

LCOS 10.94

WLAN Management

09/2026

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1 WLAN management

1.1 Initial situation

The widespread use of wireless access points (APs) and wireless routers provides great convenience and flexibility in network access for businesses, universities and other organizations.

Yet in spite of the numerous advantages WLAN infrastructures offer, there are still a number of unsettled issues:

- > All APs must be configured and require appropriate monitoring in order to recognize unwelcome WLAN clients, etc. The administration of the APs, especially for larger WLAN infrastructures with the appropriate security mechanisms, requires advanced qualifications and experience on the part of those responsible, and it ties up considerable resources in the IT departments.
- > The manual customization of the configurations in the APs when changes are made to the WLAN infrastructure can be time-consuming, with the result that different configurations can be present in the WLAN at the same time.
- > Combined utilization of the shared communications medium (air) requires effective coordination of the APs to avoid frequency interference and optimize network performance.
- > In public places, APs are a potential security risk because the devices themselves, including the security-related data in them such as passwords, etc., are susceptible to theft. In addition, rogue APs may be able to connect to the LAN unnoticed, bypassing the security policies that are in place.

1.2 Technical concepts

Centralized WLAN management is the solution to these problems. The configuration of the AP is then no longer carried out in the devices themselves but by a central authority instead, the WLAN controller (WLC). The WLC authenticates the APs and transmits the correct configuration to the approved devices. This allows for convenient configuration of the WLAN from a central point and the changes to the configuration affect all of the APs simultaneously. Optionally the configuration provided by the WLC is not stored in the AP's flash memory but in RAM, so security-related data cannot fall into the hands of unauthorized persons in the event that devices are stolen. Only in "standalone" operation is the configuration optionally saved for a defined period to flash memory (in an area that cannot be read out with LANconfig or other tools).

1.2.1 WLC features in the R&S®LANCOM vRouter

As of LCOS 10.30 the R&S®LANCOM vRouter additionally supports the functions of a WLAN controller. You decide which role your R&S®LANCOM vRouter should play: VPN gateway or WLAN controller. The R&S®LANCOM vRouter now supports the role of a virtual WLC (vWLC), which means it is capable of managing access points. This fully virtualizes the functions of a WLAN controller on virtualization platforms such as VMWare ESXi or Microsoft Hyper-V. The number of managed access points depends on the vRouter license category. All vRouter licenses issued after the release of LCOS 10.30 include a vWLC option.

Product	VPN licenses	AP licenses
vRouter 50	10	10
vRouter 250	50	50
vRouter 500	100	100
vRouter 1000	200	200
vRouter unlimited	1000	1000

 Rohde & Schwarz Networks and Cybersecurity recommends running a vRouter instance either primarily as a VPN gateway/router or as a WLAN controller. The recommended usage may also be split: For example, at the license level “vRouter 1000” (200 VPN licenses and 200 AP licenses):

- 100 concurrent VPN connections and 100 managed APs or
- 150 concurrent VPN connections and 50 managed APs.

1.2.2 The CAPWAP standard

The CAPWAP protocol (Control And Provisioning of Wireless Access Points) introduced by the IETF (Internet Engineering Task Force) is a standard for the centralized management of large WLAN infrastructures.

CAPWAP uses two channels for data transfer:

- Control channel, encrypted with Datagram Transport Layer Security (DTLS). This channel is used to exchange administration information between the WLC and the AP.

 DTLS is an encryption protocol is based on TLS but, in contrast to TLS itself, it can be used for transfers over connectionless, unsecured transport protocols such as UDP. DTLS therefore combines the advantages of the high security provided by TLS with the fast transfer via UDP. This also makes DTLS suitable for the transfer of VoIP packets (unlike TLS) because, even after the loss of a packet, the subsequent packets can be authenticated again.

- The payload data from the WLAN is transferred through this data channel from the AP via the WLC into the LAN—encapsulated in the CAPWAP protocol.

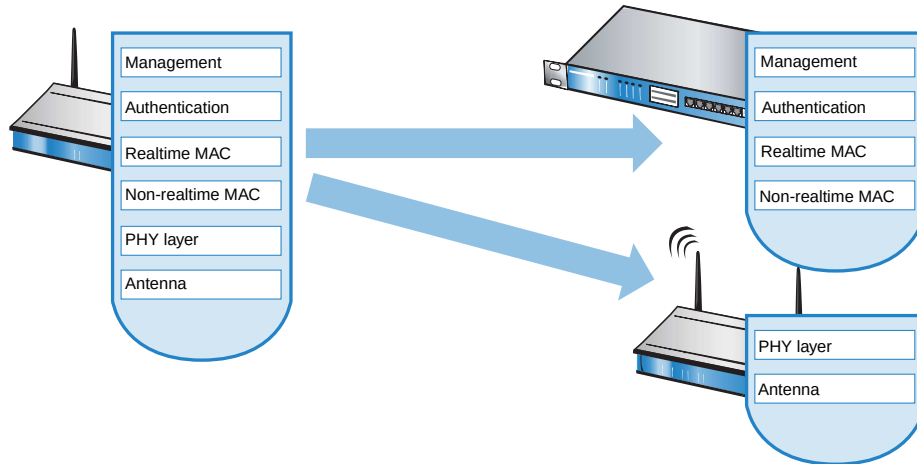
1.2.3 Smart controller technology

In a decentralized WLAN structure with stand-alone APs (operating as so-called "rich access points") all functions for data transfer take place in the PHY layer, the control functions in the MAC layer, and the management functions are integrated in the APs. Centralized WLAN management divides these tasks among two different devices:

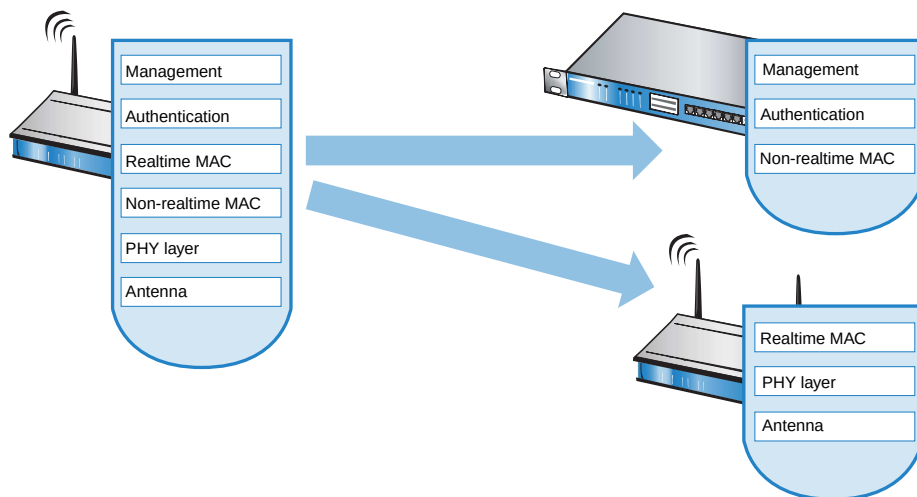
- The central WLC assumes the administration tasks.
- The decentralized APs handle the data transfer at the PHY layer and the MAC features.
- A RADIUS or EAP server can be added as a third component RADIUS or for authentication of WLAN clients (which can also be the case in stand-alone WLANs).

CAPWAP describes three different scenarios for the relocation of WLAN functions to the central WLC.

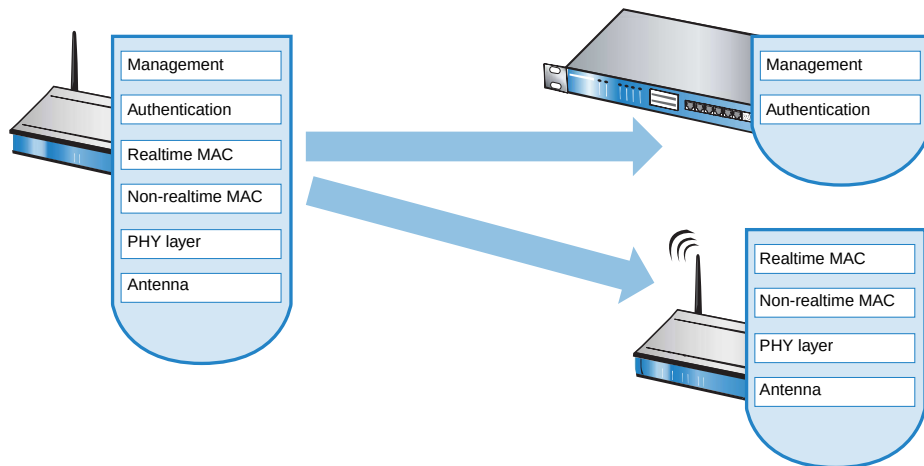
- Remote MAC: In this case, all of the WLAN functions are transferred from the AP to the WLC. Here, the APs only serve as "extended antennas" without independent intelligence



- Split MAC: With this variant, only a portion of the WLAN functions are transferred to the WLC. Normally, realtime applications will continue to be processed in the AP; the non-realtime applications are processed via the central WLC.



- Local MAC: The third possibility provides for complete management and monitoring of the WLAN data traffic directly in the APs. The only information exchanged between the AP and the WLC is for network management and ensures that the APs have a uniform configuration.



Smart Controller Technology from Rohde & Schwarz Networks and Cybersecurity uses the local MAC procedure. Thanks to the reduction of centralized tasks, these WLAN infrastructures offer optimum scalability. At the same time, infrastructure of this type prevents the WLC from becoming a central bottleneck that has to process large portions of the overall data traffic. In remote MAC and split MAC architectures, all payload data is forced to run centrally via the WLC. In local MAC architectures the data can alternatively be broken out from the APs directly to the LAN to provide high-performance data transfer. With break-out into the LAN, data can also be directly routed into special VLANs. This makes it very easy to set up closed networks, such as for guest access accounts.

Layer 3 tunneling and layer 3 roaming

WLCs with LCOS also support the transfer of payload data through a CAPWAP tunnel. This allows selected applications such as VoIP to be routed via the central WLC, for example. If WLAN clients change to a different radio cell, the underlying IP connection will not be interrupted because it continues to be managed by the central WLC (layer-3 roaming). In this way, mobile SIP telephones can easily roam between Ethernet subnets, even during a call.

Managing data streams centrally can also make configuring VLANs at the switch ports unnecessary in environments with numerous VLANs because all CAPWAP tunnels are centrally managed on the WLC.

1.2.4 Communication between access point and WLAN controller

Communication between an AP and the WLC is always initiated by the AP. In the following cases, the devices search for a WLC that can assign a configuration to them:

- When shipped, the WLAN modules in R&S@NC APs are set to the 'Managed' operating mode. In this mode, APs search for a central WLC that can provide them with a configuration, and they remain in "search mode" until they discover a suitable WLC or until the operating mode of the WLAN module is changed manually.
- While the AP searches for a WLC, its WLAN module is switched off.
- Ex-factory, the WLAN modules in R&S@NC wireless routers are set to the 'access point' operating mode. In this mode, wireless routers function as standalone access points with a configuration that is stored locally in the device. For integration into a WLAN infrastructure that is centrally managed by WLAN controllers, the operating mode of the WLAN modules in wireless routers has to be switched into the 'managed' mode.

- ❗ Communication between the access point and the WLAN-Controller takes place via **CAPWAP** as well as via **SCEP**. For **CAPWAP** the **UDP port 1027** is used in the default configuration (can be changed in the WLAN-Controller configuration). For the communication via **SCEP** the protocol **HTTP (TCP port 80)** is used.

The AP sends a "discovery request message" at the beginning of communication to find the available WLCs. This request is sent as a broadcast. However, because in some structures a potential WLC cannot be reached by a broadcast, special addresses from additional WLCs can also be entered into the configuration of the APs.

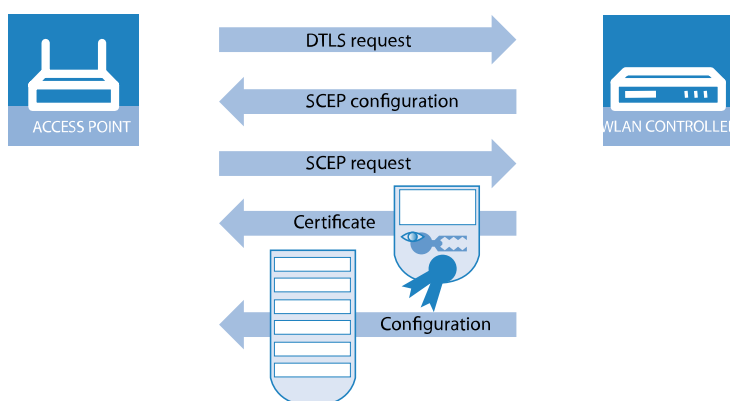
- ❗ The DNS names of WLCs can also be resolved. All APs with LCOS 7.22 or higher have the default name 'WLC-Address' preconfigured so that a DNS server can resolve this name to a WLC. The same applies to the DHCP suffixes learned via DHCP. This also makes it possible to reach WLCs that are not located in the same network, without having to configure the APs.

From the available WLCs, the AP selects the best one and requests it to establish the DTLS connection. The "best" WC for the AP is the one with the least load, i.e. the lowest ratio of managed APs compared to the maximum possible number of APs. In case of two or more equally "good" WLCs, the AP selects the nearest one in the network, i.e. that with the fastest response time.

The WLC then uses an internal random number to determine a unique and secure session key, which it uses to secure the connection to the AP. The CA in the WLC issues a certificate to the AP by means of SCEP. The certificate is protected by a one-time-only "challenge" (password). The AP uses this certificate for authentication at the WLC to collect the certificate.

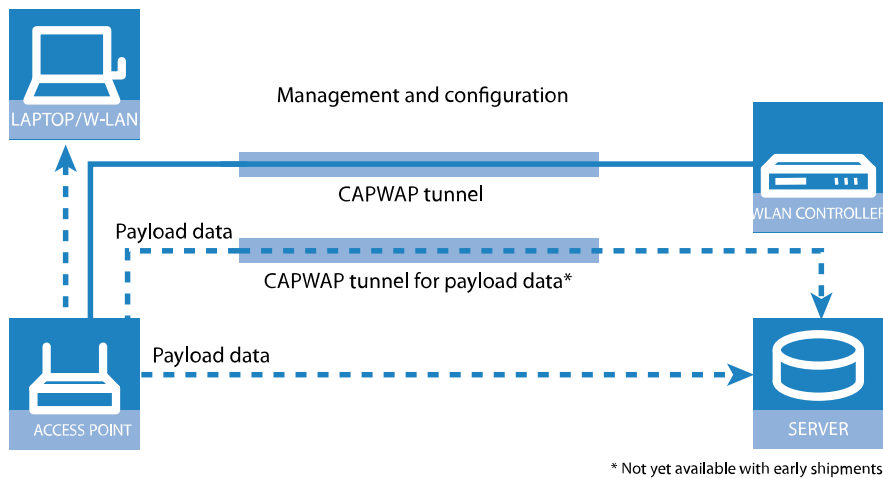
The AP is provided with the configuration for the integrated SCEP client via the secure DTLS connection – the AP uses the SCEP to retrieve its certificate from the SCEP CA. Once this is done, the assigned configuration is transferred to the AP.

- ❗ SCEP stands for Simple Certificate Encryption Protocol, CA for Certification Authority.



Authentication and configuration can both be carried out either automatically or only with a corresponding entry of the AP's MAC address in the AP table of the WLC. If the AP's WLAN modules were deactivated at the beginning of the DTLS communication, these will be activated after successful transfer of the certificate and configuration (provided they are not explicitly deactivated in the configuration).

The management and configuration data will then be transferred via the CAPWAP tunnel. The payload data from the WLAN client is then released in the AP directly into the LAN and transferred, for example, to the server.



1.2.5 Zero-touch management

With their ability to automatically assign a certificate and configurations to the requesting APs, WLCs implement true "zero-touch management". Simply connect new APs to the LAN—no further configuration is necessary. This simplification to only having to install devices reduces the workload for IT departments, especially in decentralized structures, because no special IT or WLAN expertise is required for the setup at the remote locations.

1.2.6 Split management

APs are able to search for their WLC in remote networks—a simple IP connection, such as via a VPN path, is all you need. As the WLCs only influence the WLAN part of the configuration in the AP, all other functions can be managed separately. This division of the configuration tasks makes WLCs ideal for establishing a company-wide WLAN infrastructure that is based at the headquarters and includes all of the branch and home offices connected to it.

1.2.7 Protection against unauthorized CAPWAP access from the WAN

The WLC or R&S®NC router with activated WLC option handles CAPWAP requests from the LAN and the WAN in the same way. In the case of requests from WAN remote stations, it accepts the APs into its AP management and, under certain circumstances, it sends a default configuration. If configured appropriately, the CAPWAP service is no longer available to WAN remote stations, meaning that for WAN remote stations, APs are no longer accepted and configurations are not provisioned.

The configuration is done under **WLAN Controller > General** in the section **Wireless LAN controller**. If the automatic acceptance of new APs is enabled, you can use the feature **Accept**

new AP over WAN connection to control whether the CAPWAP service is available to WAN remote stations.

No

The device accepts no new APs over the WAN connection.

Only via VPN

The device only accepts new APs if the WAN connection is via VPN.

Yes

The device accepts all new APs over the WAN connection.

1.3 Basic configuration of the WLAN controller function

To get started, a WLC requires the following two pieces of information to carry out the mainly automated configuration of the APs:

- > Current time information (data and time) for checking the validity of the necessary certificates.
- > A WLAN profile that the WLC can assign to the APs.

Further optional examples for configuration include setting up redundant WLC, the manual disconnection and connection of APs, and backing up any necessary certificates.

 By default the WLC listens for connections on the UDP port 1027 (configurable). The certificates are distributed by SCEP, which uses the TCP port 80 (HTTP).

1.3.1 Setting the time information for the WLAN controller

The management of APs in a WLAN infrastructure is based upon the automatic distribution of certificates via the Simple Certificate Enrollment Protocol (SCEP).

The WLC can only check the temporal validity of these certificates if it is set with the current time. If the time is not set in the WLC, the WLAN LED illuminates in red and the device is not operational.

 Routers with the WLC option do not have a WLAN LED.

To set the time in the device start LANconfig, click on the entry for the WLC with the right-hand mouse key and select **Set date/time** from the context menu. Alternatively in WEBconfig you can click on **Extras** and then **Set date and time**.

 Alternatively, WLCs can automatically retrieve the current time from a time server by means of the Network Time Protocol (NTP). Information on NTP and its configuration can be found in the LCOS reference manual.

As soon as the WLC has valid time information it begins with the generation of the certificates (root and device certificate) and it determines a random number. Once the necessary certificates have been generated, the WLC indicates that it is operational and the WLAN LED blinks red.

- ! Once operational, you should make a backup copy of the certificates ([Backing up the certificates](#))

1.3.2 Example: Default configuration

1. Open up the configuration of the WLC by double-clicking on its entry in LANconfig.
2. Activate the options for the automatic acceptance of new APs and the provision of a default configuration under **WLAN controller > General**.

On the following pages you may configure 'Profile' parameters, which will be simultaneously used for multiple devices. Managed access points may be defined and an optional notification as well as a default parameter set may be configured.

Wireless LAN controller

Here you define the basic parameters for your wireless LAN controller (WLC).

☐ Wireless LAN controller enabled

☒ Automatically accept new APs (Autoaccept)

☒ Automatically provide APs with a default configuration

☐ Synchronize main device password

WLC connections

☒ WLC tunnel active

☐ WLC data tunnel active

Static WLC list... WLC discovery...

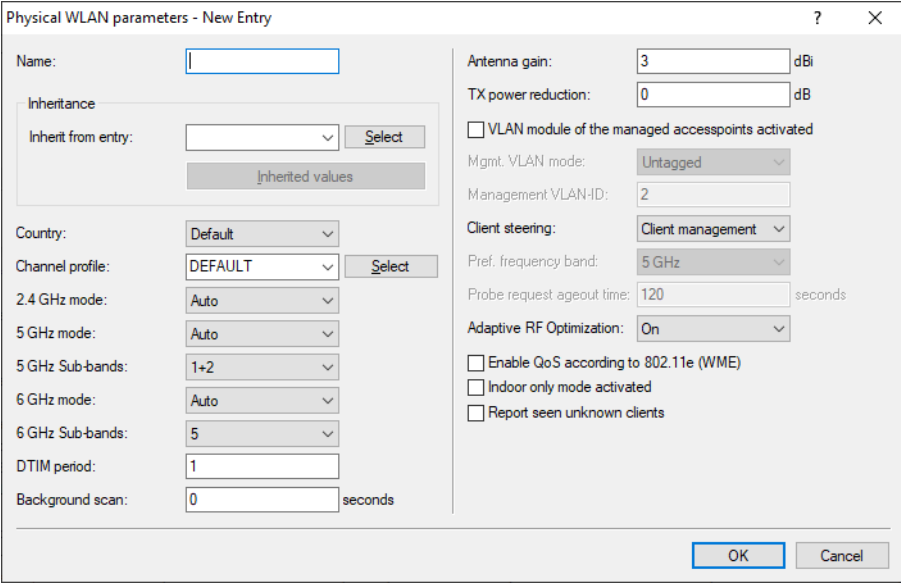
- > **Automatically accept new APs (Auto-accept)** Enables the WLC to provide a certificate to all new APs without a valid certificate. To this end, either a configuration for the AP has to be entered into the AP table, or 'Automatically provide APs with a default configuration' has to be activated.
- > **Automatically provide APs with a default configuration:** This enables the WLC to assign a default configuration to any new AP, even if no explicit configuration has been stored for it.

By combining these two options, the WLC can automatically integrate any managed-mode AP found in the LAN into its WLAN infrastructure. This may, for example, be a temporary measure during the rollout phase of a WLAN installation.

3. On the **Profiles** page, move to the logical WLAN networks. Add a new entry with the following values:

- › **Name:** Give the WLAN a name. This name is used only for administrative purposes in the WLC.
 - › **SSID:** This SSID is used for the WLAN clients to connect.
 - › **Encryption:** Select the encryption method suitable for the WLAN clients being used, and enter a key or passphrase, as applicable.
 - › Deactivate the MAC check. Instructions on the use of MAC filter lists in managed WLAN infrastructures can be found under [Checking WLAN clients with RADIUS \(MAC filter\)](#).
4. A new entry also has to be added to the physical WLAN parameters. In most cases involving the default configuration, just entering a name is sufficient. Adjust the other settings to meet your needs, if necessary.

- ! For normal AP applications you should use only the 5-GHz subbands 1 and 2. Subband 3 is for special applications only (e.g. BFWA, Broadband Fixed Wireless Access).



Physical WLAN parameters - New Entry

Name:

Inheritance
Inherit from entry:

Country:

Channel profile:

2.4 GHz mode:

5 GHz mode:

5 GHz Sub-bands:

6 GHz mode:

6 GHz Sub-bands:

DTIM period:

Background scan: seconds

Antenna gain: dBi

TX power reduction: dB

☐ VLAN module of the managed accesspoints activated

Mgmt. VLAN mode:

Management VLAN-ID:

Client steering:

Pref. frequency band:

Probe request ageout time: seconds

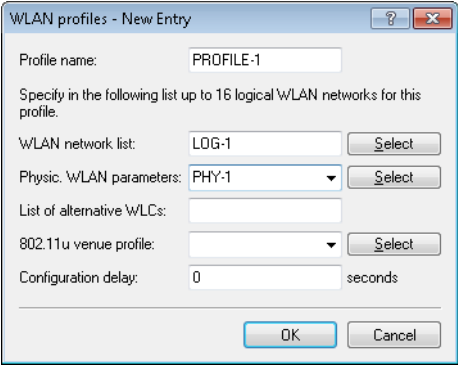
Adaptive RF Optimization:

☐ Enable QoS according to 802.11e (WME)

☐ Indoor only mode activated

☐ Report seen unknown clients

5. Create a new WLAN profile, give it an unique name, and assign the above logical WLAN network and physical WLAN parameters to it.



WLAN profiles - New Entry

Profile name:

Specify in the following list up to 16 logical WLAN networks for this profile.

WLAN network list:

Physic. WLAN parameters:

List of alternative WLCs:

802.11u venue profile:

Configuration delay: seconds

6. Change to the **AP configuration** view, open the **Access point table** and add a new entry by clicking on the **Default** button. Assign the WLAN profile to it as defined above. Leave **AP name** and **Location** empty.

- ! The **MAC address** is set to 'ffffffff' for the default configuration and it cannot be edited. This entry is thus a standard for any AP that is not explicitly listed in this table with its MAC address.

1.3.3 Assigning the default configuration to the new access points

With these settings you have defined all of the necessary values for the WLC to provide the APs with the required WLAN parameters. Upon assignment of the configuration, the APs change their status in the WLC management from "New access point" to "Expected access point", and they are listed in the device display under **Exp. APs**. Once the default configuration has been assigned to all new APs, the New APs LED switches off.

- ! After the initial start-up phase, the option **Automatically accept new APs** can be deactivated again so that no further APs are automatically accepted into the network.

i On the following pages you may configure 'Profile' parameters, which will be simultaneously used for multiple devices. Managed access points may be defined and an optional notification as well as a default parameter set may be configured.

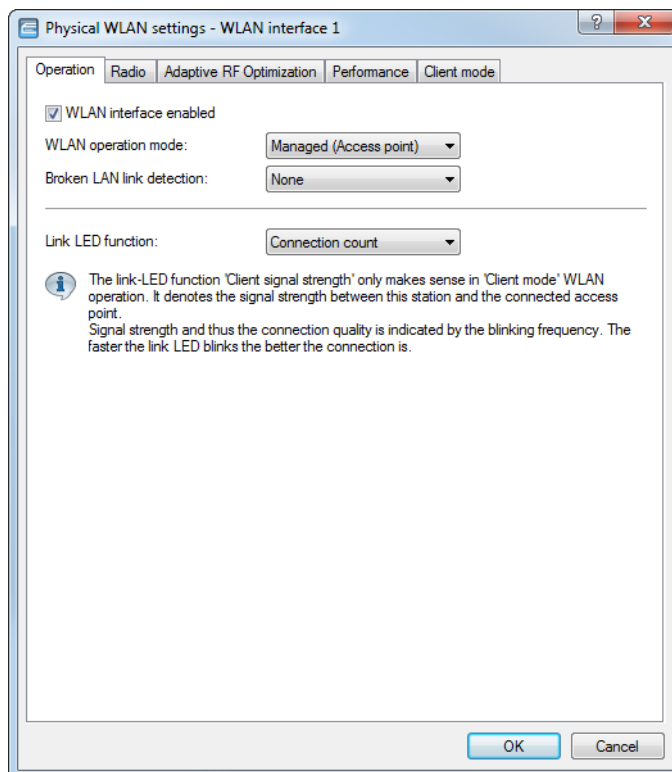
1.3.4 Configuring the access points

R&S®NC access points and R&S®NC wireless routers differ with regard to the ex-factory default settings in the WLAN modules.

- > When shipped, the WLAN modules in APs are set to the 'Managed' operating mode. In this mode, APs search for a central WLC that can provide them with a configuration, and they remain in "search mode" until they discover a suitable WLC or until the operating mode of the WLAN module is changed manually.
- > Ex-factory, the WLAN modules in wireless routers are set to the 'access point' operating mode. In this mode, wireless routers function as standalone APs with a configuration that is stored locally in the device. For integration into a WLAN infrastructure that is centrally managed by WLCs, the operating mode of the WLAN modules in wireless routers has to be switched into the 'managed' mode.

❗ The operating mode can be set separately for every WLAN module. For models with two WLAN modules, one module can work with a local configuration and the second module can be centrally managed with a WLC.

For individual devices, the operating mode of the WLAN modules can be found in LANconfig under **Wireless LAN > General > Physical WLAN settings > Operation mode**:



If you need to change the operating mode for multiple devices, you can use a simple script on the devices with the following lines:

```
# Script
lang English
flash 0
cd Setup/Interfaces/WLAN/Operational
set WLAN-1 0 managed-AP 0
# done
exit
```

1.4 Configuration

Most of the parameters for configuring the WLAN controller correspond with those of the access points. For this reason, this section does not explicitly describe all of the WLAN parameters, but only those aspects necessary for operating the WLAN controller.

1.4.1 General settings

This area is for the basic settings of your WLC.

➤ Automatically accept new APs (auto accept)

Enables the WLC to provide all new APs with a configuration, even those not in possession of a valid certificate.

Enables the WLC to provide a certificate to all new APs **without** a valid certificate. a valid certificate. One of two conditions must be fulfilled for this:

- A configuration for the AP is entered into the AP table under its MAC address.
- The option 'Automatically provide APs with the default configuration' is enabled.

➤ Automatic provision of the default configuration

This enables the WLC to assign a default configuration to every new AP (even those **without** a valid certificate), even if no explicit configuration has been stored for it. In combination with auto-accept, the WLC can accept all managed-mode APs which are found in the WLAN infrastructure managed by it (up to the maximum number of APs that can be managed by one WLC). Any APs accepted by default are also entered into the MAC list.

 This option can also lead to the acceptance of unintended APs into the WLAN infrastructure. For this reason this option should only be activated during the start-up phase when setting up a centrally managed WLAN infrastructure.

Combining the settings for auto-accept and default configuration can cater for a variety of different situations for the setup and operation of APs:

Auto accept	Default configuration	Suitable for
On	On	Rollout phase: Use this combination only if you can be sure that no APs can unintentionally connect with the LAN and thus be accepted into the WLAN infrastructure.
On	Off	Controlled rollout phase: Use this combination if you have entered all of the approved APs into the AP table along with their MAC addresses, assuming that these are to be automatically accepted into the WLAN infrastructure.
Off	Off	Normal operation: No new APs will be accepted into the WLAN infrastructure without the administrator's approval.

1.4.2 Profiles

The profiles area is used to define the logical WLAN networks, physical WLAN parameters, and the WLAN profiles which combine these two elements.

WLAN profiles

The WLAN profiles are collections of the various settings that are to be assigned to the APs. The allocation of WLAN profiles to the APs is set in the AP table.

For each WLAN profile you can specify the following parameters under **WLAN controller > Profiles > WLAN profiles**:

The screenshot shows a dialog box titled "WLAN profiles - New Entry". It contains the following fields and controls:

- Profile name:** A text input field.
- Specify in the following list up to 16 logical WLAN networks for this profile.** (Instructional text)
- WLAN network list:** A text input field followed by a "Select" button.
- Physic. WLAN parameters:** A dropdown menu followed by a "Select" button.
- List of alternative WLCs:** A text input field.
- 802.11u venue profile:** A dropdown menu followed by a "Select" button.
- Configuration delay:** A text input field with the value "0" and a "seconds" label.
- Device LED profile:** A dropdown menu followed by a "Select" button.
- LBS server profile:** A dropdown menu followed by a "Select" button.
- Wireless ePaper profile:** A dropdown menu followed by a "Select" button.
- Wireless IDS profile:** A dropdown menu followed by a "Select" button.
- Time server profile:** A dropdown menu followed by a "Select" button.
- OK** and **Cancel** buttons at the bottom.

Profile name

Name of the profile under which the settings are saved.

Log. WLAN network list

List of the logical WLAN networks that are assigned via this profile.



From this list, APs use only the first 16 entries that are compatible with their own hardware. This means that 16 WLAN networks for purely 2.4-GHz operations and 16 for purely 5-GHz operations can be defined in a profile. Consequently, each AP—be it a model offering 2.4 GHz or 5 GHz support—can choose from a maximum of 16 logical WLAN networks.

Physic. WLAN parameters

A set of physical parameters that the AP WLAN modules are supposed to work with.

IP address of alternative WLCs

A list of WLCs that the APs should attempt to connect with. The AP starts searching for a WLC with a broadcast. Defining alternative WLCs is worthwhile when a broadcast cannot reach all WLCs (e.g. if the WLC is located in another network).

802.11u venue profile

Select the Hotspot 2.0 profile from the list. You create the Hotspot 2.0 profiles in the configuration menu using the button of the same name.

