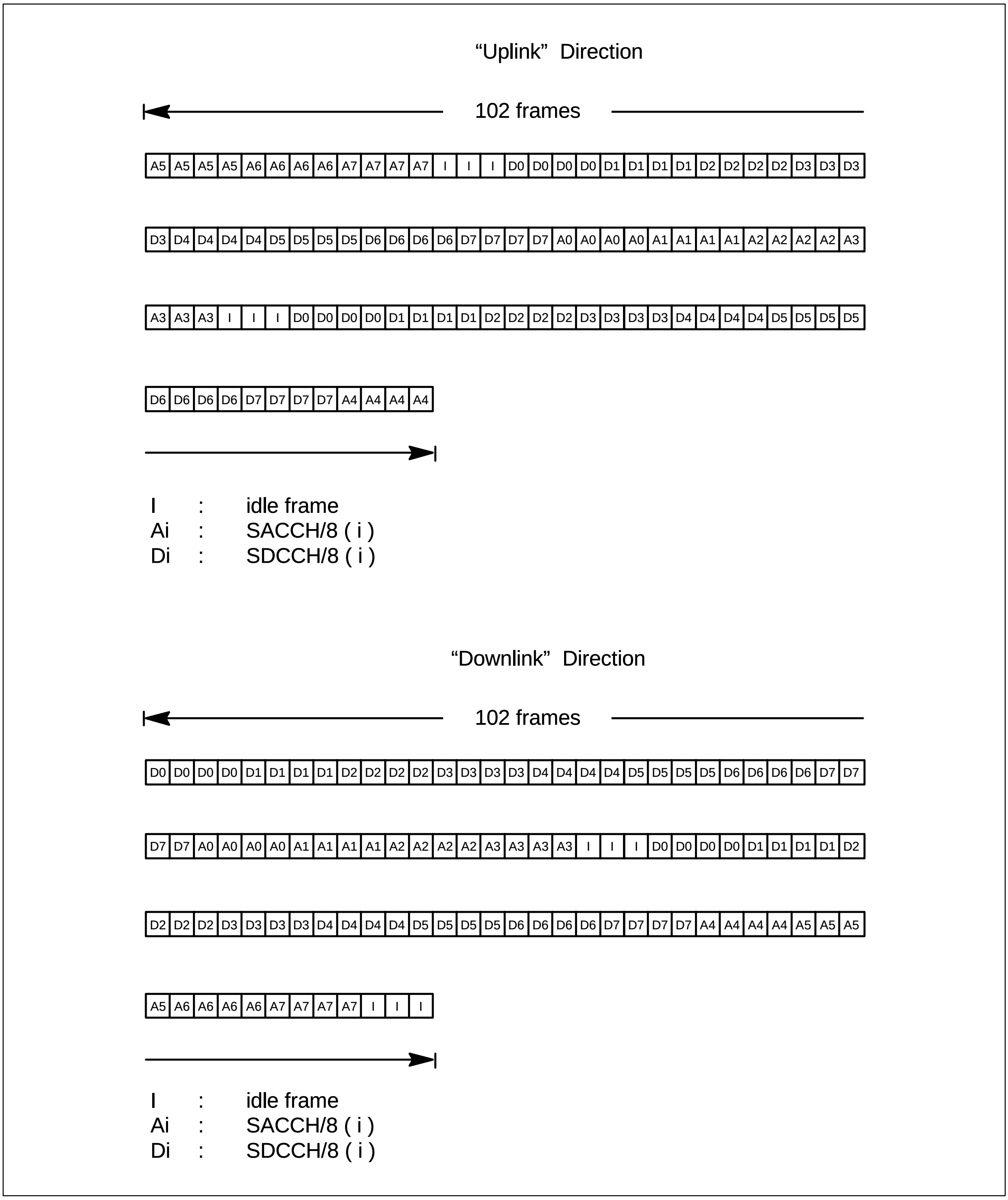


**Figure 8-6 Logical channel multiplexing onto an 8 x channel (SACCH + SDCCH)**

### 8.1.3 LAPDm (level 2)

A LAPD protocol is used to ensure that signaling information is reliably transferred between mobile stations and the base station. The LAPD is tailored (LAPDm) to take radio communication aspects such as error rates, handover, and unacknowledged frames into account. It enables two modes of transmission, acknowledged and unacknowledged.

#### 8.1.3.1 Unacknowledged mode

Unacknowledged frames are transmitted over unidirectional channels such as BCCH, CBCH, RACH, PCH, and AGCH.

The following mechanisms are used to counter information that was not received or inaccurate frames:

- The BCCH channel contents, like those of the CBCH channel, are retransmitted in cycles.
- The BTS reiterates subscriber paging messages along the PCH channel throughout a designated period of time.
- The mobile station reiterates messages along the RACH channel when no system response is received on the AGCH channel.

#### 8.1.3.2 Acknowledged mode

Acknowledged frames are transmitted along dedicated channels (SACCH, which is acknowledged on SAPI3 but unacknowledged on SAPI0 [measurement and SYS INFO 5, 5bis, 5ter and 6], SDCCH, FACCH). This allows for repetition if erroneous frames are received.

### 8.1.4 Application level (level 3)

Provision is made for different classes of signaling procedures at application level, (see *Figure 8–7*) including the following:

- class 1 procedure : radio resource management
- class 2 procedure : promobility management
- class 3 procedure : call handling
- class 4 procedure : supplementary service procedures
- class 5 procedure : short message service procedures

Procedure classes are arranged in the following hierarchical levels (level 3 sublevels):

- RR sublevel (Radio Resource management), which is dedicated to class 1 procedures
- MM sublevel (Mobility Management), which is dedicated to class 2 procedures
- CM sublevel (Connection Management), which is dedicated to class 3, 4, and 5 procedures

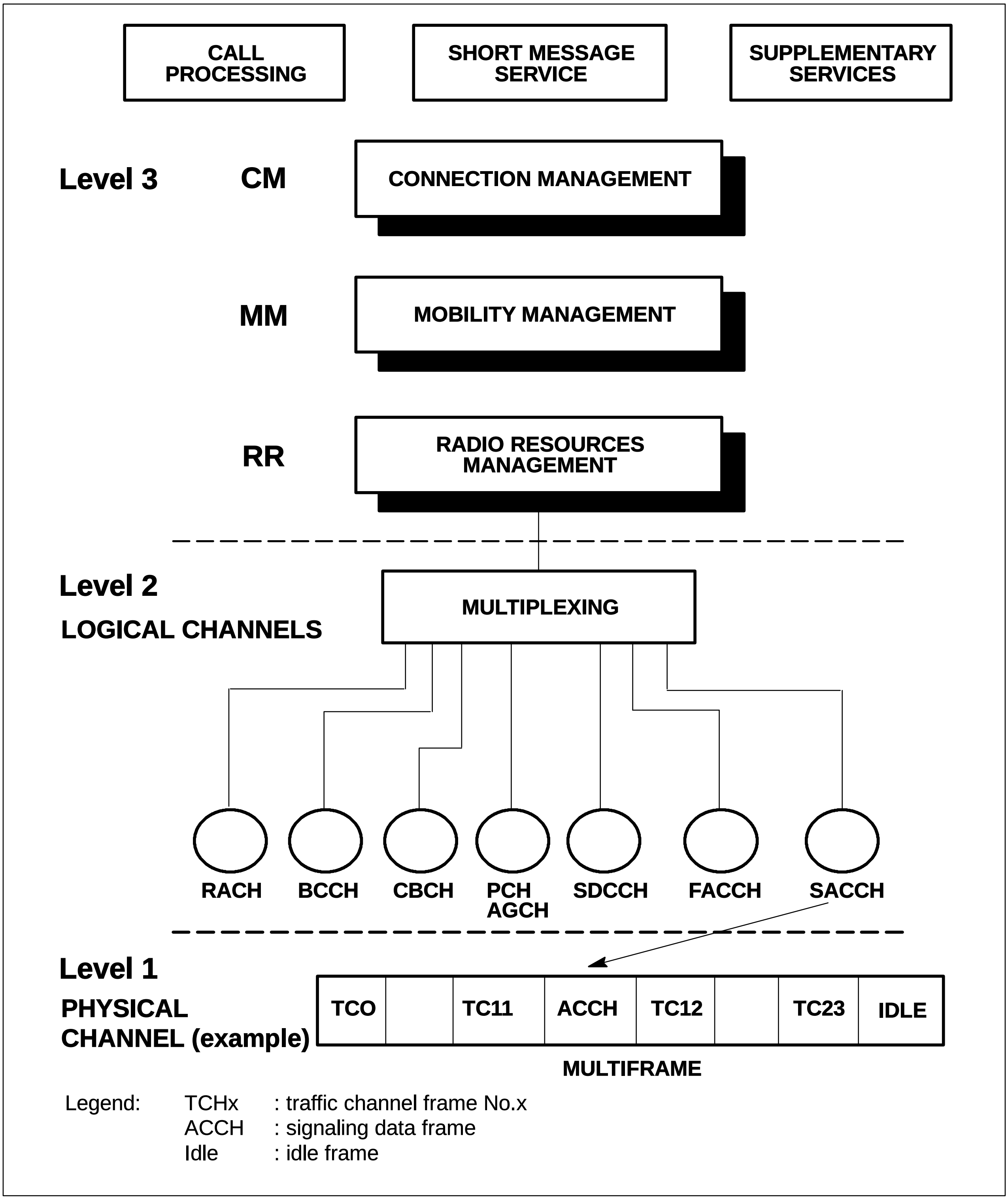


**Figure 8-7 Level 3 protocols**

Each level in the hierarchy uses lower level services to establish a connection. For example, to activate a supplementary service, the CM protocol requests the opening of the connection to MM, which requests the opening of an RR connection. Any connection requires a radio connection.

