Induction Course for
MII Certificate Examination 2013

Lawrence Chow

INFORMATION TECHNOLOGY PART I

Content

- Part I
  - Archiving Architecture
  - Network Architecture
  - Hardware and Software management
- Part II
  - Data mining for operations, quality assurance and planning purposes
  - IT standards
  - Replacement planning

Archiving architecture

- Computer Basic
- Redundant array of independent disk (RAID)
- Hierarchy Storage
- Storage Network Technology
- Archiving Policy

Computer Basic

- Control Unit
  - Interpret / decode program instruction
- Arithmetic Logic Unit (ALU)
  - Arithmetic operation
  - Logic operation
- Memory
  - RAM
  - ROM
- Input / Output (I/O)
  - Peripherals ….Hard disk, Keyboard
- Computer Speed
  - Clock
  - Memory
  - Processor
    - Instruction per second (IPS), kIPS, MIPS, GIPS, MOPS

Computer Basic

Multiples of bits				
SI decimal prefixes		Binary	IEC binary prefixes	
Name (Symbol)	Value		Name (Symbol)	Value
kilobit (kbit)	10^3	2^{10}	kibibit (Kibit)	2^{10}
megabit (Mbit)	10^6	2^{20}	mebibit (Mibit)	2^{20}
gigabit (Gbit)	10^9	2^{30}	gibibit (Gibit)	2^{30}
terabit (Tbit)	10^{12}	2^{40}	tebibit (Tibit)	2^{40}
petabit (Pbit)	10^{15}	2^{50}	pebibit (Pibit)	2^{50}
exabit (Ebit)	10^{18}	2^{60}	exbibit (Eibit)	2^{60}
zettabit (Zbit)	10^{21}	2^{70}	zebibit (Zibit)	2^{70}
yottabit (Ybit)	10^{24}	2^{80}	yobibit (Yibit)	2^{80}

Name (Symbol)	Standard SI	Name (Symbol)	Value
kilobyte (kB)	$10^3 = 1000^1$	2^{10}	kibibyte (KiB)
megabyte (MB)	$10^6 = 1000^2$	2^{20}	mebibyte (MiB)
gigabyte (GB)	$10^9 = 1000^3$	2^{30}	gibibyte (GiB)
terabyte (TB)	$10^{12} = 1000^4$	2^{40}	tebibyte (TiB)
petabyte (PB)	$10^{15} = 1000^5$	2^{50}	pebibyte (PiB)
exabyte (EB)	$10^{18} = 1000^6$	2^{60}	exbibyte (EiB)
zettabyte (ZB)	$10^{21} = 1000^7$	2^{70}	zebibyte (ZiB)
yottabyte (YB)	$10^{24} = 1000^8$	2^{80}	yobibyte (YiB)

1 word = 2 bytes = 16 bits *Depend on system*

Computer Basic

- 1 byte = 8 bits
- 1 kilobyte (K / Kb) = 2^10 bytes = 1,024 bytes
- 1 megabyte (M / MB) = 2^20 bytes = 1,048,576 bytes
- 1 gigabyte (G / GB) = 2^30 bytes = 1,073,741,824 bytes
- 1 terabyte (T / TB) = 2^40 bytes = 1,099,511,627,776 bytes
- 1 petabyte (P / PB) = 2^50 bytes = 1,125,899,906,842,624 bytes
- 1 exabyte (E / EB) = 2^60 bytes = 1,152,921,504,606,846,976 bytes
- Most Significant Bit

Computer Basic

- Binary operation
- Bitwise OR

	0	1	0	1	(decimal 5)
OR	0	0	1	1	(decimal 3)
=	0	1	1	1	(decimal 7)

- Bitwise AND

	0	1	0	1	(decimal 5)
AND	0	0	1	1	(decimal 3)
=	0	0	0	1	(decimal 1)

Computer Basic

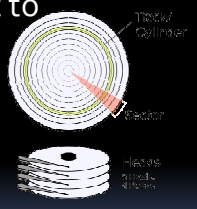
- Memory
  - Volatile memory
    - RAM
  - Non-volatile memory
    - Tape, Optical disk
- Accessibility
  - Random access
    - RAM, Optical disk
  - Sequential access
    - Tape

