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- **Data race**: the results of the program can change depending on how events happen to occur.
- A set of hardware primitives with the ability to atomically read and modify a memory location.
- **Atomic exchange** or **atomic swap** interchanges a value in a register for a value in memory.
- A processor tries to set the lock by doing an exchange of 1, which is in a register, with the memory address corresponding to the lock.
- A pair of instructions in which the second instruction returns a value showing whether the pair of instructions was executed as if the pair were atomic.
- Instructions: **load linked (ll)** and **store conditional (sc)**.
- If the contents of the memory location specified by the load linked are changed before the store conditional to the same address occurs, then the store conditional fails.
- Translating and starting a program: compiler, assembler, linker, loader, dynamically linked library (DLL).
- **Pseudoinstruction**: a common variation of assembly language instructions often treated as if it were an instruction in its own right.
- Pseudoinstructions give MIPS a richer set of assembly language instructions than those implemented by the hardware.
- The assembler turns the assembly language program into an *object file*, which is a combination of machine language instructions, data, and information needed to place instructions properly in memory.
- Assemblers keep track of labels used in branches and data transfer instructions in a **symbol table**.
- The object file for UNIX systems typically contains six distinct pieces: *object file header*, *text segment*, *static data segment*, *relocation information*, *symbol table*, *debugging information*.
- **Linker** or **link editor** takes all the independently assembled machine language programs and "stitches" them together.
- There are three steps for the *linker*:
  1. Place code and data modules symbolically in memory.
  2. Determine the addresses of data and instruction labels.
  3. Patch both the internal and external references.
- When the linker places a module in memory, all *absolute* references must be *relocated* to reflect its true location.
- The linker produces an *executable file* that can be run on a computer.
- **Executable file**: a functional program in the format of an object file that contains no unresolved

references.

- **Loader**: a systems program that places an object program in main memory so that it is ready to execute.
- Disadvantages of *statically* linked libraries:
  - The statically linked program keeps using the outdated libraries unless relinked again.
  - The library can be large relative to the program.
- **Dynamically linked libraries (DLLs)**: library routines are not linked and loaded until the program is run.
- The lazy procedure linkage version of DLLs, where each routine is linked only after it is called.
- The linker/loader finds the desired routine, remaps it, and changes the address in the indirect jump location to point to that routine.
- Java is *compiled* first to instructions that are easy to interpret: the **Java bytecode** instruction set.
- An **interpreter**, e.g. **Java Virtual Machine (JVM)**, is a program that simulates an instruction set architecture.
- **Just In Time compiler (JIT)**: a compiler that operates at runtime, translating the interpreted code segments into the native code of the computer.