DECT and IP-DECT Engineering Rules and Site Survey Kit Manual

Installation manual

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Table of Content

History

Edition	Date	Description
04	1826	Introduction of IP-xBS rules
05	1905	Chapter 7 is deeply modified
06	1912	SSK Chapters 9, 10 completely modified
07	2025	Antenna chapter 8.1.4 completely modified
08	2318	Addition of SIP-DECT products

1 Introduction

1.1 General

The purpose of this document is to define the engineering rules relative to the TDM DECT (IBS, RBS), IP-xBS (aka xBS), IP-DECT and SIP-DECT technologies in the first part of the document (7 first chapters) and to describe the Site Survey Kit (SSK) in the last chapters. If you are only interested in the **SSK** go directly to **Chapter 8**.

For xBS solution, it is highly recommended to read doc[4] or doc[5] before reading this document.

The recommendations cover the technical and methodology aspects from the offer to the maintenance on IBS, RBS, xBS, IP-DECT and SIP-DECT projects.
This manual contains guidelines for surveying IBS, RBS, xBS, IP-DECT and SIP-DECT System sites. A site survey is necessary in advance of a product offer or in advance of installation.
Radio coverage is rather difficult to predict based on maps and other information, making an on-site survey necessary to determine the number and position of the DECT Access Points in the majority of cases. A survey will serve to complete the information necessary to plan an installation.

In this manual, the term transceiver is used for a transmitter/receiver for DECT. In DECT terms, a transceiver is called an RFP (Radio Fixed Part). For IBS, RBS and xBS the general name for a transceiver is called: Base Station (BS). However, for the IP-DECT solution the general name for a transceiver is called: DECT Access Point (DAP).

There are eight types of BSs:

- the 4070IA RBS NG Indoor with two omnidirectional internal antennas
- the 4070EA RBS NG Outdoor with two external antennas
- the 8379 IBS NG Indoor with two omnidirectional internal antennas
- the 8379 IBS NG Outdoor with two external antennas
- the 8378 DECT IP-xBS Indoor with two omnidirectional internal antennas
- the 8378 DECT IP-xBS Indoor for two external antennas (to be separately ordered)
- the 8378 DECT IP-xBS Outdoor with two external antennas.
- the 8328 SIP-DECT Indoor with two omnidirectional internal antennas

Note: Only use Outdoor version for outdoor installation

Be aware, that Ethernet cabling must be protected against lightning when used outside. Special protection devices are available from different manufacturers (Consult the Internet, the lightning suppressor or surge protector must be compatible with PoE and 10/100 or 1Gigabit).

There are two types of DAPs:

- the 4080 IP-DECT AP Integrated Antennas or the 8340 Smart IP-DECT AP Integrated Antennas with (two) omnidirectional internal antennas and
- the 4080 IP-DECT AP or the 8340 Smart IP-DECT AP External Antennas to which directional or external antennas can be fitted.

A DAP has an operating temperature range from 0° to 45° centigrade. Bear this in mind when installing a DAP outside.
An Outdoor box is available for mounting a DAP outside. Check the specifications of the Outdoor box for the exact temperature range.
Be aware, that Ethernet cabling must be protected against lightning when used outside. Special protection devices are available from different manufacturers. (Consult the Internet.)

For more information on the technical aspects, consult the Customer Engineer Manual for IP DECT.

The Site Survey rules for a IBS, RBS, xBS, IP-DECT, SIP-DECT system are based on coverage for:

1. A good quality connection between a handset and a BS or a DAP.
2. For xBS, IP-DECT and SIP-DECT only, a (simplex) radio connection, which is required to synchronize the xBSs with each other or the DAPs with each other.

For the Site Survey of a IBS or RBS system, there is one “air” connection that should be checked:

BS – Handset communication.
Measurements must be done for three items:

- Signal Strength
- Error Rate
- Voice Quality

For the Site Survey of an xBS, IP-DECT or an SIP-DECT system, there are two “air” connections that should be checked:

xBS or DAP or SIP-DECT – Handset communication (same as for the IBS, RBS systems).
Measurements must be done for three items:

- Signal Strength
- Error Rate
- Voice Quality

xBS to xBS or DAP to DAP or SIP-DECT to SIP-DECT communication.
Measurements must be done for

- Signal Strength

Besides this, also the synchronization hierarchy should be considered.
These items are discussed in the next chapters.

1.2 Objective

***Note**: When it is mentioned base or base station, consider that it can mean DAP (if we speak of IP-DECT systems) or BS (if we speak of IBS, RBS, xBS or SIP-DECT systems).*
The objective of a site survey is to determine the number and positions of bases to implement radio coverage in the area required and to determine how to install the bases including the connection to the DECT system.
The result of a Site survey gives you a clear overview of where bases must be installed, how the coverage will be, where the cell boundaries are and the required number of bases.

1.3 Procedure

The procedure for a site survey comprises the following steps:

- Acquiring site information.
- Preparing tools.
- Execution of Site Survey.
- Reporting the results.
- Checklist to check whether there are no things forgotten.

The sections in this manual are arranged according to the execution sequence.

1.4 Abbreviations

The following abbreviations are used in this manual:

CHO	**C**onnection **H**and**O**ver
CRC	**C**yclic **R**edundancy **C**heck
DAP	**8340 D**ECT **A**ccess **P**oint
DECT	**D**igital **E**nhanced **C**ordless **T**elecommunications
LED	**L**ight **E**mitting **D**iode (lamp)
OXE	**O**mni PC**X** **E**nterprise
OXO	**O**mni PC**X** **O**ffice
PP	**P**ortable **P**art (handset)
RFP	**R**adio **F**ixed **P**art (DECT transmitter/receiver connected to DECT system); RFP is also called: Base Station or DAP
RFPI	**R**adio **F**ixed **P**art **I**dentification (unique DECT system and RFP identifier)
RPN	**R**adio **P**art **N**umber
RSSI	**R**adio **S**ignal **S**trength **I**ndication (received signal strength)
SSK	**S**ite **S**urvey **K**it
TDM	**T**ime **D**ivision **M**ultiplexing
xBS	**8378 DECT IP-xBS**

1.5 Reference documents

[1]	IP-DECT Customer Engineer Manual Getting Started	8AL90871USBA
[2]	OXE Mobility document	8AL91009USAG
[3]	OXO Mobility document	8AL91204USAE
[4]	Getting_started_with_8378_DECT_IP-xBS-solution_on_OXE	8AL90356ENAA
[5]	Getting_started_with_8378_DECT_IP-xBS-solution_on_OXO	8AL90357ENAA
[6]	8328 SIP-DECT System guide	8AL91449ENAA
[7]	8368 SIP-DECT System guide	8AL91459ENAA

2 Required Information

The following information should preferably be available in advance of a survey:

Maps of the site

Maps of the site are an essential requirement in advance of a survey!
A map of the complete site (if more than one building) and plans of each floor of each building are required. Make sure that dimensions are clearly stated on the maps. Additional information such as the use of buildings (e.g. office, hotel, factory, store, etc.), construction materials (walls, floors, ceilings, etc.), cabling infrastructure, etc. are helpful in estimating positions of the bases in advance.

Number of users (PPs)

Number of users (handsets), both initial and foreseeable growth, and areas of above average and below average traffic density.

Allowed and prohibited base positions

A customer may prohibit installation of bases in certain areas, require the bases to be installed out of sight, etc.

Details of required coverage

It should be clear in advance where coverage is required, e.g. whether elevators, stairwells, toilets, outdoor areas etc. are to be covered as well.

Position of the DECT System and available Cabling

Check whether existing cabling can be used for the connection between the DECT System and the bases. (CAT5 or better to be used.) If the type and quality of the available cabling is not sufficient for the connection of the bases new cabling must be installed.

Sensitive electronic equipment

Check whether sensitive electronic equipment is present or not, e.g. laboratory, medical, etc. Although the transmitted power of the bases is very low (about 250 mW[1]) it might interfere with sensitive electronic equipment.

Traffic information

It is necessary to gather information on user density, amount of traffic, whether redundancy is required, etc. This must be clear in advance because it determines the number of bases that are required and therefore also the cabling that is required.

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[1] In some regions the maximum transmitted power is lower.

3 Coverage and Speech Quality

3.1 General

There is always a relation between coverage and speech quality. The further you get away from the base, the lower the quality. Therefore, it is important to see the relation between the coverage and the expected voice quality. Figure 1 gives an impression on the relation between coverage and voice quality in an indoors environment.

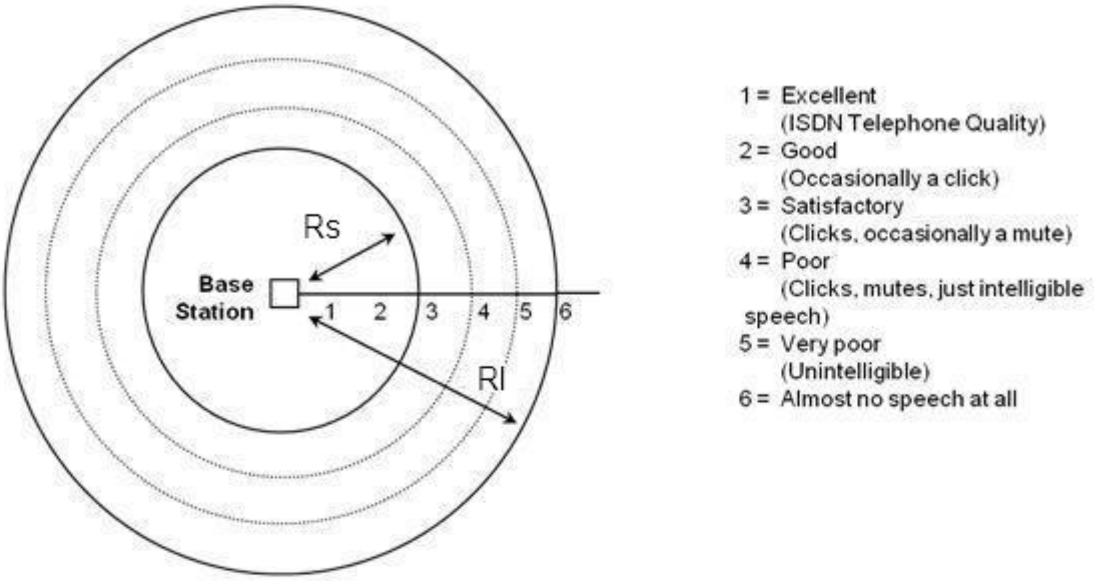


Figure 1: Coverage and Speech Quality in open Environment

Remark: Rs is a distance corresponding to a RSSI level of -70 dBm (for easy coverage) or – 60dBm (for tricky coverage). Detailed tables of coverage are given in the next chapters.
Rl is a distance depending on the RF sensitivity of the handsets and on the environment (interferers, fading, etc…).
1 (Excellent) corresponds to a quality index (see “Setting up the Equipment” chapter) equal to 15 or 16.
2 (Good) corresponds to a quality index equal to 13 or 14.
3 (Satisfactory) corresponds to a quality index comprised between 10 and 12 (and also corresponds to Rs).
4 (Poor) corresponds to a quality index equal to 8 or 9.
5 (Very poor) corresponds to a quality index comprised between 4 and 7.
6 (Almost no speech at all) corresponds to a quality index ≤3 (and also corresponds to Rl).

Be aware that DECT is a digital communication system. It incorporates a “transmission errors hiding” system. This means that it tries to hide the transmission errors. The results of this mechanism are as follows:

- Small incidental transmission error → Not noticeable in speech
- Minor transmission error → Click in speech
- Major transmission error → Mute of speech

Note: *Even though a poor speech quality might well be acceptable, the need to have proper xBS to xBS, DAP to DAP or SIP-DECT to SIP-DECT synchronisation (see further) is an important factor that might “force” a better than really needed speech quality.*

Three important elements must be processed either sequentially or simultaneously

- ❑ Covering the area where the service is to be provided

Coverage = Accessibility

- ❑ Ensuring the establishment of communications to stations in a zone with heavy communication users.

Capacity = Availability

- ❑ Ensuring user satisfaction

Audio Quality = Comfort

Coverage: This initial function is fundamental for radio systems.
The choice of base positions is crucial for correct coverage.
Identifying the materials present on the site, zone or in the building is essential.
The presence of metal surfaces and dense structures can result, on the one hand, in partial or total screening (partitions, pipes, machines, etc.) but can also become a good wave guide.
Therefore, it is essential to visit the site when this is possible or to undertake in-depth drawing analysis with the architect taking into account the materials used. The rules for calculating the number of bases based on a number of bases per m² can only be used if this visit has qualified the site as being exempt of coverage difficulties.

Traffic: The notion of traffic is often raised following the initial coverage study.
The capacity calculations can lead to a significant increase in the number of bases to be installed and a reappraisal of base distribution. Non- homogeneous distribution of the traffic may entail dividing the site up into several utilization zones.

Audio quality: The quality of a system is the quality as seen by subscribers and, ultimately, it is the end appreciation that will make the DECT system a success or a solution that is not totally satisfactory.
This is obviously linked to the first two functions because a subscriber who is not covered or has no channels available will not be satisfied. It is also associated closely with the performance of the products. The quality level also depends on the service expected by customers; for example, a company that wants to be able to reach a small number of its employees on the move will put up with a few imperfections whereas in the case of “Full DECT” a quality equivalent to fixed wired sets will be demanded on the office sets.

Quality for radio systems is a term that can include all of these topics. In this case, we talk of Quality of Service (QoS).

The base technology also impacts on this quality.

For these three elements, the bases have a crucial role because

- ♦ their sensitivity will intervene to determine the coverage and capacity
- ♦ their algorithms and handover thresholds will impact on the capacity and quality

The actions to carry out to ensure QoS are:

1) Determine the aims and needs of the customer
2) Select the best position for the terminals and the type of antenna to be used
3) Check the resulting traffic capacity
4) Identify whether the previous results need to be adapted according to the sets used and the quality of service expected by the customer.

3.2 Which speech quality is required?

The required speech quality depends on the customer requirements and the environment. The following quality levels are required:

Excellent and Good
In business and office environments, the excellent and good quality is mandatory!! A lower speech quality is not allowed!
Also, in First Aid environments, only excellent and good voice quality is allowed!!

Excellent, Good, Satisfactory
In less critical areas like basements, stocks and cold stores, a satisfactory quality is also allowed. In a noisy environment people will not notice a click in the voice connection anymore, because the environment produces a lot of background noise already. This environmental background noise may also contain clicks. Sometimes, the speech of the telephone extension cannot be heard because of the background noise.

Notes:

- *It may be necessary to install a hardwired emergency telephone in those areas where the quality is satisfactory. This ensures that people can always make a call in case of emergency.*
- *If you agree with the customer on lower speech quality, then make sure that this is well documented and signed by the customer. If the customer complains about it afterwards, then you can always refer to the agreement. Also, be aware that, if the speech quality is low in certain areas, you might get blamed for having delivered a bad system!!*

3.3 Factors affecting speech quality

The following factors affect the voice quality as well:

Moving speed
The DECT techniques allow (formally) a maximum moving speed of 5 km/h. Bear this in mind if your DECT system must cover an elevator.

Metal Construction
If the construction materials of the building are mainly made of metal, there will be a lot of reflections. *In that case the voice quality will be poor (a lot of "clicks" and "mutes") even if you are next to the base.* Only if the handset doesn't move, the voice quality will be good.

When the quality index is lower than 8, then there are too many reflections in the environment for a successful DECT, xBS or IP-DECT installation. Consider using directional antennas instead. If you choose this solution, do an accurate measurement on these antennas on the spot where you want to apply them.

When applying directional antennas, you should later check whether the xBS to xBS or DAP to DAP communication (for xBS and IP-DECT only) is sufficient for synchronization.

If you want to have a more accurate survey in metal environments, you must use a small DECT system which a minimum of four *base*s and demonstrate to the customer the maximum possible quality.

4 Dect offer process

The entire offer process must be founded on a formal QoS commitment.

4.1 Project classification

The aim of this classification is to assist sales, pre-sales and post-sales technical support managers to ask themselves a series of questions regarding offer optimization and the identification of technical and sales risks. The radio measurement services on site are the only means of securing the offer. Recommendations regarding sizing and methods are detailed in § General rules.

4.1.1 Classification of customer objectives

The customer's objectives in terms of mobility and business approach may be as follows:

- ❑ **Mobility / “DECT”**
  Part of the company is mobile. The aim is for these mobiles to be accessible at all times.
- ❑ **Installation of a "Full DECT" completely wireless PABX**.
  The interest lies in doing away with the wiring and in the High-Tech aspect afforded to the company. We talk of Full DECT or Full Wireless when more than 80% of users are in DECT cordless. In this type of installation, two types of implementation are possible:
- ➢ With **operating/running costs optimization** by doing away with office moving costs.
- ➢ With **investment costs optimization.**
  The customer's requirement may be a Full DECT system
  - without a 100% coverage obligation
  - without the obligation to do away with office moving costs totally

The use of this mobility may be just as important in the QoS choices.

Therefore, you must specify the type of users (discussions, basement or roof maintenance, etc. sales agents, hot line, etc.)

4.1.2 Classification of user distribution

The different business activities in some companies may result in classifying a site by geographic zones according to user homogeneity criteria.
A very different example of distribution is shown in the 2 schematics below even though the average traffic is the same. The calculations according to average traffic must not be done without prior analysis regarding homogeneity being carried out.

Homogeneous distribution:
User population correctly distributed with a majority centered on the average.

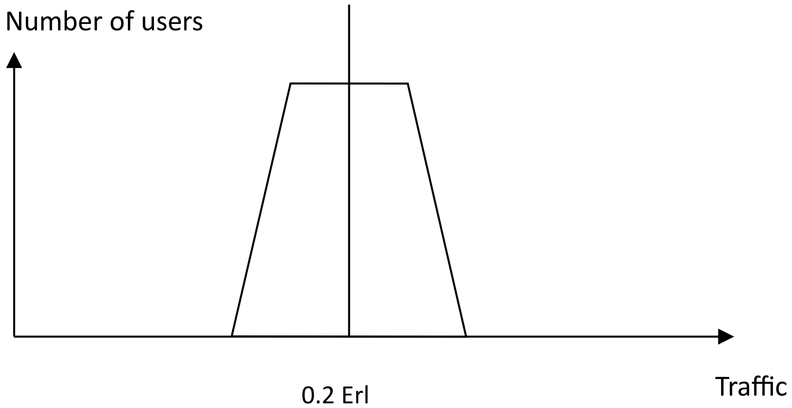


Figure 2: Homogeneous distribution

Non- homogeneous distribution:
Company having several activities with very differing traffic requirements.

Two cases are possible:
- The geographic distribution is common
- The geographic distribution is separate.

Depending on the case, this results in very variable capacity in traffic density, in turn resulting in a different base station density.

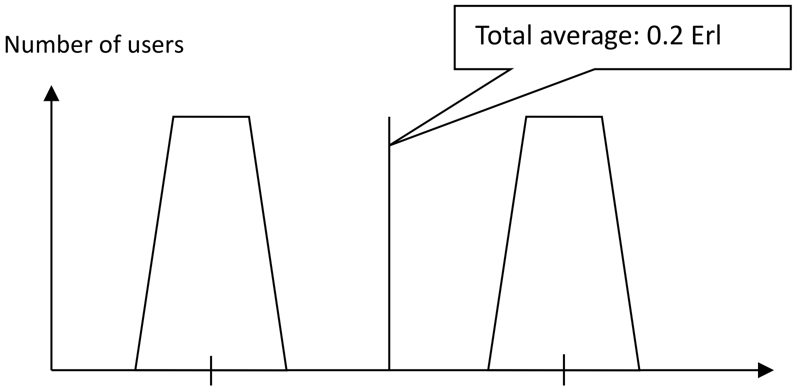


Figure 3: Non-homogeneous distribution

4.1.3 Technical classification of the site

This classification is used to determine the QoS expected by the customer at a given point. It is based on two parameters: capacity and coverage.

4.1.3.1 Capacity objectives

The traffic capacity notion is an important aspect that must be integrated in this classification approach. Capacity according to the activities:

♦ Very high traffic	Telemarketing, Hot Line, market rooms, etc.	(>0.3Erl)
♦ High traffic	Sales, buyers, etc…	(0.3E> >0.2E)
♦ Average traffic	Technique, project, administration, etc…	(0.2E> >0.1E)
♦ Low traffic	Store, lab, storage, etc.	(<0.1Erl)

The figures can be used for sizing if the customer has no accurate idea of the actual traffic.

4.1.3.2 Radio coverage classification of the site

The site can be classified in two categories for the coverage aspect

- ❑ Site with no coverage problem(s) (= **Easy**)
  Offices, tertiary, store rooms (no obstacles and no metallic partitions), etc…

  Watch out for ordinary office metal doors which can change the complexity of the site by producing field variations.

- ❑ Site with difficult coverage (Metallic environment) (=**Tricky**)

  Production plant, certain buildings using metallic partitions, clean rooms, etc…

  A real life fading measurement (door openings, usual circulation, etc.) is essential to classify the site as **easy** (fading <20dB) or **tricky** (fading >20dB).

  However, the delay spread parameter, resulting from multiple reflections in the case of large metallic buildings (> 30m x 30m), may be critical.

  This risk is detected by associating a poor-quality level (< 8) and a good radio field level.

4.1.4 Classification as zone

A zone is a space where the characteristics in terms of customer objectives, traffic distribution and coverage difficulties are homogeneous.
Eliminating disparities in a zone allows us to obtain a result that is optimized as regards the service expected by the customer. A site can comprise several zones.

This classification also allows the QoS objectives of the customer to be specified better and to limit our commitment to the real requirement zone by zone.

4.1.5 Classification summary tables

The tables below are intended to assist offer managers and measurement managers in their approach. The first column shows the objective of the customer and the other columns the classifications in profiles, traffic and coverage, finishing with the recommendation in terms of principles.

DECT case	User profiles	Traffic	Coverage	Principle
Ordinary mobility	Homogeneous over the entire site	Low risk, users are mobile. A final calculation indicating the capacity per m² must be handed over to the customer	**Easy:** Calculate the number of base stations required to cover the site, with a ceiling of **- 70 dBm** (*1)	**Terminals per m²** See “Coverage calculation” chapter according to the antenna used
			Tricky: Preliminary coverage study with measurements and ceiling of **- 60 dBm** and quality level of ≥12	**Preliminary coverage study**
			Several zones of different difficulties	Apply the previous 2 principles to each zone

(*1):

The ceiling recommended for coverage calculation, while maintaining a quality level of ≥12 for a DECT network using ALE DECT handsets, is given hereafter:

- For base station to handset deployment with TDM base stations (IBS/RBS NG), xBS and for DAP to handset deployment with IP-DECT DAPs (such as 4080 IP-DECT AP or 8340 Smart IP-DECT AP with integrated or external antennas) use the following table:

Type of coverage	Ceiling: Minimum RSSI level between an ALE DECT handset and a base
Easy coverage	- 70 dBm
Tricky coverage	- 60 dBm

An additional margin of 10 dB should be considered (- 60 dBm and - 50 dBm) in the case of a request for a Full DECT QoS level close to fixed (wired) line quality.

In addition, be careful and do not apply this rule on specific sites producing cavity type effects where the resonance effects may corrupt this measurement. In this case, do a specific study.

Case of a Full DECT optimization of running costs	User profiles	Traffic	Coverage	Principle
No cost office moving	Homogeneous over the entire site.	Calculate the number of base stations required to handle the site traffic with a margin. Indicate the hypotheses.	**Easy:** Calculate the number of base stations required to cover the site with a ceiling depending on the mobile sets used*. (Use the least good sets).	Take the highest number of base stations from the 2 calculations and **distribute** them as equally as possible on the site. Take a 5% base station or DAP margin to add to cover one-off traffic situations
			Tricky: Preliminary coverage study with radio measurements to determine the number of base stations. The ceiling is dependent on the mobile sets used*. (Use the least good sets). And also take a quality level of ≥12	Take the highest number of base stations from the 2 calculations and **adapt the coverage study result** if necessary. A check on the capacity must be carried out.
			Several zones of different difficulties	Apply the previous 2 principles on the different zones
	Not Homogeneous There are zones with very different traffic values	Calculate the number of base stations required to handle the traffic starting with the highest traffic density and applying it to the entire site. Indicate the hypotheses. (**<u>Traffic density uniformization</u>**)	**Easy:** Calculate the number of base stations required to cover the site with a ceiling depending on the mobile sets used* (use the least good sets).	Take the highest number of base stations from the 2 calculations and **distribute** them as equally as possible on the site. Take a 5% base station margin to add for one-off traffic situations
			Tricky: Preliminary coverage study to determine the number of base stations. The ceiling is dependent on the mobile sets used* (take the least good sets).and also take a quality level of ≥12	Take the highest number of base stations from the 2 calculations and **adapt the coverage study result** if necessary. A check on the capacity must be carried out.
			Several zones of different difficulties	Apply the previous 2 principles on the different zones

Case of a Full DECT optimization of investment costs	User profiles	Traffic	Coverage	Principle
	Homogeneous over the entire site	Same as the previous case except for the fact that the **traffic value used as hypothesis must not be increased.**		
	Not Homogeneous There are zones with very different traffic values.	**Divide into zones and treat each zone as the case of a Full DECT site with running costs optimization**		

4.2 Offer completion methodology

The completion of a Radio offer must follow the following stages:

4.2.1 Stage 1: Collection of customer requirements

4.2.1.1 Phase 1: Determine the customer's objectives

This initial phase is usually conducted by the commercial manager.

- Objectives:
    - Determine the customer's requirements per zone
    - Determine the site complexity
    - Retrieve the plans/drawings
    - Retrieve the information relative to the traffic and user distribution.
- Results:
    - Classification of the project and associated risks.
    - Completion of the dossier for cost hypotheses

4.2.1.2 Phase 2: Analysis of the site

This second phase can be completed by the commercial manager, offer technical support or radio measurements manager, preferably on site.

- Objectives:
    - Confirm the project complexity
    - Complete the information retrieved in phase 1 (plans/drawings, traffic, distribution)
    - Retrieve information relative to the site.
- Results:
    - Confirm classification of the project and associated risks.
    - Quantify the measurements services to be carried out
    - Propose an initial approach for base numbers by integrating the traffic and coverage data and their positions.

This phase is preferable to activate phase 3 in good conditions for the sizing of the resources needed by the service and to provide an initial strategy recommendation to follow as regards the measurements to be carried out.

4.2.1.3 Phase 3: Radio coverage study

In all cases, **real life** radio measurements are recommended to confirm the positioning and quantity of bases (RSSI and quality level measurements using a SSK).

They are essential in the zones classified as tricky coverage.

- Objectives:
    - Confirm the number of zones
    - Determine the characteristics of the building, partitions and environment.
    - Determine the field and Audio Quality levels (measurement of the Q quality factor) at the strategic points on the site.
- Results:
    - Identify the different zones and give the following results per zone
    - Measurement dossier confirming the real coverage and associated audio quality level
    - Confirm the quantity and positioning of the bases
    - Identify the residual risks
    - Propose QoS levels per zone on which ALE could give a commitment.

If this measurement reveals that the environment is disruptive, the network will be declared as tricky Radio Coverage and its classification may be changed.

If the site does not exist when the offer is made, this first stage will be replaced by the drafting of more advanced hypotheses.

4.2.2 Stage 2: Drafting of the offer

The offer will be drafted in the light of the coverage study and the hypotheses retained.

Different zones are displayed according to the QoS.

4.2.3 Stage 3: Drafting of the commitment limits

The commitment level per zone, the average of all the sets in this zone, must be specified by a QoS level. It will be based on a DECT mobile set in static position, with the following two notions:

- **Call establishment success rate**	= Accessibility, availability
- **Audio quality rate**	= Quality, comfort

corresponding to the absence of cut-offs and interference on an established communication.

Four levels are recommended:

Level 1:

The coverage is perfect on this zone, i.e. no cut-offs, no interference and no failure in call establishment.

Seen by the user as almost as a wired set, this corresponds to the Full DECT request.

A commitment of this type is always with a limit of less than 100%. The recommended values are:

- Call establishment success rate	>99.5%
- Audio quality rate	>98%

Precautions: Clearly specify the zones of this type, avoid the common parts, rest rooms, stairs, elevators and room angles/extremities. (Consider the field level recommendations relative to Full DECT).

Level 2:

The coverage allows for good quality communications with the possibility of saturation during a peak period.

The recommended commitment values for this level are:

- Call establishment success rate	>95%
- Audio quality rate	>95%

Precautions: Clearly specify the zones of this type, avoid the common parts, rest rooms, stairs, elevators and room angles/extremities. (Consider the field level recommendations relative to Full DECT).

Level 3:

The coverage is good, but some areas are probably in a shadow zone. Therefore, cut-offs and interferences are to be expected.

The recommended commitment values for this level are:

- Call establishment success rate	>90%
- Audio quality rate	>85%

Precautions: Clearly specify the zones of this type, considering the recommendations for field level relative to DECT.

Level 4:

The coverage is not guaranteed.

Work-around solutions are proposed according to the customer's needs.

(Case of rarely frequented zones where the accessibility can be obtained by installing one-off solutions)

In the case where the customer has demands that exceed our own assessment, then depending on the commercial context, we must

- ♦ either **sell a pre-study** that is more comprehensive, to better specify the ALE level of commitment
- ♦ or **present two offers** specifying the hypotheses
  - version 1: what ALE feels is sufficient
  - version 2: what would be required to meet the customer's demands

When a **commitment for results** is requested, we must

- avoid fixing the resources (number of bases, etc.) as a more in-depth study may enable us to reduce the number of bases and, as a result, increase our global margin.
- increase the assessment to cover the risk relative to the number of bases (5% if the requirements expression data are accurate and more in the case of uncertainties).

In all cases, do not make a results commitment for a site that has not been visited.

5 General rules

5.1 Traffic calculation rules

Even though, in most cases today, the number of bases is linked more to coverage rather than traffic objectives, it is a good idea to make sure of the suitability of the customer's capacity, in the Full DECT case.

The calculations must be carried out zone by zone. (Reminder: a zone is a space that is homogeneous regarding difficulty of coverage, traffic, and the required quality level).

To calculate the number of possible close base stations (or terminals) as well as the traffic when there is a reduction in the number of frequencies, refer to document ″IBS NG: Rules of installation for China and South America base stations″ 3AK 29000 1555 UUZZA.

With **5 US frequencies**, the maximum number of close IBS NG **US** base stations is between 3 and 5 which limits simultaneous communications to a number between 10 and 20, while with 10 frequencies, the maximum number of close IBS NG EU base stations is between 6 and 9 which limits the simultaneous communications to a number between 25 and 40.

⇒ **With 5 frequencies rather than 10, the traffic reduction factor is in the order of 2.**

5.1.1 User DECT traffic

User traffic has two components ti = tci + tsi

- the tci traffic due to the user's communications
- the tsi signaling traffic.

Three cases can arise when **determining the tci traffic**:

- The customer indicates the DECT traffic of the different users – in this case, use these values

- The customer indicates the telephone traffic of the different users without making any distinction between DECT and wired and often uses an average value: in this case take 100% for the users who just have DECT and only 50% for the others.

- The customer does not indicate any values – in this case, take 0.12 Erl for users just having DECT and only 0.06 Erl for the others who have, for example, a wired terminal.

Determining the tsi traffic

Let tsi=0 x tci for xBS, IP-DECT, IBS, RBS, SIP-DECT base stations with the following exception for xBS, IBS, RBS bases:
Let tsi=0.5 x tci for signaling traffic exchanged with the OXE for certain telephone features (e.g. for sets using the manager/secretary, supervisor, multi MCDU or multi-key MCDU functions).

5.1.2 DECT traffic of users in a zone

The calculation is done per user type (same traffic and same DECT terminal).

$$Tu=\Sigma\ ni \times ti$$

ni is the number of users of the same type.

ti is the average traffic per user of this type expressed in Erlang

5.1.3 Traffic capacity calculation

The total load of the terminals is higher than the DECT traffic of the zone users. You must consider the traffic of the visitors and the load due to DECT mechanisms (Handover).

By default, and without more accurate information, traffic of the visitors is estimated to be 10% of the DECT traffic of the sets in the zone. The load due to the DECT mechanisms is equal to 20% of the DECT traffic of the users (those in the zone + visitors).

The total load for a zone is: $T = Tu \times 1.1 \times 1.2 \approx Tu \times 1.3$

5.1.4 Number of terminals

This is the number of terminals to be offered to the customer to meet their needs in terms of traffic.

The calculation method is given for TDM bases (RBS/IBS), for the xBS, for the IP-DECT DAPs (with OXE and with OXO), for the SIP-DECT bases.

This calculated number can still be increased in the case of a Full DECT installation according to the requirements of the customers.

The number of terminals finally determined for the traffic aspect must be compared with the number of terminals determined by the coverage requirements.

The higher number will be used for the proposal to the customer.

Full DECT installation:

Full DECT installation with running cost optimization, the number of base stations proposed and costed must be equal to the number of base stations calculated, increased by 30%.

This is used to guarantee for the customer that, after commissioning or any subsequent office moving, there will be no more than 5% of the cells to restart.

Restarting a cell consists in passing it from 1 to 2 base stations because the station traffic serviced is higher than the average.

Conversely, if after moving, this is not the case, the zone must be brought back to 1 single base station.

In fact, in the case of a Full DECT installation, with running cost optimization, 95% of the base stations sold will be installed on commissioning and the remaining 5% will be used to handle the case of excess traffic cells.

Full DECT installation with investment cost optimization, the number of base stations proposed and costed must be equal to the number of base stations calculated.

Subsequently, the customer must adapt the coverage to the noted traffic disparities, which will be translated by moving or even adding base stations.

Remark: For traffic calculations you must know:

- *the number of users,*
- *the type of users.*

There are four user types distinguished:

TRAFFIC	**APPLICATION**	**ERLANG/USER**
Low	Normal offices, stores, labs, storages, etc	< 0.1
Average	Exec-secretary groups, technique, projects, administration, etc	0.1 – 0.2
High traffic	Helpdesks, Tele-services, sales, buyers, etc.	0.2 – 0.3
Very high traffic	Telemarketing, Hot Lines, market rooms, etc.	> 0.3

Table 1: Four user types

5.1.4.1 Calculation of the RBS number

The terminal traffic capacity is linked to 2 parameters:

- the terminal type which sees -11 channels (82x2 DECT, 82x4 DECT)
- the minimum number of base stations seen by a terminal at any place in the zone.

Traffic capacity of a terminal C c.b

- Where “c” is the number of channels seen by the terminal
- Where “b” is the number of base stations seen at any place by the terminal

The table below gives the admissible load per base station with a blocking probability of 1%:

Nr of visible BS Nr of channels	1	2	3	4
11	C 11.1 = 5.2	C 11.2 = 6.5	C 11.3 = 7.3	C 11.4 = 7.8

If in a same zone, the users have different terminals which do not see the same number of channels, the calculation must be done as follows:

T is the traffic requirement of the zone and T (11) that of the terminals seeing 11 channels.

The number of base stations for the requirements of these terminals is if T=T(11):

N (11) = T (11) / C 11.b

Example:

Hypotheses:

Customer requirement: Full DECT zone to cover with the RBS and with running cost optimization.

Subscriber traffic:

- 200 users at 0.1 E with 82x2/82x4 DECT HS
- 50 users at 0.15 E with 82x2/82x4 DECT HS
- 40 users at 0.25 E with 82x2/82x4 DECT HS
- 10 users at 0.3 E with 82x2/82x4 DECT HS

Cell overlap: At all places the terminal sees at least 2 base stations.
This data item can be the result of measurements or of a hypothesis.

Calculation

DECT traffic of users in the zone:

T u (11) = 200 x 0.1 + 50 x 0.15 + 40 x 0.25 + 10 x 0.3 = 40.5 E

Total load for the zone:

T = 40.5 x 1.10 x 1.20 = 53.5 E

Calculation of the number of base stations:

The calculation for the traffic requirement of the base stations seeing 11 channels

N (11) = T (11)/ $C_{11.2}$ = 53.5 / 6.5 = 8.2 => 9

The total of 9 base stations must be increased by 30% to take into account the requirements of the customer regarding optimization of the running costs.

The final number is 12 base stations.

5.1.4.2 Calculation of the IBS number

All the terminals see 6 channels.
The table below gives the admissible load per base station with a blocking probability of 1%:
This load is a function of the minimum number of base stations seen by a terminal at any place in the zone.

Nr of base stations Number of channels	1	2	3	4
6 channels	C 6.1=1.9	C 6.2=2.8	C 6.3=3.3	C 6.4=3.7

The calculation of the number of base stations for the traffic requirement is then: N = T / C 6.b

5.1.4.3 Calculation of the xBS number

The xBS support load balancing of the RTP processing (relaying and recording of RTP) between base stations in the same PARI. Therefore, the limitation in traffic capacity is the number of available channels in a zone.

The xBS is a 12-slot base station, where one slot is used for air synchronization and 11 slots can be used for traffic. But for traffic calculation, one slot is restricted to BHO (Bearer Handover on the same base station, typical because of interference from other DECT phones in the area), leaving 10 channels for traffic.

The Master base station can carry 11 traffic channels, but to calculate the numbers of base stations, always use 10 or 8 channels depending on reservation of 2 slots for emergency call.

In multiple PARI installation, the Master with an external Sync BS reference cannot carry any traffic. The xBS is only used for synchronization. This is done to secure synchronization.

In the call server, there is an option to reserve or not 2 slots for emergency call, this will limit the channels for traffic to 8 (9 for the master).

All the handsets can see all 12 channels, so from handset point there is no limitations.

The terminal traffic capacity is linked to the parameter:

- the minimum number of base stations seen by a terminal at any place in the zone.

Traffic capacity of a terminal C c.b

- Where “c” is the number of channels seen by the terminal
- Where “b” is the number of base stations seen at any place by the terminal

The table below gives the admissible load per base station with a blocking probability of 1%:

Nr. of visible BS / Nr. of channels	1	2	3	4
Master xBS: 11	C11.1 = 5,7	NA	NA	NA
Slave xBS: 10	C 10.1 = 5,0	C 10.2 = 6,4	C 10.3 = 7,0	C 10.4 = 7,5
Master w. Emergency reservation: 9	C 9.1 = 4.4	NA	NA	NA
Slave w. Emergency reservation: 8	C 8.1 = 3,7	C 8.2 = 4,8	C 8.3 = 5,3	C 8.4 = 5,6
Master with an External Sync BS: 0	C 0.1 = 0	NA	NA	NA

The Capacity in erlang is based on the Engset traffic model, with 0.2 Erlang/user and traffic sources adjust to the capacity of the base station(s).

T is the traffic requirement of the zone and T (c) that of the terminals seeing c channels. The number of base stations for the requirements of these terminals is if T=T(x):

N (c) = T (c)/ C c.b

Example 1:

Hypotheses:

Customer requirement: Full DECT zone to cover with the xBS and with running cost optimization.

Subscriber traffic:

- 200 users at 0.1 E
- 50 users at 0.15 E
- 40 users at 0.25 E
- 10 users at 0.3 E

overlap: At all places, the terminal sees at least 2 base stations.

Setup **without** slot reservation for emergency call (10 channels)

This data item can be the result of measurements or of a hypothesis.

Calculation

DECT traffic of users in the zone:

T u (11) = 200 x 0.1 + 50 x 0.15 + 40 x 0.25 + 10 x 0.3 = 40.5 E

Total load for the zone:

T = 40.5 x 1.10 x 1.20 = 53.5 E

Calculation of the number of base stations:

The calculation for the traffic requirement of the base stations seeing 10 channels

N (10) = T (10)/ C10.2 = 53.5 / 6,4 = 8,4 => 9

The total of 9 base stations must be increased by 30% to take into account the requirements of the customer regarding optimization of the running costs.

The final number is 12 base stations.

Example 2:

Hypotheses:

Customer requirement: Full DECT zone to cover with the xBS and with running cost optimization.

Subscriber traffic:

- 200 users at 0.1 E
- 50 users at 0.15 E
- 40 users at 0.25 E
- 10 users at 0.3 E

overlap: At all places, the terminal sees at least 2 base stations.

Setup with slot reservation for emergency call (8 channels)

This data item can be the result of measurements or of a hypothesis.

Calculation

DECT traffic of users in the zone:

T u (11) = 200 x 0.1 + 50 x 0.15 + 40 x 0.25 + 10 x 0.3 = 40.5 E

Total load for the zone:

T = 40.5 x 1.10 x 1.20 = 53.5 E

Calculation of the number of base stations:

The calculation for the traffic requirement of the base stations seeing 10 channels

N (10) = T (10)/ C10.2 = 53.5 / 4.8 = 11,1 => 12

The total of 9 base stations must be increased by 30% to take into account the requirements of the customer regarding optimization of the running costs.

The final number is 16 base stations.

5.1.4.4 Calculation of the 4080/8340 IP-DECT number

Note about capacity:

Max. number of simultaneous calls: 12

Please note that this maximum number of calls is only applicable when the DAP is synchronization source/master. If the DAP is not the synchronization master, the maximum number of simultaneous calls is 11.

