ITU Kaleidoscope 2016

ICTs for a Sustainable World

5G IN RURAL AND LOW-INCOME AREAS: ARE WE READY?

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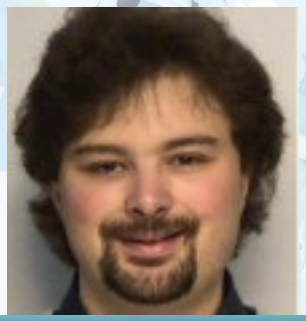

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Outline

- Introduction
- Key Questions
- Our Contributions
- Challenges
- Main Pillars
- Architecture vision
- Conclusions and Future Work

Introduction

- 69% of the world population is covered by the third generation (3G) network.

- The Internet penetration rate in North America is above 80%.

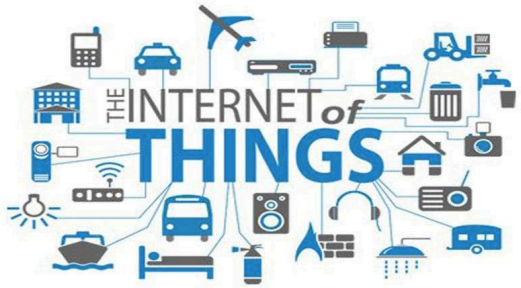
BUT…

At least two billion people are currently experiencing a complete lack of wireless cellular coverage!

The connectivity divide

- The lack of connectivity is experienced by people living in rural and low-income areas
- Telecommunication networks are widely deployed in urban zones rather than in rural and and low-income ones.
- Urban zones are covered by “first class” networks, like the forthcoming 5G technology.

