Spectrum Crunch - An impetus for LiFi

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Institute for Digital Communications

& Li-Fi Centre, The University of Edinburgh

Professors and Heads of Electrical Engineering Conference, 13 Jan 2016 , London

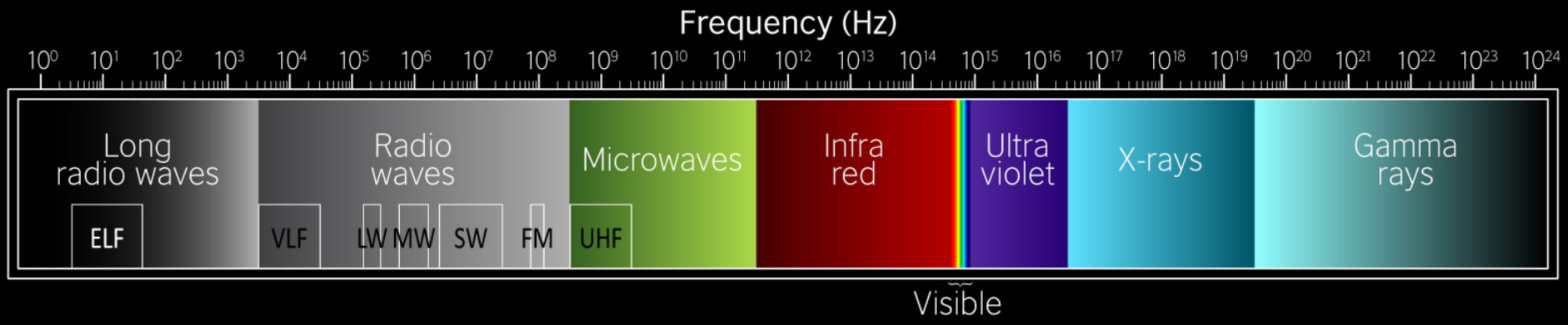
9:41 AM
Messages
Wednesday
12
Calendar
Photos
Camera
Videos
280
Maps
73°
Weather
Passbook
Notes
Reminders
Clock
Stocks
Newsstand
iTunes
App Store
Game Center
Settings
Phone
Mail
Safari
Music

This year, for the first time, there will be more mobile phones on Earth than there are people
9:41 AM
Wednesday
12
Settings
Phone
Mail
Safari
Music

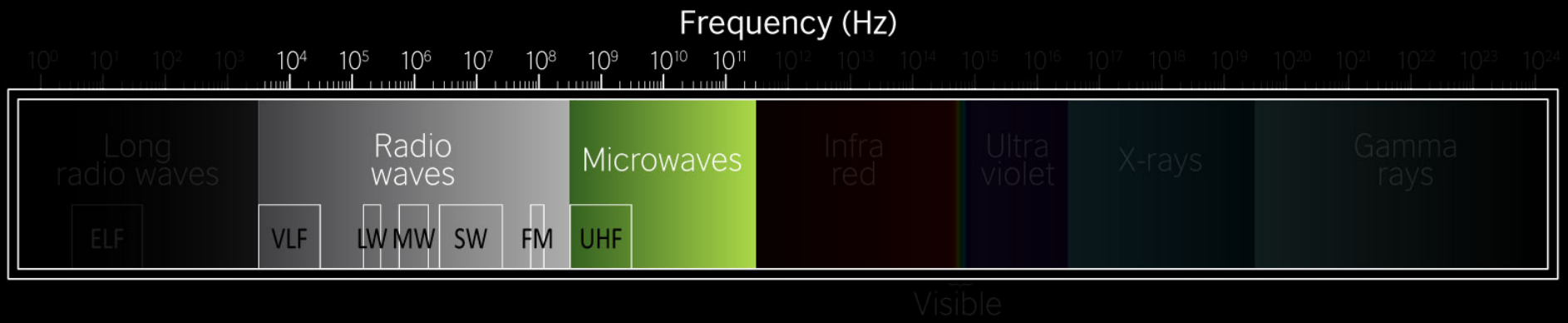
This year, for the first time, there will be more mobile phones on Earth than there are people
...over 7,300,000,000

...by 2018, sending the equivalent of 1.8 million years of HD video every month

The Electromagnetic Spectrum



The Electromagnetic Spectrum



3 kHz
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3 kHz
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3 MHz
30 MHz
30 MHz
Radio 4 (FM)
300 MHz
300 MHz
Terrestrial TV
3G mobile
3 GHz
3 GHz
Astra 2D
30 GHz
30 GHz
300 GHz

