IBM Public Cloud - A responsible.computing() provider

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Author Profile

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Prior to his current role, Michel was responsible for accelerating the digital transformation journey of major clients, supporting them to adopt full cloud packages, and running security and application migrations such as SAP and Oracle.

Before joining IBM, Michel spent fifteen years working closely with clients in their infrastructure and Internet services across a variety of industries such oil and gas, and capital markets. He holds an MBA from IE University Spain and a Diplôme d'Ingénieur from USJ Beirut.

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Executive Summary

Cloud is one of many disruptive technologies that organizations, even in regulated industries, are embracing. Organizations and governments are under constant pressure to demonstrate capabilities that are sustainable while serving the good of society and the planet.

IBM continues to heavily invest through IBM Research and IBM Systems to provide technologies that are sustainable for the future, consume less in raw materials and are more operationally efficient. The most recent and significant breakthroughs announced by IBM were the creation of a 2 nanometer computer processor chip in May 2021, IBM z16 platform in April 2022, IBM LinuxONE Emperor 4 in September 2022, and IBM's new Artificial Intelligence Unit (AIU) processor in October 2022.

IBM has been a pioneer in the technology industry to serve communities and to make a positive impact on society and on the planet. IBM characterizes this practice as "Good Tech" and it is centered on promoting innovation while protecting data privacy and enabling trust.

The responsible.computing() initiative acknowledges the fact that while technology can be used for good it also has an impact that cannot be ignored, and that impact comes in many shapes and forms. responsible.computing() is a holistic approach to the modern challenges around computing. It integrates aspects of sustainability, climate, ethics, openness, privacy and security.

In the case of IBM Cloud, the aim is to prove that a secure cloud can be open and hybrid and that a LinuxOne system can combine high security while preserving energy efficiency. A few years ago, a combination of these aspects was considered hard to achieve. We are shaping ways to restore trust in IT by responsibly applying technology and by sharing our experience with others.

Initiative Introduction

In an era where technology is pivotal in shaping politics, digital economies and transitional industries such as the automotive industry, the responsible.computing() framework expands beyond just sustainability and climate change and adds other domains such as ethics, security and openness. The framework consists of six domains of focus that demonstrate how IBM reflects responsibility:

- Data Center: Reducing the environmental impact of building and maintaining data centers
- Infrastructure: Taking an end-to-end approach into the lifecycle of computing units such as sourcing precious and rate metals and reducing their usage, reducing energy and computing units, and ultimately recycling the units
- Code: writing efficient, open and secure code
- Data usage: Implementing data privacy and transparency practices and requesting consent for use and authorization for any data acquisition
- Systems: Producing ethical and unbiased systems including explainable AI
- Impact: Addressing societal issues such as social mobility

This paper looks to provide more information and share examples of how IBM public cloud is a responsible computing provider using the above framework.

I – responsible.computing(data center)

Natural resources

responsible.computing(data center) considers the potential impact on the environment of an advanced modern data center. The energy consumption, impact on CO2 emissions, use of toxic materials and rare metals is a special focus area when evaluating which data center is the best for your systems.

Data centers consume tremendous amounts of electricity, accounting for as much as 1.5% of the world's energy use[i]. IBM Cloud is available in over 46 data centers, nine regions and 27 availability zones globally[ii]. While it is hosting 47 of the Fortune 50 companies, IBM Cloud is taking measures to reduce environmental impacts in its data centers, as outlined below.

Energy efficiency

In 2021, IBM's weighted average PUE is 1.53[iii] which puts IBM on track to achieve the goal to improve the average cooling efficiency of data centers by 20% by 2025 against a base year of 2019. PUE is the ratio of the total energy consumed by the data center, divided by the energy consumed by the IT equipment:

PUE = Total energy entering the datacenter / Energy used by IT equipment inside the datacenter

The closer the value is to 1 (where 100% of electricity consumption goes toward useful computation), the more efficient the cooling delivery.

In Europe, 39 IBM data centers in 18 countries are registered under the EU Code of Conduct for Energy Efficiency in Data Centres.[iv].

In the US, IBM is part of the U.S. Environmental Protection Agency's ENERGY STAR® and The Green Grid (industry collaboration) data center energy efficiency initiatives. These initiatives have established recommended operating criteria and metrics that inform and encourage data center operators and owners to reduce energy consumption in a cost-effective manner without compromising the objectives of mission-critical operations.

Renewable energy

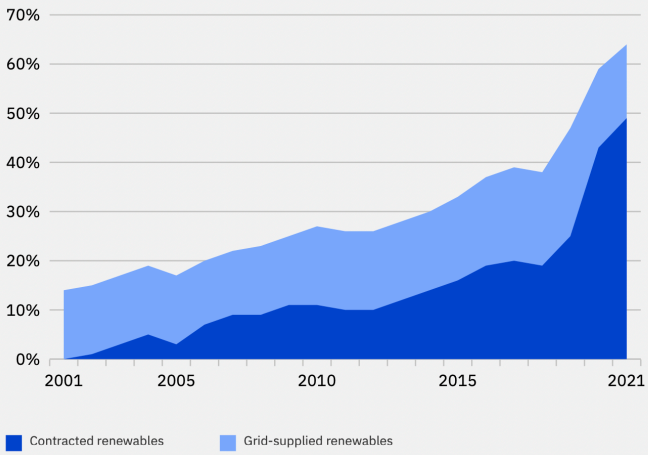
In February 2021, IBM established its third-generation renewable electricity procurement goal: to procure 75% of the electricity IBM consumes worldwide from renewable sources by 2025, and 90% by 2030[v].

