Hardware Diagnostics

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A vital skill for the network technician
Agenda

- Introduction
- What’s inside a computer and how does it work?
- Why are hardware diagnostics important?
- Common issues
- Useful tools
- Tips and tricks
- Contacting the manufacturer
Introduction

Understanding hardware is often the forgotten art within the IT industry. Such is the demand and requirement for software knowledge and qualification that the skill of understanding how your hardware works, and more importantly how it works alongside your software, seems to take a back seat. It should just work shouldn’t it?, plug it in and press ON, and off you go. In most cases this is what you should expect, however what do you do when a piece of hardware is not functioning as expected?

In this session we are going to look at the art of diagnosing hardware issues, how to determine if a fault or error is caused by corrupt software or a failing piece of hardware, and some of the useful tools and tricks used to stress test and confirm exactly what is causing the fault/error.

This may seem obvious to some but often hardware is misdiagnosed as the cause of a problem, or the wrong component may be swapped if the correct diagnostics were not carried out.
What’s inside a computer case?

So the first thing we should look at when talking about hardware is what exactly is inside a PC case. This will give you an understanding of where the components are located and is a key step in diagnosing possible hardware faults. We will be talking in most cases about desktop computers, although much of what we will refer to will also apply to notebook/laptop computers, I will point out where the differences occur.

Every computer will include the following –

- A power supply unit (PSU)
- A mainboard (or motherboard)
- A processor (CPU – Central Processing Unit)
- Memory (RAM – Random Access Memory)
- A hard disk drive (HDD)
- SATA cable or IDE cable (Serial ATA or Intelligent Drive Electronics)
In addition to the above vital components for a computer to work there are also some additional components listed below –

- Optical drive (CD/DVD drive)
- Add in PCI/PCIe cards (Separate graphics cards, sound cards, network cards, which plug into the mainboard)
- Multiple hard disk drives for extra disk storage space

Now let’s have a look at those vital components in a bit more detail, how they work and why they fail.

**Hard drive –**

Hard drives are one of the most complex components of a computer and due to this there is a lot that can go wrong. All hard drives share a basic physical structure; however the quality of the internal components will greatly affect the performance of the drive. We are going to look at what these common parts are and how they relate to each other.

- **The platters** – The platters are the actual disks inside the drive that store the data magnetically. Made from a light aluminium alloy and coated in a magnetisable material. The magnetic layer has tiny domains (regions) of magnetisation that are used to store information that is transferred through the read/write heads. Most drives have two platters at least and the larger the storage capacity of the drive, the more platters there will be. Platters are magnetised on both sides and data can be written to both sides, meaning a drive with two platters has four sides to store data.

- **The spindle and motor** – The platters are separated by disk spacers and are clamped to a rotating spindle that turns all the platters together. The spindle motor is normally built into the spindle or sometimes directly under it, it will spin the platters at a constant rate, e.g. 7,200RPM.

- **The read/write heads** – The heads read and write data to and from the platters. Normally you will see one head per platter, per side. So if the drive has two platters, there will be four read/write heads. Each head is attached to a single actuator shaft, meaning all heads move together in unison. Mostly, only one head is active at a time (either reading or writing data), when not in use the heads rest on the stationary platters but when the platters spin they create air pressure that lifts the heads off the platters. The space between the head and the platter is so small that even a single dust particle or a fingerprint can stop the disk spinning. Therefore drives must be assembled in a clean room (a work area where air quality, temperature and humidity are highly regulated).

- **The head actuator** – All heads are attached to a single head actuator or actuator arm that moves the heads around the platters. Modern drives
use a voice coil actuator, which controls the movement of a coil toward or away from a permanent magnet based on the amount of current flowing through it. This guidance system is known as a servo.

The platters, spindle, spindle motor, read/write heads and the head actuator are all contained in a chamber called the head disk assembly (HDA). Also included in the drive is the logic board (circuit board) that controls the movement of the internal parts and also the transfer of data in and out of the drive.

So why do hard drives fail?
In most cases hard drives will fail in one of four ways –

1. Electronic failure
2. Mechanical failure
3. Logical corruption
4. Firmware corruption

It is possible to get combinations of these faults. Depending on what has failed on the drive will determine if the data is recoverable. So let’s have a look at those failures in a bit more detail and the symptoms you may see.

1. **Electronic failure** – This will usually relate to the controller (circuit) board within the hard drive. An electrical spike or power surge can cause this. **Symptom** – The drive will not spin up and will appear dead. All data can be recovered from an electrical failure.

