UDI Architecture In-Depth

http://www.sco.com/forum1999/conference/developfast/f8

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Agenda

- **UDI Portability and Extensibility**
- UDI Execution Model
- UDI Data Model
- Intro to UDI Specifications
- Q & A

Driver Portability with UDI

- **100% driver source portability**
  - Binary portability for IA32 and IA64 and ...
- **Complete driver encapsulation**
  - All APIs defined
- **OS-neutral and platform-neutral**
  - OS policy removed from driver
  - Transparent endianness conversions

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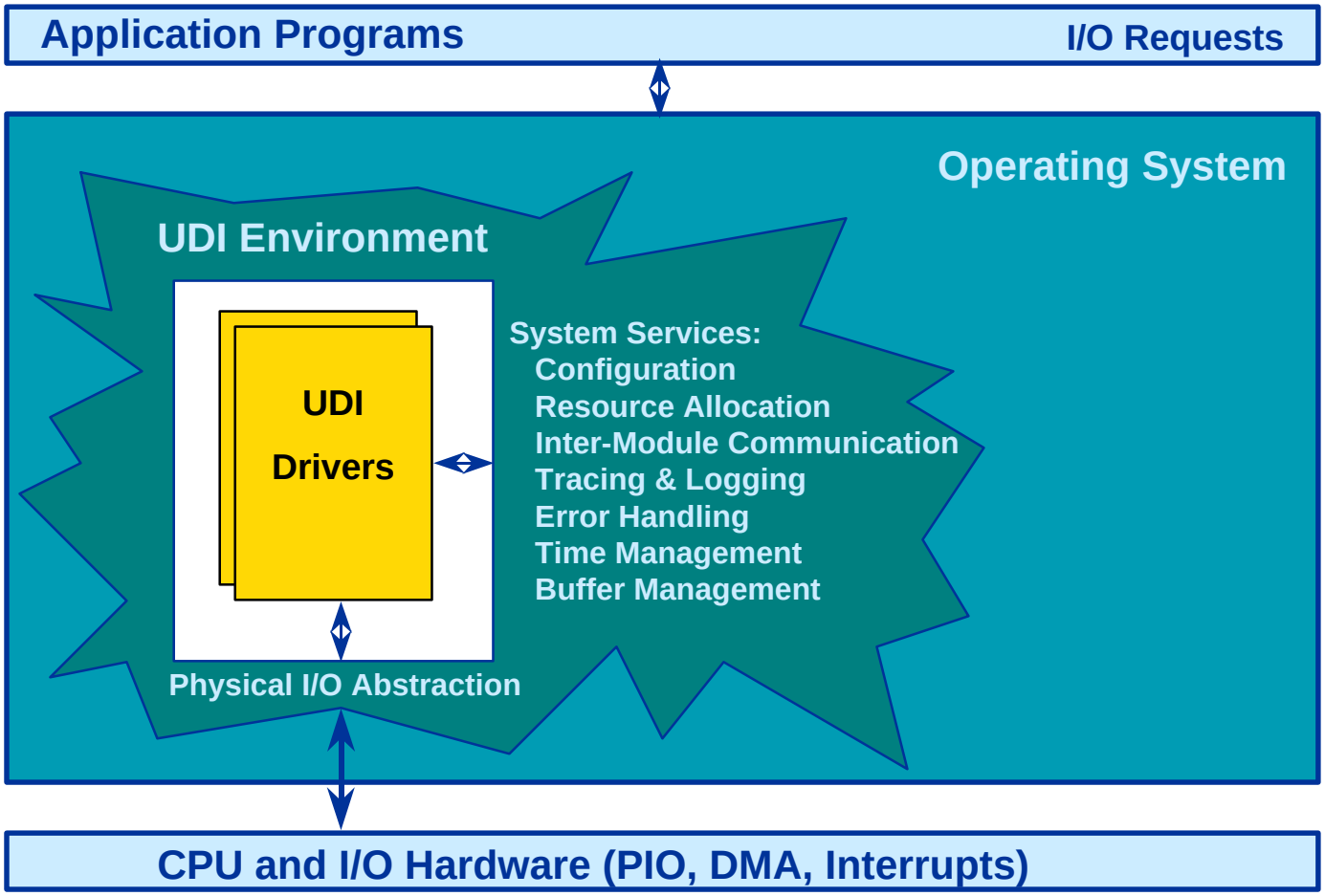
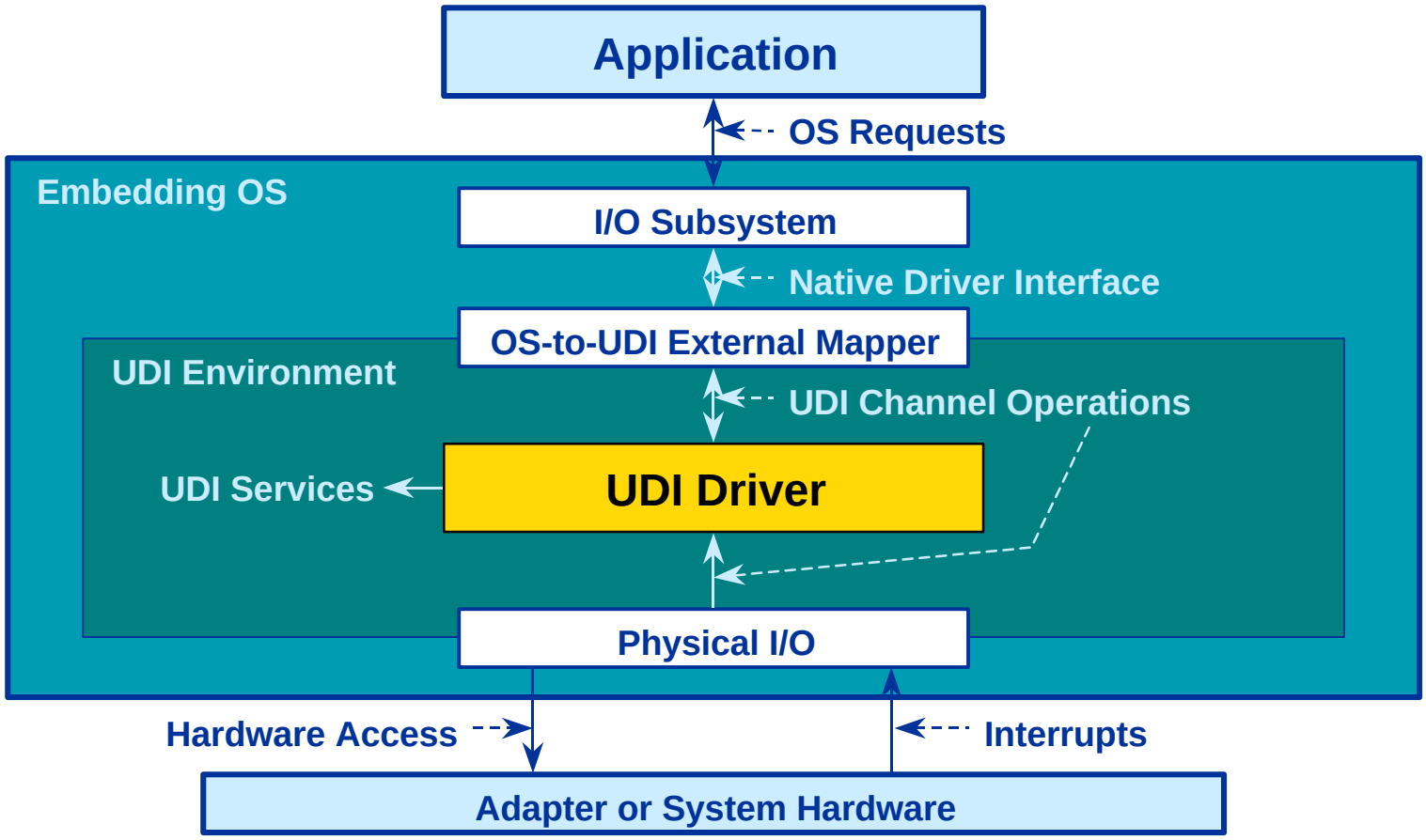
UDI Fully Encapsulates Drivers



