MICROSENS

Application Note

Using RADIUS with G6 Devices

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Summary

This Application Note helps to configure and operate RADIUS functionality of a MICROSENS G6 switch. It explains the basic RADIUS concept and then concentrates on particular RADIUS aspects.

The content of the document builds on information provided with the Quick Installation Guide that is shipped together with MICROSENS G6 devices. Additionally, familiarity with the concept of Authentication over RADIUS is required to take advantage out of this Application Note.

For further information about RADIUS facilities, standards, parameters and options please refer to the chapter "RADIUS Servers" in [1] (see page 5).

Glossary

Terms, acronyms and abbreviations used in the document.

Term	Description
802.1X	IEEE Std. 802.1X-2004 (Port-Based Network Access Control)
Authentication Server	Definition of authentication component, that stores the users credentials for network access
Authenticator	Definition of network access component, that grants or denies network access to the user (supplicant)
CHAP	Challenge Handshake Authentication Protocol (RFC 1994)
EAP	Extensible Authentication Protocol (RFC 3748)
EAPOL	EAP over LAN
LAN	Local Area Network
MAC	Media Access Control
MACC	Management Access Control
MD5	Message-Digest Algorithm 5 (RFC 1321)
MTU	Maximum Transmission Unit
NAS	Network Access Server – the authenticator or RADIUS client
PACC	Port-based Network Access Control
RADIUS	Remote Authentication Dial-In User Service
Supplicant	Definition of a user or client, who requests network access

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Typographical Conventions

The following typographical elements are used in this document:

Typographical Elements	Explanation
●	List element, 1st order
◦	List element, 2nd order
www.microsens.de	Hyperlink to a website or email address
Note:	A note tags an important fact
□	Work step
<…>	Placeholder for a real value. Replace <IP Address> with e.g. 192.168.1.2.
{…|…}	Choose one of the values offered, e.g. from {Disabled|Enabled}, choose Enabled.
Visualisation	A string that appears in the Web Manager
`Command`	A string to enter in the Command Line Interface
» `Output`	A string output by the Command Line Interface
▒	Work step(s) in the Web Manager (GUI)
■	Work step(s) in the Command Line Interface (CLI)

The following symbols are used in this document:

Symbol	Explanation
	Switch
	Arbitrary computer
	Server

Information available from the MICROSENS Website

Registered users can find the latest firmware versions as well as further information on our web site:

- Registration: www.microsens.de > Partner-Login > Follow the link 'Please register here' > Fill in the online registration form and submit it
  - You will receive an email from MICROSENS with a user name and a password
- Login: www.microsens.de > Partner-Login > Enter user name and password > Click the 'Login' button
  - Firmware images: Navigate to the device and select the tab 'Services'
  - For further information select one of the other tabs

Note:
Make sure the browser allows the execution of scripts.

Bibliography

[1] Product Manual Firmware Generation 6

This manual is included in each software archive containing Firmware G6. It can also be downloaded from the link “Documentation” in the firmwares' Web Manager navigation bar.

1 Introduction to RADIUS

RADIUS is an acronym for *Remote Authentication Dial-In User Service*. This protocol is used for user management in the context of authentication and authorisation of users in complex network infrastructures. Therefore it is widely known as "AAA" or "Triple A" system.

Instead of maintaining all registered users on every network access device, every users' login and access data is handled by a central server, the so-called RADIUS server.

Explained in a simplified way, the usage of RADIUS for accessing a network works like this:

Every time a user or application (④,⑤,⑥; also called "supplicant") initially wants to access the network (①), the RADIUS client (③; also called "authenticator") sends an "Access Request" message to the RADIUS server (②; also called "authentication server"). The RADIUS server checks the received user's credentials against the data contained in its database for legitimate users.

In case the user is legitimate to access the network, the RADIUS server (②) sends an "Access Accept" to the switch (③), which causes the switch to grant the network access for the user (④,⑤,⑥).

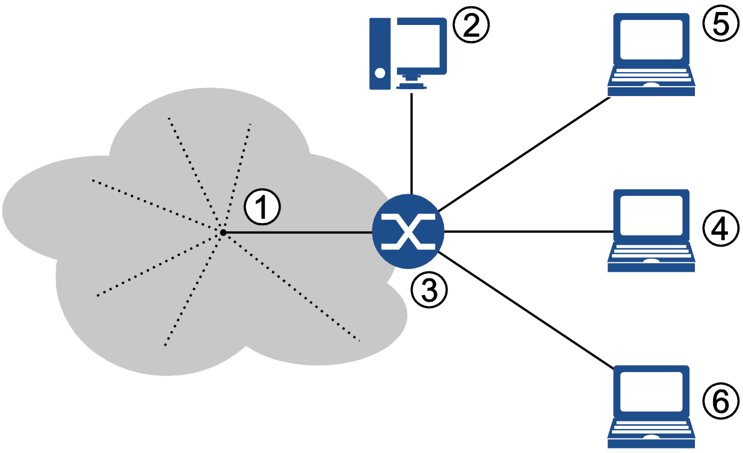


Figure 1:
Topology for Access Control with RADIUS

Otherwise the RADIUS server sends an "Access Reject" message to the switch, which causes the switch to block the network access for the respective user.

Note:
For more information about the RADIUS protocol please refer to the respective RFCs 2865, 2866 and 2869.

1.1 Methods of Network Access Control with RADIUS

Even without a successful server login, actually the access to the network can become a security threat (Denial-of-Service attacks, spoofing etc.). To address these security issues, the IEEE defined a standard to already secure network ports at the port level, thus preventing unauthorised access directly at the edge.

MICROSENS switches are designed to support two different methods of port-based network access control (PACC):

- Access Control via IEEE 802.1X
- Access Control via MAC Authentication.

Note:
If the supplicant does not support IEEE 802.1X authentication, an automatic fallback to authentication via MAC Authentication only is possible.

1.1.1 Access Control via IEEE 802.1X

A user (supplicant ④,⑤,⑥) requests network access (using EAPOL[1]) via the switch it is connected to (authenticator ③) by presenting his credentials (username/password or certificate) to a RADIUS server (authentication server ②). When successfully authenticated by the RADIUS server, and if the user is authorised, the switch port is opened, otherwise the network access remains blocked or limited.

The client must implement an IEEE 802.1X compliant supplicant which handles the communication during the authentication process.

The authenticator not necessarily needs to understand EAPOL. He just forwards EAPOL packets encapsulated in the RADIUS protocol to the authentication server. So during the authentication process, supplicant and authentication server are communicating indirectly via the authenticator. If the user is successfully authenticated, the RADIUS server finally sends an RADIUS "Access-Accept" message to the authenticator. This causes the authenticator to grant the supplicant access to the network. The authenticator confirms the authorisation to the supplicant by sending an "EAP-Success" message. The authentication process terminates.

1.1.2 Access Control via MAC Authentication

A user is identified by the MAC address of his network device only, given he uses a non-802.1X device (like a VoIP phone etc.). This MAC address is checked by a RADIUS server. When successfully verified by the RADIUS server, the switch port the user is connected to is opened, otherwise the network access remains blocked or limited.

To authenticate a MAC address on a RADIUS server, the MAC address is treated as username by the RADIUS client. The format of the MAC address field and the value used for the password can be configured.

A maximum of 250 MAC addresses is permitted for the whole system with a range of 1 to 9 MAC addresses per port. If the maximum number of permitted users is exceeded, the whole port becomes unauthorised for all users.

[1] EAPOL: Extensible Authentication Protocol (RFC 3748) over LAN

As long as the MAC discovery phase is not finalised, the network port is blocked to prevent any network interference.

