zSTSU Session Z5023
Introduction to Communications Server for z/OS

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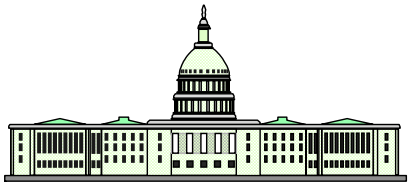


Agenda

- **The Communications Server (CS) Name**
  - History
- **Overview of TCP/IP**
  - IPv6
- **Overview of VTAM**
  - Subarea vs. APPN
- **Communications Server Functions**
  - Enterprise Extender, OSA, and HiperSockets
  - APIs
  - Assorted TCP/IP Applications, FTP, and TN3270
  - Sysplex Functions

What is Communications Server?

- **The Communications Server name is used for products running on different platforms:**
  - zSeries (zSeries), pSeries (RS/6000), xSeries (NetFinity, etc), or OEM
- **Communications Server is currently provided for:**
  - z/OS, OS/2, Windows NT, Windows 2000, Unixware, Netware, AIX, UNIX, Linux
- **With non-zSeries, generally thought of as a Gateway product, helping to integrate disparate network types**
- **With z/OS and OS/390, Communications Server is a base element (part of the operating system)**
  - Consists of TCP/IP and SNA Services

What is Communications Server?

- **With z/OS, Communications Server has undergone many name changes:**
  - Communications Server
  - eNetwork Communications Server
  - Secureway Communications Server
  - IBM Communications Server
- **Consists of prior products, TCP/IP and VTAM, for MVS**
- **Has been continuously enhanced with new functions**

TCP/IP History

- **ARPANET procotol suite introduced concepts of layering and virtualizing in the world of networking in early 1970s**
  - Funded by Defense Advanced Research Projects Agency (DARPA)
  - Later Bolt, Beranek, and Newman (BBN) developed TCP/IP protocols for Berkeley UNIX on the VAX
    - Code distributed for free with University of California's Berkeley's UNIX operating system
    - First release of Berkeley Software Distribution in 1983 (4.2BSD)
    - Spread rapidly and several releases followed
- **New WANs in US created and attached to ARPANET**
  - Developed into the Internet

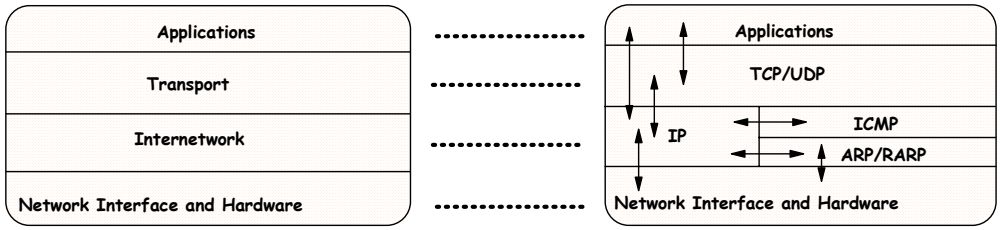
SNA History

- **SNA developed and distributed by IBM**
  - Specifications have also been provided so that a large number of other vendors also provide products that implement SNA
- **1974 - SNA Announced**
  - Systems Network Architecture
  - SNA is an architecture defining protocols such as:
    - Link Protocols
    - Node Intercommunication Protocols
    - Application Protocols
- **VTAM is the mainframe and NCP is the front-end SNA product**
  - Run with three main operating systems
    - MVS, VM, VSE

Communications Server History

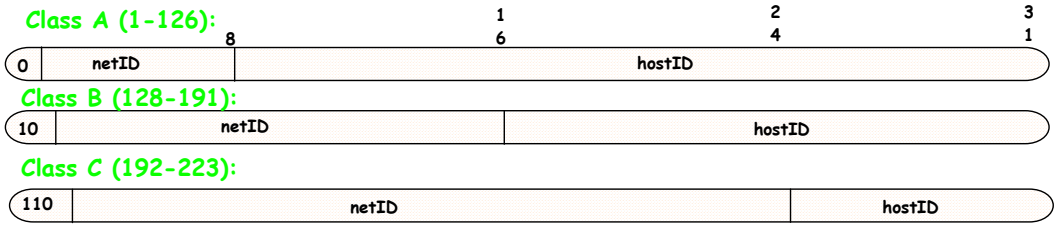
- **VTAM available as mainframe software since 1974**
  - Has been continuously enhanced
- **TCP/IP available as mainframe software since the 1980s**
  - Has been continuously enhanced
  - Original MVS software was ported from VM
- **TCP/IP and VTAM combined into single product in 1996**
  - Has been continously enhanced

What is TCP/IP?



- **Application Layer**
  - User process cooperating with partner on same or different host, i.e. Telnet, FTP, SMTP
- **Transport Layer**
  - TCP (connection oriented) and UDP (connectionless)
- **Internetwork Layer**
  - Shields higher levels from the physical network architecture
- **Network Interface Layer**
  - Interface to network hardware, called link or data link layer

What is TCP/IP?



- **TCP/IP uses four octet addressing structure (IPv4 32 bits)**
  - Broken into netID and hostID portion
  - Subnetting can be used to indicate portion of host bits are to be used to indicate additional networks
  - IPv6 slowly being implemented - huge address expansion (128 bits)
- **Interface between applications and transport layer is defined by port numbers and sockets**
  - Each process that wants to communicate with another process identifies itself by a 16 bit port number

What is IPv6?

- **IPv6 is an evolution of the current version of IP, which is known as IPv4**
  - Work on new IETF standard started in early 90's
  - Not backward compatible, but migration techniques defined

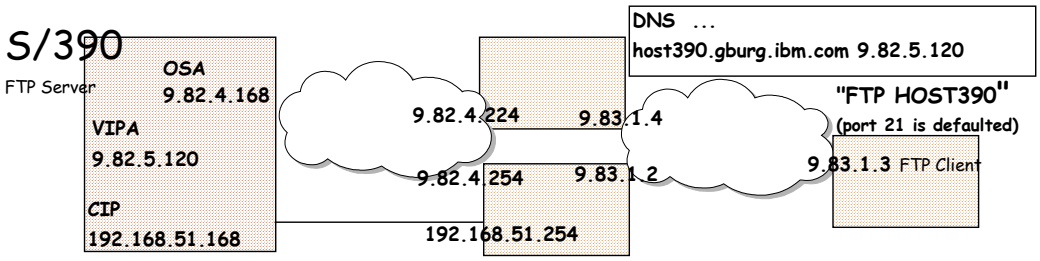
IPv4 Address:
9.67.122.66

- **Changes from IPv4 to IPv6**
  - Expanded Routing and Addressing
    - Address space increased from 32 bits to 128 bits
    - Scalability of multicast routing improved by adding a "scope" field
  - Header Format Simplification
    - Reduced common-case processing cost of packet handling

