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

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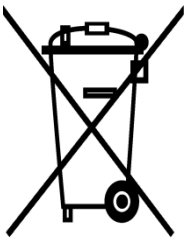

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1. Introduction

1.1 General

The purpose of this document is to define the engineering rules relative to the DECT and IP-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**.

The recommendations cover the technical and methodology aspects from the offer to the maintenance on DECT and IP-DECT projects.
This manual contains guidelines for surveying DECT and IP 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 on the basis of 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 TDM DECT solution 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 two types of BSs:
- the IBS/RBS NG Indoor with (two) omnidirectional internal antennas and
- the IBS/RBS NG Outdoor with (two) external antennas.

There are two types of DAPs:
- the 4080 IP-DECT AP Integrated Antennas with (two) omnidirectional internal antennas and
- the 4080 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 DECT or IP DECT system are based on coverage for:

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

For the Site Survey of a TDM DECT system (traditional DECT 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 IP-DECT system, there are two "air" connections that should be checked:

- ❖ DAP – Handset communication (same as for the traditional DECT systems).
  Measurements must be done for three items:
  - Signal Strength
  - Error Rate
  - Voice Quality
- ❖ DAP – DAP 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 TDM 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:

CRC	**C**yclic **R**edundancy **C**heck
DAP	**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

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 has to 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.

[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.

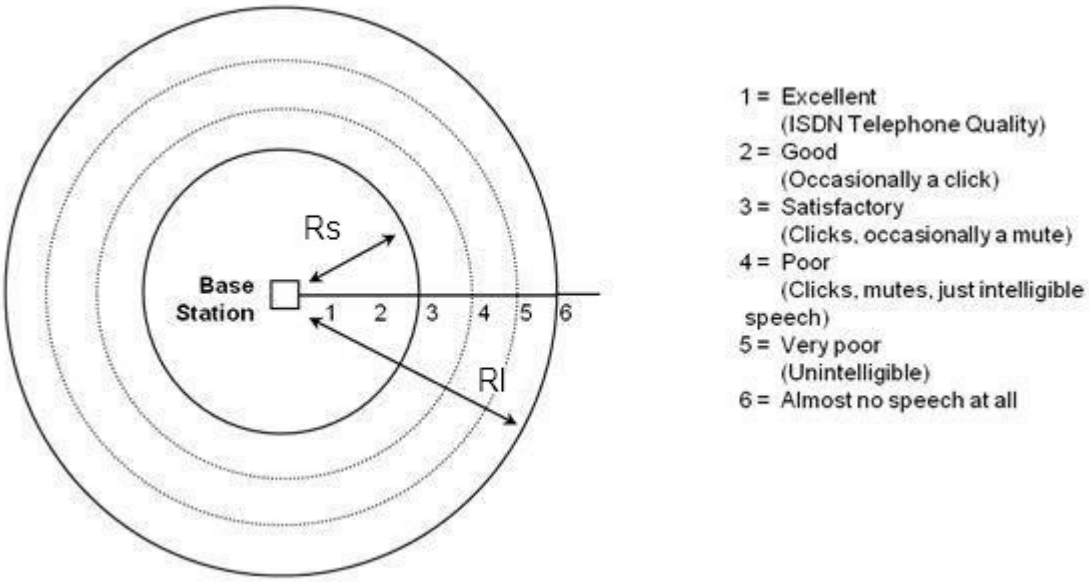


Figure 1: Coverage and Speech Quality in open Environment

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 DAP – DAP communication (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 or IP-DECT installation. Consider to use 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 on check whether the DAP to DAP communication (for 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 *bases* 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.

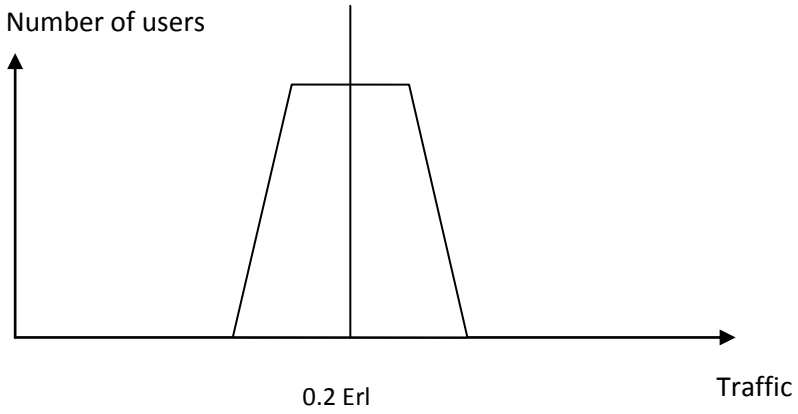


Figure 2: Homogeneous distribution

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.

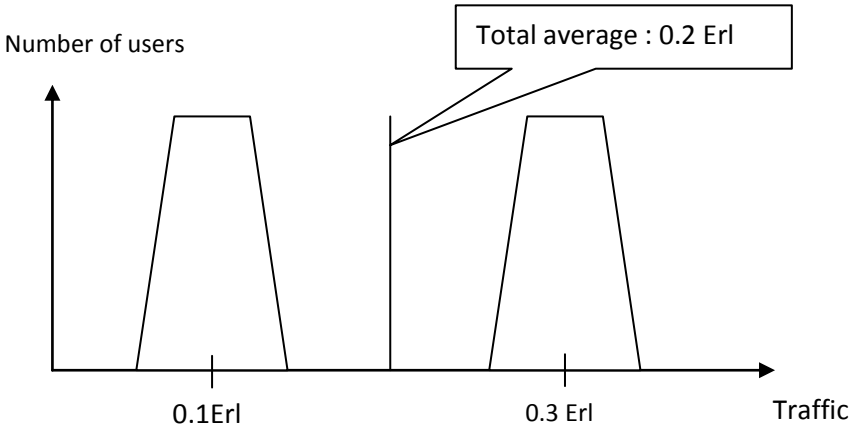


Figure 3: Non homogeneous distribution

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 Alcatel-Lucent DECT handsets, is given hereafter:

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

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

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

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. (**Traffic density uniformization**)	**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 Alcatel-Lucent 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

4.2.3.1.1

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. (Take into account the field level recommendations relative to Full DECT).

Level 2:

The coverage allows for good quality communications with the possibility of saturation during a particular 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. (Take into account 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, taking into account 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 Alcatel-Lucent level of commitment

♦ or **present two offers** specifying the hypotheses

version 1: what Alcatel-Lucent 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 DAP to DAP communication (only for IP-DECT deployment)

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.

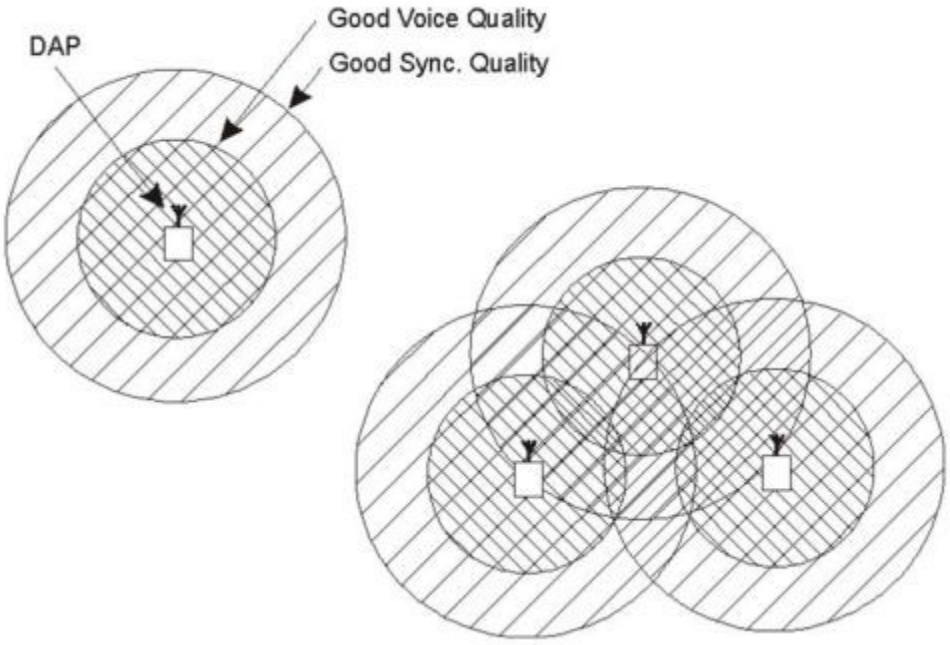


Figure 4: Cells for good Voice Quality and for Synchronization

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 Alcatel-Lucent DECT handset and a base**
Easy coverage	- 70 dBm
Tricky coverage	- 60 dBm

An additional margin of 10 dB should be taken into account (- 60 dBm and - 50dBm) 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 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.*

5.2 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.
Be aware of the fact 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 the following picture, you see a simple theoretical example of a synchronization structure:

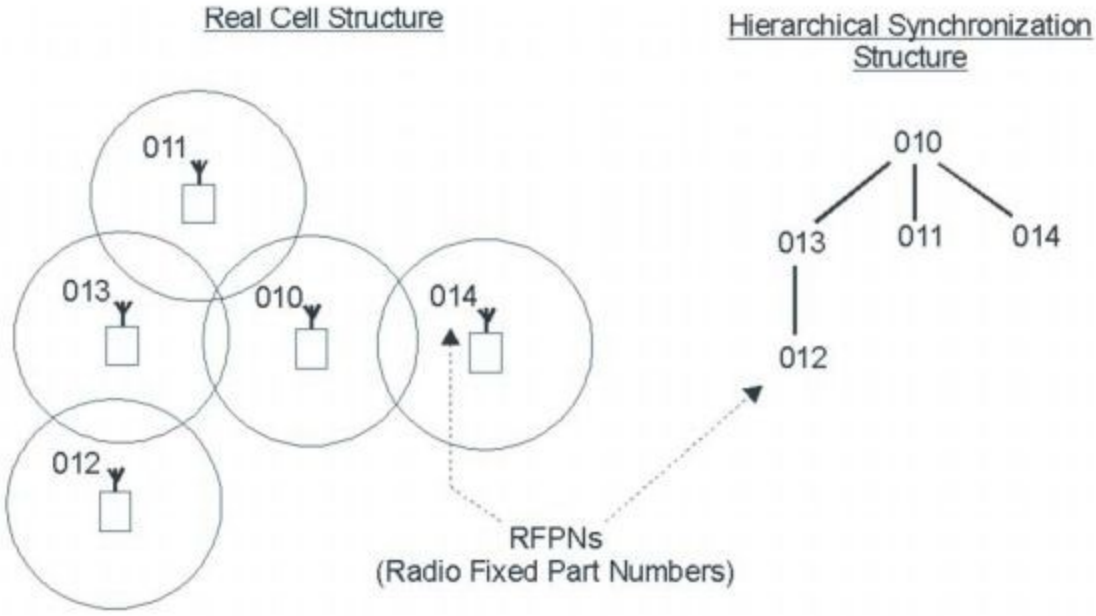


Figure 5: DAP Synchronization Structure

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 a number of 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, in order 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.

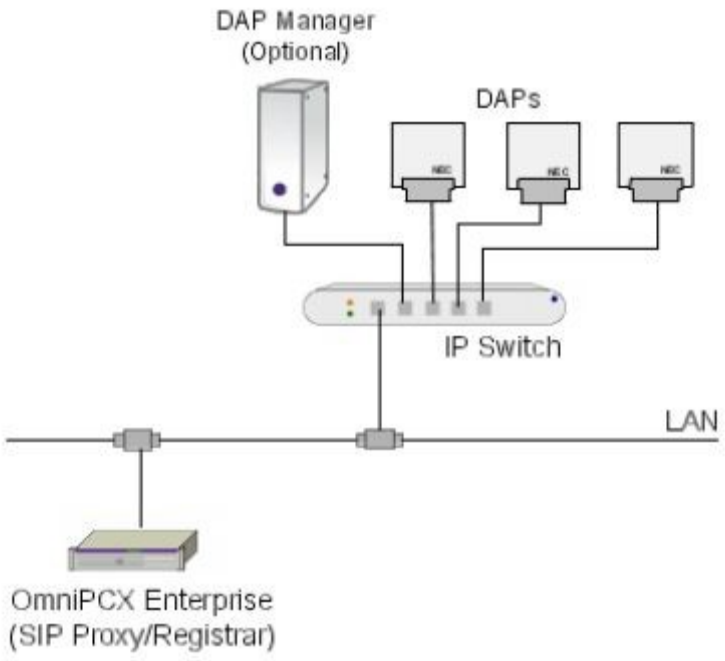
5.3 IP-DECT network rules with OXE

5.3.1 Typical Configurations

The IP DECT system must be implemented in a company infrastructure.
As mind setting tool, this chapter gives you four typical configurations.
You should consider which configuration you must implement at the customer site.
In the IP DECT Advance Data Manual, you will find more information about the system behaviour over a router, in chapter “System Behavior over Router”.

5.3.2 Simple Configuration

Figure below shows an example of a simple configuration. All IP DECT devices are put in one subnet. This subnet is based on one or more IP switches. If the switches serve more than one VLAN, all IP DECT devices are put in one VLAN (therefore behaving as one subnet).

