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How Can 6G Respond to Pandemics ?



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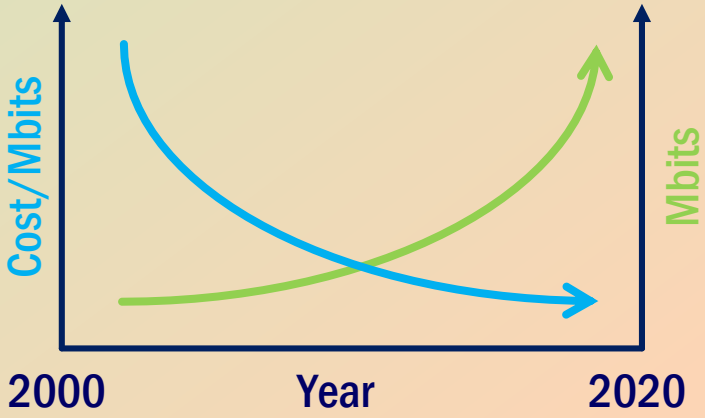
The Mobile Revolution

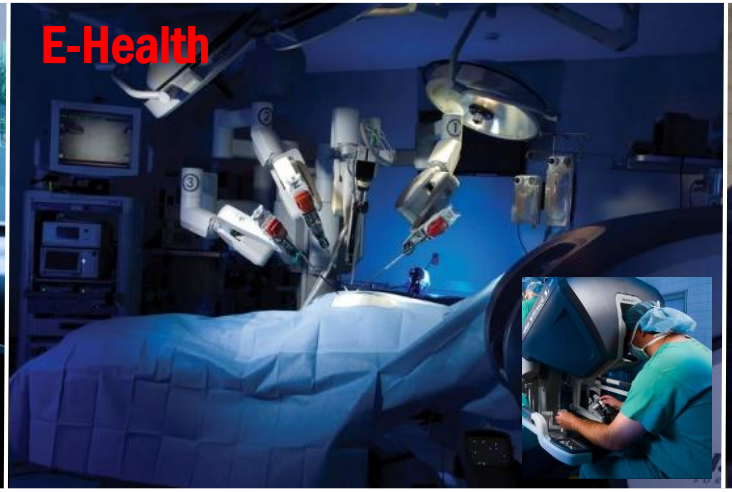
As the result of the merger of the internet and wireless communication, mobile is the most rapidly adopted consumer technology in history.

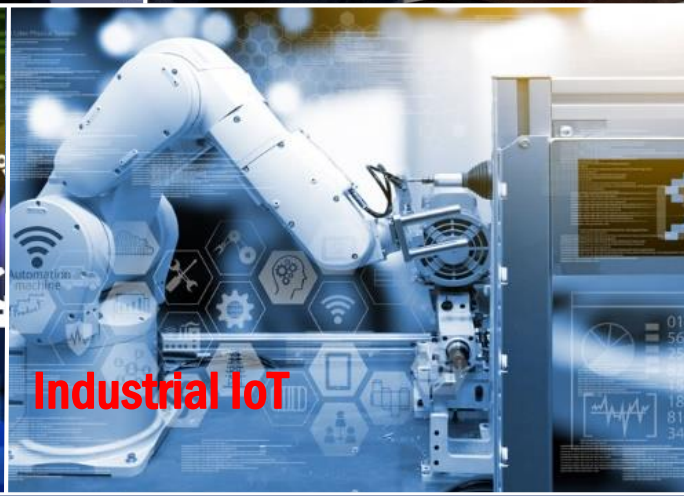


"We had no idea that this would turn into a global and public infrastructure"
Vinton Cerf, One of "the Fathers of the Internet"

"People want to talk to other people - not a house, or an office, or a car. Given a choice, people will demand the freedom to communicate wherever they are, unfettered by the infamous copper wire. It is that freedom we sought to vividly demonstrate in 1973"
Martin Cooper, "Father of the (Handheld) Cell Phone"

6G Use Cases





S. Dang, O. Amin, B. Shihada, & M. –S. Alouini, “What Should 6G Be?”, Nature Electronics, January 2020.

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Fighting the Pandemic
&
Saving the Economy:



Role of Wireless Com Technologies in the Covid-19 Pandemic

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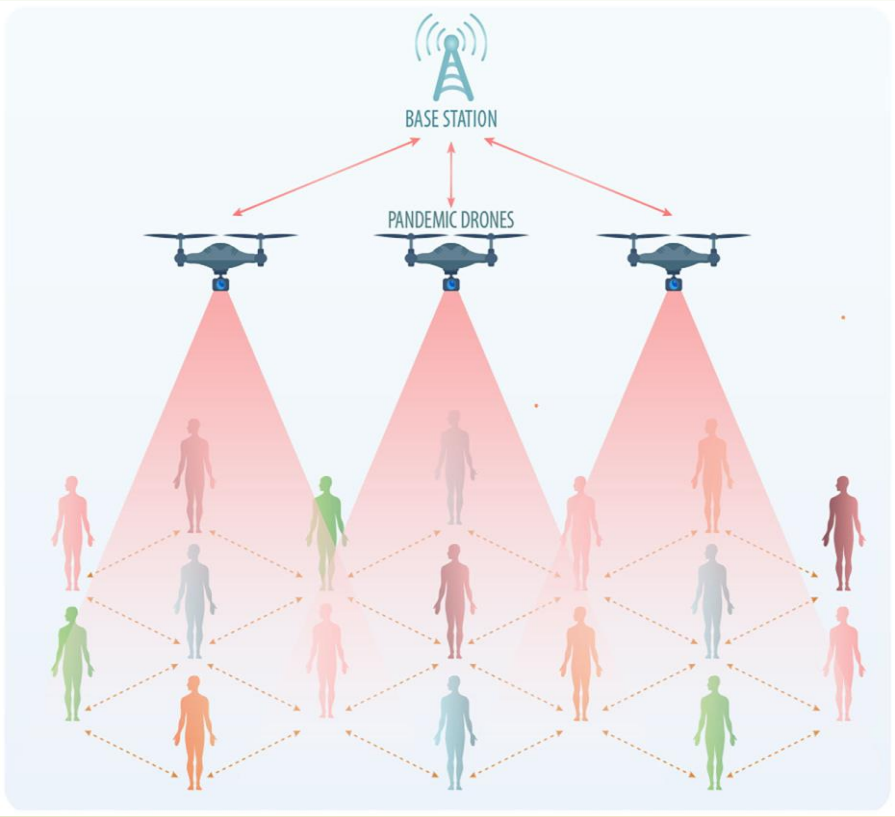
N. Saeed, A.Bader, T. Al-Naffouri, & M. –S. Alouini, “When Wireless Communication Responds to COVID-19: Combating the Pandemic and Saving the Economy”, Frontiers in Communications and Network, September 2020.

