Spectralink IP-DECT Server 400/6500 and DECT Server 2500/8000

Synchronization and Deployment Guide

14169000-IG, Edition 13.0
October 2018, Original document

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Introduction

This guide is intended for qualified technicians who will deploy Spectralink IP-DECT/DECT Server Solutions. To qualify to deploy a IP-DECT/DECT Server Solution, you must have understood and completed the technical training successfully. This guide covers both 1G8 and 1G9 deployment.

Scope

The Synchronization and Deployment Guide provides instructions and best practices for deployment of the following solutions:

- Spectralink IP-DECT/DECT Server 8000 and 2500
- Spectralink IP-DECT/DECT Server 6500 and 400

The purpose of this guide is to familiarize you with the procedures that are needed to carry out a site survey as well as understand the requirements to ensure synchronization is successfully implemented. At the completion of this guide you should be comfortable with the following:

- Using a handset to measure and record Q - and RSSI values (RF values).
- Selecting a proper mounting location for base stations and repeaters.
- Making sure that the company LAN meets the LAN Synchronization requirement limits, and documenting the deployment.

Before You Begin

This guide assumes the following:

- You have a working knowledge of deployment in general
- You have completed the technical training

Related Documentation

For information about Server IP-DECT/DECT Server Solutions not covered by this manual, refer to the following documentation:

Subject	Documentation
Spectralink DECT Handset	For more information about the handset, refer to the user guide available online at http://support.spectralink.com/products.
Site Survey Function in Handset	For more information about the handset, refer to the user guide available online at http://support.spectralink.com/products.
Spectralink IP-DECT/DECT Server	For more information about the server, refer to the guide available online at http://support.spectralink.com/products.
Spectralink Technical News	Newsletter that describes software changes, bug fixes, outstanding issues, and hardware compatibility considerations for new software releases. To subscribe, go to www.spectralink.com.
Spectralink DECT Training material	

Terminology and Acronyms

The table below refers to common terms and acronyms that are related to the Spectralink IP-DECT/DECT solutions.

Term	Definition
AC	Authentication Code
ARI	Access Rights Identity - Wireless identity of the Spectralink IP-DECT/DECT Server.
CLI	Command Line Interface
CUCM	Cisco Unified Communications Manager
dB	Decibels (deciBells)
DECT	Digital Enhanced Cordless Telecommunications
Deployment	The act of locating the mounting location and installing base stations and repeaters. System performance is dependant on the deployment made - and, therefore, the survey performed.
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
e.i.r.p.	Equivalent Isotropic Radiated Power
Erlang	The erlang is a dimensionless unit that is used in telephony as a measure of offered load or carried load on service-providing elements such as telephone circuits or telephone switching equipment.
GAP	Generic Access Profile
Handover	A process initiated by the handset in which the speech channel carrying an active conversation is passed from one base station to another.
HW PCS	Hardware Product Change Status - Hardware edition
IGMPv3	Internet Group Management Protocol version 3
IP	Internet Protocol
IPEI	International Portable Equipment Identity - Serial number of the handset
IWU	Inter Working Unit

Term	Definition
LAN	Local Area Network
LAN synchronization	Method for synchronizing IP base stations over LAN
LED	Light Emitting Diode
Li-ion	Lithium-ion
MAC	Media Access Control - hardware address of a device connected to a network
MTU	Maximum Translation Unit
MWI	Message Waiting Indication
Ni-MH	Nickel -Metal Hydride
NIC	Network Interface Card
NTP	Network Time Protocol
PBX	Private Branch eXchange
PCS	Product Change Status (Edition)
PoE	Power over Ethernet
PP	Portable Parts - wireless handset
PTP	Precision Time Protocol (IEEE-1588v2)
Q Value	Signal Quality Factor value. An expression of the bit failure rate in the communication between the handset and a base station. The value has a max. of 64, equal to no bit errors measured.
RF	Radio Frequency
RFP	Radio Fixed Part - base station
RPN	Radio Part Number - base station number
RSSI	Received Signal Strength Indicator
RSSI Value	Radio Signal Strength Indication value. A relative expression for the signal strength of a base station as measured by the handset at a given location.
RTP	Real-time Transport Protocol
SfB	Skype for Business
SIP	Session Initiated Protocol

Term	Definition
Site survey	A site survey comprises the act of locating the best places for base stations by measuring RSSI levels with DECT handsets. Complete survey consists of measuring with multiple base stations, combining RSSI and Q value reading in real surroundings.
Spectralink DECT Server	Spectralink DECT Server 2500/8000
Spectralink IP-DECT Server	Spectralink IP-DECT Server 200/400/6500
Speech channel	A speech channel is used to carry communication between the handset and the base station or repeater.
SRTP	Secure Real-time Transport Protocol
SUOTA	Software Update Over The Air
SW PCS	Software Product Change Status - Software edition
Synchronization Over the Air (OTA)	Method for synchronizing IP base stations over Air (radio)
TFTP	Trivial File Transfer Protocol
TLS	Transport Layer Security
TTL	Time To Live
UDP	User Datagram Protocol
UPnP	Universal Plug and Play
VoIP	Voice over Internet Protocol
WLAN	Wireless Local Area Network
WRFP	Wireless Radio Fixed Part - Wireless Repeater

About Synchronization

In a multi-cell DECT system the base station radios must be synchronized to each other in order to achieve the optimum handover experience, when handsets are moving around among base stations. Spectralink supports synchronization of digital DECT base stations via the wire and IP-DECT base stations via the radio. Further, IP-DECT base stations can use corporate LAN for synchronization as well.

Note:

When performing a site survey it is important to use the same system settings that are to be used in the final system setup. Especially on sites where it is planned to enable DECT Security Step A, it is highly recommended that a site survey is performed with the early encryption and re-keying option set to required because the re-keying procedure that is part of the DECT Security Step A is defined in a way that makes it very sensitive to bit error on the radio link.

Types of Synchronization

- LAN Based Synchronization (Server 400/6500/2500/8000)
- Radio Based Synchronization (Over The Air) (Server 400/6500/2500/8000)
- Digital DECT Base Stations (Server 2500/8000)

Note:

Synchronization of digital DECT base stations is controlled by the server and requires no configuration. Therefore, configuration of digital DECT base stations will not be described further.

