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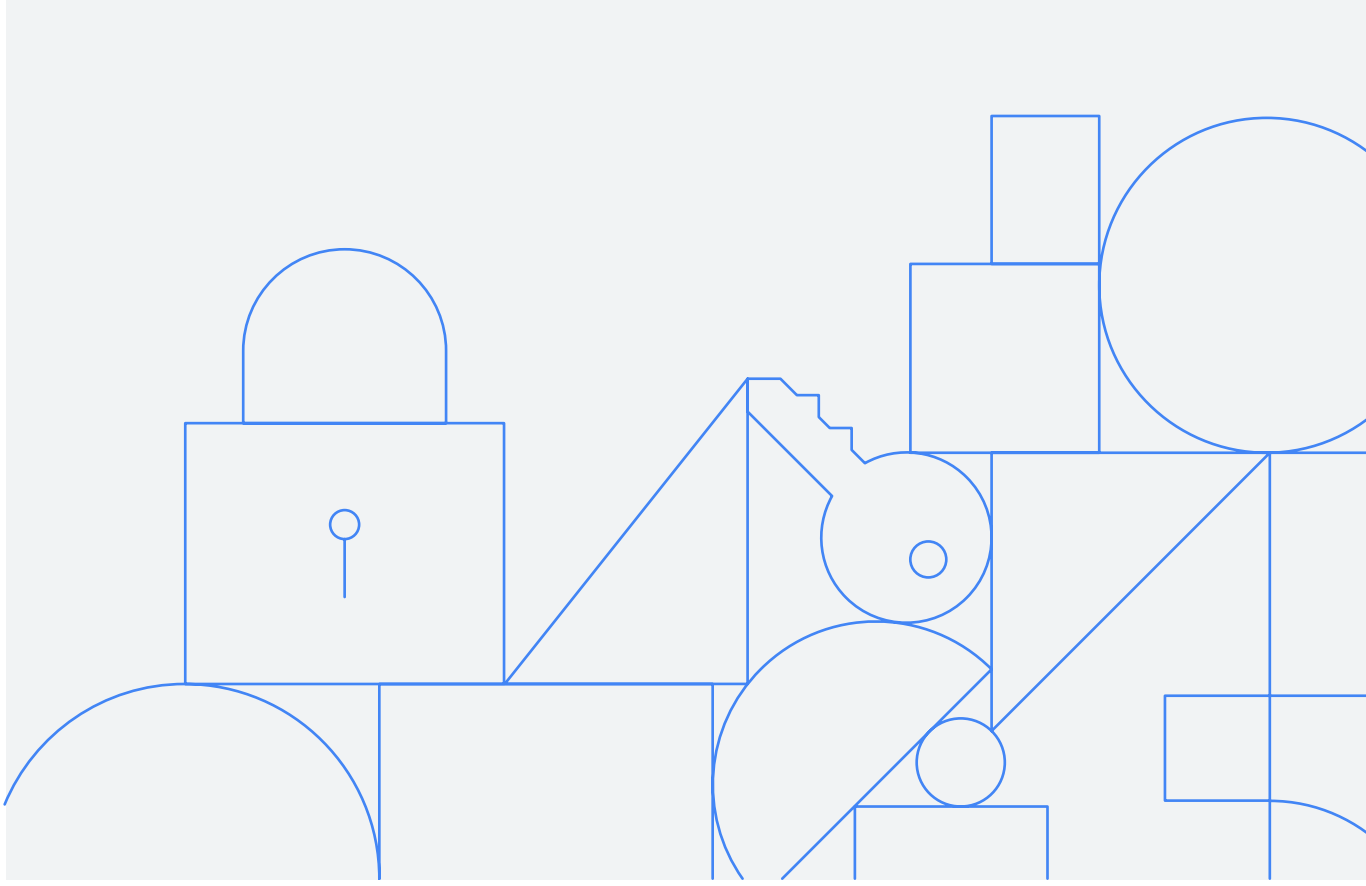
Google security whitepaper



