Qualcomm

Direct-to-Mobile India Trial

5G Broadcast Technology Validation

Qualcomm Technologies, Inc.

August 2026

Contents

1 Executive Summary

Management takeaway: The Delhi 5G Broadcast trial, enabled through the support of Prasar Bharati, Reliance Jio, Media Broadcast GmbH, Rohde & Schwarz, Sener, Telimart, Motorola, and participating Qualcomm teams, provides a credible field evidence base for India’s Direct-to-Mobile journey. The next decision point is no longer basic feasibility, but the deployment model: HPHT macro coverage, LPLT densification, indoor coverage economics, device readiness, and broadcast-broadband service integration.

1.1 Trial Objective

The Delhi trial was undertaken to inform whether 5G Broadcast can serve as a practical D2M pathway under Indian field conditions. It assessed a mixed HPHT/LPLT deployment model, commercial-ready smartphone reception, CPE-assisted delivery, and broadcast-broadband convergence use cases as inputs to future scale-up decisions.

1.2 Trial Achievement & Findings

- **Operational validation:** Live 5G Broadcast delivery, HPHT/LPLT operation, smartphone reception, CPE-assisted Wi-Fi distribution, public-warning relevance, and service-layer convergence were demonstrated.
- **Coverage insight:** Reception depended on terrain, clutter, building penetration, receiver position, RSRP, SNR, and MCS selection, not distance alone.
- **Planning implication:** HPHT can provide the outdoor macro-coverage anchor, while LPLT densification and selective unicast supplementation are central to indoor and dense-urban service continuity.

1.3 Key Metrics

- **Trial duration:** Live and operational for approximately three months, including drive testing and stakeholder demonstrations.
- **Deployment configuration:** One HPHT site at Pitampura TV Tower and one LPLT site at Rohit House, Tolstoy Road.
- **Operating frequencies:** 578 MHz for HPHT and 570 MHz for LPLT.
- **Transmit power reference:** Approximately 4.6 kW EIRP for HPHT and 47 W EIRP for LPLT.

- **Service configuration:** 720p content delivery with two services and 10% FEC.
- **Application-layer outcome:** Reviewed segment loss was below 1% in the assessed scenario.
- **Planning reference:** Shared HPHT/LPLT coverage predictions used an RSRP threshold of -109 dBm.
- **Indicative HPHT range:** Planning simulations indicated approximate outdoor coverage ranges of 25–30 km at 3 kW, 40–45 km at 5 kW, and 60–65 km at 10 kW, subject to antenna assumptions.
- **MCS planning:** MCS 13 required approximately 11 dB SNR for no-error reception, while MCS 9 required approximately 9 dB SNR, illustrating the trade-off between throughput and robustness.

1.4 Perspective on Scaling

Scaling should be treated as a phased deployment-readiness exercise. Existing HPHT broadcast infrastructure can anchor outdoor reach, while the economic breakpoint between LPLT densification, indoor coverage expectations, SFN planning, MCS robustness, and selective unicast fallback will determine service continuity and city-level rollout viability.

1.5 Go-to-Market Approach

The go-to-market pathway should be phased: first, CPE-assisted service availability and stakeholder pilots; second, high-demand and public-interest use cases such as live sports, linear channels, venue casting, emergency alerts, education, and public-service media; and third, broader adoption as native device readiness matures. A hybrid broadcast-unicast model can reduce adoption risk while enabling ecosystem learning.

1.6 Make in India Approach

The next phase can support Make in India objectives through local antenna and RF component design, domestic deployment engineering, Indian coverage-planning tools and expertise, test and certification capability, and participation by local device, CPE, infrastructure, and service partners. This can help convert D2M from a technology trial into an India-relevant industrial and standards-aligned deployment opportunity.

The Delhi evidence supports continuation toward a controlled scale-up phase, preferably in another dense urban environment, with clear success metrics for indoor coverage, service continuity, MCS configuration, LPLT economics, and hybrid broadcast-unicast operation.

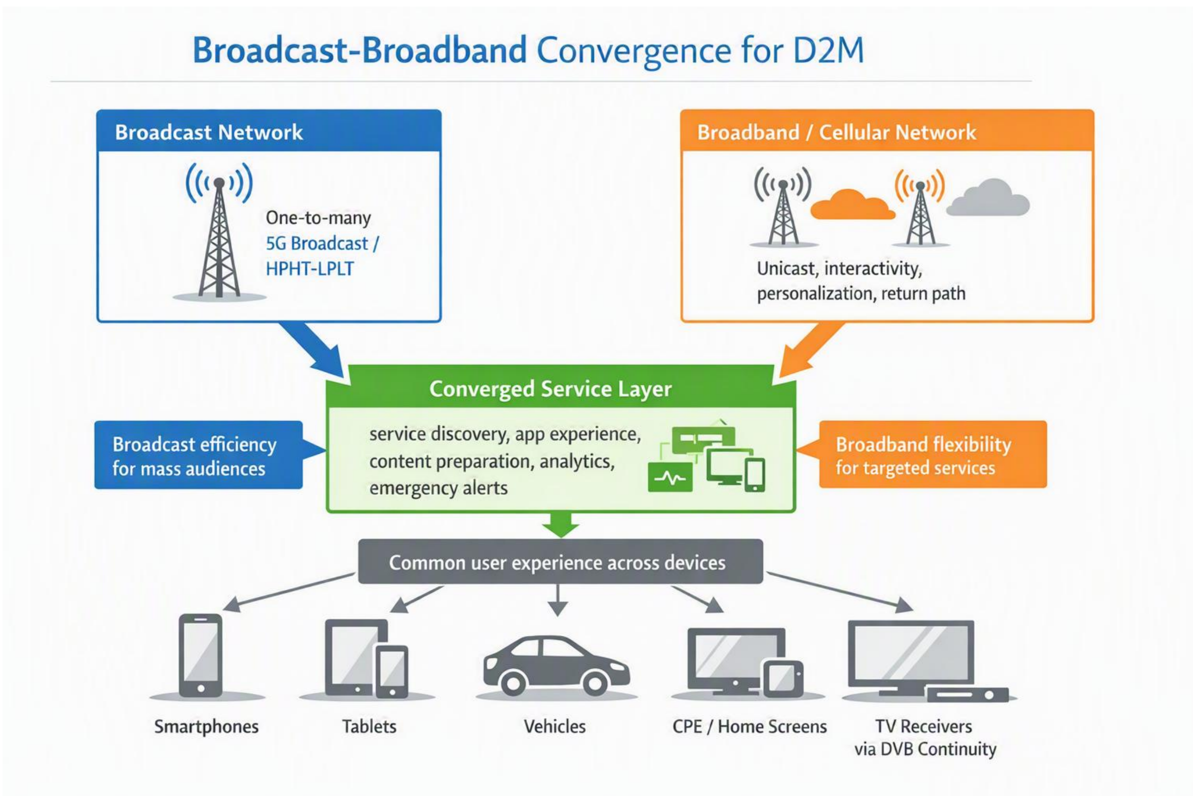
2 Strategic Context and Rationale

2.1 Why the D2M decision matters now

India's D2M discussion is no longer a narrow technology evaluation. It sits at the intersection of broadcast modernisation, spectrum strategy, mobile consumption patterns, and industrial policy. The 5G Broadcast trial in Delhi provided field evidence at a time when India was examining credible and scalable pathways for future Direct-to-Mobile services.

The strategic question for India remains how terrestrial media delivery can evolve in a mobile-first, 5G-centric environment. 5G Broadcast was relevant to that discussion because it aligned broadcast delivery with the device, chipset, standards, and operational logic of the broader cellular ecosystem. This alignment is important in a market where long-term scale, handset integration, interoperability, and deployment economics are central considerations.

Figure 2-1: Broadcast-broadband convergence for D2M. The figure illustrates the convergence model assessed through the Delhi trial: broadcast networks provide efficient one-to-many delivery for mass-audience services, while broadband and cellular networks provide unicast flexibility, interactivity, personalisation, analytics, and return-path capabilities. A common service layer can combine these capabilities for smartphones, tablets, vehicles, CPE, home screens, and legacy TV continuity. This convergence is central to the D2M opportunity because it allows India to evaluate 5G Broadcast not as an isolated broadcast technology, but as part of a broader media-delivery architecture aligned with 5G-era devices and services.



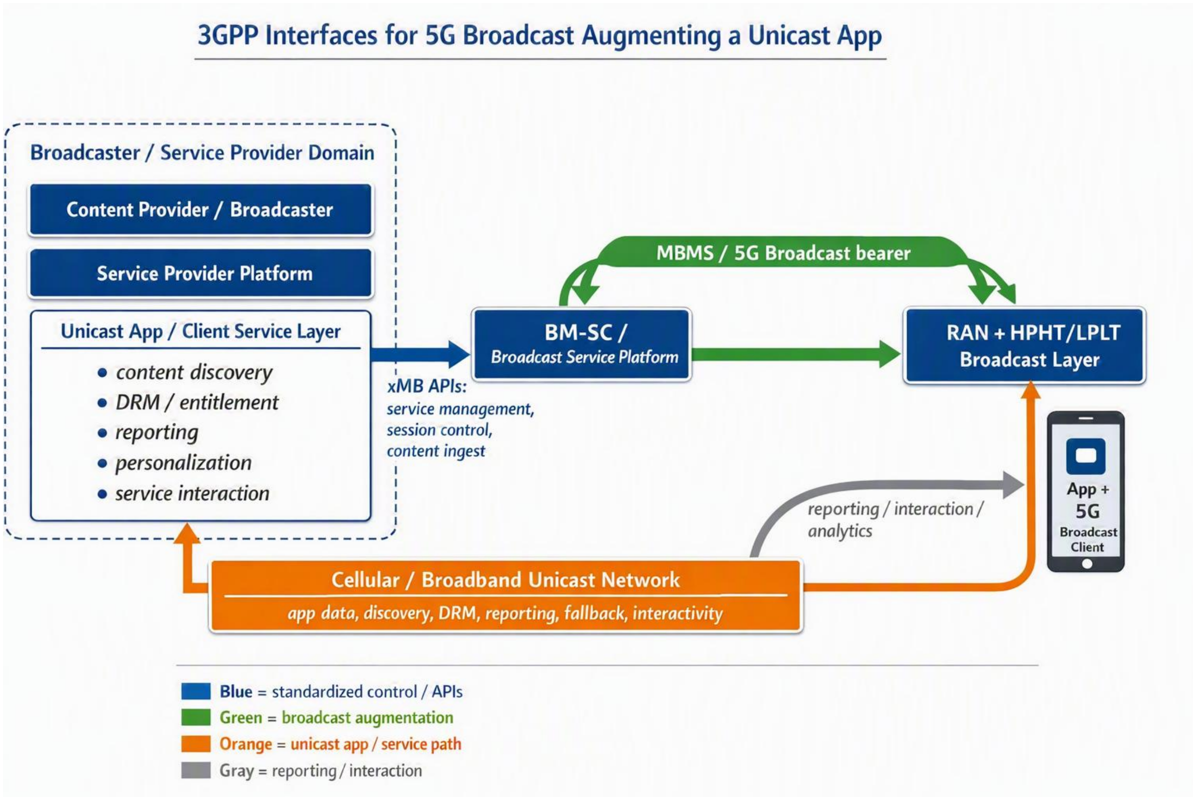
2.2 Why 5G Broadcast is a strong strategic anchor

5G Broadcast is a broadcasting technology designed to reuse cellular modem hardware and has been standardised in 3GPP since Release 16. It supports features relevant to broadcasters and public-service use cases, including HPHT deployments, operation without a SIM card, UHF spectrum support, fixed reception, public-warning capabilities, and convergence with unicast and interactive services. This combination allows 5G Broadcast to be assessed not only as a broadcast waveform, but also as a potential platform for broadcast-broadband convergence supported by a global standard and device roadmap.

