Towards Energy-efficient ICT for a Better World
迈向高能效ICT，创造美好世界

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Energy Consumption Issue of Datacenters

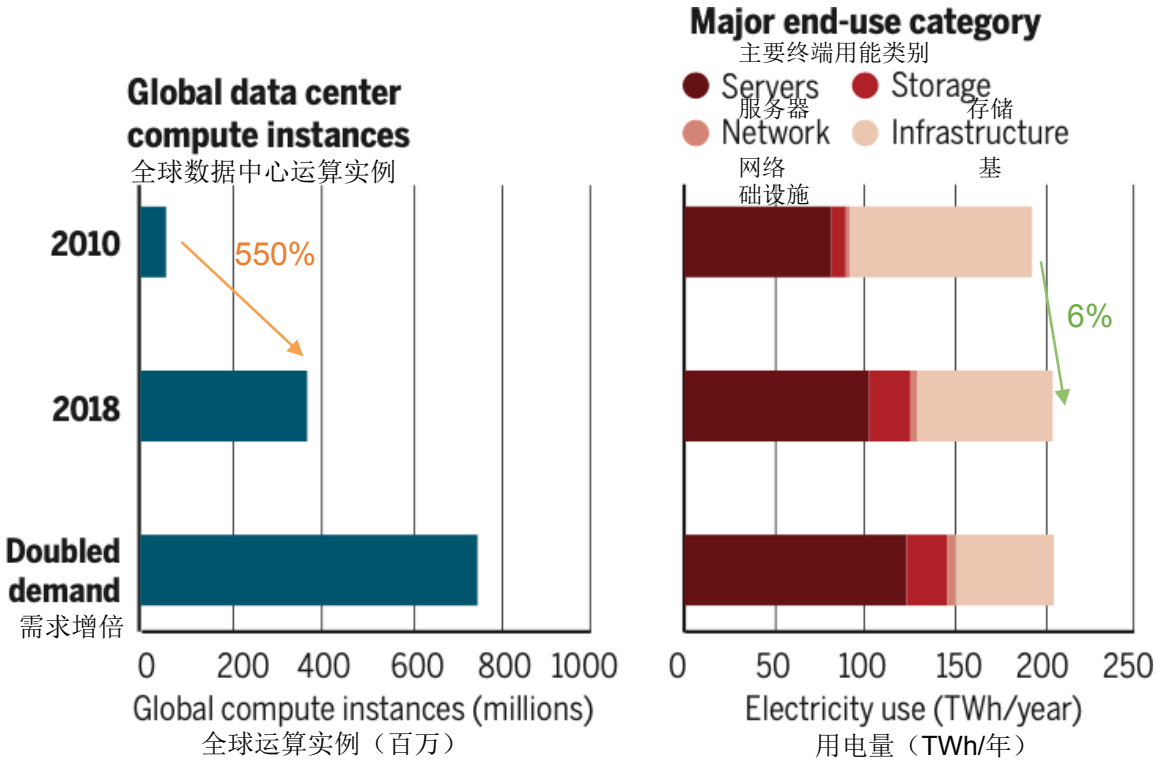
数据中心的能耗问题

Data Centres Of The World Will Consume 1/5 Of Earth's Power By 2025 到2025年，全球数据中心将使用1/5的地球电力

By João Marques Lima | **PUBLISHED:** 05:30, 12 December, 2017 | **UPDATED:** 00:32, 12 December, 2017