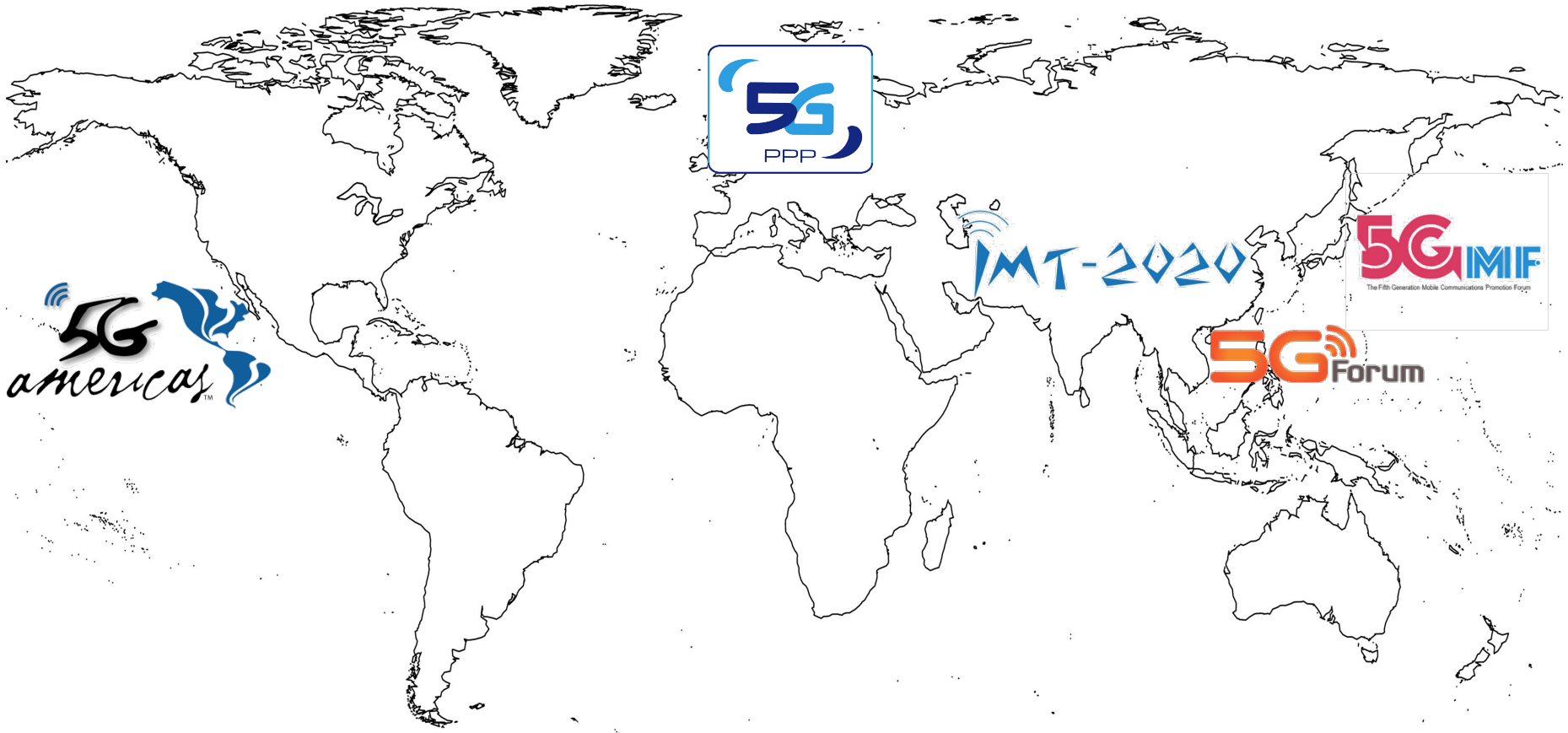
5G Services



- Tactile Internet
- Internet of Things
- Virtual Reality

- Very High Definition Videos
- e-Health

5G Research and Standardization Activities



- 5G is being investigated by a variety of organizations, including partnerships, research projects and international events

5G Technology Advantages

- High level of flexibility
  - deploy services and network resources where and when they are really needed
- Exploitation of commodity hardware
  - development of software solutions implementing networking functions
- Converged solution
  - networks and services cooperate to deliver high bandwidth and extremely low delay to users.

IDEA: 5G networks can be the solution to the connectivity divide

Key Questions

- What are the main challenges that need to be faced for the adoption of 5G networks in rural and low-income zones?
- Is it possible to define a holistic 5G architecture explicitly designed to serve such zones?

Our Contributions

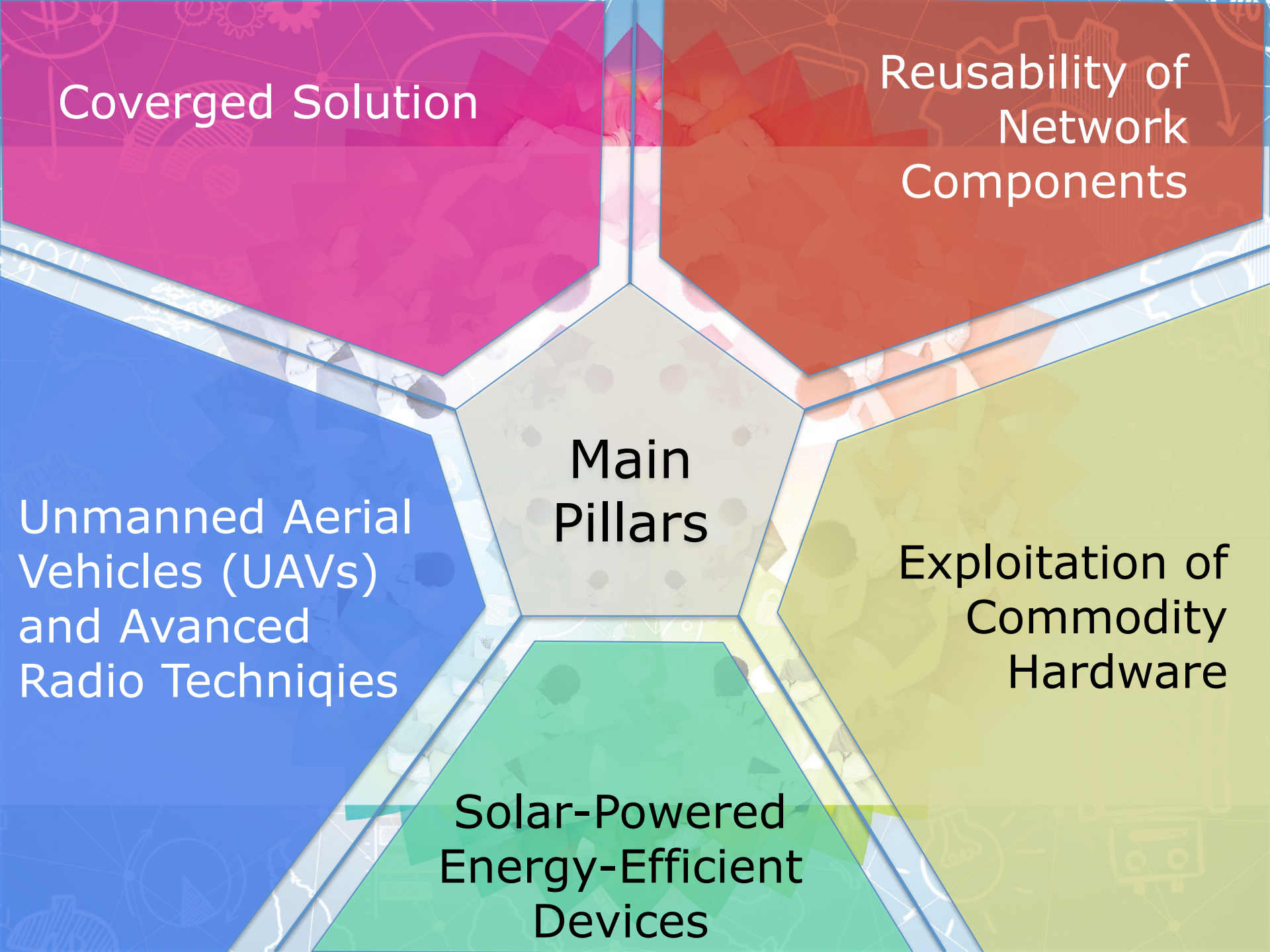
- We highlight the main challenges that need to be faced for the exploitation of 5G networks in rural and low-income zones.
- We select the main pillars that should be pursued to face the aforementioned challenges.
- We sketch a new 5G architecture explicitly designed to serve rural and low-income zones.