In the Indian D2M context, 5G Broadcast merited careful consideration because it combined broadcast efficiency with mobile ecosystem compatibility, operational flexibility, and a long-term standards roadmap. The Delhi trial was significant because it allowed this proposition to be assessed under Indian field conditions rather than only at the level of technical principle.

A further strength demonstrated by 5G Broadcast was that its interworking with cellular did not depend on proprietary integration alone. The 3GPP framework included standardised service-layer and northbound interface specifications for MBMS and 5G Broadcast, including xMB-based APIs and associated media-delivery protocols, which allowed content providers, broadcast service platforms, and cellular network functions to be integrated through defined reference points. This mattered for D2M because it supported hybrid broadcast-unicast service models, service discovery, content preparation, consumption reporting, and potential unicast fallback or supplementation using interfaces aligned with the broader cellular ecosystem. In practical terms, the availability of standardised interfaces lowered integration risk, improved vendor interoperability, and gave India a clearer path to combine HPHT/LPLT broadcast coverage with cellular service-layer capabilities as D2M moved from trial validation towards scalable deployment.

Figure 2-2: 3GPP interfaces for 5G Broadcast augmenting a unicast app. The figure reflects the typical service architecture in which the broadcaster or service provider already operates a platform and app over unicast. Functions such as content discovery, DRM and entitlement, reporting, personalisation, analytics, and service interaction remain primarily in the broadcaster/service-provider domain. 5G Broadcast then augments this app and service platform through standardised xMB APIs, session-control functions, and broadcast bearer delivery towards the HPHT/LPLT layer. This distinction is important for D2M because 5G Broadcast is not a replacement for the app or unicast service layer; it is a scalable broadcast delivery augmentation to an existing service-provider platform.

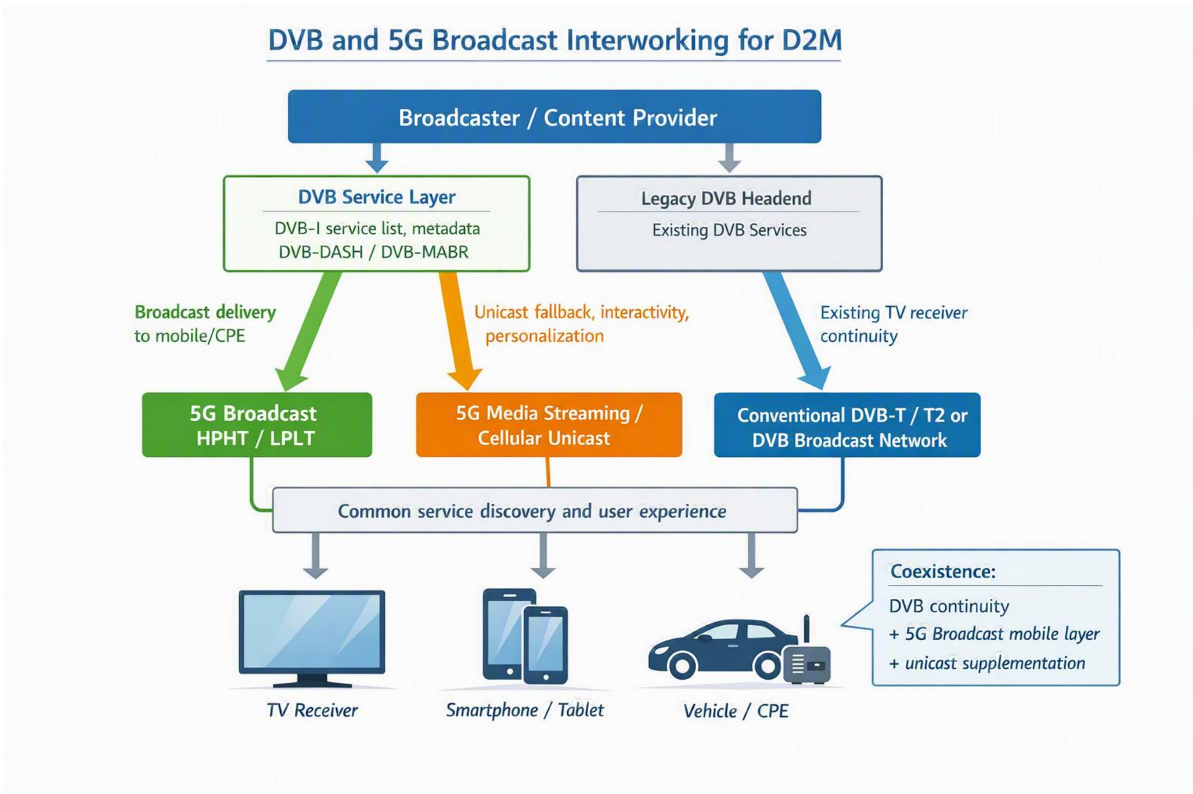


2.3 Why coexistence with DVB strengthens the D2M pathway

The Delhi trial also showed that 5G Broadcast does not need to be evaluated as a binary replacement for existing DVB-based broadcasting. Instead, the trial evidence supports a coexistence model in which 5G Broadcast can serve as a complementary mobile-centric delivery layer, while DVB infrastructure, service definitions, and content workflows continue to support existing television receivers and established broadcast obligations. This outcome is important for India because it reduces transition risk and allows D2M to evolve without forcing a premature replacement of legacy broadcast assets.

The strategic value of this coexistence is strongest at the service layer. DVB-I and related IP-based service approaches can provide a common framework for service discovery, presentation, and user experience across different delivery paths. In such a model, conventional DVB delivery can continue where it is most appropriate, while 5G Broadcast becomes an additional standardised transport option for mobile and connected devices. This gives broadcasters and service providers a pathway to preserve service continuity while progressively introducing 5G-era capabilities such as mobile reception, broadcast-unicast convergence, and service-layer interworking.

Figure 2-3: DVB and 5G Broadcast interworking model for D2M. The figure illustrates how DVB-I and related DVB IP delivery approaches can provide a common service-discovery and presentation layer across conventional DVB delivery, 5G Broadcast, and cellular unicast or 5G Media Streaming. In this model, existing DVB services can continue to serve television receivers, while 5G Broadcast provides the mobile and CPE delivery layer and unicast supports fallback, interactivity, personalisation, or residual coverage gaps. This interworking model reinforces the Delhi trial outcome that DVB continuity and 5G Broadcast adoption can proceed together rather than as mutually exclusive choices.



At the network and spectrum-planning level, coexistence was better viewed as a managed migration question rather than a technology conflict. 5G Broadcast could be introduced through HPHT and LPLT configurations in broadcast spectrum, with channel planning, guard conditions, transmission parameters, and coverage objectives designed around national deployment priorities. This allowed India to evaluate phased approaches by geography, service, or use case, instead of assuming that all DVB services had to be displaced before D2M could progress.

From the trial perspective, DVB coexistence strengthens rather than weakens the 5G Broadcast deployment case. It allows India to protect existing broadcast investments while using 5G Broadcast for the incremental use cases that are most relevant to D2M: smartphones, tablets, vehicles, CPE, emergency warning, live-event offload, public-service media, and other mobile-first services. The Delhi trial and proposed Mumbai follow-up therefore function as evidence-generation exercises for a phased national roadmap in which DVB continuity and 5G Broadcast adoption can proceed together.

3 Trial Objectives

The Delhi phase was designed to answer a focused set of questions on deployment architecture, coverage, rollout economics, ecosystem readiness, and service viability. A central objective was to distinguish the complementary roles of HPHT and LPLT: HPHT was expected to provide the outdoor macro-coverage anchor, while LPLT was expected to strengthen indoor, dense-urban, and hotspot coverage. Therefore, preparation of coverage-prediction maps for HPHT and LPLT, including SFN planning and interaction between sites, was treated as an essential exercise for translating the trial into a realistic D2M deployment roadmap. The core objectives were as follows:

- Assess private broadband service participation in broadcast-enabled delivery models by combining an LPLT footprint with existing HPHT broadcast infrastructure.
- Establish the outdoor coverage value of the Pitampura HPHT site and the role of a single LPLT site in central Delhi as inputs to wider D2M planning, including the extent to which LPLT can improve indoor and dense-urban service continuity.
- Estimate the infrastructure mix needed for D2M scale-up, including HPHT macro coverage, LPLT densification for indoor coverage, SFN requirements, and the LPLT or unicast support needed to address residual coverage gaps.
- Generate evidence on rollout CAPEX, infrastructure and device-OEM readiness, and the broader commercial viability of D2M in India.
- Assess whether the economics of LPLT network deployment can support indoor-coverage expectations relevant to D2M scalability, since indoor reach is expected to materially influence mass-market service experience and commercial viability.
- Demonstrate public-interest and service relevance through broadcast-broadband convergence, emergency warning message delivery, 5G Broadcast reception on commercial-ready smartphones and CPE-assisted Wi-Fi delivery, and DVB service delivery.
- Create a credible evidence base to inform next-phase decisions by Prasar Bharati, government stakeholders, and the wider ecosystem.