Computer Basic

- 磁碟存取時間（disk access time）
- 磁碟讀寫資料時，所需時間分三個部份，其公式如下
- disk access time=seek time+ rotation time +transmission time，分述如下：
- 搜尋時間（seek time）
- 將讀寫頭移動到正確的磁柱（也就是正確的磁軌）上所需之時間。
- 旋轉時間（rotation time）
- 等候所要存取之磁區旋轉到磁頭之正下方所需之時間，又稱為潛伏時間（latency time）。
- 資料傳輸時間（data transfer time）
- 真正進行讀寫中，讀寫一個磁區所需的時間。

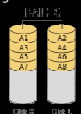
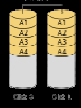
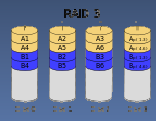
Computer Basic

- Disk capacity calculation
  - cylynders x heads x sectors x 512 bytes = () /1024 to convert to kilobytes =() /1024 to convert to megabytes



- Logical Unit Number (LUN)
  - is a number used to identify a **logical unit,** which is a device addressed by the SCSI protocol or protocols which encapsulate SCSI, such as Fibre Channel or iSCSI

Redundant array of independent disk (RAID)

Level	Description	Minimum # of drives**	Space efficiency	Fault tolerance	Array failure rate***	Read performance	Write performance	Figure
RAID 0	Block-level striping without parity or mirroring	2	1	0 (none)	$1-(1-r)^n$	nX	nX	
RAID 1	Mirroring without parity or striping	2	1/n	n−1 drives	r^n	nX*****	1X	
RAID 2	Bit-level striping with dedicated Hamming-code parity	3	$1 - 1/n \cdot \log_2(n-1)$	RAID 2 can recover from one drive failure or repair corrupt data or parity when a corrupted bit's corresponding data and parity are good.	Variable	Variable	Variable	
RAID 3	Byte-level striping with dedicated parity	3	1 − 1/n	1 drive	$1-(1-r)^{(n-1)/2}$	(n−1)X	(n−1)X*	

Redundant array of independent disk (RAID)

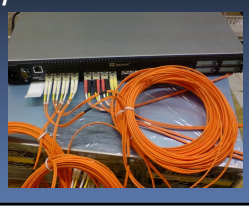
Level	Description	Minimum # of drives**	Space efficiency	Fault tolerance	Array failure rate***	Read performance	Write performance	Figure
RAID 4	Block-level striping with dedicated parity	3	1 − 1/n	1 drive	$1-(1-r)^{(n-1)/2}$	(n−1)X	(n−1)X*	
RAID 5	Block-level striping with distributed parity	3	1 − 1/n	1 drive	$1-(1-r)^{(n-1)/2}$	(n−1)X*	(n−1)X*	
RAID 6	Block-level striping with double distributed parity	4	1 − 2/n	2 drives	$1-(1-r)^{(n-2)/2}$	(n−2)X*	(n−2)X*	
RAID 10	Mirroring without parity, and block-level striping	4	2/n	1 drive / span ****		nX	(n/2)X	

Hierarchy Storage

- Online Storage
  - Fibre Channel
  - High transfer rate
- Secondary Storage
  - SATA disk
- Tertiary Storage
  - Tape library, Virtual Tape Library (VTL)
- Off-line Storage
  - Tape, MOD

Storage Network Technology

- Network Attached Storage (NAS)
  - file-level computer data storage connected to a computer network providing data access to a heterogeneous group of clients
- Storage Area Network (SAN)
  - dedicated network that provides access to consolidated, block level data storage
  - SAN switch



Archiving Server

- 24 x 7 operation
- Fault tolerance
  - Redundancy
- Preventive Maintenance (PM)
  - Health check
  - Vendor report
- Housing Keeping Task
  - Disk storage monitoring
  - Data compression
- Resilience
  - Backup system and storage

Archiving Policy

- Image receiving
- Image stacking
- Image routing
- Image archiving
- Image retrieving
- Image pre-fetching

Network architecture

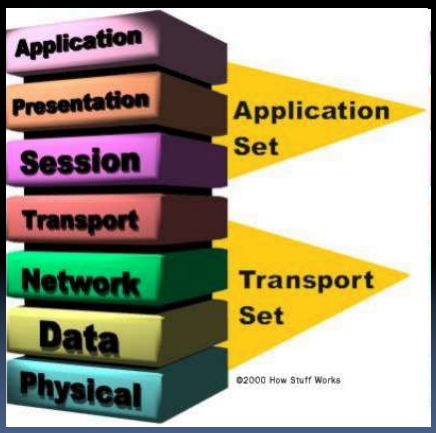
- Network Scale
- Open System Interconnect Model (OSI)
- Network Protocol
- IP address basic / IP subnetting
- Data packet and routing
- Network hardware components