Note:
Authenticating a supplicant based on its MAC address only is not as strong as the use of IEEE 802.1X authentication protocols. MAC addresses can be copied easily, so an intruder can get network access if he is able to clone an authorised MAC address.

Note:
For more information about using IEEE 802.1X or MAC Authentication with MICROSENS switches please refer to the chapter "Port-based Access Control" in [1].

1.2 Management Access Control with RADIUS

Imagine the network administrator leaving the company, a former employee with comprehensive management access rights to all the network's configuration and management devices like routers, switches, file servers etc.

Depending on the company's network infrastructure it will be a great deal of time and effort to block all his credentials on all respective devices. This is, when RADIUS joins the game.

The RADIUS server not only manages the user's access to the company network. It can store the credentials and therefore the access rights for every network management device (called "Management Access Control", MACC).

E.g., when the user opens the login dialog of a switch to gain access to the management backend, the device sends the user's credentials to the respective RADIUS server inside an "Access Request" message. As shown in chapter 1, the RADIUS server checks whether the user is legitimate to access the switch and, if successful, responds with an "Access Accept" message to the switch. But instead of granting access to the network the switch now opens its management backend to the user.

So when an employee with unwanted management access to network devices has to be blocked, it is relatively simple and inexpensive to change his status in the RADIUS server's user database once and for all, instead of for every single device.

1.3 RADIUS Shared Secret

Within the communication between RADIUS server and RADIUS authenticator the shared secret is used for message authentication and user password encryption.

To ensure that the "Access Request" message originates from the legitimate RADIUS client (since it is easy to spoof the respective IP address deceiving a legitimate RADIUS client), both the RADIUS client and server use an identical text string as "shared secret".

The RADIUS client uses the shared secret to calculate an MD5 hash of the entire "Access Request" message and sends the resulting value as RADIUS attribute 80 ("Message Authenticator") to the RADIUS server (see section 3 "RADIUS Attributes" on page 23).

The RADIUS server verifies this "Message Authenticator" by calculating the MD5 hash of the request with his shared secret. If the "Message Authenticator" appears inside an "Access Request" message and both MD5 hashes comply, the RADIUS server responds to the RADIUS client. Otherwise he will silently ignore the request message.

Note:
In order to use strong shared secrets, the string should be at least 22 characters long, randomly comprising upper and lower case letters, numbers and punctuation. Do not use the same shared secret for all RADIUS client/server pairs used in the company network as it is not feasible to change the shared secrets on all devices, once the shared secret is compromised.

2 Configuring Access Control for RADIUS

As described in section 1.1 "Methods of Network Access Control with RADIUS", MICROSENS switches support both 802.1X and MAC authentication for RADIUS authentication of legitimate users.

This section containes two examples for configuring each of those authentication methods. Figure 1 "Topology for Access Control with RADIUS" on page 6 serves as a basis for these examples.

Note:
For more information about the configuration of RADIUS with MICROSENS G6 devices please refer to the chapter "RADIUS Servers" in [1].

2.1 Example 1: Access Control with 802.1X Authentication

2.1.1 Procedure of 802.1X Authentication

In general, a successful 802.1X authentication process occurs as follows:

Step a: The client (④) requests network access (①) via a specific port of the switch (③). This causes the switch to block this port for LAN access instantly.

Note:
Alternatively, depending on its configuration the switch can forward the unauthorised user to a special VLAN. Subsequently, the procedure with a blocked port is described.

Step b: The switch afterwards asks the client to reveal its credentials ("EAP Identity Request").

Step c: The client responds with its credentials ("EAP Identity Response").

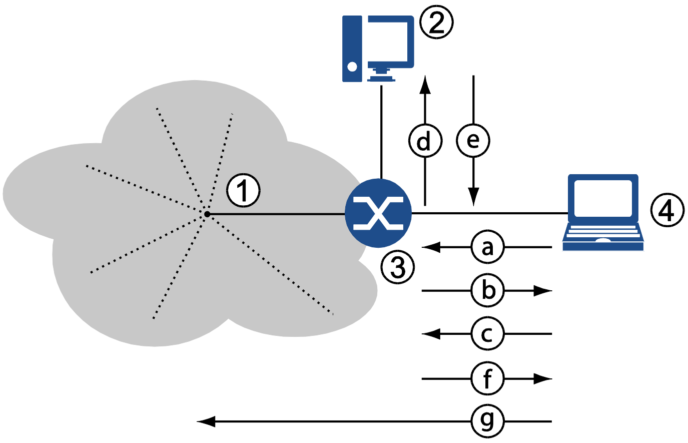


Figure 2: 802.1X Authentication

Step d: The Switch forwards the EAP Identity Response in an Access Request to the RADIUS server (②) as a "RADIUS Access Request" message.

Note:
Depending on the kind of authentication method, RADIUS server (②), switch (③) and client (④) exchange various messages to secure the connection and authentication ("Challenge") in case the user is stored as legitimate user in the RADIUS database.

Step e: After the client has passed the challenge successfully, the RADIUS server sends a "RADIUS Access Accept" to the switch.

Step f: The switch forwards an "EAP Success" message to the client and opens the respective port, possibly with restricted access based on the attributes that the RADIUS server sent inside the "RADIUS Access Accept" message.

Step g: Now the client is able to connect to LAN services or the internet.

Note:
For a more detailed description of the 802.1X communication flow, refer to the chapter "Port-based Access Control" in [1].

2.1.2 Prerequisites

In order to ensure the communcation between client, switch and RADIUS server some basic measures must be put into place:

- The client must be able to use EAP for authentication (see the client's manual for respective 802.1X configuration).
- Port-based access control must be generally enabled on the switch and the respective port's authorised mode has to be set to 802.1X.
- The switch knows the IP address of the RADIUS server (and for good measure the IP address of a fallback RADIUS server).
- The user must be stored in the RADIUS database as legitimate user with respective access rights (see the RADIUS manual for management of permitted users and their access control rights).

2.1.3 802.1X Authentication Configuration Steps

Note:
The following steps describe a basic 802.1X authentication setting. For a more complex configuration please refer to the chapter "Port-based Access Control" in [1].

Using the Web Manager:

Configuration Steps for Example 1

□ Open the Web Manager of the respective switch.

□ Select the **Authentication Server** screen.

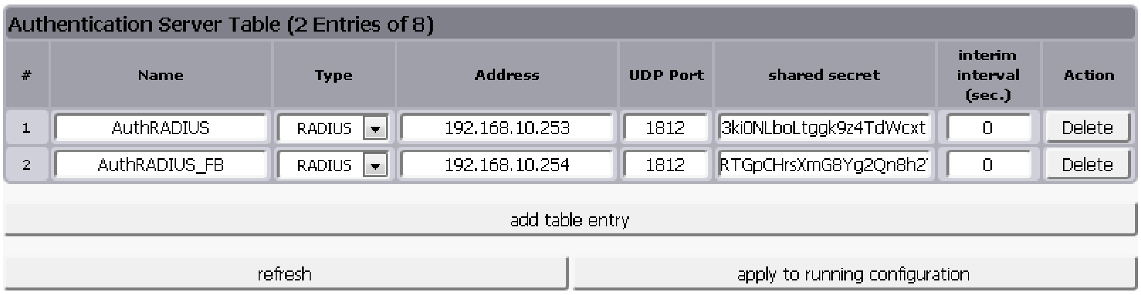
□ Click on **add table entry** to create a new RADIUS server entry.

Note:
A maximum of 8 RADIUS server entries is possible.

