PROJECT MONTEREY

The Volume Enterprise UNIX Platform

IBM - SCO - Intel

Intel IDF February 2000

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Agenda

- Monterey /64 Features and Functions
- Compilation Models
- Alpha and Beta
- Education Plan and Porting Centers
- Monterey /64 IHV Program
- Monterey /64 DDK
- Monterey /64 UDI
- Summary

Project Monterey Goals

- Establish the Monterey product line as the volume, enterprise class industry leader in UNIX OS segment
  - POWER and Intel architectures
  - Standards based offering
  - Largest UNIX application portfolio
  - Single offering for channel delivery
  - Distributed broadly to OEMs and resellers
  - Single offering from "workgroup-class servers" to "enterprise-class servers"

Monterey/64 Execution Roadmap

1998 Q4 | 1999 | 2000

Monterey/64

Build Mindshare

Development Tools

ISV Support

IHV Support

OEM Support: OEM Council Formed; Expand OEM Support; First Customer Ship

UDG-PI: Phase 1 UDG-PI Kickoff; Document UDG-PI subset; Publish Phase-1 UDG-PI; Launch Phase-2 UDG-PI; Publish Phase-2 UDG-PI

Monterey/64 OEMs

- Compaq
- Sequent
- Bull
- Unisys
- ACER
- ICL
- CETIA
- Netfinity
- Samsung

Sun OEMs

- NCR
- SNI
- Toshiba
- Fujitsu

HP OEMs

- NEC
- Stratus

Undecided Vendors

- Dell
- SGI
- Data General
- Hitachi

Monterey OS Delivers

- *A Robust, Scalable UNIX® Platform for Critical Applications*
- *The Connections You Need for e-business and Network Computing*
- *Security You Can Count On*
- *Systems and Network Management that Puts You In Control*
- *A User Experience that Speaks for Itself*
- *The Tools to Build Tailored Solutions*
- *Service and Support to Help Keep Your Business Running*

Monterey-64 and Standards

- An IA-64 ABI and API for LP64
- Elf/Dwarf2 object model
- Based on UNIX98 APIs
- Standard header files
- Standards Compliant Tools
- Standard definition for derived data types
- Common Install format
- Universal Device Driver Interface (UDI)

Monterey/64 is a Standards based Operating System

Pthread Debug Library

Monterey/64 supplies a new pthread debug library (libpthdebug.a):

- Provides a set of function (API) to use for pthread debugging.
- Allow 3rd party debugger tools to access this information.

New environment variables for libpthreads.a

- Determine how pthread library maintains lists for the debugger.

Environment Variables	Default	Information Record
AIXTHREAD_MUTEX_DEBUG	ON	Mutual exclusion lock (mutex)
AIXTHREAD_RWLOCK_DEBUG	ON	Read-write locks
AIXTHREAD_COND_DEBUG	ON	Conditional variables

- The default setting is ON. Set to OFF may improve the performance of applications.

Easy to Debug Multithreaded applications

Debug Malloc Implementation

Make application development easier and more efficient. Debug Malloc is a new facility that:

- Provides memory overlay detection capabilities

- Can be turned on by simply exporting the `MALLOCTYPE` and **`MALLOCDEBUG`** environment variables.
  - For example, `# MALLOCTYPE=debug`
    `# MALLOCDEBUG=align:n, .`
  - No other modifications on executable files necessary

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Memory leaks debugging assistance

Malloc Multiheap

By default, the malloc subsystem uses only single heap

- Memory allocation requests are done serially.
- Impact on multiprocessor system performance.

Malloc Multiheap can be enabled.

- `MALLOCMULTIHEAP=[heaps:n]|[considersize]`

- Example:
  - `MALLOCMULTIHEAP=true;`
  - `MALLOCMULTIHEAP=heaps:3,considersize`

Better performance for malloc

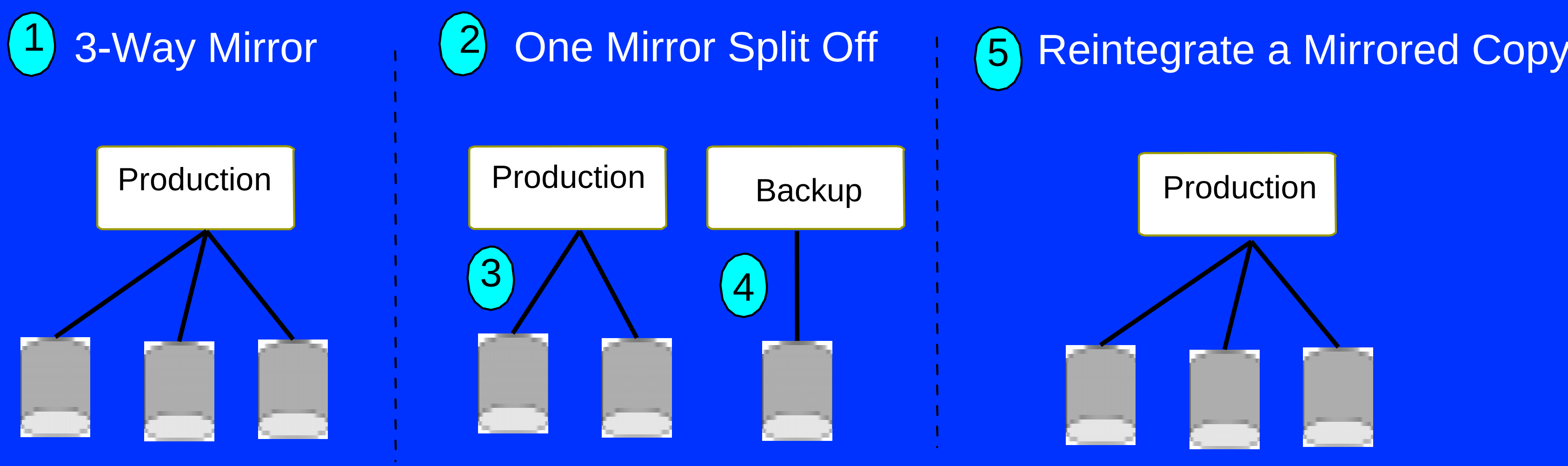
Multiple Run Queues

Improve SMP Scalability of the dispatcher

- Implement multiple run queues with load balancing on SMP Systems
  - Single global run queue with a set local run queues (1:1 Queue/CPU)
- Better processor affinity and cache affinity

Better SMP performance

Online JFS Backup (Split Mirroring)



Making an online backup of a mounted JFS file system.

Creates a snapshot of the logical volume that contains the file system.

- Logical volume and its JFS log logical volume must be mirrored.
- File system activity should be minimal (quiescing) while the split is taking place.

