Buses Explained (ISA / VESA / EISA / PCI)

- **Transportation By BUS**
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Have you ever been stuck on the expressway during rush hour and passed one of the signs that limits the speed from 45mph to 55mph? Your computer system is not much different than the expressways where speed and traffic is concerned.

Manufacturers list technical capabilities by the highest limit available. Manufacturers or resellers do not always discuss or divulge all of the specifications. The problem is, the traffic within the computer can't always perform as fast as the technical limits may indicate. Because of the traffic jam that can be created it is important to understand what options are available when purchasing a computer.

This article will address one area of computers, where traffic jams are often created and which most buyers of computers overlook. This article is directed to those of you who are not highly technical and attempts will be made to simplify many areas to ease the understanding. So with the introduction out of the way, here we go.

Transportation By BUS

Computer components send and receive data between different devices by the use of a **bus**. The design and type of the bus therefore has a crucial effect on how well a computer system will operate. If you have a high speed drive and a fast CPU, but a slow bus, data will be held up and the individual components will not operate at the speed they are capable.

Over the years, software programs and features have created more data traffic. One major culprit is the GUI *(graphical user interface)* type of program. Windows is an example of a GUI program. Graphical images, versus text or character based data, cause more traffic. Rush hour occurs more frequently.

Industry Standards

Manufacturers have developed standard methods for connecting different devices and for the design of bus technology. This has benefited everyone by allowing the purchase of devices from different manufactures and not having to worry that the devices will talk to each other.

Bits	Bus Type	Description
16 Bit	ISA	Industry Standard Architecture
32 Bit	EISA	Extended Industry Standard
	Micro-Channel	IBM's proprietary architecture
	VESA (VL-Bus)	Video Electronics Standards Association
64 Bit	PCI	Peripheral Component Interconnect

Why so many standards and why do they keep changing? Read on

Faster and Faster

Today's computer peripherals are becoming faster and faster and applications are requiring more sophistication. ISA and EISA were adequate, but time marches on. Before discussing the pro and cons for each bus type, I think it is important to discuss a few buzzwords. Stick with it, I'll try to make it simple.

Buzz Words

- **MHz** - Think of 33 **MHz** or 66 MHz as miles per hour or speed.
- **Mbps** (Mega bytes processed per second, transfer rate) translates how many cars could travel the highway within a time period of one second. *A higher Mbps value represents a faster device.*
- **Bit specifications** are the number of lanes on the highway. 16 bit = 16 lanes, 32= 32 lanes, etc. *The more lanes, the more traffic that can be accommodated.*
- **Voltage references**, like 5V or 3.3V, is similar to miles per gallon with the exception that the *lower the voltage, the better the gas mileage.*

Bus Comparisons

Now that you are armed with the buzzword definitions, lets compare the different bus types.

Property	Bus Type			
	ISA	**EISA**	**VESA**	**PCI**
MHz	8.3	8.3	33	33
Bits	16	32	32	32 or 64
Mbps	8.3	33	160	132 or 264
Voltage	5	5	5	3.3 or 5

You should be to able to quickly see that the PCI technology surpasses the others.

Benefits of PCI

A PCI bus does provide improved performance for high speed devices such as graphic display adapters, network cards, and disk controllers. PCI is also auto configurable and is controlled by software and not jumpers or switches on a board. This is a feature referred to as "Plug-and-Play" or "PnP".

The clock speed (MHz) of a PCI bus works independently of the CPU speed. A VL-bus is tied to the CPU speed.

A PCI bus also works independent of the CPU. When a VL-bus is active, the CPU must wait. PCI peripherals can continue to place data on the bus, even when the CPU is active.

A PCI bus can operate at 3.3V which is important for battery life on portables and the new energy saving "Green PC" requirements.

A PCI bus will operate on several computer platforms, such as the PowerPC from Apple and IBM and DEC's Alpha chip.

Because a PCI bus requires less components, pins and boards, there is a higher reliability rate. There are less parts to manufacturer and fewer parts that will break.

Cables

- Ethernet RJ-45
- Serial RS-232 with RJ-45 Jack

Cables Explained

Type	Description	Speed
Category 5 UTP	Unshield twisted pair (UTP) high performance. The twisting gives the cable a certain immunity from the infiltration of unwanted interface. *The most common used in the USA.*	10 or 100Mbps
Category 5 SCTP	Screened twisted pair (SCTP). Same as Cat5 with an additional protection from unwanted interference by an overall shield. If used, all components of the network most use SCTP. *Used almost exclusively in European countries.*	10 or 100Mbps
Category 5E	Same as CAT5 with more stringent standards and will support gigabyte Ethernet.	10/100Mbps or 1000Gbps
Category 6	Same as CAT5E with even more stringent standards and will support gigabyte Ethernet.	10/100Mbps or 1000Gbps
Category 7	Same as CAT6 with even more stringent standards. The standard for CAT7 is still in progress. All 4 pairs are individually shielded and an overall shield enwraps all 4 pairs. It will require an entirely new connector other than RJ45	10/100Mbps or 1000Gbps
Terms	Description	
Crosstalk	The bleeding of signals carried by one pair onto another pair through the electrical process of induction. This is an unwanted effect that can cause slow transfer or completely inhibit the transfer of data. The purpose of the wire twists is to significantly reduce crosstalk.	
Ambient Noise or Electromagnetic Interference (EMI)	Similar to crosstalk in that it is an unwanted signal that is induced into the cable. The difference is the ambient noise (EMI) is typically induced from a source that is external to the cable such as an electrical cable, other device or even an adjacent CAT cable.	
Attenuation	The loss of signal in a cable segment due to the resistance of the wire plus other electrical factors that cause additional resistance (Impedance and Capacitance for example). A longer cable length, poor connections, bad insulation, a high level of crosstalk or ambient noise will increase the total level of attenuation.	

Installation Guidelines

Run all cables in a "star" configuration. they should emanate from central location. Visualize a wagon wheel with the spokes being the cable and the hub being the central location.

Cable length should **not exceed 295 feet** for each run.

Maintain the twists of the pairs all the way to the point of termination with **no more than 0.5" untwisted.**

Make **gradual bends** when necessary. No shaper than a 1" radius.

When using cable ties, only **use moderate pressure when pulling the tie**.

Cross-connect cables using the correct CAT rated punch blocks and components.
Don't ever splice cables.
Use low to moderate force when pulling cables.
Use cable lubricant when pulling cables to eliminate using a large force.
Keep cables as far away as possible from potential sources of EMI (electrical cables, transformers, light fixtures, etc.)
Install proper cable supports, no more than 5 feet apart. Cable supported by ceiling tiles usually violates most building codes.
Label every termination point. Use a unique number for each cable.
Always test every installed segment with a cable tester.
Install jacks in such a way as to avoid collecting dust.
Always leave extra slack on the cables, neatly coiled up in the ceiling or nearest concealed place.
Use grommets when passing through metal studs
Never use staples
Use plenum rated cable where building codes require it.

Ethernet RJ-45

RJ-45 (10/100BaseT) uses pins 1,2,3 and 6,7,8 - These must be used in pairs as follows...

Straight-thru

Pin	Color
1	white/orange
2	orange
3	white/green
4	blue (not used)
5	white/blue (not used)
6	green
7	white/brown
8	brown

Crossover

Pin	Color	Color
1	white/orange	white/green
2	orange	green
3	white/green	white/orange
4	blue (not used)	blue (not used)
5	white/blue (not used)	white/blue (not used)
6	green	orange

7	white/brown	brown
8	brown	white/brown

Serial RS-232 with RJ-45 Jack

The following represents the most common configuration for a RS-232/RJ45 connector used on a 'dumb terminal' with a cat5 cable connected to a concentrator. If a serial port on the PC is being used, pins 2 and 3 have to be reversed. Most of the time it is only necessary to use pins 2, 3, 7 and 20.

Pin	Color	Signal	Mnemonic
1	Black	Chassis Ground	GND
2	Green	Transmit	TXD
3	Red	Receive	RXD
4	Brown	Request to Send	RTS
5	Orange	Clear to Send	CTS
6		Data Set Ready	DSR
7	Yellow	Signal Ground	SGND
8	White	Data Carrier Detect	DCD
20	Blue	Data Terminal Ready	DTR

Chips

What is a chip?

A chip is a **microprocessor** and is sometimes referred to as the **CPU** (Central Processing Unit). The chip is the heart and soul of the machine and almost everything has to pass through it.

Chip Manufacturers

The two most popular chip manufactures are *Intel & Advanced Micro Devices (AMD)* . Other chip manufacturers are *Cyrix*, *Chips and Technologies* (C&T), **IBM, NEC** and **Motorola**.

Speed

There are **three measurements** used to determine how fast a chip will operate. Basically think of speed in terms of miles per hour when driving a car. In the similar manner where your car may be capable of going 80 mph, but traffic or road conditions may not allow you to do so, the same thing is true of processor operations. Thus the purpose of the three different measurements.

CPU Clock Speed

This represents a relative indicator of performance from one chip to another. The CPU Clock Speed is normally the advertised speed for a chip because it is the fastest of the three measurements.

Memory Bus Speed

In simplest terms, this is how fast the chip can talk to memory. Some times this is represented as a value expressed as part of the chip model number. For example in older models, the number two in the model number 486DX2/66 represents the memory bus speed. What it means is the memory bus speed is 33 (66/2) and the real speed is doubled to get to the clock speed of 66. With newer chip models there is no reference to this speed.

Expansion Bus Speed

This represents the speed at which your PCI or VESA bus can run. In simple terms, this represents how fast the components in your system can communicate with the chip. The majority of the time, the Expansion Bus Speed is the same as the Memory Bus Speed.

Voltage

It is obvious that chips require power in order to operate, but not all chips use the same amount of voltage. A lower voltage value is good for portables because it will consume less battery life. The voltage has no effect on the execution speed. Of special note is considering the capability of upgrading to a different chip in the future. You can not easily upgrade to a chip with a different voltage rating unless you replace the motherboard.

Data Bus Width

This represents how large a bite of cache memory can be accessed in a single read or write. The larger the number, the bigger the chunks, therefore the faster the performance.

Floating Point

This option speeds up numeric computations, **only if the software application supports floating-point**. *Of note is that most applications do not use floating-point operations.*

Super-scalar

This feature allows a chip to execute more than one instruction in a single clock cycle. Therefore Super-scalar chips are faster.

Cache Design

This specifies the size of the on-board cache and storage capabilities. A larger cache value minimizes the time consuming accesses to use off-chip or main memory. Write-back (wb) cache can store both read and write results, whereas write-through (wt) can only retain reads. Thus write-back translates into faster operations.

Upgrade Concerns

If you are thinking of upgrading to a newer chip, keep in mind that even though faster chips are available, if your other computer components are not updated to match the new speed, you may not gain much, if any improvement. Also, depending on the age and style of your motherboard, your machine may not be compatible with some of the newer chips.

Of course all of this new technology means that the other computer components and software applications will have to speed up in order to prevent a bottleneck. *What does it mean? Don't expect to buy a computer today that will last for five years. It could easily be outdated within one year.*

Current Status

Last update 10/27/06

Performance Dual-Core

If you're editing movies and music, or simply using your system to watch a bunch of video streams, the Performance Dual-Core processors will enable your applications to avoid those annoying, unintentional pauses that are sometimes a prelude to a lock-up.

AMD Athlon 64 FX-62

Introduced in **May 2006** with dual-core chips and integrated memory controller. Putting the controller alongside the two CPUs, rather than in a separate area of silicon, enables faster memory access since data doesn't have to traverse a traditional front-side bus. The FX-62 uses the AM2 socket, which upgrades the integrated memory controller to work with faster DDR2 RAM. The socket also brings support for AMD's virtualization technology to the desktop. All of AMD's dual-cores use HyperTransport interconnect to communicate between the processor cores and I/O subsystems. Thermal rating of 125w.

AMD Athlon 64 X2 5000+

Introduced in **May 2006**, it also uses the AM2 socket. At peak operation HyperTransport can deliver up to 8GB/sec of total system bandwidth. On the downside, although it has a thermal rating of 89W, it seems to run hot. AMD's Cool'n'Quiet driver is available to downshift power usage when the extra juice isn't needed.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Socket
Athlon 64 FX-62	2.8Ghz	2x1MB	2000MHz	Yes	AM2
Athlon 64 FX-60	2.8Ghz	2x1MB	2000MHz	Yes	939
Athlon 64 X2 5000+	2.6Ghz	2x512KB	2000MHz	Yes	AM2
Athlon 64 X2 5200+	2.6Ghz	2x1MB	2000MHz	Yes	AM2 Due in 4Q 2006

Intel Core 2 Extreme X6800

Introduced in **July 2006**. The X6800 appears to be more amenable than most CPUs to overclocking.

Intel Core 2 Duo E6700, E6600, E6400, E6300

Introduced in **July 2006**. The E models are slower than the Extreme X6800. The E6700 is only 9% slower than the X6800. The E6300 is 37% slower than the top of the line. All models have the same fast front-side bus and are amenable to overclocking.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Intel VT	Fab Proc
Core 2 Extreme X6800	2.93Ghz	4MB (shared)	1066MHz	Yes	Yes	65nm
Core 2 Duo E6700	2.66Ghz	4MB (shared)	1066MHz	Yes	Yes	65nm
Core 2 Duo E6600	2.40Ghz	4MB (shared)	1066MHz	Yes	Yes	65nm
Core 2 Duo E6400	2.13Ghz	4MB (shared)	1066MHz	Yes	Yes	65nm
Core 2 Duo E6300	1.86Ghz	4MB (shared)	1066MHz	Yes	Yes	65nm

Mainstream Dual-Core

Mainstream Dual-Core perform sufficiently for the vast majority of users who run office productivity applications along with the heavy Web surfing. The mainstream dual-cores run more than sufficiently fast to run Microsoft's Windows Vista operating system.

