

## Competitive Assessments for HAP Delivery of Mobile Services in Emerging Countries

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- Introduction – High Altitude Platforms
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- Analyzed architectures
  - Satellite-based backhaul architecture
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- Conclusion

## Introduction – HAPs: examples of form factors

Aerostats, a.k.a. "Lighter Than Air" (LTA)

Aerodynes



Tethered balloons

Aerostats

Unmanned aircrafts

Manned aircrafts

Unmanned Aerial Vehicles (UAV)

### HAPs:

- High Altitude Platforms a.k.a. stratospheric vehicles, generally positioned at 17-22 km altitude.
- Each HAP can cover 60-400+ km wide.
- Expected cost per unit 4-50 M€.

## Context of the study

Targets Mobile Network Operators (MNOs) which:

- Already operate a mobile network in urban zones of an emerging country.
- Seek to expand their networks to a rural zone.

It is supposed that neither the use of a national fiber backbone nor of a terrestrial backhaul are conceivable.

## How to deploy at a reasonable cost a network able to connect a rural population scattered on a large area?

This study assesses the profitability of three architectures with different backhaul solutions and different business roles through an example deployment scenario in a rural region of Uganda.

Preliminary assumptions :

Surface to cover (km <sup>2</sup> )	1800
Penetration rate (subscribers per km <sup>2</sup> )	10
3GPP radio technology	High Speed Packet Access (HSPA)
Number of sites to interconnect	108
Total maximum throughput via the backhaul links (Mb/s)	756

- Note: Only the backhaul-specific equipment is considered for this study. Existing access equipment on the cell sites and aggregation sites, including energy requirements and costs, is excluded from the given estimations and comparisons between the architectures.

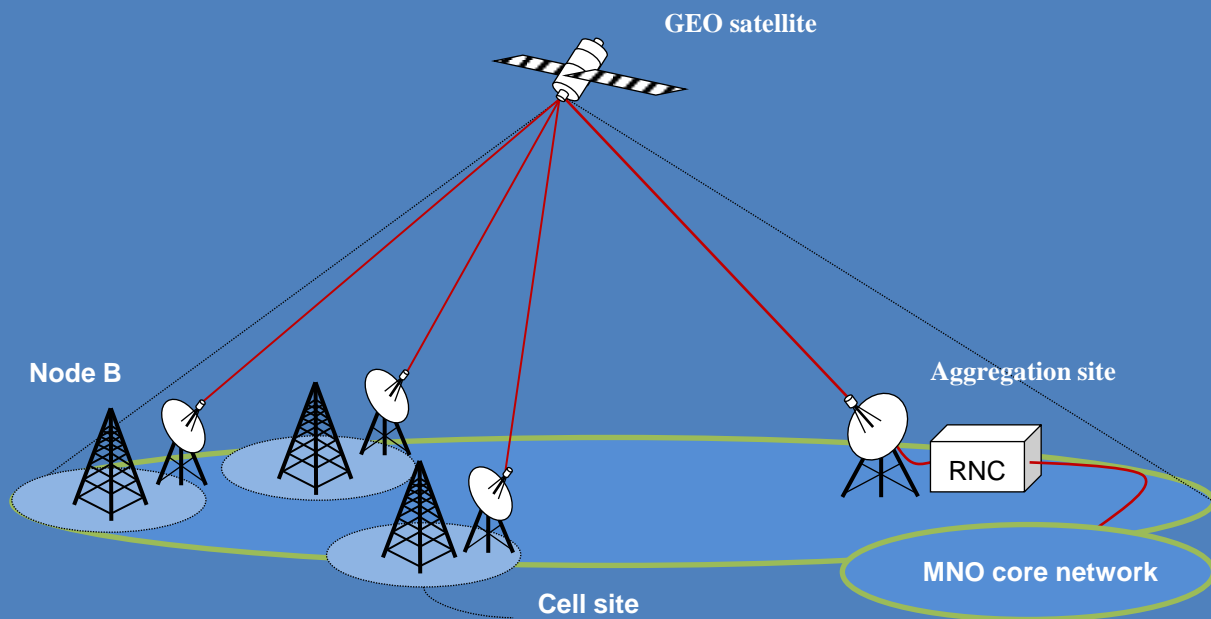
## Architecture 1

## Satellite-based backhaul architecture

Objective: assess the cost to provide a satellite-based backhaul between the cell sites of a rural zone in Uganda and one remote aggregation site.

