Deployment / Site Survey Manual

For
IP DECT
Systems

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Great care has been taken to ensure that the information contained in this handbook is accurate and complete. Should any errors or omissions be discovered or should any user wish to make a suggestion for improving this handbook, he is invited to send the relevant details to:

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IMPORTANT NOTICE

To provide a high accuracy, the components in the Site Survey Kit have been carefully selected!

Do NOT mix components between Site Survey Kits. Also do not exchange G955 handsets with other G955 handsets.

IMPORTANT SAFETY INFORMATION

CAUTION

RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE.

DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS

WARNING :

If a battery cabinet is defect or needs to be replaced, please contact your local NEC service organization to start a customer return material authorization procedure.

Never use alternative batteries, battery packs or battery cabinets with this Site Survey Kit. Do not try to open or repair the battery cabinets or its internal battery packs.

WARNING:
The battery cabinets shall only be charged with the supplied Ansmann charger that comes with this Site Survey Kit.

The Site Survey Kit shall only be used in combination with the supplied battery cabinets and the Ansmann charger.

WARNING:

The contents of this Site Survey Kit shall only be used in an indoor environment.

The Site Survey Kit is not for outdoor use

PRODUCT DISPOSAL INFORMATION (EN)

For countries in the European Union

The symbol depicted here has been affixed to your product in order to inform you that electrical and electronic products should not be disposed of as municipal waste.

Electrical and electronic products including the cables, plugs and accessories should be disposed of separately in order to allow proper treatment, recovery and recycling. These products should be brought to a designated facility where the best available treatment, recovery and recycling techniques is available. Separate disposal has significant advantages: valuable materials can be re-used and it prevents the dispersion of unwanted substances into the municipal waste stream. This contributes to the protection of human health and the environment.

Please be informed that a fine may be imposed for illegal disposal of electrical and electronic products via the general municipal waste stream.

In order to facilitate separate disposal and environmentally sound recycling arrangements have been made for local collection and recycling. In case your electrical and electronic products need to be disposed of please refer to your supplier or the contractual agreements that your company has made upon acquisition of these products.

At www.nec-unified.com/weee you can find information about separate disposal and environmentally sound recycling.

For countries outside the European Union

Disposal of electrical and electronic products in countries outside the European Union should be done in line with the local regulations. If no arrangement has been made with your supplier, please contact the local authorities for further information.

Contents:

Preface

No legal rights can be obtained from information in this manual.

Note: *This manual is applicable for the Site Survey Kit with the AP300 and G955.*

Note: *This manual is applicable for doing a Site Survey for IP DECT systems.*

In case you must execute a Site Survey for Traditional DECT systems, please use the other manual in the Site Survey Kit, the: **"Deployment / Site Survey Manual** - **For Traditional DECT".**

1 INTRODUCTION

1.1 General

This manual contains guidelines for surveying 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 transceivers (DECT Access Points) in the majority of cases. A survey will serve to complete the information necessary to plan an installation.

In DECT terms, a transceiver is called an RFP (Radio Fixed Part). However, for the IP DECT solution the general name for a transceiver is called: DECT Access Point (DAP). Therefore in this manual, the term DAP will be used as DECT transceiver.

There are two main types of DAPs:

- DAPs with Integrated Antennas with (two) omnidirectional internal antennas
- DAPs with External Antennas to which directional or external antennas can be fitted.

A DAP type AP300 has an operating temperature range from 0° to 40° centigrade.
A DAP type AP400 has an operating temperature range from -5° to 45° centigrade.
When you want to install a DAP outdoors, an Outdoor box is available which provides temperature isolation. 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 an IP DECT system are based on coverage for:

- A good quality connection between a handset and a DAP.
- A (simplex) radio connection, from DAP to DAP, which is required to synchronize the DAPs with each other.

So for the Site Survey for 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.

In the Chapter 3.4 DAP to DAP Communication and in Chapter 3.5 Synchronization Structure, these items are discussed.

1.2 Objective

The objective of a site survey is to determine the number and positions of DAPs to implement radio coverage in the area required and to determine how to install the DAPs including the connection to the DECT system.

The result of a Site survey gives you a clear overview of where DAPs must be installed, how the coverage will be, where the cell boundaries are and the required number of DAPs.

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 chapter are arranged according to the execution sequence

1.4 Abbreviations

The following abbreviations are used in this manual:

- CRC = Cyclic Redundancy Check
- DAP = DECT Access Point.
- DECT = Digital Enhanced Cordless Telecommunications.
- FE = Frame Error
- LED = Light Emitting Diode (lamp)
- PP = Portable Part (handset)
- RFP = Radio Fixed Part (DECT transmitter/receiver connected to DECT system). RFP is also called: Base Station or DAP in IP DECT system.
- RFPI = Radio Fixed Part Identification (unique DECT system and RFP identifier)
- RPN = Radio Part Number
- RSSI = Radio Signal Strength Indication (received signal strength).
- SSK = Site Survey Kit

2 INFORMATION REQUIRED IN ADVANCE

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 DAP positions 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 DAP positions**
  A customer may prohibit installation of DAPs in certain areas, require the DAPs 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 DAPs (CAT 5 or CAT 6 to be used). If the type and quality of the available cabling are not sufficient for the connection of the DAPs, 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 DAPs is very low (about 250 mW) 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 DAPs that are required and therefore also the cabling that is required.

A DAP must always have at least one channel free to allow handover (either-intra-cell or inter-cell handover). So if you are using a 11 channel DAP, make sure that the maximum expected traffic density will not be more than 10 channels simultaneously. (See also Section 8.4 TRAFFIC DENSITY CALCULATIONS)

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 DAP, 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 open environment

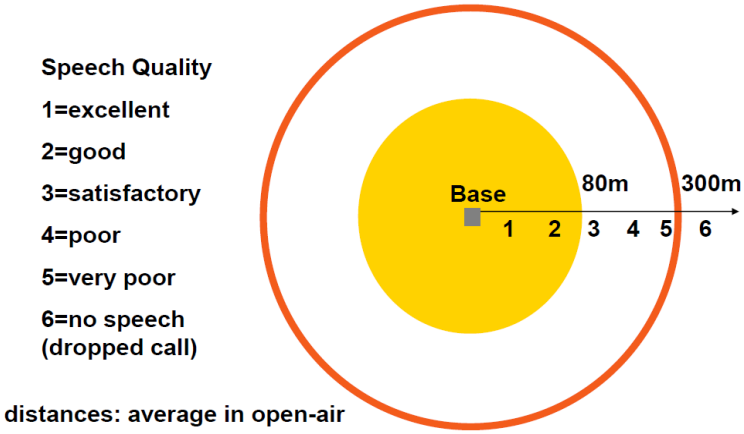

Figure 1 Coverage and Speech Quality in open Environment.