Mirroring and Striping

Support RAID 0+1 entirely in software

- Combines RAID 1 (mirror) data availability with RAID 0 (striped) performance
- No special hardware needed
- Example

number of copies

```
# mklv -y 'raid10' -c '2' '-S4K' rootvg 5 hdisk0 hdisk1 hdisk2 hdisk3
```

stripe size

Utilize a new partition allocation policy called super strict

- New `-s` option flag in `mklv` command
- Does not allow partitions from one mirror to share a disk with partitions from a second or third mirror

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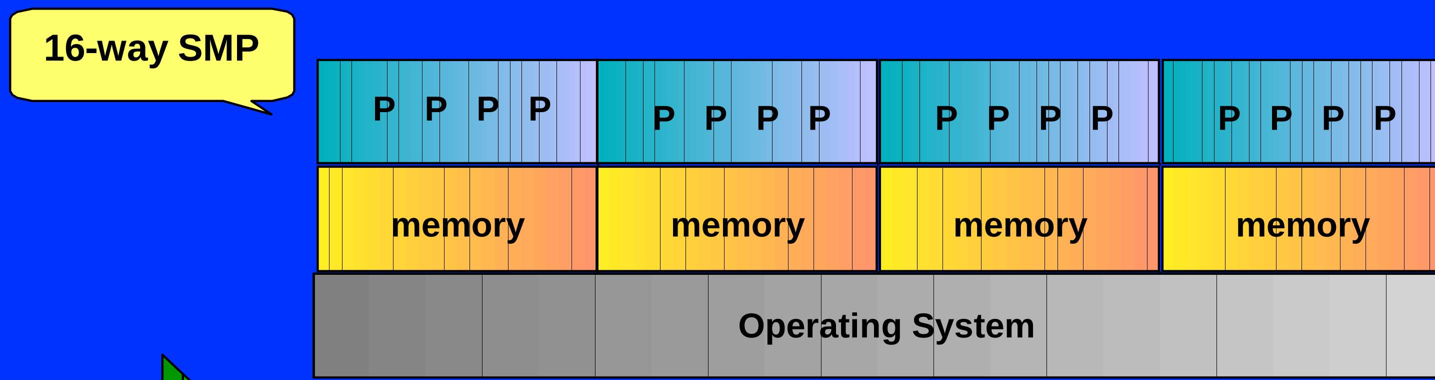
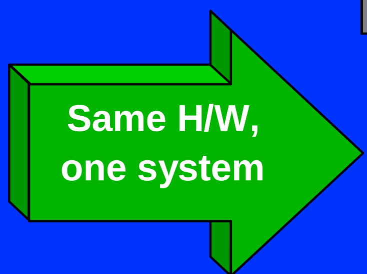
Striping for Speed, Mirroring for Reliability

Workload Manager

Virtual Partitioning

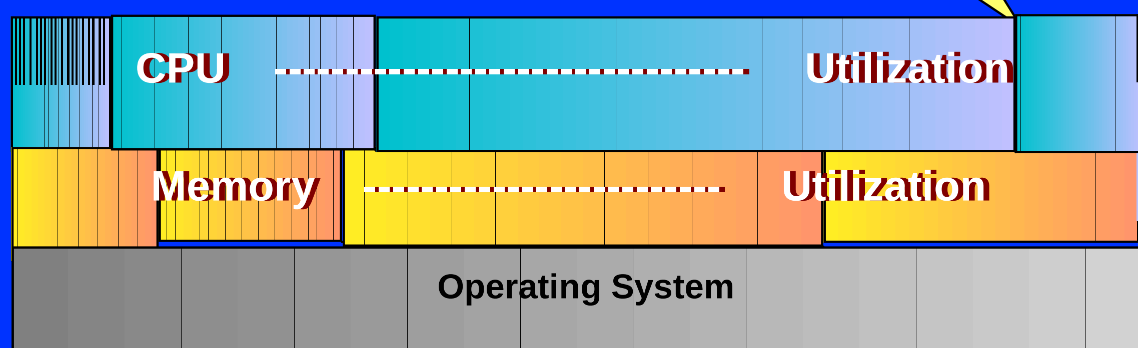




Workload Management Steps

1. System Administrator setup
2. Monterey/64 automatically gives resources according to entitlements

Resource Allocation Boundary

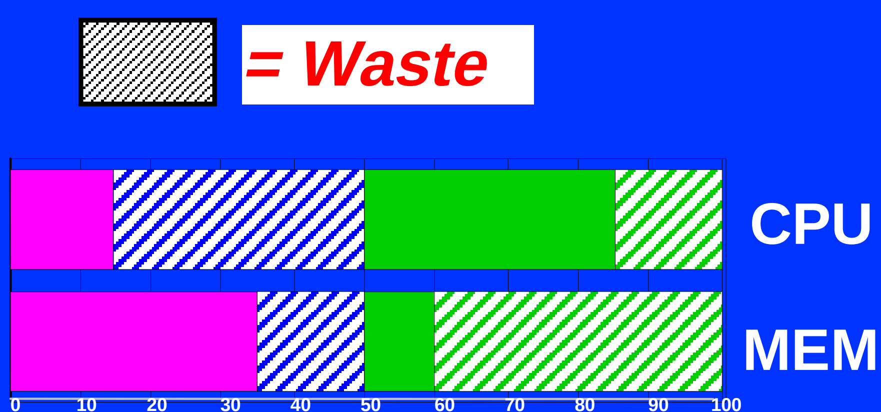


Balancing the workload

Partitioning vs. WLM...

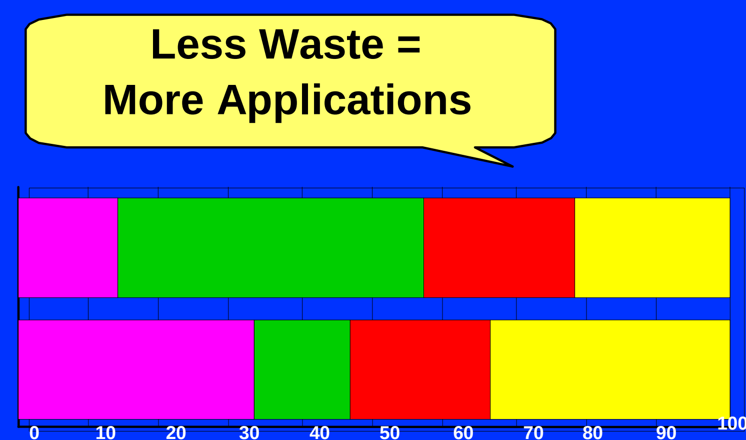
O/S Partitioning

- O/S Fault isolation
- Resources can be wasted when requirements do not neatly match fixed partition boundaries



