R5. Connecting Systems

UNDERSTANDING ITS/CVO TECHNOLOGY APPLICATIONS
Reference Manual

MODULE 5 - CONNECTING INFORMATION SYSTEMS TO EACH OTHER AND TO USERS

Acronyms for the module

- TCP - Transmission Control Protocol
- IP - Internet Protocol
- OSI - Open System Interconnection
- DHCP - Dynamic Host Configuration Protocol
- HTTP - Hypertext Transfer Protocol
- FTP - File Transfer Protocol
- SMTP - Simple Mail Transfer Protocol
- DNS - Domain Name System
- SNMP - Simple Network Management Protocol
- UDP - User Datagram Protocol
- LAN - Local Area Network
- WAN - Wide Area Network
- FDDI - Fiber Distributed Data Interface
- ATM - Asynchronous Transfer Mode
- ISDN - Integrated Services Digital Network
- SMDS - Switched Multimegabit Data Service

Taken from Understanding Data Communications From Fundamentals to Networking on page 584

Historical Perspective

- Early 1970s: produced a vision for the future that information is instantly available and is organized in a consistent database that allows a company to operate faster to stay in touch with the real world
- Computer networks as we know it today may have started in the late 1960s or early 1970s with the ARPAnet development.
- Mid 1970s: business had big dream: on-line corporations, wired desktops and totally consistent databases
- Late 1970s: computer industry was beginning to mature
- The late 1970s also saw networking conferences dominate debates over the relative merits of circuit versus packet switching to transmit data from one end to another and standardizing the way computers communicate to each other.
- 1980s: in 1981, IBM introduced the personal computerMid 1980s: the 1980s also ushered in the era of end-user and team productivity
- A LAN allowed not only connection from the host-terminal environment but also complete interconnection with the personal computer.
- Late 1980s: throughout the 1980s, LANs grew dramatically. LANs were no longer used solely to provide host-to-terminal connectivity but to implement distributed processing as well.
- Standardization of internetworking protocols (architectures) was now taking shape. The ISO reference model (the OSI model) was now defined.
- 1990s: the term *client/server* has multiple meanings and is sometimes used interchangeably with the term *distributed processing*.
- One definition of client/server computing involves client computers relying on a server computer for shared data and peripherals.

There are four major architectures for connecting LANs and WANs

- Systems Network Architecture (SNA)
- Transmission Control Protocol/Internet Protocol (TCP/IP)
- Architectures built on the framework of the OSI Model
- Digital Network Architecture (DNA)