Google Cloud

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Table of contents

Google Cloud

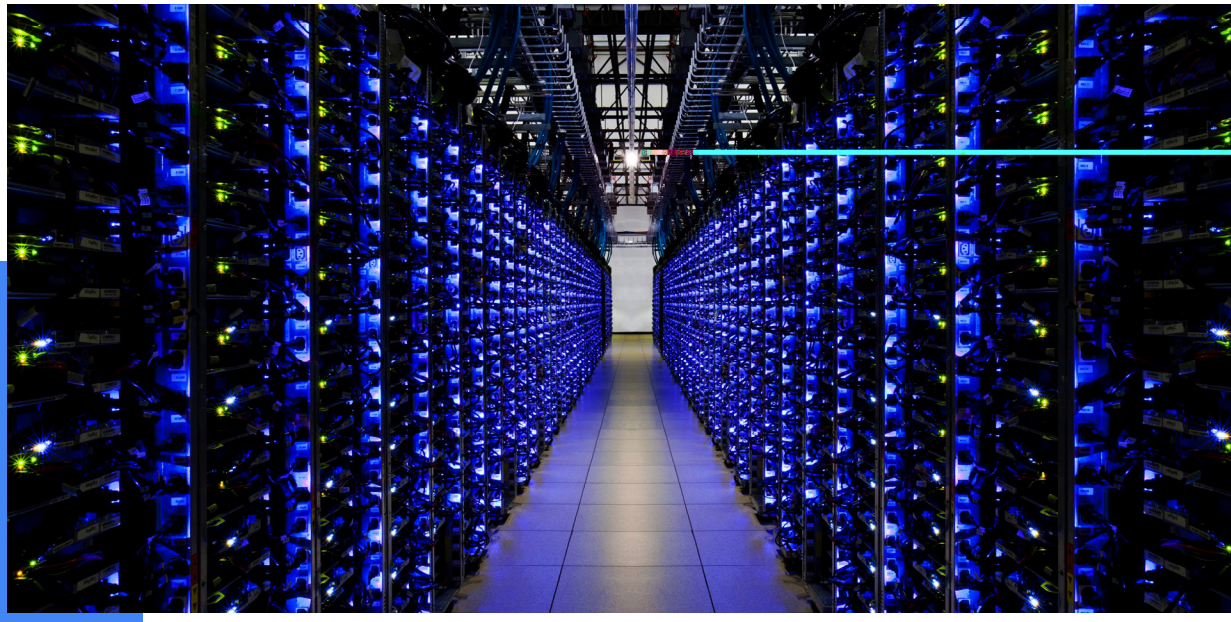
Table of contents

Introduction

Traditionally, organizations have looked to the public cloud for cost savings, or to augment private data center capacity. However, organizations are now primarily looking to the public cloud for security, realizing that providers can invest more in people and processes to deliver secure infrastructure.

As a cloud pioneer, Google fully understands the security implications of the cloud model. Our cloud services are designed to deliver better security than many traditional on-premises solutions. We make security a priority to protect our own operations, but because Google runs on the same infrastructure that we make available to our customers, your organization can directly benefit from these protections. That's why we focus on security, and protection of data is among our primary design criteria. Security drives our organizational structure, training priorities and hiring processes. It shapes our data centers and the technology they house. It's central to our everyday operations and disaster planning, including how we address threats. It's prioritized in the way we handle customer data. And it's the cornerstone of our account controls, our compliance audits and the certifications we offer our customers.

This paper outlines Google's approach to security and compliance for Google Cloud, our suite of public cloud products and services. This whitepaper focuses on security including details on organizational and technical controls regarding how Google protects your data. Details on compliance and how you can meet regulatory requirements are covered here.



Google's security culture

Google has created a vibrant and inclusive security culture for all employees. The influence of this culture is apparent during the hiring process, employee onboarding, as part of ongoing training and in company-wide events to raise awareness.

