TELECOM INFRA PROJECT

Network as a Service (NaaS) Site Economics

TIP White Paper

Network as a Service (NaaS) Solution Project Group

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1

Abstract

Abstract

This whitepaper describes the intricacies and challenges of building a profitable site for ultra-rural and rural areas and how Network as a Service (NaaS) can be an answer to many such challenges. Managing the overall TCO and planning an economically viable solution must be carefully vetted since low population densities and lack of existing infrastructure makes the task of Network Design and Deployment even more complex.

Motivation

The mobile industry is continually investing and innovating to extend the reach of commercially sustainable networks and encouraging new users to benefit from access to mobile internet services and continues to step up efforts to close these gaps and connect the unconnected. Achieving ideal site economics is vital to addressing connectivity challenges and bring more people online.

The key hurdles in extending coverage to some of the remote regions with sparse population are following:

1. **Low User Readiness**: Lack of digital skills and smartphone affordability are prime drivers of connectivity gaps.

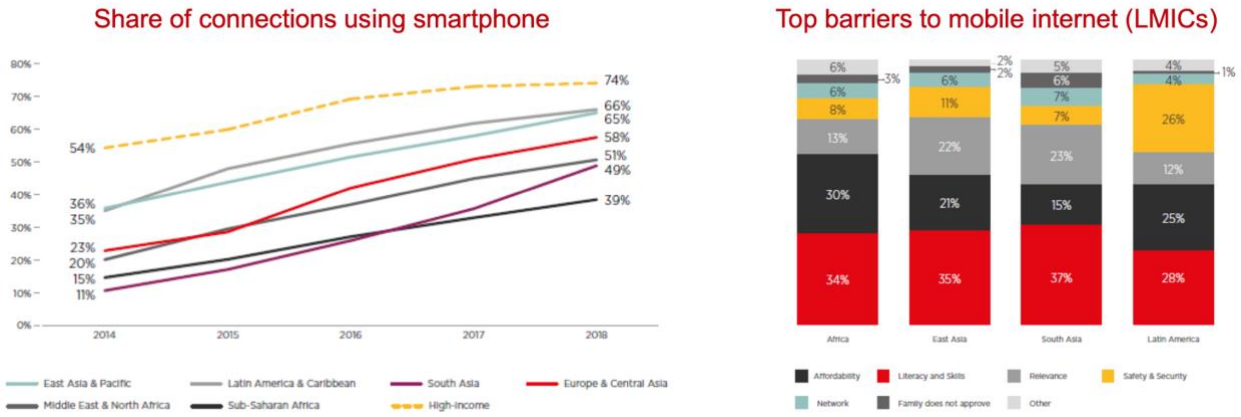

Figure 1: Low User readiness Challenges (Source: GSMA)

2. **High Rural Opex**: Considering a typical rural deployment business plan (5-year period) CAPEX only accounts for 16% of the 5-year TCO with the remainder being Opex expenses. In addition to Network Opex, Non-network costs also form a large portion of the overall Opex (See Figure 7.)

3. **Large and uncertain investments**: Rural and ultra-rural deployment pose a risk to ROI for investors which makes it harder to lure investment for connectivity projects. Innovative solutions with the help of regulatory subsidies can be a way to address some of these challenges.
4. **Population Density**: In rural and ultra- rural areas, serving small communities with dedicated infrastructure is a challenge for each individual MNO. Using Site/RAN sharing technologies, the NaaS model can help to overcome this problem. In this way, multiple MNOs can share the same infrastructure and optimize the business model.

In this whitepaper we will address how NaaS helps in managing high rural Opex challenges and its importance in maintaining overall sustainable site economics.

2

NaaS: Vision and Approach

NaaS: Vision and Approach

The NaaS approach is to create a neutral host cellular infrastructure open to any MNO to extend rural coverage. A NaaS provider helps offset the upfront Capex costs for the MNOs to extend rural coverage and relies on a refined revenue sharing model that mutually benefits both the MNO and the NaaS provider.

