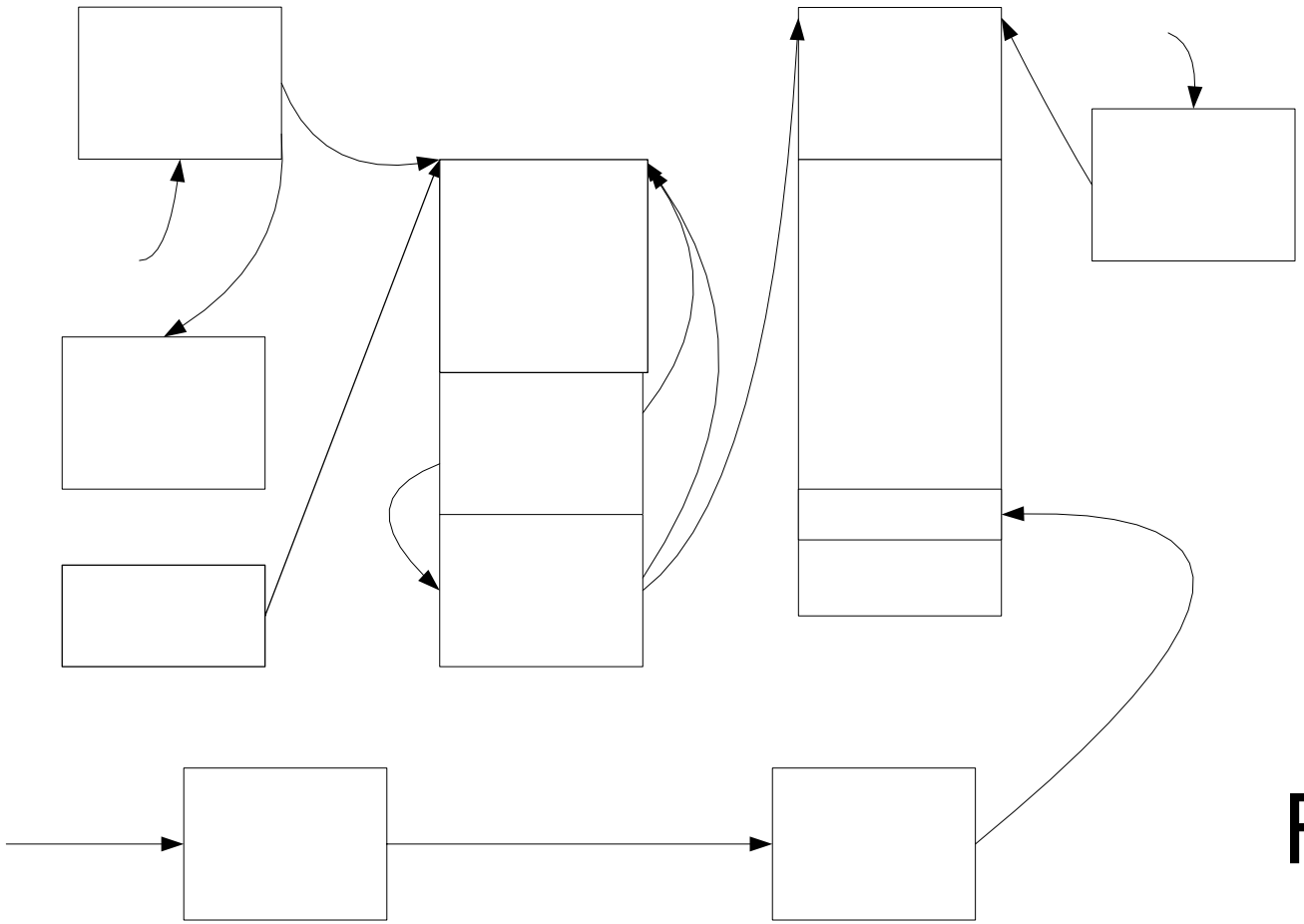
Windows Kernel Internals
Advance Virtual Memory

