1. **Workload**: A workload refers to a specific application, service, or capability that can be run in the Cloud or on premises. Examples include containers, databases, and virtual machines.
2. **Retiring**: This involves removing a workload from a platform, typically because it's unnecessary, not cost-effective, secure, or compatible with a specific platform.
3. **Retaining**: Retaining a workload means intentionally keeping it, often on premises or in a hybrid Cloud environment where it continues to be managed by the business.
4. **Rehosting**: Rehosting involves migrating a workload to the Cloud without making any changes to its code or architecture. This is often referred to as "lift and shift."
5. **Replatforming**: This process entails migrating a workload to the Cloud while making some changes to its code or architecture. Replatforming, also known as "move and improve," allows organizations to benefit from Cloud scalability, reliability, and cost-effectiveness.
6. **Refactoring**: Refactoring involves changing the code of a workload, such as adopting a Cloud-based microservices or serverless architecture. This process aims to make workloads more efficient, scalable, or secure.
7. **Reimagine**: Reimagining in Cloud computing involves rethinking how an organization uses technology to achieve its business goals. It can lead to improvements in efficiency, cost reduction, increased agility, and better alignment with customer needs.

Running compute workloads in the Cloud offers numerous benefits to organizations:

1. **Total Cost of Ownership (TCO) Reduction**: Cloud computing eliminates the need for organizations to purchase and maintain physical infrastructure, leading to cost savings. Cloud providers offer pay-as-you-go models and discounts for long-term commitments, further reducing TCO.
2. **Scalability**: Cloud computing allows organizations to easily scale their resources up or down based on demand, avoiding large upfront investments in infrastructure. This flexibility enables businesses to meet changing demand quickly and efficiently.
3. **Reliability**: Cloud providers offer high levels of reliability and uptime, with multiple data centers distributed globally to ensure continuous operation. Additionally, automated monitoring and problem detection mechanisms help maintain service availability.
4. **Security**: Cloud providers implement robust security measures, including data encryption, identity and access management, network security, and compliance monitoring. This ensures data protection and compliance with industry regulations.
5. **Flexibility**: Cloud computing offers organizations the flexibility to choose and adapt Cloud services based on their evolving needs. Whether it's increasing storage space or deploying new applications, Cloud services can be easily adjusted to meet business requirements.
6. **Abstraction**: Cloud providers abstract the underlying infrastructure complexity, allowing organizations to focus on their core business activities instead of managing hardware, software, and networking intricacies. This abstraction simplifies the deployment and management of Cloud services.
7. **Speed and Innovation**: Cloud computing accelerates product and service delivery by eliminating the need to develop and maintain infrastructure. It also provides access to cutting-edge technologies and tools, enabling organizations to innovate rapidly and stay ahead of the competition.

Overall, running compute workloads in the Cloud offers a cost-effective, scalable, reliable, and secure platform for organizations to drive innovation and achieve their business goals.

* **Virtualization**:
  + Allows multiple systems to run on the same hardware
  + Creates Virtual Machines (VMs) that share processing, storage, and networking resources
* **Google Cloud Compute Engine**:
  + Infrastructure as a Service (IaaS) product
  + Enables creation and running of VMs on Google infrastructure
  + No upfront investments; thousands of virtual CPUs available
  + VMs configured like physical servers with CPU power, memory, storage, and OS specifications
* **Creation of VM Instances**:
  + Through Google Cloud Console, CLI, or infrastructure automation tools like Terraform
  + API facilitates communication between software programs
* **Billing and Discounts**:
  + Compute Engine bills by the second with sustained use discounts
  + Committed use discounts available for one or three-year commitments
  + Preemptable and Spot VMs offer cost savings for non-urgent workloads
* **Preemptable and Spot VMs**:
  + Offer cost savings of up to 90% for non-urgent workloads
  + May be terminated by Compute Engine if resources are needed elsewhere
  + Spot VMs have more features than preemptible VMs but same pricing
* **Machine Properties**:
  + Users can choose machine properties like virtual CPUs, OS, and memory
  + Options include predefined machine types or custom machine types
* **Infrastructure as a Service (IaaS)**:
  + Allows users to share compute resources via virtual machines (VMs) for hardware virtualization
  + Each developer can deploy their own OS, access hardware, and build applications in a self-contained environment
* **Containers**:
  + Similar to VMs but more efficient
  + Provide isolated environments for running software services and optimizing hardware resources
  + Virtualize software layers above the operating system level
* **Key Differences**:
  + VMs virtualize entire machines down to hardware layers
  + Containers virtualize software layers above the OS level
* **Advantages of Containers**:
  + Faster startup and lower memory usage compared to VMs
  + Packaged with application and dependencies for easy deployment
  + Independently developed, tested, and deployed
  + Well-suited for microservices architecture
* **Microservices Architecture**:
  + Comprised of smaller, individual services running containerized applications
  + Communication between services via APIs, REST, or gRPC
* **Benefits of Containers**:
  + Create predictable, isolated environments for development
  + Easy to update specific parts of an application without affecting the rest
  + Portable and can run virtually anywhere, simplifying development and deployment

