We exist to empower informed decision making, so that organizations can achieve their goals with greater confidence.
Introduction to Cloud Computing
• What is cloud computing and how is it useful?
• Discuss history of cloud computing
• Types of cloud computing and services
• What is new in the cloud?

Cloud Computing Issues
• Discuss issues in cloud computing
• Challenges of migrating to the cloud
• GAO reported cloud challenges

Cloud Cost Models
• Discuss different cloud providers and provider pricing calculators
• Cloud computing cost models including Cost Estimating Relationships (CERs), common cost drivers, and total ownership cost
• DoD cloud management approach
What is the “Cloud”?

- The “cloud” started off as a tech industry slang term.
- The definition for the cloud can seem foggy, but essentially, it’s a term used to describe a global network of servers, each with a unique function.
- In the simplest language, Cloud Computing is simply a sophisticated outsourcing of IT services.
- First diagrams typically showed technical diagrams representing servers and networking infrastructure that make up the Internet as a cloud.
- Today, "the cloud" is a widely accepted term within the IT community.
Cloud Computing Definition - Formal

What is the “Cloud”?

- Internet-based computing where large groups of remote servers are networked
- Allows sharing of data-processing tasks, centralized data storage, and online access to computer services or resources
- Any computer related task that is done entirely on the Internet
- Allows users to deal with the software without having the hardware
- Everything is done remotely
- Little or nothing is saved locally
- Physical assets are also required
What is the “Cloud”?  

- Cloud computing is a method to provide shared computing resources, including applications, computing, storage, networking, development, and deployment platforms as well as business processes.
- Today, most businesses use cloud-based services — even if they don’t think of it as a cloud (e.g., Microsoft 365, Slack, or DocuSign).
- Consumers utilize computing resources only when they want to and are only charged for the resources they use, for the time they use those resources.

Cloud Computing History

- **Mainframes**
  - Start of Automation phase
  - Localized Infrastructure
  - 1950s

- **Rise of the PC**
  - Rise of demand of personal desktops
  - Decentralized computing
  - Birth of IT Services Industries
  - 1960s

- **Client/Server Architecture**
  - Virtual private network offered
  - Demand for high bandwidth
  - Dot Com revolution
  - 1990s

- **Hosted Environment**
  - IT infrastructure management outsourcing
  - Increase use of virtualization
  - 2000

- **Cloud Computing**
  - Emergence of “as a service”
  - Delivery of IaaS, PaaS, SaaS, NaaS
  - Collaborative computing
  - Utility computing model
  - Beyond 2010
NIST Cloud Definition

Four Deployment Models
- Private Clouds
- Community Clouds
- Public Clouds
- Hybrid Clouds

Three Service Models
- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

Five Essential Characteristics
- On Demand Self Service
- Broad Network Access
- Resource Pooling
- Measured Service
- Rapid Elasticity
Cloud Computing - Types and Services

Public Cloud
- Done by service providers

Community Cloud
- Organizations from a specific community with common concerns

Private Cloud
- Operated solely for a single organization

Hybrid Cloud
- Composition of two or more clouds (private, community or public)
- Virtual Private Cloud Public cloud provider creates private environment

Other Cloud Types
- Distributed Cloud
- Multi Cloud
- Poly Cloud
- Big Data Cloud
- High Performance Cloud (HPC)
Cloud Computing – What’s New?