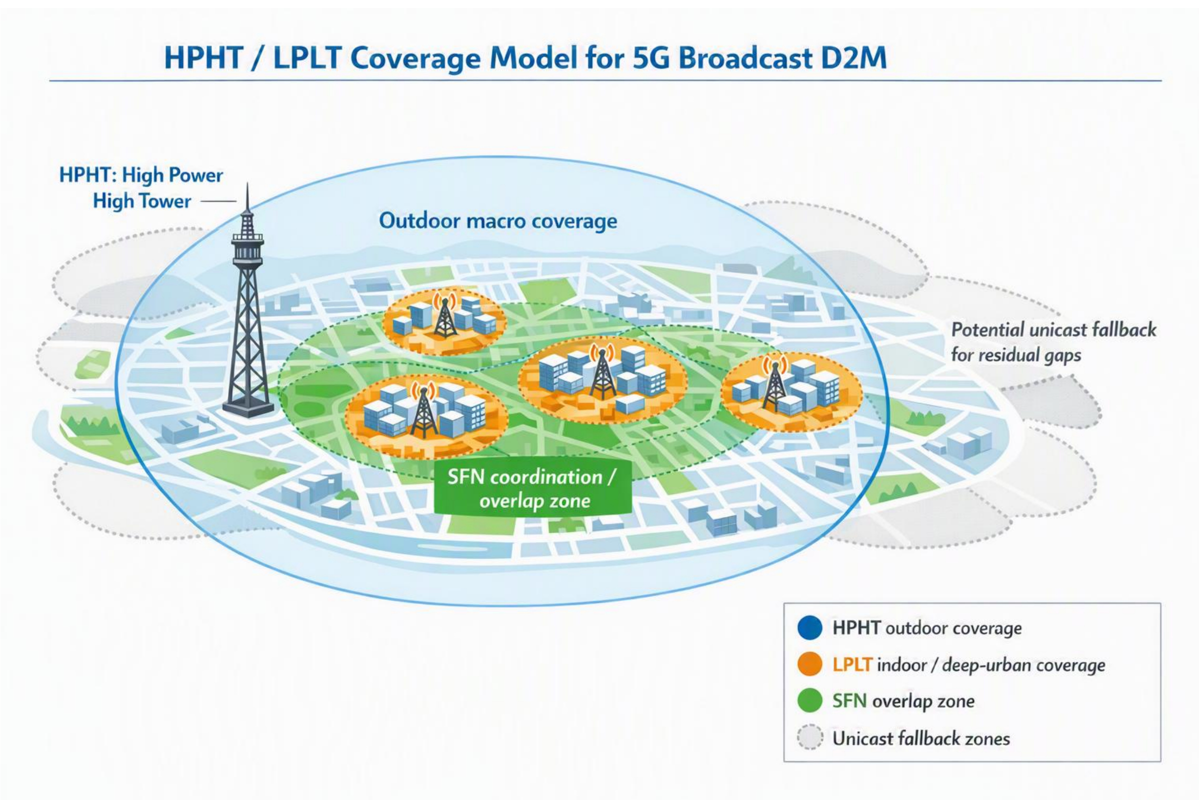
4 Trial Deployment and Methodology

4.1 Deployment Overview

The Delhi trial was implemented as a two-site configuration combining one HPHT site and one LPLT site. This was a strategically important design choice because it allowed the trial to move beyond a single-link demonstration and instead reflect the mixed-architecture reality that India is likely to require for practical D2M deployment. In this architecture, HPHT should be understood primarily as the outdoor macro-coverage layer, while LPLT is the likely densification layer for indoor, deep-urban, and localised coverage improvement. The HPHT site was located at the Pitampura TV Tower in Delhi and the LPLT site at Rohit House, Tolstoy Road in Delhi. Media Broadcast loaned the HPHT infrastructure needed for the trial, and the LPLT antenna was designed and manufactured in India by Telimart. The deployment supported 720p content delivery with two services and a 10% FEC setting. Validation points included the Jio office at Prakashdeep for the LPLT setup and a Qualcomm site in Aerocity, at 16.5 km line-of-sight, for the HPHT setup.

Parameter	LPLT	HPHT
Frequency	570 MHz	578 MHz
EIRP	47 W	4.6 kW
MCS	Signalling 2 / Data 13	Signalling 2 / Data 13
Site	Rohit House, Tolstoy Road, Delhi	Pitampura TV Tower, Delhi
Validation point	Jio Office (Prakashdeep)	Aerocity – Delhi (16.5 km, line-of-sight)

Figure 4-1: Illustrative HPHT/LPLT coverage model. The figure summarises the coverage logic assessed through the Delhi trial and being refined through ongoing coverage-prediction work. A high-tower HPHT transmitter, such as the Pitampura TV Tower, provides the broad outdoor macro-coverage layer. Within that footprint, LPLT nodes at lower heights can be used in dense-urban areas to improve indoor, street-canyon, and localised coverage. Overlapping coverage areas require SFN planning, while residual edge or indoor gaps may need unicast supplementation. The key trial-report takeaway is that HPHT establishes outdoor reach, LPLT materially influences indoor service quality, and the economics of LPLT densification is central to D2M scalability.



Note: This HPHT/LPLT coverage model is an illustrative planning view derived from the Delhi study. The coverage assumptions, SFN overlap areas, indoor-coverage contribution of LPLT, and any unicast fallback zones are being refined progressively using measured data and coverage-prediction outputs.

4.2 Measurement and testing approach

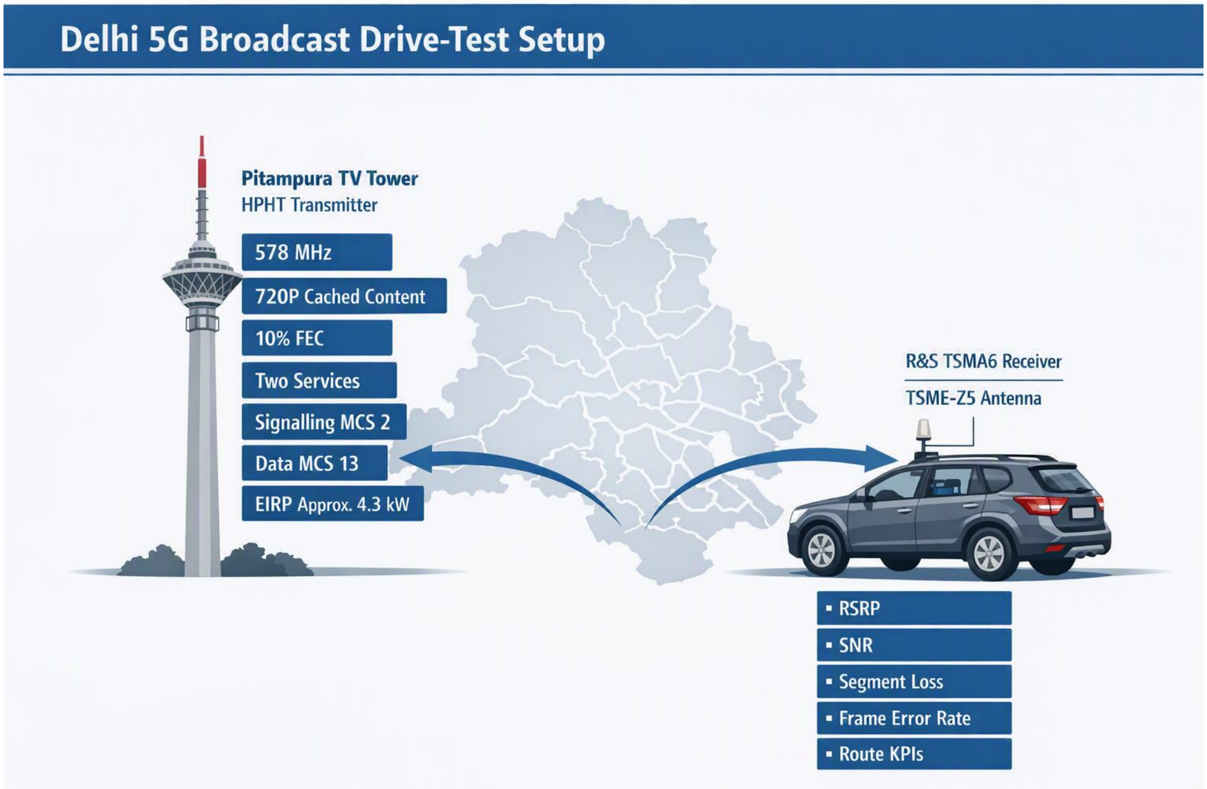
The measurement campaign combined live drive testing, KPI collection, review, and data consolidation as part of one integrated Delhi field study. The campaign collected parameters such as RSRP, SNR, coverage range, frame error rate, segment loss, and route-wise performance using both Qualcomm test UE and the Rohde & Schwarz sniffer tool. The analysis examined route-wise results, MCS trade-offs, coverage extrapolation, and the relationship between RF measurements and application-layer service behaviour. It also showed that coverage behaviour was terrain- and clutter-dependent rather than purely distance-based. These measurements are framing deployment-oriented questions, including the standalone outdoor coverage zone achievable from the Pitampura HPHT site, the reach of a single central-Delhi LPLT site, the likely number of HPHT and/or LPLT sites required to approach high levels of indoor coverage using broadcast, the SFN assumptions needed for coordinated multi-site operation, and the extent to which additional LPLT or unicast support may be needed to address indoor and urban coverage gaps.

The methodology also supported evidence-based stakeholder engagement. The trial was designed to enable live demonstrations and structured discussion on network planning, deployment feasibility, and business alignment. This type of evidence is useful for public institutions and ecosystem participants because it brings together technical validation, operational feasibility, and deployment relevance.

4.3 Drive-test setup and measurement configuration

The Delhi drive-test configuration used the Pitampura TV Tower HPHT transmission site as the primary broadcast source. The test configuration used 720p cached content with 10% FEC, two services, 578 MHz frequency, and MCS configuration with signalling at MCS 2 and data at MCS 13. The HPHT EIRP was reported as approximately 4.3 kW. The receive-side setup used R&S TSMA6 equipment with a TSME-Z5 antenna configuration and measured performance across multiple drive routes.

Figure 4-2: Delhi 5G Broadcast drive-test setup. This figure summarises the HPHT transmitter configuration, receive-side drive-test configuration, frequency, bandwidth, MCS, EIRP, equipment, antenna details, and Pitampura TV Tower site location used for the Delhi drive-test setup.



5 Field Trial Data and Associated Analysis

This section summarises the field-trial data and analysis from the Delhi **HPHT/LPLT** drive-test study. The study combined HPHT outdoor route measurements, HPHT indoor observations, government-building checks, Shastri Bhawan spot testing, LPLT drive testing, and LPLT indoor measurements into a single validation view. The purpose of this chapter is to translate the integrated field evidence into deployment-relevant inputs for D2M planning in India.

5.1 HPHT outdoor drive-test and RSRP coverage

The HPHT outdoor drive-test data included internal routes and RSRP coverage plotting from the Pitampura TV Tower transmission site. The RSRP legend used the following bands: above -70 dBm, -71 to -80 dBm, -81 to -90 dBm, -91 to -100 dBm, -101 to -110 dBm, and below -110 dBm. These outdoor plots reinforced that coverage should be interpreted through measured RSRP, SNR, route geometry, clutter, and receive conditions rather than distance alone.

HPHT internal routes – RSRP coverage plot. This figure shows the HPHT internal-route RSRP coverage plot, including the RSRP colour legend and route-level coverage distribution.

