## TechU

**CLOUD 101**

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**2020** IBM Systems Technical University
October 26-29, 2020| Virtual Conference

IBM.

1

# Agenda

- Introduction
- Concepts and Benefits
- Deployment Options
- Preparing for Clouds
- Risks and Benefits
- IBM Power cloud
- Final Thoughts

http://www.blurgroup.com/wordpress/wp-content/uploads/2011/03/Cloud-Technology.jpg

2

2

# Introduction and Concepts



3

# So what is Cloud Computing?

- According to NIST
  - (National Institute of Standards and Technology)
    - 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

- Cloud computing can provide computation, software, data access, and storage services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services

- Natural evolution of virtualization, SOA, autonomic and utility computing

4

# Key characteristics

- Agility
- APIs
- Low Cost
- Device and location independence
- Multi-tenancy
- Reliability
- Scalability
- Performance
- Security
- Easy Maintenance

5

# Why bother?

- Reduced cost
  - Can reduce both capital and operating costs
  - Resources only paid for when being used
- Refined usage of personnel
  - Managed clouds free personnel to focus on the business rather than maintaining hardware and software
- Scalable
  - Can scale up or down
- Flexible
- Reduce downtime
- Disaster Recovery
- Rapid deployment of test and development workloads
- Critical Workloads

6

# Concepts

- Virtualization
  - Sharing resources between many servers/LPARs for many customers/clients
- Scalability
  - Flexible scaling up AND down
- Manageability
  - Rapid provisioning based on demand
  - Service automation management
  - Pervasiveness – services delivered over the network on any platform
- Flexible pricing
  - Usage based

7

7

# 3 Layers – Layer 1

- Infrastructure
  - Infrastructure as a service (IaaS)
    - Where the virtualized platform is delivered as a service
    - Typically a virtual machine is delivered
    - Physical assets – servers, network devices, disks, etc
    - Example – IBM's Power VS Cloud



8

8

# 3 Layers – Layer 2

- Platform
  - Platform as a service (PaaS)
    - Includes IaaS resources plus the solution stack and middleware
    - Facilitates deployment of the applications
    - Provides application infrastructure



9

9

# 3 Layers – Layer 3

- Application
  - Software as a service (SaaS)
    - Application is delivered as a service
    - Applications upgraded by provider



10

10

# Virtualization Models 1/2

- ASP
  - Application Service Provider or traditional, typically a SaaS provider
  - Dedicated servers for each application
  - Use where regulations require dedicated
- Multitenancy
  - A single instance of software serving multiple clients
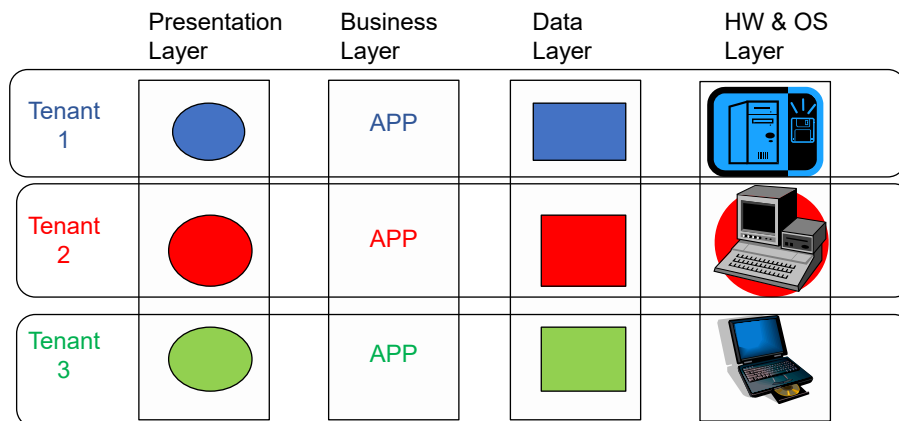    - Lots of issues around data privacy and customizations

11

11

# Virtualization Models 2/2

- Virtualized
  - OS Virtualization
    - Vmware, Xen, Amazon AMIs
  - Hardware virtualization
    - POWER LPARs
  - Use these for single tenant applications with SOA
  - Can have multiple tenants on same server in different LPARs