Max. number of simultaneous relay calls: 12

Max. number of DAPs per network: 256

Max. number of DAPs with DAPs in Branch Offices: 256

Max. number of simultaneous calls per network with 256 DAPs: 11 x 255 +12 =2817. This depends on the network configuration and available DAP channels.

The terminal traffic capacity is linked to 2 parameters:
- the terminal type which sees 11 channels or 12 channels
- the minimum number of DAPs seen by a terminal at any place in the zone.

Traffic capacity of a terminal C c.b
- Where “c” is the number of channels seen by the terminal
- Where “b” is the number of base stations seen at any place by the terminal

The table below gives approximately the admissible load per DAP with a blocking rate of 1%:

Nr of visible DAPs / **Nr of channels**	**1**	**2**	**3**	**4**
11	C 11.1 ≈ 5.2	C 11.2 ≈ ND *	C 11.3 ≈ ND *	C 11.4 ≈ ND *
12 (only for master)	C 12.1 ≈ 5.9			

* ND: Not Defined

If in a same zone, the users have different terminals which do not see the same number of channels, the calculation must be done as follows:
T is the traffic requirement of the zone and T (11) that of the terminals seeing 11 channels.

The number of DAPs for the requirements of these terminals is if T=T(11):

N (11) = T (11)/ C 11.b

Traffic density calculations must be done to make sure that you have a low blocking probability in the system.
For calculations choose, by default, C11.1 and a blocking probability of 1%.

You can calculate the traffic density as follows:

$$Nbr\ of\ DAPs\ = \frac{Nbr\ of\ Users\ \times \frac{Erlang}{user}}{Max.load\ per\ DAP}$$

Remark: The DAP Manager will distribute the subscription data to one of the DAPs. Distribution has the following characteristics:

The DAP Manager tries to distribute the subscription records equally over the DAPs.

The maximum number of subscription records per DAP is 25.

If the number of DAPs found is N_DAPs for N_Users check that:

N_Users ≤ 25 if N_DAPs = 1 (Not recommended if the DAP is out of service)

N_Users ≤ (N_DAPs -1) x 25 if 1< N_DAPs ≤ 10 (-1 to consider if one DAP is out of service)

N_Users ≤ N_DAPs x 22 if N_DAPs > 10

Example:

In one cell there will be 50 users: 20 high traffic, 15 average traffic and 15 low traffic.

The blocking probability is 1%.

The load will be: (20 x 0.25) + (15 x 0.15) + (15 x 0.1) = 8.75 E

Total load for the zone:

T = 8.75 x 1.10 x 1.20 = 11.5 E

Calculation of the number of DAPs:

The calculation for the traffic requirement of the DAPs seeing 11 channels (400 DECT, 8232 DECT, 8242 DECT)

N_DAPs = N (11) = T (11)/ $C_{11.2}$ = 11.5 / 5.2 = 2.2 => 3

Checking (knowing that 1< N_DAPs=3 ≤10): N_Users=50 ≤ (3-1) x 25 => True =>OK

The total of 3 DAPs must be increased by 30% to take into account the requirements of the customer regarding optimization of the running costs.

Conclusion: **The final number to foresee is 4 DAPs.**

Remark: You need to install the DAPs close to each other.

Note: *If you install some DAPs close to each other for extra traffic density, make sure that the distance between the DAPs is always more than 1 meter and preferably more than 5 meters.*

5.1.4.5 Calculation of the SIP-DECT number

The SIP-DECT support load balancing of the RTP processing (relaying RTP) between base stations in the PARI. Therefore, the limitation in traffic capacity is the number of available channels in a zone.

The SIP-DECT is a 12-slot base station, where one slot is used for air synchronization and 11 slots can be used for traffic. But for traffic calculation, one slot is restricted to BHO (Bearer Handover on the same base station, typical because of interference from other DECT phones in the area), leaving 10 channels for traffic.

All the handsets can see all 12 channels, so from handset point there is no limitation.

The terminal traffic capacity is linked to the parameter:

- the minimum number of base stations seen by a terminal at any place in the zone.

Traffic capacity of a terminal C c.b

- Where “c” is the number of channels seen by the terminal
- Where “b” is the number of base stations seen at any place by the terminal

The table below gives the admissible load per base station with a blocking probability of 1%:

Nr. of visible BS Nr. of channels	1	2	3	4
10 narrow band	C10.1 = 5.0 Erl	C10.2 = 6.4 Erl	C10.3 = 7.0 Erl	C10.4 = 7.5 Erl

The Capacity in erlang is based on the Engset traffic model, with 0.2 Erlang/user and traffic sources adjust to the capacity of the base station(s).

T is the traffic requirement of the zone and T (c) that of the terminals seeing c channels. The number of base stations for the requirements of these terminals is if T=T(x):

N (c) = T (c)/ C c.b

Example 1:

Hypotheses:

Customer requirement: Full DECT zone to cover with the SIP-DECT and with running cost optimization.

Subscriber traffic:

- 200 users at 0.1 E
- 50 users at 0.15 E
- 40 users at 0.25 E
- 10 users at 0.3 E

overlap: At all places, the terminal sees at least 2 base stations.

This data item can be the result of measurements or of a hypothesis.

Calculation

DECT traffic of users in the zone:

T u (10) = 200 x 0.1 + 50 x 0.15 + 40 x 0.25 + 10 x 0.3 = 40.5 E

Total load for the zone:

T = 40.5 x 1.10 x 1.20 = 53.5 E

Calculation of the number of base stations:

The calculation for the traffic requirement of the base stations seeing 10 channels

N (10) = T (10) / C10.2 = 53.5 / 6.4 = 8.4 => 9

The total of 9 base stations must be increased by 30% to take into account the requirements of the customer regarding optimization of the running costs.

The final number is 12 base stations.

5.1.5 Customer wants to replace IBS/RBS bases by xBS or IP-DECT DAPs

Additional bases may be needed due to air synchronization if a customer wants to replace IBS/RBS bases by xBS or IP-DECT DAPs. The following rules based on the number of bases to be replaced give a number of bases or a percentage to be added (valid for classical sites). It considers the parameters concerning the implementation as floors, isolated bases, bases with cable length >> 100 m, …:

If the number of IBS/RBS bases to replace is ≤ 10, up to 1 additional base may be needed.
If the number of IBS/RBS bases to replace is > 10, up to 10% of additional bases may be needed.

6 General rules only for IP-DECT deployment

6.1 DAP to DAP communication

The DAP to DAP communication is used to synchronize the internal clock in the DAPs with each other. This means that a DAP must be able to receive a signal from another DAP.

In the following figure, you see the radio signal around the DAP. This is called the cell.

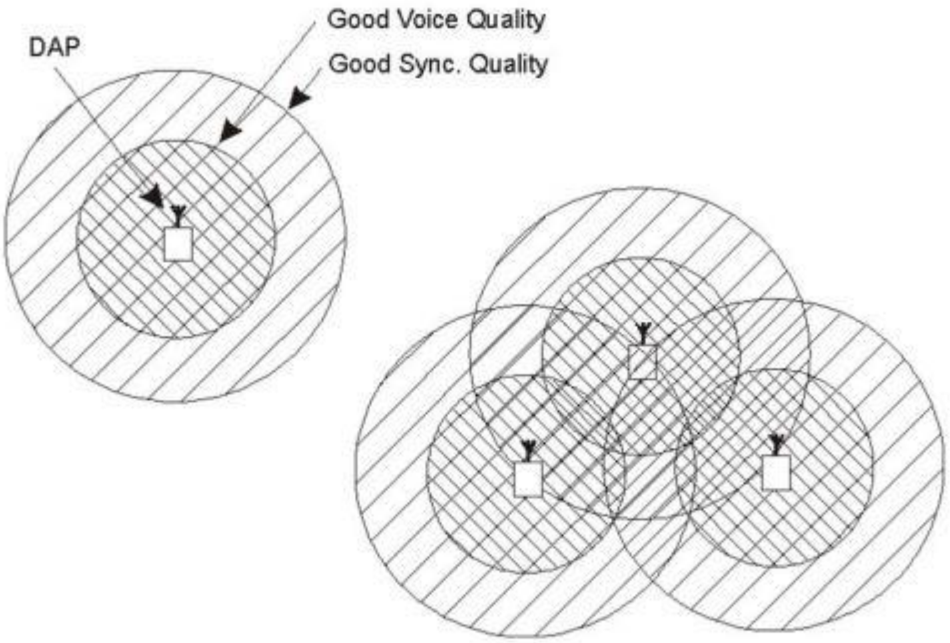


Figure 4: Cells for good Voice Quality and for Synchronization

A DAP (radio) cell can be seen theoretically as a circle around the DAP. In Figure 4 you see two circles around the DAP: one in which you have sufficient radio signal strength for a good voice quality, and another (wider) circle with sufficient signal strength for synchronization. There must always be overlap in the cells to make sure that the voice quality between two DAP cells remains good. The wider cell limit around the DAP will therefore have quite some overlap with the other cell, and will reach to the DAP of the other cell. This means that the DAPs of the overlapping cells receive (weak) radio signals from each other. However, these radio signals are still strong enough for synchronization purposes.

The minimum required signal strength for synchronization is –80 dBm.

The DAP to handset deployment is done with the following deployment engineering rules (same rules for TDM base stations and IP-DECT DAPs)

Type of coverage	Ceiling: Minimum RSSI level between an ALE DECT handset and a base
Easy coverage	- 70 dBm
Tricky coverage	- 60 dBm

An additional margin of 10 dB should be considered (- 60 dBm and - 50 dBm) in the case of a request for a Full DECT QoS level close to fixed (wired) line quality.

For IP-DECT deployment (but not for TDM deployment) each DAP must be able to receive a signal from another DAP.
Compliance with the “DAP to handset” engineering rules given above is much more stringent than the “DAP to DAP” synchronization rules.
A checking of the “DAP to DAP” synchronization requiring the strict minimum signal strength of -80 dBm is necessary.

Notes:

- *As a matter of fact, the synchronization cell limit determines the synchronization cell size. It is highly recommended to execute a Site Survey to determine the cell size for synchronization besides the cell size for speech.*
- *The example in Figure 4 is a worst-case scenario. In practice, a DAP will see more than one other DAP with sufficient signal strength. Out of these “visible” DAPs, it selects the DAP that has the shortest synchronization path to the master.*

6.2 Synchronization Structure

For DAP to DAP synchronization, there must be sufficient signal strength as described in the previous section. When DAPs try to synchronize to each other, there is also a hierarchy. The top-level DAP in this hierarchy is called the Synchronization Master. One DAP must be assigned as Synchronization Master. Assigning a DAP as Synchronization Master must be done after the installation is completed and the system is up and running.
In the following picture, you see a simple theoretical example of a synchronization structure:

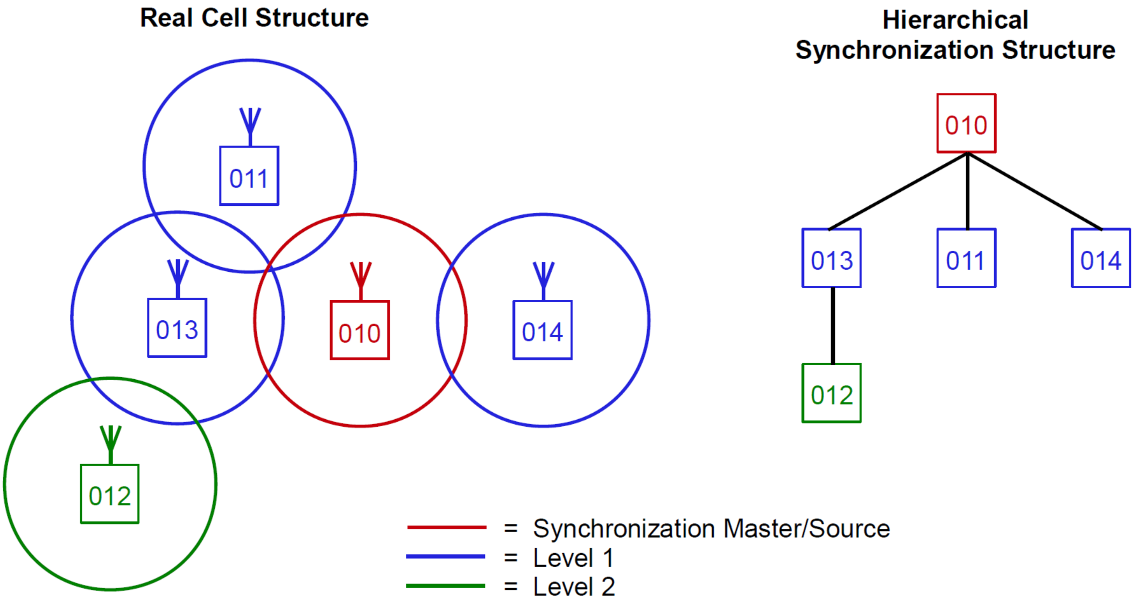


Figure 5: DAP Synchronization Structure

A “Synchronization Cluster” means a group of DAPs synchronizing with each other over the air and therefore allowing seamless handover between the DAPs.
In a simple IP-DECT configuration (see chapter “Simple configuration”), DAPs must be in one Synchronization Cluster, so not split up into more Synchronization Clusters. Seamless handover is supported between all DAPs.
Be aware of the fact, in case of failure of one or several DAPS, that, if the DAP structure consists of more than one group of DAPs (without synchronization path between them) each group has its own synchronization source or “Pseudo Master”.
In a configuration with a main location (where DAPs are deployed constituting one synchronization cluster) and a remote location (where other DAPs are deployed constituting another synchronization cluster), it should not be any overlap in radio signals between the synchronization clusters.
If a handset is between two synchronization clusters, it should see no Access Point for any location (main or remote). So, between two synchronization clusters, in both directions, the RSSI level (which is more significant than a distance for RF considerations) must be **≤ -95dBm**.
Note*: Under conditions of typical cases, the distance between the locations must be at least 1000 meters (This is just an indication but if in doubt it is the RSSI level that counts). When using directional antennas with higher gains than classical antennas, the distance should be more and according to the gain increase.*

When a DAP is started up, it will try to synchronize to a DAP in the environment. Each DAP has its own unique identifier, the RPN (Radio Part Number). The RPN is a hexadecimal three-digit number. A DAP will always try to synchronize to a DAP that has a lower RPN, even if the path goes via a DAP with a higher RPN. A DAP will always try to find the shortest path to the master.

In the figure 5 you see an example of a simple DAP structure. When the system starts up, the DAPs try to synchronize to the DAP with the lowest RPN. For DAP 010 it means that it will become the synchronization source! The DAPs with RPNs 011, 013 and 014 will synchronize to RPN 010. However, RPN 012 will synchronize to RPN 013 although RPN 013 is a higher number. Finding a synchronization source is not limited to one level deep only. DAP 012 knows that DAP 013 is synchronized to a DAP (010) that has a lower number than itself. Therefore DAP 012 will synchronize to DAP 013, because it is aware that DAP 013 gets its source from a DAP with a lower number.

The first DAP that reports itself to the DAP Controller, will get the lowest RPN number. This means that it will become the source for providing the synchronization to the DAP hierarchy.

While doing a Site Survey you must already think of the synchronization structure. In many situations, it will be necessary to install one or more extra DAPs to establish a synchronization path (e.g., between buildings, floors) or to make a synchronization chain (number of DAPs to the master) shorter. If you do so, you should make notes on the map of the building.

Note: *Try to keep the synchronization path to the master (source) as short as possible. (Keep the synchronization structure as flat as possible.) This can be achieved by selecting the master in the middle of a cluster of DAPs.*

Also write down the synchronization structure that is necessary for the site. The engineer who must get the system up-and-running must know the synchronization structure from the Site Survey, to force the system to behave as such. The engineer can do that by (re)arranging the RPN numbers of the DAPs.

After the installation, the engineer should check the actual synchronization structure: See appendix C.

6.3 IP-DECT network rules with OXE

see more details about topologies, DHCP, TFTP server configurations, DAP controler in doc[1] and doc[2]

6.4 IP-DECT Lite network rules with OXO

See more details about DAP-lite in doc[3]

7 General rules only for 8378 DECT IP-xBS deployment

7.1 xBS to xBS communication

The xBS to xBS radio communication is used to synchronize the internal clock in the xBS with each other. This means that a xBS must be able to receive sufficient radio signal from at least another xBS. For reliability of the synchronization, it's better if a xBS can receive sufficient radio signal from two or more xBS.

In the following figure, you see the radio signal around the xBS. This is called the cell.

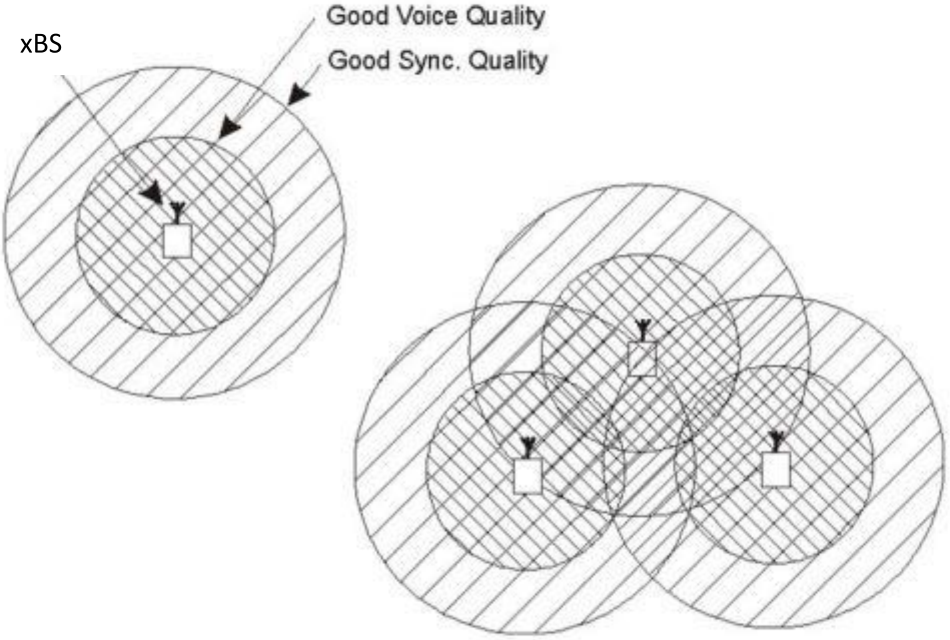


Figure 6: Cells for good Voice Quality and for Synchronization

A xBS (radio) cell can be seen theoretically as a circle around the xBS. In Figure 6 you see two circles around the xBS: one (smaller) in which you have enough radio signal strength for a good voice quality (xBS to Handset coverage area), and another (wider) circle with enough signal strength for synchronization (xBS to xBS coverage area). There must always be overlap of the smaller circles in the cells to make sure that the voice quality perceived by the DECT handset when moving between two xBS cells remains good. The wider cell limit around the xBS will therefore have quite some overlap with the other cell and overlap must reach to the xBS of the other cell to achieve synchronization. This means that the xBS of the overlapping cells receive (weak) radio signals from each other. These radio signals are still strong enough for synchronization purposes.

The minimum required signal strength for synchronization is –80 dBm.

The xBS to handset deployment is done with the following deployment engineering rules (same rules for TDM base stations and IP-xBS and IP-DECT DAPs)

Type of coverage	Ceiling: Minimum RSSI level between an ALE DECT handset and a base
Easy coverage	- 70 dBm
Tricky coverage	- 60 dBm

An additional margin of 10 dB should be considered (- 60 dBm and - 50 dBm) in the case of a request for a Full DECT QoS level close to fixed (wired) line quality.

For IP-xBS deployment (but not for TDM deployment) each xBS must be able to receive a signal from another xBS, what we call “xBS to xBS” radio communication or “xBS to xBS” synchronization. **A site checking of the “xBS to xBS” synchronization requiring the strict minimum signal strength of -80 dBm is necessary.**

Notes:

- *Compliance with the “xBS to handset” engineering rules given above is much more stringent than the “xBS to xBS” synchronization rules.*
- *As a matter of fact, the -80dBm strict minimum signal strength determines the synchronization cell size. A Site Survey is needed to determine the cell size for synchronization (xBS to xBS) besides the cell size for speech (xBS to Handset).*

7.2 General description

The 8378 DECT IP-xBS system requires synchronization between the xBS to secure functionality, especially CHO (Connection HandOver). There are two types of synchronization:

1) Data synchronization which is needed to allow handset to make connection handover between two base stations. The main data synchronized is:
    a. Synchronization tree information
    b. xBS list in the group
    c. Statistics

2) Air synchronization, to secure that all the base stations are synchronized to the same timing (+/- 2 µs) – required to be able to make connection handover (seamless audio) when a handset moves between base stations

Data synchronization is managed by the Data Sync Primary xBS (configured automatically by the call server), so all xBS with same Data Sync Primary xBS will have their data synchronized. The Data Sync Primary xBS and the xBS that is data synchronized by the Data Sync Primary have the same PARI. The maximum group of base station is one PARI (254 base stations). To make CHO, the Base stations need to have the same Data Sync Primary and to be air synchronized.

Air synchronization is managed by the DECT Sync Master. The DECT Sync Master is the highest-level xBS in a synchronization tree of xBS and it provides reference timing to all slaves xBS included in the synchronization tree. In a PARI on a geographical site, there is a single DECT Sync Master in the DECT synchronization tree, providing reference timing to all xBS. This enables the handsets to discover all xBS’s and perform connection handover when moving from one xBS to the other.

The DECT Sync Master can be assigned either automatically or manually:

- Automatically: The system finds the DECT Sync Master and slave xBS’s setup by itself using the DECT synchronization tree algorithm. Automatic assignment (default configuration) is intended and recommended for use in single PARI installation and in BO installations.

- Manually: The installer configures the DECT Sync Master(s) via the administration tool of the CS. Manual assignment is intended only for multi PARI installations with External Synchronization references (only xBS, RBS or IBS can act as External Synchronization references, not IP-DECT) used for inter-PARI synchronization.

7.2.1 xBS synchronization deployment strategy

The basic element for the 8378 DECT IP-xBS system is one PARI system, where all base stations are Air synchronized and Data synchronized. Figure 7 shows a simple one PARI system.

L represents the level which is also the number of hops from the master

Ⓜ Master

Ⓢ Slave

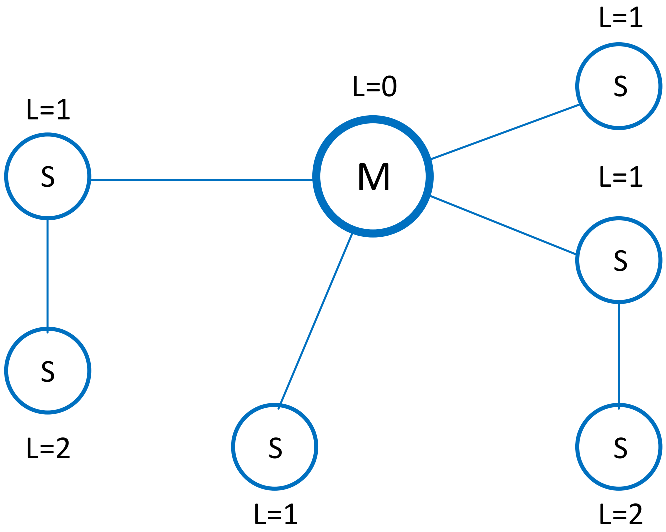


Figure 7: Air synchronization with self-referenced DECT Sync Master

If the installation is limited to one PARI, the site surveys shall be done without any concerns to the air synchronization planification, just follow the site survey guidelines, then the system will automatically create the synchronization between all the base stations in the PARI.

If it is a Multi PARI installation, the synchronization needs to be planned and be part of the site survey. The Sync Highway needs to be configured manually, with Master, External sync BS, Slave and the inter-PARI sync branch.

In the example shown below the xBS shown in the black structure (SYNC HIGHWAY) are manually set up by the installer to ensure a stable DECT sync across PARI’s. The sync tree for the xBS’s outside the synchronization backbone (inter-PARI sync branch) is either automatically (recommended) or manually configured.

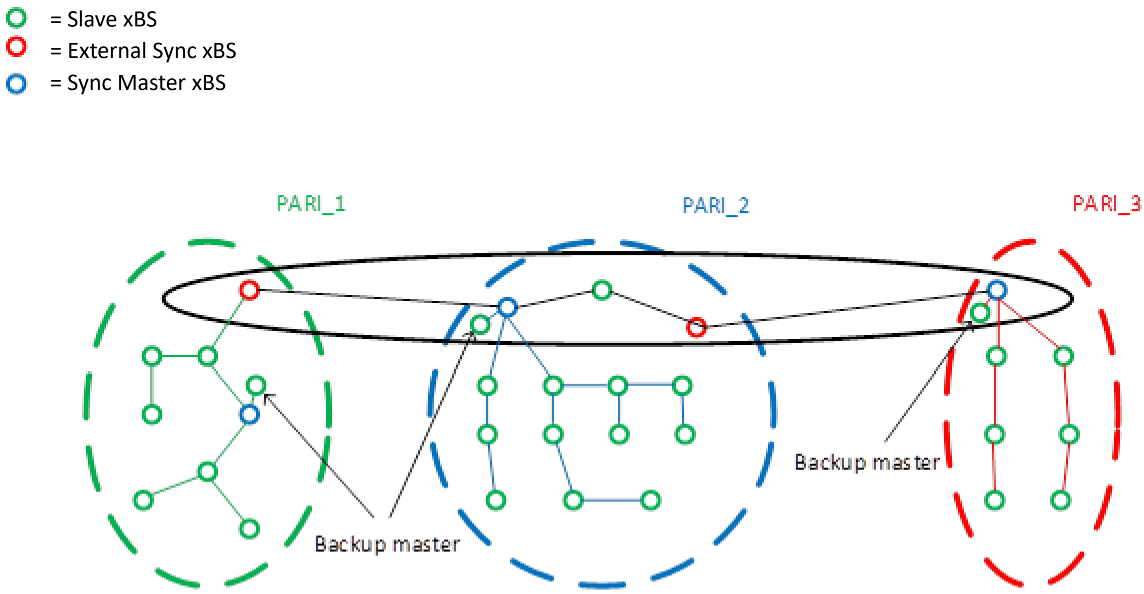


Figure 8 Multi PARI installation

HOPS: the number of hops between two xBS of a synchronization chain is derived by how many xBS part the chain are between the two xBS. To minimize the number of hops between the Sync Master and the farest xBS, the Sync Master needs to be placed central in the deployment.
The total number of hops (hops in PARI_1 + hops in PARI_2 + …) must always be less than 24.
The maximum number of hops per PARI can be configured in the OXE CS, the sum of the different settings must be <=24. The number of hops really used in a deployment can be verified by checking the synchronization trees.

7.2.2 Basic recommendation for synchronization

Doc[4] and Doc[5] give an overview on how to deploy and configure the xBS solution.

7.2.2.1 OXO synchronization deployment strategy

The recommendation for one PARI deployment is to let the xBS system handle the selection of Sync Master and calculate the synchronization tree automatically.

7.2.2.2 OXE synchronization deployment strategy

The recommendation for one PARI deployment is to let the xBS system handle the selection of Sync Master and calculate the synchronization tree automatically.

If it is a Multi PARI installation, the synchronization needs to be planned and be part of the site survey. With more than two PARI the Sync Highway need to be configured manually, with Sync Master and backup Sync Master, External Sync BS and the inter-PARI sync branch.

7.3 Deployment - steps

7.3.1 Deployment OXO or OXE (One PARI)

1) Execute site survey to decide where the base stations shall be placed. See chapter Site survey preparation 11 and Site survey execution 12.
2) One PARI – see section 7.4
3) Verify the installation

7.3.2 Deployment OXE (Multi PARI)

1) Based on the maps / placement of building (and if required execute pre-site survey), define the Sync Highway.
2) Execute site survey to decide where the base stations shall be placed. See chapter Site survey preparation 11 and Site survey execution 12.
3) Multiple PARI – see section 0
4) Verify the installation

7.4 One xBS PARI deployment

To manage all the different types of deployment foreseen, a set of configuration parameters has been developed. The configuration of the system depends on the complexity of the deployment. The following deployment complexities are defined:

1) Easy deployment: All xBS have same PARI, the xBS have a uniform coverage (all xBS belong to the “xBS to xBS” coverage area of minimum 2 or more neighbor xBS) leading to a stable synchronization tree (stable means that all xBS remain permanently in the sync tree. Note that a change of the Sync Master is possible from time to time depending on variations of the radio environment, without affecting performance of the xBS system.
2) Complex deployment: All xBS have same PARI, there can be critical synchronization path(s), or area(s) that can cannot keep the global synchronization tree stable.
3) BO installations: Deployment on different locations.

The deployments and configuration parameters that are used in the different deployment are described below.

7.4.1 Easy deployment

Used for deployments where all the xBS have a uniform coverage (all xBS belong to the “xBS to xBS” coverage area of minimum 2 or more neighbor xBS) leading to a stable synchronization tree.

M Master

S Slave

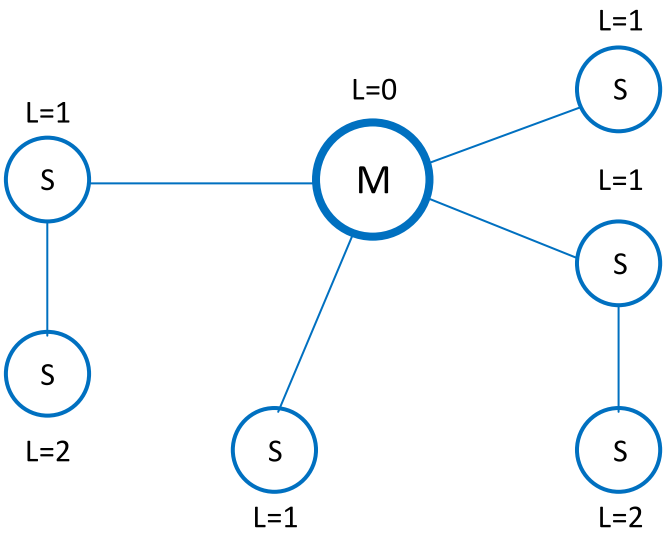


Figure 8: Air synchronization with self-referenced DECT sync master

Note: the figure above shows an example of a synchronization tree but doesn’t show the number of neighbors xBS that a xBS sees.

The automatic sync mode is the default mode for OXE and OXO.

7.4.2 Complex deployment

Used for deployments where there can be critical synchronization path(s), or area(s) that can cannot keep the global synchronization tree stable.

When having a PARI with two (or more) separate DECT synchronization trees relatively close together, e.g. in two buildings next to each other, they will from time to time be able to synchronize to each other. To prevent this the Cluster configuration can be used, which forces the base stations only to synchronize to base stations from the same Sync Cluster(s). Per default every base station belongs to the same Sync Cluster, but this can be configured by the CS.

The Sync Cluster information is used by the base stations while searching to identify which other base stations is in the same Sync Cluster(s). When distributing RSSI values and calculating potential DECT sync trees, only in the same Sync Cluster is considered.

Except from the above the synchronization algorithm used is the same as described under DECT synchronization. The Sync Cluster principle within the same PARI (no handover possible) is illustrated in Figure 9

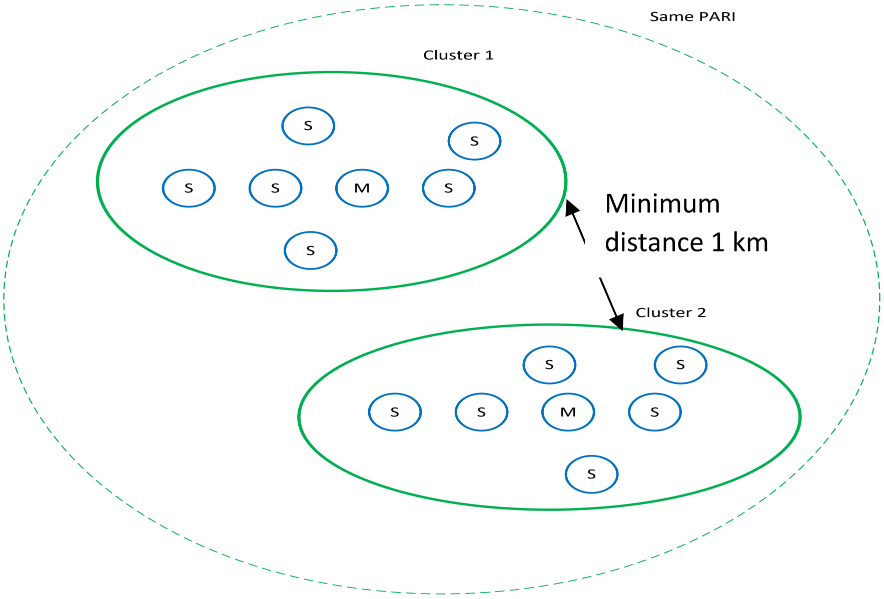


Figure 9 DECT sync tree of two neighbor buildings, where it is not possible to make a stable synchronization

The Sync Cluster principle can also be used for deployments where there is a critical synchronization path. With the Sync clusters the sync tree can be shaped as the installer have planned. This is shown in Figure 10, illustrating how the DECT sync tree would look like.

In this case, there are the possibility of synchronization between the 4 Sync Clusters since Sync Cluster 4 contains base stations which are part of the other 3 Sync Clusters (handover possible). Sync Cluster 4 is manually set up by the installer and is a fixed setup. Which xBS’s that should be in Sync Cluster 1, 2 and 3 are also selected by the installer manually.

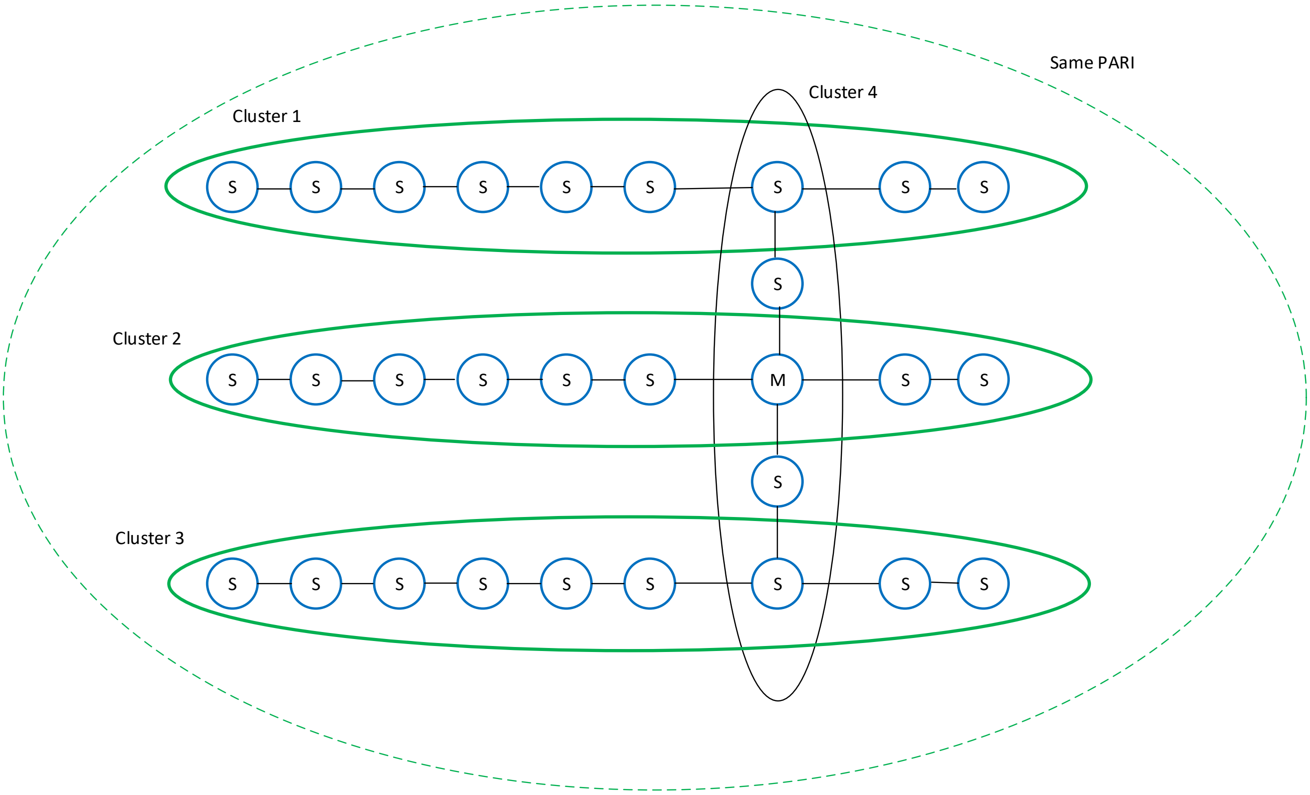


Figure 10: DECT sync tree of building with 3 floors with Sync Clusters ensuring sync via elevator shaft

Settings for Complex deployment: See cluster in OXE doc[2] or in OXO doc[3]

In a configuration where xBS's are deployed constituting one sync cluster and where other xBS's are deployed constituting another sync cluster not synchronized with the first, it should not be any overlap in radio signals between the sync clusters.

If a handset is between two sync clusters, it should see no xBS from any sync cluster. So, between two sync clusters, in both directions, the RSSI level (which is more significant than a distance for RF considerations) must be **≤ -95dBm**.

***Note**: Under conditions of typical cases, the distance between the sync clusters must be at least 1000 meters (This is just an indication but if in doubt it is the RSSI level that counts). When using directional antennas with higher gains than classical antennas, the distance should be more and according to the gain increase.*

7.4.3 Branch office deployment

The branch office deployment shall be used where one PARI is used on different locations. The deployment must not be “nearby”, meaning that a handset must never see both subsystems at the same time. There will be no CHO between two BO installations, only roaming.

Branch offices in 8378 DECT IP-xBS solution are differentiated using the “Site Number Id”. The following is given for 8378 DECT IP-xBS systems and branch offices:

- Each branch office is configured independently and communicates directly with the call server.
- There is no information exchange between the base stations in different branch offices.
- A dedicated Data Sync Primary will be set by the CS for, and physically located at each branch office.

Figure 11 is an illustration of a single-PARI xBS branch office installation on three Sites. Each Site has as an independently configured Data Sync Primary and DECT Sync Master.

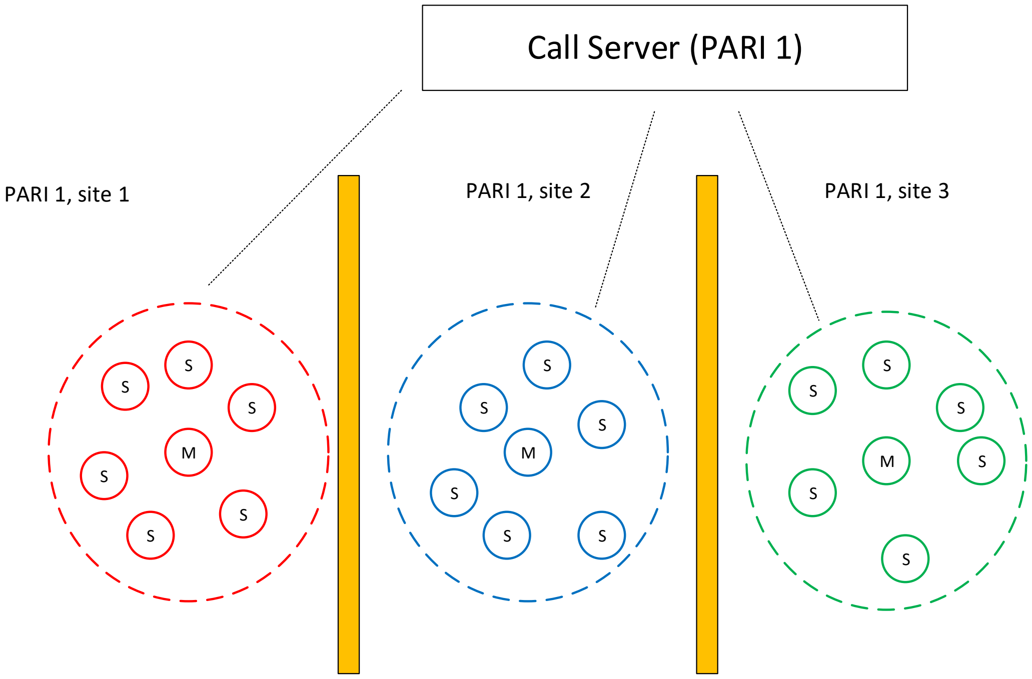


Figure 11: Example of three branch offices with xBS on a single PARI/Call Server. Each office/site has a dedicated Data Sync Primary and different DECT/External synchronization configuration.

Settings for BO: See SITE in OXE doc[2] or in OXO doc[3]

7.5 Multi PARI deployment

Before configuration of the system, the site survey needs to be performed, to get the placements of all Base stations to secure capacity and coverage. Start the Site Survey by estimating the position of the Sync Master. The xBS which should be the Synchronization Master.

The deployment rules are slightly different depending if it is a new installation with only xBS or the deployment is an extension to an existing IBS/RBS installation.

7.5.1 One xBS PARI in adjunction of one TDM PARI

In that case, a Sync Master and a Backup Sync Master xBS must be manually configured with the PARI and RPN of the External Sync BS (the IBS or RBS used as timing reference for air synchronization). The other xBS will synchronize automatically on this Sync Master.

