

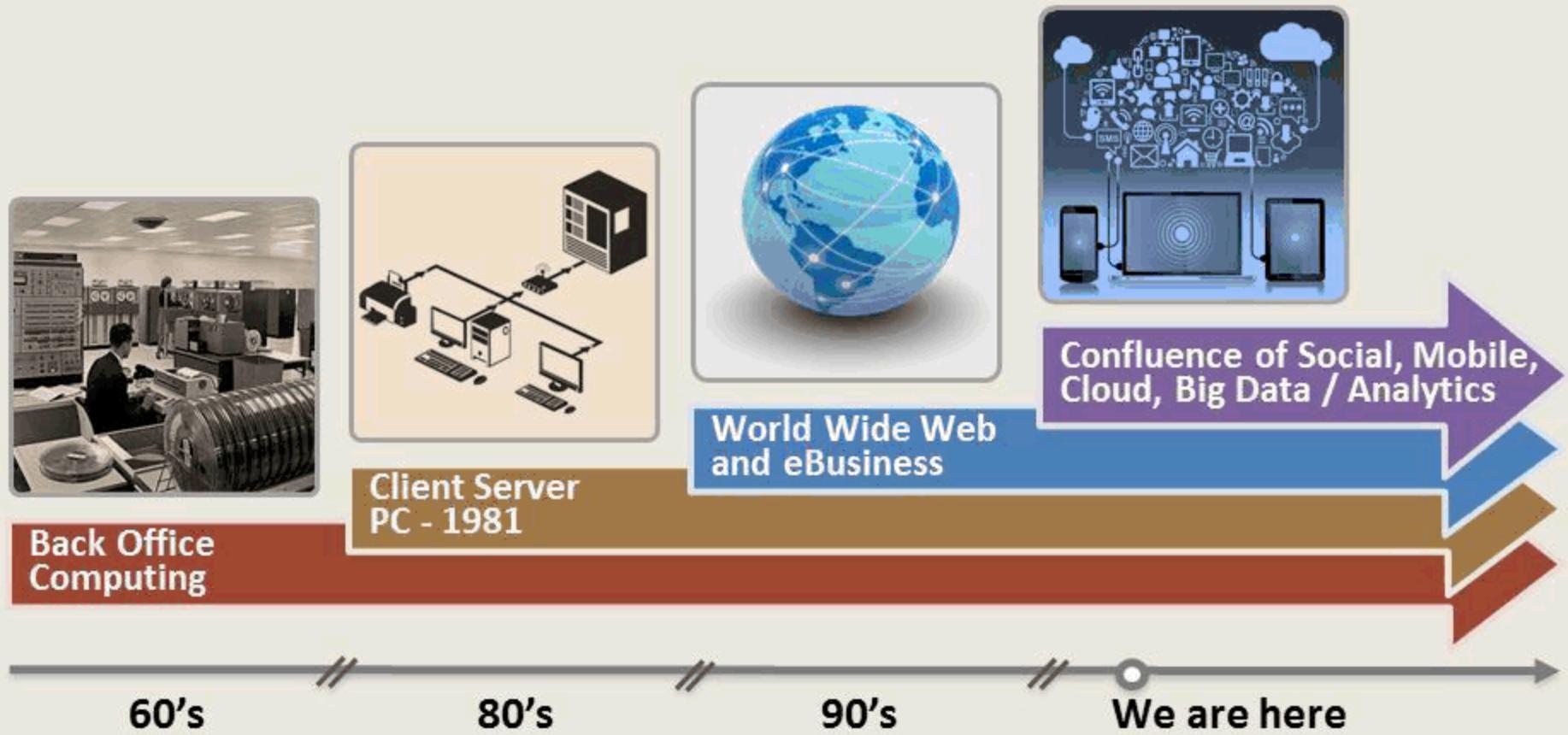
# IT Infrastructures

-- Review



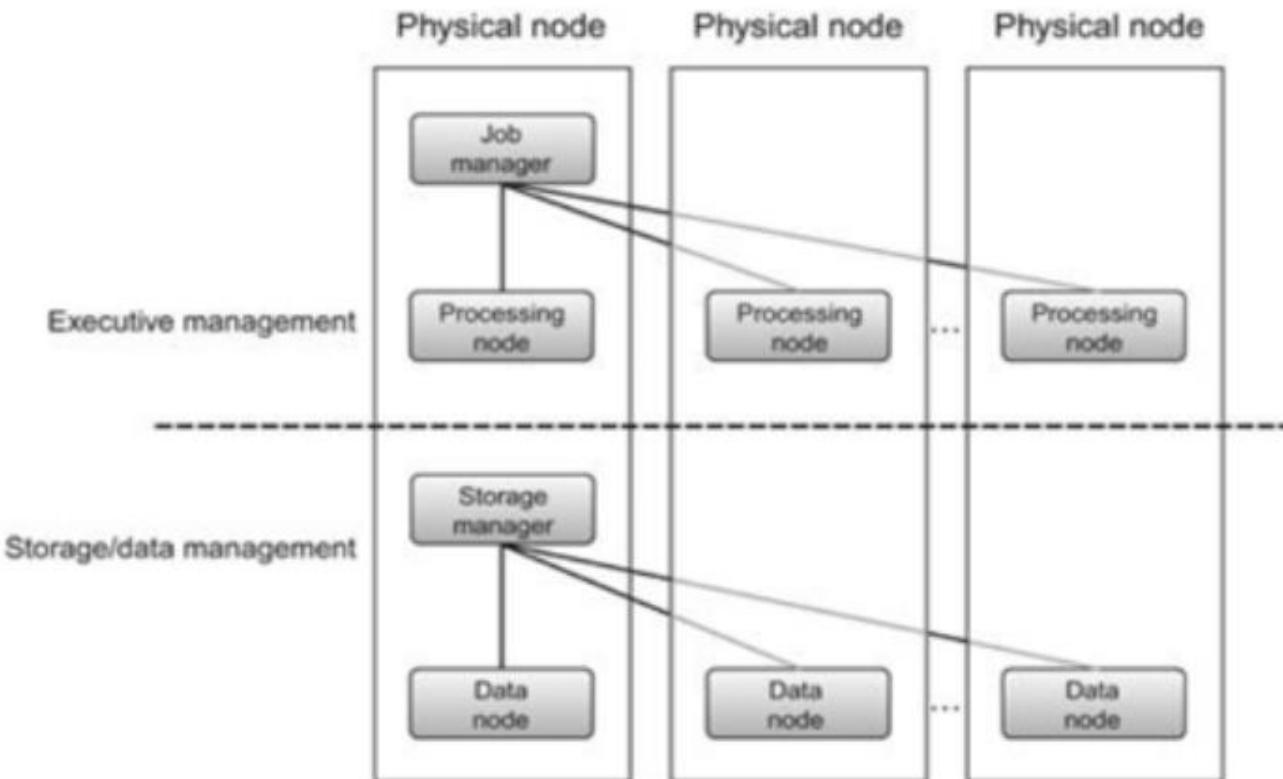
**LING Zong, Ph. D.**  
**Senior Software Engineer / Scientist**  
**IBM Almaden Research Center**  
**San Jose, California, U.S.A.**

# IT Development



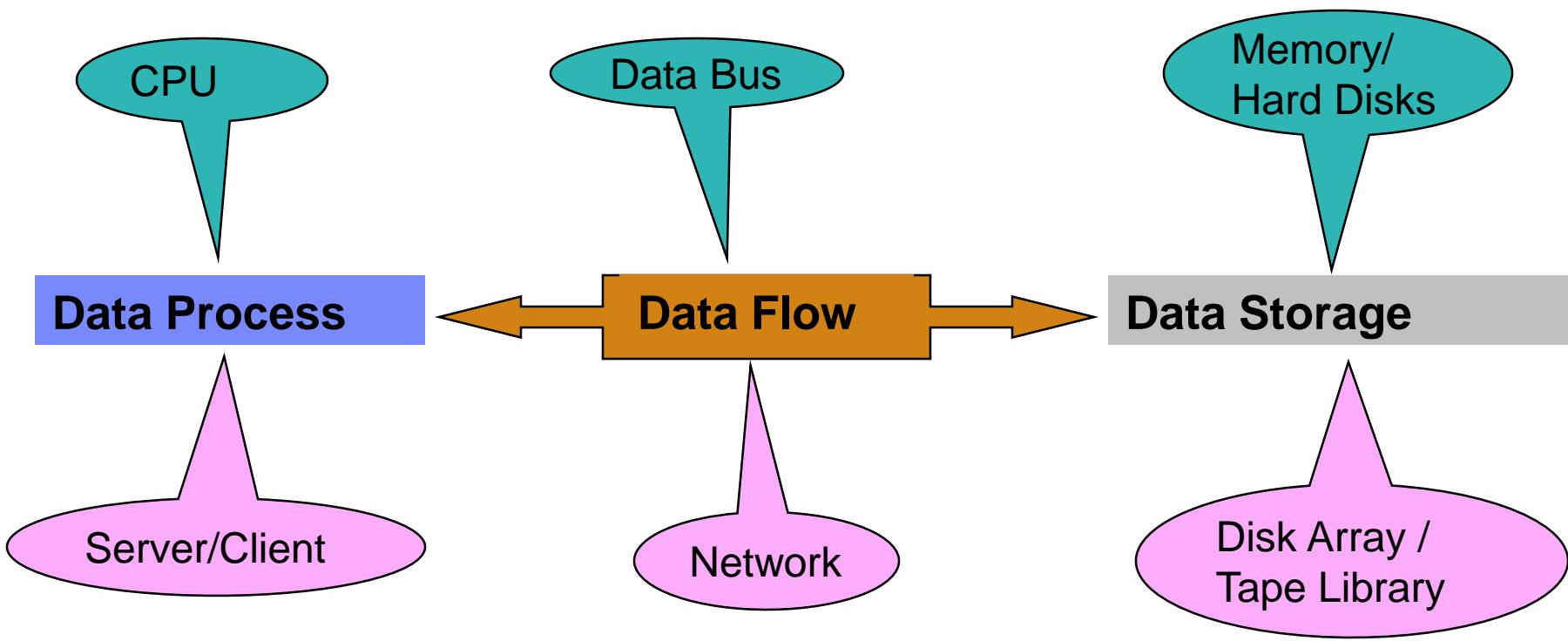
# Key Computing Resources for Big Data

- Processing capability: CPU, processor, or node.
- Memory
- Network
- Storage



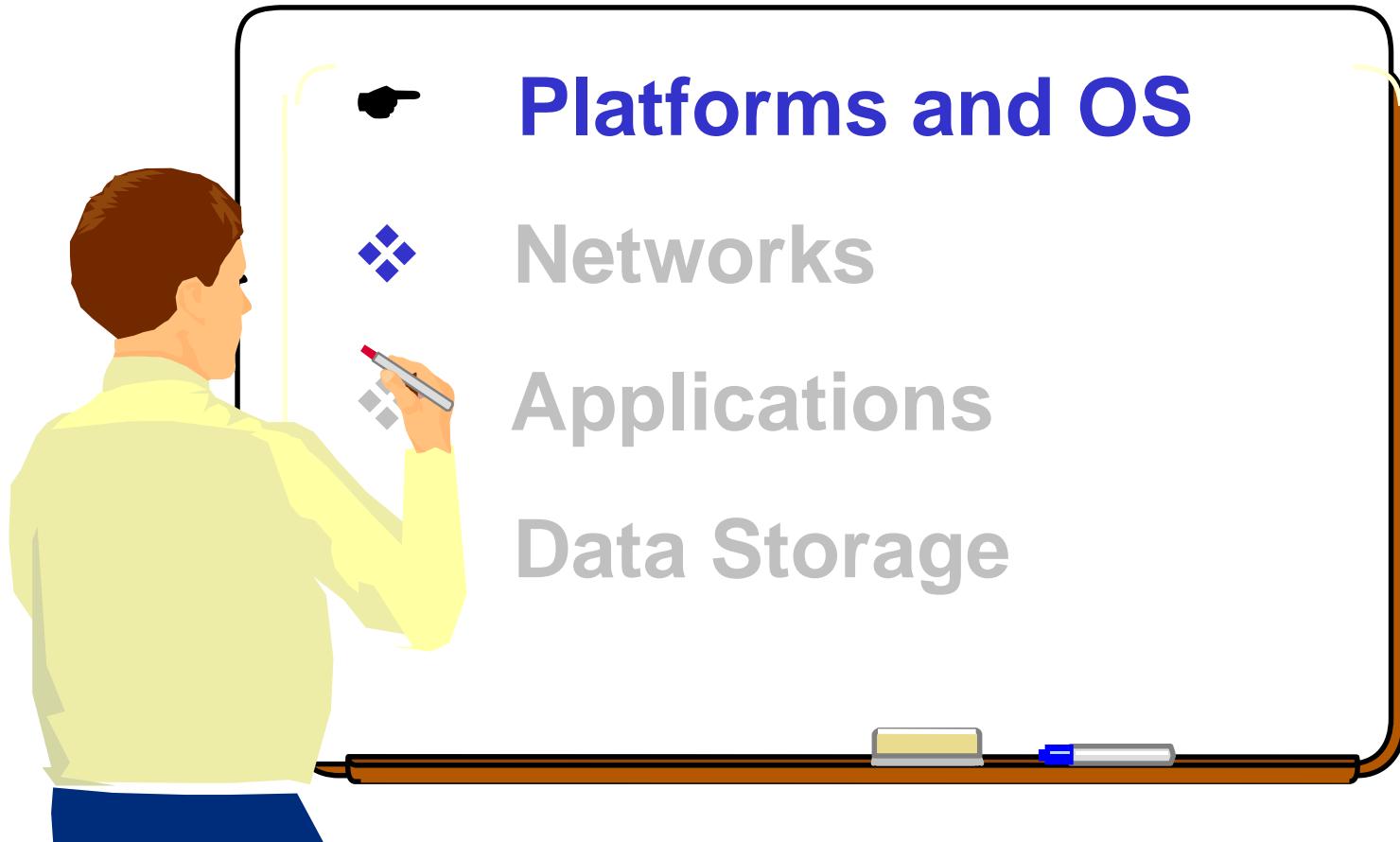
“Big Data Analytics”, David Loshin, 2013

# IT Components



**data-centric vs. computing-centric**

# CONTENTS



# Computing Platforms (HW & SW)

- PC (Personal Computer)
- Laptop
- Server
- Midrange
- Mainframe
- Supercomputers

计算平台可以看作是一个框架，无论是在硬件上还是在软件上，它允许软件运行

- A computing platform can be viewed as a framework, either in hardware or software, allowing software to run.
  - 框架是一个已定义的支持结构，可以在其中开发另一个项目
- Typical platforms include a computer's architecture, operating system, programming languages and related runtime libraries or graphical user interface.

# Hardware Platform examples

- **Supercomputer architectures.**
- A **mainframe** computer with its custom operating system, say an IBM z/OS.
- A **midrange** computer with its custom operating system, say an IBM OS/400.
- **RISC processor based machines running UNIX variants:**
  - Sun computers running the Solaris operating system.
  - DEC Alpha cluster running under OpenVMS.
- **Macintosh, custom Apple Computer hardware and Mac OS operating system (now migrated on x86).**
  - Newton devices running the Newton OS, also from Apple.
- **Commodity computer platforms, such as:**
  - Wintel, that is, Intel x86 or compatible hardware and Windows operating system.
  - x86 with other Unix-like systems such as BSD variants.
- **Gumsfix full function miniature computers with Linux.**
- **ARM architecture found in mobile devices.**
- **Any variety of video game console.**

# Software Platform examples

- Java - JDK and JRE
- .NET Framework
- Mozilla Prism XUL and XUL Runner
- Adobe AIR
- Mono

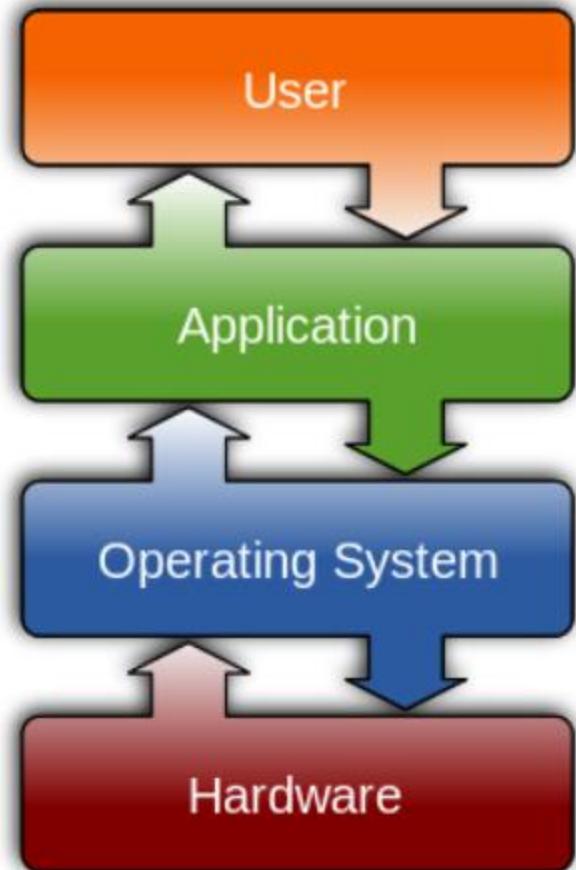
# Computer Operating System (I)

操作系统(OS)是一种管理计算机硬件和软件资源的软件

- **Operating system (OS)** is a type of software which manages the hardware and software resources of a computer.
- 操作系统的任务包括控制和分配内存、处理指令的优先级、控制输入和输出设备、促进网络和管理文件
- OS tasks include **controlling and allocating memory, prioritizing the processing of instructions, controlling input and output devices, facilitating networking, and managing files.**

内核是所有操作系统的最低级别

- The **kernel** is the lowest level of any operating system
- 大多数操作系统包含管理图形用户界面(Windows)的系统软件。其他使用CLI或命令行接口(Unix)
- Most operating systems contain system software that manages a graphical user interface (Windows). Others use CLI, or command line interface (Unix)



[http://en.wikipedia.org/wiki/Operating\\_system](http://en.wikipedia.org/wiki/Operating_system)

# Computing Operating Systems (II)

操作系统充当计算机上运行的应用程序的主机

- The operating system acts as a **host for applications** that are run on the machine.

作为主机，操作系统的目的一之一就是处理硬件操作的细节。这使应用程序不必管理这些细节，并且使编写应用程序更加容易

- As a host, one of the purposes of an operating system is to handle the details of the operation of the hardware. This relieves application programs from having to manage these details and makes it easier to write applications.  
几乎所有的计算机，包括手持计算机、台式计算机、超级计算机，甚至视频游戏机，都使用某种类型的操作系统
- Almost all computers, including handheld computers, desktop computers, supercomputers, and even video game consoles, use an operating system of some type.  
然而，一些最老的型号可能使用嵌入式操作系统，该系统可能包含在光盘或其他数据存储设备上
- Some of the oldest models may however use an **embedded operating system**, that may be contained on a compact disk or other data storage device.

- Common contemporary operating systems include

—Microsoft Windows, Mac OS, Linux, and Solaris

—Microsoft Windows has a significant majority of market share in the desktop and notebook computer markets  
微软Windows在台式机和笔记本电脑市场上占有绝大多数的市场份额

- Servers generally run on Unix or Unix-like systems

—AIX, HP-UX, IRIX, Linux, Minix, Ultrix, and Xenix

- 嵌入式设备市场被分为几个操作系统
- Embedded device markets are split amongst several operating systems

客户服务——故障排除单CPU使用的多线程应用程序在Windows服务器上，使用“复制”命令？

**Case study:** a customer service -- troubleshooting single CPU usage of a multi-thread application on a windows server, **using “copy” command ?**

# OS on Mainframes

整个20世纪60年代，操作系统领域中出现了许多主要特性。IBM System/360的开发生产了一系列大型机，它们的容量和价格各不相同，计划为它们开发一个单一的操作系统OS/360(而不是为每个单独的型号开发专门的程序)。单一操作系统跨越整个产品线的概念对System/360的成功至关重要。事实上，IBM当前的大型机操作系统是这个原始系统的遥远后裔：为OS/360编写的应用程序仍然可以在现代机器上运行。OS/360首创了许多概念，在某些情况下，这些概念在大型机领域之外是看不到的。例如，在OS/360中，当一个程序启动时，操作系统会跟踪所使用的所有系统资源，包括存储、锁、数据文件等。当进程终止时，操作系统将重新申领所有资源。一个替代的CP-67系统启动了一系列专注于虚拟机概念的操作系统。

- Through the 1960s, many major features were pioneered in the field of operating systems.
- The development of the IBM System/360 produced a family of mainframe computers available in widely differing capacities and price points, for which a single operating system OS/360 was planned (rather than developing ad-hoc programs for every individual model).
- This concept of a single OS spanning an entire product line was crucial for the success of System/360 and, in fact, IBM's current mainframe operating systems are distant descendants of this original system; applications written for the OS/360 can still be run on modern machines.
- OS/360 pioneered a number of concepts that, in some cases, are still not seen outside of the mainframe arena. For instance, in OS/360, when a program is started, the operating system **keeps track of all of the system resources** that are used including storage, locks, data files, and so on. When the process is terminated, all of the resources are re-claimed by operating system.
- An alternative CP-67 system started a whole line of operating systems focused on the **concept of virtual machines**.

# OS on Microcomputers

微型计算机上的操作系统第一代微型计算机不具备或不需要为大型机和小型机开发的复杂操作系统，最简单的操作系统被开发出来，通常从ROM加载，称为监视器。一个明显的早期的基于磁盘的操作系统是CP / M，这是支持许多早期微机在ms - DOS密切模仿，成为广受欢迎的操作系统选择IBM PC（IBM版本的它被称为DOS或PC DOS），其继任者使微软成为世界上最赚钱的公司。上世纪80年代，苹果电脑公司（现在的苹果公司）放弃了广受欢迎的Apple II系列微型电脑，转而推出了带有创新图形用户界面(GUI)的苹果Macintosh电脑

- The first microcomputers did not have the capacity or need for the elaborate operating systems that had been developed for mainframes and minis; minimalistic operating systems were developed, often loaded from **ROM** and known as *Monitors*.
- One notable early **disk-based operating system** was CP/M, which was supported on many early microcomputers and was closely imitated in MS-DOS, which became wildly popular as the operating system chosen for the IBM PC (IBM's version of it was called IBM DOS or PC DOS), its successors making Microsoft one of the world's most profitable companies.
- In the 80's Apple Computer Inc. (now Apple Inc.) abandoned its popular Apple II series of microcomputers to introduce the Apple Macintosh computer with an innovative **Graphical User Interface (GUI)** to the Mac OS.

IBM超级计算机Watson是一个为复杂分析而设计的工作负载优化系统，通过集成大量并行POWER7处理器和IBM DeepQA软件来回答Jeopardy!问题在三秒内回答。Watson由一个由90个IBM Power 750台服务器组成的集群(加上10个机架中额外的I/O、网络和集群控制器节点)、2880个POWER7处理器核和16 tb的RAM组成。每台Power 750服务器使用一个3.5 GHz的POWER7八核处理器，每个核有四个线程。POWER/处理器的大规模并行处理能力与Watson的IBM DeepQA软件完美匹配，后者的工作负载可以轻松地分解为多个并行任务。

# OS on IBM Super Computer Watson

Watson is a workload optimized system designed for complex analytics, made possible by integrating massively parallel POWER7 processors and the IBM DeepQA software to answer *Jeopardy!* questions in under three seconds.

Watson is made up of a cluster of ninety IBM Power 750 servers (plus additional I/O, network and cluster controller nodes in 10 racks) with a total of 2880 POWER7 processor cores and 16 Terabytes of RAM. Each Power 750 server uses a 3.5 GHz POWER7 eight core processor, with four threads per core. The POWER7 processor's massively parallel processing capability is an ideal match for Watson's IBM DeepQA software which is a workload that is easily split up into multiple parallel tasks.

