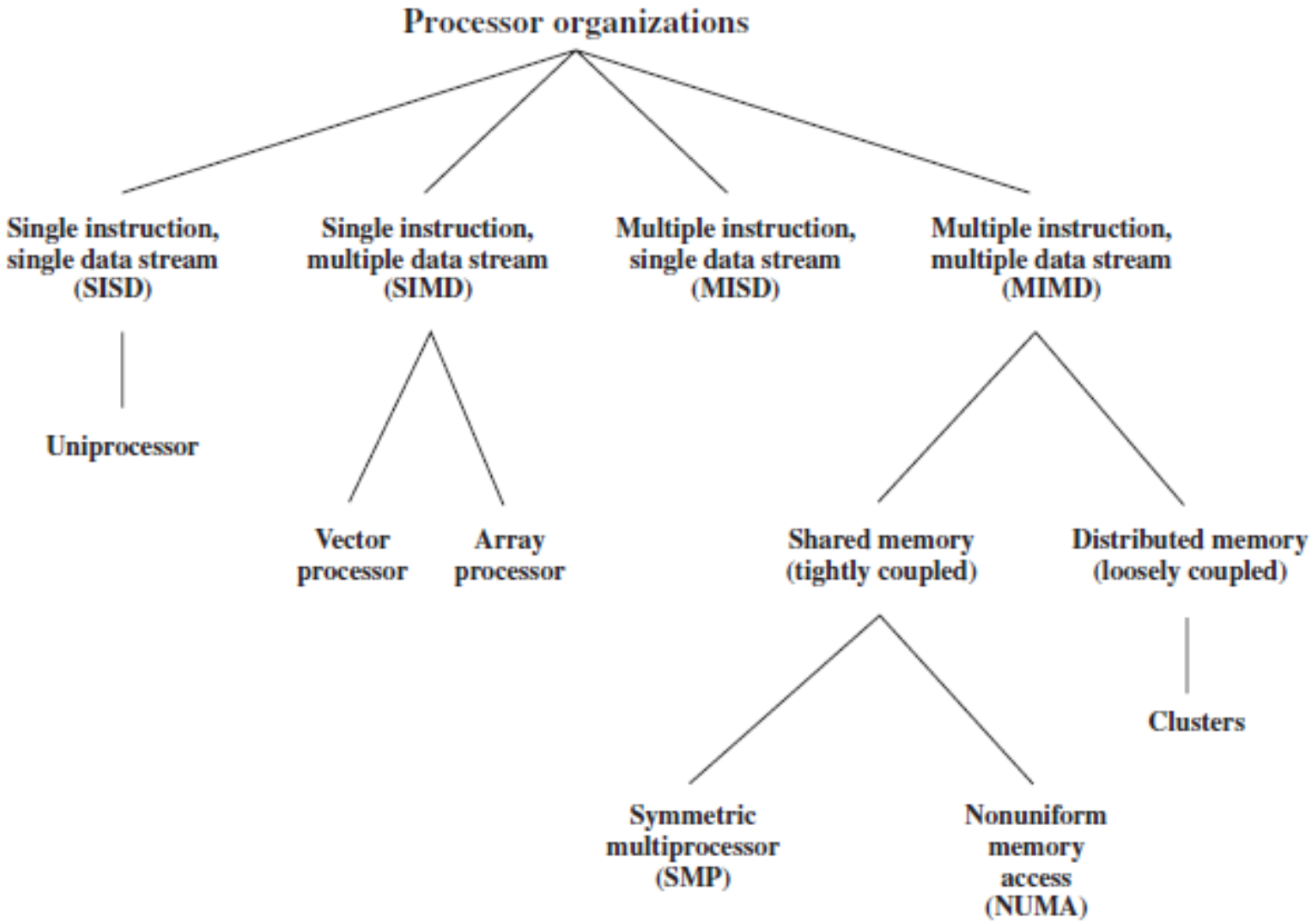
PARALLEL PROCESSING

MULTIPLE PROCESSOR ORGANIZATIONS



MULTIPLE PROCESSOR ORGANIZATIONS

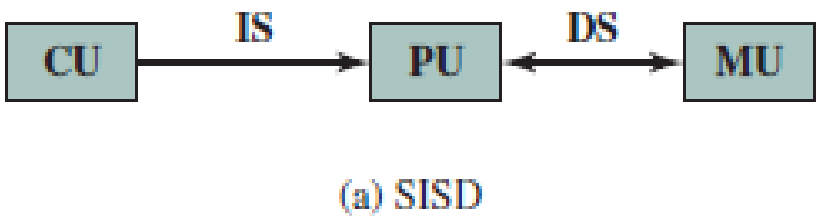
Types of Parallel Processor Systems

- Single instruction, single data (SISD) stream: A single processor executes a single instruction stream to operate on data stored in a single memory. Uniprocessors fall into this category.
- Single instruction, multiple data (SIMD) stream: A single machine instruction controls the simultaneous execution of a number of processing elements on a lockstep basis. Each processing element has an associated data