CLOUD COMPUTING APPLICATIONS

Future Trends in Cloud Computing

Prof. Reza Farivar

What does the future look like?

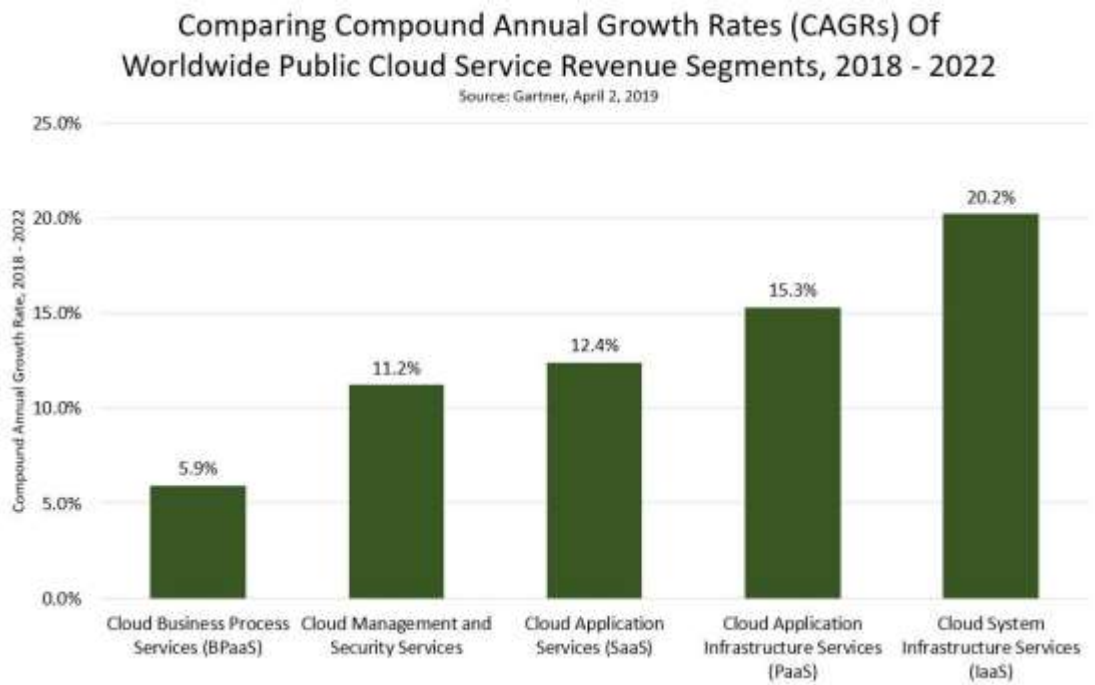
1. Adoption of cloud computing will continue to grow rapidly

- By the end of 2019, more than 30% of technology providers' new software investments will shift from cloud-first to cloud-only
- Gartner Forecast for Public Cloud Revenue (Nov. 2019)
- By 2022, up to 60% of organizations will use an external service provider's cloud managed service offering
  - Double the percentage of organizations from 2018

