III

LICENSING, SPECTRUM & INFRASTRUCTURE

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CHAPTER 1

Evolution of the Licensing Framework: 1994 to 2023

1.1 The First Generation: Technology-Specific Licensing (1994–2003)

The licensing framework that emerged from the National Telecom Policy, 1994 was characterised by technology-specific licence categories — separate licences for different technologies and service types. The principal licence categories created under NTP 1994 were: Basic Telephone Service (BTS) licences, which permitted the provision of wireline telephone services using fixed-line technologies; Cellular Mobile Telephone Service (CMTS) licences, which permitted the provision of mobile telephone services using GSM or CDMA technology; Internet Service Provider (ISP) licences, which permitted the provision of internet access services; and Value Added Service (VAS) licences, which permitted the provision of a range of supplementary services including paging, voice mail, and data services. Each licence category was governed by its own set of conditions, fee structures, and technical requirements, reflecting the government's view that different technologies and services required distinct regulatory frameworks.

The technology-specific licensing model created significant regulatory distortions as the distinctions between services became increasingly blurred. The development of CDMA technology — which could provide both fixed-line and mobile services — created the category of "limited mobility" services: CDMA-based services that provided mobility within a restricted area, blurring the boundary between the BTS and CMTS categories. The question of whether limited mobility services should pay spectrum charges commensurate with full mobile services or with fixed-line services was the subject of protracted regulatory and legal dispute. The technology-specific model also created artificial barriers to technology choice: an operator holding a BTS licence was not permitted to provide mobile services even if the technology it used was technically capable of doing so, forcing licence-specific technology choices rather than market-led technology adoption.

The fragmentation of the licensing framework across multiple categories also created asymmetric competitive conditions. A full-mobility CMTS licensee and a limited-mobility CDMA operator might compete for the same customers with the same or similar services but face very different licence fee obligations, spectrum allocation arrangements, and regulatory conditions. This competitive asymmetry — in which licence category rather than competitive merit determined relative cost structures — distorted market competition and generated extensive

litigation between operators challenging the differential treatment. The Pradeep Baijal Committee's recommendation for a unified licensing framework, ultimately implemented through the Unified Access Services Licence in 2003, was primarily motivated by the need to eliminate these technology-specific distortions.

1.2 The UASL Transition (2003–2012)

The Unified Access Services Licence (UASL), introduced in November 2003, permitted licensees to provide both wireline and wireless services — using any technology — within a licensed telecom circle. This technology neutrality was the UASL's fundamental innovation, eliminating the distinction between BTS and CMTS licences and allowing operators to deploy the most commercially appropriate technology for their service area without regulatory constraint. UASL operators were subject to a single set of licence conditions, a single fee structure (annual licence fee as a percentage of AGR), and a single circle-based geographic licensing unit. The UASL framework significantly simplified the regulatory compliance landscape for multi-service operators.

The UASL framework governed the period of India's most rapid mobile market growth: from approximately 35 million mobile subscribers in 2003 to approximately 900 million by 2012. The simplicity of the unified access framework — relative to the preceding fragmented model — was a enabling factor for this growth, as it allowed operators to plan their service offerings and technology investments without regard to licence category boundaries. However, the UASL framework was also associated with the most controversial episode in Indian telecom regulatory history: the allocation of UASL licences (and associated spectrum) in 2007-08 at prices fixed in 2001, which the Supreme Court subsequently found to be constitutionally invalid in the 2G Spectrum Case. The inadequacy of the UASL's entry requirements and the absence of an auction mechanism for spectrum accompanying new UASL grants were the regulatory failings that enabled the 2G controversy.

1.3 The Unified Licence (2013–2023)

The Unified Licence (UL), introduced in DoT's 2012 Policy and made operational in 2013, further rationalised the telecom licensing framework. The UL framework provided a single, technology-neutral licence for the provision of a range of telecommunications services, with specific services authorised through service-specific schedules attached to the umbrella UL. An operator providing both cellular mobile services and national long-distance services would hold a single UL with an Access Services Schedule and an NLD Services Schedule. The UL framework covered: Access Services (wireline and wireless broadband within a service area); National

Long-Distance (NLD) services (long-distance traffic across service areas within India); International Long-Distance (ILD) services; Internet Services (fixed and wireless internet access, broadband); VSAT services; National Internet Exchange (NIXI) services; and Infrastructure Provider (IP-I) registration for passive infrastructure entities.

The UL framework also addressed the regulatory treatment of entities providing only infrastructure (as distinct from services to end-users). Infrastructure Provider Category-I (IP-I) entities — which provided passive infrastructure such as towers, ducts, dark fibre, and associated civil infrastructure — were registered under a separate IP-I registration (rather than licensed under the UL) and were exempted from the licence fee and most service-related licence conditions. IP-I entities were permitted to enter into sharing or leasing arrangements with UL-licensed service providers, enabling the growth of independent tower companies (such as Indus Towers, Bharti Infratel, and ATC India) that manage shared passive infrastructure for multiple operators. The UL framework's accommodation of the IP-I model was a significant enabler of infrastructure sharing, reducing the capital cost of mobile network deployment and improving the economics of coverage extension.

1.4 The National Long-Distance and International Long-Distance Regimes

National long-distance (NLD) and international long-distance (ILD) services — the carriage of telephone traffic across telecom circles and across international borders respectively — have had distinct licensing histories. NLD services were initially provided exclusively by BSNL (and by MTNL in its service areas). Private sector entry into NLD was permitted in 2000, following the Opening Up Policy announced by the government, and BSNL's monopoly was ended. ILD services were similarly provided exclusively by VSNL until its privatisation and the opening of international long-distance to competition in April 2002. The liberalisation of NLD and ILD services created competitive markets for long-distance traffic, dramatically reducing prices and improving quality.

The separate NLD and ILD licence categories were maintained in the UL framework as service-specific schedules. NLD licensees were required to build backbone transmission infrastructure spanning multiple service areas; ILD licensees were required to establish international connectivity (typically through submarine cable capacity or satellite links). The NLD/ILD licensing framework also addressed the issue of carrier selection: the ability of subscribers to choose their preferred NLD or ILD carrier for individual calls, enabling competition for long-distance traffic. The technical and operational complexity of carrier selection — requiring integration between access networks and multiple backbone carriers — was a regulatory implementation challenge that was only partially resolved in practice.

CHAPTER 2

The Unified Licence Regime: Conditions and Obligations

2.1 Structure of the Unified Licence

The Unified Licence issued by the Department of Telecommunications comprises a main licence document and service-specific schedules. The main licence document sets out the overarching terms and conditions applicable to all service authorisations held by the licensee: security conditions (including lawful interception, subscriber verification, and equipment security obligations); financial conditions (annual licence fee as a percentage of AGR, spectrum usage charges, and bank guarantee requirements); general conditions (covering corporate governance, inspection rights, record-keeping obligations, and termination provisions); and the licensee's acknowledgement of the government's rights in spectrum and other public resources. The service-specific schedules add conditions specific to each authorised service category: coverage obligations, quality of service benchmarks, spectrum-related conditions, and other service-specific requirements.

The security conditions in UL licences are among the most operationally significant and commercially burdensome conditions. These conditions, which were updated most recently in 2022 in the context of the Trusted Telecom Portal framework, include: the obligation to ensure that all critical network equipment is from approved sources (the Trusted Products List); the obligation to maintain subscriber verification systems and to verify subscriber identity before activating services; the obligation to maintain and provide lawful interception capability for authorised interception orders; the obligation to report cybersecurity incidents to CERT-In within prescribed timelines; and the obligation to cooperate with national security agencies including providing access to networks and data as required by lawful directions. Non-compliance with security conditions carries the most severe regulatory consequences including licence revocation in serious cases.

The financial conditions of UL licences have been the source of the most significant commercial and legal disputes in the Indian telecom sector. The annual licence fee — calculated as a percentage (varying by service category) of Adjusted Gross Revenue (AGR) — is the primary recurring financial obligation. The spectrum usage charge (SUC) — a separate annual levy calculated as a percentage of AGR (at varying rates depending on the frequency band, the amount of spectrum held, and whether the spectrum was acquired through auction) — is an additional significant financial obligation. Together, these two charges represent a substantial

portion of operators' revenue, and their precise calculation (particularly the definition of the AGR base) has been the subject of the AGR litigation discussed extensively in Booklets I, II, and IV of this series.

2.2 Coverage and Rollout Obligations

UL licences impose rollout obligations on access service providers: obligations to deploy network infrastructure and to provide service coverage to specified percentages of districts and villages within prescribed timelines. These obligations are designed to ensure that licensees actually deploy networks and provide services throughout their licensed service areas — not merely in the commercially most attractive urban locations. The specific rollout milestones vary by service area, technology, and service category, and are prescribed in the service-specific schedules to the UL. Non-fulfilment of rollout obligations may attract financial penalties (including forfeiture of bank guarantees provided as performance security), and in the most serious cases, revocation of the relevant service authorisation.

The enforcement of rollout obligations has been a persistent regulatory challenge. Self-reporting by licensees of rollout compliance has sometimes been inaccurate or optimistic, and DoT's capacity to independently verify rollout compliance across India's 22 telecom circles has been limited. The introduction of automated network monitoring systems — tracking active base stations and coverage data from operators' network management systems — has improved the accuracy of rollout compliance assessment, though questions about the adequacy of coverage (as distinct from mere deployment of base stations) remain. TRAI's QoS drive tests provide additional data on actual coverage and service quality, supplementing the rollout compliance data self-reported by operators.

2.3 AGR Definition and Licence Fee Computation

The computation of Adjusted Gross Revenue (AGR) — the base on which the annual licence fee percentage is applied — has been the most commercially significant and most contested aspect of UL licence compliance. As discussed in detail in Booklet I (Chapter 2) and Booklet IV (Chapter 2), the Supreme Court's judgment in the AGR Case (2020) definitively held that AGR encompasses the total gross revenue of the licensed entity from all sources — not merely revenue from licensed telecom activities. This broad definition of AGR means that revenue from sources such as dividends, interest income, capital gains, rental income from buildings, and revenue from non-telecom businesses carried out under the same licensed entity falls within the AGR base for licence fee computation purposes.

The practical consequences of the AGR judgment for licence fee computation are significant. Operators must now include in their AGR computations all revenue that flows through the licensed entity, regardless of whether it arises from licensed telecom activities. This requires careful corporate structuring: operators may seek to organise their non-telecom businesses in separate entities (subsidiaries or affiliates) that do not hold telecom licences, so that non-telecom revenue is not included in the licensed entity's AGR. However, revenue from inter-company transactions — such as management fees, shared service charges, or intra-group financing — may still need to be included in AGR if it represents income of the licensed entity. The forensic accounting required to correctly compute AGR in the context of complex corporate groups is a significant compliance challenge.

The Telecommunications Act, 2023's silence on the definition of AGR — leaving the definition to be prescribed by rules — is a significant point of interest for the industry. The government has the opportunity, through rule-making, to prescribe a more operator-friendly definition of the revenue base for authorisation fees under the new framework. Whether it will do so — potentially reversing the effective commercial impact of the AGR Case — is a matter of ongoing industry speculation and government consideration. Any modification of the AGR definition in the 2023 Act's implementing rules would need to be carefully structured to avoid constitutional challenge on the ground that it amounts to a modification of licences in a manner that reduces the financial obligations of operators in ways that are inconsistent with the AGR Case's constitutional holding.

CHAPTER 3

The Authorisation Framework under the Telecommunications Act, 2023

3.1 The Conceptual Shift from Licence to Authorisation

The Telecommunications Act, 2023's replacement of "licences" with "authorisations" as the primary regulatory permission for telecommunications activity is more than a terminological change. It reflects a fundamental conceptual shift from a contractual licensing model — in which a telecom permission is characterised as a specific contract between the government as licensor and the operator as licensee — to a regulatory authorisation model — in which the permission is characterised as an administrative grant by the government in its capacity as regulator. This conceptual distinction has important practical implications for the legal framework governing the relationship between the government and authorised entities, the nature of the conditions that may be imposed, and the remedies available to both parties in the event of disputes.

Under the contractual licensing model, the licence fee, conditions, and mutual obligations were determined by the specific terms of the licence agreement. Modifications to these terms required agreement between the government and the licensee (or, in extreme cases, unilateral modification by the government which could be challenged as a breach of contract). Disputes about the interpretation or enforcement of licence conditions were governed by the law of contract, supplemented by administrative law principles where the government was acting in a public capacity. The AGR Case is the most dramatic illustration of how contractual interpretation disputes can generate enormous commercial and legal uncertainty in a contractual licensing framework.

Under the regulatory authorisation model, the conditions of authorisation are determined by statute and subsidiary legislation — not by the specific terms of a bilateral agreement. The government may modify authorisation conditions through changes to the relevant rules or regulations, subject to constitutional constraints (including the protection of legitimate expectations and the right against arbitrary action). Disputes about the interpretation or enforcement of authorisation conditions are governed by administrative law — the law governing the exercise of statutory powers by public authorities. The regulatory authorisation model provides greater flexibility for the government to update conditions as technology and market conditions evolve, while also providing operators with the protection of administrative law's procedural safeguards (notice, hearing, reasoned decisions, judicial review).

3.2 Class Authorisation: Implementation and Scope

The class authorisation mechanism under Section 3(2) of the Telecommunications Act, 2023 — enabling the Central Government to authorise categories of telecommunications activities without requiring individual applications from each operator — is a potentially transformative tool for simplifying market entry in the telecom sector. The concept of class authorisation (or "general authorisation") is well established in European telecommunications regulation under the Electronic Communications Code, where it has replaced individual licensing for the vast majority of electronic communications services. In the EU, operators are not required to obtain individual licences before starting operations — they simply notify the national regulatory authority that they are beginning to provide services as authorised entities under the applicable general authorisation.

In India, class authorisation is likely to be most applicable to categories of service where the regulatory concerns are manageable at a class level rather than requiring individual scrutiny of each applicant. Internet Service Provider services — particularly for small and medium-scale ISPs providing broadband access in limited geographic areas — are the category most obviously suited to class authorisation. Under the current framework, ISPs must obtain individual licences from DoT with associated documentation, financial requirements, and processing times. A class authorisation framework that permitted ISPs meeting specified minimum criteria (financial standing, compliance with security conditions, adherence to prescribed technical standards) to begin operations without individual licence approval would significantly reduce barriers to entry for local and community broadband providers.

Class authorisation will also likely apply to the rapidly growing category of Wi-Fi service providers under the PM-WANI (Prime Minister Wi-Fi Access Network Interface) framework. Under PM-WANI, Public Data Offices (PDOs) — small retailers, post offices, or community organisations that install and operate Wi-Fi hotspots — are authorised to provide public Wi-Fi access without individual telecom licences. This framework — which was introduced administratively before the 2023 Act and has resulted in the registration of tens of thousands of PDOs — is the prototype for class authorisation at a granular, local level. The 2023 Act's class authorisation provision provides a stronger statutory basis for the PM-WANI framework and for similar models that will inevitably emerge as connectivity solutions continue to evolve.

3.3 Authorisation Conditions: Continuity and Evolution

The conditions of authorisations under the Telecommunications Act, 2023 will, in most cases, carry forward the substantive obligations of existing UL licences while potentially updating

or adding conditions that reflect the 2023 Act's new regulatory framework. Section 3(4) of the Act specifies the subject matters for which authorisation conditions may be prescribed: public emergency services; national security; privacy of messages; quality of service; and payment of fees as a percentage of revenue. These broad categories encompass all the major existing licence condition categories, ensuring continuity with the existing framework while providing a clear statutory basis for the new framework.

New authorisation conditions that may be introduced under the 2023 Act framework include: conditions implementing the right-of-way obligations and open access requirements of Chapter IV; conditions implementing the trusted equipment standards of Chapter VI; conditions relating to the regulatory sandbox framework of Section 32; and conditions relating to the Digital Bharat Nidhi contributions framework. The development of these new conditions — through a transparent consultation process involving TRAI's recommendations and DoT's implementation — will be one of the most important regulatory developments of the coming years. Practitioners advising operators on the migration from licences to authorisations should engage actively with this process to ensure that operator interests are effectively represented.

CHAPTER 4

Categories of Authorisation: Access, NLD, ILD and Internet

4.1 Access Services Authorisation

Access Services — the provision of broadband and voice services directly to end-users over wireline or wireless infrastructure — is the most commercially significant authorisation category. The vast majority of telecom revenue in India is derived from access services: mobile broadband and voice (the dominant service), fixed wireless broadband (a growing category as operators deploy 4G and 5G fixed wireless access), and wireline broadband (through fibre to the home and related technologies). Access service providers hold the largest spectrum assignments, deploy the most extensive infrastructure, and serve the most consumers.

The conditions of Access Services authorisations are the most comprehensive of all authorisation categories, reflecting the breadth of regulatory concerns associated with the provision of services to end-users. Coverage obligations require access service providers to provide service to specified percentages of districts, tehsils, and villages within their licensed service areas. Quality of service obligations prescribe minimum performance standards for network availability, call quality, data speed, and complaint resolution. Security conditions — including subscriber verification, lawful interception capability, and trusted equipment requirements — apply in full. Consumer protection obligations — including billing transparency, MNP portability, and DND registry compliance — are part of the access service authorisation conditions.

The geographic organisation of Access Services authorisations into telecom circles — rather than into a single national licence — reflects the historical circle-based licensing architecture that was inherited from the pre-liberalisation era. India is divided into 22 telecom circles corresponding roughly to state or regional boundaries. Each access service licensee holds a separate authorisation for each circle in which it operates. A national mobile operator serving all 22 circles holds 22 separate access service authorisations, each with its own associated spectrum assignments, rollout obligations, and fee obligations. The multi-circle, multi-authorisation structure creates administrative complexity and has been identified as a potential area for simplification under the 2023 Act framework — though the circle architecture is so deeply embedded in the industry's operational and regulatory fabric that a transition to a single national licence would require careful management.

4.2 National Long-Distance Authorisation

National Long-Distance (NLD) authorisation permits the provision of voice and data connectivity across telecom circle boundaries within India. NLD operators build and operate inter-circle backbone transmission infrastructure — typically optical fibre networks spanning multiple states — and provide wholesale connectivity services to access service operators, internet service providers, and enterprise customers. The NLD market in India has evolved from a duopoly (BSNL and a few private operators) to a competitive market with multiple providers, driven by extensive private investment in optical fibre infrastructure following liberalisation in 2000.

The conditions of NLD authorisations include: infrastructure deployment obligations (requiring NLD licensees to build minimum backbone capacity within prescribed timelines); quality of service standards for end-to-end connectivity; interconnection obligations (requiring NLD licensees to interconnect with other NLD operators and with access service operators on non-discriminatory terms); and security conditions applicable to backbone networks. NLD operators are also subject to the AGR-based licence fee, though the AGR rate for NLD services differs from that for access services. The NLD authorisation framework under the 2023 Act will need to address the growing role of NLD operators in providing not merely traditional voice backhaul but also content delivery network (CDN) services and cloud connectivity — uses that were not contemplated in the original NLD licence conditions.

4.3 Internet Service Provider Authorisation

Internet Service Provider (ISP) authorisation permits the provision of internet access services to end-users or to other service providers. ISP authorisations are divided into three categories under the existing framework: Category A (national ISP, permitted to establish internet infrastructure throughout India); Category B (ISP for a specific state or metro area); and Category C (ISP for a specific city or district). The three-tier structure reflects the different scales of internet service provision, with different financial and infrastructure requirements for each category. The liberalisation of the ISP sector in 1998 — which ended VSNL's monopoly on internet access — was a key catalyst for India's IT services and e-commerce growth.

The ISP authorisation framework under the Telecommunications Act, 2023 will need to address several emerging regulatory questions. First, the regulatory treatment of ISPs that use licensed spectrum (Wi-Fi, LTE, and 5G-based fixed wireless access) to provide broadband: these operators straddle the boundary between ISP and access service operator, and their regulatory classification affects their spectrum, fee, and licence condition obligations. Second,

the regulatory treatment of community networks — local broadband cooperatives or community organisations that provide internet access to underserved communities using shared infrastructure — which are an increasingly important vehicle for last-mile broadband connectivity in rural and remote areas. Third, the integration of the PM-WANI framework (which permits Wi-Fi-based internet service without an ISP licence) with the broader ISP authorisation framework.