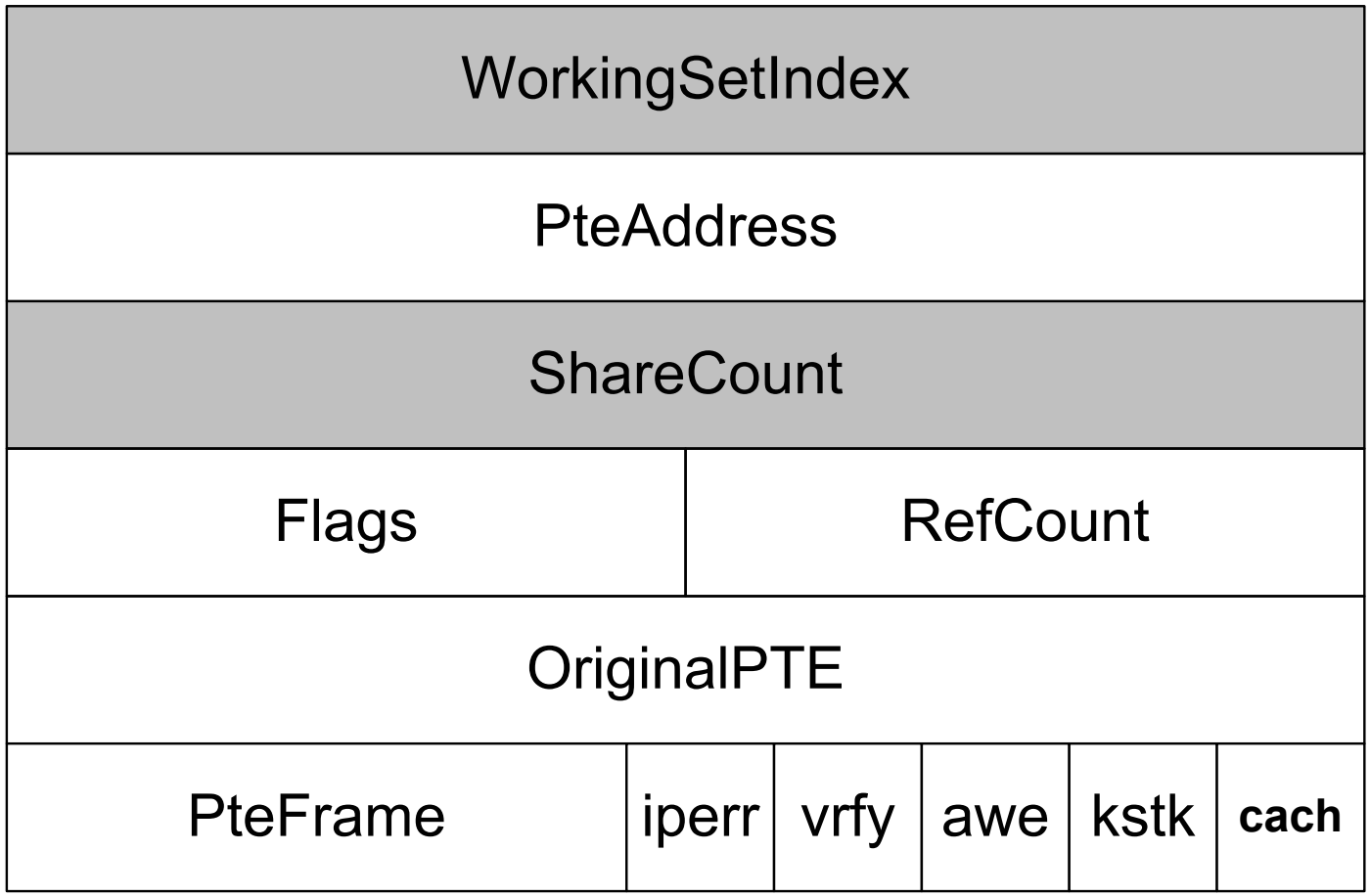
*David B. Probert, Ph.D.
Windows Kernel Development
Microsoft Corporation

