



Data Center Transformation with Google

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Introduction

At Google, we understand and embrace the fact that we're not a first mover as a public cloud provider. Rather, our move to cloud is focused on finding the right capability for the right customer problems, to drive real value and minimize complexity. **Our cloud is different because Google is a different technology company.** We're not a retailer or a software company trying to leverage your technical debt for a healthy balance sheet. We exist to help you leverage data, and engage with you securely at massive scale. This is our focus. We went through the journey to cloud ourselves first, and then decided to productize our technology and expertise to share with others. Along the way, we open sourced critical technologies such as Kubernetes, to make them better and serve the world.

¹Forrester
[Public Cloud Evolution 2018](#)

²IDC
[Cloud Pulse 2019](#)



We've found that **enterprises developing digital leadership increasingly move out of their data centers** to focus on core business innovation, and save on complex infrastructure costs. This trend is reinforced by recent global macroeconomic events, like the COVID-19 pandemic and volatile oil prices, and microeconomic events in certain industries, such as the emergence of disruptors or massive swings in customer bases. This puts challenges related to demand peaks (e.g. remote workers VDI needs) and business continuity under a magnifying glass. Many CIOs are under pressure to complete migrations quickly - 68% of CIOs are seeking to migrate existing applications to the cloud ¹, with 75% of all enterprise workloads not yet migrated ². Motivations range from cost or risk reductions, to refocusing on agility and speed. As they assess their options, many enterprises face an enormous challenge of balancing the function of their existing infrastructure with a new operating model in the cloud. This involves thousands of variables, different technologies, different processes and skills, disparate teams, and competing interests.

At Google, we're here to help you **navigate and execute data center transformations to lower risk and cost, while maximizing business value.** We've already done this with customers such as Cardinal Health, Sabre, Loblaw Digital, Bitly, Boa Vista, and Credit Karma and have a complete set of solutions that are purpose built to serve the enterprise. From mainframe to cloud-native, we help enterprises like yours move to the cloud while helping decide what's right for each organization individually. And we develop services, experience, expertise and technology in order to migrate and then modernize any kind of enterprise workload and data center asset.

This guide is intended to **help you craft your strategy out of the data center** and into public cloud. It surfaces typical industry patterns, key dimensions to be taken into account while designing the journey, as well as Google's capabilities and approach to executing a successful modernization, to help you drive lower costs and increased agility.

Going with Google Cloud

When IT departments first had the option of cloud, it was not embraced with open arms. But underlying drivers have evolved over the years, from cloud being simply a route to cost-savings, to a means for scaling business operations, to an enabler of digital transformation. Today, the question is not whether or not the cloud can be viable, but rather how one might take advantage of all the cloud has to offer. Whether your organization has just started planning or has already made the move, the strategic decision of choosing the right cloud partner for this journey is critical.

Alphabet has 9 products with over 1 billion users each. Google Cloud customers benefit from the storage architecture to edge network devices that have been proven to support our own products at scale, with data centers 100% owned and operated by Google. No other cloud provider can make this claim. We have been running the world's most used platforms at scale for years, and bring that expertise to our customers.

Any cloud provider can offer the basics necessary to host services and applications. While Google Cloud certainly provides the foundations one would expect from cloud, such as storage and compute, we go beyond these to provide best in class and innovative services that only Google can deliver. This is what makes our cloud different.

Best in class security

We deliver end-to-end security solutions from the data center all the way to the device with a purpose-built infrastructure and security by default. Only Google Cloud is named a leader in both data security and public cloud-native security according to Forrester.³

Hybrid and Multi-Cloud

We believe in an open cloud and we have designed Google Cloud to support whatever system best suits your needs, whether hybrid or multi-cloud. Our open source DNA influenced how we developed [Anthos](#), an open hybrid and multi-cloud platform, not locked to proprietary hardware you might see with other clouds. By extending our cloud to the data center in an open manner, the first step towards cloud migration is made without any strings attached.

Full managed no ops

We strive to make cloud easy to use - automating manual tasks and configuration wherever possible so your teams can focus on development and less on managing infrastructure. We extend this approach not only to our technical solutions like BigQuery, but to how we think about saving you money on our platform through automatic discounts that we apply by default on your behalf.

³Forrester Research names Google Cloud a Leader in Public Cloud Platform Native Security Wave.

Forrester Research names Google Cloud a Leader in the Data Security Portfolio Vendors Wave

Embedded AI and ML

We embed intelligence in everything, making it easy for you to apply artificial intelligence and machine learning (AI/ML) in your own organization. Although all vendors have AI/ML, our customers quickly find that the Google AI Platform produces a different level of results. Our AI benefits from deep integration with Big Data analytics and from YouTube, Google Search, and more as part of the training models behind the algorithms. Our leader position in this space according to Forrester proves not all AI/ML platforms are the same.⁴

[*The Forrester New Wave™: Computer Vision Platforms, Q4 2019](#)

Sustainability

We match 100% of the energy consumed by its global operations with renewable energy, and maintain a commitment to carbon neutrality. Google was the only cloud Infrastructure as a Service global provider graded “A” by Greenpeace.

Best of Google

We bring you the best of Google in our solutions, and we can help you create a more innovative and collaborative culture in your organization. Google Cloud brings the best of Google’s innovative products and services to enable enterprises to create new user experiences, transform their operations and launch new products.

We’ve done this before

Not only have we run and grown our own portfolio of multiple billion-user products for years, we’ve helped our customers take advantage of all that Google has to offer from our technology to our culture.



The road ahead

You'll likely have many variables to consider when choosing an approach to data center migration. Typical considerations include whether you want to partially or completely exit the data centers, and the best time frames for doing so. The differentiating business value of the workloads being migrated, the desire for transformation, and the organizational readiness for cloud adoption all need to be examined. Balancing all of this can be complex when considering a large IT estate. An assessment of your organization's desired end-state, both technically and organizationally, informs the default approach to migration. We provide a variety of technologies and professional services offerings to make transformation easier, and a compelling platform for rehosting of legacy workloads.

Partial replacements offer enhanced capabilities to choose between OPEX and CAPEX spending, and are commonly used to provide disaster recovery, adopting new cloud-native capabilities, and enhanced business continuity services. They can also be used to free on-premises hardware for deployment with Anthos or as a testbed for a full data center replacement strategy. This choice becomes a balance between the familiar, rigid controls in a data center, and the new possibilities the cloud brings in removing technical debt.

⁵Google can help you understand your cloud maturity through Professional Services engagements, or you can perform a simple self-evaluation using the [Google Cloud Maturity Assessment Tool](#)

⁶[Migrating Applications to the Cloud: Rehost, Refactor, Revise, Rebuild, or Replace?](#)

Hedge your bets

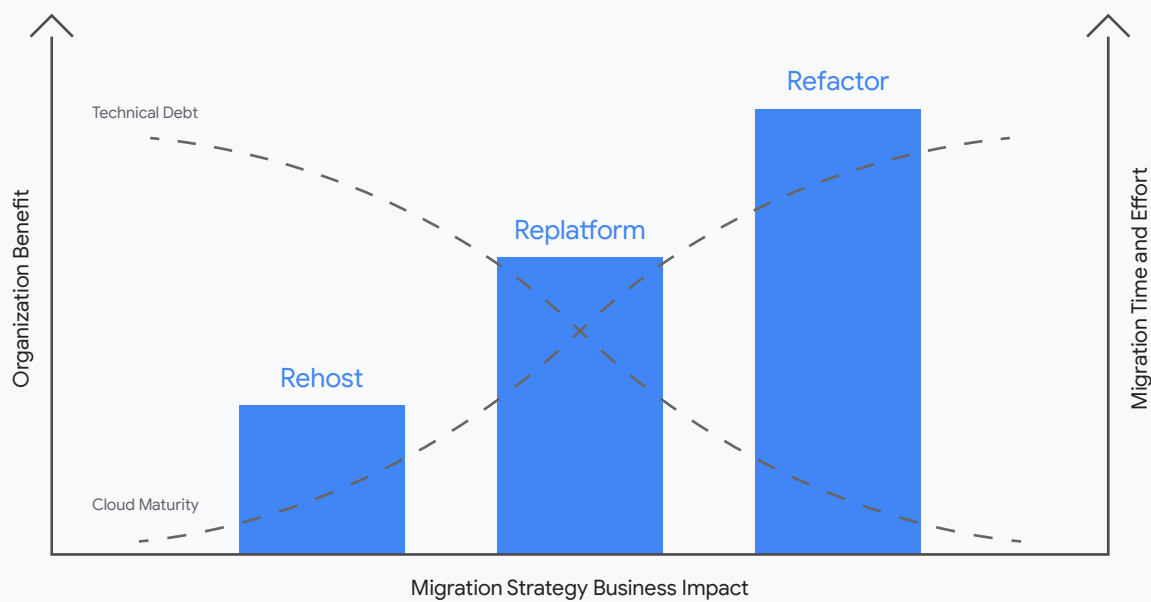
Many customers choose Public Cloud to help lower the burden on their existing data centers, while also expanding the capability to use cloud-native solutions and services. Most journeys to the cloud start with categorizing and prioritizing just a few workloads, which is key to executing any migration or replacement. Categorization and prioritization depends on the business value of the workloads, technology landscape and organizational cloud maturity.⁵

Going all in

"We're not in the business of IT" is a familiar phrase uttered by many CIOs as they make the move to embrace cloud and decommission their data centers. In this approach, a full data center exit strategy will be key, and require every application and solution to be evaluated and eventually migrated or modernized to work with cloud-based solutions. The benefits gained from partial replacement are extended to include new capabilities and solutions.

Prepare for the journey

Our migration approach encompasses the familiar 'R - strategy' from Gartner⁶. We believe this view can be further simplified by considering the end state of the proposed services and applications. As a result, we simplify these traditional R's to Rehost, Replatform and Refactor; also known as 'Lift and Shift', 'Move and Improve' and 'Transform', respectively.



