Network Configuration Example

Configuring Link Aggregation Between EX Series Switches and Ruckus Wireless Access Points

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CHAPTER 1

Link Aggregation with Ruckus Wireless Access Points

About This Network Configuration Example

This document describes how to configure a Juniper Networks EX Series Ethernet Switch to interoperate with a Ruckus Wireless access point. The step-by-step instructions in this document will help Juniper Networks and Ruckus Wireless customers configure the joint solution.

As wireless LAN technology advances, enterprise-class APs based on the latest IEEE 802.11ac standard are now capable of passing wireless traffic in excess of 1 Gbps. The Ruckus Wireless ZoneFlex R710 AP is a good example of the new generation of high-performance devices. In most configurations, APs support one or more Gigabit Ethernet ports for connecting the APs to the network. Prior to 802.11ac, these uplinks could never exceed the capacity of a single gigabit link and the secondary Ethernet ports were used for active/standby redundancy. As bandwidth demands push the limits of the single uplink, vendors such as Ruckus Wireless have implemented support for Ethernet port grouping on APs to use multiple links for increased capacity.

This network configuration example describes how to implement a multi-gigabit uplink using the Ethernet port grouping feature on Ruckus Wireless APs and the Ethernet link aggregation feature on Juniper Networks EX Series switches.

Customer Use Case for Link Aggregation with Ruckus Wireless APs

In today's enterprise networks, wireless LAN has moved from a convenience to business critical. Employees are increasingly mobile and require pervasive high-speed network connectivity wherever they are in the workplace. The new tools being deployed to make employees more effective not only require mobility, but also consume more network resources.

This shift in enterprise networks is driving the continued evolution of wireless LAN technologies. Allowing customers to increase network capacity to deliver new ways of working is the key value in a Juniper Networks and Ruckus Wireless joint solution.

By leveraging the link aggregation features of EX Series switches in conjunction with the 802.11ac features of the Ruckus Wireless ZoneFlex R710 AP, customers can get the highest levels of performance out of their wireless network. The concurrent use of multiple Ethernet ports connected to a high-speed wired network ensures that a customer is protected from bottlenecks created at the AP uplink port as traffic demand peaks on the wireless network.

New wireless standards offer tremendous value to customers. The use of port grouping capabilities in the infrastructure guarantees that the performance gains enabled by these standards is not lost due to the wired network.

Related Documentation

- Technical Overview—Link Aggregation on page 7
- Example: Configuring Link Aggregation with Ruckus Wireless APs on page 10

Technical Overview—Link Aggregation

Link aggregation technology has been a mainstay in data center and campus wired networks for many years. Link aggregation and protocols such as Link Aggregation Control Protocol (LACP) are well understood and deployed frequently for both capacity and resiliency reasons.

While link aggregation has been common on the wired network, it is only with the introduction of 802.11ac that the wireless network has exceeded the capacity of a single Gigabit Ethernet link. Other Ethernet technologies exist (or are being drafted) such as 2.5- and 5-Gigabit Ethernet and 10-Gigabit Ethernet, where a single uplink could meet the 802.11ac demands. However, these technologies do not support a standard vehicle for 10 Gigabit Ethernet PoE, suffer from cabling distance limitations, or are not standardized. These reasons make it more practical and cost effective to group multiple Gigabit Ethernet connections into one logical connection for the AP.

For the vast majority of enterprise WLANs, a single gigabit backhaul for APs is more than sufficient. 802.11ac theoretical limits are much higher than a single gigabit connection, but the practical maximum only slightly exceeds the 1-gigabit limit. Before deploying link aggregation, you should consider wireless client capabilities and data demands, as well as the cost of running two Ethernet cables and dedicating two wiring closet switch ports to each AP.

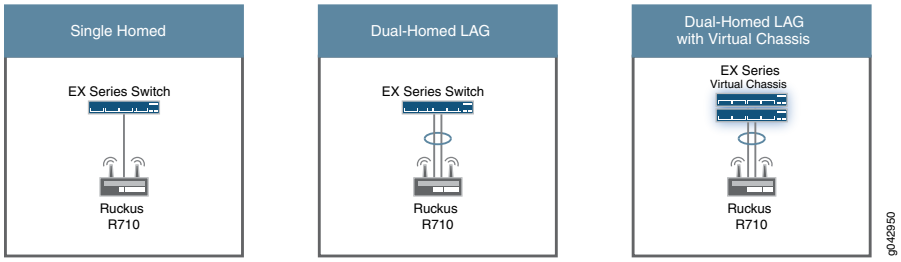
APs exceeding the capacity of a single link will only occur in extreme cases—for example, concurrent dual-band operation over the widest possible channels and highest possible MCS rates in each band, with all traffic flowing in the same direction. In such cases, a single Gigabit Ethernet backhaul will saturate and limit the AP capacity to less than 1 Gbps. To alleviate this backhaul limitation, you can use link aggregation to bond multiple Gigabit Ethernet links into a single, high-capacity logical link.

