Networking Standards
Mark Davies, Digital Equipment Corporation

ABSTRACT

The enterprise network is currently a multivendor environment consisting of many defacto and proprietary standards. During the 1990s, these networks will evolve towards networks which are based on international standards in both the LAN and WAN space. Also, you can expect to see the higher level functions and applications begin the same transition.
The Open Network Advantage
Market Requirements

OPEN NETWORKS!!!

- Multi-protocol, multi-platform, multi-vendor networks working together
- International AND defacto standards
- Effortless communications within and between enterprises
- Ability to move to standards at own pace
What is an Open System?

Defined as:

A vendor-neutral computing environment:

- compliant with International and defacto standards
- permits system and network interoperability or software applications portability
- includes consistency of data and human access
- satisfies one or more of a business's functional requirements
Standards

Benefits from networks based on international and defacto standards

- Vendor independence
- Applications portability
- Investment protection
- Improved communications leading to increased productivity
- Network flexibility
Network Architectures: DECnet, OSI, TCP/IP

DECnet
- Application
- DNA Session Control
- Transport (NSP)
- Network (CLNS)
- Data Link
- Physical

OSI
- Application
- Presentation
- Session
- Transport (TP 0,2,4)
- Network (CLNS/CONS)
- Data Link
- Physical

IP
- Internet Applications Protocols
- Transport (TCP / UDP)
- Network (IP)
- Data Link
- Physical
What is TCP/IP?

- a.k.a. ----> The Internet Protocol Suite
- In use since late 1970s
- Developed for Advanced Research Project Agency Network (ARPANET)
- Used to allow interaction of many private ARPA subnetworks in government and research
- Inclusion with Berkeley UNIX encouraged rapid growth
- Growth of UNIX-based workstations and multivendor networking, in lieu of OSI, insures a long life for TCP/IP
The Internet Protocols

- Physical/Datalink (Ethernet, X.25)

- Network Layer
  -- Internet Protocol (IP)
  -- Internet Control Message Protocol (ICMP)
  -- Address Resolution Protocol (ARP)
  -- Internet Gateway

- Transport Layer
  -- Transmission Control Protocol (TCP)
  -- User Datagram Protocol (UDP)

- Applications Layer
  -- Simple Mail Transfer Protocol (SMTP)
  -- File Transfer Protocol (FTP)
  -- Virtual Terminal (TELNET)
  -- Network File System (NFS)
### The Internet Protocols (TCP/IP)

<table>
<thead>
<tr>
<th>Layer</th>
<th>Protocols</th>
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<td>7 – Application</td>
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<td>6 – Presentation</td>
<td>XDR</td>
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<td>4 – Transport</td>
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<tr>
<td>1 – Physical</td>
<td>Ethernet / Point-to-Point</td>
</tr>
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</table>
What is OSI?

- Emerging technology
- a.k.a. —> Open Systems Interconnection
- A layered network architecture
  based on a seven-layer model
- Developed by the International Organization
  for Standardization (ISO)
- OSI defines the standards for communications
  between open systems on a global scale
- Supported by governments and major computer
  vendors (Digital, IBM, HP,
  Sun, UNISYS, Siemens, etc)
- Required by Government OSI Profiles (GOSIP)
- Foundation for global addressing and
  new distributed applications (EDI)
GOSIP in the Open Systems Environment

Elements of a standards based "Open System":

**APPLICATION SOFTWARE**

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<th>5</th>
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<tr>
<td>OPERATING SYSTEM SERVICES</td>
<td>USER INTERFACE SERVICES</td>
<td>PROGRAM SERVICES</td>
<td>DATA MGMT. SERVICES</td>
<td>DATA INTERCHG SERVICES</td>
<td>GRAPHICS SERVICES</td>
<td>NETWORK SERVICES</td>
</tr>
</tbody>
</table>