3 kHz
300 kHz
NOT ALLOCATED
RADIONAVIGATION
Fixed
FIXED
MARITIME MOBILE
MARITIME MOBILE
FIXED
MARITIME MOBILE
FIXED
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Radiolocation
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Aeronautical Mobile
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Aeronautical Mobile
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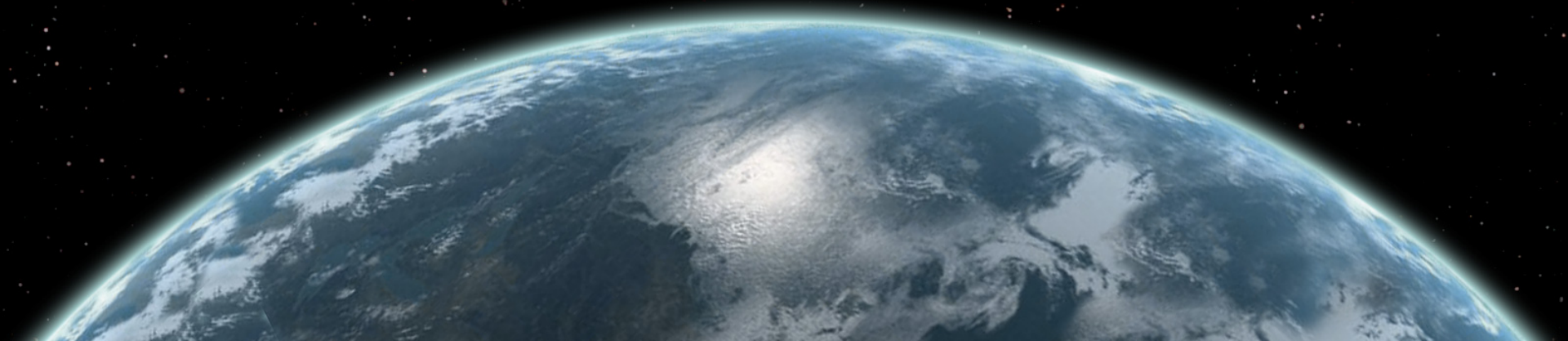
BROADCASTING (AM RADIO)
BROADCASTING
FIXED
MOBILE
RADIO-LOCATION
AMATEUR
RADIOLOCATION
MOBILE
3 MHz
30 MHz
FIXED
MOBILE
AMATEUR
MARITIME MOBILE
BROADCASTING
AERONAUTICAL MOBILE (R)
AMATEUR SATELLITE
30 MHz
300 MHz
LAND MOBILE
FIXED
AMATEUR
BROADCASTING (TV CHANNELS 2-4)
RADIO ASTRONOMY
BROADCASTING (TV CHANNELS 5-6)
BROADCASTING (FM RADIO)
AERONAUTICAL RADIONAVIGATION
BROADCASTING (TV CHANNELS 7 - 13)
MOBILE
FIXED
300 MHz
3 GHz
BROADCASTING (TV CHANNELS 21-36)
BROADCASTING
AERONAUTICAL RADIONAVIGATION
RADIOLOCATION
3 GHz
30 GHz
FIXED-SATELLITE (space-to-Earth)
FIXED
AERONAUTICAL RADIONAVIGATION
MOBILE
30 GHz
300 GHz
RADIO ASTRONOMY
RADIOLOCATION
INTER-SATELLITE
FIXED-SATELLITE (space-to-Earth)
RADIOLOCATION

By 2020…

By 2020...

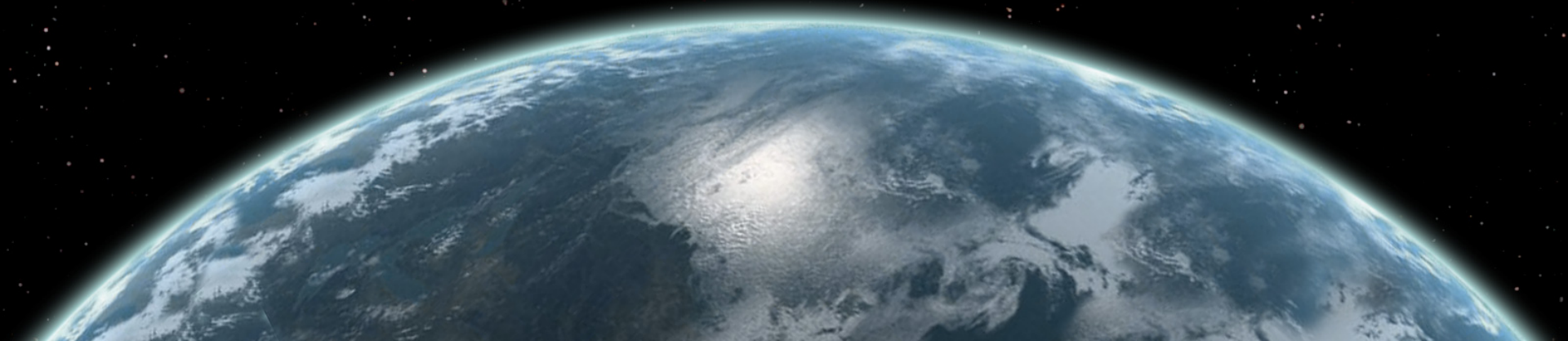
1000 wireless devices per person



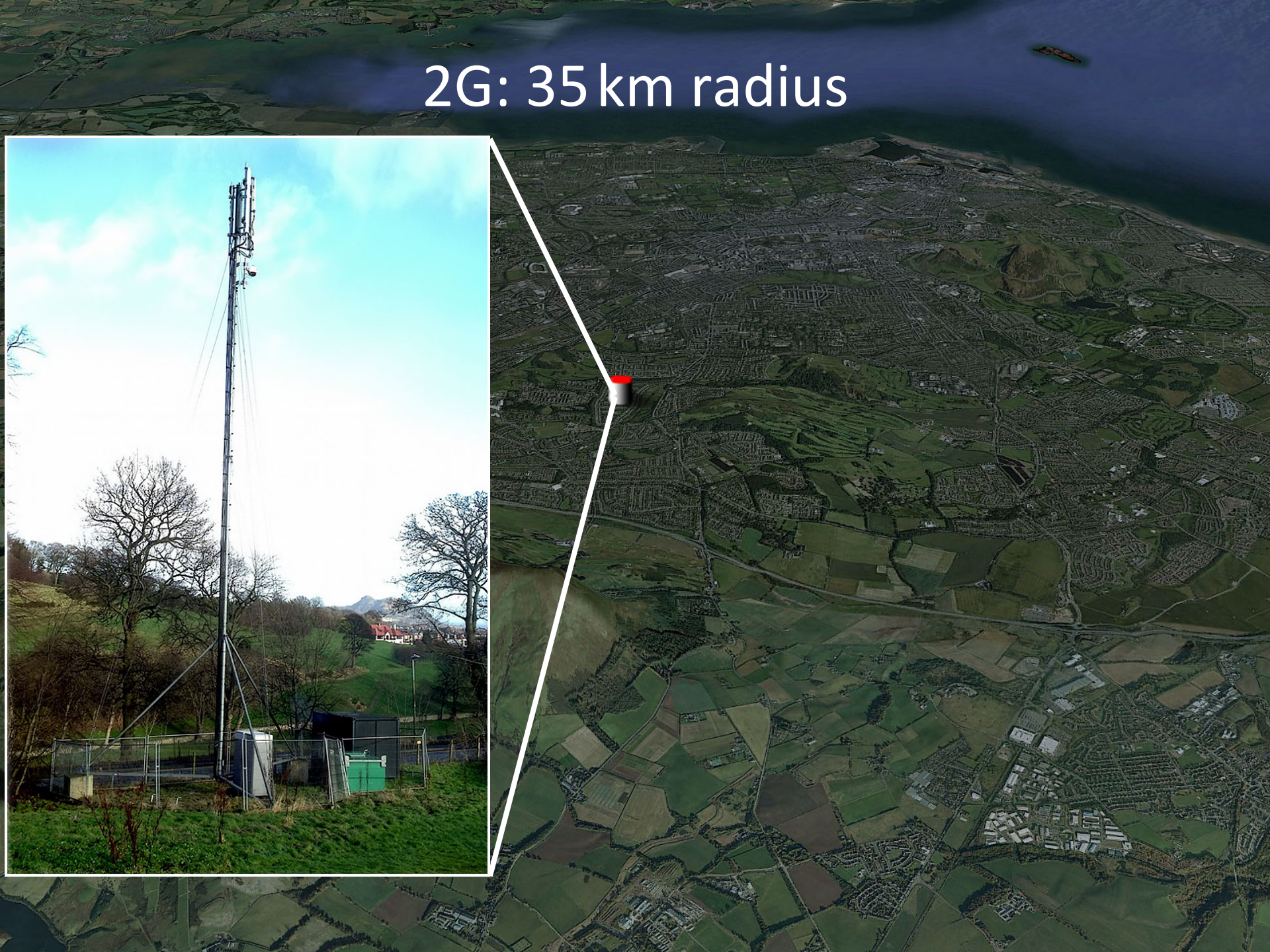
By 2020...