Link Aggregation on EX Series Switches

Link aggregation is a standard feature in Junos® OS. This rich aggregation feature set is supported between Juniper Networks devices, servers, and third-party network equipment, such as Ruckus Wireless equipment.

EX Series switches support a number of link aggregation models that can be used effectively with the Ruckus Wireless solution. When connecting an AP to a single EX Series switch, you can use a standard dual-homed configuration. If you are using Juniper Networks Virtual Chassis technology in the wiring closet, you can distribute the link aggregation group across multiple switches for increased resiliency. Examples of the possible connection models are shown in Figure 1 on page 8.

Figure 1: Connecting EX Series Switches to Ruckus Wireless APs



For more information about link aggregation on EX Series switches, see *Understanding Aggregated Ethernet Interfaces and LACP*.

For more information about Virtual Chassis, see *EX Series Virtual Chassis Overview*.

Link Aggregation on Ruckus Wireless APs

The ZoneFlex R710 AP supports link aggregation and the LACP protocol (Link Aggregation Control Protocol) as defined in the 802.1ax (formerly 802.3ad) standard, allowing the bonding of its two Gigabit Ethernet ports to form a single 2 Gbps link.

In addition to allowing link bonding, the ZoneFlex R710 AP link aggregation feature includes the following options:

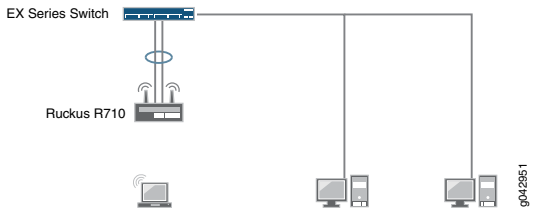
- LACP rate option—Defines the rate at which the AP asks its link partner (for example, an EX Series switch) to transmit LACP control packets (LACPDUs). A slow rate and a fast rate are supported:
  - Slow rate—Requests the link partner to transmit LACPDUs every 30 seconds. This rate is adequate for the vast majority of enterprise WLAN cases.
  - Fast rate—Requests the link partner to transmit LACPDUs every 1 second. A faster rate allows the link endpoints to respond quicker to any changes on the physical interface—for example, to fail over more quickly in case one of the ports is disconnected—at the expense of more overhead.
- Transmit hash option—Defines how the AP chooses to distribute packets between the two physical Ethernet links that comprise the aggregated link. You should consider network topology and expected traffic flows when choosing which transmit hash option to use, with the goal of spreading traffic as evenly as possible between the two physical links.

  The supported transmit hash options are:
  - Layer 2 hashing—Uses the source and destination MAC addresses in the packet to determine which physical link the packet is sent over. This is a fully 802.1ax-compliant option and is the default option.

    Layer 2 hashing is most appropriate for environments with predominately east-west traffic patterns, as shown in Figure 2 on page 9. In these environments, wireless clients are communicating directly with other wireless or wired clients on the same

VLAN. Layer 2 hashing on the AP load-balances the traffic based on the MAC addresses of the devices and distributes traffic across the LAG members.

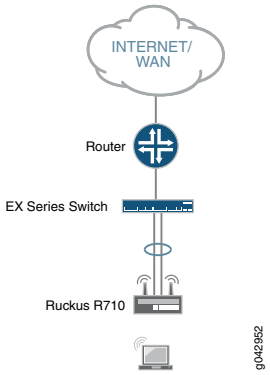
Figure 2: Example of Environment with Predominately East-West Traffic



- Layer 3 and Layer 4 hashing—Uses source and destination IP addresses as well as source and destination ports. This hashing mode uses upper layer protocol information, when available, to generate the hash. Using this information allows packets destined for a particular network peer to be distributed across both physical links on a per-flow basis. For fragmented packets, Layer 4 information is omitted. This hashing mode is not fully 802.1ax-compliant.

  Layer 3 and Layer 4 hashing allows the AP to evenly distribute flows across the LAG members in the case where the Layer 2 next-hop address might be common. This hashing mode results in the most optimal balancing of traffic across links in environments where traffic is primarily north-south, as shown in Figure 3 on page 9. In these environments, wireless clients access network resources through a default gateway rather than having direct communication with peers.