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 satisfactory speech quality might well be acceptable, it may be true that the distance between the DAPs cannot be lower, because the DAPs need to synchronization between each other (see further).*

3.2 Which Quality is Required Where

The required 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 areas where First Aid staff is located, 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. Although a satisfactory quality may be acceptable, due to DAP – DAP synchronisation combination, the cell size may need to be taken smaller.

Note: *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.*

Note: *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 Other Quality Effecting Factors

The following factors effects the voice quality as well:

- **Moving speed.**
  The DECT techniques allow a maximum moving speed of 5 km/h when moving straight to or from the Base station. If not moving straight to or from the Base Station, moving speeds can be (much) higher.

- **Elevators**
  Voice Quality is generally lower in elevators, when the elevator cabin is made of metal (Faraday's cage). In exceptional cases, moving speed should be checked.

- **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 DAP.* Only if the handset doesn't move, the voice quality will be good.
  If you know (or expect) that there is a lot of metal in the construction of the building, make sure that you do a site survey thoroughly and very accurate. During the site survey, check for frame errors (in handset display indicated as "FE") and check the voice quality.

  When the number of frame errors (FE) is four or higher per reading refresh interval, then there are too many reflections in the environment for a successful (IP) DECT installation. Consider to use directional antennas instead. If you choose for 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 is sufficient for synchronization.

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

3.4 DAP to DAP Communication

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

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

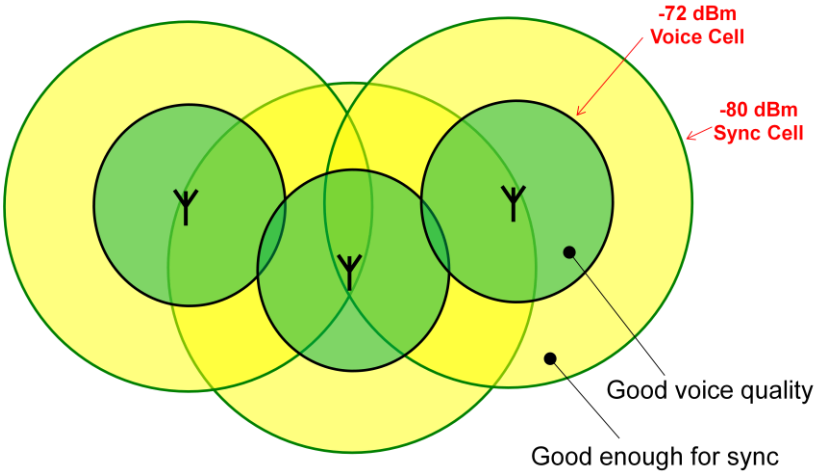

Figure 2: Cells for good Voice Quality and for Synchronization.

A DAP (radio) cell can be seen theoretically as a circle around the DAP. In Figure 2 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.***

Note: *In normal office buildings, signal propagation for synchronization will be automatically sufficient when you do a traditional Site Survey.*

Note: *As a matter of fact, this synchronization cell limit determines the synchronization cell size. However, there is no common rule to calculate the synchronization cell size from the cell size required for speech connections. You must always execute a Site Survey to determine the cell size for synchronization besides the cell size for speech.*

Note: *The example in Figure 2 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.*

3.5 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.

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.

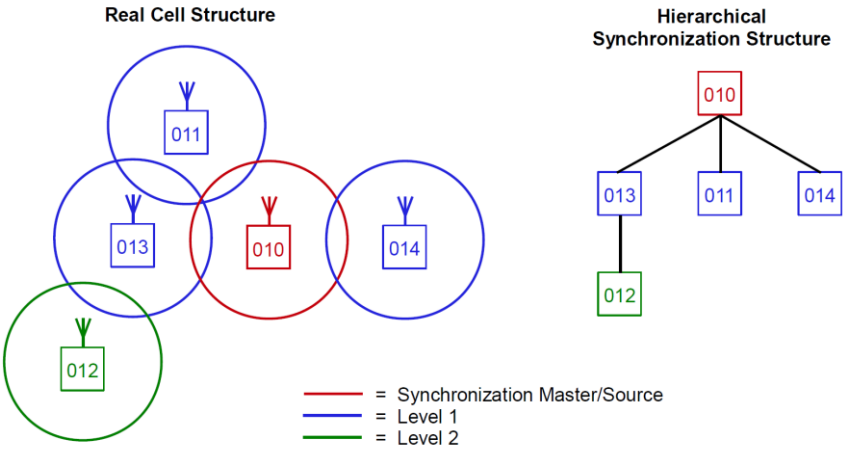

Figure 3: DAP Synchronization Structure

In Figure 3: DAP Synchronization Structure 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 in the DAP Manager WEB page (DAP Controller).

After the installation, the engineer should check the actual synchronization structure. In the Performance Manager, there is a possibility to take a snapshot of the synchronization structure ("Save Visibility" button in Performance Manager).

4 COVERAGE CALCULATION

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

The transmission path between DAP and the PP 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 causes also attenuation, called “insertion loss”. Table 1. Typical Insertion Loss of general obstacles. gives typical insertion losses of some obstacles.

MATERIAL	INSERTION LOSS (dB)
Glass	2
Glass, metal reinforced grid	10
Glass, metal clad sunguard	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 1. Typical Insertion Loss of general obstacles.

With the actual DECT equipment, the "available link budget" is 38 dB. This is the maximum allowed loss in the link, under constraints of excellent and good speech quality and the ability for the user to move.

The distance between DAP and PP can be calculated by using the “DECT range calculation chart” see figure 2.

It must be used as follows:

At the map of the building, start at the possible DAP location. Move away from the DAP location. Calculate the distance; encountering an obstacle, calculate the insertion loss. At the chart, start in the left lower corner **(0,0)**, move horizontally to the right corresponding with the (actual) distance. Move vertically corresponding with the insertion loss of the encountered “obstacle”, etc. If the curve is crossed, read the max. distance for the case of that specific DAP/RFP in that specific situation. This gives an indication of the cell size in that specific direction.

