RAM

Overview

- In this chapter, you will learn how to
  - Identify the different types of RAM packaging
  - Explain the varieties of DRAM
  - Install RAM properly
  - Perform basic RAM troubleshooting

Program Execution

- Program code is copied from your hard disk into RAM before it is executed...

What RAM means?

- Random Access Memory
  - Random Access
    - RAM, hard drive, usb drive, ...
  - Sequential Access
    - Tape

DRAM

- DRAM (Dynamic Random Access Memory) is the most popular type of electronic memory
  - Special type of semiconductor that stores individual 1’s and 0’s using microscopic capacitors and transistors
Organizing DRAM

- DRAM is considered as the standard RAM
  - low cost
  - high speed
  - ability to store data in a relatively small package
- The RAM stores programs and data in 8-bit (1-byte) chunks of memory
- DRAM chips are always referenced with respect to their depth and width
  - 1 Meg x 4
  - 256 K x 1

The depth and width are measured in units of bits
They can only be differentiated using the information printed on the chip itself
The physical size and the internal organization of the chip are not directly correlated

Byte Size RAM

The Northbridge can produce byte-sized pieces out of eight-bit-sized RAM chips

Multiple Rows of RAM

The Northbridge for 8088 systems could handle two rows of RAM.

Location of DRAM

- The Northbridge knows the real location of the DRAM

RAM Sticks
DIPP (Dual Inline Pin Packages)

- The first generation DRAM chips used DIPPs
  - Two rows of pins extending from either side of the package
  - Very delicate, making the installation process difficult

30-pin SIPP (Single Inline Pin Package)

- SIPP is a type of package where the RAM is soldered to a small board that can be inserted into the motherboard
  - Made RAM installation and removal much simpler
  - Plugged directly into the motherboard through a special socket
  - Easy to install but are delicate

30-pin SIMM (Single Inline Memory Modules)

- SIMMs are physically similar to SIPPs, but have no pins
  - Inserted into special SIMM sockets
  - Always 8 data bits (1 byte) wide
  - All nonparity 30-pin SIMMs have an even number of chips
  - The type of motherboard would indicate whether parity or nonparity chips are needed

SIMM Chips and Parity

- When purchasing SIMM chips the question is whether you need parity or not
- You could get a clue from the chips already in the PC – an even (nonparity) or odd (parity) number of chips
- Some PCs let you turn parity off so you could mix and match

Different Chip Layouts on a SIMM

- 8 chips = "8" SIMM
- 9 chips = "9" SIMM
- 4 chips and 1 chip = "5" SIMM

Speed

- The system clock controls the CPU speed
- The earlier types of RAM were called Fast Page Mode (FPM) RAM
- Access speed (in nanoseconds) refers to the time taken by the FPM DRAM chip to supply the chipset with the requested data
  - Each motherboard required a certain speed
### Talking the Talk

- Each SIMM is called a **stick**
- Never say 30-pin SIMM or ask for parity or nonparity. Instead say “by 3” or “by B” or “by 9”. These are the most common widths
  - X8 is nonparity
  - X9 is parity
  - X3 is a x9 in a 3-chip package
- Three common sizes are 256KB, 1 MB, 4MB – so ask for a ”4x8” or ”1x3”
- Never give speed in nanoseconds – say I’d like some 50’s

"I’d like 16 sticks of 1x8 sixties, and four sticks of 256x9 eighties."

### Banking

- Combining the widths of DRAM to match the width of the external data bus is called **banking**
- The number of SIMMs that make up a bank depends on the chipset, which in turn depends on the CPU’s external data bus size

### Banking

- The most important banking rule is that all SIMMs in the same bank must be identical
- The connectors where the bank is installed are also collectively called a bank

### Banking

- A bank without any SIMMs is called an unpopulated bank, and a bank filled with SIMMs is called a populated bank
- A bank must be either completely populated or completely unpopulated
- This formula can be used to determine the number of sticks needed to make a bank – One bank = Width of the CPU’s external data bus ÷ Width of the SIMM/DIMM
  - It takes four 30 pin slots in a 486 to make a bank

### 72-pin SIMMs

- Modern CPUs have 64-bit external data buses and do not use the 30-pin SIMMs
  - 72-pin SIMMs are an inch longer than 30-pin SIMMs, and have a notch in the middle
  - Each 72-pin SIMM is 32-bits wide
  - The term “X 32” describes nonparity SIMM and “X 36” describes parity SIMM