12

12

# Traditional ASP (Application Service Providers)

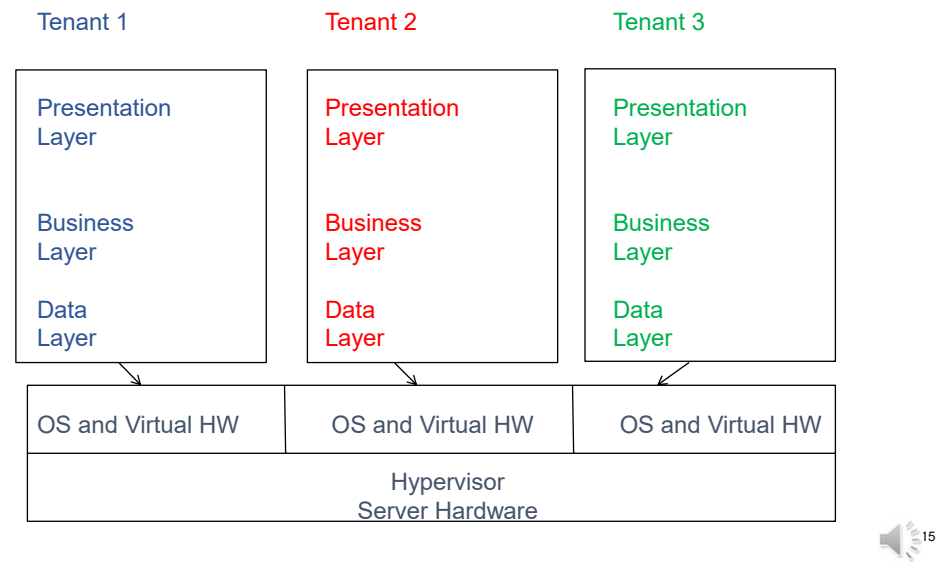| | Presentation Layer | Business Layer | Data Layer | HW & OS Layer |
|---|---|---|---|---|
| Tenant 1 | ⬤ | APP | ▮ | 🖥️ |
| Tenant 2 | ⬤ | APP | ▮ | 💻 |
| Tenant 3 | ⬤ | APP | ▮ | 💻 |

13

13

# ASP Model

- No redesign needed
- Isolation
- Provides more customization than a shared environment
- Backup and DR is per tenant

- BUT
- Poor scalability
- High operational costs

14

14

# Virtualized Model

| Tenant 1 | Tenant 2 | Tenant 3 |
|---|---|---|
| Presentation Layer | Presentation Layer | Presentation Layer |
| Business Layer | Business Layer | Business Layer |
| Data Layer | Data Layer | Data Layer |

| OS and Virtual HW | OS and Virtual HW | OS and Virtual HW |
|---|---|---|

Hypervisor
Server Hardware

15

15

# Virtualized Model

- No application redesign needed
- Isolation
- Provides more HW and OS customization than a shared environment
- Backup and DR is still per tenant

- BUT
- Not as scalable as shared middleware but better than ASP
- Higher administration overhead than sharing

16

16

# Reasons to reach for the Clouds

- Cost reductions from sharing
- Enhanced Security
  - To ensure maximum IT investment protection
- Performance
  - Higher performance per core for optimal application response times and lower software licensing costs
- Availability
  - Zero planned downtime to allow the highest possible availability of mission-critical application workloads
- Scalability
  - Unlimited elastic scaling to meet changing business demands

17

17

# Automation

- Critical to cloud computing
- Required to be able to scale
- Provides standardization
- Reduces manual intervention and potential errors
- Assists with audits and process governance
- Helps maintain quality

18

18

# Provisioning and Elasticity

- Elasticity (and scalability)
    - Ability to start and stop instances as needed
    - Pay only for what is used when it is used
- Provisioning
    - Automated maintenance of configurations
    - Add and remove resources as needed
    - Management of changes

19

19

# Deployment Options

20

20

## Deployment Options for Cloud Computing

**Private**
IT capabilities are provided "as a service," over an intranet, within the enterprise and behind the firewall

**Public**
IT activities / functions are provided "as a service," over the Internet

**Hybrid**   Internal and external service delivery methods are integrated

21

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# Public Cloud

- Easy and inexpensive
- Hardware, bandwidth and application costs covered by provider
- Flexible pricing
- IT becomes a service
- Requires dynamic provisioning and automation

22

# Hybrid Cloud

- Allows you to transition to cloud while maintaining PCI and other regulatory compliance
- A mix of internal and external clouds
- Services are placed where they can meet the requirements for compliance, performance, etc
- Allows for savings with security and flexibility

- **Multicloud**
- Cloud approach made up of more than one cloud service from more than one cloud vendor – private or public

- Can be combined into hybrid multicloud

23

23

# Private Cloud

- Also called internal clouds
- Implemented wholly within the datacenter
- Everything within the corporate firewall
- No multitenancy
- Address sharing while retaining data security, governance and reliability
- Can be operated by the corporation's IT or by a third party cloud service provider
- Provides control and some of the savings