□ Define the following values for the new entry:

- **Name**: Choose a meaningful name for the RADIUS server. This is the symbolic name which has to be used for PACC later on.
- **Type**: Leave the default type "RADIUS" as it is. The alternative type "TACACS+" is also possible but not relevant for this example.
- **Address**: Enter the IP address of the RADIUS server.
- **UDP Port**: Leave the default port "1812" as it is. This port is commonly used for RADIUS authentication.
- **shared secret**: Enter the shared secret. This entry must correspond to the shared secret that is configured for this RADIUS client in the RADIUS server.
  For more information about the shared secret see chapter 1.3 "RADIUS Shared Secret" on page 8.
- **Interim interval**: This value is only important for RADIUS accounting. Leave the default value "0" as it is (accounting feature is disabled).

Configuration Steps for Example 1

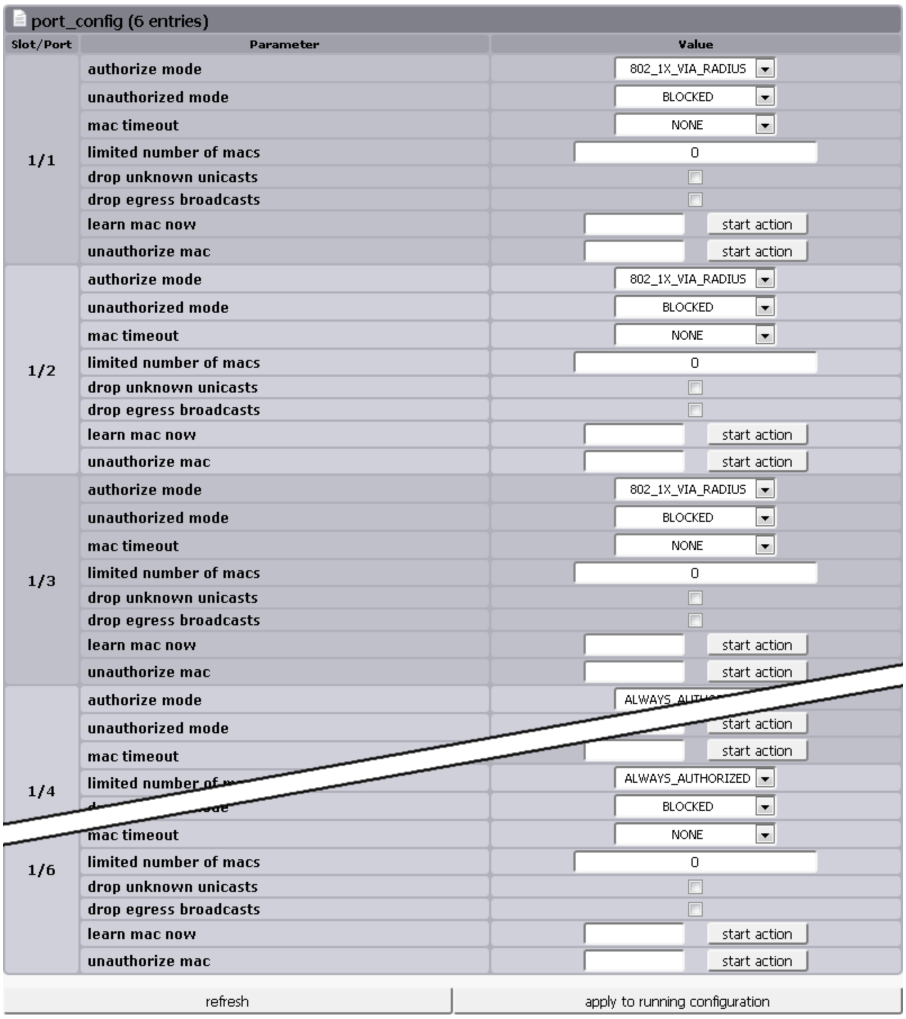


Authentication Server Table (2 Entries of 8)

#	Name	Type	Address	UDP Port	shared secret	interim interval (sec.)	Action
1	AuthRADIUS	RADIUS	192.168.10.253	1812	3ki0NLboLtggk9z4TdWcxt	0	Delete
2	AuthRADIUS_FB	RADIUS	192.168.10.254	1812	RTGpCHrsXmG8Yg2Qn8h2	0	Delete

Figure 3: Example 1 - WebManager - Authentication Server

- □ Click the button **apply to running configuration** to save the new RADIUS server entry.
- □ Select the **Port Access** screen, then select the tab **Port Configuration**.
- □ Set the **Authorized Mode** of the respective port(s) to "IEEE 802.1X via RADIUS".
- □ Leave all other default settings as they are.



port_config (6 entries)

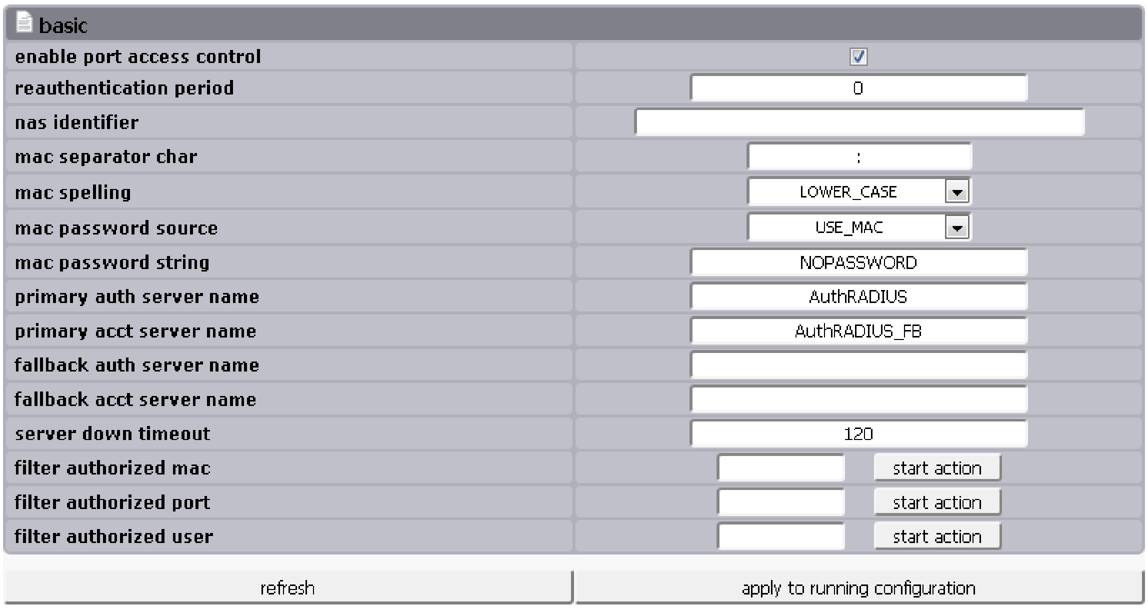
Slot/Port	Parameter	Value
1/1	authorize mode	802_1X_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/2	authorize mode	802_1X_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/3	authorize mode	802_1X_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/4	authorize mode	ALWAYS_AUTH
	unauthorized mode	start action
	mac timeout	start action
	limited number of m	ALWAYS_AUTHORIZED
	ode	BLOCKED
	mac timeout	NONE
1/6	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action

Figure 4: Example 1 - WebManager - Port Configuration

Configuration Steps for Example 1

Note:
Alternatively, if unauthorised users shall not be blocked but forwarded to a special VLAN, set **Mode if unauthorized** to "use unauth VLAN" and configure this VLAN in the **VLANs** screen on the tab **Basic Configuration**. Do not forget to enable VLAN filtering, too.

