Building a home lab : From OK to Bada$$$

By Maxime Mercier

Disclaimer

- The following presentation is a generic guideline on building a home lab.
- It should not be used for production servers without proper redundancy
- I, Maxime Mercier, should not be held responsible for any problems that might occur while following this guideline to build your own specific server.

The basics

- Who am I?
- What are your needs?
- Your budget
- Components analysis
- Conclusion

Who am I ?

- Hardware enthusiast since 1994
  - I was taking apart my 1st 486 at the age of 13
  - Adding parts and overclocking it at 14
  - I choose all my computers parts for every PC I bought after that
  - More recently, I modified a LGA771 x5470 to fit in a socket 775 Asus motherboard with modded bios. I'm running it stable on air at 3.8Ghz

- Freeloader and sometime helper at the Hackfest
  - I enjoy spending time with those guys
  - I played a main part in making "Hackfest City"
  - They gave me the nickname "The hacking plumber"

Figuring out the needs

- What do you want to use it for
  - A small lab to play with
  - A medium size lab to host a few VM for personal use
  - A big lab to simulate a business environment
- Servers types
  - Your old desktop
  - A used workstation
  - A tower server
  - A half-length server
  - A full length server

Figuring out the needs

- What will it run
  - A firewall
    - Network interfaces
  - A single OS
    - Differents OS have differents needs
  - Hypervisor
    - Vmware -- More hardware dependent
    - Proxmox -- Eats up ram GB like candies.
      - Few VMs
      - A bunch
      - Tons !!!

Figuring out the needs

- How much do you want to spend
  - Low budget < 500$
    - Aim for high production olders servers (x54XX) 1u are cheaper
      Older generations tend to be louder and 1u are louder than 2u.
    - Use an old desktop
    - Workstation and tower server are affordable
  - Medium budget 500$ to 1500$
    - High end older servers (x56XX serie cpu)
    - More hdds
    - More RAM
    - Possible to find a half-length server running a xeon e3
  - High budget > 1500$ - Get what you want
    - E5 v4
    - Tons of ram
    - Bigger/more hdds

Server CPU generations

Generation	Socket	Core number	Speed	Cache	RAM	Lithography	Rating
51XX	LGA771	2	2.13 à 3 Ghz	4 MB	Chip Dual	65 nm	35 à 80 W
52XX	LGA771	2	1.86 à 3.5 Ghz	6 MB	Chip Dual	45 nm	20 à 80 W
53XX	PLGA771	4	1.6 à 3.0 Ghz	8 MB	Chip Dual	65 nm	40 à 150 W
54XX	LGA771	4	2.13 à 3.4 Ghz	12 MB	Chip Dual	45 nm	40 à 150 W
55XX	FCLGA1366	2ht à 4ht	1.86 à 3.3 Ghz	4 à 8 MB	Int. 144 GB Triple	45 nm	80 à 130 W
56XX	FCLGA1366	2ht à 6ht	1.6 à 3.6 Ghz	4 à 12 MB	Int. 144 GB Triple	32 nm	40 à 130 W
E5-26XX	FCLGA2011	2ht à 8ht	1.8 à 3.3 Ghz	5 à 20 MB	Int. 384 GB Quad	32 nm	60 à 150 W
E5-26XX v2	FCLGA2011	4ht à 12ht	1.7 à 3.5 Ghz	10 à 30 MB	Int. 768 GB Quad	22 nm	50 à 150 W
E5-26XX v3	FLCLGA2011-3	4ht à 18ht	1.6 À 3.5 Ghz	10 à 45 MB	Int. 768 GB Quad	22 nm	55 à 160 W
E5-26XX v4	FLCLGA2011-3	4ht à 22ht	1.7 à 3.5 Ghz	10 à 55 MB	Int. 1.54 TB Quad	14 nm	55 à 160 W