IPv6 Address:
3ffe:1900:4545:2::09ff:fef7:62dc

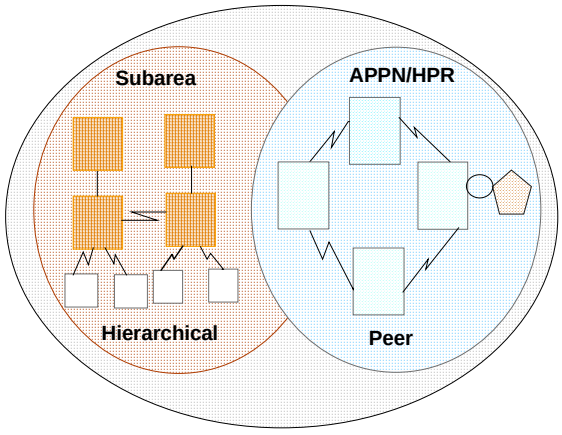
- **Improved Support for Options**
  - New encoding allows for more efficient forwarding
  - Greater flexibility for introducing new options in the future
- **Plug-and-Play Support**
  - Autoconfiguration of host address, default routers, MTU size, and other IP-related information

Overview of TCP/IP Protocols



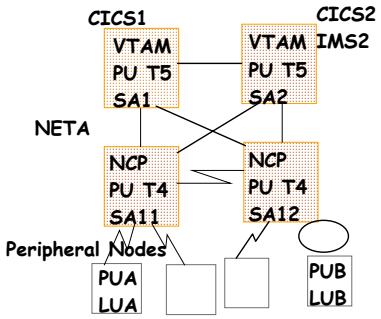
- **Client workstations usually only have a default route defined.**
  - If packets are not destined for local hosts they are sent to the default router.
- **Routers may have statically defined routes but they usually run a dynamic routing protocol and "learn" routes.**
- **A port is a 16-bit number used to identify the higher level protocol or application.**
  - Well-known ports between 1 and 1023 are defined for standard servers.
  - Ephemeral ports between 1024 and 65535 are used (by clients) when the port number does not need to be known by the remote side.

What is SNA?



- **SNA originally consisted of subarea protocols**
- **Advanced Peer to Peer networking introduced mid 1980s**
- **High Performance Routing introduced in 1990s**

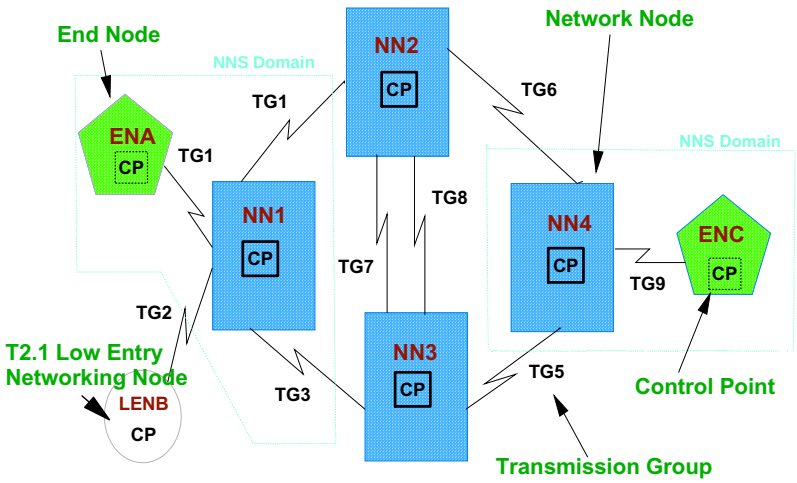
Subarea Networking



- **VTAMs are known as SSCPs (have SSCPname)**
  - Have SSCP-SSCP sessions with other VTAMs
    - Use to find resources

- **VTAMs and NCPs are subarea nodes**
  - Each has a unique subarea number within the network
  - Networks may be interconnected (SNI)
  - Each resource within or connected to a subarea has element number and name
  - VTAM owns NCP(s) and its resources
    - Routing between subareas done via predefined PATH tables

