LiFi at the heart of future intelligent communications networks

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orange™

Li-Fi Conference

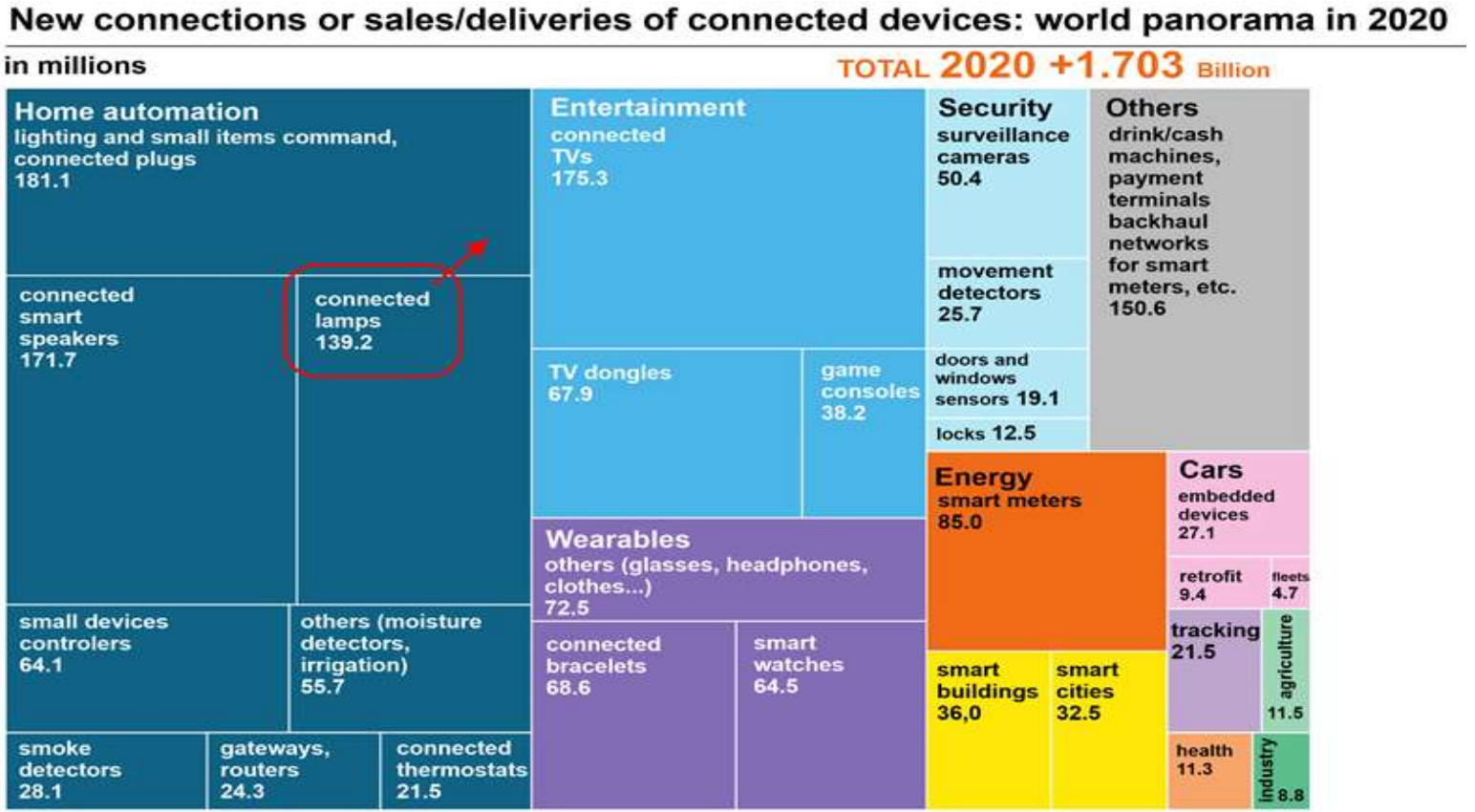
June 24th 2021

In 2017 for the first time, more objects where connected than human beings on Earth.

8.38 billion compared to 7.5 billion.