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

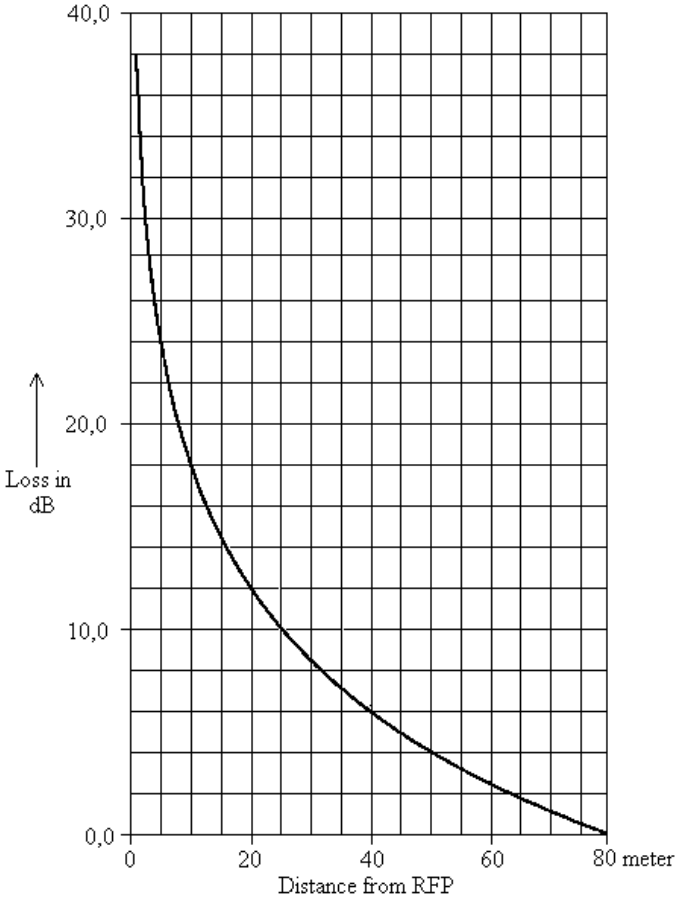

Figure 4. Coverage and Speech Quality in open Environment.

In “open air” the range is 80 m. from the DAP/RFP, again under constraints of good communication quality.

Start the Site Survey with determining 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, sometimes you can rely on the signal propagation through the floors.*

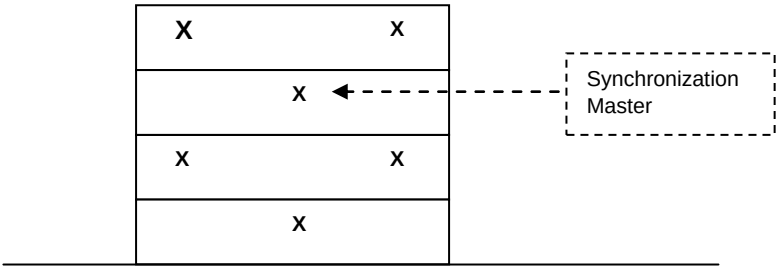

Figure 5: Example of Synchronization Master in the Middle of the Building

The result of this coverage calculation should be a map with possible DAP Positions.

The cell boundaries must be determined by walking around and doing measurements. Therefore tools are required. This is explained in chapters 6. TOOLS – "Site Survey Kit".and Chapter 7. PREPARATION and Chapter 8. EXECUTION.

5 ETHERNET AND POWER PROVISION

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.

Note: *When the required cable length between the IP network equipment (Switches, Routers) and the DAP exceeds 100 meters, you can use "Long Range Ethernet" equipment in the connection. Several manufactures of Ethernet equipment offer such a solution, which allows cables lengths of more than one kilometre.*

Give attention to the following matters related to 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.

6 TOOLS – "Site Survey Kit"

Note: *For safety reasons, the Site Survey Kit should never be used, when the ambient temperature is equal to or higher than 45°C (113°F).*

6.1 GENERAL

The "Site Survey Kit" allows you to do a Site Survey for your IP DECT system.

The contents of the "Site Survey Kit" is as follows:

- Suitcase to carry all of the items (except for the Tripod)
- A Base Station AP300 with internal antennas.
- A Base Station AP300 with connectors for external antennas.
- One directional antenna 8dBi with two cables.
- One Ethernet cable RJ45 – RJ45 (1 m.)
- One plastic board for mounting the Battery cabinet and the Base Station.
- Two Battery cabinets including batteries and a power converter from battery voltage to 48 Volt for the Base Station power provision.
- A power supply for charging the Batteries.
- 3x G955 handsets for measurements.

Note: *The G955 Site Survey handsets are specifically selected for the Site Survey Kit. Do not use these handsets for other purposes, and do not use other G955 handsets instead of the handsets that came with the Kit. If a handset needs to be replaced, you need to send the Site Survey Kit for repair. You will then get a new certificate with updated serial numbers.*

- 2x Bluetooth module Module, built in two of the handsets.
- 2x Bluetooth Headset for G955

- 3x desktop charger for G955
- 3x AC adapter for desktop charger.
- 3x Pouch (vertical)for G955 handset.
- Documentation.
  - DECT Site Survey Manual for IP DECT (= this document)
  - DECT Site Survey Manual for Traditional DECT
  - Gx55 Quick Reference Guide
  - Charger 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.

The following picture shows the contents of the Site Survey kit.

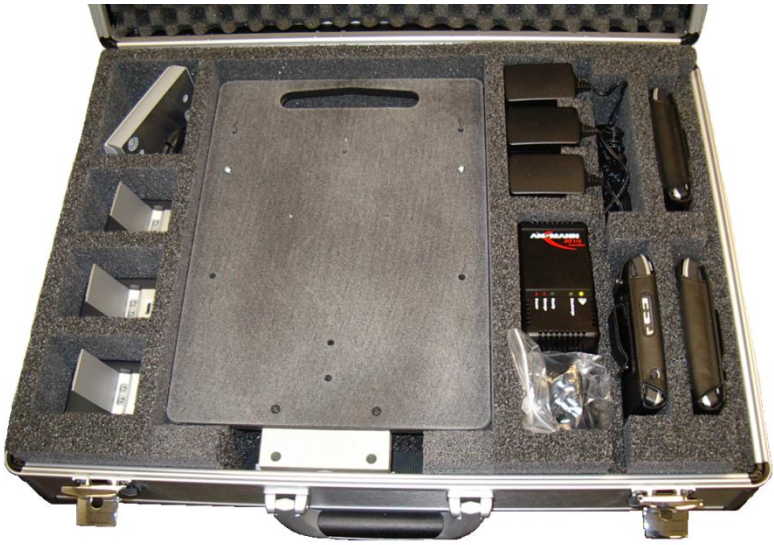

Figure 6. Site Survey Kit.

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.
- Recommended: **digital photo camera**, to make pictures of the locations where DAPs must be installed. Please note that the customer has to give you permission to make pictures.

6.2 Charging Batteries

6.2.1 Survey Kit Batteries

To charge the batteries in the Survey Kit, execute the following steps:

1. Take the Battery Charger out of the case and one of the battery Cabinets.

In the following picture you see an overview of the connectors, LED indications and switch at the side of the Battery cabinet.

