



## LAG/LLDP/PoE Configuration

Technical Note

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### **Intended Audience**

This document provides an overview of how to configure LLDP, PoE and Link Aggregation for Ruckus Access Points and network access switches from Ruckus and several other vendors. Some knowledge of networking technologies is recommended.

This document is written for and intended for use by network engineers.

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## Overview

### Technologies and Standards

There are several technologies and standards, which will be discussed in this document. Let's start with a brief overview of what they are and why they are used in the networking.

#### Link Layer Discovery Protocol (LLDP)

LLDP is a vendor agnostic industry standard specified in IEEE802.1AB. It is used by network connected devices to exchange information about their own system properties. This exchange is conducted over Layer 2 and generally over an Ethernet network. One of the common uses of LLDP is the ability to identify devices that are connected to a network switch. This protocol also provides additional information about device capabilities. For LLDP to work as intended, it should be supported and enabled on connected devices.

Information exchanged by LLDP can be also used by network management applications and by automation scripts.

Media Endpoint Discovery is an extension for LLDP, also known as LLDP-MED. This standard is published as ANSI/TIA-1057. It specifies the rules for information exchange between media devices e.g. VoIP phones, PoE devices.

#### Link aggregation and Link Aggregation Control Protocol (LACP)

LACP is an industry standard that is published as IEEE 802.3ad. LACP specifies the rules for binding several physical network ports into a single logical channel; this process is also called link aggregation or NIC teaming. In general, physical link aggregation offers the benefit of delivering extra bandwidth for network connected devices, it can also be deployed with the goal to provide switch-port redundancy.

For LACP to work both peers have to exchange protocol packets and negotiate the link binding process. There are several different parameters that can be defined to control this operation.

LACP mode of operation can be either active or passive, this selection defines the conditions for enabling the protocol on a link.

Other important configuration parameters set the minimum and maximum number of links, which can be bundled; the number of links should be within the range for the link aggregation to form.

Top end 802.11ac Wireless Access Points are capable of providing greater than 1Gbps throughput. Aggregating 2 x 1 GE interfaces becomes a requirement for avoiding the bottleneck between AP and a switch.

Ruckus ICX switches have the ability to attach LACP links to different switches in a stack, therefore increasing High Availability (HA) to the solution.

#### Power over Ethernet

Power over Ethernet (PoE) is the technology, which provides power to the devices connected over Ethernet cabling. A network switch acts as a power source allowing a limited amount of power to be drawn from some or all switch ports. On the other end of the Ethernet cable a connected network device like an access point or an IP phone will consume that power and operate without external power supply and mains power cabling.

There are several IEEE802.3 standards that apply to the PoE implementations. Most common ones are the following:

- The IEEE802.3af standard
  - 15.4W of power per switch-port

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- 12.95W of power available to a device
- The IEEE802.3at standard
  - 30W of power per switch-port
  - 25.50W of power available to a device

Note: due to some dissipation of energy taking place in the cable itself power available to a device would be lower.

It is common that configuration options have to be applied to a switch, so PoE levels can be either automatically negotiated or statically assigned.

Some later model network switches may also be capable of providing power levels in excess of the 802.3at standard limit, for example Ruckus ICX switches can support up to 95W on selected ports. This is not a standard but an industry specification.