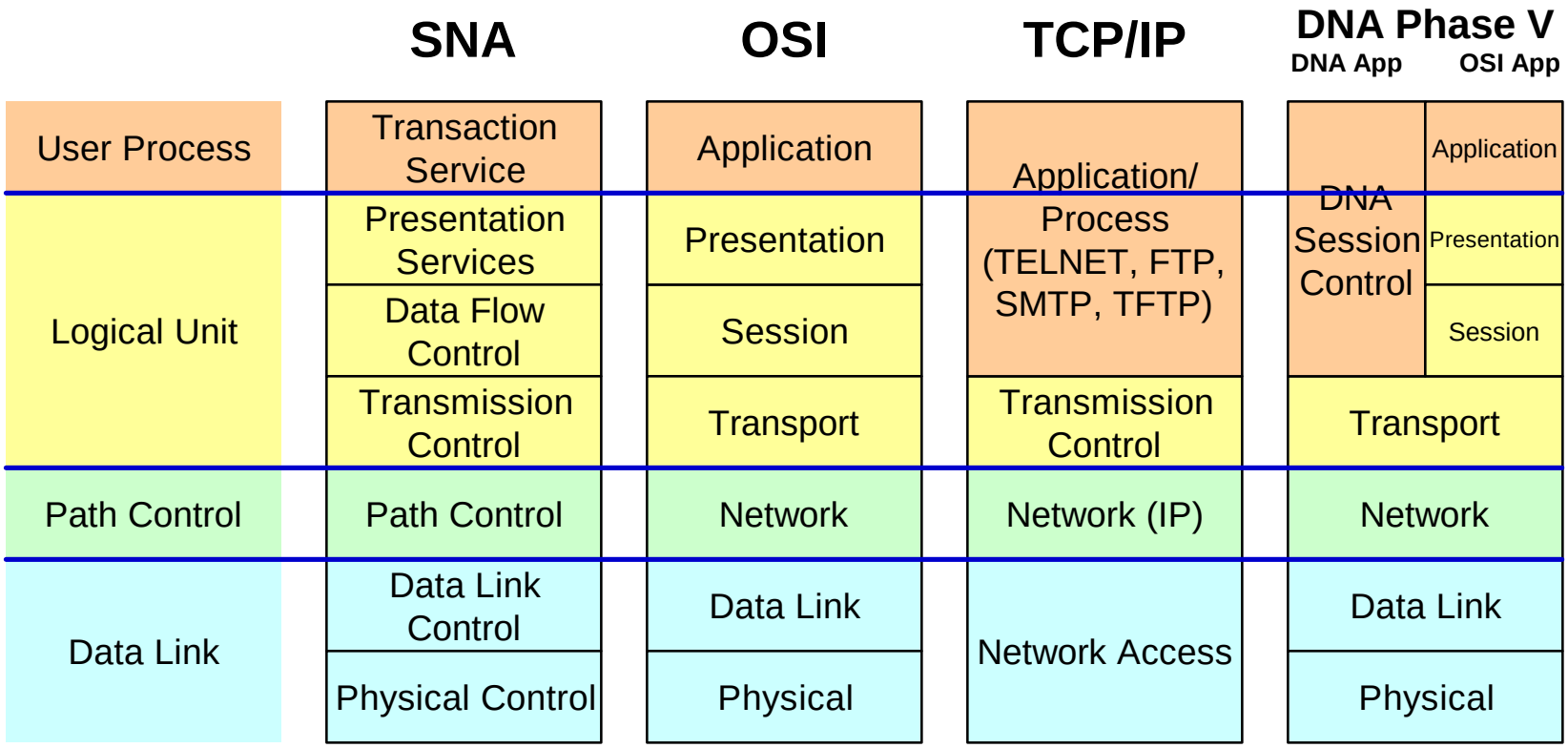
Network Architectures/Protocols

- SNA is IBM's proprietary architecture for designing and implementing interconnected networks.
- TCP/IP was developed in the 1970s by the Department of Defense's (DOD) Defense Advanced Research Projects Agency (DARPA).
  - The IP resides on hosts and gateways and relays data from the source host to the destination host.
  - The TCP resides only on the hosts and assures reliable data delivery. TCP provides a virtual circuit between the two hosts.
- OSI is a set of standard protocols proposed by the ISO in 1977.
- DNA Phase V has integrated ISO standards into the architecture. It is designed to support large networks internetworking with dissimilar systems.

There are four major architectures for connecting LANs and WANs

- SNA is IBM's proprietary architecture for designing and implementing interconnected networks.
- Using SNA is complex and requires trained technical personnel.
- However, the advantage to end users is that if their network is SNA based and their terminals are SNA compatible, they can plug in their terminals and access distributed databases and information systems quickly.
- The SNA network is managed by using software named telecommunications access method (TCAM), residing on the main processor.
- There are a number of versions of this software, but the most popular today is the virtual telecommunications access method (VTAM).
- Advanced peer-to-peer (APPN) is an enhancement to the basic SNA.
- TCP/IP is more flexible than SNA, since TCP/IP was designed to connect the diverse networks of multiple agencies, libraries, universities, defense agencies, and private corporations.
- Many businesses use TCP/IP protocols in their networks since OSI standards are slow to be implemented.
- OSI is a set of standard protocols proposed by the ISO in 1977.
- Implementation of these standards is expected to provide better connectivity, transfer of data, and interoperability of networks.
- The OSI architecture uses seven hierarchically separate layers to communicate between two end users.

A comparison of the seven layers of SNA, OSI, TCP/IP and DNA Phase V



Seven Layers

- The OSI reference model will be the basis of all future development. But there are still other architectures that were in existence or sprung up around the wait for the ubiquitous implementation of OSI.
- SNA, which is now over 20 years old and has had very few modifications from the original architecture
- DEC Net is also 20+ years old, but has gone through several iterations with an attempt to create openness
- TCP/IP, a set of protocols that work on a different architecture developed back in the late 1960s and deployed more in the early 1970s for the government. Now it is the protocol for the Internet and the primary set of protocols that LAN and WAN users are implementing for openness and robustness in their networking needs.

TCP/IP Suite

- Four-layer protocol stack
- Created by the Internet community in the 1970s to replace the original DOD network control program (NCP)
- Layer 1 is the network access layer
- Layer 2 is the Internet Protocol layer (IP)
- Layer 3 is the Transmission Control Protocol layer (TCP) (also termed as “transport” layer)
- Upper layers are termed as “applications” or “process” layers

TCP/IP Suite

- Layer 1 is equivalent to both physical and data link layers of the OSI model and sends data between two processors in the same network.
- Layer 2 routes data among more than one network.
- These three layers are also referred to as “lower layers” and essentially perform the networking functions.
- Layer 3, considered the reliability layer, is in charge of sending the data in sequence and without errors. This layer also includes another protocol, known as User Datagram Protocol (UDP), which allows users to send messages without connection establishment and without any guarantee of delivery or sequencing.
- The upper layers provide the services for three types of applications - electronic mail (SMTP), file transfer (FTP and TFTP), and terminal emulation (TELNET).

LANs & WANs

- LANs are high-bandwidth networks designed for geographically local areas, such as a building or a campus. A typical LAN can support hundreds of users from distances of 100 meters to over a kilometer and at speeds in excess of 10 Mbps. These characteristics have made LANs ideal for office and manufacturing applications using microprocessors and workstations. LANs operate by providing a high-bandwidth channel shared by all processors (nodes) connected to it. Only one node-printer, microprocessor, file server- can transmit at a time. Many nodes share the LAN, switching from one transmitter to another within microseconds. The two most common LAN technologies employed today are Ethernet and token ring.
- Today's enterprise networks consist of LANs of various protocols, supporting myriad media and architectures, connected to wide area networks consisting of a variety of communication systems. These complex networks span cities, countries, and continents and are being influenced by emerging technologies driven by user demands and vendor innovations. The industry offers several WAN segment options depending on whether the information is to be packet switched or frame relayed once it leaves the source LAN segment and reaches the destination LAN node. Depending on the transmission technologies used, available WAN options can be categorized as follows:
  - Switching systems (circuit or packet switching)
  - Frame Relay systems
  - Broadcast systems (satellite or microwave)
  - X.25 Networks

There are three main types of switched networks

- Circuit-switched networks
  - Telephone System
- Message-switched networks
- Packet-switched networks
  - Postal Service

Switching Systems

- Circuit-switched networks
  - Operate by forming a dedicated connection between the two partners
- Message-switched networks
  - Use the store-and-forward principle via several intermediate nodes
- Packet-switched networks
  - All information transmitted across the network is approximately equal and relatively short. The traffic on the network divided into smaller manageable pieces, called packets, are multiplexed into high-capacity intermachine connections.

