Hes·so VALAIS WALLIS

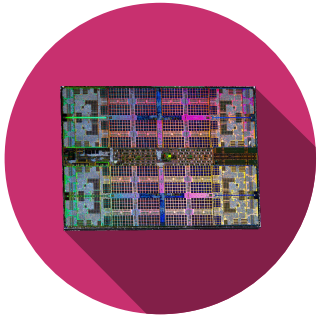
School of Engineering

Computer Architecture

History

His

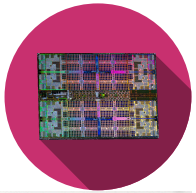
Information and Communication Systems program



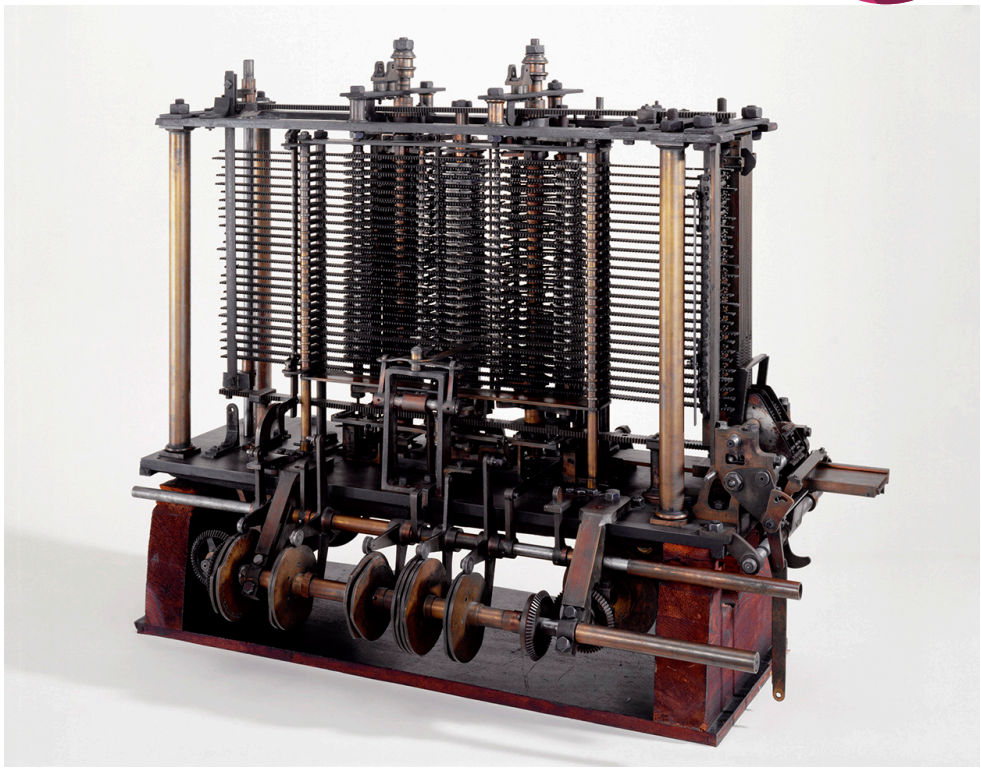
Silvan Zahno silvan.zahno@hevs.ch

First Computer

Babbage Analytical Engine



- 1834-1871



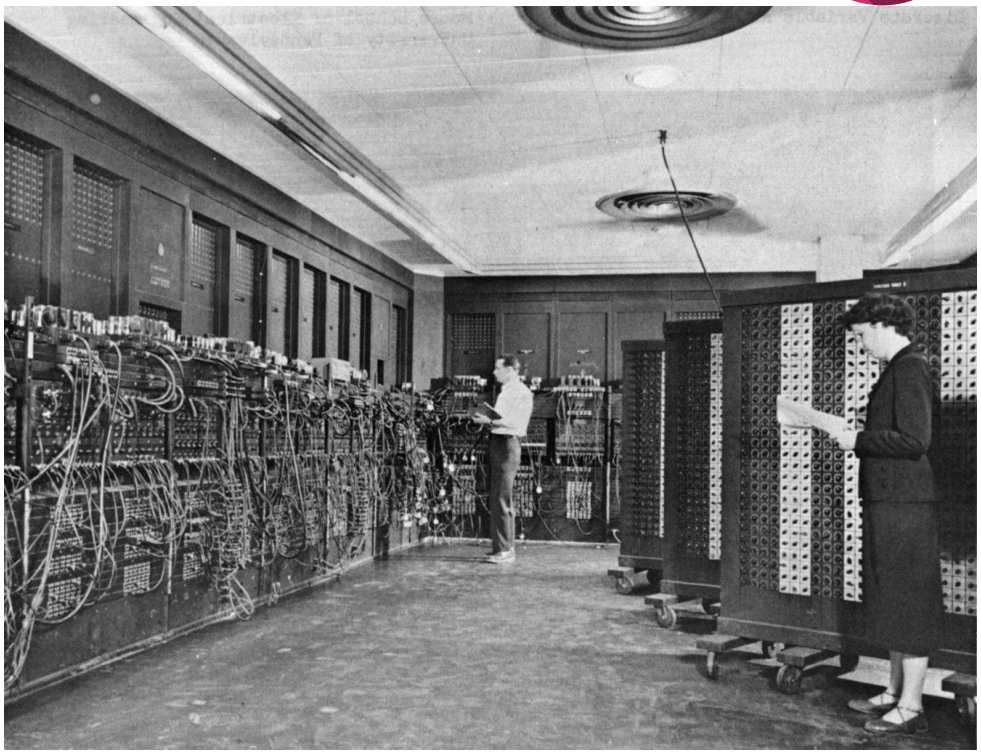
[1]

- Arithmetical calculations
