Chapter 27. Introduction to the ISO - OSI Model

Introduction to the ISO - OSI Model

The ISO (International Standards Organization) has created a layered model, called the OSI (Open Systems Interconnect) model, to describe defined layers in a network operating system. The purpose of the layers is to provide clearly defined functions that can improve Internetwork connectivity between "computer" manufacturing companies. Each layer has a standard defined input and a standard defined output.

Understanding the function of each layer is instrumental in understanding data communication within Local, Metropolitan or Wide networks.

OSI Model Explained

This is a top-down explanation of the OSI Model. It starts with the user's PC and it follows what happens to the user's file as it passes though the different OSI Model layers. The top-down approach was selected specifically (vs. starting at the Physical Layer and working up to the Application Layer) for ease of understanding. It is used here to show how the user's files are transformed (through the layers) into a bit stream for transmission on the network.

These are the 7 Layers of the OSI model:

- 7. Application Layer (Top Layer)
- 6. Presentation Layer
- 5. Session Layer
- 4. Transport Layer
- 3. Network Layer
- 2. Data Link Layer
- 1. Physical Layer (Bottom Layer)

Layer 7 - Application Layer

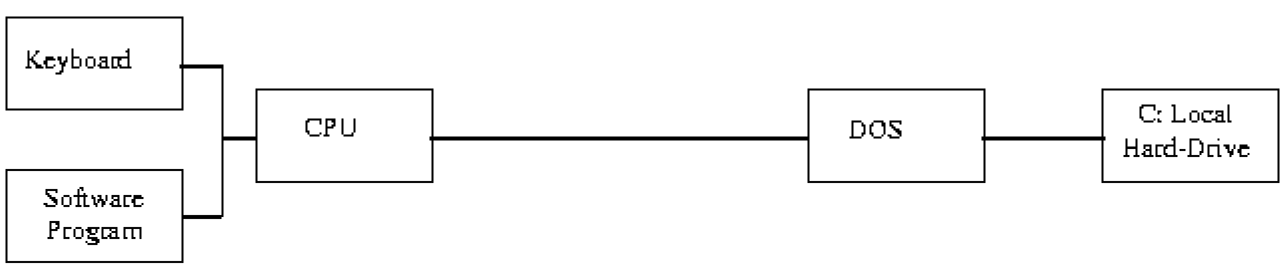


Fig. 1. Basic PC Logical Flowchart

A basic PC logic flowchart is shown in Fig. 1. The Keyboard & Application are shown as inputs to the CPU (requesting access to the hard disk). The Keyboard requests accesses through user inquiries (such as "DIR" commands) and the Application seeks access through "File Openings" and "Saves". The CPU, through the Disk Operating System, sends and receives data from the local hard disk ("C:" in this example).