Employee background checks

Before they join our staff, Google will verify an individual's education and previous employment, and perform internal and external reference checks. Where local labor law or statutory regulations permit, Google may also conduct criminal, credit, immigration, and security checks. The extent of these background checks is dependent on the desired position.

Security training for all employees

All Google employees undergo security training as part of the orientation process and receive ongoing security training throughout their Google careers. During orientation, new employees agree to our Code of Conduct, which highlights our commitment to keep customer information safe and secure. Depending on their job role, additional training on specific aspects of security may be required. For instance, the information security team instructs new engineers on topics like secure coding practices, product design and automated vulnerability testing tools. Engineers also attend technical presentations on security-related topics and receive a security newsletter that covers new threats, attack patterns, mitigation techniques and more.

Internal security and privacy events

Google hosts regular internal conferences to raise awareness and drive innovation in security and data privacy, which are open to all employees. Security and privacy is an ever-evolving area, and Google recognizes that dedicated employee engagement is a key means of raising awareness. One example is “Privacy Week,” during which Google hosts events across global offices to raise awareness of privacy in all facets, from software development, data handling and policy enforcement to living our privacy principles. Google also hosts regular “Tech Talks” focusing on subjects that often include security and privacy.

Our dedicated security team

Google employs security and privacy professionals, who are part of our software engineering and operations division. Our team includes some of the world’s foremost experts in information, application and network security. This team is tasked with maintaining the company’s defense systems, developing security review processes, building security infrastructure and implementing Google’s security policies. Google’s dedicated security team actively scans for security threats using commercial and custom tools, penetration tests, quality assurance (QA) measures and software security reviews. Within Google, members of the information security team review security plans for all networks, systems and services. They provide project-specific consulting services to Google’s product and engineering teams. They monitor for suspicious activity on Google’s networks, address information security threats, perform routine security evaluations and audits, and engage outside experts to conduct regular security assessments. We specifically built a full-time team, known as Project Zero, that aims to prevent targeted attacks by reporting bugs to software vendors and filing them in an external database.

The security team also takes part in research and outreach activities to protect the wider community of Internet users, beyond just those who choose Google solutions. Some examples of this research would be the discovery of the POODLE SSL 3.0 exploit and cipher suite weaknesses. The security team also publishes security research papers, available to the public. The security team also organizes and participates in open-source projects and academic conferences.

Our dedicated privacy team

The Google privacy team operates separately from product development and security organizations, but participates in every Google product launch by reviewing design documentation and performing code reviews to ensure that privacy requirements are followed. They help release products that reflect strong privacy standards: transparent collection of user data and providing users and administrators with meaningful privacy configuration options, while continuing to be good stewards of any information stored on our platform. After products launch, the privacy team oversees automated processes that audit data traffic to verify appropriate data usage. In addition, the privacy team conducts research providing thought leadership on privacy best practices for our emerging technologies.

Internal audit and compliance specialists

Google has a dedicated internal audit team that reviews compliance with security laws and regulations around the world. As new auditing standards are created, the internal audit team determines what controls, processes, and systems are needed to meet them. This team facilitates and supports independent audits and assessments by third parties.

Collaboration with the security research community

Google has long enjoyed a close relationship with the security research community, and we greatly value their help identifying vulnerabilities in Google Cloud and other Google products. Our Vulnerability Reward Program encourages researchers to report design and implementation issues that may put customer data at risk, offering rewards in the tens of thousands of dollars. In Chrome, for instance, we warn users against malware and phishing, and offer rewards for finding security bugs.

Due to our collaboration with the research community, we've squashed more than 700 Chrome security bugs and have rewarded more than $1.25 million — more than $2 million has been awarded across Google's various vulnerability rewards programs. We publicly thank these individuals and list them as contributors to our products and services.

Operational security

Far from being an afterthought or the focus of occasional initiatives, security is an integral part of our operations.