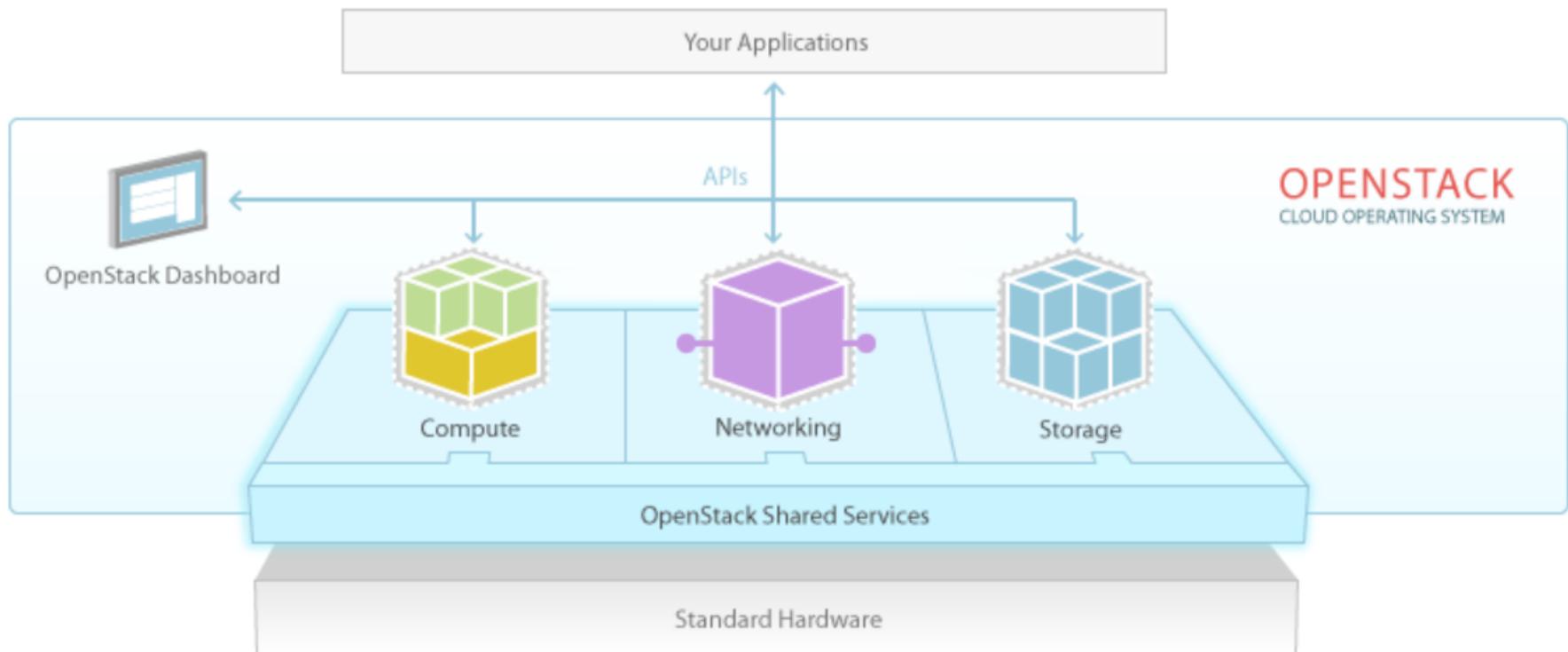




openstack  
CLOUD SOFTWARE

# OS for Cloud

## OpenStack: The Open Source Cloud Operating System



<http://en.wikipedia.org/wiki/OpenStack>

<http://www.openstack.org/software/>

# OS for Big Data Applications

大数据应用的操作系统  
• 用于业务分析和数据仓库的IBM大型机z/OS  
• 中层数据中心操作系统  
• 新的英特尔数据平台提供了其Hadoop发行版的最新版本  
• 用于云计算的弹性OS

- **IBM Mainframe z/OS for business analytics and data warehousing**
- **Mesosphere Datacenter Operating System**
- **New Intel Data Platform features the latest version of its Hadoop distribution**
- **Elastic OS for Cloud Computing**

# “Analytics Operating System”

分析操作系统Spark是一个开源分析操作系统。它作为一个平台来运行迭代的、交互式的实时分析，可以嵌入到应用程序中。IBM使用这个引擎作为我们的分析和商业平台的一部分，沃森健康云等。数据科学家和数据工程师如今都在使用这种技术，但Spark这样的平台面临的最大障碍之一是缺乏具备这些数据技能的人员。作为回应，IBM承诺在全球培养100万数据科学家和数据工程师。

- **Spark is an open source analytics operating system.**
- **It serves as a platform to run iterative, interactive analytics in real time, which can be embedded into applications.**
- **IBM uses this engine as a part of our Analytics and Commerce platforms, Watson Health Cloud and more.**
- **Data scientists and data engineers use this technology today, but one of the biggest obstacles for platforms like Spark is a lack of people with these data skills. In response, IBM has committed to educating one million data scientists and data engineers worldwide.**

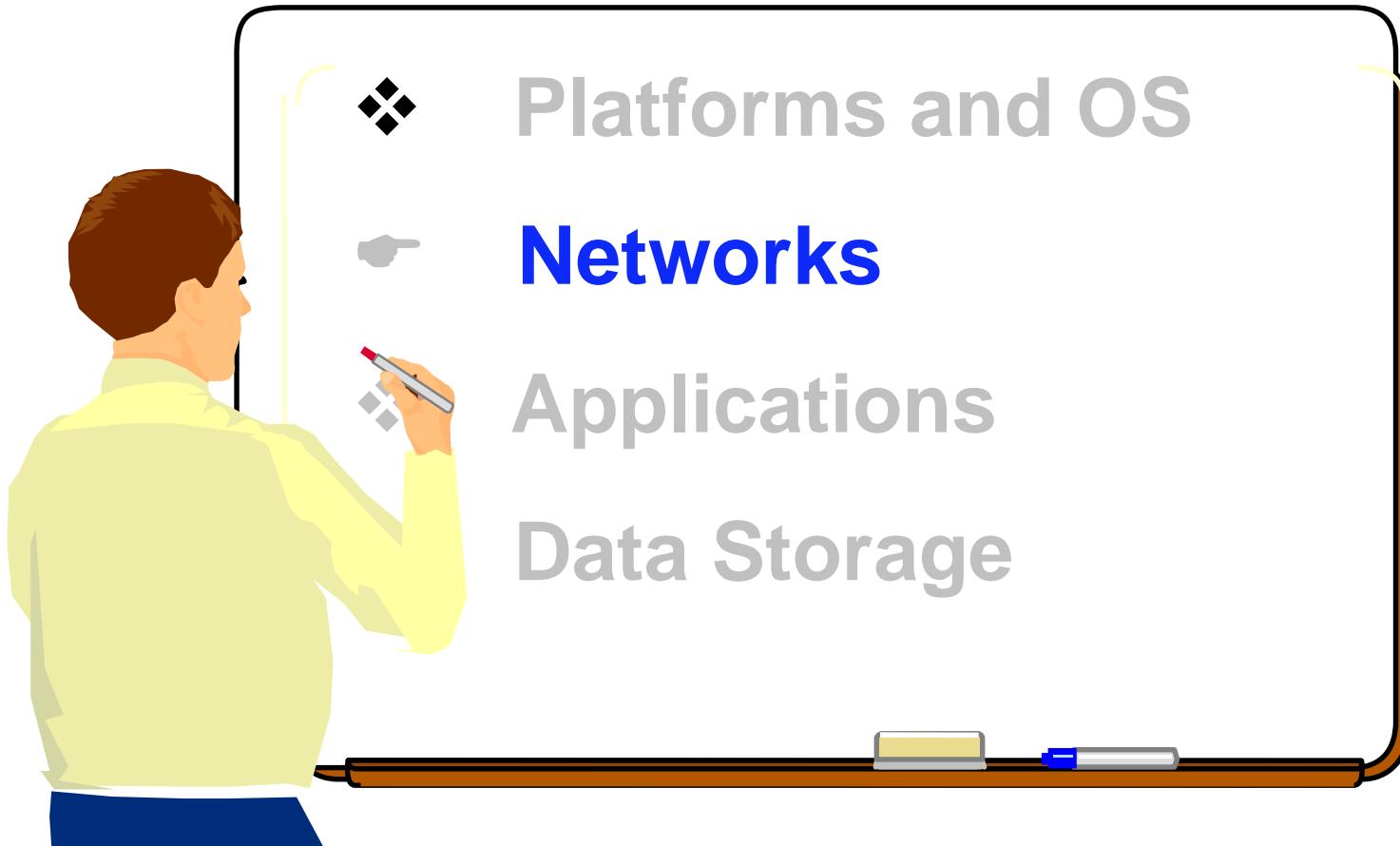
# National Strategic Computing Initiative (NSCI)

## NSCI objectives:

NSCI 的目标: 加速交付一个集成了硬件和软件能力的百亿亿次计算系统，在代表政府需求的一系列应用中提供大约100倍于当前10千万亿次浮点运算系统的性能。增加用于建模和仿真的技术基础与用于数据分析计算的技术基础之间的一致性。建立，在未来15年，未来高性能计算系统可行的道路，即使目前的半导体技术已经达到极限(后摩尔定律时代)。通过采用一种整体的方法来解决相关因素，如网络技术、工作流、向下伸缩、基础算法和软件、可访问性和劳动力开发，提高一个持久的国家高性能计算生态系统的能力和能力。发展长期的公私合作，以确保美国政府、工业和学术部门在最大程度上分享研究和开发进展的利益

- Accelerating delivery of a capable exascale computing system that integrates hardware and software capability to deliver approximately **100** times the performance of current 10 petaflop systems across a range of applications representing government needs.
- Increasing coherence between the technology base used for modeling and simulation and that used for data analytic computing.
- Establishing, over the next **15 years**, a viable path forward for future HPC systems even after the limits of current semiconductor technology are reached (the “post- Moore’s Law era”).
- Increasing the capacity and capability of an enduring national HPC ecosystem by employing a holistic approach that addresses relevant factors such as networking technology, workflow, downward scaling, foundational algorithms and software, accessibility, and workforce development.
- Developing an enduring public-private collaboration to ensure that the benefits of the research and development advances are, to the greatest extent, shared between the United States Government and industrial and academic sectors.

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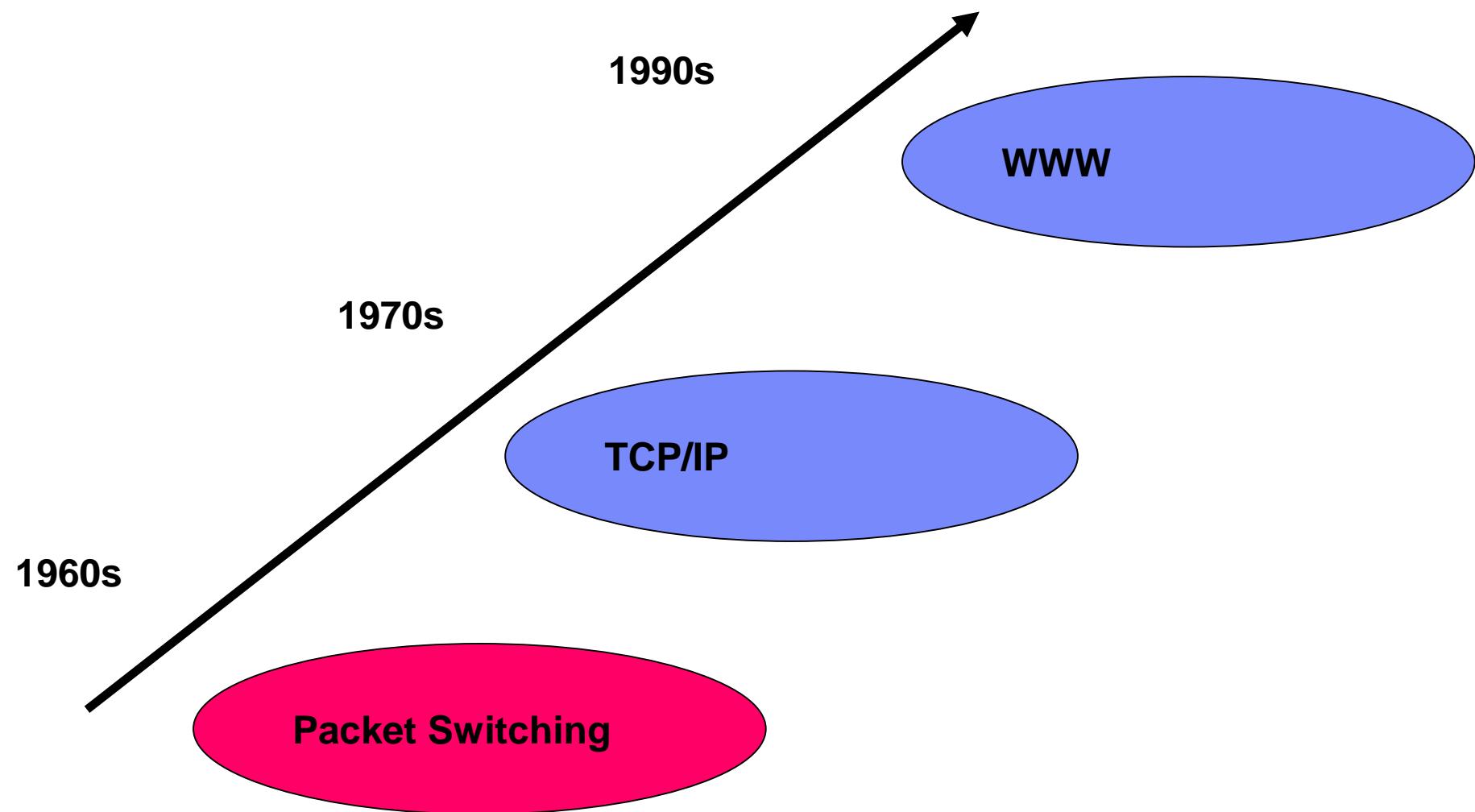
# Computer Networks

## Important Networking concepts include:

- Hubs
- Routers
- Printers
- Firewalls
- Switches
- Fiber Optic panels
- Storage area networks (SAN)
- Server network interfaces
- Other Local Area Network (LAN) components
- Wide Area Network (WAN) circuits
- Metropolitan Area Network (MAN) circuits

重要的网络概念包括:  
——中心  
——路由器  
——打印机  
——防火墙  
——开关  
-光纤面板  
-存储区域网络(SAN)  
-服务器网络接口  
-其他局域网(LAN)组件  
广域网(WAN)电路  
-城域网(MAN)电路

# Network Evolution -- 3 Major Milestones

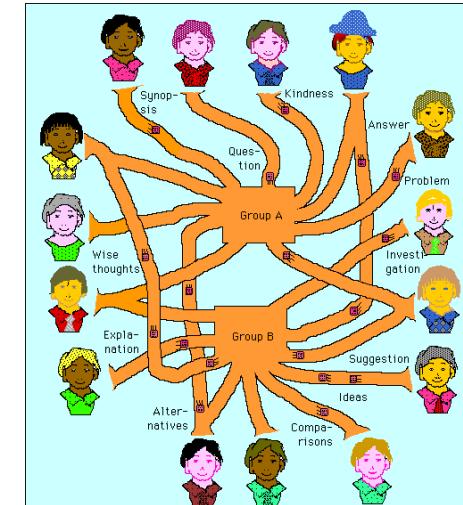


# Up to 1970, most computers are **isolated** in the sense that data or computing resources are not linked electronically

直到1970年，大多数计算机在数据或计算资源没有电子连接的意义上是孤立的



Isolated islands



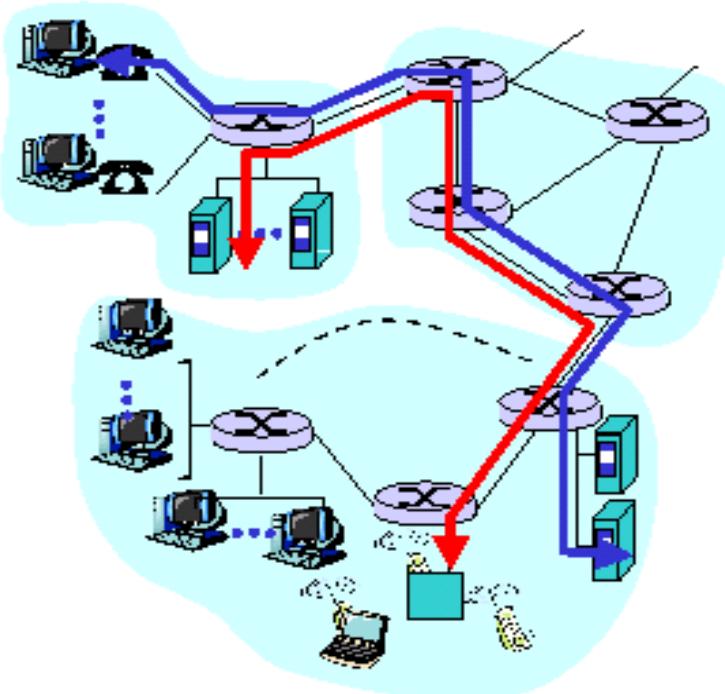
# Circuit Switching

Circuit switching is used in telephone communication.

## Network Core: Circuit Switching

End-end resources reserved for "call"

- link bandwidth, switch capacity
- dedicated resources: no sharing
- circuit-like (guaranteed) performance
- call setup required



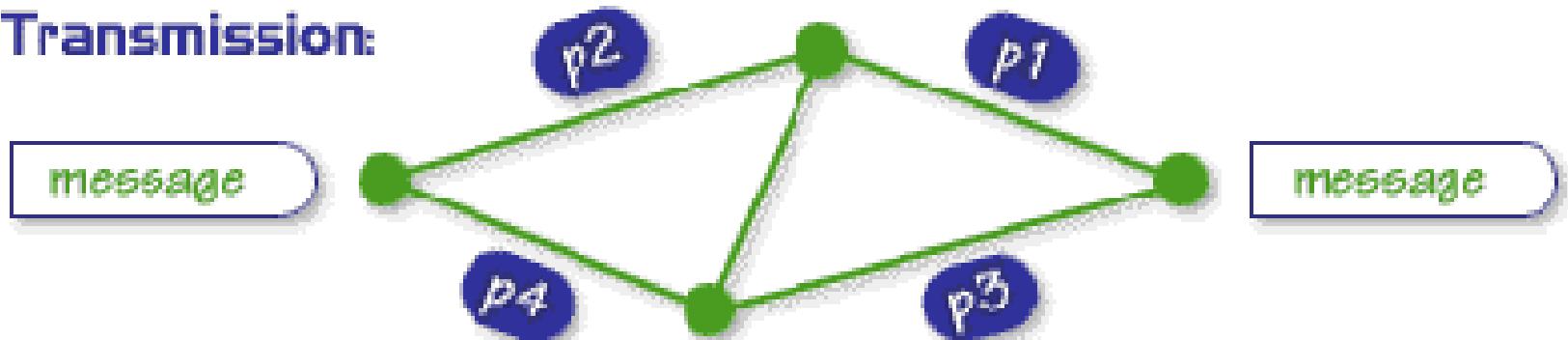
# Packet Switching

**Packet Switching is used in Internet communication**

**Message:** People look up to me for obvious reasons...

**Packets:** p1 People look  
p2 up to me fo  
p3 r obvious r  
p4 easons...

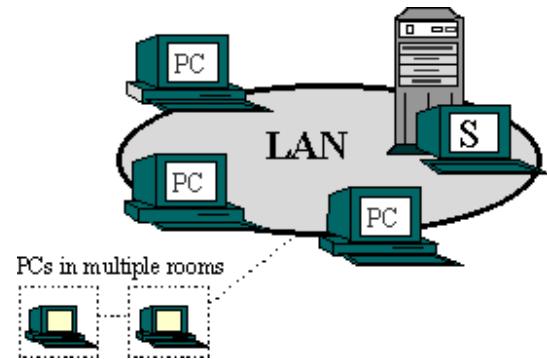
**Transmission:**



# Packet-Switched Networks

- A local area network (LAN) is a network of computers close together.

局域网(LAN)是由紧密相连的计算机组成的网络

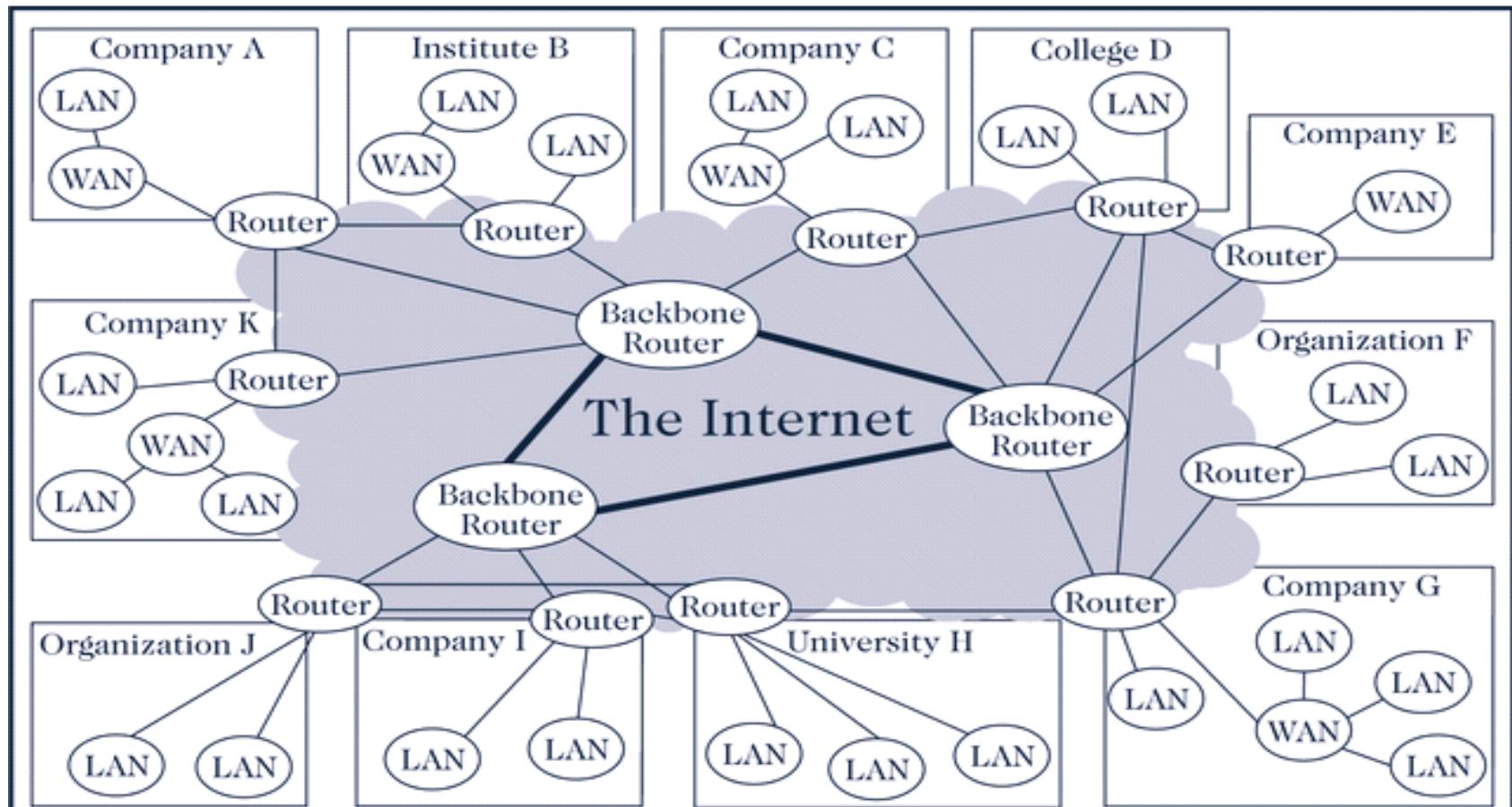


- A wide area network (WAN) is a network of computers connected over a great distance.

