



TELECOM INFRA PROJECT®

# Mumbai Suburban Railway Transit

The Urban Neutral Host Success  
Story



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# 1. What is a Neutral Host Network?

Neutral Host Networks (NHNs) are telecom infrastructure systems designed to be shared by multiple mobile network operators (MNOs) and other service providers. These networks are typically owned and managed by a third-party entity (the "neutral host") rather than any one MNO. The primary goal of NHNs is to optimize the use of telecom infrastructure, reduce costs, and enhance service coverage and capacity.



## Key Aspects of Neutral Host Solution

Shared Infrastructure	Multi-Access
Equal Opportunity (Even Playing Field)	Technology Agnostic
Cost-Effective	Third Party Ownership
Scalability	



## Typical Neutral Host Solution Components

<p><b>User Interface</b></p> <p>Allow MNOs to interact with the Neutral Host platform, managing their network services and configurations.</p>	<p><b>Orchestration Layer</b></p> <p>Responsible for service orchestration including VNF instantiation, scaling, and service chaining.</p>	<p><b>Connectivity Options</b></p> <p>Integration with public and private networks, allowing seamless connectivity between centralized resources and on-premises infrastructure.</p>
<p><b>Network Infrastructure</b></p> <p>The physical and virtual network resources that form the backbone of Neutral Host, facilitating data transmission.</p>	<p><b>Virtualized Network Functions (VNFs)</b></p> <p>Software-based network functions like firewalls, routers, load balancers, etc., that run on virtual machines.</p>	

**CloudExtel** has deployed the first fully shared Neutral RAN solution in India at nine extremely high-traffic venues, hosting 2 major Indian MNOs and serving their mobile customers.

TIP acted as a catalyst for CloudExtel’s neutral host operation deployment, including sharing best practices frameworks, deployment playbooks, and fostering ecosystem collaboration.



## 2. The Mumbai Suburban Railway

The Mumbai Suburban Railway system (colloquially known as the Mumbai Local) is operated by Indian Railways across two zonal divisions: Western Railways (WR) and Central Railways (CR). The “fast express” commuter rail corridors on both lines are shared with long-distance and freight trains, while inner suburban services operate on exclusive parallel tracks. WR operates the Western Line and CR operates the Central Line, Harbour Line, Trans-Harbour Line, Vasai–Roha Line and Neral–Matheran, and Panel–Karjat Line. It comprises a total of 150 stations and ~480 KM of track length. The Mumbai Local carries 7 million passengers per day, which is the highest in the world in any transit corridor.

The Western Railway Line in Mumbai extends from Churchgate, the city's business center, to Dahisar, which is the edge of Greater Mumbai, and further to Dahanu Road, covering a total distance of 123 Kms and 37 stations. There are more than 2,900 services per day.



2900+ Services

7 Mn Passengers / Day



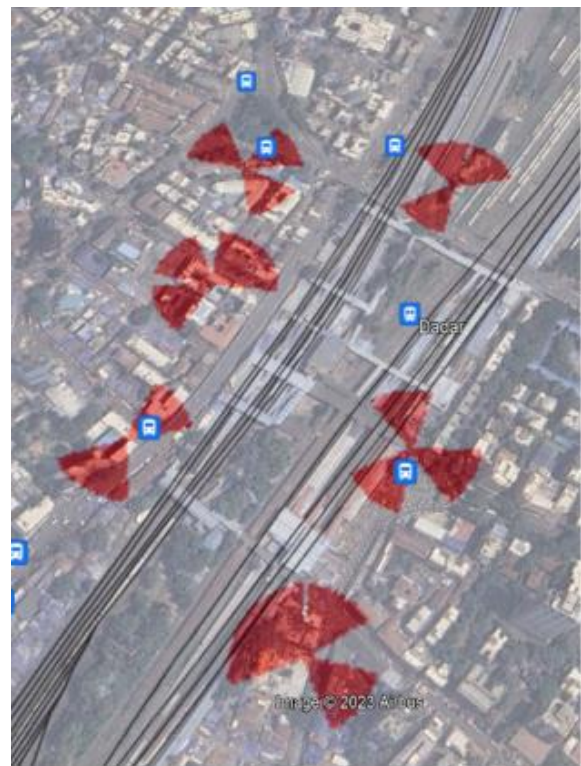
## How were MNOs previously solving the Capacity and Coverage needs at railway stations

MNOs were utilizing their existing sites to provide the coverage and capacity for the platforms from the outside:

- MNOs have deployed Macro Sites near the railway platforms, but the objective of these nearby sites was to also cover adjacent clutter, including road traffic and buildings, not just dedicated to Railway coverage
- 1 or 2 sectors of these Macro sites may be facing the railway stations and may cover 20-30% of the railway platforms each
- However, more than 3 to 4 sites are required to provide coverage and capacity for all the platforms and passenger areas

### Challenges faced by MNOs

- 200x user density at the stations compared to Macro site's typical coverage areas.
- Poor user experience where even best effort web-browsing was not possible.
- Nearby sites are not providing direct coverage to the platforms, resulting in many sectors being required to serve the railway station.
- Poor signal quality on platforms due to multiple signals from these Macro sites, and thus lack of a single dominant server.
- Due to safety, security and limited allowable working hours, Railway authority minimizes permissions to access the premises.



