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## Tema 1: Visió general del Sistema Operatiu.

Programa intermediari entre l'usuari i el maquinari.

Objectius del sistema operatiu:

- Executar programes d'usuari.
- Adjudicar recursos del sistema a l'usuari d'una manera fàcil.
- Fer un ús del maquinari eficient i segur.

Components en un sistema:

- El maquinari
- Els usuaris
- El programari d'usuari
- El Sistema Operatiu

Que és un Sistema Operatiu?

- Gestor de recursos:
  - Gestiona tots els recursos del sistema
  - Adjudica recursos als usuaris temporalment de manera que el sistema funcioni de manera segura i eficient.
- Programa de control:
  - Controla l'execució de la resta de programari d'usuari. I en detecta els errors del programa o l'ús inadequat per part dels usuaris.

Components d'un Sistema Operatiu:

- El nucli:
  - El nucli és la part del Sistema Operatiu que es manté constantment en memòria. Ens comuniquem amb el nucli a través de crides a sistema.
- El programari de sistema:
  - El programari de sistema és tot aquell programari que forma part del sistema operatiu però que no requereix de privilegis ni estar carregat constantment a memòria.
  - Proporcionen un entorn adequat pel desenvolupament i execució de programes d'usuari.
    - Manipulació i modificació de fitxers.
    - Informació sobre l'estat del sistema.
    - Suport a la programació en diversos llenguatges.
    - Càrrega i execució de programes.
    - Comunicacions.
    - La visió que molta gent té del sistema operatiu és el programari de sistema, no el Sistema Operatiu en si mateix a través de les crides a sistema. Malgrat això hi pot haver sistemes operatius que implementin parts importants com a programari de sistema.
- El programari d'usuari:
  - Implementen serveis orientats a l'usuari fent ús de crides a programari de sistema i crides a sistema.

Serveis que ofereix el Sistema Operatiu:

- Entorn de desenvolupament de programari.
- Arranc del sistema:
  - En un inici només hi pot haver un sistema operatiu carregat a memòria (podria ser un hipervisor).
  - El Sistema Operatiu és copiat en totalitat o part a memòria.
  - Inicialitza les estructures de maquinari i programari necessàries per controlar la màquina i oferir els seus serveis.
  - Atén les excepcions/interrupcions/trapa capturades pel Sistema Operatiu.
  - Posa en marxa la closca (shell) del Sistema Operatiu.
    - Interfície Gràfica d'Usuari (GUI):
      - Interfície més amigables amb paradigma d'escriptori.
      - Perifèrics necessaris: Pantalla, teclat i ratolí.
      - Interacció orientada a la manipulació d'objectes dins el paradigma.
      - Inventat per Xerox PARC.
      - Exemples:
        - La interfície Aero de Microsoft és una GUI que té una CLI (“Símbolo de Sistema”)
        - La interfície Aqua d'Apple és una GUI amb diverses CLI disponibles.
        - GNU/Linux té diverses GUI (GNOME, KDE, XFCE ...) i diverses CLI (bash, csh, tcsh ...). Per que un sistema GNU/Linux sigui usable fa falta com a mínim una CLI.
    - Interfície de Línia d'Ordres (CLI):
      - Pot ser implementat a nivell de nucli però sovint és una aplicació de sistema.
      - Hi ha moltes versions amb petites o grans diferències.
      - Que fa?
        - Llegeix comandes.
        - Les executa. Les comandes poden ser internes del CLI o carregar un binari a memòria i executar-lo.
- Execució de programes:
  - Gestió de Processos:
    - Un procés és la unitat mínima d'assignació de recursos del sistema.
    - Un procés és un programa en procés d'execució. Entrarem en més detall al Tema 2
    - Un procés necessita recursos del maquinari:
      - Temps de CPU.
      - Espai a memòria.
      - Accés a dispositius.
      - Accés a fitxers.
    - El sistema operatiu assigna recursos als processos
    - Serveis necessaris:
      - Crear/eliminar processos:
      - Suspendre/reprenre processos.
      - Mecanismes de sincronització.
      - Mecanismes de comunicació.