- Punch cards to input instructions
- Components
  - Mill for arithmetic calculations
  - Store acting as memory

First Computer

ENIAC

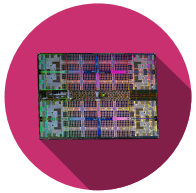
- 1945



[3]

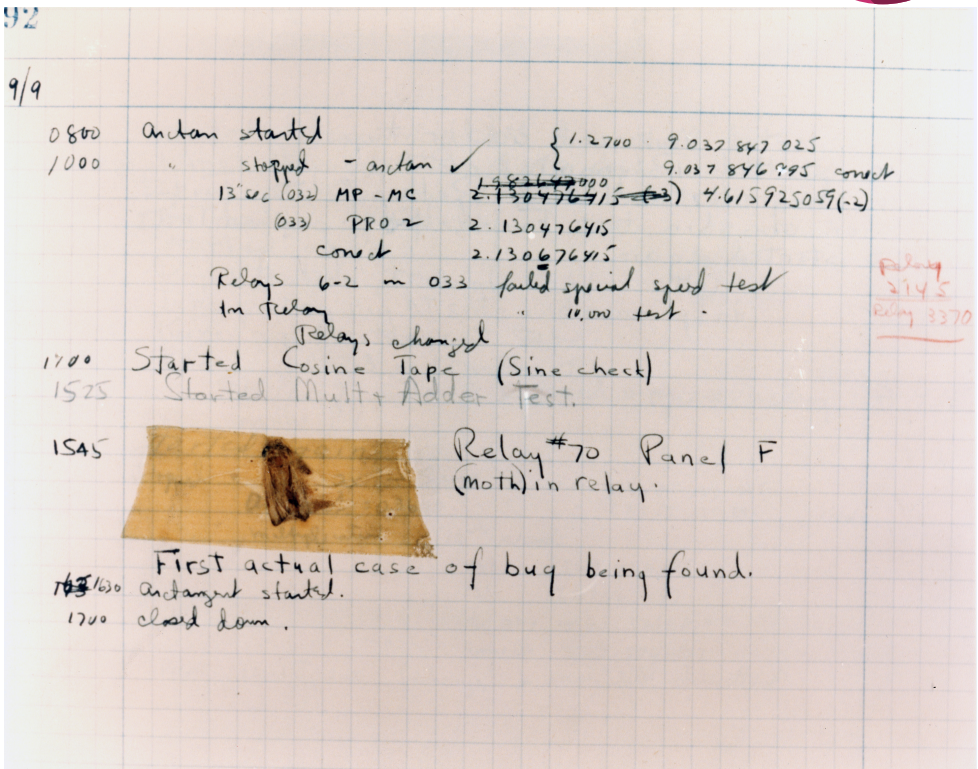
- Electronic Numerical Integrator and Computer
- For calculating ballistic tables
- 18’000 vacuum tubes
- 5’000 calculation/sec
- Programmed with cables and switches