Source: data-economy.com
来源: data-economy.com

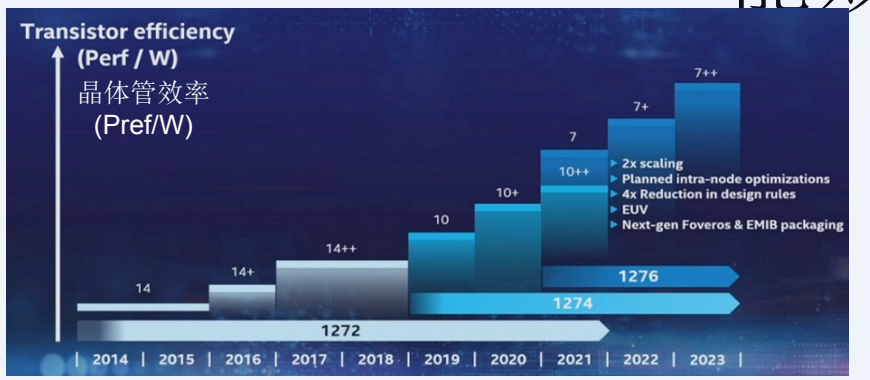
- Real growth is much slower (2010-2018)
  实际增长要缓慢得多*（2010-2018年）
  - 550% increase of compute instances
    运算实例增长550%
  - 6% increase of electricity usage
    用电量增长6%



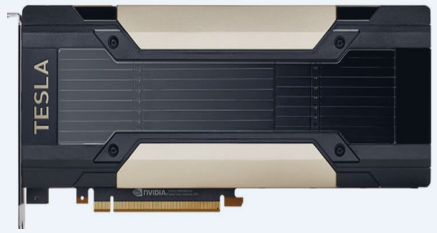
*Masanet, Eric, Arman Shehabi, Nuoa Lei, Sarah Smith, and Jonathan Koomey, 2020, Recalibrating Global Data Center Energy-Use Estimates. Science 367(6481): 984–986
重新校准全球数据中心能耗估算，《科学》

Techniques to Improve Energy Efficiency

能效提升技术



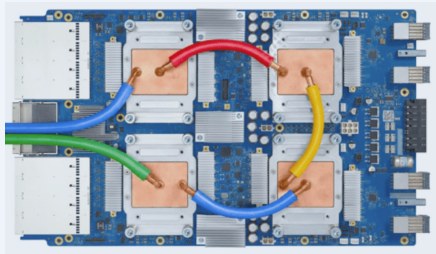
Transistor Technology Improvement
晶体管技术改进