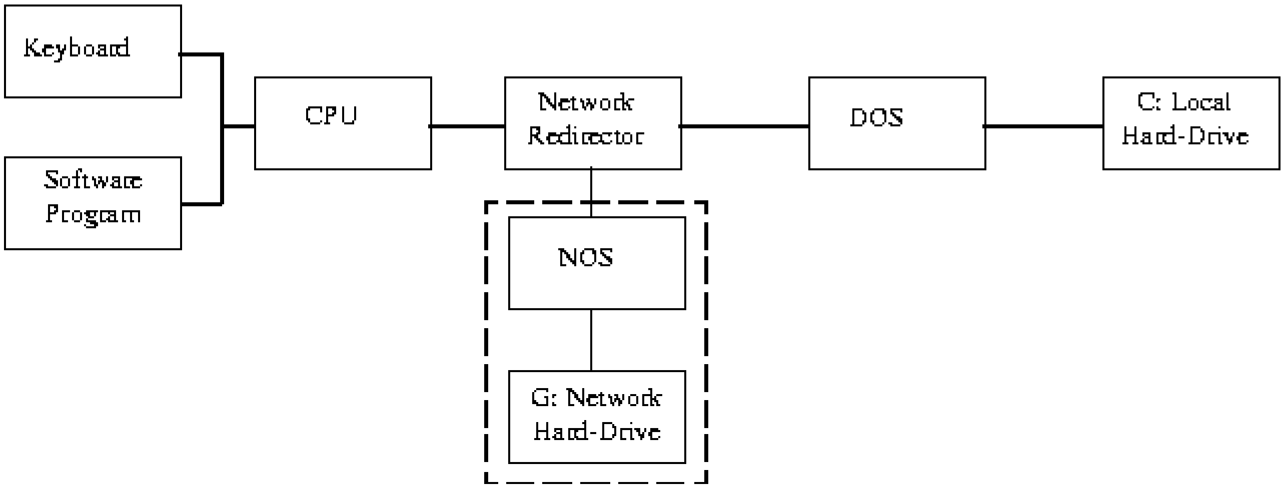


Fig. 2. Simple Network Redirection

A PC setup as a network workstation has a software "Network Redirector" (the actual name depends on the network - we will use a generic term here) placed between the CPU and DOS (as shown in Fig 2.). The Network Redirector is a TSR (Terminate and Stay Resident) program: it presents the network hard disk as another local hard disk ("G:" in this example) to the CPU. All CPU requests are intercepted by the "Network Redirector". The Network Redirector checks to see if either a local or a network drive is requested. If a local drive is requested, the request is passed on to DOS. However, if a network drive is requested, the request is then passed on to the network operating system (NOS).

Electronic mail (E-Mail), client-server databases, games played over the network, print and file servers, remote logons, and network management programs (or any "network aware" applications) are all aware of the network redirector. They have the ability to communicate directly with other "network applications" on the network. The "Network Aware Applications" and the "Network Redirector" make up Layer 7 (the Application layer of the OSI Model, as shown in Fig. 3).

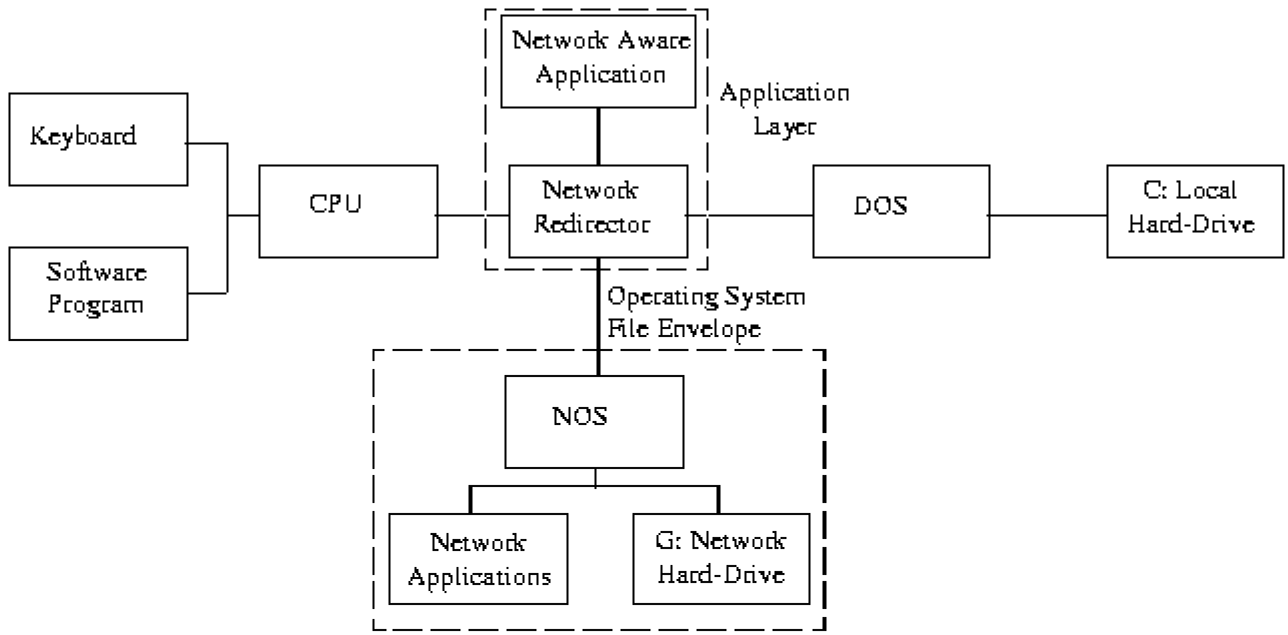
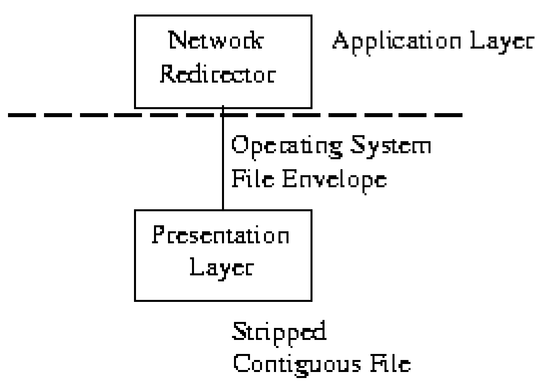