- □ Click the button **apply to running configuration** to save the changes to the running configuration.
- □ Select the tab **Basic Configuration**.
- □ Check the option **Port Access Control enabled**.
- □ Enter the name for the **Primary Authentication Server** that was defined above.
- □ If applicable, enter the name for the **Fallback Authentication Server** that was defined above.
- □ Leave all other default settings as they are.



basic

enable port access control	☑
reauthentication period	0
nas identifier	
mac separator char	:
mac spelling	LOWER_CASE
mac password source	USE_MAC
mac password string	NOPASSWORD
primary auth server name	AuthRADIUS
primary acct server name	AuthRADIUS_FB
fallback auth server name	
fallback acct server name	
server down timeout	120
filter authorized mac	start action
filter authorized port	start action
filter authorized user	start action

Figure 5: Example 1 - WebManager - Basic Configuration

- □ Click the button **apply to running configuration** to save the changes to the running configuration.

Using the Command Line Interface (CLI):

Configuration Steps for Example 1

Add new RADIUS servers for user authentication:

- □ **`Management.RADIUS.server[*].name = AuthRADIUS`**
- □ **`Management.RADIUS.server[*].name = AuthRADIUS_FB`**

Configuration Steps for Example 1

Enter the IP addresses for the respective RADIUS servers:

□ `Management.RADIUS.server[AuthRADIUS].host_address = 192.168.10.253`
□ `Management.RADIUS.server[AuthRADIUS_FB].host_address = 192.168.10.254`

Enter the shared secret for both the primary RADIUS server and the fallback RADIUS server:

□ `Management.RADIUS.server[AuthRADIUS].shared_secret = 3ki0NLboLtggk9z4TdWcxt`
□ `Management.RADIUS.server[AuthRADIUS_FB].shared_secret = RTGpCHrsXmG8Yg2Qn8h27F`

Set the authorised mode of the respective slot/port to IEEE 802.1X authorisation:

□ `Protocol.PACC.port_config[slot/port].authorize_mode = 802_1X_VIA_RADIUS`

If necessary, change the unauthorised mode to VLAN forwarding, configure the respective VLAN and enable VLAN filtering:

□ `Protocol.PACC.port_config[slot/port].unauthorized_mode = USE_UNAUTHORIZED_VLAN`
□ `Protocol.VLAN.vlan_id_config.unauthorized_vlan_id = {0…4095}`
□ `Protocol.VLAN.enable_vlan_filtering = {Enable|Disable}`

Set the entries for the RADIUS servers:

□ `Protocol.PACC.primary_auth_server_name = AuthRADIUS`
□ `Protocol.PACC.fallback_auth_server_name = AuthRADIUS_FB`

Enable the port access control:

□ `Protocol.PACC.enable_port_access_control = Enabled`

2.2 Example 2: Access Control with RADIUS MAC Authentication

2.2.1 Procedure of RADIUS MAC Authentication

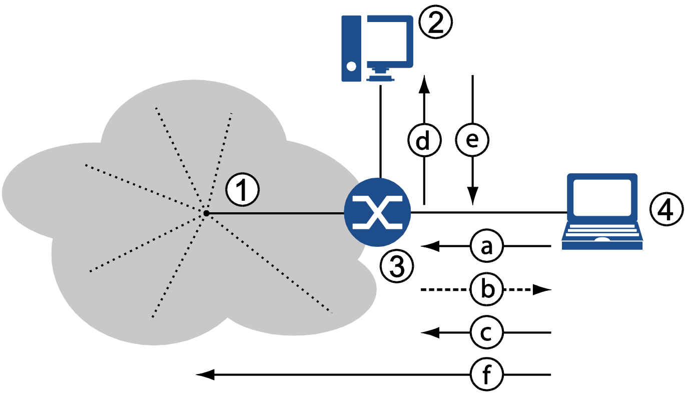


Figure 6: RADIUS MAC Authentication

If a client is not capable of 802.1X authentication (or 802.1X authentication is disabled on the device), it is possible to authenticate via its MAC address.

In general, a successful RADIUS MAC authentication process occurs as follows:

Step a: The client (④) tries to send a frame to the network (①) via a specific port of the switch (③). This causes the switch to block this port for LAN access instantly.

Note:
Alternatively, depending on its configuration,

the switch can forward the unauthorised user to a special VLAN. Subsequently, the procedure with a blocked port is described.

Step b: In a combined MAC-802.1X-authentication mode the switch asks the client to reveal its credentials via EAP ("EAP Identity Request") following step a. Because the client does not support 802.1X, he will not respond. The switch then repeats the request for a specific time.

Note:
In a pure MAC authentication mode, the request to the RADIUS server is sent directly instead, so that this step b is skipped.

Step c: After expiration of this term, without the client's EAP response, the switch accepts only one data packet for extracting the source MAC address and "learning" it (i.e. storing it inside its configuration).

Note:
This scenario assumes that the switch's ports are configured for authentication via both 802.1X and MAC address. If the configuration is determined to authentication by MAC address only, the repeated request is omitted and the switch immediately takes the source MAC from the first data packet for authentication at the RADIUS server.

Step d: The switch generates the access request to the RADIUS server (②) as a "RADIUS Access Request" message.

Inside this message, the switch will send the MAC address as "User Name" (RADIUS attribute 1), "Password" (RADIUS attribute 2, encrypted using the shared secret) and "Calling-Station-ID" (RADIUS attribute 31). According to its configuration, the RADIUS server uses one or more of these attributes for authenticating the user against its database entries.

Step e: After the user verification is successfully completed, the RADIUS server sends a "RADIUS Access Accept" to the switch. The switch then opens the respective port, possibly with restricted access based on the attributes that the RADIUS server sent inside the "RADIUS Access Accept" message.

Step f: Now the client is able to connect to LAN services or the internet.

Note:
It is possible to add MAC addresses of known clients manually to skip the RADIUS authentication process. This procedure known as "MAC Locking" is out of the scope of this example.

2.2.2 Prerequisites

In order to ensure the communication between client and switch and the communication between switch and RADIUS server some basic measures must be put into place:

- port-based access control must be generally enabled on the switch and the respective port's authorised mode has to be set to RADIUS MAC Authentication.
- The switch knows the IP address of the RADIUS server (and for good measure the IP address of a fallback RADIUS server).
- The switch must be configured to recognise the MAC address in an appropriate format (MAC separator, letter case) and whether the MAC address should be sent as password too.
- The client's MAC address must be stored in the RADIUS database as legitimate user with respective access rights (see the RADIUS manual for management of permitted users and their access control rights).

2.2.3 RADIUS MAC Authentication Configuration Steps

Note:
The following steps describe a basic MAC authentication setting. For a more complex configuration please refer to the chapter "Port-based Access Control" in [1].

Using the Web Manager:

Configuration Steps for Example 2

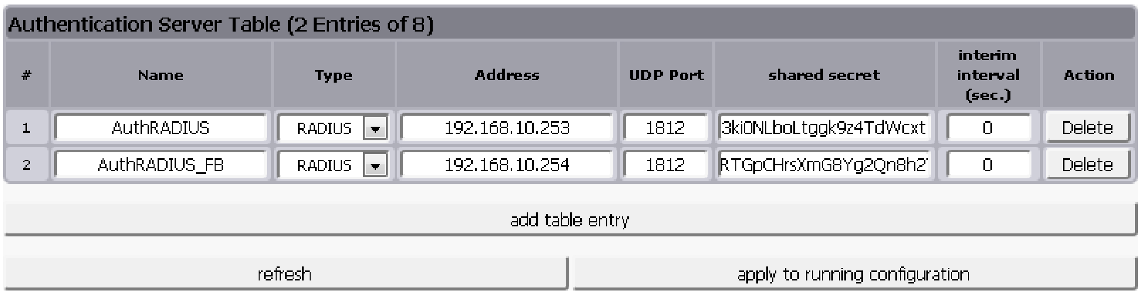
□ Open the Web Manager of the respective switch.

