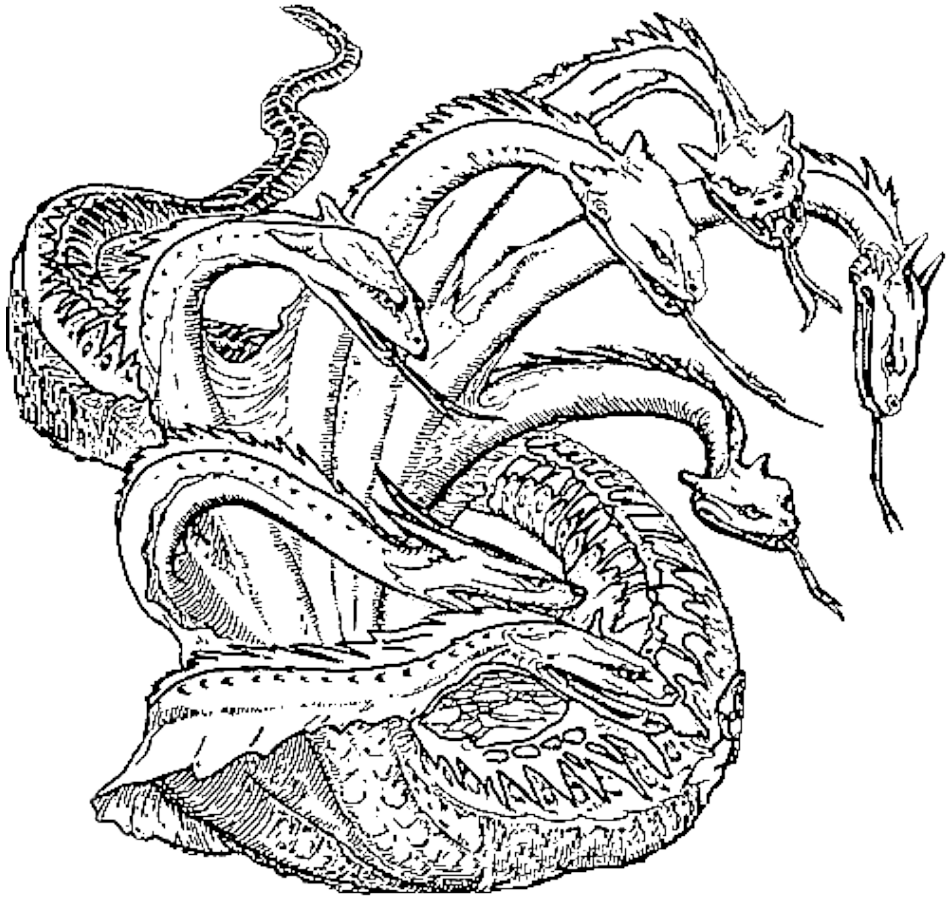


Multiprocessing with UEFI

Daryl McDaniel
Sr. Systems Engineer
Software and Solutions Group

15 June, 2010

Common Terms

BSP	BootStrap Processor
AP	Application Processor
Framework	Core firmware services supporting drivers and protocols.
GUID	128bit Globally Unique IDentifer
Protocol	A set of related services, named by a GUID and encapsulated within a structure. Similar to a DLL or C++ Class.
Boot Services	UEFI Services supporting drivers and OS boot operations.
Runtime Services	UEFI services available during OS runtime.

Multi-Processor Programming

- Platform Control
  - Enumerate Processors
  - Start / Stop / Reset Individual Processors
- Resource Exclusivity
  - Semaphores & Mutexes
  - Atomic Operations
    - > Increment / Decrement
    - > Test & Set / Compare & Exchange
- Inter-Processor Communications

Platform Control

- FrameworkMpService Protocol
  - GetGeneralMPInfo
  - GetProcessorContext
  - StartupAllAPs
  - StartupThisAP
  - SwitchBSP
  - SendIPI
  - EnableDisableAP
  - WhoAmI
- Startup functions are blocking.
- Timeout returns control to BSP, AP is unaffected.

- (PI) MpService Protocol
  - GetNumberOfProcessors
  - GetProcessorInfo
  - StartupAllAPs
  - StartupThisAP
  - SwitchBSP
  - EnableDisableAP
  - WhoAmI
- Startup functions may be either blocking or non-blocking.
- Timeout terminates the AP.