Configuration delay

Here you specify a time delay before an AP managed by the WLAN controller activates the configuration transmitted to it.

A rule of thumb for calculating the delay is (regardless of the topology): One second per managed AP, e.g. 200 seconds for 200 APs.

 The delay does not apply to transmitted scripts.

Device LED profile

The device LED profile selected here applies to the WLAN profile. To manage the devices LED profiles, see **WLAN controller > Profiles > Advanced profiles > Device LED profiles**.

LBS general profile

The general LBS profile selected here applies to the WLAN profile. You select the general LBS profile under **WLAN Controller > Profiles > Advanced profiles** with the button **LBS - General**.

Wireless ePaper profile

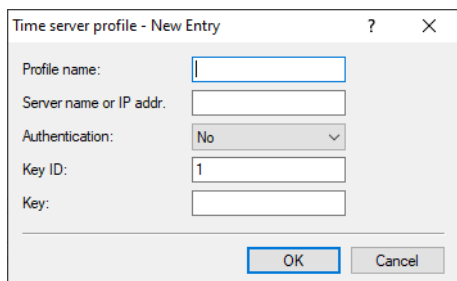
The Wireless ePaper profile selected here applies to the WLAN profile. You manage the Wireless ePaper profiles under **WLAN Controller > Profiles > Advanced profiles** with the button **Wireless ePaper profiles**.

Wireless IDS profile

The Wireless IDS profile selected here applies to the WLAN profile. You manage the Wireless IDS profiles under **WLAN Controller > Profiles > Advanced profiles** with the button **Wireless IDS profiles**.

Time server profile

The Time server profile selected here applies to the WLAN profile. You manage the Time server profiles under **WLAN Controller > Profiles > Advanced profiles** with the button **Time server profiles**.



Time server profile - New Entry

Profile name:

Server name or IP addr:

Authentication:

Key ID:

Key:

Profile name

The name of this NTP profile.

Server name or IP addr.

The server name or IP address of the NTP server.

Authentication

Enables or disables MD5 authentication for the server.

Key ID

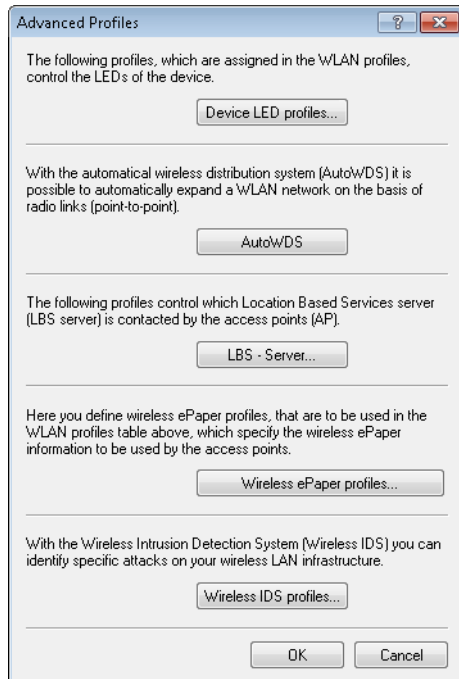
Identifies the key used for MD5 authentication for the server.

Key

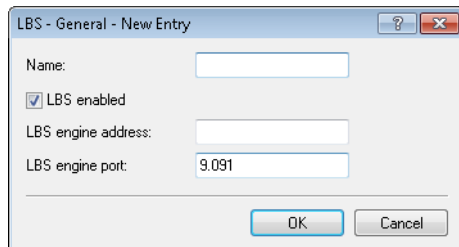
The value of the key for authentication with the NTP server.

General LBS profile and device location profile

In order to conveniently manage the settings for location-based services servers (LBS) and the AP locations by means of a WLC, you create the appropriate profiles for LBS servers via the menu **WLAN Controller > Profiles** and the button **Advanced profiles**.



The button **LBS - Server** opens the dialog for creating a general LBS server profile.



Name

Enter a descriptive name for the profile.

LBS enabled

Enable or disable LBS.

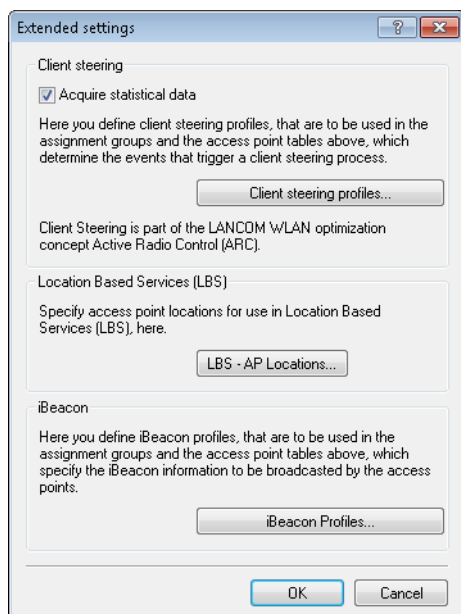
LBS server address

Enter the address of the LBS server.

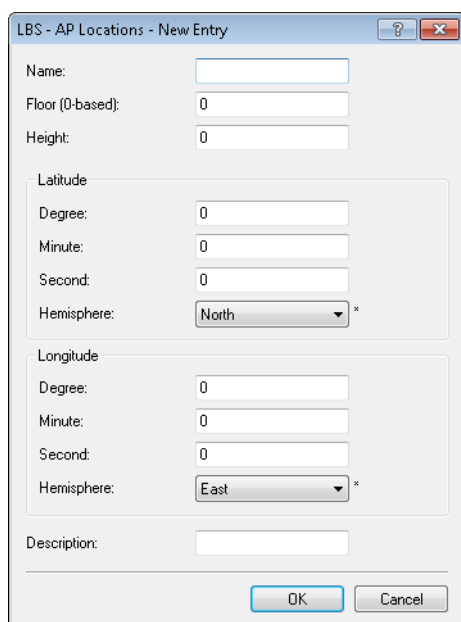
LBS server port

Enter the port used by the LBS server (default: 9091).

You create the corresponding profile for locations of the LBS APs under **WLAN controller > AP configuration** with the button **Extended settings**.



The button **LBS - AP locations** opens the dialog for creating a location profile for the LBS APs.



Name

Enter a descriptive name for the profile.

Floor (0-based)

Here you enter the floor on which the device is located. This allows you to differentiate between the top floor and bottom floor, for example.

Height

Here you enter the height of the device installation. It is possible to specify a negative value so that you can differentiate between a location above and below sea level.

Degrees (latitude)

This field specifies the angle in degrees of the geographic coordinate system.

Minutes (latitude)

This field specifies the minutes of the geographic coordinate system.

Seconds (latitude)

This field specifies the seconds of the geographic coordinate system.

Hemisphere (latitude)

This field specifies the orientation of the geographic coordinate system. The following values are possible for geographical latitude:

- > North: Northerly latitude
- > South: Southerly latitude

Degrees (longitude)

This field specifies the angle in degrees of the geographic coordinate system.

Minutes (longitude)

This field specifies the minutes of the geographic coordinate system.

Seconds (longitude)

This field specifies the seconds of the geographic coordinate system.

Hemisphere (longitude)

This field specifies the orientation of the geographic coordinate system. The following values are possible for geographical longitude:

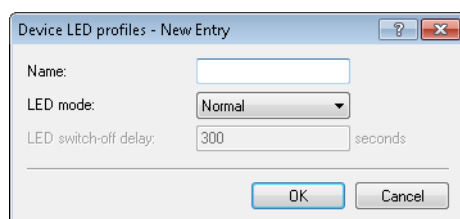
- > East: Easterly longitude
- > West: Westerly longitude

Description

Enter a description of the device.

Device LED profiles

The LEDs on the device are configurable so that you can, for instance, operate an AP while drawing a minimum of attention to it. In order to perform this configuration by WLC, you need to create the corresponding profile under **WLAN Controller > Profiles > Device LED profiles** and assign this to a WLAN profile.



The screenshot shows a dialog box titled "Device LED profiles - New Entry". It has a standard Windows-style title bar with a question mark icon and a close button. Inside the dialog, there are three input fields: "Name:" with an empty text box, "LED mode:" with a dropdown menu showing "Normal", and "LED switch-off delay:" with a text box containing "300" and the unit "seconds" to its right. At the bottom of the dialog, there are two buttons: "OK" and "Cancel".

Name

Give a name to the device LED profile here.

LED mode

The following options are available:

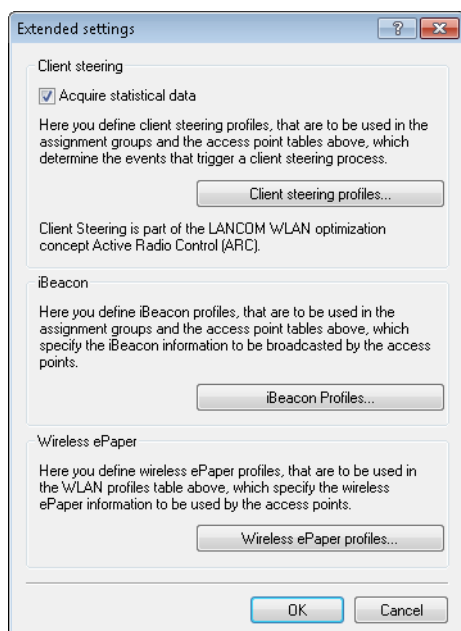
- **Normal:** The LEDs are always enabled, also after rebooting the device.
- **Timed off:** After a reboot, the LEDs are enabled for a certain period of time and are then turned off. This is useful for the LEDs to indicate critical errors during the restart process.
- **All off:** The LEDs are all off. Even after restarting the device, the LEDs remain off.

LED switch-off delay

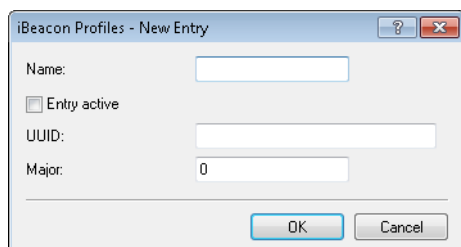
The **Timed off** option uses the setting in the field **LED switch-off delay** in seconds to control the time before the LEDs are disabled after a restart.

ESL- and iBeacon profiles

In order to use a WLC to manage the settings of the Wireless ePaper information and iBeacon information of the individual APs, you create the corresponding profiles for Wireless ePaper and iBeacon via **WLAN-Controller > AP-Configuration** with the button **Extended settings**.



The button **iBeacon profiles** is used to create iBeacon profiles for the assignment groups and the AP table, which specify the iBeacon information to be broadcast by the individual APs.



Name

Name of the profile

Entry active

Activates or deactivates this profile.

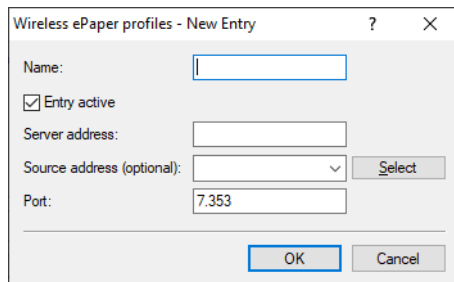
UUID

Unique identification of the transmitter

Major

Specifies the Major value of the iBeacon.

The button **Wireless ePaper profiles** is used to create Wireless ePaper profiles for the WLAN-profiles table, which specify the Wireless ePaper information to be broadcast by the individual APs.



A dialog box titled "Wireless ePaper profiles - New Entry" with a question mark icon and a close button. It contains the following fields and controls:

- Name:** A text input field.
- Entry active:** A checked checkbox.
- Server address:** A text input field.
- Source address (optional):** A dropdown menu with a "Select" button next to it.
- Port:** A text input field containing the value "7.353".
- Buttons:** "OK" and "Cancel" buttons at the bottom.

Name

Name of the profile

Entry active

Activates or deactivates this profile.

Server address

IP address of the Wireless ePaper Server.

Source address (optional)

Enter loopback address here.

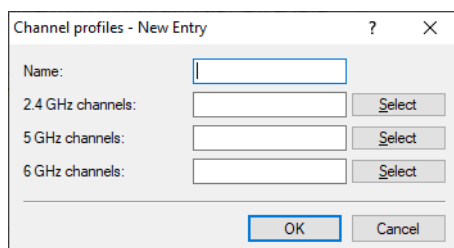
Port

Specifies the port.

Channel Profile Table

You create the configuration of the WLAN channels via **WLAN Controller > Profiles > Advanced Profiles > Channel Profiles**. Within the channel profile, the WLAN channels can be defined for each frequency band. In this way, you can also uniquely define channels whose numbering is repeated in different frequency bands (e.g., at 2.4 GHz and 6 GHz). Then link newly created channel profiles within the physical WLAN profile.

 The DEFAULT profile activates all allowed channels.



A dialog box titled "Channel profiles - New Entry" with a question mark icon and a close button. It contains the following fields and controls:

- Name:** A text input field.
- 2.4 GHz channels:** A text input field with a "Select" button next to it.
- 5 GHz channels:** A text input field with a "Select" button next to it.
- 6 GHz channels:** A text input field with a "Select" button next to it.
- Buttons:** "OK" and "Cancel" buttons at the bottom.

Name

Name of the profile.

2.4 GHz channels

Select the 2.4 GHz channels for this profile.

5 GHz channels

Select the 5 GHz channels for this profile.

6 GHz channels

Select the 6 GHz channels for this profile.

Link Aggregation profiles

LACP according to IEEE 802.1AX allows several Ethernet connections to be bundled in a so-called LAG (Link Aggregation Group) in order to increase the achievable data throughput within the LAG. For this purpose, the outgoing packets on the sending side are distributed to the various individual links within the LAG on the basis of the configured frame distribution policy.

You create the configuration of the link aggregation profiles under **WLAN Controller > Profiles > Advanced Profiles > Link aggregation profiles**.

Name

The name of this LAG (Link Aggregation Group).

Activated

Enables or disables this LAG (Link Aggregation Group).

System priority

The system priority of this LAG (Link Aggregation Group).

Frame distribution policy

Frame distribution policy of this LAG (Link Aggregation Group). Possible options:

Flow-Hash

For outgoing packets, a flow hash is formed over the IP addresses and TCP/UDP ports contained and the packets are distributed to the individual links of the LAG on the basis of this. This achieves a distribution at session level, so that sessions of a single client can also be distributed to multiple links. This setting is recommended for most scenarios.

Source-Dest-MAC

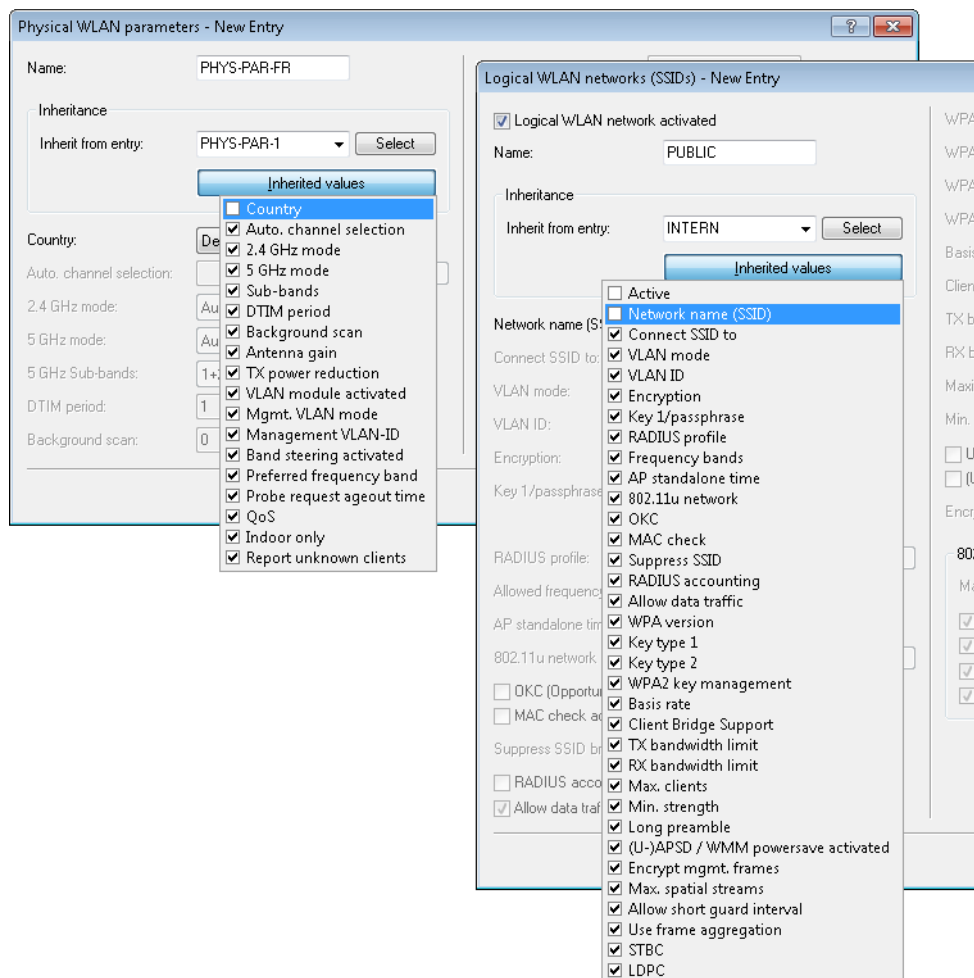
Outgoing packets are distributed to the individual links of the LAG based on the contained pair of source MAC address and destination MAC address.

Inheritance of parameters

A WLC is capable of managing a wide range of different APs at different locations. However, WLAN profiles include settings that are not equally suitable for every type of AP that can be managed. For example, there are differences between the country settings and the device properties.

In order to avoid having to maintain multiple redundant WLAN profiles to cater for countries or device types, it is possible to "inherit" selected properties from the logical WLAN networks and the physical WLAN parameters.

1. You should initially generate the basic settings that are valid for the majority of the managed APs.
2. You can then start to generate entries for the more specific values, e.g. physical settings for a certain country, or a logical WLAN network for public access by mobile clients.



3. Select the entry from which the values are to be inherited and mark the values for inheritance. Parameters inherited in this way are displayed in the configuration dialog in gray and they cannot be edited.
4. Depending on the application, the WLAN settings collected in this way are then grouped into separate profiles, and these are then assigned to their respective access points.

❗ Inheritance fundamentally allows chains over multiple stages (cascading). This means, for example, that country and device-specific parameters can be grouped for convenience.

Recursion is also possible—profile A inherits from profile B, and at the same time B inherits from A. However, the parameters available for inheritance are limited to one "inheritance direction" per parameter.

Logical WLAN networks

Under **WLAN Controller > Profiles > Logical WLAN networks** you set the logical WLAN network parameters that the WLC assigns to the APs. The following parameters can be defined for each logical WLAN network:

Logical WLAN network activated

Enable the logical WLAN network by clicking on this option.

Name

Here, specify a name which uniquely identifies the logical WLAN network.

Inheritance

If you wish to create entries that differ only slightly from existing ones, you can choose a "parent" entry here and select the parameters which are to be applied each time it is used.



A "parent" entry itself can contain inherited entries. Try to ensure that the structure of inherited entries is not too complex, otherwise they may be difficult to understand and configure.

Network name (SSID)

Enter the SSID of the WLAN network here. All stations that belong to this WLAN network must use the same SSID.

SSID connect to

Here you select which of the AP's logical interfaces is to be associated with the SSID, i.e. where the AP sends the data packets for this SSID.

- > "LAN": The AP forwards the data packets locally into the LAN (LAN-1) by default. It must be configured appropriately to do this.
- > "WLC-Tunnel-x": The SSID is connected to a WLC bridge layer-3 tunnel. The AP sends all data packets to this tunnel and thus to the WLC. This tunnel must be configured on the WLC.
- > "L2TP-ETHERNET-x": The SSID is connected to an L2TPv3-Ethernet tunnel. This enables the automatic break-out of WLAN SSIDs through L2TP-Ethernet tunnels. General information about L2TPv3 can be found in the reference manual in section "Layer-2 tunneling protocol (L2TP)". L2TPv3 tunnels are recommended as an alternative to the classic WLC layer-3 tunnel if the latter limits the WLAN throughput. Higher maximum throughputs can be achieved with L2TPv3. Then adjust the usage of the L2TP-ETHERNET-x interface used on the WLC, e.g. for further use on the IP router or LAN bridge.



Both the WLC and the managed access points must support LCOS 10.50 or higher.



Note that although forwarding all data packets to the WLC allows you to define routes and filters centrally, this creates a heavy load on the WLC. This model demands a correspondingly high bandwidth in order to transfer all of the data traffic of this and any other SSIDs that are connected to this WLC via WLC tunnel.

VLAN mode

This item sets the AP VLAN mode for packets belonging to this WLAN network (SSID). VLAN IDs are used if the VLAN module is enabled in the physical WLAN parameters of the AP. Otherwise the AP ignores all VLAN settings in the logical networks. Even with VLAN activated, it is possible to operate the network untagged.

- > "Untagged": The AP does not tag data packets from this SSID with a VLAN ID.



Even with VLAN activated, it is possible to operate a WLAN network untagged. The VLAN ID '1' is reserved internally for this.

- > "Tagged": The AP marks the data packets with the VLAN ID specified as follows.

VLAN-ID

VLAN ID for this logical WLAN network



Please note that to use VLAN IDs in a logical WLAN network, you must set up a management VLAN ID (see physical WLAN parameters).

Encryption

This item sets the encryption method or, in the case of WEP, the key length for packet encryption in this WLAN.

Key 1 / passphrase

You can enter the key or passphrase as an ASCII character string. An option for WEP is to enter a hexadecimal number by adding a leading "0x". The following character string lengths result for the formats used:

- > WPA-PSK: 8 to 63 ASCII characters
- > WEP128 (104 bit): 13 ASCII or 26 hex characters
- > WEP64 (40 bit): 5 ASCII or 10 hex characters

RADIUS profile

Specify which RADIUS profile the AP should receive for this network, so that it can connect directly to the RADIUS server if necessary. Leave this field blank if the WLC is to handle RADIUS requests.

 You configure the RADIUS profiles in the corresponding table.

Allowed frequency bands

Here you set the frequency band used by network participants for transmitting data on the wireless network. You can select the 2.4-GHz band, the 5-GHz band, or both bands. In addition, the 6 GHz band is available.

Indefinite standalone operation

If the standalone operation for the WLC is configured so that the WLAN networks are broadcast indefinitely (value: 9999), this applies to networks with local break-out on the LAN as well as to networks connected via WLC tunnel. If the WLC fails, both types of network will continue to be broadcast: However, this only makes sense for local break-out networks on the LAN, since networks connected via the WLC tunnel have lost their end point (the WLC) and are therefore out of operation.

This option allows the two types of networks to be treated separately.

- > With this option enabled, local break-out networks will indefinitely operate standalone. In contrast, networks that break-out via a WLC tunnel are only broadcast if the WLC can be reached.
- > Without this option enabled, the time specified under **AP standalone time** applies.

AP standalone time

The time in minutes that a managed-mode AP continues to operate in its current configuration.

The configuration is provided to the AP by the WLC and is optionally stored in flash memory (in an area that is not accessible to LANconfig or other tools). Should the connection to the WLC be interrupted, the AP will continue to operate with the configuration stored in flash for the time period entered here. The AP can also continue to work with this flash configuration after a local power outage.

If there is no connection to the WLC after this time period has expired then the flash configuration is deleted and the AP goes out of operation. As soon as the WLC can be reached again, the WLC transmits the configuration to the AP again.

This represents an effective measure against theft as the AP deletes all security-related configuration parameters after this time has expired.

 If the AP establishes a backup connection to a secondary WLC then the countdown to the expiry of standalone operation stops. The AP and its WLAN networks remain active as long as there is a connection to a WLC.

 Please note that the AP only deletes the configuration in flash memory after the time for standalone operation has expired, and not when the power is lost!

Timeframe

Select one of the time frames defined in **WLAN controller > General > Time frame**. This can be used to restrict the broadcast of this SSID to the times defined there. This can be used, for example to activate a WLAN in a school only during class times.

802.11u network profile

Select the Hotspot 2.0 profile from the list.

OKC activated

This option enables the opportunistic key caching. OKC makes it easy for WLAN clients to quickly and conveniently roam between WLAN cells in wireless environments with WPA2-Enterprise encryption.

MAC check activated

The MAC addresses of the clients that are allowed to associate with an AP are stored in the MAC filter list (**Wireless LAN > Stations/LEPS > LEPS-MAC > Station rules**). The **MAC filter enabled** switch allows you to switch off the use of the MAC filter list for individual logical networks.

Suppress SSID broadcast

You can operate your wireless LAN either in public or private mode. A wireless LAN in public mode can be contacted by any mobile station in the area. Your wireless LAN is put into private mode by activating the closed network function. In this operation mode, mobile stations that do not know the network name (SSID) are excluded from taking part in the wireless LAN.

With the closed-network mode activated, WLAN clients that use an empty SSID or the SSID "ANY" are prevented from associating with your network.

The option **Suppress SSID broadcast** provides the following settings:

- > **No:** The AP publishes the SSID of the cell. When a client sends a probe request with an empty or incorrect SSID, the AP responds with the SSID of the radio cell (public WLAN).
- > **Yes:** The AP does not publish the SSID of the cell. When a client sends a probe request with an empty SSID, the AP similarly responds with an empty SSID.
- > **Tightened:** The AP does not publish the SSID of the cell. When a client sends a probe request with a blank or incorrect SSID, the AP does not respond.

 Simply suppressing the SSID broadcast does not provide adequate protection: When legitimate WLAN clients associate with the AP, this transmits the SSID in cleartext so that it is briefly visible to all clients in the WLAN network.

RADIUS accounting activated

Select this option if you want to enable the RADIUS accounting in this logical WLAN network.

Allow traffic between stations of this SSID

Check this option if all stations logged on to this SSID may communicate with one another.

WPA-Version

Here you select which WPA version the AP is to offer to the WLAN clients for encryption.

- > WPA1: WPA2 only
- > WPA2: WPA2 only
- > WPA3: WPA3 only
- > WPA1/2: WPA1 and WPA2 in one SSID (radio cell)
- > WPA2/3: WPA2 and WPA3 in one SSID (radio cell)
- > WPA1/2/3: WPA1, WPA2 and WPA3 in one SSID (radio cell)

WPA1 session key type

If you use "802.11i (WPA)-PSK" for encryption, the method for generating a WPA1 session or group key can be selected here:

- > AES: The AP uses the AES method.
- > TKIP: The AP uses the TKIP method.
- > AES/TKIP: The AP uses the AES method. If the client hardware does not support the AES method, the AP will change to the TKIP method.

WPA2 and WPA3 session key types

The method for generating the session or group key for WPA2 and WPA3 is selected here.

Basis rate

The defined basis rate should allow the slowest clients to connect to the WLAN even under poor reception conditions. A higher value should only be set here if all clients in this logical WLAN can be reached "faster". By setting the transmission rate to auto, the AP collects information about the transmission rates of the various WLAN clients. Clients automatically notify the AP of this rate with each unicast communication. The AP takes the lowest transmission rate from the list of associated clients and applies this to all multicast and broadcast transmissions.

Client bridge support

Enable this option for an AP if you have enabled the client-bridge support for a client station in WLAN client mode.



Client-bridge mode is only available between two R&S@NC devices.

TX bandwidth limit

With this setting, you define the overall bandwidth that is available for transmission within this SSID. A value of 0 disables the limit.

RX bandwidth limit

With this setting, you define the overall bandwidth that is available for reception within this SSID. A value of 0 disables the limit.

Client TX bandwidth limit

Here, you set the transmit-direction bandwidth limit (in kbps) available to each wireless client on this SSID. A value of 0 disables the limit.

Client RX bandwidth limit

Here, you set the receive-direction bandwidth limit (in kbps) available to each wireless client on this SSID. A value of 0 disables the limit.

Client TX bandwidth limit

Here, you set the transmit-direction bandwidth limit (in kbps) available to each wireless client on this SSID. A value of 0 disables the limit.

Client RX bandwidth limit

Here, you set the receive-direction bandwidth limit (in kbps) available to each wireless client on this SSID. A value of 0 disables the limit.

Maximum count of clients

Here you set the maximum number of clients that may associate with this AP. Additional clients wanting to associate will be rejected by the AP.

Min. client signal strength

This value sets the threshold value in percent for the minimum signal strength for clients when logging on. If the client's signal strength is below this value, the AP stops sending probe responses and discards the client's requests.

A client with poor signal strength will not detect the AP and cannot associate with it. This ensures that the client has an optimized list of available APs, as those offering only a weak connection at the client's current position are not listed.

Client disassociation signal strength

If values drop below this threshold, the client is disassociated. This prevents the client from sticking with a WLAN connection that is actually unusable because of the poor signal rather than switching to a better cell phone connection—behavior that is all too common for mobile phones and can be very annoying for the user.

 This threshold only works if the value **Minimum client signal strength** is also set and the **Client disassociation signal strength** is less than this value.

Enable LBS tracking

This option specifies whether the LBS server is permitted to track the client information.

 This option configures the tracking of all clients in an SSID. In the Public Spot module you determine whether the LBS server is allowed to track the users who are logged on to the Public Spot.

LBS tracking list

With this entry, you set the list name for the LBS tracking. When a client successfully associates with this SSID, the AP transfers the specified list name, the MAC address of the client, and its own MAC address to the LBS server.

Use long preamble for 802.11b

Normally, the clients in 802.11b mode negotiate the length of the preamble with the AP. "Long preamble" should only be set when the clients require this setting to be fixed.

(U)APSD / WMM Power Save activated

Enable this option to signal stations that the power saving function (U)APSD ([Unscheduled] Automatic Power Save Delivery) is supported.

(U)APSD is established in the 802.11e standard, and helps VoWLAN devices to increase their battery life. The related devices switch to power saving mode after login on a (U)APSD-capable AP. If the AP receives data packets for the related devices thereafter, it temporarily stores the data and waits until the VoWLAN device is available again. It then forwards the data. Afterwards, (U)APSD increases the latency time of the radio module, whereby it ultimately consumes less power. The individual rest periods may be so short that a VoWLAN device can still use the power saving function in the call state itself. However, the relevant devices must also support (U)APSD.

WMM (Wi-Fi Multimedia) Power Save is a power saving function of the Wi-Fi Alliance and is based on U-APSD. Certain R&S®NC APs are WMM® Power Save CERTIFIED by the Wi-Fi Alliance.

Max. spatial streams

The spatial multiplexing function allows the AP to transmit multiple data streams over separate antennas in order to increase the data throughput. The use of this function is only recommended when the remote device can process the data streams with corresponding antennas.



In the 'Auto' setting, the AP uses all of the spatial streams supported by this WLAN module.

Allow short guard interval

This option is used to reduce the transmission pause between two signals from 0.8 μ s (default) to 0.4 μ s (short guard interval). This increases the effective time available for data transmission and thus the data throughput. However, the wireless LAN system becomes more liable to disruption that can be caused by interference between two consecutive signals.

The short guard interval is activated in automatic mode, provided that the remote station supports this. Alternatively the short guard mode can be switched off.

Use frame aggregation

Frame aggregation is used to combine several data packets (frames) into one large packet and transmit them together. This procedure reduces the overhead of the packets to increase the throughput.

Frame aggregation is not suitable when working with mobile receivers or time-critical data transmissions such as voice over IP.

STBC (space time block coding) activated

Activate the space time block coding here.

STBC is an encoding method according to IEEE 802.11n. The "STBC" (Space Time Block Coding) function varies the transmission of data packets over time in addition to space to minimize temporal effects on the data. The temporal offset of transmissions provides the receiver with an even better chance of receiving error-free data packets, regardless of the number of antennas. This results in improved reception conditions in a MIMO system.

LDPC (low density parity check) activated

Activate the low density parity check here.