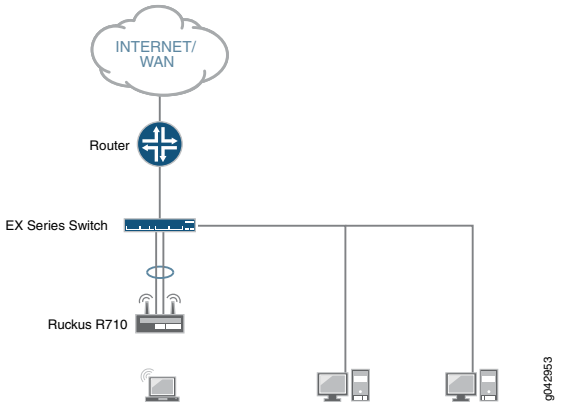
Figure 3: Example of Environment with Predominately North-South Traffic



- Layer 2 and Layer 3 hashing—Uses both Layer 2 source and destination MAC addresses and Layer 3 source and destination IP addresses. This hashing mode places all traffic to a particular network peer on the same physical link. For traffic other than IP traffic, Layer 2 hashing is used. This policy is intended to provide a more balanced distribution of traffic than Layer 2 alone, especially in environments where a Layer 3 gateway device is required to reach most destinations. This algorithm is 802.1ax-compliant.

Leveraging Layer 2 and Layer 3 information for the LAG hashing provides a balance between east-west traffic and north-south traffic flows. This load balancing scheme is more flexible and is completely standards compliant, but traffic might not be as evenly distributed across LAG members in all cases. Figure 4 on page 10 provides an example of an environment where traffic is both local and across a gateway device.

Figure 4: Example of Environment with Mixed East-West and North-South Traffic



Related Documentation

- Example: Configuring Link Aggregation with Ruckus Wireless APs on page 10

Example: Configuring Link Aggregation with Ruckus Wireless APs

This example shows how to configure a 2-gigabit uplink between a Ruckus Wireless AP and an EX Series switch by using the link aggregation features supported on the devices.

Requirements

This example uses the following hardware and software components:

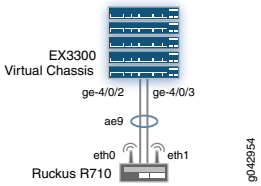
- EX3300 switch running Junos OS Release 12.3 or later
- Ruckus Wireless Zoneflex R710 AP running version 100.2.0 or later

Overview and Topology

The tested topology uses an EX3300 Virtual Chassis connected through two Ethernet ports to a ZoneFlex R710 AP. The configuration for connecting to a standalone EX3300 is similar.

Figure 5 on page 11 shows the topology used in this example.

Figure 5: Topology Used in this Example



In this example, the switch provides power to the AP through Power over Ethernet (PoE). The ZoneFlex R710 AP can operate in two PoE modes: 802.3af and 802.at (PoE+) modes. If it is operating in 802.3af mode, the second Ethernet port (eth1) is disabled. Thus, to support link aggregation, the ZoneFlex 710 AP must operate in 802.3at mode. In its default configuration, the EX3300 switch automatically uses LLDP-MED to negotiate 802.3at mode with the ZoneFlex R710 AP. No additional configuration of the switch is required to achieve this.

Configuration

This section provides step-by-step instructions for:

- Configuring the ZoneFlex R710 Wireless AP on page 11
- Configuring the EX3300 Virtual Chassis on page 12

Configuring the ZoneFlex R710 Wireless AP

Step-by-Step Procedure

To configure link aggregation on the AP, you must use the **set bond** command from the AP CLI. The command has the following syntax:

```
set bond <profile> {options}
  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

   ** <profile>: bond0, ...
   ** options:
     - lacp-rate [0,1], 0 for slow, 1 for fast
     - xmit-hash [0,1,2], 0 for L(ayer2), 1 for L3+4, 2 for L2+3
     - {add|delete} <ethX>
  ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

To create a LAG, you need only create the bond profile and add the two physical Ethernet interfaces to the LAG. The options for configuring the LACP rate and the transmit hash mechanism are optional. Note that bond0 is the only valid bond profile name.

NOTE: **Ensure that both Ethernet ports have been administratively enabled before starting this procedure.**

To configure the AP for link aggregation:

1. Verify that the AP power mode is 802.3at:

```
rkscli: get power-mode
PoE Configured Mode     : Auto
Power Consumption Status : 802.3at PoE+
OK
```

2. Create the bond0 profile for the LAG group and add the two physical Ethernet interfaces to the LAG.

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

When you create the LAG group, LACP is automatically enabled.

3. (Optional) Set the transmit hashing option to Layer 3 and Layer 4 to optimize hashing for common enterprise WLAN environments.

```
rkscli: set bond bond0 xmit-hash 1
```

Configuring the EX3300 Virtual Chassis

Step-by-Step Procedure

To configure the LAG on the EX3300 Virtual Chassis:

1. At the chassis level, specify the number of aggregated Ethernet interfaces to be created on the switch.

```
user@ex3300# set chassis aggregated-devices ethernet device-count 10
```

2. Configure LACP on aggregated Ethernet interface ae9.

```
user@ex3300# set interfaces ae9 aggregated-ether-options lacp active
```

3. Specify that interface ae9 is an access interface belonging to VLAN AP-to-WLC and configure the VLAN.

