CS310 Operating Systems

Lecture 0: Course Introduction

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What is so interesting about OS course?

- Knowledge of OS and Computer Architecture gives you almost complete picture of ”how computers work?”
- Operating System is evolving as processor architecture is evolving!
- You will frequently use OS concepts in any area of your work
- It will help you in getting a job in any company in the domain of Architecture, System, Networking, Internet, Embedded Systems and many more..

What is so interesting about OS course?

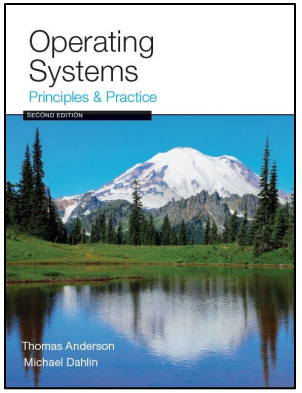
- Some of you may actually design OS features, in future
- Many of you will create systems that utilize the core concepts in operating systems.
  - Whether you build software or hardware
  - The concepts and design patterns appear at many levels
- All of you will build applications, etc. that utilize operating systems
  - The better you understand their design and implementation, the better use you'll make of them.
- Most of applications in future will demand exploitation of parallelism available in the hardware
  - Multithreaded programming
  - In this course you will learn about Multithreading

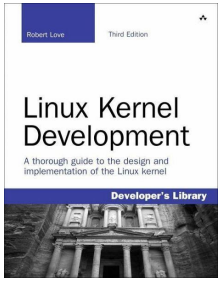
Classes : Logistics

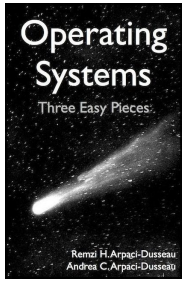
- Zoom
- You will learn only if you are attentive in the class
  - It's up to you ..
- Assignments: Many
- Need to bring back personal interaction – even if it is virtual
- Humans not good at interacting text-only

Infrastructure, Textbook & Readings

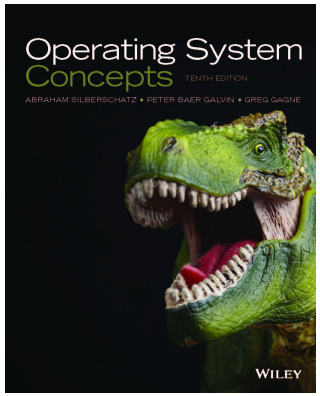
- Infrastructure
  - Google Classroom
  - Gradescope
- Textbook: Operating Systems: Principles and Practice (2nd Edition) Anderson and Dahlin
- Supplementary Material
  - Operating Systems: Three Easy Pieces, by Remzi and Andrea Arpaci-Dusseau, available for free online
    - https://pages.cs.wisc.edu/~remzi/OSTEP/#instructors
  - Linux Kernel Development, 3rd edition, by Robert Love



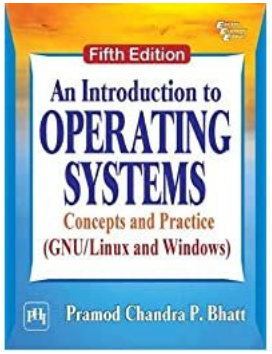




Infrastructure, Textbook & Readings



- Supplementary Material: Books
  - Operating System Concepts, 10th Edition, Avi Silberschatz, Peter Galvin, and Gred Gagne, John Wiley & Sons
  - Modern Operating System, William Stallings
  - An Introduction to Operating Systems: Concepts and Practice (GNU/Linux), PHI, Pramod C P Bhatt



Online video resources and course websites of Operating System course

- CS162, Operating Systems and Systems Programming, University of California Berkeley, https://inst.eecs.berkeley.edu/~cs162/sp21/

  https://youtu.be/itfEcA3TXq4

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Syllabus

- OS Concepts: How to Navigate as a Systems Programmer!
  - Process, I/O, Networks and Virtual Machines
- Concurrency
  - Threads, scheduling, locks, deadlock, scalability, fairness
- Address Space
  - Virtual memory, address translation, protection, sharing
- File Systems
  - I/O devices, file objects, storage, naming, caching, performance, paging, transactions, databases
- Reliability & Security
  - Fault tolerance, protection, security
- Computer System: Linker
- Virtualization
- Cloud Infrastructure

Better learn by yourself if you don’t know..

