Managing network bonding devices

WHAT?

Combine two or more network interfaces into a single bonded device.

WHY?

Network bonding can increase bandwidth and/or provide redundancy.

EFFORT

Approximately 15 minutes to read and understand the content.

REQUIREMENTS

- Network connection
- Basic understanding of networking and IP addresses
- Existing network interfaces to include in the bonded device
- Switch support, depending on the bonding mode

This article is about network *bonding*. To configure network *teaming*, see Managing network teaming devices (https://documentation.suse.com/smart/network/html/network-team-managing-devices/index.html).

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Contents

1 Configuring network bonding

Network bonding combines two or more network interfaces into a single bonded device to increase bandwidth and/or provide redundancy. You can configure network bonding with YaST or by manually creating `ifcfg` files. The behavior of the bonded device is configured using *bonding modes*.

1.1 Requirements

- Network connection
- Basic understanding of networking and IP addresses
- Existing network interfaces to include in the bonded device
- Switch support, depending on the bonding mode

1.2 Restrictions

Do not split bonds over multiple switches

In most hardware setups, all network interfaces in a bonded device must be connected to the same switch. For more information, consult your switch vendor documentation.

IBM POWER: Bonding modes 5 and 6 (`balance-tlb` and `balance-alb`) unsupported by ibmveth

The bonding drivers in `tlb` mode and `alb` mode send Ethernet Loopback packets with both the source and destination MAC addresses listed as the Virtual Ethernet MAC address. These packets are not supported by Power firmware. Therefore, bonding modes 5 and 6 are unsupported by ibmveth.

Bonding and virtualization

Bonded devices are made up of multiple network interfaces. In most configurations you should only configure bonding in the host. Virtual interfaces to guests are then created as a bridge with the bonded devices, simplifying guest creation and deployment.

It is possible, but not recommended, to configure bonding in a guest. When configuring bonding in a guest, you must assign multiple interfaces to the guest and configure the host without bonding. You must also be careful to configure the host and its network bridges so that you do not mix bonding in the host and guests.

1.3 Bonding modes

The following bonding modes are available:

(*0*) *balance-rr*

Packets are transmitted in round-robin fashion from the first to the last available interface. Provides fault tolerance and load balancing. Requires switch support. Certain switches might fail with this mode.

(*1*) *active-backup*

Only one network interface is active. If it fails, a different interface becomes active. Provides fault tolerance. This is the default mode. No specific switch support is required.

(*2*) *balance-xor*

Traffic is split between all available interfaces based on the number of interfaces included in the bonded device. Provides fault tolerance and load balancing. Requires switch support. Certain switches might fail with this mode.

(*3*) *broadcast*

All traffic is broadcast on all interfaces. Provides fault tolerance. Requires switch support. Certain switches might fail with this mode. If possible, use mode *1* instead, or use this mode to provide sniffing capability by connecting each member of the bond to a different switch or device.

(*4*) *802.3ad*

Also called *LACP*. All interfaces in the LACP group must share the same speed and duplex settings, and must be connected to the same switch. Provides fault tolerance and load balancing. Requires **`ethtool`** support in the interface drivers, and a switch that supports and is configured for IEEE 802.3ad Dynamic link aggregation. If your switch supports it, this is the preferred mode.

(*5*) *balance-tlb*

Adaptive transmit load balancing. Provides fault tolerance and load balancing. Requires **`ethtool`** support in the interface drivers. No specific switch support is required, but certain switches might fail with this mode.

(*6*) *balance-alb*

Adaptive load balancing. Provides fault tolerance and load balancing. Requires **`ethtool`** support in the interface drivers. No specific switch support is required, but certain switches might fail with this mode.

Consult your hardware manual to check which modes your switch supports.

For a more detailed description of the modes, see https://www.kernel.org/doc/Documentation/networking/bonding.txt.