AMD Athlon 64 X2 4600+, 4200+

In **2005**, the 4600+ was listed as a high-end offering. As of October 2006, the 4600+ and 4200+ remain as solid as ever, but now they fall firmly in the middle of the dual-core pack. In 2006 the two chips are being made in versions for the newer AM2 socket, which supports DDR2 memory. Older versions for the 939 socket have been "end-of-lifed" by AMD.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Socket
Athlon 64 X2 4600+	2.4Ghz	2x512KB	2000MHz	Yes	AM2
Athlon 64 X2 4200+	2.6Ghz	2x1MB	2000MHz	Yes	AM2

Intel Pentium Extreme Edition 965, 955

Introduced in **January 2006** and based on the NetBurst architecture used in most Pentiums. Support has been added for Intel's **Hyper-Threading** which makes it easy to run multiple threads providing better multitasking performance. Also added is **hardware-assisted Virtualization** technologies which was largely unsupported in Intel's first dual-core chips. This lets users run whole operating systems and apps in separate partitions, turning one physical CPU into a couple of virtual processors. Uses Intel's advanced **65nm semiconductor fabrication**

process,which upgrades them from the 90nm used for the earlier 8XX line and putting them on par with the Core 2 Duos.

Intel Pentium D 960, 950, 945, 920, 915

Ranging in clock speed from 2.8GHz to 3.6GHz. Support HyperThreading and Intel's Virtualization technology. To pare down its huge array of dual-core SKUs, Intel in mid-August 2006 issued a notice that it would stop selling the 3GHz 930 and the 3.2GHz 940 by the end of 2006. While both the Core 2 Duo and the 9XX use the same Intel 775 socket, the Core 2 Duos require a motherboard equipped with the proper Intel core-logic chipset and updated firmware.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Intel VT	Fab Proc
Pentium Extreme Edition 965	3.73Ghz	2x2MB	1066MHz	Yes	Yes	65nm
Pentium Extreme Edition 955	3.46Ghz	2x2MB	1066MHz	Yes	Yes	65nm
Pentium D 960	3.60Ghz	2x2MB	800MHz	Yes	Yes	65nm
Pentium D 950	3.40Ghz	2x2MB	800MHz	Yes	Yes	65nm
Pentium D 945	3.40Ghz	2x2MB	800MHz	Yes	Yes	65nm
Pentium D 920	2.80Ghz	2x2MB	800MHz	Yes	Yes	65nm
Pentium D 915	2.80Ghz	2x2MB	800MHz	Yes	Yes	65nm

Bargain Dual-Core

AMD Athlon 64 X2 3800+

The 3800+ has the same 2000MHz HyperTransport bus as its higher-end 5000+ sibling With a 2GHz clock and 2x512KB L2 cache. AMD's low-end dual-core isn't outmoded technologically, but it's positioned as an entry-level offering and priced accordingly. If you want to run Vista on a dual-core you can't get into the market any cheaper than with one of these CPUs.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Socket
Athlon 64 X2 3800+	2.0Ghz	2x512KB	2000MHz	Yes	AM2 & 939

Intel Pentium D 805, 820

Both models are fabricated in Intel's **older 90nm process** technology and have **smaller L2 caches** than their 9XX cousins (2x1MB versus 2x2MB). Other than that there's no significant difference. Both are good on power consumption with a 95W thermal design power spec.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Intel VT	Fab Proc
Pentium D 820	2.80Ghz	2x1MB	800MHz	Yes	No	90nm
Pentium D 805	2.66Ghz	2x1MB	533MHz	Yes	No	90nm

Faster Single-Core

AMD Athlon 64 3800+, 3500+, 3200+

Single-core Athlon 64 designs were among the first desktop processors to implement AMD's groundbreaking 64-bit architecture.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Socket

Athlon 64 3800+	2.4Ghz	512KB	2000MHz	Yes	AM2 & 939
Athlon 64 3500+	2.2Ghz	512KB	2000MHz	Yes	AM2 & 939
Athlon 64 3200+	2.0Ghz	512KB	2000MHz	Yes	AM2

Intel Pentium 4 670, 661, 660, 651, 641, 631, 524, 521

This family still delivers solid performance, ranging from a 3.8GHz clock and 2MB L2 cache for the 670 down to a not-unimpressive 3.0GHz with the same cache for the 631. The 5XX series preceded the 6XX and is fabricated using older 90nm technology.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Intel VT	Fab Proc
Pentium 4 670	3.80Ghz	2MB	800MHz	Yes	No	90nm
Pentium 4 661	3.60Ghz	2MB	800MHz	Yes	No	65nm
Pentium 4 660	3.60Ghz	2MB	800MHz	Yes	No	90nm
Pentium 4 651	3.40Ghz	2MB	800MHz	Yes	No	65nm
Pentium 4 641	3.20Ghz	2MB	800MHz	Yes	No	65nm
Pentium 4 631	3.00Ghz	2MB	800MHz	Yes	No	65nm
Pentium 4 524	3.06Ghz	1MB	800MHz	Yes	No	90nm
Pentium 4 521	2.80Ghz	1MB	800MHz	Yes	No	90nm

Low-End Single-Core

AMD Sempron 3600+, 3500+, 3400+, 3200+, 3000+

The Semprons come in two different sockets: older 754 or AM2 supporting DDR2. The Semprons also boast a faster system bus and uses less power than the Celerons. All of AMD's current processors are fabricated using 90nm process technology. A 65nm process is being readied at the company's new Dresden facility.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Socket
Sempron 3600+	2.0Ghz	256KB	1600MHz	Yes	AM2
Sempron 3500+	2.0Ghz	128KB	1600MHz	Yes	AM2
Sempron 3400+	1.8Ghz	256KB	2000MHz	Yes	AM2
Sempron 3400+	2.0Ghz	256KB	2000MHz	Yes	754
Sempron 3200+	1.8Ghz	128KB	1600MHz	Yes	AM2
Sempron 3000+	1.6Ghz	256KB	800MHz	Yes	AM2
Sempron 3000+	1.8Ghz	128KB	1600MHz	Yes	754

Intel Celeron D 356, 355, 352, 351, 350, 346, 345, 341, 340, 331, 326

The "D" after Celeron does not put these parts in the same class as the Pentium D. These are low-end, single-core processors. This family is divided up between Intel's 775 and 478 socket. Both types use a 533MHz front-side bus. The Celeron D 340, 345, and 350 use the 478 socket. They don't support Intel's 64-bit EM64T instruction set extensions. The Celeron D 326, 331, 341, 346, 351, 352, 355, and 356 are socket 775 and do support EM64T.

Processor	Clock Speed	L2 Cache	Bus Speed	64 bit	Intel VT	Fab Proc

Celeron D 356	3.33Ghz	512KB	533MHz	Yes	No	65nm
Celeron D 355	3.33Ghz	256KB	533MHz	Yes	No	90nm
Celeron D 352	3.20Ghz	512KB	533MHz	Yes	No	65nm
Celeron D 351	3.20Ghz	256KB	533MHz	Yes	No	90nm
Celeron D 350	3.20Ghz	256KB	533MHz	No	No	90nm
Celeron D 346	3.06Ghz	256KB	533MHz	Yes	No	90nm
Celeron D 345	3.06Ghz	256KB	533MHz	No	No	90nm
Celeron D 341	2.93Ghz	256KB	533MHz	Yes	No	90nm
Celeron D 340	2.93Ghz	256KB	533MHz	No	No	90nm
Celeron D 331	2.66Ghz	256KB	533MHz	Yes	No	90nm
Celeron D 326	2.53Ghz	256KB	533MHz	Yes	No	90nm

History

This article won't help you cure any problems or provide any solutions. It is for those of you who enjoy an occasional look at the past. I did not intend to slight other chip manufacturers, but instead tried to present those models that made a difference in the usage and popularity of computers. Hope you enjoy.

1968 - 1970	**Datapoint 2200**
	In 1968 **Phil Ray** and **Gus Roche** founded a firm called **Computer Terminal Corporation** (CTC). In 1969 *CTC* wanted to build a "smart" terminal which could mimic the terminals of all the major computer vendors. To do this it would have to have its own microprocessor. They hired **Jack Frassanito** to help them with the design. The original design was on printed circuit boards but size constraints created heating problems. CTC contacted both *Intel* and *Texas Instruments* about reducing the circuitry to a single chip but neither Intel or TI completed the chip before CTC unveiled its **Datapoint 2200 terminal in June of 1970.** When CTC contacted their customers to find out how things were going, they discovered that a number of their customers were not using them as terminals but programming the microprocessor themselves in machine language! **They were using them as PCs!** (*Jack Frassanito's name is on the patent which was issued on July 25, 1972.*) *Thanks to **Rick Gaffney** for providing the above information.*
1971	**Intel 4004**
	The world's first general purpose microprocessor. If consisted of 2,300 transistors and supported only 45 instructions. It ran at an amazing speed of 1 MHz using 4 bit architecture. It was created by the team of *Ted Hoff, Stan Mazor, Federico Faggin and Masatoshi Shima*.
1972	**Intel 8008**
	Intel finally came back to CTC with their design of the first 8 bit microprocessor but by then CTC was no longer interested. Intel designated their chip the 8008 and put it in their catalogue of chips. This is the first 8-bit model and it contained 3,500 transistors. The 8th bit provided the ability to **manage alpha-numeric data**. There were two clock speeds of 500 & 800Khz and supported up to 16KB of memory.

Hardware 101

1974

Intel 8080

This chip allowed 16 bit addressing, 6,000 transistors and a whopping speed of 2 MHz. This is the chip that was used in the *MITS Altair* computer. The Altair was the third microcomputer. Bill Gates and Paul Allen started *Microsoft* and wrote their first BASIC interpreter for this chip and the Altair computer.

The following is a correction provided by Chris Titus of Milford, MA to my original statement that the Altair was the first microcomputer.

The Altair computer actually appeared first on the cover of the January 1975 issue of Popular Electronics magazine. According to Les Solomon, of Popular Electronics, the cover photo taken in the Fall, was made using a nonworking mock up of the Altair. The Altair continued to experience difficulties right up through shipping the first systems.

In July 1974, *Radio-Electronics* magazine published a construction article (and offered a booklet of instructions, tutorial experiments, schematics and PCB diagrams) for the *Mark-8* computer. A company in New Jersey sold circuit boards, and a mail-order company in Texas sold kits of parts. **The Mark-8, not the Altair, is the second home computer**. **It beat the Altair by six months. And it worked.** Larry Steckler, the editor of Radio-Electronics saw a working model--the one on the cover--in February or March of 1974. *The original Mark-8 is now in the Smithsonian's permanent Information Age exhibit.*

Motorola 6800

The 6800 contained 4,000 transistors and was designed by *Chuck Peddle* and *Charlie Melear*. It was mainly used for automotive controls and small business computers.

1975

Zilog Z80

The Z80 was mainly responsible for bringing PCs into business. It was designed by the *Faggin and Shima* team, contained 8,500 transistors and ran at 2.5 MHz. It hosted the *CP/M* operating system and was used by early pioneer computer makers such as **Osborne** and **Kaypro**. *Names long forgotten*.

1976

Intel 8085

This chip had a single 5V power supply, 8 bits and up to 8Mhz clock speed.

MOS 6502

Chuck Peddle left Motorola and under his new company, *MOS Technologies*, created the 6502. This is the first chip that *Steve Woznia*k used to create the *Apple II* design. It was also used in the *Commodore* and *Atari* machines. It was basically an enhanced version of the 6800 with 9,000 transistors, provided faster graphic operations and sold for about $25.

1978

Intel 8086

The 8086 was the start of the x86 family. It was a 16 bit chip with 29,000 transistors and up to 10Mhz clock speed.

1979

Intel 8088

Almost identical to the 8086 but had an external 8 bit data bus. This chip is based on the 8086 and was the model that *IBM* used in their first PCs. This chip helped launch *DOS* and *Lotus 123*.

Motorola 68000

The 68000 used 32 bits and 68,000 transistors. *Apple's Lisa and Macintosh* computers were based on this chip, which also introduced the first successful graphical user interface (GUI) systems. Many *Unix* based systems, such as *NCR* and *Motorola*, used this chip for their Unix servers.

Hardware 101

1982	Intel 80286
	This model introduced the concept of **general protection** and **virtual memory**. It supported up to 16MB of physical memory, 134,000 transistors and a 16 bit bus. A blazing speed of 8 to 25 MHz. ***IBM's AT*** bus was first used with this chip.
1985	Intel 80386
	Third genereation chip that introduced **linear addressing**, used a 32 bit design and contained 275,000 transistors. It could address up to 4GB of memory and clock speeds of 33Mhz. The first versions of ***Windows*** and ***OS/2*** were introduced with this chip. This model also made users more aware of the type of chip and operating system being used instead of the actual brand computer.
1986	MIPS R2000
	The first RISC based chip was introduced containing 185,000 transistors.
1987	Sun SPARC
	Sun introduces its first chip, with only 50,000 transistors, that spawned several generations of ***RISC*** based workstations. These workstations were geared for heavy graphic use.
1989	Intel 80486
	It contained 1,200,000 transistors and introduced the ability to include a **floating-point** unit and 8K of internal RAM cache within the chip. This greatly improved the execute speed for GUI interfaces, such as Windows. Speed was increased to 66 MHz using internal clocking.
1993	Intel Pentium
	After the longest gap in the development of new models, Intel created the Pentium that contains 3,100,000 transistors. It is capable of executing two instructions at the same time using a **dual-pipeline** design. Initially ran very hot. This chip became the defacto standard in it's time.
	IBM/Motorola PowerPC 601
	From the results of a joint effort, a new RISC chip was created using 2,800,000 transistors. This chip was used in ***IBM's RS/6000*** and ***Apple's Power Macs*** computers.
1996	Intel Pentium Pro
	The Pentium Pro increased the ability to **execute three instructions at once** and contains 5,500,000 transistors. It contains a second chip that provides Level 2 caching.

1997	**Intel Pentium MMX**

Introduced in the early part of 1997 and labeled as model **MMX.** It was designed to improve the performance for multimedia and communications. The estimates were a boost of performance of up to 60%. Speed increased to 200 MHz.

How did it work

To accomplish the speed improvements, **Intel** added 57 new instructions to the chip set. What used to require several dozen CPU steps was accomplished in a single step or operation.