memory, so that instructions are executed on different sets of data by different processors. Vector and array processors fall into this category.

MULTIPLE PROCESSOR ORGANIZATIONS

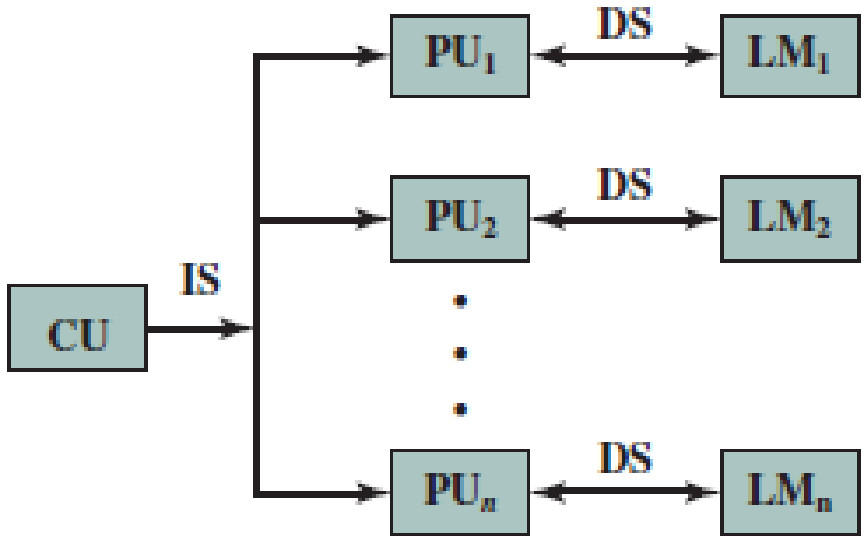
Types of Parallel Processor Systems

- Single ins… executes … single mer… am: A single processor …ate on data stored in a …egory.



(a) SISD

- Single instruction, multiple data (SIMD) stream: A single machine instruc… execution of a number of proces… . Each processing element has an as… instructions are executed on differe… processors. Vector and array proces…



(b) SIMD (with distributed memory)

