TUNED-IN

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KRRR
RRRBRLR
Ting
What year did I land in ?
2024
Not bad!
I'm Jenny
Mateo, nice to meet you. What's that thing ?
I found this machine by chance, and it seems to allow time travel. To be honest, I was aiming for the dinosaurs...


Wait, you're taking pictures? Your camera's super flat!
That's my cellphone!
You can take pictures with your CELLPHONE ???
You're late to the party..!
But look at mine! They're only 20 years
Wow, a relic! So, you're from 2004?
C'mon...
When I press here, the keyboard
What's "TikTok"?
What's "Facetime"?
I didn't see a dinosaur, but at least I saw the phone of the future! That's almost as cool!
Oh, "Ma" is calling.
MA
Hi, Mateo! Could you bring me some fruit for the fruitcake?
You got it !
Let me know what time you'll be home!
Who's your friend, right next to you? :)
That's Jenny ! She's fascinated by my cellphone and would like to know how it works, but I don't know anything about it...
Hello, Ma'am!
You should explain it to her


Hello, Jenny! I'm an engineer at the ANFR, the french National Frequency Agency.
Omg, what a convenient plot twist!
Could you explain everything that's changed between 2004 and 2024 in terms of phones and all that?
It's just so crazy to me!
Of course! But you could start by going to the Telecommunications Museum. I've got tickets, I'll e-mail them to you... Just a moment... Done !
TURN-RIGHT
Mateo, Is there an actual GPS in your cellphone???
You haven't seen anything yet!
TELECOMMUNICATION MUSEUM
Ta-daaa !

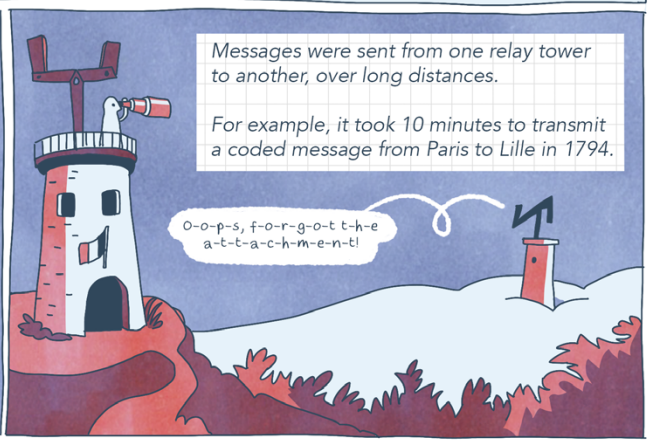
Telecommunications refers to the emission, transmission and reception of an information signal from a transmitter to a receiver.

Here are some examples of telecommunications-based technologies :

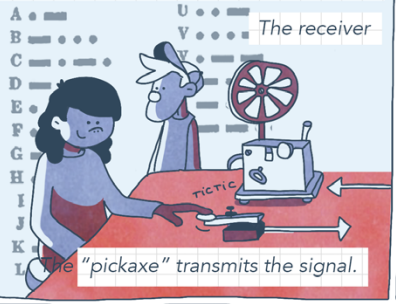
One of the first telecommunication systems was Chappe's optical telegraph, in 1790.

Messages were coded by large, manually articulated arms.

Example of an ~~official~~ code:



Samuel Morse invented the electric telegraph and patented the "Morse" code in 1840. Each letter is a short or long signal.