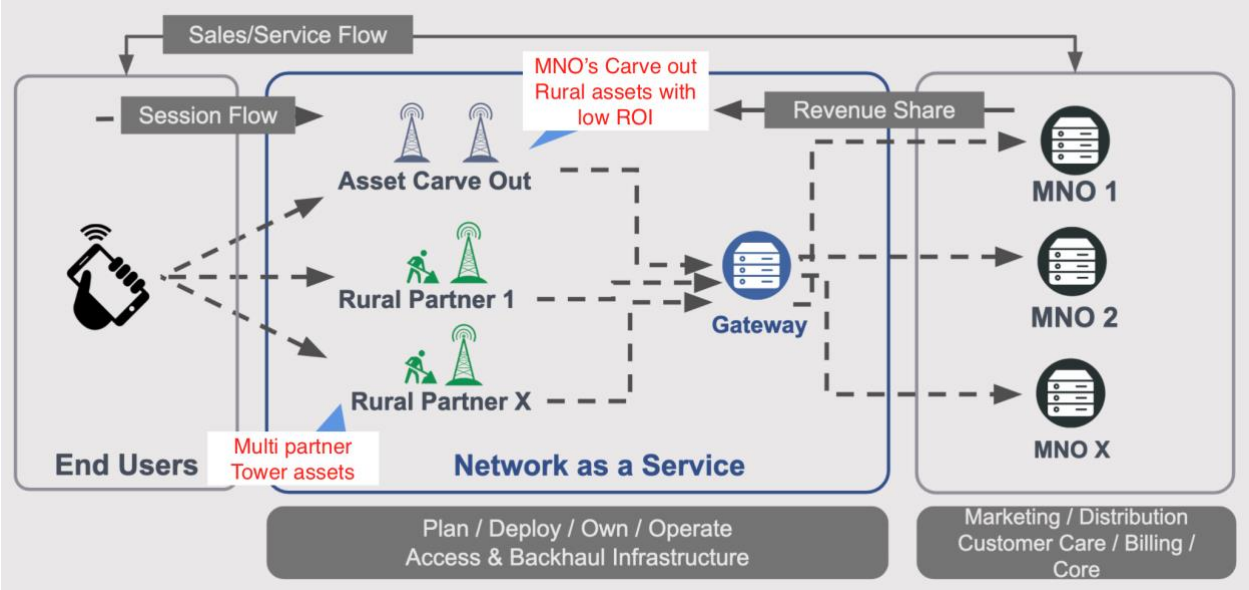

Figure 2: NaaS Concept

NaaS Architecture

NaaS describes a business model in which MNOs own and operate the spectrum, core network, customers, and retail operations. However, the NaaS company owns and operates the RAN network, last mile backhaul, and rural gateway. This simplifies the network operation and overheads of an MNO and helps them focus on their key urban markets with high ROI. The segregation of activities between a NaaS and an MNO is presented in Figure 3 below.

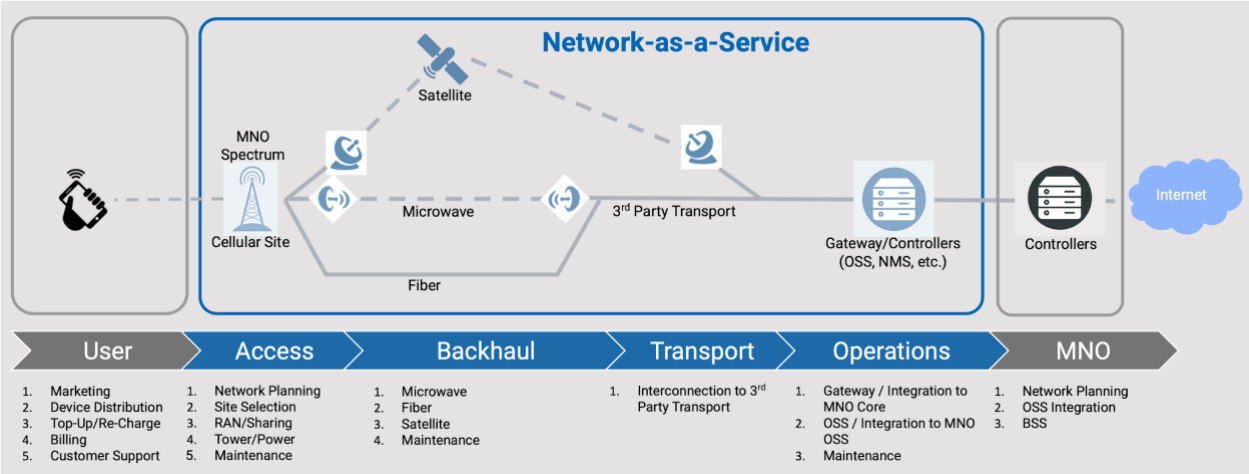

Figure 3: MNO and NaaS Responsibilities

3

NaaS: Strategy Definition

NaaS: Strategy Definition

Strategy and scope definitions are the key and a first step towards building an economically sustainable NaaS infrastructure. The strategy should be aligned with both near and long-term goals while also adhering to the financial resources that are outlined for the objective. Some important considerations that can help define this process are highlighted in the section below.

