Mobile and Ubiquitous Computing
2022-2023
MEIC/METI- Alameda & Taguspark

A Global Overview

A Glimpse of the Past…

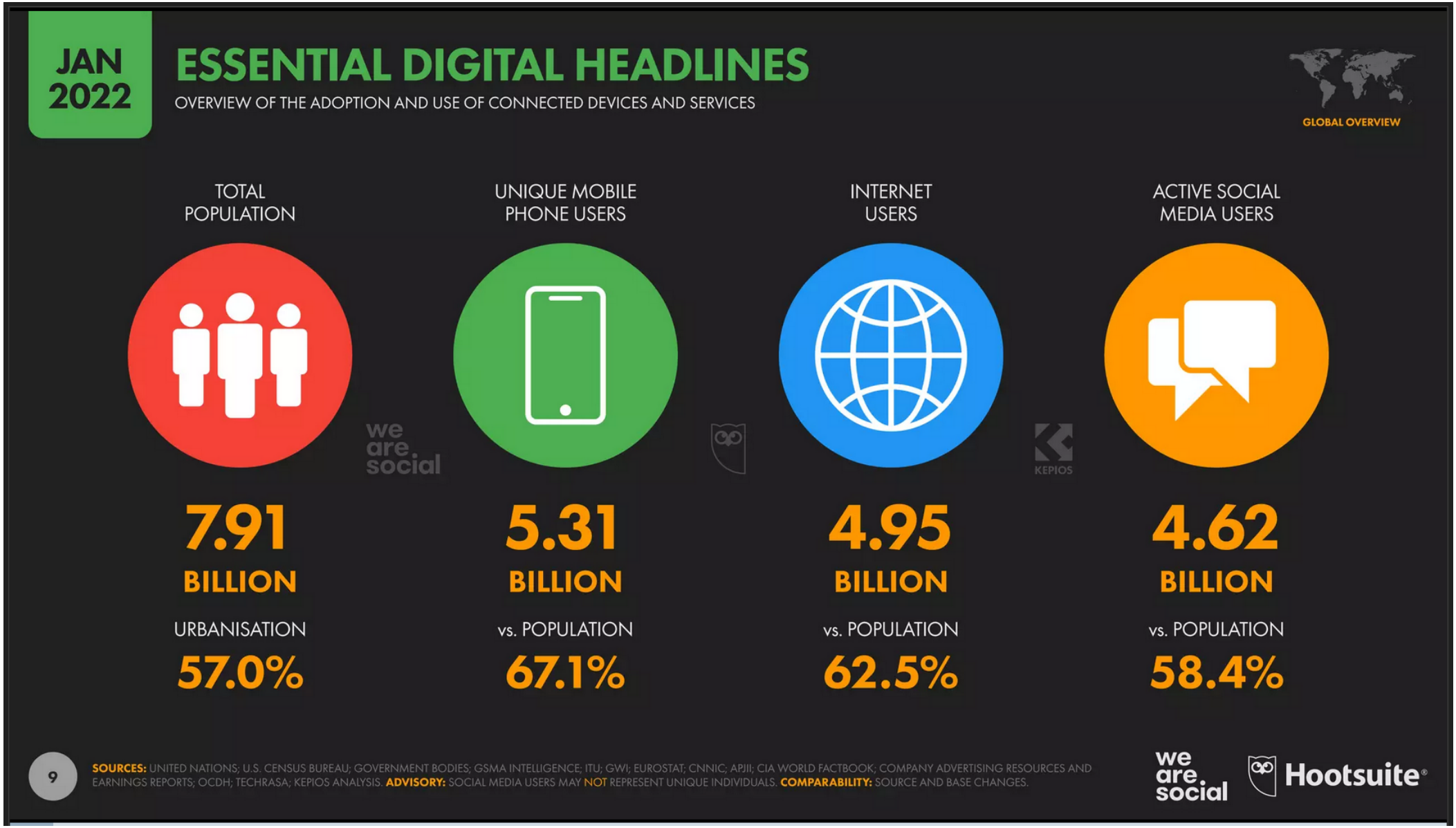
Fig. 4 -The console and a few peripheral units from an IBM System/360 model 30.

Fig. 5 -The Whirlwind computer, the large-scale supercomputer of the 1950s and 1960s developed for automated strategic air defense applications. It could display real time video. The last Whirlwind computer was shut down in 1983.

Fig. 7 -The DEC PDP-8, a popular minicomputer of the late 1960s and early 1970s. The yellow box identifies the processors; the components above are hard disk drives, which wouldn't be necessary in an embedded system.