```
user@ex3300# set interfaces ae9 unit 0 family ethernet-switching port-mode
access
user@ex3300# set interfaces ae9 unit 0 family ethernet-switching vlan members
 AP-to-WLC
user@ex3300# set vlans AP-to-WLC vlan-id 202
```

4. Add the ge-04/0/2 and ge-4/0/3 interfaces to the LAG.

```
user@ex3300# set interfaces ge-4/0/2 ether-options 802.3ad ae9
user@ex3300# set interfaces ge-4/0/3 ether-options 802.3ad ae9
```

Results

From configuration mode, confirm your configuration by entering the following **show** commands:

```
user@ex3300# show chassis
aggregated-devices {
    ethernet {
        device-count 10;
    }
}

user@ex3300# show interfaces
ge-4/0/2 {
    ether-options {
        802.3ad ae9;
    }
```

```
}
ge-4/0/3 {
    ether-options {
        802.3ad ae9;
    }
}
ae9 {
    aggregated-ether-options {
        lacp {
            active;
        }
    }
    unit 0 {
        family ethernet-switching {
            port-mode access;
            vlan {
                members AP-to-WLC;
            }
        }
    }
}
```

```
user@ex3300# show vlans
AP-to-WLC {
    vlan-id 202;
}
```

Verification

Confirm that the configuration is working properly.

- Verifying the LAG Configuration on the AP on page 13
- Verifying the LAG Configuration on the Switch on page 13

Verifying the LAG Configuration on the AP

Purpose Verify that the LAG configuration on the AP is correct and that the LAG is operational.

Action Enter the **get bond** command at the AP CLI.

```
rkscli: get bond
<bond0>
        Mode:           8023AD
        LACP-rate:      fast
        MII-Mon:        100 (ms)
        Xmit-Hash:      layer3+4
        Slaves:         2
        Slave-0:        eth0, ACTIVE, UP, link-fail-count: 0
        Slave-1:        eth1, ACTIVE, UP, link-fail-count: 0
OK
```

Meaning The LAG is configured correctly and is operational.

Verifying the LAG Configuration on the Switch

Purpose Verify the state of the link between the switch and the AP and the state of LACP.

Action

1. Verify the link state of the aggregated Ethernet interface.

```
user@ex3300> show interfaces ae9
Physical interface: ae9, Enabled, Physical link is Up
  Interface index: 333, SNMP ifIndex: 826
  Link-level type: Ethernet, MTU: 1514, Speed: 2Gbps, BPDU Error: None,
  MAC-REWRITE Error: None, Loopback: Disabled, Source filtering: Disabled,
  Flow control: Disabled, Minimum links needed: 1,
  Minimum bandwidth needed: 1bps
  Device flags   : Present Running
  Interface flags: SNMP-Traps Internal: 0x4000
  Current address: 3c:61:04:56:e5:8c, Hardware address: 3c:61:04:56:e5:8c
  Last flapped   : 2015-09-18 15:29:18 PDT (3d 19:28 ago)
  Input rate     : 2032 bps (0 pps)
  Output rate    : 2032 bps (0 pps)

  Logical interface ae9.0 (Index 91) (SNMP ifIndex 827)
    Flags: Up SNMP-Traps 0x80004000 Encapsulation: ENET2
    Statistics        Packets        pps         Bytes          bps
    Bundle:
        Input :             0          0             0            0
        Output:          2636          0        158132            0
    Adaptive Statistics:
        Adaptive Adjusts:          0
        Adaptive Scans  :          0
        Adaptive Updates:          0
    Protocol eth-switch
```

2. Verify the state of the LACP protocol.

```
user@ex3300> show lacp interfaces ae9
Aggregated interface: ae9
    LACP state:       Role   Exp   Def  Dist  Col  Syn  Aggr  Timeout  Activity

      ge-4/0/2       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active

      ge-4/0/2     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active

      ge-4/0/3       Actor    No    No   Yes  Yes  Yes   Yes     Fast    Active

      ge-4/0/3     Partner    No    No   Yes  Yes  Yes   Yes     Fast    Active

    LACP protocol:        Receive State  Transmit State          Mux State
      ge-4/0/2                Current   Fast periodic Collecting distributing

      ge-4/0/3                Current   Fast periodic Collecting distributing
```

Meaning The aggregated Ethernet interface is operational and the LACP protocol is active between the LAG partners.

Related Documentation

- Technical Overview—Link Aggregation on page 7

Conclusion

By following industry standards and completing a rigorous interoperability testing program, the Ruckus Wireless and Juniper Networks implementations of link aggregation have

been proven to be compatible. In scenarios where the highest levels of WLAN performance are required, Juniper Networks recommends the use of link aggregation between the EX Series switches and the Ruckus Wireless ZoneFlex R710 AP.