Off-site Planning, Prior to Visit

Below you will find at list of questions and considerations to take into account during the planning phase prior to visiting a site.

If Customer Wants to Replace Existing IP-DECT/DECT System

Is it an IP-DECT base station or a digital DECT base station?

- IP-DECT base station:
  - Consider PoE, Active equipment, Switch PoE.
  - Is this reusable for the new system?
  - Do LAN switches support LAN synchronization?
- Digital DECT base station:
  - Can the cabling be reused? (yes/no/partly)

    Investigate:
    - Is all cabling twisted pair end to end (recommended equal to CAT5e)? Is cabling present where DECT coverage is needed?
    - Are all junction points of good quality?
    - From these investigations the costs to get cabling up to a satisfactory standard can be estimated.

Note:

Today new systems can be a combination of wired and IP.

Investigate Site

- What is the site?
  - Are there more buildings?
    - If there are more buildings - consider the distance between the buildings, and whether it is possible to establish synchronization between base stations.
  - Are there more sites (sub-sites)?
    - If there are several sites - the remote site(s) (i.e. those where it will not be possible to establish synchronization) must be IP-DECT/DECT system(s).
- Study blueprints of building

- Consider the building materials
  - More dense materials means less radio propagation and therefore more base stations
  - Environment
  - Moving interior (warehouse, production facility). Much equipment moving around will influence the propagation
  - Metal can cause reflections which will influence propagation (i.e. metal blinds, metal beams, metal shelves, rebars, shielding foils)
  - Where are fire doors/walls placed? These will influence propagation
- System usage
  - Where are people placed? (those that will use the IP-DECT/DECT system)?
  - Are there areas with (extra) high voice-traffic load like:
    - Canteen
    - Nurse office
    - Etc.
- Rough estimation of equipment (if possible)

  A rough/budgetary estimate of equipment/base stations can be calculated according to below:
  - Open area (indoor)
  - Office area
    - DECT systems: [Size of area to cover in m2]/800 = number of digital DECT base stations Necessity: approximately 25 m between the base stations and 15 m overlap to enable handover.
    - IP-DECT systems (Radio Synchronization): [Size of area to cover in m2]/600 = number of LAN base stations Necessity: approximately 22 m between the base stations and overlap from base station to base station.

      IP-DECT system (LAN synchronization): [Size of area to cover in m2]/800 = number of LAN base stations Necessity: approximately 25 m between the base stations and 15 m overlap to enable handover.

      Note:

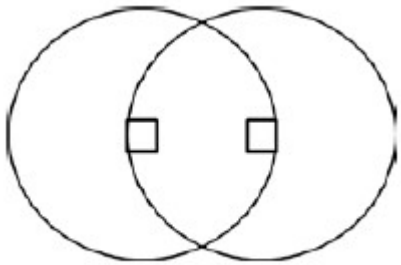
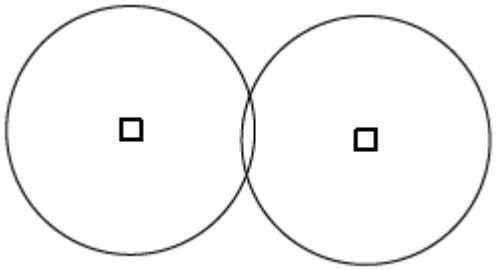
      Be aware that this will not be an exact figure. A deployment of the site will be necessary to get a correct number.

"Conclusion"

Based on the above analysis, the installer must be able to determine whether to install a Spectralink DECT Server or Spectralink IP-DECT Server or a combination.

- IP-DECT/DECT systems with IP-DECT base stations can benefit from synchronization over LAN
- Digital DECT base stations have 4/8 channels whereas IP-DECT base stations have up to 12 channels (11 channels if using radio synchronization, 12 channels if using LAN synchronization).
- Digital DECT base stations and IP-DECT base stations with LAN synchronization can have longer distance between base stations as opposed to IP-DECT base stations with Radio synchronization (Over The Air (OTA)).

  Synchronization is essential for handing over calls from one base station to another.

Radio Synchronization (OTA)	LAN Synchronization and Digital DECT Base Stations
	

Note:

Before going on a site, remember to have confirmation from the customer regarding accessibility to all areas where the customer needs IP-DECT/DECT to make measurements for deployments.

On-site Investigation

Below you will find considerations to take into account when investigating a site.

Aligning Expectations With Customers

- Start your on-site visit with meeting the customer and align expectations to coverage (areas) and dropped calls (expect 2-3-% dropped calls).
- Take a walk around the premises to create an overview and check that the information uncovered during the pre-planning phase is correct/valid.

  Consider:

  - internal structure material
  - moving interior
  - are there materials that affect/absorb propagation
  - is the interior as expected?
- Create a rough overall plan for how to execute the deployment.
- If deploying IP-DECT base stations with Radio synchronization, create a blueprint with base station placement and synchronization chain.

On-site Deployment

Deployment Tools

Bring the following tools on a site for deployment:

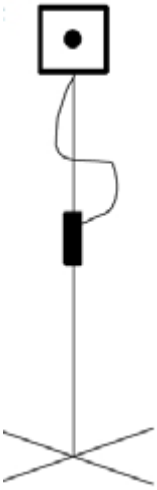
- 1 Spectralink IP-DECT Server 400
- 1 Battery pack min. 8V/max. 60V
- 1 Tripod (app 2m high)
- 1 Cable with RJ45 plug (pin 1 must be connected to pin 3, pin 2 must be connected to pin 6)

Note:

Preferably the tripod shall place the Spectralink IP-DECT Server 400 at the height where you will place the server/base stations/repeaters in the final installation.

If 2 people perform the deployment at IP-DECT sites, you shall also bring:

- Minimum 1 Spectralink DECT repeater (the repeater must be set up to synchronize on the Spectralink IP-DECT Server 400 used for the deployment).
- 9V Battery pack
- 1 Tripod (app 2m high)



- 1 Cable to connect battery pack and Spectralink DECT repeater (with RJ11 plug in for the repeater) For a description of pin connections, see the information on the Power Supply.