Cloud Service Models Will Continue to Evolve

- **BPaaS** Business Process as a Service
- **FaaS** Functions as a Service
- **iDaaS** Identity as a Service
- **FWaaS** Firewall as a Service
- **iPaaS** integration Platform as a Service
- **MBaaS** Mobile Backend as a Service
- **SECaaS** Security as a Service
- **Cloud delivered Security as a Service (SECaaS)**
- **XaaS** Anything as a Service

Cloud Computing Innovation: **WHAT’S NEW?**
Cloud Computing Issues

Security and Privacy
- Data protection
- Physical control
- Identity management
- Physical and personnel security
- Availability
- Application security
- Privacy

Compliance
- Business continuity and data recovery
- Logs and audit trails
- Unique compliance requirements
- Public records
- Legal issues including records-keeping in the public sector

Legal
Challenges to Migrating to the Cloud

- Connecting Old Data with New Cloud Applications
- Time and Cost of Migration
- Program Termination
- Building a cloud from scratch
- Cloud vs. On-premise mindset
- Security and Compliance Adjustments
- Choosing the Proper Storage Options
- Getting Staff Prepared for the Migration
GAO Reported Cloud Challenges

1. Meeting Federal Security Requirements
2. Obtaining guidance
3. Acquiring knowledge and expertise
4. Certifying and accrediting vendors
5. Ensuring data portability and interoperability
6. Overcoming cultural barriers
7. Procuring services on a consumption (on-demand) basis

“As a result of these identified issues, it is likely that agency-reported cloud spending and savings figures were underreported”

“Agencies Need to Develop Modernization Plans for Critical Legacy Systems.”
# GAO Reported Cloud Challenges

## Table 1: The 10 Most Critical Federal Legacy Systems in Need of Modernization

<table>
<thead>
<tr>
<th>Agency</th>
<th>System name</th>
<th>System description</th>
<th>Age of system, in years</th>
<th>Age of oldest hardware, in years</th>
<th>System criticality (according to agency)</th>
<th>Security risk (according to agency)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>System 1</td>
<td>A maintenance system that supports wartime readiness, among other things</td>
<td>14</td>
<td>3</td>
<td>Moderately high</td>
<td>Moderate</td>
</tr>
<tr>
<td>Department of Education</td>
<td>System 2</td>
<td>A system that contains student information</td>
<td>46</td>
<td>3</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Department of Health and Human Services</td>
<td>System 3</td>
<td>An information system that supports clinical and patient administrative activities</td>
<td>50</td>
<td>Unknown^b</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Department of Homeland Security</td>
<td>System 4</td>
<td>A network that consists of routers, switches, and other network appliances</td>
<td>Between 8 and 11^c</td>
<td>11</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Department of the Interior</td>
<td>System 5</td>
<td>A system that supports the operation of certain dams and power plants</td>
<td>18</td>
<td>18</td>
<td>High</td>
<td>Moderately high</td>
</tr>
<tr>
<td>Department of the Treasury</td>
<td>System 6</td>
<td>A system that contains taxpayer information</td>
<td>51</td>
<td>4</td>
<td>High</td>
<td>Moderately low</td>
</tr>
<tr>
<td>Department of Transportation</td>
<td>System 7</td>
<td>A system that contains information on aircraft</td>
<td>35</td>
<td>7</td>
<td>High</td>
<td>Moderately high</td>
</tr>
<tr>
<td>Office of Personnel Management</td>
<td>System 8</td>
<td>Hardware, software, and service components that support information technology applications and services</td>
<td>34</td>
<td>14</td>
<td>High</td>
<td>Moderately low</td>
</tr>
<tr>
<td>Small Business Administration</td>
<td>System 9</td>
<td>A system that controls access to applications</td>
<td>17</td>
<td>10</td>
<td>High</td>
<td>Moderately high</td>
</tr>
<tr>
<td>Social Security Administration</td>
<td>System 10</td>
<td>A group of systems that contain information on Social Security beneficiaries</td>
<td>45</td>
<td>5</td>
<td>High</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Familiar Cloud Service Providers

- AWS
- Kubecost
- CloudHealth by VMware
- Azure
- Google Cloud
- Spot
- Cloudability
Gartner Magic Quadrant for Cloud Infrastructure and Platform Services 2020
Cloud Service Models

Typical Findings for Cloud Offerings

**Pros**
- Best at **small scale** with a simple cost structure and few teams
- Integration into PowerBI and AWS (through Cloud) allows for **better reporting and dashboards**
- Provides recommendations for how **you can save** based on your usage
- Allows to set **budgeting alerts**
- **No additional cost** for customers