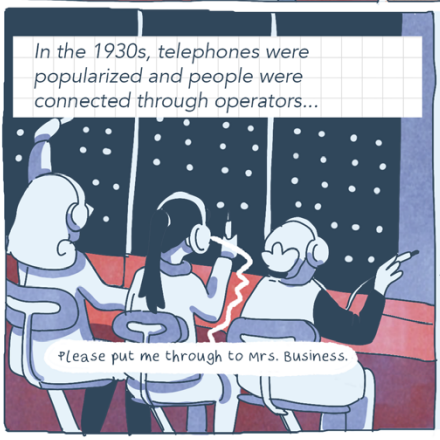


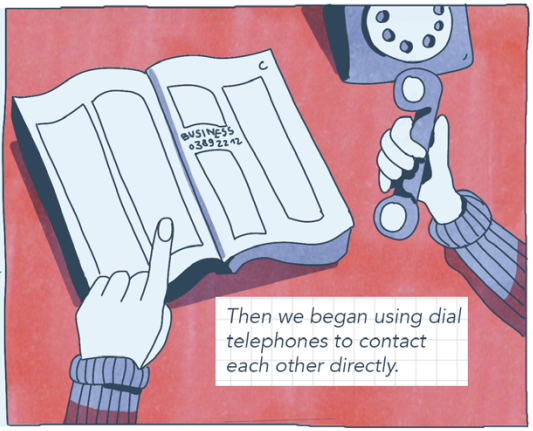
The receiver

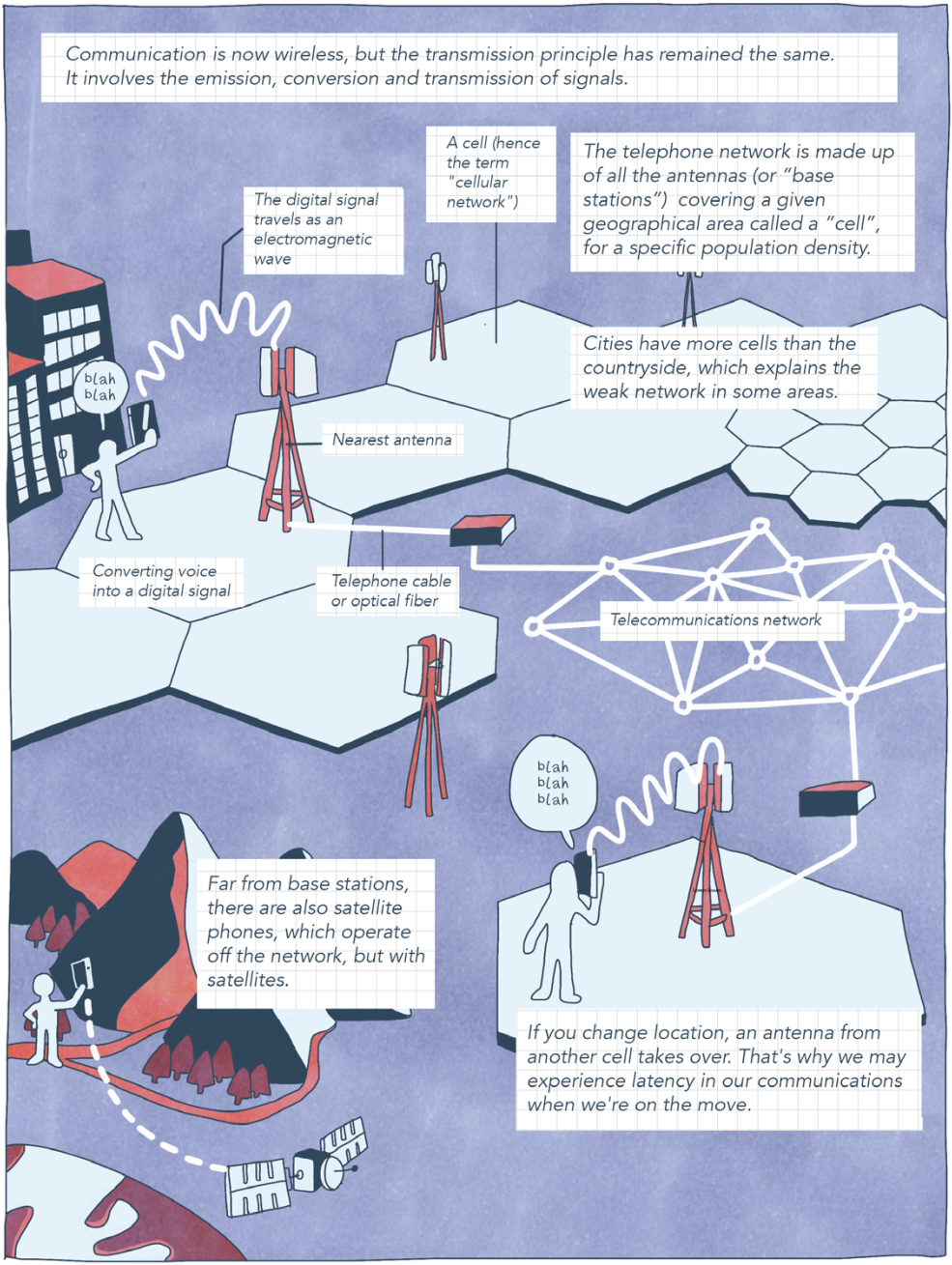
The "pickaxe" transmits the signal.

This system will enable messages to be sent remotely, first electrically, then wirelessly (that's radiotelegraphy).

The first telephone was invented in 1876. The signal would be sent in the same way as with the telegraph, but by then we'd figured out how to transmit voices.






Communication is now wireless, but the transmission principle has remained the same. It involves the emission, conversion and transmission of signals.
A cell (hence the term "cellular network")
The telephone network is made up of all the antennas (or "base stations") covering a given geographical area called a "cell", for a specific population density.
The digital signal travels as an electromagnetic wave
Cities have more cells than the countryside, which explains the weak network in some areas.
blah blah
Nearest antenna
Converting voice into a digital signal
Telephone cable or optical fiber
Telecommunications network
blah blah blah
Far from base stations, there are also satellite phones, which operate off the network, but with satellites.
If you change location, an antenna from another cell takes over. That's why we may experience latency in our communications when we're on the move.

Until the 1980s, wireless communications were reserved for military use. Gradually, private individuals began adopting these new technologies.

1G ***(G for generation)***
In the 1980s, Motorola was among the first companies to develop and market this cellphone, enabling voice transmission over long distances.

2G ***(There was about one generation every 10 years)***
Better voice quality (the signal is now digital). Introduced in the 1990s, 2G also enables text messages to be sent and received. The GSM system maintains the connection to relay antennas as users move around.

3G
The biggest leap : mobile Internet was introduced with 3G in the 2000s

4G
Higher speeds, better network coverage

5G
You're here!

Now, browsing or downloading videos is almost as fast as with a wired connection to the Internet!

4G is already going so fast! I don't really understand why you're developing 5G...

We'll ask my mom! I think she'll know the answer.

Great! Let's not forget to bring her some fruit.


clop
Look who's back!
How was the museum?!
Great!
Here's some fruit
Jenny has some questions!
Well, you've had 3G, then 4G, which is already very fast. Why develop 5G or even 6G? I don't get it.
Back in my day, we had 10MB, paid 4cts per text, and we were happy, you know?
Yeah, especially if you're gonna burn through all your 4G watching dumb stuff on TikTok.
«- Welcome to Extreme Movers ! Today we're gonna see if this van survives a 1km drop!!! You ready???
- Uh... Actually I was just here for the vehicle inspection."
Okay, Dad. Here's part of the explanation : 5G is faster at transmitting large amounts of data! It makes things like connected devices more useful and widespread.
And to understand how 5G does that, you need to know how electromagnetic waves work...
A "wave" is a temporary disturbance that propagates and transmits energy.
You can see a wave propagating when a pebble is thrown into the water (from a 1km-high cliff, for example).
It's not the water that's moving. It's the disturbance of the water's surface that carries the energy from one point to another.

