

Multi-processor

Snoopy protocol (总线监听协议)

目的

解决 多处理器中 cache 的一致性 (**cache coherence & consistency**)

- coherence : 不同 cache 的同一个数据不同
- consistency : cache 与 memory 的数据不同

特点

- Send all requests for data to all processors
- Processors snoop to see if they have a copy and respond accordingly
- Requires **broadcast**, since caching information is at processors
- Works well with **bus** (natural broadcast medium)
- Dominates for **small scale** machines (most of the market)
- 分布式, 与之相对的是 directory-based schemes (集中式)

类型

Basic Snoopy Protocols

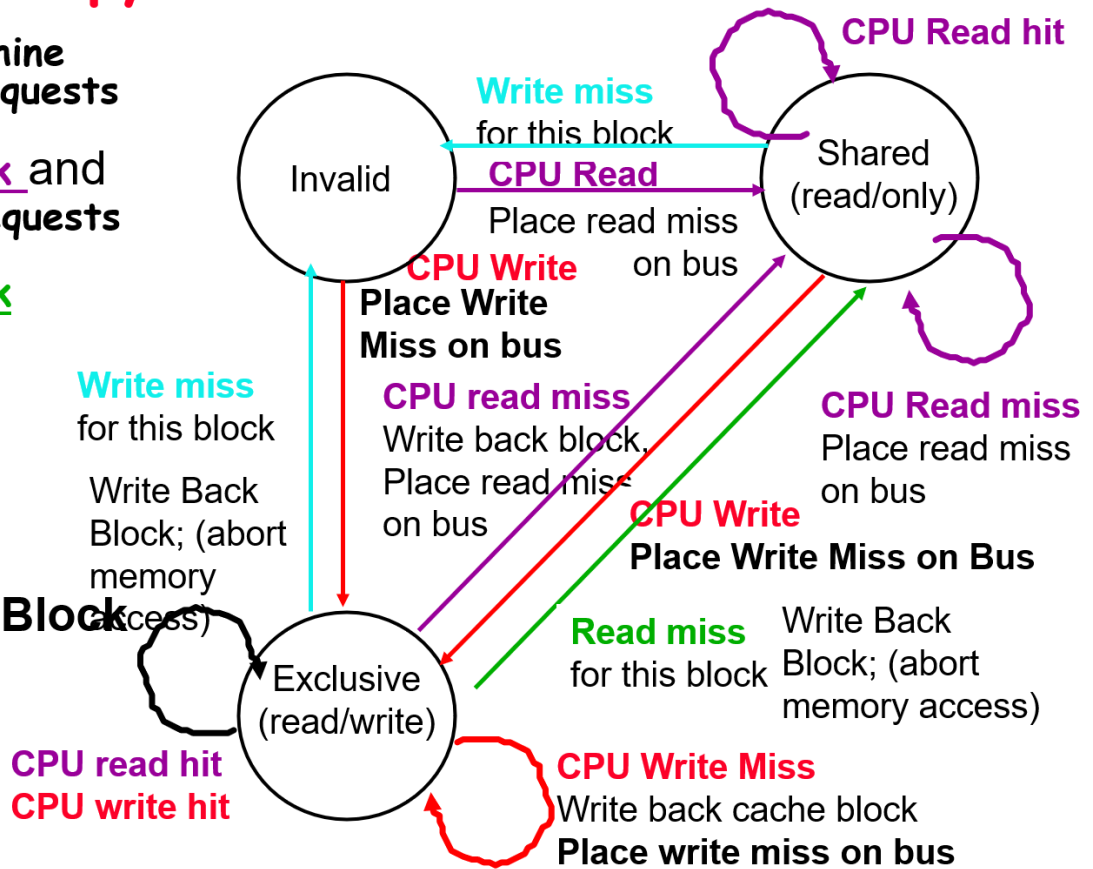
- Write Invalidate Protocol:
 - Multiple readers, single writer
 - Write to shared data: an invalidate is sent to all caches which snoop and invalidate any copies
 - Read Miss:
 - » Write-through: memory is always up-to-date
 - » Write-back: snoop in caches to find most recent copy
- Write Broadcast Protocol (typically write through):
 - Write to shared data: broadcast on bus, processors snoop, and update any copies
 - Read miss: memory is always up-to-date
- Write serialization: bus serializes requests!
 - Bus is single point of arbitration

cache的状态机描述

Snoopy-Cache State Machine-III

State machine
for **CPU** requests
for each
cache block and
for **bus** requests
for each
cache block