Rehost focuses on moving workloads in the shortest time frame, with the minimum possible amount of change. In a Replatform migration, each workload or technology is examined, with a view towards modernizing some aspects of the workload whilst migrating, in order to take advantage of cloud-native capabilities without significant rewrite of code. With Refactor, existing workloads and applications are redesigned and rewritten to take full advantage of cloud-native technologies. This is a potentially significant undertaking, so is generally focused on those services which provide (or have potential to provide) significant differentiating value to a business. Replatforming and Refactoring ease the ability to manage Multi- and Hybrid-cloud environments, allowing a consistent operating model across all platforms.

As you choose between Rehost, Replatform, and Refactor, there's a tradeoff between lowering technical debt and increased cloud maturity. Lowering your technical debt improves TCO and time-to-market, and will also lead to a reduction in platform risk and the maintenance effort required, as the responsibility of the environment becomes shared with the cloud vendor. Cloud Maturity improves your cloud-native posture, speed and agility, and ability to adopt microservices based architectures, but also requires new skills and a more significant culture change. No matter which migration strategy you choose, Google has the solutions required to get you to the cloud.

| Migration strategy | Google Cloud products and solutions | Capabilities |
|----------------------------------|--|--|
| Rehost (Lift and Shift) | Migrate for Compute Engine | Seamlessly migrate virtual machines into Google Compute Engine built-in testing, rightsizing, and rollback all reduce risk and help accelerate migration pace and scale. |
| | Google Cloud VMware Engine | Migrate your existing legacy apps and VMware-based workloads into GCP using VMware-native tooling and run them in the same way as on-premises. |
| | Microsoft and Windows on Google Cloud | Move Microsoft workloads to Google Cloud; quickly start to optimize costs and begin your modernization journey. |
| | Migrate Oracle workloads to Google Cloud | To migrate Oracle workloads with specific configurations, Google Cloud offers a Bare Metal solution, where you can simply Lift and Shift your workloads to Google Cloud. |
| Replatform (Move and Improve) | Migrate for Anthos | Convert virtual machines to run in containers, in Google Kubernetes Engine or in Anthos deployments running in AWS, Azure or on-premises. |
| | Dataflow, Data Fusion and BigQuery Data Transfer | Ingest data into Google Cloud databases from on-premises data stores, or other cloud environments. |
| | Anthos, GKE, App Engine and Cloud SQL | Leverage cloud-native services to directly replace legacy technology. |
| Refactor (Transform) | Cloud Build | Automated, continuous integration and deployment at cloud-scale, with security at the core. |
| | Cloud Run and Cloud Functions | Rapid, serverless, fully-managed deployment of applications running almost any language, at Google scale. |
| | Mainframe Applications Modernization | Analyse and automatically refactor legacy mainframe workloads to run natively as Java or C++ in Google Cloud. |
| | Apigee | Best in class cross-cloud API management and security. ⁷ |

Choose your path

Every enterprise works and makes decisions in different ways. Each decision is influenced by a number of different dimensions, and understanding them is critical for successfully doing business with a cloud provider.

Below are specific observations and recommendations for key decision makers in any sized organization. We've included the most impactful dimensions here, and are ready to discuss your specific journey and further dimensions in person.

⁷[Apigee named Leader in Gartner Magic Quadrant for Full Lifecycle API Management](#)

⁸Neutral [Hybrid Cloud explanation](#) from Wikipedia

⁹Neutral [Multi-Cloud explanation](#) from Wikipedia

¹⁰[Forrester Study](#) on the economic benefits of Anthos



The more clouds, the better

Most enterprises today are in a Hybrid Cloud⁸ or even a Multi-Cloud⁹ deployment situation - whether they realize it or not. For example, many businesses find that grass-roots groups are adopting cloud services, without approval from technical governance. This gets emphasized even more if SaaS services (e.g. Salesforce, Workday etc.) are fully accounted for, in addition to IaaS and PaaS. Larger enterprises may also need to consider future or past acquisitions, and how those will integrate with their choice of cloud strategy.

Google Cloud has focused on simplifying Multi- and Hybrid Cloud by open sourcing Kubernetes with the intent to have it run anywhere. This led us to launch Anthos in 2019, a Hybrid and Multi-Cloud application platform that provides a single pane of glass, and drives cost reductions and increased productivity for our customers.¹⁰

Making business sense of Cloud

The level of investment made by Public Cloud providers to provide scalable, secure, and reliable services can be much higher than traditional enterprises are used to investing. By adopting Public Cloud technology, you can take advantage of the quality and speed of innovation in cloud services, without the investment in building them from the ground up.

Google has deep experience in assisting customers to migrate their capabilities to cloud. Through this experience we've found the following business considerations critical to driving success.

● Great expectations

When setting up a Modernization Program to Cloud, the starting point should be deriving business benefits from cloud capabilities, and then accounting for the IT benefits created through this journey. Line of business decision-makers need to be involved early, and shown the value of the transformation opportunities available. By balancing and aligning critical success metrics that matter to the business, and to the specific decision-makers, they can become invaluable force multipliers during the transformation.

● Rich Cloud, poor Cloud

When looking at financial performance, innovation and cost management are conflicting strategies. Businesses that don't innovate will struggle to remain relevant over time. Cloud enables both lowering cost and lowering the bar to provide innovation. Cloud is also often enabling new business models and digitalization.

The next challenge is managing both CAPEX and OPEX. Google Cloud can help you manage expenses with options to balance both - cloud is not an only-OPEX approach. We also offer options to increase return on past investment in the data center thanks to Anthos, as well as maintain CAPEX spending through long term commitments to consuming our cloud infrastructure, if that is in the best interest of your financial business planning.

● Cloud on a budget

Migrations to Cloud should first focus on leveraging higher level, managed cloud services as much as possible for efficiency and cost savings. For this, we provide a multitude of services, including Google Kubernetes Engine, BigQuery and DataProc.

Enterprises sometimes assume that their internal IT cost is lower than running the same service on cloud. It's important to consider a broad set of metrics and determine what is contained in the cost metrics of the enterprise. This often varies massively by company. Some include all overhead and cross functional cost, such as management and support functions, procurement, architecture, technical governance, engineering, support, incident and problem management, platform continuous improvement, platform retirement, etc. Many do not, which could distort cost comparisons with cloud.

Here are core criteria to be met by an enterprise for cost efficiency on cloud:

01

Proactively track your cloud spending Establish a cost monitoring methodology, to be able to react quickly and automatically to service usage spikes and surges.

03

Refactor some critical application architecture elements for Public Cloud - check communications patterns (reduce cloud network costs), logging patterns, and everything that creates on demand usage cost - this can ramp up if not managed and capped.

05

Increase your compute density, which is a massive cost savings lever. In the context of computing, density refers to the number of objects that a single physical server can run at one time. Modern cloud applications are based on containers, and on average, they show better compute density than Bare Metal or virtual machines. Many of our customers see cloud VM density as low as 20% of their existing data center. This demonstrates typical inefficiencies of running workloads on traditional hardware.

02

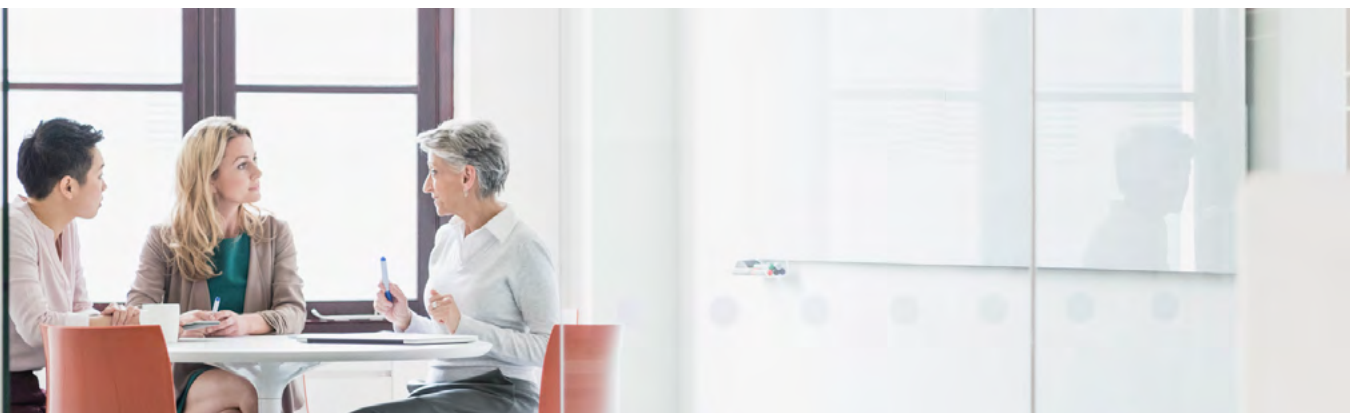
Take advantage of Google Cloud's built-in cost reduction methods, including sustained use discounts, preemptible VMs, right sizing recommendations, idle VM notifications, custom VM sizes, billing alerts, and others Google provides built in methods to help you manage your cloud spending.

04

Enable applications to scale up and down on demand. Internal IT usually provides a fixed cost asset to run on, sized for peak and resilience. This is the largest driver of overhead cost. Use cloud scalability to react to peaks, and modify resilience concepts to leverage the quick availability of spare resources on Public Cloud.

06

Fully leverage high level managed Cloud services. This saves your enterprise a massive amount of work in developing, managing and maintaining many layers of the IT stack and creates very significant cost and complexity savings. Google Cloud Run is a great example of a "no-ops" service which allows you to scale applications without facing the conventional bottleneck of growing your DevOps team.



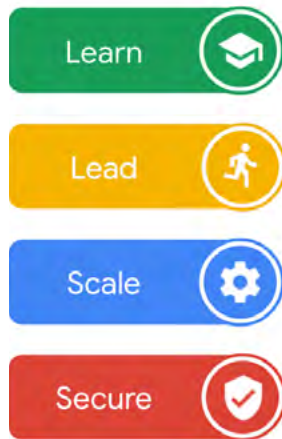
Next are migration costs, as migration implies running both the legacy data center and the new cloud environment in parallel for a transition period. In that regard, Google has designed our **Rapid Assessment and Migration Program** to allow you to alleviate migration costs.

