Data Gravity Index DGx™

Report measuring the intensity of Data Gravity and its effect on the Global 2000 Enterprises

DIGITAL REALTY®

V1.5

Contents

About the Data Gravity Index™

As the largest global provider of multi-tenant datacenter capacity,[1] Digital Realty has a unique vantage point on how technology infrastructure is built, deployed and operated. Our customers continue to solve the most complex infrastructure, connectivity and workload use cases on our platform globally. This includes use cases across network peering, hyperscale, low-latency, high-performance computing, big data and artificial intelligence.

Recently, we have witnessed the emergence of a new megatrend occurring on our platform: the explosion of enterprise data growth globally. This drove us to understand more. We conducted research between August 2019 and August 2020 and drew upon more than a dozen third-party data sources, ranging from the World Economic Forum and United Nations to global consulting and market research firms. We also developed a patent-pending formula to measure, quantify and determine the implications of the explosion of enterprise growth. The methodology is based on the analysis of thousands of attributes of Global 2000 Enterprise companies' presences in each metro, along with variables for each metro, including GDP, population, number of employees, technographics, IT spend, average bandwidth and latency, as well as flows of data.

The Data Gravity Index DGx™ is an annual report designed to facilitate industry dialogue and assist both our Enterprise and Service Provider customers as they shift their infrastructure strategy to address this emerging megatrend. Version 1.5 expands to a total of 53 metros and 23 industries with new insights and forecasts on data creation, intensity and gravitational force of enterprise data growth.

1. 451 Research, Market Forecast, Leased Datacenter Global Providers, 2020.
Capacity measured in terms of both the number of datacenters and operational square footage.

About Digital Realty

Digital Realty supports the world's leading enterprises and service providers by delivering the full spectrum of data center, colocation and interconnection solutions. PlatformDIGITAL®, the company's global data center platform, provides customers a trusted foundation and proven Pervasive Datacenter Architecture PDx™ solution methodology for scaling digital business and efficiently managing data gravity challenges. Digital Realty's global data center footprint gives customers access to the connected communities that matter to them with 280+ facilities in 45+ metros across 20+ countries on 6 continents.

To learn more about Digital Realty, please visit **digitalrealty.com** or follow us on **LinkedIn** and **Twitter**.

DIGITAL REALTY®

Ascenty
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interxion™
A DIGITAL REALTY COMPANY

MC DIGITAL REALTY
A Digital Realty and Mitsubishi Corporation JV

Foreword

Data Gravity measured and quantified for the Global 2000[1] Enterprises

The Digital Economy

The digital economy is remaking both private and public enterprises across all industries, transforming how they create and deliver value.

Requires a New Business Architecture

To succeed, enterprises need to operate ubiquitously and on-demand, augmented by real-time intelligence to best serve customers, partners and employees across channels, business functions, and multiple points of business presence.

Data Gravity is the Obstacle

Data Gravity inhibits enterprise workflow performance, raises security concerns, and increases costs, all complicated by regulatory requirements and other artificial constraints. With Data Gravity, the laws of physics and IT intersect to provide a proxy for a new age of business architectures that Enterprises will be driven to adopt and Service Providers will be pressed to support.

Forces a Shift to Data-Centric Architecture

Data Gravity forces a new architecture, one that inverts traffic flow and brings users, networks and clouds to privately hosted enterprise data. With this new architecture, Data Gravity barriers are removed and new capabilities are unlocked.

Elevates the Role of a Multi-Tenant Datacenter

To implement this data-centric architecture, Enterprises and Service Providers need a secure, neutral meeting place to host their infrastructure in proximity to, yet separate from each other. A multi-tenant datacenter platform enables such a deployment paradigm.

1. Defined by Forbes' annual ranking of the world's 2000 largest public companies

Data Gravity[1] Index Formula[2]

A methodology to measure the creation, aggregation, and private exchange of enterprise data globally.

$$\left(DM \times DA \times BW \right) / L^2$$

DATA MASS · DATA ACTIVITY · BANDWIDTH · LATENCY

Calculating Data Gravity

Data Mass
Data that is accumulated (Stored or Held)

Data Activity
Data that is in motion (Creation, Interactions)

Bandwidth
The Total Aggregate Bandwidth available to this location

Latency
The Average Latency between this location and ALL other locations

Bandwidth is a multiplier to Data Gravity. Higher Bandwidth represents more potential.

Latency is an inhibitor to Data Gravity. Higher Latency represents less potential.

1. Dave McCrory, *Data Gravity in the Clouds*, Dec. 2010
2. Digital Realty Market Intelligence & Analytics, Sept. 2020

Data Gravity Index Score Reflects Intensity

The Data Gravity Index Score measures the intensity and gravitational force of enterprise data growth for Global 2000 Enterprises across 53 metros and 23 industries globally. The score, as measured in gigabytes per second, provides a relative proxy for measuring data creation, aggregation and processing.

Data Gravity scores, as measured in gigabytes per second, illustrative of actual results
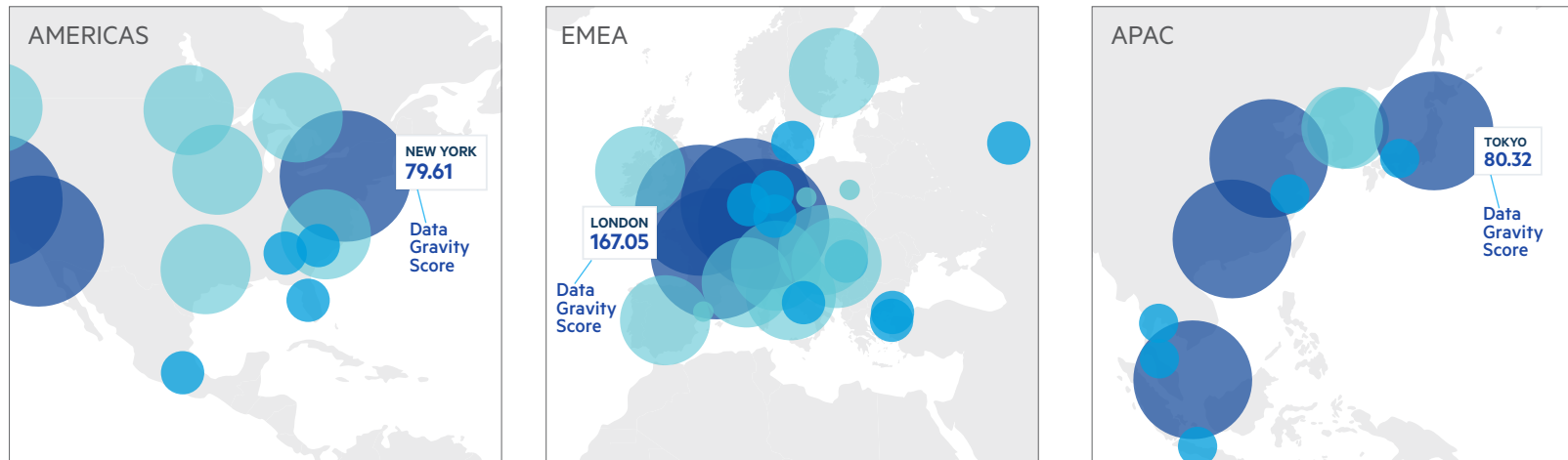
Figs. 1, 2 and 3. *Data Gravity Index,* Dec. 2020

The Data Gravity Score considers 1,000+ attributes from 13 authoritative sources on G2000 Enterprises including:

Firmographic Data
- Industry segment(s)
- Employee data
- Revenue data
- Location data
- Corporate entity

Technographic Data
- IT spend
- Preferred vendors
- Network traffic distribution
- Network PoPs
- DC PoPs
- Cloud PoPs

Industry Benchmarks
- Data creation/ transfer rates
- Latency by access method, user type, location, application type
- Growth rates
- Cloud usage
- Networking services
- Distributed services
- Data technologies
- End points, user devices
- Application use cases

Continuous Data Creation Lifecycle Underpins Data Gravity

DATA CREATION

DATA PROCESSING

DATA AGGREGATION & EXCHANGE

DATA ENRICHMENT

PEOPLE & THINGS

INTERACTIONS & TRANSACTIONS

STRUCTURED & UNSTRUCTURED STORAGE
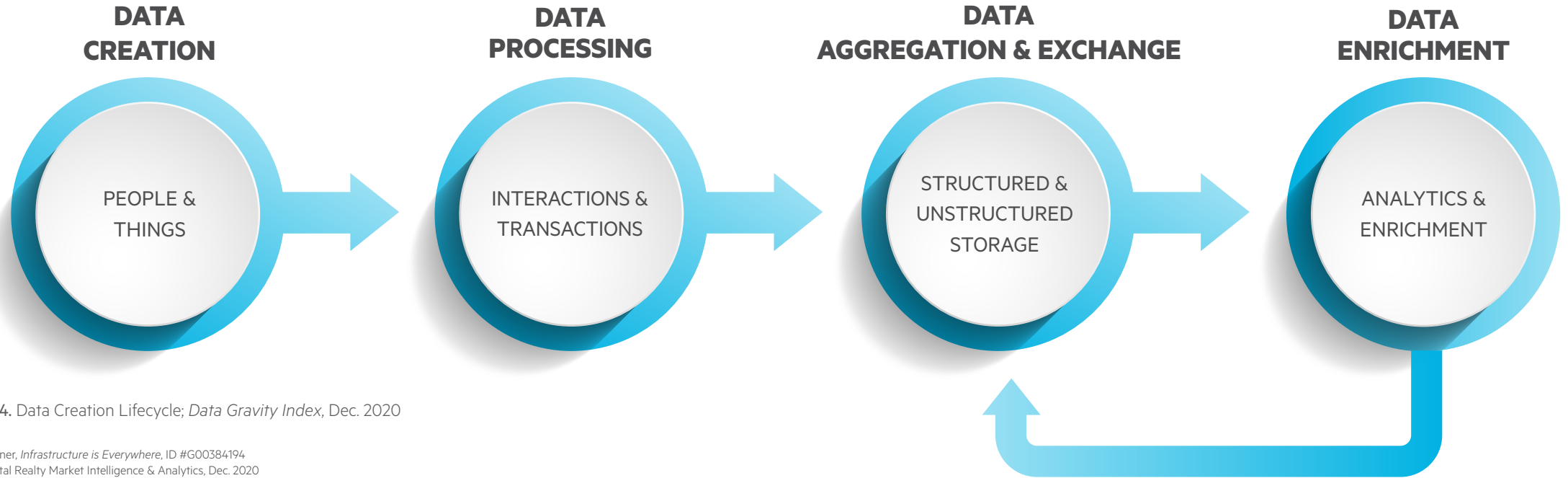
ANALYTICS & ENRICHMENT

Fig. 4. Data Creation Lifecycle; *Data Gravity Index,* Dec. 2020

1. Gartner, *Infrastructure is Everywhere*, ID #G00384194
2. Digital Realty Market Intelligence & Analytics, Dec. 2020
3. Digital Realty Market Intelligence & Analytics, Dec. 2020
4. Gartner, *100 Data and Analytics Predictions Through 2024*, ID #G00721868

Enterprises serve an increasing number of users and endpoints that are creating and exchanging data

By 2022, more than 50% of enterprise data will be created outside the data center or cloud[1]

Files and messages invoke concurrent interactions and transactions between users and machines