Vulnerability management

Google administrates a vulnerability management process that actively scans for security threats using a combination of commercially available and purpose-built in-house tools, intensive automated and manual penetration efforts, quality assurance processes, software security reviews and external audits. The vulnerability management team is responsible for tracking and following up on vulnerabilities. Once a vulnerability requiring remediation has been identified, it is logged, prioritized according to severity, and assigned an owner. The vulnerability management team tracks such issues and follows up frequently until they can verify that the issues have been remediated. Google also maintains relationships and interfaces with members of the security research community to track reported issues in Google services and open-source tools. More information about reporting security issues can be found at Google Application Security.

Malware prevention

An effective malware attack can lead to account compromise, data theft, and possibly additional access to a network. Google takes these threats to its networks and its customers very seriously and uses a variety of methods to prevent, detect and eradicate malware. Google helps tens of millions of people every day to protect themselves from harm by showing warnings to users of Google Chrome, Mozilla Firefox and Apple Safari when they attempt to navigate to websites that would steal their personal information or install software designed to take over their computers. Malware sites or email attachments install malicious software on users' machines to steal private information, perform identity theft, or attack other computers. When people visit these sites,

software that takes over their computer is downloaded without their knowledge. Google's malware strategy begins with infection prevention by using manual and automated scanners to scour Google's search index for websites that may be vehicles for malware or phishing. Approximately one billion people use Google's Safe Browsing on a regular basis. Google's Safe Browsing technology examines billions of URLs per day looking for unsafe websites. Every day, we discover thousands of new unsafe sites, many of which are legitimate websites that have been compromised. When we detect unsafe sites, we show warnings on Google Search and in web browsers. In addition to our Safe Browsing solution, Google operates VirusTotal, a free online service that analyzes files and URLs enabling the identification of viruses, worms, trojans and other kinds of malicious content detected by antivirus engines and website scanners. VirusTotal's mission is to help in improving the antivirus and security industry and make the Internet a safer place through the development of free tools and services.

Google makes use of multiple antivirus engines in Gmail, Google Drive, servers and workstations to help identify malware that may be missed by antivirus signatures.

Monitoring

Google's security monitoring program is focused on information gathered from internal network traffic, employee actions on systems and outside knowledge of vulnerabilities. At many points across our global network, internal traffic is inspected for suspicious behavior, such as the presence of traffic that might indicate botnet connections. This analysis is performed using a combination of open-source and commercial tools for traffic capture and parsing. A proprietary correlation system built on top of Google technology also supports this analysis. Network analysis is supplemented by examining system logs to identify unusual behavior, such as attempted access of customer data. Google security engineers place standing search alerts on public data repositories to look for security incidents that might affect the company's infrastructure. They actively review inbound security reports and monitor public mailing lists, blog posts, and wikis. Automated network analysis helps determine when an unknown threat may exist and escalates to Google security staff, and network analysis is supplemented by automated analysis of system logs.

Incident management

We have a rigorous incident management process for security events that may affect the confidentiality, integrity, or availability of systems or data. If an incident occurs, the security team logs and prioritizes it according to its severity. Events that directly impact customers are assigned the highest priority. This process specifies courses of action, procedures for notification, escalation, mitigation, and documentation. Google's security incident management program is structured around the NIST guidance on handling incidents (NIST SP 800–61). Key staff are trained in forensics and handling evidence in preparation for an event, including the use of third-party and proprietary tools. Testing of incident response plans is performed for key areas, such as systems that store sensitive customer information. These tests take into consideration a variety of scenarios, including insider threats and software vulnerabilities. To help ensure the swift resolution of security incidents, the Google security team is available 24/7 to all employees. If an incident involves customer data, Google or its partners will inform the customer and support investigative efforts via our support team. We outline Google's end-to-end data incident response process in our whitepaper.