□ Select the **Authentication Server** screen.

□ Click on **add table entry** to create a new RADIUS server entry.

□ Define the following values for the new entry:

- **Name**: Choose a meaningful name for the RADIUS server. This is the symbolic name that has to be used later for PACC.
- **Type**: Leave the default type "RADIUS" as it is.
- **Address**: Enter the IP address of the RADIUS server.
- **UDP Port**: Leave the default port "1812" as it is.
- **shared secret**: Enter the shared secret. This entry must correspond to the shared secret that is configured in the RADIUS server.
  For more information about the shared secret see chapter 1.3 "RADIUS Shared Secret" on page 8.
- **Interim interval**: This value is only important for RADIUS accounting. Leave the default value "0" as it is (feature is disabled).



Authentication Server Table (2 Entries of 8)

#	Name	Type	Address	UDP Port	shared secret	interim interval (sec.)	Action
1	AuthRADIUS	RADIUS	192.168.10.253	1812	3ki0NLboLtggk9z4TdWcxt	0	Delete
2	AuthRADIUS_FB	RADIUS	192.168.10.254	1812	RTGpCHrsXmG8Yg2Qn8h2	0	Delete

Figure 7: Example 2 - WebManager - Authentication Server

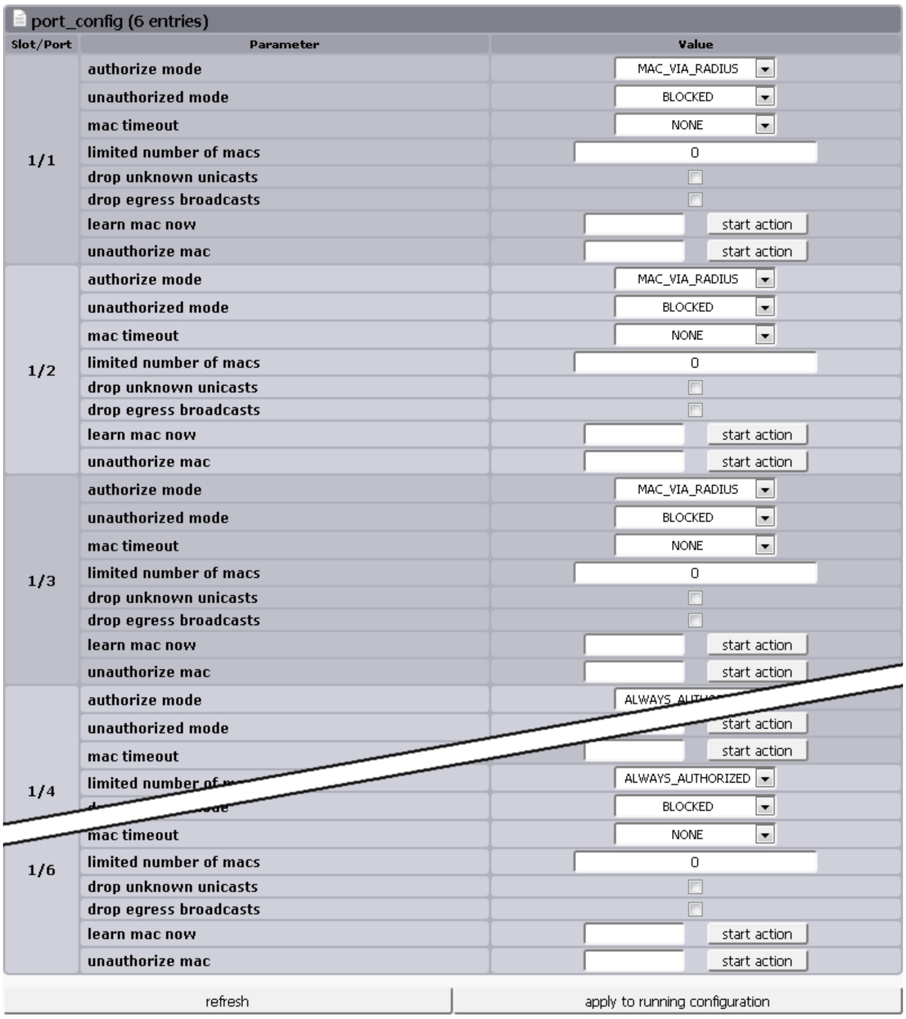
□ Click the button **apply to running configuration** to save the new RADIUS server entry.

□ Select the **Port Access** screen, then select the tab **Port Configuration**.

□ Set the **Authorized Mode** of the respective port(s) to "MAC via RADIUS".

□ Leave all other default settings as they are.

Configuration Steps for Example 2



port_config (6 entries)

Slot/Port	Parameter	Value
1/1	authorize mode	MAC_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/2	authorize mode	MAC_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/3	authorize mode	MAC_VIA_RADIUS
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
1/4	authorize mode	ALWAYS_AUTH
	unauthorized mode	start action
	mac timeout	start action
	limited number of	ALWAYS_AUTHORIZED
		BLOCKED
	mac timeout	NONE
1/6	limited number of macs	0
	drop unknown unicasts	☐
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action

Figure 8: Example 2 - WebManager - Port Configuration

Note:
In this example the ports are configured for authentication by MAC address only. So the switch assumes that the connected device does not support 802.1X by default and therefore ignores any incoming 802.1X EAPOL messages. If that is not assured, set the **Authorized Mode** to “MAC or 802.1X via RADIUS”.

Note:
Alternatively, if unauthorised users shall not be blocked but forwarded to a special VLAN, set **Mode if unauthorized** to “use unauth VLAN” and configure this VLAN in the **VLANs** screen on the tab **Basic Configuration**. Do not forget to enable VLAN filtering as well.

Configuration Steps for Example 2

□ If necessary, set the following options:

- **MAC Timeout**: Defines how long authorised (i.e. learned) MAC addresses are valid after inactivity.
- **limited number of MACs**: Limits the number of permitted MAC addresses on this port. Default is “0” for unlimited number of MAC addresses. This option works independently from the selected authorisation mode.
- **learn MACs**: The respective value from the drop-down-list determines the number of next incoming MAC addresses to be learned manually. Clicking on **learn** starts the learning process. This action fills the MAC database for the authorisation mode “MAC Locking”.

□ Click the button **apply to running configuration** to save the changes to the running configuration.

□ Select the tab **Basic Configuration**.

□ Check the option **Port Access Control enabled**.

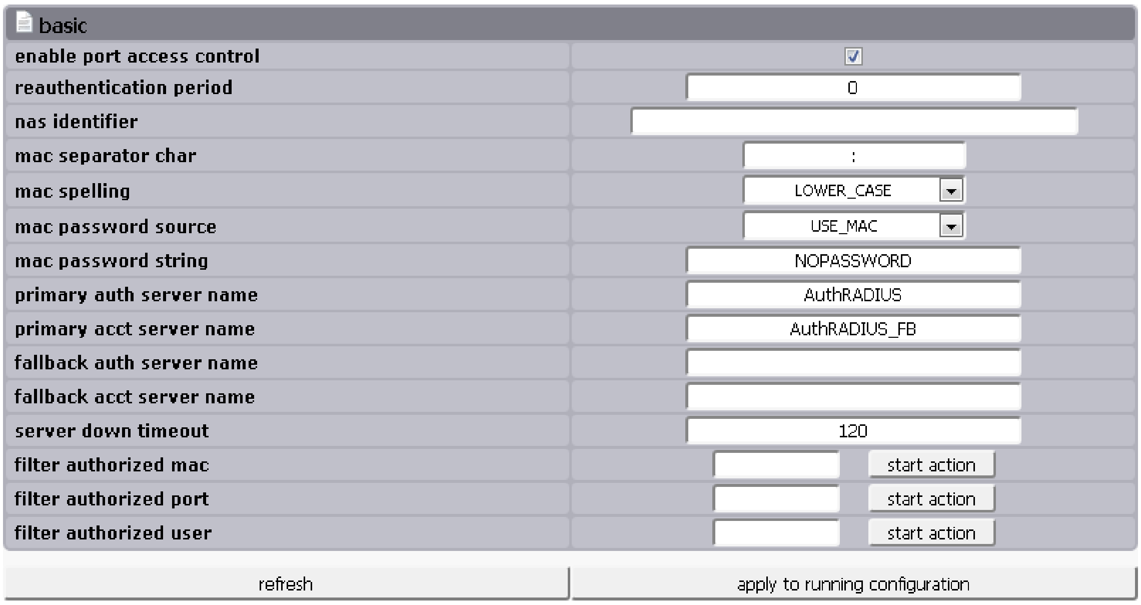
□ Enter the name for the **Primary Authentication Server** that was defined above.

