DIGITAL EQUIPMENT CORPORATION
TAPESTRY SEMINAR SERIES

DECnet/OSI

A Technical Overview

digital™

ACT005-01/A

Topics

- The Value of Standards
- Seven Layer OSI Model
- OSI Products and Applications
- DECnet/OSI
- DECnet/OSI Phase V Migration

The Value Of Standards

- Why standards?
- Standards organizations
- ISO approval process
- What is OSI?
- OSI terms
- Overview of a layered architecture

The Value Of Standards

Why Standards?

- Information is business's most important resource
- Over 90% of all DP sites have equipment from more than one vendor
- Provide a common architecture across multiple platforms
- Facilitate the sharing of information throughout the enterprise
- Reduce duplicate implementation and support costs

Standards Organizations

- International Standards Organization – ISO
- Corporation for Open System – COS
- American National Standards Institute – ANSI
- Institute of Electrical and Electronic Engineers – IEEE
- International Consultative Committee for Telephony and Telegraphy – CCITT
- Omnicom Inc.
- National Institute of Standards and Technology – NIST
- Standard Promotion and Application Group – SPAG

*Government Open Systems Interconnect Profile – GOSIP

ISO Approval Process

- NWI – New Work Item
- DP – Draft Proposal
- DIS – Draft International Standard
- IS – International Standard

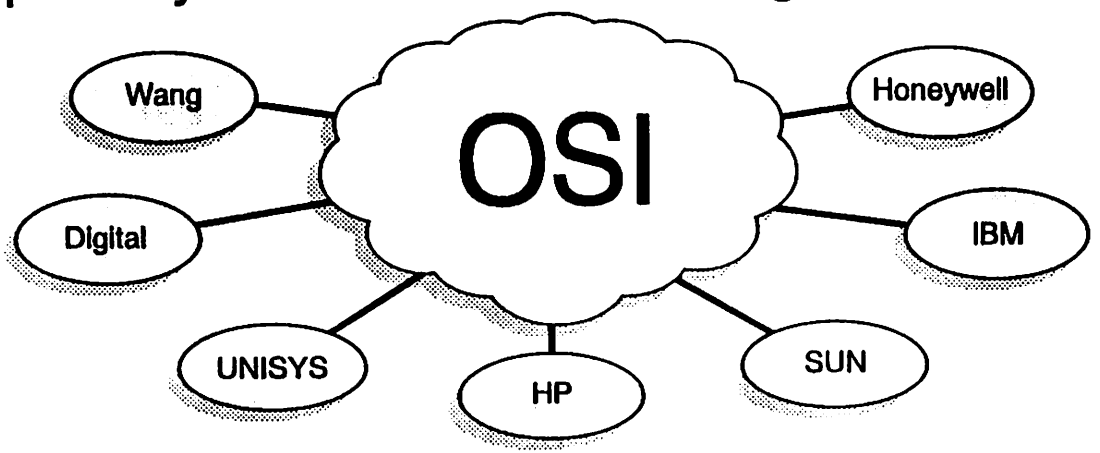
Average time for entire process is three-to-four years

Digital And Open Systems

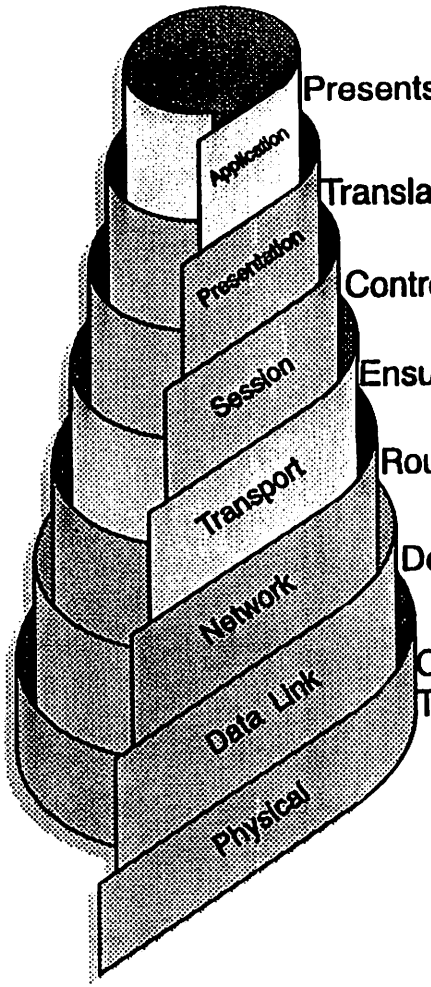
- Participation in ISO since 1979
- Over 120 committees worldwide
- Chairmanship of committees such as OSI network layer, protocols for security, NBS Implementers workshop, and COS
- Leadership in COS, OSInet, OSIcom, EUROsinet

What Is OSI?

- Seven layer peer-to-peer Network Architecture
- Standards set by ISO
  - ISO–7548 Basic Reference Model Definition
- OSI origin based on existing architectures
- Network Standards for the 21'st century
- Accepted by customers, vendors, governments



OSI Reference Model



Presents User's Application

Translates Data

Controls Dialogue

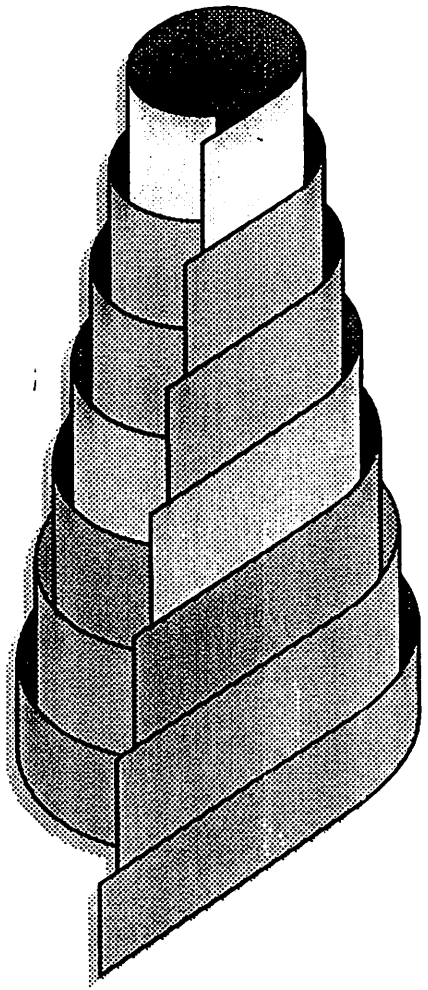
Ensures Message Integrity

Routes Packets

Detects Errors

Connects Device To Network

OSI Terms



'PDU'

'Entity'

'CONS'

'CLNS'

'COS'

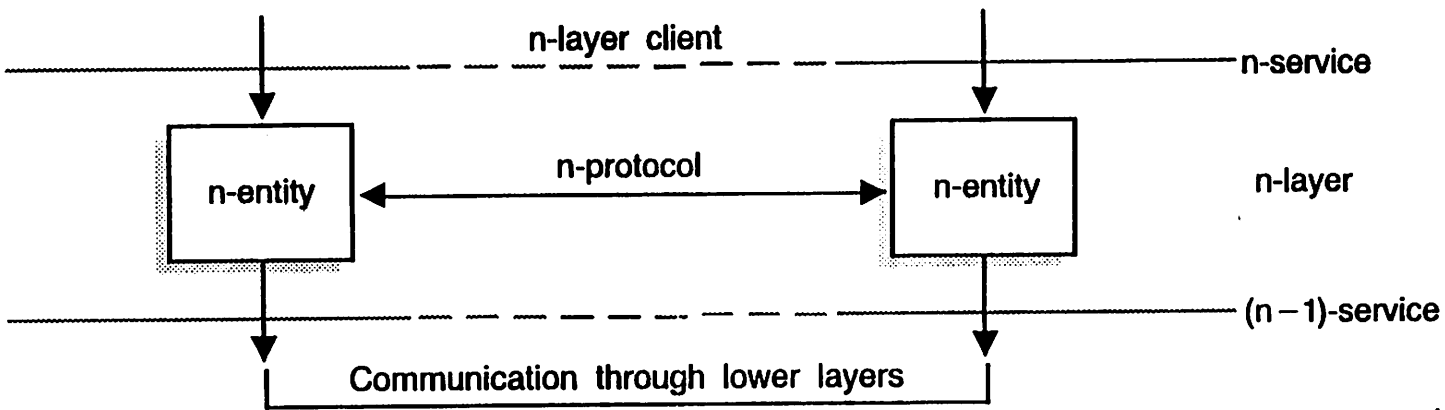
'SDU'

'X.25'

'GOSIP'

Principles Of A Single Layer

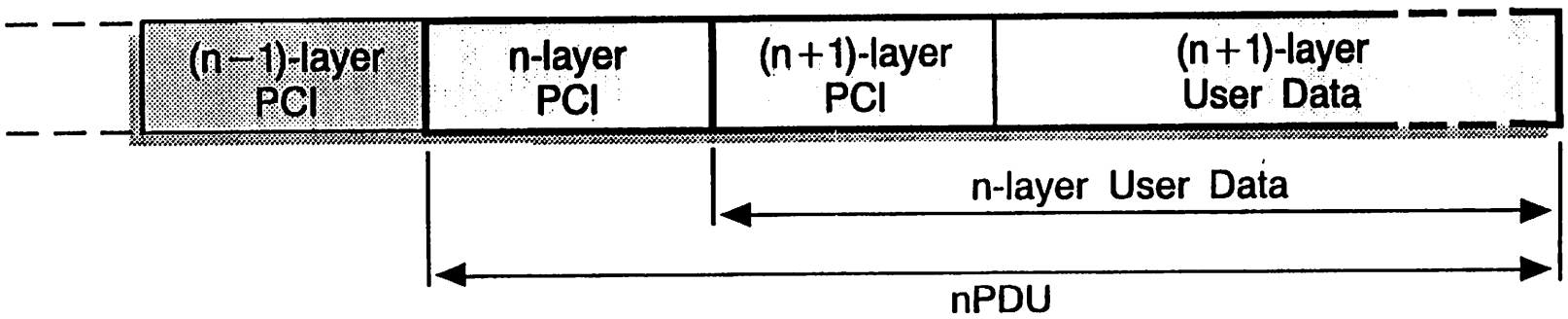
- The protocol is conveyed using the service of the next lower level
- The N-protocol is carried as data by the (N-1) service
- The lower layer has no knowledge of, or interest in, the content of the data it conveys



ACT005 – 12/A

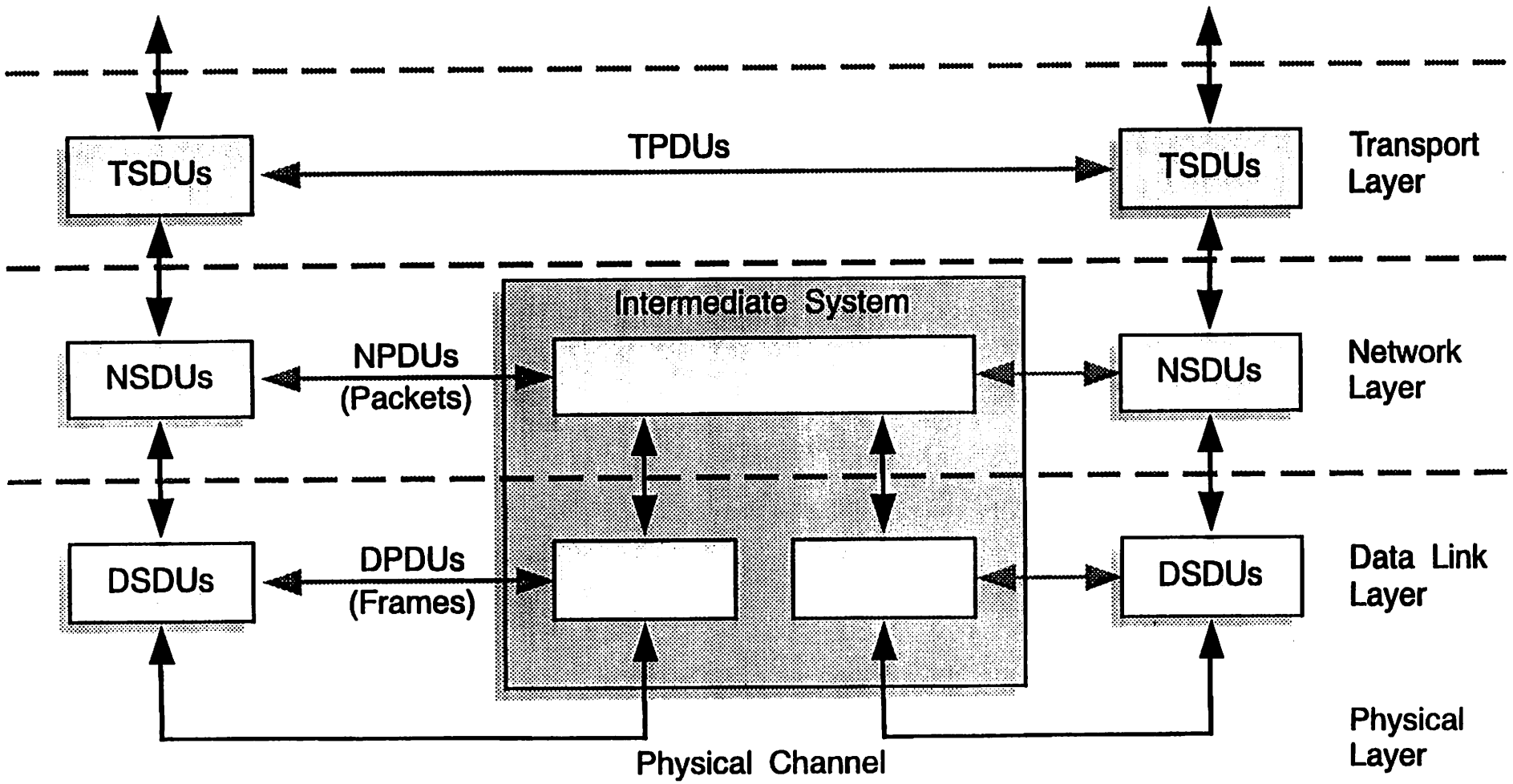
Nesting Of Protocol Control Information

- Each layer of the architecture specifies particular Protocol Control Information (PCI) to be added to the user data
- The user data and PCI form the Protocol Data Unit – PDU



ACT005 – 13/A

Message Flow Within DNA/OSI



ACT005–14/A

Topics

- The Value of Standards
- Seven Layer OSI Model
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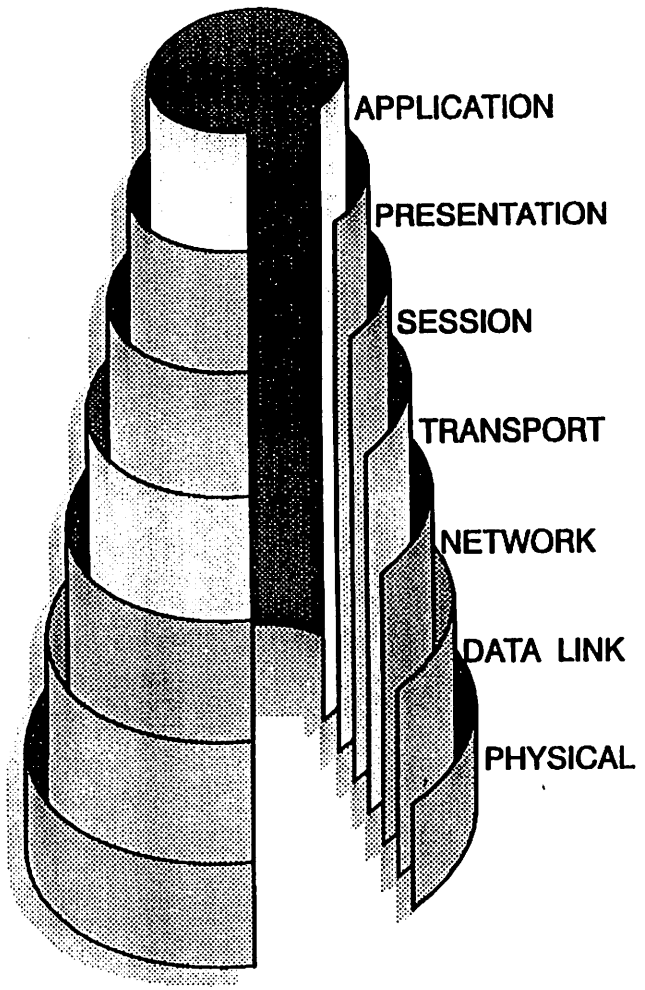
- DECnet/OSI
- DECnet/OSI Phase V Migration

Seven Layer OSI Model

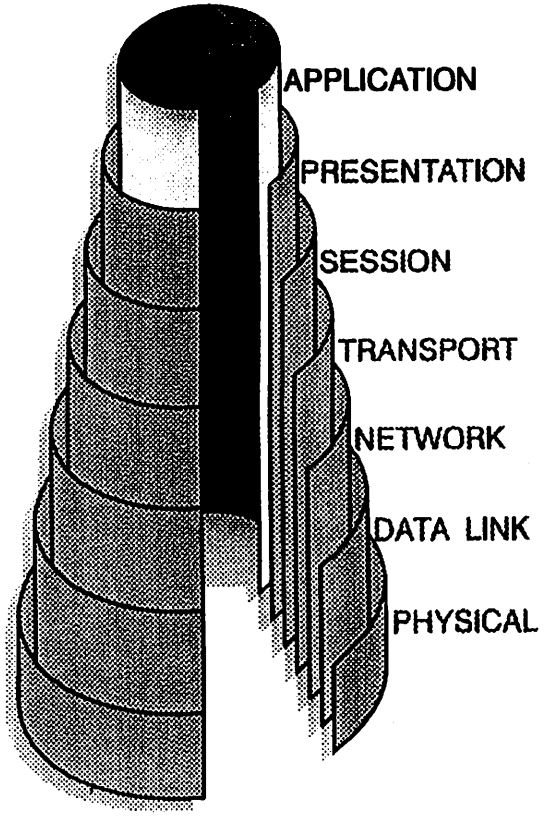
- Application Layer
- Presentation Layer
- Session Layer
- Transport Layer
- Network Layer
- Data Link Layer
- Physical Layer