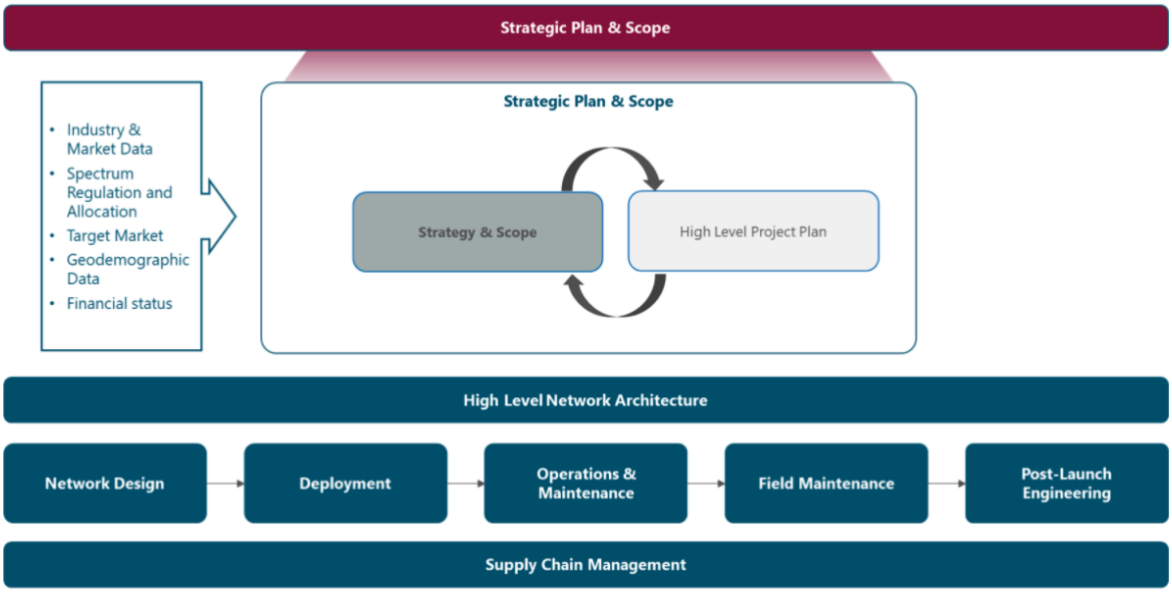

Figure 4: NaaS strategic plan and scope

Enhanced Market Insights

Data analytics can help the NaaS operators enhance the overall value of their business in regard to service optimization, customer satisfaction, and revenues. Data analytics capabilities can help turn enormous structured and unstructured data into actionable customer insights which is valuable input for the network planning and design phase and is a first step towards achieving site economics.

Infrastructure

The biggest obstacle towards providing rural coverage is lack of existing infrastructure to support the set coverage objectives. This is also one of the most important pieces of the strategy definition since it defines how much leverage a NaaSCo will have with MNOs and is also one of the key drivers of how to achieve site economics. There are several cost elements to infrastructure depending on the type of site (Macro, Mini-Macro, Small Cell) selected for the region, which is defined based on the inputs from site planning and analytics.

Spectrum allocation and regulation is also a part of infrastructure strategy. However, in a NaaSCo setup, spectrum is owned by the MNOs. Depending on regulations in the country or countries in which a NaaSCo plans to operate, there are regulatory challenges as well.

Energy dimensioning along with operating and maintaining the infrastructure also needs tactical planning especially in remote regions where several locations are not being served by grid power. Exploring alternative energy sources and optimizing power consumption is equally important while crafting infrastructure plans.

Transport network dimensioning for rural and ultra-rural regions is an equally uphill climb since remote regions often lack availability of terrestrial backhaul solutions and resorting to a non-terrestrial (Satellite) backhaul is the only choice in many such cases.

QoS

User experience can be estimated by inspecting quality of service statistics for the region planned for deployment on the site, this can be based on the existing network data or coverage statistics. These user experience statistics (like throughput, latency, and congestion), averaged over a certain period and aggregated per province, can also be helpful in determining the most representative markets that are under-covered and present an opportunity to build an economically sustainable site.

Demographics

Strategy definition is very well aligned to the region demographics along with the literacy rate and financial status of the region NaaSCo intends to provide service since these factors drive the adoption rate of a new service. Device penetration can also be a factor in regions which are under-connected and under-served to help with the decision-making process of selecting and deploying new technology (2G, 3G, 4G).

Number of Supported MNOs

The higher the number of MNOs supported by using the same infrastructure, the better TCO can be achieved for the NaaS.

4

Site Economics

Site Economics

In the earlier sections, we briefly touched upon NaaS concepts and the vital components essential to the definition of NaaSCo strategy.

In this section, we address the core topic of this paper (Site Economics) by diving further into granular details and presenting an in-depth analysis of how site economics appears in a NaaS network.