Before the sender transmits the data packets, it expands the data stream with checksum bits depending on the modulation rate. These checksum bits allow the receiver to correct transmission errors. By default the 802.11n standard uses 'Convolution Coding' (CC) for error correction, which is well-known from 802.11a and 802.11g; however, the 11n standard also provides for error correction according to the LDPC method (Low Density Parity Check).

In contrast to CC encoding, LDPC encoding uses larger packets to calculate checksums and can also recognize more bit errors. The improved ratio of payload to checksum data enables LDPC encoding to provide a higher data transfer rate.

Physical WLAN parameters

Here the physical WLAN parameters are set for assignment to the access points. For each set of physical WLAN parameters you can specify the following parameters under **WLAN controller > Profiles > Physical WLAN parameters**:

Name

Unique name for this combination of physical WLAN parameters.

Inheritance

Selection of a physical WLAN parameter set defined earlier and from which the settings are to be inherited.

Country

The country in which the access points are to be operated. This information is used to define country-specific settings such as the permitted channels, etc.

Channel profile

Select a channel profile. See [Channel Profile Table](#) on page 24.

 The DEFAULT profile activates all allowed channels of the set country.

DTIM period

If just one mobile client operates power-saving mechanisms, broadcasts and multicasts are no longer transmitted in the radio cell immediately. Instead, they are buffered and sent after the beacon that is transmitted regularly by the access point. The clients are informed about their next relevant beacon so they can synchronize with the broadcasts and multicasts, and this allows them to leave their radio module switched off for most of the time and to activate it only when necessary.

The DTIM period specifies how many beacons are sent before the buffered broadcast and multicasts are transmitted. Higher values allow clients to save more power, but also increase the latency of delivering these packets.

The default value is 1, i.e. buffered broadcasts and multicasts are sent after every beacon.

Management VLAN-ID

The VLAN ID of the management network used to manage the APs.

-
- ⚠ The Management VLAN ID **must** be set to a value not equal to zero in order for VLANs to be used over the WLAN networks. This also applies when the management network itself is not to be tagged with VLAN IDs (Mgmt-VLANID=1).
 - ⚠ VLAN activation only applies to WLAN networks which are connected by means of these physical WLAN parameters.
-

Client steering

This entry sets the method used for client steering and whether the AP should activate band steering. In this case, a dual-port access point can forward a WLAN client to a preferred frequency band.

With client steering, certain criteria are used to help WLAN clients located within transmission range to connect to the best suited AP. These criteria are centrally defined in the WLAN controller. Managed access points constantly report the current values to the WLAN controller, which uses these criteria to decide which access points may respond to requests from WLAN clients. For this reason, client steering is only possible with access points that are centrally managed by a WLAN controller.

Off

Client steering is deactivated.

On

The AP lets the WLC handle the client steering.

Client management

The client steering is handled decentrally by the APs.

AP-based band steering

The AP independently steers the WLAN client to a preferred frequency band.

Report seen unknown clients

By default, the access point only reports associated clients to the WLC. If all other seen clients should be reported, i.e. unassociated clients as well, you can activate this switch. This will increase the traffic on the network. You should therefore activate this switch only temporarily or for test purposes.

-
- ⚡ If you have a large number of unknown clients (e.g., with a Public Spot or in areas with lots of traffic), you should not activate this switch, otherwise you will be flooded by inbound messages.
-

-
- ⓘ All other physical WLAN parameters correspond to those for the standard configuration of APs.
-

- ⚠ To successfully acquire a profile, HTTP access to the WLC from the local network must be allowed.

1.4.3 Access point configuration

IP parameter profiles

This table is used to configure specific network profiles that are assigned with APs that must not be automatically configured by the WLC by means of DHCP. In this way you set which specific IP parameters are used by an AP.

Name

Name of the IP parameter profiles.

Inheritance

Selection of an IP parameter profile defined earlier and from which the settings are to be inherited (see [Inheritance of parameters](#) on page 26).

Domain name

Name of the domain (DNS suffix) which is to use this profile.

Netmask

Netmask of the profile

Default gateway

The gateway used by the profile as standard.

DNS default

The DNS (Domain Name System) to be used by the profile.

DNS backup

Second, alternative DNS if the first is unavailable.

Start address

The start of the IPv4 address range from which a new AP receives an IP address if the WLC can allocate an assignment group to the AP and you have not defined a specific IP address for the AP in the AP table.

End address

The end of the IPv4 address range from which a new AP receives an IP address if the WLC can allocate an assignment group to the AP and you have not defined a specific IP address for the AP in the AP table.

For further information on assignment groups, please refer to the section [IP-dependent auto configuration and tagging of APs](#) on page 74.

List of access points

The access point table is a central element of the configuration for WLCs. Here, the WLC assigns WLAN profiles (i.e. the combinations of logical and physical WLAN parameters) to the access points via their MAC addresses. Furthermore, the mere existence of an entry in the access-point table for a particular access point affects its ability to establish a connection to a WLC. Under **WLAN Controller > AP Configuration > Access point table** you can define the following parameters for each access point:

Active

Activates or deactivates this entry.

Update management active

Activating update management for this access point enables it to download the latest firmware and script versions automatically. All other settings are adjusted under access point update ([Central firmware and script management](#)).

MAC address

MAC address of the access point

AP name

Name of the access point in managed mode.

Location

Location of the access point in managed mode.

Comment

Enter a comment for this entry.

Groups

Assigns the access point to one or more groups

WLAN profile

WLAN profile from the list of defined profiles.

Client steering profile

Client-steering profiles control how the WLC decides which access points are to accept a client at the next login attempt.

LBS AP location profile

LBS location profile from the list of defined profiles.

Control channel encryption

Encryption for the communication over the control channel. Without encryption, access points and WLC exchange their control data in cleartext. In both cases authentication is by certificate.

Antenna grouping

Antenna grouping can be configured in order to optimize the gain from spacial multiplexing.

IP address

Here you specify a fixed IP address of the access point.

IP parameter profile

Here you specify the profile name used by the WLC to reference the IP settings for the access point. If you retain the default setting DHCP, the WLC ignores the setting for the fixed IP address and the access point is forced to obtain its IP address via DHCP.

Channel (Wireless ePaper interface)

Here you specify how the channel is selected for the Wireless ePaper interface.

iBeacon profile (iBeacon interface)

Select an iBeacon profile from the list of profiles created.



You create iBeacon profiles under **WLAN Controller > AP configuration > Extended settings > iBeacon profiles.**

Minor

Set a minor ID for the iBeacon module.

2402 MHz, 2426 MHz, 2480 MHz

Specify here which channels the iBeacon module uses to transmit.

Transmission power

Specify the power used by the iBeacon module to transmit. The following values are possible:

- > **High**: The module sends with maximum power (default).
- > **Medium**: The module sends with medium power.
- > **Low**: The module sends with minimum power.

Mode WLAN ifc.1 1

This setting allows you to configure the frequency band in which the access point operates the 1st physical WLAN interface. When set to **Default**, the access point independently selects the frequency band for the physical WLAN interface. The access point prefers the 2.4 GHz band, if available.

Mode WLAN ifc.1 2

This setting allows you to configure the frequency band in which the access point operates the 2nd physical WLAN interface. When set to **Default**, the access point independently selects the frequency band for the physical WLAN interface. The access point prefers the 5 GHz band, if available.



If a managed access point only has one physical WLAN interface, the access point ignores the settings for the 2nd physical WLAN interface.

Auto Channel selection

Access points automatically carry out channel selection for the frequency band available in the country of operation, assuming that no entry is made here.

Enter the channels to be available for automatic selection by the first WLAN module. If you enter just one channel here, the access point uses this channel only and no automatic selection takes place. For this reason you should ensure that the channels entered here are legal for use in the defined country of operation. The access point ignores channels that are invalid for the frequency band.

Max. channel bandwidth

Enter how and to what extent the access point specifies the channel bandwidth for the physical WLAN interface(s). The following values are possible:

- > **Automatic**: The access point automatically detects the maximum channel bandwidth (default).
- > **20 MHz**: The access point uses channels bundled at 20 MHz.
- > **40 MHz**: The access point uses channels bundled at 40 MHz.
- > **80 MHz**: The access point uses channels bundled at 80 MHz.
- > **80+80 MHz**: The access point uses two channels bundled at 80 MHz.
- > **160 MHz**: The access point uses channels bundled at 160 MHz.
- > **320 MHz** (Only WLAN interface 3): The access point uses channels bundled at 320 MHz.

By default, the physical WLAN interface automatically determines the frequency range used to modulate the data onto the carrier signals. 802.11a/b/g use 48 carrier signals in one 20-MHz channel. The use of double the frequency range of 40 MHz means that 96 carrier signals can be used, resulting in a doubling of the data throughput.

802.11n can use 52 carrier signals in a 20-MHz channel for modulation, and even up to 108 carrier signals in a 40-MHz channel. The use of the 40 MHz option for 802.11n therefore means a performance gain of more than double.

Antenna gain mode

Until now, access points commissioned with a WLAN controller have been set up with an antenna gain of 3 dBi per module, as this is the most suitable value for most indoor access points equipped with standard antennas. In particular for outdoor access points with integrated high-gain antennas, this value had to be adjusted manually. As of LCOS 10.30 the standard antenna gain of a managed access point is transmitted to the WLAN controller and used there automatically. This feature only works if both the access point and the WLAN controller have at least the firmware version 10.30. This setting for the antenna gain mode prevents you from having to manually correct some of the access points after a rollout.

Possible values:

Standard

The antenna gain value preset in the access point is used.

Userdefined

The value entered in the field **Antenna gain** is used.

Antenna gain

This item allows you to specify the antenna gain factor (in dBi) minus attenuation of the cable and (if applicable) lightning protection. Based on this, as well as depending on the country where the system is operated and the frequency band, the access point calculates the maximum permitted transmission power.

If you leave the field blank, the access point uses the default setting from the configuration group in the relevant WLAN profile.

You can reduce the transmission power to a minimum of 0.5 dBm in the 2.4-GHz band or 6.5 dBm in the 5-GHz band. This limits the maximum value that can be added to 17.5 dBi in the 2.4-GHz band and 11.5 dBi in the 5-GHz band.

 Be sure that your combination of antenna, cable and lightning-protection complies with the legal requirements of the country where the system is operated.

The receiver's sensitivity is unaffected by this.

 The current transmission power is displayed by WEBconfig or telnet under **Status > WLAN-statistics > WLAN-parameters > Transmission-power** or with LANmonitor under **System information > WLAN card > Transmission power**.

TX power reduction

If you use an antenna with a high amplification factor, you can use this entry to attenuate the transmission power of your access point to the level permitted on the frequency band in the country of operation.

If you leave the field blank, the access point uses the default setting from the configuration group in the relevant WLAN profile.

The same values and constraints apply as for the field **Antenna gain**.

Stations

The station rules define which WLAN clients can associate with the WLAN networks of the APs that are centrally managed by the WLC. Furthermore, the method offers a convenient way to give each WLAN client an individual authentication passphrase and a VLAN ID.

To use the station rules, it is imperative that the RADIUS server is activated in the WLC under **WLAN Controller > Stations/LEPS > LEPS-MAC > Station rules**. As an alternative, requests can be forwarded to another RADIUS server. More information on RADIUS is available under [RADIUS](#).

For every logical WLAN in which WLAN clients are authenticated by RADIUS, the MAC check has to be activated.

MAC address

MAC address of the WLAN client for this entry. The following entries are possible:

Individual MAC address

A MAC address in the format 00a057112233, 00-a0-57-11-22-33 or 00:a0:57:11:22:33.

Wildcards

The wildcards '*' and '?' uses to specify MAC address ranges, e.g. 00a057*, 00-a0-57-11-??-?? or 00:a0:?:11:.*.

Vendor ID

The device contains a list of the major manufacturer OUIs (organizationally unique identifier). The MAC address range is valid if this entry matches the first three bytes of the MAC address of the WLAN client.



It is possible to use wildcards.

SSID pattern

WLAN clients with the corresponding MAC addresses have access that is limited to this SSID.



The use of wildcards makes it possible to allow access to multiple SSIDs.

Name

You can enter any name you wish and a comment for any WLAN client. This enables you to assign MAC addresses more easily to specific stations or users.

Passphrase

Here you may enter a separate passphrase for each physical address (MAC address) that is used in a 802.11i/WPA/AES-PSK-secured network. If no separate passphrase is

specified for this MAC address, the passphrases stored in the **802.11i/WEP** area will be used for each logical wireless LAN network.

TX bandwidth limit

Transmission-bandwidth restriction for WLAN clients currently authenticating themselves. A WLAN device in client mode communicates its setting to the AP when logging on. This then uses these two values to set the minimum bandwidth.

RX bandwidth limit

Reception-bandwidth restriction for WLAN clients currently authenticating themselves. A WLAN device in client mode communicates its setting to the AP when logging on. This then uses these two values to set the minimum bandwidth.

❗ The RX bandwidth restriction is only active for WLAN devices in client mode. For value is not used by normal WLAN clients.

Comment

You can enter a comment here.

VLAN-ID

The ID of the VLAN that this client belongs to. Consequently the client can only be reached by packets originating from the same VLAN. Packets sent by the client are marked with this VLAN ID. You only need to set this value if you want this client to belong to a different VLAN than the logical WLAN (SSID) that it is connected to. Valid VLAN IDs are in the range 0 to 4094. 0 means that the client belongs to the VLAN of its logical WLAN (SSID), if this belongs to a VLAN at all.

❗ If you use IPv6, or if multicast is operating on a VLAN, different group keys must be assigned to the different VLANs of an SSID. Otherwise the different multicasts are not be assigned to the correct clients. When using IPv6, for example, clients are informed of IPv6 prefixes that do not function on the VLAN ID. The group keys are configured under **Wireless LAN > Encryption > VLAN group key mapping**.

If filter rules contradict, the individual rule has a higher priority: A rule without wildcards in the MAC address or SSID takes precedence over a rule with wildcards. When creating these entries, the user should ensure that filter rules do not contradict. The definitions in the filters can be checked in a Telnet session with the trace command `trace WLAN-ACL`.

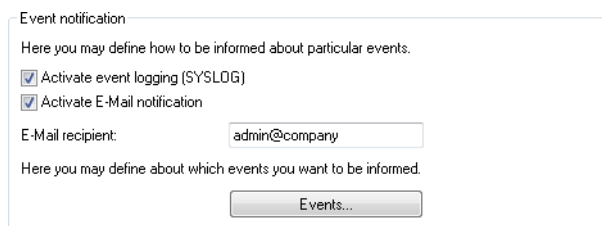
❗ The filter criteria in the station list either allow or deny WLAN clients to access your wireless network. The entries **Name**, **Bandwidth limit**, **VLAN ID** and **Passphrase** are meaningless if the device uses valid filter criteria to deny access to the WLAN.

Options for the WLAN controller

The **Options** area in the WLC configuration is used to define notifications in case of events and to set various default values.

Event notification

Notifications can be sent via SYSLOG or e-mail. You can define the following parameters:



Event notification

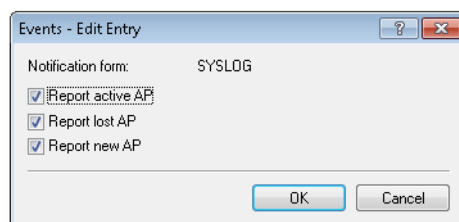
Here you may define how to be informed about particular events.

☒ Activate event logging (SYSLOG)

☒ Activate E-Mail notification

E-Mail recipient:

Here you may define about which events you want to be informed.



Events - Edit Entry

Notification form: SYSLOG

☒ Report active AP

☒ Report lost AP

☒ Report new AP

LANconfig: **WLAN Controller > Options**

Activate event logging (SYSLOG)

Activates notification by SYSLOG.

Activate e-mail notification

Activates notification by e-mail.

Events

Selects the events that trigger notification. Possible values:

- > Report active AP
- > Report lost AP
- > Report new AP

1 WLAN management

Default parameters

For some parameters, default values can be defined centrally and these serve as reference default values for other parts of the configuration.

Here you define the logical WLAN networks for activation and operation via the associated access points (APs).

Logical WLAN networks (SSIDs)...

Here you define the physical WLAN parameters which apply to all of the logical WLAN networks that share a managed access point.

Physical WLAN parameters...

The following setting can be referenced in table entries by value 'Default'.

Default country:

Europe

Europe
Finland
France
Germany
Ghana
Greece
Guatemala
Honduras
Hong Kong
Hungary
Iceland
India
Indonesia
Ireland
Israel
Italy
Japan
Jordan
Kuwait
Latvia
Lebanon
Liechtenstein
Lithuania
Luxembourg
Macau
Macedonia
Malaysia
Malta
Mexico

Here you define entire WLAN profile: France on the managed APs. This includes physical WLAN parameters.

By default, the WLAN controller will communication between AP and RA the WLAN networks list.

With the automatic wireless distribution WLAN network on the basis of radio

settings which can be used

To enable direct

able to automatically expand a

LANconfig: **WLAN Controller > Profiles > Default country**

> Default country

The country in which the access points are to be operated. This information is used to define country-specific settings such as the permitted channels, etc.

> Possible values:

> Selection from the list of available countries

> Default:

> Europe

Default values

The following parameters are default settings which can be referenced in access point table entries by value 'Default'.

Mode WLAN ifc.1: 2.4 GHz

Mode WLAN ifc.2: 5 GHz

Control channel encryption: DTLS

LANconfig: **WLAN controller > AP configuration >**

WEBconfig: **LCOS menu tree > Setup > WLAN-Management > AP-Configuration**

> WLAN-Interface 1

Frequency of the first WLAN module. This parameter can also be used to deactivate the WLAN module.

> WLAN-Interface 2

Frequency of the second WLAN module. This parameter can also be used to deactivate the WLAN module.

> Encryption

Encryption for the communication over the control channel. Without encryption the control data is exchanged as cleartext. In both cases authentication is by certificate.

Virtualization and guest access via WLAN controller with VLAN

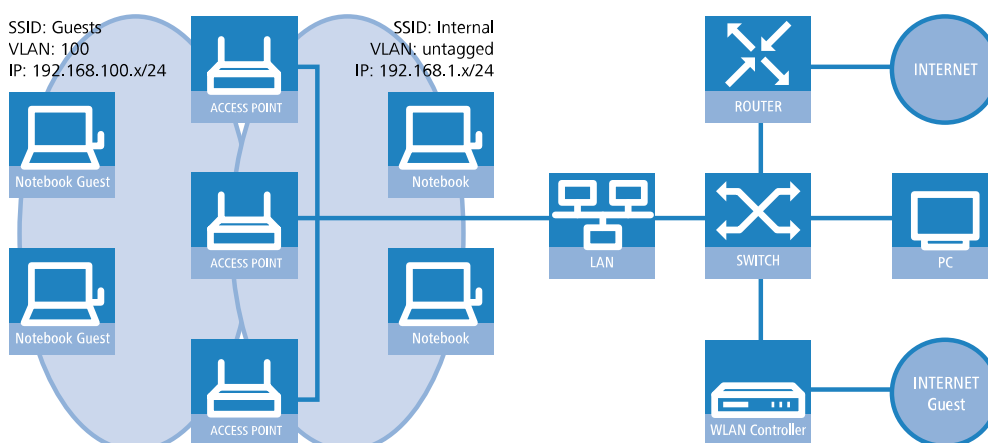
Many companies wish to offer Internet access to their visitors via WLAN. In larger installations the required settings apply to multiple access points, and these can be programmed centrally in the WLAN controller.

Targets

- > Wireless LAN infrastructure available to internal employees and guests
- > Shared physical components (cables, switches, access points)
- > Separation of networks with VLAN and ARF
- > Break-out of data streams to certain target networks:
 - > Guests: Internet only
 - > Internal employees: Internet, all local devices and services
- > Guests login to the WLAN with a Web form.
- > Internal employees use WLAN encryption for authentication.

Establish

- > Management of the access points is handled by the WLC.
- > The WLC serves as the DHCP server for the WLAN clients in the guest network.
- > The guest network is provided with Internet access via the WLC (e.g. separate DSL access or Internet access via the company DMZ).
- > The wired infrastructure is based on managed VLAN-capable switches:
 - > Access point VLAN management is handled by the WLC.
 - > The VLAN management of the switches is handled separately by the switch configuration.
- > The access points operate within the internal VLANs.



Wireless LAN configuration of the WLAN controllers

During the configuration of the WLAN, the necessary WLAN networks are defined and, along with the physical WLAN settings, are assigned to the access points managed by the controller.

1. Create a logical WLAN for guests and one for the internal employees:
 - The WLAN with the SSID `GUESTS` uses the VLAN ID `100` (VLAN operating mode **Tagged**) and uses **no** encryption.
 - The WLAN with the SSID `INTERNAL` receives no VLAN ID (VLAN operating mode **untagged**, i.e. packets are transferred in the Ethernet without a VLAN tag) and uses WPA encryption, e.g. **802 11i (WPA)-PSK**.

> LANconfig: **WLAN Controller > Profiles > Logical WLAN networks (SSIDs)**

Logical WLAN networks (SSIDs) - New Entry

☒ Logical WLAN network activated

Name: GUEST

Inheritance

Inherit from entry:

Inherited values

Network name (SSID): GUEST

Connect SSID to: LAN at AP

VLAN mode: Tagged

VLAN ID: 2

Encryption: None

Key 1/passphrase: ☐ Show

RADIUS profile: DEFAULT

Allowed frequency bands: 2.4/5 GHz

AP standalone time: 0 minutes

802.11u network profile:

☐ OKC (Opportunistic Key Caching) activated

☐ MAC check activated

Suppress SSID broadcast: No

☐ RADIUS accounting activated

☐ Allow data traffic between stations of this SSID

WPA version: WPA1/2

WPA1 session key type: TKIP

WPA2 session key type: AES

WPA2 key management: Standard

Basis rate: 2 Mbit/s

Client Bridge Support: No

TX bandwidth limit: 0 kbit/s

RX bandwidth limit: 0 kbit/s

Maximum count of clients: 0

Min. client signal strength: 0 %

☐ Enable LBS tracking

LBS tracking list:

Convert to unicast: DHCP

☐ Use long preamble for 802.11b

☒ (U)APSD / WMM powersave activated

Encrypt mgmt. frames: No

802.11n

Max. spatial streams: Auto

☒ Allow short guard interval

☐ Use frame aggregation

☒ STBC (Space Time Block Coding) activated

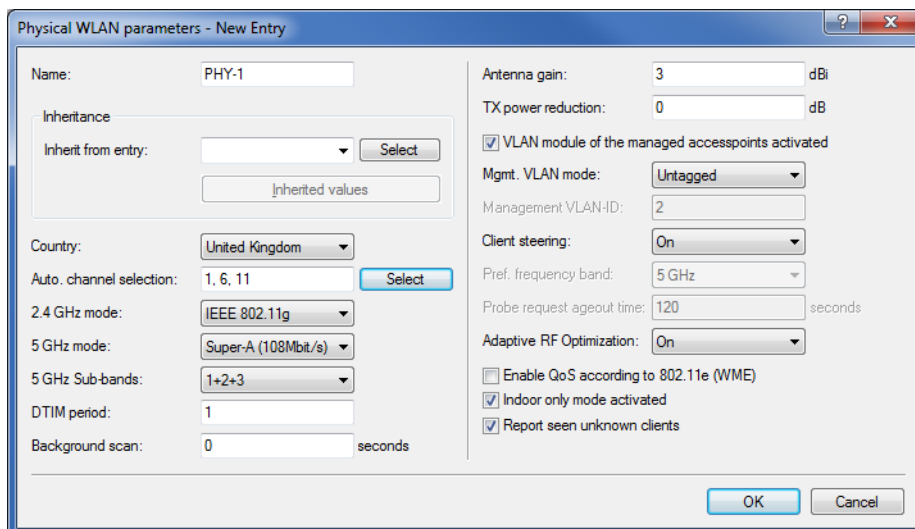
☒ LDPC (Low Density Parity Check) activated

1 WLAN management

! If you set the **VLAN mode** to **untagged**, LANconfig will gray-out the **VLAN ID** input field in the add/edit dialog shown above. However, the corresponding table **Logical WLAN networks (SSIDs)** still displays the assigned VLAN as a value in the grayed-out box. This entry is only of internal significance, as the acceptable range is between 2 and 4094. Ultimately it is the VLAN operating mode which is decisive: If this is set to **untagged**, then a VLAN ID is not transmitted under any circumstances.

2. Create a set of physical parameters for the access points.
The management VLAN ID is set to 1, which serves to activate the VLAN function (but without a separate management VLAN for the device; the management data traffic is transmitted untagged).

> LANconfig: **WLAN-Controller** > **Profiles** > **Physical WLAN parameters**



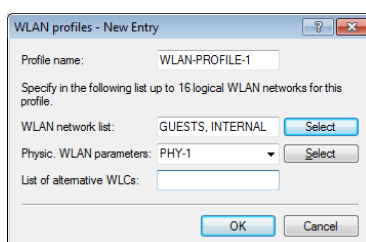
The dialog box 'Physical WLAN parameters - New Entry' contains the following fields and options:

- Name:** PHY-1
- Inheritance:**
 - Inherit from entry: [dropdown] [Select]
 - Inherited values: [button]
- Country:** United Kingdom
- Auto. channel selection:** 1, 6, 11 [Select]
- 2.4 GHz mode:** IEEE 802.11g
- 5 GHz mode:** Super-A (108Mbit/s)
- 5 GHz Sub-bands:** 1+2+3
- DTIM period:** 1
- Background scan:** 0 seconds
- Antenna gain:** 3 dBi
- TX power reduction:** 0 dB
- ☒ **VLAN module of the managed accesspoints activated**
- Mgmt. VLAN mode:** Untagged
- Management VLAN-ID:** 2
- Client steering:** On
- Pref. frequency band:** 5 GHz
- Probe request ageout time:** 120 seconds
- Adaptive RF Optimization:** On
- ☐ **Enable QoS according to 802.11e (WME)**
- ☒ **Indoor only mode activated**
- ☒ **Report seen unknown clients**

Buttons: OK, Cancel

3. Create a WLAN profile that you can assign to the access points.
The two logical WLAN networks and the set of physical parameters defined earlier are collected into this WLAN profile.

> LANconfig: **WLAN-Controller** > **Profiles** > **WLAN-Profiles**



The dialog box 'WLAN profiles - New Entry' contains the following fields and options:

- Profile name:** WLAN-PROFILE-1
- Specify in the following list up to 16 logical WLAN networks for this profile.**
- WLAN network list:** GUESTS, INTERNAL [Select]
- Physic. WLAN parameters:** PHY-1 [Select]
- List of alternative WLCs:** [text field]

Buttons: OK, Cancel

4. Assign this WLAN profile to the access points managed by the controller.
Do this by entering each access point with its MAC address into the access point table.
Alternatively you can use the **Default** button to create a default profile, which applies to all access points.

> LANconfig: **WLAN controller** > **AP configuration** > **Access point table**

Configuring the switch (R&S@LANCOM GS-2326P)

In this section we describe the configuration of the switch using the R&S@LANCOM GS-2326P as an example.

- 1. Under **Configuration** > **VLAN** > **VLAN-Membership**, create an additional VLAN group for the guest network.

To differentiate between the VLANs in the switch, two groups are used. The internal network for the employees is mapped to the group `default`, and that for the guests is mapped to the group `guests`.

- > The VLAN group for the internal employees uses the default VLAN ID 1. This VLAN ID used for internal administration applies on all ports and is operated untagged, i.e. all untagged incoming data packets are given the VLAN ID 1 for internal routing, and this is removed again from outgoing data packets (see also "PVID" in the next step).
- > The VLAN group for the guests uses the VLAN ID 100, which you entered earlier when configuring the WLAN in the controller. This ID applies only to the ports which the WLAN controller and the access points are connected to (in this example: Port 10 to 16, green checkmarks for **Port members**). The switch does not remove tags from outgoing data packets. i.e. all tagged incoming packets with VLAN ID 100 retain this tag and are routed only to the ports that are members of the corresponding group.

2. Under **Configuration > VLAN > Ports** set the **Port Type** for all ports to **C-port**. See the documentation about your switch for details about this setting.
3. Configure the **Egress rule** for each port.
 - All ports except port 10 to 16 are given the **Access** rule. As a result, these ports forward only tagged packets and all others are dropped.
 - The ports 10 to 16 are given the rule **Hybrid**. As a result, these ports forward both untagged and tagged packets.

Ethertype for Custom S-ports 0x 88A8

VLAN Port Configuration

Port	Port Type	Ingress Filtering	Frame Type	Egress Rule	PVID
*	<>	☐	<>	<>	
1	C-port	☐	All	Access	1
2	C-port	☐	All	Access	1
3	C-port	☐	All	Access	1
4	C-port	☐	All	Access	1
5	C-port	☐	All	Access	1
6	C-port	☐	All	Access	1
7	C-port	☐	All	Access	1
8	C-port	☐	All	Access	1
9	C-port	☐	All	Access	1
10	C-port	☐	All	Hybrid	1
11	C-port	☐	All	Hybrid	1
12	C-port	☐	All	Hybrid	1
13	C-port	☐	All	Hybrid	1
14	C-port	☐	All	Hybrid	1
15	C-port	☐	All	Hybrid	1
16	C-port	☐	All	Hybrid	1
17	C-port	☐	All	Access	1
18	C-port	☐	All	Access	1
19	C-port	☐	All	Access	1
20	C-port	☐	All	Access	1
21	C-port	☐	All	Access	1
22	C-port	☐	All	Access	1
23	C-port	☐	All	Access	1
24	C-port	☐	All	Access	1
25	C-port	☐	All	Access	1
26	C-port	☐	All	Access	1

Apply Reset

⚠ Ensure that the **PVID** (port VLAN ID) for each port is set to a value of 1. The PVID is the VLAN ID that a port assigns to incoming data packets which do not already have a VLAN tag; Therefore, the PVID corresponds to the VLAN ID of the `default` group.

4. OPTIONAL: If you wish to allow access to the guest network via Ethernet, go to **Configuration > VLAN > Ports** and, for example, set the **PVID** to 100 for ports 17 to 20 and, under **Configuration > VLAN > VLAN-Membership**, assign these ports to the group `Guests`. All untagged incoming data packets arriving at these ports are given VLAN ID 100.

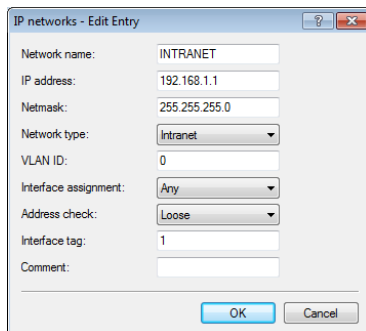
⚠ Note that these data packets can only leave the switch via the ports of the guest network.

Configuring the IP networks in the WLAN controller

To separate the data streams on layer 3, two different IP networks are employed (ARF – Advanced Routing and Forwarding).

1. For the internal network, set the **INTRANET** to the address 192.168.1.1.
This IP network uses the **VLAN ID** 0. This assigns all untagged data packets to this network (the VLAN module in the controller itself must be activated for this). The **interface tag** 1 is used for the subsequent break-out of data in the virtual router.

1 WLAN management

> LANconfig: **TCP/IP** > **General** > **IP networks**


IP networks - Edit Entry

Network name: INTRANET

IP address: 192.168.1.1

Netmask: 255.255.255.0

Network type: Intranet

VLAN ID: 0

Interface assignment: Any

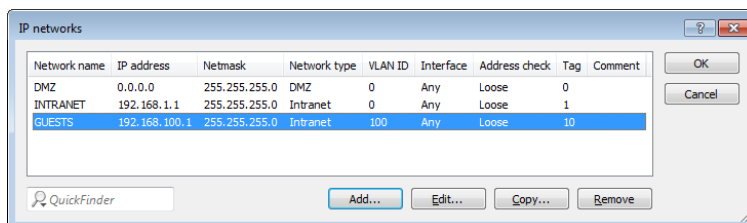
Address check: Loose

Interface tag: 1

Comment:

OK Cancel

2. For guests, create a new IP network with the address 192.168.100.1. This network uses the **VLAN ID** 100. In this way, all data packets with this ID are assigned to the guest network. Here, too, the **interface tag** 10 is used later by the virtual router.