For each cell site, a link budget was estimated on the basis of several commercial geostationary satellites operating in Uganda in the C band and able to provide:

- Uplink (UL) of 2Mb/s.
- Downlink (DL) of 5 Mb/s.
- 72 MHz transponders.
- A link availability of 99.96%.

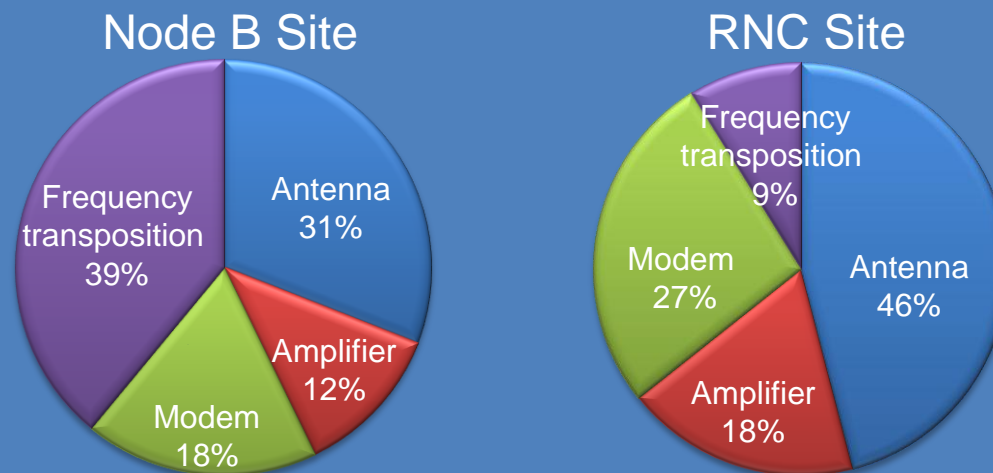


## Architecture 1

This architecture:

- Results in a high OPEX of 11.3 M€ (i.e. 105 k€ per cell site, including the related bandwidth on the aggregation site).
- Is intended to provide a general reference to the HAP-based use cases, which themselves rely on relatively rough level of cost estimations.

## Satellite-based backhaul architecture



CAPEX generated by the backhaul equipment on Node B and RNC sites.

CAPEX per cell site (k€)	50
CAPEX for the aggregation site (k€)	920
Total CAPEX for the backhaul (M€)	6.4
OPEX per cell site plus related fraction of OPEX on the aggregation site (k€)	105
Total OPEX (M€)	11.3

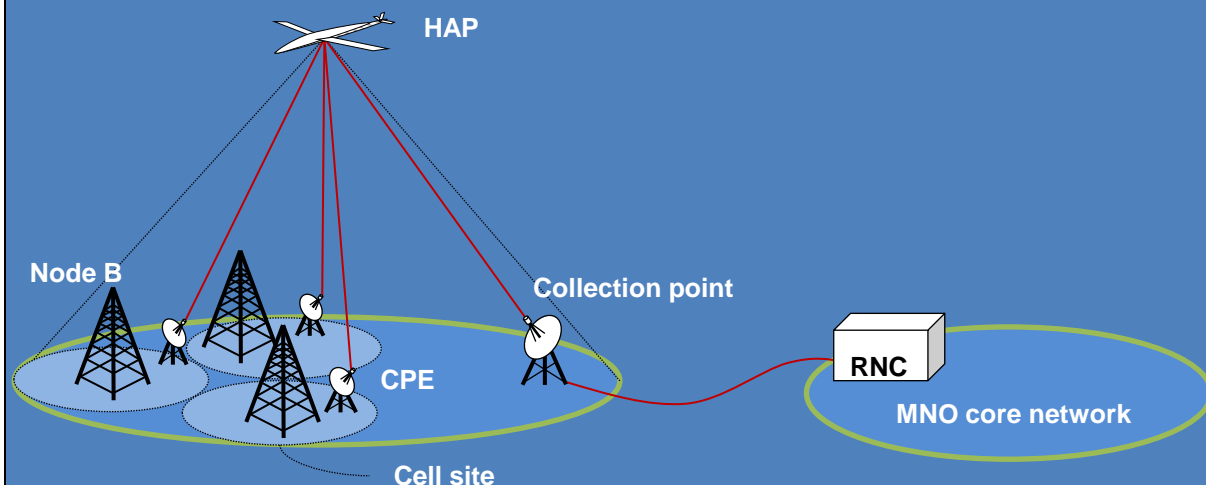
## Architecture 2 HAP-based backhaul architectures single business role

Compared to architecture 1, the MNO, which directly operate the HAP(s), must support the costs of:

- HAP development and acquisition.
- A backhaul from the aggregation site to the RNC.

