

HOW-TO

APNUS025 How to configure SLAAC and RA Server

March 2023

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1. Glossary

NDP :	Network Discovery Protocol
SLAAC :	Stateless Local Autoconfiguration Address
RA :	Router Avertissement
DHCPv6 :	Dynamic Host Configuration Protocol version 6
EUI :	Extended Unique Identifier
IPv6:	Internet Protocol version 6

2. Introduction

There are different type of IPv6 configuration in WaveOs available in version 4.22.0.1 to provide a solution to address the global issue of depleting address spaces due to increased demand for IP addresses due to technological advancements.

In this test, we will use RA server stands for DHCPv6 SLAAC only in WaveOs therefore IPv6 client addresses can be allocated by automatic addressing through SLAAC.

This post provides an extensive configuration example with details on how to configure SLAAC in WaveOS for Acksys Router, AirBox in AP mode with RA Server enabled and another Acksys Router, Airlink in IPv6 Client Mode in SLAAC.

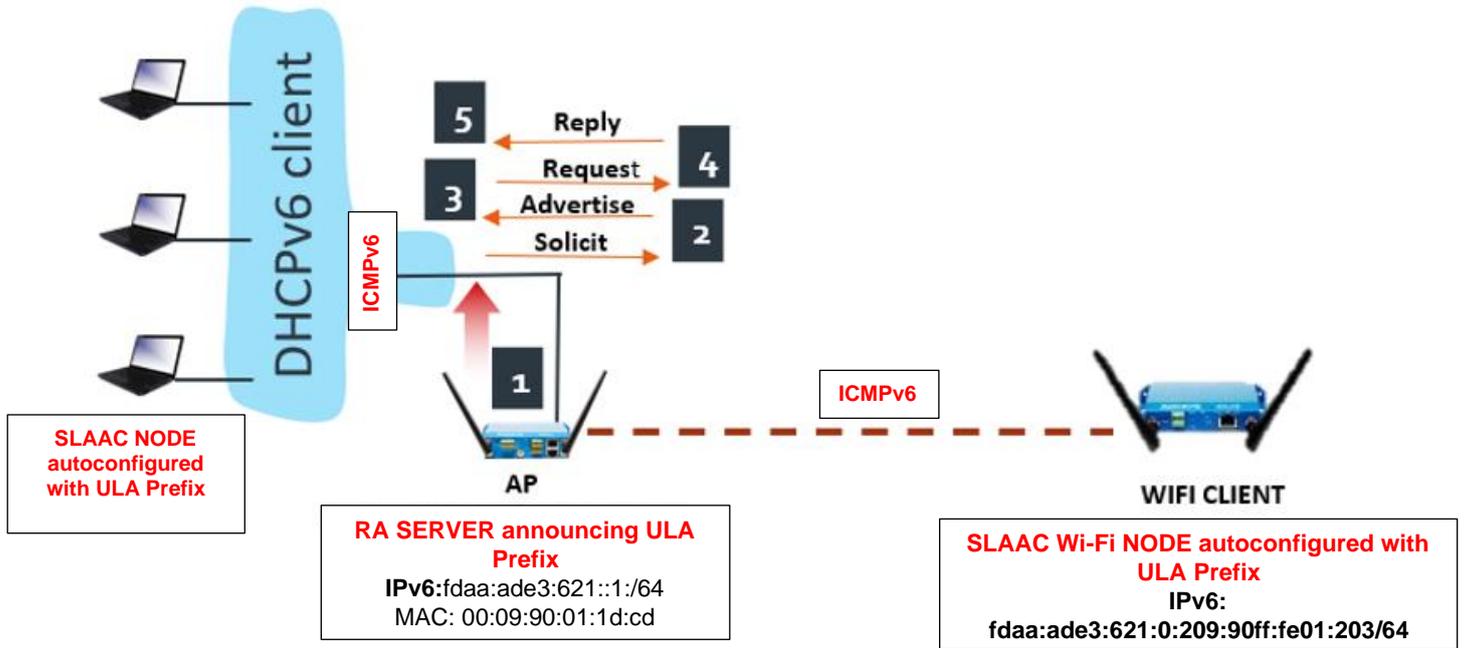
3. Configuration Overview and Prerequisites

Before we begin, let's overview the configuration that we are attempting to achieve and the prerequisites that make it possible :

- RA server: One AirBox router or any type in WaveOs 4.22.0.1 as AP role in Bridge mode
- SLAAC Wi-Fi node: Airlink Router as Client in Bridge mode or any device supporting dhcpv6 client
- Laptop to configure the routers

4. Configuration architecture

In this network architecture, there are a Router Advertising Server and IPv6 node autoconfiguring in SLAAC.