The names of level 3 messages exchanged on the radio interface are printed in uppercase characters throughout the remainder of this section.

### 8.1.4.1 Radio resources (RR) management procedures

These enable communication between the mobile stations and the fixed network to be initialized, reestablished, controlled, and cleared.

From V12, the CM888 and TF889 allow:

- to allocate directly a TCH in the inter–zone for call setup or handover (HO)
- to reuse the same frequency on both zones.

#### Network originating call

The network calls the mobile station by sending subscriber paging messages (PAGING REQUEST) on the PCH channel. If the station is located in the cell, it replies with a channel request message (CHANNEL REQUEST) over the RACH channel. The network replies over the AGCH channel and assigns a dedicated SDCCH channel (IMMEDIATE ASSIGNMENT).

#### Mobile station originator

The mobile station asks for a network channel (CHANNEL REQUEST) and is assigned a dedicated SDCCH channel (IMMEDIATE ASSIGNMENT).

#### Call reestablishment

When the request for a channel (CHANNEL REQUEST) is the result of a request to reestablish a call, a TCH channel is assigned.

#### Ciphering

The network initiates information ciphering (CIPHER MODE COMMAND) to ensure that messages remain confidential. The mobile station returns the necessary acknowledgement (CIPHER MODE COMPLETE). During this procedure, the MSC may request MS identity also called IMEI.

### Allocating traffic channel

When a telephone call has been set up, the network assigns a traffic channel to the mobile station (ASSIGNMENT COMMAND). The mobile station switches from the SDCCH channel to the TCH traffic channel and returns an acknowledgement (ASSIGNMENT COMPLETE). The channel in question is then used to carry voice or data, except in the case of errors (ASSIGNMENT FAILURE).

This procedure is also used when the measurement results show a low signal quality and a high signal level on a traffic channel already assigned. In this case, the BTS can perform an intra-cell handover.

### Radio measurement processing

The Radio Measurement Processing performed by the BTS ensures that the network and the mobiles can communicate with each other with minimum interference at the lowest possible transmission power and with the best transmission quality.

Measurements processed by the BTS include signal strength and signal quality. The mobile takes measurements in the downlink direction (BTS → MS), while the BTS takes them in the uplink direction (MS → BTS). Other measurements include signal strength on the BCCH frequency of the surrounding cells and the MS_BS distance.

The BTS averages these measurements for each connection. The averaged measurements are then used as the basis for a decision-making process for the following:

- power control
- call clearing
- inter-cell handover
- intra-cell handover

These decisions are made by comparing the measurements with a series of O&M-defined thresholds.

Measurements of the downlink signal strength and quality are sent to the BTS by the MS in the MEASUREMENT REPORT message sent in at least every other SACCH block. On the uplink and downlink channels, the averaging period of the signal strength and quality is one SACCH block period.

This event contains the following information:

- Measurements reported by the MS in MEASUREMENT REPORT:
  - Downlink RXLEV (signal strength)
  - Downlink RXQUAL (signal quality)
  - Downlink surrounding cell RXLEV (RXLEV_NCELL(n))

 

- Measurements in Layer 1 Header of SACCH block:
  - MS_BS Distance (mobile BTS distance)
  - MS_TXPWR_CONF (TX power used by the mobile transmitted in the last SACCH block)
- Measurements taken by the BTS:
  - Uplink RXLEV (signal strength)
  - Uplink RXQUAL (signal quality)
  - Current BTS power

The processing of these measurements is synchronized with the reception of SACCH blocks from MS. A MEASUREMENT RESULT event is generated every time a SACCH block is received. The entire MEASUREMENT REPORT message from the MS is included in the MEASUREMENT RESULT event. If the BTS does not receive a MEASUREMENT REPORT message from the mobile, the MEASUREMENT RESULT event is created without it (uplink measurements only).

Measurements are only stored for connections for which O&M parameters have been defined and the BTS has been instructed by the BSC to start measurement.

Measurement processing always precedes the execution of a decision function (power control, handover, or call clearing):

- Power control

  Power control minimizes interferences, saves mobile's batteries and ensures good transmission quality. The measurements averages are compared with the relevant thresholds to determine whether power control (of the BTS or the mobile) is required.

- Handover decision

  The handover decision strategy used by the BTS for radio link control is based on the radio link measurements reported by the MS or BTS and on the O&M parameters set for the serving cell.

- Call clearing

  MS_BS distance is used on a cell–by–cell basis to prevent a call from grossly exceeding the cell boundaries and straying into another time slot.

  If the call clearing distance threshold comparison shows that call clearing is required, the BTS informs the BSC of this by sending a CALL CLEARING REQUEST message.

  The network initiates call clearing by releasing the radio channel (CHANNEL RELEASE), which allows the mobile to break the level 2 call connection.

In case of RXQUAL, RXLEV, or Distance handover, the cell evaluation takes into account the HO_margin used for the Power budget handover. Specific values of HO_margin are then used, respectively called RXQUAL_HO_margin, RXLEV_HO_margin or Distance_HO_margin. These parameters allow to establish the list of target cells for the best cell selection. And the HO-margin values can be negative.

The Radio Measurement processing must take into account the handover algorithms, the type of the current cell, and the type of the neighbouring cells.

The handover can be an intra-network handover (macrocell → macrocell or microcell → microcell) or an inter-network (macrocell → microcell or microcell → macrocell).

When the network instructs handover (HANDOVER COMMAND), the mobile station gains access to a new channel (HANDOVER ACCESS). If the change from one cell to the next is asynchronous, the network realigns the mobile station's transmission (PHYSICAL INFO). In all cases, the mobile station confirms this when handover is accomplished (HANDOVER COMPLETE) or it signals an error (HANDOVER FAILURE).

### 8.1.4.2 Mobility Management (MM) procedures

**Location**

A mobile station on the move must keep the network informed of its position (for paging needs). The MS monitors the nearby cells and determines which cell has the strongest signal. When the cell meets selection requirements (correct network, change of location area, unbarred cell), the MS initializes a location updating procedure (LOCATION UPDATING REQUEST), and the network accepts (LOCATION UPDATING ACCEPT) or refuses (LOCATION UPDATING REJECT) the new subscriber location.

The mobile station warns the MSC when it is going into its "switched off" state (IMSI DETACH) or when it needs reactivation (IMSI ATTACH).

If the OMC "attach bit" is set to 1, the MSC always knows which mobile stations are active. If a mobile station that is switched off receives a call, the MSC does not run the calling procedure, which would not succeed since the mobile station is switched off. Since no attempt is made to contact the mobile station, an unnecessary use of resources is avoided.

**Authentication**

The network must authenticate subscribers who attempt to gain access to a cell. The mobile station has a unique ciphering key (Kc) for this.

The network identifies the key and calculates the response from a random number and returns it to the MS (AUTHENTICATION REQUEST). The MS must calculate the response using its own ciphering key. The response is sent back to the network (AUTHENTICATION RESPONSE), where it is checked to ensure that it matches. The network can at that point grant or deny (AUTHENTICATION REJECT) access.

#### Identification

The network assigns a temporary TMSI identity to the MS (TMSI REALLOCATION COMMAND) for security reasons. The MS confirms its temporary identity (TMSI REALLOCATION COMPLETE).

The network may also request the MS or subscribers for their identity (IDENTITY REQUEST, IDENTITY RESPONSE).

#### Setting up calls

When a call is set up, the MS gives the reason for the call (CM SERVICE REQUEST). The network agrees (CM SERVICE ACCEPT) or refuses (CM SERVICE REJECT) to set up the call based on MS characteristics (subscription, for example).

### 8.1.4.3 Connection management (CM) procedures

Connection Management (CM) procedures are used to process station–to–station (CC) calls, short messages (SMS), and supplementary services (SS).