24

24

# Cloud Computing Options

- Private
    - Used solely by the organization
    - Private cloud
        - Lives completely in the datacenter
    - Private managed cloud
        - Managed by a third party (lives in datacenter)
    - Hosted private cloud
        - Hosted and managed by a third party but for private use only
- Hybrid
    - Shared cloud services
        - Cloud shared with other customers of the service
        - Composed of two or more clouds that interoperate
- Public
    - Public cloud services – available to the general public
    - Sometimes called external cloud
    - ITAS – IT as a service

25

25

# Cloud Layers

- Client
    - Computer hardware or software that depends on cloud computing for application delivery/
- Application
    - SaaS or cloud application services deliver software over the internet for customers to use
- Platform
    - PaaS – delivers a computing platform and/or solution stack as a service
- Infrastructure
    - IaaS delivers a platform virtualization environment as a service
- Server
    - Hardware and operating system

26

26

# IaaS – Infrastructure as a Service

- Delivers computer infrastructure as a service
- Typically a platform virtualization environment such as a virtual machine
- Utility computing options
- Cloud computing options
- Easier provisioning of compute resources
- Consumer can easily request and receive a new compute instance
- Client owns nearly all the security

27

27

# PaaS – Platform as a Service

- Delivers a computing platform and/or solution stack
- Often uses cloud infrastructure or supports cloud applications
- Saves customer from having to buy and manage hardware and software
- Consists of the hardware and software framework that allows software to run
- Clients can manage security for middleware, database and application runtime environments

28

28

# SaaS – Software as a Service

- Deliver software over the internet so no need to install and run an application
- Allows for multi-tenancy
- Usually pay as you go
- SaaS provider manages the environment and all upgrades
- Consumer can request a software instance without worrying about where and how it will be hosted
- Developer could request new test database etc
- Consumer can focus on the application instead of the underlying infrastructure
- Security is responsibility of Cloud Provider

29

29

# Cloud Systems View
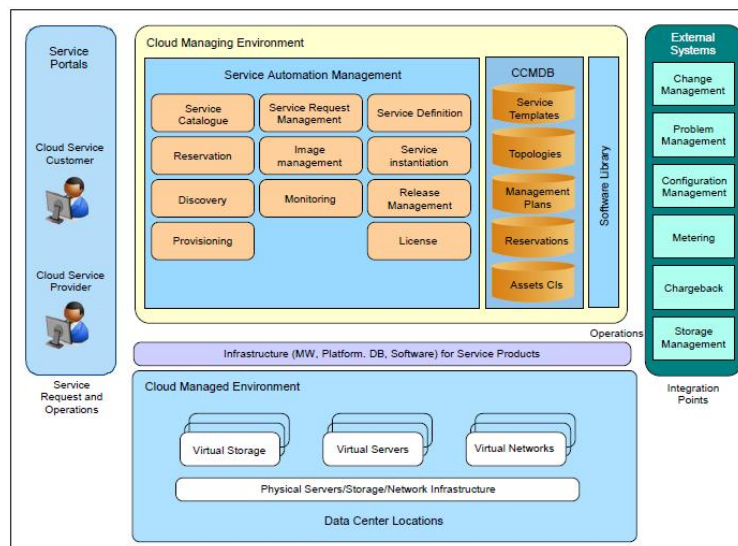


Figure 4   Cloud technical solution: System view

Redpiece 4553  http://www.redbooks.ibm.com/abstracts/redp4553.html

30

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# Preparing for Cloud



31

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# Preparing for Cloud

- Analyze existing processes
- What can be automated?
- Approvals are critical so delegation capabilities are important
    - i.e. provisioning resources should not need manual intervention
- Identify and remove manual approval steps
- Identify security and compliance needs



32

# Architecting your Cloud

- Monitoring tools and standards
- Capacity Planning
- Service Catalog
- Cost and Usage Optimization
- Data Protection
- Security and Policy Enforcement Methods
- Service resiliency methods
- Billing and Cost Allocation methods and tools
- Skills and Context

33

33

# Security 1/2

- Concerns about:
  - Lack of visibility and control
  - Protection of sensitive information
  - Storage of regulated information in a shared, externally managed environment
- Privileged User Access:
  - access control measures need to be employed to protect sensitive data
  - Who at the cloud provider has access to the environment and where are they located
- Regulatory Compliance:
  - external audits and security certifications should be conducted to ensure the security and integrity of data in the clouds

34

34

# Security 2/2

**If all is not lost ... where is it?**

- Data Location:
  - locations of where data is stored must be taken into consideration in terms of local authority's privacy laws, jurisdictions, etc.
- Data Segregation:
  - data encryption techniques must be used to segregate different sets of data in a multi-tenancy situation
- Recovery:
  - systems back-up and data recovery must be implemented in the clouds
- Security Scans
  - Are these required by your security department?
  - Does the cloud provider allow them?