By 2024, G2000 Enterprises in these 53 metros will be required to add nearly 30 more petaFLOPs (pFLOPS) to process new digital workflows[2]

Enterprise Data has to be gathered and formatted for presentation, exchange and compliant storage

By 2024, across these 53 metros, G2000 Enterprises will be adding storage at a combined rate of 622 terabytes per second for aggregation & exchange[3]

Analytics, Machine Learning and AI enable enterprises to embed workflow intelligence

By 2022, 65% of CIOs will incorporate AI into their ERP strategies to gain competitive advantage[4]

Macro Trends Amplifying Data Gravity
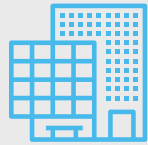
|	Enterprise Data Stewardship	Mergers & Acquisitions	Digitally-Enabled Interactions	Data Localization	Cyber—Physical
WHAT	The enterprise is **fast becoming the world's data steward**	Globalization is driving corporate **M&A to achieve scale**	**Increasing digitization** of enterprise workflows	Expanding legal and regulatory policies **requiring local data storage**	**Integration of physical and digital** security systems to improve enterprise cybersecurity
WHY	By 2025, **80% of data worldwide** will reside in enterprises[1]	**M&A Volumes** are expected to return to pre-Covid levels in 2021[2]	Digitally-enabled interactions rank **2x greater** importance vs. physical interactions[3]	By 2022, **87% of IT Leaders** will maintain local copies of customer and transaction data for compliance[4]	By 2023, **70%** of security products will integrate IT-OT-IoT systems[5]
HOW	**Increases the volume of data** that needs to be aggregated and stored	**Increases # of data sources** participating in data exchange	**Increases enterprise data exchange** volumes globally	**Increases # of enterprise locations** of data aggregation	**Increases types and volumes** of data creation & exchange
	Source: [1]IDC #US44413318, Data Age 2025, The Digitization of the World From Edge to Core, November 2018	Source: [2]Goldman Sachs, BRIEFINGS Newsletter June 16, 2020	Source: [3]McKinsey, B2B Decision Maker Pulse Survey, April 2020	Source: [4]451 Research , Infrastructure Imperative – IT Leader Survey, November 2019	Source: [5]Gartner, Emerging Technology Analysis- Cyber-Physical Security. ID: G00726994

Why Data Gravity Impedes G2000 Enterprises

As a cohort, Global 2000 Enterprises have the greatest propensity to need to address Data Gravity. This segment spends $2.6T annually on IT Infrastructure & Networking,[1] operating the most complex systems and serving millions of users and endpoints, with coverage across many points of presence globally.
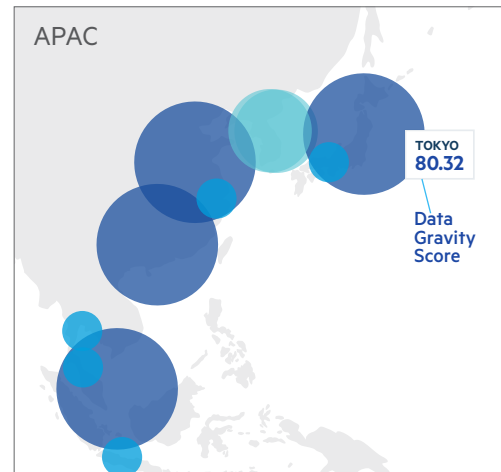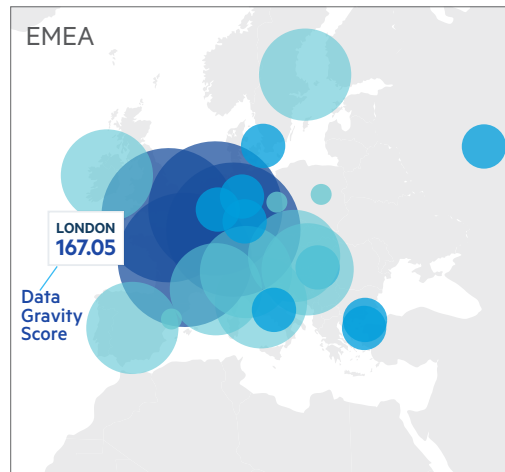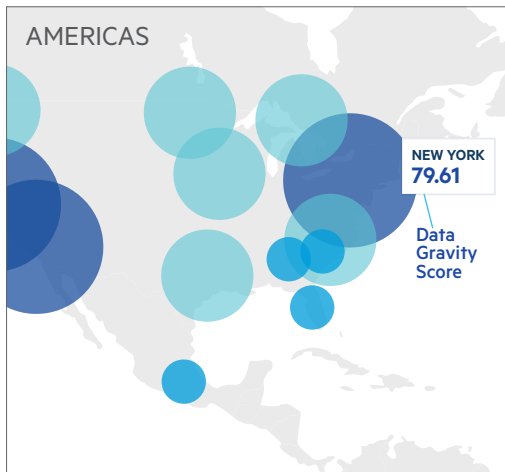
Figs. 5, 6 and 7. *Data Gravity Index,* Dec. 2020

G2000 ENTERPRISE IT COMPOSITE PROFILE [1,2,3,4,5,6,7,8]

13+	Countries w/Business Presence (Average per Enterprise)
19K	Business Units in 53 Metros
36+	Points of Presence (PoPs)
7K+	Datacenter PoPs
100M+	Employees
11M+	Applications
57K+	SAAS Applications
$2.6T+	Annual IT & Network Spend
$18B+	Annual IAAS Spend
$8B+	Annual PAAS Spend
$40B+	Annual SAAS Spend
$7B+	Annual Colocation Spend

1. Gartner 2. HG Insights; 3. Intricately; 4. Synergy Research; 5. Gartner; 6. IDC; 7. Telegeography; 8. Digital Realty Market Intelligence & Analytics

Highlights

Data Gravity Index DGx™ measures, quantifies and predicts the intensity of Data Gravity across Global 2000 Enterprises.

1   **Accelerating growth across all regions and metros.** Data Gravity Intensity, as measured in gigabytes per second, is expected to grow by a compound annual growth rate of 139% globally through 2024 as data stewardship drives global enterprises to increase their digital infrastructure capacity to aggregate, store and manage the majority of the world's data.

2   **Permeating across all industry segments.** No industry is immune to the effects of Data Gravity. Data Gravity Intensity* is expected to grow by a compound annual growth rate of 144% through 2024 across nearly three quarters of the 23 industry segments analyzed. Global Mergers & Acquisitions activity is expected to return to pre-Covid levels and drive accelerated growth of global enterprises[1], including increasing the number of enterprise data sources participating in data exchange.

3   **Pairs of metros share unique attraction rate.** Specific metro pairs were identified as having flows between each other, directly increasing their Data Gravity Intensity both within their metro and their high attraction between metros. This shift in importance towards digitally-enabled interactions across global enterprises will increase data exchange volumes exponentially.

4   **Approaching quantum computing levels of data creation, processing & storage.** By 2024, it is estimated G2000 Enterprises across 53 metros will create data at a rate of 1.4 million gigabytes per second and will require nearly 20,000 petabytes of additional data storage annually. Data location matters to global enterprises as they look to meet compliance requirements by maintaining local copies of critical data.

5   **Requires data-centric enterprise architecture & connected community approach to address.** Current backhaul architecture cannot address enterprise Data Gravity needs, including data exchange across multiple internal/external platforms, local data copies and ability to run performant analytics across each global point of presence. Data Gravity requires a connected community approach between enterprises, connectivity, cloud and content providers integrating core, cloud and edge at centers of data exchange, implementing a secure, hybrid IT and data-centric architecture globally at points of business presence.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. Goldman Sachs, *BRIEFINGS* Newsletter June 16, 2020

Forecasts

Global Data Gravity Intensity forecasts through 2024 by region, metro, metro-to-metro exchange, industry, and forecasts for data creation, processing and storage

Global Forecast

Accelerating growth around the world. Data Gravity Intensity, as measured in gigabytes per second, is expected to grow across 53 metros by a compound annual growth rate of 139% globally through 2024 as data stewardship drives global enterprises to increase their digital infrastructure capacity to aggregate, store and manage the majority of the world's data.
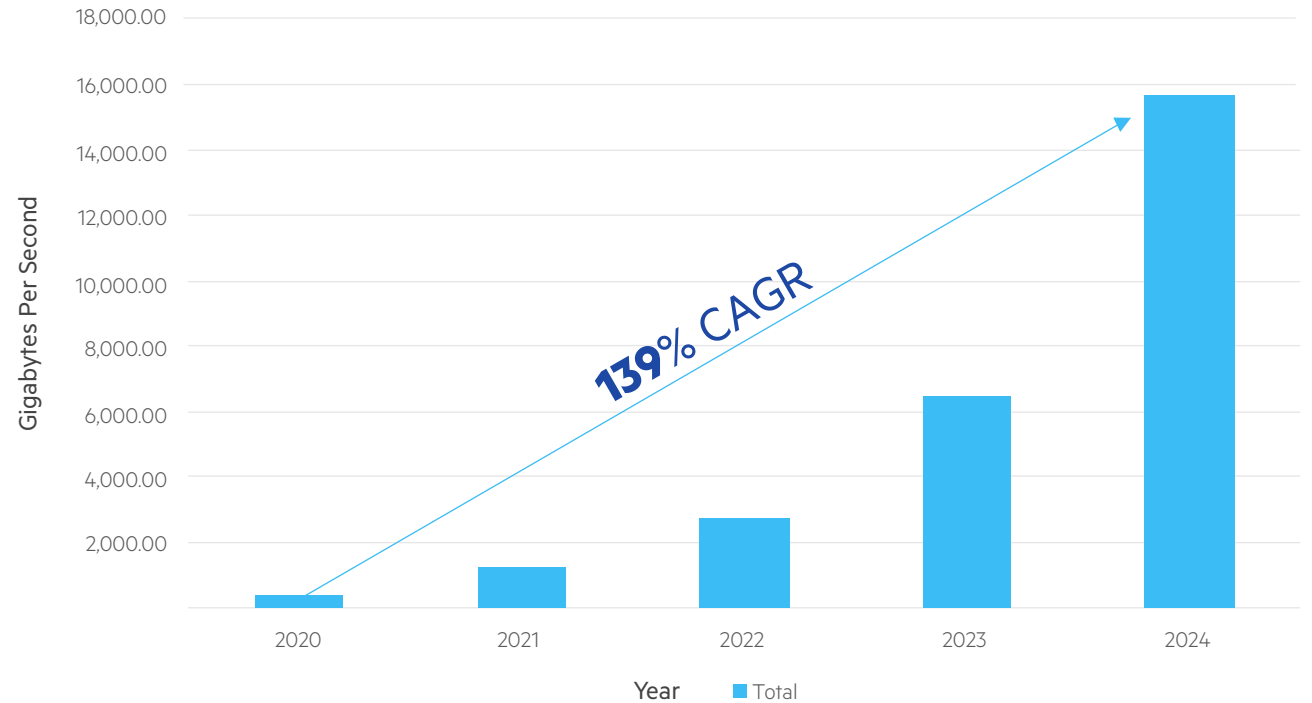
Data Gravity Intensity Global Forecast[1,2]

Fig. 8. *Data Gravity Index,* Dec. 2020

1. Data Gravity Intensity is calculated by the Data Gravity Index Formula: $(DM \times DA \times BW) / L^2$
2. Data Gravity Intensity is defined by the Data Gravity Index Score. See Methodology for scoring and data.