1000 wireless devices per person

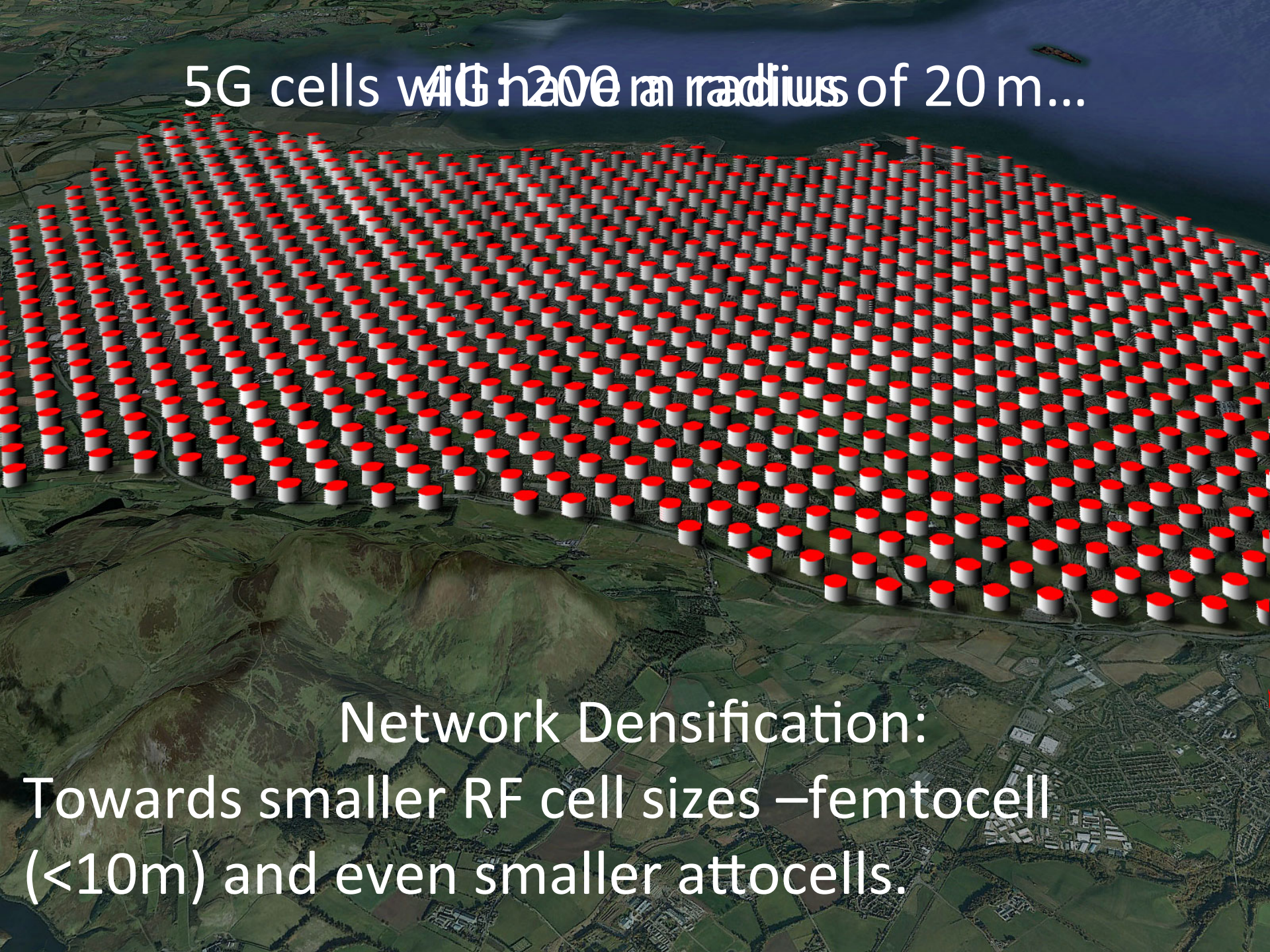
Available radio spectrum will run out



2G: 35 km radius



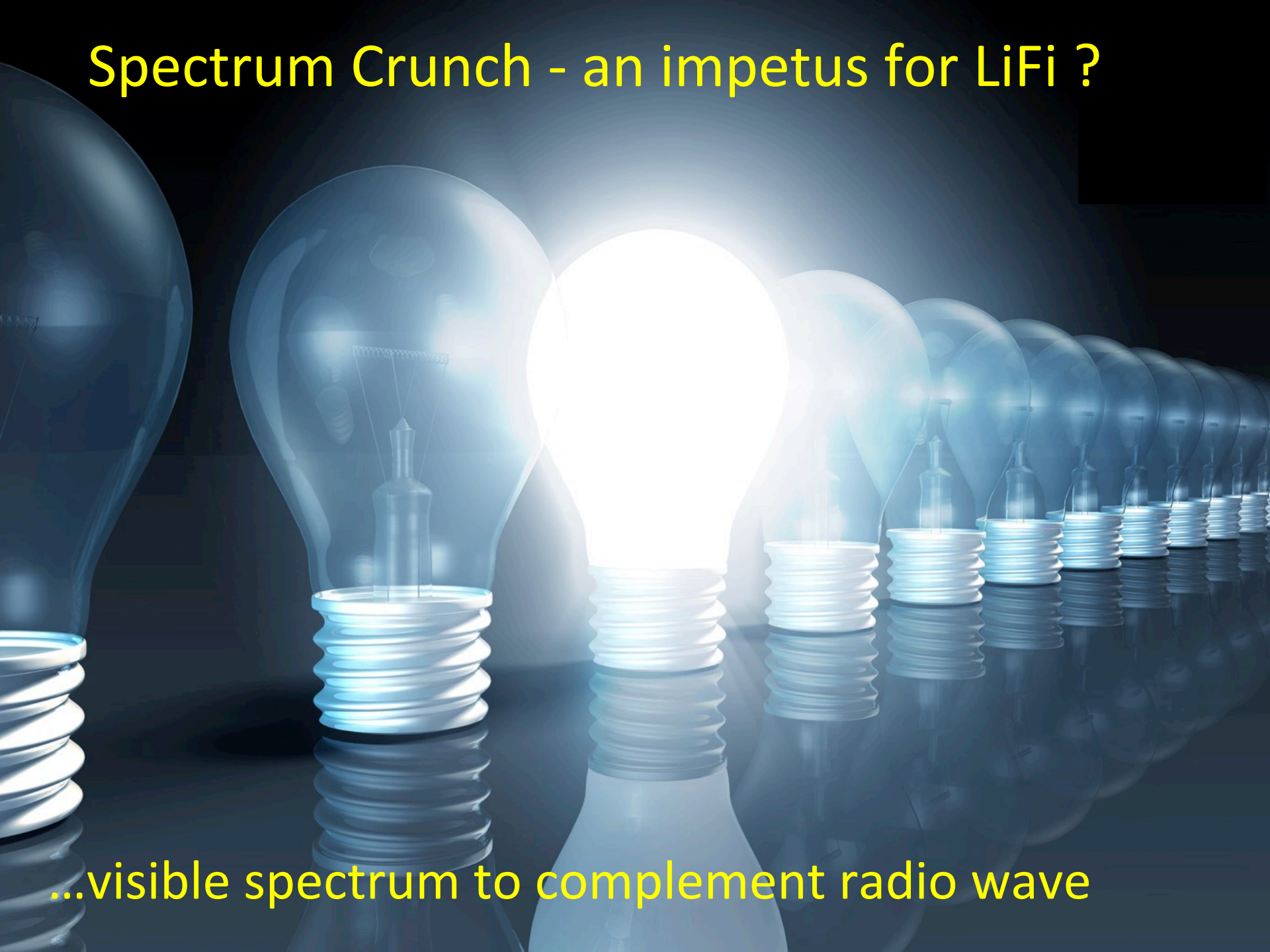
3G: 5 km radius


5G cells with a radius of 20 m...
4G: 200 m radius
Network Densification:
Towards smaller RF cell sizes –femtocell (<10m) and even smaller attocells.