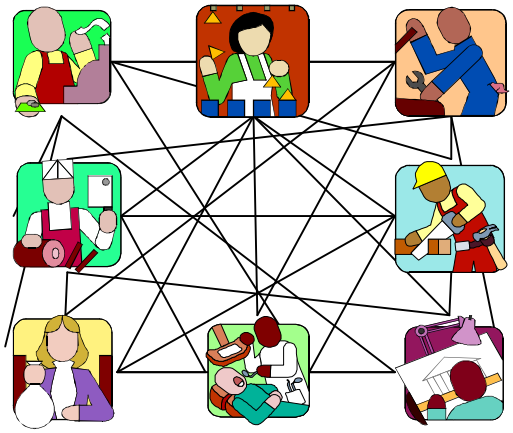
ATM and SMDS are both switched data services

- ATM:
  - packet-oriented transfer mode
  - both ATM and Frame Relay take advantage of the digital line's higher reliability and fidelity to provide fast packet switching
  - connection oriented
  - optimized to accommodate both real-time and non-real-time data efficiently and cost effectively
  - not protocol dependent
- SMDS:
  - high-speed switched data service, providing connectionless transport at high speeds
    (T1 and greater)

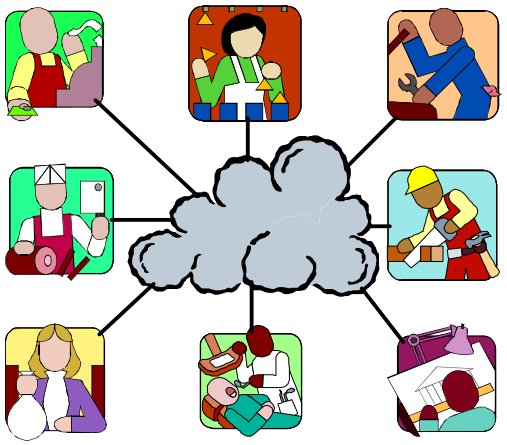
ATM and SMDS

- ATM represents an evolving networking technology designed to facilitate the integration of voice and data on both LANs and WANs. Since voice communication is time-dependent and cannot tolerate delays, a mechanism was required to transport time-dependent voice as well as data, so one would not interfere with the other. The mechanism developed was the use of very short, fixed length packets known as cells. By multiplexing 53 byte fixed length cells (5 byte header and 48 byte information field) ATM can transport both packetized voice and data without delaying voice so that it becomes distorted at the receiver due to transmission delays.
- SMDS was developed to facilitate the transmission of connectionless data packets throughout a metropolitan area within a radius of approximately fifty miles, typically using T1, T3 and, when available, Synchronous Optical (SONET) transmission facilities. Here the term connectionless is used to note that a transmitting device does not first have to establish a session connection with a receiver prior to transmitting data. Connectionless transmission is primarily used on LANs. Thus, SMDS can be viewed as providing and extension of LAN transmission across a metropolitan area. Since SMDS is a public network service, it provides a communications capability for both inter- and intra-company communications.

Frame Relay provides a simpler approach than a leased line network



Leased Line Network
(detailed analysis required)



Frame Relay Network
(single access point into cloud)

Frame Relay

- Frame differs from a packet in its length and header. A frame can be a bit- or character-oriented. Frame relay uses separate channel for control characters or header/trailer information, while packet switching uses the same channel for both control and user-defined data streams. Frame relaying is performed by setting up a virtual circuit between the source and the destination. Frame relay is a connectionless service that provides flow and error control in addition to other standard services.
- Frame is particularly suited for bursty traffic, because it offers better routing and error detection. It can be deployed in connecting disparate LANs over wide area links.

What is the Internet?

- “Born” in the 1970s from a U.S. Defense Department network called the ARPAnet
- About ten years later, Ethernet local area networks (LANs) and workstations came on the scene
- In the late1980s, the National Science Foundation (NSF) created five supercomputer centers and built its own network (based on the ARPAnet’s IP technology) and connected the centers with 56 Kbps telephone lines
- In 1987, a contract to manage and upgrade the network was awarded to Merit Network Inc. in partnership with IBM and MCI
- The ARPAnet was an experimental network designed to support military research - in particular, research about how to build networks that could withstand partial outages (like bomb attacks) and still function.
- To send a message on the network, a computer only had to put its data in an envelope, called an Internet Protocol (IP) packet, and “address” the packets correctly.
- The most important aspect of the NSF’s networking effort is that it allowed everyone to access the network; up to that point, Internet access had been available only to researchers in computer science, government employees and government contractors.

What is the Internet?

- On October 24, 1995, the Federal Networking Council (FNC) unanimously passed a resolution defining the term Internet. This definition was developed in consultation with the leadership of the Internet and Intellectual Property Rights (IPR) Communities:
  - "The Federal Networking Council (FNC) agrees that the following language reflects our definition of the term "Internet".
  - "Internet" refers to the global information system that --
    - is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons;
    - is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and
    - provides, uses or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure described herein."

