Fundamental of Digital Innovation

Nofie Iman

Contents

Computer Networks and ISDN Systems 30 (1998) 107–117

COMPUTER NETWORKS and ISDN SYSTEMS

The anatomy of a large-scale hypertextual Web search engine [1]

Sergey Brin [2], Lawrence Page [*,2]

Computer Science Department, Stanford University, Stanford, CA 94305, USA

Abstract

In this paper, we present Google, a prototype of a large-scale search engine which makes heavy use of the structure present in hypertext. Google is designed to crawl and index the Web efficiently and produce much more satisfying search results than existing systems. The prototype with a full text and hyperlink database of at least 24 million pages is available at http://google.stanford.edu/

To engineer a search engine is a challenging task. Search engines index tens to hundreds of millions of Web pages involving a comparable number of distinct terms. They answer tens of millions of queries every day. Despite the importance of large-scale search engines on the Web, very little academic research has been done on them. Furthermore, due to rapid advance in technology and Web proliferation, creating a Web search engine today is very different from three years ago. This paper provides an in-depth description of our large-scale Web search engine — the first such detailed public description we know of to date.

Apart from the problems of scaling traditional search techniques to data of this magnitude, there are new technical challenges involved with using the additional information present in hypertext to produce better search results. This paper addresses this question of how to build a practical large-scale system which can exploit the additional information present in hypertext. Also we look at the problem of how to effectively deal with uncontrolled hypertext collections where anyone can publish anything they want.

Keywords: World Wide Web; Search engines; Information retrieval; PageRank; Google

1. Introduction

The Web creates new challenges for information retrieval. The amount of information on the Web is growing rapidly, as well as the number of new users inexperienced in the art of Web research. People are likely to surf the Web using its link graph, often starting with high quality human maintained indices such as **Yahoo!** [3] or with search engines. Human maintained lists cover popular topics effectively but are subjective, expensive to build and maintain, slow to improve, and cannot cover all esoteric topics. Automated search engines that rely on keyword matching usually return too many low quality matches. To make matters worse, some advertisers attempt to gain people's attention by taking measures meant to mislead

* Corresponding author.

[1] There are two versions of this paper — a longer full version and a shorter printed version. The full version is available on the Web and the conference CD-ROM.

[2] E-mail: {sergey, page}@cs.stanford.edu

[3] http://www.yahoo.com/

0169-7552/98/$19.00
PII S0169-7552(98)00110-X

https://www.sciencedirect.com/science/article/abs/pii/S016975529800110X

Computer Networks and ISDN Systems 30 (1998) 107–117

COMPUTER NETWORKS and ISDN SYSTEMS

The anatomy of a large-scale hypertextual Web search engine [1]

Sergey Brin [2], Lawrence Page [*,2]

Computer Science Department, Stanford University, Stanford, CA 94305, USA

Abstract

In this paper, we present Google, a prototype of a large-scale search engine which makes heavy use of the structure present in hypertext. Google is designed to crawl and index the Web efficiently and produce much more satisfying search results than existing systems. The prototype with a full text and hyperlink database of at least 24 million pages is available at http://google.stanford.edu/

To engineer a search engine is a challenging task. Search engines index tens to hundreds of millions of Web pages involving a comparable number of distinct terms. They answer tens of millions of queries every day. Despite the importance of large-scale search engines on the Web, very little academic research has been done on them. Furthermore, due to rapid advance in technology and Web proliferation, creating a Web search engine today is very different from three years ago. This paper provides an in-depth description of our large-scale Web search engine — the first such detailed public description we know of to date.

Apart from the problems of scaling traditional search techniques to data of this magnitude, there are new technical challenges involved with using the additional information present in hypertext to produce better search results. This paper addresses this question of how to build a practical large-scale system which can exploit the additional information present in hypertext. Also we look at the problem of how to effectively deal with uncontrolled hypertext collections where anyone can publish anything they want.

Keywords: World Wide Web; Search engines; Information retrieval; PageRank; Google

1. Introduction

The Web creates new challenges for information retrieval. The amount of information on the Web is growing rapidly, as well as the number of new users inexperienced in the art of Web research. People are likely to surf the Web using its link graph, often starting with high quality human maintained indices such as **Yahoo!** [3] or with search engines. Human maintained lists cover popular topics effectively but are subjective, expensive to build and maintain, slow to improve, and cannot cover all esoteric topics. Automated search engines that rely on keyword matching usually return too many low quality matches. To make matters worse, some advertisers attempt to gain people's attention by taking measures meant to mislead

* Corresponding author.

[1] There are two versions of this paper — a longer full version and a shorter printed version. The full version is available on the Web and the conference CD-ROM.

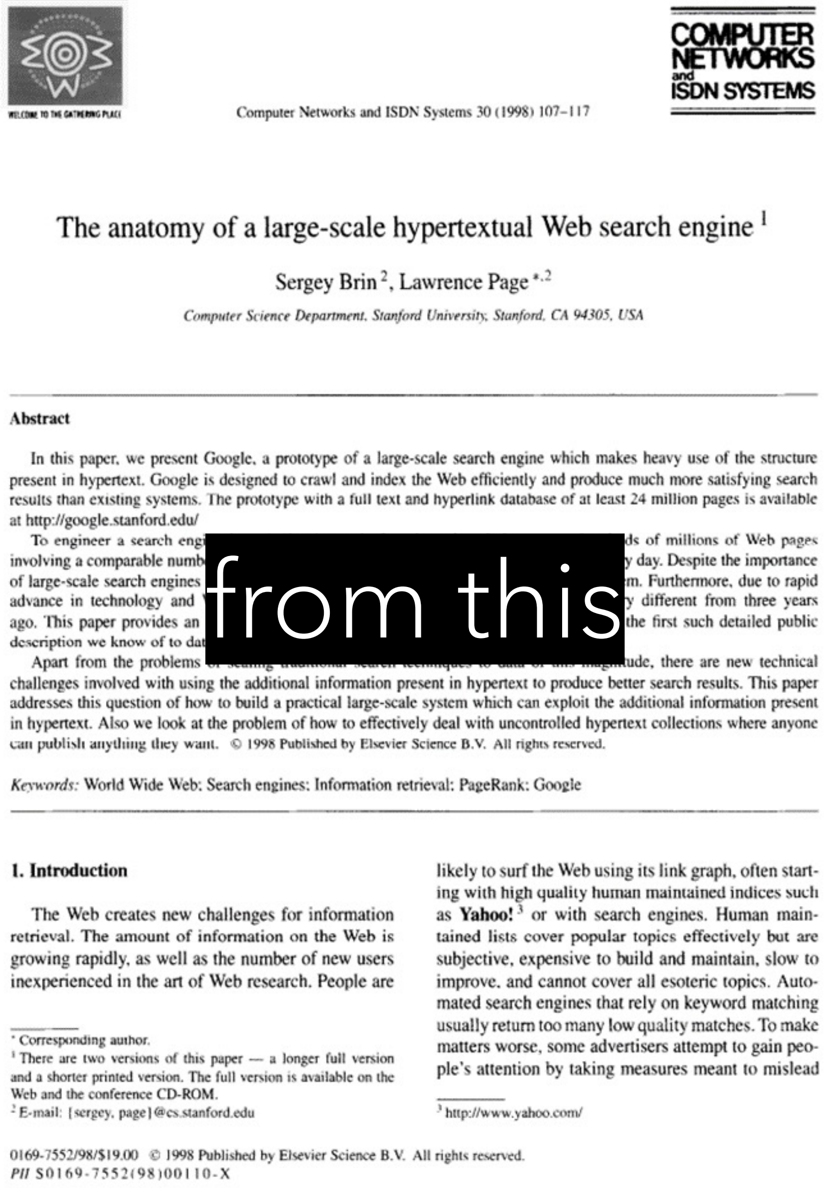
[2] E-mail: {sergey, page}@cs.stanford.edu

[3] http://www.yahoo.com/

0169-7552/98/$19.00
PII S0169-7552(98)00110-X

https://www.sciencedirect.com/science/article/abs/pii/S016975529800110X

https://www.theverge.com/2019/12/4/20994361/google-alphabet-larry-page-sergey-brin-sundar-pichai-co-founders-ceo-timeline


Computer Networks and ISDN Systems 30 (1998) 107–117

The anatomy of a large-scale hypertextual Web search engine [1]

Sergey Brin [2], Lawrence Page [*,2]

Computer Science Department, Stanford University, Stanford, CA 94305, USA

Abstract

In this paper, we present Google, a prototype of a large-scale search engine which makes heavy use of the structure present in hypertext. Google is designed to crawl and index the Web efficiently and produce much more satisfying search results than existing systems. The prototype with a full text and hyperlink database of at least 24 million pages is available at http://google.stanford.edu/

To engineer a search engi [redacted] ds of millions of Web pages involving a comparable numb [redacted] y day. Despite the importance of large-scale search engines [redacted] m. Furthermore, due to rapid advance in technology and [redacted] y different from three years ago. This paper provides an [redacted] the first such detailed public description we know of to dat [redacted]

Apart from the problems [redacted] ude, there are new technical challenges involved with using the additional information present in hypertext to produce better search results. This paper addresses this question of how to build a practical large-scale system which can exploit the additional information present in hypertext. Also we look at the problem of how to effectively deal with uncontrolled hypertext collections where anyone can publish anything they want.

Keywords: World Wide Web; Search engines; Information retrieval; PageRank; Google

from this

1. Introduction

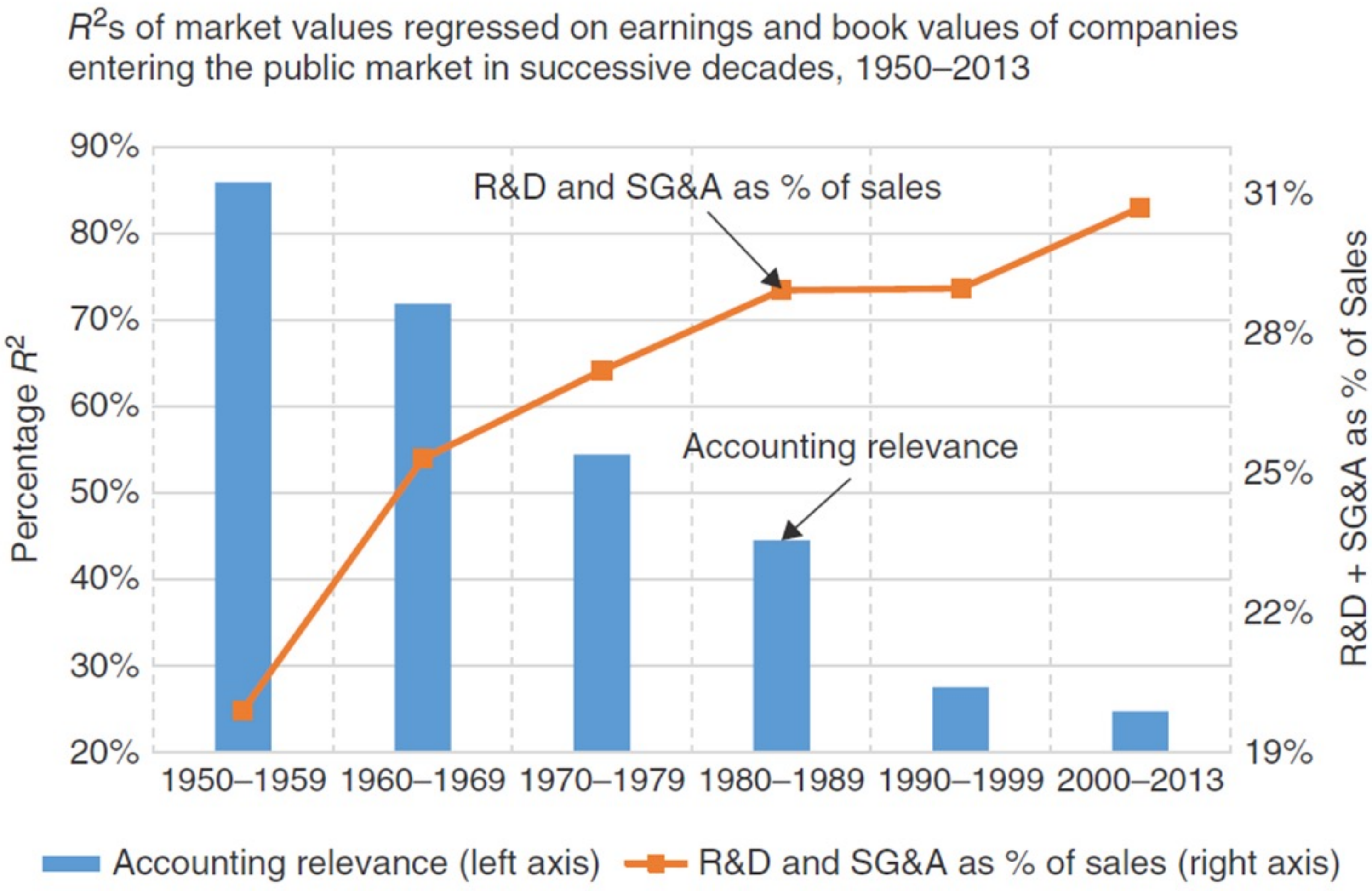
The Web creates new challenges for information retrieval. The amount of information on the Web is growing rapidly, as well as the number of new users inexperienced in the art of Web research. People are likely to surf the Web using its link graph, often starting with high quality human maintained indices such as **Yahoo!** [3] or with search engines. Human maintained lists cover popular topics effectively but are subjective, expensive to build and maintain, slow to improve, and cannot cover all esoteric topics. Automated search engines that rely on keyword matching usually return too many low quality matches. To make matters worse, some advertisers attempt to gain people's attention by taking measures meant to mislead

* Corresponding author.
[1] There are two versions of this paper — a longer full version and a shorter printed version. The full version is available on the Web and the conference CD-ROM.
[2] E-mail: {sergey, page}@cs.stanford.edu
[3] http://www.yahoo.com/

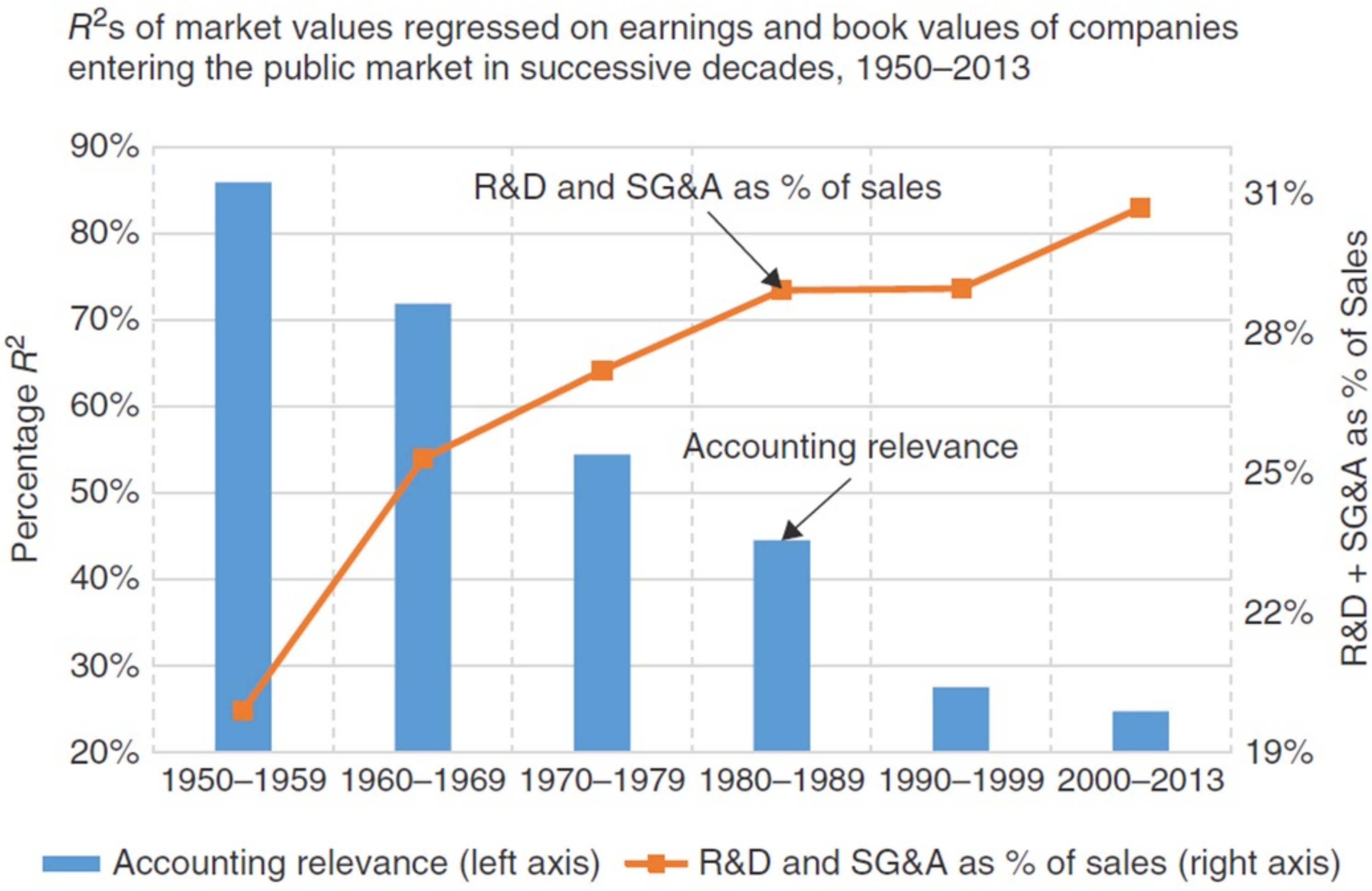
0169-7552/98/$19.00 © 1998 Published by Elsevier Science B.V. All rights reserved.
PII S0169-7552(98)00110-X

https://www.sciencedirect.com/science/article/abs/pii/S016975529800110X

https://www.theverge.com/2019/12/4/20994361/google-alphabet-larry-page-sergey-brin-sundar-pichai-co-founders-ceo-timeline