Fighting the Pandemic: Monitoring the Spread



Outdoor monitoring: Connected drones monitoring social distancing.

Proximity tracking for workers to maintain safe working distance.

Fighting the Pandemic: Healthcare Automation

Concept of a wireless health monitoring system.

Fighting the Pandemic & Saving the Economy: Virtual Education, Video-Conferencing, E-Commerce, and Automation

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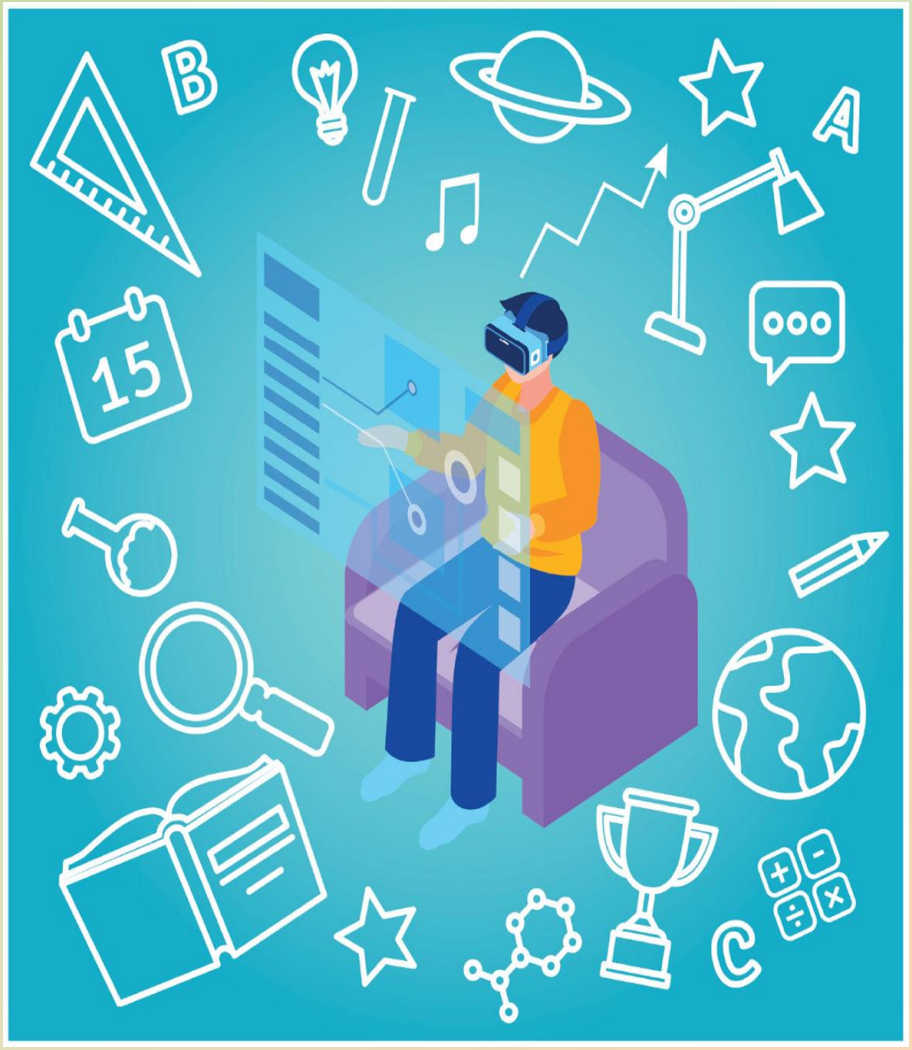
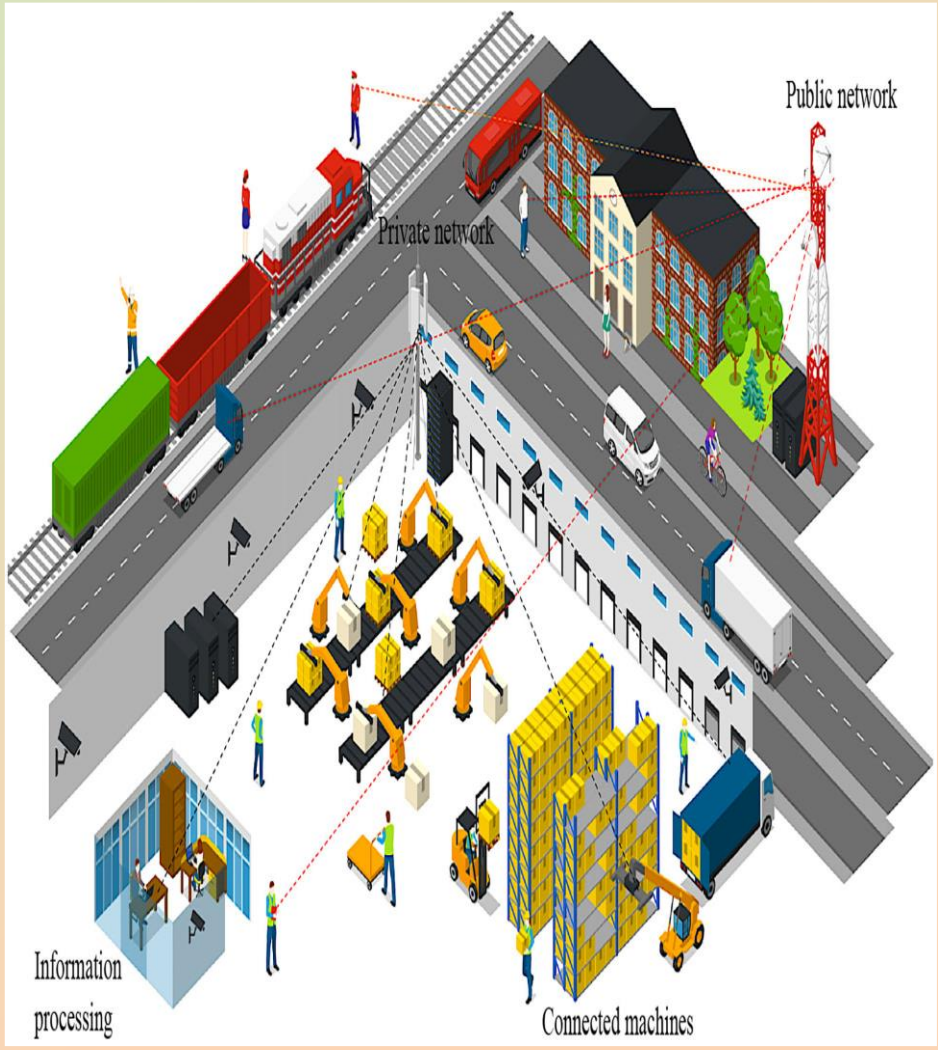