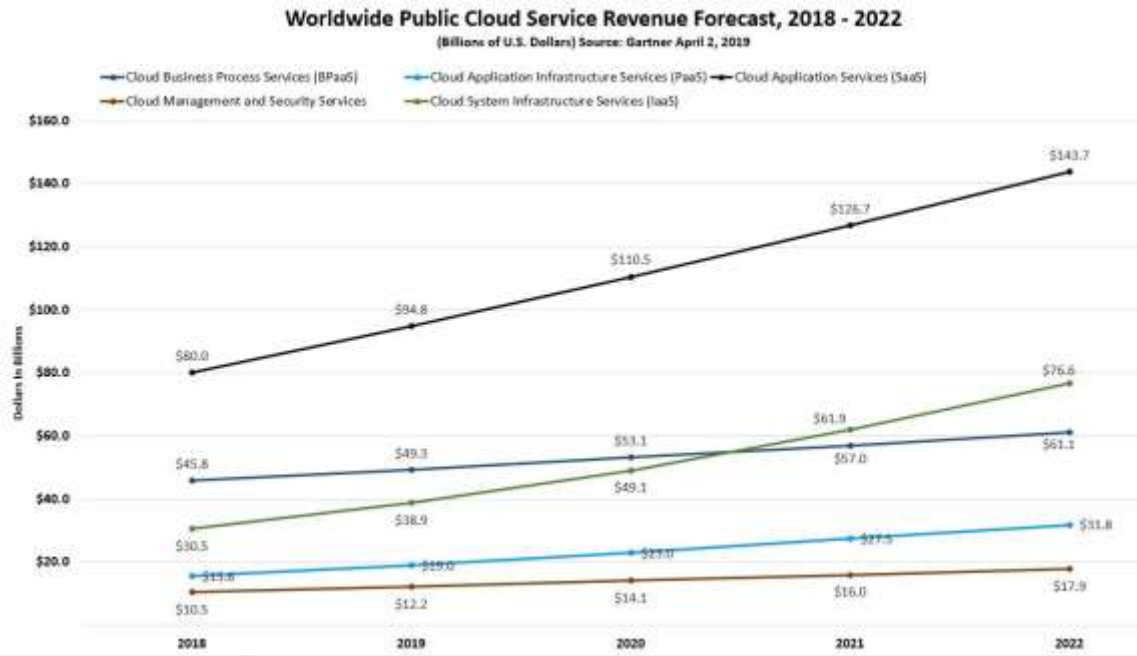
Table 1. Worldwide Public Cloud Service Revenue Forecast (Billions of U.S. Dollars)

	2018	2019	2020	2021	2022
Cloud Business Process Services (BPaaS)	41.7	43.7	46.9	50.2	53.8
Cloud Application Infrastructure Services (PaaS)	26.4	32.2	39.7	48.3	58.0
Cloud Application Services (SaaS)	85.7	99.5	116.0	133.0	151.1
Cloud Management and Security Services	10.5	12.0	13.8	15.7	17.6
Cloud System Infrastructure Services (IaaS)	32.4	40.3	50.0	61.3	74.1
Total Market	**196.7**	**227.8**	**266.4**	**308.5**	**354.6**