Technology with security at its core

Google Cloud runs on a technology platform that is conceived, designed and built to operate securely. Google is an innovator in hardware, software, network and system management technologies. We custom-designed our servers, proprietary operating system, and geographically distributed data centers. Using the principles of "defense in depth," we've created an IT infrastructure that is more secure and easier to manage than more traditional technologies.

State-of-the-art data centers

Google's focus on security and protection of data is among our primary design criteria. Google data center physical security features a layered security model, including safeguards like custom-designed electronic access cards, alarms, vehicle access barriers, perimeter fencing, metal detectors, and biometrics, and the data center floor features laser beam intrusion detection. Our data centers are monitored 24/7 by high-resolution interior and exterior cameras that can detect and track intruders. Access logs, activity records, and camera footage are available in case an incident occurs. Data centers are also routinely patrolled by experienced security guards who have undergone rigorous background checks and training. As you get closer to the data center floor, security measures also increase. Access to the data center floor is only possible via a security corridor which implements multi-factor access control using security badges and biometrics. Only approved employees with specific roles may enter. Less than one percent of Googlers will ever set foot in one of our data centers.

Powering our data centers

To keep things running 24/7 and ensure uninterrupted services, Google's data centers feature redundant power systems and environmental controls. Every critical component has a primary and alternate power source, each with equal power. Diesel engine backup generators can provide enough emergency electrical power to run each data center at full capacity. Cooling systems maintain a constant operating temperature for servers and other hardware, reducing the risk of service outages. Fire detection and suppression equipment helps prevent damage to hardware. Heat, fire, and smoke detectors trigger audible and visible alarms in the affected zone, at security operations consoles, and at remote monitoring desks.

Environmental impact

Google reduces the environmental impact of running our data centers by designing and building our own facilities. We install smart temperature controls, use "free-cooling" techniques like using outside air or reused water for cooling, and redesign how power is distributed to reduce unnecessary energy loss. To gauge improvements, we calculate the performance of each facility using comprehensive efficiency measurements. We're the first major

Internet services company to gain external certification of our high environmental, workplace safety and energy management standards throughout our data centers. Specifically, we received voluntary ISO 50001 certification and incorporated our own protocols to go beyond standards.

Custom server hardware and software

Google's data centers house energy-efficient, custom, purpose-built servers and network equipment that we design and manufacture ourselves. Unlike much commercially available hardware, Google servers don't include unnecessary components such as video cards, chipsets, or peripheral connectors, which can introduce vulnerabilities. Our production servers run a custom-designed operating system (OS) based on a stripped-down and hardened version of Linux. Google's servers and their OS are designed for the sole purpose of providing Google services. Server resources are dynamically allocated, allowing for flexibility in growth and the ability to adapt quickly and efficiently, adding or reallocating resources based on customer demand. This homogeneous environment is maintained by proprietary software that continually monitors systems for binary modifications. If a modification is found that differs from the standard Google image, the system is automatically returned to its official state. These automated, self-healing mechanisms are designed to enable Google to monitor and remediate destabilizing events, receive notifications about incidents, and slow down potential compromise on the network.

Hardware tracking and disposal

Google meticulously tracks the location and status of all equipment within our data centers from acquisition to installation to retirement to destruction, via barcodes and asset tags. Metal detectors and video surveillance are implemented to help make sure no equipment leaves the data center floor without authorization. If a component fails to pass a performance test at any point during its lifecycle, it is removed from inventory and retired. Google hard drives leverage technologies like FDE (full disk encryption) and drive locking, to protect data at rest. When a hard drive is retired, authorized individuals verify that the disk is erased by writing zeros to the drive and performing a multiple-step verification process to ensure the drive contains no data. If the drive cannot be erased for any reason, it is stored securely until it can be physically destroyed. Physical destruction of disks is a multistage process beginning with a crusher that deforms the drive, followed by a shredder that breaks the drive into small pieces, which are then recycled at a secure facility. Each data center adheres to a strict disposal policy and any variances are immediately addressed. We outline Google's end-to-end data deletion process in our whitepaper.