> LANconfig: **TCP/IP** > **General** > **IP networks**


IP networks

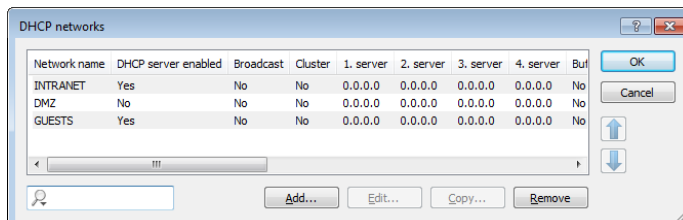
Network name	IP address	Netmask	Network type	VLAN ID	Interface	Address check	Tag	Comment
DMZ	0.0.0.0	255.255.255.0	DMZ	0	Any	Loose	0	
INTRANET	192.168.1.1	255.255.255.0	Intranet	0	Any	Loose	1	
GUESTS	192.168.100.1	255.255.255.0	Intranet	100	Any	Loose	10	

QuickFinder

Add... Edit... Copy... Remove

OK Cancel

3. Enable the DHCP server for both IP networks.

> LANconfig: **TCP/IP** > **General** > **IP networks**


DHCP networks

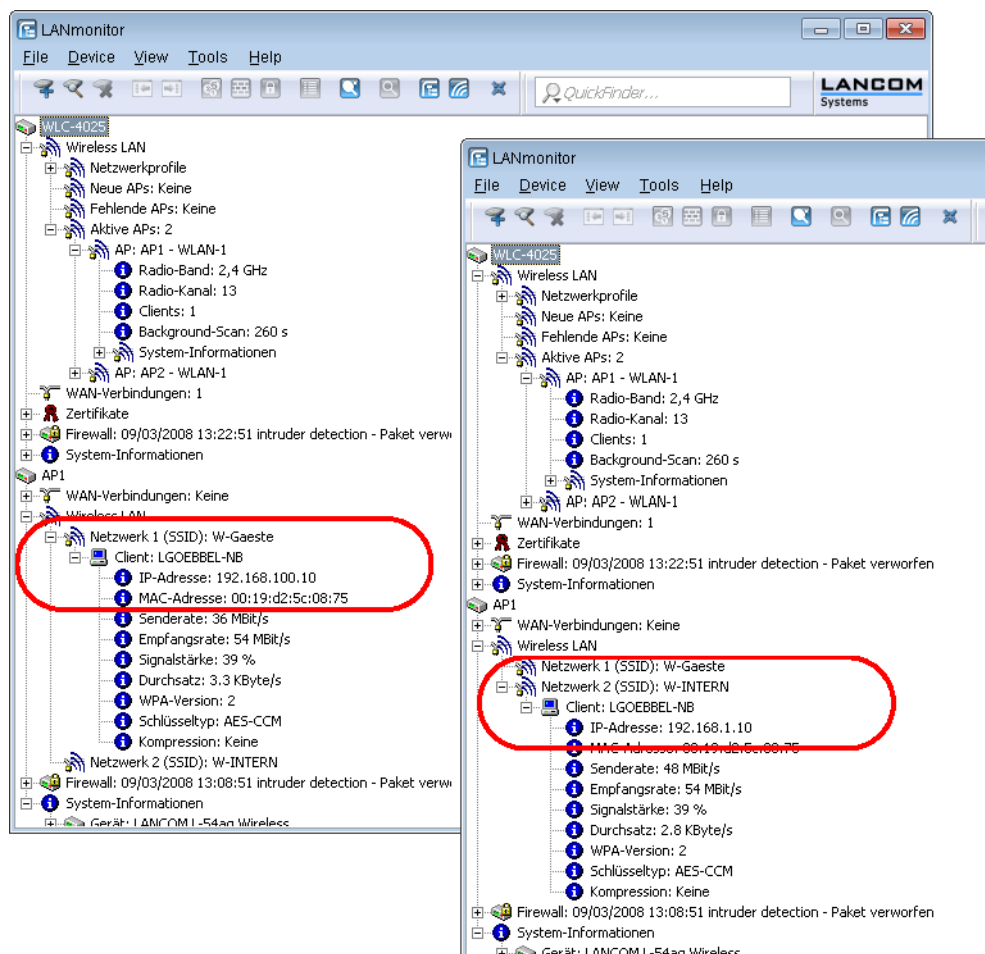
Network name	DHCP server enabled	Broadcast	Cluster	1. server	2. server	3. server	4. server	Buf
INTRANET	Yes	No	No	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	No
DMZ	No	No	No	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	No
GUESTS	Yes	No	No	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	No

QuickFinder

Add... Edit... Copy... Remove

OK Cancel

With these settings, the WLAN clients of the internal employees and guests are assigned to the appropriate networks.

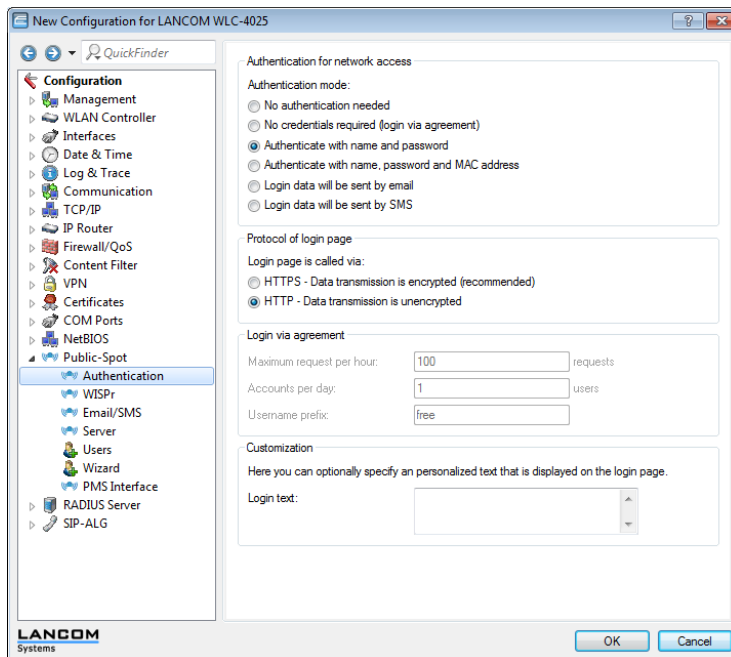


Configuring Public Spot access accounts

The Public Spot allows you to provide a strictly controlled point of access to your wireless LAN. Authentication is performed by requesting user information via a web interface. If necessary, you can set a time limit for the access.

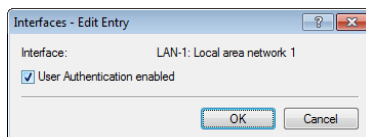
1. You should activate authentication for network access by name and password.

➤ LANconfig: **Public Spot > Authentication > Authentication for network access**



2. Activate user authentication for the controller's interface that is connected to the switch.

➤ LANconfig: **Public Spot > Server > Operation settings > Interfaces**

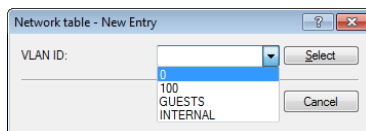


3. Restrict access to the Public Spot.

You restrict use of the Public Spot to data packets from this virtual LAN by entering the VLAN ID of "100" for the guest network into VLAN table. Other data packets from other VLANs will be forwarded to the Public Spot without a login.

⚠ If the interface is not restricted to the VLAN ID, the controller will no longer be reachable at the specified physical Ethernet port!

➤ LANconfig: **Public Spot > Server > VLAN table**



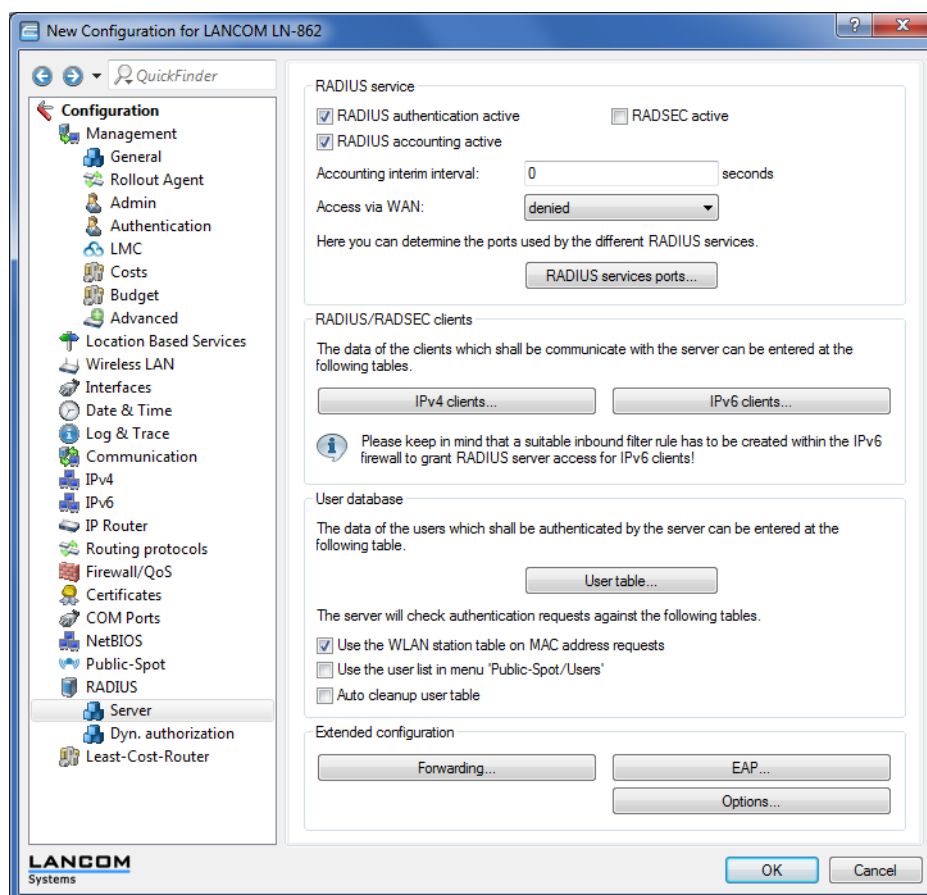
4. Enable the option to clean up the user table so that your device automatically deletes entries that are no longer needed.

➤ LANconfig: **RADIUS > Server > User table > Auto cleanup user table**

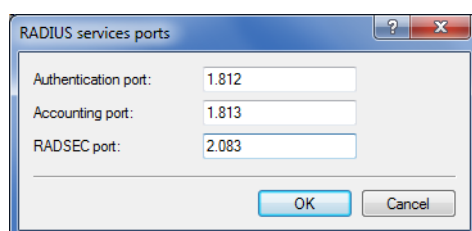
Configuring the internal RADIUS server for Public Spot operation

The Wizard stores the Public Spot access accounts in the user database of the internal RADIUS server. In order to use these Public Spot access accounts, the internal RADIUS server has been preconfigured with default values. You can inspect this setup in **LANconfig** as follows:

1. Navigate to **RADIUS > Server > RADIUS service**.
2. Ensure that checkmarks have been set for **RADIUS authentication active** and **RADIUS accounting active**.



3. Click the button **RADIUS services ports**.



! The default settings are available here for inspection.

Configuring Internet access for the guest network

1. In order to provide Internet access for guest network users, there is a wizard to set up access to a provider network.
2. Limit access to the provider network.
In order for this access to be available to users of the guest network only, set the routing tag "10" for the corresponding route. This ensures that only data packets from the IP network "GUEST" with the interface tag "10" are transmitted to the provider's network. The different routing tag values ensure that data cannot be routed between the guest network and the internal network.

› LANconfig: **IP router** > **Routing** > **Routing table**

IP address	Netmask	Tag	Enable state	Router	Distance	Mask	Comment
192.168.0.0	255.255.0.0	0	On, sticky for RIP	0.0.0.0	0	Off	
172.16.0.0	255.240.0.0	0	On, sticky for RIP	0.0.0.0	0	Off	
10.0.0.0	255.0.0.0	0	On, sticky for RIP	0.0.0.0	0	Off	
224.0.0.0	224.0.0.0	0	On, sticky for RIP	0.0.0.0	0	Off	
255.255.255.255	0.0.0.0	10	On, sticky for RIP	PROVIDER	0	On	

3. Optional: If necessary, use **Device** > **Configuration Management** > **Upload certificate or file** in LANconfig to upload an HTML template and an image as a template to the device for output of the voucher.

The image can be a GIF, JPEG or PNG file of max. 64 KB in size.

WLAN layer-3 tunneling

Introduction

The CAPWAP standard for centralized WLAN management offers two different channels for transmissions:

- › The obligatory control channel transports administrative data between the managed AP and the WLC.
- › The optional data channel transmits the payload data from the various WLAN networks (SSID) between the managed AP and the WLC.

The decision whether to use of the optional data channel between the managed AP and the WLC depends on the route to be taken by the payload data:

- › If you deactivate the data channel, the AP forwards the payload data directly to the LAN. In this case, you control the allocation of WLAN clients to specific LAN segments, for example by assigning VLAN IDs. The advantage of this application lies in the low load on the WLC and on the network as a whole, because the AP transmits only the management data via the CAPWAP tunnel and it transmits the payload data over the shortest available route.
- › If you activate the data channel, the AP additionally forwards the payload data to the central WLC. This approach has the following advantages:
 - › The APs can provide access to networks that are only available on the WLC, such as a central Internet access for a Public Spot.
 - › The WLANs provided by the APs (SSIDs) can be separated from one another without the use of VLAN. Avoiding the use of VLAN reduces the effort required for the configuration of other network components such as switches, etc.
 - › WLAN clients associated with the APs and in different IP networks can roam to other APs without interruption to their IP connections, because the connection is continually managed by the central WLC and not by the APs (layer-3 roaming).

The use of data channels forms additional logical networks on the basis of the existing physical infrastructure. These logical networks are known as overlay networks.

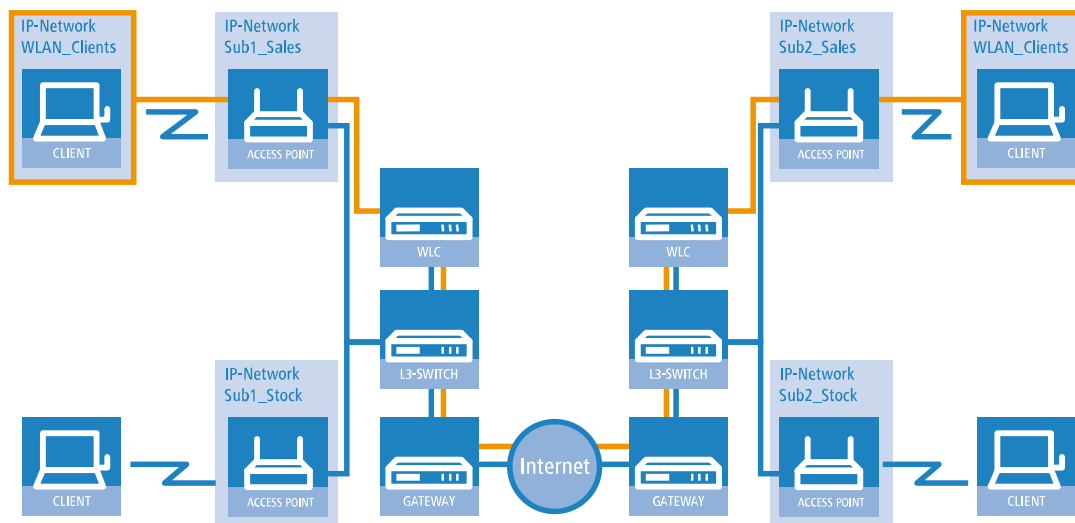


Figure 1: Overlay network across multiple IP networks

Using the data channel even allows you to span logical overlay networks across multiple WLCs.

Several WLCs within a single broadcast domain can support the same overlay network. Disable the WLC data channel between these WLCs (WEBconfig: LCOS Menu Tree > Setup > WLAN-Management > WLC-Cluster > WLC-Data-Tunnel-active). Otherwise the multiple reception of the broadcast messages would give rise to loops. Since routers drop broadcast messages, you can activate the CAPWAP data channel for WLCs in separate networks.

The APs use virtual WLC interfaces (WLC tunnels) to manage each SSID's data channels between AP and WLC. Depending on the model, each WLC provides 16 to 32 WLC tunnels that you can use when configuring the logical WLANs.

❗ Virtual WLC interfaces are available for selection in all dialogs used to select logical interfaces (LAN or WLAN), such as in the port table of the LAN and VLAN settings or for the definition of IP networks.

Tutorials

The following sections present specific scenarios with step-by-step instructions for a number of standard situations when operating WLCs.

Overlay network: Separating networks for access points without using VLAN

In many cases, networks in a shared physical infrastructure are separated by using VLANs. However, this method assumes that the switches operated in the network are VLAN-capable and that these are configured for VLAN operations. Consequently, the administrator has to rollout the VLAN configuration for the whole network.

WLCs enable you to separate the networks while minimizing the use of VLANs. The APs use a CAPWAP data tunnel to direct the payload from the WLAN clients straight to the WLC, which then assigns the data to the corresponding VLANs. In this situation, VLAN configuration is only required for the WLC and a single, central switch. All of the other switches in this example work without a VLAN configuration.

❗ With this configuration, you reduce the VLAN to the core of the network structure (illustrated with a blue background). What's more, only 3 of the switch ports in use require a VLAN configuration.

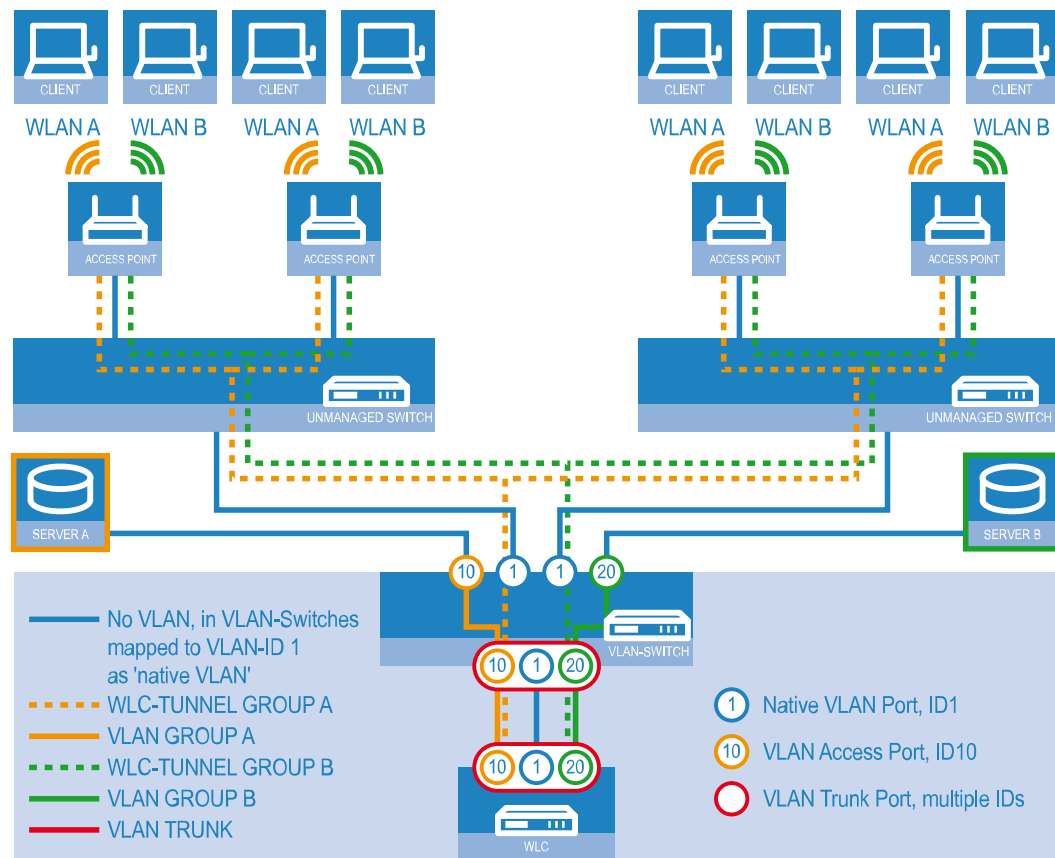


Figure 2: Example application: Overlay network

The diagram shows a sample application with the following components:

- > The network consists of two segments, each with its own (not necessarily VLAN-capable) switch.
- > Each segment contains several APs, each of which is connected to one of the switches.
- > Each AP provides two SSIDs for the WLAN clients in two different user groups, shown in the diagram in green and orange.
- > Each user group has access to its own dedicated server that is separated from other user group. The servers can only be accessed via the corresponding VLANs, i.e. through the access ports configured on the switch.
- > A single WLC manages all of the APs in the network
- > A central, VLAN-capable switch connects the switches in each segment, the servers for each group, and the WLC.

The aim of the configuration: A WLAN client that associates with an SSID is to have access to its "own" server, regardless of which AP is being used and regardless of the segment in which the client is located.

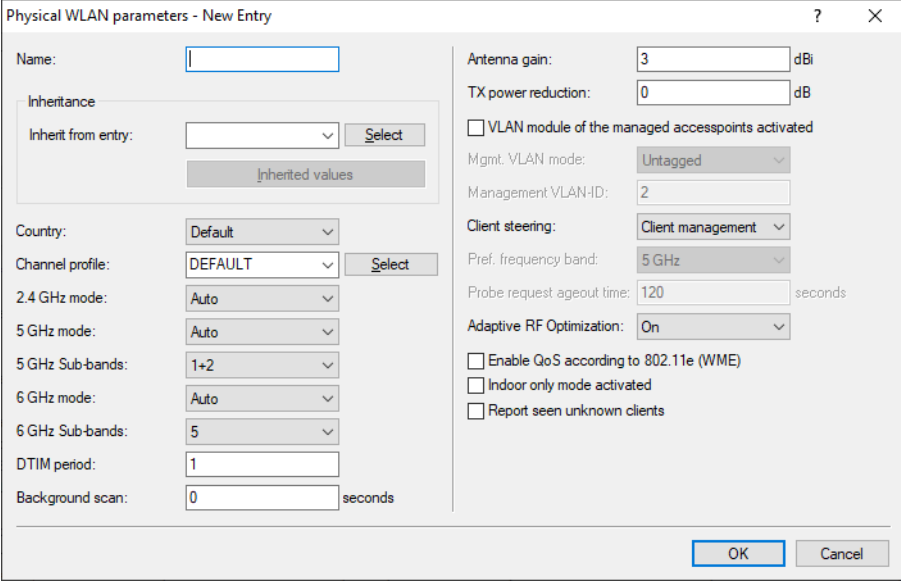
❗ The following description assumes a working basic configuration of the WLC. The configuration of the VLAN switch is not part of this description.

Configuring the WLAN settings

1. For each SSID, create an entry in the list of logical networks, each with a suitable name and the corresponding SSID. Connect the SSID to a WLC tunnel, for example the first SSID to "WLC-TUNNEL-1" and the second to "WLC-TUNNEL-2". Set the VLAN mode to 'tagged', set the VLAN ID '10' for the first logical network and the VLAN ID '20' for the second logical network. In LANconfig you find these settings under **Configuration > WLAN Controller > Profiles > Logical WLAN networks (SSIDs)**.

2. Create an entry in the list of physical WLAN parameters with the appropriate settings for your APs, such as the country 'Europe' with the channels 1, 6 and 11 in 802.11b/g/n and 802.11a/n in mixed mode. For this profile in the physical WLAN parameters, enable the option to turn on the VLAN module on the APs. Set the operating mode for the management VLAN in the APs

to 'Untagged'. In LANconfig you find this setting under **Configuration > WLAN Controller > Profiles > Physical WLAN parameters**.

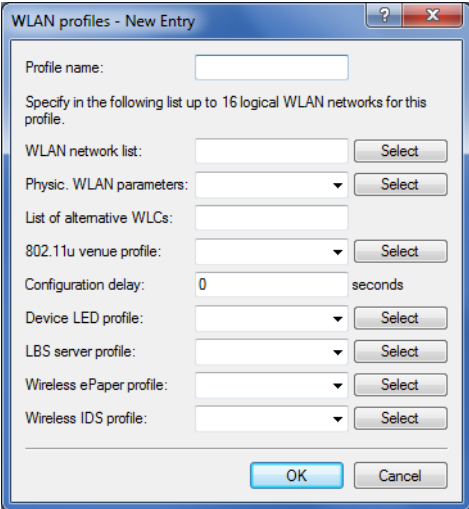


The 'Physical WLAN parameters - New Entry' dialog box contains the following fields and options:

- Name:** Text input field.
- Inheritance:**
 - Inherit from entry: Dropdown menu with a 'Select' button.
 - Inherited values: Button.
- Country:** Dropdown menu (Default).
- Channel profile:** Dropdown menu (DEFAULT) with a 'Select' button.
- 2.4 GHz mode:** Dropdown menu (Auto).
- 5 GHz mode:** Dropdown menu (Auto).
- 5 GHz Sub-bands:** Dropdown menu (1+2).
- 6 GHz mode:** Dropdown menu (Auto).
- 6 GHz Sub-bands:** Dropdown menu (5).
- DTIM period:** Text input field (1).
- Background scan:** Text input field (0) with 'seconds' label.
- Antenna gain:** Text input field (3) with 'dBi' label.
- TX power reduction:** Text input field (0) with 'dB' label.
- ☐ VLAN module of the managed accesspoints activated
- Mgmt. VLAN mode:** Dropdown menu (Untagged).
- Management VLAN-ID:** Text input field (2).
- Client steering:** Dropdown menu (Client management).
- Pref. frequency band:** Dropdown menu (5 GHz).
- Probe request ageout time:** Text input field (120) with 'seconds' label.
- Adaptive RF Optimization:** Dropdown menu (On).
- ☐ Enable QoS according to 802.11e (WME)
- ☐ Indoor only mode activated
- ☐ Report seen unknown clients

Buttons: OK, Cancel.

3. Create a WLAN profile and give it a suitable name. Then assign the logical WLAN networks and the physical WLAN parameters created previously to this WLAN profile. In LANconfig you find this setting under **Configuration > WLAN Controller > Profiles > WLAN profiles**.



The 'WLAN profiles - New Entry' dialog box contains the following fields and options:

- Profile name:** Text input field.
- Specify in the following list up to 16 logical WLAN networks for this profile.
- WLAN network list:** Text input field with a 'Select' button.
- Physic. WLAN parameters:** Dropdown menu with a 'Select' button.
- List of alternative WLCs:** Text input field.
- 802.11u venue profile:** Dropdown menu with a 'Select' button.
- Configuration delay:** Text input field (0) with 'seconds' label.
- Device LED profile:** Dropdown menu with a 'Select' button.
- LBS server profile:** Dropdown menu with a 'Select' button.
- Wireless ePaper profile:** Dropdown menu with a 'Select' button.
- Wireless IDS profile:** Dropdown menu with a 'Select' button.

Buttons: OK, Cancel.

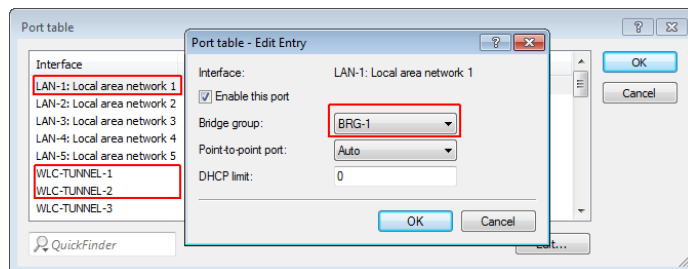
- For each managed AP, create an entry in the AP table with a suitable name and the associated MAC address. Assign the previously created WLAN profile to this AP. In LANconfig you find these settings under **Configuration > WLAN Controller > AP config. > Access point table**.

Configuring the interfaces on the WLC

- Assign a separate logical LAN interface, e.g. 'LAN-1', to each physical Ethernet port. Make sure that the other Ethernet ports are not assigned to the same LAN interface. In LANconfig you find these settings under **Configuration > Interfaces > LAN > Ethernet ports**.

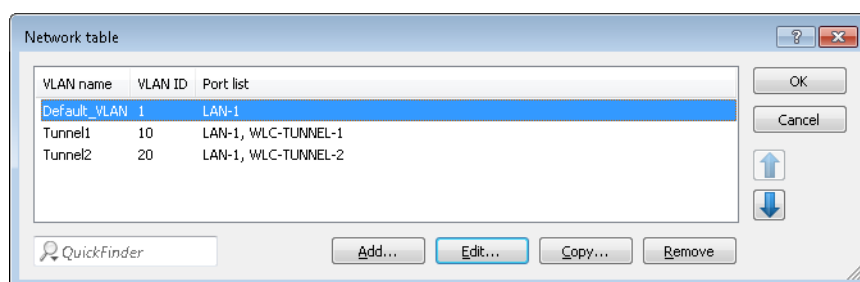
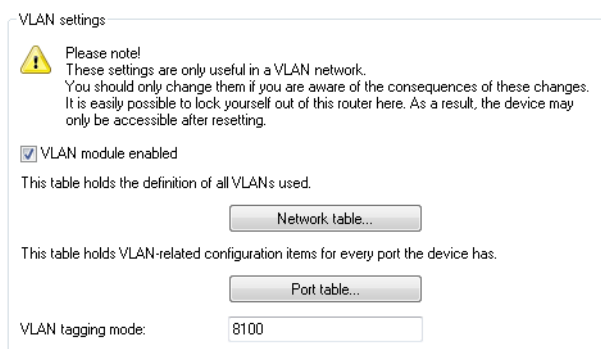
- Assign the logical LAN interface 'LAN-1' and the WLC tunnels 'WLC-tunnel-1' and 'WLC-tunnel-2' to the bridge-group 'BRG-1'. Make sure that the other LAN ports are not assigned to the same

bridge group. In LANconfig you find this setting under **Configuration > Interfaces > LAN > Port table**.

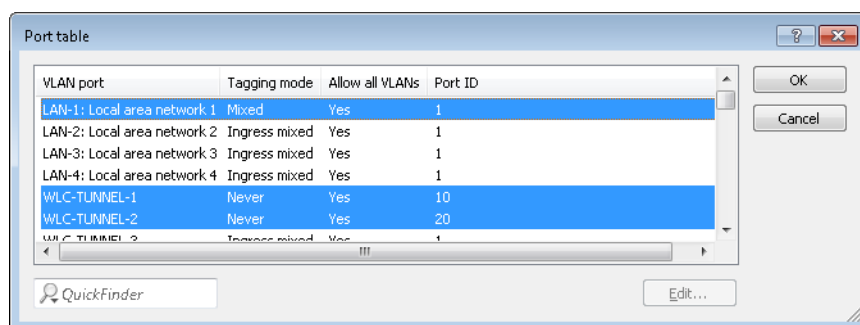


❗ By default, the LAN interfaces and WLC tunnels do not belong to a bridge group. By assigning the LAN interface 'LAN-1' and the two WLC tunnels 'WLC-Tunnel-1' and 'WLC-Tunnel-2' to the bridge group 'BRG-1', the device transmits all data packets between LAN-1 and the WLC tunnels via the bridge.

7. Activate the VLAN module of the WLC under **Interfaces > VLAN** and, under **VLAN table**, assign the LAN port you selected above (LAN 1) and also the corresponding WLC tunnel to the desired VLAN.



8. Under **Interfaces > VLAN > Port table**, set the Tagging mode of the tunnel interface and the LAN interface, and set the corresponding port VLAN ID.



Depending on how the switch is configured, set the Tagging mode of the LAN interface to 'Mixed' or 'Always'.