APPN Networking

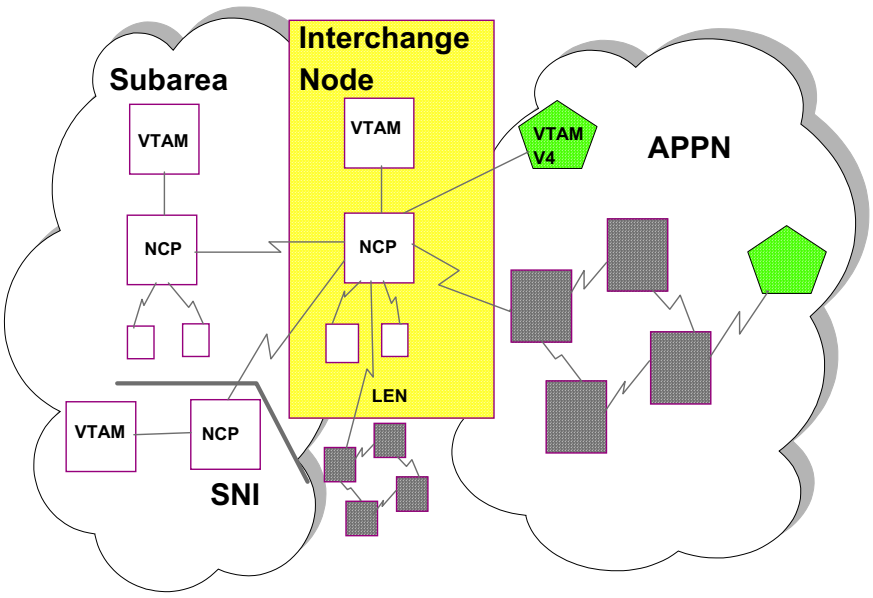


- **LUs dynamically located**
- **Routes dynamically calculated**

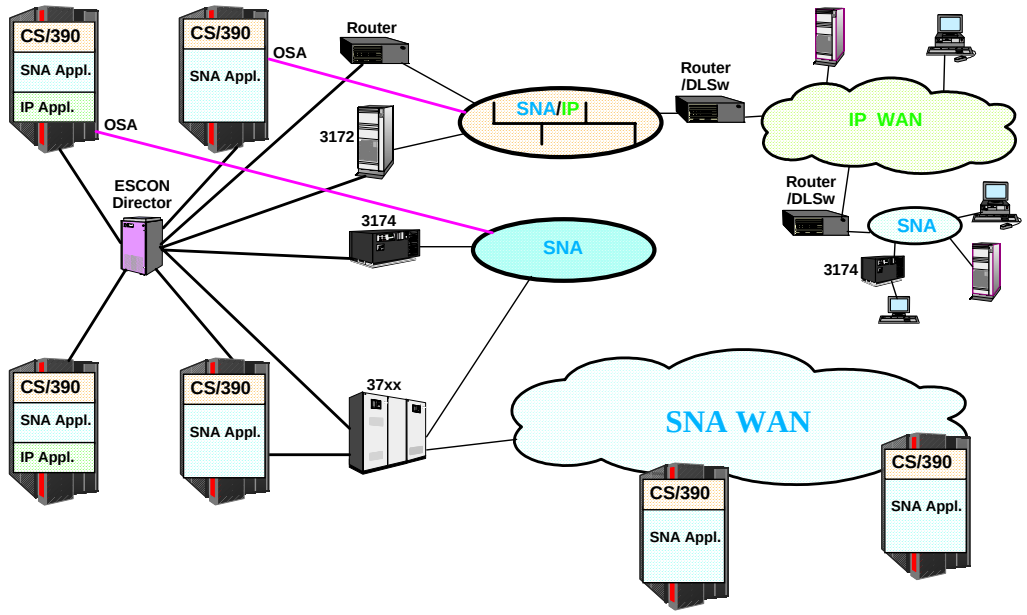
SNA Networking

- **High Performance Routing (HPR)**
  - Additional functions on top of APPN
    - Non-disruptive session switching
    - Adaptive Rate Based Flow/Congestion Control
- **Communication between two partners (LUs) accomplished via BINDing session(s)**
  - LUs have unique names within own network
    - Name is in the form NETID.LUNAME
  - Networks may be interconnected using SNI or Border Node
- **All SNA sessions use mode and class of service to differentiate types of sessions**
  - Pacing (flow control)
  - Prioritization
  - Differing size messages

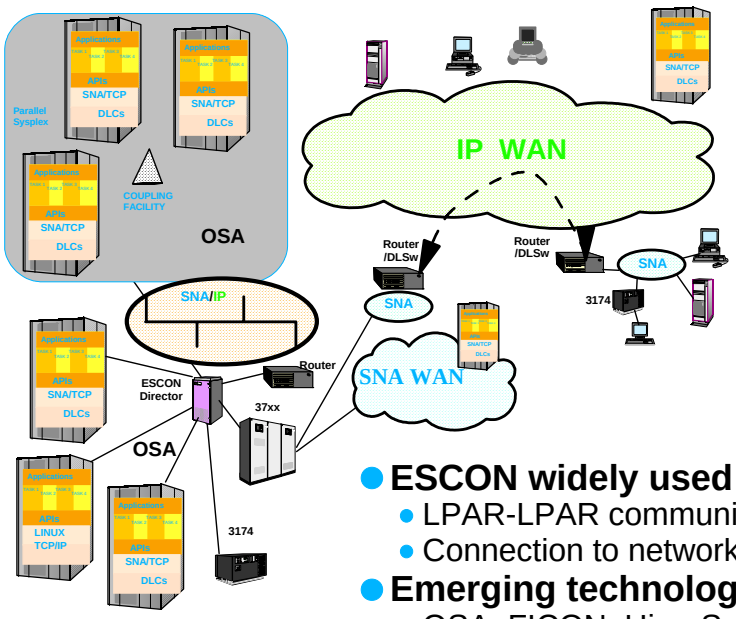
SNA Networking Today



Past S/390 Networking Environment

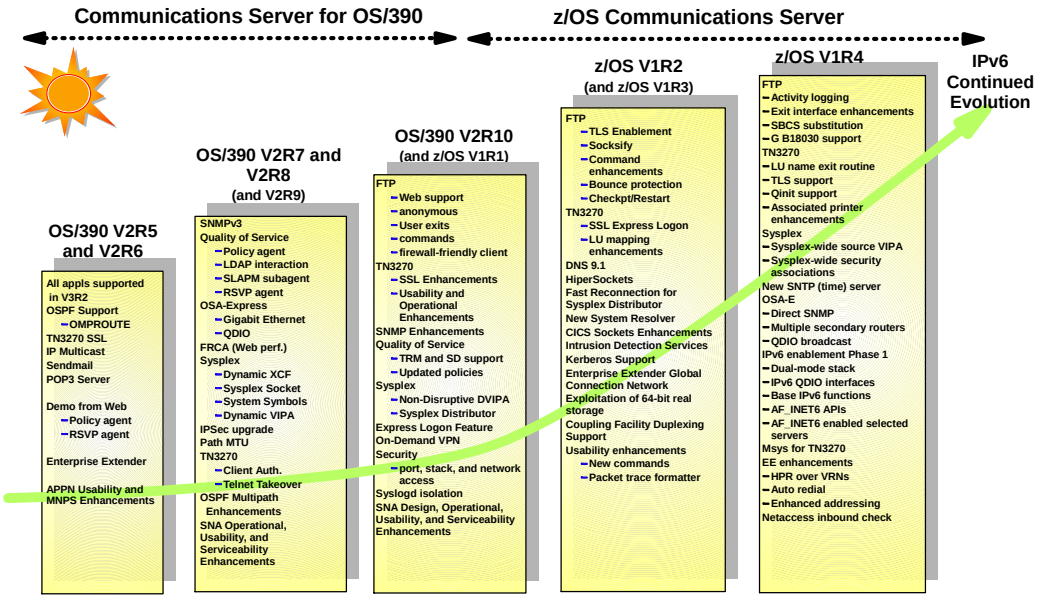


Emerging zSeries Networking Environment



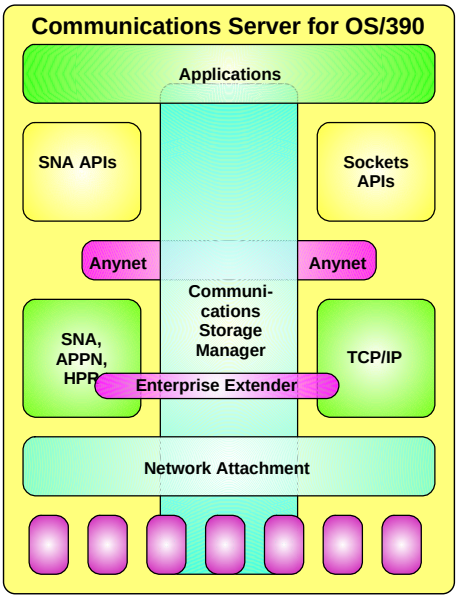
- **ESCON widely used for:**
  - LPAR-LPAR communication
  - Connection to network equipment
- **Emerging technologies:**
  - OSA, FICON, HiperSockets

