

Presentation and progress on the IOT Satellite case study

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1. Introduction

Satellite Virtual Network Functions Optimization is an emerging technology that allows you to optimize the use of CubeSats, reducing costs and simplifying operations.

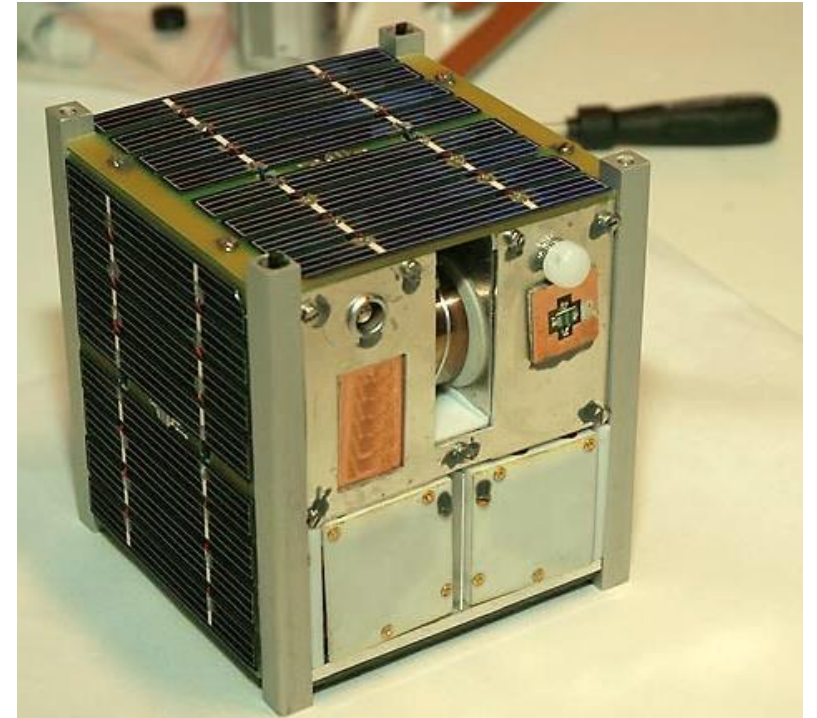
In this presentation, we will see Software-Defined Networking (SDN) and Network Function Virtualization (NFV) and how this technologies can help make satellite communication more efficient and improve the performance of CubeSats.

2. What is CubeSat

A cubesat is a type of miniaturized satellite having a cubic shape, a volume of 1 dm^3 and a weight $< 2 \text{ kg}$.

The term "cubesat" denotes not only the nanosatellites, but also the whole project which uses this type of satellites (**CubeSat project**).

They are cheap and are made using *COTS** components.

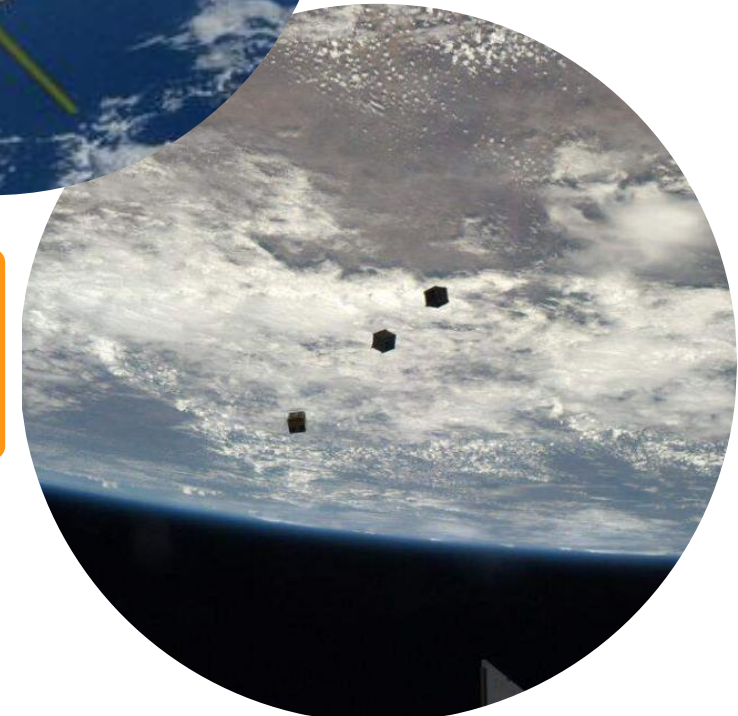
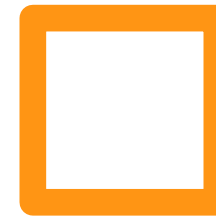