**Cons**
- Requires **good tag hygiene** for granular cost visibility
- Can’t see idle or unallocated **resource costs**
- Difficult to see **costs outside** of provider, including multi-cloud and cluster costs
- Difficult to rely on **exclusively** as the organization scales, even for high-level finance and with PowerBI integration
- **Not built to be proactive**, only to see cost reports after the fact (with the ability to set warnings)
Common Cloud Cost Drivers

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Predictor Variables (Cost Drivers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migration Costs</td>
<td>- Storage Size</td>
</tr>
<tr>
<td></td>
<td>- Number of Physical Servers</td>
</tr>
<tr>
<td></td>
<td>- Number of Virtual Machines</td>
</tr>
<tr>
<td>Annual Costs</td>
<td>- Storage Size</td>
</tr>
<tr>
<td></td>
<td>- Number of Physical Servers</td>
</tr>
<tr>
<td></td>
<td>- Number of Virtual Machines</td>
</tr>
<tr>
<td></td>
<td>- Number of Workloads under CloudOps</td>
</tr>
<tr>
<td></td>
<td>- Complexity of Workloads</td>
</tr>
<tr>
<td></td>
<td>- Security Requirements</td>
</tr>
<tr>
<td></td>
<td>- Monitoring Requirements</td>
</tr>
<tr>
<td></td>
<td>- CloudOps Multiplier</td>
</tr>
<tr>
<td></td>
<td>- GB RAM</td>
</tr>
<tr>
<td></td>
<td>- GB Storage</td>
</tr>
<tr>
<td>IaaS Costs</td>
<td>- CPUs</td>
</tr>
<tr>
<td></td>
<td>- Memory</td>
</tr>
</tbody>
</table>

Cloud migration costs and its drivers is an area of continued research.
# Sample Cloud Cost Estimating Relationships (CERs)

<table>
<thead>
<tr>
<th>CER (Annual Cost)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>A + B*(Physical Servers)*</td>
<td>DHS Cloud Analysis, 2018</td>
</tr>
<tr>
<td>(Number of Workloads*Workload Complexity)<em>Cloud Ops Multiplier) + ((Number of Workloads</em>Workload Complexity)<em>Security Requirements) + ((Number of Workloads</em>Workload Complexity)*Monitoring Requirements)</td>
<td>David S. Linthicum, InfoWorld, March 2017</td>
</tr>
<tr>
<td>A + B*(GB RAM)*</td>
<td>PRICE/MITRE</td>
</tr>
<tr>
<td>A (CPUs) + B (Local Disk Storage) + C (Memory) - D</td>
<td>PRICE/MITRE, 2020</td>
</tr>
</tbody>
</table>

Examples of sound Cloud Computing CERs and their cost drivers
Sample Cloud Cost Estimation Relationship (CER) using CloudOps

CloudOps is the ability to operate in a cloud environment once the applications and data arrives. How much will this cost?

- NW: Number of workloads under cloudops
- CW: Complexity of workloads (on a scale of 1.01 to 2.0)
- SR: Security requirements (on a scale of 100 to 500)
- MR: Monitoring requirements (on a scale of 100 to 500)
- COM: Cloudops multiplier (on a scale of 1,000 to 10,000), based on resources used, including the cost of cloud services and the cost of people

The typical calculation looks like this:

\[ \text{CloudOps Cost Per Year} = (NW \times CW \times COM) + (NW \times CW \times SR) + (NW \times CW \times MR) \]

Thus, a typical use case would be:

\[ \text{CloudOps Cost Per Year} = ((1,000 \times 1.75) \times 5,000) + ((1,000 \times 1.75) \times 350) + ((1,000 \times 1.75) \times 250) \]

This example comes to $9.8 million per year = $8,750,000 + $612,500 + $437,500. Thousand fairly complex workloads (CW=1.75), with above-average security complexity (SR=350), average monitoring complexity (MR=250), and low resource usage (COM=1,000).