A Glimpse of Today…

A Glimpse of Today…



A Glimpse of Today…

JAN 2022

UNCONNECTED POPULATIONS

COUNTRIES AND TERRITORIES WITH THE LARGEST UNCONNECTED POPULATIONS AND THE LOWEST LEVELS OF INTERNET ADOPTION

GLOBAL OVERVIEW

ABSOLUTE: LARGEST UNCONNECTED POPULATIONS

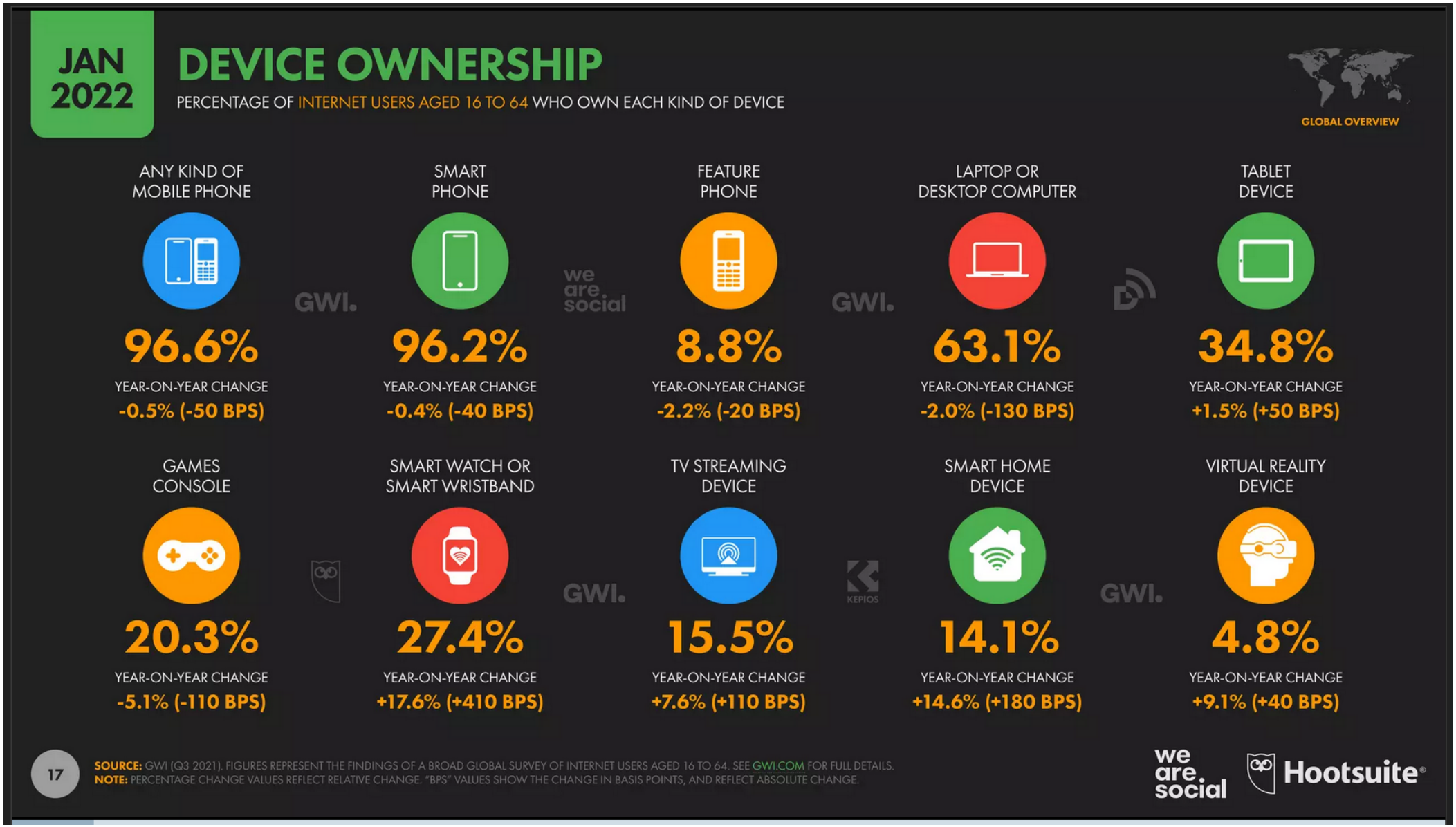
#	LOCATION	UNCONNECTED POPULATION	% OF POP. OFFLINE
01	INDIA	742,003,000	53.0%
02	CHINA	421,432,000	29.1%
03	PAKISTAN	144,434,000	63.5%
04	BANGLADESH	114,511,000	68.5%
05	NIGERIA	104,888,000	49.0%
06	ETHIOPIA	89,502,000	75.0%
07	DEM. REP. OF THE CONGO	77,293,000	82.4%
08	INDONESIA	73,047,000	26.3%
09	BRAZIL	49,375,000	23.0%
10	TANZANIA	46,794,000	75.0%