Server CPU - Side notes

- Thermal envelope (Rating)
  - Isn’t the CPU Watts consumption, It is the heat dissipation needed from the server
  - Higher end CPU lower their consumption while idling

Server CPU - Side notes

- Parallele Xeon line-up
  - x34XX serie - Socket 1056
    - Basically a desktop CPU with Xeon name
  - x75XX
    - For quad cpu configuration. Based on the x55XX serie
  - E3 serie - Socket 1055, 1050
    - Same as the x34XX serie. Desktop clone
  - e5-24XX serie - Socket 1356
    - Triple channel (Bad batch?) xeon e5
  - E7 serie - various socket
    - Basically for quad cpu configuration
    - When you really need the horsepower

Ram types - Not all dimms are equals

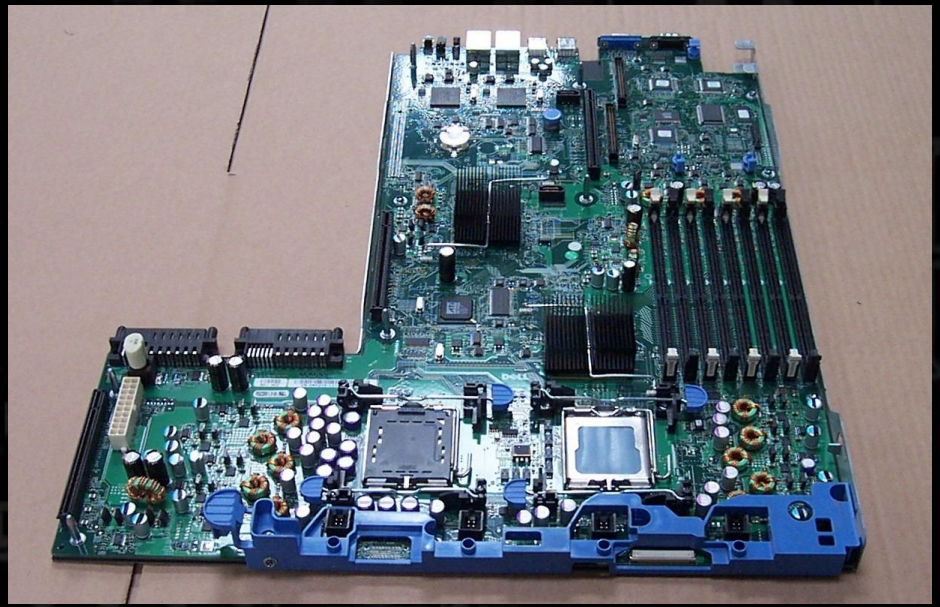
- Buffered/Registered
  - Made for servers
  - Can be of much bigger capacity
  - Come with ECC to detect data corruption
- Unbuffered
  - Made for desktop or low-cost servers
  - Smaller capacity
  - May have ECC but are much more expensive on ebay

Ram types - Not all dimms are equals - PC2

- Older generation (LGA771)
  - Use ddr2 (pc2)
  - Higher voltage required (1.5V to 1.8V)
  - From 400Mhz to 800Mhz
  - Can go in dual channel memory configuration
  - Up to 8GB dimms in some systems

Ram types - Not all dimms are equals - PC2

- Dual LGA771 - Dell 2950
  - The chipset run the memory
  - The CPUs access the chipset
    To reach the RAM
  - Only support 4gb DIMMS
  - Only support Dual core cpus

