Light Communication Alliance: a key institution for a greener ICT

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Content

Light Communication Alliance (LCA)

Motivations for a greener ICT

Optical technologies are keys to make ICT greener

Optical wireless technologies pave the way to new added value services in a sustainable way

Conclusion

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Light Communication Alliance in a nutshell

Objectives of the LCA

The objectives and the role of the LCA can be summarized through the three following actions:

- Motivations: Delivering the benefits of ubiquitous Light Communications to serve people & technologies, requires a far-reaching & coherent ecosystem working at a determined pace.

- Missions: Driving a consistent, focused & concise approach to market education that will highlight the benefits, use cases & timelines for Light Communications.

- How? By aligning leaders across every industry to develop or envisage business models using Light Communication systems & technologies by defining a standard of education in an efficient communication & co-operation frame.

LCA members (I)

Membership opened to any company having an interest in Light Communication technologies. A member can be an industrial company (operators, equipment vendor, technology and chipsets developer, software vendors, …) or a research institute/university.

The members are asked to provide consistent messaging of the LCA and contribute during the regular meetings to provide inputs. In return, the members can find a support of the LCA to provide them a higher visibility in different events, find new opportunities of collaboration between the LCA members, or to participate to an Alliance strategy for the benefit of all the LCA members.

The inclusion model is strongly motivated to orient this technology in the right direction, and aligned with the big evolutions of the ICT, or anticipating new needs for vertical segments.

21 companies are members of the LCA and are split into six categories:

1. LiFi key players
2. Applications
3. Operators
4. Equipment vendors
5. Networking and security
6. University/Research institute

General Chairman:
Marc Fleschen

LiFi/OCC key players

Lucibel
NavTech
OLEDCOMM
PureLiFi
Signify
Velmenni
Zero 1

Applications

Crantec
OLEDCOMM
Signify
Zero1

Operators

Emirates Integrated Telecommunications Company (EITC)
Liberty Global
Orange
Post Luxembourg

Equipement vendors

BKS Digital Connectivity Solutions
GETAC
MinebeaMitsumi
Nokia
Signify
VIAVI

Networking and security

BKS
Crantec
MinebeaMitsumi
Nokia
Orange
Post Luxembourg
QRCrypto

University/Research Institute

CEA
University of Strathclyde
Institut Mines Telecom

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LCA members (II)

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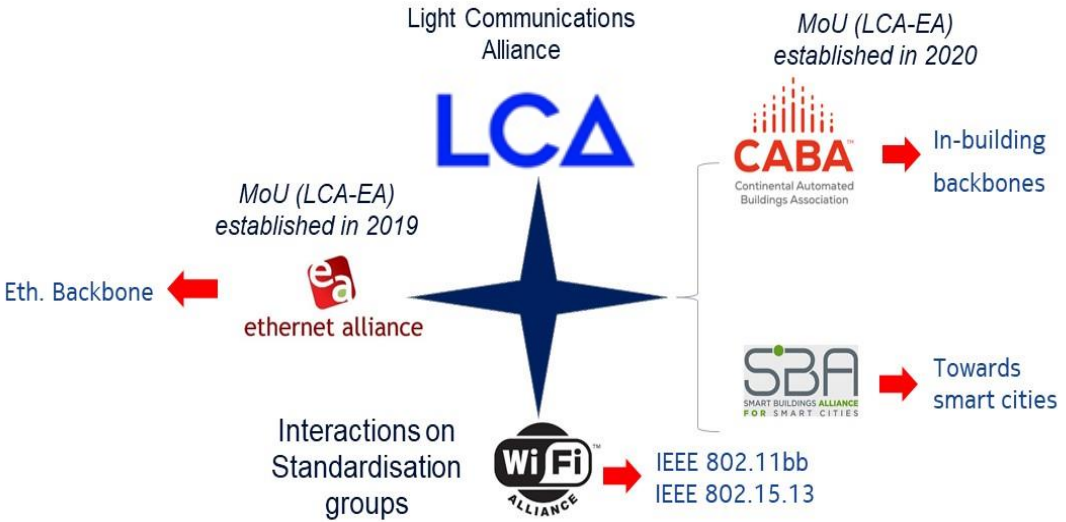
Partners of the LCA

The Light Communications Alliance has created links with other Alliances. These Alliances are:

- The Wi-Fi Alliance, for discussions on the standards.
- The Ethernet Alliance to interact with them on the Ethernet Backbone, like Power over ethernet technologies.
- The CABA Alliance, focused on the in-building topics
- The Smart building Alliance targeting the identification of relevant solutions for Smart Cities.