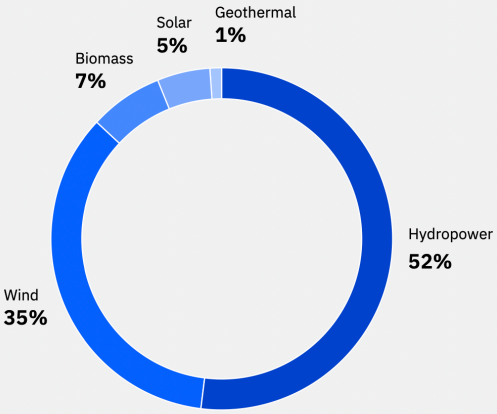
In 2021, 67% of the electricity consumed in IBM data centers came from renewable sources, including both contracted and grid-supplied, up from 61% in 2020[vi].

In the UK, IBM Cloud already uses a network of data centers that are powered 100% by renewable electricity. Additionally, in Spain IBM built a new cloud Multizone Region (MZR) that is also supplied by renewable electricity.

IBM procures renewable electricity generated from wind, hydropower, biomass, solar and geothermal installations around the globe in an approach that recognizes that all sources of renewable electricity contribute to decarbonizing the global economy.

Use of renewable electricity as percent of global electricity consumption, and by source (2021)



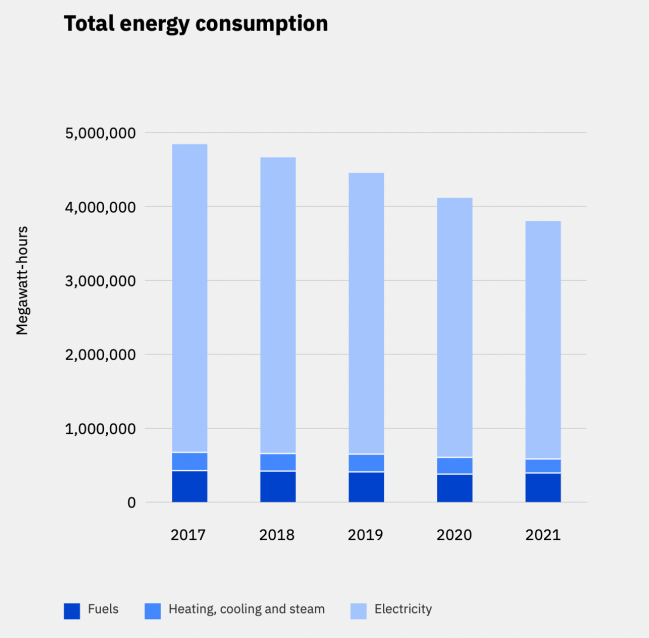


GHG emissions reductions

Clients on IBM Cloud can request reports on their associated greenhouse gas (GHG) emissions derived from cloud services and solutions. In addition to the GHG emissions, the report provides a summary of the estimated electricity consumption, including from renewable sources.

IBM began reporting its CO2 emissions in 1995. In February 2021, it announced an aim to reach net-zero greenhouse-gas emissions by 2030, with a target of 65% lower emissions by 2025 from 2010 levels[vii]. The latest ESG report addendum[viii], shows a 61.6% GHG reduction achieved in 2021 against base year 2010.

These reductions occurred primarily due to an increase in renewable electricity purchases, lower energy consumption, and IBM's continued focus on energy conservation.



IBM Cloud Carbon Calculator

IBM Cloud is working closely with IBM Research to execute programs and activities aimed at reducing carbon emissions and increasing overall energy efficiency of IBM Cloud data centers worldwide. IBM Research is building a solution to help estimate the carbon footprint of customer workloads, particularly running in a multi-tenant environment, whether on IBM Cloud, in hybrid cloud environments or on-prem data centers.

One major feature that will become available to the IBM Cloud clients in 2023 is the Carbon Calculator, a tool that provides insights into carbon emissions associated with their use of IBM cloud. The IBM Cloud Carbon Calculator can provide an AI-informed dashboard giving immediate access to standards-based emissions data for multiple types of workloads and locations, down to the individual cloud service. This enables users to mitigate emissions, fulfill compliance requirements, and meet shareholder expectations. The Carbon Calculator helps identify potential energy and CO2 emission “hot-spots” over time – which in turn are opportunities for reducing carbon footprint. The tool can also generate auditable data for carbon emission reports mandated by regulatory authorities. For IBM Cloud customers who need detailed analysis and reporting on cloud carbon emissions together with their other estates, the carbon calculator integrates with IBM Envizi to unify analytics and reporting.