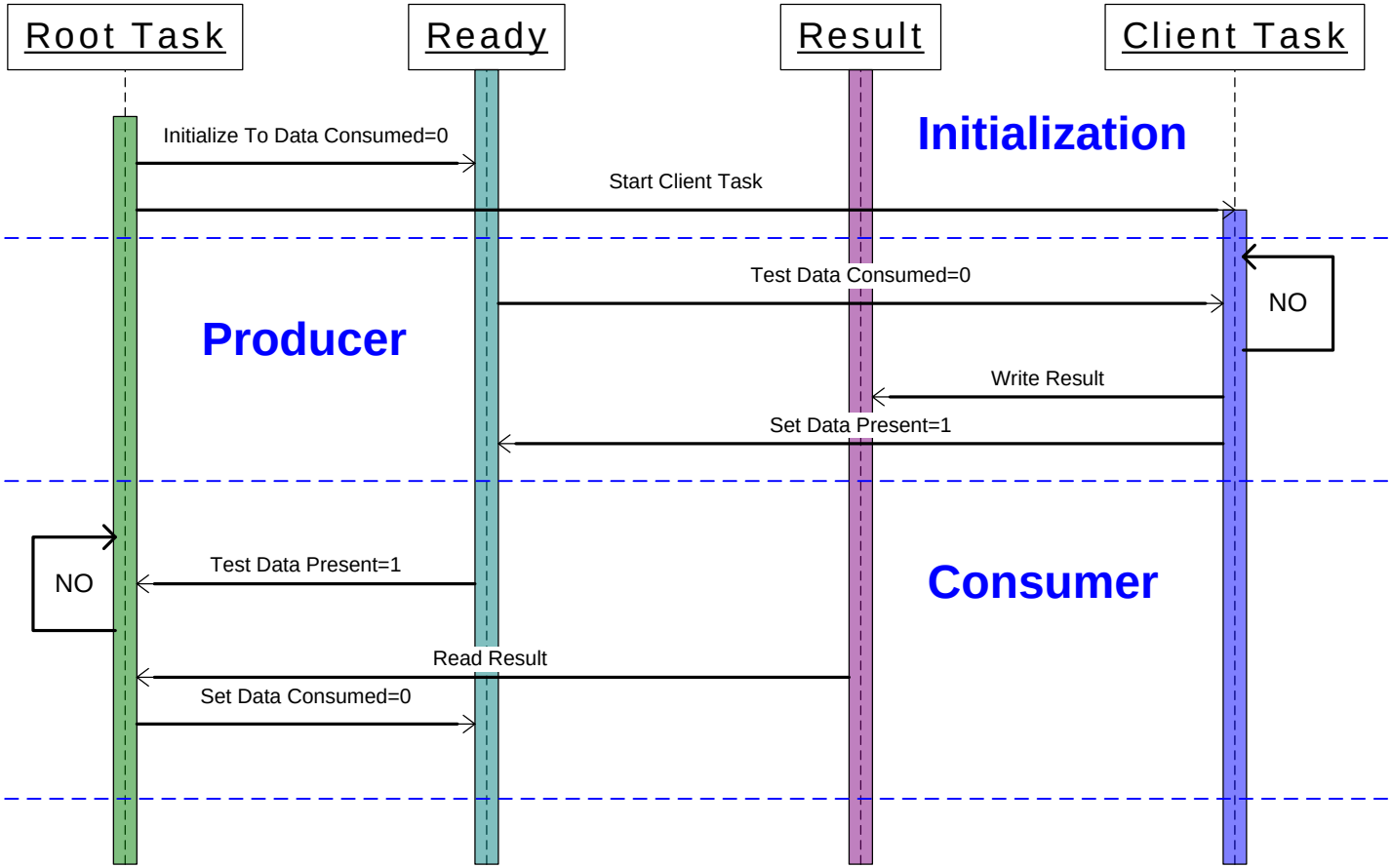
Resource Exclusivity

- Synchronization Library
  - GetSpinLockProperties(void)
  - InitializeSpinLock(&SpinLock)
  - AcquireSpinLock(&SpinLock)
  - AcquireSpinLockOrFail(&SpinLock)
  - ReleaseSpinLock(&SpinLock)