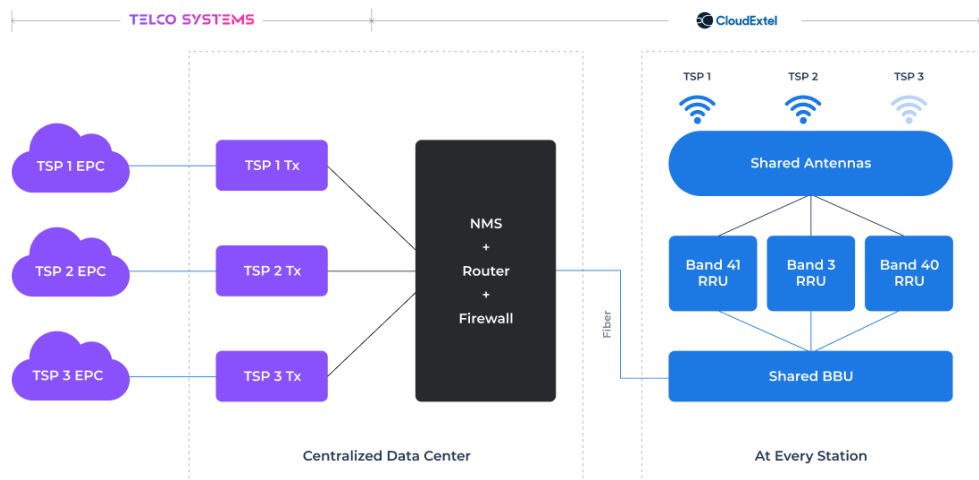
*Sample Coverage Surrounding One of the Larger Stations*



## Benefits of CloudExtel’s Solution Architecture

<p><b>Cost Savings</b></p> <p>Neutral Host Networks eliminates the need for MNOs to invest upfront in hardware, reducing capital expenditures and operational costs.</p>	<p><b>Flexibility &amp; Scalability</b></p> <p>Easily scale network resources based on demand, optimizing resource allocation.</p>	<p><b>Simplified Management</b></p> <p>Centralized management interface streamlines network configuration and monitoring.</p>
<p><b>Environmentally Sustainable</b></p> <p>Shared Active Infrastructure leads to more energy efficiency and results in lower energy consumption, thus reducing carbon emissions.</p>	<p><b>Optimal Space Utilization</b></p> <p>The reduction in space requirement is directly proportional to the number of sharing MNOs, more space saving with higher number of sharing MNOs.</p>	<p><b>New Technology Enabler</b></p> <p>Shared RAN enables upgrades to newer technologies at only an incremental cost. It also enables faster deployment when compared to a traditional MNO rollout.</p>

### Network Architecture





# 3. RF Design | Input and Result

## Assumptions for Design

<p><b>Per User Experience</b></p> <ul style="list-style-type: none"> <li>- 2 Mbps</li> <li>- On average 3 mins waiting time on the platform</li> <li>- Existing throughput at 300 kbps with surrounding macro coverage</li> </ul>	<p><b>Simultaneous Active Users for 3 MNOs</b></p> <ul style="list-style-type: none"> <li>- 3000 to 3500 simultaneous active users</li> <li>- Band 40 = 100%</li> <li>- Band 41= 65%</li> </ul>	<p><b>Antenna Height</b></p> <ul style="list-style-type: none"> <li>- 5 mts</li> </ul>
<p><b>Peak Hour Payload for LTE</b></p> <ul style="list-style-type: none"> <li>- 275 to 300 GB</li> </ul>	<p><b>External Interference Threshold</b></p> <ul style="list-style-type: none"> <li>- -90 dBm</li> </ul>	<p><b>Existing Average signal Quality (SINR)</b></p> <ul style="list-style-type: none"> <li>- ~4 to 6 dB</li> </ul>
<p><b>No. of Passengers</b></p> <ul style="list-style-type: none"> <li>- 2,34,672 (in 14 Hrs)</li> <li>- 29,334 (Peak Hours)</li> </ul>	<p><b>No. of Users (Active Simultaneous)</b></p> <ul style="list-style-type: none"> <li>- 2,250</li> </ul>	<p><b>Data Usage (10 MB / User per Day)</b></p> <ul style="list-style-type: none"> <li>- 290</li> </ul>

Railway platforms to be considered as outdoor since it's quasi open and also must comply with EMF Safety Norms





