CONSUMER PROTECTION ASSOCIATION HIMMATNAGAR DIST. : SABARKANTHA GUJARAT



Comments on

Pre-Consultation Paper on Review of existing TRAI Regulations on Interconnection matters

Introduction :

The review of existing TRAI Regulations on Interconnection Matters is necessary to ensure that the regulatory framework remains relevant, effective, and aligned with the rapidly evolving telecommunications landscape. Below are the key reasons why this review is required :

1. Adaptation to Emerging Technologies

Context:

Technologies like 5G, Internet of Things (IoT), edge computing, and artificial intelligence (AI) are transforming telecom networks, shifting from legacy circuit-switched systems to IP-based architectures.

Need for Review :

Current interconnection regulations, designed for 2G/3G networks, may not address the requirements of modern technologies, such as low-latency routing

for 5G, massive device connectivity for IoT, or dynamic traffic management for edge computing.

Example :

Regulations may lack provisions for network slicing in 5G, which requires flexible interconnection to support diverse use cases (e.g., autonomous vehicles vs. smart meters).

Outcome :

A review ensures rules support seamless interoperability and performance for new technologies, fostering innovation and adoption.

2. Addressing Consumer Experience Challenges

Context:

Consumers face issues like call drops, poor voice quality, or data delays during cross-network interactions, often linked to inefficient interconnection.

Need for Review :

Existing regulations may not enforce stringent Quality of Service (QoS) standards at interconnection points, impacting user satisfaction for services like VoIP, streaming, or AR/VR.

Example :

Lack of clear QoS benchmarks for interconnection can lead to latency issues, critical for real-time applications like telemedicine or gaming.

Outcome :

Updated rules can mandate robust QoS and transparency, improving reliability and trust in telecom services.

3. Promoting Fair Competition

Context:

India's telecom market has dominant players alongside smaller operators and new entrants, creating risks of unfair interconnection practices.

Need for Review :

Current regulations may not adequately prevent anti-competitive behavior, such as dominant operators imposing high charges or delaying interconnection agreements.

Example :

Smaller operators may struggle to secure equitable access to interconnection facilities, limiting their ability to compete in 5G or IoT markets.

Outcome :

A review can introduce non-discrimination clauses and streamlined dispute resolution, leveling the playing field.

4. Aligning with Cost and Efficiency Goals

Context :

Interconnection Usage Charges (IUC) and infrastructure costs impact operators' finances, which can trickle down to consumers.

Need for Review :

Legacy IUC models may not reflect the lower termination costs of IP-based networks, leading to inefficiencies or inflated tariffs.

Example : TRAI's past move to reduce IUC (e.g., to zero for domestic calls in 2021) shows the need for periodic reassessment to align with tech advancements like 5G VoIP.

Outcome :

Revised regulations can promote cost-reflective pricing or models like bill-andkeep, enhancing affordability and network efficiency.

5. Supporting Digital India and Rural Connectivity

Context:

Initiatives like Digital India and BharatNet aim to bridge the urban-rural digital divide, requiring robust interconnection in underserved areas.

Need for Review :

Existing rules may not incentivize operators to establish interconnection points in low-revenue rural regions, limiting 4G/5G expansion.

Example : Inadequate interconnection infrastructure can cause poor service quality in rural areas, hindering access to e-governance or digital education.

Outcome :

A review can introduce incentives or mandates for rural interconnection, aligning with national connectivity goals.

6. Ensuring Security and Resilience

Context :

Emerging technologies like IoT and AI increase the risk of cyber threats and data breaches at interconnection points.

Need for Review :

Current regulations may lack provisions for securing modern interconnection infrastructure or ensuring resilience during outages.

Example :

IoT ecosystems (e.g., smart grids) require secure data exchange across networks, which legacy rules may not address.

Outcome :

Updated frameworks can mandate cybersecurity standards and redundancy plans, protecting networks and consumers.

7. Harmonizing with Global Best Practices

Context:

Global telecom markets are adopting flexible interconnection models (e.g., EU's cost-oriented approach, U.S.'s bill-and-keep) to support innovation.

Need for Review :

India's regulations may lag behind global standards, potentially hindering cross-border services or international partnerships.

Example :

Lack of alignment with global IP peering standards could complicate interconnection for OTT or cloud services with international providers.

Outcome :

A review can incorporate best practices, enhancing India's competitiveness in the global telecom ecosystem.

8. Resolving Operational and Dispute Challenges

Context :

Operators often face disputes over interconnection terms, capacity, or QoS, delaying service rollouts.

Need for Review :

Existing dispute resolution mechanisms may be slow or unclear, impacting network performance and consumer services.

Example :

Delays in agreeing on Pol capacity can lead to congestion, as seen in past operator conflicts.

Outcome :

Revised regulations can streamline arbitration and enforce clear timelines, minimizing disruptions.

9. Future-Proofing the Regulatory Framework

Context :

The telecom sector is poised for further advancements, such as 6G, quantum communication, or expanded IoT applications.

Need for Review :

Static regulations risk becoming obsolete, unable to accommodate future technologies or business models.

Example :

Current rules may not support decentralized interconnection models for edge computing or AI-driven networks.

Outcome :

A review can make regulations technology-agnostic and flexible, ensuring longterm relevance.

In short, the review of TRAI's interconnection regulations is critical to address the challenges posed by emerging technologies, consumer expectations, and market dynamics. It ensures that interconnection—the backbone of telecom interoperability—supports innovation, competition, affordability, and reliability in the telecom ecosystem. By updating rules, we can align with global standards, enhance consumer experiences, and drive initiatives like Digital India forward.