First Bug



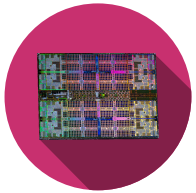
- Grace Hopper 1947
- Harvard Mark II

- Moth was found in relay #70



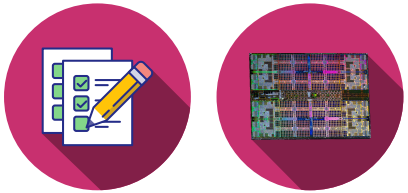
[2]

Which computer architectures do you know?



[2]

Which computer architectures do you know?



x86 architecture: This is one of the most popular architectures for personal computers, servers and workstations. It is based on the Intel 8086 processor and has evolved over the years to include various generations of processors including Pentium, Core and Xeon.

ARM architecture: This architecture is widely used in mobile devices, embedded systems and other low-power devices. It is known for its low power consumption and high efficiency.

RISC-V architecture: This is an open source instruction set architecture that is gaining popularity in the industry due to its simplicity, modularity and extensibility.

PowerPC architecture: This architecture was developed by IBM and is used in various systems including high-end workstations, servers, gaming consoles and embedded systems.

SPARC architecture: This architecture was developed by Sun Microsystems and is used in their workstations and servers. It is known for its high performance and scalability.

MIPS architecture: This architecture is used in various systems including routers, game consoles and other embedded systems. It is known for its simplicity and low power consumption.

Z80 architecture: This architecture was popular in the 1980s and was used in many home computers and game consoles. It is known for its simplicity and low cost.

DEC Alpha architecture: This architecture was used in high-end workstations and servers in the 1990s. It is known for its high performance and scalability.