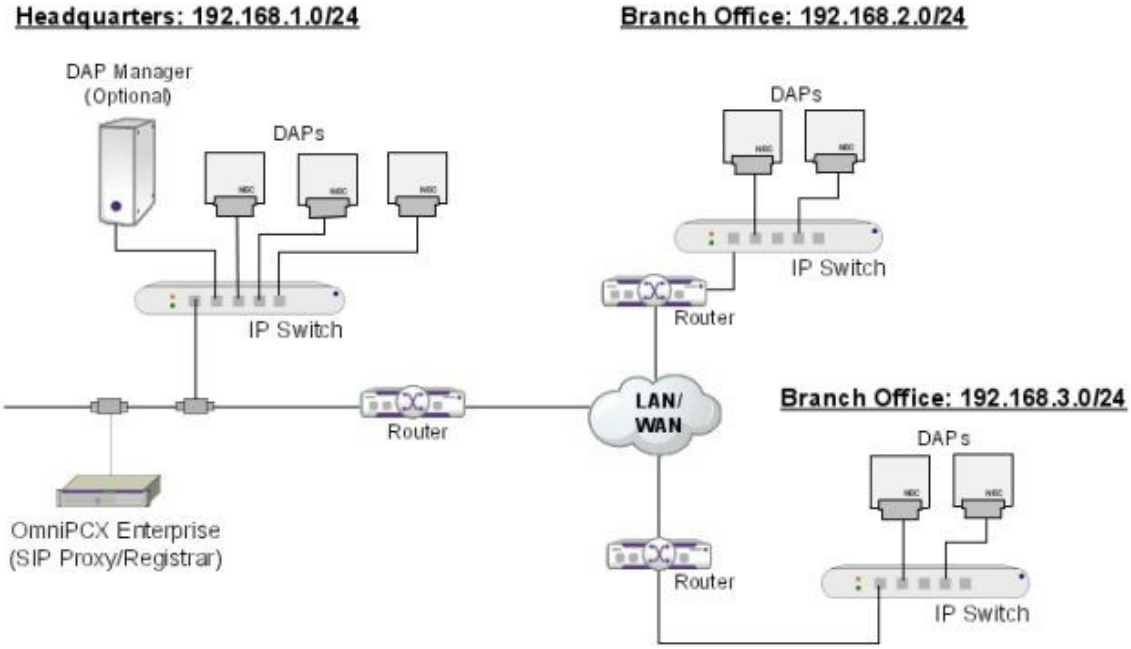


"Example of **Simple IP DECT network configuration**"

5.3.3 Branch Office Solution

Figure hereafter shows an example of a Branch Office configuration with a main office (head quarter) and two Branch Offices.
Main Office and Branch Offices are in different subnets connected via routers. Routers can be connected over the WAN.
The general characteristics of an IP DECT configuration with Branch Offices are as follows:

- Allows interconnections with limited bandwidth between Head Quarter and Branch office(s).
- Allows interconnections with poor QoS between Head Quarter and Branch office(s) (Radio Links, ADSL etc.)
- No OXE PBX needed in Branch Office(!).
- Seamless handover is supported in Branch Offices and in Main Office.
- No handset handover between Head Quarters and (individual) Branch Offices.
- Head Quarter and individual Branch Offices must be in separate subnets (router(s) needed).
- No IP multicast support required for Routers.
- Multicast TTL = 1, which means that IP multicast packages does not cross a router.

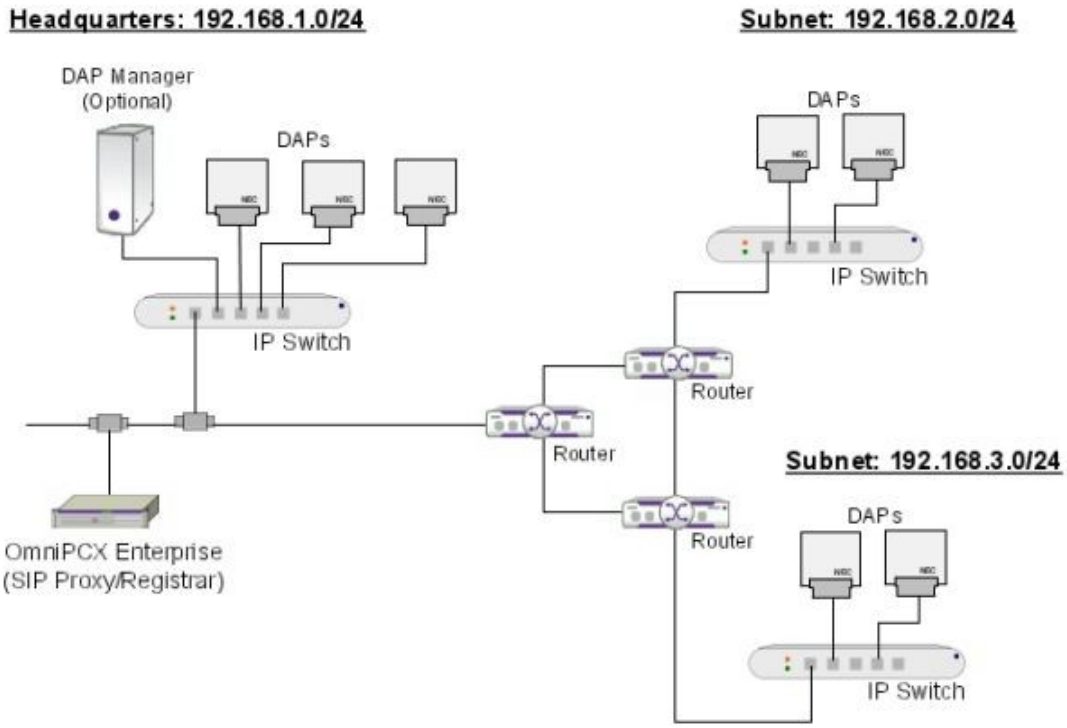


"Example of an IP DECT configuration with **Branch Offices**"

5.3.4 Routed Head Quarter

Figure below shows an example of a Routed Head Quarter configuration with a head quarter and two subnets connected via one or more routers. The subnets in the network are part of one company network.
The general characteristics of an IP DECT Routed Head Quarter configuration are as follows:

- Used for a Large Campus network that is split up into different (geographical) subnets.
- The network supports QoS and IP connectivity all over the Campus.
- IP DECT configuration behaves as one large IP DECT system.
- Full support of seamless handover between all DAPs in the IP DECT system.
- Routers must support IP Multicast routing.
- The IP Multicast address for IP DECT is the same in all segments.
- Multicast TTL > 1, which means that the routers pass on the IP multicast packages.
- In the IP DECT configuration, you must enter the subnet mask that is needed to cover all networks for up to four subnets as in the previous example.

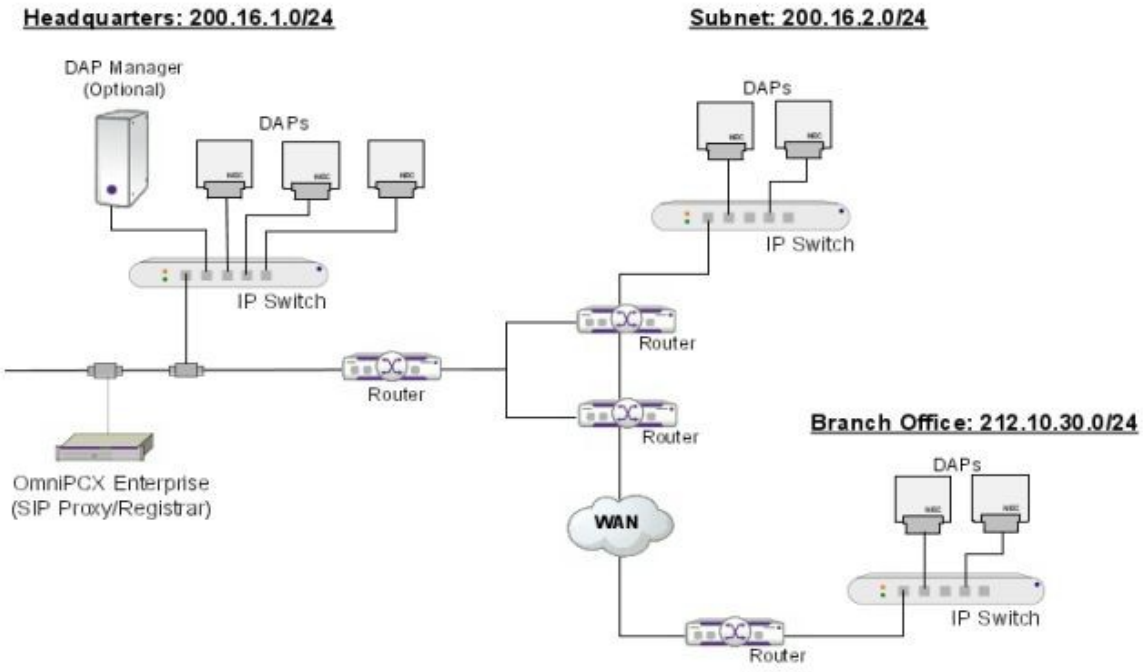


"Example of an IP DECT **Routed Head Quarter** configuration"

5.3.5 Routed Head Quarter with Branch Offices

Figure below shows an example of a Routed Head Quarter configuration with a head quarter, one subnet connected via one or more routers and a Branch Office. The subnets in the network are part of one company network, the Branch Office is connected over the WAN (or low throughput LAN).
The general characteristics of an IP DECT Routed Head Quarter configuration with Branch Office(s) are as follows:

- Hybrid of Routed Head Quarter and Branch Offices (see previous sections).
- Used for a Large Campus network that is split up into different (geographical) subnets in combination with (remote) Branch Offices.
- In the Routed Head Quarter part, all characteristics which are mentioned previously for the Routed Head Quarter are applicable.
- For the Branch Office, all characteristics which are mentioned in the section covering the Branch Offices are applicable.
- In the Head Quarter the Multicast TTL >1, in the branch Office the Multicast TTL =1(!).
- Edge Router, connected to the WAN, should not forward Multicast packages to the WAN.
- Full support of seamless handover between all DAPs in the Head Quarters configuration with the subnet.
- Routers in the Head Quarter must support IP Multicast routing.
- In the IP DECT configuration, you must define which subnets are in the Head Quarters and which subnet(s) is/are Branch Office subnets. You must do that by means of specifying the subnet mask that is needed to cover all Head Quarters subnetworks.



"Example of an IP DECT Routed Head Quarter configuration with Branch Office"

5.3.6 Multicast and IGMP

The IP multicast is required for switches and routers

- At the level 2,
  - Data equipment must be compatible with IGMP v2,
  - The Spanning Tree Protocol (STP) must be disabled on the ports used for DAPs, or have STP PortFast enabled, or configured as RSTP edge port.

- Switches must support IP Multicast, with IGMP (snooping) disabled or a proper IGMP network setup.
- It is strongly recommended to set the switch port in "Fast Forwarding" mode,

- At the level 3, ALE recommends using the PIM Dense Mode

Note: The PIM Dense Mode protocol is a multicast routing protocol that uses the underlying unicast routing information base to flood multicast datagrams to all multicast routers. Prune messages are used to prevent future messages from propagating to routers without group membership information.
The PIM-Sparse Mode protocol is a multicast routing protocol that can use the underlying unicast routing information base or a separate multicast- capable routing information base. It builds unidirectional shared trees rooted at a Rendezvous Point (RP) per group, and optionally creates shortest-path trees per source.
ALE recommends the PIM Dense Mode protocol, but the PIM Sparse Mode protocol using is also possible. Nevertheless the tree creation takes more time in the PIM Sparse Mode protocol, when several DAPs (DECT Access Points) reset at the same time.

5.3.7 DHCP and TFTP Requirements

The DAPs must get their IP addresses, configuration file and firmware from the IP network using a DHCP Server and a TFTP Server.
Note: The internal DHCP server and the internal TFTP server provided in the DAP configurator are designed to work up to 20 DAPs and for simple configurations. The "DHCP Offer" transaction (with internal DHCP server) uses 255.255.255.255 (broadcast) as destination. So this configuration is not working when 2 (or more) routers are cascaded, the broadcast message can reach the first router but not the second and the others. Normally the DHCP Offer transaction has to be an unicast message that can go through the different routers.
It is not recommended to use the DHCP and TFTP servers of the OXE PBX due to somerestrictions.
The OXE DHCP is not suitable to declare some different IP addresses ranges for different subnets (e.g.: 155.132.29.210-155.132.29.214 and 172.24.29.218-172.24.29.222) with adapted netmasks?
OXE DHCP is not suitable to distribute DHCP leases based on MAC addresses?
To store the data into the DAP, it is necessary that the DAP gets a DHCP offer with an "Unlimited" or also called "Infinite" lease.
DHCP Offer transaction has to use an unicast message as destination in order to address all the configurations.
An external DHCP is able to offer all the options needed.

5.3.7.1 DHCP Server

When a DAP starts up, it tries to contact a DHCP server on the network. It should get the following items from the DHCP server:
1. IP Address
2. Subnet Mask
3. Default Gateway IP address
4. Next Boot Server IP address. This is the IP address of the TFTP Server (DHCP option 066).

(The IP address of the TFTP server has to be normally in the field : tftp_server_name).
5. Configuration file name (dapcfg.txt) available via the TFTP server (DHCP option 067).

Note that you must enable option 67 in the DHCP server whether you fill in a file name or not. If you do not fill in a file name, the DAP will try to upload the default configuration file name dapcfg.txt. If you fill in a file name in option 67, the DAP will upload the configuration file name that you have entered here. It is strongly recommended to leave the file name field blank.
The easiest way to provide the DAPs with the correct data from the DHCP server, is using the DHCP server that comes with the DAP Controller installation software. The DAP Configurator tool allows you to setup the required DHCP server configuration easily.

Note: The DHCP Server that comes with the installation of the DAP Controller/Manager is by default installed when you do the installation for "Multiple System". If you do the installation for "Single System", the DHCP server is not installed by default.
However, if you select "Custom" installation you can choose to install or not install the DHCP server.
However, if you don't want to use the DHCP server that comes with the DAP Controller installation, e.g. because there is DHCP server already in the network, you can use a DHCP server of your choice. But make sure that the required parameters are delivered to the DAPs.

5.3.7.2 TFTP Server

The configuration file and the firmware are uploaded to the DAP(s) using a TFTP server.
The DAP Controller software includes a TFTP Server. You can select that TFTP server using the DAP Configurator. When you use the TFTP server that comes with the DAP Controller, the TFTP Server configuration is automatically setup correctly.