Fig. 3. PC Workstation with Network Aware Software

Layer 6 - Presentation Layer

The Network Redirector sends CPU operating system native code to the network operating system: the coding and format of the data is not recognizable by the network operating system. The data consists of file transfers and network calls by network aware programs.

For example, when a dumb terminal is used as a workstation (in a mainframe or minicomputer network), the network data is translated into (and from) the format that the terminal can use. The Presentation layer presents data to and from the terminal using special control characters to control the screen display (LF-line feed, CR-carriage return, cursor movement, etc..). The presentation of data on the screen would depend on the type of terminal that's used: VT100, VT52, VT420, etc.



Similarly, the Presentation layer strips the pertinent file from the workstation operating system's file envelope. The control characters, screen formatting, and workstation operating system envelope are all stripped or added to the file (if the workstation is receiving or transmitting data to the network). This could also include translating ASCII file characters from a PC world to EBCDIC in an IBM Mainframe world.

The Presentation Layer also controls security at the file level: this provides both file locking and user security. The DOS Share program is often used for file locking. When a file is in use, it is locked from other users to prevent 2 copies of the same file from being generated. If 2 users both modified the same file, and User A saved it, then

User B saved it, then User A's changes would be erased!

At this point, the data is contiguous and complete (i.e. one large data file). See Fig. 4.

Layer 5 - Session Layer

The Session layer manages the communications between the workstation and the network. The Session layer directs the information to the correct destination, and identifies the source to the destination. The Session layer identifies the type of information as data or control. The Session layer manages the initial start-up of a session, and the orderly closing of a session. The Session layer also manages Log on procedures and Password recognition (See Fig. 5).

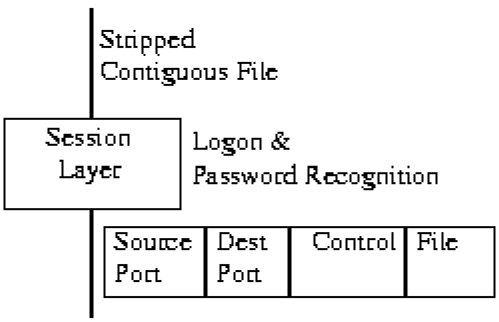
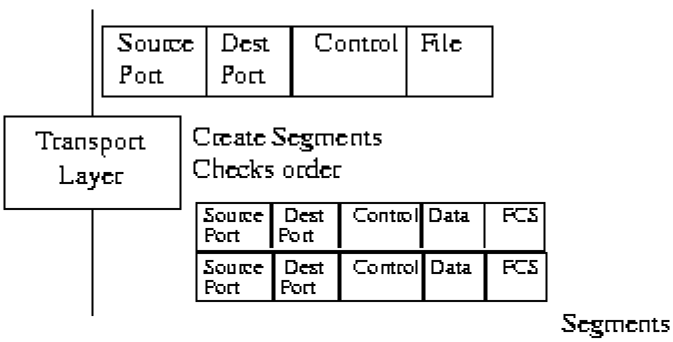


Fig. 5. Session Layer

Layer 4 - Transport Layer

In order for the data to be sent across the network, the file must be broken up into usable small data segments (typically 512 - 18K bytes). The Transport layer breaks up the file into segments for transport to the network, and combines incoming segments into a contiguous file. The Transport layer does this logically, not physically, and it is done in software as opposed to hardware.