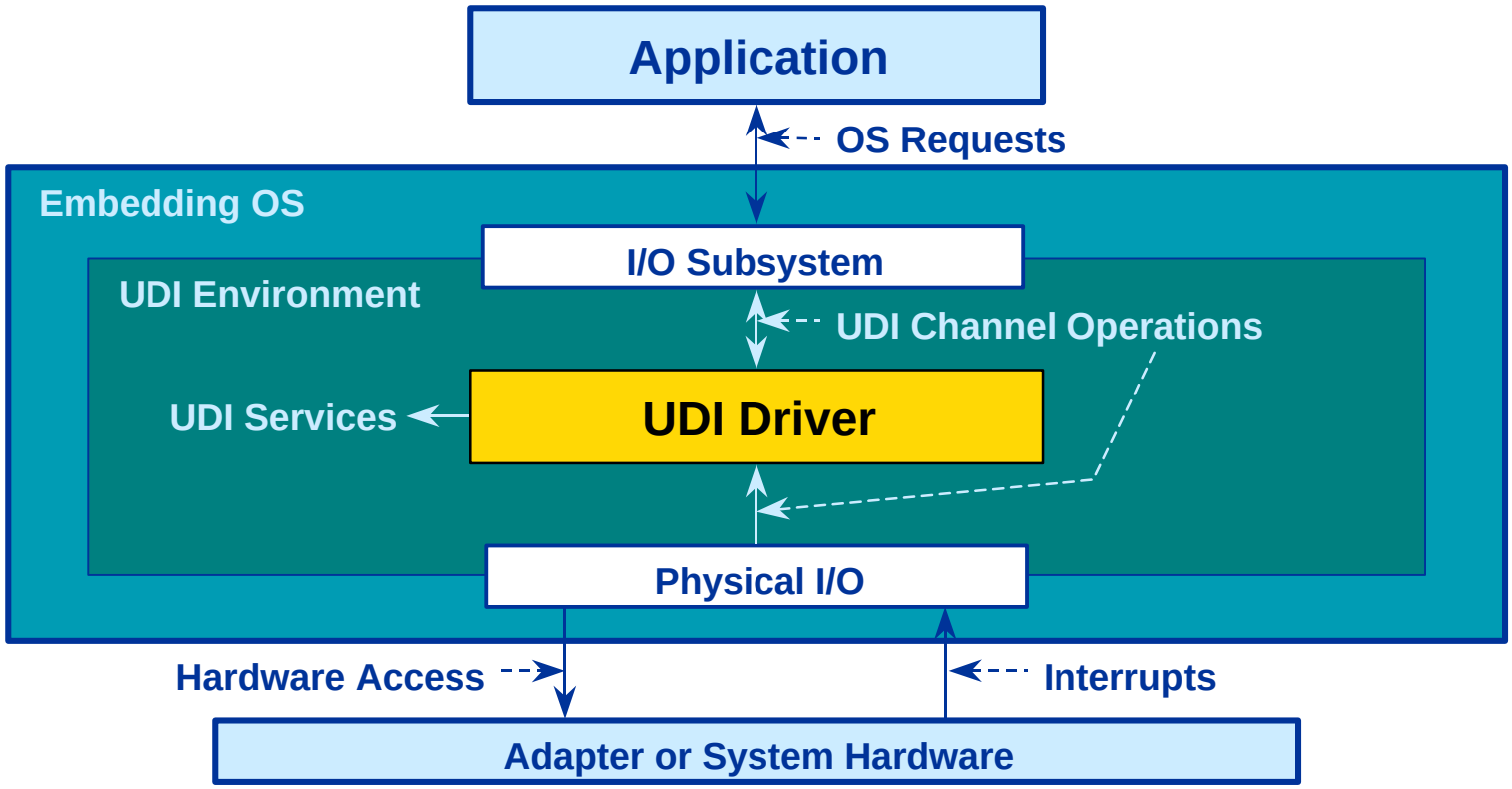
Path From Application to Driver

Layered Implementation



Path From Application to Driver

Integrated Implementation



Uniformity Across Device Types

- **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

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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.**