Regional Forecast

Accelerating growth across all regions. Data Gravity Intensity, as measured in gigabytes per second, is expected to grow by a compound annual growth rate of 133% or higher in each region through 2024.

Forecast Highlights[1]

- By 2024, EMEA is expected to remain the home to the greatest intensity of Data Gravity.

- EMEA and APAC Data Gravity Intensity are increasing at faster rates than North America.

- EMEA region Data Gravity Intensity will exit 2024 at almost double the rate of North America.

Data Gravity Intensity Regional Forecast[1,2]

■ 2020   ■ 2021   ■ 2022   ■ 2023   ■ 2024

APAC — 153% CAGR
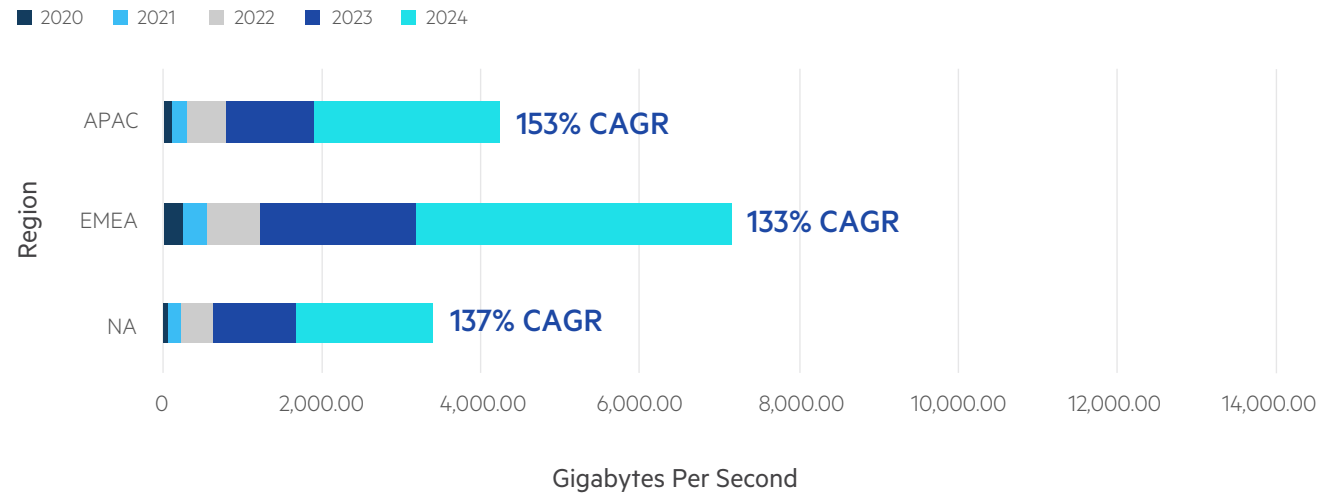
EMEA — 133% CAGR

NA — 137% CAGR

Gigabytes Per Second

Fig. 9. *Data Gravity Index,* Dec.. 2020

1. Data Gravity Intensity is calculated across 53 metros using the Data Gravity Index Formula: $(DM \times DA \times BW) / L^2$
2. Data Gravity Intensity is defined by the Data Gravity Index Score. See Methodology for scoring and data.

1. Data Gravity Intensity Regional Forecast is calculated across 53 metros for Global 2000 Enterprises

DGx

Metro Forecast Highlights

From 2020 to 2024, the overall top 6 metros with the highest CAGR* (in descending order) are:

Jakarta | Singapore | Rome | Hong Kong | Melbourne | Atlanta

Jakarta is developing as a connectivity center, is a major banking and financial hub, and represents a significant portion of trade and services for Indonesia.

Singapore is a critical business and data hub for global enterprises with presence in the APAC region given its pro-business policies and diverse connectivity options.

Rome is host to many industries, and with very low latency and an observed increase in available bandwidth in the region, is forecasted to experience high growth in data gravity intensity.

Hong Kong is an international financial and trade hub and connectivity gateway between APAC and the rest of the world for global enterprises.

Melbourne drives large amounts of data creation as a leading financial center and headquarters for many of the world's largest financial services and natural resources firms.

Atlanta is home to major global enterprises participating in the cloud ecosystem and is a carrier-dense connectivity metro.

*CAGR calculation based on Global 2000 Enterprises across 53 metros.
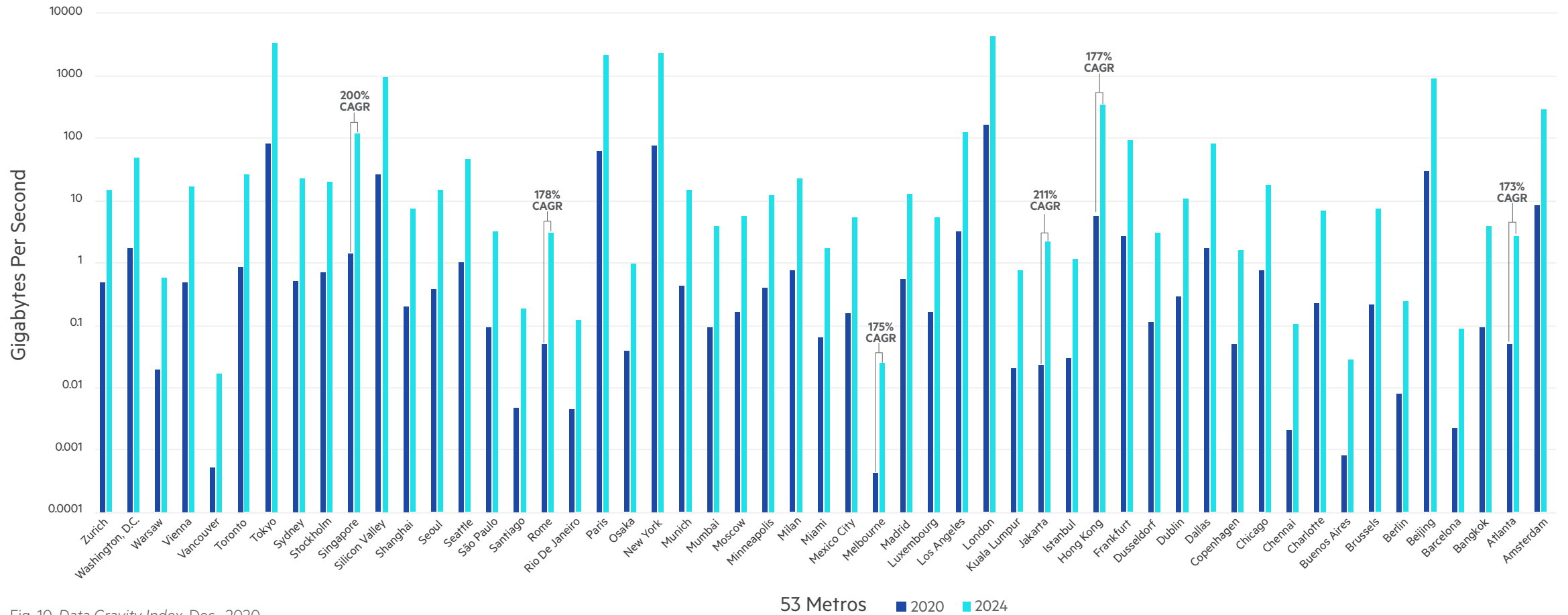
Global Metro Forecast 2020-2024

Fig. 10. *Data Gravity Index*, Dec . 2020

1. Data Gravity Intensity is calculated by the Data Gravity Index Formula: (DM x DA x BW) / L²
2. Data Gravity Intensity is defined by the Data Gravity Index Score. See Methodology for scoring and data.

Inter-Metro Forecast
Global Metro to Metro Gravity*

Pairs of metros share unique attraction rate. Specific metro pairs were identified as having flows between each other, directly increasing their Data Gravity Intensity both within their metro and with their high attraction between metros. This shift in importance towards digitally-enabled interactions across global enterprises will increase data exchange volumes exponentially. Proximity matters as a driving factor for pairs of metros that share a high attraction rate.

1. London and Amsterdam are at the top in both 2020 and 2024. London is a leading financial center for international enterprises, and Amsterdam is headquarters to some of the world's largest companies and a leading financial hub for Europe. Data is exchanged for finance and trade purposes, among other reasons, creating a very high level of attraction.

2. Paris and London have the second-highest attraction in both 2020 and 2024. Paris and London are both financial centers with large populations. With diverse G2000 Enterprise presence, their combined data being shared and generated makes their attraction very high.

3. Hong Kong to Tokyo is projected to be one of the top 10 attraction between metros by 2024. Hong Kong is a large financial center with high volumes of trade and is considered a gateway to China. Tokyo is Japan's industrial capital and, in addition to being a financial center, drives large amounts of data creation. While the attraction is predicted to increase between 2020 and 2024, this attraction is expected to stay in the top 10 for a long time.

*Metro to metro calculation based on the Data Gravity Index v1.0 released in Sept. 2020 that covers 21 metros, including Amsterdam, Beijing, Chicago, Dallas, Dublin, Frankfurt, Hong Kong, London, Los Angeles, Mexico City, New York, Paris, São Paulo, Seattle, Seoul, Shanghai, Silicon Valley, Singapore, Sydney, Tokyo and Washington, D.C.

Top 10 Metro to Metro Connections 2020		
Attraction	**Metro A**	**Metro B**
14,344.22	London	Amsterdam
12,162.51	Paris	London
7,604.18	Washington, D.C.	New York
4,533.48	Silicon Valley	Los Angeles
1,611.46	Frankfurt	Paris
1,211.34	London	Frankfurt
1,109.79	Shanghai	Beijing
420.32	New York	Silicon Valley
386.90	New York	London
369.07	Dublin	London

Top 10 Metro to Metro Connections 2024		
Attraction	**Metro A**	**Metro B**
387,160.00	London	Amsterdam
351,187.93	Paris	London
220,339.51	Washington, D.C.	New York
167,647.26	Silicon Valley	Los Angeles
54,800.54	Frankfurt	Paris
34,162.12	Beijing	Shanghai
27,464.84	London	Frankfurt
12,193.56	New York	Silicon Valley
11,183.59	New York	London
10,795.09	Hong Kong	Tokyo

Fig. 11. *Data Gravity Index,* Dec. 2020

1. Attraction between metros is calculated by adding Data Masses together and adding the Data Activity numbers together, then multiplying them with Bandwidth and finally dividing the result by the Latency squared between them.
2. See Methodology for scoring and data.

Global Industry Forecast

No industry is immune to the effects of Data Gravity. Through 2024, Data Gravity Intensity* is expected to have grown by a compound annual growth rate of 144% for G2000 Enterprises across almost three quarters of the 23 industry segments** analyzed. Global Mergers & Acquisitions activity is expected to return to pre-Covid levels and drive accelerated growth of global enterprises[1], including increasing the number of enterprise data sources participating in data exchange. While Data Gravity is permeating across all industry segments, this report focuses on seven distinct G2000 industries with the greatest need to address Data Gravity, including Banking and Financial Services, Insurance, Manufacturing, Mining & Natural Resources, Pharmaceuticals and Chemicals, Professional Services and Retail.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater
**Industry segments analyzed for the G2000 Enterprises include Agriculture, Banking and Financial Services, Computer and Electronic Products, Construction and Real Estate, Educational Services, Health Care and Social Assistance, Industry Associations, Insurance, Manufacturing, Media and Entertainment, Mining and Natural Resources, Pharmaceuticals and Chemicals Manufacturing, Professional, Scientific and Technical Services, Public Administration, Retail Trade, Service Industry, Telecommunication, Transportation and Warehousing, Travel and Tourism, Utilities, Wholsesale Trade and Holding Companies.