Network Scale

- Local Area Network (LAN)
  - interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media
- Metropolitan area network (MAN)
  - networks which are geographically separated but in same metropolitian city
- Wide Area Network (WAN)
  - that links across metropolitan, regional, or national boundaries

Open System Interconnect

- Open System Interconnect (OSI) developed by International Standards Organization (ISO)



OSI by function

OSI Model			
	Data unit	Layer	Function
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5. Session	Inter-host communication, managing sessions between applications
	Segments	4. Transport	End-to-end connections, reliability and flow control
Media layers	Packet/Datagram	3. Network	Path determination and logical addressing
	Frame	2. Data link	Physical addressing
	Bit	1. Physical	Media, signal and binary transmission

Protocol by layer

Internet protocol suite
Application layer
DHCP DHCPv6 DNS FTP HTTP IMAP IRC LDAP MGCP NNTP BGP NTP POP RPC RTP RTSP RIP SIP SMTP SNMP SOCKS SSH Telnet TLS/SSL XMPP •(more)
Transport layer
•TCP UDP DCCP SCTP RSVP •(more)
Internet layer
•IP IPv4 IPv6 ICMP ICMPv6 ECN IGMP IPsec •(more)
Link layer
•ARP/InARP NDP OSPF Tunnels L2TP PPP •Media access control •Ethernet DSL ISDN FDDI •(more)

Protocol by layer

- Physical
  - SONET, T1, T3, cat 5e, cat 6
- Link
  - Ethernet, FDDI
  - Circuit, ATM, FR switches
- Network
  - Routing, Call control
  - IP internetworking

7	Application
6	Presentation
5	Session
4	Transport
3	**Network**
2	**Link**
1	**Physical**

Protocol by layer

- Transport
  - Error and congestion control
  - TCP, UDP
- Session, Presentation, Application
  - Data, voice encodings
  - Authentication
  - web/http, ftp, telnet

7	**Application**
6	**Presentation**
5	**Session**
4	**Transport**
3	Network
2	Link
1	Physical

TCP/IP

- IP addressing
- Data packet
- Transmission Control Protocol (TCP)
  - TCP provides reliable, ordered, error-checked delivery of a stream of octets between programs running on computers connected
- Internet Protocol (IP)
  - relaying datagrams across network boundaries

Transmission Control Protocol TCP (Transport layer)

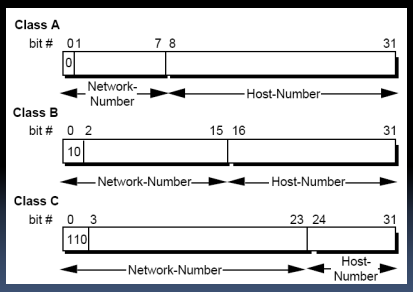
- Due to network congestion, traffic load balancing, or other unpredictable network behavior, IP packets can be lost, duplicated, or delivered out of order
- Technique known as positive acknowledgment with retransmission is used to guarantee reliability of packet transfers
- Reassembles the individual segments and ensures they are correctly ordered
- Error free as it streams them to an application

Internet Protocol IP (Network Layer)

- delivering packets from the source host to the destination host solely based on the IP addresses
- connectionless datagram
- IP addressing

IP addressing

- Principle Classful IP address formats
- Example:
  - Class A Network (/8 Prefixes)
  - A maximum of 126 (2^7-2) /8 networks can be defined. The calculation requires that the 2 is subtracted because the /8 network 0.0.0.0 is reserved for use as the default route and the /8 network 127.0.0.0 (also written 127/8 or 127.0.0.0/8) has been reserved for the "loopback" function.
  - Each /8 supports a maximum of 16,777,214 (2^{24}-2) hosts per network. The host calculation requires that 2 is subtracted because the all-0s ("this network") and all-1s ("broadcast") host-numbers may not be assigned to individual hosts.