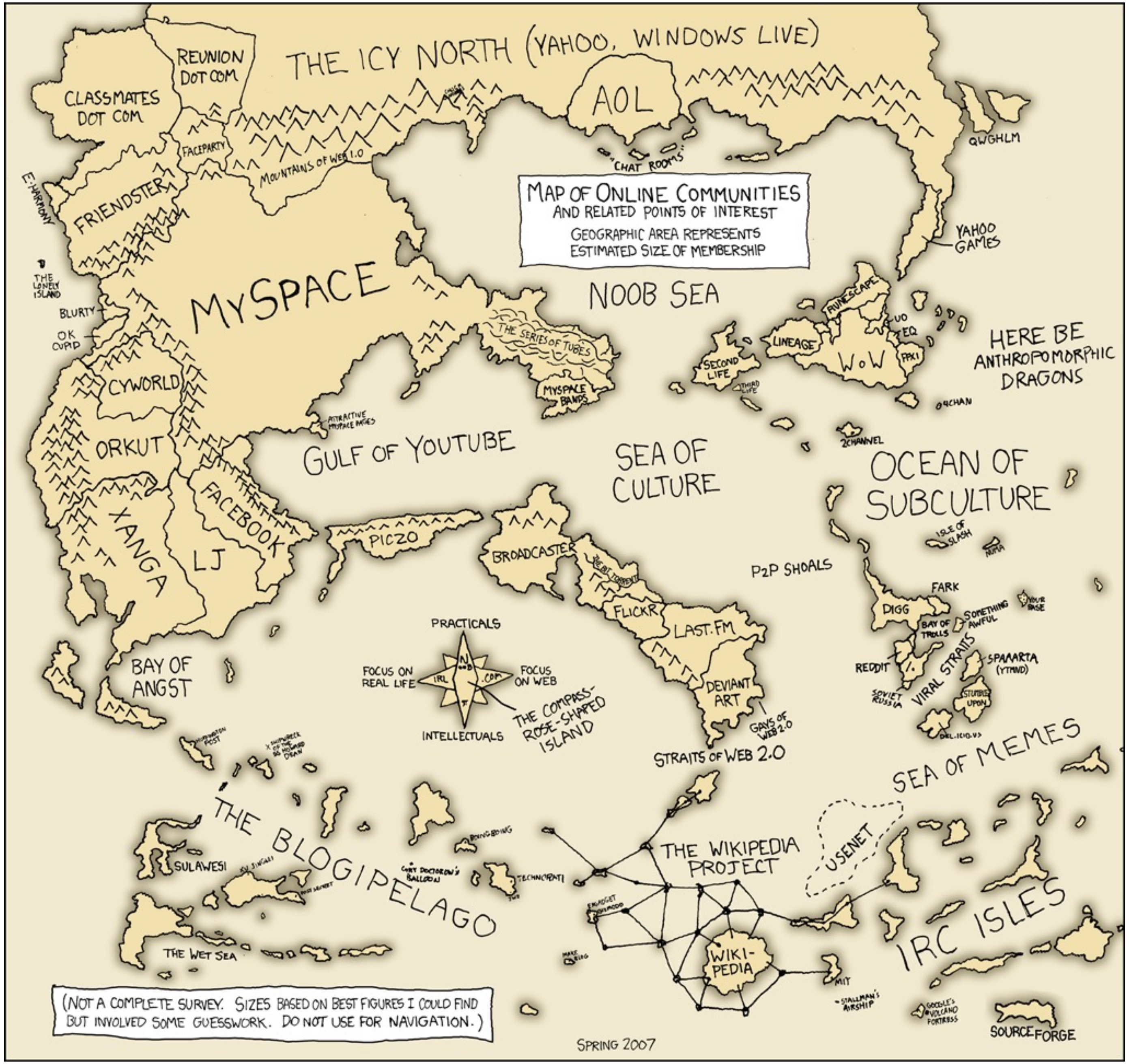
Lev and Gu (2016). *The End of Accounting and The Path Forward for Investors and Managers*. NJ: John Wiley & Sons.



Lev and Gu (2016). *The End of Accounting and The Path Forward for Investors and Managers*. NJ: John Wiley & Sons.

Technological capabilities as new asset?

Newer companies are entering the market by endowing more intangible capital (as can be seen from the rising R&D and SG&A curve). They relied more on intangibles (incl. brand, technology, algorithm, etc.) than fixed assets and capital, making the relevance of old/conventional financial accounting information decreases sharply (from 80% in the 1950s to 25% in the 2000s).

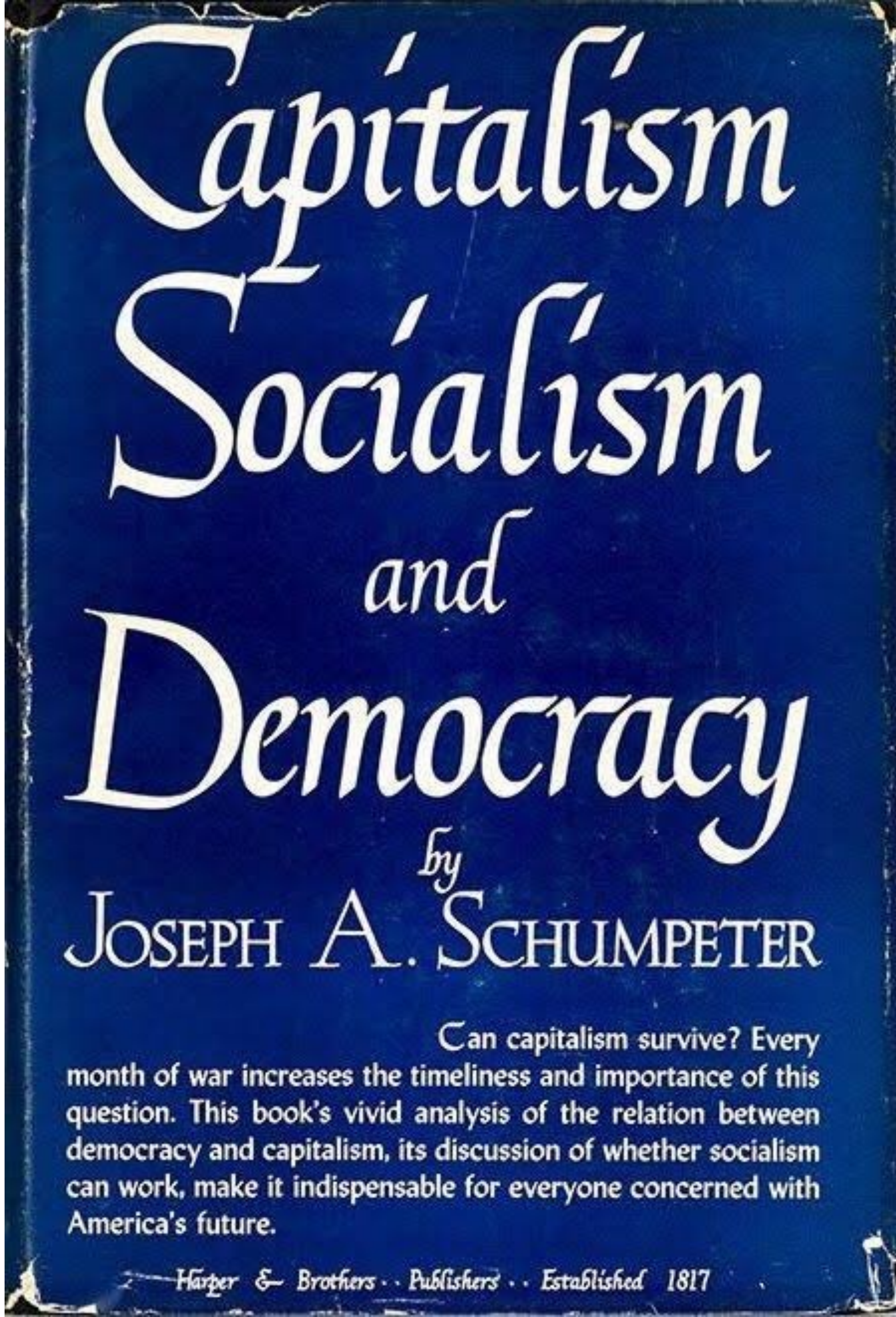


Look how quickly the world changes. This map, drawn by Randall Munroe in 2007, represented the most popular online communities of the time as islands and continents. Land size was based roughly on the number of users of each service.

https://xkcd.com/256/

Innovation as Creative Destruction

- "Innovation would **destroy** existing technologies and methods of production by newer and more efficient products."
- Digital economy's discontinuity, uncertainty
  - Telephone line » optical networks » wireless » the Internet protocol platforms
  - Mergers, acquisitions, investment and disinvestment worldwide
  - Social and political restructuring



Digital Market Restructuring

- **Industrial restructuring**
  - disappearing industry boundaries, entry barriers, market positions
  - interfirm alliances, cost-reducing innovations
- **Deregulation**
  - collapse of natural monopoly
  - competitive entry and repricing
  - privatization, M&A, strategic alliances
- **Newly competitive positioning**
  - 'hypercompetitive' strategy
  - substituting for protected market position
- **Technological assumption shift**
  - digital, wide-bandwidth, wireless, platforms
- **Business ecosystems** = cooperative business models
  - act in unison and share core capabilities


TAKSI


GO CAR
TAKSI
BLUE BIRD GROUP


GO RIDE
Jl. Kemang Dalam 1
Rumah hijau pagar hitam
Add Destination
GO-JEK
GO-CAR
GO CAR
LAYANAN TRANSPORTASI DARI GO-JEK
KINI SEMAKIN LENGKAP DENGAN GO-CAR*


TikTok
TIKTOK SHOP BUKA LAGI, GANDENG
TOKOPEDIA SEBAGAI PARTNER

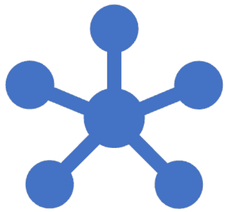
Digital Innovation

- Digital innovation is the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology.
  - Include a range of innovation outcomes: new products, platforms, services, UX, etc.
  - Broad swath of digital tools and infrastructure for making innovation possible: 3D printing, data analytics, mobile computing, etc.
  - Possibility that outcomes may be diffused, assimilated, or adapted to specific use contexts such as typically experienced with digital platforms

(Old) Fundamental Assumptions

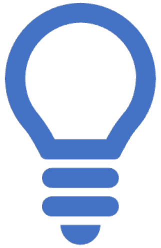
#1

Innovation is a well-bounded phenomenon focused on fixed products



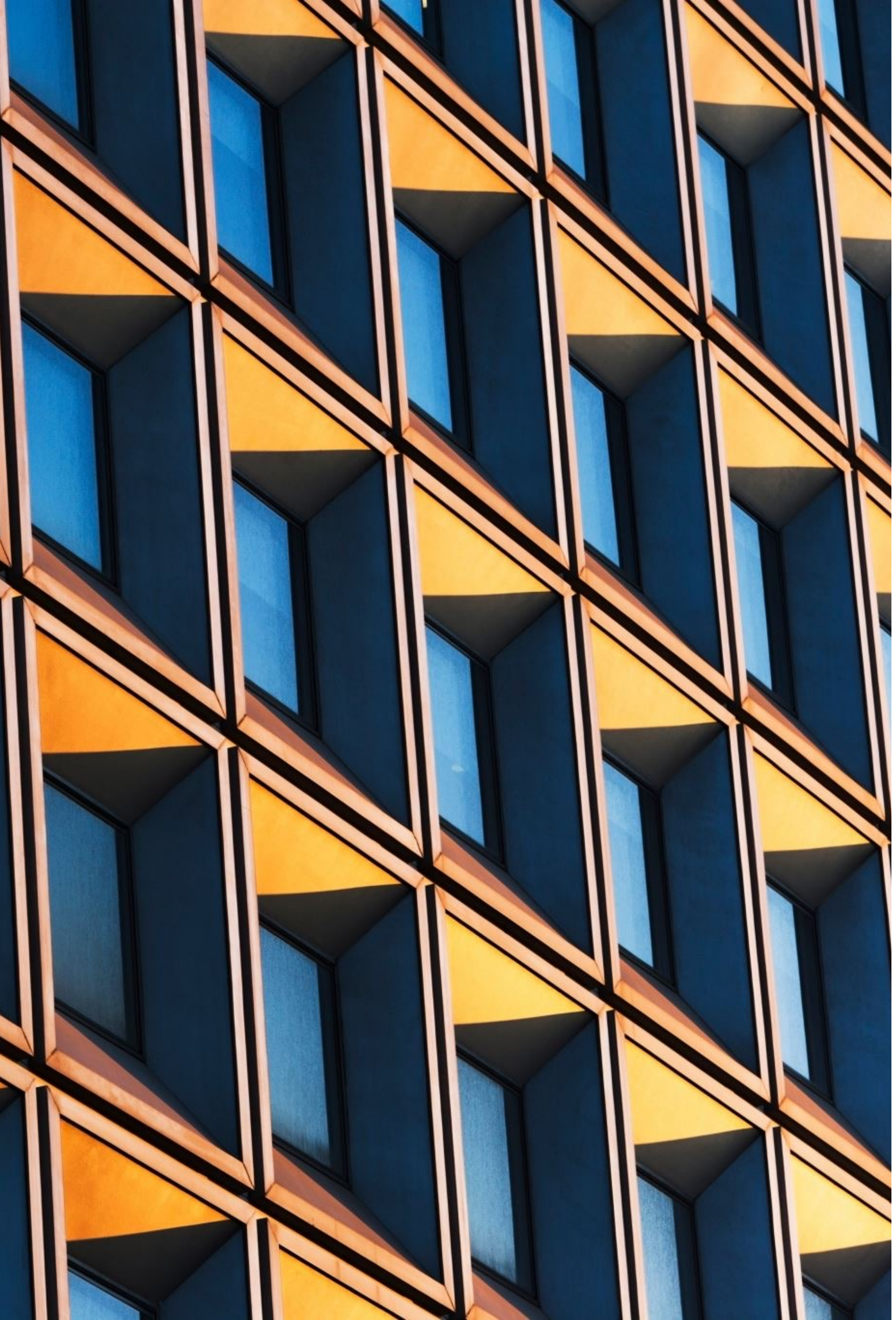
#2

The nature of innovation agency is centralized



#3

Innovation processes and outcomes are distinctly different phenomenon



#1 Innovation is a well-bounded phenomenon focused on fixed products

- Most digital designs remain somewhat **incomplete** and in a **state of flux**
- Unprecedented level of **unpredictability** and **dynamism**
- Boundaries have become more **porous** and **fluid**
- Innovation processes and outcomes have become **less bounded** in terms of their temporal structure
- Less clear as to when a particular process of innovation phase **starts** and/or **ends**
- Innovation processes unfold in a **nonlinear** fashion across time and space
- Innovation processes and outcomes reflect newer **success criteria** and **underlying factors**

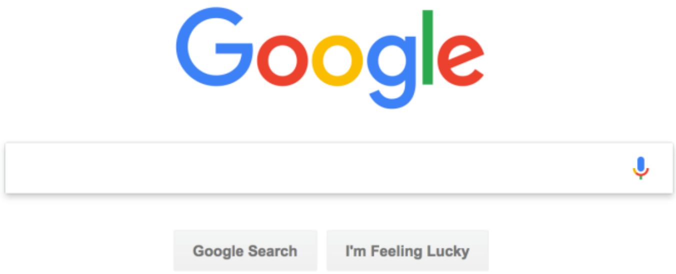


Image credit: Unsplash

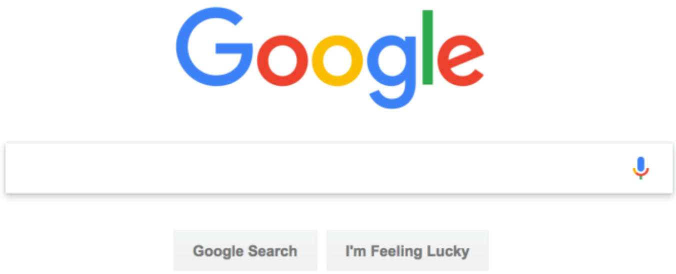
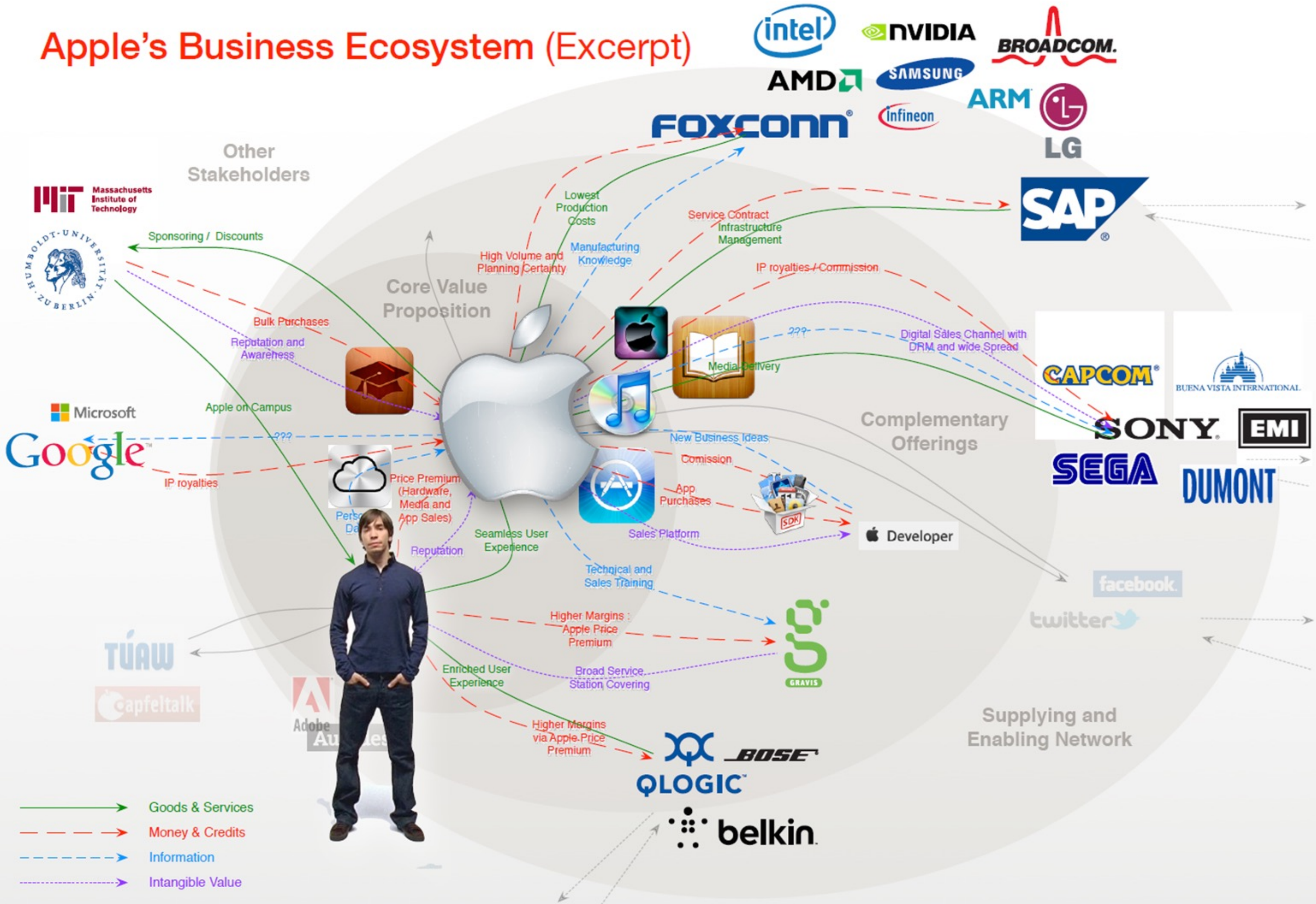