□ If applicable, enter the name for the **Fallback Authentication Server** that was defined above.

□ If necessary, set the MAC address related values:

- **RADIUS MAC Authentication Password**: The switch uses the client’s MAC address as user name. If the RADIUS server needs the MAC address sent as password, set the respective option.
- **Static Password**: If the RADIUS server demands a password other than the MAC address, enter it here.
- **MAC address separator**: To recognise the correct source MAC address, the switch must know the valid separator.
- **MAC address letter case**: To recognise the correct source MAC address, the switch must know the correct letter case.

Configuration Steps for Example 2



enable port access control	☑
reauthentication period	0
nas identifier	
mac separator char	:
mac spelling	LOWER_CASE
mac password source	USE_MAC
mac password string	NOPASSWORD
primary auth server name	AuthRADIUS
primary acct server name	AuthRADIUS_FB
fallback auth server name	
fallback acct server name	
server down timeout	120
filter authorized mac	
filter authorized port	
filter authorized user	

Figure 9: Example 2 - WebManager - Basic Configuration

□ Click the button **apply to running configuration** to save the changes to the running configuration.

Using the Command Line Interface (CLI):

Configuration Steps for Example 2

Add new RADIUS servers for user authentication:

□ `Management.RADIUS.server[*].name = AuthRADIUS`

□ `Management.RADIUS.server[*].name = AuthRADIUS_FB`

Enter the IP addresses for the respective RADIUS servers:

□ `Management.RADIUS.server[AuthRADIUS].host_address = 192.168.10.253`

□ `Management.RADIUS.server[AuthRADIUS_FB].host_address = 192.168.10.254`

Enter the shared secret for both the primary RADIUS server and the fallback RADIUS server:

□ `Management.RADIUS.server[AuthRADIUS].shared_secret = 3ki0NLboLtggk9z4TdWcxt`

□ `Management.RADIUS.server[AuthRADIUS_FB].shared_secret = RTGpCHrsXmG8Yg2Qn8h27F`

Configuration Steps for Example 2

If necessary, change the unauthorised mode to VLAN forwarding, configure the respective VLAN and enable VLAN filtering:

□ **Protocol.PACC.port_config[slot/port].unauthorized_mode = USE_UNAUTHORIZED_VLAN**
□ **Protocol.VLAN.vlan_id_config.unauthorized_vlan_id = {0…4095}**
□ **Protocol.VLAN.enable_vlan_filtering = {Enable|Disable}**

Set the authorised mode of the respective slot/port to IEEE 802.1X authorisation:

□ **Protocol.PACC.port_config[slot/port].authorize_mode = MAC_VIA_RADIUS**

Note:
In this example the ports are configured for authentication by MAC address only. So the switch assumes that the connected device does not support 802.1X by default and therefore ignores any incoming 802.1X EAPOL messages. If that is not assured, set the **Authorized Mode** to "MAC or 802.1X via RADIUS":

□ **Protocol.PACC.port_config[slot/port].authorize_mode = MAC_OR_802_1X_VIA_RADIUS**

Set the entries for the RADIUS servers:

□ **Protocol.PACC.primary_auth_server_name = AuthRADIUS**
□ **Protocol.PACC.fallback_auth_server_name = AuthRADIUS_FB**

If necessary, set the MAC address related values:

□ **Protocol.PACC.mac_password_source = {USE_MAC|USE_PASSWORD}**
□ **Protocol.PACC.mac_password_string = <password>**
□ **Protocol.PACC.mac_separator_char = <character>**
□ **Protocol.PACC.mac_spelling = {LOWER_CASE|UPPER_CASE}**

Enable the port access control:

□ **Protocol.PACC.enable_port_access_control = Enabled**

2.3 Example 3: Prevention of Authentication Time-Out Problems

Network devices in stand-by mode (e.g. printers) or shut down (e.g. PCs) are unauthorised by MAC time-out or intended log-off (via "EAPOL logoff" using IEEE 802.1X). Additionally, a failed reauthentication of the device can be a reason for switching to port mode "BLOCKED".

Those port blocked devices are unable to accept further connection requests from the network (e.g. print jobs or Wake-on-LAN Magic Packets).

There are three ways to deal with authentication time-out problems:

1. Using the RADIUS attribute type 28 ("Idle-Timeout")
2. Disabling the switch's parameter "MAC Timeout"
3. Using the switch's port blocking mode "Incoming Blocked"

Note:
Disabling the MAC aging either via RADIUS attribute or MAC aging parameter could pose a

security risk. Therefore we recommend using the switch's port mode "Incoming Blocked" that is available from firmware version FW G6 v10.6.1d on.

2.3.1 Using the RADIUS attribut type 28 ("Idle-Timeout")

With the respective value "0" the RADIUS attribute type 28 protects the device's MAC address from aging due to inactivity. For more information on RADIUS attribute type 28 please refer to page 25.

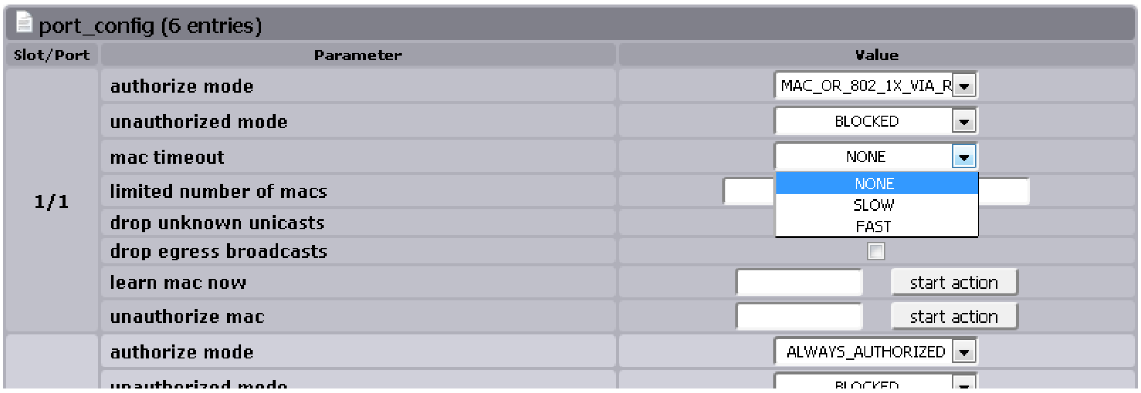
Note:
This attribute is not used with 802.1X authentication.