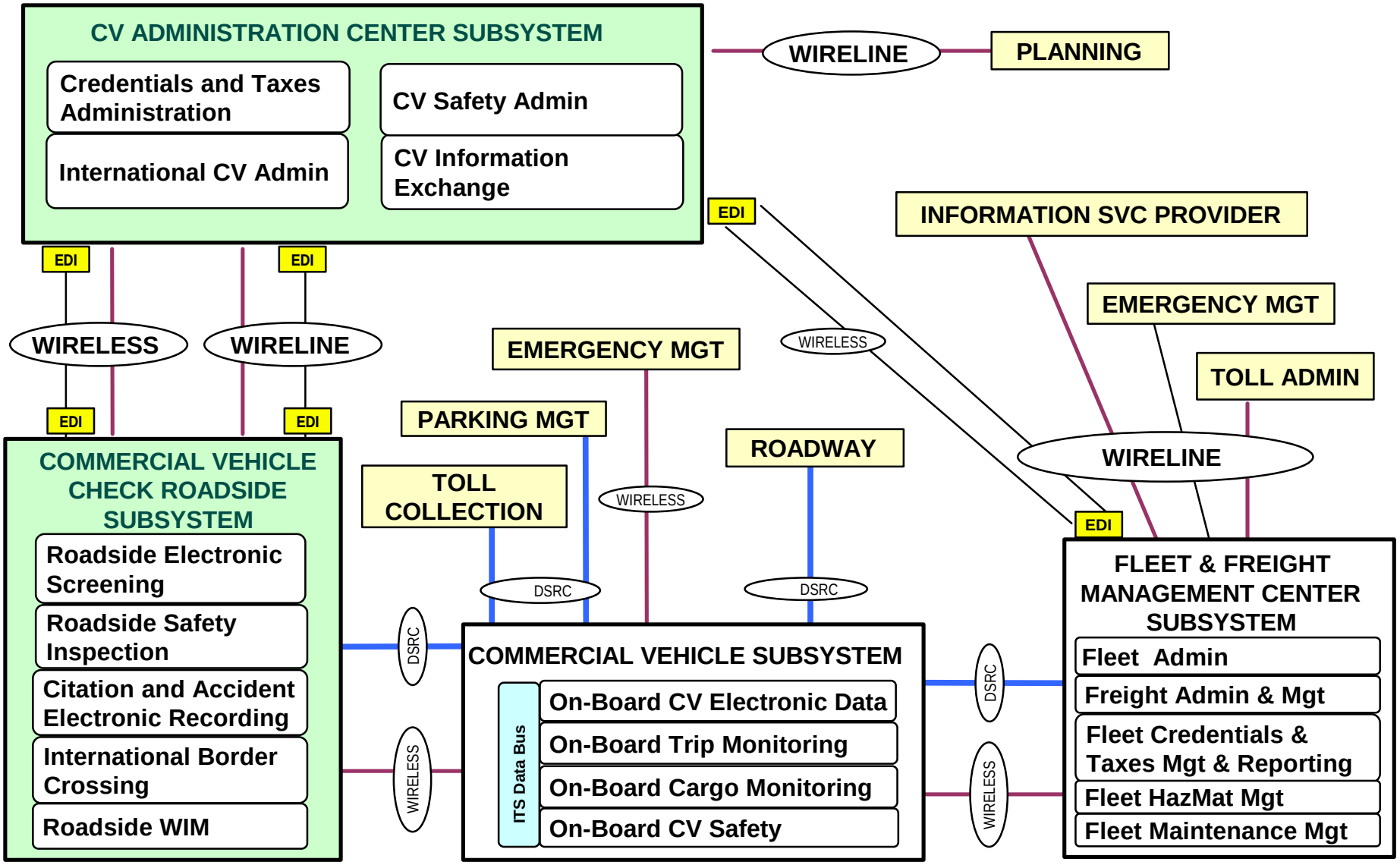
What is the Internet?

- The Internet, often called simply "the Net," is a worldwide system of computer networks and, in a larger sense, the people using it. It was conceived by the Advanced Research Projects Agency (ARPA) of the U.S. government in 1969 and was called the ARPAnet. The original intent was to construct a network that would continue to function even if a large portion of it were destroyed, for example, in the event of nuclear war.
- The Internet is now a public, cooperative, and self-sustaining facility accessible to tens of millions of people worldwide. Physically, the Internet uses a portion of the total resources of the currently existing public telecommunication networks. Technically, what distinguishes the Internet is its use of a set of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol). Two recent adaptations of Internet technology, the intranet and the extranet, also make use of the TCP/IP protocol.
- For many Internet users, electronic mail (e-mail) has practically replaced the Postal Service for short written transactions. Electronic mail is the most widely used application on the Net. You can also carry on live "conversations" with other computer users, using IRC (Internet Relay Chat). More recently, Internet telephony hardware and software allows real-time voice conversations on the Net.
- The most widely used part of the Internet is the World Wide Web (often abbreviated "WWW" or called "the Web"). Its outstanding feature is hypertext, a method of instant cross-referencing. In most Web sites, certain words or phrases appear in text of a different color than the rest; often this text is also underlined. When you select one of these words or phrases, you will be transferred to a site relevant to the word or phrase. Sometimes there are buttons, images, or portions of images that are "clickable." If you move the pointer over a spot on a Web site and the pointer changes into a hand, this indicates that you can click and be transferred to another site.
- Using the Web, you have access to millions of pages of information. Web "surfing" is done with a Web browser, the most popular of which are Netscape and Microsoft Internet Explorer. The appearance of a particular Web site may vary slightly depending on the browser you use. Also, later versions of a particular browser are able to render more "bells and whistles" such as animation, virtual reality, sound, and music files, than earlier versions.