Cloud at the Edge

Gartner estimated that by 2025, 75% of enterprise data will be processed at the edge, outside a traditional centralized data center or cloud[ix]. IBM plays a key role in edge computing that relies on edge devices such as IoT devices to process data. This is where enterprise applications move closer to data generation sources and therefore edge computing provides improved processing and response times, better bandwidth availability and increased privacy of personal and sensitive

information. In January 2021 IBM launched the Cloud Satellite which enables clients to process and analyse data closer to the point of data creation, while also taking advantage of IBM Cloud services.

Quantum Computing

While Quantum computers are very energy efficient, they currently require significant investment to build, set up and operate – and exhibit short innovation and update cycles. Thus, access to dedicated systems can be cost challenging today. IBM has addressed this by providing IBM Quantum Services which are secure, portable, containerized runtime and programming tools to access the latest world-leading cloud-based quantum systems and simulators via the IBM Cloud. IBM's commitment to achieving quantum advantage includes doubling quantum volume (QV) every year[x]. QV is a hardware-agnostic metric that IBM defined to take into account the number of qubits, connectivity, as well as gate and measurement errors. IBM now hosts various quantum computing systems – many are available for free on IBM Cloud, while some are exclusively available to members of the IBM Q Network.

IBM has democratized access via the IBM Q Network to industry collaborators, including our 140+ community of Fortune 500 companies, academic institutions, national labs, and startups, to solve problems previously unsolvable through classical computing paradigms. These organizations join over 200,000 users who have run hundreds of billions of executions on IBM's quantum systems and simulators through the IBM Cloud, allowing them the ability to tackle challenging problems across finance, materials, logistics, and chemistry in ways never imagined before.

IBM has taken an Open Quantum Software Ecosystem approach to Quantum computing both by spearheading and participating in various supporting OpenSource initiatives such as OpenQASM3 assembly language, Qiskit, an open source software development kit (SDK) for working with OpenQASM and the *IBM* Q quantum processors, as well as releasing an open roadmap[xi] for scaling quantum technology — to transition from small-scale devices to million qubit devices in the near future.

IBM Research[xii] is also addressing some of the most pressing societal use cases through Quantum Computing, combining its differentiating strengths across Quantum Computing and AI to enable our collective sustainable future. These range from focussing on next-generation batteries to address the surging global electricity demands, to the creation of more sustainable gadgets, to the creation of new catalysts to 'fix' nitrogen and produce more efficient artificial fertilizers with less environmental impact to support the growing world population needs, and finally the creation of a cloud-based knowledge base of methods and materials for capturing CO2 emitted by industrial plants and furthuring its research application in slowing down climate change.

II – responsible.computing(infrastructure)

If data centers are the cloud computing “home”, the infrastructure is the “family” residing within. responsible.computing (infrastructure) considers the Environmental, Social and Governance (ESG) aspects of the hardware, software and network devices. It provides an actionable framework to reduce waste and consumption of these devices.

Product Design for the Environment (DfE)

In addition to its long-standing corporate policies for protecting the environment and conserving energy and natural resources, in 1991 IBM established the Product Design for the Environment (DfE) Stewardship program to focus on product environmental design and performance. The IBM Product Design for the Environment program is incorporated into IBM's worldwide Environmental Management System (EMS) which is certified to the ISO 14001 EMS standard. Information on product environmental attributes such as energy efficiency, materials content, chemical emissions, design for recycling, end-of-life management, and packaging are documented in IBM’s Product Environmental Profile (PEP) tool and reviewed at various checkpoints during the development process. IBM has 40+ years of leadership in voluntarily prohibiting or restricting substances of concern from our processes and products — before regulations required that we do so.