Source: https://www.infoworld.com/article/3182492/calculate-your-cloud-costs-with-this-simple-formula.html
Most Cloud Services Provide Pricing Calculators - Example

Pricing Calculator | Microsoft Azure

Categories for Cloud Products

1. Select a product to add to your estimate

2. Virtual Machines added. View
Azure Pricing Calculator - Example

Pricing Calculator | Microsoft Azure

3 Customize your Product

4 Estimate for your Cloud product ready to be plugged into SEER
Repeat the steps as needed to obtain prices for your Cloud solutions.
Azure Pricing Calculator - Example

Pricing Calculator | Microsoft Azure

6

Create Purchased HW/SW elements to include cloud hosted services

Are we done?

No. We are missing the Labor!

The Azure Pricing Calculator (and any other online calculators) will provide a quote for the **product only** (i.e., VM, Storage, Service, Hub, etc.) You **still need to estimate the labor to setup and configure the solution.**
Cloud Computing Cost

Not Everything is in the Cloud!

- Deciding to move to the cloud is a decision about outsourcing
- A cloud service is an application or device which is accessed thru the internet
- Each type of cloud service varies between how much of the service is organizationally managed and how much is managed by the cloud provider service
- Cost estimates should capture costs that are not in the cloud service offering to understand **Total Cost of Ownership**
Estimating Cloud Cost Needs a Process

Understanding the Cost of Cloud Decisions requires a Process

- Identify and document Ground Rules and Assumptions
- Describe Project Characteristics (Select Kbases and parameters)
- Establish requirements and Technical Baseline (Create WBS in SEER)
- Focus on project specific risk drivers
- Perform tradeoff analysis
- Review and Validate Estimates
  Use SEER reports and charts
What Are You Estimating?

Establishing Ground Rules and Assumptions

1. What is in the cloud?
2. What is on premise?
3. What else is needed?
What Do You Need from the Cloud?
Understanding Total Ownership Cost

The analyst needs to consider more than what the service providers provide.
Cloud Computing Cost

Most Ownership Costs are Potentially Not in the Cloud
DoD Cloud Management Approach

Three-Tiered Approach to Cloud Computing
How Is It Going – milCloud 2.0?

- CSRA (now GD) won the $500 million milCloud 2.0 contract in June 2017
- Launched three months ahead of schedule in February 2018
- In May 2018, the DoD mandated that agencies move more than 100 data centers to milCloud 2.0 by the end of FY20
- This included 32,000 separate servers, many of which did not meet the latest security requirements
- Just one in five mission partners were moving to milCloud 2.0, and sources tell us that migration progress has continued to be slow

- **Good News** - addition of Amazon Web Services (AWS) to the milCloud 2.0 contract, milCloud 2.0 is poised to provide both fit-for-purpose and general-purpose clouds to meet a wide variety of DoD requirements

How Is It Going – DEOS?

➢ The contract was ultimately awarded to GDIT in late October 2020

➢ **DISA will take the lead** in migrating its users to the cloud-based environment, which will deliver Microsoft Office 365-based collaboration and email services

➢ **Broader deployment across the DoD** will roll out this summer 2021

➢ **Good News:** President of GDIT, said the company “stands ready to execute this critical work, which will provide enterprise-wide visibility and collaboration capabilities across the Department of Defense.”

How Is It Going – JEDI?

➢ On July 6, 2021, the Department of Defense (DOD) announced that it was terminating the $10 billion Joint Enterprise Defense Infrastructure (JEDI) cloud project.

➢ Program would have provided enterprise-wide commercial cloud capabilities for DOD’s classified and unclassified networks.

➢ Originally awarded to Microsoft in 2019, the JEDI program has been plagued by legal challenges.

➢ In resetting its approach to enterprise cloud capability, DOD announced a new cloud initiative: the Joint Warfighter Cloud Capability (JWCC).