5G Technology Challenges

	Rural Scenario	Low-Income Scenario
Service Type	HD Video, Emergency Service, e-Health, e-Learning	Basic Connectivity, Emergency Service, Delay Tolerant, e-Health, e-Learning
Network Constraints	Coverage, Guaranteed Bandwidth	Coverage
Energy Sources	Power Grid, Renewable Sources	Unreliable Power Grid and/or Renewable Sources
Network Cost from the User Side	Same as standard urban users	Low
Business Model	Subsidized by the government	Subsidized by the government
Required Network Flexibility	High	High
User Mobility	Pedestrian, Vehicular	Pedestrian, Low Speed Vehicular

Socio-Economic Challenges

Challenge	Explanation
Affordability	The cost of broadband connectivity can be a financial barrier
Applications and service relevant to users	Users need applications that are necessary to their primary development needs.
Improvements in human skills	ICT-based skills in the areas such as computer networking, web and basic applications development and elementary network security are essential in all societies.
Impact of the networking on environment	The networking can drive energy efficiency, smart systems and services to enable more productivities. However, networking is to be also a growing source of material consumption and greenhouse gas (GHG) emissions.


Coverged Solution
Reusability of Network Components
Main Pillars
Unmanned Aerial Vehicles (UAVs) and Avanced Radio Techniqies
Exploitation of Commodity Hardware
Solar-Powered Energy-Efficient Devices

Coverged Solution

The last mile of the network should be orchestrated in conjunction with the metro and core one.

The network provider is also acting as a service provider.

Reusability of Network Components

Virtualize most of the network components by means of virtual functions shared among the network elements and managed by a centralized entity