- Proficiency in C
  - Pointers
  - Function Pointers
  - Memory Management (malloc, free, stack vs heap)

What additional stuff you can expect

- A lot more programming assignments
  - No spoon feeding – google it – read books - do programming by yourself
    - You are now in the 3rd year.. Don't expect hand holding
- No class in case less than 90% students available
  - So learn it by yourself
- How to handle monotony ?
  - You need to be alive in the class
  - Don't take classes while watching matches …
- Learn by sincere effort
  - No free lunches… need to earn your grade by working hard
  - Your learning matters to me … nothing else .. So please don't try usual tricks..

Earn your Grade …

- Total 1000 points
- Midsem Exam: 250 points
- Endsem Exam: 300 points
- Home Assignments: 200 points
  - 10 assignments of 15 points each
- Coding Assignment
  - 10 assignments of 20 points each
- Presentation on a topic / project: 50 points
- Class participation
  - 50 points
  - Regular engagement
  - Aliveness in the class and asking questions

Earn your Grade …

- 930 – 1000: A*
- 901 – 929: A+
- 851 – 900 A
- 801 – 850 B+
- 751 – 800 B
- 701 – 750 C+
- 600 – 700 C
- 500 - 599 D
- 400 - 499 E
- Below 400 F

Hope you have clarity on how grades will be given !

Earn your Grade …

- Online exams: Proctortrack
  - In case of regular classroom exam: Paper / Copy
- All assignments will be evaluated by TAs

- Good Luck

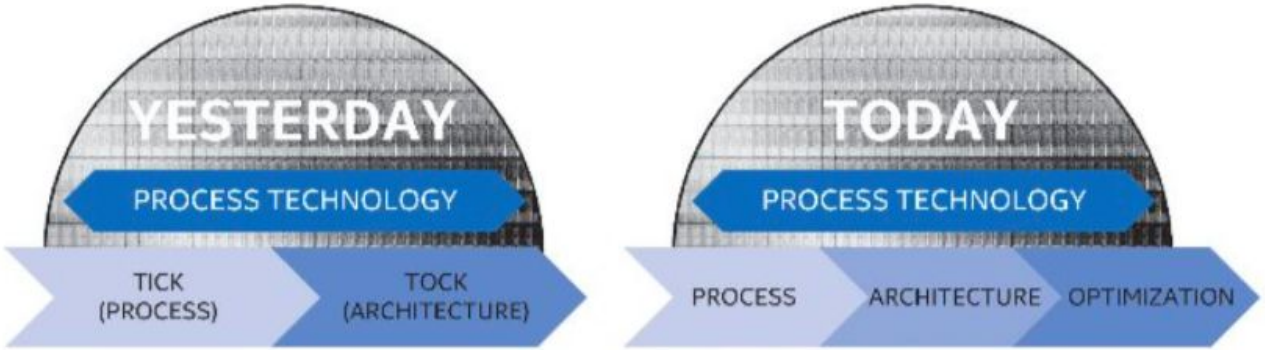
Personal Integrity

- Please demonstrate honest and Ethical behavior You will get Fail Grade if found cheating or helping others in cheating..

Any input ?