广域网(WAN)是远距离连接的计算机网络



# Router-based Architecture



*Router-based architecture of the Internet*

# Historical Perspective

如何使网络上的计算机相互之间进行可靠而方便的通信

How to make those computers on the network  
communicate with each other **reliably and easily?**

Circuit-switching vs Packet-switching

- In the early 1960's
  - ALOHAnet
  - ARPANET

# ALOHAnet

also known as **ALOHA**, was a pioneering computer networking system developed at the University of Hawaii.

It was first deployed in 1970, and while the network itself is no longer used, one of the core concepts in the network is the basis for the widely used Ethernet.

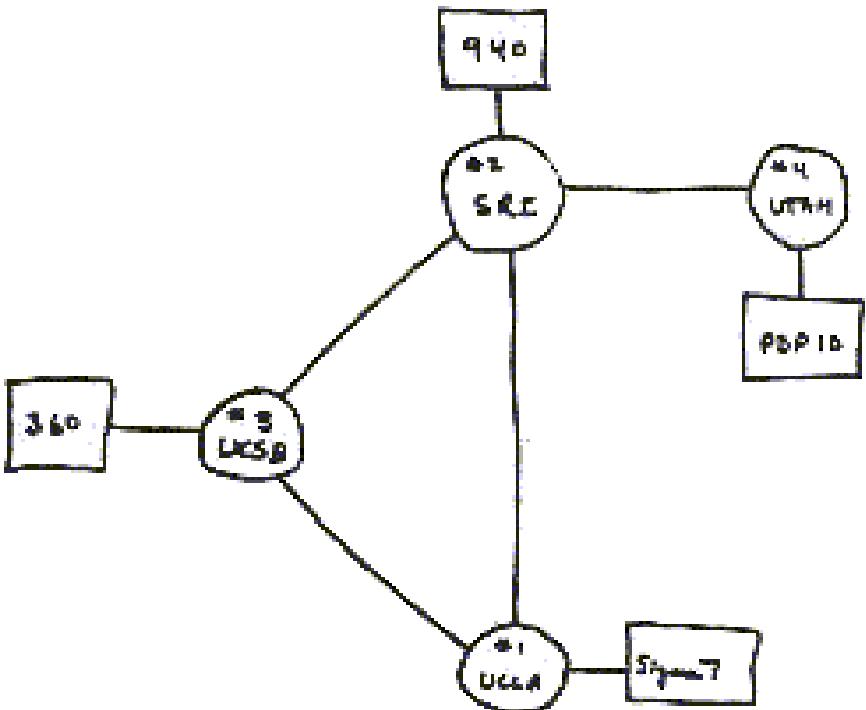
也被称为ALOHA，是夏威夷大学开发的一种开创性的计算机网络系统。它于1970年首次部署，虽然网络本身不再使用，但网络的核心概念之一是广泛使用的以太网的基础。



# ARPANET: Advanced Research Projects Agency NETwork

高级研究计划署网络

1969年，这张纸上潦草地写着阿帕网最早的四个节点。他们几乎没有意识到，这是网络的开始，每天将被数以千万计的人使用



DEC 1969

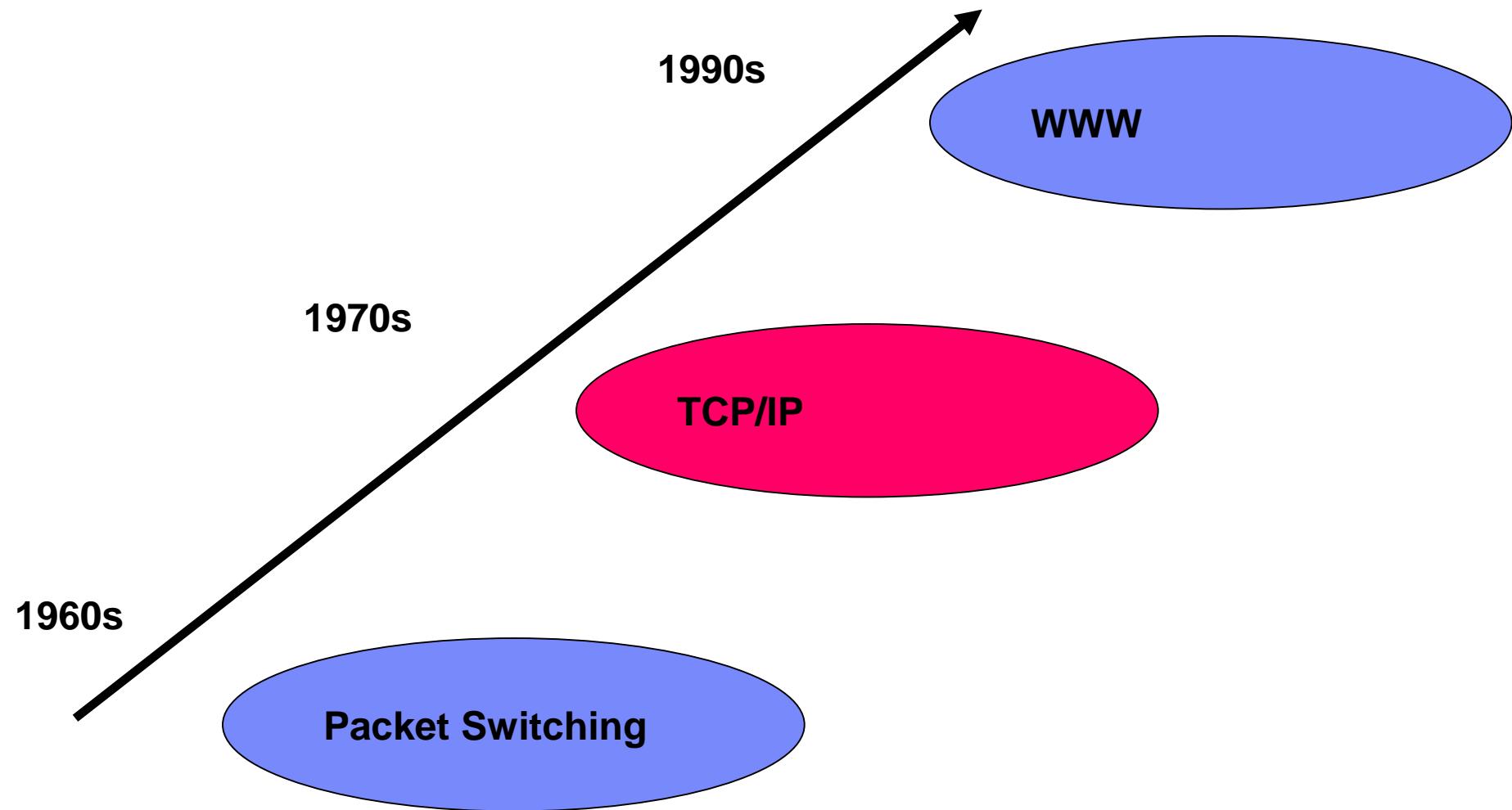
## Scrawled on this paper in 1969

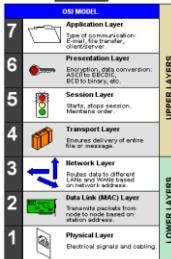
were the first four nodes of the ARPANET. Little did they realize that this was the beginning of the network that would be used by tens of millions of people each and every day

## A 4-computer internet became operational

- U. California, Los Angeles
- U. California, Santa Barbara
- SRI (Stanford Research Institute) International
- University of Utah

# Network Evolution -- 3 Major Milestones





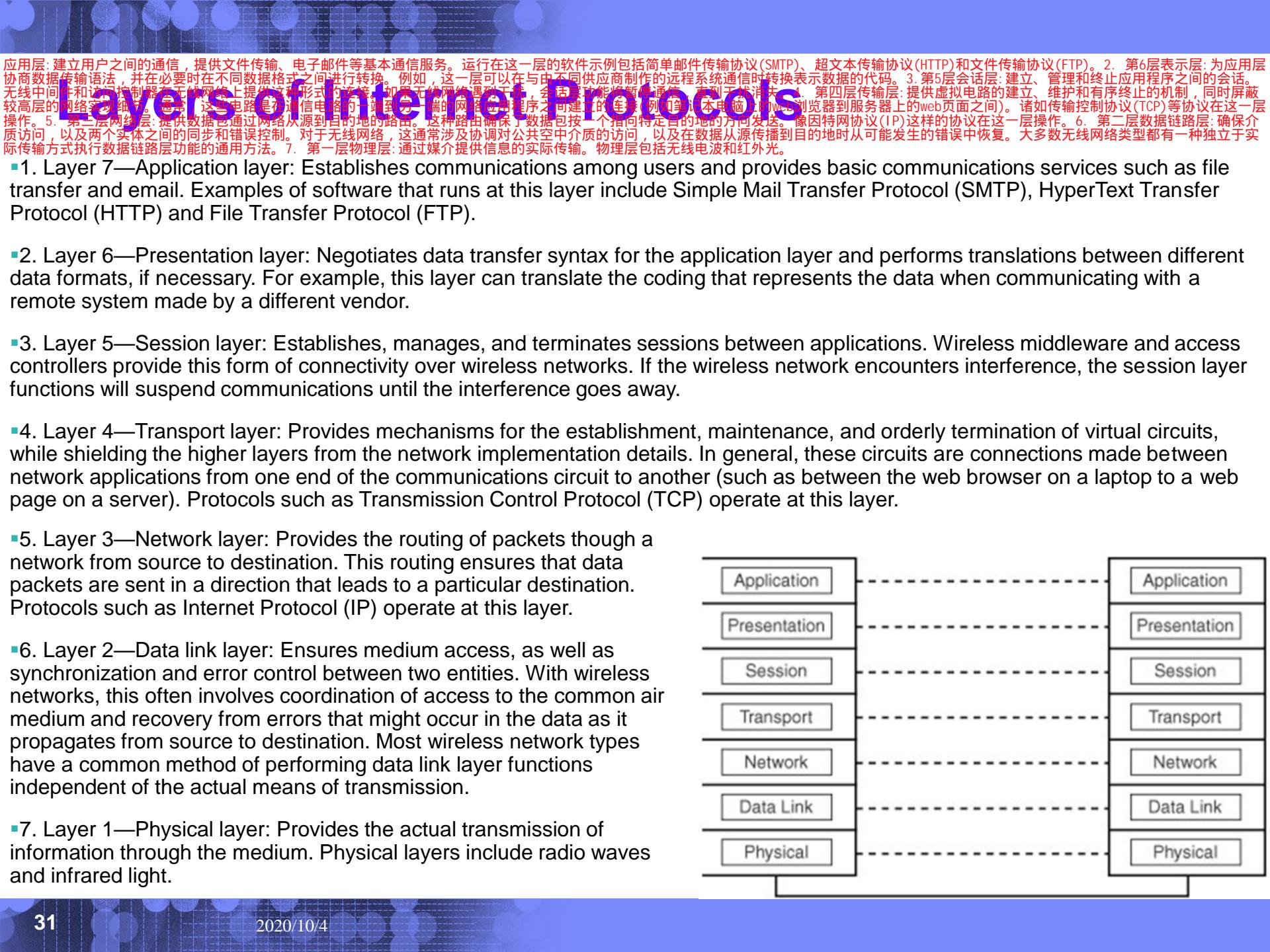
# Internet Protocols

传输控制协议(TCP)和因特网协议(IP)是两个支持因特网操作的协议(通常称为TCP/IP)。TCP控制在通过Internet传输之前将消息分解成数据包，以及在这些数据包到达目的地后重新组合这些数据包。IP为被传输的每个数据包指定了地址细节。这种开放的架构有四个关键的规则，它们促成了互联网的成功。独立网络不应该要求任何内部更改连接到网络。  
1. 没有到达目的地的数据包必须从源网络重新传输。2. 路由器计算机充当收发设备；它们不保留关于它们所处理的数据包的信息。3. 网络上不存在全局控制。

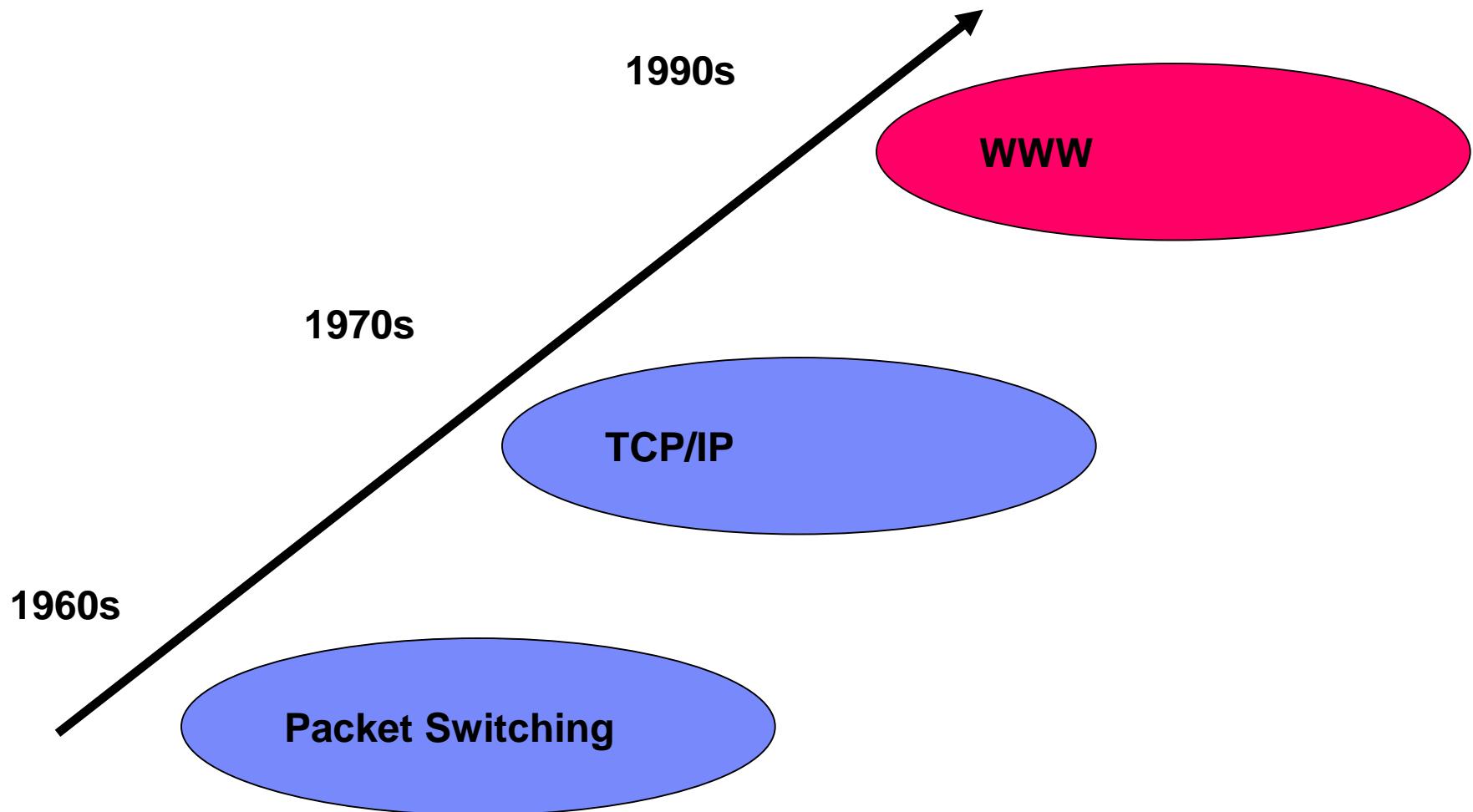
- The Transmission Control Protocol (TCP) and the Internet Protocol (IP) are the two protocols that support the Internet operation (commonly referred to as **TCP/IP**).
- The **TCP** controls the **disassembly** of a message into packets before it is transmitted over the Internet and the **reassembly** of those packets when they reach their destination.
- The **IP** specifies the **addressing details** for each packet being transmitted.

This open architecture has **four key rules** that have contributed to the success of the Internet.

- Independent networks should **not** require any internal **changes** to be connected to the network.
- Packets** that do not arrive at their destinations must be **retransmitted** from their source network.
- Router** computers act as **receive-and-forward** devices; they do not retain information about the packets that they handle.
- No global control** exists over the network.



# Network Evolution -- 3 Major Milestones



互联网:一个大型系统的联网电脑,跨越世界万维网:电脑在互联网上的一个子集,一个易于使用的标准接口的原始目标美国国防部控制武器系统和其他转移研究文件使用互联网的迅速增长在过去的30年中,电子邮件1972年开始Usenet始于1979年(新闻组:在20世纪80年代,随着PC的出现,将学术网络和公司网络结合起来的需要变得明显起来

# Internet and World Wide Web

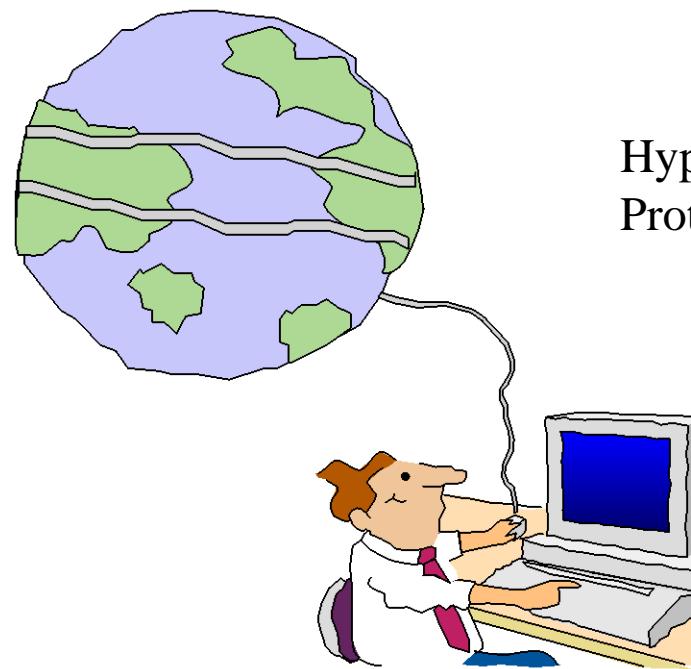
- **Internet**: A large system of connected computers that spans the world
- **WWW**: A subset of the computers on the Internet that has an **easy-to-use standard interface**
- **Original goals of U.S. Department of Defense**
  - Control weapon systems and transfer research files
- **Other uses of the Internet have mushroomed over the last 30 years**
  - **E-mail** began in 1972
  - **Usenet** started in 1979 (Newsgroup: Members can read and post)
  - Other applications such as **games**
- In the 1980's, with the advent of PC's, the need to integrate academic networks and corporate networks became apparent.

# INTERNET Main Functions

- Electronic Mails (EMAIL)
- File Transfer (FTP)
- Remote Access
- WWW service (URL)
- Announcement
- News



Web Server



Hypertext Transfer  
Protocol (HTTP)

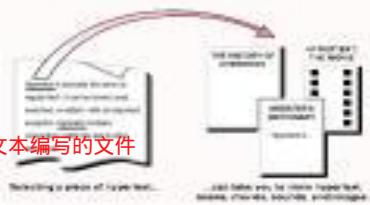
Web Client  
using Brower

# World Wide Web or Web

网络更多的是一种思考和组织信息存储和检索的方式，而不是一种特定的技术  
两个关键元素  
•超文本  
图形用户界面  
•网络使人们更容易使用互联网，从而创造了一个急剧扩大的互联网社区

- The Web is more **a way of thinking** about and organizing information storage and retrieval than it is a specific technology
  - **Two key elements**
    - **Hypertext**
    - **Graphical User Interface**
- Web makes it much easier for people to use the Internet, thus **creating a drastic expansion** of the Internet community





# Hypertext

超文本是一种页面链接机制，它可以将相关的页面信息相互连接起来，而不管信息存储在哪里。

- 我们都做“超级短信”
- 一个很好的例子：图书管理员
- 这个概念在1945年由Vannevar Bush正式提出
- 1989年：欧洲核子研究中心的蒂姆·伯纳斯-李开始开发超文本服务器（现在称为网络服务器），用于存储用超文本编写的文件标记语言（HTML），让其他计算机连接到它并读取这些文件

- Hypertext is a **page-linking mechanism** that would interconnect related pages of information, regardless of where the information is stored.
- We all do “**hypertexting**”
  - A good example: **a librarian**
- The concept was formalized and articulated in **1945 by Vannevar Bush**
- **1989: Tim Berners-Lee**, at CERN (Conseil Europeen pour la Recherche Nucleaire), started to develop a **hypertext server** (now called Web server), which stores files written in Hypertext Markup Language (**HTML**) and lets other computers connect to it and read these files

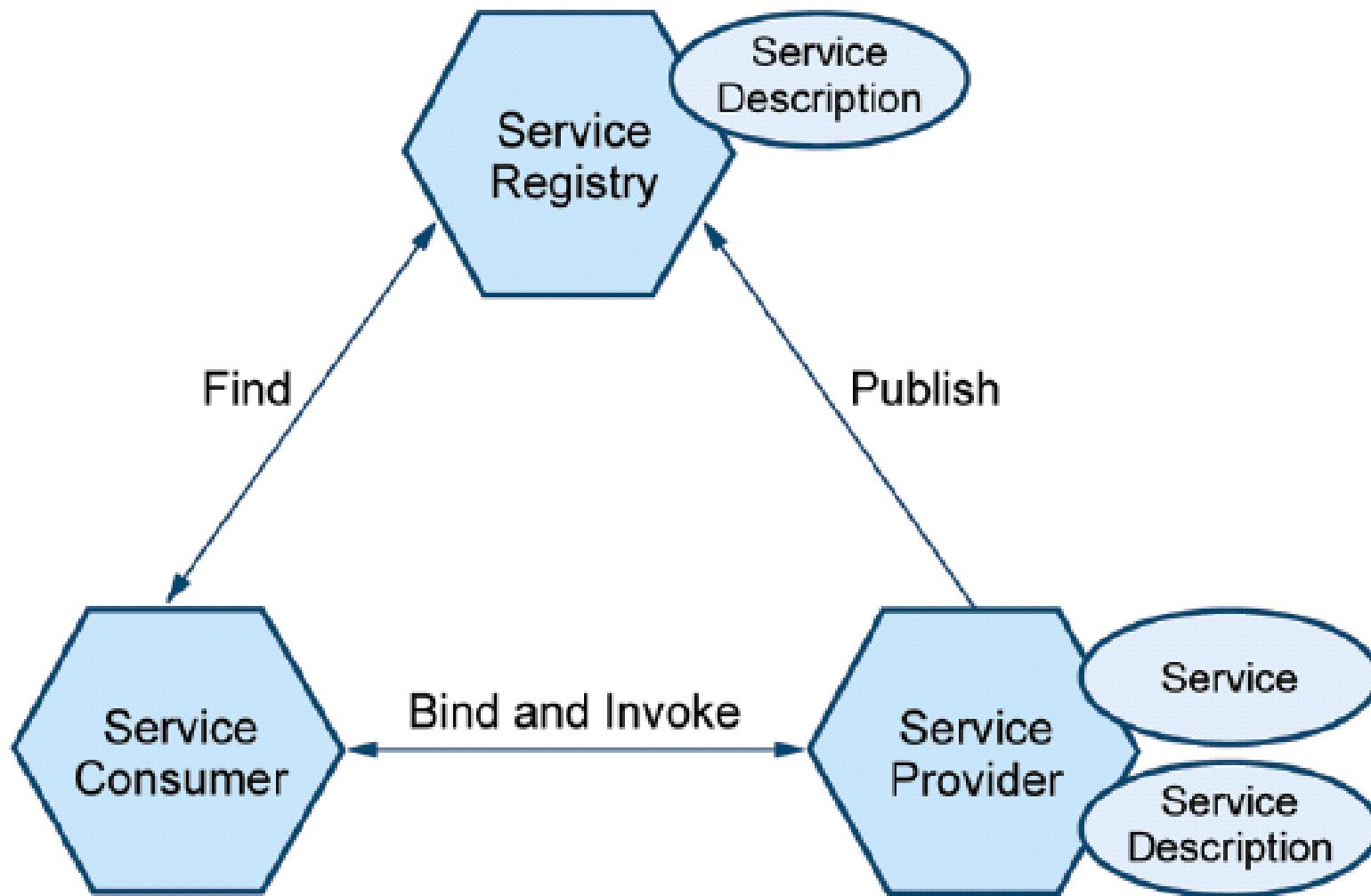
超文本传输协议(HTTP)是在Internet上传递Web页面的一套规则。

- HTTP使用客户端/服务器模型
- 用户的Web浏览器打开一个HTTP会话并向远程服务器发送一个Web页面请求。
- 在响应中，服务器创建一个HTTP响应消息，该消息被发送回客户端的Web浏览器。
- 协议名和域名的组合称为统一资源定位器(URL)