RELATIVE: LOWEST LEVELS OF INTERNET ADOPTION

#	LOCATION	% OF POP. OFFLINE	UNCONNECTED
232	NORTH KOREA	>99.9%	25,938,000
231	CENTRAL AFRICAN REPUBLIC	92.9%	4,613,000
230	ERITREA	92.0%	3,341,000
229	COMOROS	91.5%	822,000
228	SOUTH SUDAN	89.1%	10,248,000
227	SOMALIA	86.3%	14,333,000
226	NIGER	85.5%	21,881,000
225	KIRIBATI	85.4%	105,000
224	BURUNDI	85.4%	10,623,000
223	DEM. REP. OF THE CONGO	82.4%	77,293,000

SOURCES: ITU; GSMA INTELLIGENCE; EUROSTAT; GWI; CIA WORLD FACTBOOK; CNNIC; APJII; LOCAL GOVERNMENT AUTHORITIES; UNITED NATIONS. **NOTES:** FIGURES IN THE "% OF POP. OFFLINE" COLUMN REPRESENT THE PERCENTAGE OF THE POPULATION THAT DOES NOT YET USE THE INTERNET. ABSOLUTE VALUES HAVE BEEN ROUNDED TO THE NEAREST THOUSAND. THE INTERNET (AT LEAST AS THE REST OF THE WORLD KNOWS IT) REMAINS BLOCKED FOR EVERYDAY CITIZENS IN NORTH KOREA. **COMPARABILITY:** SOURCE AND BASE CHANGES.

A Glimpse of Today…



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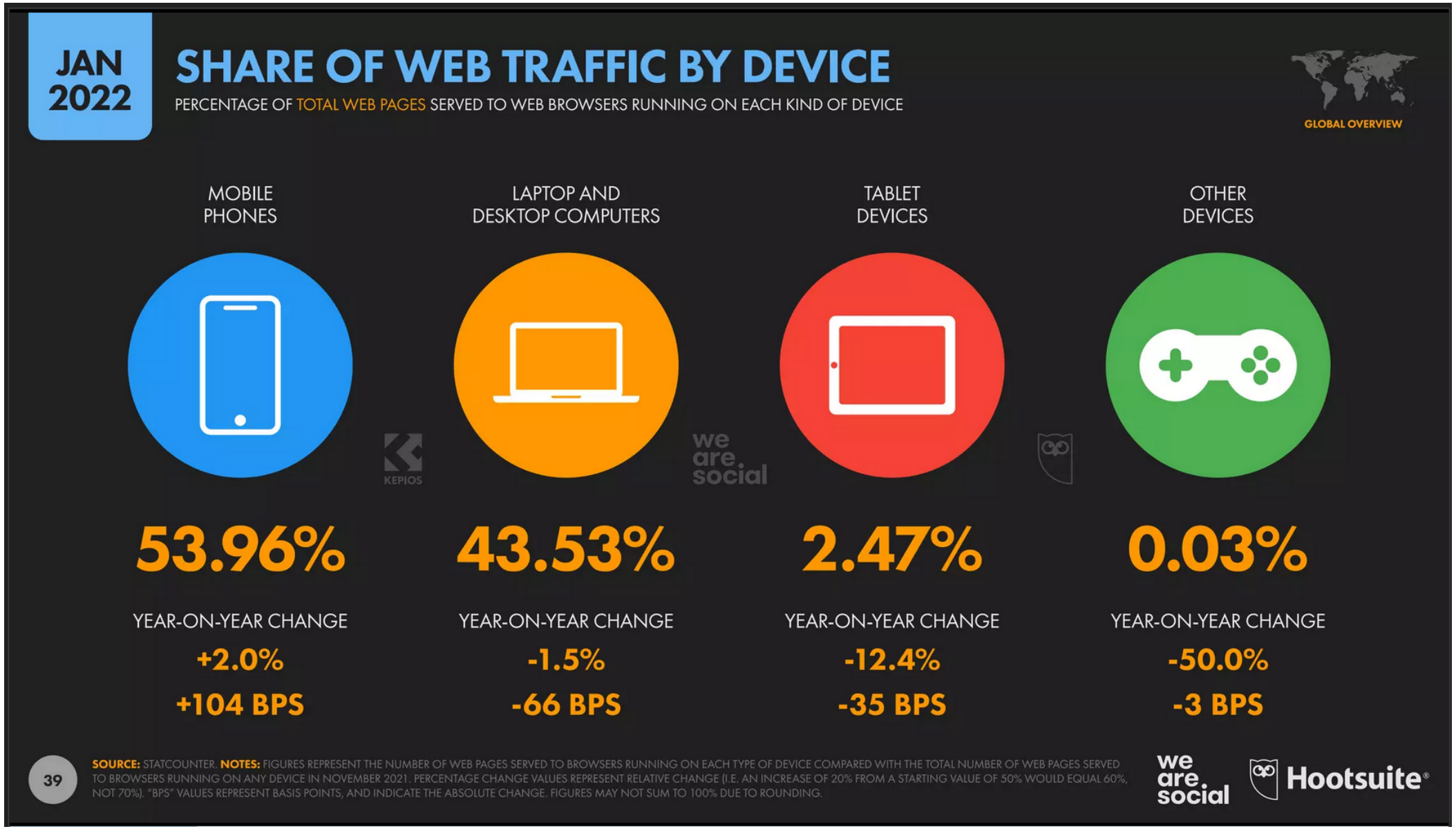