Workload Management

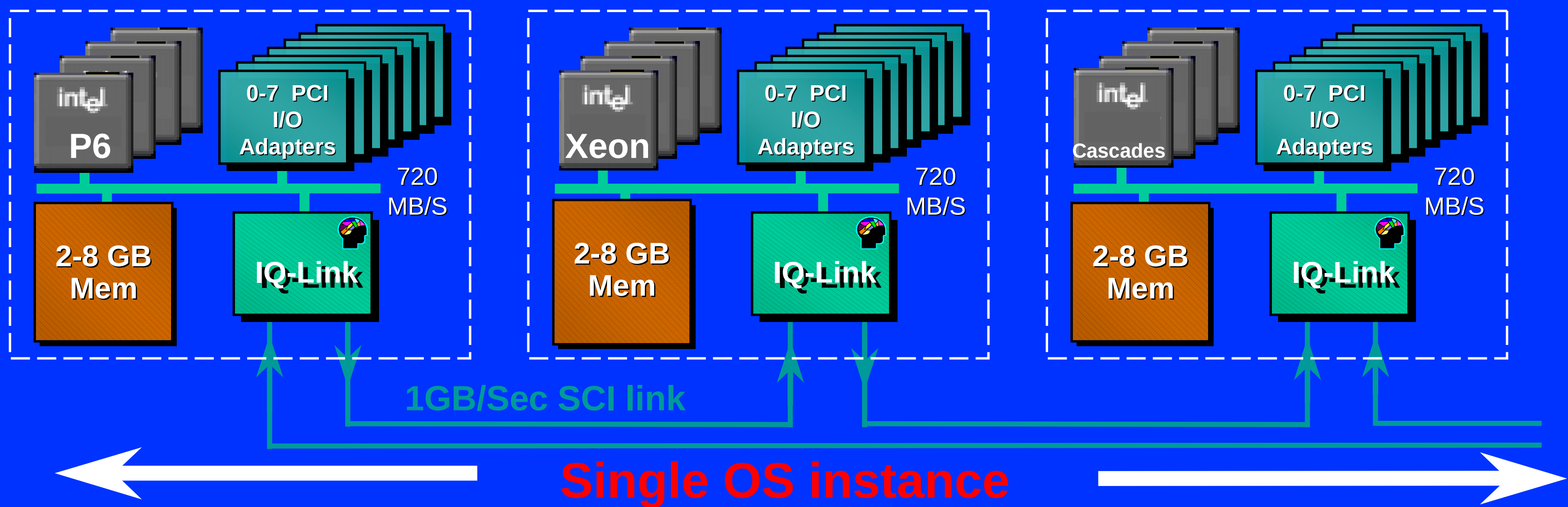
- CPU Time vs. CPUs
- Independent CPU time and memory management provide flexibility
- Single O/S Administration



What is NUMA?

- “Non-Uniform Memory Access”
  - A method to respond to the SMP big-bus scaling road block
  - Two or more processor / memory nodes ("quads") coupled to form single MP (multi-processor) server
  - Runs a single NUMA-aware OS instance
  - NUMA fabric coupling supports low latency, cache coherent traffic

IA-32 NUMA-Q Implementation



- System provides one physical address space and one I/O address space
- Scales massively and retains SMP programming model
- Design Tuned for Performance
  - Maximizes use of lowest latency memory…key advantage
  - L3 Cache and scheduling affinity mitigate remote memory access
- Customer investment protection continues as <u>new processors</u> come

NUMA Content in Monterey / 64

- Based on IA-32 implementation -- ready for IA-64 !
- NUMA APIs provide the following types of services:
  - Services used to make queries on the system topology
  - Services to manipulate assignment and allocation of system resources
- APIs are advisory in nature -- use on non-NUMA hardware will cause no problems
- Differentiates Monterey from other IA-64 operating systems
  - Monterey can assist applications to take advantage of NUMA-based platforms for high scalability and data-center capacities

Monterey/64 Support

- Three compilation models:
  - IA-32
  - ILP32
  - LP64

No “Mixing” of Models Permitted

Choose the Appropriate Compilation Model

IA-32 Environment

- Targeted Binary Compatibility for existing UnixWare7 applications
- Allows Single Binary to be used on all IA Platforms
- As in UnixWare 7 today

ILP32 Environment

- 32-bit Source compiled for IA-64
  - Same Data Layout As IA-32
- Similar Performance to LP64
  - Data Conversion In/Out Of Kernel
  - Some Misaligned Data Objects
  - Smaller Data Size (better cache use)
  - Address Space and therefore Memory limited to 4GB
- Fully Supported
- Source Compatibility with Little-Endian
- Appropriate for Recompile-and-Go Software

Monterey/64 Environments

- LP64 (IA-64 64-bit) Environment
  - New and High-End Software
  - UNIX Industry-wide 64-bit Model
  - New Instruction Set, Longs, Pointers are 64 Bits

Alpha Program Update

- **Alpha “package” includes SDE and OS and will be available Feb. 29th**
  - OS and SDE must stay in sync
  - Beta updates will refresh the “whole” package
- **UnixWare Based SDE**
  - Sample code will be provided for compile/debug example
  - Cross-compiler and debugger will be in SDE package
- **Itanium ™ Processor based systems planned for Alpha and Beta**
  - Systems will be shipped by Intel; OS and SDE by IBM
  - Shared systems will be available at Solution Partnership Centers (SPCs)

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Alpha is just around the corner

Beta Program Schedule

Beta planned for spring 2000

- Beta in May for key dependencies
- Expanded beta over June, July, and August
- Beta will have all key Monterey/64 OS capabilities
- Solution centers can provide Migration help
- ISV Migration Training will be available in April and beyond

SDE Contents

- Packaged for UnixWare 7
- IBM VisualAge V5.0 Cross Compiler
- Monterey/64 header files and libraries
- Startup scripts to override include and library paths
- Basic ReadMe documentation

Porting Centers

- 1st qtr: Setting up SPCs and training materials
- 2nd qtr: ISVs can get porting/training assistance
- 3rd qtr: Broader coverage w/partner centers added

Practical hands-on experiences

- UnixWare SDE systems and Monterey/64 systems
  - Itanium ™ processor based systems to be available for scheduled test use
- Over the year, centers will acquire "focus areas" for
  - Performance tuning
  - Scalability and high-end tuning
  - Applications and systems available
  - Porting and migration assistance

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Porting Centers Available to you

Education Plans

- Education Modules:
  - Overview of IA-64 Architecture
  - Software Conventions
  - Assembly coding with Samples
  - Cross-Compiler flags, Usage with Samples
  - Shared Library Creation for Monterey vs AIX
  - Linking, Dynamic Linking/Loading
  - Debugger Commands and How-to-Use

Education to help you port to Monterey/64

Education Plans (cont)