Image credit: Unsplash

#2 The nature of innovation agency is centralized

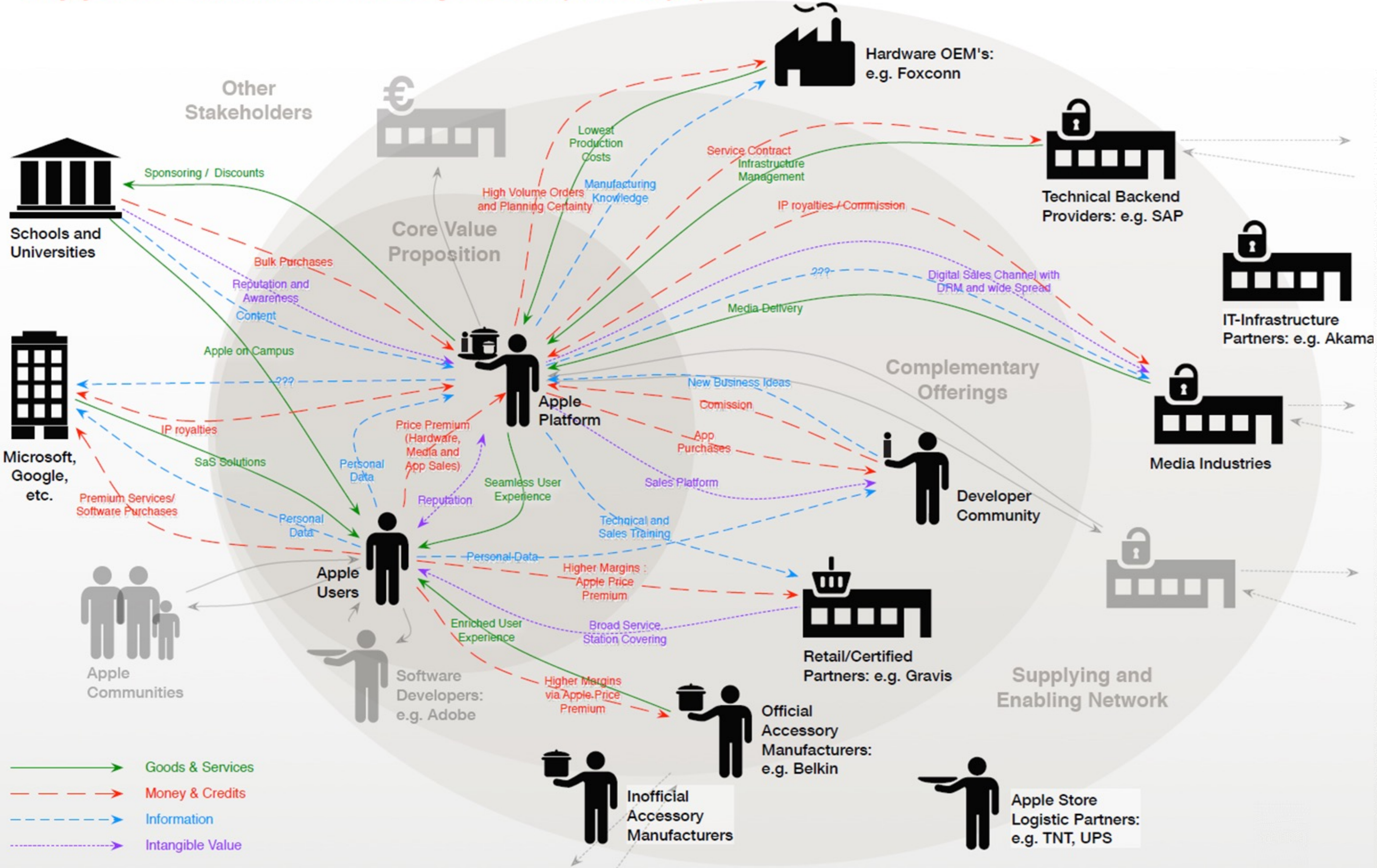
- The shift toward **distributed innovation** (Lakhani & Panetta, 2007; Sawhney & Prandelli, 2000), open innovation (Chesbrough, 2003), network-centric innovation (Nambisan & Sawhney, 2007)
- Unexpected **collection of actors** with diverse goals and motives engage in the innovation process (Bogers & West, 2012)
- Such collectives can **opt in** and **out** while their goals change, new competencies are needed, motivations shifts, complementary capabilities need to be garnered, new constraints and opportunities emerge, or varying contributions become recognized (Lusch & Nambisan, 2015)
- **Digital platforms** and **open standards** enable collectives to pursue innovation collaboratively (Boudreau, 2010; Gawer & Cusumano, 2014; Parker et al., 2016)

Apple's Business Ecosystem (Excerpt)



Schmiedgen (2013). Design Thinking Barcamp 2013 - Hamburg / Service Experience Camp Berlin - 2013.

Apple's Business Ecosystem (Excerpt)



Schmiedgen (2013). Design Thinking Barcamp 2013 - Hamburg / Service Experience Camp Berlin - 2013.

#3 Innovation processes and outcomes are distinctly different phenomenon

- Dependencies between innovation processes and innovation outcomes are **complex** and **dynamic**
- Generate multiple "**wakes of innovation**", unexpected interactions and collaborations between different stakeholders
- Innovation processes and outcomes are **shaping** and **being shaped** by the other.


CREATIVE
MIC
MuVo
TX FM
256MB

Image credit: Unsplash

New Logics of Digital Innovation

- Dynamic problem-solution design
- Socio-cognitive sensemaking
- Technology affordances and constraints
- Orchestration

New Logics of Digital Innovation

Dynamic problem-solution design

Socio-cognitive sensemaking

This refers to the approach of continuously adapting and refining solutions to fit evolving problems. It’s like adjusting your route on a road trip based on traffic or road closures to reach your destination efficiently.

Orchestration

New Logics of Digital Innovation

Dynamic problem-solution design

Socio-cognitive sensemaking

This involves understanding how people think and interact within social contexts to make sense of complex situations. It's like interpreting social cues and norms to understand what's going on in a group conversation or social gathering.

Orchestration

New Logics of Digital Innovation

This means considering both the capabilities and limitations of technology when designing solutions. It's like understanding what a smartphone can and cannot do when developing a new app or software.

ocio-cognitive
nsemaking

Technology affordances and constraints

Orchestration

New Logics of Digital Innovation

This involves coordinating various elements or components in a harmonious way to achieve a desired outcome. It’s like conducting an orchestra, where different instruments play together under the direction of a conductor to create beautiful music.

ocio-cognitive
nsemaking

Technology affordances and constraints

Orchestration

Innovate in Methods to Study Innovation

COMPUTATIONAL SOCIAL SCIENCES

CONFIGURATIONAL ANALYSIS

COMPLEXITY THEORY METHODS

COMPUTATIONAL SOCIAL SCIENCES

This method uses computers and data analysis to study how people interact and influence innovation. Imagine if you could use computers to analyze millions of social media posts to understand how people talk about new ideas or products. Computational social sciences do just that, helping researchers **uncover patterns and trends** in human behavior related to innovation.

CONFIGURATIONAL ANALYSIS

Configurational analysis looks at how different factors come together in various combinations to drive innovation. Think of it like solving a puzzle: instead of focusing on one piece at a time, configurational analysis looks at how all the pieces fit together to create the whole picture of innovation. It helps researchers **identify which combinations of factors** lead to successful innovation and which ones don't.

COMPLEXITY THEORY METHODS

Complexity theory helps us understand how complex systems, like economies or ecosystems, behave and evolve over time. Imagine if you were trying to understand a traffic jam. Complexity theory wouldn't just look at individual cars; it would study how interactions between cars, roads, drivers, and other factors create the traffic jam. Similarly, in innovation, complexity theory helps researchers **see how various factors interact** to shape the innovation process.

What is the difference?

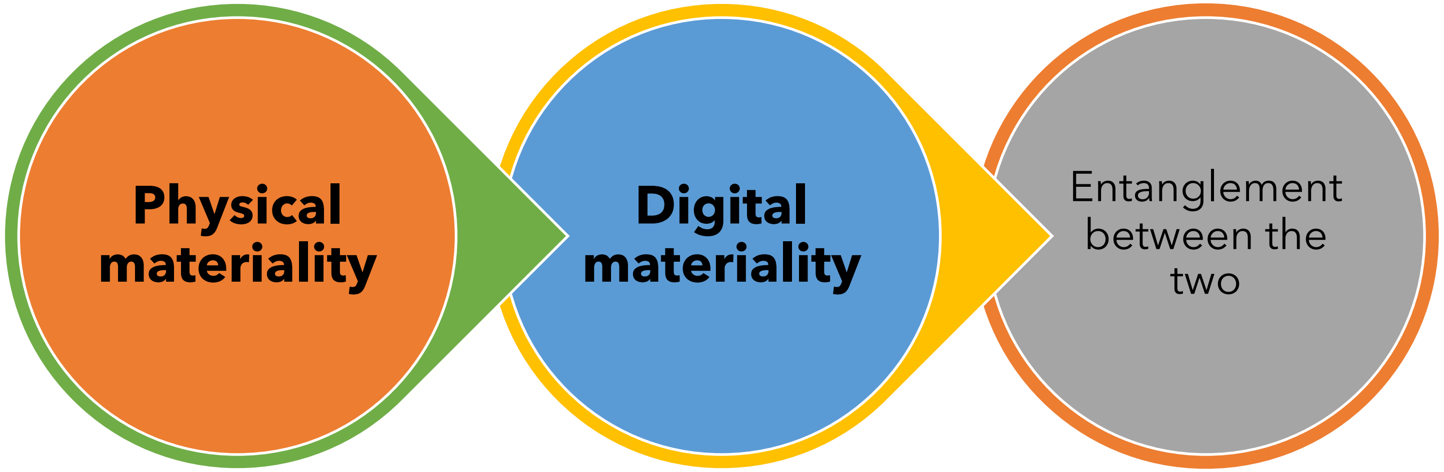
What is the difference?

Our understanding of tangible concepts (i.e., bicycle) is often grounded in direct sensory experiences. We can observe the shape, color, texture, and functionality of a bicycle through our senses, which helps us comprehend it more easily. Tangible concepts are usually easier for humans to grasp because they align with our innate ability to perceive and interact with the physical world.

What is the difference?

Understanding intangible concepts (i.e., electric signals through telephone line) often requires more abstract thinking and mental representation. We cannot see or touch electric signals directly, so we rely on mental models and explanations to understand how they work. Intangible concepts may be more challenging for humans to comprehend because they often involve complex systems or ideas that are not immediately accessible through our senses.

Digital Innovation



Artifact that can be touched/seen, hard to change, connote a sense of place and time.

Software incorporated into an artifact can do by manipulating digital representations.

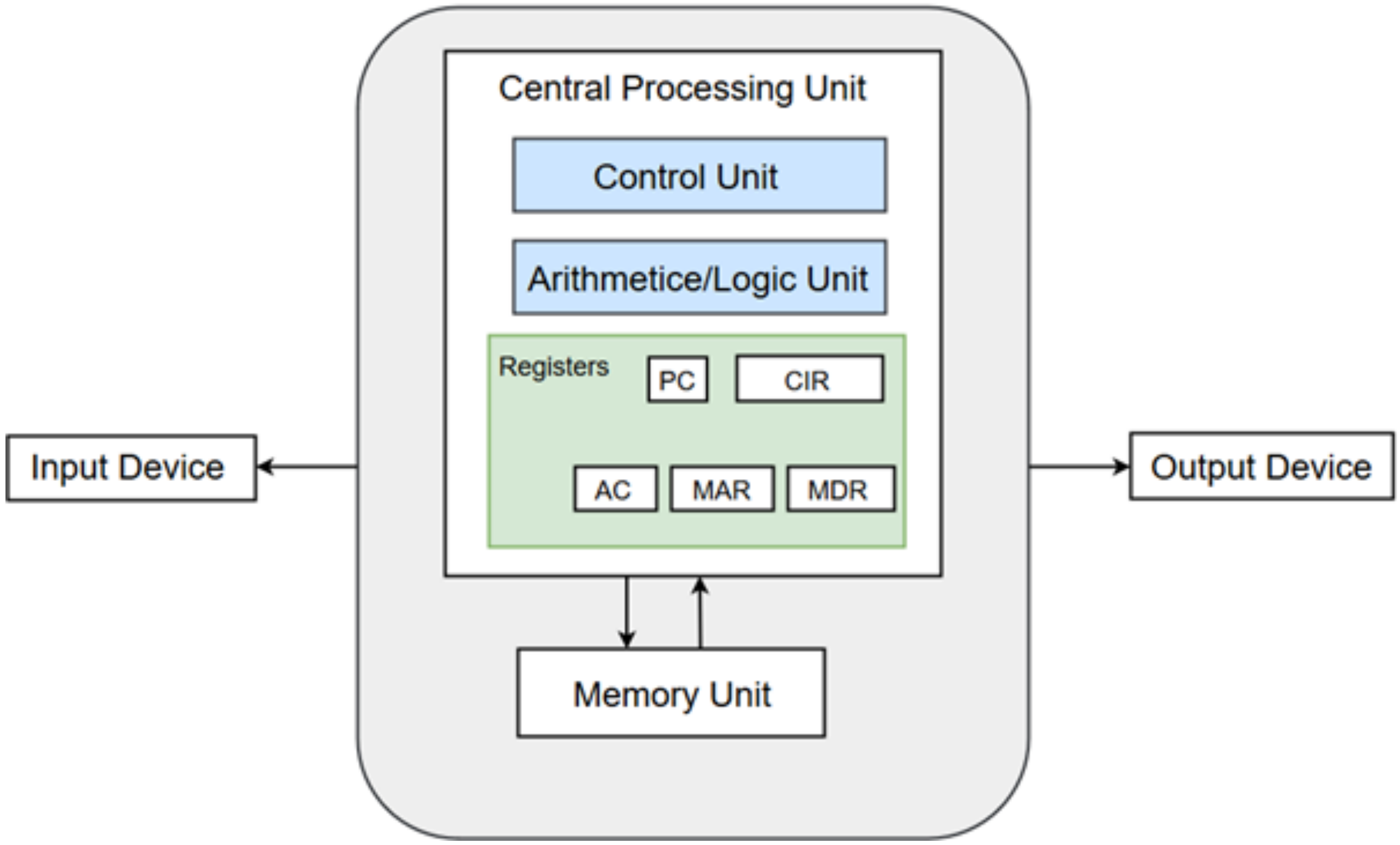
Fundamental properties of digital technology

- **reprogrammability**
  von Neumann architecture

- **data homogenization**
  discrete representation of binary 0 and 1

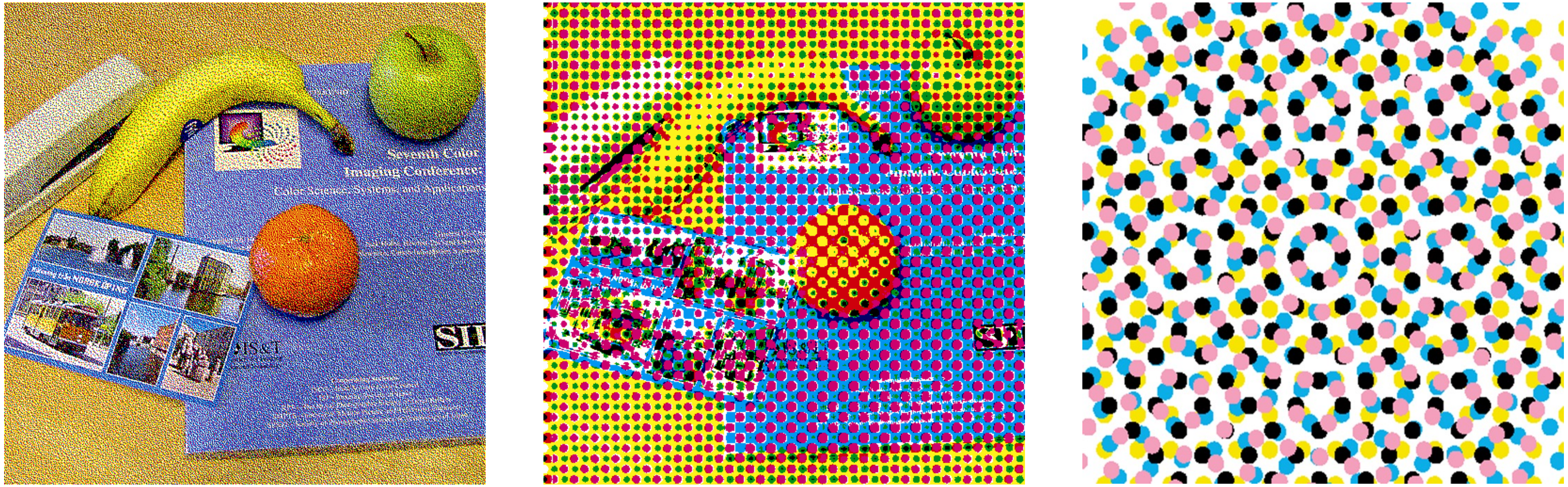
Technology affordances: An action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system (Majchrzak & Markus, 2012).