2 sub-architectures investigated:

- A single-role oriented architecture using unmanned solar planes with fronthaul availability of 99%.
- A multi-role and integrated terrestrial-aerial-satellite architecture using unmanned solar airships with fronthaul availability of 99.90%.



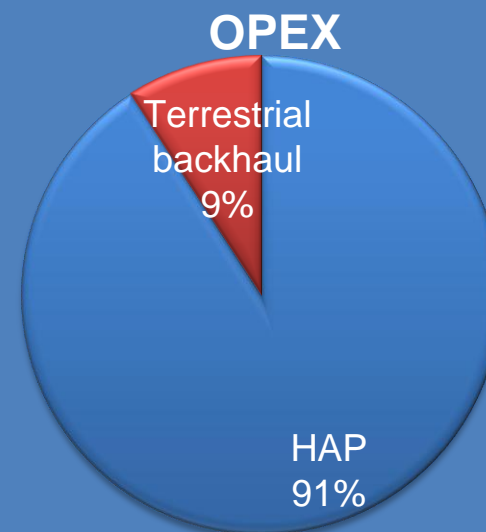
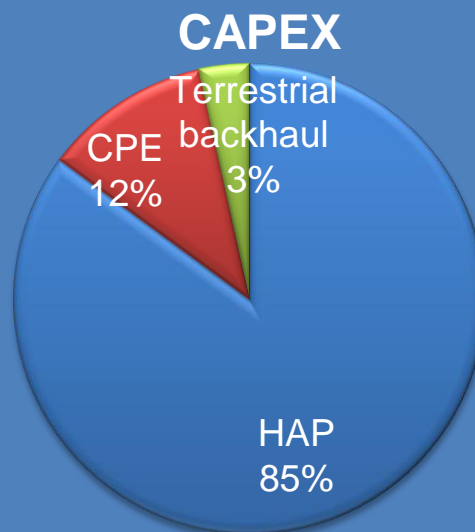
	Unmanned solar plane	Unmanned airship
Number of available cells	18	97
Covered area (km <sup>2</sup> )	2734	2827
Total fronthaul throughput (Mb/s) in clear air	2160	11640
Development cost (M€)	50	225
CAPEX per HAP (M€)	4	30
OPEX per HAP (M€)	1	4

## Architecture 2 HAP-based backhaul architectures single business role

### Results:

- CAPEX and OPEX: Case 2a (use of unmanned planes) is the most favorable.
- The best cost per user per month<sup>1</sup> is attained by case 2a, with about 9.5 €.
- But costs are still high, and case 2a offers the lowest fronthaul link availability.

(1) With a network investment amortized over a 5-year period, HAP development costs excluded.



CAPEX and OPEX generated by the backhaul equipment on Node B and RNC sites. Solar planes are used as HAPs here.