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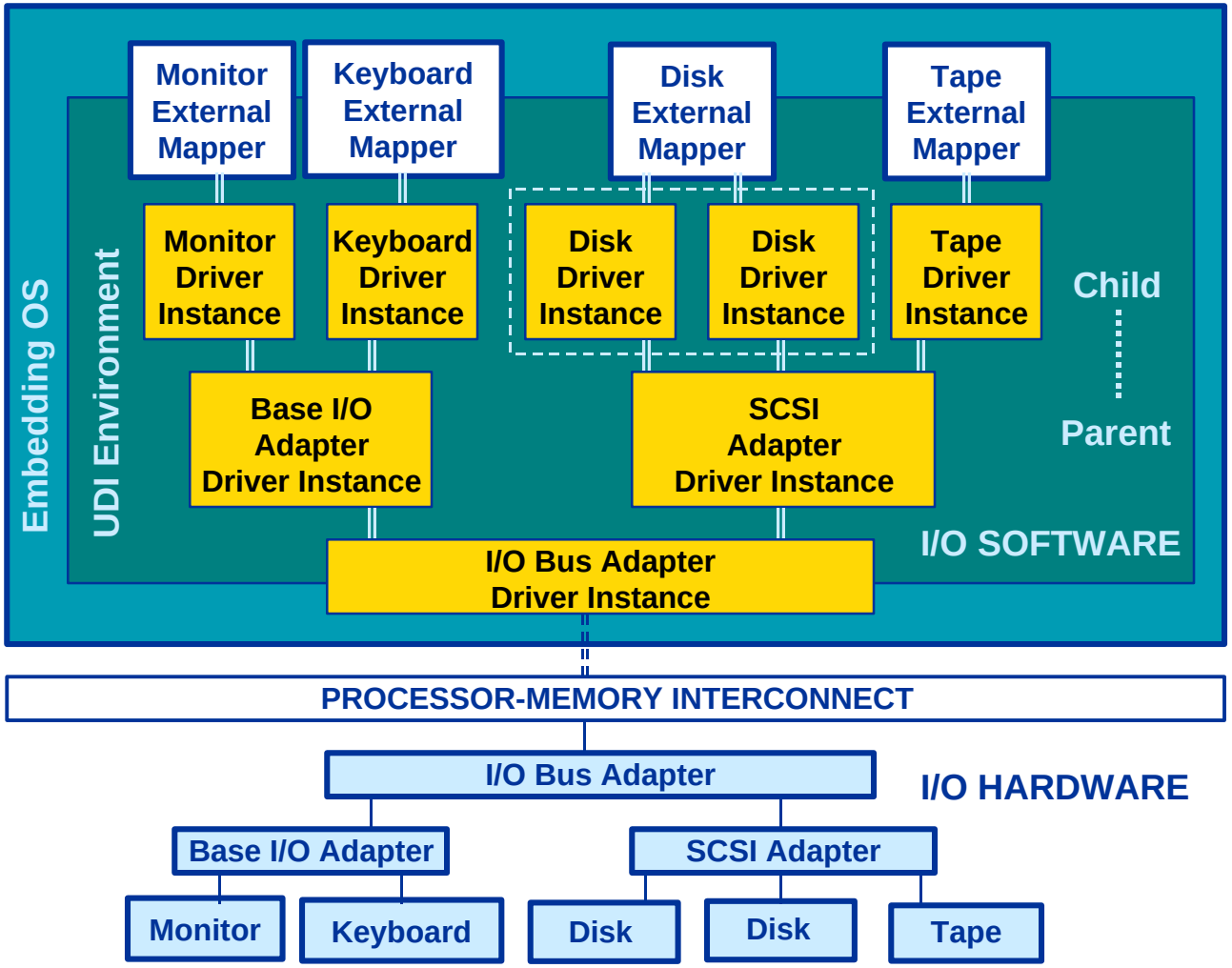