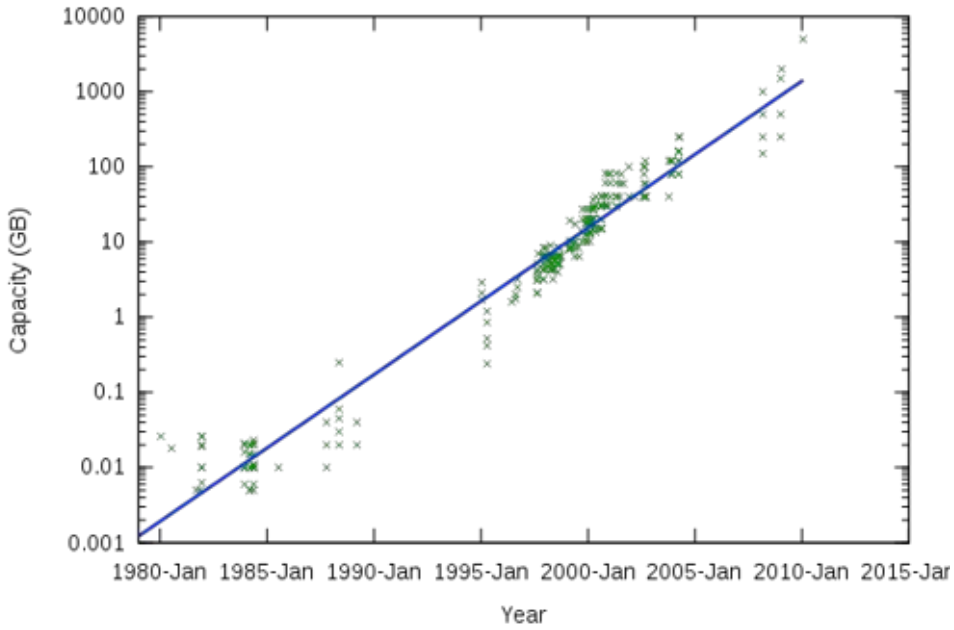
Computing world is changing very fast!

But then Moore's Law Ended…

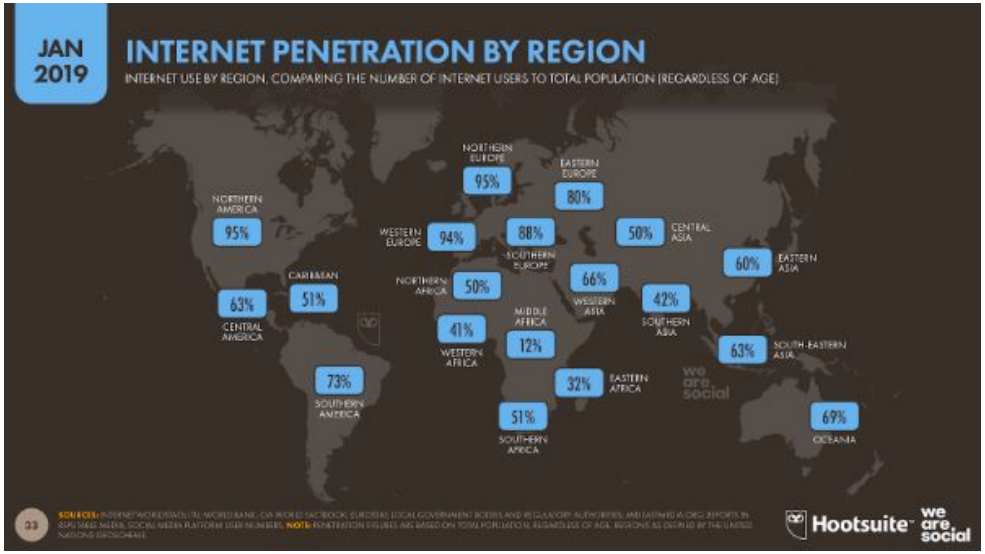


- Moore's Law has (officially) ended -- Feb 2016
  - No longer getting 2 x transistors/chip every 18 months…
  - or even every 24 months
- May have only 2-3 smallest geometry fabrication plants left:
  - Intel and Samsung and/or TSMC
- Vendors moving to 3D stacked chips
  - More layers in old geometries