2. **Mechanical failure** – One of the physical components within the hard drive has failed. Like with any man-made component, this can happen at any time and will fail through wear and tear. **Symptom** – The drive will make a loud clicking or ticking sound as soon as the drive tries to spin up. Data from these drives can be recovered in most cases but must be done in a ‘clean room’

3. **Logical corruption** – Different to electrical and mechanical failures as there is normally nothing physically wrong with the drive, just the information on it. These can be the easiest or the most difficult to resolve. Faults could be anything from an invalid entry in the file allocation table, all the way through to complete corruption or loss of the file system. **Symptom** – Normally you will see a Windows® error during boot up. Be careful if running software fixes as you can easily make recoverable data unrecoverable. Always research the error before attempting any fixes.

4. **Firmware corruption** – This is the software code programmed into the drive itself. **Symptom** – The drive will spin up correctly but will be inaccessible through either the BIOS or Windows. Sometimes you will be able to see the drive in Windows but it will crash when trying to access
data from it. You are not able to re-program hard drive firmware yourself; this must be done by a specialist. Often data from drives with firmware corruption can be recovered after the drive has been re-programmed.

Mainboards

If you go back around ten years, mainboards were just central circuit boards that housed the CPU and memory, but all additional components would have to be plugged into the mainboard. Meaning you would buy the mainboard, but you would also need a separate graphics card (so you get a display), a separate soundcard (so you get sound), a separate network card (so you can connect to a network) and so on.

However in most modern mainboards all these additional components are built in, these are referred to as onboard devices. To be honest there are far too many capacitors, chips and other circuitry on a mainboard to go through everything that could fail on a board but let’s have an overview look at what makes up a mainboard –

- **BIOS (Basic Input/Output System)** – The BIOS is the software built into mainboard that determines what the computer can do without access to programs from a disk drive. The BIOS contains all the code required to control USB devices, the display, disk drives, peripheral communications and a number of miscellaneous functions. The BIOS is typically stored on a ROM chip on the mainboard. These days they are regarded as ‘flash BIOS’, which means that the data has been stored on a flash chip which can be updated if necessary.

- **Mainboard chipset** – A term used to refer to the core functionality of the mainboard. The chipset is made up of the Northbridge and the Southbridge.

- **Northbridge** – The Northbridge is a chip or chips which connect the CPU to memory, the PCI bus and any video functions handled by the mainboard. It does this via the FSB (Front Side Bus). Think of the Northbridge as having a direct connection to the CPU via the FSB.

- **Southbridge** – The Southbridge is the chip which controls all of the computer’s I/O functions, such as USB, audio, the BIOS and the IDE controller. In short it handles all of the functions of the CPU except memory, PCI and video. The Southbridge does not have a direct connection to the CPU. Any information must pass through the Northbridge before reaching the Southbridge.

- **Front Side Bus** – Simply put, a bus on a mainboard is a circuit which connects one part of the mainboard to another. The more data the bus can transfer at any one time, the faster the bus speed. This speed is measured in Mhz. The FSB connects the CPU to the Northbridge.

If a component on a mainboard has failed you will see a knock on symptom. For example if the USB controller has failed then you will not be able to
connect any USB devices, or if the video controller has failed then you will get no display. Seems simple but there are many software based reasons why these symptoms could be displayed and these should be investigated thoroughly before assuming your mainboard has failed. If any of these onboard components have failed then the entire mainboard will require replacement, as you are unable to swap the onboard chips/components. If you want to know more about your mainboards, you will need the mainboard manual from the supplier which will have diagrams and descriptions.

**Laptops**

It is worth mentioning the difference with laptops/notebooks at this point. Laptops are not as easily accessible to change parts as desktop computers. They are generally fully contained units with only access to change upgradeable parts such as the hard drive and memory. This makes them easy to upgrade but not as easy to diagnose faults. Apart from the memory and hard drive you will not be able to swap mainboard components out as they are all hard wired and the mainboard itself is not easily accessible. In some modern notebooks even the CPU is hard wired to the mainboard. You can stress test laptop mainboard components in the same way as desktop computers, using techniques which we will look at later in this session.