The Transport layer provides error checking at the segment level (frame control sequence). This makes sure that the datagrams are in the correct order: the Transport layer will correct out of order datagrams. The Transport layer guarantees an error-free host to host connection. It is not concerned with the path between machines.

Layer 3 - Network Layer

The Network layer is concerned with the path through the network. It is responsible for routing, switching, and controlling the flow of information between hosts. The Network layer converts the segments into smaller datagrams than the network can handle: network hardware source and destination addresses are also added. The Network layer does *not* guarantee that the datagram will reach its destination.

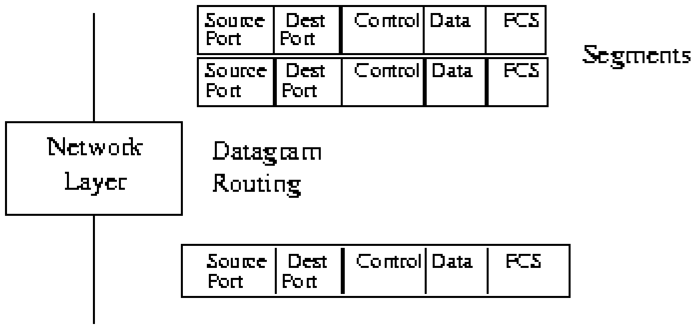


Fig. 7. Network Layer

Layer 2 - Data Link Layer

The Data Link layer is a firmware layer of the network interface card. The Data Link layer puts the datagrams into packets (frames of bits: 1s & 0s) for transmission, and assembles received packets into datagrams. The Data Link layer works at the bit level, and adds start / stop flags and bit error checking (CRC or parity) to the packet frame. Error checking is at the bit level only: packets with errors are discarded and a request for re-transmission is sent out. The Data Link layer is primarily concerned with bit sequence.

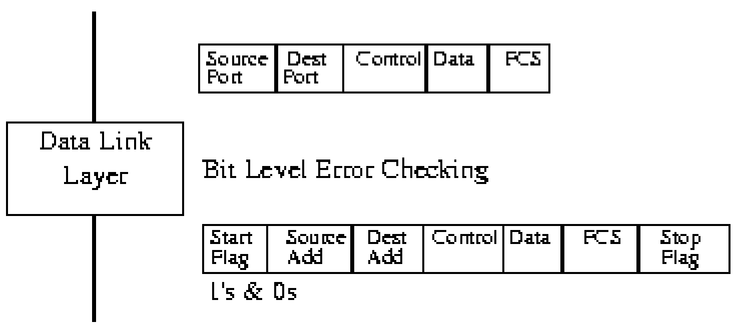


Fig. 8. Data Link Layer

Layer 1 - Physical Layer

The Physical layer concerns itself with the transmission of bits. It also manages the network card's hardware interface to the network. The hardware interface involves the type of cabling (coax, twisted pair, etc.), frequency of operation (1 Mbps, 10Mbps, etc.), voltage levels, cable terminations, topography (star, bus, ring, etc.), etc. Examples of Physical layer protocols are as follows: 10Base5 - Thicknet, 10Base2 - Thinnet, 10BaseT - twisted pair, ArcNet, FDDI, etc. (see Fig. 9).