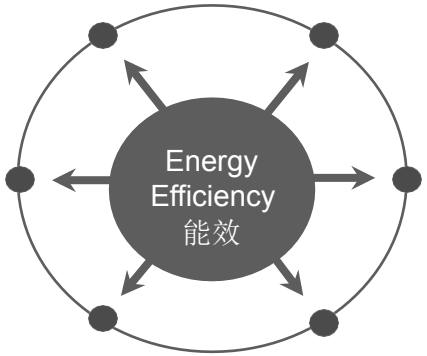
Heterogeneous Computing
异构运算

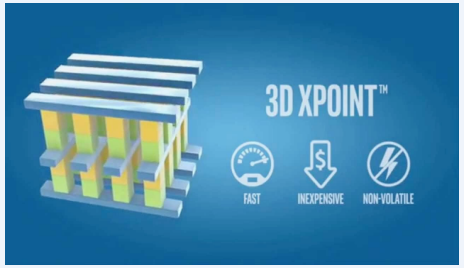
GPU

FPGA

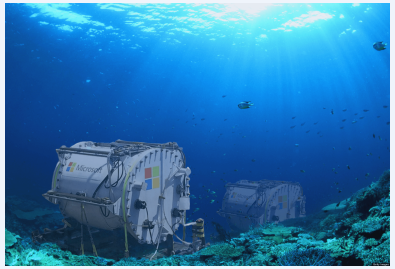


Accelerator
加速器





New Storage Devices
新存储设备

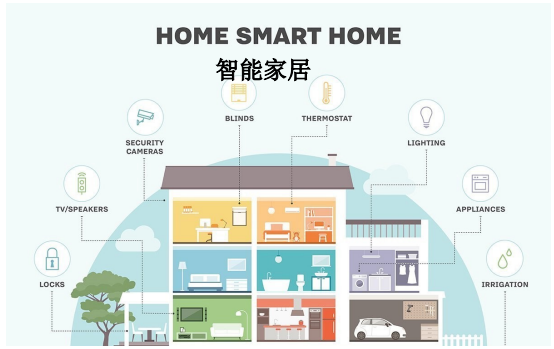


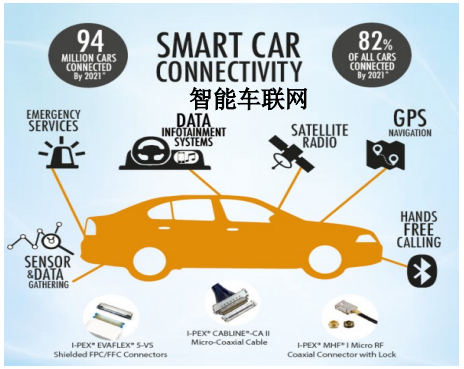
Cooling
制冷

Virtualization
虚拟化

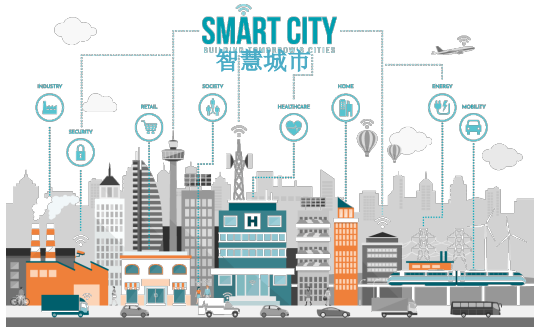
IoT, Energy Boon or Bane?

