Comparison Between Private and Public IP Addresses

Feature	Public IP Address	Private IP Address
Definition	A globally unique IP assigned by an Internet Service Provider (ISP) to identify a device on the internet.	An IP address used within a private network to communicate among internal devices.
Scope	Used to access the internet and can be reached from anywhere in the world.	Used for internal communication within a local network (LAN) and cannot be accessed directly from the internet.
Uniqueness	Unique across the entire internet.	Not unique; different private networks can have the same private IP addresses.
Assigned By	Assigned by ISPs and managed by the Internet Assigned Numbers Authority (IANA).	Assigned by a network administrator or automatically by a router using DHCP.
Address Range	Any address outside the private IP range.	Reserved ranges: **- 10.0.0.0 – 10.255.255.255** **- 172.16.0.0 – 172.31.255.255** **- 192.168.0.0 – 192.168.255.255**
Example	`8.8.8.8` (Google's DNS)	`192.168.1.1` (Common home router IP)
Security	More vulnerable to cyberattacks since it is exposed to the internet.	More secure as it is hidden behind a firewall or NAT (Network Address Translation).
Cost	Assigned by ISPs, often requires payment.	Free to use within local networks.
NAT Requirement	Not needed.	Requires NAT to access the internet.
Use Cases	Websites, online services, cloud hosting, gaming, VPNs, etc.	Home networks, corporate networks, schools, offices, etc.

Comparison Between IPv4 and IPv6

Feature	IPv4	IPv6
Definition	Internet Protocol version 4, the fourth version of IP, widely used for internet communication.	Internet Protocol version 6, the latest version, designed to replace IPv4 and address its limitations.
Address Length	32-bit	128-bit
Address Format	Numeric, written in **dotted decimal** (e.g., `192.168.1.1`)	Alphanumeric, written in **hexadecimal** and separated by colons (e.g., `2001:0db8:85a3:0000:0000:8a2e:0370:7334`)
Total Address Space	~4.3 billion addresses	**3.4×10^{38}** (virtually unlimited)
Availability	Addresses are nearly exhausted, requiring techniques like NAT (Network Address Translation)	Abundant addresses, no need for NAT
Security	Security features are optional (e.g., IPsec)	Security features like IPsec are built-in
Speed & Efficiency	More efficient in small networks but slower in larger-scale deployments due to NAT and address exhaustion	More efficient routing, faster processing due to simplified header structure
Address Allocation	Uses manual and DHCP-based allocation	Supports auto-configuration using SLAAC (Stateless Address Autoconfiguration)
NAT Requirement	Requires NAT due to limited addresses	No NAT needed due to a vast number of available addresses
Compatibility	Works with most network devices and software	Not fully supported by all legacy devices and software
Adoption Rate	Still the dominant protocol	Growing but not yet universally adopted

Comparison Between TCP and UDP

Feature	TCP (Transmission Control Protocol)	UDP (User Datagram Protocol)
Connection Type	Connection-oriented (establishes a connection before data transfer)	Connectionless (no prior connection required)
Reliability	Reliable (ensures data delivery with error checking and retransmission)	Unreliable (no guarantee of delivery, order, or error checking)
Speed	Slower due to error checking, acknowledgments, and retransmissions	Faster since there is no overhead for reliability checks
Data Ordering	Ensures correct sequence of data packets	No sequence control; packets may arrive out of order
Error Checking	Uses checksums, acknowledgments, and retransmissions to ensure error-free delivery	Uses a simple checksum, but no retransmission mechanism
Flow Control	Implements flow control using mechanisms like sliding window and congestion control	No flow control; data is sent regardless of the receiver's state
Packet Overhead	Higher due to connection management and error checking	Lower, making it efficient for real-time applications
Use Cases	Used for applications that require reliability, such as web browsing (HTTP, HTTPS), email (SMTP, IMAP, POP3), and file transfers (FTP)	Suitable for real-time applications where speed is crucial, such as video streaming, VoIP, online gaming, and DNS lookups
Example Protocols	HTTP, HTTPS, FTP, SMTP, Telnet	DNS, VoIP, DHCP, SNMP, Online Gaming