Also bring:

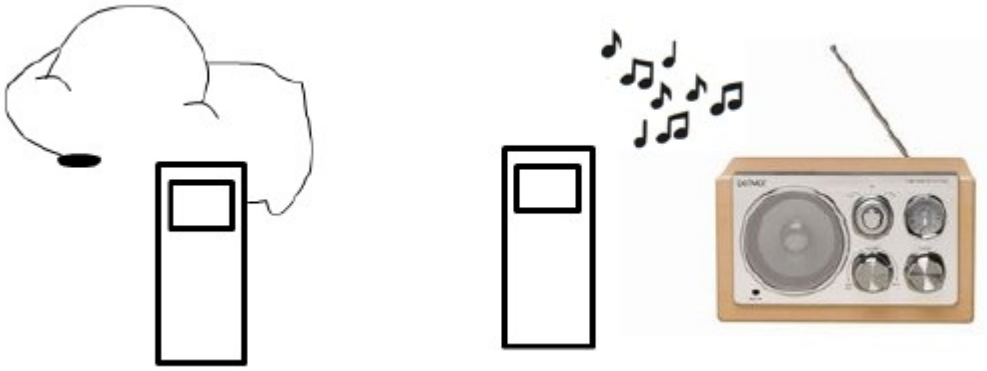
- 2 handsets
  - 1 Spectralink Standard Handset (7522/7532, 7622/7642, 7722/7742).

    Note:

    The handset can only measure correctly when off hook.

    When measuring, carry the handset with your hands covering the antennas to assimilate normal user conditions (heads or surroundings blocking the radio signals when holding the handset to the ear).

  - 1 Spectralink DECT Handset of any type.
- Consider also to bring a device you can use to play sound in the handset.



- A good idea would be also to bring a laptop with network cable to connect with the Spectralink IP-DECT Server 400.
- If you bring a repeater, you should also bring power supply for the repeater, and repeater programming kit (Product ID: 02509210).
- When bringing a repeater, you must also bring a serial to USB converter to be able to connect the repeater to the laptop.
- It could also be beneficial to bring a power supply for the Spectralink IP-DECT Server 400.

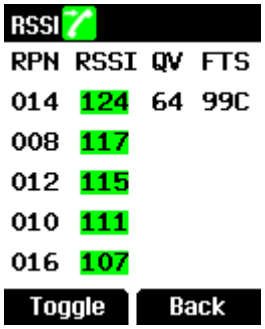
For more information about using the handset for deployment, see Site Survey Function in Handset User Guide.

Important Parameters

When deploying, there are 3 parameters which are equally important:

- RSSI values: Value indicating signal strength
- Q value: Value indicating the signal quality (preferably steady at 64)
- Sound Quality: Measured by walking away from the base station with the handset and measure where the RSSI value drops below 75 and the Q value stays constant at 64.

Example and Description of Values (RPN, RSSI, Quality) (Only relevant to Spectralink Handset 7202/7212/7502/7522/7532/7622/7642/7722/7742)



Descriptions of the values above:

- RPN (Radio Part Number) values range from 0 - 255.
- RSSI (Received Signal Strength Indicator) values range from 35 - 124. Counting down from 124.
- QV (Quality) values range from 0-64.

  A signal quality of 64 is a connection without errors, this number will be reduced by one for each error (such as reflections or noise). Preferably this value should be steady at 64.
- FTS (Frequency, Timeslot, State)
  - Time slot values range from 0 to B (there are 12 time slots)
  - State: E = Economy mode active. B, C indicates if last handover was a connection handover or a bearer handover.

    Note:

    To only see handover type, disable Economy mode in the handset menu (**Settings** > **Advanced** > **Economy mode**).
- First line shows that the actual base station has RPN number 14, signal strength (RSSI) 124, signal quality of connection is 64, 99C means ninth frequency, time slot 9, and that the last handover was a connection handover (C).
- Last four lines are candidates for connection handover (if any). Only the RSSI value and the RPN value is shown.

Descriptions of RSSI colours:

	RSSI
Green	> 80 RSSI/- 70 dBm
Yellow	< 80 RSSI/- 70 dBm and > 70 RSSI/- 80 dBM
Red	< 70 RSSI/- 80 dBM

Example and Description of Values (RPN, RSSI, Quality) (Only relevant to Spectralink Handset Butterfly)

Below is an example of RPN values:

N	14	16	18	2C
S	83	72	68	72
08	64	S108	3BC	

- The hexadecimal numeral system is used to describe RPN values and time slots. RPN values range from 00 to FF.
- Time slot values range from 0 to B (there are12 time slots)
- Third line shows that the actual base station has RPN number 8, signal quality of connection is 64, signal strength (RSSI) 108, 3BC means third frequency, time slot B, and that the last handover was a connection handover (C).
- A signal quality of 64 is a connection without errors, this number will be reduced by one for each error (such as reflections or noise). Preferably this value should be steady at minimum 64.
- The value of signal strength range from 110 to 35. Counting down from 110.

To Check RSSI values in Handset

1. Press **Menu** to enter main menu.
2. Scroll to **Status**, and press **Select**.
3. Scroll to **RSSI**, and press **Select**. The bearer quality is shown in the display.