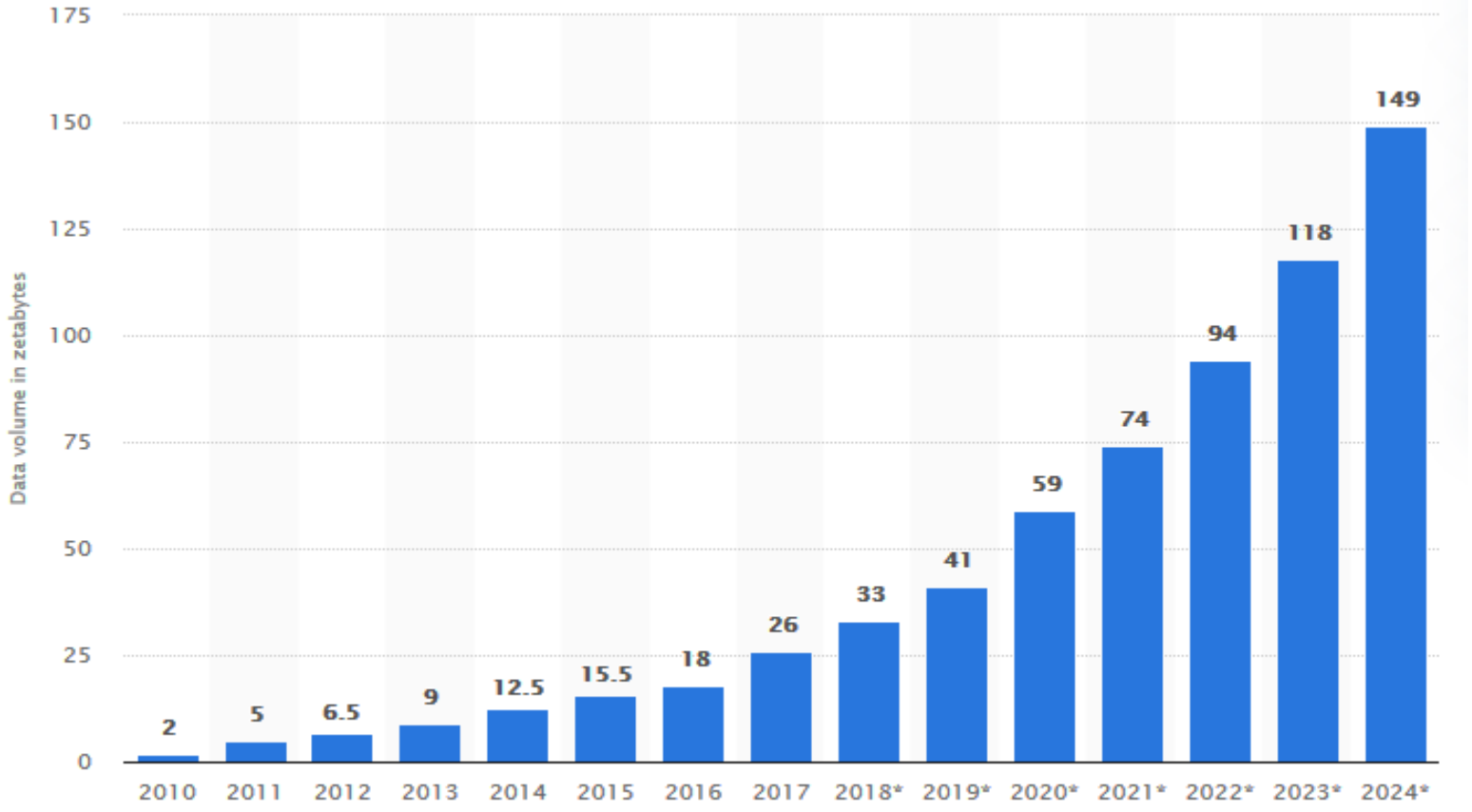
Source : Gartner

Connected devices sold in 2020 in the world



Analysys Mason; Strategy Analytics

Volume of data/information created, captured, copied, and consumed worldwide from 2010 to 2024 (in zettabytes)