Annual Growth Rate



Revenue Forecast



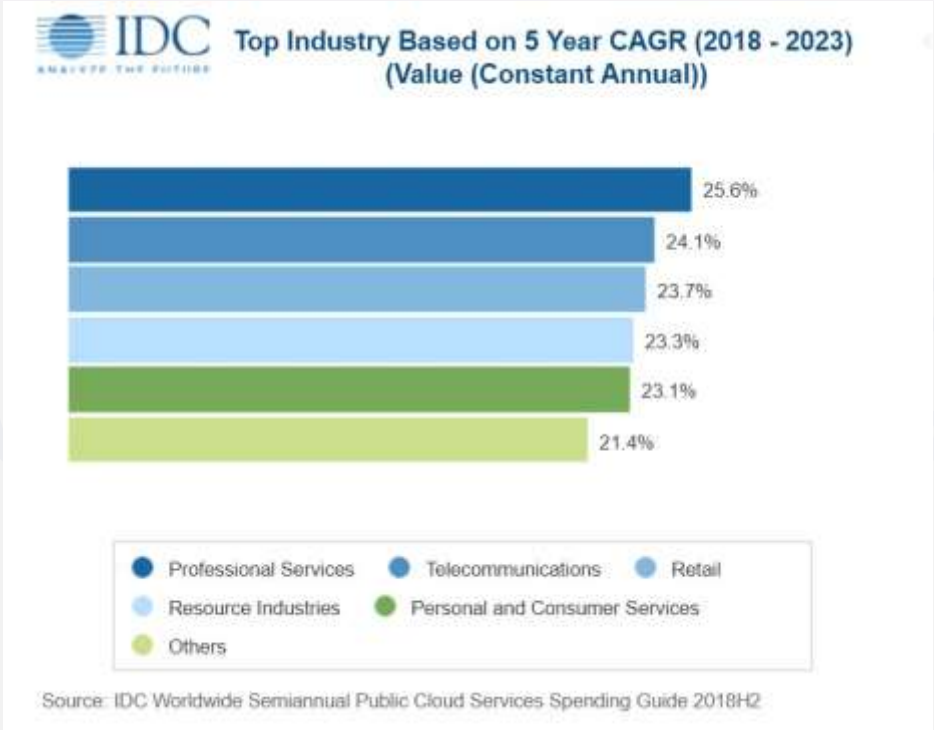
2. The cloud will become more global

- More systems will be able to operate seamlessly across multiple locations
- Datacenters deployed all over the world
  - Seamless transition
- World-scale distributed systems
  - E.g. Google Spanner
- Organic cloud providers in other countries
  - Tencent Cloud, Alibaba Cloud

3. Regulated Industries Moving to the Cloud

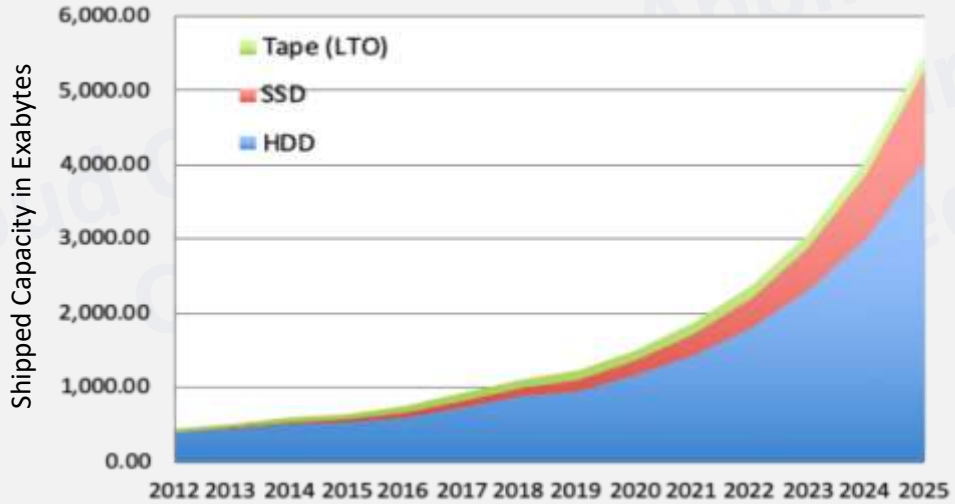
- Sectors like energy, financial / banking, and telecommunications industry
  - IDC forecast → professional services, discrete manufacturing, and banking will account for more than one third of all public cloud services spending
- Regulations such as the European Union General Data Protection Regulation (GDPR) place restrictions on where customer data can be stored
  - Unique contracts with cloud storage providers
  - Privacy regulations, data retention, breaching response, and data ownership

Regulated Industries Moving to the Cloud



4. Increased Storage Capacity

- SSDs will continue to increase market share and dominate ($150/TB)
- HDD will continue to be the backend for cloud storage ($30/TB)
  - Enterprise-class nearline: Low cost, high capacity, 24x7 reference / backup role
- Magnetic tape Cold storage technologies will keep improving ($10/TB)