ACT005-16/A

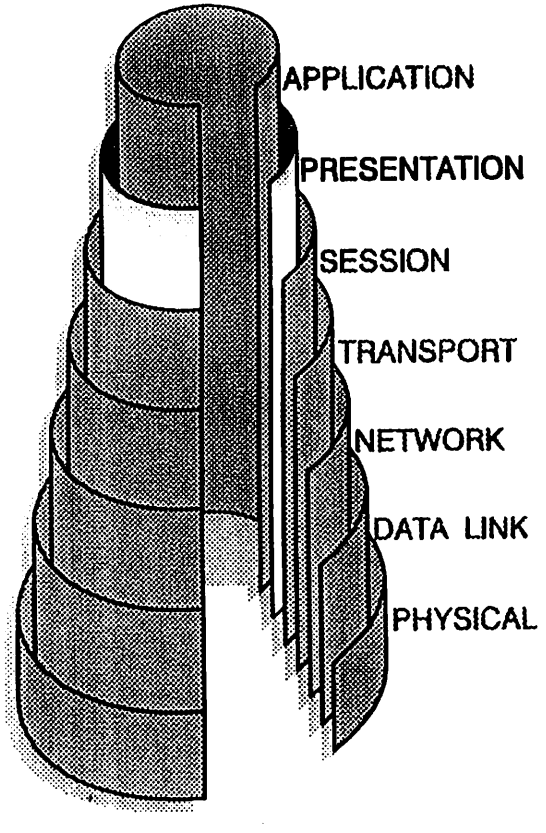
Application Layer

- Provides services for end-user and application tasks
- Interface between communications environment and application process
- **Specific Applications Service Elements – SASE**
  - File Transfer, Access and Management - FTAM (ISO 8571)
  - Virtual Terminal Protocol - VTP (ISO 9040 – ISO 9041)
  - Message Handling System - X.400 MHS
  - Job Transfer and Management - JTM
- **Association Control Service Element – ACSE**



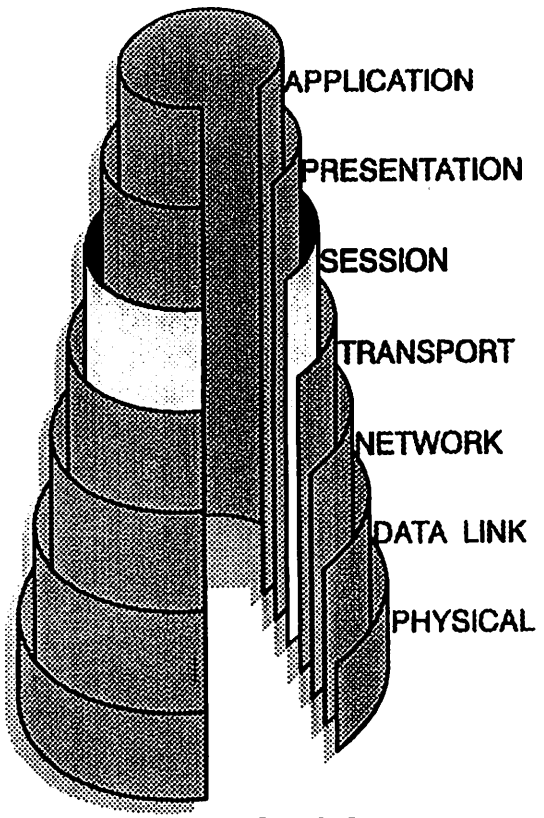
Presentation Layer

- Conversion of data for application processes
- Provides a specialized data transfer service to the application layer
- Transfers data in a system-independent way
- ISO 8822 – OSI Presentation Service Definition
- ISO 8823 – OSI Presentation Protocol Specification
- ISO 8824 – ASN.1 Notation
- ISO 8825 – ASN.1 Encoding Rules



Session Layer

- Responsible for system-dependent aspects of communication
- Matches incoming requests to appropriate users
- Manages transport connections for users
- Enforces access control policies

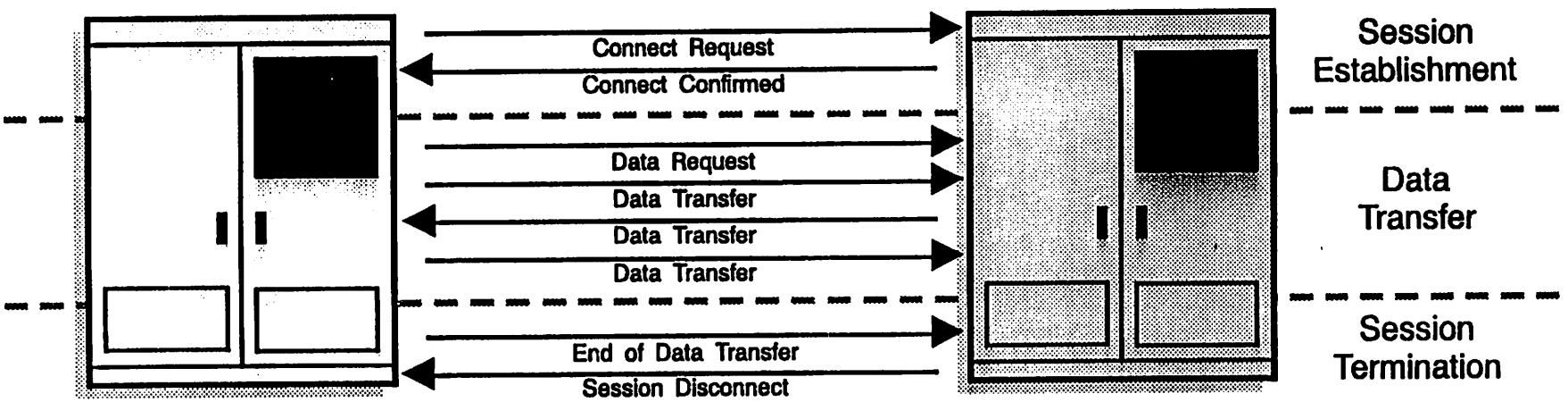


- ISO 8326 – OSI Session Layer Service Definition
- ISO 8327 – OSI Session Layer Protocol Specification

ACT005-19/A

Session Connection Control

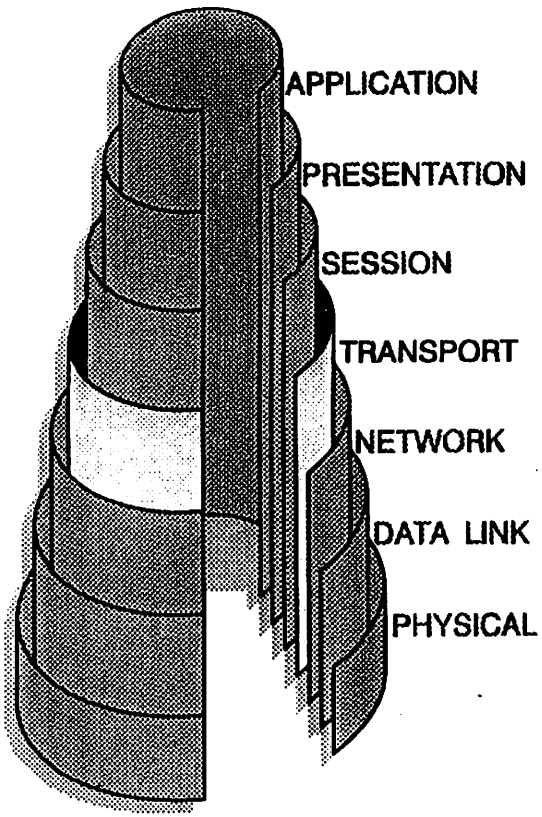
- Making an outgoing connection
- Receiving an incoming connection
- Handles Disconnect or Abort request to end logical link



ACT005–20/A

Transport Layer

- Transparent data transfer between end systems
- Starting/stopping logical links
- Flow control and congestion avoidance
- Segmentation and reassembly
- Multiplexing over CONS links
- Piggybacking
- End to end error detection/recovery

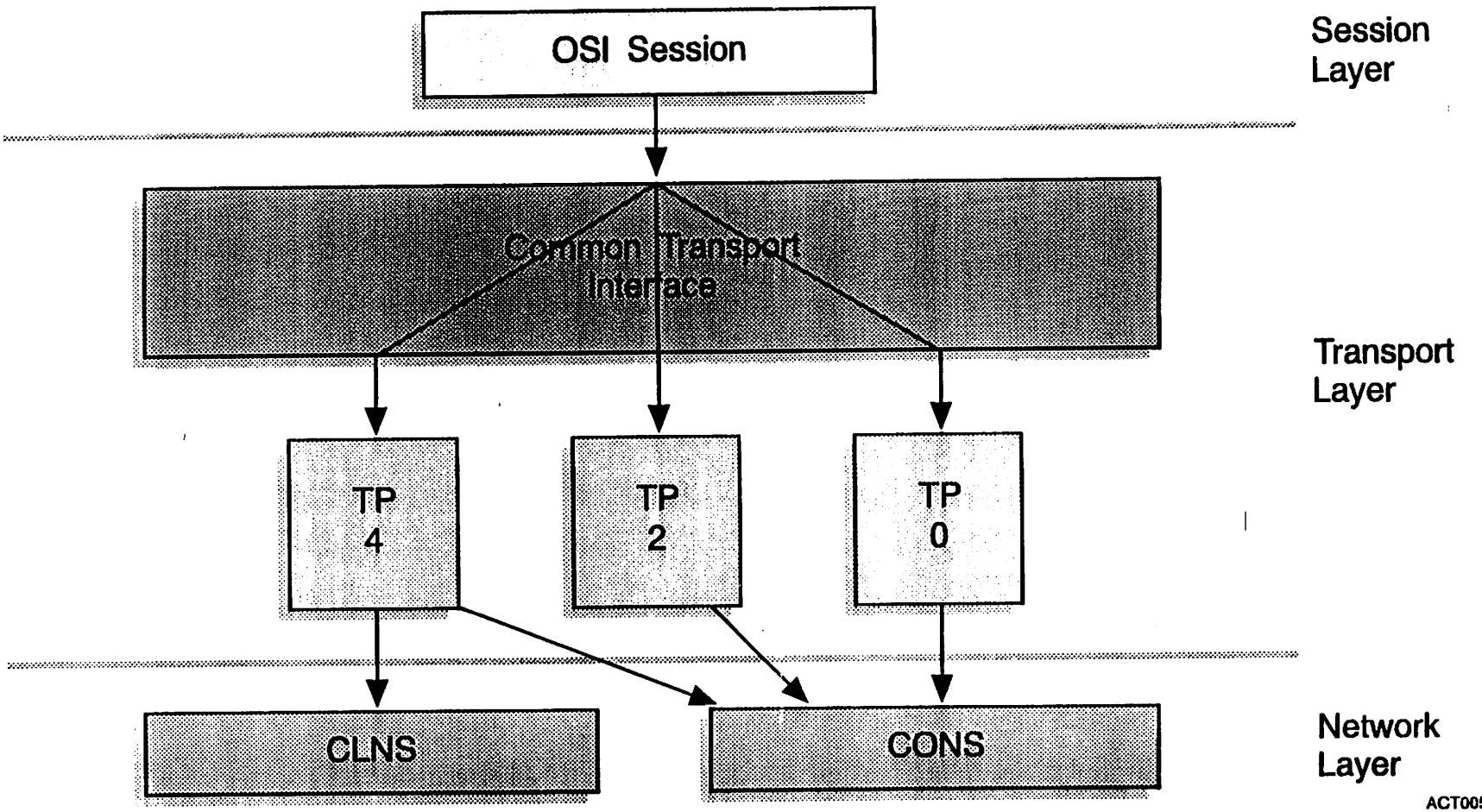


- ISO 8072 – OSI Transport Layer Service Definition
- ISO 8073 – OSI Transport Layer Protocol Specification

Transport Service Classes

- Class 0
  - Simple protocol with limited features
  - No multiplexing, flow control, or error checking
  - Required for X.400 MHS
- Class 2
  - Multiplexes transport connections over single network connection
  - Flow control optional
  - Used over X.25 networks only
- Class 4
  - Most complex - but most reliable
  - Multiplexing, flow control, and error detection and recovery
  - Good for LAN and subnetworks
  - Uniform service independent of network
- Class 1 & 3 not supported by DNA/OSI

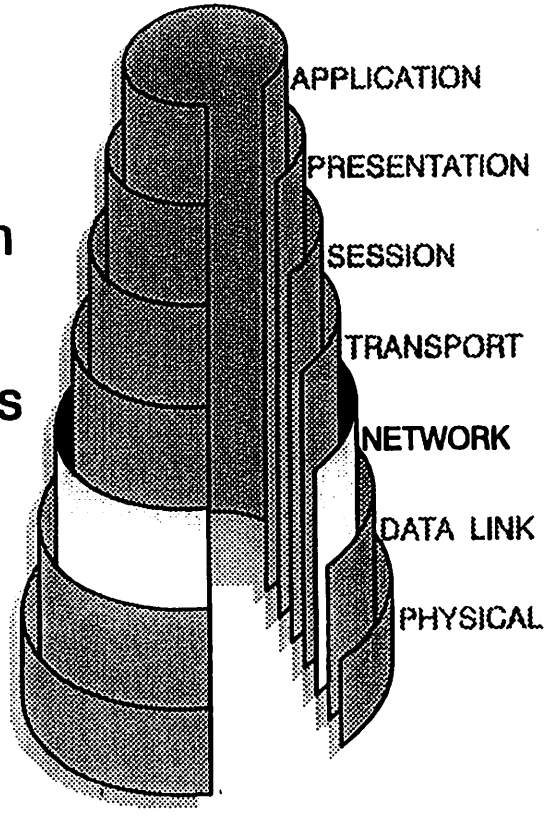
Transport Protocols And Network Services



ACT005 – 23/A

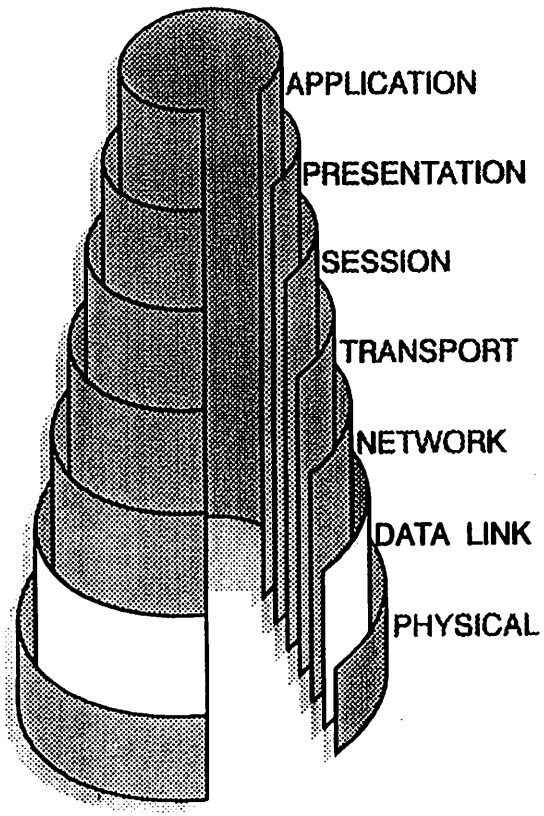
Network Layer

- Establishes, maintains, and terminates communication between nodes
- Sets up the most economical path between communicating nodes
- Routes messages through intervening nodes to their destination
- Controls the flow of messages between nodes
- ISO-9542 provides End System to Intermediate System Routing Protocol
- Proposed Intermediate System to Intermediate System [IS to IS] protocol



Data Link Layer

- Passes data between directly connected nodes
- Features supported
  - Connection establishment and release
  - Data transfer
  - Framing and synchronization
  - Sequence control - pipelining
  - Error detection and recovery
  - Flow control
  - ID and parameter exchange
- ISO 8802-3, 8802-4, 8802-5, HDLC, CCITT X.25, ISDN, FDDI



Topics

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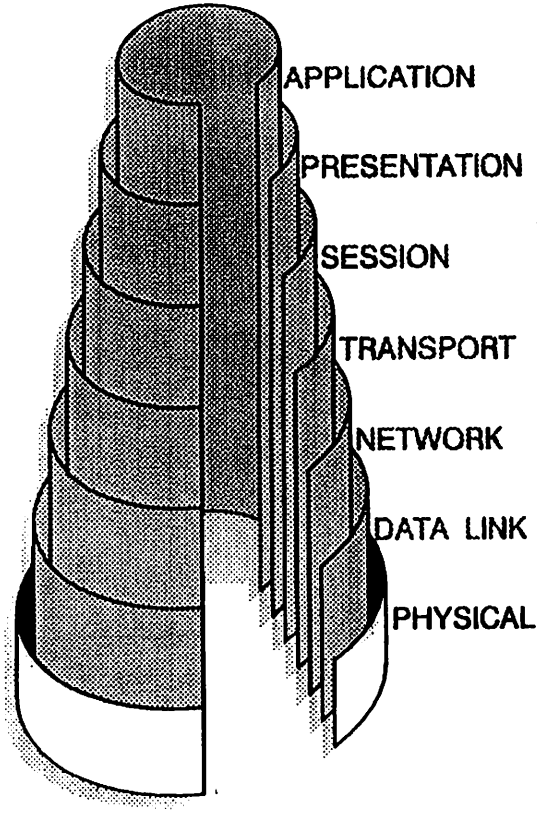
DECnet/OSI