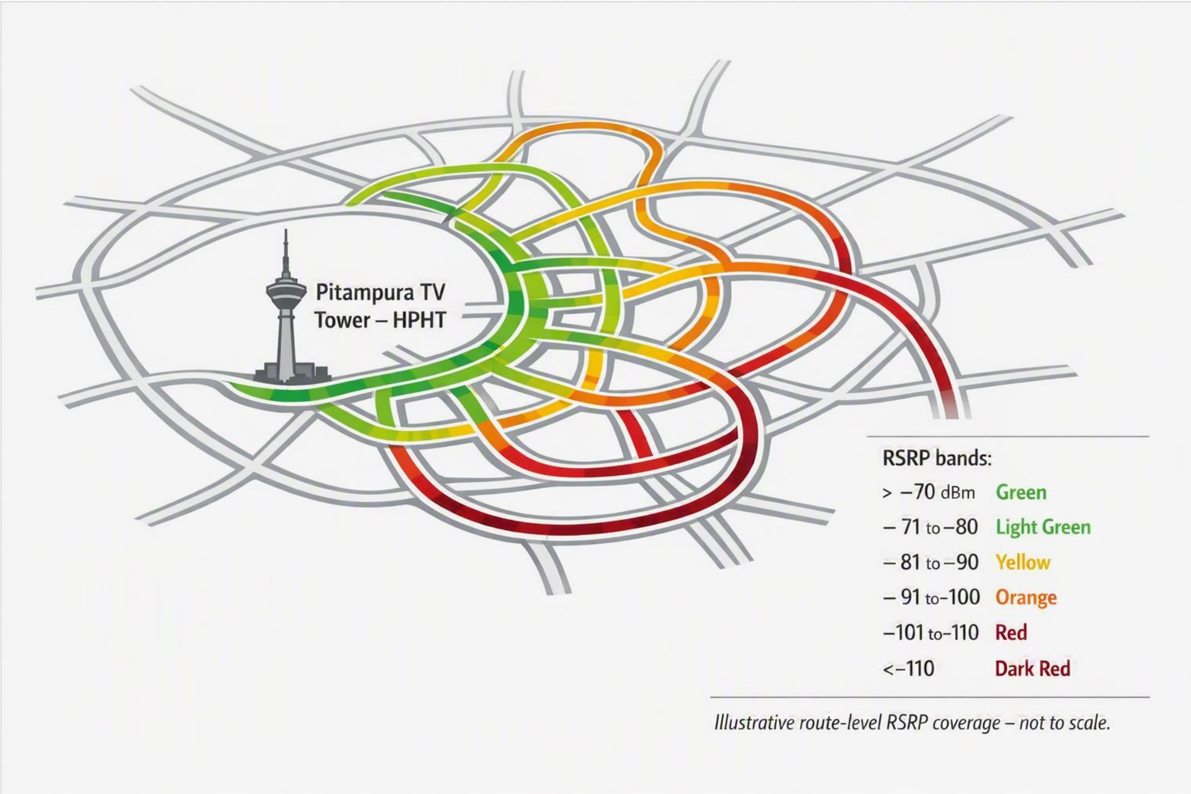


Figure 5-1: *HPHT internal drive-test routes around the Pitampura TV Tower, showing the RSRP coverage bands used to interpret route-level signal strength and outdoor macro-coverage behaviour (for illustrative purposes only).*

Interpretation: The HPHT outdoor data confirms the value of Pitampura as a macro-coverage reference site. However, the field plots also show that usable coverage is not a simple radial function of distance from the tower. Delhi's urban clutter, road orientation, building density, receiver placement, and line-of-sight conditions all affect reception quality. This supports a measurement-led planning approach for ongoing D2M deployment analysis.

5.2 HPHT indoor-location observations

The HPHT indoor-location measurements covered a set of malls and public locations at distances ranging from approximately 2 km to 18 km from the Prasar Bharati tower. The measured observations were as follows:

Indoor location	Distance from Prasar Bharati tower	Video observation	RSRP	SNR
Aggrawal City Mall	2 km	Video streamed smoothly	-88 dBm	21 dB
North Ex Mall	3 km	Video streamed smoothly	-91 dBm	19.12 dB
Ring Road Mall	3 km	Video streamed smoothly	-95 dBm	19.94 dB

Unity One Rohini	4 km	Video buffered for 3 seconds in a 1-minute video	-103 dBm	12.65 dB
Pacific Mall, Tagore Garden	7 km	Video buffered for 5 seconds in a 1-minute video	-103 dBm	13.45 dB
Janakplace Shopping Mall	10 km	Video not streaming	-110 dBm	8.78 dB
Vegas Mall	15 km	Video streamed smoothly	-103 dBm	12.69 dB
V3S Mall	15 km	Video not streaming	-118 dBm	3.14 dB
Ambience Mall, Vasant Kunj	17 km	Video buffer for 20 seconds in a 1-minute video	-108 dBm	9.17 dB
Pacific D21 Mall	18 km	Video not streaming	-128 dBm	2.3 dB

HPHT indoor-location measurements. This figure shows the indoor-location map or table, including the mall locations, distances, RSRP, SNR, and video-buffer observations.

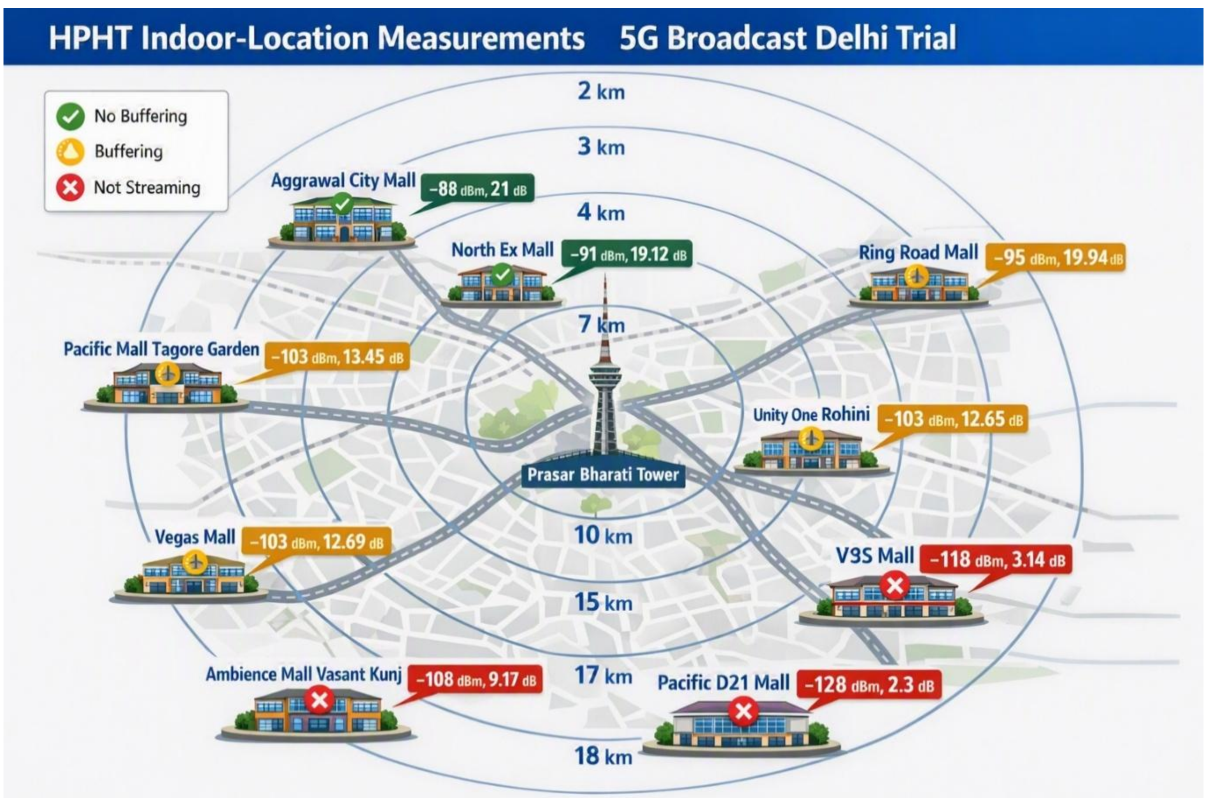


Figure 5-2: *HPHT indoor-location measurements across Delhi malls and public locations, correlating distance, RSRP, SNR, and observed video continuity outcomes (for illustrative purposes only).*

Interpretation: The indoor HPHT data shows a clear relationship between signal quality and video continuity, but it also demonstrates that distance alone does not determine service outcome. For example, Vegas Mall at 15 km showed no buffering with RSRP around -103 dBm and SNR around 12.69 dB, while some closer or comparable locations experienced buffering or no streaming. This suggests that building penetration, local clutter, indoor receiver placement, and local propagation conditions can dominate over distance. For D2M scale-up, HPHT can provide a strong outdoor and partial indoor baseline, while reliable indoor service requires explicit indoor planning, LPLT supplementation, and selective unicast fallback for difficult locations.

5.3 HPHT government-building and Shastri Bhawan observations

The government-building checks included locations such as Shastri Bhawan, Electronics Niketan, Prasar Bharati HQ, Khurshid Lal Bhawan, and Sanchar Bhawan. Testing was conducted using a Motorola device, and video streaming was not observed at the government-building locations included in this check at the entrance level.

HPHT Shastri Bhawan testing observations. This figure shows the Shastri Bhawan testing table or measurement slide, including floor-wise RSRP, SNR, and video-buffer results.

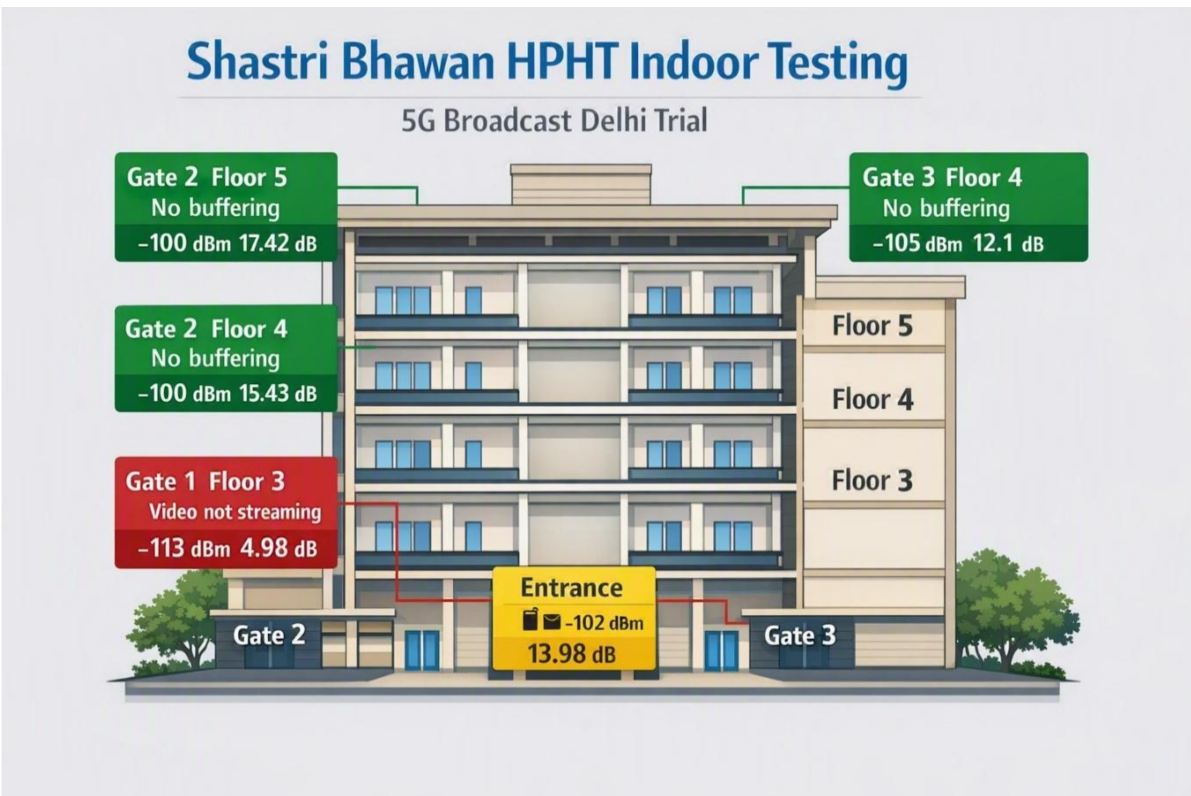


Figure 5-4: *Shastri Bhawan spot-check results showing floor-wise RSRP, SNR, and video-continuity behavior across selected gates and indoor locations (for illustrative purposes only).*

Interpretation: The government-building and Shastri Bhawan observations reflect the practical challenge of indoor coverage in large public buildings. The Shastri Bhawan results indicate that video continuity was possible where SNR remained above roughly 12 dB and RSRP was around -100 to -105 dBm, while no streaming was observed at -113 dBm and 4.98 dB SNR. This reinforces the need to treat indoor public-building coverage as a distinct planning category rather than assuming that outdoor HPHT coverage will automatically translate into acceptable indoor user experience.

