THE Et Direct Memory Access (DMA): 3 slow I/O deurces such as keyboard, can senel one character every one will second. 1 mils = 1000 mics. The CPU can process the character in 2 micho seconds through an I 5 S lecture #5 Feb. 19. 2018 5 Monday. 1 mils 1 Franking Mussich I all char 1000 Wirs Manard is follow the second > Sends 1 Char every 1000 mics. The CPU needs 2 mics for the service noutine to handle the interruption. (CPU) mud 2 2 1000-2 1000 mirs 1000 mics 2000 mics The CPU is left 1000-2-998 mics for Asynchronous Ilo processing. (nothing (bitsurday) SIT get of promision most But, In high speed ID devices (i.e Hard Disk) The HD can send or recieve chair every 4 mics. Chor char Chour 1 4 mics This leaves the CPU with 4-2=2 mics for Hsynchronous multiprocessing.

* In this case the OS sends one block of data 2 each time of sends an interrupt to the CPU to process this block. SCRU) ALC: NOT Memory Memory 100al buffer one block of date 141 Primary Storage (memory_RAM) "volatile" Memory is largest storage media accessed G041 directly by the CPU. 1012 1 chi words 0591 41 Memory is array of words, each has address. word size = 2 & bytes 3 more Common 4 bytes and the second The CPU performs the following instructions: (a) Load instruction: Fetch (get) instruction 5 from memory to the IR (Instruction Register) it ((b) Store Instruction: staring a Register into 5 Memory location. 6 5 -

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Et Instruction Cycle: store the result CDU Eyer program 3 perform the * Instruction Cycle * operations with 1. D. fetch the given operands. 110 IR clocode 100 Analyze the Instruction 110 1. dei Et Secondary Storage: "Hard Disks, topes, CDs, Flash memories. Ling LIFE Factors that affect the secondary Storage: 11) speed (2) Cost (3) Volatility. " poils/ Ciego" No Main The Fastest Storage medium in the system: Register Ceiches RAM Shower HD Tapes * Cache Memory: chashing: is simply copying data to a faster starage medium to speed up execution of ensure gard performance.

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-Examplesi (1) Memory (RAM) is considered as a Cache for HD. (2) Registers are considered as Cache for memory. (3) Instruction Carche Register (ICR) (4) (cycle) FARIE PEOGRAM IR 2 2 ICP; 10 & (2) are concurrent Eparelleli]. from ICR to TR is much faster than 1 RAMTOIR -1 Coche is the fostest carche type because it's build with in CPU. -2 bigger but slower. letc lecture #6 Feb. 21.2018 X Weelinesday 152 (20.7) Et Hardware Protection: Same The How the OS protects the Computer Resources? 5 - Ilo devices any any and a point Memory Memory Marge Angle and - A CPU. Samer 2 up 5 0

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A A 2 N. 10 * Dual mode of operation: Ly The OS runs in two modes: D (a) monitor (supervisor) mede: In this case the OS B executes process on behalf of it self. (i.e interrupts) D (b) User mode: The OS executes on behallf of the 7 user E it runs user programs]. 7 E Implementation: Is one bit is assigned called "made bit" and formal a conta so Olycomentor mode. ×(A) 1: user mode at aspected sit to the off of the Despect (Definition: montash wish A Privilleged Instruction is an instruction that's executed only in monitor mode. "OS" PROVIDENT LANGE UNITED AN I': 29165AL JOSICHUG & E IIO protection: All I 10 instructions are made privilleged Instructions It Memory Protection: 1 14 Day of Day of 1 and the To protect the memory Allocation space of user program & the OS it self. You and Rough

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OS 15 1-11 Base Roopister User 1 4282 liver Rogister Base Register Unit Dayister 1000 Usera 5262 Base Register base Roopistor limit Rogister Usera 2000 Quuit Pogister * > leaded to the memory * where user program -(LA) <address starts from 4262 & has a limit of 1000 * Logical Address (LA): is the offset of the instruction in your bisolum. 2. LA = the address seen in your program * Physical Hodress, is the actual address in Memory & PA = Logical Address + Base Register. (i.e) PA = 736 + 4262 = 4998 The most Important concept; is How the OS Compute the PIA? Rimit Register Bose Register Base + limit *(CPU* PA F Memory fourt