35

35

# Implementing a secure Cloud

- Implement and maintain a security program.
  - Enforcement and auditing and policies
- Build and maintain a secure cloud infrastructure.
  - Firewall configurations, server security, roles
- Ensure confidential data protection.
- Implement strong access and identity management.
- Establish application and environment provisioning.
- Implement a governance and audit management program.
- Implement a vulnerability and intrusion management program.
- Maintain environment testing and validation.

36

36

# Software and Service Delivery

- You may need to know where your data and services are – can they tell you?
- Is your data required to be located in a specific country? Not allowed to be in certain countries?
- How about the support people?
- Response time
- System management & maintenance planning
- Proactive communication
  - notifications regarding maintenance activities
- System monitoring
  - key-performance-index (KPI)

37

37

# Scalability

- Ability to respond to large volumes of service requests & users
- Ability to handle high volumes of services during peak demands
- Ability for system expansion with minimal costs
- Consistent service quality and system performance
- Reliability as service request volumes grow
- Ability to have service requests handled automatically

38

38

# High Availability

- Facilities with reliable power, cooling, and network infrastructure
- High-availability infrastructure, including networking, server infrastructure, and software
- N+1 redundancy
- 24/7 operational capability
- Clearly documented failover and disaster recovery plans

- MAKE SURE you understand the implications of different kinds of outages – regional, etc

39

39

# Risks & Benefits

40

40

# Risks

- Performance
  - Insufficient bandwidth
  - Provider runs out of resources
- Impact of mishandling data
- Unwarranted service charges
  - Metering and monitoring
- Financial or legal problems of vendor
- Vendor operational problems or shutdowns
- Data recovery and confidentiality problems
- General security concerns and governance
- PCI, HIPAA and other regulatory compliance
- Lock-in
- Data and application portability

41

41

# Business Benefits of Cloud

- Responsiveness and agility in delivering new solutions
  - Decreases time to market
- Enhanced employee mobility
  - access anytime, anywhere from anything
- Incremental pricing means availability without capital outlays
- Rapidly adjusts the volume of users as workload increases or decreases
- New product releases are automatic and at no additional cost
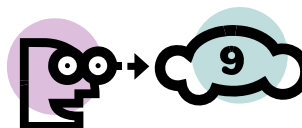
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# IT Benefits of Cloud

- Allows IT to choose areas of focus
- Integrate emerging technologies without the high risk and cost
- Leverage service provider expertise
- Optimize investment in existing infrastructure

43

43

# How POWER addresses Cloud Security

- POWER provides enterprise level security, certified to meet the stringent requirements of the EAL4+ Common Criteria certification
- Highly stable and reliable POWER roadmap continues to deliver advanced virtualization capabilities for years
- Industrial-strength PowerVM virtualization is 'baked into' the hardware of all Power Systems platforms
- Built-in RAS features of POWER
- Functions like LPM
- Workload optimized Systems
- Automation functions – management with automation

44

44

# AIX Cloud Solutions

- AIX in the IBM Cloud
    - IBM Power Systems Private Cloud
    - IBM Power Virtual Server in the IBM Cloud
- AIX in the Google Cloud
- AIX in the Azure Cloud (Skytap)
- AIX from other CSPs and MSPs
- Enterprise Cloud Edition
    - Includes PowerVC, Cloud Management console, Power SC, AIX 7.2 and other software

https://www.ibm.com/cloud/solutions

45

45

# Questions to ask

- Do you need to rapidly bring services to market?
- Are resources constrained (people and infrastructure)?
- Is testing adequate? Do you need to roll back?
- Do users need to be able to request and provision their own test environments?
- Do users need to know service costs?
- Is optimization important?
- Flexibility? Scalability?
- Do I have a plan to switch back if this does not work?
- What if my cloud goes down?
- Will I be locked into this cloud vendor?
- Will a single cloud meet my needs, or do I need multi-cloud?
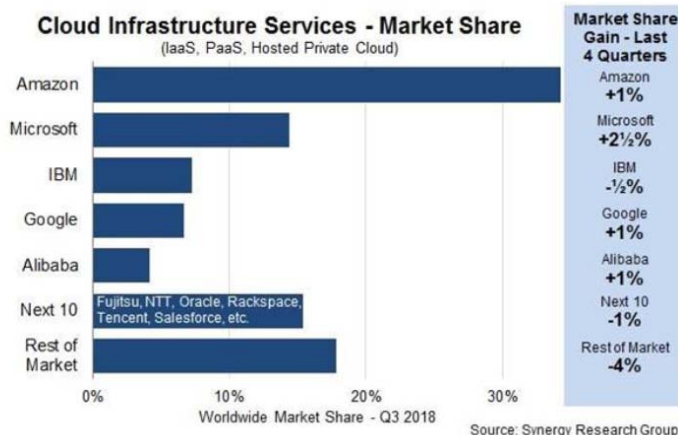
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46

## IDC 2019 Multicloud Management Cloud Survey

- August 2019, IDC Multicloud Management Survey of almost three hundred US-based enterprise IT decision-makers.