Below is an example photo of a standard Intel® mainboard and below an example diagram showing where the key components are located on the mainboard.
Below is a diagram of where the key connections are located on the mainboard, on the next page is the legend

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Conventional PCI bus add-in card connector</td>
</tr>
<tr>
<td>B</td>
<td>PCI Express x1 add-in card connector</td>
</tr>
</tbody>
</table>
C Battery
D Piezoelectric speaker
E PCI Express x1 add-in card connector
F PCI Express x16 add-in card connector
G Back panel connectors
H 12 V internal power connector (ATX12V)
I Rear chassis fan header
J LGA1156 processor socket
K Processor fan header
L DIMM Channel A sockets (2)
M DIMM Channel B sockets (2)
N Front chassis fan header
O Chassis intrusion header
P Main power connector (2 x 12)
Q SATA connectors
R Alternate front panel power LED header
S Front panel header
T Standby power LED
U Intel ME “M” state LED
V Front panel USB headers (4)
W Intel Q57 Express Chipset
X BIOS setup configuration jumper block
Y Clear CMOS header
Z Intel Remote PC Assist header
AA Serial port header
BB S/PDIF header
CC Front panel audio header
DD Internal mono speaker header

If you need to know anything about your mainboard, the first place to start would be to download the mainboard manual from the manufacturer. If it is an RM system the mainboard manual will be available on our support website. – http://www.rm.com/support/knowledgelibrary.asp

Memory –
A computer has two types of memory. The manufacturer installs programs into chips on the mainboard; you cannot change the programs on these chips at all. This type of memory is known as Read Only Memory or ROM. These programs handle the start up, find all your drives and manage the interrupt commands from your keyboard or any other input device.
The other type of memory is used when saving, creating and retrieving personal information; it is called Random Access Memory or RAM. RAM chips or sticks must be installed into the mainboard so that users have a ‘memory’ area which will store temporary information about software and files. The type of memory you need is determined by what the chipset of mainboard supports, this needs to be confirmed before buying upgrade memory. This information can be found in the mainboard manual.

**Why memory fails –**

The most common cause is electrostatic shock from improper handling. Also power surges or failing power supplies can cause memory damage, sometimes gradually. If your PC is excessively dusty then the contacts between the memory module and the memory port of the mainboard can be interfered with, thus causing system errors or in some cases the computer may not boot at all.

**Symptoms –**

1. Blue screen errors during the install procedure of Windows.
2. Random crashes or blue screen errors during the running of Windows. Note that many other things can cause this symptom and you should rule out the software first.
3. Crashes during memory intensive operations. 3D games, benchmarks, compiling, video editing, etc.
4. Distorted graphics on screen. This could also be related to the video card/chip.
5. Failure to boot. This can be accompanied by repeated beeps, which is the accepted BIOS beep code for a memory problem. The mainboard manual or BIOS manufacturer will have a list of what these BIOS beep codes mean.

**CPU –**

This should be your absolute last port of call if you are trying to diagnose a particularly strange set of symptoms. In short CPU’s very rarely fail. I worked in Hardware Product development and support for 5 years and can probably count on 1 hand the amount of genuine CPU failures I saw. Problems generally come from using a PSU that is either under or too far over specification for the mainboard and CPU. Of course like any man-made component they can fail under normal operation but I would certainly rule out everything else before even considering that your CPU is at fault.

**PSU –**

A computer power supply or PSU draws energy from an electrical wall socket and converts it into electricity at the correct voltages to power the computers mainboard and other devices. Each mainboard will have a minimum/maximum supported specification. PSU’s can become overstressed if
the computer demands more power than the PSU can deliver, this will result in PSU failure.

Heat – Another important thing to consider with PSU’s is heat. PSU’s will run warm in normal operation and the casing of the PSU will be warm to touch. However if you are getting random shut downs it would be worth touching the PSU, if it is failing due to overheating it will feel excessively hot to touch (be careful!). Many symptoms such as crashing, random shut downs can be caused by failing PSU’s but as many other components and software can cause these symptoms, you should rule these out first unless it is obvious that your PSU is failing.

That covers very briefly the jobs that the key components carry out inside a computer and some examples of why they fail. Next we are going to look at the importance of hardware diagnostics and some common issues found when investigating possible hardware faults.

Why	
  are	
  hardware	
  diagnostics	
  important	
  for	
  you	
  and	
  us?

- The time
- The problem of misdiagnosis
- Software vs hardware – The age old battle
Let me give you an example;

You have a CC3 workstation that keeps restarting itself at random times. No other computers in the room are showing this symptom. You could easily presume that the mainboard was faulty or that the PSU was failing in some way. Therefore you may call the manufacturer and arrange to have parts swapped. An engineer would come out the next day and swap the mainboard and or the PSU. Later that day after the engineer has left the workstation again restarts itself - very frustrating. So you go back to the manufacturer and advise that the replaced parts did not fix the problem and they apologise and arrange to send another engineer the next day to replace the hard drive, memory and CPU and suggest that should fix it. So the next day an engineer arrives and replaces HDD, Memory and CPU. A week later no problems are reported and you are happy the issue has been fixed. Great.......well not exactly.