- Additional Modules:
  - Unixware 7 course
  - Endian issues, samples, hands-on workshop
  - Migrating to 64 bit
  - Monterey feature differences vs AIX
- Education will be customizable:
  - Offered at Partnership Centers starting in April
  - Available online
  - Mix and match desired modules

ISV Communications

- **Monterey Developers Website**
  - www.projectmonterey.com
  - 700+ Developers signed up
  - Links to Partners, Porting Resources
  - Online Solution Developers Toolbox being established
  - Migrating C and C++ Applications' Guide
- **SPC and Education sites**
  - http:www.developer.ibm.com/spc
  - http://www.developer.ibm.com/welcome/educ.html

Compilers and other Tools

IBM Compiler:

- VisualAge C/C++ Version 5.0 (ANSI 98)
- Same compiler as AIX
- Already used to compile Monterey/64 OS
- Includes IBM Distributed Debugger
- Cross-compiler is available for early development
- Native version available in beta timeframe

ANSI C/C++ Optimizing compiler

Alternative Compilers

- **Cygnus GNUpro Tools:**
  - **gcc C Compiler**
  - **g++ C++ Compiler**
  - **gdb Debugger**
  - **gas Assembler**
  - **Same tools will be available on AIX**
- **Availability Schedule for compilers/Debugger:**
  - **Cygnus will support 5 beta customers**
  - **Beta 1->> 5/2000; Beta 2->>7/2000**
  - **GA->>10/2000**

Alternative Compilers

- Edinburgh Portable Compiler (EPC):
  - C Compiler
  - C++ Compiler ANSI 92
  - Fortran 95 Compiler with F77,VAX, Sun extensions
  - Debugger that supports all 3 languages
  - Same compilers will be available on AIX
- Availability Schedule for compilers/Debugger:
  - C/C++ Beta->> cross compiler 5/2000; Native 7/00
  - F95 Beta->> 5/2000
  - GA->> 10/2000 for all 3 compilers

Other Tools

- Perl
  - Beta->> with OS
  - GA->> with OS
- Apache Web Server
  - Beta->>
  - GA->>
- Java Support:
  - JVM V1.3
  - JIT

Contacting Us

Visit the Monterey developer web site @

www.projectmonterey.com

Visit the Monterey partner web sites @

www.ibm.com/servers/monterey

www.sco.com/monterey

www.sequent.com/monterey

PROJECT MONTEREY

The Volume Enterprise UNIX Platform

IBM - SCO - Intel

Monterey IHV Program

IHV Program Overview

- Monterey is a family of UNIX OS environments
- Consistent device driver model going forward
  - UDI
  - Support for Legacy driver models will continue

Project Monterey and UDI

INTERPHASE CORPORATION

HEWLETT PACKARD

SCO

COMPAQ

IBM

project UDI

SBS Technologies, Inc.

intel

Sun microsystems

We're the dot in .com

adaptec

LOCKHEED MARTIN

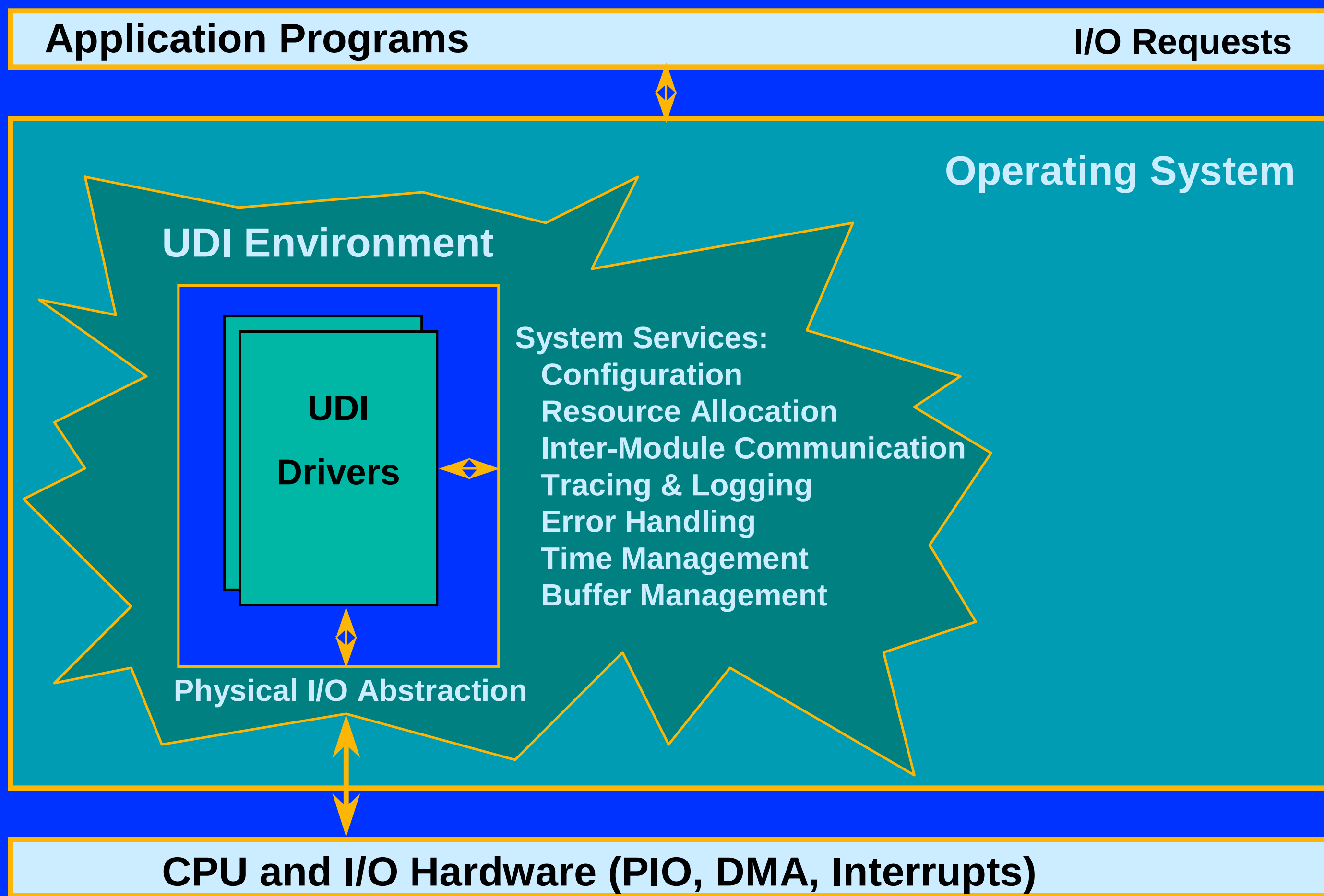
What is Project UDI?