1.4 Configuring network bonding with YaST

1. Start the graphical version of YaST, or run the command **`yast2`** to start YaST in text mode.
2. Select *System* › *Network Settings*.
3. Select *Add* and change the *Device Type* to *Bonding*.
4. Select *Next* to open the *Network Card Setup* menu.
5. In the *Address* tab, select how to assign an IP address to the bonded device:
   - *Dynamic Address*: Automatically assign a dynamic IP address. The default setup is to use DHCP with both IPv4 and IPv6. You can change these settings if required.
   - *Statically Assigned IP Address*: Manually assign an *IP Address*, *Subnet Mask*, and *Hostname*.
   - Do not use *No Link and IP Setup*. This option is only used for individual network interfaces that will be added to a bonded device.
6. In the *Bond Ports* tab, select the network interfaces to include in the bonded device by activating the check boxes.
7. From the *Bond Driver Options* drop-down box, choose a bonding mode. The default mode is `active-backup`.

   Do not remove `miimon=100`. Without this parameter, data integrity is not checked regularly.
8. Select *Next*.
9. If you are prompted to adapt the existing configuration for bonding, select *Continue*.
10. Select *OK* to create the bonded device.
11. Select *Quit* or press **F9** to close YaST.

1.5 Configuring network bonding with `ifcfg`

1. Create a configuration file named `/etc/sysconfig/network/ifcfg-bond0`. If you need more than one bonded device, give them ascending numbers. For more information, see **`man ifcfg`**, **`man ifcfg-bonding`**, and `/etc/sysconfig/network/ifcfg.template`. In the configuration file, define the following parameters:

```
STARTMODE=MODE ❶
BOOTPROTO=IP_ASSIGNMENT ❷
IPADDR=IPv4_ADDRESS ❸
IPADDR6=IPv6_ADDRESS ❸

BONDING_MASTER="yes" ❹

BONDING_SLAVE0="FIRST_DEVICE_NAME" ❺
BONDING_SLAVE1="SECOND_DEVICE_NAME" ❺

BONDING_MODULE_OPTS="mode=BONDING_MODE ❻ miimon=100" ❼
```

❶ Defines how the bonded device starts. Use `auto` to start the interface automatically on every reboot, or use `manual` to prevent the interface from starting automatically.

❷ Defines how IP addresses are assigned to the bonded device: Use `static` to manually assign static IP addresses, or use `dhcp` to automatically assign dynamic IP addresses.

❸ Specifies the IPv4 and IPv6 addresses for the device, if you are manually assigning `static` IP addresses.

❹ Identifies this interface as a bonded device.

❺ Specifies two or more network interfaces to include in the bonded device.

❻ Defines the bonding mode for this interface.

❼ Specifies how often, in milliseconds, each bond member is inspected for link failures.

EXAMPLE 1: BOND CONFIGURATION

```
STARTMODE=auto
BOOTPROTO=static
IPADDR="192.168.1.2/24"
IPADDR6="fd00:deca:fbad:50::2/64"

BONDING_MASTER="yes"

BONDING_SLAVE0="eth0"
BONDING_SLAVE1="eth1"
```

```
BONDING_MODULE_OPTS="mode=802.3ad miimon=100"
```

2. Back up the existing `ifcfg` files for the bond member interfaces, in case you need to restore them later.

3. Adjust the `ifcfg` files for *both* bond member interfaces so that they contain only the following content:

```
BOOTPROTO='none' (1)
STARTMODE='hotplug' (2)
```

(1) `BOOTPROTO=none` uses the **`ethtool`** options (when provided), but does not set up the link on startup because the bond member interface is controlled by the bond device.

(2) `STARTMODE=hotplug` allows the bond member interface to join the bond automatically when it is available.

4. Check if everything is included in Wicked's configuration file:

```
> sudo wicked show-config
```

5. Start the bonded device:

```
> sudo wicked ifup all bond0
```

If you need additional debug information, use the option `--debug all` after the **`all`** subcommand.

! Do *not* use **`systemctl`** to start or stop the bonded device. Always use the **`wicked`** command.

6. Check the status of the bonded device:

- Get the state of the bonded device from Wicked:

```
> sudo wicked ifstatus --verbose bond0
```

- Get the state of the bonded device and the bond members:

```
> ip addr
```

Each command shows a slightly different view depending on your needs.