Statista 2021

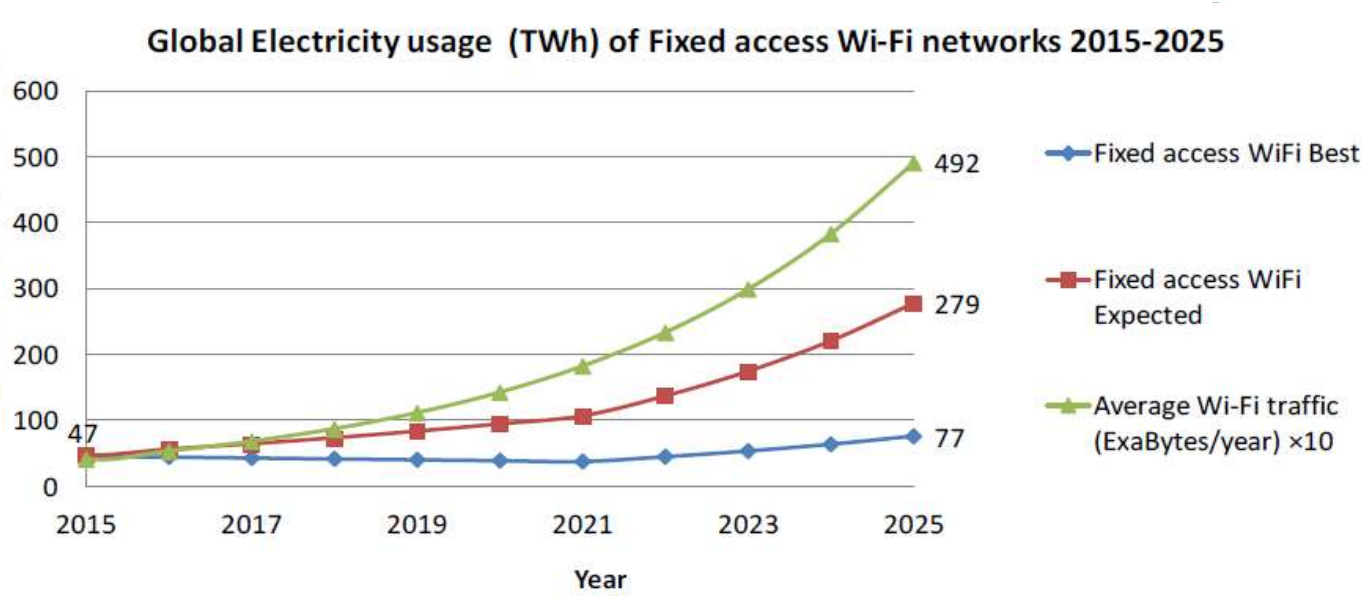
We are aware of limits of each technology, with various possible nature:

- Security,
- Radio and electronic interferences,
- Physical materials: water, wood, stone, metal,…
- Impact on environment,
- …

That highlights the need of complementarity of technologies.

Our goal: combining growth with responsible action.

Trends in global traffic and power usage of Wi-Fi access networks



Model includes:
Model includes:

- Global electricity usage of CPE (46 TWh) in 2011 and 2012 (51 TWh)
- Fixed access Wi-Fi data traffic in 2011 (154 EB/y) and 2012 (200 EB/y) and so on..
- Annual electricity intensity improvement (EI) 22.5% p.a. (best) and 15% p.a. (expected)

- From 2022, for EI only, 5% is assumed possible for both scenarios.

Modems & gateways are becoming more energy efficient,
but their number is increasing significantly as traffic increases.

Source: Dr. Anders S.G. Andrae (Huawei)
at the Nordic Digital Business Summit, Helsinki, Finland, October 5, 2017
Adaptations of http://www.mdpi.com/2078-1547/6/1/117

Environmental certification: more and more buildings certified

And low-emissivity windows are becoming more widespread

... with a significant impact on mobile coverage

Frequencies	Non-coated glazing (single, double, laminated)	Low-E glazing (double, triple, laminated)
700 MHz – 5 GHz	0> 10 dB	20 > 35 dB
5 GHz – 20 GHz		20 > 50 dB

Magnitude of the average transmission losses (polarisation, incidence, frequency) for all measured samples

CSTB, Centre Scientifique et Technique du Bâtiment - Division Champs Electromagnétiques, Réf. DSC/ECE/2018-121 – 29/11/2019

Future intelligent networks
a new paradigm combining
new standards of usages,
social, environmental
& technical disruptions

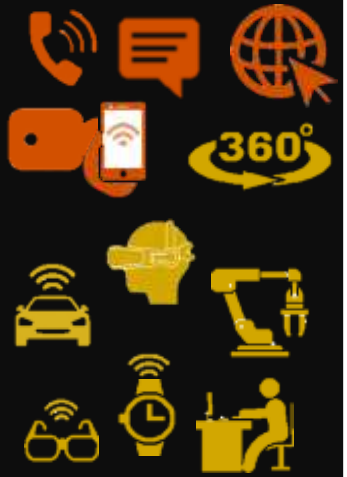
40 years of
increased traffic,
types of information being transmitted,
connected objects,
and more varied user demand
have led to the development of
several communications technologies

