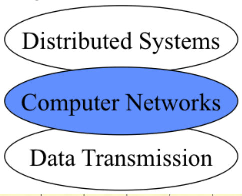
- Computer Network: A collection of *interconnected autonomous* computers
  - Generality: Built from general purpose hardware - not optimised for any particular application or data type
- Computer Network vs. Distributed System
  - Transparency
  - DS is a software system that runs on top of CN

互联的自治计算机

使用一般的硬件.

分布式一般透明的

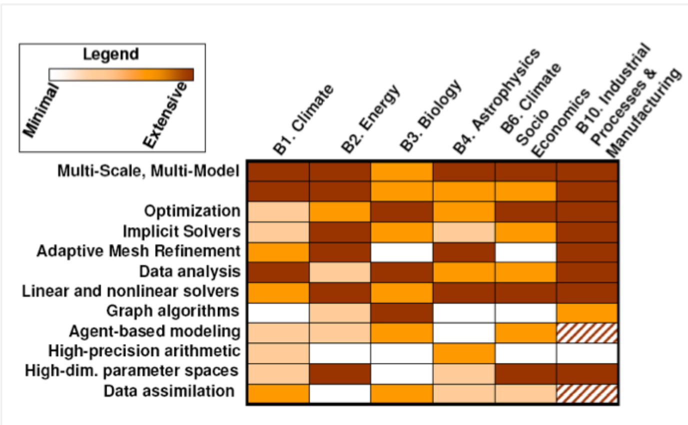
DS在CN上运行



- Petascale Computing (10^{15})
- Multicore computing
  - 1-24 cores commodity architectures
  - 100+cores proprietary architectures
  - 400+ GPU cores

- Exascale Computing (10^{18})
- Manycore computing
  - ~1000-core commodity architectures (heterogeneous, merged with GPUs etc)
- 1M nodes
- 1B processor cores

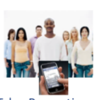
Drivers: Traditional Workloads



Drivers: Data

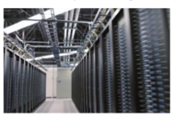
- Data volume, velocity, and variety is growing at an astounding rate with a full 90% of the world's data less than two years old.
- "Big Data is big. It's 2.5 quintillion bytes of data every day big."
- Almost 90% of this data is unstructured

Homeland Security
•600,000 records/sec



Telco Promotions
•100,000 records/sec

- 300M users
- 10000 data centres
- 30000 servers
- 25 Terabytes of Log Data - daily



Traffic
•250000 GPS probes/sec

Moore's Law

- Moore's law predicts a 60% annual increase in the number of transistors that can be put on a chip

Chip	Date	MHz	Transistors	Memory	Notes
4004	4/1971	0.108	2,300	640	First microprocessor on a chip
8008	4/1972	0.108	3,500	16 KB	First 8-bit microprocessor
8080	4/1974	2	6,000	64 KB	First general-purpose CPU on a chip
8086	6/1978	5-10	29,000	1 MB	First 16-bit CPU on a chip
8088	6/1979	5-8	29,000	1 MB	Used in IBM PC
80286	2/1982	8-12	134,000	16 MB	Memory protection present
80386	10/1985	16-33	275,000	4 GB	First 32-bit CPU
80486	4/1989	25-100	1.2M	4 GB	Built-in 8K cache memory
Pentium	3/1993	60-233	3.1M	4 GB	Two pipelines; later models had MMX
Pentium Pro	3/1995	150-200	5.5M	4 GB	Two levels of cache built in
Pentium II	5/1997	233-400	7.5M	4 GB	Pentium Pro plus MMX

Figure 1-10. The Intel CPU family. Clock speeds are measured in MHz (megahertz) where 1 MHz is 1 million cycles/sec.

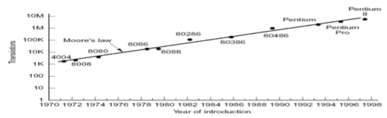
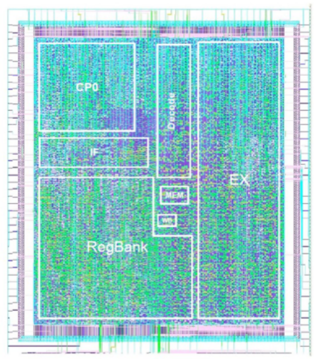


Figure 1-11. Moore's law for CPU chips.