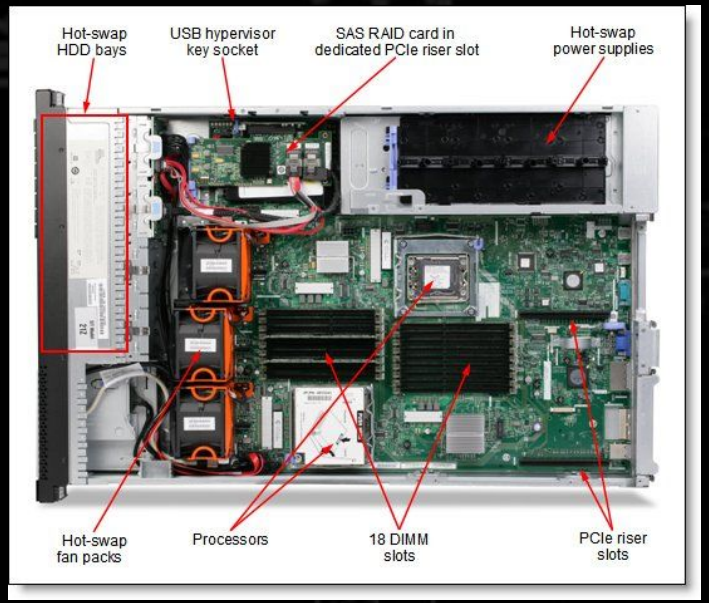


Ram types - Not all dimms are equals - PC3

- Affordable generation (FCLGA1366) and $$ Generation (FCLGA2011)
  - Use ddr3 (pc3 pc3l)
  - Voltage required (1.35V to 1.5V)
  - From 800Mhz to 1866Mhz
  - Can go in triple and quad channel memory configuration
  - Up to 16GB dimms

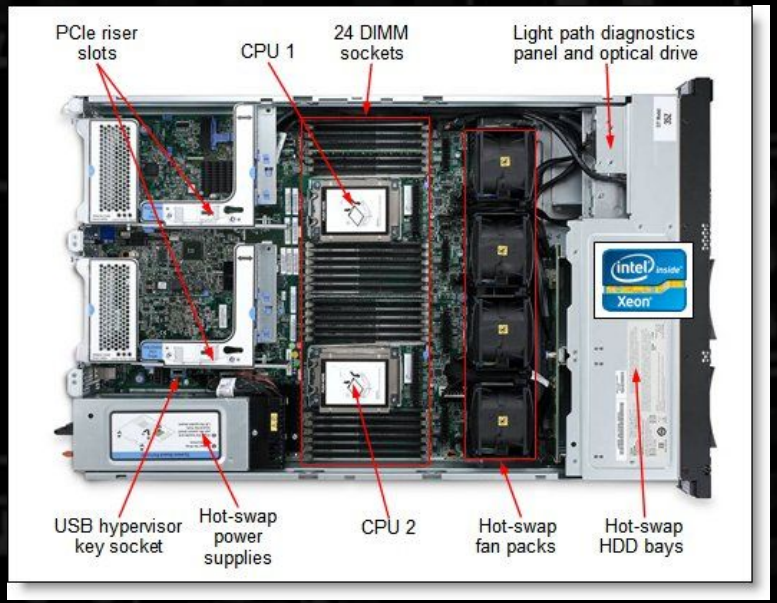
Ram types - Not all dimms are equals - PC3

Dual FCLGA1366 - x3650 m3



- The cpu run the memory
- The dimms are closer to the CPU
- RtM, can't put them all over the place.

Dual FCLGA2011 - x3650 m4



Ram types - Not all dimms are equals - PC4

- Expen$$$ive generation (FCLGA2011-3)
  - Use ddr4 (pc4)
  - Voltage required (1.2V)
  - From 1600Mhz to 2400Mhz
  - Can go in quad channel memory configuration
  - 32GB dimm$$$ can be found

Ram types - Not all dimms are equals - Notes

- In server memory, ranks are important Ex: a dual FCLGA1366
  - Can only support 12 4rx4 PC3 dimms
  - It can support up to 18 PC3 dimms in 1rx8, 2rx8 or 2rx4
- Those rank can be compared to multi threads
  - 2rx* will perform better than 1rx*
- The more channels you populate, the lower the frequency (FCLGA1366)
  - 3 dimms/cpu = max 1333mhz
  - 6 dimms/cpu = max 1066mhz
  - 9 dimms/cpu = max 800mhz
- Mhz isn't the only important number. Latency play a role
  - Low latency PC3 1333 can perform better than high latency PC4 1866