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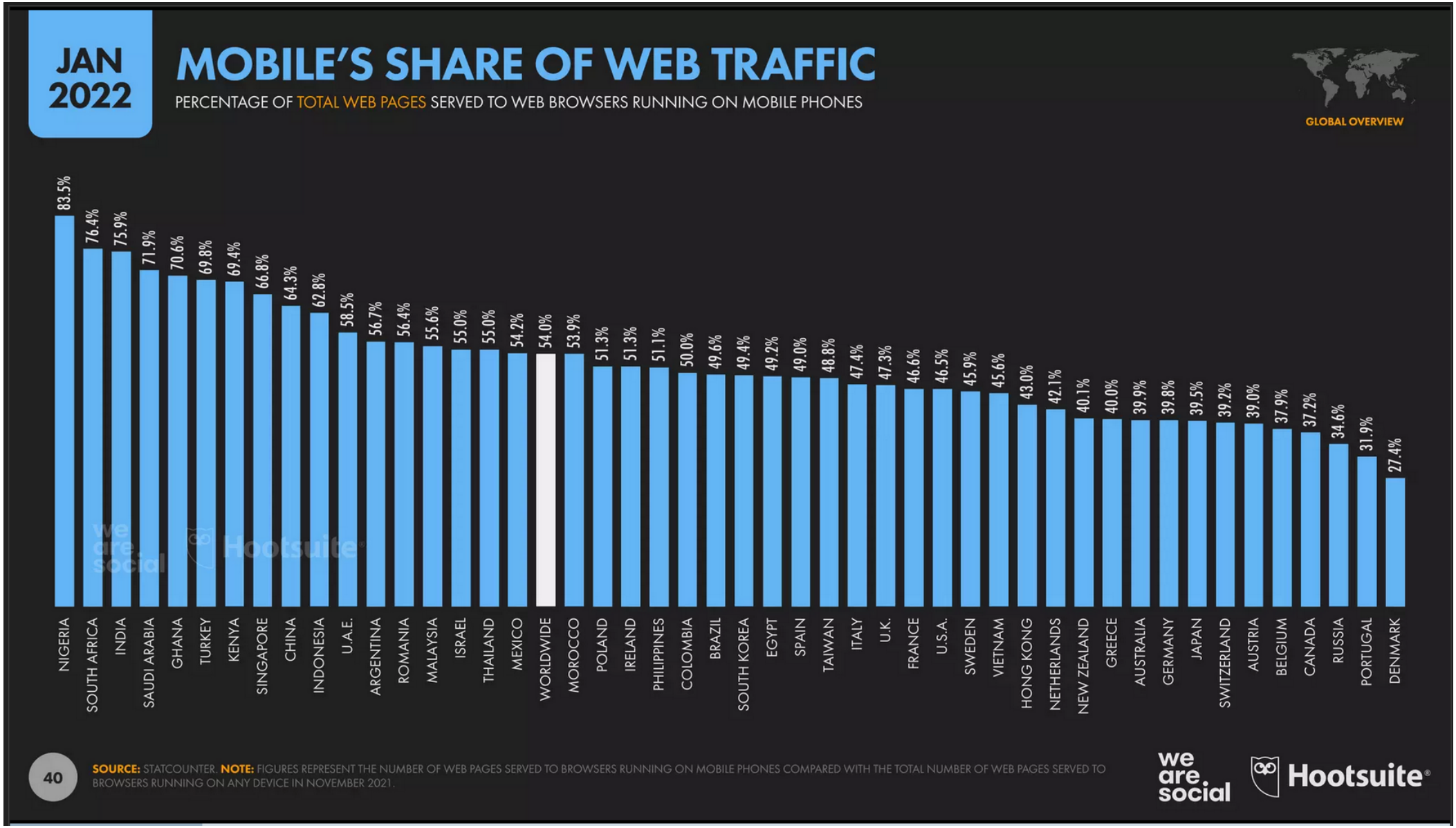