Energy: Cooling

服务器需要冷却

Energy: Processing and Clocks

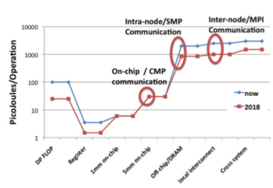


- New VLSI Paradigms
- Asynchronous Hardware
- GALS: Globally Asynchronous Locally Synchronous

硬件的全局不同步(不同部分不同功能)
局部同步

Energy: Data

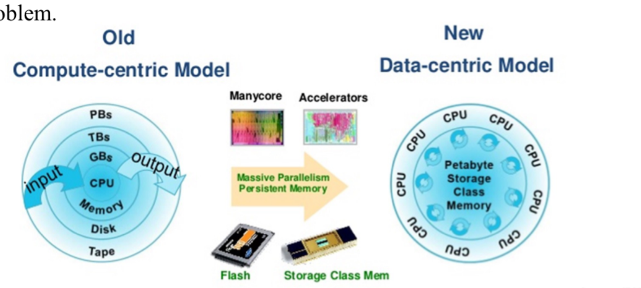
Power $\approx B \times l^2 / A$



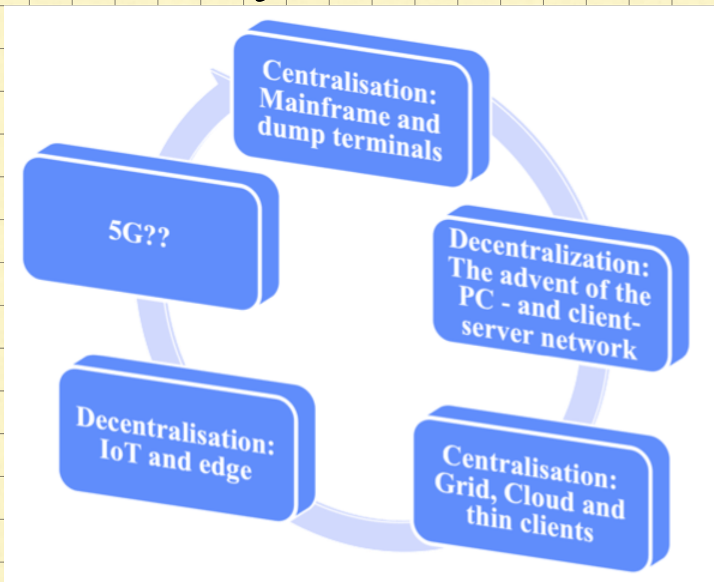
- Energy cost of data movement relative to the cost of a flop

- Power consumed increases proportionally to the bit-rate, so as we move to ultrahigh-bandwidth links, the power requirements are crucial factor.
- Improvements in chip lithography (making smaller wires) will not improve the energy efficiency or data carrying capacity of electrical wires.
- Without major breakthroughs in packaging technology or photonics, it will not be feasible to support globally flat bandwidth across a system
- Optical technology not a generic solution

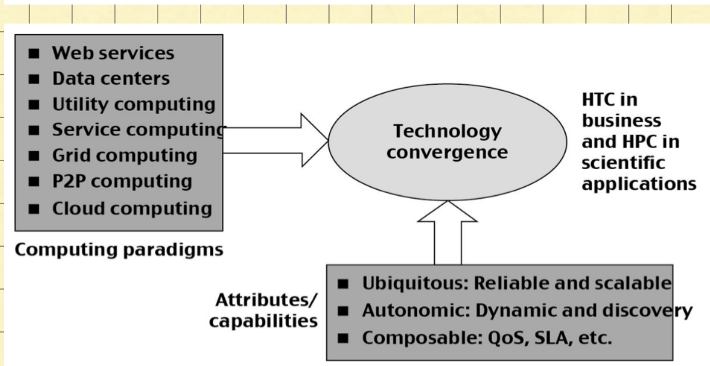
- Power consumption is highly distance-dependent, so bandwidth is likely to become increasingly localised as power becomes a more difficult problem.

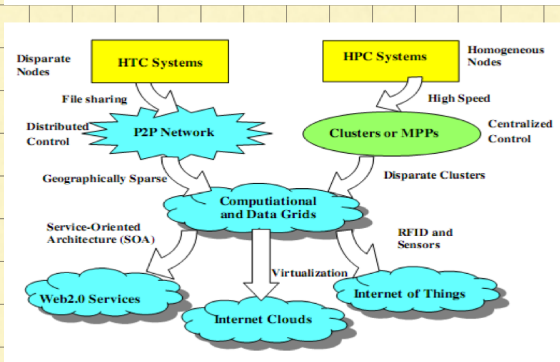


Systems Cycle



- HPC moving from centralized supercomputers to geographically distributed desktops, desksides, clusters, and grids to clouds over last 30 years
- R/D efforts on HPC, clusters, Grids, P2P, and virtual machines has laid the foundation of cloud computing that has been greatly advocated since 2007
- Location of computing infrastructure in areas with lower costs in hardware, software, datasets, space, and power requirements – moving from desktop computing to datacenter-based clouds