Internet Basics 101

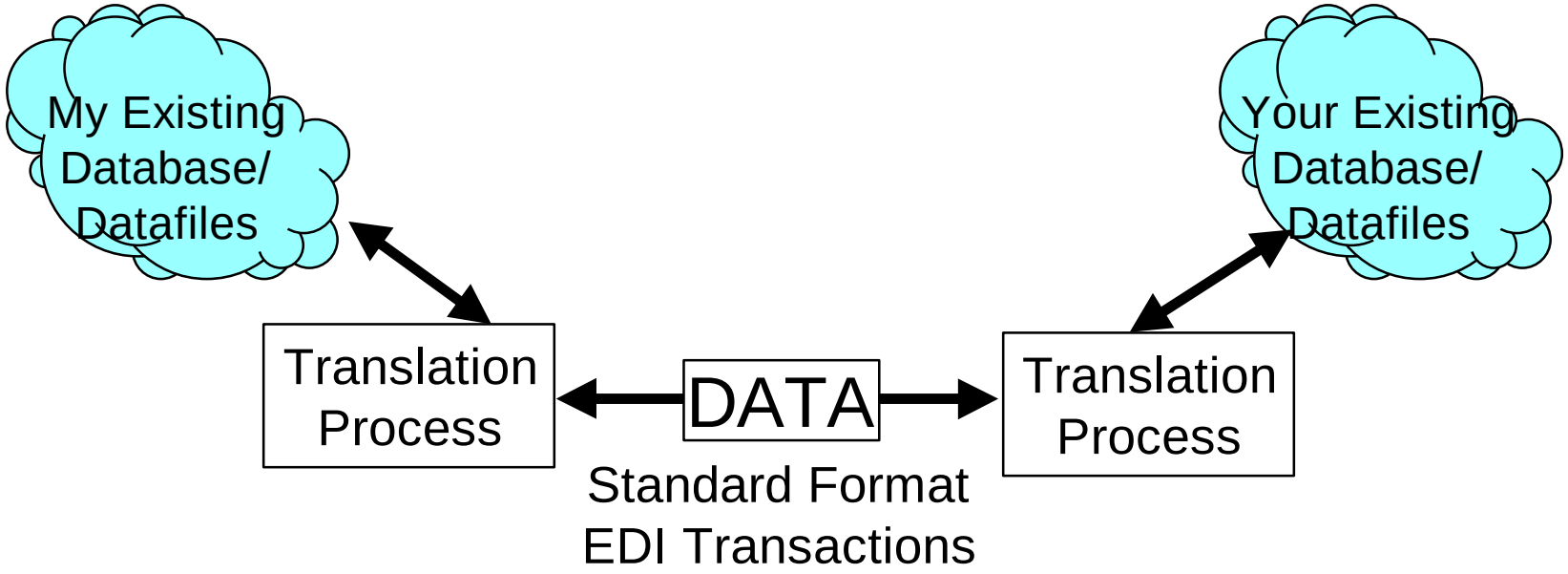
- WWW:
  - World-Wide Web
  - Though the World-Wide Web is commonly used in place of "Internet", they do not mean the same thing. The Web refers to a body of information - an abstract space of knowledge, while the Internet refers to the physical side of the global network, a giant mass of cables and computers.
- Hyperlink:
  - An active cross-reference from one resource to another. The cross-reference is called active because it is presented in a medium which allows the reader to follow it, for example by mouse-clicking it. A reader can follow hyperlinks in an HTML document using a Web browser, or navigate through online help, or follow hyperlinks between terms defined in a glossary.
- Hypertext:
  - Text with hyperlinks. Readers can access the material in a variety of possible sequences, as opposed to more traditional, linear text.
  - Hypertext is the method of presenting information where selected words in the text can be “expanded” at any time to provide other information about the word. That is, these words are links to other documents which may be text, files, pictures, anything.
- Browser:
  - a browser is any program for reading hypertext
  - web clients are basically hypertext readers, so they are called browsers
  - two major browsers on the market
    - Netscape (Communicator / Navigator)
    - Microsoft (Internet Explorer)
  - other minor browsers on the market
    - Opera, Arachne, Amaya, Mosaic, HotJava, Softerm

ITS/CVO architecture is connected by compatible communication links and standards



EDI uses open standards to exchange information

EDI uses open standards to exchange information. Information transmitted in EDI transactions is organized to be processed automatically by computers, rather than manually by people.