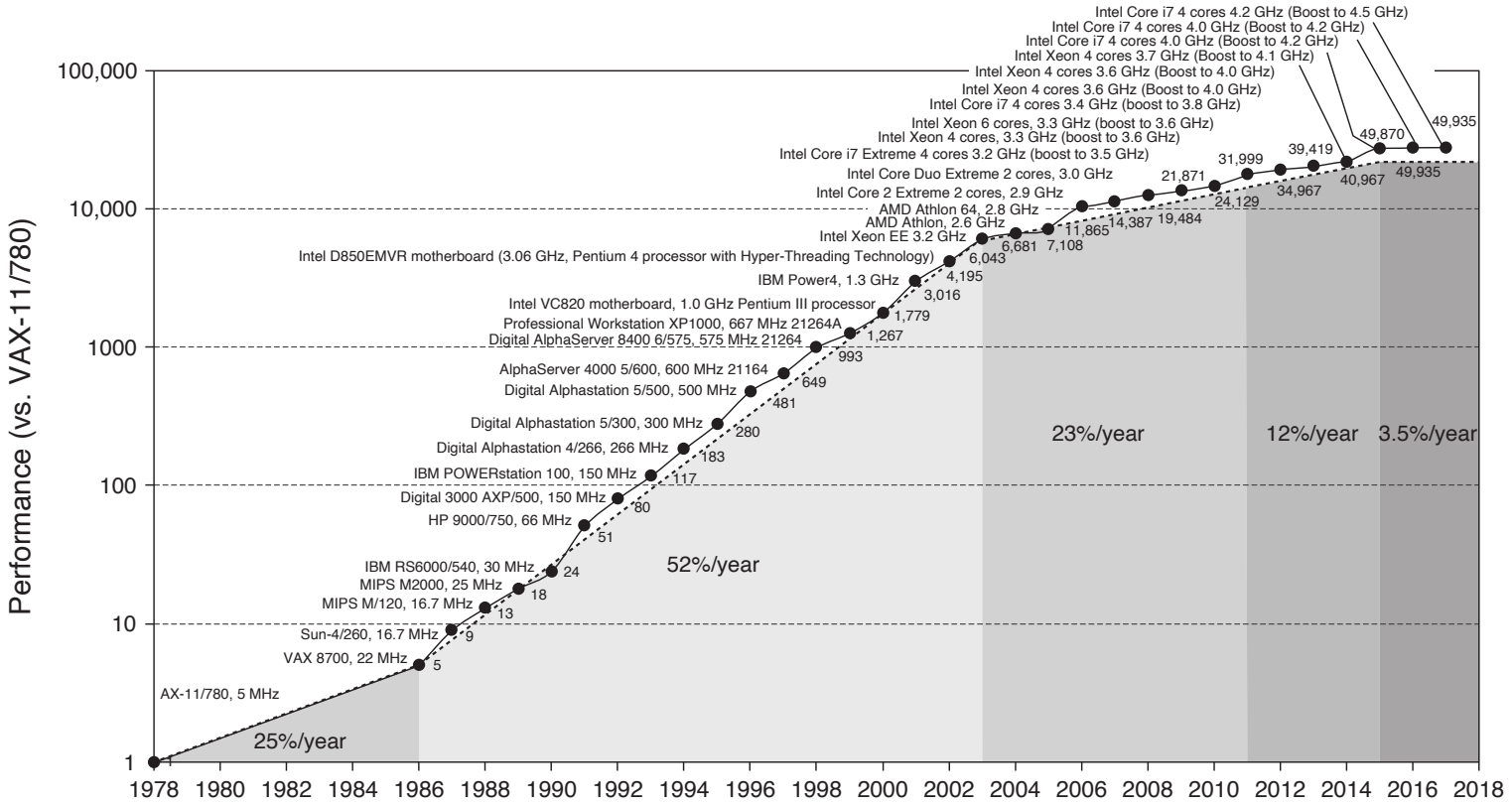
Itanium architecture: This architecture was developed by Intel and is used in high-end servers and workstations. It is known for its high performance and scalability.

IBM System/360 architecture: This architecture was introduced in the 1960s and was one of the first mainframe computer architectures. It is known for its backward compatibility and reliability.

[2]