## Inputs to iBwave and RF Prediction Plots

Design Inputs

iBWave Prediction

RSRP Target ~ 79dBm @95% Area

SINR > 3dB @95% Area

Cell Load < 70%

TDD FrameConfig CFI=format2 SSF=format7

iBwave Results

A. RSRP achieved 96% area with >-79 dBm

B. SINR achieved 97% area with >4 dBm

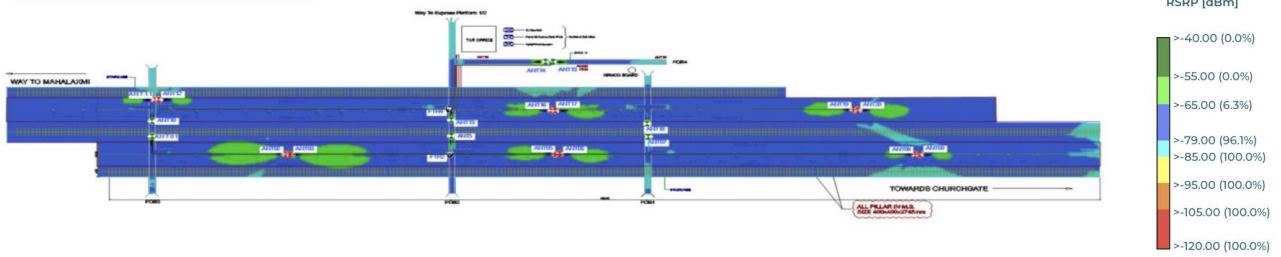
C. MADR for 95% area with 52 Mbps

D. Cell Throughput Supported

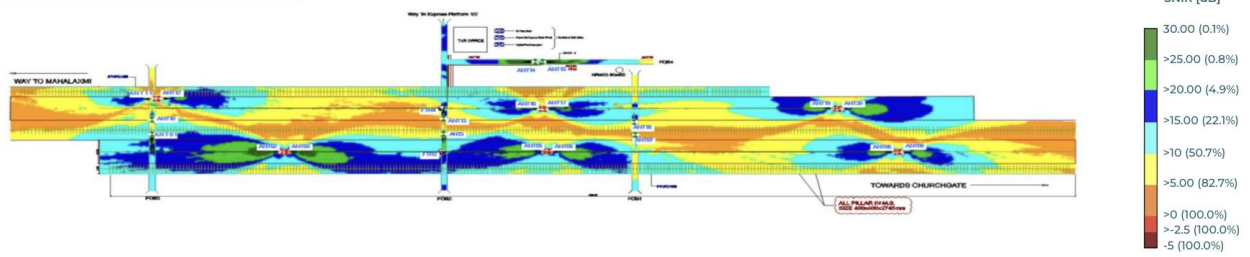
- 10 MHz = 18.33 Mbps
- 20 MHz = 37.54 Mbps



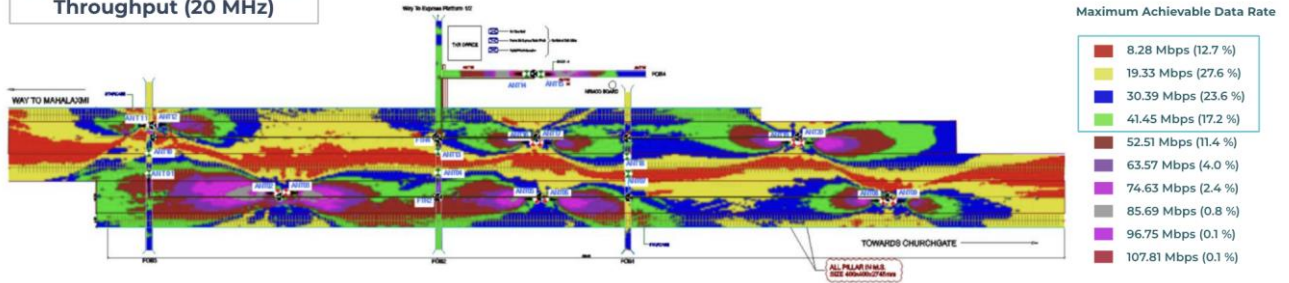
LTE TDD - LTE / LTE RSRP



LTE TDD - LTE / SNIR



Coverage Prediction - Cell Throughput (20 MHz)





# 4. Network Performance & User Experience

## Meeting the SLAs with relevant KPI's

In order to meet the KPIs on the railway stations in a very high dense traffic scenario, it was important to address capacity, user experience, network up-time and handover completion. A combination of all these 4 parameters will be used to monitor the network performance.

Objective	KPI	Peak Hour Threshold
Capacity	PRB Utilization*	75%
User Experience	Average DL User throughput (Kbps)**	>3000 Kbps
Network Up-time	Radio Network Availability	99.9%
HOSR	Inter and Intra ENodeB Handover success rate	>99%

\* With the ever-increasing consumption of data, the performance & KPIs are guaranteed till the PRB utilization is under 75%. Post this which the MNO can decide on adding an additional sector optimizing their total cost of ownership.

\*\* The Average DL throughput per user during peak hours should be more than 3000 Kbps.