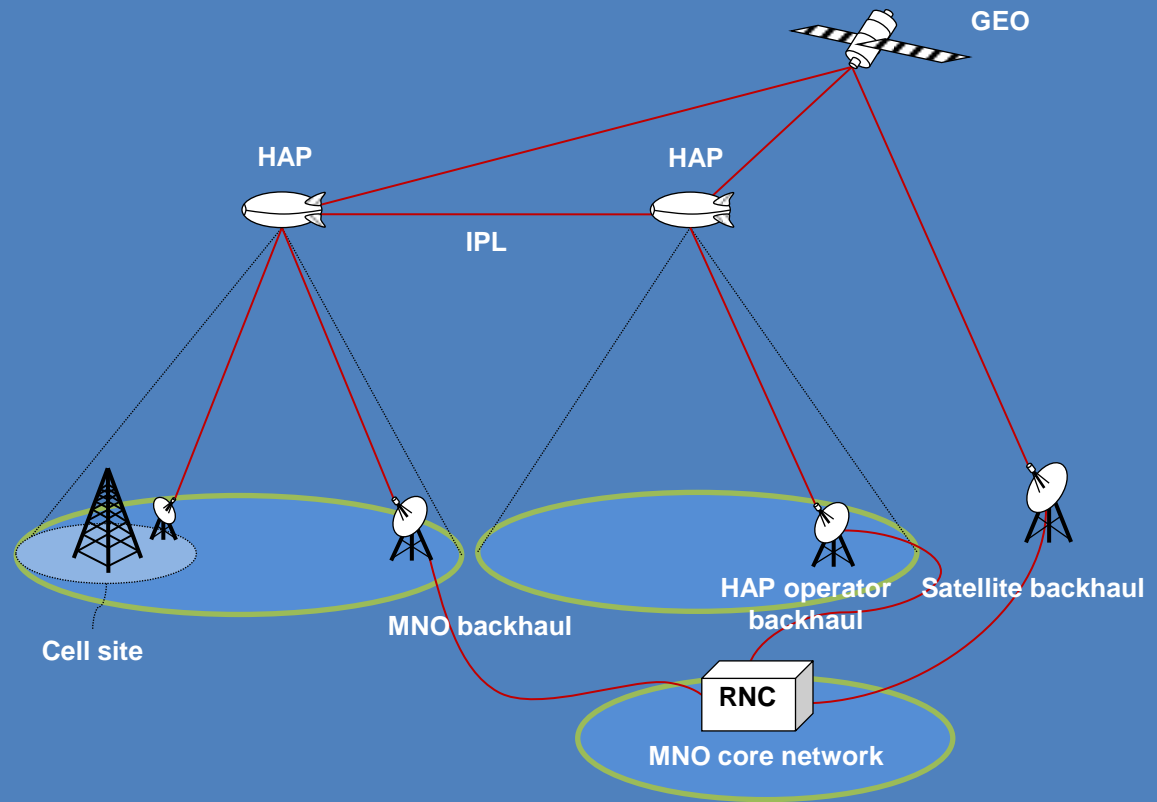
	2a – unmanned plane	2b – unmanned airship
Total CAPEX for the backhaul (M€)	4.7	30.9
Total OPEX for the backhaul (M€)	1.1	4.1



## Architecture 3 HAP-based backhaul architectures multiple business roles

An integrated terrestrial-aerial-satellite architecture with distinct business roles:

- HAP operator - In charge of deploying and maintaining one or several HAPs.
- Service provider – In this case is a MNO operating a mobile network in the considered area.
- Other roles (e.g. satellite operator).



## Architecture 3 HAP-based backhaul architectures multiple business roles

### HAP operator model

- Important initial costs.
- The eventual profitability depends on the openness, neutrality and flexibility of the architecture.

#### Primary concerns:

- The number of service providers being in competition in a given area.
- The ability to provide value-added services (VAS).

As an example of VAS, HAPs can provide valuable functionalities in terms of redundancy and contextual capacity increase for backhauling.

Example of a demand and income forecast:

Year	0	3	6	9
Aerial backhaul link 10 Mb/s	192	164	148	230
Aerial backhaul link 10 Mb/s with high availability	86	172	260	260
Complete backhaul link 10 Mb/s with high availability	86	86	86	86
Platform capacity (%)	63.3	73.5	85.8	100
Income (ex VAT) (M€)	3.7	4.6	5.6	5.9

### Service provider model

- Lighter initial costs supported.
- More flexible choices in terms of link availability and redundancy.

With the projected tariffs, cost per user per month for the example MNO would be decreased down to 2.1 € in the case of architecture 3, for 108 simple aerial backhaul links.

## Conclusion

HAPs can be used as an alternative or complementary fast-evolving technology to provide mobile services in rural areas of emerging countries, where business models need to be carefully tailored to the reality of their related markets. However, Service Providers and MNOs generally have narrow investment perspectives.

### **Keys to a sound business model and long term viable activity for HAP operators :**

- Keep their HAP-based backhaul offers durably attractive for MNOs, in comparison to other technologies.
- HAP technologies should be part of a competitive multi-technology architecture where they are best needed and efficient.
- HAP modular payloads must be carefully designed so as to draw optimal revenue from high value-added services.
- Further increase the performance of the integrated terrestrial-aerial-satellite infrastructure and the profitability of its related business models by introducing Low Altitude Platforms (LAPs) and advanced mobility patterns (e.g. predicted and controlled mobility).

# Business Models for Mobile Platforms

*Access and Competitiveness in Multi-Sided Markets*

# BMMP

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*held in conjunction with*



## Thank you

Laurent Reynaud