The frequency of a wave can be more or less high. It is expressed in Hertz (Hz):
1Hz = 1 oscillation per second,
1GHz = 1 billion oscillations per second

Low frequencies: slow oscillations

1 wavelength

High frequencies : fast oscillations

1 wavelength

Telecommunications use electromagnetic waves. These waves are made up of electric and magnetic waves traveling perpendicularly.

Magnetic field

Electric field

Unlike electromagnetic waves, such as light, which can propagate through both a material medium and a vacuum, mechanical waves, such as sound, require a material medium like water or air to travel and cannot propagate in a vacuum.

So that's why there's light but no sound in space, then! 'Cause there's no air!

So what does all this have to do with telecommunications?

All these technologies operate on different frequency bands to avoid creating interference.

RNC

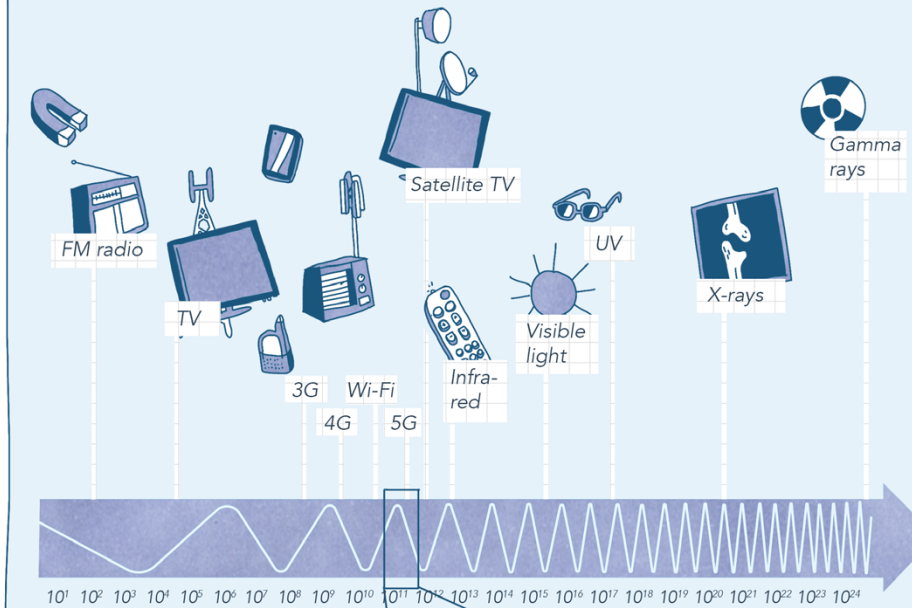
GPS (connected watches)
1575,42 MHz
1176,45 MHz

TV :
30-3000 MHz

Wifi:
2,4 GHz
5 GHz

4G:
2,1 GHz

All devices that use electromagnetic waves operate across the frequency spectrum, and therefore operate at higher or lower frequencies.



We need to agree on which technologies use which part of the spectrum to communicate.

If multiple devices operate on the same frequencies, they can cause signal interference

That's why we use airplane mode, for example, so that our phones don't interfere with airplane signals

Many frequency bands are already saturated. That's why 5G is being developed using higher frequencies.

In 2020, the 5G frequency bands (3.4 – 3.8 GHz) were allocated through an auction process. The price was approximately 70 million euros per 10 MHz block. Four operators submitted applications: SFR, Bouygues Telecom, Free, and Orange.

The allocation was as follows :

In 2025, there are other bands dedicated to 5G : at 700MHz, soon at 1800 MHz, and in the future we'll find some at over 26 GHz.

All this information is readily available on the National Frequency Agency (ANFR)website.

clic clic

On average, there is one 4G antenna/km².

One can even see where nearby antennas are located.

5G

Oh right, we've got great reception here!

That's because there's an antenna on the building next door!

Wait, so we're being blasted with waves all the time??

An have you seen that video where they put popcorn next to a Wi-Fi router and it starts popping?

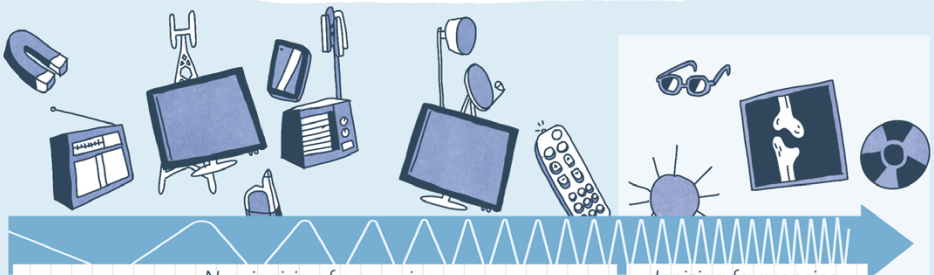
Well, indeed, electromagnetic radiation can be harmful to your health...