Projection by Forbes 2020

5. The Cloud Will Continue to Support AI

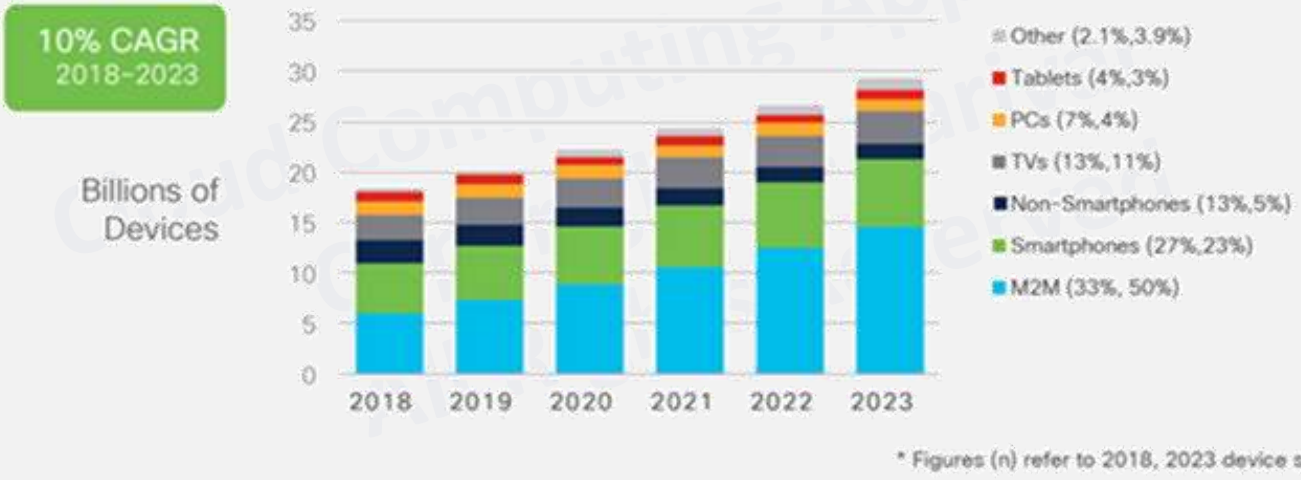
- If there is one industry growing more rapidly than cloud, it is AI
  - Big Data Analytics CAGR: 10% - 12% (*Adroit market research April 2020*)
  - Cloud CAGR: 20% - 25%
  - AI CAGR: 35% - 55%
- Cloud computing is essential for the growth of AI
  - Most types of hardware do not have the capabilities to run AI applications efficiently
  - AI relies on big data processing to improve its services through machine learning
- AI can be used to operate and manage cloud computing
  - Symbiotic relationship
- Digital Transformation

6. GPUs in the Cloud / Data Center Accelerator

- The data center accelerator market was valued at USD 1.60 billion in 2017 and is expected to reach USD 21.19 billion by 2023, at a CAGR of 49.47%
- The growing demand for AI in HPC data centers is driving the market growth
- CPU, GPU, FPGA, and ASIC
  - The market for FPGA is expected to grow at the highest CAGR during the forecast period
  - The growth can be attributed to the increasing adoption of FPGAs for the acceleration of enterprise workloads
- Cloud Gaming Market to exceed $8bn by 2025
  - The video streaming segment in cloud gaming market is anticipated to attain a growth rate of over 25% from 2019 to 2025

7. The Future of Cloud Computing Access is Mobile

- Flexibility demanded by the mobile workforce
  - Cloud-based applications → anytime, anywhere access
- Mobile networks becoming faster
  - 5G speeds → 1 - 3 Gbps, eventually up to 10 Gbps
- Global device and connection growth (CISCO)



* Figures (n) refer to 2018, 2023 device share

8. The rise of Function as a Service (FaaS)

- Function as a Service mindset will be adopted more and more
- API based enterprises
- Microservices
- Function-as-a-Service (FaaS) Market Size - $3.33 Billion in 2018, to reach USD 31.53 Billion by 2026 at a Growth (CAGR) of 32.3%
  - “Reports and Data, Feb 2020”
- Function-as-a-Service Market to Reach $24.0 Billion, Globally, by 2026 at 29.7% CAGR
  - “Allied Market Research, April 2020”