Each network element is composed of a set of virtual elements

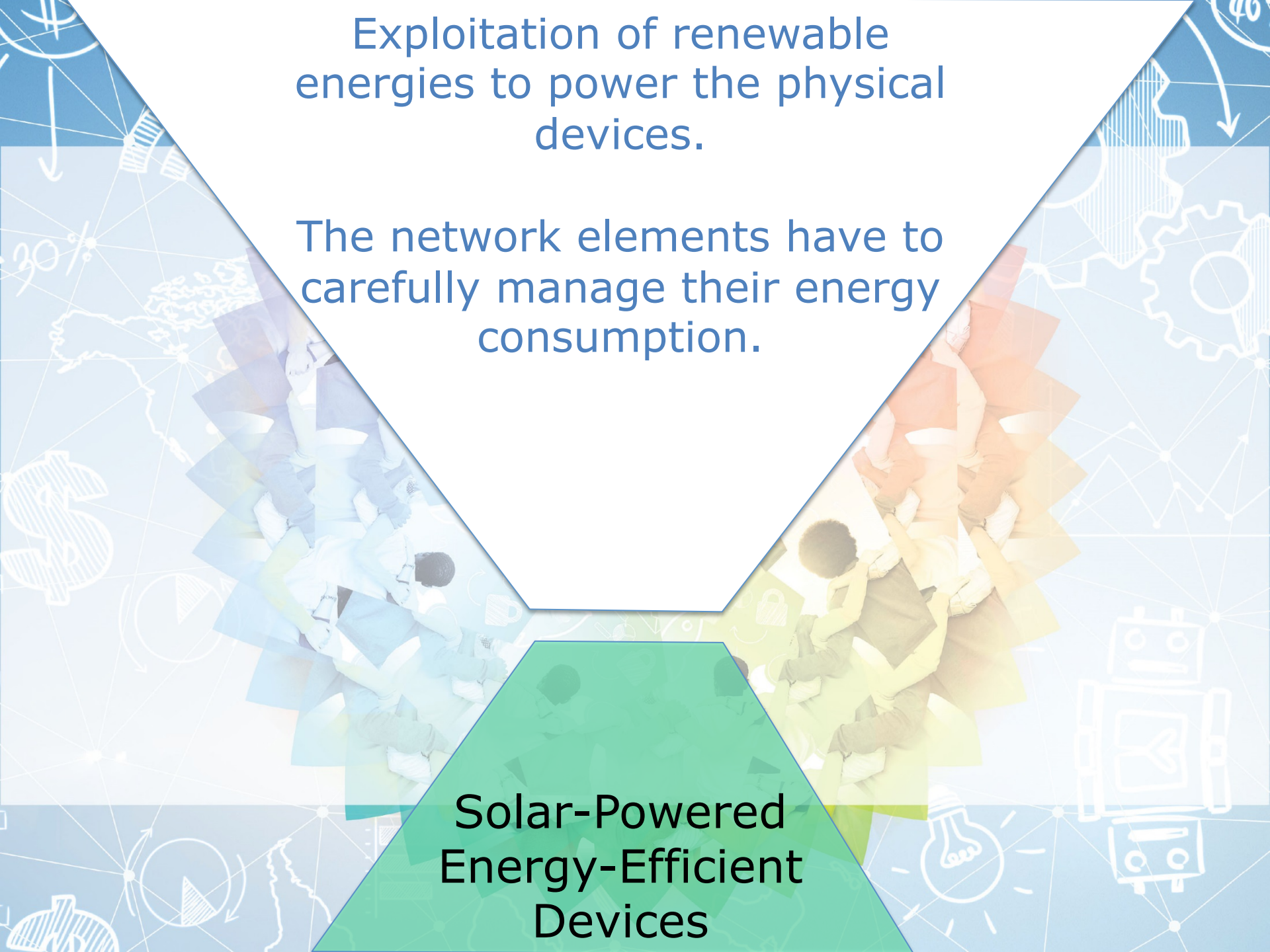
The network components are softwarized, and therefore it is possible to adopt general purpose hardware for most of devices.

The impact on the performance (e.g., bandwidth and delay) should be always taken into account.

Exploitation of Commodity Hardware

Exploitation of renewable energies to power the physical devices.

The network elements have to carefully manage their energy consumption.