Concept of e-learning using AR/VR.



Automated industrial network

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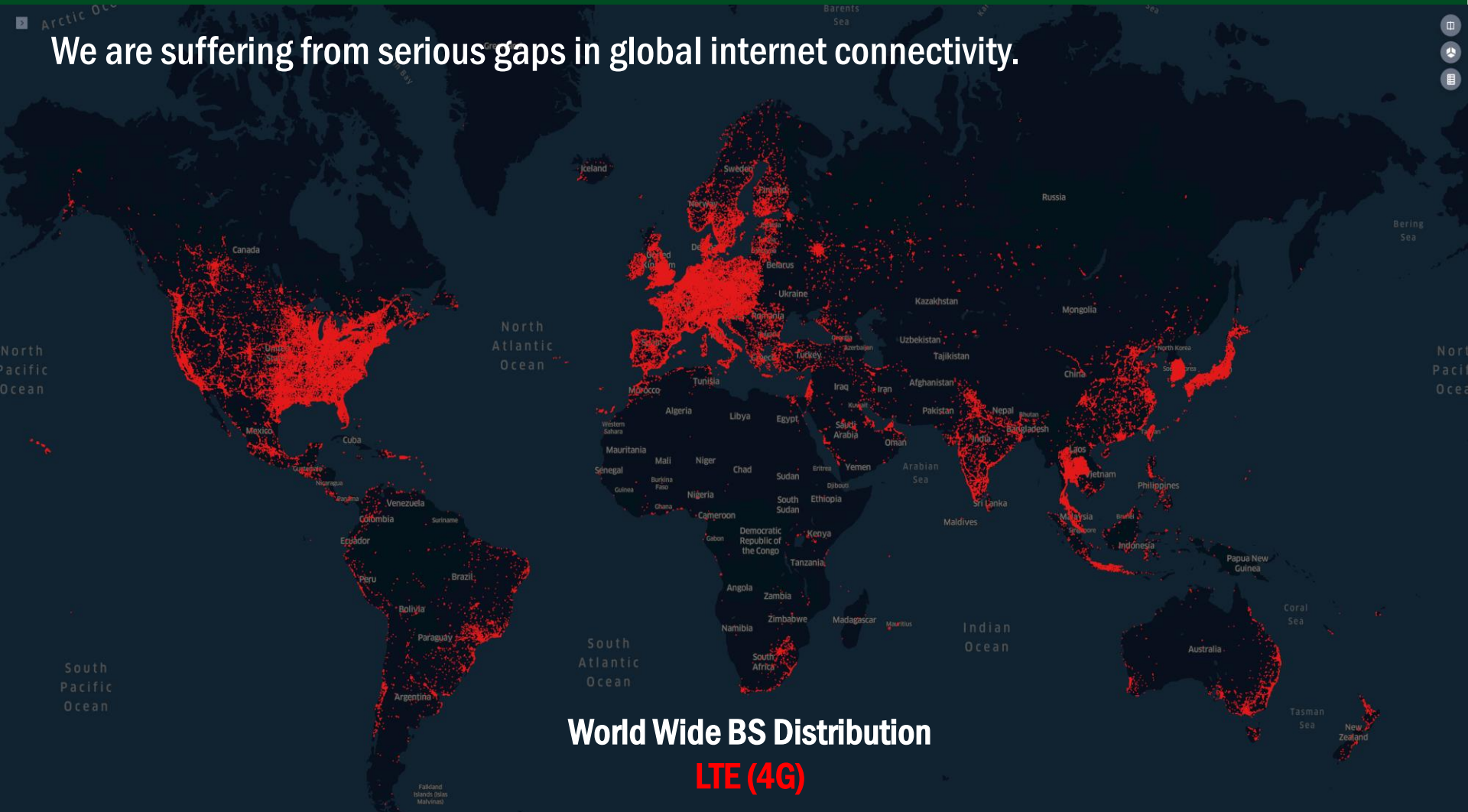
Connectivity Matters the Most



Connectivity Divide Concern

We are suffering from serious gaps in global internet connectivity.