CPU types - Evolution and differences

- LGA771
  - Memory controller isn't in the CPU.
  - Memory capacity influenced by the chipset, mostly 48GB max
  - May support 8GB PC2 dimms
  - Dual channel is possible
  - Up to 4 cores
- FCLGA1366 - Personal favorite
  - Memory controller integrated in the CPU
  - Can run up to 144GB/CPU using 16gb 2rx4 dimms with the 56XX serie
  - Triple channel is possible
  - Up to 6 cores with hyperthreading
- FCLGA2011 and FCLGA2011-3
  - Memory controller integrated in the CPU
  - Can deal with more ram that you will need
  - Quad channel possible
  - Tons of cores for hundreds of VMs

CPU types - Side notes

- W34XX and xeon E3
  - A desktop knock-off CPU with xeon name on it
  - Basically the same as the desktop version without overclocking potential
  - Can run ECC dimms, but unbuffered --> $$$
  - Will be used in half-length or single socket servers
  - Mostly support only 32GB RAM
  - The servers using those haven't been mass-produced
    - Cost much more on ebay
    - Rarely seen too
  - Better off with a workstation

CPU types - xeon E3

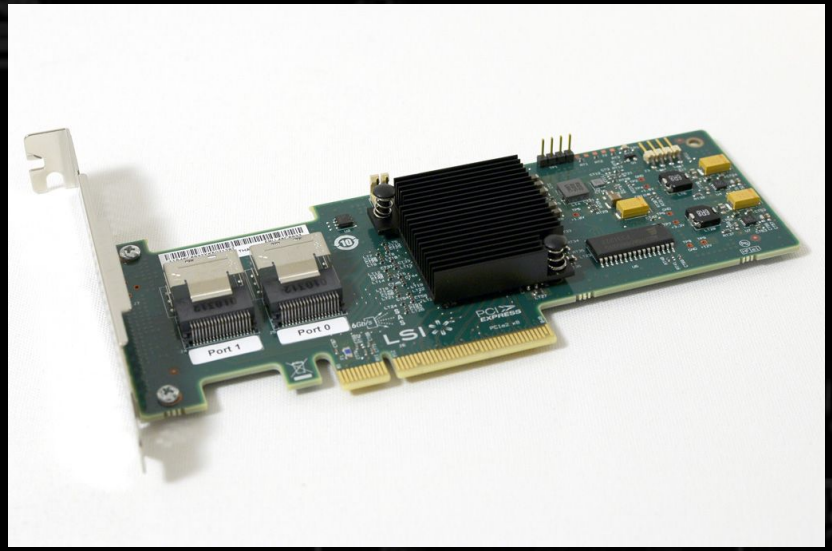
Dell r210

Hdds - SAS/Sata controller, SSD

- Server onboard controller is sata - Can’t run SAS drives
  - Use it for cd/dvd-rom
  - You can connect your sata drives with it
  - Proxmox don’t mind
- Dedicated SAS controller card - Can run Sata drives
  - Without integrated cache
    - Proxmox is fine with it. Make sure it support JBOD for Proxmox (google it)
    - Vmware will be slower
  - With integrated cache
    - Proxmox is fine with it (he won't use it with zfs) but make sure it support JBOD
    - Great with Vmware as long it as a BBU to protect the card cache
    - Without BBU, make sure you have a UPS protection
- SSDs
  - Better with TRIM for longevity
  - Proxmox use it as write cache (Proxmox don’t support TRIM yet)

Hdds - SAS/Sata controller, SSD

IBM m1015, no cache no BBU



IBM m5015 512MB cache & BBU

Network interfaces

- Not all network controller are equals
  - Realtek … Really?
  - Intel and broadcom chipset perform better
  - Easy to find cards with 4 1Gb ports
  - Team them up for added speed/redundancy
  - 10Gb cards are expensives and you need a switch that connect to it
  - Higher end chipset offload the cpu in network tasks
    - Intel i340, i350
  - The more you have, the better for a firewall