- Primary reasons to go tocloud are still automation, analytics, and governance

- 93.2% stated they were using 'multiple infrastructure clouds' for their business operations.
  - 81 percent use multiple public clouds and one or more private or dedicated clouds
  - 11 percent use multiple private or dedicated clouds
  - 7.5 percent use one public cloud and one or more private or dedicated clouds
  - 0.5 percent operate in multiple public clouds only.

- Need to find balance between agility and cost

- Most important reasons to be using multiple clouds?
  - 61.5% of enterprises said leveraging cloud-specific capabilities
  - 54.5% claimed business unit/team preference determine cloud usage
  - 54.5% used multiple clouds to reduce cloud

- 86% of surveyed organizations expect containers, microservices, and Kubernetes to have significant impacts on their multicloud management strategies in the coming years.

47

47

# Cloud Players



Cloud Infrastructure Services - Market Share
(IaaS, PaaS, Hosted Private Cloud)

| | Market Share Gain - Last 4 Quarters |
|---|---|
| Amazon | Amazon +1% |
| Microsoft | Microsoft +2½% |
| IBM | IBM -½% |
| Google | Google +1% |
| Alibaba | Alibaba +1% |
| Next 10 (Fujitsu, NTT, Oracle, Rackspace, Tencent, Salesforce, etc.) | Next 10 -1% |
| Rest of Market | Rest of Market -4% |

Worldwide Market Share - Q3 2018

Source: Synergy Research Group

https://blog.cloudlogicit.com/post/one-cloud-to-rule-them-all-part-1-of-3

48

48

24

October 10, 2020

## Clouds in your life today

- Online Games
- Google Apps
  - Docs, email, calendar
- Dropbox
- Box.net
- Salesforce.com
- Amazon
- Zynga
- Netflix
- Zoom
- Facebook
- NY Times – Time-machine
- Slide Share
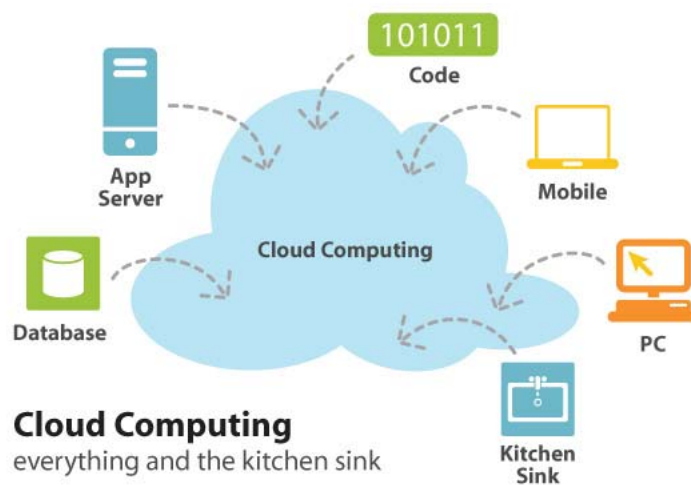- Cloud Backup (IBM, Azure, iCloud, etc)
- And many many more

http://dvice.com/pics/cloud_apps2.jpg

49

49

## Cloud Myths



http://bluemilecloud.com/wp-content/uploads/2010/10/cloudstration.jpg

50

50

25

# Busting Cloud Myths

1. There's one single cloud
2. All you need is your credit card
3. The cloud reduces your workload
4. You can seamlessly blend your private cloud with public cloud providers
5. You will never be able to blend them
6. Cloud computing always saves you money
7. A cloud provider can guarantee security
8. If you're running VMs then you're doing cloud computing
9. Cloud computing is about technology

http://www.businessweek.com/print/technology/content/jun2009/tc20090622_355135.htm