As the setup is an extension to an IBS / RBS installation, the xBS near to the IBS / RBS border needs to be configured as Sync Master for the new installation, mark as the blue circled M in Figure 13.

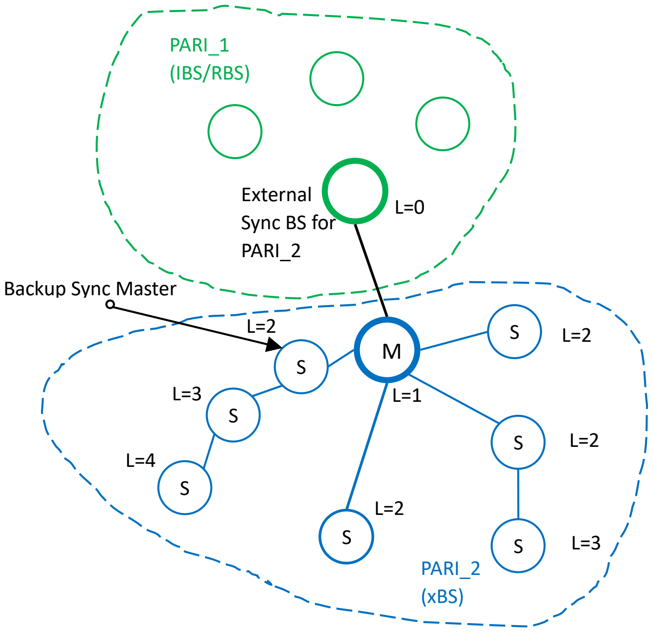


Figure 12: External synchronization configuration (1 TDM PARI, 1 xBS PARI)

Note: The Sync Master that is setup to synchronize to an External Sync BS cannot carry any traffic.

Because external synchronization is used, the Backup Sync Master is mandatory to secure redundancy. This Backup Sync Master needs to be placed near to the Sync Master; it must see the same External Sync BS. The Backup Sync Master could carry traffic not supported by the Sync Master but if the Sync Master fails, the Backup Sync Master will not be able any more to support this traffic. If this is not acceptable, an additional xBS must be placed near Sync Master and Backup Sync Master to support the traffic in all conditions. The Back-up Sync Master will be acting as Sync Master (meaning no traffic) if the original Sync Master is down.

It is highly recommended that the Sync Master and the backup Sync Master can see more than one External Sync BS.

7.5.2 Several xBS PARI in adjunction of one TDM PARI

To deploy Multi PARI installation with more than two xBS PARI, the first step is to define the xBS of the Inter-PARI branch (SYNC HIGHWAY + all SYNC MASTERs), which all are the manually configured synchronization tree between the PARI's and inside each PARI.

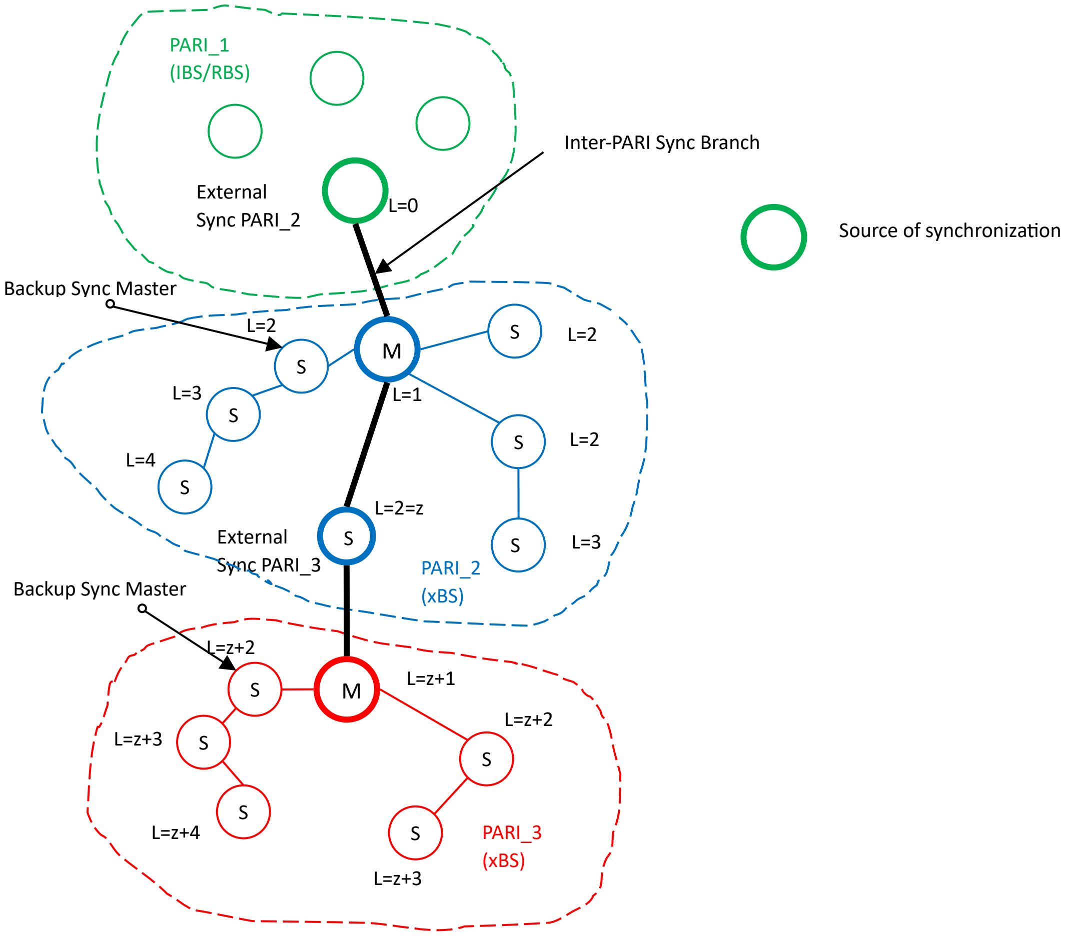


Figure 13: External synchronization configuration (1 TDM PARI, several xBS PARI)

If there are more than one xBS PARI used in addition to an existing IBS or RBS deployment, next is to configure the SYNC HIGHWAY (Inter-PARI Sync Branch) to secure synchronization between the PARI's and to have a constant and known number of hops. This is done by manually configuring the tree from the Sync Master to the External Sync BS for the next xBS PARI. The other xBS not part of the SYNC HIGHWAY will synchronize automatically to the Sync Master or to any other xBS part of the SYNC HIGHWAY.

Then the next xBS PARI shall be configured, starting with the Sync Master, the Backup Sync Master and the Sync Highway (if needed, only if another xBS PARI is following).

Note: The Sync Highway and the Inter-PARI branch must be used only when the placement of the three or more PARIs are in a line, sequentially with the source of synchronization not central.

7.5.3 Two xBS PARI not in adjunction to a TDM PARI

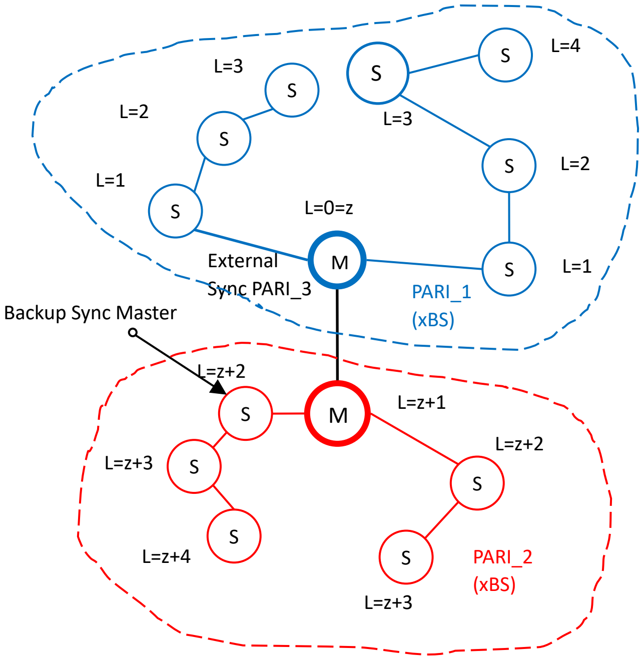
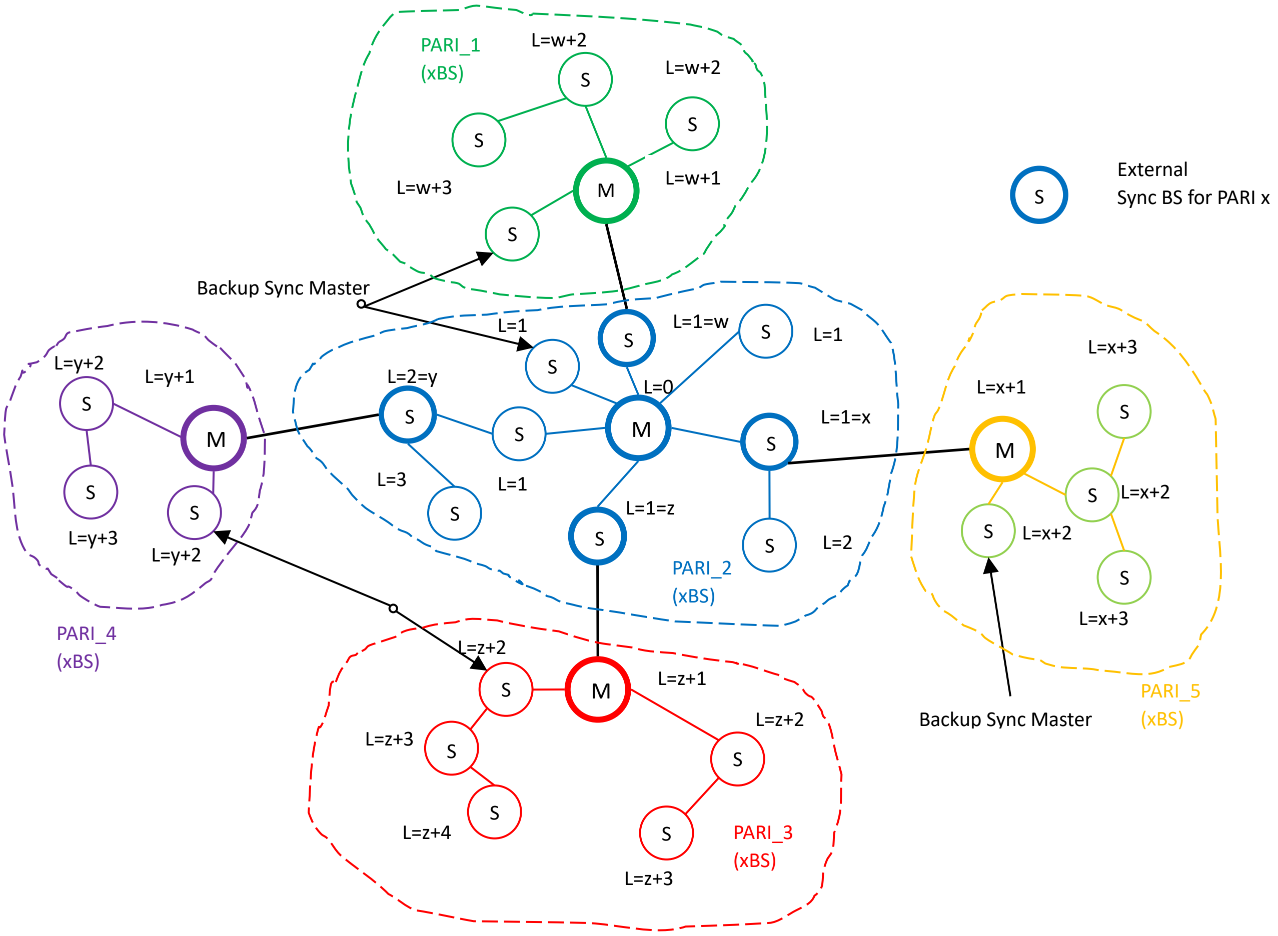


Figure 14: External synchronization configuration (two xBS PARI)

If there are only two xBS PARI and no existing IBS or RBS deployment, only the Sync Master must be manually configured on each PARI and the Backup Sync Master on the second PARI. Both Master will be located at the interface between the two coverages, one synchronizing the second. Doing this will minimize the number of hops. There is no need of any SYNC HIGHWAY with only two xBS PARI and no TDM PARI.

7.5.4 Three or more xBS PARI (not TDM PARI)

The main Sync Master has a central position to minimize the number of hops. In the figure below, it is the Master for PARI_2. A Back-up Sync Master is also configured. They are not configured to synchronize on any external BS, this Sync Master is free running.
The maximum number of hops in PARI_2 can be set first to 12 for example and 12 in each other PARI. If PARI_2 needs less hops than 12, the maximum number of hops in this PARI can be decreased (to 6 for example, if we are sure that less than 6 hops are needed between the Sync Master and the farest xBS in the same PARI) and increase the maximum number of hops to 18 in the others PARI (always as an example).
On each other PARI, two specific xBS at the edge of the PARI must be configured as Sync Master and a Backup Sync Master must be configured at the edge of the PARI, with synchronization to a xBS of an external PARI.
Note: The inter-PARI branch (and Sync Highway) is not used in this example because the PARIs are not placed in line, in a row. It is not possible to configure several Sync-Highway within a single PARI/SITE. But the use of a Sync Highway is only way to guarantee the number of hops between the Sync Master and the xBS used to synchronize the Sync Master of another PARI.



Settings for External synchronization, Sync Master, Backup Sync Master and Sync Highway: See these settings in OXE doc[2]

8 General rules only for 8328 or 8368 SIP-DECT deployment

For the 8328 SIP-DECT refer to doc[6].

8.1 BS to BS communication

The BS to BS communication is used to synchronize the internal clock in the BSs with each other. This means that a BS must be able to receive a signal from another BS so seamless handover from BS to BS can be achieved.

In the following figure, you see the radio signal around the BS. This is called the cell.

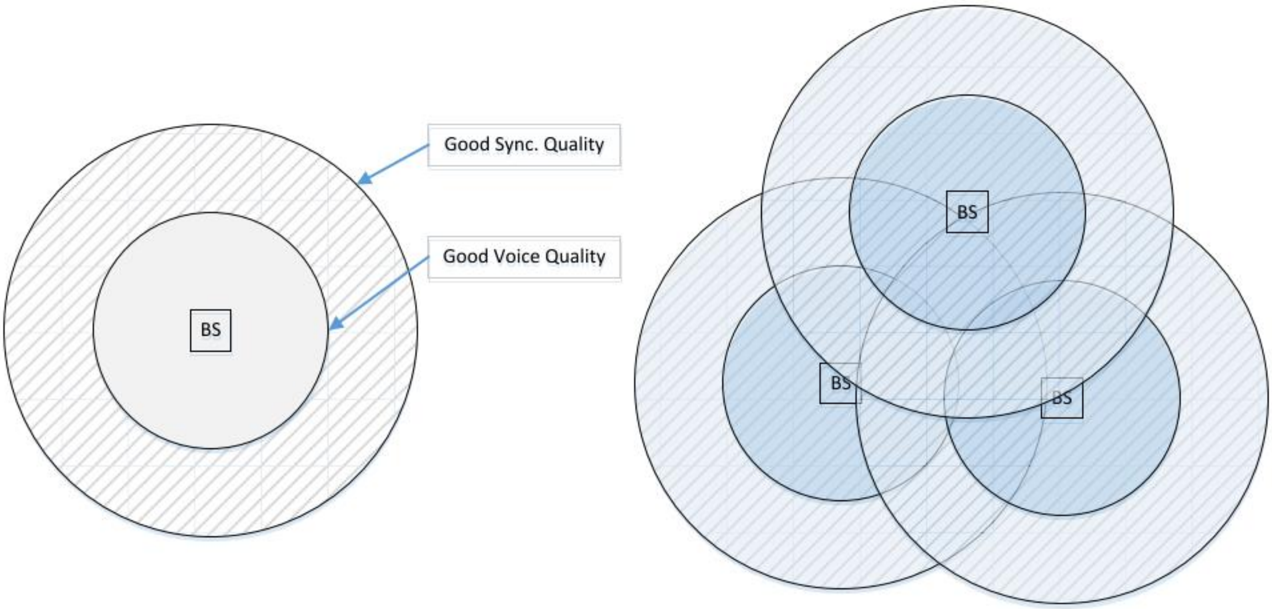


Figure 15 Cells for good Voice Quality and for Synchronization

A BS cell can be seen theoretically as a circle around the BS. In Figure 15 you see two circles around the BS: one in which you have sufficient radio signal strength for a good voice quality, and another (wider) circle with sufficient signal strength for synchronization. There must always be overlap in the cells to make sure that the voice quality between two BS cells remains good. The wider cell limit around the BS will therefore have quite some overlaps with the other cell or cells and will therefore in so cases reach to the BS of the other cell. This means that the BSs of the overlapping cells receive (weak) radio signals from each other. However, these radio signals are still strong enough for synchronization purposes.

The required signal strength for synchronization is better than -75dBm, and never below -80dBm

The BS to Handset deployment is done with the following deployment engineering rules.

Type of coverage	Ceiling: Minimum RSSI level between an ALE DECT handset and a base
Easy coverage	- 70 dBm
Tricky coverage	- 60 dBm

Table 2 Typical Coverage scenarios

An additional margin of 10 dB should be considered (- 50 dBm and - 60 dBm) in the case of a request for a Full DECT QoS level 1 close to fixed line quality.

For BS deployment each BS must be able to receive a signal from another BS.

Compliance with the “BS to HS” engineering rules given above is much more stringent than the “BS to BS” synchronization rules.

A checking of the “BS to BS” synchronization requires a signal strength better than -75 dBm and never below -80 dBm.

Notes:

- As a matter of fact, the synchronization cell limit determines the synchronization cell size. It is highly recommended to execute a Site Survey to determine the cell size for synchronization besides the cell size for speech.
- The example in Figure 15 is a worst-case scenario. In practice, a BS will see more than one other BS with sufficient signal strength. Out of these “visible” BSs, it selects the BS that has the shortest. synchronization path to the DECT Primary.

8.2 Synchronization structure (Multicell system)

8.2.1 The SIP-DECT System is designed with two types of primaries.

- **Data Primary –** Will always be the lowest RPN (typical RPN00) and this is used to sync data to all other base stations in the system. This base station cannot be removed from the Web UI. (RFPI of the Data Primary) but can be physical removed/replaced.
  In case this base station fails or for whatever reason becomes unavailable, the system will continue to function without issues, as all other base stations have the same data, a new data primary is appointed (lowest RPN).
  The Data Primary BS is responsible for driving the initial discovery and onboarding of new BS’s, as well as DECT reconfiguration and DECT Tree synchronization.
- **DECT Primary –** The DECT primary can change based on the DECT tree configuration, and it is possible to have multiple DECT Primary in the same system, depending on the system configuration.

For BS-to-BS air synchronization, there must be sufficient signal quality as described in the previous section. When BSs try to synchronize to each other, there is also a hierarchy. The top-level BS in this hierarchy is called the DECT Primary (or Sync MASTER). One BS must be assigned as DECT Primary. There are different ways to assign the DECT Primary depending on system configuration, “Auto configure DECT sync source tree”. (Enabled/Disabled). It is highly recommended to have this feature enabled and let the DECT system auto configure the DECT tree.

8.2.2 DECT tree auto configuration: (first time startup).

In a multicell system you need to define RPN00, RPN (Radio Part Number, is a hexadecimal two-digit number) this can be done by adding an extension/handset to a BS. A BS with an extension defined will act as a Data Primary BS and can start forming a Multi Cell system.

8.2.3 When DECT tree is formed the first time.

When the DECT tree has been formed the system will start working on finding the most optimal tree structure. A BS will always try to find the shortest path to the DECT Primary.

NOTE: The DECT tree can change over time depending on the environment, A good tree tries to tradeoff between signal quality and tree depth. Due to fluctuations in RSSI, the tree calculation may change on evaluation. Also, the algorithm prefers to keep an existing tree as opposed to changing to a slightly better tree.

8.2.4 Adding/Removing BS from a running system.

If you add or remove one or more BS from a running system, a new DECT tree will automatically be formed using the above-mentioned rules. (Assuming “Auto configure DECT sync source tree” is enabled).

NOTE: If a BS is removed, all BS synchronized to this BS (below it) in the DECT tree will go into searching and try to connect to other BS in the DECT tree. If it is not possible to connect to another BS, BS’s will stay in searching if the setting “Allow multi primaries” is disabled.
(E.g In figure 16 below, if RPN01 is lost, RPN02 will go into searching, as it is out of range of RPN00, RPN03 and RPN04).

If the DECT primary BS is removed or fails, all BS’s will go into “Free running” state and while they select a new DECT primary, this takes 1-2 min. When the new DECT primary is selected BS’s will go into searching mode while forming the new DECT tree, the entire process takes 2-3 min.

NOTE: If you have multiple DECT Primaries only the BS’s in the specific DECT tree will be effected.

8.2.5 Reboot a system.

If a system is rebooted, it will always try to go back to the last existing DECT tree before the reboot. On the multicell system there is a feature to “Save DECT tree” this can be used if you have a very good DECT tree, then you will always have the option to go back to this DECT tree structure, even if this was not the structure right before a reboot.

8.2.6 Synchronization island.

A “Synchronization island” means a group of BSs synchronizing with each other over the air and therefore allowing seamless handover between the BSs.

In a simple BS multicell configuration BSs must be in one Synchronization island, so not split up into more Synchronization islands. Seamless handover is supported between all BSs. BS’s unable to synchronize will stay in searching forever.

You may manually appoint multiple DECT primaries to create multiple synchronizations islands.

NOTE: To allow more than one DECT Primary in one system “Allow multi primary” needs to be enabled.

In case you want the system to auto create multiple DECT primaries, you must enable “Auto create multi primary“ but it is not recommended. Instead of searching forever a BS will be appointed as a new DECT primary.

In a configuration with a main location (where BSs are deployed constituting one synchronization island) and a remote location (where other BSs are deployed constituting another synchronization island), it should not be any overlap in radio signals between the synchronization Islands.

If a handset is between two islands, it should see no BS for any location (main or remote). So, between two islands, in both directions, the RSSI level (which is more significant than a distance for RF considerations) must be **≤ -95dBm**.

Note: Under conditions of typical cases, the distance between the locations must be at least 1000 meters (This is just an indication but if in doubt it is the RSSI level that counts).

8.2.7 Synchronization example.

In the following figure 16, you see a simple theoretical example of a synchronization structure:

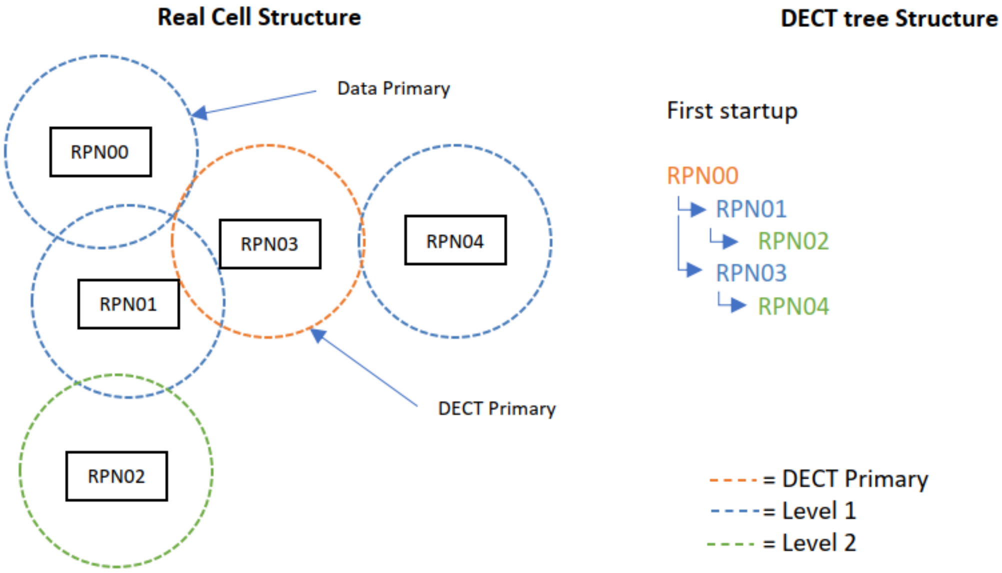


Figure 16 BS Synchronization

In the Figure 16 you see an example of a simple BS structure. First example shows how the BS's are placed in a physical installation, where example 2 and 3 show the DECT tree structure, on first startup and Final DECT tree.
Notice the different between "First startup" and "Final State" RPN00 will start as both Data and DECT Primary, but when the DECT tree have found the shortest path, BS RPN03 will become the DECT Primary. The BSs with RPNs 00, 01 and 04 will synchronize to RPN 03. However, RPN 02 will synchronize to RPN 01.

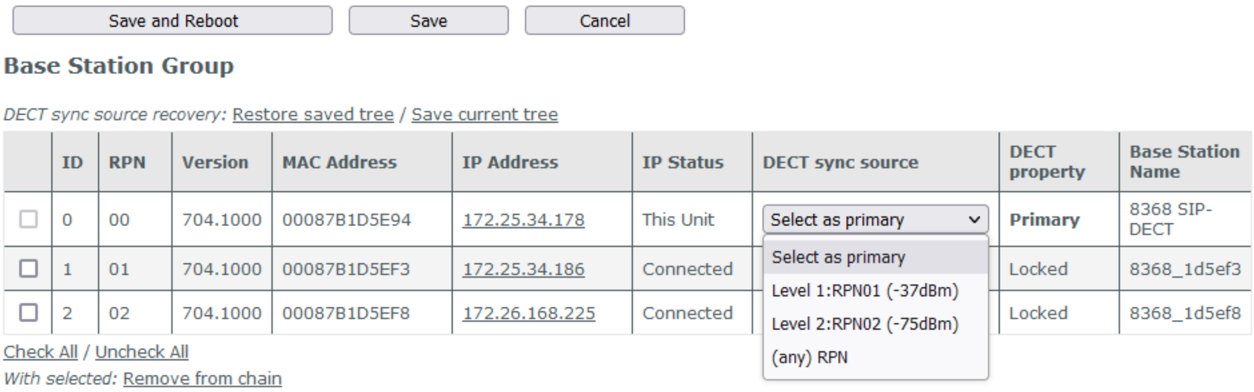
NOTE: The DECT Primary is selected based on different parameters like Sync Levels, RSSI etc.

The total number of Sync level (hops) must always be less than 24.

8.2.8 Manual DECT tree configuration.

It is possible to manually configure the DECT tree, this is NOT recommended.
If a BS becomes out of order, the tree won't be automatically recalculated.

To manually configure the DECT tree, disable the setting "Auto configure DECT sync source tree". When this feature is disabled, you can configure the DECT tree as you want, using the dropdown on the Multi Cell page and press the *Save* button when finished.



Base Station Group

DECT sync source recovery: Restore saved tree / Save current tree

	ID	RPN	Version	MAC Address	IP Address	IP Status	DECT sync source	DECT property	Base Station Name
☐	0	00	704.1000	00087B1D5E94	172.25.34.178	This Unit	Select as primary	Primary	8368 SIP-DECT
☐	1	01	704.1000	00087B1D5EF3	172.25.34.186	Connected		Locked	8368_1d5ef3
☐	2	02	704.1000	00087B1D5EF8	172.26.168.225	Connected		Locked	8368_1d5ef8

Check All / Uncheck All

With selected: Remove from chain

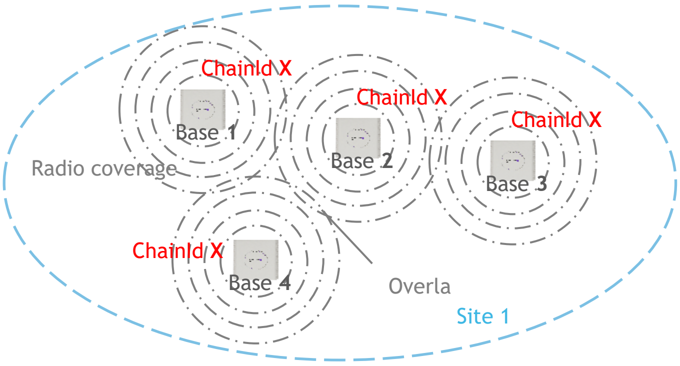
NOTE: Be careful that you don’t create synchronization loops, as this will make the system fail.

Always aim to connect to the BS with best RSSI and create as few Synchronization levels as possible.

8.2.9 Deployment types

To manage all the different types of deployment foreseen, a set of configuration parameters exist.
The configuration of the system depends on the complexity of the deployment.
The following deployment complexities are defined:

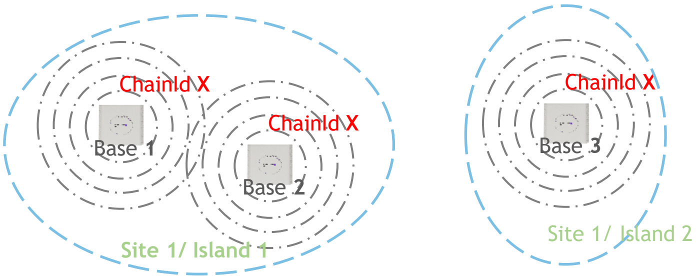
1) Easy deployment: All BS have same Chain Id, the BS have a uniform coverage (all BS belong to the “BS to BS” coverage area of minimum 2 or more neighbor BS) leading to a stable synchronization tree (stable means that all BS remain permanently in the sync tree. Note that a change of the DECT primary (aka Sync Master) is possible from time to time depending on variations of the radio environment, without affecting performance of the BS system.



The automatic sync mode is the default mode

- ”Auto configure DECT sync source tree” setting is enabled
- “Allow multi primary” setting is disabled
- “Auto create multi primary” settings is disabled

2) Complex deployment: All BS have same Chain Id, there can be critical synchronization path(s), or area(s) that can cannot keep the global synchronization tree stable. The synchronization will be split on two or several trees.



When there are areas where a unique synchronization cannot be achieved.

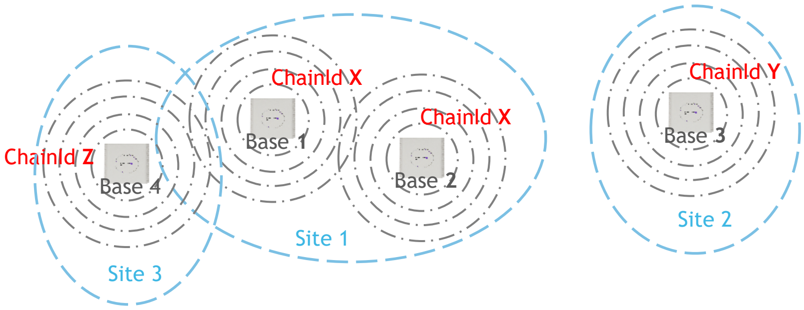
- Areas well separated: the areas are **mandatory** separated by more than 1km.
    - ”Auto configure DECT sync source tree” setting is enabled
    - “Allow multi primary” setting is enabled
    - “Auto create multi primary” settings is enabled

  The synchronization tree is automatically built

- Areas where bases are not enough separated: the areas are separated by less than 1km. Each area will have its DECT primary (aka Sync MASTER) which is manually set, and the sync source of each base is also manually set. This configuration allows to make roaming between the areas (this configuration is NOT recommended).
    - ”Auto configure DECT sync source tree” setting is disabled
    - “Allow multi primary” setting is enabled
    - “Auto create multi primary” setting is disabled

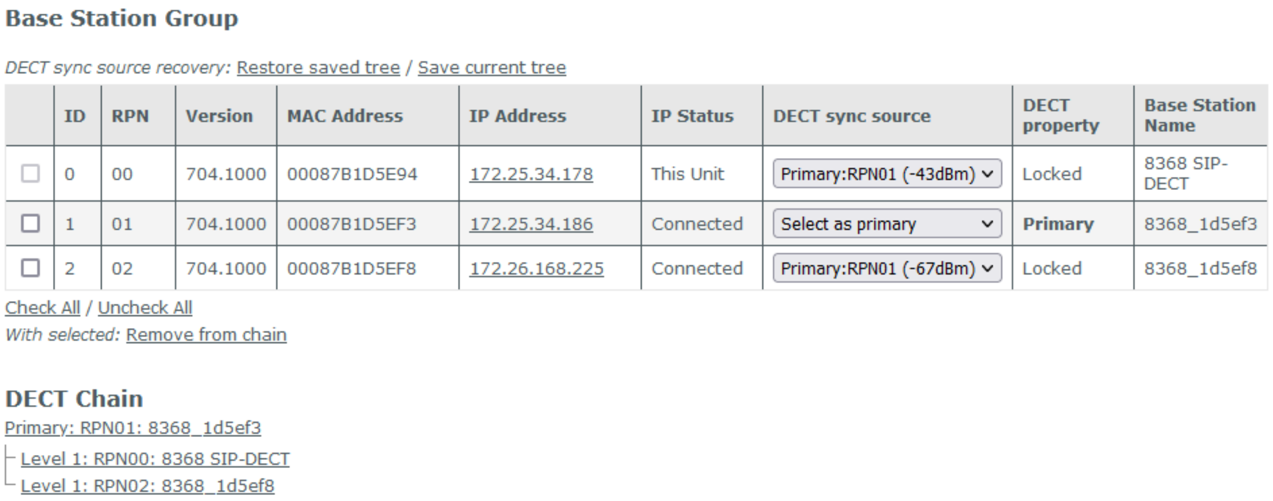
  It is recommended to manage manual sync configuration directly on the WEB interface (click the *Save* button to complete the configuration) rather than using configuration files (in that case make sure than the configuration files set the 3 above settings to the correct value)
  Note: The cluster principle developed on xBS doesn’t exist on SIP-DECT. This means that complex deployments on xBS cannot directly be migrated to SIP-DECT. Instead, BS could be added to achieve a deployment where each base station sees others in a stable manner otherwise a manual configuration is also possible.

3) Deployment with different Chain Ids.
Case where different customers share the same location.
The automatic sync mode is recommended.



8.3 Verify the deployment

The actual synchronization RSSI may be read on the base multi cell (or dual cell) webpage. It is recommended to have a RSSI value most of time better than -75dBm, and never below -80dBm. Below is an example of this, which is a screen shot from the base station web page



Base Station Group

DECT sync source recovery: Restore saved tree / Save current tree

	ID	RPN	Version	MAC Address	IP Address	IP Status	DECT sync source	DECT property	Base Station Name
☐	0	00	704.1000	00087B1D5E94	172.25.34.178	This Unit	Primary:RPN01 (-43dBm)	Locked	8368 SIP-DECT
☐	1	01	704.1000	00087B1D5EF3	172.25.34.186	Connected	Select as primary	**Primary**	8368_1d5ef3
☐	2	02	704.1000	00087B1D5EF8	172.26.168.225	Connected	Primary:RPN01 (-67dBm)	Locked	8368_1d5ef8

Check All / Uncheck All

With selected: Remove from chain

DECT Chain

Primary: RPN01: 8368_1d5ef3
- Level 1: RPN00: 8368 SIP-DECT
- Level 1: RPN02: 8368_1d5ef8

9 Coverage Calculation

9.1 Coverage performance principles

9.1.1 Base station positioning methods

9.1.1.1 Base station distribution

The **general rule is to distribute the base stations over the whole site or zone** to put the mobile handset in a context in which it will see several base stations in the different directions. This is used to guarantee the fact that it will see some base stations better than others.

For some traffic extension or local traffic cases, one-off doubling of the base stations will be authorized by waiving this rule.

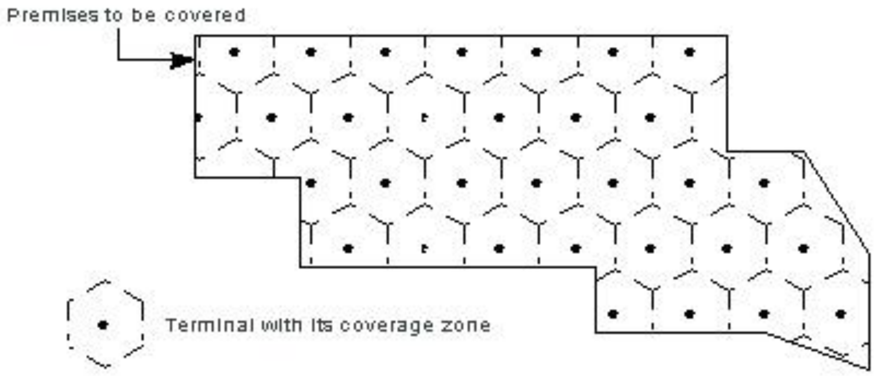
If the traffic is predominant as regards the coverage difficulty, base station meshing will be weaker thereby allowing each mobile handset to see a maximum number of base stations within the predefined field level limits.

9.1.1.2 Measurement and scheduling principle

The first phase is carried out on a two-dimensional horizontal surface; the aim is to obtain a radio level that is better than the coverage ceiling defined according to the type of set and the category of the coverage type. This level is used to retain a margin as regards the mobile handset sensitivity (about -92 dBm) to have greater protection against fading effects (fluctuation in the order of 20 /30 dB).

The measurements obtained must be stable for a minimum of 5 seconds; if this stability cannot be obtained, the lowest level must be used as a basis.

It can be assumed that base station distribution will be done as per a network of hexagonal cells as shown in the schematic below.



The above method assumes:

- that the antennas systems used initially are omnidirectional type. The use of specific antenna systems can be used in special cases that will be dealt with in the antennas chapter, either for quality reasons or to optimize the number of base stations.
- that the base stations on the adjacent floors have no influence.

Initially, when the traffic requirement is not high, the planning can be done without taking into account any inter-floor mutual assistance. Taking this into account can be done in the second phase, allowing optimization of the number of base stations for the coverage.

You must always check the capacity of the final traffic obtained in this way before finalizing any decision.

This optimization phase will comply with the following process:

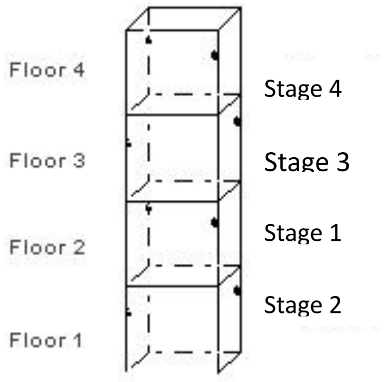
* Measurement of the level on the adjacent floors, remembering the fact that this is not always homogeneous. (Use the least good cases for planning).

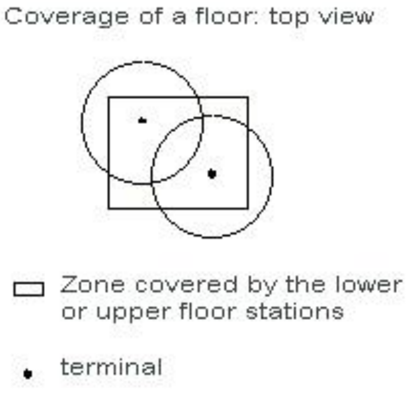
* Proceed with base station position interleaving between the floors if the level is sufficient to have mutual assistance (-60 to -70 dBm depending on the type of coverage retained)

- ♦ Check the efficiency of the mutual assistance between the floors.
  Remark: This position interleaving can be a rule to be applied generally when no geo-localization is needed.

Note: ***When geo-localization is needed the base stations must be the one above the other (no interleaving in order to determine with reliability the floors where the handset of someboby can be**). **So, sites with geo-localization require a specific site survey. The geo-localization needs specific engineering rules with addition of bases (it can be doubled or tripled) and a suitable positioning of the bases.***

The best way to continue is to start the study, when no geo-localization is required, with floor 2, position the radio base stations to obtain floor 2 coverage in line with the previous recommendations, repeat the operation on floor 1 and 3 off-setting the base stations, confirm the final coverage level obtained on floor 2 and then repeat the same base station positions on the even and odd numbered floors.
If the upper floors do not have the same layout as floors 2 and 3, they must also be analyzed by repeating the different stages.
The number of base stations on the first and last floors must be confirmed as they will not have the same mutual assistance capacity.





9.1.2 Theoretical coverage estimation

The coverage can be calculated in advance, before executing a site survey. Calculation is based on the following theory.

The transmission path between the base and the handset is the link. It is subject to radio-propagation related peculiarities, such as:

- Dynamically changing environment;
- Attenuation of the signal, due to fixed and moving objects;
- Multi-path propagation of the signal.

The signal from the transmitter is attenuated in the link before arriving at the receiver. The link consists usually of a path through “free air” and obstacles as walls, etc. Air causes attenuation and the obstacles cause also attenuation, called “insertion loss”. Table 3 gives typical insertion losses of some obstacles.

MATERIAL	INSERTION LOSS (dB)
Glass	2
Glass, metal reinforced grid	10
Glass, metal clad sun guard	10
Wall, indoor, plaster, wood	2
Wall, brick, 10 cm	3.5
Wall concrete, 10 cm	6
Wall concrete, 15 cm	9
Wall concrete, 20 cm, large windows	6
Wall concrete, 40 cm	17
Ceiling, concrete, reinforced, tiles	17 - 20

Table 3 Typical Insertion Losses of some Obstacles

The maximum allowed loss in the link is calculated to comply with -70 dBm for easy coverage and -60 dBm for tricky coverage, under constraints of excellent and good speech quality and the ability for the user to move.