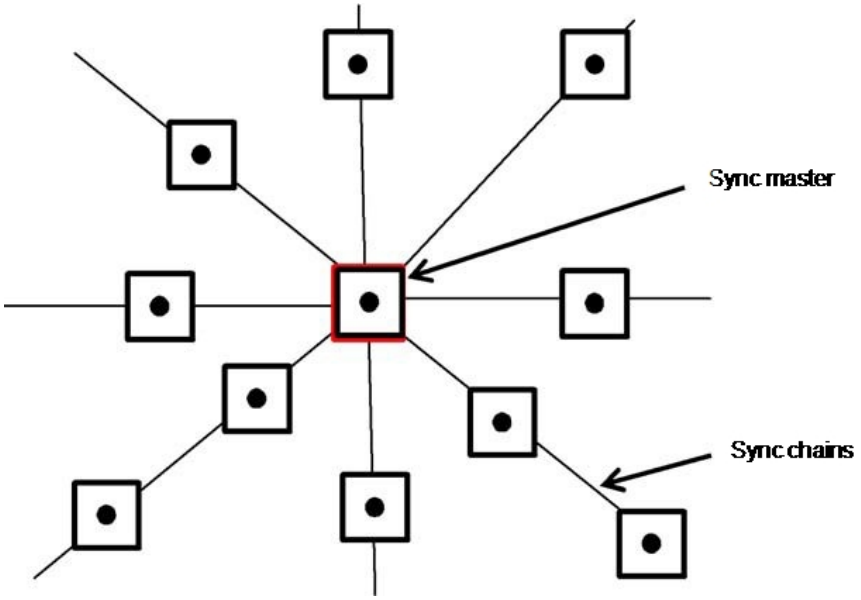
Deployment Rules of Thumb

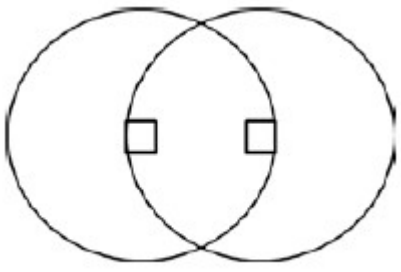
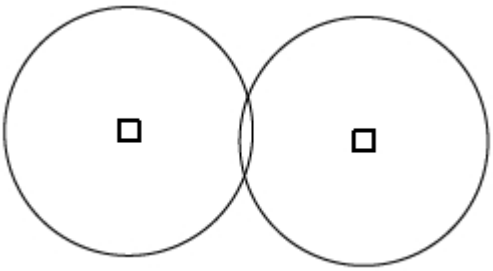
- Be systematic
- Document
- Do not assume - Measure

IP-DECT Base Station using Radio Synchronization (Over The Air)

Note:

It is recommended to deploy a system as a star system with the sync master placed in the middle.



Necessary overlap in synch chains	Necessary overlap between synch chains
	

Deployment Procedure

Start by placing your tripod with the Spectralink IP-DECT Server 400 (from your deployment tools) where you plan the first base station (the sync master) to be:

Take picture of the placement and note it on a blueprint of the building.

- Remember to consider that the first base station (sync master) shall be placed centrally in the installation so the rest of the system can spread from it (remember to consider all 3 dimensions.

Note:

Take picture of the placement and note it on a blueprint of the building.

- Make a call between the two handsets. During the deployment there must always be an active call established.

Note:

Measurements are only valid on handsets in a connected call!

- Play music/talk into the handset without headset. Wear the headset and listen to the sound quality all the time.
- At the same time as listening to the sound quality, use your handset to measure how far the base station will cover sufficiently.

  This is done by walking away from the base station with the handset and measure where the **RSSI value drops below 75 and the Q value stays constant at 64**. Do this in all directions from the base.

  For a description of the parameters and RPN values, see "Important Parameters" on page 17.

Note:

The handset can only measure correctly when off hook.

When measuring, carry the handset with your hands covering the antennas to assimilate normal user conditions (heads or surroundings blocking the radio signals when holding the handset to the ear).

- To perform a site survey using a Spectralink Standard Handset (7522/7532, 7622/7642, 7722/7742), enter **Survey** mode on the handset. For more information about using the

handset for deployment, see Site Survey Function in Handset User Guide.

Note:

It is important to measure all places where coverage is required.

Do not assume that there is coverage - it has to be measured!

- Consider where to place the next base station so that the handset gets opportunity to handover to the next base station. Determine where to place the next base stations.
- Move your tripod with the Spectralink IP-DECT Server 400 to the next placement.

Note:

Take picture of the placement and note it on a blueprint of the building.

- Continue until the whole site is deployed.

Note:

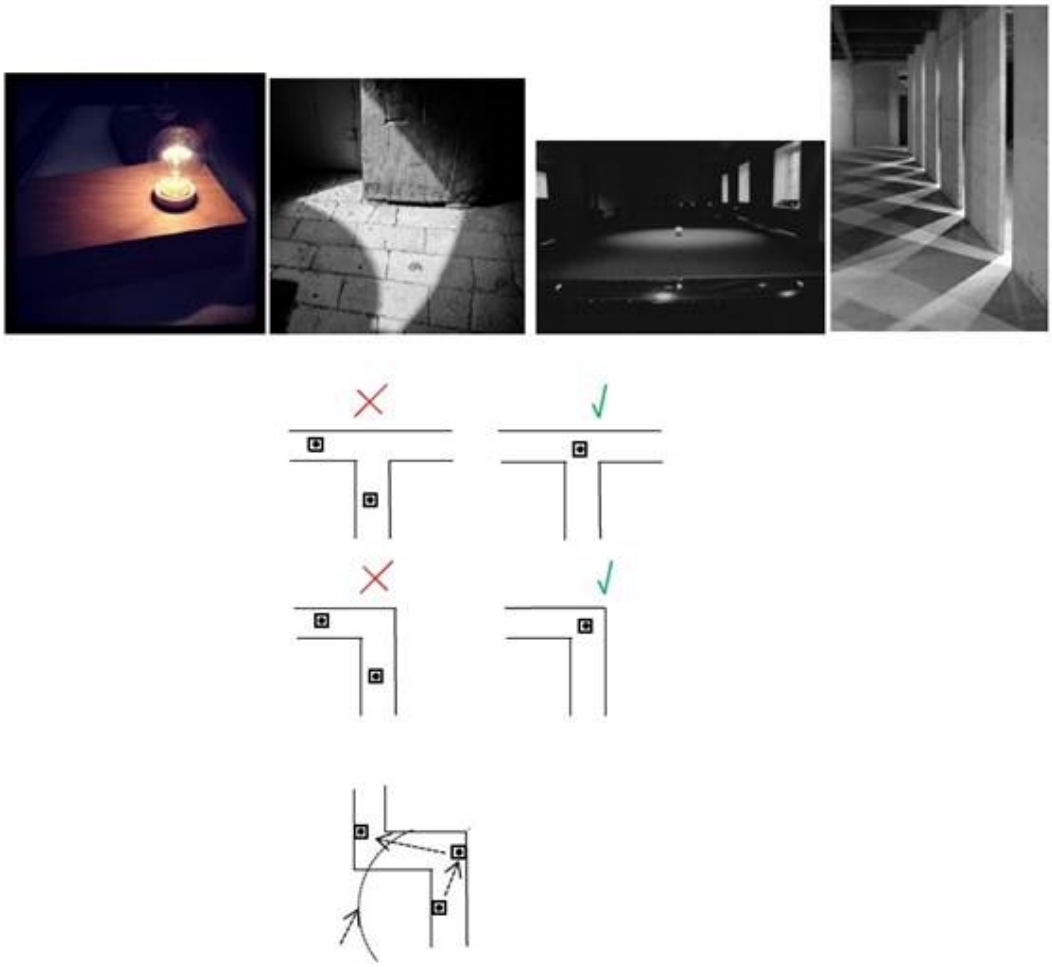
Remember to document each placement for base stations (incl. sync master).