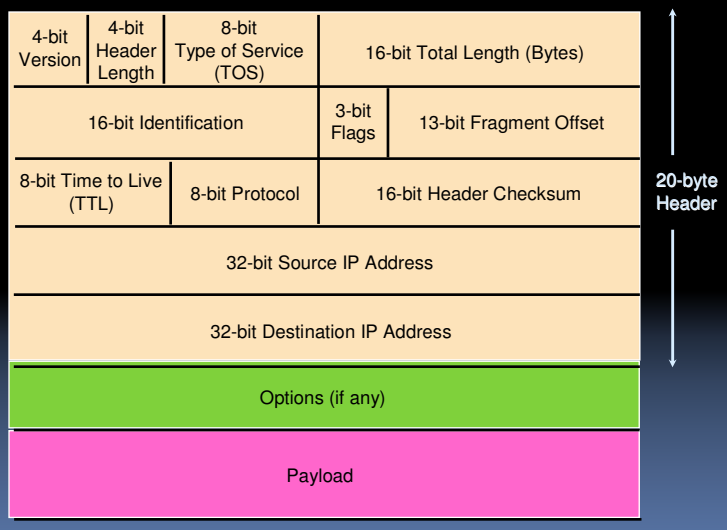
Subnetting Example

- Assume that you have been assigned the 132.45.0.0/16 network block. You need to
- establish eight subnets

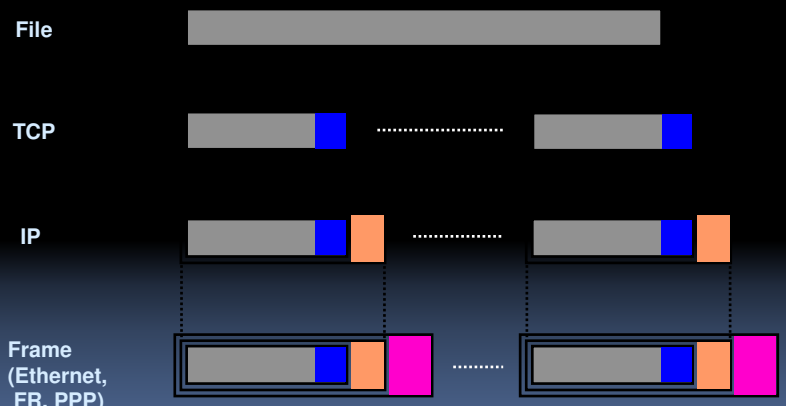
Subnetting Example

- 1. _____ binary digits are required to define eight subnets.
- 2. Specify the extended-network-prefix that allows the creation of 8 subnets.
- _____
- 3. Express the subnets in binary format and dotted decimal notation:
- #0 _____
- #1 _____
- #2 _____
- #3 _____
- #4 _____
- #5 _____
- #6 _____
- #7 _____
- 4. List the range of host addresses that can be assigned to Subnet #3 (132.45.96.0/19).
- _____
- _____
- _____
- _____
- _____
- 6. What is the broadcast address for Subnet #3 (132.45.96.0/19).
- _____

IP Packet Structure

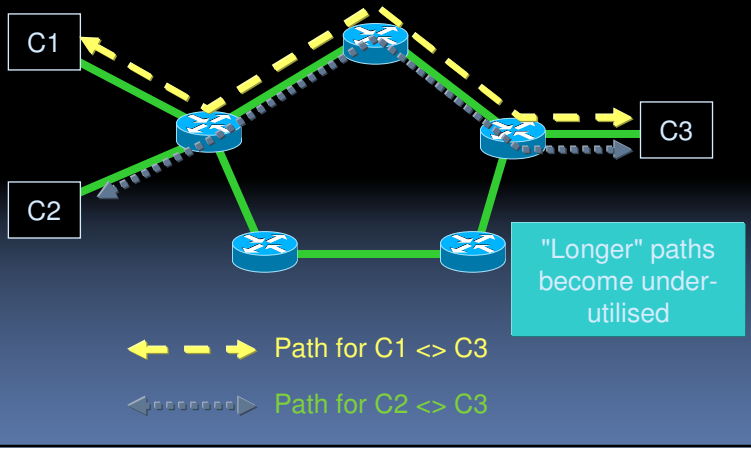


Data Transfer Over Frame-based Networks



Routing example

- Routing Protocols Create A Single "Shortest Path"