Sequential Processor Performance

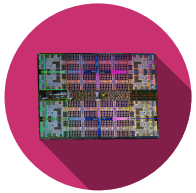
Logplot - Performance vs. Years

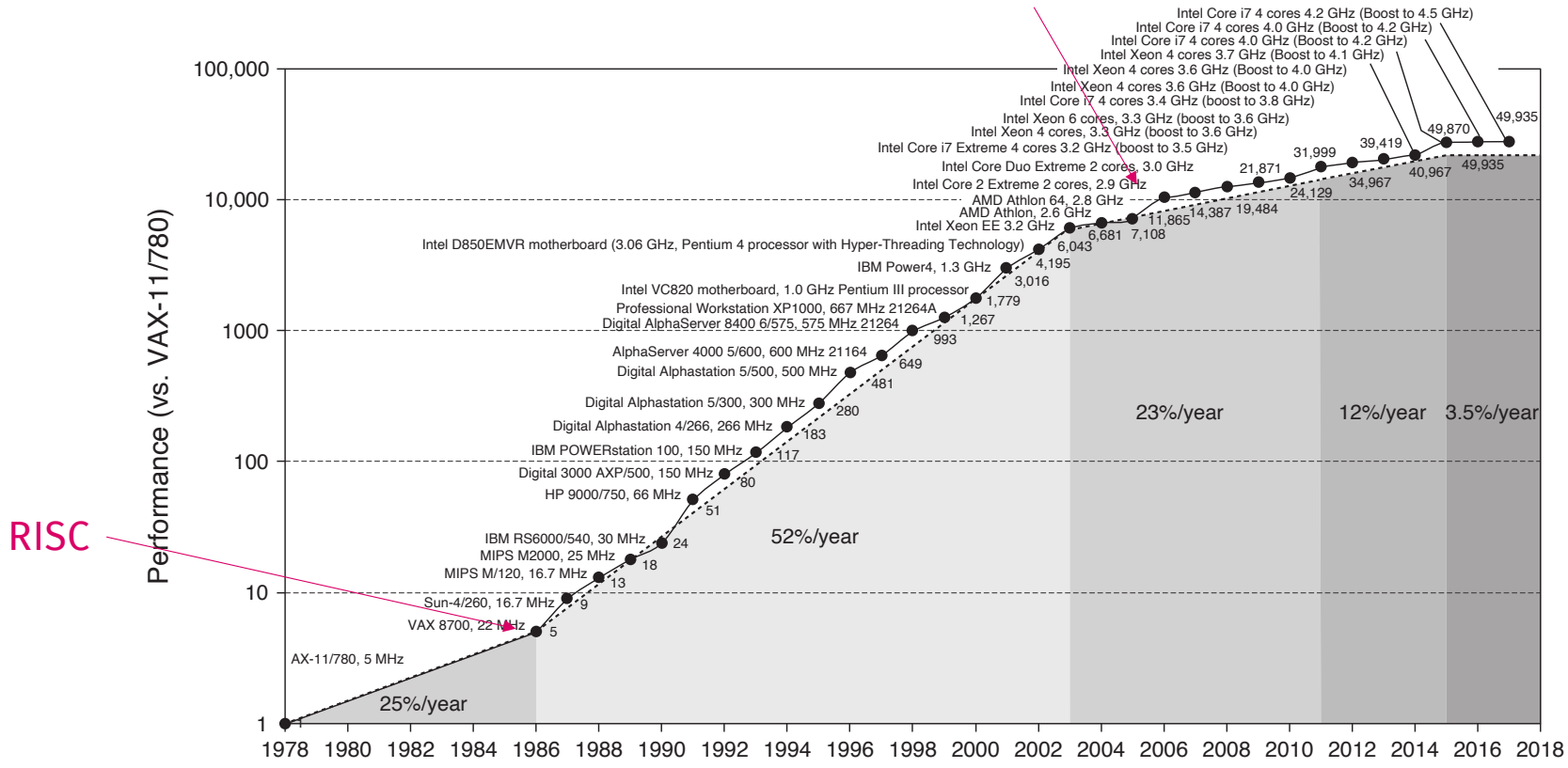


[4]

Sequential Processor Performance

Logplot - Performance vs. Years





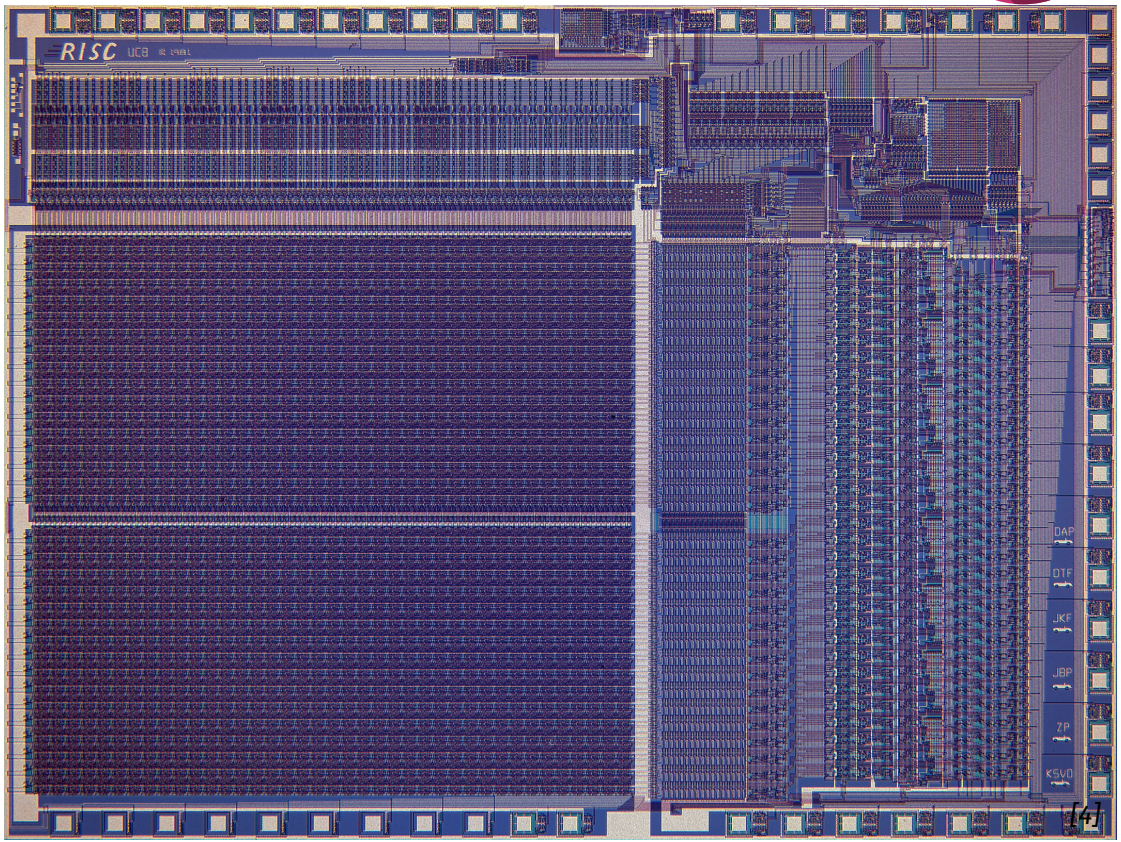
[4]