Supplementary service (SS) procedures are transparent for the BSS to which the BTS belongs.

#### Mobile station originating call

The mobile station sets up an MM connection and sends the destination address (SET UP). The network indicates the following:

- the call is being routed (CALL PROCEEDING)
- the destination station is ringing (ALERTING)
- when the called subscriber goes off hook (CONNECT)

#### Network originating call

The network sets up an MM connection and warns that the subscriber is being called (SET UP). The MS confirms the call (CALL CONFIRM), indicates to the network that the mobile station is ringing (ALERTING), and reports when the subscriber goes off hook (CONNECT).

### Call clearing

The called or calling subscriber clears the call by breaking the telephone connection (DISCONNECT). The MS or network replies with an MM connection release message (RELEASE) that is confirmed by the other party (RELEASE COMPLETE). The call is cleared by disconnecting MS–network radio resources (RR).

### Short messages (SMS)

Short messages can be of two types, point-to-point or cell broadcast:

- Short point-to-point messages include two categories, depending on their direction (uplink or downlink):
  - The mobile station receives a short message from the MSC (SMS – MT/PP).
  - The mobile station sends a short message (to another mobile station for example) (SMS – MO/PP).

  The mobile or network must then establish an SAPI3 connection, contrary to an SAPI0. Establishment of an SAPI3 connection must satisfy the following contraints:

  - An SAPI0 connection must already exist (the mobile is on a call or a call is set up).
  - An SAPI3 connection is created only on the SDCCH channel or the SACCH of a TCH if it exists.

  Disconnection of the SAPI0 link involves disconnection of the SAPI3 link if it exists.

- Short messages of cell broadcast type (SMS–CB) are general interest messages sent out periodically on the CBCH channel to all mobile stations of one or more specified cells (up to five messages sent).

  The BSC must store the characteristics of five short messages for each cell. Two BROADCAST REQUEST messages sent to the BTS must be spaced 6 seconds apart to ensure that the first message has been received by the BTS before the broadcast of the next message.

  No SAPI0 connection is set up for short messages of the cell broadcast type since the mobile stations are on receive only (no acknowledgment).

 

## 8.2 Abis interface

The Abis interface enables message transfers between the BSC and the BTSs. This interface uses external PCM links.

This interface allows the following:

- the BSC and BTSs to work together to set up communication with mobile subscribers
- the BSC to control BTSs radio equipment and manage physical resources
- future upgrades of the BTS and the BSC
- upgradeability of this interface to support future services provided by the cellular system

### 8.2.1 Abis Interface functions

The Abis interface carries subscriber traffic (voice or data) and signaling data between the BSC and the BTS and is, therefore, subdivided into two major areas. One area deals with subscriber traffic and the other with call processing and BTS operation and maintenance signaling needs.

Digital PCM links provide the BTSs with level 1 physical access to the BSC.

### 8.2.2 Subscriber call traffic

Permanent circuits carry subscriber traffic between the BTS and the BSC.

The BSC matches time slots and traffic channels when the BTS is initially configured, but this may change if faults are detected.

The following occur if a PCM fault is detected:

- With a redundant PCM, the LAPD channels and the TDMA of the faulty PCM will be supported by the redundant PCM.
- Without a redundant PCM, the only defense of the LAPD and TDMA of the faulty PCM is for the site LAPD (BCF), to be kept as the only link by using the operational PCM.

With a remote TransCoder Unit (TCU), a time slot corresponds to four multiplexed traffic channels:

- speech: The voice transcoder adapts the 13 kbit/s data rate (input to the BTS) to 16 kbit/s.
- data in transparent mode: The data rate (600, 1200/75, 1200, 2400, 4800, or 9600 bit/s) is adapted to 16 kbit/s.
- data in non–transparent mode: 9600 bit/s data rate

This correspondence is performed by the BSC during initial BTS configuration and may be modified if a fault is detected.

 

### 8.2.3 Signaling on the Abis interface

Signaling message handling complies with the first three layers of the OSI model (see *Figure 8–8*).

#### 8.2.3.1 Level 1 layer organization

Layer 1, the physical layer, provides the physical transmission medium.

It occupies one or more time slots on the PCM links that connect the BTS to the BSC.

#### 8.2.3.2 Level 2 layer organization

Layer 2 provides protected signaling message transfer capabilities between the BTS and the BSC, adhering to LAPD protocol standards.

This protocol conveys messages between the BSC and BTS LAPD terminal ports inside level 2 frames and provides error detection and corrective functions.

Inter BSC–BTS LAPD links are identified by numbers called Terminal Equipment Identifiers (TEI). Each TEI is related to one link.

Three service access points can be activated:

- the RSL link that supports radio resource management procedures (SAPI 0 and SAPI3)
- the OML link that handles operations and maintenance functions (SAPI 62)
- the L2ML link that relates to the layer 2 handling functions. It supports the mechanisms that assign TEIs. This procedure has not been used in the BTS until now because the TEIs are wired at the hardware level.

The RSL SAPI is used on BSC–TRX links.

The OML SAPI is used on BSC–TRX links and BCF interconnection links as well.

SAPI3 carries short point–to–point messages between the mobile and the BSC.

#### 8.2.3.3 Level 3 layer organization

Layer 3, the application layer, is divided into two areas, RSL and OML. The RSL handles signal management needs and the OML supports operations and maintenance functions.

 

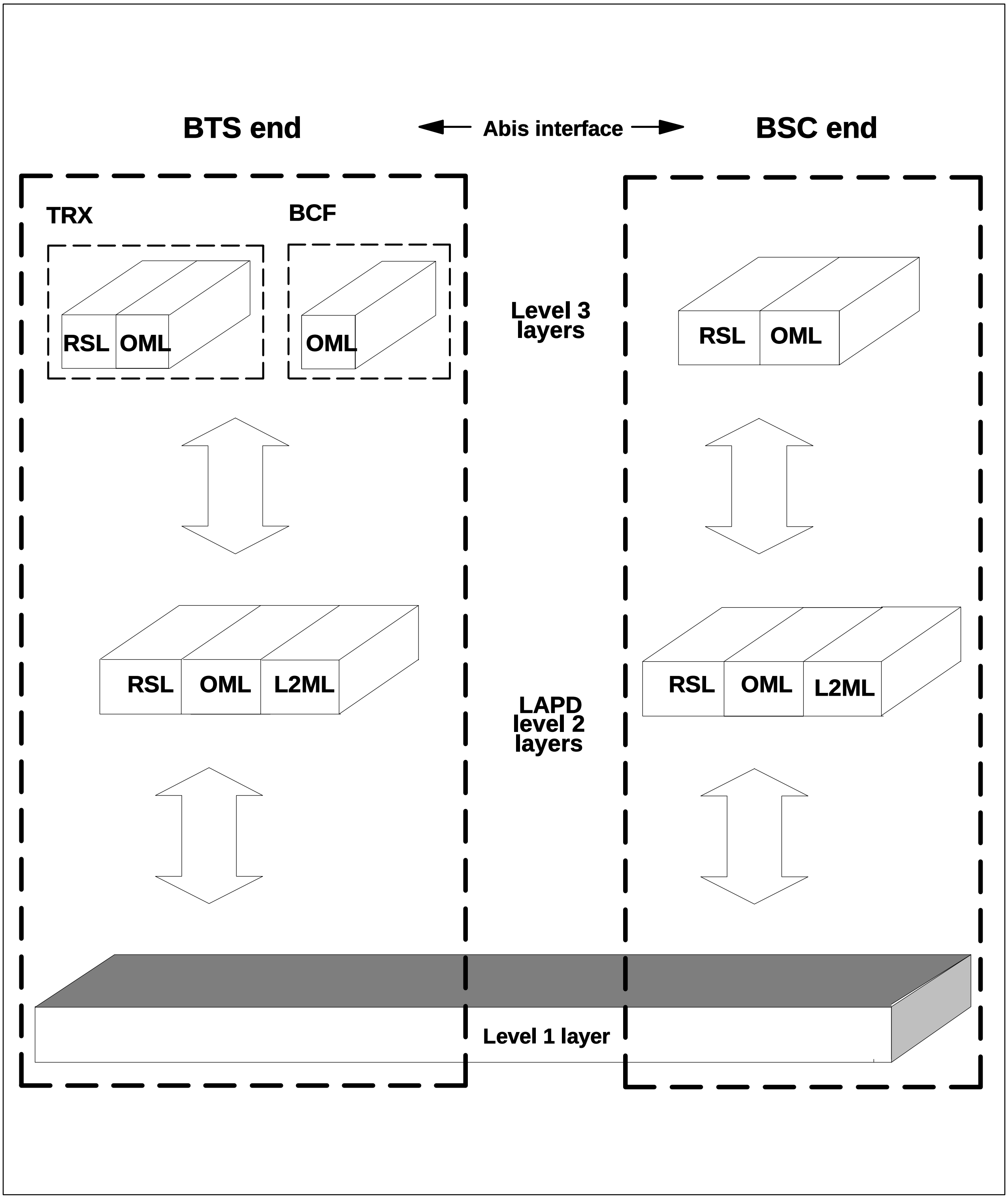


**Figure 8-8 Abis interface architecture**

### 8.2.4 Call processing signaling

Call processing management procedures on the RSL link use: transparent and non–transparent messages.