- DECnet/OSI Data Link Layer Protocols
- DECnet/OSI Local Area Networks
- Support of X.25 Networks
- DECnet/OSI End System to Intermediate System Protocol
- DECnet/OSI Network Layer
- DECnet/OSI Network Layer Functions
- Link State Routing
- DECnet and OSI Addressing
- ISO Addressing Authorities
- DECnet/OSI Multiple Routing Domains
- Other Network Layer Features of DECnet/OSI
- Distributed Name Service
- Network Management
- Enterprise Management Architecture – EMA

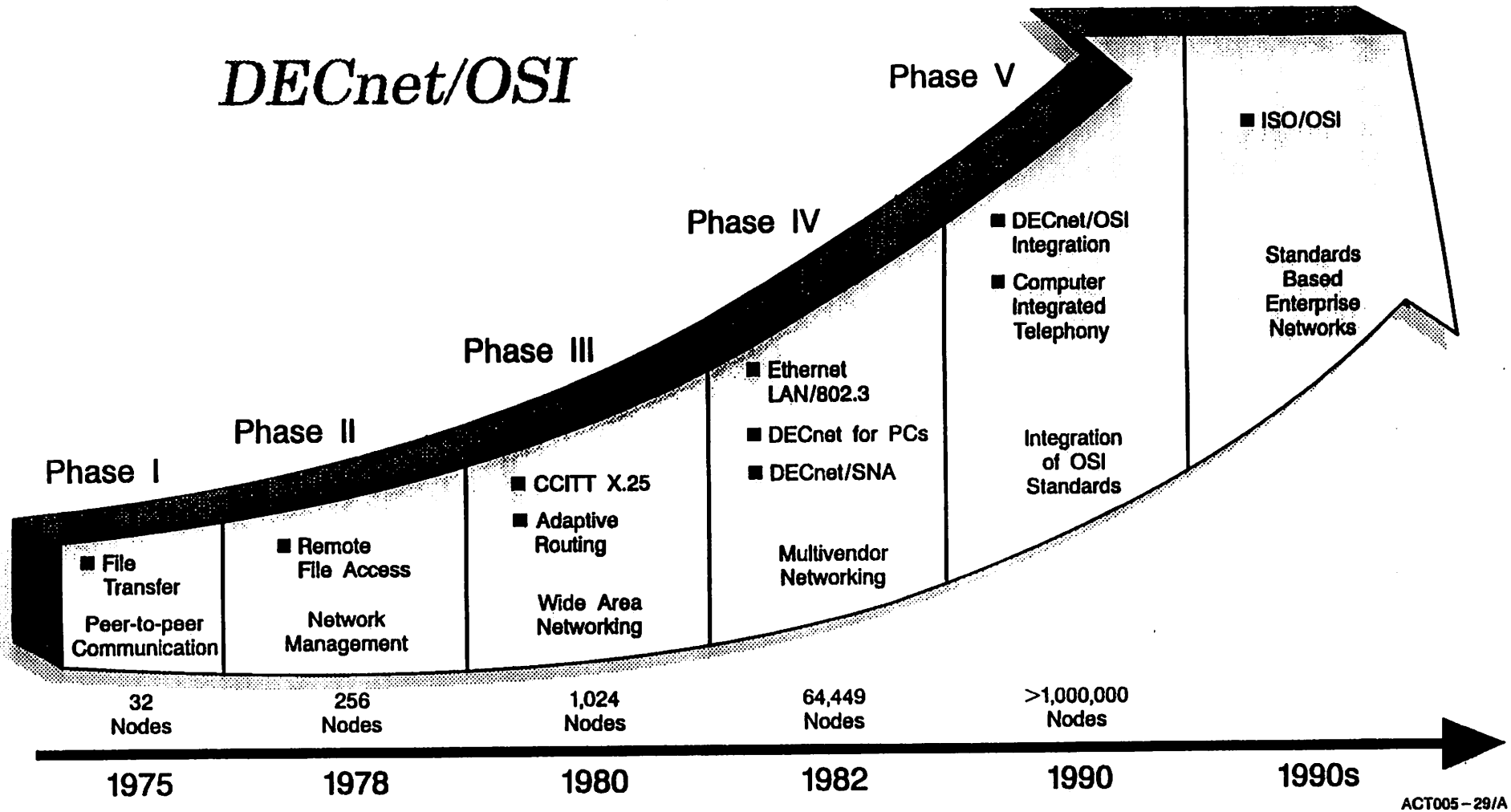
Physical Layer

- Handles the electrical and mechanical transmission interface between directly connected systems
- Extensive use of industry standards (EIA, CCITT, IEEE, ISO, ANSI)
- Switched network support – X.21, ISDN
- Modem connect features
  - Call control and monitoring
  - Call sharing
  - Network management



- ISO 8802-3, ISO 8802-4, ISO 8802-5, EIA RS-232-D and RS423, CCITT V.24 and V.35, FDDI, ISDN

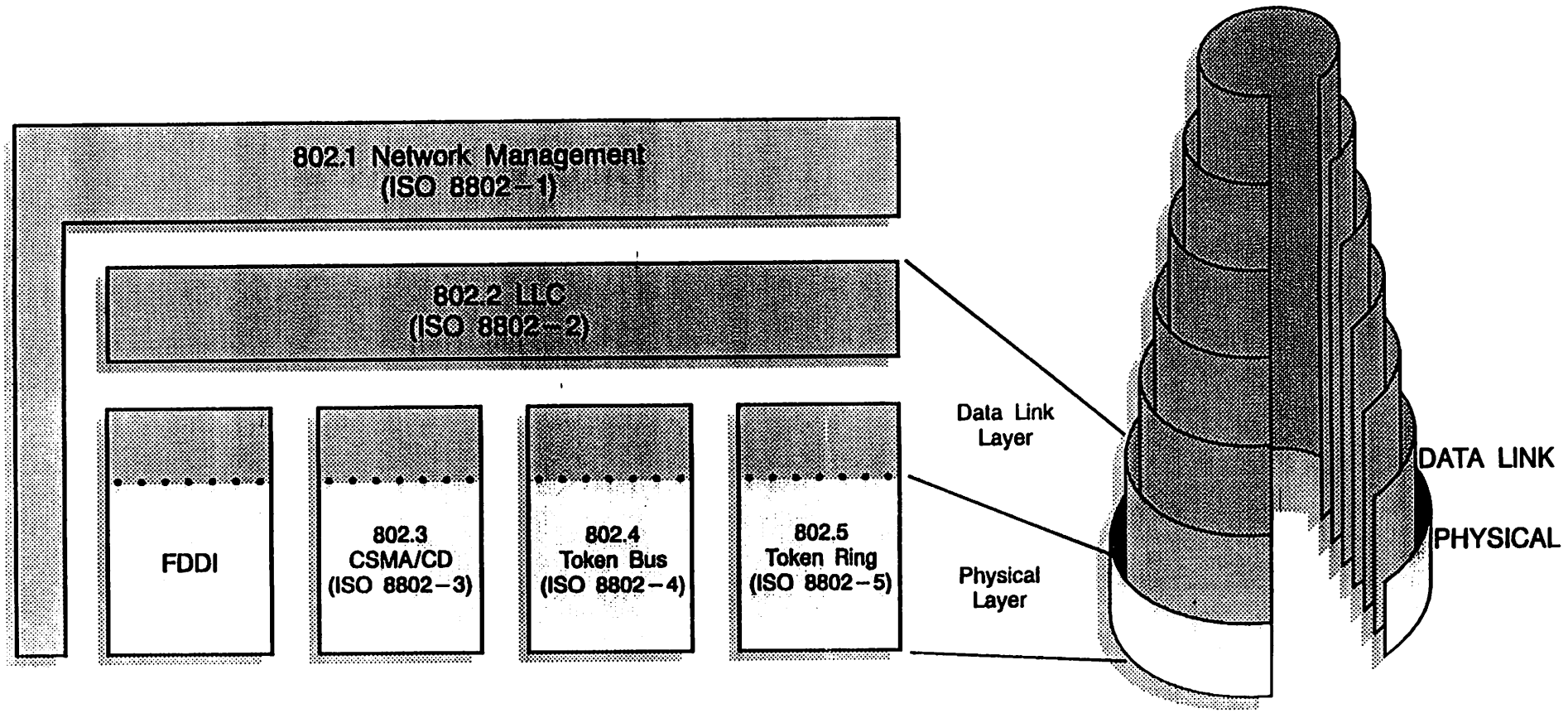
Digital's Commitment To Standards



DECnet/OSI Data Link Layer Protocols

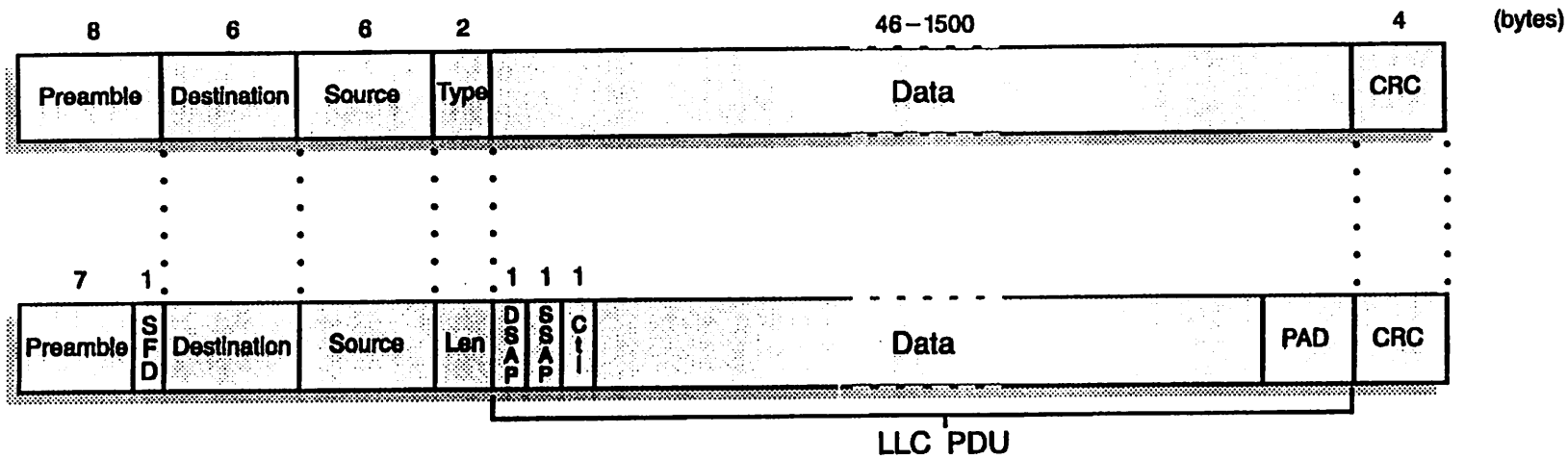
- DDCMP – synchronous or asynchronous
- HDLC – synchronous only
  - Extended sequence numbering
  - Error detection - 32 bit option
  - Includes LAPB support
- X.25 – packet switched data networks
- CSMA/CD – LAN
  - Ethernet V2.0
  - ISO 8802-3, IEEE 802.3
- FDDI – Fiber Distributed Data Interface

The IEEE 802 Standards

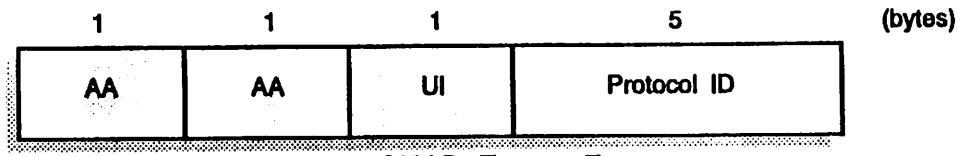


ACT005–31/A

Ethernet & IEEE 802.3



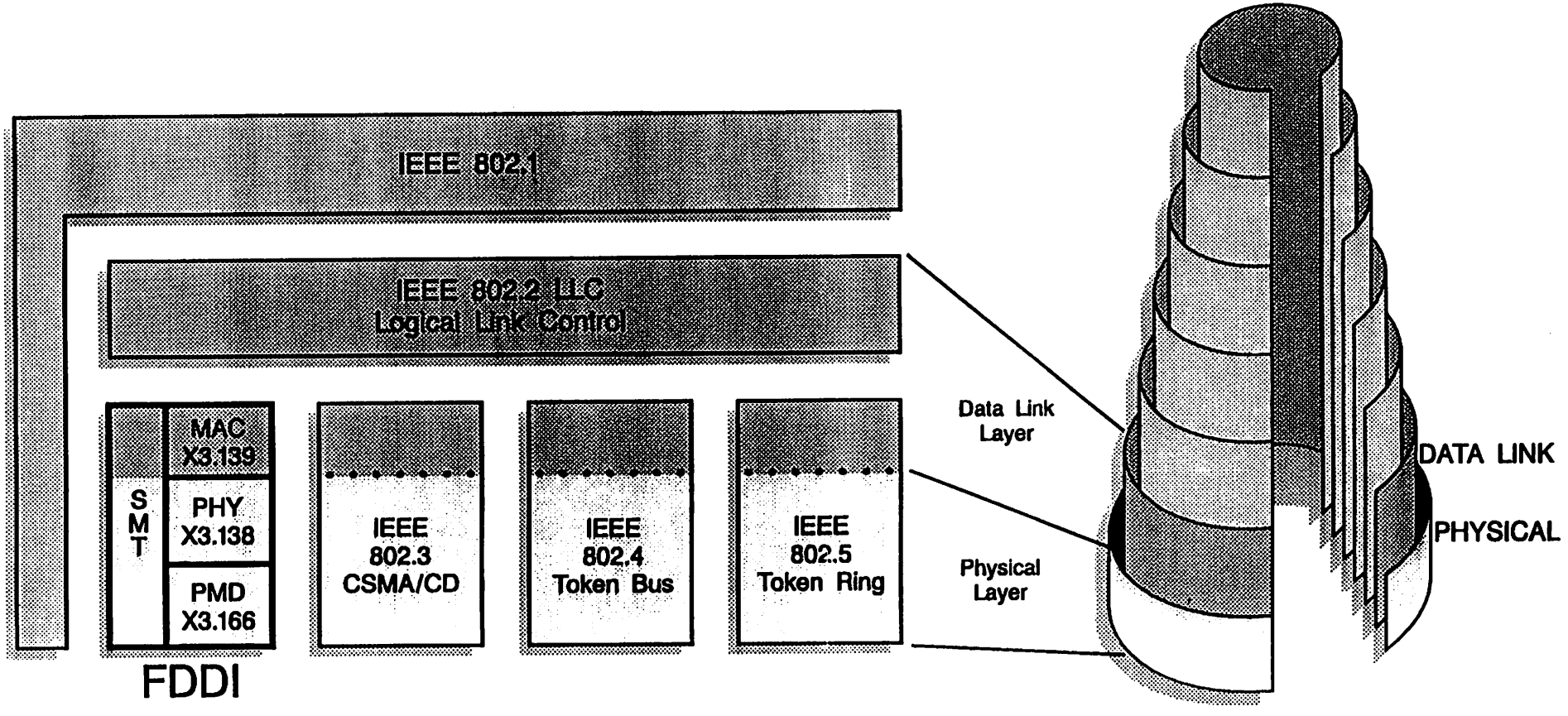
SSAP & DSAP:



ISO 8802.2 SNAP Frame Format

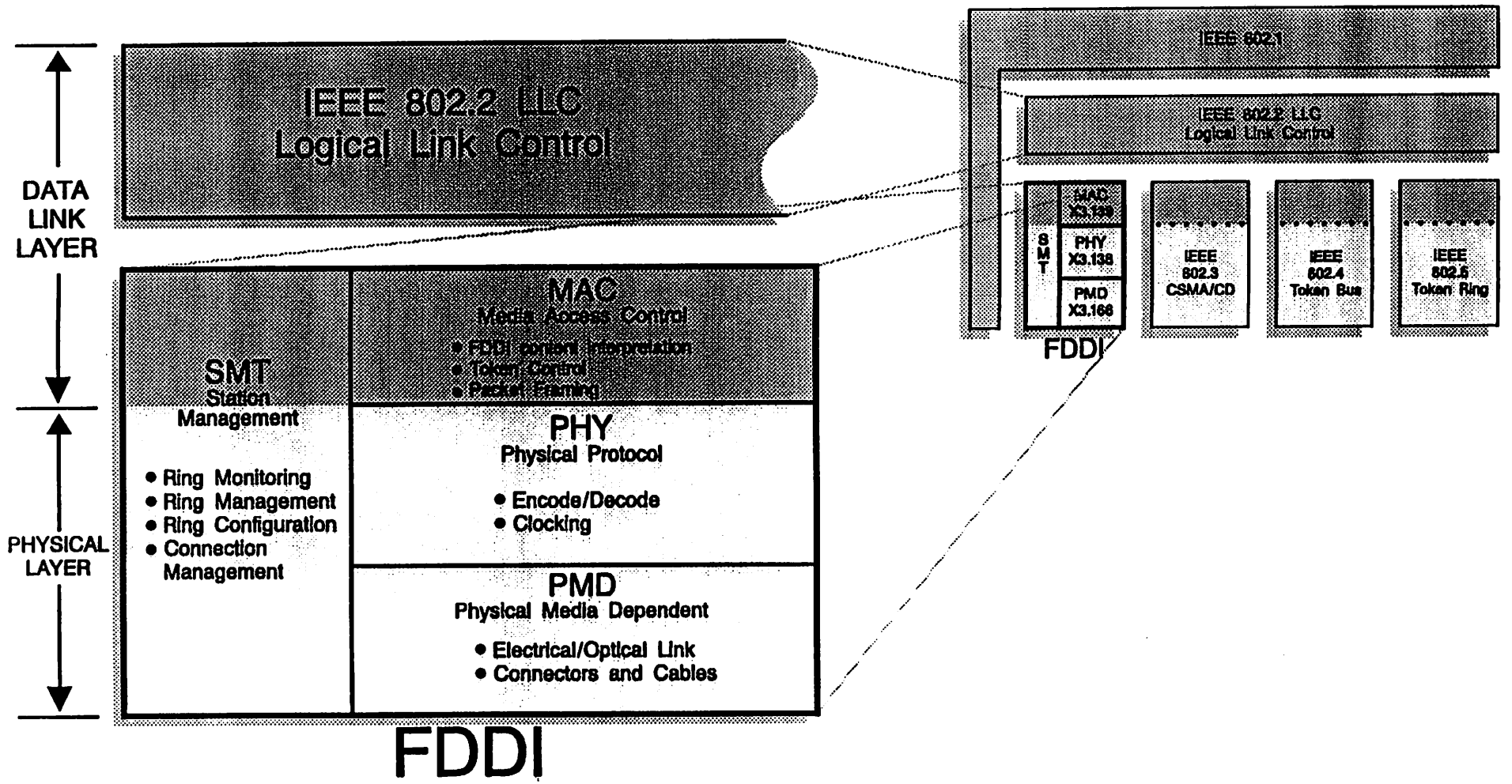
SFD	= Start Frame Delimiter	Len	= Length of PDU
Destination	= Destination Address	DSAP	= Destination Service Access Point
Source	= Source Address	SSAP	= Source Service Access Point
Type	= Protocol Type	SNAP	= Sub Network Access Protocol
		UI	= Unnumbered Information

FDDI And Other LAN Standards



ACT005-33/A

FDDI And Other LAN Standards



ACT005–34/A

FDDI Characteristics

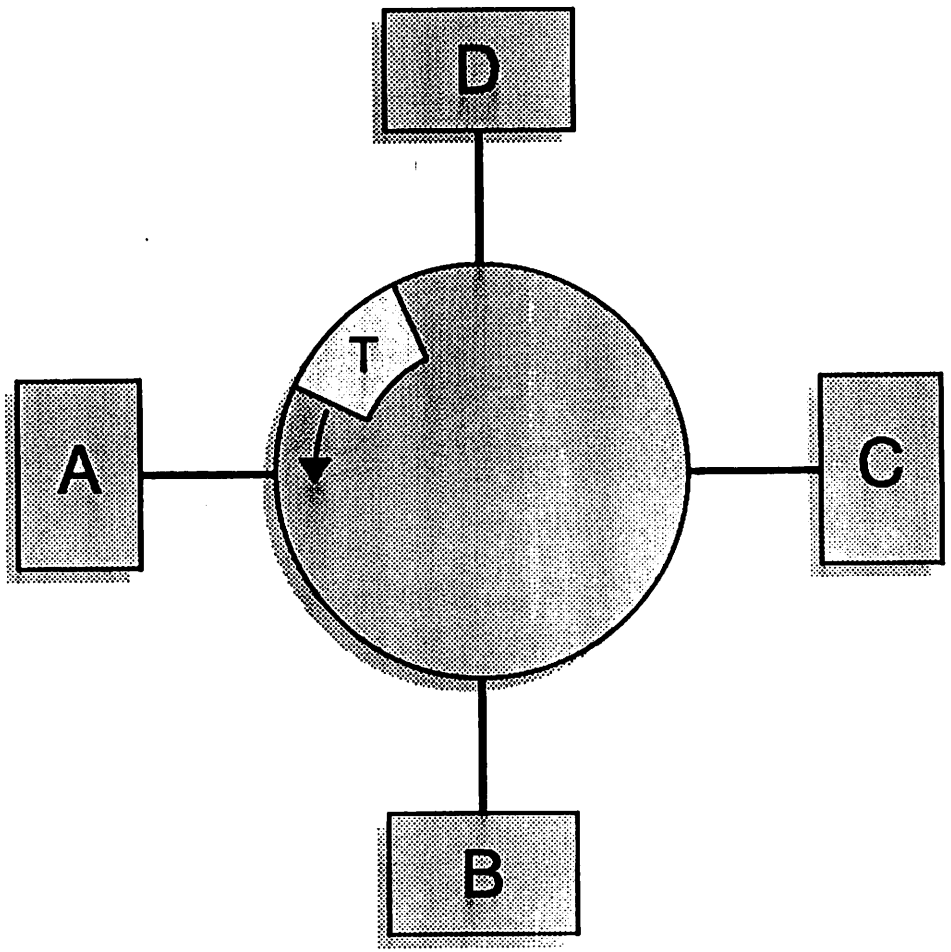
- 100 Mbps token passing ring with 125 Mbaud transmission rate
- 62.5/125 micron multimode fiber @ 1300 nm
- Circumference up to 200 km
- Inter-station distance up to 2 km
- Support for up to 500 stations

Differences: FDDI - 802.3 - 802.5

	FDDI	IEEE 802.3	IEEE 802.5
Media	Optical fiber	Coax Twisted Pair Optical fiber	Twisted Pair Optical fiber
Bandwidth	100 Mbps	10 Mbps	4 or 16 Mbps
Encoding	NRZI-4B/5B	Manchester	Manchester
Seizes token	By absorption	(CSMA/CD)	By flipping a bit
Releases token	After transmit	(CSMA/CD)	After receive (4 Mbps) After transmit (16 Mbps)
Frame size	4500 bytes max	1500 bytes max	No maximum
Link monitoring	Explicit spec	No spec	No spec

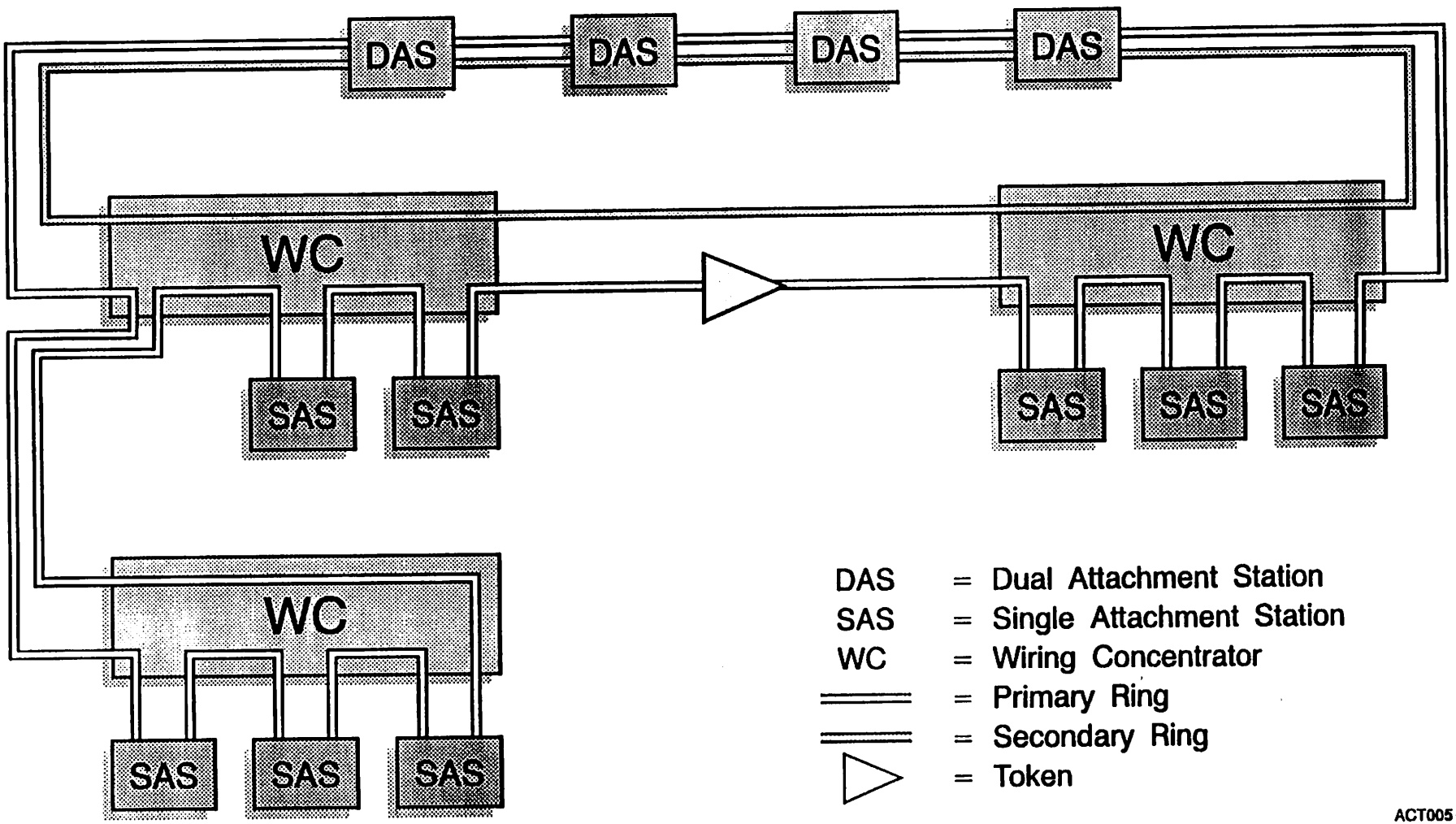
ACT005-36/A

FDDI Token Operation



ACT005–37/A

FDDI Architecture



DAS = Dual Attachment Station
SAS = Single Attachment Station
WC = Wiring Concentrator
= Primary Ring
= Secondary Ring
= Token

ACT005-38/A

Support Of X.25 Networks

- Native X.25 calls
- DECnet/OSI data link mapped calls
- X.29 inbound/outbound terminal
- OSI transport class 0, 2, 4
- Packet or frame level trace facility
- Security and accounting facility
- Host-based or gateway access

DECnet/OSI End System To Intermediate System Protocol

- End systems
  - Talk directly to other end systems - single hop
  - Talk to intermediate systems
  - Uses ISO 9542 routing protocol
- Intermediate systems
  - Talk to end systems
  - Enter data onto backbone
  - Route data to destination
  - Uses proposed ISO IS-IS protocol
  - Typically dedicated devices (OSI L1-L3)
  - May provide portal services (encapsulation)

DECnet/OSI Network Layer

- Provides end to end data transfer across network
- Provides routing – finds best path dynamically
- ISO Connectionless Network Service – ISO-8473
  - 'Internet' Protocol
  - Send data message without first establishing connection (datagram service)
  - Allows duplicate, out of order, or lost packets
  - Does not allow modification or mis-delivery
- ISO Connection-mode Network Service – ISO-8348
  - Send data message only after first establishing connection
  - Used to support X.25 subnetworks

DECnet/OSI Network Layer Functions

- Adaptive routing
  - Administrative and public domains
  - End systems and intermediate systems
  - Sub-networks
  - DECnet has sub-domains (areas)
    + level 1 routing
- Segmentation and reassembly – per link
- Lifetime control
- Congestion avoidance marking

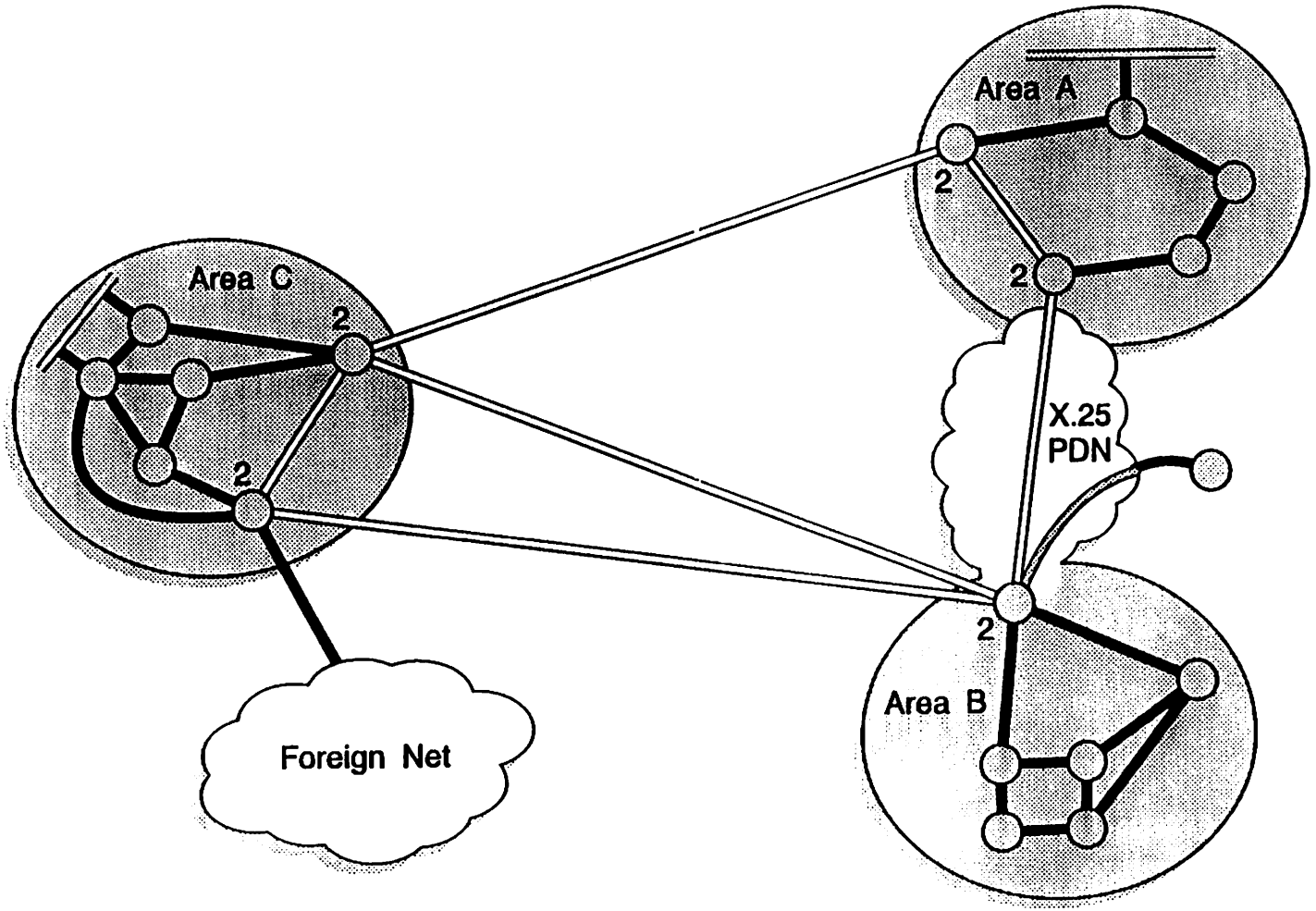
Link State Routing

- Nodes sense their local environment (links, neighbors)
- Node broadcast this information to the entire network
- Each node builds up a topological map of the whole network
- Each node independently computes routes
- Updates in local environment status are conveyed via Link State Protocol data units (LSPs)

Advantages And Disadvantages Of Link State Routing

- Advantages
  - Scales well with network size
  - Converges rapidly after changes
  - Rarely exhibits loops and stamps them out quickly
  - Easy to diagnose: each node has a full topology map
  - Easier to secure than distance vector
- Disadvantages
  - Very difficult to design and build correctly
  - Needs specialized mechanisms to deal with highly-connected networks (e.g. LANs)

Example Of Link-State Routing

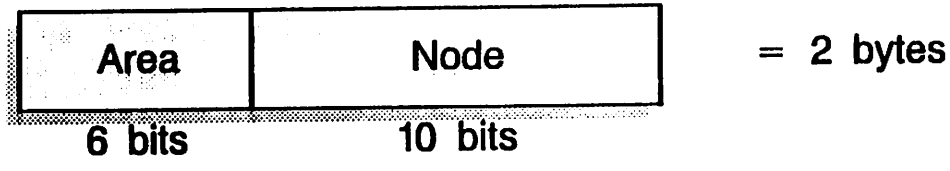


DECnet And OSI Addressing

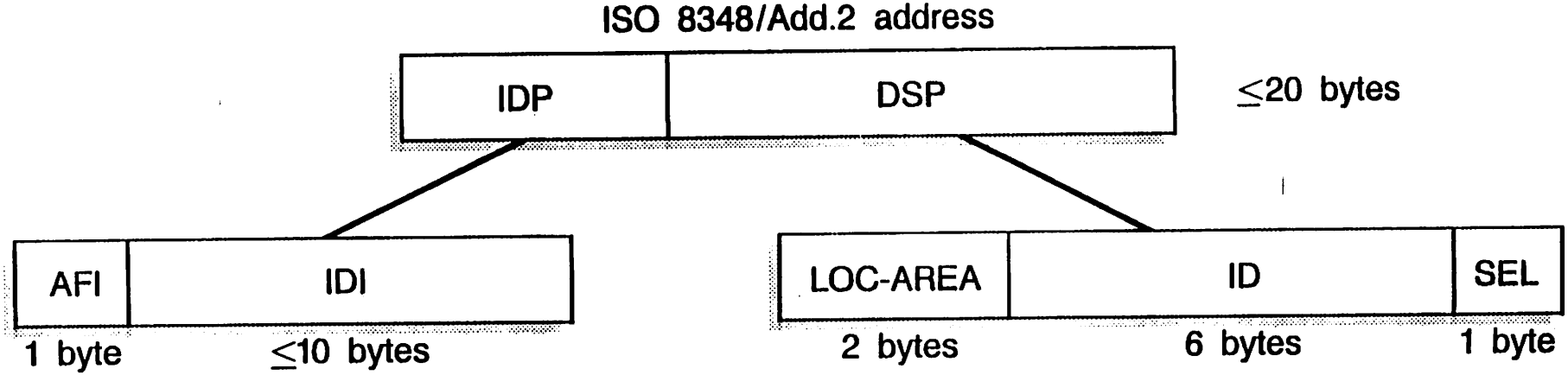
- IDP – Initial Domain Part
  - AFI - Authority and Format Identifier
  - IDI - Initial Domain Identifier - number
  - 11 bytes in length
- DSP – Domain Specific Part
  - DECnet area address
    - + 2 bytes
    - + 65,000 areas per subnet
  - DECnet ID
    - + 6 bytes
    - + 280,000,000,000,000 nodes/area
  - Protocol selection byte