So in the example above, the computer was out of action for almost three full days. Also we never actually learnt what caused the random restart. Now some would say it doesn’t matter too much as the symptom is now gone, but you could have got that machine working the same day. If a piece of hardware is not behaving as you would expect then there is a possibility that there could be a corruption in the device driver (which the operating system needs to see and use the device) or a corruption with another piece of software installed onto the computer. If you are ever unsure if the symptom is caused by software or hardware, the lesson to remember is; always first assume the symptom is caused by software.

So if we take the logic from the above example (which is a true story), at the point the problem was reported. We could have checked with the other technicians to see if anything new was installed on that computer recently or if anything has changed. If not then the next step would be to check nothing has been changed at the server for the image of that computer (driver packs or updates) and if not then we would rebuild the computers operating system from the network image.

As I mentioned the above example was a true story which I have seen many times over. In this example the random restarts were caused by a new software application installed locally at the computer which had made changes to the Windows registry, causing it to corrupt and cause random restarts. By changing the hard drive it appeared we had fixed the problem, but it took three days and we did not confirm what caused the problem.

If we had checked if anything new had been installed or if we had rebuilt the computer, it would have been up and running again the same day.

This is a good example why putting some time into diagnostics can save you a lot of time in the long run.

Assuming the cause of a fault is not efficient for you or us and you will rarely guess the correct cause.

As strange as it sounds, the first and possibly the most important rule of hardware diagnostics is; assume it’s a software fault!
Common Issues

- The theory of diagnostics
- How to test your hardware
- Specific symptoms and how to approach them
- The Blue Screen of Death

Common Issues

So far, all I have advised is to blame the software! So after checking the correct drivers are installed and having checked there are no operating system errors causing the symptom it may be that you have a hardware failure on your hands. Let’s have a look at what we do in this situation.

There are some rules you should stay within for most hardware diagnostics, these will save you a lot of time –

- Be able to consistently recreate the symptom
- Only change one thing at a time
- Do not assume anything
- Write down results

The method to remember is, change one thing, test the symptom again, and write down the results. (We will be looking at these four steps in greater detail in the tips and tricks section of this session).
This is the fastest way to get to the root cause; if you change more than one thing between tests you will not know what was causing the fault if you resolve it, or you could cause another symptom.

So how do we narrow down the list of what is causing the fault? There are some common symptoms which relate to particular hardware components, knowing a little more about these may save you some time and lead you to the cause of the fault faster.

Below is a list of components and some example symptoms which may relate to a hardware failure, plus the steps you should take to diagnose if this is a hardware fail –

**Hard drive**

‘No operating system found’ error at boot up:
The first place to look is in the BIOS settings to see if the hard drive is detected by the mainboard. Look for the disk drives or hard drive menu in the BIOS (often under the advanced tab) and check that the hard drive is being detected. If it is being seen in the BIOS then it is probably a Windows boot loader error and you should try reinstalling the operating system, however it could still be a hardware failure. If it is then the reinstall of the operating system will most likely fail with a read/write error. At this point replace the hard drive and SATA cable and test the rebuild again.

If the hard drive is not being seen in the BIOS then you definitely have a physical connection issue or hardware failure. These are the things to do at this point –

Take another hard drive out of a computer with the same specifications and swap it with this one. Does the symptom of ‘no operating system found’ follow the hard drive you have removed or does it remain with the original computer? This is referred to as a Swap Test. If the symptom travels with the hard drive, then the drive is the cause, if the drive works correctly in the new computer then you know the hard drive is fine and the fault is either caused by the mainboard (failing SATA controller), cabling or PSU. Use the same logic to rule out the cabling, take a SATA cable from a computer you know works and test it on this computer. You will eventually narrow down the list of possible causes to one component.

There are also some hard drive diagnostic software tools you can run which we will look at later.

**Video/graphics**

No display is one of the most common symptoms in the IT industry, with many possible causes.
The first thing to check is that another component is not causing the no display symptom; boot the computer and check the power lights come on and you hear a POST beep (mainboard power on test), it sounds obvious but I’ve seen many systems sent in for no display that actually had dead mainboards or PSU.
So providing the system is powering on correctly the next thing to check is - do you get a display in the BIOS? (There are only raw drivers loaded at this level so this is a good diagnostic step).