Each signaling message contains the following:

- a "discriminator" byte. The least significant bit in this byte (called "T") indicates if the message is transparent. The other bits specify the procedure to which the message belongs.
- a "type" byte that indicates the message used (each message has a specific code)
- one or more additional bytes that contain useful information

#### 8.2.4.1 Transparent messages

Transparent messages pass through the BTS but remain unchanged (neither interpreted nor modified).

They are conveyed in DATA INDICATION messages in the MS → BTS → BSC direction and in DATA REQUEST messages in the BSC → BTS → MS direction.

All the messages sent by mobile stations over the radio interface are transparent except for MEASUREMENT REPORT and CHANNEL REQUEST radio messages. The CHANNEL REQUEST message is sent by the MS to the BTS and is sent back to the BSC after it has been treated as CHANNEL REQUIRED.

The MEASUREMENT REPORT message is processed by the BTS L1M module.

All the messages sent by the BSC over the Abis interface are transparent messages, except for Abis ENCRYPTION COMMAND, PAGING COMMAND, BCCH INFORMATION, SACCH FILLING, and IMMEDIATE ASSIGN COMMAND messages. They are sent to mobile stations as CIPHER MODE COMMAND, PAGING REQUEST TYPE 1, and IMMEDIATE ASSIGNMENT radio messages.

Short point–to–point messages are also transparent to the BTS.

#### 8.2.4.2 Non–transparent messages

Non–transparent messages presuppose BTS involvement. They enable the BTS and BSC to manage the following:

- radio link management
- dedicated signaling channel management
- common signaling channel management
- traffic channel management
- cell broadcast short message management
- transceiver (TRX) management

 

#### Radio link management

These messages are used to do the following:

- establish connections:
- convey transparent messages:
- release connections:
- feed back errors:

#### Dedicated signaling channel management

These messages are used to do the following:

- activate radio channels
- indicate that an active connection has been broken
- deactivate the SACCH of an active channel
- enable ciphering
- detect handovers
- feed back measurement results
- modify a traffic channel
- release a channel

#### Common signaling channel management

These messages are used to do the following:

- transfer system messages issued on the BCCH
- feed back CCCH channel traffic loads
- page subscribers over the network
- mobile station channel requests and dedicated channel assignments
- feed back IMMEDIATE ASSIGN message losses in overload conditions

#### Cell broadcast short

These messages are used to do the following:

- send messages to all MSs of a cell

#### TRX management

These messages are used to do the following:

- transfer system information sent over dedicated channels
- feed back interference level over idle channels:

- feed back specific error messages

#### TRX configuration

These messages are used to do the following:

- download the parameters of a current cell
- download the parameters of up to 16 neighbouring cells relative to a current cell
- download the parameters of the rest of the neighbouring cells list, if the current cell has been defined with more than 16 neighbouring cells

#### Connection processing

These messages are used to do the following:

- start the radio measurement processing of an active connection
- stop a previously initiated measurement process
- request varied information about the connection
- indicate that a call clearing is needed for the connection
- indicate that a handover is needed for the connection
- cancel a handover procedure that was previously initiated to the BSC
- start an observation session for an active connection on which a radio measurement processing is in operation at the BTS
- stop an observation session that was previously initiated on a radio channel
- indicate that unknown neighbouring cells in the BTS have been captured by the mobile
- update the classmark information (RF power capability and revision level) of the mobile assigned to a channel
- indicate that a power control has been performed by the BTS

 

## 8.2.5 Operations and Maintenance functions

Messages from the OML part of the Abis interface level 3 layer are used for O&M purposes.

These functions provide a logical functional breakdown, which is independent with respect to the used BTS type:

- GSM entity management
- downloading
- site management
- cell management
- Abis signaling link management
- Abis traffic link management
- GSM time management
- TDMA frame management
- radio time slot management
- frequency hopping management
- RF transmission management
- RF reception management
- cell barring
- fault reporting

### 8.2.5.1 Entity management

Entity management messages are used to do the following:

- reset one or more GSM entities (corresponds to a hardware reset)
- reset data on one or more GSM entities
- request PROM identification
- request status
- The status of each entity may be one of the following:
  - bootstrap running – program not downloaded
  - bootstrap running – program downloaded
  - program running – entity not configured
  - program running – entity configured
- activate software
- request software load marking:

#### 8.2.5.2 Downloading

Downloading messages are used to do the following:

- start the downloading operation
- download
- end the downloading operation

#### 8.2.5.3 Site management

Site management messages are used for the following:

- site configuration purposes (number of cells, number of PCM links, etc.)
- Alarm configuration
- Backup battery release

#### 8.2.5.4 Cell management

For frequency bands other than the GSM 900 bands, the “CELL REQUEST” message is an “extended” message (EXT).

Cell management messages are used for the following:

- cell configuration
- cell modification
- TRXs power level modification
- authorization of sending event reports to the concerned TRX:
- ban of sending event reports to the concerned TRX:

#### 8.2.5.5 Abis signaling link management

Abis signaling management messages are used to do the following:

- connect Abis signaling links
- release Abis signaling links

#### 8.2.5.6 Abis traffic link management

Abis traffic link management messages are used to do the following:

- connect Abis traffic links
- release Abis traffic links

#### 8.2.5.7 GSM time management

The messages of the GSM time management inform each cell of the GSM time.

The GSM TIME REQUEST (BSC => BTS) and GSM TIME RESPONSE (BTS => BSC) messages are not used. Only the EVENT REPORT mechanism is supported by this function.

 

### 8.2.5.8 TDMA frame management

TDMA management function messages are used to set up TDMA frames.

### 8.2.5.9 RF time slot management

RF time slot management messages are used to set up time slots in a TDMA frame.

### 8.2.5.10 Frequency hopping management

Frequency hopping in a band which is not a GSM 900 band uses the FREQUENCY HOPPING CONFIG REQUEST message in “extended” mode (EXT).

Frequency hopping management messages are used to define the law that governs time slot hopping in a TDMA frame.

### 8.2.5.11 Frequency management

The frequency management function is supported within BTS with cavity coupling.

The messages of this function allows:

- configuration of the radio frequency transmitters
- cancellation of the transmitter configuration

### 8.2.5.12 RF transmission management

For frequency bands other than the GSM 900 bands, the RF TRANS CONF. REQUEST message is said to be in “extended” mode (EXT).

RF transmission management messages are used to define the set of frequencies used in a TDMA frame.

### 8.2.5.13 RF reception management

The RF RECEPT messages of the RF reception management function are not handled. Only the EVENT REPORT mechanism is supported.

 

#### 8.2.5.14 Cell barring

This process blocks the cell within 30 seconds after a loss of the link with the BSC to ensure that the mobile stations do not try to access the cell when it is not available.

The link concerned is the OML link of the TRX that supports the BCCH. If a layer 2 error occurs, the TRX triggers the LAPD reconnection procedure for 610 seconds. After 30 seconds, if the LAPD link is not reestablished, the TRX modifies the SYS INFO to indicate that the cell is barred. If the link is reestablished after the 30 seconds and before the 610 seconds, the TRX resumes the original SYS INFO broadcast. After the 610–second timer elapses, the TRX resets itself.

#### 8.2.5.15 Fault–reporting mechanism

The fault–reporting mechanism is a general mechanism supported by all cellular system entities. It is used to feed back abnormal events by sending EVENT REPORT messages that are sent to the BSC. Some event reports may be filtered to reduce the number of messages that relate to the same cause.

### 8.2.6 BTS synchronization by the BSC

The network uses the PCM links that connect the BSC and BTS to carry a long–term high-precision clock that allows the BTS to generate the time reference.

 

## 8.3 Ater interface

The Ater interface handles message exchanges between the BSC and the TCU.

### 8.3.1 Ater interface goals

As specified by the system, the Ater interface architecture enables user traffic (speed and data) and signaling to be conveyed between the BSC and the TCU. It interfaces with the mixer to route signals to the transcoding functions (speech and data) or to the switching function (signaling channels and BSC–TCU link). It also detects and manages PCM alarms. Information is carried on links following a code.