At the map of the building, start at the possible base location. The loss between the base and the handset can be calculated by using the “DECT range calculation versus beta” see Table 4. Add the losses due to the different encountered obstacles (See Table 3).

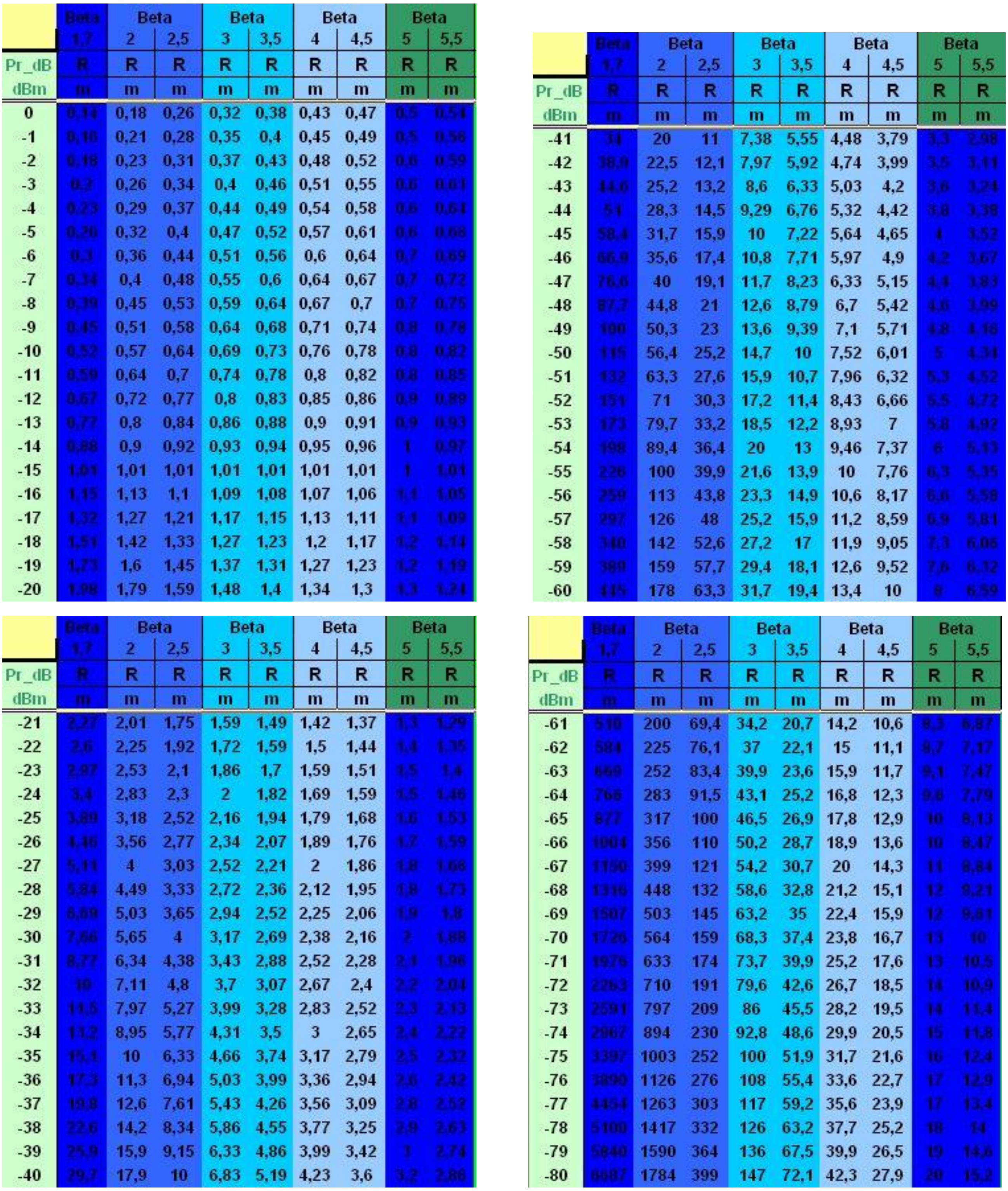
Example: You are in a typical office (=> Beta < 3.5) The coverage is estimated tricky (=> -60 dBm), there are 1 indoor wall (2 dB) and 1 brick wall (3.5 dB) between the base and the handset in a specific direction:

-60 +2 +3.5= -54.5 ≈ -54

In the table if beta = 3.5 and Pr = -54.5 dBm so R = 13 m

This gives an indication of the cell size in that specific direction (R is the radius of the cell). **Note**: For US, instead of -60 dBm use -57 dBm (-60 +3), instead of -70 dBm use -67dBm (-70 +3).

It must be emphasized that outside the calculated range, communication is possible, but a good voice quality is no longer guaranteed!



	Beta	Beta		Beta		Beta		Beta	
	1,7	2	2,5	3	3,5	4	4,5	5	5,5
Pr_dB	R	R	R	R	R	R	R	R	R
dBm	m	m	m	m	m	m	m	m	m
0	0,14	0,18	0,26	0,32	0,38	0,43	0,47	0,5	0,54
-1	0,16	0,21	0,28	0,35	0,4	0,45	0,49	0,5	0,56
-2	0,18	0,23	0,31	0,37	0,43	0,48	0,52	0,6	0,59
-3	0,2	0,26	0,34	0,4	0,46	0,51	0,55	0,6	0,61
-4	0,23	0,29	0,37	0,44	0,49	0,54	0,58	0,6	0,64
-5	0,26	0,32	0,4	0,47	0,52	0,57	0,61	0,6	0,66
-6	0,3	0,36	0,44	0,51	0,56	0,6	0,64	0,7	0,69
-7	0,34	0,4	0,48	0,55	0,6	0,64	0,67	0,7	0,72
-8	0,39	0,45	0,53	0,59	0,64	0,67	0,7	0,7	0,75
-9	0,45	0,51	0,58	0,64	0,68	0,71	0,74	0,8	0,78
-10	0,52	0,57	0,64	0,69	0,73	0,76	0,78	0,8	0,82
-11	0,59	0,64	0,7	0,74	0,78	0,8	0,82	0,8	0,85
-12	0,67	0,72	0,77	0,8	0,83	0,85	0,86	0,9	0,89
-13	0,77	0,8	0,84	0,86	0,88	0,9	0,91	0,9	0,93
-14	0,88	0,9	0,92	0,93	0,94	0,95	0,96	1	0,97
-15	1,01	1,01	1,01	1,01	1,01	1,01	1,01	1	1,01
-16	1,15	1,13	1,1	1,09	1,08	1,07	1,06	1,1	1,05
-17	1,32	1,27	1,21	1,17	1,15	1,13	1,11	1,1	1,09
-18	1,51	1,42	1,33	1,27	1,23	1,2	1,17	1,2	1,14
-19	1,73	1,6	1,45	1,37	1,31	1,27	1,23	1,2	1,19
-20	1,98	1,79	1,59	1,48	1,4	1,34	1,3	1,3	1,24
-21	2,27	2,01	1,75	1,59	1,49	1,42	1,37	1,3	1,29
-22	2,6	2,25	1,92	1,72	1,59	1,5	1,44	1,4	1,35
-23	2,97	2,53	2,1	1,86	1,7	1,59	1,51	1,5	1,4
-24	3,4	2,83	2,3	2	1,82	1,69	1,59	1,5	1,46
-25	3,89	3,18	2,52	2,16	1,94	1,79	1,68	1,6	1,53
-26	4,46	3,56	2,77	2,34	2,07	1,89	1,76	1,7	1,59
-27	5,11	4	3,03	2,52	2,21	2	1,86	1,8	1,66
-28	5,84	4,49	3,33	2,72	2,36	2,12	1,95	1,8	1,73
-29	6,69	5,03	3,65	2,94	2,52	2,25	2,06	1,9	1,8
-30	7,66	5,65	4	3,17	2,69	2,38	2,16	2	1,88
-31	8,77	6,34	4,38	3,43	2,88	2,52	2,28	2,1	1,96
-32	10	7,11	4,8	3,7	3,07	2,67	2,4	2,2	2,04
-33	11,5	7,97	5,27	3,99	3,28	2,83	2,52	2,3	2,13
-34	13,2	8,95	5,77	4,31	3,5	3	2,65	2,4	2,22
-35	15,1	10	6,33	4,66	3,74	3,17	2,79	2,5	2,32
-36	17,3	11,3	6,94	5,03	3,99	3,36	2,94	2,6	2,42
-37	19,8	12,6	7,61	5,43	4,26	3,56	3,09	2,8	2,52
-38	22,6	14,2	8,34	5,86	4,55	3,77	3,25	2,9	2,63
-39	25,9	15,9	9,15	6,33	4,86	3,99	3,42	3	2,74
-40	29,7	17,9	10	6,83	5,19	4,23	3,6	3,2	2,86
-41	34	20	11	7,38	5,55	4,48	3,79	3,3	2,98
-42	38,9	22,5	12,1	7,97	5,92	4,74	3,99	3,5	3,11
-43	44,6	25,2	13,2	8,6	6,33	5,03	4,2	3,6	3,24
-44	51	28,3	14,5	9,29	6,76	5,32	4,42	3,8	3,38
-45	58,4	31,7	15,9	10	7,22	5,64	4,65	4	3,52
-46	66,9	35,6	17,4	10,8	7,71	5,97	4,9	4,2	3,67
-47	76,6	40	19,1	11,7	8,23	6,33	5,15	4,4	3,83
-48	87,7	44,8	21	12,6	8,79	6,7	5,42	4,6	3,99
-49	100	50,3	23	13,6	9,39	7,1	5,71	4,8	4,16
-50	115	56,4	25,2	14,7	10	7,52	6,01	5	4,34
-51	132	63,3	27,6	15,9	10,7	7,96	6,32	5,3	4,52
-52	151	71	30,3	17,2	11,4	8,43	6,66	5,5	4,72
-53	173	79,7	33,2	18,5	12,2	8,93	7	5,8	4,92
-54	198	89,4	36,4	20	13	9,46	7,37	6	5,13
-55	226	100	39,9	21,6	13,9	10	7,76	6,3	5,35
-56	259	113	43,8	23,3	14,9	10,6	8,17	6,6	5,58
-57	297	126	48	25,2	15,9	11,2	8,59	6,9	5,81
-58	340	142	52,6	27,2	17	11,9	9,05	7,3	6,06
-59	389	159	57,7	29,4	18,1	12,6	9,52	7,6	6,32
-60	445	178	63,3	31,7	19,4	13,4	10	8	6,59
-61	510	200	69,4	34,2	20,7	14,2	10,6	8,3	6,87
-62	584	225	76,1	37	22,1	15	11,1	8,7	7,17
-63	669	252	83,4	39,9	23,6	15,9	11,7	9,1	7,47
-64	766	283	91,5	43,1	25,2	16,8	12,3	9,6	7,79
-65	877	317	100	46,5	26,9	17,8	12,9	10	8,13
-66	1004	356	110	50,2	28,7	18,9	13,6	10	8,47
-67	1150	399	121	54,2	30,7	20	14,3	11	8,84
-68	1316	448	132	58,6	32,8	21,2	15,1	12	9,21
-69	1507	503	145	63,2	35	22,4	15,9	12	9,61
-70	1726	564	159	68,3	37,4	23,8	16,7	13	10
-71	1976	633	174	73,7	39,9	25,2	17,6	13	10,5
-72	2263	710	191	79,6	42,6	26,7	18,5	14	10,9
-73	2591	797	209	86	45,5	28,2	19,5	14	11,4
-74	2967	894	230	92,8	48,6	29,9	20,5	15	11,8
-75	3397	1003	252	100	51,9	31,7	21,6	16	12,4
-76	3890	1126	276	108	55,4	33,6	22,7	17	12,9
-77	4454	1263	303	117	59,2	35,6	23,9	17	13,4
-78	5100	1417	332	126	63,2	37,7	25,2	18	14
-79	5840	1590	364	136	67,5	39,9	26,5	19	14,6
-80	6687	1784	399	147	72,1	42,3	27,9	20	15,2

Table 4 DECT Range calculation versus beta (Pe=23dBm)

***Note**: For US, the distance (R) corresponds at “Pr_dB + 3” in* Table 4.

For IP-DECT only: Start the Site Survey by estimating the position of the Synchronization Master. The DAP which should be the Synchronization Master (DAP with lowest RPN) should be placed in the middle of a site or building(s)!

Try to install xBS or DAPs in open areas, like corridors, halls (preferably in the middle). This ensures a better propagation to other xBS or DAPs.

Note: *For synchronization between xBS or between DAPs, the signal propagation through the floors can be used.*

The result of this coverage calculation should be a map with possible xBS or DAP positions. Now the cell boundaries must be determined by walking around and doing measurements. Therefore, tools are required. This is explained in chapters 11 - Site survey preparation and 12 - Site survey execution.

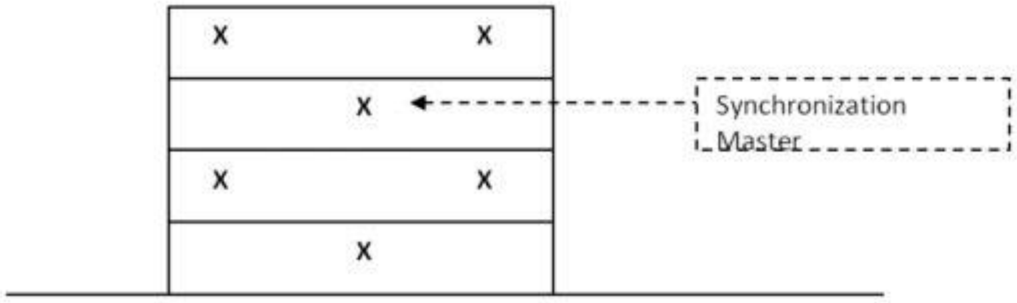


Figure 17: Example of Synchronization Master in the middle of the Building

9.1.3 TDM US coverage

US IBS NG base stations work in odd mode (using odd timeslots) **or in even mode** (using even timeslots) **according to the RPN value** (Odd or even).
For reasons of regulation (FCC Part 15 Subpart D Section 15.323 c5) **two US base stations at least** (One working in **odd** mode and one working in **even** mode) **must be installed and operational for each US deployment.**

Remarks*: It is recommended to alternate odd and even base stations in the hexagonal cells of the networks.*

Except for the US region, all the other regions (EU, CH and SA) currently work with IBS NG base stations in odd mode.
RPN stands for Radio fixed Part Number.

9.1.4 Antennas and accessories

One of the parameters for optimal coverage of a specified zone is, apart from the position of the base station, the type of antennas emission.

Two types of antennas can be used: Omnidirectional and directional.
Directive antennas can be used when:

- the complexity of the coverage forces us to use only a very small part of the theoretical zone obtained by omnidirectional antennas and, as a result, multiply their number significantly.
- the zone to cover is very long as regards its width (tunnel, ship, long corridor, etc.)
- zone separation is necessary, for example: to limit the Campus effect risks

If a site has very high traffic with a requirement for high frequency re-use, spray type antennas systems must be used.

The table below details the main antennas used at present, selected as per the OXE operating manual.

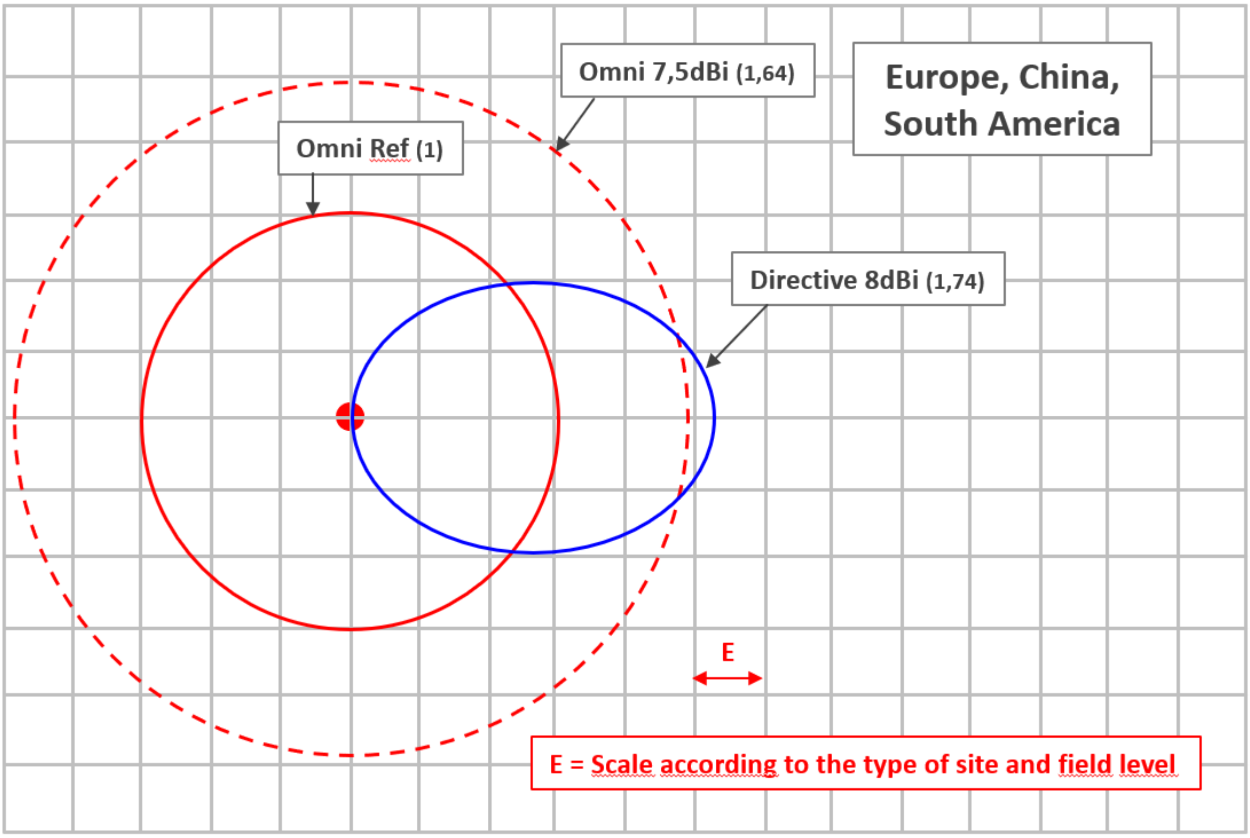
Type	Opening angles	Uses	Recommended positioning
2.15 dBi omni-antenna (default antennas)	V=80^0 H=360^0	Large hall(s) with little traffic, open space(s), ordinary offices	Clear space that is as visible as possible, away from obstacles (>3m), in the center of the area to cover and 20 cm from the ceiling
7.5dBi omni-antenna	V=17^0 H=360^0	Large outside area such as a car park, not recommended for indoor use.	Clear space, away from obstacles, not too high (<5m) because the vertical opening is limited.
8 dBi directional antenna with left circular polarization 8 dBi directional antenna with right circular polarization	V=70^0 H=70^0	Indoors in rectangular corridor and metallic environments (such as a hangar) to minimize polarization rotations losses (V to H or H to V) due to reflections (3 dB loss instead of 20 to 30 dB)	In all types of space: Ceiling, wall, poles, etc. Can be tilted to direct the energy to the required area.
17 dBi Shrouded YAGI (not in the ALE catalog)	V= 24° H= 25°	For long distances between two buildings	Poles, accurate positioning must be performed.

Note 1: For Europe, China and South America zone, the antenna gain must be $\leq$ 12 dBi.

Note 2: For the US zone, if the antenna gain exceeds 3 dBi by n dB, the peak emitted power must be reduced by the same number n dB.
E.g.: For an antenna gain of 8 dBi, the transmitted power must be reduced by at least 5 dB by adding a 5 dB attenuator in series with the antenna for example or when using xBS then reduce the emission power by 5 dB.

The difference in antennas coverage is shown in the schematics given hereafter:

Antennas coverage for EUROPE, CHINA and SOUTH AMERICA



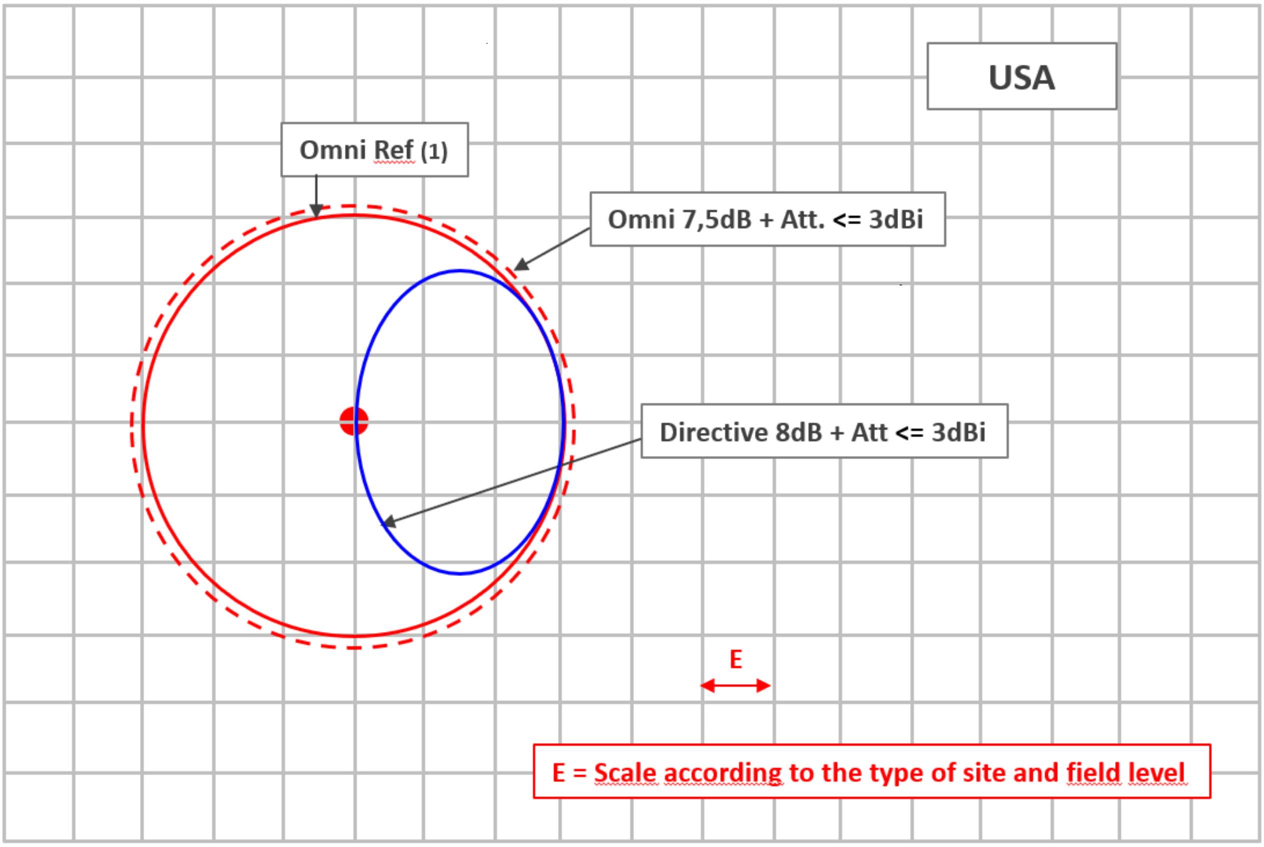
Europe, China and South America	For a field level of -60 dBm	For a field level of -70 dBm
Outdoors environment	E =40m => **r=120m**/standard ant.	E =130m => **r=340m**/standard ant.
Indoors clear space	E =14m => **r=40m**/standard ant.	E =34m => **r=100m**/standard ant.
Indoors office space	E =6.5m => **r=19m**/standard ant.	E =13m => **r=38m**/standard ant.
Difficult site (Plant, etc.)	E =4.5m => **r=13,5m**/standard ant.	E =8m => **r=24m**/standard ant.

N.B.: Tolerance is ~20%.

These elements may be used to check the number of base stations obtained according to the measurements by providing an order of scale.

Antennas coverage for the US

Horizontal view



N.B.: Directive antennas for the US are not used to increase the range but to reduce the reception of reflected waves (multi-trajectory in difficult environments).

US	For a field level of -60 dBm	For a field level of -70 dBm
Outdoors environment	E =28m => **r=82m**/standard ant.	E =77m => **r=230m**/standard ant.
Indoors clear space	E =10m => **r=30m**/standard ant.	E =25m => **r=75m**/standard ant.
Indoors office space	E =5m => **r=15m**/standard ant.	E =10m => **r=30m**/standard ant.
Difficult site (Plant, etc.)	E =3.7m => **r=11m**/standard ant	E =6.7m => **r=20m**/standard ant.

N.B.: Tolerance is ~20%.

These elements may be used to check the number of base stations obtained according to the measurements by providing an order of scale.

N.B.: For the US zone, $E_{\_US} = E_{\_EU}$ *x 69% since* $Pe_{\_U\,S} = Pe_{\_EU}$ *–4dB.*
Given this reduction in power, ***the number of base stations per*** m^2*, without considering the traffic (just considering the geographic coverage****), is, theoretically, to be multiplied by about 2*** *(or 2.0± 0.5)* ***for the US zone*** *as regards the number of base stations that would be obtained in the Europe, China and South America zones with the same audio quality.*

⇒ **With a reduction in the emitted power of 4 dB, the coverage is reduced by a factor of about 2** *(or 2.0± 0.5)***.**

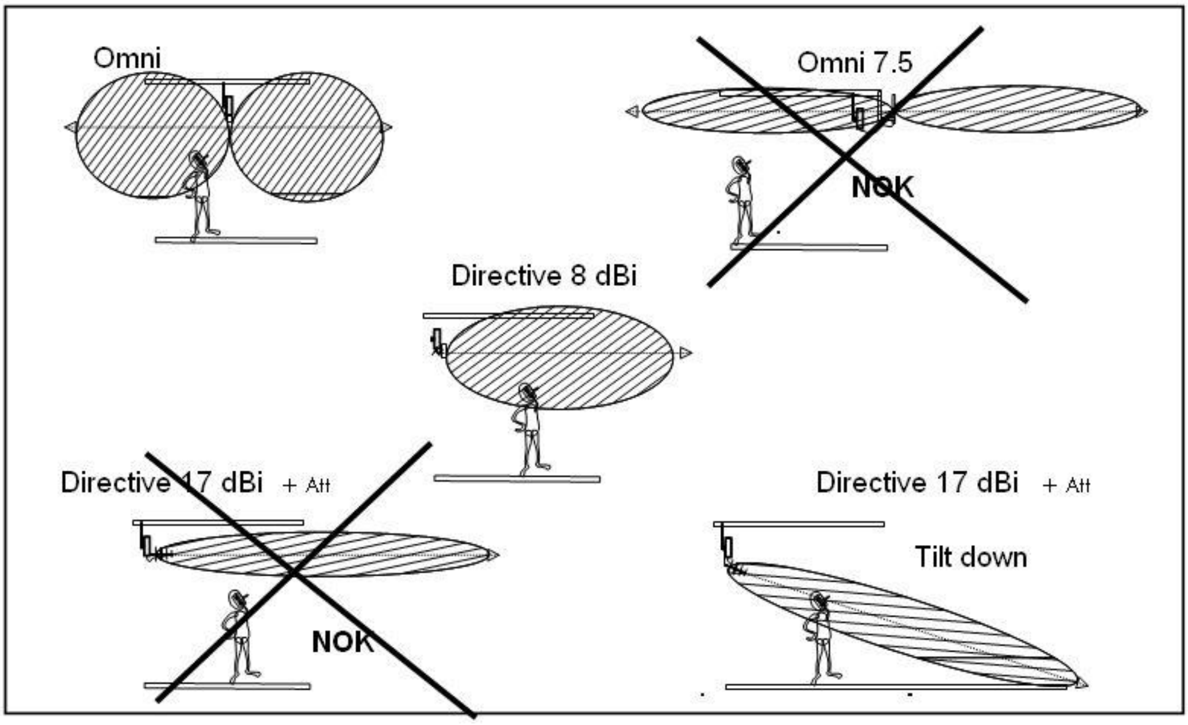
⇒ **With 5 frequencies instead of 10, the traffic reduction factor is in the order of 2.**

⇒ **A low traffic US coverage requires about twice (1.5 min.) more base stations than a low traffic Europe coverage.**

⇒ **A high traffic US coverage required about 4 times (3 min.) as many base stations as a high traffic Europe coverage.**

Vertical view of the coverage zone of different antennas

(See Tech Comm.: TC0213)



9.1.4.1 2.15 dBi Gain antenna (omni-directional)

This the standard antenna which is mounted on the base stations by default on the indoor and the outdoor versions. It is a linear vertical antenna.

9.1.4.2 7.5 dBi Gain antenna (omni-directional)

Usage recommendations:

This is an antenna which has a high level of directivity in the vertical plane and therefore has a very narrow lobe (17° at 3 dB).

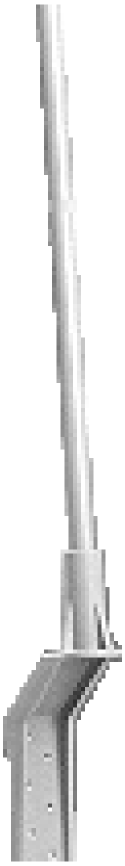
Use outside in a direct line of view. The antenna must be at least 20 λ away from any obstacles in the centre of the area to be covered.

It must be limited to a maximum of 4/6m in height.

Typical usage: outside car park, square, gardens, esplanade, etc.

Confirm the reference 3BD52212AA availability in the DECT Accessories datasheet

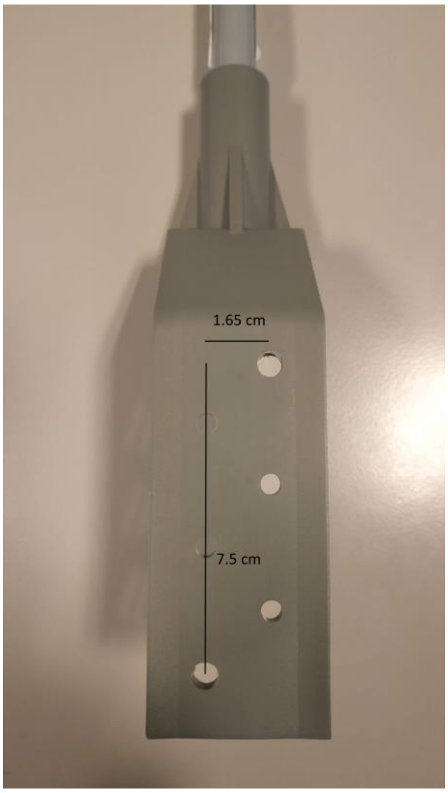
Frequency band	1880-1930 MHz
VSWR	1.5
Impedance	50 ohms
Polarization	**Linear Vertical**
Gain	7.5 dBi
3 dB beamwidth vertical	17°
3 dB beamwidth horizontal	360°
Dimensions:	
Height	736 mm
Diameter	15 mm
Weight	235 g
Windload	160 km/h
Temperature	-30°C to +55 °C
Connector	SMA female
Associated accessories	None



CAUTION

The use of this antenna requires the addition of the "DC Blocking" module on 4070 IBS hardware or 4070 RBS to avoid a DC short-cut.

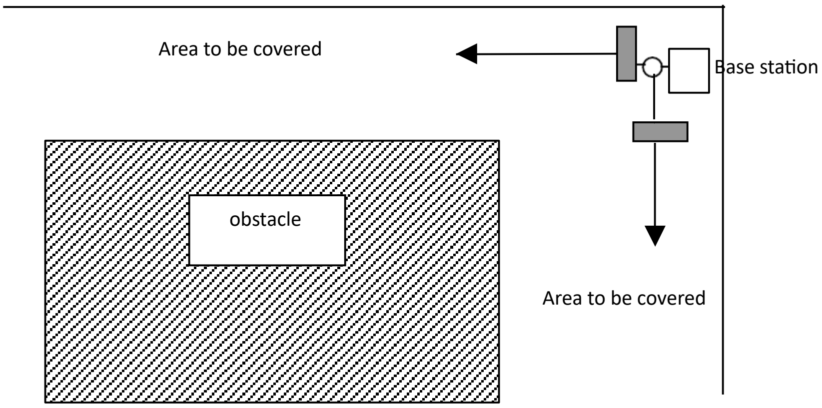
7.5 dBi antenna drilling plan:



9.1.4.3 8 dBi Gain right circular antenna (directional)

Usage recommendations:

This antenna may be used very effectively both indoors and outdoors. This antenna allows the coverage area to be adapted; for example: corridor, alleys, roads, etc...
Coupling is possible.



Because of its circular polarization, this antenna is **mandatory** in indoor areas which are subject to high levels of interference from deep fading and multiple reflection (factories, foundries, etc.).

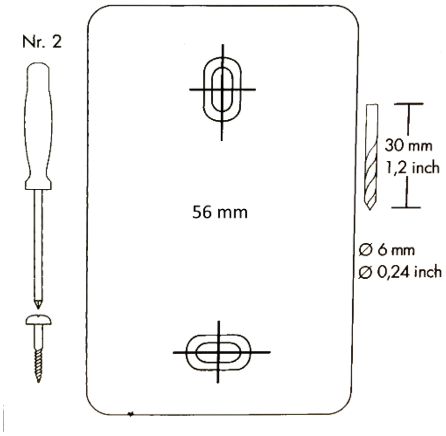
Example of assembly in 90° coverage

It may be used outdoors, for example, between metal buildings which form a corridor.

Confirm the reference 3BD52205AA availability in the DECT Accessories datasheet

Frequency band	1850-1990 MHz
VSWR	1.5
Impedance	50 ohms
Polarization	**Circular (right)**
Gain	8.0 dBi
3 dB beamwidth vertical	70°
3 dB beamwidth horizontal	70°
Front to Back ratio	20 dB
Dimensions	101x95x32 mm
Weight	115 g
Windload	200 km/h
Temperature	-40 °C to + 80 °C
Connector	SMA female
Associated accessories	Wall mounting material included

<u>8dBi antenna drilling plan for direct mount on a wall</u>:



9.1.4.4 8 dBi Gain left circular antenna (directional)

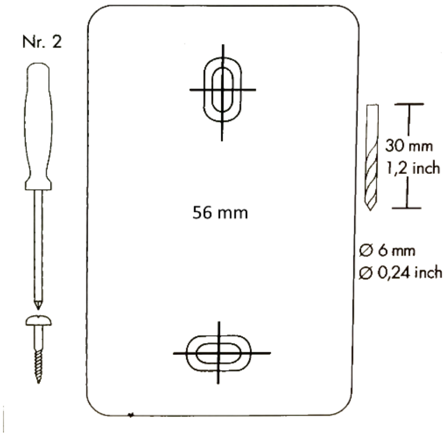
Usage recommendations:

See the right circular antenna usage recommendations.

Confirm the reference 3BD52206AA availability in the DECT Accessories datasheet

Frequency band	1850-1990 MHz
VSWR	1.5
Impedance	50 ohms
Polarization	**Circular (left)**
Gain	8.0 dBi
3 dB beamwidth vertical	70°
3 dB beamwidth horizontal	70°
Front to Back ratio	20 dB
Dimensions	101x95x32 mm
Weight	115 g
Windload	200 km/h
Temperature	-40 °C to + 80 °C
Connector	SMA female
Associated accessories	Wall mounting material included

8dBi antenna drilling plan for direct mount on a wall:



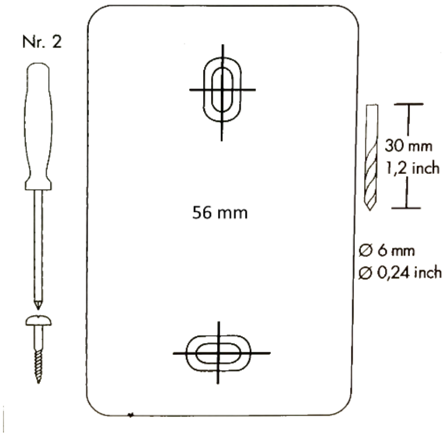
9.1.4.5 8 dBi Gain dual antenna (linear, directional, indoor)

<u>Usage recommendations</u>: for indoor use where gain is needed

Confirm the reference 3BN67185AA availability in the DECT Accessories datasheet

Frequency band	1880-1930 MHz
VSWR	1.5
Impedance	50 ohms
Polarization	**+/- 45° slant**
Gain	8.0 dBi
3 dB beamwidth vertical	75°
3 dB beamwidth horizontal	85°
Front to Back ratio	12 dB
Port isolation	30 dB
Dimensions	101 x 95 x 32 mm
Weight	110 g
Windload	160 km/h
Temperature	-40 °C to + 80 °C
Connector	2x TNC female
Associated accessories	Delivered with two cables TNC male / SMA female, 50 cm. Wall mounting material included.

<u>8dBi antenna drilling plan for direct mount on a wall</u> :



9.1.4.6 SMA DC blocking capacitor

Case of use

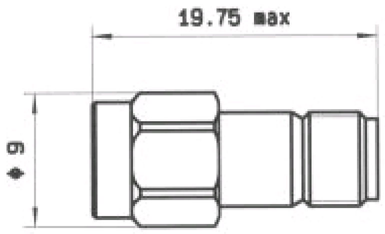
This module is to be inserted in series with the coaxial cable into the level of the antenna each time there is a risk of loop in DC.

The 7.5 dBi omni-antenna "vertical" requires the DC Blocking module when connected on 4070 RBS or 4070 IBS hardware (not on the 8379 IBS hardware).

The use of attenuator module for example would require also the installation of this DC Blocking module.

It is necessary to insert one of them on each antenna of the base station.