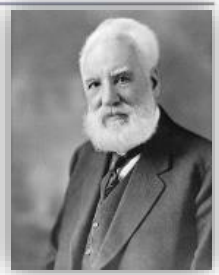


Light Communication Technologies in a nutshell

LiFi technology is a bidirectional technology requiring an additional physical layer (transponder including LED(s) or Lasers (VCSELs) and Photodetector(s)) and in some versions a new data link layer (new MAC layer). The spectrum exploited for this technology includes the visible spectrum (350 nm – 700 nm), but also the IR spectrum (800 – 1000 nm). Typically, IR is used for the upstream traffic. For the downstream traffic, either visible light or IR light can be used depending on the use case. The technology delivers a user experience substantially similar to Wi-Fi except using the light spectrum, offering high data rate, mobility, handover and more.

The **OCC technology** describes a unidirectional technology exploiting the camera as a photodetector associated with an application able to interpret the information received to be easily exploited by the user through a graphic interface. The light signal is in the visible domain for classical cameras. The bit rate is limited to the potential of the camera technology.

The **FSO technology** describes a bidirectional wireless optical communication system, currently used for the backhauling in outdoor, but also has potential for in-door applications for high bit rate connections, with no requirement for mobility. The spectrum exploited is between 950 nm and 1550 nm. One advantage of this technology is its capability to offer a high bit rate wireless connection with a collimated optical beam to improve security and continuity in the data transmission.



Alexander Graham Bell
In 1881 he invents the Photophone : sound transmitted with an optical ray over 200 m.

Professor Harald Haas
Professor Harald Haas, Professor of Mobile Communications at the University of Edinburgh, coined the term "Li-Fi" at his 2011 TED Global Talk where he introduced the idea of "wireless data from every light"

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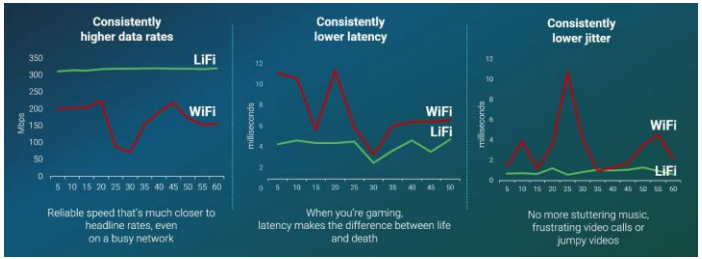
LiFi technology

One standard, the IEEE 802.11bb, targets a mass market by adopting an optical antenna instead of a RF antenna and is based on the Wi-Fi protocols.

Several companies are proposing a LiFi technology like TruLiFi by Signify, pureLiFi or OLEDCOMM among many other companies.

The bit rate can be as high as 100 Gbit/s (demonstrated at CES 2022).



Mostafa Afgani, « Practical and Commercial LiFi for Everyone »Optical Wireless Communications for Indoor Access Networks - Practical Solutions Beyond Table-top Demos at OFC 2022, March 2022

"Le LiFi dans votre poche", Webinar on June 1st, 2022

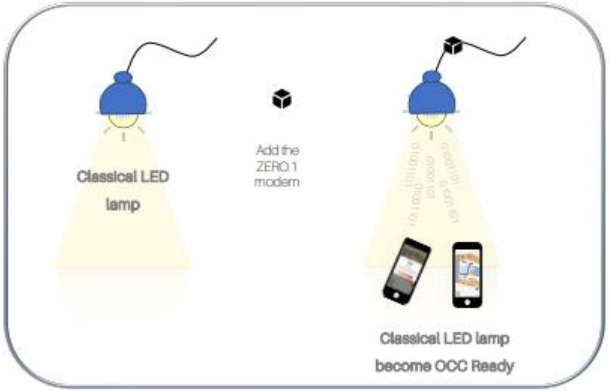
"Le LiFi dans votre poche", Webinar on June 1st, 2022

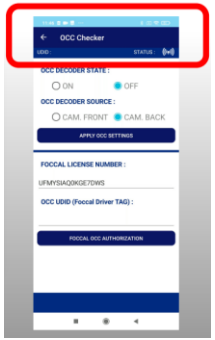
LiFi is a complementary technology wr to RF technologies offering high bit rates, a high level of security, and an alternative for EM sensitive environments

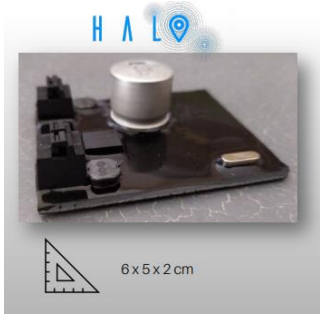
Optical Camera Communication (OCC)

- Wireless communications
- Offering In-door positioning capabilities
- Decoding of data from embedded cameras of a smartphone
- Based on the standard: IEEE 802.15.7
- Services offered:
  - Geo mapping
  - Data analysis
  - Location based services