Communications Server Enhancements



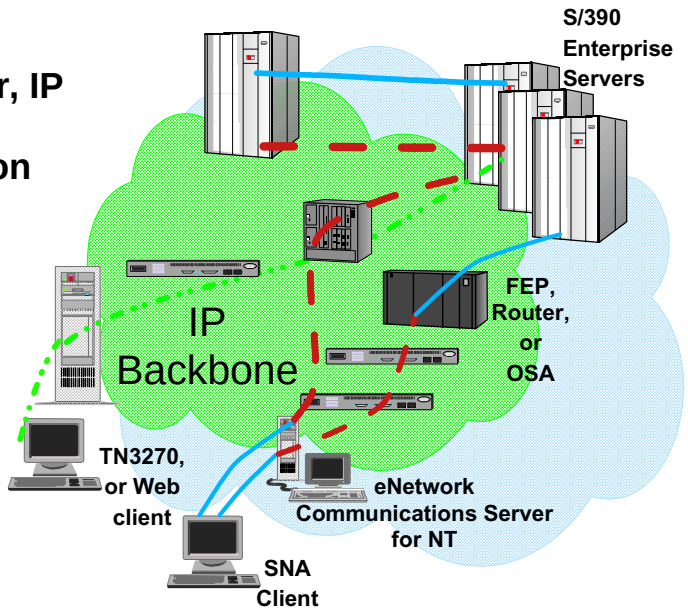
Communications Server for OS/390 - z/OS

- **Integrated Services**
  - Provide common services within CS
    - Network attachment
    - Storage management
    - High Performance Data Transfer
  - TCP/IP and SNA integration
    - TN3270
    - Network access
    - Internal optimizations
    - Enterprise Extender
  - Standard TCP/IP applications
- **Multi-protocol Solutions**
  - Sockets (TCP/IP) applications
    - Unix services offers S/390 users access to a wide range of UNIX-based applications over IP or SNA networks
  - SNA applications
    - SNA applications are supported over SNA or IP networks



Enterprise Extender and AnyNet

- Allows use of IP network for SNA sessions
- For Enterprise Extender, IP network looks like APPN/HPR TG in session route
- AnyNet provides "SNA over IP" and "TCP over SNA"



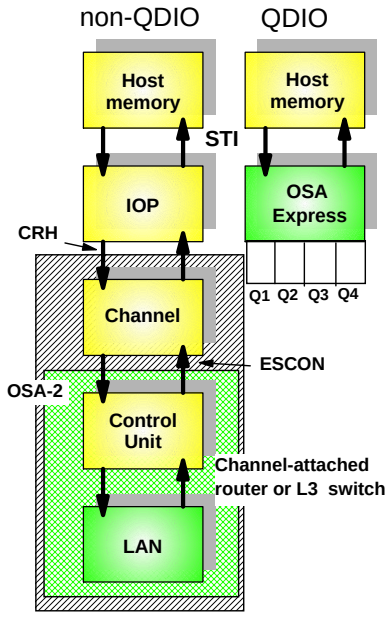
TCP/IP Data Link Controls

- CDLC - channel to 3745/3746
- CLAW - channel to RS/6000, Cisco Routers
- CTC - channel to another IBM zSeries
- ATM - to ATM network via OSA2 or OSA-Express
- MPCPTP - to other zSeries via channel or XCF, to another stack, or to routers/R6K via channel
- HYPERCHANNEL - to other TCP/IP hosts
- MPCIPA - to other TCP/IP hosts via QDIO or HiperSockets
- LCS - to other TCP/IP hosts via 3172, 8232, router, OSA, etc.
- SAMEHOST - to other address spaces or stacks in same LPAR
- MPCOSA - to FDDI or Fast Ethernet LAN via OSA2 configured as MPC HPDT
- HiperSockets -- to other TCP/IP (z/OS, Linux, and/or VM) hosts on the same zSeries CEC

Open Systems Adapter (OSA) Evolution

- **1995 OSA and 1996 OSA-2**
- **1999 OSA-E**
  - June 1999 OSA-E Gigabit Ethernet (QDIO mode only)
  - January 2000 OSA-E Fast Ethernet, 155ATM (LANE, Native)
  - October 2001 OSA-E 4/16/100 Mbps Token-Ring
  - June 2003 OSA-E 1000BASE-T Ethernet
- **OSA-E Modes**
  - QDIO mode
    - Originally required OS/390 V2R7+, later adapters have higher OS requirements
    - Supports TCP/IP traffic only
  - Non-QDIO mode (default OAT or OSA/SF is required)
    - Supports TCP/IP traffic (TCP/IP Passthru) and/or Supports SNA traffic
      - Maximum of 8 IP addresses per OAT entry
      - Maximum of 2048 (512 on non-zSeries) IP addresses per port
- **Enterprise Extender (EE)**
  - Communicates encasulated SNA over TCP/IP network
  - Provided by z/OS Communications Server
  - Supports any TCP/IP link, including all OSA-E in QDIO mode
- **OSA-Express Home Page**
  - http://www.ibm.com/servers/eserver/zseries/networking/osax.html

High-Speed IP Access Queued Direct IO (QDIO)

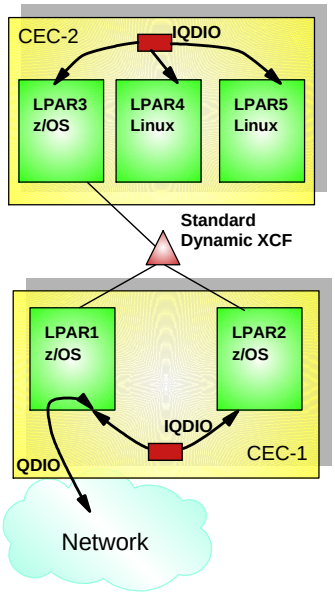


	IP QDIO	IP L CS	SNA LSA
Gigabit Ethernet	X		
Fast Ethernet	X	X	X
Token-Ring	X	X	X
1000BASE-T Ethernet	X	X	X

QDIO Characteristics

- OSA-E microprocessor communicates directly with S/390 using data queues in S/390 memory
- Continuous direct data exchanges
- Communications remains active
- Utilizes Direct Memory Access (DMA) protocol
- Reduced Latency
- 4 outbound QoS queues for priority queuing of data
- IP Only (use Enterprise Extender for QDIO advantages to SNA)
- IP-Assist to handle MAC addressing, ARP processing, some filtering
- Dynamically maintains the OSA Address Table (OAT) in a shared environment
- Supports high-speed LPAR-to-LPAR communication
- Direct Memory Access (DMA) protocol reduces IO interrupts
- TCP/IP Netstat display and purge of QDIO ARP cache

HiperSockets



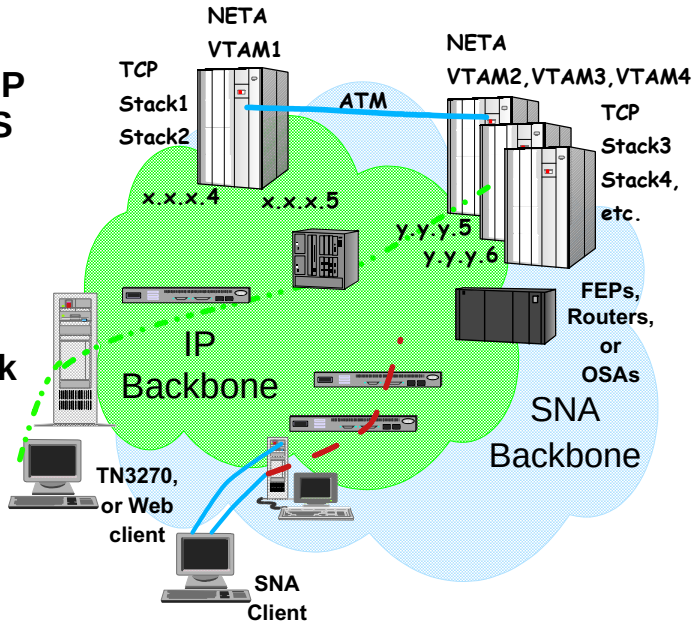
- **zSeries**
  - Up to 4 (z800/z900) or 16 (z990) "simulated virtual LANs" per CEC
- **Each LAN has its own CHPID**
  - New type, IQD
  - Controlled like regular CHPID
- **Each image configures own use of available HiperSockets CHPIDs**
  - Can continue to use other network connectivity, as well
- **Performance**
  - Like cross address space memory move using memory bus -- not STI bus
  - Does not use CPU cache, thus no effect on other activity
- **HiperSockets Accelerator**
  - Minimized stack processing when using OSA Express to HiperSockets data paths