9. Low-code / No-code applications in the Cloud (Citizen Development)

- Microsoft predicts 500 million new apps in 2020-2025
  - 450 with low-code / no-code tools
  - A 1 million developer shortfall in the U.S. alone
- The new cloud battleground
  - AppSheet → Google cloud, integration with G suite
  - Microsoft PowerApps (Power platform), Integration with MS
  - Betty Blocks
  - FileMaker → Apple
  - Quick Base
  - Unqork → Financial services niche
- Better Agility, reduced costs, higher productivity
- Visual interface is the key to the power of no-code platforms
- model-driven, declarative, template based applications
  - Back office (database)
    - Functionality to administer your business data for internal use
  - Portals and Web Applications
    - bridges the gap between your back and front office, when your application needs to be used publicly
  - Mobile applications

9. Increased Adoption Means Increased Risk

- Security Breaches
  - A 2018 Gartner survey of 110 senior executives at large global organizations found cloud computing was the top security concern
- Shared Security model
  - Gartner → through 2022, at least 95% of cloud security failures will be caused by organizations / end users
- Threats
  - Reduced visibility and control
  - Vulnerabilities in management APIs
  - Multi-tenant data leakage due to failure of separation control
  - Incomplete data deletion
  - Stolen credentials
  - Insider abuse

10. IoT and Cloud

- Global Internet of Things (IoT) Market Size was Valued at USD 164 Billion in 2018 and is Expected to Grow at a CAGR of 38.62% by 2025
- Rapid adoption of cloud-based IT solutions is a key driver of Internet of Things (IoT) growth during the forecast period.
- With the emergence of big data analytics and the need to manage large quantities of data generated by internet-enabled devices, the data management IoT solution is expected to hold the largest market share in terms of revenue.

11. Hybrid Cloud / Multi Cloud / Omni Cloud

- Containers become mainstream
- More standardization across many cloud providers
- IaaS
- Containers / Kubernetes
  - The container orchestrator is the fabric enabling applications extend across disparate cloud infrastructure
- Google Anthos
  - Kubernetes
  - GKE On-prem –Kubernetes-based software platform that's consistent with GKE.
    - Customers can deploy this on any compatible hardware and Google will manage the platform.
  - Istio –federated network management across the platform
  - …

12. Demand for Cloud Professionals Will Grow

- According to the **Bureau of Labor Statistics**, employment of computer and IT occupations is projected to grow 13% from 2016 to 2026
  - faster than average for all occupations

CLOUD COMPUTING APPLICATIONS

Summary of the CCA Course

Prof. Reza Farivar

Topics Covered

- Foundations, Cloudonomics
- IaaS, PaaS, SaaS, MaaS, MBaaS
- Glue, networking protocols, RPC
- Virtualization, Containerization
- Serverless
  - Function as a Service
- Batch Big Data
  - MapReduce
  - Hadoop
  - Spark
- Big Data Streaming
  - Storm
  - Spark Streaming

Topics Covered

- Storage in the Cloud
  - Distributed Big Data Storage
    - Redis, HBase, Spark SQL, Kafka
  - Cloud-based Storage
    - Object, Block, File System, Hybrid cloud / On-prem, Backup, Internet level personal filesystem
  - Cloud Based Databases
    - RDBMs, Aurora, Spanner, Azure CosmosDB
- Graph processing
  - Pregel, Spark GraphX, GraphFrames
- Machine Learning in the Cloud
  - ML Workflow, Life Cycle
  - Big Data Machine Learning Algorithms
- Analytics
  - Data Warehouses (Data Cube, Columnar Storage)
  - Data Lake
- Future

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Course Wrap-up

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Future Classes

- Distributed system foundations
  - Cloud Computing Concepts
- Cloud Computing Capstone
- Data Mining Capstone
- Cloud Networking

Remove Public Github Repos

- Thousands of man-hours of work spent on the MPs
- Learning opportunity
- Student code

Give us feedback

1. UIUC ICES
   - From the University
   - Optional, highly recommended
2. Coursera feedback form
   - Share specific feedback
   - Only course instructor reads it
3. Public reviews and testimonials
   - If you enjoyed the course, spread the word!

Final Word

Thank you!

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https://www.linkedin.com/groups/12404264/