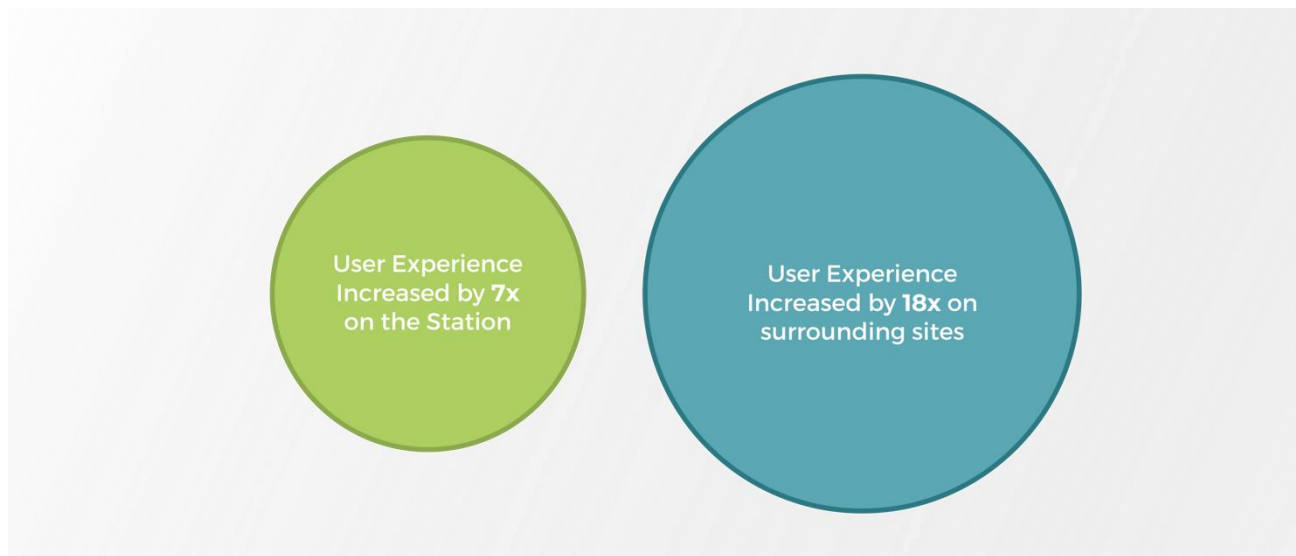


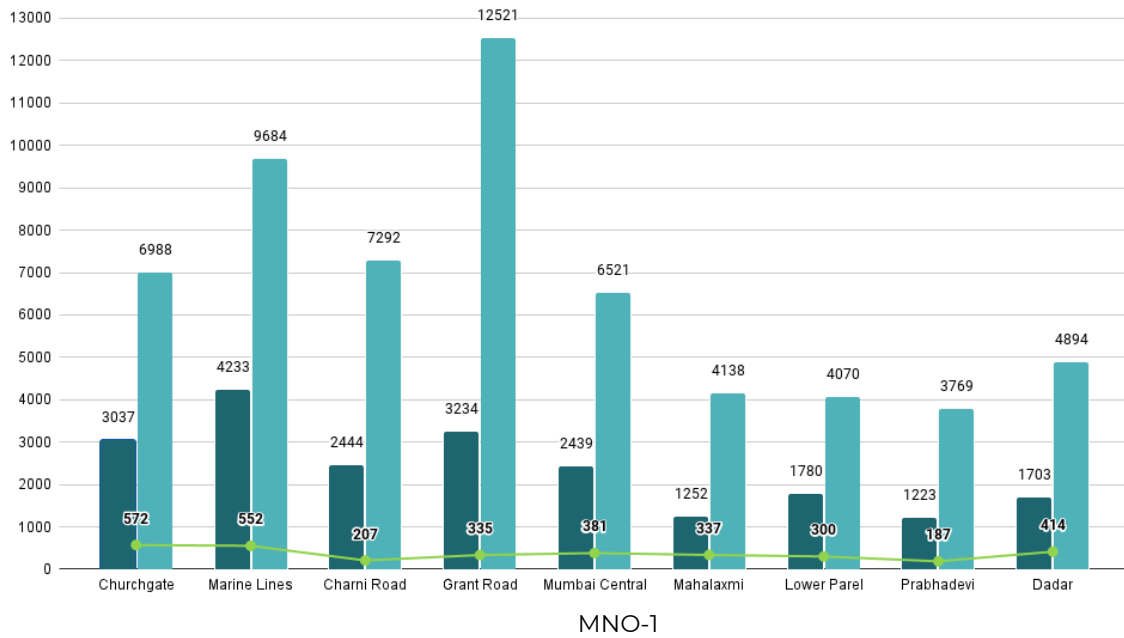
## 4.1 User Experience - Throughput

MNOs were not able to address & provide dedicated capacity on these railway stations. Their current deployment of sites was mainly catering to a larger area surrounding the railway station and hence, hardly any capacity was left for the users on the railway stations. The user experience on the railway station was poor and with best effort the MNOs were only able to deliver throughput of an average of 380 Kbps during busy peak hours.

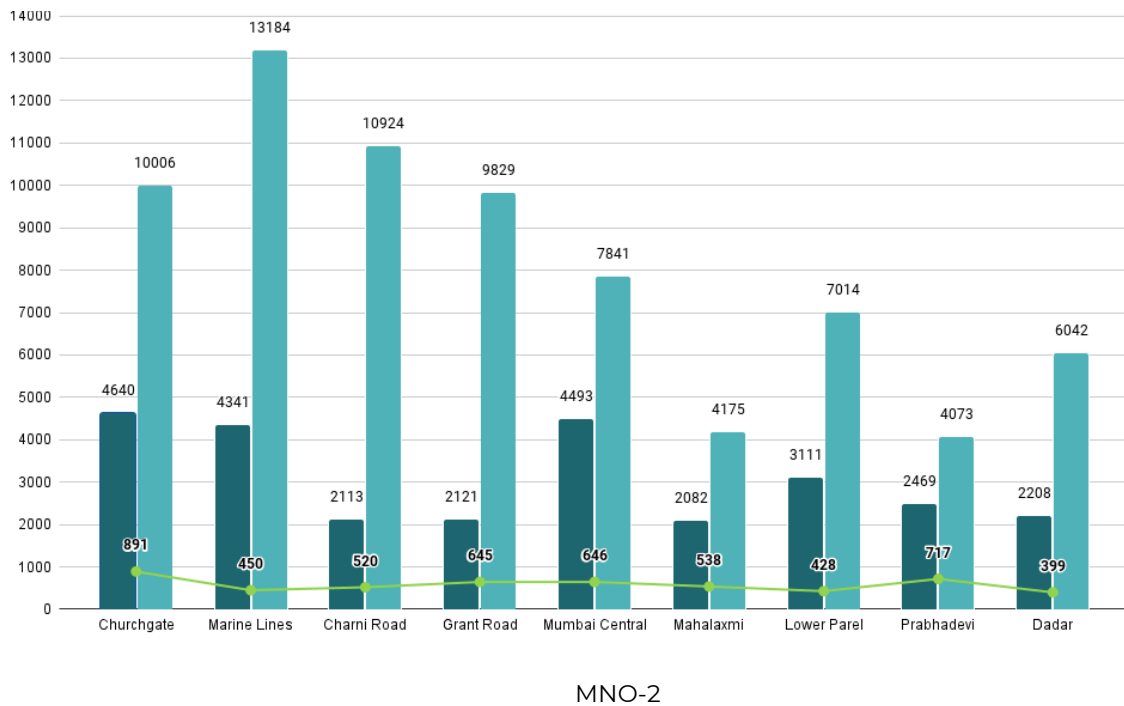
Since the launch of the Shared RAN solution, which is dedicated for the railway stations, the surrounding sites have been offloaded. This has resulted in an 18x improvement from 380 Kbps to ~6.6 Mbps for users attached to those sectors that were previously serving the stations along with the surrounding areas.