- Open industry group since 1993
  - Platform and OS vendors
  - IHVs
  - Solutions providers
- Enables 100% driver source portability
  - Defines architecture, APIs and packaging format
  - Supports source and binary distributions
- Provides uniformity across device types
  - Defines common execution model, inter-module communication and system services
  - Communication tailored to each device model
- Co-exists with legacy driver support

Why develop UDI?

- IHVs have huge matrix of drivers to develop/port
  - # Devices × OSes × OS versions × platforms
- Finite development & support resources
  - Must choose porting order (target prioritization)
  - Some OSes and/or platforms not supported
- Driver porting not core business
- UDI requires one driver source for all compliant OSes
  - UDI abstracts H/W and S/W environment
  - All driver interfaces completely specified
- More bang for the buck for IHVs
  - UDI moves up IHV porting order
  - UDI-compliant OSes get better coverage

UDI Encapsulates Drivers



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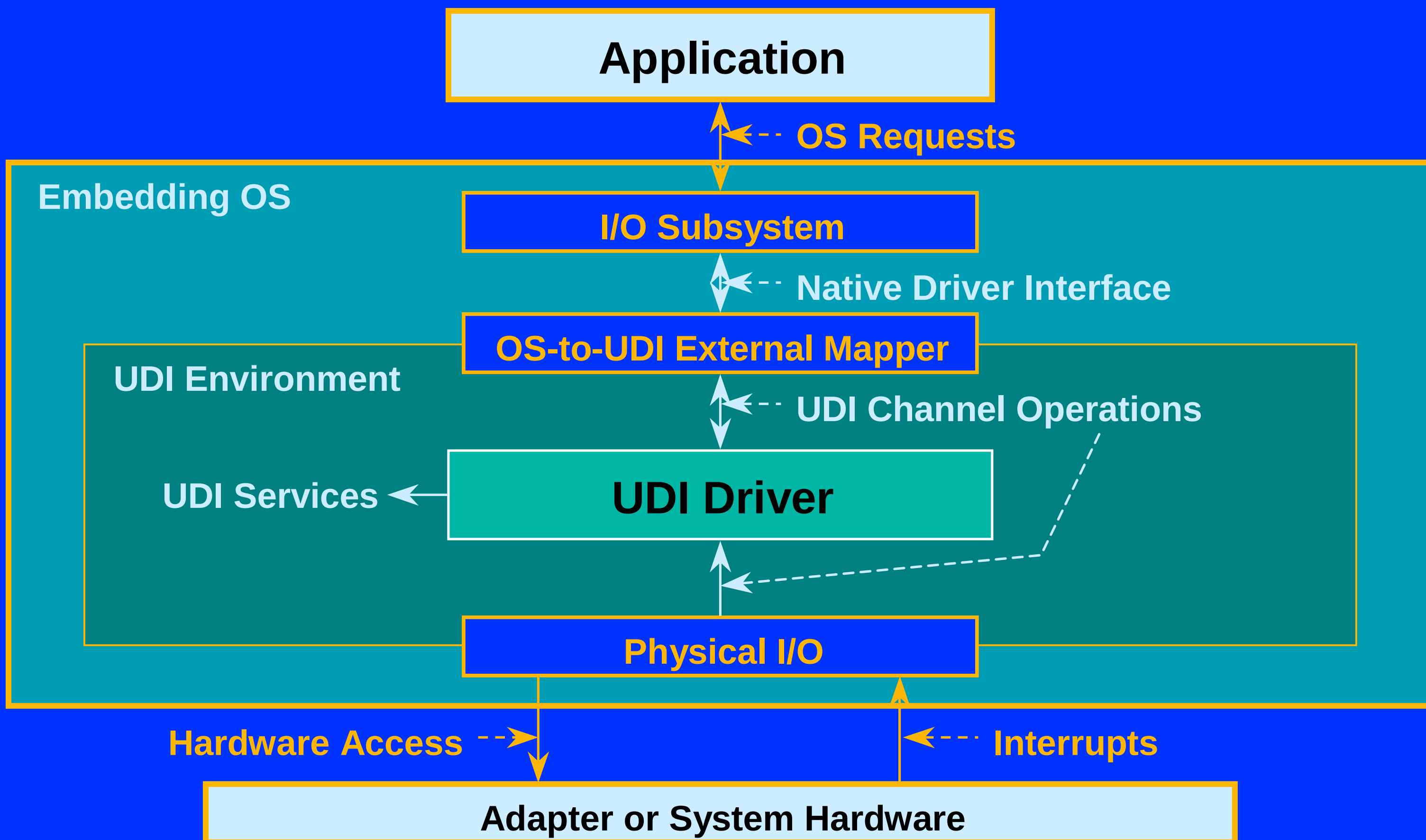
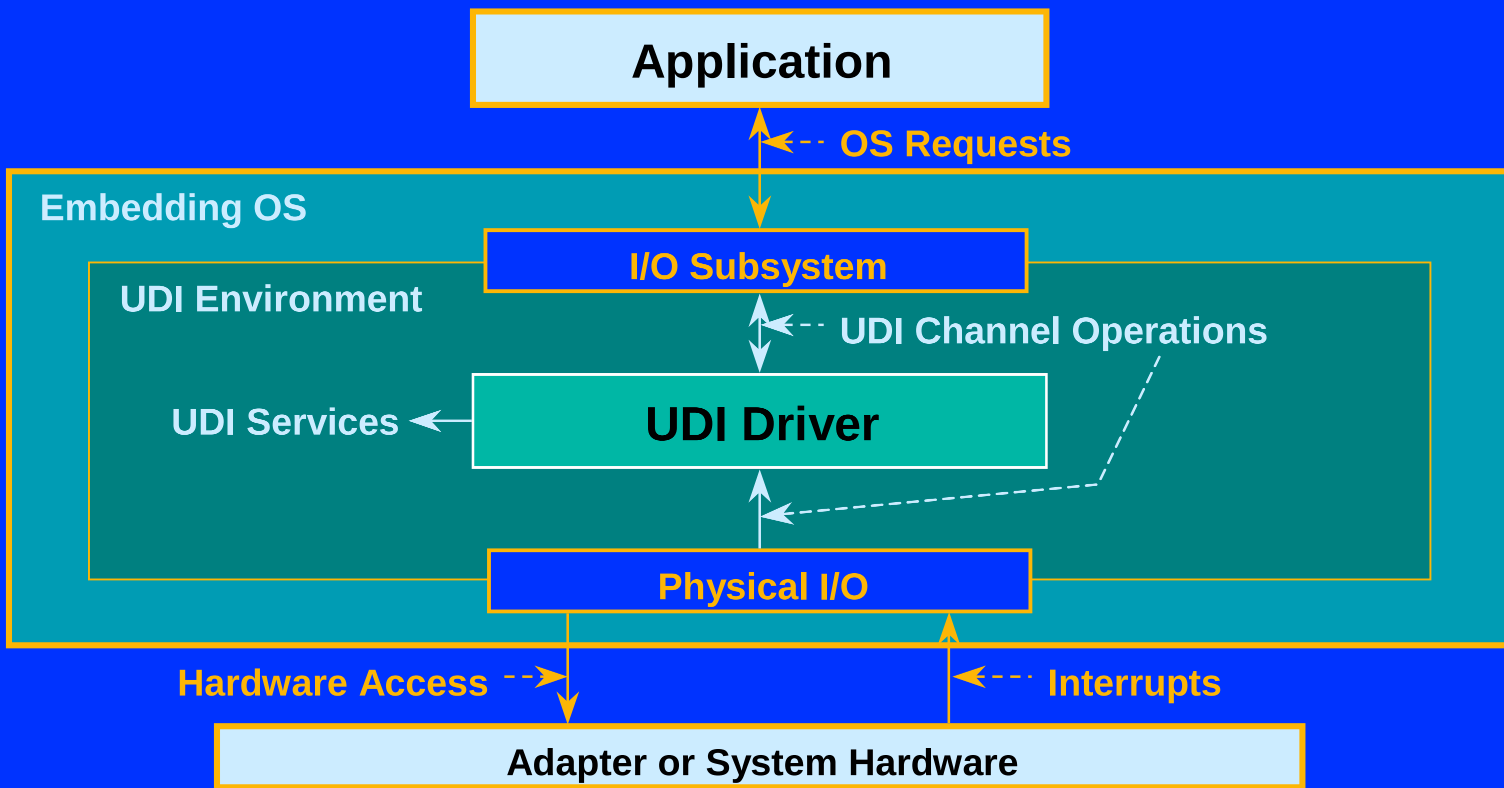
Path From Application to Driver
Layered Implementation