VTAM Data Link Controls

- **CDLC**
  - To 3745/3746 or 3x74 via channel
- **LSA**
  - To 3172 or router via channel
  - To LAN via OSA2 or OSA-Express (non-QDIO)
- **CTC**
  - To another VTAM via channel using subarea protocols
- **Subarea MPC**
  - To another VTAM via multiple subchannels using subarea protocols
- **MPC+**
  - To another VTAM via channel or XCF (HPR) or to a router via channel - uses CSM
- **MPC**
  - To another VTAM or router via channel (APPN)
- **LDLC**
  - To Enterprise Extender partner (using IP network)

LPARs and Communications Server

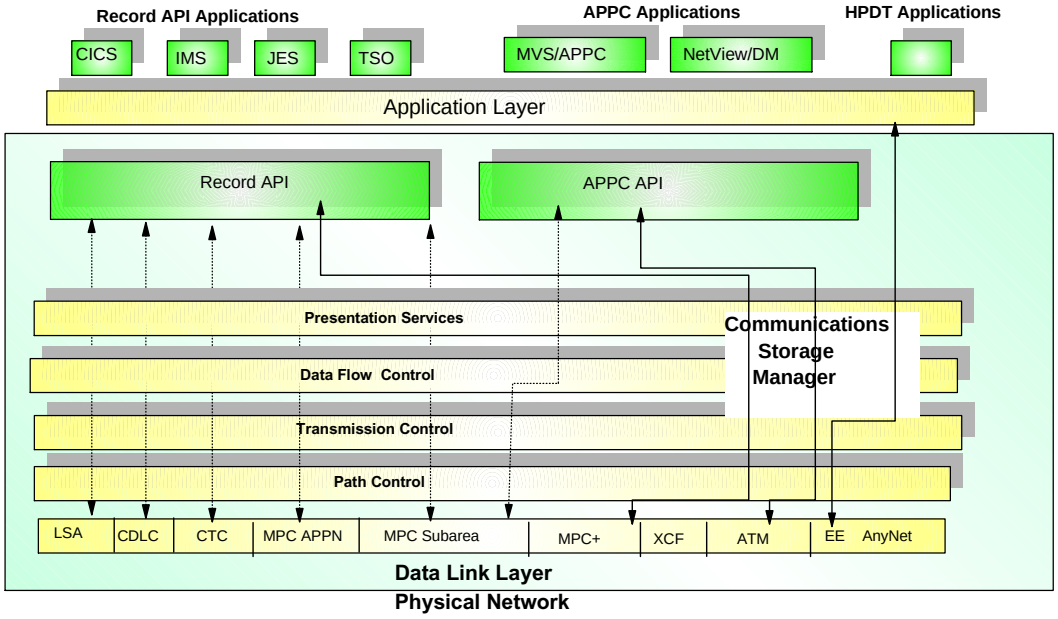
- Only one VTAM per z/OS or OS/390
- May run multiple TCP/IP stacks on a single z/OS or OS/390
- May use different physical networks for SNA and TCP/IP
- May use single network for both



Operating System Environment

- VTAM runs as a started task in MVS environment
- TCP/IP requires UNIX Systems Services (USS), as well as MVS
  - Other TCP/IP requirements:
    - A fully functional Hierarchical File System (HFS)
    - Security environment, such as RACF

VTAM API Structure



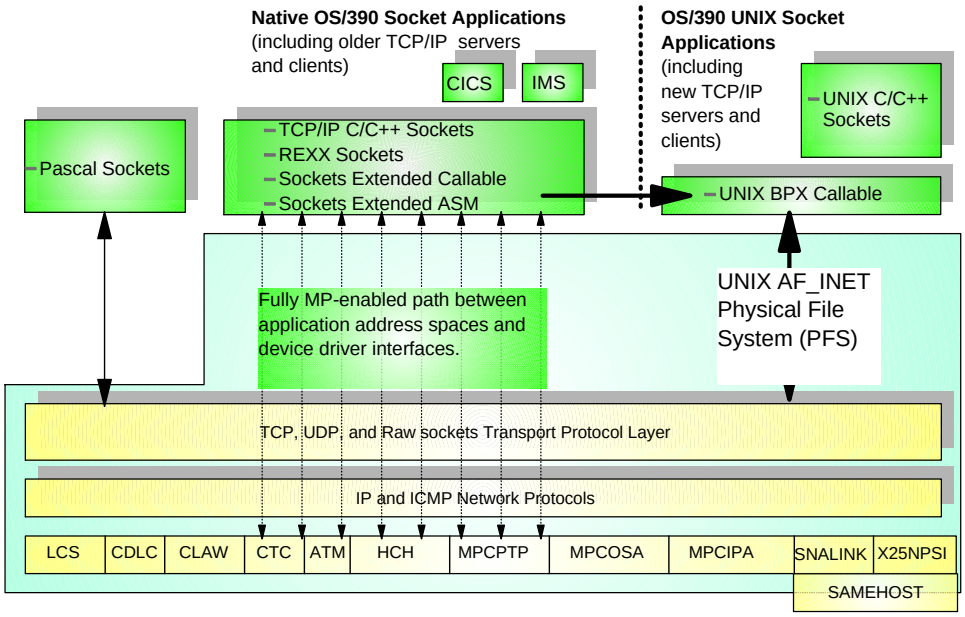
VTAM APIs

- **Record Application Program Interface (RAPI)**
  - Original API
  - Used by many applications, i.e. JES, CICS, NetView
- **Advanced Program to Program Communication API (APPC API)**
  - Developed in 1980s to facilitate LU6.2 application programming
  - Used by many applications, i.e. MVS/APPC, NetView/DM, NetView
- **High Performance Data Transfer API (HPDT API)**
  - Data can be accessed directly to/from CSM

VTAM Applications

- **VTAM doesn't provide applications with its code**
  - Subsystems which use VTAM are separate
    - Part of OS/390, i.e. JES, TSO
    - Separate products, i.e. DB/2, CICS
- **VTAM provides copious commands/messages for management purposes**
- **VTAM provides exits, interfaces, agents for other products. Examples:**
  - CMIP agent for NetView Topology Manager
  - Exits to provide performance information to NetView/Performance Monitor
  - Interfaces to allow NetView commands/messages
  - Interfaces to provide NetView with session awareness data