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Timer 1099 Et CPU protection: 10,000 esme Integer Timer + # of Clock ficks, .IFI - With every clock tick the timer is decremented by 1 10 when the timer reaches zero it sends an interrupt to 113 15 the CPU. 16 When the CPU recieves interruption it Interruption 111 executes the interruption service routine is service Raitine HE which is responsible for checking the CPU. 11 Timer can be used in computer time Calculation. ALS. It Operating System Structure: 1 (1) process Manargement. (2) Mensoy memogement. (3) File System (IIO) Management. -The OS services ain be provided in two methods; ly system Call; it's an assembly language Instruction. R * System programs. 2

Feb. 24.218 lecture #7 Saturday LAT Process angle of your I get did your proug where the K. Process Concepter money which it which > Definition: A process is a program in execution Process = program = job und is simple wild will will estimate * There are different process types in the Systems the man of Barn Strong man (1) Batch Processi generally, Batch process has Low priority. C (2) Time sharing process: pharma paray (1) USERS , Much in Bring proving provingers (- program developement ?? 1 - data entry. - demmanoi (3) System tasks 1202 moders of Interrupt page ustan 100

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* Process Contents: The process contains: (1) Code Section (Program Counter "PC") "PC"; is the address of the Instruction executed (a) currently. (2) Dates Section: Memory allocation were Input of Output data is stored (3) Stock Section: Gbbal wighter: Static. · 「 」 「 」 1261500 18 proglam E Carda Section "PC" (9) ALL GUT CO. Stack Section Data Section Process.

* Process States: (1) NEW; The process is newly Created augu Bel Neully Creates) " Pool " Procom 2) READY: The process is Looded in to Menning I ready to run and halle the CPU. The process is in READY queue waiting to have the CRU to runs 3) RUNNING: The process is having the CPU & exacution. (4) WAITING: waiting for some event to happen, typically, waiting for I/O. (5) TERMINATED: The process finishes execution. FXIT ou scheduling NEW TERMINATE READY RUNNING hterrup Ilo Completed ILO needed WAITING Major process state.

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16 12 lecture #2 Feb. 26.208 -Monday Pa It where data about the process is stored? -40 > Answer Process Control Block (PCB); 2.5 It's a kind of a data structure, generally it's RO 10 PCR a table allo Datapl Process ID 115 (1) process ID. Process state 1110 (2) Process State. program Counter (3) program Counter (PC). (4) Registers. (5) Scheduling Info. -(6) Memory Info (Base of limit Registers) (7) Accounting Into-1 Scheduling of System Queues. 1 Quere scheduling Algerathmy (EIFO) 1 Intermolicite queue T. medium Term scheduling P ev scheduling Perinters dol (1009) manp dal -Ready quere "Short-Term" (CPU 1/"Long_Term Finish execution Exit queue is Finished herrup I 10 is Completeel Ilo is required I/O queve "HD schedulicy Algorithm" HD equeue

- Epilonet Term "job" schedulingti-It's selecting a job from the job quelle to be admitted to memory and in term it's added to the READY quelle. This selection "Interrupt "is Invoked " Called ", this intoked (seconds, Minites). That is, the OS has enough D time to decide conefully which jub to fetch. "Long-Tenn" P Et Short-Term Schedulings 2 It's selecting a process "jub" from READY queue to be given to CPU to RUN. (will i seconds, micro seconds, Name seconds), Therefore it should be very fast. "short-Tenu" 1... > Definition > Degree of wullti-programming is the # of jobs 11 in the memory "READY queue". Therefore, 1 city-Term scheduling controls the degree of wullti-programming. 1 It Job Scheduling: 10 IF most jobs in memory are CPU band gobs, then the CPU will always be busy "high CPU utilization", but the IN queues are empty. On the other hand, If most jobs are I/O bound jobs, then the I/O queues are always full and CPU almost free "Low CPU utilization" (1) In both cases the system is unbalanced! Long_Term Scheduling: Selects a mix of CPUZ IN bound jobs So the system will be reasonably balanced

lecture #9 Feb. 28.2018 Wednesday 4 Et Process Creation; * parent process creates children processes, which, in turn create other processes, forming a Tree of processes, and internation of a sound its 2 transport tool astrong 20 parente INIT > Resource shanned :- Ohild (1) parent & children share all & parent Cs resources. (2) children shake subset of childre 00 powent's resources. (3) Parent & child share no resources "porent & children Compete for All resources" 9 Execution ;- control (which) 9 - Parent-gehildren execute concurrently. 3 Parent waits until chibren terminate. Address Space - " Allocation of process in Memory 3 child duplicate of parent. child has approgram logoled into it. Unix examples! Fork system call cheates new process exercice system call used after a fork to replace the process memory space



fork Computation (fork) (CPU) concurrently parallal Process termination :-* Process executes last statement & asks the operating System to delete it exit output data from child to parent · Via Fork? - process resources are deallocated by OS. when a process is killed all stits resources are deallocated. * panent may terminate execution of a childnen processes "Abort" a task assigned to child is no A Vonger required a and to all child has exceeded allocated DUE 1 nesources. - Panent is exiting. # OS doesn't allow duild to continue if its powent terminates. # cascading Tennination: IF the parent process ends exit all children & Subchildren! are exited.