ZERO.1







“Le LiFi dans votre poche”, Webinar on June 1st, 2022

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Join the LCA

- Join the LCA for helping the world to communicate by :
  - Collaborating with active members of this field
  - Contributing to the emergence of a new green technology and by building new products
  - Helping 6G to be greener through a technology complementarity
  - Driving a research on this topic to innovate an push the limits

- WebSite: http://lightcommunications.org/

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Motivations for a greener ICT

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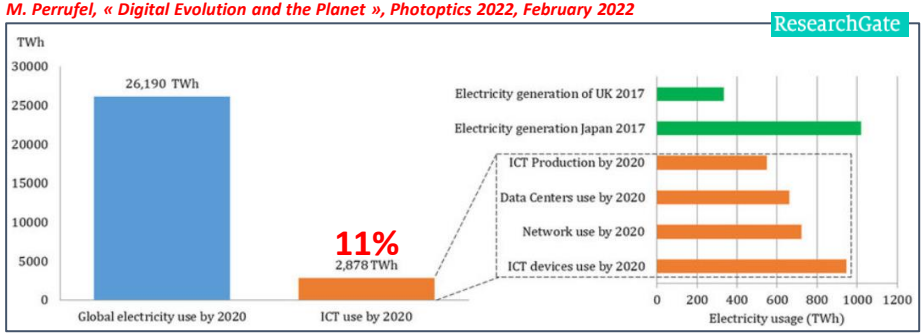
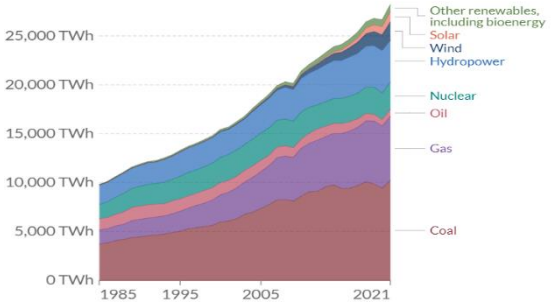
Analysis of the electricity demand projection by 2030

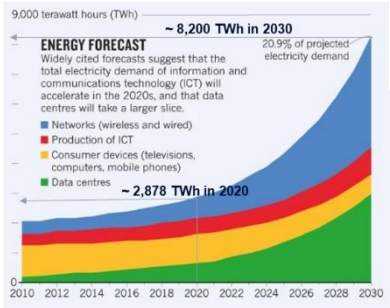
The ICT electricity demand in percentage with respect to the worldwide electricity production could reach 30% in 2030!

M. Perrufel, « Digital Evolution and the Planet », Photoptics 2022, February 2022

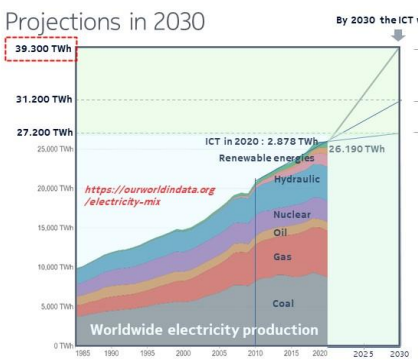




https://ourworldindata.org/electricity-mix



https://www.nature.com/articles/d41586-018-06610-y



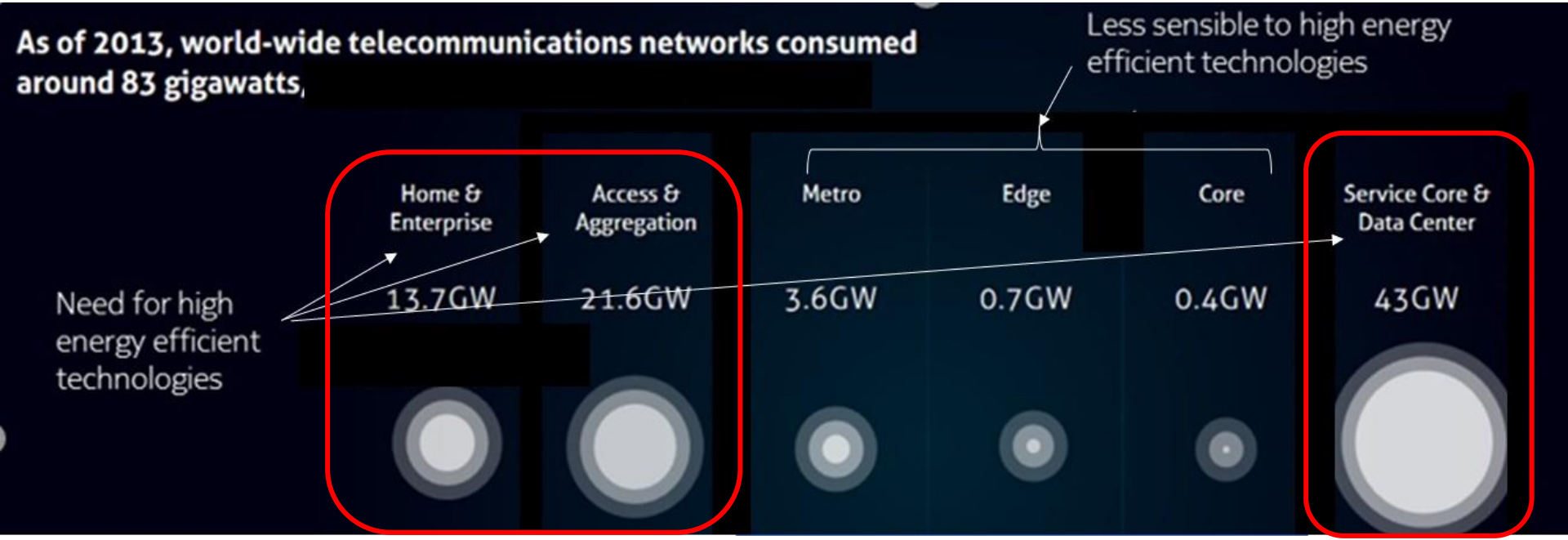
- Optimistic assumption (strong acceleration of the electricity production) ➔ 20,9%
- Conservative assumption (slope of 2010-2020) ➔ 26,3 %
- Pessimistic assumption (energy crisis) ➔ 30 %

