

Introduction to Basic Concepts: Naming Schemes



Naming in Distributed Systems

- In distributed systems, names are used to **uniquely identify** entities, to refer to locations, and more.
- An important issue with naming is that a name can be resolved to the entity it refers to; **name resolution** thus refers to the means by which a process is allowed to access a named entity, which is supported by a **naming system**.
- The implementation of a naming system is itself **often** distributed across multiple machines.



Example: Internet Naming

- As in any distributed system, every computer connected to the Internet needs to be “addressable”, so that other computers on the net are able to “talk” to each other. Naming entities is the addressing mechanism via which a computer on the Internet is uniquely identified.
- Possible approaches to addressing mechanisms include:
 - Centralised
 - Free-for-all
 - By delegating naming responsibilities

The Internet is the biggest distributed system of all, being a huge network of networks.



Centralised Naming Approach

- Centralised naming is the most obvious approach to guaranteeing that **any name is handed out once and only once**. In this approach, there is **a single point of contact**, that either validates that a name is unique, or alternatively makes up a unique name and hands that out on demand.
- Its main limitation is that the **single point of contact** has to deal with every request, and, as a consequence, it is **not a very scalable solution**, and it creates **a single point of failure**.

If the central system breaks, then everything stops working.



Free-for-All Naming Approach

- Free-for-all allows any object that wants a name to make up its own name.
- Although this is a massively 'distributed' solution which avoids a single point of failure, it does not guarantee uniqueness.



The 'Delegating Naming Responsibilities' Approach

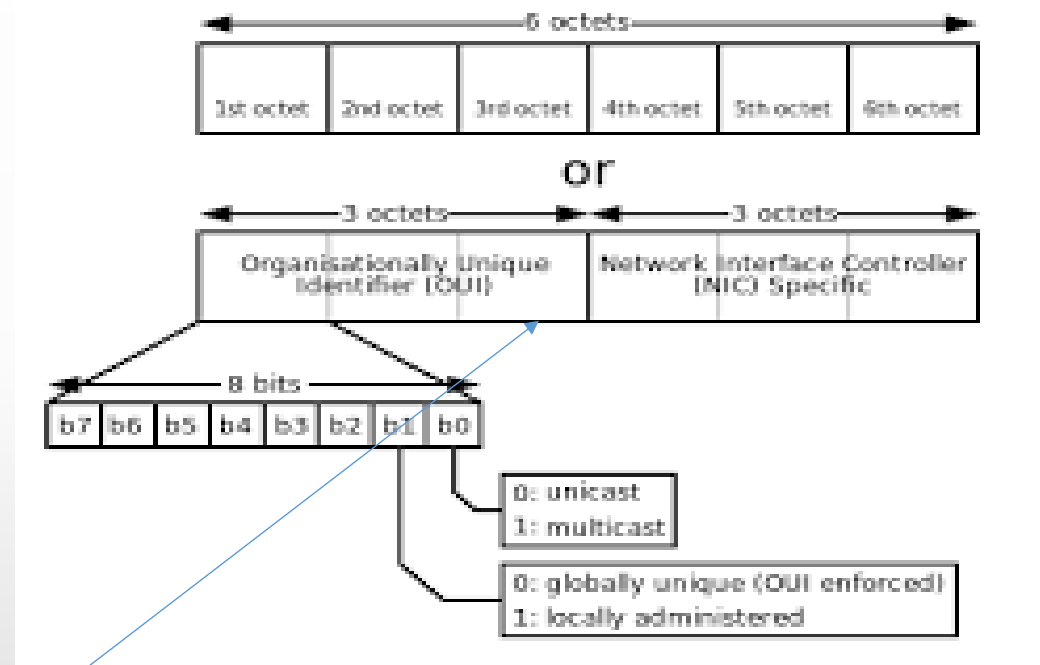
- In this approach, the authority to allocate names is **delegated to smaller parts of the system**, and governed by some rules.
- This approach **better balances** the conflicting issues associated with single points of failure and scalability, but it raises questions as to what rules are appropriate for each system.
 - E.g., a rule could state that every device in a particular organisation has to have a name that includes the name of the organisation; another rule could state that every device in a particular country has to have a name that includes the name of the country; etc.
- In the following slides, we talk about three of the most widely used by-delegation naming mechanisms: MAC addresses, IP addresses and Domain Names.



MAC Addresses

- The Media Access Control (MAC) address is a unique identifier given to each *network device* in a system: this means that every ethernet or wifi card in a computer has one MAC address.
 - Note that, since most computers have several network devices, there are more MAC addresses than there are computers. A MAC address is a 48 bit number, so that means there are 281,474,976,710,656 different numbers, or enough for every person living on Earth to have lots of different network devices.
- A MAC consists of two main parts: the 'Organisationally Unique Identifier' (OUI) and the 'Network Interface Controller' (NIC).
- A MAC address does not tell you where a device is on a network.

Figure source: quora.com



The OUI is a 24 bit number that is purchased from the Institute of Electrical and Electronics Engineers (IEEE), which acts as a central authority from which vendors of hardware can purchase unique identifiers. Once a vendor has an OUI to use in the MAC addresses for its hardware, as long as that particular vendor makes sure that the NIC part of the address is unique, then the combination of the OUI and the NIC will be unique.