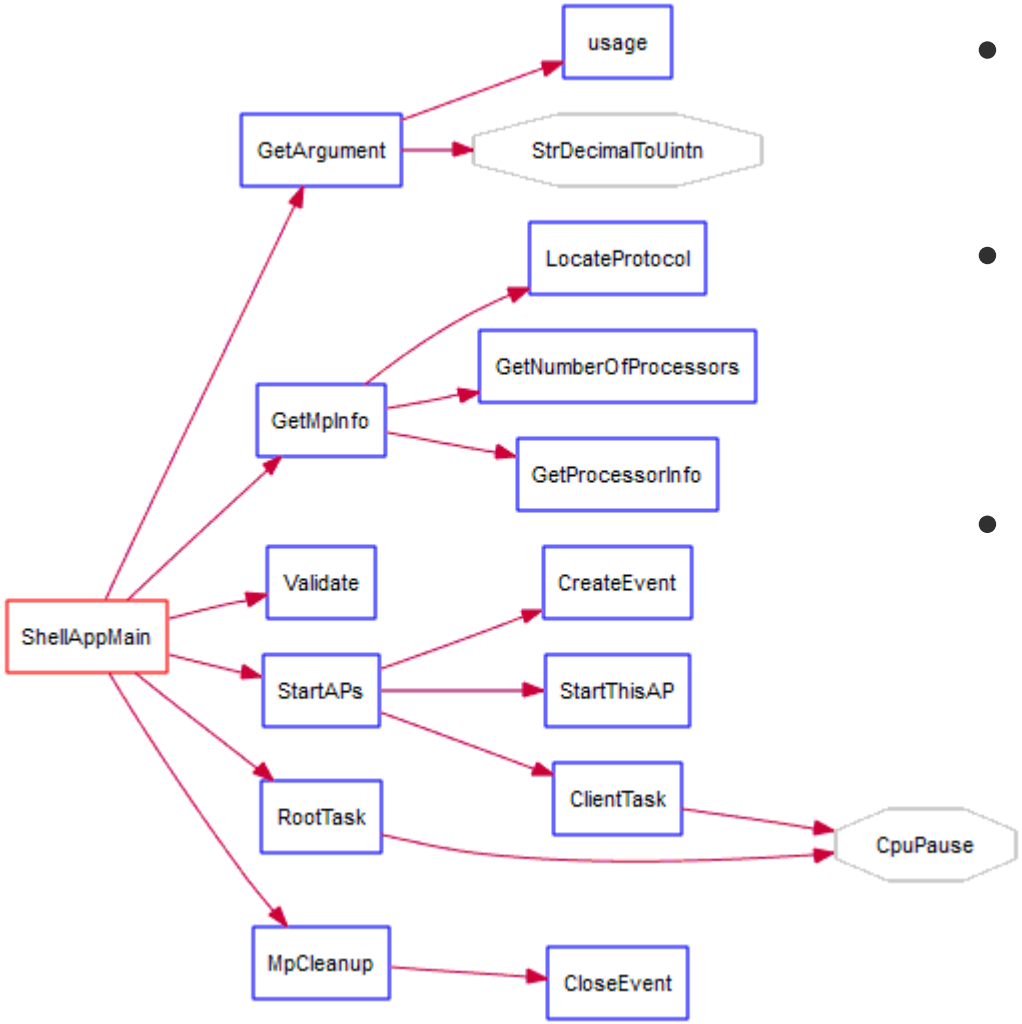
  - InterlockedIncrement(&Value)
  - InterlockedDecrement(&Value)

  - InterlockedCompareExchange32(&Value, Comp, Xchg)
  - InterlockedCompareExchange64(&Value, Comp, Xchg)
  - InterlockedCompareExchangePointer(&Value, &Comp, &Xchg)

Inter-Process Communication



StartCore Structure



- Library Functions
  - StrDecimalToUintn
  - CpuPause
- UEFI Functions
  - LocateProtocol
  - CreateEvent
  - CloseEvent
- MpService Functions
  - GetNumberOfProcessors
  - GetProcessorInfo
  - StartupThisAp