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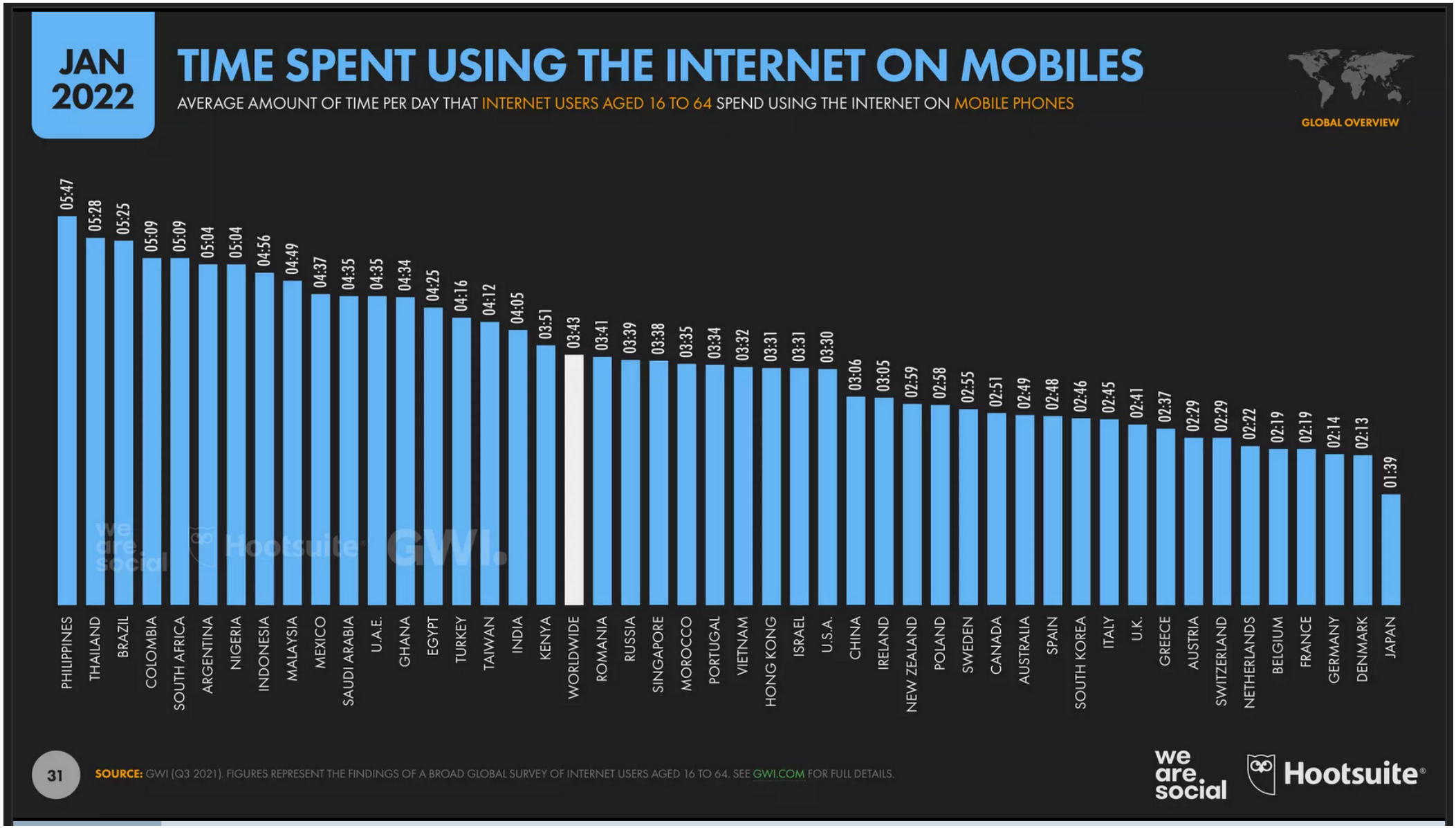