In most cases the tunnel interfaces are operated with the mode 'Never', because packets here (from the WLAN) always arrive untagged and the WLC marks them with the port VLAN ID

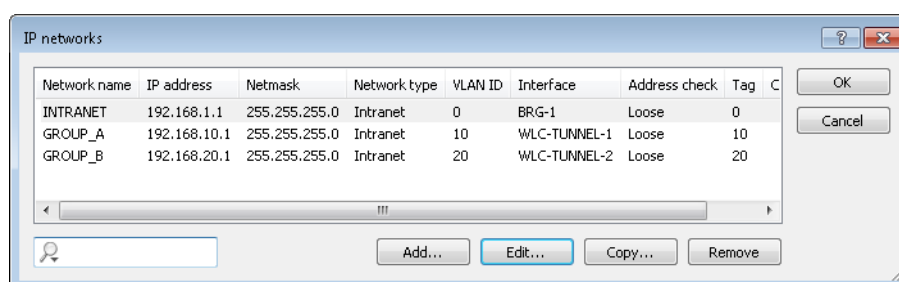
! When you activate the VLAN module, please observe that the ARF networks configured on the WLC must be given a VLAN ID. In the VLAN configuration outlined above, you need to set the VLAN ID for the IP network to '1' in order for the WLC to reach the network without a VLAN tag.

i A similar configuration is achieved by making the access point set a VLAN tag for packets that are to be sent via the tunnel, in which case the VLAN module of the WLC is not used.

However, this bridging of the various WLC tunnels with one another causes broadcasts to be redirected into all of the tunnels; with a certain number of tunnels/SSIDs and APs, this can lead to load problems on the network and on the WLC. The VLAN module configuration presented here prevents this.

9. In addition you configure the IP settings for the networks that are separated on layer 2 under **IPv4 > General > IP networks**.

! To prevent the device from connecting these networks via layer 3, a separation must also be configured on layer 3, for example by using a port tag or by means of the firewall.



10. The WLC optionally acts as a DHCP server for the APs. To set this up, activate the DHCP server for the 'INTRANET'. In LANconfig you find these settings under **IPv4 > DHCPv4 > DHCP networks**.

DHCP networks - New Entry

Network name:

DHCP server enabled:

☐ Evaluate broadcast bit

☐ DHCP cluster

Forwarding of DHCP queries

1. server address:

2. server address:

3. server address:

4. server address:

Source address (opt.):

☐ Place server replies in intermediate storage

☐ Adapt server replies to the local network

Lease time

Maximum lease time: minutes

Default lease time: minutes

Addresses for DHCP clients

First address:

Last address:

Netmask:

Broadcast:

Default gateway:

Name server addresses

Primary DNS:

Secondary DNS:

Primary NBNS:

Secondary NBNS:

"Layer 3 roaming"

Allowing payload data from the wireless LAN to pass-through the WLC tunnel to the WLC enables roaming even beyond the limits of broadcast domains. In this example application, a layer-3 switch between the floors prevents the transmission of broadcasts, and thus separates the broadcast domains.

In this example, two user groups A and B each have access to their own WLAN (SSID). On all floors of the building, the APs provide two SSIDs, 'GROUP_A' and 'GROUP_B'.

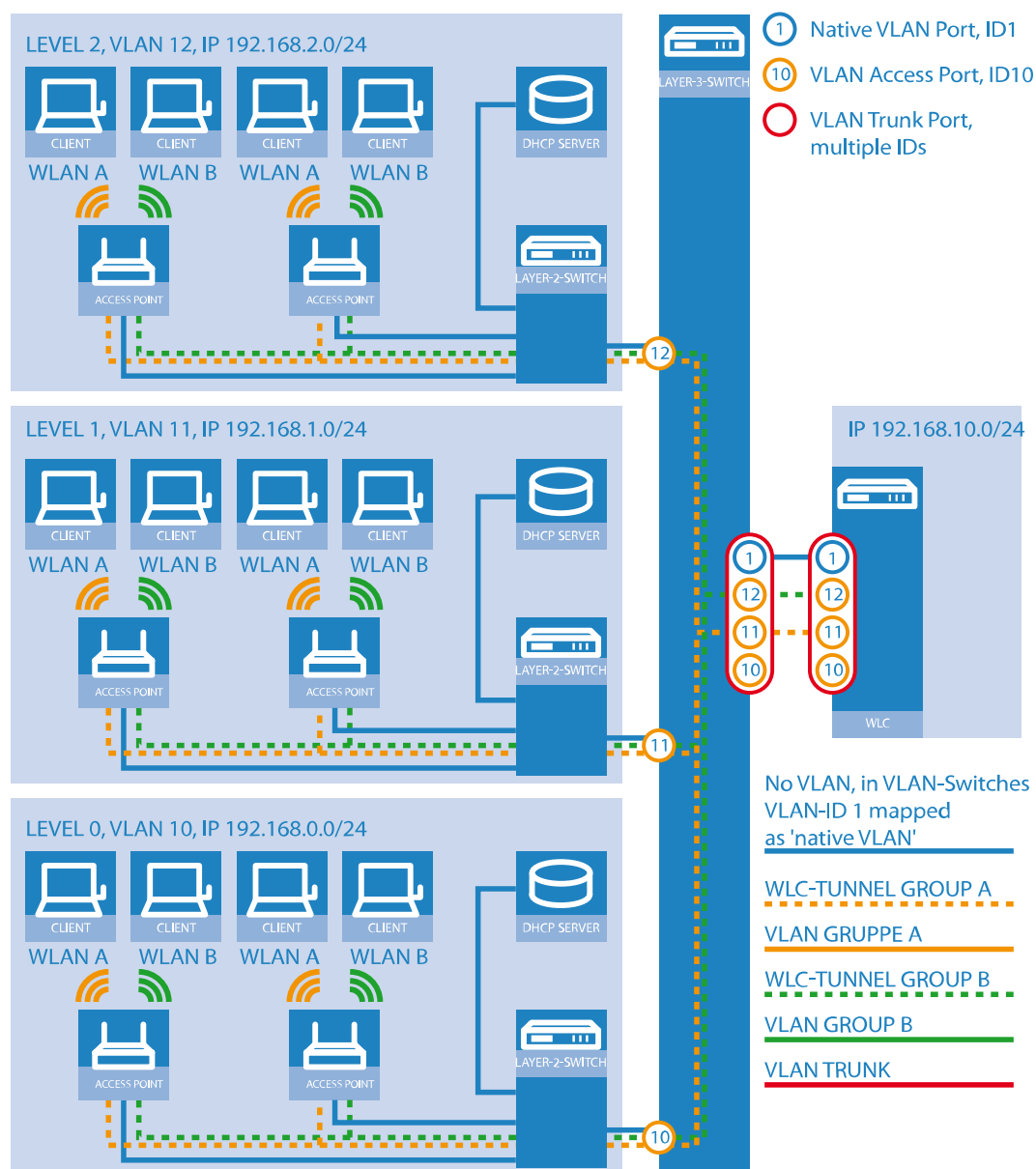


Figure 3: Example application for layer-3 roaming

The diagram shows a sample application with the following components:

- The network consists of three segments on separate floors of a building.
- A central layer-3 switch connects the segments and divides the network into three broadcast domains.
- Each segment uses its own IP address space and its own VLAN.
- Each segment operates a local DHCP server, which transmits the following information to the APs:
 - IP address of the gateway
 - IP address of the DNS server
 - Domain suffix

! This information enables the APs to contact the WLC in another broadcast domain.

The aim of the configuration: When moving to another floor, a WLAN client that associates with a particular SSID is to retain access to its "own" WLAN, regardless of which AP is being used and regardless of the segment in which the client is located. Since the segments in this example use different IP address ranges, this scenario can only be implemented by managing the APs directly with the central WLC via layer 3 and across the boundaries of the VLANs.

! The configuration corresponds to the example [Overlay network: Separating networks for access points without using VLAN](#) on page 57.

WLAN controller with Public Spot

This scenario is based on the first scenario (overlay network) and enhances it to include specific settings for user authentication.

The configuration of a Public Spot can be greatly simplified if the payload data sent from the WLAN to the WLC is routed through a WLC tunnel. A Public Spot can, for example, provide guests with Internet access in parallel with, but separated from, an internal wireless LAN.

In this example, the employees of a company have access to a private WLAN (SSID), while the guests use a Public Spot to access the Internet. In all areas of the building, the APs provide two SSIDs, 'COMPANY' and 'GUESTS'.

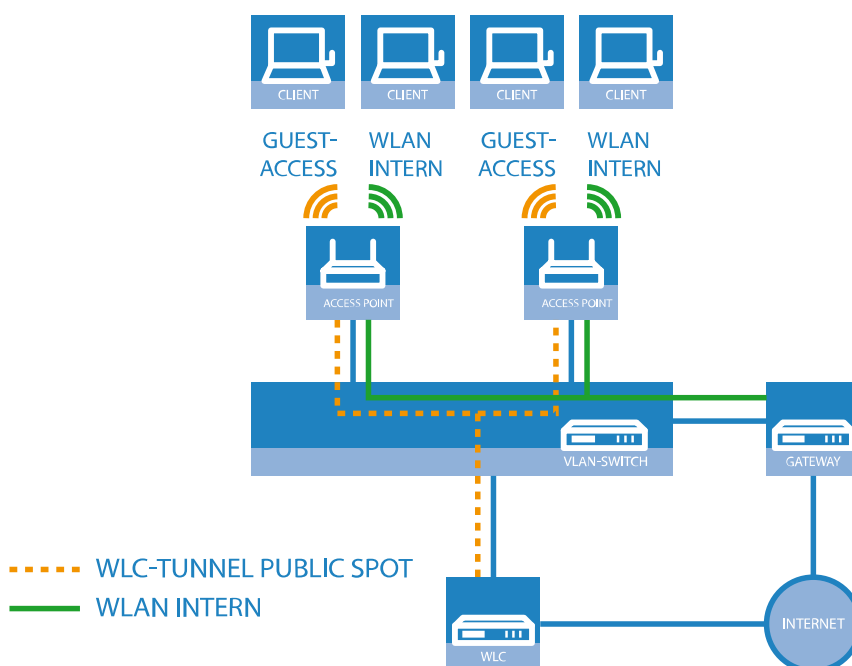


Figure 4: Example application: WLAN controller with Public Spot

The aim of the configuration: A WLAN client that associates with the internal SSID should have access to all internal resources and the Internet via the central gateway. The APs break-out the payload data from the internal clients locally and pass it on directly to the LAN. The guests' WLAN clients associate with the Public Spot. The APs send the payload data from the guest clients through a WLC tunnel directly to the WLC, which uses a separate WAN interface for Internet access.

1. The internal WLAN and the guest WLAN each require an entry to be created in the list of logical networks, each with a suitable name and the corresponding SSID. Link the SSID for internal

use with the 'LAN at AP', and the SSID for guests with (for example) 'WLC-TUNNEL-1'. Disable encryption for the guest network SSID so that the guests' WLAN clients can associate with the Public Spot. You should also prevent inter-station traffic for this SSID. In LANconfig you find

1 WLAN management

this setting under **Configuration > WLAN Controller > Profiles > Logical WLAN networks (SSIDs)**.

Logical WLAN networks (SSIDs) - New Entry

☒ Logical WLAN network activated

Name: COMPANY

Inheritance

Inherit from entry: Select

Inherited values

Network name (SSID): WLAN-Intern

Connect SSID to: LAN at AP

VLAN mode: Untagged

VLAN ID: 2

Encryption: 802.11i (WPA)-PSK

Key 1/passphrase: Show

Generate password

RADIUS profile: DEFAULT Select

Allowed frequency bands: 2.4/5 GHz

AP standalone time: 0 minutes

802.11u network profile: Select

☐ OKC (Opportunistic Key Caching) activated

☐ MAC check activated

Suppress SSID broadcast: No

☐ RADIUS accounting activated

☒ Allow data traffic between stations of this SSID

WPA version: WPA2

WPA1 session key type: TKIP

WPA2 session key type: AES

WPA2 key management: Standard

Basis rate: 2 Mbit/s

Client Bridge Support: No

TX bandwidth limit: 0 kbit/s

RX bandwidth limit: 0 kbit/s

Maximum count of clients: 0

Min. client signal strength: 0 %

☐ Enable LBS tracking

LBS tracking list:

Convert to unicast: DHCP

☐ Use long preamble for 802.11b

☐ (U)APSD / WMM powersave activated

Encrypt mgmt. frames: No

802.11n

Max. spatial streams: Auto

☒ Allow short guard interval

☒ Use frame aggregation

☒ STBC (Space Time Block Coding) activated

☒ LDPC (Low Density Parity Check) activated

OK Cancel

Logical WLAN networks (SSIDs) - New Entry

☒ Logical WLAN network activated

Name: GUESTS

Inheritance

Inherit from entry: Select

Inherited values

Network name (SSID): WLAN-Public

Connect SSID to: WLC-TUNNEL-1

VLAN mode: Untagged

VLAN ID: 2

Encryption: None

Key 1/passphrase: Show

Generate password

RADIUS profile: DEFAULT Select

Allowed frequency bands: 2.4/5 GHz

AP standalone time: 0 minutes

802.11u network profile: Select

☐ OKC (Opportunistic Key Caching) activated

☐ MAC check activated

Suppress SSID broadcast: No

☐ RADIUS accounting activated

☐ Allow data traffic between stations of this SSID

WPA version: WPA2

WPA1 session key type: TKIP

WPA2 session key type: AES

WPA2 key management: Standard

Basis rate: 2 Mbit/s

Client Bridge Support: No

TX bandwidth limit: 0 kbit/s

RX bandwidth limit: 0 kbit/s

Maximum count of clients: 0

Min. client signal strength: 0 %

☐ Enable LBS tracking

LBS tracking list:

Convert to unicast: DHCP

☐ Use long preamble for 802.11b

☐ (U)-APSD / WMM powersave activated

Encrypt mgmt. frames: No

802.11n

Max. spatial streams: Auto

☒ Allow short guard interval

☒ Use frame aggregation

☒ STBC (Space Time Block Coding) activated

☒ LDPC (Low Density Parity Check) activated

OK Cancel

- Create an entry in the list of physical WLAN parameters with the appropriate settings for your APs, such as the country 'Europe' with the channels 1, 6 and 11 in 802.11b/g/n and 802.11a/n in mixed mode. In LANconfig you find this setting under **Configuration > WLAN Controller > Profiles > Physical WLAN parameters**.

Physical WLAN parameters - New Entry

Name:

Inheritance

Inherit from entry: Select

Inherited values

Country: Default

Channel profile: DEFAULT Select

2.4 GHz mode: Auto

5 GHz mode: Auto

5 GHz Sub-bands: 1+2

6 GHz mode: Auto

6 GHz Sub-bands: 5

DTIM period: 1

Background scan: 0 seconds

Antenna gain: 3 dBi

TX power reduction: 0 dB

☐ VLAN module of the managed accesspoints activated

Mgmt. VLAN mode: Untagged

Management VLAN-ID: 2

Client steering: Client management

Pref. frequency band: 5 GHz

Probe request ageout time: 120 seconds

Adaptive RF Optimization: On

☐ Enable QoS according to 802.11e (WME)

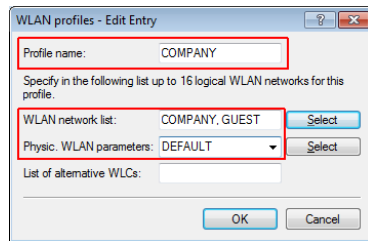
☐ Indoor only mode activated

☐ Report seen unknown clients

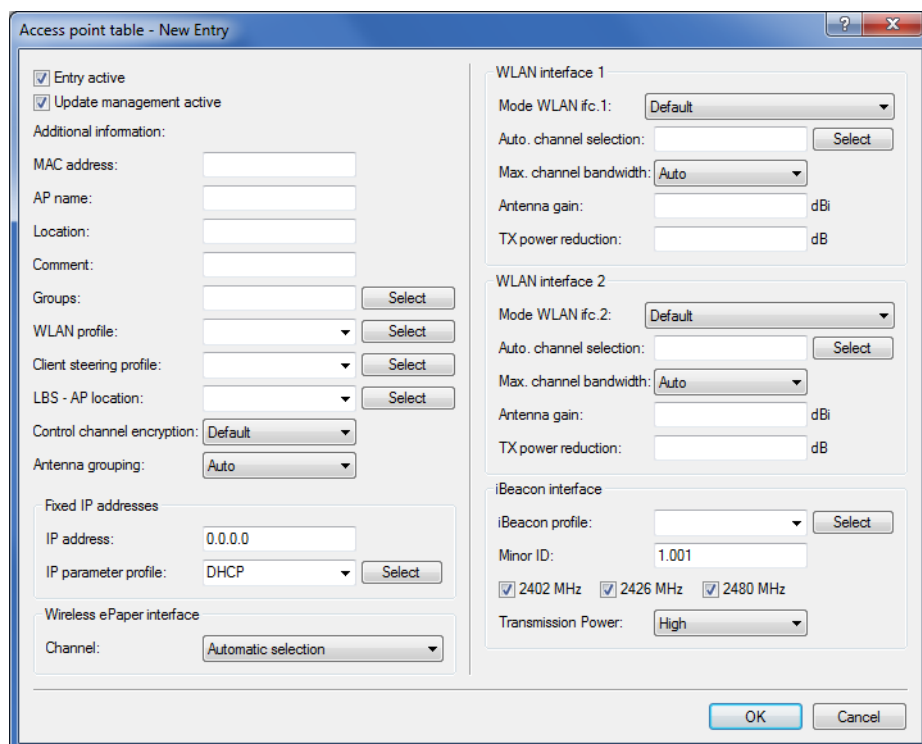
OK Cancel

1 WLAN management

3. Create a WLAN profile and give it a suitable name. Then assign the logical WLAN networks and the physical WLAN parameters created previously to this WLAN profile. In LANconfig you find this setting under **Configuration > WLAN Controller > Profiles > WLAN profiles**.



4. For each managed AP, create an entry in the AP table with a suitable name and the associated MAC address. Assign the previously created WLAN profile to this AP. In LANconfig you find this setting under **Configuration > WLAN Controller > AP config. > Access point table**.



5. Assign a separate logical LAN interface, e.g. 'LAN-1', to each physical Ethernet port. Set the 4th Ethernet port to the logical LAN interface 'DSL-1'. The WLC then uses this LAN interface

for the guest network Internet access. In LANconfig you find this setting under **Configuration > Interfaces > LAN > Ethernet ports**.

The screenshot shows the LANconfig interface. Under the 'Ethernet switch settings' section, the 'Ethernet ports' button is highlighted. A dropdown menu is open, showing four options: 'ETH 1 (LAN-1)...', 'ETH 2 (LAN-1)...', 'ETH 3 (LAN-1)...', and 'ETH 4 (LAN-1)...'. The 'Ethernet ports' button is also highlighted in the 'LAN bridge settings' section. Below it, the 'Port table...' button is visible.

6. Verify that the logical LAN interface 'WLC-tunnel-1' is not allocated to a bridge group. This ensures that the other LAN interfaces do not transmit any data to the Public Spot. In LANconfig you find this setting under **Configuration > Interfaces > LAN > Port table**.

The screenshot shows the 'Port table - Edit Entry' dialog box. The 'Interface' field is set to 'WLC-TUNNEL-1'. The 'Bridge group' dropdown menu is set to 'none' and is highlighted with a red box. The 'Point-to-point port' is set to 'Auto' and the 'DHCP limit' is set to '0'. The 'OK' and 'Cancel' buttons are at the bottom.

7. For the guest Internet access, create an entry in the list of DSL remote sites with the hold time '9999' and the pre-defined layer 'DHCPD'. This example assumes that Internet access is provided by a router with DHCP server. In LANconfig you find this setting under **Configuration > Communications > Remote sites > Remote sites**.

The screenshot shows the 'Remote sites - Edit Entry' dialog box. The 'Name' field is set to 'INTERNET' and is highlighted with a red box. The 'Short hold time' is set to '9.999' seconds. The 'Layer name' dropdown menu is set to 'DHCPD' and is highlighted with a red box. The 'Service' field is empty. The 'MAC address type' is set to 'Local'. The 'DSL ports' field is empty. The 'VLAN ID' is set to '0'. The 'OK' and 'Cancel' buttons are at the bottom.

8. For internal users, create the IP network 'INTRANET' with (for example) the IP address '192.168.1.100' and the interface tag '1'. For the guest access, create the IP network 'GUEST-ACCESS' with (for example) the IP address of '192.168.200.1' and the interface tag '2'. The virtual router in the WLC uses the interface tags to separate the routes for the two

networks. In LANconfig you find this setting under **Configuration > TCP/IP > General > IP networks**.

IP networks - Edit Entry

Network name: INTRANET

IP address: 192.168.1.100

Netmask: 255.255.255.0

Network type: Intranet

VLAN ID: 0

Interface assignment: Any

Address check: Loose

Interface tag: 1

Comment:

OK Cancel

IP networks - Edit Entry

Network name: GUEST

IP address: 192.168.200.1

Netmask: 255.255.255.0

Network type: Intranet

VLAN ID: 0

Interface assignment: Any

Address check: Loose

Interface tag: 2

Comment:

OK Cancel

9. The WLC is able to act as a DHCP server for APs and the associated WLAN clients. To set this up, activate the DHCP server for the 'INTRANET' and the 'GUEST-ACCESS'. In LANconfig you find this setting under **Configuration > TCP/IP > DHCP > DHCP networks**.

! Activation of the DHCP server is obligatory for the guest network and optional for the internal network. There are other ways of realizing a DHCP server for the internal network.

DHCP networks - New Entry

Network name: [Select]

DHCP server enabled: Auto

☐ Evaluate broadcast bit

☐ DHCP cluster

Forwarding of DHCP queries

1. server address: 0.0.0.0

2. server address: 0.0.0.0

3. server address: 0.0.0.0

4. server address: 0.0.0.0

Source address (opt.): [Select]

☐ Place server replies in intermediate storage

☐ Adapt server replies to the local network

Lease time

Maximum lease time: 0 minutes

Default lease time: 0 minutes

Addresses for DHCP clients

First address: 0.0.0.0

Last address: 0.0.0.0

Netmask: 0.0.0.0

Broadcast: 0.0.0.0

Default gateway: 0.0.0.0

Name server addresses

Primary DNS: 0.0.0.0

Secondary DNS: 0.0.0.0

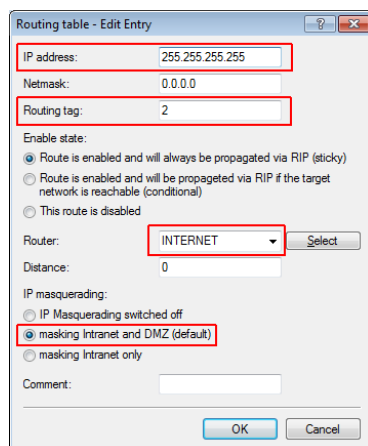
Primary NBNS: 0.0.0.0

Secondary NBNS: 0.0.0.0

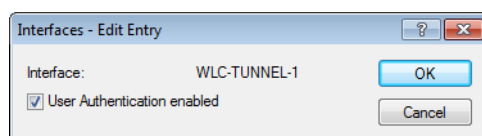
OK Cancel

10. Create a new default route in the routing table to direct the data from the guest network to the Internet connection used by the WLC. Select the routing tag '2' and the router 'Internet'. Also

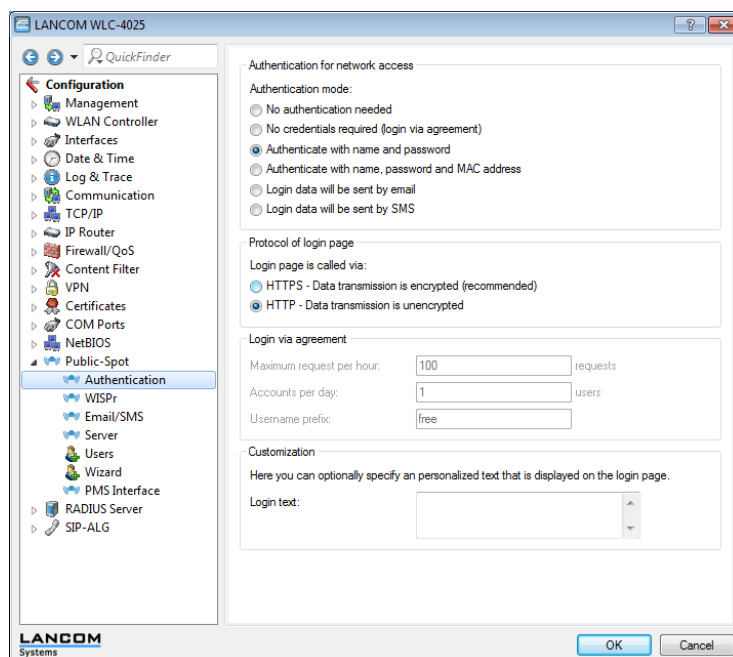
activate the option 'Masking intranet and DMZ (default)'. In LANconfig you find this setting under **Configuration > IP router > Routing > Routing table**.



11. Activate the Public Spot user authentication for the logical LAN interface 'WLC-Tunnel-1'. In LANconfig you find this setting under **Configuration > Public Spot > Server > Operational settings > Interfaces**.



- 12 The final step is to enable authentication via the Public Spot for the WLC. In LANconfig you find this setting under **Configuration > Public Spot > Authentication**.



In addition to configuring the WLC, you must also configure the Public Spot either to use the internal user list or to use a RADIUS server, according to your needs.

1.4.4 IP-dependent auto configuration and tagging of APs

The easiest way to manage all of the APs that you add to a managed network is to use a flat hierarchy. However, in the largest installations with hundreds of APs across several locations, this type of organization quickly becomes confusing and creates a high level of administrative effort. Setting up **Assignment groups** can help to simplify the management of distributed APs. The WLC can automatically configure each new AP based on the IP addresses it receives. Manual assignment of an IP parameter profile, a WLAN profile and a Client-steering profile by an administrator is no longer required.

The following describes how an assignment group is used when an unassociated AP registers with a central WLC: After the new APs are installed on site (e.g. at a company or branch network), they try to establish a connection to the specified WLC and obtain a configuration via CAPWAP. The WLC detects the connection requests and, for each new AP, it checks the AP table for a suitable AP profile (e.g., the default profile) and/or whether a suitable assignment group has been defined. If one or more configuration options are available, the WLC checks them for the following states:

1. For a new AP there is an assignment group but no AP profile. In this case, the WLC assigns the profile specified in the assignment group to the new AP.
2. For a new AP there is both an assignment group as well as an AP profile. In this case, the WLC ignores the assignment group and assigns the profile defined in the AP profile to the new AP.
3. For a new AP, there is an AP profile but no assignment group. The behavior is the same as point (2).

If a new AP has neither an AP profile nor an assignment group, the WLC issues an alarm to notify the administrator of the incorrect configuration.

After successful group assignment, the WLC automatically creates an AP profile for every new AP in the access point table. In the **Groups** field, the WLC references the assignment group used when it added the new AP.

 An AP is only ever allowed to receive one assignment group. If the IP address ranges of the assignment groups overlap, LCOS immediately detects the configuration error and writes the messages to the corresponding status table under **Status > WLAN-Management > AP-Configuration**.

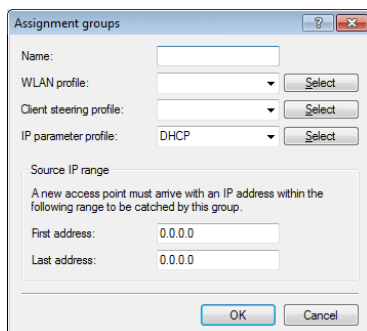
The group field also gives you the option of assigning individually definable tags to an AP. For example, these **Tag groups** can be used to act as filter criteria in order for the WLC to restrict the actions it performs to a selection of APs.

Setting up assignment groups for IP-dependent auto configuration

The following tutorial shows you how you setup assignment groups on a WLC for the IP-dependent automatic configuration of new APs.

1. Open the configuration dialog for your device and select **WLAN controller > AP configuration > Assignment groups**

- Click on **Add** to create a new group.



The 'Assignment groups' dialog box contains the following fields and controls:

- Name:** A text input field.
- WLAN profile:** A dropdown menu with a 'Select' button.
- Client steering profile:** A dropdown menu with a 'Select' button.
- IP parameter profile:** A dropdown menu with 'DHCP' selected and a 'Select' button.
- Source IP range:** A section with a note: 'A new access point must arrive with an IP address within the following range to be caught by this group.' Below this are two input fields: 'First address:' (containing '0.0.0.0') and 'Last address:' (containing '0.0.0.0').
- At the bottom are 'OK' and 'Cancel' buttons.

- Enter under **Name** a unique descriptor for the assignment group, for example, `Berlin_branch`.
- Select the **WLAN profile** that the WLC automatically assigns to a new AP if the IP address of the new AP is within the source IP range.
- Enter the **IP parameter profile** if the new AP should receive a manual network configuration. Otherwise, leave the value as **DHCP**, whereby the AP automatically gets a network configuration from the DHCP server. The DHCP server must be configured to do this.

If you wish to assign a manual network configuration in which a new AP receives a different IP address, you specify the corresponding address range in the **IP parameter profile** under **Address assignment pool**.

- Optional:** Specify a **Client-steering profile** in order to forward future WLAN clients to the ideal AP in case there are several new APs within transmission range.

! If you activate client steering, this must be activated for every AP in the managed infrastructure. Refer to section [Client steering by WLC](#) on page 95 for further information on this.

- Enter the start and end of the **Source IP range** relevant to the assignment group.
A new AP must register at the WLC with an IP address from this range in order to obtain the configuration for this group.
- Close all dialog windows with **OK** and save the configuration to your device.

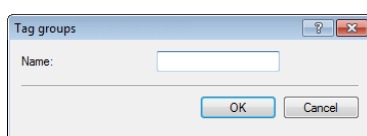
From now on, the WLC assigns the profiles referenced in the assignment groups to all new APs. The LCOS console can now provide you with information about the categorization, see [Overview of CAPWAP parameters with the show command](#) on page 116.

! Please ensure that the access point table does not contain an AP profile (e.g., the default profile), which the WLC would assign to the unassociated APs. If an appropriate AP profile is available, this always takes higher priority than the assignment groups.

Setting up tag groups for the detailed selection of APs

The following tutorial shows you how a tag group can be added to an AP configuration on a WLC. To do this, you first create a tag group and then assign it to a WLAN profile.

- Open the configuration dialog for your device and select **WLAN controller > AP configuration > Tag groups**
- Click on **Add** to create a new group.



The 'Tag groups' dialog box contains the following fields and controls:

- Name:** A text input field.
- At the bottom are 'OK' and 'Cancel' buttons.

- Under **Name** you enter the new tag and save the entry with **OK**.

4. Navigate to the dialog with **WLAN controller > AP configuration > Access point table**.
5. Select an existing AP profile with **Edit** or add a new one, if necessary.
6. Under **Groups** select the tag group(s) created earlier.
Multiple tag groups can be specified in a comma-separated list.

 The tag groups are independent of the assignment groups, the assignment of which is specified in the same field. Assignment groups are generally assigned by the device, so this does not need to be done by the user. The manual allocation of an assignment group has no effect on the AP configuration, which is in line with the state check described under *IP-dependent auto configuration and tagging of APs* on page 74. The only effects are on the filtering in the command `show capwap group` at the console

 The manual addition of assignment group for filtering purposes is not recommended. You should create separate tag groups instead.

7. Close all dialog windows with **OK** and save the configuration to your device.

From now on the WLC gives the tags in the edited WLAN profile to those APs that received it.