The Efficacy of existing interconnection frameworks in the current telecom ecosystem in India :

The efficacy of existing interconnection frameworks in India's current telecom ecosystem is a multifaceted issue, shaped by technological advancements, regulatory policies, market dynamics, and the evolving needs of a rapidly digitizing nation. As In 2025, India's telecom sector is the world's second-largest, with a subscriber base exceeding 1.2 billion, driven by widespread wireless connectivity and increasing internet penetration. The interconnection frameworks, are critical to ensuring seamless communication between networks, fair competition, and affordable services. Below is an analysis of their efficacy based on available insights into the telecom landscape.

Challenges and Limitations

1. Asymmetry in Market Power :

The dominance of large players like Reliance Jio, which commands nearly 40% of the wireless subscriber base (474.61 million as of May 2024), creates an uneven playing field. Smaller operators struggle to negotiate favorable interconnection terms, potentially undermining competition. Historical disputes, such as the 2016 Jio-Airtel interconnection conflict over points of interconnection (PoIs), highlight enforcement gaps despite regulatory mandates.

2. Adaptation to Emerging Technologies :

The rapid rollout of 5G and the anticipated shift to 6G pose challenges. The current framework, while progressive, lags in addressing next-gen

interconnection needs, such as ultra-low latency for IoT or network slicing in 5G.

3. Fair-Share Contribution Debate :

Telecom Service Providers (TSPs) argue that Large Technology Giants (LTGs) like Google and Netflix, which drive significant data traffic, should contribute to network costs. The existing framework lacks mechanisms to enforce such a "fair-share" model, a concept gaining traction globally (e.g., South Korea). This gap risks overburdening TSPs as data consumption grows—projected to reach 100 million terabytes by 2022 and likely far higher now.

4. Infrastructure Gaps :

Only 36% of telecom towers are fiberized, critical for 5G efficacy. The interconnection framework indirectly supports initiatives like BharatNet, but rural connectivity remains patchy, with wireline subscribers at just 28.41 million versus 1.14 billion wireless. This urban-rural divide limits the framework's reach and effectiveness.

Opportunities for Enhancement

Dynamic Pricing Models : Revisiting interconnection charges to reflect realtime market dynamics and technological costs could balance operator viability and consumer affordability.

Strengthened Enforcement : Empowering TRAI with greater enforcement powers, as suggested in studies of developing countries, could ensure compliance and resolve disputes faster.

Inclusive Ecosystem Policies : Integrating LTGs into the cost-sharing framework and incentivizing fiberization (e.g., via tax breaks) could modernize the ecosystem.

Future-Proofing : Accelerating updates for 5G/6G-specific interconnection, such as policies for small cell deployment and satellite gateways, would keep India competitive globally.

In short, the existing interconnection frameworks in India's telecom ecosystem are moderately effective, having enabled widespread connectivity, competition, and affordability. However, their efficacy is tempered by challenges like market imbalances, financial pressures, and slow adaptation to emerging technologies. As India aims for global leadership in 5G and beyond, the framework must evolve—through regulatory agility, stakeholder collaboration, and innovative policies—to sustain growth and ensure a balanced, resilient telecom ecosystem.

Challenges faced by service providers in implementing interconnection :

Service providers face a variety of challenges when implementing interconnection in the telecom ecosystem. These challenges stem from regulatory, technical, financial, and market-related factors, all of which impact the seamless integration and operation of networks. Below is a detailed breakdown of the key types of challenges faced by telecom service providers (TSPs):

1. Regulatory and Policy Challenges

Complex Compliance Requirements :

The Telecom Regulatory Authority of India (TRAI) imposes strict interconnection regulations, such as the Telecommunication Interconnection Regulations (2018), mandating non-discriminatory and timely agreements. However, the process of negotiating and finalizing these agreements can be bureaucratic and time-consuming, delaying implementation.

Disputes Over Interconnection Usage Charges (IUC) :

Although TRAI shifted to a Bill and Keep (BAK) regime in 2021, eliminating IUC for domestic calls, disagreements persist over its impact. Smaller operators argue that the lack of termination charges disadvantages them against larger players with higher traffic volumes, complicating cost recovery.

Pending Reforms for Emerging Tech :

The current framework is not fully equipped for 5G-specific interconnection needs (e.g., network slicing, low-latency requirements). TRAI's ongoing review is yet to yield concrete updates, leaving providers in limbo as they roll out nextgen services.

Fair-Share Contribution Debate :

TSPs face resistance from Large Technology Giants (LTGs) like Google and Netflix, who generate massive data traffic but contribute nothing to network costs. The absence of a regulatory mechanism to enforce cost-sharing creates friction and delays in aligning interconnection policies with modern usage patterns.

2. Technical and Infrastructure Challenges

Insufficient Fiberization :

Only about 36% of telecom towers in India are fiberized, far below the 70% recommended for effective 5G deployment. This limits backhaul capacity, creating bottlenecks in interconnection between core networks and last-mile infrastructure, especially in rural areas.

Legacy System Integration :

Many operators, particularly older ones like BSNL and Vodafone Idea, rely on legacy 2G/3G infrastructure. Integrating these with modern 4G/5G networks for interconnection is technically challenging and costly, leading to service quality issues.

Points of Interconnection (Pol) Congestion :

Historical disputes, such as the 2016 Jio-Airtel Pol conflict, highlight capacity constraints. Even today, ensuring adequate Pols to handle surging data traffic (e.g., from OTT platforms) remains a logistical hurdle, especially during peak usage.