1. Goldman Sachs, *BRIEFINGS* Newsletter June 16, 2020

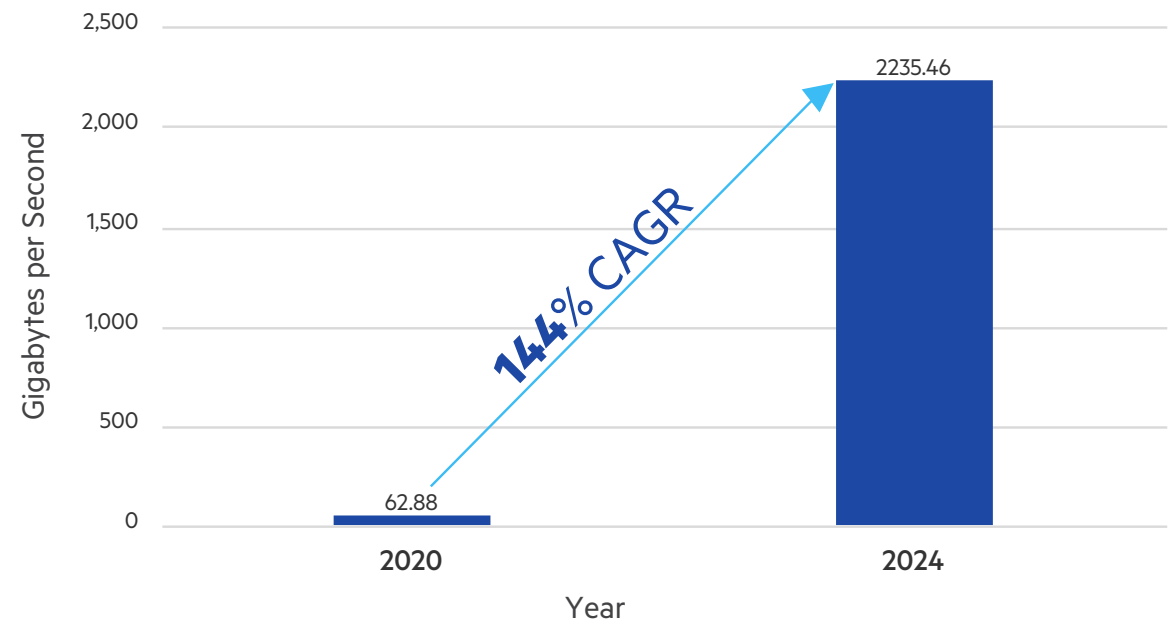## Global Industry Data Gravity Intensity* CAGR 2020 – 2024

Fig. 12. *Data Gravity Index*, Dec. 2020

Global Data Gravity Intensity Forecast: Banking & Financial Services

In a 2020 McKinsey survey[1], financial executives reported a jump in digital acceleration nearly twice as large as those reported in consumer packaged goods companies. Through 2024, Banking and Financial Services firms across G2000 Enterprises are expected to increase their Data Gravity Intensity* by a projected compound annual growth rate of 146%. Metros forecasted to see the highest Data Gravity, in descending order, include London, New York, Tokyo, Paris, Hong Kong, Amsterdam, Beijing, Silicon Valley, Frankfurt, Toronto, Singapore, Washington, D.C., Charlotte, Sydney, Milan and Seoul.

Global Data Gravity Intensity* CAGR 2020-2024 – Banking and Financial Services

Fig. 13. *Data Gravity Index,* Dec. 2020

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, How COVID-19 has pushed companies over the technology tipping point, Oct. 2020

2024 Global Data Gravity Intensity Forecast:
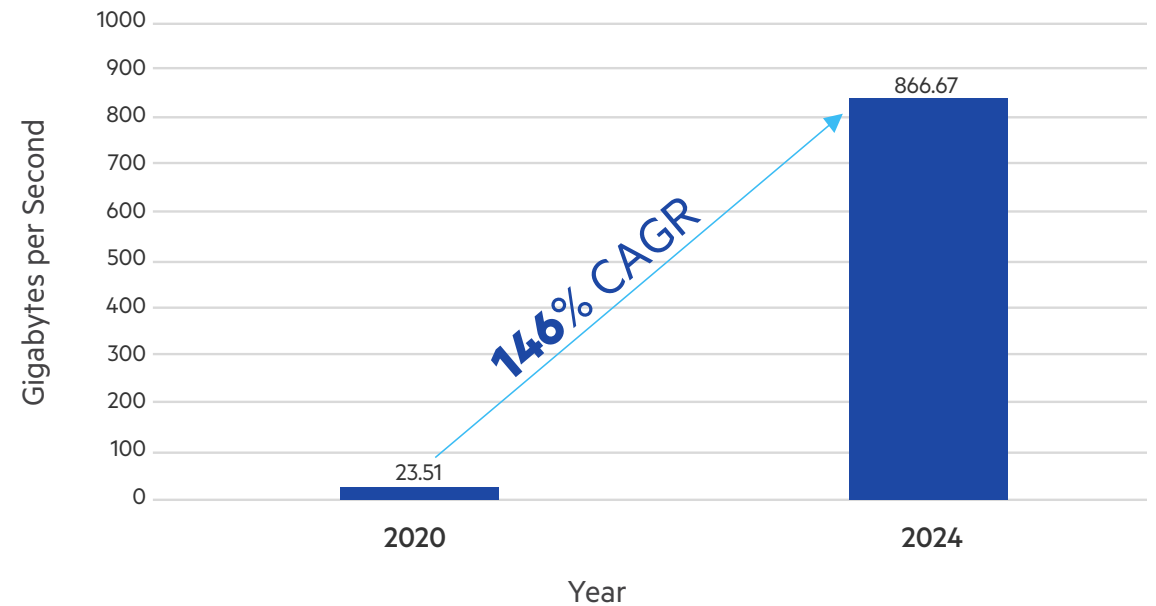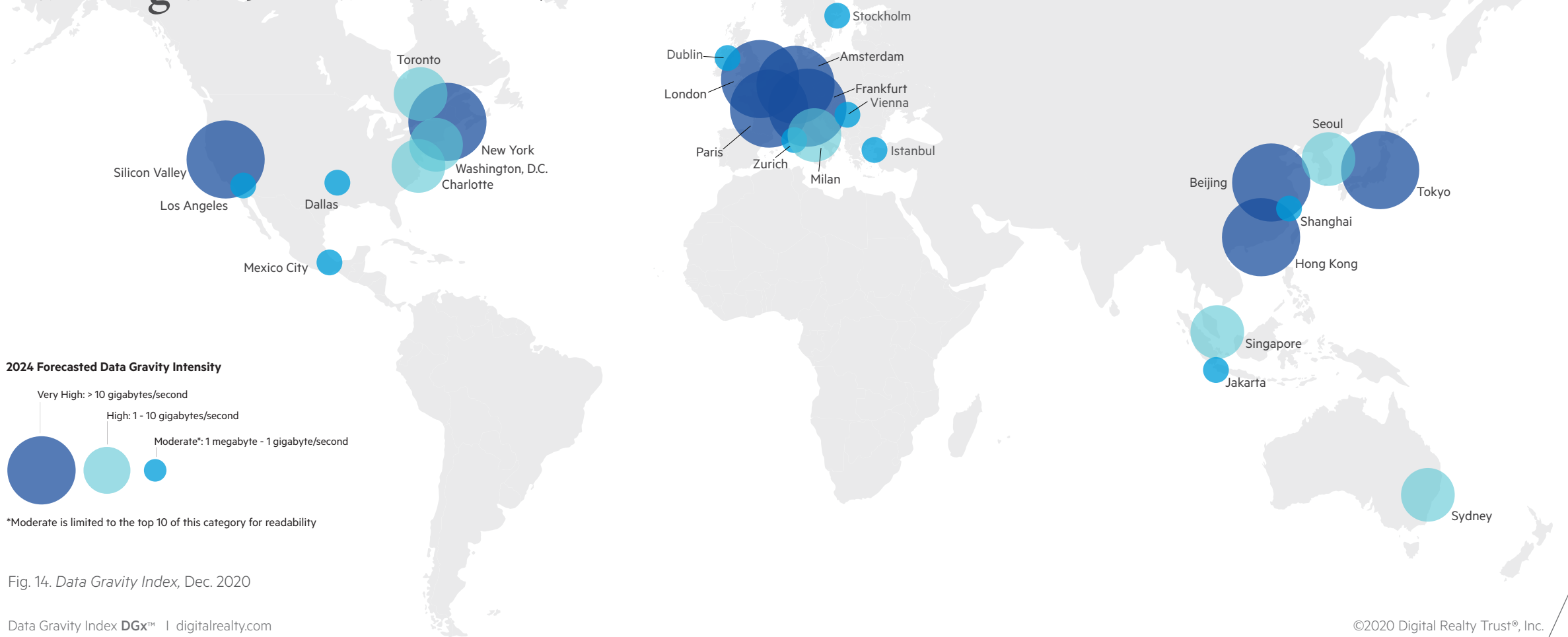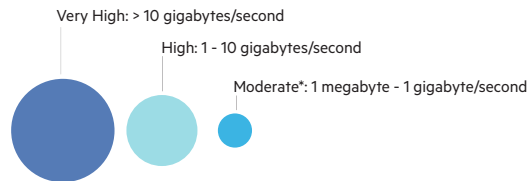# Banking and Financial Services

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Stockholm
Dublin
Amsterdam
London
Frankfurt
Vienna
Paris
Zurich
Milan
Istanbul
Toronto
New York
Washington, D.C.
Charlotte
Silicon Valley
Los Angeles
Dallas
Mexico City
Seoul
Beijing
Tokyo
Shanghai
Hong Kong
Singapore
Jakarta
Sydney

Fig. 14. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Insurance

Through 2024, it is estimated G2000 Enterprises in the Insurance industry will face an acceleration of Data Gravity Intensity*, as measured in gigabytes per second, which is expected to have grown by a compound annual growth rate of 143% globally. As digitally-enabled interactions continue to increase in importance[1], so will the growth of enterprise data exchange volumes, specifically in the metro areas for London, New York, Tokyo, Paris, Hong Kong, Los Angeles, Minneapolis, Zurich, Beijing, Toronto and Munich.