In 2030, without any reaction the worldwide ICT energy consumption could represent between entre 20 and 30% of the worldwide electricity production.
➔ Urgency to control the energy consumption of ICT.

Need to react to recontrol the electricity consumption of ICT

Where the energy consumption is critical?

From GreenTouch project (2010 – 2015)



The power consumption must be optimised in the Data Centres AND at the periphery of the network infrastructure

Optical technologies are keys to make the ICT greener

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Network infrastructure

For Orange, the results done for 2020:

Energy of Orange Networks in 2020

Network	Consumption in 2020
RTC	224 GWh
xDSL	538 GWh
FTTH	34 GWh
3G/4G (RAN+ Cœur)	895 + 48 GWh
Datacenters IT	169 GWh

Fiber, the optimal network to connect users with less electricity energy

These data published by the French operator Orange for 2020 show that:

- Optical technologies are contributing to reduce the electricity demand

M. Perrufel, « Digital Evolution and the Planet », Photoptics 2022, February 2023

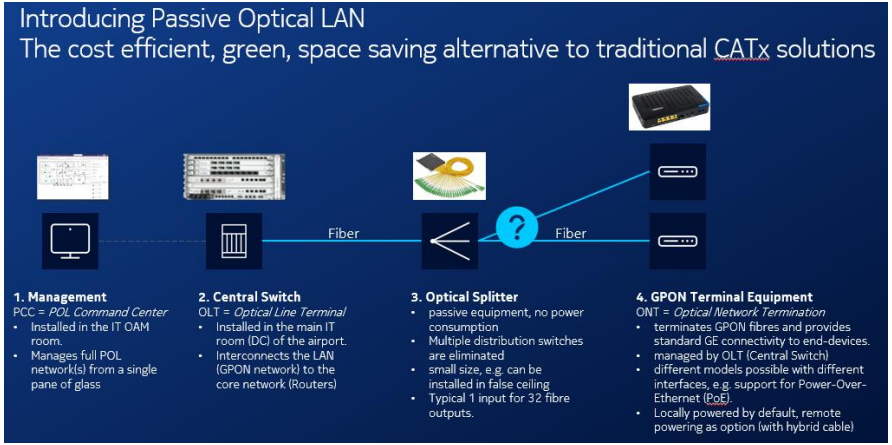
Directions to reduce the electricity demand constraint

There are different directions to reduce the electricity demand constraint:

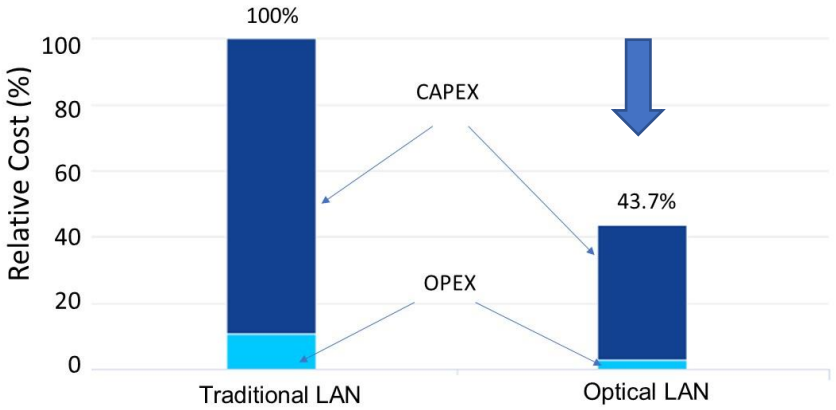
- Extract from the grid, the identified network element(s) that is (are) responsible for a non negligible part of the electricity demand, by adopting micro-grids.
- Re-design the product by adopting eco-design rules.
- Adopt eco-management techniques:
  - Take into account the environment to optimise the consumption: for example system put in sleep mode when there is no need for any activity. AI could play an important role.