*COTS = *Commercial Off-the-Shelf component*

Why use a CubeSat:

They orbit at 500 km from the earth and are used for:

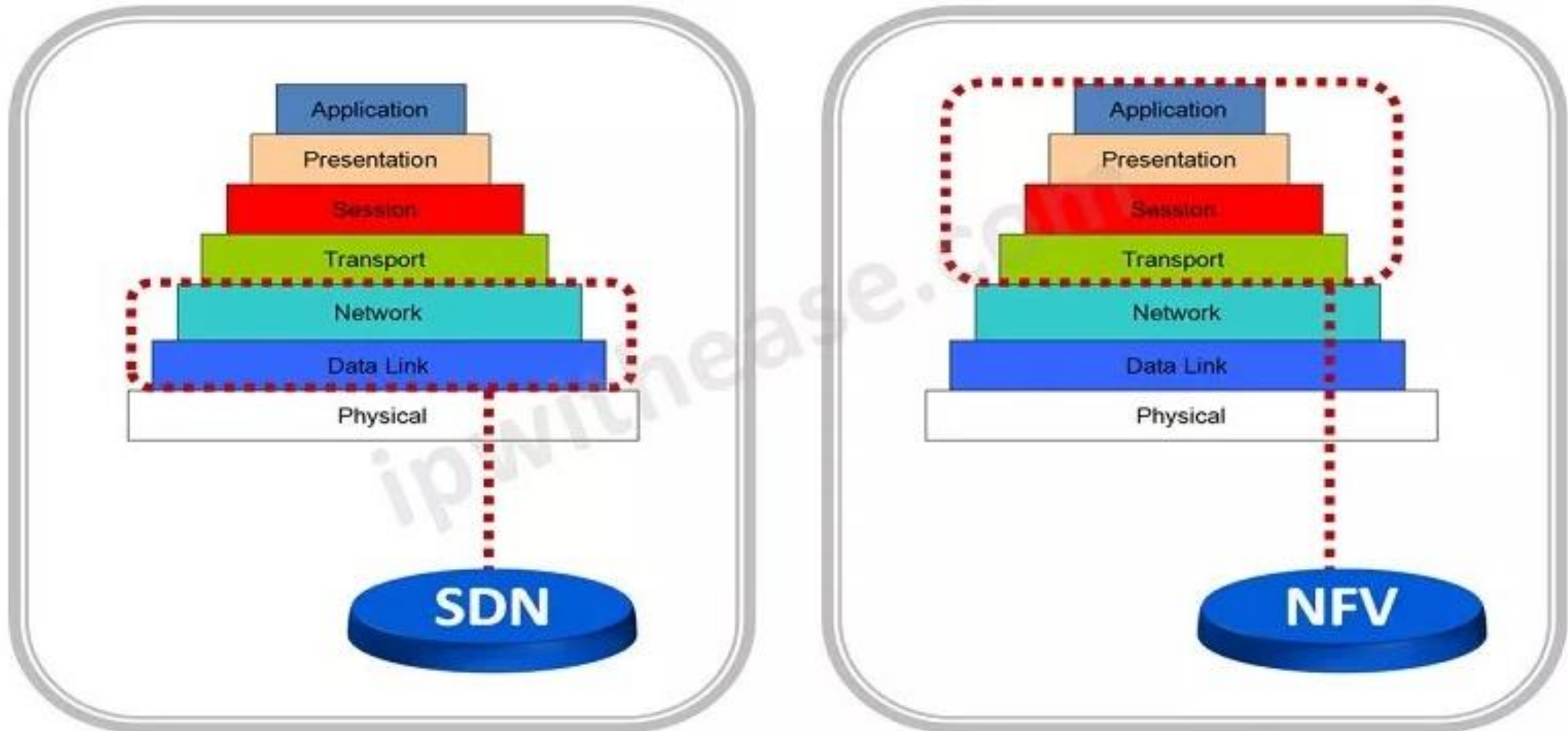
- Remote sensing
- Communications
- Scientific experiments
- Biological research
- Missions to the Moon



3. Software-Defined Networking (SDN) and Network Function Virtualization (NFV)

- **SDN (Software-Defined Networking)** is a network architecture that separates network control from data packet forwarding, in order to create greater flexibility and agility in managing networks.
- **Network Function Virtualization (NFV)** is the concept of using IT virtualization technologies to virtualize entire classes of network node functions into building blocks that can be connected to create communication services

3. Software-Defined Networking (SDN) and Network Function Virtualization (NFV)



Software-Defined Networking (SDN)

Software-defined networking (SDN) is the concept of dynamically controlling, changing, and managing network behavior programmatically through open interfaces and abstraction of lower-level functionality.

