**Network Bonding**

**Introduction**

Network bonding is a technique used to combine multiple network interfaces (NICs) into a single logical interface to achieve redundancy, load balancing, or increased throughput. It is commonly used in servers and high-availability environments to enhance network performance and reliability.

**Working**

* Network bonding allows combining multiple physical network interfaces into a single logical interface to provide redundancy and increased performance.
* The bonding process is managed by the **bonding kernel module**, which creates a virtual interface (e.g., bond0) to represent the aggregated links.
* Physical network interfaces (e.g., eth0, eth1) are configured as slaves under the bonded interface and are controlled by the bonding driver.
* The behavior of the bonded interface is determined by the configured bonding mode, which specifies how traffic is handled and how redundancy is achieved.
* In bonding, the kernel monitors the health of each slave interface through periodic checks, such as link status monitoring using **miimon**.
* If a failure is detected in any of the slave interfaces, the bonding driver automatically removes the failed interface from the bond and reroutes traffic to the remaining healthy interfaces.
* Traffic distribution in bonded interfaces depends on the bonding mode. Modes like Round Robin distribute packets sequentially across all interfaces, while 802.3ad (LACP) uses hashing algorithms for dynamic load balancing.
* The bonded interface can increase network bandwidth by aggregating the capacity of multiple slave interfaces, depending on the configured mode.
* Failover ensures that the system continues to function even if one or more physical interfaces fail, maintaining uninterrupted network connectivity.
* Certain bonding modes, such as 802.3ad (LACP), require switch-level support and configuration to establish dynamic link aggregation.
* When a failed interface is repaired or comes back online, it is reintegrated into the bonded group without disrupting network traffic.

**Bonding Modes**

**Mode 0: Round Robin (Balance-rr)**

* Packets are transmitted sequentially across all slave interfaces.
* Ensures load balancing and aggregation of bandwidth.
* Provides fault tolerance by redistributing traffic if one interface fails.
* Does not require switch configuration, but may lead to out-of-order packet delivery for protocols like TCP.

**Mode 1: Active Backup**

* Only one interface is active at a time; others are on standby.
* If the active interface fails, a standby interface takes over immediately.
* No special switch configuration is needed since only one MAC address is visible to the network.
* Ensures high reliability but does not provide load balancing or bandwidth aggregation.

**Mode 2: XOR (Exclusive OR)**

* Transmits packets based on a hash of source and destination MAC addresses, ensuring that a specific traffic flow consistently uses the same interface.
* Provides load balancing and some redundancy.
* Requires switch support but does not use LACP.

**Mode 3: Broadcast**

* Transmits all packets on all slave interfaces simultaneously.
* Provides maximum redundancy, as the same packet is sent across all interfaces.
* Does not improve performance since there is no load balancing.

**Mode 4: 802.3ad (LACP - Link Aggregation Control Protocol)**

* Implements dynamic link aggregation with load balancing and fault tolerance.
* Aggregates NICs into a single logical link and distributes traffic based on a hashing algorithm (e.g., MAC, IP, or transport protocol).
* Requires switch support and configuration to enable LACP.
* Ensures efficient utilization of bandwidth and high availability.

**Mode 5: Balance-TLB (Transmit Load Balancing)**

* Balances outgoing traffic based on the current load on each slave interface (traffic outlet in one interface).
* Incoming traffic is handled by a single slave (traffic inlet in one interface), ensuring minimal reordering.
* Does not require switch configuration.
* Can detect link failures and redirect traffic to healthy interfaces.

**Mode 6: Balance-ALB (Adaptive Load Balancing)**

* Includes all features of Mode 5 (Balance-TLB) but adds load balancing for incoming traffic using ARP negotiation.
* Does not require switch support and works with standard Ethernet switches.
* Dynamically adjusts traffic distribution for better load balancing.

### **Steps to Configure Network Bonding in Linux**

**1. Install the Bonding Module**

Load the bonding kernel module using the below command.

*sudo modprobe bonding*

**2. Create a Bonding Interface**

Edit or create a configuration file for the bonding interface, e.g., /etc/sysconfig/network-scripts/ifcfg-bond0

*DEVICE=bond0*

*BOOTPROTO=none*

*ONBOOT=yes*

*BONDING\_OPTS="mode=1 miimon=100"*

*IPADDR=192.168.1.100*

*NETMASK=255.255.255.0*

*GATEWAY=192.168.1.1*

**Configure the Slave Interfaces**

Edit the configuration files for the physical NICs (e.g., ifcfg-eth0 and ifcfg-eth1)

# Slave 1

*DEVICE=eth0*

*BOOTPROTO=none*

*ONBOOT=yes*

*MASTER=bond0*

*SLAVE=yes*

*# Slave 2  
DEVICE=eth1*

*BOOTPROTO=none*

*ONBOOT=yes*

*MASTER=bond0*

*SLAVE=yes*

**Restart Networking**

Restart the networking service to apply the changes using the below command.

*sudo systemctl restart network*

**Verify the Bonding Configuration**

Use the following command to check the status of the bonding interface using the below command.

*cat /proc/net/bonding/bond0*