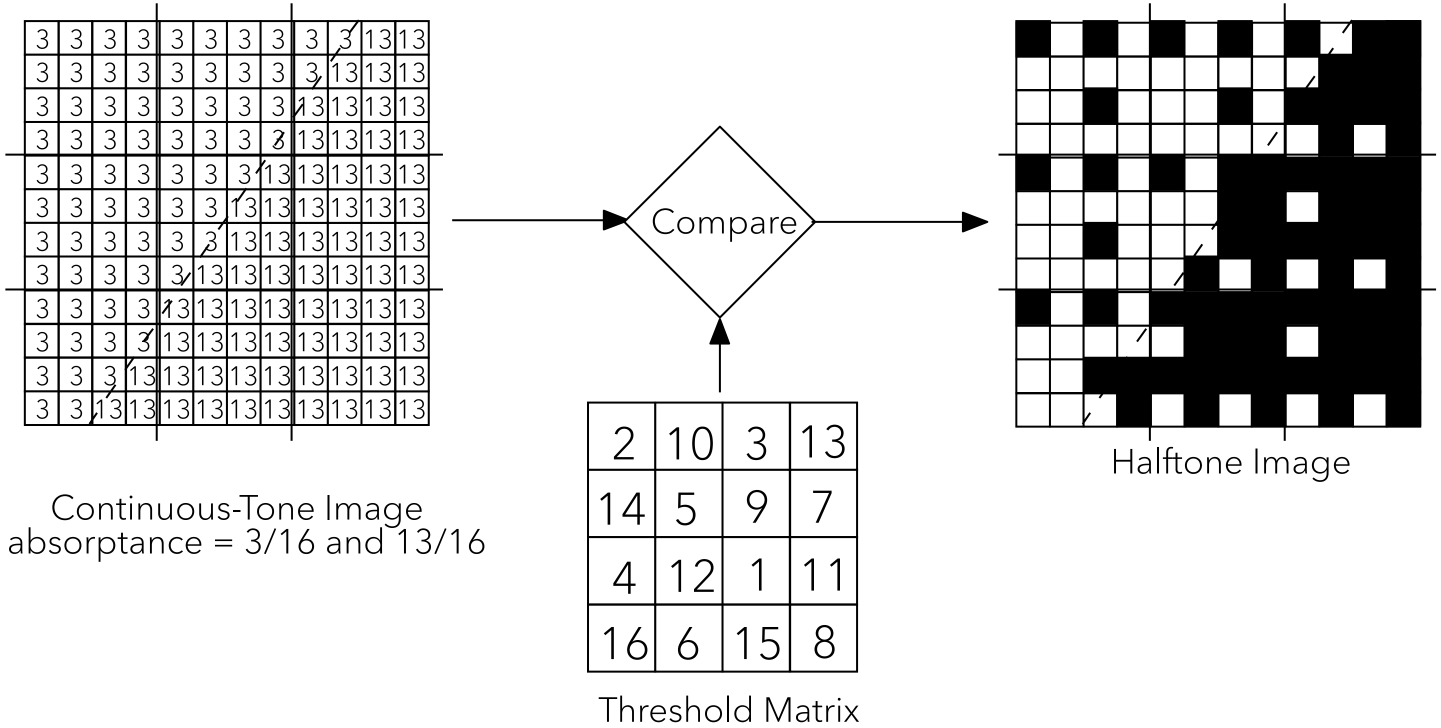
Von-Neumann Basic Structure:



Decimal - Binary - Octal - Hex – ASCII
Conversion Chart

Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII	Decimal	Binary	Octal	Hex	ASCII
0	00000000	000	00	NUL	32	00100000	040	20	SP	64	01000000	100	40	@	96	01100000	140	60	`
1	00000001	001	01	SOH	33	00100001	041	21	!	65	01000001	101	41	A	97	01100001	141	61	a
2	00000010	002	02	STX	34	00100010	042	22	"	66	01000010	102	42	B	98	01100010	142	62	b
3	00000011	003	03	ETX	35	00100011	043	23	#	67	01000011	103	43	C	99	01100011	143	63	c
4	00000100	004	04	EOT	36	00100100	044	24	$	68	01000100	104	44	D	100	01100100	144	64	d
5	00000101	005	05	ENQ	37	00100101	045	25	%	69	01000101	105	45	E	101	01100101	145	65	e
6	00000110	006	06	ACK	38	00100110	046	26	&	70	01000110	106	46	F	102	01100110	146	66	f
7	00000111	007	07	BEL	39	00100111	047	27	'	71	01000111	107	47	G	103	01100111	147	67	g
8	00001000	010	08	BS	40	00101000	050	28	(	72	01001000	110	48	H	104	01101000	150	68	h
9	00001001	011	09	HT	41	00101001	051	29	)	73	01001001	111	49	I	105	01101001	151	69	i
10	00001010	012	0A	LF	42	00101010	052	2A	*	74	01001010	112	4A	J	106	01101010	152	6A	j
11	00001011	013	0B	VT	43	00101011	053	2B	+	75	01001011	113	4B	K	107	01101011	153	6B	k
12	00001100	014	0C	FF	44	00101100	054	2C	,	76	01001100	114	4C	L	108	01101100	154	6C	l
13	00001101	015	0D	CR	45	00101101	055	2D	-	77	01001101	115	4D	M	109	01101101	155	6D	m
14	00001110	016	0E	SO	46	00101110	056	2E	.	78	01001110	116	4E	N	110	01101110	156	6E	n
15	00001111	017	0F	SI	47	00101111	057	2F	/	79	01001111	117	4F	O	111	01101111	157	6F	o
16	00010000	020	10	DLE	48	00110000	060	30	0	80	01010000	120	50	P	112	01110000	160	70	p
17	00010001	021	11	DC1	49	00110001	061	31	1	81	01010001	121	51	Q	113	01110001	161	71	q
18	00010010	022	12	DC2	50	00110010	062	32	2	82	01010010	122	52	R	114	01110010	162	72	r
19	00010011	023	13	DC3	51	00110011	063	33	3	83	01010011	123	53	S	115	01110011	163	73	s
20	00010100	024	14	DC4	52	00110100	064	34	4	84	01010100	124	54	T	116	01110100	164	74	t
21	00010101	025	15	NAK	53	00110101	065	35	5	85	01010101	125	55	U	117	01110101	165	75	u
22	00010110	026	16	SYN	54	00110110	066	36	6	86	01010110	126	56	V	118	01110110	166	76	v
23	00010111	027	17	ETB	55	00110111	067	37	7	87	01010111	127	57	W	119	01110111	167	77	w
24	00011000	030	18	CAN	56	00111000	070	38	8	88	01011000	130	58	X	120	01111000	170	78	x
25	00011001	031	19	EM	57	00111001	071	39	9	89	01011001	131	59	Y	121	01111001	171	79	y
26	00011010	032	1A	SUB	58	00111010	072	3A	:	90	01011010	132	5A	Z	122	01111010	172	7A	z
27	00011011	033	1B	ESC	59	00111011	073	3B	;	91	01011011	133	5B	[	123	01111011	173	7B	{
28	00011100	034	1C	FS	60	00111100	074	3C	<	92	01011100	134	5C	\	124	01111100	174	7C	|
29	00011101	035	1D	GS	61	00111101	075	3D	=	93	01011101	135	5D	]	125	01111101	175	7D	}
30	00011110	036	1E	RS	62	00111110	076	3E	>	94	01011110	136	5E	^	126	01111110	176	7E	~
31	00011111	037	1F	US	63	00111111	077	3F	?	95	01011111	137	5F	_	127	01111111	177	7F	DEL




Compare
Continuous-Tone Image
absorptance = 3/16 and 13/16
2 10 3 13
14 5 9 7
4 12 1 11
16 6 15 8
Threshold Matrix
Halftone Image

These properties provide environments of open and flexible affordances that results in 2 unique characteristics of organizational innovation with digital technology:

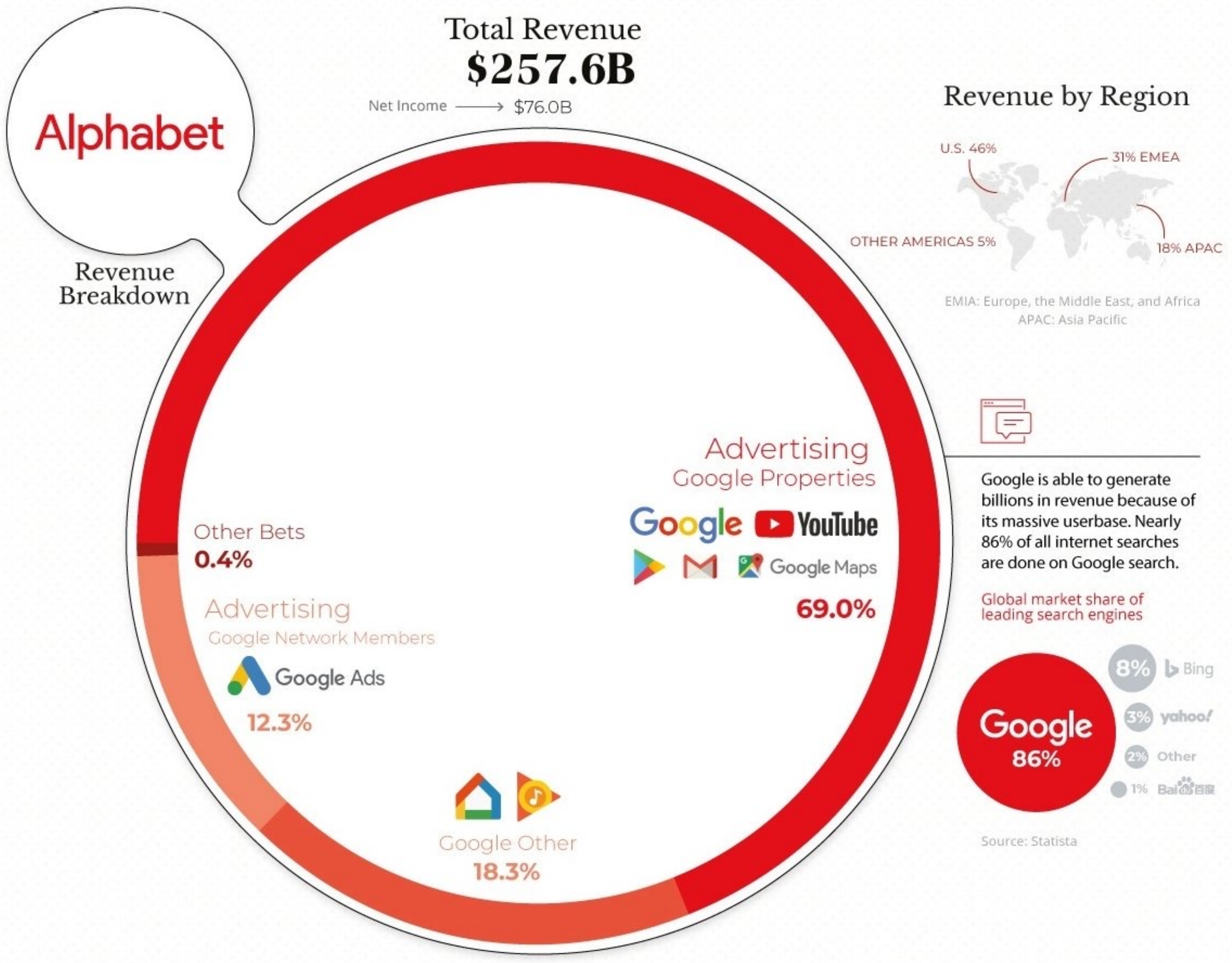
#1 Convergence

#2 Generativity

https://blog-assets.freshworks.com/freshdesk/wp-content/uploads/2019/05/08175019/When-is-it-best-to-use-chatbots-vs.-humans-for-customer-service-1.png

#1 Convergence

- brings previously **separate user experience**
  - triple play/quadruple play: TV, internet, mobile phone
- embedded into previously **nondigital physical artifacts**
  - smart technology/products
- bring together previously **separate industries**
  - Skype, Netflix, Gojek


Total Revenue
$257.6B
Net Income → $76.0B
Alphabet
Revenue Breakdown
Advertising
Google Properties
Google
YouTube
Google Maps
69.0%
Other Bets
0.4%
Advertising
Google Network Members
Google Ads
12.3%
Google Other
18.3%
Revenue by Region
U.S. 46%
31% EMEA
OTHER AMERICAS 5%
18% APAC
EMIA: Europe, the Middle East, and Africa
APAC: Asia Pacific
Google is able to generate billions in revenue because of its massive userbase. Nearly 86% of all internet searches are done on Google search.
Global market share of leading search engines
Google 86%
8% Bing
3% yahoo!
2% Other
1% Baidu
Source: Statista

Total Revenue
$365.8B

Net Income ⟶ $94.7B

Revenue Breakdown

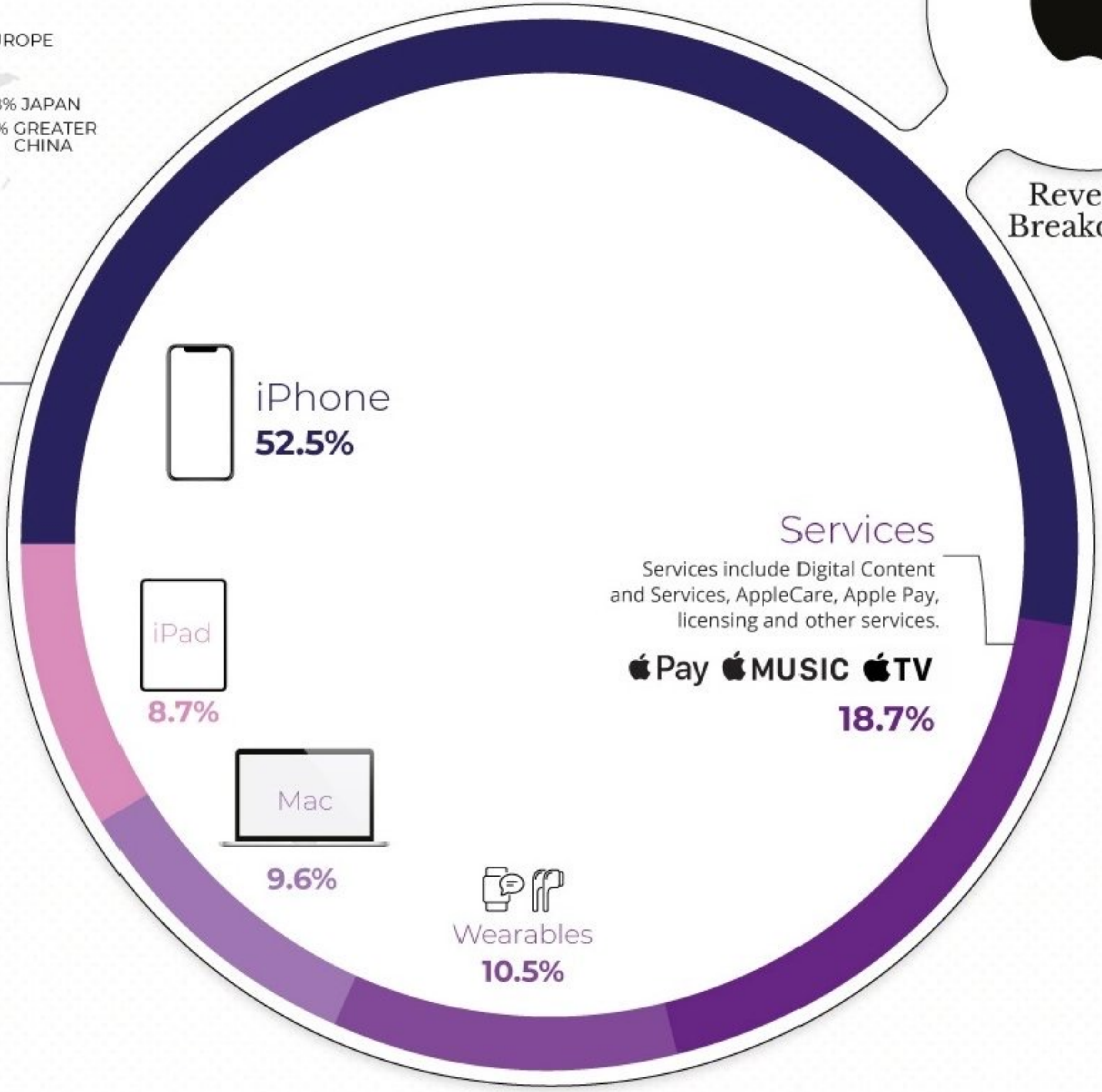
Revenue by Region

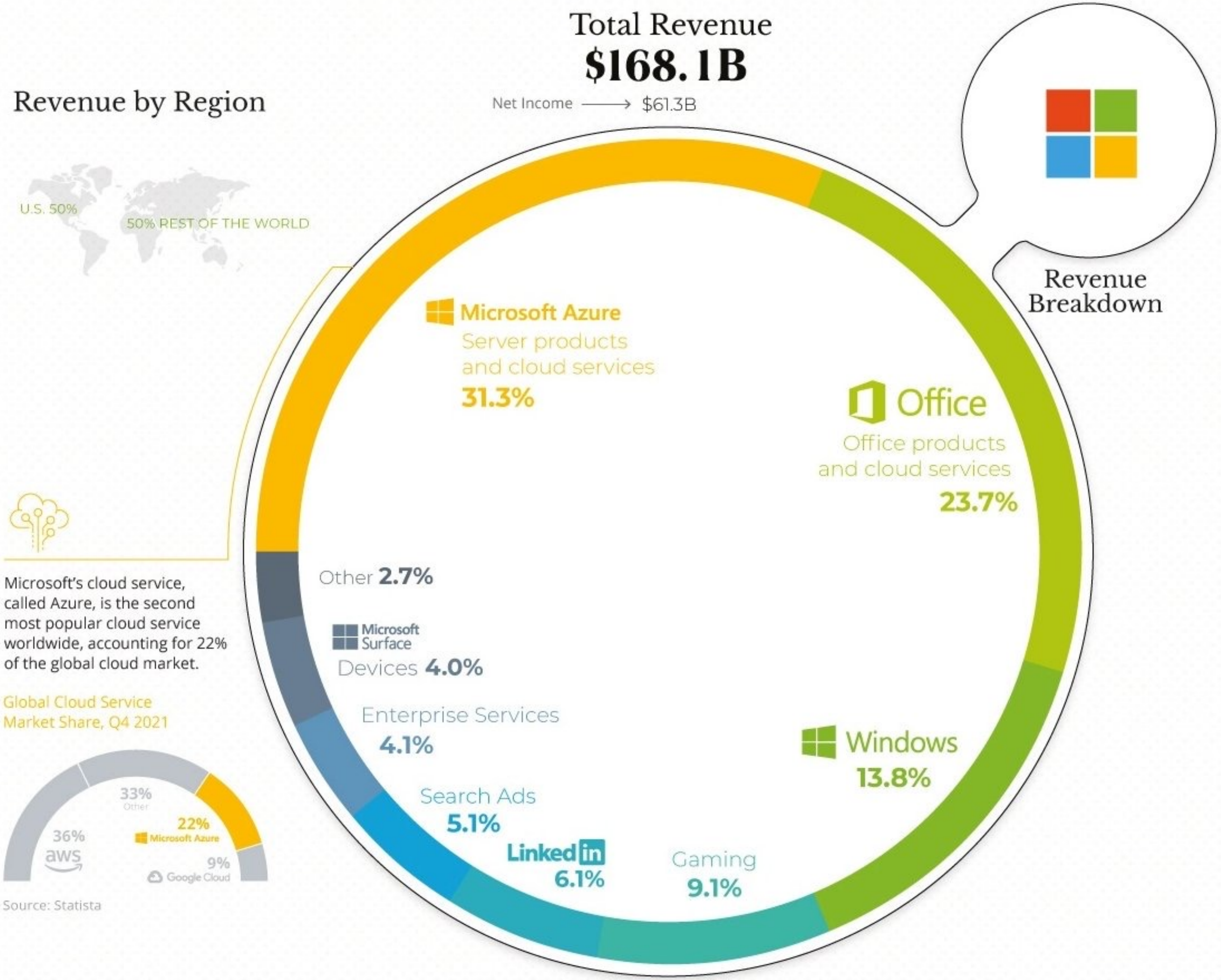
iPhone sales continue to be a massive revenue driver for Apple. In Q4 2021, iPhones accounted for 22% of all smartphone sales worldwide.