GetMpInfo

```
// Find the MP Services Protocol
Status = gBS->LocateProtocol( &gEfiMpServiceProtocolGuid, NULL, &MpProto);
if (EFI_ERROR(Status)) {
  Print(L"Unable to locate the MpService procotol: %r\n", Status);
  break;
}

// Get Number of Processors and Number of Enabled Processors
Status = MpProto->GetNumberOfProcessors( MpProto, &NumProc, &NumEnabled);
if (EFI_ERROR(Status)) {
  Print(L"Unable to get the number of processors: %r\n", Status);
  break;
}

// Get Processor Health and Location information
Status = MpProto->GetProcessorInfo( MpProto, ProcNum, &Tcb);
if (EFI_ERROR(Status)) {
  Print(L"Unable to get information for proc. %d: %r\n", ProcNum, Status);
}
```

StartAPs

```
// Create an Event, required to call StartupThisAP in non-blocking mode
Status = gBS->CreateEvent(  , TPL_NOTIFY, NULL, NULL, &Event);
if(Status == EFI_SUCCESS)
{
  Print(L“Successful Event creation.\n");

  // Start a Task on the specified Processor.
  Status = MpProto->StartupThisAP( MpProto, Procedure, ProcNum, Event,
                                   TIMEOUT, ProcedureArgument, NULL);
  if(Status == EFI_SUCCESS) {
    Print(L“Task successfully started.\n");
  }
  else  {
    Print(L"Failed to start Task on CPU %d: %r\n", ProcNum, Status);
  }
}
else {
  Print(L"Event creation failed: %r\n", Status);
}
```

Client Task

```
// Count from 1 to LoopCount
LoopCount = Tcb->MaxCount;   // How high to count.
do {
  ++Counter;                 // Do WORK
  while(Tcb->Ready != 0) {   // Wait until Result has been Consumed
    CpuPause();                // Hint to CPU that this is a spin loop
  }
  Tcb->Result = Counter;     // Report my results
  Tcb->Ready = 1;            // Signal that Result has been Produced.
} while(--LoopCount);      // Do WORK LoopCount times
// We have now done all of our work and could exit right now.

// For debugging and paranoia's sake, Send one last "special" value.
while(Tcb->Ready != 0) {   //  Wait until Result has been Consumed.
  CpuPause();                // Hint to CPU that this is a spin loop
}
Tcb->Result = 0xFEEDFACE;  // Indicate that ClientTask is exiting
Tcb->Ready = 1;            // This should be ignored
```

Root Task

```
// Retrieve and Display NUMLOOPS values from the Client Task
for(count = NUMLOOPS; count > 0; --count) {
  // Wait until the ClientTask signals data is ready
  while( Tcb->Ready == 0) {
    CpuPause();   // Hint to CPU that we are in a spin-loop
  }

  // Display what we received from the Client
  Print(L"%3d: %4d %4d %4d %4d\n",
        NUMLOOPS-count, Tcb->ProcNum, Tcb->MaxCount,
        Tcb->Result, Tcb->Ready);

  Tcb->Ready = 0;           // Tell the Client Task she can run
}
// Give the ClientTask a chance to signal she is done.
while( Tcb->Ready == 0) {
  CpuPause();   // Hint to CPU that we are in a spin-loop
}
// Print the final state of the Tcb.
Print(L"END: %4d %4d %4d %4d\n", Tcb->ProcNum, Tcb->MaxCount,
                                Tcb->Result, Tcb->Ready);
```

Summary

- Multi-Processor Programming
  - Platform Control
    - > Mp Service Protocol
  - Resource Exclusivity
    - > Synchronization Library
  - MP-Safe Libraries
    - > Synchronization Library
    - > Base Library
  - Interprocess Communication
- The StartCore Application
  - Flexible, Supports Framework and PI Firmware
  - Scalable, Two Cores or Twenty or ??????

Additional resources:

- More web based info:
  - Specifications and Implementation sites: www.tianocore.org, www.uefi.org, www.intel.com/technology/efi
  - UEFI Community Web Site: http://www.tianocore.org
  - StartCore sample application: www.tianocore.org.
  - OS Web links:
    - > Link to Microsoft UEFI Support and Requirements: http://www.microsoft.com/whdc/system/platform/firmware/uefireg.mspx
    - > Red hat link: https://fedoraproject.org/wiki/Features/EFI
  - Technical book from Intel Press: "Beyond BIOS: Implementing the Unified Extensible Firmware Interface with Intel's Framework" www.intel.com/intelpress
  - Whitepaper "Installing UEFI-based Microsoft Windows Vista SP1* (x64) on HP EliteBook and Compaq Notebook PCs" on www.hp.com

Q & A