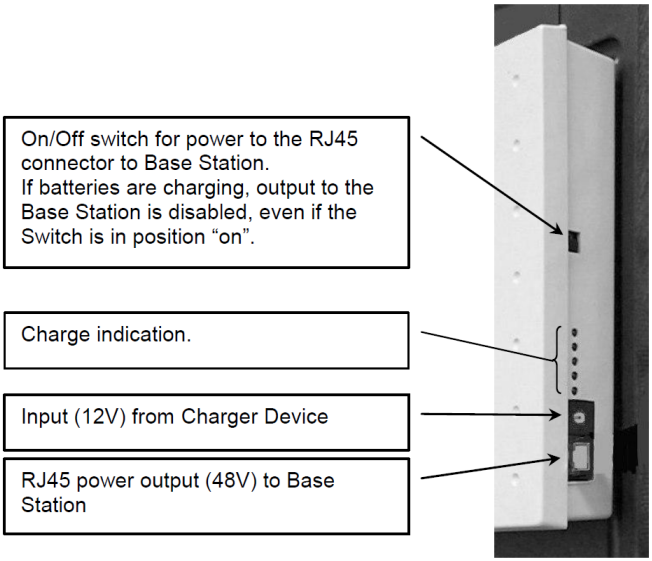

Figure 7. Site Survey Kit.

2. Set the “On/Off” switch on the Battery Cabinet 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 Cabinet.
5. On the Battery Cabinet, 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.
   - When de green LED flashes fast, the charging sequence is finished.

Note: *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.*

Note: *Pressing the Yellow button on the Charger, starts discharging the batteries!*

Note: *A complete charging sequence takes about four hours.*

6. After charging is finished, switch the “On/Off” switch to position “Off”.

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

6.2.2 Handset Batteries

Charge the handset batteries for more than ***8 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.

6.2.3 Bluetooth Headset Batteries

Charge the Bluetooth headsets prior to executing a Site Survey. Please note that the Bluetooth headsets are charged via a USB connector on your computer or Laptop. Charge the handset batteries for more than ***8 hours*** to make sure that they are fully charged

6.3 SETTING UP THE TOOL

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

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

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 the following picture:

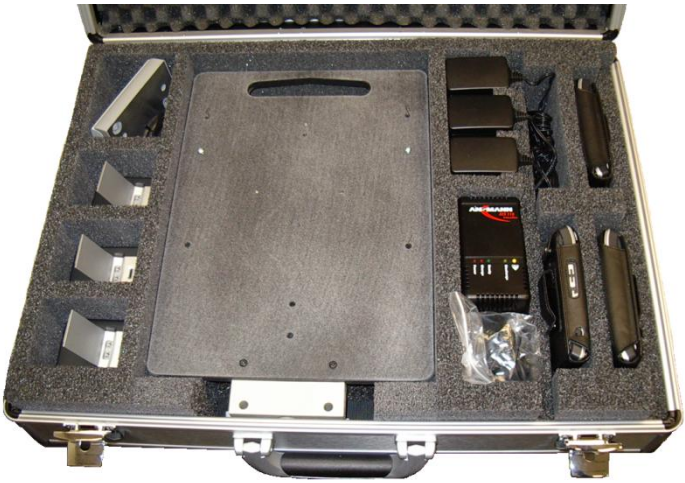

Figure 8. Battery Cabinets Removed from Site Survey Kit.

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

3. Watch the “key holes” in the Battery Cabinet and put the key holes over the screws on the plastic board. (See Figure 9. Mounting a Battery Cabinet on the Plastic Board.).

4. Push the Battery Cabinet down to lock the key holes over the screws. Now the Battery Cabinet is fixed to the plastic board.

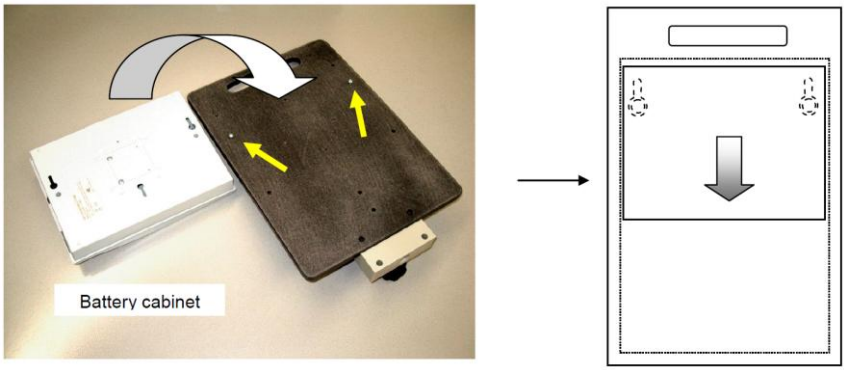

Figure 9. Mounting a Battery Cabinet on the Plastic Board.

5. Connect the power cable (RJ45 – RJ45) between the Battery Cabinet and the Base Station, as shown in Figure 10. Mounting the Cable between the Battery Cabinet and the Base Station.

Figure 10. Mounting the Cable between the Battery Cabinet and the Base Station.

6. Mount the plastic board with Battery Cabinet and Base Station to the Tripod. (See Figure 10. Mounting the Cable between the Battery Cabinet and the Base Station.

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 Cabinet. The red LEDs on the battery cabinet should be on, indicating the charge level of the batteries.
   When the top LED on the Base Station is steady on, it is ready for use. (Starting up can take up to 2 minutes.).

8. Continue with the next chapter

6.4 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 Base Station.

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

1. You must remove the Base Station with the omni directional antennas from the plastic board. To do that, use a screw driver as shown in Figure 11. Removing the cover from the Base Station. and disconnect the RJ45-cable.

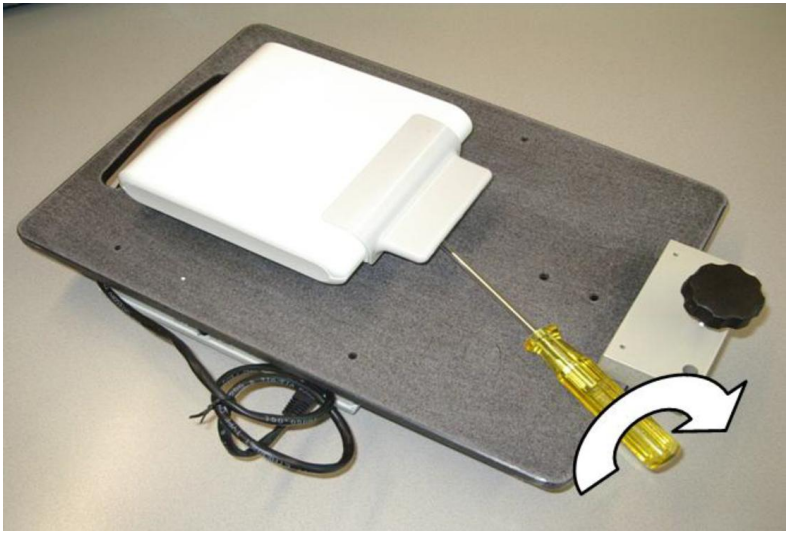

Figure 11. Removing the cover from the Base Station.

2. Connect the RJ45-cable to the other Base Station that is equipped with antenna connectors.
3. Mount the Base Station to the plastic board.
4. Mount the cables between the directional antenna and the connectors on the Base Station.