Global Data Gravity Intensity* CAGR 2020-2024 – Insurance

Fig. 15. *Data Gravity Index,* Dec. 2020

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, *B2B Decision Maker Pulse Survey,* April 2020

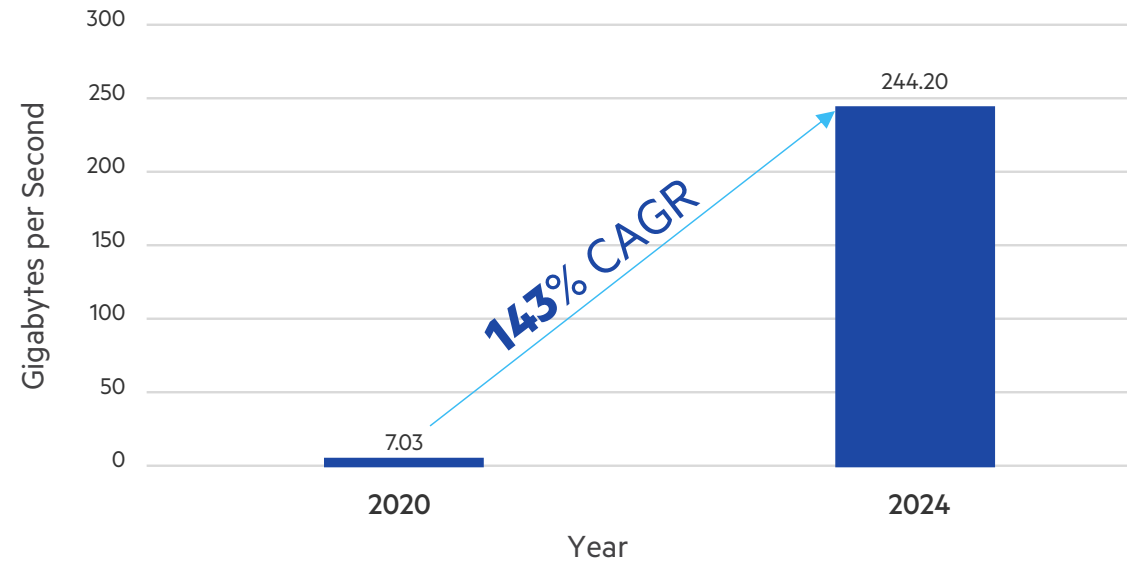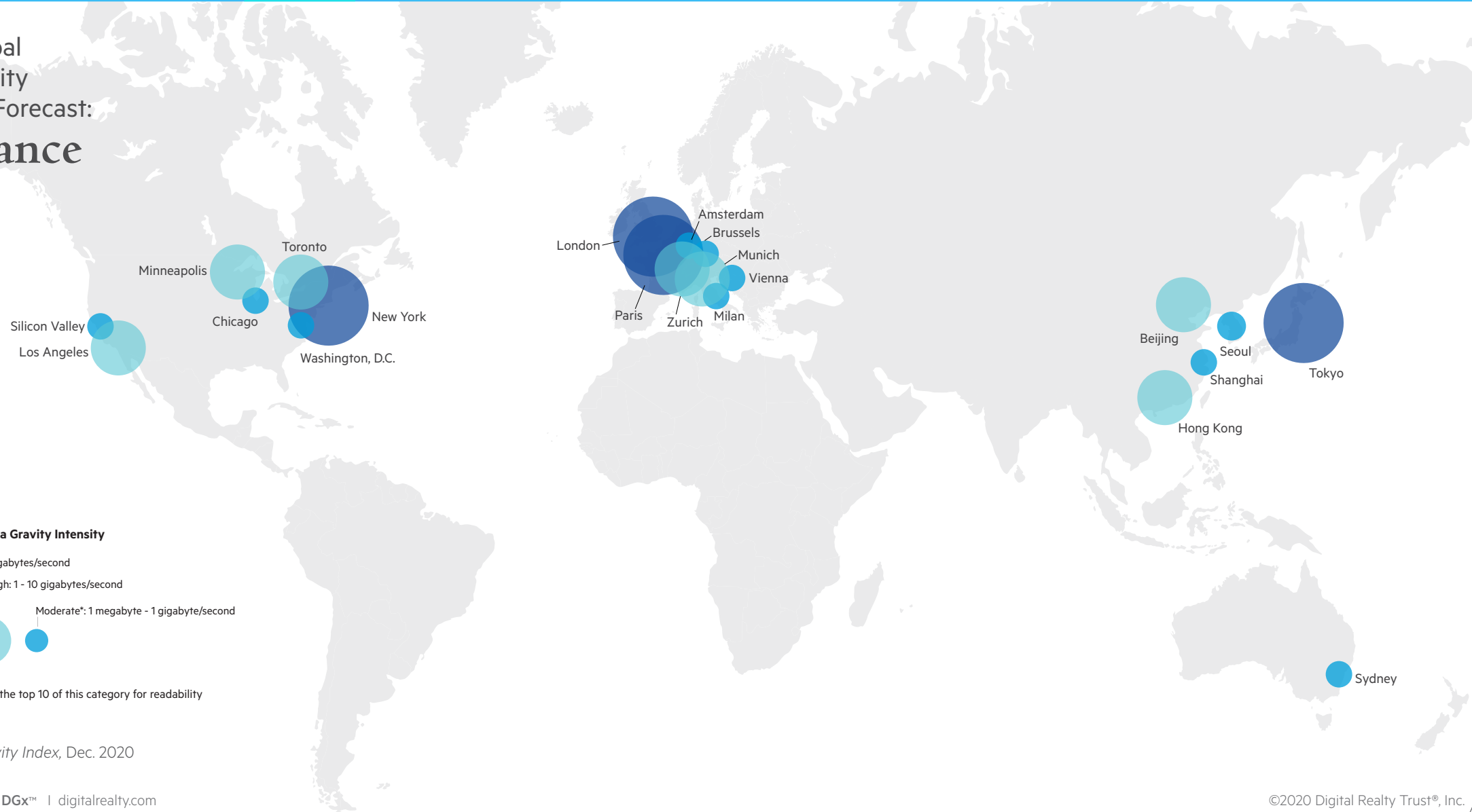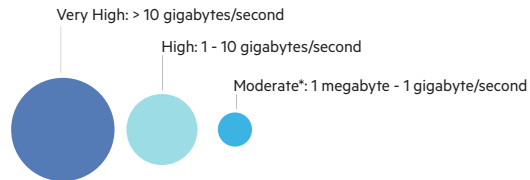## 2024 Global Data Gravity Intensity Forecast:
Insurance

Amsterdam
Brussels
London
Munich
Vienna
Paris
Zurich
Milan
Toronto
Minneapolis
Chicago
Silicon Valley
New York
Los Angeles
Washington, D.C.
Beijing
Seoul
Shanghai
Tokyo
Hong Kong
Sydney

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 16. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Manufacturing

In response to increased in-home consumption, large manufacturers will participate in emerging ecosystems and seek acquisitions in data and analytics[1], thus increasing the number of data sources participating in data exchange. Through 2024, G2000 manufacturers will face an acceleration of Data Gravity Intensity*, as measured in gigabytes per second, which is expected to increase by a compound annual growth rate of 144% globally. Metros forecasted to see the highest impact, in descending order, include Tokyo, Paris, London, New York, Amsterdam, Hong Kong, Singapore, Chicago and Beijing.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, *Implications for Consumer Goods M&A,* June 2020

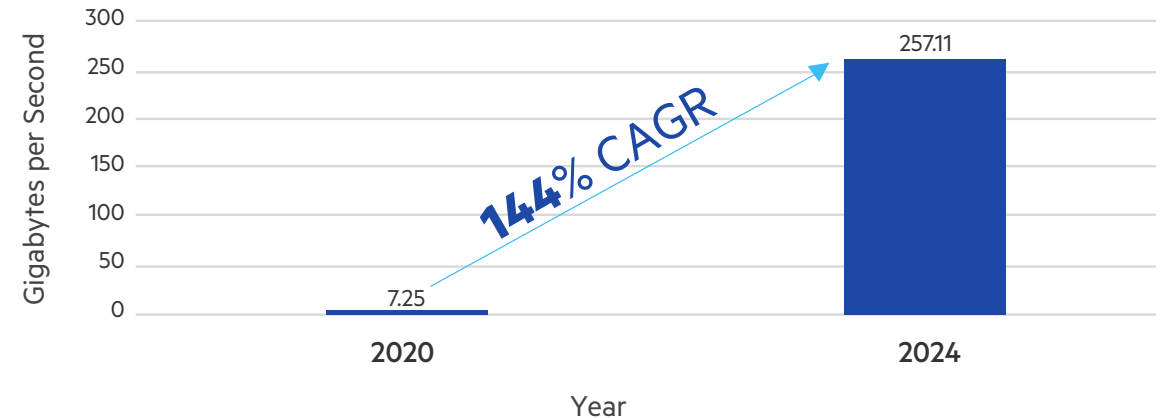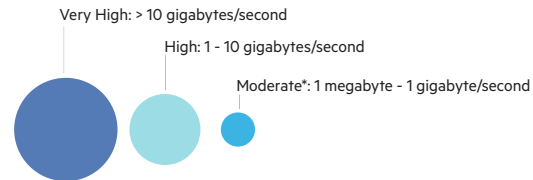### Global Data Gravity Intensity* CAGR 2020-2024 – Manufacturing

Fig. 17. *Data Gravity Index,* Dec. 2020

DGx

2024 Global
Data Gravity
Intensity Forecast:

Manufacturing

Dublin
Amsterdam
London
Brussels
Paris
Frankfurt
Luxembourg
Munich
Milan

Silicon Valley
Chicago
New York
Washington, D.C.
Los Angeles

Beijing
Seoul
Tokyo
Hong Kong
Singapore

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 18. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Mining & Natural Resources

Mining & Natural Resources firms rely on digital acceleration to automate tasks and workflows, improve productivity and boost output recovery. Data generated by IoT sensors and telemetry for predictive analytics used to improve mining and extraction recovery and throughput will drive an increase in enterprise data exchange volumes globally. Through 2024, Data Gravity Intensity* for G2000 Mining & Natural Resources firms is expected to increase at a compound annual growth rate of 130% for the metro areas of London, Beijing and Paris (in descending order).

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

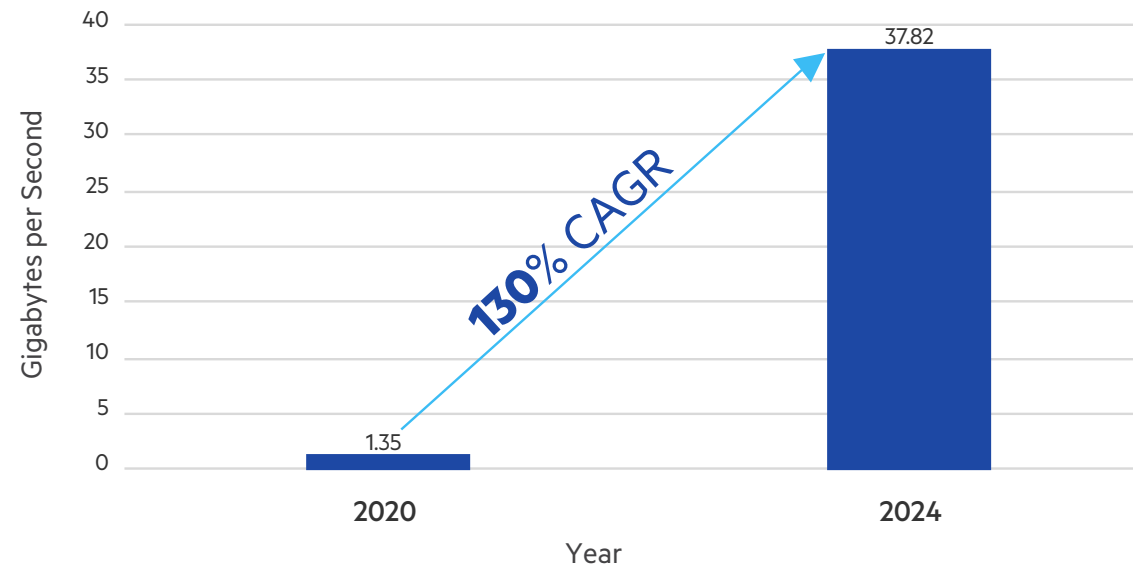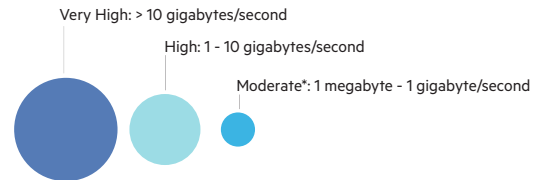**Global Data Gravity Intensity* CAGR 2020-2024 – Mining**

