Material and some slide content from:

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Cloud Computing, and REST-based Architectures

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Cloud precursors

- Grid Computing:
  - Combination of computing resources from multiple administrative domains applied to common tasks.
    - Usually used to create ‘super computers’ that can work on specific parallel computation tasks.
- Utility Computing:
  - Combining computation, storage, and services metered like utilities.

Cloud Computing

- "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. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models." [NIST]

NIST Essential Characteristics

- On-demand self-service:
  - Consumers can provision computing capabilities without human interaction.
- Broad network access:
  - Capabilities are available over the network through standard mechanisms.
- Resource pooling:
  - Computing resources are pooled to serve multiple consumers.
  - Location independence. [perfomance/security]

NIST Essential Characteristics

- Rapid elasticity
  - Resources can be easily added and removed.
- Measured service [services and/or resources]
  - Metering of storage, processing, bandwidth, etc.

Benefits

- Agility [quickly respond to changes]
- Scalability [resources can be added, peak load]
- Cost [resources can be released; multi-tenancy (amortization)]
- Reliability [different sites, experts in control]
- Security [works both ways]

Technology

- Thick and thin clients
- Broadband
- Data centres
    - Large capacity
    - Globally distributed
- APIs
    - Administration
    - Development
    - Resource migration

Virtualization

- Virtualization [decoupling physical & computing resources]
  - Emulation (QEMU) [VM simulates partial HW]
  - Paravirtualization (Xen) [SW int to VM]
  - Full (VMWare) [complete sim of HW]
  - Network [abstract network e.g., VPNs]

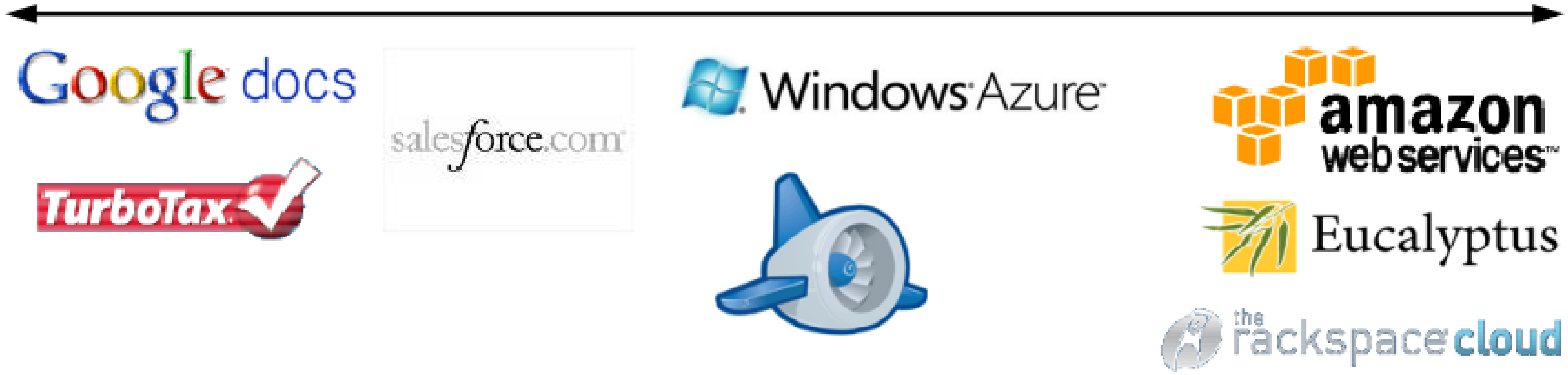
Cloud Layers

- SaaS (e.g., Google Docs) [multi-tenancy, single release for all users]
  - Vendor-controlled remote applications.
  - Concerns: control, performance, security, privacy.
- PaaS (e.g., AppEngine)
  - Vendor-controlled environment.
  - Concerns: as for SaaS w/ limited technology choices.
- IaaS (e.g., Amazon EC2)
  - Vendor-provided resources; consumer provisions VM.
  - Concerns: more expertise needed to leverage flexibility.

Cloud Spectrum

less flexible
more constrained
less effort

more flexible
less constrained
more effort



Layers of Control

In-house Deployment	Hosted Deployment	IaaS Cloud	PaaS Cloud	SaaS Cloud
🟩 Data	🟩 Data	🟩 Data	🟩 Data	🟧 Data
🟩 APP	🟩 APP	🟩 APP	🟧 APP	🟥 APP
🟩 VM	🟩 VM	🟧 VM	🟧 Services	🟥 Services
🟩 Server	🟧 Server	🟥 Server	🟥 Server	🟥 Server
🟩 Storage	🟧 Storage	🟥 Storage	🟥 Storage	🟥 Storage
🟧 Network	🟧 Network	🟥 Network	🟥 Network	🟥 Network

🟩 Organization controlled

🟧 Organization & service provider share control

🟥 Service Provider controlled

[1] **Visualizing the Boundaries of Control in the Cloud. Dec 2009.**
http://kscottmorrison.com/2009/12/01/visualizing-the-boundaries-of-control-in-the-cloud/

Cloud Security NFPs

- Users want assurances of:
  - Confidentiality [keep unauthorized users out]
  - Integrity [data has not altered]
  - Authenticity [data provenance]
  - Anonymity [users are unidentifiable]
  - Privacy [user data is properly controlled]
- Data remanence is problematic:
  - How can you purge data from the cloud?

REST

- Representational state transfer (REST)
- Key constraints:
  - Client/server
  - Servers to not maintain session state
  - Clients must not depend on direct server access
  - Clients communicate using a uniform interface
    - e.g., URIs and self-descriptive payloads

REST Operations

- Four main operations: GET, POST, PUT, DELETE
- Operation can change functionality:
  - GET /resources/ —> list resources
  - PUT /resources/ —> replace resources
  - POST /resources/ —> append to resources
  - DELETE /resources/ —> delete resources
- URIs are often versioned:
  - /api/v2.0/list/
  - /api/v3.0/list/
- REST endpoints enable direct testing:
  - e.g., `curl --include` https://api.github.com/users/meldo