### 8.3.2 General characteristics

Physical access between BSC and TCU is provided by PCM digital links carrying time slots at 64 kbit/s. These time slots include the following:

- signaling reserved channels according to the CCITT No. 7 (CCS7)
- speech and data channels (16 kbit/s)
- BSC–TCU signaling links (LAPD)

Ater PCM E1 links carry up to 31 speech or data channels groups, which is equivalent to 120 communications.

Ater PCM T1 links carry up to 24 or data channels groups, which is equivalent to 92 communications.

A group is a set of four 16–kbit/s channels that belong to the same Ater PCM time slot.

The channel position in a group is defined by its row:

- Row 1 represents the channel corresponding to the 0 and 1 binary positions of the PCM time slot.
- Row 2 represents the channel corresponding to the 2 and 3 binary positions of the PCM time slot.
- Row 3 represents the channel corresponding to the 4 and 5 binary positions of the PCM time slot.
- Row 4 represents the channel corresponding to the 6 and 7 binary positions of the PCM time slot.

Ater interface functions, like those of the A–interface, are distributed on 3 layers:

- Level 1: physical layer
- Level 2: transport layer
- Level 3: application layer (includes the processing of messages that are specific to the BSC–TCU link following the LAPD protocol)

### 8.3.3 Signaling transport

Signaling messages are carried on specific time slots (TS):

- signaling TS between the BSC and the TCU

  One LAPD channel per TCU must be reserved for TCU OAM signaling.

  One LAPD channel per LSA must be reserved for TCU Call Processing signaling
- SS7 TS between the BSC and the MSC

The LAPD channel for TCU OAM signaling is located on TS1 of the PCM on the four first ports of each LSA. That why the PCM0 to PCM3 of each LSA must be connexcted to Ater interface only.

This LAPD channel is used by the BSC for the following:

- TCU monitoring (mixer, PCM interface, transcoder and control units, LAPD signaling terminal, etc.)
- TCU configuration (BSC-TCU signaling link, A-interface PCM, semaphore channels, A interface circuits, synchronization and transcoding functions)
- TCU initialization
- TCU software downloading
- A and Ater interfaces management
- synchronization management
- transcoding management

SS7 TS is for BSC-MSC link and for specific configurations.

Signaling messages on the LAPD TSs are processed only by the TCU. SS7 TSs are switched by the TCU but remain transparent for it.

 

## 8.4 A interface

The A interface handles message exchanges between the Network and Switching Subsystem (NSS), more precisely its switching center called the MSC, and the radio subsystem. The radio subsystem (BSS) contains a base station controller (BSC) with a transcoder unit (TCU) and one or more base transceiver stations (BTS).

The interface design does the following:

- enables BSS and NSS interworking for mobile station call setup procedures, according to the function sharing concept defined by the system
- handles all services offered to users by ensuring communication between the mobile station and the MSC
- enables easy adjustment to all new services planned by the system that will be made available to users in the future
- enables interconnection of different types of BSS and NSS as a result of standardization of the procedures used on the interface

### 8.4.1 A–interface goals

The interface architecture enables user traffic (speech and data) and signaling to be conveyed between the BSS and the NSS. Therefore, it can be divided into two parts. The first part handles traffic exchanges, and the second one handles signaling exchanges.

The physical access between BSS and NSS is provided by external PCM links (see *Figure 8–9*). They enable detection of defects according to the CCITT G732 or G711 note, and offer error detection based on the CRC method.

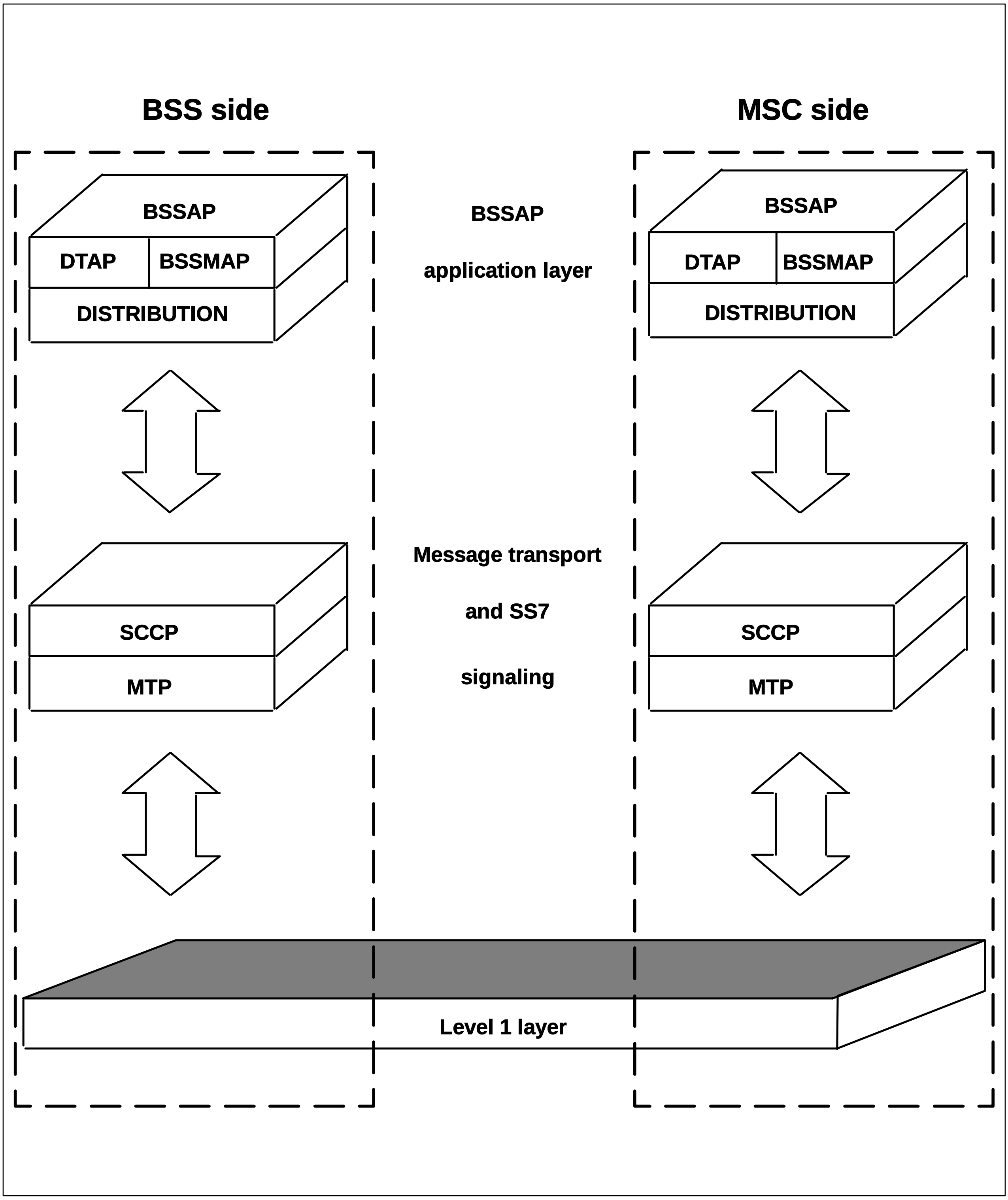


**Figure 8–9 Architecture of the A–interface**

### 8.4.2 User traffic transport

Transport of traffic requires allocating terrestrial resources between BSS and NSS (resource allocation management on the A interface is performed by the MSC). They are circuits identified by a time slot number and a PCM link number. Circuits are conveyed on one or more PCM links, among the links that connect the BSS to the NSS. If the PCM link does not carry any signaling, all time slots may be allocated to these circuits.

PCM links convey the information in time slots at 64 kbit/s. Four 16–kbit/s full–rate traffic channels are multiplexed onto one time slot (Ater interface). Speech rate adjustment and data rate adaptation are performed at the TCU, which then transmits 64–kbit/s radio channels to the MSC.

To provide overall management of resources, a blocking/de–blocking (BLOCKING) procedure enables a circuit to be made available or unavailable. The BSS performed this procedure and must inform the MSC, so it can take it into account when new resources are to be allocated.

### 8.4.3 Signaling transport

Signaling is conveyed using the CCITT No 7 semaphore protocol (SS7). This protocol is divided into two parts: the Message Transfer Part (MTP) and the Signaling Connection Control Part (SCCP) (see *Figure 8–4*).

To ensure reliable transfer of signaling, the SCCP uses services provided by the MTP to do the following:

- establish a semaphore connection
- transport data with or without using a semaphore connection

The MTP is divided into three layers: level 1, level 2, and level 3.

#### 8.4.3.1 Role and architecture of MTP level 1 layer

The level 1 layer, or physical layer, is the lowest one. It uses one or more time slots in PCM links connecting the BSS to the NSS.