1.5 Access point administration

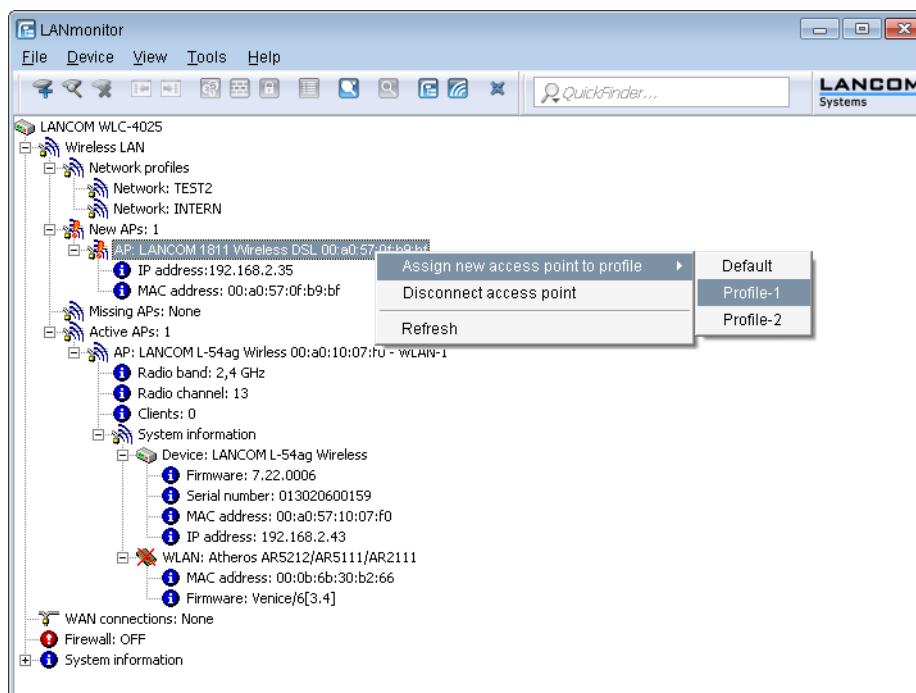
1.5.1 Accepting new access points into the WLAN infrastructure manually

If you prefer not to accept APs into the WLAN infrastructure automatically, you can also manually accept APs.

Using LANmonitor to accept access points

It is very easy to accept new APs with LANmonitor. A configuration is selected that will be assigned to the AP after transmission of a new certificate.

In LANmonitor, click on the new AP with the right-hand mouse key. From the context menu that pops up, you select the configuration which is to be assigned to the device.



! Assignment of the configuration causes the AP to be entered into the AP table in the WLC. It takes a few seconds for the WLC to assign a certificate to the AP and for this to become an active element in the central WLAN infrastructure. Due to this, the newly accepted AP is briefly signaled as a "Lost AP" by the red Lost AP LED, in the device's display, and in LANmonitor until assignment of the certificate is completed.

Accepting access points via WEBconfig with provision of a certificate

New APs that do not have a valid certificate but do have an entry in the AP table can be manually accepted with WEBconfig.

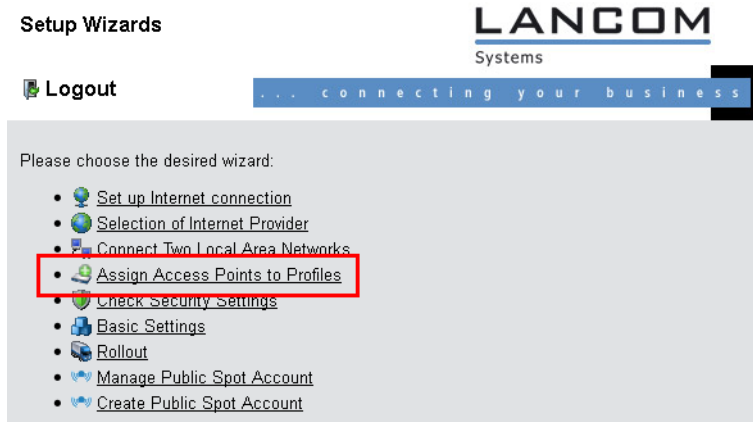
1. Open the WLC configuration with WEBconfig.
2. Under **Extras > LCOS menu tree > Setup > WLAN-Management** select the action **Accept AP**.
3. When requested for additional arguments, enter the MAC address of the AP to be accepted and confirm with **Execute**.



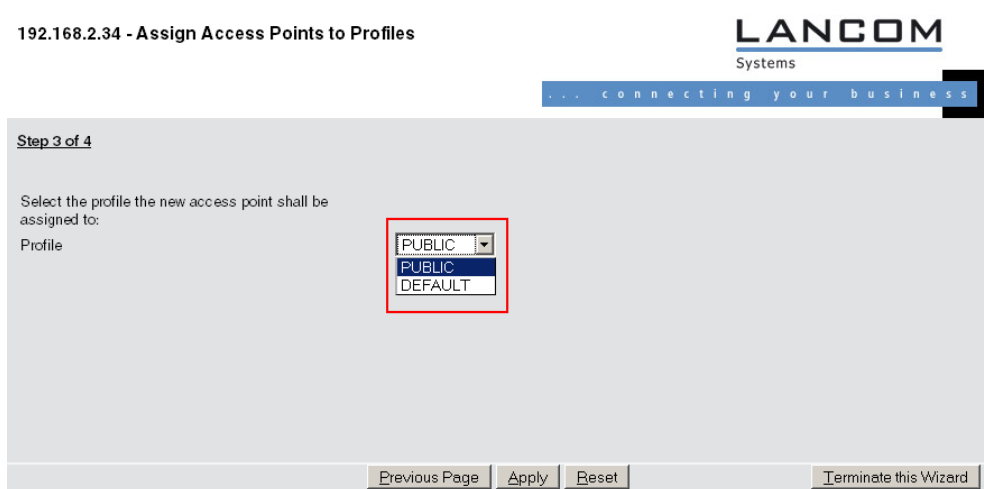
Accepting access points via WEBconfig with provision of a certificate and configuration

New APs that do not have a valid certificate and do not have an entry in the AP table can be manually accepted by means of a wizard in WEBconfig. A configuration is selected that will be assigned to the AP after transmission of a new certificate.

1. Open the WLC configuration with WEBconfig. Click on **Setup Wizards** and select the wizard **Assign access points to profiles**.



2. Click on the link to start the wizard. Select the desired AP by means of its MAC address and choose the WLAN configuration that is to be assigned to it.



- ⓘ Assignment of the configuration causes the AP to be entered into the AP table in the WLAN controller. It takes a few seconds for the WLC to assign a certificate to the AP and for this to become an active element in the central WLAN infrastructure. Due to this, the newly accepted AP is briefly signaled as a "Lost AP" by the red "Lost AP" LED, in the device's display, and in LANmonitor until assignment of the certificate is completed.

Adding new APs with the WEBconfig Setup Wizard

As of LCOS 9.00, WLCs have a revised Setup Wizard **Assign Access Points to Profiles**, which makes it easier to add new APs via WEBconfig. Just a few mouse clicks with the new Setup Wizard allows you to

- > Make a targeted search for a new AP;
- > Accept one or more new APs at the same time;
- > Assign a WLAN profile or a channel list to a new AP;
- > Allow a new AP to inherit the configuration from an accepted AP;
- > To exchange the configuration in a new AP for that of an accepted missing AP. When exchanging a configuration, the new AP receives the complete configuration of the accepted missing AP

(except for its MAC address). When the new AP has been integrated, the WLC then deletes the configuration of the accepted missing AP.

10.99.8.12 - New Access Points assignment

You can leave the profile empty and use the group configuration to auto assign a profile and an ip address to your APs.

Click **Accept AP** to include the new AP with its new settings into the network.

! If you have allowed an AP to be configured via assignment groups, there is no need for any further settings for this AP in the Setup Wizard. The WLC automatically assigns the settings for the appropriate groups to the AP.

1.5.2 Manually removing access points from the WLAN infrastructure

The following actions are required to remove an AP under management of the WLC from the WLAN infrastructure:

1. In the AP, switch the WLAN operating mode of the WLAN module from 'Managed' to 'Client' or 'Access Point'.
2. In the WLAN controller, delete the configuration for the AP and/or deactivate **Automatically provide APs with a default configuration** via **Extras > LCOS menu tree > Setup > WLAN-Management > Autoaccept-AP**.
3. Disconnect the AP in WEBconfig by selecting **Extras > LCOS menu tree > Setup > WLAN-Management** and the action **Disconnect AP**, or alternatively in LANmonitor.
4. When requested for additional arguments, enter the MAC address of the AP to be disconnected and confirm with **Execute**.

Disconnect-AP

Enter here any additional arguments for the command you are about to execute:

Arguments:

1.5.3 Deactivating access points or permanently removing them from the WLAN infrastructure

Occasionally it is necessary to temporarily deactivate or even permanently remove a WLC-managed AP.

Deactivating an access point

To deactivate an AP, set its corresponding entry in the AP table to 'inactive' or delete the entry from the table. In the AP, the WLAN modules in managed mode are switched off and the corresponding SSIDs are deleted.

! The WLAN modules and the WLAN networks (SSIDs) are still switched off even if standalone operation is activated.

An AP deactivated in this way remains connected to the WLC and the certificates are retained. The WLC can reactivate the AP and its managed-mode WLAN modules at any time simply by

activating the entry in the AP table or by making a new entry in the AP table along with the appropriate MAC address.

If the connection to a deactivated AP is broken (either unintentionally due to a failure or intentionally by the administrator) then the AP begins a new search for a suitable WLC. Although the former WLC can check the validity of the certificate, due to the fact that there is no (active) entry in the AP table the AP treats it as a secondary WLC. If the AP finds a primary WLC then it will register with it.

Permanently removing an access point from the WLAN infrastructure

In order to permanently remove an AP from a centrally managed WLAN infrastructure, the certificates in the SCEP client have to be either deleted or revoked.

- > If you have access to the AP, the certificates are quickly deleted by resetting the device.
- > If the device has been stolen and consequently needs to be removed from the WLAN infrastructure, then the certificates in the WLC's CA have to be revoked. This is done in WEBconfig by navigating to **Extras > LCOS menu tree > Status > Certificates > SCEP-CA > Certificates** and accessing the **Certificate status table**. Here you delete the certificate for the MAC address of the APs which are to be removed from the WLAN infrastructure. The certificates are not actually deleted, but they are marked as expired.



In case of a backup solution featuring redundant WLCs, the certificates have to be revoked in all of the WLCs!

1.6 Central firmware and script management

WLCs allow the configurations of multiple R&S@NC WLAN routers and APs to be managed from a central location in a consistent and convenient manner. With central firmware and script management, uploads of firmware and scripts can be automated for all of the WLAN devices.

To achieve this, the firmware and script files are stored on a Web server (firmware as *.upx files, scripts and *.lcs files). The WLC checks once daily, or when prompted by a user, to compare the available files with those on the devices. Alternatively, this procedure can be handled by a cron job—overnight, for example. If an update can be carried out, or if the AP is not running the desired firmware version, then the WLC downloads the file from the Web server and uploads it to the appropriate WLAN routers and APs.

The configuration of firmware and script management provides precise control over the distribution of the files. It is possible, for example, to limit certain firmware versions to certain device types or MAC addresses.

An update can be carried out in two possible states:

- > When a connection is established; the AP subsequently restarts automatically.
- > If the AP is already connected, the device does not restart automatically. In this case the AP is manually restarted with the menu action **Setup > WLAN-Management > Central-Firmware-Management > Reboot-updated-APs** or by a timed cron job.

- > The action **Setup > WLAN-Management > Central-Firmware-Management > Update-Firmware-and-Script-Information** updates the script and firmware directories.

The parameters for configuration can be found under the following paths:

LANconfig: **WLAN controller > AP update**

WEBconfig: **Setup > WLAN-Management > Central-Firmware-Management**

1.6.1 General settings for firmware management

> Firmware-URL

The path to the directory with the firmware files.

- > Possible values: URL in the form `Server/Directory` or `http://Server/Directory`
- > Default: Blank

 Note that the Web server specified must permit directory listing. The firmware management uses this to retrieve information about the available firmware.

> Simultaneously loaded FW

The number of firmware versions loaded simultaneously into the main memory of the WLC.

 The firmware versions stored here are downloaded from the server just once and then used for all update processes.

- > Possible values: 1 to 10
- > Default: 5

> Firmware loopback address

Here you have the option to configure a sender address for the device to use in place of the one that would otherwise be used automatically for this target address.

As an address, the device accepts the name of the IP networks whose address is to be used, any valid IP address, or the name of a loopback address.

Default:

- > Empty

 If the list of IP networks or loopback addresses contains an entry named "INT" or "DMZ", the associated IP address of the IP network or the loopback address named "INT" or "DMZ" is used.

Firmware management table

This table is used to store information about which firmware versions are to be operated with which devices (MAC address) and device types.

Device types

Select here the type of device that the firmware version specified here is to be used for.

- > Possible values: All or a selection from the list of available devices.
- > Default: All

MAC address

Select here the device (identified by its MAC address) that the firmware version specified here is to be used for.

- > Possible values: Valid MAC address
- > Default: Blank

Version

Firmware version to be used for the devices or device types specified in this entry. If necessary, an update for the specified devices or device types will be made to this firmware version. This is stated in the form: "xx.yy", e.g. 10.40. Default: Blank

Date

The date allows you to downgrade to a specific firmware version within a release, for example from a Release Upgrade (RU) on an earlier upgrade.

- > Possible values: 8 characters from 0123456789. The entry must match the format of the UPX header, e.g. "01092014" for the September 01, 2014.
- > Default: Blank

General settings for script management

> Script URL

The path to the directory with the script files.

Possible values:

- > URL in the form `Server/Directory` or `http://Server/Directory`
- > Default: Blank

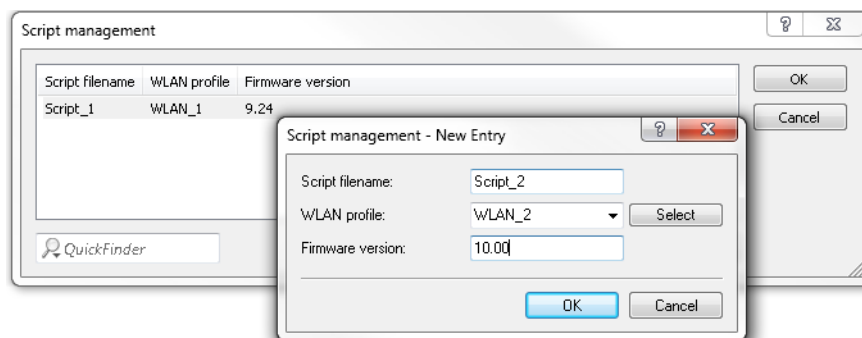
Script management table

In this table, scripts are assigned to a WLAN profile depending on the name of the script file.

Configuring a WLAN router and Access Point in the Managed mode is handled via WLAN profiles. A script can be used for setting those detailed parameters in managed devices that are not handled by the pre-defined parameters in a WLAN profile. Distribution is also handled by WLAN profiles to ensure that the wireless routers and APs with the same WLC configuration also use the same script.

As only one script file can be defined per WLAN profile, versioning is not possible here. However, when distributing a script to a wireless router or Access Point, an MD5 checksum of the script file

is saved. This checksum allows the WLC to determine whether the script file has to be transmitted again in case a new or altered script has the same file name.



Script filename

Enter the CAPWAP slot you selected for the script upload to the WLAN controller (WLC_Script_1.lcs, WLC_Script_2.lcs or WLC_Script_3.lcs). If the WLAN controller obtains the script from a web server, the script name on the web server has to be entered. Possible values: File name in the form *.lcs. Default: Blank.

WLAN profile

Select here the WLAN profile that the script file specified here should be used for. Possible values: Selection from the list of defined WLAN profiles. Default: Blank

Firmware version

By specifying a firmware version, you determine the LCOS version set in the script that is rolled out.



Please enter the firmware version in the form "xx.yy", e.g. 10.00 or 9.24.

Internal script storage (script management without HTTP server)

In contrast to firmware files, script files are very small. The WLC's internal script storage allows the storage of up to three scripts of up to 64KB each. If script requirements do not exceed this volume, an HTTP server does not need to be configured for this purpose.

Script files are simply loaded from the designated storage location using WEBconfig. After upload, the list of available scripts must be updated with **Setup > WLAN-Management > Central-Firmware-Management > Update Firmware and Script Information**.

The internal scripts can be referenced from the script management table using the relevant names (WLC_Script_1.lcs, WLC_Script_2.lcs or WLC_Script_3.lcs).

ⓘ Please be careful with upper and lower case letters when entering script names.

Upload Certificate or File

Select which file you want to upload, and its name/location, then click on 'Start Upload'.
In case of PKCS12 files, a passphrase may be necessary.

File Type: SSL - Certificate (*.pem, *.crt, *.cer [BASE64])

File Name/Location: SSL - Private Key (*.key [BASE64 unencrypted])

Passphrase (if required): SSL - Root CA Certificate (*.pem, *.crt, *.cer [BASE64])

Caution: Files are not performed by the interface, they can be seen in the VPN configuration.

☐ Replace existing

SSH - Container as PKCS#12-File (*.pfx, *.p12)

SSH - RSA Key (*.key [BASE64])

SSH - DSA Key (*.key [BASE64])

SSH - ECDSA Key (*.key [BASE64])

SSH - accepted public keys

VPN - Root CA Certificate (*.pem, *.crt, *.cer [BASE64])

VPN - Device Certificate (*.pem, *.crt, *.cer [BASE64])

VPN - Device Private Key (*.key [BASE64 unencrypted])

VPN - Container (VPN1) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN2) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN3) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN4) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN5) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN6) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN7) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN8) as PKCS#12-File (*.pfx, *.p12)

VPN - Container (VPN9) as PKCS#12-File (*.pfx, *.p12)

1.7 RADIUS

RADIUS stands for “Remote Authentication Dial-In User Service” and is referred to as a “triple-A protocol”. The three “A”s stand for

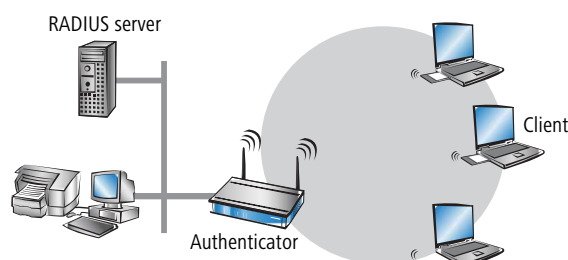
- > Authentication
- > Authorization
- > Accounting (billing)

This protocol allow you to grant users access to a network, to assign them certain rights and to track their actions. Where necessary, the RADIUS server can also be used in the billing of user services such as WLAN hot spots. For every action performed by the user, the RADIUS server can run an authorization procedure releasing or blocking access to network resources on a per user basis.

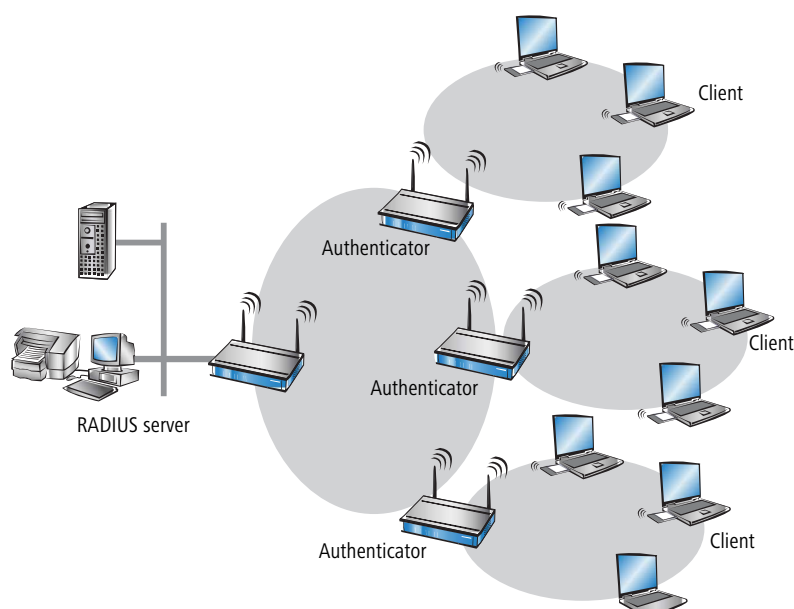
3 different devices are required for RADIUS to work.

- > Client: This is a device (PC, notebook etc.) from which the user wishes to dial in to the network.

- **Authenticator:** A network component positioned between network and client and which forwards on the authorization. This task can be performed by an access point, for example. The authenticator is referred to as the Network Access Server (NAS).



- **Authentication server:** RADIUS server on which user data is configured. This is usually located within the same network for which it issues access authorizations. It is accessible to the client via the authenticator. Some scenarios may also allow the use of an access point for this task.



The authenticator has no initial information on the clients wanting to register. This is all stored in a database on the RADIUS server. The registration information the RADIUS server needs for the authentication process is stored in the database there and can vary from network to network. The authenticator has just the one task, that of transferring the information between the client and the RADIUS server.

Access to a RADIUS server can be configured in several ways:

- Using PPP when dialing into a network
- Via WLAN
- Via a public spot for users who register using a browser
- Via the 802.1X protocol

1.7.1 Checking WLAN clients with RADIUS (MAC filter)

To use RADIUS to authenticate WLAN clients and grant them WLAN access based on their MAC address, an external RADIUS server can be used, as can the internal user table in the WLC.

In LANconfig enter the approved MAC addresses into the RADIUS database in the configuration section **RADIUS > Server** on the **General** tab. Enter the MAC address as **Name** and as **Password** and select the authentication method **All**.

1.7.2 External RADIUS server

By default the WLC forwards account and access management requests to a RADIUS server. In order for APs to contact the RADIUS server directly, the necessary server information has to be specified here. This ensures that the RADIUS application continues to function even if the WLC is unavailable. However, this means that the RADIUS server requires settings for each and every AP, and the managed APs must be able to access the RADIUS server from their management

network. If the RADIUS server is on another IP network, then it is vital that the gateway is set in the IP parameter profile.

LANconfig: **WLAN controller > Profiles > RADIUS profiles**

Name

Specify an identifier for this entry.

Backup profile

From the list of RADIUS server profiles, select a profile as the backup server.

Authentication server

IP address

Enter the IP address of authentication server.

Port

Enter the port used by the authentication server.

Secret

This entry contains the shared secret used for authorization.

Show

Enables / disables the display of the key.

Source address (optional)

Enter the loopback address of the device, where applicable.

Protocol

From the drop-down menu, choose between the standard RADIUS protocol and the secure RADSEC protocol for RADIUS requests.

Accounting server**IP address**

Enter the IP address of accounting server.

Port

Enter the port used by the accounting server.

Secret

This entry contains the shared secret used for authorization.

Show

Enables / disables the display of the key.

Source address (optional)

Enter the loopback address of the device, where applicable.

Protocol

From the drop-down menu, choose between the standard RADIUS protocol and the secure RADSEC protocol for RADIUS requests.

1.7.3 Dynamic VLAN assignment

Larger WLAN infrastructures often require individual WLAN clients to be assigned to certain networks. Assuming that the WLAN clients are always within range of the same APs, then assignment can be realized via the SSID in connection with a particular IP network. If on the other hand the WLAN clients frequently change their position and logon to different APs then, depending on the configuration, they may find themselves in a different IP network.

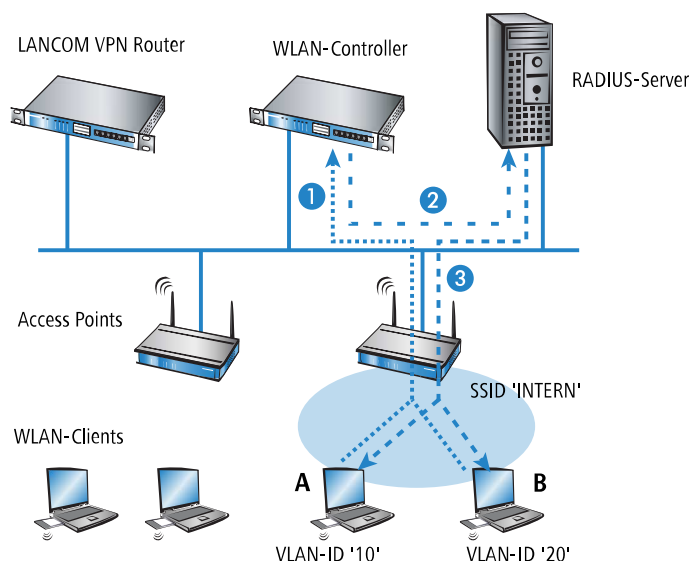
For WLAN clients to remain within a certain network **independent** of their current WLAN network, dynamically assigned VLANs can be used. Unlike the situation where VLAN IDs are statically configured for a certain SSID, in this case a RADIUS server directly assigns the VLAN ID to the WLAN client.

Example:

- > The WLAN clients of two employees log into an AP in the WPA2-secured network with the SSID 'INTERNAL'. During registration, the RADIUS requests from the WLAN clients are directed to the AP. If the corresponding WLAN interface is in the operating mode 'managed' the RADIUS requests are automatically forwarded to the WLC. This forwards the request in turn to the defined RADIUS server. The RADIUS server can check the access rights of the WLAN clients. It can also use the MAC address to assign a certain VLAN ID, for example for a certain department. The WLAN client in Marketing, for example, receives the VLAN ID '10' and WLAN client from Research & Development receives '20'. If no VLAN ID is specified for the user, the SSID's primary VLAN ID is used.
- > The WLAN clients of the guests log into the same AP in the unsecured network with the SSID 'PUBLIC'. This SSID is statically bound to the VLAN ID '99' and leads the guests into a certain network. Static and dynamic VLAN assignment can be elegantly operated in parallel.

❗ Assignment of the VLAN ID by the RADIUS server can be controlled by other criteria, such as a combination of user name and password, for example. In this way the unknown MAC address of a visitor to a company can be assigned a VLAN ID that permits guest access for Internet access only, for example, but that prohibits access to other network resources.

- ❗ As an alternative to an external RADIUS server, WLAN clients can be assigned with a VLAN ID via the internal RADIUS server or the stations table in the WLC.



1. Activate VLAN tagging for the WLC. This is done in the physical parameters of the profile by entering a value greater than '0' for the management VLAN ID.
2. For authentication via 802.1x, go to the encryption settings for the profile's logical WLAN network and choose a setting that triggers an authentication request.
3. To check the MAC addresses, activate the MAC check for the profile's logical WLAN network.

- ❗ For the management of WLAN modules with a WLC, a RADIUS server is required to operate authentication via 802.1x and MAC-address checks. The WLC automatically defines itself as the RADIUS server in the APs that it is managing—all RADIUS requests sent to the AP are then directly forwarded to the WLC, which can either process the requests itself or forward them to an external RADIUS server.
4. To forward RADIUS requests to another RADIUS server, use LANconfig to enter its address into the list of forwarding servers in the configuration section 'RADIUS servers' on the **Forwarding** tab. Alternatively, external RADIUS servers can be entered in WEBconfig under **Menu tree > LCOS Setup > RADIUS > Server > Forward servers**. Also, set the standard realm and the empty realm to be able to react to different types of user information (with an unknown realm, or even without a realm).
 5. Configure the entries in the RADIUS server so that WLAN clients placing requests will be assigned the appropriate VLAN IDs as based on the identification of certain characteristics.

- ❗ Further information about RADIUS is available in the documentation for your RADIUS server.

1.7.4 Activating RADIUS accounting for logical WLANs in the WLAN controller

The configuration for logical WLAN networks is to be found in the following menu:

LANconfig: **WLAN Controller > Profiles > Logical WLAN networks (SSIDs)**
RADIUS accounting activated

This is where you can activate RADIUS accounting for this logical WLAN network.

Possible values:

> Yes, No

Default:

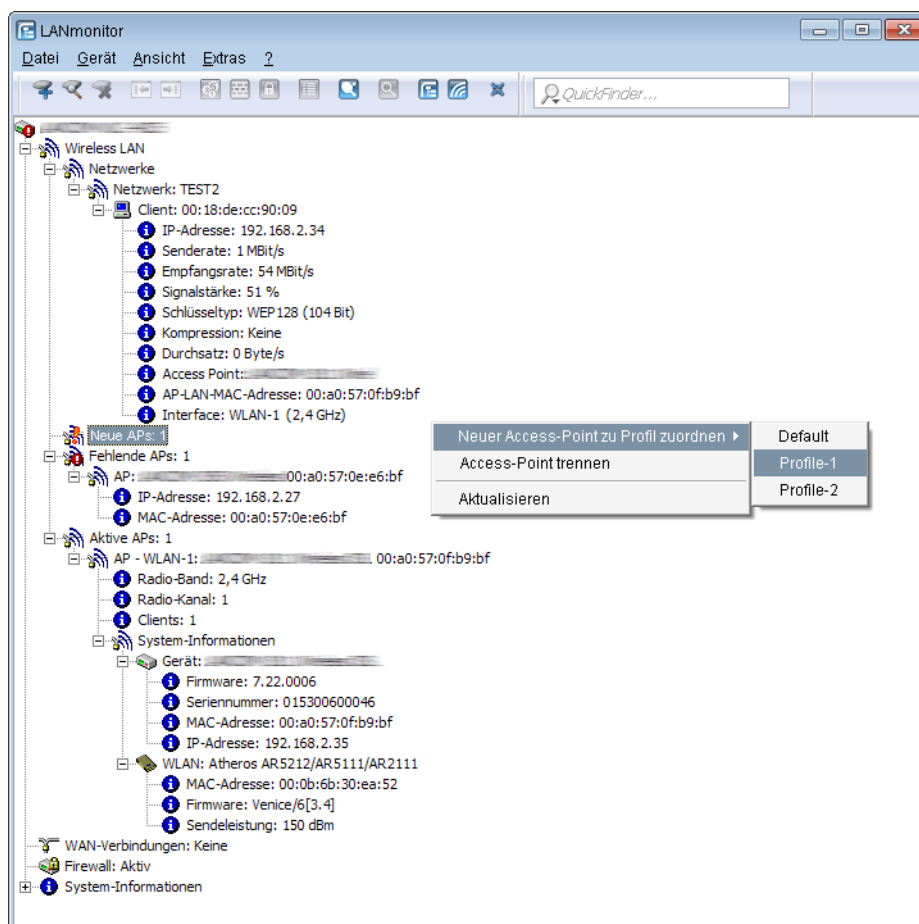
> No



The APs supporting the logical WLAN network as configured by the WLC must have a LCOS version 8.00 or higher.

1.8 Displays and commands in LANmonitor

LANmonitor gives you a quick overview of the WLCs in your network and the APs within the WLAN infrastructure. LANmonitor displays the following information, among other things:



- > Active WLAN networks with the logged-in WLAN clients and the descriptor of the APs that they are associated with.
- > Display of new APs with IP and MAC address
- > Display of missing APs with IP and MAC address
- > Display of managed APs with IP and MAC address, the utilized frequency band, and the channel

i For APs with an older firmware version and unable to transmit this data, the WLC takes the channel and frequency information from the **Active radios** status table under **Status > Active-Radios > WLAN-Management > AP-Status**.

Using the right-hand mouse key, a context menu can be opened for the APs and the following commands are available:

- > **Assign new access point to profile**

Enables a new AP to be allocated to a profile and accepted into the WLAN infrastructure.

- > **Disconnect access point**

Terminates the connection between AP and WLC. The AP then carries out a new search for a suitable WLC. This command can be used after a backup event to disconnect APs from a backup WLC and to redirect them to the correct WLC.

> **Refresh display**

Updates LANmonitor's display.

1.9 RF optimization

Selecting the channel from the channel list defines a portion of the frequency band that an AP uses for its logical wireless LANs. All WLAN clients that need to connect to an AP have to use the same channel on the same frequency band. The 2.4-GHz band works with channels 1 to 13 (depending on the country) and the 5-GHz band works with channels 36 to 64. On each of these channels, only one AP can actually transfer data. In order to operate another AP within radio range with maximum bandwidth, the AP must make use of a separate channel—otherwise all of the participating WLANs have to share the channel's bandwidth.