Q4 2021 Global Smartphone Sales

Apple	22%
Samsung	18%
Mi	12%
oppo	9%
vivo	8%
Other	32%

Source: Gartner



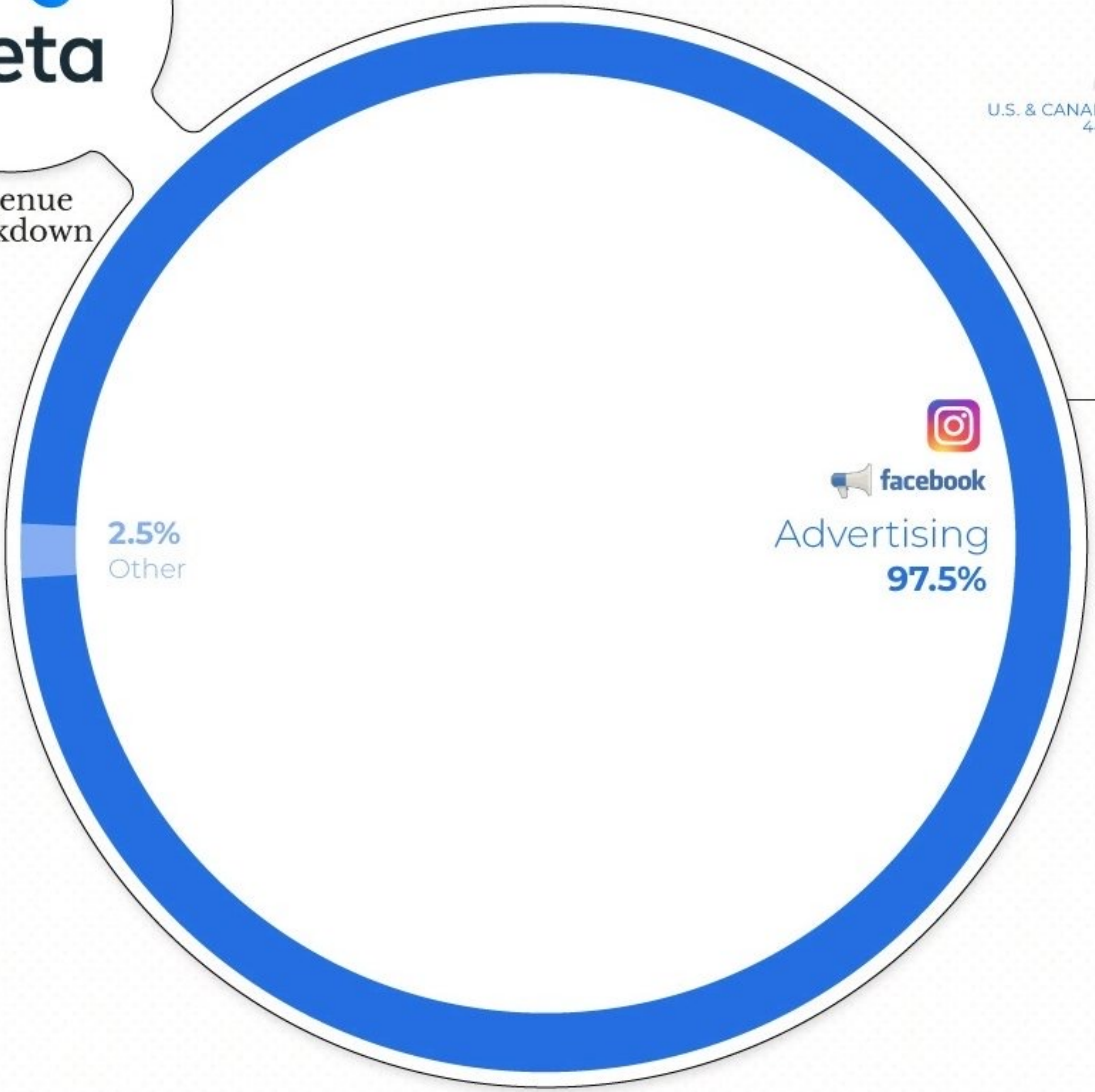

Total Revenue
$168.1B
Net Income → $61.3B
Revenue by Region
U.S. 50%
50% REST OF THE WORLD
Revenue Breakdown
Microsoft Azure
Server products and cloud services
31.3%
Office
Office products and cloud services
23.7%
Windows
13.8%
Gaming
9.1%
LinkedIn
6.1%
Search Ads
5.1%
Enterprise Services
4.1%
Microsoft Surface
Devices 4.0%
Other 2.7%
Microsoft's cloud service, called Azure, is the second most popular cloud service worldwide, accounting for 22% of the global cloud market.
Global Cloud Service Market Share, Q4 2021
36% aws
33% Other
22% Microsoft Azure
9% Google Cloud
Source: Statista

Meta

Revenue Breakdown

Total Revenue
$117.9B

Net Income ⟶ $39.4B

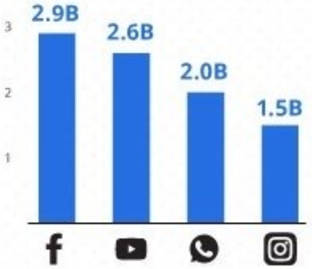


Revenue by Region

Facebook is still the largest social media platform in the world, with approximately 2.9 billion monthly active users (MAU).

Most popular social media networks

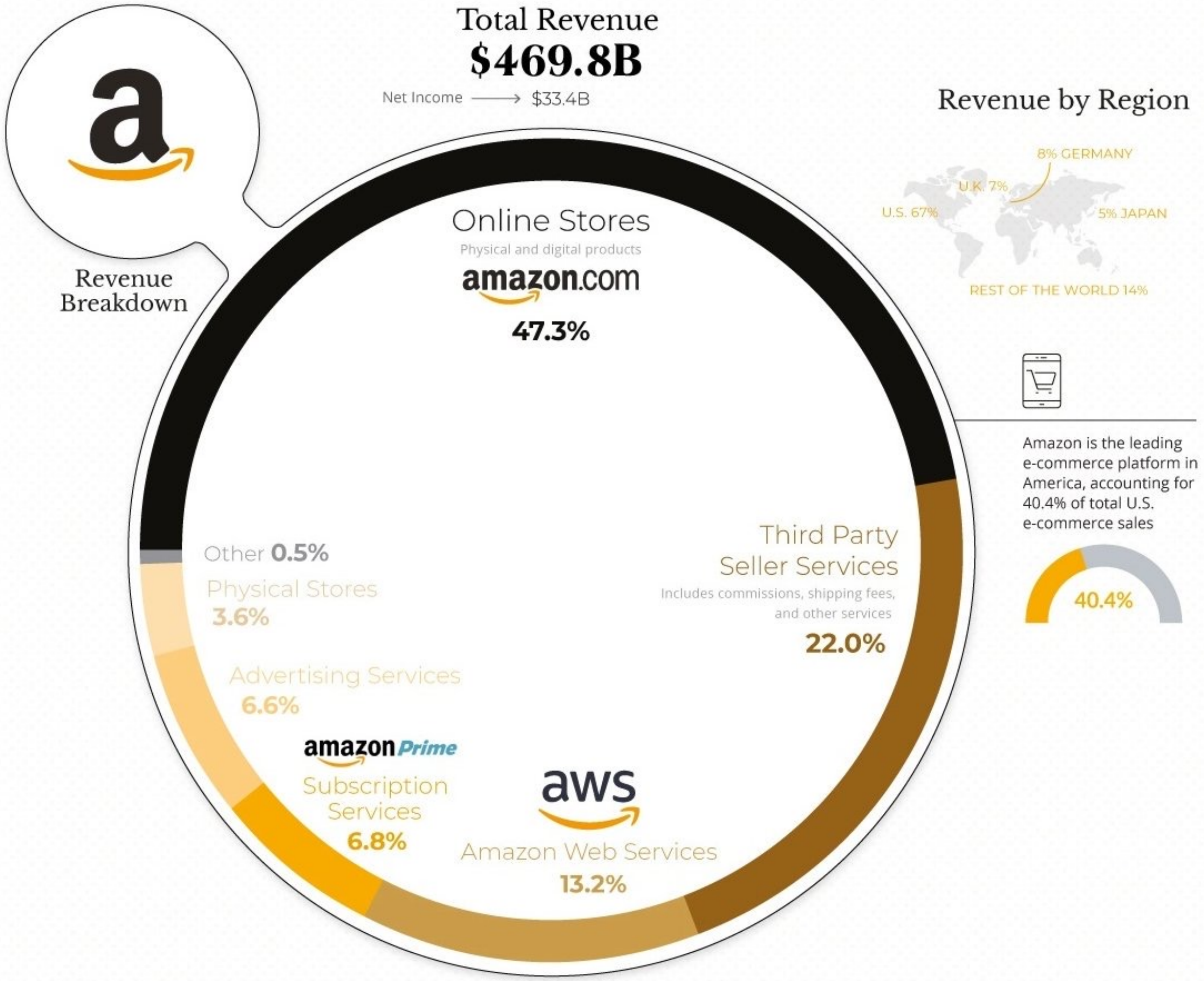
MAU as of Jan 2022



Source: Statista

Meta also owns the 3rd and 4th most popular apps, WhatsApp and Instagram.

Figures may not add up to 100% due to rounding


Total Revenue
$469.8B
Net Income → $33.4B
Revenue Breakdown
Online Stores
Physical and digital products
amazon.com
47.3%
Third Party Seller Services
Includes commissions, shipping fees, and other services
22.0%
aws
Amazon Web Services
13.2%
amazon Prime
Subscription Services
6.8%
Advertising Services
6.6%
Physical Stores
3.6%
Other 0.5%
Revenue by Region
8% GERMANY
U.K. 7%
U.S. 67%
5% JAPAN
REST OF THE WORLD 14%
Amazon is the leading e-commerce platform in America, accounting for 40.4% of total U.S. e-commerce sales
40.4%

Consequently…

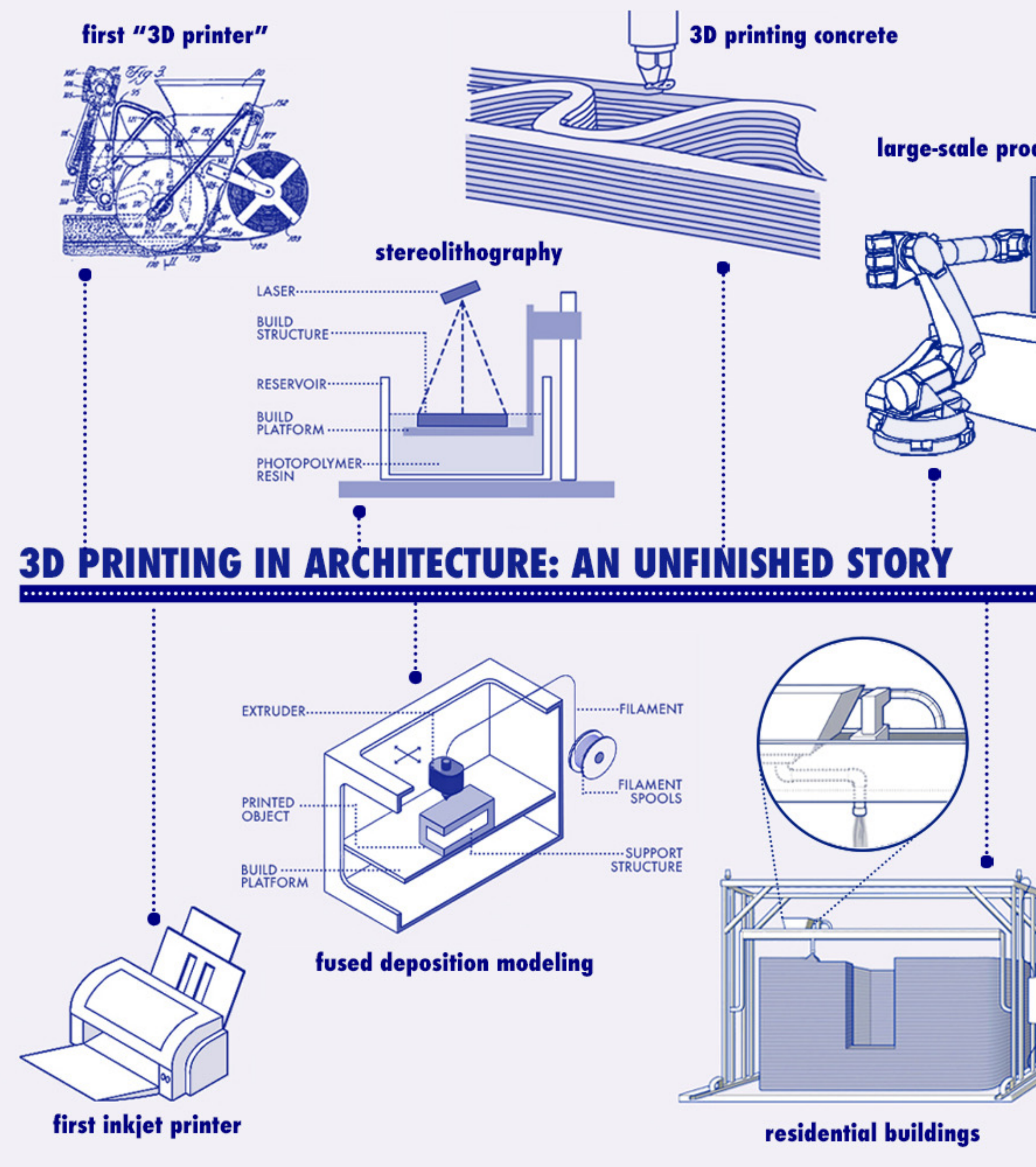
- Apple is mostly an iPhone company (52.5%)
- Facebook is 97.5% an advertising company
- Google/Alphabet is 86% advertising
- Amazon is mostly a store & marketplace (72.9%)
- Microsoft is diversified

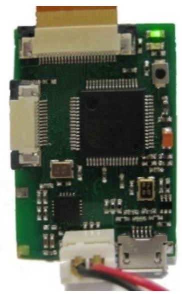
An key part of corporate strategy is to understand what, ultimately, drives firm revenue – especially in the digital economy.

#2 Generativity

- **procrastinated binding of form and function** (Zittrain, 2006); new capabilities can be added after produced
  - iOS & App store
- manifested in **the wakes of innovation** (Boland et al., 2007)
  - 3D visualization in architecture & construction project, 3D printing in prototyping manufacturing
- leaves unprecedented volume of digital traces as by-product (**derivative innovations**)
  - jogging exercise data, social media conversation and big data


3D PRINTING
IN PROGRESS

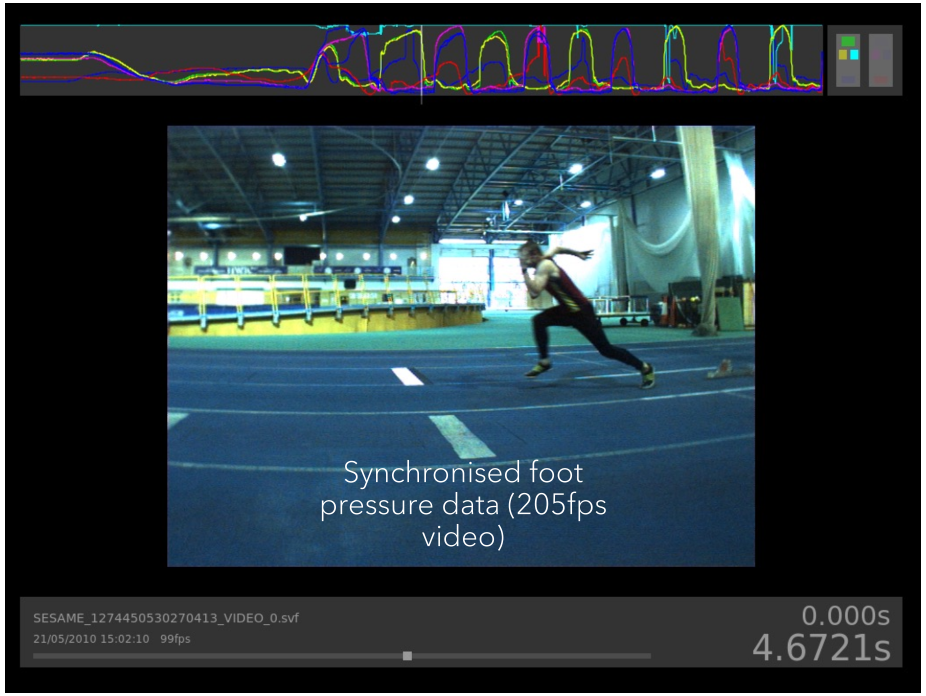

first "3D printer"
3D printing concrete
stereolithography
LASER
BUILD STRUCTURE
RESERVOIR
BUILD PLATFORM
PHOTOPOLYMER RESIN
3D PRINTING IN ARCHITECTURE: AN UNFINISHED STORY
EXTRUDER
FILAMENT
FILAMENT SPOOLS
PRINTED OBJECT
SUPPORT STRUCTURE
BUILD PLATFORM
fused deposition modeling
first inkjet printer
residential buildings