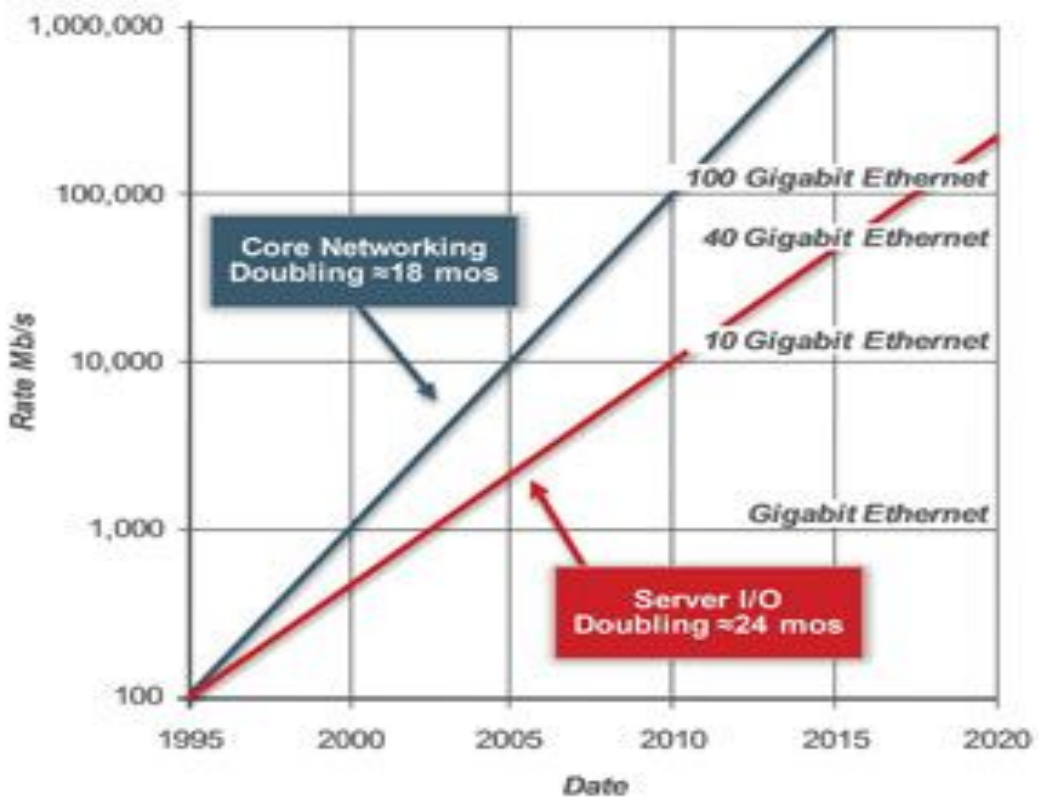
Storage Capacity is Still Growing!