- Take pictures of where exactly the base station must be placed.
- Note it on a drawing of the premises.

Placement of Base Stations

When determining where to place the base stations, following points must be considered:

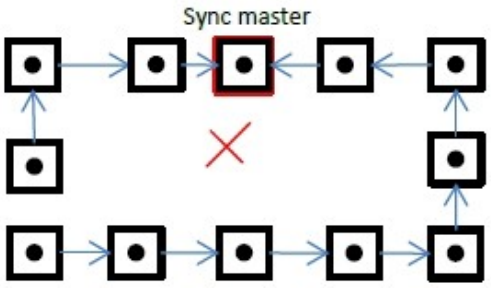
- To get maximum coverage from a base station the base stations must be as visible as possible.
- A guideline can be to consider where a light bulb can be placed to light up the maximum area.

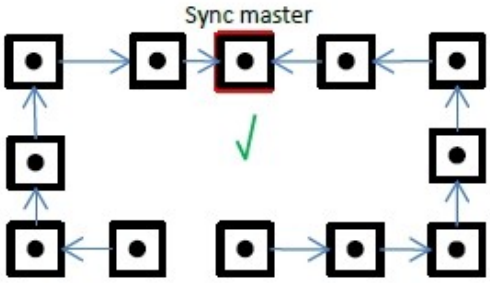


RSSI 70

- Traffic – how many simultaneous calls can be expected in an area.
  - In an assembly area e.g. in a canteen there will probably be many simultaneous calls during lunch.
  - To get an estimate of the simultaneous calls Erlang can be calculated.

- Sync latency in sync chains.





- Propagation through building materials – dense materials influence propagation negatively. Base stations shall be placed away from reflecting materials like metal.
- Base stations shall be placed away from other DECT base stations.
- “When in doubt deploy”, i.e. to ensure a good coverage place one more rather than one less base station.
- A good documentation of the deployment is needed to build the synchronization chains.

Note:

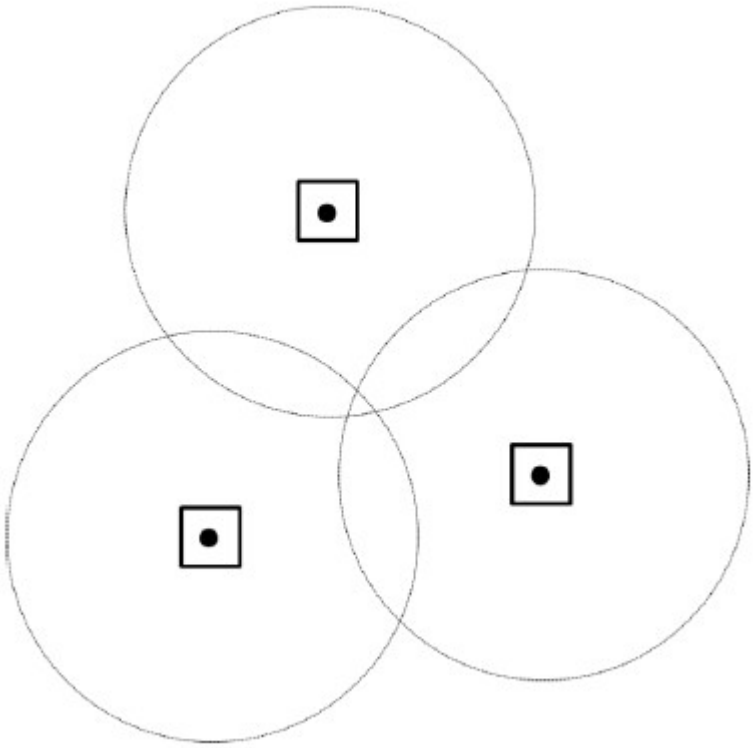
Take picture of the placement and note it on a blueprint of the building.

IP-DECT Base Stations using LAN Synchronization and Digital DECT Base Stations

In IP-DECT/DECT systems, it is important to ensure an overlap on the base stations at all timers of 15 m to ensure a call can be handed over at normal walking speed.

Note:

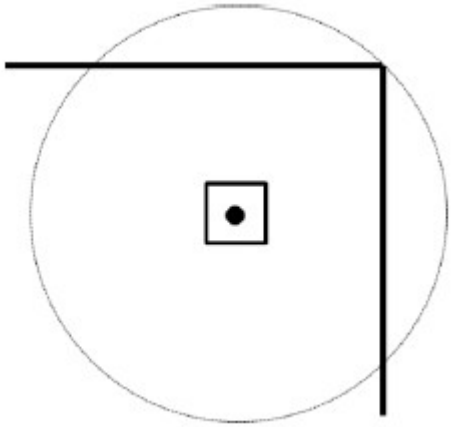
Synchronization between the digital DECT base stations is not an issue in these systems, as synchronization between the base stations is handled automatically by the DECT servers.



Deployment Procedure

Start by placing your tripod with the Spectralink IP-DECT Server 400 (from your deployment tools) where you plan the first base station to be:

- Place the first base station in a corner of the building so there is coverage in the corner.



Note:

Take picture of the placement and note it on a blueprint of the building.

- Make a call between the two handsets. During the deployment there must always be an active call established.

Note:

Measurements are only valid on handsets in a connected call!

- Play music/talk into the handset without headset. Wear the headset and listen to the sound quality all the time.
- At the same time as listening to the sound quality, use your handset to measure how far the base station will cover sufficiently.