MULTIPLE PROCESSOR ORGANIZATIONS

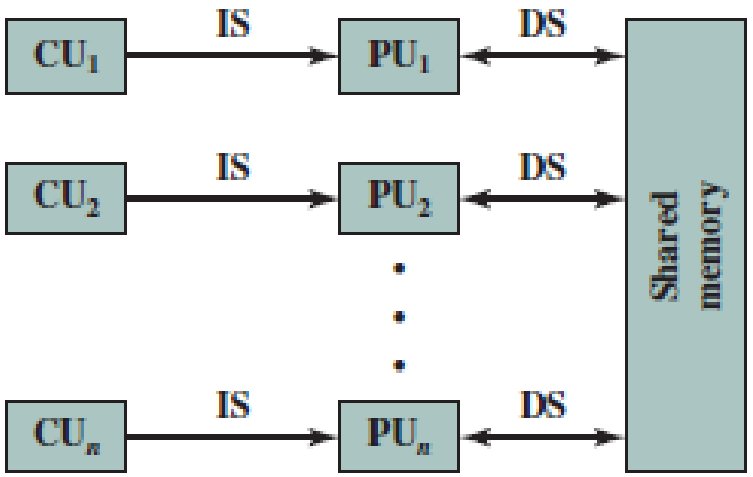
Types of Parallel Processor Systems

- Multiple instruction, single data (MISD) stream: A sequence of data is transmitted to a set of processors, each of which executes a different instruction sequence. This structure is not commercially implemented.
- Multiple instruction, multiple data (MIMD) stream: A set of processors simultaneously execute different instruction sequences on different data sets. SMPs, clusters, and NUMA systems fit into this category.

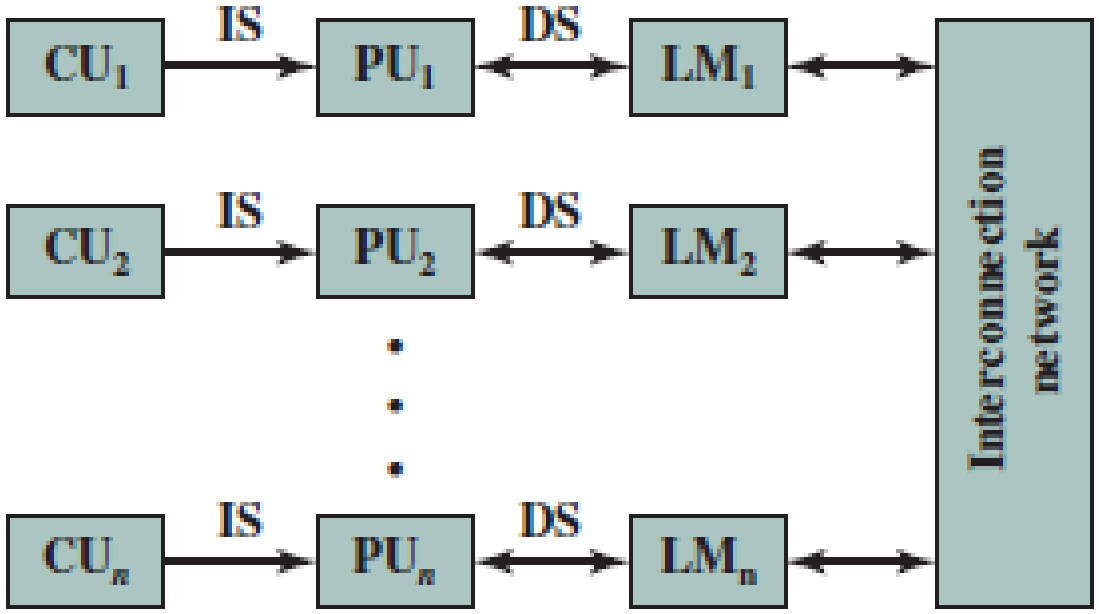
MULTIPLE PROCESSOR ORGANIZATIONS

Type

- Mu
  trc
  ins
- Mu
  sin
  da



(c) MIMD (with shared memory)



(d) MIMD (with distributed memory)

CU = Control unit
IS = Instruction stream
PU = Processing unit
DS = Data stream
MU = Memory unit
LM = Local memory

SISD = Single instruction, single data stream
SIMD = Single instruction, multiple data stream
MIMD = Multiple instruction, multiple data stream

SYMMETRIC MULTIPROCESSORS

- The term *SMP* refers to a computer hardware architecture and also to the operating system behavior that reflects that architecture. An SMP can be defined as a standalone computer system with the following characteristics:
  1. There are two or more similar processors of comparable capability.
  2. These processors share the same main memory and I/O facilities and are interconnected by a bus or other internal connection scheme, such that memory access time is approximately the same for each processor.
  3. All processors share access to I/O devices, either through the same channels or through different channels that provide paths to the same device.
  4. All processors can perform the same functions (hence the term *symmetric*).
  5. The system is controlled by an integrated operating system that provides interaction between processors and their programs at the job, task, file, and data element levels.