Shared Memory Data Structures

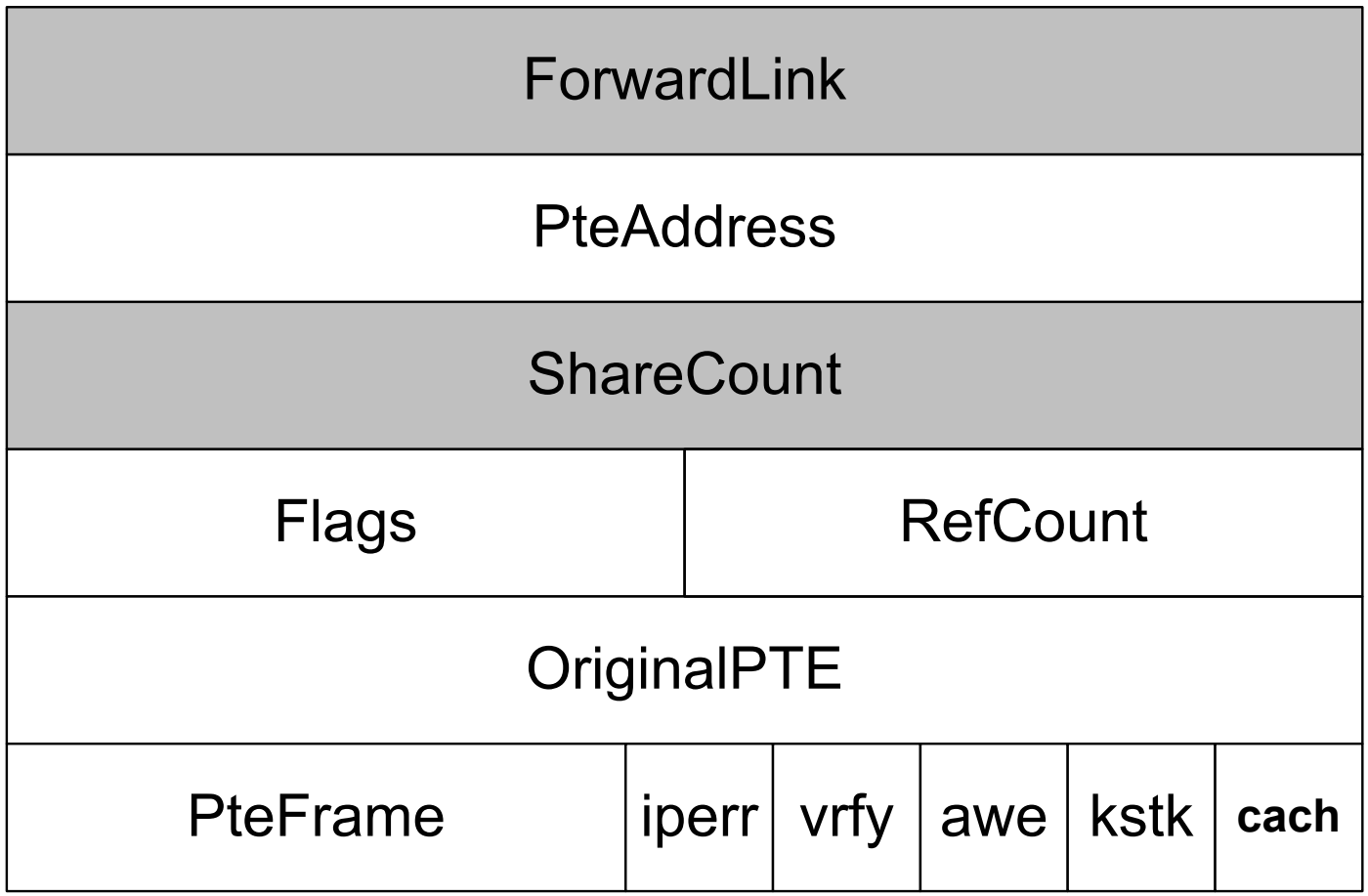


File Ob

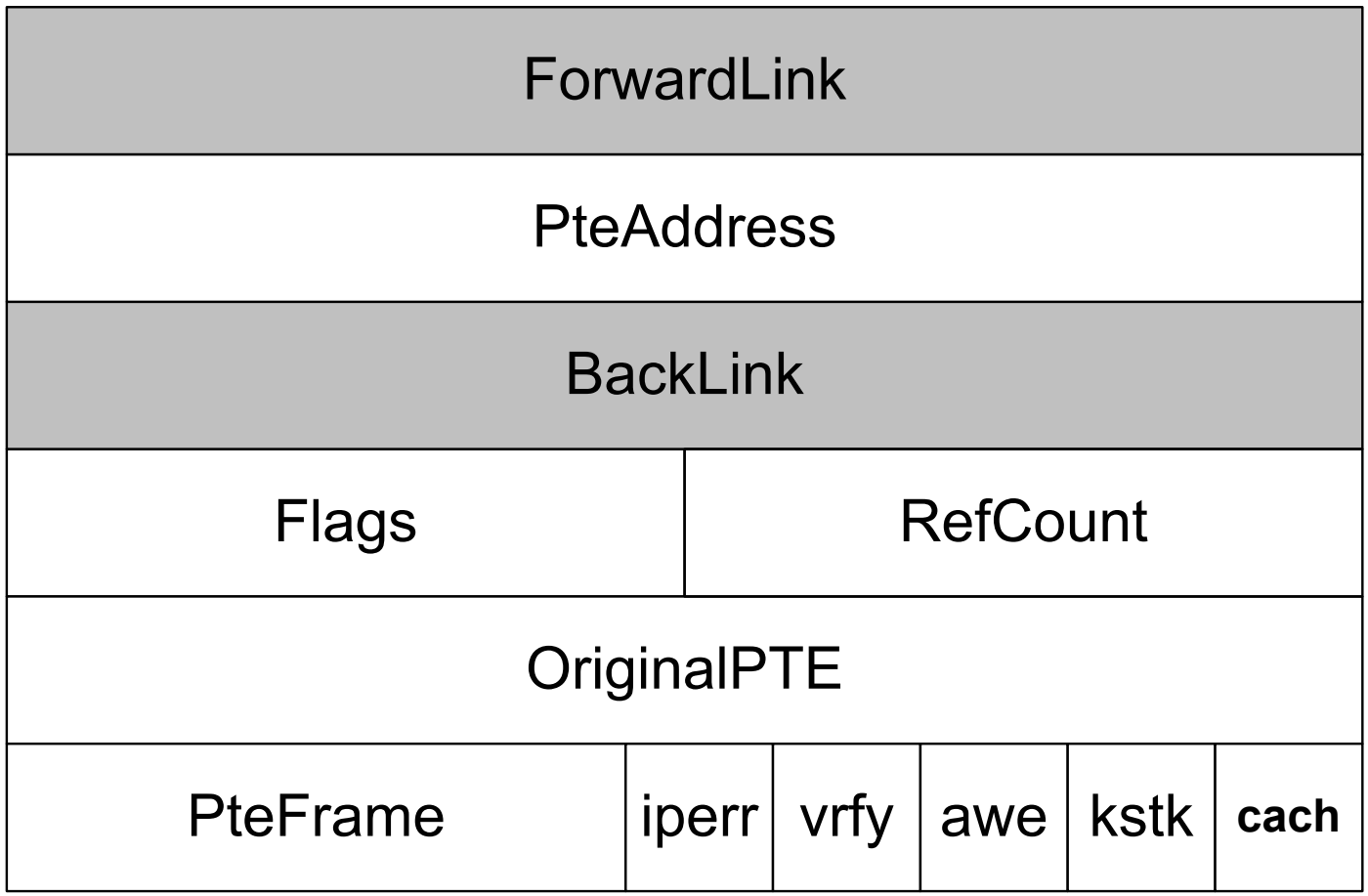
PFN: Working Set Page