***Note**: The TFTP Server that comes with the installation of the DAP Controller/Manager is by default installed when you do the installation for "Multiple System". If you do the installation for "Single System", the TFTP server is not installed by default.*
However, if you select "Custom" installation you can choose to install or not install the TFTP server. See installation procedure in Section "Installing the DAP Controller Release 5.2" of Alcatel-Lucent 4080 IP-DECT CE.
Note: Do not use the TFTP Server that comes with the DAP Controller for permanent use. The TFTP Server is included in the DAP Controller software, in order to allow you to setup a system easily, without DAP Controller permanently connected. In a customer network with the DAP Manager permanently connected, please use the TFTP server that the IT Manager recommends you to use.
Remark: If you get some issues with an external TFTP server use the internal DHCP server (in the DAP configurator) to generate more surely dapcfg.txt and ds.txt files (so they can be used also as templates). In this case you have to put in the field "tftp_server_name" of the DHCP settings the IP address of the DAP controller.
Note: To find the configuration files, see: D:\Documents and Settings\All Users\Application Data\Alcatel-Lucent\DAP Controller\name_of_the_system
name_of_the_system is the name given to the system used in the Dap controller

Example of configuration files ("dapcfg.txt" & "ds.txt"): See appendix D

5.3.7.3 Operation without DHCP or TFTP Server

See Alcatel-Lucent 4080 IP-DECT CE for detailed information.

5.3.7.4 Using other DHCP and/or TFTP Servers

Note: If you install the DAP controller/Manager software as "Single System" the DHCP and TFTP servers are normally not installed. This means that you must use your own DHCP or TFTP server. Consult the "4080 IP-DECT Advanced Data Manual", Chapter "Other DHCP/TFTP Servers" for examples of other servers.
It is possible to use a DHCP server or TFTP server of your choice. However, the DHCP server must provide the five parameters as mentioned in chapter "DHCP Server". Also remember the lease time specification if you want to store IP configuration and/or DAP configuration data in the DAP(s).
The TFTP server must be capable of handling as many simultaneous TFTP requests as there are DAPs. Remember, if the DAPs start up simultaneously, they do a TFTP request simultaneously.
In the IP DECT Advanced Data Manual, you find examples of how to setup other DHCP and TFTP servers.

5.3.8 INSTALLING THE DAP Controller/Manager

5.3.8.1 Preconditions

Make sure that you have decided which DHCP Server you are going to use. Also make sure that you have decided which TFTP server you are going to use.
Also make sure that the network components (Switches, Routers) are correctly configured for VoIP and IP multicast. Be fully aware of the network topology! Make sure that the network supports IP multicast between all network components that are used for 4080 IP-DECT CE.

DAP manager hardware requirements:

- At least 2.6 GHz CPU speed
- Minimum 1-Gb RAM
- CD-ROM drive
- Minimum 1-Gb hard disk space

DAP manager software requirements:

- Windows Internet Information Services (IIS)

Besides the operating system, the Windows WEB server, called IIS (Internet Information Services) is required. However, during installation, IIS is automatically installed.
When you install the DAP Controller software under Windows XP or Windows 2003, the system may ask for the Operating System CD-ROM/DVD-ROM.
Note: On the client computer, you must use Internet Explorer 6.0 or higher to view the DECT Manager WEB pages.

DAP manager platforms:

- Microsoft Windows XP Professional, SP2/SP3 32 bits
- Windows 7 Professional/Enterprise/Ultimate 32/64 bits
- Windows Server 2003 SP2 32 bits
- Windows Server 2003 R2 SP2 32 bits
- Windows Server 2008 SP2 32/64 bits
- Windows Server 2008 R2 SP2 64 bits

5.3.8.2 Installing the DAP Controller Release 5.2

Install the right DAP configurator :
DAPController-5_20_xxx-ALU_INT
DAPController-5_20_xxx-ALU_NA
DAPController-5_20_xxx-ALU_SC

Note: After that a DAP configurator is installed (ex: DAPController-5_20_xxx-ALU_INT) it is not possible to install another different DAP configurator on the same PC (ex: DAPController-5_20_xxx-ALU_SC).

The International (INT) version is for everywhere where standard DECT is used (EMEA countries and countries that use the European frequencies and power levels).

Note: In Europe, only the "DAP Controller - International" will be delivered, so no other frequencies than the European frequencies and power levels are possible in Europe.

North America (NA) version is for USA/Canada.

Note: In North America, only the "DAP Controller - North America" will be delivered, so no other frequencies than the North America frequencies and power levels are possible in North America.

Selected countries (SC) version is used in countries with other frequency ranges than EMEA or North America (where there are "weird" requirements).

Selected countries: Brazil, Taiwan (Province of China), Thailand, Latam excl. Brazil/Uruguay, Egypt, Uruguay

And then there's a "Dual Band" version for the cruise line industry.

Remark: There is a DAP configurator for the Site Survey Kit: DAPController-5_20_xxx-ALU_SSK (for all countries).

The frequency range depends on the region where DECT is used:
- 1880 MHz - 1900 MHz for European countries
- 1910 MHz - 1930 MHz for Latin America region
- 1900 MHz - 1920 MHz for China
- 1920 MHz – 1930 MHz North America (lower transmission power, –3 dB)

Note: For more detailed information, see "4080 ip-dect installation manual_enf"

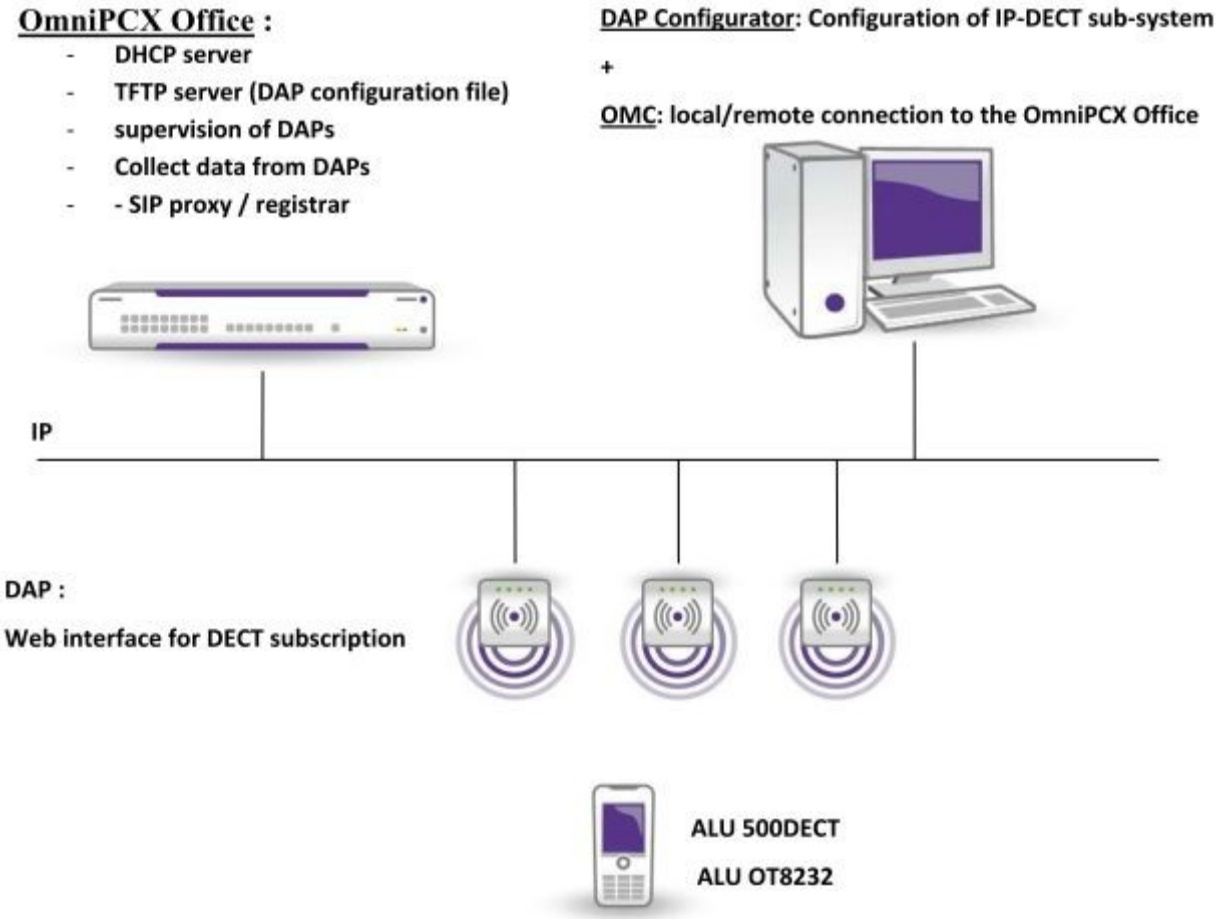
PROCEDURE: "Installation" (See Alcatel-Lucent 4080 IP-DECT CE for more detailed information).
Actions
1. Make sure that you are logged in with Administrator Rights!
2. Un-zip the DAP installer package.
3. Double click setup.exe or setup .
4. You will now see a security screen from Windows saying "Do you want to allow the following program to make changes to your computer?" Click Yes.
5. Click Next to proceed.
6. Now the installation of "Prerequisites" takes place. Click Next to continue.
7. The system is ready to start the installation of the DAP Controller. Click Next to continue.
8. Select the system type that you prefer, "Multiple System" or "Single System".

Select Single System if you want to manage only one IP DECT system, or Multiple System if you want to manage more than one IP DECT system with your PC. Click Next.
Note: If you select "Single System" the DHCP Server and TFTP Server are not installed (by default). However, if you want to install them anyway, select the option "Custom" in step 9, and select DHCP Server and TFTP Server to install.
Remark: As" Multiple System" is not supported by the Alcatel-Lucent" solution it is recommended to select "Single System", the Services will be installed with startup parameters "Automatic".
9. Specify the "Setup Type". Select Standard and click Next. Note that if you want to fine tune the installation you should select "Custom".and click "Next".
10. Click Install to start the installation.
11. When the installation is finished, you will see the window "InstallShield Wizard Completed".

When the checkbox "Launch DAP Configurator is checked, the DAP Configurator will start after clicking Finish. If not, the installation will finish, but the DAP Configurator will not be started. However, you can start the DAP Configurator from the Programs menu later. Click Finish.

5.4 IP-DECT Lite network rules with OXO

5.4.1 Typical IP-DECT Lite configuration



5.4.2 IP-DECT Lite limitations

- All DAPs must be in the **same IP subnet**
- No more than 16 DAPs
- No more than 50 DECT handsets
- No Branch Offices
- No IP-DECT and DECT IBS on the same system

5.5 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 particular 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.**

5.5.1 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 IP-DECT DAPs and TDM base stations with the following exception for TDM 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).

5.5.2 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

5.5.3 Traffic capacity calculation

The total load of the terminals is higher than the DECT traffic of the zone users. You must take into account 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: $T = Tu \times 1.1 \times 1.2 \approx Tu \times 1.3$

5.5.4 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 on the one hand for TDM bases (RBS/IBS NG) and, on the other hand, for the IP-DECT DAPs (with OXE and with OXO).

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	Help desks, 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

5.5.4.1 Calculation of the RBS number

The terminal traffic capacity is linked to 2 parameters:
- the terminal type which sees -11 channels (400 DECT, 8232 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 (400-8232)	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 400 DECT HS or 8232 DECT HS
- 50 users at 0.15 E with 400 DECT HS or 8232 DECT HS
- 40 users at 0.25 E with 400 DECT HS or 8232 DECT HS
-10 users at 0.3 E with 400 DECT HS or 8232 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:

$$T_u(11) = 200 \times 0.1 + 50 \times 0.15 + 40 \times 0.25 + 10 \times 0.3 = 40.5\ E$$

Total load for the zone:

$$T = 40.5 \times 1.10 \times 1.20 = 53.5\ E$$

Calculation of the number of base stations:

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

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

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.

5.5.4.2 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

5.5.4.3 Calculation of the 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)

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.*

5.5.5 Customer wants to replace IBS/RBS bases by IP-DECT DAPs

Additional bases may be needed due to air synchronization if a customer wants to replace IBS/RBS bases by 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 takes into account 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. Coverage Calculation

6.1 Coverage performance principles

6.1.1 Base station positioning methods

6.1.1.1 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.

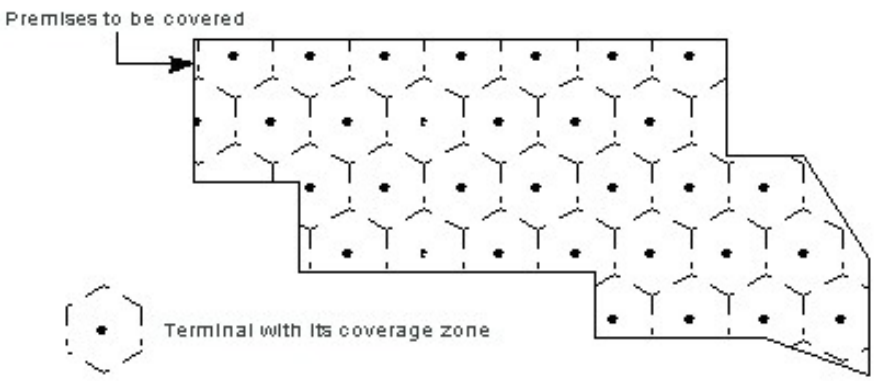
If the traffic is predominant as regards the coverage difficulty, base station meshing will be weaker thereby allowing each mobile handset to see a maximum number of base stations within the predefined field level limits.