- **2Q 1997**
  - **Pentium II** @233 and 266Mhz. Pentium II chips incorporate the MMX technology.
  - **Pentium MMX** @ 233Mhz.
- **3Q 1997**

  - Tillamook - code name for Pentium MMX designed for notebooks.

AMD K6

A 32-bit microprocessor that had RISC86 core that was used in the Nexgen Nx586 and Nx686 microprocessors. Special decoder units translated complex x86 instructions into short RISC-like instructions. This design allowed execution of up to 6 RISC-like instructions per cycle. It had the ability to run at frequences higher then processors with CISC-based cores. It supported the MMX instruction set. Models were produced for both desktop and laptops. There were 2 clock speeds available:166 and 266Mhz.

1998	**Celeron**

In 1998/99, 266 & 300MHz models were inroduced that used a 66MHz system bus. Newer models were the 366 & 400MHz that used a 100MHz system bus. All models had 128KB of integrated cache.

In a test run by *PC Week* labs, they discovered the **366 & 400 chips outperform older Pentium II chips running on a 66MHz bus**. A bigger surprise was that they also outperformed the Pentium II 350 and 400MHz models. The Celeron chip is cheaper than the Pentium II.

On the drawing board it appeared that the Pentium II chips should perform better. The theory for the surprising results is the fact that the Celeron runs the L2 cache at full clock speed and that the Pentium II runs the L2 cache at half the clock speed.

The Celeron was a "dog" when first introduced. But with the added feature of L2 cache, this was the best bargain and performer for the typical user.

AMD K6-2

Provided faster execution of MMX instructions by adding an extra MMX unit to the processor code. Applications performance was boosted by using new 3DNow! instructions Clock speeds ranged from 200 to 570Mhz and bus speed was 66 or 100Mhz

1999	
	Pentium MMX 300Mhz
	Introduced in early 1999, was the 300MHz model for notebooks only. By using Intel's 0.25 micron process, it further reduced power consumption.
	Pentium II
	The Pentium II models in 1999 are 450, 400, 350, 333, 300, 266 and 233MHz. The 350, 400 & 450 run with a 100MHz bus. All other models use a 66MHz bus. All models have 512KB of external L2 cache and include the MMX technology.
	Pentium II XEON
	Pentium II XEON 1999 processors were available at speeds of 400 and 450MHz with the option of 1MB or 2MB or L2 cache. The XEON models were intended to provide the best performance for applications running on operating systems such as ***Windows NT, NetWare and UNIX***. This model is replaced the Pentium Pro line. XEON model was not recommend if you were running Windows 95 or 98.
	Pentium III
	In early March 99 the 32 bit 450 & 500MHz arrived and included 70 new instructions for enhanced 3-D graphics, audio and video. A 533MHz version arrived later in 1999.
	Pentium III XEON
	450MHz with options of 512KB, 1MB or 2MB of L2 cache. This chip was targeted for servers. A 500MHz, code named Tanner, arrived in the 3rd quarter of 99.
	AMD K6-III
	Enhanced version of the K6-2 with a bus width of 32.
	AMD K7
	x86 processors that featured multiple superscalar integer and floating point units, a bus speed of 400Mhz, L1 cache from 128 to 512KB, 32 bit and additional 3DNow! instructions. Clock speed ranged from 500 to 3200Mhz. There were several versions...

- **Athlon, XP & MP** - high performance desktops - Used the Thunderbird code adding on-die 256KB L2 cache. Bus speeds up to 266Mhz and clock speeds up to 1.4Ghz. The XP version had bus speeds up to 333Mhz.
- **Athlon 4 & XP-M** - high performance mobles
- **Duron** - Budget desktop and mobile processors - Because of the cache size, bus speed and more powerful FPU unit, it out performed the Celeron chips.

- **Sempron** - Budget desktop processors - Eventuall replaced the Duron models.

2000	
	Pentium IV
	This chip is a 32-bit processor and has a family consisting of...

- **Pentium 4** - Desktop CPU
- **Mobile Pentium 4 & 4M** - for notebooks
- **Celeron** - low cost version

- **Xeon & Xeon MP** - High performance versions

Memory Explained

- How Memory Works
- Module Components
- Memory Types
- Technology
- Evolution Chart
- Error Checking
- Measuring Speed
- Adding Memory
- Recommended Memory

How Memory Works

In order to enable computers to work faster, there are several types of memory available today. Within a single computer there is no longer just one type of memory. Because the types of memory relate to speed, it is important to understand the differences when comparing the components of a computer. So get your memory ready as the following will explain what all those crazy abbreviations mean.

But first, here is a brief description of how memory works.

All actual computing starts with the the **CPU** (Central Processing Unit).

The **chipset** supports the CPU and contains several **controllers** that control how information travels between the CPU and other components in the PC.

The **memory controller** is part of the chipset and establishes the information flow between memory and the CPU.

A **bus** is a data path that consists of parallel wires and connects the CPU, memory and other devices. The bus architecture determines how much and how fast data can move around the **motherboard**.

The **memory bus** goes from the memory controller to the computer's memory sockets. Newer systems have a **frontside bus** (FSB) from the CPU to main memory and a **backside bus** (BSB) from the memory controller to L2 cache.

For the PC to get information...

The CPU sends a request to the memory controller to memory and gets a report back of when the information will be available. This cycle can vary in length according to memory speed as well as other factors, such as bus speed.

Residing on the motherboard, the **system clock** sends a signal to all components, just like a metronome ticking. Each click of the clock represents a clock cycle. A clock running at 100Mhz represents 100 million clock cycles per second. Every action is timed by the clock where different actions require a different number of clock cycles.

Many people assume that the speed of the processor is the speed of the computer. Most of the time, the system bus and other components run at different speeds. **Because all information processed by the CPU is written or read from memory, the performance of a system is dramatically affected by how fast information can travel between the CPU and memory. Therefore, faster memory technology contributes greatly to the overall system performance.**

Cache memory is a relatively small amount (normally less than 1 MB) of high speed memory and resides very close to the CPU. It is designed to supply the CPU with the most frequently requested data. It takes a fraction of the time, compared to normal memory, to access cache memory.

The concept is that 20% of the time, what is needed is in cache. The cache memory tracks instructions, putting the most frequent used instruction at the top of the list. Once the cache is full, the lowest need is dropped.

Today, most cache memory is incorporated in the CPU. It can also be located just outside of the CPU. Cache that is closest to the CPU is labeled **Level 1**, the next closest **Lever 2**, etc.

Interleaving is a process in which the CPU alternates between two or more memory banks. Every time the CPU addresses a memory bank, the bank needs about one clock cycle to reset. The CPU can save processing time by addressing a second bank while the first bank is resetting.

Module Components

PCB (Printed Circuit Board)

The green board that holds the memory chips is made up of several layers. Each layer contains **traces** and **circuitry** to control the movement of data. Usually, higher quality memory modules use more layers. The more layers, the more space there is between traces. With more space between traces, the module has less chance of noise interference and is more reliable.

Traces (Internal Trace Layer)

Think of traces as roads that data travels on. The width and curvature as well as the distance between affect both the speed and reliability.

Contact Fingers

The contact fingers (connections or leads) are used to plug the memory chips into the module. Contacts can either be **tin** or **gold**. Gold is a better conductor than tin, but more expensive. To help avoid corrosion, It's always best to match the metal of the module to the metal of the socket.

Chip Packaging

This is the material coating around the actual silicon. Today's most common packaging are...

DIP (Dual In-Line Package)

This type of packaging was used when memory was installed directly on the computer's system board. It installed into holes extending into the surface of the PCB and could either be soldered or inserted into sockets.

SOJ (Small Outline J-Lead)

This type of packaging was used for surface mount components where they mounted directly onto the surface of the PCB.

TSOP (Thin Small Outline Package)

This is also a surface mount design and was first used to make thin credit card modules for notebook computers.

CSP (Chip Scale Package)

CSP doesn't use pins to connect to the board. It uses electrical connections to the board on the underside of the package. RDRAM chips utilize this type of packaging.

Chip Stacking

For higher capacity modules, it is necessary to stack chips on top of one another. Stacking can be internally (not visible) or externally (visible).

Memory Types

SIMM (Single In-line Memory Modules)

SIMMs are used to store a single row of DRAM, EDO or BEDO chips where the module is soldered onto a PCB. One SIMM can contain several chips. When you add more memory to a computer, most likely you are adding a SIMM.

The first SIMMs transferred 8 bits of data at a time and contained 30 pins. When CPU's began to read 32-bit chunks, a wider SIMM was developed and contained 72 pins.

72 pin SIMMS are 3/4" longer than 30 pin SIMMs and have a notch in the lower middle of the PCB. 72 pin SIMMs install at a slight angle.

DIMM (Dual In-line Memory Modules)

DIMMs allow the ability to have two rows of DRAM, EDO or BEDO chips. They are able to contain twice as much memory on the same size circuit board. DIMMs contain 168 pins and transfer data in 64 bit chunks.

DIMMs install straight up and down and have two notches on the bottom of the PCB.

SO DIMM (Small Outline DIMM)

SO DIMMs are commonly used in notebooks and are smaller than normal DIMMs. There are two types of SO DIMMs. Either 72 pins and a transfer rate of 32 bits or 144 pins with a transfer rate of 64 bits.

RDRAM - RIMM

Rambus, Inc, in conjunction with Intel has created new technology, **Direct RDRAM**, to increase the access speed for memory. RIMMs appeared on motherboards sometime during 1999. The in-line memory modules are called RIMMs. They have 184 pins and provide 1.6 GB per second of peak bandwidth in 16 bit chunks. As chip speed gets faster, so does the access to memory and the amount of heat produced. An aluminum sheath, called a heat spreader, covers the module to protect the chips from overheating.

SO RIMM

Similar in appearance to a SO DIMM and uses Rambus technology.

Technology

DRAM (Dynamic Random Access Memory)

One of the most common types of computer memory (RAM). It can only hold data for a short period of time and must be refreshed periodically. DRAMs are measured by storage capability and access time.

- Storage is rated in megabytes (8 MB, 16 MB, etc).
- Access time is rated in nanoseconds (60ns, 70ns, 80ns, etc) and represents the amount of time to save or return information. With a 60ns DRAM, it would require 60 billionths of a second to save or return information. The lower the nanospeed, the faster the memory operates.
- DRAM chips require **two CPU wait states** for each execution.
- Can only execute either a read or write operation at one time.

FPM (Fast Page Mode)

At one time, this was the most common and was often just referred to as DRAM. It offered faster access to data located within the same row.

EDO (Extended Data Out)

Newer than DRAM (1995) and requires only **one CPU wait state.** You can gain a 10 to 15% improvement in performance with EDO memory.

BEDO (Burst Extended Data Out)

A step up from the EDO chips. It requires **zero wait states** and provides at least another 13 percent increase in performance.

SDRAM (Static RAM)

Introduced in late 1996, retains memory and does not require refreshing. It synchronizes itself with the timing of the CPU. It also takes advantage of interleaving and burst mode functions. SDRAM is faster and more expensive than DRAM. It comes in speeds of 66, 100, 133, 200, and 266MHz.

DDR SDRAM (Double Data Rate Synchronous DRAM)

Allows transactions on both the rising and falling edges of the clock cycle. It has a bus clock speed of 100MHz and will yield an effective data transfer rate of 200MHz.

Direct Rambus

Extraordinarily fast. By using **doubled clocked** provides a transfer rate up to 1.6GBs yielding a 800MHz speed over a narrow 16 bit bus.

Cache RAM

This is where SRAM is used for storing information required by the CPU. It is in kilobyte sizes of 128KB, 256KB, etc.

Other Memory Types

VRAM (Video RAM)

VRAM is a video version of FPM and is most often used in video accelerator cards. Because it has two ports, It provides the extra benefit over DRAM of being able to execute simultaneous read/write operations at the same time. One channel is used to refresh the screen and the other manages image changes. VRAM tends to be more expensive.

Flash Memory

This is a solid-state, nonvolatile, rewritable memory that functions like RAM and a hard disk combined. If power is lost, all data remains in memory. Because of its high speed, durability, and low voltage requirements, it is ideal for digital cameras, cell phones, printers, handheld computers, pagers and audio recorders.

Shadow RAM

When your computer starts up (boots), minimal instructions for performing the startup procedures and video controls are stored in ROM (Read Only Memory) in what is commonly called BIOS. ROM executes slowly. Shadow RAM allows for the capability of moving selected parts of the BIOS code from ROM to the faster RAM memory.

Evolution of Memory

Year Introduced	Technology	Speed Limit
1987	FPM	50ns
1995	EDO	50ns
1997	PC66 SDRAM	66MHz
1998	PC100 SDRAM	100MHz
1999	RDRAM	800MHz
1999/2000	PC133 SDRAM	133MHz
2000	DDR SDRAM	266MHz

Error Checking

In order to ensure that memory is working correctly, data integrity, there are two primary means - parity and error correction code (ECC) or no checking at all - non-parity.

Parity

This is the most common used method. It can detect errors, but not correct them.

ECC (Error Correction Code)

ECC can detect and correct single-bit errors. It is used in high-end PC's and servers.

Non-Parity

Because there has been an increased quality of memory components and an infrequency of errors, more and more manufacturers do no include error checking capabilities. This also lowers the cost of the PC.

Speed - Access Time, Megahertz (MHz), Bytes Per Second

Prior to SDRAM, speed was expressed in terms of **nanoseconds** (ns). This measured the amount of time it takes the module to deliver a data request. Therefore the lower the nanosecond speed, the faster. Typical speeds were 90, 80, 70 and 60ns. Older 486 machines may have 80 or 90. More recent Pentiums will have 60 or 70.

Often the last digit of a memory part number will represents the speed such as -6 = 60ns.

SDRAM speed is measured in **megahertz (MHz)**. Speed markings on the memory chips may still specific nanoseconds, but in this case in represents the number of nanoseconds between clock cycles. To add to the confusion the markings on the chips don't match the Mhz value. Here is a conversion chart.