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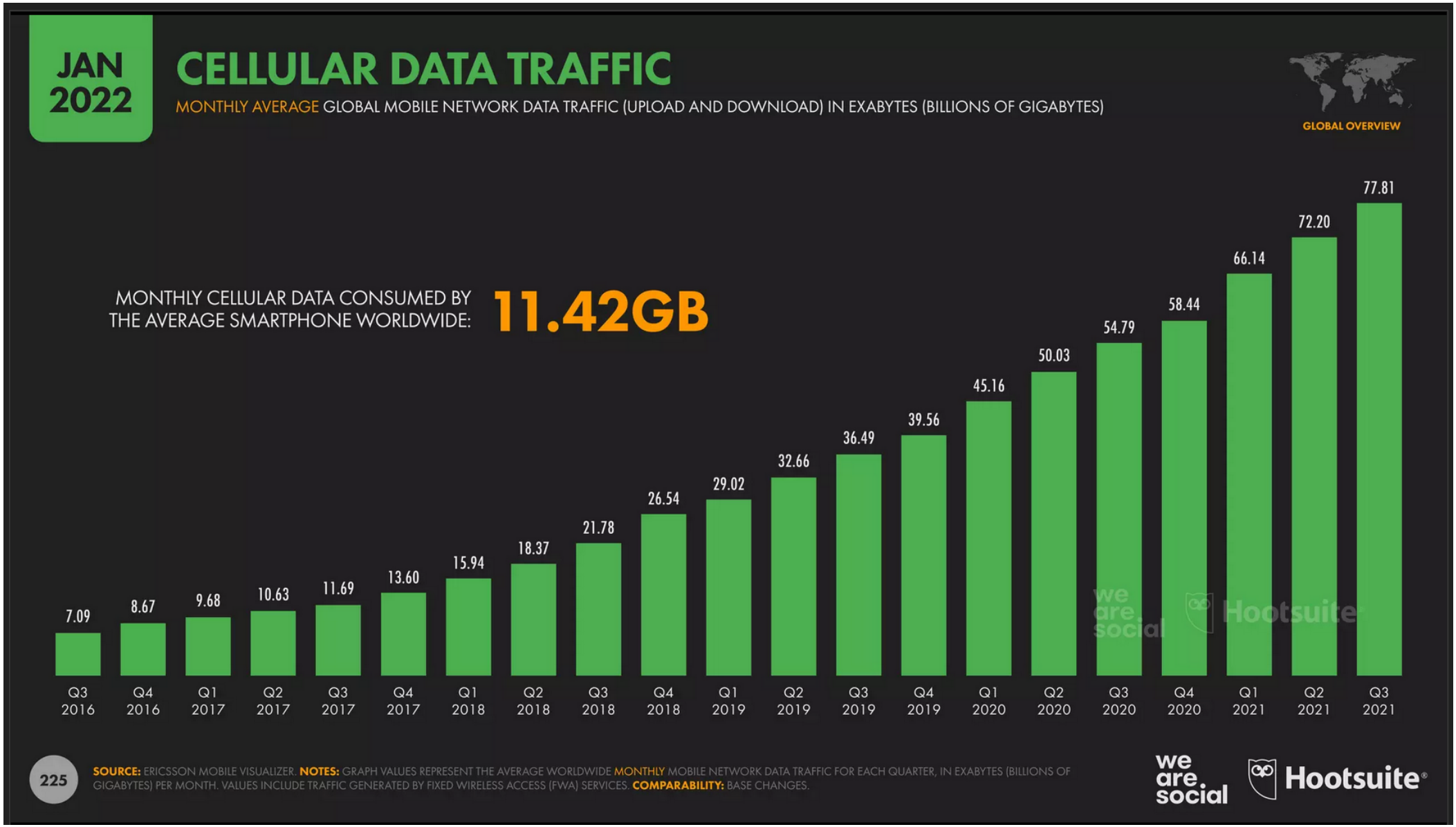


Mobile Computing Today

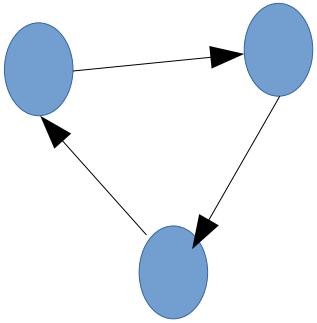
- Where do we stand ?
- Where we do not want to go !
- How far away are we ?
- Are we going in the right direction ?
- What are the challenges ?

A Glimpse of the Future?...

Google Glasses

http://www.youtube.com/watch?v=JSnB06um5r4

Where do we stand ?