LinuxONE systems

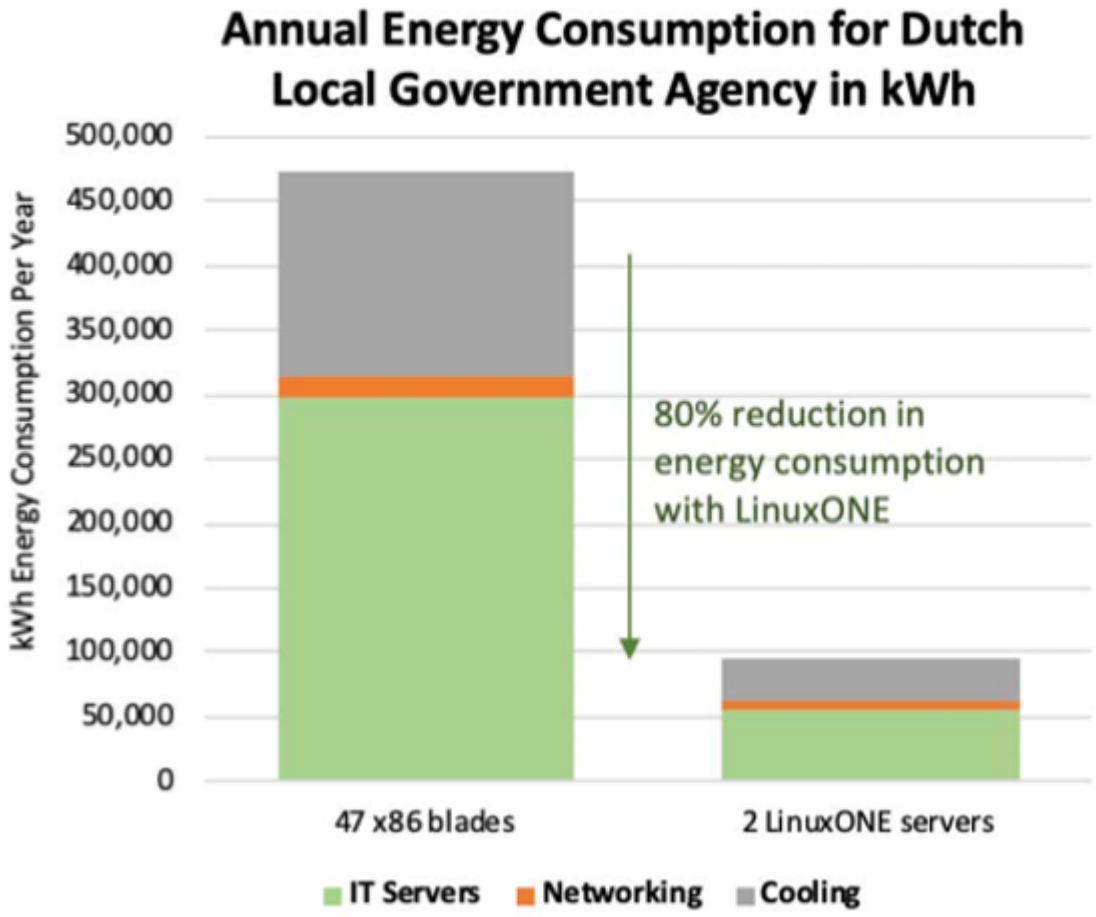
Facilities in data centers consume 10 to 50 times the energy per floor space of a typical office. IBM LinuxONE offers a solution as the system of choice for enterprises looking for dramatic reduction in both floor space and energy consumption. In September 2022, IBM unveiled the next generation of its LinuxONE server, LinuxONE Emperor 4, designed to help clients such as Citibank meet their scale and security goals in addition to meeting sustainability goals. For example, consolidating Linux workloads on five IBM LinuxONE Emperor 4 systems instead of running them on comparable x86 servers under similar conditions can reduce energy consumption by 75%, space by 50%, and the CO2 footprint by over 850 metric tons annually[xiii].

A large insurance company in the Asia Pacific region consolidated their workloads running on 55 x86 servers onto a single IBM LinuxONE system with a dramatic decrease in energy and floorspace usage. Floor space was reduced by 86% and annual energy consumption dropped by 62%[xiv].

x86 and LinuxONE Energy and Floor Space Comparisons for Asia Pacific Insurance Company

Data Center Requirements	x86	LinuxONE	Savings
Energy	890,016 kWh	335,508 kWh	62%
Floor space	42.57 meters	6.11 meters	86%

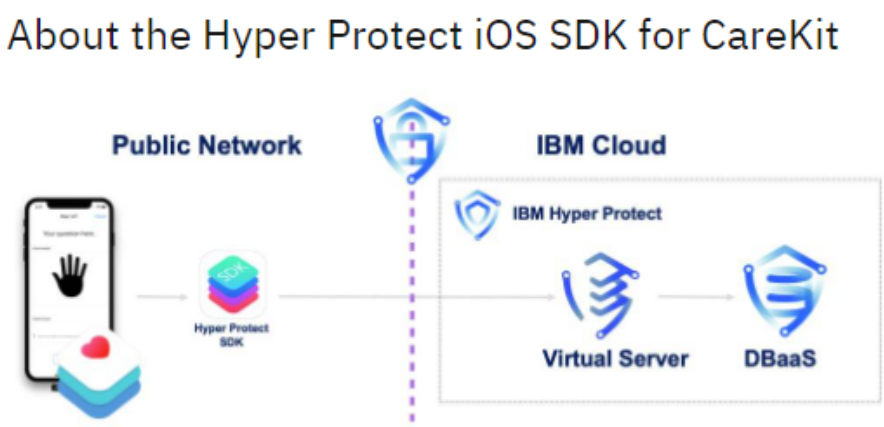
A Dutch Government Agency moved from x86 to LinuxONE to comply with a new gas emissions law; Linux applications moved from 47 x86 blades to 11 IFLs on LinuxONE leading to a reduction of 80% in energy consumption and a reduction of 946 metric tons of CO2 emissions over five years.



LinuxONE provides Hyper Protect Services on IBM Cloud through 3 different functionalities:

1. IBM Cloud Hyper Protect Crypto Services: A fully managed, dedicated key management and Cloud Hardware Security Module (HSM) service. This is the only service in the industry built on FIPS 140-2 Level 4-certified hardware. The service allows customers to have exclusive control over their encryption keys. IBM refers to this capability as Keep Your Own Key (KYOK).
2. IBM Cloud Hyper Protect DBaaS: A service that provides complete data confidentiality for highly sensitive data in the public cloud. The databases currently supported are PostgreSQL and MongoDB EE databases.
3. IBM Cloud Hyper Protect Virtual Servers: A service that provides complete authority over an enterprise's LinuxONE Virtual Servers for workloads with sensitive data or business IP.