On the stations, since CloudExtel we have provided dedicated capacity for LTE, the user experience improved to 1.5 Mbps initially, and with further optimization of the surrounding sites, a throughput of ~2.73 Mbps was achieved, giving a ~7x improvement in user experience on the station.





Throughput-Kbps ■ MNO Pre (Surrounding Sites) ■ CloudExtel Experience ■ MNO Post (Surrounding Sites)



Throughput-Kbps ■ MNO Pre (Surrounding Sites) ■ CloudExtel Experience ■ MNO Post (Surrounding Sites)

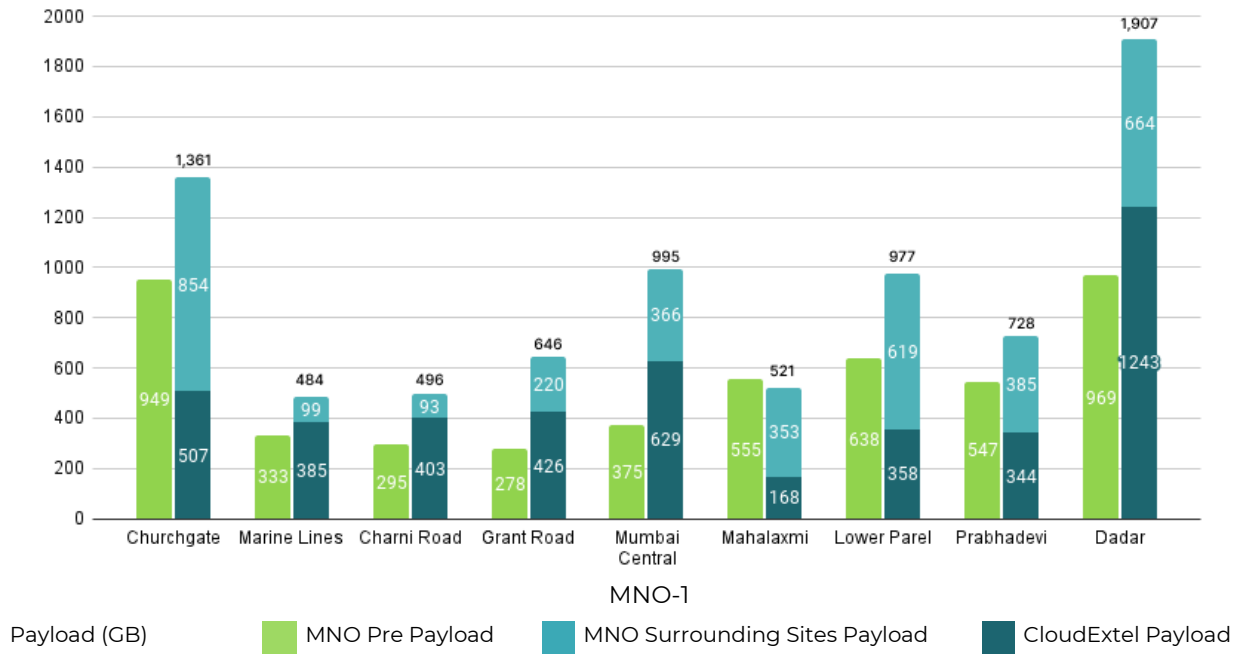


## 4.2 Payload

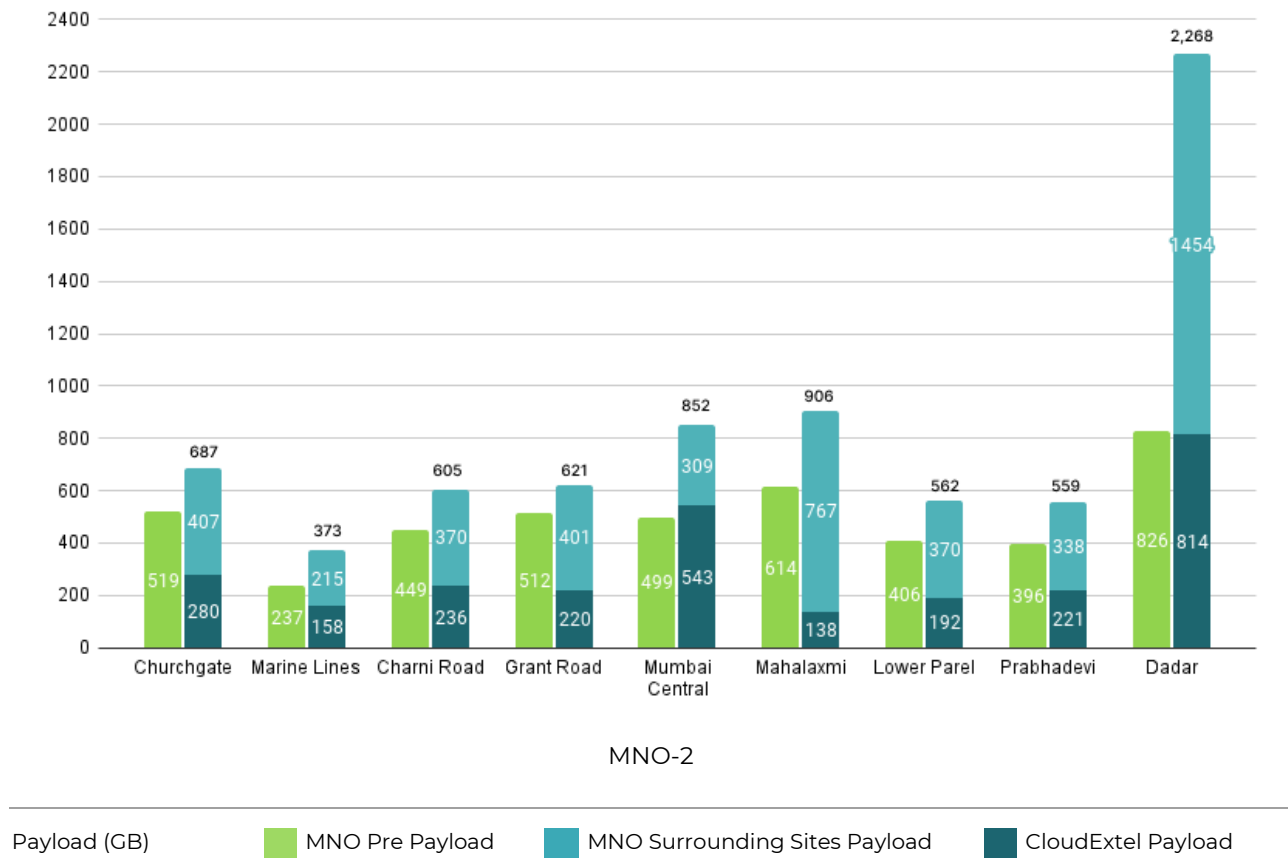
As per the design, CloudExtel launched one dedicated sector per platform providing approximately 300GB per MNO per day traffic, but it was observed that due to high utilization of the radio resources there was a scope of uplifting more traffic on the Shared RAN network. Hence, a sector split was implemented on every radio. The sector split enabled two sectors being served on the same platform, providing doubling of capacity. As a result, more sectors were added into the station which resulted in the traffic to increase by ~2.5x.