- Thanks to cellular connections and Wi-Fi networks:
  - we have near-constant access to computing power and online data,
  - giving us what might be called *near-ubiquitous computing*

- We seem to be producing an attention economy that lives off users attention and data mining:
  - “If the service is free, you are the product.”

- It’s not quite the ambient intelligence that was envisioned but it’s a step in that direction.

Where are we going to?
Where we do not want to go!

- A fundamental desired characteristic is ***calm computing***, i.e. the system:
  - remains in the background
  - does what we want it to do seamlessly.

- However, today's technology are more likely ***jittery technology***:
  - constant beeping for messages, posts, updates, news, etc.…
  - phantom vibration: the perception of a phone's vibration in the absence of an event
  - even watching TV is no longer as it used to be due to second screening and chatterboxing.

Where are we going to?
Where we do not want to go!

- We create new technology but technology changes us also!

- Pros:
  - Having so much information ready at the fingertips.
  - Cheap access to quickly deployed telecoms.
  - Increasing productivity.

- Cons:
  - Attention Economy
  - Privacy Loss
  - Focus Loss

A Glimpse of the (would like to be) Future…

> The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it…Today's multimedia machine makes the computer screen into a demanding focus of attention rather than allowing it to fade into the background.

By Mark Weiser, Scientific American September 1991

Challenges

- Context-awareness
- Adaptability
- Cyberforaging
- Resource Discovery
- Offloading
- Replication
- Energy
- Security
- Operating system
- Networking
- Etc.

Applications
Middleware
Operating System

Context-Awareness

- **Invisibility** implies no configuration, no interaction. The system simply makes what the user wants

- This requires the system to be **pro-active** and **correct**.

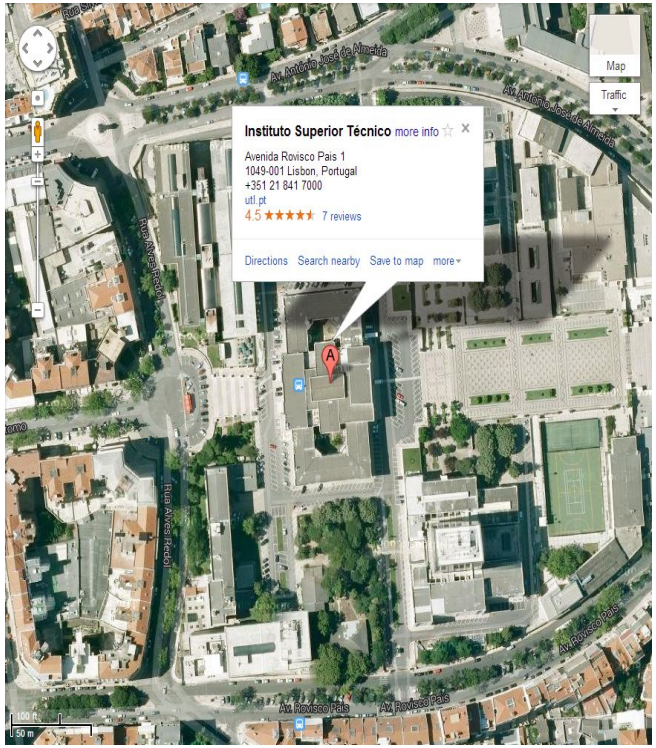
- The system must get all the **context information** to **predict** what the user wants and act accordingly.

- Context information includes many aspects; from the most obvious which is location to many others as user's agenda, temperature, presence, etc…

- Basically, based on context, the system captures the user-intent.

Location

- Triangulation:
  - lateration, which uses multiple distance measurements between known points,
  - angulation, which measures angle or bearing relative to points with known separation.
- Proximity:
  - measures nearness to a known set of points.
- Scene analysis:
  - examines a view from a particular point.
- Privacy, Symbolic, Scale, Cost, Absolute/Relative, Accuracy and Precision.



Adaptability

- The system must be capable of dealing with the variability of the environments.

- Such variability ranges all aspects:
  - network on /off/slower/faster, memory available or not, CPU available or not, etc… all resources may vary with time and location

- Capability of automatically adapting to the environment while remaining invisible.

- Ubiquitous (invisible) systems must be able to handle all the spectrum of resource variability, thus including fault-tolerance aspects (when resources are unavailable).

- Balancing pro-activity and invisibility.

It is not the strongest of the species that survives, nor the most intelligent;

It is the one that is most adaptable to change.