Take your first steps

Google has developed the [Google Cloud Adoption Framework \(GCAF\)](#) to help you when considering a data center migration and transformation program. The framework builds a structure on the rubric of people, process, and technology, providing a solid assessment of where customers are in their journey to the cloud, and actionable programs that get them to where they want to be. The framework encompasses four key themes of cloud adoption - Lead, Learn, Scale and Secure.

Cloud Adoption Epics

Each epic is discrete, is aligned to manageable stakeholder groups, and can be further broken down into individual user stories.



The Google Cloud Adoption Framework

The speed and ability of your organization to modernise your infrastructure and derive transformational value from the cloud will be determined by the ability to embrace new ways of working - a strong vision and governance from leadership; collaborative, innovative learning; automated, scalable infrastructure; and above all a secure foundation are crucial to set you on the path to a successful migration and modernization journey. Our Cloud Adoption Epics represent the intersections of People, Process, and Technology.

| GCAF Epic | Approach | Measurement |
|-----------|---|---|
| Lead | <p>Creating the organisation and culture for transformation</p> <p>Effectiveness in cloud adoption is determined by a visible vision and a mandate issued top-down from executive sponsors, the motivational momentum generated bottom-up from your teams' cross-functional collaboration, and how this infuses into the organisation over time.</p> | Measurable set of OKRs - Objectives and Key Results ¹¹ , and aligned incentives for all key decision makers and influencers. |
| Learn | <p>Evolving knowledge, skills, careers and people</p> <p>Upskill your IT staff while also taking advantage of the experiences shared by third-party contractors and partners.</p> | New skills and certifications ¹² . Build a culture of informal learning and rapid iteration with cloud. |
| Scale | <p>Building a modern cloud architecture</p> <p>Abstract away your infrastructure with managed and serverless cloud services, as well as the quality of your CI/CD process chain and the programmable infrastructure code that runs through it.</p> | Release cycles and deployment times improved, SRE ¹³ methodology and adoption. |
| Secure | <p>Ensuring trust, compliance and security in cloud</p> <p>Protect your services from unauthorized and inappropriate access with a multilayered, identity-centric security model. Dependent also on the advanced maturity of the other three themes.</p> | Secure by default, end-to-end, new capabilities, entity level trust (people, devices, and services). |



The first step towards cloud starts with Lead. Once your organization has the necessary leaders ready to champion and embrace a culture of cloud, we're then ready to guide you through your journey to Learn, Scale, Secure and beyond. This leadership can be internal to your organization, or external by leveraging our extensive network of partner capabilities.

Evolve your culture

The importance of culture change is critical to cloud adoption and data center transformation. Evolving your organization's culture means utilizing the technological tools made available through cloud, and unlocking their potential to help your business become more agile, innovative and future-proof. For Alphabet, our culture is core to what sets us apart. Our proven history in innovation spans the work we've done with Google Search; revolutionizing the way people find and use information, to Kubernetes; forever changing the computing landscape, and more recently with our achievements in Quantum Supremacy¹⁴; the first step towards enabling quantum computing. All of our achievements build upon our culture and sense of purpose, which encourages our people to think big and change the world for the better.

¹¹OKRs as defined in [Measure What Matters](#) by John Doerr

¹²Google Cloud Certification Leads in [Most Valuable Certifications of 2019](#)

¹³Google's [Site Reliability Engineering \(SRE\) Model](#)

¹⁴[Google confirms 'quantum supremacy' breakthrough](#)

Build a Cloud operating model

Successful cloud adoption is generally driven by a central function within an organisation. In its most lightweight form, this may simply be a group of evangelists sharing knowledge. At larger scale, this typically becomes a full-time organisation, which offers a variety of services to development teams, as well as governance and oversight of the platform. We typically call this a Cloud Center of Excellence (CCoE), where the overall cloud operating model is defined.

Based on our experience with numerous customers moving to the cloud as well as our own, we have compiled a set of mandatory controls and technical services that typically need to be used by customers to operate in the cloud, which are reviewed through engagements with our Professional Services team or a consulting partner.

These two objectives - controls and services - go hand-in-hand. The controls provide a framework governing how development teams interact with the cloud platform, by defining what they are permitted to do. These range from the trivial, such as naming conventions, through to more impactful controls such as prescription on development language and tooling. The technical services provided are shared, centrally managed offerings that enable development teams to rapidly develop and deploy software, as long as they remain within the established controls.



● Procurement for the Cloud

Cloud transformation involves much more than just technical considerations. When planning your regional transformation, one of the key functions of this CCoE would be to manage the contractual and procurement aspects of a migration. It's common for an organization to have experience with thousands of Requests for Proposal (RfPs) to acquire their existing estates, involving a huge amount of procurement and legal effort.

Managing existing contracts, and potentially seeking new providers for services running in the cloud, will likely be a significant factor in your migration considerations. Adopting cloud will impose a very new element to the procurement efforts in most enterprises. It changes much of what procurement units are used to, and removes many of the players they are used to working with (hardware, data centers, energy providers, etc.). Including your procurement staff early, and planning for enablement and evolution of procurement skills and procedures, will be critical to the success of your cloud modernization project.

Go big

At Google Cloud, we benefit from being in a unique position. We have 9 products with over 1+ billion users each - no other cloud provider has our scale. Our customers share the same robust and secure infrastructure that we rely on. When we innovate and bring transformational change to the market, we never forget our open source roots. We have a saying about thinking "10x" in all that we do, and with cloud adoption, our goal is to help you see your own 10x vision. It's one thing to simply move your workloads and run them as you did before, with the same approach. It's an entirely different thing to fully embrace the cloud and re-examine everything - from your operations and practices, to the capabilities of your applications themselves.

While the move to cloud can be promising, there are a few table stakes that still must be attended to and Google Cloud has you covered.

● In with the old

Data, and access to data, is one of the primary challenges of any IT System. This area is especially sensitive and complex in migrations to cloud.

Depending on the migration pattern chosen from the options above, there are a few major enablers that can de-risk the process and pull in significant time to market. The first is Region Extensions in Google Cloud. These are colocation data center facilities, run by Google Cloud or Google Cloud Partners, mostly within 1 millisecond network latency from a Google Cloud Region. These Region Extensions serve as a temporary or permanent migration target for Data Services (Databases, Datastores, etc.) and legacy IT Services that can not be migrated to the cloud. This can also include special purpose hardware appliances, customer controlled Key Management and Identity Systems, mainframes, etc.

Due to the low latency proximity of Region Extensions to Google Cloud's Regional data centers, the services located in the Region Extension function like they are located in the same data center. This allows parts of the data center workload (often Application Servers) to run in Google Cloud, with legacy and data services being Lifted and Shifted into the Region Extension as a first, lower risk quick step. This concept also enables Disaster Recovery services to be run in the cloud, making a split of legacy and cloud ready services possible, and bringing the effort and risk down to manageable levels.

The second and third solutions are [Google Cloud VMware Engine](#) and the Google Cloud [Bare Metal Solution](#). Both represent very helpful technology bridges designed to ease the adoption hurdles of specific workloads, and to enable migrations for workloads that otherwise would have a negative impact on business risks and migration timelines. These create easier Rehost or Lift and Shift approaches. If parts of the IT landscape cannot be transformed to cloud with acceptable risk, time and investment, it's no longer a blocking factor for a data center transformation or replacement project. These components can instead be moved to a Region Extension, GCVE, or Bare Metal Solution, and their cloud transformation can be deferred until later.

● Everything is software

At Google, everything runs in a container. On a typical week, Google launches several billion containers to support our own products. We've developed a certain expertise when it comes to supporting the needs of developers, especially at scale. Developers are often the champions for change from internal IT to cloud, and for leveraging higher level managed services. Building on this, the leverage of, or migration to, a state of the art software factory and Continuous Integration / Continuous Delivery (CI/CD) pipeline is a key enabler and value add in the cloud. It not only creates positive mindshare and adoption through increasing developers job satisfaction, but also allows customers to save significant cost by consolidating and shutting down legacy software development processes and tooling. This can create very significant operational simplification, reduce errors and outages, and increase software quality and delivery agility.

● It's the network

Google Cloud's approach to networking is unique. While we can certainly dive deep into the technical specifications of our network, the way we approach networking all together is part of what makes us different. We're the only provider to enable the ability to span a single VPC worldwide; opening up new possibilities and architectures that were never before possible.

Overall, it can be expected that during any large migration, fairly high bandwidth (depending on use cases, but measured in the 10s of Gigabits range) will be required between data centers and cloud, which must be highly available and connect to multiple cloud Regions for redundancy. The lower the latency from data center to cloud (Regions and Region Extensions), the easier the migration will be and it pays off to spend time optimizing the latency.

Connecting cloud with an on-premise data center will be a significant step for enterprise security and compliance groups. Often, the data center is considered a trusted zone, and all outside is untrusted (the "castle with a moat"). Expect heavy need to prove technical controls and budget ample time to get approvals and mindshare. This timeline is usually measured in months, not days.

One of the significant challenges is to understand the communication behaviours of the overall IT System, and identify the traffic patterns of your components and services. Some may talk a lot within, but not as much to other parts of the system, or some may communicate with multiple external components. Tools exist to map out such communication and group components (for mainframes e.g. Google's Cornerstone), both based on source code and on observed System and Network behaviour. A migration would then plan to move such groups into the cloud as a whole, to reduce the amount of communication needed from legacy data centers to cloud.

● It's still the network

Google has a large public cloud network, with hundreds of global edge cache nodes, so we can support products at scale. The connectivity from Google Cloud to your customers warrants special attention. Most of our customers exist to serve their respective clients or users. If this includes services delivered through networks, those networks need review during migration to cloud. Consider that, in many cases, clients or users might be connected to the data center through private lines, not just through the internet.