Rural Connectivity Gaps :

With wireline subscribers at just 28.41 million compared to 1.14 billion wireless (as of mid-2024), extending interconnection to underserved rural regions is hampered by poor infrastructure, high deployment costs, and low ROI, despite initiatives like BharatNet.

3. Financial and Economic Challenges

High Operational Costs :

Uneven Cost Distribution :

Larger players like Reliance Jio, with extensive infrastructure and subscriber bases, can absorb interconnection costs more easily than smaller operators. This asymmetry forces smaller TSPs to negotiate from a weaker position, often delaying agreements.

4. Market and Competitive Challenges

Dominance of Large Operators :

Reliance Jio's 40% market share (474.61 million subscribers as of May 2024) gives it leverage in interconnection negotiations. Smaller operators struggle to secure favorable terms, leading to delays or suboptimal agreements that affect service quality.

Competitive Pressure on Tariffs :

Low tariffs, a byproduct of fierce competition, leave little room for TSPs to invest in interconnection enhancements. This race to the bottom prioritizes customer acquisition over network stability, exacerbating implementation challenges.

Disputes and Litigation :

Interconnection disputes often escalate to legal battles or regulatory arbitration (e.g., the 2016 Jio vs. incumbents case). These conflicts stall implementation, drain resources, and create uncertainty in the ecosystem.

5. Operational and Stakeholder Challenges

Coordination Among Stakeholders :

Interconnection involves multiple parties—operators, infrastructure providers, and regulators. Misalignment in priorities (e.g., rural expansion vs. urban 5G rollout) and delays in consensus-building slow down execution.

Resistance to Infrastructure Sharing :

While TRAI encourages tower and fiber sharing to reduce costs, competitive instincts and concerns over data security lead some operators to resist, complicating interconnection efforts.

In shot, Service providers face a complex web of challenges in implementing interconnection, ranging from regulatory gaps and technical limitations to financial pressures and market imbalances. Addressing these requires a multi-pronged approach: streamlining regulations, incentivizing infrastructure investment (e.g., through subsidies or tax breaks), enforcing fairshare contributions from LTGs, and fostering collaboration among operators. Resolving these challenges will be crucial to ensuring a robust, future-ready telecom ecosystem that supports India's digital ambitions.

Impact of emerging technologies on interconnection requirements :

Below are key areas and types of suggestions that aim to address the evolving telecom landscape and ensure a robust regulatory framework.

1. Impact of Emerging Technologies on Interconnection

5G and Beyond :

Discuss how 5G networks, with features like ultra-low latency, network slicing, and massive IoT connectivity, affect interconnection requirements. For

example, suggest whether current regulations support seamless interconnection for 5G services or need updates to handle increased data traffic and dynamic routing.

Edge Computing :

Highlight how edge computing, which brings processing closer to users, impacts interconnection points. Propose whether regulations should address latency-sensitive applications requiring localized interconnection agreements.

Internet of Things (IoT) :

Comment on how IoT's diverse use cases (e.g., smart cities, industrial automation) strain existing interconnection frameworks. Suggest provisions for handling massive device connectivity and data exchange across networks.

Artificial Intelligence (AI) and Automation :

Address how AI-driven network management (e.g., traffic optimization, predictive routing) influences interconnection. Propose whether regulations should mandate standards for AI interoperability between operators.

Over-the-Top (OTT) Services :

Discuss the role of OTT platforms (e.g., VoIP, streaming) in interconnection. Suggest whether regulations should clarify responsibilities for interconnection costs between telecom operators and OTT providers, especially with rising data demands.

2. Alignment of Regulations with Technological Advancements Obsolescence of Legacy Systems :

Identify regulations tied to outdated technologies (e.g., 2G/3G circuitswitched networks) and propose updates to focus on IP-based networks, which dominate modern telecom.

Flexibility for Innovation : Suggest making regulations technology-agnostic to accommodate future advancements (e.g., 6G, quantum communication). For instance, propose frameworks that allow operators to negotiate interconnection terms for emerging tech without rigid mandates.

Interoperability Standards : Recommend global or regional standards for interconnection to ensure compatibility with technologies like cloud-native networks and software-defined networking (SDN).

3. Fair Competition and Market Dynamics

Level Playing Field : Comment on whether current interconnection rules prevent dominant operators from imposing unfair terms on smaller players. Suggest measures like transparent pricing or mandatory interconnection agreements to promote competition.

Non-Discriminatory Access : Propose regulations ensuring all operators, including new entrants, have equal access to interconnection facilities, especially for technologies like 5G or IoT networks.

Dispute Resolution : Highlight gaps in resolving interconnection disputes (e.g., over quality of service or pricing) and suggest mechanisms like arbitration or TRAI-led mediation tailored to tech-driven issues.

4. Cost Efficiency and Interconnection Charges

Cost Reflective Pricing :

Suggest revising Interconnection Usage Charges (IUC) to reflect actual costs in modern networks, considering technologies like 5G reduce termination costs due to IP-based systems.

Zero-Rating IUC for New Tech :

Propose whether IUC should be eliminated for certain technologies (e.g., VoIP over 5G) to encourage adoption, as seen in past TRAI discussions on IUC reduction.

Cost Sharing for Infrastructure :

Comment on how operators should share costs for interconnection infrastructure (e.g., fiber backhaul, edge nodes) to support emerging tech without burdening smaller players.