The Payload from MNO 1 increased from 4.9 TB to 8.1 TB per day resulting in a 64% increase in traffic. Initially there was a drop in payload due to cannibalization of data, but once the networks were optimized, the overall payload surpassed the initial level and began to grow steadily.

This was only possible by getting closer to the customer, providing a dominant signal which mitigated the impact of interference and ensuring sufficient dedicated and scalable capacity was deployed.



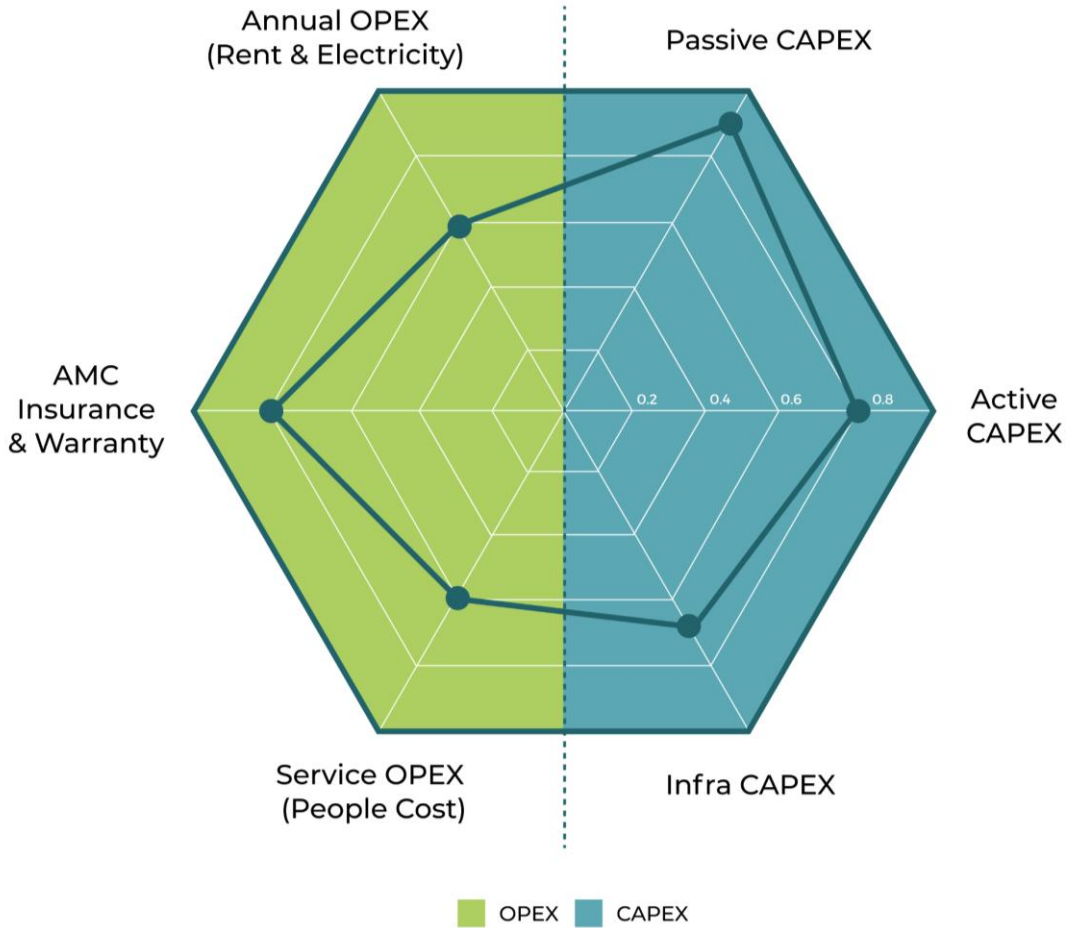
Similar uplift of payload was observed across MNO 2 as well. The payload increased from 4.4 TB to 7.4 TB per day resulting in a 67% increase in traffic. An anomaly was observed at Mahalaxmi station where the overall payload had reduced. Upon deep diving into the KPIs for this station, it was found that the MNO has rolled out multiple small cells in the nearby vicinity resulting in offloading of their macros sites which were serving Mahalaxmi Station.