We're s c r e w e d

Also that video's fake.

https://www.anfr.fr/gerer/lobservatoire-des-reseaux-mobiles/lobservatoire-en-carte

First of all, the upper part of the spectrum has proven harmful effects. These are known as "ionizing" waves: they have the ability to dislodge electrons from atoms, and are used in medical imaging, for example.



Any wave that raises body temperature by more than 1°C can present health risks. It's all a matter of power.

For example, microwaves use the same frequency as WiFi — but at a much higher power, which allows them to heat food.

Exposure to electromagnetic waves is regulated by the EU, well below the warming thresholds.

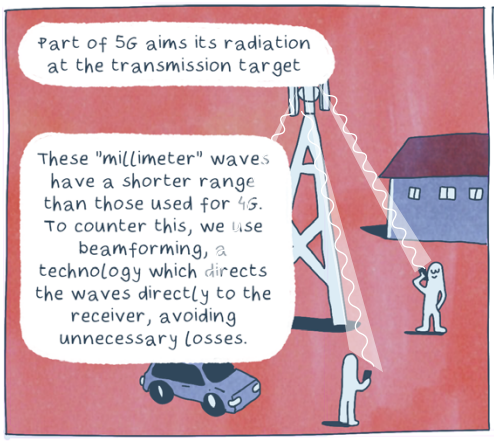
In fact, we absorb far more radiation from our own cellphones than from relay antennas.

Moreover, wave emissions differ significantly between 4G and certain 5G bands.

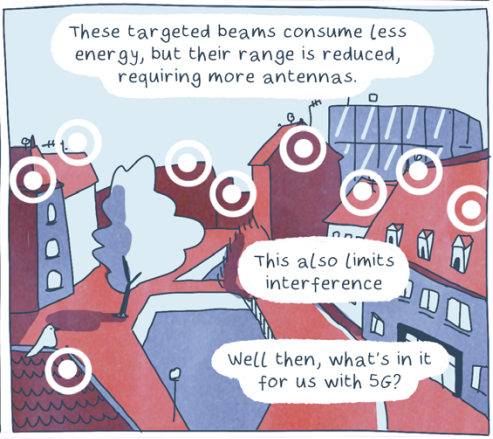
Unlike 4G, which "sprays" its signal all around...

Part of 5G aims its radiation at the transmission target

These "millimeter" waves have a shorter range than those used for 4G. To counter this, we use beamforming, a technology which directs the waves directly to the receiver, avoiding unnecessary losses.