5. Quality of Service (QoS) and Consumer Impact

QoS for New Technologies :

Discuss how interconnection regulations can ensure high QoS for 5G, IoT, or edge computing applications. For example, suggest benchmarks for latency, jitter, or packet loss at interconnection points.

Consumer Experience :

Highlight how interconnection issues (e.g., call drops, data delays) affect consumers using modern services like AR/VR or autonomous vehicles. Propose regulations prioritizing end-user experience.

Transparency :

Recommend that operators disclose interconnection performance metrics to consumers, especially for tech-heavy services, to build trust and accountability.

6. Security and Privacy Concerns

Data Security at Interconnection Points :

Suggest regulations to secure data exchanged during interconnection, especially for IoT or AI-driven services vulnerable to breaches.

Privacy Compliance :

Propose aligning interconnection rules with data protection laws (e.g., India's Digital Personal Data Protection Act) to safeguard user information in tech-driven networks.

Cybersecurity Standards :

Comment on whether TRAI should mandate cybersecurity protocols for interconnection infrastructure to counter threats amplified by emerging technologies.

7. Global and Regional Alignment

International Best Practices :

Reference global frameworks (e.g., EU's roaming regulations, FCC's net neutrality rules) to suggest how TRAI can adapt interconnection policies for technologies like 5G or cloud networks.

Cross-Border Interconnection :

Discuss challenges in interconnecting with international networks for technologies like IoT or OTT services. Propose harmonized standards or reciprocal agreements to ease global connectivity.

8. Stakeholder-Specific Challenges

Telecom Operators :

Share operational challenges in interconnecting for new technologies, such as high capital costs or technical complexity, and suggest regulatory relief or incentives.

Consumer Groups :

Emphasize affordability and accessibility, proposing that interconnection regulations prevent cost pass-through to end-users adopting emerging tech.

Tech Providers :

Highlight how equipment vendors or cloud providers face interconnection barriers and suggest policies to integrate their solutions seamlessly.

Startups and Innovators :

Comment on how interconnection rules can support small-scale innovators deploying IoT or AI solutions, such as by simplifying access to networks.

9. Future-Proofing the Framework

Sandbox for Testing :

Suggest TRAI create a regulatory sandbox to test interconnection models for emerging technologies, similar to its 2023 sandbox proposal for digital communication.

Periodic Reviews :

Propose regular updates to interconnection regulations (e.g., every 2–3 years) to keep pace with technological advancements.

Stakeholder Collaboration :

Recommend ongoing forums or working groups involving industry, academia, and consumers to refine interconnection policies proactively.

Interconnection Regulations

Section 1: Impact of 5G on Interconnection

- Current regulations assume circuit-switched networks, unfit for 5G's IPbased architecture.

- Proposal: Mandate IP interconnection standards and dynamic routing protocols.

- Justification: 5G's network slicing requires flexible interconnection to ensure QoS for diverse use cases (e.g., autonomous vehicles vs. smart meters).

Section 2: Cost Efficiency

- Issue: High IUC discourages smaller operators from adopting 5G.

- Proposal: Transition to zero-rated IUC for 5G VoIP calls.

- Justification: Reduces costs for operators, encourages 5G adoption, and aligns with global trends (e.g., EU's IUC reduction).

Best practices from global interconnection frameworks for possible adoption in India

Below are targeted suggestions for inputs/comments focusing on international interconnection frameworks that TRAI could consider for adoption. These inputs aim to enhance competition, innovation, and consumer welfare while aligning with India's telecom landscape.

1. European Union (EU) – Technology-Neutral and Cost-Oriented Interconnection

Best Practice :

The EU's European Electronic Communications Code (EECC) mandates technology-neutral interconnection rules, ensuring operators can interconnect regardless of network type (e.g., 4G, 5G, or IP-based). Interconnection charges are cost-oriented, based on Long-Run Incremental Cost (LRIC) models, promoting fair pricing.

Input for TRAI :

- Propose adopting a technology-neutral framework to replace India's legacy circuit-switched interconnection rules, accommodating 5G, IoT, and cloud networks.

- Suggest implementing a standardized LRIC model for Interconnection Usage Charges (IUC) to ensure charges reflect actual costs, reducing disputes and encouraging competition.

- Example: EU's zero-rating of IUC for IP-based calls has lowered consumer costs and we propose a similar phased approach for India's 5G VoIP services.

Justification : Aligns with India's shift to IP-based networks and supports smaller operators by preventing dominant players from imposing high charges.

2. United States – Bill-and-Keep Model and Deregulation

Best Practice : The U.S. Federal Communications Commission (FCC) uses a "bill-and-keep" model, where operators do not charge each other for

terminating traffic, reducing interconnection disputes. The FCC also deregulates interconnection for IP-based networks, relying on market-driven agreements.

Input for TRAI :

- Recommend piloting a bill-and-keep model for specific services like 5G VoIP or IoT data exchange to simplify interconnection and lower costs.

- Propose reducing regulatory oversight for IP-based interconnection agreements, allowing operators to negotiate terms, with TRAI intervening only in disputes.

- Suggest clear guidelines for voluntary peering agreements, inspired by U.S. practices, to support edge computing and content delivery networks (CDNs).

Justification : Encourages innovation by minimizing regulatory burdens and aligns with India's growing data traffic from OTT and cloud services.

3. Singapore – Flexible Interconnection for Emerging Technologies

Best Practice : Singapore's Infocomm Media Development Authority (IMDA) promotes flexible interconnection frameworks, encouraging operators to adopt direct IP peering and cloud-based interconnection for 5G and IoT. IMDA also mandates transparency in interconnection agreements to prevent anti-competitive behavior.