Society is Increasingly Connected…

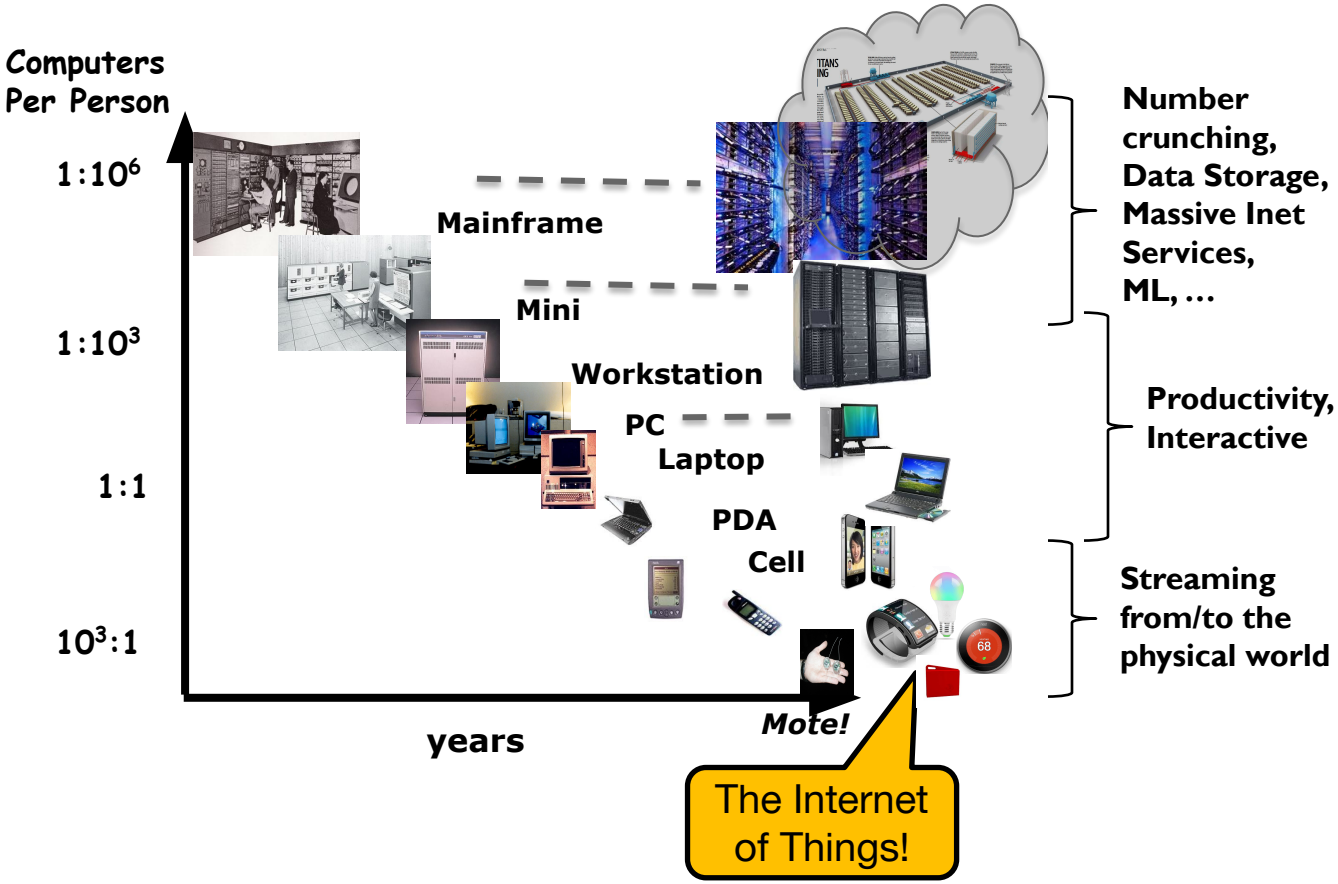


Network Capacity Still Increasing



(source: http://www.ospmag.com/issue/article/Time-Is-Not-Always-On-Our-Side)

People-to-Computer Ratio Over Time



Bell's Law: new computer class per 10 years

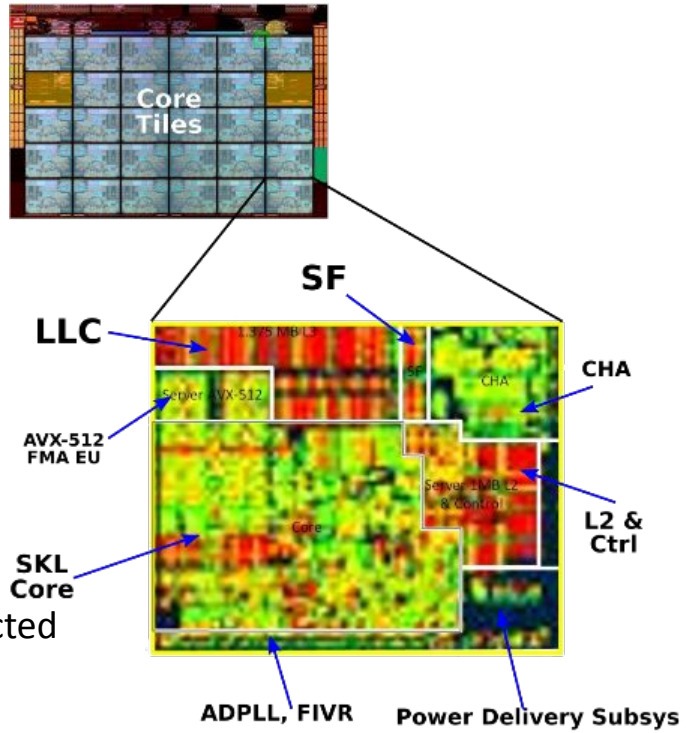
Challenge: Complexity

- Applications consisting of…
  - … a variety of software modules that …
  - … run on a variety of devices (machines) that
    - » … implement different hardware architectures
    - » … run competing applications
    - » … fail in unexpected ways
    - » … can be under a variety of attacks

- Not feasible to test software for all possible environments and combinations of components and devices
  - The question is not whether there are bugs but how serious are the bugs!