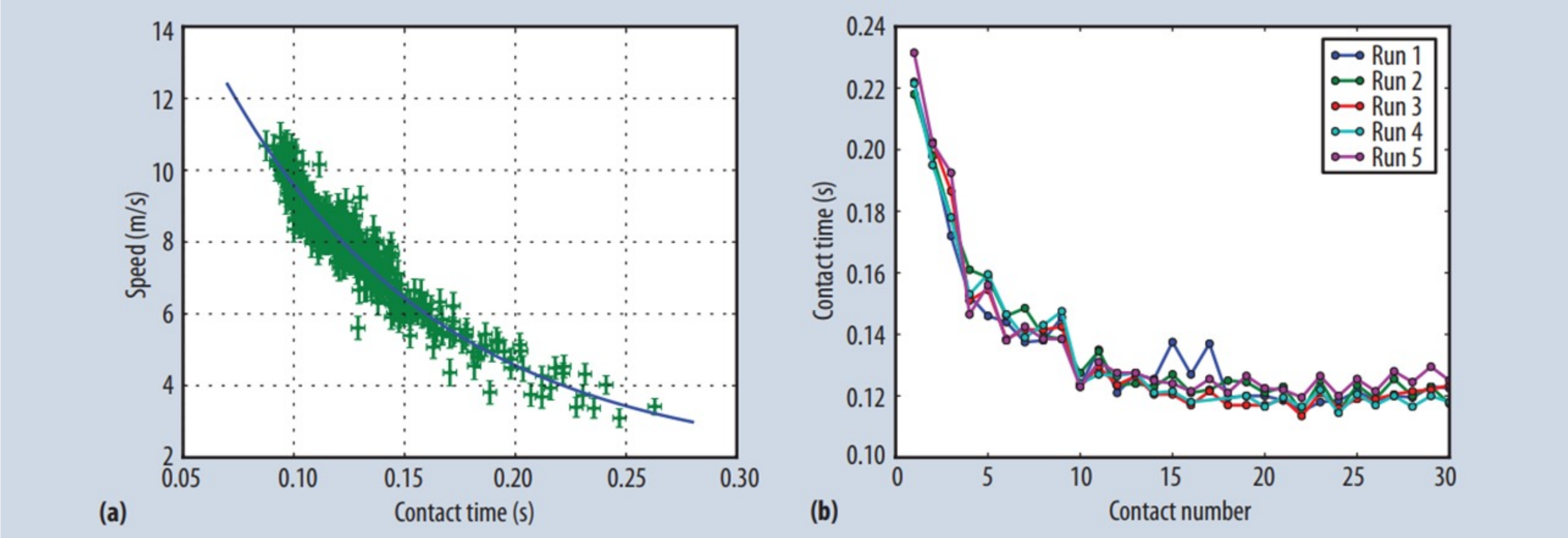


Custom wireless sensor node

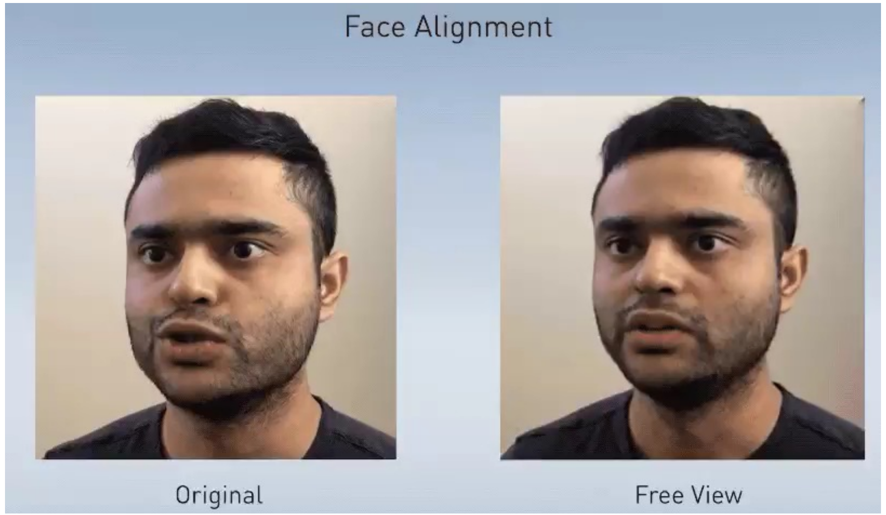
Insole Augmented with Force Sensitive Resistors

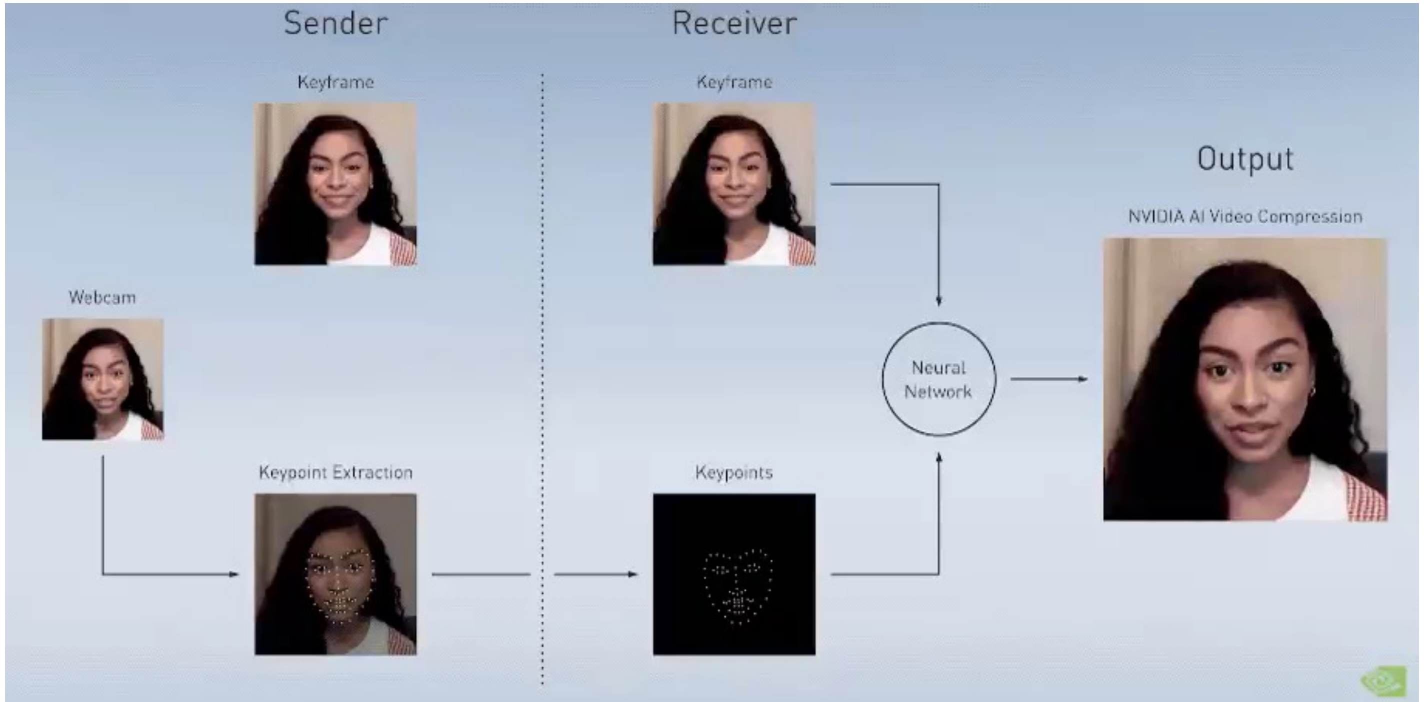
Insole Augmented with Force Sensitive Resistors





Harle, R., & Hopper, A. (2012). Sports Sensing: An Olympic Challenge for Computing. *Computer, 45(6)*, 98–101.





Nvidia has unveiled AI face-alignment that means you're always looking at the camera during video calls. Its new Maxine platform uses GANs to reconstruct the unseen parts of your head — just like a deepfake. The same technology can also be used to save on bandwidth. Only key facial movements are recorded and transmitted; the rest of the face is AI-generated in real time. The results are super impressive.

https://www.theverge.com/2020/10/5/21502003/nvidia-ai-videoconferencing-maxine-platform-face-gaze-alignment-gans-compression-resolution

#1 Importance of Digital Platform

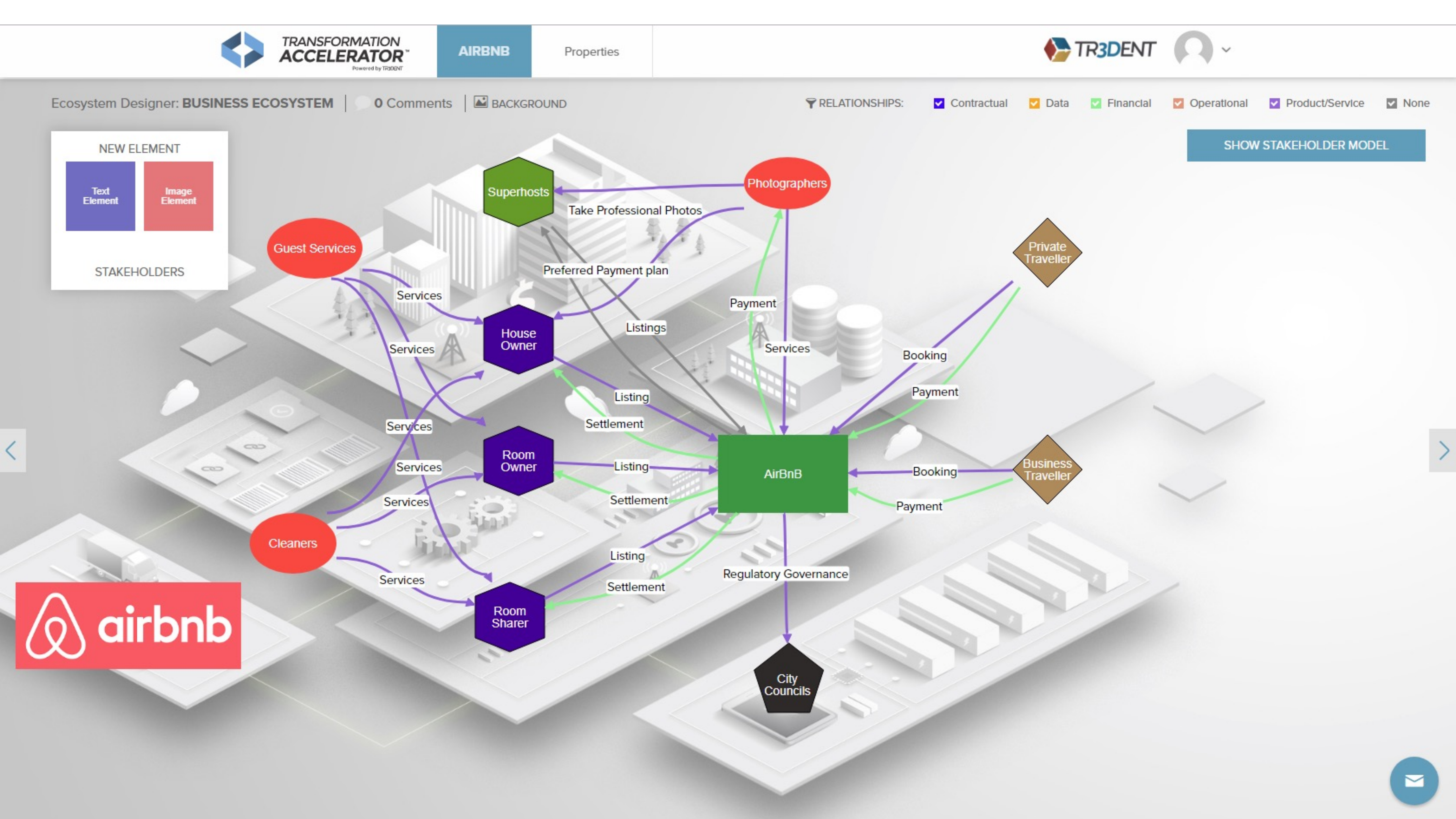
- A **building block**, providing an essential function to a technological system—which **acts as a foundation** upon which other firms can develop **complementary** products, technologies, or services (Gawer, 2009)
- Is not new, but digital technology make it widely spread and hypothetically unlimited
  - firms now innovate by creating platforms rather than single products, form an ecosystem that includes heterogeneous actors
  - allow firms to build not just platform of products but of digital capabilities throughout the organization to support its different functions, e.g., OEMs consolidate design & control of components that were formerly dispersed among suppliers

#1 Importance of Digital Platform

- Implications:
  - balancing generativity vs. control, e.g., Apple iOS & jailbreak
  - shared more data and processes across organizational boundaries, e.g., 3D visualization between design firms, construction firms, etc.
  - innovation activities become increasingly horizontal, e.g., same app for different devices
- Too much heterogeneity and boundless innovation creates chaos


KOREA DAEWOO'S CHIEF IN EXILE
GERMANY BEHIND DAIMLER'S HUGE LOSS
HIGH TECH MOTOROLA'S BIG GAMBLE
BusinessWeek
INTERNATIONAL EDITION / FEBRUARY 5, 1996
A PUBLICATION OF THE McGRAW-HILL COMPANIES
THE FALL OF AN AMERICAN ICON
AUSTRALIA A $3.50 DENMARK D. KR. 28.00 GERMANY DM 7.00 HONG KONG HK $30 KOREA WON 3,000 SINGAPORE S. $6.70 SWEDEN S. KR. 35.00 UNITED STATES US $2.95


September 23 — September 29, 2013 | businessweek.com
Bloomberg
Businessweek
What, Us Worry?
Exclusive: Apple's Craig Federighi, Tim Cook, and Jony Ive have never been more certain they're right p60
$4.99



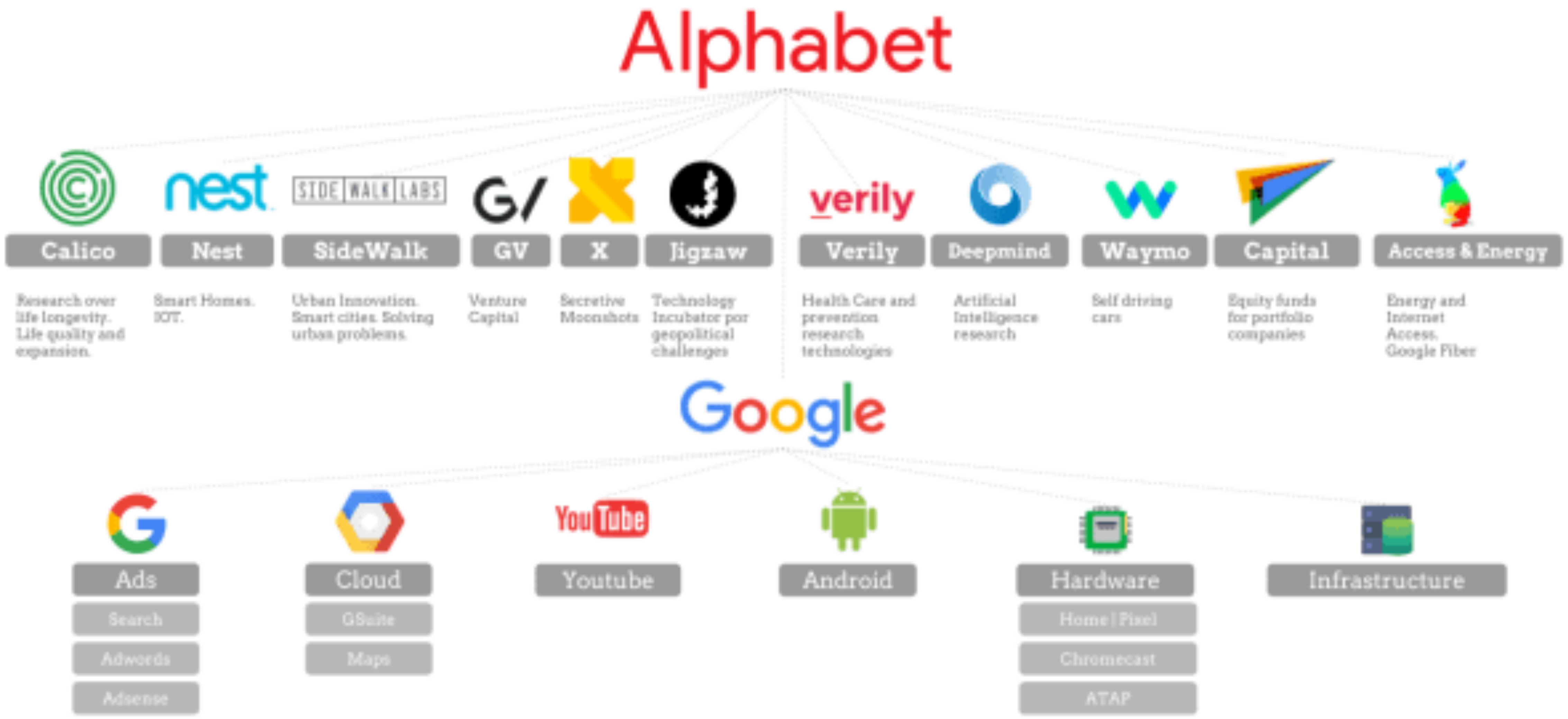
TRANSFORMATION ACCELERATOR
AIRBNB
Properties
TR3DENT
Ecosystem Designer: BUSINESS ECOSYSTEM
0 Comments
BACKGROUND
RELATIONSHIPS:
Contractual
Data
Financial
Operational
Product/Service
None
SHOW STAKEHOLDER MODEL
NEW ELEMENT
Text Element
Image Element
STAKEHOLDERS
Superhosts
Photographers
Take Professional Photos
Guest Services
Preferred Payment plan
Private Traveller
Payment
Services
House Owner
Listings
Services
Booking
Payment
Listing
Services
Settlement
Room Owner
Listing
AirBnB
Booking
Business Traveller
Services
Settlement
Payment
Services
Cleaners
Listing
Services
Regulatory Governance
Settlement
Room Sharer
airbnb
City Councils

#2 Emergence of Distributed Innovation

- Democratized innovation, distributed control across **multiple** organizations (Chesbrough, 2006; von Hippel, 2005), harness creativity outside of organization
- Increase the **heterogeneity** of knowledge resources in order to innovate from specialized, self-contained professions or industries (Barrett et al. 2012)

#2 Emergence of Distributed Innovation

- Implications:
  - Knowledge resources will be increasingly **heterogeneous** and often temporarily integrated, changing dynamically in response to unpredictable changes from inside and outside firm's ecosystem
  - Innovation increasingly requires that **others** be enable to innovate as well, e.g., API SDK
  - Emergence of new **industrial structures**, parallel coexistence of long tail & superstars
  - Introduces new forms of **risk**, **unintended** consequences


Alphabet
nest
SIDE WALK LABS
G/
verily
Calico
Nest
SideWalk
GV
X
Jigzaw
Verily
Deepmind
Waymo
Capital
Access & Energy
Research over life longevity. Life quality and expansion.
Smart Homes. IOT.
Urban Innovation. Smart cities. Solving urban problems.
Venture Capital
Secretive Moonshots
Technology Incubator por geopolitical challenges
Health Care and prevention research technologies
Artificial Intelligence research
Self driving cars
Equity funds for portfolio companies
Energy and Internet Access. Google Fiber
Google
YouTube
Ads
Search
Adwords
Adsense
Cloud
GSuite
Maps
Youtube
Android
Hardware
Home | Pixel
Chromecast
ATAP
Infrastructure

Alphabet

Other bets

Transportation & logistics

- WAYMO — Autonomous driving
- Wing — Autonomous drone delivery

Infrastructure

- SIDEWALK LABS — AI & IoT for smart city planning
- LOON — Internet connectivity balloons with autonomous navigation

Healthcare

- verily — AI in diagnostics, interventions, and other healthcare R&D
- Calico — Machine learning for anti-aging drug R&D

Investment arms

- capitalG — Growth equity fund with ML training for portfolio companies
- GV — CVC arm with 60+ deals to AI startups since 2013