MHz Speed	Total Clock Cycles per Second	Divide by 1 billions to get nanoseconds per clock speed.
66	66,000,000	15
100	100,000,000	10
133	133,000,000	8

To calculate **bytes per second** you need to know the **Bus Width** and **Bus Speed** of your PC. The first thing to remember is 8-bits = 1 byte. If you have a 64-bit bus, than 8 bytes of information can be transferred at one time. (64 / 8 bits = 8 bytes)

If your bus speed is 100Mhz (100 million clock cycles per second) and the bus width is 1 byte wide, the speed is 100 MB's per second. With a 64-bit width, the speed is 800 MBs per second (64 / 8 * 100,000,000)

Rambus modules are measured in megabytes per second. Rambus modules are either 400 or 300Mhz. Because they send two pieces of information every clock cycle, you get 800 or 600Mhz. They have a 16-bit bus width or 2 bytes (16/8). The 400Mhz module speed is 1600MB a second or 1.6GB a second. (400,000,000 * 2) * 2. The 300Mhz module provides 1.2GBs a second.

Adding Memory

If you are running Windows 95 or 98, a minimum of 16 MBs of memory is necessary. If you have several applications open at once, you will find by increasing your memory, everything will run faster. Currently the cost for adding additional memory is very low. Installation of memory is also fairly simple. It does not require any reconfiguration.**The difficult part is determining what type of memory you need.**

Type | Socket | Amount

More information on memory determination...
Looking Inside | Check the Manual | Identification | Still not sure

Type

- **FPM** – Fast Page - If you have a 486, you probably have FPM
- **EDO** – Extended Data Out - If you have an early Pentium system, you probably have EDO
- **SDRAM** - If you have a Pentium or Celeron system purchased in 1999, you probably have SDRAM

Sockets

Memory modules plug into a socket on the motherboard. There are three socket types.

- **SIMM** – **30 pin** – 3 inches in length

- **SIMM – 72 pin** – 4 inches in length
- **DIMM** – **168 pin** – 5 inches in length

Most older 486 machines will use 30 pin modules. Later model 486 and Pentium machines will probably use 72 pin modules. More recent Pentium machines may have 168 pin.

Amount

Memory sizes increase by the power of 2. This results in sizes of 1, 2, 4, 8, 16, 32, 64, 128, 256 MBs.

- On some older 486 machines, one memory module can be added at a time.
- On most Pentium machines, modules must be added in pairs. Each pair must be of the same size
- SDRAM modules can be added one at a time.

  For example, if you have 8 MBs of memory on a Pentium, you have two 4 MB modules. To increase to 16 MBs, you need to add two more 4 MB modules. To increase to 24 MBs, you need to add two 8 MB modules.

Looking Inside

Now that you know the parameters, how do you determine which type you need? Looking inside the computer will not provide all of the information. It will confirm how many modules you currently have. You can also confirm the type and quantity of open sockets. If you only have four sockets and each socket contains a module, you will have to replace some of the existing memory modules.

Check the Manual

The other place to find the correct information is your owner's manual. The manufacturer should have listed the type of memory required. You will need to determine the parity and speed.

Identification

Now that you have the necessary information, you find an ad for memory and still you may not be able to determine which modules you need. Why? Because the computer industry thrives on confusion and abbreviations. Here's how to interpret the coding scheme.

30 pin modules

For 30 pin modules you will see something like

- 1 x 9-60
- 4 x 9-70
- 4 x 8-70

The **first number** is the size in MB's. In our example this would be 1MB or 4MB.

The **second number** represents parity. The value 9 represents parity and 8 represents non-parity. (Of course that makes a lot of sense!) The 9 or 8 also identifies that it is a 30 pin module.

The **third value** represents the speed.

72 pin modules

For 72 pin modules you will see something like

- 1 x 32-60
- 2 x 32-70
- 4 x 36-60
- 8 x 36-70

Just like the 30 pin modules, the **first value** represents the size, EXCEPT it only represents ¼ of the total memory size. Don't ask why, just accept it. So the value of 4 represents a 16 MB (4 x 4) module. A value of 8 represents a 32 MB (4 x 8) module.

The **second value**, again just like the 30 pin, represents parity and the number of pins. 36 is used for parity and 32 for non-parity. You aren't asking why again, are you?

The **third value** represents the speed, the same as the 30 pin.

Still not sure

If you still are not sure what type of memory you need, call the manufacturer or call us. We have a database of about 90% of all manufactured computers that can provide us with the type of memory and upgrade options. You will need to provide the manufacturer and model of your PC.

Recommended Memory

To help you determine the amount of minimum recommended memory for different versions of Windows, we have prepared this handy chart.

Bottom Line - The more memory the better

User Type	Win 3.x	Windows 95 or 98	Windows NT
Word processing, E-mail, and data entry	12-24	16-24	32-40
Fax/communications, database administration, spreadsheets, and more than 2 applications open at a time	24-32	24-32	40-48
Complex documents, accounting, business graphics, presentations, and network connectivity	32-48	32-48	48-64
Proposals, reports, spreadsheets, business graphics, databases, scheduling, and presentations	24-32	32-48	32-48
Complex presentations, sales/market analysis, project management, and Internet access	32-48	48-64	48-64
Statistical applications, large databases, research/technical analysis, complex presentations, video conferencing, and network connectivity	48-64	64-96	64-96
Page layout, 2-4 color line drawings, simple image manipulation, and simple graphics	48-64	64-96	64-96
2D CAD, multimedia presentations, simple photo-editing, and web development	64-96	96-128	96-128
Animation, complex photo-editing, real-time video, 3D CAD, solid modeling, finite element analysis, and network connectivity	96-256	128-256	128-256

Hardware 101

CRT, LCD, Plasma Monitors Explained

- LCD Technology
- Plasma Technology
- Analog Technology
- Analog Sizes
- Monitor Glossary

A popular question when someone is considering a new computer is **"What is the best monitor?"** There is no simple answer to this question. My first response is "What applications are you going to be using?" The reason for this question is to determine whether or not "advanced graphic" applications are going to be used.

- Graphic design individuals usually require a higher quality monitor.
- Whereas individuals using word processing, spreadsheet and general data applications can get by with a monitor of lessor quality.

So once you are armed with this knowledge, selecting the correct monitor should be a snap? *Well, almost.* **There are still other features to consider such as price, warranty, and reliability.** But hopefully this explanation will enable you to make an accurate comparison and understand all those weird abbreviations.

Flat Screen vs Flat Panel

Of note is that some monitors are listed as having flat screens. These are still CRT monitors that have a **flat screen** vs the slightly curved models. LCDs are referred to as **flat panels**.

LCD Technology

Liquid Crystal Display (LCD) monitors are based on liquid crystals acting like shutters where they allow light to either pass through or block it. LCD technology was introduced to computers with notebooks. They provide superior qualtity because there is no translation from analog to digital.

Advantages

- Crisper and more precise picture quality
- True, more saturated color
- Flat displays provide less distortion
- Uses 90% less space than a CRT monitor
- Energy efficient due to using less power and emiting less heat

If you are in the market for an LCD monitor, you should be aware that even though the specifications may be close, LCD monitors may not be equal in quality.

The most popular sizes are 15 and 17 inches. Unlike CRT monitors, the **listed size of an LCD represents the true viewable size**. A 15 inch CRT provides about 14 inches of viewable space. A 17 inch CRT provides about 16 inches of viewable space. So the viewable size on a 15 inch LCD is in between a 15 and 17 inch CRT. Currently the maximum size for a LCD is 40 inches.

How it Works

An LCD panel consists of five layers.

1. **White backlight** that provides the illumination.
2. **Polarizing filter** that ensures the light waves from the backlight are aligned in one direction.
3. Very s**mall pattern of red, green and blue colors** forming one pixel. This layer works as a filter, only allowing light through one of the three colors. The amount of fire power issued controls the "twist", affecting the amount of light.
4. Actual **Liquid Crystal cells**. Behind the cells is a grid of wires that can be addressed by x, y coordinates. Your video display controller issues a command to fire at the approriate coordinates.
5. Another **polarizing filter** that is perpendicular to layer two.

To simplify, polarized light gets colorized and may or may not emerge from the last polarizing layer depending on the "twist".

One of the problems with LCD displays is that when viewed from a side angle, the color intensity drops. Different technology is used in creating the pattern alignment to improve viewing from the side. The side angle view quality is one of the things that makes a difference in comparing different models.

Contrast Ratio & Brightness

Two specifications to check in comparing LCDs is the contrast ratio and brightness. Both of these specs have to be considered in overall quality. **Typically the higher the brightness, the lower the side viewing angle**.

The contrast ratio is a measurement comparing the brightest (white) and darkest (black) pixels. A good contrast ratio is at least 500:1. **A minimum contrast ratio to consider is 350:1.**

Brightness is measured in nits. The average LCD currently is in the range of 250-280 nits. Ultra-bright models are capable of 450 nits. A higher nit level isn't always good. In a darker room, 450 nits would make you reach for your sun glasses.

Viewing Angle

A viewing angle of 160 degrees will provide viewing by a group of people. **If you never have to view your monitor from a side angle, a minimum viewing angle of 110 degrees is adequate**.

Response Time

This is the amount of time required for panel pixels to turn from completely white to black and back again. This time is measured in milliseconds (ms). Larger values for response time represent a slower response. **A minimum response time should be at least 25ms and 17ms is recommended.** If you have a digital video card, you can use LCDs with a 16ms response time. Most users only have an analog video card.

Panel Quality

Many manufacturers use a third party firm to provide the panels. Panels are rated as A, B or C grades. Even within a given manufacturer, different models will use different grade panels. There are no specs that provide information as to the panel grade. B and C grade panels are used by mass merchant sites who want to move a volume at the lowest price.

Bezel Size

If you multiple displays, the thinner the bezel the better. This allows you to put two LCDs side by side with very little space between the displays.

Portrait and Landscape

Allows you to see a full-size page as you would normally view it. You can rotate the screen between portrait and landscape mode without having to restart your computer.

Failures

The biggest failure with LCDs is the backlight. Backlights are not cheap to replace. The better models come with a three year warranty.

LCD comparison to CRT

Feature	LCD	CRT
Resolution	Fixed pixel format will support resolutions lower or higher than native resolution	Fixed resolution is only optimal at published resolution.
Refresh Rates	Virtually flicker-free	Only flicker-free if the refresh rate is 75Hz or higher.
Color	True color temperatures can be simulated	True color must be calibrated
Picture Formation	Individually formed pixels provide excellent focus, clarity and sharpness. Pictures appear smoother.	Because pixels are formed by grouping multiple dots or stripes, pictures are not as sharp.
Viewing Angle	Limited to 160 degrees.	Excellent viewing angle.
Power	Use 70% less energy. No emissions.	Emissions and electro-magnetic interferences are always present.
Display Interface	Digital, but most come with an analog interface for plug-n-play compatability.	Only remaining analog device among digital computers.
Brightness and Contrast	Brightness levels are measured in nits. Active matrix LCD monitors range from 150 to 280 nits.	CRT monitors have a maximum brightness of only 150 nits.

Plasma Displays

Plasma displays are also considered flat panels and can be 32 to 61 diagonal inches. They work similiar to LCD displays.

The difference is in place of **layer three**...

- Each cell has a mixture of neon and argon or xenon
- One side of the cell is white and the other side is coated with a red, green or blue phosphor
- Wires are attached to each cell
- When the cell is charged, the inert gas is heated
- The plasma emits invisible Ultra Violet light, but when charged, it emits a visible color.

LCD vs Plasma

- o LCD
  - Higher resolution.
  - Consume less power
- o Plasma
  - Higher contrast ratio of 850:1
  - Can be viewed from a wider side angle

Just like CRTs, can burn the image on the screen if it is left on the same display too long.

Analog CRT Technology

Before digging into each feature, perhaps a simple explanation of how a CRT monitor displays images should be clarified.

- The image you see on the monitor is a series of tiny dots, called pixels.
- Each pixel contains a mixture of three colors: red, green and blue.

It would appear that once a program defines the color mixture for a given pixel, the monitor would not have to re-display this pixel until the screen actually changes. *Nah, that would be too simple.* **The monitor is constantly re-displaying the pixels, a row at a time.** The time it takes to redisplay is referred to as the refresh rate.

Resolution and Size

Resolution represents the number of horizontal and vertical pixels. Resolution sizes ranges are

- 640 x 480
- 800 x 600
- 1024 x 768
- 1280 x 1024
- 1600 x 1200

Most monitors support several ranges. By default many monitors will start at the 640 x 480 range. Only the larger size monitors, 17 inch and greater, can support the higher ranges of 1280 and 1600.

So what does the resolution control? **The higher the resolution values the crisper and smaller the image**. If an image required 5 x 5 pixels to display on a screen with 640 x 480 resolution, it would take less space to show this image than on a resolution of 1024 x 768.

Because there are more dots on a higher resolution, you can see more on the screen. **The down side is the images are smaller in size. This is why larger size monitors are needed to run the larger resolutions.** The confusion here is the "larger" the resolution values, the "smaller" the image. Basically the pixel size is reduced in order to produce more pixels on the screen.

Graphic Resolution

For graphic applications, sharp images are important. Therefore a higher resolution along with a larger screen provides the best solution. **At least 1024 or greater and 17" in size.**

Non-Graphic Resolution

For non-graphic applications, **resolution sizes up to 1024 and 15"** monitors are fine.

A special note on resolution sizes. Having a monitor that can handle a large resolution doesn't always mean it will work on your system. You must also have a video adapter card that will handle the resolution size of your choice.

Refresh Rate

As stated earlier, monitors are constantly re-painting the pixels. Because a higher resolution requires more pixels, a faster refresh rate is required in order to reduce visible flicker. **The refresh rate is the number of times per second that each line is re-painted.** It is normally expressed in hertz (Hz).

If the refresh rate is too slow, the screen will have a flicker. A visible flicker can be very annoying and cause excessive eye strain.

Graphic and Non-Graphic

A reasonable refresh rate, at the resolution size you want to use, **should be greater or equal to 70 Hz.** One of the main differences between the lower vs. high end monitors is the speed of the refresh rate.