**APPLICATION PLATFORM**

1. POSIX.1, POSIX.2, GNMP, POSIX.6
2. FIPS 158 - X Window System
3. Ada, C, COBOL, FORTRAN, PASCAL, PCTE+, SCCS
4. IRDS (Data Dict/Dir Component), SQL, RDA
5. ODA/ODIF, SGML, CGM, IGES, STEP
6. GKS, PHIGS
7. FIPS 146 - GOSIP
<table>
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<th>STANDARDS:</th>
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<td>VIRTUAL TERMINALS</td>
<td>VTP</td>
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<td>USER INTERFACES</td>
<td>X WINDOWS/MOTIF</td>
</tr>
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<td>DIRECTORY SERVICES</td>
<td>X.500</td>
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<tr>
<td>TRANSACTION PROCESSING</td>
<td>ISO TP</td>
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<tr>
<td>REMOTE PROCEDURE CALLS</td>
<td>RPC</td>
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<tr>
<td>APPLICATION PORTABILITY</td>
<td>X/OPEN</td>
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<tr>
<td>INTER-NETWORK</td>
<td>ISO IS - IS (DP 10584)</td>
</tr>
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<td>ISO ES - IS (ISO 9542)</td>
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<tr>
<td>LOCAL AREA NETWORK</td>
<td>ISO 8802</td>
</tr>
<tr>
<td>OFFICE AUTOMATION</td>
<td>ODA/ODIF</td>
</tr>
<tr>
<td>CIM</td>
<td>MMS/MAP</td>
</tr>
</tbody>
</table>
# U.S. GOSIP Standards Based System Elements

## APPLICATION LAYER

<table>
<thead>
<tr>
<th></th>
<th>MHS</th>
<th>FTAM</th>
<th>ODA</th>
<th>VTP</th>
<th>EDI</th>
<th>MHS</th>
<th>X.500</th>
<th>NET MGT</th>
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<tr>
<td>7</td>
<td>X.400</td>
<td>ISO 8571</td>
<td>ISO 9041</td>
<td>ANSI X.12</td>
<td>1988</td>
<td>ISO 9594</td>
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## PRESENTATION LAYER

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<tr>
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## SESSION LAYER

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<tr>
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<th>ISO 8327</th>
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## TRANSPORT LAYER

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<thead>
<tr>
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<th>TRANSPORT CLASS 4</th>
<th>TRANSPORT CLASS 0</th>
<th>CONNECTIONLESS</th>
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<tbody>
<tr>
<td>4</td>
<td>ISO 8073</td>
<td>ISO 8073</td>
<td>ISO 8602</td>
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</table>

## NETWORK LAYER

<table>
<thead>
<tr>
<th></th>
<th>CLNP</th>
<th>SNDCF</th>
<th>X.25 PLP</th>
<th>CONS</th>
<th>ISDN</th>
<th>ES-IS</th>
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<tr>
<td>3</td>
<td>ISO 8473</td>
<td>DP 10584</td>
<td>ISO 8208</td>
<td>ISO 8348</td>
<td>Q.931</td>
<td>ISO 9542</td>
<td>DP 10584</td>
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</table>

## DATA LINK LAYER

<table>
<thead>
<tr>
<th></th>
<th>802.2, LLC TYPE 1 CLASS 1</th>
<th>HDLC LAPB</th>
<th>ISDN LAPD</th>
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<tr>
<td>2</td>
<td>ISO 8802/2</td>
<td>ISO 7776</td>
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## PHYSICAL LAYER

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<tr>
<th></th>
<th>802.3</th>
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<th>802.5</th>
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U.S. GOSIP Version 1.0

Requirements Summary:

- Issued January 1989 as FIPS-146
- Mandatory in RFPs as of August 1990
- FTAM- Phase 2
  - Limited Purpose
    T1 Simple File Transfer
    M1 Management
  - Full Purpose
    T2 Positional File Access
    A1 Simple File Acess
    M1 Management
  - Initiator/responder, Sender/Receiver
  - Transport Protocol Class, Connectionless Network Service
- MHS
  - CCITT X.400 MHS 1984
  - P1, P2
  - TP 0, CONS, X.25 or TP4, CLNS
U.S. GOSIP Version 2.0

Requirements Summary:

- Issued March 1991 Revision to FIPS 146
- Mandatory in RFPs as of October 1992
- FTAM Phase 2
  - Full Purpose
    T1,T2 Simple, Positional File Access
    A1 Simple File Access
    M1 Management
    FTAM 1,2,3 Document Types
    Initiator/Responder, Sender/Receiver
- VTP
  - Telnet
  - Forms (optional)
  - TP4, CLNS
- MHS
  - CCITT X.400 MHS 1984
  - P1,P2
  - TP 0, CONS, X.25 or TP4, CLNS
- Office Document Architecture
## Summary Protocols