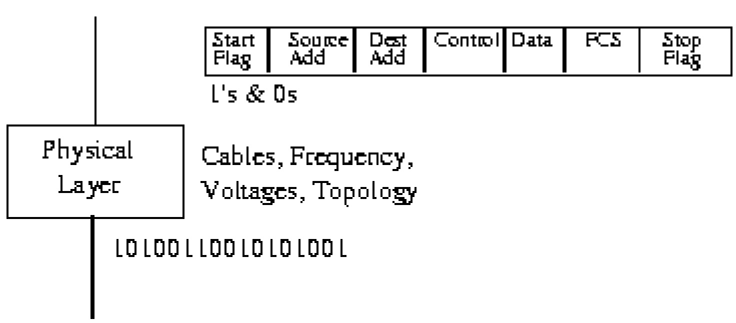
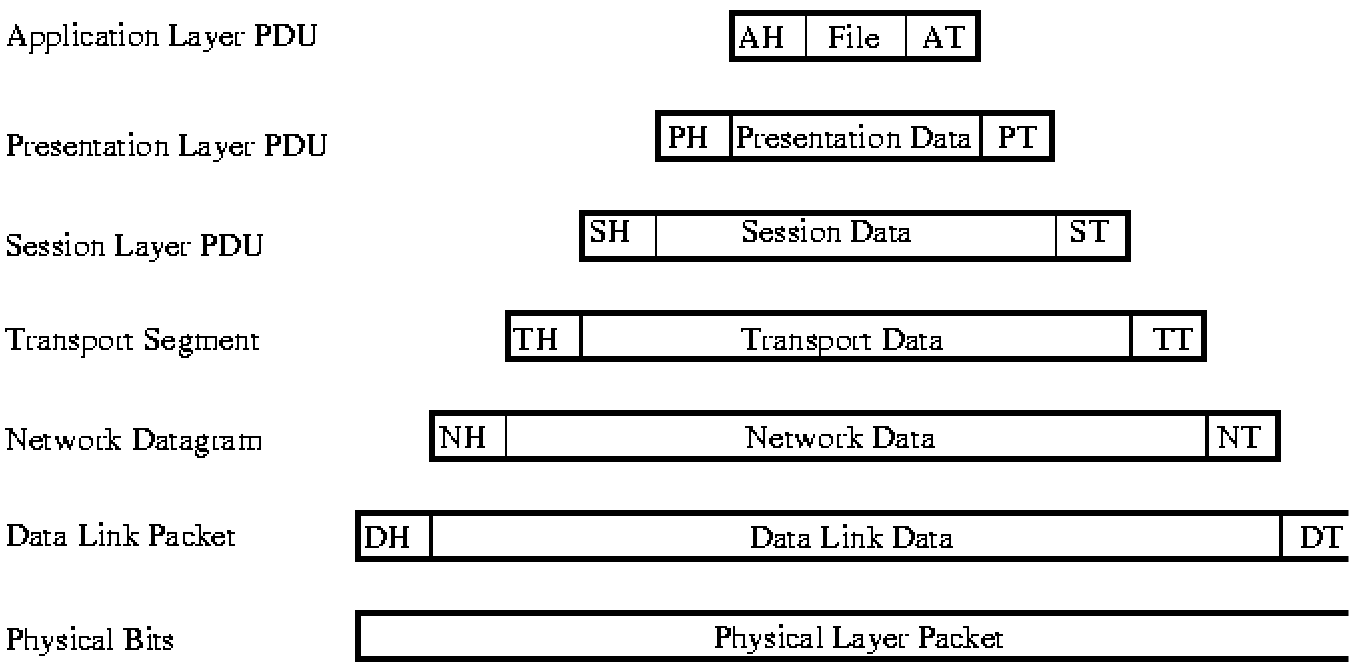