6.1.1.2 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 omni-directional 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:

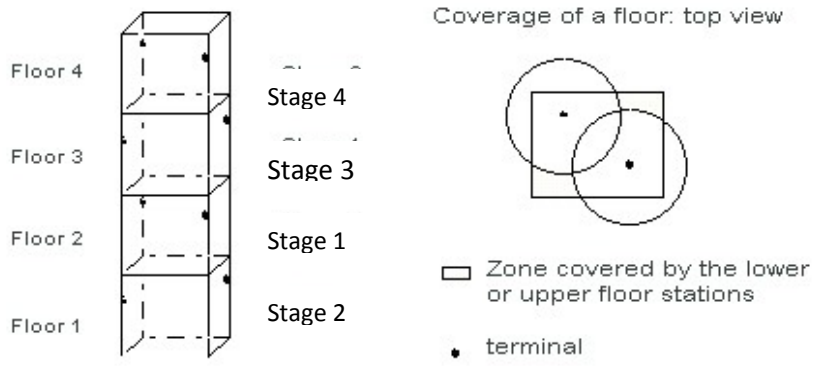
* Measurement of the level on the adjacent floors, remembering the fact that this is not always homogeneous. (Use the least good cases for planning).

* 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.



6.1.2 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 2 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 2: Typical Insertion Losses of some Obstacles

The maximum allowed loss in the link is calculated in order 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 3. Add the losses due to the different encountered obstacles (See table 2).

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 -57dBm (-60 +3), instead of -70 dBm use -67dBm (-70 +3).

It must be emphasised 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

	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
-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

	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
-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

	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
-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 3: DECT Range calculation versus beta (Pe=23dBm)

Note: For US, the distance (R) corresponds at "Pr_dB + 3" in table 3.

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

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

The result of this coverage calculation should be a map with possible DAP positions. Now the cell boundaries must be determined by walking around and doing measurements. Therefore tools are required. This is explained in chapters 9 - Preparation and 10 - Execution.

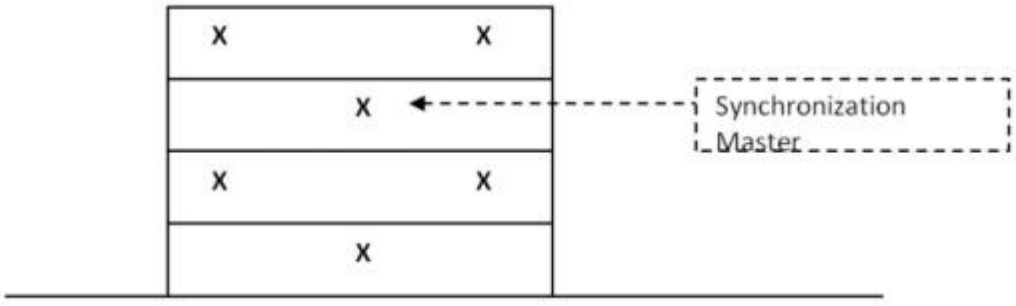


Figure 6: Example of Synchronization Master in the middle of the Building

6.1.3 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.

6.1.4 Antennas

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.

6.1.4.1 Types of antennas that can be used

Two types of antennas can be used: Omni directional 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 omni-directional 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.

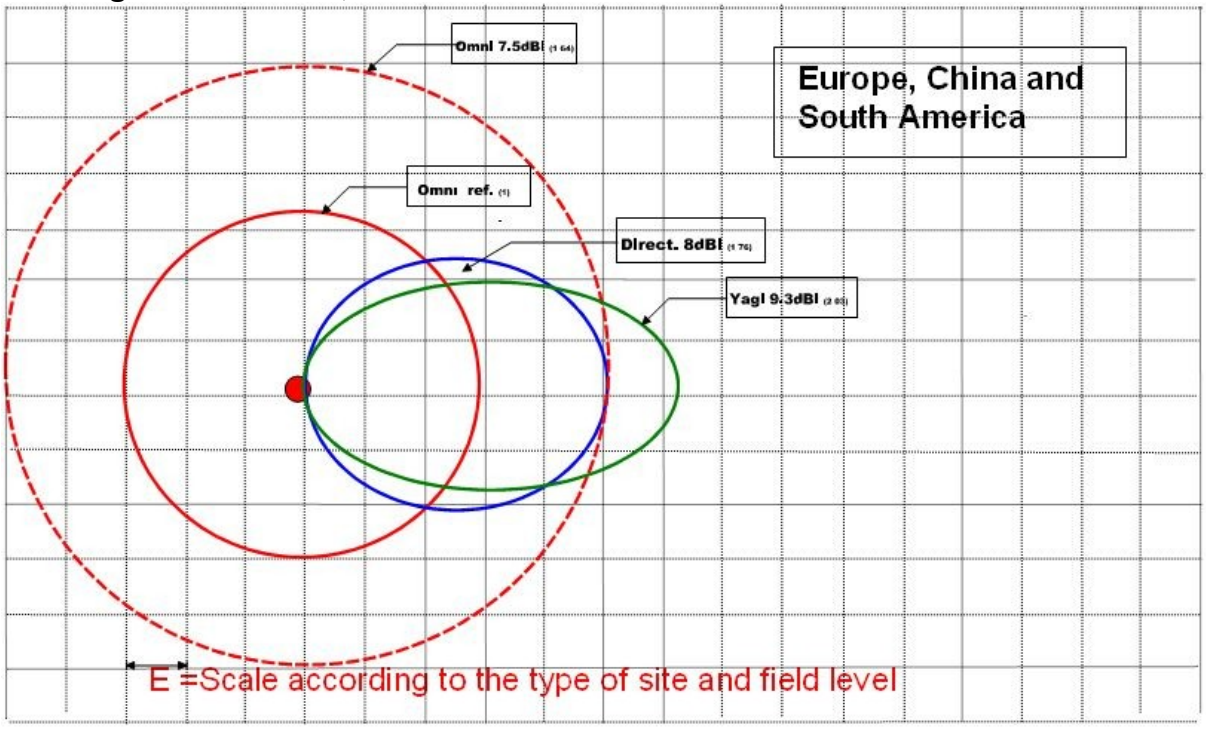
Type	Opening angles	Uses	Recommended positioning
Omni 2 dBi	V=80^0 H=360^0	Large hall(s) with little traffic, open space(s), ordinary offices	Clear space that is as visible as possible, away from obstacles (>3m), in the center of the area to cover and 20 cm from the ceiling
Omni 7.5dBi	V=17^0 H=360^0	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.
Directional 8 dBi with left and right circular polarization	V=70^0 H=70^0	Indoors in rectangular corridor and metallic environments (such as a hangar).	In all types of space: Ceiling, wall, poles, etc. Can be tilted to direct the energy to the required area.

Note 1: For Europe, China and South America zone, the antenna gain must be ≤ 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.

The difference in antennas coverage is shown in the schematics below:

Antennas coverage for EUROPE, CHINA and SOUTH AMERICA



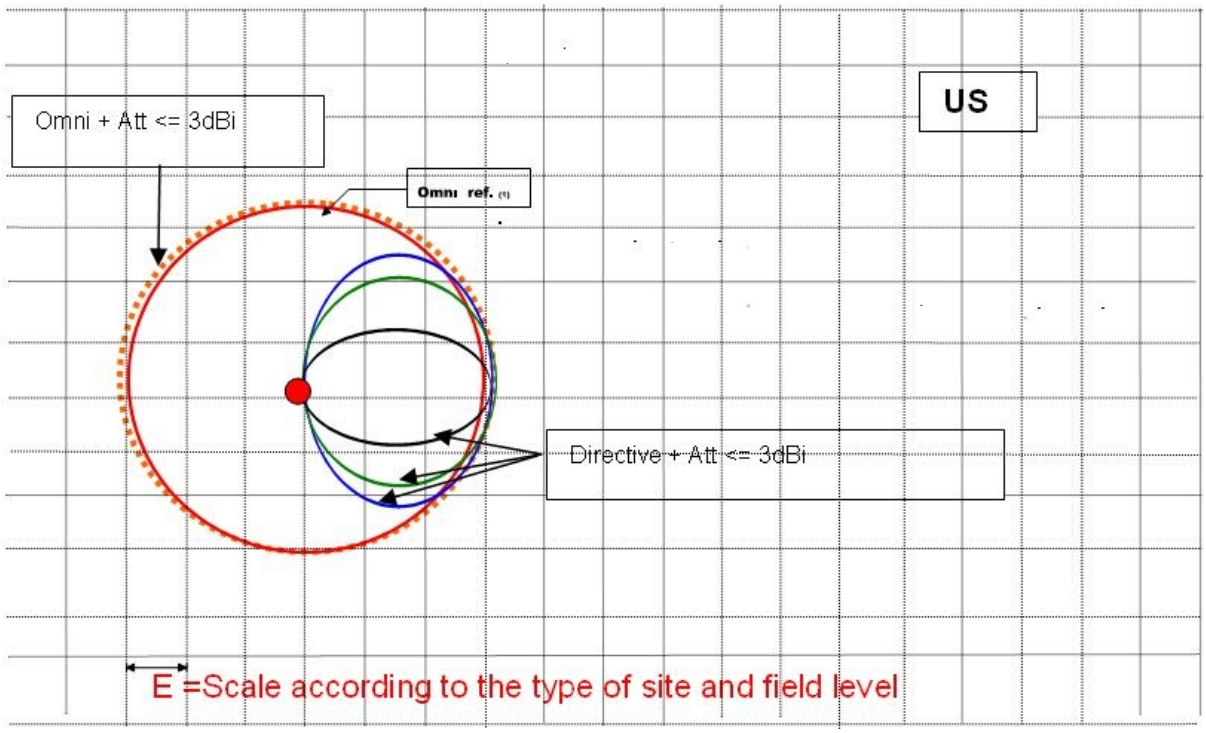
Europe, China and South America	For a field level of -60 dBm	For a field level of -70 dBm
Outdoors environment	E =40m => **r=120m**/standard ant.	E =130m => **r=340m**/standard ant.
Indoors clear space	E =14m => **r=40m**/standard ant.	E =34m => **r=100m**/standard ant.
Indoors office space	E =6.5m => **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 $Pe_{\_US} = Pe_{\_EU} - 4dB$.
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)***.**

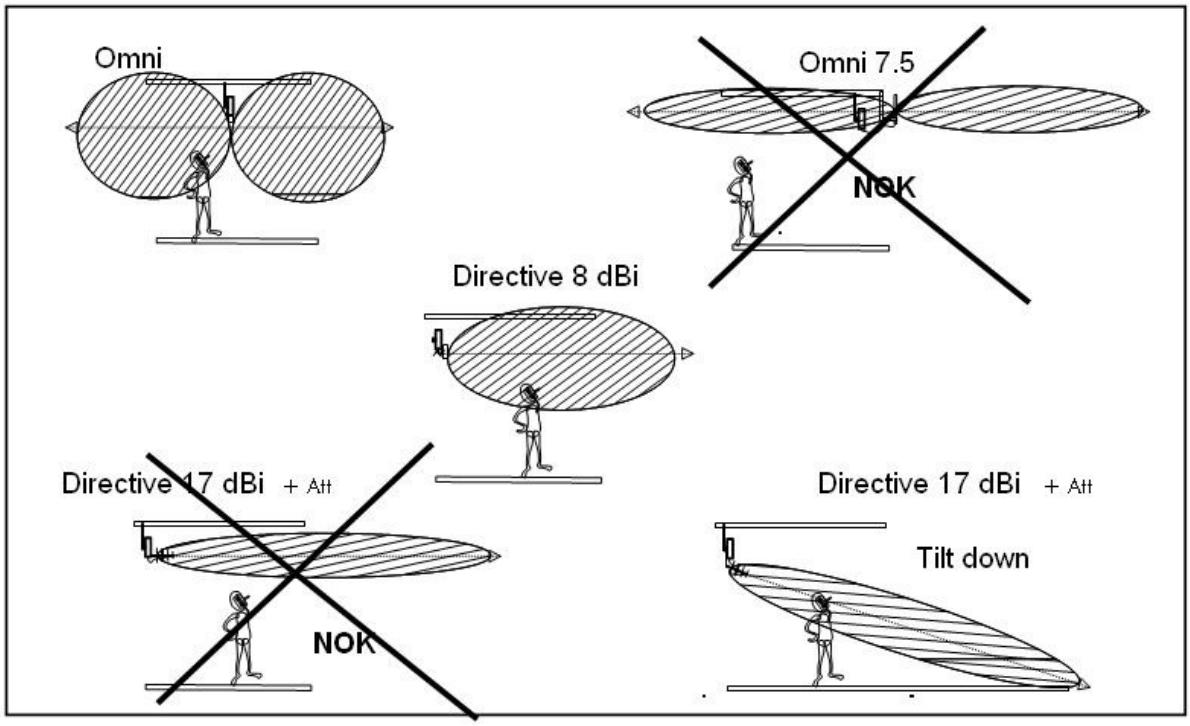
⇒ With 5 frequencies instead of 10, the traffic reduction factor is in the order of 2.

⇒ 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)



6.1.4.1.1 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.

6.1.5 DECT rules as regards a 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

(Omni-directional 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 Alcatel DECT bases with omni-directional 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 Omni directional antenna G≤2 dBi	**DECT Directive antenna G=12 dBi**
WLAN Omni directional antenna G≤2 dBi	d≥ 2.5meters	d≥ 7 meters
WLAN Omni directional 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 Omni directional antenna G≤2 dBi	**DECT Directive antenna G=12 dBi**
WLAN Omni directional antenna G≤2 dBi	d≥ 1meter	d≥ 2.5 meters
WLAN Omni directional 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.

6.1.6 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 canoverload 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 4 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 the 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. (*)
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 4 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.

(*)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 4: 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 Erl	21	67	122	182	309	442	578	930	1290	1656	1730	1804
	0.2 Erl	10	34	61	91	154	221	289	465	645	828	865	902
	0.3 Erl	8	22	41	61	103	147	193	310	430	552	577	601
	0.4 Erl	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 Erl	14	53	102	156	273	398	527	862	1208	1652	1633	1705
	0.2 Erl	8	27	51	78	137	199	263	431	604	781	817	852
	0.3 Erl	8	18	34	52	91	133	276	287	403	521	544	568
	0.4 Erl	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 5:

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).**

6.1.7 Recommendations relative to the wiring

6.1.7.1 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 taken into account:

- 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:

Characteristics: For a RBS connected on a DECT4/8 coupler	**Values**	**Comments**
Impedance at 576 KHz	85 Ohm < < 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.