Phase V Addressing

A Phase IV Network Address looks like this:



A Phase V Network Address looks like this:

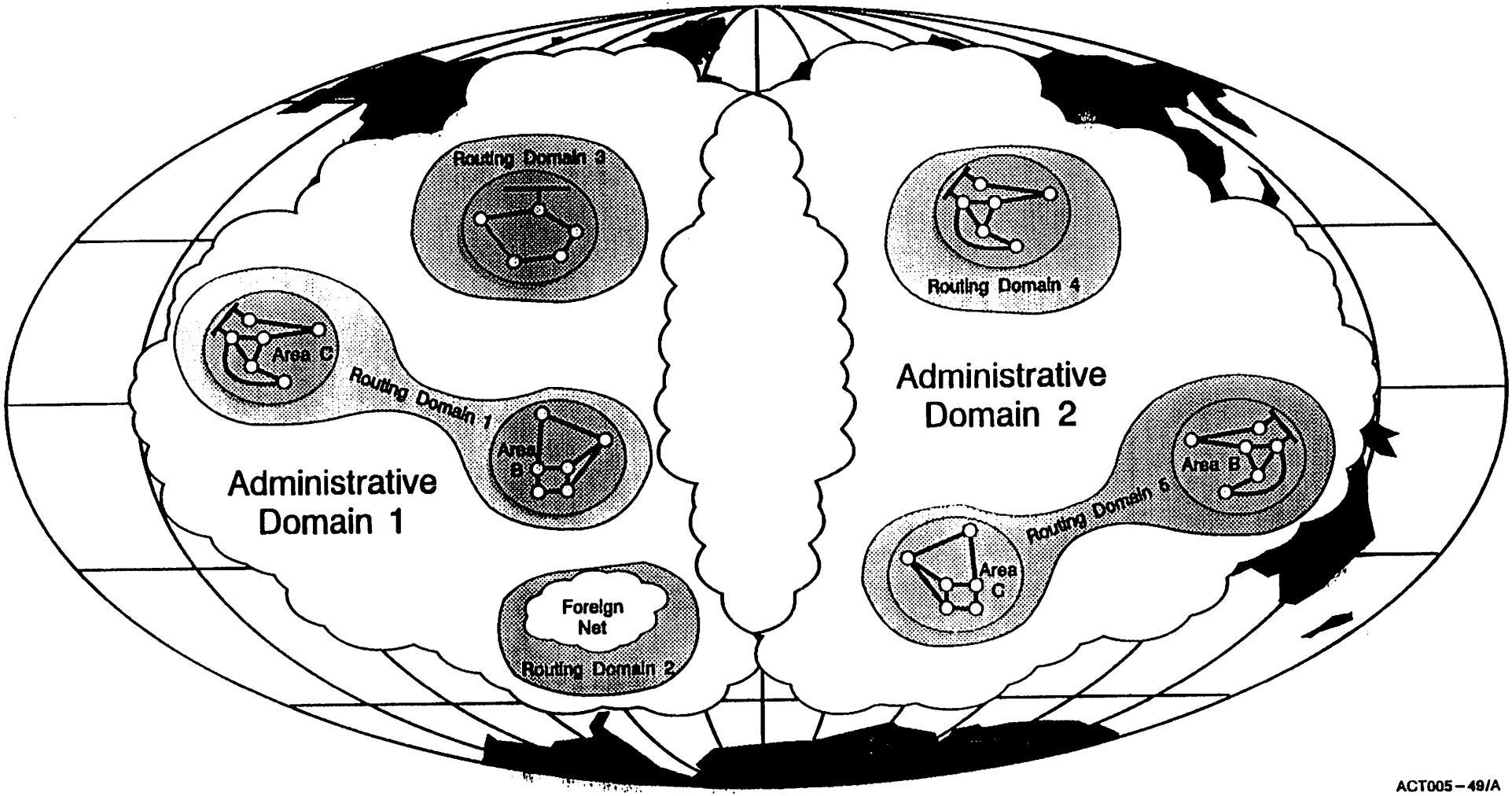


ACT005–47/A

ISO Addressing Authorities

- X.121 – for X.21 and X.25 networks
- E.163 – POTS for telephone network
- E.164 – for ISDN networks
- F.69 – for Telex
- ISO Geographic
- ISO Non-geographic

Global Address Domain

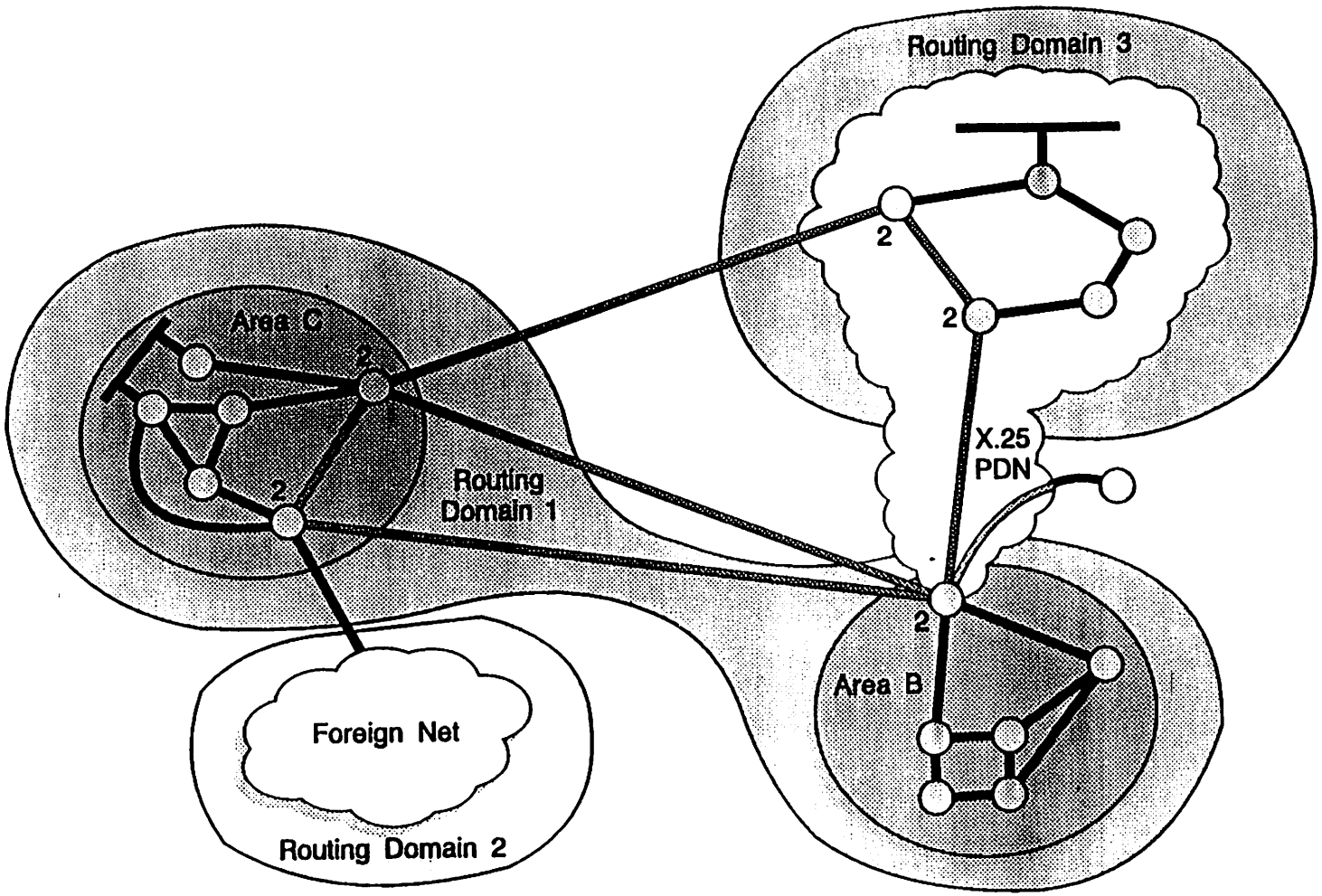


ACT005 – 49/A

DECnet/OSI Multiple Routing Domains

- Reasons for inter-domain routing:
  - Limits routing overhead
  - Scaleable for performance and management
  - Robustness - protected from MIS-management
  - Interoperability - with non-DNA routing algorithms
- Done with static or derived routing
  - Performed at the DECnet Level 2 Router
  - Suggested that it be performed by dedicated router

Example Of Multiple Routing Domains



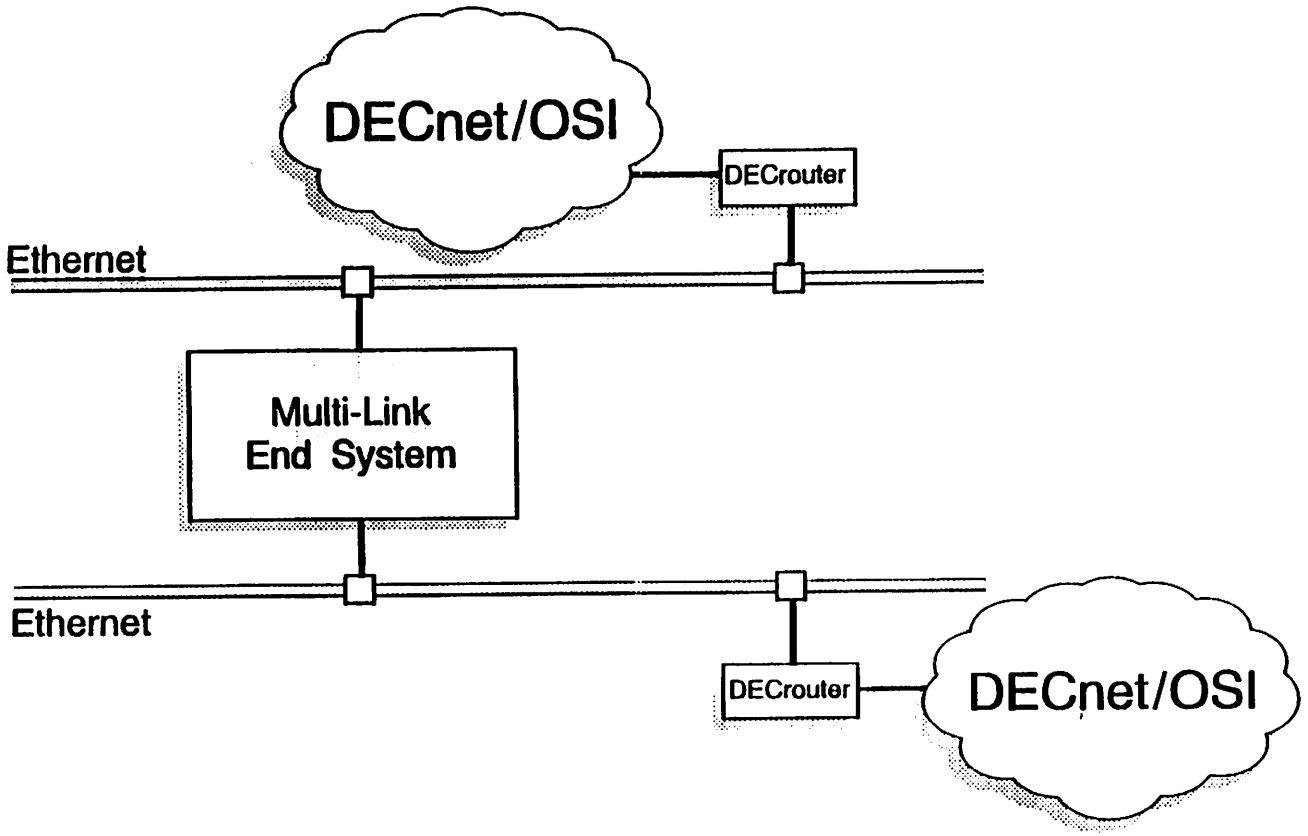
ACT005 – 51/A

Other Network Layer Features Of DECnet/OSI

- Phase V routers support Phase IV routing
- Autoconfiguration of end systems (IDP and area)
- Multi-linked end system – load sharing/ multiple subnets
- Multi-homing end system – Multiple addresses
- Dynamically established data links – X.25/X.21
- Equal cost path splitting