In the first step, services will migrate from data center to cloud, but will keep communicating with the users via the legacy data center, as that is where the users are connected. This adds latency to the workload, and limits the ability of your application to scale and leverage Google Cloud's global networking capabilities. Because of this, it's a key value driver to redesign client / user connectivity to be cloud-native, including the case that the client runs on a cloud themselves. This case is important for internet and private network connections.

Such redesign can be a major, multi-year project, especially if private lines with production traffic must be moved. Outage windows might be impossible to avoid, risks need to be managed, customers need to change configs or hardware on their side and collaborate, and third party network providers will often be involved. These connections may have been established years ago and information about them might have been lost in the meantime.

● Don't forget the fine print

A large part of enterprise IT spend is created by licenses for commercial software, subscriptions and support. The need of Bring Your Own Licence (BYOL) is frequently coming together with the need of supporting Bare Metal solutions (to cater for some specific license terms). Using cloud or Bare Metal solutions can provide a platform for difficult license challenges. Also, new opportunities exist to remove complex license models via the adoption of cloud-native solutions.

Existing license models can have a very significant impact on the success and timelines of any cloud project. Key factors are:

01

Can the licenses be used on cloud (Bring-Your-Own-License)?

02

Which licenses become useless when the product is not needed anymore (net saving potential), or replaced with a cloud-native feature?

03

Do the licenses have limitations, e.g. on geographies, number or type of systems? If yes, can we technically enforce these limitations?

04

How can license usage be audited when deployed in the cloud?



05

Does the charging model create any cost explosions on cloud if not set up appropriately, e.g. for some commercial databases?

07

Is support included or charged extra? If charged, how is it metered and does that change the cost on cloud?

06

How are the licenses metered? Are they Universal Access Licenses with “unlimited” use? If yes, how is “unlimited” defined during, and critically after the duration of the license contract?

08

Is a Bare Metal Solution suitable for BYOL, and is the required license model already available in the Regions that you need them?

Ensure you understand the license situation of the enterprise, and work with the relevant parties that own that conversation to review their major contracts and how a move to cloud impacts their situation. Given early focus, this can be successfully managed and balanced. Cloud is a cost efficient option to run common enterprise software, and enhances your ability to replace some of them with cloud-native managed solutions.

Make the move

When approaching a data center migration project execution, we always envision a large-scale migration as an agile execution model involving all parties (customer, partner and Google Cloud) that will follow two principles:



One team approach:

The teams will be composed of members from the different participating companies that work and collaborate together towards a common goal, as one team.



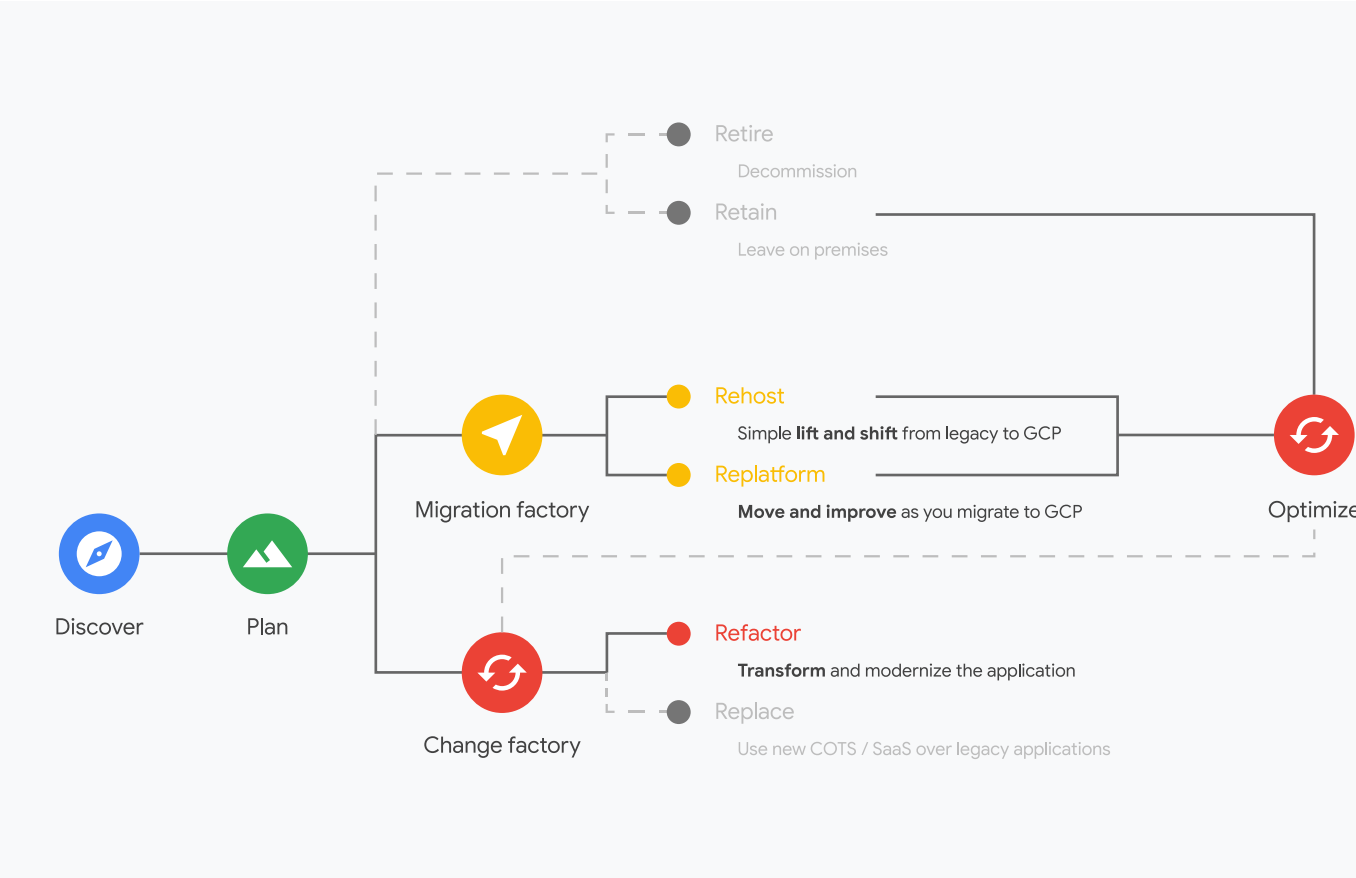
Agile approach:

The delivery approach to be guided by the agile software development values:

- Individuals and interactions over processes and tools.
- Working solution over comprehensive documentation.
- Customer collaboration over contract negotiation.
- Responding to change over following a plan.

More than following strict methods, we believe in self-organizing and collaborating teams that are guided by a clear vision and a common set of OKRs (Objectives and Key Results). Also, we believe that the values of agile execution are key to the success of any innovation endeavour - regularly producing new increments in functionality in short iteration cycles (migration sprints).

Our migration approach is explained in more detail below:



Our **Migration Factory approach** lies at the core of the migration program, executing through waves of Discover & Assess - Plan - Migrate - Optimize. These steps, while appearing linear, are iterative and will be executed in parallel through agile sprints across the different workloads and workstreams. Surrounding the migration factory is the Cloud Center Of Excellence as described earlier, overseeing the business strategy of the migration and the migration program management, whilst aligning the delivery to the governance model and control framework.

Migration Wave #1

- 01 Assess
- 02 Plan
- 03 Migrate
- 04 Optimize

01

02

03

04

01

Migration Wave #2

- 01 Assess
- 02 Plan
- 03 Migrate
- 04 Optimize

Migration Wave #3

- 01 Assess
- 02 Plan
- 03 Migrate
- 04 Optimize

01

Get results fast, for large volumes of Rehost & Replatform

02

Proven method to scale migration velocity

03

Leveraging automation, driven by IT/Cloud Operations teams

Discover & assess

Before beginning the migration, we assume a Cloud Maturity Assessment will have been completed, and you have an understanding of your organization's readiness for cloud adoption and current capabilities. This will help you determine your **default migration path** for each workload, and the required organisational changes to support your migration approach.

The path you take for each of your applications might differ from the default path, depending on the characteristics and strategy of the application that you're trying to migrate. The **application mapping to a migration path is the primary outcome for the assess phase**. Migration path categorization typically follows the Gartner-style "6 Rs" model, as outlined earlier.

We generally see large organisations Lift and Shift 70-80% of their workloads initially, focusing their transformation efforts on the areas where they can maximise impact; like moving a data warehouse to BigQuery, or refactoring an e-commerce platform for scale. Additionally, once workloads have moved to the cloud as part of a Lift and Shift, modifying it to leverage more cloud-native tooling later on becomes an easier task.

The assess phase will leverage automated discovery data, CMDB tools, and information from key stakeholders gathered through interviews and questionnaires.

Plan

We strongly recommend an agile approach to migration, so don't suggest building a detailed plan for the complete migration at the start. Our approach is to build a high-level timeline and effort estimation based on the data gathered during the initial assessment.

Workloads are clustered into groups based on their relative business value, dependencies between them, and the effort to migrate them. We determine the number of groups based on your organisation's appetite for change and desired migration velocity. And the outcome of the plan stage is not only a "migration ready" organization and technical infrastructure, but also a well defined migration backlog.

Foundational architecture

Prior to beginning migrations at scale, it is important to set up a cloud foundation or 'landing zone' which fulfills the migration requirements while following Google good practice. This foundation should be based on the controls defined within your Cloud Operating Model, remembering that the cloud offers new ways of achieving controls compared to typical on-premises environments. As an example, consider that security policies can be automatically enforced through scripted configuration and deployments. The areas we expect to be configured prior to migrations starting are sourced from the epics in the Google Cloud Adoption Framework, and include:



Organization - define GCP organizational structure, folder and project hierarchy, based on business units, development stages or geographies as appropriate.



Network - establish connectivity between clouds and on-prem. Define templates for how to connect and segregate resources.



IAM - setup identity and access management and define access policies.



Cost Management - set up billing accounts, define billing policies and reporting approach.