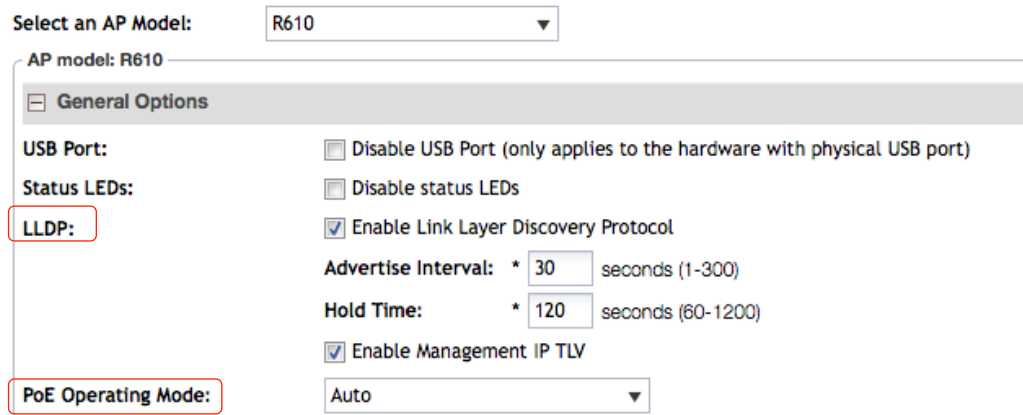
## Configuration

### Ruckus Access Point and Controller

Enabling LLDP and PoE mode

LLDP can be enabled on per model basis in Ruckus SmartZone (SZ) or Virtual SmartZone (vSZ) controller. Lets look at this configuration in the GUI of a vSZ version 3.4.1 for a R610 model access point. Go to Wireless Network > Access Points > Model-based Settings> Enable Link Layer Discovery Protocol; refer to Figure 1.

The same configuration GUI page has a configuration option to set PoE Operating Mode with options Auto/802.3af/802.3at. If the 802.3af mode is selected and the AP requirement is above the 802.3af standard power requirements it will only operate with a subset of hardware features. An AP datasheet will have to be consulted for the power requirements and the impact of operation in 802.3af mode.



Select an AP Model: R610

AP model: R610

**General Options**

USB Port:  Disable USB Port (only applies to the hardware with physical USB port)

Status LEDs:  Disable status LEDs

**LLDP:**  Enable Link Layer Discovery Protocol

Advertise Interval: \* 30 seconds (1-300)

Hold Time: \* 120 seconds (60-1200)

Enable Management IP TLV

**PoE Operating Mode:** Auto

FIGURE 1 LLDP CONFIGURATION IN VSZ

Interface bonding

Several Ruckus 802.11ac access point models can support aggregation of 2 x 1GE interfaces, this feature is also called interface bonding. If an AP can deliver more than 1 Gbps of throughput you may consider using the interface bonding.

For the feature to work LLDP has to be enabled on the Ruckus AP and on the switch.

Dynamic link aggregation with LACP also has to be configured on the switch ports designated for the AP connection. The switch configuration will be discussed later in this document using examples of the switches from different vendors.

Ruckus AP configuration for bonding Ethernet Interfaces has to be applied via CLI as shown below

```
rkscli: set bond bond0 add eth0
OK
rkscli: set bond bond0 add eth1
OK
```

Once it is done, the next step is to ensure that 802.3at power negotiation is recognized by AP. It is not sufficient just to have a switch port capable of providing such power budget.

```
rkscli: get power-mode
PoE Configured Mode: Auto
```

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*Power Consumption Status : 802.3at PoE+*

OK

*rkscli: get eth*

*Port Interface 802.1X Logical Link Physical Link Label*

```
-----  
0 eth0 None Up Up 1000Mbps full 10/100/1000 PoE  
1 eth1 None Up Up 1000Mbps full 10/100/1000
```

Note: AP may accept PoE via one port only, that port will have to be connected to the switch regardless if the second port is used for bonding or not.

Let's look at configuration of access switches next.



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### Ruckus ICX switch with FastIron

We can use a Ruckus ICX PoE capable switch with software version 08.0.30 or later which could be either ICX7450, 7250, or 7150. In this case, we will use an ICX7450-48P. Switch configuration will be done via CLI.

#### CLI Commands

We assume that the switch CLI is accessible via Console, Telnet or SSH protocol and login credentials are provided. We will be connecting an R610 Access Points to the switch-ports 1/1/5 and 1/1/7 and configure LLDP, PoE and link aggregation.