➢ AWS and Microsoft are currently the only two cloud service providers, but other providers (e.g., Oracle, Google, and IBM) will be evaluated for potential eligibility later.

source: https://www.csis.org/analysis/pentagon-issues-order-66-terminate-jedi
Common Questions about Cloud Service Costs

✓ Is everything in the cloud?
✓ Are there calculators available?
✓ Are there reliable Cost Estimation Relationships (CERs)?
✓ Are there DoD Rules to follow?
✓ How does one price cloud solutions?
✓ and the **big question**…

Is the Cloud Cheaper?
Surveys Would Challenge the Claim!

Survey of **100 IT decision-makers** in companies with 500 or more employees conducted by NetEnrich found that **85 percent claimed either moderate or extensive production use of cloud infrastructure.**

"... the **top cloud computing issue is security** (68 percent), followed by IT spend and **cost overruns** (59 percent), **day-to-day maintenance** (36 percent), and **root-cause analysis and post-mortems** (22 percent).

Also, 48 percent claim that their IT organization is finding the **cost of recruiting cloud professionals to solve the cloud problems to be an ongoing issue.**"

The **“cloud isn’t so cheap after all”** conclusion is the dirty little secret of Silicon Valley right now, backed by a decade’s worth of data...

The **core issue is that the expectations are the wrong ones.** While cloud providers and even cloud experts have been selling cloud computing as an operational cost-savings technology, the reality is that **the cloud can be more expensive due to cost of the talent needed, of migration, and of cloud operations (cloudops).**

Cloud Computing Cost Models

What are we getting and what are we forgetting?

Costs Often Include
- Fixed Pricing Model
- Pay-per-use Model
- Subscription
- Hybrid
- Pay for Resources

Cost Often Overlooked
- Decommissioning
- Unused Capacity
- Usage Patterns
- Cloud Brokers
- Security/Down Time
Cloud Computing Cost Models

Typical Cost Models Often Include

- Fixed Pricing Model
- Pay-per-use Model
- Subscription
- Hybrid
- Pay for Resources

Static pricing models. The most famous service providers on the cloud such as Google, Amazon Web Services, Oracle, Azure and others use fixed pricing models.

Pay on a recurring basis to access software as an online service. An example is an FTP dropbox or iCloud storage.

Customer pays for resources utilized. For example – you pay per instances of a server and amount of RAM.

Only pay for what is used. Customer pays in function of the time or quantity he consumes on a specific service.

Combination of the pay-per-use and subscription pricing models. Prices set using subscription model but when the use limitation exceed, pay-per-use pricing is used.
Cloud Computing Cost Models

Surveys of data centers often identify aged servers with no use still running—so-called "comatose" servers.

Paying per GB of data stored, and data volumes increase exponentially.

Need to anticipate breeches and outages. Ransomware and cyber attacks are pervasive.

Typical Costs Factors Likely Overlooked

- Decommissioning
- Unused Capacity
- Usage Patterns
- Cloud Brokers
- Security/Down Time

Understating how much capacity is going to be needed outside the user experience.

Cloud brokers provide the experience and guidance to move onto the cloud for a fee.
Conclusion

Three Takeaways From Today

1. The Cloud is Pervasive

2. Not everything is in the Cloud

3. Expect the Cloud to cost more than expected
Questions?
Presenters

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Bob Hunt has over 40 years of cost estimating and analysis experience. He received his Society for Cost Estimating and Analysis (SCA) Certification in 1991. He has served in senior technical and management positions at Dulos Incorporated (President), Galorath Federal Incorporated (President), Galorath Incorporated (Vice President for Services), CALIBRE Systems (Vice President), CALIBRE Services (President), SAIC (Vice President), the U.S. Army Cost and Economic Analysis Center (Chief of the Vehicles, Ammunition, and Electronics ICE Division, U.S. Army Directorate of Cost Analysis (Deputy Director).

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