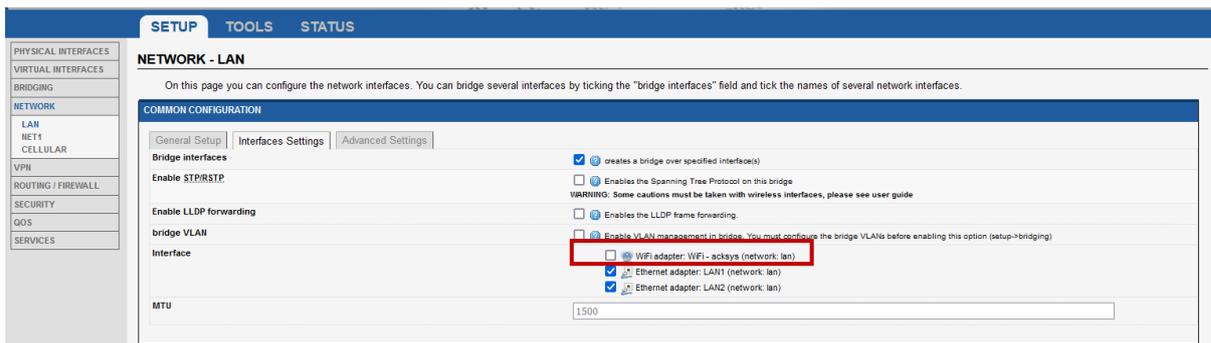
5. Devices configuration

If you have familiarized yourself with the configuration scheme and have all of the devices in order, we can start configuring the routers using instructions provided in this section.

Configuring AirBox Router in AP mode

LAN interface configuration:

By default, the LAN1 and LAN2 interfaces are bridged with WIFI interface in case of dual LAN interfaces (Acksys AirBox) and in this test, the WIFI Adapter will be associated to the IPv6 interface we will create.



Wi-Fi IPV6 interface configuration (used by the RA server to distribute the ULA prefix):

- Let configure Networks by login to the router's GUI and go to **Setup** → **Network** → **Add Network**. Enter a name for the network and click the "Add" button.

NETWORK OVERVIEW									
NAME	ENABLED	IPv6 ADDRESS	IPv6 GATEWAY	IPv4 ADDRESS	NETMASK	IPv4 GATEWAY (METRIC)	PERSISTENCE	ACTIONS	
lan	<input checked="" type="checkbox"/>			192.168.1.253	255.255.255.0		Default		
Cellular	<input type="checkbox"/>						Default	WAN config.	

- You will be redirected to the Network settings window where you can start configuring the WIFI interface. Below is screenshot of configurations WIFI interface :
 - Description interface: IPv6
 - Protocol: SLAAC
 - Delegated prefix length: 60
 - Allowed prefix classes: all
 - IPv6 ULA Prefix: fdaa:ade3:0621::/48
 - Click on Save

NETWORK - IPV6

On this page you can configure the network interfaces. You can bridge several interfaces by ticking the "bridge interfaces" field and tick the names of several network interfaces.

COMMON CONFIGURATION

General Setup | **Interfaces Settings** | Advanced Settings

Enable interface

Network description IPv6

Protocol SLAAC

Delegated prefix length 60

Allowed prefix classes all

DNS server(s)

IPV6 GLOBAL CONFIGURATION

IPv6 ULA Prefix fdaa:ade3:0621::/48

- Edit the IPv6 network created and associated its to the WIFI adapter:

NETWORK - IPV6

On this page you can configure the network interfaces. You can bridge several interfaces by ticking the "bridge interfaces" field and tick the names of several network interfaces.