Fig. 19. *Data Gravity Index*, Dec. 2020

2024 Global
Data Gravity
Intensity Forecast:

Mining & Natural Resources

Silicon Valley

Dallas

London

Amsterdam

Paris

Madrid

Moscow

Beijing

Tokyo

Hong Kong

Singapore

Rio De Janeiro

Sydney

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 20. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Pharmaceuticals and Chemical

A 2020 McKinsey survey found that pharmaceuticals executives reported a jump nearly twice as large in digital acceleration as those reported in consumer packaged goods companies[1]. Pharmaceuticals and Chemicals firms across G2000 Enterprises are expected to see an increase in Data Gravity Intensity*, with a projected compound annual growth rate of 142% through 2024. Metros that will have the highest forecast, in descending order, include Tokyo, New York, London, Paris and Dallas.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, How COVID-19 has pushed companies over the technology tipping point, Oct. 2020

Global Data Gravity Intensity* CAGR 2020-2024 – Pharmaceuticals and Chemicals
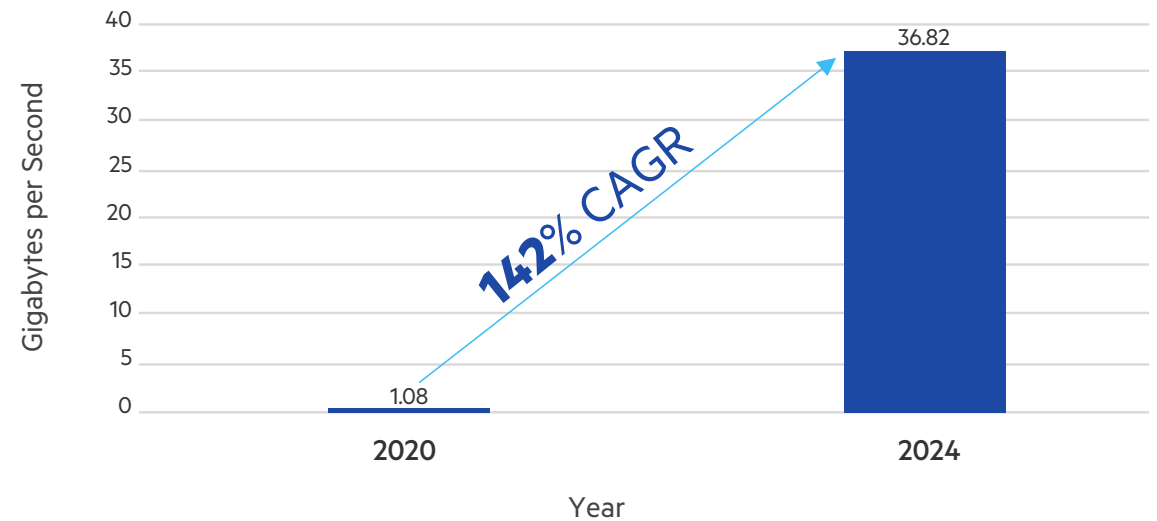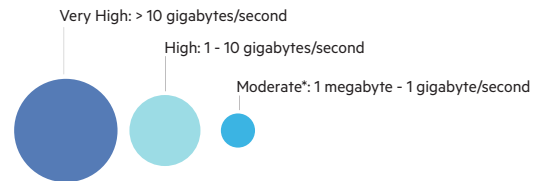

Fig. 21. *Data Gravity Index,* Dec. 2020

DGx

2024 Global
Data Gravity
Intensity Forecast:

Pharmaceuticals and Chemicals

Amsterdam
Brussels
London
Frankfurt
Paris

Silicon Valley
Los Angeles
Dallas
New York

Beijing
Seoul
Tokyo

Mumbai

Hong Kong

Singapore

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 22. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Professional Services

Cited by a 2020 McKinsey survey[1], Professional Services executives reported a jump in digital acceleration nearly twice as large as those reported in consumer packaged goods companies. Through 2024, Professional Services firms across G2000 Enterprises are expected to increase their Data Gravity Intensity* by a projected compound annual growth rate of 139%. Metros forecasted to have the highest Data Gravity Intensity, in descending order, include Silicon Valley, London, Paris, New York, Tokyo, Amsterdam and Washington, D.C.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, How COVID-19 has pushed companies over the technology tipping point, Oct. 2020

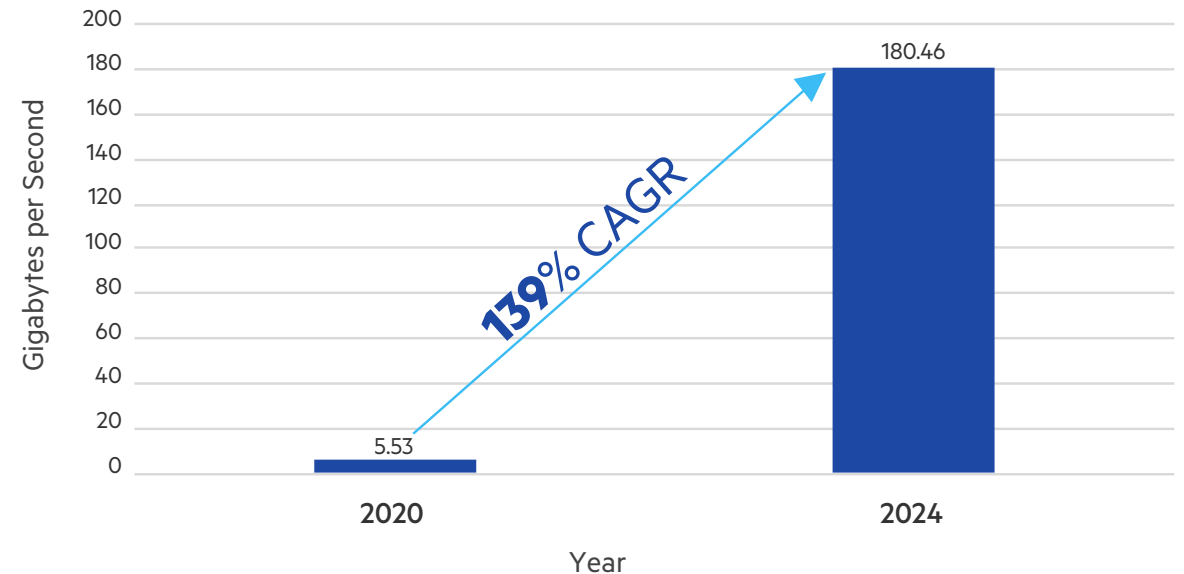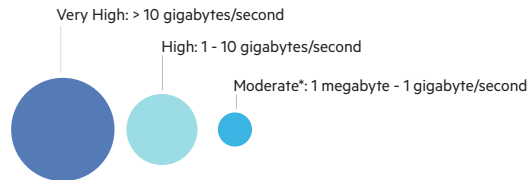**Global Data Gravity Intensity* CAGR 2020-2024 – Professional Services**

Fig. 23. *Data Gravity Index,* Dec. 2020

2024 Global
Data Gravity
Intensity Forecast:

Professional Services

Stockholm
Dublin
Amsterdam
London
Frankfurt
Paris
Madrid

Silicon Valley

New York

Los Angeles

Washington, D.C.

Beijing
Seoul
Tokyo

Hong Kong

Singapore

Sydney

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 24. *Data Gravity Index,* Dec. 2020

Global Data Gravity Intensity Forecast: Retail

The fundamental enabler of digitization for retail companies will be data and analytics capabilities—the transparency, governance and accuracy of which have never been more important[1]. G2000 firms in the retail sector are expected to realize a 137% compound annual growth rate through 2024 for Data Gravity Intensity*, thus increasing enterprise data exchange volumes globally. Metros forecasted to see the highest intensity, in descending order, include London, Seattle, Paris, Amsterdam, Tokyo and New York.

*Defined as meeting a threshold of 1 gigabyte of data per second or greater

1. McKinsey, *Fashion's Digital Transformaton: Now or Never,* May 2020
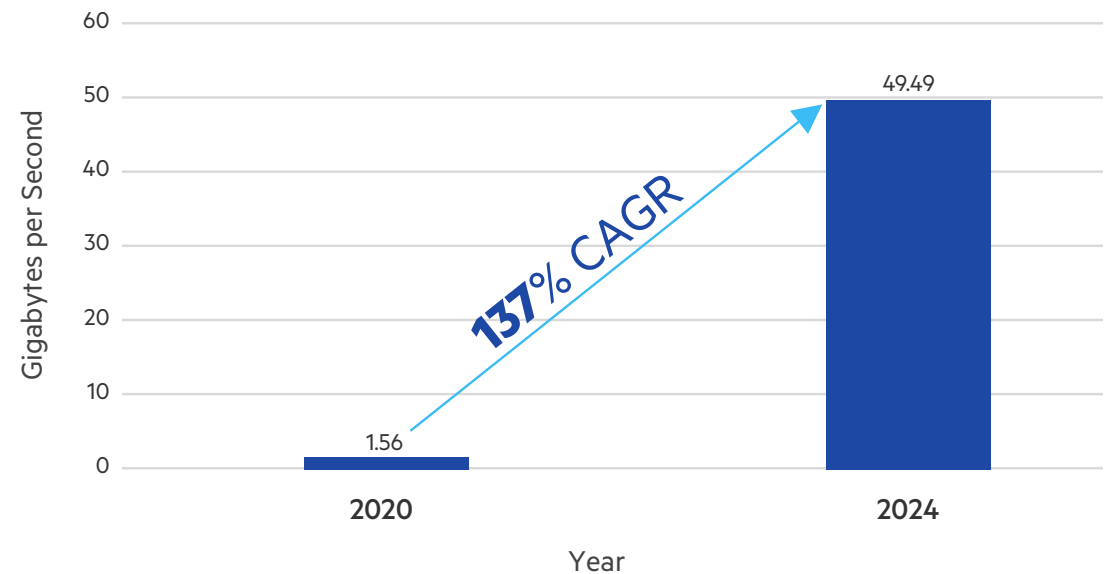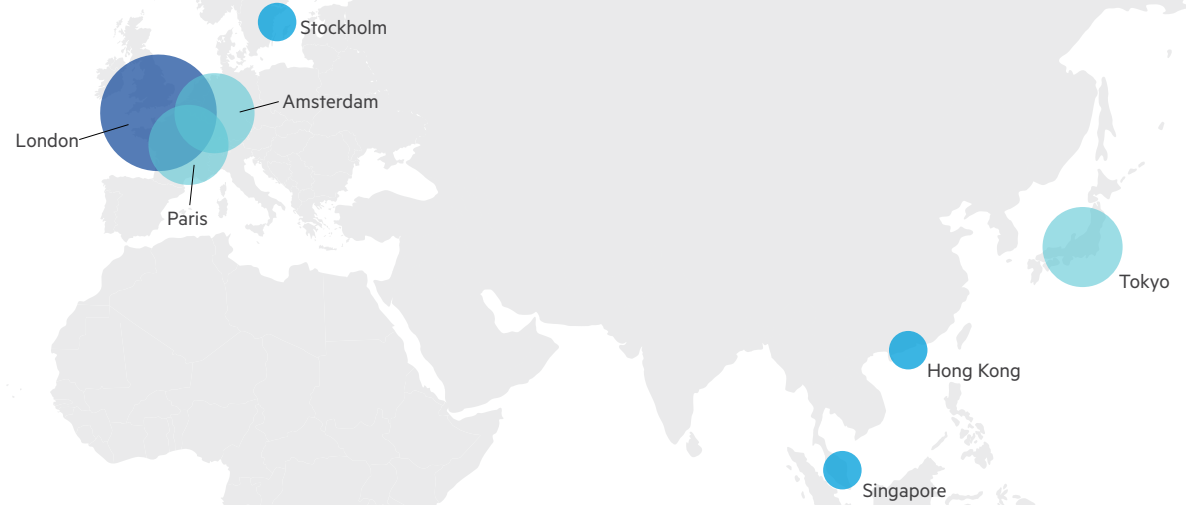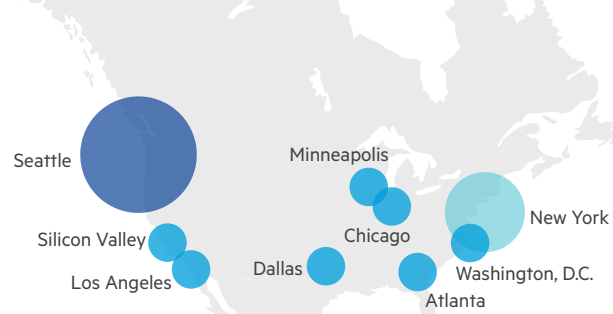
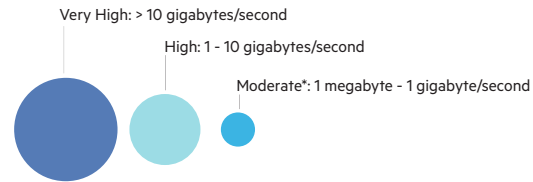### Global Data Gravity Intensity* CAGR 2020-2024 – Retail