SMP Advantages

- **Performance:** If the work to be done by a computer can be organized so that some portions of the work can be done in parallel, then a system with multiple processors will yield greater performance than one with a single processor of the same type
- **Availability:** In a symmetric multiprocessor, because all processors can perform the same functions, the failure of a single processor does not halt the machine. Instead, the system can continue to function at reduced performance.
- **Incremental growth:** A user can enhance the performance of a system by adding an additional processor.
- **Scaling:** Vendors can offer a range of products with different price and performance characteristics based on the number of processors configured in the system.

SMP Organization

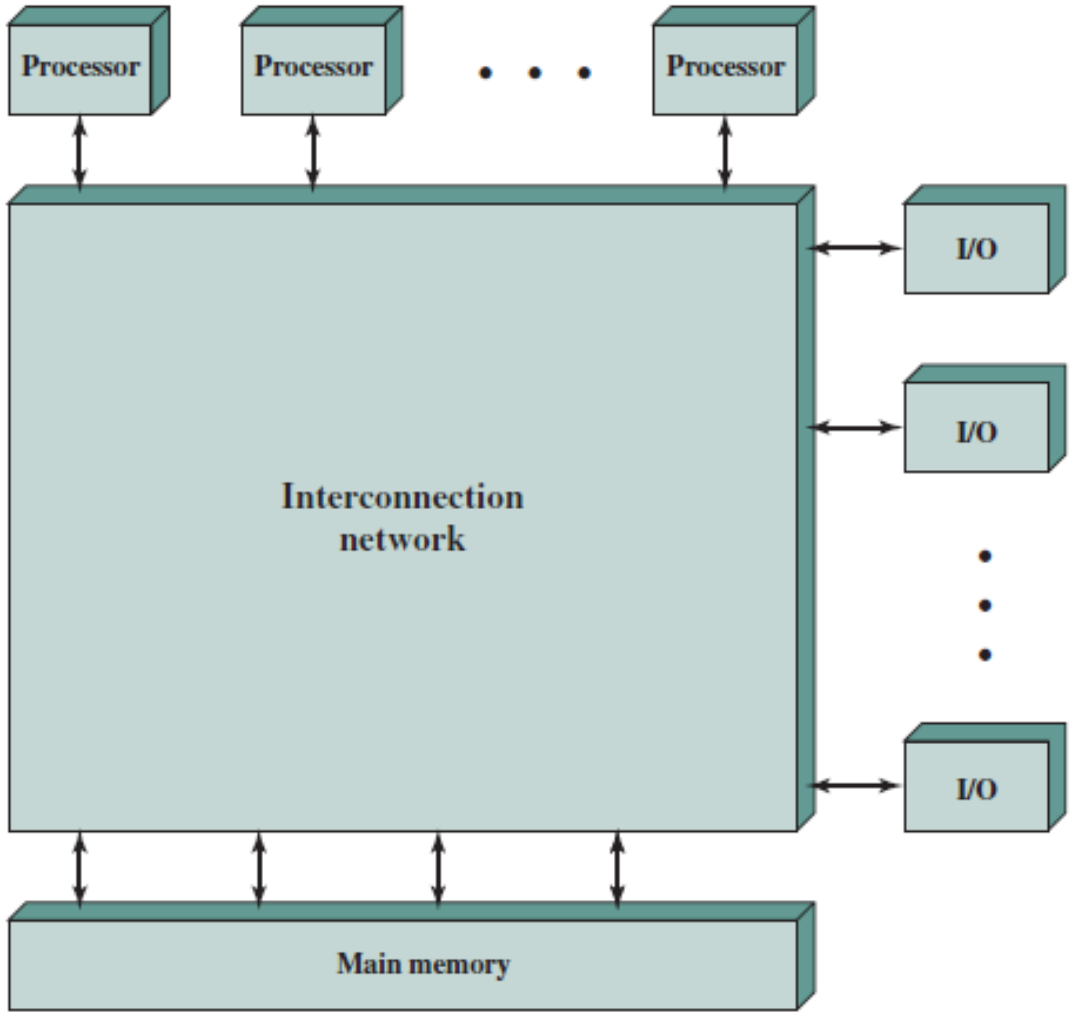


Figure 17.4 Generic Block Diagram of a Tightly Coupled Multiprocessor

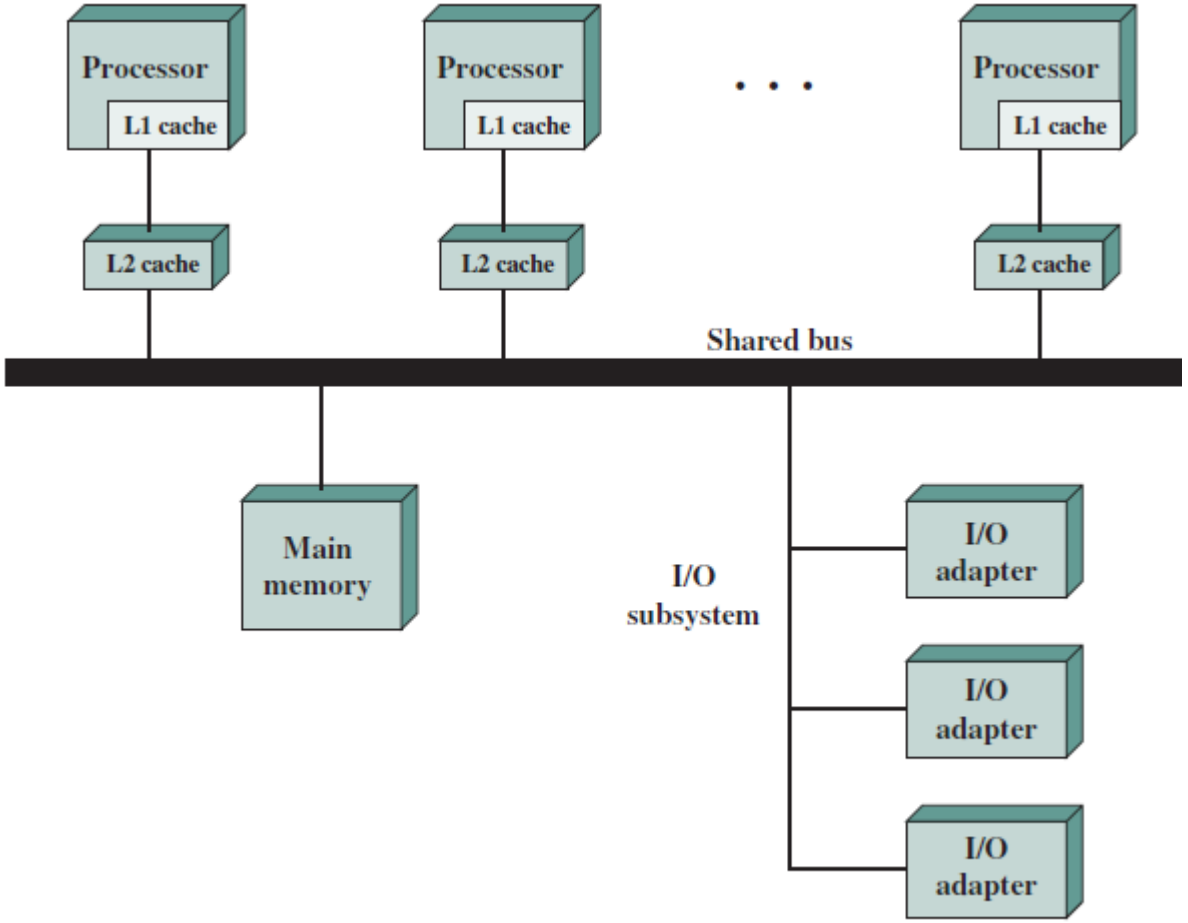
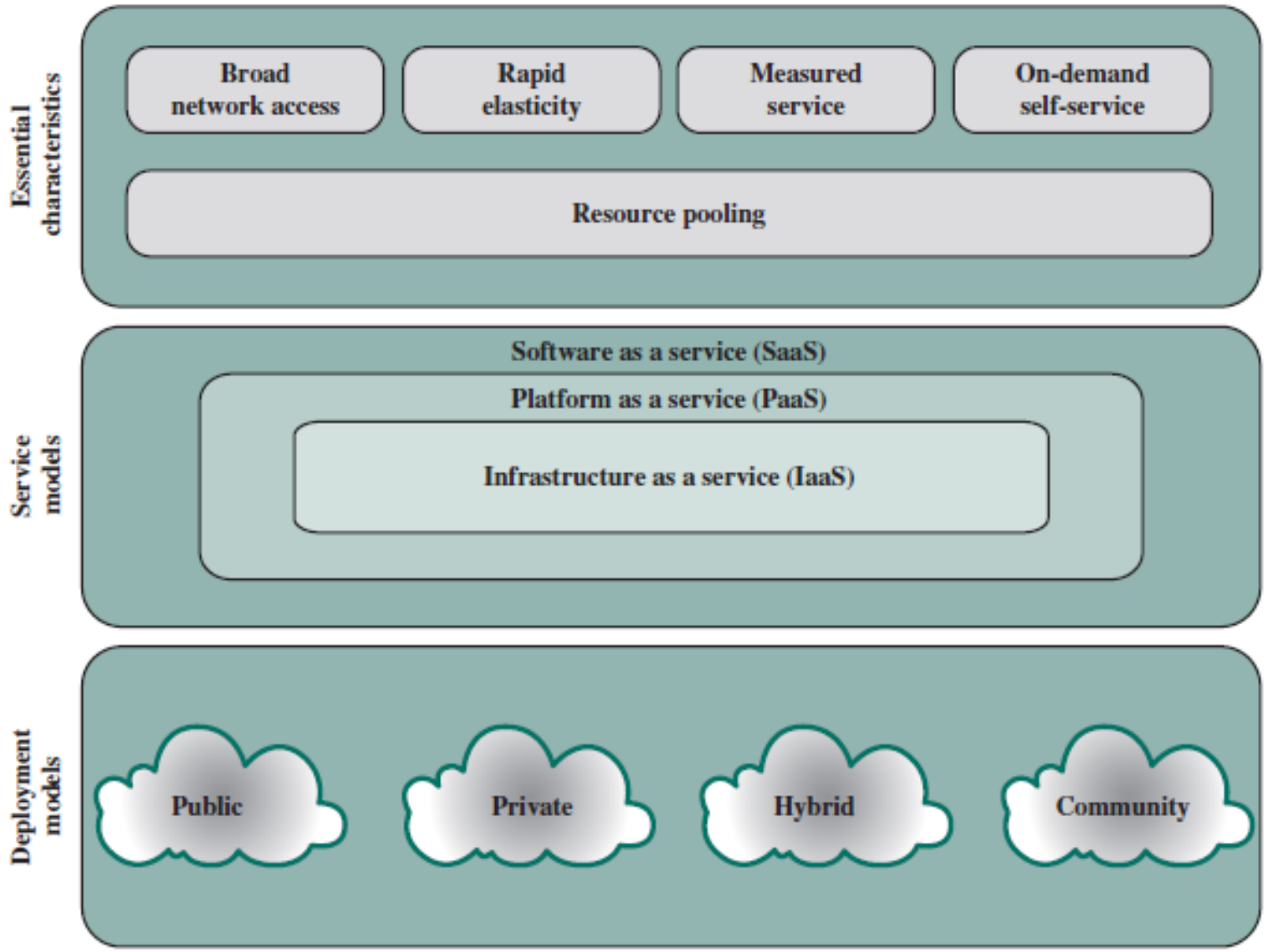