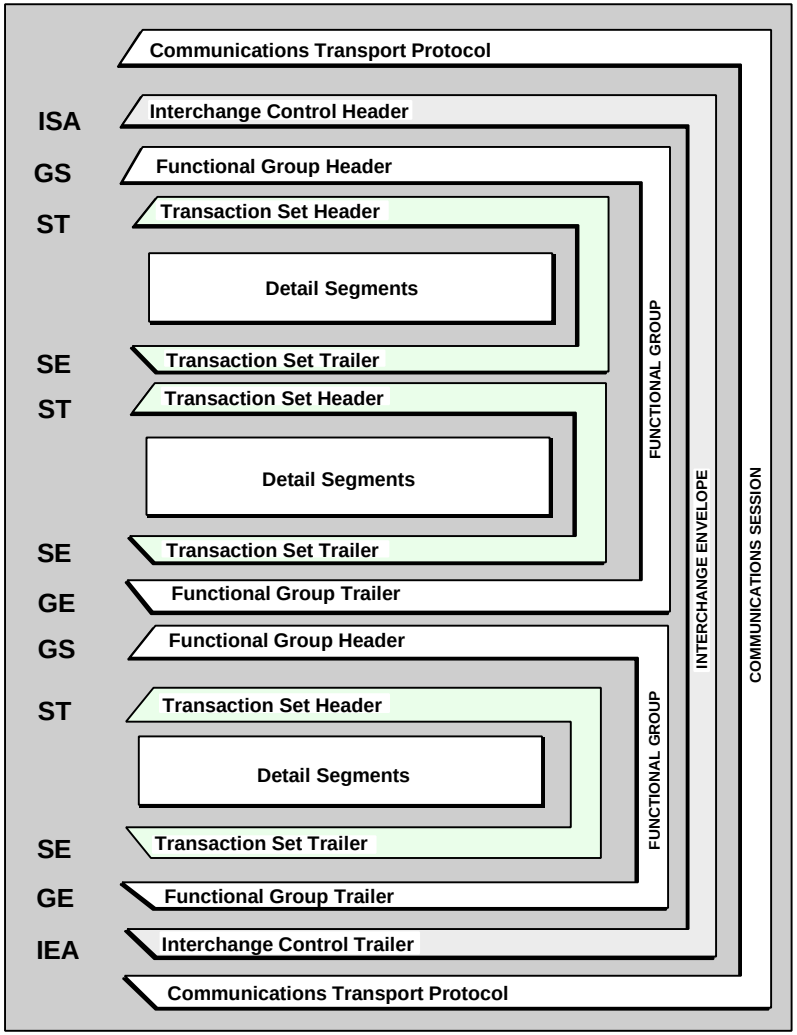
Definition of EDI Terms

- Transaction Set
  - A meaningful unit of information exchanged between trading partners.
  - A transaction set corresponds to a business document or form and defines that business information in a standard syntax.
  - It consists of a header segment, one or more data segments in a specified order, and a trailer segment.
- Map (noun)
  - A definition of the relationship between application data and the X12 standard segments and elements.
- Mapping (verb)
  - The process of converting data from one format to another according to the "map" (noun). Generally a piece of software is invoked.

EDI implementation is guided by standards, guidelines and agreements

- EDI Standards for transaction sets (TS):
  - Standards are the technical documentation approved by American National Standards Institute (ANSI) Accredited Standards Committee (ASC) X12 that define the structure and meaning of data passed between trading partners.
- EDI Implementation Guides:
  - Implementation Guides provide instructions and reference information on the use of an EDI standard to satisfy specific business needs, and contain both business and technical information. For the 286 they are specific to each type of credential, such as the EDI IG for TS 286 Carrier to State IRP.
- Trading Partner Agreements:
  - These agreements insure compliance with national standards for computer security and privacy, and legally bind the trading partners to the terms, conditions and regulations included in the agreement.

The EDI message structure wraps the ASCII data for transmission



Source: Accredited Standards Committee X12 Draft Version 3 Release 6, Published December 1995

EDI Transmission Structure

- The structure of a transaction set (TS) begins with a TS header data segment (ST) which indicates the beginning of the set, identifies the TS type, and includes a serial TS control number which is also keyed to the data interchange control number of the functional group. At the end of the TS, a TS trailer data segment (SE) contains a total of the number of data segments included in the TS and repeats the TS control number. Both the header and trailer, as with all data segments, are recognized by their data segment identifiers.
- To achieve efficiencies in electronic communications, TS are transmitted in groups. The EDI standards use the term “functional groups,” defined as one or more TSs enclosed by functional group header and trailer segments. The functional group header and data segment (GS) indicates the beginning of a functional group and includes data elements to identify the sender and intended receiver, as well as control information including data interchange date, time and sender’s control number, and the issuer and version of the EDI standards applied. The functional group trailer data segment (GE) indicates the end of the group of TSs, and repeats that data interchange control number.

Standard Transaction Set (TS) 286 supports electronic application for all CVO regulatory & tax credentials

- The 286 Transaction Set supports information exchanged for several credential types using a common transaction set.
- Separate message types have been defined for:
  - Vehicle Registration, Interstate (IRP) and Intrastate
  - IFTA Registration
  - Operating Authority Application (SSRS and other)
  - Oversize/Overweight Permit
  - Vehicle Titling
  - HazMat Permits

The detailed definition of the 286 TS is provided in the X12 Standard. This provides the framework for later definition of specific message types.

EDI Implementation Guidesspecify how an EDI standard will be used to satisfy business needs

A series of Implementation Guides are being produced for the TS 285 and TS 286 transaction sets:

- Safety and Credentials Information Exchange (285)
- Interstate Registration Plan (286)
- IFTA Registration (286)
- Intrastate Registration (286)
- Oversize/Overweight Permitting (286)
- Single State Registration Plan (286)

Example: EDI Implementation Guide for IRP

Purpose

To provide guidance and reference information for public and private agencies to implement and maintain connections using TS 286 for IRP credential transactions.

To provide specific coding information for implementing TS 286 transactions that take place between the applicant and the issuing jurisdiction.

Scope

Presents the **business case**: envisioned environment for the transaction; information concerning timing of transactions; security; acknowledgements; and legal considerations.

Presents details of the **transaction set**: control segments; segment usage; and transaction examples based on the ANSI ASC X12 syntax for various message types (e.g., IRP Supplemental).

EDI IGs

- The intended audience is an experienced EDI programmer tasked with implementing the TS-286 for such transactions.
- Transmissions will include the date and time. A date-time stamp will be assigned to a transaction set when it is received.
- Security: Trading partners are responsible for following Federal Information Processing Standards (FIPS) and other statues relating to computer security and privacy, including the Privacy Act of 1974. The following documents provide guidance in these areas:
- Recovery Procedures: Received messages are uniformly acknowledged with a 997 (Functional Acknowledgment) transaction set. The location and nature of syntax errors communicated with 997. Problems with the meaning of the message are communicated with an appropriate comment in the MSG segment.
- Legal Considerations: Record keeping - Consider the legal issues when developing policies and procedures for the recording of EDI data; Authentication - Verify the authenticity of the sender and receiver, as well as the content of the messages; Trading Partner Agreements - Address the importance of trading partner agreements. Identify other related selected issues that should be considered when drafting an agreement. Trading partners are bound by the terms and conditions in this agreement and its included regulations. A model trading partner agreement has been developed by the American Bar Association (ABA) and addresses the major issues when using EDI. This model agreement may be customized to meet specific needs of trading partners; Third Party Agreements - Identify any issues that users and networks should consider when negotiating EDI contracts; Laws, Rules, and Regulations - Consider existing laws, rules, and regulations that should be consulted during implementation.