Ok, here’s what we’d do; turn the computer off and make sure the monitor is on. Then power on the computer and watch the screen, look to see if you can see a splash screen or the BIOS POST screen, or alternatively go into the BIOS settings at boot up.

If you get a display at BIOS level then you do not have a hardware failure on your video card/chip. This will either be caused by corrupt device drivers or incorrect configuration of the software. A common error is manually setting the refresh rate for the monitor too high for the monitor being used, the knock on effect is that if the refresh rate is not supported by the monitor, it will not show a display.

To fix this symptom, boot the machine into Windows Safe Mode (normally press F8 during boot up) and you should be able to now see a display in the operating system and will be able change the configuration as per your hardware support.

So what happens if we do not get a display at BIOS level? We come back to our swap test philosophy. Think about the physical components involved in delivering a display –

- Mainboard with onboard video (You may have an add-in video card, more on this later)
- A VGA or DVI cable
- A monitor
- PSU

The first thing to do would be to swap the monitor for a known working one. If you still see no display then swap the monitor back and then swap the video cable from the computer to the monitor. If you are still getting no display at this point then you can be fairly confident you have a physical fault in the computer. Contact the manufacturer for hardware replacement passing on all the diagnostics you’ve done to get to this point.

Add in video cards –

Rule number one with add-in video cards is the following – You cannot use the VGA/DVI ports on the add-in card and use the onboard VGA/DVI ports on the mainboard. What I mean is, if you use an add-in PCI/PCIe video card then it automatically disables the onboard video. I have seen many people trying to use dual display with a single output graphics card and an onboard video port - this will not work!

Other things to be aware of with dual display graphics are to check both ports on the card if you’re getting no display. In the hardware, one will be set as the primary display and it may not be the one you have it plugged into. Also similar to the hard drive example you could try a graphics card from a known working computer. If the new graphics card works then the fault was on the graphics card. If the new graphics card also shows no display then the fault is most likely with a controller on the mainboard. At this point contact the
manufacturer for hardware replacement passing on the diagnostics you’ve done.  
*Remember - Swap tests are an accurate way of learning if a component is affecting the symptom.*

**Memory**

A nice easy one….well kind of. In most cases when memory fails the machine will not be able to load the operating system and will error at BIOS level. You will hear a set of beeps from the mainboard (normally three short beeps but may differ depending on the mainboard), at this point you should try the following –

- Remove one stick of memory and boot the system up
- If it is still failing then swap the memory sticks around and boot the system up with the other stick of memory.

If your computer only has one stick of memory then try and find a computer with the same hardware spec and swap test the memory both ways. See, easy and fairly obvious. However, sometimes memory can corrupt but still allow the system to boot and will give some weird and wonderful symptoms, such as strange lines across the display or words or files not being shown correctly. In these cases we would suggest using a memory tester such as RMEMTEST. This will analyze the memory in DOS, running benchmark tests and will report back any errors. If you are getting strange unexplainable symptoms on a computer then running a memory tester such as RMEMTEST is a good place to start.

**Audio**

Most modern mainboards have onboard sound chips built onto them. Like any onboard device, if it has failed then the whole mainboard will need replacing.

With audio it’s fairly obvious if there is a problem as there will be no sound!! If you have checked the audio drivers are correctly installed, the next thing to do is to check volumes. Go into the Windows audio settings and make sure none of the output devices are muted or have the volume set to 0%. This is extremely common.

If you are using a notebook or RM One there may also be a physical switch on the casework to mute the sound which is worth checking.

Also be aware that lots of audio drivers come with their own software and settings which work independently of the Windows audio settings, please check this when looking at your software volumes. (Actually at this point I must mention that you should first try a different set of headphones, sorry I know it may seem obvious but it happens more often than you think!!)

So with the obvious things out of the way, what is left?

Audio cabling. If you are using a headphone port on the front of the computer for example, then remove it and plug the headphones into the rear
headphone port (coloured green). The front headphone ports are just running from an extension cabling from the mainboard and it may just be the front port itself which has failed.

If you are getting no audio from the front or rear display and have checked the software in detail then there may be a fault with the onboard audio device and the mainboard would require replacing.