The advantages are:

- create dynamic and customized network policies more efficiently,
- simplify network management,
- enable the use of network devices from different vendors,
- and reduce operating costs.

Network Function Virtualization (NFV)

NFV (Network Function Virtualization) is a network function that is implemented and managed in software rather than through dedicated hardware.

This means that instead of using specific hardware devices to perform network functions such as routing, firewalling or application acceleration, NFVs are run in virtualized environments, such as virtual machines or containers.

4. Satellite Virtual Network Functions Optimization (SVNF)

The SVNF use the two techniques mentioned to improve the performance of the satellite network using virtualization and VNF optimization techniques.

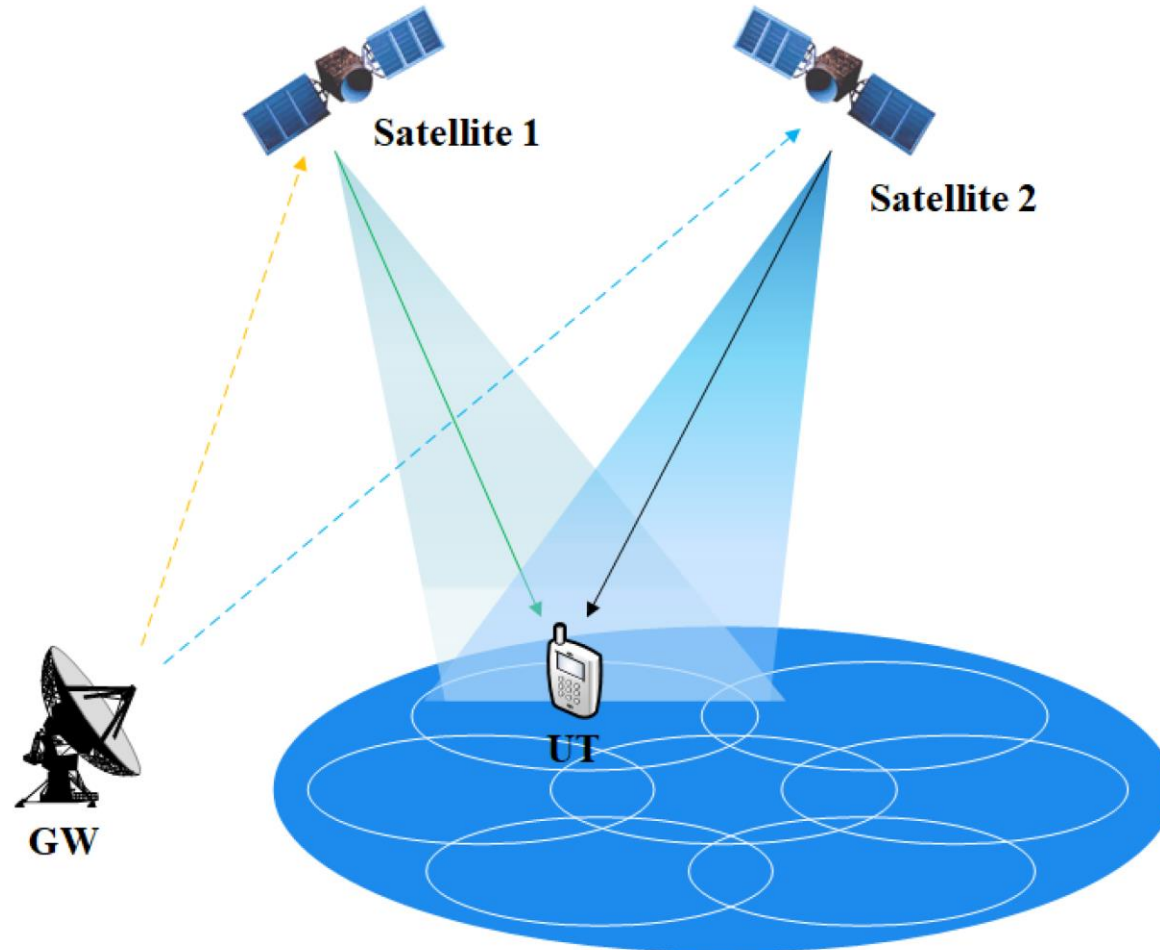
The aim of SVNFO is to improve the **efficiency of the satellite network, reduce latency** times and improve the quality of service for end users.