Key Engineering Challenges:

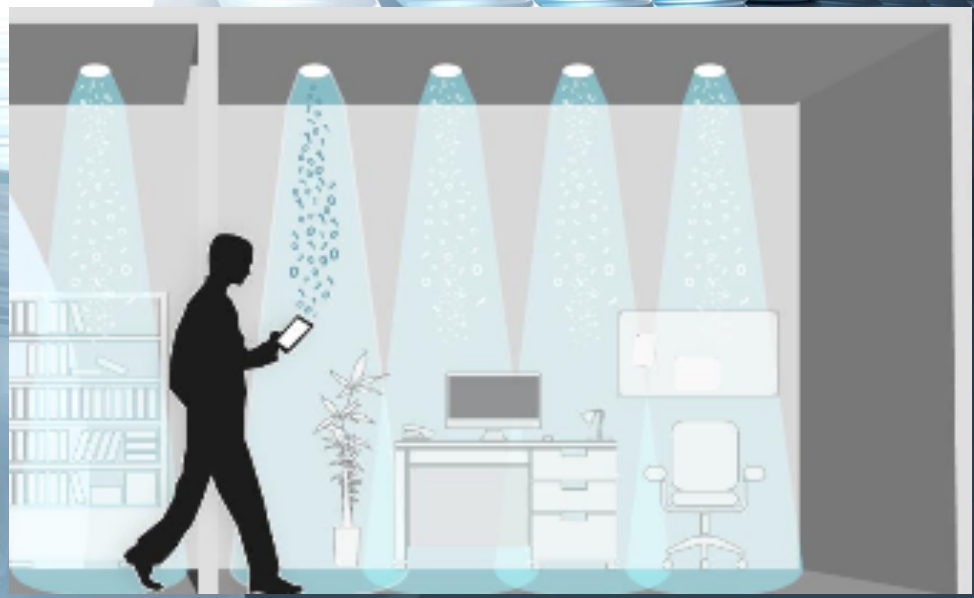
- Network densification ‘creates’ no new spectrum
- Interference management
- Energy consumption – Radio communications consume ~2% of world energy, identical to airline industry

Spectrum Crunch - an impetus for LiFi ?