COMMON CONFIGURATION

General Setup | **Interfaces Settings** | Advanced Settings

Bridge interfaces creates a bridge over specified interface(s)

Enable STP/RSTP Enables the Spanning Tree Protocol on this bridge
WARNING: Some cautions must be taken with wireless interfaces, please see user guide

Enable LLDP forwarding Enables the LLDP frame forwarding.

bridge VLAN Enable VLAN management in bridge. You must configure the bridge VLANs before enabling this option (setup->bridging)

Interface

WiFi adapter: WiFi - IPv6 (network: IPv6)

WiFi adapter: WiFi - IPv4 (network: IPv4)

Ethernet adapter: LAN1 (network: IPv6)

Ethernet adapter: LAN2 (network: IPv4)

MTU 1500

IPV6 GLOBAL CONFIGURATION

IPv6 ULA Prefix fdaa:ade3:0621::/48

NOTE:

Delegated prefix length: 60 as delegated prefix length is applicable to subscriber-hosts with IPv6 Prefix assigned by the **DHCPv6 Server in SLAAC Only (RA server)**. An IPv6 prefix is more similar to a route than it is to an IP address. The length of the prefix plays crucial role in forwarding decisions and prefix assignment through DHCPv6 pools in the local DHCPv6 server.

IPv6 ULA Prefix: Global unique prefix similar to global unicast address. Range in DHCPv6 pools IPv6 address to each device from the Router Advertisement Server and each subnet in the device will be allocated a /64 IPv6 address range from this /48 ULA range.

AirBox Network Overview

Let have a look on the network where the only interesting Network to be used is IPv6.

NETWORK OVERVIEW									
NAME	ENABLED	IPv6 ADDRESS	IPv6 GATEWAY	IPv4 ADDRESS	NETMASK	IPv4 GATEWAY (METRIC)	PERSISTENCE	ACTIONS	
LAN	<input checked="" type="checkbox"/>			192.168.1.253	255.255.255.0		Default		
IPv6	<input checked="" type="checkbox"/>	SLAAC		NONE			Default		
Cellular	<input type="checkbox"/>						Default	WAN config.	

In this note, WAN interface (Cellular) is disable therefore it is not configured as shown below:

WAN INTERFACE		
<div style="display: flex; justify-content: space-between; align-items: center;"> <div> 3G/4G/LTE Cellular radio (Cellular) </div> <div style="text-align: right;"> </div> </div>		
FRIENDLY NAME	ACTIONS	
Cellular	Interface disabled	

Configuring RA server on the AirBox Router

The AirBox router as AP have different type of DHCPv6 server and in this note, DHCPv6 server is configured in SLAAC OFNLY.DHCPv6 Server in SLAAC Only works as Router Advertising Server in charge of IPv6 addresses in SLAAC for End devices.

Let configure DHCP Server in SLAAC Only (RA server Enabled) for node to configure their address in SLAAC **Setup** → **Services**→**DHCPv6** and enter the following information below:

- SLAAC only
- No need to configure RA announce DNS
- No need to configure DNS server as local test
- Announce as default route : “set default router“ to tell RA server to push default gateway

INTERFACE SETTINGS : IPV6	
Select DHCPv6 service	SLAAC Only
RA announce DNS	<input type="checkbox"/>
DNS server(s)	2001:4860:4860::8888 <small>You can specify multiple IPv6 DNS servers here, press enter to add a new entry. In case of RA server activated, those will be advertised as RDNS entries.</small>
Announce as default route	set default route
Prefixes are announced offlink	<input type="checkbox"/> <small>If offlink is set, clients will not be able to communicate. Specific forward rules will be needed.</small>

Configuring the AP role on the WiFi interface:

By default, the WIFI interface is disable and need to be enabled before configuring the AP and for this note, we will configure the Access Point with the following information:

- in GUI and go to **Setup** → **Physical Interfaces** → **Enable the WIFI Interface.**

Wi-Fi INTERFACE						
<div style="display: flex; justify-content: space-between; align-items: center;"> <div> Wi-Fi 4 (802.11n) Wireless interface </div> <div style="text-align: right;"> </div> </div>						
CHANNEL	802.11 MODE	SSID	ROLE	SECURITY	ACTIONS	
Automatic	802.11b+g+n	acksys	Access Point (Infrastructure)	none	Interface disabled	

- Click the "Edit" button located to the right and configure your WIFI SSID.

Wi-Fi INTERFACE						
Wi-Fi 4 (802.11n) Wireless interface						
	CHANNEL	802.11 MODE	SSID	ROLE	SECURITY	ACTIONS
	Automatic	802.11b+g+n	acksys	Access Point (Infrastructure)	none	

- You will be redirected to the settings window where you can start configuring the WIFI interface. Below is capture of configurations WIFI interface :
 - ESSID : IPv6
 - Network : WIFI Interface associated to IPv6 network
 - Wireless Security : No encryption
 - Apply and save

WIRELESS SETTINGS : WIFI

The *Device Configuration* section covers physical settings of the radio hardware which is shared among all defined wireless networks. Per network settings like encryption or operation mode are in the *Interface Configuration*. If *SRCC* role is selected, most of the *Device Configuration* is irrelevant (please refer to the product user guide).