Infrastructure-as-code - define Multi-Cloud infrastructure as code approach, configure initial code/scripting for Cloud Deployment Manager or using Terraform.



CI/CD - define Multi-Cloud continuous integration / deployment toolset.



Operations - set up central monitoring and alerting or operations, and automated policy scanning.



Logging and Auditing - establish auditing approach and create audit projects.



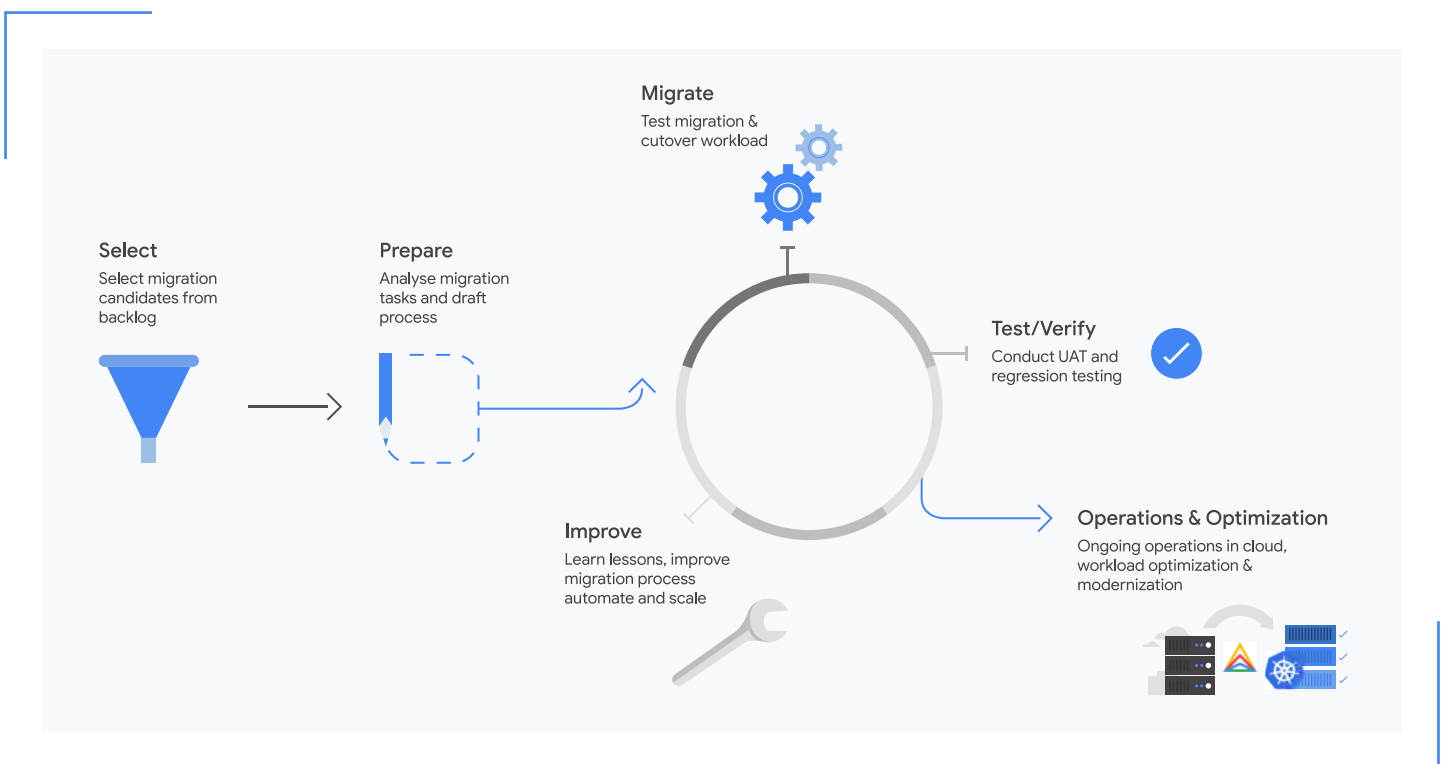
Secrets Management - setup central key management system and approach.

Migrate

Google has a variety of technologies to accelerate migration of workloads, with an emphasis on modernisation and transformation. Our 'Migration Factory' methodology works alongside tools such as [Migrate for Compute Engine](#), [Migrate for Anthos](#), and equivalent data tools. We seek to maximise value to the business through adoption of cloud, while minimising risk and complexity.

¹⁵[Migrating a Monolithic Application to Microservices](#)

We use the concept of the migration factory to address the challenge of executing a large migration where applications are predominantly rehosted or replatformed. It delivers a proven, scalable approach aligned to the Google Cloud Adoption Framework in order to migrate large amounts of workloads, at a high velocity, high-quality and minimal business impact.



One of the fundamental benefits of the factory approach combined with agile execution is the **constant improvement** both in tools and in process, this results in the most efficient execution model. This is appropriate for large volumes of refactoring or replatforming of applications.

Meanwhile, for applications that are planned for refactoring, our approach is one of 'breaking the monolith'¹⁵ - rather than simply rewriting applications to mimic existing functionality, we recommend taking a business use case approach and migrating individual features to a cloud-native microservices architecture. By taking small pieces of functionality, and small teams, the organisation develops an understanding of how to operate in the cloud. Once this has been proven, we recommend splitting this team and sharing knowledge, to iterate at scale.

Optimize

Migrating workloads is not a one-time activity with a final end state. Workloads should constantly be inspected and optimized for cost, performance and operational efficiency. Rehosted applications running on compute instances can be further rightsized or be later targets for refactoring; and monitoring and availability can be further enhanced taking advantage of cloud-native operations tooling and SRE principles.

As the organisation increases cloud maturity and gains experience, we typically see an evolution in the cloud operating model, encouraging greater adoption of platform services and a shift to modern development practices.

We're in it together

Now that you've learned more about how to make the move, how can you get started?

Most enterprises choose not to make this change alone, and instead seek to partner with a specialist organization to help in their datacenter transformation journey. At Google Cloud, we have a variety of ways to help you on your journey to cloud, including a broad and deep network of partners; our own specialist Professional Services Organization; comprehensive training and enablement, and solution documentation to answer any questions you might have.

Google Cloud partners

We have a network of thousands of trusted partners to help you move to, build, and work in the cloud. Partners with a Cloud Migration Specialization are vetted, certified, and have the technical know-how and track-record to help you make the journey to the cloud.

Our most successful deployments are delivered by partners, migrating and modernizing customer's data centers at massive scale and velocity. Partners also bring deep vertical understanding to help you go through a true digital transformation driven by innovation.

Many of our partners have built dedicated teams and innovation centers around GCP solutions that can be leveraged not just for the migration, but also for on-going managed services to ensure your business and technical goals are met.

Google Cloud professional services

Google Cloud Consulting services work hand in hand with you and with the Google Cloud partner(s) to educate your team on best practices and guiding principles for a successful data center transformation. We will bring our deep technical expertise and services to help you unlock business value from the cloud across a range of solutions, as well as offering consulting advice on how to adapt your business to best take advantage of the cloud. If you are primarily working with a partner, our Partner Success Services can provide you and your partner with Google's best practices and advisory services to give you peace of mind.

When you have a specific need for technical expertise, and a desire to leverage the best of Google knowledge sharing, our Professional Services offerings can deliver critical capabilities for your business. If your organization is leveraging bleeding-edge technology or extremely transformative technology partnerships, our PSO team can also support customers who push the envelope of possibilities. Our PSO teams can help your business go '10x'.

You're not alone

We see our customers and partners as part of a large and open community, and work together with them to discover new ways to solve important challenges. We see customers adopting Google Cloud to solve their most difficult problems, and to drive business value in new ways.

By moving your infrastructure to Google Cloud, you'll be joining these organizations and many others who are reducing technology costs, reinventing their organizational culture, and driving innovation.



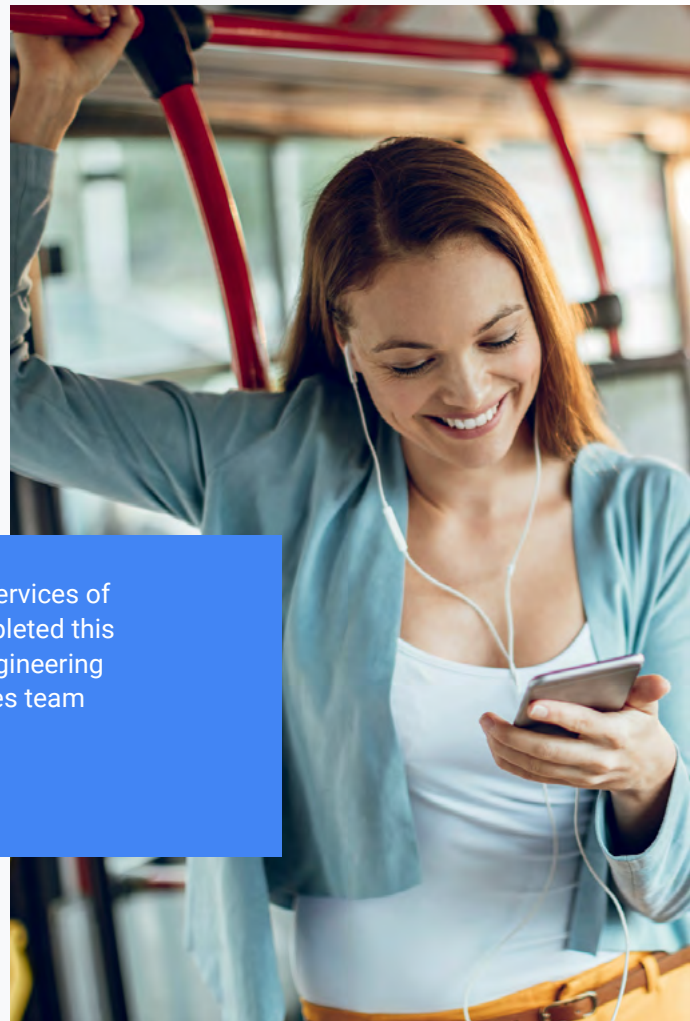
Open X is a leader in programmatic advertising, powering monetization and advertising revenue for publishers (i.e. websites, mobile apps, CTV and OTT apps, etc.) and providing highly targeted audiences for advertisers, brands, and agencies. They migrated **5 data centers in 10 months**, including:

- **12Pb** of data
- **10k+** virtual machines migrated to GCP
- **100+** applications containerised

“This was no simple lift-and-shift. We fully utilized the cloud-native services of Google Cloud to refactor and optimize the OpenX platform. We completed this unprecedented migration in record time due to a fantastic OpenX engineering team, as well as support from the Google Cloud Professional Services team and Google training and support.”