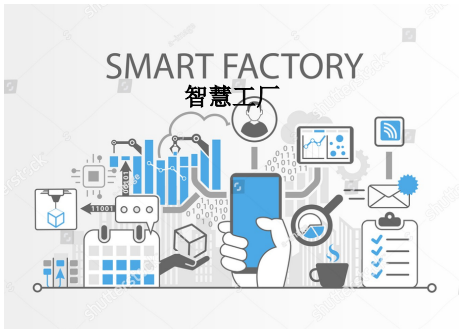
物联网之于能源，是福还是祸？*





IoT
物联网





IoT devices induce extra energy

物联网设备产生额外用能

- Remote Energy Use

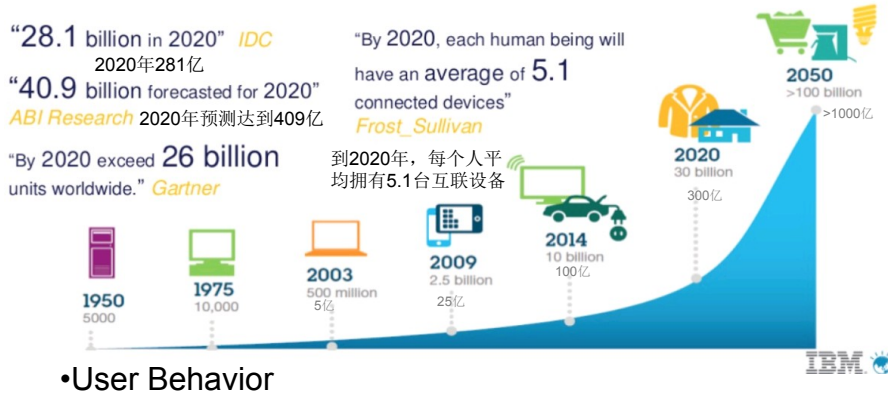
  远程用能

  - 30 Billion installed IoT devices

    安装300亿台物联网设备

  - Zettabytes data generated daily

    每天生成泽字节数据



- User Behavior

  用户行为

- Device Production

  设备生产

  …

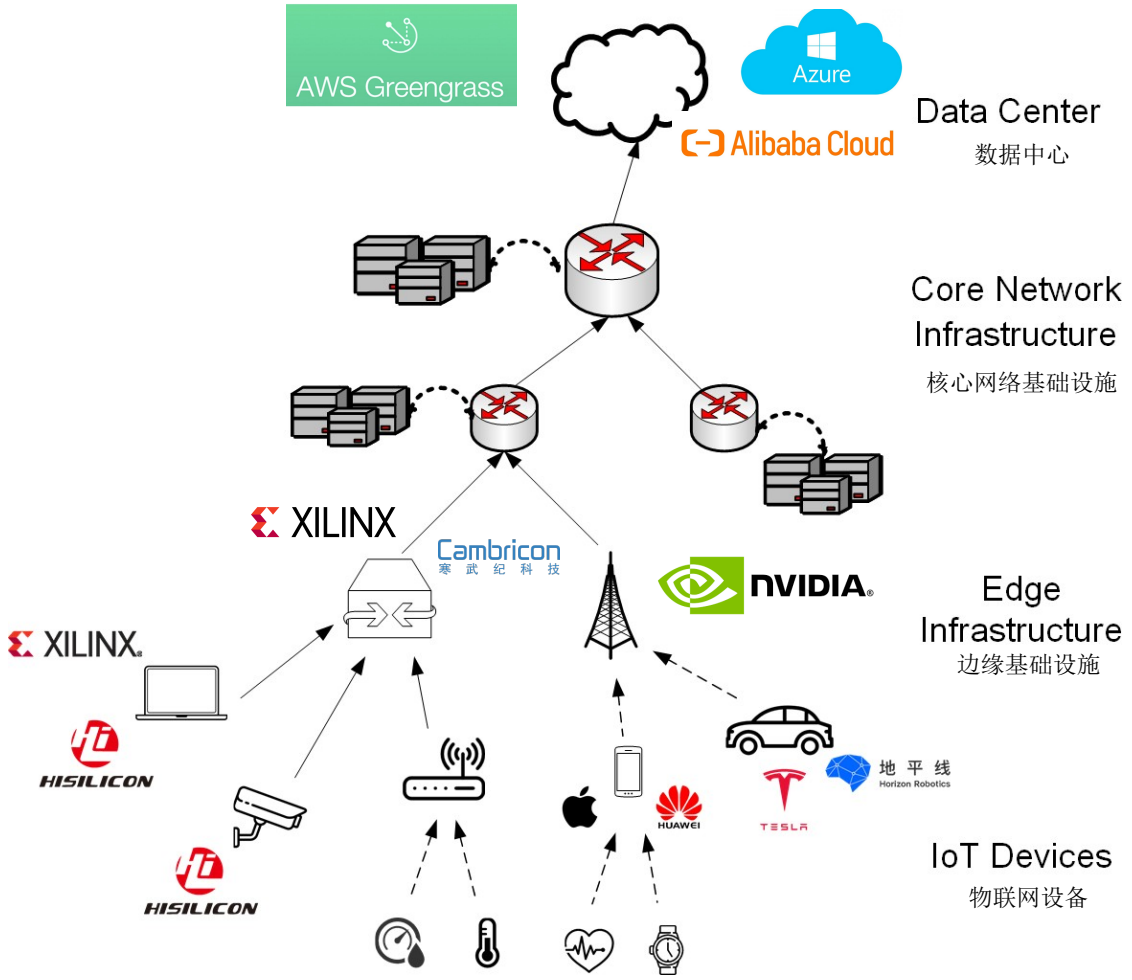
*Hittinger, Eric, and Paulina Jaramillo, 2019, Internet of Things: Energy Boon or Bane? Science 364(6438): 326.
物联网，是福还是祸？《科学》364(6438): 326.

