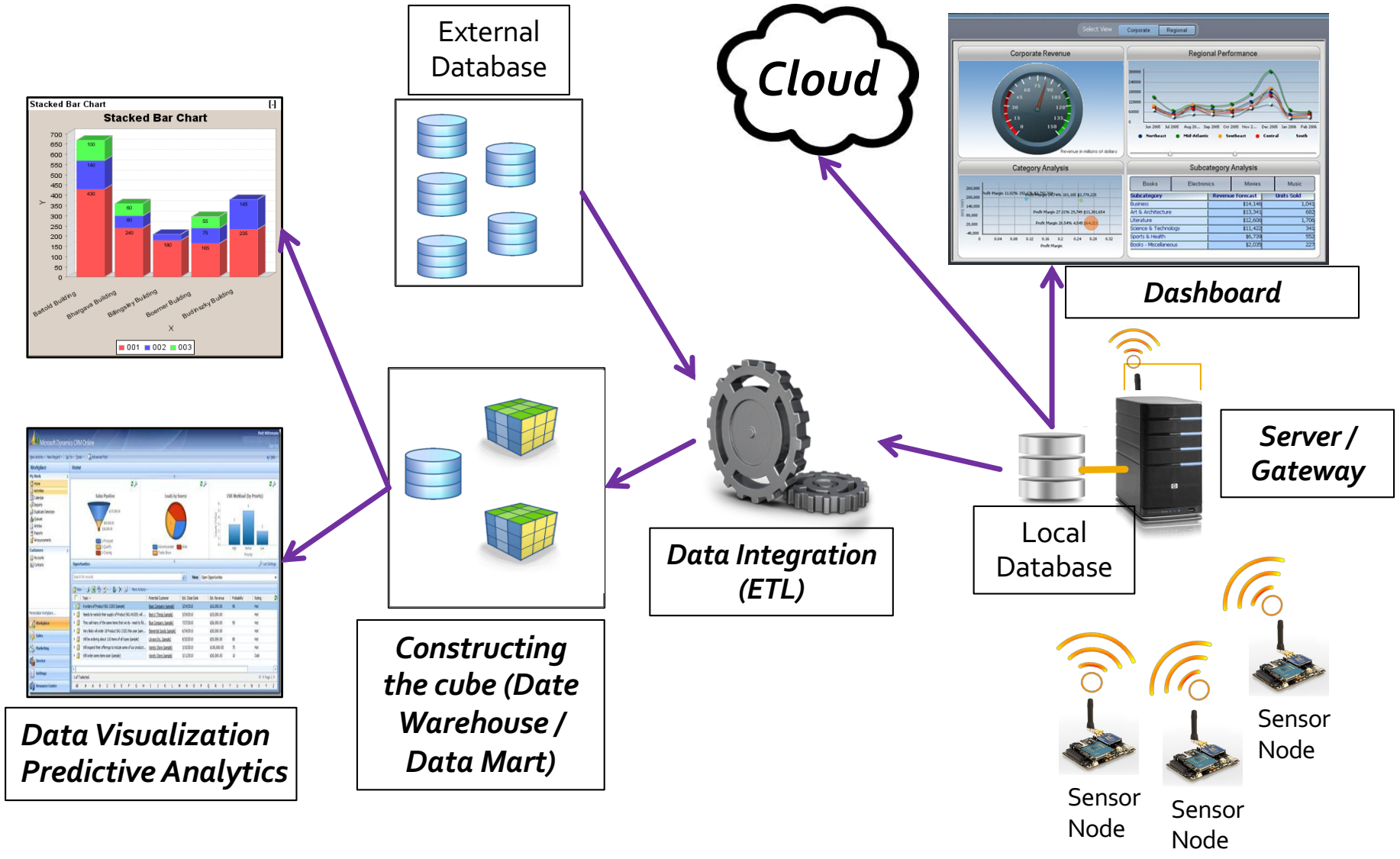
L07 Cloud Computing

IT3779
Smart Object Technologies

Overview IoT System Architecture



Learning Outcomes

- Explain what cloud computing is and the essential and common characteristics
- Distinguish and compare different service and deployment models
- Explain roles of cloud computing for smart objects
- Describe what is fog computing