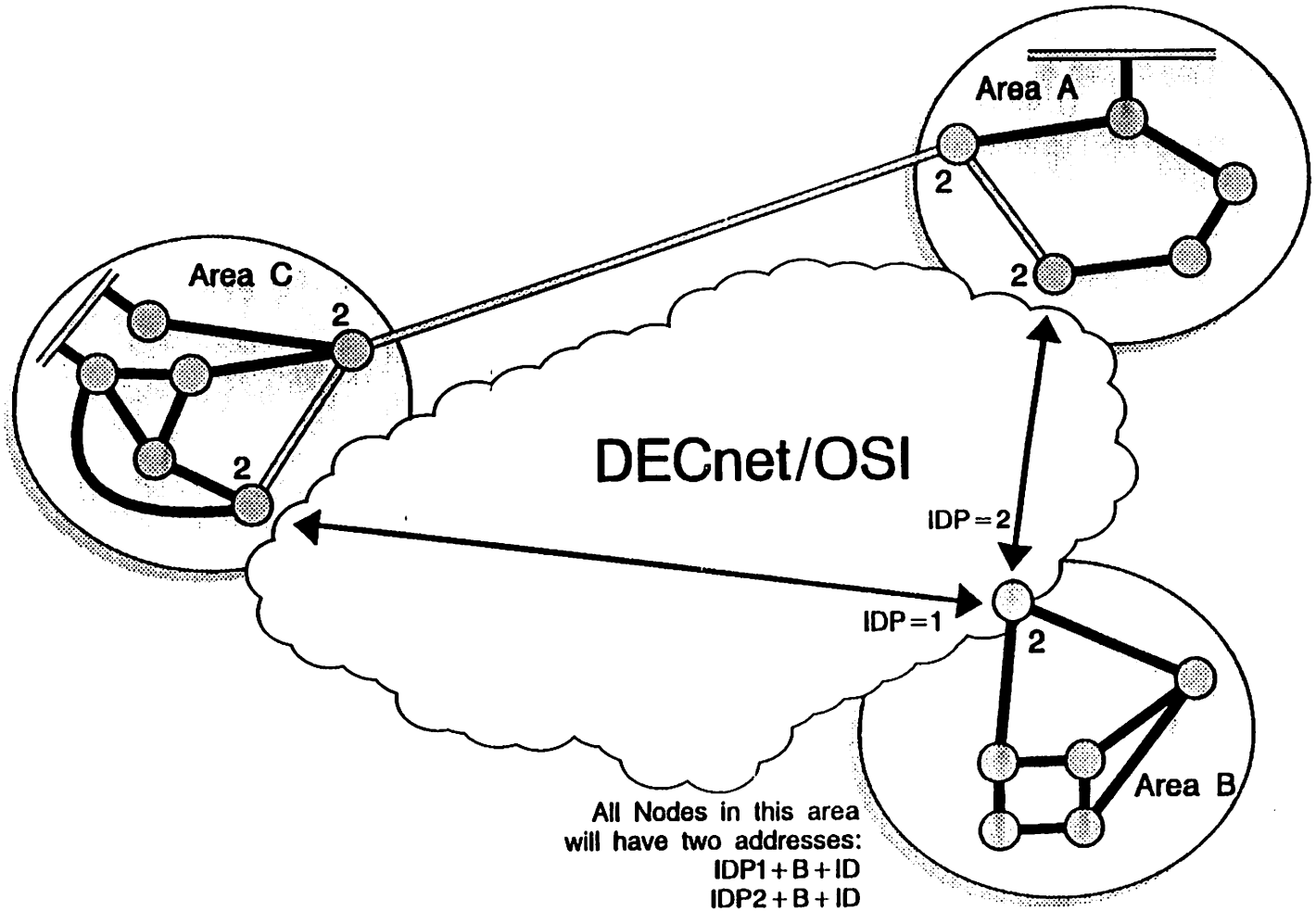
Multi-link End Systems

- An End System with more than one circuit



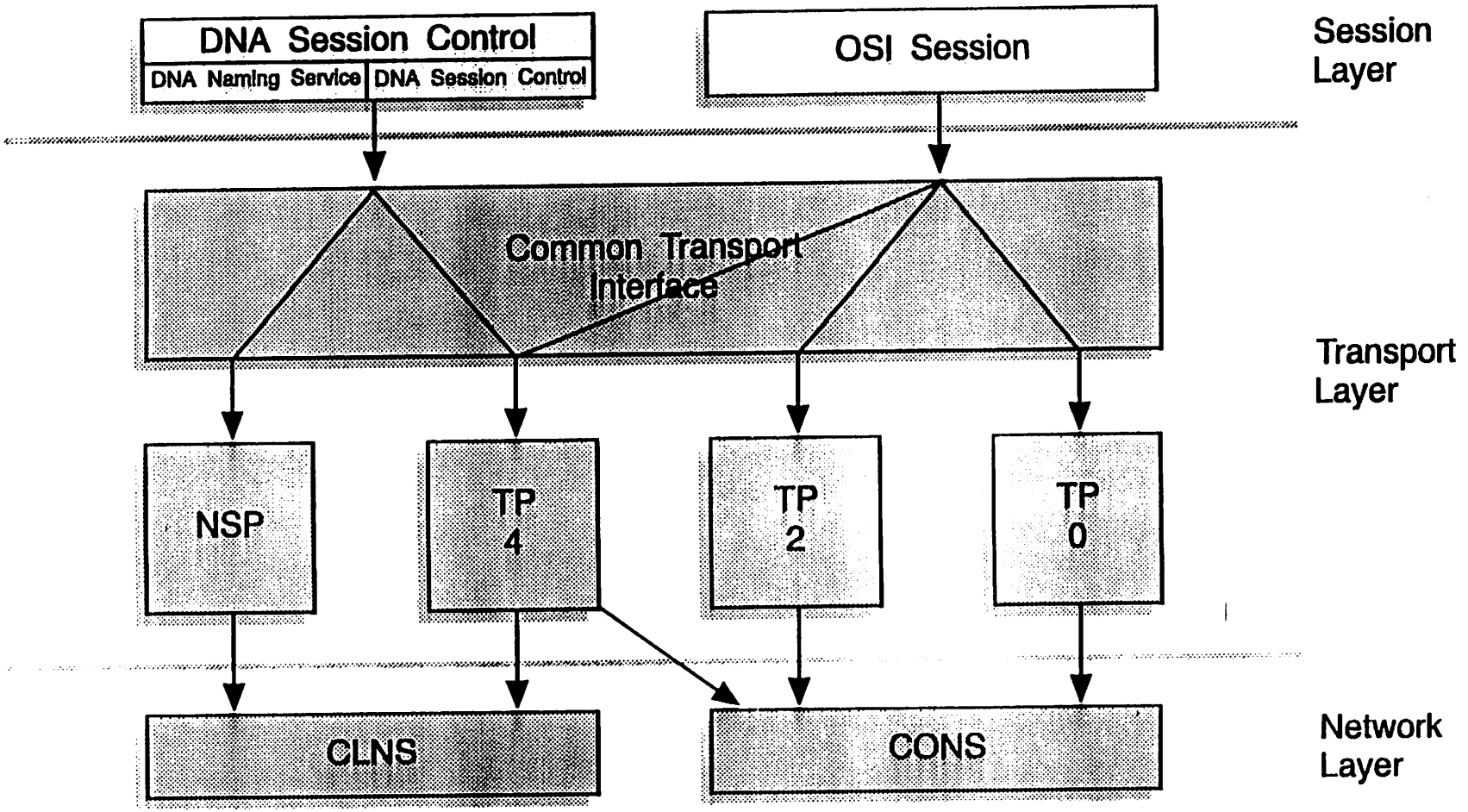
ACT005 – 53/A

Multi-homed Systems



ACT005-54/A

DECnet/OSI Tranport Protocols And Network Services



ACT005-55/A

DNA Naming Service – DECnet/OSI Session Layer

- Provides global names for nodes, devices, applications, and other objects in multiple DNA networks
- Available now as a DSS product for Phase IV
- In Phase V, it becomes a central and required part of DECnet for all DNA implementations
- Design goals:
  - Scaleable
  - Robust
  - Self configuring
  - Fast
  - Totally decentralized management

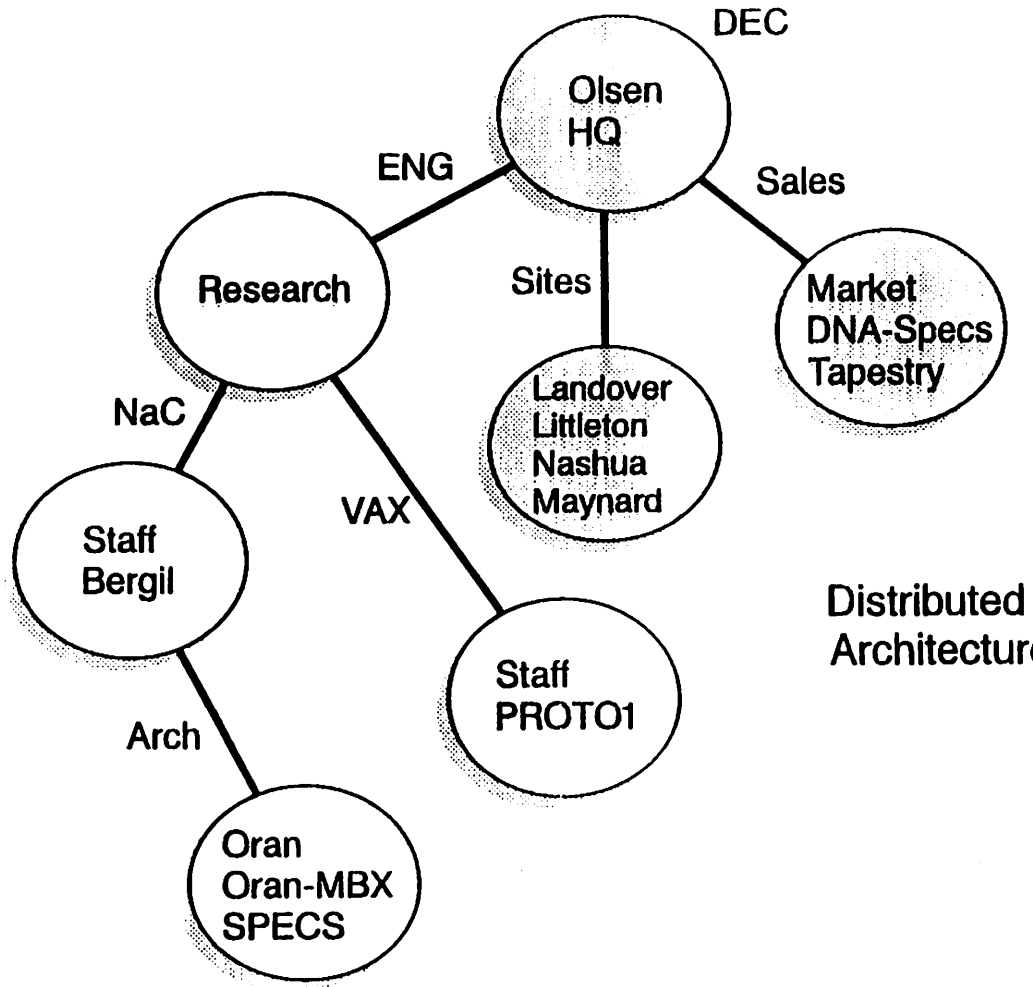
Naming Service Concepts

- Names are stored in directories.
  A directory can contain:
  - Object entries
  - Child directory entries
  - Soft links
- Directories are linked together into a rooted tree, called a namespace
- Namespaces, and all entries therein, have globally unique identifiers associated with them

Example Names

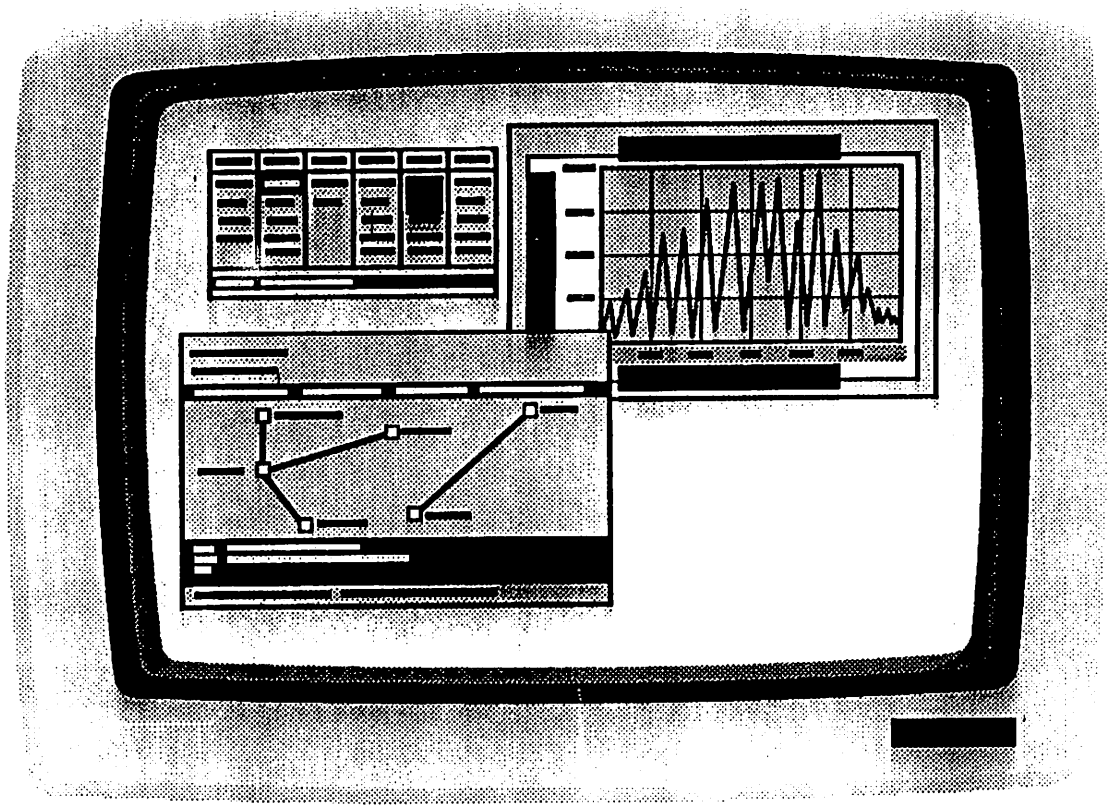
- Parts.widgets.left-handed.SMOKESHIFTER
- Government:Treasury.Bills.CurrentSeries
- DEC:.Engineering.Networks.Arch.Specifications
- ULTRIX.Sources."OSITransport.c"
- DNA$ReverseTranslation.%X09004532AB

Example Namespace



Distributed Systems Architecture

Open Systems Enterprise Management Architecture



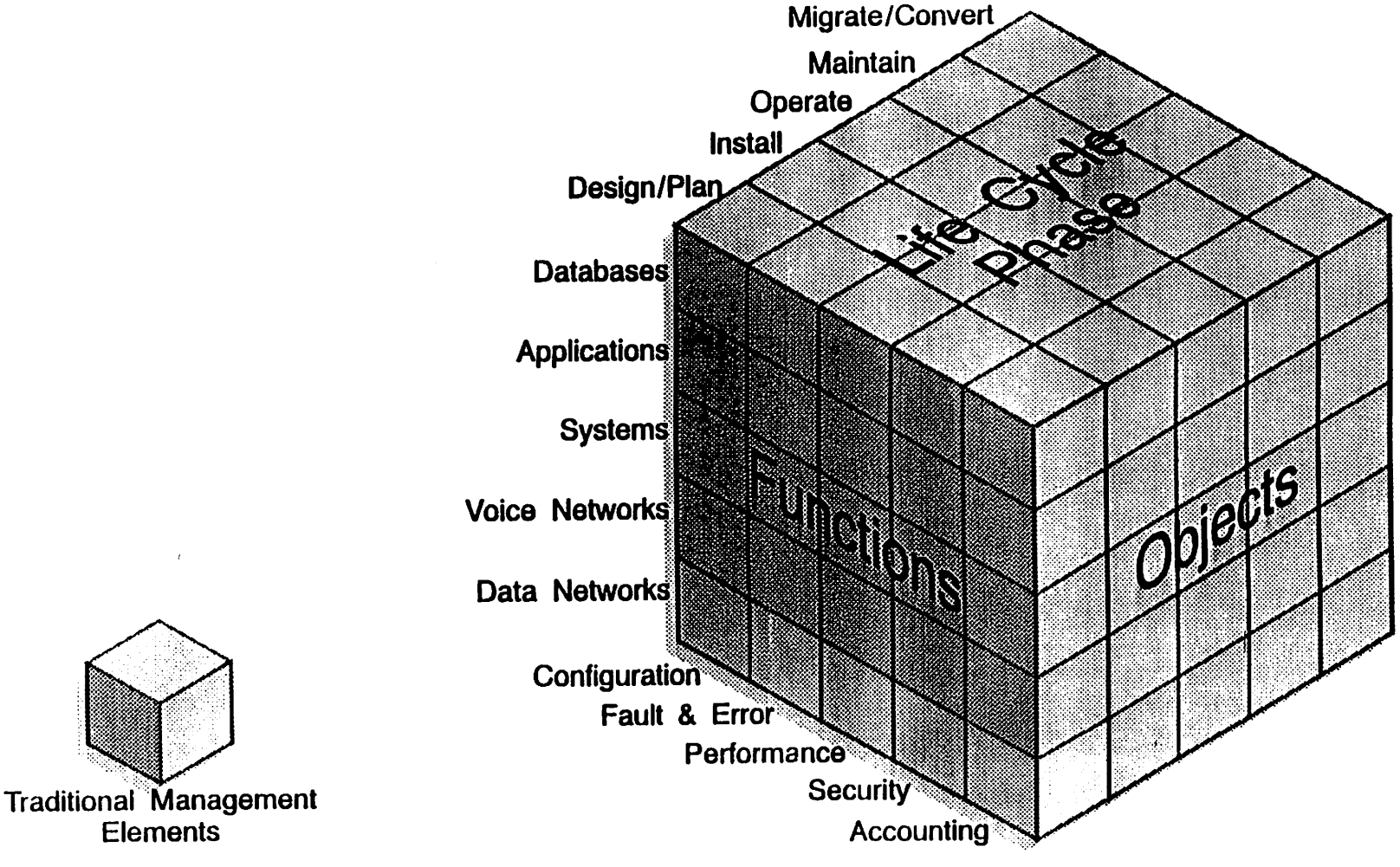
Network Management

- Common Management Information Protocol/ Common Management Information Service – CMIP/CMIS
  - Management Information Control and Exchange – MICE
  - Management Event Notification – MEN
  - Replaces NICE and EVL
- Maintenance Operation Protocol – MOP
  - Down/up line loading
  - Link loopback testing
  - Remote system console control
- Network Control Language – NCL
  - User access to network management
  - Scripting and wildcarding
  - Access to name server for nodes
  - Migration module for Phase IV nodes

Enterprise Management Architecture – EMA

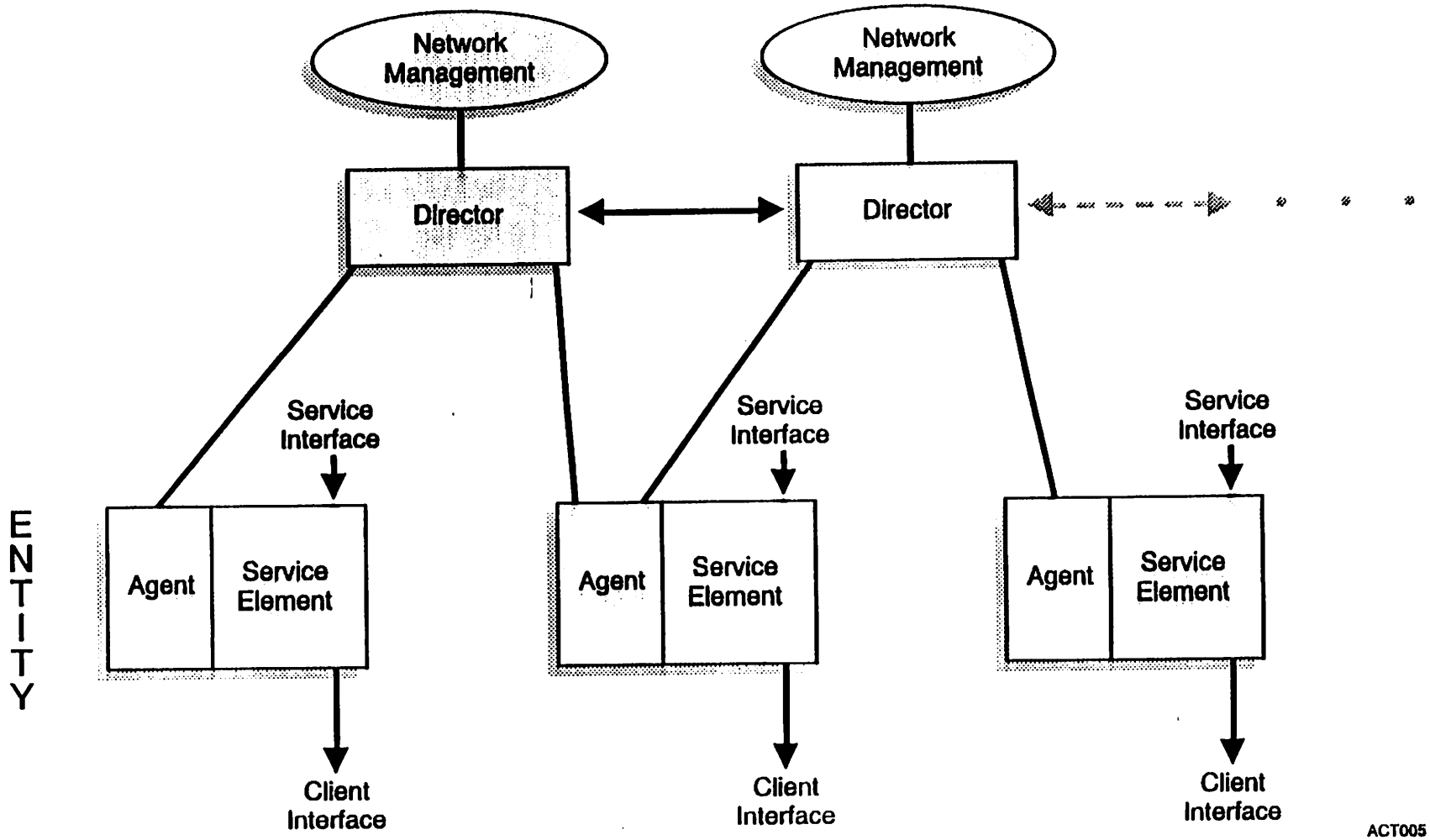
- Standards based architecture addresses all OSI management areas
- Open, consistent, and easy to use modular interfaces
- Flexible management domains
- Consistent database of management information
- 'Entity-Director' model
- Allow for monitoring and control of DNA and non-DNA networks