Mobile Networks

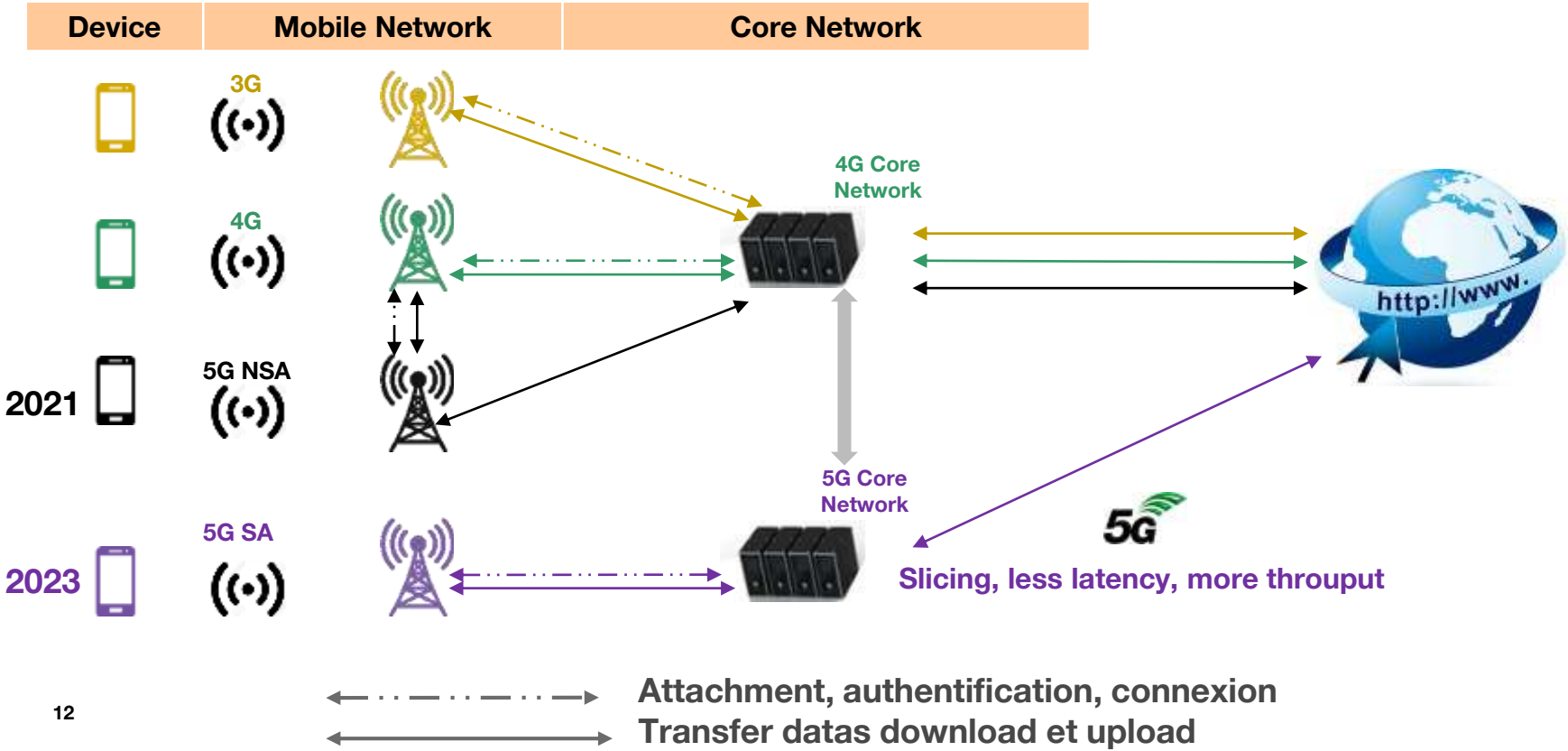
complementary to Fiber, Satellite, Wi-Fi & Light Connectivity

Mobile network evolution

1G	2G	3G	4G	5G
1980	1990	2003	2009	2020
VOICE	SMS	INTERNET	VIDEO	Multi Services



Mobile network evolution



5G caracteristics

From 2021

700 MHz
FDD Frequency-division duplexing

Indoor	Coverage	Throuput
++	++	= 4G

Bandwidth 20MHz

3.4-3.8 GHz
TDD Time-division duplexing
(Download & Upload simultaneous)

Indoor	Coverage	Throuput
-	-	+ 4G

Bandwidth 100MHz
Mimo antennas, beamforming

New antennas
Auctions closed
New devices

Throuput
More users, already a lot of devices compatible

VoWi-Fi

From 2023

26 (24-27) GHz
TDD Time-division duplexing
(Download & Upload simultaneous)

Indoor	Portée	Débit
--	--	+++

Bandwidth 400 MHz
Mimo antennas, beamforming

New auctions
New devices
New Core Network (next virtualized)