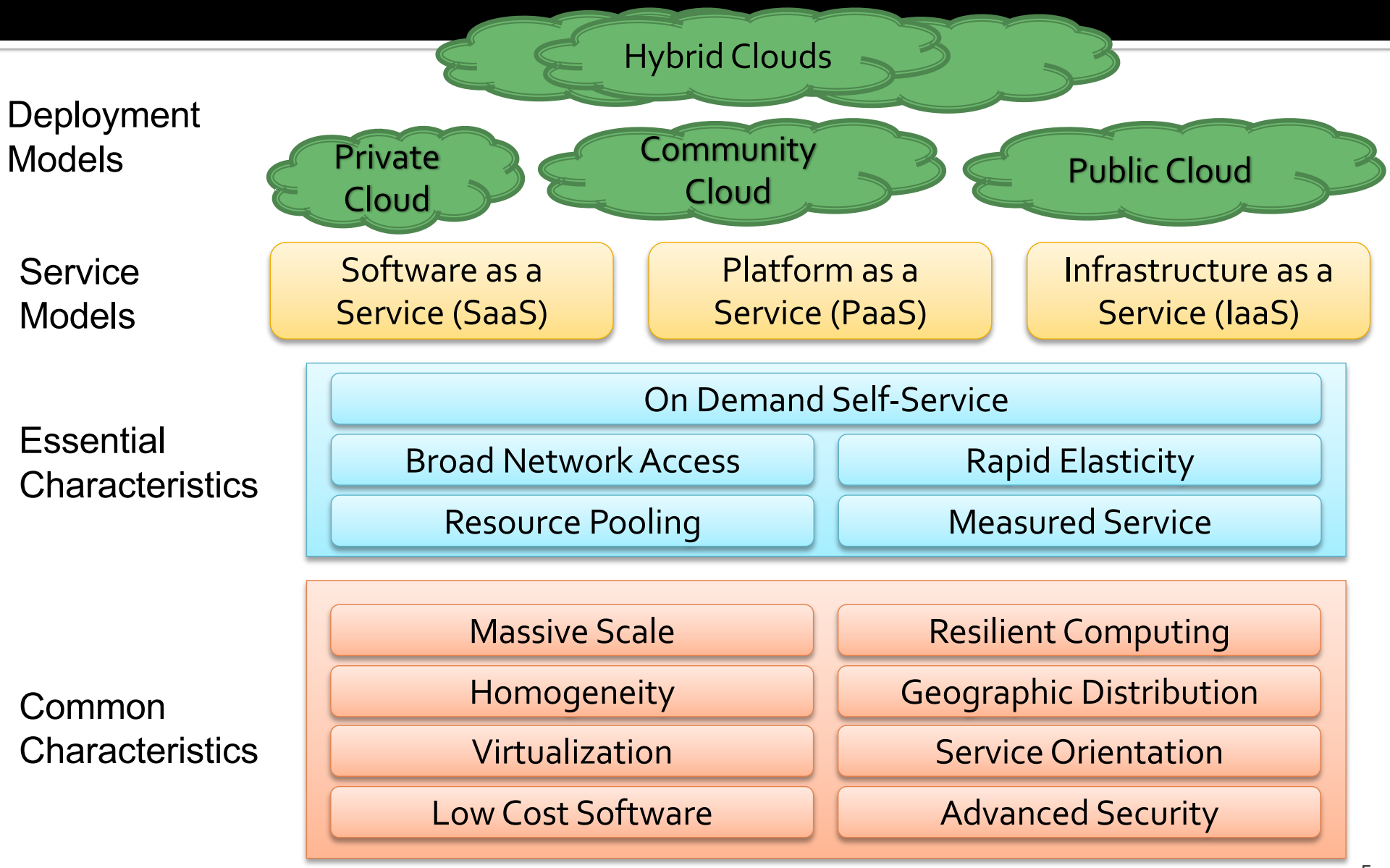
What is Cloud Computing?