51

51

# Busting Cloud Myths
## CIO Magazine Top 7

1. Moving to cloud automatically saves money
2. The cloud is not safe for storing data
3. Cloud computing can be layered over an unchanged IT infrastructure
4. Transitioning to the cloud is quick and easy
5. The cloud is difficult to audit
6. The cloud is an IT job killer
7. A single hyperscale cloud platform is sufficient

https://www.cio.com/article/3373842/7-cloud-myths-debunked.html

52

52

## Busting Cloud Myths – Gartner Top 10

1. Cloud is always about money
2. You have to be cloud to be good
3. Cloud should be used for everything
4. The "CEO said so" is a cloud strategy
5. We need ONE cloud strategy or vendor
6. Cloud is always more secure than on premises
7. Multi-cloud will prevent lock-in
8. Once I have moved to the cloud I am done
9. Enterprises are moving back from public cloud
10. We have a cloud implementation/adoption/migration strategy

https://www.gartner.com/smarterwithgartner/the-top-10-cloud-myths/

53

53

# More cloud myths

- People will lose their jobs
- Cloud's are free or really really cheap
- Performance is never a problem
- You can replace MS Office with google, or other cloud apps
- Cloud is easy to setup and manage
- Security is good
- Moving to cloud mitigates responsibility for outages

Truth - Cloud is a complex resource that requires understanding and hard work to manage correctly

54

54

# Legal Issues 1/2

- Location and use of data
- Different privacy laws in different countries
- Need to understand obligations
- Terms of use and reliability
- Who are all the parties in the cloud stack – roles?
- Backup / restore and disaster recovery plans
- Service levels
- Business continuity
- Change control

55

55

# Legal Issues 2/2

- Exit strategy and lock-in
- Portability – can I move my data elsewhere
- Electronic record retention requirements
  - Backups and archives
- Can I get my data and apps back?
- What if providers change or go insolvent?
  - EMC shut down Atmos, Vaultscape shut down
  - Iron Mountain and Cirtas got out of the cloud business
  - 2011 Article - http://www.computerworld.com/s/article/9216159/What_happens_to_data_when_your_cloud_provider_evaporates_
- When and how is data transferred
- SLAs
  - Specifically what is covered?  Web?  Data?  All of it? What do they mean by an outage?
- Don't even try to say: The cloud ate my data

56

56

# Cloud Outages in 2019 and 2020

- Google Cloud Outage Detector:
  - https://downdetector.com/status/google-cloud/map/
- Feb 7, 2020 – Twitter
- May 2019 – Salesforce
- May 2019 - Microsoft
- July 2019 – Apple cloud
- July 2019 - Cloudflare
- 2019 – Google cloud
- Aug 2019 – Amazon AWS
- 2011
  - Amazon EC2 and EBS
    - http://blogs.gartner.com/lydia_leong/2011/04/21/amazon-outage-and-the-auto-immune-vulnerabilities-of-resiliency/
    - http://broadcast.oreilly.com/2011/04/the-aws-outage-the-clouds-shining-moment.html
- Cloud Adoption and Risk report from Macafee – 2019
  - 69 percent of CISOs trust their cloud providers to keep their data secure
  - 12 percent believe cloud service providers are solely responsible for securing data
    - https://www.mcafee.com/enterprise/en-us/assets/skyhigh/white-papers/cloud-adoption-risk-report-2019.pdf

57

57

# Amazon Outage in 2011

- EC2 – Elastic Compute Cloud did not go down
- EBS – Elastic Block Store
- RDS – Relational Database Service
- Root cause seems to have been a network configuration change
  - Caused a significant burst in replication data
  - Overloaded the capability of multiple availability zones
  - Triggered cascading set of issues
- SLAs
  - Only covered EC2 which did not go down
  - Did not cover data services (EBS and  RDS) which did go down
- *Thoughts*
  - Price of service is not everything
  - QOS and resiliency are also critical
  - Understand the SLAs – make sure they apply to what you need end to end
  - Communication during an outage is critical
- Amazon's Published Post Mortem
  - http://aws.amazon.com/message/65648/

58

58

# Key Message - Design for failure

- Physical
  - Redundant n+1 hardware, software like vmotion or LPM, PowerHA
- Virtual Resource
  - Redundant virtual resources (LPARs, etc)
- Availability Zones
  - Redundant resources across availability zones within a region
- Region
  - Redundancy across regions
- Cloud
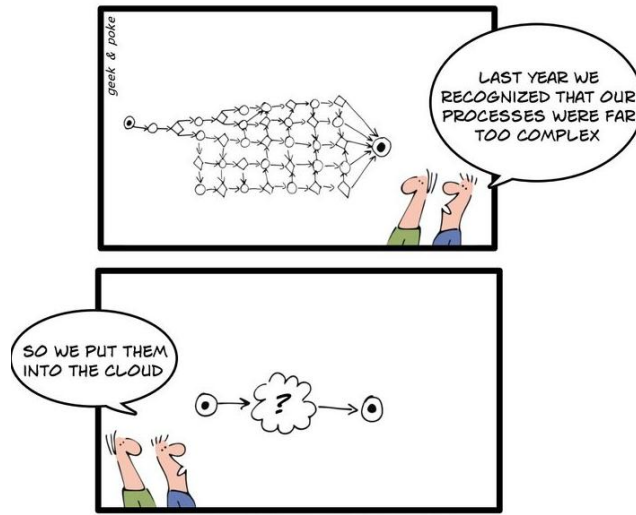  - Ability to survive the total loss of a cloud provider