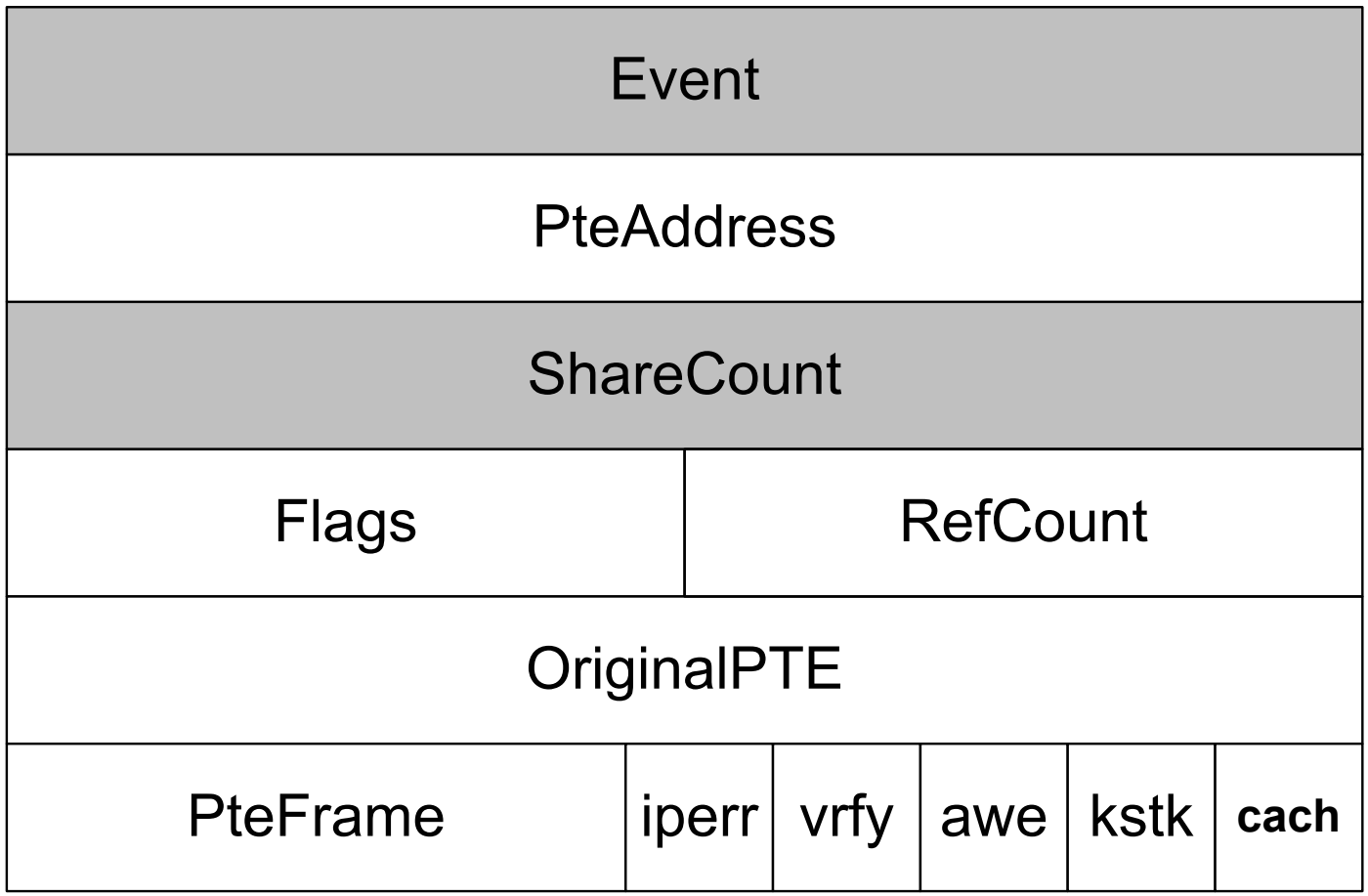
PFN: Free Page



PFN: Standby Page



PFN: Transition page



PFN Fields

PteAddress: VA of PTE referencing page

RefCount: count of WS or IO locks

OriginalPte: PTE to restore on soft-fault

PteFrame: PageFrame for PteAddress

Flags:

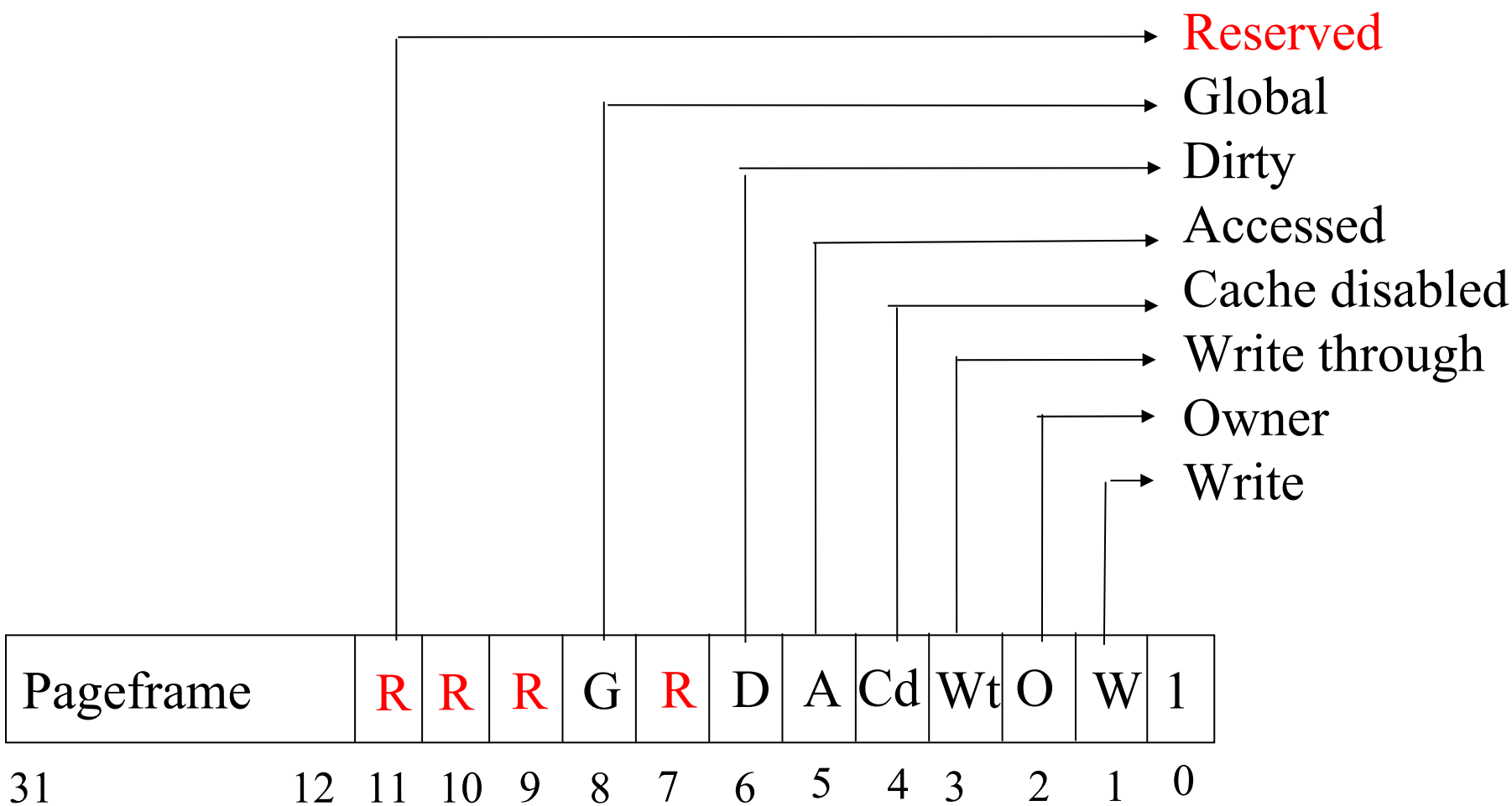
Modified : 1
ReadInProgress : 1
WriteInProgress : 1
PrototypePte: 1