  This is done by walking away from the base station with the Site Survey Handset and measure where the **RSSI value drops below 70 and the Q value stays constant at 64**. Do this in all directions from the base stations.

  For a description of the parameters and RPN values, see "Important Parameters" on page 17.

Note:

The handset can only measure correctly when off hook.

When measuring, carry the handset with your hands covering the antennas to assimilate normal user conditions (heads or surroundings blocking the radio signals when holding the handset to the ear).

- To perform a site survey using a Spectralink Standard Handset (7522/7532, 7622/7642, 7722/7742), enter **Survey** mode on the handset. For more information about using the

handset for deployment, see Site Survey Function in Handset User Guide.

Note:

It is important to measure all places where coverage is required.

Do not assume that there is coverage - it has to be measured!

- Note how far the place is from the tripod with the Spectralink IP-DECT Server 400.
- Find the next place for the base station app 2 x the above distance from the first placement
- Consider where to place the next base so that the handset gets opportunity to handover to the next base station.
- Move your tripod with the Spectralink DECT Server 400/2500. and measure whether this will give sufficient overlay (i.e. RSSI value min 70, Q value stays constant at 64 and good sound quality) at the same place as measured at the previous placement.
- If necessary, move the base station to get sufficient overlay.
- When it is determined where to place the next base stations.

Note:

Take picture of the placement and note it on a blueprint of the building.

- Continue until the whole site is deployed.

Note:

Remember to document each placement for base stations (incl. sync master).

- Take pictures of where exactly the base station must be placed.
- Note it on a drawing of the premises.

Placement of Base Stations

When determining where to place the base stations, following points must be considered:

- To get maximum coverage from a base station the base stations must be as visible as possible.
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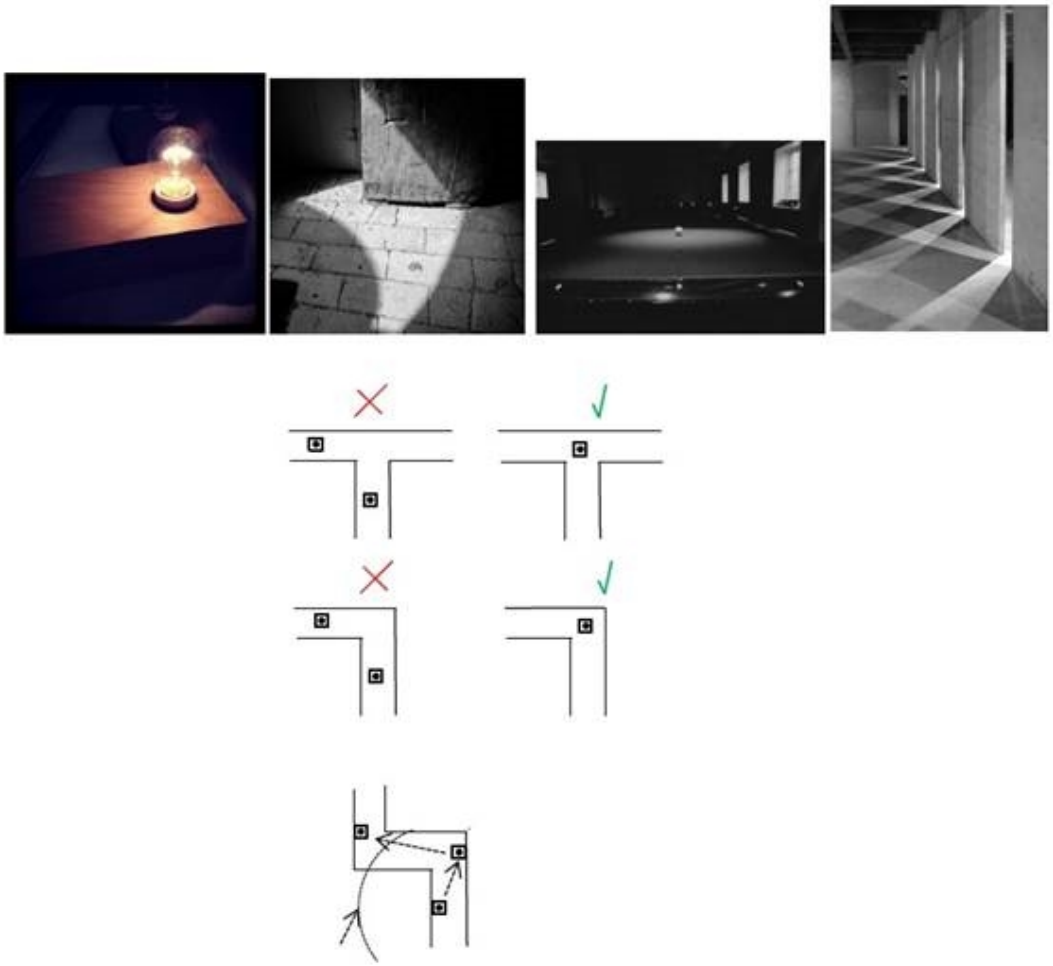


RSSI 75

- Traffic – how many simultaneous calls can be expected in an area.
  - In an assembly area e.g. in a canteen there will probably be many simultaneous calls during lunch.
  - To get an estimate of the simultaneous calls Erlang can be calculated.
- Propagation through building materials – dense materials influence propagation negatively. Base stations shall be placed away from reflecting materials like metal.
- Base stations shall be placed away from other DECT base stations.
- “When in doubt deploy”, i.e. to ensure a good coverage place one more rather than one less

base station.

- A good documentation of the deployment is needed to build the synchronization chains.

Note:

Take picture of the placement and note it on a blueprint of the building.

LAN Based Synchronization

Below you will find a description of how LAN based synchronization works, and what must be considered when synchronizing.

Note:

LAN based synchronization only works when using a Spectralink Handset.

The latest generation of Spectralink IP-DECT Base Stations support the use of corporate Local Area Network (LAN) for synchronization of the DECT radios when running software release PCS15C or later.

In a multi-cell DECT system, the base station radios must be synchronized to each other in order to achieve the optimum handover experience, when handsets are moving around among base stations. Spectralink supports the synchronization of digital DECT base stations via the wire and IP-DECT base stations via the radio. IP-DECT base stations can use the LAN for synchronization as well.