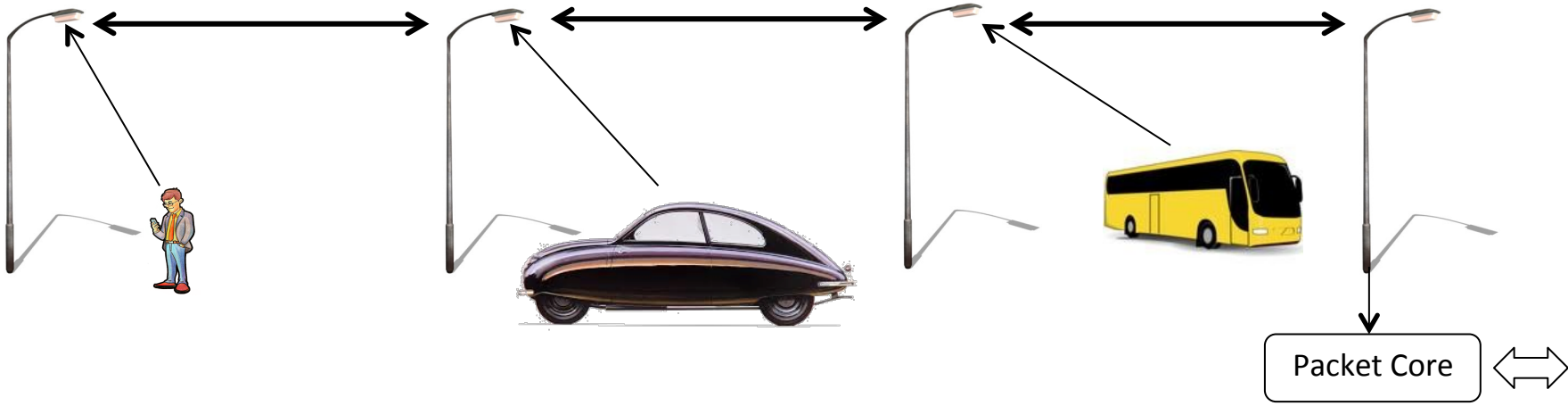
…visible spectrum to complement radio wave

LiFi: lighting + wireless data from same LED lamp



LiFi can aid network densification

LiFi for Access

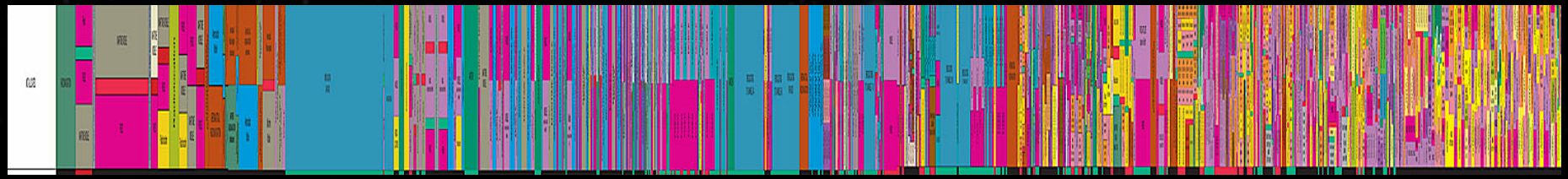


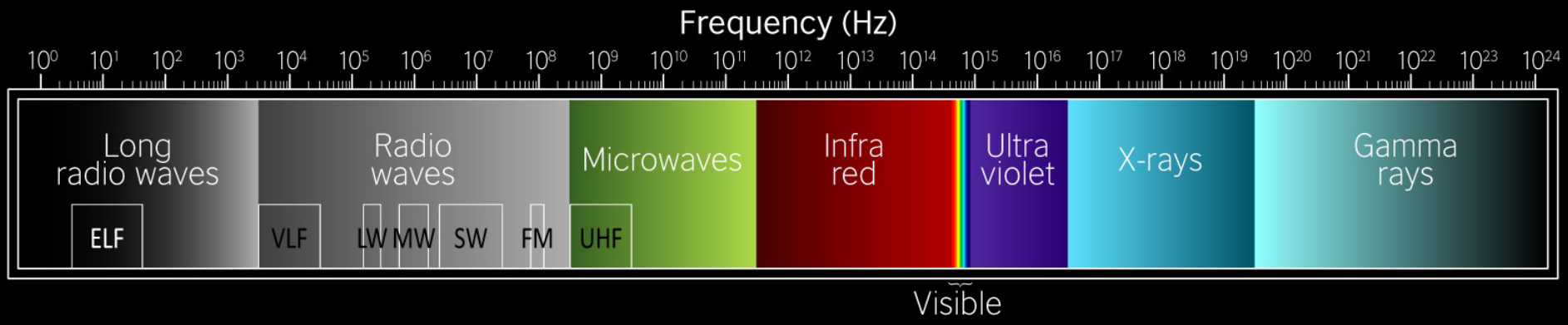
- LiFi could add THz of un-regulated bandwidth to the network
- Could theoretical provide very high peak bit rates
- Could act as a man in the middle technology to moving hotspots such as the connected car/bus which then include a 802.11ad WiFi node

LiFi USPs

- No EM interference
- No fast fading
- Benign channel - dominated by line-of-sight
- Highly directional; no isotropic radiation
- No transmission through opaque objects
- Huge unlicensed (optical) spectrum