A global network with unique security benefits

Google's IP data network consists of our own fiber, public fiber, and undersea cables. This allows us to deliver highly available and low latency services across the globe.

In other cloud services and on-premises solutions, customer data must make several journeys between devices, known as “hops,” across the public Internet. The number of hops depends on the distance between the customer’s ISP and the solution’s data center. Each additional hop introduces a new opportunity for data to be attacked or intercepted. Because it’s linked to most ISPs in the world, Google’s global network improves the security of data in transit by limiting hops across the public Internet.

Defense in depth describes the multiple layers of defense that protect Google’s network from external attacks. Only authorized services and protocols that meet our security requirements are allowed to traverse it; anything else is automatically dropped. Industry-standard firewalls and access control lists (ACLs) are used to enforce network segregation. All traffic is routed through custom GFE (Google Front End) servers to detect and stop malicious requests and distributed denial-of-service (DDoS) attacks. Additionally, GFE servers are only allowed to communicate with a controlled list of servers internally; this “default deny” configuration prevents GFE servers from accessing unintended resources. Logs are routinely examined to reveal any exploitation of programming errors. Access to networked devices is restricted to authorized personnel.

Securing data in transit

Data is vulnerable to unauthorized access as it travels across the Internet or within networks. For this reason, securing data in transit is a high priority for Google. The Google Front End (GFE) servers mentioned previously support strong encryption protocols such as TLS to secure the connections between customer devices and Google's web services and APIs. Cloud customers can take advantage of this encryption for their services running on Google Cloud Platform by using the Google Cloud Load Balancing. Google Cloud Platform also offers customers additional transport encryption options, including Google Cloud VPN for establishing IPSec virtual private networks. Our encryption in transit whitepaper and application layer transport security whitepaper provide more in-depth information on this topic.

Low latency and highly available solution

Google designs the components of our platform to be highly redundant. This redundancy applies to our server design, how we store data, network and Internet connectivity, and the software services themselves. This “redundancy of everything” includes the handling of errors by design and creates a solution that is not dependent on a single server, data center, or network connection. Google’s data centers are geographically distributed to minimize the effects of regional disruptions on global products such as natural disasters and local outages. In the event of hardware, software, or network failure, platform services and control planes are automatically and instantly shifted from one facility to another so that platform services can continue without interruption. Google’s highly redundant infrastructure also helps customers protect themselves from data loss. Google Cloud Platform resources can be created and deployed across multiple regions and zones. Allowing customers to build resilient and highly available systems.

Our highly redundant design has allowed Google to achieve an uptime of 99.984% for Gmail for the last years with no scheduled downtime. Simply put, when Google needs to service or upgrade our platform, users do not experience downtime or maintenance windows.

Service availability

Some of Google's services may not be available in some jurisdictions. Often these interruptions are temporary due to network outages, but others are permanent due to government-mandated blocks. Google's Transparency Report also shows recent and ongoing disruptions of traffic to Google products. We provide this data to help the public analyze and understand the availability of online information.

Independent third-party certifications

Google Cloud provides a number of third-party certifications, detailed here.

Data usage

Our philosophy

Google Cloud customers own their data, not Google. The data that customers put into our systems is theirs, and we do not scan it for advertisements nor sell it to third parties. We offer our customers a detailed data processing amendment for GCP and G Suite both of which describe our commitment to protecting customer data. It states that Google will not process data for any purpose other than to fulfill our contractual obligations. Furthermore, if customers delete their data, we commit to deleting it from our systems within 180 days. Finally, we provide tools that make it easy for customers to take their data with them if they choose to stop using our services, without penalty or additional cost imposed by Google. Read our Trust Principles to learn more about Google Cloud's philosophy and commitments to customers.