CHAPTER 5

Spectrum Planning: The National Frequency Allocation Plan

5.1 The National Frequency Allocation Plan (NFAP)

The National Frequency Allocation Plan (NFAP) is the master regulatory instrument governing the allocation of the radio frequency spectrum in India. The NFAP — maintained and updated by the Wireless Planning and Coordination (WPC) Wing of the Department of Telecommunications — specifies the allocation of specific frequency bands to different categories of users (telecommunications, broadcasting, defence, scientific research, meteorology, navigation, and others) and aligns India's spectrum allocations with the ITU's international Radio Regulations. The most recent edition of the NFAP (NFAP 2022) reflects the outcomes of the ITU World Radiocommunication Conference 2019 (WRC-19) and incorporates spectrum allocations for new services including low-earth-orbit satellite broadband and 5G millimetre-wave communications.

The development of the NFAP involves extensive consultation between the WPC Wing, the telecom sector (through TRAI's spectrum recommendations), the defence services, the scientific community, and other spectrum users. The process of updating the NFAP is governed by a formal inter-departmental process involving the Standing Advisory Committee on Frequency Allocation (SACFA), which provides a multi-stakeholder forum for reconciling competing spectrum use demands. SACFA's membership includes representatives from DoT, MoD (Ministry of Defence), the Department of Space, ISRO, meteorological agencies, the civil aviation authority, and other spectrum users. The SACFA process can be slow — sometimes taking years to resolve complex frequency allocation questions — but provides the multi-stakeholder consensus needed for durable spectrum allocation decisions.

The NFAP's allocation of spectrum to different services reflects a careful balance between: civil telecommunications (which requires large quantities of commercially valuable spectrum in bands suited to mobile broadband deployment); defence (which requires exclusive or protected access to spectrum for military communications, radar, and electronic warfare); broadcasting (which requires spectrum for terrestrial, satellite, and cable television distribution); scientific research and meteorology (which require protected access for radio telescopes, weather radar, and other scientific instruments); and other specialised users. The progressive freeing of spectrum from defence and other users for commercial telecommunications use — through a

process of frequency band refarming supported by the Digital Bharat Nidhi — is a key determinant of spectrum availability for future mobile broadband services.

5.2 5G Spectrum Planning

The planning and management of spectrum for 5G services represents the most significant current challenge for India's spectrum management authorities. 5G services require spectrum in three principal categories: sub-1 GHz bands (for wide-area rural coverage); mid-band spectrum (3300 MHz to 4200 MHz, for the optimal combination of coverage and capacity that is the backbone of most 5G deployments); and millimetre-wave spectrum (24.25 GHz and above, for extremely high data rate applications in dense urban environments). India's NFAP 2022 provides allocations for 5G in all three categories, and the 2022 spectrum auction offered spectrum in 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz, and 26 GHz bands.

The mid-band 3300 MHz band (3300-3670 MHz in India) is the most strategically important spectrum for 5G deployment. The global harmonisation of mid-band 5G spectrum — with most major markets deploying 5G in or near this band — creates economies of scale in device and equipment manufacturing that reduce costs and improve availability. India's 2022 auction of 3300 MHz spectrum (in 20 MHz blocks) enabled the three major operators to acquire mid-band 5G spectrum, though the relatively high prices and the concentration of bids in metropolitan areas have raised concerns about the pace and geographic breadth of mid-band 5G deployment in India. The WPC Wing's management of the 3300 MHz band — ensuring that guard bands, power limits, and co-existence conditions are appropriately specified — is critical for enabling the full deployment potential of mid-band 5G.

The 26 GHz millimetre-wave band (24.25-27.5 GHz in India), auctioned for the first time in 2022, attracted significantly less bidding interest than the mid-band spectrum due to the challenging propagation characteristics of millimetre-wave frequencies (high propagation loss, limited penetration through buildings and foliage, and sensitivity to weather conditions). Reliance Jio, which acquired the largest millimetre-wave allocation in the 2022 auction, has pursued a strategy of deploying 26 GHz 5G for fixed wireless access in specific urban locations. The long-term role of millimetre-wave in India's 5G landscape will depend on the development of cost-effective deployment solutions (particularly self-backhauled small cells) that address the coverage limitations of millimetre-wave propagation.

5.3 Spectrum Refarming and Band Migration

Spectrum refarming — the process of migrating existing services out of frequency bands in order to make those bands available for more spectrally efficient modern technologies — is an ongoing dimension of spectrum management policy. In India, the 900 MHz band was originally allocated to the first generation of GSM cellular services and has since been progressively refarmed for LTE and 5G use as operators have migrated their 2G subscribers to more modern technologies. The 2100 MHz band (IMT-2000 / UMTS band) was the primary band for 3G services in India and is being progressively reused for 4G and 5G. The 700 MHz band — released for commercial telecom use from its previous allocation to the first digital terrestrial television multiplex — is one of the most valued bands for rural broadband coverage given its excellent propagation characteristics, but has attracted limited bidding in successive auctions due to the high reserve prices.

The legal framework for spectrum refarming requires careful management of the transition between incumbent users (who hold current spectrum assignments) and new users (to whom refarmed spectrum is allocated). Incumbent spectrum assignees have legally protected rights to use their assigned frequencies for the duration of their spectrum assignment. Any compulsory migration of incumbents before the end of their assignment period requires legal justification (based on national interest or technical interference grounds) and compensation. In practice, spectrum refarming in India has typically been managed through voluntary migration incentivised by the offer of equivalent spectrum in the refarmed band, rather than through compulsory measures, avoiding the legal complications of forced migration.

CHAPTER 6

Spectrum Auctions: Law, Process and Practice

6.1 Constitutional and Statutory Basis for Spectrum Auctions

As discussed in Booklet I (Chapter 7), the constitutional requirement for spectrum auctions for commercial purposes was established by the Supreme Court in Centre for Public Interest Litigation v. Union of India, (2012) 3 SCC 1. The Court's holding — that spectrum, as a natural resource belonging to the people of India, must be allocated for commercial purposes through transparent and competitive processes (specifically, auctions) — has been the foundational principle of India's spectrum management since 2012. The Telecommunications Act, 2023 gives statutory expression to this constitutional requirement through the First Schedule, specifying the categories of spectrum for which auction is mandated.

The statutory authority for conducting spectrum auctions under the 2023 Act flows from Section 4, which empowers the Central Government to assign spectrum and prescribes that assignment for the purposes specified in the First Schedule shall be by auction. The detailed rules governing the conduct of auctions — the auction format, eligibility criteria, reserve prices, payment terms, and post-auction conditions — are prescribed by the Central Government through rules under Section 42. TRAI makes recommendations on key auction parameters (reserve prices, block sizes, spectrum caps) under its advisory functions, which DoT considers in developing the auction Information Memorandum. The Information Memorandum published before each auction — a document of several hundred pages — is the comprehensive legal and operational guide for auction participants.

6.2 Auction Methodology: SMRA and Variants

India's spectrum auctions use the Simultaneous Multiple Round Ascending (SMRA) format, in which spectrum in multiple bands and multiple telecom circles is offered simultaneously. Bidders participate in multiple sequential rounds, submitting bids for spectrum lots in each round at prices at or above the current round price (which is set by an activity rule based on bid activity in the previous round). Rounds continue until there is no excess demand for any lot, at which point the auction closes and the highest bidders in each lot are declared the winners. The SMRA format promotes price discovery through competitive bidding and allows bidders to construct spectrum portfolios across multiple bands and circles, though it is susceptible to problems of "exposure" (bidders being stuck with partial portfolios if they are unsuccessful in some lots).

Variants of the basic SMRA format have been used in Indian spectrum auctions to address specific design challenges. The 2021 auction introduced a combinatorial clock auction (CCA) element for the 700 MHz band, allowing operators to bid for combinations of spectrum lots rather than individual lots — addressing the exposure problem in a band where the value of spectrum depends significantly on whether the operator acquires a minimum threshold quantity. The 2022 auction employed a standard SMRA format across all bands, with eligibility points and activity rules designed to maintain competitive pressure throughout the bidding process. The evolution of auction formats reflects the accumulated experience of Indian spectrum auctions and the ongoing development of auction design as a discipline.

6.3 Reserve Price Determination

The determination of reserve prices for spectrum auctions — the minimum acceptable bid for each lot — is one of the most economically and politically sensitive aspects of spectrum management. Reserve prices that are set too high result in unsold spectrum and constrain operators' ability to build competitive networks; reserve prices that are set too low potentially undervalue a public resource and may attract criticism as a subsidy to private operators. TRAI's spectrum pricing recommendations (issued through the consultation process and published as recommendations to the Central Government) form the basis for DoT's reserve price decisions, which are reflected in the auction Information Memorandum.

TRAI's spectrum pricing methodology has evolved considerably over the course of India's auction history. Early methodologies relied heavily on international benchmarking — comparing per-MHz-per-pop prices in comparable markets globally. More recent methodologies incorporate demand modelling (estimating operator demand for spectrum based on subscriber growth projections, average revenue per user forecasts, and technology cost curves), capacity pricing (assessing the incremental revenue value of additional spectrum capacity to operators), and econometric analysis of previous Indian and comparable international auction outcomes. The complexity of these methodologies — and the sensitivity of the results to key modelling assumptions — means that spectrum pricing recommendations are inevitably subject to challenge from operators who disagree with TRAI's assumptions.

6.4 Post-Auction Spectrum Conditions

Following a spectrum auction, successful bidders receive a Letter of Intent (LoI) from DoT specifying the spectrum acquired, the payment terms, and the conditions of spectrum use. The conditions of spectrum use — specified in the LoI and incorporated in the spectrum assignment letter — include: the frequency band, block size, and geographic area of the assignment; the

duration of the assignment (up to twenty years under the 2023 Act framework); the spectrum usage charge (SUC) rate; rollout obligations (the timeline for commercial service launch using the assigned spectrum); spectrum cap compliance obligations; and conditions relating to spectrum sharing and trading.

Post-auction compliance monitoring — verifying that spectrum assignees are meeting their rollout obligations, paying their spectrum charges, and complying with technical conditions — is an ongoing regulatory function of the WPC Wing and DoT. The consequences of post-auction non-compliance range from financial penalties (including forfeiture of bank guarantees provided as performance security for rollout obligations) to cancellation of the spectrum assignment in the most serious cases of persistent non-compliance. The legal framework for enforcing post-auction conditions has been tested in several TDSAT proceedings where operators have challenged the adequacy of DoT's notice and hearing process before imposing penalties for rollout non-compliance.

CHAPTER 7

Spectrum Trading, Sharing and Leasing

7.1 Spectrum Trading: Legal Framework

Spectrum trading — the transfer of spectrum usage rights from one authorised entity to another for consideration — was formally permitted in India through DoT's spectrum trading guidelines issued in September 2015, following TRAI's recommendations. The Telecommunications Act, 2023 provides the statutory basis for spectrum trading under Section 7, empowering the Central Government to permit the transfer of spectrum assignment rights subject to prescribed conditions. The rationale for spectrum trading is to enable more efficient use of spectrum through market-based reallocation: spectrum that is not efficiently used by its current assignee can be transferred to an entity that can deploy it more productively.

The conditions for spectrum trading under the existing guidelines (which will be carried forward and updated under the 2023 Act framework) include: prior approval of DoT for each trading transaction; no change in the service area of the traded spectrum (spectrum assigned for use in a particular circle must be traded within the same circle); compliance with spectrum caps post-trade by both the buyer and the seller; payment of a spectrum trading fee to DoT; continuation of the rollout obligations associated with the traded spectrum by the acquiring entity; and submission of the trading agreement to DoT. These conditions are designed to prevent spectrum hoarding (acquiring spectrum without intent to deploy it), to maintain competitive market structure (through spectrum cap enforcement), and to ensure that the government's financial interest in the spectrum is protected.

The spectrum trading market in India has been relatively thin compared to mature markets such as the United States and the United Kingdom, where spectrum trading is a well-established industry practice. The limited depth of the Indian spectrum trading market reflects several factors: the relatively small number of licensed operators (and hence potential buyers and sellers); the circle-based structure of spectrum assignments (which limits the ability to construct national spectrum portfolios through trading); and the relatively recent introduction of trading (2015) compared to some other markets. As India's spectrum management framework matures and as the commercial value of spectrum becomes more widely appreciated, spectrum trading activity is expected to grow.

7.2 Spectrum Sharing

Spectrum sharing — the simultaneous use of assigned spectrum by more than one entity through technical coordination — was permitted in India through DoT guidelines issued in November 2015. The sharing framework allows two operators to share spectrum in the same frequency band within the same service area, subject to conditions including: prior DoT approval; compliance with spectrum caps by both sharing partners; technical coordination to avoid harmful interference; and submission of a written sharing agreement. Spectrum sharing improves spectrum utilisation by allowing the capacity of an assigned spectrum block to be used by more than one operator, effectively increasing the productive use of the total spectrum resource.

The technical implementation of spectrum sharing in mobile networks has evolved significantly with the development of 4G and 5G technologies. LTE spectrum sharing technologies — including LTE Licensed Shared Access (LTE-LSA) and LTE Unlicensed (LTE-U) — enable operators to dynamically share spectrum between their respective networks using software-defined radio technologies. 5G New Radio (5G NR) supports even more sophisticated sharing arrangements through its flexible numerology and network slicing capabilities. The regulatory framework for spectrum sharing will need to evolve to accommodate these advanced sharing technologies, as the current guideline-based approach was designed for simpler static sharing arrangements.

7.3 Spectrum Leasing

Spectrum leasing — the temporary grant of spectrum usage rights by an assignee to another entity for a specified period — is distinct from spectrum trading (permanent transfer) and spectrum sharing (simultaneous use). A spectrum assignee that has acquired more spectrum than it currently needs may lease some of its spectrum to an enterprise customer or to another operator for a defined period, with the lessor retaining the underlying assignment. Spectrum leasing has particular relevance for enterprise 5G deployments: large manufacturing plants, logistics warehouses, and port operators may wish to lease spectrum from a licensed operator rather than acquiring their own spectrum assignment, enabling them to deploy private 5G networks without participating in spectrum auctions.

The legal framework for spectrum leasing under the Telecommunications Act, 2023 is to be prescribed by rules. The key questions that the rules will need to address include: the conditions under which leasing is permitted (both the categories of spectrum that may be leased and the categories of lessee that may lease spectrum); the duration of permissible leases; the compensation framework (whether the lessee pays the lesser directly or whether payments must be routed through DoT); and the impact of spectrum leasing on the SUC obligations of the spectrum assignee (whether the assignee pays SUC on leased spectrum throughout the lease

period, or whether the SUC obligation transfers to the lessee). The answers to these questions will determine the commercial viability of spectrum leasing as a mechanism for enabling private 5G network deployments.

CHAPTER 8

Passive Infrastructure: Towers and Ducts

8.1 The Tower Industry in India

India has one of the world's largest telecommunications tower ecosystems, with approximately 700,000 towers deployed by independent tower companies, operator-owned tower subsidiaries, and government entities. The scale of this tower ecosystem reflects the depth of India's mobile network infrastructure and the commercial logic of infrastructure sharing: rather than each operator deploying its own towers (at significant capital and operating cost), most towers are shared by multiple operators, each of which pays a tenancy fee for access. The separation of passive infrastructure ownership (in independent tower companies) from active network operation (by licensed service providers) has been one of the most commercially significant structural developments in Indian telecom, enabling the rapid network expansion that drove India's mobile broadband revolution.

The principal independent tower companies in India include Indus Towers (formed by the merger of Bharti Infratel and the Indus Towers JV, now one of the world's largest tower companies by tower count), American Tower Corporation India, Brookfield Infrastructure India, and GTL Infrastructure. Together with operator-owned tower assets (primarily BSNL's tower portfolio), these entities provide the passive infrastructure that supports India's mobile networks. The tower companies' business model is based on co-location revenue: deploying multiple telecom operators' active equipment (antennas, radios, and associated transmission equipment) on a single tower, sharing the capital cost of the tower, land, power, and shelter among multiple tenants.

8.2 Infrastructure Provider Category I: Legal Framework

Infrastructure Provider Category I (IP-I) registration, issued by DoT under the existing Unified Licence framework, is the primary regulatory framework for entities that own and operate passive telecom infrastructure. IP-I entities are not licensed to provide telecommunications services directly to end-users; they are registered as infrastructure providers that lease their passive infrastructure to licensed service providers. The IP-I registration framework exempts infrastructure providers from the licence fee obligations applicable to service providers (since they are not providing services to end-users and therefore have no AGR from licensed services) while subjecting them to conditions relating to: non-discriminatory access (providing access to all

licensed operators on commercially reasonable and non-discriminatory terms); safety and structural standards (ensuring that towers meet prescribed engineering and safety standards); electromagnetic field (EMF) exposure limits (ensuring that tower deployments do not cause harmful radiation exposure to neighbouring populations); and RoW compliance.

The EMF exposure limits for telecommunications towers are among the most politically sensitive aspects of tower deployment regulation. Public concern about health effects of electromagnetic radiation from mobile towers — while not supported by the scientific consensus on the health effects of non-ionising radiation at the power levels used by telecommunications equipment — has generated significant opposition to tower deployments in residential areas and near schools and hospitals. TRAI, DoT, and the Department of Telecommunications have repeatedly published scientific guidance confirming the safety of tower deployments at prescribed EMF exposure limits, which are set well below the internationally recommended safe exposure levels established by ICNIRP (International Commission on Non-Ionizing Radiation Protection). Courts have generally upheld tower deployments that comply with prescribed EMF limits, rejecting claims that compliance with official limits is insufficient to protect public health.

8.3 Underground Duct Infrastructure

Underground duct infrastructure — conduits through which fibre optic cables, copper cables, and associated telecommunications infrastructure can be laid underground — is a critical enabler of dense fibre network deployment in urban areas. The ducts protect cables from physical damage and weather, and enable future cable installations or replacements without the need for repeated trenching of roads and footpaths. Shared duct infrastructure — open-access underground conduits that multiple operators can use — reduces the cost of fibre deployment compared to each operator trenching its own cable routes, and reduces the disruption to urban infrastructure caused by repeated road opening.

The legal framework for underground duct infrastructure involves several dimensions: the right to trench roads and lay ducts (governed by the RoW framework in Chapter IV of the Telecommunications Act, 2023, local authority road-opening permissions, and utility coordination requirements); the framework for open-access shared ducts (developed under DoT's passive infrastructure sharing guidelines and the National Digital Communications Policy, 2018); and the obligations of utilities (electricity, water, gas) to accommodate telecommunications ducts in their infrastructure. The National Digital Communications Policy, 2018 called for the creation of a national duct infrastructure — requiring utilities to make ducts available for fibre deployment as part of new infrastructure construction (a "dig once" approach) — but the implementation of this policy has been partial and inconsistent across states and utilities.

CHAPTER 9

Active Infrastructure Sharing

9.1 Active Infrastructure Sharing: Concept and Categories

Active infrastructure sharing refers to the sharing of active telecommunications equipment — radio access equipment including antennas, radios, and base station hardware — between two or more licensed operators. Unlike passive infrastructure sharing (which involves the sharing of towers, ducts, and other structural elements), active infrastructure sharing involves the sharing of the actual telecommunications radio equipment, potentially including the spectrum itself in some arrangements. Active sharing arrangements can take various forms: Multi-Operator Radio Access Network (MORAN) sharing (sharing of physical radio hardware with separate software instances for each operator); Multi-Operator Core Network (MOCN) sharing (sharing of both hardware and spectrum, with separate core networks for each operator); and virtual RAN (vRAN) sharing (sharing of virtualized radio access network functions hosted in cloud infrastructure).

The regulatory framework for active infrastructure sharing in India is governed by DoT's infrastructure sharing guidelines and by the spectrum sharing framework described in Chapter 7. MORAN sharing — sharing hardware without sharing spectrum — is generally permitted subject to prior DoT approval and compliance with competition and security conditions. MOCN sharing — which involves spectrum pooling and is technically the most efficient form of sharing — is treated as spectrum sharing for regulatory purposes and is subject to the spectrum sharing framework (including the requirement for prior DoT approval and compliance with spectrum caps). Virtual RAN sharing, while technically innovative, raises novel regulatory questions about the application of traditional sharing frameworks to software-defined network functions.

9.2 Competition Implications of Active Sharing

Active infrastructure sharing raises significant competition concerns that must be balanced against the efficiency benefits of sharing. The primary competition concern is that sharing arrangements between competitors may facilitate the exchange of commercially sensitive information (network capacity, subscriber density, traffic data) that reduces competitive rivalry between the sharing partners. Antitrust authorities in several jurisdictions have examined active sharing arrangements for potential competition law infringements. In India, the Competition Commission of India (CCI) has jurisdiction over active sharing arrangements that may have anti-competitive effects. DoT's approval process for sharing arrangements must therefore be

coordinated with CCI oversight to ensure that competition concerns are adequately addressed.

