

COMPUTER ADDRESS 1

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Computer Address

Primary Disciplinary Field(s): Computer Science, Information Technology, Networking

1. Core Definition and Dual Functionality

The concept of a **computer address** serves as a fundamental principle in computing, representing a unique identifier--whether numerical or alphanumeric--that specifies the location or destination of a resource within a system or across a network. This generalized term covers two distinct, critical domains of functionality: internal data localization within memory architecture and external network designation for communication endpoints. The reliance on precise addressing is what enables both the efficient execution of software instructions by the Central Processing Unit (CPU) and the reliable global routing of data packets across the internet.

In its most granular context, a computer address defines the exact spatial position of data retained in a computer's local reserve, such as volatile Random-Access Memory (RAM) or permanent storage. This type of identifier, often termed a **memory address**, is typically a sequence of bits used by the hardware and operating system kernel to retrieve, store, or manipulate individual bytes or blocks of information. The organization of these addresses forms the basis of the computer's memory hierarchy, allowing for rapid access times necessary for modern computational speed.

The second major application of the computer address is as a designation code or title that indicates a specific machine, service, or destination within a networked environment. This category includes identifiers such as the Internet Protocol (IP) address, Uniform Resource Locators (URLs), and electronic mail destinations. These addresses are essential for communication protocols to establish pathways and guarantee that information sent from a source machine successfully reaches its intended recipient, regardless of geographic distance or network complexity.

2. Historical Development of Addressing Schemes

The evolution of computer addressing is intrinsically linked to the development of computer architecture itself, dating back to the implementation of the stored-program concept. Early addressing was straightforward, involving physical addresses directly mapped to hardware registers or memory modules. As systems grew in complexity, necessitating multiprocessing and virtualized environments, addressing moved from simple physical pointers to sophisticated logical schemes managed by Memory Management Units (MMU). The introduction of virtual memory allowed multiple processes to operate independently in what appeared to be continuous address spaces, vastly improving resource utilization and security.

Network addressing emerged later, driven by the need for interconnected systems. The development of protocols like TCP/IP established a hierarchical and standardized method for

locating hosts globally. The initial deployment of **Internet Protocol version 4 (IPv4)** provided a 32-bit address space, which served as the cornerstone of the early internet. However, the rapid expansion of interconnected devices and the impending exhaustion of the 32-bit space mandated the transition to **Internet Protocol version 6 (IPv6)**, which uses a 128-bit address space to provide a practically limitless supply of unique network identifiers, thus ensuring the continued scalability of the global network infrastructure.

3. Key Categories of Computer Addresses

Computer addresses can be segregated based on their function, layer of operation within the network stack, and level of abstraction:

Memory Address: These are low-level numerical indices used internally for data access. They are managed by the operating system and CPU. Modern systems often use **virtual addresses**, which are logical addresses manipulated by running programs, and **physical addresses**, which are the actual addresses used by the hardware. The translation between these two ensures memory protection and efficient resource allocation.

Network Address (IP Address): This is a logical address assigned at the Network Layer (Layer 3 of the OSI Model). IP addresses are hierarchical, meaning they contain both a network prefix component used for routing and a host identifier component used for locating a specific device. They are crucial for communication across different networks (inter-networking).

Hardware Address (MAC Address): The Media Access Control address is a physical address assigned permanently to the Network Interface Controller (NIC). It operates at the Data Link Layer (Layer 2) and is used for identifying devices within a local network segment (LAN). Unlike IP addresses, which can change based on network configuration, MAC addresses are unique globally and are generally fixed by the manufacturer.

Application-Layer Address: These are high-level, human-readable identifiers used by end-user applications. Key examples include the **Uniform Resource Locator (URL)**, which identifies resources like web pages by combining a domain name with path information, and the standard email address format (e.g., user@domain.com), which designates a specific electronic mailbox. These rely on intermediary services like the Domain Name System (DNS) to translate the human-readable string into a routable numerical IP address.

4. Addressing Complexity and User Accessibility

The diversity and abstract nature of computer addresses contribute to the observation that such identifiers are often "not easily found by the technologically unskilled." This difficulty arises because the most critical addressing details--namely memory pointers, IP addresses, and MAC identifiers--are deliberately abstracted away from the typical user interface by operating systems and network protocols. Abstraction layers, while simplifying user interaction (e.g., typing a domain

name instead of a cryptic IP string), necessitate specialized knowledge when troubleshooting or performing low-level configurations.

For most daily tasks, users interact exclusively with application-layer addresses (URLs, email addresses). When an IP address is encountered, it is often dynamic, changing frequently via Dynamic Host Configuration Protocol (DHCP), which further complicates identification for non-experts. Furthermore, network security measures, such as Network Address Translation (NAT) implemented by routers, mask internal private IP addresses from the public internet, meaning the address observed externally is not the address used internally by the device.

Mastery of computer addressing requires understanding the relationship between these different layers--how a URL resolves to a public IP, how the public IP maps to a private IP via NAT, and how the private IP is associated with a specific MAC address for final delivery on the local network segment. This multi-layered translation process confirms why detailed address identification remains the purview of network administrators and system engineers.

5. Further Reading

Authoritative sources for detailed exploration of computer addressing include:

[Computer Memory \(Wikipedia\)](#)

[Internet Protocol address \(Wikipedia\)](#)

[Memory Address \(Wikipedia\)](#)

[Domain Name System \(Wikipedia\)](#)

[MAC address \(Wikipedia\)](#)