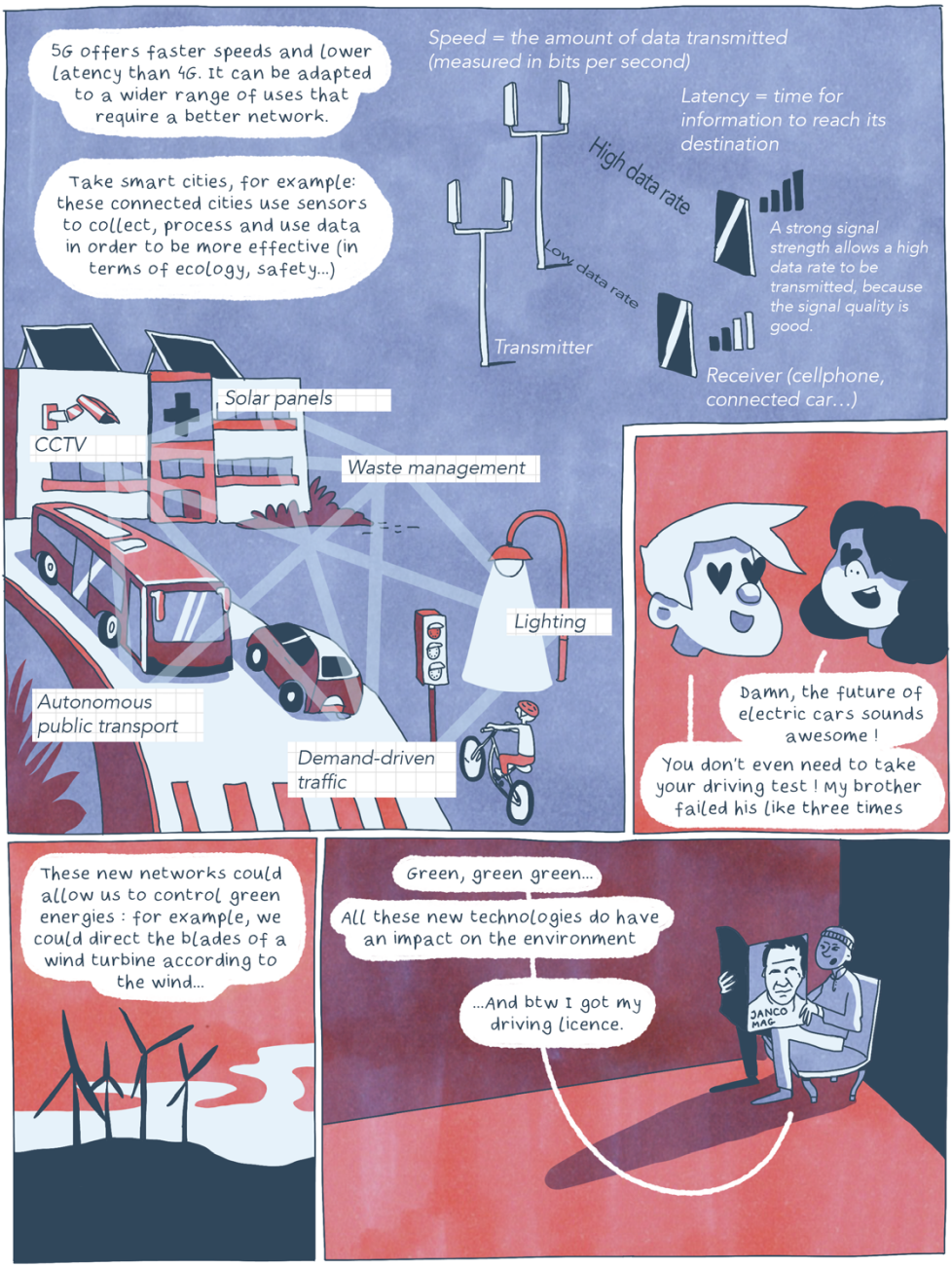


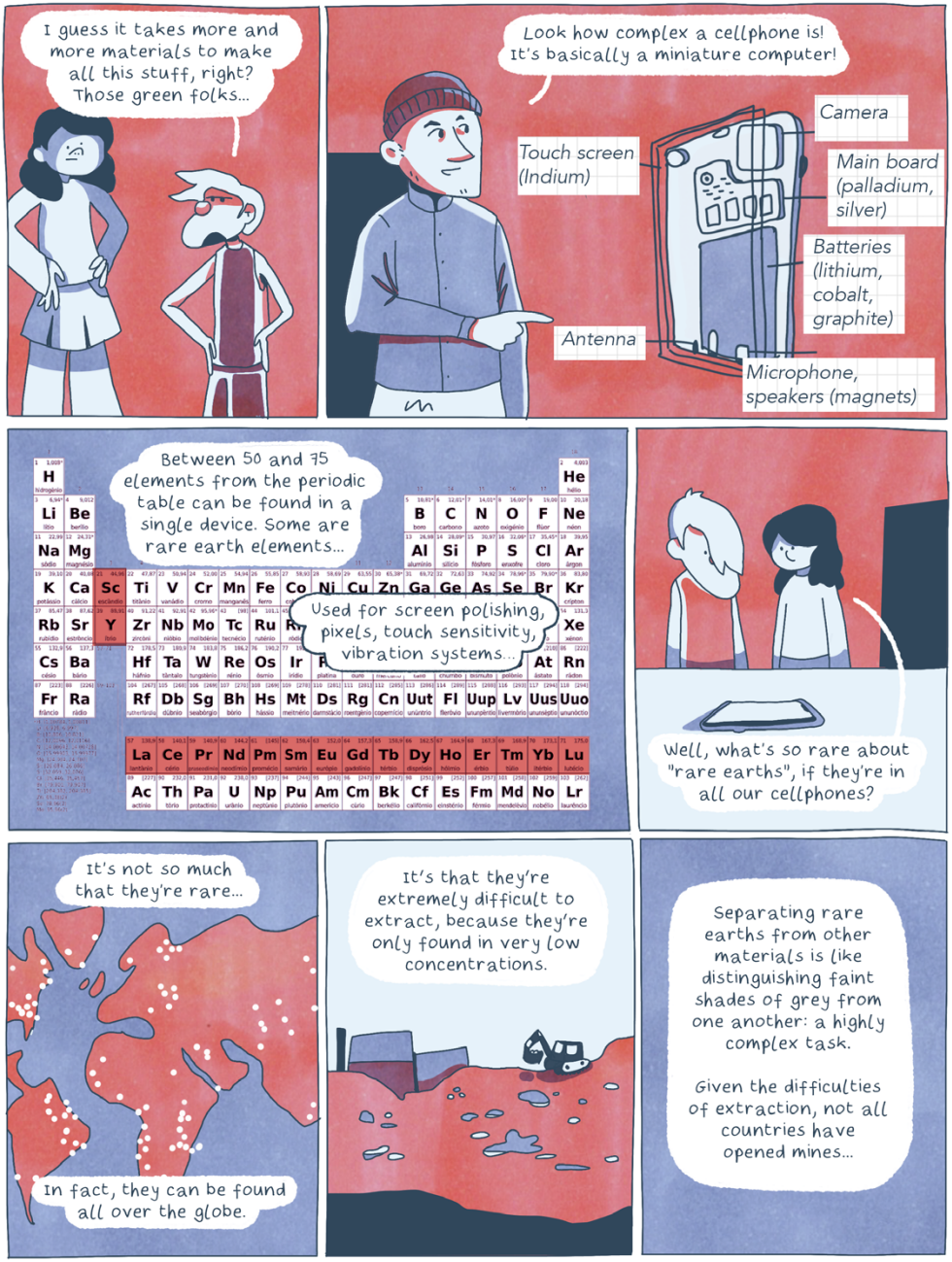
These targeted beams consume less energy, but their range is reduced, requiring more antennas.