5. Case study

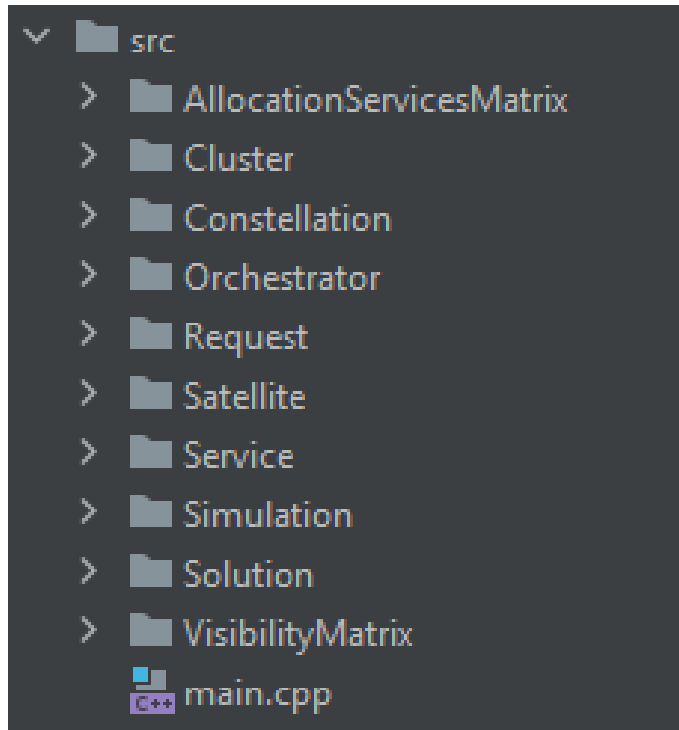
Important goals of the case study:

- Defined the architecture:
 - The satellites and their structure
 - The orchestrator (gateway) and its structure
 - The clusters and their structure
 - Constellation and its structure
 - Services and VNFs
- Create a simulation environment that simulates the space segment, including the satellites VNFs, the Allocation Services Matrix

Example of the environments designed



Structure of the simulation



Constellation are equal at the
total number of TimeSlot = 77
Satellites are 5
Cluster are 8

```

solution = {Solution}
  constellations = {std::vector<Constellation>}
    [0] = {Constellation}
      satellites = {std::vector<Satellite>}
        [0] = {Satellite}
          id = {int} 0
          cpu = {float} 30
          ram = {float} 30
          cpuUsed = {float} 10
          ramUsed = {float} 10
          services = {std::vector<Service>}
            [0] = {Service}
              id = {int} 0
              name = {std::string} "AA"
              cpuUsed = {float} 10
              ramUsed = {float} 10
            [1] = {Service}
          [1] = {Satellite}
          [2] = {Satellite}
          [3] = {Satellite}
          [4] = {Satellite}
          mMax = {int} 5
        [1] = {Constellation}
        [2] = {Constellation}
        [3] = {Constellation}
        [4] = {Constellation}
        [5] = {Constellation}

```

```

clusters = {std::vector<Cluster>}
  [0] = {Cluster}
  [1] = {Cluster}
  [2] = {Cluster}
  [3] = {Cluster}
  [4] = {Cluster}
  [5] = {Cluster}
  [6] = {Cluster}
  [7] = {Cluster}
  services = {std::vector<Service>}
    [0] = {Service}
      id = {int} 0
      name = {std::string} "AA"
      cpuUsed = {float} 10
      ramUsed = {float} 10
    [1] = {Service}
    [2] = {Service}
    [3] = {Service}
    [4] = {Service}
    [5] = {Service}
    [6] = {Service}
    [7] = {Service}

```

And now?

- Implement the optimization algorithm: implement an optimization algorithm that optimizes the VNF allocation based on the objectives and constraints
- Define the performance metrics to evaluate the optimization algorithm, such as the VNF utilization, the communication latency, and the power consumption
- Evaluate the optimization algorithm: run the simulation with different optimization algorithms and evaluate their performance using the defined metrics



Thanks for
listening

References:

CubeSats:

- <https://en.wikipedia.org/wiki/CubeSat>
- https://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/CubeSats

SDN and NFV:

- <https://ipwithease.com/sdn-vs-nfv/>