Technical characteristics



General tolerances: +/- 0.5 mm

R F CHARACTERISTICS

FREQUENCY RANGE : 1 - 12.4 GHz
IMPEDANCE : 50 Ohms

FREQUENCY	1 - 4 GHz	4 - 12.4GHz
V.S.W.R	<= 1.10	<= 1.25
INSERTION LOSS	<= 0.25 dB	<= 0.5 dB

MAIN LINE MAXIMUM DC VOLTAGE : 250 V
TYPICAL CAPACITANCE : 100 pF
AVERAGE POWER at 25 °C : 25 W

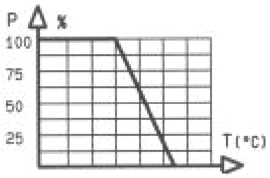
MECHANICAL CHARACTERISTICS

CONNECTORS : SMA male/female per MIL-C 39012
WEIGHT : < 5 g

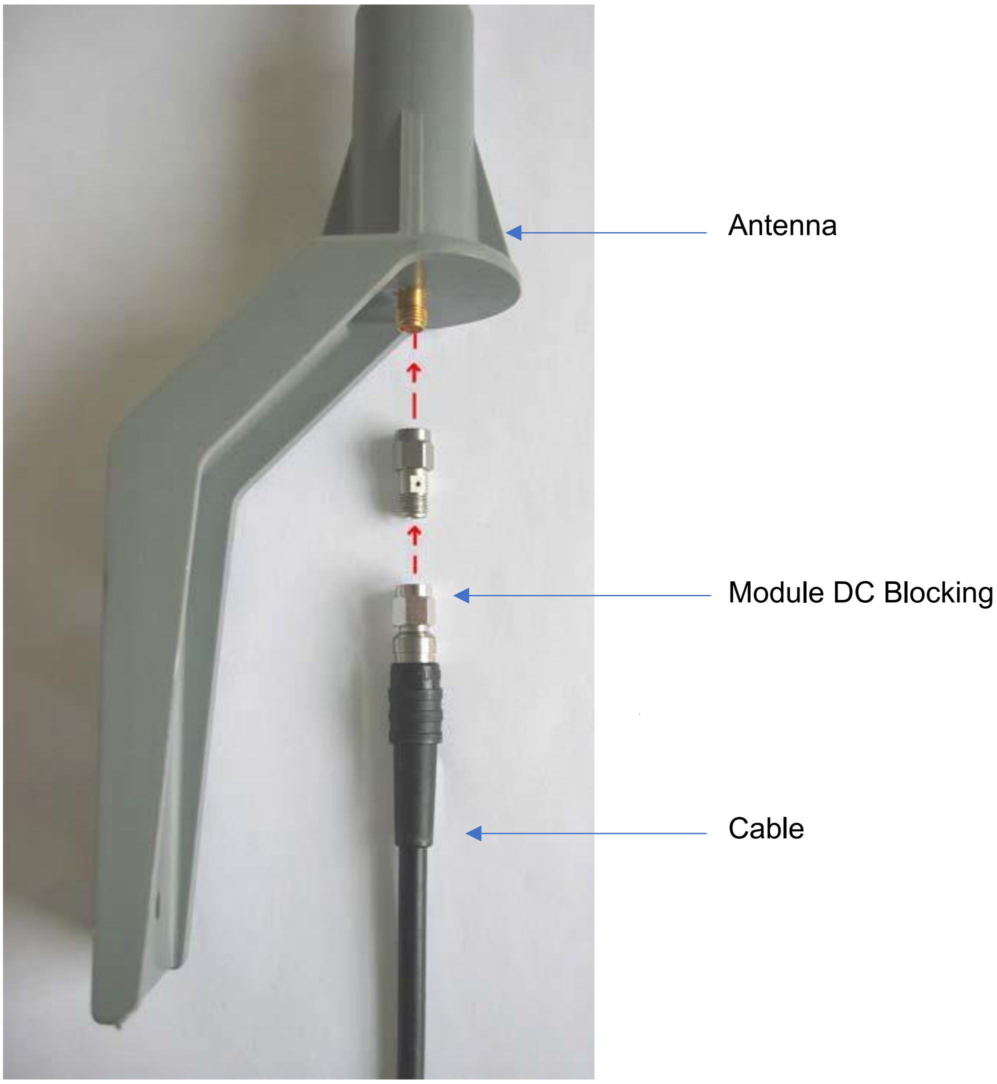
ENVIRONMENTAL CHARACTERISTICS

OPERATING TEMPERATURE RANGE (°C) : -40 , +85
STORAGE TEMPERATURE RANGE (°C) : -40 , +85

Power derating
Versus temperature



Installing the DC Blocking module

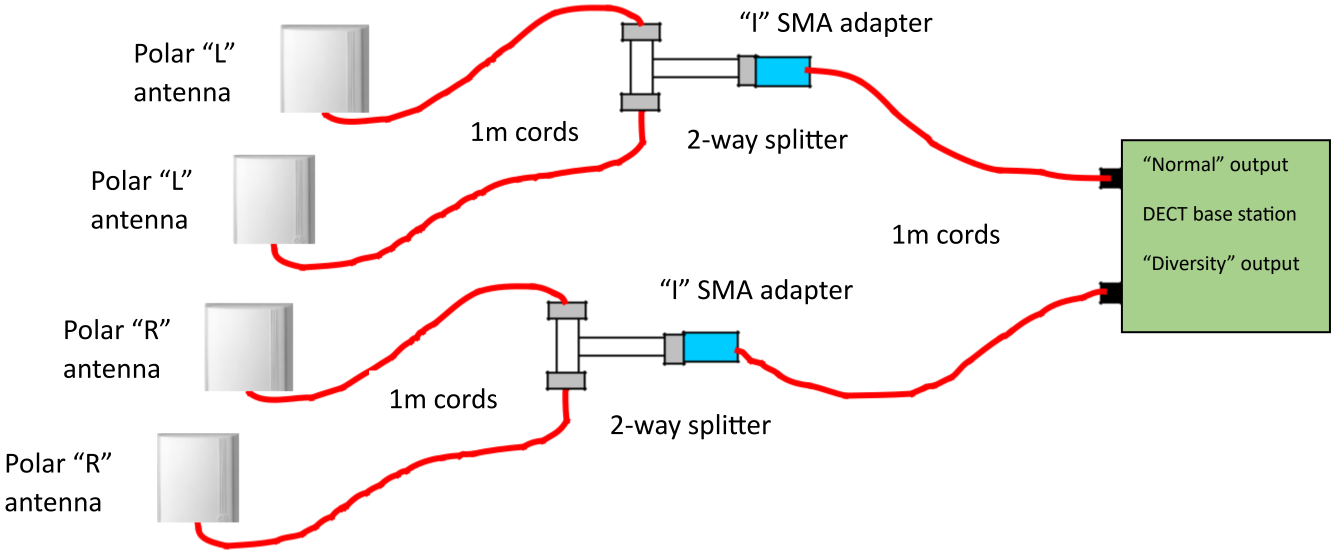


The sealing of the unit is ensured in a conventional way (heat-shrink tube, self-amalgamating tape, etc).

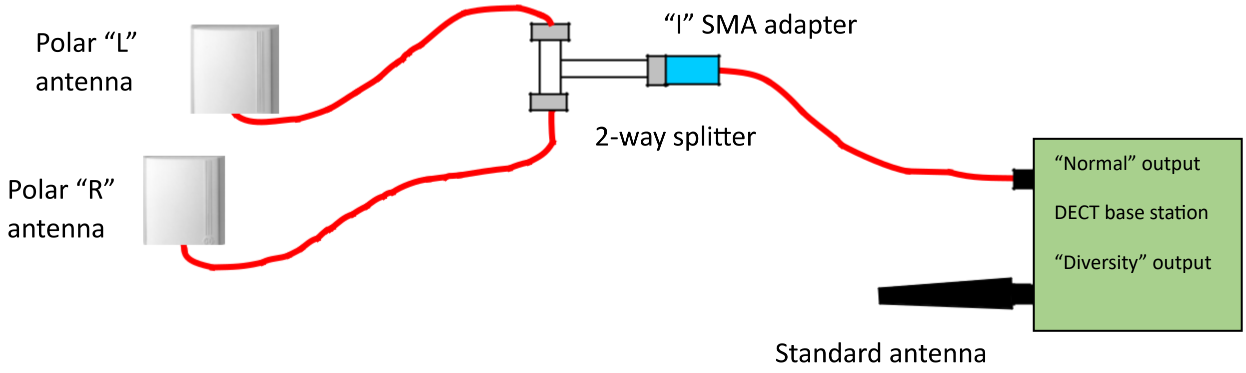
9.1.4.7 Example of antenna networks encountered

Antennas covering different directions can be associated together with an antenna power splitter (aka 2-way splitter or 2 channel separator).

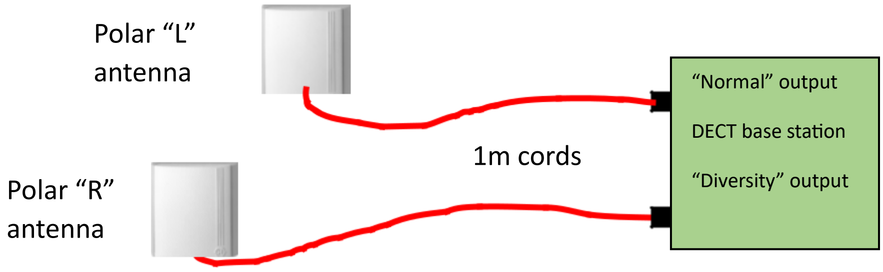
Type 1: 2 ways + diversity



Type 2: 2 ways with no directive diversity (installation into a tunnel for instance)



Type 3: 1 way + diversity



9.1.4.8 Case of sites with large metallic structures

In the case of industrial sites where reflection and multi-trajectory phenomena may cause much interference, it is recommended to use circular polarization antennas and to study more particularly the use of directive antennas.

Hence there are four main problems to be fixed, in a given environment, once it has been established that the problems highlighted by the customer are indeed due to radio propagation:

1- **Achieve the maximum field strength level while attempting to maintain a "direct line of sight"**.

Solution: Make the base station network denser, in locating the base stations (mainly the radiating system) in positions which provide optimum radio field strength for the points to be covered (high up and far away from any obstacles).

2- **Prevent creating multiple reflections**.

Solution: Concentrate the wave beam in the required direction(s), using directional antennae with moderate gain (< 10 dBi); the gain of these antennae supports point 1. "Tilt down" antenna may be used to increase this effect.

3- **Reduce disruptive effects related to polarization rotation (reflection)**.

Solution: Use of non-linear polarization antennae: circular polarization or at 45°.

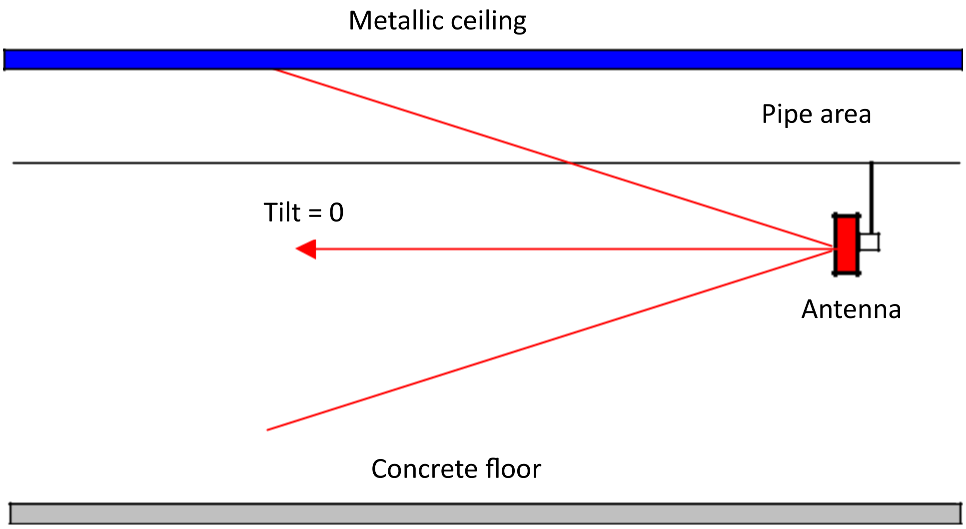
4- Reduce the effects of fading holes.

Solution: Implement effective antenna diversity (in the bases), space diversity by installing the antennae at an optimum distance from each other, and polarization diversity by using different polarization (left and right circular polarization).

Caution: In some specific cases as "clean room" (micro-electronic) or full metallic rooms (floor, walls, ceiling) with small size, the technical solutions described above are not enough efficient. In fact, it is the "multi delay spread" effect which is responsible of the propagation faults.
The DECT system is **unable** to protect itself.
This kind of site is detectable by the following effects:

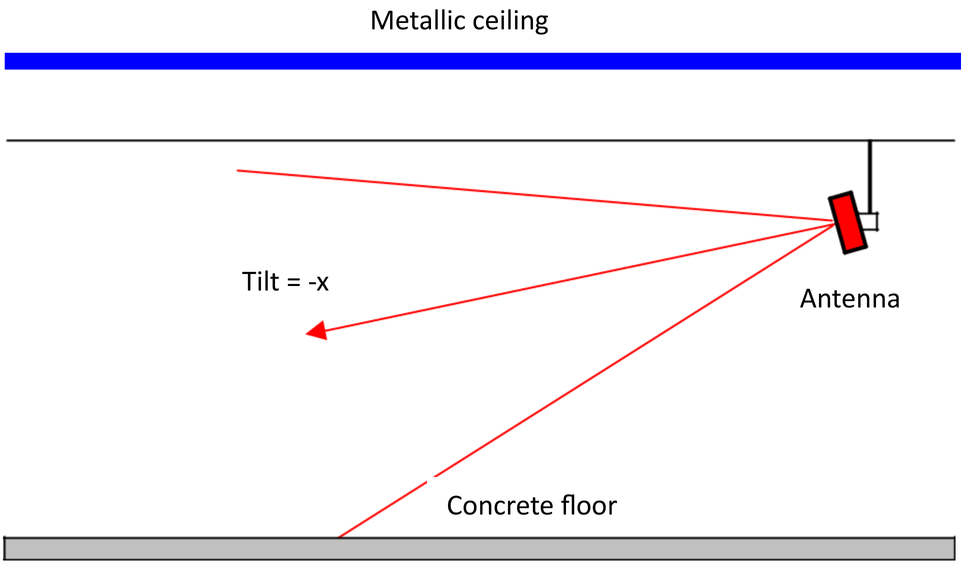
- Very low attenuation of the RF signal (RSSI permanent –33/-43 dBm).
- The RF fading measured is also very low (5 at 10dB).
- Under the radio base tested, the "Q" Quality indicator changes permanently from 0 to the maximum

ANTENNA INSTALLED WITHOUT TILT DOWN



This diagram shows that an important part of the power is lost in the pipe area and ceiling.

ANTENNA INSTALLED WITH TILT DOWN



This diagram shows that the power is re-concentrated on the effective covered area. Be careful the "tilt down" will be limited if this area is wide.

Note: The diagrams are only drawn to give an idea of the “tilt down” effect. The scale is of course not realistic.

Photo document showing the details of installation carried out in industrial site with "disturbed radio conditions" for a network "retuning".

Type 1 installation

Details of a type 1 installation

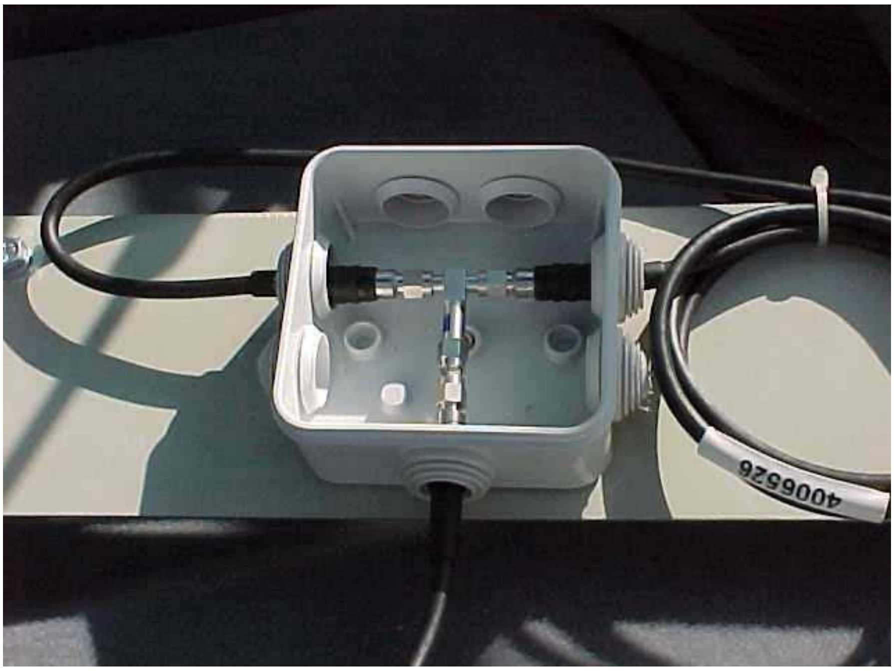
Installing the antennae "back to back" to enable tilt down

Type 2 installation, two ways at 90°

Details of making and installation

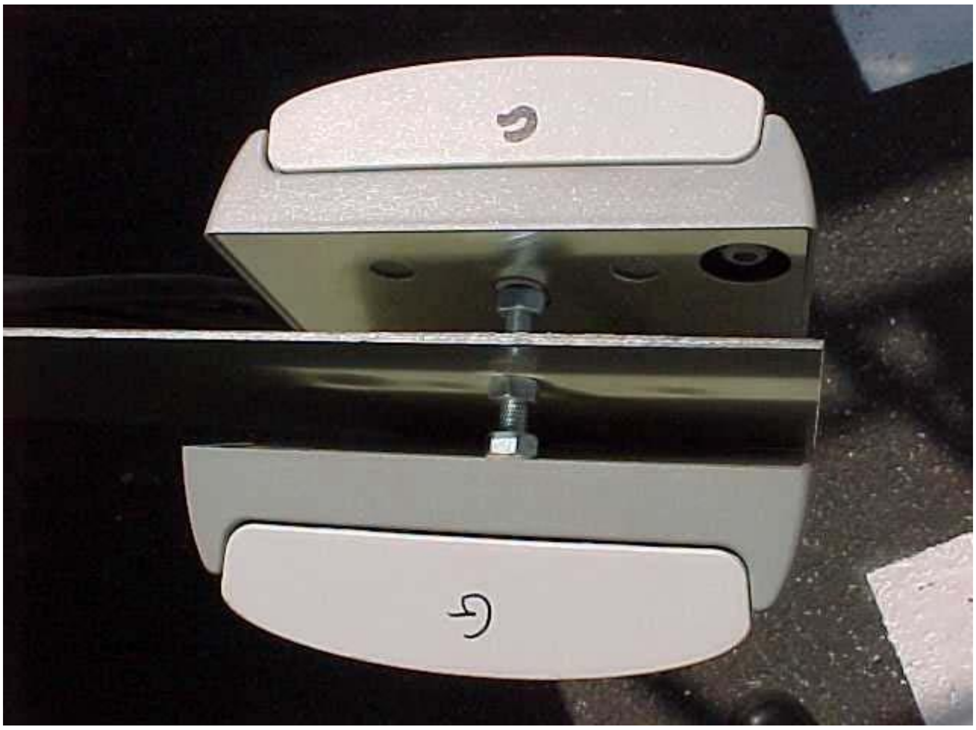
Basic plate

The two-way splitter in its waterproof box.



Details of making and installation

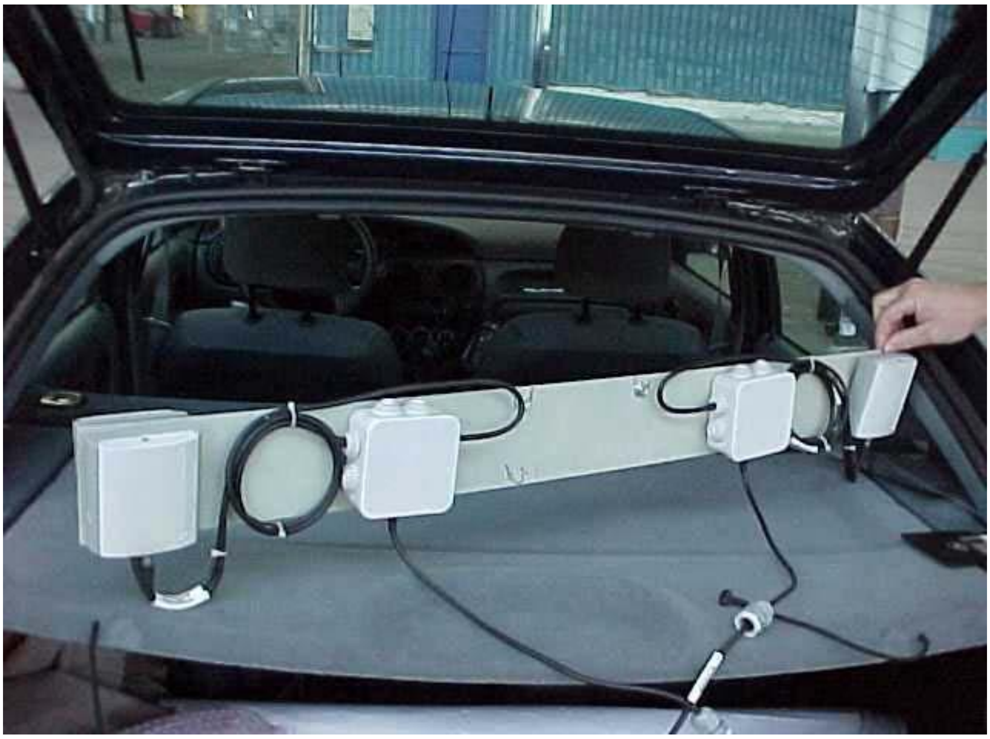
Close-up on antenna installation to enable tilt down adjustment.



Details of making and installation

The coaxial connection

An installation ready to be used



A base station properly installed with its standard antennae

Outdoor base station on 50 mm pipe well clear of the building

Type 1 or 3 installations:

You will find hereafter the details of making the support plate to enable receiving the equipment: antennae, cables, 3 db splitter and outdoor base station.

The dimensions of this plate are not critical except one, which is the physical space between the two antenna axes, a distance which defines the space diversity interval.

In theory, this interval must always be an odd number of $\lambda/4$ (**λ** = wavelength = 16 cm for DECT) and respect the d = $(2n - 1)\ x\ \lambda/4$ criterion so that the diversity gain is potentially optimum.

In our case, the value of "n" is 12 (d = 92 cm), arbitrary value compatible with a reasonable physical size. It must be pointed out that the greater the antenna spacing, the greater the likelihood of obtaining optimum diversity gain.

As the standard antennae of the base station are initially 12 cm apart, which corresponds to 3 x **λ/4**, the previous criterion is respected. For a different installation, distances of 20, 28, 36, 44 cm, etc. could be used.

On the plate, in addition to this "space" diversity, there will be "polarization" diversity, since the two antennae chosen will have the following types:

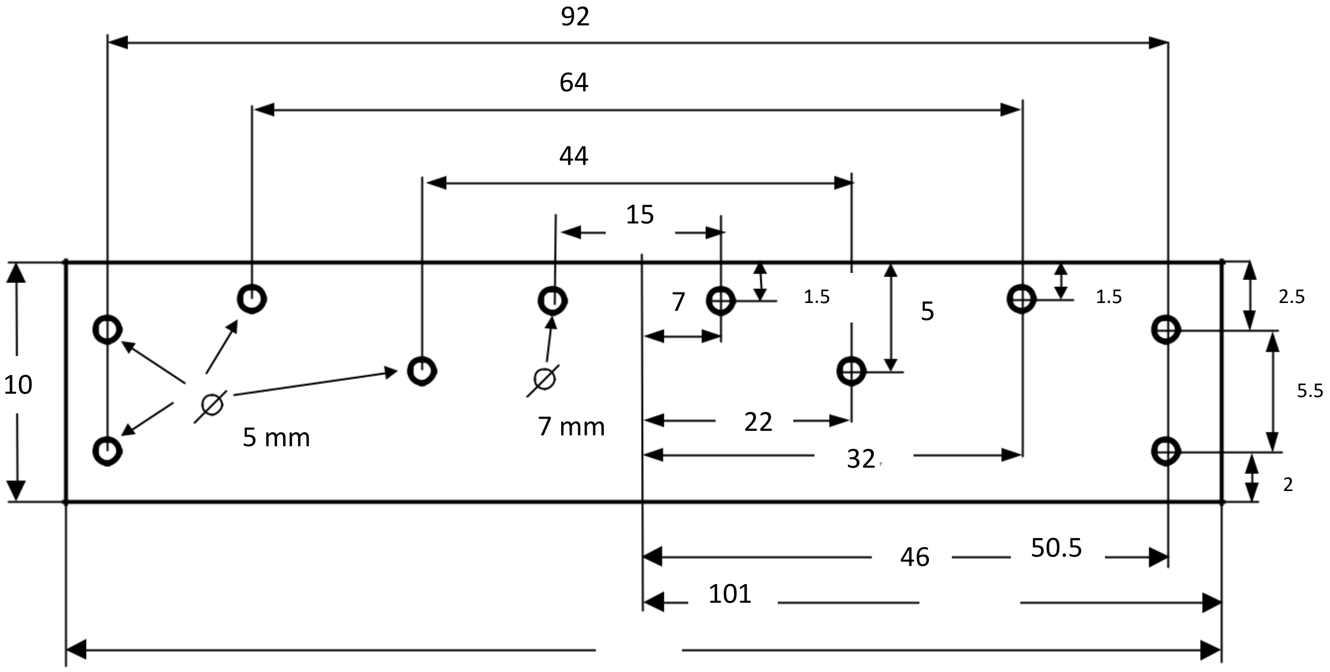
- Left hand circular polarization for one (LHCP).

- Right hand circular polarization for the other (RHCP).

The left and right antennae can be located on either end of the plate.

Refer to the various photographs provided to help you install the antennae.

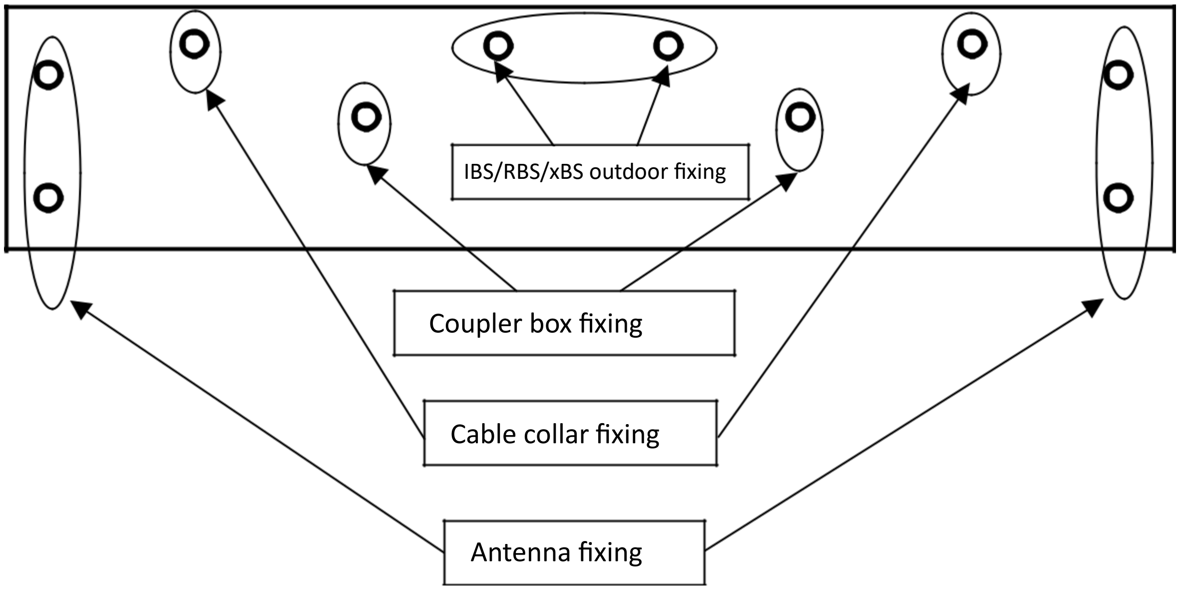
Dimension plan of the 8 dBi circular antenna support plate



Material: Aluminium, duralumin, etc.

Plate thickness: 2 mm.

Location of equipment

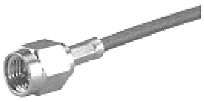


9.1.4.9 Antennas mounting

Designation	ALE Reference	Description	Illustration
Small antenna mounting kit	Confirm the reference **3BD52224AA** availability in the DECT Accessories datasheet	Makes it possible to swerve, orientate, fix the 8.0 dBi antennas on the pole, and wall. The kit is made up of a fixing element and a clip for mounting on a mast (ø 40-90 mm)	 

9.1.4.10 Antenna connections

Cables and cords	ALE Reference	Use	Loss
Coaxial cable (ø 3 mm, length 100 m)	Confirm the reference **3BD52225AA** availability in the DECT Accessories datasheet	Used for important swerves and for installations requiring cable discretion	0.15 dB/m
Cord (ø 5 mm, length 1 m) SMA male / N male	Confirm the reference **3BD52217AA** availability in the DECT Accessories datasheet	Yagi antennas connection "N" female connector	0.9 dB

Connectors and Adapters	ALE Reference	Use	Illustration
SMA male connector for ø 3 mm cable	Confirm the reference **3BD52211AA** availability in the DECT Accessories datasheet	Crimp connector for coaxial cable (ø 3 mm).	
Straight adapter SMA female / SMA female	Confirm the reference **3BD52221AA** availability in the DECT Accessories datasheet		

Antenna Splitters	ALE Reference	Insertion loss	Illustration
2-way Splitter	Confirm the reference **3BD52218AA** availability in the DECT Accessories datasheet	3.2 dB	
3-way Splitter	Confirm the reference **3BD52219AA** availability in the DECT Accessories datasheet	5.0 dB	

Reminder

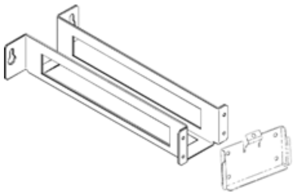
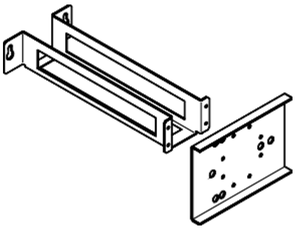
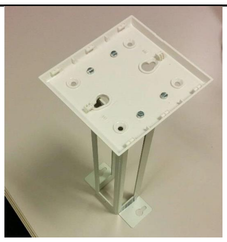
The 2-way splitter is used to have two antennas on a base output, but **in any case,** must be used to couple the 2 outputs of a base (normal and diversity on a single antenna (or networked antennas). This can cause **serious problem of operation**.

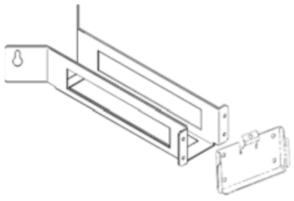
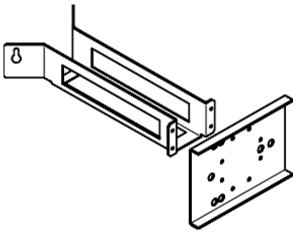
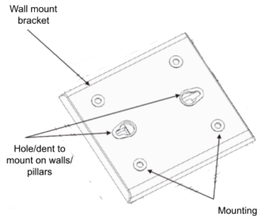
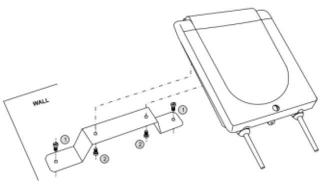
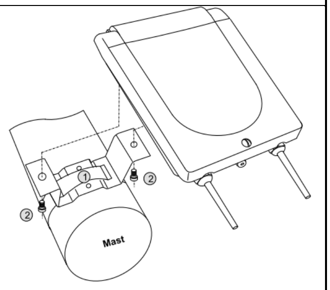
Miscellaneous	ALE Reference	Use	Illustration
SMA female/SMA male Antenna Lightning Arrester Or Lightening protector (50ohm, 0-6GHz, 0.1dB insertion loss)	Confirm the reference **3BD52220AA** availability in the DECT Accessories datasheet	Protection for the base station against lightening (RF coaxial link). For very specific cases where the bases are located indoor, but the antennas are deported outdoor (on poles for ex.) with long coaxial cables.	Must be accurately connected to the building ground 
DC Blocking module	Confirm the reference **3BD52212AA** availability in the DECT Accessories datasheet	DC isolation for antennas like the 7.5dBi when mounted on RBS or old IBS 4070 versions (see details in the SMA DC blocking capacitor section above)	
SMA Fixed Attenuator	Not sold by ALE, 50 ohm, SMA male/SMA female, 2W low power, DC to 6GHz	From 1 to 40 dB	

Observations

The protector against lightening is a component which is inserted between each antenna output active on the base station and the antenna system or the coaxial link to which it is connected. It tries to short circuit to ground any over voltage induced by electromagnetic fields from various origin.

9.1.4.11 Base Stations accessories

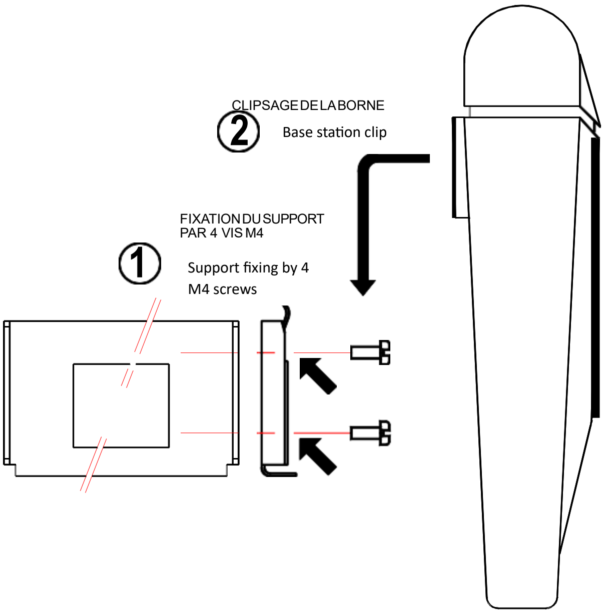
Fixing supports of base stations	ALE Reference	Use	Illustration
Hanging This support is composed of following items: – 2 hanging small chains of 2 meters long, – 2 fixing rods of the base station.	Confirm the reference **3BD52213AA** availability in the DECT Accessories datasheet	The indoor base station is hung under a fixed support (beam, ceiling, framing, ...) so that it is interfered by obstacle. This position is highly recommended in most installations, since it makes easier the omni-antenna radiation of the base station.	
Wall swerve This support is composed of 30 cm long metal section and of a fixing plate for outdoor base stations.	Confirm the reference **3BD52215AA** availability in the DECT Accessories datasheet	The base station is swerved 30 cm from a vertical support which can interfere the radiation if this base. Examples: – reinforced concrete pillar, – metallic pillar, – metallic wall. This swerve gives a better omnidirectional radiation.	 (Indoor IBS / RBS)  (Outdoor IBS/RBS/xBS)  (Indoor xBS) See details on how to fix the swerve on the indoor xBS in the next chapters

Fixing supports of base stations	**ALE Reference**	**Use**	**Illustration**
Corner swerve This support is composed of 30 cm long metal section and of a fixing plate for outdoor base stations.	Confirm the reference **3BD52214AA** availability in the DECT Accessories datasheet	The base station is swerved 30 cm from an angle wall or from a pole. This allows to install at path intersection or at a corner of buildings.	 (Indoor IBS/RBS)  (Outdoor IBS/RBS/xBS) (Indoor xBS) See details on how to fix the swerve on the indoor xBS in the next chapters
Wall Attachment for an Indoor IBS/RBS	Included in the indoor base station packaging	1. Attach the metal attachment bracket to the wall with the 2 screws (ø 3.5 x 25mm) and 2 dowels (ø 6 x 30mm) 2. Slide the indoor base to the bracket	
Wall Attachment for an Indoor xBS	Included in the indoor base station packaging	1. Attach the plastic bracket to the wall with the 2 screws and 2 dowels 2. Slide the indoor base to the bracket	
Wall Attachment for an Outdoor IBS/RBS/xBS	Included in the outdoor base station packaging	1. Attach the wall support to the wall with two screws (not provided) 2. Attach the outdoor base to the support with the two screws provided	
Mast Attachment for an Outdoor IBS/RBS/xBS	Included in the outdoor base station packaging	1. Attach the mast support to the mast with a pipe-collar (not provided) 2. Attach the outdoor base station to the support with the two screws provided	

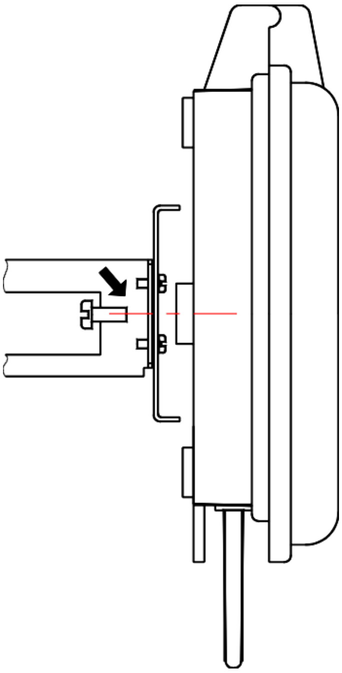
Fixing the swerve elements on the indoor IBS/RBS base station :

The “Wall swerve” must be fixed on a wall with two screws separated by 10.1 cm.

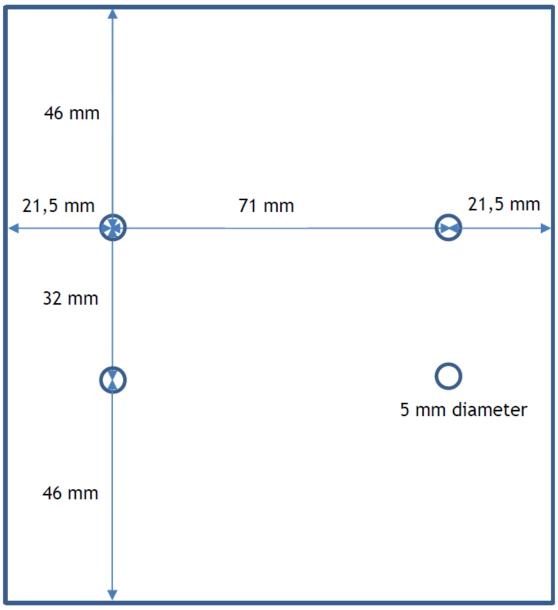
The “Corner swerve” must be fixed on a wall with two screws separated by 5 cm from the corner.

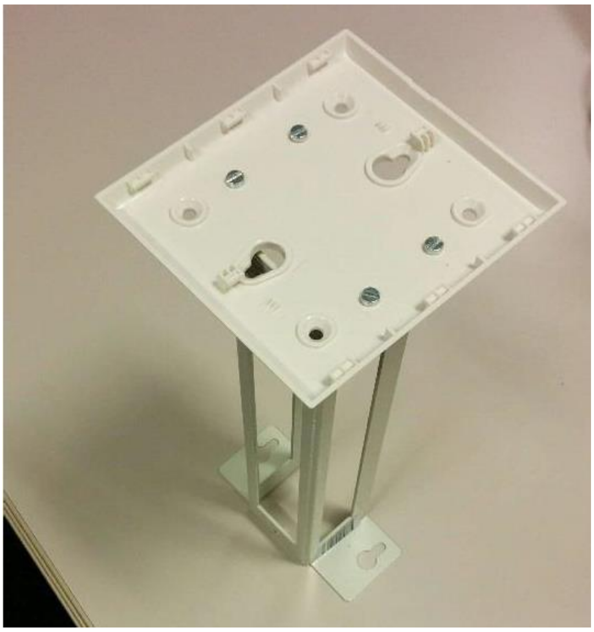


Fixing the swerve elements on the outdoor base station :

IBS/RBS/xBS outdoor base station


Fixing the swerve elements on the xBS indoor base station :

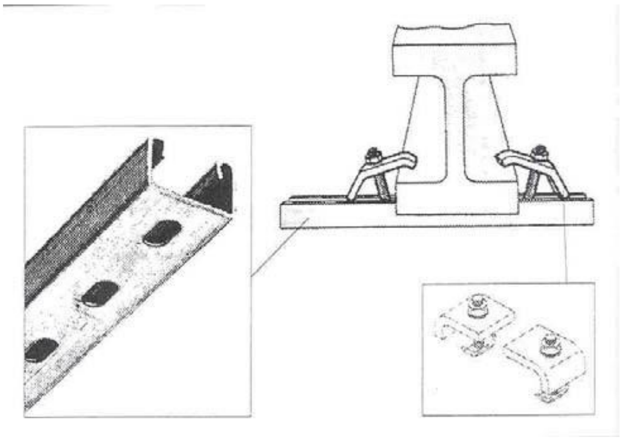




Other types of base station mounting :

Other mounting systems exist; see electrician catalogues.

Example: "toad" mounting with metallic rail for a mounting on IPN metallic frame. To be used with wall swerve for vertical mounting.



9.1.5 DECT rules as regards a WLAN and other radio technologies

9.1.5.1 WLAN

The DECT network may be disrupted by a WLAN. This disruption will be a function of the WLAN emission level and the type of antenna used by the 2 networks (Omnidirectional or directional antennas).

To avoid interaction between networks, you must comply with the distances between the base station antennas.

For the WLANs, there are several levels of emitted power which, for the sake of simplicity, are divided into 2 sub-groups:

NTP_WLAN network ≤20 dBm and >10 dBm
NTP_WLAN network ≤10 dBm

The minimum distances to be respected with the ALE DECT bases with omnidirectional antennas having a gain of **2 dBi** are as follows:

NTP_WLAN network ≤20 dBm and >10 dBm:	**- Minimum distance = 2.5 meters**
NTP_WLAN network ≤10 dBm:	**- Minimum distance = 1 meter**

In the case of the terminals, the problems are the same.

For other antenna types, refer to the tables below:

10 dBm < NTP_WLAN ≤ 20 dBm

	DECT **Omnidirectional antenna** **G≤2 dBi**	**DECT** **Directive antenna** **G=12 dBi**
WLAN **Omnidirectional antenna** **G≤2 dBi**	d≥ 2.5meters	d≥ 7 meters
WLAN **Omnidirectional antenna** **G≤6 dBi**	d≥3.5meters	d≥ 11 meters
WLAN **Directive antenna** **G≤12 dBi**	d≥7 meters	d≥ 22 meters
WLAN **Directive antenna** **G≤21 dBi**	d≥20 meters	d≥ 65 meters

NTP_WLAN ≤ 10dBm

	DECT Omnidirectional antenna G≤2 dBi	DECT Directive antenna G=12 dBi
WLAN Omnidirectional antenna G≤2 dBi	d≥ 1meter	d≥ 2.5 meters
WLAN Omnidirectional antenna G≤6 dBi	d≥1.5 meter	d≥ 3.5 meters
WLAN Directive antenna G≤12 dBi	d≥2.5 meters	d≥ 7 meters
WLAN Directive antenna G≤21 dBi	d≥6.5 meters	d≥ 20 meters

***Note**: Given its spectrum spread, the WLAN is not disrupted much by the DECT network.*

9.1.5.2 LTE

A LTE base station uses the downlink band 1805 MHz – 1880 MHz, transmitting with 40W (+46 dBm).

To have no interference from the LTE, the path loss between the LTE antenna and the DECT antenna shall be:

- Ch 0: -73 dB (equal to 57m)
- Ch 5: -75 dB (equal to 71 m)
- Ch 9: -86 dB (equal to 252m)

One solution is to not use the 3 DECT channels near to the LTE: channel 7,8 and 9. This will reduce the required distance from 250m to 70m between the LTE base station and the DECT base station.
Another solution is to put filters rejecting the LTE band that can be placed between the DECT radio and the antennas.