# Web Page Delivery

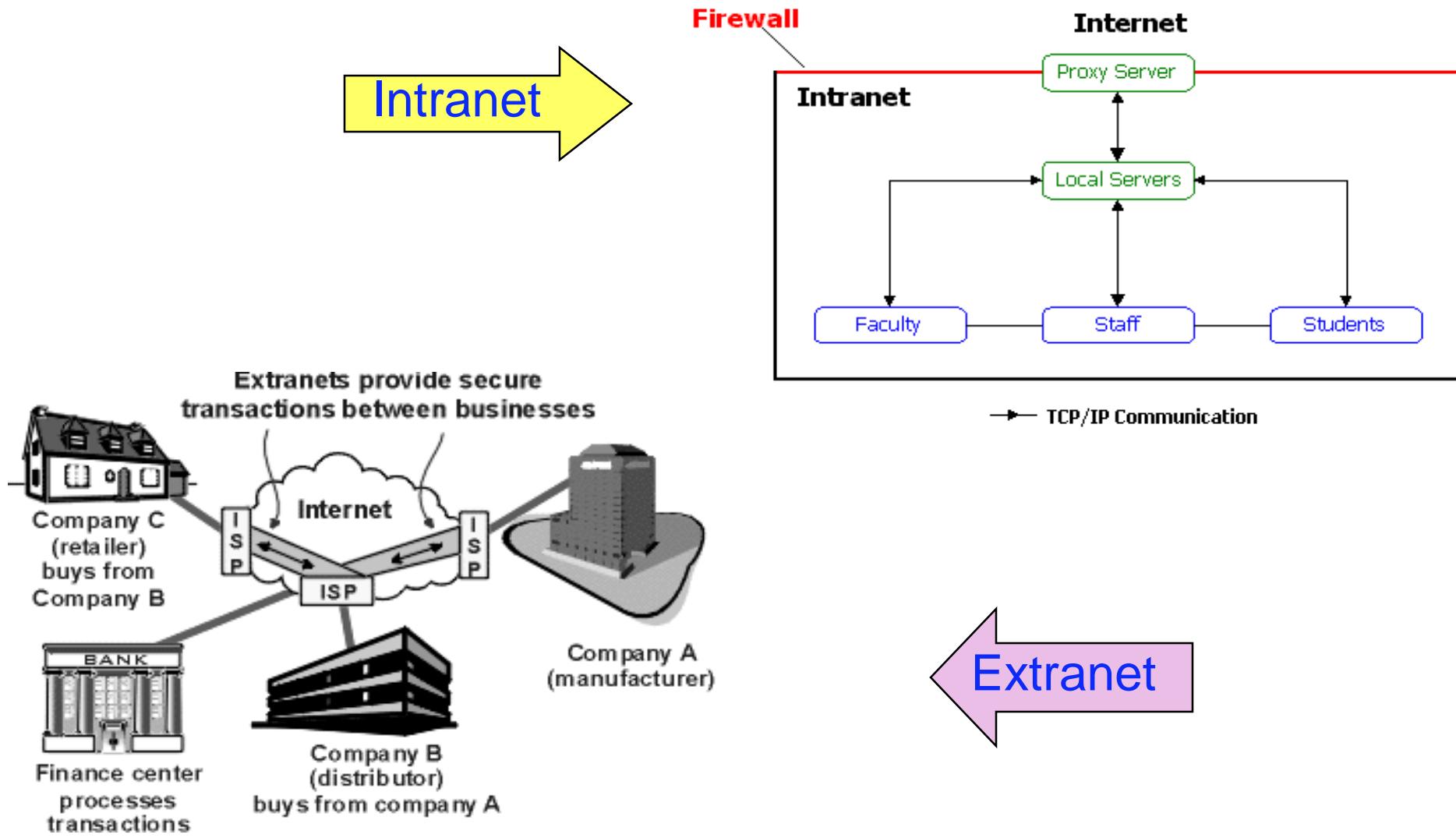
- **Hypertext Transfer Protocol (HTTP) is the set of rules for delivering Web pages over the Internet.**
- **HTTP uses the client/server model**
  - A user's Web **browser** opens an **HTTP session** and sends a request for a Web page to a remote server.
  - In response, the server creates an HTTP response message that is sent back to the client's Web browser.
- The combination of the protocol name and the domain name is called a **uniform resource locator (URL)**. e.g., <http://www.almaden.ibm.com>

# Web Services Model

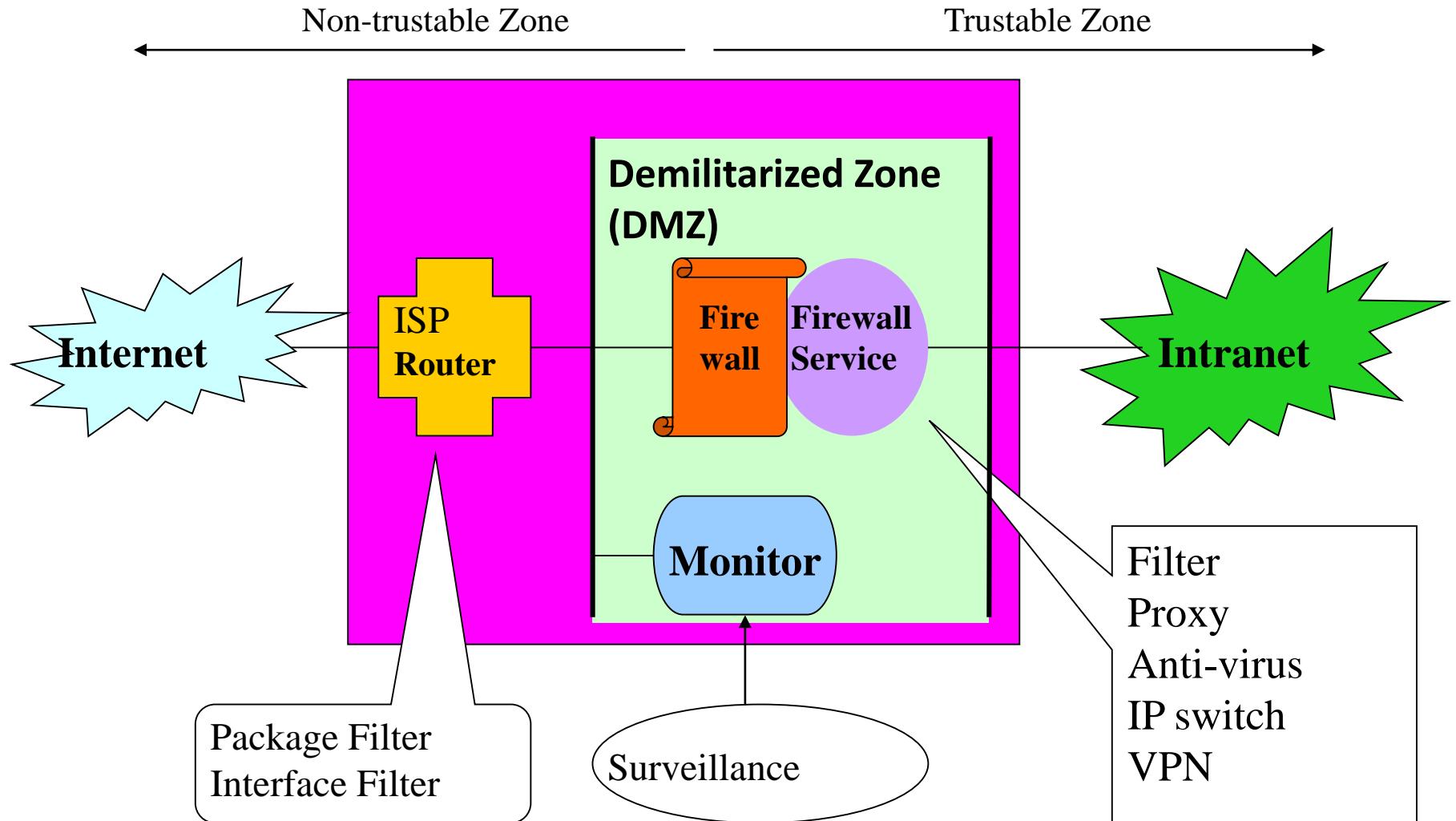


See more from: Web Development Technologies.doc

# Intranets and Extranets



# DMZ and Firewall



Case Study: Terminology DMZ in Korea

# GENI -- Exploring networks of the future

- **Global Environment for Network Innovations (GENI)**
- GENI is a virtual laboratory for exploring future internets at scale.
- GENI creates major opportunities to understand, innovate, and transform global networks and their interactions with society.
- GENI opens up new areas of research at the frontiers of network science and engineering, and increases the opportunity for significant socio-economic impact

全球网络创新环境(GENI) GENI是一个大规模探索未来互联网的虚拟实验室。GENI为理解创新、改造全球网络及其与社会的互动创造了重大机会。GENI在网络科学和工程前沿开辟了新的研究领域，并增加了产生重大社会经济影响的机会



<http://www.geni.net/>

# Six considerations for big data networks

For big data applications, there are needs for

- 1.Network resiliency to failures
- 2.Solving network congestion
- 3.Network consistent performance across both space and time
- 4.Prepare now for big data scalability later
- 5.Network partitioning to handle big data
- 6.Application awareness for big data networks

对于大数据应用，有这样的需求

1. 网络对故障的弹性
2. 解决网络拥塞
3. 跨越空间和时间的网络一致性性能
4. 现在就为以后的大数据可伸缩性做好准备
5. 网络划分处理大数据
6. 应用大数据网络意识

# 5G Networks are needed

如果5G要有效地满足现代世界的需求，它需要扩展的范围将不仅仅是移动电话网络的基础设施。那么5G意味着什么呢？与10 gbps的下载速度相比，平均100 mbps由4 g数据容量比2010年减少1000倍pre-data传输滞后1毫秒的自动车辆安全连接七万亿无线设备服务七十亿人零停机时间减少90%的能源需求感知通过新的高效微基站技术5 g需要提供所有这一切而服从的公式等于下降按数据量增加的速率传输数据的成本。

- 5G will need to extend farther than just the infrastructure of our mobile phone networks if it is to effectively meet the needs of a modern world. So what does 5G mean:
- Download speeds of **10Gbps** compared to the average 100Mbps delivered by 4G
- 1000 times the data capacity compared to 2010
- A reduced pre-data transmission lag of 1 millisecond for automated vehicular safety
- Connectivity of seven trillion wireless devices serving seven billion people
- Zero perceived downtime
- 90% reduced energy needs through new efficient micro base station technology
- 5G will need to offer all of this while complying to the golden formula of an equal drop in the cost of transmitting data to the same rate that data volume increases.

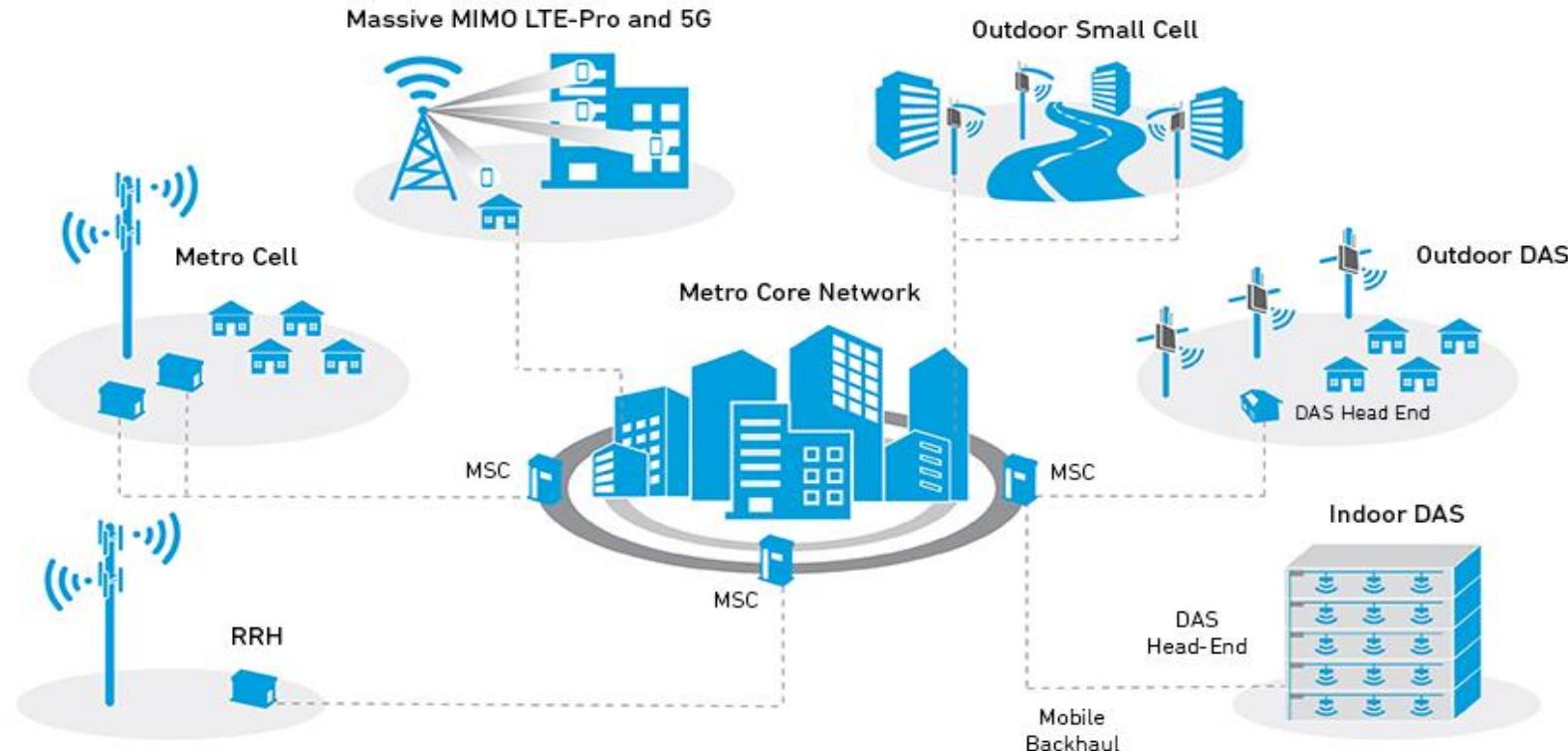
Generation	Started at	Technology	Data rates	Main network	Handover	Sub generation
1G	1980	Analog wireless	2 kbps	PSTN	Horizontal	1G only
2G	1991	Digital wireless, GPRS, EDEG	10 kbps to 500kbps	PSTN, GSM, WCD	Horizontal	2.5G, 2.75G
3G	2001	Broad Band IP Tech	400kbps to 30 mbps	Packet, GSM, TDMA	Horizontal & Vertical	3.5G, 3.75G
4G	2008	LTE, Wi-max	200mbps to 1gbps	Internet	Horizontal & Vertical	4G only
5G	Will start 2020	IPv4	Higher than 1Gbps	Internet	Horizontal & Vertical	5G till now



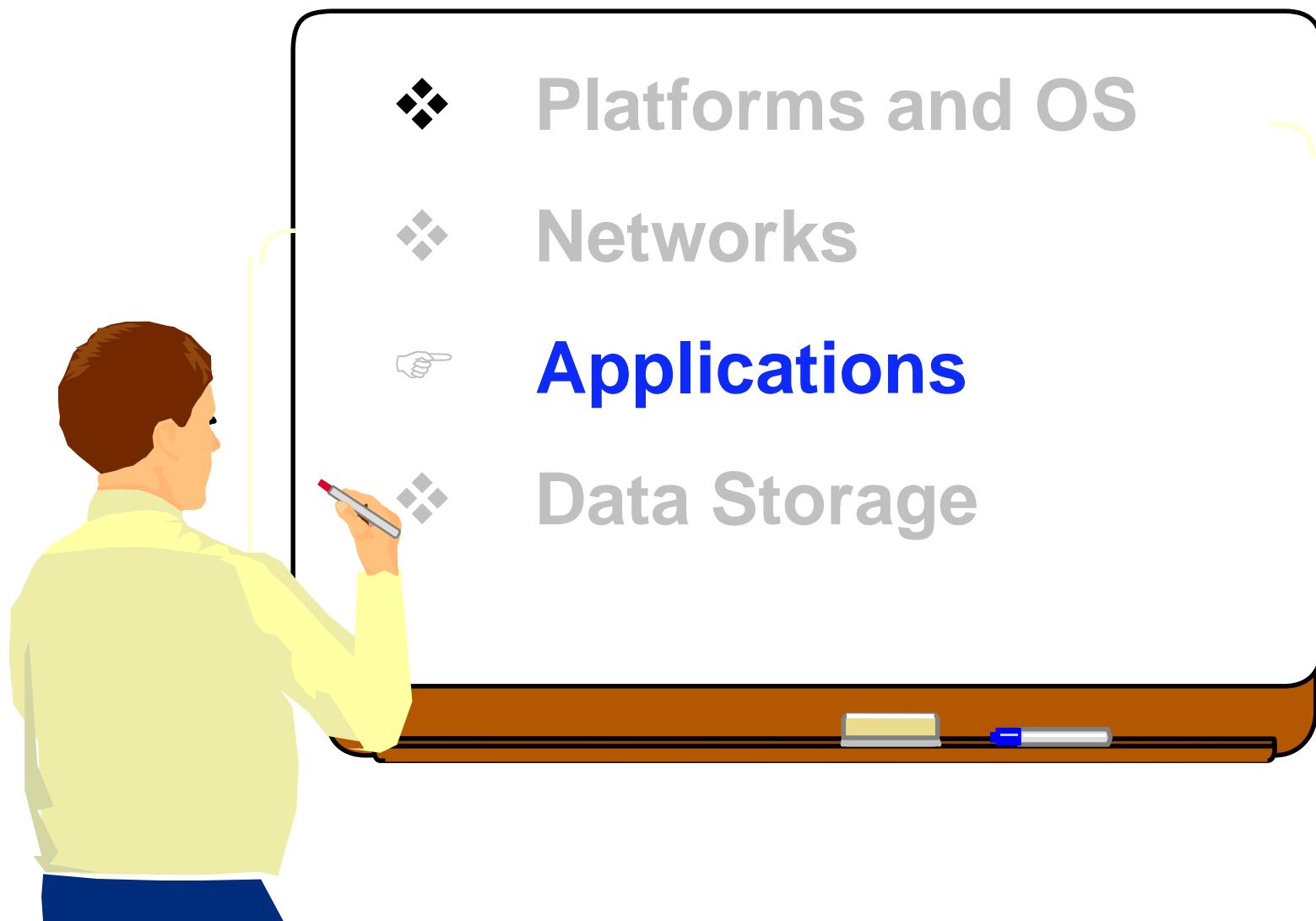
# 5G Networks

5G网络是下一代移动互联网连接，在智能手机和其他设备上提供比以往更快的速度和更可靠的连接。结合尖端网络技术和最新研究，5G将提供比目前更快的多用户连接，预计平均下载速度将很快达到每秒钟1GBps。这些网络将有助于推动物联网技术的巨大发展，提供传输海量数据所需的基础设施，从而实现一个更智能、更互联的世界。随着发展的顺利进行，5G网络预计将于2020年在世界各地推出，与现有的3G和4G技术一起提供更快的连接，无论你在哪里都能保持在线。

- ◆ 5G networks are the next generation of mobile internet connectivity, offering faster speeds and more reliable connections on smartphones and other devices than ever before.
- ◆ Combining cutting-edge network technology and the very latest research, 5G should offer connections that are multitudes faster than current connections, with average download speeds of around 1GBps expected to soon be the norm.
- ◆ The networks will help power a huge rise in Internet of Things technology, providing the infrastructure needed to carry huge amounts of data, allowing for a smarter and more connected world.
- ◆ With development well underway, 5G networks are expected to launch across the world by 2020, working alongside existing 3G and 4G technology to provide speedier connections that stay online no matter where you are.



# CONTENTS



# Application Tools

Single Usage Tools



Screw-Driver

Multiple Usage Tools



By using tools, are all men created equal ?!

# Computers

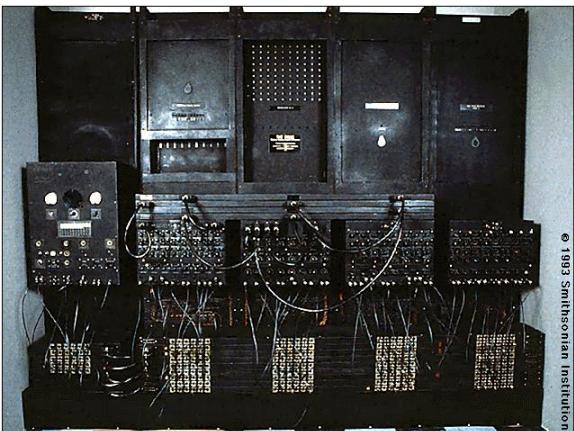
IBM 360



IBM 7090



ILLIAC 4



ENIAC

What do they do? They compute.

That is why they are called COMPUTERS.

# Should we continue to call them “Computers”?

- **(Scientific) Computing**
- **Data Processing**
- **Symbolic Processing**
- **Word Processing**
- **Email Handling**
- **Web Surfing**
- **Gaming**
- ....



(科学)计算  
•数据处理  
•符号处理  
•文字处理  
•邮件处理  
•网上冲浪  
•游戏



**Is this really a cell phone?**

What makes “computers” not do computing?

# Computer Software

计算机软件

- 计算机软件是提供计算机执行任务能力的程序和程序。
- 有三个主要的软件类:
  - 系统软件运行计算机硬件和计算机系统。
  - 编程软件提供工具，以编写计算机程序和软件使用不同的编程语言
  - 应用软件

- Computer software are the programs and procedures that provide a computer the ability to perform a task.
- There are **three** major software classes:
  - **System software** runs the computer hardware and the computer system.
  - **Programming software** provides tools for writing computer programs and software using different programming languages
  - **Application software**

# Application software classification

- Analytical software
  - Statistical packages
- Collaborative software
  - Blogs, Wiki's
- Computer-mediated communication
  - E-mail, Web Browsers
- Business software
  - CRM, enterprise business software, etc
- Database Software
  - Oracle, DB2, Microsoft SQL, Informix, NoSQL
- Entertainment and Multimedia and Art Software
  - Video games, picture editing sw,

分析软件

- 统计软件包
- 协作软件
- 博客、Wiki
- 电脑中介沟通
- 电子邮件，网络浏览器
- 商业软件
- 客户关系管理，企业商业软件等
- 数据库软件
- Oracle, DB2, Microsoft SQL, Informix, NoSQL
- 娱乐和多媒体软件和艺术
- 视频游戏，图片编辑软件

中间件软件  
——消息队列  
系列的礼服  
·IT管理软件  
- 蒂沃利，CA Uni center，惠普  
Openview等

## ■ Middleware software

- Message Queue Series, Tuxedo

## ■ IT Management software

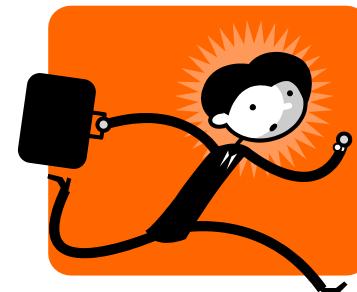
- Tivoli, CA Unicenter, HP Openview, etc.