2.3.2 Disabling the device's parameter "MAC Time-Out"

Using the Web Manager:

Configuration Steps for Example 3 (MAC Timeout)

- □ Open the Web Manager of the respective switch.
- □ Select the **Port Access** screen.
- □ Select the tab **Port Configuration**.



port_config (6 entries)

Slot/Port	Parameter	Value
1/1	authorize mode	MAC_OR_802_1X_VIA_R
	unauthorized mode	BLOCKED
	mac timeout	NONE
	limited number of macs	
	drop unknown unicasts	
	drop egress broadcasts	☐
	learn mac now	start action
	unauthorize mac	start action
	authorize mode	ALWAYS_AUTHORIZED
	unauthorized mode	BLOCKED

Figure 10: Example 3 - WebManager - Port Configuration - MAC Timeout

- □ Change the MAC Timeout value of the respective slot/port to "NONE" to disable MAC address aging on this port.
- □ Click the button **apply to running configuration** to save the changes to the running configuration.

Using the Command Line Interface (CLI):

Configuration Steps for Example 3 (MAC Timeout)

Disable the MAC time-out on the respective slot/port:

```
□ Protocol.PACC.port_config[slot/port].mac_timeout = NONE
```

Enable the port access control:

```
□ Protocol.PACC.enable_port_access_control = Enabled
```

2.3.3 Using the switch's port blocking mode "Incoming Blocked"

Note:
Using the port blocking mode "Incoming Blocked" avoids security risks based on disabled MAC address aging. We recommend using this mode that is available from firmware version FW G6 v10.6.1d on.

If this mode is enabled on a switch's port, the port access control only controls incoming data on this port (ingress). Without valid authentication on this port (via MAC Authentication or IEEE 802.1X) all incoming data is blocked. In contrast, outgoing data (egress) like Wake-on-LAN packets are continuously forwarded to this port.

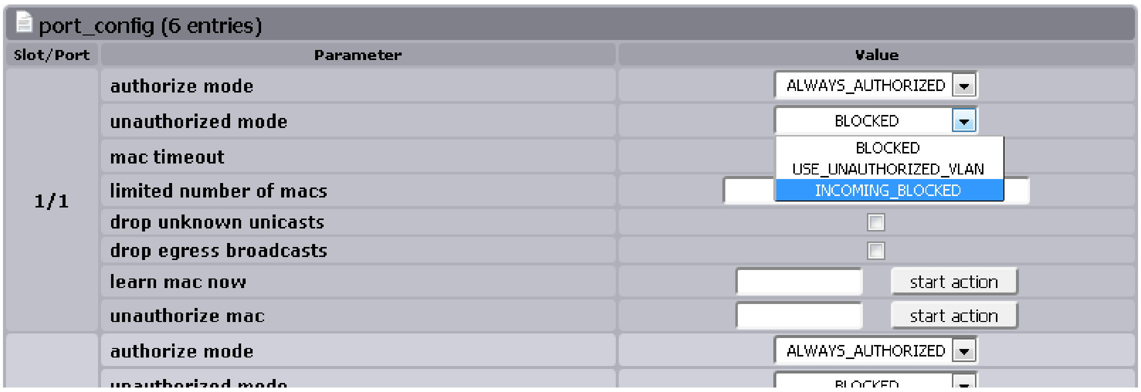
Using the Web Manager:

Configuration Steps for Example 3 (Port Block Mode "Incoming Blocked")

□ Open the Web Manager of the respective switch.

□ Select the **Port Access** screen.

□ Select the tab **Port Configuration**.



port_config (6 entries)

Slot/Port	Parameter	Value
1/1	authorize mode	ALWAYS_AUTHORIZED
	unauthorized mode	BLOCKED
	mac timeout	
	limited number of macs	
	drop unknown unicasts	□
	drop egress broadcasts	□
	learn mac now	start action
	unauthorize mac	start action
	authorize mode	ALWAYS_AUTHORIZED
	unauthorized mode	BLOCKED

Figure 11: WebManager - Port Configuration – Incoming Blocked

□ Change the value for the blocking mode of the respective slot/port to "INCOMING_BLOCKED".

□ Click the button **apply to running configuration** to save the changes to the running configuration.

Using the Command Line Interface (CLI):

Configuration Steps for Example 3 (Port Block Mode "Incoming Blocked")

Disable the MAC time-out on the respective slot/port:

□ **`Protocol.PACC.port_config[slot/port].unauthorized_mode = INCOMING_BLOCKED`**

Enable the port access control:

□ **`Protocol.PACC.enable_port_access_control = Enabled`**

3 RADIUS Attributes

3.1 Attribute Basics

As described in section 1, the MICROSENS switch works as the RADIUS client and therefore exchanges messages with the RADIUS server e.g. in order to allow or reject network access to the user.

These messages contain so-called RADIUS attributes with special types of detailed information about the user, e.g. regarding authentication or additional configuration values. The RADIUS attribute format is designed as follows:

- Type: Contains an RFC-assigned number, that represents the respective attribute.
- Length: Defines the complete bit length of this attribute.
- Value: Contains the information for this attribute, that RADIUS client or server need for further procedures.

A RADIUS message is not limited to only one attribute but contains a collection of attributes, describing e.g. the user's unique credentials, his remote IP address or even some vendor specific attributes for detailed authentication or configuration.

Note:
For more information about RADIUS attributes please refer to the respective RFCs 2865, 2868 and 2869.

3.2 RADIUS Attribute Support of MICROSENS G6 Devices

Note:
MICROSENS switches do not support vendor specific attributes (attribute type 26). They ignore vendor specific attributes in RADIUS response messages.

3.2.1 RADIUS Access Request Attributes

MICROSENS G6 devices support the following RADIUS attributes inside "Access Request" messages.

Note:
If not otherwise specified, the respective RADIUS attribute is obligatory for the RADIUS Access Request.

Type	Value	Description
1	User-Name	The user's login name. Depending on the authentication method this can be a string, a MAC address or any other network access identifier.
2	User-Password	*Optional* The user's login password to be authenticated. Must be contained in EAP-MD5 based methods, e.g. "RADIUS MAC Auth." or 802.1X with simple password authentication or "MACC".

Type	Value	Description
4	NAS-IP-Address	*Optional* IP address of the authenticator that sends the user's credentials for authentication.
5	NAS-Port	*Optional with NAS-Port-Type attribute 61* Physical port of the authenticator which sends the user's credentials for authentication.
6	Service-Type	*Optional* Determines the type of service the user has requested or is to be provided. E.g. a Cisco ISE RADIUS server expects exactly this parameter and the value defined below to identify MAC authentication requests. MICROSENS G6 devices support the following service types: `10`: Call Check **Note:** This value is not used with 802.1X authentication.
12	Framed-MTU	*Optional* Contains the Maximum Transmission Unit (MTU) for the user.
24	State	*Optional* Contains the state information to be exchanged between RADIUS server and client. This attribute is never exchanged within the initial access request message, but in an access challenge and also within the following access request.
30	Called-Station-Id	*Optional* Contains the ID of the RADIUS client (e.g. the MAC address) the user called for his access request.
31	Calling-Station-Id	*Optional* Contains the user's ID (e.g. the MAC address).
32	NAS-Identifier	*Optional* ID of the authenticator which sends the user's credentials for authentication. The NAS identifier is to be configured with the CLI interface via **`Protocol.PACC.nas_identifier`**

Type	Value	Description
61	NAS-Port-Type	*Optional with NAS-Port attribute 5* Physical port type of the authenticator that sends the user's credentials for authentication. Since MICROSENS G6 devices support PACC only at Ethernet ports, only the following tunnel type is supported: 15: Ethernet **Note:** This value is not used with MACC requests and cannot be changed.
79	EAP-Message	*Optional* Encapsulates EAP packets in order to transfer those packets between RADIUS server and user via authenticators which are unable to cope with EAP.
80	Message Authenticator	*Obligatory with EAP-Message attribute 79* *Optional without EAP-Message attribute 79* Signs the access request (HMAC-MD5 checksum of the entire access request and the shared secret) to prevent spoofing of access request using authentication protocols like CHAP or EAP.