Interlacing

Hardware 101

A non-profit member organization dedicated to facilitating and promoting personal computer graphics through improved graphics standards for the benefit of the end user.

Networks Explained

- Network Definition
- Protocols
- Ethernet
- Topology
- Servers
- Phone Lines
- Glossary
- Cables
- Transceivers
- Repeaters
- Bridges and Routers
- Switches
- Remote Connections
- Phone Talk

Network Definitions

In simple terms a computer network is **a series of computers and devices appearing as a single system to the user**. Networks have become popular and useful because of the ability to distribute the computer workload over several machines and to provide and store information on several machines.

- LAN - **Local Area Network** is used to connect computers and share data. Local means in the same building or near enough to be **connected by cable**. LANs are capable of transmitting data at very high speeds.
- VLAN - **Virtual LAN** is a network of computers that behave as if they are connected to the same wire, though they may actually be physically located on different segments of a LAN.
- WAN -**Wide Area Network** where connections are made using high speed **phone lines.** A good example of a WAN is the Internet.
- WLAN - **Wireless Local Area Network** where a group of computers and associated devices can communicate with each other wirelessly.

Protocols

Protocols are a **set of standards that define how each computer identifies itself within the network.** The protocol also defines the data format and how the data should be processed once it reaches its destination. Data is transferred in "packets".

- TCP/IP (*Transmission Control Protocol/Internet Protoco*l)**.** This is the most common protocol and is used by Unix/Linux/Windows based machines. The Internet also relies on TCP/IP.
- FTP (*File Transmission Protocol*), An application for sending files between computers over a TCP/IP network and the Internet.

- HTTP (*HyperText Transport Protocol*) The communications protocol used to connect to servers on the World Wide Web.
- DHCP (*Dynamic Host Configuration Protocol*) A protocol that lets one device on a local network, known as a DHCP server, assign dynamic IP addresses to the other network devices, typically computers.
- RTP (*Real-time Transport Protocol*) A protocol that enables specialized applications, such as Internet phone calls, video and audio, to occur in real time.
- SNMP (*Simple Network Management Protocol*) A widely used network monitoring and control protocol.
- Telnet A user command and TCP/IP protocol used for accessing remote computers.
- NetBEUI, created by Microsoft for Windows, is mainly used in a small peer-to-peer Windows only network.
- IPX is used to network Novell servers.
- AppleTalk used by Apple machines.

Ethernet

Ethernet (IEEE 802.3) **is the most popular technology used for networks**. Ethernet provides a good balance between speed, price and ease of installation and is the most popular LAN technology in use today. It supports speeds up to 10Mbps.

Fast Ethernet (IEEE 802.3u) is replacing Ethernet and support speeds up to 100Mbps.

Gigabit Ethernet (IEEE 802.3z & 802.3ab) supports data transfer rates of 1000Mbps.
Other LAN types are...

- Token Ring
- FDDI (*Fiber Distributed Data Interface*)
- LocalTalk

Mbps (*Megabits per second*) represents one million bits per second, a unit of measure for data transmission.

IEEE (*Institue of Electrical and Electronics Engineers*) An international non-profit, professional organization directed toward the advancement of theory and practice of electrical, electronics, communications and computer engineering. *Boy, what a mouthful!*

Topolgy

Topology is the method in which a network method is configured. Each device on the network, typically a computer or server, is called a **node**. Nodes on an Ethernet network are connected either by **Bus** or **Point-to-Point** topology.

- The **Bus** method consists of nodes connected to a long cable in a series. Any break in the long cable will cause the entire series to be inoperable.
- The **Point-to-Point** topology connects exactly two nodes together. If a break occurs in a Point-to-Point, only the two node links are affected, not the entire network. Point-to-Point normally uses 10BaseT, 100BaseT or 1000BaseT cabling and is the **recommended topology.**

Cables

There are four major types of cable...

- **Thickwire / 10BASE5** is typically used to join smaller network segments into one large LAN.
  - o Can support up to **100 nodes** and a **distance of 500m**
  - o Used because of its immunity to electrical noise.
  - o Requires heavy **coaxial cable** which is expensive and difficult to work with.
  - o Each **node must be exactly 2.5m** apart and is connected by tapping into the wire with a special tool.
  - o Best used as a backbone for a BUS topology network.
- **Thin Coax / 10BASE2** is thinner, more flexible and cheaper than Thickwire.
  - o Can support up to **30 nodes** that **must be at least 0.5m but no further than 185m** apart.
  - o Nodes are connected using a **BNC** connector.
  - o Best used to connect departments or areas to the backbone of a BUS topology on the network.
- **Twisted Pair / 10BASET / 100BaseT / UTP / Cat5 / Cat6** is similar to telephone cable and is the most popular and **recommended**.
  - o Inexpensive
  - o Used with Point to Point topology and is **limited to 100m** per each segment.
  - o **Most important if you are using a 100BaseT or greater configuration you should have the cable certified.**
- **Fiber Optic / 10BASE-FL** is used basically the same way as Twisted Pair
  - o More expensive.
  - o Effectively insulates the network from lightning strikes and other electric interference.
  - o Node connections can be **up to 2km long** and can handle higher speeds of data transmission.
  - o Should be used when connecting two buildings or if you have an environment with large amounts of electromagnetic interference.

Transceivers

Transceivers also referred to as **MAUs** *(Media Attachment Units)* provide an AUI (*Application User Interface*) connection to the computer. In simple terms, it is used to **convert the connector type from an RJ45 to AUI**.

Repeaters

Repeaters are **used to connect any type of cable**. They basically provide extra signal strength when you exceed the length limits. Data is transmitted near the speed of light on a network and the timing of transmitted data is crucial. Because of this, the path between any two nodes can't contain more than four repeaters.

Routers, Bridges & Gateways

Routers and Bridges are **used to split networks that become too large**. These devices differ from repeaters by their capability to **store and forward** data to each network when they sense the network is available. Thus preventing timing problems.

A **Bridge** connects two different kinds of local networks, such as a wireless network to a wire Ethernet network.

A **Router** connects multiple networks together, such as a local network and the Internet.

A **Gateway** interconnects networks with different, incompatible communication protocols.

A **Default Gateway** is the device that forwards Internet traffic to your internal network

Switches

Switches are devices that connect computing devices to host computers, allowing a large number of devices to share a limited number of ports.

An **unmanaged swtich** is a basic switch that works right out of the box and does not allow the user remote network administration capability.

A **managed switch** has an IP address that lets you monitor and administer your network.

Layer 2 is an OSI (*Open Systems Architecture*) device, the data link layer; this layer is responsible for moving data across the physical links in a network.

Layer 3 is an OSI device that determines network addresses, routes and quality of service for information transport. A router is a Layer 3 device and switches can also have Layer 3 capability.

QoS (*Quality of Sevice*) is a mechanism which gives priorities to certain types of traffic to ensure the throughput. For example, streaming multimedia.

Servers

Servers are devices which **allow the use of terminals, printers and modems to be connected to the network.** For example you can connect a Server to a node along with several terminals or printers. Servers offer the benefit of data not having to travel over the entire network. If you are printing to a printer connected to the same server as your terminal, the data is transmitted within your "domain" or server segment. Thus reducing the network load.

Remote Communications

Because companies are adding new locations, have employees in the field or working from home, **the need to talk to the "corporate" computer has become a necessary requirement.**

This article is going to address the different configurations that are possible and touch upon some solutions. Because of the complexity, each solution could be an article in itself, but the intent of this article is to introduce you to the capabilities and methods.

As you will see...

- depending on where you are connecting **from**
- what you are connecting **to**
- **what you want to do** once you are connected
- **Will influence and dictate what options and methods you will want to use.**

Connection Type

There are **three main types of remote connections**. There are situations where a remote connection may require the need of more than one type of connection.

Character Based

This is a connection where you are only using a CRT (dumb terminal), i.e. not a PC, to "log in" or telnet/SSH to a UNIX/Linux based system. You may already be using this type of connection. **This connection type can only run "character based" applications and NOT *Windows* or graphical based applications.**

It is possible to make this type of connection using a dumb **terminal emulator** running on a PC. The emulator basically turns your PC back into a dumb terminal and emulates a specific brand CRT such as *Wyse, TeleVideo, Esprit*, etc.

Some examples of emulators are *CROSSTALK, Bitcom, TinyTerm,* and *PowerTerm*.

Send/Receive Data Only

This type of connection is most commonly used to transmit EDI or E-Mail data. The connection can be made upon demand or on an automated basis. Customized program scripts, that run behind the scenes (*i.e. background mode*) are usually used to automate the sending and/or receiving of data once the connection is established.

An example of software tools used in this type of connection are SMTP and FTP. FTP is currently the most common and reliable method.

This connection type is also used to transmit data files from a PC to, perhaps, your notebook computer.

Network Connection

Network communications can include running "character based" applications, ***Windows*** or graphical applications or simply transmitting data. Using a browser to access the Internet is an example of a remote network connection.

From Where

There are basically three different types of situations that may require remote connections. Each of these has their own unique sets of problems and solutions.

Fixed Site

This situation is where you have more than one office, plant or warehouse. The distance could be across town or in another city. Basically any distance that doesn't allow you to run your own cable, but requires the use of phone lines. Usually a "dedicated" connection such as ISDN, DSL or a T1 line.

Mobile Site

This represents a situation where you are connecting from different locations each time. An example would be where sales agents are traveling to different customer sites and making a connection from the customer's site or a hotel room. A computer, modem or Internet connection and appropriate software is required to make the connection.

Home Site

This situation is similar to the "fixed" connection. At the minimum, it will require a computer and an Internet connection.

To What

Depending on the type of computer system you are connecting to, different equipment and software will be required at both ends.

UNIX/Linux System

If you are connecting to a UNIX system, you are probably using a "character-based" application. If you are making the connection to run the character-based application you only need a dumb terminal or a PC using emulator software and using SSH for a secure connection..

Windows System

If you are connecting to a computer running **Windows**, you will need special communications software at both ends, i.e. Host and Remote. The computer you are connecting from is the "Remote". The computer you are connecting to is the "Host".

Examples of communication software for this purpose are **VNC, pcAnywhere, Carbon Copy, Citrix and Windows Terminal Server**.

Via Internet

This would require that your main computer has a dedicated connection to the Internet.

Phone Line

Choosing the correct phone line type depends on the

- Length of the connection
- How much data will be transferred
- How fast you want data transferred.

Basically the higher the speed that can be transmitted, the higher the cost.

Currently, there are several methods that one can use to connect to the Internet. The different options vary in speed, cost, reliability, and availability. **The goal for your company's Internet connection is to obtain the highest speed at the lowest cost.** *Seems simple? Well, not always.*

In case the abbreviations used in this article confuse you, and they will, we have provided a handy definition list at the end of this article.

ISDN

Integrated Services Digital Network (ISDN) accommodates speeds at either 64 or 128 Kbps. It works with data, voice and video signals.

- **Method:** Dedicated line with 1 or 2 channels at 56Kbps per channel.
- **Speed:** Maximum of 128Kbps with 2 channels.
- **Availability:** 90% coverage.
- **Cost:** $50-$400 to depending on type of service. Can be set at a fixed rate or variable depending on usage. Can require a 1-year contract.
- **Other Requirements:** Router and/or ISDN modem. Account with an ISP.
- **Pros:** Cost, availability, reliability, can be fixed rate..
- **Cons**: Operates in half-duplex mode

DSL

- **Method:** Uses copper pair wiring. sDSL provides the same transfer speed for uploading or downloading. aDSL provides a faster download speed but slower upload.
- **Speed:** Speeds are quoted as up to a specific rate. No assurance you will actually get the highest speed. Actual performance can result in a 70% loss.
- **Availability:** Limited

- **Cost:** Depending on the speed, $50-$125/month.
- **Other Requirements:** Need to be within 18,000 feet of CO, Router.
- **Pros:** Faster and cheaper than ISDN, fixed monthly rate, easy set-up.
- **Cons**: Operates in half-duplex mode

Cable - DSL (*Digital Subscriber Line*)

Communications are available over the same cable as used for cable TV. This can provide a high speed connection. The downside of cable is the fact that it is a shared line. The more people in your area that have cable, the slower you connection becomes.

- **Method:** Uses the same cable as cable TV.
- **Speed:** Maximum is 10,000Kbps for download, 128-256Kbps upload. Because the cable line is shared with others, speed can vary.
- **Availability:** Limited.
- **Cost:** $50-$300/month.
- **Other Requirements:** Cable modem. (Usually supplied by cable supplier)
- **Pros:** High speed, low cost, fixed rate, easy set-up.
- **Cons:** Availability, perhaps slower speeds as more users sign up. May not be able to get a dedicated IP address. Operates in half-duplex mode

T1

- **Method:** Dedicated line with up to 24 channels. Each channel provides 64Kbps
- **Speed:** 1,500-2,000Kbps
- **Availability:** Almost everywhere
- **Cost:** $375 - 1500+ month
- **Other Requirements:** Routers, DSU/CSU
- **Pros:** High speed, very reliable, fixed rate. Operates in full-duplex mode
- **Cons:** Expensive

Half Duplex: Data transmission that can occur in two directions over a single line, but only one direction at a time.

Full Duplex: Has the capability to receive and transmit data simultaneously.

Speaking Phone Talk

If you decide to discuss options with an ISP or phone company, you will discover that they speak a strange language. To help you learn this new language; here are a few commonly used buzz-words.

- **Kbps:** Thousand bytes per second.
- **POTS:** Plain old telephone service. Standard analog phone line.
- **DSL:** Digital Subscriber Line
- **sDSL:** Symmetrical Digital Subscriber Line. Same speed both directions.
- **ISDN:** Two 64Kbps channels that can be combined for a maximum of 128Kbps.
- **ISP:** Internet Service Provider
- **CPE:** Customer Premises Equipment. Catch-all term for your connection equipment.
- **CO:** Central Office - Aggregation point for all phone lines in a given area.