The spot checks made at Shastri Bhawan provided more granular measurements:

Location	Video observation	RSRP	SNR
Gate 2, Floor 4	No buffering observed	-100 dBm	15.43 dB
Gate 2, Floor 5	No buffering observed	-100 dBm	17.42 dB
Gate 3, Floor 4	No buffering observed	-105 dBm	12.1 dB
Gate 1, Floor 3	Video not streaming	-113 dBm	4.98 dB
Entrance of building premise	Buffering observed	-102 dBm	13.98 dB

HPHT RSRP coverage plot at other government-building. This figure shows the RSRP coverage plot covering select government-buildings including Electronics Niketan, Prasar Bharati HQ, Khurshid Lal Bhawan, and Sanchar Bhawan.

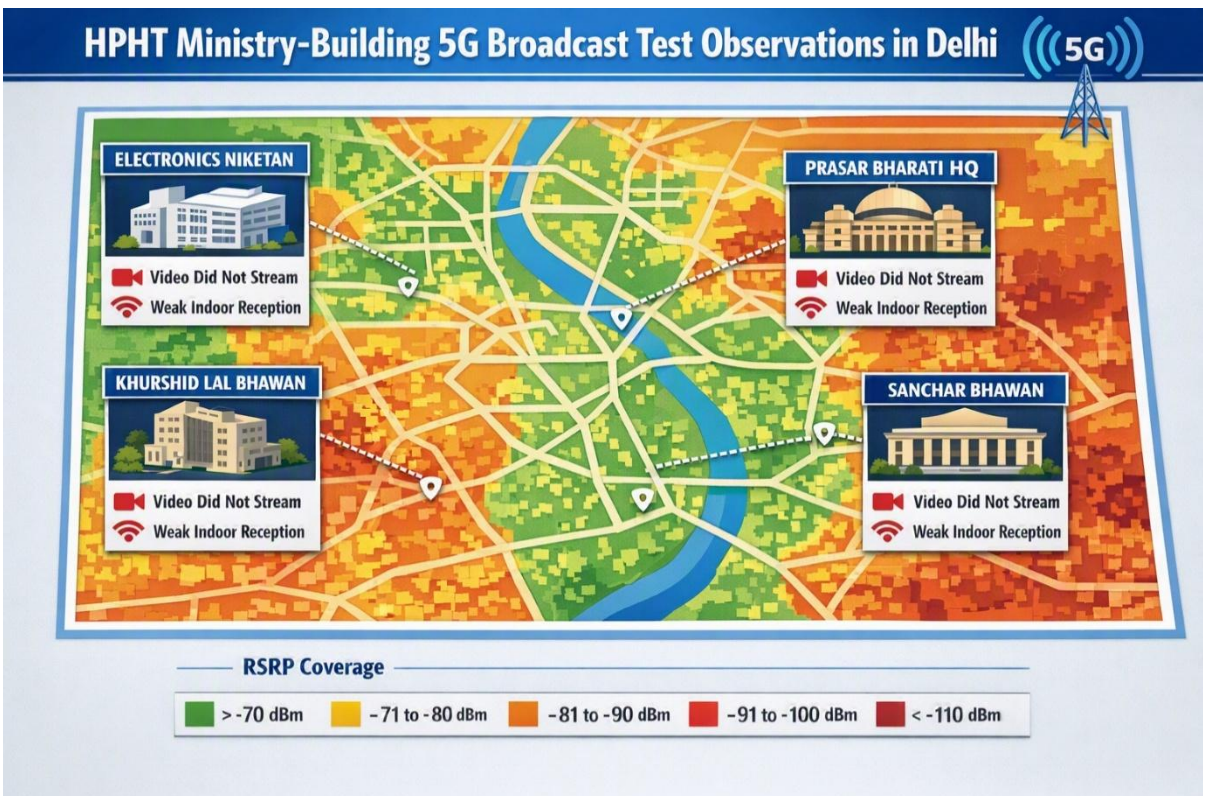


Figure 5-3: *HPHT government-building observations for Electronics Niketan, Prasar Bharati HQ, Khurshid Lal Bhawan, and Sanchar Bhawan, highlighting the indoor public-building coverage challenge (for illustrative purposes only).*

However, measurements on higher floors and at building ends facing Pitampura showed improved reception. This confirmed the initial assessment that good indoor penetration in these government buildings will require LPLT supplementation or unicast offload. An alternative may be CPE-assisted Wi-Fi delivery.

5.4 LPLT outdoor drive-test and RSRP coverage

The LPLT outdoor measurements included RSRP coverage plotting around the Rohit House, Tolstoy Road site. The same RSRP legend bands were used: above -70 dBm, -71 to -80 dBm, -81 to -90 dBm, -91 to -100 dBm, -101 to -110 dBm, and below -110 dBm. The results provide an initial view of how a low-power, low-tower layer can contribute to localised coverage improvement in dense urban areas.

LPLT drive-test RSRP coverage plot. This figure shows the LPLT drive-test RSRP coverage plot, including the LPLT route and RSRP colour legend.

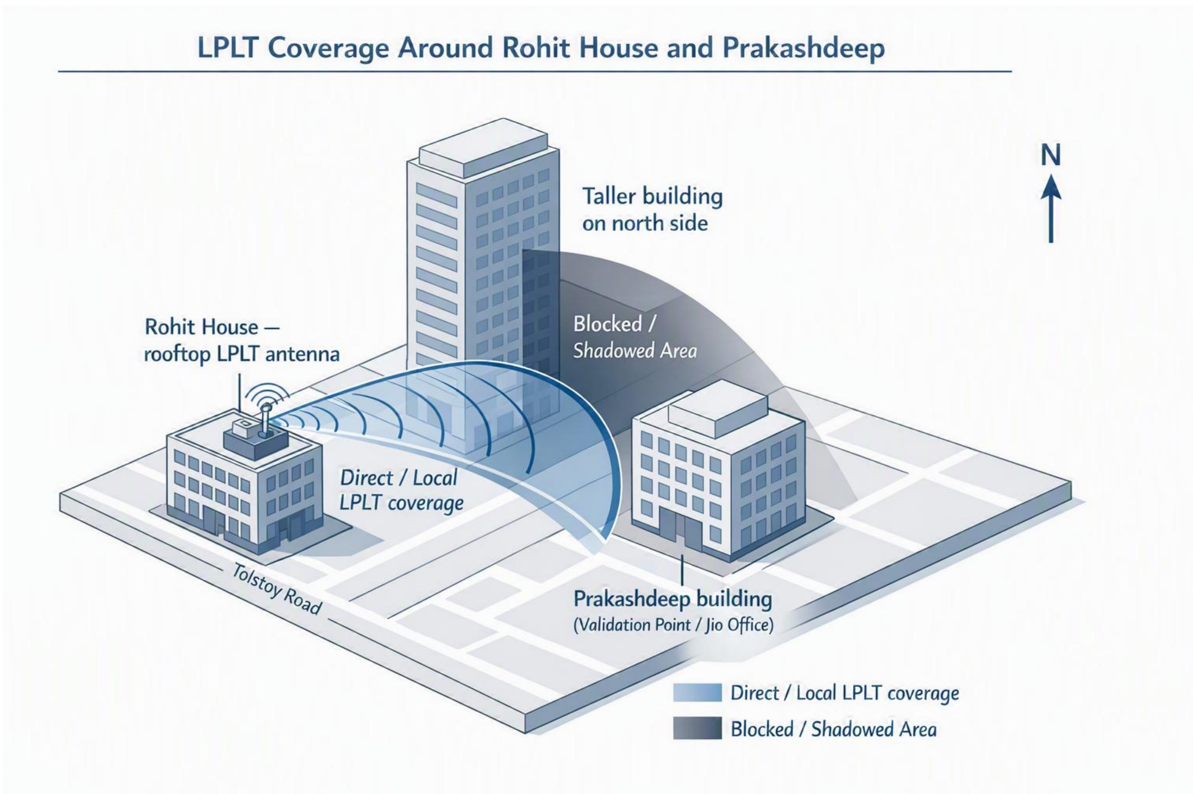


Figure 5-5: Illustrative LPLT propagation view around Rohit House, showing the rooftop LPLT antenna, Prakashdeep building in proximity, and a taller building creating a signal-shadow area behind it.

Interpretation: The LPLT plot should be interpreted as a localised densification result rather than a macro-coverage result. The role of LPLT is not to replicate HPHT reach, but to improve street-level, indoor, and hotspot coverage where HPHT alone may be insufficient. The Delhi LPLT results therefore support the broader mixed-architecture model: HPHT provides outdoor macro reach, while LPLT provides targeted densification in high-demand or difficult-propagation zones.

5.5 LPLT indoor-location observations

The LPLT indoor measurements covered four locations near the LPLT site:

Indoor location	Distance from LPLT tower	Video observation	RSRP	SNR
Atmaram House	50 m	No buffering observed	-104 dBm	15.77 dB
IndusInd Bank	80 m	Video not streaming	-113 dBm	Not available
HDFC Bank	300 m	No buffering observed	-77 dBm	23.36 dB
IDBI Bank	300 m	No buffering observed	-100 dBm	19.87 dB

LPLT indoor-location measurements. This figure shows the LPLT indoor-location map or table, including Atmaram House, IndusInd Bank, HDFC Bank, and IDBI Bank.

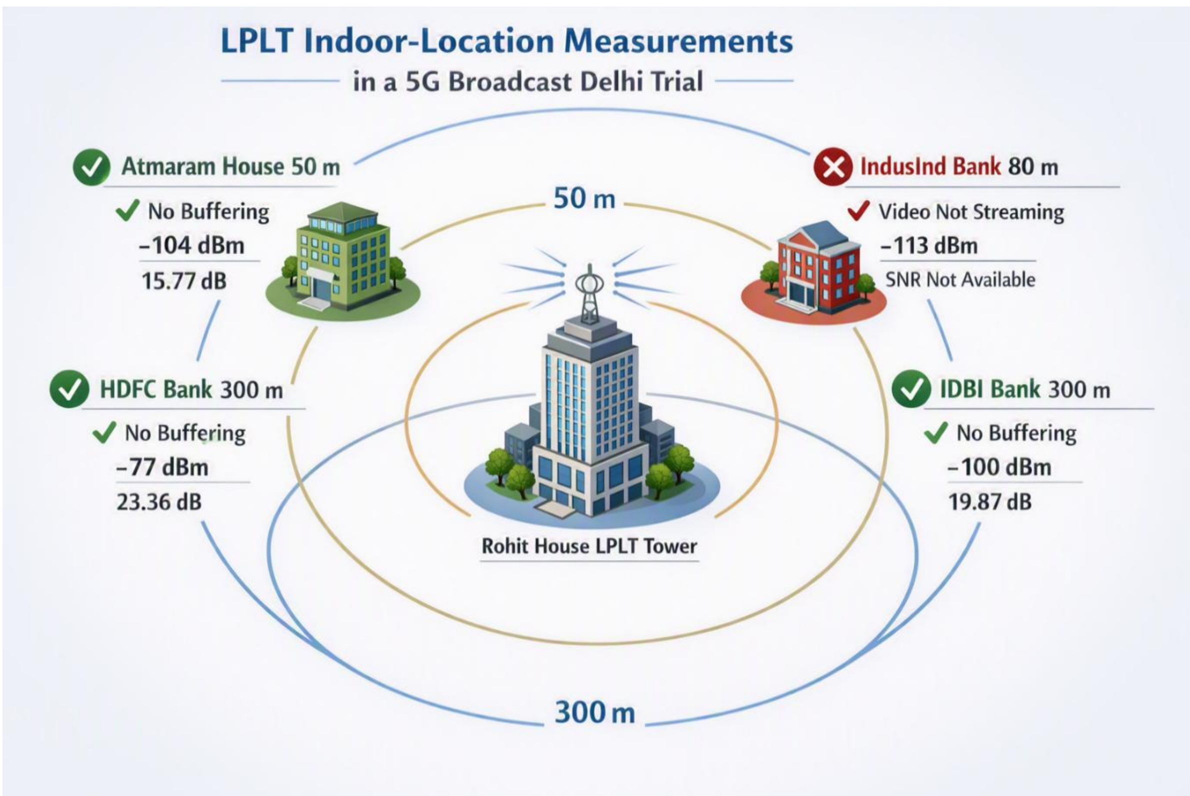


Figure 5-6: *LPLT indoor-location measurements near the Rohit House site, showing service outcomes at Atmaram House, IndusInd Bank, HDFC Bank, and IDBI Bank (for illustrative purposes only).*