3.2.2 RADIUS Access Accept Attributes

MICROSENS G6 devices support the following RADIUS attributes inside "Access Accept" messages.

Note:
If not otherwise specified, the respective RADIUS attribute is obligatory for the RADIUS Access Accept message.

Type	Value	Description
1	User-Name	*Optional* The user's login name. Depending on the authentication method this can be a string, a MAC address or any other network access identifier.
11	Filter-Id	*Obligatory in MACC Access Accept messages* To assign privileges to a RADIUS authorised user on any management interface, the MICROSENS switch matches this attribute (string) with a locally known user as parameter.

Type	Value	Description
24	State	*Optional* Contains the state information to be exchanged between RADIUS server and client. This attribute is never exchanged within the initial access request message, but in an access challenge and also within the following access request.
26	Vendor-Specific	*Optional* Vendor-specific attributes (VSA) allow the use of proprietary RADIUS attributes not included in the respective RFCs. MICROSENS G6 devices support the following value for attribute 26: **9**: Cisco Systems, Inc. The implementation supports the following vendor-specific option: **1**: cisco-avpair This attribute can contain the following value (AVP): `cisco-avpair="device-traffic-class=voice"` This AVP identifies and authenticates the device as a phone and prompts the switch to grant access to the voice VLAN for the device.
28	Idle-Timeout	*Optional* Used with RADIUS MAC Authentication. Possible values: `0`: The MAC address is saved statically and does not age on inactivity (for "silent devices" like printers etc.) `1`…**`n`**: Sets the aging time in seconds on inactivity for this user's MAC address. After this duration of idle time the user has to be authenticated again for further network access. As long as the user is active, this value is set to the maximum global aging time "n", which is configured via **`Device.MAC.used_aging_time`** **Note:** This attribute is not used with 802.1X authentication.

Type	Value	Description
64	Tunnel-Type	*Optional with Tunnel-Private-Group-ID attribute 81* Indicates the tunneling protocol(s) to be used. MICROSENS G6 devices support the following tunnel type: **31**: VLAN **Note:** If a dynamic VLAN assignment is established, any value that is not "31" will be ignored. In this case the attribute 81 has to be included.
65	Tunnel-Medium-Type	*Optional with Tunnel-Private-Group-ID attribute 81* Indicates which transport medium to use for the tunnel. MICROSENS G6 devices support the following tunnel type: **6**: IEEE-802
79	EAP-Message	*Optional* Encapsulates EAP packets in order to transfer those packets between RADIUS server and user via authenticators which are unable to cope with EAP.
80	Message Authenticator	*Obligatory with EAP-Message attribute 79* *Optional without EAP-Message attribute 79* Signs the access request (HMAC-MD5 checksum of the entire access request and the shared secret) to prevent spoofing of access request using authentication protocols like CHAP or EAP.
81	Tunnel-Private-Group-ID	*Optional with Tunnel-Type attribute 64 or Tunnel-Medium-Type attribute 65* Indicates the VLAN ID for this authentication response.

3.2.3 RADIUS Access Reject Attributes

MICROSENS G6 devices support the following RADIUS attributes inside "Access Reject" messages.

Note:
If not otherwise specified, the respective RADIUS attribute is obligatory for the RADIUS Access Reject message.

Type	Value	Description
79	EAP-Message	*Optional* Encapsulates EAP packets in order to transfer those packets between RADIUS server and user via authenticators which are unable to cope with EAP.

Type	Value	Description
80	Message Authenticator	*Obligatory with EAP-Message attribute 79* *Optional without EAP-Message attribute 79* Signs the access request (HMAC-MD5 checksum of the entire access request and the shared secret) to prevent spoofing of access request using authentication protocols like CHAP or EAP.

3.2.4 RADIUS Access Challenge Attributes

MICROSENS G6 devices support the following RADIUS attributes inside “Access Challenge” messages.

Note:
If not otherwise specified, the respective RADIUS attribute is obligatory for the RADIUS Access Challenge message.

Type	Value	Description
24	State	*Optional* Contains the state information to be exchanged between RADIUS server and client. This attribute is never exchanged within the initial access request message, but in an access challenge and also within the following access request.
27	Session-Timeout	*Optional* Sets the time in seconds until the session is terminated. After this duration of network connection the user has to be authenticated again for further network access.
28	Idle-Timeout	*Optional* Used with RADIUS MAC Authentication. Possible values: `0`: The MAC address is saved statically and does not age on inactivity (for “silent devices” like printers etc.) `1…n`: Sets the aging time in seconds on inactivity for this user’s MAC address. After this duration of idle time the user has to be authenticated again for further network access. As long as the user is active, this value is set to the maximum global aging time “n”, which is configured via **`Device.MAC.used_aging_time`** **Note:** This attribute is not used with 802.1X authentication.
79	EAP-Message	*Optional* Encapsulates EAP packets in order to transfer those packets between RADIUS server and user via authenticators which are unable to cope with EAP.
80	Message Authenticator	*Obligatory with EAP-Message attribute 79* *Optional without EAP-Message attribute 79* Signs the access request (HMAC-MD5 checksum of the entire access request and the shared secret) to prevent spoofing of access request using authentication protocols like CHAP or EAP.

3.3 Example 4: RADIUS Message Exchange

A typical RADIUS protocol message exchange between RADIUS client and RADIUS server appears as follows:

A user with the MAC address "0060a705aadd" establishes a connection to the MICROSENS switch and wants to access the network. Note that the MAC address also works as user name for authentication (PACC with MAC authentication).

The switch acts as RADIUS client and sends the following RADIUS attributes (called "Attribute Value Pair") inside an "**Access Request**" message to the RADIUS server:

```
Attribute Value Pairs
  AVP: l=14 t=User-Name(1): 0060a705aadd
  AVP: l=18 t=User-Password(2): Encrypted
  AVP: l=6 t=NAS-IP-Address(4): 10.100.82.127
  AVP: l=6 t=NAS-Port(5): 103
  AVP: l=8 t=NAS-Port-Id(87): Port 3
  AVP: l=6 t=NAS-Port-Type(61): Ethernet(15)
  AVP: l=6 t=Service-Type(6): Call-Check(10)
  AVP: l=15 t=NAS-Identifier(32): G6 Switch 127
  AVP: l=19 t=Called-Station-Id(30): 00:60:A7:04:90:1E
  AVP: l=19 t=Calling-Station-Id(31): 00-60-a7-05-aa-dd
  AVP: l=18 t=Message-Authenticator(80): e31a16c669aa1b746c0063e336
```

The RADIUS server verifies these credentials with his database entries for legitimate users and sends the following "**Access Accept**" message to the RADIUS client, if the database search is successfull:

```
Attribute Value Pairs
  AVP: l=14 t=User-Name(1): 0060a705aadd
  AVP: l=6 t=Idle-Timeout(28): 300
  AVP: l=6 t=Tunnel-Type(64) Tag=0x01: VLAN(13)
  AVP: l=6 t=Tunnel-Medium-Type(65) Tag=0x01: Unknown(802)
  AVP: l=4 t=Tunnel-Private-Group-Id(81) Tag=0x01: 2
```

Note:
The numbers in brackets correspond to the particular attribute values as they are defined in the RFCs and described above.

Note:
For analysing the communication between RADIUS client and server it is recommended to use a network packet analyser like Wireshark. This tool shows packet information very similar to the form represented in this example.

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