- The term "Cloud computing" is often used in discordant context, referring to very different and distinct things

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

-- NIST (National Institute of Standards and Technology)

The NIST Cloud Definition Framework



Based upon original chart created by Alex Dowbor - http://ornot.wordpress.com

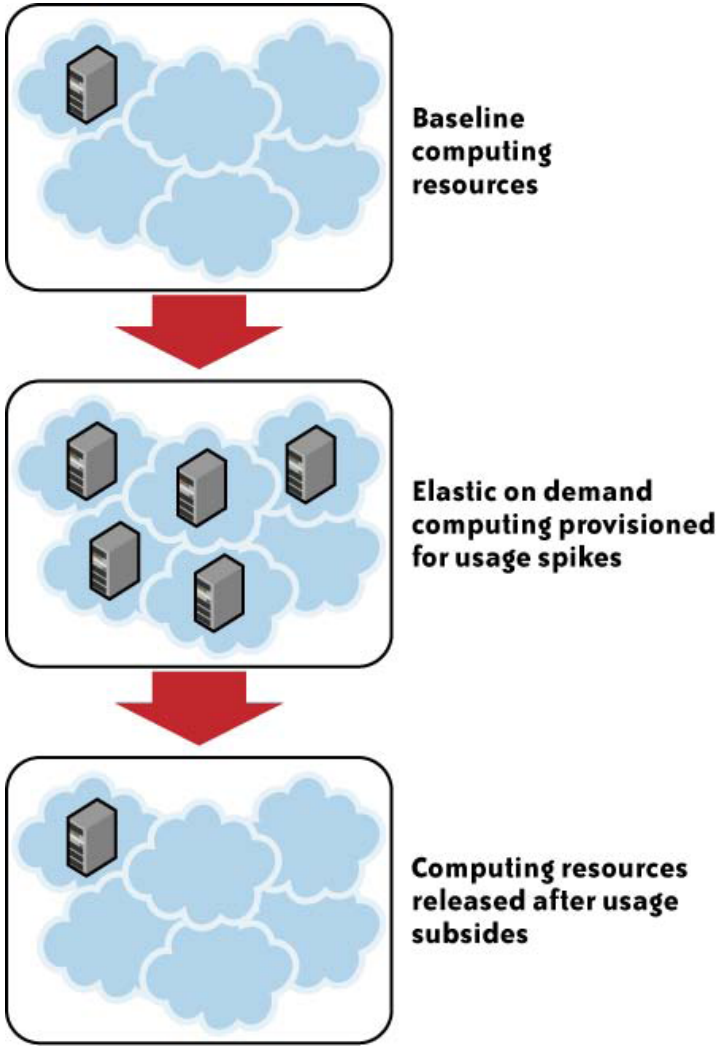
Essential Characteristics

- *Broad network access*
  - Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).
- *Resource Pooling*
  - resources are shared (i.e., multiple users use the same resource) at the network level, host level, and application level.
- *Rapid Elasticity*
  - Rapidly increase and decrease their computing resources as needed, as well as release resources for other uses when they are no longer required.

Essential Characteristics

- *Measured Service*
  - Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service. Service is metered and billed if needed.
- *On-demand self-service*
  - A consumer can unilaterally provision computing capabilities (e.g server time, network storage) as needed automatically without requiring human interaction with each service's provider

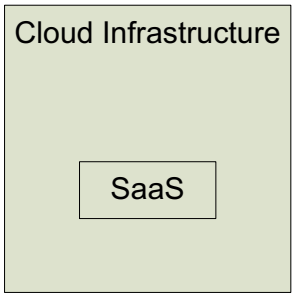
Elasticity

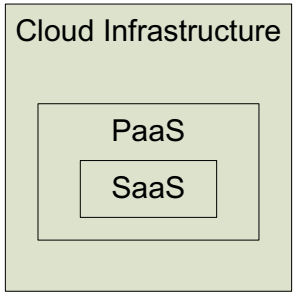

Baseline computing resources
Elastic on demand computing provisioned for usage spikes
Computing resources released after usage subsides

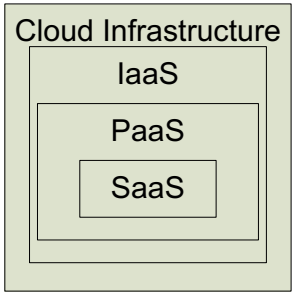
Service Models

- Concept of services
  - Reusable , fine-grained components offered
- Different services delivered from the cloud
  - Software as a service (SaaS)
  - Platform as a service (PaaS)
  - Infrastructure as a service (IaaS)