These services provide key security differentiation giving customers complete authority over their data, workloads and encryption keys. Apple CareKit, an open-source framework for developing iOS health applications, uses an SDK powered by IBM Cloud Hyper Protect Services to ensure data is always encrypted, whether in flight or at rest or in use. Hyper Protect Services provide complete authority over sensitive data and associated workloads — restricting access even for cloud admins.



Supply chain requirements

IBM is a founding member of the Responsible Business Alliance (RBA), formerly the Electronic Industry Citizenship Coalition, a non-profit industry group that helps its members support continuous improvement in the social, environmental and ethical responsibility of their supply chains. The RBA has a Code of Conduct and a range of programs, training and assessment tools to support continual improvement, and IBM requires our suppliers to adhere to this Code of Conduct. IBM has a series of environmental requirements for its suppliers. Suppliers must:

- Define, deploy and sustain a management system that addresses the intersections of their operations with employees, society and the environment
- Measure performance and establish voluntary, quantifiable environmental goals in the areas of waste, energy and greenhouse gas emissions
- Publicly disclose results associated with these voluntary environmental goals and other environmental aspects of their operations

- Conduct self-assessments and audits, as well as management reviews, of their management system
- Cascade these requirements to their suppliers who perform work that is material to the products, parts and/or services supplied to IBM

End-of-life products

IBM began offering product takeback programs for clients in Europe in 1989 and has extended and enhanced these activities over the years. Today, IBM's Global Asset Recovery Services organization offers Asset Recovery Solutions to commercial customers in many countries generating business value from reusing IT assets. In 2019, IBM processed 20,800 metric tons of end-of-life products and product waste and sent only 0.8% (by weight) of the 20,800 metric tons processed worldwide in 2019 to landfills or incineration facilities for treatment, versus our corporate goal of sending 3% or less.

III – responsible.computing(impact)

Solutions running on IBM Cloud powered by AI and analytics have a pervasive impact on many aspects of human life and address areas such as aging, social mobility, social justice, racial issues, and sustainable agriculture. Below are a few use cases and aspects of IBM Cloud utilization.

Smart Home for aging and vulnerable residents

Karantis360[xv], a UK-based company, have developed a mobile application to support caregivers with the information they need to provide excellent service and to connect families with their elderly relatives. Karantis360 combined machine learning, Internet of Things, and cloud technology from IBM with movement, door, pressure, humidity and water sensors from EnOcean to ensure the wellbeing of clients. The company selected IBM Cloud because it provides portability with multi-device use, as caregivers often share or use more than one smartphone or tablet. IBM Cloud also provides the required high security and privacy of data as the company also dealt with highly sensitive data that must be constantly secured.

COVID pandemic

The IBM Functional Genomics Platform is a comprehensive database linking genotype to phenotype. It includes the world's largest and highest quality annotated reference data for microbial data: over 220,000 genomes, 67 million genes, 51 million proteins, and 237 million functional domains representing thousands of bacterial and viral microorganisms.

The platform uses IBM Cloud resources with over 1468 CPUs, 6TB RAM, and 160TB of hard drive space[xvi]. In response to the global COVID-19 pandemic, IBM offered access to the platform to process all newly sequenced public SARS-CoV-2 genomes, yielding over 2M sequences including genomes, genes, proteins and functional domains. By describing the collective biological activity of a microbe, researchers can accelerate development of health interventions.

Research and education in Europe

Education and Research Institutions require solutions that give them the flexibility to build and deploy any app or workload, anywhere. They would like to avoid vendor lock-in, embrace open-source and ensure compliance with European data privacy and security laws.

The Open Clouds for Research Environments (OCRE) is an EU-funded project that aims at easing access to commercial cloud services for researchers and research institutions in 40 European countries.

The OCRE Catalogue displays the compliant Cloud-based digital service providers who have been contracted to supply the European Research and Academic communities by means of the OCRE framework.

From January 1st 2021, more than 10,000 research and education institutions in Europe are able to consume IBM Cloud, with ready-to-use agreements through the IBM Business Partners SoftwareONE and AppXite. This was the result of their participation in the OCRE tender (Open Clouds

for Research Environments). Research and education institutions can order the full IBM Cloud catalog (>200 services) and can benefit from special OCRE offers from IBM. To see the list of cloud suppliers in each country, please follow this link and interactive map: https://www.ocre-project.eu/services/cloud-suppliers

IBM public cloud is a perfect fit for the OCRE project as it provides the most open cloud platform in the market with a relentless focus on data privacy and security. IBM Cloud is a major contributor and investor to a variety of open-source projects to fuel future innovation and is built on open-source Kubernetes. Red Hat OpenShift on IBM Cloud (ROKS) can be consumed by research and education institutions through the OCRE frame agreement.