Hackfest servers

- Before 2015
  - Bests servers where dual xeons 5160 to run the events
  - At most they had 48GB ram
  - A few SAS drives from 73GB to 300GB in raid 10 all 3.5 inches
- After 2015
  - 4 servers
  - Dual xeons x5650, x5670
  - 144GB ram each servers
  - SAS drives from 146GB to 900GB all 2.5 inches
- 2017 edition
  - Added a dual x5680 with 160GB ram to run the multiple VMs

Hackfest servers - 2017 - x3650 m3

- I've lend them a IBM x3650 m3 to use with their servers
  - Dual x5680@3.33Ghz for 12 cores / 24 threads
  - 160GB ram in triple channel configuration on cpu0 and dual channel on cpu1
    - Not optimal, but I used some spare parts
    - Official version use 18x 8GB PC3L dimms in triple channels for 144GB total
  - 8x 146GB 15k 2.5" in raid 10 configuration. 6 for the array and 2 hots spares
  - Dual backplane configuration to support up to 16 drives
    - 4 Hdds on each backplanes for added redundancy
    - Each backplane has 3 Raid 0 hdds + 1 hot spare. The other mirror it (Raid 1)
- It ran a bunch of stuff for HF2017
  - 17 teams with 5 VMs each where on it
    - 4 out of 5 VMs where Windows
  - ~70GB of total Hdds space was used using ZFS cloning capacity
    - This show in labs environments, big hdds capacity may not be a factor
    - Better with fast hdds (15k) and tons of RAM

My home server

- IBM Tower server x3500 m3
  - Dual L5640@2.26Ghz for 12 cores / 24 threads
    - 60W rated cpus for low power usage
  - 96Gb ram in triple channel configuration
    - 6x 16GB PC3L dimms running at 1333Mhz
  - 8x 146GB 15k 2.5” in raid 10 configuration. 6 for the array and 2 hots spares
  - 1x 4TB HGST 7.2K 3.5” (Should be in raid 1, I know)
- It use it to:
  - Run 2 Pfsenses in CARP
  - A bunch of Debian to run games servers
  - A FreeBSD for network shares
  - An AD (wip) - Time restriction with home tasks…
  - Personal Web pages hosting
  - A winXP bitch for unsafe .exe

Conclusion

- To reduce costs, aim for mass productions servers
  - 1u Dell r610, HP dl360 g6-g7, Ibm x3550 m2-m3
  - 2u Dell r710, HP dl380 g6-g7, Ibm x3650 m2-m3
  - 1u servers are cheaper than 2u but louder
  - Tower servers and workstations often allow for more upgrades options and make less noises
  - Buy your ram and hdd in bulk
  - Team up with friends to reduce shipping/import costs
- Choose your hypervisor before buying parts
  - Vmware is more hardware dependent
    - SAS controller with cache & BBU
  - Proxmox with zfs need ram
    - +72gb memory to make it comfortable

Special thanks to Martin Dubé who let me use his template


Sharpie
XS470
Mastercraft


BOWMORE
ISLAY
SINGLE MALT
SCOTCH WHISKY
THE FIRST ISLAY MALT
LE PREMIER MALT D'ISLAY
AGED 18 YEARS
BOWMORE
ISLAY
SINGLE MALT
SCOTCH WHISKY
THE FIRST ISLAY MALT
LE PREMIER MALT D'ISLAY
AGED 12 YEARS

ASUS BIOS
Version : 1305
Build Date: 06/19/09

Processor
Type : Intel(R) Xeon(R) CPU X5470 @ 3.33GHz
Speed : 3350MHz
Count : 4

System Memory
Available : 6144MB

↔ Selec
↑↓ Select
F1 Genera
F10 Save a
ESC Exit