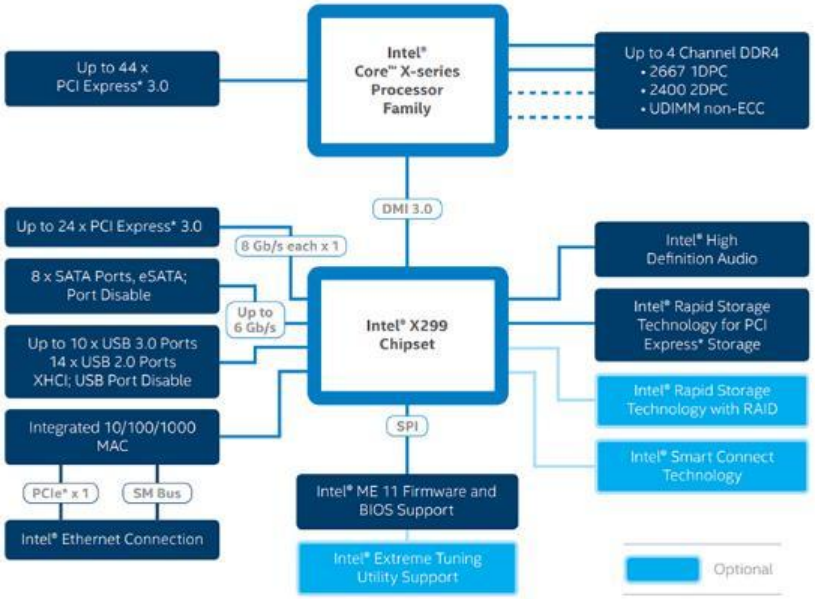
The World Is Parallel: Intel SkyLake (2017)

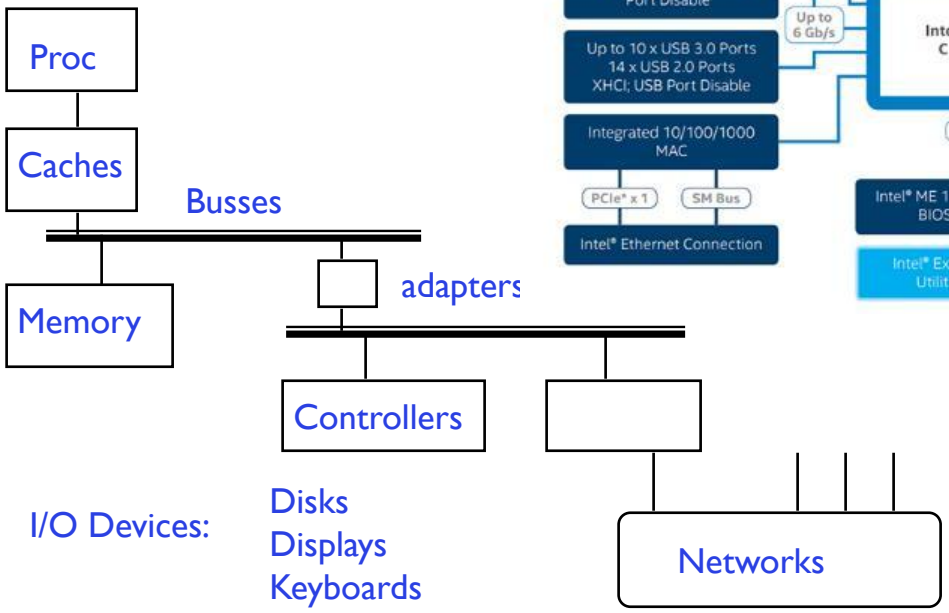
- Up to 28 Cores, 56 Threads
  - 694 mm² die size (estimated)
- Many different instructions
  - Security, Graphics
- Caches on chip:
  - L2: 28 MiB
  - Shared L3: 38.5 MiB (non-inclusive)
  - Directory-based cache coherence
- Network:
  - On-chip Mesh Interconnect
  - Fast off-chip network directly supports 8-chips connected
- DRAM/chips
  - Up to 1.5 TiB
  - DDR4 memory