 With a completely empty channel list, the APs could automatically select channels which overlap in some areas, so reducing signal quality. Similarly, the APs might select channels which the WLAN clients cannot use due to the country settings. To steer APs towards certain channels, the non-overlapping channels 1, 6, 11 can be activated in the channels list.

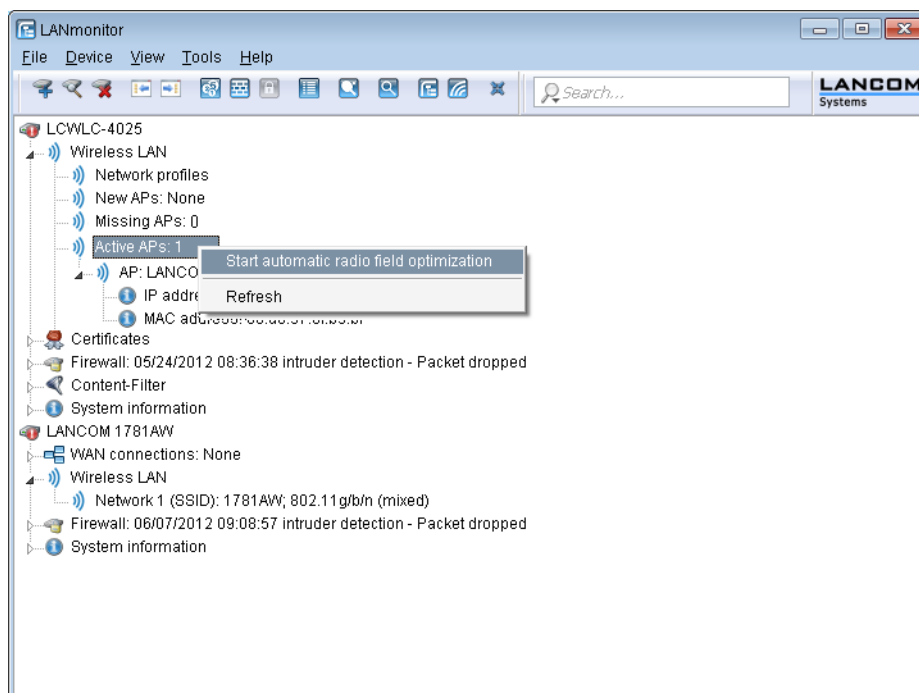
In larger installations with several APs it can be difficult to set a channel for every AP. With automatic radio-field (RF) optimization, the WLCs provide an automatic method of setting the optimum channels for APs that work in the 2.4-GHz band and 5-GHz band.

 You should ensure that APs transmitting in the 5-GHz band are set to the "indoor only" mode.

Command line: **Setup > WLAN-Management > Start-automatic-radio-field-optimization**

 You can invoke optimization for a particular AP by entering its MAC address as a parameter for the action.

LANmonitor: Right-click on the list of active APs or on a specific device, and in the context menu select **Start automatic RF optimization**.



Optimization is then carried out in the following stages:

1. The WLC assigns the same channel to all APs. The selected channel is the one being used by the majority of APs.
2. The APs carry out a background scan and report the results to the WLC.
3. Based on the devices found by the background scan, the WLC sets an interference value for each AP.
4. It then deletes the AP channel list for all APs. With the channel list now empty, each AP receives a configuration update with a new channel list for its respective profile.
5. The WLC disables the radio modules of all APs.
6. The individual APs now go through the following sequence. This begins with the AP with the highest interference value being the first to select a channel.
7. In the order of the interference values the WLC enables the radio modules in the APs, which then start their automatic calibration. Each AP automatically searches for the best channel from the channel list assigned to it. To determine which channel is the best, the AP scans for interference in order to allow for the signal strengths and channels occupied by other APs. Because the former list in the WLC configuration was deleted, this is now the profile channel list. If the profile channel list is empty, then the AP has freedom of choice from the channels that are not occupied by other radio modules. The selected channel is then communicated back to the WLC and entered into the AP channel list there. For this reason, the AP receives the same channel the next time a connection is established. The AP channel list has a higher weighting than the profile channel list.

 If an AP has multiple radio modules, each module goes through this process in succession.

 Radio-field optimization is a component of the R&S@NC Active Radio Control (ARC).

1.9.1 Group-related radio field optimization

A WLC allows the grouping of APs by location information, device properties or network structure. This grouping can also be used as a basis for radio field optimization. Instead of performing a radio field optimization either for all APs or just for one of them, you can address all of the APs within a building tract, with a particular name, or with a particular firmware version.

Groups can be addressed via WEBconfig and also via the console by means of the Group parameters:

```
do /Setup/WLAN-Management/start optimization <Group>
```

The APs can be filtered with the following group-parameter options:

-g <Group name>

APs, which belong to the group. Multiple group names can be separated by commas.

-l <Location>

APs with the corresponding location setting.

 The combination of **-l** and one of the location options **-c** to **-r** is not useful.

-c <Country>

APs with the corresponding country setting.

-i <City>

APs with the corresponding city setting.

-s <Street>

APs with the corresponding street setting.

-b <Building>

APs with the corresponding building setting.

-f <Floor>

APs with the corresponding floor setting.

-r <Room>

APs with the corresponding room setting.

-d <Device name>

APs with the corresponding device name.

-a <Antenna>

APs with the corresponding number of antennas.

 A combination of the options **-d** and **-a** is not useful.

-v <Firmware>

APs with this firmware version only.

-x <Firmware>

APs with a firmware version less than that specified here.

-y <Firmware>

APs with a firmware version less than or equal to that specified here.

-z <Firmware>

APs with a firmware version greater than that specified here.

-t <Firmware>

APs with a firmware version greater than or equal to that specified here.



Combinations are possible, e.g. to address APs with a firmware version between two versions.

-n <Intranet-Address>

APs located on the intranet with the address specified here.

-p <Profile name>

APs included in the WLAN profile specified here.

1.10 Client steering by WLC

With client steering, certain criteria are used to help WLAN clients located within transmission range to connect to the best suited AP. These criteria are centrally defined in the WLC. Managed APs constantly report the current values to the WLC, which uses these criteria to decide which APs may respond to requests from WLAN clients. For this reason, client steering is only possible with APs that are centrally managed by a WLC.

In managed networks a WLC centralizes the client steering for all connected APs. In this case, client steering works as follows:

1. The WLC collects the data about the associated WLAN clients from the APs connected to it. These data are the basis for the WLC to control the client steering.
2. All APs are configured so that client steering is handled by the WLC.
3. An unassociated WLAN client sends a probe request to the APs within its range.
4. Using CAPWAP, the APs transmit the request and the signal strength of the WLAN client to the WLC.
5. For each AP within range of the WLAN client, the WLC calculates a value from three factors:
 - > Signal strength value
 - > A value calculated from the number of clients associated at the AP
 - > Frequency band value

The WLC weights these factors and multiplies them together to derive the final value.

6. APs with the highest value, or a value that deviates from it within a specified tolerance level, receive a message from the WLC that they may accept the WLAN client at the next login attempt.
7. WLAN clients attempting to connect to an AP before it has received the response from the WLC are rejected.
8. If a WLAN client is acting "sticky", i.e. it does not attempt to connect to another AP with a good connection quality even though its current connection is of a lower quality, the WLC can prompt the current AP to log off the WLAN client. The WLAN client is then forced to connect with the AP offering the better connection.



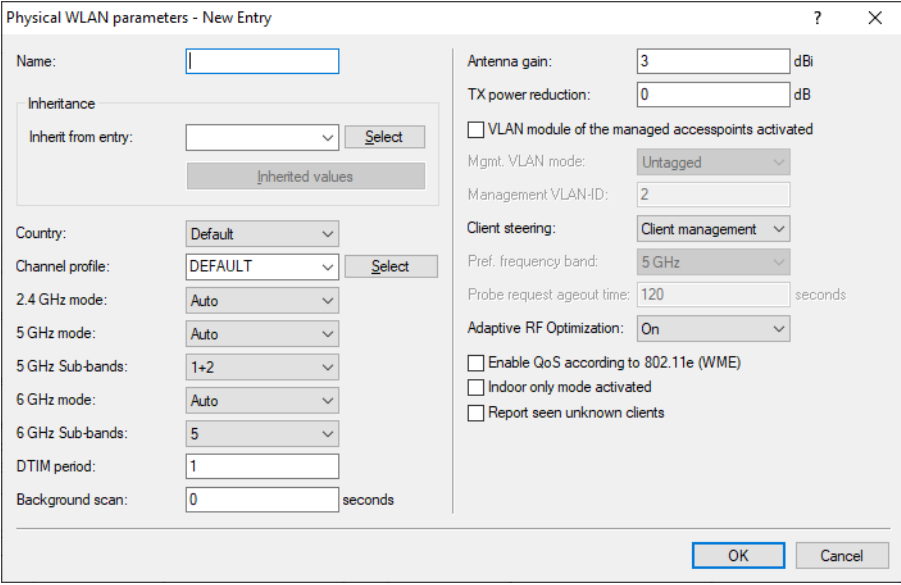
If an AP loses connection to the WLC which is responsible for client steering, the AP accepts all connections from authenticated WLAN clients.

- ! In order to optimize managed client steering, all APs require the installation of LCOS9.00 or later. If you have mixed operations with APs using earlier versions of LCOS, your WLAN will not be capable of optimizing the distribution of clients.
- ! In scenarios with time-critical roaming, such as with VoIP phones, you should not use client steering, as this can delay the client's login process.

1.10.1 Configuration

You configure client steering with LANconfig as follows:

- First, in the WLC you activate client steering for an AP under **WLAN controller > Profiles > Physical WLAN parameters** using the selection list **Client steering**.
 - > **Off**: Client steering is deactivated.
 - > **AP-based band steering**: The AP independently steers the WLAN client to a preferred frequency band.
 - > **On**: The AP lets the WLC handle the client steering.



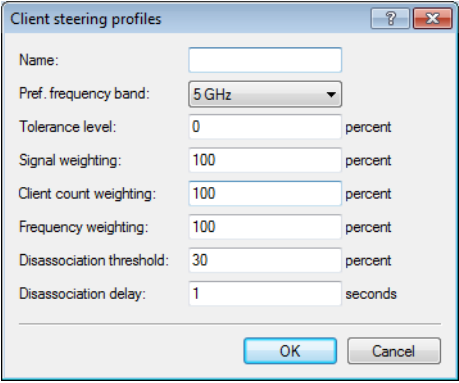
The dialog box 'Physical WLAN parameters - New Entry' contains the following fields and options:

- Name:** Text input field.
- Inheritance:**
 - Inherit from entry:** Dropdown menu with a 'Select' button.
 - Inherited values:** Button.
- Country:** Dropdown menu (Default).
- Channel profile:** Dropdown menu (DEFAULT) with a 'Select' button.
- 2.4 GHz mode:** Dropdown menu (Auto).
- 5 GHz mode:** Dropdown menu (Auto).
- 5 GHz Sub-bands:** Dropdown menu (1+2).
- 6 GHz mode:** Dropdown menu (Auto).
- 6 GHz Sub-bands:** Dropdown menu (5).
- DTIM period:** Text input field (1).
- Background scan:** Text input field (0) with 'seconds' label.
- Antenna gain:** Text input field (3) with 'dBi' label.
- TX power reduction:** Text input field (0) with 'dB' label.
- ☐ **VLAN module of the managed accesspoints activated**
- Mgmt. VLAN mode:** Dropdown menu (Untagged).
- Management VLAN-ID:** Text input field (2).
- Client steering:** Dropdown menu (Client management).
- Pref. frequency band:** Dropdown menu (5 GHz).
- Probe request ageout time:** Text input field (120) with 'seconds' label.
- Adaptive RF Optimization:** Dropdown menu (On).
- ☐ **Enable QoS according to 802.11e (WME)**
- ☐ **Indoor only mode activated**
- ☐ **Report seen unknown clients**

Buttons: OK, Cancel.

- The menu **WLAN-Controller > AP-Configuration > Client steering profiles** contains two preconfigured default profiles (high density, default), which are sufficient for most use cases. Optionally, you create a new client steering profile by clicking on **Add**.

Client-steering profiles control how the WLC decides which APs are to accept a client at the next login attempt.



The dialog box 'Client steering profiles' contains the following fields and options:

- Name:** Text input field.
- Pref. frequency band:** Dropdown menu (5 GHz).
- Tolerance level:** Text input field (0) with 'percent' label.
- Signal weighting:** Text input field (100) with 'percent' label.
- Client count weighting:** Text input field (100) with 'percent' label.
- Frequency weighting:** Text input field (100) with 'percent' label.
- Disassociation threshold:** Text input field (30) with 'percent' label.
- Disassociation delay:** Text input field (1) with 'seconds' label.

Buttons: OK, Cancel.

The items have the following meanings:

Name

Name of the client-steering profile.

Pref. Frequency band

Specifies the frequency band to which the WLC steers the WLAN client.

> **2.4GHz:** The WLC steers the WLAN client to the 2.4-GHz frequency band.

> **5GHz:** The WLC steers the WLAN client to the 5-GHz frequency band.

Tolerance level

The calculated value for an AP may deviate from the maximum calculated value by this percentage value in order for the AP to be allowed to accept the client at the next login attempt.

Signal-Strength-Weighting

Specifies the percentage weighting of the signal-strength value used to calculate the final value.

Associated-Clients-Weighting

Specifies with how many percent the number of clients associated with an AP is entered into the final value.

Frequency-Band-Weighting

Specifies the percent weighting of the value for the frequency band used to calculate the final value.

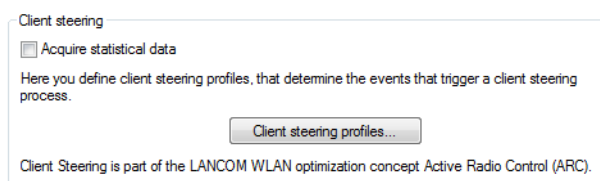
Disassociation threshold

Specifies the percentage of the maximum signal strength. If the current signal strength falls below this value, the client is disconnected.

Disassociation delay

Specifies the number of seconds in which no data is transferred between AP and client before the AP disconnects the client.

3. Optional: Enable the capture of client-steering statistics with the parameter **Acquire statistical data**. This statistical data is suitable for analysis by LANmonitor, for example.



Client steering

☐ Acquire statistical data

Here you define client steering profiles, that determine the events that trigger a client steering process.

Client steering profiles...

Client Steering is part of the LANCOM WLAN optimization concept Active Radio Control (ARC).

-  Statistics capture increases the load on the WLC. Rohde & Schwarz Networks and Cybersecurity does not recommend the permanent recording of statistics.

4. Now assign one of the client-steering profiles to the corresponding AP in the AP table under **WLAN controller > AP configuration > Access point table**.

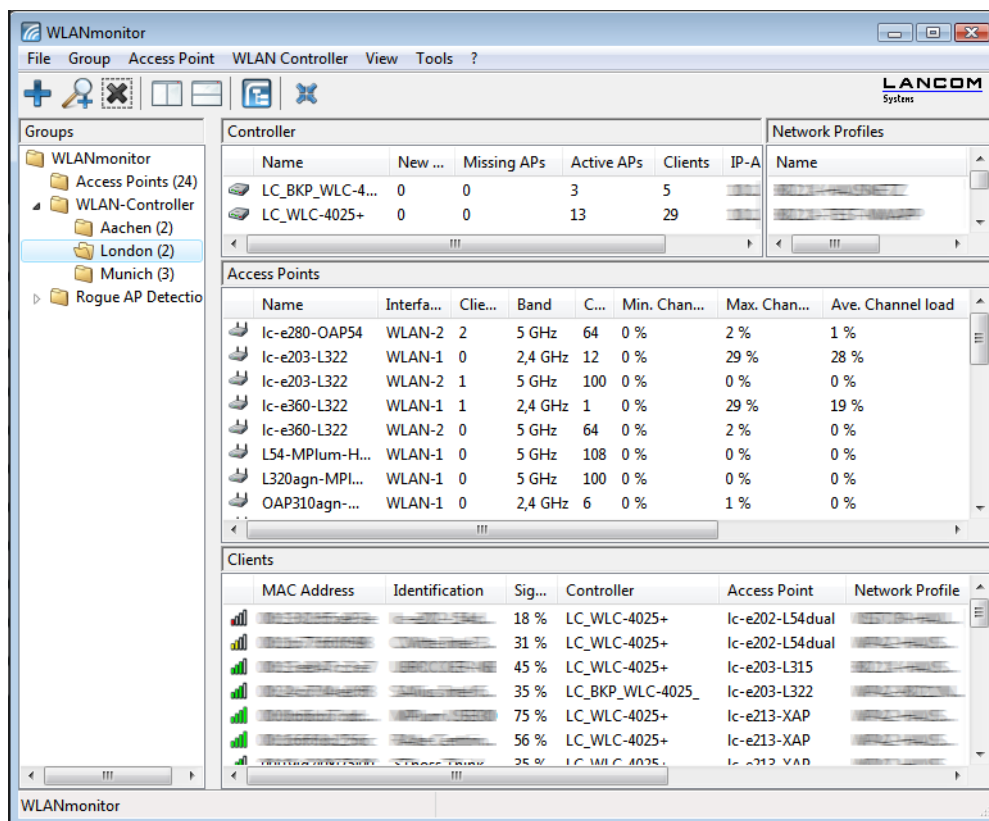
5. Optional: If necessary, assign a suitable client-steering group to the defined assignment groups.

You have now completed the configuration of the client steering.

1.11 Channel-load display in WLC mode

The loads on the various channels used by each AP which is managed by a WLC are displayed as three values, the minimum, maximum and average channel load. The values displayed are

measured every three minutes. Consequently, the first values are displayed after three minutes at the earliest.



1.12 Backing up the certificates

At system startup, a WLC generates the basic certificates for the assignment of certificates to the APs, including the root certificates for the CA (Certification Authority) and the RA (Registration Authority). Based on these two certificates, the WLC issues device certificates for the APs.

If multiple WLCs are employed in parallel in the same WLAN infrastructure (for load balancing) or if a device is being replaced or reconfigured, the same root certificates should always be used to avoid problems operating the managed APs.

1.12.1 Create backups of the certificates

To restore the CA or RA, the relevant root certificates with private keys will be required as generated automatically when the WLC was started. Furthermore the following files with information on issued device certificates should also be backed up. To ensure that this confidential information remains protected even when exported from the device, it is initially stored to a password-protected PKCS12 container.

WEBconfig

1. Open the configuration of the WLC in WEBconfig and go to **Extras > LCOS menu tree > Setup > Certificates > SCEP-CA > CA-certificates**.

2. Select the command **Create PKCS12 backup files** and enter the passphrase for the PKCS12 container as the additional argument.

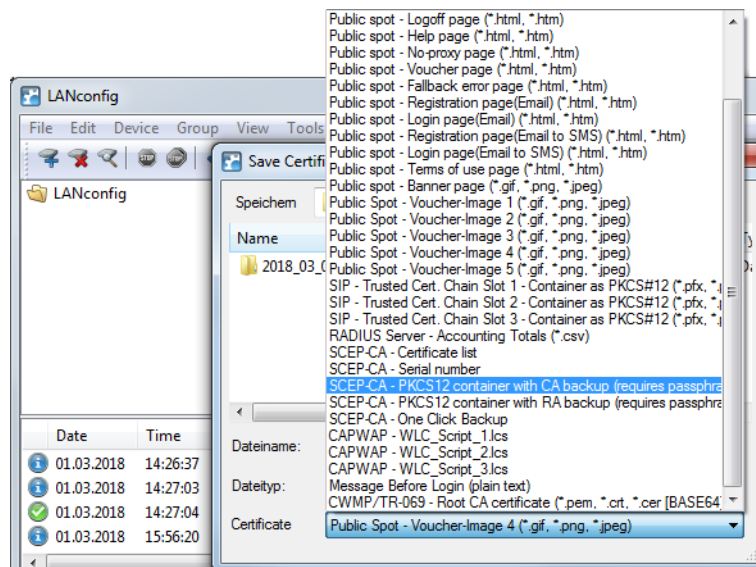
Create-PKCS12-Backup-Files

Enter here any additional arguments for the command you are about to execute:
 Arguments

This command backs up the certificates and private keys to the PKCS12 files and these can then be downloaded from the device.

LANconfig

1. Highlight the WLC in the device view section and in the menu **Device > Configuration management** select the item **Save certificate as file**.
2. Set the **Certificate type** to PKCS12 container and click **Save**.



1.12.2 Uploading a certificate backup into the device

1. Click on **Extras > File management > Upload certificate or file**.
2. Select the two entries for SCEP-CA as data type one after the other:
 - > PKCS12 container with CA backup
 - > PKCS12 container with RA backup

- For each upload, enter the file name, storage location, and the passphrase that was defined when the backup file was created. Confirm with **Start upload**:

Upload Certificate or File

Select which file you want to upload, and its name/location, then click on 'Start Upload'.
In case of PKCS12 files, a passphrase may be necessary.

File Type:

File Name/Location:

Passphrase (if required):

Caution: Files are not being checked for correct contents or passphrase during upload. These checks are performed by the individual modules using these files. When uploading certificates, possible error messages can be seen in the VPN status trace immediately after download.

- After loading the CA backup, the file `controller_rootcert` in the directory **Status > File-System > Contents** must be deleted.
Enter the following commands in the console:

```
cd /Status/File-System/Contents
del controller_rootcert
```

- After restoring the backup, delete all files that start with `controller_` or `eaptls_`.
- After that, access the directory **Setup > Certificates > SCEP-Client** and execute the command `Reinit`:

```
cd /Setup/Certificates/SCEP-Client
do Reinit
```

1.12.3 Backing up and restoring further files from the SCEP-CA

To be able to fully restore the SCEP-CA, it is important to have the information on the device certificates issued for the individual APs by the SCEP-CA.

! If the root certificates only were backed up, then any issued device certificates can no longer be revoked!

For this reason the following files have to be saved in addition to the certificates themselves:

- > SCEP certificate list: List of all certificates ever issued by the SCEP-CA.
- > SCEP serial numbers: Contains the serial number for the next certificate.

- Click on **Extras > File management > Download certificate or file**.
- Select the entries listed above as data type one after the other and then confirm with **Start download**:

Download Certificate or File

Select which file you want to download, then click on 'Start Download':

File Type:

- To upload these files to the device, go to the entry page of WEBconfig and select the command **Upload certificate or file**.

4. Select the entries listed above as data type one after the other, enter each file name and storage location and confirm with **Start upload**:

Upload Certificate or File

Select which file you want to upload, and its name/location, then click on 'Start Upload'.
In case of PKCS12 files, a passphrase may be necessary.

File Type:

File Name/Location:

Passphrase (if required):

Caution: Files are not backed up by the individual services. If files are not backed up, the services can be seen as corrupted.

Use checks are available for error

Public Spot - Welcome Page (*.html, *.htm)
Public Spot - Login Page (*.html, *.htm)
Public Spot - Error Page (*.html, *.htm)
Public Spot - Start Page (*.html, *.htm)
Public Spot - Status Page (*.html, *.htm)
Public Spot - Logoff Page (*.html, *.htm)
Public Spot - Help Page (*.html, *.htm)

- ❗ After installing a new certificate list, expired certificates are removed and a new CRL is created. Furthermore, the CA reinitializes itself automatically if certificates and keys are successfully extracted after loading the certificate backup.

1.12.4 One-click backup of the SCEP-CA

In order to simplify the backup of the CA in the WLC, the device offers the option to generate a complete certificate record with a single action (one-click backup). This record makes it possible to completely back up and restore the CA and prevent certificate conflicts from occurring.

These conflicts can occur if you have downloaded the individual PKCS12 containers from the device separately and then reloaded: If the WLC has created a new CA in the meantime and has issued new certificates, the deviating CAs temporarily lead to authentication problems for the different services in LCOS. If you cannot wait until the individual services request new certificates, a manual resolution requires deleting the SCEP files from the LCOS file system and re-initialization of the SCEP clients. By reloading a one-click backup, on the other hand, LCOS performs the necessary steps automatically.

Creating a backup file

In order to create a certificate record, perform the action **Create PKCS12 backup files** under **Setup > Certificate > SCEP-CA > CA certificate**. This action generates a ZIP file within the LCOS file system that contains all necessary files. To protect the certificates and keys contained therein, the ZIP file is automatically protected with the device password, unless you enter another password. The ZIP file that was generated can then be downloaded, for example, in WEBconfig via **Extras > File management > Download certificate or file > SCEP-CA - One Click Backup**.

Reloading the backup file

In order to reload certificate records, load the saved ZIP file directly into the device using the passphrase. In WEBconfig, for example, this is done by selecting **Extras > File management > Upload certificate or file > SCEP-CA - One Click Backup**. Enable the option **Replace existing CA certificates** so that the device automatically restores the certificate record after the upload.

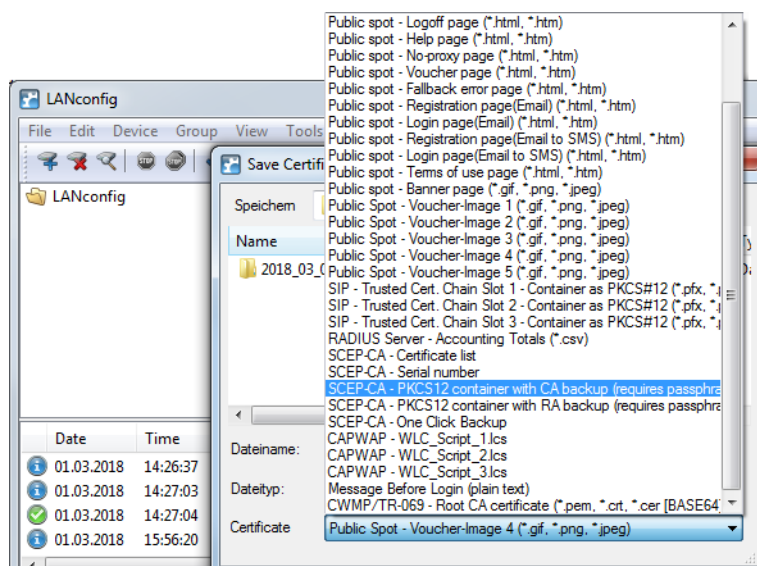
- ❗ If you do not use this option, or if you upload the backup file to the device by other means, you must execute the action **2.39.2.2.11 Restore-certificates-from-Backup** in order for the device to restore the certificate record.

1.12.5 Using LANconfig to backup and restore certificates

Certificates are stored and uploaded with LANconfig as follows:

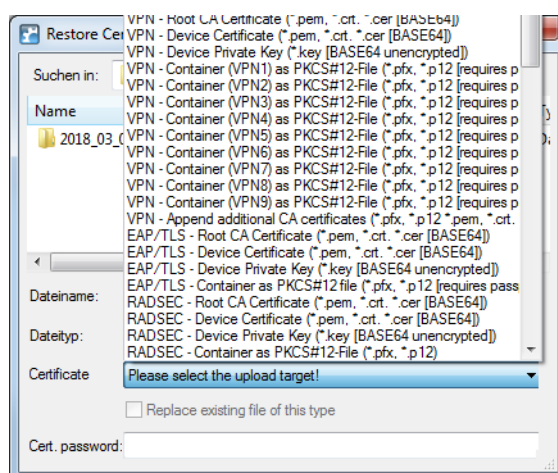
Save

1. Highlight the WLC in the device view section and in the menu **Device > Configuration management** select the item **Save certificate as file**.
2. Set the **Certificate type** to PKCS12 container and click **Save**.



Upload

1. Highlight the WLC in the device view section and in the menu select **Device > Configuration management** and the item **Upload certificate or file**.
2. Set the **Certificate type** to PKCS12 container.
3. Now navigate to the desired file, enter the password if necessary and click **Open**.



One Click Backup

For the One Click Backup, select the entry "SCEP-CA - One Click Backup" from the dialog list.

1.13 Backup solutions

WLCs manage a large number of APs, which in turn may have a large number of WLAN clients associated with them. WLCs thus play a crucial role in the functioning of the entire WLAN infrastructure—for which reason the organization of a backup solution in case of temporary WLC failure is in many cases indispensable.

In case of a backup event, a managed AP should connect to an alternative WLC. Because this connection will only function if the certificate in the AP has been authorized by the backup controller, it is essential that all WLCs sharing a backup solution have identical root certificates.

1.13.1 WLC cluster

If you are operating multiple WLCs in your network, you can collect these devices into a cluster. The APs in a managed WLAN are no longer managed by a single, central WLC but by multiple, synchronized WLCs. For large networks in particular, a WLC cluster provides numerous advantages:

- > Automatic network “load balancing” between the individual APs and WLCs;
- > Increased failover reliability through the provision of backup WLCs (“hot standby”) and automatic redistribution of the APs in the case of a WLC failure;
- > Setting up a certificate hierarchy: Management of certificates by a central certification authority (CA), represented either by a master WLC or an external station (such as a server).

As of LCOS 9.00, the cluster function received numerous enhancements described below.

Enabling/disabling CAPWAP in the WLC

In order to operate multiple WLCs in a cluster, they must all have identical configurations. This is not the case on one WLC by default, since it automatically generates certain configuration parts (such as certificates). By disabling CAPWAP on all devices except one, you have the option of setting one of the devices in your WLC cluster as a master controller. The other WLCs can be synchronized with the master WLC's configuration.

Learn more about mirroring a configuration in the section [Config-Sync](#).

WLC tunnel for internal communication

The use of WLC tunnels is essential for a WLC cluster. The WLCs in the WLC cluster use this tunnel to communicate with one another and keep their status information aligned. With the feature extensions as of LCOS 9.00, the way that LCOS deals with WLC tunnels is also improved:

- > WLCs are able to find one another automatically.
- > You have the option to statically configure WLC tunnels.
- > WLCs disconnect a WLC tunnel only after a timeout.
- > WLC tunnels can be switched on or off globally.

The settings for the WLC tunnels and other WLCs (remote WLCs) are located in the section **WLAN controller > General > WLC cluster**. The setting **WLC tunnel active** allows you to disable the usage of WLC tunnels, which in effect causes the clustering feature to be switched off.

Finding the ideal WLC

The algorithms implemented in LCOS ensure that the APS are intelligently distributed between the individual WLCs. This allows the APs to equally distribute the network load between all of the WLCs in a cluster, or to select an alternative WLC if one should fail. For this, an AP first sends out a discovery request on the network to identify all available WLCs. The WLCs then respond with

a discovery response which an AP uses to create a prioritized list of WLCs. This AP prioritizes the list based on various criteria.

An AP works through the different criteria sequentially: If multiple WLCs appear to be ideal candidates after applying a criterion, the AP uses the next criteria to prioritize. This process ends when a WLC finally identifies just one WLC as being ideal after the prioritization described in the following.

Criteria for prioritization

- **Specificity of the AP configuration:** An AP evaluates whether a WLC can provide it with a configuration, and whether this contains a specific AP profile or a default profile. The AP prioritizes a specific AP profile as highest, followed by a default profile. If a profile is missing, it is given the lowest priority.
- **The preference value:** The AP evaluates the preference value that you have assigned to a WLC. The higher the number between 0 and 255, the higher the AP prioritizes the WLC.

If there still remain several WLCs which are considered to be ideal, the prioritization process continues by evaluating the connection status and the type of selection process (automatically vs. manually initiated):

- When the **calculation is triggered for the first time**, an AP calculates a weighted value for each of the remaining WLCs by taking the number of APs connected to each WLC and comparing this with the maximum possible number of APs (**license usage**). Ultimately, the ideal WLC is taken as that with the lowest license usage.



If a WLC has reached the maximum possible number of AP connections (license quota exhausted), an AP no longer considers the affected WLC for the current selection.

- In the case of **automatic checking** of the ideal AP distribution, an AP stays with the WLC it is connected to if this WLC is included in the list of the remaining WLCs. Otherwise, a **randomized algorithm** causes the AP to select an arbitrary AP.
- In the case of a **manually triggered check**, a **randomized algorithm** ensures that the APs distribute the available license quotas as evenly as possible across the network.