POL are eco-designed solutions

- The eco-design can be applied at the component, at the system or at the network level.
- A longer lifetime of a product imposes new rules:
  - A main structure designed for a long operation time (ex: fibre infra)
  - A modular part to adapt the main structure to the needs, and make the upgrade at a minimum carbon footprint (ex. peripheric systems)



https://www.nokia.com/networks/fixed-networks/optical-lan-pol/



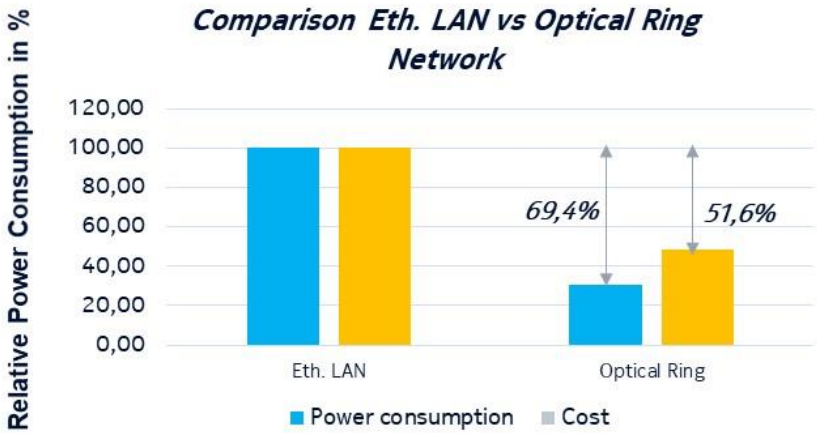
Optical Ring LAN are also green solutions

Ethernet LAN solution

- Assumption: 10 access points to interconnect
- 10 Eth. SW having access ports to insert and extract data

Optical Ring LAN solution

- Assumption: 10 access nodes to interconnect
- It assumes ten optical nodes, and one Ethernet switch (interconnection node)



Optical ring networks are also less power consuming than Ethernet LANs

Optical wireless technologies pave the way to new added value services in a sustainable way

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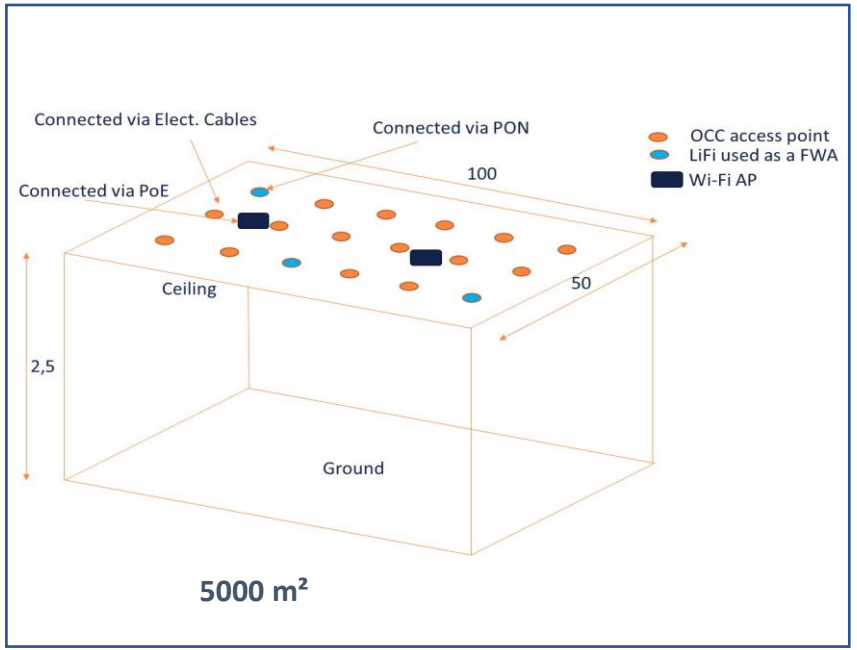
Use case: In-buildings

In-building use case, covering public/private buildings, and offering an heterogenous network with Wi-Fi, OCC and LiFi.