Characteristics: For an IBS connected on a UA coupler	Values	Comments
Impedance at 682 KHz	85 Ohm < < 135 Ohm	Impedance variation on the line < 15%
Crosstalk at 682 KHz	> 44 dB	
Attenuation at 682 KHz	< 25 dB	
Propagation time	< 7 µs	
DC loop resistance	< 155 Ohms	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.

6.1.7.2 IP-DECT specifications and recommendations relative to wiring

6.1.7.2.1 IP Specifications

- IP Network: 10/100Base-T IEEE802.3
  Note: Maximum cable length according to the IEE802.3 specification: ***100 meters****.*
- Connector: RJ45
- Cable: Cat 5 / Cat 6 UTP.
  Note: Cat 7 is not supported!
- IP Version: IPv4
- DHCP/TFTP support: Yes
- Quality of Service: IEEE802.1Q, IEEE802.1p

6.1.7.2.2 PoE specifications

- Voltage at 4080 IP-DECT via PoE: 36 . . . . 57 V. DC
- PoE Class: Class 2
- Power Consumption: 6 Watt maximum

6.1.7.2.3 Dimensions / Environment

- Dimensions (W x D x H) : 145 x 43 x 174
- Outside temperature range: 0° C . . . 45° C
- IP Specification: In Outdoor Box = IP66
- Relative Humidity: 5 . . . 95 %

6.1.7.2.4 Audio Algorithm

- 4080 IP-DECT: G.711
- 4080 IP-DECT with Daughter Board: G.711 and G.729

6.1.7.2.5 Country/Region support

- EMEA: 1880 – 1900 MHz
- Latin America: 1910 – 1930 MHz
- North America: 1920 – 1930 MHz (3 dB lower output power)

6.1.7.2.6 LEDs

6.1.7.2.6.1 LED status

The 4080 IP-DECT is equipped with two LEDs.

Top LED – Yellow

This LED represents the status of the 4080 IP-DECT.

LED Status (Top LED, Yellow)	Meaning
Off	No power
0,5 sec. On - 0,5 sec. Off	Loading software/firmware
Short flash every 0,25 seconds	IP Network error (not connected, no DHCP/TFTP server, no DAP Controller
Fast blink	DAP operational, but trying to synchronize to another DAP
Continuous fast blink	Hardware error
Steady On	DAP operational (and synchronized to other DAP or is the synchronization master).

4080 IP-DECT LED Status on top LED

Lower LED – Red/Green

This LED is used to indicate the start-up and network status.

LED Status (lower LED, Red/Green)	Meaning
RED Steady on	Power but FPGA starting up
RED flashing	Trying to connect to the network
Green flashing	Network status display and showing network activity
Off	4080 IP-DECT operational

Lower LED status on the 4080 IP-DECT.

6.1.7.2.6.2 LED colours

The colour of the top LED might be different depending on the operational mode. The following operational modes are distinguished:

- Normal (single band) mode

In the normal single band mode, the top LED will be Yellow.

- Dual Band Mode

In Dual Band mode, the LED colour shows the operational frequency:
Green: Europe/International
Red: North America / USA

- Site Survey mode (only applicable for the 4080 IP-DECT in the Site Survey Kit.)

Green: Europe/International
Red: North America / USA
Blue: Latam
Magenta: China and Thailand

6.1.7.2.7

6.2 ESTIMATION of the NUMBER of BASES

6.2.1 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 tables 9a & 9b.
- Estimation for coverage in typical office.
  See tables 10a & 10b to find information about coverage in "typical office" environment.
- Estimation for coverage in drywall office.
  See tables 11a & 11b to find information about coverage in "drywall office" environment.
- Estimation for coverage in brickwall office.
  See tables 12a & 12b to find information about coverage in "brickwall office" environment.

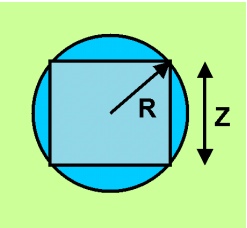
A complex site may be more easily split into areas which are estimated separately and the resulting number of bases totalled together.

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.

6.2.2 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"

6.2.3 Easy or tricky coverage

See chaper "Classification summary tables" to determime if the coverage is classified as easy (-70 dBm) or as tricky (-60 dBm).

6.2.4 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 6 : Description of building type

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

6.2.4.1 Determination of the propagation index (beta)

By default see table 6 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 7 : 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 synchronzatiion are to be determined.*

6.2.5 Determination of Z versus propagation index (beta) and received signal

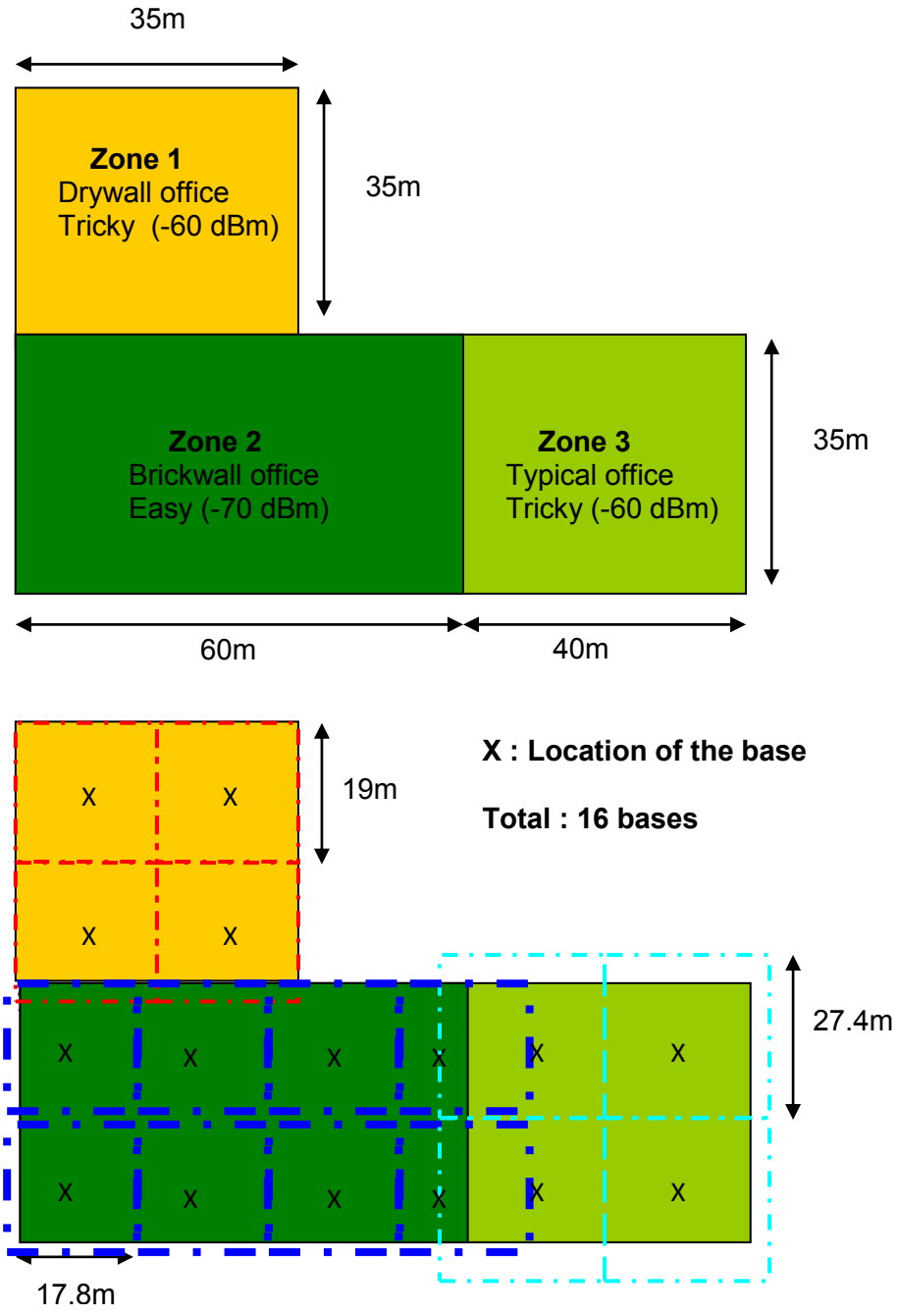
PROPAGATION INDEX (OFFICE TYPE)	COVERAGE			
	RSSI (dBm)	A (m^2)	R (m)	Z (m)
INDOORS CLEAR SPACE Beta <2.8	-60	3204	40.0	56.6
	-70	19994	100.0	141.4
TYPICAL OFFICE Beta <3.5	-60	751	19.4	27,4
	-70	2798	37.4	52.9
DRYWALL OFFICE Beta ≈4	-60	361	13.4	19.0
	-70	1136	23.8	33.7
BRICKWALL OFFICE Beta ≈5	-60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

Table 8 : Coverage versus propagation index (beta)

6.2.6 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 Alcatel-Lucent 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 15Mbps.



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

6.2.7 Estimation for coverage in clear space

Tables 9a and 9b 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 9a: 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 9b: Estimated number of required bases for coverage in easy (-70 dBm) clear space

6.2.8 Estimation for coverage in typical office

Tables 10a and 10b give information about the number of bases, that are required for estimation the coverage in typical office. 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.
- - These tables have been calculated on the basis that each base provides 751 sq.m. coverage (if tricky coverage => -60 dBm) or 2798 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	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 10a: 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 10b: Estimated number of required bases for coverage in easy (-70dBm) typical office

6.2.9 Estimation for coverage in drywall office

Tables 11a and 11b give information about the number of bases, that are required for estimation the coverage in drywall office. 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 361 sq.m. coverage (if tricky coverage => -60 dBm) or 1136 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	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 11a: 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 11b: Estimated number of required bases for coverage in easy (-70 dBm) drywall office

6.2.10 Estimation for coverage in brickwall office

Tables 12a and 12b give information about the number of bases, that are required for estimation the coverage in brickwall office. 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 128 sq.m. coverage (if tricky coverage => -60 dBm) or 317 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	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 12a: 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 12b: Estimated number of required bases for coverage in easy (-70 dBm) brickwall office

6.2.11 Determination of the distance for DAP air synchronization

See table 13 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 13 : Distance for DAP synchronization vs index of propagation (beta)

6.3 Specific rules for difficult sites

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

6.3.1 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.

6.3.2 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 services 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.

7. Ethernet and power provision for IP-DECT

A DAP needs a connection to the Ethernet and needs to be powered over the Ethernet (Power over Ethernet). The Ethernet can be 10 Mbit/s or 100 Mbit/s full duplex. However the maximum cable length between the DAP and Ethernet equipment (most likely an Ethernet Switch) is **100** meters (over cat 5, unshielded twisted pair). For more info on cable length, consult the IEEE 802.3 specifications. This cabling constraint needs to be taken into consideration in the execution of the site survey.

Check that the nearest Ethernet Switch to which you must connect the DAP, is less than 100 meters cable length away. If not, consult the IT Staff to solve this problem.

Give attention to the following matters related to the Ethernet:

- Most likely the DAP and other IP phones will be part of one VLAN. Make sure that the Ethernet connection supports the VLAN in which all the other DAPs are.
- Make sure that the Quality-Of-Service that is offered by the IP network is sufficient for the Voice-over-IP application IP DECT.
- Make sure that the IP Network supports transparent IP-Multicast between all DAPs and DAP Controller.
- It is strongly recommended to make a one-to-one connection between an IP Switch port and a DAP. Do not connect more than one DAP to one Switch port.
- When setting up the network it might be useful to know that the IP connection on a DAP supports full duplex and supports “auto negotiation” when connected to a port on an Ethernet Switch.
- When more than 5 DAPs are connected to the same Ethernet Switch, it might be cheaper to provide the DAP power via a power “hub” at the Ethernet Switch. Consider this and, if possible, discuss this with the local IT Staff.

8. Tools – “Site Survey Kit”

8.1 General

Important: *Installation and use of this Site Survey Kit and its accessories is 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°C (113°F).*

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

***Note**: DAP can be used instead of base hereafter.*

The contents of the “Site Survey Kit” are as follows:

- Suitcase to carry all of the items (except for the Tripod)
- A “4080 IP-DECT AP Integrated Antennas” with omni-directional internal antennas[2].
- A “4080 IP-DECT AP External Antennas” with connectors for external antennas[3].
- One directional antenna 8dBi with two cables.
- One Ethernet cable RJ45 – RJ45 (1m)

[2] The SSK is actually fitted with a non-branded variant of the 4080 IP-DECT AP Integrated Antennas
[3] The SSK is actually fitted with a non-branded variant of the 4080 IP-DECT AP External Antennas

- One plastic board for mounting the Battery Unit and one of the DAPs
- Two Battery Units including batteries and a power converter from battery voltage to 48 Volt for power provision to the DAP mounted on the plastic board.
- Three ALU 400 handsets for measurements.
- Note: These handsets are not delivered with the purchased SSK; the Business Partner has to buy them separately and add them to the SSK.
- When ALU 400 handsets are used: two headsets for ALU 400
- Three Desktop chargers for ALU 400
- Three AC adapters for Desktop chargers.
- Three Pouches for ALU 400 handset.
- Documentation:
  - Site Survey Manual for Survey Kit Alcatel-Lucent Enterprise(= this document)
  - ALU 400 User Guide
  - Charger (for the battery units) User Guide

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 8 shows the contents and lay-out of the Site Survey Kit.

Figure 8: Site Survey Kit

Note:
• 4080 IP-DECT Site Survey Kit for on-site Coverage Installation
3BN67186xA
(North America : NA - rest of world : AA)
• 4080 IP-DECT Telescopic Tripod for the Site Survey Kit
3BN67187AA

***Remark**: Previous IBS/RBS DECT coverage tool is*
3BN6716xAA
(North America : NA - rest of world : AA)

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 DAPs must be installed. Please note that the customer has to give you permission to take pictures.

