What is private IP? What is public IP? How do they two work together to solve the problem of not enough IP addresses?

Private IP addresses are a set of IP addresses reserved for use within private networks, such as home, office, or enterprise environments. These addresses are not routable on the public internet, meaning devices with private IP addresses cannot communicate directly with devices outside their local network without going through a device like a router that performs Network Address Translation (NAT).

A public IP address is an IP address that is assigned to a device, such as a computer or router, to allow direct access over the internet. Unlike private IP addresses, public IP addresses are routable and accessible globally, enabling devices to communicate with other devices across different networks.

Example

In a home network, a router might have a public IP address assigned by the ISP (Internet Service Provider) for internet communication. The router assigns private IP addresses, such as 192.168.1.2, 192.168.1.3, etc., to devices like computers, smartphones, and printers within the local network. These devices use the router to access the internet, with the router performing NAT to translate between private and public IP addresses.

They work together as:-

- **Device Configuration:**

  - Devices within a local network are assigned private IP addresses by the router using DHCP.
  - Example: A computer might get the IP address `192.168.1.2`, a smartphone `192.168.1.3`, etc.

- **Internet Communication:**

  - When a device needs to communicate with the internet, it sends its request to the router.
  - Example: The computer `192.168.1.2` wants to access `example.com`.

- **NAT Translation:**

  - The router receives the request and uses NAT to translate the private IP address (`192.168.1.2`) to the router's public IP address.
  - Example: The router translates `192.168.1.2` to `203.0.113.45` (router's public IP).

- **Routing to the Internet:**

  - The request is sent to the destination (e.g., `example.com`) using the public IP address `203.0.113.45`.
  - The destination server responds to the public IP address `203.0.113.45`.

- **Response Handling:**

  - The router receives the response and uses NAT to translate the public IP address back to the appropriate private IP address.
  - Example: The router translates the response from `203.0.113.45` back to `192.168.1.2` and sends it to the computer.

- **Maintaining Sessions:**

  - NAT maintains a table of active sessions to ensure that incoming responses are correctly routed to the originating device.