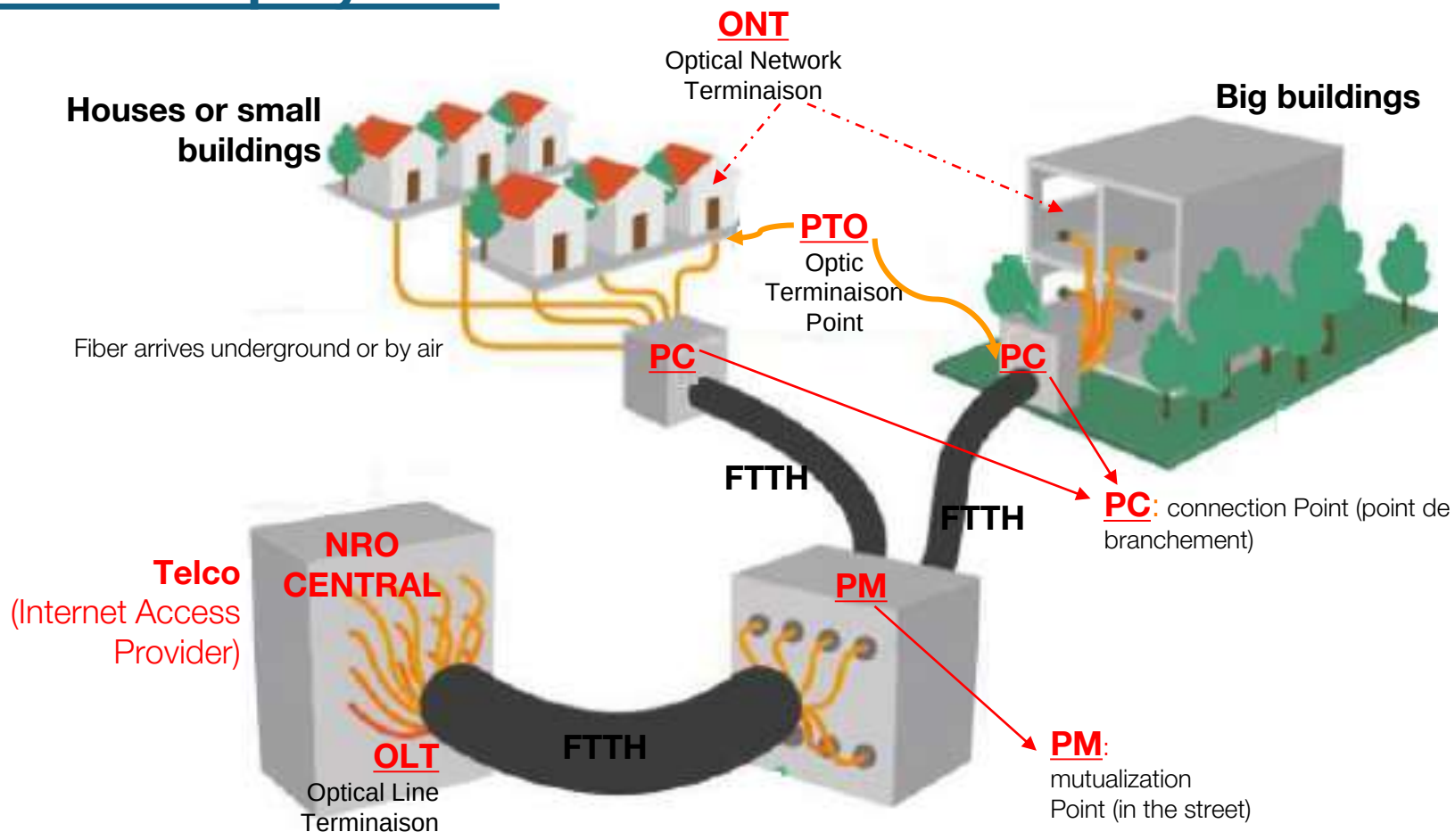
Slicing (NSSF)
Throuput
Latency
More users in specific areas