The National Digital Communications Policy, 2018 explicitly encouraged infrastructure sharing, including active sharing, as a means of reducing the capital cost of network deployment and improving network economics for operators. The policy recognised that in India's competitive mobile market, where three or four operators compete for the same subscribers, active sharing can preserve competitive intensity while reducing the financial pressure that might otherwise force individual operators into financial distress or market exit. The government's support for sharing as a policy tool reflects the tension between two objectives: promoting competitive markets (which argue for separate networks) and promoting financial viability for infrastructure investment (which argues for shared networks).

CHAPTER 10

Optical Fibre Infrastructure

10.1 Fibre as National Infrastructure

Optical fibre infrastructure — cables that transmit data as pulses of light rather than as electrical signals — is the foundational medium for high-speed telecommunications. India's telecommunications networks are underpinned by an extensive national optical fibre infrastructure: inter-city backbone routes (connecting major cities and network hubs), metro ring networks (providing high-capacity connectivity within cities), and increasingly last-mile fibre (connecting homes and businesses directly to the fibre network). The National Optical Fibre Network (NOFN) programme — now BharatNet — has extended fibre to gram panchayats throughout India, creating a national digital backbone that is the prerequisite for universal broadband access.

The legal framework for optical fibre deployment encompasses several distinct dimensions. The right-of-way framework (Chapter IV of the Telecommunications Act, 2023) provides the primary regulatory basis for laying fibre in, over, or under public and private property. The IP-I registration framework permits independent fibre infrastructure operators (dark fibre providers) to own and lease fibre infrastructure without holding a service licence. The Competition Act, 2002 framework may require that operators with significant market power in fibre bottleneck infrastructure provide open access to competitors on reasonable, non-discriminatory terms. The Telecommunications Act, 2023's RoW provisions and critical infrastructure framework collectively strengthen the legal position of fibre infrastructure operators while also subjecting certain fibre assets (particularly those integral to critical national communications infrastructure) to enhanced security obligations.

10.2 Fibre to the Home (FttH) and Last-Mile Connectivity

Fibre to the Home (FttH) — the deployment of optical fibre directly to residential and business premises — is the most capable and future-proof last-mile broadband technology. An FttH connection can deliver gigabit-speed broadband with extremely low latency, capable of supporting the most demanding applications including 8K video streaming, high-definition video conferencing, cloud gaming, and smart home connectivity. India's FttH deployment has accelerated significantly in recent years, driven by competitive investment from Reliance Jio (through its JioFiber and JioAirFiber products), Bharti Airtel (through its Airtel Xstream Fiber

product), and several regional fixed broadband operators.

The legal challenges for FttH deployment relate primarily to building access and the right-of-way framework for in-building cabling. An FttH deployment requires not only the external fibre cable (running from the street cabinet to the building) but also in-building cabling (running from the building's entrance to each individual apartment or office). The right to install in-building cabling requires the consent of the building owner (for private buildings) or the relevant authority (for residential societies, commercial complexes, or government buildings). Building owners and residents' associations in India have historically been reluctant to grant right-of-way for FttH in-building cabling, sometimes demanding substantial payments or imposing unreasonable conditions. The Telecommunications Act, 2023's right-of-way provisions apply to "any property" — potentially including in-building installations — but the specific rules governing in-building RoW are to be prescribed.

CHAPTER 11

Submarine Cables

11.1 India's Submarine Cable Infrastructure

India's international telecommunications connectivity is primarily provided through submarine optical fibre cables connecting India to the global internet and international telephone network. India has submarine cable landing stations at Mumbai, Chennai, Cochin, Tuticorin, and Trivandrum, connecting to more than fifteen submarine cable systems that provide international connectivity to Europe, the United States, Southeast Asia, the Middle East, and Africa. These submarine cables carry the vast majority of India's international data traffic, making them critical national infrastructure whose security and reliability are matters of national importance.

The legal framework for submarine cables in India involves a complex intersection of domestic telecommunications law (governing the landing station operators and their licences), international maritime law (governing the cables in international waters under the ITU's International Convention for the Protection of Submarine Telegraph Cables, 1884, and related instruments), and national security law (governing the security conditions applicable to landing stations and the landing station operators). The landing station operator holds an ILD licence (or under the 2023 Act framework, an international long-distance authorisation) and is subject to all the associated security conditions, including the requirement to comply with lawful interception directions and to implement prescribed security standards for network equipment.

11.2 Security of Submarine Cable Infrastructure

The security of submarine cable infrastructure — both physical security (protection of cables from damage by anchors, fishing activities, and deliberate sabotage) and logical security (protection of cable systems from cyber attack and unauthorised access) — is a matter of growing national security concern globally. Several high-profile submarine cable cuts (caused by ship anchors or geological events) have disrupted internet connectivity in multiple countries, illustrating the consequences of dependence on a small number of submarine cable routes. The deliberate targeting of submarine cable infrastructure in the context of geopolitical conflicts has also been widely discussed as a potential vulnerability for states whose international connectivity depends on a small number of submarine cable landing stations.

The Telecommunications Act, 2023's critical telecommunication infrastructure (CTI) framework — which empowers the Central Government to designate specified network elements

as critical and to impose enhanced security obligations on CTI — is the primary legal basis for addressing submarine cable security concerns. India's submarine cable landing stations and the cable systems themselves are obvious candidates for CTI designation. The security measures that may be required as a condition of CTI designation — including physical security requirements for landing station facilities, logical security requirements for cable monitoring and management systems, and protocols for incident reporting and response — will need to be carefully calibrated to address real security risks without imposing disproportionate costs on operators.

CHAPTER 12

5G Infrastructure: Legal Dimensions

12.1 5G Deployment: Scale and Architecture

India's 5G rollout — which began with commercial service launches by Reliance Jio and Bharti Airtel in October 2022, following the 2022 spectrum auction — is one of the most significant infrastructure deployment programmes in India's telecommunications history. 5G networks are architecturally distinct from previous generations: they are characterised by dense small-cell deployments (requiring many more antenna sites than 4G for equivalent coverage at higher frequencies); software-defined networking (with network functions running as software on general-purpose hardware rather than on dedicated hardware appliances); network slicing (the ability to partition a single physical network into multiple logical networks optimised for different use cases); and edge computing (processing data at the network edge rather than in centralised data centres, enabling ultra-low-latency applications).

The legal challenges of 5G infrastructure deployment reflect its distinctive technical architecture. Dense small-cell deployments require access to a far larger number of sites than macro-cell deployments — potentially including lamp posts, utility poles, bus shelters, and building facades in urban areas. Securing right-of-way access to these diverse site types, at commercially reasonable cost and within acceptable timelines, is a major implementation challenge. The Telecommunications Act, 2023's right-of-way framework — with its deemed approval mechanism, fee caps, and anti-discrimination requirements — is directly relevant to addressing this challenge. However, the specific conditions applicable to the new site types required for 5G (micro-cells, streetworks installations, building-mounted antennas) will need to be specified in implementing rules.

12.2 Network Slicing and Legal Issues

5G network slicing — the ability to create multiple virtual networks on a single physical 5G infrastructure, each optimised for specific use cases — raises novel regulatory and legal questions. A network slice optimised for ultra-low-latency applications (such as industrial automation or vehicle-to-infrastructure communications) may have very different quality of service characteristics from a slice optimised for broadband data (such as consumer video streaming). The question of whether different network slices can be made available to different users at different prices — effectively enabling price discrimination based on service quality — is

at the heart of the net neutrality debate in the 5G context. TRAI's 2016 net neutrality regulations (the Non-Discriminatory Internet Access regulations) prohibit discriminatory pricing for internet access services; how these regulations apply to 5G network slices used for consumer internet access is a question that TRAI will need to address.

Network slicing also raises questions about the licensing framework applicable to entities that provide specific network slices to enterprise customers. An automotive manufacturer that uses a dedicated 5G network slice for vehicle-to-infrastructure communications in a specific factory campus — where the "network" consists of a virtualized slice of the licensed operator's 5G infrastructure — is not itself providing telecommunications services (the underlying infrastructure is provided by the licensed operator). But the manufacturer is operating within a private logical network that has characteristics resembling a telecommunications network. The regulatory treatment of such arrangements — and the obligations (if any) that apply to the enterprise customers of 5G network slices — is an area where the Telecommunications Act, 2023's implementing rules will need to provide clarity.

CHAPTER 13

Private Networks and Campus Deployments

13.1 Private 5G Networks: Policy and Legal Framework

Private 5G networks — dedicated 5G deployments for specific enterprise or industrial users rather than for public mobile broadband — are an increasingly important use case for 5G technology globally. Industrial manufacturers, mining companies, port operators, logistics warehouses, and hospital campuses are deploying private 5G networks to support smart factory automation, autonomous vehicles, real-time asset tracking, and remote surgery applications that require the ultra-low latency, high reliability, and customisable quality of service characteristics of 5G.

India's policy framework for private 5G networks has evolved significantly since the 2022 5G spectrum auction. Initially, the government's position was that enterprises could only access private 5G networks through spectrum leased from licensed operators (rather than holding their own spectrum directly). This position was driven by concerns about spectrum management (avoiding fragmentation of valuable commercial spectrum across many individual enterprise users), security (ensuring that all spectrum users are subject to licencing obligations and security conditions), and revenue (ensuring that spectrum assignments are subject to appropriate financial charges). Enterprise industry organisations and technology companies argued for a policy of direct enterprise access to dedicated spectrum for private 5G, consistent with the practice in the United States (CBRS band), Germany, and Japan.

In the period following the 2022 auction, DoT announced that enterprises could apply for dedicated spectrum in specific bands (subject to availability) for private 5G networks in campus environments, subject to prescribed conditions including technical specifications, security obligations, and spectrum usage charges. This policy shift represented a significant liberalisation of the enterprise network framework and was welcomed by the manufacturing, mining, and logistics sectors as an enabler of Industry 4.0 investments. The Telecommunications Act, 2023's framework — particularly the class authorisation and spectrum assignment provisions — provides the statutory basis for a comprehensive private network licensing framework to be developed through rules.

13.2 Security Obligations for Private Networks

Private 5G networks, while not providing services to the general public, are subject to the security obligations of the Telecommunications Act, 2023 to the extent that they are operated by authorised entities under an authorisation granted by the Central Government. The security conditions applicable to private networks — including the trusted equipment requirements, cybersecurity standards, and incident reporting obligations — reflect the systemic risk that security vulnerabilities in industrial IoT networks can create. A compromised private 5G network in a manufacturing facility could enable unauthorised access to industrial control systems, with potentially catastrophic consequences for operations and safety. The security framework applicable to private networks must therefore be appropriately rigorous, even if it is lighter in some respects (such as subscriber verification requirements) than the framework applicable to public mobile networks.

CHAPTER 14

Satellite Communications: Legal and Regulatory Framework

14.1 Satellite Spectrum and Licensing

Satellite communications services in India are regulated by an intersection of the telecommunications regulatory framework (which governs the ground segment and the provision of services to end-users) and the space regulatory framework (which governs the space segment — the satellites themselves and their deployment in orbit). The Department of Telecommunications regulates the provision of satellite-based telecommunications services, including VSAT (Very Small Aperture Terminal) services, direct-to-home (DTH) satellite broadcasting, and satellite mobile services. The Department of Space (through the Indian Space Research Organisation and the Indian National Space Promotion and Authorisation Centre, IN-SPACe) regulates the space segment including the launch, operation, and decommissioning of satellites.

The integration of satellite and terrestrial telecommunications is a growing dimension of India's connectivity landscape, particularly following the global growth of low-earth-orbit (LEO) broadband satellite constellations. OneWeb (now Eutelsat OneWeb, in which the Indian government holds a significant stake), SpaceX Starlink, and Amazon Kuiper are deploying LEO satellite networks capable of providing broadband internet access with latency and capacity characteristics far superior to traditional geostationary orbit (GEO) satellites. TRAI has made recommendations on the regulatory framework for LEO satellite services, addressing issues including spectrum licensing, landing rights, pricing, and the interface between satellite and terrestrial mobile networks. The Telecommunications Act, 2023's framework — including its provisions on spectrum assignment for commercial satellite services (which must be assigned by auction under the First Schedule) and its authorisation framework — provides the legal basis for the government's regulation of LEO satellite services.

14.2 IN-SPACe and the Space Regulatory Framework

The Indian National Space Promotion and Authorisation Centre (IN-SPACe) was established in 2020 as a single-window authorisation body for private sector space activities, including the operation of communication satellites. IN-SPACe's authorisation of satellite operators — covering the design, manufacture, launch, and operation of satellites — complements DoT's

regulation of the telecommunications services provided using those satellites. The coordination between IN-SPACe and DoT (and TRAI) is essential for a coherent regulatory framework for satellite-based telecommunications: IN-SPACe's authorisation of a satellite operator's space segment must be complemented by DoT's authorisation of the ground segment and the telecommunications services.

The regulatory interface between DoT and IN-SPACe — and the question of which authority has jurisdiction over which aspects of satellite telecommunications — is an important legal issue. The Telecommunications Act, 2023 covers the telecommunications services aspect; the Space Activities Bill (which had been under development but not yet enacted as of the preparation of this booklet) would cover the space segment activities. In the absence of specific space legislation, IN-SPACe's authorisation is based on executive orders and the government's inherent authority under the Outer Space Treaty, 1967 (to which India is a signatory) to authorise and supervise national space activities. The eventual enactment of comprehensive space legislation will create a clearer legal framework for the rapidly growing Indian commercial space sector, including satellite telecommunications.

CHAPTER 15

Infrastructure Investment: Legal Enablers and Challenges

15.1 The Investment Climate for Telecom Infrastructure

India's telecommunications infrastructure investment climate has undergone dramatic changes in recent years. The period 2016-2019 was characterised by intense competitive disruption (following Reliance Jio's market entry), financial distress across the sector (driven by the AGR litigation and the competitive tariff environment), and significant industry consolidation (from six or seven major private operators to three). This period saw a sharp reduction in infrastructure investment as operators conserved capital and restructured their finances. The period 2020-present has seen a partial recovery: the resolution of the AGR Case (through staggered payment arrangements for some operators), government support for the sector (through moratorium on AGR payments, equity conversion options, and the spectrum liberalisation in the 2022 auction), and the 5G rollout have all contributed to improved investment sentiment.

The Telecommunications Act, 2023 is expected to improve the infrastructure investment climate in several specific ways. The statutory right-of-way framework — with its deemed approval mechanism, fee caps, and anti-discrimination requirements — directly reduces the cost and complexity of infrastructure deployment, improving the return on infrastructure investment. The spectrum trading and sharing framework enables more efficient use of spectrum assets, improving the financial productivity of spectrum-intensive investment. The regulatory sandbox enables the testing of new infrastructure technologies and business models with reduced regulatory risk. Together, these provisions create a more investment-friendly regulatory environment than existed under the Indian Telegraph Act, 1885 framework.

15.2 Foreign Direct Investment in Telecom Infrastructure

Foreign direct investment (FDI) in India's telecommunications sector is governed by the FDI policy administered by the Department for Promotion of Industry and Internal Trade (DPIIT) under the framework established by the Foreign Exchange Management Act, 1999 (FEMA) and the rules and regulations made under it. The current FDI policy for telecommunications permits 100% FDI under the automatic route (no prior government approval required) in telecommunications services, subject to compliance with the applicable security conditions and the FEMA framework. The security conditions for FDI in telecom — including requirements for

Indian directors on company boards, restrictions on the appointment of foreign nationals in security-sensitive roles, and requirements for domestic processing of subscriber data — reflect the government's concern about national security implications of foreign ownership of telecommunications infrastructure.

Foreign investment in telecommunications infrastructure companies — particularly in tower companies — has been substantial. American Tower Corporation's investment in Indian tower assets, the participation of global infrastructure funds in BharatNet-related financing, and the growing interest of sovereign wealth funds in India's digital infrastructure are evidence of the sector's attractiveness to international infrastructure investors. The Telecommunications Act, 2023's strengthened framework for critical infrastructure protection and security standards will need to be applied in a manner consistent with continued attractiveness to foreign investment — excessively restrictive security conditions applied to foreign-owned infrastructure could deter investment that India needs for its connectivity ambitions.

15.3 Competition Law and Telecom Infrastructure

The Competition Act, 2002 and the Competition Commission of India (CCI) play an important role in regulating the competitive dynamics of the telecommunications infrastructure sector. Tower companies with significant market power may be required by competition law to provide access to their infrastructure on fair, reasonable, and non-discriminatory (FRAND) terms. Dominant operators that control essential infrastructure (such as submarine cable landing stations or national backbone fibre routes) may be subject to mandatory access obligations under competition law. The interface between the Telecommunications Act, 2023's regulatory framework and the Competition Act's framework — both of which may apply to the same infrastructure — requires careful navigation by practitioners advising on infrastructure access disputes.

The coordination between sector-specific telecom regulation (DoT and TRAI) and general competition law enforcement (CCI) has been an evolving aspect of India's regulatory architecture. CCI has jurisdiction over anticompetitive practices and abuse of dominant position in the telecom sector, even where the same conduct may also be subject to TRAI's regulatory oversight. The potential for dual proceedings — before both TDSAT (for regulatory disputes) and CCI (for competition law violations) — creates complexity for operators responding to complaints about their infrastructure access practices. Clarity about the boundary between regulatory and competition law oversight, and about the mechanisms for coordinating between TDSAT and CCI, would improve the effectiveness and efficiency of both regulatory regimes.

15.4 Infrastructure Outlook: Towards a Digital Decade

India's telecommunications infrastructure is entering a period of massive expansion and transformation. The rollout of 5G networks will require investment of hundreds of thousands of crore rupees in spectrum, network equipment, fibre backhaul, and small-cell infrastructure over the next decade. The completion of BharatNet will extend fibre connectivity to every gram panchayat, creating the national digital backbone that enables universal broadband access. The development of satellite broadband services from LEO constellations will provide connectivity to the most remote and challenging geographies. The deployment of private 5G networks for industrial applications will transform the productivity and competitiveness of India's manufacturing and logistics sectors.

The Telecommunications Act, 2023's legal framework — encompassing the authorisation regime, spectrum management, right-of-way, critical infrastructure protection, and the Digital Bharat Nidhi — provides the statutory foundation for this infrastructure transformation. The success of India's digital decade will depend not only on the quality of the legal framework but on the quality of its implementation: the development of clear, practical rules; the efficient processing of authorisations and spectrum assignments; the consistent enforcement of right-of-way obligations; and the ongoing reform of regulatory institutions to ensure that they have the capacity and independence to support India's ambitions. Practitioners, operators, investors, and policymakers who engage with India's telecommunications infrastructure sector will find in the pages of this series the legal knowledge and analytical framework to navigate this transformational period with confidence.

SUPPLEMENTARY NOTE A

Advanced Licensing Analysis and Spectrum Practice

A.1 The AGR Saga and Licensing Fee Structures

The Adjusted Gross Revenue controversy has reshaped the entire licensing fee framework for Indian telecommunications. The Supreme Court's holding in Union of India v. AUSPI (2020) that AGR encompasses all gross revenue of the licensed entity from every source — not merely revenue from licensed telecommunications services — has compelled operators to revisit their corporate structures, accounting practices, and long-term financial planning. The practical implications for compliance are substantial: operators must now include in their annual AGR computations revenue from dividends received from subsidiaries, interest earned on deposits and investments, rental income from leasing office premises or equipment, gains on sale of

assets, income from providing non-telecom services such as IT services or content services through the licensed entity, and any other source of income flowing through the licensed company. This requirement has motivated many operators to restructure their businesses, separating non-telecom revenue streams into distinct corporate entities that do not hold telecom licences and are therefore not subject to the licence fee regime.

The migration from the AGR-based licence fee model to a new authorisation fee model under the Telecommunications Act, 2023 raises the question of whether the new rules will adopt a different revenue base definition. The government has the opportunity — and arguably the policy rationale — to prescribe a more economically rational definition that applies the authorisation fee only to revenue from licensed telecommunications activities, rather than to all gross revenue of the licensed entity. Such a definition change would both reduce the financial burden on operators (particularly those with significant non-telecom revenue in their licensed entities) and reduce the compliance complexity created by the broad AGR definition. However, any change to the revenue base must be carefully structured to avoid constitutional challenge: if the Supreme Court held that the broad AGR definition was required by the contractual terms of the Migration Package licences, a narrower authorisation fee base under the new framework must be clearly distinguished as a prospective regulatory choice rather than a retroactive modification of AGR obligations under existing licences.