PageColor : 4
PageLocation : 3
RemovalRequested : 1
CacheAttribute : 2

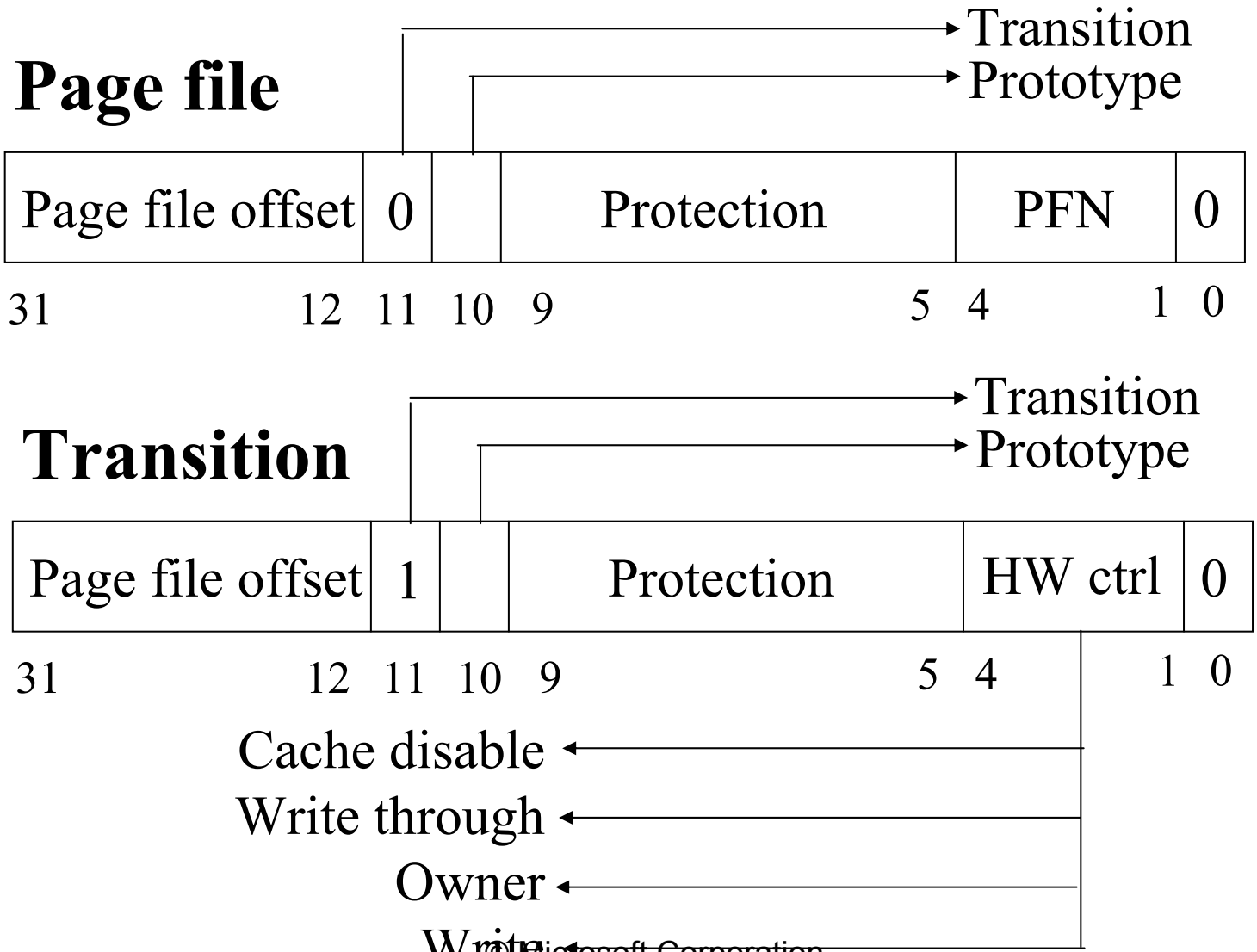
Page Table Entries

- Some fields defined by hardware
- Six PTE states:
  - Active/valid
  - Transition
  - Modified-no-write
  - Demand zero
  - Page file
  - Mapped file