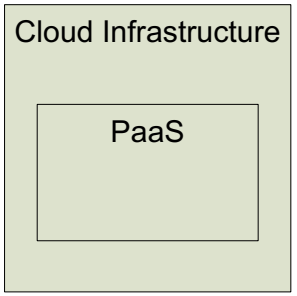
Service Models

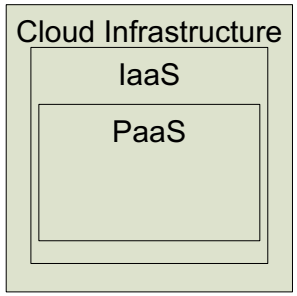




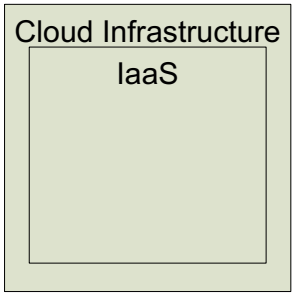


Software as a Service (SaaS) Architectures





Platform as a Service (PaaS) Architectures



Infrastructure as a Service (IaaS) Architectures

IaaS

- Delivery of computer infrastructure as a service.
- Infrastructure includes:
  - Computer hardware
  - Computer network
  - Server (OS)
  - Storage

PaaS

- Provides resources required to build custom applications and services
- Includes application design, development, testing, deployment and hosting
- Other services include:
  - Team collaboration
  - Web service integration
  - Database integration
  - Security

SaaS

- SaaS is the model in which an provider's application is hosted as service to customers who access it through Internet
- Examples of SaaS
  - Email
  - CRM
  - Content management
  - Data Analytics

Deployment models

- There are many considerations for cloud computing architects to make when moving from a standard enterprise application deployment model to a cloud-based model
- We can choose to deploy to private cloud, community cloud, public cloud, or hybrid cloud

Private Cloud

- Built for the exclusive use of one client, providing the utmost control over data, security, and quality of service
- The company owns the infrastructure
- May be deployed in an enterprise datacenter, or at a colocation facility.
- Built and managed by a company's own IT organization or by a cloud provider.

Community Cloud

- The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

Public Cloud

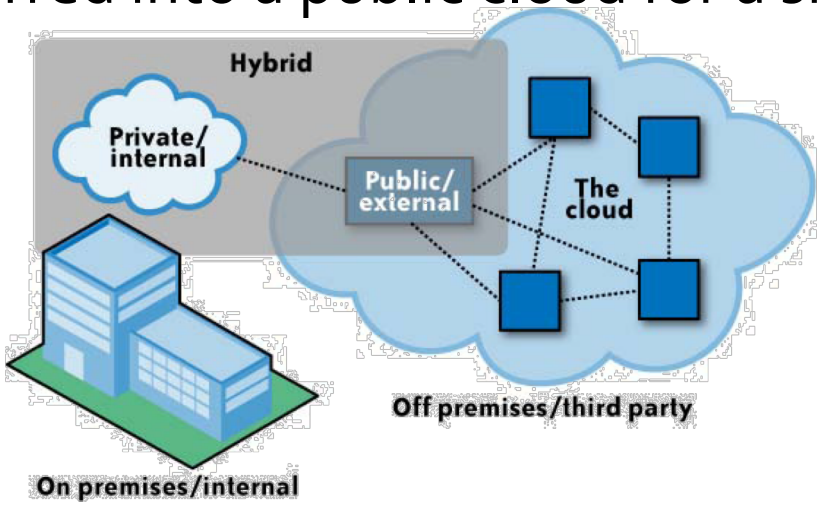
- Run by third parties, and applications from different customers are likely to be mixed together on the cloud's servers, storage systems, and networks
- Hosted away from customer premises
- Can be much larger than a company's private cloud, offering the ability to scale up and down on demand
  - Shift infrastructure risks from enterprise to cloud provider

Hybrid Cloud

- Combine both public and private cloud models
- Augment a private cloud with the resources of a public cloud
  - used to maintain service levels in the face of rapid workload fluctuations
  - Used to handle planned workload spikes.
  - Sometimes called "surge computing," a public cloud can be used to perform periodic tasks that can be deployed easily on a public cloud.