Computer Architectures

RISC 1

- Basic Pipelined Processor

~50’000 Transistors



[4]

Image Credit: Berkeley RISC I © University of Berkeley

Computer Architectures

Original i7 Nehalem

- Instruction Level Parallelism
  - Superscalar
  - Very Long Instruction Word (VLIW)
- Long Pipelines
- Advanced Memeory and Caches
- Data Level Parallelism
  - Vector
  - GPU
- Thread Level Parallelism
  - Multithreading
  - Multiprocessor
  - Multicore
  - Manycore

~700’000’000 Transistors

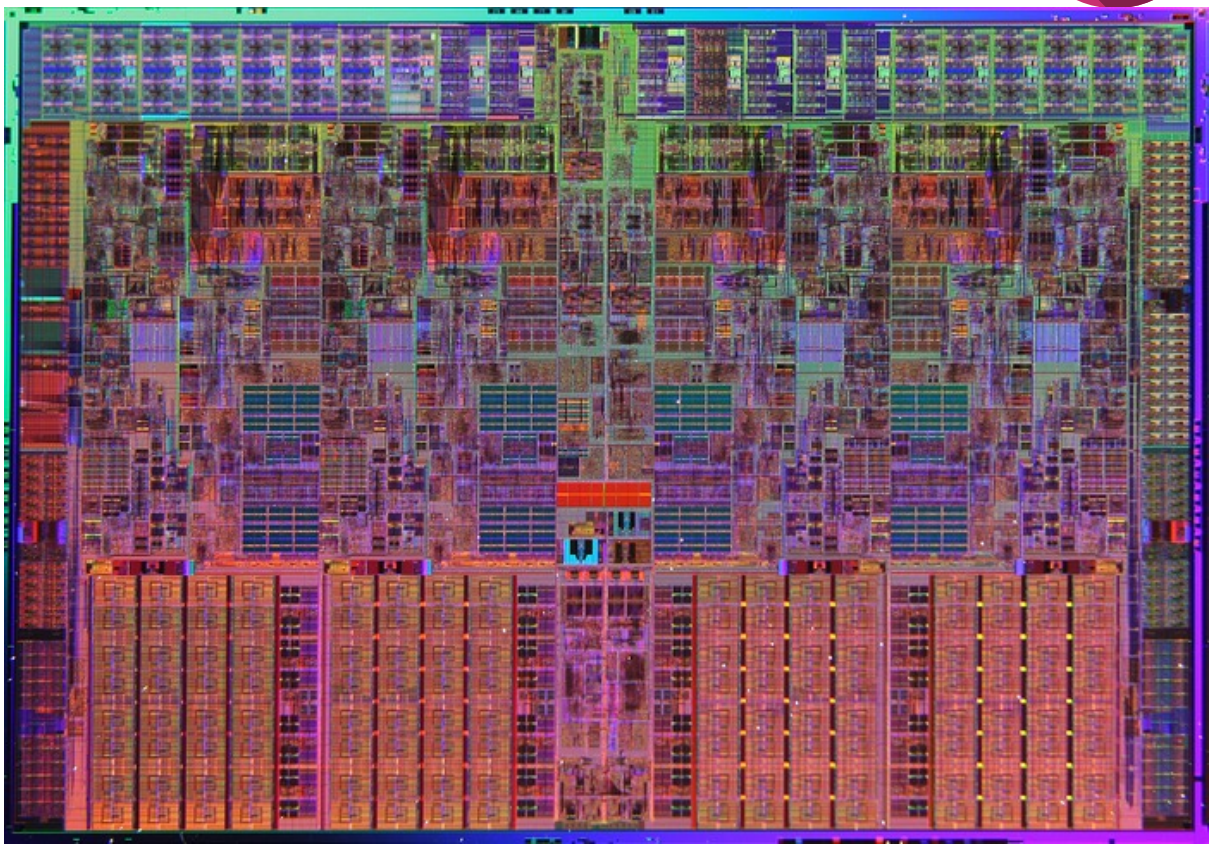
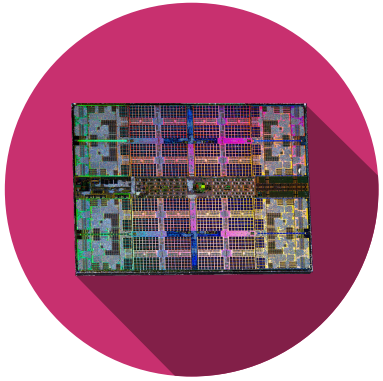
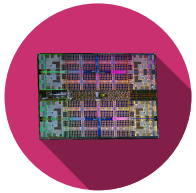