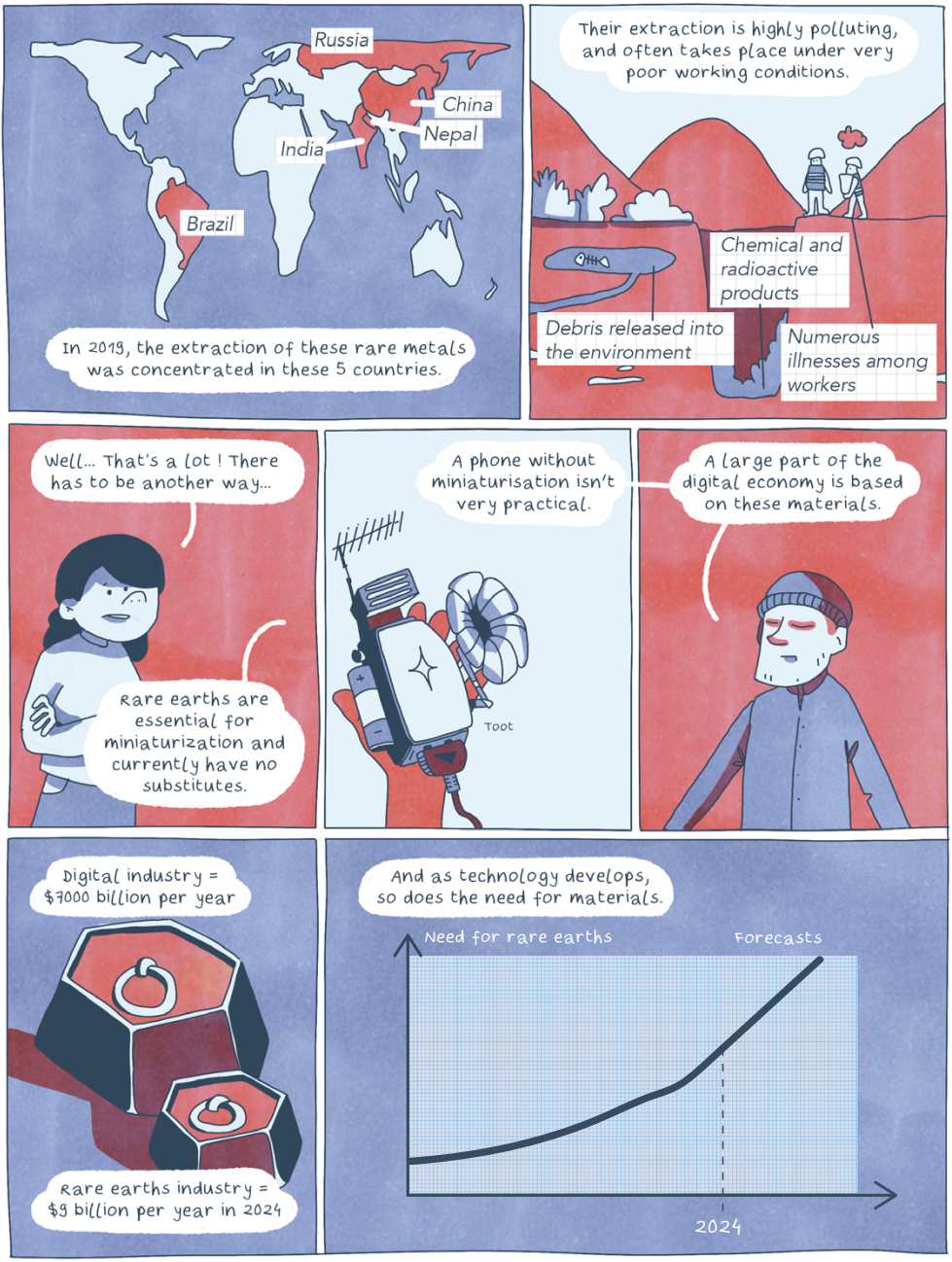


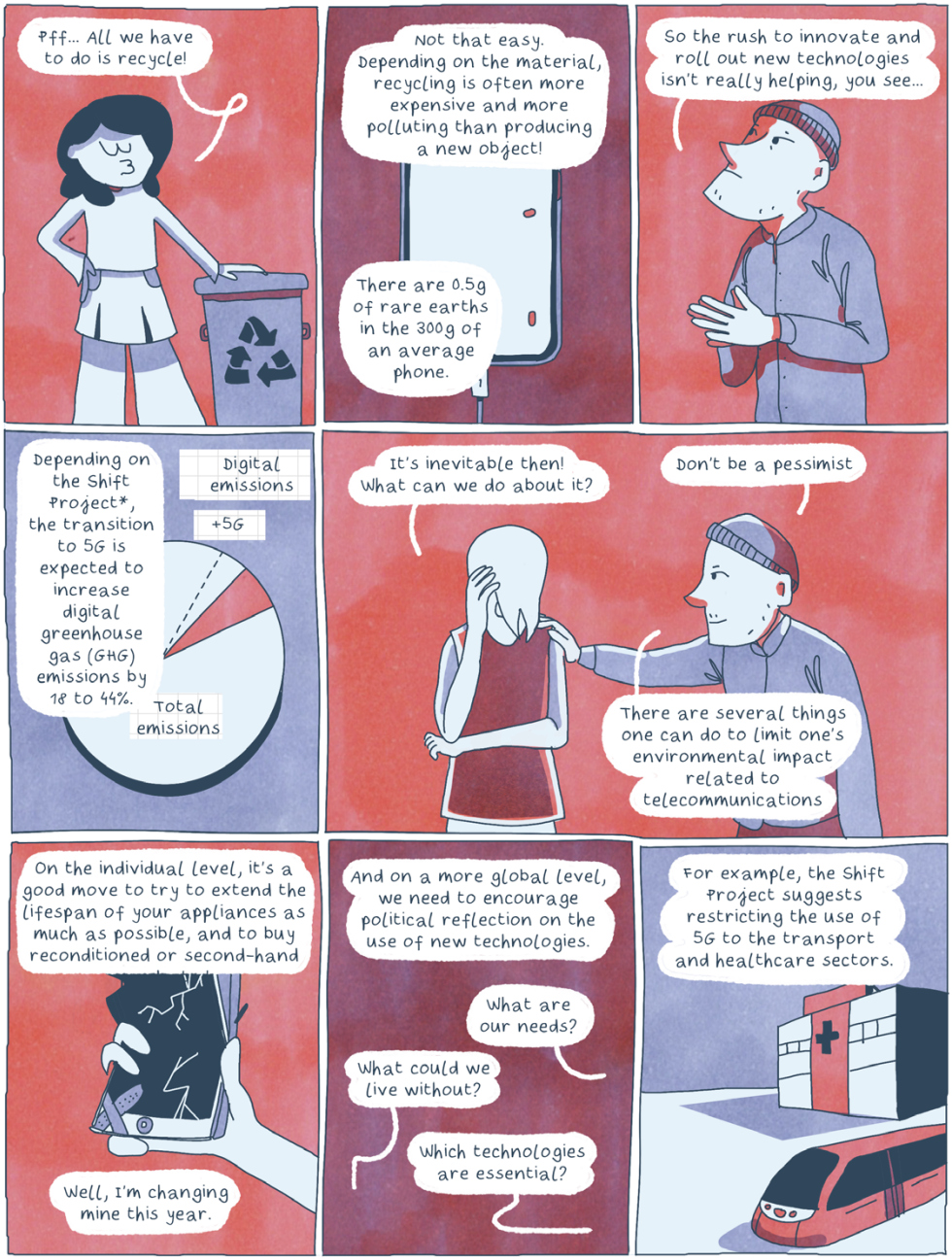
This also limits interference

Well then, what's in it for us with 5G?