Each IRP business transaction requires the definition of a specific EDI Message Type

Carrier to State Message Types

Initial and Renewal Application

IRP Supplement:

- Add Vehicle
- Add/Delete Vehicle
- Add Jurisdiction
- Weight Change
- Change Ownership
- Replace/Duplicate Credential

Trip Permit Application

Payment Methods

State to Carrier Message Types

IRP Renewal Notice

IRP Credential Returned

Temporary Credential Returned

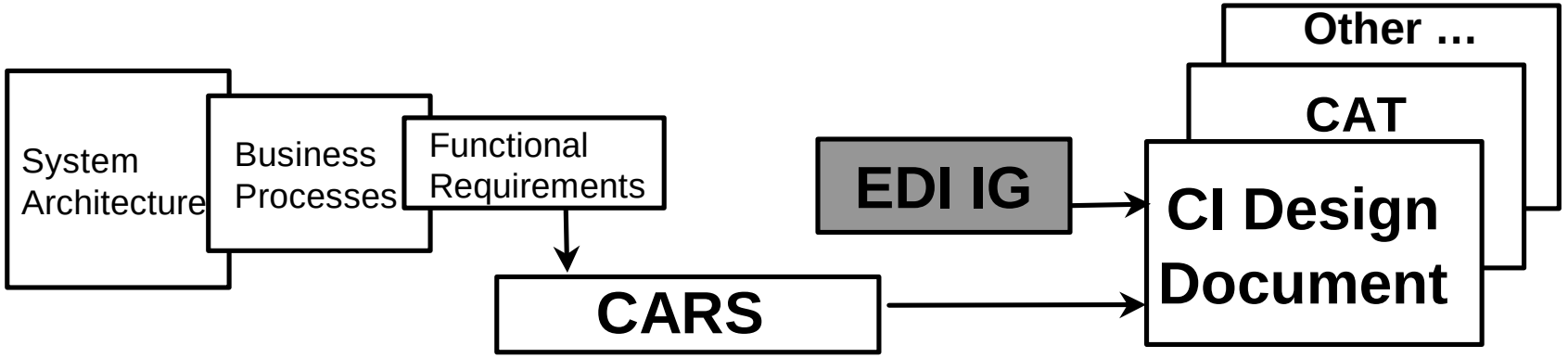
Trip Permit Returned

IRP Application Rejection

Fee Calculation (Invoice Notice)

The details of each of these message types is defined with examples in an Implementation Guide (IG).

The combination of the CARS and the EDI IG provide the inputs necessary to design systems



- The credentials administration requirements, along with the EDI Implementation Guides, provide the basis for producing a design document for each subsystem (e.g., CAT, CI, …)
- APL is working to develop unambiguous interface definitions that can be implemented by any vendor who wants to follow open standards and be consistent with the CVISN architecture

Electronic Signatures & Certifications, Affidavits and Power of Attorney

State CVO procedures generally require original signatures on paper documents for:

- Carrier certification that application content is accurate
- Affidavits for a variety of purposes including application for refunds
- Power of attorney to allow a third party to act on behalf of the carrier

Electronic Signatures - Terminology

- affidavit: a sworn statement in writing made especially under oath or on affirmation before an authorized magistrate or officer
- certify: to attest authoritatively; to guarantee as to signature and amount (as a personal check) by so indicating on its face;
- certification: the act of certifying; the state of being certified; a certified statement
- certificate: a document containing a certified statement, especially as to the truth of something; specifically a document that one has fulfilled the requirements of and may practice in a field; a document indicating ownership or debt
- power of attorney: a legal instrument authorizing one to act as the attorney or agent of the grantor

Electronic Signatures - Technology

- Digital signature technology is viable but immature
  - Public Key Cryptography
  - Private Key Cryptography
  - Digital Certificates
  - Hardware Keys / Smart Cards
  - Biometric Methods
  - User ID & PIN
- Simple approaches are readily available that probably provide higher security than is provided by current paper base level

Electronic Signatures - Institutional Considerations

- Electronic processes require an electronic signature (or substitute) to be a replacement for pen and paper systems if the full benefits of automation are to be received.
- Progress toward a replacement is slow as it requires changes to legislation as well as administrative procedures.
- Technologies for electronic or digital signatures exist & this technology is evolving rapidly
- States should position themselves institutionally to be able to evolve with the technology: Change laws to allow electronic signatures but don't legislate a specific technology
- The EDI Trading Partner Agreement can be used to define the rules for signatures, affidavits, certifications & power of attorney