Image Credit: Intel



Processor Bugs / Vulnerabilities

Vulnerabilities in modern computers



Meltdown

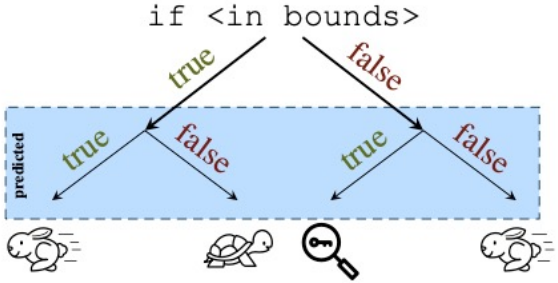
Reading Kernel Memory from User Space

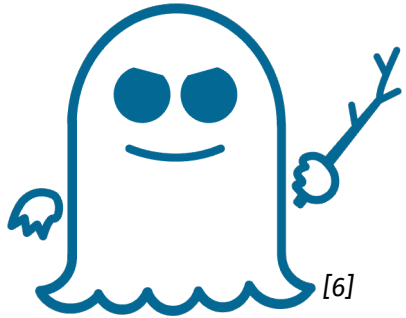
```
# rcx = kernel address, rbx = probe array
xor rax, rax       # Clear rax (set to 0) to avoid residual values
retry:
mov al, byte [rcx] # Load a single byte from the kernel address in rcx
shl rax, 0xc       # Multiply the byte value by 4096 (0x1000)
                   # to create an index for the probe array
jz retry           # If rax == 0, retry (optional mitigation attempt)
mov rbx, qword [rbx + rax]
                # Access the probe array at an index based on the secret byte.
                # This causes a **cache access** that leaks the byte through timing.
```

Spectre

Microarchitectural attack which exploits out-of-order execution

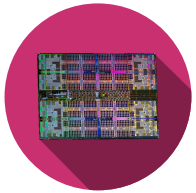
Instructions are not executed in the correct order





[6]

References



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[4]

J. L. Hennessy and D. A. Patterson, *Computer Architecture: A Quantitative Approach*, 6th Edition. Elsevier, 2019.

[5]