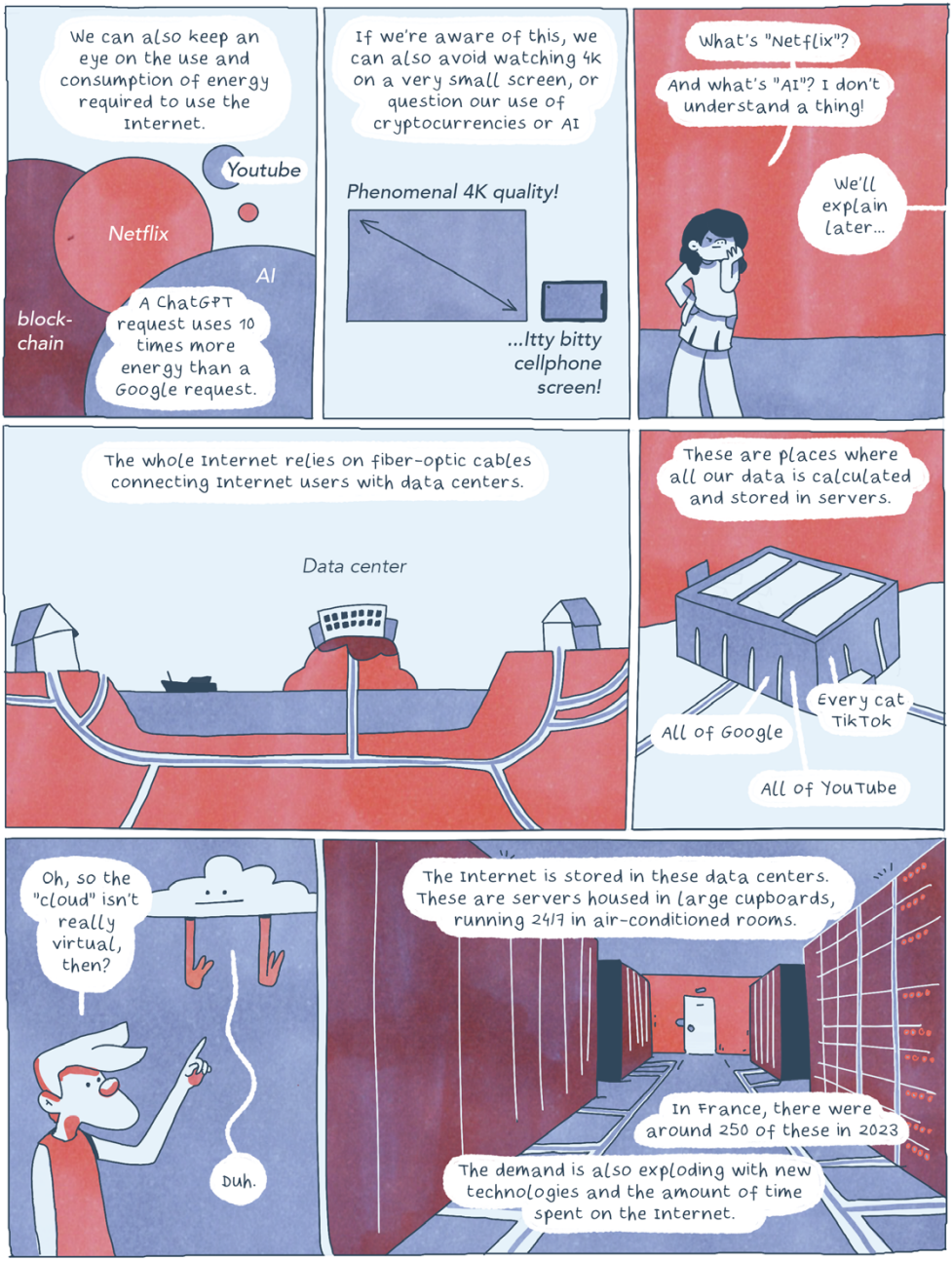

5G offers faster speeds and lower latency than 4G. It can be adapted to a wider range of uses that require a better network.
Take smart cities, for example: these connected cities use sensors to collect, process and use data in order to be more effective (in terms of ecology, safety...)
Speed = the amount of data transmitted (measured in bits per second)
High data rate
Low data rate
Transmitter
Latency = time for information to reach its destination
A strong signal strength allows a high data rate to be transmitted, because the signal quality is good.
Receiver (cellphone, connected car...)
Solar panels
CCTV
Waste management
Lighting
Autonomous public transport
Demand-driven traffic
Damn, the future of electric cars sounds awesome !
You don't even need to take your driving test ! My brother failed his like three times
These new networks could allow us to control green energies : for example, we could direct the blades of a wind turbine according to the wind...
Green, green green...
All these new technologies do have an impact on the environment
...And btw I got my driving licence.
JANCO MAG


I guess it takes more and more materials to make all this stuff, right? Those green folks...
Look how complex a cellphone is! It's basically a miniature computer!
Camera
Touch screen (Indium)
Main board (palladium, silver)
Batteries (lithium, cobalt, graphite)
Antenna
Microphone, speakers (magnets)
Between 50 and 75 elements from the periodic table can be found in a single device. Some are rare earth elements...
Used for screen polishing, pixels, touch sensitivity, vibration systems...
Well, what's so rare about "rare earths", if they're in all our cellphones?
It's not so much that they're rare...
In fact, they can be found all over the globe.
It's that they're extremely difficult to extract, because they're only found in very low concentrations.
Separating rare earths from other materials is like distinguishing faint shades of grey from one another: a highly complex task.
Given the difficulties of extraction, not all countries have opened mines...


Russia
China
India
Nepal
Brazil
In 2019, the extraction of these rare metals was concentrated in these 5 countries.
Their extraction is highly polluting, and often takes place under very poor working conditions.
Chemical and radioactive products
Debris released into the environment
Numerous illnesses among workers
Well... That's a lot ! There has to be another way...
Rare earths are essential for miniaturization and currently have no substitutes.
A phone without miniaturisation isn't very practical.
Toot
A large part of the digital economy is based on these materials.
Digital industry = $7000 billion per year
Rare earths industry = $9 billion per year in 2024
And as technology develops, so does the need for materials.
Need for rare earths
Forecasts
2024

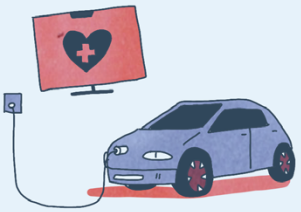


* *The Shift Project est une association qui s'est donné pour objectif l'atténuation du changement climatique et la réduction de la dépendance de l'économie aux énergies fossiles, particulièrement au pétrole.*