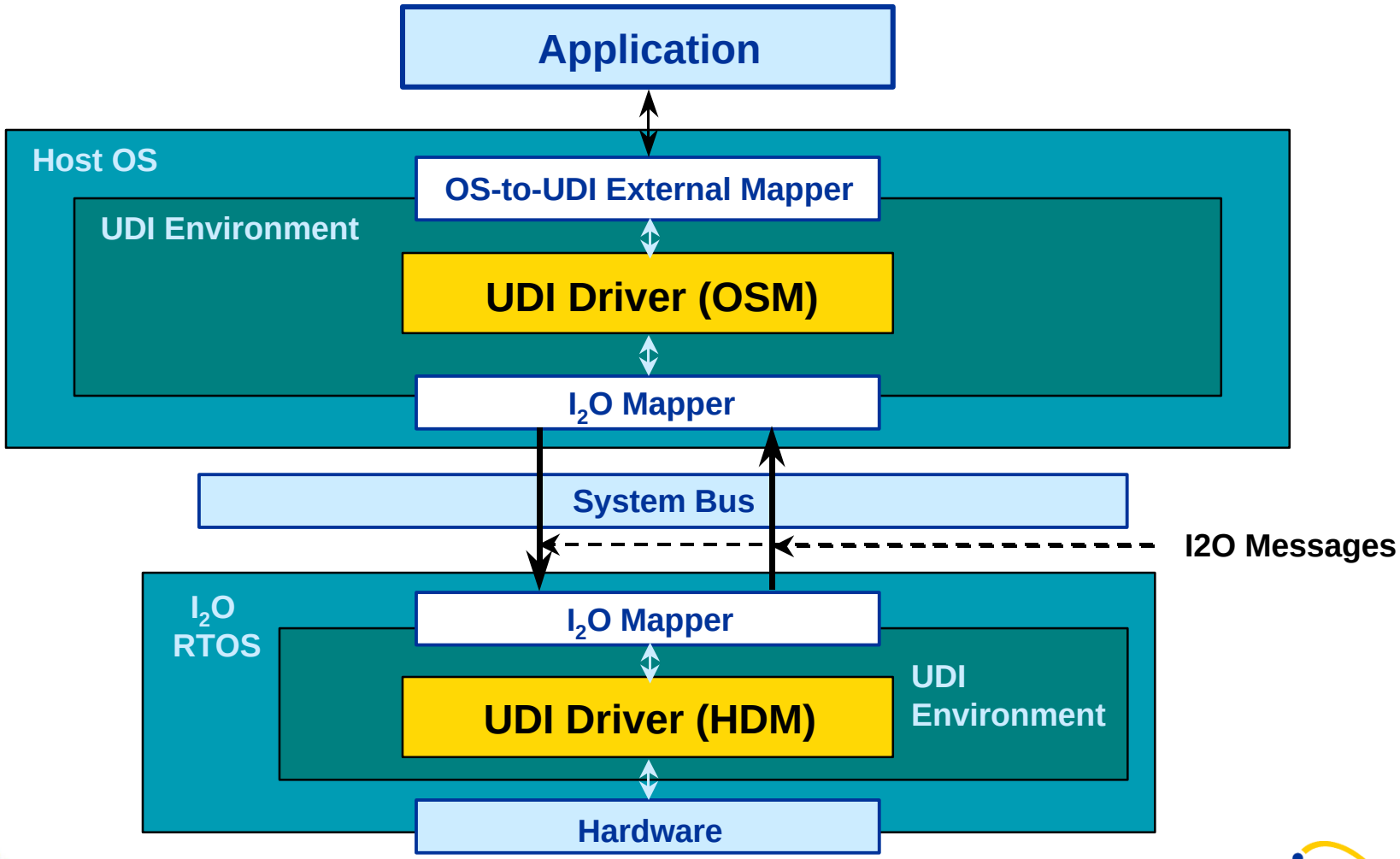
UDI Execution Model