Moonshots & other R&D

- Jigsaw — Conversational AI to spot online abuse
- DeepMind — AlphaGo, healthcare AI, and special projects for Google
- X — Moonshot projects including ML in robotics

Google

Google cloud services

- Google Cloud — AutoML: ML model training; Cloud TPU for AI workloads; BigQuery and other analytics tools
- chronicle — AI-based cybersecurity
- kaggle — Online machine learning community

Consumer electronics

- nest, Google Home, Pixel, Wear OS, android — Google Assistant, Android neural network API, smart thermostat, smart cameras, Pixel visual core

Investment arms

- Gradient Ventures — AI-focused investment fund
- Google Assistant Investment — Early stage voice tech

Media, advertising, & marketing

- YouTube — ML-based recommendations and violations review
- Google AdSense — AutoAds
- Google Marketing Platform — Smart Bidding, customer analytics

Other AI initiatives

- Google AI — Google Brain, Quantum AI, perception, translation, and more

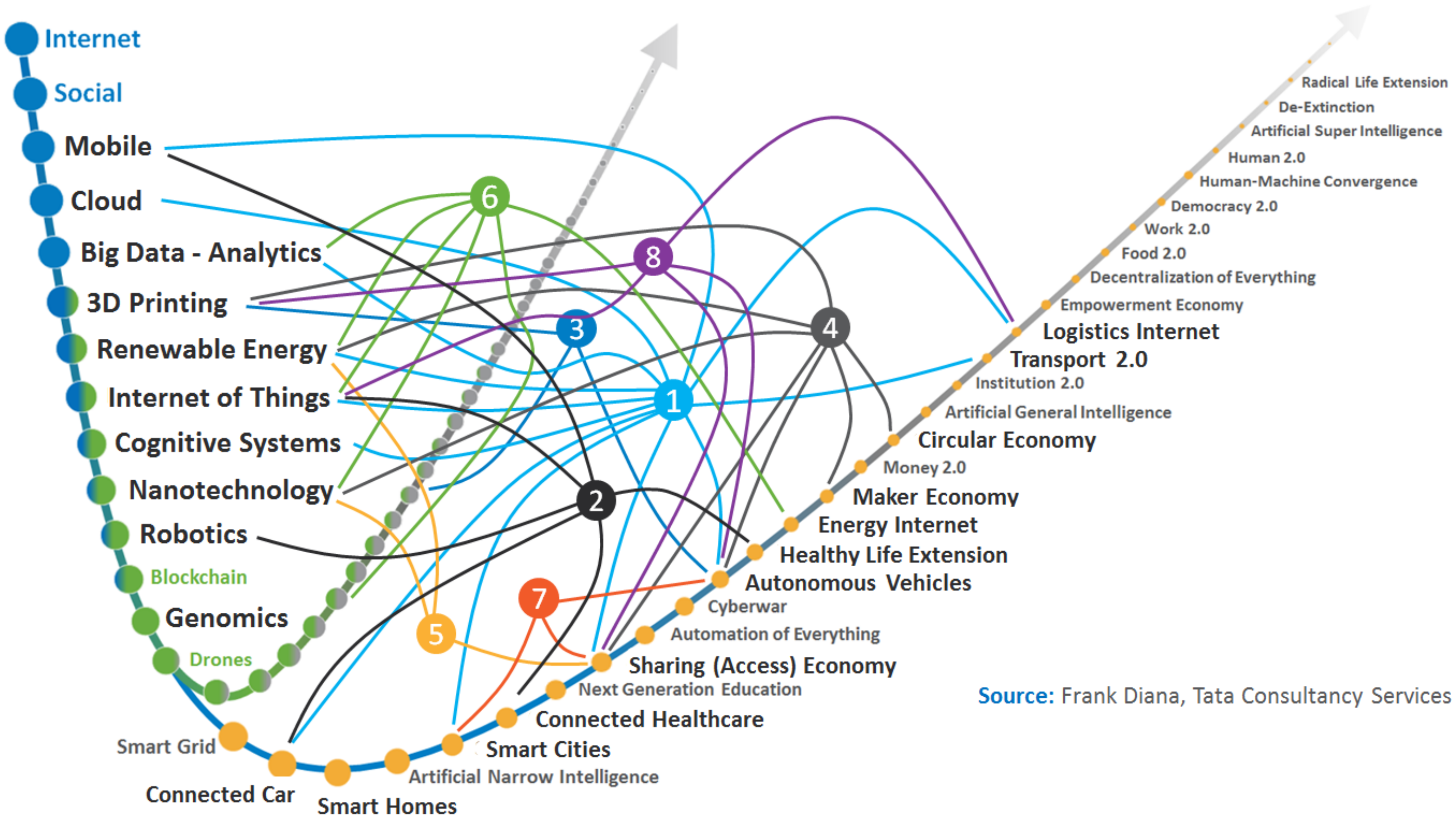
#3 Prevalence of Combinatorial Innovation

- Creating new products or services by **combining** existing modules with embedded digital capabilities, e.g., running shoes and microchip/GPS, Facebook's API

#3 Prevalence of Combinatorial Innovation

- Implications:
  - Modularity is a crucial condition for combinatorial innovation, but adopted from physical world and assume stable and fixed boundaries » need to be expanded; boundary of a product is unknowable and the products/services remains incomplete
  - Firms need to invest in new forms of creativity » build environments of constrained serendipity (Faraj et al., 2011)
  - Ideas will not only spread, follows the S-curve, but will mutate and evolve as they spread
  - A heightened complexity of the innovation process » heterogeneous modules, diverse actors, systemic risk, unintended consequences

- Consequently, firms must now (1) learn how to build up and organize **digital platform** and (2) learn how to carefully **deal with fault lines**.



Source: Frank Diana, Tata Consultancy Services

Key Takeaways

- The logic of digital innovation is **very different** than traditional/nondigital innovation
- Revenue can come from a **variety of sources** due to the diverse nature of digital business models and opportunities.
- Firms are shifting their innovation focus from creating single products to **building platforms** that serve as the foundation for broader ecosystems involving diverse actors.
- Understanding the foundation of digital innovation will help you **curate** your **digital strategies**, e.g.:
  - How do you acquire the necessary knowledge
  - How do you establish network and build relationship
  - How to keep ahead of the competition

On a More Personal Level

- 5 billion people use the internet. Less than 1% understand it.
- But you can't sit (and watch TikTok) and wait for this new technology to unfold. You must learn and use the new technology, and play your part in shaping the future.

Potential Benefit

Equip yourselves with the skills and knowledge needed to thrive in future careers, regardless of your field of study.

Develop the ability to identify challenges, brainstorm solutions, and leverage technology to address real-world problems effectively.

Gain insights into how to identify entrepreneurial opportunities, develop innovative solutions, and bring ideas to market, fostering an entrepreneurial mindset and spirit of innovation.

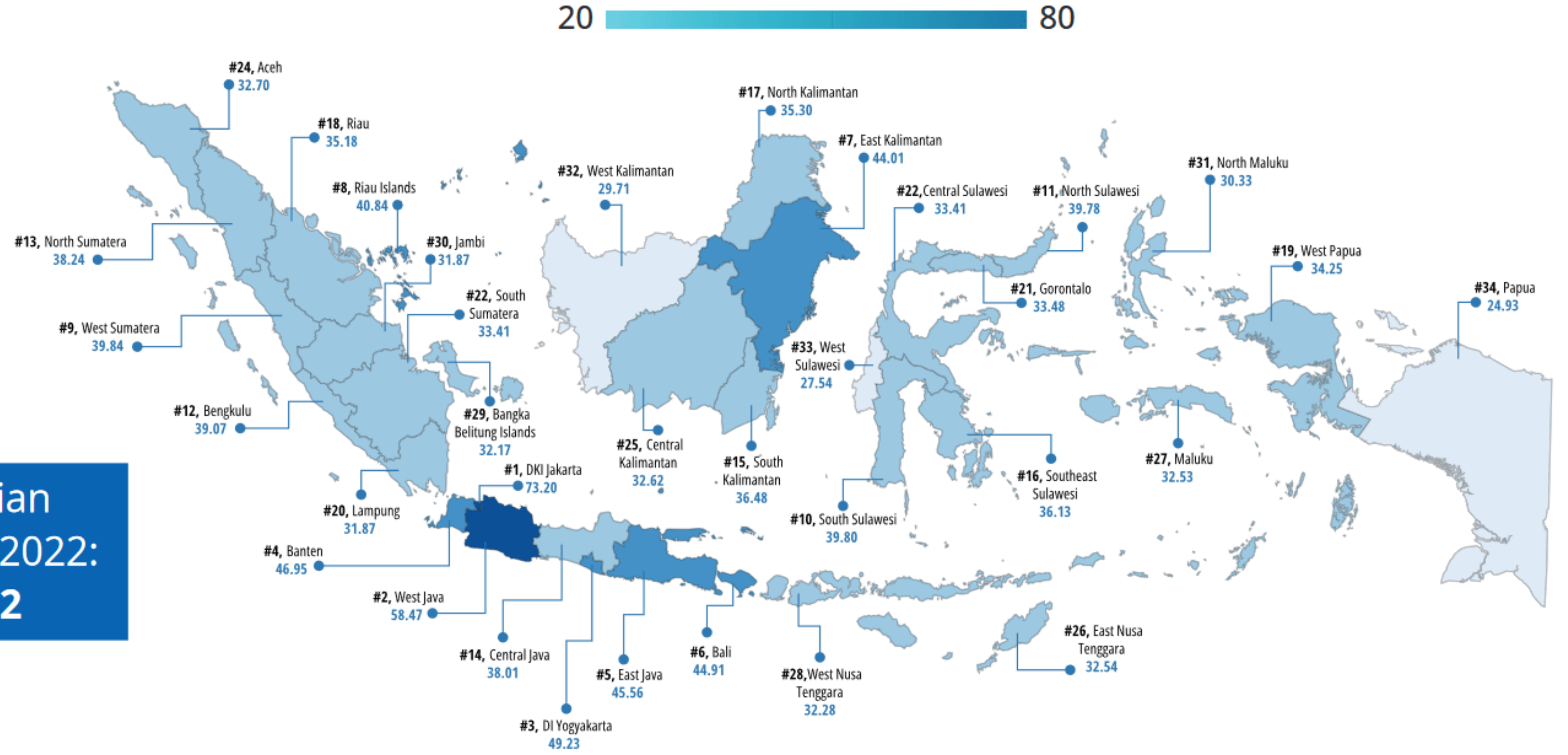
Gain a deeper understanding of digital technologies, trends, and emerging concepts, enhancing their technological literacy and adaptability.

Better positioned to compete in the global job market and contribute to the competitiveness of your countries and organizations by harnessing the power of technology to drive innovation and growth.

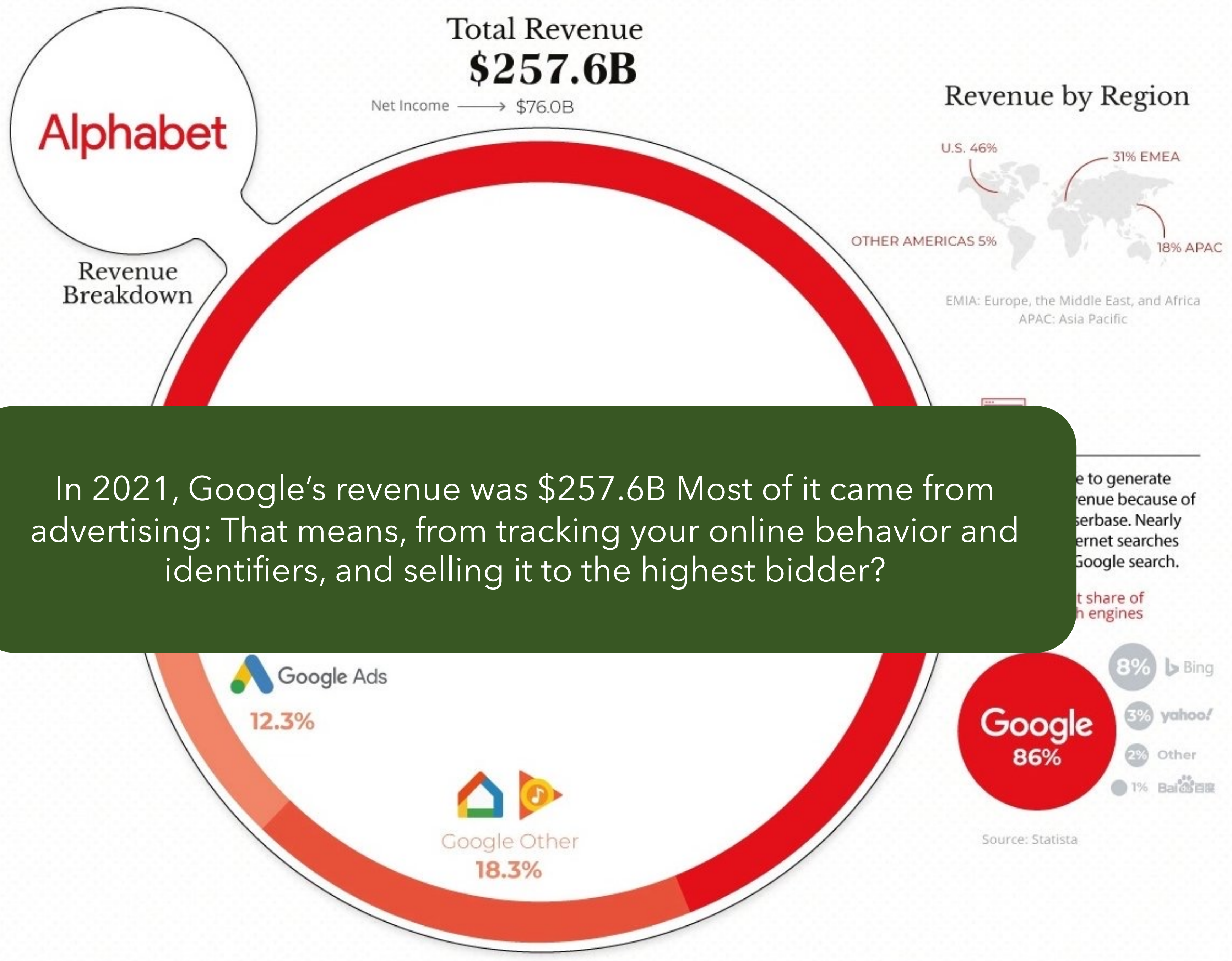
Explore how technology can be used to create positive social impact and promote sustainability.

Cultivate a growth mindset and a willingness to learn, adapt, and embrace change, which are essential attributes for success in today's dynamic world.

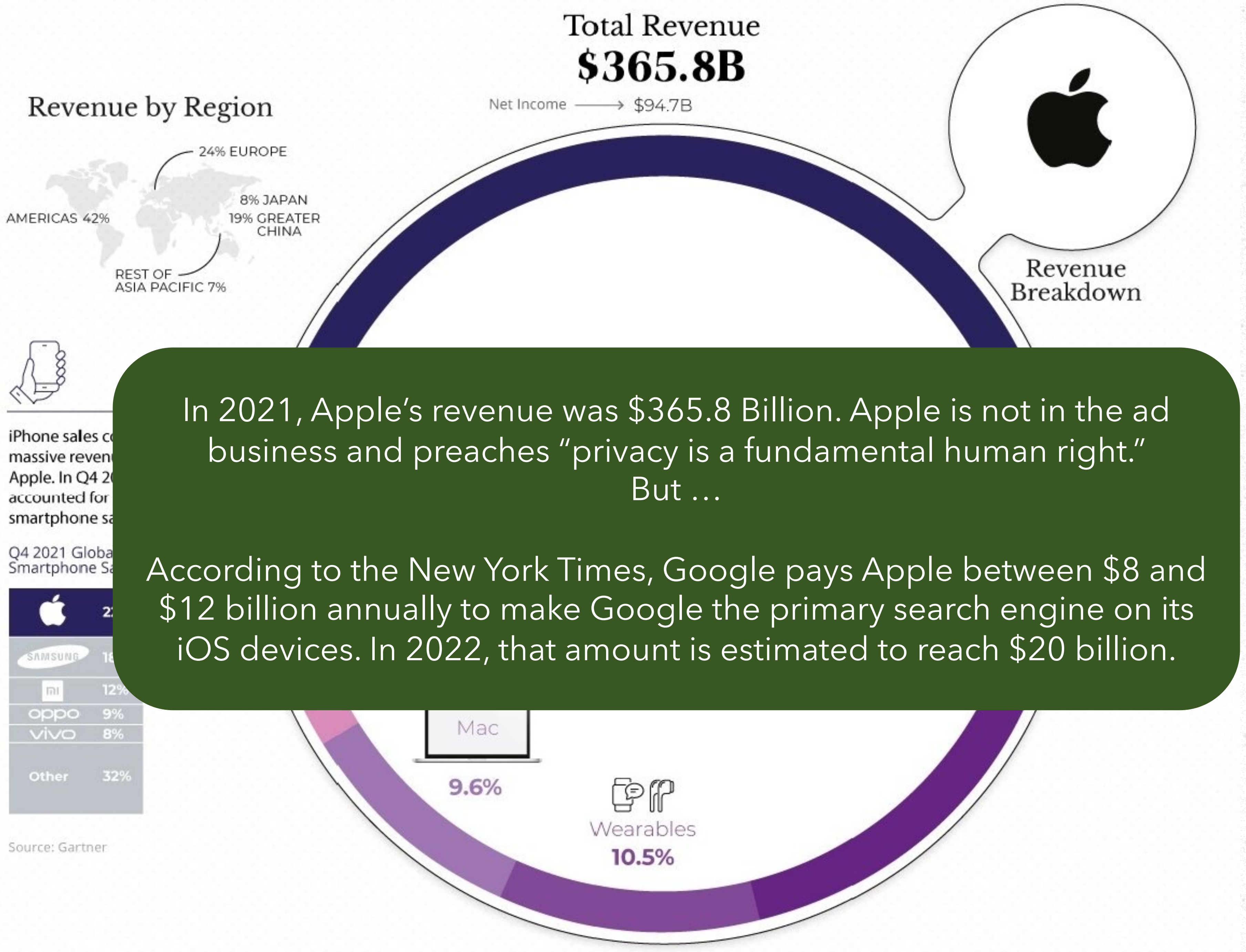
MAP OF THE DISTRIBUTION OF DIGITAL COMPETITIVENESS INDEX SCORES PER PROVINCE IN 2022