CS V2R5+ TCP/IP API Structure



TCP/IP APIs

- Pascal API
- IMS Sockets
- CICS Sockets
- C Sockets
- Sockets Extended Macro API
- Sockets Extended Call Instruction API
- REXX Sockets
- UNIX Sockets
- UNIX Assembler Callable Services

TCP/IP Systems Management Applications

- Netstat client
- Ping client
- SNMP NetView client
- TRACERTE client
- UNIX OMPROUTE SNMP subagent
- UNIX SNMP client
- UNIX SNMP server and subagent
- UNIX Policy agent
- UNIX pasearch command
- UNIX RSVP agent
- UNIX SLA subagent
- UNIX trmdstat
- UNIX TRM daemon
- UNIX trap forwarder daemon

TCP/IP Applications

- **Remote Logon and File Transfer**
  - UNIX FTP server
  - FTP client
  - TN3270 Telnet server
  - TN3270E Telnet server
  - UNIX Telnet server
  - TSO Telnet client
- **Remote Printing**
  - LPD daemon
  - LPR client
  - NPF server

TCP/IP Applications

- **Remote Execution**
  - TSO REXEC client
  - UNIX REXEC client
  - REXECD/RSHD server
  - UNIX REXECD server
  - TSO RSH client
  - UNIX RSHD server
- **Routing**
  - NCPROUTE daemon
    - Works with NCP IP routing
  - OMPROUTE daemon
    - Can implement OSPF, RIP1, RIP2
  - OROUTED daemon
    - Can implement RIP1, RIP2

TCP/IP Applications

- **Mail Facility**
  - UNIX popper
  - UNIX sendmail agent/server
  - SMTP server
- **Network Computing**
  - TFTP
  - DHCP Server
  - DHCP/PXE
  - TIMED
  - BINL
- **Miscellaneous**
  - MISCSERV

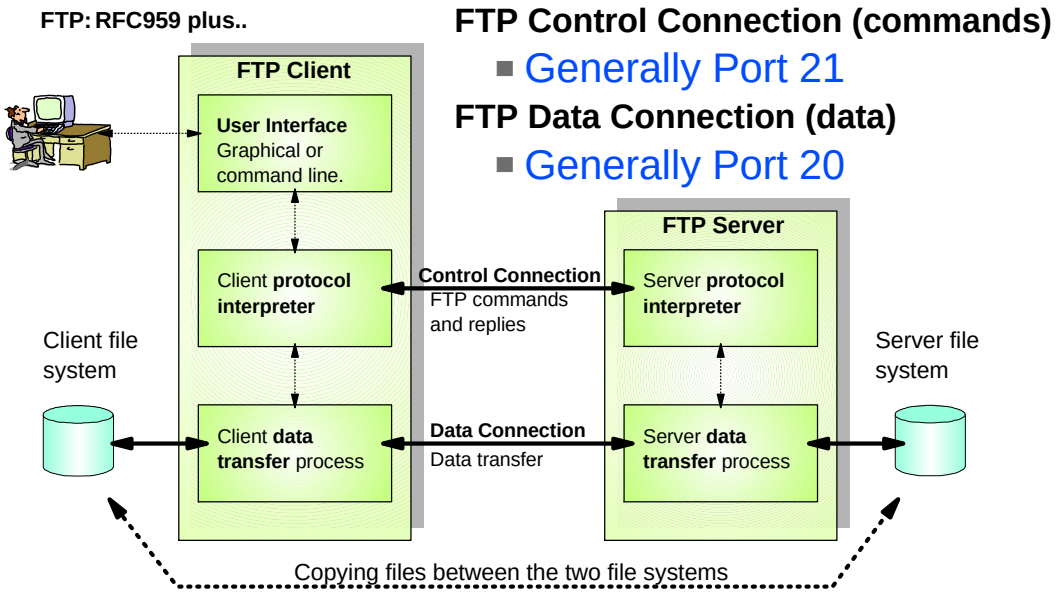
TCP/IP Applications

- **Query Resolution**
  - DNS name Server V4
  - DNS name Server V9
  - PORTMAPPER server
  - NSLOOKUP client
  - UNIX DIG client
  - UNIX dnsdomainname
  - UNIX domainname
  - UNIX host
  - UNIX hostname
  - UNIX nslookup client
  - UNIX nsupdate client
  - UNIX portmapper server
  - TSO DIG client

OS/390 & z/OS FTP Server & Client

- FTP is one of the most widely used TCP/IP applications on OS/390 and z/OS
- Both an FTP client and an FTP server are included as part of the base CS OS/390 functions
- The FTP functions on z/OS and OS/390 support both traditional MVS data sets and files in the hierarchical file system
- Because OS/390 and z/OS is a native EBCDIC system, the FTP Server and client convert between ASCII and EBCDIC when copying text files or data sets in/out of OS/390 or z/OS
- The MVS data set structure is very different from the stream-oriented file system model that the FTP protocols orginally were developed for. There is a variety of configuration options and end-user commands to control various aspects of how to map MVS data set structure attributes to/from a stream-oriented file system model

File Transfer Protocol



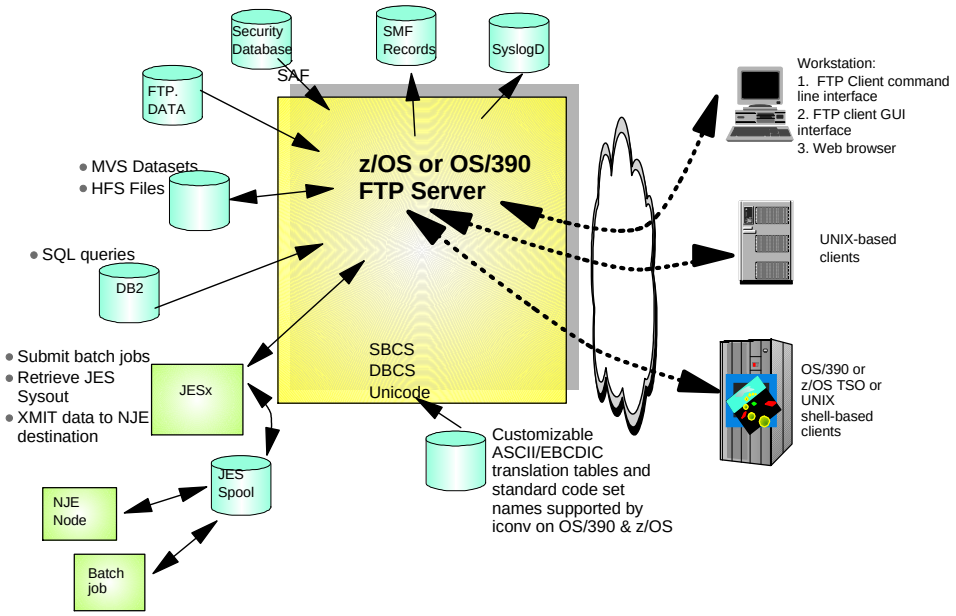
FTP Control Connection (commands)