- **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



Example UDI & I_2O Combination



UDI Regions

- **Basic unit for execution and scheduling**
  - Each call into the driver region is serialized
- **No direct data sharing between regions**
  - *You have to go through channels*
- **Region attributes (e.g. priority hints) specified at build time**

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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

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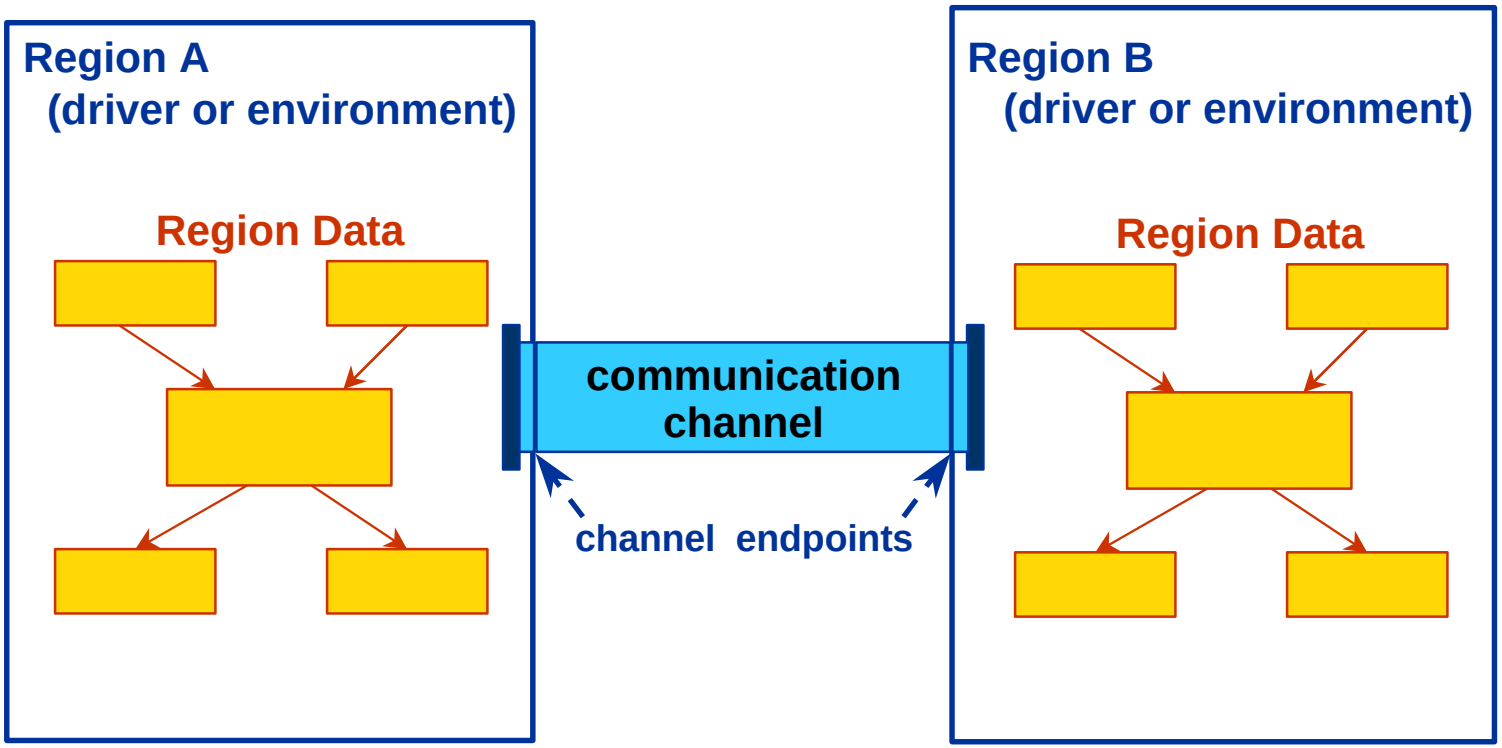
Regions and Channels