Dynamics of Site Economics

Similar to a traditional MNO, the main factors that impact the dynamics of site economics in a NaaS network are Capex and Opex expenses and their proportion to the overall revenue each site generates. However, contrary to a traditional MNO the composition of sites is not standard across a NaaS network. Site build comprises a mix of OEMs, backhaul type, backhaul bandwidth, and other aspects which can cause significant variance to overall site profitability based on the site type, backhaul, and the equipment vendor.

With ever growing needs of capacity expansion and dwindling ARPUs, margins across the telecom space are getting squeezed further. This accelerates the needs of finding innovative and alternative solutions that can help alleviate the margin pressure felt by the Mobile Network Operators (MNOs) across the globe.

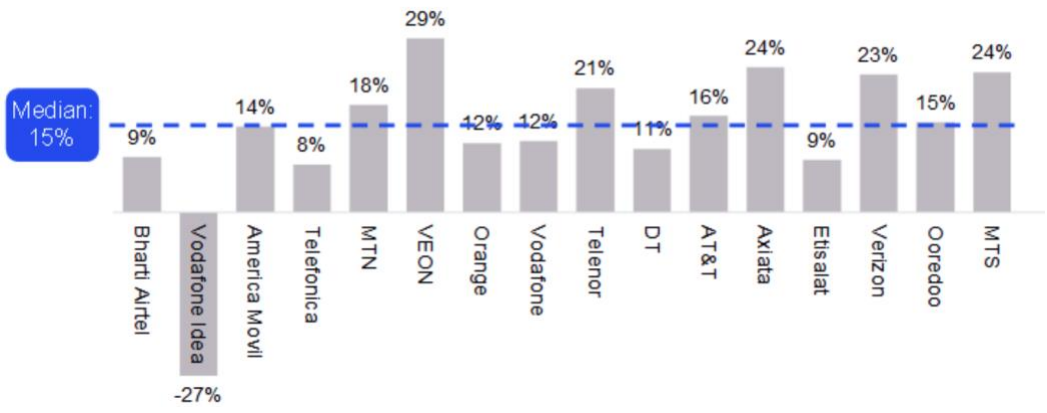

Figure 5: Operating Margins for some major MNOs

Site economics analysis for the NaaSCo can be split in two major areas:

- Capex-Opex/Expenses

- Income/Revenues

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Expenses

Expenses

Site Build (Capex)

Capex decisions are driven by the annual planning process and largely remain insulated from excessive scrutiny at traditional MNO's. Capacity upgrades do account for the large portion of annual capex. The flowchart below illustrates the decision process and segregation for Capex at an incumbent MNO.

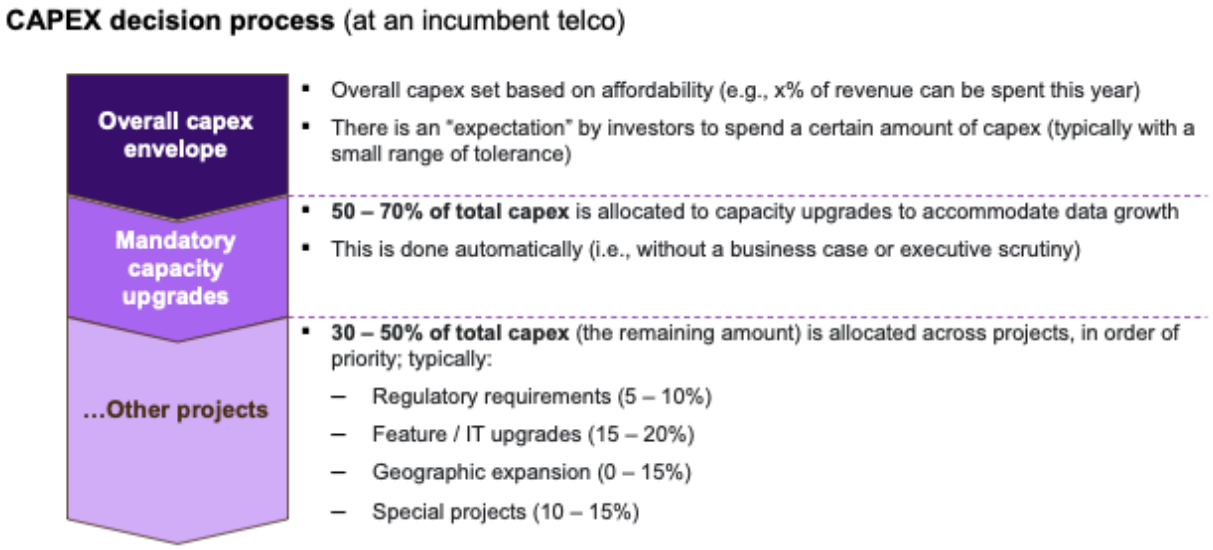

Figure 6: Capex Decision process (Source: McKinsey)