Hybrid Cloud

- Complexity in determining how to distribute applications across both a public and private cloud.
  - Relationship between data and processing resources.
  - If the data is small, or the application is stateless, a hybrid cloud can be much more successful than if large amounts of data must be transferred into a public cloud for a small amount of processing



Why Cloud Computing?

- Ease the software maintenance
  - No CD to install on all computers
  - No need to worry about software upgrade
- Convenient for telecommuters
  - Simply log in and use the applications anywhere, and anytime
- No equipment outlay required
  - No need to pay for servers not required
  - Guard against obsolete hardware
  - No need to worry about capacity planning
    - Add and remove capacity anytime

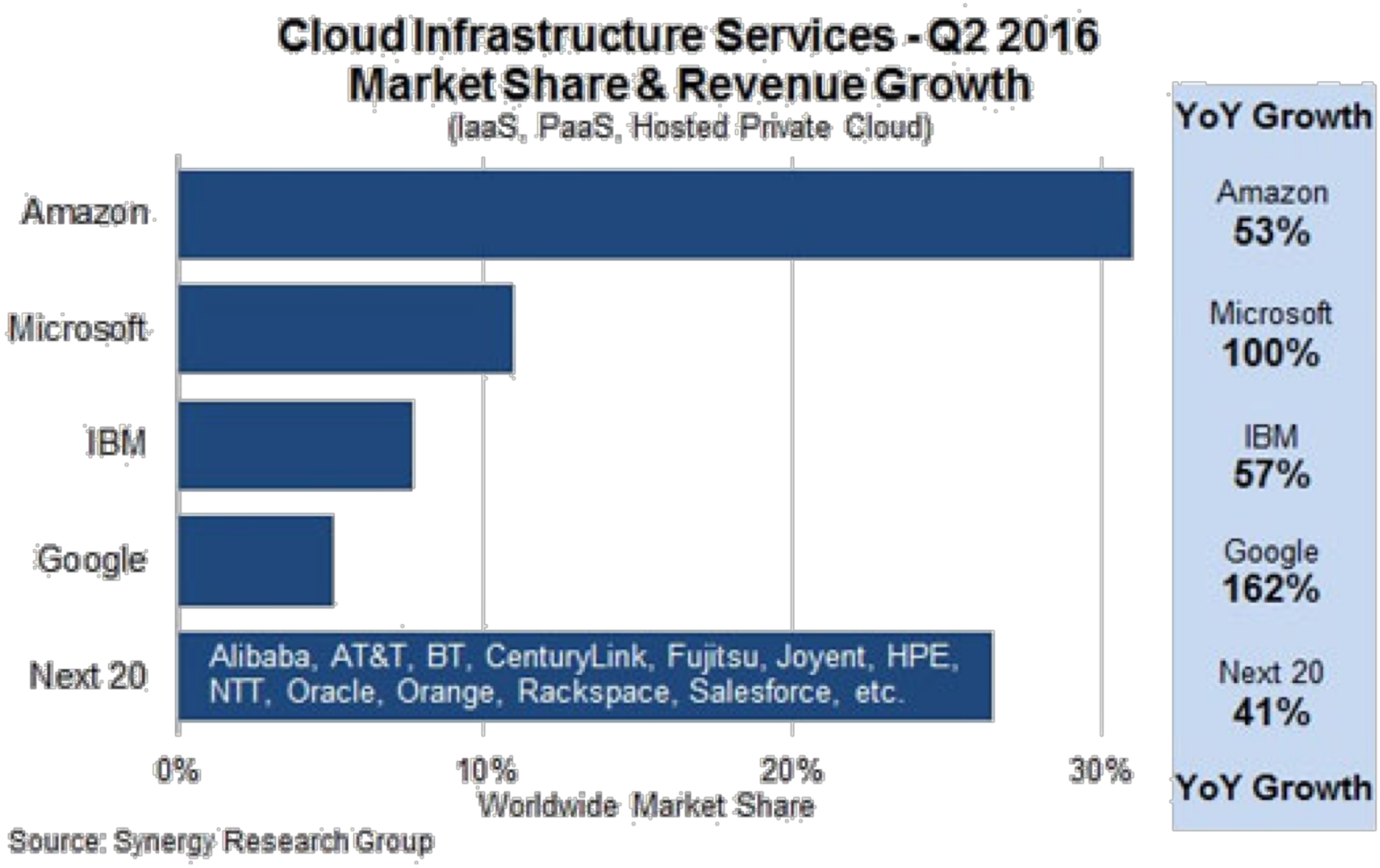
Why Cloud Computing?