**Network cards –**

You will have lots of ways already of testing network connections I’m sure. If you suspect the network card/port might have a fault there are a few things you can do quickly to confirm it –

- Check Device Manager to see if the network card is detected. Under network adaptors if you cannot see the card it may be disabled in the BIOS or may have physically failed.
- Test the card outside of a Windows environment. You could try waking the system up with Wake on Lan using a Magic Packet, or you could try booting the system up using PXE boot across the network.
- Try a PCI network card in this computer on the same network cable. This is a key test as this will localise the problem to the network port itself if the PCI network card works without error. If the PCI card also has connection problems, you will know it is an infrastructure problem and very unlikely to be caused by the computer in question. Check the network cables and switches at this point.

These tests will check if the card is physically working and able to communicate with the server. If these tests fail then you can be fairly confident that the network port or the network controller on the mainboard has failed.

There are many other symptoms we could look at for each device but these are a good example of the techniques used in diagnosing computer hardware. One way to put it is –

*Do not look for what is causing the symptom, confirm what isn’t causing the symptom, and soon your list of possible causes will get smaller and smaller.*

Now this sounds a bit new age I accept, but it does make sense. Start with a list of all the possible causes and test the simplest or most obvious first, so many technicians assume as the error or symptom is complicated that they should start with the most complicated fix. Most hardware fails are diagnosed during the testing of the obvious things – software, cables and connections.

Moving on from this there is one common symptom which is often incorrectly blamed on hardware....
The Blue Screen of Death!

A problem has been detected and Windows has been shut down to prevent damage to your computer.
The problem seems to be caused by the following file: interlpm.sys

DRIVER UNLOADED WITHOUT CANCELLING PENDING OPERATIONS

If this is the first time you've seen this Blue error screen, restart your computer. If this screen appears again, follow these steps:

Check to make sure any new hardware or software is properly installed.

If this is a new installation, ask your hardware or software manufacturer for any Windows updates you might need.

If problems continue, delete or remove any newly installed hardware or software. Disable boot memory options such as clicking or shadowing.

If you need to use Safe Mode to remove or disable components, restart your computer, press F8 to select Advanced Startup options, and then select Safe Mode.

Technical Information:

*** STOP: 0x000000ce (0xf7528f8,0x00000000,0xf7528f8,0x00000000)

interlpm.sys

beginning dump of physical memory

physical memory dump completed

Contact your system administrator or technical support group for further assistance.

Ok so we’ve all seen them, the Blue Screen of Death is a very common error with Windows operating systems. It is a STOP error and will be displayed to prevent damage to the computers file system.

There is definitely an opinion that most blue screen errors are caused by failing or malfunctioning hardware, normally suspected is the hard drive failing; this is actually not the case.

Yes, blue screen errors can be displayed due to failing hardware but you are going the long expensive way round if that is your first suspicion.

Common causes of blue screen errors are –

• Incompatible/corrupt device drivers (.dll/.inf)
• Incompatible/corrupt software application install
• Corrupt Windows registry
• Hardware failure

This is probably the order in which you should suspect blue screen errors. However it may be obvious what is causing the error as you may have just installed a new piece of hardware and on first boot you see a blue screen error.

This still does not mean that the piece of hardware is faulty, check the following –

• Can you boot the system into Windows Safe Mode without error? (bypassing the loading of any device drivers)
• Remove the new piece of hardware and try it in a different spec of computer. It is vital you do not pick a computer with the same hardware spec as the error may be due to a conflict with a mainboard driver relating to that specific mainboard, and you will see the same error.
• Have you tried re-imaging the computers operating system?
All of these things can be checked quickly and will give you very accurate information about where the error is coming from. If the blue screen error follows the new piece of hardware wherever it goes, then you will know it is failing, but if it works without error on the different spec computer for example, then you have confirmed the hardware is not faulty and your error is due to the operating system.

I’m sure we will all continue to see blue screen errors, please remember; they should always be proved to be a hardware fault by first completely ruling out software corruption as the cause.

Useful software tools

• I/O Meter

• BurnInTest Pro

• Rmemtest

• HDDScan
Useful tools and tricks

So you’re happy your problem isn’t a software issue but we may still not be clear on which component is failing or malfunctioning. To dig deeper into what or why hardware is failing there are some software tools which can analyze and stress test the hardware components. We’re going to have a look at a few of these and highlight what each one does and the advantages they offer.