# 5. TCO, Commercial Model & Uses Cases

## TCO Analysis



CloudExtel has delivered up to ~30% TCO savings due to the Neutral Host approach, making the RAN sharing business model a path breaking approach in modernizing and upgrading the current wireless networks.





The savings that are realized by deploying Active Shared RAN in the manner CloudExtel has designed are as follows

<p><b>Passive CAPEX</b></p> <p>Operating multiple MNOs on a widespread DAS system requires more attenuators and combiners vs in a Shared RAN deployment. The quantity of attenuators &amp; combiners drastically reducing helps in optimizing the passive CAPEX.</p>	<p><b>Infra CAPEX</b></p> <p>Presently all the operators provide dedicated power supply and civil infrastructure to support their dedicated RAN deployment at the same location. With Shared RAN, the need for incremental Electric and Civil infrastructure reduces due to sharing. Single supply source is sufficient to support multiple operators resulting in cost savings with Shared RAN compared to dedicated MNO deployments.</p>
<p><b>Active CAPEX</b></p> <p>Presently all MNOs are deploying their own dedicated Active Infrastructure, leading to duplicate expenditures at high traffic strategic locations. In a Shared RAN, by utilizing shared active equipment, Active CAPEX at such high traffic locations can be reduced. The impact of this to TCO will increase further as Shared RAN deployments achieve higher volumes, thus further reducing the cost of active equipment on a per unit basis.</p>	<p><b>Services OPEX</b></p> <p>In a Shared RAN deployment, the field teams of each MNO are not required to install or service the specific location. Because the Neutral Host is able to complete planning, deployment, I&amp;C and servicing completely independently, the MNOs never have to do a truck roll to send their engineers to site. Furthermore, even data requirements for regulatory filings can be provided by the Neutral Host to each partner MNO. At scale, this will have a significant impact on operating costs.</p>



<h3>AMC, Warranty and Insurance</h3> <p>Similar to the savings that can be achieved on CAPEX through sharing the underlying active equipment, the cost of AMC, warranty and insurance of the active equipment is also optimized through sharing. These items are typically an annual recurring percentage of the capex investment, and thus can be shared across the partner MNOs.</p>	<h3>OPEX (Rent and Electricity)</h3> <p>MNOs operating distinct RAN networks will consume linearly the same amount of power and consume equal amounts of space, each. Through a shared RAN deployment, the combined equipment occupies a fraction of the space and consumes less electricity because of efficiencies from a combined architecture. By using the same active infrastructure to support multiple MNOs, Neutral Hosts can deliver substantial savings in power consumption and rent.</p>
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## Commercial Model

In traditional venue solutions, passive infrastructure providers will only be able to provide passive elements and each partner MNO will be installing its own active elements. This design is purely based on coverage and does not address the capacity for a given location. The Neutral Host has no incentive to upgrade the network for additional capacity, unless they decide to absorb the cost themselves, hence this model is not suitable for railway / transit or other high traffic density hotspot locations.

Furthermore, the traffic pattern of commuters on these platforms are quite dynamic throughout the day, and even through different periods of the year. There is a mix of various complex scenarios including stationary users on the platforms, pedestrian users across the station as well as those crossing over foot-over-bridges, and, the most challenging of all, users that are in motion inside the train as they enter and exit the station at speed.

In particular, at the time of train entry and exit, especially during the morning and evening peak hours, there is very high user density coupled with extremely high handovers from and to the surrounding outside macro sites. This causes a signaling and control channel storm to handle the activity. Because of this dynamic nature, Neutral Hosts faced with such challenges need to apply special design expertise to every location considering the nature of traffic and the capacity required. The proposed commercial model also needs to allow for and incentivize such considerations.

In matured markets the price per GB is very high so a revenue sharing model is a possibility. But in emerging markets like India, the consumption of data is still increasing exponentially and the price per GB is very low, so it would be commercially less attractive for MNOs to pursue a pay per volume model.