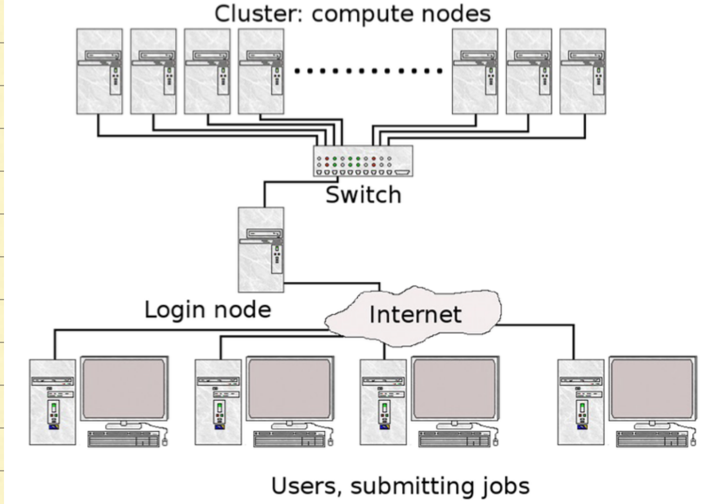
HPC: High-Performance Computing

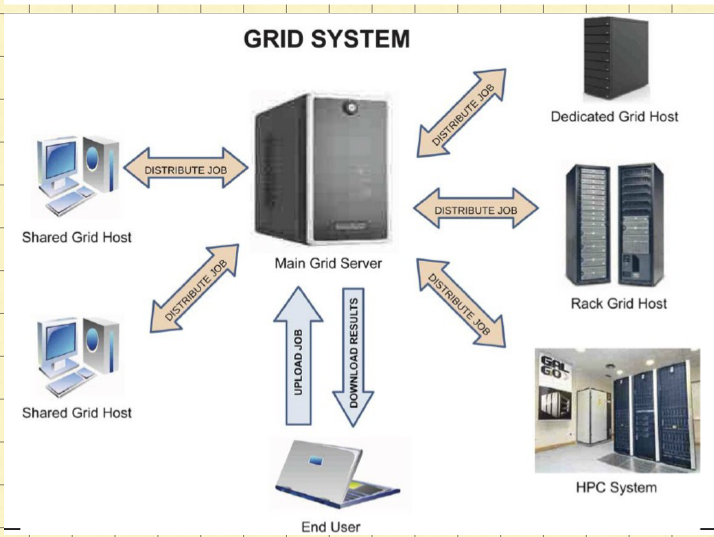
HTC: High-Throughput Computing

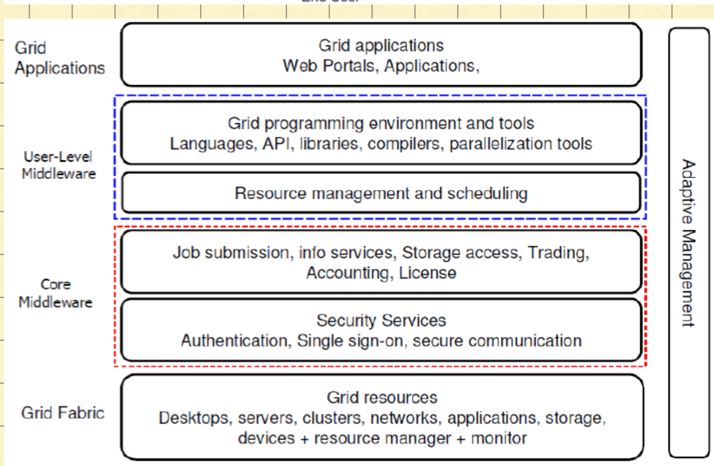
P2P: Peer to Peer

MPP: Massively Parallel Processors

Source: K. Hwang, G. Fox, and J. Dongarra, *Distributed and Cloud Computing,* Morgan Kaufmann, 2012.







Grid Standards and Middleware

Table 1.9 Grid Standards and Toolkits for scientific and Engineering Applications

Grid Standards	Major Grid Service Functionalities	Key Features and Security Infrastructure
OGSA Standard	Open Grid Service Architecture offers common grid service standards for general public use	Support heterogeneous distributed environment, bridging CA, multiple trusted intermediaries, dynamic policies, multiple security mechanisms, etc.
Globus Toolkits	Resource allocation, Globus security infrastructure (GSI), and generic security service API	Sign-in multi-site authentication with PKI, Kerberos, SSL, Proxy, delegation, and GSS API for message integrity and confidentiality
IBM Grid Toolbox	AIX and Linux grids built on top of Globus Toolkit, autonomic computing, Replica services	Using simple CA, granting access, grid service (ReGS), supporting Grid application for Java (GAF4J), GridMap in IntraGrid for security update.