D. Wentzlaff, “Computer Architecture ELE 475 / COS 475.” Princeton University, 2019.

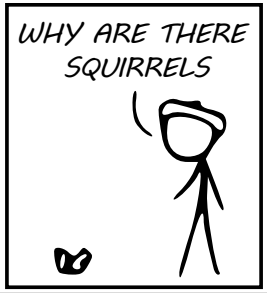
[6]

“Meltdown and Spectre.” Accessed: Mar. 11, 2025. [Online]. Available: https://spectreattack.com/

QUESTIONS

CAN BE ASKED BY ANYONE ANYTIME

WHY ARE THERE MIRRORS ABOVE BEDS
WHY DO I SAY UH
WHY IS SEA SALT BETTER
WHY ARE THERE TREES IN THE MIDDLE OF FIELDS
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SVCHOST.EXE RUNNING
WHY AREN'T ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY WUBA LUBBA DUB DUB MEANING
WHY IS THERE A WHALE AND A POT FALLING
WHY ARE THERE SO MANY BIRDS IN SWISS
WHY IS THERE SO LITTLE RAIN IN WALLIS
WHY IS WALLIS WEATHER FORECAST ALWAYS WRONG
WHY ARE THERE MALE AND FEMALE BIKES
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REACH UP
HOW FAST IS LIGHTSPEED
WHY ARE OLD KLINGONS DIFFERENT



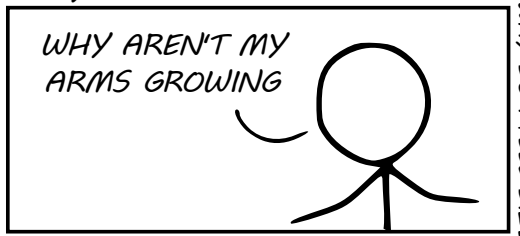
WHY AREN'T THERE DINOSAUR GHOSTS
WHY IS THERE HELL IF G
WHY ARE THERE TINY SPIDERS IN MY HOUSE
WHY DO SPIDERS COME INSIDE
WHY ARE THERE HUGE SPIDERS IN MY HOUSE
WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE
WHY ARE THERE SPIDERS IN MY ROOM
WHY ARE THERE SO MANY SPIDERS IN MY ROOM
WHY DO SPYDER BITES ITCH
WHY IS DYING SO SCARY
WHY IS THERE NO GPS IN LAPTOPS
WHY DO KNEES CLICK
WHY AREN'T THERE F GRADES
WHY

WHY DO IGUANAS DIE
WHY IS THERE CAFFEINE IN MY SHAMPOO
WHY HAVE DINOSAURS NO FUR
TIME
WHY ARE SWISS AFRAID OF DRAGONS
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY IS 42 THE ANSWER TO EVERYTHING
WHY CAN'T NOBODY ELSE LIFT THORS HAMMER
WHY IS MARVIN ALWAYS SO SAD
WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN

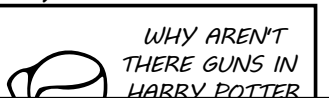
WHY ARE THERE FEMALE M

WHAT IS https://xkcd.com/1256/
WHY DO THEY SAY T-MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMMING MORE ACIDIC

WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON TWITTER
WHY IS HTTPS IMPORTANT
WHY IS YKK ON ALL ZIPPERS



WHY ARE THERE WEEKS
WHY DO I FEEL DIZZY
WHY IS THERE A SWARM OF ANTS
WHY IS THERE PILEGRIM
WHY IS THERE LAVA
WHY ARE THERE SO MANY CROWS IN ROCHESTER
WHY IS TO BE OR NOT TO BE FUNNY
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE DOGS AFRAID OF FIRE
WHY IS THERE NO KING IN EN
WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE FPGA's EVERYWHERE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOCKS
WHY IS LIFE SO
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO PEOPLE DIE



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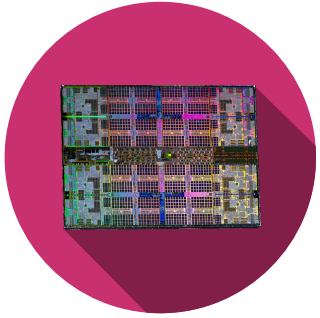
Hochschule für Ingenieurwissenschaften



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