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

5. Mount the directional antenna to the plastic board. The combination should look like the photos in Figure 12. Directional Antenna mounted.

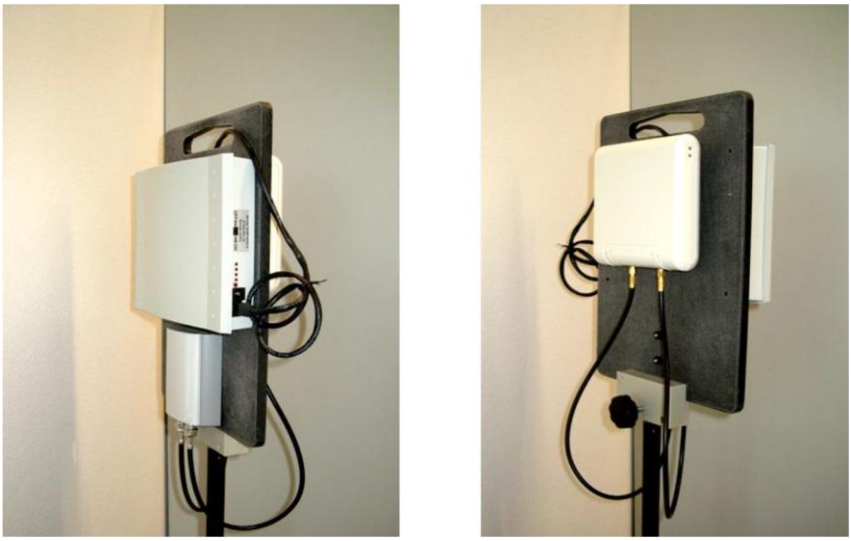

Figure 12. Directional Antenna mounted.

6. Switch on the power on the Battery Cabinet and wait for the LED to be steady-on on the Base Station.

To remove the directional antenna and install the Base Station with the omni directional antennas again, follow the above procedure in reverse order.

7 PREPARATION

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

7.1 CHECKING THE SURVEY EQUIPMENT FOR CORRECT OPERATION

To check the equipment, execute the following procedure:

1. Make sure that the Survey Base Station Battery Cabinets and handset batteries are fully charged.
2. Mount the Plastic board (with Base Station and Battery Cabinet on it) to the Tripod.
3. If not yet done, connect the Battery Cabinet to the Base Station. Switch the Base Station on using the switch on the Battery Cabinet and check that the LED is steady on (after a while). This means the Base Station is up and running.
4. Make sure that the G955 handsets are switched on and “on-hook”.
5. Go “off-hook” on one G955. A tone must be heard. If not, check that the Base Station is switched on and that the battery of the handset is fully charged.
   Repeat this step for each G955 handset.
6. Put the tripod with the DAP and the Battery Unit in an open environment, outdoors. Keep a distance of 50 meters between the Survey Base station and the handset and make sure that there is nobody/nothing in-between.
7. Press: `<menu> *789872*` on each G955 handset that you want to involve in the Site Survey.
8. Now you will see Site Survey information displayed in the top part of the display. (for explanation of the fields, consult Section 8.2 SETTING UP THE EQUIPMENT).

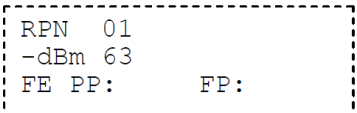

Figure 13 Site Survey Display.

9. Check the RSSI reading (behind the –dBm indication). You will see that it fluctuates. Keep the handset still for at least two minutes and determine the average value. The average RSSI value should be better than – 65 dBm. (> – 65 dBm)

7.2 MAPS

Maps should be prepared in a format that can be easily 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.

7.3 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 10B. CHECKLIST FOR SURVEY DATA.)

7.4 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 80 m.
- In halls the DAP has a range of < 80 m.
- In buildings the DAP has a range of about 15-40 m. 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 for DAP positions, rather than an enclosed area so that the radio signal passes through as few walls as possible to reach as large an area as possible.

- Radio reception inside a vehicle may be poor unless very close to the DAP.

- The DAP should be placed high enough to be unaffected by surrounding objects. For example, an DAP in a car park needs to be placed higher than a vehicle that may be parked next to it.

- RPFs 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 etc. (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.

7.5 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.

8 EXECUTION

8.1 GENERAL

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

There are three main criteria for the cell boundary:

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

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

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

In Figure 14. Site Survey / Deployment in Action. the functions of the persons are depicted.

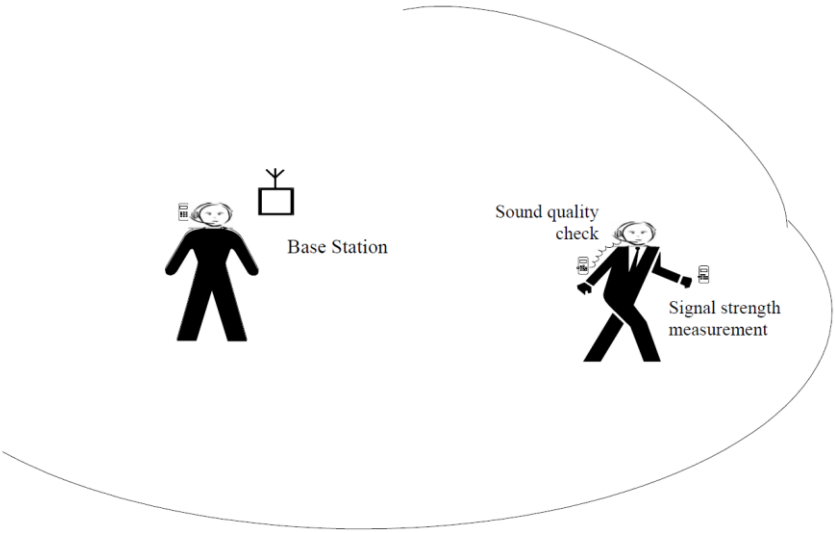

Figure 14. Site Survey / Deployment in Action.

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

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

Warning: *Conducting a site survey involves safety hazards such as (but not limited to) "working at height" and other hazards dependent upon the location where the survey is conducted.*
Remember to conduct a Health & Safety risk assessment before commencing work and to take appropriate measures to avoid or reduce the risk of injury to yourself and others.