I/O Meter – Hard Drive analyzer

Iometer is both a workload generator (that is, it performs I/O operations in order to stress the system) and a measurement tool (that is, it examines and records the performance of its I/O operations and their impact on the system). It can be configured to emulate the disk or network I/O load of any
program or benchmark. It can generate and measure loads on single or multiple (networked) systems. Iometer can be used for measurement and characterisation of:

- Performance of disk and network controllers.
- Bandwidth and measurement of delays in data.
- Network throughput to attached drives.
- System-level hard drive performance.
- System-level network performance.

**BurnInTest Pro**

BurnInTest is a software tool that allows all the major sub-systems of a computer to be simultaneously stress tested for endurance, reliability and stability. BurnInTest tests the CPU, hard drives, RAM, CD-ROMs, CD burners, DVD drives, sound cards, 2D graphics, 3D graphic, network connection, printers, video playback and USB. This software is extremely useful for bringing intermittent or hidden problems to the surface.
If you are seeing random freezing or computers shutting themselves down for example, you can use BurnInTest to try and force the system to fail. Once you have it failing consistently when running BurnInTest, you can then run the tests one by one to see which component is causing the failure.

**RMemtest –**

RM have produced an MS-DOS® based memory tester which will indicate if you have faulty memory. Download the software from DWN14052 in the Support Knowledge Library, copy to a bootable floppy/CD/USB pen and from MS-DOS, run rmemtest.exe.

This will run a continuous memory check and will give you a pass or a fail after every test routine. Bad memory will normally fail within 80 test sweeps. Once you are convinced the memory has passed or failed, you can reboot the workstation without exiting the program.

**HDDScan –**

![HDDScan for Windows version 3.1](image)

**HDD operation and fail modes**

Although hard drives are much more robust than people give them credit for, they can fail due to their mechanical nature (spinning disk and moving heads). The read/write heads of a modern hard drive hover extremely close to the disk surface in order to allow high capacities. Vibration and temperature in particular, can result in ‘head crashes’ which cause surface damage to the disk. Data written on the disks can therefore easily become unreadable in places.

The HDD will attempt to copy affected data to other parts of the disk.
(reallocated sectors) but there are limited spare sectors and sometimes data is completely unreadable. Other forms of damage are in the HDD motors which spin up the drive. If there is mechanical wear/tear/fault, the drive logs the number of retries to successfully spin the drive up to full speed. All these attributes are logged and viewable via a SMART log on the drive itself. It helps diagnose and keep track of the drive’s health and provides useful information in determining if a PC fault lies with the HDD or somewhere else.

Tips and tricks

Earlier on I mentioned four steps which should apply to any hardware diagnostics being done, they were –

• Be able to consistently recreate the symptom
• Only change one thing at a time
• Do not assume anything
• Write down results

So let’s have a look at them in more detail and why they’re important.

Be able to consistently recreate the symptom – This is the most important step in any diagnostics. You must be able to consistently recreate the symptom/fault for a couple of reasons: firstly so you
know the actions taken to cause the fault, this information should be recorded so you can refer to it at a later date. Secondly, if you start to apply fixes to the fault, how will you know if the fix applied has made any difference if you are not able to reproduce the fault?

Before thinking about what is causing the issue you need to think about how to recreate the symptom/fault. This can sometimes be the most time consuming aspect of hardware fault finding, but it is the most vital as it will give you accurate information about the fixes being applied further down the line.

Only change one thing at a time –
Now this may sound like me telling you how to suck eggs (I have never understood why you would want to suck an egg) but this is a step that is often missed, mostly because people are trying to fix the fault quickly.
Understandable, but by changing more than one thing at a time you can cause yourself all sorts of trouble. I have seen many hardware faults where the following has happened -
I have interviewed the technician about what has been tried already and have been given a list of settings that have been changed or components that have been swapped. None of which have improved the symptoms. When asked if they had run tests after making each single change they replied – No but it doesn’t matter as it still doesn’t work, or dunno!
After maybe looking at other causes without any luck I would go back and apply some of the fixes or changes the technician had already tried but this time stopping after each change and trying to recreate the symptoms. During this testing I would often fix the symptom, I found the setting or component which was causing the fault.
So why did this not come to light through the technicians testing?
What had happened was that he made a change which fixed the fault and then made 2 other changes at the same time, one of which conflicted with the fix and therefore continues to show the symptom.

This is a very common occurrence and a good example why testing after any change to settings or components is vital.
Also worth mentioning is that if you make a change to a setting or a component and it does not affect the symptom of fault, make sure you change that setting or component back to its original state otherwise any testing you do from here in will not be in the same environment as the user who was originally seeing the symptom/fault.