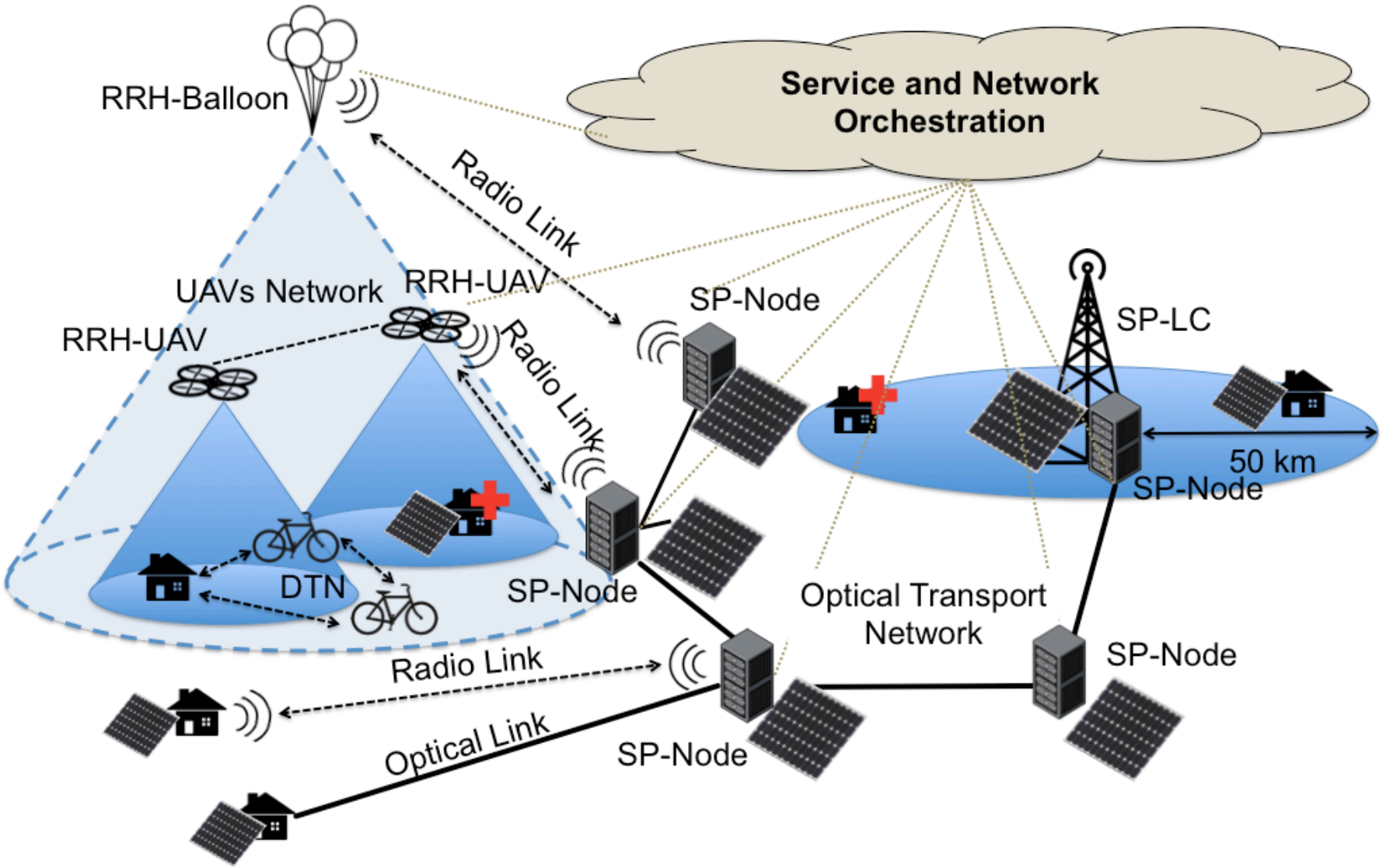
Solar-Powered Energy-Efficient Devices

Unmanned Aerial Vehicles (UAVs) and Avanced Radio Techniqies

Radio Elements mounted on top of UAVs.

Massive antenna arrays to deploy radio elements covering ultra-large cell sizes.

Proposed Architecture



Conclusions and Future Works

- We have focused on the problem of providing 5G services in rural and low-income areas, by considering the main challenges that need to be faced.
- We have proposed a set of pillars to follow, as well as a reference architecture.
- As next step, we plan to evaluate the costs for adopting the proposed solution (CAPEX and OPEX)
- We plan also to face different technological aspects
  - optimal UAVs trajectory
  - practical radio issues such as the impact on the uplink channel
  - dimensioning of the solar panels.


Thank you for your attention.
Questions?