8.2 SETTING UP THE EQUIPMENT

After having taken the preparatory steps (see Chapter 7. PREPARATION), execute the following steps:

1. Make sure that the Survey Base Station and handset batteries are fully charged.
2. Mount the Plastic board (with Base Station and Battery Cabinet on it) to the Tripod.
3. If not yet done, connect the Battery Cabinet to the Base Station.
4. Switch the DAP on using the switch on the Battery Unit and wait for the LED to be steady on; the DAP is up and running.
5. Set-up a Survey DAP at a planned DAP position.
   Choose the locations for the Survey Base Station as close as possible to the locations where the DAPs can be actually installed. Look also for suitable cable ducts. Put the Survey Kit in the position with the battery pack at the side of the wall.
6. Adjust the tripod to put the Survey Base Station near the ceiling (for an office environment) or as high up as possible in a large area (such as a warehouse). If the Survey Base Station is outside then put it at a height of about 5 m.
7. Make sure that the G955 handsets are switched on and “on-hook”.
8. Press: `<menu> *789872*` on each G955 handset that you want to involve in the Site Survey.
9. Now you are in the service menu. The following two lines are displayed in the top of the display.

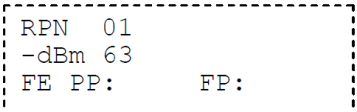

Figure 15 Site Survey Display.

10. Go off hook and dial the one digit extension number of one of the other G955 handsets that you use in the Site Survey.
    Or if you are doing the site survey on your own, dial “0” and you will hear dial tone continuously, which can be used to check the sound quality. You can skip step 11 if you are doing the site survey on your own.
11. If you dialed another extension, the dialed extension starts ringing. Go off hook. Now you have a voice connection which can be used to check the sound quality.
12. In the G955 display you will see the following important fields displayed:

- **RPN:**
  This is the unique number of your Base Station. In the Site Survey kit, this should always be 01. By means of this number you can see that the handset is "locked" to (looks at) your Site survey Base Station.

- -**dBm**
  The –dBm value is the actual signal strength of the signal received from the Base Station. It will never be better than about –30dB, because the value is internally limited in the G955 to this value.

- **FE**
  Here you see the Frame Errors. Frame errors may occur from time to time. Each 1 seconds the accumulative value over the 1 seconds is displayed! Note that you see the frame errors received at the DAP and the frame errors received at the PP (handset) are displayed.

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

- **Voice Quality**
  Check the speech quality. This can be done in the following ways:
  Using the voice connection from the G955 to the G955 handset. Then you have a voice connection and you can check the speech quality.
  If you are all on your own, go off hook (if you are already off hook, go on hook first) 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 - dBm**
  Check the -dBm reading in the display.
  The cell boundary is reached when the -dBm value is **–72 dBm**.

- **Frame errors.**
  Frame errors may occur in DECT, but not too many.
  The number of frame errors per reading may not be more than 4!
  If the number of frame errors is more than 4, normally it is an indication that there are many reflections, which will result in clicks in the sound. Check the sound quality to find out if this is still acceptable or not.

Note: *The survey handset should be held at about 1,2m above the ground when making measurements.)*

14. Note the results on the relevant maps. Take care that the relation between the DAPs position and the corresponding cell is clearly defined, using the numbering scheme given in Chapter 9. REPORTING RESULTS.
    Note that for a multi-story building it must be clear on what floor the Site Surveys 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.

15. Repeat steps 5...14 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 2). (-80 dBm). In case of any doubt about the signal strength between the DAPs for Synchronization, please check the signal strength for Synchronisation. (For more info, consult Chapter 3.4 DAP to DAP Communication and Chapter 3.5 Synchronization Structure.)

16. It may, at this stage, be necessary to move some of the planned DAP positions or add new DAP positions to eliminate shadows or optimize 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.

17. 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 IP Equipment (IP Switches) should be considered. DAP positions must be defined such that later installation problems are minimized, 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.
    An DAP can be installed within a metre or two of the planned position without adversely affecting radio reception.

18. To leave the Site Survey mode on the handset: Go on hook.

    Then press: `<menu> *789872* <clr>`

8.3 HINTS and TIPS on “HOW TO SURVEY

8.3.1 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 etc.
- 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, make sure that all doors are closed. Close all fire doors as well.*

8.3.2 How to Survey A Single Floor

The following is the basic procedure to determine the cell centre and the cell boundaries. In Figure 16 Example of a Single Floor Coverage., an example of a single floor is depicted.

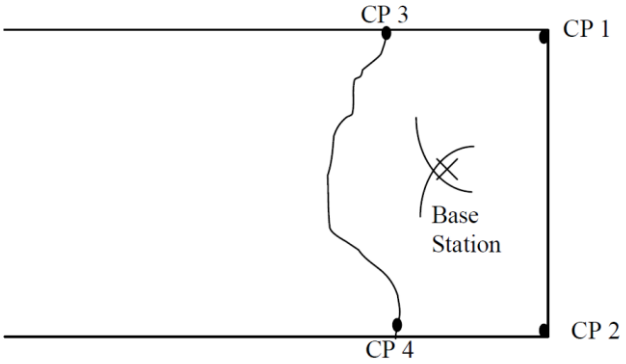

Figure 16 Example of a Single Floor Coverage.

The procedure is as follows:

1. Determine the outer points in the building. These points are the so-called “Critical Points”. (In Figure 16 Example of a Single Floor Coverage., these are CP1 and CP2).
2. Place the Survey Base Station on CP 1 on a height of approximately 1.2 meters. Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. Place the Survey Base Station on CP2 on a height of approximately 1.2 meters. Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
4. The best location for the cell centre is where the critical point contours cross.
5. Position the Site Survey Base Station on the CP1/CP2 cross, and raise it to the height where the base station must be fitted.
6. Now check the cell boundary. Check that the RSSI value at CP1 and CP2 are sufficient. Draw the cell on the map.
7. Determine new Critical Points (CP 3 and CP 4 in Figure 16 Example of a Single Floor Coverage.) at the external walls and repeat the procedure from step 1 onwards.

8.3.3 How to Survey a Wider Single Floor

If the width of the area is more (see Figure 17. Example of a Single Floor Coverage.) than the area that is depicted in Figure 16 Example of a Single Floor Coverage., then the following procedure must be executed:

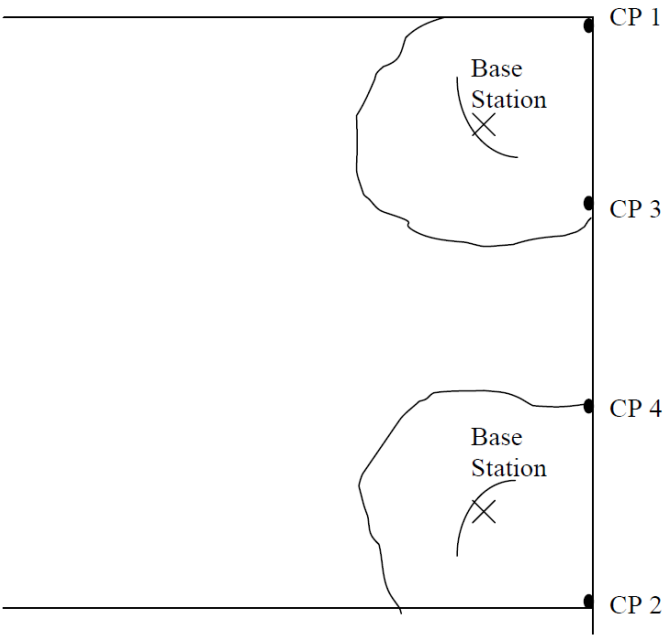

Figure 17. Example of a Single Floor Coverage.