World Wide BS Distribution

LTE (4G)

E. Yaacoub and M.-S. Alouini, "A Key 6G Challenge and Opportunity - Connecting the Base of the Pyramid: A Survey on Rural Connectivity," Proceedings of IEEE, April 2020. Available on arxiv.

Urban Connectivity

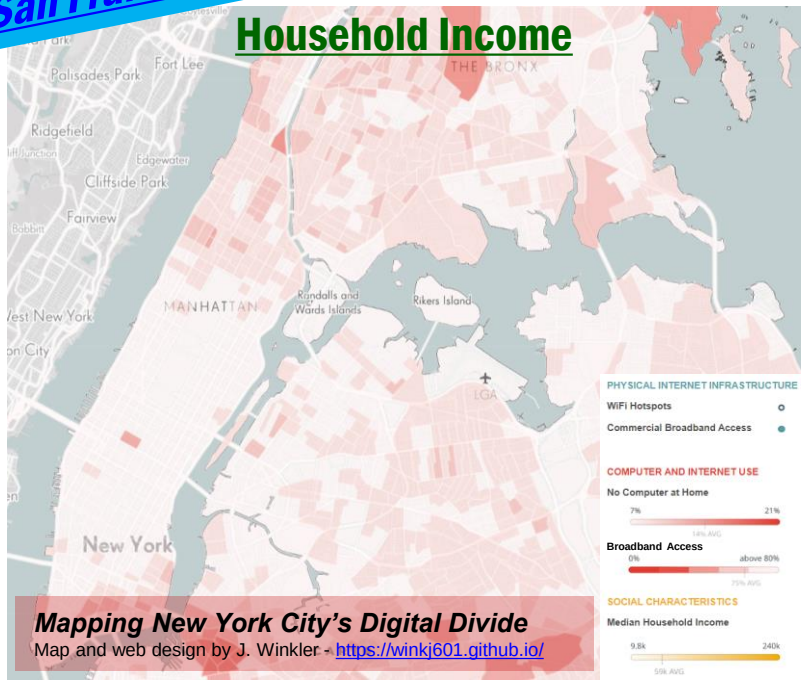
Digital Divide Is Wider Than We Think. The New York Times

The Former Homeless Man Bringing Web Access to the Bronx. BBC

Can San Francisco Finally Close its Digital Divide? SFWEEKLY

- In communities with low income, the digital disparity is much more profound.
- People who have high-quality internet service are more likely to benefit from health care, self-education and social/governmental services.
- It needs collaboration and agreement among various stakeholders, i.e., government, policy makers, service provider, manufacturer and community members.

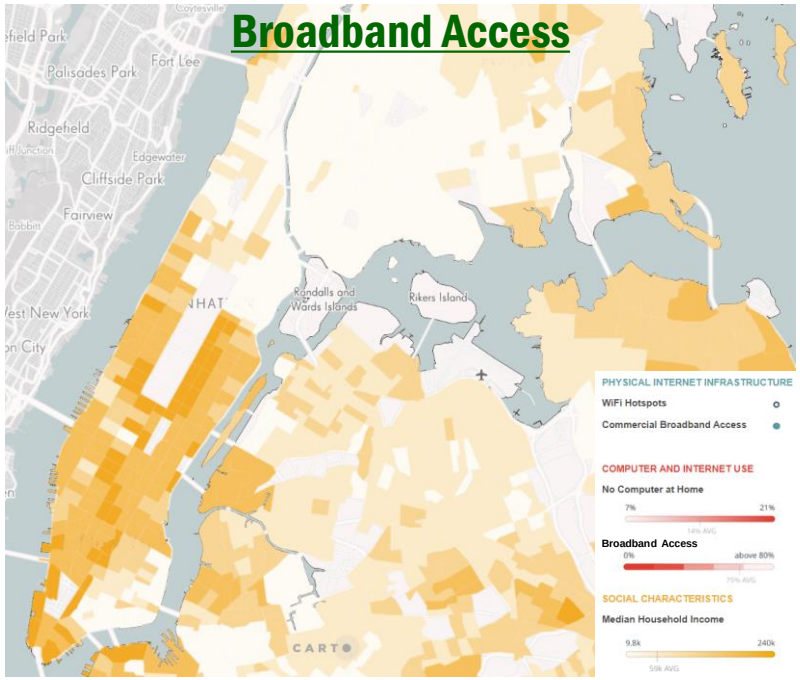
Household Income



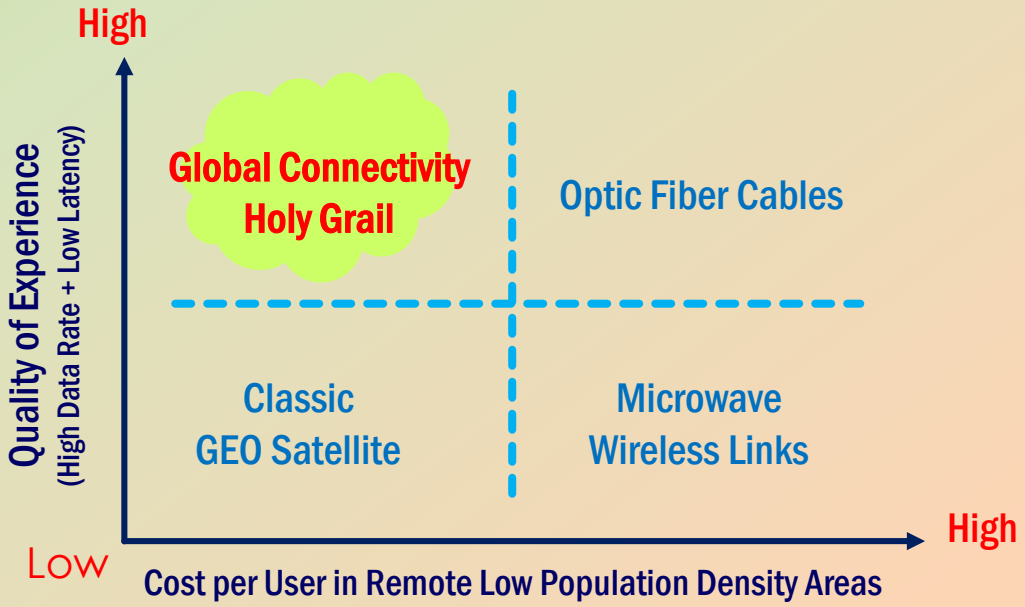
Mapping New York City's Digital Divide
Map and web design by J. Winkler - https://winkj601.github.io/