VoNR
New uses

Fiber

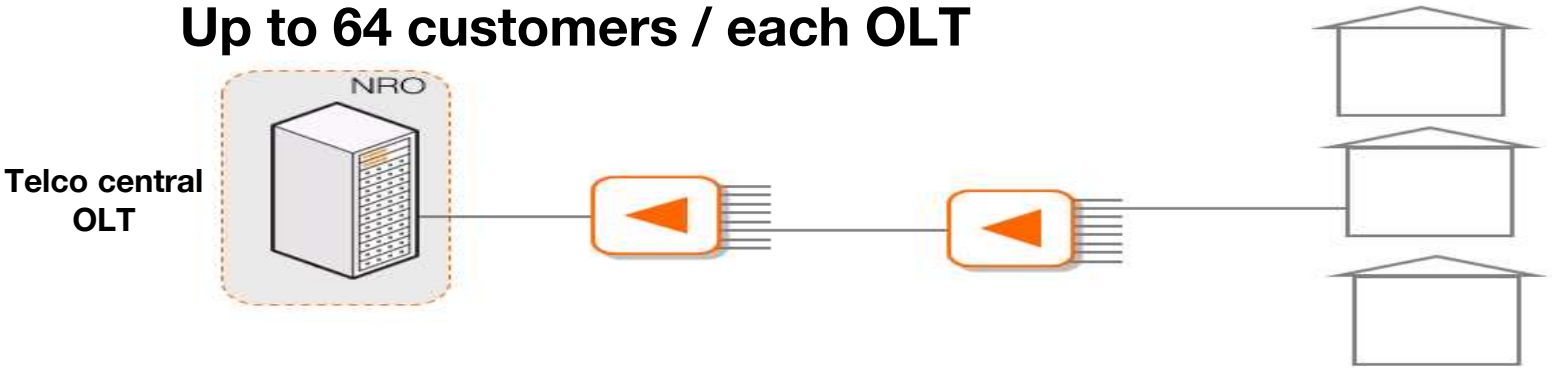
complementary to 5G, Satellite, Wi-Fi & Light Connectivity

Fiber FTTH deployment



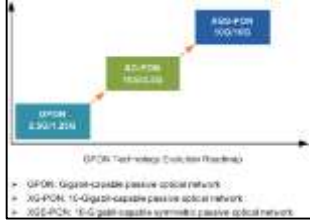
Fiber FTTH architecture

P2M (point to multi point) or PON (passive optical network)



From central, the Fiber will be shared between several houses/buidings/customers.
Despite less throuput, this concept is a good compromise **for Telcos**

Fiber PON



Today

	GPON Gigabit-PON (shared up to 64 customers)	XG-PON 10Gb PON (shared up to 64 customers) Multi channel	XGS-PON Symétric XG-PON Multi channel	NG-PON2 Next Gen PON2 Multi channel
Upload (Gbps)	1,2	**2,5/10**	**10**	**40**
Download (Gbps)	2,5	**10**	**10**	**40**
Upstream band (nm)	1260-1360	1260-1280	1260-1280	1524-1544 1525-1540 1532-1540
Downstream band (nm)	1480-1500	1575-1580	1575-1580	1596-1603
Video (nm)	1530-1565	1530-1565		

asymmetry **symmetry**

Satellite

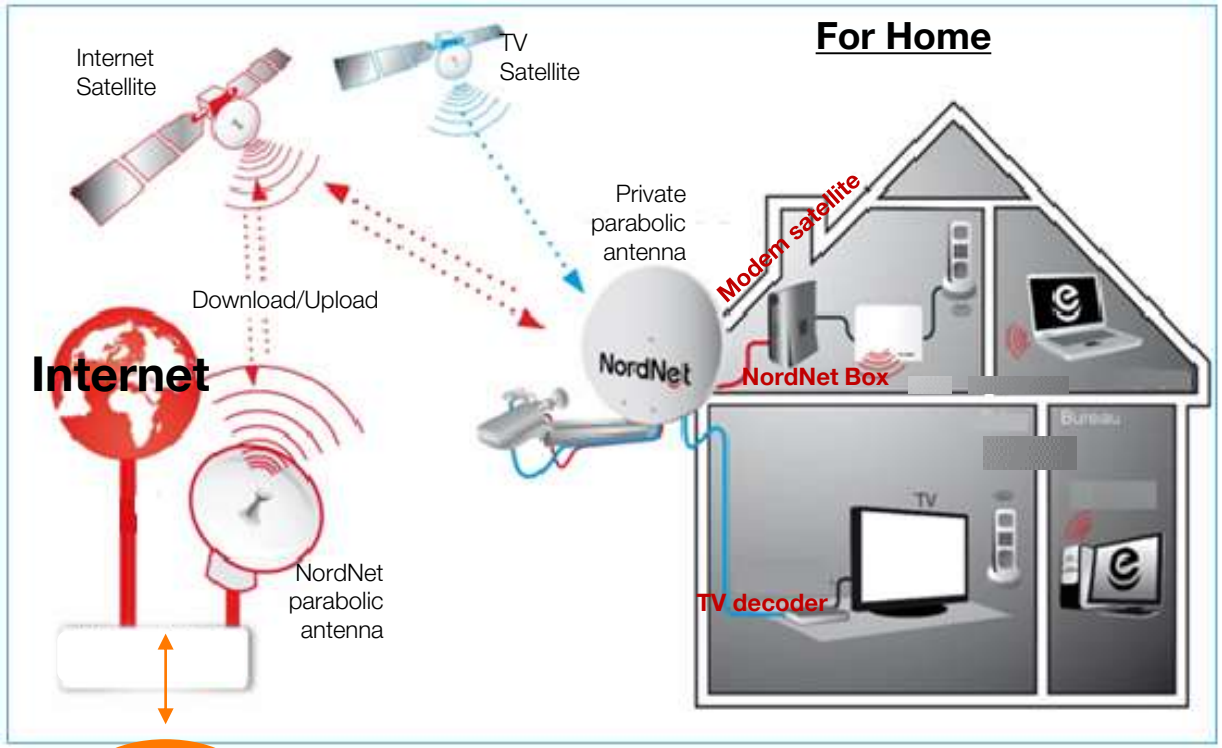
complementary to 5G, Fiber, Wi-Fi & Light Connectivity