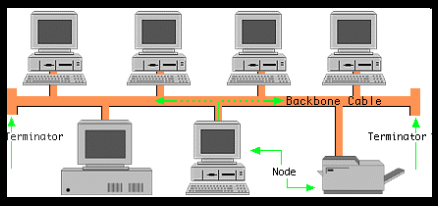


Network hardware components

- Network interface cards (NIC)
  - computer hardware accessory that provides a computers the physical interface to a networking medium, such as Ethernet. It provides low-level addressing through the assignment of a MAC address
- Repeater and hubs
  - retransmitted at a higher power level, or to the other side of an obstruction, so that the signal can cover longer distances without degradation
- Bridges
  - network bridge connects multiple network segments at the data link layer (layer 2) of the OSI model to form a single network
- Switches
  - device that forwards and filters OSI layer 2 datagrams between ports based on the MAC addresses in the packets
- Routers
  - an internetworking device that forwards packets between networks by processing the routing information included in the packet or datagram (Internet protocol information from layer 3)
  - The routing information is often processed in conjunction with the routing table

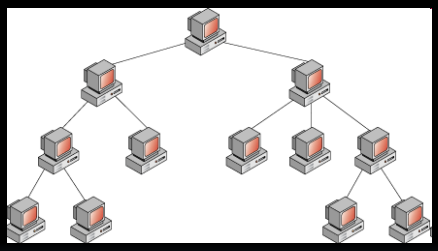
Network Topologies

- Bus
  - shared communications line/cables
  - Carrier Sense Multiple Access (CSMA)
  - Collision Detection



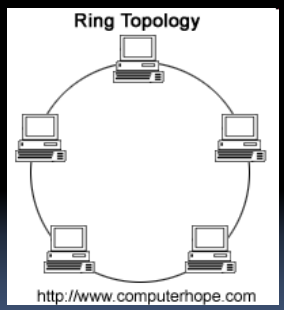
Network Topologies

- Tree
  - variation of bus topology



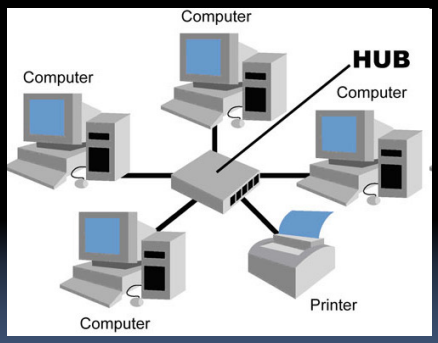
Network Topologies

- Ring
  - each node connects to exactly two other nodes, forming a single continuous pathway for signals through each node - a ring
  - Fibre Distributed Data Interface (FDDI)
  - Token Ring protocol
  - IEEE 802.5



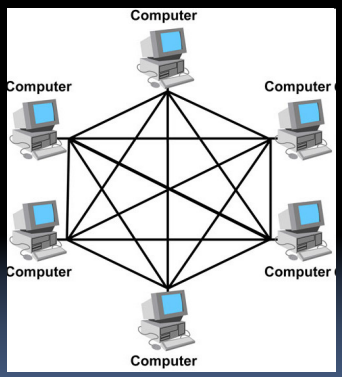
Network Topologies

- Star
  - most common computer network topologies
  - consists of one central switch, hub or computer, which acts as a conduit to transmit messages
  - Twisted pair cable (LAN cable)



Network Topologies

- Mesh
  - networking where each node must not only capture and disseminate its own data, but also serve as a *relay* for other nodes
  - Mostly use in wireless network



Hardware and Software Management

Hardware Management

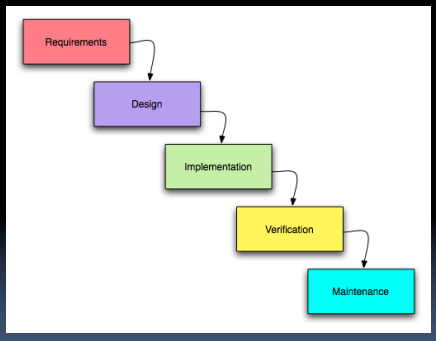
- Hardware life cycle management
- Inventory Record
- Tracking information about a hardware
- An administrator normally creates a database that stores information regarding hardware. It is common to use an asset tracking method, such as barcode tracking. In this kind of system, a barcode is attached to each piece of hardware. IT specialists scan a barcode to bring up a corresponding asset file from a database. By doing so, they can learn where an item is supposed to be located, when it was received, whether it is a piece they own or have leased, and whether it has a history of malfunction.

Hardware Management

- Schedule repairs and place orders as soon as indicated by information in an asset database. By ordering new items as soon as stock is low and scheduling repairs as soon as equipment malfunctions, an administrator can cut cost significantly.
- Repairs normally are less costly than replacements.