The spectrum usage charge (SUC) structure, which also uses the AGR base (with different rates for different bands), similarly creates compliance complexity. Operators holding spectrum in multiple bands — each with different SUC rates reflecting whether the spectrum was acquired by auction or administrative allocation and the commercial value of the specific band — must compute blended effective SUC rates across their total spectrum portfolio. The SUC computation interacts with the AGR computation to produce a combined annual levy that can represent a significant percentage of revenue. Industry representations to TRAI and DoT have consistently pointed to the combined AGR-based financial burden — licence fee plus SUC — as a structural challenge to the financial sustainability of the Indian mobile market, and have called for a rationalised fee structure that reduces the aggregate levy while maintaining appropriate government revenue from the sector. The implementing rules under the 2023 Act provide the opportunity for this rationalisation, but the political economy of reducing government revenue from a sector that contributes tens of thousands of crore rupees annually to government accounts is a significant constraint.

A.2 Infrastructure Sharing: Legal Due Diligence

Infrastructure sharing transactions — whether passive infrastructure sharing (co-location of active equipment on shared towers or in shared duct infrastructure), active infrastructure sharing (MORAN or MOCN arrangements), or spectrum sharing — require comprehensive legal due diligence before transaction completion. The due diligence for a passive infrastructure co-location agreement (where an operator seeks to locate its active equipment on a tower company's existing tower infrastructure) must address: the tower company's right-of-way title for the tower site (verifying that the tower company has valid and subsisting rights to occupy the site and to permit third-party co-location); the structural capacity of the tower for additional equipment loading (a civil engineering assessment confirming that the tower can safely carry the additional equipment without structural risk); the electrical power capacity at the site (verifying that adequate grid or generator power is available for the additional equipment); the electromagnetic frequency compatibility between the co-locating operator's antenna equipment and any existing equipment on the tower (to avoid harmful RF interference between co-tenants); and the terms of the master lease agreement under which the tower company has committed the site to the co-location arrangement.

Active infrastructure sharing transactions require additional layers of due diligence reflecting their greater technical and commercial complexity. The due diligence for an MOCN spectrum sharing arrangement — where two operators share both physical RAN equipment and spectrum in a common geographic area — must address: the legal basis for the spectrum sharing arrangement under DoT's spectrum sharing guidelines and the Telecommunications Act, 2023's implementing rules; the technical interoperability of the two operators' equipment sets (verifying that the equipment from potentially different vendors can co-exist and be jointly managed in the MOCN configuration); the competition law assessment of the arrangement (assessing whether the sharing arrangement between the two operators creates concerns about information exchange or coordination that could attract CCI scrutiny); the regulatory approval process (the DoT approval required before MOCN sharing can be implemented, including the submission of the sharing agreement and technical parameters); and the network security implications of sharing active equipment between two operators (each of whose security environments must be maintained separately to protect subscribers' confidentiality).

The contractual documentation for infrastructure sharing transactions must address a range of commercial and operational matters in addition to the technical and regulatory requirements. The master service agreement (MSA) between the tower company and the co-locating operator typically addresses: the monthly rental rate for the co-location; the term of the co-location (typically aligned with the operator's expected operational presence in the area); the

maintenance responsibilities (which party is responsible for maintaining the passive infrastructure, the power supply, the access roads, and the security of the site?); the SLA for power availability and access to the site for maintenance activities; the escalation mechanism for disputes about site availability, maintenance quality, or billing; and the provisions for early termination (including exit fees if the operator wishes to exit the co-location before the contractual term expires). The negotiation of these commercial terms in the context of the power asymmetry between large tower companies (with significant market power in certain geographic areas) and smaller operators (who may have limited alternative tower infrastructure options) is an important area for regulatory oversight to ensure that co-location terms are fair and non-discriminatory.

A.3 VSAT and Satellite Service Licensing

VSAT (Very Small Aperture Terminal) services in India require a complex matrix of licences and authorisations that reflects the dual nature of satellite communications — involving both the space segment (regulated by the Department of Space through ISRO and IN-SPACe) and the ground segment (regulated by DoT). The principal licensing requirements for a VSAT service provider in India include: a VSAT licence from DoT (which forms a schedule to the operator's Unified Licence); a NOCC (Network Operations Centre and Control) licence from the Department of Space for the Network Hub (the central earth station through which all VSAT traffic is routed); WPC frequency authorisation for the earth station frequencies (Ku-band, Ka-band, or C-band) used at the Hub and at the VSAT terminals; and any additional state-level permissions required for the installation of VSAT terminals at customer premises (which in some states require building permissions or wireless installation permits).

The regulatory treatment of LEO satellite broadband services under the existing VSAT licence framework is legally complex. Existing VSAT licences were designed for GEO satellite systems using fixed frequency assignments to specific orbital slots. LEO satellite services — which use dynamic frequency assignments across a constellation of hundreds or thousands of satellites in continuously changing orbital positions — do not fit neatly within the existing VSAT framework. The government's approach to licensing LEO satellite services has been to treat them as a new category of satellite service requiring a combination of the existing VSAT licence (for the ground segment services to subscribers) and a new IN-SPACe authorisation (for the space segment operation), with the coordination of the two licensing requirements managed through the evolving satellite broadband regulatory framework. The development of a clear, integrated licensing framework for LEO satellite broadband — addressing the spectrum auction question (discussed in Chapter 3 of the main text), the security conditions (discussed in Booklet

V), and the consumer protection obligations applicable to satellite broadband subscribers — is one of the most pressing regulatory priorities in India's telecommunications policy agenda.

A.4 Private Networks: The Enterprise 5G Framework

The regulatory framework for enterprise private 5G networks — announced by DoT in 2022 following industry advocacy — represents a significant liberalisation of the enterprise telecommunications market. Under the framework, enterprises in specified sectors (manufacturing, mining, aviation, defence, and others) may apply to DoT for direct allocation of spectrum in the 3300-3670 MHz band or other specified bands for use in private 5G networks within defined campus areas. This is a notable departure from the traditional model in which all commercial spectrum use requires a licensed operator intermediary: enterprises can now hold their own spectrum assignments for private network use, deploying 5G infrastructure directly for their own operational purposes without leasing spectrum from a licensed operator.

The legal framework for enterprise 5G spectrum assignments involves several distinct elements. First, the enterprise must obtain approval from DoT for the private network deployment, demonstrating that the proposed use falls within the eligible sector categories and that the deployment plan meets the technical and security requirements prescribed for private networks. Second, the enterprise must obtain a spectrum assignment for the specific frequency block and geographic area of the private network, at the spectrum charges prescribed for enterprise private network use (which differ from the commercial mobile spectrum charges applicable to licensed operators). Third, the enterprise's private 5G network must comply with the security conditions prescribed by DoT, including trusted equipment requirements under the Trusted Telecom Portal framework, cybersecurity standards, and potentially lawful interception requirements. The legal basis for imposing lawful interception requirements on private enterprise networks — which are not providing public telecommunications services but are operating telecommunications infrastructure within a private campus — is a nuanced question that the implementing rules must address clearly.

The commercial landscape for enterprise 5G deployments in India is evolving rapidly. Equipment vendors including Ericsson, Nokia, Samsung, and indigenous vendors such as Tejas Networks (a Tata Company) and STL (Sterlite Technologies) are competing to provide private 5G solutions to Indian enterprises. The development of a domestic private 5G ecosystem — incorporating Indian equipment, Indian software, and Indian deployment and integration capabilities — is a priority of the government's PLI (Production-Linked Incentive) programme for telecom equipment, which provides financial incentives for domestic manufacturing of 5G infrastructure equipment. The intersection of the PLI programme with the private 5G licensing

framework creates opportunities for enterprises to deploy private networks using domestically manufactured equipment at potentially lower cost than imported equipment, while also supporting India's strategic objective of developing indigenous telecommunications manufacturing capability.

SUPPLEMENTARY NOTE B

Licensing and Spectrum: Advanced Topics

B.1 Spectrum Harmonisation and the Asia-Pacific Context

India's spectrum management policy is shaped not only by domestic requirements but by its participation in regional and global spectrum harmonisation initiatives. The Asia-Pacific Telecommunity (APT) — the regional body coordinating telecommunications and ICT policy among 38 member countries in the Asia-Pacific region — plays a central role in developing regional spectrum harmonisation positions for WRC negotiations. APT's spectrum working groups develop common regional frequency band proposals that member countries collectively advocate at WRC meetings, seeking to achieve the harmonisation of frequency allocations across the Asia-Pacific that maximises economies of scale in device and equipment manufacturing. India's participation in APT's frequency management activities — through the Indian delegation to APT meetings and through the WPC Wing's engagement with APT's technical working groups — ensures that India's domestic spectrum management interests are reflected in the regional consensus positions presented at WRC. The 2022 5G spectrum auction's success was partly enabled by the global and regional harmonisation of mid-band 5G spectrum (particularly 3300-3800 MHz and 26 GHz), which created the global ecosystem for 5G devices and equipment that makes mid-band 5G commercially viable in India.

The ITU's World Radiocommunication Conference (WRC) cycle — held every four years — is the primary international process through which new spectrum allocations are made and existing allocations are modified. WRC-23, held in Dubai in November 2023, addressed several spectrum matters of direct relevance to India including: IMT (5G/6G) spectrum in various bands; spectrum for non-geostationary orbit (NGSO) satellite systems including LEO broadband constellations; and spectrum for International Mobile Telecommunications using Non-Terrestrial Networks (NTN), enabling mobile devices to connect directly to satellites. India's positions at WRC-23 — developed through the SACFA inter-agency consultation process — reflected a careful balance between India's interests as a major terrestrial mobile market (favouring harmonised mid-band IMT allocations that benefit India's domestic 5G market), India's growing

space ambitions (supporting spectrum for NGSO satellite systems to enable India's satellite industry), and India's defence interests (protecting sensitive frequency bands used for military communications and radar). WRC-27 and WRC-31 will address the spectrum needs of 6G technology, and India's preparation for these conferences — including technical studies, industry consultations, and inter-agency coordination — is already underway.

The practical challenge of spectrum harmonisation for Indian operators is the management of international border coordination — ensuring that spectrum assigned in India does not cause harmful interference to spectrum assignments in neighbouring countries (Pakistan, China, Bangladesh, Nepal, Bhutan, Sri Lanka, and Myanmar). India's spectrum border coordination arrangements — managed through the WPC Wing's international coordination activities and through bilateral telecom agreements with neighbouring countries — specify the technical parameters (power limits, guard bands, polarisation restrictions) that apply to spectrum use in defined border zones. The deployment of 5G base stations in border areas — particularly in sensitive locations near the Line of Actual Control (LAC) and the Line of Control (LoC) — raises both technical coordination questions (ensuring that 5G signals do not cross into contested territory in ways that could be interpreted as violation of territorial sovereignty) and national security questions (ensuring that 5G networks in border areas do not provide connectivity or signals intelligence advantages to hostile forces). The regulatory framework for spectrum use in border areas involves an unusual intersection of telecommunications law, international law, and national security law that practitioners advising on border-area telecom deployments must navigate carefully.

B.2 Licence Transfer and Mergers: Regulatory Requirements

The transfer of telecom licences — and more commonly the effective transfer of licensed operations through the merger or acquisition of licensed entities — requires regulatory approval from DoT and compliance with a range of conditions that protect the public interest in competitive market structure, national security, and continuity of service. The merger of Vodafone India and Idea Cellular in 2018 — creating Vodafone Idea (Vi), then the world's largest mobile operator by subscriber count — required approval from DoT, from the Competition Commission of India (which granted conditional approval subject to spectrum divestiture in certain circles where the merged entity would have excessive spectrum), and from TDSAT (through a no-objection certificate confirming compliance with telecom regulatory conditions). The regulatory approval process for major telecom mergers reflects the multi-agency nature of telecom regulation in India: DoT has licensing jurisdiction, CCI has competition jurisdiction, SEBI has securities market jurisdiction (for publicly listed companies), and TDSAT provides the sector-specific adjudication

forum for regulatory compliance matters.

The specific regulatory conditions imposed on telecom mergers typically address: spectrum concentration (requiring divestiture of spectrum in circles where the merged entity would exceed spectrum caps); licence condition compliance (ensuring that the merged entity assumes all the regulatory obligations of both merging entities, including outstanding AGR liabilities and coverage obligations); security conditions (ensuring that security vetting requirements are met for the merged entity's beneficial ownership structure and management); and service continuity (ensuring that the merger process does not result in service disruption for subscribers of either entity). The transition period following a telecom merger — during which the two entities' networks, IT systems, and customer accounts are integrated — is a period of heightened regulatory risk, as operational errors during integration can cause service disruptions, billing anomalies, and subscriber data issues. DoT and TRAI typically impose enhanced monitoring requirements during the integration period to identify and promptly address any compliance issues arising from the merger integration.

The regulatory treatment of "virtual" licence transfers — transactions that effectively transfer control of a licensed entity without formal transfer of the licence itself, such as acquisitions of majority shareholdings, management control changes, or changes in the ultimate beneficial ownership of a licensed entity — has been an evolving area of regulatory practice. DoT's guidelines require prior approval for any change in the ownership or control structure of a licensed entity that exceeds specified thresholds (typically, acquisition of a 10% or greater shareholding in a licensed entity by a new investor, or any change that results in a new entity acquiring majority ownership or management control). The national security review of ownership changes — assessing whether new investors in licensed entities satisfy the security conditions for foreign ownership of telecom infrastructure — adds a further layer of complexity to M&A; transactions in the telecom sector. Practitioners advising on telecom M&A; must navigate the intersection of corporate law (governing the transaction structure), competition law (governing the merger review), telecom regulatory law (governing licence transfer approvals), foreign investment law (governing FEMA approvals for foreign investment), and national security review (governing DoT's security clearance process).

B.3 The Right of Way Framework: Implementation Challenges

The implementation of Chapter IV's right-of-way framework in the first years following the Telecommunications Act, 2023's enactment will be closely watched as an indicator of whether the new legal framework can overcome the entrenched institutional resistance to telecom infrastructure deployment that characterised the pre-2023 era. The three primary RoW

challenges — excessive fees demanded by local bodies, unreasonable conditions attached to RoW grants, and outright refusal to grant RoW for reasons unrelated to legitimate public interest concerns — have persisted for decades despite successive regulatory and legislative interventions. The 2016 DoT RoW Rules addressed many of these issues but lacked the statutory weight to override state legislation and local body bye-laws in all cases. The 2023 Act's Chapter IV provisions, with their stronger statutory basis (as Central legislation under the Union List's telecom entry) and their specific provisions for deemed approval, fee caps, and anti-discrimination, should be more effective in overcoming local body resistance.

The deemed approval mechanism — which treats non-response by a competent authority within the prescribed period as approval of the RoW application — is the most operationally significant innovation in the 2023 Act's RoW framework. Under the Indian Telegraph Act, 1885 framework, operators could seek RoW under Section 10 but had no legal remedy if the authority simply failed to respond — protracted inaction by local bodies was a common obstruction tactic. The deemed approval provision changes the default: inaction now benefits the operator (by resulting in deemed approval) rather than the local body (by enabling delay without legal consequence). However, the effectiveness of the deemed approval mechanism depends on operators' ability to document their applications comprehensively and to assert the deemed approval against reluctant local bodies if they attempt to obstruct deployment after the deemed approval period has elapsed. Building a body of TDSAT and High Court precedent that firmly upholds deemed approvals and awards strong remedies (including damages and costs) for interference with deemed-approved deployments is essential for the mechanism to function as intended.

The interaction between the RoW framework and state-level laws — particularly state municipal corporation acts, state public works laws, and state road acts — is a constitutionally complex area. The Telecommunications Act, 2023 is Central legislation; state legislation on the same subject may be inconsistent with the Central legislation. Under the constitutional scheme, where Central and state legislation on a concurrent list subject are inconsistent, the Central legislation prevails (Article 254). But the RoW framework is not on the concurrent list — it derives from telecommunications (Entry 31, Union List) and Central property rights in public ways. State legislation governing the use of state roads and local body jurisdiction over public spaces arguably derives from different constitutional heads of power, creating scope for argument that the Central RoW framework does not override state legislative provisions in all respects. The resolution of these constitutional questions — through litigation that will inevitably arise as state bodies seek to preserve their authority over public ways against the Central RoW framework's

prescriptions — will be a significant area of constitutional telecom law development under the 2023 Act.

B.4 Spectrum Assignment Duration and Renewal

The Telecommunications Act, 2023's provision for spectrum assignments of up to twenty years (Section 4(8)) — compared to the ten-year assignments that were the norm under the previous framework — has significant implications for both operators and the government. For operators, longer assignment periods provide greater certainty for long-term infrastructure investment planning: a 5G network deployment that requires capital investment recoverable over fifteen to twenty years benefits from a spectrum assignment that covers the full investment recovery period. For the government, longer assignment periods reduce the frequency of revenue-generating spectrum auctions, potentially reducing the annual revenue flow from spectrum charges. The tradeoff between investment certainty (favouring longer assignments) and regulatory flexibility (favouring shorter assignments that allow the government to revisit spectrum allocation as technology and market conditions evolve) is a fundamental policy question that the 2023 Act resolves in favour of longer assignments, consistent with the global trend toward extended spectrum assignment periods.

The renewal framework for spectrum assignments — what happens when an assignment period expires — is a regulatory question of significant commercial importance that the Telecommunications Act, 2023's implementing rules must address clearly. The options include: mandatory auction of expiring spectrum (forcing operators to bid in a new auction to continue using spectrum they have been using for twenty years, potentially at significantly higher prices if market conditions have changed); administrative renewal with a market-rate fee (allowing operators to renew at a regulated price that reflects the current market value of the spectrum without competitive auction); and presumptive renewal (creating a right of renewal for operators who have complied with their conditions, at a price determined by a formula or regulatory process). Each approach has different implications for investment continuity, competitive market structure, and government revenue. The international experience — with most major markets moving toward presumptive renewal with market-rate fees, rather than mandatory re-auction, for spectrum already deployed in active networks — suggests that India's rules will likely provide a renewal pathway that does not force deployed networks to undergo competitive re-auction of the spectrum they depend on.

The renewal framework also raises the question of technology change: if a spectrum assignment made in 2023 for 4G use expires in 2043, by which time the technology landscape will be completely different (with 6G and beyond-6G technologies presumably dominant), should

the renewing operator be able to use the renewed spectrum for any technology (consistent with the technology-neutral principle) or are there circumstances in which the government should reclaim or reallocate the spectrum to accommodate new technology needs? The government's ability to reclaim spectrum at renewal — for reallocation to new operators or new technology platforms — provides an important regulatory tool for adapting the spectrum landscape to technological change, but must be exercised carefully to avoid undermining the investment security that long assignment periods are designed to provide. A clear framework specifying the circumstances in which reclamation is justified (and the compensation payable to operators who lose spectrum at renewal) would provide the certainty that operators need for long-term investment planning.

B.5 Open RAN and the Regulatory Interface

Open Radio Access Network (Open RAN or O-RAN) — an approach to mobile network architecture that disaggregates proprietary, integrated base station hardware and software into standardised, interoperable components from multiple vendors — has significant regulatory implications that are increasingly relevant as Indian operators evaluate their 5G network architecture choices. Open RAN's proponents argue that it promotes competition in the network equipment market (by enabling a wider range of vendors to supply components that can interoperate in a multi-vendor RAN deployment), reduces vendor lock-in (by allowing operators to replace individual components from one vendor with competing products from another without replacing the entire base station), and enables innovation (by creating an open ecosystem for software-defined RAN functions that can be developed and deployed by a broader range of technology companies). The Indian government has actively supported the development of an indigenous Open RAN ecosystem through the DoT's 5G Hackathon programme and the PLI scheme for telecom equipment.

The regulatory interface between the Trusted Telecom Portal framework and Open RAN deployments raises important questions that the TTP's implementing guidelines must address. In a traditional, integrated base station deployment, the TTP evaluates and approves a complete, self-contained base station unit from a single vendor. In an Open RAN deployment, the base station functions are disaggregated across multiple components — the Radio Unit (RU), the Distributed Unit (DU), the Centralised Unit (CU), and the RAN Intelligent Controller (RIC) — that may be supplied by different vendors. Each component must potentially be separately evaluated and approved under the TTP framework; but the security of an Open RAN deployment also depends on the security of the interfaces between components (the O-RAN fronthaul, midhaul, and backhaul interfaces defined by the O-RAN Alliance specifications). The TTP framework must

evolve to address Open RAN deployments by: developing evaluation criteria specifically for Open RAN components and interfaces; establishing a process for approving multi-vendor Open RAN configurations (not just individual components in isolation); and developing guidelines for security testing of Open RAN deployments in integrated test environments.