(Charles Darwin)

Resource Discovery

- Protocols to discover nearby resources.
- Use those resources if that is needed or Advantageous.
- Examples:
  - use a printer at the hotel where I've just arrived;
  - using more powerful CPU from a nearby laptop;
  - use a higher quality screen (HD, bigger screen, etc.);
  - use storage available from a local server or from the cloud.
- Scalable and correct discovery protocols (flooding, false positives, completeness).

Cyberforaging

- Dealing with variable, uncertain or unavailable resources can be done by taking advantage of other equivalent resources in the surroundings.

- E.g. lack of network availability may be solved with a shared hotspot.

- Invisibility implies:
  - discovering available resources
  - use such resources
  - automatically, without bothering the user

- Opportunities provided by cyberforaging:
  - take advantage any resource available (e.g. network, printer, **CPU**, storage, screen, etc.)

Replication

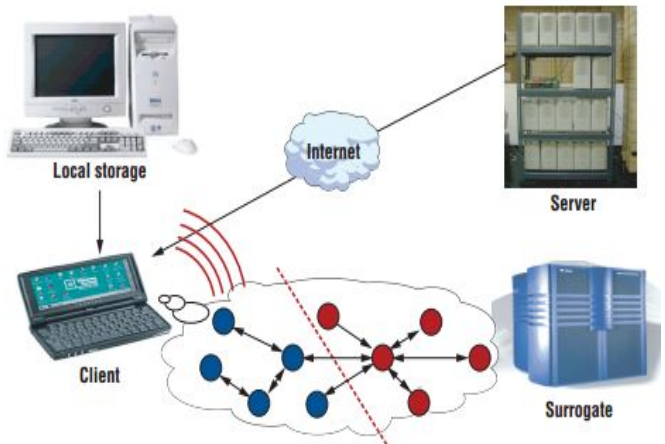
- Maintaining multiple consistent copies of data for accessibility and fault tolerance.

- Accessing data and code anywhere
- Data staging on untrusted surrogates
- File hoarding
- Object replication

Offloading

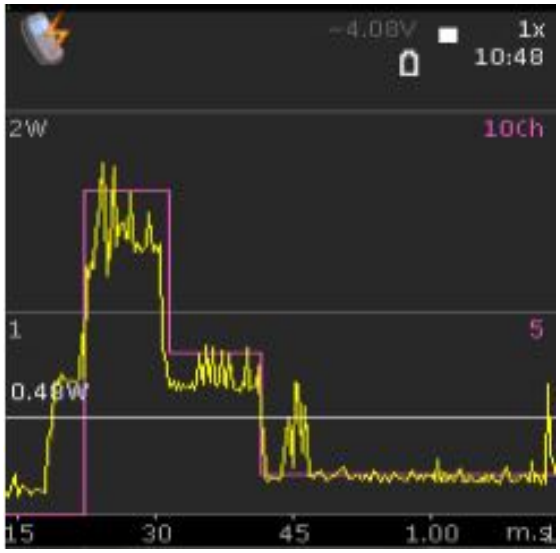
- Offload computation from the mobile device to a more powerful CPU

- Implies deciding if it is really advantageous:
  - Time/Cost to compute.
  - Time/Cost to send and receive (what to transmit).
  - Time/Cost to decide what to offload (static and/or dynamic).
  - Run-time code changes to support offloading.



Energy

- Find where battery being mostly used.



- Minimize what most consumes energy:
  - Reduce/aggregate number of messages.
  - Redesign communication protocols. (e.g. minimize wait-state)
  - Better match between messages sending and communication protocol.

App	Run-time	#Routine calls (#Threads)	% Battery	3rd-Party Modules Used	*Where is the energy spent inside an app?*
browser	30s	1M (34)	0.35%	-	38% HTTP; 5% GUI; 16% user tracking; 25% TCP cond.
angrybirds	28s	200K (47)	0.37%	Flurry[7],Khronos[41]	20% game rendering; 45% user tracking; 28% TCP cond.
fchess	33s	742K (37)	0.60%	AdWhirl[42]	50% advertisement; 20% GUI; 20% AI; 2% screen touch
nytimes	41s	7.4M (29)	0.75%	Flurry[7],JSON[43]	65% database building; 15% user tracking; 18% TCP cond.
mapquest	29s	6M (43)	0.60%	SHW[44],AOL,JSON[43]	28% map tracking; 20% map download; 27% rendering

Conclusions

- Hardware Evolution
- Ubiquity of Devices
- Vision: Invisible Computing
- Challenges to Make Invisible Computing a Reality

- Context-awareness
- Adaptability
- Cyberforaging
- Resource Discovery
- Offloading
- Replication
- Battery Usage
- Security
- Etc.

Applications
Middleware
Operating System