https://www.leolabs.space/

LeoLabs website (and their radars) offers the possiblity to track different satellites

nordnet

Using new Neosat satellite



Up to
Download 100 Mbps
Upload 5Mbps

Ping up to 700 ms

Nordnet satellite Kit	**299€**
Nordnet access	**50€/month**

STARLINK

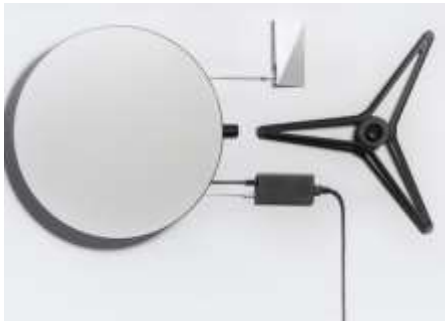
#ElonMusk

January 18th 2021, 1015 Starlink satellites are deployed in the world.

Announced by E Musk in 2021/2022, but not validated by Orange :

Download up to 300 Mbps , Latency: 20 ms

Starlink Kit	**499€**
Starlink Access	**99$/month**



Using new Starlink satellite

Wi-Fi 6 (ax) & Wi-Fi 6E

complementary to 5G-Fiber-Satellite & Light Connectivity

WiFi technology evolutions

Version	2,4 GHz	5 GHz	6 GHz	Troughput max theoritical **	Less Latency	Large Range	Highest subcarrier modulation	Standard	Date
Wi-Fi 4	X	X		**150 Mbps**	+	+++ (up to 70m)	64-QAM	802.11.n	2009
Wi-Fi 5		X		4 x 867 Mbps = **3,5 Gbps**	++	++	256-QAM	802.11.ac	2014
Wi-Fi 6 *	X	X		**9,6 Gbps** **	++	++	1024-QAM (Subcarrier spacing 78,125 KHz)	802.11.ax	2019 *(WFA)* 2020 *(IEEE)*
Wi-Fi 6E *	X	X	X	**11 Gbps** **	+++	+	1024-QAM (Subcarrier spacing 78,125 KHz)	802.11.ax	2019 *(WFA)* 2020 *(IEEE)*

Wi-Fi 6E = Wi-Fi 6 Extended

Wi-Fi 6E = Wi-Fi (2,4 GHz + 5GHz) **+ 6GHz ***

* In Europe, exactly between 5,935 à 6,425 GHz (+ 500MHz), and in US between 5,935 and 7,125 GHz.
* 6 GHz is also used by CBTC and TV .
* No licence to pay to use 6GHz , not a lot of data Traffic in 2021.

Wi-Fi 6 & 6E = OFDMA (Orthogonal Frequency Division Multiple Access) **+ best Mu-MIMO** (Multi-Utilisateur Multiple-Input Multiple-Output, better troughput in Download & Upload (2021))

Wi-Fi 6E = TWT (Target Wake Time) . The equipment remains on standby until a Wi-Fi alert from the router, less energy consumption for the equipments.