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*

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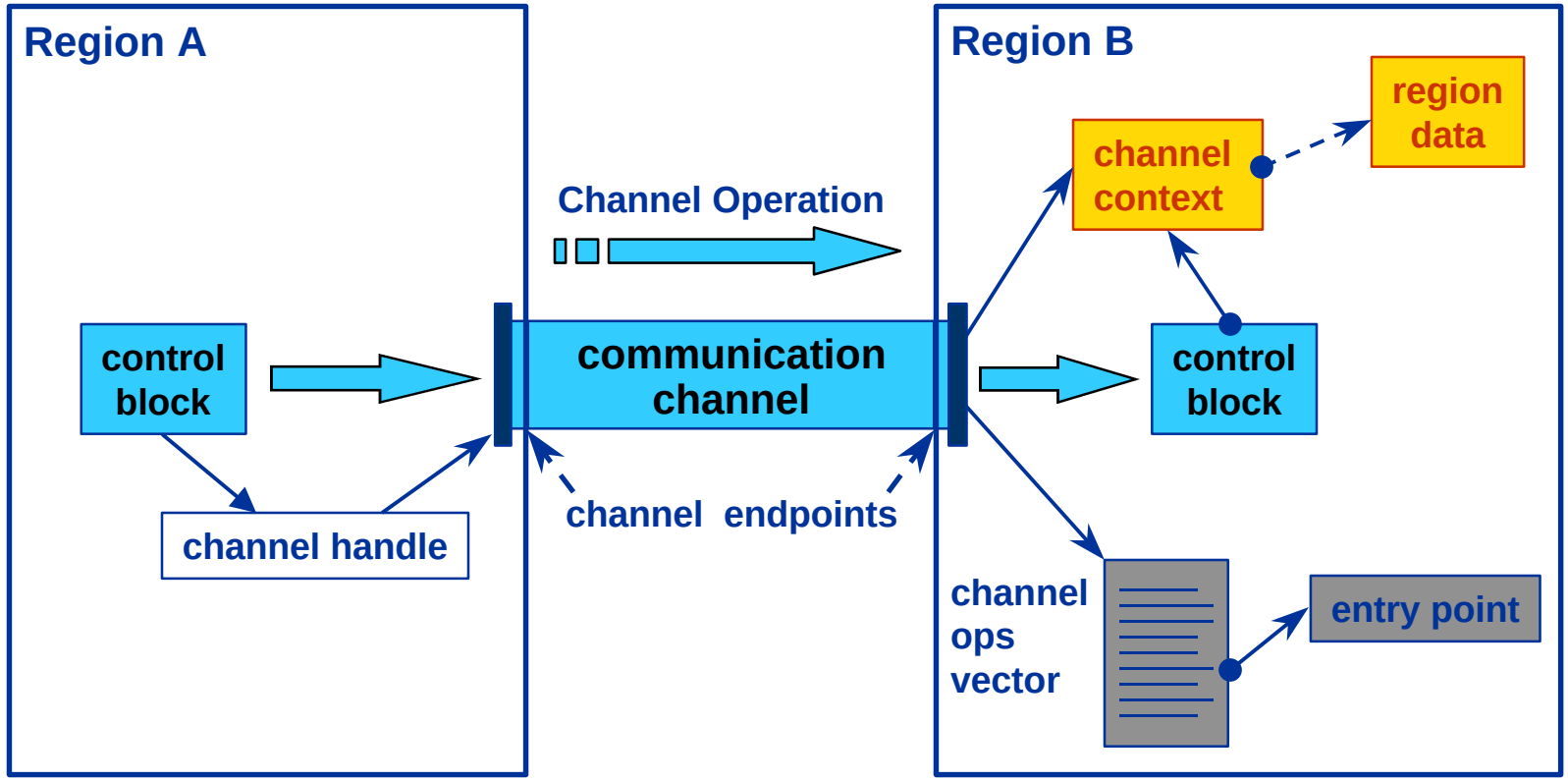
UDI Channel Communications



Metalanguages and Channels

- **Metalanguages define:**
  - Number and types of channels
  - Channel operation types on each channel
    - » Control block plus meta-specific parameters
  - Control block types for each operation
    - » Struct includes meta-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

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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
- “Pseudo-threads” interleaved between callbacks

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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 accesses implicitly synchronized
    - » Region data accessible only from that region
    - » Only one thread per region active at a time
      - Other calls deferred until active call returns
        - Typically by adding CB to a region queue
  - 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

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UDI Specifications

http://www.sco.com/UDI/specs.html

- **UDI Core Specification**
  - UDI Architecture
    - » Execution, Data and Configuration Models
  - Fundamental Data Types
  - Core Services and Utility Functions
  - Core Metalanguages
  - Packaging & Distribution

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UDI Specifications
(continued)

- **UDI Physical I/O Specification**
  - DMA, Programmed I/O (PIO), Interrupts
  - Bus Bridge Metalanguage
- **UDI PCI Bus Binding Specification**
  - PCI enumeration attributes, etc.

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UDI Specifications
(continued)

- **UDI Network Driver Specification**
  - Network Interface Card Metalanguage
  - See session F13: UDI Network Drivers
- **UDI SCSI Driver Specification**
  - SCSI Metalanguage
  - See session F12: UDI SCSI Drivers

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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 *

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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

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UDI Information

Web page

http://www.sco.com/UDI

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