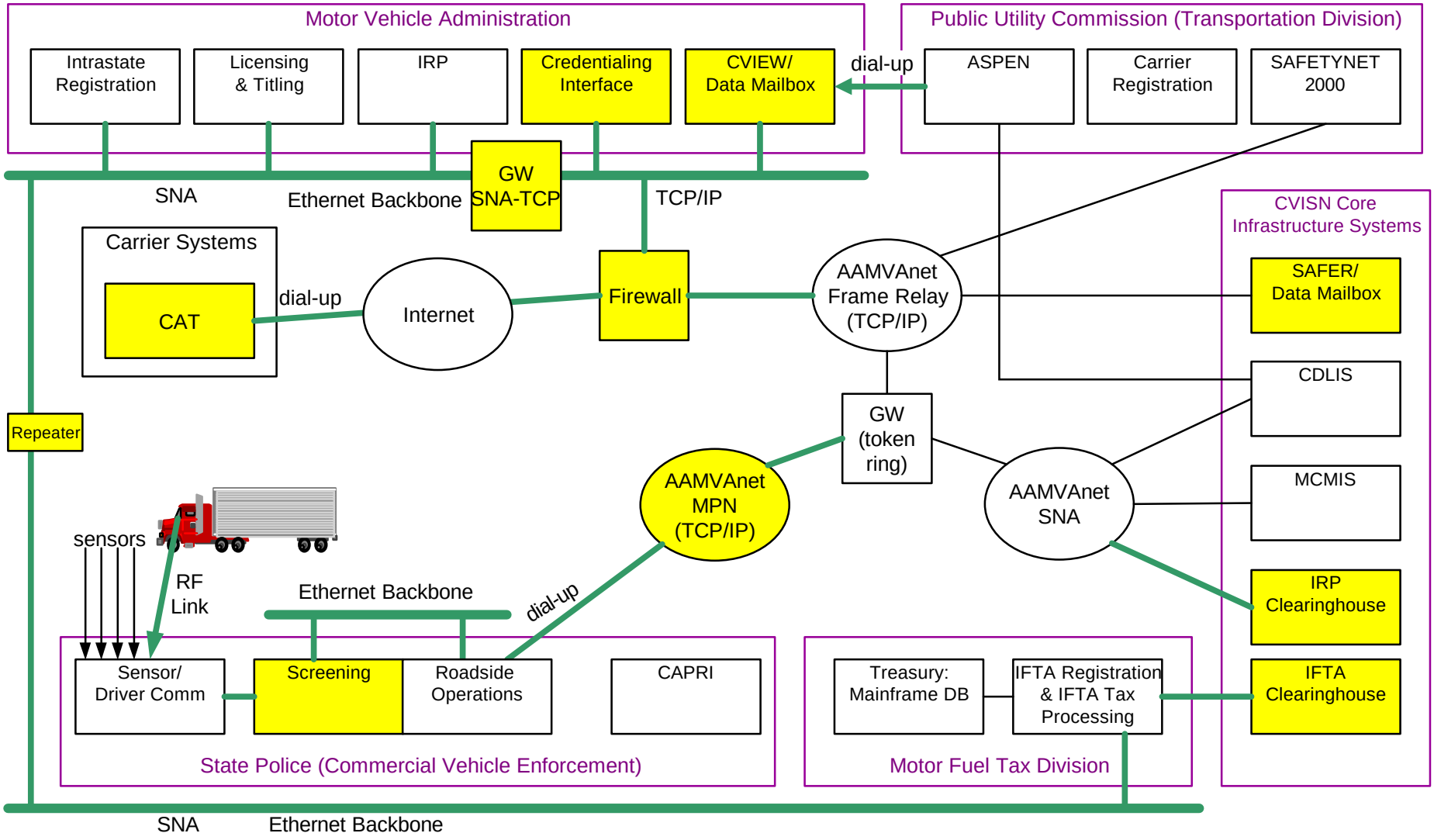
Selected State Experience with Electronic Signatures: No common practice has yet emerged

California	Accepts electronic submissions with signed hard copy follow-up. Secretary of State is pursuing a state-wide solution for all agencies.
Iowa & Minnesota	Face legislative opposition to changing state law to allow (or at least not prohibit) electronic signatures.
Maryland	Plans to allow placing a paper signature on file once & them permitting electronic processes thereafter

Selected State Experience with Electronic Signatures: No common practice has yet emerged

New York	Wide variety of applications and approaches. Some parts of state law allow electronic signatures now, others don't. To resolve this, a comprehensive "electronic records" bill is moving, with some legislative resistance. Electronic One-Stop will use PIN numbers for validation.
Oregon	No provision for computer filing at the current time. Requires original signature on application for authority. Does not require original signatures on registration applications or affidavits. Accepts these documents by fax.
Pennsylvania	Working on a state-wide solution for all agencies. Change in state law will be needed.

Proposed Midland network configuration



Proposed Midland network configuration

- New networks and network connections are shown in **GREEN dashed lines**.
- New computer systems and new networks are highlighted in **YELLOW**.
- There are still the five original areas, but there are new/additional computer systems:
  1. CI
  2. CVIEW
  3. Screening
  4. IFTA Clearinghouse
  5. IRP Clearinghouse
  6. SAFER
- There are new network pieces:
  1. Gateways or Repeaters to connect different types of networks.
  2. The Firewall between the Internet and the AAMVAnet Frame Relay.
  3. The AAMVAnet Multi-protocol Network (MPN)
  4. The RF link between the commercial vehicle and the Sensor/Driver Comm
  5. The new LAN in the MVA area.
  6. The new LAN in the State Police area.
  7. The dial-up connections between ASPEN and CVIEW and between ROC and the AAMVAnet MPN.
  8. The new LAN/WAN to connect the Motor Fuel Tax Division and the MVA.

  Note that we don't show exactly what kinds of network components will be used . . . yet.
- There are many new network connections between the Midland computer components.
- CVISN Core Infrastructure systems and their existing connections have been added.
- The Carrier Automated Transactions (CAT) product and its connections for electronic credentialing have been added.

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