Digital's Enterprise Network Management Vision



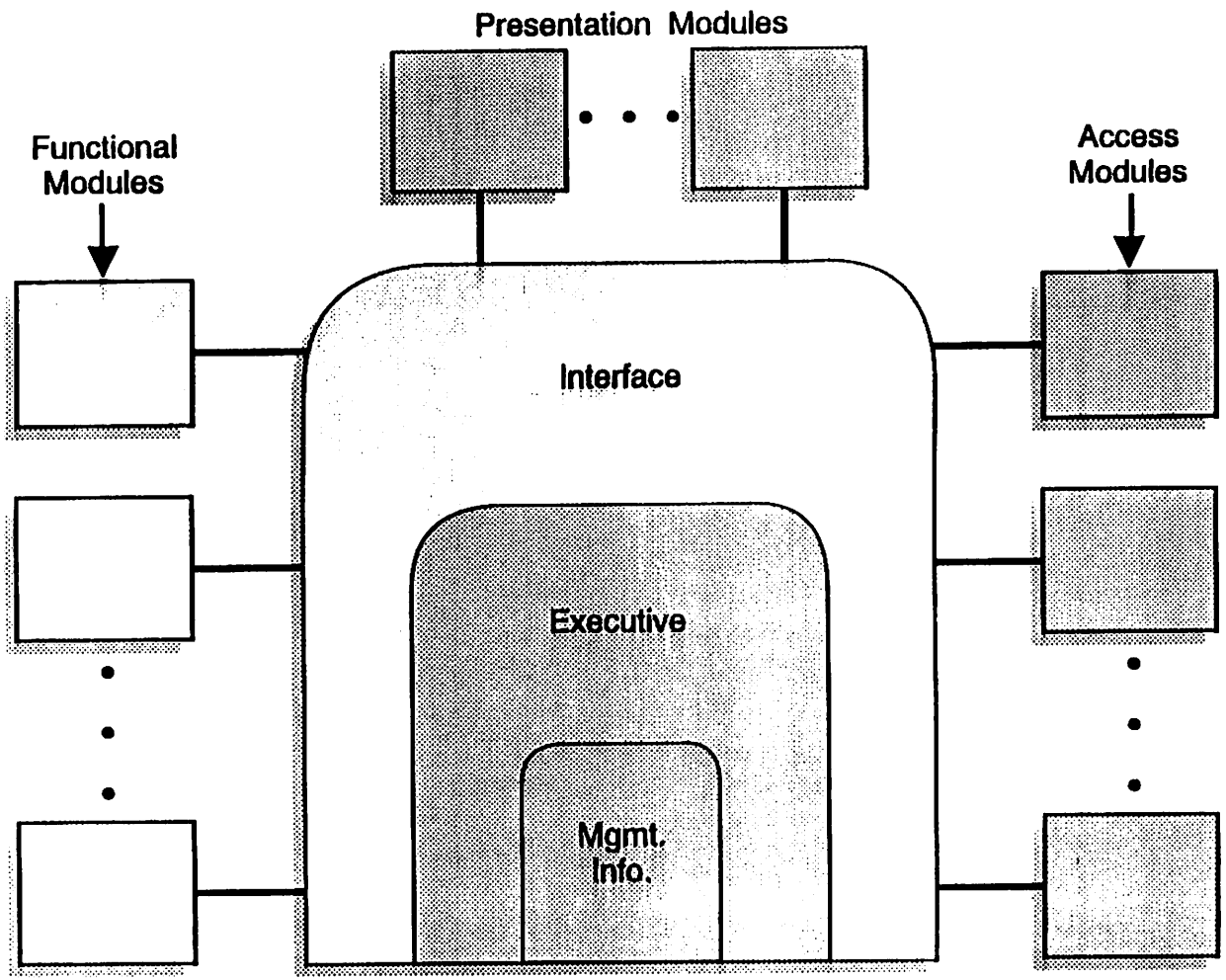
ACT005 – 63/A

Director Entity Model



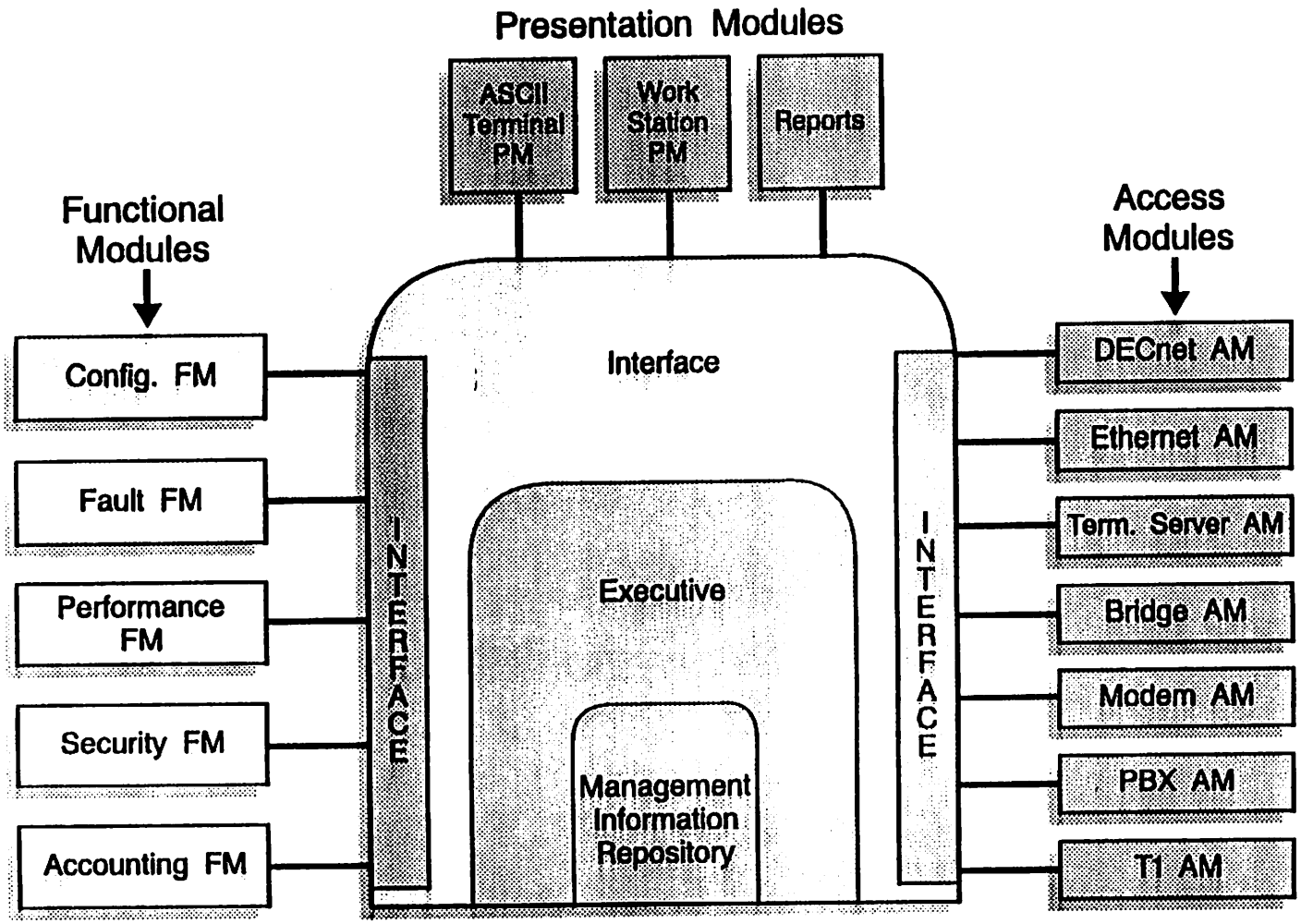
ACT005 – 64/A

Digital's Enterprise Management Architecture



ACT005 – 65/A

EMA System Structure



ACT005-68/A

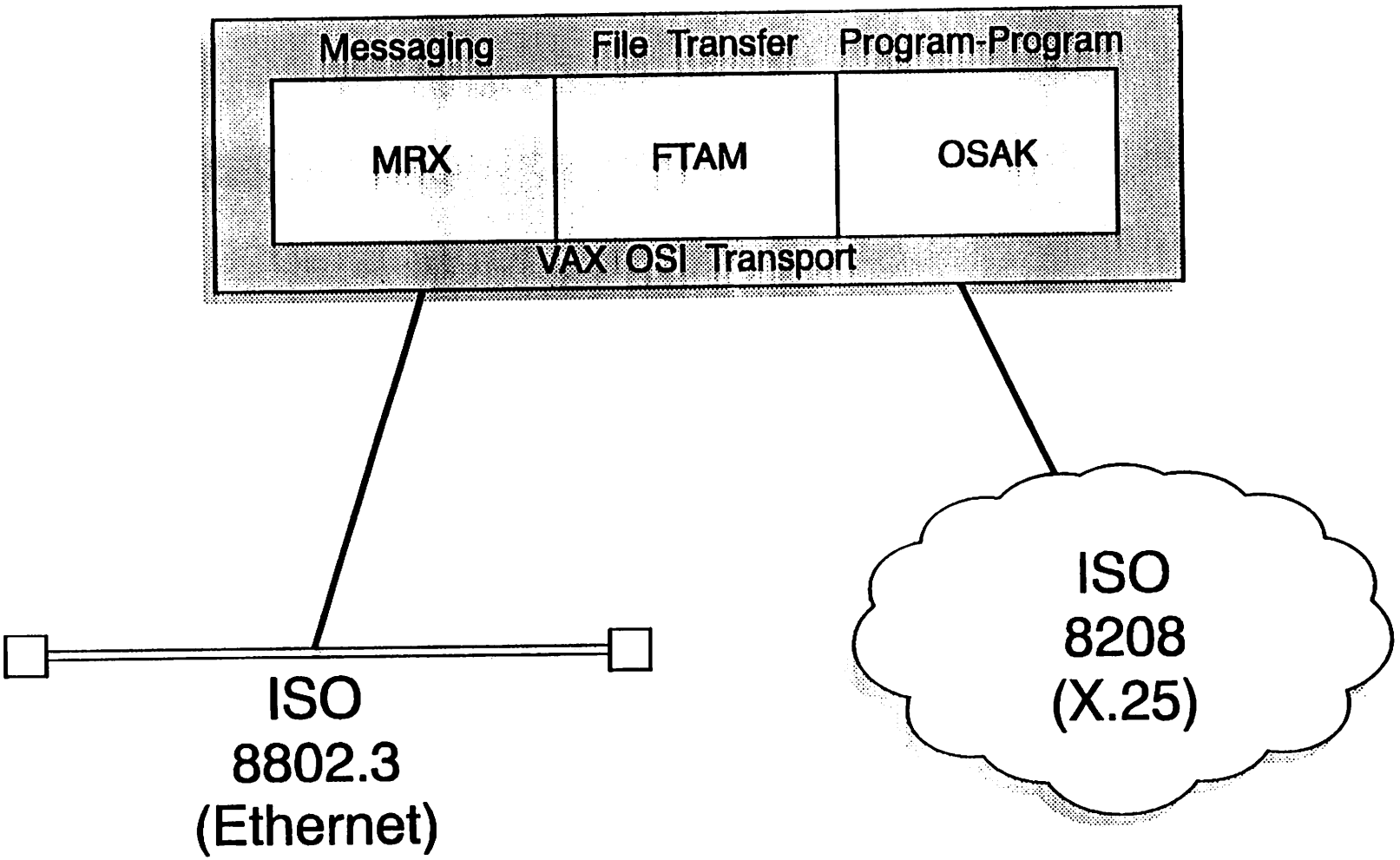
Topics

- The Value of Standards
- Seven Layer OSI Model
- OSI Products and Applications
- DECnet/OSI
- DECnet/OSI Phase V Migration

OSI Products And Applications

- Message Router X.400 Gateway – MR/X
- File Transfer and Access Management – FTAM
- VAX OSI Application Kernel – OSAK

Digital Provides OSI Today

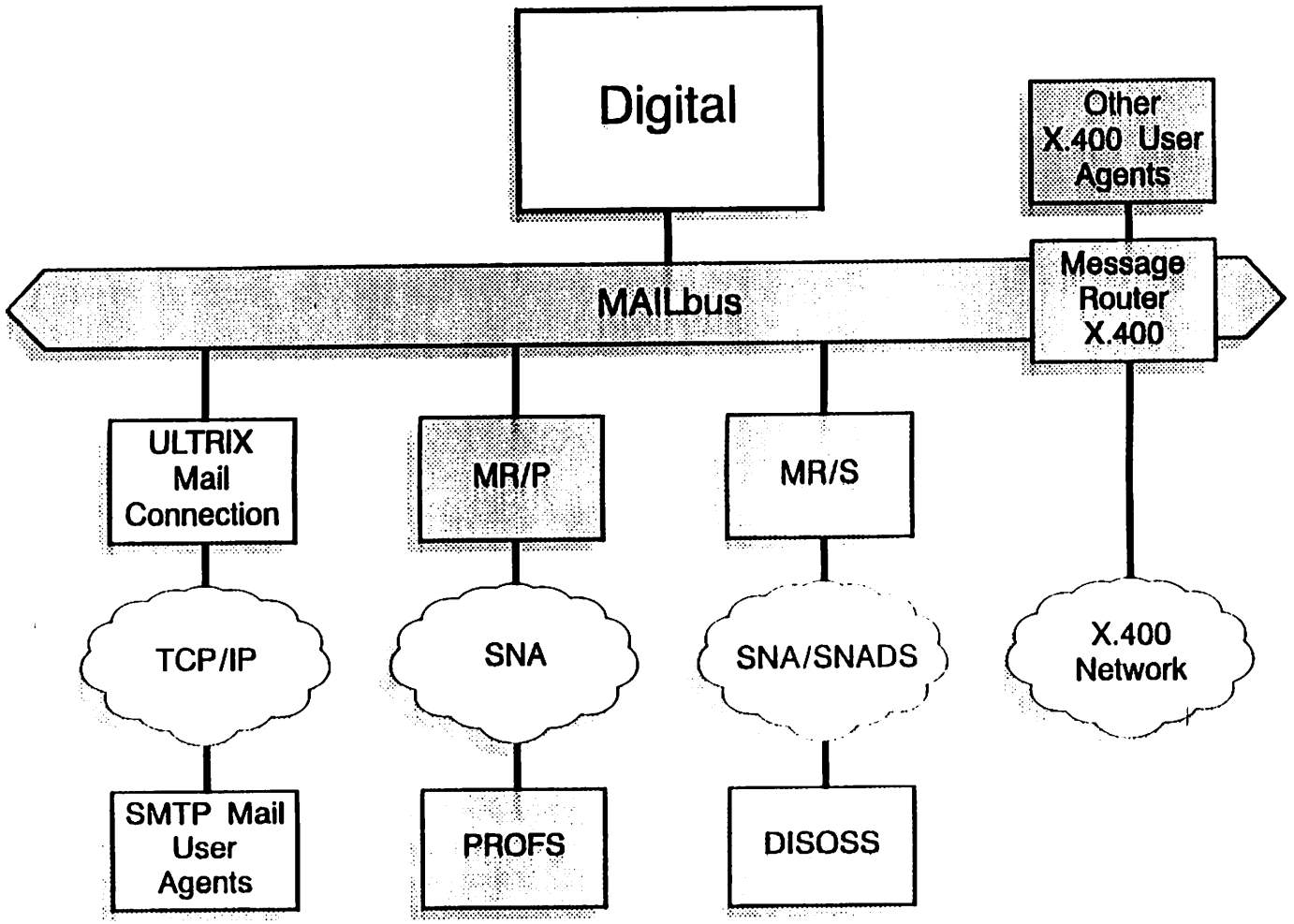


ACT005–69/A

Message Router X.400 Gateway – MR/X

- Layered VMS application
- Conforms to CCITT X.400 1984 recommendations
- Demonstrated interworking with over 30 vendors
- Allows access from all Digital MAILbus products to X.400 conforming systems
- VAX OSI Transport Service – VOTS included to provide the Network, Transport, and Session Layers of the OSI stack
- Operates over X.25 WAN or ISO 8802–3 LAN