If you make changes to the `ifcfg-bond0` file after starting the device, reload its configuration with the command **`wicked ifreload bond0`**.

2 Enabling hotplugging for network bond members

In some network environments (such as High Availability), you might need to replace a bond member interface with a new one, for example, if a network interface has a fault. However, before you can replace the interface, you must configure the networking setup to recognize when a new device is added.

2.1 Requirements

- A bonded device is already configured.

2.2 Enabling hotplugging for network bond members

1. Check that the bond members are configured with `BOOTPROTO=none` and `STARTMODE=hotplug`. If you configured the bonded device with YaST, this is the default setting.
2. List the hardware information for the network interfaces. You can use **`grep`** to show only the information required for this procedure:

   ```
   > sudo hwinfo --netcard | grep -E "SysFS BusID|Device File"
     SysFS BusID: 0000:00:17.0
     Device File: eth0
     SysFS BusID: 0000:00:19.0
     Device File: eth1
   ```

   For each bond member, make a note of the associated `SysFS BusID`.
3. Open the file `/etc/udev/rules.d/70-persistent-net.rules`. For each bond member, change the value of `KERNELS` to match the `SysFS BusID` from the previous step. For example:

   ```
   SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", KERNELS=="0000:00:17.0",
   ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth0"
   ```

```
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*", KERNELS=="0000:00:19.0",
ATTR{dev_id}=="0x0", ATTR{type}=="1", KERNEL=="eth*", NAME="eth1"
```

This configures the `udev` rules to match the device by bus ID instead of by MAC address, allowing the bond to detect a new device in the same slot but with a different MAC address.

When one of the bond member interfaces is removed from the system, the kernel removes it from the bond automatically. When a new card is added to the system, `udev` uses the bus-based persistent name rule to rename the interface to the name of the bond member, and calls **`ifup`** for it. The **`ifup`** call automatically joins the new interface into the bond.

At boot time, `network.service` does not wait for the hotplugged bond members, but for the bond to become ready, which only requires one available bond member.

3 Removing a bonded device

Use this procedure to remove the configuration for a bonded or teamed device and restore the member interfaces to their original, separate configuration.

The following examples use the device name `team0`. Replace this with the actual name of your device.

1. Stop the device:

   ```
   > sudo wicked ifdown team0
   ```

2. Hide the configuration file by renaming it from `/etc/sysconfig/network/ifcfg-team0` to `/etc/sysconfig/network/.ifcfg-team0`.
   Alternatively, if you definitely do not need the configuration anymore, remove the file instead of renaming it.

3. To re-enable the network interfaces that were included in the device, restore their original configuration from the backup files.

4. Reload the network configuration:

   ```
   > sudo wicked ifreload all
   ```

5. Check the status of the remaining network interfaces:

   ```
   > ip addr
   ```

4 Network bonding or network teaming: feature comparison

Network bonding and *network teaming* are different methods for combining network connections to provide a single combined interface. Bonding is handled exclusively in the kernel. Teaming includes a small set of kernel modules that provide an interface for `teamd` instances, but everything else is handled in user space.

TABLE 1: BONDING AND TEAMING FEATURE COMPARISON

Feature	Bonding	Teaming
broadcast, round-robin TX policy	yes	yes
active-backup TX policy	yes	yes
LACP (802.3ad) support	yes	yes
hash-based TX policy	yes	yes
user can set hash function	no	yes
TX load-balancing support (TLB)	yes	yes
TX load-balancing support for LACP	no	yes
Ethtool link monitoring	yes	yes
ARP link monitoring	yes	yes
NS/NA (IPV6) link monitoring	no	yes
RCU locking on TX/RX paths	no	yes
port prio and stickiness	no	yes
separate per-port link monitoring setup	no	yes

Feature	Bonding	Teaming
multiple link monitoring set-up	limited	yes
VLAN support	yes	yes
multiple device stacking	yes	yes

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