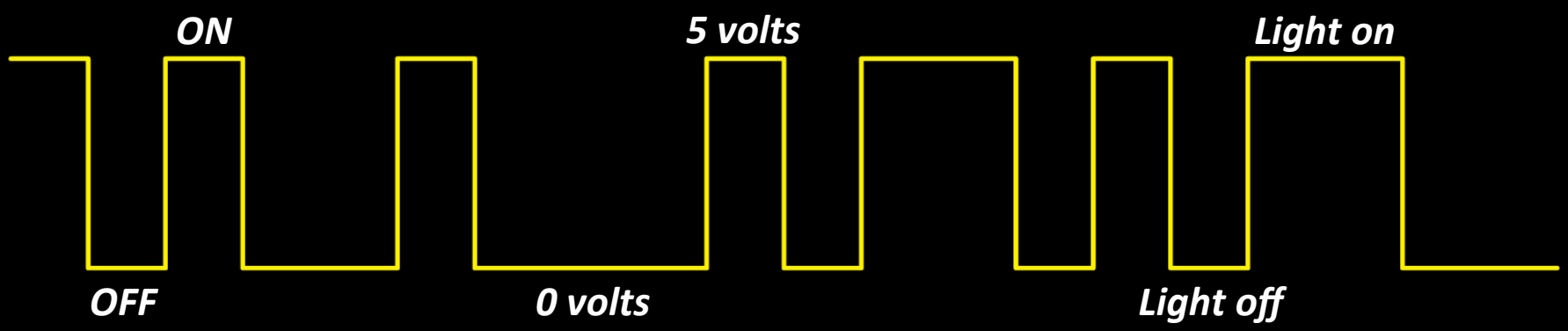
The Electromagnetic Spectrum





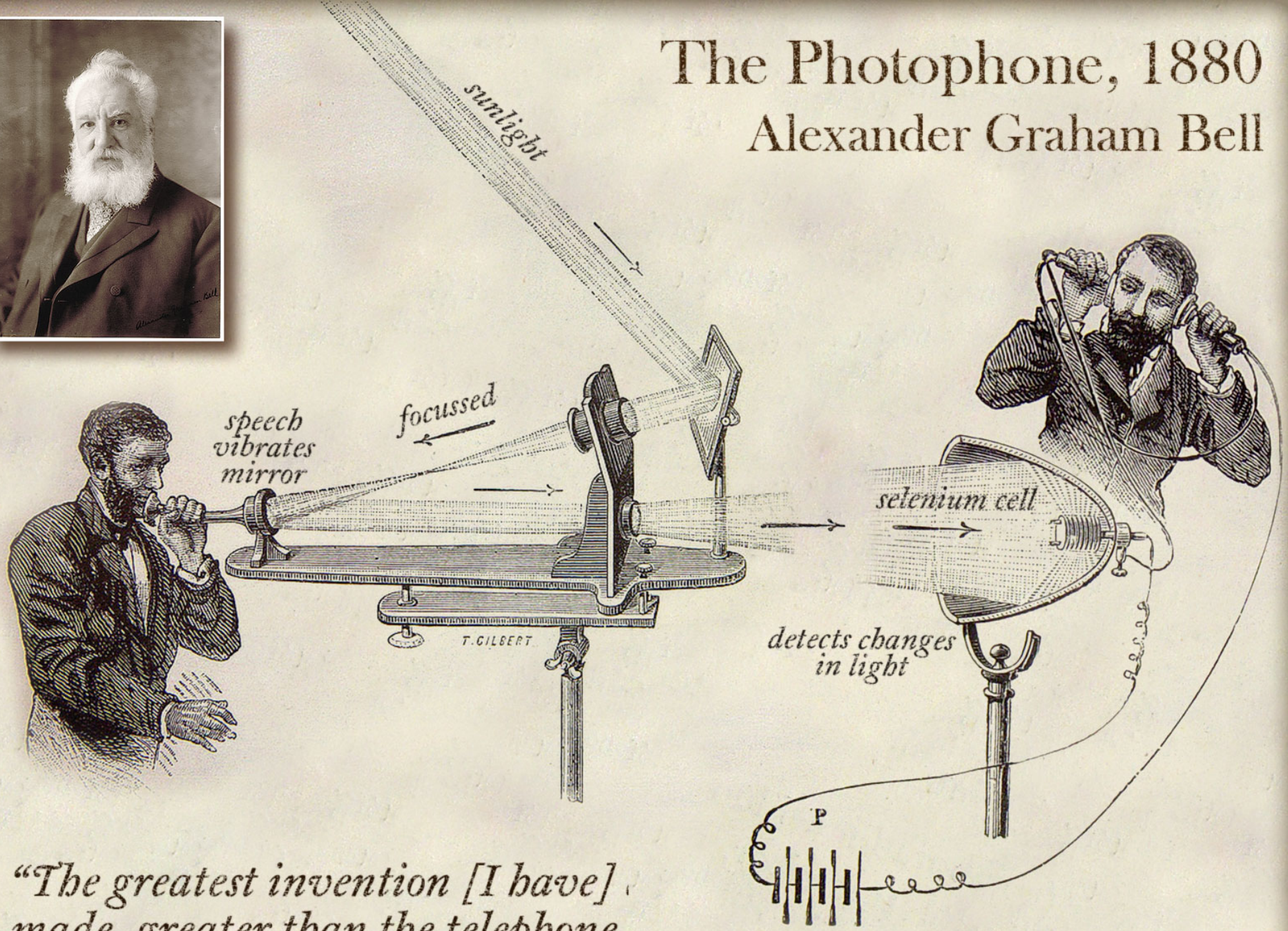
10 thousand times larger than the radio spectrum

10100100010110101100



The Photophone, 1880

Alexander Graham Bell

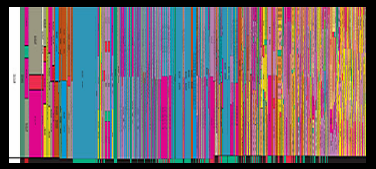


"The greatest invention [I have] made, greater than the telephone.