### Four 72-pin SIMM Slots
72-pin SIMMs

- A label can be used for identifying between a parity and nonparity 72-pin SIMM
- Types of parity SIMMs
  - True (parity bit for every 8 bits)
  - TTL (emulates parity and costs less)

SIMM Sizes and Talk

- 1x32 = 4MB, no parity
- 1x36 = 4MB, parity
- 2x32 = 8MB, no parity
- 2x36 = 8MB, parity
- Thru 4, 8, 16 x 32(or 36)

- All x32’s are nonparity – all x36’s are parity
- The size is figured like this: 2x32 means 2MB of 32-bits, or 8MB of 8-bits
  (size=8MB)

"I’d like 4 sticks of 4x32 fifties"

DIMM (Dual Inline Memory Module)

- The DIMM is the most popular DRAM package in use today
- 168-pin DIMM
  - Extra pins to handle functions such as buffering and ECC
  - 144-pin SO-DIMMs (Small Outline) are used in

The Magic Banking Formula

- How many 30-pin SIMMs are needed to make a bank on a 486?
  - 30-pin SIMMs are 8 bits wide
  - We need four (32 ÷ 8) 30-pin SIMMS per bank
- How many 168-pin DIMMs are need to make a bank on a Pentium III?
  - A Pentium III has a 64-bit external data bus
  - We need one (64 ÷ 64) DIMM per bank

<table>
<thead>
<tr>
<th>SIMM Sizes</th>
<th>bits wide</th>
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<tr>
<td>30-pin SIMM</td>
<td>8 bits wide</td>
</tr>
<tr>
<td>72-pin SIMM</td>
<td>32 bits wide</td>
</tr>
<tr>
<td>168-pin DIMM</td>
<td>64 bits wide</td>
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</tbody>
</table>

Summary

<table>
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<th>CPUs, External Data Bus, and Address Bus Sizes</th>
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<td>CPU</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Intel 8086</td>
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<tr>
<td>Intel 8088</td>
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<tr>
<td>Intel 80286</td>
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<tr>
<td>Intel 80386</td>
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<tr>
<td>AMD Athlon</td>
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<tr>
<td>AMD Duron</td>
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<tr>
<td>Intel Pentium</td>
</tr>
<tr>
<td>Intel Pentium II</td>
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<td>Intel Pentium III</td>
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</tbody>
</table>

Improvements in DRAM Technology
**EDO DRAM (Obsolete)**

- **EDO (Extended Data Out)** is a type of DRAM that provides the system quicker access to data
  - Looks exactly like the regular DRAM, so you should label it
  - To take advantage of the EDO, the chipset must be designed to handle it
  - Now considered obsolete

**SDRAM**

- **SDRAM** (Synchronous Dynamic Random Access RAM) are tied to the system clocks
  - Faster than DRAMs
  - Only available on DIMMs
  - Use clock speed instead of access speed
  - SDRAM is always a DIMM, but a DIMM isn’t always SDRAM

**PC100/133 Standards**

- The PC100 and 133 standards define the construction of a high-speed DRAM
  - Require the use of DIMMs or SO-DIMMs, and a unique chip called the serial presence detect (SPD) to be installed on every DIMM stick
  - The SPD provides the system with all the details of DIMM

**ECC**

- **ECC** (Error Correction Code) is a special type of RAM used by high-end systems
  - Major advance in error checking on DRAM
  - RAM sticks of any size can use the ECC DRAM, but it is most common as 168-pin DIMMs
  - A motherboard should be designed to use ECC, to take advantage of the ECC RAM

**RDRAM**

- **RDRAM** (Rambus DRAM) is a “new” type of RAM
  - Speeds of up to 800 MHz
  - Comes on sticks called RIMMs
  - 184-pin for desktops and 160-pin SO-RIMM for laptops
  - All slots must be populated - unused slots must have a CRIMM (Continuity RIMM)

**DDR SDRAM (Double Data Rate)**

- **DDR SDRAM** (Double Data Rate SDRAM) doubles the throughput of SDRAM
  - 184-pin DIMM packages
  - Speed of 200 MHz and higher.
  - Used in lower-end systems
**DDR2 and DDR3**

- DDR2
  - 240 pin/200 pin for laptop
  - Faster speed
  - Higher latency
  - 4 bit pre-fetch buffer
  - Effective clock rate of 200~533MHz