For a NaaSCo, capex decisions are made in a frugal manner and involve in-depth research and insight. In contrast to traditional MNOs, where Capex is mainly driven towards capacity expansion, NaaSCo weighs its Capex more towards coverage expansion, since the major coverage areas under a NaaSCo umbrella are rural and ultra-rural communities where the impact of capacity issues are relatively low. This exercise is performed by planning new site builds (greenfield) that can cover the uncovered regions and boost the coverage footprint to make the NaaSCo infrastructure more enticing for the MNOs to invest in. Adding an overlay of new technology (LTE/5G) on existing legacy sites, along with backhaul upgrades to boost user QoE, is also an area where NaaSCo allocates Capex.

Site Maintenance (Opex)

In a traditional MNO ecosystem Opex costs for a Rural site are the biggest obstacle towards expanding rural

coverage. Overall Opex expenses can be split into two major categories of network and non-network expenses.

- **Network Opex:** Network Opex consists of all the essential network operating expenses associated with the operations of a cell site such as energy, transport, maintenance and more.
- **Non-Network Opex:** HR and management costs form a big portion of non-network Opex. Some key non-network Opex costs are highlighted below:
    - Legal, accounting, and fiscal services
    - Travel expenses
    - Offices and office equipment
    - Overheads
    - Regulatory expenses
    - Marketing expenses
    - Device subsidies

It can be clearly observed from the cost breakup presented in the figure below, which considers a typical rural deployment business plan (5-year period, 5,000 customers & 2.4x RoI), that Opex expenses form the majority of the overall cost for a typical rural deployment.

Capex only accounts for 16% of the 5-year TCO with the remainder being Opex expenses. Non-network costs account for 53% of the overall Opex which includes regulatory fees of approximately 6% which might vary based on geographies.

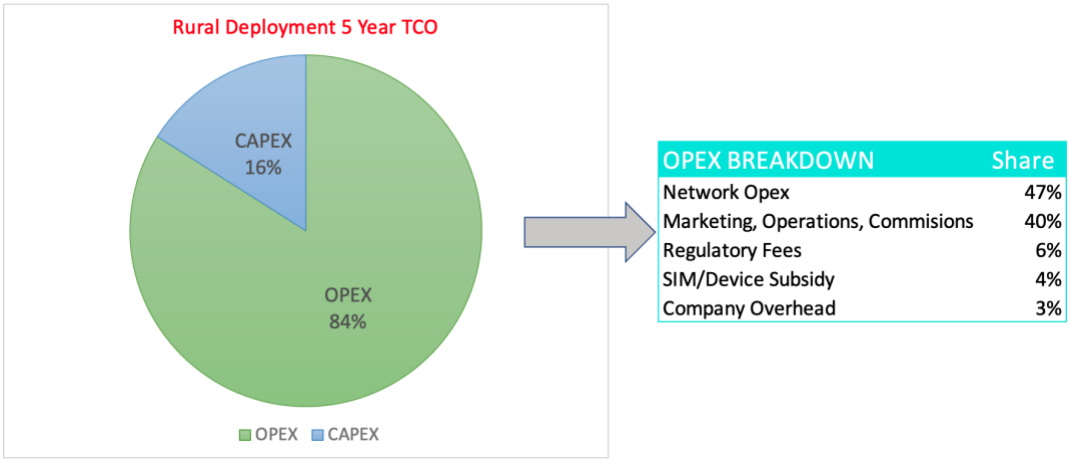

Figure 7: Typical Rural Deployment Cost Breakdown (Source: GSMA)

The above scenario considers 5,000 customers for the rural sites, which might sound very optimistic when you imagine sparsely populated ultra-rural regions with extremely low population density.

How Does a NaaSCo Keep Opex Low?

As highlighted in preceding sections, a NaaSCo acts as a wholesale network service provider for the MNOs. This helps drive the non-network Opex costs significantly lower compared to a traditional MNO. No or low marketing expenditure, negligible or relatively lower regulatory fees (depending on the region of operation), absence of SIM/device subsidies and low company overhead can contribute to the profitability and sustainability of the NaaSCo.

Disaggregated Networks

The network build of a NaaSCo is not like the traditional MNOs, which utilize legacy OEMs that bears the cost of expensive licenses and uses proprietary interfaces that form a closed ecosystem, driving expenses higher. Rather, a NaaSCo deploys a network as an amalgamation of legacy OEMs along with a disaggregated network which supports open interfaces and software that helps keep the overall costs significantly lower.

