

# LAN Based Radio Synchronization

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## Introduction

The latest generation of Spectralink IP-DECT base stations supports the use of Local Area Network (LAN) for synchronization of the DECT radios when running software release PCS15C or later. This document describes how this works, and what must be considered when deploying LAN based 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. Up until now Spectralink has supported to synchronize digital base stations via the wire and IP base stations via the radio. However, with improvements, now - the IP base stations can use company 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 meets a number of strict network quality criteria.

## Precision Time Protocol Background

Precision Time Protocol version 2 (PTPv2) is used to synchronize the DECT radios 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](http://en.wikipedia.org/wiki/Precision_Time_Protocol)

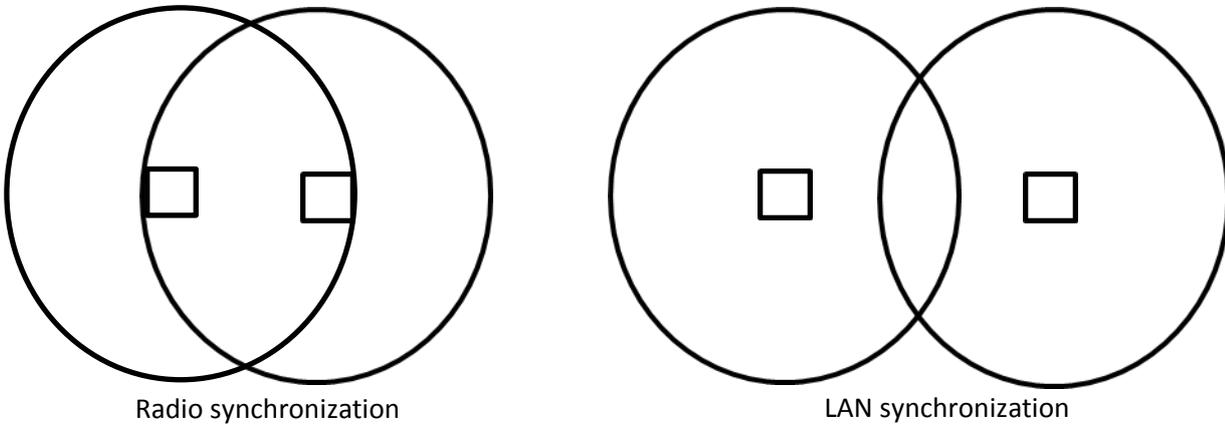
PTPv2 is based on a master-slave architecture, where the active master is automatically selected among the base stations. Each network segment will have one active master and the remaining base stations will be slaves. If the current master is failing a new one is automatically selected without disrupting 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 radio synchronization is administrated centrally from the web GUI of the IP-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 radio synchronization is used. Here the deployment requirements are the same as for the digital 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.



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 and timing. LAN synchronization only works properly if multicast and timing requirements are met.

**Note: As 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 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 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](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 base stations will not be able to achieve 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.

### LAN Sync Requirements:

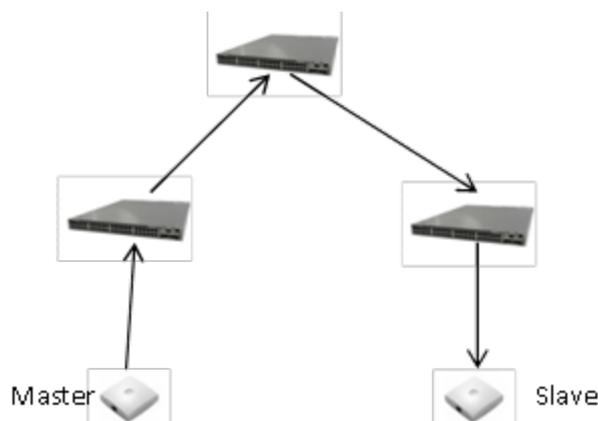
1. Maximum of 500 nanoseconds jitter of multicast Ethernet packets between all IP base stations being synchronized.
2. Any single switch in the network cannot exceed 100nsec of jitter.
3. PTPv2 event traffic must be given strict priority over all other network traffic.
4. Multicast and the IGMP protocol (if used) must be configured per Spectralink requirements.

Several factors influence the packet delay:

- 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 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 100 nanoseconds.

Unfortunately it is usually difficult to find the forwarding jitter specified for a given switch. Lab tests however seem to indicate 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).

Some switches offer features to help keeping PTPv2 entities synchronized. This functionality is currently neither supported by nor tested with the base station software.

## Configuration and Administration

A few configuration settings are used to control base station synchronization via LAN.

### IP-DECT Server System Settings

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

Default sync type	This setting controls the default synchronization type for new base stations. The following values can be selected: <ul style="list-style-type: none"> <li>• Free running</li> <li>• Radio (default)</li> <li>• LAN</li> </ul>
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: <ul style="list-style-type: none"> <li>• Ethernet</li> <li>• IPv4 (default)</li> <li>• IPv6</li> </ul> IPv4 is the default and recommended in most networks.

### Base Station Individual Settings

The settings specific for individual base stations are located under Administration -> Base Stations -> Edit -> Synchronization:

Type	This setting controls the synchronization type for the specific base station. The following values can be selected: <ul style="list-style-type: none"> <li>• Free running</li> <li>• Radio</li> <li>• LAN</li> </ul>
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## Base Station Synchronization Status

The synchronization status is displayed on the Administration -> Base Stations page of the web GUI. The Sync column displays a green icon for base stations that are currently running as slaves and a blue one for the current master.

Show  entries Search:

No	Serial	Description	RPN	Cluster	Firmware	Status	Uptime	Sync	Prim/Sec	Lost
0	8453575	Hermod Basement	0	Default	devel 46921	✓ connected	0:00:18:10	✓	LAN	0 1%
1	8453414	Hermod Basement	1	Default	devel 46921	✓ connected	0:00:18:10	🕒	LAN	
2	8453906	Hermod R&D	2	Default	devel 46921	✓ connected	0:00:18:10	✓	LAN	0 0%
3	8453421	Hermod Basement	3	Default	devel 46921	✓ connected	0:00:13:58	✓	LAN	0 0%

Showing 1 to 4 of 4 entries First Previous 1 Next Last

Synchronization: 🕒 Free running ✓ Synchronized ✗ Searching 🕒 Unknown

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

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.