Do not assume anything –
Ok, back to sucking eggs.....Well not exactly. Hardware can do some strange things and it is best to take the approach not to rule anything out until you have proven it is not involved. Be methodical, look at everything that could possibly cause the fault (even the crazy ones!) and then set about disproving them one by one, starting with the easiest and most obvious.
Write down results –
We are all guilty of not doing this. Keeping an accurate log of information about recreating the symptom, any tests run and the results of those tests will benefit you and your team greatly.
Not only will it be useful while you are still attempting to fix the fault in question, as you can see easily what has been done and what to test next. But also, what if this problem arises again 12 months after originally fixing it? I speak from experience when I say that trying to remember the steps taken and the cause of one particular problem from a year ago is not always easy. There are a few faults I wish I had kept a record of, as it would have made my life a lot easier when I saw the same fault again sometime later.

So that’s the theory of how to format your fault finding but what about some specifics. Below are some useful tools to have lying around for finding out if your hardware is at fault –

**MS-DOS bootable USB flash drive** – Useful for testing hardware outside of a Windows environment and running DOS based benchmarking software.

**WinPE bootable USB flash drive** – Similar to your MS-DOS drive this is useful to have as it will load default USB and graphics drivers. If devices work in WinPE but not in Windows XP for example you will know you have a driver fault.

**POST card** –

A POST card is a diagnostic tool that reports error codes provided at the POST (Power On Self Test). It would be used when a computer refuses to boot or is not showing any display. It will report a two digit hexadecimal code which is outputted by the BIOS at power on. A list of what these codes mean will be
available from the BIOS or mainboard manufacturer. POST cards are extremely useful for proving if you have a dead mainboard for example.

**A Windows XP CD**  
It’s definitely worth having a vanilla Windows XP CD close by as a diagnostics step. Trying to reinstall the operating system from CD rather than your network image brings a couple of advantages; firstly it takes your network image and infrastructure out of the equation, if you are still seeing the fault during or after installing vanilla windows XP then you know you mostly likely have a hardware issue.  
Also if you have a failing hard drive, a Windows install will normally crash during the copying of files. If your install crashes from your network image and from a vanilla Windows XP CD then it is likely you have a hardware fault.
Information required when reporting a hardware fault –

So once you are at the point where you are happy (well, not happy!) that you have a hardware failure, if the machine is under warranty, you will need to contact the hardware manufacturer to arrange replacement parts. There is some key information that the manufacturer will need to be able to process your hardware call quickly. Below is a list of what RM require from you to log a hardware call –

• The serial number of the affected PC/PC’s. Your serial number will be on a sticker on the PC, it is programmed into the BIOS and there is a software tool we have created called ‘RMsysinfo’ which will gather lots of information about your hardware, including the serial number.
• How many PCs are affected by the symptoms you are seeing?
• Has the symptom been there since the PC was brand new or has this developed recently?
• Have you tried a rebuild or a restore of the operating system? This is a good test for seeing if a fault is software or hardware caused.
• Write down any error messages or fault codes, as these may help us work out the cause.
• Has anything recently changed on the PC either with the software installed or by adding a new hardware component?
• RM Support will sometimes need to ask basic diagnostic questions. As we’ve looked at, occasionally very complex looking issues can be caused by very simple things, therefore we have to rule out the obvious
before moving on to a more technical form of diagnostics. Do not be offended if you are asked if you have plugged a cable in!

- It is also important to know the full location of the equipment so if we need to arrange for a field visit or a service centre collection that we can add the correct address and room number. Also a named contact and number for the day of the visit will be required.
- Once you have as much of the above information as is applicable to your issue, please contact RM Support.

RM has a dedicated Hardware Support team who are happy to assist with some of the diagnostics we have discussed in this session. Work with them, they are experienced at diagnosing hardware, if they ask for you to try a particular test or step it will be because we want to fix the problem first time and the information from this test will help us do that.

RM is hugely passionate about hardware first time fixes. That means that when we send an engineer to replace parts, we fix the problem in one visit. Everyone involved with hardware at RM wants to achieve this but we can’t do it without your help. Collating the above information helps us to know which parts to send and gives us a much better chance of that first time fix that you and RM are looking for.

**Summary**

There is a lot more we could have gone into with more time but hopefully in this session you have picked up some techniques and common practices in how to better diagnose your hardware. Physical hardware is not going away; it will always have a role to play. So understanding how it works and how to analyze it when faults arise are vital skills for any network manager or technician.
Hardware Diagnostics

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