- **RBOC:** Regional Bell Operating Company. Monopolies created during the breakup of the Bell System in 1983.
- **ILEC:** Incumbent Local Exchange Carrier. A RBOC that typically owns the last mile of copper phone line and local exchange.
- **CLEC:** Competitive Local Exchange Carrier. A company that competes with an ILEC by supplying their own network and switching services.
- **FCC:** Federal Communications Commission. Busy bodies.

Glossary

The terms are listed in a logical manner on how they relate to each other instead of alphabetically.

Packets

Basically, when your machine connects to a network, either locally or on the Internet, **data is transmitted in packets**. Packets are groups of information that contain a **message** and **address information**.

Messages could contain an E-mail message, login and password, web site address, data, etc.

Address contents contain destination and source information, i.e. **routing information**. The routing information controls who should get the message, who sent the message and should there be a response. Visualize a super highway where each vehicle represents a packet containing information, i.e. messages. The driver knows where to deliver the message by the address information and what to do with the message based on routing information.

Protocols

So that everyone follows the same methods and so that computers can talk to each other, protocols or rules have been established.

ICMP (*Internet Control Message Protocol*) is used to communicate IP status and error messages between hosts and routers.

ARP (*Address Resolution Protocol*) is the protocol used to dynamically map internet addresses to a physical hardware device.

PPTP (*Point to Point Tunneling Protocol*) is a VPN protocol that allows Point to Point Protocol to be tunneled through an IP network.

RARP (Reverse Address Resolution Protocol) is used by a host computer to obtain an IP address based on the address of the host's network card.

RIP (*Routing Information Protocol*) is basically used between main host machines to re-direct or route traffic to the correct location. Somewhat like exit ramps on the superhighway.

Hosts: When you connect to a local server or make a connection on the Internet, you are connecting to a host computer. Host computers can be identified or accessed by either a domain name or IP address.

Domains

Domain is a element of the naming hierarchy used on the Internet.
Domain Name is a unique name that identifies a host site, either on an Internet or local Server site.

An example of a **domain name** would be **www.AHinc.com**
An example of a **domain** would be **AHinc**

DNS (*Domain Name Server*) is used to translate from the Domain Name to an IP address. The Domain Name is like your personal name and the IP address is like your social security number. If there was a DNS that contained both pieces of information, by providing your name, your social security number could be found. The main difference is there are people with the same name, but a Domain Name has to be unique.

Security

Because passwords and other confidential data are sent over a network, security methods must be employed to prevent snoopy people from reading stuff that doesn't belong to them.

Authentication is a process by which a user's identity is checked within the network.

Encryption is a type of network security used to encode data so that only the intended destination can access or decode the information.

AES (*Advanced Encryption Standard*) that uses up to 256-bit key encryption to secure data or symmetric 128-bit block data encryption.

DES (*Data Encryption Standard*) is a cryptographic algorithm method developed by the US National Bureau Standards.
SSL (*Secure Socket Layer*) is an application layer security protocol used to provide authentication and communication privacy of data transmitted over the Internet.
PAP (*Password Authentication Protocol*) and **CHAP** (*Challenge Handshake Authorization*) (*yep, were back to more protocols*) are used to identify and authenticate a user and their associated password.
RADIUS (*Remote Authentication Dial-in User Service*) is a protocol that uses an authentication server to control network access.
VPN (*Virtual Private Network*) is a security measure to protect data as it leaves one network and goes to another over the Internet.
IPSec (*Internet Protocol Security*) is a VPN protocol used to implement secure exchange of packets at the IP layer.
ACL (*Access Control List*) is used within a network security system to allow selective use of services. In the case of NAS usage, an ACL is used to control access to or denial of files or volumes. A list associated with an AFS directory specifies the actions a user or group is permitted to perform on a directory and its files.
Firewall - A firewall can consist of either a hardware device or software or combination of both. It is used to divide a network into separate parts for security reasons. Thus, it won't allow someone beyond the firewall, i.e. first part of the network, unless they have authorization. This prevents unauthorized users from gaining access to a computer network or that monitor transfers of information to and from the network.
SPI (*Stateful Packet Inspection*) is a firewall technology that inspects incoming packets of information before allowing them to enter the network.
DMZ Demilitarized Zone that removes the router's firewall protection from a computer, allowing it to be seen from the Internet.
DoS (*Denial of Service*) defines a type of attack designed to prevent legitmate users from accessing a resource by overwhelming that resource with useless and malicious traffic.
Intrusion Attack is a type of Internet attack in which an attacker tries to gain access to the information transmitted through the network.
Intrusion Prevention System is a mechanism to detect malicious software, such as Internet worms, Trojan Horses and DoS that can't be detected by a conventional firewall.

Wireless

Access Point is a device that allows wireless-equipped computers and other devices to communicate with each other and with a wired network.

802.11a Wireless network standard with a maximum data transfer rate of 54Mpbs in the frequency range of 5GHz. It has a greater bandwidth that 802.11b but a shorter range.

802.11b Wireless network standard with a maximum data transfer rate of 11Mpbs in the frequency range of 2.4GHz.

802.11g Wireless network standard with a maximum data transfer rate of 54Mpbs in the frequency range of 5GHz and backward compatibility to 802.11b devices.

802.11n Wireless network standard with a maximum data transfer rate of 300Mpbs in the frequency range of of 2.4 or 5GHz and backward compatiblity to 11a, b and g devices.

DTIM (*Delivery Traffic Indication Manager*) is a message included in data packets that can increase wireless efficiency.

SSID (*Service Set Identifier*) Your wireless network's name.

WEP (*Wired Equivalency Protocol*) is a security protocol for wireless networks. WEP aims to provide security by encrypting data over radio waves so that it is protected as it is transmitted from one end point to another. A shared key (similar to a password) is used to allow communication between computers and the router. WEP is fairly easy for hackers to crack and has mainly been replaced by WPA.

Wi-Fi is a brandname of the Wi-Fi Alliance used to describe wireless (WLAN) technology based on the 802.11 standards. **Wi-Fi Alliances** is a trade group that performs testing, develops specifications, certifies interoperability of products and promotes wireless networking technology, The Wi-Fi Alliances owns the trademark to Wi-Fi.

WPA (*Wi-Fi Protected Access*) is a security protocol for wireless networks that builds on WEP. It secures wireless data transmission by using akey similar to WEP with the added strength is that key changes dynamically. The changing key makes it much more difficult for a hacker to learn the key and gain access to the network.

WPA2 is the second generation of WPA security and provides a stronger encryption mechanism though AES.

WPA Personal is a version of WPA that uses long and constantly changing encryption keys to make them difficult to decode.

WPA Enterprise is a version of WPA that uses the same dynamic keys as WPA Personal and also requires each wireless device to be authroized according to a master list held in a special authentication server.

Other Terms

Bandwidth is the transmission capacity of a given device or network. Think of as lanes on the highway. The more lanes, the greater the bandwidth and the amount of traffic that can be sent or received.
Broadband is an always-on fast Internet connection.
Cookie is a piece of information sent by a Web site to your Web browser. Your system saves the piece of information and is expected to send it back to the server whenever it is requested.

This technique seems innocent enough at the first look, but can be a source of getting a virus. I have my browser set to notify me of any cookie before accepting it. If I am viewing a web site that I am not familiar with or don't trust, I don't accept the cookie.

Hop is the data link between two gateways.
MAC (*Media Access Control*) is an unique address that a manufacturer assigns to each networking device.
NAT (*Network Address Translation*) os a technology that translates IP addresses of the local area network to a different IP address for the Internet.
PoE (*Power over Ethernet*) is a technology enabling an Ethernet network cable to deliver both data and power. This elimanates having to plug the unit into a AC power outlet.
Ping (*Packet Internet Groper*) is an Internet utility to determine whether a particular IP address is online.
Subnet Mask is an address code that determines the size of the network. A common network mask is 255.255.255.0.
VOIP (*Voice over Internet Protocol*) that enables people to use the Internet to transmit packets of voice data using IP rather than traditional circuit transmissions.

Understanding DVD

The advantage of DVD's over CD's are...

- 5 to 6 times the capacity
- longer shelf life
- faster retrieval

Both CD's and DVD's store data in microscopic grooves running in a spiral around the disc. Reflective bumps (lands) and non-reflective highs (pits) aligned along the grooves represent the zeros and ones of digital information.

DVD technology writes in smaller pits by reducing the laser's wavelength from 780mm to 625-650mm, resulting in higher capacity. In addition, the DVD tracks are closer together.

DVD's access data faster than CD and users more error correction. A DVD 1x is faster than 8x CD.

Most DVD's can read CD's and CD-R's, so the transition from CD to DVD is simple. It is important to understand the **different types** of DVD drives (*here we go with more abbreviations, sorry*)...

DVD Types

- **DVD-RAM** - Random Access Memory (Read and Write)
- **DVD-R** or **DVD+R** Recordable (Only write one time)
- **DVD-RW** or **DVD+RW** Re-recordable or Rewritable (Read and Write)
- **DVD-ROM** Read Only Memory (Read Only)

Random versus Sequential

- **DVD-RAM** uses **random** access technology
- **DVD-R, +R, -RW, +RW or ROM** use a **sequential** technology.

Random Access: DVD-RAM (Read & Write)

- o Can be used as the ideal technology for backup or storage. Unlike tape storage that can only read data sequentially, DVD-RAM can access data randomly just like a normal hard drive. This makes a selective recovery process much easier and faster.
- o Can be overwritten up to 100,000 times.
- o Provides 4.7GB (Type 2) per side storage capacity or 9.4GB (Type 4) two-sided.
- o Life expectancy of 100 years.
- o Can only be written and read with DVD-R/RAM drives.
- o Since first introduced in 1998, the price for has dropped from $2,000 to less than $500.

Sequential: DVD-R, +R, -RW, +RW or ROM

This group of DVD's are intended for the hi-tech graphics, video for movies and audio for music. They provide **better quality for graphics and sound** along with higher capacity of **4.7GB.**

Writable: One Time

- **DVD-R**
  - Can only be **written** with **-R** type drives.
  - Can be **read** with **-R or +R** type drives.
- **DVD+R**
  - 2 hours of video in SP mode or 4 hours in EP mode.
  - Can only be **written** with **+R** type drives.
  - Can be **read** with **-R or +R** type drives.

Writable: Re-writable up to 1000 Times

- **DVD-RW**
  - Contains protection technology that prevents copying of CSS-protected discs.
  - Can only be **written** with **-R** type drives.
  - Can be **read** with **-R or +R** type drives.
- **DVD+RW**
  - Can hold 2 hours of MPEG2.
  - Can only be **written** with **+R** type drives.
  - Can be **read** with **-R or +R** type drives.

Read Only

- **DVD-ROM**
  - Can only be **used for reading**.

Movies you buy or rent are usually DVD-ROM

PDA Devices

The **Palm Pilot** has been around for several years. When I first saw one I thought cute, nice toy, but who needs it. Well, once again I proved myself wrong!

We use the Palm for customer contact list, schedule, memos, to do's, and time tracking.

One of my early concerns was would it recognize my horrible handwriting. I even have trouble reading my own handwirting. After about 10 minutes of learning how to print letters palm-style, I was off and running.

The beauty of the Palm lies in the simplicity of use. The Palm OS is very solid. Synchronizing data from and to your PC is as easy as pressing a single button. The basic concept of usage for the Palm is anywhere, anytime, anyplace.

There are hundreds of free or very reasonably priced software packages that you can download from the Internet. One of my favorite sites is http://www.tucows.com. Installing new software doesn't get any easier. There is even an Excel look-alike spreadsheet package that automatically interfaces with Excel.

Custom database options for the Palm

We were probably late in using handheld PDA devices, such as the Palm Pilot. But we are now finding an almost unlimited use for these handy, small and easy-to-use devices. What has opened the door is a software product called **ThinkDB** that can easily create custom applications. In a nutshell this product...

- Allows us to **quickly develop custom forms and databases**
- Allows the user to **easily enter or maintain data**
- Automatically **synchronize with an Access database**
- Allows **non-PDA users to access and maintain the same data**

Your data resides in one easy-to-use, always connected, handheld program. Whether you are away from the office or need a quick update, ThinkDB keeps you in control and up-to-date by using **dbSync**. Information from your handheld is automatically updated to and from your corporate data.

There are more than 300,000 PDA users who are already using ThinkDB. According to the ThinkDB people, the three most popular uses are...

- Collecting important data in the field in a structured way
- Broadcasting data to mobile teams
- Synchronizing corporate data with a mobile workforce

An example of a simple application is to retain customer and contact information. The Palm OS already provides a program to store contact information and associated company information, but it is limited in its capability. By creating a custom database you can define special fields to help define and classify your customers.

Depending on your needs, you could...

- Track all past sales and/or purchasers
- YTD and/or Last Year Customer Sales
- Current Orders
- Basically any data that helps your sales force
- Retain information on your product line such as technical notes, specifications, related products, etc. This data could also be provided to your customers for their convenience.
- Use it for performing physical inventory counting
- Use your imagination - What data do you want at your finger tips when in or out of the office?

For our own use, we have developed a contact management, project and time capture system.

The use of this technology could help eliminate those wasteful forms, such as expense reports, time cards, project reporting, surveys, procurement forms, research reports, and sales tracking.

Power Protection Explained

- Determining UPS Size
- Testing your UPS
- Types of power problems
- Types of power protection

Determining UPS Size

First decide what equipment you want to use the UPS for. At a minimum it should be your computer and perhaps one terminal. By having a terminal on the UPS this will allow you to shutdown the computer before the UPS runs out of juice.

On the back of the equipment there should be a listing in either watts or amps. You need to calculate the voltage-amps (VA) power rating. If watts is given, VA=watts x 1.7. If amps is given, VA=amps x 120. Add up the total VA values. **You will need an UPS with at least the total VA value.**

It is recommended to go higher than your VA total. A VA of 600 on a UPS rated at 600 will run for about 5 minutes. By increasing the UPS to 900, the same VA of 600 will increase the run time to 15 minutes.

Testing Your UPS

These simple instructions will allow you to verify the battery power of your UPS. Over time, UPS batteries wear out. This leads to a loss of power capacity and runtime. Testing your unit monthly will ensure that the batteries are still providing the required runtime for your system.