VS

Broadband Access



Global Connectivity Holy Grail



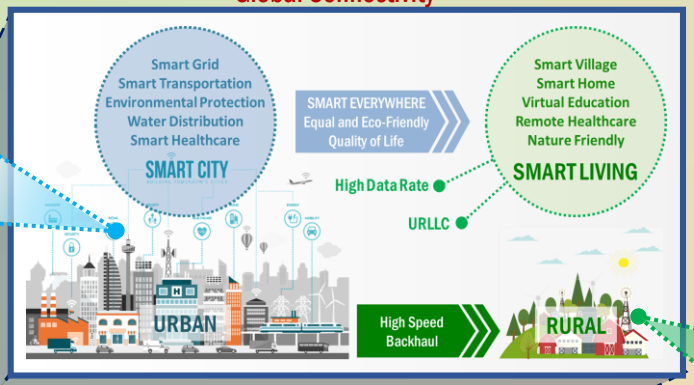
"A telephone subscriber here may call up and talk to any other subscriber on the Globe. An inexpensive receiver, not bigger than a watch, will enable him to listen anywhere, on land or sea, to a speech delivered or music played in some other place, however distant."
— *Nikola Tesla 1919*

Integrated Space-Air-Ground Networks

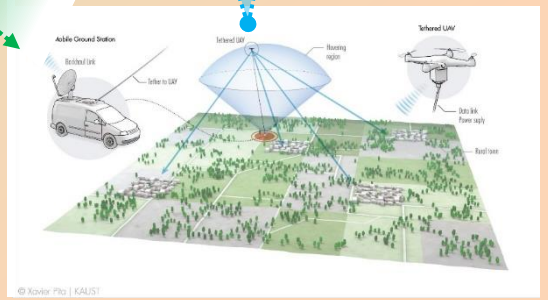
UAV Communication

Mega-Constellation

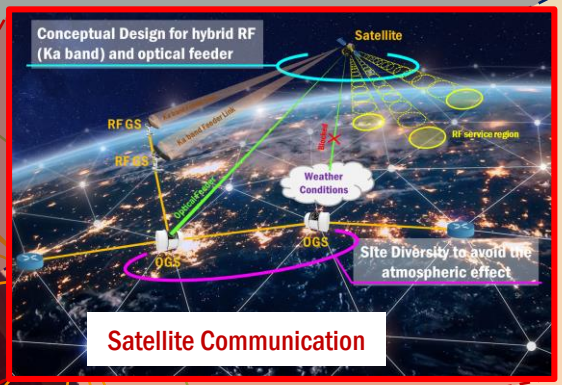
Global Connectivity



Low Altitude Platform



Digital Divide: Rural Connectivity



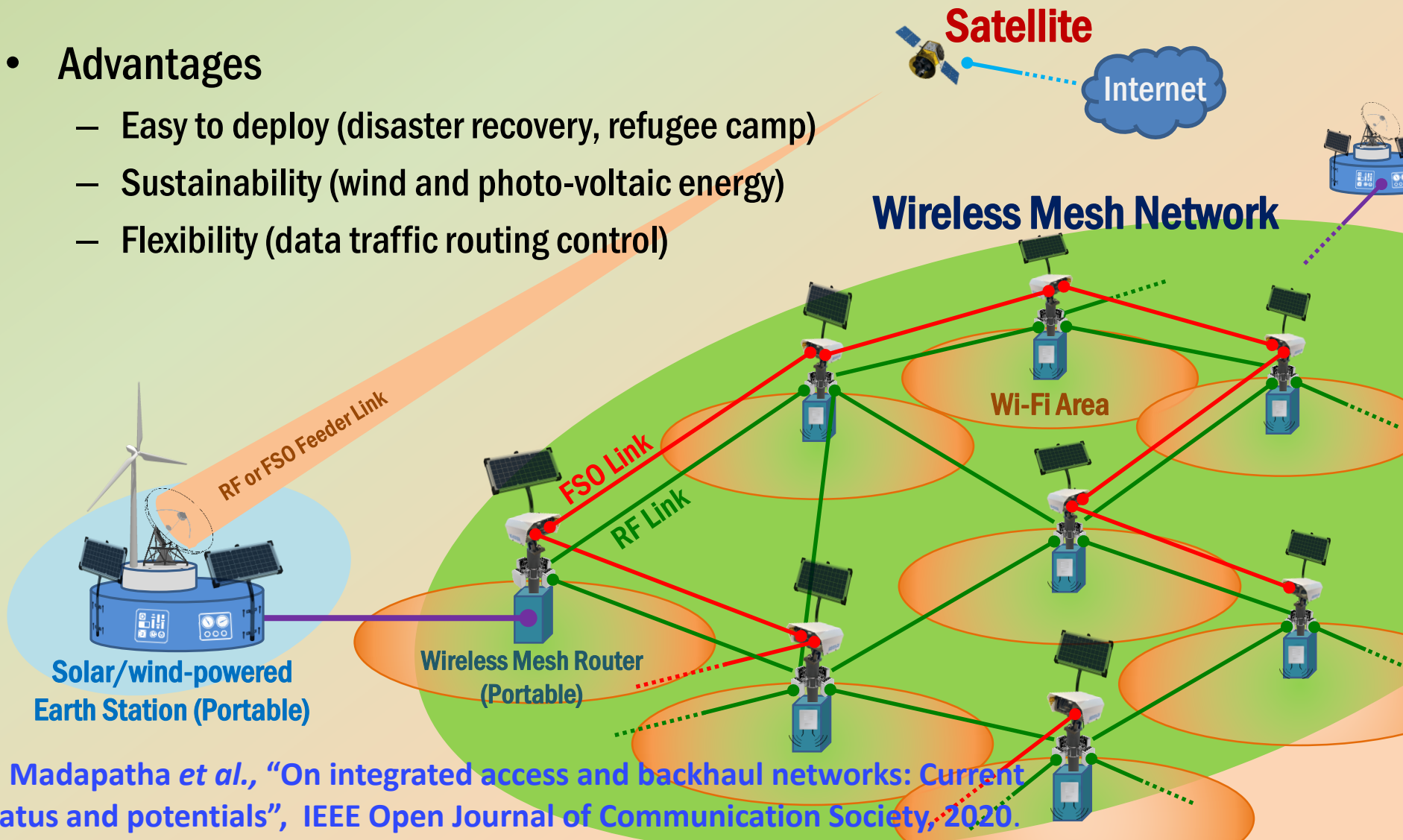
Satellite Communication

High Altitude Platform

Integrated Space-Aerial-Terrestrial Network

Integrated Backhaul Access

- Advantages
  - Easy to deploy (disaster recovery, refugee camp)
  - Sustainability (wind and photo-voltaic energy)
  - Flexibility (data traffic routing control)