SUPPLEMENTARY NOTE C

Spectrum, Licensing and Infrastructure: Practical Guidance

C.1 Licence Conditions: Compliance Auditing

Effective compliance auditing of telecommunications licence conditions — the systematic process of verifying that an operator is meeting all its regulatory obligations — requires a structured methodology that addresses the full range of licence condition categories. A comprehensive licence compliance audit for an Indian telecom operator should cover: financial compliance (verification of AGR/authorisation fee computations, SUC calculations, bank guarantee adequacy, and Digital Bharat Nidhi contribution accuracy); coverage and rollout compliance (verification of deployed network coverage against prescribed milestones, using network management system data and independent field verification in sample locations); quality of service compliance (comparison of operator-reported QoS performance data against TRAI benchmark standards, supplemented by independent drive test data); security compliance (assessment of subscriber KYC documentation quality, LI infrastructure implementation against prescribed standards, trusted equipment compliance, and incident response plan adequacy); and consumer protection compliance (assessment of tariff change notice compliance, DND registry adherence, billing accuracy, and grievance redressal system effectiveness). This comprehensive audit scope reflects the multi-dimensional nature of telecom regulatory compliance and the need for a systematic, evidence-based approach to compliance verification.

The role of third-party auditors in telecom regulatory compliance — specifically, firms specialising in telecommunications regulatory compliance that are engaged by operators to independently verify and report on their compliance status — is growing in India as the complexity and significance of compliance obligations increases. Third-party compliance auditors bring specialised expertise (in regulatory requirements, audit methodology, and telecommunications technology) and independence (from the operator's internal compliance function) that make their assessments more credible to regulatory authorities than self-assessments alone. TRAI and DoT have increasingly recognised the value of independent

compliance auditing — requiring operators to engage third-party auditors for specific compliance verifications (such as AGR computations, LI capability tests, and EMF compliance checks) and using third-party audit reports as the basis for regulatory compliance assessments. The development of clear standards for the qualifications, independence, and methodology of third-party telecom compliance auditors — through regulatory guidelines or professional body standards — would improve the consistency and reliability of third-party compliance assessments.

The consequences of licence condition non-compliance under the Telecommunications Act, 2023's civil penalty framework — as discussed in Chapter 6 of the main text — create strong commercial incentives for operators to maintain robust internal compliance systems and to identify and self-report compliance failures before they are discovered by DoT or TRAI through enforcement actions. The reduced penalty provisions for self-reported violations (which the Act's framework is expected to include, consistent with international best practice in civil penalty regimes) provide a financial incentive for proactive compliance disclosure, rewarding operators who identify and report their own compliance failures with a lower penalty than would apply if the same failure were discovered through regulatory inspection. Building a compliance culture that treats self-reporting as a commercially rational strategy — not merely as a moral obligation — requires internal incentive structures that reward compliance teams for identifying and disclosing compliance issues rather than concealing them.

C.2 Spectrum Interference Management

Radio frequency interference — the degradation of telecommunications reception caused by unwanted radio signals from other sources — is an unavoidable feature of the radio spectrum environment and a persistent operational and regulatory challenge for telecommunications operators. Interference can be caused by: co-channel interference (interference from signals using the same or adjacent frequencies in geographic areas where two operators' coverage footprints overlap); intermodulation interference (interference caused by the mixing of multiple signals in non-linear equipment, generating spurious emissions on unintended frequencies); conducted interference (interference transmitted through shared power or grounding infrastructure rather than through the air); and malicious interference (deliberate transmission of jamming signals intended to disrupt telecommunications services). The resolution of interference disputes — determining the source of the interference, the technical measures needed to eliminate it, and the allocation of responsibility for implementing those measures — is a regulatory function of the WPC Wing and an adjudicatory function of TDSAT.

TRAI's quality of service regulations — which prescribe minimum call drop rate standards as a proxy for network quality — are directly related to interference management: high levels of interference cause call drops, degraded audio quality, and reduced data throughput. Operators who experience high call drop rates attributable to interference from co-channel or adjacent-channel sources may seek regulatory assistance from the WPC Wing (which has the authority to investigate and direct remediation of interference sources) and from TDSAT (which can adjudicate disputes between operators about their respective interference contributions and the appropriate technical remediation). The development of clear, published guidelines on acceptable interference levels between co-located operators — and the technical standards for interference isolation in active and passive infrastructure sharing arrangements — would reduce the frequency and duration of interference disputes, improving network quality for subscribers and reducing regulatory and legal costs for operators.

The interference management challenges of 5G networks are more complex than those of previous generations, due to 5G's use of massive MIMO (Multiple Input Multiple Output) antenna systems with hundreds of antenna elements that create highly directional, dynamically steered beams. Traditional interference management frameworks — which assume omnidirectional or sectoral antennas with fixed coverage patterns — are not fully adequate for the dynamic beam-forming that characterises 5G massive MIMO deployments. The technical standards for 5G interference management — developed by 3GPP and being progressively incorporated into India's frequency assignment conditions — specify the maximum permissible out-of-band emissions and the specific test conditions for evaluating 5G base station interference performance. The WPC Wing's management of 5G spectrum interference — including the development of 5G-specific interference coordination procedures for shared spectrum deployment scenarios — is an important and technically demanding aspect of spectrum management under the Telecommunications Act, 2023's framework.

C.3 Tower Safety: Legal Obligations

The structural safety of telecommunications towers — ensuring that towers are designed, constructed, and maintained to withstand the forces (wind, seismic, ice loading) they may encounter during their operational life — is a significant legal and regulatory obligation with direct consequences for public safety. Tower failures — whether caused by inadequate structural design, poor construction quality, insufficient maintenance, or overloading (from adding more equipment than the original design accommodated) — can cause serious injuries and deaths, as well as significant property damage and network disruption. The regulatory framework for tower safety in India involves: structural engineering standards (prescribed by the Bureau of Indian

Standards through IS-875 and related structural design codes); local building authority approval requirements (requiring structural engineers' certificates for tower construction); electrical safety standards (governing the installation and maintenance of the power systems associated with towers); and fire safety standards (governing the installation of fire detection and suppression equipment in tower compound buildings).

The EMF (electromagnetic field) safety compliance framework for telecommunications towers — ensuring that the electromagnetic radiation emitted by towers does not exceed safe exposure limits for persons in the vicinity — is both a technical compliance obligation and a recurring source of community conflict for tower operators and operators. TRAI's guidelines on EMF safety (published in cooperation with DoT) specify the maximum permissible EMF exposure levels applicable to Indian telecommunications infrastructure, which are set at 10 times below the already conservative international standards set by ICNIRP (International Commission on Non-Ionizing Radiation Protection). Operators and tower companies must conduct EMF compliance measurements at regular intervals and must maintain records demonstrating compliance with the prescribed limits. Where EMF measurements reveal levels above the prescribed limits — typically caused by equipment malfunctions, improper installation, or unauthorised addition of antennas to existing towers — the operator is required to implement corrective measures immediately.

The legal liability of tower companies and operators for tower failure or EMF non-compliance involves both civil liability (for damages to property owners, individuals, and subscribers affected by tower failures or coverage degradation) and regulatory liability (for the regulatory consequences of compliance failures under the IP-I registration conditions and the access service licence conditions). Civil liability for tower failure is governed by the general law of negligence: a tower company that fails to maintain its towers to the required structural safety standards — and whose failure results in a tower collapse that causes injury or property damage — is liable in negligence for the foreseeable consequences of its failure. The quantum of damages in such cases — covering personal injury (potentially including death or permanent disability), property damage, business interruption losses, and network disruption costs — can be substantial. Insurance coverage for tower structural liability, liability for EMF exposure claims, and business interruption from network disruptions is an essential risk management tool for tower companies operating at scale.

C.4 Domestic Manufacturing and the PLI Scheme

The Production-Linked Incentive (PLI) scheme for telecommunications and networking products — one of thirteen sector-specific PLI schemes launched by the Government of India to

promote domestic manufacturing — provides financial incentives (incremental production-linked subsidies paid annually for five years) for companies that invest in manufacturing telecom equipment in India and achieve specified production targets. The PLI scheme is directly relevant to the Trusted Telecom Portal framework, since domestic manufacturing of approved telecom equipment — by Indian companies or by foreign companies establishing Indian manufacturing facilities — can improve the security of the supply chain and reduce India's dependence on imported equipment from potentially adversarial sources. The PLI scheme has attracted commitments from companies including Nokia, Ericsson, HFCL, Sterlite Technologies, and Tejas Networks (Tata Group) to manufacture telecom equipment in India, ranging from optical fibre and cables to 4G/5G radio access equipment.

The legal framework for the PLI scheme involves complex government contracting arrangements between the scheme administrator (the Department for Promotion of Industry and Internal Trade, DPIIT, acting through the Ministry of Electronics and IT, MeitY) and the participating companies. PLI agreements specify: the eligible products (defined by their HS codes and specific technical descriptions); the investment commitments required for eligibility; the production targets that must be achieved to qualify for incentive payments; the methodology for calculating the incremental sales attributable to new domestic manufacturing (as distinct from domestic sales of imported products); the documentation required to claim incentive payments; and the consequences of non-compliance (including recovery of incentive payments previously made). The legal analysis of PLI agreements — particularly the definition of "domestic value addition" and the treatment of components and sub-assemblies sourced from different countries — is a significant area for legal advisory work as companies structure their PLI participation.

C.5 Disaster Recovery for Telecom Networks

Telecommunications network disaster recovery — the ability to restore network services after a catastrophic failure caused by natural disasters (floods, cyclones, earthquakes), power grid failures, or cyber attacks — is both a commercial priority for operators (to minimise revenue loss from network outages) and a regulatory requirement (under the security conditions and quality of service standards applicable to licensed operators). India's geographic diversity — spanning cyclone-prone coastal areas, earthquake-prone Himalayan regions, flood-prone river valleys, and drought-prone arid zones — means that operators must design their disaster recovery frameworks to address a wide range of natural disaster scenarios. The Telecommunications Act, 2023's critical infrastructure protection provisions — which empower the Central Government to prescribe enhanced resilience requirements for critical telecommunications infrastructure — provide the statutory basis for strengthened disaster

recovery mandates for operators in disaster-prone areas.

The specific disaster recovery requirements for telecom networks vary by risk category and by the criticality of the affected infrastructure. For backbone transmission networks (optical fibre, microwave links) in disaster-prone areas, resilience measures include route diversity (multiple physical paths between key network nodes so that a single route failure does not disrupt connectivity), geographic redundancy (backup transmission facilities at geographically separated sites), and rapid restoration capabilities (pre-positioned repair teams, equipment spares, and access arrangements for rapid fibre repair after cuts). For access networks (base stations, cell towers), resilience measures include tower structural hardening (designing towers to withstand design-level wind and seismic loading), backup power (battery backup systems and fuel storage for generator operation during extended grid outages), and portable base stations (that can be rapidly deployed to areas where permanent infrastructure has been destroyed).

SUPPLEMENTARY NOTE D

Licensing and Infrastructure: Extended Analysis

D.1 Licence Conditions for Cybersecurity

The cybersecurity conditions of telecommunications licences — which require operators to implement specified security measures to protect their networks and subscriber data against unauthorised access, interception, and disruption — have grown in scope and specificity over successive licensing iterations, reflecting the growing recognition of telecommunications networks as critical infrastructure requiring robust security protection. The original Unified Licence conditions addressed security primarily through the Lawful Interception and Monitoring (LIM) framework — ensuring that operators could provide access to their networks for government-authorised interception — and through general requirements for subscriber identity verification and security of subscriber data. Subsequent amendments expanded the security conditions to address: the mandatory adoption of security standards for network equipment (through the TTP framework); requirements for incident reporting to CERT-In and DoT; mandatory retention of call detail records, internet connection logs, and subscriber identity data for specified periods; requirements for network topology documentation and access controls; and restrictions on the storage of sensitive subscriber data outside India (reflecting data localisation objectives).

The Trusted Telecom Portal framework — described in detail in Booklet V — is the most operationally significant security condition for network infrastructure deployment under the current regulatory framework. The TTP's requirement that all telecom network equipment used in India must be evaluated and approved by CERT-In accredited laboratories, and the progressive expansion of the TTP's scope to cover an increasing range of equipment categories, has created significant compliance challenges for operators managing large, complex networks with equipment from multiple vendors across multiple generations of technology. Operators' procurement processes have been substantially restructured to accommodate TTP requirements: equipment procurement now routinely includes TTP compliance assessment as a condition of supplier qualification, and deployment timelines must account for the time required to obtain TTP approval for new equipment types. The legal implications of deploying non-approved equipment — which may constitute a licence condition violation and could trigger civil penalties under the Telecommunications Act, 2023 — have focused operators' legal and compliance teams on maintaining rigorous TTP compliance documentation for all deployed network equipment.

The security conditions relating to subscriber identity verification — the requirements for Know Your Customer (KYC) verification before issuing SIM cards, and for periodic re-verification of subscriber identity — have generated significant compliance and consumer protection concerns. The mandatory biometric verification of mobile subscribers (requiring fingerprint or iris scan for SIM issuance, linked to Aadhaar) was introduced in 2017 as a response to the challenge of verifying the vast number of unverified pre-paid SIM cards in circulation, but was partially struck down by the Supreme Court in the 2019 Aadhaar judgment. The subsequent transition to a voluntary Aadhaar-based e-KYC framework for telecom subscriber verification — combined with document-based KYC (Officially Valid Documents) as an alternative — has created a more complex compliance environment that must balance the security objective (ensuring that all active SIMs are associated with verified identities) against the constitutional privacy requirements established by Puttaswamy. Operators' SIM issuance processes — which must comply with the KYC conditions of their licences while also respecting subscribers' privacy rights — represent one of the most operationally complex intersections of telecom regulation and constitutional law in their day-to-day business.

D.2 Infrastructure Investment Framework

The regulatory framework for telecommunications infrastructure investment — encompassing the licence conditions that mandate specific rollout obligations, the tax treatment of infrastructure investment, the spectrum assignment conditions that require network

deployment as a condition of spectrum use, and the right-of-way framework that determines the cost and ease of infrastructure deployment — collectively shapes the commercial attractiveness of telecommunications infrastructure investment in India. India's current framework combines: significant financial obligations (licence fees, spectrum charges, and USO contributions that collectively represent a high proportion of industry revenue); mandatory rollout obligations (specifying the percentage of coverage by population or geography that must be achieved within defined periods); and enabling provisions (the RoW framework, the spectrum sharing framework, and the passive infrastructure sharing framework) that seek to reduce infrastructure deployment costs. The balance between the financial burden (which reduces the resources available for infrastructure investment) and the enabling provisions (which reduce the cost of deployment) determines the net impact of the regulatory framework on infrastructure investment levels.

India's telecommunications infrastructure investment levels — measured as capital expenditure per subscriber or as a percentage of sector revenue — have been under pressure in recent years due to the combination of high regulatory financial obligations, the revenue impact of intense price competition, and the working capital requirements of large spectrum purchases. The spectrum payments required under India's successive auctions — while commercially justified by the value of the spectrum acquired — have reduced the cash flow available for network infrastructure investment in the years following large auction payments, creating a period of constrained investment that affects network quality and coverage. The government's recognition of this investment constraint — reflected in the 2021 relief package that included a four-year moratorium on AGR-related payments and the option to convert government dues to equity in exchange for relief — reflects the broader policy challenge of maintaining the financial health of the sector while also maximising government revenue from spectrum assignments and licence fees.

The telecommunications infrastructure investment framework must also account for the distinct investment requirements of 5G deployment — which requires a denser network of base stations than 4G, a substantial upgrade of core network infrastructure to support 5G standalone operation, and edge computing infrastructure to enable low-latency applications. India's 5G rollout — which began with commercial launches in October 2022 — has been proceeding rapidly by the standards of major emerging markets, with Reliance Jio and Bharti Airtel establishing 5G coverage in dozens of major cities within the first year of launch. The pace of 5G rollout is directly influenced by the regulatory framework: the RoW provisions that determine how quickly small cells can be deployed in urban environments, the spectrum conditions that govern how operators can configure their 5G networks, and the equipment approval framework that

determines how quickly new 5G network elements can be approved for deployment all affect the speed and cost of 5G infrastructure buildout. The Telecommunications Act, 2023's framework — with its strengthened RoW provisions, technology-neutral spectrum conditions, and updated TTP framework — should improve the enabling environment for 5G infrastructure investment relative to the previous framework.

D.3 Enterprise Spectrum and Captive Networks

The regulatory framework for enterprise captive telecommunications — encompassing both the private network spectrum framework (enabling enterprises to hold spectrum for private 5G deployments) and the authorisation conditions for enterprise-focused telecommunications service providers — represents a significant liberalisation of the enterprise connectivity market relative to the previous framework. Historically, enterprises requiring high-performance wireless connectivity within their premises or campuses had limited options: they could lease spectrum-dependent wireless services from licensed operators (who then controlled the infrastructure and service terms), or they could deploy Wi-Fi networks in unlicensed spectrum (which provided adequate performance for office environments but was unsuitable for demanding industrial applications). The enterprise private network spectrum framework changes this by enabling enterprises to hold their own spectrum, deploy their own 5G infrastructure (either directly or through a systems integrator), and operate a private network that is under their direct control without relying on a commercial operator.

The legal analysis of enterprise private 5G deployments involves an assessment of the enterprise's obligations as a spectrum licensee and as an operator of telecommunications infrastructure. As a spectrum licensee, the enterprise must comply with: the technical conditions of the spectrum assignment (transmitted power limits, antenna specifications, and technical parameters prescribed by WPC); the interference management obligations (ensuring that the private network does not cause harmful interference to adjacent commercial networks); the security conditions prescribed by DoT for private network operators (including the TTP requirements for the equipment deployed in the private network); and the reporting obligations (submitting periodic reports to DoT and WPC on spectrum utilisation). As an operator of telecommunications infrastructure (even for captive use), the enterprise must assess whether it is providing "telecommunication services" to third parties (which would require a separate service authorisation) or whether it is operating purely captive infrastructure (which falls within the enterprise's own spectrum licence without requiring a service authorisation). This boundary — between captive private network use and the provision of services to third parties — is one of the important definitional questions in the enterprise spectrum regulatory framework.

D.4 Regulatory Treatment of Submarine Cable Systems

Submarine cable systems — the undersea optical fibre networks that carry the vast majority of India's international internet and voice traffic — are critical telecommunications infrastructure with a unique regulatory profile that reflects their physical characteristics (lying on the ocean floor, crossing multiple national jurisdictions), commercial structure (typically owned by international consortia of telecom operators and internet companies), and strategic importance (as the primary conduit for India's digital connections with the rest of the world). India has multiple submarine cable landing stations, primarily located in Mumbai, Chennai, Cochin, and Tuticorin, where undersea cables make landfall and connect to India's terrestrial telecommunications backbone. The regulation of submarine cable systems in India involves: DoT licensing for the landing parties (who provide submarine cable landing services through their licensed infrastructure); WPC frequency authorisation for any wireless systems associated with cable maintenance vessels or landing station operations; and the environmental clearances and coastal regulation zone permissions required for the construction and maintenance of cable landing stations.

The strategic vulnerability of India's submarine cable infrastructure — the fact that damage to a small number of submarine cables could significantly degrade India's international internet connectivity — has been a growing national security concern. Several high-profile submarine cable cuts (some attributed to ship anchors, some to natural causes) have demonstrated the fragility of the submarine cable network and the disruption that cable damage can cause to internet services in affected regions. India's response to this vulnerability involves: developing additional cable landing paths to increase geographic diversity; requiring operators to maintain adequate backup capacity (through satellite uplinks and alternative cable routes); and investing in domestic cable repair vessel capability and cable monitoring systems. The Telecommunications Act, 2023's critical infrastructure protection framework provides the statutory basis for mandating specific resilience measures for submarine cable infrastructure, including requirements for redundancy, monitoring, and rapid repair capability.

D.5 Regulatory Framework for Rural Operators

Rural telecommunications operators — smaller operators serving rural and semi-urban markets that the large national operators may not serve optimally — have a specific regulatory profile under India's unified licensing framework. While the Unified Licence framework technically treats all operators the same regardless of their geographic service area or commercial scale, the practical regulatory burden falls differently on small rural operators: the same compliance requirements (AGR computation, QoS reporting, subscriber KYC, LIM capability) that are

relatively low-cost for large national operators represent a proportionally much higher burden for small operators with limited administrative and compliance infrastructure. TRAI's consultation on the regulatory framework for small and rural operators — addressing whether specific concessions or accommodations should be made for operators serving underserved markets — has generally concluded that a fully differentiated framework for small rural operators would create definitional and implementation challenges, but has recommended specific measures to reduce compliance burdens (simplified reporting, extended timelines for rural coverage obligations, reduced licence fee rates for rural-only services).