Complicate?

# Why Software Engineering ?

- **The problem is *complexity***
- **Many sources, but *size* is key:**
  - UNIX contains **4 million lines** of code
  - Windows 2000 contains  **$10^8$  lines** of code

**Software engineering is about managing this complexity.**



# Software Engineering Body of Knowledge

## Computing Fundamentals

- Algorithms and Data Structures
- Computer Architecture
- Mathematical Foundations
- Operating Systems
- Programming Languages

## Software Product Engineering

- Requirements Engineering
- Software Design
- Software Coding
- Software Testing
- Software Operations & Maintenances

## Software Management

- Project Process Management
- Risk Management
- Quality Management
- Configuration Management
- Dev. Process Management
- Acquisition Management

## Software Domains

- Artificial Intelligence
- Database Systems
- Human-Computer Interaction
- Numerical & Symbolic Comp.
- Computer Simulation
- Real-Time Systems



Source: <http://www.sei.cmu.edu/pub/documents/99.reports/pdf/99tr004.pdf>

# Hot Software Engineering Skills Today and Tomorrow

- Visual Basic -- Programming Language
- Microsoft Access – Relational Database (small applications)
- PowerBuilder application development tools – RAD Database Tool
- C and C++ programming -- Programming Languages
- SAP – Enterprise Wide Application Software (financial, manufacturing, product data management)
- MVS, Unix and Windows NT – Host Operating Systems (IBM, Sun, HP, Microsoft)
- Microsoft Exchange – E-Mail Server
- Lotus Notes – Web Based Publishing/Management Application Software
- Database management, administration and development -Oracle and Sybase to a lesser extent. – Oracle dominates the DBMS market
- Internet/World Wide Web: Web-related skills; e.g., Java, ActiveX, CGI and Internet Security – Definitely – look at explosion in web and e-commerce
- Object-oriented skills -- Analysis, design, development



好好学习 C++!



# Software Engineering Today

- Software Engineering
  - An engineering discipline that includes these processes and products:
- – Software Engineering Management
- – Software Requirements Analysis
- – Software Configuration Management
- – Software Design
- – Software Construction
- – Software Testing
- – Software Engineering Infrastructure
- – Software Engineering Process
- – Software Evolution and Maintenance
- – Software Quality Analysis



Source: SWEBOK – <http://www.swebok.org>

# Software Engineering Summary

- **Software Engineering has a bright future**
  - Job opportunities
- **Web will be a major driver of software engineering growth**
- **Successful software engineers** will constantly learn and adapt new technologies
  - Learn how to solve problems
  - Learn how to communicate (verbal and written)
  - **Learn how to provide services**



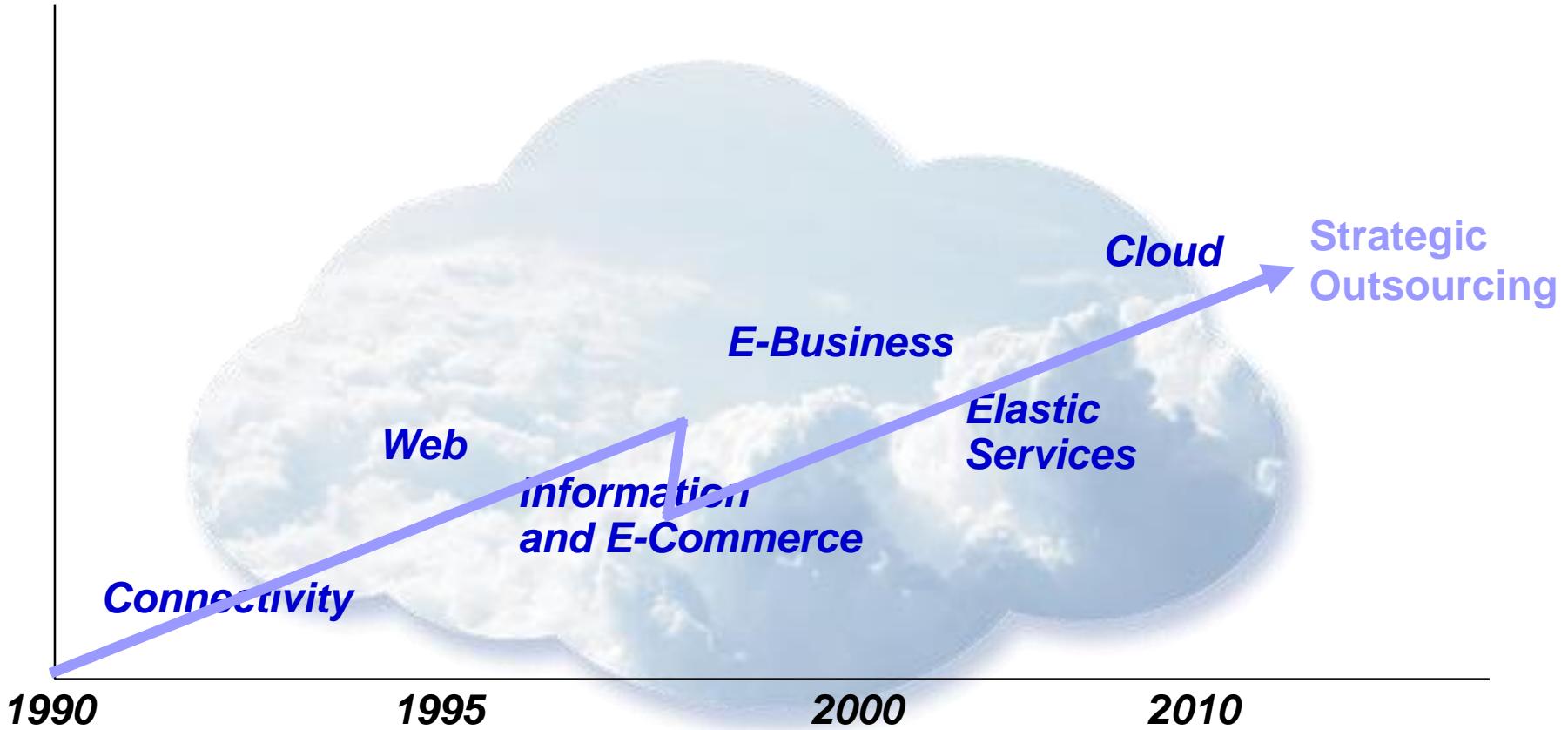
Knowledge is Power!

# Software as a Service

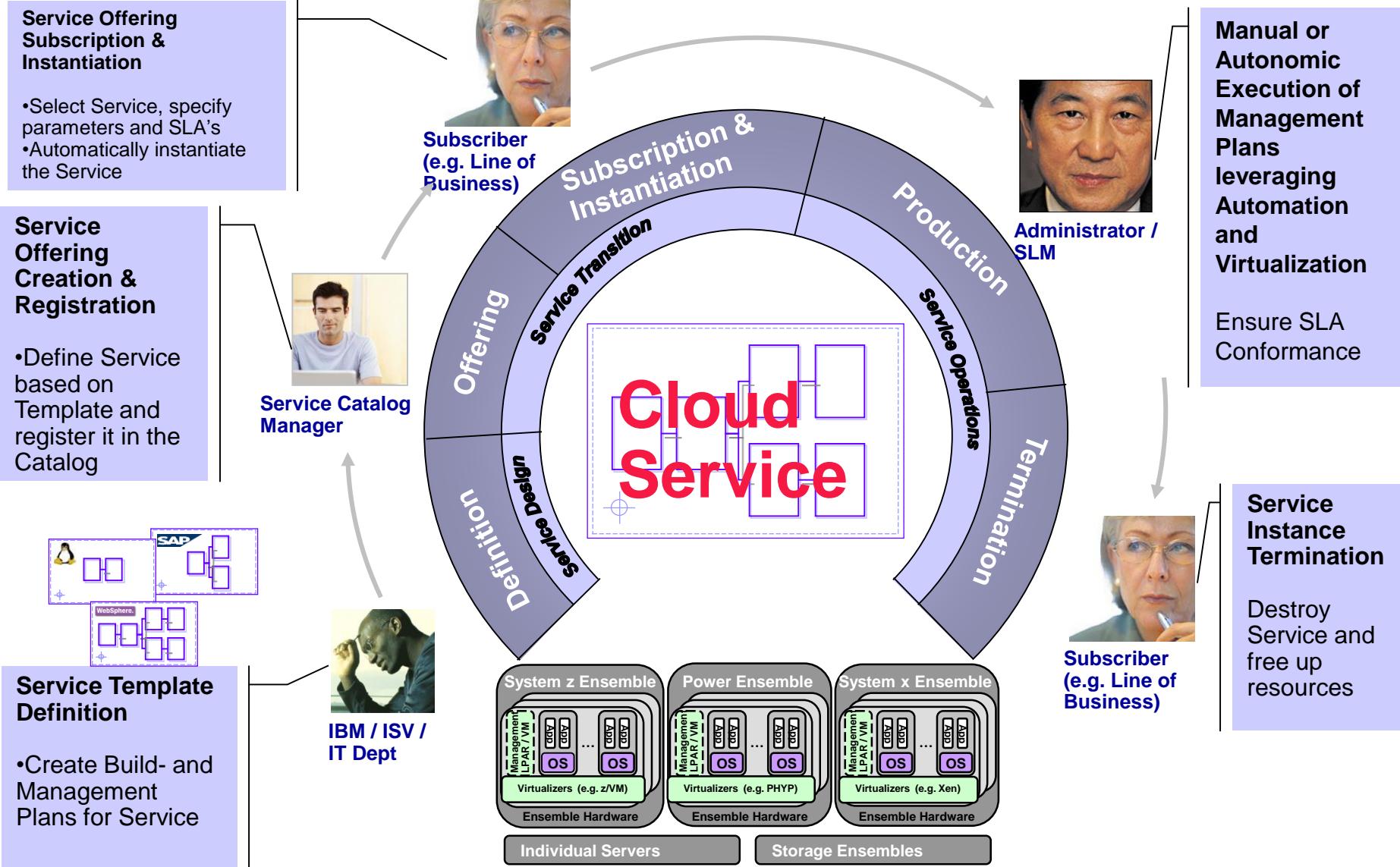
大量的企业或“打包”软件正从安装的产品转变为托管的服务(CRM, HR, BI是重要的部门，供应链ERP即将到来)  
•客户无需在本地机器上安装软件，而是通过网络浏览器订阅或按次使用来访问该功能  
和谷歌提供S-as-a-S应用程序的电子邮件，电子表格，和办公室文件的“免费”  
换你知道吗？  
•许多“部署”软件应用程序已经成为一个重要的托管或“供应商管理”的S-as-a-S组件的混合

- Significant amount of enterprise or "packaged" software is being transformed from an installed product to a hosted service (CRM, HR, BI are significant sectors, Supply Chain and ERP are coming)
- Instead of installing the software on a local machine, the customer pays on a subscription or per use basis to access the functionality using a Web browser
  - **And Google offers S-as-a-S applications for email, spreadsheets, and office documents for "free" (in exchange for you know what)**
- Many "deployed" software applications have become hybrids with a significant hosted or "vendor-managed" S-as-a-S component

# Most recent innovation in a set of technologies



# New Computer Applications -- Cloud Service



# Cloud Computing

云计算

用户体验和商业模式

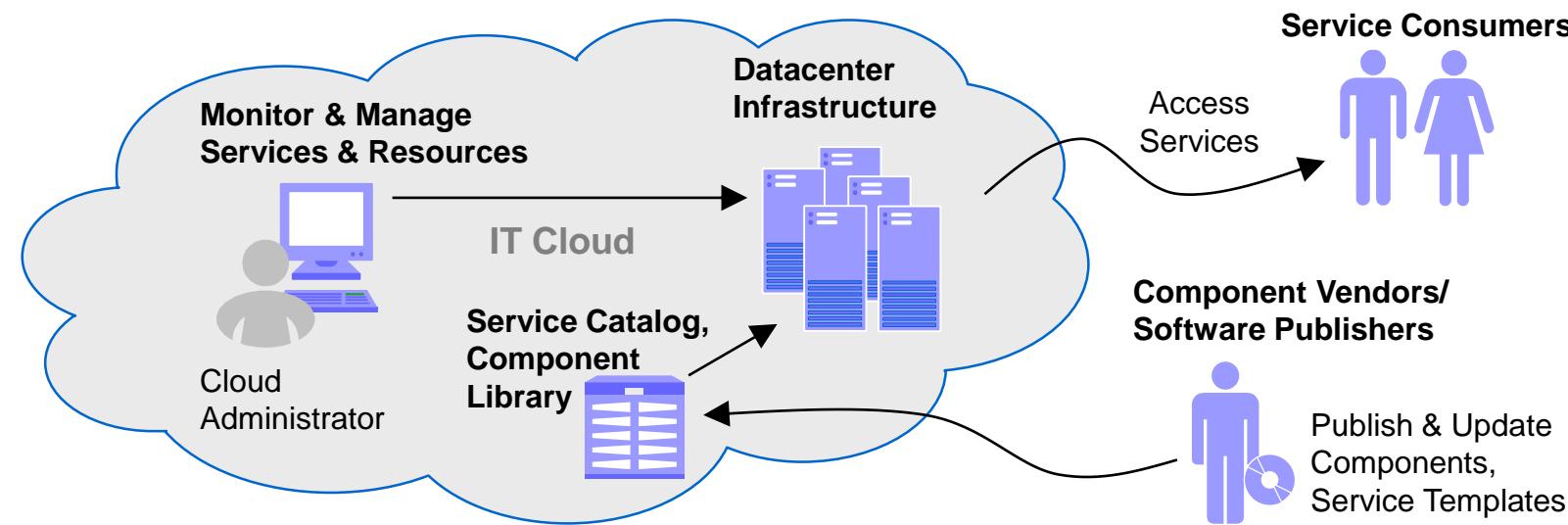
- 云计算是一种新兴的IT交付方式，在其中应用程序、数据和IT资源以灵活的定价模式通过web以标准化的方式快速地提供给用户。
- 基础设施管理和服务交付方法
- 云计算是一种大量高度虚拟化资源管理，从管理的角度来看，他们像一个巨大的资源。
- 然后可以使用它来交付具有弹性伸缩的服务

## A user experience and a business model

- Cloud computing is an emerging style of IT delivery in which applications, data, and IT resources are **rapidly provisioned** and provided as **standardized offerings** to users over the web in a **flexible pricing model**.

## An infrastructure management and services delivery methodology

- Cloud computing is a way of **managing** large numbers of highly **virtualized resources** such that, from a management perspective, they resemble a single large resource.  
This can then be used to deliver services with **elastic scaling**.



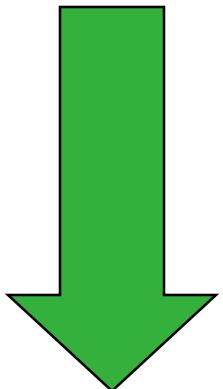
# Requires Architectural Shift

**single instance → multi tenancy**



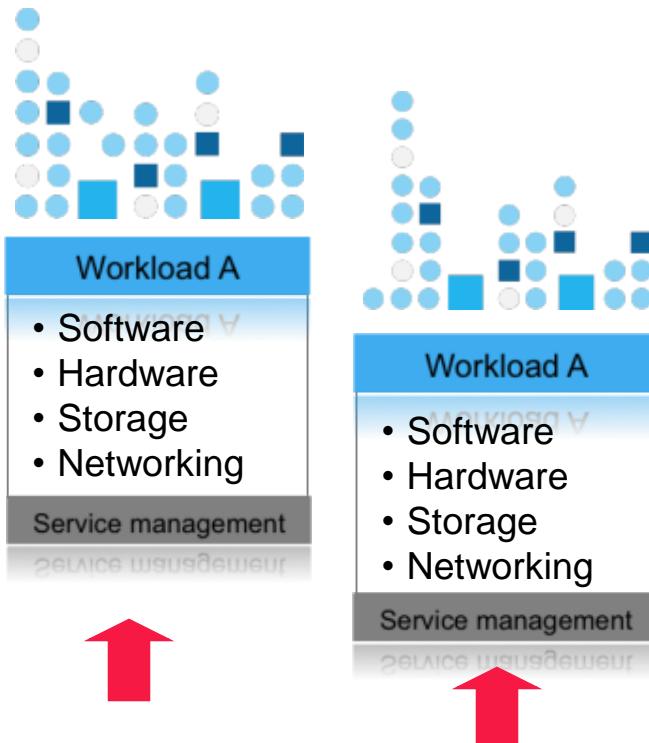
多租户的效率  
共享资源(一个实例来运行所有资源)  
可定制的  
通过配置定制  
可伸缩的  
许多应用程序需要Internet规模

- **Multi-tenant efficient**
  - Sharing resources (One instance to run them all)
- **Customizable**
  - Customization through configuration
- **Scalable**
  - Many applications require Internet scale



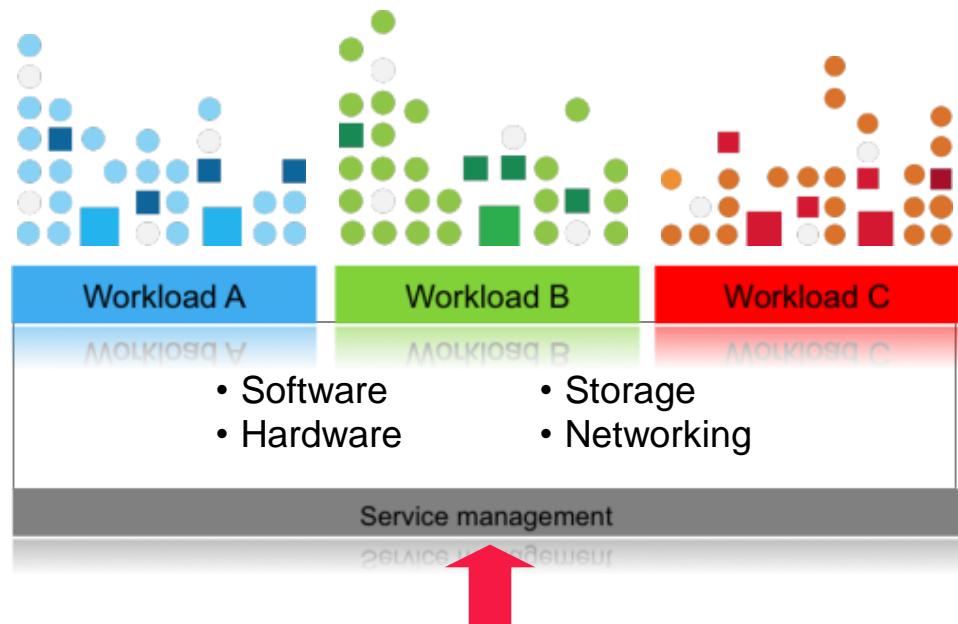
# What's the difference?

## Without cloud computing



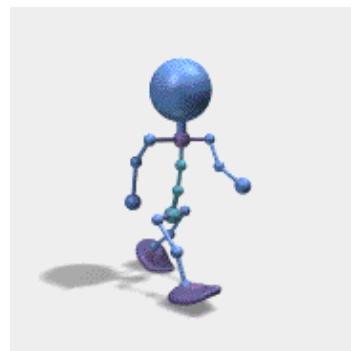
## With cloud computing

- Virtualized resources
- Location independent
- Rapid scalability
- Automated **service** management
- Standardized **services**
- Self-service

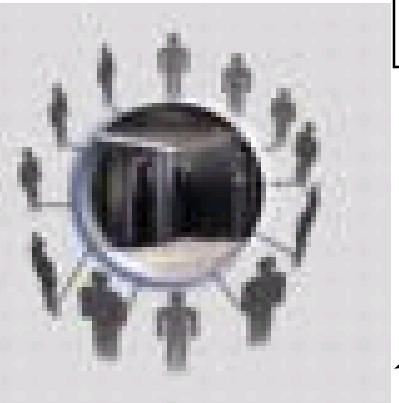


Note: Elements of cloud computing taken from NIST, Gartner, Forrester and IDC cloud computing definitions

# Evolution of Cloud Computing

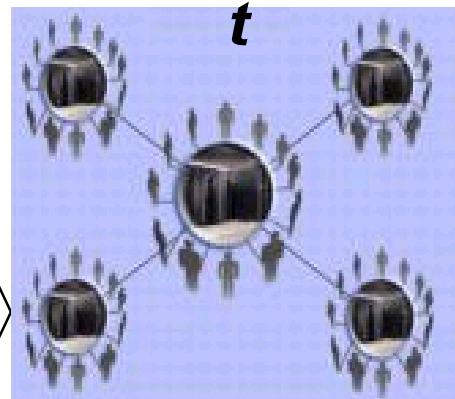


**Past**



**Drivers**

- Standard hardware
- Client-Server
- Internet
- e-business



**Centralized**

- Shared processes
- Limited applications
- Limited access

**Drivers**

- Virtualization
- High-Speed Network
- Web 2.0
- SaaS

**Present**

*t*

**Re-centralized**

- Shared Infrastructure
- Transparent delivery of services
- Ubiquitous access with high bandwidth, low latency

**Distributed**

- Dedicated Infrastructure
- Explosion of Applications
- Ubiquitous Access
- Islands of Computing



# Cloud Changes Everything

软件是如何交付的?

- TRAD: 在自配置的环境上本地安装
- 云: 服务随时可用的在线, 而不是onpremise

## How is software delivered?

- **TRAD:** Install locally on self-provisioned environment
- **CLOUD:** Service readily available online, not on-premise

## How is the deployment maintained?

- **TRAD:** Configure and maintain according to own timeline
- **CLOUD:** Config and maint handled by service provider

## Frequency of updates, changes, new features?

- **TRAD:** Usually measured in months, can be years
- **CLOUD:** Small batches; can be updated multiple times/day

独特性的部署?