DEVICE CONFIGURATION

General Setup | a/b/g Data Rates | 802.11n Mcs | Advanced Settings

802.11 mode: 802.11b+g+n (2.4 GHz)
Changing the mode may affect the list in the 'a/b/g data rates' tab

HT mode: 20MHz
Automatic 40MHz HT mode is not compatible with AP, Ad-hoc, Mesh and multi-interfaces

Automatic channel select: Automatic channel select is not compatible with Ad-hoc, Mesh and multi-interfaces

Exclude DFS channels: If checked, ACS will never select a DFS channel

The Max Tx Power mentioned above is the legal limit for the selected country, it may be higher than the effective maximum power that can be provided by the radio card

INTERFACE CONFIGURATION

General Setup | Wireless Security | Advanced Settings | MAC Filter | Frame filters

Role: Access Point (Infrastructure)

ESSID: IPv6

Maximum simultaneous associations: Max allowed by radio card (see documentation)
Specifies the maximum number of clients to connect

Hide ESSID: In order to comply with the DFS regulation, clients might not associate if you check this option and select a DFS channel. See the user guide for more details.

Network:

- LAN:
- IPv6:
- Cellular:
- unspecified -or- create:

Choose the network you want to attach this wireless interface to

SETUP TOOLS STATUS

PHYSICAL INTERFACES: WIFI, CELLULAR, LAN1, LAN2

VIRTUAL INTERFACES: BRIDGING, NETWORK, VPN, ROUTING / FIREWALL, SECURITY, QOS, SERVICES

WIRELESS SETTINGS : WIFI

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Automatic channel select: Automatic channel select is not compatible with Ad-hoc, Mesh and multi-interfaces

Exclude DFS channels: If checked, ACS will never select a DFS channel

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INTERFACE CONFIGURATION

General Setup | Wireless Security | Advanced Settings | MAC Filter | Frame filters

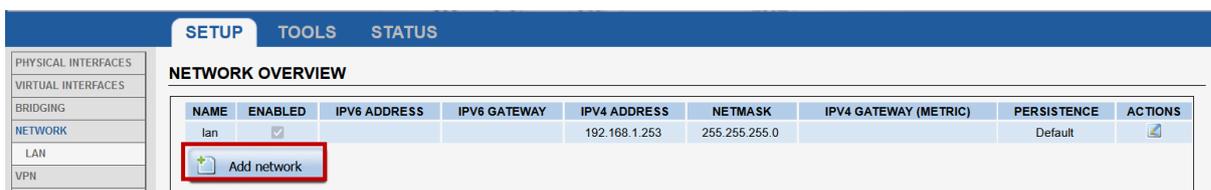
Security: No encryption
WARNING: The WEP encryption is only supported with 11abg mode.

Configuring SLAAC WIFI node: Airlink

To fully understand how the IPv6 auto-addressing work, we are going to configure the client therefore it can be configured via SLAAC. Stateless address autoconfiguration (SLAAC) as the IPv6 type makes the operating system attempt to configure the IPv6 address for the interface from router advertisements (RA) that advertise the prefix and related information

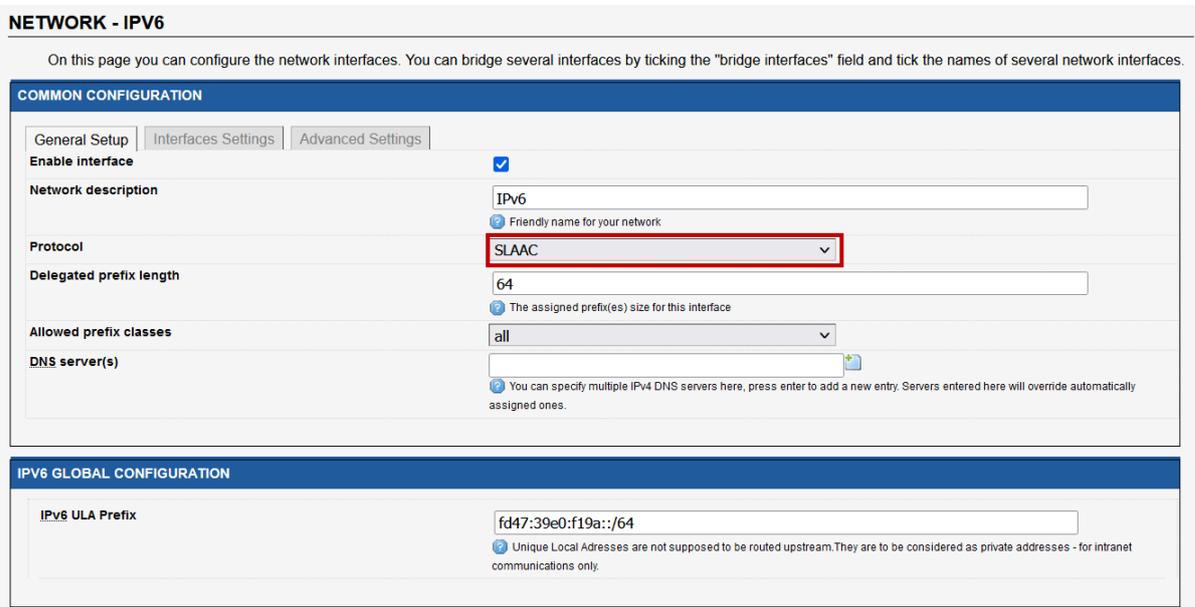
Configuring Wi-Fi interface in SLAAC mode:

Let configure Networks by login to the router's GUI and go to **Setup** → **Network** → **Add Network**. Enter a name for the network and click the "Add" button.

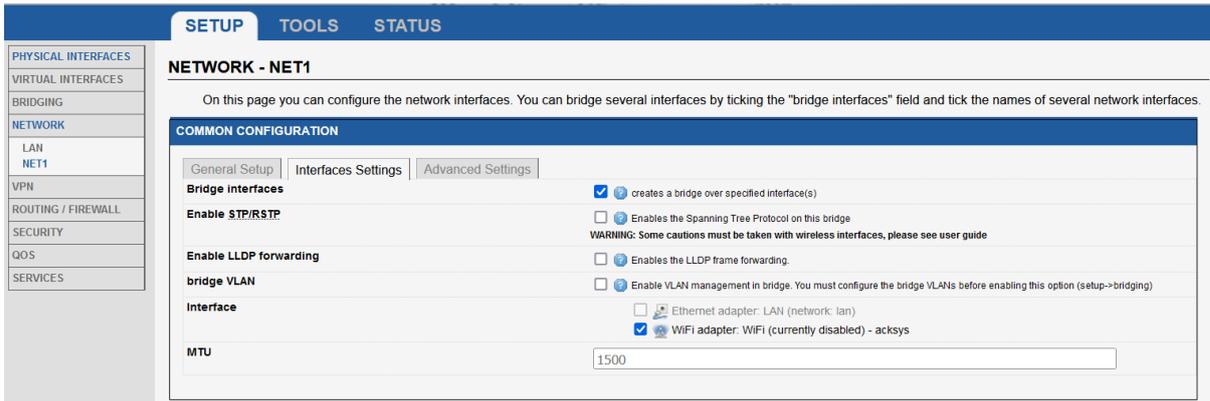


You will be redirected to the Network settings window where you can start configuring the WIFI interface. Below is capture of configurations WIFI interface :

- Description interface :IPv6
- Protocol : SLAAC
- Delegated prefix length : 64
- Allowed prefix classes : all



- Edit the IPv6 network and associated to the WIFI adapter:
- Apply and save



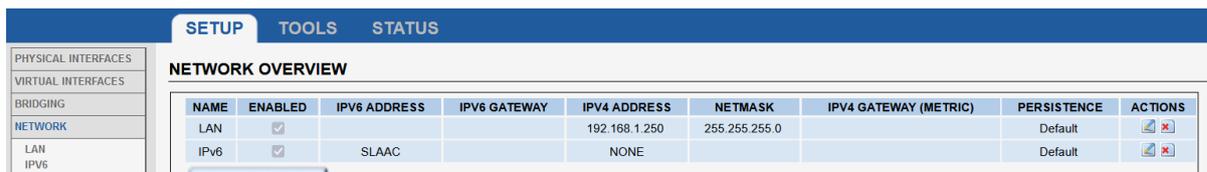
NOTE

The length of a delegated prefix always be a multiple of 4. A single network at a customer site will be a /64 and user-provided IPv6 prefix for distribution to clients

Protocol:SLAAC (Stateless Address Autoconfiguration) which IPv6 auto-addressing via RA server.

Airlink Router Network Overview

NOTE : We have changed the client IPv4 LAN address to avoid conflict with the router in AP mode.