We can also keep an eye on the use and consumption of energy required to use the Internet.
Youtube
Netflix
AI
block-chain
A ChatGPT request uses 10 times more energy than a Google request.
If we're aware of this, we can also avoid watching 4K on a very small screen, or question our use of cryptocurrencies or AI
Phenomenal 4K quality!
...Itty bitty cellphone screen!
What's "Netflix"?
And what's "AI"? I don't understand a thing!
We'll explain later...
The whole Internet relies on fiber-optic cables connecting Internet users with data centers.
Data center
These are places where all our data is calculated and stored in servers.
All of Google
Every cat TikTok
All of YouTube
Oh, so the "cloud" isn't really virtual, then?
Duh.
The Internet is stored in these data centers. These are servers housed in large cupboards, running 24/7 in air-conditioned rooms.
In France, there were around 250 of these in 2023
The demand is also exploding with new technologies and the amount of time spent on the Internet.


I had no idea what came with having a cellphone...
Are you okay?
I think she's having an existential crisis
What a messed-up world...
But that's only natural, given that you've discovered so many things!
Everything changes so fast! My phone doesn't even go online.
In 20 years, we've gone from a corded phone to a cellphone!
We now have internet access almost everywhere!
To recap, the signal you send travels to the nearest antenna
The antenna installed by your provider connects to the network
5G, compared to 3G or 4G, uses higher frequencies, making it more efficient at transmitting information.
The signal travels to the antenna closest to the recipient through cables, fiber optics, or dedicated wireless connections
Yeaaah, girl, I'll send you a voice note, I don't really have time right now
So, what time do you think we'll meet up, girl? 2pm works for me, but let me know if you'd prefer a different time, you know. I'll stop to grab some iced tea on the way and then I'm coming over....

Improved throughput and latency make it possible to develop different wireless telecoms applications : remote health monitoring, autonomous transport...

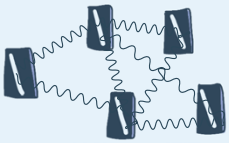


However, digital technology has a significant ecological impact, as our "needs" continue to grow.

Industry players are already working on 6G technology for 2030 !

What ? But Grandma doesn't even have 3G !

6G will integrate AI into its structure. It will be based on even higher-frequency waves, with a shorter range than 5G.



We can imagine our devices functioning as relays.

We'll be able to download 100 hours of Netflix in 1 sec

Make multiplayer virtual reality super-efficient

Fully develop autonomous cars...

But Grandma's car is still diesel-powered

Oh great, just what I needed, to dowload 100 hours of video in 1 sec !

In any case, I wonder what telecommunications will look like in the future !

Hm, if only someone had a time machine, we could go and see for ourselves...

..Oh wait, I do.

Oh right, good point. Le'ts go !

Off to the 6G !!!


... Fail

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À propos

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