#### 8.4.3.2 Role and architecture of MTP level 2 layer

The level 2 layer enables semaphore channels to be created. It carries messages (sets of information) between two semaphore points as accurately as possible. It provides the following for the semaphore channels:

- error detection and corrective action functions using the so–called “basic” method
- initial alignment procedures (initialization of channels at BSS and NSS before message sending)

### 8.4.3.3 Role and architecture of MTP level 3 layer

The level 3 layer manages the network aspect of the semaphore No. 7 protocol. It handles the following procedures:

- load sharing procedure. It balances traffic between the semaphore channels (based on the principle of sharing, according to the number of the assigned circuit) and ensures that all messages relating to one call are transmitted on the same channel.
- channel switching procedures (signaling is transferred to another channel as soon as the current channel becomes unoperational)
- inhibiting procedure, which inhibits or enables a channel
- semaphore point unavailability procedure (stop sending messages when the semaphore point can no longer receive data)

### 8.4.3.4 Role and architecture of the SCCP

Signaling transfer between BSS and NSS uses SCCP services of “class 0” (connectionless services) and “class 2” (connection–oriented services).

The following functions occur at SCCP level:

- manage semaphore channels, so that all messages relating to one communication are identified by the same reference,
- address and route messages (the SCCP uses services provided by the MTP for that purpose)

### 8.4.3.5 Role and architecture of the application layer

The application layer (BSSAP) uses MTP and SCCP layers, and supports signaling message exchanges between the MSC and the BSS.

The layer is split into two parts, the DTAP and the BSSAP (see *Figure 8–9*). A distribution function routes messages to the DTAP or the BSSAP.

**DTAP (Data Transfer Allocation Part)**

This part is used to transfer “CALL CONTROL” and “MOBILITY MANAGEMENT” messages to and from mobile stations. Messages are not processed but routed by the BTS. In this case, the mobile application message is directly sent to the SCCP connection.

**BSSAP (BSS Application Part)**

This part supports all procedures dedicated to call and resource management.

BSSAP procedures can be “global” for a whole cell or a BSS or “usual” to one radio resource.

 

## 8.5 OMN interface (BSS/OMC–R)

The OMN interface enables the radio operations and maintenance center (OMC–R) to operate network radio subsystems (BSS). This is done via the BSC, which is responsible for all direct action. Components of the network are managed by an objet–oriented model that deals with managed objects (OE).

The OMN (Operations and Maintenance Network) is a data network using a TCP/IP data transmission network for radio subsystem centralized operations. This interface is based on the OSI reference model for its four first layers (see *Figure 8–10*).

The OMC–R is the ManaGing System (MGS) and the BSC is the ManageD System (MDS).

### 8.5.1 Architecture of the OMN interface

The OMC–R communicates with the BSC e3 across the OMN proprietary interface.

*Figure 8–10* shows the TCP/IP protocols used for the server.

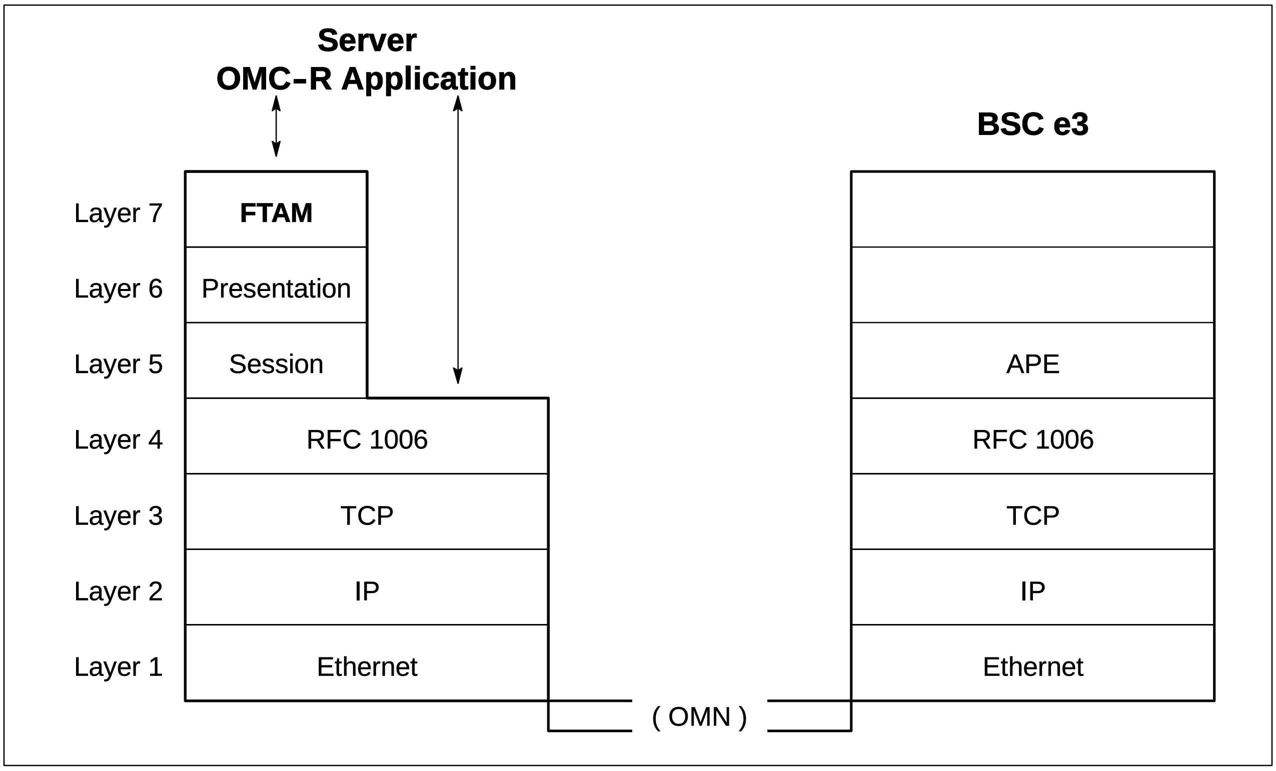


**Figure 8–10 Communication structure of an OMC–R server linked with BSC**

## 8.6 MAP interface

The MAP interface enables a mobile network switching center (MSC), associated to a VLR or a HLR, to communicate with the other network entities.

### 8.6.1 MAP interface goals

The interface carries out signaling messages that are required by the protocol application part (MAP) for all radio mobile applications. It handles exchange between all NSS entities and enables a MSC/VLR to communicate with the following:

- another MSC/VLR
- a GMSC (access system to the MSC/VLR)
- an HLR (the Home Location Register is part of the NSS)
- an EIR (Equipment Identity Register)
- an SMS (Short Messages Service center)

### 8.6.2 Signaling transport

Signaling messages are conveyed through a transport mechanism based on the CCITT No. 7 signaling system.

This protocol is divided into three parts (see *Figure 8-11*):

- Message Transfer Part (MTP)
- Signaling Connection Control Part (SCCP)
- Transaction Capabilities Application Part (TCAP)

The SCCP uses services from the MTP and provides reliable signaling transport.

The MTP is divided into three layers: level 1, level 2, and the level 3.

#### 8.6.2.1 Role and architecture of MTP level 1 layer

The level 1 layer, or physical layer, is the lowest one. It uses one or more time slots in PCM links connecting the NSS entities together.