9.1.6 Elements to size for TDM base stations

Elements to size	Rules
Total number of sets	The total number of sets comprises the resident sets and the visitor sets of the customer's other nodes (calculation of the shells for incoming roaming and calculation of the total node traffic).
ADPCMs channels for RBS base stations **(AEMD daughter board in DECT4 board)**	**The requirement in ADPCM channels** requires the implementation of AEMD boards (8 ADPCM channels) in the DECT4 cases or DECT8 boards (32 ADPCM channels) in the DECT8 case **Mono ACT:** Actis calculates the number of AEMDs useful for an average traffic of 0.2 Erl per set. In the case of a different traffic, this parameter must be modified. **Multi ACT: No mutual assistance between different crystal AEMDs**. The calculation done at present by Actis is based on the global traffic of the node. The AEMDs must be distributed over all the DECT crystals according to the load of each ACT. As a result, for each ACT the following must be checked: - type of traffic, - number of external visitors - number of internal mobile users (resident sets on a same node) that can overload a visited ACT be taken into account in the sizing. This may lead us to increase the number of AEMDs as regards the initial Actis calculation. Table 5 below is used to control this number of AEMDs. **Example:** A company that has two ACTs; the first corresponds to the head office and the second to an R&D center. It is certain that the traffic, number of external visitors and the quantity of internal persons visiting each ACT will be different. In this type of case, two solutions are possible: -Reassign the different base stations to make the 2 ACTs homogeneous and, as a result, distribute the resources uniformly (boards and modules). - Isolate that part of the site causing imbalance or which blocks the previous solution by creating an ACT that is remoted and which will be sized separately in Actis and then resize the central ACT. (*)

Elements to size	Rules
Location zone	The location zone is used to situate the position of a set. This favors set paging. In the case of a company with high internal and external incoming call traffic (>1000 calls per hour, example Call Center) thus generating high demand for paging, it is recommended to divide the default zone defined by the system into several location zones (multi zones function). **Caution** in a multi zones case, the set that is located at the edge of the zones will undertake successive locations. This means that the overlap limit area of the 2 zones must be selected so that it is an area with a low density of permanent users (e.g.: transit area, corridor, etc.). (*)
DECT synchronization	Make sure a backup DTM daughter board has been installed for DECT synchronization.
Number of Inter Crystal links	Actis proposes 1 link by default per peripheral ACT and undertakes a sizing calculation. **Caution**: do not take into account the 4 ITs reserved for DECT synchronization on the INT links in a multi Crystal configuration. At present this complies with the same calculation principle as for the AEMDs and as a result, you must control the sizing for each ACT. Table 5 below is used to control this number. (*)
Server Notification and parallel group calls	In R1.4 and R2.1 (B3.513.26.2), the number of DECT sets in a parallel group is limited to 10. In R2.1 from B3.515.15, R3.X and R4.X, the number of DECT sets in a parallel group is limited to 20. It is recommended to distribute the sets of these groups on at least three base stations to guarantee simultaneous ringing of the sets. A specific study concerning the traffic and the response times must be carried out before making any commitments.
Adding DECT sets and bases	Be careful in the case of extensions: the sizing calculation must be done again in order to guarantee and maintain the initial quality.

(*) In the case where accurate information is not available, you must inform the customer of the hypotheses made and propose an additional QoS observation when the system is running. This service will enable the AEMD sizing, the location zone or the number of inter crystal links to be confirmed or adjusted.

Table 5 For RBS bases (not useful for IBS)

The following table gives, for a number of AEMD boards or DECT8 boards and an average traffic per set selected, the number of mobile handsets that can be served (resident sets + external visitors + inter ACT visitors) according to a congestion probability.

Number of sets with a blocking rate of 0.1 % integrating external and internal visitors													
Number of DECT8		1	1	1	1	2	2	3	4	5	7	7	7
Number of AEMDs		1	2	3	4	6	8	10	15	20	25	26	27
Number of ADPCMs		8	16	24	32	48	64	80	120	160	200	208	216
Average traffic per set	0.1	21	67	122	182	309	442	578	930	1290	1656	1730	1804
	0.2	10	34	61	91	154	221	289	465	645	828	865	902
	0.3	8	22	41	61	103	147	193	310	430	552	577	601
	0.4	8	17	31	46	77	110	145	232	323	414	432	451

Number of sets with a blocking rate of 0.01 % integrating external and internal visitors													
Number of DECT8		1	1	1	1	2	2	3	4	5	7	7	7
Number of AEMDs		1	2	3	4	6	8	10	15	20	25	26	27
Number of ADPCMs		8	16	24	32	48	64	80	120	160	200	208	216
Average traffic per set	0.1	14	53	102	156	273	398	527	862	1208	1652	1633	1705
	0.2	8	27	51	78	137	199	263	431	604	781	817	852
	0.3	8	18	34	52	91	133	276	287	403	521	544	568
	0.4	8	16	26	39	68	99	132	216	302	390	408	426

Reminder: Limit of 800 ADPCMs, hence 100 AEMDs per ACT

Example: With 2 AEMD boards, a blocking rate of 0.1% and an average traffic of 0.2 Erl, 34 DECT sets can be served.

Table 6

The following table gives, for a number of INT boards and an average traffic per set selected, the number of mobile handsets that can be served (resident sets + external visitors + inter ACT visitors) according to a congestion probability.

Blocking rate		0.1 %				0.01 %			
Number of INTs		1	2	3	4	1	2	3	4
Number of channels		78	168	288	408	78	168	288	408
Average traffic per set	0.1 Erl	660	1604	2911	4242	601	1504	2771	4068
	0.2 Erl	330	802	1455	2121	300	752	1385	2034
	0.3 Erl	220	535	970	1414	200	501	924	1356
	0.4 Erl	165	401	728	1061	150	376	693	1017

Example: With 2 INTOF boards, a blocking rate of 0.1% and an average traffic of 0.2 Erl per set, the number of DECT sets served could be 802.

Note: In the case of DECT4 boards, for security reasons, we recommend distributing the AEMD daughter boards on the DECT4 boards; this must be checked during the configuration. As a result, we recommend ordering the necessary AEMD boards so that there is at least one AEMD board per DECT4 coupler.

In the case of a multi-ACT DECT architecture, this sizing is valid for each ACT separately **(there is no mutual assistance between the AEMD boards located in different ACTs).**

9.1.7 Recommendations relative to the wiring

9.1.7.1 Recommendations relative to the wiring for IBS/RBS NG

The characteristics of the cables and their references are detailed in the product operational guide. (Tech com: TC0128).

However, some important precautions need to be considered:

- When there is a risk regarding the coverage (partial preliminary coverage study measurements), we recommend leaving a margin of several meters in the cable lengths as this allows the position of the base stations to be changed slightly.
- When traffic distribution is not fully known or when the customer wants a Full DECT network, doubling the cables for each risk base station provides an added security.
- When customers want to use their own cables, you must qualify these cables by carrying out specific measurements at the extremities covering attenuation, crosstalk and propagation times; the measurement limits are detailed in the tables below:

For a RBS connected on a DECT4/8 coupler		
Characteristics	**Values**	**Comments**
Impedance at 576 KHz	85 Ohm < R < 135 Ohm	
Crosstalk at 576 KHz	> 66 dB	In fact, these 2 data items are linked, and these limits can be changed as regards each other The limits will be: If crosstalk >66 dB then Att <29 dB Example: Cable category 5 If crosstalk >45 dB then Att <17 dB Example: Cable category 3
Attenuation at 576 KHz	< 17 dB	
Propagation time	< 11 µs	
DC loop resistance	< 270 Ohms	Limit relative to the line current. For example, for information: In 0.4 mm about 900m In 0.5 mm about 1400m In 0.6 mm about 2000m These distances are dependent on the characteristics of the cables used.

<table>
<tr><th colspan="3">For an IBS connected on a UA coupler</th></tr>
<tr><th>Characteristics</th><th>Values</th><th>Comments</th></tr>
<tr><td>Impedance at 682 KHz</td><td>85 Ohm < R < 135 Ohm</td><td>Impedance variation on the line < 15%</td></tr>
<tr><td>Crosstalk at 682 KHz</td><td>> 44 dB</td><td rowspan="2"></td></tr>
<tr><td>Attenuation at 682 KHz</td><td>< 25 dB</td></tr>
<tr><td>Propagation time</td><td>< 7 µs</td><td></td></tr>
<tr><td>DC loop resistance</td><td>< 155 Ohms</td><td>Limit relative to the line current.
For example, for information:
In 0.4 mm about 500m
In 0.5 mm about 800m
In 0.6 mm about 1200m
These distances are dependent on the characteristics of the cables used.</td></tr>
</table>

9.2 Estimation of the number of bases

9.2.1 General

A rough estimation of the number of bases, can be useful for an initial negotiation about a new DECT system.

Note: *This estimation method is based on "average sites" and is not applicable for any site. The result is only an indication and must not be used for the final product offer. A Site Survey is always required to determine the exact number of* bases.
No rights can be obtained from these estimation tables.

This estimation method is based on tables. These tables are based on the following assumptions:

- Radiation between floors is undervalued.
- Average building types.
- Average call density.

There are eight tables for four types of estimations:

Estimation for coverage in clear space.
This gives information about the number of bases required for "clear space" environment. The information is given in Table 10 & Table 11

Estimation for coverage in typical office.
See Table 12 & Table 13 to find information about coverage in "typical office" environment.

Estimation for coverage in drywall office.
See Table 14 & Table 15 to find information about coverage in "drywall office" environment.

Estimation for coverage in brickwall office.
See Table 16 & Table 17 to find information about coverage in "brickwall office" environment.

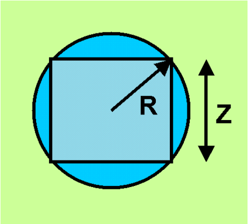
A complex site may be more easily split into areas which are estimated separately, and the resulting number of bases totalled together.

To use the estimation tables in this chapter, execute the following procedure:

1. Collect site info from the customer.
2. Find out the length(s) and the width(s) of the area(s) to be covered.
   Round up these dimensions to the nearest multiple of 20 metres.
3. Find out for each area (or zone) if the coverage is easy (-70 dBm) or tricky (-60dBm) and what is the building type (propagation index).
4. Find out how many handsets will be purchased for use on the system
5. Remember that the customer can always add more handsets in the future once the basic infrastructure (bases and common equipment) is in place.

9.2.2 Basic Guidelines Process for manual calculation of predictive coverage

The following predictive method can be used to produce a budgetary design. Many environment variables like wave propagation, type of building, wall structure, interferences, etc…may unexpectedly affect the QoS and the complexity of the RF coverage plan.
To determine the coverage area of a radio based on the building type and desired average user performance you can use the tables hereafter. The Z factor represents the length of a square that corresponds to the coverage area of the access point.



R=”The coverage radius of a base that can be used to define a perimeter or radial footprint”
Z=“The side of the square contained within the perimeter (R) =$2^{0.5}$R”
A=”The area of the square =Z^2”

9.2.3 Easy or tricky coverage

See chapter “Classification summary tables” to determine if the coverage is classified as easy (-70 dBm) or as tricky (-60 dBm).

9.2.4 Building type

Identifying the building type and its RF characteristics is critical in determining how many radios will be needed. The following table shows some basic building types that are common in the enterprise market. If the building does not fall into one of these categories, then some amount of professional service may be needed.

BUILDING TYPE	DESCRIPTION
Typical Office Space	This is the most common enterprise building. This type of building consists of large open cubicle areas with walled offices and conference rooms. **Beta < 3.5**
Drywall Office Space	This type of building consists of mostly offices with dry wall characteristics. **Beta ≈ 4**
Brick / Concrete Walled Office Space	This type of building consists of concrete or brick walls for both exterior and for interior office space. Old buildings found on college campuses are good examples of this type of building. **Beta ≈ 5**
Hospital	**Beta ≈ 4**
Warehouse / Manufacturing with no obstacles, metallic separations	This type of building consists of large areas with high ceiling **Beta < 3.5**
Difficult environment	There are some buildings such as sports arenas, stock exchanges, warehouse or manufacturing with large metallic parts, clean rooms that do not fit into one of the typical categories. These buildings typically require some special consideration or professional service. **1.8 < Beta < 5**

Table 7 Description of building type

Note 1: See if the facility is composed of different building types.

9.2.4.1 Determination of the propagation index (beta)

By default, see Table 7 or if possible, measure RSSI at 10m or 20m to determine the propagation index (beta) with a better accuracy.

RSSI (dBm) @ 10 m	RSSI > -43	-43 > RSSI > -50	-50 > RSSI > -55	-55 > RSSI > -65	RSSI < -65
RSSI (dBm) @ 20 m	RSSI > -51	-51 > RSSI > -61	-61 > RSSI > -67	-67 > RSSI > -80	RSSI < -80
Beta	Beta < 2.8 **Clear Space**	2.8 < Beta < 3.5 **Typical Office**	3.5 < Beta < 4.0 **Drywall Office**	4.0 < Beta < 5.0 **Brickwall Office**	Beta > 5.0 **Difficult Environment**

Table 8 Beta vs received signal

***Note**: Values according to a base with Pe = 23 dBm.*
***Remark**: Pay attention to the jammers in the proximity of* bases *because they will interfere and blocking cases for air synchronization are to be determined.*

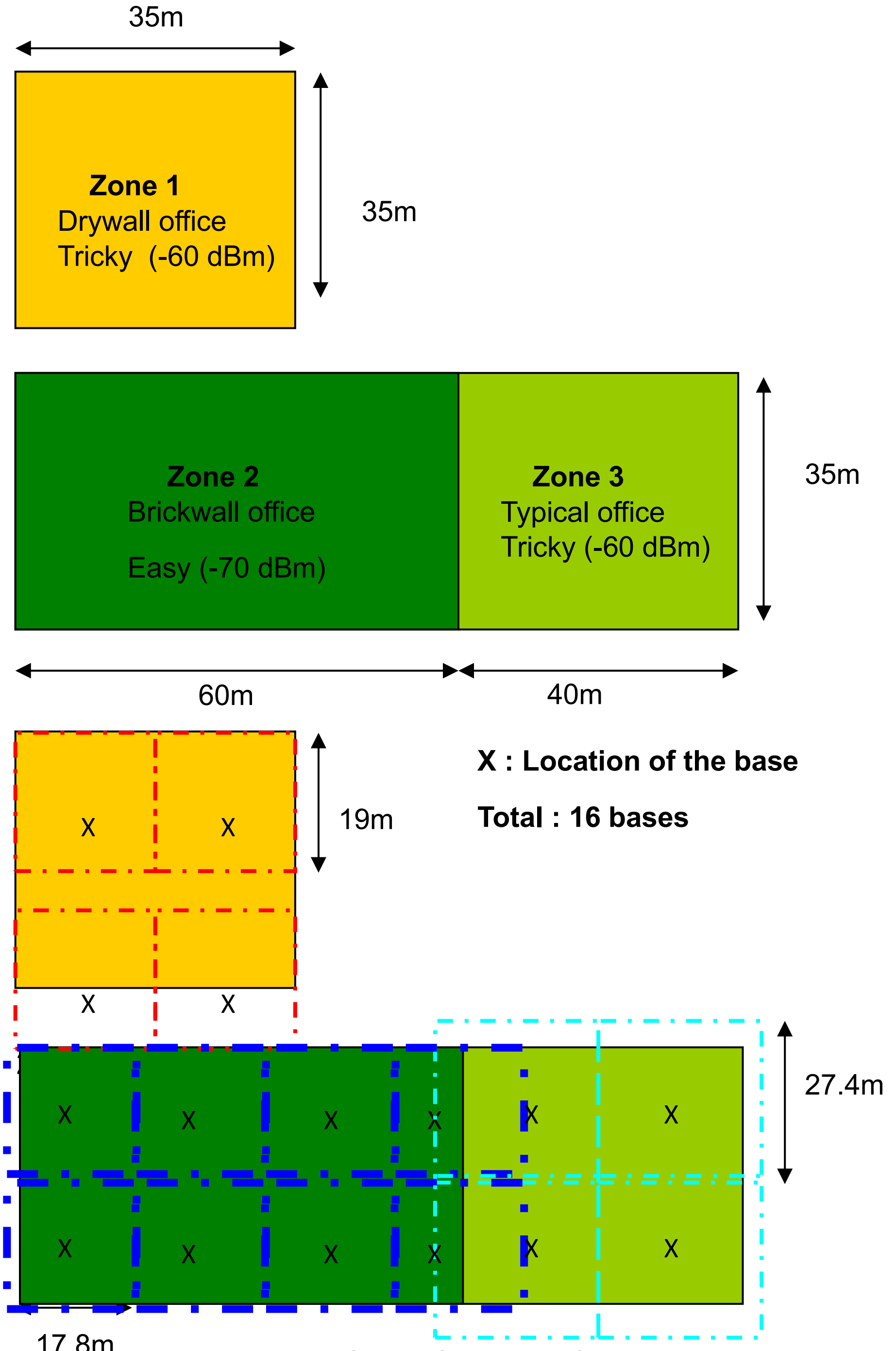
9.2.5 Determination of Z vs propagation index (beta) and received signal

PROPAGATION INDEX (OFFICE TYPE)	**COVERAGE**			
	RSSI (dBm)	**A (m^2)**	**R (m)**	**Z (m)**
INDOORS CLEAR SPACE **Beta <2.8**	-60	3204	40.0	56.6
	-70	19994	100.0	141.4
TYPICAL OFFICE **Beta <3.5**	-60	751	19.4	27,4
	-70	2798	37.4	52.9
DRYWALL OFFICE **Beta ≈4**	-60	361	13.4	19.0
	-70	1136	23.8	33.7
BRICKWALL OFFICE **Beta ≈5**	-60	128	8.0	11.3
	-70	317	12.6	17.8

Table 9 Coverage versus propagation index (beta)

9.2.6 Determination of the quantity of bases

In this step you define the coverage area for each floor in the building in zones and divide it into squares of areas equal to the Z factor squared corresponding to the building type (see previous tables) and calculate how many bases are needed. The center of each square indicates the approximate location of the ALE bases.
The following example is for a floor composed of a drywall office space (Zone 1 with typical reliability {>90% ⇒ Rx > -65 dBm}) and a typical office area divided in 2 zones: zone 2 with good reliability {99% ⇒ Rx ≥ -60 dBm} and zone 3 with typical reliability {>90% ⇒ Rx ≥ -65 dBm }. Application is voice on 802.11b and data on 802.11a with an average user throughput of 15 Mbps.



Figures 7a & 7b : Quantity of bases

Zone 1 (Tricky Drywall office) ⇒ Number of bases = (35 x 35) / 361 = 1225 /361= 3.4 ≈ 4 bases (rounded up to next highest integer)

Or = (35/19) x (35/19) = 1.84 x 1.84 ≈ 2 x 2 => 4 bases

Given the rectangular shape, the second calculation is preferable => 4 bases

Zone 2 (Easy Typical Office) ⇒ Number of bases = (60 x 35) / 317 = 2100 / 317= 6.6 ≈ 7 bases
Or (60/17.8) x (35/17.8) = 3.4 x 2.0 ≈ 4 x 2 => 8 DAPs
Given the rectangular shape, the second calculation is preferable => 8 bases
Zone 3 (Tricky Typical Office) ⇒ Number of bases = (40 x 35) / 751 = 1400 / 751= 1.9 ≈ 2 bases
Or (40/27.4) x (35/27.4) = 1.5 x 1.3 ≈ 2 x 2 = 4 bases
Given the rectangular shape, the second calculation is preferable => 4 bases
Total = 4 + 8 + 4 = 16 bases

9.2.7 Estimation for coverage in clear space

Table 10 and Table 11 give information about the number of bases, that are required for estimation the coverage in clear space. Using the table, bear in mind the following remarks:

- Using the length and width of each area, rounded up to multiples of 20 metres, look-up the number of bases from the tables.

- Theses tables have been calculated on the basis that each base provides 3204 sq.m. coverage (if tricky coverage => -60 dBm) or 19994 sq.m. coverage (if easy coverage => -70 dBm).

⚠- The resulting estimate is used for budgetary purposes to guide the customer on whether to proceed with a site survey. A firm price can only be quoted after a Site Survey.

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	1	2	2	2	3	3	3	4	4	4	5	5	5
40	1	1	2	2	2	3	3	3	4	4	4	5	5	5
60	2	2	4	4	4	6	6	6	8	8	8	10	10	10
80	2	2	4	4	4	6	6	6	8	8	8	10	10	10
100	2	2	4	4	4	6	6	6	8	8	8	10	10	10
120	3	3	6	6	6	9	9	9	12	12	12	15	15	15
140	3	3	6	6	6	9	9	9	12	12	12	15	15	15
160	3	3	6	6	6	9	9	9	12	12	12	15	15	15
180	4	4	8	8	8	12	12	12	16	16	16	20	20	20
200	4	4	8	8	8	12	12	12	16	16	16	20	20	20
220	4	4	8	8	8	12	12	12	16	16	16	20	20	20
240	5	5	10	10	10	15	15	15	20	20	20	25	25	25
260	5	5	10	10	10	15	15	15	20	20	20	25	25	25
280	5	5	10	10	10	15	15	15	20	20	20	25	25	25

Table 10 Estimated number of required bases for coverage in tricky (-60 dBm) clear space

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	1	1	1	1	1	1	2	2	2	2	2	2	2
40	1	1	1	1	1	1	1	2	2	2	2	2	2	2
60	1	1	1	1	1	1	1	2	2	2	2	2	2	2
80	1	1	1	1	1	1	1	2	2	2	2	2	2	2
100	1	1	1	1	1	1	1	2	2	2	2	2	2	2
120	1	1	1	1	1	1	1	2	2	2	2	2	2	2
140	1	1	1	1	1	1	1	2	2	2	2	2	2	2
160	2	2	2	2	2	2	2	4	4	4	4	4	4	4
180	2	2	2	2	2	2	2	4	4	4	4	4	4	4
200	2	2	2	2	2	2	2	4	4	4	4	4	4	4
220	2	2	2	2	2	2	2	4	4	4	4	4	4	4
240	2	2	2	2	2	2	2	4	4	4	4	4	4	4
260	2	2	2	2	2	2	2	4	4	4	4	4	4	4
280	2	2	2	2	2	2	2	4	4	4	4	4	4	4

Table 11 Estimated number of required bases for coverage in easy (-70 dBm) clear space

9.2.8 Estimation for coverage in typical office

Table 12 and Table 13 give information about the number of bases, that are required for estimation the coverage in typical office. Using the table, bear in mind the remarks given for the coverage in clear space:

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	2	3	3	4	5	6	6	7	8	8	9	10	11
40	2	4	6	6	8	10	12	12	14	16	16	18	20	22
60	3	6	9	9	12	15	18	18	21	24	24	27	30	33
80	3	6	9	9	12	15	18	18	21	24	24	27	30	33
100	4	8	12	12	16	20	24	24	28	32	32	36	40	44
120	5	10	15	15	20	25	30	30	35	40	40	45	50	55
140	6	12	18	18	24	30	36	36	42	48	48	54	60	66
160	6	12	18	18	24	30	36	36	42	48	48	54	60	66
180	7	14	21	21	28	35	42	42	49	56	56	63	70	77
200	8	16	24	24	32	40	48	48	56	64	64	72	80	88
220	8	16	24	24	32	40	48	48	56	64	64	72	80	88
240	9	18	27	27	36	45	54	54	63	72	72	81	90	99
260	10	20	30	30	40	50	60	60	70	80	80	90	100	110
280	11	22	33	33	44	55	66	66	77	88	88	99	110	121

Table 12 Estimated number of required bases for coverage in tricky (-60 dBm) typical office

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	1	2	2	2	3	3	3	4	4	5	5	5	6
40	1	1	2	2	2	3	3	3	4	4	5	5	5	6
60	2	2	4	4	4	6	6	6	8	8	10	10	10	12
80	2	2	4	4	4	6	6	6	8	8	10	10	10	12
100	2	2	4	4	4	6	6	6	8	8	10	10	10	12
120	3	3	6	6	6	9	9	9	12	12	15	15	15	18
140	3	3	6	6	6	9	9	9	12	12	15	15	15	18
160	3	3	6	6	6	9	9	9	12	12	15	15	15	18
180	4	4	8	8	8	12	12	12	16	16	20	20	20	24
200	4	4	8	8	8	12	12	12	16	16	20	20	20	24
220	5	5	10	10	10	15	15	15	20	20	25	25	25	30
240	5	5	10	10	10	15	15	15	20	20	25	25	25	30
260	5	5	10	10	10	15	15	15	20	20	25	25	25	30
280	6	6	12	12	12	18	18	18	24	24	30	30	30	36

Table 13 Estimated number of required bases for coverage in easy (-70dBm) typical office

9.2.9 Estimation for coverage in drywall office

Table 14 and Table 15 give information about the number of bases, that are required for estimation the coverage in drywall office. Using the table, bear in mind the remarks given for the coverage in clear space:

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	2	3	4	5	6	7	8	9	11	12	13	14	15
40	2	4	6	8	10	12	14	16	18	22	24	26	28	30
60	3	6	9	12	15	18	21	24	27	33	36	39	42	45
80	4	8	12	16	20	24	28	32	36	44	48	52	56	60
100	5	10	15	20	25	30	35	40	45	55	60	65	70	75
120	6	12	18	24	30	36	42	48	54	66	72	78	84	90
140	7	14	21	28	35	42	49	56	63	77	84	91	98	105
160	8	16	24	32	40	48	56	64	72	88	96	104	112	120
180	9	18	27	36	45	54	63	72	81	99	108	117	126	135
200	11	22	33	44	55	66	77	88	99	121	132	143	154	165
220	12	24	36	48	60	72	84	96	108	132	144	156	168	180
240	13	26	39	52	65	78	91	104	117	143	156	169	182	195
260	14	28	42	56	70	80	98	112	126	154	168	182	196	210
280	15	30	45	60	75	88	105	120	135	165	180	195	210	225

Table 14 Estimated number of required bases for coverage in tricky (-60 dBm) drywall office

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	2	2	3	3	4	5	5	6	6	7	8	8	9
40	2	4	4	6	6	8	10	10	12	12	14	16	16	18
60	2	4	4	6	6	8	10	10	12	12	14	16	16	18
80	3	6	6	9	9	12	15	15	18	18	21	24	24	27
100	3	6	6	9	9	12	15	15	18	18	21	24	24	27
120	4	8	8	12	12	16	20	20	24	24	28	32	32	36
140	5	10	10	15	15	20	25	25	30	30	35	40	40	45
160	5	10	10	15	15	20	25	25	30	30	35	40	40	45
180	6	12	12	18	18	24	30	30	36	36	42	48	48	54
200	6	12	12	18	18	24	30	30	36	36	42	48	48	54
220	7	14	14	21	21	28	35	35	42	42	49	56	56	63
240	8	16	16	24	24	32	40	40	48	48	56	64	64	72
260	8	16	16	24	24	32	40	40	48	48	56	64	64	72
280	9	18	18	27	27	36	45	45	54	54	63	72	72	81

Table 15 Estimated number of required bases for coverage in easy (-70 dBm) drywall office

9.2.10 Estimation for coverage in brickwall office

Table 16 and Table 17 give information about the number of bases, that are required for estimation the coverage in brickwall office. Using the table, bear in mind the remarks given for the coverage in clear space:

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	2	4	6	7	9	11	13	15	16	18	20	22	23	25
40	4	16	24	28	36	44	52	60	64	72	80	88	92	100
60	6	24	36	42	54	66	78	90	96	108	120	132	138	150
80	7	28	42	49	63	77	91	105	112	126	140	154	161	175
100	9	36	54	63	81	99	117	135	144	162	180	198	207	225
120	11	44	66	77	99	121	143	165	176	198	220	242	253	275
140	13	52	78	91	117	143	169	195	208	234	260	286	299	325
160	15	60	90	105	135	165	195	225	240	270	300	330	345	375
180	16	64	96	112	144	176	208	240	256	288	320	352	368	400
200	18	72	108	126	162	198	234	270	288	324	360	396	414	450
220	20	80	120	140	180	220	260	300	320	360	400	440	460	500
240	22	88	132	154	198	242	286	330	352	396	440	484	506	550
260	23	92	138	161	207	253	299	345	368	414	460	506	529	575
280	25	100	150	175	225	275	325	375	400	450	500	550	575	625

Table 16 Estimated number of required bases for coverage in tricky (-60 dBm) brickwall office

Dimensions (m)	**20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**180**	**200**	**220**	**240**	**260**	**280**
20	2	3	4	5	6	7	8	9	11	12	13	14	15	16
40	3	9	12	15	18	21	24	27	33	36	39	42	45	48
60	4	12	16	20	24	28	32	36	44	48	52	56	60	64
80	5	15	20	25	30	35	40	45	55	60	65	70	75	80
100	6	18	24	30	36	42	48	54	66	72	78	84	90	96
120	7	21	28	35	42	49	56	63	77	84	91	98	105	112
140	8	24	32	40	48	56	64	72	88	96	104	112	120	128
160	9	27	36	45	54	63	72	81	99	108	117	126	135	144
180	11	33	44	55	66	77	88	99	121	132	143	154	165	176
200	12	36	48	60	72	84	96	108	132	144	156	168	180	192
220	13	39	52	65	78	91	104	117	143	156	169	182	195	208
240	14	42	56	70	84	98	112	126	154	168	182	196	210	224
260	15	45	60	75	90	105	120	135	165	180	195	210	225	240
280	16	48	64	80	96	112	128	144	176	192	208	224	240	256

Table 17 Estimated number of required bases for coverage in easy (-70 dBm) brickwall office

9.2.11 Determination of the distance for xBS or DAP air synchronization

See Table 18 hereafter (To be not used for US).

Distance (m) @ -80 dBm	D > 210	210 > D > 72	72 > D > 42	42 > D > 20	D < 20
Beta	Beta < 2.8 **Clear Space**	2.8 < Beta < 3.5 **Typical Office**	3.5 < Beta < 4.0 **Drywall Office**	4.0 < Beta < 5.0 **Brickwall Office**	Beta > 5.0 **Difficult Environment**

Table 18 Distance for DAP synchronization vs index of propagation (beta)

9.3 Specific rules for difficult sites

The purpose of this section is to propose a particular process for these sites.

9.3.1 Recommended stages

In the case of industrial sites with large dense metallic structures or clean room type sites, a specific study must be carried out.

The procedure to follow is to propose a temporary installation followed by additional measurements and then an adjustment phase. This stage may result in us changing antenna type(s), modifying the positions and the RF output powers of the base stations and, finally, adjusting the number of base stations.

9.3.2 Recommendations concerning the commitments

The commitment on this type of tricky project must be limited:

- Either to an offer with just a commitment on the means with no guarantee on the result(s) and providing customer support to improve the quality
- Or to making a quality level 3 offer with an additional service offer to evolve the quality subsequently.
- For sites with a zone presenting Clean Room type effects, there is no satisfactory solution at the DECT level.

10 Tools – “Site Survey Kit”

10.1 General

Important: *Installation and use of this Site Survey Kit and its accessories have to be performed by qualified service personnel only.*

Warning: *For safety reasons the Site Survey Kit should only be used when the ambient temperature is below 45℃ (113℉).*

The “Site Survey Kit” (SSK) allows you to do a Site Survey for your IP DECT system or DECT system or xBS system.

The contents of the “Site Survey Kit” are as follows (Name: SSK-INT A-LE):

The content of the DECT Site Survey Kit is:

- One suitcase
- One 8378 IP-xBS integrated antenna dedicated for the survey kit (it doesn’t run the same FW as the standard 8378 IP-xBS).
- One 8378 IP-xBS for external antenna dedicated for the survey kit (it doesn’t run the same FW as the standard 8378 IP-xBS).
- One gain antenna 8dBi with two TNC to SMA cables
- 2x power banks to power the base stations with 2 micro-USB to USB A cable to charge the batteries
- 2x power cables to connect power bank to base stations
- One ethernet cable to connect a PC on a Base station
- One support to assembly Base station, power bank and external antenna
- 2x 8242 DECT handset with battery and belt clip
- 2x Dual desktop charger for 8242 DECT handsets
- 2x verticals pouches for 8242 DECT Handsets
- 2x wired headsets for 8242 DECT Handsets
- 2x power supply for 8242 DECT Handsets dual charger

Note: *A tripod is **not** included in the Site Survey package. However, you can order the standard Site Survey tripod separately.*

Warning: *Only use the tripod that can be ordered separately with this Site Survey Kit, follow the installation instructions and take notice of the warnings in the manual that comes with this tripod. Never use the tripod in an inclined plane or unstable underground. For future reference it is advised to keep the tripod manual in the suitcase of the Site Survey Kit.*

Figure 18: Layout of the Site Survey Kit

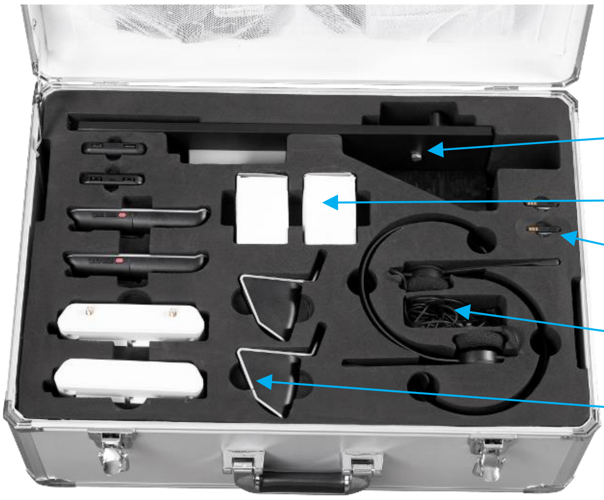
SSK package content

2 batteries for the base station

2 DECT handsets

Base station for external antennas

Base station with integrated antennas



SSK package content

Support plate

2 handset power supplies

2 handset spare batteries

2 headsets

2 handset cradle

SSK package content

2 handset pouches

2 USB type A / micro-USB cables

2 TNC / SMA cables

1 power supply cable

Figure 19, Figure 20, Figure 21: Layout of the Site Survey Kit show the contents and layout of the Site Survey Kit.

Figure 22: Layout of the Site Survey Kit

- ***New SSK****: 8378 IP-xBS SURVEY KIT Worldwide*
  Ref: 3BN67191AA
- *8378 IP-xBS* ***Telescopic Tripod*** *for the Site Survey Kit*
  Ref: 3BN67192AA

Besides the equipment in the Site Survey Kit, you will need the following tools:
Measuring equipment (such as a tape measure).

Clipboard, pencils for marking the survey map(s), and an eraser.

Digital photo camera (recommended) taking pictures of the locations where IP-xBS must be installed. Please note that the customer has to give you permission to take pictures.

10.2 Charging the batteries

10.2.1 Survey Kit Power Bank

The Site Survey Kit uses a power bank as its power source.

Note*: To sustain battery life, is important to fully charge the power bank at least once every six months.*

To charge the power bank, perform the following steps:
Connect the USB/micro-USB cable to one power supply and to the micro-USB connector in the middle of the power bank.
The power supply provided for the handset in SSK package can be used to charge the power bank.
Full charging time with this power supply will take about 5 hours when the battery is not used.

Note*: It is recommended to charge the power bank until all 4 charge indicators on the display have turned static (are not animated anymore).*
Note*: The power bank autonomy is up to 4 hours when supplying the base station and without being connected to its own power supply.*

10.2.2 Handset Batteries

Charge the handset batteries at least 3 hours in the handset to make sure that they are fully charged.
Use the handset chargers that come with the Site Survey Kit.

Always make sure that the batteries are in good condition.

10.3 Setting up the SSK tool

Important: *Installation and use of this Site Survey Kit and its accessories must be performed by qualified service personnel only.*

Note:*When using the tripod a level surface is required. In situations where this is not guaranteed the use of stabilization material as recommended by the original tripod supplier is required. If this is not feasible a second person is required to keep the tripod stable at all times.*

10.4 Setup Overview

The following gives a brief overview of the most important parts of the Site Survey Kit. Make also sure that you read the following pages, as they will explain the process in more details.

Figure 23: the complete kit assembled, using internal antennas

Figure 24: the complete kit assembled, using external antennas

10.5 Detailed Setup

10.5.1 Assembly details when using internal antennas:

Figure 25: Fixing plate, side with IP-xBS support and battery holder

Figure 26: connect the cable to the power bank using the USB-A connector and to the IP-xBS side using the DIN connector

Figure 27: clip the power bank on the battery holder

Figure 28: mount IP-xBS on its support

Fix the fixing plate on the tripod. Tighten the butterfly nut enough to be sure that the fixing plate is correctly fixed on the tripod.

10.5.2 Assembly details when using external directive antennas:

Figure 29: Fixing plate, side with IP-xBS support and battery holder

Figure 30: Fixing plate, side with pre-mounted external antennas

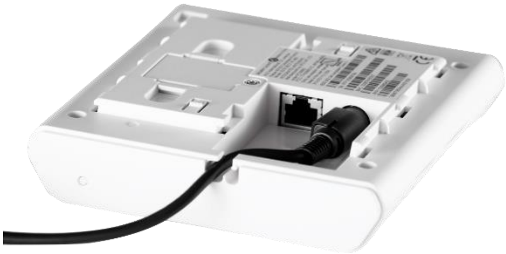


Figure 31: connect the cable to the power bank using the USB-A connector and to the IP-xBS (version with external antennas) side using the DIN connector

Figure 32: connect the two antenna TNC/SMA cables to the two N connectors of external antennas

Figure 33: connect the two TNC/SMA cables on the IP-xBS SMA antenna connectors then connect to the IP-xBS to its battery, mount the IP-xBS on its support.

Note: *Be careful fixing the SMA cable connectors to the SMA connectors on the Base Station. Using a wrench can easily damage the connectors. Fix them “hand tight” only or use a dedicated SMA Torque Wrench*

Figure 34: fully assembled fixing plate connected to the tripod

Tighten the butterfly nut enough to be sure that the fixing plate is correctly fixed on the tripod

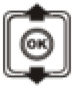
11 Site survey preparation

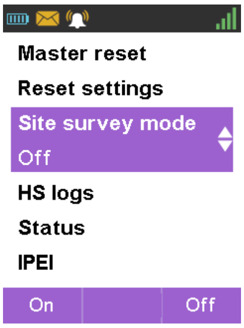
The thoroughness with which all preparations can be done depends upon the information available regarding the site to be surveyed.

11.1 Checking the Survey Equipment for correct operation

To check the equipment, execute the following procedure:

1. Make sure that the Survey Base Station battery and handset batteries are fully charged.
2. Mount the Base Station and Power Bank on the fixing plate and to the tripod.
3. If not yet done, connect the battery to the Base Station. Check that the LED is steady on and green (after a while). This means the Base Station is up and running. To change the region, see section 11.1.3 – SSK: Change region.
4. Make sure that the 8242 DECT handsets are switched on and “on-hook”. To register 8242 DECT handsets (if needed), see section 11.1.1- Registration of handset(s).
5. Repeat this step for each 8242 DECT handset.
6. Put the tripod with the Base Station and the power bank in an open environment, outdoors (or in a corridor, indoors with typical office space having beta < 3.5). Keep 20 **meters** between the Survey Base station and the handset and make sure that there is nobody/nothing in-between.
7. On each 8242 DECT handset that you want to involve in the Site Survey, in idle homepage, press OK key to get menu screen, type ***7378423*** (mnemonic: ***service*)** from the keypad to display the Service Menu, select “Site survey mode” and select “On”.





Master reset

Reset settings

Site survey mode

Off

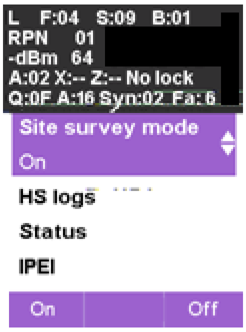
HS logs

Status

IPEI

Figure 35: Site survey mode menu / 8242 DECT handset

8. Now you will see Site Survey information displayed in the top part of the display (for explanation of the fields, consult section 12.2 - Setting up the Equipment).



```
L   F:04  S:09  B:01
RPN   01
-dBm  64
A:02 X:-- Z:-- No lock
Q:0F A:16 Syn:02 Fa:6
```

[redacted]

Site survey mode

On

HS logs

Status

IPEI

Figure 36: Site survey display / 8242 DECT handset

Check the RSSI reading (behind the -dBm indication). You will see that it fluctuates. Keep the handset still for at least two minutes and determine the average value. Close to the base station the average RSSI value should be around - 30 dBm.

11.1.1 Registration of handset(s)

Powering up the handset the first time, it must register on the base using Access Code 7750 (‘SSK0’). The handset registration can be done without using the base station web interface.

The base can register 10 handsets (number 1 to 10). Once registered, only these handsets can be used.

To deregister properly one handset, use the base station WBM interface.

A long press on the reset button makes a factory reset (all the handsets are deregistered).

To assist verification of correct registration, the handset will display the registration number as SSK<N>, where <N> is the registration.

11.1.2 Activation of the audio tone

This will allow to do the site survey alone by using the two handsets.
On the handset which stays close to the base:

1. enter in the service menu and activate the tone generator:
   a. Press ‘menu’ button’, and
   b. press digit: ***7378423***
   c. In ‘service menu’, scroll to “**Test Tone on OK**”
   d. Use softkeys ‘On’ and ‘Off’ to toggle the option
2. make a call to the other handset (the phone number is always the number x behind its name “SSKx” which is displayed on its screen in idle)
3. while in call, press ‘OK’ button on the handset staying close to the base and a tone will be heard on the second handset. A second press on the ‘OK’ button stops the tone.