Fig. 25. *Data Gravity Index,* Dec. 2020

2024 Global
Data Gravity
Intensity Forecast:

Retail

Seattle
Minneapolis
Silicon Valley
Chicago
New York
Los Angeles
Dallas
Washington, D.C.
Atlanta

Stockholm
Amsterdam
London
Paris

Tokyo
Hong Kong
Singapore

2024 Forecasted Data Gravity Intensity

Very High: > 10 gigabytes/second

High: 1 - 10 gigabytes/second

Moderate*: 1 megabyte - 1 gigabyte/second

*Moderate is limited to the top 10 of this category for readability

Fig. 26. *Data Gravity Index,* Dec. 2020

Data Gravity Intensity Quantified – Enterprise Data Creation

By 2024, it is estimated G2000 Enterprises across the 53 metros will create 1.4 million gigabytes of data per second.

Calculating Enterprise Data Creation (Gigabytes Per Second) [1,2]

Fig. 27. *Data Gravity Index,* Dec. 2020

1. Data creation was calculated by combining data created by both G2000 Enterprise employees and end points..
2. See Methodology for scoring and data.
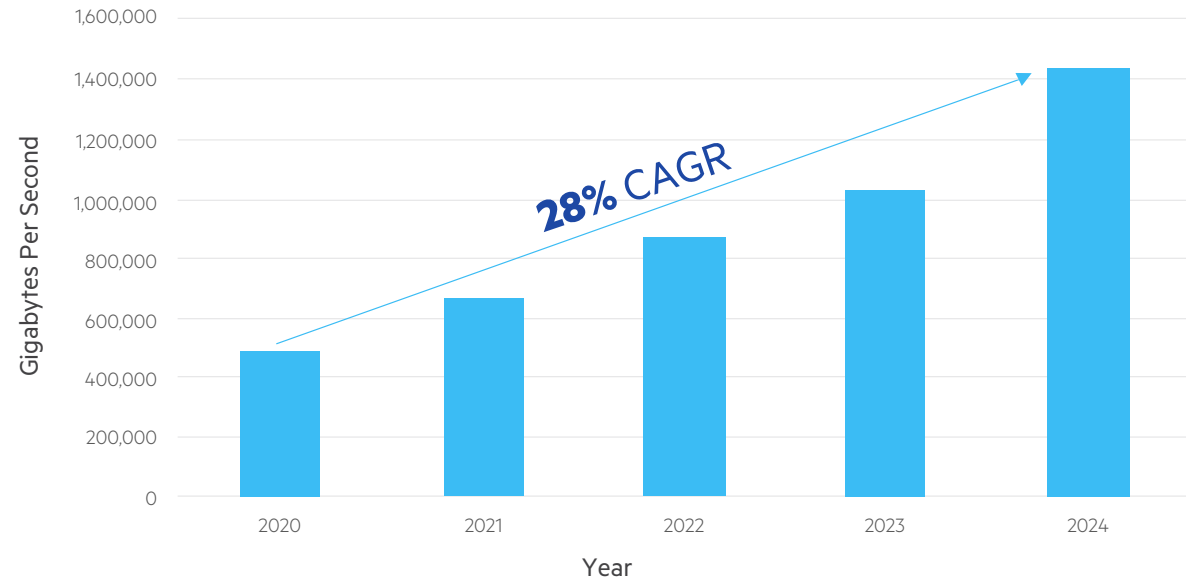
Enterprise Data Processing

By 2024, G2000 Enterprises across 53 metros will require an increase of over 40% in compute processing to accommodate the increased new digital workflows.
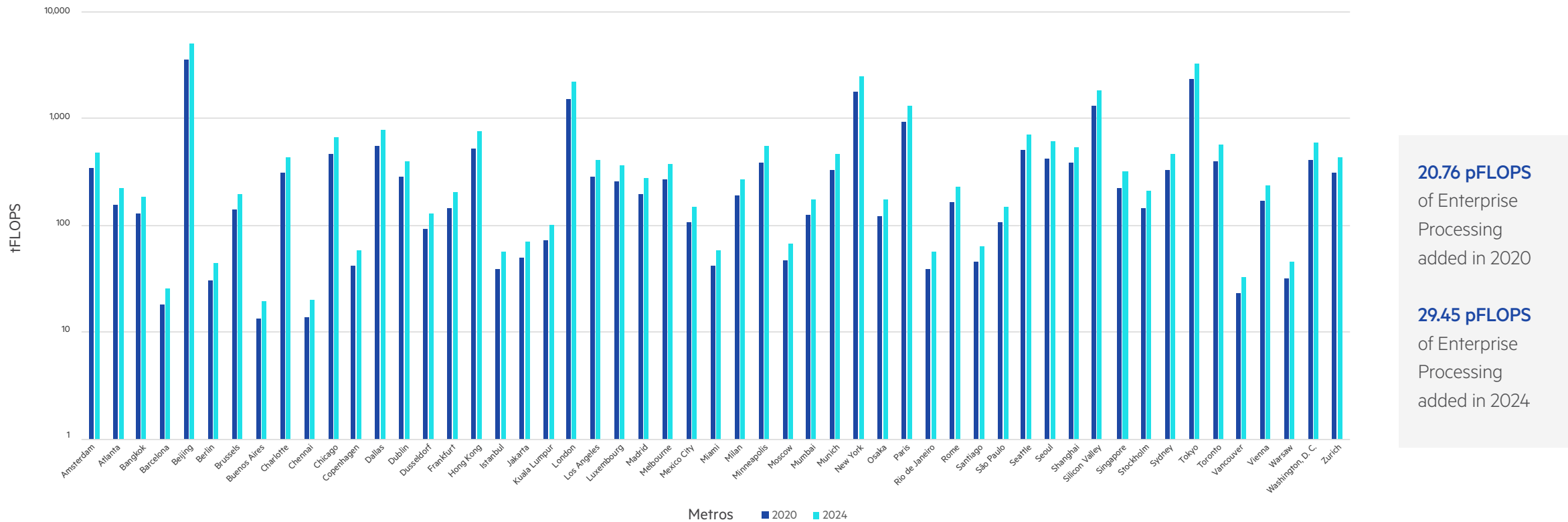

Fig. 28. *Data Gravity Index, Dec.* 2020

20.76 pFLOPS
of Enterprise
Processing
added in 2020

29.45 pFLOPS
of Enterprise
Processing
added in 2024

Metros   ■ 2020   ■ 2024

Data Gravity Intensity Quantified – Enterprise Data Storage

By 2024, it is estimated G2000 Enterprises across the 53 metros will require nearly 20,000 petabytes of additional data storage annually.

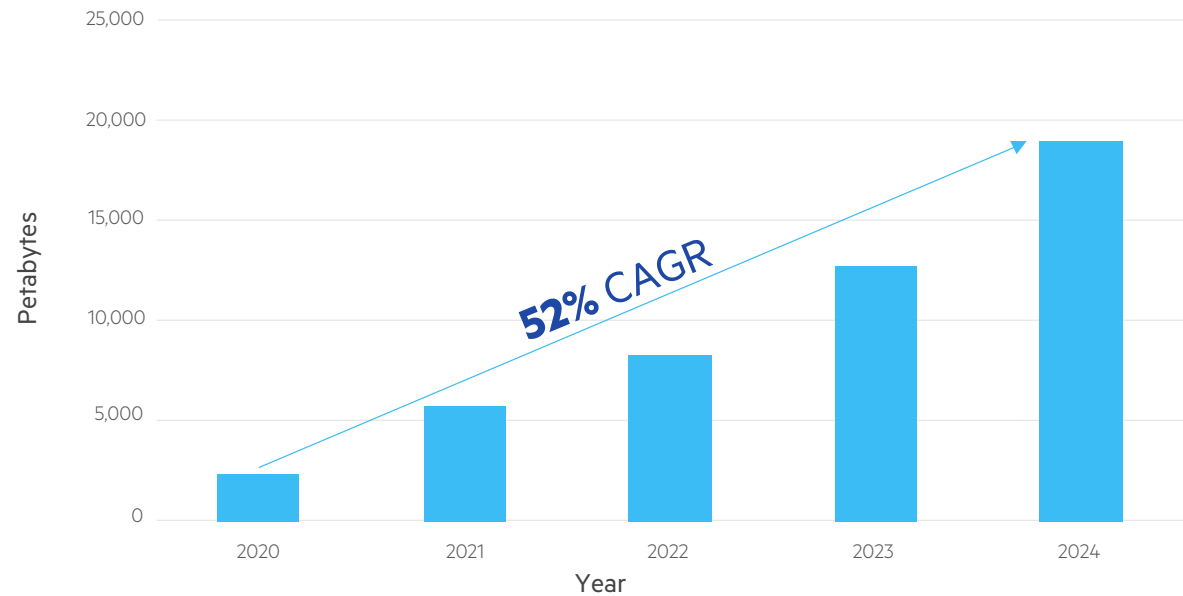## Calculating Enterprise Data Storage Growth (petabytes)[1,2]

Fig 29. *Data Gravity Index,* Dec. 2020

1. Data Storage was calculated by taking the storage capacity, growth and annual rate of deployment of Enterprise storage (HDD, SSD, and Tape) and analyzing across 53 metros.
2. See Methodology for scoring and data.