Interpretation: The LPLT indoor results are directionally encouraging because three of the four tested indoor locations showed no buffering. However, the IndusInd Bank result shows that very short distance from the LPLT site does not guarantee successful streaming if local penetration, receiver placement, or obstruction conditions are unfavourable. This is an important planning lesson for D2M: LPLT densification must be planned with building-level propagation and service-quality targets, not only with distance rings around low-power sites.

5.6 MCS 13 reception-quality interpretation

The reception-quality plots for MCS 13 used the following SNR-based categories: no errors when SNR was at least 11 dB, errors when SNR was between 8 dB and 11 dB, and no reception when SNR was below 8 dB. This classification was used across HPHT and LPLT analysis to connect RF conditions to expected service behaviour.

5G Broadcast reception quality for MCS 13. This figure shows the MCS 13 reception-quality plot from the Delhi drive-test material, with no-error, error, and no-reception regions based on SNR thresholds.

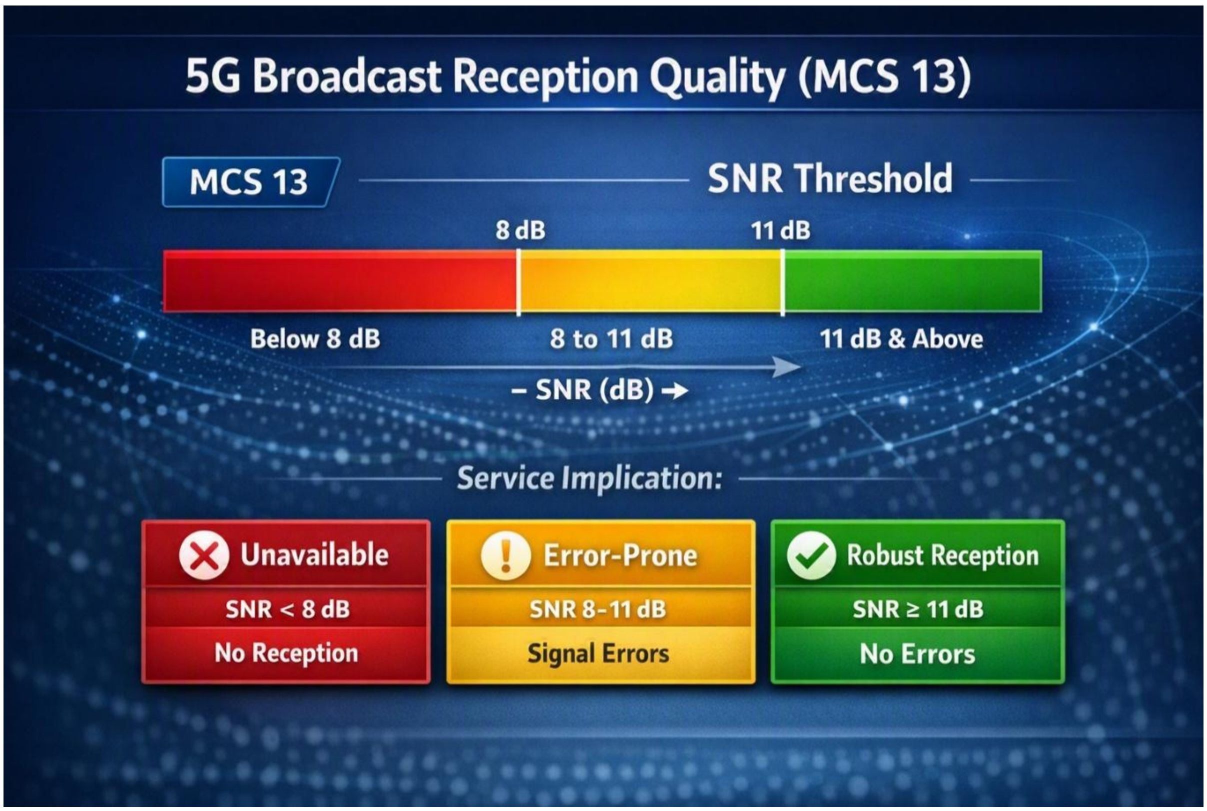


Figure 5-7: *MCS 13 reception-quality thresholds showing no-reception, error-prone, and no-error regions based on SNR levels.*

Interpretation: The MCS 13 thresholding is consistent with several observed field outcomes. Locations with SNR comfortably above 11 dB generally showed better continuity, while locations below the lower threshold were more likely to show no streaming. Borderline cases between 8 dB and 11 dB require careful interpretation because buffering or intermittent service may depend on local channel variation, receiver behaviour, and application-layer buffering. This confirms that MCS 13 can support useful throughput but requires adequate SNR margin for robust service continuity.

5.7 MCS planning and robustness trade-off

The Delhi measurements also compared MCS 13 and MCS 9 reception-quality thresholds. For MCS 13, no-error reception required SNR of at least 11 dB, while no reception was associated with SNR below 8 dB. For MCS 9, no-error reception required SNR of at least 9 dB, with no reception below 6 dB. This shows that lower MCS settings can improve robustness and extend usable coverage at the cost of reduced throughput.

MCS 9 and MCS 13 reception-quality comparison. This figure shows the MCS 9 and MCS 13 reception-quality plots from the Delhi study, highlighting the lower SNR requirement for MCS 9 and the higher throughput potential of MCS 13.

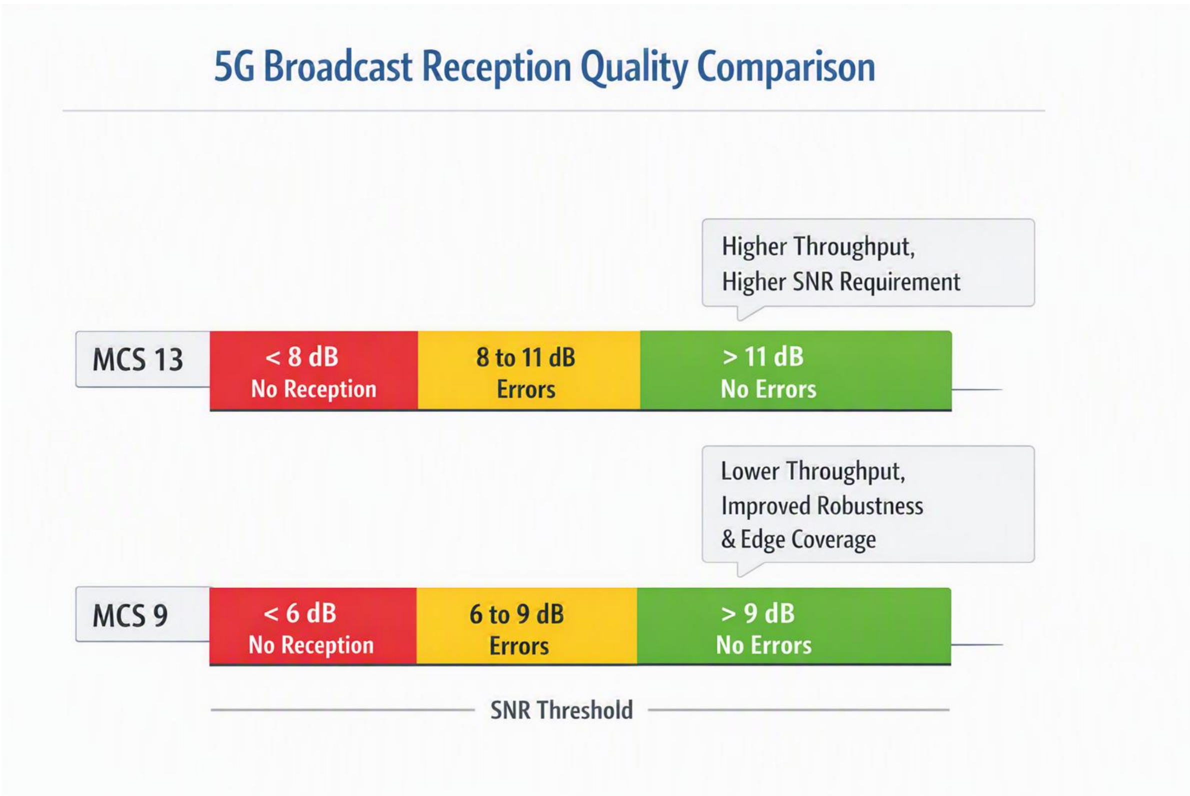


Figure 5-8: *Comparison of MCS 9 and MCS 13 SNR thresholds, illustrating the trade-off between robustness, edge coverage, and throughput.*

Interpretation: MCS selection is one of the most important planning levers for D2M. MCS 13 may be attractive for throughput and service capacity, but MCS 9 offers a more robust profile for edge coverage, indoor penetration, and cluttered urban areas. Ongoing planning work is therefore evaluating multiple MCS configurations against comparable routes and indoor locations to determine the practical operating profile for mass-market service.

5.8 Extrapolated deployment-profile data

The deployment-profile extrapolation was used to relate measured radio conditions to indicative 5G Broadcast capacity under a defined planning configuration. The analysis combined SNR values obtained from the Rohde & Schwarz sniffer with link-level performance assumptions for Rel-19 5G Broadcast. The assumed configuration used 1.25 kHz subcarrier spacing, 8 MHz channel bandwidth, 128 ms time-frequency interleaving, and full allocation of the carrier to broadcast transmission. Under these assumptions, the extrapolated throughput increased with MCS level, ranging from approximately 1.07 Mbps at MCS 0 to approximately 23.86 Mbps at MCS 26. Reference points relevant to the Delhi study included approximately 5.97 Mbps for MCS 9 and approximately 8.94 Mbps for MCS 13.

Extrapolated 5G Broadcast deployment-profile data. This figure presents the extrapolated relationship between MCS level, required SNR, transport block size, and indicative throughput for the stated Rel-19 5G Broadcast planning configuration.