Wi-Fi 6E = WPA3

Wi-Fi 6E = BSS COLOR

Wi-Fi 6E = Beamforming

-European Union status :
- Decision to release 6 GHz spectrum in April 2021
- Could be operational in France at the end 2021

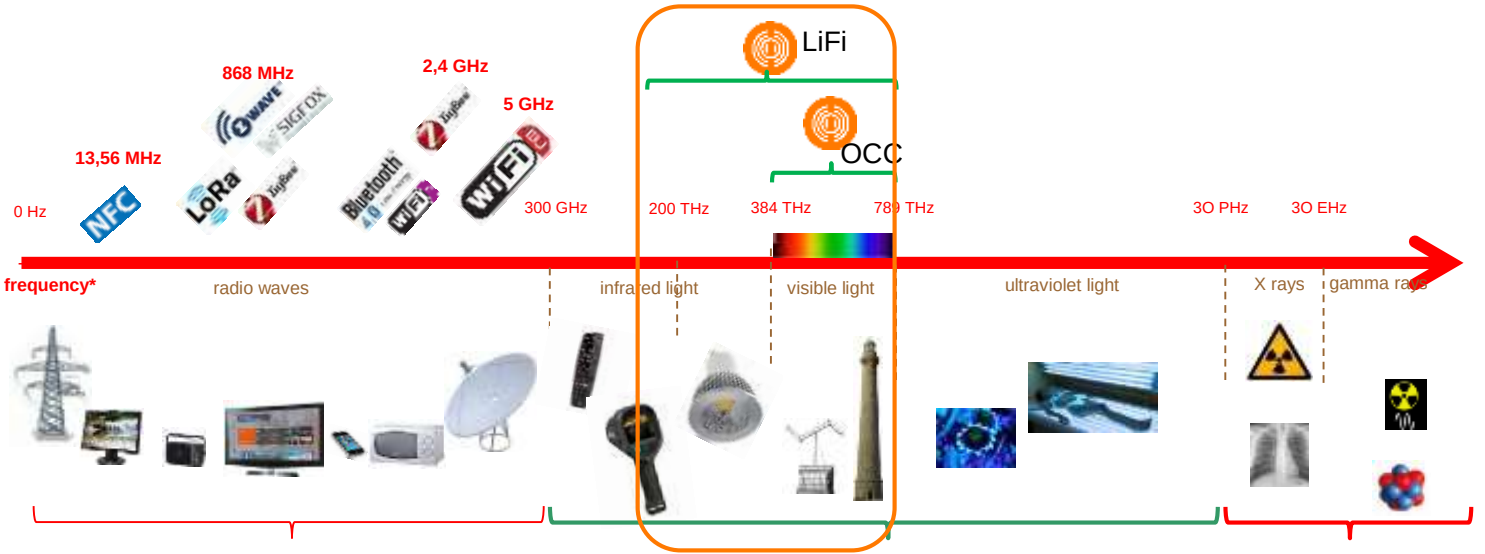
Light Connectivity

complementary to 5G, Fiber, Satellite & Wi-Fi

Light technologies

Main technologies and wireless communications use only the **finite resource** of the radio spectrum, in a 300 GHz bandwidth, when the optical spectrum can offer more possibilities.

logo



Radio bandwidth: 300 GHz

Optical bandwidth: 29,9 PHz
among which 589 THz are usefull
(for infrared + visible light)

Reserved band
(unusable for telecoms)

no interferences between RF and optical technologies

LiFi: Light Fidelity **OCC**: Optical Camera Communication

Light equipments

Up to 7,7 Gbps (CEA /June 2020)

LiFi

OCC

Connected seat

Fixed & Wireless connectivity
Complete, do not compete

Fiber

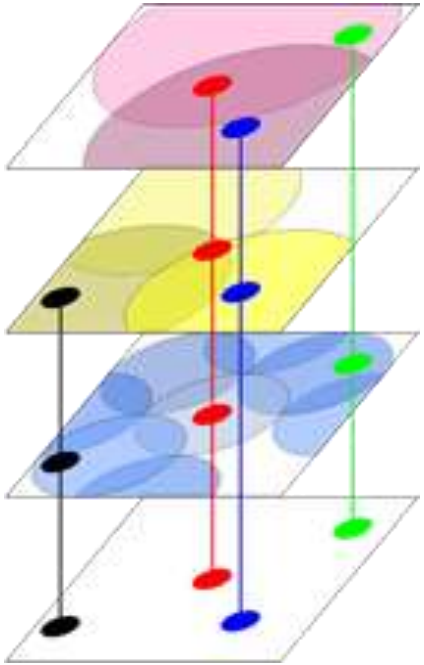
Mobile

Satellite

multi-techno experiences
will be the key
depending on each use case

LiFi

Our vision for a future intelligent communication network



IA integrated into networks.

Vertical handover between different technologies.

Network without cut for a best customer experience (best signal, best throughput, best latency).

Light technologies have the capacity to be associated with high-performance networks.

- **It's Time to Think & Build a New Intelligence Network**

Thank You

Let’s talk!

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