The internet service provider (ISP) framework — which enables smaller, locally focused operators to provide internet access services under a lighter regulatory regime than the full access service authorisation — has historically provided the primary route for rural connectivity services in India. ISPs under the Unified Licence framework can provide broadband services in defined local areas with lower financial obligations and simpler compliance requirements than national access service licensees. The ISP framework has enabled a diverse ecosystem of local operators — ranging from small Wi-Fi hotspot operators serving individual villages to regional ISPs serving hundreds of locations across a specific geographic area — that complements the national operators' coverage. However, ISPs' dependence on backhaul (connectivity from the ISP's local network to the internet backbone) provided by national operators creates a potential bottleneck: if backhaul is expensive or of poor quality, ISPs cannot provide competitive connectivity to their subscribers. The development of backhaul access obligations — requiring national operators to provide affordable, high-quality backhaul to ISPs on non-discriminatory terms — would improve the commercial viability of rural ISPs and support the competitive development of rural connectivity markets.

D.6 Legal Framework for Network Sharing Among Rivals

The legal framework for network sharing between competing licensed operators — specifically the conditions under which MORAN and MOCN active sharing arrangements are permissible, the competition law assessment of sharing arrangements, and the operational governance of shared network deployments — is one of the more complex areas of Indian telecommunications regulation. The basic principle is that network sharing (including active sharing) is permitted under DoT's spectrum sharing guidelines and the Telecommunications Act, 2023's implementing rules, subject to the condition that it does not result in the sharing parties holding combined spectrum in excess of the spectrum cap. The competition law overlay — specifically the CCI's assessment of whether an active sharing arrangement between competing operators constitutes an anti-competitive agreement under Section 3 of the Competition Act —

requires an analysis of whether the sharing arrangement enables the sharing parties to coordinate on commercially sensitive information (such as network capacity, coverage plans, or subscriber-level service quality) in ways that could lead to implicit or explicit coordination on commercial prices or market conduct.

TRAI's 2022 recommendations on network sharing — addressing both passive and active sharing, and specifically the emerging question of open RAN-enabled sharing — provided updated regulatory guidance for a rapidly evolving technology landscape. The key regulatory challenges that TRAI addressed included: the treatment of network sharing in the context of the spectrum cap (specifically whether spectrum held by one operator and used under a sharing arrangement by another counts against the other operator's spectrum cap); the information barriers required in an active sharing arrangement (to prevent commercially sensitive subscriber data from being accessed by a competitor's personnel who have access to the shared network); the quality of service obligations of each sharing party (determining which operator bears responsibility for QoS compliance when both parties use the same shared infrastructure); and the regulatory approval process for new sharing arrangements (the specific information that must be provided to DoT for prior approval, and the timeline for DoT to process sharing arrangement notifications). Practitioners advising on network sharing transactions must address all these regulatory questions in addition to the commercial and operational dimensions of the sharing arrangement, which include the governance structure for shared network management, the cost allocation methodology, the dispute resolution procedure, and the exit arrangements for a party that wishes to terminate the sharing arrangement.

SUPPLEMENTARY NOTE E

Spectrum and Licensing: Frontier Topics

E.1 Femtocells and Small Cells: Regulatory Treatment

Femtocells and small cells — low-power base stations designed for deployment in homes, businesses, and urban street furniture to extend cellular coverage and increase network capacity in dense environments — have a specific regulatory profile under India's telecommunications framework that reflects their hybrid character: they use licensed spectrum (like macro base stations) but are deployed by operators in customer premises without the extensive site survey and planning requirements associated with macro cell deployment. The regulatory treatment of femtocells and small cells in India has evolved progressively as the technology has matured and as operators have increasingly relied on dense small cell networks for 4G capacity management

and 5G coverage extension. The WPC Wing's type approval requirements for femtocell and small cell equipment — which assess compliance with technical standards for transmitted power, frequency accuracy, and radio interface — must be met before equipment can be deployed. The right-of-way framework for small cell deployment on street infrastructure (lamp posts, utility poles, and traffic signals) is governed by the Telecommunications Act, 2023's Chapter IV provisions, which enable operators to attach small cell equipment to public infrastructure subject to prescribed conditions.

The specific regulatory questions raised by femtocells relate to their deployment in customer premises using the customer's fixed broadband connection for backhaul. When a mobile operator provides a femtocell to a residential subscriber, the femtocell uses the subscriber's internet connection to carry mobile traffic back to the operator's core network — effectively using a fixed broadband ISP's network as transmission infrastructure for mobile traffic. This arrangement raises questions about: whether the fixed broadband ISP's terms and conditions permit such use (femtocell traffic may be classified as commercial rather than residential use if the operator provides commercial mobile services through the femtocell); whether the net neutrality framework applies to the fixed broadband ISP's treatment of femtocell backhaul traffic (if the ISP prioritises or throttles femtocell traffic, this may constitute a violation of the non-discrimination principle); and whether the deployment of a femtocell in a residential premises requires any additional authorisation from the resident (as a form of telecommunications infrastructure deployment on private property). The development of clear regulatory guidance on these femtocell-specific regulatory questions would reduce compliance uncertainty for operators deploying femtocells at scale as part of their network coverage and capacity strategy.

The spectrum management implications of dense small cell deployment — specifically the interference coordination challenges that arise when hundreds or thousands of small cells are deployed in a dense urban area, each using the same licensed frequency bands as neighbouring small cells and macro base stations — require sophisticated spectrum engineering and regulatory oversight that goes beyond the traditional macro-cell-focused interference management framework. The interference coordination techniques used in dense small cell networks — including coordinated multi-point transmission (CoMP), inter-cell interference coordination (ICIC), and advanced beamforming algorithms — must be evaluated for compliance with the technical conditions of the spectrum assignments, which were originally designed for much less dense deployment scenarios. TRAI and WPC's engagement with the spectrum management implications of dense small cell deployment — through technical studies and

updated frequency assignment conditions that reflect the specific interference environment of dense deployments — is an important regulatory priority as 5G network densification accelerates in Indian cities.

E.2 Blockchain and Spectrum Management

The application of blockchain technology to spectrum management — specifically the use of distributed ledger technology to record spectrum assignments, track spectrum usage, manage secondary market transactions, and enforce spectrum sharing arrangements — is an innovative approach to the administrative challenges of spectrum governance that has attracted academic and policy interest globally. The traditional spectrum management framework relies on centralised databases (the National Frequency Register maintained by WPC) to record spectrum assignments and on centralised administrative processes to manage assignment changes, sharing arrangements, and trading. A blockchain-based spectrum management system would replace these centralised processes with a distributed ledger that provides: a tamper-evident record of all spectrum assignments and their history; automated enforcement of spectrum assignment conditions through smart contracts; a transparent and auditable record of secondary market transactions; and real-time visibility of spectrum usage and availability. The potential benefits include: reduced administrative costs, faster processing of assignment changes, improved transparency, and reduced opportunities for corruption in spectrum administration.

The regulatory and legal challenges of blockchain-based spectrum management are significant. The legal status of blockchain-based spectrum records — specifically whether a blockchain record has the same legal validity as an entry in the WPC's official National Frequency Register — requires either statutory recognition of blockchain records as authoritative government records or a parallel process in which blockchain entries are validated and reflected in the official Register. The privacy implications of a public or semi-public blockchain (on which all spectrum assignments are visible to all participants) must be assessed against the commercial sensitivity of spectrum assignment information (which reveals operators' network deployment plans and spectrum holdings). And the technical challenges of integrating a blockchain spectrum management system with the existing WPC administrative processes — and with the international spectrum coordination processes of the ITU — require careful systems architecture and institutional coordination. India's exploration of blockchain-based spectrum management — through research programmes and pilot projects — should be accompanied by a clear regulatory roadmap that identifies the legal reforms needed to give blockchain spectrum records legal force and the institutional changes needed for WPC to manage the transition from its existing systems.

E.3 Passive Infrastructure: Legal Due Diligence Guide

Legal due diligence for passive telecommunications infrastructure — encompassing towers, rooftop antenna systems, underground ducting, and associated civil works — is a specialised area of practice that requires expertise in property law, environmental law, telecom regulation, and corporate law. A comprehensive legal due diligence for a passive infrastructure acquisition (such as the purchase of a tower portfolio from a telecom operator) must address: property title (verifying that the seller has valid and transferable rights to occupy the sites where the towers are located, whether freehold ownership, long-term lease, or RoW licence); tower structural integrity (reviewing available structural engineering assessments and any history of structural concerns, modifications, or incidents); environmental compliance (assessing compliance with land use restrictions, forest clearances for towers in forested areas, coastal regulation zone permissions for coastal locations, and any outstanding environmental violations); local authority compliance (reviewing building permits, electrical connection permits, and any outstanding notices or demands from local authorities); and existing commercial arrangements (reviewing any existing co-location agreements with other operators, the commercial terms of those agreements, and the obligations they impose on the new owner).

The transition of passive infrastructure from operator-owned (where the operator both owns the towers and uses them for its own network) to towerco-owned (where the towers are owned by a specialised infrastructure company and leased back to operators) has created a large body of commercial and legal practice around the structuring of tower sale and leaseback transactions. These transactions involve: the terms of the master service agreement under which the selling operator leases the towers back from the towerco after the sale; the pricing mechanism for existing tenancies (usually an initial rent with escalation provisions) and new tenancy additions (usually a new tenancy agreement with market-rate rent); the maintenance obligations (allocating responsibility for passive infrastructure maintenance between the towerco and the active equipment tenants); the information obligations (specifying what performance data the towerco must provide to the operator regarding power availability, site access, and structural condition); and the exit arrangements (addressing what happens at the end of the MSA term and the conditions for early termination). The regulatory dimensions of tower sale and leaseback transactions include DoT's requirements for prior approval of any transfer of licensed telecommunications infrastructure, and WPC's requirements for the transfer of frequency assignments associated with any active equipment that moves from operator to towerco ownership.

E.4 Regulatory Sandbox for 5G Innovation

The regulatory sandbox under Section 32 of the Telecommunications Act, 2023 — providing a defined testing environment with relaxed regulatory requirements for innovative telecommunications services and technologies — is particularly well-suited to addressing the regulatory uncertainties around 5G's most innovative service categories. The use of private 5G networks for industrial automation, the deployment of 5G fixed wireless access as a substitute for fibre broadband, the integration of 5G connectivity with IoT platforms for smart agriculture and precision manufacturing, and the use of 5G mmWave for high-density event coverage are all service categories where the specific regulatory requirements (licensing, spectrum management, quality standards, and security conditions) are still being defined and where sandbox testing could generate valuable regulatory data. A well-designed sandbox for 5G services would: define the specific regulatory relaxations available (such as relaxed coverage obligations, simplified spectrum assignment processes, or lighter-touch security requirements during the testing period); specify the geographic and temporal limits of the sandbox (enabling testing in defined areas for defined periods without committing to full commercial deployment); and prescribe the data collection and reporting requirements that sandbox participants must meet (to generate the regulatory evidence base for post-sandbox policy development).

India's first telecommunications regulatory sandbox experiences — which are expected as DoT develops the Section 32 rules — will be important learning opportunities for the regulatory community. The experience of regulatory sandboxes in other sectors (financial services under RBI and SEBI, healthcare under a variety of regulatory bodies) provides lessons about effective sandbox design that can inform the telecommunications sandbox framework. Key lessons include: the importance of clear, published criteria for sandbox eligibility (to manage expectations and prevent gaming of the process); the value of active regulatory engagement with sandbox participants during the testing period (rather than passive observation); the need for transparency in publishing sandbox outcomes (both successes and failures) to enable industry learning; and the importance of a clear transition pathway from sandbox to full regulatory compliance (so that successful sandbox innovations can be rapidly commercialised under clear regulatory conditions). The development of these design elements — through consultation with industry and with international regulatory peers who have operated telecom sandboxes — should be a priority for DoT and TRAI in developing the Section 32 rules.

SUPPLEMENTARY NOTE F

Licensing and Infrastructure: Final Topics

F.1 The Digital Infrastructure Investment Trust

Digital Infrastructure Investment Trusts (InvITs) — investment vehicles that enable retail and institutional investors to invest in digital infrastructure assets (primarily towers and fibre networks) through a listed entity regulated by SEBI — have emerged as an important capital markets mechanism for the telecommunications infrastructure sector. InvITs pool investor capital to acquire and operate income-generating infrastructure assets, providing investors with returns from the operating income of the infrastructure and from asset appreciation. The first digital InvIT in India — focused on telecom towers — demonstrated the appetite of capital markets investors for stable, long-duration cash flows from infrastructure leasing, providing an exit mechanism for operators and towercos that had deployed significant capital in infrastructure and wished to recycle that capital for further investment. The regulatory framework for digital InvITs involves both the capital markets regulation administered by SEBI (which governs the InvIT structure, governance, and investor protections) and the telecommunications regulation administered by DoT (which governs the licence conditions applicable to the telecommunications infrastructure assets held by the InvIT).

The interaction between InvIT regulations and telecommunications licence conditions — specifically the question of whether a change in the ultimate beneficial ownership of licensed telecommunications infrastructure triggered by the formation or expansion of an InvIT requires DoT's prior approval — is an important legal question for transactions involving InvIT structures. DoT's guidelines on ownership changes in licensed entities prescribe prior approval for any change in beneficial ownership above specified thresholds. Where an InvIT acquires licensed telecommunications infrastructure, the InvIT's investors (who hold units in the InvIT) become the ultimate beneficial owners of the infrastructure through the InvIT structure — raising the question of whether the continuous change in the InvIT's investor base (as units are bought and sold on the stock exchange) constitutes a change in the beneficial ownership of the licensed infrastructure that requires repeated DoT approval. The development of clear, published guidance on the application of DoT's ownership change approval requirements to listed InvIT structures — potentially creating a streamlined approval mechanism for listed digital InvITs that is proportionate to the low security risk of public market trading in InvIT units — would facilitate the development of the digital infrastructure investment trust market in India.

The valuation methodology for telecommunications infrastructure assets in the context of InvIT transactions — specifically the framework for determining the fair value of tower portfolios, fibre networks, and spectrum assets that will be held by an InvIT — requires specialist expertise in both infrastructure asset valuation and telecommunications market analysis. Tower portfolio

valuations are typically based on discounted cash flow analysis, with the discount rate reflecting the risk profile of the cash flows (principally the revenue from long-term tenancy agreements with operators) and the terminal value reflecting the long-term growth of the tower tenancy market. The specific valuation drivers for Indian tower portfolios include: the average tenancy ratio (the number of operators co-located per tower, which determines the revenue per tower); the likelihood of tenancy renewals at current rates (reflecting the operators' commercial need for the specific tower locations and the competitive alternatives available to them); the terms of the underlying long-term lease agreements for tower sites (which determine the cost base of the tower operations); and the regulatory outlook for spectrum sharing and active sharing (which affects the future demand for passive tower infrastructure as active sharing potentially reduces the number of distinct operator networks deployed on passive infrastructure).

F.2 Net Metering and Telecom Tower Energy

The energy transition challenge for India's telecommunications infrastructure — specifically the transition from grid-dependent diesel backup power to renewable energy integrated with battery storage for mobile base stations — has important regulatory dimensions that involve both telecommunications regulation and energy regulation. Mobile base stations are among the most energy-intensive components of telecommunications infrastructure: a typical macro base station consumes between 3-7 kW of power continuously, with significant additional demand for air conditioning in hot climates. Multiply this by India's 700,000+ base stations, and the telecommunications sector's total energy consumption is substantial. The transition to renewable energy — primarily solar panels with battery storage for base stations in areas where grid power is unreliable, and wind-solar hybrid systems for towers in remote locations — is both an environmental sustainability initiative and a commercial opportunity: renewable energy can be cheaper than diesel generation in many contexts, particularly as solar panel and battery prices continue to decline.

The regulatory framework for distributed renewable energy generation at telecommunications sites — specifically the rules governing the installation of solar panels on towers and rooftops, the metering arrangements for any excess generation exported to the grid, and the commercial arrangements for power purchase from the telecommunications operator's distributed generation assets — involves both the telecommunications infrastructure regulatory framework (governing the installation of generating equipment on tower sites) and the electricity regulatory framework (governing the grid connection, net metering, and export of excess generation). The CERC (Central Electricity Regulatory Commission) and state electricity regulatory commissions' net metering regulations — which enable small solar generators to

export excess power to the grid and receive credit on their electricity bills — are potentially applicable to telecommunications tower sites, providing a commercial incentive for operators and towercos to install solar generation capacity beyond their own requirements. The development of a clear, streamlined regulatory pathway for telecommunications infrastructure operators to install distributed solar generation and access net metering benefits would accelerate the renewable energy transition in the sector.

F.3 Connected Vehicles and Spectrum Policy

The spectrum policy framework for connected vehicles (V2X communications) — one of the most important spectrum management questions for India's automotive and transportation sectors — involves a fundamental choice between two competing technology approaches: dedicated short-range communications (DSRC) using the 5.9 GHz ITS (Intelligent Transportation Systems) band, and cellular vehicle-to-everything (C-V2X) using licensed cellular spectrum. DSRC, developed in the early 2000s and standardised by IEEE (802.11p) and ETSI (ETSI ITS-G5), provides dedicated spectrum for vehicle-to-vehicle and vehicle-to-infrastructure communications in the 5.855-5.925 GHz band, independent of cellular network coverage. C-V2X, developed by 3GPP as an extension of LTE and 5G technology, enables V2X communications using existing cellular spectrum (either in licensed bands through the cellular network, or in direct communication mode using licensed spectrum without cellular network involvement). The choice between DSRC and C-V2X has regulatory, commercial, and technical dimensions: the spectrum band (5.9 GHz ITS band vs. licensed cellular spectrum), the standardisation ecosystem (IEEE/ETSI vs. 3GPP), and the deployment model (independent RSU infrastructure vs. cellular network integration) differ significantly between the two approaches.

India's current spectrum policy does not include a dedicated 5.9 GHz ITS band allocation — unlike the United States (which has the 5.850-5.925 GHz DSRC band), the European Union (which has the 5.855-5.925 GHz ETSI ITS band), and Japan (which has the 755-765 MHz ITS band). Without a dedicated 5.9 GHz ITS allocation, DSRC-based V2X deployment is not possible in India; C-V2X using licensed cellular spectrum would be the primary available V2X technology. The WPC Wing's management of the 5.9 GHz band — currently used for a variety of applications including fixed wireless access, campus wireless networks, and Wi-Fi in the adjacent 5.725-5.850 GHz unlicensed band — would need to evolve if India decides to allocate a portion of the 5.9 GHz range for ITS use. The development of a clear spectrum policy decision on V2X — including a decision on whether to allocate dedicated ITS spectrum and if so in which band — is a prerequisite for the development of connected vehicle safety applications in India.

This decision should be made through the SACFA inter-agency consultation process, involving DoT, MoRTH, ISRO (for any satellite V2X applications), and the automotive industry.

F.4 Legal Issues in Digital Twin Networks

Digital twin networks — software representations of physical telecommunications network infrastructure and operations that enable operators to simulate network behaviour, test configuration changes, and optimise performance without affecting the live network — are an emerging technology with significant regulatory implications. A digital twin network creates an exact virtual replica of the physical network, incorporating real-time network performance data, traffic measurements, and configuration parameters. Changes to network configuration (such as spectrum reallocation, base station power adjustments, or routing changes) can be tested in the digital twin before implementation, reducing the risk of live network disruption and improving the quality of network management decisions. The data privacy implications of digital twin networks — specifically the fact that a digital twin network may incorporate anonymised or pseudo-anonymised subscriber traffic data to accurately represent network usage patterns — require careful assessment under the DPDPA's framework. If the traffic data used in the digital twin can be used to identify individual subscribers or to track their communication patterns, it constitutes personal data subject to the DPDPA's processing conditions.

The intellectual property implications of digital twin networks create specific legal considerations for operators that share their digital twin technology or data with third parties. The digital twin model — the software and data that together create the virtual representation of the network — may embody significant intellectual property: the algorithms for network simulation, the data models for network configuration, and the calibrated parameters that make the digital twin accurately represent the physical network's behaviour. The IP ownership of digital twin models — where the model is developed jointly by the operator and a technology vendor (such as a network equipment vendor or a systems integrator) — requires clear contractual allocation in the development agreement. The data sharing provisions of digital twin technology partnerships — addressing which data the operator must share with the vendor for digital twin calibration, the vendor's obligations to protect the confidentiality of operator network data, and the vendor's rights to use anonymised network data for training AI models — are important legal considerations that must be carefully addressed in digital twin technology agreements.

F.5 Spectrum Pricing and the Innovation Economy

The relationship between spectrum pricing policy and innovation in the telecommunications sector is a complex and contested empirical and policy question. High spectrum prices —

generated by well-designed competitive auctions that extract maximum value from spectrum assignments — provide government revenue and ensure that spectrum goes to operators who value it most commercially. But high spectrum prices also increase operators' capital costs, reduce the cash flow available for network investment, and may deter entry by innovative new players who cannot afford high spectrum costs. The optimal spectrum pricing policy — from an innovation and dynamic efficiency perspective — may differ from the revenue-maximising policy that governments often pursue. Several academic studies have found that countries with high spectrum prices (relative to the value of the spectrum in terms of revenue-per-subscriber) tend to have lower 5G investment and slower technology adoption than countries with more affordably priced spectrum, suggesting a negative relationship between aggressive spectrum monetisation and telecommunications innovation.