C. Madapatha *et al.*, "On integrated access and backhaul networks: Current status and potentials", IEEE Open Journal of Communication Society, 2020.

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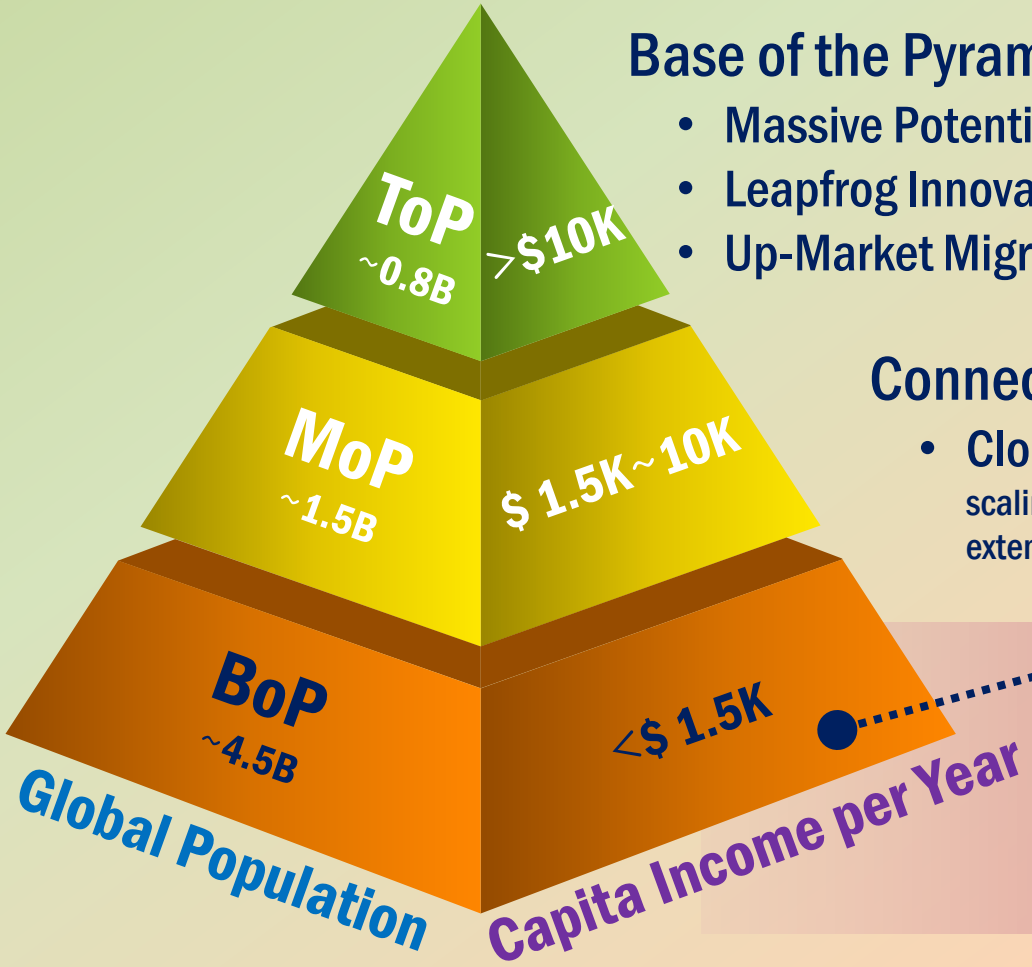
The New Normal



Base of the Pyramid Model



Base of the Pyramid (BoP) as Leverage Point

- Massive Potential Market – Creating new markets from unserved needs
- Leapfrog Innovation – Incubating new distributed & disruptive technologies
- Up-Market Migration – Potential for growth through reverse innovation

Connectivity as Key Enabler

- Cloud-based platform - A potential solution for BoP scaling challenge (overcome high costs associated with the extended distribution)

- A huge market of creative and resilient consumers and producers
- Largely excluded from formal markets
- Growing fast but underutilized productive sector

C. K. Prahalad and S. L. Huart, "The fortune at the bottom of the pyramid ," Strategy+Business, Number 26, First Quarter 2002.