The LAN based synchronization has several advantages over synchronizing via the radio. The configuration is much simpler because no synchronization chains need to be configured and maintained. The synchronization is self-healing, because the system itself can handle if any base station is failing. Finally, the system can be deployed with fewer base stations, because the base stations are no longer required to be in range of each other.

It may, however, not be the ideal solution in all cases. LAN based synchronization requires that the base stations involved in a handover are on the same network segment and the network deployment (including LAN switches) meets a number of quality criteria.

Precision Time Protocol Background

Precision Time Protocol version 2 (PTPv2) is used to synchronize the radios of the IP-DECT base station via the LAN. PTPv2 is defined in the standard IEEE 1588-2008 and a brief introduction can be found here: http://en.wikipedia.org/wiki/Precision_Time_Protocol.

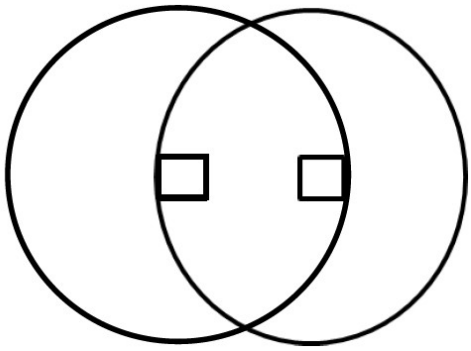
PTPv2 is based on a master-slave architecture, where the active master is automatically selected among the base stations with the lowest serial number. Each network segment will have one active master and the remaining base stations will be slaves. If the current master is failing a new one will be automatically selected without disrupting the current synchronization state.

The PTPv2 datagrams are sent as multicast and transported via UDP on IPv4 or IPv6 or as raw Ethernet packets without IP.

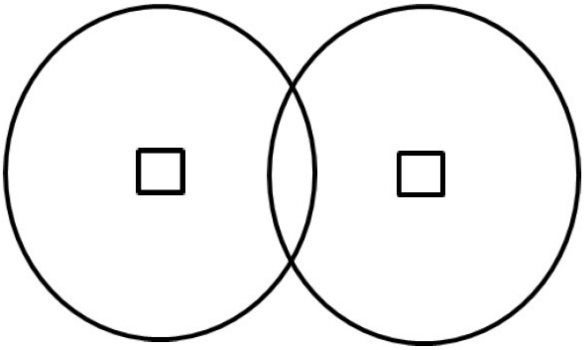
The LAN based synchronization is administrated centrally from the web based Administration Page of the IP-DECT/DECT Server. The synchronization itself however is handled autonomously by the base stations, and the server is not involved and hence does not need to be on the same network segment.

Deployment of Base Stations

When the base station radios are synchronized via radio, the base stations that synchronize to each other must be within radio coverage of each other. This is not required when LAN based synchronization is used. Here, the deployment requirements are the same as for the digital DECT base stations and the coverage overlap is only required for the handsets to be able to perform handovers. The figure below illustrates the difference in coverage requirements for radio and LAN based synchronization.



Radio synchronization



LAN synchronization

It should be noted that depending on the deployment - Synchronization via LAN and radio can be combined in the same DECT installation. Even when a base station is configured to synchronize via LAN, it transmits the signal required for synchronization via radio. Therefore, base stations synchronizing via radio can retrieve their synchronization signal from a base station synchronizing via LAN. The other way around is not possible.

Network Requirements

For PTPv2 to work the requirements for the network are quite strict with regard to:

- multicast
- timing

Note:

LAN synchronization only works properly if multicast and timing requirements are met. An assessment of the corporate LAN network MUST be done to evaluate if the LAN network is suitable enough for LAN based synchronization.

Multicast

The PTPv2 multicast packets cannot traverse routers and consequently the IP-DECT base stations that needs to be synchronized must be on the same switched network segment.

Regardless of the transport selected, IPv4, IPv6 or Ethernet, the network switches must allow multicast traffic to and from all the LAN base stations. The multicast addresses used are listed below:

Protocol	Multicast address
IPv4	224.0.1.129
IPv6	FF02::181
Ethernet	01:1B:19:00:00:00

If IPv4 or IPv6 is used as transport and IGMP snooping

(http://en.wikipedia.org/wiki/IGMP_snooping) is supported by the switch, the switch can utilize this to automatically configure on which ports the multicast packets should be sent. Note that this requires an IGMP querier to be present on the network segment (many IGMP snooping switches offers this functionality).

If multicast is not working properly on the network, the IP-DECT base stations will not be able to achieve LAN synchronization.

Timing and Jitter

For PTPv2 to be accurate enough to synchronize the DECT radios the network jitter must be low, that is the network packet delay must be close to constant.

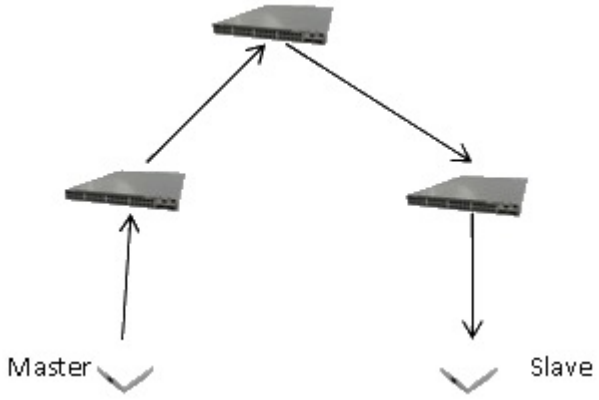
The PTPv2 algorithms in the base stations have built-in filtering, which make them able to cope with some level of jitter. However, prolonged periods of large jitter can cause unstable or even loss of synchronization.

The corporate LAN must support the following specifications:

- Maximum of 500 nanoseconds jitter of multicast Ethernet packets between all IP-DECT base stations being synchronized.
- Any single switch in the network cannot exceed 100nsec of jitter.
- PTPv2 event traffic must be given strict priority over all other network traffic.
- Multicast and the IGMP protocol (if used) must be configured per Spectralink requirements.
- Network topology
- The traffic patterns on the network
- The quality and configuration of the switches

Network Topology

Every time a PTPv2 packet passes through a switch - jitter is potentially added. Therefore, the number of switches between all base stations must be kept low. Because every individual base station can assume the role as PTPv2 master or slave regardless of its position in the network topology, a worst case position of master and slave must be considered when deploying the base stations in the network. The figure below illustrates this with a core switch with two access switches connected. Here the worst case path length is three switches.