Data access and restrictions

Administrative access

To keep data private and secure, Google logically isolates each customer's data from that of other customers and users, even when it's stored on the same physical server. Only a small group of Google employees have access to customer data. For Google employees, access rights and levels are based on their job function and role, using the concepts of least-privilege and need-to-know to match access privileges to defined responsibilities. Google employees are only granted a limited set of default permissions to access company resources, such as employee email and Google's internal employee portal. Requests for additional access follow a formal process that involves a request and an approval from a data or system owner, manager, or other executives, as dictated by Google's security policies. Approvals are managed by workflow tools that maintain audit records of all changes. These tools control both the modification of authorization settings and the approval process to ensure consistent application of the approval policies. An employee's authorization settings are used to control access to all resources, including data and systems for Google Cloud products. Support services are only provided to authorized customer administrators whose identities have been verified in several ways. Googler access is monitored and audited by our dedicated security, privacy, and internal audit teams, and we provide audit logs to customers through Access Transparency for GCP.

For customer administrators

Within customer organizations, administrative roles and privileges for Google Cloud are configured and controlled by the project owner. This means that individual team members can manage certain services or perform specific administrative functions without gaining access to all settings and data.

Law enforcement data requests

The customer, as the data owner, is primarily responsible for responding to law enforcement data requests; however, like other technology and communications companies, Google may receive direct requests from governments and courts around the world about how a person has used the company's services. We take measures to protect customers' privacy and limit excessive requests while also meeting our legal obligations. Respect for the privacy and security of data you store with Google remains our priority as we comply with these legal requests. When we receive such a request, our team reviews the request to make sure it satisfies legal requirements and Google's policies. Generally speaking, for us to comply, the request must be made in writing, signed by an authorized official of the requesting agency and issued under an appropriate law. If we believe a request is overly broad, we'll seek to narrow it, and we push back often and when necessary.

For example, in 2006 Google was the only major search company that refused a U.S. government request to hand over two months of user search queries. We objected to the subpoena, and eventually a court denied the government's request. In some cases we receive a request for all information associated with a Google account, and we may ask the requesting agency to limit it to a specific product or service. We believe the public deserves to know the full extent to which governments request user information from Google. That's why we became the first company to start regularly publishing reports about government data requests. Detailed information about data requests and Google's response to them is available in our Transparency Report and government requests whitepaper. It is Google's policy to notify customers about requests for their data unless specifically prohibited by law or court order.

Third-party suppliers

Google directly conducts virtually all data processing activities to provide our services. However, Google may engage some third-party suppliers to provide services related to Google Cloud, including customer and technical support. Prior to onboarding third-party suppliers, Google conducts an assessment of the security and privacy practices of third-party suppliers to ensure they provide a level of security and privacy appropriate to their access to data and the scope of the services they are engaged to provide. Once Google has assessed the risks presented by the third-party supplier, the supplier is required to enter into appropriate security, confidentiality, and privacy contract terms.

Regulatory compliance

Our customers have varying regulatory compliance needs. Our clients operate across regulated industries, including finance, pharmaceutical and manufacturing.

Our most up-to-date compliance information is available here.

Conclusion

The protection of your data is a primary design consideration for all of Google's infrastructure, products and personnel operations. Our scale of operations and collaboration with the security research community enable Google to address vulnerabilities quickly or prevent them entirely.

We believe that Google can offer a level of protection that very few public cloud providers or private enterprise IT teams can match. Because protecting data is core to Google's business, we can make extensive investments in security, resources and expertise at a scale that others cannot. Our investment frees you to focus on your business and innovation. Data protection is more than just security. Google's strong contractual commitments make sure you maintain control over your data and how it is processed, including the assurance that your data is not used for advertising or any purpose other than to deliver Google Cloud services.

For these reasons and more, over five million organizations across the globe, including 64 percent of the Fortune 500, trust Google with their most valuable asset: their information. Google will continue to invest in our platform to allow you to benefit from our services in a secure and transparent manner.