8.2 Charging the batteries

8.2.1 Survey Kit Battery Units

To charge the Battery Units in the Site Survey Kit, execute the following steps:

1. Take the Battery Charger and one of the Battery Units.
   In Figure 9 you see an overview of the connectors, LED indications and switch at the side of the Battery Unit.
2. Set the "On/Off" switch on the Battery Unit in the "Off" position.
3. Connect the Battery Charger to the Mains. The "Power" LED is on.
4. Connect the Battery Charger to the Battery Unit.
5. On the Battery Unit, switch the "On/Off" switch to position "On".
   The Green LED flashes slow to test the batteries.
   The Charge LED on the charger will be steady "on" to indicate that the charging sequence has started.
   The Green LED is "off" during the charging sequence.
6. When the green LED flashes fast, the charging sequence is finished.

   Notes:
   - *When the batteries are charged for the first time, make sure that the complete charging sequence is not interrupted until the batteries are fully charged. After that make sure that the next three times that the batteries are charged, the charging sequence is also not interrupted before it is completely finished.*
   - *Pressing the Yellow button on the Charger, starts discharging the batteries!*
   - *A complete charging sequence takes about four hours*.
7. After charging is finished, switch the "On/Off" switch to position "Off".

8. Disconnect the Battery Charger from the Battery Unit. Repeat the charging procedure for the second Battery Unit. Be aware of the previous “Notes” and do not interrupt the charging sequence.

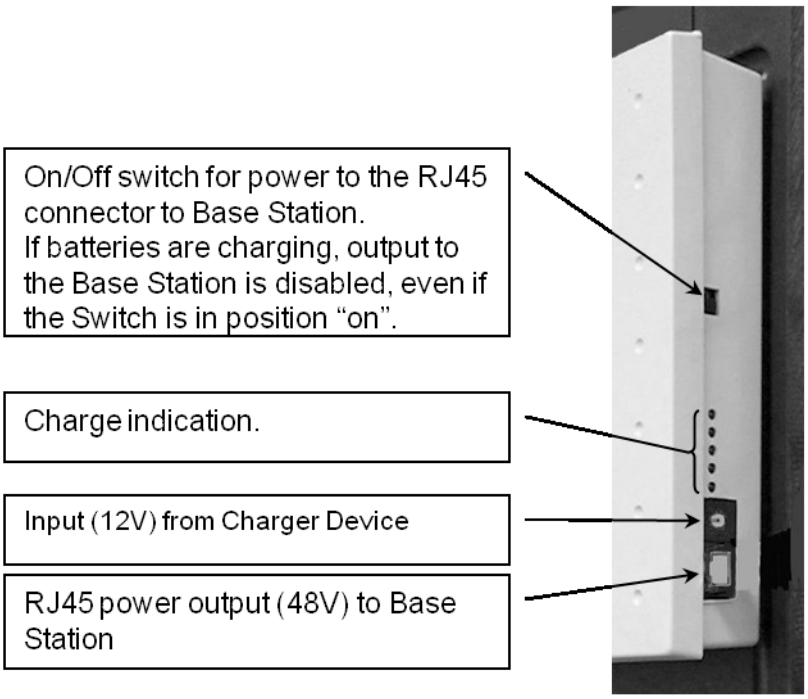


Figure 2: Controls on the Battery Cabinet

8.2.2 Handset Batteries

Charge the handset batteries for at least 3.5 hours to make sure that they are fully charged. Use the chargers that come with the Site Survey Kit.

Always make sure that the batteries are in good condition.

8.2.3 Setting up the SSK tool

In the previous section, you have charged the batteries. Now you are ready to setup the tool for operation. To setup the tool for operation, execute the following steps:

1. When you have taken out the battery cabinets from the case, the case will look like in Figure 10.

Figure 10: Battery Cabinets Removed from Site Survey Kit

2. Take out the plastic board. At the (rear) other side of the plastic board, the wall plate of the DAP is mounted. In the following steps you will mount one of the Battery Units to the plastic board (at the counter side of where the wall plate of the DAP is mounted). The other one is considered as a spare Battery Unit.

3. Watch the “key holes” in the Battery Unit and put the key holes over the screws on the plastic board. (See Figure 11).

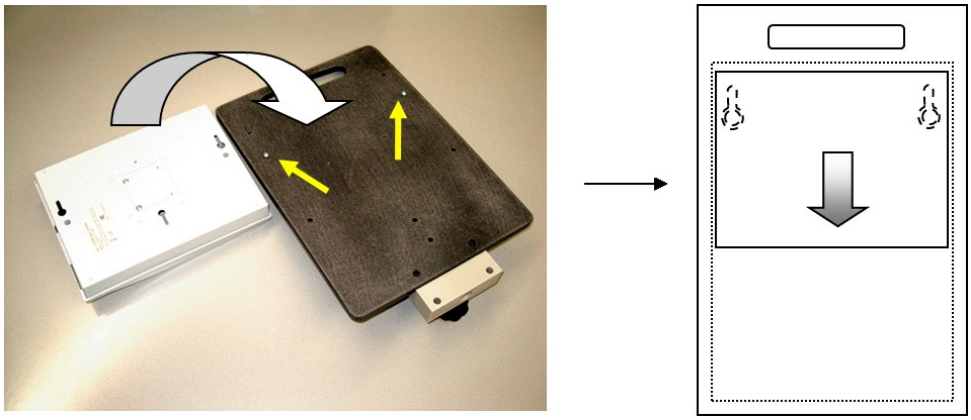


Figure 11: Mounting a Battery Unit on the Plastic Board

4. Push the Battery Unit down to lock the key holes over the screws. Now the Battery Unit is fixed to the plastic board.
5. Connect the power cable (RJ45 – RJ45) between the Battery Unit and the DAP as shown in Figure 12.

Figure 12: Mounting the Cable between the Battery Unit and the DAP

6. Mount the plastic board with Battery Unit and DAP to the Tripod (Figure 12).

   Note: *Although the battery pack is on the same level as the AP300, there is no noticeable influence of the battery pack on the antennas in the AP300, nor on the radiation.*

7. Switch on the power, using the switch at the side of the Battery Unit.
   The red LEDs on the battery cabinet should be on, indicating the charge level of the batteries. When the yellow LED on the DAP is steady on, it is ready for use. (Starting up can take up to 2 minutes.)

8.3 Using directional antennas

The Site Survey Kit allows you to use directional antennas. An 8 dBi directional antenna is included in the Site Survey Kit. The following step procedure explains how to mount the antenna to the plastic board, and how to connect to the DAP (4080 IP-DECT AP External Antennas).

Note: *When changing antennas, always make sure that the DAP is switched off!*

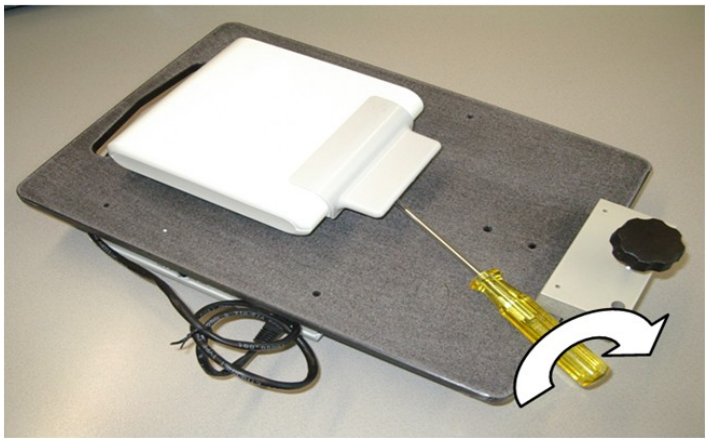


Figure 10: Removing the cover from the Base Station

1. You must remove the DAP with the omni-directional antennas (4080 IP-DECT AP Internal Antennas) from the plastic board. To do that, use a screw driver as shown in Figure 12 and disconnect the RJ45-cable.
2. Connect the RJ45-cable to the DAP that is equipped with antenna connectors (4080 IP-DECT AP External Antennas).
3. Mount the 4080 IP-DECT AP External Antennas to the plastic board.
4. Mount the cables between the directional antenna and the connectors on the 4080 IP-DECT AP External Antennas.

   Note: *Be careful fixing the SMA cable connectors to the SMA connectors on the 4080 IP-DECT AP External Antennas. Using a wrench can easily damage the connectors. Fix them "hand tight" only or use a dedicated SMA Torque Wrench.*

5. Mount the directional antenna to the plastic board. The combination should look like the photos in Figure 13.

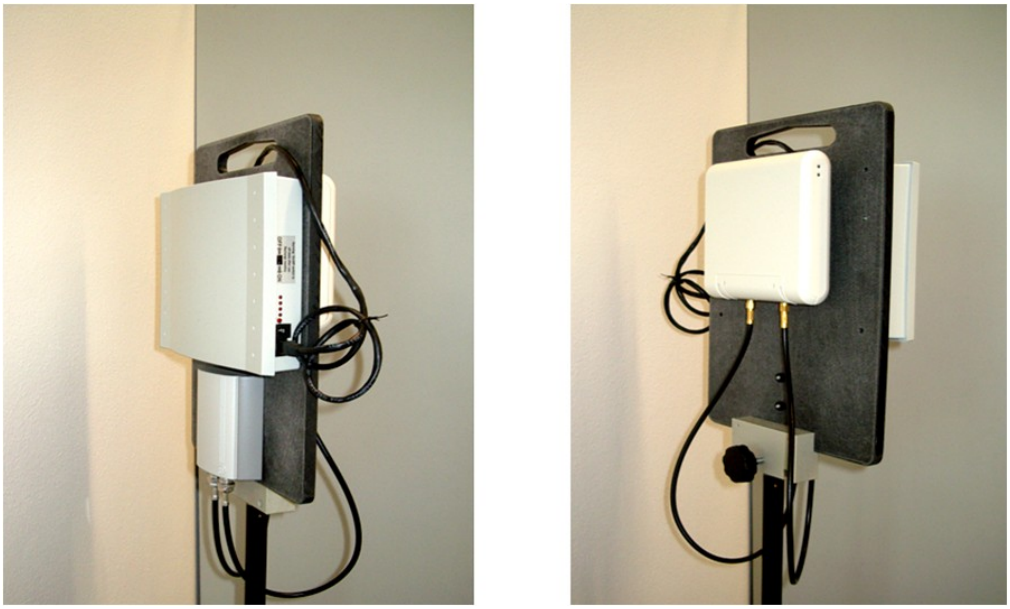


Figure 13: Directional Antenna mounted

6. Switch on the power on the Battery Unit and wait for the LED to be steady-on on the 4080 IP-DECT AP External Antennas.

To remove the directional antenna and install the DAP with the omni-directional antennas follow the above procedure in reverse order.

9. Preparation

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

9.1 Checking the Survey Equipment for Correct Operation

To check the survey equipment, execute the following procedure:

1. Make sure that the Survey's Battery Units and handset batteries are fully charged.
2. Mount the Plastic board (with DAP and Battery Unit on it) to the tripod.
3. If not yet done, connect the Battery Unit to the DAP. Switch the DAP on using the switch on the Battery Unit and check that the LED is steady on (after a while). This means the DAP is up and running.
4. Make sure that the ALU 400 handsets are switched on and "on-hook".
5. Go "off-hook" on one ALU 400. A tone must be heard. If not, check that the DAP is switched on and that the battery of the handset is fully charged.
   Repeat this step for each ALU 400 handset.
   (If everything is OK, and yet you don't hear a tone on a handset, the problem might be that the handset is not subscribed.)
6. Put the tripod with the DAP and the Battery Unit in a corridor. Keep a distance of **20 metres** between the ALU 400 handsets and the DAP and make sure that there is nothing/nobody in-between.
7. For the ALU 400 handset(s) you want to involve in the Site Survey:
   - Switch the handset off.

- Press simultaneously the “Hang up”, the “Phone book” and the “Switch On/Off” keys until the handset switches on.

Figure 14: ALU 400 Site Survey

- Long press key “9”.
- Now you will see Site Survey information displayed in the display. (For explanation of the fields, consult section 10.2 - Setting up the Equipment)
- Check that the RSSI reading is better than –64 dBm. If not then, the Survey Kit must be repaired.

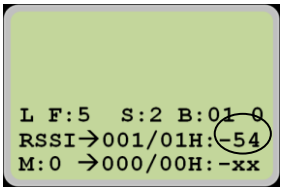


Figure 15: Site Survey Display

9.2 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.

9.3 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 12 - Checklist for Survey Data).

9.4 DAP Positions During Survey

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

The following DAP ranges can be used as a rough guide to planning the DAP positions:

- In the line of sight the DAP has a range of about 80m.
- In halls the DAP has a range of < 80m.
- In buildings the DAP 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 of 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 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 DAP.
- The DAP should be placed high enough to be unaffected by surrounding objects. For example, a DAP in a car park needs to be placed higher than a vehicle that may be parked next to it.
- DAPs 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 DAP or a PP might interfere with sensitive laboratory equipment, medical equipment, and so on (E.g., do not install a DAP in an operating-room in a Hospital!)
- Check that no significant interference from un-suppressed engines or electric motors has been experienced.

9.5 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.

10. Execution

10.1 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 DAP, 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 16 the functions of the persons are depicted.