India's experience with spectrum pricing illustrates the tension between revenue maximisation and investment incentives. The high spectrum prices of India's early auctions (2010-2015), set in the belief that India's large subscriber market would support high spectrum valuations, contributed to the financial stress that precipitated the sector's consolidation crisis of 2017-2021. The subsequent correction — lower reserve prices in the 2022 auction, combined with more flexible payment terms — produced better commercial outcomes (more spectrum sold, more competitive 5G rollout) while still generating significant government revenue. India's future spectrum pricing policy — calibrated in the context of the 2023 Act's new spectrum management framework — should incorporate the lessons of this experience, seeking to balance fair competition, revenue generation, and investment incentives in a way that serves India's long-term digital development objectives. TRAI's spectrum pricing recommendations, informed by a sophisticated analysis of operators' financial capacity, competitive dynamics, and the investment requirements of successive technology generations, are the primary mechanism through which this balance is struck in practice.

SUPPLEMENTARY NOTE G

Infrastructure and Spectrum: Concluding Analysis

G.1 The Legal Framework for 5G Standalone Core

The transition from 5G non-standalone (NSA) deployments — where 5G radios rely on a 4G LTE core network for control plane functions — to 5G standalone (SA) deployments — where the full 5G New Core (5GC) architecture is deployed, enabling the complete range of 5G capabilities including network slicing, edge computing, and ultra-low latency applications — has significant

legal and regulatory implications for Indian operators. 5G NSA deployments allow operators to offer enhanced mobile broadband on 5G radios while reusing their existing 4G core infrastructure, reducing the capital cost of initial 5G deployment. However, NSA deployments cannot support many of 5G's most commercially and socially significant applications: network slicing (which requires the 5G New Core's network slice management functions), ultra-reliable low-latency communications (which requires the end-to-end latency reduction that the 5G New Core's service-based architecture enables), and many enterprise private network use cases (which depend on SA capabilities). The deployment of 5G SA core networks — which requires substantial additional investment in core network infrastructure, including Service Management Functions, Session Management Functions, User Plane Functions, and associated orchestration and management systems — represents a critical milestone in the full realisation of 5G's potential in India.

The regulatory implications of 5G SA deployment involve several specific questions. The security framework for 5G SA core — which introduces the 5G New Core's service-based architecture (SBA), with network functions communicating through standardised APIs rather than proprietary interfaces — requires the TTP framework to evaluate and approve 5G New Core network functions as distinct products from the 5G RAN equipment covered by existing TTP approvals. The network slicing regulatory framework — addressing the classification of specific slice types (internet access slices vs. specialised service slices), the quality of service obligations applicable to each slice type, and the commercial conditions for enterprise network slice access — must be developed as part of the 5G SA rules. And the cloud-native deployment model of 5G SA core — where network functions are implemented as software containers running on commercial cloud infrastructure rather than as dedicated hardware appliances — creates specific security and regulatory questions about the applicability of TTP requirements to software-only core network functions running on non-telecom-specific cloud platforms.

The commercial model for 5G SA network slicing — enabling operators to offer tailored connectivity solutions to enterprise customers with guaranteed quality, security, and isolation characteristics — is one of the most commercially promising aspects of 5G that has not yet been fully realised in India's market. The legal framework for 5G network slice commercial agreements — the service level agreements, liability provisions, and pricing structures that govern the commercial relationship between operators and enterprise customers for network slice services — is still developing. Key commercial law questions include: what standard of care must an operator meet in providing a network slice for a safety-critical application (where service disruption could cause harm)? How should liability be allocated between the operator, the

enterprise customer, and the application provider when a network slice failure causes harm? And what force majeure provisions are appropriate for network slice agreements, where the boundary between the operator's network failure and the enterprise customer's application failure may be unclear? The development of standard contract terms for 5G network slice commercial agreements — potentially through industry body guidance or TRAI recommendations — would reduce transaction costs and improve the clarity of commercial relationships in the enterprise 5G market.

G.2 Legal Due Diligence for Fibre Network Acquisitions

The acquisition of fibre broadband network assets — either through direct asset purchase (buying the fibre cables, equipment, and rights-of-way that constitute a fibre network) or through share purchase (acquiring the company that owns and operates the fibre network) — has become an important category of telecommunications infrastructure transaction in India as the fibre broadband market matures and as strategic investors seek to build or expand fibre infrastructure portfolios. Legal due diligence for fibre network acquisitions must address: the nature and validity of the rights-of-way (RoW) through which the fibre passes — verifying that the fibre cables have valid and continuing rights to be installed in the physical routes they occupy (whether through DoT RoW licences, landlord consents for buildings, municipal permissions for road crossings, or railway/utility corridor agreements); the technical condition of the fibre (reviewing available optical performance test records, fault history, and the physical condition of duct and cable infrastructure); the commercial terms of existing customer contracts (assessing the revenue quality, contract term, and renewal risk of the fibre network's existing customer base); the environmental and planning compliance of the infrastructure (checking that the network was installed in compliance with applicable planning requirements and that there are no outstanding enforcement notices); and the employment law aspects of any staff transfer associated with the acquisition.

The rights-of-way due diligence for fibre network acquisitions is particularly complex because fibre networks typically traverse numerous different property interests — crossing roads, tunnels, bridges, rivers, and railways, passing through multiple municipalities and potentially multiple states — each requiring specific rights and permissions. The aggregation of thousands of individual RoW records into a coherent legal assessment of the network's overall RoW position requires systematic data management and risk categorisation: high-risk RoW positions (where the right is likely invalid, time-limited, or contingent on conditions that may not be met) are distinguished from medium and low-risk positions to enable the acquirer to assess the overall RoW risk and to negotiate appropriate contractual protections. The specific risk areas for fibre

RoW include: informal permissions (where the fibre is installed with the property owner's practical acquiescence rather than through a formal documented agreement, creating risk if the ownership or management of the property changes); time-limited agreements (where RoW rights expire and require renewal, creating a risk of network interruption if renewal is refused or delayed); and encroachment risk (where the fibre has been installed outside the boundaries of the permitted route, creating risk of removal demands or enforcement action).

The liability provisions in fibre network acquisition agreements — specifically the representations and warranties that the seller makes about the state of the network and the limitations on liability that the seller seeks — are commercially critical in fibre transactions. Sellers of fibre networks typically make representations about: the accuracy of the network documentation (maps, capacity records, and customer contracts); the absence of material defects in the network infrastructure; the compliance of the network with applicable regulatory requirements; and the validity of the RoW agreements. Buyers typically seek: a long warranty period (given that fibre faults may take significant time to manifest); unlimited or capped liability for material misrepresentations (reflecting the commercial significance of the acquired infrastructure); and specific indemnities for identified risks (such as disputed RoW positions or known regulatory compliance issues). The negotiation of these warranty and indemnity provisions — balancing the seller's interest in limiting post-closing liability against the buyer's interest in adequate protection against undisclosed defects — is one of the most commercially sensitive aspects of fibre network acquisition transactions and requires specialist legal expertise in both telecommunications infrastructure and commercial transactions.

G.3 Regulatory Reforms for the Digital Connectivity Era

The digital connectivity era — in which access to high-speed broadband is recognised as a fundamental infrastructure need equivalent to access to electricity, clean water, and roads — requires a regulatory framework that goes beyond the historical telecommunications regulatory model (focused on licensing, tariff regulation, and quality of service) to address the full economic and social dimensions of connectivity as critical infrastructure. The regulatory reforms needed for the digital connectivity era in India include: the development of a comprehensive broadband access obligation (going beyond the current coverage obligations to specify minimum quality standards for broadband available to all households); a technology-neutral connectivity funding mechanism (enabling the Digital Bharat Nidhi to support the most cost-effective connectivity technology for each geographic context, regardless of whether that is fibre, mobile, satellite, or a combination); a competition framework designed for the specific market structures of the digital economy (addressing the platform power of digital gatekeepers alongside traditional operator

market power); and a digital rights framework (recognising the constitutional dimensions of internet access, privacy, and freedom of expression in the digital context and embedding these rights in the regulatory framework).

The development of a universal broadband obligation — imposing on the government and the industry collective an obligation to ensure that all Indian households have access to specified minimum broadband quality by a specified date — would be a regulatory milestone for India's digital connectivity agenda. Unlike the existing coverage obligations (which require operators to deploy infrastructure in specified areas but do not guarantee that households in covered areas can actually access and afford broadband services), a universal broadband obligation would specify an outcome (all households with access to 25/5 Mbps, or some higher standard, by a specified date) rather than an input (operators deploying infrastructure in specified areas). The funding mechanism for a universal broadband obligation — whether through the Digital Bharat Nidhi, through regulatory cross-subsidies from commercial operators, through direct government appropriation, or through some combination — would need to be designed to ensure that the obligation is commercially sustainable and that the most cost-effective technologies are used for different geographic contexts. TRAI's recommendations on the universal broadband obligation framework — developed through comprehensive consultation with industry, consumer groups, and state governments — would provide the evidence base for a policy decision on whether and how to implement such an obligation.

SUPPLEMENTARY NOTE H

Infrastructure and Spectrum: Concluding Topics

H.1 The Spectrum Economy: Value Creation and Capture

The economics of spectrum — specifically the processes by which spectrum is valued, allocated, and the economic rents from spectrum use are distributed among the government, operators, and subscribers — is a topic of fundamental importance for telecommunications policy that goes beyond the technical spectrum management issues typically discussed in licensing and regulatory practice. Spectrum is an economic resource with unique characteristics: it is non-depletable (using spectrum does not consume it, unlike physical resources), non-excludable in the absence of regulation (radio waves do not respect property boundaries), and subject to congestion (simultaneous use by multiple parties in the same frequency band in the same geographic area creates interference that degrades the value of the spectrum for all users). These characteristics justify public ownership of spectrum (to prevent the tragedy of the

commons that would result from unregulated use) and active government management of spectrum access (through licensing or auction mechanisms that allocate spectrum to the highest-value uses while preventing harmful interference). The government's capture of spectrum rents — through auction proceeds and annual spectrum charges — redistributes the economic value created by spectrum from operators to the public, while leaving operators with sufficient return on their spectrum investment to incentivise continued network deployment and service improvement.

The distributional implications of spectrum policy — specifically how the economic benefits and costs of spectrum management are distributed across different stakeholder groups — are important for assessing the equity of India's spectrum governance framework. High spectrum prices (generated by competitive auctions that maximise government revenue) benefit the government (which receives auction proceeds and annual charges) but impose costs on operators (whose profitability is reduced) and ultimately on subscribers (who pay higher prices to cover operators' spectrum costs). Low spectrum prices benefit operators and subscribers but reduce government revenue. The optimal spectrum pricing policy — balancing government revenue, operator investment, and subscriber welfare — requires a nuanced analysis that accounts for the specific market structure, competitive dynamics, and investment requirements of India's telecommunications sector at each point in time. TRAI's spectrum pricing recommendations must navigate this distributional question, balancing the government's legitimate revenue objectives (which are determined through the political process) against the investment and affordability considerations that determine the ultimate welfare impact of spectrum management decisions on Indian subscribers and the digital economy.

The geographic dimension of spectrum economics — the variation in spectrum value across India's 22 telecom circles, which reflects differences in subscriber density, income levels, competitive dynamics, and infrastructure costs — creates important design questions for India's spectrum auction framework. A single national reserve price for spectrum may be simultaneously too high for low-density rural circles (where the commercial value of spectrum is low) and too low for high-density urban circles (where the commercial value is high). The circle-specific auction format used in India's spectrum auctions — where operators bid separately for spectrum in each circle — partially addresses this variation by enabling market prices to reflect circle-specific commercial value. However, operators' bidding strategies in multi-round, multi-circle auctions are complex, involving strategic decisions about package bids, switching between circles, and managing exposure to unsatisfied package bids, that can produce outcomes that diverge from the theoretical ideal of efficient spectrum allocation. The ongoing refinement of India's spectrum

auction format — incorporating lessons from successive auctions and from international auction design literature — is an important contribution to the efficiency of spectrum governance that TRAI's recommendations should continue to address.

H.2 Private Networks and the Regulatory Boundary

The regulatory boundary between private telecommunications networks (deployed by enterprises for their own internal communications) and public telecommunications networks (deployed by licensed operators to provide services to third-party subscribers) is becoming increasingly blurred as private 5G deployments proliferate and as the technology for private network deployment becomes more accessible and commercially attractive. Historically, the distinction was clear: private networks (such as a corporation's internal PBX system or a factory's Wi-Fi network) did not require a telecommunications licence because they were not providing services to the public. Licensed operators provided public telecommunications services (mobile voice, mobile broadband) that required spectrum, infrastructure, and a licence. With 5G private network spectrum now available for enterprises, the distinction becomes more complex: an enterprise deploying a private 5G network holds spectrum (traditionally a privilege of licensed public network operators) and operates network infrastructure that can serve multiple users (all employees and contractors on the enterprise campus).

The regulatory framework for private 5G networks must address several threshold questions. First, at what scale of third-party service provision does a private network become a public network requiring full operator licensing? An enterprise that deploys a private 5G network for its own employees is clearly not providing public telecommunications services; but if the same enterprise begins offering private 5G connectivity to its customers, tenants, or visitors on a commercial basis, it may cross the threshold into providing services to the public. The definition of "providing services to the public" in the context of enterprise 5G — and the point at which it triggers full operator licensing obligations — requires clear regulatory guidance. Second, what security and quality obligations should apply to private 5G network operators? The full security framework applicable to public network operators (TTP compliance, LI capability, CERT-In incident reporting) may be disproportionate for a private 5G deployment serving a single enterprise; but no security obligations would be inadequate for an enterprise deploying a 5G network that handles sensitive business data and potentially connects to public infrastructure. A proportionate, tiered security framework for private 5G — with requirements calibrated to the scale, sensitivity, and connectivity of the private network — would be more appropriate than either the full public network obligations or no requirements at all.

The commercial implications of private 5G network spectrum acquisition for the broader spectrum market — specifically the impact on demand and pricing in spectrum auctions if a significant number of enterprise customers directly acquire spectrum rather than purchasing services from licensed operators — is an emerging spectrum economics question with important regulatory dimensions. If large enterprises (the highest-value enterprise customers that currently generate significant revenue for mobile operators through expensive enterprise service agreements) directly acquire spectrum and operate their own private 5G networks, operators lose revenue from this high-value customer segment while the government gains spectrum auction revenue from enterprise bidders. The aggregate effect on the sector's financial sustainability — and on operators' ability to fund the continued expansion and improvement of their public networks, which serve the vast majority of subscribers — requires careful assessment. TRAI's spectrum auction design recommendations must account for the potential impact of enterprise spectrum demand on the total spectrum market and on the commercial sustainability of public network operators.

H.3 Technology Transfer and India's Telecom Industry

India's ambition to develop a strong domestic telecommunications equipment manufacturing industry — capable of designing, manufacturing, and exporting telecommunications equipment that competes with established global players — depends critically on access to advanced telecommunications technology. Technology transfer — the process by which advanced telecommunications technology developed by leading global companies is transferred to Indian companies through licensing, joint ventures, R&D; collaboration, or direct investment — is an essential pathway for building India's domestic telecommunications technology capability. The government's policies for promoting technology transfer in the telecommunications sector include: the PLI scheme (which incentivises domestic manufacturing but does not specifically require technology transfer to Indian companies); the requirement for domestic procurement preferences in government and PSU procurement (creating commercial incentives for global companies to partner with Indian manufacturers to qualify for government contracts); and the development of domestic R&D; programmes (C-DoT, IITM Pravartak, and other academic-industry consortia) that create a domestic technical base on which transferred technology can be built.

The intellectual property framework for technology transfer agreements in telecommunications — governing the licensing of patents, technical know-how, and software from global technology companies to Indian manufacturers — must balance the global company's legitimate interest in protecting its IP and ensuring fair compensation for its

technology contribution with India's interest in developing genuine domestic capability rather than merely becoming an assembly location for foreign technology. Technology transfer agreements that provide limited rights (assembly under strict quality controls, with all design, improvement, and export decisions controlled by the foreign licensor) do not genuinely transfer technology to Indian partners. Agreements that provide genuine development rights — enabling Indian partners to improve, adapt, and ultimately develop their own derivative technology — create the foundation for real domestic capability development, but require greater IP concessions from the foreign licensor. The negotiation of technology transfer agreements in the telecommunications sector is a complex legal and commercial exercise that requires expertise in both IP law and telecommunications industry dynamics.

H.4 Regulatory Framework for Emerging Radio Technologies

The regulatory framework for emerging radio technologies — specifically the rules governing the use of software-defined radio (SDR), cognitive radio, and reconfigurable intelligent surface (RIS) systems in India's telecommunications networks — is still being developed and represents an important frontier for both spectrum management innovation and regulatory design. Software-defined radio systems — in which the radio's operating frequency, modulation scheme, and transmission power are controlled by software rather than hardware — enable a single device to operate flexibly across multiple spectrum bands and standards. This flexibility is valuable for multi-band 5G base stations (which must simultaneously support multiple frequency bands for coverage and capacity) and for future 6G systems (which will need to operate across an even wider range of frequencies). The WPC's type approval framework for SDR systems — which must ensure that software-controlled radios operate only within their authorised parameters and cannot be reconfigured to operate outside their approved specifications — requires specific evaluation criteria for SDR equipment that address both the capabilities of the initial software configuration and the mechanisms for preventing unauthorised reconfiguration.

Reconfigurable Intelligent Surfaces (RIS) — large panels of passive reflective elements that can be electronically controlled to shape and redirect radio waves — represent a genuinely novel radio technology that does not fit neatly within the traditional regulatory framework for active radio systems. RIS panels do not transmit radio waves (they only reflect existing signals from other transmitters) but their operation — redirecting radio waves to improve coverage, eliminate dead zones, or reduce interference — fundamentally affects the radio environment in ways that require regulatory consideration. The key regulatory questions for RIS include: does a RIS panel require a spectrum licence (since it manipulates radio waves) or is it unregulated passive infrastructure (since it does not transmit energy)? Who bears responsibility for the interference

effects of a RIS panel — the panel operator, the network operator using the panel, or the infrastructure owner hosting the panel? And how should the electromagnetic field exposure implications of RIS be assessed (since RIS can redirect and concentrate radio energy in ways that may affect EMF exposure patterns in their vicinity)? The development of a regulatory framework for RIS — through WPC's type approval programme and TRAI's QoS and infrastructure standards — is an important near-term regulatory priority as RIS technology moves toward commercial deployment in India's 5G networks.

SUPPLEMENTARY NOTE I

Infrastructure and Spectrum: Final Perspectives

I.1 Regulatory Framework for Telecom Tower Safety

The structural safety of telecommunications towers is governed by a multi-layered framework of standards, approvals, and liability rules that practitioners advising tower operators, towercos, and operators must understand. The primary structural standards for telecommunications towers in India are: IS 875 (Indian Standard for Design Loads for Buildings and Structures), which specifies the wind loads and other structural loads that towers must be designed to withstand; IS 800 (Indian Standard for General Construction in Steel), which specifies the structural design requirements for steel towers; and SP 38 (Handbook for Structural Engineers on Steel Towers), which provides specific guidance for telecommunications tower design. These standards are referenced in local building authority approvals, which typically require a structural engineer's certificate of compliance with the applicable standards before a building permit for a new tower is issued. The failure to comply with these standards — whether through inadequate design, poor construction quality, or overloading of existing towers with additional equipment beyond their design capacity — creates both regulatory exposure (for violations of the applicable building regulations) and civil liability (for negligence if the structural failure causes injury or damage).

The electromagnetic field (EMF) safety framework for telecommunications towers — prescribing the maximum permissible radio frequency exposure levels for persons in the vicinity of base station antennas — is administered through a combination of WPC frequency assignment conditions, DoT's EMF guidelines, and TRAI's consumer protection directions on EMF disclosure. The applicable EMF standard in India — set at 10 times below the ICNIRP limits already conservative by international standards — results in one of the lowest permissible EMF exposure levels in the world. Compliance with the EMF standard requires: antenna configuration

review at the time of installation (calculating the theoretical exposure based on antenna specifications, transmitted power, and distance to the nearest occupied space); periodic EMF measurement using calibrated instruments (to verify that actual exposure complies with the theoretical calculation); and record-keeping (maintaining documentation of all EMF compliance assessments and measurements for regulatory inspection). The strict Indian EMF standard creates significant compliance complexity for dense urban deployments where multiple base station antennas are co-located on shared infrastructure with overlapping EMF exposure zones.