Transport Backhaul

The primary driver that inflates the Opex costs for a NaaSCo is the transport backhaul. Since this pertains to rural and ultra-rural regions where the access to terrestrial backhaul is limited, the only option to provide backhaul remains satellite. Due to extremely high costs associated with a satellite backhaul, it poses the

biggest challenge in Opex cost management for a NaaSCo.

In the LATAM region, a NaaSCo is exploring innovative ways to solve backhaul problems by harnessing NLOS links with several live links already active and carrying production network traffic. Pioneering such initiatives helps with open reduction in a NaaSCo.

Energy Consumption

With low availability of grid power in the remote areas, managing energy costs is complicated, since these sites run on generators for the most part of the day, which, while expensive, provide the most reliable alternative to grid power.

NaaSCo explores Smart power solutions where a site power can be dynamically adjusted pertaining to network conditions lowering the energy costs and providing operational efficiencies. Small regions, where only a small population needs to be connected, can be covered using low power radios that help optimize and moderate power usage, utilizing solar as the power source.

Company Size

The key to deliver a successful NaaSCo proportion is to keep the company nimble while also keeping the overhead expenses to a minimum.

Based on the study conducted on a LATAM region NaaSCo it is suggested that the overall company size should be proportional to an average headcount of 1 person per 100 sites. This provides the NaaSCo required agility, however, the resources sometimes are stretched too thin and adding contingent resources can be explored during the busy deployment periods.

Income

Total income is a combination of direct revenue and indirect revenue. This section explores the components of revenue for an MNO in order to facilitate comparison to the NaaS model.

Direct Revenue

Subscription revenue, advertisement revenue along with In-app purchases (for operators with digital services) are the direct revenue sources for an MNO.

Top-line for MNOs is relatively simple and consistent across markets & operators. Highlighted below are the most important metrics that are used to track the top-line across the board in both developed and emerging markets.

Beginning Subs + Gross Adds - Churn/Deacts = Ending Subs

Average Subs x Average Revenue per User = Revenue

The basic distinctions that set developed and emerging market MNOs apart are the following:

Developed markets:

- More postpaid subscribers
- Higher cost per gross add (due to potential device subsidies)
- Installment plans for devices

Churn is very important - as subscribers are more likely to remain tied to one operator due to the prevalence of postpaid contracts, installment plans and other factors.

Emerging markets:

- More prepaid subscribers
- Multiple SIM cards
- Bring your own device

Tracking Churn is tricky since subscribers own multiple SIM cards

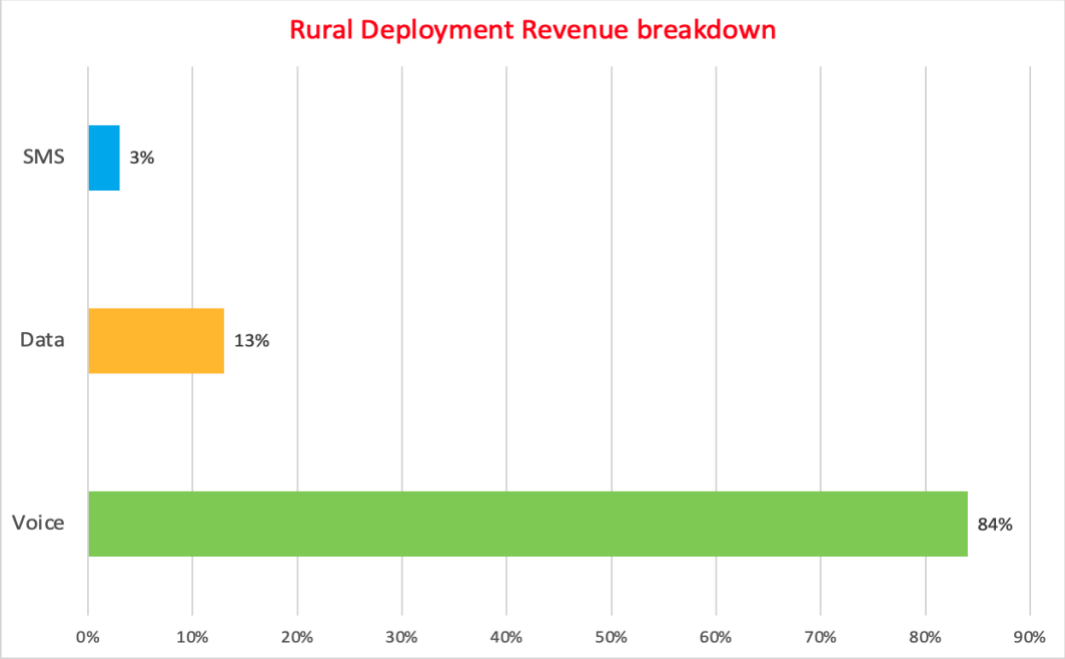

Figure 8: Typical Rural Deployment Revenue Breakdown (Source: GSMA)

Figure 8 highlights the revenue breakdown for rural sites, representative for the emerging market context. In rural markets, 2G services still account for close to 87% of the overall revenue and help subsidize the cost for MBB services. Lack of digital skills and smartphone affordability are one of the major factors contributing to low use of data services.