- Gestió de memòria:
  - Necessitem les dades i el codi a memòria.
  - El subsistema de gestió de memòria determina el contingut de la memòria de manera que optimitzi l'ús de la CPU i al resposta del sistema als usuaris.
  - El rang de memòria assignat a un procés s'anomena espai d'adreces del procés.
  - Serveis necessaris:
    - Control de l'ús i el propietari de la memòria.
    - Decidir quins processos i fragments entren i surten de la memòria.
    - Reservar i alliberar memòria quan sigui necessari.
- Comunicació entre programes.
- Assignació de recursos.
- Accés a dispositius. (Gestió Entrada/Sortida)
  - Oculta la complexitat i les peculiaritats de la gestió dels diferents dispositius.
  - L'accés a dispositius i fitxers es fa a través d'una API (Interfície de Programació d'Aplicació) genèrica i uns descriptors de fitxers que permeten al Sistema Operatiu identificar l'element al que estem accedint.
  - Serveis necessaris:
    - Gestionar la memòria per fer E/S incloent l'ús de memòria intermèdia o buffering (espai temporal de memòria per transferir dades), l'ús de memòria cau o caching (guardar parts de dades en zones de memòria d'accés més ràpid) i gestió de cues o spooling (Tècnica que, mitjançant una cua, fa possible el flux d'elements entre dos dispositius de velocitats diferents. La denominació anglesa spool vé de la sigla SPOOL (Simultaneous peripheral operation on-line) ).
    - Interfície genèrica de gestió de dispositius.
- Accés a fitxers.
  - El sistema operatiu proporciona una visió uniforme i virtual de les dades i els dispositius
    - Abstruïu les característiques físiques en unitats d'emmagatzematge virtuals.
    - Cada mitjà d'emmagatzematge es controla amb un dispositiu diferent.
  - Gestió del sistema de fitxers
    - Fitxers organitzats en directoris (habitualment).
    - El Sistema Operatiu implementa un control d'accés per determinar qui pot accedir a que.
  - Serveis necessaris:
    - Crear i eliminar fitxers i directoris.
    - Manipular fitxers i directoris.
    - Mapatge de fitxers en espai d'emmagatzematge.
    - Serveis de còpies de seguretat.
- Gestió del disc:
  - El disc emmagatzema dades permanents i dades que no caben a memòria física.
  - Fer-ne una gestió eficient és important.
  - Serveis que ofereix el sistema operatiu per la gestió del disc:
    - Gestió de l'espai lliure i ocupat.
    - Algorismes de planificació d'accés a disc.
- Detecció i gestió d'errors (programari i maquinari).
- Comptabilitat i Auditoria (registre de l'ús dels recursos).

- Protecció i Seguretat:
  - Protecció:
    - Mecanisme que controla l'accés de processos o usuaris a recursos gestionats pel sistema operatiu.
      - El sistema operatiu identifica als usuaris per nom i pel seu número identificador (UID).
        - L'identificador s'associa als fitxers i processos de l'usuari.
      - Els usuaris estan associats a grups amb un identificador (GID) i també s'associen a fitxers i processos per determinar els nivells de privilegi.
  - Seguretat:
    - Defensa del sistema contra atacs interns o externs per mitjà de virus, atacs, suplantació d'identitat .

#### Accés al sistema operatiu.

- Un Sistema Operatiu és un programari guiat per esdeveniments de tres tipus:
  - Interrupcions generades pel maquinari.
    - Asíncrones.
    - Provocades per dispositius.
    - Entre 2 instruccions de llenguatge màquina.
    - Periòdicament s'executa la interrupció de rellotge per així evitar que un usuari pugui acaparar tots els recursos.
  - Excepcions generades per errors en el programari.
    - Síncrones.
    - Provocades per una instrucció de llenguatge màquina.
    - Es resolen dins la instrucció.
    - Les excepcions entren en codi del Sistema Operatiu tot i així podrien ser ateses per codi d'usuari.
  - Trapes o crides a sistema (nucli) generades per peticions del programari.
    - Provocades per una instrucció explícitament.
    - Per demanar un servei al nucli.
    - Les crides a sistema entren en codi de sistema operatiu.
    - Són la API del Sistema Operatiu.
    - Són molt similars en ús a qualsevol biblioteca de llenguatge (C, C++, Java).
    - Llibreries de llenguatge:
      - Els llenguatges de programació ofereixen una API de més alt nivell i més fàcil d'utilitzar que la del Sistema Operatiu.
      - Ofereixen independència de Sistema Operatiu i arquitectura, per tant incrementen la portabilitat del programari.
      - Lliguen el llenguatge amb el Sistema Operatiu.
      - Algunes funcions i accions són auto-contingudes (no requereixen una crida a sistema)
      - Altres han de demanar serveis al sistema (nucli) i han de fer crides a sistema (nucli).