The procedure is as follows:

1. Determine the outer points in the building (see Figure 17. Example of a Single Floor Coverage.). These points are the so-called “Critical Points”. (CP1 and CP2).
2. Place the Survey Base Station on CP 1 on a height of approximately 1.2 meters. Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.
3. Place the Survey Base Station on CP2 on a height of approximately 1.2 meters. Walk away from the Base Station at an angle of roughly 45 degrees. Write down where the cell boundary is.

4. Now you probably found out that the contours of CP1 and CP2 do not overlap. Move the Site Survey Base Station to a point on the contour line of CP1. This point is considered as being the cell centre.

   Measure the cell boundary for cell 1.

5. Move the Site Survey Base Station to a point on the contour line of CP2. This point is considered as being the cell centre.

   Measure the cell boundary for cell 2.

6. Where the cells cross the outer walls of the building, two new Critical Points (CP3 and CP4) are defined.

7. Use the procedure “How to Survey A Single Floor” in Section 8.3.2 How to Survey A Single Floor to determine the cell centre of the next cell.

8.3.4 How to Survey a Multi Floor Area

There are two approaches in surveying a multi story building:

- Survey each floor as an individual part.
  It is safer to survey each floor as an individual part (but more DAPs are needed).
  The radiation between floors is not used for coverage, but is only used to allow higher traffic density.
  In this approach you are always sure that the coverage on each floor is reliable, but more DAPs may be needed.

- 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 Base Stations 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 produces holes in the coverage on the higher and lower floors. Therefore, coverage via floors is not always reliable! So make accurate measurements of the losses through floors to see if radiation between floors can be used.*

8.4 TRAFFIC DENSITY CALCULATIONS

Traffic density calculations must be done to make sure that you have a low blocking probability in the system.

For traffic calculations you must know:

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

There are three user types distinguished:

TRAFFIC	APPLICATION	ERLANG/USER
Low	normal offices	0,05
Average	Exec-secretary groups	0,1– 0,15
High traffic	help desks, Tele-services	0,2 – 0,25

Table 2. Three user types

Table 2. Three user types shows an overview of the maximum Erlang values for the number of available DAP channels with a blocking probability of 0,5%. In IP DECT the number of channels is either 11 or 12 channels (12 channels if the DAP is the synchronization Source/Master, 11 channels for all other DAPs).

Table 3 Erlang values at blocking probability of 0,5%. shows an overview of the maximum Erlang values for the number of available DAP channels with a blocking probability of 0,5%.

CHANNELS AVAILABLE ON AN DAP	ERLANG VALUE
11	4,6
12	5,25

Table 3 Erlang values at blocking probability of 0,5%.

With a blocking probability of 1% the following maximum Erlang values are allowed per DAP:

CHANNELS AVAILABLE ON DAP	ERLANG VALUE
11	5,15
12	5,85

Table 4 Erlang values at blocking probability of 1%.

Now you can calculate the required number of DAPs as follows:

$$\text{Nbr of DAPs} = \frac{\text{Nbr of users X Erlang/user}}{\text{Max. load per DAP}}$$

Example:

In one cell there will be 50 users: 10 high traffic, 15 average traffic and 15 low traffic. The load will be: (10 x 0,25) +(5 x 0,15) + (15 x 0,05) = 5,5 Erlang. The blocking probability is 0,5 %, which means a maximum load of 4,6 Erlang per DAP.

$$1{,}2 = \frac{(10 \times 0{,}25) + (15 \times 0{,}15) + (15 \times 0{,}05)}{4{,}6}$$

Conclusion: 1,2 DAPs are needed. This must be rounded up to a natural value, which is 2 in this example. This means that one DAP is not sufficient.

Note: *If you install 2 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.*

9 REPORTING RESULTS

9.1 General

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:

It is very important to report the result accurately on the maps and the details in a document. In this chapter you will find an example of a simple site. Although the site is simple, the reporting method is the same for more comprehensive sites.

For a large site where a thorough survey has been impossible, it may be prudent to add 10% extra DAPs to the product offer to allow for unforeseen problem areas. The survey report should include:

- A specification of the construction of the buildings and construction materials**.**
- Customer requirements for**:**
  - the number of handsets
  - required coverage
  - performance requirements (traffic density, grade of service etc.)
- The location of the involved IP Switches, IP Routers
- Availability of “Power over Ethernet”.
- Cabling details. Include a specification of cables already present on the site and a list of new cabling required. Include the distance between DAPs and the IP Network equipment for existing and new cabling**.**
- Copies of the maps of the site with the positions of Site Survey DAP and the cell boundaries**.**
  - Different cell boundaries can be marked with different patterns to avoid confusion i.e. dotted, dashed, dot dash etc. Or use different colours
  - Use the **numbering conventions** as shown in the example in the next section.
- 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**.**

  When possible, use a photo camera to take pictures of the DAP locations **.**
- 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**.**

9.2 Site Survey Map

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

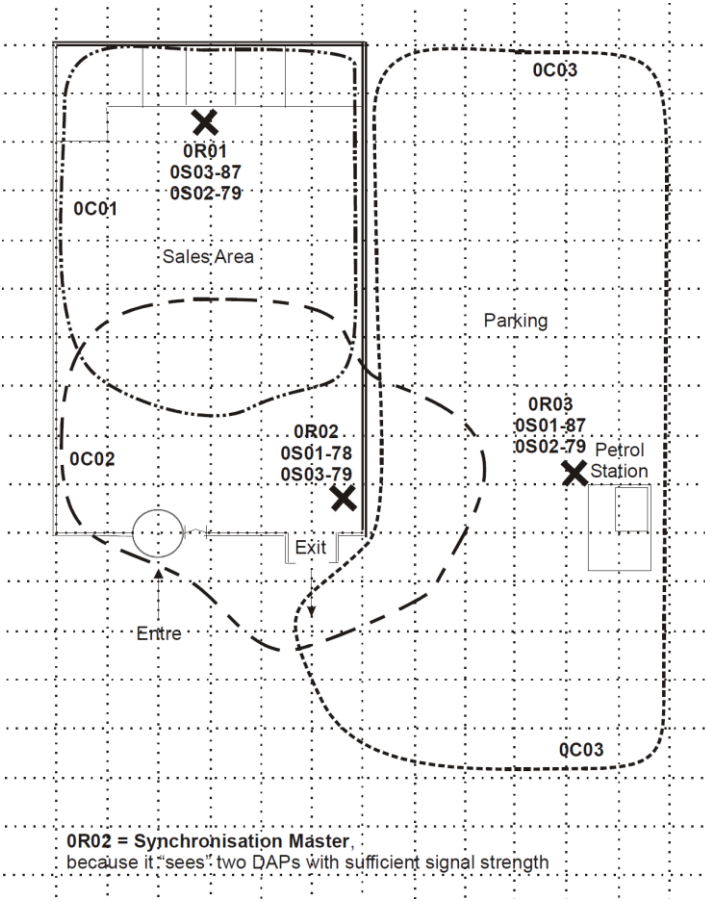

Figure 18. Example Site Plan.