Indirect Revenue

An MNO can realize an indirect revenue in the following scenarios, however, there are some costs associated with producing indirect revenue which can come in the form of content and subscriber acquisition cost

- Increased MBB user base; Increased Data ARPU
- Churn reduction

Income Components at a NaaSCo

A NaaSCo generates its income from the revenue sharing agreement that it forges with partner MNOs to help them extend their coverage. It is possible for a NaaSCo to support multiple operators by utilizing MORAN (Multi Operator RAN Network) which also helps bring down the overall TCO. Revenue sharing is rather simple where service providers agree on a wholesale bundle cost that gets pegged against the

NaaSCo network usage.

The key elements to a NaaSCo revenue are agreed ARPM (average revenue per minute/erlang) for voice usage and ARPMB (average revenue per MB) for data usage over the RAN network that NaaSCo operates.

Ideally the revenue for a NaaSCo is proportional to the network usage, however, in order to cover for contingencies, the NaaSCo bakes in a fixed minimum network usage commitment from the MNO that helps cover for part of the fixed costs associated with owning the network infrastructure while also addressing variance in network usage based on seasonal traffic.

The outbreak of COVID in 2020 resulted in a significant jump in network usage in the operators across the globe, as lockdowns triggered changes in usage patterns and consumption for many customers. Such unprecedented scenarios placed stress upon network infrastructure and the overall site economics for a NaaSCo, which in turn placed the partnerships between NaaSCos and MNOs under pressure.

Pricing and Tariff Structure

Since NaaSCos generally do not have access to user-based information (due to the lack of access to the Packet Core) the following alternatives can be used to charge services consumed by MNOs:

- Volume based: NaaSCo can charge MNO based on how much traffic is consumed for each service Voice and Data split for 2G, 3G, 4G/5G services.
- Flat rate (CIR-Reserved capacity): NaaSCo can use this model to charge voice services (i.e., 2G).
- Subscriber based: NaaSCo can charge MNO based on a flat rate based on the connected users reserved capacity in the site.
- Combination of volume based flat rate and subscriber-based tariff is also an option

Inherent Risks in the Various Tariff Models

Some of the key risks in the tariff models suggested are outlined below.

Flat rate (CIR - Reserved capacity):

- If consumption exceeds current rate, losses might occur.
- If CIR - Reserved capacity is higher than current consumption, losses might occur (overpaying on backhaul)

Volume based:

- Strict QoS schemas for voice services should be available in the transport network
- HQoS is required when more than two MNO are supported in the network. NaaSCo will require skilled people for fine tuning and rolling out HQoS settings across the network contributing to slightly higher OPEX.

Optimizing Network Efficiency

In order to optimize network efficiency, there are several suggested approaches a NaaSCo can undertake.

- Commercial bundles: Work together with MNO to create particular service packages to encourage better network utilization at nights or during off-peak hours of the network.
- Maintaining network fairness: Bandwidth Management: By managing user capacity via IPs, however, this effort might need some additional hardware deployed in the network that can sniff the data packets.

NaaSCo Opex Breakdown

We reviewed the full year Opex breakup for the year 2020 of a NaaSCo, in the table illustrated below.

Operating Expenses	Contribution to Overall Opex
HR	10.5%
Legal & Accounting services	2.9%
Travel	0.0%
Offices and office equipment	0.5%
Other Public Payments	2.3%
Network costs (RAN + TX)	19.0%
Site Maintenance (Includes items like Power, Fuel, Technician and Misc)	34.4%
Satellite Costs	30.5%
EBITDA	14.6%

The satellite costs to connect remote regions place undue pressure on overall Opex and are as expensive as the network costs (RAN+TX) and HR expenses combined. If a NaaSCo is able to bring the satellite costs down by exploring ways like heavy user throttling and better bandwidth management, there can be significant improvement to the overall EBITDA.

However, with just a few years in operation the NaaSCo is generating an EBITDA comparable to major

carriers and is poised to grow further as the TCO improves.

Summary

MNOs must prepare their network for scale and flexibility that supports exponential increases in network demand, a wide variety of devices and applications, higher data rates, lower latency, and greater power efficiencies – all while maintaining a low cost.