Depending upon the model of UPS you own, you may either perform a manual test on your unit or use APC's PowerChute(R) plus software to monitor and log the results of the automatic battery test.

To perform a manual test you..

- Simply press the test button located on the UPS.
- After testing, if you find that the battery indicator has turned red, then you may need to replace your batteries or upgrade your UPS.

The new APC systems have user-replaceable batteries which can be changed with no system downtime! If your UPS has neither a self-test button nor PowerChute, you have a very old model. It's probably time to upgrade your UPS.

Power Problem Types

Blackout

This is when the power drops to practically or absolutely nothing. In a study by IBM of the five major causes of power disturbances, blackouts rated for only 1% of the total. UPS are the only devices that will handle blackouts.

Brownout

This is a temporary reduction in power which can last from seconds to hours. This is the most significant of power problems and accounts for 87%. Utility companies will sometimes actually cause a brownout on purpose to provide a little power to everyone during high demands. Conditioners or an UPS with conditioner will handle brownouts.

Surges

A surge is a transient increase of power for more than a fraction of a second and less than 2.5 seconds. Surges cause a power supply to generate heat. Heat is the major cause of equipment failure. SURGE SUPPRESSORS DO NOT SUPPRESS SURGES, they only suppress spikes. Conditioners or an UPS with conditioner will handle surges.

Spikes

Spikes are an intense increase/decrease in voltage. They are more extreme than a surge and of shorter duration. Spikes can mess up the computer's memory causing weird or strange things to happen. In extreme cases, spikes can actually melt wiring. An IBM study predicts a power disturbance at least twice a day. Surge suppressor protect against spikes. Don't ask why they don't call them spike suppressor.

Types of Power Protectors

Surge Suppressor

There are three types of suppressor.

- o Metal-oxide (MOV) based. They become less effective with each surge. Not very durable to offer reliable protection.
- o Silicon avalanche diodes. Do not degrade.
- o MOV or silicon based combined with a "gas tube". They can handle large amounts of energy. Suppressor should have rating of IEEE 587 or UL 1449.

UPS

These also come in three types.

- o An online UPS continuously draws current from power line and the computer gets all of its power from the UPS. At one time these were the most reliable because there is only an instant between the time power drops and the UPS kicks in. Most important in hospital life support systems.
- o Off-line or standby waits for a problem and kicks in when the power fails. The benefit is that the batteries don't wear out as soon as onlines. Current off-line models kick in just as quick as online models.
- o Line interactive is a hybrid of online/offline. The computer draws very little power from the UPS unless the power drops. Average battery life is five years.

Line Voltage Regulators

These protect against voltage fluctuation but don't handle surges, spikes or blackouts.

Isolation Transformers

These protect equipment from electrical noise. They are used with mainly communication and process control equipment.

Power Line Conditioner

This is a combination of line voltage regulator, isolation transfer and surge suppressor. It handles everything but blackouts.

Telephone Line Surge Suppressor

This is a type of surge suppressor. Because a modem provides little or no power protection, power problems over phone lines can be more destructive than over electrical power lines.

SCSI Explained

- Why SCSI
- Bus Width & Speed
- SCSI Chart
- Other SCSI Benefits
- What is LVD
- Connector Guide
- Cable Guide

If you are thinking of getting a new server or a workstation where the main requirement is for heavy duty file access, you must consider using a **Small Computer Systems Interface** (**SCSI**, pronounced scuzzy).

Why SCSI

Most servers spend a considerable amount of their time reading and writing to storage devices. Currently the SCSI interface provides the **fastest method** to perform this operation.

Most workstations use the IDE or EIDE interface. Probably the reason is that IDE drives are cheaper than SCSI type devices. For most workstation usage, the IDE interface is more than adequate. But if high speed disk access is crucial, the choice should be SCSI. Other articles in our newsletter have referred to the fact that you can't measure a system's performance based on the CPU speed alone. This is especially true in the case of a server when tasks are not normally CPU bound, but are file I/O bound.

Are all SCSI interfaces created equal? Of course not! As time marches on, improvements have been made to the original SCSI design. The terminology that has been used to define the improvements does not exactly represent the changes. There are terms like Fast SCSI, Fast Wide SCSI, Ultra SCSI, Wide Ultra SCSI, Ultra2 SCSI and Wide Ultra2 SCSI. *From these titles can you tell what is the best?* My guess is probably not.

Should you know the difference? My guess is yes, if you are planning to acquire new equipment or update old equipment. So we have finally arrived at the purpose of this article. That is to define the differences and to provide you with the knowledge that will help you understand.

Bus Width and Speed

The definitions below are listed in order from the slowest to the fastest type. In simple terms, there are two measurements to consider: **Bus Width** and **Bus Speed**. One other consideration is the **number of SCSI devices** that can be configured in one machine.

- **Bus width** is measured in bits and is either **8 or 16 bits**. Easiest way to understand this is to relate to lanes on a highway. A 16 lane highway will allow for more traffic than an 8 lane highway. Of course the 16 lane highway will cost more.
- **Bus speed** is measured in megabytes (MB). The rating represents how many megabytes can be accessed in a second. A higher rating represents faster access.

SCSI Chart

Type	Alternate Name	Bus Width (bits)	Bus Speed (MB's/sec)	Max. Devices	Bus Length (Meters)		
					Single	HVD	LVD

SCSI-1		8	5	8	6	25	
Fast SCSI		8	10	8	3	25	
Ultra SCSI	Narrow Ultra SCSI	8	20	8	1.5	25	
Ultra2 SCSI	Narrow Ultra2 SCSI	8	40	8		25	12
Fast Wide SCSI		16	20	16	3	25	
Wide Ultra SCSI		16	40	16	1.5	25	
Wide Ultra2 SCSI		16	80	16		25	12
Ultra3 SCSI	Ultra160 SCSI	16	160	16			12
Ultra320 SCSI		16	320	16			12

Other SCSI Benefits

Besides the speed issues, another important feature of SCSI interfaces is that backwards compatibility has been incorporated in all new improvements. A rare situation for computer technology.

Thus, if you have older SCSI devices, they will still work as you upgrade to newer technology. Different SCSI technologies can be mixed on the same machine. Even though a new SCSI method may be used, older SCSI devices will not run any faster and newer SCSI devices will only run as fast as the SCSI controller allows.

SCSI devices provide the capability of interfacing with a wide variety of devices. Supported peripherals are tape drives, optical drives, hard disk drives, scanners, printers, disk array subsystems (RAID) and CD-ROM drives.

What is LVD

- The terms LVD and Ultra2 SCSI are used interchangeably.
- It is a **subset of the SCSI-3** standard.
- It provides SCSI bus data rates of **80 Mbytes/sec**.
- It provides **differential data integrity**
- It extends the SCSI bus **cable lengths to 25 meters** (12 meters with 16 devices)
- LVD was defined in the original SCSI standards.

The increased bandwidth of 80 Mbytes means **optimal performance where rapid response is required** and random access and large queues are the norm. When using applications such as CAD and CAM, digital video and any RAID environment, the increased bandwidth is immediately noticeable as information is moved quickly and effortlessly.

The **lower voltage requirements** of LVD allow for the integration of the differential drivers and receivers into the drive's onboard SCSI controller. The older Ultra HVD design requires separate and costly high-voltage components.
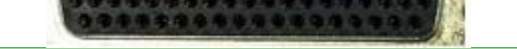
LVD is fully compatible with the existing single-ended SCSI base. A unique circuit determines the type of SCSI bus the device is being used on, LVD or single-ended, and configures the drive operation to the appropriate bus capability.

LVD devices will work on SCSI-1and SCSI-2 bus segments. Older SCSI-1 and SCSI-2 single-ended devices will work on an LVD bus.

Connector Guide

Sample	Type	Pins	Used By	Comments

IDC50-M	50	Narrow: SCSI-1 & 2, Ultra SCSI	Internal 8 bit
IDC50-F			
HD68-M	68	Ultra2 LVD and Ultra Wide SCSI3	Internal/External. About 1 7/8" wide
HD68-F			
CN50-M	50	SCSI 1 & 2	External. Also called Centronics C50
CN50-F			
HD50-M	50	SCSI 2 & 3	External About 1 3/8" wide
HD50-F			
DB25-M	25	SCSI-1	External Used by older Macs, Zip drives and scanners
DB25-F			
HDI30-M	30		External Apple PowerBooks
DB50-M	50	SCSI-1	Used on old Sun Sparcstations
DB50-F			
DB37-M	37	SCSI-1	
DB37-F			

	VHDCI-M	68	Ultra SCSI 2 & 3	Popular on RAID cards. 0.8mm
	VHDCI-F			
	HPCN50	50		Used in Japan on Digital cameras
	HDCN60	60		Used on old IBM rs6000's

Cable Guide

SCSI Type	Code	Pins	Comments
SCSI -1	A	50	External - Centronics C50
			Internal - Ribbon cable
SCSI-2	A	50	External - High Density D50M
			Internal - Ribbon Cable
SCSI-3	P	68	External - High Density D68M
			Internal - High Density
			External - VHDCI connector

RAID Explained

Redundant Arrays of Inexpensive Disks, as named by the inventors and commonly referred to as RAID, is a technology that supports the integrated use of two or more hard-drives in various configurations for the purposes of achieving greater performance, reliability through redundancy, and larger disk volume sizes through aggregation. RAID is also sometimes referred to as "Redundant Arrays of Inexpensive *Drives*" or "Redundant Arrays of *Independent* Disks/Drives". RAID is an umbrella term for computer data storage schemes that divide and replicate data among multiple hard disk drives. RAID's various designs balance or accentuate two key design goals: increased data reliability and increased I/O (input/output) performance.

A number of standard schemes have evolved which are referred to as *levels*. There were five RAID levels originally conceived, but many more variations have evolved, notably several nested levels and many non-standard levels (mostly proprietary).

RAID combines physical hard disks into a single logical unit by using either special hardware or software. Hardware solutions often are designed to present themselves to the attached system as a single hard drive, and the operating system is unaware of the technical workings. Software solutions are typically implemented in the operating system, and again would present the RAID drive as a single drive to applications.

There are three key concepts in RAID: mirroring, the copying of data to more than one disk; striping, the splitting of data across more than one disk; and error correction, where redundant data is stored to allow problems to be detected and possibly fixed (known as fault tolerance). Different RAID levels use one or more of these techniques, depending on the system requirements. The main aims of using RAID are to improve reliability, important for protecting information that is critical to a business, for example a database of customer orders; or where speed is important, for example a system that delivers video on demand TV programs to many viewers.
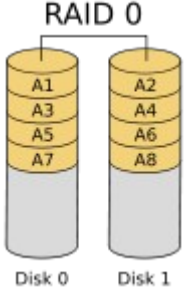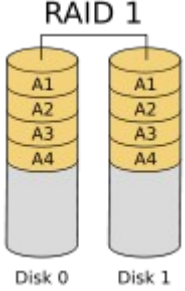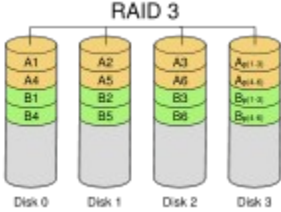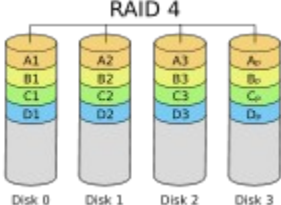
The configuration affects reliability and performance in different ways. The problem with using more disks is that it is more likely that one will go wrong, but by using error checking the total system can be made more reliable by being able to survive and repair the failure. Basic mirroring can speed up reading data as a system can read different data from both the disks, but it may be slow for writing if the configuration requires that both disks must confirm that the data is correctly written. Striping is often used for performance, where it allows sequences of data to be read from multiple disks at the same time. Error checking typically will slow the system down as data needs to be read from several places and compared. The design of RAID systems is therefore a compromise and understanding the requirements of a system is important. Modern disk arrays typically provide the facility to select the appropriate RAID configuration.

RAID systems can be designed to keep working when there is failure - disks can be hot swapped and data recovered automatically while the system keeps running. Other systems have to be shut down while the data is recovered. RAID is often used in high availability systems, where it is important that the system keeps running as much of the time as possible.

RAID is traditionally used on servers, but can be also used on workstations. The latter was once common in storage-intensive applications such as video and audio editing, but has become less advantageous with the advent of large, fast, and inexpensive hard drives based on perpendicular recording technology.

Standard levels

A brief summary of the most commonly used RAID levels. The SNIA Dictionary also contains definitions of the RAID levels that have been vetted by major storage industry players, and is referenced below as applicable.
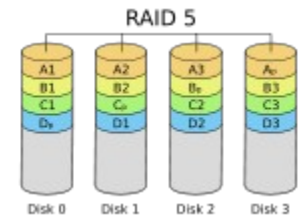
Level	Description	Minimum # of disks	Image
RAID 0	Striped set without parity. Provides improved performance and additional storage but no fault tolerance. Any disk failure destroys the array, which becomes more likely with more disks in the array. A single disk failure destroys the entire array because when data is written to a RAID 0 drive, the data is broken into fragments. The number of fragments is dictated by the number of disks in the drive. The fragments are written to their respective disks simultaneously on the same sector. This allows smaller sections of the entire chunk of data to be read off the drive in parallel, giving this type of arrangement huge bandwidth. When one sector on one of the disks fails, however, the corresponding sector on every other disk is rendered useless because part of the data is now corrupted. RAID 0 does not implement error checking so any error is unrecoverable. More disks in the array means higher bandwidth, but greater risk of data loss. SNIA definition.	2	
RAID 1	Mirrored set without parity. Provides fault tolerance from disk errors and single disk failure. Increased read performance occurs when using a multi-threaded operating system that supports split seeks, very small performance reduction when writing. Array continues to operate so long as at least one drive is functioning. SNIA definition.	2	
RAID 3	Striped set with dedicated parity. This mechanism provides an improved performance and fault tolerance similar to RAID 5, but with a dedicated parity disk rather than rotated parity stripes. The single parity disk is a bottle-neck for writing since every write requires updating the parity data. One minor benefit is the dedicated parity disk allows the parity drive to fail and operation will continue without parity or performance penalty. SNIA definition	3	
RAID 4	Identical to RAID 3 but does block-level striping instead of byte-level striping. SNIA definition	3	

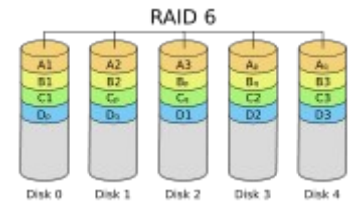|		
RAID 5	Striped set with distributed parity. Distributed parity requires all but one drive to be present to operate; drive failure requires replacement, but the array is not destroyed by a single drive failure. Upon drive failure, any subsequent reads can be calculated from the distributed parity such that the drive failure is masked from the end user. The array will have data loss in the event of a second drive failure and is vulnerable until the data that was on the failed drive is rebuilt onto a replacement drive. SNIA definition	3
RAID 6	Striped set with dual parity. Provides fault tolerance from two drive failures; array continues to operate with up to two failed drives. This makes larger RAID groups more practical, especially for high availability systems. This becomes increasingly important because large-capacity drives lengthen the time needed to recover from the failure of a single drive. Single parity RAID levels are vulnerable to data loss until the failed drive is rebuilt: the larger the drive, the longer the rebuild will take. With dual parity, it gives time to rebuild the array without the data being volatile while the failed drive is being recovered. SNIA definition	4

Nested levels

Main article: Nested RAID levels

Many storage controllers allow RAID levels to be nested. That is, one RAID that can use another as its basic element, instead of using physical drives. It is instructive to think of these arrays as layered on top of each other, with physical drives at the bottom.