9.3 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 : 01/05/2012

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 2012	

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 is 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 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

IP Switchs all provide Power over Ethernet (PoE). So, no PoE inserters are required.

6.3. 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.*

6.4. 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.

10 POST SURVEY

A Post Survey is a Site Survey that needs to be done after the IP 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 IP DECT system will execute the Post Survey.

Use the following procedure:

1. Make sure the IP DECT system is up and running properly and that all DAPs are up and running for more than 10 minutes.
2. Start up the Performance Manager as described in the IP DECT Advanced Data Manual.
3. Click the button “Update Visibility” in the Performance Manager window. After that, click the “Get visibility file”. Now the file “visadm.txt” is created.
4. Use the Sync Analyzer tool (see IP DECT Tools and Maintenance manual, Chapter “Maintenance Tooling – Sync Analyzer”) to analyze the contents of this visadm.txt 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.
5. 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.
6. Generate a “visadm.txt” file again. Analyze the synchronization structure again.
7. Subscribe at least two G955 handsets (or other handsets that has a Signal Strength indication in the display) to the system.
8. 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.
9. If the area is not properly covered, report this to the provider of the IP DECT system and consider what improvements should be made.

A ESTIMATION OF THE NUMBER OF DAPs

A.1 GENERAL

A rough estimation of the number of DAPs, 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 DAPs.*
No rights can be obtained from these estimation tables.

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

- No radiation between floors.
- Average building types.
- Average call density.

There are two tables for two types of estimations:

- **Estimation for coverage of typical indoor environments.**
  This gives information about the number of DAPs required for typical indoor environments. The information is given in Table 5 Estimated number of required DAPs for coverage of typical indoor environments..

- **Estimation for coverage in typical open space (indoor/outdoor)**
  In Table 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors). you find information about coverage in an open space environment.

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

One example of this would be a site with an office building, an open warehouse and a car park, using Table 5 Estimated number of required DAPs for coverage of typical indoor environments.for the offices and Table 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors). for the warehouse and the car park.

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 if the single area(s) of the site fall(s) within the scheme for "Estimation for coverage in typical Open Space" and calculate the number of DAPs for this/these area(s).
4. The remaining areas are most likely "Typical Indoor Environments". If so, calculate the number of DAPs according to the table for "Estimation for coverage of typical Indoor Environments".
   If there are parts of the site that do not fit into the specification "Typical Indoor" or "Typical Outdoor" then, you cannot use the estimation tables at all!!

A.2 ESTIMATION FOR COVERAGE OF TYPICAL INDOOR ENVIRONMENTS

Table 5 Estimated number of required DAPs for coverage of typical indoor environments. gives information about the number of DAPs, that are required for estimation the coverage of typical indoor environments. 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 DAPs from the Table 5 Estimated number of required DAPs for coverage of typical indoor environments..
- This table have been calculated on the basis that each DAPs provides 1200 sq.m. coverage**.**
- 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**.**
- A complex site may be more easily split into areas which are estimated separately and the resulting number of DAPs totalled together. One example of this would be a site with an office building, an open warehouse and a car park, using Table 5 Estimated number of required DAPs for coverage of typical indoor environments.for the offices and Table 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors)**.**for the warehouse and the car park**.**

Dimensions (m)	20	40	60	80	100	120	140	160	180	200	220	240	260	280
20	1	1	2	2	3	3	4	4	5	5	6	6	7	7
40	1	2	2	3	4	4	5	6	6	7	8	8	9	10
60	2	2	3	4	5	6	7	8	9	10	11	12	13	14
80	2	3	4	6	7	8	10	11	12	14	15	16	18	19
100	3	4	5	7	9	10	12	14	15	17	19	20	22	24
120	3	4	6	8	10	12	14	16	18	20	22	24	26	28
140	4	5	7	10	12	14	17	19	21	24	26	28	31	33
160	4	6	8	11	14	16	19	22	24	27	30	32		
180	5	6	9	12	15	18	21	24	27	30	33			
200	5	7	10	14	17	20	24	27	30	34				
220	6	8	11	15	19	22	26	30	33					
240	6	8	12	16	20	24	28	32						
260	7	9	13	18	22	26	31							
280	7	10	14	19	24	28	33							

Table 5 Estimated number of required DAPs for coverage of typical indoor environments.

A.3 ESTIMATION FOR COVERAGE IN TYPICAL OPEN SPACE

Table 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors).gives information about the number of DAPs, that are required for estimation for coverage in typical open space (indoor/outdoor). 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 DAPs from theTable 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors)..
- This table have been calculated on the basis that each DAP provides 2400 sq.m. coverage**.**

- The resulting estimate is used for budgetary purposes ONLY, 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	1	1	2	2	2	2	3	3	3	3	4	4
40	1	1	1	2	2	2	3	3	3	4	4	4	5	5
60	1	1	2	2	3	3	4	4	5	5	6	6	7	7
80	1	2	2	3	4	4	5	6	6	7	8	8	9	10
100	2	2	3	4	5	5	6	7	8	9	10	10	11	12
120	2	2	3	4	5	6	7	8	9	10	11	12	13	14
140	2	3	4	5	6	7	9	10	11	12	13	14	16	17
160	2	3	4	6	7	8	10	11	12	14	15	16	18	19
180	3	3	5	6	8	9	11	12	14	15	17	18	20	21
200	3	4	5	7	9	10	12	14	15	17	19	20	22	24
220	3	4	6	8	10	11	13	15	17	19	21	22	24	26
240	3	4	6	8	10	12	14	16	18	20	22	24	26	28
260	4	5	7	9	11	13	16	18	20	22	24	26	29	31
280	4	5	7	10	12	14	17	19	21	24	26	28	31	33

Table 6 Estimated number of required DAPs for coverage of typical open space (indoor and outdoors).

B 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.
- **IP Network Equipment, like IP Switches**
  Position of the IP Switches and other network equipment.
- **Connections between IP Switches and DAP(s)**
  For each DAP the following details of its connection to a IP Switch are required:
  - length of cable.
  - whether existing cabling is present that might be used and if so, the type of cabling. Must be CAT 5 or CAT 6.
  - cabling layout (risers, horizontal wiring, distribution frames) and whether existing cabling can be used or new wiring is required.