Fig. 9. Physical Layer

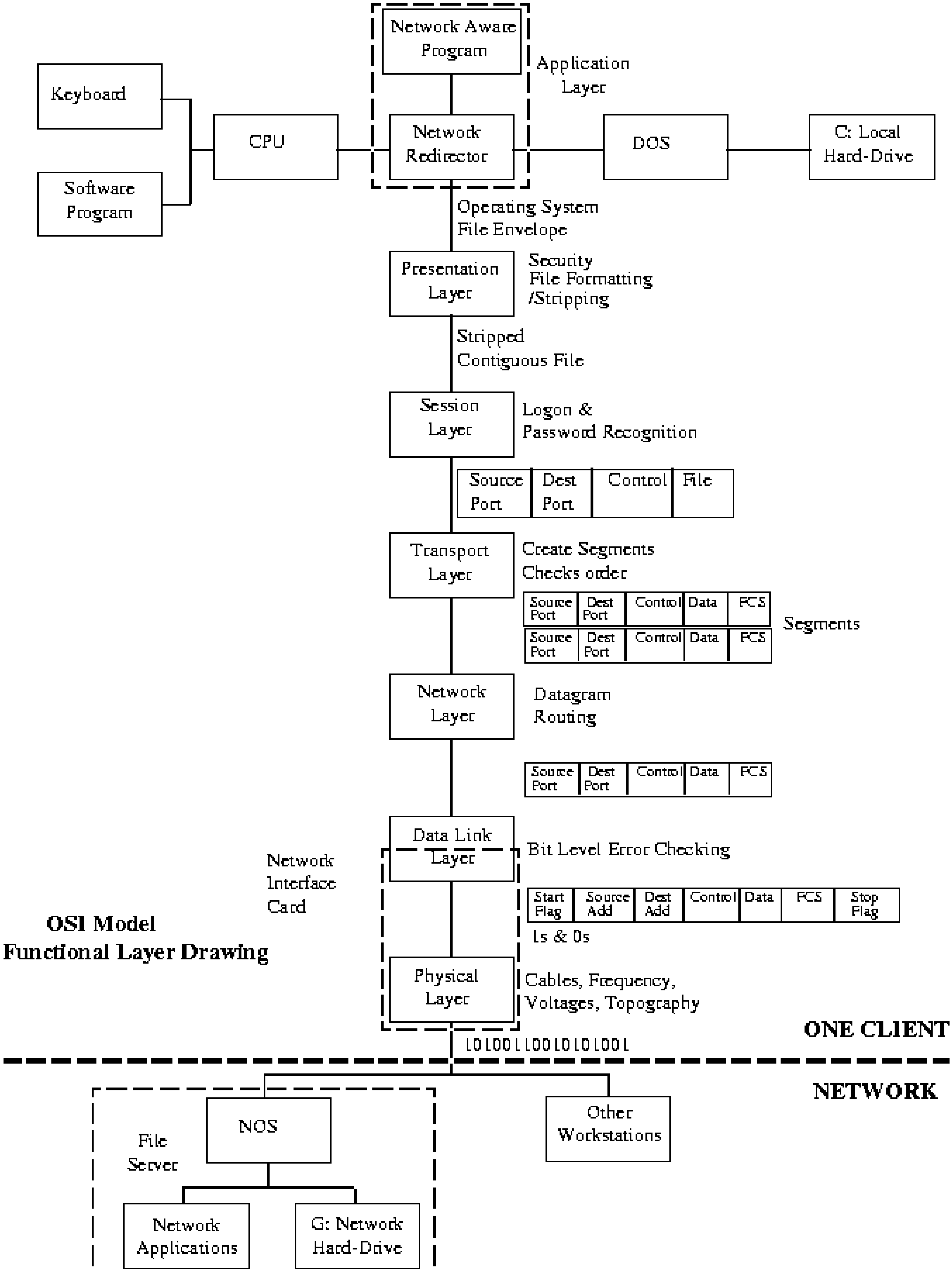
Layer-Specific Communication

Each layer may add a Header and a Trailer to its Data (which consists of the next higher layer's Header, Trailer and Data as it moves through the layers). The Headers contain information that specifically addresses layer-to-layer communication. For example, the Transport Header (TH) contains information that only the Transport layer sees. All other layers below the Transport layer pass the Transport Header as part of their Data.



PDU - Protocol Data Unit (a fancy name for Layer Frame)

OSI Model Functional Drawing


Network Aware Program
Application Layer
Keyboard
Software Program
CPU
Network Redirector
DOS
C: Local Hard-Drive
Operating System File Envelope
Presentation Layer
Security
File Formatting /Stripping
Stripped Contiguous File
Session Layer
Logon & Password Recognition
Source Port
Dest Port
Control
File
Transport Layer
Create Segments
Checks order
Source Port
Dest Port
Control
Data
FCS
Segments
Network Layer
Datagram
Routing
Data Link Layer
Bit Level Error Checking
Network Interface Card
Start Flag
Source Add
Dest Add
Control
Data
FCS
Stop Flag
1s & 0s
OSI Model
Functional Layer Drawing
Physical Layer
Cables, Frequency, Voltages, Topography
ONE CLIENT
1010011100101010011
NETWORK
NOS
File Server
Other Workstations
Network Applications
G: Network Hard-Drive

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