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  **Containers Benefits**:

* Improve agility, enhance security, optimize resources, and simplify application management in the cloud
* Often used alongside virtual machines in organizations

 **Need for Management Solutions**:

* Organizations may have millions of containers, requiring oversight and management for security and efficiency

 **Kubernetes (K8s)**:

* Open-source platform for managing containerized workloads and services
* Developed by Google, it orchestrates containers on multiple hosts, facilitates scaling, and enables easy deployments and rollbacks

 **Google Kubernetes Engine (GKE)**:

* Google's managed Kubernetes service in the Cloud
* Consists of compute engine instances grouped into clusters
* Supports customization of clusters with various machine types, node numbers, and network settings
* Provides API and web-based console for easy application deployment, scaling, monitoring, and troubleshooting

 **Case Study: Ubie**:

* Japan-based healthcare technology startup
* Relied on Kubernetes in GKE, specifically GKE Autopilot mode, to reduce infrastructure costs and maintenance requirements
* Achieved 20% cost reduction and eliminated infrastructure maintenance tasks with GKE Autopilot

 **Alternative: Cloud Run**:

* Fully managed serverless platform for deploying and running containerized applications without worrying about underlying infrastructure
* Automatically scales and manages infrastructure based on application needs
* Ideal for stateless applications that need to scale quickly, such as web applications

 **Summary**:

* GKE suitable for complex applications requiring control over Kubernetes environment
* Cloud Run ideal for simple, lightweight applications needing a fully managed, scalable platform
* **Serverless Computing Overview**:
  + Resources like compute power are provisioned automatically as needed
  + Businesses provide code for functions, and the Cloud provider manages the infrastructure
  + Includes Function as a Service (FaaS) for event-driven functions
* **Google Cloud Serverless Products**:
  + Cloud Run: Fully managed environment for containerized applications
  + Cloud Functions: Hosting for single-purpose functions triggered by events
  + App Engine: Service for building and deploying web applications
* **Benefits of Serverless Computing**:
  + Reduced operational costs: No need to invest in infrastructure or maintenance
  + Scalability: Automatic scaling based on demand, pay only for resources used
  + Faster time to market: Eliminates infrastructure setup, allowing focus on code development
  + Reduced development costs: Simplifies development process, focusing on application logic
  + Improved resilience: Cloud provider manages failover and disaster recovery capabilities
  + Pay-per-use pricing: Optimizes costs by paying only for resources consumed
* **Case Study: Mashme.io**:
  + Educational technology company providing video collaboration experiences
  + Challenges include low latency, continuous integration, and cost-effectiveness
  + Chose Google Kubernetes Engine (GKE) for low latency and global network capabilities
  + Leveraged Google Cloud's infrastructure for scalability and continuous updates without disruptions
* **Traditional vs. Modern Cloud Application Development**:
  + Traditional approach: Monolithic applications with tightly coupled components
  + Modern approach: Cloud-native applications built as a collection of microservices
* **Benefits of Modern Cloud Application Development**:
  + **Architecture**: Microservices architecture enables independent deployment of scalable components, accelerating time to market.
  + **Deployment**: Applications deployed to the cloud using managed or partially managed services, freeing up staff for other tasks.
  + **Cost Efficiency**: Pay-as-you-go pricing model minimizes costs by paying only for resources utilized.
  + **Development Efficiency**: Developers utilize prebuilt APIs and cloud tools for quicker application development and deployment.
  + **Scalability**: Cloud-based applications easily scale up or down to meet user demands, with features like load balancing and automatic failover ensuring high availability.
  + **Reliability**: Robust monitoring and management tools provided by cloud service providers enhance application reliability by quickly identifying and responding to issues.