Path From Application to Driver

Integrated Implementation



Uniformity Across Devices

- Basic model common for all drivers
  - Execution and Data Models
    - Common buffer model
  - Configuration Model
  - Inter-Module Communication
    - Between drivers and/or environment modules
  - System Services and Utility Functions

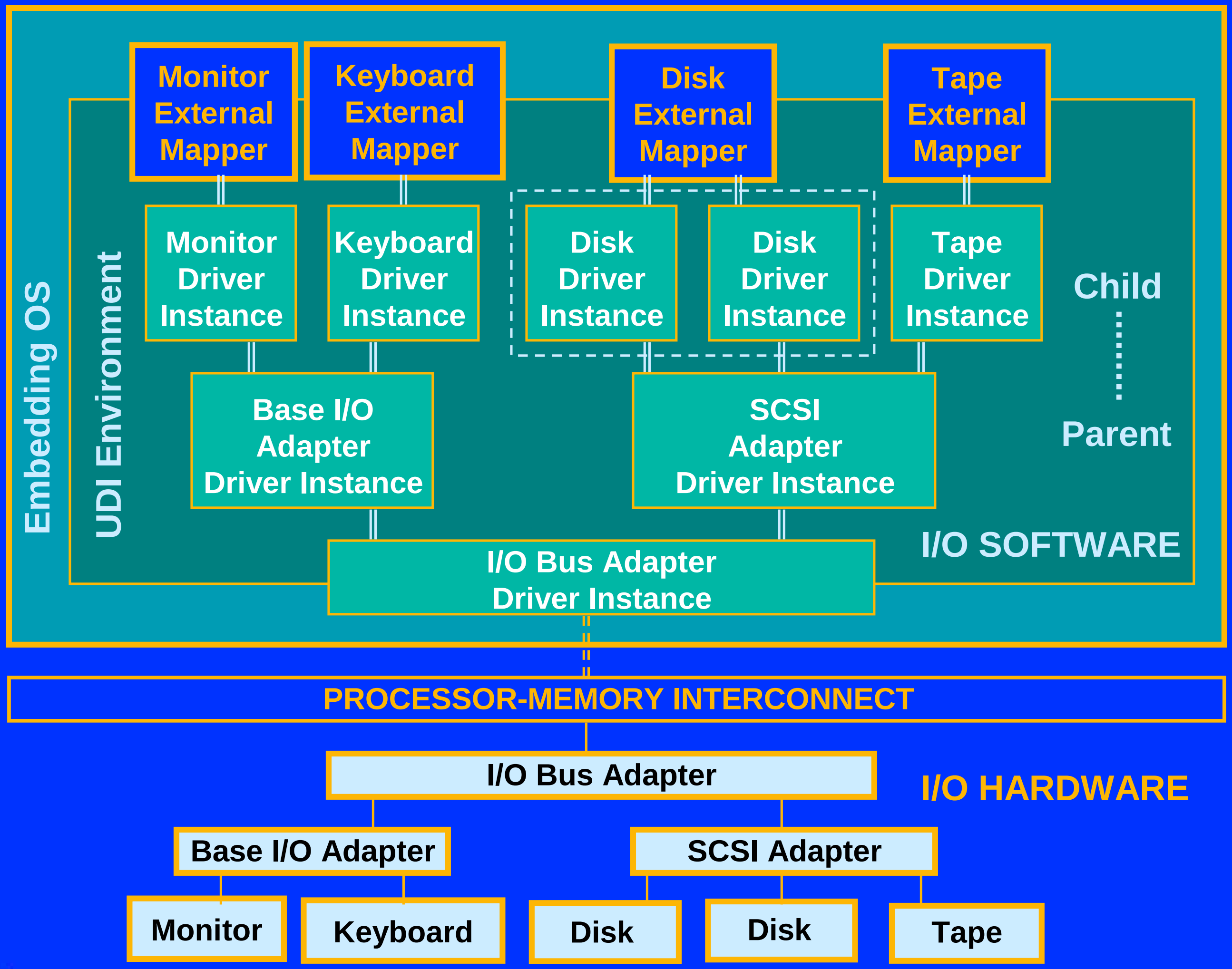
UDI Metalanguages

- Device-type specific communication
- Defines communication paradigm between cooperating modules
  - Operations and sequences to implement technology-specific functionality
- Analogous to SCSI CAM, DLPI, etc.