- DDR3
  - Comes with a promise of a power consumption reduction of 40%
  - "Dual-gate" transistors
  - 8 bit pre-fetch buffer
  - Effective clock rate of 400~800MHz

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**Memory Modules Wrapup**

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**Dual-Channel Architecture**

- Dual-channel architectures use two sticks of RAM together to increase throughput
- Double-sided SIMMs/DIMMs
  - Double-side sticks have chips on both sides

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**CL2, CL3, what does that mean?**

- CAS Latency
- CL2: CPU has to wait two CPU clock cycles before getting data

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**Tin or Gold Leads**

- Connectors inside memory slots are tin or gold
  - Edge connectors on memory modules follow suit
- Tin leads should match tin connectors
- Gold leads should match gold connectors
  - Prevents corrosive chemical reactions between metals

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**Installing RAM**
Do You Need RAM?

- Two symptoms point to needing more RAM
  - General system sluggishness
  - Disk thrashing or excessive hard drive accessing

<table>
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<tr>
<th>Operating System</th>
<th>Reasonable Minimum</th>
<th>Solid Performance</th>
<th>Power User</th>
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<tbody>
<tr>
<td>Windows 98/SE</td>
<td>64 MB</td>
<td>128 MB</td>
<td>192 MB</td>
</tr>
<tr>
<td>Windows ME</td>
<td>128 MB</td>
<td>256 MB</td>
<td>512 MB</td>
</tr>
<tr>
<td>Windows 2000</td>
<td>128 MB</td>
<td>256 MB</td>
<td>512 MB</td>
</tr>
</tbody>
</table>
| Windows XP
  (Home or Professional) | 256 MB            | 512 MB            | 1 GB       |

Mixing DRAM Packages

- Modern motherboards have been designed with slots for more than one type of DRAM
- The motherboard jumper may have to be moved to enable two different types of DRAMs to work together
- Most current motherboards have only DIMM slots

Speed

- Mixing DRAM speeds can cause the system to lock up every few seconds, leading to data corruption
- Experimenting won't harm anything but the data
- You can use faster DRAM than the motherboard recommends but won't see an increase in performance
- You can put different speeds of DRAM in different banks as long as they are both faster than the speed specified

Banks

- All systems number their banks, usually starting at zero
- All banks do not take all sizes of DRAM
- Some systems require you to populate bank 0 first...most systems don’t care

Installing SIMMs

- A notch on one side will prevent you from installing it incorrectly
- Insert on an angle, then rotate up and snap into place

Installing DIMMs

- Swing the side tabs away from upright
- Push the DIMM down somewhat hard – the two tabs should move back into place
Installing SO-DIMMs in Laptops

- Remove the panel or lift the keyboard
- Slide the pins into position, snap the SO-DIMM down into the retaining clips
- Make sure the system is off
  - No AC connection
  - Remove all batteries

Troubleshooting RAM

- Parity errors, ECC error messages, system lockups, and page faults are a few types of memory errors
- Real and phantom are the two types of parity errors
  - If you get the error “Parity error at xxxxx”, write down the address – a real parity error will occur at the same place in memory and indicates a bad RAM stick
- Real errors are errors that the chipsets detect from the parity chip

Testing RAM

- Hardware RAM testing devices can be used to troubleshoot errors
- An economical option is to replace the existing sticks with new ones

Next Gen Memory

- Desirable RAM characteristics are
  - Non-volatility
  - Low price
  - Fast speed
  - Low power consumption
- MRAM (Magnetoresistive RAM)
  - Will use magnetism instead of electrical charges
    - Like videotapes, audio cassettes, and hard drives
  - Smaller chip size, faster, cheaper
- FeRAM (Ferroelectric RAM)
  - Use ferroelectric capacitors
- Phase-change technology
  - PCM, PRAM, Ovonic Unified Memory, Chalcogenide RAM
  - Use the unique behavior of chalcogenide glass

Check the RAM

- A halt before the RAM check could indicate improperly installed RAM

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DELL Inspiron 7500 COMPAQ BIOS Rev A12 (6/379)
CPU - Pentium III 600 MHz

Troubleshooting RAM

- Phantom errors arise due to software problems, heat or dust, and fluctuations in force
- NMI (non-maskable interrupt) is a type of interruption that cannot be ignored by the CPU resulting in a Blue Screen of Death (BSoD)
- Bad RAM and parity error can trigger an NMI
- If you get intermittent parity errors, check out the power supply