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Operating Systems and Internetworking

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Contents

Part I

Operating Systems

Lecture - Introduction

13:00 26/09/23 Tamer Elboghdadly

Operating Systems

- The Operating System sits inbetween the hardware and application software
- It usually is not the actual GUI, but provides functionality for the applications which implement it
- OSes typically provide abstractions for applications so that they can run on different hardware

User and Kernel Mode

- User mode
  - The programs that a user directly interacts with
  - Uses an API to access hardware, rather than having direct access
- Kernel mode
  - The programs that run the operating system
  - Has direct access to hardware

System and Application Software

- Application software
  - Programs that allow a user to perform a task
  - Requires the support of system software to run
- System software
  - Software directly related to the operating system
  - Manages the boot process
  - Hardware drivers
  - File system management

The main functions of an Operating System

- Resource management
  - Manages the memory, CPU and other hardware to allow multiple programs to run concurrently
  - Handles requests from applications to allocate more resources
- ”Extended machine”
  - Handles reading and writing to control registers, handlling interrupts, etc
  - Provides higher level APIs for other software to interact with the hardware

CPU Organisation

Registers

Figure 1.1: General purpose registers in an x86 Intel CPU

Name	Use	Description
EAX	Accumulator	The default register for many addition and multiplication instructions
EBX	Base	Stores the base address during memory addressing.
ECX	Count	The default counter for repeat (REP) prefix instructions and LOOP instructions.
EDX	Data	Used for multiply and divide operations
ESI	Source Index	Store source index
EDI	Destination Index	Store destination index
EBP	Base Pointer	Mainly helps in referencing the parameter variables passed to a subroutine.
ESP	Stack Pointer	Provides the offset value within the program stack.

Part II

Internetworking

Lecture - Network Services

09:00 25/09/23 Athanasios Paraskelidis

DHCP

- DHCP stands for Dynamic Host Configuration Protocol
- The main motivation of DHCP was to provide a set of configuration parameters to automatically configure new devices as they are added to the network. The main parameters are as follows:
  - IP address
  - Gateway address
  - Subnet mask
  - DNS server address
- Before DHCP, either devices were configured manually, or the bootstrap protocol (BOOTP) was used
- The main improvements over BOOTP are:
  - Support for temporary allocation of IP addresses
  - DHCP clients can automatically discover the local DHCP server
  - Once the server is setup, there is almost 0 human interaction unless something goes wrong
  - Still compatible with BOOTP clients
- A lease is the length of time that an allocated IP address can be used before either a new address is needed, or a request to continue using the current address needs to be approved
- An IP address can be released by the client if it is nolonger needed, e.g. the device shuts down or nolonger needs to communicate on the network
- Advantages
  - Saves manually configuring every single device
  - Ability to move to a different network without having to reset any network settings on the device
  - Allows more efficient use of the IP space, as inactive devices do not need to keep a lease on an address
- Disadvantages
  - DHCP uses UDP to configure devices, so the communication is unreliable and insecure
  - Possibly allows unauthorised clients, but this can be avoided using MAC address white/blacklisting
  - Potential for malicious DHCP servers setup on a network that provide incorrect network settings

DNS

- DNS stands for Domain Name System
- This is the system which devices use to convert the human-readable domain names into IP addresses which computers can use to communicate to the server
- DNS is a globally distributed mapping database between domain names and IP addresses
- There are 3 main components
  - A **name space**
  - **Servers** that make the name space available
  - **Resolvers** which make the request from clients to servers
- As DNS is globally distributed, some data is maintained locally, but also retrievable globally
  - No single server holds all DNS records
- A DNS lookup can be performed my any device
  - Remote DNS data is usually cached locally to improve performance
- DNS has 'loose coherency'
  - The database is always internally consistent
  - Each version of the database has a serial number, which is incremented every time the database changes
  - Changes to the master copy of the database are replicated to secondary servers regularly, depending upon the timing set by the zone administrator
  - Cached data expires depending upon timing set by the zone administrator
- There is no limit to the size of the database
  - Having a very large number of records on one server would decrease performance
  - Therefore, the database is spread across many servers around the internet
- There is no limit to the number of queries which can be made at any time, or by a single user
- Queries are usually distributed between multiple DNS servers as well as local caches
  - e.g. nameserver1 and 2
- Clients can query and use the data from any server, primary or secondary
- Clients will typically have their own local cache of more frequently accessed records
- DNS uses both TCP and UDP
  - TCP is used for communication between servers, for example when replicating records from a primary to secondary server
  - UDP is used for communication between clients and servers
- The database can be updated dynamically
  - Add, delete or modify any record on the server
  - These only need to be performed on the main server, as the secondary servers will replicate the changes over time

- There are two main types of servers
  - Authoritative
    - Primary server - Where data is added and modified
    - Secondary server - Servers which replicate the primary server to share the load
  - Non-authoritative
    - Caching servers - temporarily retain records from authoritative servers to improve resolving performance and reduce load on authoritative servers
- Domains can be resolved either Iteratively or Recursively
  - Iteratively
    - The client's domain name resolver starts by querying the root nameserver
    - The root nameserver responds with the address of the nameserver on the next level down
    - The domain name resolver then queries this nameserver, and so on until the nameserver with the full domain is found
  - Recursively
    - The client's domain name resolver queries the root nameserver
    - The root nameserver itself queries the nameserver on the next level down
    - This process repeats until the nameserver with the full address is found
    - The IP address of the domain is then passed back up the chain and to the requester

Domain Names

- A domain name is the sequence of labels from a node to the root, separated by dots
  - e.g. port.ac.uk has 3 labels
    - port
    - ac
    - uk
  - There can be up to 127 labels in a domain name
  - But there can only be 255 characters in the domain overall
- The root domain or Top Level Domain (TLD) of a domain is the final label, e.g. the TLD of port.ac.uk would be uk
- A subdomain is any domain which resides below the TLD. In the case of port.ac.uk,
  - uk is the TLD
  - ac is the Second Level Domain
  - port is the actual domain name
- Name servers store information about domains in units called zones
  - Each zone usually corresponds to a subdomain, for example the .uk TLD has many sub-zones, such as .ac.uk, .gov.uk and .co.uk