Configuring Wi-Fi Node SSID:

- For IPv6 Node to connect on AP, we have to configure the AP SSID in GUI and go to **Setup** → **Physical Interfaces** → **Enable the WIFI Interface**.



- Click the "Edit" button located to the right and configure your WIFI SSID.



You will be redirected to the settings window where you can start configuring the WIFI interface. Below is capture of configurations WIFI interface :

- Role : Client
- ESSID : IPv6
- Network : WIFI Interface associated to IPv6 network
- Wireless Security : No encryption
- Apply and save

WIRELESS SETTINGS : WIFI

The *Device Configuration* section covers physical settings of the radio hardware which is shared among all defined wireless networks. Per network settings like encryption or operation mode are in the *Interface Configuration*.
If *SRCC* role is selected, most of the *Device Configuration* is irrelevant (please refer to the product user guide).

DEVICE CONFIGURATION

General Setup | a/b/g Data Rates | 802.11n Mcs | Advanced Settings

802.11 mode 802.11b+g+n (2.4 GHz) ▼
Changing the mode may affect the list in the 'a/b/g data rates' tab

HT mode 20MHz ▼
Automatic 40MHz HT mode is not compatible with AP, Ad-hoc, Mesh and multi-interfaces

Automatic channel select Automatic channel select is not compatible with Ad-hoc, Mesh and multi-interfaces

Exclude DFS channels If checked, ACS will never select a DFS channel

The Max Tx Power mentioned above is the legal limit for the selected country, it may be higher than the effective maximum power that can be provided by the radio card

INTERFACE CONFIGURATION

General Setup | Wireless Security | Advanced Settings | Roaming | Frame filters

Role Client (Infrastructure) ▼

Multiple ESSIDs

ESSID IPv6

Network

lan:
 IPv6:
 unspecified -or- create:

Choose the network you want to attach this wireless interface to

SETUP | TOOLS | STATUS

WIRELESS SETTINGS : WIFI

The *Device Configuration* section covers physical settings of the radio hardware which is shared among all defined wireless networks. Per network settings like encryption or operation mode are in the *Interface Configuration*.
If *SRCC* role is selected, most of the *Device Configuration* is irrelevant (please refer to the product user guide).

DEVICE CONFIGURATION

General Setup | a/b/g Data Rates | 802.11n Mcs | Advanced Settings

802.11 mode 802.11b+g+n (2.4 GHz) ▼
Changing the mode may affect the list in the 'a/b/g data rates' tab

HT mode 20MHz ▼
Automatic 40MHz HT mode is not compatible with AP, Ad-hoc, Mesh and multi-interfaces

Automatic channel select Automatic channel select is not compatible with Ad-hoc, Mesh and multi-interfaces

Exclude DFS channels If checked, ACS will never select a DFS channel

The Max Tx Power mentioned above is the legal limit for the selected country, it may be higher than the effective maximum power that can be provided by the radio card

INTERFACE CONFIGURATION

General Setup | Wireless Security | Advanced Settings | MAC Filter | Frame filters

Security No encryption ▼
WARNING: The WEP encryption is only supported with 11abg mode.

6. STATUS

If you've followed all the steps presented above, your configuration should be finished and let have an overview on status of the Network, Wireless.

AirBox Wireless Status

For IPv6 Node to connect in WIFI, we can see the AirLink IPv6 node connected on the AP SSID as below :
In GUI and go to **Status** → **Wireless**

ASSOCIATED STATIONS								
ASSOCIATED STATIONS RESULTS : 1								
GRAPH	RADIO	NAME / SSID	MODE	MAC	CHANNEL	SIGNAL	NOISE	SIGNAL/NOISE
	WiFi	IPv6	Infrastructure	00:09:90:01:02:03	6	-32 dBm	-85 dBm	53 dB

AirBox IPv6 Network Status

If you've followed all the steps presented above, after configuring RA server and restarting the services, the IPv6 address of the bridge interface is predictable.

INTERFACES						
IPv6						
IP CONFIGURATION						
IPv4 Stack not configured						
IPv6 Stack IPv6: fdaa:ade3:621::1 Netmask: 64 Scope: global IPv6: fe80::209:90ff:fe01:1dcd Netmask: 64 Scope: link						
GRAPH	PHYSICAL INTERFACE	MAC ADDRESS	TX COUNT (IN BYTES)	RX COUNT (IN BYTES)	INTERFACE MODE	MTU
	WiFi	00:09:90:01:1d:cd	4574	1934	Role: Access Point (infrastructure) SSID: IPv6 Channel: 6	1500

NOTE:

The Interface is finished with prefix::1 and in this case, the router can be reached on GUI with the URL [fdaa:ade3:621::1]/cgi-bin/guiweb.