- 传统: 每个客户都是不同的 (网络, hw存储)
- 云: 云部署是记录的部署
- 传统: 单身租赁
- 云: 多租户
- TRAD: 一般与其他产品隔离, 无干扰
- 云: 吵闹的邻居, 不可预测的背景

## Uniqueness of deployment?

- **TRAD:** Each customer is different (network, hw, storage)
- **CLOUD: The cloud deployment is the deployment of record**
- **TRAD:** Single tenancy
- **CLOUD: Multi-tenancy**
- **TRAD:** Generally isolated from other products, no interference
- **CLOUD: Noisy neighbors, unpredictable backgrounds**

## In case of failure or problems?

- **TRAD:** Determine root cause and fix (test / release a patch)
- **CLOUD: Keep production going; maintain operability (return to operation ASAP and document for next time)**

客户档案

- 传统: 大投资后, 客户接受奋斗
- 云: 进入门槛低; 如果受挫, 就会去别的地方
- TRAD: 企业规模 (IBM擅长于此)
- 云: 小, 钦质, PAYGO (IBM还不擅长这个)

## Customer profile

- **TRAD:** After big investment, customers accept struggle
- **CLOUD: Low barrier to entry; if frustrated, will go elsewhere**
- **TRAD:** Enterprise scale (IBM is good at this)
- **CLOUD: Small, Premium, PAYGO (IBM not yet good at this)**

## How tested?

- **TRAD:** Cleanrooms, isolated, ideal conditions
- **CLOUD: Noisy neighbors, multi-tenants, dirty data**
- **TRAD:** Model and predict in isolation
- **CLOUD: Not feasible to model N! combinations**

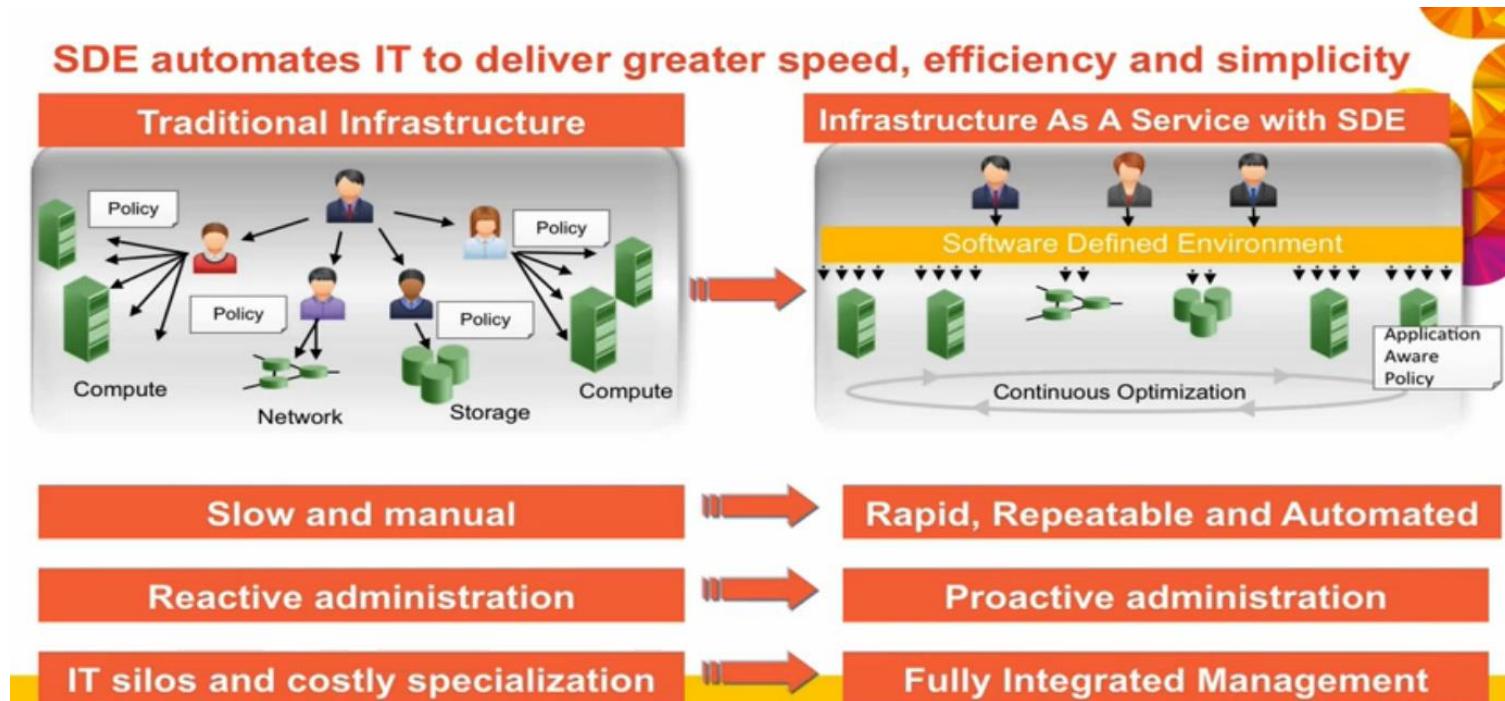
TRAD: Traditional

# Software Defined Environments (SDE)

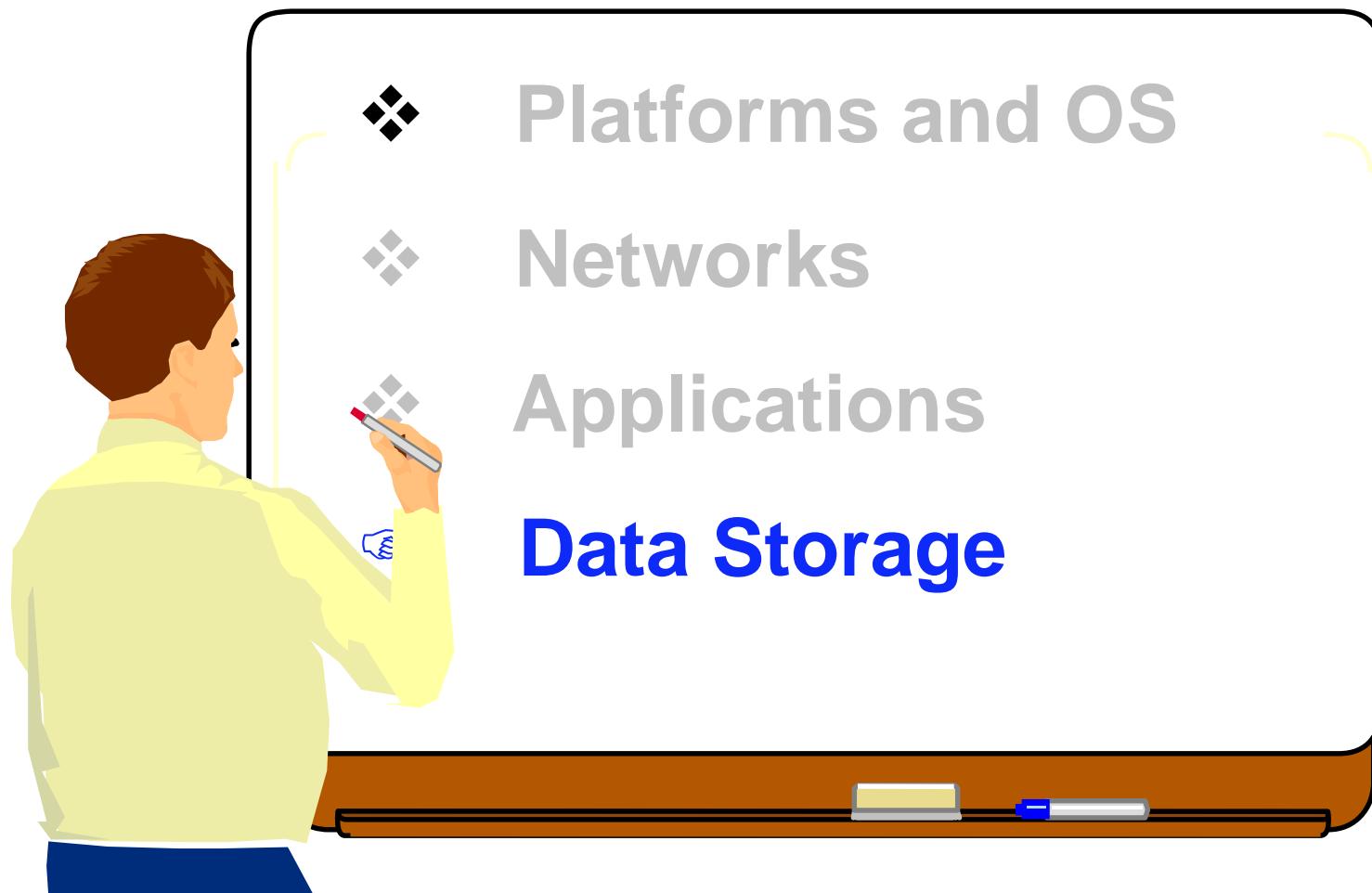
当包括计算、存储和网络在内的整个基础设施都在云中实现软件定义和可编程时，一种高度可配置和完全可编程的全新统一控制平面就出现了，其工作负载被编译到该平面上。这是软件定义环境(SDE)的基础

When the entire infrastructure including compute, storage and network becomes software defined and programmable in the cloud, a new unified control plane emerges which is highly configurable and fully programmable with the workloads being compiled onto it.

This is the foundation of Software Defined Environments (SDE).

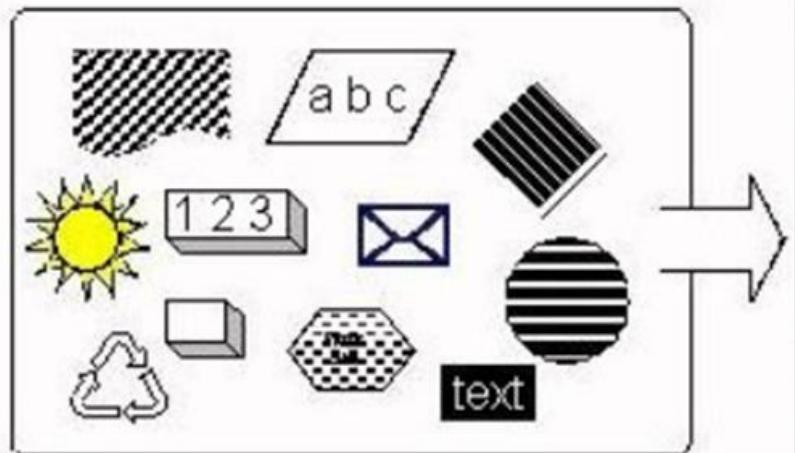


# CONTENTS



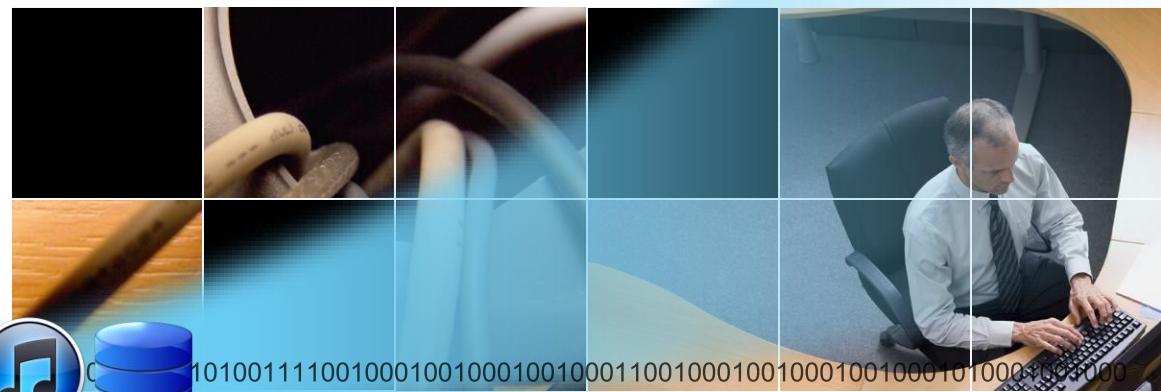
# Data in Computer

# Real-World Information



## Computer Data

```
01110101011010101  
10100101011010101  
01010101011010101  
01000101011010101  
01101010101001100  
00101011101100111  
10101001010101010
```



# Computer Data Storage

“计算机数据存储”这个词一般指的是集成电路,磁性或光学磁盘,和/或盒式磁带设备所使用的计算机系统来记录和保留数字数据的间隔时间。  
•存储通常称为大容量存储——磁盘、可移动光盘、盒式磁带和其他类型的媒体:  
-比随机存取内存(RAM)慢得多  
-远比内存便宜  
-专为永久保存数据而设计

- The term “computer data storage” broadly refers to **integrated circuits, magnetic or optical disks, and/or cartridge tape devices** used by computer systems to record and retain digital data for some interval of time.
- Storage more commonly referred to as **mass storage** – **magnetic disks, removable optical disks, tape cartridges, and other types of media** is:
  - Much slower than RAM (Random Access Memory)
  - Far less expensive than RAM
  - Designed for permanent retention of data

# Storage Classification

存储的特性包括一个分层的层次结构，或主、次、三级和脱机存储的划分，或与中央处理单元(CPU)的距离

**Characterization of storage includes a tiered hierarchy, or the division of primary, secondary, tertiary and off-line storage or distance from the central processing unit (CPU).**

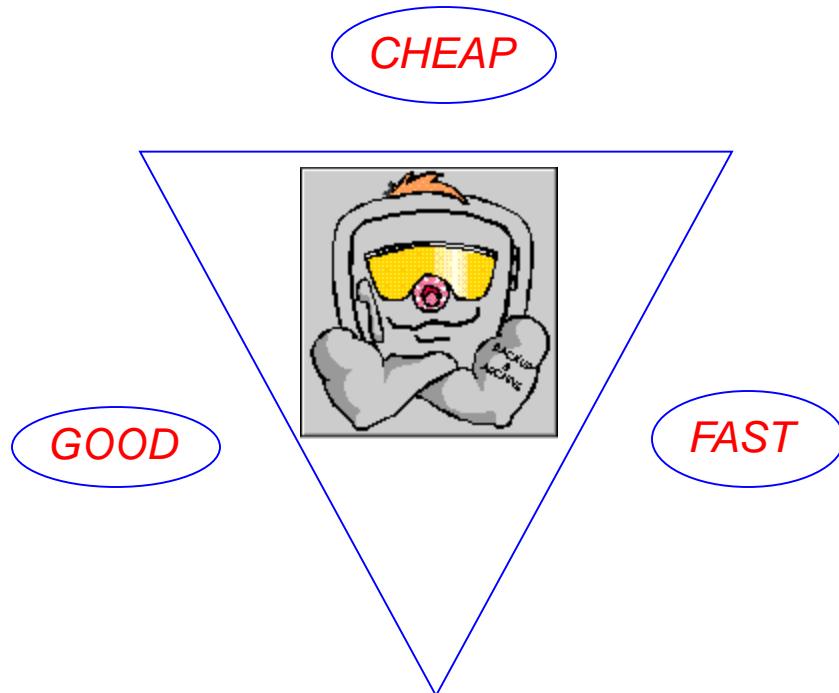
- **Primary storage** is internal memory that is accessible to the central processing unit without the use of the computer's input/output channels.
- **Secondary storage** is memory that is not directly attached to the central processing unit of a computer, requiring the use of computer's input/output channels. Secondary storage is used to retain data that is not in active use.
- **Tertiary storage** or **tertiary memory**, is a computer storage system consisting of one or more storage drives and an automatic media library, for example a tape library or optical disc jukebox.

主存储器是中央处理器不需要使用计算机的输入/输出通道就可以访问的内部存储器。  
•辅助存储器是不直接连接到计算机中央处理单元的内存，需要使用计算机的输入/输出通道。辅助存储器用于保存不处于活动状态的数据。  
•二级存储或三级存储器是一种计算机存储系统，包括一个或多个存储驱动器和一个自动媒体库，例如磁带库或光盘点唱机。



# Data Storage Solution Triangle

- ❖ Where the data is stored?
- ❖ How the data is accessed?
- ❖ How the data is protected?
- ❖ How the data is managed?



Which 2 sides of the triangle do you want to use for your storage solution?

# Magnetic Disks

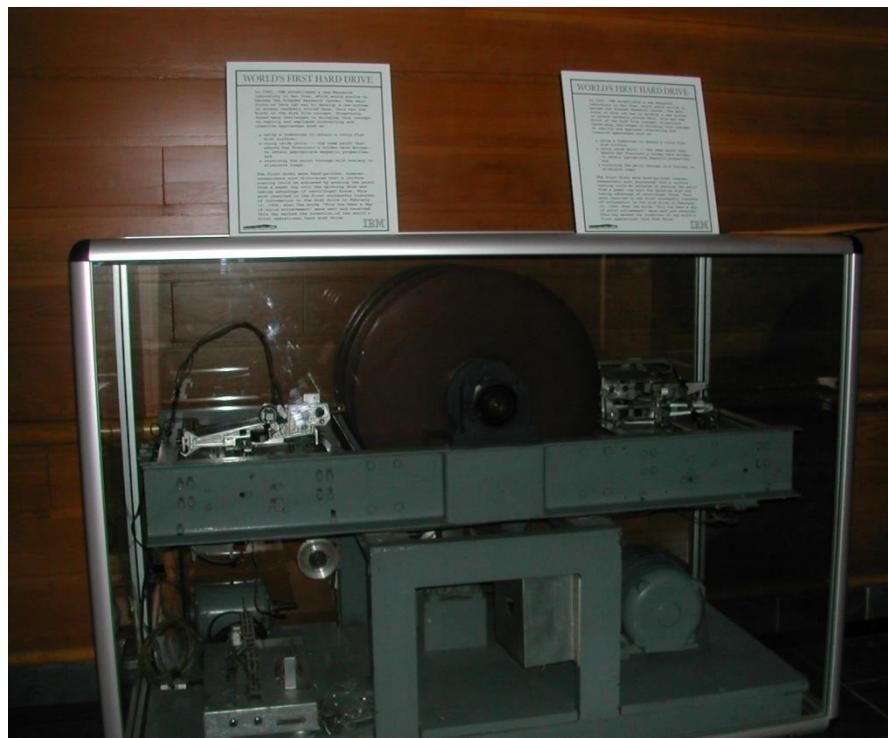
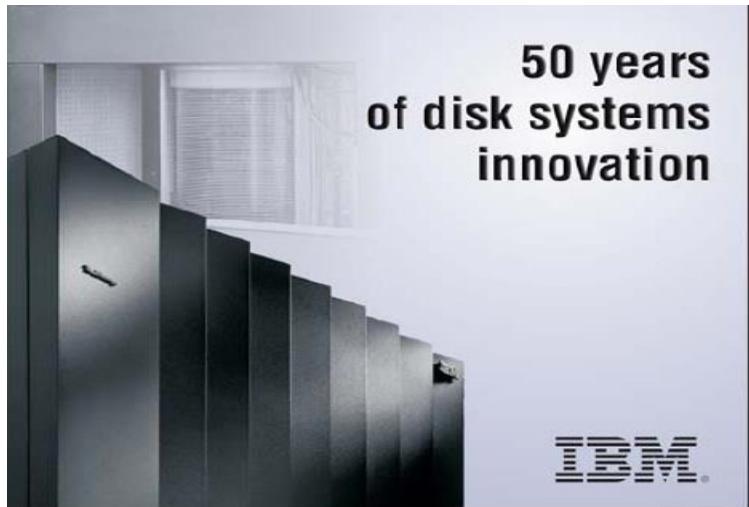
在磁盘上，数据被编码为微小的磁化针在磁盘的表面。你可以在磁盘上记录和删除数据任何次数，就像你可以用盒式磁带一样。软盘：一个典型的5英寸软盘可以容纳360K或1.2MB(兆字节)。3英寸软盘通常存储720K, 1.2MB或1.44MB的数据。硬盘：硬盘可以存储20MB到200GB以上的任何地方。硬盘的速度也比软盘快10到100倍。可移动墨盒：可移动墨盒是包裹在金属或塑料墨盒中的硬盘，所以你可以像软盘一样移动它们。可移动墨盒速度非常快，尽管通常不如固定硬盘快。



- On magnetic disks, data is encoded as microscopic magnetized needles on the disk's surface. You can record and erase data on a magnetic disk any number of times, just as you can with a cassette tape. Magnetic disks come in a number of different forms:
  - **floppy disk** : A typical 5½-inch floppy disk can hold 360K or 1.2MB (megabytes). 3½-inch floppies normally store 720K, 1.2MB or 1.44MB of data.
  - **hard disk** : Hard disks can store anywhere from 20MB to more than 200GB. Hard disks are also from 10 to 100 times faster than floppy disks.
  - **removable cartridge** : Removable cartridges are **hard disks** encased in a metal or plastic cartridge, so you can remove them just like a floppy disk. Removable **cartridges** are very fast, though usually not as fast as fixed hard disks.

# World's First Hard Disk Drive

- ❖ IBM 350 disk storage unit
- ❖ 1955 - 1961
- ❖ 50 x 24 inches
- ❖ 5 MB
- ❖ 0.0088 MB/s



In mid-1960, Nikita Khrushchev, of the Soviet Union took a historic tour of the IBM manufacturing plant in San Jose, CA. Thomas J. Watson, Jr., of Khrushchev's right, waved Khrushchev's delegation to set up this visit. Henry Cabot Lodge, U.S. ambassador to the U.N., is on Khrushchev's left. The first thing they toured when Khrushchev arrived was the cafeteria, where they enjoyed a large lunch which put Nikita in a jovial mood.

# Optical Disks

光盘是用激光在光盘表面烧出微孔来记录数据的。为了读取磁盘，另一束激光照射在磁盘上，并通过反射模式的变化检测孔洞。光盘有三种基本形式：CD-ROM：大多数光盘是只读的。当您购买它们时，它们已经填充了数据。可以从CD-ROM读取数据，但不能修改、删除或写入新数据。WORM：代表一次写，多次读。蠕虫磁盘可以写入一次，然后读取任何次数；但是，您需要一个特殊的蠕虫磁盘驱动器来将数据写入蠕虫磁盘。可擦光(EO)：EO磁盘可以像磁盘一样被读、写和擦除。



- Optical disks record data by burning microscopic holes in the surface of the disk with a laser. To read the disk, another laser beam shines on the disk and detects the holes by changes in the reflection pattern.
- Optical disks come in three basic forms:
  - CD-ROM : Most optical disks are read-only. When you purchase them, they are already filled with data. You can read the data from a CD-ROM, but you cannot modify, delete, or write new data.
  - WORM : Stands for *write-once, read-many*. **WORM** disks can be written on once and then read any number of times; however, you need a special WORM disk drive to write data onto a WORM disk.
  - erasable optical (EO) : EO disks can be read to, written to, and erased just like magnetic disks.

# Solid State Drives (SSD)

固态驱动器-在电、机械和软件方面都与传统的(磁性)硬盘兼容。

区别在于，存储介质不是磁性的(如硬盘)或光学的(如CD)，而是固态半导体，如电池支持的RAM、EPROM或其他电可擦RAM，如闪存芯片。

这提供了比硬盘更快的访问时间，因为无论存储位置是什么，都可以在同一时间随机访问SSD数据。SSD访问时间不依赖于与旋转磁盘上的数据扇区同步的读/写接口头。

SSD还提供了更大的物理弹性，物理振动，冲击和极端温度波动。唯一的缺点是每兆字节的存储成本更高——尽管在某些应用程序中，ssd的高可靠性使其比更换多个故障硬盘更便宜。另外，在企业服务器加速应用程序中，SSD的好处是，与单独使用基于硬盘的RAID相比，它减少了所需的服务器数量。

**A solid state drive** - is electrically, mechanically and software compatible with a conventional (magnetic) hard disk.

- The difference is that the storage medium is not magnetic (like a hard disk) or optical (like a CD) but **solid state semiconductor** such as battery backed RAM, EEPROM or other electrically erasable RAM like chip such as flash.

This provides **faster** access time than a hard disk, because the SSD data can be randomly accessed in the same time whatever the storage location. The SSD access time does **not** depend on a read/write interface head synchronizing with a data sector on a rotating disk.

- The SSD also provides greater physical resilience to physical vibration, shock and extreme temperature fluctuations. The only downside is a **higher cost per megabyte** of storage - although in some applications the higher reliability of SSDs makes them cheaper to own than replacing multiple failing hard disks. Also in enterprise server acceleration applications - the benefit of the SSD is that it reduces the number of servers needed compared to using hard disk based RAID on its own.



# RaceTrack memory ← a New IBM Invention

- uses the “spin” of the electron to store data
- no moving parts (HDD)
- no wear-out mechanism (SSD)

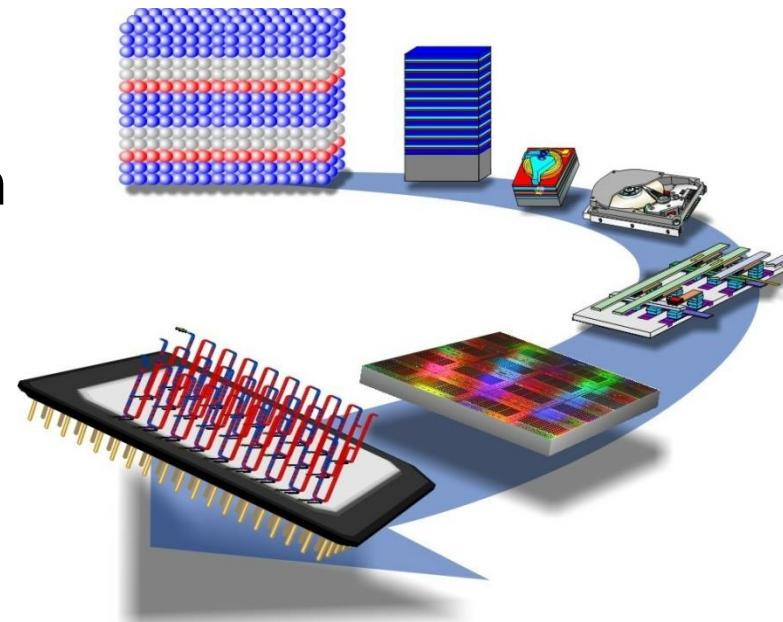
For example, this technology could enable a handheld device such as an mp3 player to store around 500,000 songs or around 3,500 movies – 100 times more than is possible today – with far lower cost and power consumption.