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* **Rehost Migration Path ("Lift and Shift")**:
  + Move legacy applications from on-premises to cloud environment without modifying the application itself.
* **Benefits**:
  + Cost savings, scalability, reliability, and security of cloud computing.
* **Drawbacks**:
  + **Complexity**: Requires careful planning and allocation of resources.
  + **Risk**: Involves potential risks that need to be identified and addressed.
  + **Vendor Lock-in**: Could lead to dependency on a particular cloud provider, making it challenging to switch providers later.
* **Google Cloud Solutions for Rehosting Legacy Applications**:
  + **Google Cloud VMware Engine**: Facilitates migration of VMware workloads to the cloud without needing to re-architect applications or operations.
  + **Bare Metal Solution**: Fully managed cloud infrastructure allowing organizations to run Oracle workloads on dedicated bare metal servers in the cloud.

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* **APIs (Application Programming Interfaces)**:
  + Set of instructions facilitating communication between different software programs.
  + Acts as an intermediary, enabling standardized and efficient data exchange and interaction.
* **Analogy**:
  + Similar to a waiter in a restaurant: Takes orders, communicates with the kitchen, and delivers food to customers.
* **Applications**:
  + Widely used across various platforms, including social media, mobile apps, and web services.
  + Enables developers to access functionality and data from other programs, saving time and effort.
* **Google's APIs**:
  + Provides access to Google's products and services.
  + Examples include search APIs, Google Maps APIs, and translation APIs.
* **Business Opportunities with APIs**:
  + **New Products and Services**: Organizations can create APIs allowing developers to access their data, leading to the creation of new products and services.
  + **Revenue Streams**: Charging developers for API access can generate new revenue streams, offsetting development and maintenance costs.
  + **Partnerships**: Exposing APIs can foster partnerships with other companies or developers, creating new business opportunities and collaborations.
* **Considerations**:
  + Organizations should carefully consider customer and partner needs to develop APIs that provide value and contribute to business growth.
* **Effective API Management with Apigee**:
  + **Apigee API Management**: Google Cloud's API management service.
  + **Benefits**:
    - Enhanced scale, security, and automation for managing APIs effectively.
    - Provides features for securing APIs, including authentication, authorization, and data encryption.
    - Tracks and analyzes API usage in real time with historical reporting.
    - Facilitates API development and deployment through a visual API editor and a test sandbox.
    - Offers API versioning, documentation, and throttling capabilities to limit API requests.
* **Case Study: AccuWeather**:
  + **Success**: AccuWeather shares weather data through APIs with global partners, enabling applications for various platforms.
  + **Objective**: Expand customer base to include individual developers and tailor offerings to their needs.
  + **Solution**: Utilized Apigee API Management platform to:
    - Implement different tiers of offerings with varying rate limits and pricing.
    - Enable developers to customize API consumption according to their requirements.
    - Attract and build traffic with the customizable Apigee developer portal.
    - Monitor API usage, traffic patterns, and user sign-ups with built-in analytics.
* **Hybrid and Multi-Cloud Solutions**:
  + **Hybrid Cloud**: Combination of on-premises/private cloud infrastructure and public cloud services.
    - Allows organizations to migrate some data and applications to the cloud while keeping others on premises.
    - Interconnects between private and public clouds enable interoperability.
  + **Multi-Cloud**: Utilizing multiple public cloud providers as part of the architecture.
    - Ideal for organizations needing flexibility and secure connectivity between different networks.
    - Can incorporate specific elements of different public clouds to benefit from their strengths.
  + Organizations can choose hybrid cloud, multi-cloud, or a combination based on their needs to create a customized environment.
* **Benefits of Hybrid and Multi-Cloud Solutions**:
  + Move specific workloads to the cloud while keeping others on premises.
  + Benefit from the flexibility, scalability, and lower computing costs offered by cloud services for specific workloads.
  + Add specialized services like machine learning, content caching, data analysis, long-term storage, and IoT to the organization's computing resources toolkit.
* **Google Cloud's Solution: GKE Enterprise**:
  + **GKE Enterprise**: Managed, production-ready platform for running Kubernetes applications across multiple cloud environments.
    - Provides consistent management of Kubernetes clusters, applications, and services regardless of the deployment environment.
    - **Benefits**:
      * **Multi-Cloud and Hybrid-Cloud Support**: Runs Kubernetes clusters on Google Cloud, AWS, Azure, and other public clouds.
      * **Centralized Management**: Single console for managing Kubernetes clusters, applications, security, and compliance.
      * **Security and Compliance**: Includes features for securing Kubernetes clusters and applications and complying with industry regulations.
      * **Networking and Load Balancing**: Tools for network management and load balancing of Kubernetes applications.
      * **Monitoring and Logging**: Rich set of tools for monitoring and maintaining application consistency across networks and clouds.

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