Potential Solution: Edge Computing

潜在解决方案：边缘计算

- Computing near or at data sources
  在数据源附近或数据源上进行计算
  - Cloud Support
    云支持
    - AWS Greengrass
    - Azure Edge Zone
    - Alibaba Link IoT Edge

    …
  - Edge Infrastructure
    边缘基础设施
    - Edge servers
      边缘服务器
    - Edge accelerators
      边缘加速器
    - 5G, NB-IoT, LoRA …
      窄带物联网, LoRA …
  - IoT Devices
    物联网设备
    - Sensors
      传感器
    - Low power chips (AIoT)
      低耗电芯片



5G Base Stations Are Hungry

5G基站严重不足

- Challenges of 5G deployment
  5G部署挑战
  - number of 5G BS's is 3X 4G LTE

    5G基站数量：3X 4G LTE
    - due to higher frequencies
      因为频率更高
  - power of one 5G BS is 3X 4G LTE

    一个5G基站的功耗：3X 4G LTE
    - 64T64R MIMO vs 4T4R in 4G

      64T64R MIMO vs 4T4R，4G

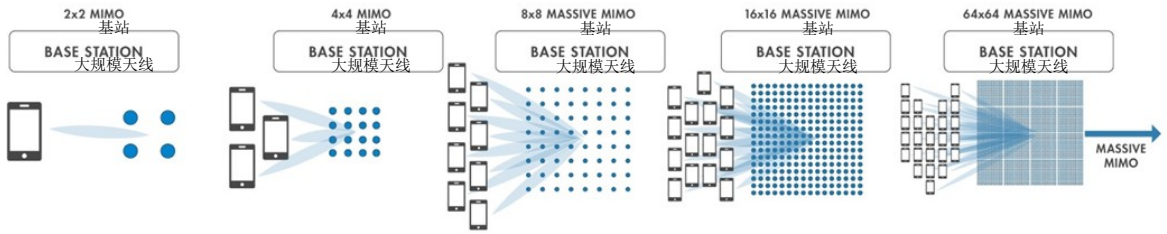


image source: mathworks.com
图片来源: mathworks.com

3倍功耗？业内进展不大

在谈到基站耗电问题时，李正茂表示，经过一年的发展，业内进展不大。

“原因很简单，这是一个客观规律。带宽增加了5倍，因为你每一个基站过去4G的时候是20兆一个载波的，现在变成了100兆增加了5倍，功耗增加是一个客观的事实。”

Triple Power Consumption? Little Progress Made in the Industry

When talking about the power consumption of base stations, Li Zheng mao said that after a year of development, the industry has made little progress.

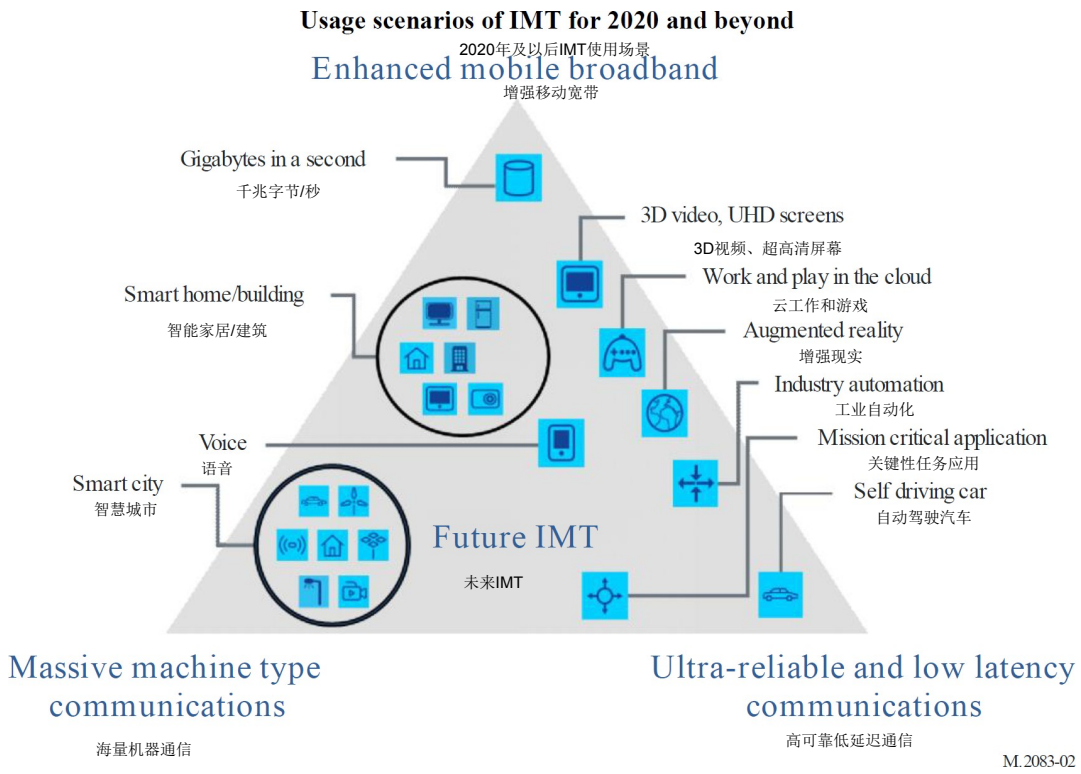
“The reason is very simple: this is an objective law. The bandwidth has increased by 5 folds. A base station was 20 MB per carrier wave in the 4G era, but now it has become 100 MB, representing a five-fold increase. The increase in power consumption is an objective fact”.