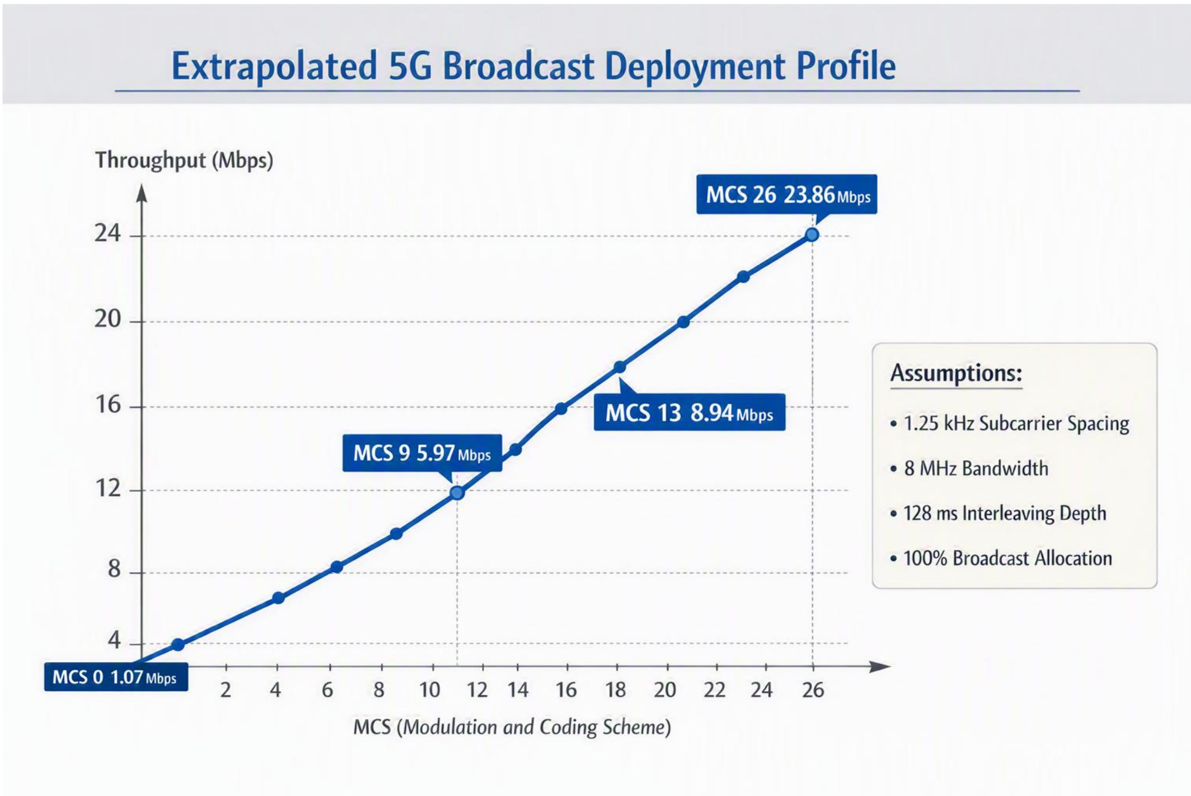


Figure 5-9: *Extrapolated 5G Broadcast deployment profile showing the relationship between MCS level, required SNR, transport block size, and achievable throughput under the stated Rel-19 planning assumptions.*

Interpretation: The extrapolated profile should be interpreted as a planning reference rather than as a final deployment guarantee. It provides a structured way to compare robustness and capacity across MCS settings by linking SNR requirements to indicative throughput. The results also indicate the planning trade-off observed elsewhere in the Delhi study: lower MCS values provide greater robustness for edge, indoor, and cluttered locations, while higher MCS values improve throughput where sufficient SNR margin is available. The extrapolation remains subject to calibration using larger measurement sets, receiver-performance improvements, indoor measurements, and SFN scenarios.

5.9 Key planning implications from HPHT/LPLT field data

The combined HPHT and LPLT field-trial data provide the following planning implications:

- HPHT from Pitampura provides a meaningful outdoor macro-coverage anchor and a useful reference for city-level D2M planning.

- Indoor HPHT results show that some locations can receive usable service even at moderate distance, but building penetration and local propagation conditions strongly influence video continuity.
- Government-building and Shastri Bhawan observations show that public-building indoor coverage must be treated as a distinct planning problem.
- LPLT can provide targeted local coverage improvement, but its effectiveness depends on site placement, building geometry, penetration conditions, and receiver location.
- Short distance from an LPLT site does not guarantee successful indoor reception; building-level effects can override proximity.
- SNR is a stronger predictor of video continuity than distance alone, especially for indoor and cluttered environments.
- MCS 13 provides useful throughput but requires higher SNR margin; MCS 9 improves robustness and is being evaluated for difficult coverage zones.
- HPHT/LPLT planning should be tied to service-quality outcomes such as buffering and segment continuity, not only to RF coverage plots.
- Deployment planning is combining HPHT macro reach, LPLT densification, SFN design, indoor penetration modelling, and selective unicast fallback.
- The Mumbai phase is using the Delhi evidence to refine indoor-coverage assumptions, validate MCS trade-offs, and determine the economic breakpoint between additional LPLT deployment and unicast supplementation.

5.10 Key Technical and Deployment Learnings

The Delhi phase supports several preliminary learnings that can inform subsequent policy and deployment discussions:

- A mixed HPHT/LPLT architecture is operationally relevant for Indian D2M deployment and should remain central to planning discussions, with HPHT treated as the outdoor macro-coverage layer and LPLT as the indoor and dense-urban supplementation layer.
- The Pitampura HPHT site provides an essential reference point for understanding standalone outdoor broadcast coverage and for anchoring wider network dimensioning assumptions.
- A single LPLT site in central Delhi is useful for understanding targeted coverage behaviour, but indoor performance and dense-urban continuity will likely depend on broader LPLT site planning and the economics of deploying that layer at scale.
- Coverage behaviour in dense cities is environment-dependent and therefore requires measurement-led planning rather than simplistic distance assumptions.
- Indoor service ambitions, including high levels of Delhi-area coverage, subject to planning assumptions and validation, are likely to require careful balancing of HPHT reach, LPLT supplementation, and targeted use of unicast to address residual coverage holes.
- Drive-test data supports early extrapolation and dimensioning work, while ongoing planning includes HPHT/LPLT coverage-prediction maps and SFN analysis to test practical scale-up assumptions.
- Application-layer drive-test review indicated very low total segment loss, below 1% in the reviewed scenario, suggesting substantial potential for unicast offload in that assessed case.

- MCS selection materially affected coverage and throughput trade-offs: lower MCS values such as MCS 9 improved coverage robustness, while higher MCS values such as MCS 13 supported higher throughput.
- Planning simulations using existing broadcast infrastructure indicated approximate outdoor coverage ranges of 25–30 km at 3 kW, 40–45 km at 5 kW, and 60–65 km at 10 kW, subject to antenna assumptions.
- The RSRP threshold used for the shared HPHT and LPLT coverage predictions was -109 dBm, providing a common reference point for interpreting prediction outputs.
- Indoor coverage measurement is being expanded through additional indoor measurements, segment-loss correlation against RSRP, and penetration-loss offset modelling.
- The most meaningful value of 5G Broadcast lies in mobile-centric, one-to-many delivery and convergence with unicast, not in a narrow replication of legacy broadcast logic.
- A key structural benefit is 3GPP alignment: ecosystem commonality is critical for scalable mass-market adoption.

5.11 Implications for India's D2M Evolution

The Delhi trial was both a technical exercise and a strategic signal. It produced field evidence that 5G Broadcast could support India's D2M ambitions in a way that aligned with mobile consumption, spectrum efficiency, and the mainstream telecom ecosystem. On that basis, the trial strengthened the case for continued evaluation of 5G Broadcast as India considered how to modernise terrestrial media delivery.

India's D2M roadmap would benefit from careful assessment of technology paths that unify broadcast reach with 5G-era devices, services, and operational models. The assessment identified potential advantages for 5G Broadcast in interworking with cellular, DVB-I integration, Indian standards alignment, indoor performance, reverse-path possibility, device-ecosystem support indicators, and device-readiness trajectory. These factors were relevant to the foundations of a viable national platform. The Delhi trial reinforced this by demonstrating practical relevance for broadcast-broadband convergence, emergency warning delivery, 5G Broadcast reception on commercial-ready smartphones and CPE-assisted Wi-Fi delivery, and DVB service delivery over a 5G-aligned architecture.

Accordingly, the Delhi outcomes supported a forward-looking deployment discussion on how 5G Broadcast could be incorporated into India's future D2M framework. The key question was not only whether the technology could operate, but how it could be translated into a broader deployment roadmap with the right mix of infrastructure, devices, spectrum considerations, and ecosystem participation.

Looking ahead, the Delhi results supported a more structured pathway for India. That pathway needed to consider how shared HPHT/LPLT deployment models could be recognized within future D2M planning, how phased city-level trials could be used to refine CAPEX and coverage assumptions, and how device- and infrastructure-readiness issues could be surfaced early enough to keep ambition aligned with ecosystem availability. The findings also pointed to the value of treating D2M not only as a media-delivery question, but as part of a broader public-interest framework that included efficient spectrum use, emergency communications, and convergence with mainstream 5G evolution. In this pathway, HPHT coverage prediction, LPLT indoor-coverage planning, and SFN analysis were treated as essential inputs, because the economics of the LPLT deployment layer would materially influence whether D2M could move from field validation to sustainable national scale.

5.12 Conclusions from the Delhi Trial and Implications for Next-Level Engagement

The principal conclusion from the Delhi trial is that 5G Broadcast has generated field evidence that can support a more informed and forward-looking D2M engagement by the public broadcaster and broader institutional ecosystem. The trial did not impose a predetermined deployment model; rather, it created a practical evidence base by combining existing HPHT broadcast infrastructure with LPLT deployment support, broadcast equipment, measurement capability, antenna contributions, commercial-ready device validation, and 3GPP ecosystem integration. As a result, the institutional stakeholders involved in D2M are now better positioned to assess how 5G Broadcast could complement public-service objectives, existing broadcast assets, and India's future D2M evolution.

- **Field validation:** The Delhi trial advanced 5G Broadcast from conceptual assessment to field-based validation under Indian deployment conditions.
- **Broadcast infrastructure relevance:** Because the HPHT layer was anchored on existing broadcast infrastructure, the trial strengthened the case for treating these assets as a foundational element in any D2M planning discussion.
- **Complementary densification:** Because indoor, dense-urban, and hotspot coverage cannot be assumed from HPHT reach alone, LPLT emerged as a complementary layer whose economics and siting requirements merit further evaluation.
- **Measurement-led planning:** Because coverage outcomes were influenced by terrain, clutter, building penetration, receiver location, RSRP, SNR, segment loss, and MCS selection, scale-up decisions can be more robust if they are grounded in measured data.
- **Service use-case relevance:** Because smartphone reception, CPE-assisted delivery, DVB service delivery, public-warning use cases, and broadcast-unicast convergence were demonstrated, 5G Broadcast can be considered as a service-enabling platform rather than only as a radio technology.
- **Standards maturity, ecosystem readiness, device availability, and certification pathway:** Because the technology is anchored in 3GPP, supported by reusable service-layer components, and demonstrated on commercial-ready smartphone hardware, the trial points to a maturing ecosystem rather than an isolated technical setup. The use of commercial-ready devices also provides a practical basis for future assessment against applicable conformance, interoperability, test, and certification requirements, subject to the relevant regulatory, standards, and certification processes.
- **Continuing market evaluation:** Jio's continuing discussions with technology partners suggest that operator and content ecosystem interest remains active across both technology elements and business aspects.
- **Next-level engagement:** The Delhi evidence gives the public broadcasting and institutional ecosystem a stronger basis to engage on HPHT/LPLT coverage, indoor performance, SFN design, LPLT economics, device readiness, service-layer integration, public-interest applications, and selective unicast fallback.