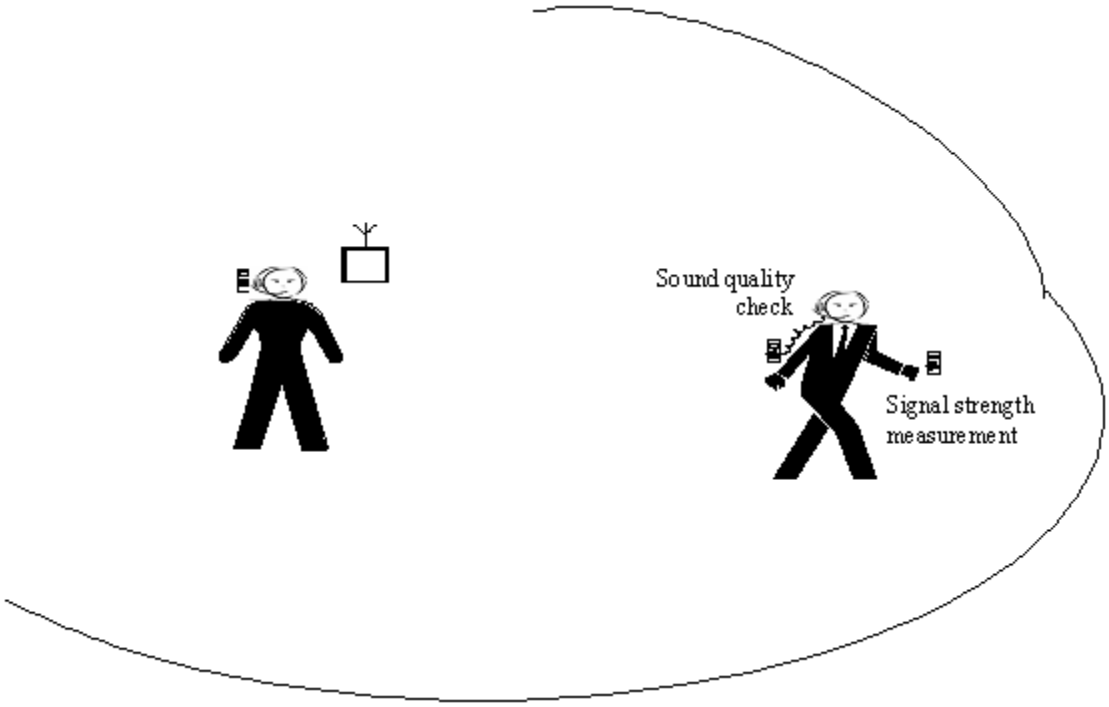


Figure 16: Site Survey / Deployment in Action

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 DAP 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.

10.2 Setting up the Equipment

After having taken the preparatory steps (see chapter 9 - Preparation), execute the following steps:

1. Switch the DAP on using the switch on the Battery Unit and wait for the LED to be on steady; the DAP is up and running.
2. Set-up the "Site Survey DAP" at a planned DAP position.
   Choose the locations for the "Site Survey DAP" as close as possible to the locations where the DAPs can actually be installed. Look also for suitable cable ducts.
3. Adjust the tripod to put the "Site Survey DAP" near the ceiling (for an office environment) or as high up as possible in a large area (such as a warehouse). If the "Site Survey DAP" is outside then put it at a height of about 5m.
4. Switch the ALU 400 handset on.
5. Activate the Site Survey Mode on the handset; see step 7 in chapter 9.1 - Checking the Survey Equipment for Correct Operation.
6. The following lines (with most likely other values) are displayed at the bottom of the display.

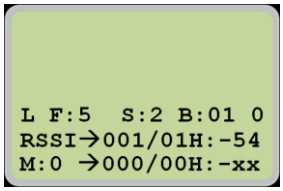


Figure 17: Handset display

7. Go “off hook” and dial the one digit extension number of one of the other ALU 400 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.

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

9. In the Site Survey Mode the ALU 400 displays information in three different screens; only the first two are of importance when executing a Site Survey; use the up/down navigation keys
   to move between the various screens.

   The two screens contain the following important information:

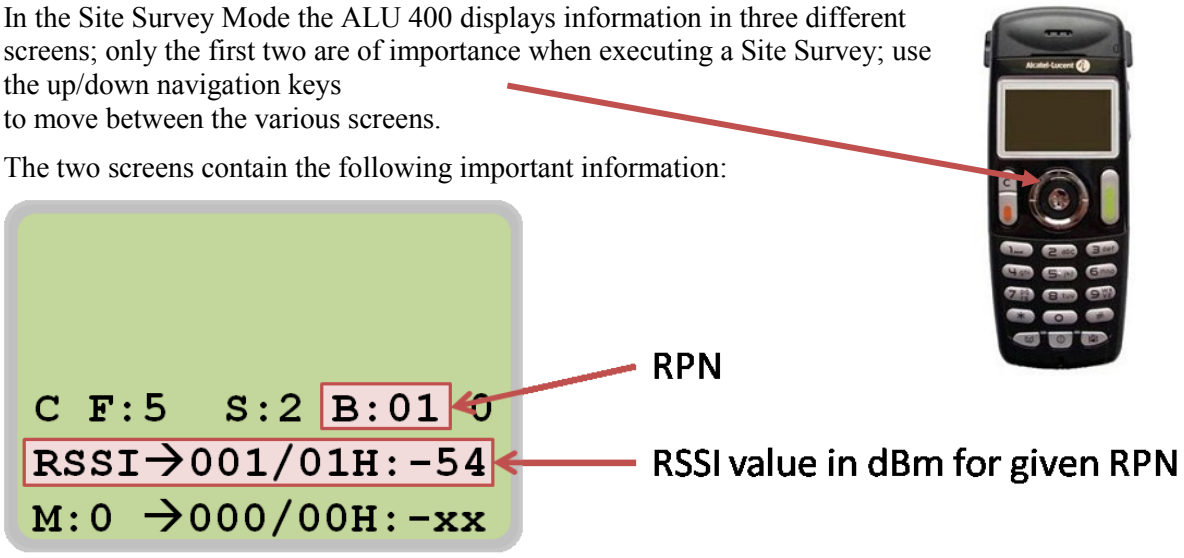


Figure 18: Screen 1 of the Survey Mode

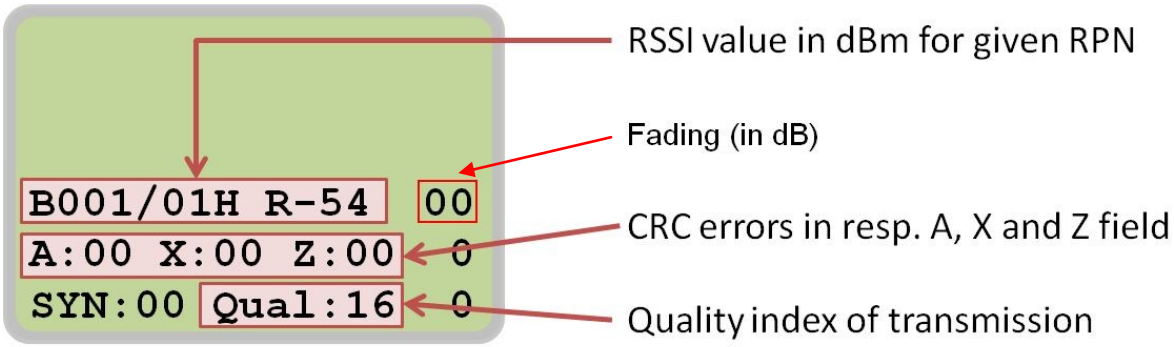


Figure 19: Handset Screen 2 of the Survey Mode

- **RPN:**
  This is the unique (hexadecimal) number of the DAP. In the Site Survey kit, this will always be 01. By means of this number you can see that the handset is “locked” to (looks at) your “Site Survey DAP”.

- **RSSI value in –dBm for given RPN**
  The –dBm value, which is the last value on the line, is the actual signal strength (RSSI) of the signal received from the DAP.
  Note that this information is actually given in both screens (in a slightly different format).
- **Fading (in dB)**
- **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).

10. 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 ALU 400 to the ALU 400 handset as mentioned in step 8. Now you have a voice connection and you can check the speech quality.
    - If you are all on your own, go off hook and dial a "0". You will hear a 425 Hz tone. Use this tone for sound quality check.

    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).

    ❖ 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.)

11. Note the results on the relevant maps. Take care that the relation between the "Site Survey DAP" position and the corresponding cell is clearly defined, using the numbering scheme given in chapter 11 - Reporting Results.

    Note that for a multi-story building it must be clear on what floor the "Site Survey DAP" 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 effect radio reception. If possible arrange for the object to be moved and check the cell boundary again.

12. Repeat steps 3 - 11 for the remaining planned DAP 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 4).

13. It may, at this stage, be necessary to move some of the planned DAP positions or add new DAP positions to eliminate shadows or optimise cell size. If so, it may also be necessary to do additional measurements to check that the new DAP positions do not create other problems.

14. Choose the DAP positions required. This may need to be done in consultation with a customer engineer.

    In choosing DAP positions, the required cabling to the DECT System should be considered. DAP 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 DAP positions, including wiring considerations, special installation instructions etc.

    Depending on the materials (no metal in it, thin materials etc.) of the ceiling, a DAP can be concealed above a suspended ceiling, provided it is not of a metal construction.

    A DAP can be installed within a metre or two of the planned position without adversely affecting radio reception.

15. Turn the handset off to leave the Site Survey mode on the handset.

10.3 Hints and Tips on “How to Survey”

10.3.1 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.*

10.3.2 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 DAP coverage.

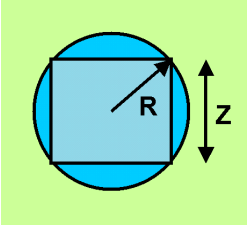
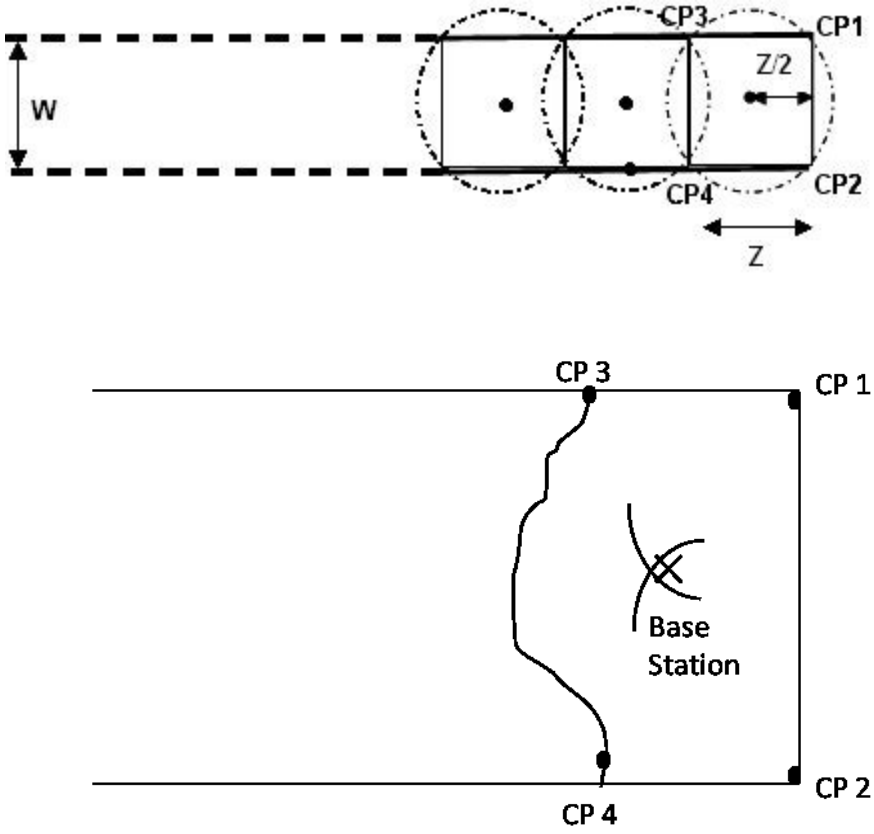


Figure 20: Coverage of a DECT cell vs radius (R)



Figures 21a & 21b: 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 Figures 21a & 21b, these are CP1 and CP2).
2. Place the DAP of the Site Survey on CP 1 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. Place the DAP of the Site Survey on CP2 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP at an angle of roughly 45 degrees. Write down where the cell boundary is.
4. The best location for the cell centre is where the critical point contours cross.
5. Position the DAP of the Site Survey on the CP1/CP2 cross, and raise it to the height where the DAP must be fitted.

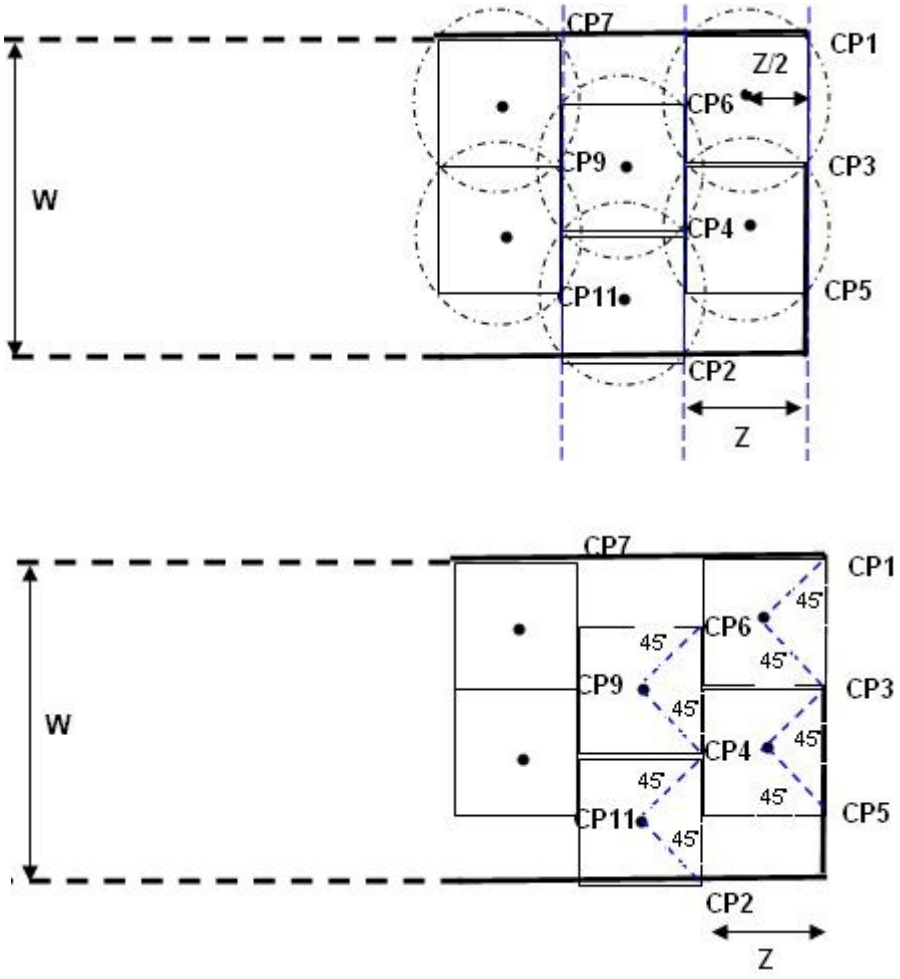
6. Now check the cell boundary. Check that the RSSI value at CP1 and CP2 are sufficient (-70 dBm for easy coverage or -60 dBm for tricky coverage). Draw the cell on the map.
7. Determine new Critical Points (CP 3 and CP 4 in Figures 21a & 21b) at the external walls and repeat the procedure from step 1 onwards.
8. For IP-DECT DAPs 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 **–80 dBm** is achieved at the position obtained for the previous DAP or for another DAP (A DAP must always "sees" another DAP at a RSSI level ≥-80 dBm).