IPv6: fdaa:ade3:621::1 Netmask: 64 Scope: global

IPv6: fe80::209:90ff:fe01:1dcd Netmask: 64 Scope: link

Airlink Wi-Fi Status

If you've followed all the steps presented above, your configuration should be finished and see the AP on which AirLink router is associated as below :

ASSOCIATED STATIONS								
ASSOCIATED STATIONS RESULTS : 1								
GRAPH	RADIO	NAME / SSID	MODE	MAC	CHANNEL	SIGNAL	NOISE	SIGNAL/NOISE
	WiFi	IPv6	Infrastructure	00:09:90:01:1D:CD	6	-30 dBm	-95 dBm	65 dB

Airlink IPv6 Network Status

If you've followed all the steps presented above, your configuration should be finished. But as with any other configuration, it is always wise to test the setup in order to make sure that it works properly.

The Client is well associated to the access point and had received SLAAC IP address from the DHCPv6 in SLAAC only configured on the AP.

Then Go to Status → Network in order to check if the client receive IP address from AP via RA Server

IP CONFIGURATION						
IPv4 Stack not configured						
IPv6 Stack IPv6: fdaa:ade3:621:0:209:90ff:fe01:203 Netmask: 64 Scope: global IPv6: fe80::209:90ff:fe01:203 Netmask: 64 Scope: link						
GRAPH	PHYSICAL INTERFACE	MAC ADDRESS	TX COUNT (IN BYTES)	RX COUNT (IN BYTES)	INTERFACE MODE	MTU
	WiFi	00:09:90:01:02:03	3440	314	Role: Client (infrastructure) SSID: IPv6 Channel: 6	1500

Now Acksys Router as Client IPv6 node for the AP has a global unicast address and a default gateway from the Router Advertisement Router (DHCP SLAAC only).

When the Airlink as client IPv6 nodes is connected to an IPv6 enabled network (AirBox in AP role), the first thing it typically do is to auto-configure themselves with a link-local address use to communicate at Layer 3 with other IPv6 devices in the local segment.

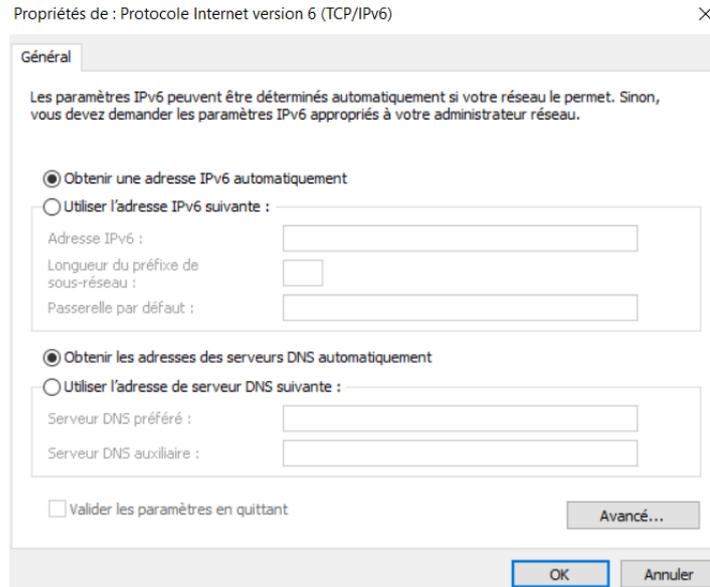
The most widely adopted way of auto-configuring a link-local address is by combining the link-local prefix FE80::/64 and the MAC address of the interface as shown on the screenshot of the Client Network Status.

IPv6: fdaa:ade3:621:0:209:90ff:fe01:203 Netmask: 64 Scope: global
Mac Address: 00:09:90:01:02:03

Once the Client Airlink gets back the Router Advertisement from AP (RA Server), it combines the prefix **fdaa:ade3:621::1/64** with its MAC address (**00:09:90:01:02:03**) resulting in the global unicast address **fdaa:ade3:621:0:209:90ff:fe01:203/64**. Because the Router Advertisement came from AP Router, Airlink sets its IPv6 default gateway to the link-local address of RA.