Nested RAIDs are usually signified by joining the numbers indicating the RAID levels into a single number, sometimes with a '+' in between. For example, RAID 10 (or RAID 1+0) conceptually consists of multiple level 1 arrays stored on physical drives with a level 0 array on top, striped over the level 1 arrays. In the case of RAID 0+1, it is most often called RAID 0+1 as opposed to RAID 01 to avoid confusion with RAID 1. However, when the top array is a RAID 0 (such as in RAID 10 and RAID 50), most vendors choose to omit the '+', though RAID 5+0 is more informative.

- RAID 0+1: striped sets in a mirrored set (minimum 4 disks; even number of disks) provides fault tolerance and improved performance but increases complexity. The key difference from RAID 1+0 is that RAID 0+1 creates a second striped set to mirror a primary striped set. The array continues to operate with one or more drives failed in the same mirror set, but if two or more drives fail on different sides of the mirroring, the data on the RAID system is lost.

- RAID 1+0: mirrored sets in a striped set (minimum 4 disks; even number of disks) provides fault tolerance and improved performance but increases complexity. The key difference from RAID 0+1 is that RAID 1+0 creates a striped set from a series of mirrored drives. In a failed disk situation RAID 1+0 performs better because all the remaining disks continue to be used. The array can sustain multiple drive losses as long as no two drives lost comprise a single pair of one mirror.

- RAID 5+0: stripe across distributed parity RAID systems

- RAID 5+1: mirror striped set with distributed parity (some manufacturers label this as RAID 53).

on-standard levels

Given the large amount of custom configurations available with a RAID array, many companies, organizations, and groups have created their own non-standard configurations, typically designed to meet the needs of at least one but usually very small niche groups of arrays. Most of these non-standard RAID levels are proprietary.

Some of the more prominent modifications are:

- CalDigit Inc *HDPro* adds parity RAID protection (RAID 5 and RAID 6) to subsystems which provides high-speed data transfer rate for 2K film, uncompressed high-definition video, standard-definition video, DVCProHD and HDV editing.
- ATTO Technology's *DVRAID* adds parity RAID protection to systems which demand performance for 4K film, 2K film, high-definition audio and video.
- Storage Computer Corporation uses *RAID 7*, which adds caching to RAID 3 and RAID 4 to improve I/O performance.
- EMC Corporation offered *RAID S* as an alternative to RAID 5 on their Symmetrix systems (which is no longer supported on the latest releases of Enginuity, the Symmetrix's operating system).
- The ZFS filesystem, available in Solaris, OpenSolaris, FreeBSD and Mac OS , offers *RAID-Z*, which solves RAID 5's write hole problem.
- Network Appliance's Data ONTAP uses RAID-DP (also referred to as "double", "dual" or "diagonal" parity), which is a form of RAID 6, but unlike many RAID 6 implementations, does not use distributed parity as in RAID 5. Instead, two unique parity disks with separate parity calculations are used. This is a modification of RAID 4 with an extra parity disk.
- Accusys *Triple Parity* (RAID TP) implements three independent parities by extending formula of standard RAID 6 algorithms on its FC-SATA and SCSI-SATA RAID controllers so as to tolerate three-disk failure.
- Linux *MD RAID10* (RAID10) implements a general RAID driver that defaults to a standard RAID 1+0 with 4 drives, but can have any number of drives, including an odd number. MD RAID10 can even run striped and mirrored with only 2 drives with the f2 and o2 layouts

Implementations

The distribution of data across multiple drives can be managed either by dedicated hardware or by software. When done in software the software may be part of the operating system or it may be part of the firmware and drivers supplied with the card.

Operating system based ("software raid")

Software implementations are now provided by many operating systems. A software layer sits above the (generally block-based) disk device drivers and provides an abstraction layer between the logical drives (RAID arrays) and physical drives. Most common levels are RAID 0 (striping across multiple drives for increased space and performance) and RAID 1 (mirroring two drives), followed by RAID 1+0, RAID 0+1, and RAID 5 (data striping with parity).

Microsoft's server operating systems support 3 RAID levels; RAID 0, RAID 1, and RAID 5. Microsoft desktop operating systems support RAID 0 only. There is no software support for fault tolerance RAID levels in the desktop operating systems.

Since the software must run on a host server attached to storage, the processor (as mentioned above) on that host must dedicate processing time to run the RAID software. This is negligable for raid 0 and raid 1 but may be more significant for complex parity based schemes. Furthermore all the busses between the processor and the disk controller must carry the extra data required by raid which may cause congestion on those busses.

Another concern with operating system based raid is the boot process, it can be difficult or impossible to set up the boot process such that it can failover to another drive if the usual boot drive fails and therefore such systems can require manual intervention to make the machine bootable again after a failure. Finally operating system based raid usually uses formats proprietary to the operating system in question so it cannot generally be used for partitions that are shared between operating systems as part of a multi-boot setup.

Most operating system based implementations, allow RAID arrays to be created from partitions rather than entire physical drives. For instance, an adminstrator could you to divide an odd number of disks into two partitions per disk, mirror partitions across disks and stripe a volume across the mirrored partitions to emulate a RAID 1E configuration. Using partitions in this way also allows mixing reliability levels on the same set of disks. For example, one could have a very robust RAID-1 partition for important files, and a less robust RAID-5 or RAID-0 partition for less important data. (Some high end hardware controllers offer similar features e.g. Intel Matrix RAID.) Using two partitions on the same drive in the same RAID array is, however, dangerous. If, for example, a RAID 5 array is composed of four drives 250 + 250 + 250 + 500 GB, with a 500 GB drive split into two 250 GB partitions, a failure of this drive will remove two partitions from the array, causing all of the data held on it to be lost.

Hardware-based

Since these controllers use proprietary disk layouts, they typically cannot span controllers from multiple manufacturers. Two advantages over software RAID are that the BIOS can boot from them, and that tighter integration with the device driver may offer better error handling.

A hardware implementation of RAID requires at a minimum a special-purpose RAID controller. On a desktop system, this may be a PCI expansion card, PCI-Express Expansion Card or might be a capability built into the motherboard. Any drives may be used - IDE/ATA, SATA, SCSI, SSA, Fibre Channel, sometimes even a combination thereof. In a large environment the controller and disks may be placed outside of a physical machine, in a stand alone disk enclosure. The using machine can be directly attached to the enclosure in a traditional way, or connected via SAN. The controller hardware handles the management of the drives, and performs any parity calculations required by the chosen RAID level.

Most hardware implementations provide a read/write cache which, depending on the I/O workload, will improve performance. In most systems write cache may be non-volatile (e.g. battery-protected), so pending writes are not lost on a power failure.

Hardware implementations provide guaranteed performance, add no overhead to the local CPU complex and can support many operating systems, as the controller simply presents a logical disk to the operating system.

Hardware implementations also typically support hot swapping, allowing failed drives to be replaced while the system is running.

Firmware/driver based raid ("Fake RAID")

Operating system based raid cannot eassily be used to protect the boot process and is generally impractical on Windows desktops (as detailed above). Hardware raid controllers are expensive. To fill this gap companies introduced cheap "raid controllers" that do not contain a raid controller chip. Instead they consist of a standard disk controller chip with special firmware and drivers. During early stage bootup the raid is implemented by the firmware, when a modern protected mode operating system (usually Windows) is loaded the drivers take over.

Since these controllers are sold as raid controllers (which prior to thier introduction implied a controller that did raid in hardware) and it is rarely made clear to users that the raid is done in software they have become known as "Fake RAID". Despite this name the raid itself, while implemented in software, is real.

Hot spares

Both hardware and software implementations may support the use of *hot spare* drives, a pre-installed drive which is used to immediately (and automatically) replace a drive that has failed, by rebuilding the array onto that empty drive. This reduces the mean time to repair period during which a second drive failure in the same RAID redundancy group can result in loss of data, though it doesn't eliminate it completely; array rebuilds still take time, especially on active systems. This is especially important as the failure of drives in an array is unlikely to be completely independent. The drives will have recieved a similar load pattern so are likely to come into wear out failure at about the same time.

Raid 6 uses the same number of drives as raid 5 with a hot spare and eliminates the window of vulnerability to a second drive failure mentioned above but requires a more advanced raid controller.

Reliability terms

Failure rate
> The mean time to failure (MTTF) or the mean time between failure (MTBF) of a given RAID is the same as those of its constituent hard drives, regardless of what type of RAID is employed.

Mean time to data loss (MTTDL)
> In this context, the average time before a loss of data in a given array.[4]. Mean time to data loss of a given RAID should be higher, but can be lower than that of its constituent hard drives, depending upon what type of RAID is employed.

Mean time to recovery (MTTR)
> In arrays that include redundancy for reliability, this is the time following a failure to restore an array to its normal failure-tolerant mode of operation. This includes time to replace a failed disk mechanism as well as time to re-build the array (i.e. to replicate data for redundancy).

Unrecoverable bit error rate (UBE)
> This is the rate at which a disk drive will be unable to recover data after application of cyclic redundancy check (CRC) codes and multiple retries.

Write cache reliability
> Some RAID systems use RAM write cache to increase performance. Failure of the RAM can lose data.

Atomic write failure
> Also known by various terms such as torn writes, torn pages, incomplete writes, interrupted writes, non-transactional, etc.

Issues with RAID

Correlated failures

The theory behind the error correction in RAID assumes that failures of drives are independent. Given these assumptions it is possible to calculate how often they can fail and to arrange the array to make data loss arbitrarily improbable.

In practice, the drives are often the same ages, with similar wear. Since many drive failures are due to mechanical issues which are more likely on older drives, this violates those assumptions and failures are in fact statistically correlated. In practice then, the chances of a second failure before the first has been recovered is not nearly as unlikely as might be supposed, and data loss can in practice occur at significant rates.

Atomicity

This is a little understood and rarely mentioned failure mode for redundant storage systems that do not utilize transactional features. Database researcher Jim Gray wrote "Update in Place is a Poison Apple" during the early days of relational database commercialization. However, this warning largely went unheeded and fell by the wayside upon the advent of RAID, which many software engineers mistook as solving all data storage integrity and reliability problems. Many software programs update a storage object "in-place"; that is, they write a new version of the object on to the same disk addresses as the old version of the object. While the software may also log some delta information elsewhere, it expects the storage to present "atomic write semantics," meaning that the write of the data either occurred in its entirety or did not occur at all.

However, very few storage systems provide support for atomic writes, and even fewer specify their rate of failure in providing this semantic. Note that during the act of writing an object, a RAID storage device will usually be writing all redundant copies of the object in parallel, although overlapped or staggered writes are more common when a single RAID processor is responsible for multiple drives. Hence an error that occurs during the process of writing may leave the redundant copies in different states, and furthermore may leave the copies in neither the old nor the new state. The little known failure mode is that delta logging relies on the original data being either in the old or the new state so as to enable backing out the logical change, yet few storage systems provide an atomic write semantic on a RAID disk.

While the battery-backed write cache may partially solve the problem, it is applicable only to a power failure scenario.

Since transactional support is not universally present in hardware RAID, many operating systems include transactional support to protect against data loss during an interrupted write. Novell Netware, starting with version 3.x, included a transaction tracking system. Microsoft introduced transaction tracking via the journalling feature in NTFS. NetApp WAFL file system solves it by never updating the data in place, as does ZFS.

Unrecoverable data

This can present as a sector read failure. Some RAID implementations protect against this failure mode by remapping the bad sector, using the redundant data to retrieve a good copy of the data, and rewriting that good data to the newly mapped replacement sector. The UBE rate is typically specified at 1 bit in 10^{15} for enterprise class disk drives (SCSI, FC, SAS) , and 1 bit in 10^{14} for desktop class disk drives (IDE, ATA, SATA). Increasing disk capacities and large RAID 5 redundancy groups have led to an increasing inability to successfully rebuild a

RAID group after a disk failure because an unrecoverable sector is found on the remaining drives. Double protection schemes such as RAID 6 are attempting to address this issue, but suffer from a very high write penalty.

Write cache reliability

The disk system can acknowledge the write operation as soon as the data is in the cache, not waiting for the data to be physically written. However, any power outage can then mean a significant data loss of any data queued in such cache.

Often a battery is protecting the write cache, mostly solving the problem. If a write fails because of power failure, the controller may complete the pending writes as soon as restarted. This solution still has potential failure cases: the battery may have worn out, the power may be off for too long, the disks could be moved to another controller, the controller itself could fail. Some disk systems provide the capability of testing the battery periodically, which however leaves the system without a fully charged battery for several hours.