--Zhengmao Li, EVP China Mobile GSMA 2019 Beijing Innovation Forum

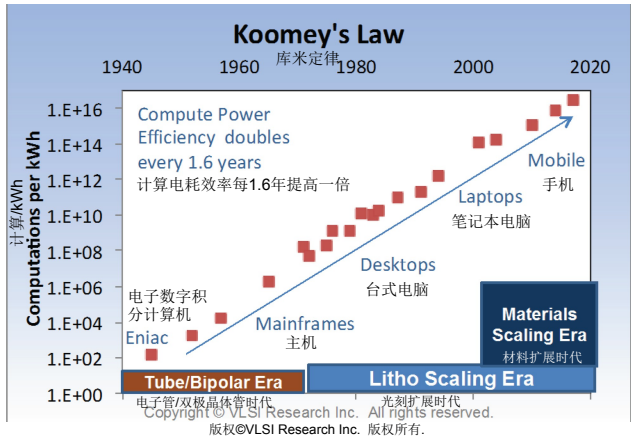
李正茂，中国移动执行副总裁，GSMA 2019北京创新论坛

Lookahead: Energy-efficient ICT for a Better World

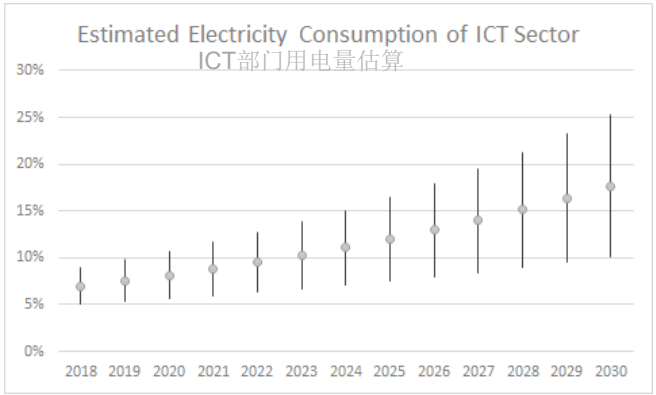
展望：高能效ICT创造美好世界



Amortize the energy cost
分摊能源成本:
kilowatt-hour / N
KWh/N
by serving more people
通过服务更多人



Improve computational energy efficiency by technology
通过技术提高计算能效



data source: enerdata.net
数据来源: enerdata.net

Academia, industry, NGOs, government work together to take up the change
学术界、行业、非政府组织、政府共同努力推动变革