Thread Resource Utilization

Deadlock Characterization

Resource Allocation Graph

How to Handle Deadlocks

- Deadlock Prevention
- Deadlock Avoidance (Resource Allocation Graph Theorem, Banker Algorithm)
- Deadlock Detection/Deadlock Recovery (Wait-for-graphs, Banker Algorithm for Detection)

Multiprogramming

CPU Scheduler (preemptive/non-preemptive)

Process execution and when CPU-scheduling occur

Dispatcher and steps it takes (dispatch latency)

Scheduling Criteria: CPU utilization, throughput, turnaround time, waiting time, response time

First Come First Served (**convoy effect**, nonpreemptive)

Shortest Job First (smallest CPU burst, exponential avg calculated, preemptive or nonpreemptive)

Round Robin (each process given a **time quantum** before preempted, long average wait time)

Priority Scheduling (CPU given process with highest process, preemptive or nonpreemptive, **starvation**, **aging**)

Multi-level Queue (separate queue for each priority, can be combined with RR or time quantum to avoid starvation)

Multi-level Feedback Queue (process moved between queues)

Thread Scheduling (kernel threads, user threads mapped to LWP/kernel-thread)

Contention Scope (**process contention scope** (preemptive), **system contention scope**) WTF IS THIS

Multi-process scheduling (**load sharing**, **asymmetric**, **symmetric (SMP)**)

CPU can only access registers (1 cycle) or main memory (**CPU stall**) or cache (fast access to memory)

Each process maintains base and limit register

Address binding: compile time (**absolute code**), load time (**relocatable code**), execution time, dynamic loading

- Address translation steps: (symbolic, compiler and relocatable address, link and absolute address)

Continuous Memory Allocation: OS and User contiguous partitions

- First-fit, best-fit, worst-fit and the issue of external (**compaction**) and internal fragmentation

Paging: physical memory (**frames**) and logical memory (**pages**)

- Use of PTBR, TLB (look up table, **TLB miss**, PTLR)
- Use of valid/invalid bits
- Allows for sharing (**reentrant code**)

Page Table Structure (hierarchical, hashed page table, inverted page table)

Swapping: process or parts of it moved from main memory to **backing store** (secondary storage): standard (slow) or **paging**