Input for TRAI :

- Suggest revising regulations to promote IP peering for 5G and IoT, reducing reliance on traditional Points of Interconnection (Pols).

- Propose mandatory disclosure of interconnection terms (e.g., QoS, pricing) to ensure transparency, similar to Singapore's approach.

- Recommend incentives for operators to deploy shared interconnection hubs for edge computing, supporting low-latency applications like autonomous vehicles.

Justification : Supports India's smart city initiatives and ensures fair access for smaller operators deploying emerging technologies.

4. Australia – Dispute Resolution and Non-Discrimination

Best Practice : The Australian Communications and Media Authority (ACMA) enforces strict non-discrimination rules, ensuring dominant operators provide equal interconnection terms to all players. It also offers a streamlined dispute resolution process, resolving interconnection conflicts within weeks.

Input for TRAI :

- Propose stricter non-discrimination clauses in interconnection agreements to prevent large operators from prioritizing their own traffic or services.

- Suggest establishing a dedicated TRAI arbitration panel for interconnection disputes, with a 30-day resolution timeline, modeled on Australia's framework.

- Recommend penalties for non-compliance with interconnection obligations to deter anti-competitive practices.

Justification : Enhances competition in India's telecom market, where new entrants and smaller operators often face challenges accessing interconnection facilities.

5. Japan – Support for IoT and Cross-Sector Interconnection

Best Practice : Japan's Ministry of Internal Affairs and Communications (MIC) promotes interconnection frameworks for IoT, enabling seamless data exchange between telecom operators and non-telecom sectors (e.g., automotive, healthcare). It also supports standardized protocols for IoT interoperability.

Input for TRAI :

- Suggest regulations enabling cross-sector interconnection for IoT ecosystems, such as smart grids or connected vehicles, with standardized APIs or protocols.

- Propose TRAI collaborate with other ministries (e.g., MeitY, Transport) to align interconnection rules with IoT-driven initiatives like Digital India.

- Recommend pilot projects for IoT interconnection hubs, similar to Japan's regional testbeds, to test scalability and security.

Justification : Positions India as a leader in IoT adoption, supporting diverse use cases while ensuring secure and scalable interconnection.

6. South Korea – Quality of Service (QoS) Focus

Best Practice : South Korea's Korea Communications Commission (KCC) mandates stringent QoS benchmarks at interconnection points, ensuring high performance for technologies like 5G and AR/VR. Operators must report latency, jitter, and packet loss metrics regularly.

Input for TRAI :

- Propose QoS benchmarks for interconnection points supporting 5G, IoT, and edge computing, with specific metrics (e.g., <10ms latency for 5G).

- Suggest mandatory QoS reporting by operators, with public disclosure to promote accountability and consumer trust.

- Recommend TRAI define penalties for failing to meet QoS standards at interconnection, ensuring reliable service for tech-heavy applications.

Justification : Improves consumer experience in India, where interconnection issues often cause call drops or data delays, especially with rising 5G adoption.

7. United Kingdom – Security and Resilience

Best Practice : The UK's Ofcom mandates cybersecurity standards for interconnection infrastructure, protecting against threats amplified by emerging technologies like IoT and AI. It also requires operators to ensure network resilience during interconnection failures.

Input for TRAI :

- Suggest incorporating cybersecurity protocols for interconnection points, aligned with India's Digital Personal Data Protection Act, to secure 5G and IoT data flows.

- Propose mandatory redundancy plans for interconnection infrastructure to maintain service continuity during outages, inspired by UK resilience rules.

- Recommend TRAI certify secure interconnection equipment to prevent vulnerabilities in modern networks.

Justification : Strengthens India's telecom security, critical for applications like smart cities and financial services relying on interconnected networks.

8. Brazil – Support for Rural and Underserved Areas

Best Practice : Brazil's Anatel promotes interconnection agreements that prioritize connectivity in rural and underserved areas, offering incentives like reduced regulatory fees for operators expanding interconnection infrastructure.

Input for TRAI :

- Suggest incentives (e.g., tax breaks, lower IUC) for operators establishing interconnection points in rural India to support 5G and IoT rollout.

- Propose mandatory interconnection obligations for dominant operators to connect with rural-focused providers, ensuring equitable access.

- Recommend TRAI fund pilot interconnection projects in underserved areas, similar to Brazil's rural connectivity programs.

- **Justification**: Aligns with India's BharatNet and Digital India goals, bridging the urban-rural digital divide.

By drawing on these global practices, TRAI can craft a forward-looking interconnection framework that supports emerging technologies, fosters competition, and enhances consumer outcomes in India.

Role of interconnection in improving consumer experience and network efficiency :

Below are targeted suggestions for inputs/comments focusing on the role of interconnection in these areas. These recommendations aim to ensure seamless connectivity, high-quality services, and optimized network performance while aligning with India's telecom ecosystem.

1. Enhancing Consumer Experience through Interconnection

Seamless Service Continuity :

Propose regulations should mandate robust interconnection agreements to minimize call drops, data interruptions, and latency, especially for 5G and VoIP services.

TRAI should enforce a maximum permissible call drop rate (e.g., <1%) at interconnection points, with penalties for non-compliance.

Justification : Consumers expect uninterrupted services for applications like video conferencing, gaming, and OTT streaming, which rely on efficient interconnection.