Valid x86 Hardware PTEs



x86 Invalid PTEs

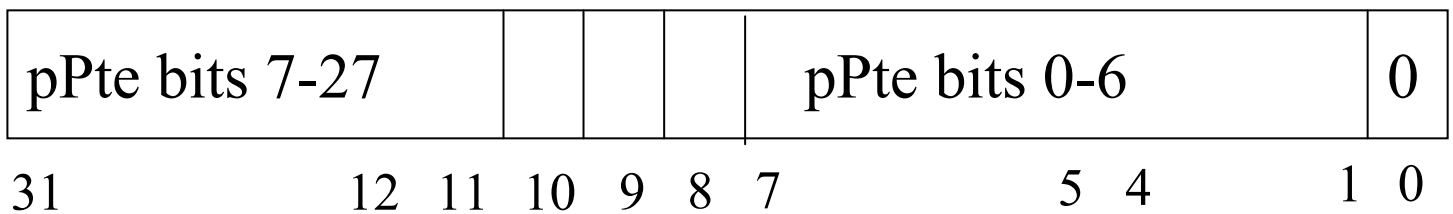


x86 Invalid PTEs

Demand zero: Page file PTE with zero offset and PFN

Unknown: PTE is completely zero or Page Table doesn't exist yet. Examine VADs.

Pointer to Prototype PTE



MMPAGING_FILE

- **PFN_NUMBER** Size, MaxSize, MinSize, FreeSpace, CurrUsage, PeekUsage, HighestPage
- pFileObject
- ModWriterMdlEntries[]
- pPageFileName
- pAllocationBitmap
- **Flags**:
  - PageFileNumber, RefCount, BootPart

MMSUPPORT

// embedded in EPROCESS

- WorkingSetExpEntry[2]
- LastTrimTime
- Flags
- PageFaultCount, PeakWorkingSetSize, GrowthSinceLastEstimate
- MinimumWorkingSetSize, MaximumWorkingSetSize
- pVmWorkingSetList
- **WSLE_NUMBER** Claim, NextEstimationSlot, NextAgingSlot, EstimatedAvailable, WorkingSetSize

MMADDRESS_NODE

- pParent, pLeft, pRight
- StartingVpn, EndingVpn

MMVAD

- **MMADDRESS_NODE** AddressTreeNode
- pControlArea
- pFirstProtoPte
- pLastContigPte
- **Flags:**
  - CommitCharge, PhysMap, ImageMap, Awe, Prot, MemCommit, Private, LargePages, WriteWatch, NoChange, FileOffset64k, SecNoChange, ReadOnly, Extendable, Inherit, CopyOnWrite

CONTROL_AREA

- pSegment
- DereferenceListEntry[2]
- nSectRefs, nPfnRefs, nMapViews, nCacheViews, nUserRefs
- nModWrites, nFlushesActive,
- Flags
- pFileObject
- iPfnBase
- Subsections[]

SUBSECTION

- pControlArea
- Flags:
  - ReadOnly, ReadWrite, SubsectionStatic, GlobalMemory, Protection, StartingSector, SectorEndOffset
- StartingSector
- nFullSectors
- pSubsectBasePtes
- nUnusedPtes
- nPtesInSubsection
- pNextSubsection
- nMappedViews

SECTION

- **MMADDRESS_NODE** AddressTreeNode
- pSegment
- Size
- InitialPageProt
- **Flags**:
  - BeingDeleted, BeingCreated, BeingPurged, NoModifiedWriting, FailAllIo, Image, Based, File, Networked, NoCache, PhysicalMemory, CopyOnWrite, Commit, FloppyMedia, WasPurged, UserReference, GlobalMemory, DeleteOnClose, FilePointerNull, DebugSymbolsLoaded, SetMappedFileIoComplete, CollidedFlush, NoChange, HadUserReference, ImageMappedInSystemSpace, UserWritable, Accessed, GlobalOnlyPerSession, Rom

SEGMENT

- pControlArea
- nPtes
- nWritableUserRefs
- Size
- PteTemplate
- nCommittedPages
- Flags
- BasedAddress
- PrototypePte
- ProtoPtes[]

Discussion