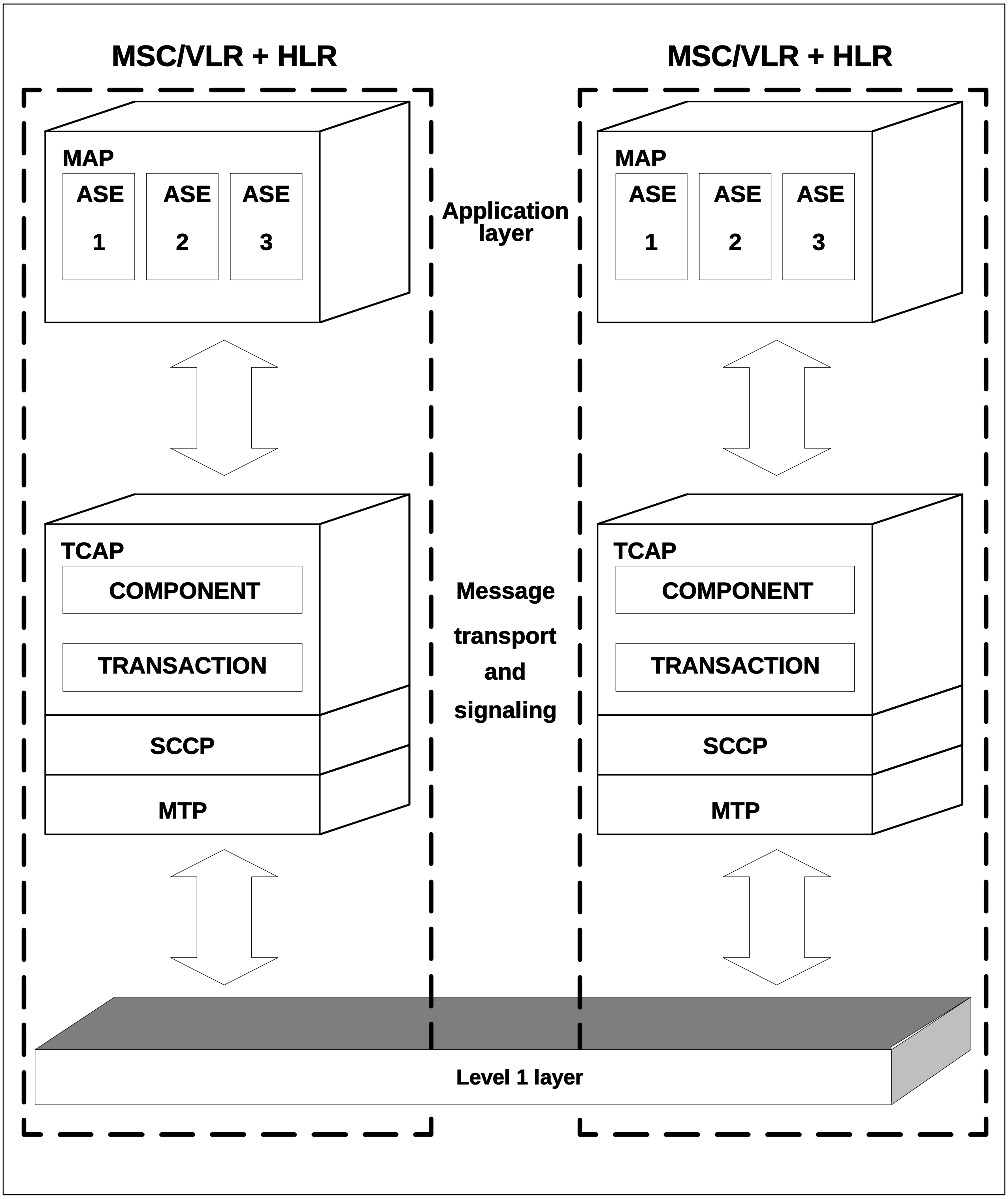


**Figure 8-11 MAP interface architecture**

#### 8.6.2.2 Role and architecture of MTP level 2 layer

The level 2 layer enables semaphore channels to be created. It is responsible for carrying messages (sets of information) between two semaphore points as accurately as possible. It provides the following for the semaphore channels:

- error detection and corrective action functions using the so-called “basic” method
- initial alignment procedures

#### 8.6.2.3 Role and architecture of MTP level 3 layer

The level 3 layer manages the network aspect of the semaphore No. 7 protocol. It manages semaphore message distribution and routing. using information stored in message headers. It also receives all messages relating to network management. By interpreting them, it is able to modify its own routing rules. It manages procedures that ensure availability of semaphore channels, semaphore networks, semaphore paths, points, and procedures relating to flow control.

#### 8.6.2.4 Role and architecture of the SCCP

Signaling transfer between BSS and NSS uses SCCP services of “class 0” (connectionless services) and “class 2” (connection-oriented services).

The connectionless service enables messages to be transmitted between two entities of the same PLMN or between two entities of different PLMN. It determines which semaphore point is to receive the message by interpreting the address, even if the destination point belongs to another PLMN. Then, the SCCP uses MTP services to transfer the message.

The SCCP, using management messages that are associated to it, enables network performance maintaining procedures to be executed by rerouting in case of defect or congestion.

#### 8.6.2.5 Role and architecture of the TCAP

The MAP uses services offered by the CCITT No. 7 transactions layer (TCAP). The transactions layer includes two sublayers: a “component” sub layer above a “transaction” sublayer.

The component sublayer provides application services used to exchange data packets perform tasks, and provide results afterward. Specific privileges give access to these services.

The transaction sublayer provides an association service that links data packets exchanged on the interface that belong to the same transaction. Communication management primitives give access to the user layer via the component sublayer, thus providing access to this service.

The MAP is a TCAP user and, may be seen as a set of Application Service Elements (ASE), in which each element is dedicated to a PLMN entity (MSC, VLR, HLR, etc.) and contains of a set of functional procedures.

 

#### 8.6.2.6 Role and architecture of the application layer

The application layer, also known as the mobile network protocol application part, does the following:

- registers or cancels location data
- manages supplementary services
- retrieves mobile subscriber's parameters upon call setup
- transfers communication
- manages mobile subscriber's data

Procedures between MSC and VLR are also specified in the MAP but, since both functions are integrated into the same AXE–10, they are internally handled by various tasks and are not seen as external procedures.

The above procedures are performed between the following units:

- a switching center (MSC) and a home location register (HLR), even when the MSC handles a gateway function (GMSC)
- a visitor location register (VLR) and a home location register (HLR)
- two switching centers (MSC)

They use the interfaces shown in *Figure 8–12.*

The following location registering and canceling procedures use exchanges between HLR and VLR:

- register location data
- cancel location data
- IMSI attach/detach (identification number of the mobile subscriber)

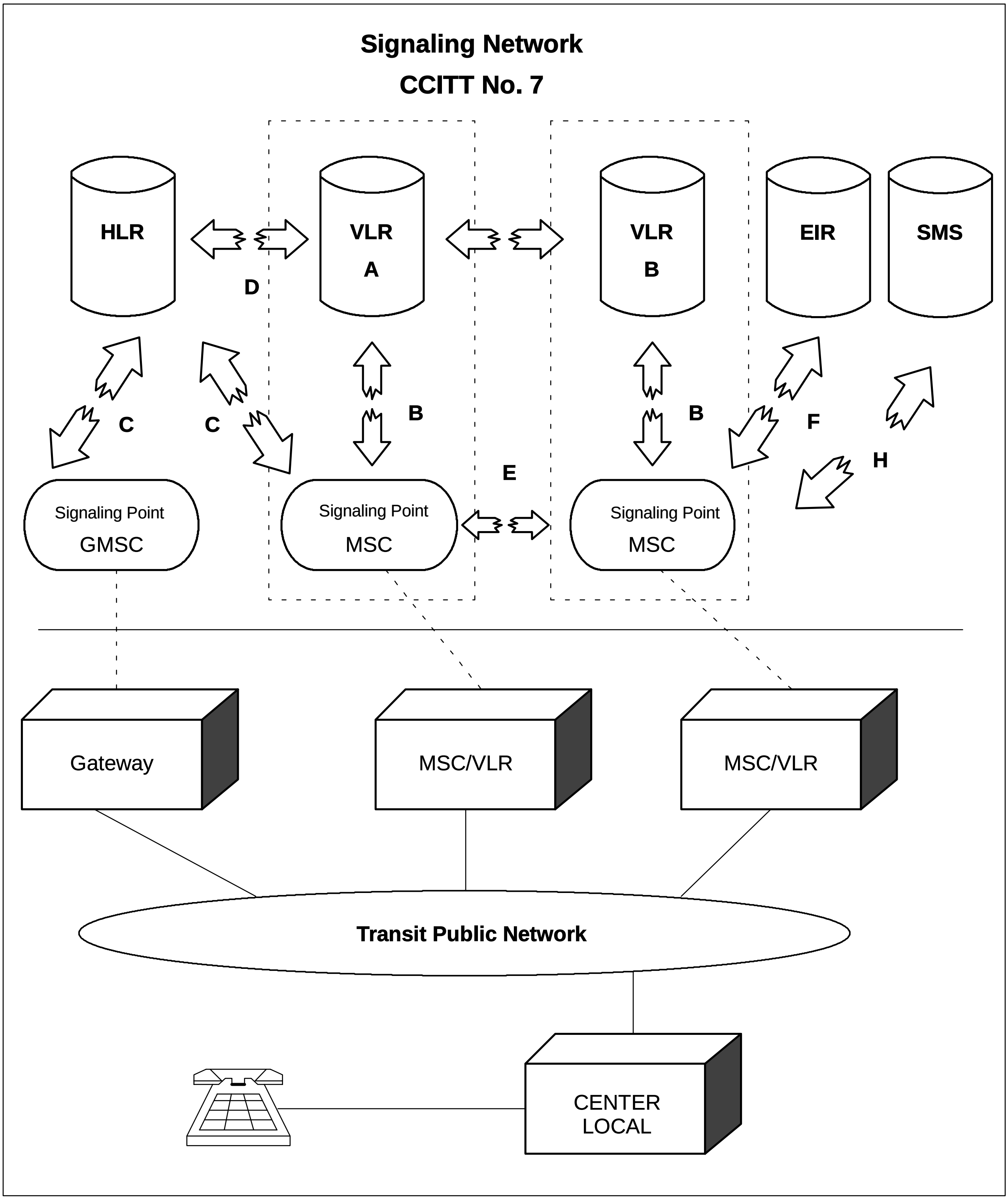


**Figure 8-12 Interfaces used by the MAP**

The following supplementary service procedures use exchanges between VLR and HLR

- activate a supplementary service
- desactivate a supplementary service
- query a supplementary service
- register a supplementary service
- remove a supplementary service
- invoke a supplementary service
- notify a supplementary service
- change or control password
- change parameters relating to a supplementary service

The procedure supported by the mobile subscriber parameter retrieval function during call setup requires exchanges between HLR and VLR for one part, and between GMSC and HLR for the other part. This procedure provides a roaming number before call setup.