Software Development Lifecycle

1. Requirements specification (Requirements analysis)
2. Software design
3. Implementation and Integration
4. Testing (or Validation)
5. Deployment (or Installation)
6. Maintenance / Version Control



Q&A

Induction Course for
MII Certificate Examination 2013

INFORMATION TECHNOLOGY

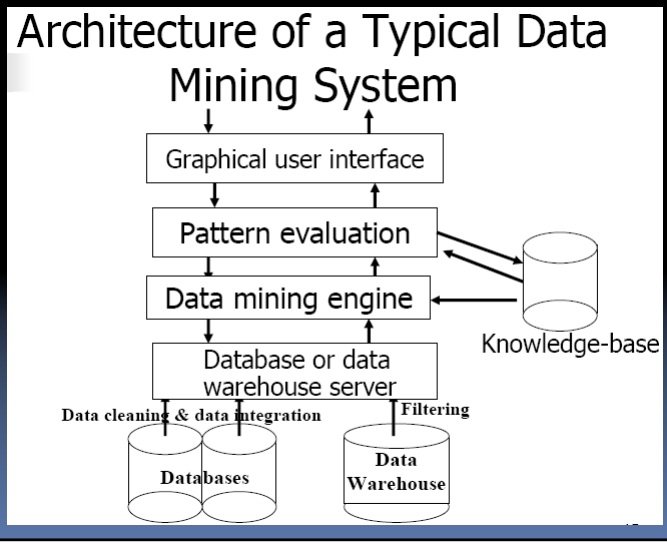
Part II

- Data mining for operations, quality assurance and planning purposes
- IT standards
- Replacement planning

Data Mining

- Data mining (knowledge discovery in databases)
- Extraction of interesting (non-trivial, implicit, previously unknown and potentially useful) information or patterns from data in large database
- Knowledge Discovery in Database (KDD)

Data Mining



Data Mining

- Database analysis and decision support
  - Market analysis and management
  - Risk analysis and management
  - Fraud detection and management
- Other application
  - Text mining
  - Web mining
  - DNA data analysis……

Data mining - techniques

- Classification and Prediction
  - Finding models that describe and distinguish classes or concepts for future prediction
  - Presentation: decision tree, classification rule, neural network
  - Prediction: Predict some unknown or missing numerical values
- Cluster analysis
  - Class label is unknown: Group data to form new classes
  - Clustering based on the principle: maximizing the intra-class similarity and minimizing the interclass similarity

Data mining – Data Preprocessing

- Data cleaning
  - Fill in missing values, smooth noisy data, identify or remove outliers, and resolve inconsistencies
- Data integration
  - Integration of multiple databases, data cubes, or files
- Data transformation
  - Normalization and aggregation
- Data reduction
  - Obtains reduced representation in volume but produces the same or similar analytical results
- Data discretization
  - Part of data reduction but with particular importance, especially for numerical data

Data Mining

- Database
  - Organized collection of data
  - Database Model
    - Hierarchical model
    - Network model
    - Relational model
    - Object model
    - .....
  - Database Management System (DBMS)
  - Structured Query Language (SQL)

Data Mining

- Relational Database Management System
  - Oracle Database
  - Microsoft SQL Server
  - MySQL
  - IBM DB2
  - Sybase

Data Mining - SQL

- Special programming language to manage data in RDBMS
- Language Syntax
  - Clauses
  - Expressions
  - Predicates
  - Queries
  - Statements

Example:

```
INSERT INTO Store_Information
(Store_Name, Sales, Txn_Date)
SELECT Store_Name, Sales, Txn_Date
FROM Sales_Information
WHERE Year(Txn_Date) = 1998 + 1;
```

IT Standards

- Transmission of image and textual information
- Through different computer platform
- Image and data are generated from various imaging modalities by different manufacturers

IT Standards

- Health Level 7
- Digital Imaging and Communications in Medicine (DICOM)
- Hospital Information System
- Health Information System
- ICD9
- SNOMED - CT
- Integrating the Healthcare Enterprise (IHE)

IT Standards

- HL7 – development of international healthcare informatics interoperability standards
- HL 7 Segments:
  - MSH – Message header segment
  - EVN – Event type segment
  - PID – Patient identification segment
  - NK1 – Next of kin segment
  - PV1 – Patient visit segment