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Let cooperating processes :-Concurrent processes are either: (1) Independent process: cannont affect or be affected by the execution of another process. (2) Carperating process: Can affect or be affected by the execution of another process. * Advantages of process cooperation: & Information Shanning 4 Computation Speed -up. > Modulanty man J Convenience a loop in the miles Producer Consumer Problem > Cexample on concurrent process interford * talking about concurrency requires! Cooperating among processes (i.e Communication among processes) I and id synchronication of processes action To illustrate the idea of cooperating process Consider the producer_consumer problem; producer process produces information. Consumer process consumes this information. applied applient and soil that

producer Data Consumer Produces Consumod Buffer Concurrently * Examples: CI > print program produces characters consumed by the printer. > Complex praduces assembly Codes consumed by the assemblers during I assembler produkes marchine language Code Consumed by the Loader Secture # 10 March 3.2018 your JUNIMUSCONS Under painter Saturday (* Data Structure Required (Const int n; USize of Buffer. type item; Il item = chair, bit, word Var int buffer [n]; inting I index where we add items in the buffer int outs' I index where we take items from the buffer, item next P. I next produced item. item nexts; 11 next consumed item. (1) we will use the Circular Buffer idea in the implementation. 32

1 Parts 0 m=7 E9] E D [5] 100 C [4] Sheel 11 5 B 531 5 7 OUT = 2 A 52 2 57 in -1 2 10. D Buffertry - definit -) perturar Data Consumer nextp BUFFERM netc * Buffer is Full: (in+1)% N= out Circular Buffer R * Buffer is Empty: in - alt * Producer Process: Repeart produce an item in next-P. while (in+1) % N = = outbuffer [im] = nextp; $in = (in + 1) \% n_{j}$ Until False

* Consumer process: Repeat while (in=out) (no operation; Ilbusy waiting Nexte - buffer Lauf]; out- (out,1)%n3 & Consume the item; · UNFIL False Et Consumer Process + Produker Process > Run Concurrently * Disaduantage: we only use (-n-1) buffers if we have n buffers. 11 A SHING (A + PH) I Alera a gradient V CONTRACTORION DE LA a support of the property of which will and the second second second and the second of the second s his huffing I wind - Hosping Stranger and anthread outbours in the man prover any that is or stime want ((Jiou) printien ols in ()

55 [1] Threads: 3 5 Process (Hearney Weight Process) 5 I code section, 1 process TD Stack Section! , Ragisters Set Data section Pergram Gunter Corde Section Cata Section opened files Mar Color Registerest PTD stack section TEVER DO HIPPHIL LECHURY DUIS AND STORING OF Y Thread (Light Weight Process) Contains: Program Counter. Registers set. Stack Section. Manual and and and All peer threads; Shake, Coole section - 11 10 10 days . Data Section. T/O Resources.

Carda Section Data schin morred Files all TD Devised Stock Agista Jack. p * advantage of threads is: Shannoy Resources. lecture # 11 March 5. 2018 6 Mondery 6 It There are two kinds of thread support:-GA (1) user lovel: It's totally the responsibility 62 of the user (very Complex & difficult) G 2) at kernel lovel, most OS support this! 6 kind of threads. 6 6 * Relation ship between user threads & kernel threads; 6 Think about user threads of processes (programs) (& Think about Kemel threads as CPUs 6

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* we have > multi-threads. > MULIFI- CPUS. 10 F (1) Many - To cone: 2. Many and 1 -Many user threads are warppeal to one kernel thread (B) Kornels thread 10 and the top luser Horeads. Disadvantage: NO concurrent execution. (2) One - To - One -Each kernel thread is assigned to one user thread. 3 K) { kernel threads. Juser threads n talent Main advantige: This allows concurrent execution. 1 ! Dis advantage; we need enough kernel threads 7 1 (ス) Many To Many: Many user threads are mapped to an equal or less number of ternel threads. (K)