59

59

# Potential Criteria for Picking a Cloud Service Provider

1. Certifications & Standards
2. Technologies & Service Roadmap
3. Data Security, Data Governance and Business policies
4. Service Dependencies & Partnerships
5. Contracts, Commercials & SLAs
6. Reliability & Performance
7. Migration Support, Vendor Lock in & Exit Planning
8. Business health & Company profile

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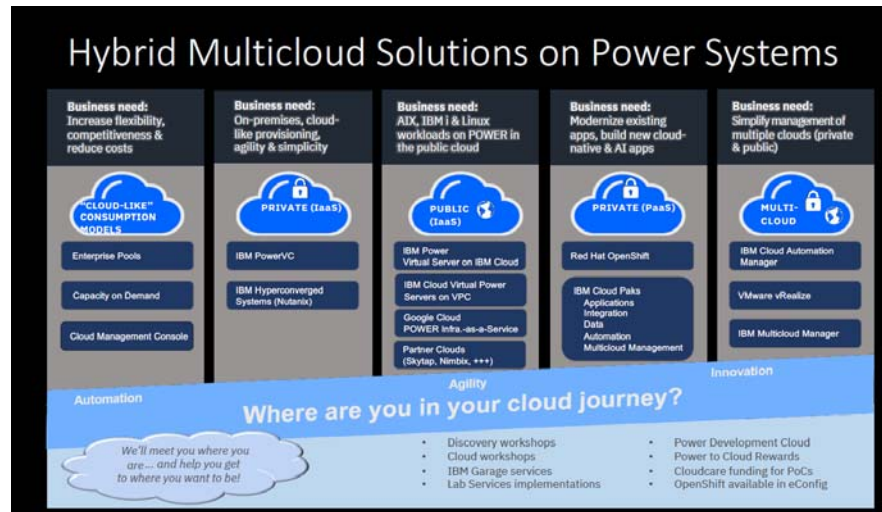
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61



62

# Hybrid Multicloud



63

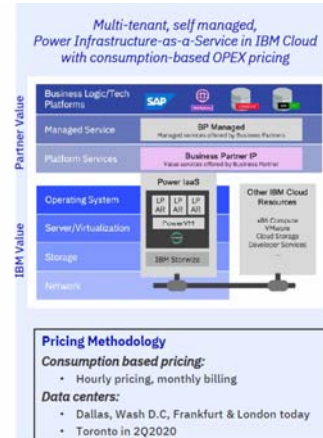# IBM Power Systems Virtual Server on IBM Cloud



64

# IBM PowerVS Cloud (IAAS)

**IBM Power Systems Virtual Server on IBM Cloud (PowerVS)**

- Self-provision and purchase monthly subscription virtual machines from IBM Cloud
- Self-service VM management of pool of compute, memory, storage & network infrastructure
- Secure access to PowerVM-based LPARs through client-owned IBM Cloud resources
- IBM manages IaaS resources and supports everything up to the operating system (OS)
- Client self-manages the OS and all software installed atop the OS
- Client can bring their own OS images and add to IBM-provided OS images
- Client can bring their own software for ISVs who support BYOL for public cloud

**Power IaaS Details**

| | |
|---|---|
| Systems: | S922 or E880 |
| Compute: | 0.25-143 cores (15 for S922, 143 for E880/980), *Dedicated or Shared option for Cores* |
| Memory: | 8-64 GB per core |
| Storage Type: | Type: Tier 3 (HDD) or Tier 1 (SSD) |
| Storage Quantity | 10 GB minimum, 10 GB increments |
| Network: | Public and/or Private IP |
| OS: | AIX / IBM i |

*Multi-tenant, self managed, Power Infrastructure-as-a-Service in IBM Cloud with consumption-based OPEX pricing*



**Pricing Methodology**
*Consumption based pricing:*
- Hourly pricing, monthly billing

*Data centers:*
- Dallas, Wash D.C, Frankfurt & London today
- Toronto in 2Q2020

65

65

# How PowerVS Cloud can help

- Grow at your own pace
  - No heavy upfront costs
  - Flexible rapid growth when needed (Scaling)
  - Pay as you use
- Run your workloads when and where you want
  - Flexible
- Disaster Recovery as a service
- Development and testing
- Choose your deployment
  - Select systems, cores, network,etc
  - Can have IBM fully manage it or use self-service