Median
EV-DCI 2022:
35.2

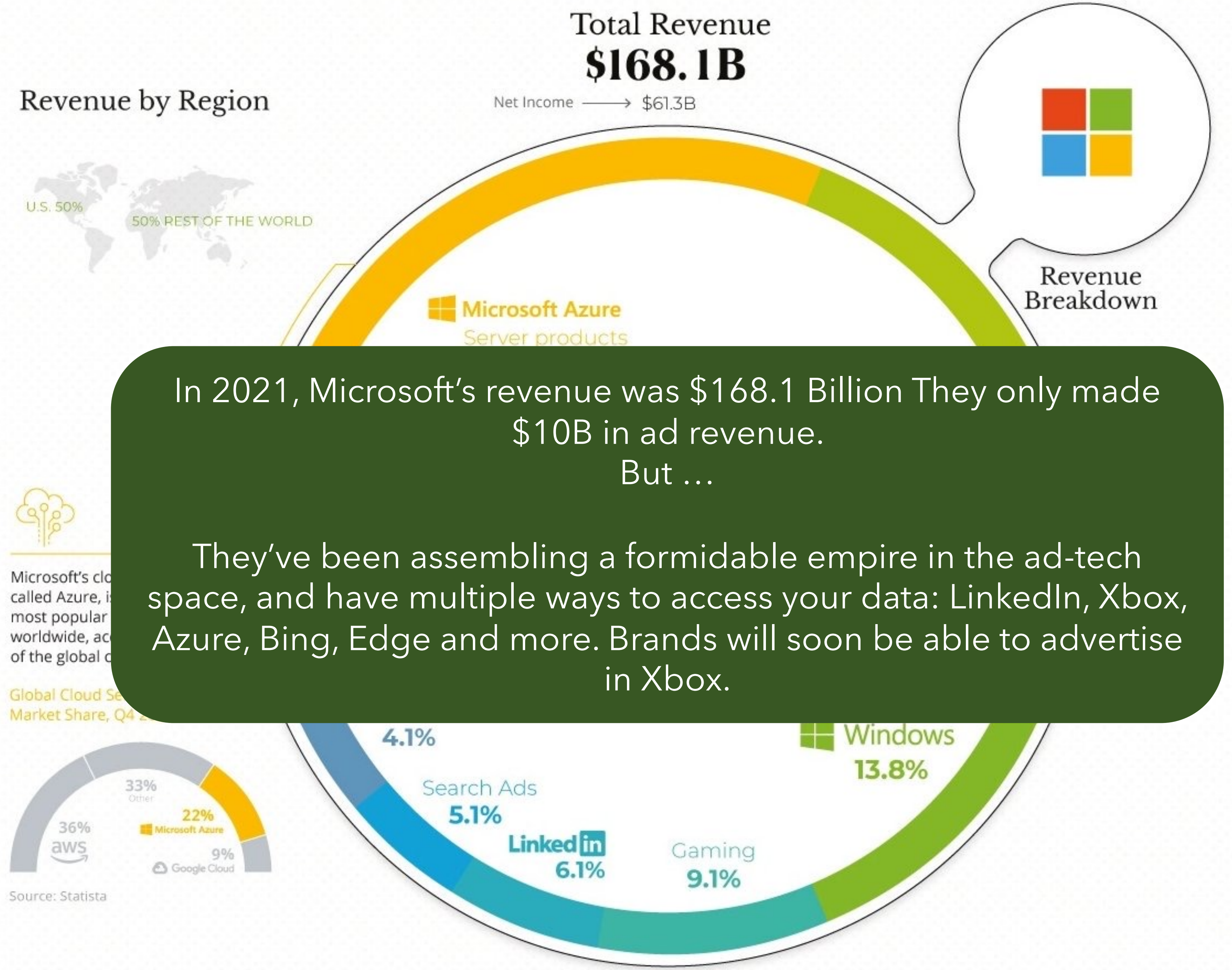


In 2021, Google's revenue was $257.6B Most of it came from advertising: That means, from tracking your online behavior and identifiers, and selling it to the highest bidder?



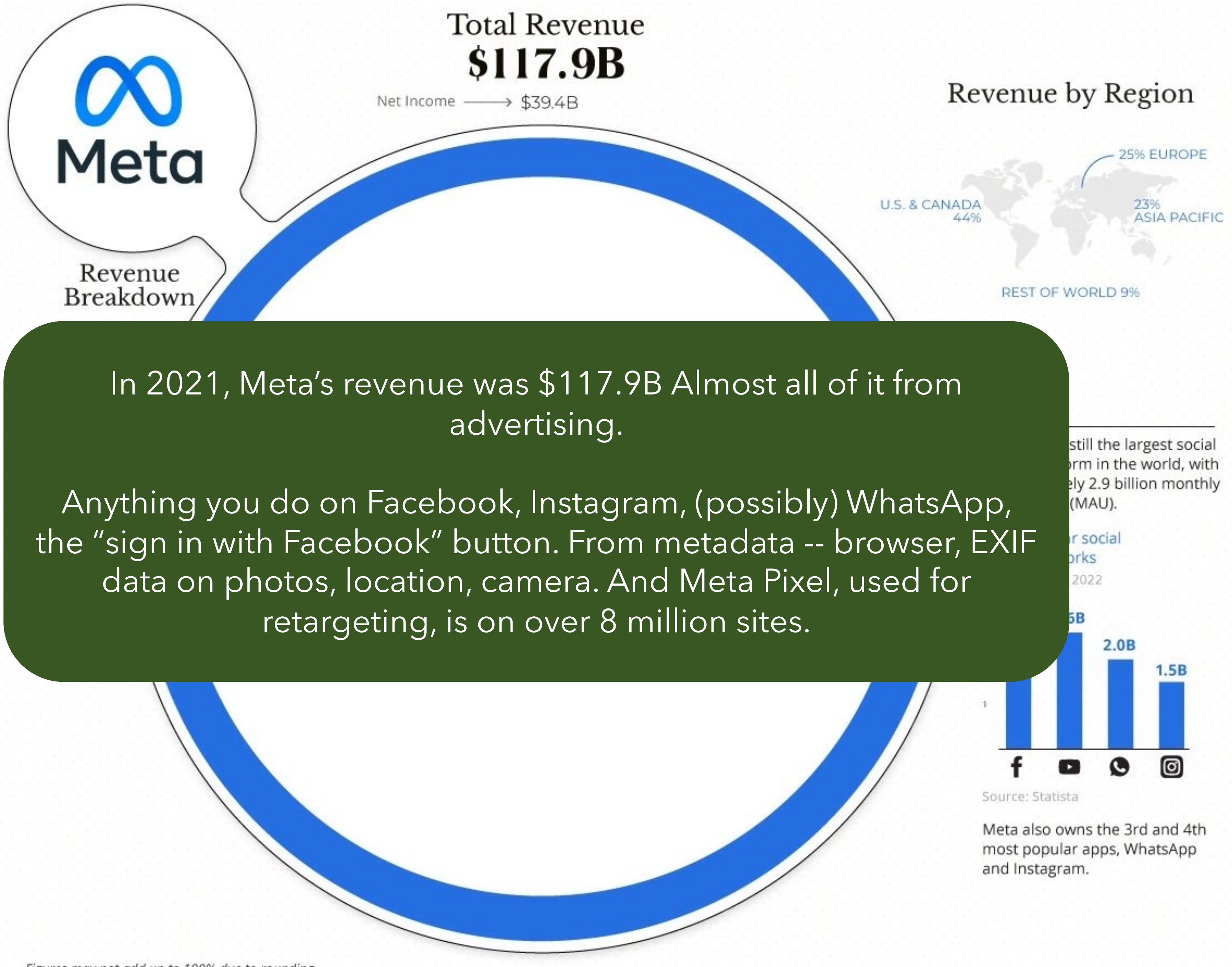
In 2021, Apple's revenue was $365.8 Billion. Apple is not in the ad business and preaches "privacy is a fundamental human right." But …

According to the New York Times, Google pays Apple between $8 and $12 billion annually to make Google the primary search engine on its iOS devices. In 2022, that amount is estimated to reach $20 billion.



In 2021, Microsoft's revenue was $168.1 Billion They only made $10B in ad revenue.
But …

They've been assembling a formidable empire in the ad-tech space, and have multiple ways to access your data: LinkedIn, Xbox, Azure, Bing, Edge and more. Brands will soon be able to advertise in Xbox.



In 2021, Meta's revenue was $117.9B Almost all of it from advertising.

Anything you do on Facebook, Instagram, (possibly) WhatsApp, the "sign in with Facebook" button. From metadata -- browser, EXIF data on photos, location, camera. And Meta Pixel, used for retargeting, is on over 8 million sites.

In 2021, Amazon's revenue was $469.8 Billion. Amazon gathers data about your preferences, so that they can sell you more stuff on Amazon.

Your purchases, reading habits on Kindle, entertainment on Prime Video, requests on Alexa, and even home visitors with Ring. Their software is so good at prediction, that third parties hire its algorithms at Amazon Forecast.

The Top 50

BIGGEST DATA BREACHES

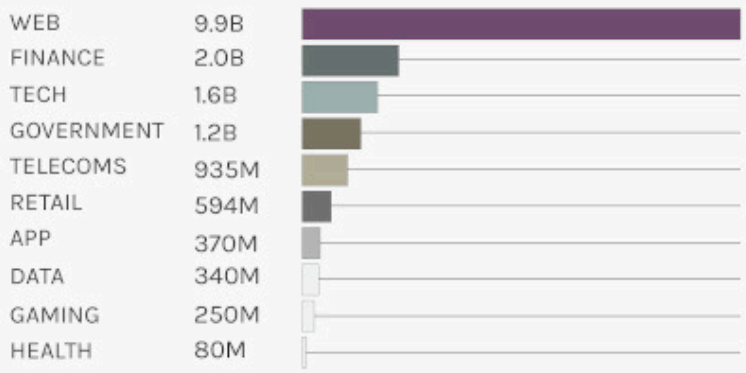
from 2004 - 2021

A data breach is an incident where protected information is copied, stolen, or exposed to an unauthorized person. The largest breach in recent times was the LinkedIn breach of 2021 in which 700 million records were lost. The visual on the right highlights the Top 50 known data breaches from 2004 to 2021.

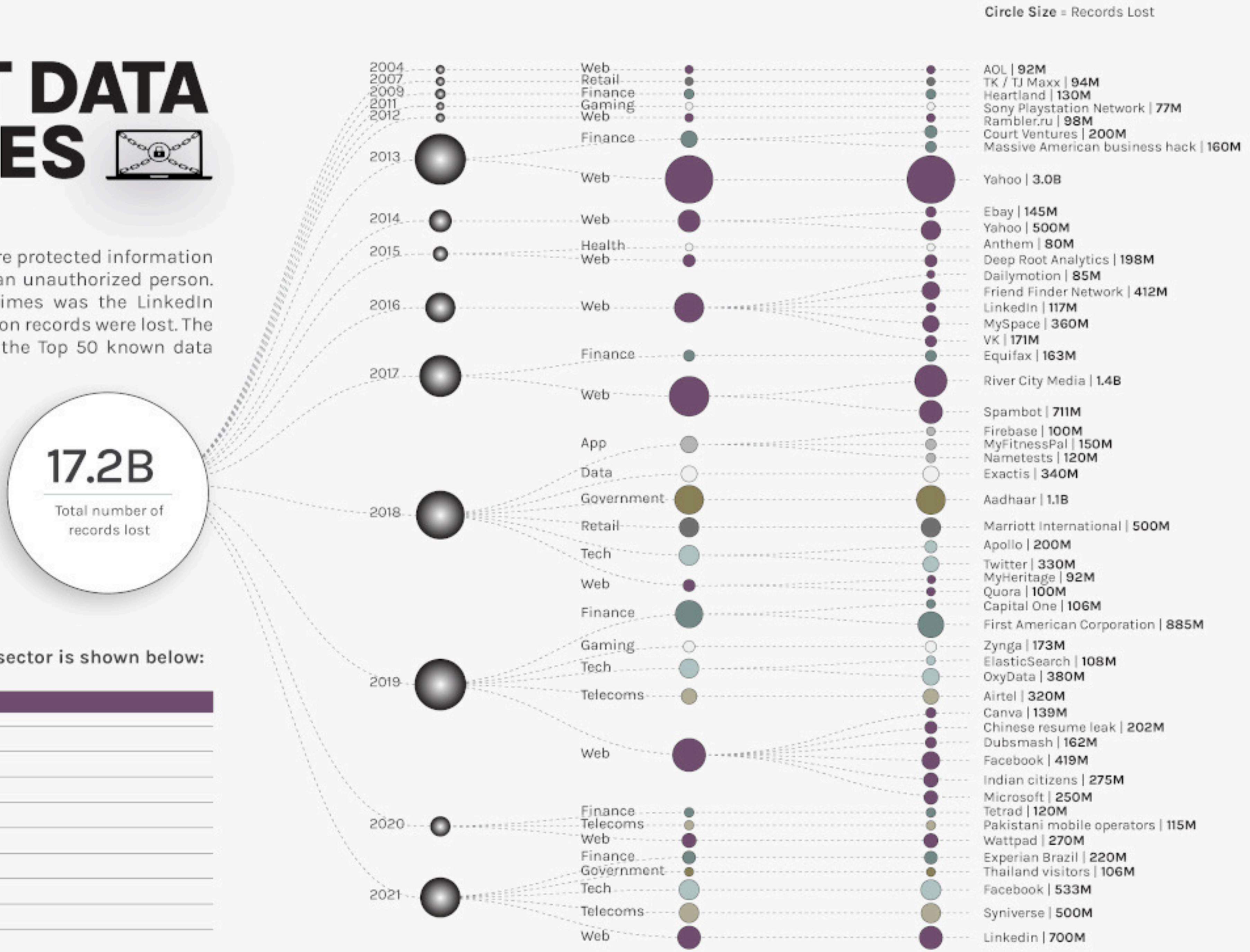
The Web sector was impacted the most. 9.9B records were lost. The Tech and Finance sectors were also severly impacted, and they lost 1.6B and 2.0B records, respectively.

SECTORS - These are industry sectors which the companies belong to. There are 10 in total.

The number of records lost per sector is shown below:

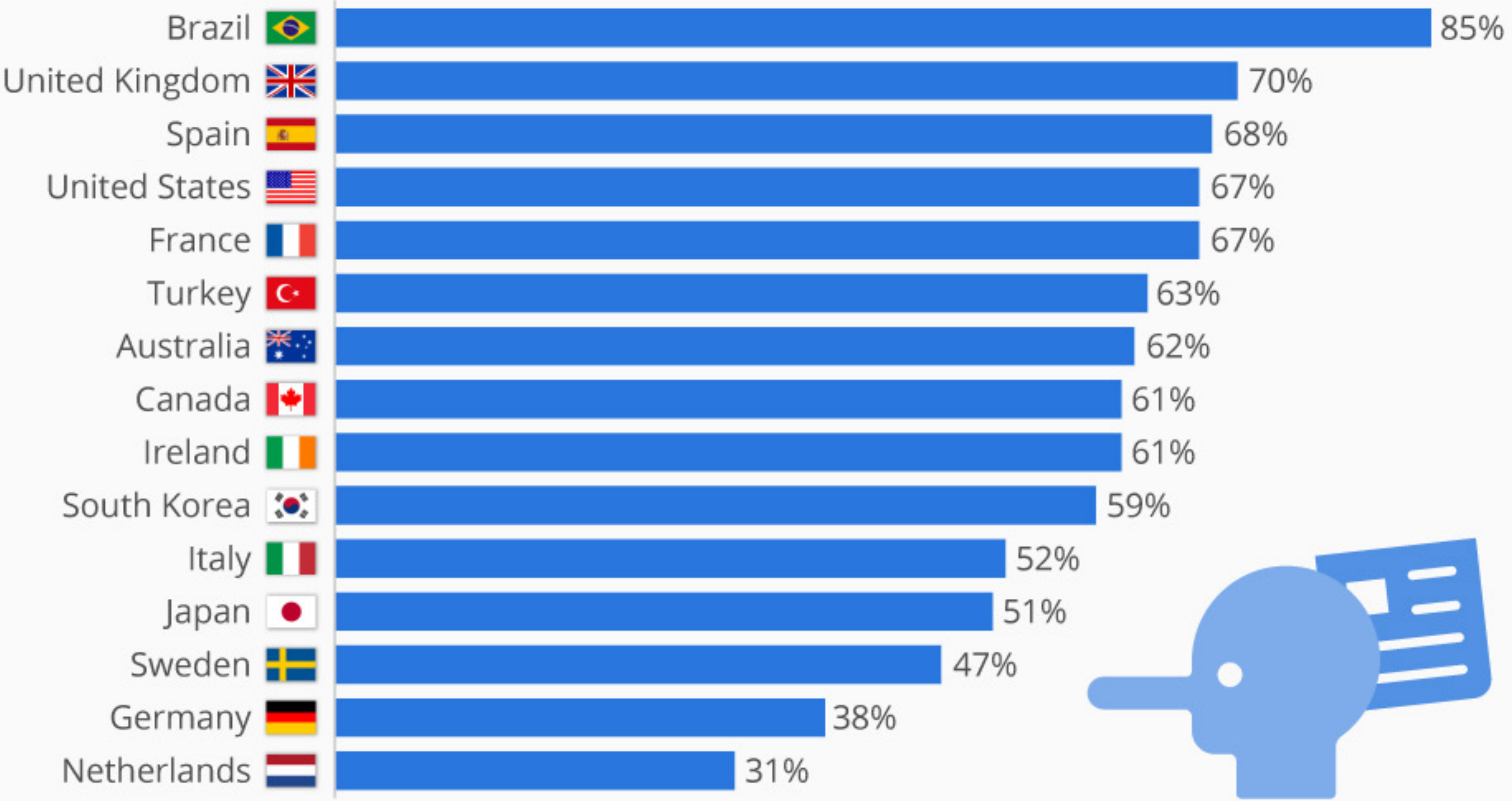


Sources: News reports



Where Concern Is Highest About Fake News On The Internet

Share concerned about what is real and fake on the internet when it comes to news in 2019*



* Selected countries

Source: Reuters Institute Digital News Report

Question to Ponder

Some will argue that tech companies created the tech and rightfully own it. But the internet was built with taxpayer money. Big tech only owns the application layer that runs on top of our free internet protocols.

Is digital innovation, at the end of the day, only about **digitization**, **commodification**, and **surveillance**? Will digital innovation only **benefit the rich and the have**? How to ensure that digital solutions are **inclusive**, **accessible**, and **equitable** to maximize their positive impact, especially on the poor and marginalized? How do we **protect our selves**?

Key References

- Amit, R., & Zott, C. (2001) Value creation in e-business. *Strategic Management Journal, 22(6-7)*, 493-520.
- Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly, 41(1)*, 223-238.
- Pagani, M. (2013). Digital business strategy and value creation: Framing the dynamic cycle of control points. *MIS Quarterly, 37(2)*, 617-632.
- Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. *Organization Science, 23(5)*, 1213-1522.

Thank you

See you anytime soon!