10.3.3 How to Survey a Wider Single Floor

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

If the width of the area is greater (see Figures 22a & 22b) 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 DAP coverage.



Figures 22a & 22b: Example of a wider Single Floor Coverage (W <2.5Z)

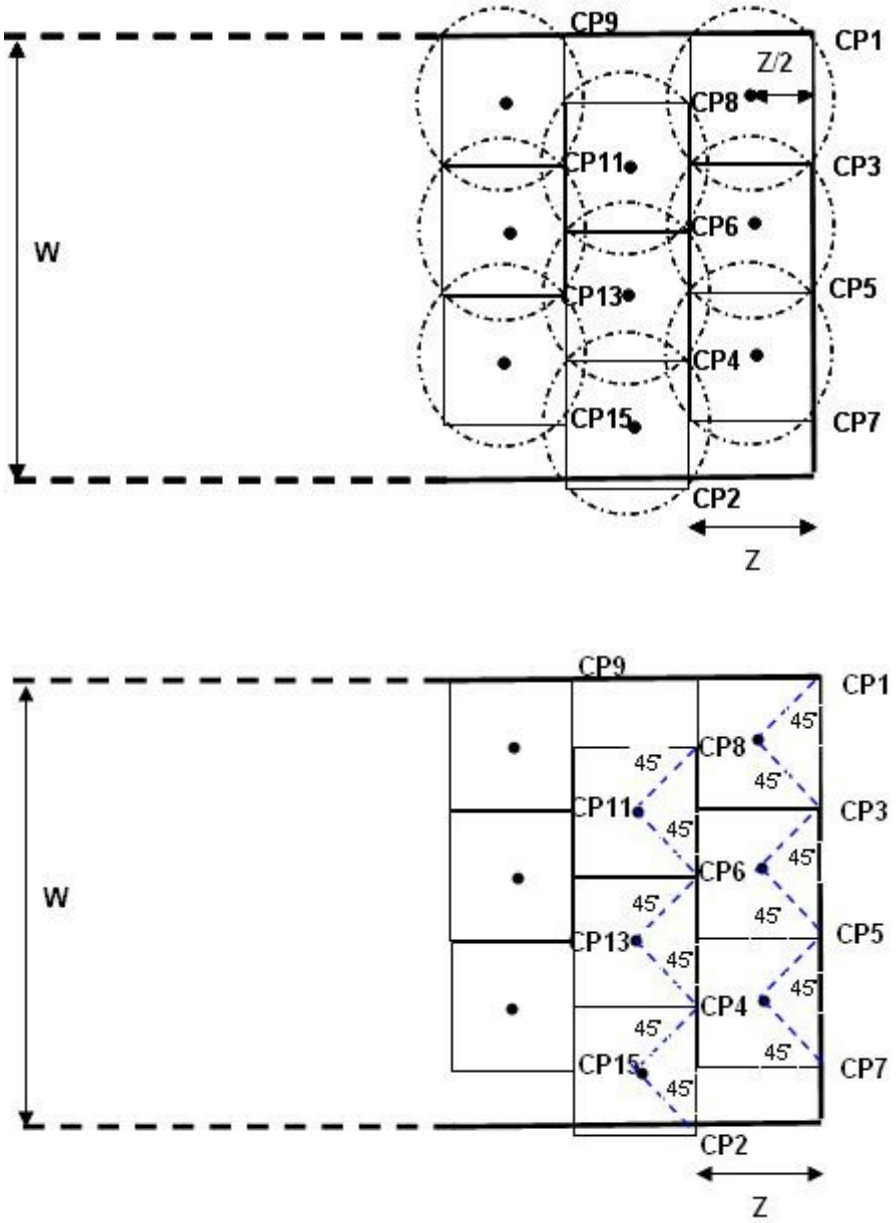
The procedure is as follows:

1. Determine one outer point in the building (see Figures 22a & 22b). This point is the so-called "Critical Point". (CP1).
2. Place the DAP of the Site Survey on CP 1 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
5. Where the cell crosses the outer wall of the building, one new Critical Point (CP3) is defined.
6. Place the DAP of the Site Survey on CP 3 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
   For IP-DECT DAPs 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 **–80 dBm** is achieved at the position obtained for the previous cell center (previous position of DAP) or for another DAP (a DAP must always "sees" another DAP at a RSSI level ≥-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 22a). CP2 is at a distance Z from the outer wall. The vertical passing through CP2 becomes the new virtual outer wall.
11. Place the DAP of the Site Survey on CP 2 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP 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 DAP of the Site Survey on CP 4 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
    For IP-DECT DAPs 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 **–80 dBm** is achieved at the position obtained for the previous cell center (previous position of DAP) or for another DAP (a DAP must always "sees" another DAP at a RSSI level ≥-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 22a). 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.

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

If the width of the area is greater (see Figures 22a & 22b) than the width of a coverage cell (Z) and lower than 3.5 Z, then the following procedure must be executed:



Figures 23a & 23b: Example of a wider Single Floor Coverage

The procedure is as follows:

1. Determine one outer point in the building (see Figures 23a & 23b). This point is the so-called "Critical Point". (CP1).
2. Place the DAP of the Site Survey on CP 1 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
5. Where the cell crosses the outer wall of the building, one new Critical Point (CP3) is defined.
6. Place the DAP of the Site Survey on CP 3 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
   For IP-DECT DAPs 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 **–80 dBm** is achieved at the position obtained for the previous cell center (previous position of DAP) or for another DAP (a DAP must always "sees" another DAP at a RSSI level ≥-80 dBm).
9. Where the cell crosses the outer wall of the building, one new Critical Point (CP5) is defined.
10. Place the DAP of the Site Survey on CP 5 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
    For IP-DECT DAPs only (nor for TDM bases), check that, with the new position of the DAP of the Site Survey, the minimum required signal strength for synchronization of **–80 dBm** is achieved at the position obtained for the previous cell center (previous position of DAP) or for another DAP (a DAP must always "sees" another DAP at a RSSI level ≥-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 23a). CP2 is at a distance Z from the outer wall. The vertical passing through CP2 becomes the new virtual outer wall.
15. Place the DAP of the Site Survey on CP 2 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 Figures 23a & 23b)
17. Position the DAP of the Site Survey on the cell center, and raise it to the height where the DAP 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 DAP of the Site Survey on CP 4 on a height of approximately 1.5 meter (±0.3m). Walk away from the DAP 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 DAP of the Site Survey on the cell center, and raise it to the height where the DAP must be fitted.
    For IP-DECT DAPs only (nor for TDM bases), check that, with the new position of the DAP of the

Site Survey, the minimum required signal strength for synchronization of **–80 dBm** is achieved at the position obtained for the previous cell center (previous position of DAP) or for another DAP (a DAP must always "sees" another DAP at a RSSI level ≥-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 23a). 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.

10.3.3.3 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 in order to comply with a network of hexagonal cells.

10.3.4 How to Survey a Multi Floor Area

There are two approaches in surveying a multi story 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!*

11. Reporting Results

It is important to make a comprehensive survey report that records test results and provides useful information for the engineer who is to actually install the equipment. The following information should be included in the survey report (see chapter 13 - 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 colours, 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.

12. 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.

13. 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]

14. 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. Analyse 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. Analyse the synchronization structure again.
6. Subscribe at least two ALU 400 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.

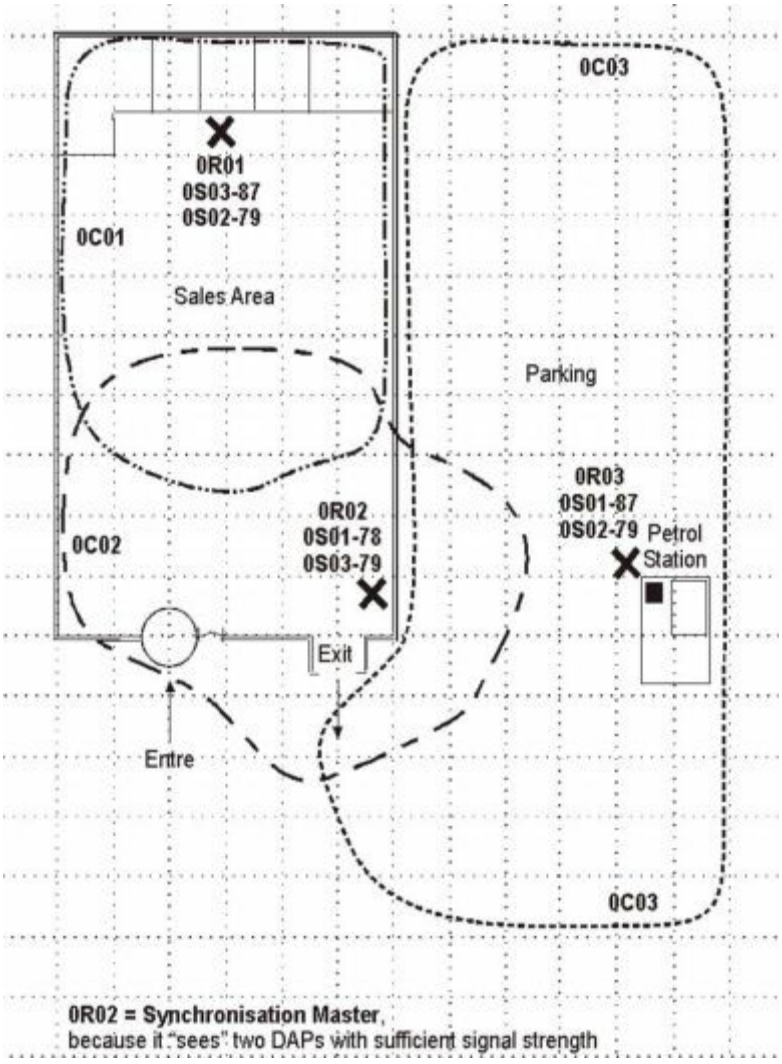


Figure A.1: Example Site Plan

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 : 01/05/2006

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 2006	

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) card board panels suspended 5m above the ground. Lowered ceilings in the offices/storage areas are also thick (1 cm) card board 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 Alcatel-Lucent 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

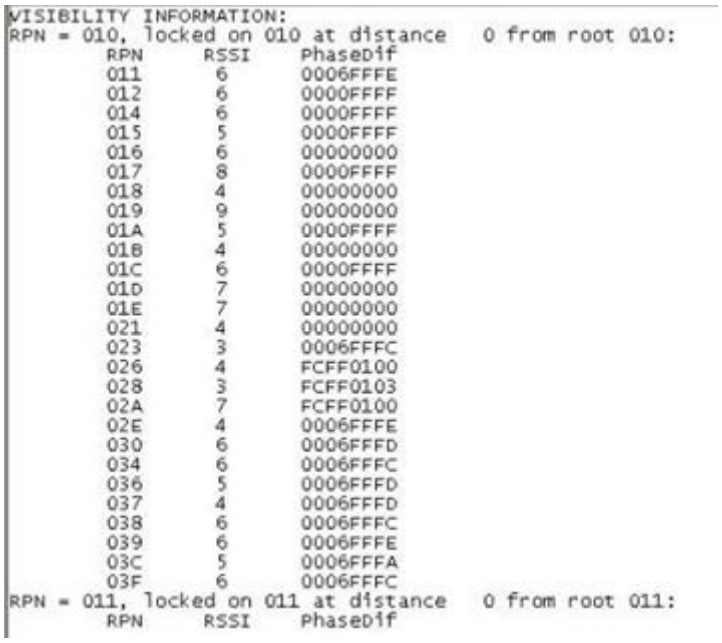
• **SARI**: The SARI is the Secondary Access Rights Identifier, which is only needed if you use Multi-Site subscriptions. If you do not use multi-site Subscriptions, leave this field to the default “FFFFFFFF”.

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) => [xxxx0007, xxxxFFF8]



```
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 ... e., , where “0” is no signal. ***The -80 dBm boundary is found at the boundary between value 3 and 4 (approximately).***

The phase difference between DAPs must also be xxxxFFFF with a maximum deviation of about 7 (higher or lower) => [xxxx0007, xxxxFFF8]

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 T0 R0 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) => [xxxx0007, xxxxFFF8]

Appendix D: EXAMPLES OF CONFIGURATION FILES

D.1: Example of “dapcfg.txt” file

```
;
; 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 “ds.txt” file

[PARI]
1022D3B3
[SARI]
FFFFFFFF
[PARAM DEV LIST]
; Do not change manually, this file was generated at Fri Mar 16 16:43:25 2012
17 0
18 0
19 0
20 0
21 0
32 11
34 16
35 3
36 255
50 0
51 134
55 0
56 23
57 112
58 5
64 255
65 0
66 8
67 1
71 11

END OF DOCUMENT