IBM Cloud takes privacy to the next level and is in fact the only cloud provider to be able to give technical assurance that IBM cannot access the encryption keys when using IBM Cloud Hyper Protect Crypto services. With "EU Cloud", only IBM personnel from the EU support the cloud environment.

IV – responsible.computing(data usage)

responsible.computing(data usage) is the act of dealing with and having control over data and its lifecycle while being accountable for the mindful, effective and efficient usage of it. As data volumes continue to explode, the time window to act on insights continues to shorten. To remain competitive, organizations must act quickly, and they rely on quality data while embracing innovation from applying artificial intelligence and machine learning. In this competitive scenario, the data we use, work with and process must be trusted, certified, and of high quality.

Data trust and privacy on cloud

Clients on IBM Cloud have full control of their data and IBM provides not just operational assurance that it won't access data, but also technical assurance that it cannot do so. IBM is committed to compliance with data privacy laws in all EU countries where it operates. IBM is one of the founding signatories to the EU Cloud Code of Conduct which has established high data protection and security standards for cloud services. The transparency created by these industry-led best practices will contribute to an environment of trust and create a high default level of data protection in the European cloud computing market.

Data Processing and EU support model

IBM Cloud provides a transparent Data Processing Addendum showing where data for each service is hosted and processed. For any change in the sub-processors, clients will be informed ahead of time and are given the right to object. Data Transfer is covered in EC Standard Contractual Clauses and EU Clients can deploy workloads knowing in advance where the services are.

In light of the Court of Justice of the European Union (CJEU) ruling in 'Schrems II' and the subsequent recommendations from the European Data Protection Board, IBM incorporated the additional safeguards required into our existing policy on government access to client data directly into our contracts (see https://www.ibm.com/blogs/policy/data-flows/ for information). The Additional Safeguards to EU Standard Contractual Clauses are included in the IBM Data Processing Addendum (see http://www.ibm.com/dpa for information).

EU Clients on IBM cloud can opt-in to an EU support model whereby some of the services on the cloud come with an "EU-only" option. This service limits operations, support, and management of the underlying IBM infrastructure to IBM employees located in the EU. In the event that temporary Level 3 support or further assistance is needed from outside of the EU, the non-EU temporary access is reviewed, approved, and supervised by an EU employee.

Confidential computing

Enterprises are concerned about data security and compliance in the cloud. Encrypting sensitive data in the cloud becomes imperative to achieve trust and data privacy in a cloud provider. IBM encrypts data at rest and in transit. In addition, confidential computing protects data while it is processed. One of the offerings that IBM provides in that regard is IBM Cloud Hyper Protect Crypto Services (HPCS). HPCS is a dedicated key management and cloud Hardware Security Module (HSM) service built on FIPS 120-2 level 4 technology, the highest level of security in the industry. IBM Cloud HPCS provides complete control of cloud data encryption keys and cloud hardware security modules, and is the industry's only Keep Your Own Key (KYOK) for data encryption at rest. KYOK provides a key-signing ceremony that guarantees that the keys are inaccessible by the cloud provider. IBM cloud is the only cloud provider that offers cloud Command Line Interface (CLI) for the HSM Key Ceremony for clients to take ownership of the cloud HSM. As opposed to an operational assurance, a technical assurance is in place to guarantee that no one, including cloud admins, has access to clients' data.

IBM is part of the Confidential Computing Consortium (https://confidentialcomputing.io/) formed in 2019 with other software vendors and cloud providers. IBM is a pioneer in confidential computing and proposed solutions in this space long before the industry consortium started. In highly regulated industries such as banking, IBM Cloud offers Cloud for Financial Services where confidential computing is one of its characteristics.

IBM is also exploring other encryption technologies such as homomorphic encryption which allows manipulation of data by permissioned parties while it remains encrypted, minimizing the time it exists in its most vulnerable state. Today, homomorphic encryption toolkits are available on GitHub for iOS, MacOS and Linux.

IBM Framework and Cloud for Financial Services

IBM has capabilities and proven methods to move data and applications to public cloud for regulated industries such as insurance, healthcare, public sector, telco, and banking. In addition, IBM provides reference architectures per industries to fulfil business, technical and regulatory requirements.

In 2020, IBM launched its cloud for Financial Services. IBM Promontory, specialized in regulatory compliance, together with IBM OpenPages and IBM Security, play a key role in developing and maintaining the IBM Framework. The latter consists of a set of policies that go beyond standard compliance and regulatory standards to include an extensive control set spanning cybersecurity, data privacy, access management, and configuration management.

IBM established the Financial Services Cloud Advisory Council to advise on the ongoing advancement of the IBM Cloud Framework for Financial Services. The Cloud Council focuses on bringing together the world's leading financial institutions to drive the strategic evolution of cloud adoption in the financial services sector. Promontory and the advisory council collaborate to make sure that the framework will be up-to-date in addressing the latest industry regulations.

Cloud clients working in regulated industries can take advantage of the policy framework to demonstrate compliance with laws and regulations such as EBA and BaFin BAIT and with security standards such as BSI C5:2020 and NIST. Major banks such as Bank of America in the US and BNPP

in Europe and MUFG in Asia Pacific utilise the framework controls to meet regulatory compliance and reduce risk when dealing with their Independent Software Vendors (ISVs).