Figure 17.5 Symmetric Multiprocessor Organization

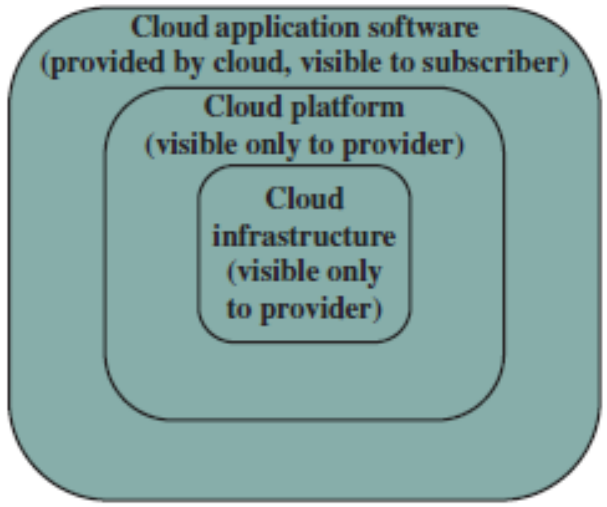
CLOUD COMPUTING

- The NIST Definition of Cloud Computing specifies that cloud computing is composed of five essential characteristics, three service models, and four deployment models.

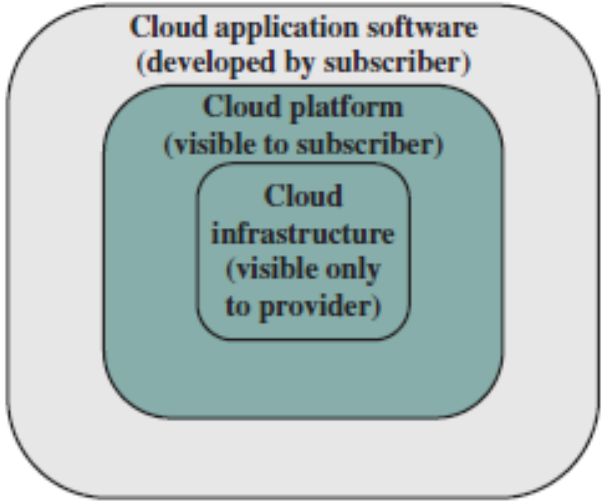
Cloud Computing Elements



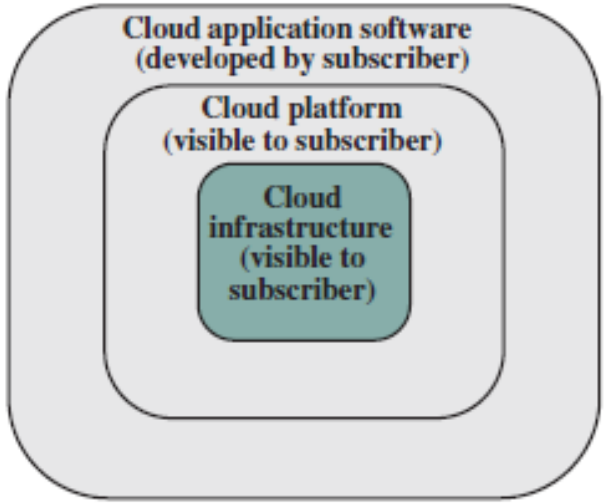
Cloud Service Models



(a) SaaS



(b) PaaS



(c) IaaS

Deployment Models

- Public cloud
- Private cloud
- Community cloud
- Hybrid cloud

Cloud Computing Reference Architecture