Quality of Service (QoS) Standards :

There should be discussion on specific QoS benchmarks for interconnection points, such as low latency (<10ms for 5G), minimal jitter, and high packet delivery rates, tailored to emerging technologies like AR/VR or IoT.

Operators should publish QoS metrics for interconnection performance quarterly to ensure transparency and accountability to consumers.

Justification : High QoS at interconnection enhances user satisfaction for latency-sensitive services, boosting trust in telecom networks.

Affordability :

There should revision of Interconnection Usage Charges (IUC) to reduce or eliminate costs for IP-based services (e.g., 5G VoIP), preventing operators from passing interconnection costs to consumers.

Example : Ther should be a bill-and-keep model for certain services to lower tariffs, inspired by global trends.

Justification : Lower interconnection costs ensure affordable services, critical for India's price-sensitive consumer base, especially in rural areas.

Cross-Network Consistency :

We propose regulations ensuring consistent service quality across networks during inter-operator calls or data sessions, addressing issues like poor voice clarity or slow data speeds in cross-network interactions.

TRAI should mandate interoperability testing for interconnection setups before commercial rollout.

Justification : Uniform experience across networks enhances consumer confidence, particularly for tech-driven services like smart home devices.

2. Improving Network Efficiency through Interconnection

Optimized Traffic Management :

There should be regulations promoting IP-based interconnection and direct peering to handle high data volumes from 5G, IoT, and OTT platforms efficiently.

Example : Propose incentives for operators to establish shared interconnection hubs for edge computing, reducing backhaul congestion.

Justification : Efficient traffic routing minimizes network bottlenecks, supporting India's growing data demand (e.g., 35 GB/month per user projected by 2025).

Scalability for Emerging Technologies :

There should be flexible interconnection frameworks that allow operators to scale infrastructure for technologies like IoT (e.g., millions of connected devices) or network slicing in 5G.

Example : TRAI should define standards for dynamic bandwidth allocation at interconnection points to support variable traffic patterns.

Justification : Scalable interconnection prevents network overload, ensuring performance for diverse use cases like smart cities or industrial automation.

Resource Sharing :

There should be a policies for encouraging operators to share interconnection infrastructure (e.g., fiber backhaul, Pols) to reduce duplication and optimize resource use.

TRAI should facilitate co-investment models for rural interconnection points, similar to BharatNet's shared infrastructure approach.

Justification : Shared resources lower capital expenditure, enabling operators to focus on network expansion and efficiency.

Automation and Al Integration :

There should be regulations supporting AI-driven traffic management and predictive routing at interconnection points to enhance efficiency.

TRAI should encourage adoption of software-defined networking (SDN) for real-time interconnection optimization, with interoperability standards.

Justification : AI and automation reduce latency and improve resource allocation, critical for high-speed 5G and IoT networks.

3. Bridging Consumer Experience and Network Efficiency

Low-Latency Interconnection for Real-Time Applications :

There should be prioritization of low-latency interconnection for consumer-facing applications like autonomous vehicles, online gaming, and telemedicine.

TRAI should mandate dedicated interconnection channels for ultrareliable low-latency communications (URLLC) in 5G networks.

Justification : Low latency improves both consumer experience (e.g., seamless gaming) and network efficiency (e.g., optimized resource use for critical services).

Transparency and Monitoring :

Operators should deploy real-time monitoring tools for interconnection performance, with public dashboards for consumer visibility.

There should be metrics like interconnection uptime, latency, and congestion levels be reported to TRAI and shared with consumers.

Justification : Transparency drives operators to maintain efficient networks, directly benefiting consumers with reliable services.

Rural Connectivity Focus :

There should be interconnection regulations prioritize rural areas by mandating efficient Pols to support 4G/5G expansion, reducing urban-rural disparities.

Justification : Efficient rural interconnection improves network coverage and consumer access, aligning with Digital India goals.

4. Addressing Challenges and Trade-Offs

Balancing Cost and Quality :

There is a need to balance low interconnection costs with investments in high-quality infrastructure to avoid degrading consumer experience.

TRAI should conduct cost-benefit studies before revising IUC, ensuring efficiency without compromising QoS.

Justification : Prevents scenarios where low charges lead to underinvestment, harming both consumers and networks.

Dispute Resolution for Efficiency :

There should be a streamlined dispute resolution mechanism for interconnection issues (e.g., QoS failures, capacity disagreements) to maintain network performance.

There should be a 30-day arbitration process under TRAI to resolve conflicts quickly.

Justification : Swift resolutions minimize disruptions, ensuring consistent consumer experience and network reliability.

Consumer Feedback Integration :

TRAI should incorporate consumer feedback mechanisms (e.g., surveys, complaint portals) to identify interconnection-related issues affecting experience.

There should be a linking of consumer complaints to operator interconnection audits.

Justification : Direct consumer input helps refine regulations, aligning network efficiency with user needs.

By focusing on these areas, TRAI can shape interconnection regulations that deliver superior consumer experiences and efficient networks, especially for emerging technologies.

Regulatory and Policy Challenges :

Regulatory and policy challenges significantly impact telecom service providers (TSPs) in India when implementing interconnection frameworks. These challenges arise from the complexities of the regulatory environment, evolving market dynamics, and the need to balance innovation with fairness and affordability. Below is a detailed analysis of the specific types of regulatory and policy challenges faced by TSPs, in the context of interconnection:

1. Complex and Lengthy Compliance Processes

Negotiation and Agreement Delays :

TRAI mandates that interconnection agreements be non-discriminatory, transparent, and finalized within stipulated timelines under the Telecommunication Interconnection Regulations (2018). However, negotiating these agreements often involves prolonged discussions due to differing priorities among operators (e.g., large vs. small TSPs). The bureaucratic process of submitting agreements to TRAI for review and approval further delays implementation, impacting network rollout timelines.