IBM is expanding its growing ecosystem of ISVs to include currently more than 100 partners. ISV partners go through an on-boarding process which includes a security controls assessment, workload migration, and readiness validation to start using Cloud for Financial Services. IBM established the Cloud Engagement Fund as part of a $1B investment in its partner ecosystem to acceleration the adoption of the cloud for financial services. Benefits can include a range of credits for IBM Cloud services, other environments or pre-sale environments. This benefit enables IBM and partners to jointly develop use cases and provides a method for learning how to use IBM Cloud services in the IBM Cloud for Financial Services context.

The ultimate goal of Cloud for Financial Services is a rapid adoption of public cloud for banks and insurance organizations to run their sensitive data workloads, reducing the operational overhead associated with security and compliance. The solution supports VMWare and Red Hat OpenShift alongside other cloud-native services.

V – responsible.computing(code)

The goal of responsible.computing(code) is to raise awareness about the impact that the code developers produce has on society and on the world as a whole. For that we point to existing tools, methods and base knowledge that developers should master to minimize negative effects on the world.

responsible.computing(code) is about being aware of the potential environmental, societal and economical impact your design and requirements choices could have and how you can minimize their negative impact.

Base principles

The important thing to keep in mind when thinking of responsible code is the idea of keeping only what is necessary, removing unnecessary features and code. In the same way that “the best trash is the one that does not exist” is true about pollution, it is true that “the best code / feature” is the one that does not exist. The less code there is, the less computing power, storage and energy needed, and it will also be easier in terms of maintaining the app.

With that in mind, and with the code that is left, here are the key aspects to responsible code :

1. Be aware of the environmental impact of code and ways to reduce it

For developers, designers and architects, choices of technology and designs are usually made about what technology is new and trending and what provides the best time to market. However, there is still too little focus on the environmental impact and energy usage a technology choice can have. It is important to look into the applications that provide required business logic while consuming as few resources (CPU, RAM, SSD/HDD, Network) as possible.

2. Make sure code is sustainable

Being responsible also means making sure code is sustainable, not just in terms of environmental aspects but also in terms of economics and development. Code that meets all the environmental requirements but doesn't bring any real business value or is unmaintainable will still be a waste of resources as the software won't be used.

3. Be aware of the societal impact of code

Code design is directly linked to an end user. The requirements chosen by developers, architects and designers can have unwanted negative societal impacts and it is important to reduce these as much as possible. This starts with taking into account disabilities, access to technologies, the way data is being processed and protected, bias and lack of inclusion.

Societal impact

Technology-facilitated abuse is a challenging issue, and there is no simple solution to eliminate it. However, by making subtle decisions—balancing intended with unintended consequences—it is possible to design technology to be resistant to abuse. To aid technologists in making these decisions, IBM has proposed five key design principles to make products resistant to coercive control.

Creating products that do not contribute to, or enable, society's problems is an ethical responsibility of all companies—not only because it is the right thing to do but also because it is the best business approach.

By sharing this set of design principles, IBM aims to improve the usability, security, and privacy of new technologies to make them inherently safer. We recommend that these become an integral part of any product design review. While these principles may be familiar to technologists, they take on additional meaning when looked at through the lens of coercive control. For more on Coercive Control Design, see https://www.ibm.com/blogs/policy/design-principles-to-combat-domestic-abuse/

Accessibility

Applications should generally be accessible in a way that doesn't just work but is also efficient to use. For example, keyboard enablement on websites should not be an afterthought. IBM has made a website and tools available to help make applications accessible at https://www.ibm.com/able/

The value of open source

IBM Cloud is built on open standards and open APIs to provide flexibility, portability and no vendor lock-in. Open source is a great way to reduce total cost of ownership and increase the maintainability of your app. Open source ressources are often more accessible and well-known than some proprietary software options, making it easier to find talent trained in those technologies who can maintain the apps.

In July 2019, IBM completed the Redhat acquisition valued at $34 Billion. Redhat offerings are based on commercially available open-source software and Red Hat Enterprise Linux is the most popular and most secure Linux distribution. The acquisition underlined the positioning of IBM Cloud as an enterprise-grade open and secure cloud-supporting hybrid and multi-cloud environment.

Approximate computing with AI systems

IBM uses approximate computing[xvii] in its algorithms to support AI and cloud workloads while reducing carbon footprint. Approximate computing uses less precision and allows random small mistakes that can cancel out over time with the purpose of saving energy and increasing efficiency of computations. The technology retains accuracy but can allow a four-fold reduction in the amount of energy consumed. IBM develops energy-efficient AI systems and innovations in software and hardware solutions that can help meet the massive energy needs for the future. The latest innovation is the Artificial Intelligence Unit (AIU), IBM's first complete system-on-chip designed to run and train deep learning models faster and more efficiently than a general-purpose CPU. According to IBM Research, the AIU chip uses a scaled version of the AI accelerator in its Telum chip. The Telum uses 7nm transistors, but the AIU will use faster 5nm transistors[xviii].