UN SDGs & 6G

- United Nation (UN) Sustainability Development Goals (SDGs) should drive the evolution of 6G
- 6G should target:
  - Improved Efficiency
  - No Bad Effects on Environment & Human Health
  - Digital Inclusion
  - More Security and Privacy
  - Resilience, Robustness, and Dependability

Is 5G/6G Really Harmful ?
Combating the Misinformation

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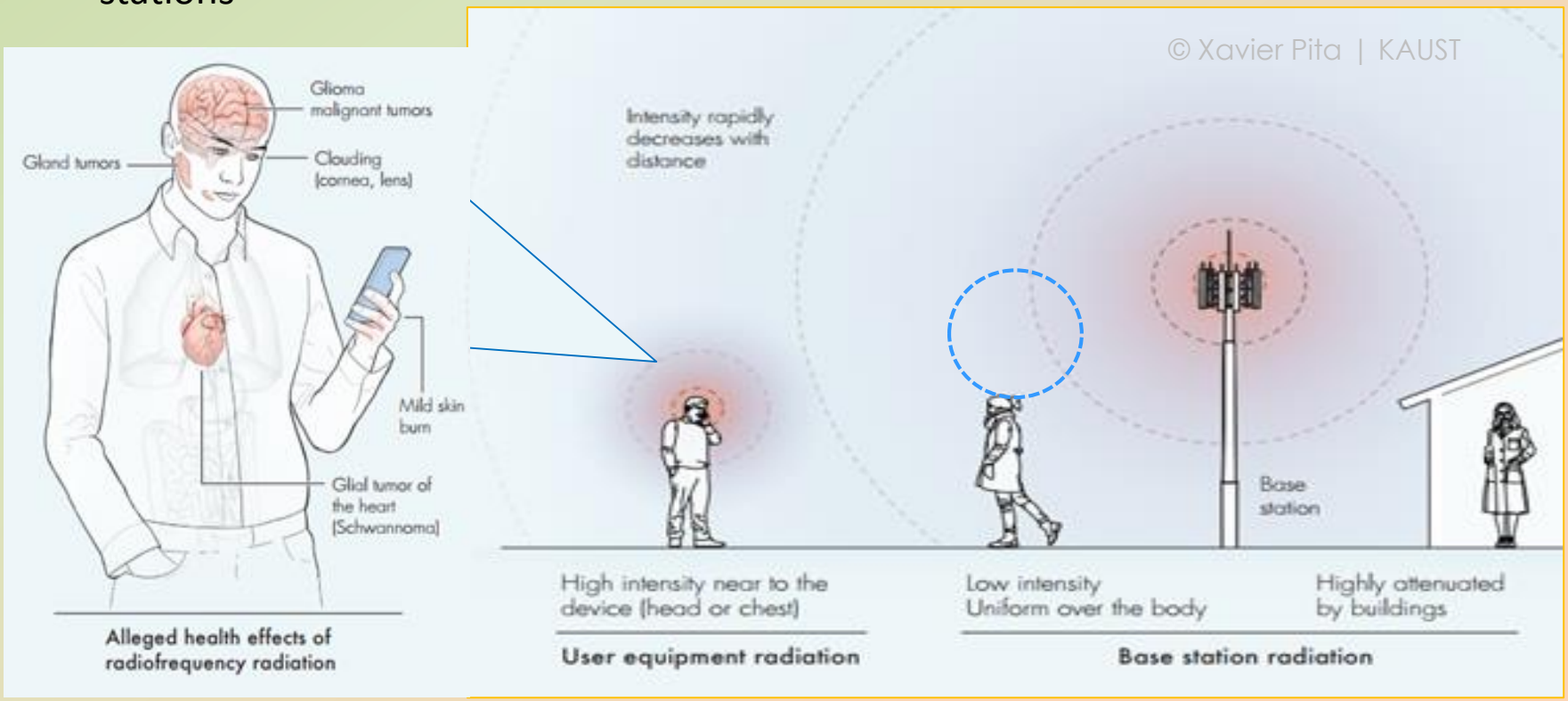
- Concern on electromagnetic field exposure
  - Potential health risks associated with the extra RF emissions from 5G/6G base stations



L. Chiaraviglio, A. Elzanaty, and M.-S. Alouini, "Health risks associated with 5G exposure: A view from the communications engineering perspective ", Under Review. June 2020, Available on Arxiv: https://arxiv.org/pdf/2006.00944.pdf

From Smart Cities to Smart Living

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Smart Grid
Smart Transportation
Environmental Protection
Water Distribution
Smart Healthcare