7. Configuring IPv6 on Windows 10

In this case, Windows is configured in its IPv6 settings in an IPv6 address automatically therefore only the allocation address is done the Router Advertisements (DHCPv6 server in SLAAC only) sent by the Acksys Router in AP mode.



```

Carte réseau sans fil Wi-Fi :

Suffixe DNS propre à la connexion. . . . :
Description. . . . . : Intel(R) Wi-Fi 6E AX211 160MHz
Adresse physique . . . . . : 28-6B-35-92-66-39
DHCP activé. . . . . : Oui
Configuration automatique activée. . . . : Oui
Adresse IPv6. . . . . : fdaa:ade3:621:0:b72:1d18:3c71:63e9(préféré)
Adresse IPv6 temporaire . . . . . : fdaa:ade3:621:0:d439:1f98:7bf6:1b6b(préféré)
Adresse IPv6 de liaison locale. . . . . : fe80::ed67:f6c6:a214:86ea%18(préféré)
Adresse d'autoconfiguration IPv4 . . . . : 169.254.33.47(préféré)
Masque de sous-réseau. . . . . : 255.255.0.0
Passerelle par défaut. . . . . :
IAID DHCPv6 . . . . . : 254307125
DUID de client DHCPv6. . . . . : 00-01-00-01-2B-15-E0-55-C4-CB-E1-06-E6-F3
Serveurs DNS. . . . . : fec0:0:0:ffff::1%1
                          fec0:0:0:ffff::2%1
                          fec0:0:0:ffff::3%1
NetBIOS sur Tcip. . . . . : Activé
    
```

The output of ipconfig /all command show the link-local address is not created using the MAC address 28-6B-35-92-66-39 but a Random Interface Identifier native with Windows devices.

Windows hosts used only MAC addresses to create Interface Identifiers (EUI-64). Globally unique addresses and Link-local ones were created using the segment's prefix plus the EUI-64 identifier which is generated from the physical address of the host.

8. TESTING

If you've followed all the steps presented above, your configuration should be finished as expected.

AirLink Network Testing

If you've followed all the steps presented above, your configuration should be finished and you can ping the Airbox IPv6 address with success as below :

```
root@CLIENT:~# ping -6 fdAA:ade3:621::1 -w 10
PING fdAA:ade3:621::1 (fdAA:ade3:621::1): 56 data bytes
64 bytes from fdAA:ade3:621::1: seq=0 ttl=64 time=1.670 ms
64 bytes from fdAA:ade3:621::1: seq=1 ttl=64 time=1.455 ms
64 bytes from fdAA:ade3:621::1: seq=2 ttl=64 time=1.500 ms
64 bytes from fdAA:ade3:621::1: seq=3 ttl=64 time=5.500 ms
64 bytes from fdAA:ade3:621::1: seq=4 ttl=64 time=2.639 ms
64 bytes from fdAA:ade3:621::1: seq=5 ttl=64 time=1.472 ms
64 bytes from fdAA:ade3:621::1: seq=6 ttl=64 time=1.886 ms
64 bytes from fdAA:ade3:621::1: seq=7 ttl=64 time=4294962.832 ms
64 bytes from fdAA:ade3:621::1: seq=8 ttl=64 time=1.607 ms
64 bytes from fdAA:ade3:621::1: seq=9 ttl=64 time=1.557 ms

--- fdAA:ade3:621::1 ping statistics ---
10 packets transmitted, 10 packets received, 0% packet loss
round-trip min/avg/max = 1.455/429498.211/4294962.832 ms
```

Windows10 Network Testing

If you've followed all the steps presented above, your configuration should be finished and you can ping the Airbox IPv6 address with success as below :

```
31/03/2023 10:40.41 /home/mobaxterm ping -6 fdAA:ade3:621::1 -w 10

Envoi d'une requête 'Ping' fdAA:ade3:621::1 avec 32 octets de données :
Réponse de fdAA:ade3:621::1 : temps=4 ms
Réponse de fdAA:ade3:621::1 : temps=2 ms
Réponse de fdAA:ade3:621::1 : temps=1 ms
Réponse de fdAA:ade3:621::1 : temps=2 ms

Statistiques Ping pour fdAA:ade3:621::1:
  Paquets : envoyés = 4, reçus = 4, perdus = 0 (perte 0%),
  Durée approximative des boucles en millisecondes :
    Minimum = 1ms, Maximum = 4ms, Moyenne = 2ms
```

Email : support@acksys.fr