#### Enabling LLDP and PoE

By default, LLDP is disabled in ICX 7450 switch. To enable it, the following global command has to be issued:

```
telnet@ICX7450-48P Router(config)#lldp run
```

PoE is disabled by default on the switch ports. To enable it, get to the interface level configuration for the port and select the port or range of ports, which require PoE and configure the "inline power" command.

```
telnet@ICX7450-48P Router(config)#interface ethernet 1/1/5
```

```
telnet@ICX7450-48P Router(config-if-e1000-1/1/5)#inline power
```

Switch will have to advertise power via LLDP and the following commands has to be issued either for the specific port i.e. port 1/1/5, which we are using in our example

```
telnet@ICX7450-48P Router(config-if-e1000-1/1/5)#lldp advertise power-via-mdi ports ethernet 1/1/5
```

or for all ports if all ports have to be configured identically

```
telnet@ICX7450-48P Router(config-if-e1000-1/1/5)#lldp advertise power-via-mdi ports all
```

#### Configuring Link Aggregation

We will configure switch ports ethernet 1/1/5 and 1/1/7 to establish an aggregated link for the R610 Access Point.

```
telnet@ICX7450-48P Router(config)#lag R610 dynamic id 3
```

```
telnet@ICX7450-48P Router(config-lag-R610)#ports e 1/1/5 e 1/1/7
```

```
telnet@ICX7450-48P Router(config-lag-R610)#primary-port 1/1/5
```

```
telnet@ICX7450-48P Router(config-lag-R610)#deploy
```

After configuration is deployed, the following output will be included in the switch running configuration:

```
!  
lag R610 dynamic id 3  
ports ethernet 1/1/5 ethernet 1/1/7  
primary-port 1/1/5  
deploy
```

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!

### Verify configuration

We will use CLI "show" commands to verify the LLDP, PoE and Link Aggregation features in operation.

To verify PoE on the switch port with AP connected use *show inline power* command. In the example below, take a note of readings on ethernet 1/1/5 i.e. a switch port with AP connection.

```
telnet@ICX7450-48P Router#show inline power
```

```
Power Capacity:      Total is 748000 mWatts. Current Free is 721500 mWatts.
```

```
Power Allocations:  Requests Honored 13 times
```

| Port | Admin State | Oper State | ---Power(mWatts)--- | PD Type | PD Class | Pri | Fault/ Error |
|------|-------------|------------|---------------------|---------|----------|-----|--------------|
|------|-------------|------------|---------------------|---------|----------|-----|--------------|

|       |    |     |   |       |     |   |     |
|-------|----|-----|---|-------|-----|---|-----|
| 1/1/1 | On | Off | 0 | 0 n/a | n/a | 3 | n/a |
|-------|----|-----|---|-------|-----|---|-----|

|       |    |     |   |       |     |   |     |
|-------|----|-----|---|-------|-----|---|-----|
| 1/1/2 | On | Off | 0 | 0 n/a | n/a | 3 | n/a |
|-------|----|-----|---|-------|-----|---|-----|

|       |    |     |   |       |     |   |     |
|-------|----|-----|---|-------|-----|---|-----|
| 1/1/3 | On | Off | 0 | 0 n/a | n/a | 3 | n/a |
|-------|----|-----|---|-------|-----|---|-----|

|       |    |     |   |       |     |   |     |
|-------|----|-----|---|-------|-----|---|-----|
| 1/1/4 | On | Off | 0 | 0 n/a | n/a | 3 | n/a |
|-------|----|-----|---|-------|-----|---|-----|

|       |    |    |      |       |         |         |       |
|-------|----|----|------|-------|---------|---------|-------|
| 1/1/5 | On | On | 5300 | 26500 | 802.3at | Class 4 | 3 n/a |
|-------|----|----|------|-------|---------|---------|-------|

|       |    |     |   |       |     |   |     |
|-------|----|-----|---|-------|-----|---|-----|
| 1/1/6 | On | Off | 0 | 0 n/a | n/a | 3 | n/a |
|-------|----|-----|---|-------|-----|---|-----|

|       |    |     |   |       |     |   |                 |
|-------|----|-----|---|-------|-----|---|-----------------|
| 1/1/7 | On | Off | 0 | 0 n/a | n/a | 3 | non-standard PD |
|-------|----|-----|---|-------|-----|---|-----------------|