LiFi- an ancient idea whose time has come

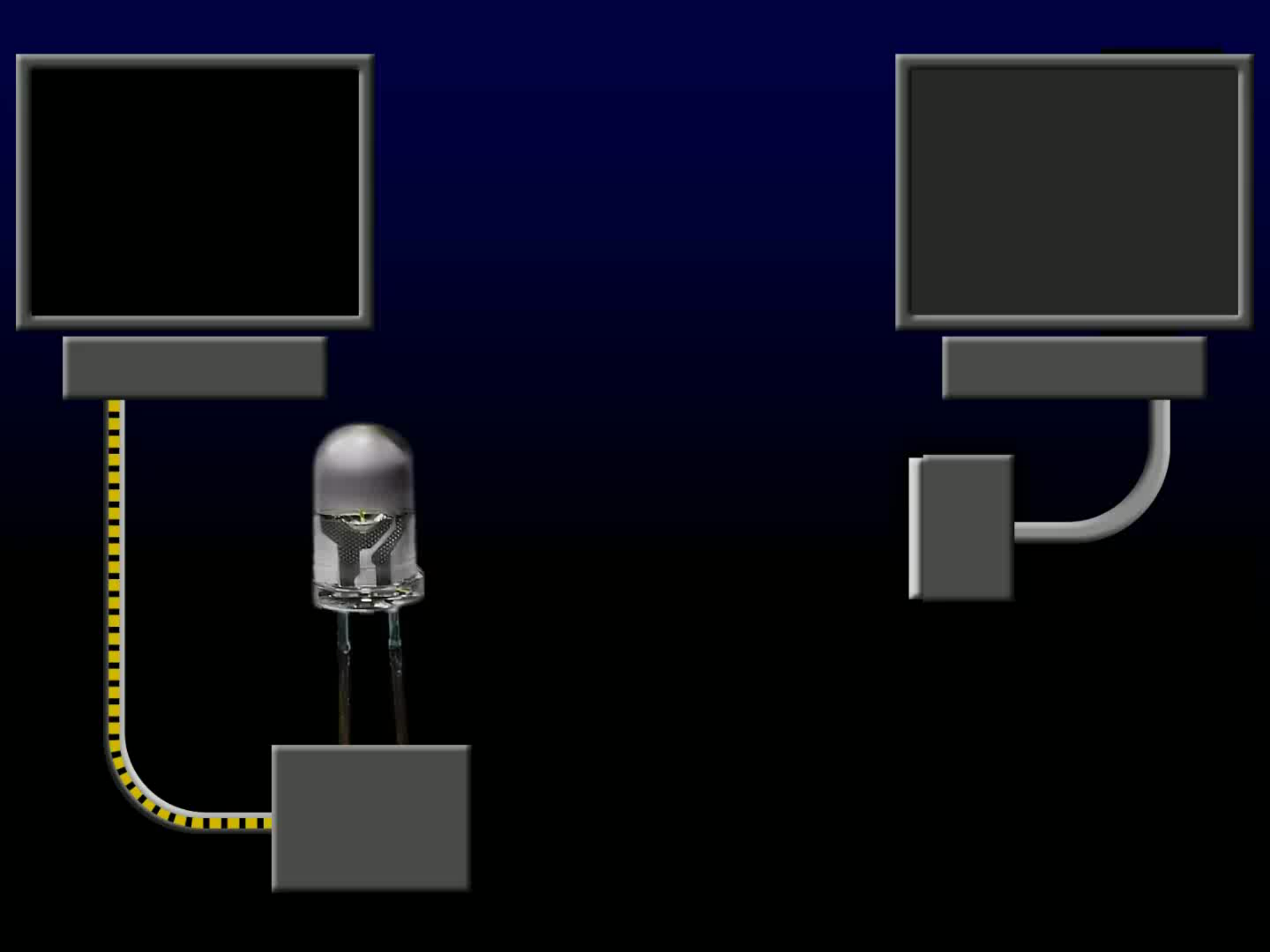
- Better artificial light sources (e.g. LEDs)
- LEDs can be turned on/off at millions of times per second

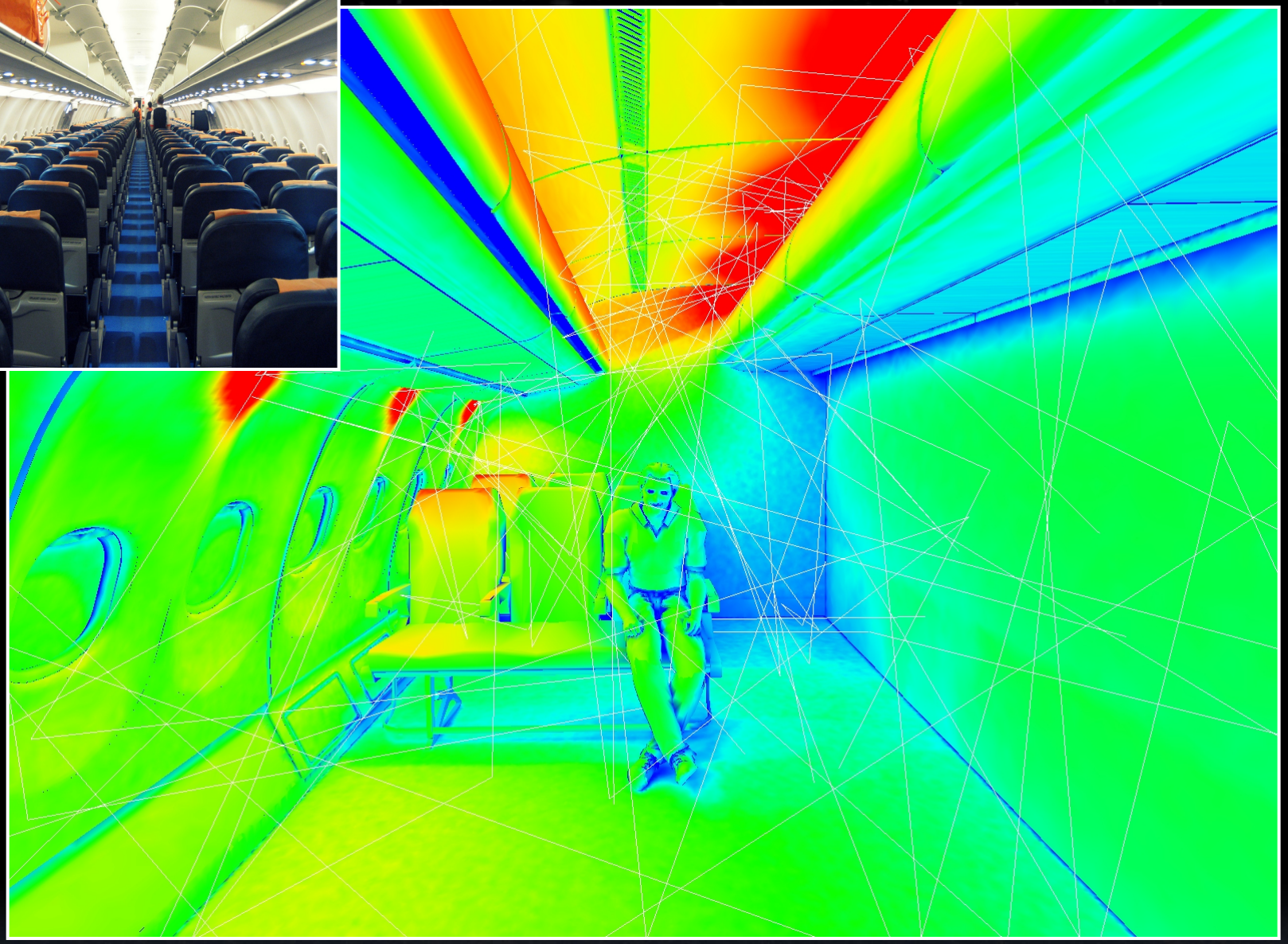
- 'Photophone' can now be implemented quite easily and reliably
- Radio frequency spectrum crunch