Paul T. Ryan, CTO, OpenX

As a result, they reduced time to market for new products and features by 50% through full CI/CD automation, utilised advanced AI capabilities to reduce costs to serve traffic by 35%, and enabled OpenX to launch new global regions almost instantaneously.



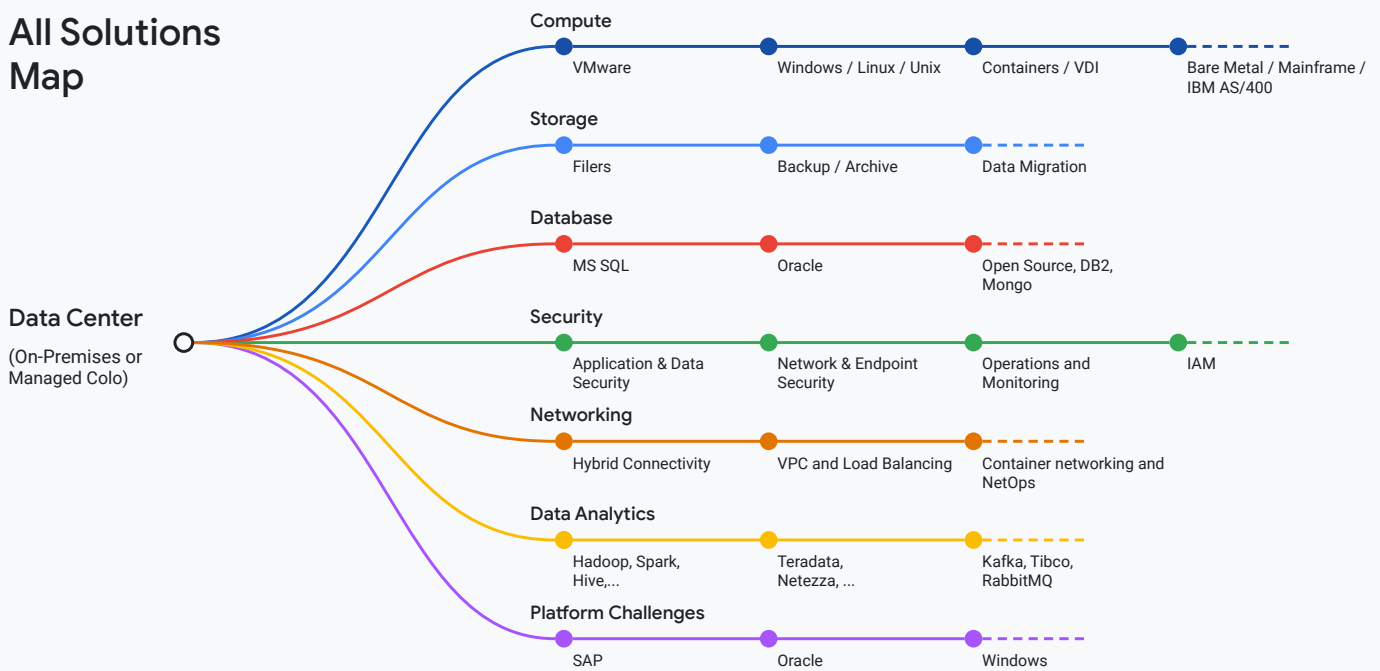
Where to go from here

At Google Cloud, we've defined paths forward for your IT assets, for your workloads and for your operating model as highlighted in this document with the Google Cloud Adoption Framework.

Path forward for your IT assets

Looking at the Data Center Transformation journey through the lens of IT assets, the following graphics represent the breadth of Google capabilities starting from a typical categorization. Each branch and leaf on this tree represent a potential technology, product, or solutions that Google can deliver to support landing those workloads on Google Cloud. Additional maps providing the next level of details are included in the appendix of this document.

All Solutions Map



Path forward for your workloads

Looking at the Data Center Transformation journey through the lens of key workloads, Google has put together specific solutions which are represented here.

| Infrastructure Modernization | Application Modernization | Data Management | Smart Analytics | AI | Security | Productivity & Collaboration |
|------------------------------|---|---|------------------------------|---------------------------------------|---------------------------------|--|
| VM Migration | Hybrid/Multi-cloud App Platform: Anthos | Enterprise Databases Migration (Oracle) | Data Warehouse Migration | Contact Center AI | Security Analytics & Operations | Work Transformation |
| VMWare as a Service | Mainframe Apps Modernization | Enterprise Databases Migration (MS SQL) | Data Lake Modernization | Build and Use Artificial Intelligence | Application Security | Modern End User Computing |
| SAP on GCP | New Business Channels using APIs | Database Modernization | Streaming Data Analytics | Document AI | Zero Trust | Care Transformation (Digital Experience) |
| Microsoft on GCP | Unlocking Legacy Apps via APIs | | Business Intelligence | | | |
| VDI Migration | Application Development & Delivery | | Data Warehouse Modernization | | | |
| Backup, DR & Archival | | | | | | |
| High-Performance Computing | | | | | | |
| Content Delivery | | | | | | |

So, what's next?

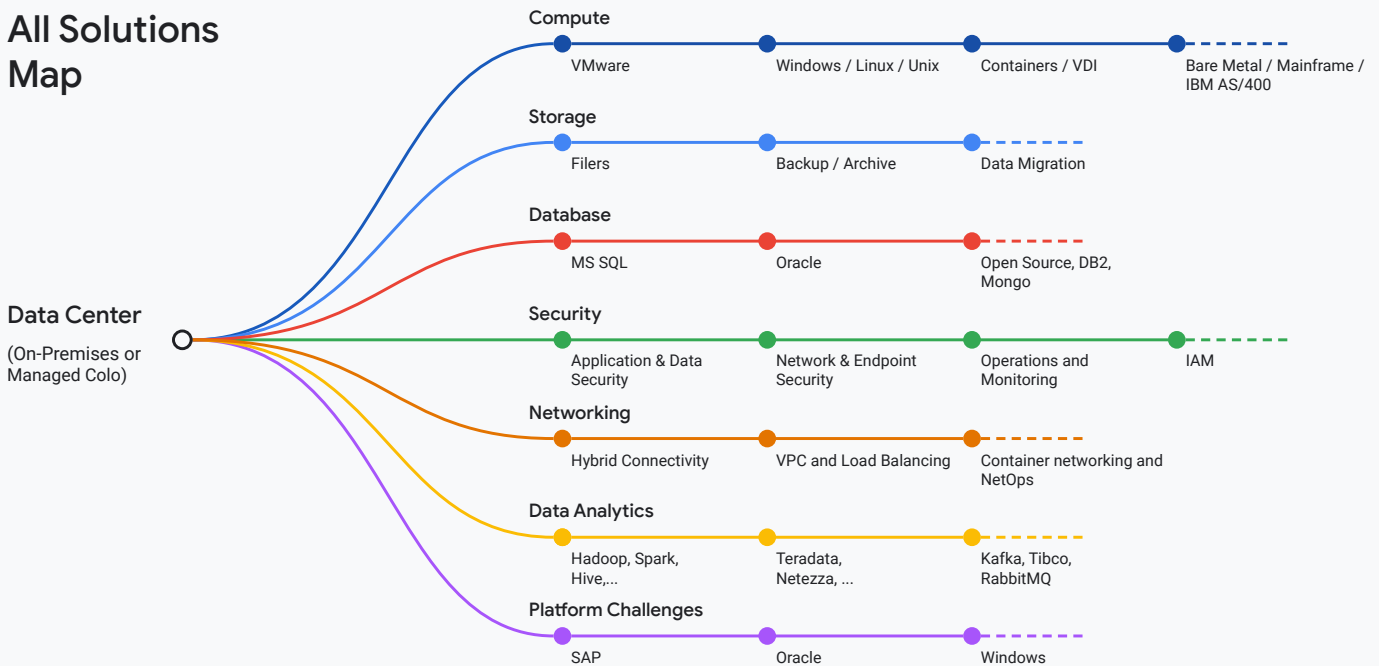
With the power of Google technology, innovation, and vision, we're here to help you succeed with cloud. We want to help our customers see cloud as more than a simple commodity but as a strategic element of their business, that not all clouds were created equal, and that the partnership that Google provides can take big ideas '10x'. Our next step together would consist in performing a joint assessment of your data center landscape.