Service providers are keen to explore ways that help offset their Capex and Opex expenses, utilizing a NaaSCo to provide connectivity and extend coverage to sparsely populated and remote regions can be an ideal solution.

6

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Glossary

A

AAA – Authentication, Authorization and Accounting

APN – Access Point Name

Apps – Applications

ACL – Access Control List

B

BA – Behavior Aggregate

BGP – Border Gateway Protocol

BTS – Base Transceiver Station

BW – Bandwidth

C

CBH - Catalyzer Bed Heaters

CBS – Committed burst size

CP – Control Plane

CIR – Committed information Rate

CoS – Class of service

CS – Circuit Switching

CSC – Carrier Supporting Carrier

CSR – Cell Site Router

CSG – Cell Site Gateway

CSPF – Constrained Shortest path First

D

DEI – Discard Eligibility Indicator bit

DHCP – Dynamic Host Configuration Protocol

DP – Data Plane

DSCP – Diff Service Code Point Field/Architecture

E

EBS – Excess Burst Size

EIR – Excess Information Rate

eNodeB – Evolved Node B in 3GGP 4G architectures

EPC – Evolved Packet Core

EVPN – Ethernet Virtual Private Network

EXP – Experimental Bits in MPLS Label

F

FACH – Forward Access Channel

FCS – Frame Check Sequence

FEC – Forward Error Correction

G

3GPP – 3rd Generation Partnership Project

GBR – Guarantee Bit Rate Service

GGSN – Gateway GRPS Support Node

GPRS – General Packet Radio Service

GRE – Generic Routing Encapsulation

GTP – GPRS Tunneling Protocol

GWCN – Gateway Core Network

H

H-QoS – Hierarchical Quality of service

I

IETF – Internet Engineering Task Force

IMS – IP Multimedia Subsystem

IP – Internet Protocol

IpT – Internet Para Todos in Peru

Ipsec – Internet Protocol Security

IS-IS – Intermediate System to Intermediate System Protocol

K

Kbps – Kilobits per second

KB – Kilo bytes

L

LDAP – Lightweight Directory Access Protocol

LBM – Loopback Messages

LBR – Loopback Replay Messages

LTM – Link Trace Messages

LTR – Link Trace Reply messages

LTE – Long Term Evolution (3GPP 4G Architecture)

M

MAC – Media Access Control

MEP – Management End Point

MEF – Metro Ethernet Forum

MetroE – Metro Ethernet Network

MME- Mobility Management Entity

MOCN – Multi Operator Core Network

MORAN – Multi Operator Radio Access Network

MPLS – Multiprotocol Label Switching

Msec – Milliseconds

MSS – Maximum Segment Size

MTU – Maximum Transmit Unit

N

NTP – Network Time Protocol

O

OSPF – Open Shortest Path First Protocol

O&M – Operations and Maintenance

OML – Organizational and Maintenance Link

P

PCH – Paging Channel

PCP – Priority Code Point

PCRF – Policy Control and Resource Function

P Router – Provider Router in a MPLS architecture (Core Node)

PE Router – Provide Edge Router in a MPLS architecture (Edge Node)

P-GW – Packet Gateway

PHP – Per Hop Behavior

Prio – Priority

PTP – Precision Time Protocol

PQ – Priority Queueing

Q

QCI – QoS Class Identifier

QoS – Quality of Service

QoE – Quality of Experience

R

RAN – Radio Access Networks (3GPP 2G, 3G, 4G, 5G, IEEE Wi-Fi)

RACH – Random Access Channel

RBS – Radio Base Station

RED – Random Early Discard

RFC – Request for Comments

RTN – Return Channel, Retro Television Network

RTC – Real time communications

RCS – Rich Communication System

RSL – Radio Signaling Link

RSVP – TE – Resource Reservation Protocol – Traffic Engineering

S

SIP – Session Initiation Protocol

SIP-I – Session Initiation Protocol - Interworking

S-GW – Serving Gateway

SGSN – Serving GRPS Support Node

SFTP – Secure File Transfer Protocol

SLA – Service Level Agreement

Sync – Synchronization

T

TCP – Transmission Control Protocol

3PP – Third Party Product

U

UE – User Equipment

UDP – User Datagram Protocol

V

VoD – Video on Demand

VoIP – Voice Over IP Protocol

VoQ – Virtual Output Queueing

VLAN – Virtual Local Area Network

VPLS – Virtual Private Line Service

VSAT – Very Small Aperture Terminal

W

Wi-Fi – Wireless Fidelity

WFQ – Weighted Fair Queuing

WRED – Weighted Random Early Discard

WRR – Weighted Round Robin

X

X2 – X2 3GPP Interface