11.1.3 SSK: Change region

As part of the handset indication, the active base country is shown. This can be changed without using the base web interface by using the handset and dialing ‘4*SSK<CC>’, where <CC> is the country code identifier (0..9) as shown in in the following table and press the off-hook key:

Code	Display	Comment
0	EU	Europe DECT mode.
1	US	USA DECT mode.
2	South AM	South America DECT mode.
3	Taiwan	Taiwan DECT mode.
4	Malaysia	Malaysia DECT mode.
5	China	China DECT mode.
6	Thailand	Thailand DECT mode.
7	Brazil	Brazil DECT mode.
8	Chile	Chile DECT mode.
9	Australia	Australia DECT mode.

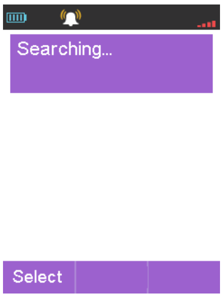
The active region is identified in the handset by the registration name: SSK<N> [<Region>], where <Region> is identified as the display column in the previous table.

When dialing the ‘change region’ number and pressing off-hook, there will be a short indication that the call is ended, and shortly after, the base will reboot and start with the new region. The handset will then search for its registration, and after a few minutes it will be registered, and the new region can be verified.

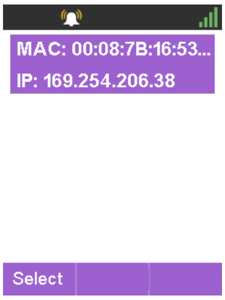
11.1.4 Configuration used for the Site Survey Kit

The configuration of the site survey kit can be done without any PC but if you need to upgrade the SSK software or delete some handset registrations, you will need to use the web-based management WBM of the SSK base station using the following configuration:

Don't connect the base station to the network but directly to a PC with a RJ45/RJ45 cable.
When the base station LED is green, you can retrieve the given IP address by pressing the menu key in idle then type *IP* on the 8242 DECT handset:



Searching...



MAC: 00:08:7B:16:53...
IP: 169.254.206.38

Reconfigure the PC to use static IP parameters. In the "Network and Sharing Center" set the "Local Area Connection" properties TCP/IPv4 in IP static also using an address in the same subnet (same IP address excepted to last octet). Configure also the network mask and the default gateway IP address with another IP address in the same subnet.

With base station having version V02 B0002:

When powering up the SSK, it starts with a DHCP request (with a vendor class-id = **tbc**) to a DHCP server.

- As no DHCP is available on the network, it will take 5-6 minutes before it is running. In that case the IP address will be on the 169.254.x.x subnet. The exact IP address can be found by pinging the subnet mask 169.254.255.255 on the PC or by typing *IP* on the 8242 DECT handset.
- Note that when a DHCP server is available on the network, a dynamic IP @ can be given by the server, you can either retrieve the given IP address by typing *IP* on the 8242 DECT handset as explained before or get it directly from the server logs.

With base stations having version higher than V02 B0002:

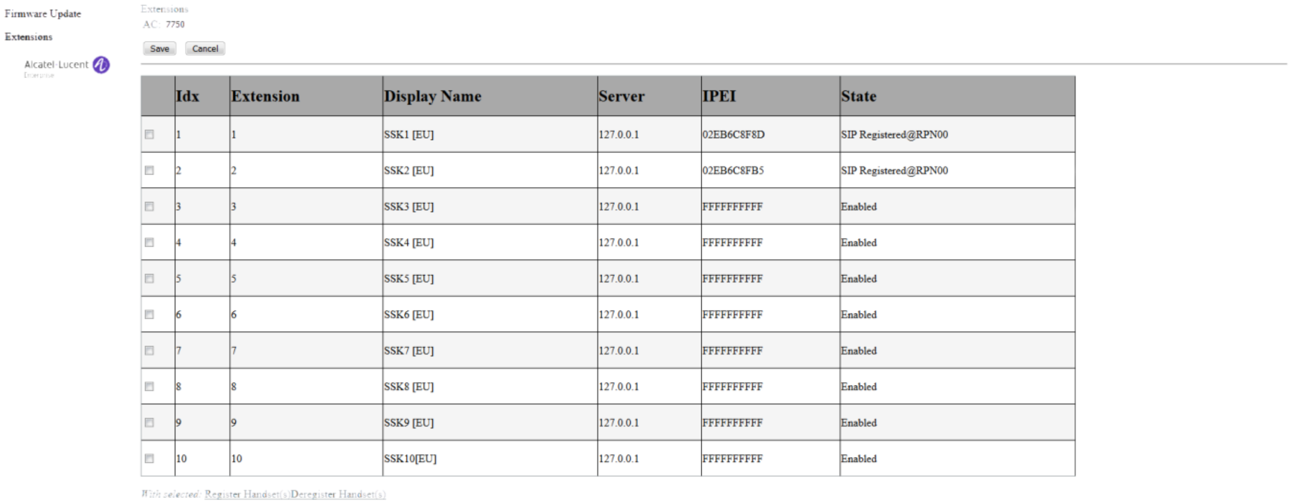
When powering up the SSK, it starts with a static the IP address 192.168.0.168. There is no more DHCP requests.

The web interface can be accessed on that address. Credentials must be input: the login is "admin" and the password is "admin". They cannot be changed.

List of compatible browsers: Firefox, Chrome, Edge 41

Firmware update screen: it allows to browse on the PC the base station firmware file that you want to load to the base. Take care to download only the FW specific to the SSK (it is named 8663_ipxbs_ssk_v00xx_b00yy) and not one from 8378 DECT IP-xBS.

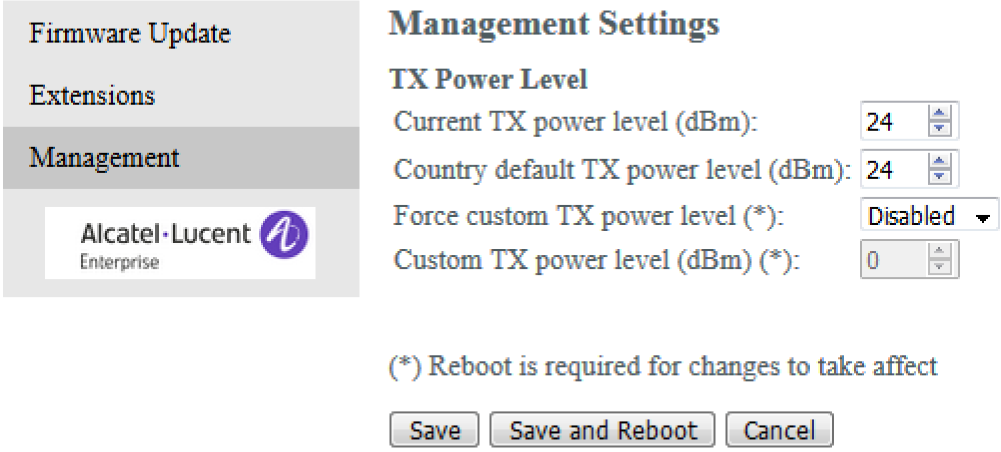
Handset (Extensions) registration page: it allows to register/deregister the handsets and to know the handsets status ("SIP Registered" when correctly registered and present, "Detached" when registered and powered off, "Enabled" when the extension is free for a new registration).



AC: 7750

	Idx	Extension	Display Name	Server	IPEI	State
☐	1	1	SSK1 [EU]	127.0.0.1	02EB6C8F8D	SIP Registered@RPN00
☐	2	2	SSK2 [EU]	127.0.0.1	02EB6C8FB5	SIP Registered@RPN00
☐	3	3	SSK3 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	4	4	SSK4 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	5	5	SSK5 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	6	6	SSK6 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	7	7	SSK7 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	8	8	SSK8 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	9	9	SSK9 [EU]	127.0.0.1	FFFFFFFFFF	Enabled
☐	10	10	SSK10[EU]	127.0.0.1	FFFFFFFFFF	Enabled

Management page: it allows to change the TX output power.



Management Settings

TX Power Level

Current TX power level (dBm): 24

Country default TX power level (dBm): 24

Force custom TX power level (*): Disabled

Custom TX power level (dBm) (*): 0

(*) Reboot is required for changes to take affect

11.2 Maps

Maps should be prepared in a format that can easily be carried around the site. When enlarging or reducing the format, make sure that dimensions are not lost (be sure that there is a calibration line at each map). Also, each map must be clearly marked with the location identity.

11.3 Other Paperwork

Before executing a survey, a query list needs to be assembled, listing the information to be gathered during the survey apart from the radio coverage information (see chapter 14 - Checklist for Survey Data).

11.4 Base station positions during survey

If possible, plan the Base Station positions to be measured before starting the survey, including alternative configurations, taking into account estimated cell sizes.

The following Base Station ranges can be used as a rough guide to plan the Base Station positions:
- In the line of sight, the Base Station has a range of about 80m.
- In halls the Base Station has a range of < 80m.
- In buildings the Base Station has a range of about 15-40m. This assumes that walls are made of light brick, plasterboard or wallboard with metal frames. Normal electrical wiring, central heating pipes, office furniture and desktop computer equipment have no significant effect. The signal shadowing effect made by stairways, lift shafts shielded rooms etc. should be considered.

The following items may well cause shadowing of the radio signal:
- Thick walls, especially cavity walls and reinforced concrete walls.
- Windows or glass in doors with steel wire reinforcement or metallic reflection film.
- Steel doors, partitions or walls.
- Fire resistant doors.
- A wall of steel cabinets, large computer equipment or machinery.
- Thick concrete floors.

During the site survey, be aware of the following:

- Choose a corridor or other large open space for Base Station positions rather than an enclosed area so that the radio signal passes through as few walls as possible to reach as large an area as possible.
- Radio reception inside a vehicle may be poor unless very close to the Base Station.
- The Base Station should be placed high enough to be unaffected by surrounding objects. For example, a Base Station in a car park needs to be placed higher than a vehicle that may be parked next to it.
- Base Stations must be placed at least 1 metre apart from each other!
- The presence of another un-synchronised DECT System or similar system in adjacent buildings may cause interference.
- A Base Station or a PP might interfere with sensitive laboratory equipment, medical equipment, and so on (E.g., do not install a Base Station in an operating-room in a Hospital!)
- Check that no significant interference from un-suppressed engines or electric motors has been experienced.

11.5 Customer Preparation

If a customer contact person is assigned, this gives the opportunity to collect additional information as required, set times and dates, discuss accessibility (access to certain areas may be restricted at certain times or altogether, some areas may be locked), and give the customer an idea of what to expect i.e. how a survey is done. It may be a good idea to have other employees on the customer site informed that a 'stranger' with a handset might be seen wandering around in their workspace.

12 Site survey execution

12.1 General

Site Survey execution should be done with at least one, preferably two persons.

There are three main criteria for the cell boundary:

- **Voice quality.**
- **Signal strength.**
- **Frame errors (if there are audible clicks in the voice connection).**

To check the voice quality, a voice connection should be set-up between two persons. One person should stay close to the Base Station, the other one should move away to determine the cell boundary. This gives a good impression on the radio signal behaviour close to the Base Station and at the cell boundary.

The person determining the cell boundary checks on voice quality, signal strength and frame errors. He/she can do this by means of a single handset with headset, or one handset for listening and another handset for checking the signal strength.

In Figure 37 the functions of the persons are depicted.

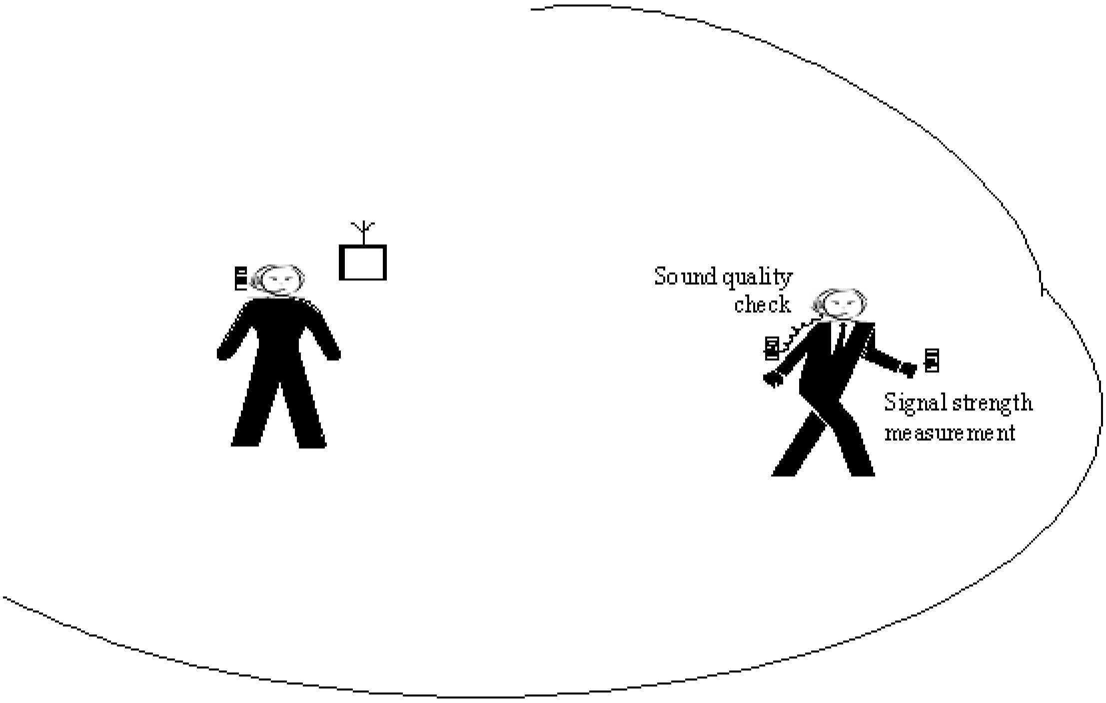


Figure 37: Site Survey / Deployment in Action

Note: *Keep the handset in vertical position when doing a Site Survey. If in horizontal position, the reading is not correct!*

If you are with two persons, one should stay at the Base Station position and the other one should determine the cell boundary.

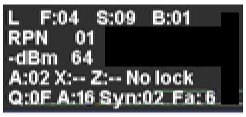
Warning: *Conducting a site survey involves safety hazards such as (but not limited to) “working at height” and other hazards dependent upon the location where the survey is conducted.*

Remember to conduct a Health & Safety risk assessment before commencing work and to take appropriate measures to avoid or reduce the risk of injury to yourself and others.

12.2 Setting up the Equipment

After having taken the preparatory steps (see chapter 11 - Site survey preparation), execute the following steps:

1. Make sure that the Survey Base Station and handset batteries are fully charged.
2. Mount the plastic boards (with Base Station and battery on them) to the tripod.
3. If not yet done, connect the Battery Cabinet to the Base Station.
4. Switch the Base Station on using the switch on the Battery Unit and wait for the LED to be steady on; the Base Station is up and running.
5. Set-up a Survey Base Station at a planned Base Station position.
   Choose the locations for the Survey Base Station as close as possible to the locations where the Base Stations can be actually installed. Look also for suitable cable ducts. Put the Survey Kit in the position with the battery pack at the side of the wall.
6. Adjust the tripod to put the Survey Base Station near the ceiling for an office environment (at a height of approximately 2 meters (±0.5m) above the ground) or as high up as possible in a large area (such as a warehouse). If the Survey Base Station is outside then put it at a height >> 2m (of about 5 m, if possible).
7. Make sure that the 8242 DECT handsets are switched on and “on-hook”.
8. On each 8242 DECT handset that you want to involve in the Site Survey, in idle homepage, press OK key to get menu screen, type ***7378423*** (mnemonic: ***service***) from the keypad to display the Service Menu, select “Site survey mode” and select “On”.
9. Now you will see the following Site Survey information displayed in the top part of the display.



```
L   F:04  S:09  B:01
RPN    01
-dBm  64
A:02 X:-- Z:-- No lock
Q:0F A:16 Syn:02 Fa:6
```

Figure 38: Site survey display

Legend for the site survey:
Line1:
Lock State | Frequency | Slot | Base RPN locked |
Line2:
RPN (up to 5 Bases/DAPs)
Line3:
RSSI (up to 5 Bases/DAPs)
Line4:
A field CRC error | X field CRC error | Z field CRC error | No Lock / Lock to: base number
Line5:
Quality index | Slow/Rapid Measurements | Syn error field | Fading.

Or when Vol- key is pressed:
Line4:
RFPI in octal
Line5:
RFPI in hex
Remark: Press Vol+ key to come back to the previous screen.

Note:

- *Long press on * key: Slow/Rapid measurements*
- *Long press on # key: No Lock / Lock to base*

The Site survey can freeze the result, it can be hidden for the user and be unhidden.
This is controlled via the side function key (under Vol- key).

- *. Press: Result is frozen, and a "P" is shown to left upper corner*
- *. Press: Site survey display is now hidden*
- *. Press: Back to normal view*

L F:03 S:09 B:02 P

Figure 39: Site survey display of frozen results

10. Go off hook and dial the one-digit extension number of one of the other 8242 DECT handsets that you use in the Site Survey.
    Or if you are doing the site survey on your own, dial "0" and you will hear dial tone continuously, which can be used to check the sound quality. You can skip step 11 if you are doing the site survey on your own.

11. If you dialed another extension, the dialed extension starts ringing. Go off hook. Now you have a voice connection which can be used to check the sound quality.

12. In the 8242 DECT handset display, you will see the following important fields displayed:

    - **RPN:**
      This is the unique (hexadecimal) number of your Base Station. In the Site Survey kit, this should always be 01. By means of this number you can see that the handset is "locked" to (looks at) your Site Survey Base Station.
    - **-dBm**
      The -dBm value is the actual signal strength of the signal received from the Base Station (RSSI value in -dBm for given RPN). It will never be better than -26 dBm because the value is internally limited in the 8242 DECT handset to this value.
    - **CRC errors in resp. A, X and Z field**
      Here you see the hexadecimal number of CRC errors in the various fields measured over 120 frames.
    - **Quality index of transmission**
      Here you see the number of error-free frames that has been received (last 16 frames are observed).
    - **Fa**
      Fading (in dB)

13. For finding the cell boundaries you must check the following parameters:

Voice Quality

Check the speech quality. This can be done in the following ways:

- Using the voice connection from the 8242 DECT handset to the 8242 DECT handset. Now you have a voice connection, and you can check the speech quality.
- If you are all on your own, call the second handset and use its tone generator as described in section 11.1.2 for sound quality check on the first handset.

Note: *The sound should be without "clicks" or other interruptions.*
If there are clicks while you are moving, it may indicate that there are a lot of reflections in the area. Reflections are caused by metal walls, etc. Check whether there is a lot of metal in the walls. In some exceptional cases, DECT cannot be installed in environments with a lot of metal due to excessive reflections against the walls and ceiling.

Signal Strength (in - dBm)

Check the -dBm reading in the display.

The cell boundary is reached when the -dBm value is -70 dBm (for easy coverage) or - 60 dBm (for tricky coverage). For air synchronization (IP-DECT, IP-xBS and SIP-DECT) the signal strength between two base stations must be most of time better than -75dBm and never less than -80 dBm.

Quality Index
Preferably all received frames should be error free, hence the Quality Index should read 16 (being that the last 16 frames were received without errors).
If the Quality Index is lower than 12 this might result in bad sound quality. Check the (audible) sound quality to find out if this is still acceptable or not.

CRC errors
CRC errors may occur in DECT, but not too many.
The number of CRC errors for either of the A, X or Z field per reading should in total not be more than 4!
The number of CRC errors is only indicative information – for the determination of the cell boundaries the Quality Index and the audible sound quality are the really determining factors.

(The survey handset should be held at about 1.5m (±0.3m) above the ground when making measurements.)

14. Note the results on the relevant maps. Take care that the relation between the “Site Survey Base Station” position and the corresponding cell is clearly defined, using the numbering scheme given in chapter 13 - Reporting Results.
    Note that for a multi-story building it must be clear on what floor the “Site Survey Base Station” was positioned and that the result may be several cell contours on different floors. In this case in particular a careful record must be kept for later unambiguous analysis.
    The position of an elevator shaft, lorry or other large movable object may also affect radio reception. If possible, arrange for the object to be moved and check the cell boundary again.
15. Repeat steps 5...14 for the remaining planned Base Station positions.
    Make sure that, when applicable, positions are also measured that may be relevant for alternative configurations.
    Cells should be at least adjacent to one another; overlap with respect to “Good Voice Quality” is not required except where traffic density requires this. Overlap of the “Good Sync Quality” call range is of course required (refer to Figure 38).
16. It may, at this stage, be necessary to move some of the planned Base Station positions or add new Base Station positions to eliminate shadows or optimise cell size. If so, it may also be necessary to do additional measurements to check that the new Base Station positions do not create other problems.
17. Choose the Base Station positions required. This may need to be done in consultation with a customer engineer.
    In choosing Base Station positions, the required cabling to the DECT System should be considered. Base Station positions must be defined such that later installation problems are minimised, i.e. the DAP can be physically attached at the planned position and the wiring can be laid with the minimum of effort. *Record details of the planned Base Station positions, including wiring considerations, special installation instructions etc.*
    Depending on the materials (no metal in it, thin materials etc.) of the ceiling, a Base Station can be concealed above a suspended ceiling, provided it is not of a metal construction. A Base Station can be installed within a metre or two of the planned position without adversely affecting radio reception.
18. Turn the handset off to leave the Site Survey mode on the handset.

12.3 Hints and Tips on “How to Survey”

12.3.1 General

During the execution of a Site Survey, you must make sure that you know all the details about the required coverage, e.g.

If a car park must be covered, must it be covered for an empty car park, full car park, only outside cars or also inside cars? If also inside the cars, then must this be measured with the doors and windows of the cars closed or open, and so on.

Must toilets be covered as well, and how good must the voice quality be in a toilet with the doors closed?

Are basements to be covered as well? If so, how good must the coverage be?

It is very important that these details are written down on paper, and that the customer agrees with that.

Note: *If you do the site survey, it is recommended that all doors are closed. Close all fire doors as well.*

12.3.2 How to Survey a Single Floor

The following is the basic procedure to determine the cell centre and the cell boundaries. In Figures 21a & 21b, an example of a single floor is depicted.

Note*: The width of the floor (W) is lower than the side of the square (Z) of a Base Station coverage.*

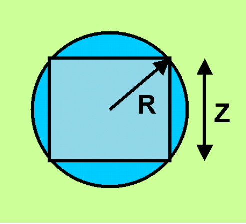


Figure 40: Coverage of a DECT cell vs radius (R)

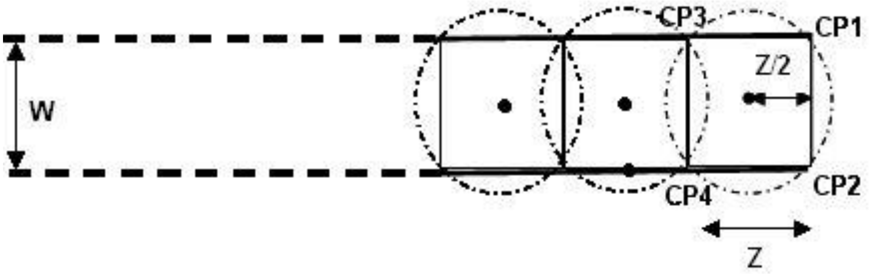


Figure 41: Example of a Single Floor Coverage

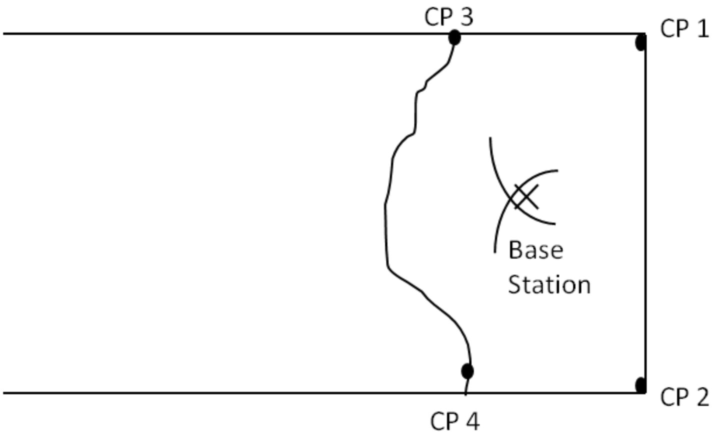


Figure 42: Example of a Single Floor Coverage

The procedure is as follows:

1. Determine the outer points in the building. These points are the so-called “Critical Points”. (In Figure 41 & Figure 42, these are CP1 and CP2).
2. Place the Base Station of the Site Survey on CP 1 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. Place the Base Station of the Site Survey on CP2 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
4. The best location for the cell center is where the critical point contours cross.
5. Position the Base Station of the Site Survey on the CP1/CP2 cross and raise it to the height where the DAP must be fitted.
6. Now check the cell boundary. Check that the RSSI value at CP1 and CP2 are enough (-70 dBm for easy coverage or -60 dBm for tricky coverage). Draw the cell on the map.
7. Determine new Critical Points (CP 3 and CP 4 in Figure 41 & Figure 42) at the external walls and repeat the procedure from step 1 onwards.
8. For IP Base Stations only (not for TDM bases), check that, when you position again the DAP of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous Base Station or for another Base Station (A Base Station must always “see” another Base Station at a RSSI level ≥-80 dBm).

12.3.3 How to Survey a Wider Single Floor

12.3.3.1 How to Survey a Wider Single Floor (W <2.5Z)

If the width of the area is greater (see Figure 43 & Figure 44) than the width of a coverage cell (Z) and lower than 2.5 Z, then the following procedure must be executed:

Note: The width of the floor (W) is greater than the side of the square (Z) of a Base Station coverage.

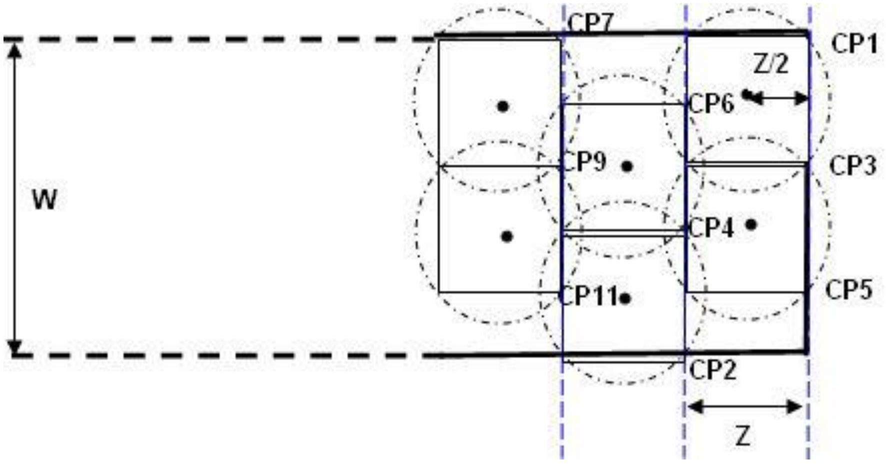


Figure 43 Example of a wider Single Floor Coverage (W <2.5Z)

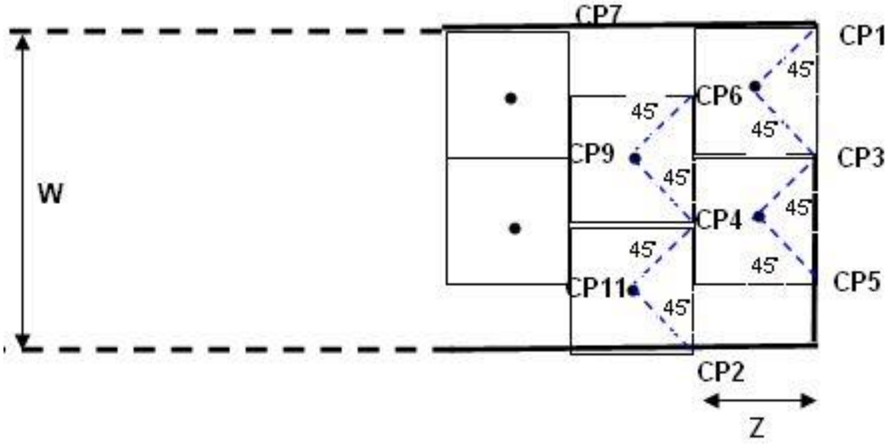


Figure 44 Example of a wider Single Floor Coverage (W <2.5Z)

The procedure is as follows:

1. Determine one outer point in the building (see Figure 43 & Figure 44). This point is the so-called “Critical Point”. (CP1).
2. Place the Base Station of the Site Survey on CP 1 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
4. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
5. Where the cell crosses the outer wall of the building, one new Critical Point (CP3) is defined.
6. Place the Base Station of the Site Survey on CP 3 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
7. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
8. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
   For IP Base Stations only (not for TDM bases), check that, with the new position of the Base Station of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous cell center (previous position of Base Station) or for another Base Station (a Base Station must most of time “see” another Base Station at a RSSI level ≥-75 dBm and never less than -80 dBm).
9. Where the cell crosses the outer wall of the building, one new Critical Point (CP5) is defined.
10. As W < 2.5Z, determine one point (CP2, so-called “Critical Point”) in the building (see Figure 44). CP2 is at a distance Z from the outer wall. The vertical passing through CP2 becomes the new virtual outer wall.
11. Place the Base Station of the Site Survey on CP 2 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
12. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
    The base station distribution will be done as per a network of hexagonal cells. So, this cell center can be adjusted to comply with the network of hexagonal cells (see Figures 22a & 22b)
13. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.

14. Where the cell crosses the virtual outer wall of the building, one new Critical Point (CP4) is defined.
15. Place the Base Station of the Site Survey on CP 4 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
16. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
17. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
    For IP Base Stations only (not for TDM bases), check that, with the new position of the DAP of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous cell center (previous position of Base Station) or for another Base Station (a Base Station must most of time “see” another Base Station at a RSSI level ≥-75 dBm and never less than -80 dBm).
18. Where the cell crosses the virtual outer wall of the building, one new Critical Point (CP6) is defined.
19. As W < 2.5Z, determine one point (CP7, so-called “Critical Point”) in the building (see Figure 44). CP7 is at a distance Z from the virtual outer wall (or 2Z from the outer wall). The vertical passing through CP7 becomes the new virtual outer wall. Go to 1 and repeat the procedure considering CP7 as new CP1 and the vertical passing through CP7 as the new virtual outer wall.

12.3.3.2 How to Survey a Wider Single Floor (W <3.5Z)

If the width of the area is greater (see Figure 45 & Figure 46) than the width of a coverage cell (Z) and lower than 3.5 Z, then the following procedure must be executed:

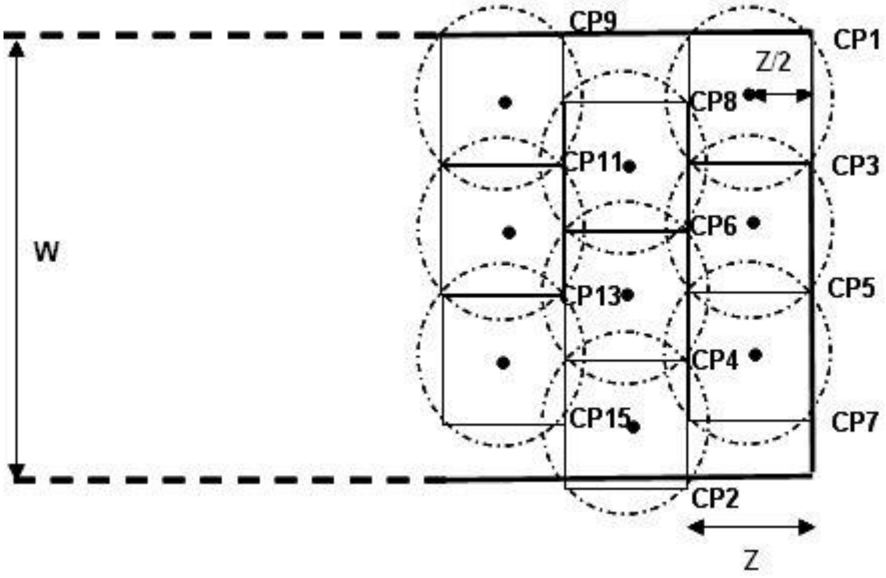


Figure 45: Example of a wider Single Floor Coverage

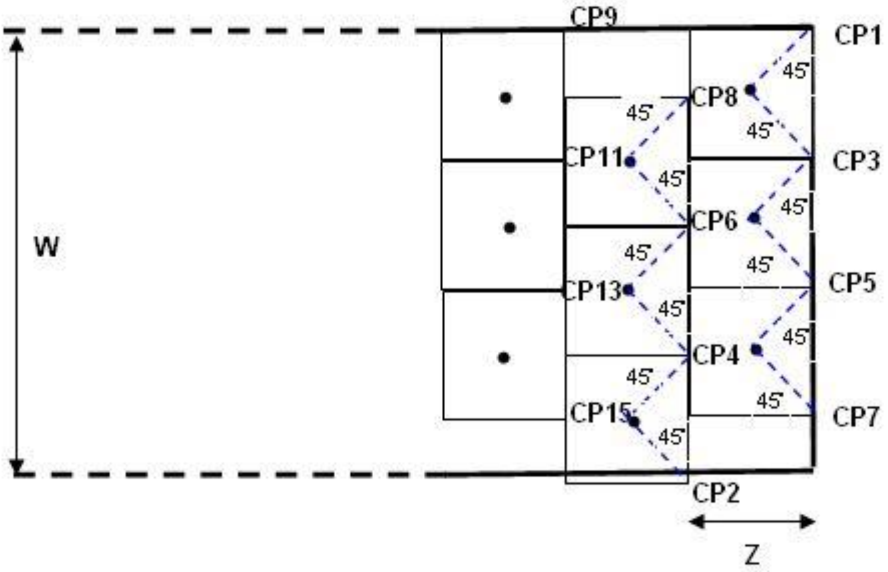


Figure 46: Example of a wider Single Floor Coverage

The procedure is as follows:

1. Determine one outer point in the building (see Figure 45 & Figure 46). This point is the so-called “Critical Point”. (CP1).
2. Place the Base Station of the Site Survey on CP 1 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
4. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
5. Where the cell crosses the outer wall of the building, one new Critical Point (CP3) is defined.
6. Place the Base Station of the Site Survey on CP 3 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
7. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
8. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
   For IP Base Stations only (not for TDM bases), check that, with the new position of the Base Station of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous cell center (previous position of Base Station) or for another Base Station (a Base Station must most of time “sees” another Base Station at a RSSI level ≥-75 dBm and never less than -80dBm).
9. Where the cell crosses the outer wall of the building, one new Critical Point (CP5) is defined.
10. Place the Base Station of the Site Survey on CP 5 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
11. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.

12. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
    For IP s only (nor for TDM bases), check that, with the new position of the Base Station of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous cell center (previous position of Base Station) or for another Base Station (a Base Station must most of time “see” another Base Station at a RSSI level ≥-75 dBm and never less than -80 dBm).
13. Where the cell crosses the outer wall of the building, one new Critical Point (CP7) is defined.
14. As W < 3.5Z, determine one point (CP2, so-called “Critical Point”) in the building (see Figure 45). CP2 is at a distance Z from the outer wall. The vertical passing through CP2 becomes the new virtual outer wall.
15. Place the Base Station of the Site Survey on CP 2 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
16. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
    The base station distribution will be done as per a network of hexagonal cells. So, this cell center can be adjusted to comply with the network of hexagonal cells (see Figure 45 & Figure 46)
17. Position the Base Station of the Site Survey on the cell center and raise it to the height where the Base Station must be fitted.
18. Where the cell crosses the virtual outer wall of the building, one new Critical Point (CP4) is defined.
19. Place the Base Station of the Site Survey on CP 4 on a height of approximately 2 meters (±0.5m). Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
20. The location for the cell centre is at roughly 45 degrees where the RSSI value is -70 dBm for easy coverage or -60 dBm for tricky coverage.
21. Position the Base Station of the Site Survey on the cell center and raise it to the height where the DAP must be fitted.
    For IP Base Stations only (nor for TDM bases), check that, with the new position of the Base Station of the Site Survey, the minimum required signal strength for synchronization of **-75 dBm** is achieved at the position obtained for the previous cell center (previous position of Base Station) or for another Base Station (a Base Station must most of time “see” another DAP at a RSSI level ≥-75 dBm and never less than -80 dBm).
22. Where the cell crosses the virtual outer wall of the building, one new Critical Point (CP6) is defined.
23. As W < 3.5Z, determine one point (CP9, so-called “Critical Point”) in the building (see Figure 45). CP9 is at a distance Z from the virtual outer wall (or 2Z from the outer wall). The vertical passing through CP9 becomes the new virtual outer wall. Go to 1 and repeat the procedure considering CP9 as new CP1 and the vertical passing through CP9 as the new virtual outer wall.

12.3.3.3 How to Survey a Wider Single Floor (W < ((n+0.5)Z)

If the width of the area is greater than the width of a coverage cell (Z) and lower than (n+0.5) Z with n integer and n >3, then a similar procedure as the one listed above must be executed to comply with a network of hexagonal cells.

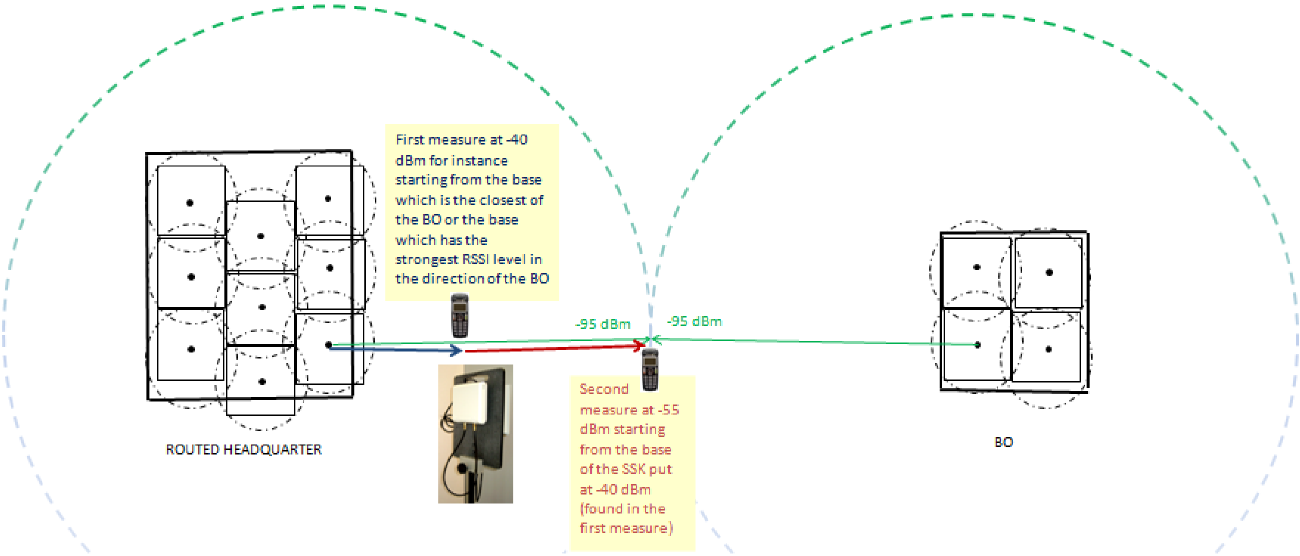
12.3.4 How to Survey a Multi Floor Area

There are two approaches in surveying a multi storey building:

3. Survey each floor as individual parts. The radiation between floors is used to allow higher traffic density even if it undervalued for coverage.
   In this approach you are always sure that the coverage on each floor is reliable.
4. Survey one floor and write down the cell boundaries on the higher and lower floor as well. Knowing the cells on the higher and lower floors, you can survey these floors, to determine where additional DAPs must be placed.