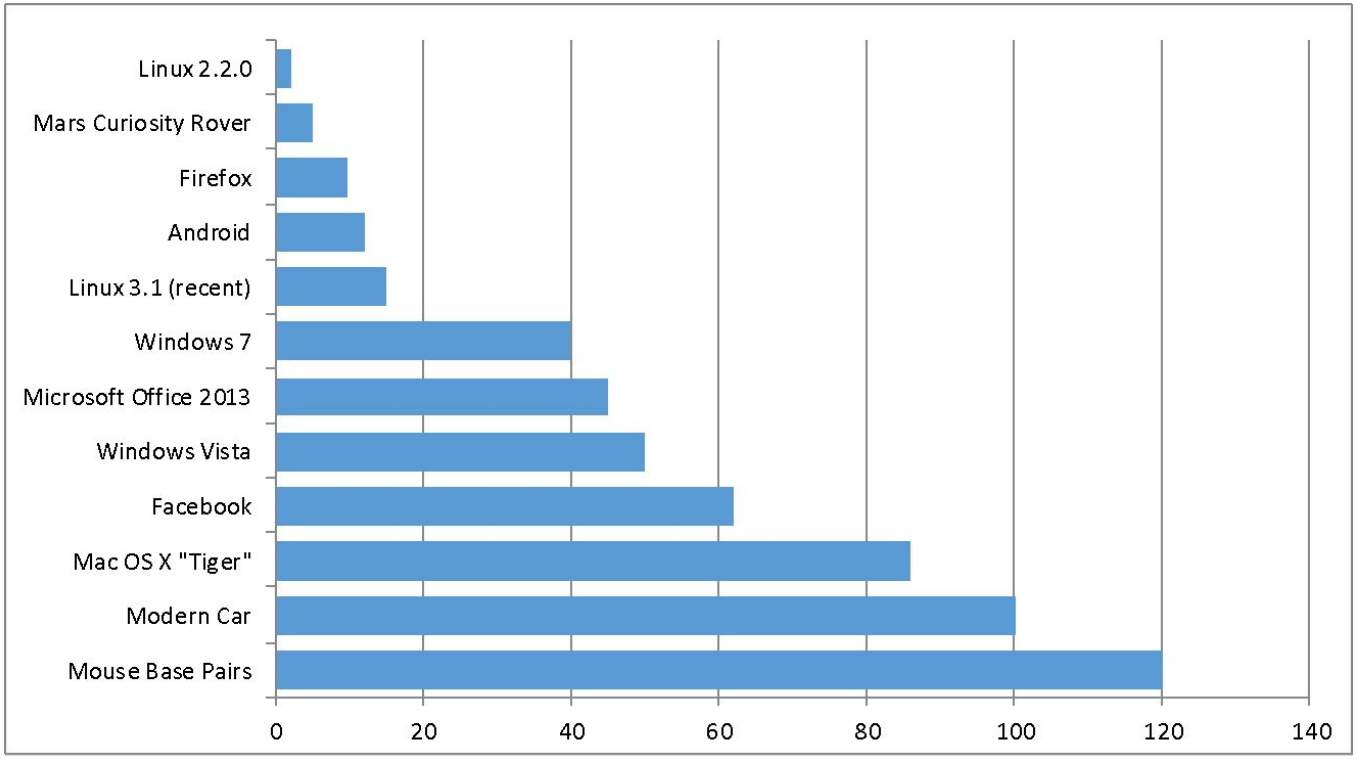
HW Functionality comes with great complexity!

Intel Skylake-X
I/O Configuration





Increasing Software Complexity



Millions of Lines of Code

(source https://informationisbeautiful.net/visualizations/million-lines-of-code/)

Questions

- Does the programmer need to write a single program that performs many independent activities?
- Does every program have to be altered for every piece of hardware?
- Does a faulty program crash everything?
- Does every program have access to all hardware?

No, no!

Operating Systems help the programmer write robust programs!

It hides complexity of the system and presents an abstract view

Enjoy Learning CS310

- It’s going to be exciting course
  - If you wish to learn …
  - Focus on what you are getting... Not on what you are not getting!
- If you have doubts, just ask
  - Rather than grumbling and complaining
- Be positive ..be honest …