Specifications adopted for the study case:

- Surface considered: 100x50 m²
- Number of Wi-Fi access points: 25 for a surface connectivity of 200 m²
- Number of LiFi AP: 12 in a FWA configuration, 250 for full deployment
- Number of OCC AP: 200 (every 5 meters)



Adoption of a reference space to do the analysis

Assumptions adopted

Wi-Fi access point:

Power consumption adopted of the Wi-Fi access point (for inside environments):

- Wi-Fi 6 2x2: P Average = 10,5W with a peak at 10,9 W
- Wi-Fi 6 2x2 including radio of security: P Average = 15,5 W with a peak at 15,9 W
- Wi-Fi 6 4x4: P Average = 11,65 W with a Peak at 19,5W
- https://www.watchguard.com/fr/wgrd-products/access-points/compare-appliances

Power consumption of a Wi-Fi repeater: 2,6 W

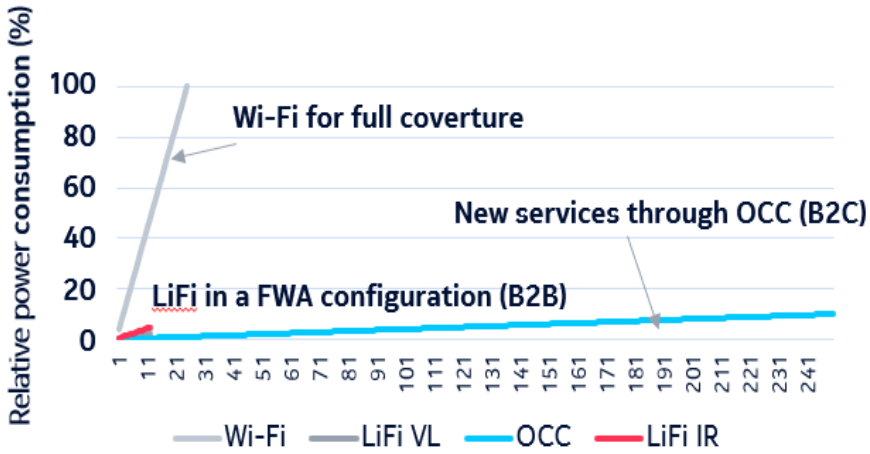
- OCC access point:
  - Specifications of products adopted for the power consumption of the modem
- LiFi access point:
  - Power consumption of the LiFi access point (for inside environments):
    - For VLC, power consumption of the Modem box adopted according to measurements made on products
    - For IR, Power consumption of VCSELS-based source + modem taking into account higher bit rates offered

Study of a reference space supporting different access technologies: Wi-Fi, LiFi and OCC

Deployment of LiFi, OCC and Wi-Fi

Scenario FWA

- LiFi is deployed in a FWA configuration to offer B2B services
  - The association of OCC and LiFi in the VL, is an efficient solution
  - IR is still efficient
- For OCC:
  - Full deployment to offer a B2C service, on the top of the existing electrical network



For scenario 1, the association OCC and LiFi FWA is extremely efficient, since it is a negligible part of the energy consumption with respect to the Wi-Fi technology

Deployment of LiFi, OCC and Wi-Fi (II)

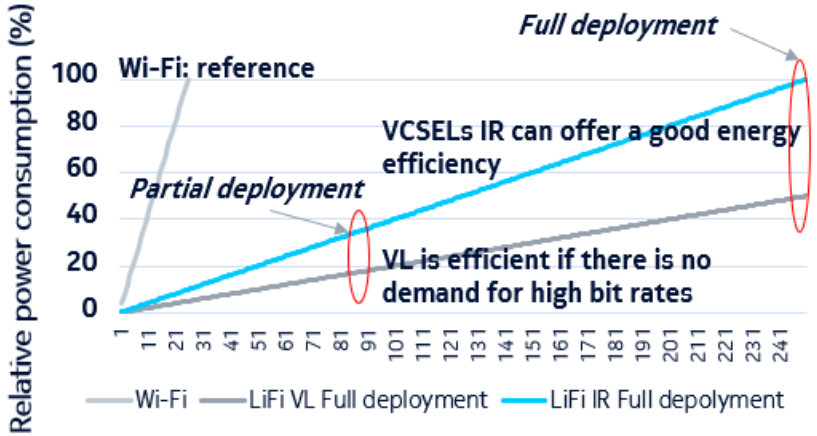
Scenario full deployment

LiFi is fully deployed in the space considered, to offer B2C services

- Max. coverture for LiFi with IR and with VL
- For full deployment:
  - VL is less power consuming than the Wi-Fi
  - IR is also efficient and takes advantages at high bit rates

For OCC:

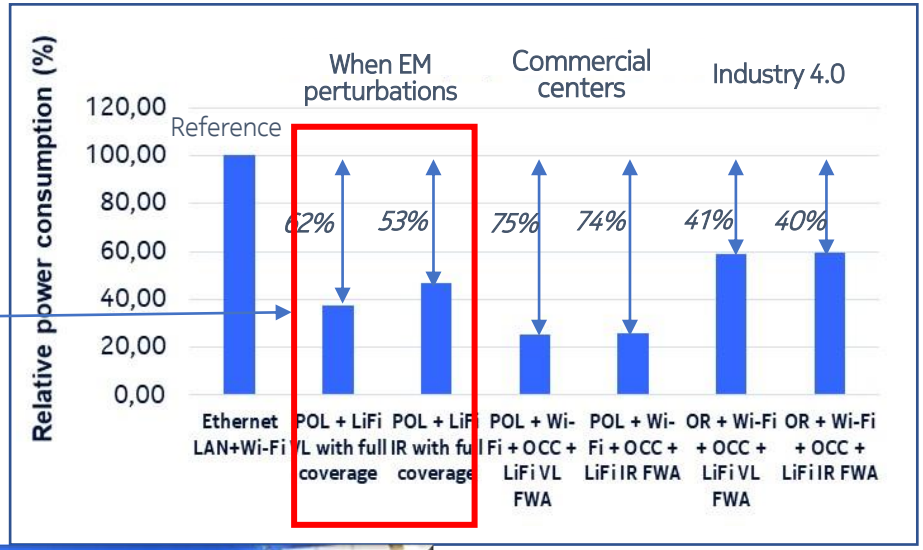
- Full deployment to offer a B2C service



For this scenario the IR sources based on a VCSEL technology could be a key enabler to offer high bit rates at an optimised energy consumption

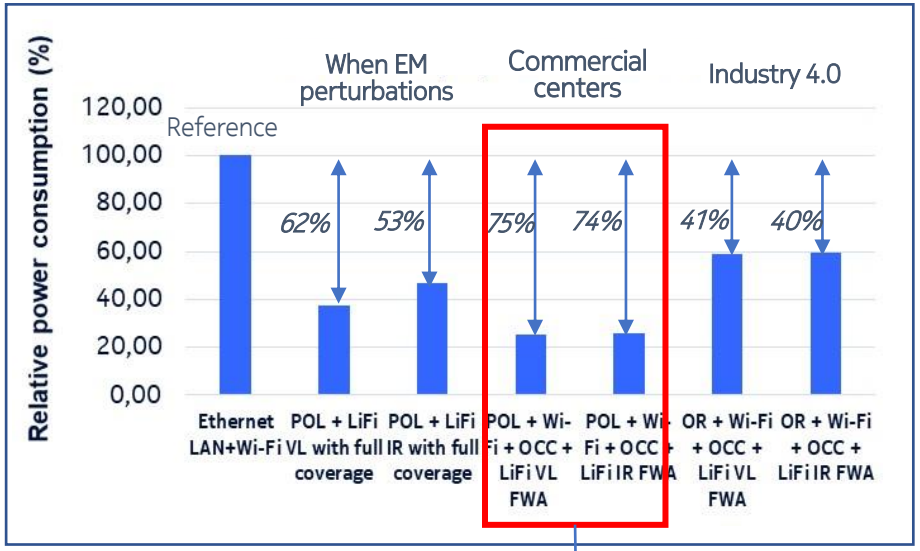
End-to-end solutions comparison: Hospitals

When RF is not tolerated (like in hospitals), then the solution could be a combination of POL and LiFi (VL or IR).



LC technologies have the potential to offer new added value services in a wireless mode

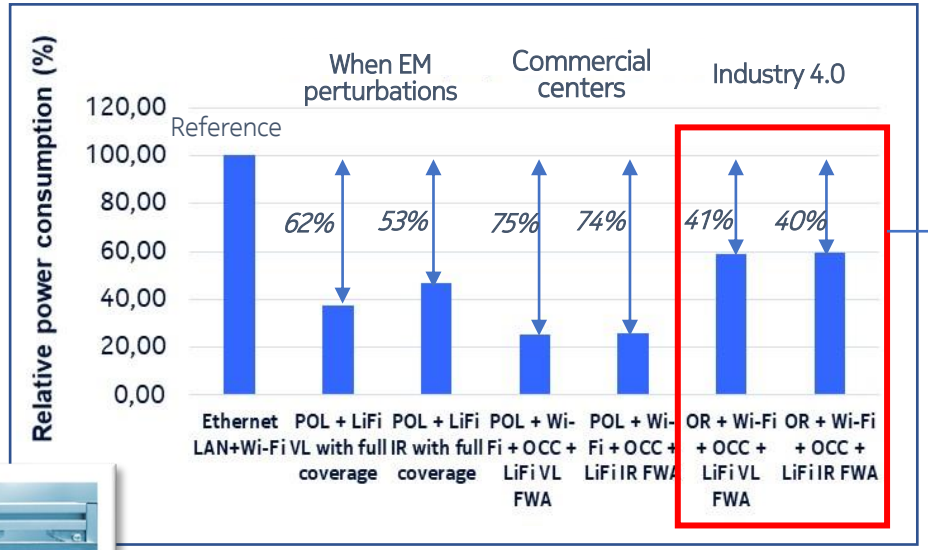
End-to-end solutions comparison: Commercial centers



Need to offer multi-services at low energy consumption. The combination of POL, Wi-Fi, OCC and LiFi FWA (for private pods it is a good trade off).