UDI Execution Model

- No global entry points
- Driver's udi_init_info structure contains entry-point pointers, size requirements...
- All driver code executed in the context of a *region*
  - Regions are associated with driver instances
    - One for each adapter/device controlled

Example Driver Hierarchy



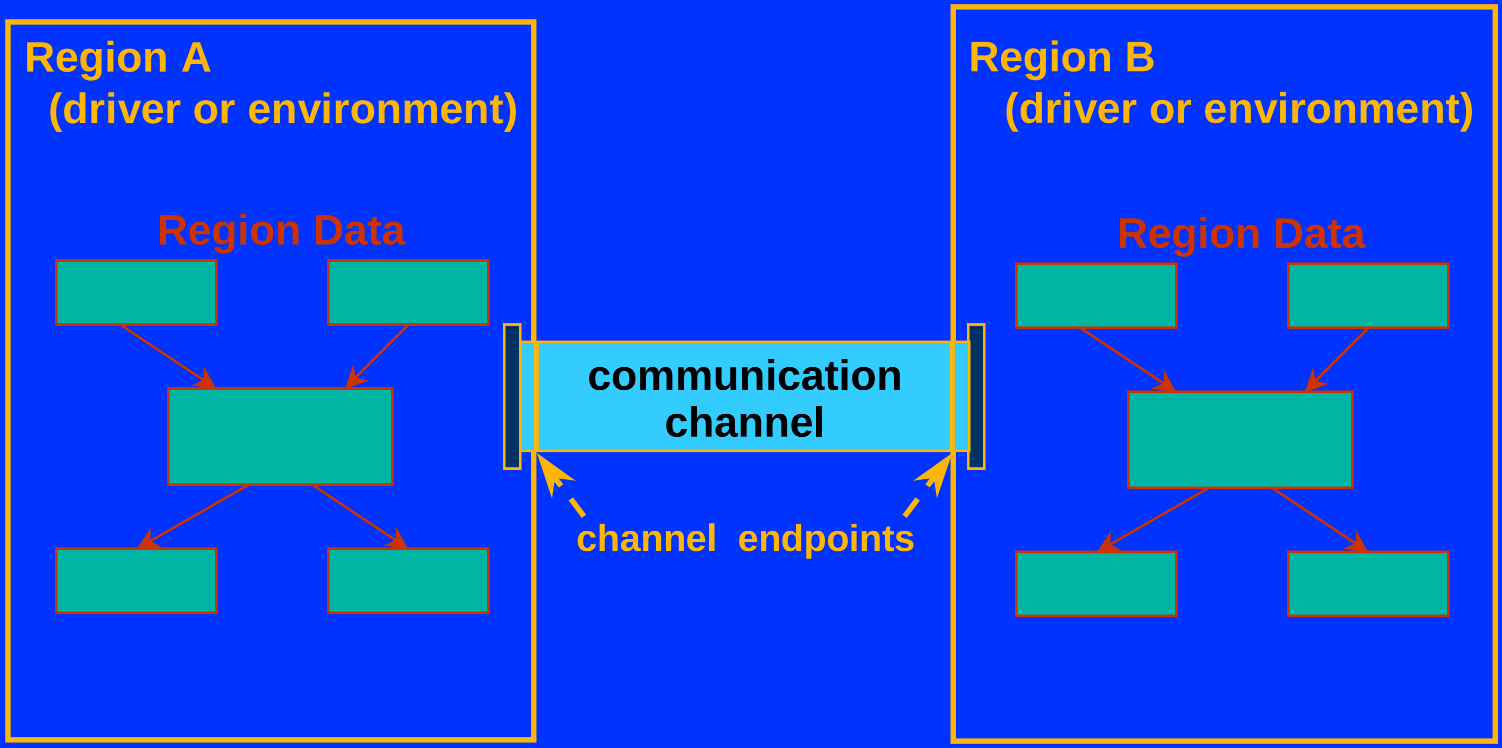
UDI Regions

- Basic unit for execution and scheduling
  - Each call into the driver region is serialized
- No direct data sharing between regions
  - Data and events are passed through *channels*
- Provide implicit multi-processor synchronization

UDI Regions (continued)

- One driver instance per device instance
- One or more regions per driver instance
  - Multi-region drivers may have higher parallelism
- Enables *instance-independence*
  - Driver state separate for each device instance
- Enables *location-independence*
  - Each region may operate in a different domain
    - e.g. address space, NUMA or network node