Note:

In the lab, the IP-DECT base stations have successfully been synchronized with 5 enterprise LAN switches between master and slave.

Traffic Load

The traffic load on the switches will also affect the jitter. High traffic load and especially a large number of large packets will increase the jitter. For example, a 1500 bytes data packet introduces an immediate 120 usec delay on a 100 Mbps link.

It is recommended that the core network links provides higher bandwidth than the access links, i.e. if the access links are 100 Mbps, the uplink and core network should be at least 1 Gbps. This will alleviate the probability of traffic saturating the network path used for the base station synchronization.

If the traffic load causes problems for the base station synchronization, it may be necessary to separate the base stations from the data network. Be aware that separation via VLAN may not help as it is still using the same physical link.

Quality and Configuration of the Switches

The LAN based synchronization is highly dependent on the quality and configuration of the deployment network. The single most important property of the switches in the network is their ability to forward multicast Ethernet packets with low jitter, i.e. close to a constant delay. The total forwarding jitter added by switches on any path through the deployment network should be less than one microsecond and preferably less than 100 nanoseconds.

Unfortunately, it is usually difficult to find the forwarding jitter specified for a given switch. Lab tests indicates that enterprise level switches generally has adequately low forwarding jitter, whereas SOHO and unmanaged switches often do not meet the requirements and thus must not be used.

When configuring the deployment network, multicast setup is critical for LAN synchronization to work. Multicast is usually either blocked, forwarded as broadcast to all ports, forwarded according to static configuration or forwarded to selected ports learned by IGMP snooping. The simplest option is to forward as broadcast to all ports, but this might create unwanted traffic on unrelated network parts. When using static configuration, the relevant multicast addresses listed earlier must be forwarded to the ports forming the deployment network. Enabling IGMP snooping on the switches allow them to automatically configure which ports the multicast packet should be forwarded to, minimizing the network load caused by the LAN synchronization. In order to keep the multicast configuration updated, a IGMP querier must be present in the network – this functionality can be enabled in many enterprise class switches.

Traffic Priority:

All time critical PTPv2 packets sent by the LAN synchronization software is by default marked with either an Expedited Forwarding (EF) (46/0x2e) priority for IPv4 and IPV6 packets or a Class of Service value of 7 for VLAN encapsulated Ethernet packets. This is to allow the switches to give preference to the LAN synchronization packets.

Since the Expedited Forwarding priority on IP packets is shared with voice RTP packets, this is not sufficient to ensure strict priority over all other traffic for the PTPv2 events packets.

There are two possible solutions to this:

- Give the highest priority to a custom IP priority and configure the server to apply this IP priority to PTPv2 traffic.
- Give the highest priority to multicast UDP packets on port 319 with the destination address 224.0.1.129 (IPv4) or FF02::181 (IPv6).

Configurations and Administrations

A few configuration settings on the Spectralink server's web based Administration Page are used to control base station synchronization via LAN.

IP-DECT/DECT Server System Settings

The system wide settings for synchronization via LAN are located under **Configuration** > **Wireless Server** > **Base stations**:

Field	Setting
Default sync type	This setting controls the default synchronization type for new base stations. The following values can be selected: • Free running • Radio (default) • LAN
LAN sync transport protocol	This setting controls the protocol used as transport for the PTPv2 packets used for synchronization. The following values can be selected: • Ethernet • IPv4 (default) • IPv6 IPv4 is the default and recommended in most networks.

Base Station Individual Settings

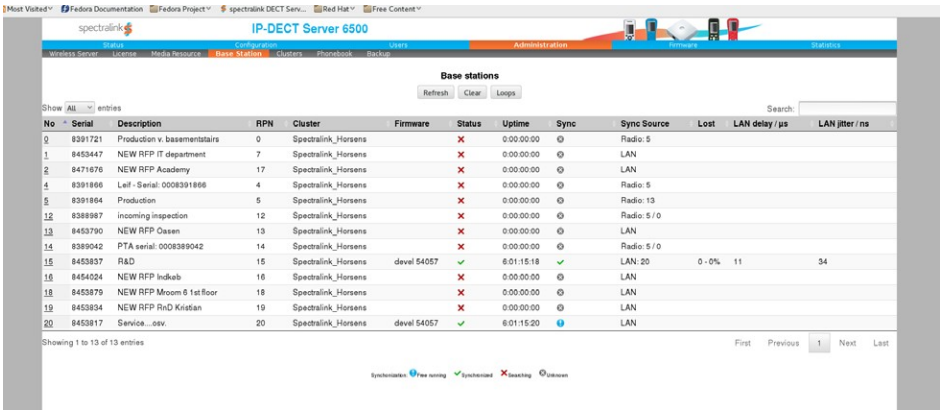
Field	Setting
Type	This setting controls the synchronization type for specific base station. The following values can be selected: • Free running • Radio • LAN • Gateway

Base Station Synchronization Status

The synchronization status is displayed on the Spectralink server's web based Administration Page under **Administration** > **Base Stations**.

The **Sync column** displays a green icon for base stations that are currently running as slaves and a blue one for the current master.

The **Lost column** displays the number of times the synchronization has been lost and a percentage which is the ratio of time the base station has been without synchronization. The lost counter must be low but is expected to grow slowly over time. The percentage will start high and must be zero after some time.



Troubleshooting

In general, always check if there is newer software to be downloaded.

Synchronization

Symptom	Problem	Resolution
All base stations are synchronization masters.	Multicast traffic is blocked in the network.	Enable multicast traffic on all switches between the base stations.
Synchronization is OK at startup but fails after a short period.	IGMP snooping is active, but no IGMP querier is present on the network to refresh multicast group memberships.	Add an IGMP querier to the network or disable IGMP snooping.
Base stations do not synchronize or loose synchronization often.	The traffic between base stations is being delayed a varying amount of time due to traffic load, switch quality or configuration.	Reconfigure/replace switches or change the network topology to minimize the transmission time variance.