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Implications

Implication #1 – A Data-Centric Architecture is Mandatory

Current backhaul architecture cannot address enterprise Data Gravity needs, including data exchange across multiple internal/external platforms, local data copies and the capabilities to run performant analytics across each global point of presence. IT architecture needs to be inverted to a data-centric architecture deployed at points of presence in neutral, multi-tenant datacenters to integrate private and public data sources.
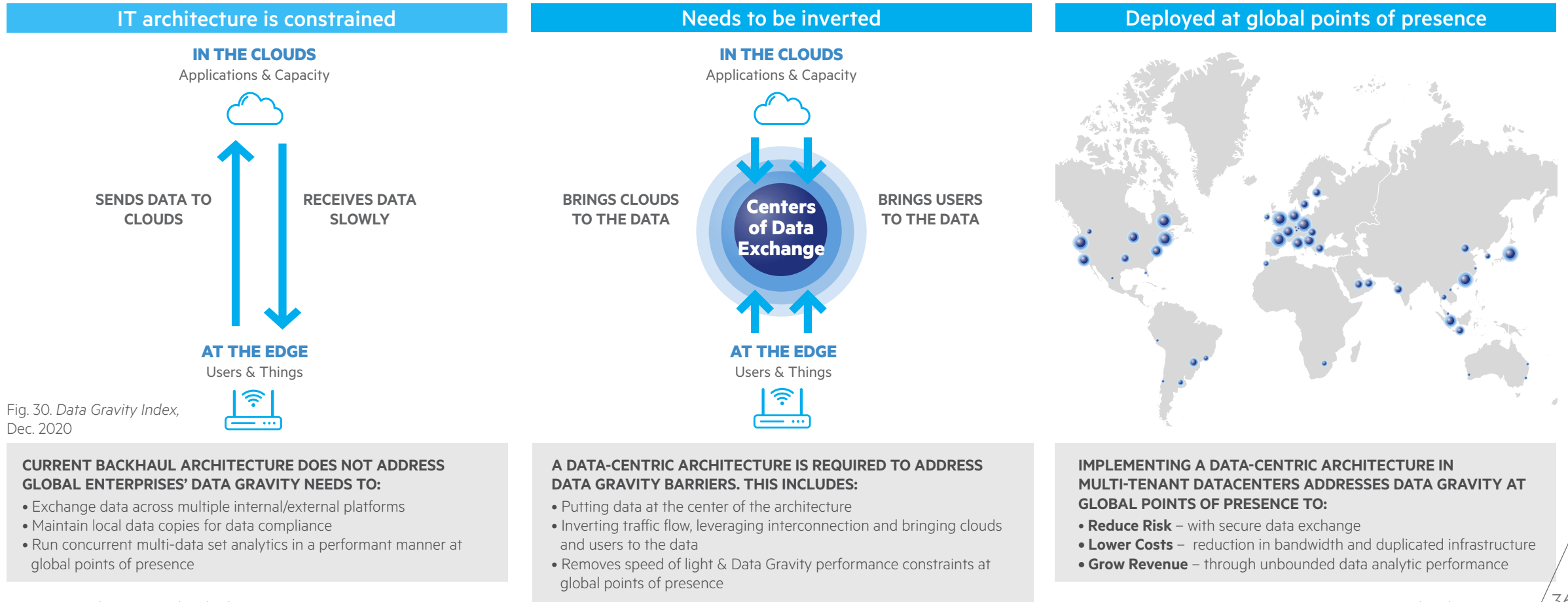
IT architecture is constrained	Needs to be inverted	Deployed at global points of presence

IN THE CLOUDS
Applications & Capacity

IN THE CLOUDS
Applications & Capacity

SENDS DATA TO CLOUDS   RECEIVES DATA SLOWLY

BRINGS CLOUDS TO THE DATA

Centers of Data Exchange

BRINGS USERS TO THE DATA

AT THE EDGE
Users & Things

AT THE EDGE
Users & Things

Fig. 30. *Data Gravity Index,* Dec. 2020

CURRENT BACKHAUL ARCHITECTURE DOES NOT ADDRESS GLOBAL ENTERPRISES' DATA GRAVITY NEEDS TO:

• Exchange data across multiple internal/external platforms
• Maintain local data copies for data compliance
• Run concurrent multi-data set analytics in a performant manner at global points of presence

A DATA-CENTRIC ARCHITECTURE IS REQUIRED TO ADDRESS DATA GRAVITY BARRIERS. THIS INCLUDES:

• Putting data at the center of the architecture
• Inverting traffic flow, leveraging interconnection and bringing clouds and users to the data
• Removes speed of light & Data Gravity performance constraints at global points of presence

IMPLEMENTING A DATA-CENTRIC ARCHITECTURE IN MULTI-TENANT DATACENTERS ADDRESSES DATA GRAVITY AT GLOBAL POINTS OF PRESENCE TO:

• **Reduce Risk** – with secure data exchange
• **Lower Costs** – reduction in bandwidth and duplicated infrastructure
• **Grow Revenue** – through unbounded data analytic performance

Implication #2 – Requires a Connected Community Approach

Solving for Data Gravity requires a connected community approach between enterprises, connectivity, cloud and content providers. This approach allows for integration between core, cloud and edge at centers of data exchange, implementing a secure, data-centric hybrid IT architecture at Global Enterprise points of business presence deployed in multi-tenant datacenters.
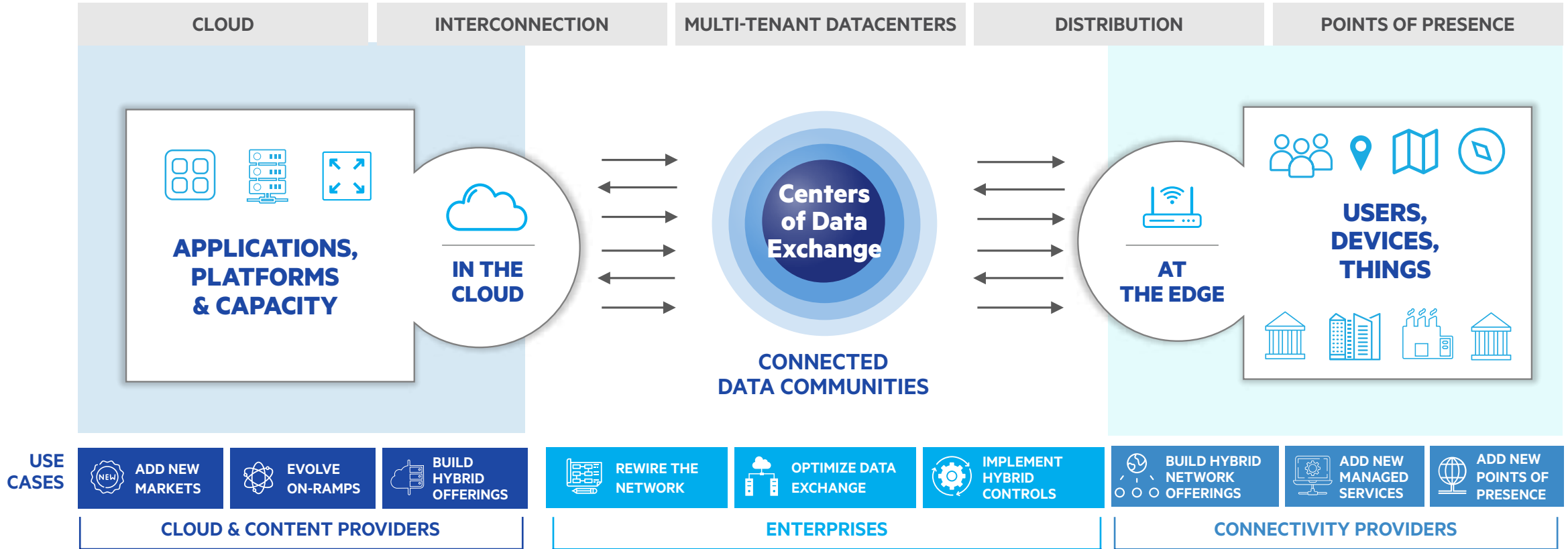

Fig. 31. *Data Gravity Index*, Dec. 2020

Methodology

Methodology

The system for measuring Data Gravity for the Global 2000 Enterprises

Data Gravity Index DGx™ implements a patent-pending formula which quantifies and predicts the continuous creation of data across 53 metros and 23 industries globally.

Analyzing Thousands of Attributes

The Data Gravity Index methodology is based upon the analysis of thousands of attributes of Global 2000 Enterprise companies' presences in each metro, along with variables for each metro, including GDP, population, number of employees, technographics, IT spend, average bandwidth and latency, as well as flows of data.

Solving for Data Mass and Data Activity

The size and attraction of data for each metro was created by solving for a Data Mass figure and a Data Activity figure. The result was then multiplied by the average Bandwidth and divided by the average Latency squared.

$$\left(DM \; \mathbf{x} \; DA \; \mathbf{x} \; BW \right) / L^2$$

DATA MASS   DATA ACTIVITY   BANDWIDTH   LATENCY

Calculating Data Gravity Between Metros

The Data Gravity between metros was calculated by adding Data Masses together and adding the Data Activity figures together, then multiplying their product by Bandwidth and dividing the result by the Latency squared between metros.

Calculating the Enterprise Data Creation Lifecycle

Data Creation was calculated by combining data created by both G2000 Enterprise employees and end points.

Data Processing was calculated by analyzing G2000 Enterprise IT processing needs to handle new data-centric workloads, such as AI & ML, analytics, costs per TFLOPs and other factors.

Data Storage was calculated by taking the storage capacity, growth and annual rate of deployment of Enterprise storage (HDD, SSD, and Tape) and analyzing across 53 metros.

Data Mass
The estimated volume of data stored in a metro over a period of time.

Data Activity
The estimated amount of data movement and interactions in a metro over a period of time.

Bandwidth
The average amount of bandwidth available in a metro or between two metros.

Latency
The average latency between all metros and a single metro or between two specific metros.

Development of Data Gravity Index referenced and/or considered various data sources, including HG Insights, Intricately, Synergy Research Group, Telegeography, PeeringDB, WonderNetworks , Dotcom-Monitor, Organization for Economic Co-Operation and Development, Wikipedia, Google Maps, Worldometer, US. Census, DataUS.io, IDC, 451 Research, Gartner, McKinsey, PWC, Accenture, World Economic Forum and United Nations.

Learn More
Unlock New Capabilities to Manage the Effects of Data Gravity

Explore this new megatrend, and see how the explosion of data growth globally forces a shift to a new data-centric hybrid IT architecture. If you have any questions or want to learn more about this industry-first report, email
datagravity@us.digitalrealty.com

Data Gravity Insights Hub

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• Virtual Events
• Visualization Tools
• New Releases

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Pervasive Datacenter Architecture (PDx™) Library

• PDx Methodology
• Blueprints
• Design Guides
• Solution Briefs

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