The association of Wi-Fi, LiFi in FWA and OCC is highly energy efficient. Possibility to offer more services at a low energy consumption thanks to the adoption of wired and wireless optical technologies

End-to-end solutions comparison: Industry 4.0



For the Industry 4.0, need for a global coverture through Wi-Fi, Optical rings to offer M2M communications capabilities, OCC for accurate in-door positioning of robots, LiFi IR FWA for highly secured high bit rate communication between production machines and the ceiling. 5G IoT completes the requirements.

For the industry 4.0, the LC technology can offer ultra high bit rates and high security. The technology complementarity is here quite efficient to offer multiple services combining LC and RF

Analysis of the different results and tendencies observed

The LiFi can be introduced as a complementary technology:

- **For EM sensitive environment**, the **LiFi technology becomes an alternative to a RF technology** to create a continuity of service. The association LiFi, OCC, Wi-Fi interconnected with an optical backbone is saving energies when compared to a Wi-Fi + Ethernet LAN solution. For this use case, POL are better adequate than OR LANs.
- **For commercial centres, t**he combination of different access point technologies is an efficient solution to offer new services at low energy. In that case **LiFi is deployed following a B2B market scheme**, to have distributed points of information, through a FWA approach. **For the backbone a POL technology is very efficient to lead to a highly energy efficient end-to-end solution.** .
- **For the industry 4.0.,** here again, **FWA** makes sense, since the **need is for highly secured data communication between the production machines and the network**. For the global coverture, the Wi-Fi can be used. **OCC could be an interesting solution for the guiding of the robotic part**. Due to the fact that the energy consumption will be dominated by the production machine, the energy gain with respect to the Eth. LAN solution is not critical. The new **performance offered by the LiFi technology (high bit rates at high security) is the main catalyst for the solution adoption.**

Towards fundamental 6G KPIs

6G KPI: Bit rate of 100Gbit/s

High bit rate (100Gbit/s targeted) ➔ objective reached at CES 2022

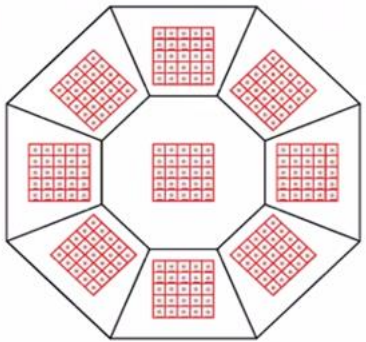
[1] C. Lee *et al.*, "26 Gbit/s LiFi System With Laser-Based White Light Transmitter," in *Journal of Lightwave Technology*, vol. 40, no. 5, pp. 1432-1439, March, 2022, doi: 10.1109/JLT.2021.3124942.

6G: high security

Since the light does not cross the walls, the security is increased

6G KPIS: Energy efficiency < 1pJ/bit

Towards zero carbon emissions ➔ the LC technology contributes to reduce the carbon emissions, by offering a high energy efficiency (1pJ/bit)



VCSEL-based MIMO source offering a total capacity of 2Tbit/s for a power consumption close to 1,9 Watts.

[1] E. Sarbazi, H. Kazemi, M. Dehghani Soltani, M. Safari and H. Haas, "A Tb/s Indoor Optical Wireless Access System Using VCSEL Arrays," *2020 IEEE 31st Annual International Symposium on Personal, Indoor and Mobile Radio Communications*, London, United Kingdom, 2020, pp. 1-6, doi: 10.1109/PIMRC48278.2020.9217158.

Conclusion

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Conclusion (I)

In-buildings can contribute to a significant part of the global electricity consumption. Therefore, providing **energy savings in that space will impact positively the worldwide ICT energy consumption reduction**.

Optical technologies **combining optical access point technologies** (LiFi and OCC) **in complementarity with other technologies like Wi-Fi and optical backbones based on PON or optical bus/rings networks** can offer new added values at low energy consumption.

We demonstrated that it is possible to propose new services in a sustainable way like:

- **Continuity of service everywhere and any time** (complementarity RF and LC)
- New strong added value services like in-door positioning or data broadcasting at low energy
- **Ultralow latency optical backbones through the optical transparency** offered by passive optical technologies based on PON architectures or Ring networks (to support X-Cast connections)

The LCA is then a key institution contributing to make the ICT greener.
It also paves the way to a sustainable 6G technology

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THANK YOU !

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