Note: *Radiation through floors depends highly on the construction materials of the floors. These materials are normally reinforced concrete, which gives a lot of signal loss. Also, in ceilings there are most likely cable ducts, which produce holes in the coverage on the higher and lower floors. Therefore, coverage via floors is not always reliable!*

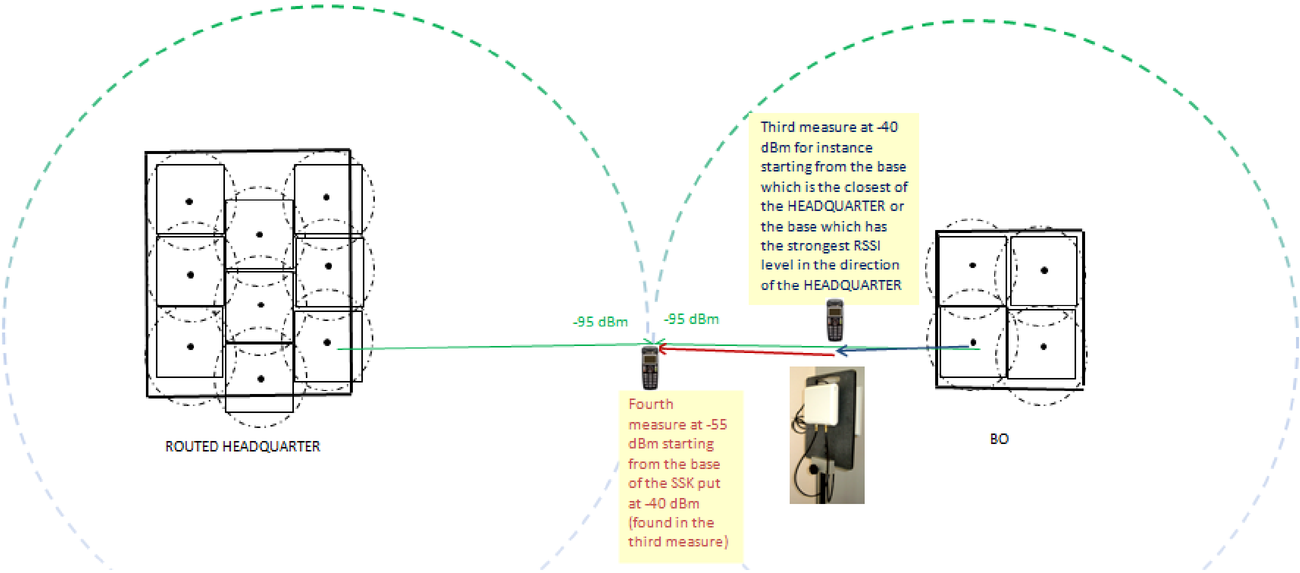
12.3.5 How to determine the -95 dBm limit for one synchronization cluster with the SSK



First measure at -40 dBm for instance starting from the base which is the closest of the BO or the base which has the strongest RSSI level in the direction of the BO

Second measure at -55 dBm starting from the base of the SSK put at -40 dBm (found in the first measure)

Figure 47: Measures starting from the HEADQUARTER (main location)



Third measure at -40 dBm for instance starting from the base which is the closest of the HEADQUARTER or the base which has the strongest RSSI level in the direction of the HEADQUARTER

Fourth measure at -55 dBm starting from the base of the SSK put at -40 dBm (found in the third measure)

Figure 48: Measures starting from the BRANCH OFFICE (remote location)

The procedure is as follows:

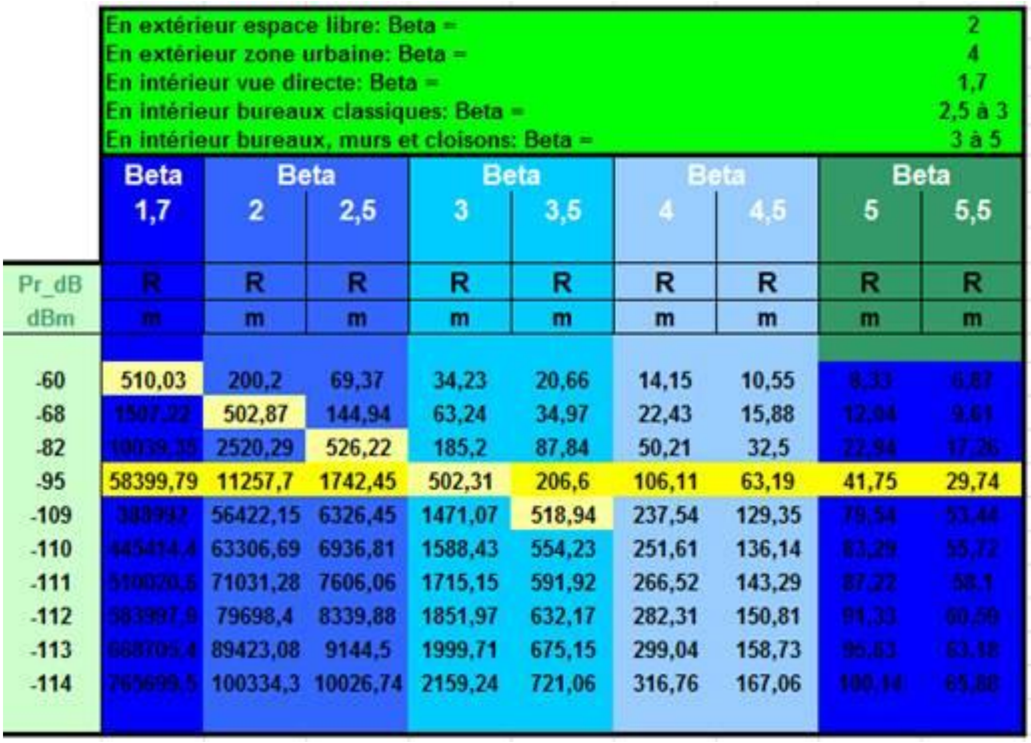
Assumption: Base Stations are deployed and operational in the Routed Headquarter (main location)

1. With a DECT handset in site survey mode registered in the main location, make a measurement at -40 dBm starting from the base of the Head Quarter which is the closest of the BO or the base of the Head Quarter which has the strongest RSSI level equal to -40 dBm in the direction of the BO.
2. Place the Base Station of the Site Survey Kit at the location of the -40 dBm measurement on a height of approximately 2 meters (±0.5m). Walk away from the Base Station in the direction of the BO.With a DECT handset in site survey mode registered on the SSK, make a measurement at -55 dBm dBm starting from the base of the SSK. Write down where the -95 dBm boundary from the Head Quarter is. It corresponds to the limit of the Head Quarter synchronization cluster in the direction of the Branch Office.
3. With a DECT handset in site survey mode registered in the remote location (or with a DECT handset in site survey mode registered on the SSK if there is no Base Station deployed in the BO), make a measurement at -40 dBm starting from the base of the Branch Office which is the closest of the Head Quarter or the base of the Branch Office which has the strongest RSSI level equal to -40 dBm in the direction of the Head Quarter (or starting from the base of the SSK if there is no Base Station deployed in the BO).
4. Place the Base Station of the Site Survey Kit at the location of the -40 dBm measurement on a height of approximately 2 meters (±0.5m). Walk away from the Base Station in the direction of the Head Quarter.With a DECT handset in site survey mode registered on the SSK, make a measurement at -55 dBm dBm starting from the base of the SSK. Write down where the -95 dBm boundary from the Branch Office is. It corresponds to the limit of the Branch Office synchronization cluster in the direction of the Head Quarter.

There must be no overlap between the synchronization clusters.

***Note**: -40 dBm and -55 dBm are RSSI levels that could be replaced by -30 dBm and -65 dBm (The aim is to have the sum of the 2 measures equal to -95 dB, knowing that the DECT handsets used with the SSK cannot measure RSSI ≤ -88 dBm (maximum guaranteed sensitivity). -95 dBm circles are symbolic representations. The -95 dBm limit is any geometrical shape given the different potential barriers between the base and the handset used for measurements.*

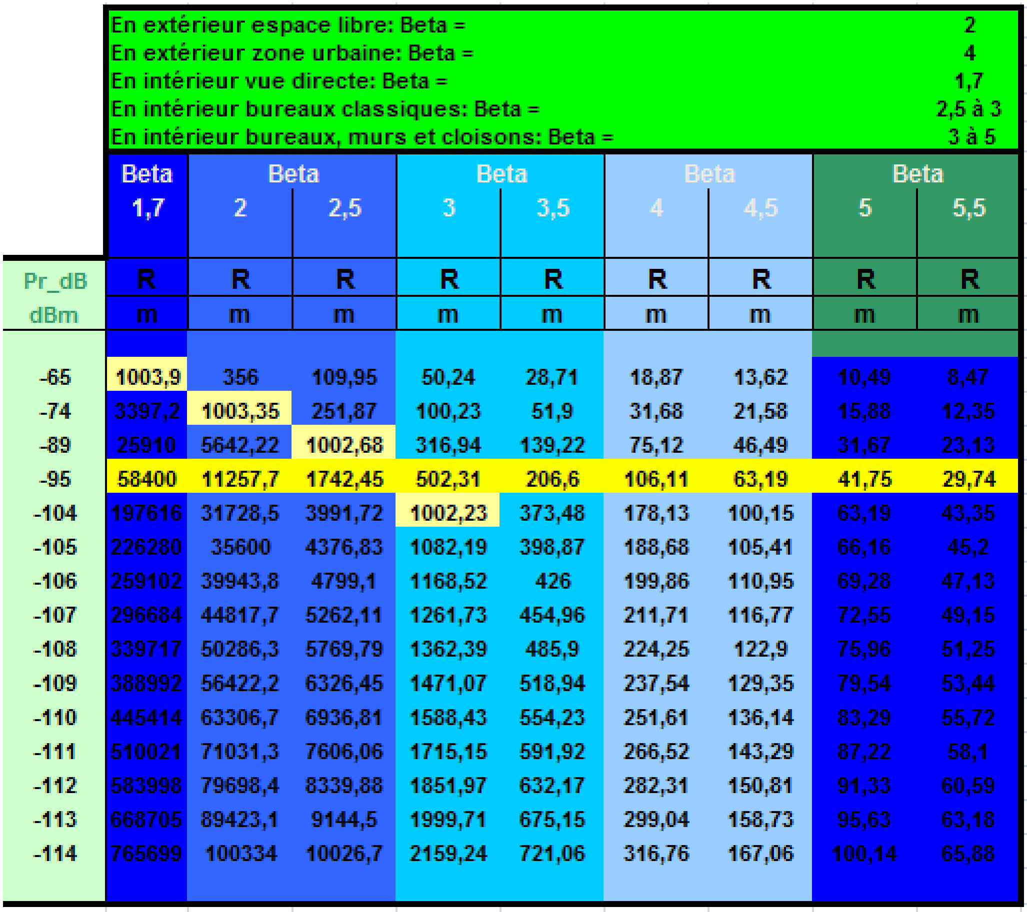
***Remark**: RSSI levels at 500m & 1000m and distance at -95 dBm vs propagation index (Beta) are given hereafter.*



En extérieur espace libre: Beta = 2
En extérieur zone urbaine: Beta = 4
En intérieur vue directe: Beta = 1,7
En intérieur bureaux classiques: Beta = 2,5 à 3
En intérieur bureaux, murs et cloisons: Beta = 3 à 5

	Beta	Beta		Beta		Beta		Beta	
	1,7	2	2,5	3	3,5	4	4,5	5	5,5
Pr_dB	R	R	R	R	R	R	R	R	R
dBm	m	m	m	m	m	m	m	m	m
-60	510,03	200,2	69,37	34,23	20,66	14,15	10,55	8,33	6,87
-68	1507,22	502,87	144,94	63,24	34,97	22,43	15,88	12,94	9,61
-82	10039,35	2520,29	526,22	185,2	87,84	50,21	32,5	22,94	17,26
-95	58399,79	11257,7	1742,45	502,31	206,6	106,11	63,19	41,75	29,74
-109	388992	56422,15	6326,45	1471,07	518,94	237,54	129,35	79,54	53,44
-110	445414,4	63306,69	6936,81	1588,43	554,23	251,61	136,14	83,29	55,72
-111	510020,6	71031,28	7606,06	1715,15	591,92	266,52	143,29	87,22	58,1
-112	583997,8	79698,4	8339,88	1851,97	632,17	282,31	150,81	91,33	60,59
-113	668705,4	89423,08	9144,5	1999,71	675,15	299,04	158,73	95,63	63,18
-114	765699,5	100334,3	10026,74	2159,24	721,06	316,76	167,06	100,14	65,88

Figure 49: RSSI level at 500m and distance at -95 dBm vs propagation index (Beta).



En extérieur espace libre: Beta = 2
En extérieur zone urbaine: Beta = 4
En intérieur vue directe: Beta = 1,7
En intérieur bureaux classiques: Beta = 2,5 à 3
En intérieur bureaux, murs et cloisons: Beta = 3 à 5

	Beta	Beta		Beta		Beta		Beta	
	1,7	2	2,5	3	3,5	4	4,5	5	5,5
Pr_dB	R	R	R	R	R	R	R	R	R
dBm	m	m	m	m	m	m	m	m	m
-65	1003,9	356	109,95	50,24	28,71	18,87	13,62	10,49	8,47
-74	3397,2	1003,35	251,87	100,23	51,9	31,68	21,58	15,88	12,35
-89	25910	5642,22	1002,68	316,94	139,22	75,12	46,49	31,67	23,13
-95	58400	11257,7	1742,45	502,31	206,6	106,11	63,19	41,75	29,74
-104	197616	31728,5	3991,72	1002,23	373,48	178,13	100,15	63,19	43,35
-105	226280	35600	4376,83	1082,19	398,87	188,68	105,41	66,16	45,2
-106	259102	39943,8	4799,1	1168,52	426	199,86	110,95	69,28	47,13
-107	296684	44817,7	5262,11	1261,73	454,96	211,71	116,77	72,55	49,15
-108	339717	50286,3	5769,79	1362,39	485,9	224,25	122,9	75,96	51,25
-109	388992	56422,2	6326,45	1471,07	518,94	237,54	129,35	79,54	53,44
-110	445414	63306,7	6936,81	1588,43	554,23	251,61	136,14	83,29	55,72
-111	510021	71031,3	7606,06	1715,15	591,92	266,52	143,29	87,22	58,1
-112	583998	79698,4	8339,88	1851,97	632,17	282,31	150,81	91,33	60,59
-113	668705	89423,1	9144,5	1999,71	675,15	299,04	158,73	95,63	63,18
-114	765699	100334	10026,7	2159,24	721,06	316,76	167,06	100,14	65,88

Figure 50: RSSI level at 1000m and distance at -95 dBm vs propagation index (Beta).

12.3.5.1 How to estimate the distance between the Head Quarter and the Branch Office

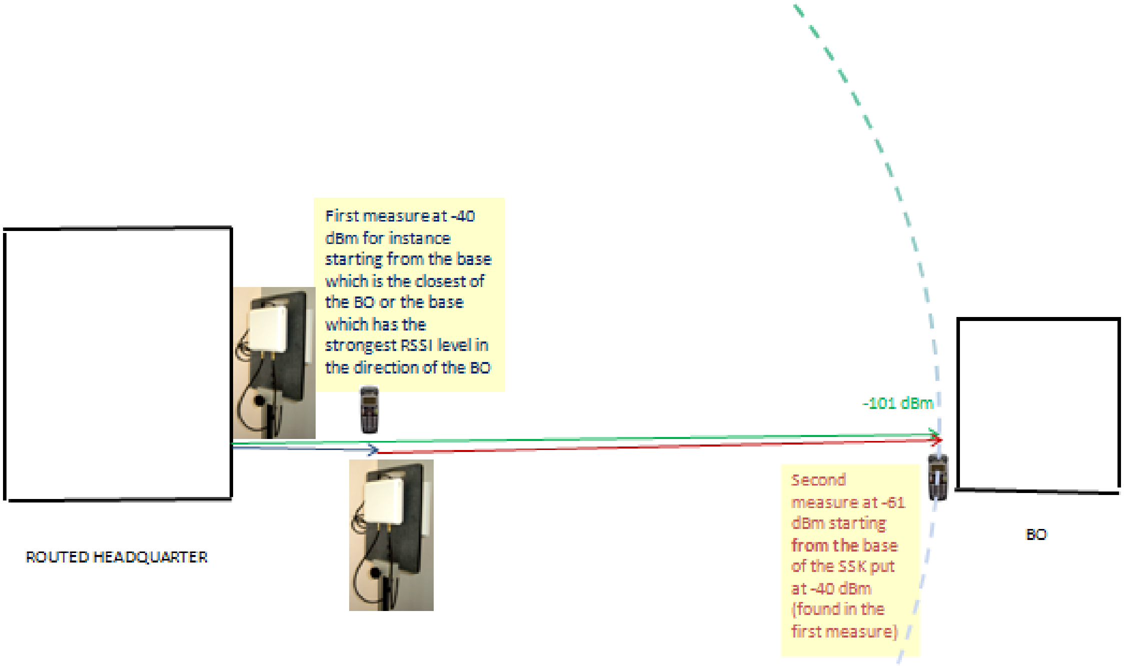


Figure 51: Estimation of the distance between the Head Quarter and the Branch Office

The procedure is as follows:

Assumption: Base Stations are not deployed in the Routed Headquarter and in the Branch Office.

1. With a DECT handset in site survey mode registered on the SSK, make a measurement at -40 dBm starting from the base of the SSK which is located in the Head Quarter and put as close as possible to the BO.
2. Place the Base Station of the Site Survey Kit at the location of the -40 dBm measurement on a height of approximately 2 meters (±0.5m). Walk away from the Base Station in the direction of the BO.With a DECT handset in site survey mode registered on the SSK, make a measurement at -61 dBm dBm starting from the base of the SSK. Write down where the -101 dBm boundary from the Head Quarter is. The Branch Office should be beyond this limit.

12.3.5.2 Checking without SSK that there is no overlap between the synchronization clusters

13 Reporting Results

It is important to make a comprehensive survey report that records test results and provides useful information for the engineer who is installing the equipment. The following information should be included in the survey report (see chapter 15 - DECT Survey Report Template for a possible template):

- A description of the site, explaining which buildings and grounds are to be included in the report. A description of the topography of outdoor areas may be useful.
- A specification of the construction of the buildings and construction materials.
- Determine the customer requirements for:
    - the number of handsets
    - required coverage
    - performance requirements (traffic density, grade of service etc.)
    - the location of the DECT System.
- Cabling details. Include a specification of cables already present on the site and a list of new cabling required. Include the distance between DAP and the DECT System for existing and new cabling.
- Copies of the maps of the site with the positions of Survey DAPs and the cell boundaries.
    - Different cell boundaries can be marked with different patterns to avoid confusion i.e. dotted, dashed, dot dash etc. Do not use colors, as these may be lost when photocopying.
    - Use the following numbering conventions:

xCyy refers to the identity of the cell, where:
x: is the level at which the measurement was made.
(-1 is basement, 0 is ground floor, 1 is 1st floor etc.)
yy: is the DAP position number which was being measured.

Example of labelling floor plans:
0C1 = Ground floor Cell 1
0C2 = Ground floor Cell 2
1C3 = First floor Cell 3
2C4 = Second floor Cell 4
-1C5 = Basement/cellar Cell 5

- A list of possible configurations will help the customer to decide exactly what is required.
- A specification of where DAPs should be placed. This can be marked on the survey map, but additional information such as height and fixing instructions should be included where appropriate.
- A specification of the areas that will be covered by the DAPs and areas that may cause problems. This can be useful when testing the system.

The theoretical maximum number of overlapping cells is 10, if all timeslots and frequencies are used. If not all timeslots and frequencies are used, this value is higher. However, this is unlikely to be reached in practical situations.

For a large site where a thorough survey has been impossible, it may be prudent to add a percentage of extra DAPs (see “Traffic calculation rules” chapter) to the product offer to allow for unforeseen problem areas.

An example of a survey report is given in Appendix A.

14 Checklist for Survey Data

- Building characteristics (list for each building)
    - Building identification (refer to maps if available)
    - Type of use
    - Dimensions (refer to maps if available)
    - Number of floors (refer to maps if available)
    - Height per floor
    - Partitioning per floor (refer to floor plans if available)
    - Construction details (type of construction and materials used)
    - Radio coverage requirements

  List areas where radio coverage is not absolutely required or are to be excluded from radio coverage.

- Radio coverage
  List areas where radio coverage is not feasible or requires specific DAPs.

- Objects inside buildings
  Details of furniture, cupboards, machinery, etc. in the interior of buildings per floor.

- DECT System
  Position of the DECT System.

- Connections between DECT System and DAP(s)
  For each DAP the following details of its connection to a DECT System are required:
    - Length of cable between DECT System and DAP.
    - Whether existing cabling is present that can be used.
    - Cabling layout (risers, horizontal wiring, distribution frames) and whether existing cabling can be used, or new wiring is required.

15 DECT Survey Report Template

Number : ………………...

From : …………………………………………………….
[Engineer doing the survey]

To : ………………………………………………………………………..
[Sales Manager]

Copy : ………………………………………………………………………..

Date : .... / ….. /….
[yyyy / mm / dd]

1. Site : ……………………………………………………………...
   [Full address of site]

2. Execution of survey
   Engineers : ……………………………………………………………...
   [Names and addresses of engineers who executed the survey]
   Customer engineer(s) : ………………………………………………
   [Name and address of customer engineer(s)]
   Date : .... / ….. /….
   [Date of survey]
3. Outline description of site
   [Short description of site (dimensions, environment, number/ type of buildings, etc.]
4. Number of handsets and expected traffic
   [Description of expected traffic and indication of above or below average traffic areas]
5. Test results
   [This *should include the site maps* and any additional information that may be useful]
6. Connections DECT System - DAPs

6.1 Location of DECT System.
[Indicate the location of the DECT System]

6.2 Existing cabling
[Indicate what cabling is available and how it is distributed across the site]

6.3 Connection of DAPs and cable lengths
[List for planned RFP approximate cable length, and whether existing wiring can be used or new cabling is required]

6.4 DAP installation
[For each DAP indicate exactly where it can be installed, e.g. "in the corridor against the wall of room 32, 2.5 m high") and whether customer restrictions apply as to where DAPs may be installed]

7. Possible configurations
   [List alternative configurations regarding the deployment of DAPs. Refer to coverage maps and detail areas where coverage cannot be guaranteed]

16 Post Survey

A Post Survey is a Site Survey that needs to be done after the DECT system is installed. It is a check on the Site Survey and the actual implementation of the system.

Normally the Installation engineer of the DECT system will execute the Post Survey.

Use the following procedure:

1. Make sure the DECT system is up and running properly and that all DAPs are up and running.
2. Start up the Performance Manager as described in the Customer Engineer manual. (One of the Appendices in the Customer Engineer Manual.)
3. Click the button “Save Visibility” in the Performance Manager window. Now the file “visadm.txt” is created. Analyze the contents of this file for the Synchronization Structure. Then determine which DAP is the best candidate for being the Master. Also try to find out how you can keep the synchronization hierarchy as “flat” as possible.
4. If necessary, force the DAP which is the best candidate for being the Synchronization Master to be the Master. Use the “DECT Manager” and give that DAP the lowest RPN. After you have made changes, reboot all DAPs.
5. Generate a “visadm.txt” file again. Analyze the synchronization structure again.
6. Subscribe at least two 8242 DECT handsets (or other handsets that has a Signal Strength indication in the display) to the system.
7. Set up a call between the two handsets. Now check the coverage and sound quality on the area that should have been covered. Pay special attention to critical environments and critical spots.
8. If the area is not properly covered, report this to the provider of the DECT system and consider what improvements should be made.

Appendix A: SURVEY EXAMPLE

A.1: Site Survey Map

In the following picture, you see the map of the site, together with the results of the Site Survey.

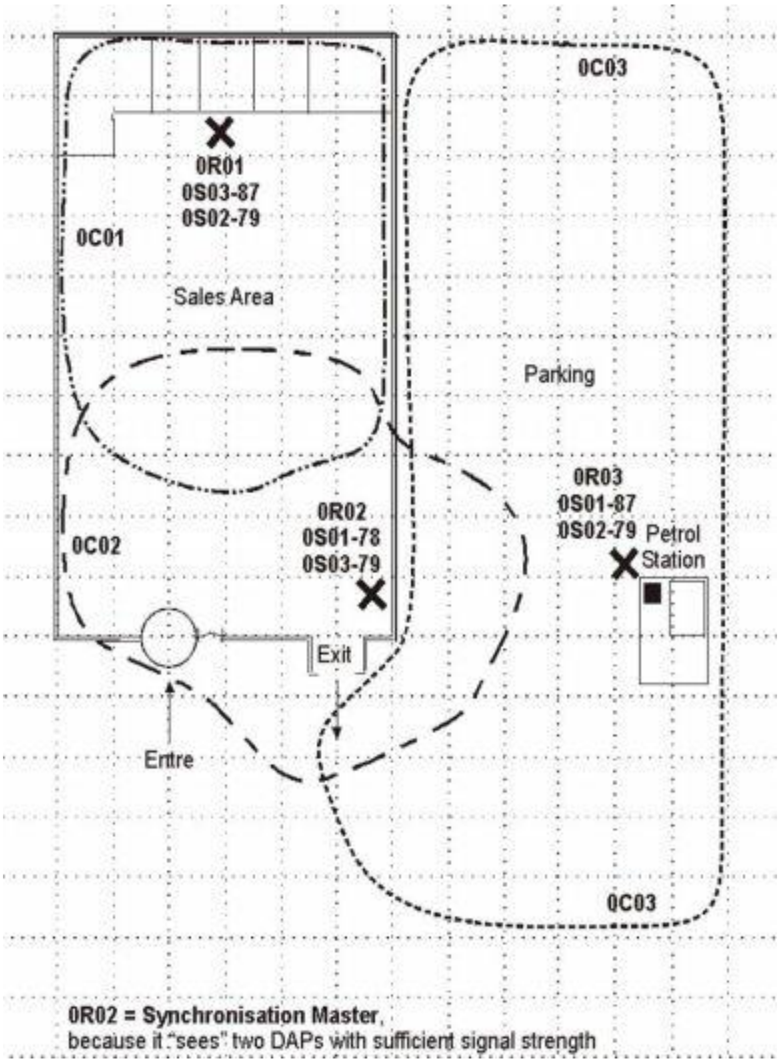


Figure 52: Example Site Plan

A.2: Example of Documentation of the Site Survey

Number : MS/001

From : John Johnson, Business Communication, U.S.

To : J. R. Hartley, Business Communication, U.S.

Copy : B.J. Mcleod, Engineering Manager, Save Stores PLC

DECT Marketing, Business Communication,

P.O. Box 1234567, 1234JD Hilversum, The Netherlands.

Date : 01/05/2018

1. Site :
   Save Stores,
   105 Washinton Road,
   Baltimore
   United States

2. Execution of survey

Engineers :	John Johnson,	Business Communication, U.S.
	Dave Nice	Business Communication, U.S.
Customer engineer(s) :	H. King	Save Stores PLC, Baltimore
Date :	12th - 15th April 2018	

3. Outline description of site

This survey is for a supermarket approximately 100m x 60m surrounded by car parks. A petrol station at the side of the road also belongs to the site. See the site plan on figure.

Construction of the building(s)
The main building is approximately 6m high. All areas are at ground level.
The building has a steel frame construction. The east and west sides of the building are constructed with brick walls to a height of 3m, above this height the walls are made of steel panels. The south side (front) of the building is mostly glass up to a height of 3,5m above this, brick. The north side (back) of the building is brick, with windows 2,5m high starting at 1m above the ground. The roof is steel.

Lowered ceilings in the sales area are made of thick (1 cm) cardboard panels suspended 5m above the ground. Lowered ceilings in the offices/storage areas are also thick (1 cm) cardboard panels suspended 3m above the ground.
The petrol station consists of a single brick building and a covered petrol pump area.

4. Number of handsets and expected traffic

The maximum number of portable handsets required is 10 (each with an Erlang value of approximately 0.08 Erlang, but the number is expected to rise to 15 in the future.

5. Test results:

Refer to the site map, figure. The DAPs and cells are numbered as follows:

xRyy refers to the identity of the DAP, where:
- x is the level (-1 is basement, 0 is ground floor, 1 is 1st floor etc.)
- yy is the DAP position number. This number should be unique.

xCyy refers to the identity of the cell, where:
- x is the level at which the measurement was made (-1 basement, 0 is ground floor, 1 is 1st floor etc.)
- yy is the DAP position number which was being measured.

XSyy-zz refers to the signal received from other DAPs for synchronization, where:
- x is the level (-1 is basement, 0 is ground floor, 1 is 1st floor etc.)
- yy is the DAP position number from which the signal is received. This number should be unique.
- zz is the signal strength value.

6. Connections to DAPs

6.1 Location of the IP equipment like Hubs and/or Switches

The site is equipped with Cisco Switches all supporting 100Mb/s.
Connection between the switches is 1 Gb/s or higher.
The local IT engineer has signed for supplying an Ethernet cable from a Switch port to the DAP locations. (In the Petrol Station, there is already an Ethernet connection for a Computer. The available bandwidth is always more than 90 Mb/s. The DAP can be connected to that same network connection.)
All DAPs are put in one VLAN: VLAN 10
There is only one Router with Firewall that supplies the connection from the LAN to the Internet. That Router/Firewall blocks all Multicast traffic. IP ports needs to be discussed with the IT engineer.

6.2 Power cabling

There are no Switches that supply power to the network (PoE). As the DAPs require Power-over-Ethernet, a Power-over-Ethernet Inserter must be installed between the IP Switch and the DAPs. The IT Staff need to take care of this, and clear agreements must be made with the IT Staff about the required PoE equipment type, price, time and date.

6.4 DAP installation

The DAPs are positioned as follows:

- DAP 0R01 is fixed to the wall inside the sales area at approximately 0,5m under the lowered ceiling.
- DAP 0R02 is fixed to the right-outside wall at a height of approximately 3m, 7 meters from the corner (front side – right side)
- DAP 0R03 is fixed inside the awning at the petrol station. The awning is made of plastic panels. Mount the DAP right behind the plastic panel, so that radiation can pass on via the plastic panel easily.

Note: *There is no redundancy; failure of a DAP would result in a large area being out of range of any other DAP.*

6.5 DAP Synchronization

The Synchronization Master must be the DAP in the middle of the DAP structure. This DAP “sees” the two other DAPs with sufficient signal strength.

In this map, the DAP with the notation 0R02 should be the Synchronization Master. This means that in the actual installation, this DAP should get the lowest RPN. The engineer should force this DAP to get the lowest RPN via the DECT Manager interface.

Appendix B: PARI and SARI

B.1: PARI

- **PARI**: Primary Access Rights Identifier. This is the Unique DECT System Identifier. It is an 8-digit hexadecimal string. It is a worldwide Unique Identifier which you should have received together with your DECT system.

***Warning**: It is recommended to use a **unique PARI**. The method to obtain an official and reserved PARI is through the ALE BPWS.*

An example is given hereafter to enter a hex value in the IP DECT DAP configurator starting from the octal value obtained from the BPWS:
Open for instance the calculator in scientific mode of your PC
Tick Oct and Qword
Enter the octal value obtained from the BPWS: 10042647314 (for instance)
Divide by 4 and you get: 2010551663
Tick Hex and out get: 1022D3B3
Enter in the DAP configurator: 1022D3B3

B.2: SARI

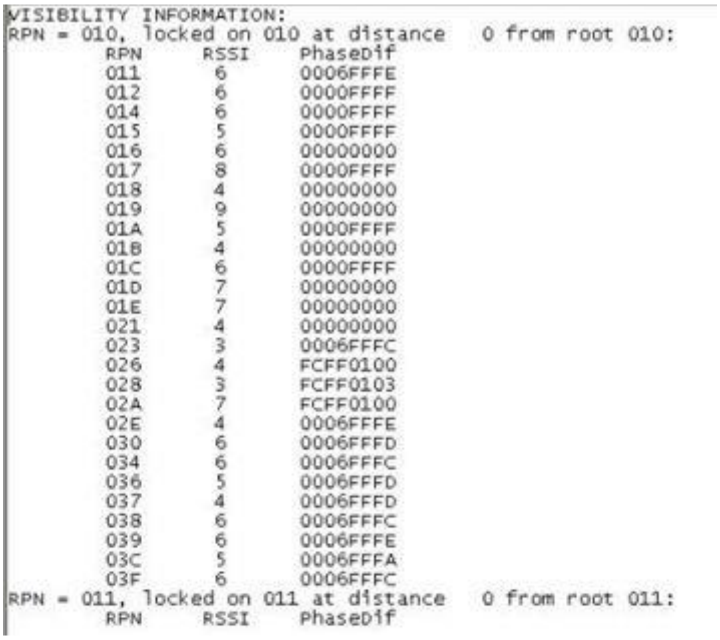
- **SARI**: The SARI is the Secondary Access Rights Identifier, which is only needed if you use Multi-Site subscriptions. If you do not use multi-site Subscriptions, leave this field to the default “FFFFFFFF”.

Appendix C: SYNCHRONIZATION STRUCTURE

C.1: Synchronization structure with OXE

In the Performance Manager with OXE (OmniPCX Enterprise), there is a possibility to take a snapshot of the synchronization structure (To see the phase difference do:” Update visibility” and “Get visibility file” in Performance Manager.)

The phase difference between DAPs is given and must be xxxxFFFF with a maximum deviation of about 7 (higher or lower) => [xxxxFFF9, xxxx0007].(The first 4 digits denote a frame and slot number).



```
VISIBILITY INFORMATION:
RPN = 010, locked on 010 at distance   0 from root 010:
          RPN       RSSI     PhaseDif
          011        6       0006FFFE
          012        6       0000FFFF
          014        6       0000FFFF
          015        5       0000FFFF
          016        6       00000000
          017        8       0000FFFF
          018        4       00000000
          019        9       00000000
          01A        5       0000FFFF
          01B        4       00000000
          01C        6       0000FFFF
          01D        7       00000000
          01E        7       00000000
          021        4       00000000
          023        3       0006FFFC
          026        4       FCFF0100
          028        3       FCFF0103
          02A        7       FCFF0100
          02E        4       0006FFFE
          030        6       0006FFFD
          034        6       0006FFFC
          036        5       0006FFFD
          037        4       0006FFFD
          038        6       0006FFFC
          039        6       0006FFFE
          03C        5       0006FFFA
          03F        6       0006FFFC
RPN = 011, locked on 011 at distance   0 from root 011:
          RPN       RSSI     PhaseDif
```

.

Remark about “Visibility Information”:

Shows an overview of the RSSI values. “Sees” means that the selected DAP sees the other DAPs with a certain signal strength. “Seen” means that the other DAPs can see the signal strength of the selected DAP. Note that although the radio signal connection is reciprocal there can be differences in the “seen” and “sees” RSSI value. This difference is caused by the fact that this visibility information is based on a snapshot.

The RSSI values are hexadecimal in the range: 0 ... f. ***The RSSI level 0 in Hex corresponds to “no signal”. The - 80 dBm boundary*** **which is** ***the minimum required signal strength for synchronization corresponds to a RSSI level in Hex between 3 and 4****.*

See RSSI table given hereafter:

RSSI in Hex	dBm value	dBm range
e	> - 30	+24 … - 30
d	< - 30	- 31 … - 35
c	< - 35	- 36 … - 40
b	< - 40	- 41 … - 45
a	< - 45	- 46 … - 50
9	< - 50	- 51 … - 55
8	< - 55	- 56 … - 60
7	< - 60	- 61 … - 65
6	< - 65	- 66 … - 70
5	< - 70	- 71 … - 75
4	< - 75	- 76 … - 80
3	< - 80	- 81 … - 85
2	< - 85	- 86 … - 90
1	< - 90	- 90 … - 95
0	< - 95	- 95 … no signal

Table of correspondence for the RSSI levels in Hex between 0, 1 ,2, 3, ….,e,f and RSSI levels in dBm.

C.2: Synchronization structure with OXO

In the IP-DECT web page of the master DAP with OXO (OmniPCX Office) you can select “Save Information in file”. In the created file you can show visibility info.

```
Display exceptions
ok
Exc: 13:15:07 2012/06/19 sfdmacnf: -4 I:00000002 (DCCT)
LIC:2433 AL:-714271 F14 S4 TO RO MFRC010177ef
fb:  198  mfb:  195  fh:  159  mfh:  156
PC: 11 (envREBOOT) fm: 8550264
DCCT:0034cb7c READY RTPT:00356650 PEND tNetTask:002ea590 PEND MCCT:002ea590 PEND CF:239 E:00000044 F100 RxU:2644 R


Show visibility info
ok
L:001, 4, 1
001, E, 0000FFFF
003, 9, 0000FFFF

Show ping results
ok
Ping test results for rpn 002 on 11:24:02 22-06-2012
One ping test consists of 3 burst of 2 pings
Total ping tests done : 129
Total ping tests with failures : 45

Day Results for rpn: 002 on 2012/06/19
Ping tests done : 20
Ping tests with failures : 0
Detailed information :
rpn  #sent #received  date last error
000,   120,      120
001,   120,      120
003,   120,      120

Day Results for rpn: 002 on 2012/06/20
Ping tests done : 44
Ping tests with failures : 0
Detailed information :
rpn  #sent #received  date last error
000,   264,      264
001,   264,      264
003,   264,      264
```

The phase difference between DAPs must also be xxxxFFFF with a maximum deviation of about 7 (higher or lower) => [xxxxFFF9, xxxx0007]. (The first 4 digits denote a frame and slot number).

Appendix D: EXAMPLES OF IP-DECT CONFIGURATION FILES

D.1: Example of “dapcfg.txt” file / OXE

```
;
; dapcfg.txt for system name_of_the_system
; Created by DapConf.exe on --/--/2012 --:--:--
;
; Please do not modify this file!!
;
[DAP-IMAGEFILE]                         ; Start of DAP image file section
4910bf08.dwl

[DS]                              ; Start of DS address section
192.168.2.21 28000-28017

[DAP]                              ; Start of DAP address section
239.192.49.49 3000-22635 5 255.255.255.0

[GK]                              ; Start gatekeeper address section
192.168.2.11 5060

[XDS]                              ; Start SIP section
local_timezone=GMT + 00:00
sip_domain=172.26.191.194
sdp_rfc3264=yes
sdp_MoH=yes
sdp_DTMF_rfc2833=yes
mwi_support=yes
dtmf_pt=97
multiple_call_appearance=yes
hash_is_release_enquiry_call=yes
unattended_transfer_method=using_replaces
call_waiting_indication=2nd waiting
486=busy busy
404=wrong wrong
480=out out
```

D.2: Example of “dapcfg.txt” file / OXO

```
; dapcfg.txt for system OXO-Lite
; Created by DapConf.exe on 01/14/2015 14:45:21
;
; Please do not modify this file!!
;

[DAP-IMAGEFILE]
4910b618.dwl
4920b618.dwl
49920202.dwl

[DS]
172.26.172.2 28000-28017

[DAP]
239.192.62.62 3000-3003 32 ;

[GK]
172.26.172.2 5059

[CDA]
172.26.172.2 30160

[QOSGLOBAL]
DSCP=0

[XDS]
realm1=172.26.172.2
user1=%s
pwd1=~lKlD^+eryK&#M
web_usr=dapwebadmin
web_pwd=~D{gW!*\a62$R0B
sdp_rfc3264=yes
sdp_DTMF_rfc2833=yes
mwi_support=yes
max_intern_dnr_len=8
sip_messaging=yes
hash_is_nbr_compl_ind=yes
dtmf_pt=97
multiple_call_appearance=yes
hash_is_release_enquiry_call=no
unattended_transfer_method=using_replaces
486=busy
TB=60
DTMF_activation_needed=no
t_ACK_timeout=32

[CONFIG]
CONFIGFILE=erase
IPCONFIG=erase

[RPNADM]
009 00:18:27:5f:06:9d
008 00:18:27:5f:01:73
007 00:18:27:5f:01:70
006 00:18:27:5f:01:69
005 00:18:27:5f:01:71
004 00:18:27:5f:01:66
003 00:18:27:5f:01:55
002 00:18:27:5f:01:5e
001 00:18:27:5f:01:58
000 00:18:27:5f:01:6c
```

```
[PARI]
1C075477

[PARAM DEV LIST]
32 11
51 134
58 5
66 10
67 3
71 11
76 16
79 1
```

Appendix E: MIX OF TDM AND IP-DECT

E.1: MIX OF TDM AND IP-DECT / OXE

OXE can support both TDM (IBS/RBS NG) DECT bases and IP-DECT DAPs on the same node but there must be no radio overlap between TDM and IP-DECT coverages (i.e. TDM DECT bases and IP-DECT DAPs must be deployed in different locations).
During OXE upgrade from lower version to k1, legacy DECT sets should be automatically converted to support TDM-IPDECT “Mix (or Mixity)” feature.
Handover is not possible between TDM DECT bases and IP-DECT DAPs but roaming is possible only for AGAP sets, if and only if handsets have been manually registered with the same directory number on two systems.
Handsets have the possibility to select the system on which to lock.
Change of system (from one system to another one) by a DECT handset may not happen immediately, but it may take some time (roughly 2 minutes).
Handsets must be able to make/receive calls and to support other services on their respective system.
GAP handsets can be registered to only one system and roaming is not provided for them, as the set type is different in TDM and IP-DECT systems.

***Reminder**: To support roaming between TDM DECT bases and IP-DECT DAPs, it is needed to register the same directory number on TDM and IP-DECT systems. Different PARIs should be configured for IBS/RBS NG bases and DAPs.*

E.2: MIX OF TDM AND IP-DECT / OXO

The following restrictions apply only to dual DECT systems:
Roaming between IBS and IP-DECT sub-systems is not possible. Roaming is only possible within the network the DECT handset has been registered to.
IBS and IP-DECT sub-systems are not synchronized. Handover is only possible between synchronized base stations, thus, within each DECT sub-system but not between IBS and IP-DECT sub-systems.
The level of service and user interface may be different for a same type of DECT handset when attached either to IBS or IP-DECT sub-system (Example: 8232 runs in A-GAP mode when connected to IBS and in GAP when connected to IP-DECT).
One given DECT subscriber can only use either IBS base stations or IP-DECT base stations.
This is defined at Subscriber creation (OMC -> add subscriber).
Nevertheless, the registration of a given handset on both IBS and IP-DECT base stations cannot be forbidden, by using 2 different subscribers (two licenses are required for the same phone: - one DECT user and one IP-DECT user), but the level of service and the user interface are different.
There must be no radio overlap between IBS and IP-DECT coverages.

END OF DOCUMENT