利用电子的“自旋”来存储数据

•没有转动部件(硬盘)

•无磨损机构(SSD)

例如，这项技术可以使一个像mp3播放器这样的手持设备存储大约50万首歌曲或大约3500部电影——比现在可能存储的数量多100倍——而且成本和功耗要低得多



# Tape Library

在计算机存储器中，磁带库是一种存储设备，它包含一个或多个磁带驱动器、用于存放磁带盒的若干插槽、用于识别磁带盒的条形码阅读器和自动加载磁带的方法(机器人)。

•最早的例子之一是IBM 3850  
大容量存储系统(MSS)，宣布于1974年

- In computer storage, a **tape library** is a storage device which contains one or more **tape drives**, a number of slots to hold **tape cartridges**, a **barcode reader** to identify tape cartridges and an automated method for loading tapes (a **robot**).
- One of the earliest examples was the IBM 3850 Mass Storage System (MSS), announced in 1974.



# Network Storage

涉及通过计算机网络访问信息的任何一种计算机存储。

• 网络存储的例子包括：

- 网络附加存储器是附加在一台计算机上的二级或三级存储器，另一台计算机可以通过本地网络、专用广域网或在网上文件存储的情况下，通过互联网访问。

- 网络计算机是不包含内部辅助存储设备的计算机。相反，文档和其他数据存储在一个网络附加存储器上

- Any type of computer storage that involves accessing information over a computer network.
- Examples of Network storage includes:

- Network-attached storage is secondary or tertiary storage attached to a computer which another computer can access over a local-area network, a private wide-area network, or in the case of online file storage, over the Internet.
- Network computers are computers that do not contain internal secondary storage devices. Instead, documents and other data are stored on a network-attached storage.

**SAN, NAS**

# Internet SCSI – iSCSI

iSCSI是Internet SCSI（小型计算机系统接口），是一种基于Internet协议(IP)的存储网络标准，用于连接数据存储设施，由Internet Engineering Task Force (IETF)开发。通过在IP网络上携带SCSI命令，iSCSI被用来促进内部网上的数据传输和管理长距离的存储。通过提高存储数据传输的能力和性能，iSCSI协议有望帮助实现存储区域网络(SAN)市场的快速发展。由于IP网络的普遍性，iSCSI可以被用在局域网(LANS)、广域网(wan)或因特网上传输数据，并且能够实现与位置无关的数据存储和检索。

**iSCSI** is Internet SCSI (Small Computer System Interface), an Internet Protocol (IP)-based storage networking standard for linking data storage facilities, developed by the Internet Engineering Task Force (IETF).

By carrying SCSI commands over IP networks, iSCSI is used to facilitate data transfers over intranets and to manage storage over long distances.

The iSCSI protocol is among the key technologies expected to help bring about rapid development of the storage area network (SAN) market, by increasing the capabilities and performance of storage data transmission. Because of the ubiquity of IP networks, iSCSI can be used to transmit data over local area networks (LANs), wide area networks (WANs), or the Internet and can enable location-independent data storage and retrieval.

# Fibre Channel and iSCSI SAN history

光纤通道技术从20世纪80年代中期就已经存在了，并在1994年被批准为标准。光纤通道对于SCSI就像TCP对于IP一样。它是用于在主机启动程序和存储目标之间传递SCSI命令的传输机制。光纤通道SAN存储在90年代中期到后期随着dot.com信息爆炸开始流行起来。那个时候，对于一个满是计算机的数据中心来说，这是访问中央存储的唯一可行的方法。光纤通道SAN需要一个专用的光纤存储网络，服务器中安装有存储特定的网络交换机和主机总线适配器(HBA)卡。从一开始，光纤通道SANs就被认为是昂贵和复杂的。

- Fibre Channel technology has been around since the mid-1980s and was a ratified standard in 1994.
- Fibre Channel is to SCSI what TCP is to IP. It is the transport mechanism used to pass SCSI commands between a host initiator and a storage target.
- Fibre Channel SAN storage popularity took off in the mid- to late-1990s with the dot.com information explosion. At the time, it was really the only viable way for a data center full of computers to access centralized storage.
- Fibre Channel SANs required a dedicated fiber optic storage network with storage-specific network switches and host bus adapter (HBA) cards installed in servers. From their onset, Fibre Channel SANs were considered to be expensive and complex.

# RAID Configurations

RAID是廉价磁盘冗余阵列(后来称为独立磁盘冗余阵列)的缩写，它是一种使用多个硬盘驱动器作为单个逻辑磁盘出现在服务器上的系统

RAID, which stands for **redundant array of inexpensive disks**, (later known as redundant array of independent disk,) is a system which uses multiple hard drives to appear as a single logical disk to a server.

The most commonly implemented RAID levels include:

- RAID 0: Striped without data protection (JBOD – Just a Bunch of Disks)
- RAID 1: Mirrored (100% redundancy)
- RAID 3: Striped data (dedicated parity disk)
- **RAID 5: Striped (parity evenly distributed across disks)**

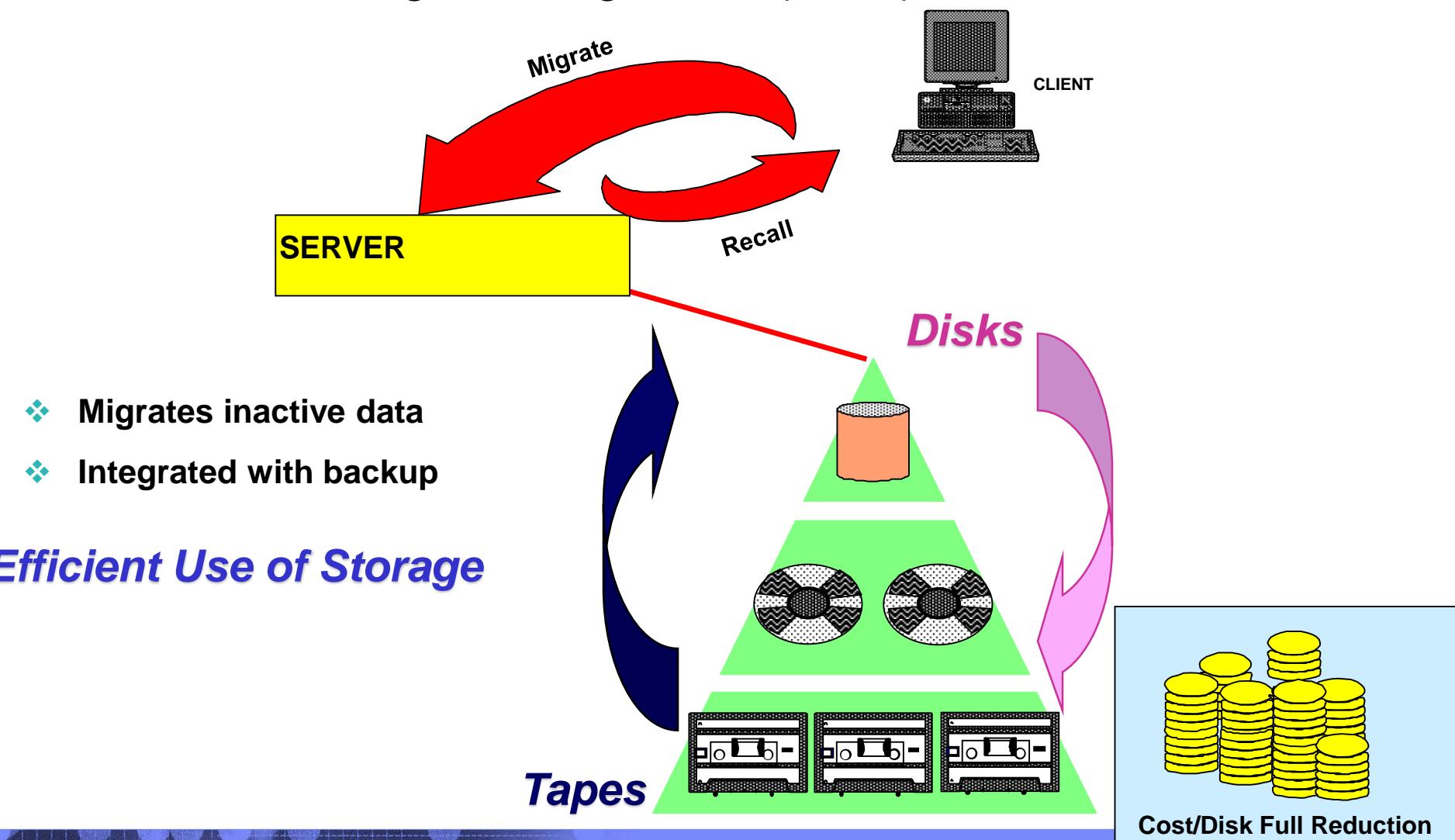
Common nested RAID levels:

- RAID 6: Striped data with parity blocks distributed across two disks
- RAID 01: A mirrored set of striped disks
- RAID 10: A striped set of mirrored disks
- RAID 30: A stripe across dedicated parity RAID systems
- RAID 100: A stripe of a stripe of mirrors

最常用的RAID级别包括:  
▪RAID 0: 没有数据保护的条纹(JBOD -只是一堆磁盘)  
▪RAID 1: 镜像(100%冗余)  
▪RAID 3: 条纹数据(专用奇偶校验磁盘)  
▪RAID 5: 条带式(奇偶校验均匀分布在磁盘上)  
常见的嵌套RAID级别:  
▪RAID 6: 条纹数据与奇偶校验块分布在两个磁盘  
▪RAID 01: 一套镜像条纹磁盘  
▪RAID 10: 一套条纹镜像磁盘  
▪RAID 30: 跨越专用奇偶RAID系统的条带  
▪RAID 100: 镜子条纹的条纹

# Storage Space Management –

hierarchical storage management (HSM)



# Basic Storage Management Operations

- **Backup**
- **Data backup**
- **Data recovery**
- **Disaster recovery**
- **Disk mirroring**
- **Replication**
- **Archiving**

备份  
·数据备份  
·数据恢复  
·灾难恢复  
·磁盘镜像  
·复制  
·存档

## Data Backup Types

- **Snapshot Backups**
- **Full Backup**
- Differential Backup
- **Incremental Backups**
- Continuous Backups (Continuous Data Protection)
- Disk Mirroring

数据备份类型

·快照备份  
·完整备份  
·微分备份  
·增量备份  
·连续备份(连续数据保护)  
·磁盘镜像

## Backup Issues

- **Backup Window**
- **Restore Time**
- Retention Time
- Application/Database Status
- Backup Resources
- Open File backup
- **Data Validation**

备份问题

·备份窗口  
·恢复时间  
·保留时间  
·应用程序/数据库状态  
·备份资源  
·打开文件备份  
·数据验证

# Data Deduplication

重复数据删除通常指消除重复或冗余信息。

• 成本效益: 降低初始存储获取成本，或延长存储能力升级间隔。

• 管理效益: 每个存储单元能够存储“更多”数据，或更长的时间保留在线数据

- **Deduplication** refers generally to eliminating duplicate or redundant information.
- **Cost Benefit:** Reduced initial storage acquisition cost, or longer intervals between storage capacity upgrades.
- **Management Benefit:** The ability to store “more” data per storage unit, or retain online data for longer periods of time.

计算机数据存储软件管理基于策略的供应和独立于硬件的数据存储管理的一种不断发展的概念。

- 软件定义的存储通常包括一种形式的存储虚拟化，以分离存储硬件和管理存储基础设施的软件。
- 支持软件定义存储环境的软件还可以为功能选项提供策略管理，如重复数据删除、复制、精简配置、快照和备份

# Software-defined Storage (SDS)

- An evolving concept for computer data storage software to manage **policy-based** provisioning and management of data storage independent of hardware.
- Software-defined storage definitions typically include a form of **storage virtualization** to separate the storage hardware from the software that manages the storage infrastructure.
- The software enabling a software-defined storage environment may also provide policy management for feature options such as **deduplication**, replication, thin provisioning, snapshots and backup.

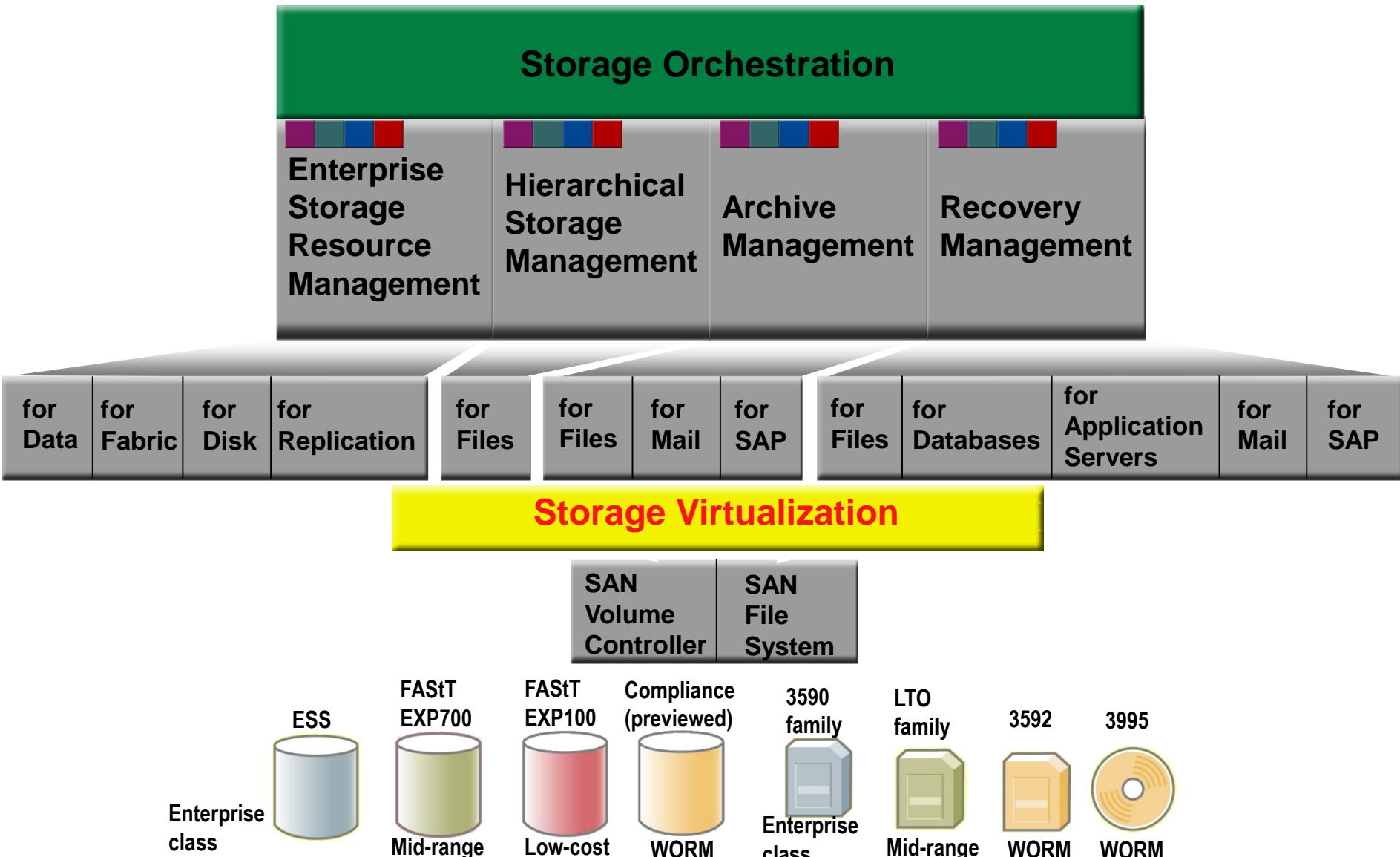
[http://en.wikipedia.org/wiki/Software-defined\\_storage](http://en.wikipedia.org/wiki/Software-defined_storage)

# Storage Management Products

- Storage Virtualization
  - Storage SVC (SAN Volume Controller)
  - VMware
  - MAID (Massive Array of Idle Disks)
- Data Management
  - Master Data Management Solutions
  - Data Cleansing Solutions
  - Data Discovery



# IBM Storage Software Products



IBM System Storage™ SAN卷控制器(SVC)支持对异类、异构存储资源的单点控制，以帮助支持改进的业务应用程序可用性和更高的资源利用率。其目标是确定IT基础设施中的所有存储资源，并确保它们适合您的业务——快速、有效、实时地进行存储，同时避免管理成本。

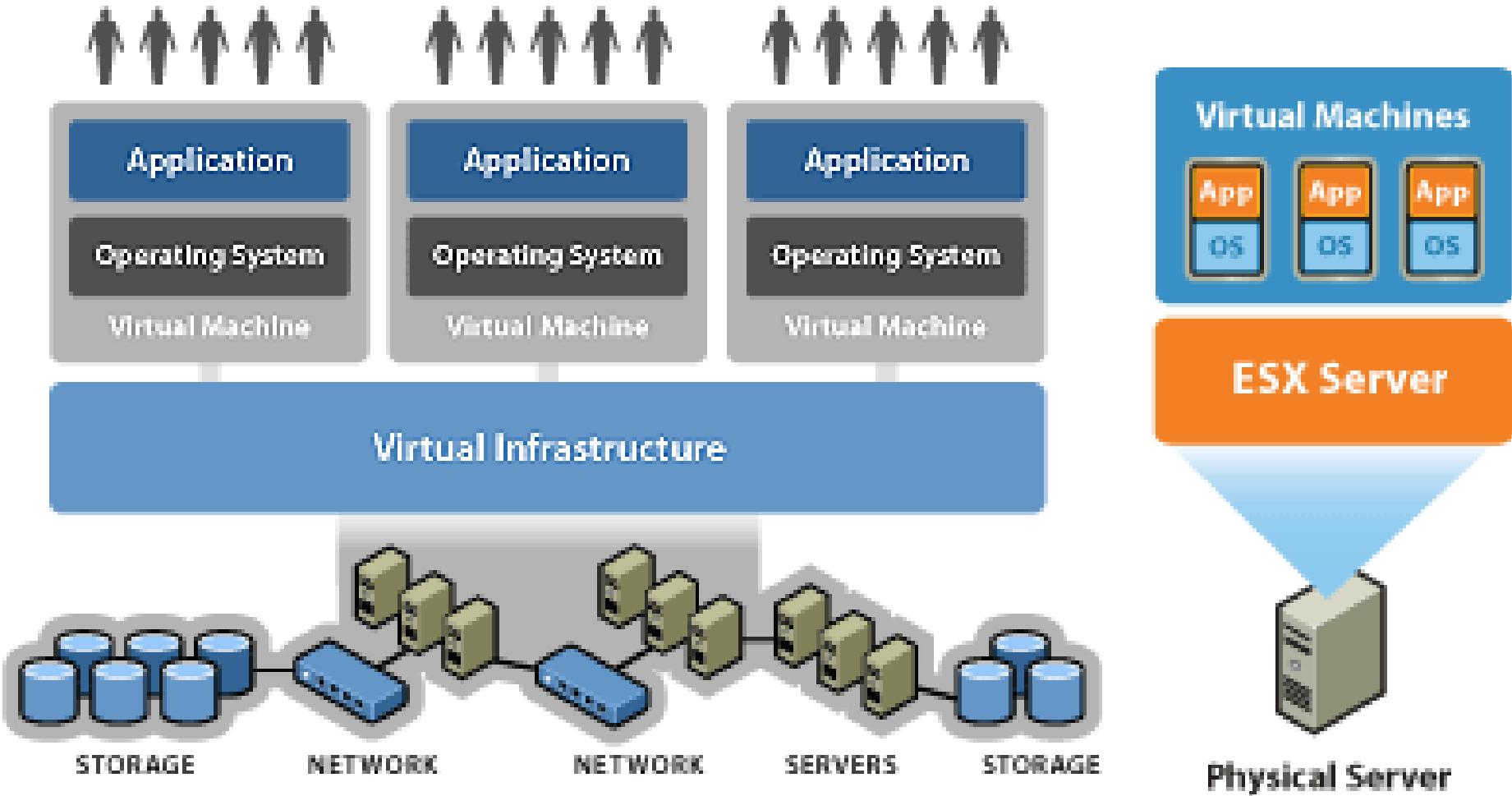
# IBM System Storage SAN Volume Controller

- The IBM System Storage™ SAN Volume Controller (SVC) enables a single point of control for disparate, heterogeneous storage resources to help support improved business application availability and greater resource utilization. The objective is to identify all storage resources in your IT infrastructure and to make sure they're used to the advantage of your business—and do it quickly, efficiently, in real time, while avoiding administrative cost.



# VMware

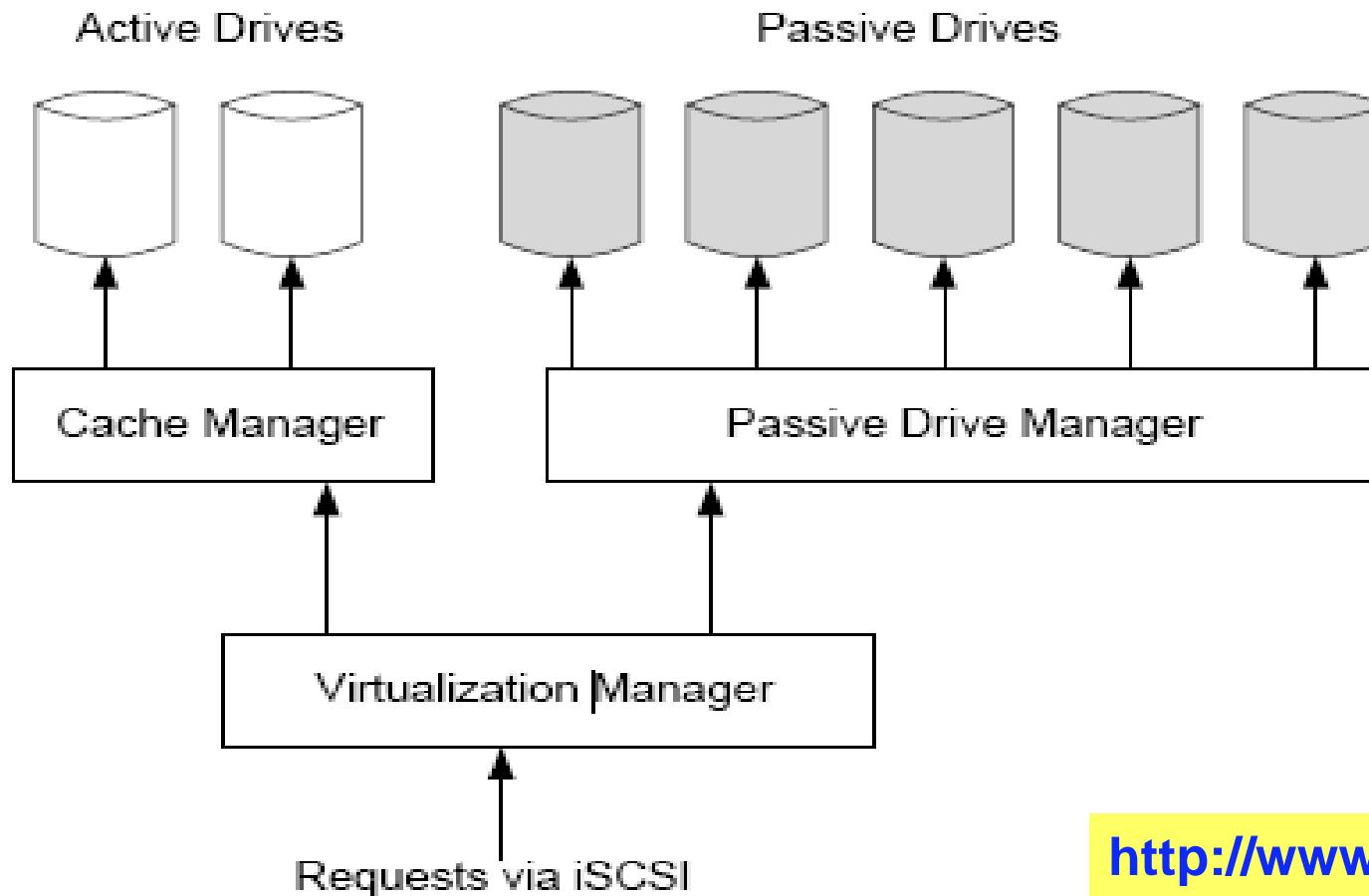
The VMware approach to virtualization inserts a **thin layer of software** directly on the computer hardware or on a host operating system.