To verify LLDP, we will check if a connected AP can be seeing via LLDP protocol. Using *show LLDP neighbors* command in the example below we validated that R610-Room1-AP is connected using link aggregation to two interfaces and is reported on both: 1/1/5 and 1/1/7.

```
telnet@ICX7450-48P Router#show lldp neighbors
```

| Lcl Port | Chassis ID     | Port ID        | Port Description | System Name    |
|----------|----------------|----------------|------------------|----------------|
| 1/1/3    | f8b1.5683.81b5 | Gi2/0/3        | Gi2/0/3          | access-stack~  |
| 1/1/5    | ec8c.a20c.3ae0 | ec8c.a20c.3ae3 | eth0             | R610-Room1-AP~ |
| 1/1/7    | ec8c.a20c.3ae0 | ec8c.a20c.3ae4 | eth1             | R610-Room1-AP~ |

To confirm that link aggregation is working, use *show lag* CLI command. The command will produce a report for all LAGs configured in the switch. In our example we check the output for LAG "R610" ID 3.

```
telnet@ICX7450-48P Router#show lag
```

```
Total number of LAGs:      2
```

```
Total number of deployed LAGs: 2
```

```
Total number of trunks created:2 (254 available)
```

```
LACP System Priority / ID:  1 / cc4e.2489.ae48
```

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LACP Long timeout: 120, default: 120

LACP Short timeout: 3, default: 3

```
=== LAG "R610" ID 3 (dynamic Deployed) ===
```

### LAG Configuration:

Ports: e 1/1/5 e 1/1/7

Port Count: 2

Primary Port: 1/1/5

Trunk Type: hash-based

LACP Key: 20003

Deployment: HW Trunk ID 2

| Port  | Link | State   | Dupl | Speed | Trunk | Tag | Pvid | Pri | MAC            | Name |
|-------|------|---------|------|-------|-------|-----|------|-----|----------------|------|
| 1/1/5 | Up   | Forward | Full | 1G    | 3     | Yes | 1    | 0   | cc4e.2489.ae48 |      |
| 1/1/7 | Up   | Forward | Full | 1G    | 3     | Yes | 1    | 0   | cc4e.2489.ae48 |      |

| Port  | [Sys P] | [Port P] | [Key] | [Act] | [Tio] | [Agg] | [Syn] | [Col] | [Dis] | [Def] | [Exp] | [Ope] |
|-------|---------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1/1/5 | 1       | 1        | 20003 | Yes   | L     | Agg   | Syn   | Col   | Dis   | No    | No    | Ope   |
| 1/1/7 | 1       | 1        | 20003 | Yes   | L     | Agg   | Syn   | Col   | Dis   | No    | No    | Ope   |

### Partner Info and PDU Statistics

| Port  | Partner        | Partner | LACP     | LACP     |
|-------|----------------|---------|----------|----------|
|       | System MAC     | Key     | Rx Count | Tx Count |
| 1/1/5 | ec8c.a20c.3ae3 | 17      | 99       | 2596     |
| 1/1/7 | ec8c.a20c.3ae3 | 17      | 91       | 2456     |

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## Cisco Switch with IOS

Configuration of switches, which run Cisco IOS is generally done via CLI. In the example below we will use Cisco 2960L, a PoE capable access switch with IOS 15.2.

### CLI Commands

We assume that connection to the CLI is available either via a serial console port or as an SSH/Telnet protocol session.

In this example, we will connect a Ruckus R610 access point to the switch ports Gi0/5 and Gi0/7 and configure a port channel.

### Enabling LLDP and PoE

PoE is enabled for all Gigabit Ethernet switch ports by default with *auto* option selected.

If has been explicitly disabled for a port the following interface level configuration CLI command will enable it:

```
cisco2960L(config)#int gigabitEthernet 0/5
cisco2960L(config-if)#power inline auto
```

Note: GigabitEthernet 0/5 interface is used in this example.

To enable LLDP use global configuration command:

```
cisco2960L(config)#lldp run
```

If the switch port is in *no shut* state, AP can be connected to Gi0/5 using AP PoE port and it will be powered up with inline power. Several more CLI commands will be necessary to complete configuration of switch ports and to setup port-channel e.g. port aggregation if two 1GE AP interfaces have to be aggregated to provide higher bandwidth.