- Redundancy and disaster planning
  - Let the cloud provider take care of ensuring redundancy for your storage and applications
  - Let the cloud provider take care of disaster planning
    - Off-site backup, alternative locations, etc.

Why NOT?

- Network outage or problems with ISP
  - Cut off access to applications or servers
- Sensitive information
  - Security concern
- Application integration issues
  - Difficult to integrate your applications if they are geographically dispersed

The Big Players in Cloud Computing



How cloud benefits Smart Objects

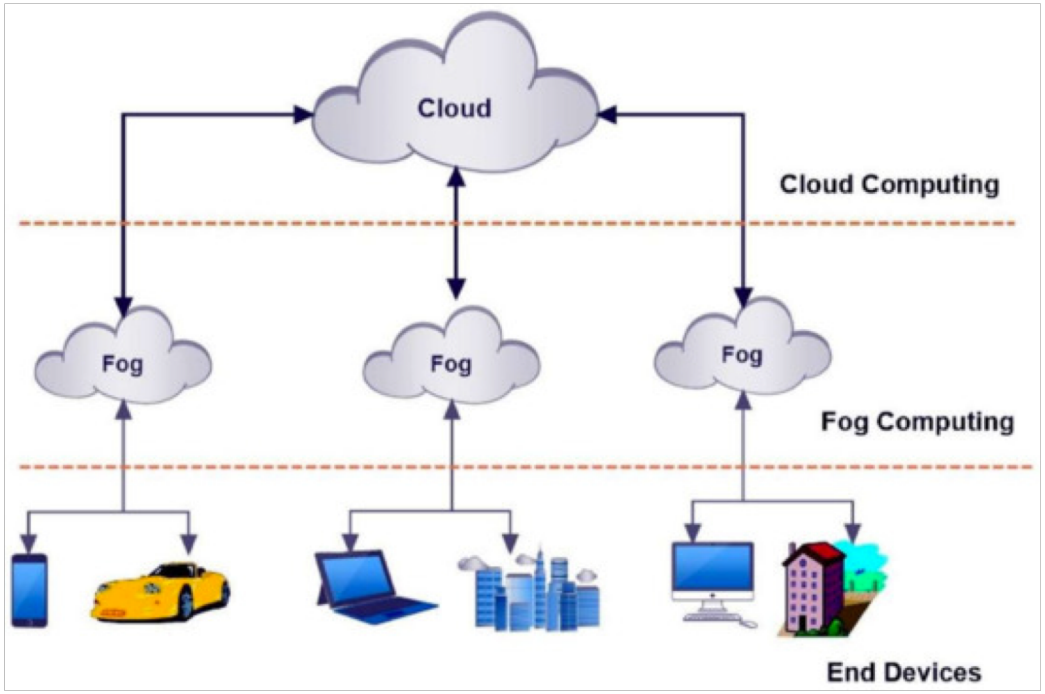
- Device Lifecyle Management
  - Easily connect millions/billions of devices due to cloud scalable architecture
  - Enables device registration, on-boarding, remote device updates, remote device diagnosis with reduced operation and support costs

How cloud benefits Smart Objects

- Better security control
  - Can help in securing the IoT devices by continuously monitoring and enforcing security policies
- Scalable Storage and Analytics
  - Data generated by IoT devices can be huge and cloud provides a scalable storage for these devices (through various NoSQL databases, or Hadoop-based data lake, etc.)
  - Runs analytics on massive volume of data without having to build in-house analytics platform

Fog Computing

- Fog computing is an extension of cloud computing that pushes some computing/ storage functions to the edge devices



Fog Computing

- Lower latency in processing, with less data to upload
- Data can still be processed when no Internet connection
- Use cases:
  - Remote locations where internet connectivity is sporadic
  - V2V - where data generated is huge and is better to be pre-processed and aggregate by on-board vehicle processing unit

End