The following handover function procedures use exchanges between different MSC:

- the procedure that handles basic handover between two MSC
- the procedure that handles a subsequent handover between two MSC
- the procedure that sends signaling messages to the mobile station, whenever an inter–MSC handover is underway or was executed
- the procedure that receives signaling messages from the mobile station whenever an inter–MSC handover is underway or was executed

The following procedures supported by the mobile subscriber data management function use exchanges between VLR and HLR:

- the procedure that requests subscriber's data
- the procedure that requests authentication data

## 8.7 Interfaces between mobile network and fixed networks

### 8.7.1 Role of the interfaces

Interfaces between a mobile network and fixed networks must provide the following features to the mobile subscriber:

- enable communication with a subscriber of a fixed network
- give access to services provided by a fixed network
- communicate with a subscriber of another mobile network

The mobile network, or PLMN, enables users to communicate with the following fixed networks (see *Figure 8–13*):

- Public Switched Telephone Network (PSTN)
- Integrated Services Digital Network (ISDN)
- Public Switch Packet Data Network (PSPDN)

Connection between PLMN and fixed network requires using an interworking unit with the MSC. Interworking provides all functions needed for PLMN connection to fixed networks (PSTN, ISDN, and PSPDN). Functions used depend on the following services that will be offered and on the fixed network. They feature:

- service interworking according to the type of teleservice requested (telephone, fax, videotex, etc.)
- network interworking for bearer services use
- signaling interworking, depending on the signaling system in use within the fixed network
- interworking for supplementary services use

### 8.7.2 Interfaces

The PLMN needs the following interfaces to communicate with fixed networks:

- interface between fixed networks and the HLR
- interface between fixed networks and the MSC

The interface with the HLR handles the prerequisite query procedure when a fixed network subscriber wants to call a PLMN subscriber. The switching center of the calling subscriber uses the mobile subscriber's ISDN number to perform the query procedure with the mobile subscriber's HLR. This procedure enables the switching center to obtain the mobile routing number and locate the mobile station.

 

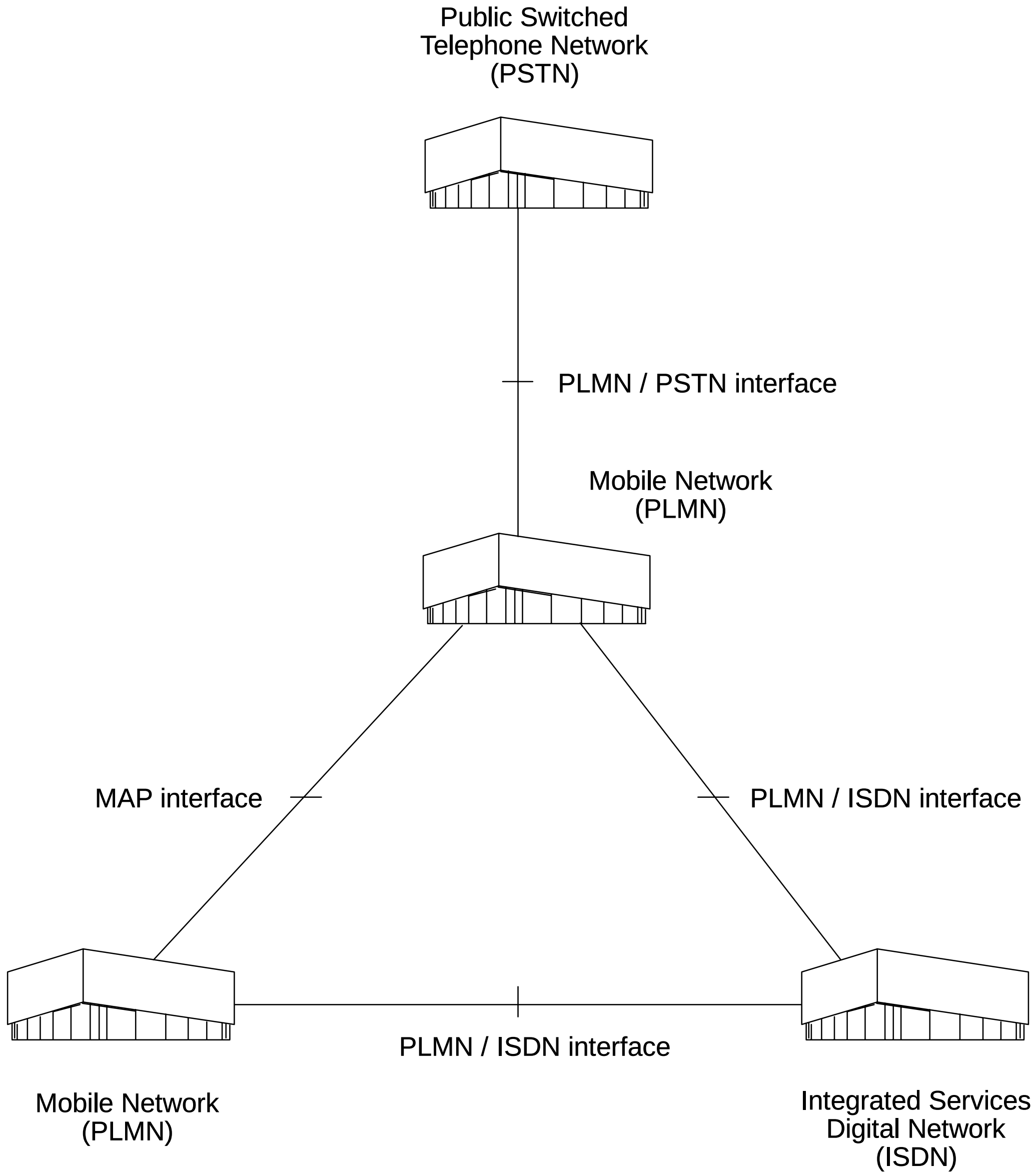


**Figure 8–13 Connections between networks**

The procedure may be performed via the switching center of the calling subscriber, or via a transit center, via a gateway MSC (GMSC). It uses the CCITT No. 7 signaling protocol TCAP layer. If the procedure is performed via a GMSC, the MAP protocol is used. The interface between fixed networks and the MSC is used for call set up and interworking, according to teleservices and bearer and supplementary services, and according to the type of the fixed network.

### 8.7.3 Interworking between PLMN and PSTN

This interworking function handles speech and data exchanges between PLMN and PSTN via the PLMN/PSTN interface. Interworking with the public network requires using the CCITT No. 7 semaphore channel signaling system, plus the Telephone User Part (TUP) between MSC and fixed network. Interworking with the PSTN depends on which information is conveyed (speech, data, or alternate speech/data).

Speech transmission complies with teleservices provided by the PLMN, so no function is needed.

Data transmission requires a modem to comply with data transmission used in the public network.

Alternate transmission of speech and data may be used in two ways: either data is transmitted after speech, or speech and data are alternately transmitted. In both cases, it complies with the teleservice and the bearer service used.

User speech and data are conveyed on PCM links that support circuits at 64 kbit/s.

### 8.7.4 Interworking between PLMN and ISDN

This interworking function enables a PLMN subscriber to access subscribers and services on the ISDN. Connection between both networks is done via the PLMN/ISDN interface.

The following are ISDN services:

- teleservices (telephone, fax, videotex, etc.)
- supplementary services (call routing, call hold, call barring, etc.)
- bearer services for data transmission

The PLMN/ISDN interworking function uses the same speech and data transmission principles as those used by the PLMN/PSTN interworking function. Signaling is performed using the same principles the ones described in the above paragraph, except that the application part is the ISUP (ISDN User Part), as specified for integrated service networks.

 

### 8.7.5 Interworking between PLMN and PSPDN

This interworking function handles connections between the mobile network and the data transmission switched public network (PSPDN). It also gives access to PAD (Packet Assembly/Disassembly) facility functions.

Connections with PSPDN require the following:

- service interworking
- network interworking
- signaling interworking
- subscribers' numerotation interworking

Access to the PAD facility may be one the following:

- basic access (via PSPDN or ISDN)
- dedicated access (direct access)

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