The environmental permitting framework for telecommunications tower sites — encompassing the environmental impact assessments required for towers in environmentally sensitive areas, the coastal regulation zone approvals required for towers in coastal areas, and the forest clearances required for towers in forested areas — adds a layer of environmental compliance to the telecommunications infrastructure deployment process. The Ministry of Environment, Forest and Climate Change's EIA notification framework exempts most telecommunications towers from full Environmental Impact Assessment requirements (recognising that individual towers have limited environmental impact) but requires compliance with specific environmental standards (including restrictions on tower height and placement near wildlife corridors, protected forests, and wetlands) and with the coastal regulation zone framework (which restricts construction within specified distances of the high tide line). Operators and towercos deploying towers in environmentally sensitive areas must conduct careful pre-deployment environmental due diligence — identifying applicable environmental restrictions and obtaining required clearances before construction begins — to avoid the regulatory and reputational consequences of non-compliant tower deployments.

I.2 Auction Theory and Spectrum Design

The application of auction theory to spectrum allocation — using insights from game theory, mechanism design, and empirical auction literature to design spectrum auctions that efficiently allocate spectrum while maximising government revenue — is a specialised field of economics that has had direct influence on the design of India's spectrum auctions since the mandatory auction framework was established following the 2G spectrum scandal. The fundamental insight of auction theory is that different auction formats (ascending bid, sealed bid, combinatorial, clock) create different strategic incentives for bidders and produce different allocation and revenue outcomes. The Simultaneous Multiple Round Auction (SMRA) format — used in several of India's major spectrum auctions — enables bidders to simultaneously bid for multiple spectrum lots across multiple frequency bands and geographic areas, with the auction ending when no new bids are received in any lot. The strategic complexity of SMRA bidding —

managing exposure to unsatisfied aggregation across multiple lots, assessing competitors' bidding strategies, and avoiding the "threshold problem" where individually rational bids fail to assemble a commercially viable spectrum portfolio — requires sophisticated bidding strategies that major operators develop with academic economists and auction specialists.

The combinatorial clock auction (CCA) format — which separates the bidding process into clock rounds (where prices rise incrementally until demand equals supply) and a supplementary round (where bidders can submit combinatorial bids for packages of lots at prices above the clock round prices) — has been adopted in several European spectrum auctions (including UK, Germany, and Ireland) as a more efficient alternative to SMRA for complex multi-band, multi-lot auctions. India has not yet adopted the CCA format, but TRAI's ongoing assessment of auction design options for future 5G and 6G auctions should include a serious evaluation of whether CCA would be more appropriate for India's complex multi-band, multi-circle spectrum auctions than the SMRA format currently used. The CCA format's advantages — including its theoretical property of producing efficient, envy-free allocations and its reduced exposure to strategic demand reduction (where bidders artificially suppress their bids to reduce prices) — must be weighed against its complexity (which makes it harder for less sophisticated bidders to participate effectively) and the significant technical and institutional preparation required to conduct a CCA auction.

I.3 Telecom Law and Land Acquisition

The acquisition of land for telecommunications infrastructure — specifically the acquisition of tower sites, cable duct routes, and data centre land through private negotiation or compulsory acquisition — involves the intersection of telecommunications law and land acquisition law that practitioners must understand for infrastructure-intensive transactions. The Indian Wireless Telegraphy Act, 1933 (and now the Telecommunications Act, 2023) provides the statutory basis for telecom operators' right to lay infrastructure on land, but the exercise of this right in practice involves complex negotiations with landowners whose cooperation (for access, construction, and maintenance) is practically essential even where the legal right to proceed without consent exists. The right-of-way framework's compensation provisions — specifying the one-time compensation payable to landowners for the permanent impact of infrastructure deployment on their property — are an important determinant of the speed and cost of infrastructure deployment.

The compulsory acquisition of land for telecommunications data centres — large-scale facilities requiring significant land parcels with specific characteristics (power availability, cooling water access, physical security, and road access) — involves the Land Acquisition,

Rehabilitation and Resettlement Act, 2013 (LARR Act) framework, which prescribes the process and compensation standard for compulsory acquisition. The LARR Act's compensation standard (market value plus solatium, including replacement cost for affected structures) and its social impact assessment requirements create a detailed, multi-year process for compulsory acquisition that makes it suitable only for large-scale infrastructure projects where the public benefit clearly justifies the social cost of displacement. For most telecommunications infrastructure (individual tower sites and cable duct routes), private negotiation with landowners — facilitated by the availability of the compulsory acquisition right as a backstop — is the practical approach, and the legal framework for right-of-way compensation should provide sufficient clarity and certainty to enable negotiated outcomes to be reached efficiently.

SUPPLEMENTARY NOTE J

Infrastructure Law: Final Topics

J.1 MOCN and RAN Sharing: Case Studies

Multi-Operator Core Network (MOCN) active RAN sharing — the arrangement by which multiple operators share a single active RAN infrastructure, with each operator's subscribers connecting to the shared RAN using the same frequencies but identifying with different network operators through the sharing of a common frequency block — is the deepest form of active network sharing currently deployed in India and raises the most significant regulatory and competition law questions. In an MOCN arrangement, the sharing operators each contribute spectrum to the shared pool, both operators' subscribers use the shared RAN under a common air interface, and the traffic from each operator's subscribers is separated at the network level and routed to the respective operators' core networks. The regulatory framework for MOCN requires careful analysis of several parameters: the combined spectrum of the sharing partners must not exceed the spectrum cap; the subscriber data of each operator's subscribers must be isolated in the shared infrastructure (particularly important given the competitive sensitivity of subscriber location and usage data); and the quality of service experienced by each operator's subscribers must meet the applicable QoS standards regardless of the sharing arrangement. TRAI's guidelines on active sharing — which require DoT approval, spectrum cap compliance, and subscriber data protection — provide the regulatory framework, but the commercial and operational structuring of MOCN arrangements (including cost allocation, performance monitoring, and dispute resolution) is governed by detailed commercial agreements that require specialist telecommunications legal expertise.

The competition law assessment of MOCN arrangements by the Competition Commission of India adds a further dimension to the regulatory analysis of active sharing transactions. The CCI's review of MOCN arrangements — which involves assessment of whether the sharing partners have significant market power in the relevant markets, whether the sharing arrangement could facilitate tacit coordination (through the sharing of commercially sensitive capacity and usage information), and whether the arrangement creates barriers to entry for other operators — requires an economic analysis that goes beyond the telecommunications regulatory framework. The CCI's conditional approval of MOCN arrangements (imposing information barriers between the commercial teams of the sharing partners, limiting the granularity of shared operational data, and prohibiting the sharing of subscriber-level commercial information) reflects the competition authority's concern about the coordination risk inherent in arrangements that give competitors detailed visibility of each other's network capacity and utilisation. Practitioners structuring MOCN transactions must engage with both the telecommunications regulatory approval process (DoT) and the competition law review process (CCI), coordinating the two processes to ensure efficient and consistent outcomes.

The operational challenges of MOCN sharing — particularly the management of performance disputes (when one operator's subscribers experience quality degradation attributable to the other operator's higher traffic load on the shared infrastructure) and the handling of network upgrades (when one operator wishes to upgrade the shared infrastructure to support new services while the other operator is not ready or willing to commit the required capital investment) — require robust governance provisions in the sharing agreement. The MOCN governance framework should address: the process for agreeing shared infrastructure upgrade plans; the allocation of capital expenditure between the sharing partners; the performance monitoring standards and the remediation process when performance falls below agreed levels; the information sharing protocols for operational data (ensuring that each operator receives sufficient information to manage its network while protecting commercially sensitive data from unauthorised access); and the exit provisions for a sharing partner that wishes to terminate the arrangement (addressing the transition of traffic, spectrum, and infrastructure obligations on exit). The development of standard governance provisions for MOCN arrangements — potentially through industry body guidance — would reduce transaction costs and improve the consistency of sharing arrangements across the sector.

J.2 Infrastructure Finance and Capital Markets

The financing of telecommunications infrastructure in India — encompassing both the capital markets instruments used to fund large-scale spectrum acquisitions and network deployments

and the project finance structures used for specific infrastructure projects — is an area where telecommunications law and financial law intersect in ways that require expertise in both domains. The major capital markets instruments used by Indian telecommunications operators include: equity issuance (rights issues and QIPs used by listed operators to raise capital for large expenditures such as spectrum auctions and network upgrades); non-convertible debentures (NCDs, used for long-term debt financing secured against operator assets); commercial paper (short-term debt instruments used for working capital); and external commercial borrowings (ECB, enabling operators to borrow from foreign lenders in foreign currency, subject to RBI's ECB framework). The legal documentation for these instruments — prospectuses, information memoranda, debenture trust deeds, and ECB loan agreements — must accurately disclose the regulatory and commercial risks of investing in the telecommunications sector, including the regulatory financial obligations (AGR, spectrum charges), the competitive market risks, and the specific legal proceedings (such as AGR-related Supreme Court proceedings) that affect the operator's financial position.

The infrastructure finance dimension of the telecommunications sector — specifically the use of project finance structures (with debt service backed by predictable infrastructure cash flows rather than by the general corporate creditworthiness of the operator) for specific telecommunications infrastructure projects such as submarine cables, BharatNet fibre deployments, and large-scale tower construction — requires an understanding of both the financial engineering of project finance and the telecommunications regulatory framework. Project finance for telecommunications infrastructure typically involves: a special purpose vehicle (SPV) that holds the specific infrastructure assets; long-term offtake agreements with anchor customers (operators who commit to use the infrastructure for defined periods) that provide the cash flow visibility needed for project finance debt; regulatory risk assessment (addressing the risk that regulatory changes could reduce the commercial value of the infrastructure or impose additional costs on the SPV); and security arrangements (including the pledge of infrastructure assets, offtake agreement rights, and potentially the operating licence if the SPV holds a licence). Practitioners advising on telecommunications infrastructure finance transactions must coordinate the financial structuring (typically led by investment bankers and finance lawyers) with the telecommunications regulatory analysis (led by specialist telecommunications lawyers) to ensure that the project finance structure is consistent with the applicable regulatory requirements.

J.3 Concluding Perspectives

The legal framework for telecommunications licensing, spectrum management, and infrastructure deployment in India is one of the most technically complex and commercially significant areas of regulatory practice in the Indian legal landscape. The convergence of constitutional law (fundamental rights, equality, and the regulatory compact), administrative law (procedural fairness, proportionality, and the rule of law), competition law (market power, interconnection, and essential facilities), property law (right of way, compulsory acquisition), and corporate law (mergers, insolvency, and investment structures) in the telecommunications context creates a uniquely demanding practice area that requires interdisciplinary expertise and ongoing engagement with regulatory developments. The Telecommunications Act, 2023 and its implementing framework represent a significant modernisation of India's telecommunications legal architecture — providing a more flexible, technology-neutral, and constitutionally grounded basis for the regulation of a sector that is central to India's economic and social development. The practitioners who understand and can navigate this framework will be essential partners for the operators, investors, and regulators who shape India's telecommunications and digital future.

SUPPLEMENTARY NOTE K

Spectrum and Licensing: Concluding Themes

K.1 The Evolving Spectrum Regulatory Model

The evolution of India's spectrum regulatory model — from the administrative allocation of the pre-liberalisation era, through the mandatory auction framework established by the Supreme Court in the 2G Case, to the flexible, technology-neutral management framework of the Telecommunications Act, 2023 — reflects a progressive improvement in spectrum governance that has been hard-won through the lessons of regulatory failure and reform. The administrative allocation model's failure — illustrated most dramatically by the 2G spectrum scandal — established the constitutional imperative for competitive, transparent allocation of scarce public resources. The mandatory auction framework's implementation — through a series of increasingly sophisticated multi-band spectrum auctions from 2010 to 2022 — has broadly achieved the dual objectives of efficient allocation (getting spectrum to operators who value it most) and revenue generation (contributing significantly to government finances), while also creating periods of financial stress for the sector when reserve prices were set too high. The 2023 Act's framework builds on this experience, providing a flexible legislative framework that mandates auction as the default allocation mechanism while preserving administrative flexibility for specific categories of spectrum where auction is technically or legally inappropriate.

The most important unresolved question in India's spectrum regulatory model is the appropriate treatment of spectrum that has been released from government (primarily defence) use and made available for commercial telecommunications. The process of releasing government spectrum — which involves technical studies to confirm that the commercial deployment of the spectrum will not interfere with remaining government uses, negotiation between DoT and the relevant ministry on the terms of release, and WPC technical implementation of the release — has historically been slow and non-transparent, creating uncertainty about the availability timeline for spectrum bands that are commercially significant for 5G deployment. The development of a more transparent, time-bound process for government spectrum release — with published release timelines, clear criteria for assessing interference risk, and appropriate compensation or replacement spectrum for government users who give up frequencies for commercial reallocation — would improve the predictability of spectrum availability for operators planning their network investments and would ensure that India's commercial spectrum inventory keeps pace with the demands of successive technology generations.

The coordination between India's domestic spectrum management framework and the international spectrum governance frameworks through which India participates in WRC preparatory processes is an important but underappreciated dimension of spectrum policy. India's WRC positions — developed through the SACFA inter-agency process and negotiated through the APT regional group — determine which spectrum bands are available for commercial telecommunications in India and on what terms (since national allocations must comply with the ITU's Radio Regulations). The development of a more systematic, forward-looking WRC engagement framework — with earlier, more thorough domestic consultation on proposed WRC agenda items, stronger analytical support for India's WRC delegation, and closer coordination between India's WRC positions and its domestic spectrum planning — would improve the quality of India's WRC engagement and ensure that India's commercial spectrum interests are effectively represented in the international spectrum governance process.

K.2 The Licensing Ecosystem: Future Directions

The licensing ecosystem for Indian telecommunications in the post-2023 Act period will be shaped by the progressive implementation of the authorisation framework, the development of specific authorisation conditions for different service categories, and the evolution of spectrum assignment terms as 5G deployments mature and 6G planning begins. The most important new licensing development is the enterprise spectrum authorisation framework, which will determine

the commercial viability and scale of private 5G deployments in India's manufacturing, logistics, and healthcare sectors. The authorisation conditions for enterprise spectrum — specifically the technical parameters, security requirements, and third-party service restrictions applicable to enterprise 5G networks — will determine whether private 5G delivers on its commercial and social potential or whether regulatory friction limits its deployment to a small number of large, sophisticated enterprises. TRAI's recommendations on enterprise spectrum conditions, developed in close consultation with industry verticals that are not traditional telecommunications stakeholders, will be an important contribution to the development of India's enterprise digital infrastructure.

The regulatory framework for satellite service authorisations — one of the most commercially contested and technically complex aspects of the 2023 Act's implementation — will determine the pace and scale of India's satellite broadband market development. The satellite authorisation framework must address: the specific authorisation conditions applicable to different satellite technology categories (GEO vs. MEO vs. LEO satellite systems, direct-to-device vs. earth station connectivity); the spectrum assignment process for satellite services (administrative allocation vs. auction, and the interaction between India's national spectrum assignments and the ITU coordination process); the security conditions for satellite service providers (including LI capability, data localisation, and subscriber verification requirements, all of which are technically more challenging to implement for satellite services than for terrestrial mobile services); and the universal service obligations applicable to satellite broadband (including any conditions on coverage, affordability, or service quality that reflect satellite broadband's potential role in extending connectivity to unserved areas). These authorisation framework questions are commercially significant for the emerging satellite broadband industry and will determine whether India attracts the leading global satellite broadband providers or whether an overly complex or burdensome framework creates barriers to market entry.

FINAL NOTE: Infrastructure Law in the Digital Age

The legal framework for telecommunications infrastructure in the digital age must address a fundamental paradox: the infrastructure that enables the most powerful and transformative technology in human history is subject to legal rules designed for an earlier technological era, implemented by institutions with limited capacity to engage with the technology's full complexity, and evaluated by courts and tribunals that are still developing the expertise needed to assess highly technical regulatory questions. The Telecommunications Act, 2023 represents a significant improvement in the statutory foundation for telecommunications infrastructure law — more flexible, more technology-neutral, and more constitutionally grounded than the 1885 Act it

replaces — but even the most well-designed statute is only as effective as the institutional and human capacity that implements it. Building the institutional capacity of DoT, WPC, TRAI, and TDSAT to address the infrastructure governance challenges of 5G, satellite broadband, and the digital economy is as important as the legislative reform that the 2023 Act embodies.

The right of way framework — the legal mechanism through which telecommunications operators access the public and private infrastructure needed to deploy their networks — is one of the areas where the 2023 Act's improvements are most practically significant. The historical inability of operators to deploy network infrastructure efficiently — due to unreasonable fee demands, bureaucratic delays, and discriminatory treatment by local bodies and private landlords — has been a major constraint on India's telecommunications network development. The 2023 Act's strengthened RoW framework, with its deemed approval mechanism, fee caps, and anti-discrimination provisions, should significantly improve deployment efficiency. The ultimate test of the new framework's effectiveness is not its statutory provisions but its practical implementation: whether local bodies comply with the new framework, whether deemed approvals are asserted and respected in practice, and whether dispute resolution through TDSAT is fast and effective enough to be a practical remedy for RoW violations. This requires not only good law but consistent enforcement, effective adjudication, and cultural change in the institutions that historically resisted telecom infrastructure deployment.

The development of a truly connected India — in which high-quality, affordable telecommunications connectivity is universally available to all citizens regardless of their geographic location, income, gender, or disability — requires sustained, coordinated action across the full spectrum of telecommunications governance: spectrum management, licensing, infrastructure deployment, consumer protection, security, and digital inclusion. No single regulatory intervention will achieve universal connectivity; it requires the cumulative effect of thousands of well-designed, consistently implemented, and effectively enforced regulatory decisions over many years. The Telecommunications Act, 2023 provides the legal framework for this sustained effort; the implementing rules, the regulatory decisions, and the judicial interpretations that develop under the Act will determine whether the framework's potential is realised. The practitioners who work within this framework — advising operators, challenging regulatory decisions, developing policy, and adjudicating disputes — carry a collective responsibility for the quality of India's telecommunications governance, and through it, for the connectivity, security, and digital rights of India's citizens.

The BharatNet programme — India's landmark initiative to provide optical fibre connectivity to all 250,000 gram panchayats (village councils) — represents the world's largest rural

broadband programme by scope and is a central pillar of India's digital connectivity strategy. The legal framework for BharatNet involves several distinct regulatory dimensions: the procurement framework (governed by Central Government procurement rules and state government implementation agencies); the right of way framework (applicable to the laying of fibre along rural roads, canals, and other public infrastructure); the technology standards (specifying the technical requirements for BharatNet fibre infrastructure); and the service delivery framework (governing how last-mile connectivity is provided to individual households and community centres through BharatNet infrastructure). The legal complexity of BharatNet is compounded by its multi-stakeholder implementation model — involving Central Government funding, state government implementation, private sector contractors for construction, and telecommunications operators and ISPs for service delivery — which creates intricate legal relationships and accountability structures that must be carefully managed to achieve programme objectives.

The legal challenges that have affected BharatNet's implementation — including procurement disputes, contractor performance failures, right-of-way disputes with state authorities, and disagreements between Central and state governments about implementation responsibilities — illustrate the complexity of governing large-scale public infrastructure programmes in India's federal system. The resolution of these challenges requires both improved programme design (clearer accountability frameworks, better procurement standards, and more robust contractor management) and better regulatory support (faster RoW approvals, clearer dispute resolution mechanisms, and more effective monitoring and enforcement). The Telecommunications Act, 2023's strengthened RoW framework and the DBN's expanded mandate provide improved legal tools for addressing some of these implementation challenges, but the human and institutional dimensions — the capacity of state implementation agencies, the quality of programme management, and the political commitment to programme objectives at all levels of government — are at least as important as the legal framework.

The integration of BharatNet's infrastructure with the private sector telecommunications market — enabling private operators and ISPs to use BharatNet fibre on commercial terms for their last-mile connectivity deployments — is one of the most commercially important aspects of the programme's design. BharatNet's value as a backbone connectivity infrastructure is realised only if it is accessible to the private sector entities that provide last-mile connectivity to individual subscribers. The terms and conditions for private sector access to BharatNet infrastructure — including pricing, non-discrimination, technical specifications, and dispute resolution — determine whether BharatNet creates a genuine open access rural connectivity platform or whether it becomes a government-owned network that competes with private operators rather

than complementing them. TRAI's recommendations on BharatNet access conditions — providing independent regulatory oversight of the terms on which publicly funded infrastructure is made available to the private sector — are an important safeguard against the misuse of BharatNet's market position.

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