Determining the ideal AP distribution

The identification of the ideal AP distribution in a WLC cluster and any redistribution that may be triggered by it occur automatically. Every AP automatically performs the [Finding the ideal WLC](#) process at irregular intervals between 30 and 60 minutes. If the result of the process is positive for the WLC which is already connected, no redistribution takes place. If a different WLC has a higher priority, the AP attempts to connect to this WLC.

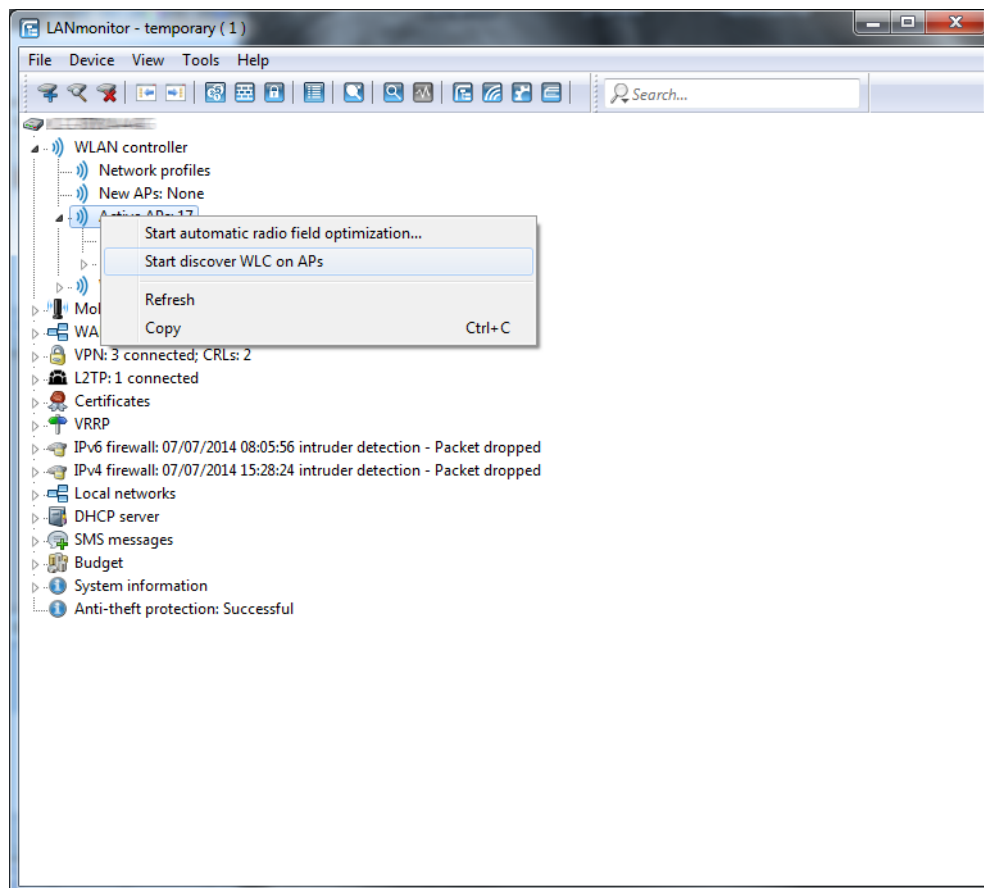
However, as an administrator you can use LANmonitor to manually trigger a calculation of the ideal AP distribution and the resulting redistribution of the APs (see [Manually initiate ideal AP distribution](#) on page 105).

Manually initiate ideal AP distribution

The following steps show you how to start the recalculation of an ideal distribution, and if necessary to trigger a redistribution.

1. Start LANmonitor and select a WLC.
2. Navigate to the menu item **Wireless LAN > Active APs**.

3. Open the context menu on any AP and select **Start WLC search on APs**.



The access points each find their optimum WLC and distribute themselves across the WLC cluster according to the specifications.

Setting up a CA hierarchy

In order to operate multiple WLCs in a WLC cluster, they all need to have identical configurations. This also includes the certificates used within the WLC cluster. The solution lies in establishing a certificate hierarchy, also known as a CA hierarchy: This involves defining the CA of a WLC as the root-CA. The other WLCs retrieve this certificate for their (sub-) CA.

The following scenario shows you the configuration steps which are necessary for setting up a CA hierarchy. As examples, the configuration is done using two WLCs:

- > WLC-MAIN represents the device with the root-CA;
- > WLC-SUB is the device which obtains a certificate from the root-CA in order to issue further certificates as a sub-CA.

Configuring the root-CA

The following section describes how to set up a root CA on a WLC. These steps assume that the device has been reset, that you have commissioned the device in the standard manner, and that you have set the correct time.

1. Login to your device via WEBconfig or the command line.
2. Navigate to the menu **Setup > Certificates > SCEP-CA > CA-Certificates**. Customize the name of the certificate authority (CA) and the registration authority (RA) with the parameters **CA-Distinguished-Name** and **RA-Distinguished-Name**.

Example: /CN=WLC-MAIN CA/O=LANCOM SYSTEMS/C=DE

3. Navigate to the menu **Setup > Certificates > SCEP-CA** and set the parameter **Operating** to **Yes**.

You have now completed the configuration of the root CA. The command `show ca cert` on the command line allows you to verify that the WLC has created the certificate correctly.

Configuring the sub-CA

The following section describes how to set up a sub-CA on a WLC. These steps assume that the device has been reset, that you have commissioned the device in the standard manner, and that you have set the correct time.

1. Login to your device via WEBconfig or the command line.
2. Navigate to the menu **Setup > Certificates > SCEP-CA** and set the parameter **Root-CA** to **No**.
3. Navigate to the menu **Setup > Certificates > SCEP-CA > CA-Certificates**. Customize the name of the certificate authority (CA) and the registration authority (RA) with the parameters **CA-Distinguished-Name** and **RA-Distinguished-Name**.

Example: /CN=WLC-SUB CA/O=LANCOM SYSTEMS/C=DE

4. Switch to the menu **Setup > Certificates > SCEP-CA > Sub-CA** and enter the distinguished name of the root-CA under the parameter **CADN**.

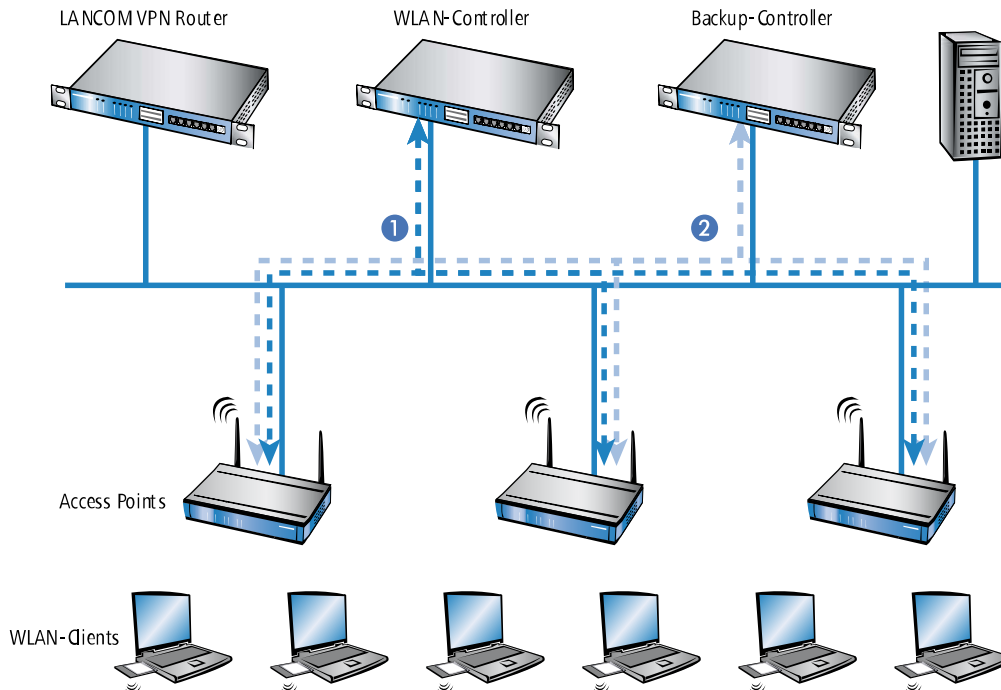
Example: /CN=WLC-MAIN CA/O=LANCOM SYSTEMS/C=DE

5. For the parameter **Challenge-Pwd**, enter the challenge password that is stored on WLC-MAIN under **Setup > Certificates > SCEP-CA**.
6. Enter the URL (address) to the root CA in the **CA-Url-address** parameter.
If another WLC with the LCOS operating system provides the root CA, all you need to do is replace the IP address in the default value with the address where the corresponding device is to be reached. Example: `http://192.168.1.1/cgi-bin/pkiclient.exe`.
7. Optional: Specify the **Ext-Key-Usage** and **Cert-Key Usage** to restrict the functions of the sub-CA. For more information, see the Menu Reference Guide.
8. Set the parameter **Auto-generated-request** to **Yes** to activate the sub-CA.
9. Navigate to the menu **Setup > Certificates > SCEP-CA** and set the parameter **Operating** to **Yes** to enable the CA server with SCEP.

You have now completed the configuration of the sub-CA. The command `show ca cert` on the command line allows you to verify that the WLC has created the certificate correctly. The hierarchy of certificates must be visible here: The WLC first displays the certificate of the root CA and then the certificate of the sub-CA.

1.13.2 Backup with redundant WLAN controllers

This is worthwhile for backing up a WLC with a second WLC, the aim being to maintain full control over all managed APs at all times. The backup WLC is configured in such a way that it obtains the necessary certificates from the backed-up primary WLC via SCEP.



1. Set the same time on the two WLCs 1 and 2.
2. Switch off the CA on the backup WLC (WEBconfig: LCOS menu tree > Setup > Certificates > SCEP-CA > SCEP-Operating).
3. In the configuration of the SCEP client in the backup WLC, create a new entry in the CA table (in LANconfig under **Certificates** > **SCEP client** > **CA table**). The CA of the primary WLC is entered here.

4. The URL is to be entered as the IP address or the DNS name of the primary WLC followed by the path to the CA `/cgi-bin/pkiclient.exe`. For example `10.1.1.99/cgi-bin/pkiclient.exe`.

- > **Distinguished-Name:** Standard name of the CA (/CN=LANCOM CA/O=LANCOM SYSTEMS/C=DE) or the name given on the primary Controller
- > Enable **RA auto-approve**
- > **Usage type:** WLAN controller

5. Then create a new entry in the certificate table with the following information:

- > **CA-Distinguished-Name:** The standard name under which the CA is entered, e.g. /CN=LANCOM CA/O=LANCOM SYSTEMS/C=DE
 - > **Subject:** Specification of the primary WLAN controller's MAC address in the form: /CN=00:a0:57:01:23:45/O=LANCOM SYSTEMS/C=DE
 - > **Challenge password:** The general challenge password of the CA on the primary WLAN controller or a password for the Controller specified manually.
 - > **Extended key usage:** critical,serverAuth,1.3.6.1.5.5.7.3.18
 - > **Key length:** 2048 bits
 - > **Usage type:** WLAN controller
6. If a SCEP configuration was previously active on the backup controller, the following actions must be executed under WEBconfig (**LCOS Menu Tree > Setup > Certificates > SCEP client**):
- > Clear-SCEP-Filesystem
 - > Update (2x: the first time, the SCEP client retrieves the new CA/RA certificates only; the second time the device certificate is updated)
7. Configure the first WLC **1** according to your requirements with all profiles and the associated AT table. The APs then establish connections to the first WLC. Each AP receives a valid certificate and a configuration for the WLAN module from the WLC.
8. Transfer the configuration from the first WLC **1**, for example using LANconfig, to the backup controller **2**. The profiles and the AP tables with the MAC addresses of the APs are transferred to the backup WLC at the same time. All APs remain logged on to the first WLC. Once the configuration is transferred, you need to give the backup controller a new IP address.

Should WLC **1** fail, the APs will automatically search for another WLC and they will find the backup WLC **2**. Because this has the same root certificate, it is able to check the validity of the APs' certificates. Because the APs are also entered into the backup WLC's AP table along with their MAC addresses, the backup WLC can fully take over the management of the APs. Changes to the WLAN profiles in the backup WLC will directly affect the managed APs.

! In this scenario, the APs remain under the management of the backup WLC until this itself becomes unavailable or is manually disconnected.

- ! If the APs are set up for standalone operation they will remain operational while searching for a backup WLC, and the WLAN clients will remain associated.

1.13.3 Backup with primary and secondary WLAN controllers

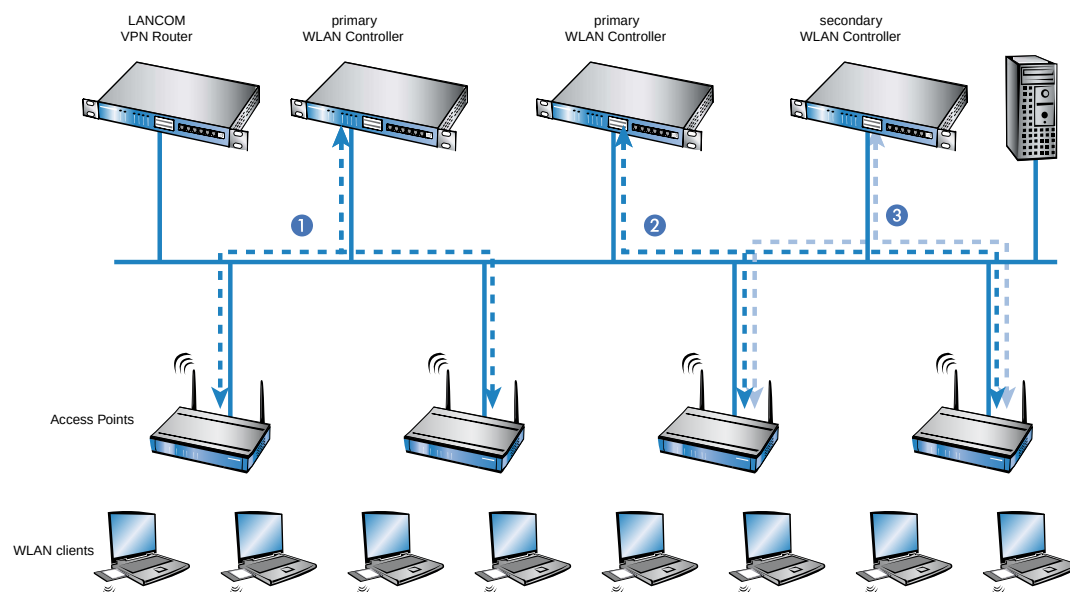
This second type of backup you can provide a larger number of "primary" WLCs with one common "secondary" backup WLC. In case a WLC should fail, the APs remain operational but they work with the current configuration of the WLAN modules. As a secondary WLC, the backup WLC cannot assign any configuration changes to the APs.

1.13.4 Primary and secondary controllers

The establishment of a WCL/AP connection is always initiated by the AP. An AP in managed mode will search the LAN for a WLC that will provide it with a configuration. During this search the AP may find various suitable WLCs:

- > The WLC can authenticate the **certificate** in the AP and it has a **configuration** stored for the MAC address of the AP. A WLC of this type is described as a "primary" WLC.
- > A WLC can authenticate the **certificate** of an AP, but it has **neither a configuration** stored for the MAC address of the AP, **nor does it have a default configuration**. A WLC of this type is described as a "secondary" WLC.

This is an example of a backup solution with three WLCs for 50 managed APs: Two of the WLCs each manage 25 APs and the third is available as a backup WLC:



- ! A WLC is now able to accommodate five times the maximum number of APs that it can manage by itself. For each five WLCs (identical models), just one additional WLC is sufficient to provide a full backup WLC in case of failure.

1. Set the same time on all of the WLCs 1, 2 and 3.
2. Transfer the CA and RA certificates from the first primary WLC 1 to the second primary WLC 2 and to the secondary "backup WLC" 3.
3. Configure the first WLC 1 according to your requirements with the profiles and the associated AP table for one half of the APs. This WLC becomes the primary WLC for the APs entered into it.

-
- ❗ For a backup solution using a secondary WLC, be sure to set the time for standalone operations such that the AP has time to find a backup WLC. This is because the backup WLC is not able to provide a new configuration for the AP.

Once the AP has established a backup connection to a secondary WLC the countdown until expiry of standalone operation is halted. The AP and its WLAN networks remain active as long as there is a connection to a WLC.

1. Configure the second WLC **2** for the other half of the APs, which subsequently treat this WLC as their primary WLC.
2. For the backup WLC **3** the time and the root certificates are set up only. No further configuration is required.
3. After being started, the APs search for a WLC by emitting a discovery message. In this case, all three WLCs respond to this message—the APs select "their" primary WLC for the DTLS connection that follows. One half of the APs decides on WLC **1** and the other half chooses WLC **2**. Because WLC **3** does not function as primary WLC for any of the APs, none of the APs log on to it.
4. Should WLC **2** fail, the APs will automatically search for another WLC. They discover the WLC **A** and **C**, whereby **A** is already under full load with its 25 APs. Backup controller **C** is able to check the validity of the certificates, i.e. it can authenticate the APs and accept them as managed APs. However, because the APs are **not** entered with their MAC numbers into the backup WLC's AP table, the backup WLC cannot manage the APs any further; they simply continue to operate with their current WLAN configurations.

-
- ❗ If WLC **A** is not under full load, for example because some of "its" APs are switched off, then some of the searching APs could log on here. WLC **A** remains a "secondary" controller for these APs because it does not have their configuration profiles. If in this case one of the APs with an entry in the AP table of WLC **A** is switched on again, then **A** accepts this reactivated AP and, in exchange, it disconnects one of the backup-event APs.

-
- ❗ If the APs are set up for standalone operation they will remain operational while searching for a backup WLC, and the WLAN clients can continue to use all of their functions.

1.13.5 Automatic search for alternative WLCs

As of LCOS 9.00, an AP no longer attempts to reconnect to the last known WLC in case of a disconnection. Instead, the AP searches in the network for an available WLC which corresponds to the criteria for the [Finding the ideal WLC](#).

1.13.6 One-click backup of the SCEP-CA

In order to simplify the backup of the CA in the WLC, the device offers the option to generate a complete certificate record with a single action (one-click backup). This record makes it possible to completely back up and restore the CA and prevent certificate conflicts from occurring.

These conflicts can occur if you have downloaded the individual PKCS12 containers from the device separately and then reloaded: If the WLC has created a new CA in the meantime and has issued new certificates, the deviating CAs temporarily lead to authentication problems for the different services in LCOS. If you cannot wait until the individual services request new certificates, a manual resolution requires deleting the SCEP files from the LCOS file system and re-initialization of the SCEP clients. By reloading a one-click backup, on the other hand, LCOS performs the necessary steps automatically.

Creating a backup file

In order to create a certificate record, perform the action **Create PKCS12 backup files** under **Setup > Certificate > SCEP-CA > CA certificate**. This action generates a ZIP file within the LCOS file system that contains all necessary files. To protect the certificates and keys contained therein, the ZIP file is automatically protected with the device password, unless you enter another password. The ZIP file that was generated can then be downloaded, for example, in WEBconfig via **Extras > File management > Download certificate or file > SCEP-CA - One Click Backup**.

Reloading the backup file

In order to reload certificate records, load the saved ZIP file directly into the device using the passphrase. In WEBconfig, for example, this is done by selecting **Extras > File management > Upload certificate or file > SCEP-CA - One Click Backup**. Enable the option **Replace existing CA certificates** so that the device automatically restores the certificate record after the upload.

 If you do not use this option, or if you upload the backup file to the device by other means, you must execute the action *2.39.2.2.11 Restore-certificates-from-Backup* in order for the device to restore the certificate record.

1.14 Automatic configuration synchronization (Config Sync) with the R&S®LANCOM WLC High Availability Clustering XL option

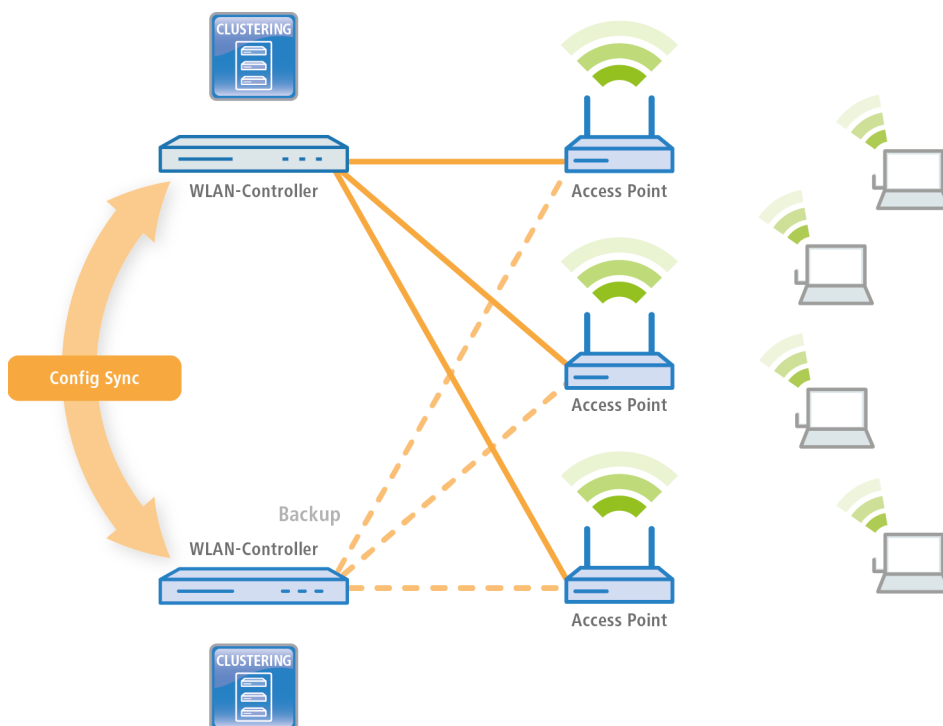
Example application, WLAN controllers:

WLAN infrastructures have become an integral part of modern corporate networks. In the age of the "all wireless office", the increasing demands on the availability of a WLAN solution make it essential to have a reliable backup and high-availability solution. In WLAN infrastructures with a single WLAN controller, any failures or maintenance downtimes (such as a firmware update) of the WLC until now caused the APs connected to it to switch to standalone operation. Consequently, the APs in standalone mode were no longer able to access the features that are provided centrally by the WLC such as a Public Spot, IEEE 802.1X authentication, or Layer-3 tunnels.

In order to avoid this and to maintain the full operation of all WLAN capabilities even if a WLC should be temporarily unavailable, one or more redundant or backup WLCs should be employed. In the backup event, the APs automatically switch from the temporarily unavailable WLC to a backup WLC. The backup WLC has the same configuration (e.g. AP table or WLAN profiles) as required by the primary WLC of the APs. The initial setup of the WLCs and any subsequent configuration changes must be carried out separately and identically on each device—a huge effort for the administrator. Manual maintenance of the configurations between multiple identical devices could lead to outdated or non-synchronous configurations on the backup WLCs, which in the case of a backup event could lead to a critical state for the entire WLAN infrastructure. The resulting troubleshooting usually turns out to be a real challenge. The users of the WLAN clients experience a loss of productivity, which could have major consequences company-wide.

New with the R&S®LANCOM WLC High Availability Clustering XL option: This software option allows multiple WLCs to be grouped into a highly-available cluster. In this way, configuration changes, features and enhancements made on one WLC are automatically transferred between the other WLCs in the cluster, without having to make manual changes on each individual device.

Common parameters in a cluster (e.g. WLAN profiles, AP tables, or Public Spot settings) remain synchronized, individual parameters (such as the IP address of the WLC) are not exchanged.



The R&S@LANCOM WLC High Availability Clustering XL option offers greatly simplified administration and huge time savings because you only need to configure one WLC in the cluster. The WLC then transfers the changes to the other cluster devices automatically. In the case of maintenance downtime (e.g. for a firmware update) or even the failure of a WLC, the APs automatically connect to another WLC which, thanks to Config Sync, already has the identical configuration without any intervention by the administrator. The result is a convenient way to high availability.

The prerequisites for a device to be a valid member of a cluster are:

- > The R&S@LANCOM WLC High Availability Clustering XL option (as of LCOS version 9.10) must be available.
- > IP communications must be available to all other devices, e.g. via LAN, WAN, or VPN.
- > It must be in the list of group members that is stored in each device.
- > A valid certificate must be available
- > It needs to authenticate itself by certificate as a member of the cluster.

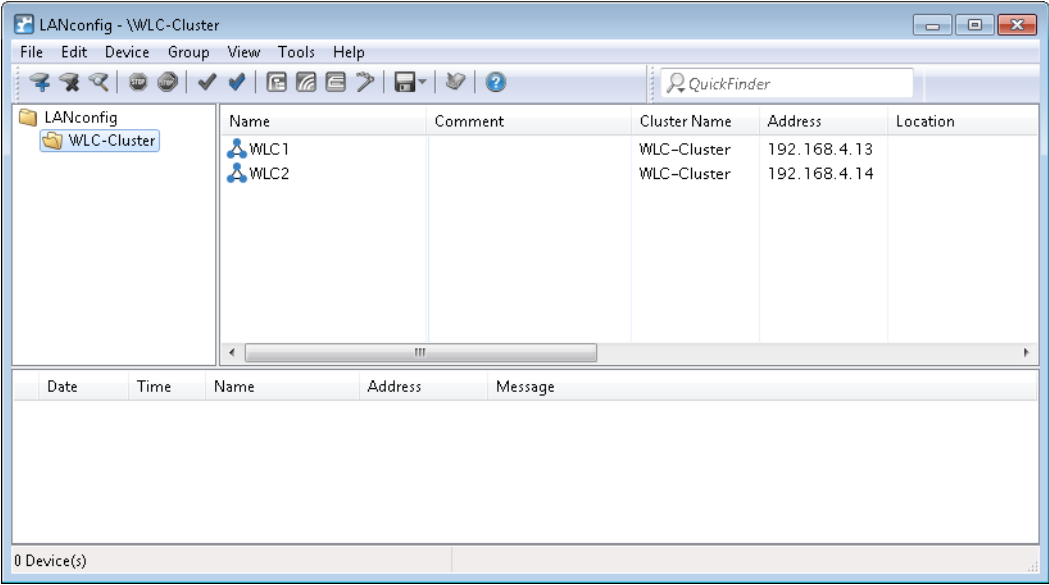
1.14.1 Special LANconfig icon for devices in a cluster or using Config Sync

LANconfig has a specific icon to mark devices that share their configuration via Config Sync. Furthermore, the **Config Cluster** column shows the configuration group for each device. LANconfig is thus able to sort and edit the device listing according to cluster name.

If you try to make changes to the configuration of a cluster member, you will receive following warning:

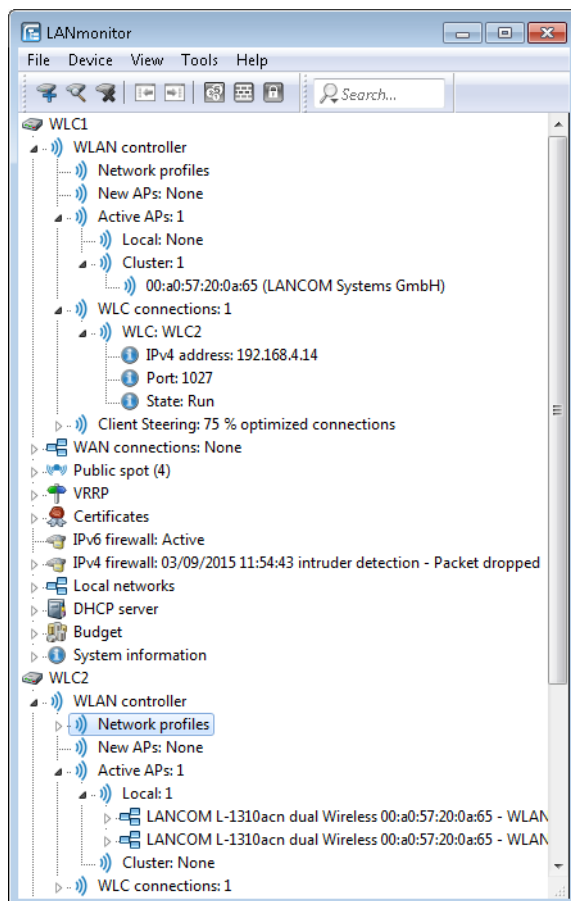
"This device belongs to the Config Cluster: [cluster name]. Editing this configuration also affects the following devices: [Listing of all devices in the same cluster]"

You can bypass this message if necessary. To do this, enable the option **Don't show again** in the displayed window.



1.14.2 Special LANmonitor icon for devices in a cluster or using Config Sync

LANmonitor has a specific icon to mark devices that share their configuration via Config Sync. Also, the name of the configuration group (cluster name) is shown after the device name. LANmonitor thus makes it easier to see which devices share the same configuration.



2 Appendix

2.1 Overview of CAPWAP parameters with the show command

The following information about the CAPWAP service can be viewed using the command line:

Table 1: Overview of all CAPWAP parameters with the show command

Parameters	Meaning
-addresses [<IfcNum>]	Shows the address tables of an individual or all WLC tunnels. In the case of an individual WLC tunnel, enter for the <IfcNum> the number of logical WLC tunnel interface, for example 10.
-groups	Shows the information for an individual or all available assignment/tag groups.

You can supplement the command `show capwap groups` with the parameters listed below, which control the scope of the displayed information:

Table 2: Overview of all CAPWAP group parameters with the show command

Parameters	Meaning
all	Shows the names configured in the setup menu and the device's internal names for all assignment/tag groups as well as the default groups that were set up. The default group represents an internal group which contains all APs.
<group1> <group2> <...>	Shows all APs of the respective assignment/tag groups.
-l <location>	Shows all APs of the respective location.
-c <country>	Shows all APs of the respective country.
-i <city>	Shows all APs of the respective city.
-s <street>	Shows all APs of the respective street.
-b <building>	Shows all APs of the respective building.
-f <floor>	Shows all APs of the respective floor.
-r <room>	Shows all APs of the respective room description.
-d <device>	Shows all APs that have the specified device name.
-v <firmware>	Shows all APs which have the specified firmware. To do this, enter the version number for <firmware> followed by the build number, e.g., 9.00.0001.
-x <firmware>	Shows all APs with a firmware version lower than the one installed on the current device.
-y <firmware>	Shows all APs with a firmware version the same or lower than the one installed on the current device.
-z <firmware>	Shows all APs with a firmware version higher than the one installed on the current device.

Parameters	Meaning
-t <firmware>	Shows all APs with a firmware version the same or higher than the one installed on the current device.
-n <intranet>	Shows all APs with an IP belonging to the specified Intranet address.
-p <profile>	Shows all APs that have been assigned with the specified WLAN profile.
rmgrp <group1 intern_name> <group2 intern_name> ...	Deletes the group(s) with the specified internal names from the memory of the device. Use this command to free up the main memory if too large a number of groups is degrading the performance of the device. The entry in the setup menu is unaffected by this action.
resetgrps	Deletes all groups except the default group.

For location information the device evaluates the information entered under **Location** in the access point table. The following field names are available:

- > co=Country
- > ci=City
- > st=Street
- > bu=Building
- > fl=Floor
- > ro=Room

For instance, the location entry `co=Germany, ci=Aachen` allows you to list all of the managed APs in Aachen from the console of the WLC with the command `+show capwap group -i Aachen`.

Example commands

```
show capwap group all
show capwap group group1
show capwap group -l yourlocation
show capwap group -s yourstreetname
show capwap group -d yourdevicename
show capwap group -p yourprofilename
show capwap group -d yourdevicename -p yourprofile -v yourfirmversion ...
```