Infrastructure as Code

IBM Cloud provides IaC (infrastructure as code) so developers can scale up and down, or provision and deprovision infrastructure in response to development or user demands. IaC leverages the DevOps practice to help developers manage their software delivery lifecycle: Developers can launch sandboxes and continuous integration/continuous deployment (CI/CD) environments. QA can quickly provision a copy of the same environments to test, and Operations can quickly provision infrastructure for security and user-acceptance testing in separate staging environments. And when the code passes testing, the application and the production infrastructure it runs on can be deployed in one step.

IBM Cloud Schematics service is built on Terraform. It automates infrastructure management and increases application performance with consistent provisioning and orchestration.

Methods for whole-team alignment

Participative methods like Enterprise Design Thinking or Liberating Structures can provide opportunities to discuss the topic of responsible computing in its full breadth - security, ethics, accessibility, environmental impact, etc. – all while involving the whole team. These methods can allow for the consideration of the different dimensions of the solution and help generate clear decisions on priorities. One very useful example is the Team Essentials for AI framework that uses design thinking to help the team reflect on the possible ethical issues of any solution.

VI – responsible.computing(systems)

Responsible computing companies need to develop systems that everyone can trust (including the company itself), which protect a user's privacy, their information, their freedom, and their rights as individuals. Ultimately, they must not discriminate, and they should provide mechanisms for feedback and improvement should they be found to discriminate. For individuals, at its simplest, an untrustworthy system may contain bias or unfairness driven through AI systems trained with biased data and use of algorithms that cannot readily be explained.

IBM Watson on IBM Cloud

AI is becoming the de-facto driving force for the advancement of various industries. Clients can run the AI/ML services in the IBM Cloud catalogue with trust and transparency. In fact, IBM Cloud introduced new bias detection, mitigation and explainability capabilities. These capabilities not only promote trust and transparency but also provide visibility into the decision-making process and the logic behind the scores. In highly regulated industries, clients and regulators want proof that models and results are trusted and fair. If a customer or regulator requests the reasoning behind a particular conclusion, clients can explain how the model contributed to the decision. Other capabilities include automatic data logs to improve auditability and compliance reporting and bias detection features to help identify harmful bias as early as build time, and later at runtime. For more information on IBM Watson on IBM Cloud, visit https://cloud.ibm.com/developer/watson/services

Three of the prominent AI services in IBM Cloud are Knowledge Catalog, Watson Studio and Watson Openscale.

Trust in data: Watson Knowledge Catalog

Watson Knowledge Catalog (WKC) infuses trust in the data and its quality. No amount of algorithmic sophistication can overcome poor data. Therefore, WKC is designed to help users understand data, govern and protect data and AI estates, and most importantly, improve data quality. WKC has multi-cloud capabilities and therefore can build the enterprise catalog of all data from different sources across multiple public and private clouds. It also allows for varying views and access to data based on personas and roles.

Trust in models: IBM Watson Studio

Trust in models means increasing confidence in model accuracy. IBM has integrated the tools and capabilities needed to more efficiently run and manage AI models, simplify AI lifecycle management, and empower data scientists to help optimize their data-driven decision-making into one industry-leading tool: IBM Watson Studio.

Watson Studio is a platform for businesses to build and train AI and machine learning models and to prepare and analyze data. It simplifies and scales data science to predict and optimize business outcomes with trust and transparency. Deploying AI with continuous model governance enables users to accelerate time to discovery, prediction, and outcomes while keeping AI explainable and tuned to an organization’s business demands. IBM also infused intelligent automation into the product that is designed to augment human skills to build and manage models, identifying and mitigating problems like bias or drift.

Fairness and Drift configuration: Watson Openscale

IBM contributes to Open-source algorithms such as AI Fairness 360 (AIF360) and AI Explainability 360 (AIX360). Watson Openscale is an enterprise-grade AI system designed to handle production workloads that open-source algorithms cannot do. The main capabilities of Openscale are:

1. Detecting and correcting AI model bias and drift
2. Explaining AI outcomes
3. Making explainability clearer and more resilient

OpenScale helps organizations maintain regulatory compliance by tracing and explaining AI decisions across workflows, and intelligently detecting and correcting bias to improve outcomes. Its visual dashboard explains AI outcomes to business users and communicates the status of AI models. OpenScale is available at IBM Cloud and the tool does not require any coding skills.

A look into the future

In a data-driven economy, IBM Cloud is a major contributor to the advancement of technology. Beyond providing technical breakthroughs, IBM preserves data privacy and security and promotes trust and ethics in its products right from design. IBM continues to invest billions of dollars in its products though research and development, receiving 9,130 patents in 2020 and 8,682 patents in 2021, the majority of which were in AI, cloud and hybrid cloud, quantum computing, and security.

IBM Cloud collaborates with industry, governments and regulators to protect the environment, reduce consumption, preserve data privacy, write efficient code, and develop trusted systems, all while tackling modern issues in society.

For more info on how to start working with a responsible cloud provider, please start by clicking on ibm.com/cloud

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