### Configure Port Channel

In a Cisco IOS switch a *Port-channel<X>* interface has to be created and configured. This configuration can be applied to a group of physical switch interfaces with a *channel-group<X>* command. Assuming that AP will connect to the switch via trunk switch-port, create the following interface in the switch, where X=1 as in our example this is 1st port channel interface in the switch:

```
interface Port-channel1
switchport mode trunk
```

There is a configurable option to setup minimal number of links for the port-channel (*port-channel min-links <Y>*) but in the switch we are using in our example the minimum number that can be set is 2. We are not applying this command as we expect to maintain connectivity when only one link is available. This shall be the link which provides the PoE.

Assign this port channel to the selected physical interfaces in the switch. Of we follow our example these will be Gi0/5 and Gi0/7. Enable LACP channel protocol and set the mode to *passive*. The final output of switch port configuration will look as following:

```
!
interface GigabitEthernet0/5
switchport mode trunk
```

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```
channel-protocol lacp
channel-group 1 mode passive
```

```
!
interface GigabitEthernet0/6
switchport mode trunk
!
```

```
interface GigabitEthernet0/7
switchport mode trunk
channel-protocol lacp
channel-group 1 mode passive
```

```
!
```

Traffic has to be load balanced across multiple interfaces of the port channel. Load balancing can be done with different methods. In the switch example we are using, it is by source-destination MAC address:

```
cisco2960L#show etherchannel load-balance
```

EtherChannel Load-Balancing Configuration:

```
src-dst-mac
```

EtherChannel Load-Balancing Addresses Used Per-Protocol:

Non-IP: Source XOR Destination MAC address

Ipv4: Source XOR Destination MAC address

Ipv6: Source XOR Destination MAC address

### Verify configuration

To verify LLDP, PoE and port aggregation we connect AP to the switch with two Ethernet cables. After the AP powers up and goes through a bootup sequence we can check if the switch can detect it as an LLDP neighbor. Cisco CLI `show lldp neighbors` command should produce an output as below:

```
cisco2960L#show lldp neighbors
```

Capability codes:

(R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device

(W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other

| Device ID      | Local Intf | Hold-time | Capability | Port ID |
|----------------|------------|-----------|------------|---------|
| access-stack-1 | Gi0/1      | 120       |            | Gi2/0/3 |

|                |       |     |   |                |
|----------------|-------|-----|---|----------------|
| R610-Room1-AP2 | Gi0/7 | 120 | B | ec8c.a20c.3ae4 |
|----------------|-------|-----|---|----------------|

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|                |       |     |   |                |
|----------------|-------|-----|---|----------------|
| R610-Room1-AP2 | Gi0/5 | 120 | B | ec8c.a20c.3ae3 |
|----------------|-------|-----|---|----------------|

Total entries displayed: 3

Note that the access point is shown connected to both switch-ports in the switch.

We can also verify inline power settings with `show power inline` CLI command. The output below shows available inline power budget in the switch detailing the used and remaining power levels. It also prints a status for every interface. Note the PoE port of the AP is connected to the Gi0/5 switch-port and it has its operational status shown as `on`. In this example, the AP is not getting PoE via Gi0/7, which is the second interface of the port-channel.

```
cisco2960L#show power inline
```

```
Available:67.0(w) Used:29.5(w) Remaining:37.5(w)
```

| Interface | Admin | Oper | Power | Device | Class | Max |
|-----------|-------|------|-------|--------|-------|-----|
| (Watts)   |       |      |       |        |       |     |

```
-----
```

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/1 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/2 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/3 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/4 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |    |      |         |   |      |
|-------|------|----|------|---------|---|------|
| Gi0/5 | auto | on | 29.5 | ieee PD | 4 | 30.0 |
|-------|------|----|------|---------|---|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/6 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/7 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

|       |      |     |     |     |     |      |
|-------|------|-----|-----|-----|-----|------|
| Gi0/8 | auto | off | 0.0 | n/a | n/a | 30.0 |
|-------|------|-----|-----|-----|-----|------|

To show the status of the port channel in the switch use `show etherchannel <X>` CLI command. There are several output options that are supported for this command. To generate a summary of the output, add `summary` keyword. Note the flags identifying bundled interfaces Gi0/5 and Gi0/7. If a detailed output is desirable add `detail` keyword.