Documentation and Reporting Burdens :

TSPs must comply with extensive documentation requirements, including detailed reports on Points of Interconnection (PoIs), traffic data, and Quality of Service (QoS) metrics. Smaller operators, with limited resources, find these compliance obligations particularly challenging, diverting focus from actual interconnection deployment.

2. Disputes Over Interconnection Usage Charges (IUC)

Impact of Bill and Keep (BAK) Regime :

TRAI's decision to eliminate IUC for domestic calls starting January 2021, adopting a BAK model where operators do not charge each other for call termination, has sparked ongoing debates. Smaller TSPs argue that this disproportionately benefits larger operators like Reliance Jio, which handle higher traffic volumes and can offset costs more easily. The lack of termination fees complicates cost recovery for operators with lower subscriber bases, creating friction in interconnection agreements.

Uncertainty in International and VoIP Policies :

While domestic IUC is phased out, charges for international calls and Voice over Internet Protocol (VoIP) services remain contentious. Inconsistent policies across jurisdictions and the absence of clear guidelines for VoIP interconnection lead to disputes, delaying seamless integration of services like WhatsApp calls or enterprise VoIP solutions.

3. Slow Adaptation to Emerging Technologies

Lag in 5G-Specific Regulations :

With India's 5G rollout accelerating (over 240,000 5G base stations by mid-2024), the interconnection framework lags in addressing next-gen requirements like network slicing, ultra-low latency, and massive IoT connectivity. TRAI's pre-consultation paper acknowledges these gaps, but actionable policies are still under discussion, with stakeholder inputs. This regulatory uncertainty hampers TSPs' ability to plan and implement 5G interconnection efficiently.

Satellite and Non-Terrestrial Networks :

The rise of satellite-based telecom services (e.g., Starlink, OneWeb) introduces new interconnection challenges. Current regulations lack clarity on integrating non-terrestrial networks with terrestrial ones, creating ambiguity for TSPs investing in hybrid connectivity models for rural areas.

4. Fair-Share Contribution Debate

Lack of Cost-Sharing Mechanisms :

TSPs face significant pressure from surging data traffic driven by Large Technology Giants (LTGs) like Google, Netflix, and Meta, which account for a substantial portion of network usage. Indian operators, supported by groups like the Cellular Operators Association of India (COAI), argue for a "fair-share" model where LTGs contribute to infrastructure costs. However, the absence of a regulatory framework to enforce such contributions leaves TSPs bearing the full cost of interconnection upgrades, straining their finances.

Resistance from OTT Providers :

Over-the-top (OTT) platforms resist any cost-sharing mandates, citing their role in driving internet adoption. TRAI's consultations on OTT regulation (ongoing since 2023) have yet to resolve this, creating a policy stalemate that complicates interconnection planning for data-heavy services.

5. Weak Enforcement and Dispute Resolution

Ineffective Dispute Redressal :

Interconnection disputes, such as those over PoI provisioning or agreement terms, often escalate to TRAI or the Telecom Disputes Settlement and Appellate Tribunal (TDSAT). However, resolution processes are slow, with cases like the 2016 Jio vs. Airtel-Vodafone PoI conflict taking months to settle. The lack of swift enforcement mechanisms allows non-compliance to persist, delaying interconnection and affecting service quality.

Limited Regulatory Teeth :

TRAI's authority to penalize non-compliant operators is constrained by legal and procedural hurdles. For instance, dominant players can delay providing Pols to smaller competitors without immediate consequences, undermining the spirit of fair interconnection.

6. Inconsistent Policies Across Ecosystems

Urban-Rural Policy Divide :

While urban areas benefit from robust interconnection frameworks, rural regions—where connectivity is critical for Digital India—face inconsistent policies. Initiatives like BharatNet aim to bridge this gap, but regulatory support for interconnecting rural networks with urban backbones is underdeveloped, leaving TSPs grappling with uneven implementation challenges.

State-Level Variations :

Telecom is a central subject, but state governments influence infrastructure deployment through right-of-way (RoW) permissions and local taxes. Inconsistent RoW policies across states complicate the physical infrastructure needed for interconnection, such as fiber optic cables or Pols.

policy In shot Regulatory and challenges in implementing interconnection in India revolve around complex compliance, disputes over IUC, slow adaptation to 5G and emerging technologies, the unresolved fairshare debate, weak enforcement, inconsistent policies, and financial pressures from broader regulatory decisions. These issues create uncertainty, delay agreements, and strain TSPs' resources, particularly for smaller operators. To address these, TRAI could streamline compliance processes, expedite dispute resolution, clarify policies for 5G and OTT contributions, and balance revenue goals with sector health. The ongoing 2025 interconnection

review offers a chance to tackle these challenges, but swift and inclusive reforms will be critical to ensuring a robust telecom ecosystem.

Through Analysis an careful consideration of key objectives, including fostering interconnection, enhancing competition, promoting nondiscriminatory practices, ensuring long-term sustainability and viability of the Telecom Sector :

The key objectives for the telecom sector in India—fostering interconnection, enhancing competition, promoting nondiscriminatory practices, and ensuring long-term sustainability and viability—require a balanced and strategic approach to policy, regulation, and market dynamics. Below is a detailed analysis of each objective, considering their implications and interconnections:

1. Fostering Interconnection

Challenges : Smaller operators often face delays or unfavorable terms when interconnecting with dominant players, creating bottlenecks. Ensuring timely and equitable agreements is critical.