The deployment implication for the public broadcasting ecosystem follows naturally from the field evidence. Because HPHT provided the macro-coverage anchor, existing broadcast infrastructure can remain central to any credible D2M pathway. Because LPLT demonstrated localised densification potential, the next planning discussion can examine how complementary lower-power layers may extend service continuity in indoor, dense-urban, and hotspot environments. Because the Delhi measurements showed that coverage was terrain- and clutter-dependent rather than purely distance-based, future assessment can rely on measured drive-test data, indoor observations, RSRP and SNR thresholds, segment-loss behaviour, MCS trade-offs, and SFN analysis rather than on theoretical range assumptions alone.

Jio's continuing interest in D2M may be interpreted as a relevant market signal while leaving institutional choices open. That interest appears to be associated with the scale and economics of premium live and linear content delivery, particularly where large numbers of users may consume the same stream concurrently. Because such traffic patterns can place avoidable load on unicast networks, a broadcast-capable delivery layer may offer efficiency benefits as a complement to broadband distribution. Parallel technology-partner discussions involving Jio may provide useful market and deployment inputs on both the technology elements and the business aspects of 5G Broadcast, including delivery efficiency, service predictability, ecosystem readiness, and economic scalability for high-demand content and public-interest services in dense metropolitan environments.

Consequently, next-level engagement can be framed as an evidence-led opportunity rather than as a prescribed course of action. The Delhi trial provides a basis to refine HPHT/LPLT coverage-prediction maps, validate SFN assumptions, assess indoor-coverage models, compare MCS profiles, and evaluate the economic threshold between additional LPLT densification and selective unicast supplementation. In parallel, visibility into technology-partner discussions involving Jio can provide useful external inputs on operational feasibility, commercial incentives, device readiness, and service-layer integration, while keeping institutional priorities and public-service objectives at the centre of any future D2M engagement.

Because the Delhi trial established initial feasibility, any Mumbai or follow-on evaluation can be used to strengthen evidence on repeatability and scale under another dense urban environment. Because the Delhi measurements highlighted indoor penetration and localised densification challenges, follow-on work can place greater emphasis on indoor measurements, route-wise correlation, building-level propagation behaviour, and service continuity. Because the Delhi application-layer review indicated meaningful broadcast-offload potential, further evaluation can quantify the conditions under which broadcast delivery may reduce unicast pressure for mass-audience services while also supporting public-interest use cases. The proposed continuation within a controlled Mumbai environment can therefore be understood as a basis for further evaluation of technology elements and business aspects, rather than as indicating a predetermined deployment pathway for the public broadcasting ecosystem.

In summary, the Delhi trial has shifted the D2M discussion from technology feasibility to evidence-based deployment consideration. The value of the trial is that it clarifies choices rather than imposes conclusions: it shows how existing broadcast infrastructure can anchor a practical HPHT/LPLT architecture, how 3GPP alignment and device readiness can reduce ecosystem risk, and how parallel market evaluation by Jio and technology partners can inform but need not define the institutional pathway. This enables future engagement to proceed from a stronger evidence base on coverage, indoor performance, LPLT economics, device readiness, service-layer integration, public-interest applications, and the role of selective unicast fallback in a scalable Indian D2M model.

6 Appendix A. Open Items for Follow-up

The following items remain open for follow-up as the trial evidence base is consolidated and the next phase is scoped:

- Coverage visuals and route maps from the Delhi drive-test review pack.
- Consolidated route-wise drive-test data across all reviewed routes.
- Additional indoor measurements to strengthen coverage and service-continuity assessment.
- Correlation of segment loss against RSRP and derivation of an indoor penetration-loss offset model.
- Coverage qualification guidance across urban, suburban, and rural conditions.
- Assessment of the number of HPHT and LPLT sites required to achieve defined geographic coverage levels, including how broadcast-to-unicast transition mechanisms may support service continuity and influence overall planning.
- Regulatory and policy implications of the comparative assessment between 5G Broadcast and other D2M technology options.
- Additional analysis on how 3GPP ecosystem alignment reduces long-term adoption risk for India.
- Policy considerations for public broadcasting, MIB, and broader government stakeholders, based on consolidated Delhi evidence and Mumbai planning outputs.
- Public-warning and national-resilience implications of 5G Broadcast-based D2M deployment.
- A summary of Mumbai-specific objectives, guardrails, and expected outputs once execution scope is confirmed.

7 Appendix B. Delhi Trial Participants and Their Roles

The Delhi 5G Broadcast trial was enabled through a multi-party collaboration that brought together public-sector institutions, private-sector ecosystem partners, and technology contributors. The participants and their respective roles are summarized below.

Participant	**Primary contribution**	**Technical or strategic relevance**
Prasar Bharati	Provided the HPHT infrastructure at Pitampura and enabled public-broadcast participation.	Anchored the trial in existing national broadcast assets and public-interest D2M objectives.
Reliance Jio	Supported the LPLT site, planning inputs, and stakeholder demonstration environment.	Brought operator, content-distribution, and broadcast-broadband convergence relevance to the trial.
Media Broadcast	Loaned HPHT broadcast equipment for the field setup.	Enabled realistic high-power broadcast validation using proven broadcast components.

Rohde & Schwarz	Supported the broadcast test environment and provided sniffer measurement capability.	Strengthened RF and service-quality measurement credibility across drive testing and analysis.
Sener	Supported the LPLT antenna contribution.	Enabled validation of the low-power, low-tower densification layer.
Telimart	Designed and supplied the LPLT antenna contribution in India.	Supported Make in India relevance and practical LPLT field deployment.
Motorola	Provided a commercial-ready smartphone for 5G Broadcast reception testing.	Demonstrated mobile form-factor readiness and strengthened the device-ecosystem narrative.
Qualcomm	Supported overall technical integration, ecosystem coordination, and 3GPP-aligned validation.	Linked the trial to the broader chipset, device, service-layer, and standards ecosystem.

8 Appendix C. Summary of Use Cases Demonstrated at the Jio Experience Center in Delhi

The Jio Experience Center in Delhi provided a stakeholder-facing demonstration environment for the 5G Broadcast-based D2M trial. The demonstrations showed that the Delhi setup was not only a radio and coverage validation exercise, but also a platform for illustrating practical service scenarios, device readiness, broadcast-broadband convergence, and public-interest applications relevant to India’s D2M roadmap.

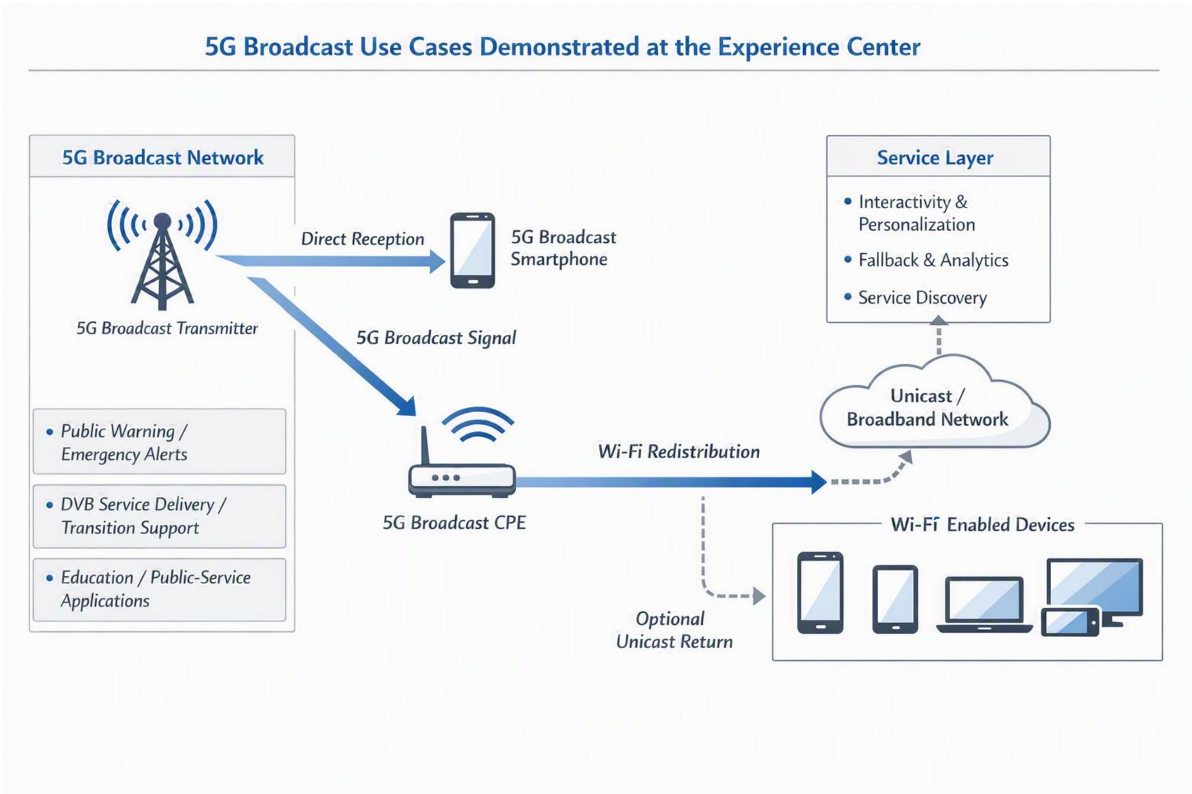


Figure C-1: 5G Broadcast use cases demonstrated at the Jio Experience Center, including direct smartphone reception, Wi-Fi-enabled 5G Broadcast CPE delivery directly to today's end devices, broadcast-unicast convergence, public-warning capability, DVB transition support, and public-service applications.

Use case	**What was demonstrated**	**Deployment relevance**
Direct-to-Mobile smartphone reception	5G Broadcast reception on a commercial-ready smartphone.	Supports the mobile-first D2M narrative and alignment with the 3GPP device ecosystem.
Broadcast-unicast convergence	Concurrent broadcast and unicast service delivery.	Shows how broadcast can support mass-audience delivery while unicast supports interactivity, personalisation, fallback, analytics, and service discovery.
CPE-assisted multi-device streaming	5G Broadcast received by CPE and redistributed over Wi-Fi to existing end devices.	Provides a practical transition model while native 5G Broadcast receiver availability matures.

Public warning and emergency alerts	Emergency warning delivery to mobile devices with potential area-specific notification.	Connects D2M with resilience, emergency communications, and public-interest objectives.
DVB service delivery and transition support	DVB service delivery over 5G Broadcast and DTT-to-mobile transition concepts.	Supports coexistence with existing DVB services and a phased migration path.
Education and public-service applications	Public-service content concepts using broadcast reach with broadband interactivity.	Broadens D2M from entertainment and live television to education, engagement, and digital public services.