SMART CITY
BUILDING TOMORROW'S CITIES

SMART EVERYWHERE
Equal and Eco-Friendly
Quality of Life

Smart Village
Smart Home
Virtual Education
Remote Healthcare
Nature Friendly

SMART LIVING

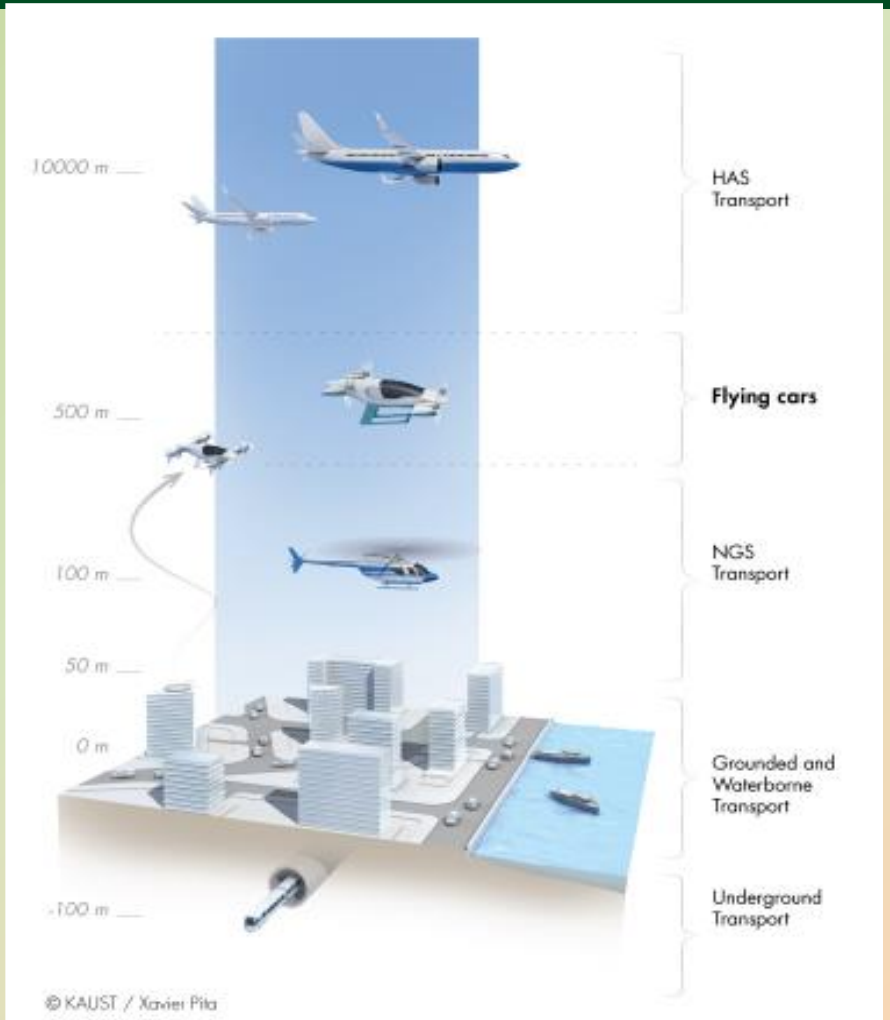
High Data Rate

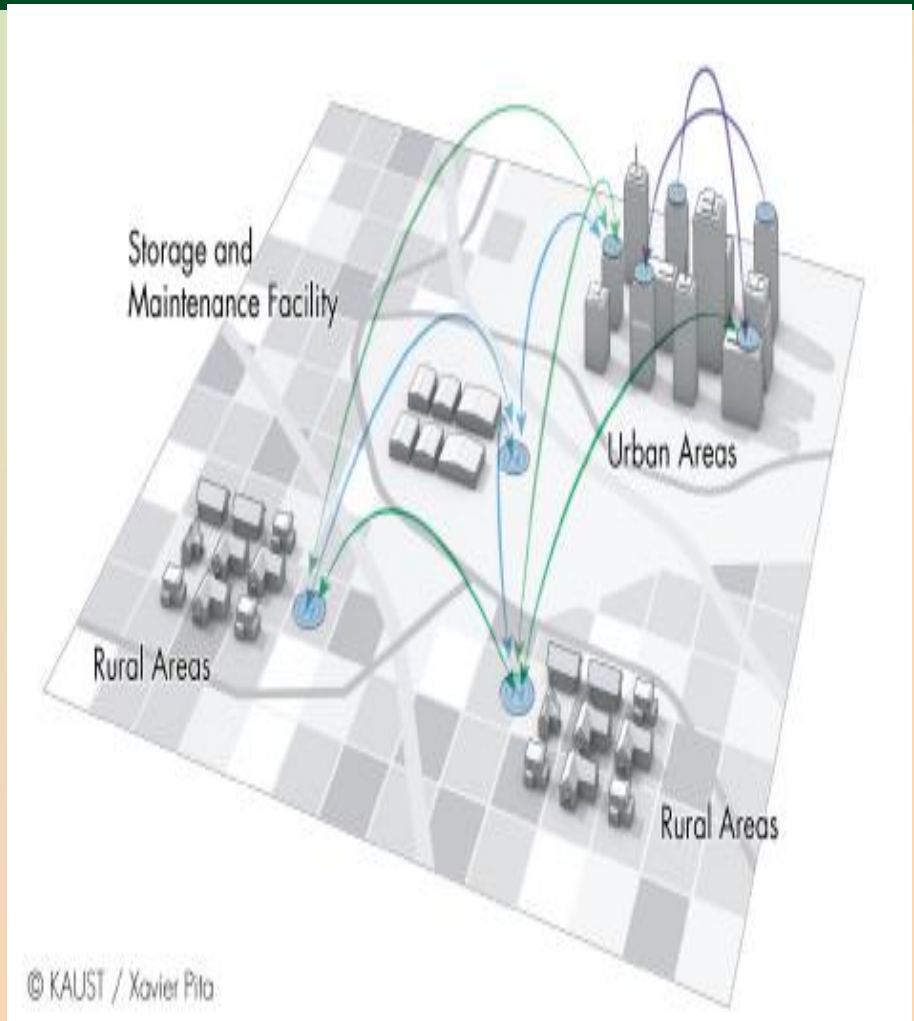
URLLC

High Speed
Backhaul

E. Yaacoub and M.-S. Alouini, "Efficient Fronthaul and Backhaul Connectivity for IoT Traffic in Rural Areas ," IEEE IoT Magazine, 2020 and available on TechRxiv

Connection with Emerging & Future Transportation Systems





[1] G. Pan and M. – S. Alouini, "Flying car transportation systems: Advances, techniques, and challenges", Under Review.
[2] N. Saeed, T. Y. Al-Naffouri, M -S. Alouini, "Wireless communications for flying cars", Under Review.

Network in a Box & Pop-up Networks

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Disaster
Emergency

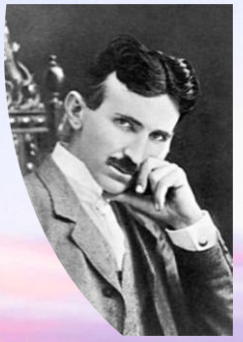
Concert
Sport Event

Defense
Mission

Scientific
Mission

Challenges of Pop-up Networks

Nikola Tesla
(10 July 1856 – 7 January 1943)



"When wireless is perfectly applied, the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole. We shall be able to communicate with one another instantly, irrespective of distance."

Nikola Tesla (1925)

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Thank You

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