```
cisco2960L#show etherchannel 1 summary
```

```
Flags: D - down      P - bundled in port-channel
```

```
l - stand-alone s - suspended
```

```
H - Hot-standby (LACP only)
```

```
R - Layer3      S - Layer2
```

```
U - in use      N - not in use, no aggregation
```

```
f - failed to allocate aggregator
```

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*M - not in use, minimum links not met*

*m - not in use, port not aggregated due to minimum links not met*

*u - unsuitable for bundling*

*w - waiting to be aggregated*

*d - default port*

*A - formed by Auto LAG*

Number of channel-groups in use: 1

Number of aggregators: 1

Group Port-channel Protocol Ports

-----+-----+-----+-----

|   |         |      |          |          |
|---|---------|------|----------|----------|
| 1 | Po1(SU) | LACP | Gi0/5(P) | Gi0/7(P) |
|---|---------|------|----------|----------|

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### Dell switch

There are multiple models of access layer switches offered by Dell. We will use a Dell N1524P switch with System Software Version 6.2.5.3 to configure these features. We will use CLI commands for consistency even that most commands are available via a very functional web GUI.

#### CLI Commands

##### Configuring PoE

For configuration of inline power detection, several detection modes are supported; we select the following: detection of 802.3at mode followed by legacy mode.

```
access-stack-1(config)#power inline detection dot3at+legacy
```

There are several options for inline power management supported by the switch. They include static, dynamic and class. We select dynamic power management option.

```
access-stack-1(config)#power inline management dynamic
```

There is an additional configuration command to set an inline power usage threshold. It may be left with default values or set to a particular value for the entire switch. The amount of power within the threshold, as well as the settings configured above, can be read in the output of `show power inline` CLI command:

```
access-stack-1#show power inline
```

Unit Status

=====

Unit..... 1

Power..... On

Total Power..... 500 Watts

Threshold Power..... 350 Watts

Consumed Power..... 0 Watts

Usage Threshold..... 70%

Power Management Mode..... Dynamic

Power Detection Mode..... dot3at+legacy

##### Configuring LLDP

By default LLDP is enabled in the switch and on all interfaces. Note: If required, LLDP receive and transmit can be disabled (or enabled) on per interface basis. This can be done on interface configuration level. The following commands will enable LLDP transmit and receive. The same commands with preceding "no" keyword will make them disabled.

```
access-stack-1(config-if-Gi1/0/16)#lldp receive
```

```
access-stack-1(config-if-Gi1/0/16)#lldp transmit
```

In addition to LLDP, we also configure Media Endpoint Discovery (MED). MED will allow endpoints to exchange additional messages and include them in the automated power management process.



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In our example, for configuring LLDP for a switch port with a Ruckus AP connection we have the following CLI options active:

```
!  
interface Gi1/0/16  
channel-group 3 mode active  
switchport mode trunk
```

```
lldp transmit-tlv sys-desc sys-cap  
lldp transmit-mgmt  
lldp notification  
lldp med confignotification  
lldp med transmit-tlv ex-pse
```

Note: The Dell switch does not show default configuration CLI in the output i.e. as LLDP receive and transmit is enabled on this interface it is not included.

### Configuring Link Aggregation

There are several options for LACP configuration available in the switch.

Global level configuration command to set LACP system priority with default value set to 1; the higher the value the lower the priority.

```
access-stack-1(config)#lacp system-priority
```

LACP port priority (default value "1") and LACP timeout (default value "long") can be set on the interface configuration level.