- Llibreries de sistema:
  - Lliguen un Sistema Operatiu (nucli) amb una arquitectura.
  - Com fem crides a sistema (nucli)?
    - Necessitem crides a adreces variables
      - Utilitzem una taula de traducció.
      - El Sistema Operatiu inicialitza les entrades al iniciar-se.
      - Instrucció de llenguatge màquina especial per aquest tipus de crides TRAP (depèn de la arquitectura).
    - Necessitem garantir la protecció.
      - El codi de la llibreria dispara la trapa.
      - La trapa executa el codi de sistema (nucli).
      - El codi de sistema (nucli) no forma part de l'executable.
      - Fan falta privilegi per executar aquest codi.
    - Utilitzem el suport que ens ofereix el maquinari.
    - Com es fa una crida a sistema?
      1. Salvar el context d'usuari.
      2. Restaurar el context del sistema (nucli).
      3. Recuperar paràmetres.
        1. Servei
        2. Paràmetres
          - S'utilitza els registres, la pila o un registre apuntant a memòria com a suport.
      4. Identificar el servei.
        - Una trapa per servei. Pot no haver prou trapes.
        - Un trapa per grup de serveis.
        - Una trapa per tots els serveis.
          - Necessitem un paràmetre per identificar el servei.
      5. Cridar al servei.
      6. Realitzar el servei.
      7. Retronar el resultat.
        - S'utilitza els registres, la pila, o un registre apuntant a memòria com a suport.
      8. Restaurar el context d'usuari.
    - Com recollim el possible valor de retorn?
- Exemples:
  - WIN32 API (Microsoft Windows).
  - POSIX API (UNIX, LINUX, Mac OS X).
  - Java API (Java Virtual Machine).

- El Sistema Operatiu necessita una manera de garantir la seva seguretat la del maquinari i la de la resta de processos. El nucli del sistema operatiu s'executa en mode d'execució privilegiat.
  - Mode d'execució no privilegiat, mode d'usuari (user mode).
  - Mode d'execució privilegiat, mode de nucli (kernel mode).
  - Exemples:
    - i8086: No tenia modes d'execució
    - i386:
      - 4 modes d'execució:
      - 0: Tots els privilegis.
      - 1: Accés a tota la memòria i a un subconjunt d'operacions privilegiades.
      - 2: Accés a tota la memòria.
      - 3: Mode d'usuari.
    - Ambdós:
      - Instrucció de trapa: INT n
        - Interrupció per programari.
        - Utilitza la IDT, taula de descriptors d'interruptió per la traducció.
        - Desa l'adreça de retorn i la paraula d'estat del processador (PSW).
        - Al entrar en una interrupció s'inhibeixen les interrupcions, es poden desinhibir a petició del programador.
    - Depèn de la rutina es canvia al nivell necessari, no tots els Sistemes Operatius utilitzen tots els modes.
      - Exemples:
        - GNU/Linux:
          - Crides a sistema (nucli) agrupades a la INT 80h
          - Pas de paràmetres utilitzant registres. (EBX, ECX, EDX, ESI, EDI)
          - Identificació del servei i retorn de resultat pel registre EAX.
          - Modes d'execució 0 i 3.
        - Microsoft Windows
          - Crides a sistema (nucli) agrupades a la INT 2eh.
          - Pas de paràmetres mitjançant un punter a memòria al registre EDX.
          - Identificació del servei i retorn de resultat per registre EAX.
          - MS-DOS modes 0 i 3. NT 4.0 modes 0, 1 i 3. A partir de W2K els 4 modes.
- El maquinari proporciona suport per passar d'un mode a una altre:
  - En la paraula d'estat del processador (PSW) hi ha el bit de mode (mode bit) que ens indica el mode en que esta executant.
    - Algunes instruccions de llenguatge màquina només es poden executar en mode de nucli.
    - Quan s'executa una crida a sistema (nucli) es canvia el mode y al tornar a usuari es canvia a mode usuari.

## Estructura dels Sistemes Operatius.

- El disseny i la implementació depenen de:
  - L'arquitectura.
  - La tipologia d'usuari.
  - La tipologia d'usos
- Objectius i especificacions d'usuari i sistema:
  - Per l'usuari el Sistema Operatiu ha de ser fàcil d'usar, aprendre, segur, robust i ràpid.
  - Pel dissenyador ha de ser: fàcil de dissenyar, implementar, mantenir, flexible, lliure d'errors i eficient.
- Principis de disseny:
  - Cal distingir:
    - Polítiques: Que cal fer?
    - Mecanismes: Com ho hem de fer?
- Els diferents components o subsistents s'agrupen de la següent manera:
  - Unitat monolítica.
  - Per capes: una capa del sistema només pot accedir a les capes inferiors.
  - Modular: El sistema esta fet per mòduls que es carreguen dinàmicament si són necessaris o no.
  - Micronucli + Servidors: Els mecanismes s'implementen al micronucli mentre que les polítiques s'implementen en diversos servidors que són programari de sistema però formen part del Sistema Operatiu.

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