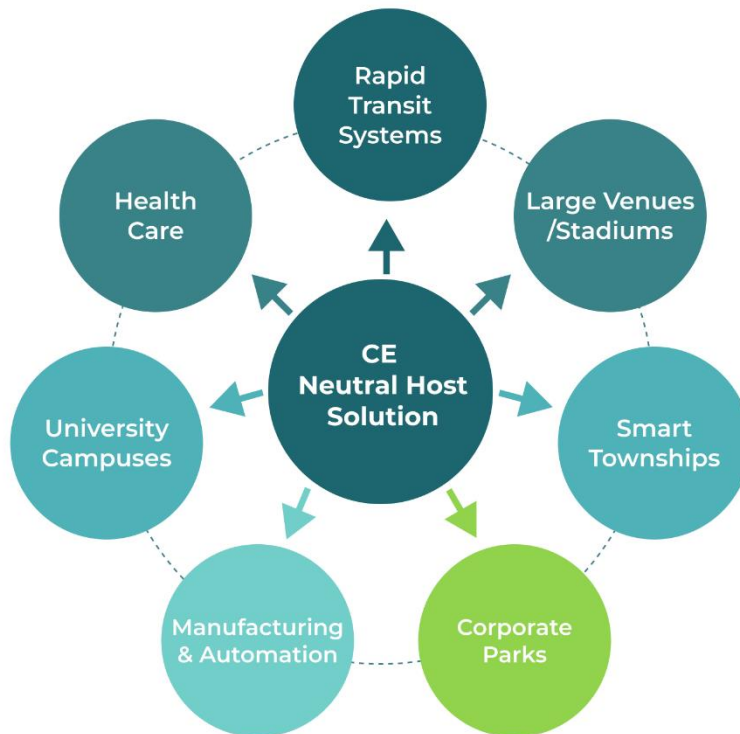
A sector-based approach with a monthly fixed fee makes it a viable solution to achieve the optimum TCO, while allowing MNOs the flexibility to decide when to upgrade capacity vs trading off quality. The monthly fixed fee per sector includes access (rent + electricity), CAPEX recovery, OPEX and O&M matched with SLA's. There is no cost for the MNO above and beyond this fixed monthly fee.

This model creates a win-win for MNOs & Neutral Hosts, allowing each to have control over their own economics while aligning the incentives for each party around quality and cost. The model also delivers a lower TCO while mimicking a pay per volume Neutral Host model.



## Use Cases of Neutral Host Networks

With the above outlined approach, Neutral Host has many benefits like reduction in total CAPEX and OPEX for connecting customers of multiple MNO's, requirement of less space, and increase in energy efficiency, resulting in lower carbon footprint and making the solution more green. This solution can be deployed at any location but is best suited for deployments where high CAPEX and OPEX is required to be invested from each MNO, space and access are limited and /or the challenge of delivering quality, coverage & capacity is very high. Below are a few examples of use cases.





## 6. About CloudExtel & TIP

### About CloudExtel

CloudExtel is India's first full-stack Neutral host provider offering digital infra services such as Small Cell Hosting, Fiber to the Home (FTTH), Intra-City Fiber, & Virtualized Networks. They cater to telcos, ISPs, data centers, enterprises and large content providers to address the challenges emerging from the hypergrowth of data consumption in India.

With a range of pioneering neutral host solutions, they are enabling the densification of 4G networks and accelerating the transition to 5G networks. CloudExtel owns and operates networks that address critical points of network stress, facilitate sharing, & adopt emerging heterogeneous network technologies.

They cater to 20% of partner-deployed small cell requirements of large Mobile Network Operators (MNOs) through 6000+ sites across 475 cities and have deployed over 12,000 kms of fiber in more than 50 cities in India. Under FTTH, CloudExtel has connected more than 850,000 homes passed across 5 cities. They have also deployed the first neutral host Shared RAN network infra in India and are one of less than 10 players globally to have done so.

CloudExtel is associated with the Neutral Host & Infra Sharing Project Group at Telecom Infra Project (TIP) which aims to promote innovative business models, in collaboration among a broad set of stakeholders, to accelerate neutral host connectivity solutions.

In 2023, Macquarie Capital, the corporate advisory, capital markets, & principal investment arm of Macquarie Group, & Advencap, a strategic investor in digital infra acquired a majority stake in CloudExtel to enhance their portfolio of services. In 2024, CloudExtel secured their first external debt from NIIF Infrastructure Finance Ltd. & Aditya Birla Finance Ltd. With a strong backing of institutional investors, they are on the path to Reinventing Digital Infrastructure in India, with enhanced coverage, capacity and speed.



## About Telecom Infra Project (TIP)

The Telecom Infra Project is a global community of companies and organizations working together to accelerate the development and deployment of open, disaggregated, and standards-based technology solutions and open business models that deliver the high-quality connectivity the world needs now and, in the decades, to come.

## About TIP's Neutral Host and Infra Sharing Project Group

The Neutral Host & Infra Sharing Project Group (PG) focuses on advancing neutral host business models for In-Building Solutions (IBS), Outdoor Densification, and Edge Solutions. By fostering collaboration among stakeholders, the PG accelerates the adoption of shared infrastructure, which reduces both CAPEX and OPEX while enabling cost-effective connectivity deployments.

A neutral host operates a shared network infrastructure that service providers use through commercial agreements. This model promotes shared passive and active network components, driving competition and lowering costs in indoor and outdoor urban environments.

The group's vision is to be a global catalyst for neutral host deployment, bringing together neutral hosts, vendors, system integrators, MNOs, policymakers, and other stakeholders to eliminate barriers and promote innovative solutions. With growing momentum from industry leaders, policymakers, and real estate stakeholders, now is the time to join the Neutral Host & Infra Sharing PG and shape the future of connectivity.

### Contact Us

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