Message Router X.400 (MRX)



ACT005-71/A

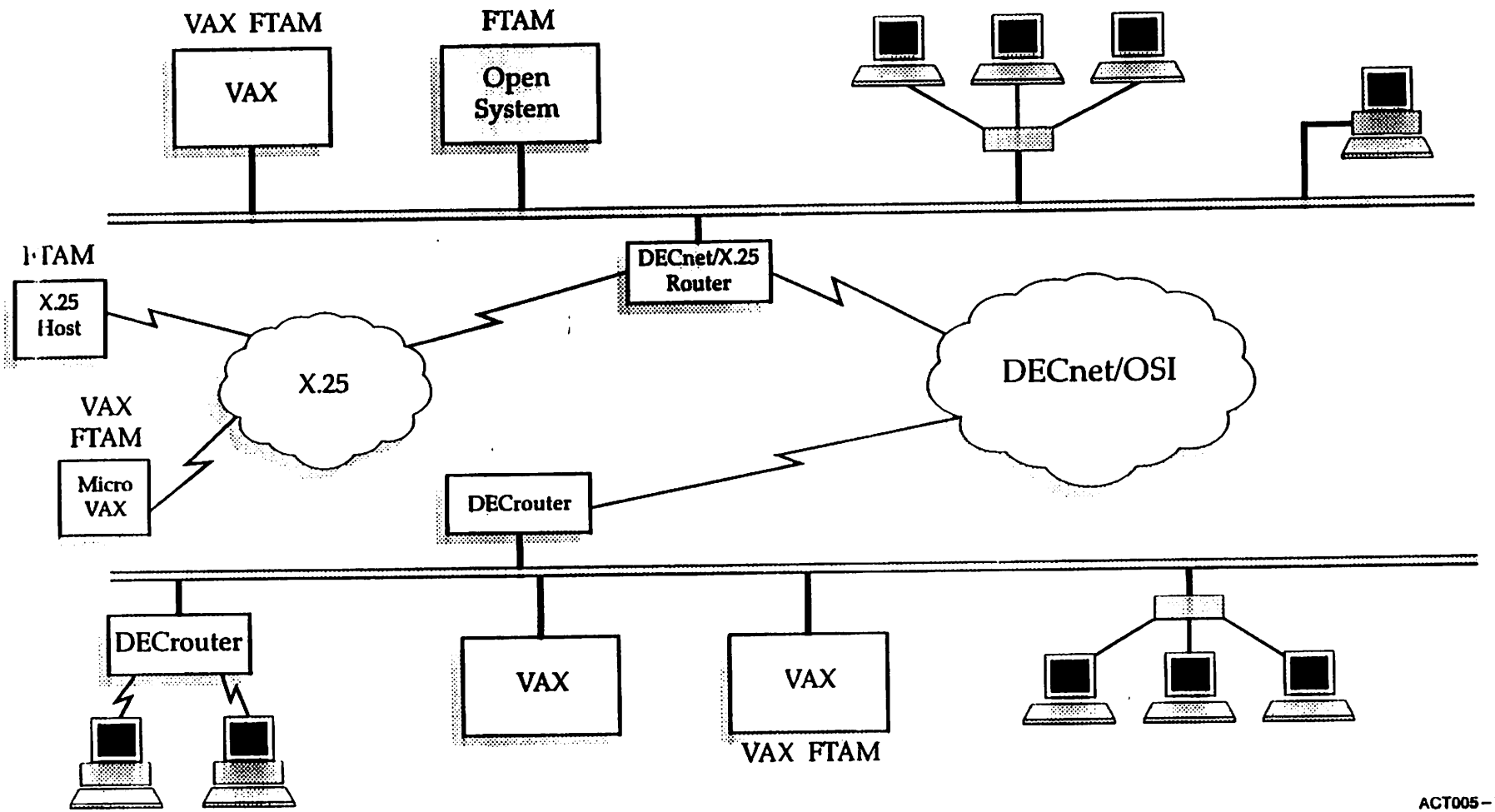
File Transfer, Access And Management Service – FTAM

- Layered VMS application
- Uses ISO 8571 – File Transfer, Access and Management protocol
- Allows transfer and access of files with other FTAM compliant systems
- Supports:
  - FTAM 1 - unstructured files with ACSII data and stream record formats
  - FTAM 2 - sequential text files with variable record formats and carriage return attributes
  - FTAM 3 - unstructured files with binary data and stream record formats

File Transfer, Access And Management Service – FTAM

- Supports any file naming convention
- Includes control programs, tracing utilities, event logging and reporting
- VOTS included to provide the Network, Transport, and Session Layers
- Operates over X.25 WAN or ISO 8802–3 LAN

File Transfer, Access And Management Service – FTAM



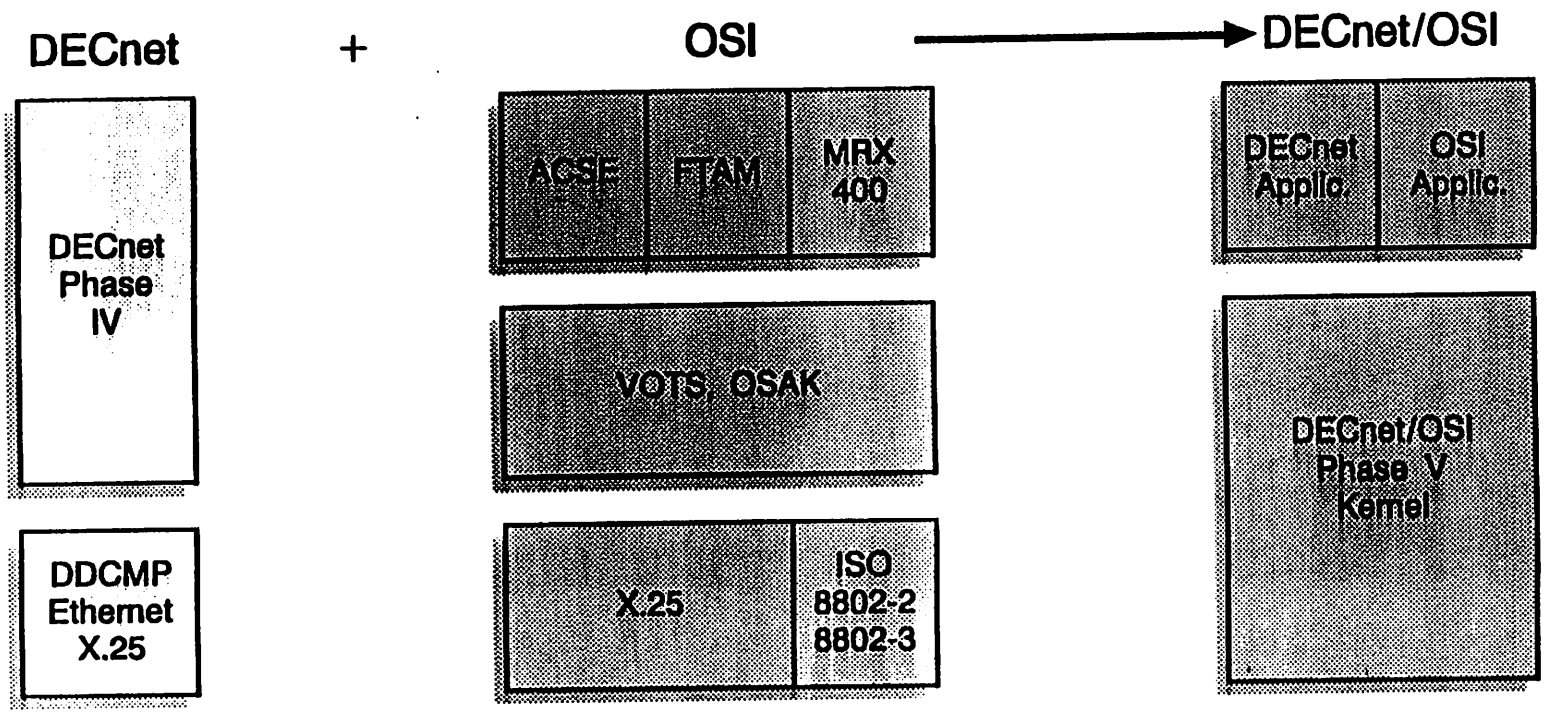
ACT005–74/B

VAX OSI Application Kernel – OSAK

- Layered VMS product
- Provides application interfaces to the OSI session (ISO 8327), Transport (ISO 8073), and Network layers (ISO 8473)
- Allows application developers to create OSI-based applications
- Conforms to Session Layer protocol ISO 8327
- Operates over X.25 WAN or ISO 8802-3 LAN

ACT005–75/A

OSI Integration Within DECnet/OSI Phase V



ACT005-76/A

Topics

- The Value of Standards
- Seven Layer OSI Model
- OSI Products and Applications
- DECnet/OSI
- DECnet/OSI Phase V Migration

New Features Of Phase V With Regards To Migration

- The new concept of IDPs appear
- The Node ID field grows from 10 bits (1023 max) to 6 bytes (extremely large)
- The Area field grows from 6 bits (63 max) to 2 bytes (64,000)
- Network Management is enhanced and extended
- New application interfaces will appear

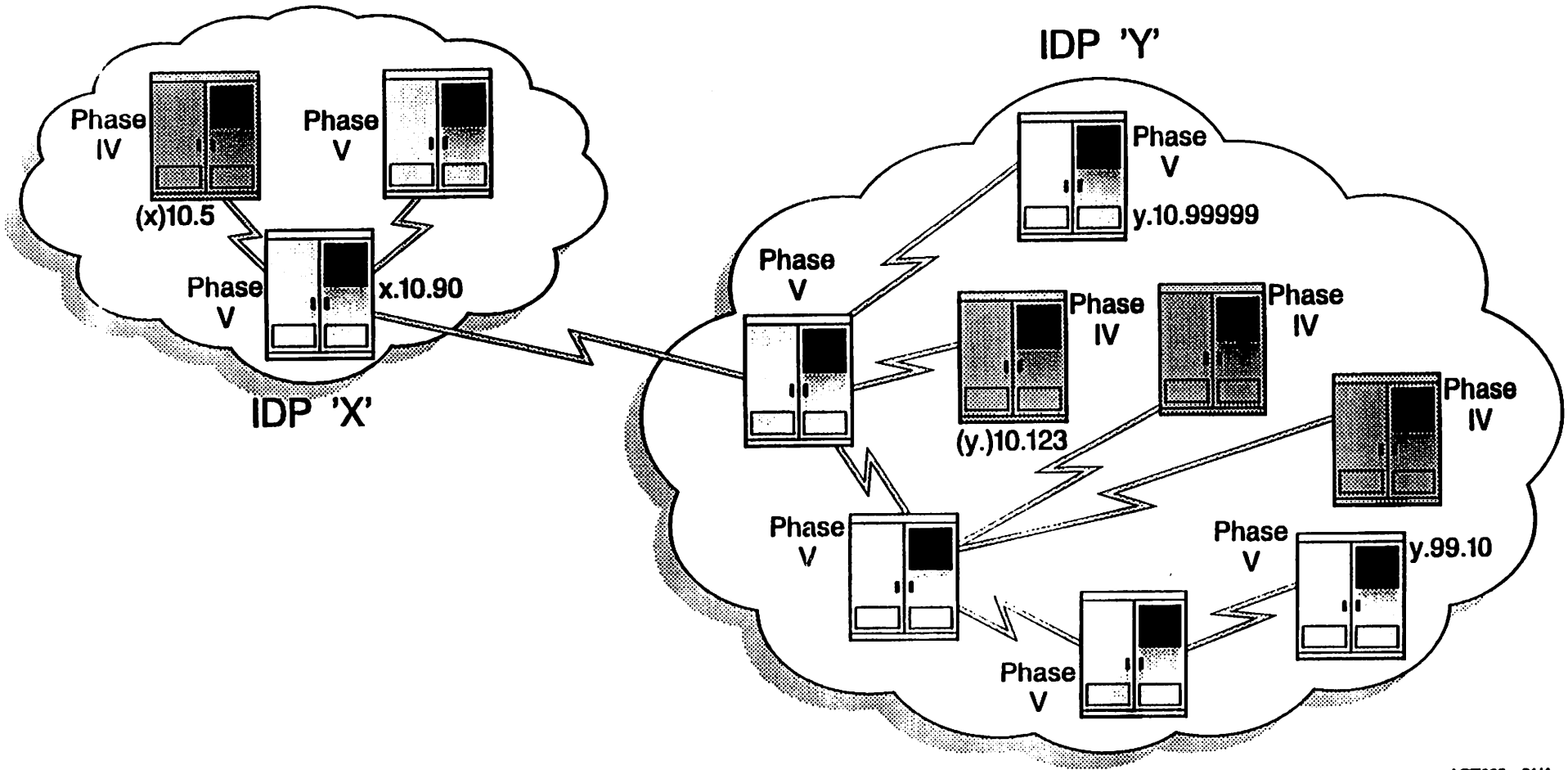
Phase IV Backwards Compatibility In Phase V Allows:

- Phase IV nodes to be directly connected to Phase V nodes
- Applications on Phase IV nodes to communicate with applications on Phase V nodes
- Applications written to use the standard Phase IV programming interfaces to run on Phase V nodes
- Network Management of both Phase IV and Phase V nodes from Phase V node

Phase IV Backwards Compatibility Rules

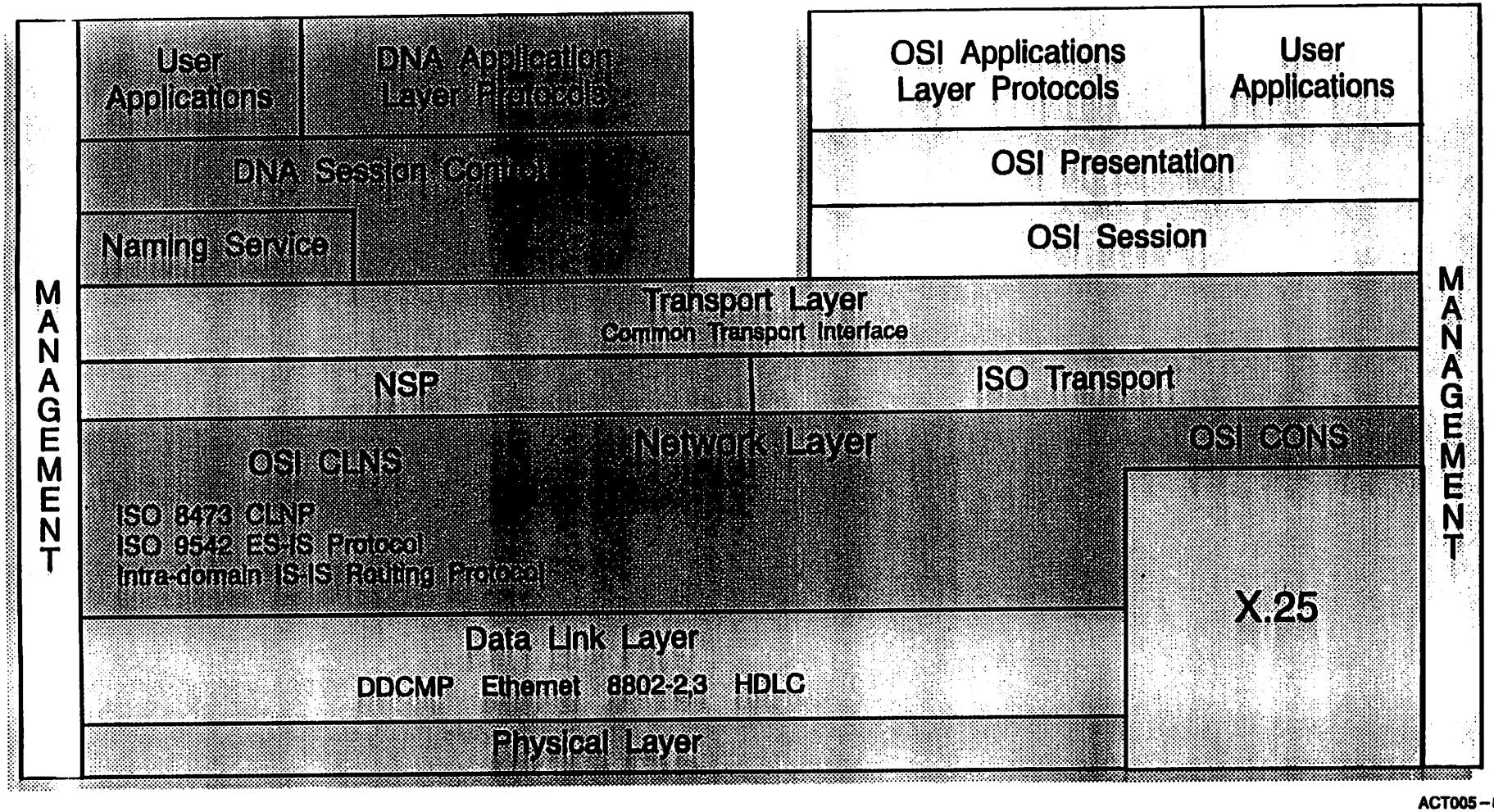
- Phase IV and Phase V nodes can be interconnected and fully interoperate if they follow the rules:
  - Phase IV nodes cannot talk to other systems with nodes IDs greater than 1023 or Areas greater than 63
  - Phase V and Phase IV nodes that wish to communicate must reside in the same IDP

Mixed Phase IV And Phase V Network



ACT005-81/A

Putting It All Together...



ACT005-82/A