Appendix A: Data center to Cloud asset maps

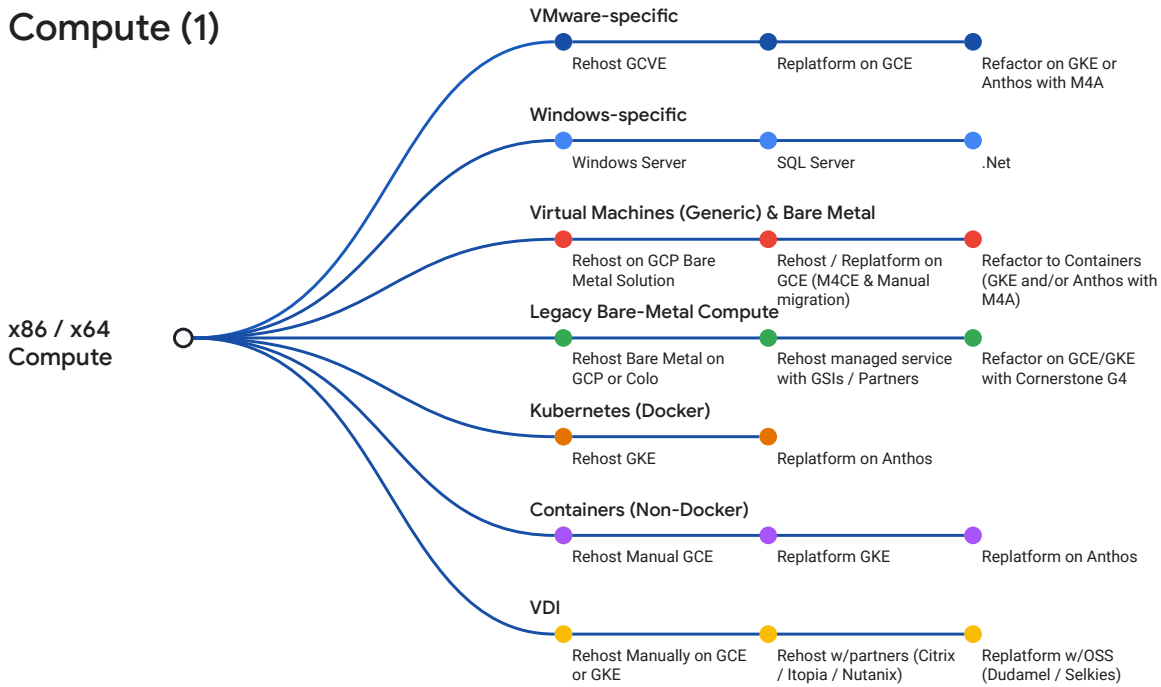
Google Cloud has the ability to support a wide range of data center technologies through the Lift and Shift of existing technology or the complete transformation to cloud-native services. Brownfield migration or Greenfield development, Google Cloud has you covered.

Starting with a high level look at data center technologies, and diving deeping into each category, the following maps show how Google Cloud’s solutions, products, services, and technologies can meet the needs of most data center workloads from Lift and Shift to true Service Transformation.

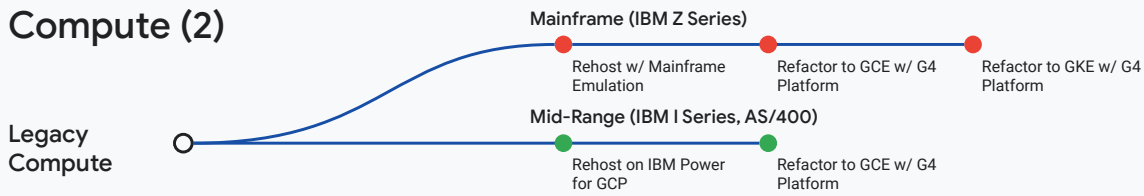
All Solutions Map



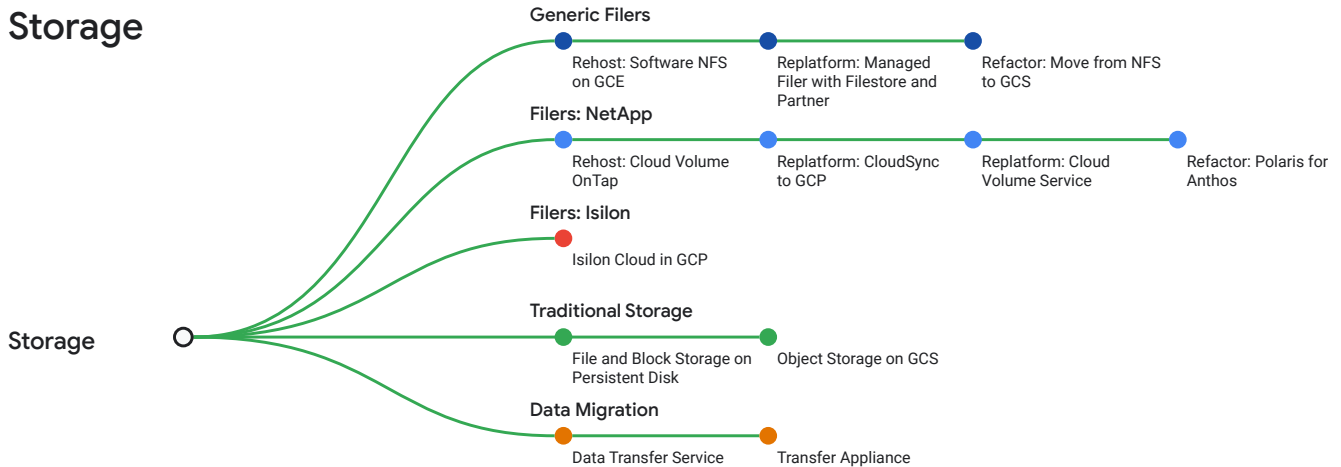
Compute (1)



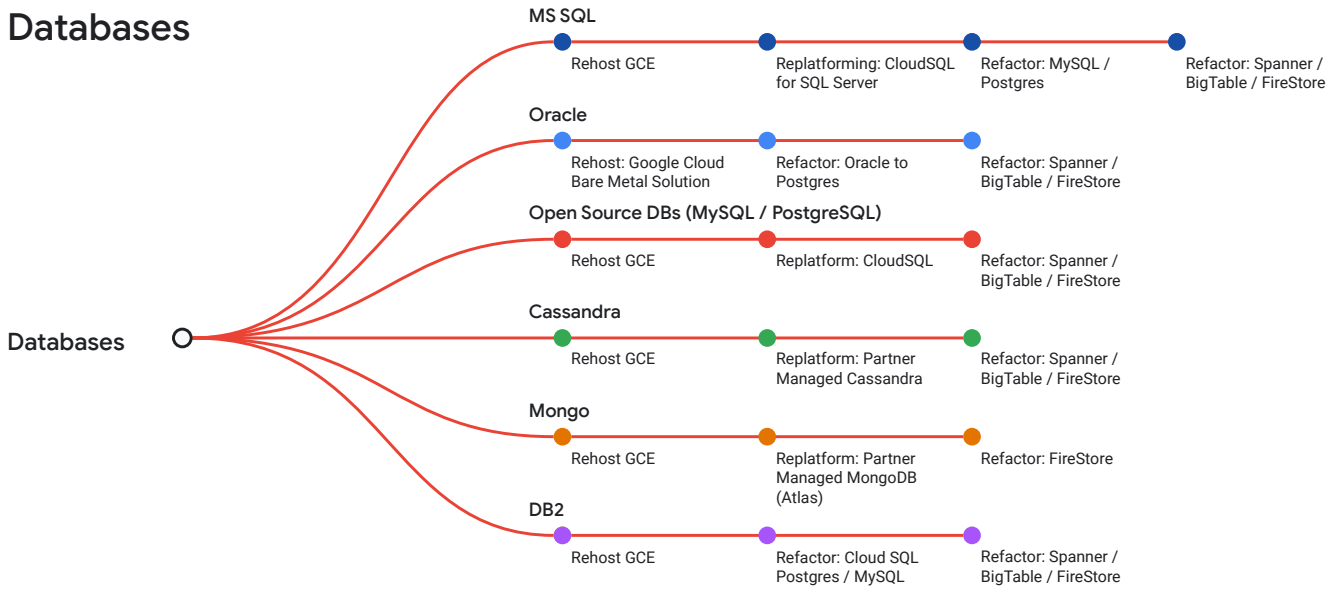
Compute (2)