# MAID (Massive Array of Idle Disks)

- ❖ A storage technology that employs a large group of disk drives in which only those drives in active use are spinning at any given time. This **reduces power consumption** and prolongs the lives of the drives.

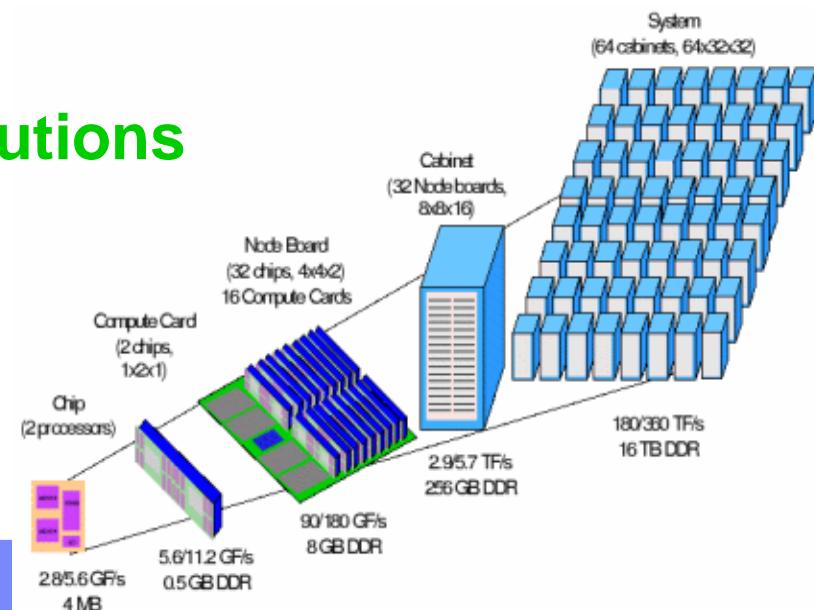
: 一种使用大量磁盘驱动器的存储技术，其中在任何给定时间只有那些处于活动使用的驱动器在旋转。这减少了电力消耗，延长了驱动器的寿命



<http://www.copansys.com/>

# Storage Management Products

- Storage Virtualization
  - Storage SVC (SAN Volume Controller)
  - VMware
  - Network Appliance
  - MAID (Massive Array of Idle Disks)
- Data Management
  - Master Data Management Solutions
  - Data Cleansing Solutions
  - Data Discovery



# Data Management

**Data management** comprises all the disciplines related to managing data as a valuable resource. The official definition is that "Data Resource Management is the development and execution of architectures, policies, practices and procedures that properly manage the full data lifecycle needs of an enterprise." This definition is fairly broad and encompasses a number of professions which may not have direct technical contact with lower-level aspects of data management, such as relational database management.

数据管理包括与将数据作为有价值的资源进行管理相关的所有学科。官方定义是“数据资源管理是正确管理企业完整数据生命周期需求的架构、策略、实践和过程的开发和执行。”这个定义相当广泛，包含了许许多与数据管理的低层方面(如关系数据库管理)没有直接技术联系的专业

- **Master Data Management Solutions**
- **Data Cleansing Solutions**
- **Data Discovery**

# Master Data Management Solutions

主数据管理解决方案

主数据管理通过集中多个领域，并根据组织的需要提供使用多种主数据使用风格的功能，帮助组织交付业务价值

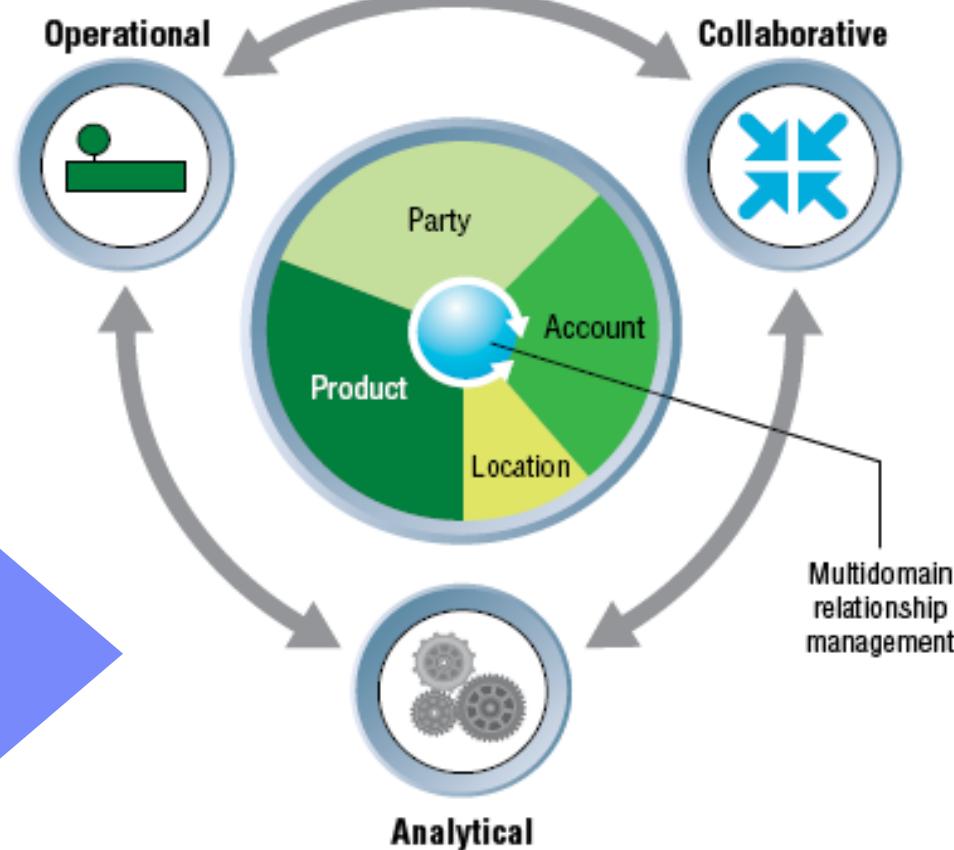
- Master data management helps organizations deliver business value by centralizing multiple domains and providing the functionality to employ multiple master data usage styles as required by the organization.

有效地管理主数据——关于公司客户、产品和账户的关键业务信息——不仅可以帮助组织提高收入，还可以帮助降低成本、增加战略灵活性和降低风险

- Effective management of master data — key business information about a company's customers, products and accounts— can help organizations not only drive revenue gains but also help reduce costs, increase strategic flexibility and lower risk.

*Master data can be used to achieve collaborative, operational or analytical benefits*

主数据可用于实现协作、操作或分析好处

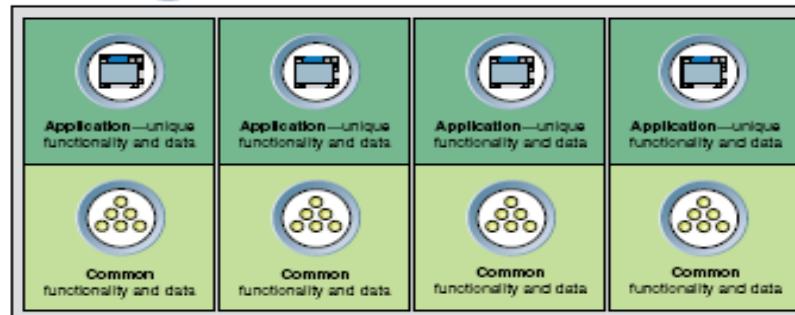


# IBM Multiform Master Data Management

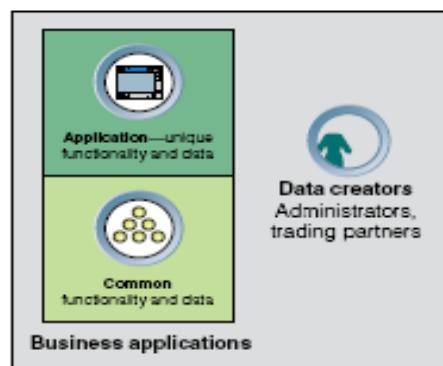
IBM Multiform MDM is characterized by multiple users and multiple usages



## Operational data usage

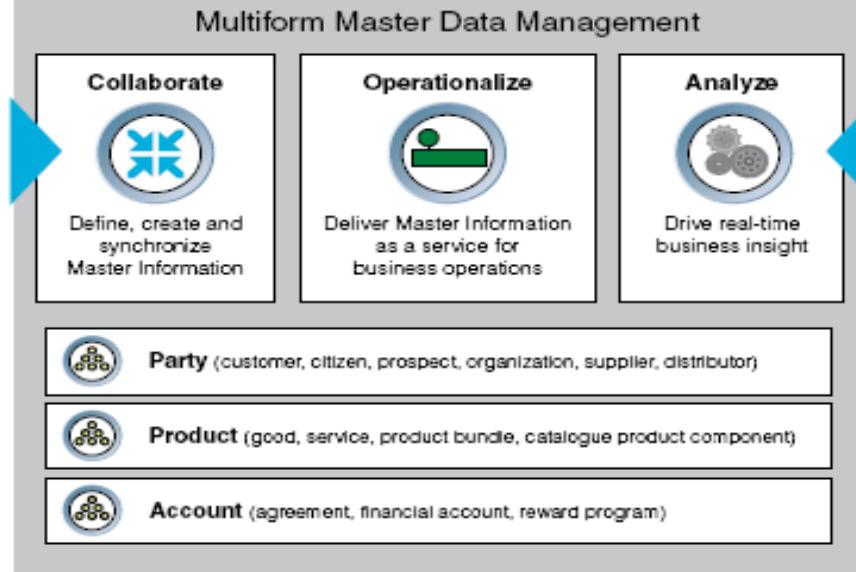


## Collaborative data usage



**Define and create master data**

## Real-time SOA data access



## Analytical data usage



**Analyze master data**

# Data Cleansing Solutions

A data cleansing solution should be considered if you need to do one or more of the following actions:

- Clean up your databases because of missing, duplicate or inaccurate data
- Avoid importing duplicates from marketing lists
- Integrate or cross-reference different application databases
- Consolidate multiple databases
- Match data in any ODBC connected database to raise and maintain data quality

如果需要执行以下操作中的一个或多个操作，应考虑使用数据清理解决方案：

- 清理您的数据库，因为丢失，重复或不准确的数据
- 避免从市场列表中进口重复的产品
- 集成或交叉参考不同的应用数据库
- 巩固多个数据库
- 匹配任何ODBC连接数据库中的数据来提高和维护数据质量

80%以上的电子数据是在过去的二十年中产生的，今天的许多信息可能永远不会离开其原始的格式。

- 公司和法律部门很快就会因为收集、处理、本地文件审查和生产存储在电子邮件、word文档、电子表格和其他电子文件中的数据而不知所措。
- 然而，没有人能够忽视这些媒体对案件结果的重要性。
- 由于这些趋势，电子发现已经成为彻底诉讼的一个重要组成部分。

# Data Discovery

- With over 80% of electronic data created in the last twenty years, much of today's information may never leave its original format.
- **Firms and legal departments** can quickly become overwhelmed with the collection, processing, native file review, and production of data stored in emails, word documents, spreadsheets, and other electronic files.
- Yet no one can ignore the significance these media hold on the outcome of a case.
- Because of these trends, **electronic discovery** has become an essential component of thorough litigation.

# IBM Data Discovery and Query Builder

用于医疗保健和生命科学的IBM Data Discovery and Query Builder是一个基于web的框架，它帮助医生和研究人员制定和运行数据库搜索，以识别和关联患者数据(如人口统计数据、实验室测试和诊断数据，以及实验室和医生记录)。这个强大的工具使具有不同专业水平的用户能够轻松地利用结构化和非结构化文本数据进行查询。用户可以：为自己或他人聚合和查询数据，保存和修改搜索。将搜索标记为公共，以便其他人运行相同的查询或修改它以供单独使用。将查询标记为私有，使其仅对开发人员或选定的团队成员可访问。该软件应用程序简化了复杂的查询，并以几种常见格式之一返回数据结果，并且可以进行排序以供观察。应用程序可以在许多操作系统和硬件平台上运行。

IBM Data Discovery and Query Builder for **healthcare and life sciences** is a Web-based framework that helps physicians and researchers formulate and run searches of databases to identify and correlate such patient data as demographics, lab tests and diagnostics, as well as laboratory and physician's notes.

This powerful tool enables users with various levels of expertise to easily form queries leveraging both structured and unstructured text data. . Users can:

- **Aggregate and query data, and save and modify searches for themselves or others.**
- **Mark a search as public to allow others to run the same query or modify it for separate use.**
- **Tag a query as private, making it accessible only to the developer or selected team members.**

The software application simplifies complex queries and returns data results in one of several common formats and can be sorted and ordered for observation. The application can run on a number of operating systems and hardware platforms.

# Big Data Integration and Data Governance

## Integrate & Link Big Data

- Big Data as a Source
- Big Data as a Target
- Data Transformations
- Data Movement
- Integrate w/existing Enterprise
- Data Lineage & Impact Analysis
- Metadata Integration w/Analytics
- Realtime & Data Federation



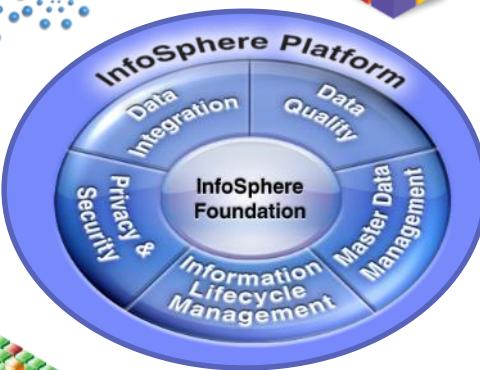
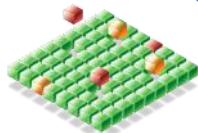
## Cleanse and Validate Big Data

- Accuracy and Entity Matching with Social Data
- De-duplication and Standardization of Machine Data
- In-line Cleansing with Integration
- Trusted Data Dashboard and Reporting on Data Quality



## Protect Big Data

- Activity Monitoring
- Data Masking
- Data Encryption
- On-Demand / In-Place Protection
- In-Line Protection (w/ETL etc.)
- Active Detection & Alerting



## Master Big Data

- Big Data as a Supplier
- Big Data as a Consumer
- Links between Big Data and Trusted Golden Records
- Leverage Master Data in Big Data Analytics
- Entity Resolution at Extreme Scale Out Levels
- Probabilistic Entity Matching



## Audit & Archive Big Data

- Queryable Archive
- Structured and Semi-Structured
- Optimized Connectors to existing Apps
- Hot-Restorable On-the-Fly
- Immutable and Secure Access
- Automated Legal Hold Capability for Data Freeze

# Emerging Areas for Collaboration: Cloud and Elastic Data Services



- **Engaging**
- **Mobile**
- **Rapidly changing**
- **Dynamic**
- **Short-lived**
- **Competitive**
- **Gateway to Enterprise Systems**
- **Fashionable**

# Big Data Storage in Future

Needs to be able to handle capacity and provide low latency for analytics work

需要能够处理容量并为分析工作提供低延迟

- **Scale-out or clustered NAS.** This is file access shared storage that can scale out to meet capacity or increased compute requirements and uses parallel file systems that are distributed across many storage nodes that can handle billions of files without the kind of performance degradation that happens with ordinary file systems as they grow.
- **Object storage.** This tackles the same challenge as scale-out NAS – that traditional tree-like file systems become unwieldy when they contain large numbers of files. Object-based storage gets around this by giving each file a unique identifier and indexing the data and its location. It's more like the DNS way of doing things on the internet than the kind of file system we're used to.
  - Object storage systems can scale to very high capacity and large numbers of files in the billions, so are another option for enterprises that want to take advantage of big data. Having said that, object storage is a less mature technology than scale-out NAS.

扩展或集群NAS。这是一种文件访问共享存储，可以向外扩展以满足容量或增加的计算需求，并使用分布在许多存储节点上的并行文件系统，这些并行文件系统可以处理数十亿个文件，而不会像普通文件系统那样在增长时出现性能下降。对象存储。这解决了与扩展NAS相同的挑战，即传统的类树文件系统在包含大量文件时变得难以处理。基于对象的存储通过给每个文件一个唯一的标识符并对数据及其位置进行索引来解决这个问题。它更像是DNS在互联网上处理事情的方式，而不是我们以前使用的那种文件系统。对象存储系统可以扩展到非常大的容量和数十亿的大量文件，因此是希望利用大数据的企业的一种选择。话虽如此，对象存储是一种不如扩展NAS成熟的技术。

# Big Data Storage in atomic levels

- As Big Data storage demands grow exponentially, the technology used to store data must shrink to atomic levels in order to ensure it's readily accessible and available.
- Future storage systems based on **atomic-scale memory** will be capable of storing massive amounts of Big Data. For instance, every movie ever made could be stored on an atomic-scale storage device the size of a fingernail. The ability to store such a vast pool of data could transform how business, industry, government and society use data each day.
- In creating the movie, IBM scientists hope the world's smallest movie will inspire young people to study science and pursue careers in science and technology.

随着大数据存储需求呈指数级增长，用于存储数据的技术必须缩小到原子水平，以确保其易于访问和可用。未来基于原子级存储器的存储系统将能够存储大量的大数据。例如，每一部电影都可以存储在一个指甲大小的原子级存储设备上。存储如此巨大的数据池的能力可能会改变商业、工业、政府和社会每天使用数据的方式。通过制作这部电影，IBM的科学家希望这个世界上最小的电影能够激励年轻人学习科学，追求科学和技术方面的职业。

# Atomic Memory

原子的记忆

2012年，IBM研究科学家仅用12个原子就创造出了世界上最小的磁性存储器位元。

目前仍处于实验阶段的原子级磁铁存储器，其密度是今天的硬盘驱动器和固态存储器芯片的100倍

In 2012, IBM Research scientists create the world's smallest magnetic memory bit using only 12 atoms.

The still-experimental **atomic-scale magnet memory** is 100 times denser than today's hard disk drives and solid state memory chips.

如今，存储一比特数据需要一百万个原子，但IBM的科学家们正在研究仅用一个原子就能存储一比特数据的原子级存储技术

Today, it takes **one million atoms to store a single bit of data**, but IBM scientists are researching atomic-scale memory technology that can **store a bit of data using only 1 atom**.

# A Small Movie About Big Data's Future

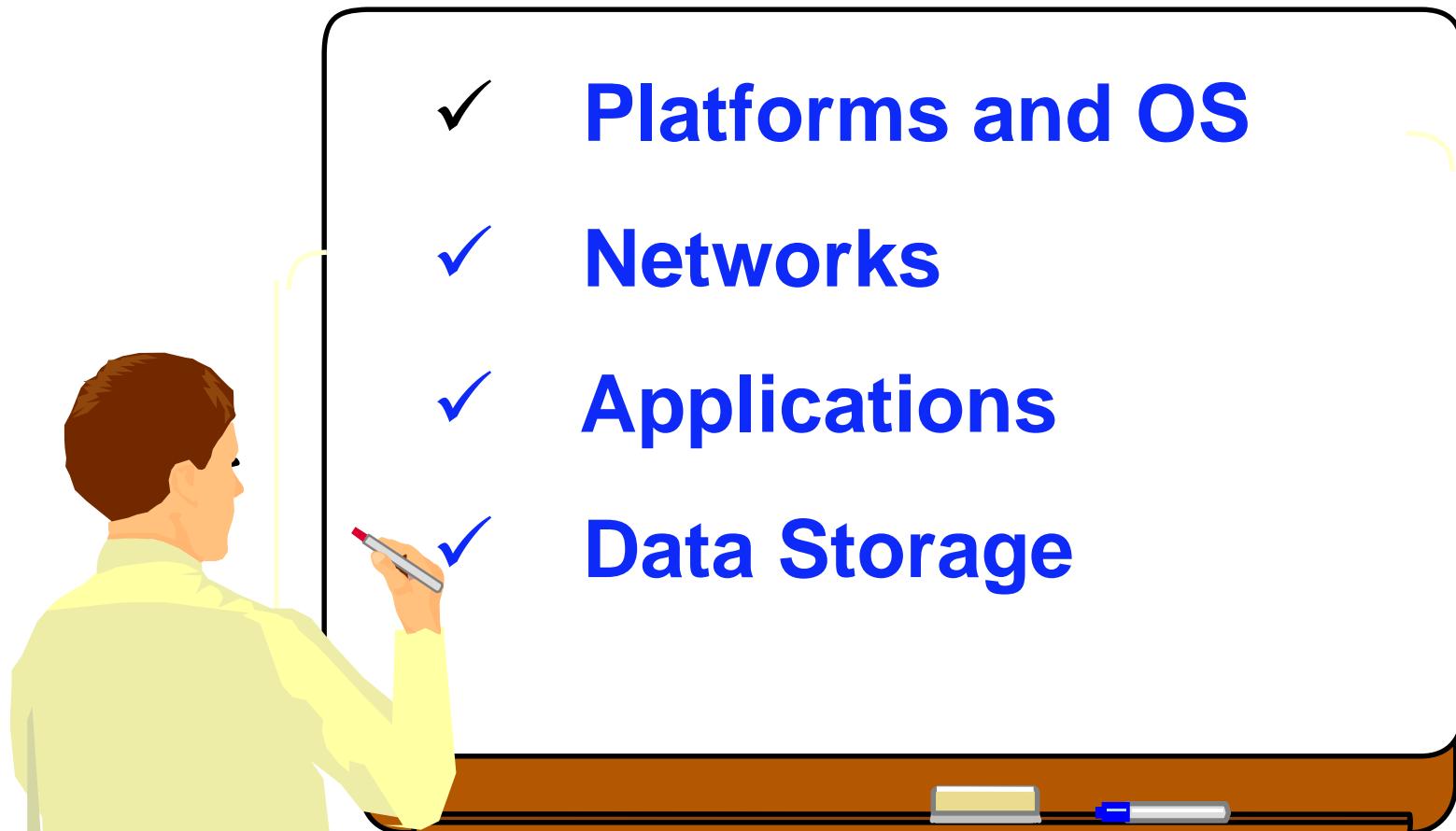
This film, called "A Boy and his Atom", was certified by the Guinness Book of Records as the World's Smallest Movie.



IBM scientists shrunk the big screen down to the atomic level, creating a record-setting movie by painstakingly moving atoms using a unique two-ton microscope. Beyond telling a story about a boy who's made of atoms, the movie has raised awareness -- via more than three million YouTube views -- of IBM storage breakthroughs that could expand the use of Big Data.

IBM的科学家们将大屏幕缩小到原子水平，通过使用独特的两吨重的显微镜，煞费苦心地移动原子，创造了一部创纪录的电影。除了讲述一个故事关于一个男孩谁是由原子构成的，这部电影引发了意识——通过超过三百万YouTube的观点——IBM存储突破，可以扩大使用大数据。

# CONTENTS



*Future, see: IBM Research — Global Technology Outlook*

# Take a Break !