- Generally Port 21

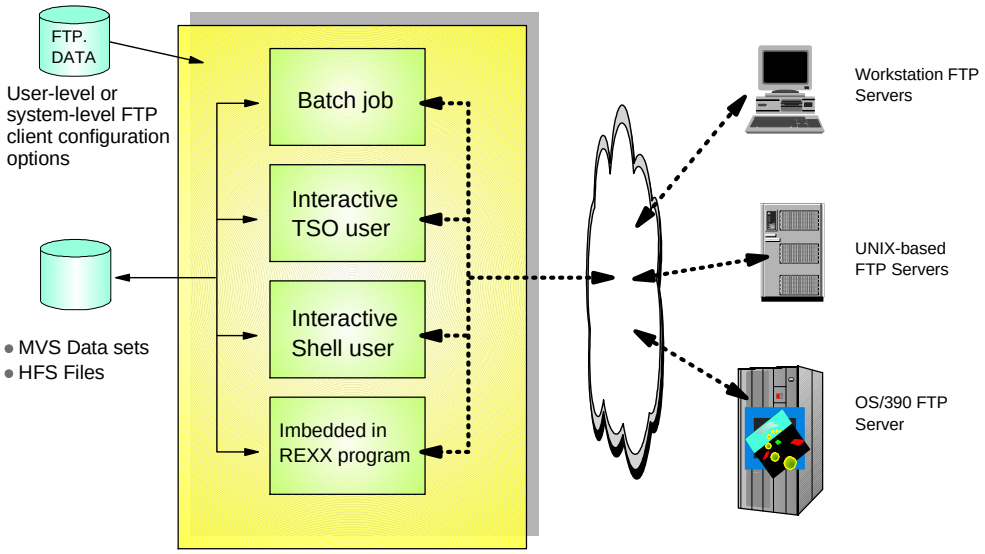
FTP Data Connection (data)

- Generally Port 20

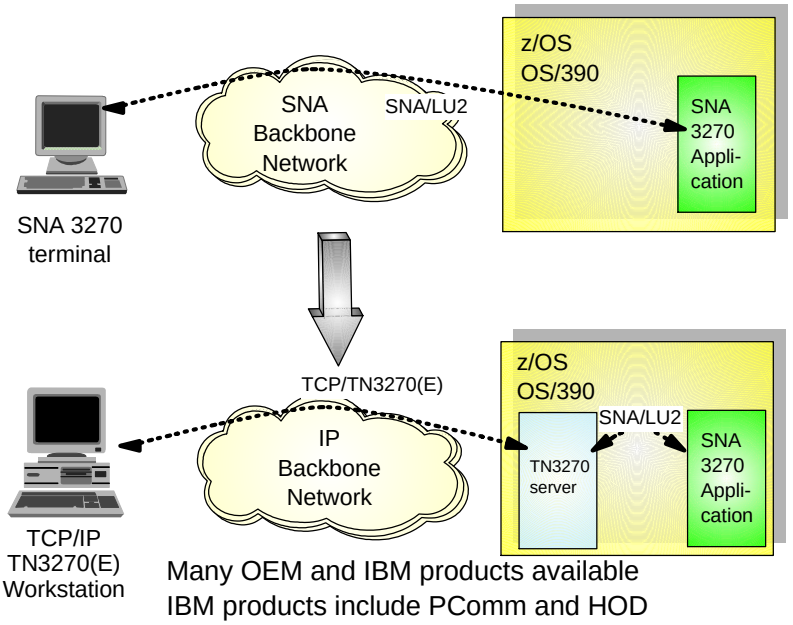
z/OS & OS/390 FTP Server Overview



z/OS FTP Client Overview



Why is TN3270 Needed?

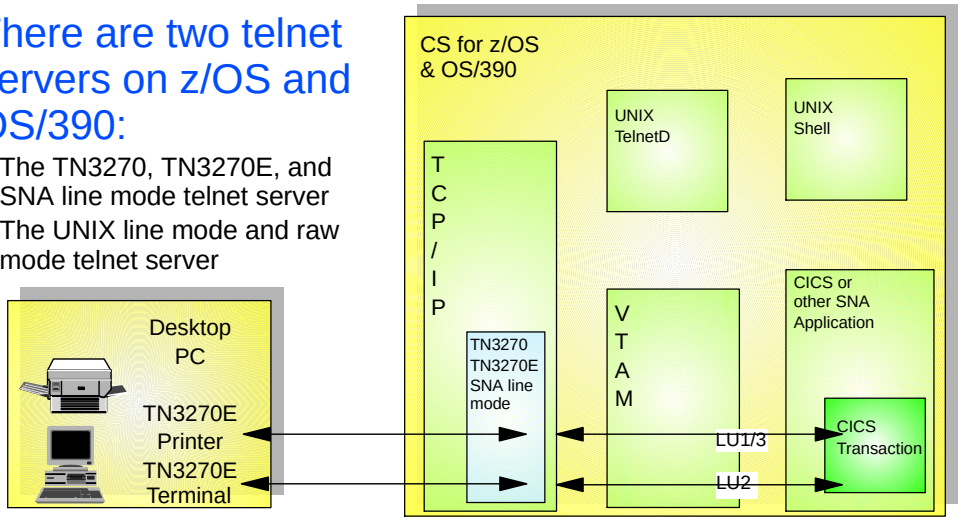


- and there are hundreds of thousands of SNA LU2-based applications out there today that will not be migrated to native sockets (ever).

Many OEM and IBM products available
IBM products include PComm and HOD

CS for OS/390 & z/OS TN3270E Server

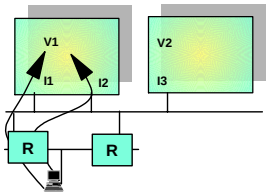
- There are two telnet servers on z/OS and OS/390:
  - The TN3270, TN3270E, and SNA line mode telnet server
  - The UNIX line mode and raw mode telnet server



- The TN3270 server was completely rewritten in CS OS/390 V2R5 with increased functions, capacity, performance, and reliability
- It supports both TN3270 and TN3270E protocols

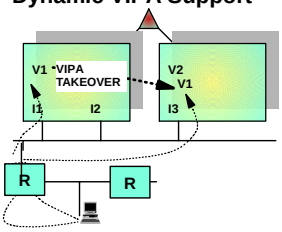
Evolution of Virtual IP Addresses (VIPA)

TCP/IP V3R2 VIPA Support



- TCP/IP V3R2 Static VIPA
  - VIPAs primarily used to represent the OS/390 host
  - Some limited deployment of application-specific VIPA, but no specific support in place for that use
  - Connection resilience to failure of network interface
  - If an application was to be moved from one OS/390 image to another, the DNS could be updated to point to V2 instead of V1.
  - One could manually (through OBEYFILE commands) move a static VIPA address from one stack to another - the concepts were identical to dynamic VIPA, but the movement was completely manual.