Market Impact : Seamless interconnection enhances customer experience, reduces churn, and supports universal access, especially in rural areas where network coverage varies.

Considerations :

- Strengthen enforcement of interconnection timelines and penalize noncompliance. - Encourage infrastructure sharing (e.g., towers, fiber) to reduce costs and improve coverage, aligning with interconnection goals.

- Leverage technologies like VoLTE and 5G to standardize interconnection protocols, ensuring future-ready networks.

2. Enhancing Competition

Benefits of Competition : A competitive market lowers tariffs, improves service quality, and accelerates technology adoption (e.g., 4G/5G rollout).

Risks of Oligopoly : Limited players can lead to tacit collusion, reduced innovation, or predatory pricing to edge out competitors. Vodafone Idea's financial struggles highlight the need for a viable third player to maintain balance.

Achieving these objectives requires a holistic approach that balances immediate market needs with long-term goals. Fostering interconnection ensures seamless connectivity, enhancing competition drives innovation and affordability, promoting nondiscriminatory practices builds trust and equity, and ensuring sustainability secures the sector's future. By aligning policies, regulations, and investments, India can maintain its position as a global telecom leader while delivering inclusive, high-quality services to all its citizens.

The 5G impact and rural connectivity :

Let's explore the impact of **5G** and the challenges and opportunities surrounding **rural connectivity** in the context of India's telecom sector, aligning with the objectives of fostering interconnection, enhancing competition, promoting nondiscriminatory practices, and ensuring long-term sustainability.

Impact of 5G on India's Telecom Sector

a. Fostering Interconnection

5G relies on advanced interconnection protocols like Voice over New Radio (VoNR) and seamless integration with 4G/3G for fallback. This demands robust agreements between operators to ensure uninterrupted services, especially for roaming and cross-network calls.

Network slicing—a 5G feature—enables operators to allocate virtual network segments for specific use cases (e.g., IoT, gaming). Interconnection agreements must evolve to handle these slices fairly, avoiding service disruptions.

Challenges :

- Smaller operators or those lagging in 5G deployment (e.g., Vodafone Idea) may face delays in interconnection with 5G-ready networks, impacting service quality.

- High infrastructure costs for fiber backhaul (essential for 5G's low latency) could strain interconnection budgets, particularly in less profitable regions.

Opportunities:

- Standardized 5G interconnection protocols can reduce disputes, building on TRAI's Bill and Keep regime.

- Infrastructure sharing (e.g., fiber, small cells) can lower costs, ensuring seamless connectivity across networks. For example, Jio and Airtel's towersharing deals demonstrate viable models.

b. Enhancing Competition

Challenges :

- Uneven 5G adoption could widen the competitive gap, with urban-focused operators gaining an edge over those prioritizing rural expansion.

c. Promoting Nondiscriminatory Practices

Challenges :

- Urban bias in 5G deployment risks discriminatory access, with rural and lowincome users left with slower 4G/3G networks.

- Interconnection disputes could arise if dominant operators offer preferential 5G access to partners, undermining fairness.

d. Ensuring Long-Term Sustainability and Viability

Challenges :

- Limited 5G device penetration (only ~25% of smartphones were 5G-enabled in 2024) delays monetization, particularly in price-sensitive markets.

Key Metrics (2024)

Country	5G Subscriptions	5G Coverage	Rural Teledensity	Rural Broadband	Avg. 5G Speed
India	~100M	~60% (urban- heavy)	~70%	~50%	~200 Mbps
South Korea	~30M	~90%	~90%	~80%	~600 Mbps
China	~700M	~85%	~80%	~70%	~300 Mbps
United States	~200M	~70%	~85%	~65%	~300 Mbps
Finland	~2M	~80%	~95%	~80%	~200 Mbps
Nigeria	~1M	~10%	~50%	~30%	~100 Mbps

Lessons for India from the other countries :

1. Interconnection :

- Finland and South Korea's collaborative agreements minimize disputes, unlike India's occasional delays. TRAI could enforce stricter timelines and shared 5G protocols, as seen globally.

2. Competition :

- The U.S. and Finland's MVNO ecosystems diversify markets, unlike India's consolidation. Subsidizing rural spectrum could attract niche players, as in Nigeria's mobile money-driven model.

3. Nondiscrimination :

- Finland's universal access mandates ensure rural 5G, contrasting India's urban bias. TRAI could adopt similar QoS benchmarks, as China's Digital Village shows.

4. Sustainability :

- South Korea and Finland's green telecom (e.g., renewable towers) align with India's goals. China's state funding contrasts with India's private model, but PPPs (as in the U.S.) could balance costs.

Conclusion

India's 5G rollout and rural connectivity efforts are ambitious but trail global leaders like South Korea, China, and Finland in scale, rural reach, and execution. South Korea's speed, China's infrastructure, Finland's equity, and the U.S.'s innovation offer models for India to emulate. Nigeria's challenges highlight India's relative strengths (e.g., BharatNet), but gaps in rural 5G and policy clarity persist. By adopting shared infrastructure, universal mandates, and PPPs, India can align its telecom sector with global benchmarks, ensuring interconnection, competition, nondiscrimination, and sustainability.

Thanks.

Sincerely Yours,

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(Prof.Dr. Kashyapnath) President