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>Internet</th>
<th>DECnet</th>
<th>OSI</th>
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<tbody>
<tr>
<td>Application</td>
<td>FTP</td>
<td>DAP</td>
<td>FTAM</td>
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<tr>
<td></td>
<td>TELNET</td>
<td>CTERM</td>
<td>VTP</td>
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<td>SMTP</td>
<td>MAIL11</td>
<td>X.400</td>
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<tr>
<td>Presentation</td>
<td>TCP</td>
<td>NSP</td>
<td>TP4</td>
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<td></td>
<td>UDP</td>
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<td>TP0, CLTS</td>
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<tr>
<td>Session</td>
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<tr>
<td>Transport</td>
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<td>Routing</td>
<td>CLNP, IP</td>
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<td>ICMP, ARP</td>
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<td>ESIS</td>
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<td>Network</td>
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<tr>
<td>Data Link</td>
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<tr>
<td>Physical</td>
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<td>Ethernet</td>
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</tbody>
</table>
Coexistence and Transition Techniques

Protocol Based:

- Dual Stacks
- Hybrid Stacks
- Transport Gateway
- Applications Gateways
- Transport Layer Interfaces
- Multi-Protocol Routers

Service Based:

- Transport Service Bridge
- Portals or Tunnels
FDDI and OTHER LAN STANDARDS

IEEE 802.1

IEEE 802.2 LLC
Logical Link Control

DATA LINK LAYER

IEEE 802.3
CSMA/CD

IEEE 802.4
TOKEN BUS

IEEE 802.5
TOKEN RING

PHYSICAL LAYER

FDDI

MAC

PHY

SMT

PMD
Estimated time frames for commercial introduction of new public network services
What is DECnet / OSI Phase V?
o Next Generation Networking Environment for the 1990s

o Based on 15 years of DECnet experience in peer to peer networking

o One framework for Small to Large Heterogeneous Networks

o Set of Common Network Services and Applications across Digital and industry standard operating environments

o Base for Key Layered Services
What is Digital Doing?

- Integration
- Products
Integration

- Provide coexistence of standard and proprietary protocols
- Provide transparency of OSI and TCP/IP network to the user
- Expand network address size in anticipation of global OSI networks
- Enhance network management capabilities based on network management standards
DECnet / OSI Phase V
Foundation for Network Application Support

OSI SYSTEMS
VAX SYSTEMS
RISC SYSTEMS

Network Application Support

IBM
Other OSI vendors

VMS
UNIX
MS-DOS
OS/2
MAC
Terminals
<table>
<thead>
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<th>Services offered:</th>
<th>Products:</th>
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<tr>
<td>Windowing Services</td>
<td>DECwindows, X Windows / Motif</td>
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<tr>
<td>Messaging Services</td>
<td>MAILbus™ Family, EDI, X.400</td>
</tr>
<tr>
<td>Data Access Services</td>
<td>SQL/Services, RDB, DBMS, VIDA for DB2, FTAM</td>
</tr>
<tr>
<td>Terminal Services</td>
<td>LAT, TELNET, CTERM, VTP</td>
</tr>
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<td>Directory Services</td>
<td>DECdns, X.500</td>
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<td>Office Automation</td>
<td>All-IN-1™ Phase II, CDA</td>
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<td>Forms</td>
<td>DECforms</td>
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<td>Transaction Processing</td>
<td>DECtp</td>
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<td>SNA Connectivity</td>
<td>DECnet/SNA Products</td>
</tr>
</tbody>
</table>
Open Systems Networking

VMS (TCP & OSI) | Vendor X TCP | ULTRIX (TCP & OSI)

PC LAN (TCP OR OSI) | MP Router | APPL GWY | Vendor Y OSI

DECnet/OSI Subnet

Open Systems Backbone (OSI and TCP/IP)

VMS (TCP & OSI) | MP Router | ULTRIX (TCP & OSI)

PC LAN (TCP OR OSI) | Vendor X OSI | Vendor Y TCP | APPL GWY

TCP/IP Subnet