```
access-stack-1(config-if-Gi1/0/16)#lacp port-priority
```

```
access-stack-1(config-if-Gi1/0/16)#lacp timeout
```

There is no option to enable/disable LACP in the switch but it can be enabled on specific port channel (LAG) setup for link aggregation via web GUI under Switching>>Link Aggregation>>LAG Membership. This is how it has been described by the vendor:

**"LACP.** Aggregates a LAG port to LACP membership. For ports with a number in the LAG row, You can click in the LACP row to toggle LACP "ON." Each click toggles between L (LACP) and blank (no LACP)."

The result of the GUI configuration will look as on Figure 2 below. LAG groups 2 and 3 have LACP (L) where LAG group 1 has no LACP (no L).

Note: To toggle between these settings a mouse over with a click on the field can be used.

LAG Membership

Detail

### LAG Membership: Detail

Unit
1

|      |  | Ports |     |     |     |     |     |     |     |     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|------|--|-------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
|      |  | Gi1   | Gi2 | Gi3 | Gi4 | Gi5 | Gi6 | Gi7 | Gi8 | Gi9 | Gi10 | Gi11 | Gi12 | Gi13 | Gi14 | Gi15 | Gi16 | Gi17 | Gi18 | Gi19 | Gi20 | Gi21 | Gi22 | Gi23 | Gi24 |
| LACP |  |       |     |     |     |     |     | L   |     | L   |      |      |      |      |      | L    |      | L    |      |      |      |      |      |      |      |
| LAG  |  |       |     |     |     |     | 2   | 1   | 2   | 1   |      |      |      |      |      | 3    |      | 3    |      |      |      |      |      |      |      |

|      |  | Ports |     |     |     |
|------|--|-------|-----|-----|-----|
|      |  | Te1   | Te2 | Te3 | Te4 |
| LACP |  |       |     |     |     |
| LAG  |  |       |     |     |     |

FIGURE 2 LAG MEMBERSHIP

```
!
interface port-channel 3
description "AP LAG testing"
hashing-mode 5
```

The algorithm for hashing mode 5 relies on the following parameters in the process:

- Source/Destination MAC
- VLAN
- EtherType
- Source MODID/port

Verify configuration

Verifying LLDP Status

To verify the status of a device connected to the switch port we use `show lldp` command with `local-device` or `remote -device` option. To get a list of all remote devices connected to the switch and communicating via LLDP use `show lldp remote-device all` command. See the output in the example below where R610-Room1-AP2 is connected to two Gigabit interfaces with link aggregation.

```
access-stack-1#show lldp remote-device all
```

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### LLDP Remote Device Summary

Local

| Interface | RemID | Chassis ID        | Port ID           | System Name      |
|-----------|-------|-------------------|-------------------|------------------|
| -----     |       |                   |                   |                  |
| Gi1/0/1   | 14025 | F8:B1:56:88:A1:E7 | Gi1/0/23          | tmelab-dst-stack |
| Gi1/0/16  | 14032 | EC:8C:A2:0C:3A:E0 | EC:8C:A2:0C:3A:E3 | R610-Room1-AP2   |
| Gi1/0/18  | 14033 | EC:8C:A2:0C:3A:E0 | EC:8C:A2:0C:3A:E4 | R610-Room1-AP2   |
| Te1/0/1   | 4504  | 00:0E:1E:9B:F1:A0 | 00:0E:1E:9B:F1:A0 |                  |

-----

Gi1/0/1 14025 F8:B1:56:88:A1:E7 Gi1/0/23 tmelab-dst-stack

Gi1/0/16 14032 EC:8C:A2:0C:3A:E0 EC:8C:A2:0C:3A:E3 R610-Room1-AP2

Gi1/0/18 14033 EC:8C:A2:0C:3A:E0 EC:8C:A2:0C:3A:E4 R610-Room1-AP2

Te1/0/1 4504 00:0E:1E:9B:F1:A0 00:0E:1E:9B:F1:A0

### Verifying Link Aggregation

To validate the functionality of link aggregation we can issue `show interfaces port-channel` command to the switch. The output lists all port channels (Po) configured in the switch. In our case, Po3 is where the R610 is connected. Note: the status is shown as Active with both physical interfaces listed.