66

66

## IBM's PowerVS Cloud Experience

- Default console through web does not allow copy/paste
- External access
    - Either VPN into your datacenter to connect or use a jump server
        - These have to be ordered and set up
    - Public network access is available, but default level is slow
- A good networking person is critical in the design and planning phases
- Proper planning is required
- Make sure to plan for backups
- Web based interface easy to use
- Very easy to add resources through the GUI
- It is IAAS so you are responsible for the operating system,etc
- Lots of documentation
- Ask about the workshops IBM sometimes offers for migration

67

67

# Final Thoughts
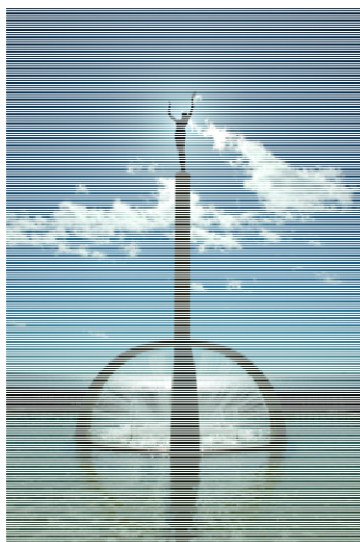


- Cloud is here to stay
- It can be implemented safely and securely
- Planning ahead is critical
- Network skills are also critical
- Understand backup options
- Understand the DR you have signed up for
- Understand what support is provided
- Understand where that support is located
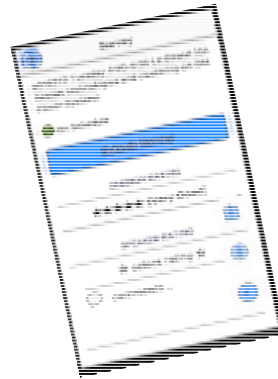- Where will your data be?
- Have an exit strategy

68

68

# Thank you!

Jaqui Lynch

jlynch@flagshipsg.net

**Please complete the Session Evaluation!**

69

69

# Thank you for your time

If you have questions please email me at:
jaqui@circle4.com or jlynch@flagshipsg.net

Also check out:
http://www.circle4.com/movies/

Copy of presentation at:
http://www.circle4.com/ptechu/cloud101-sep162020.pdf

**And the Virtual User Group**
https://www.ibm.com/support/pages/node/1120377

70

70

70

# References

- IBM Power Virtual Server
  - https://www.ibm.com/cloud/power-virtual-server
- IBM Cloud Login
  - https://cloud.ibm.com/login
- Cloud Computing
  - http://www.redbooks.ibm.com/abstracts/redp4553.html
- Cloud Security Guidance
  - http://www.redbooks.ibm.com/redpieces/abstracts/redp4614.htm
- Cloud Battle of the Titans
  - http://www.businessweek.com/print/magazine/content/11_11/b4219052599182.htm
- Busting Cloud Myths
  - http://www.businessweek.com/print/technology/content/jun2009/tc20090622_355135.htm
- Open Cloud Manifesto
  - http://www.opencloudmanifesto.org/
- The Big Switch: rewiring the world from Edison to Google, Nicholas Carr
- SNIA – Managing Clouds for Data Storage
  - http://www.snia.org/forums/csi/knowledge/CSI_Private_Hybrid_Cloud_White_Paper_final.pdf
- 8 criteria for selecting Cloud Services providers
  - https://www.cloudindustryforum.org/content/8-criteria-ensure-you-select-right-cloud-service-provider

71

71

# Cloud Types

1. First by appearance
   1. Cumulus
   2. Stratus
   3. Cirrus
   4. Nimbus
2. Then by height
   1. High-level
      1. above 20,000 feet (mostly ice)
   2. Mid-level
      1. 6,500 to 20,000 feet (mostly water, some ice)
   3. Low-level
      1. Below 6.500 feet (mostly water – can contain ice and snow)
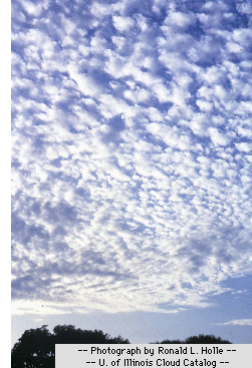
72

72

# Miscellaneous cloud types

- High level                    altocumulus
  - Cirrus and cirrostratus
- Mid level
  - Altocumulus and altostratus
- Low level
  - Nimbostratus and stratocumulus
- Clouds with vertical development
  - Fair weather cumulus and cumulonimbus
- Other cloud types
  - Contrails, billow clouds, mammatus, orographic and pileus clouds

-- Photograph by Ronald L. Holle --
-- U. of Illinois Cloud Catalog --

73

73