**MAC Addressing and Functionality of ARP &RARP**

**Introduction to MAC:**

* MAC stands for Media Access Control.
* MAC is a hardware-based address used at the Data Link Layer (Layer 2) of the OSI model.
* It is a unique 48-bit/6 Byte hardware numbers of a computer that are assigned to the NIC (network interface card) during manufacturing.
* Every device that connects to a network has a unique MAC address.

**Format of MAC Address:**

* MAC Address is a 12-digit hexadecimal number. Example- (00: 1A: 2B: 3C: 4D: 5E)
* MAC address is divided into two parts each of 24 bits.
* The first 6 digits represent the Organizationally Unique Identifier (OUI), identifying the manufacturer.
* The second part or the remaining 6 digits are vendor specific.

**Types of MAC Address:**

* **Unicast MAC Address:** 
  + Used to send data to only one specific device.
  + It represents asingle recipient on the network.
* **Broadcast MAC Address:**
* Used to communicate with all devices on a local network.
* Format: FF: FF: FF: FF: FF: FF.
* Every device process this address and responds if necessary.
* **Multicast MAC Address:**
* Used for group communication where data is sent to multiple, but not all, devices.
* The first byte of the address begins with 01 (in binary: 00000001).
* Devices that are part of the group will receive the message.

**Address Resolution Protocol (ARP):**

* Address Resolution Protocol (ARP) finds the hardware/physical address of a host from a known IP address.
* Process:
* The system has the destination's IP address but needs its MAC address.
* If the MAC address is not found in the ARP cache, the host broadcasts an ARP request to the network.
* The device with the matching IP responds with its MAC address.

**Reverse Address Resolution Protocol (RARP)**

* When an IP machine happens to be a diskless machine, it has no way of initially knowing its IP address but it does know its MAC address.
* Reverse Address Resolution Protocol (RARP) discovers the identity of the IP address for diskless machines by sending out a packet that includes its MAC address and a request for the IP address assigned to that MAC address.
* A RARP server responds with the IP address assigned to that MAC address.
* RARP uses the information it does know about the machine's MAC address to learn its IP address and complete the machine's ID portrait.

**Proxy Address Resolution Protocol (Proxy ARP):**

* Proxy ARP enables devices on one subnet to communicate with devices on another subnet without needing routing configuration.
* A router responds to ARP requests on behalf of a remote device, providing its own MAC address.
* One advantage of using Proxy ARP is that it can be added to a single router on a network without disturbing the routing tables of all the other routers that live there too.
* But there's a serious downside to using Proxy ARP:
* Using Proxy ARP will definitely increase the amount of traffic on your network segment, and hosts will have a larger ARP table than usual in order to handle all the IP to MAC address mappings.
* Proxy ARP is enabled by default on Cisco routers but should be disabled if not needed.
* Proxy ARP is not a separate protocol; it's a feature enabled on routers.
* It is a service run by routers on behalf of other devices (usually PCs) that are separated from their query to another device by a router, although they think they share the subnet with the remote device.
* This lets the router provide its own MAC address in response to ARP queries attempting to resolve a distant IP address to a functional MAC address.

**Gratuitous ARP:**

* A Gratuitous ARP is an unsolicited ARP Request or Reply sent by a device about its own IP address.
* Gratuitous means without request.
* In Gratuitous ARP, a device sends a message about itself to announce or check something on the network.
* Process:
* Let say a laptop has the IP address: 192.168.2.5 and its MAC address: 00:11:22:33:44:55.
* It sends message “Who has IP 192.168.2.5?”
* This is called as a Gratuitous ARP Request, because it is asking about its own IP address.
* Unless there is no conflict, there will be no reply.
* And it goes to all the device present on the local network.

**Format of Gratuitous ARP:**

* It can be either Gratuitous ARP Request or Gratuitous ARP Reply.
* **Gratuitous ARP Request** – Sent to detect conflict or notify presence.
* **Gratuitous ARP Reply –** Sent to announce a new MAC address for an IP without a prior request.

**Why is Gratuitous used?**

* Detect IP address conflicts.
* Informing other device about its MAC address.
* Update MAC address tables in switches.