Regions and Channels

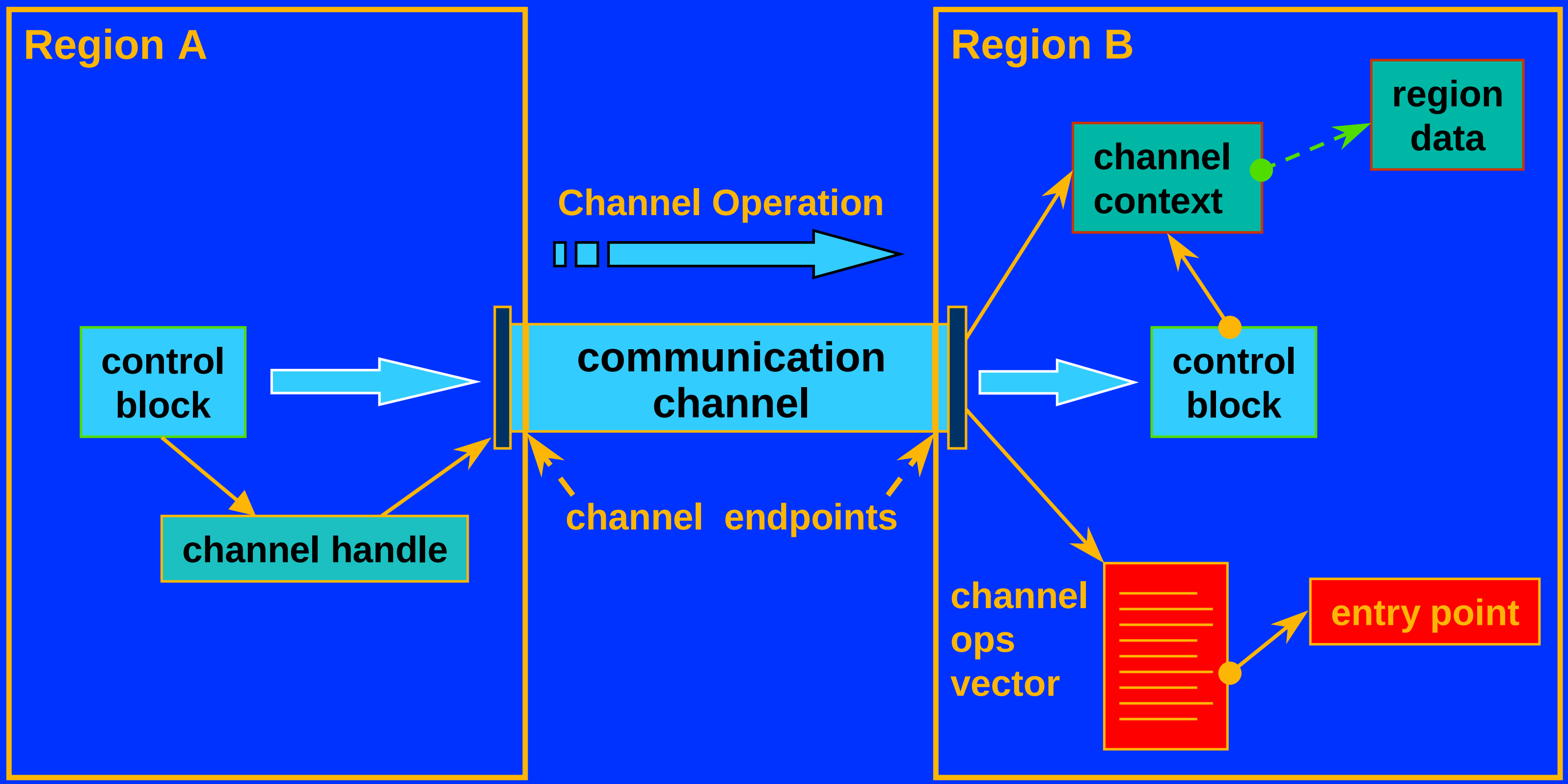


UDI Channels

Basis for Inter-Module Communication (IMC)

- **Bi-directional channels connect regions**
- **Communication via *channel operations***
  - **Strongly typed function-call interface**
  - **Asynchronous one-way operations**
    - **Each request has a corresponding response**
    - **Context managed via *control blocks***

UDI Channel Communications



UDI Metalanguages

- Metalanguages define:
  - Number and types of channels
  - Valid Channel operations
    - Control block plus metalanguage-specific parameters
  - Control block types for each operation
    - Structures include metalanguage-specific fields
    - Generic control block header common to all

UDI System Services

- System interface & resource management
  - Implemented for all UDI environments
  - Abstract OS services
- Calls from driver to environment services are called *service calls*

UDI Service Calls
Two Styles

- **Synchronous service calls**
  - **Complete without blocking**
  - **Results returned "immediately"**
- **Asynchronous service calls**
  - **Return without blocking**
  - **Delayed completion**
  - **Results returned via callback function**

Non-Blocking Execution Model

- All service calls and channel operations return without blocking
- Drivers usually return after making one service call or channel operation call
- Gives environment complete control over thread usage and driver scheduling

UDI Data Model

- Context managed via *control blocks*
  - Used with channel ops & async service calls
  - Environment uses CB to hold service call state
  - Driver uses context pointer in CB to find its data
- No memory shared between regions
  - Memory allocated in region private to that region
  - Regions share data with channel operations

UDI Control Blocks

- **CB contains *scratch* and *context* pointers (preserved across service calls, not ops)**
  - **Scratch space in CB holds per-request state**
  - **Context pointer lets driver find the context of a channel op or callback**
    - Initially set to channel context
    - Channel context struct points to global data
- **All CBs begin with generic udi_cb_t**

Implicit Synchronization

- No locking primitives required in UDI
  - All data access is implicitly synchronized
    - Region data accessible only from within that region
    - No global data
    - Only one thread per region active at a time
    - Other calls deferred until active call returns
  - Driver controls its parallelism by picking number and type of regions

Region Kill

- Different environments have different levels of trust in drivers
- UDI environments can:
  - detect misbehaved drivers (e.g. bad pointers)
  - track resource ownership and transfers
  - abruptly terminate (“region-kill”) driver instances
    - Frees all resources and shuts down device

Fundamental Data Types

- Specific-length types
  - udi_ubit8_t, udi_sbit8_t, udi_ubit16_t, udi_sbit16_t, udi_ubit32_t, udi_sbit32_t
  - udi_boolean_t (udi_ubit8_t)
- Abstract types
  - udi_size_t, udi_index_t

Fundamental Data Types
(continued)

- Opaque types
  - Contain environment-private fields and structure
  - Must be allocated using UDI service calls
  - Opaque handles
    - udi_channel_t, udi_constraints_t
  - Semi-opaque types
    - udi_cb_t *, udi_buf_t *

Core Services

- Inter-Module Communication (IMC)
- Memory Management
- Buffer Management
- Time Management
- Tracing and Logging

Core Utility Functions

- String/Memory Utilities
  - udi_strcpy, udi_strlen, udi_memcmp et al
  - udi_snprintf, udi_strtou32
- Queue Management Utilities
- Endianness Management Utilities

Core Metalanguages

- Management Metalanguage
  - Environment-initiated control operations
- Generic I/O Metalanguage
  - Generic read/write plus custom ops
  - Useful for prototyping and “one-off” extensions
  - Used to access driver diagnostics

Additional Metalanguages

- Physical I/O
  - DMA
  - Interrupts
  - Programmed I/O
  - PCI Bus bindings
- Network Interface (NIC drivers)
- SCSI

Developing Drivers Today

- Native drivers developed on AIX PPC or prototype system
  - UnixWare 7 cross compiler
- UDI driver development kit on UnixWare 7
  - Develop test and and run on Unixware 7
  - Cross compile for Monterey/64
  - www.sco.com/udi/sco/udidk.html

Monterey/64 Native DDK

- Alpha (Native model)
  - Installs on UW7.1
  - Requires Monterey/64 SDK to build drivers
  - Toronto compiler also runs on UW7.1
  - Test results on prototype system

Monterey/64 Native DDK - Cont'd

- Beta
  - Installs on Monterey/64
  - Supports UDI and non-UDI models
  - Requires Monterey/64 SDK to build drivers
  - Toronto compiler also runs on Monterey/64
  - Test results on prototype system

Monterey/64 Native DDK - Contents

- Documentation
  - DDK specific (Installation, reqs., etc.)
  - Reference and guide material
  - Support information
  - Device driver API
  - Device man pages

Monterey/64 Native DDK - Contents cont'd

- Sample source code
  - Explanation of the key code blocks
  - Build scripts
- Debugging tips and techniques (tracing, logging, etc.)
- Use of tools (debugger, log analysis, etc.)

Monterey/64 Native DDK - Contents cont'd

- Packaging and installing driver instructions
- Test suites (beta)
  - hbacert and ndcert ported to Monterey
  - UDIG compliant test suites for UDI, SCSI & NIC

Monterey/64 Native DDK - Delivery

- Alpha - web based delivery
  - web based doc search
  - HTML format
- Beta - CD and web based delivery
  - HTML format (maybe printable format also)
- All updates through the web

Monterey Native DDK Schedule

- DDK Schedule
  - Alpha
    - Hybrid environment
  - Beta
    - Native Monterey/64 environment
- FCS 9/00

Summary

- Monterey/64 supports existing and standard driver models
  - Legacy and UDI based
- Tools exist <u>today</u> to start driver development
  - UDI
    - UnixWare 7 environment
  - AIX / Native for legacy drivers
    - UnixWare 7 UDI environment and dev kit
- For more information contact
  - www.projectmonterey.com/ihv
  - www.project-udi.org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