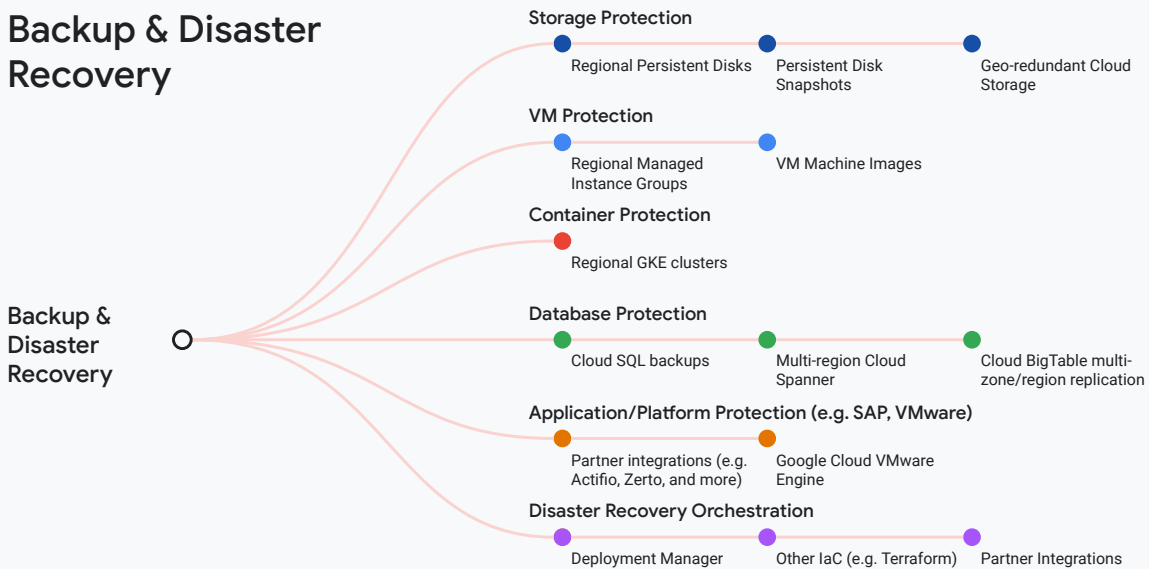
Storage



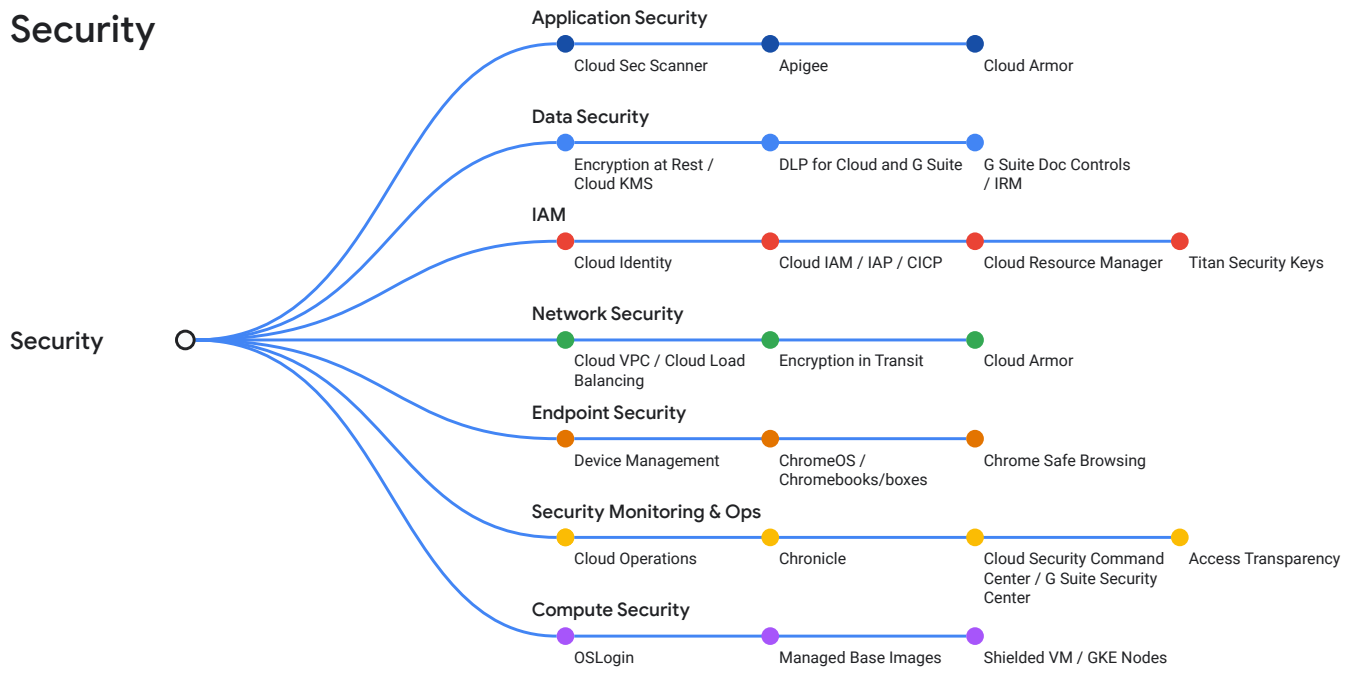
Databases



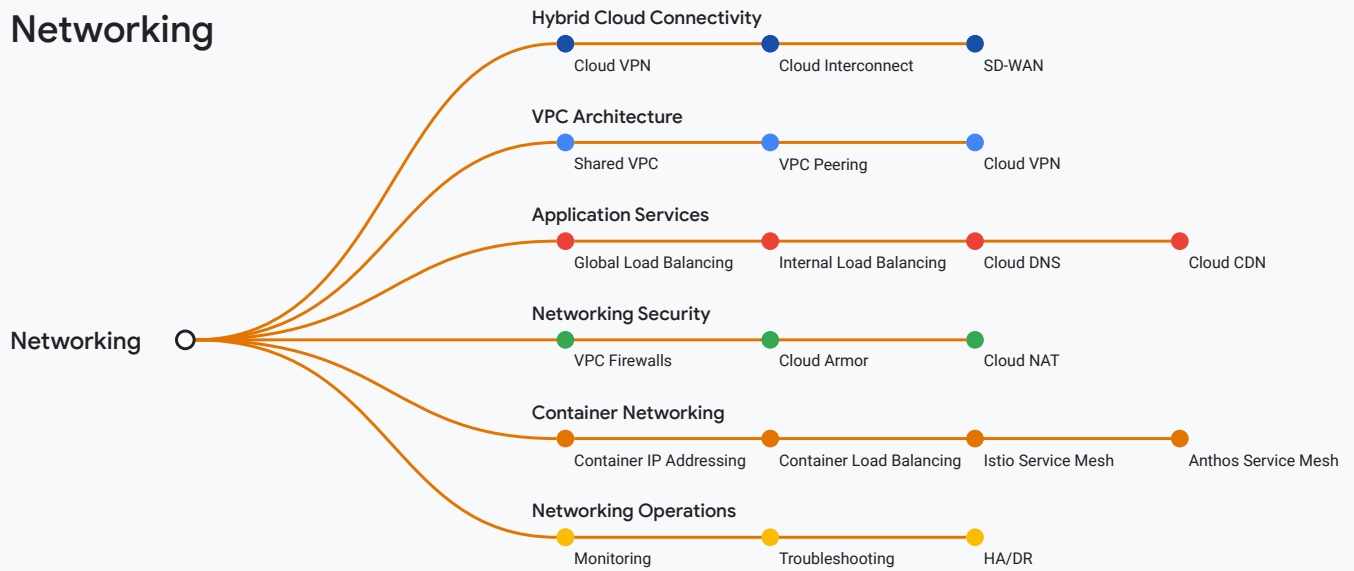
Backup & Disaster Recovery



Security

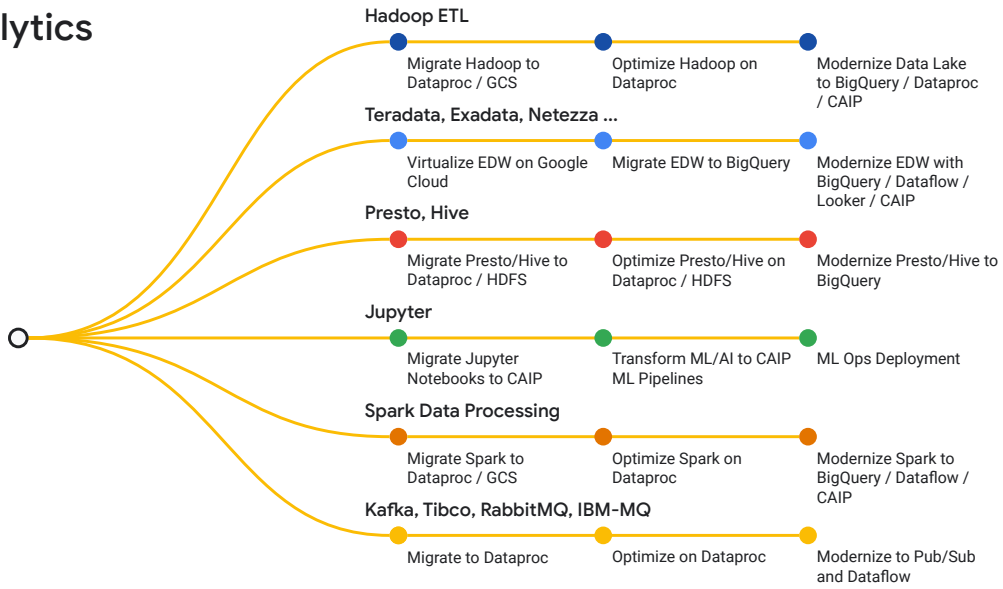


Networking



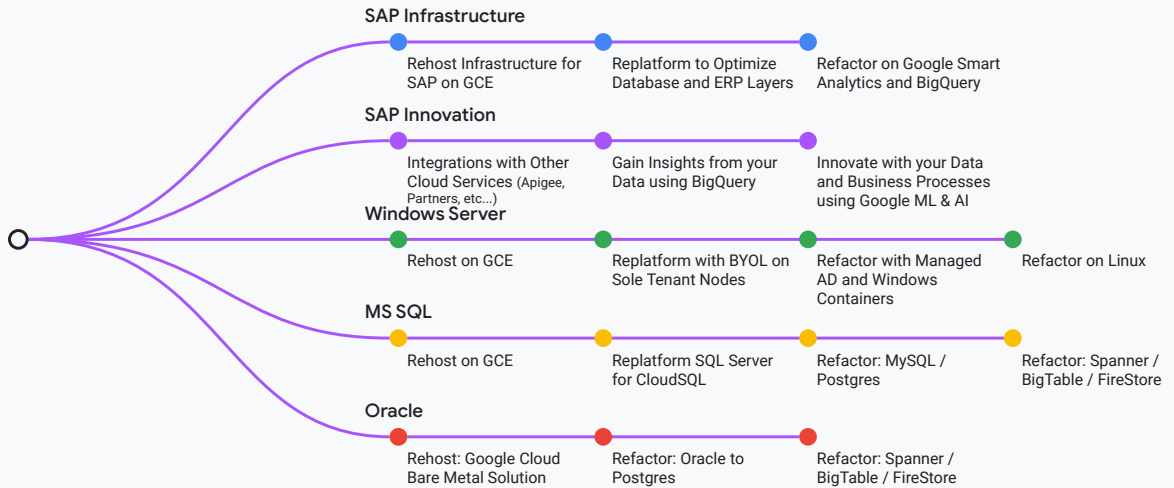
Data Analytics

Data Analytics



Platform Challenges

Template



Appendix B: Additional reading

A collection of assets for further reading.

| Type | Document |
|--------------------|--|
| Exec whitepaper | CIO's Guide to Application Migration |
| Exec whitepaper | Google Cloud Adoption Framework |
| Exec whitepaper | Building a Cloud Center of Excellence |
| Exec whitepaper | Building a Large Scale Migration Program with Google Cloud |
| Exec whitepaper | Managing Change in the Cloud |
| Tech Solution Docs | Migration - Getting Started |
| Tech Solution Docs | Migration - Discover & Assess |
| Tech Solution Docs | Migration - Building Foundations |
| Tech Solution Docs | Migration - Deploying workloads |
| Tech Solution Docs | Migrating data warehouses to BigQuery |