CS for OS/390 V2R8 Dynamic VIPA Support

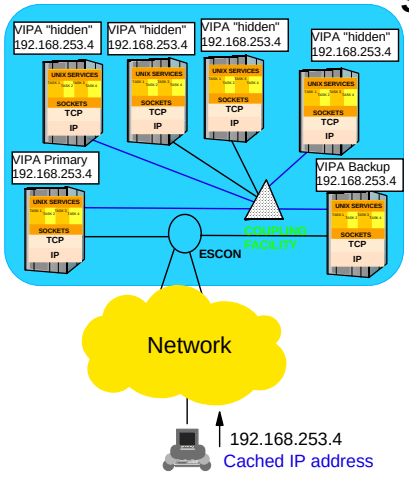


- CS for OS/390 V2R8 Dynamic VIPA (DVIPA)
  - A VIPA can either represent an OS/390 host or an individual application where the name server is updated to include resource records that identify individual applications, such as, myCICS.xyz.com at IP address V1.
  - VIPA still addresses connection resilience but now also addresses application recovery. If an OS/390 image is taken down, DVIPA backup policies can be used to define where the associated DVIPAs move to within the sysplex. DVIPA support also allows for manual movement of applications with associated DVIPA addresses.

In CS for OS/390 V2R8, only one stack at any point in time owns a specific VIPA address.

In CS for OS/390 V2R10 DVIPA movement can be non-disruptive.

TCP/IP Sysplex Functions



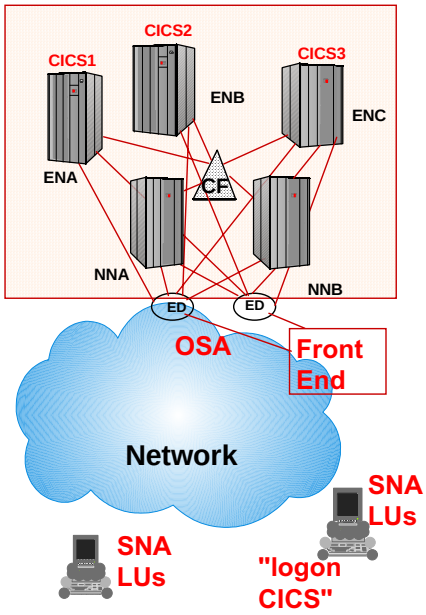
Sysplex Workload Distribution

- Removes All Configuration Restrictions
  - Few Nodes Directly Connected To WAN
    - Minimizes Cost Of Network Attachments
    - Allows transparent addition of new application serving nodes without affecting WAN
  - OSA Express may be used as TCP/IP Gateway
- All Sysplex Nodes Communicate via XCF
  - IP Addresses, Available Servers, etc.
  - XCF used for Signaling/Messaging but also for Data Transport
- One Stack Performs Routing Functions
  - Owns Sysplex-Wide VIPA And Advertises To Routers
  - Routes Connection Requests To Application Hosts
    - With Real-Time Consultation With WLM And Policy Agent
      - ✓ If WLM Not Available, target stack selection is random.
- Other Network-Connected Stack Is Backup
  - Performs Other Sysplex Duties As Required, Including Possibly Dispatching For Other VIPAs
  - Takes Over From Primary In Case Of Failure
    - Dynamic Routing Protocols, OSPF Or RIP, Required

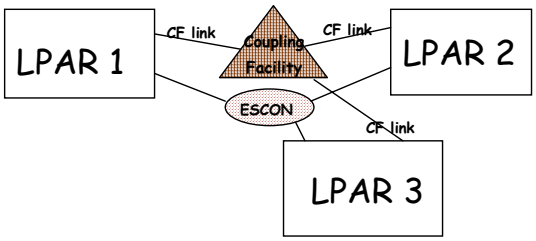
Introduced in V2R10!

SNA Sysplex Functions

- **Generic Resources**
  - Provides load balancing and availability
  - Users logon to a generic name - VTAM decides which application to use
  - Requires APPN in Sysplex
- **Multinode Persistent Sessions (MNPS)**
  - Sessions can continue with application started on another image if current image fails
  - Requires HPR
- **XCF**
  - Cross system coupling facility

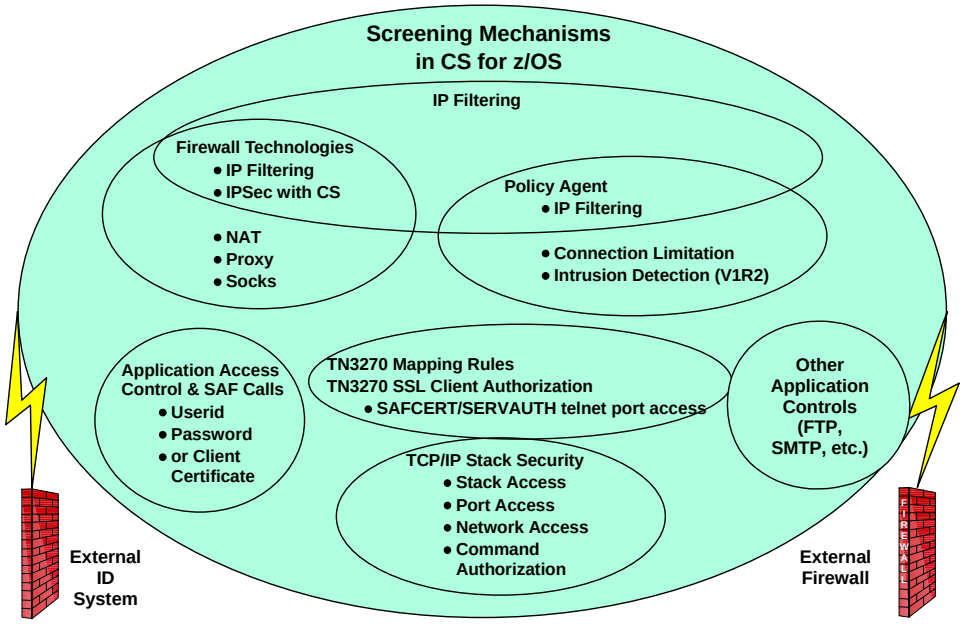


XCF



- Subsystems in a SYSPLEX may use XCF services for LPAR to LPAR communication
- XCF is defined within SYSPLEX and may consist of Coupling Facility and/or CTC connections
- In the case of CS, both VTAM and TCP/IP can use XCF for connectivity
  - VTAM PU and TRLE dynamically defined with XCFINIT=YES
  - TCP/IP requires presence of SNA XCF PU

Selected TCP/IP Security Functions



Summary

- **The Communications Server (CS) Name**
- **TCP/IP History**
- **SNA History**
- **Overview of TCP/IP**
  - Protocol Overview
  - Integration into Communications Server
- **Overview of VTAM**
  - Protocol Overview
  - Integration into Communications Server
- **Description of various network connectivity and application options**
- **A look at major CS functions**