```
access-stack-1#show interfaces port-channel
```

| Channel | Ports                      | Ch-Type | Hash Type | Min-links | Local Prf |
|---------|----------------------------|---------|-----------|-----------|-----------|
| -----   |                            |         |           |           |           |
| Po1     | Active: Gi1/0/8, Gi1/0/10  | Static  | 6         | 1         | Disabled  |
| Po2     | Inactive: Gi1/0/7, Gi1/0/9 | Dynamic | 5         | 1         | Disabled  |
| Po3     | Active: Gi1/0/16, Gi1/0/18 | Dynamic | 5         | 1         | Disabled  |

-----

Po1 Active: Gi1/0/8, Gi1/0/10 Static 6 1 Disabled

Po2 Inactive: Gi1/0/7, Gi1/0/9 Dynamic 5 1 Disabled

Po3 Active: Gi1/0/16, Gi1/0/18 Dynamic 5 1 Disabled

In the SmartZone controller both AP interfaces will be also shown with the Logical Link UP status, see Figure 3

### LAN Port Status

| Port | Interface | 802.1X | Logic Link | Physical Link    | Label |
|------|-----------|--------|------------|------------------|-------|
| 0    | eth0      | None   | Up         | Up 1000Mbps full | LAN1  |
| 1    | eth1      | None   | Up         | Up 1000Mbps full | LAN2  |

FIGURE 3 AP LAN PORT STATUS

It is also advisable to check switch port statistics for both physical interfaces that are bundled. When AP is in operation the hashing algorithms used should send and receive packets on both ports. Even when there is no exact balance achieved, the interface counters will show some non-zero values; use `show interfaces <interface>` CLI command in the switch.

Another useful command is `show lacp <interface>`, the output will show the status and statistics of an LACP exchange for the switch port. For the connection with LACP exchange is occurring status of the selected fields will be show as TRUE and PDU count incrementing, see below

```
access-stack-1#show lacp gigabitethernet 1/0/16
```

```
port Gi1/0/16 LACP parameters:
```

```
Actor:
```

```
system priority: 1
```

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```
port Admin key:      0
port oper key:       212
port oper priority:  1
port oper timeout:   LONG
port Admin timeout:  LONG
LACP Activity:       ACTIVE
Aggregation:         AGGREGATABLE
```

|                  |      |
|------------------|------|
| synchronization: | TRUE |
| collecting:      | TRUE |
| distributing:    | TRUE |

```
expired:             FALSE
```

Partner:

```
port Admin key:      0
port oper key:       17
port Admin priority:  0
port oper priority:  255
port Oper timeout:   SHORT
LACP Activity:       ACTIVE
Aggregation:         AGGREGATABLE
```

|                  |      |
|------------------|------|
| synchronization: | TRUE |
| collecting:      | TRUE |
| distributing:    | TRUE |

```
expired:             FALSE
```

port Gi1/0/16 LACP Statistics:

|                     |       |
|---------------------|-------|
| LACP PDUs send:     | 31977 |
| LACP PDUs received: | 1076  |

### Verifying Inline Power

To monitor the inline power provided by a switch port with AP connected, use *show power inline <interface>*

```
access-stack-1#show power inline gigabitethernet 1/0/16
```

```
Port    Powered Device    State Priority Status  Class  Power[mW]
```

```
-----
Gi1/0/16          auto Low   On    Class4 4700
```

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### Summary

This document outlines basic set of commands that would enable features such as LLDP, PoE and LAG between Ruckus wireless access points and enterprise grade switches such as Ruckus ICX; including vendors like Cisco and Dell.

The configuration commands for link aggregation only apply to the access points that support it.

To verify the operation of these features an additional set of commands and some examples of CLI output are included.

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### About Ruckus

Headquartered in Sunnyvale, CA, Ruckus Wireless, Inc. is a global supplier of advanced wireless systems for the rapidly expanding mobile Internet infrastructure market. The company offers a wide range of indoor and outdoor “Smart Wi-Fi” products to mobile carriers, broadband service providers, and corporate enterprises, and has over 36,000 end-customers worldwide. Ruckus technology addresses Wi-Fi capacity and coverage challenges caused by the ever-increasing amount of traffic on wireless networks due to accelerated adoption of mobile devices such as smartphones and tablets. Ruckus invented and has patented state-of-the-art wireless voice, video, and data technology innovations, such as adaptive antenna arrays that extend signal range, increase client data rates, and avoid interference, providing consistent and reliable distribution of delay-sensitive multimedia content and services over standard 802.11 Wi-Fi. For more information, visit <http://www.ruckuswireless.com>.

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