**Cache Block
State**

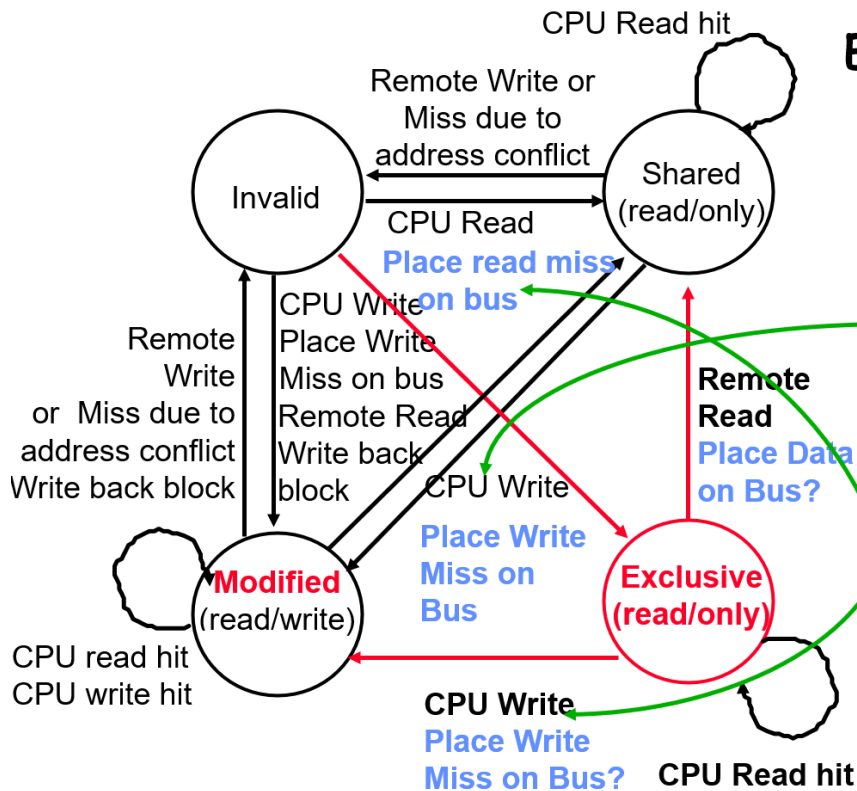


实际上，上图的 Exclusive 应该更正为 Modified。

Some extensions

实际上就是增加了新的状态。

Snoop Cache Extensions



Extensions:

- Fourth State:
Ownership
 - Shared -> Modified,
need invalidate only
(upgrade request), don't
read memory
- Berkeley Protocol**
- Clean exclusive state
(no miss for private
data on write)
- MESI Protocol**
- Cache supplies data
when shared state
(no memory access)
- Illinois Protocol**

MESI:

有协议 MSI -> 为什么还需要MESI: 对于唯一的读写者, 让其在 Exclusive 状态下运行, 防止到总线上广播信息, 影响其他通信。

SMP/Cluster/Cloud

“功能”辨析：

- infrastructure : 概念更大, 对设计者而言
- utility-computing : 对用户。 multi-cs -> uni-cs -> unix
- ubiquitous

Multi-core

New Amdahl's Law

嵌入式: system on chip (SOC)

Dark Silicon

为什么“一核有难，八核围观”？

芯片发热公式: $P = cV^2f$, V 为电压, c 为整个系统的容性, 取决于线之间的距离。

由于发热，多核的利用率往往就比较低，而且受限于工艺精度。

核并不是越多越好？

Distributed system

Availability VS Reliability

software pipeline