IT Standards

- Fundamental components of DICOM
  - Information object class
  - Defines the contents of a set of images and their relationship
  - Service class
  - Describe what to do with these objects
  - Combined to form the fundamental units-service-object pairs (SOPs)

IT Standards

http://medical.nema.org/

PS 3.1: Introduction and Overview PDF (241 KB)		
PS 3.2: Conformance PDF (6.46 MB)		
PS 3.3: Information Object Definitions PDF (6.96 MB)		
PS 3.4: Service Class Specifications PDF (1.07 MB)		
PS 3.5: Data Structure and Encoding PDF (1.43 MB)		
PS 3.6: Data Dictionary PDF (7.32 MB)		
PS 3.7: Message Exchange PDF (1.97 MB)		
PS 3.8: Network Communication Support for Message Exchange PDF (901 KB)		
PS 3.9: Retired (formerly Point-to-Point Communication Support for Message Exchange)	Retired	
PS 3.10: Media Storage and File Format for Data Interchange PDF (406 KB)		
PS 3.11: Media Storage Application Profiles PDF (1.14 MB)		
PS 3.12: Storage Functions and Media Formats for Data Interchange PDF (593 KB)		
PS 3.13: Retired (formerly Print Management Point-to-Point Communication Support)	Retired	
PS 3.14: Grayscale Standard Display Function PDF (2.88 MB)		
PS 3.15: Security and System Management Profiles PDF (1.00 MB)		
PS 3.16: Content Mapping Resource PDF (3.08 MB)		
PS 3.17: Explanatory Information PDF (3.28 MB)		
PS 3.18: Web Access to DICOM Persistent Objects (WADO) PDF (291 KB)		
PS 3.19: Application Hosting		
PS 3.20: Transformation of DICOM to and from HL7 Standards		

IT Standards

- Integrating the Healthcare Enterprise (IHE)
  - High-Level information model for driving adoption of HL 7 and DICOM standards
  - Define and stimulate manufacturers to use DICOM and HL 7 compliant equipment and information systems to facilitate daily clinical operation

IT Standards

- FDA 510k medical device
- From IEEE, IEC
- Optical fibre
  - Multi-mode
  - Single-mode
  - > 1050m
- Copper Cat 5, Cat 6 LAN
  - Max 100m

IT Standards – Server Room

- Air Conditioning
  - Computer Room Air Conditioning Unit (CRAC)
  - Up flow and Down flow Air Conditioning
  - Heat dissipation
  - Humidity
- Fire Protection
  - FM200, Door fire resistance rating, smoke detector
- Water Leakage
  - Water leak detection, Raised floor
- Power Supply
  - Power consumption and UPS

Replacement Planning

- Maintenance Factors for Replacement
  - No service support (Parts, repair staff, service contracts, diagnostics no longer available from the manufacturer, No alternative support; No service documentation or tools)
  - Maintenance costs (Accumulated > 50% new cost or increasing?)
  - Poor Reliability (Trend towards increase failures?)

Replacement Planning

- Technology Replacement Report
  - Include options to direct replacement (Use in less critical application, do not replace – not needed, change in technology; options for disposal)
  - Provide to department managers prior to their budget submission or to capital equipment committee after "wish list" received
  - Include replacement status in equipment management database (Repair/Replace decisions)

Replacement Planning

- Safety Factors for Replacement
  - Equipment-related incidents
  - Recalls (Serious or unresolved)
  - User problems (Users errors, no problem fond…)
  - Lack of essential safety features

Replacement Planning

- Facility-wide, all equipment analysis
  - Objective Criteria (Equipment management database)
  - Weighting replacement factors
  - Prioritized (Urgent, Years 1-3, Advisory)
  - Flexible (Add all quantitative and qualitative factors)
  - Simple to administer

Replacement Planning

- Data Migration
- Perform a migration assessment
- How much data needs to b migrated
- Will image quality be maintained during the migration
- What information will not be transferred to the new PACS
- Will your existing patient and/or exam data need to be modified when it is migrated

Replacement Planning

- Understand whether there will be any limitations on retrieving the migrated priors
- Make sure that the data migration vendor can handle priority migration of prior exams for patients currently on the schedule
- Understand the data migration vendor's method for validating that exams have been successfully migrated to the new PACS
- Allow for enough online server and archive space on the new PACS for the migration

Replacement Planning

- Make sure reports are migrated and linked back to exams after the migration
- Maintain your service contract on your current PACS until the migration is complete


Thank You