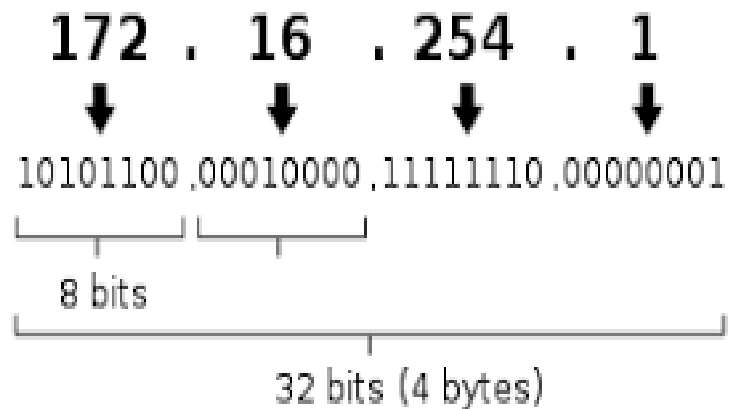
IP Addresses

- An Internet Protocol Address (IP Address) serves two purposes: it is a 'unique' identifier and also contains some information about 'where' a device is on a network.
- Most IP addresses are 32 bit numbers, but are most often written as four 8 bit numbers separated by dots (e.g. 130.88.192.9).
- The top-level authority for IP addresses is the Internet Assigned Numbers Authority (IANA), which delegates ranges of the address space to five Regional Internet Registries, which in turn delegate sub ranges of their space to Internet service providers.
 - Note that, unlike MAC addresses, the delegation of IP addresses takes place initially to geographical regions (rather than 'hardware vendors'),
 - And, for this reason, **IP addresses can tell you some information about the location of a device on a network.**

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Figure source: en.wikipedia.org

IPv4 address in dotted-decimal notation

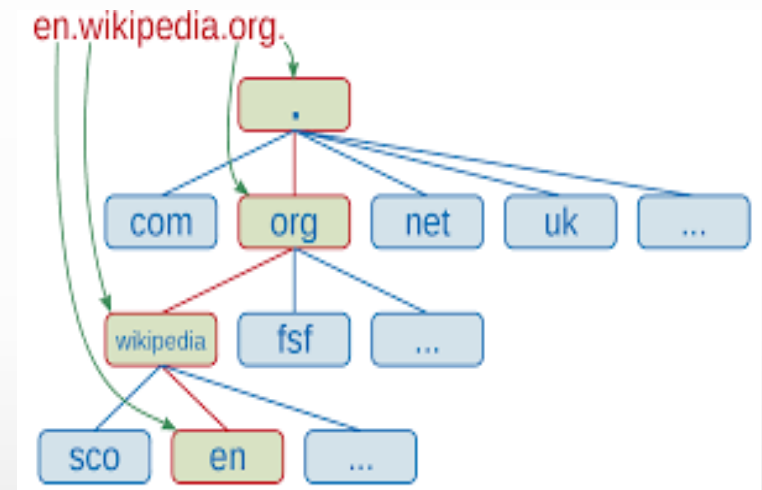


There are not enough IP addresses for each person on Earth, and so, IPv6, the latest generation of IP address, uses 128 bit numbers to overcome this problem.



Domain Names

- Domain Names were created because humans find IP addresses hard to read.
- The Domain Name System (DNS) is itself a Distributed System built on top of the Internet, used to **create associations between human-readable names and IP addresses**.
 - For example, www.bbc.co.uk, will be “translated into” an IP address that you can use to communicate with the appropriate computer.
- The ‘delegation’ model used by the DNS is complex, as it has aspects of geographical delegation
 - For example, domain names ending in ‘.co.uk’ are for UK-based companies.



- But it also separates matters out in other ways as well.
 - For example, domains ending in ‘.com’ and ‘.org’ have no geographical implications, but refer to companies and organisations.



- Unlike MAC and IP addresses, DNS cannot allocate 'batches' of names upfront, and needs to respond in real-time to requests to translate names into IP addresses.
- It achieves this by being in itself a Distributed System, consisting of a hierarchy of servers with the most authoritative server at the 'top' of the hierarchy, dealing with requests from users.

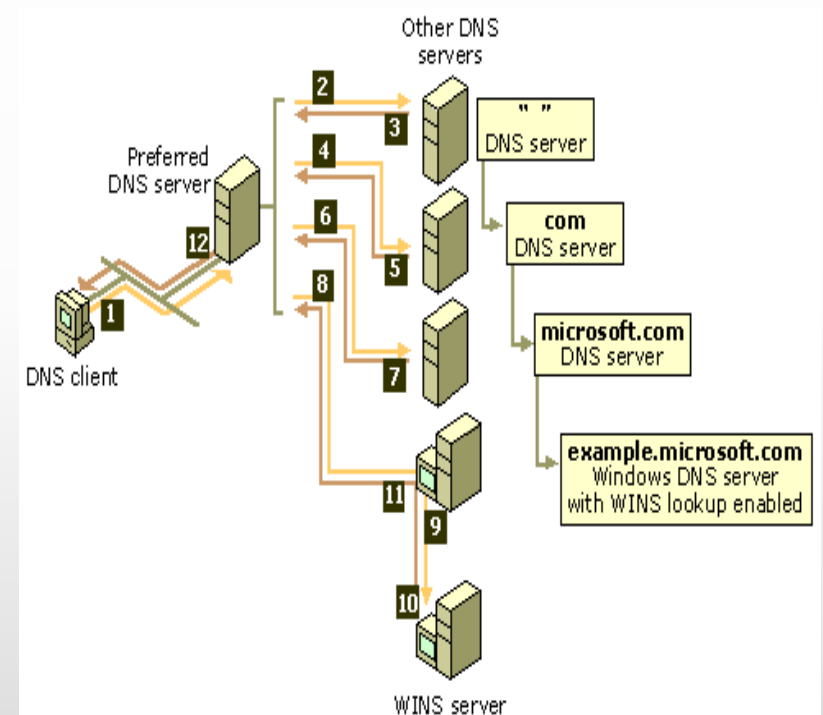


Figure source: serverfault.com