- LEDs are very energy efficient – hence fo illumination/lighting designs

LEDs turn on and off *rapidly* :
a demonstration





LiFi – Market trend

www.luxreview.com/article/2015/04/battle-heats-up-in-in-store-lighting-based-customer-promotion-systems-as-acuity-acquires-key-g

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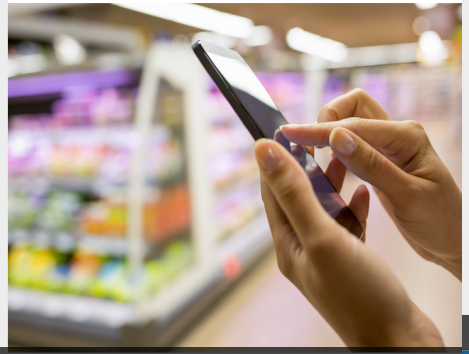
Battle heats up for in-store, lighting-based customer promotion technology as Acuity acquires key GE partner



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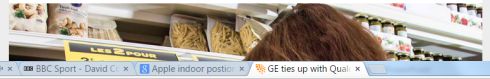
Carrefour guides shoppers to in-store discounts via the ceiling lights



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GE ties up with Qualcomm, Apple in new lighting business bet

BY LEWIS KRAUSKOPF

May 4 General Electric Co on Monday announced collaborations with Qualcomm Inc and Apple Inc as it uses digital technology and the growing appetite for data to reinvigorate its 130-year-old lighting business.

With chipmaker Qualcomm, GE is offering retailers a way to connect with shoppers' smartphones through technology embedded in LED light bulbs, the company said. One use of the "indoor positioning" technology could be to transmit customized coupons to shoppers depending on their store location.

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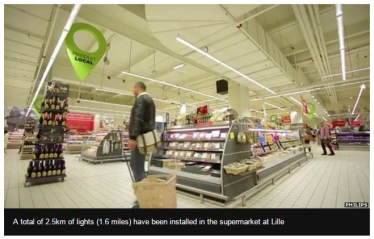
Technology

Supermarket LED lights talk to smartphone app

By Leo Kelion
Technology desk editor

22 May 2015 | Technology



A total of 2.5km of lights (1.6 miles) have been installed in the supermarket at Lille

French shoppers have become the first to experience a new LED lighting system that sends special offers and location data to their smartphones.

The technology was designed by Philips and has been installed at a Carrefour supermarket in Lille.

It transmits codes via light waves, which are undetectable to the eye but can be picked up by a phone camera.

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Light becomes data

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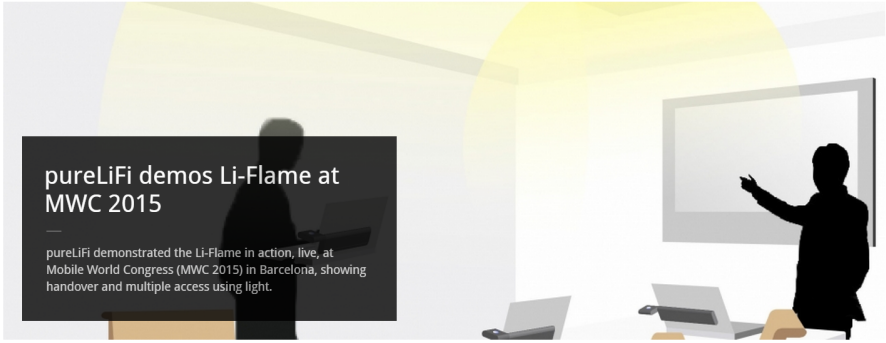
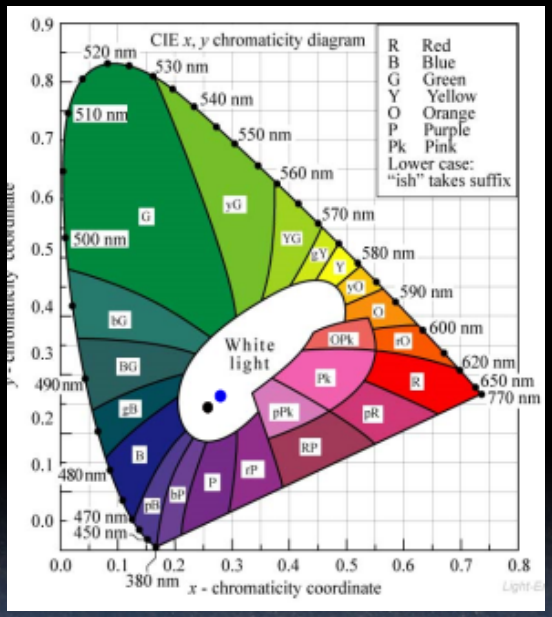


pureLiFi, the home of LiFi, is recognised as the leader in the field – the use of the visible light spectrum instead of radio frequencies to enable wireless data communication. pureLiFi provides ubiquitous high-speed wireless access that offers substantially greater security, safety and data

Six LiFi nuggets:

- There's no visible flicker
- The lights can be dimmed, and still transmit
- Sun/ambient light causes no interference
- Li-Fi uses power efficiently
- It does not need to be line-of-sight to work
- No effect on light quality metrics of colour temp, chromaticity and colour rendering index



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Thank you

Acknowledgement

- Funding from EPSRC and The Carnegie Trust
- Prof. Harald Haas, Director LiFi Centre
- Members, LiFi R&D Centre