Report of the EGTI Subgroup on Satellite-Based Connectivity Indicators

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1. Context and Objectives

The rapid evolution of satellite technologies is transforming the global connectivity landscape. New generations of Low Earth Orbit (LEO) satellite systems, alongside traditional Geostationary Orbit (GEO) networks, are expanding broadband access, supporting rural and remote connectivity, enhancing network resilience, and enabling new services such as Direct-to-Device (D2D) communications and satellite Internet of Things (IoT).

Recent market developments indicate strong growth in many countries. In several regions, satellite services are becoming a significant component of national connectivity ecosystems and, in some cases, may provide the primary means of broadband access in areas where terrestrial infrastructure is limited or economically unfeasible.

Recognizing these developments, the EGTI established a Subgroup on Satellite-Based Connectivity to assess whether existing ICT statistical frameworks and indicators adequately capture the rapid evolution of satellite-based services and to identify potential improvements to the current measurement framework. The subgroup was coordinated by Mr. Emmanuel Felix Neizer (NCA, Ghana), and, during his period of absence, supported by Mr. Panayiotis Kyriakides (EGTI Chair). Members of the subgroup included participants from regulatory authorities and ministries from Argentina, Chad, Chile, Costa Rica, Cuba, Cyprus, Dominica, Egypt, Fiji, Ghana, Indonesia, Korea (Rep. of), Mongolia, New Zealand, Papua New Guinea, Peru, Philippines, Portugal, Sweden, Tanzania, Uganda, Uruguay, Uzbekistan, Vanuatu, Zambia, as well as from experts from academia and industry (including GSOA and invited presenters). The subgroup reviewed emerging technologies and service models (including LEO broadband, Direct-to-Device (D2D) connectivity and satellite IoT), examined methodological and data-collection challenges, assessed whether existing indicators remain fit for purpose, and explored the development of a harmonized set of indicators to support national and international monitoring of satellite-based connectivity.

2. Work Completed

a. Review of the Satellite Connectivity Landscape

The subgroup held a series of virtual meetings bringing together representatives from ministries, regulators, national statistics offices, satellite operators, industry associations including the Global Satellite Operators Association (GSOA) and ITU experts. These discussions provided valuable insights into the rapidly evolving satellite connectivity ecosystem and its implications for ICT statistics.

A key finding of the subgroup was that satellite connectivity is becoming increasingly diverse, both in terms of technologies and service models. While traditional satellite services remain important, particularly for broadcasting, remote communications and emergency applications, a new generation of services is emerging, including LEO-based broadband, Direct-to-Device (D2D) connectivity, satellite-enabled IoT applications, and hybrid terrestrial-satellite networks. These developments are blurring the boundaries between traditional telecommunications categories and creating new challenges for statistical measurement.

The subgroup also received contributions from industry representatives, who showcased how recent technological advances are fundamentally changing this landscape. The adoption of 3GPP standards, improvements in satellite capabilities, and closer integration between satellite and mobile network operators are increasingly enabling commercially viable D2D services in the near future that can operate through standard smartphones without requiring specialized handsets. These developments will accelerate the convergence of terrestrial and non-terrestrial networks and expanding the potential role of satellite technologies within national connectivity ecosystems. Although satellite-to-handset communications have been pursued for many years, widespread deployment was historically constrained by a combination of technical, commercial and regulatory barriers. These included the cost and availability of devices, concerns regarding competition with mobile network operators, national security and public service obligations, service quality limitations, and lengthy regulatory approval processes.

At the same time, these new service models raise important questions for statistical measurement. As connectivity solutions, including D2D and backhaul services, are increasingly delivered through partnerships between satellite operators and mobile network operators, traditional distinctions between satellite and terrestrial services become less clear. This creates challenges related to service classification, reporting responsibilities, attribution of subscriptions and traffic, and the potential risk of double counting. Participants noted that existing statistical frameworks were largely developed in a context where satellite services operated as distinct and easily identifiable categories, whereas emerging D2D solutions are increasingly integrated into conventional mobile networks.

These developments highlighted the need to review whether existing ICT indicators remain fit for purpose and to consider how future statistical frameworks can adequately capture hybrid connectivity models while preserving international comparability and minimizing reporting burdens.

Country experiences demonstrated that satellite connectivity is no longer confined to niche or specialized applications but is increasingly integrated into national connectivity strategies. A presentation by the *Subsecretaría de Telecomunicaciones (SUBTEL) of Chile* illustrated this evolution, highlighting the growing adoption of LEO-based broadband services, particularly through Starlink, to support residential, business and rural connectivity. Chile also shared its experience as the first country in Latin America to enable commercial Direct-to-Device (D2D) services through a partnership between a mobile operator and a satellite provider, as well as ongoing pilot deployments of satellite IoT applications in sectors such as mining, agriculture, logistics and remote telemetry. It was also emphasized that D2D services, including messaging, can be accessed with existing mobile devices. These experiences highlighted both the growing importance of satellite connectivity and the challenges associated with measuring emerging service categories for which internationally agreed indicators do not yet exist.

The subgroup also benefited from a presentation by the *Regional African Satellite Communications Organization (RASCOM)*, which provided a regional perspective on satellite connectivity developments across Africa. The presentation highlighted the growing role of satellite technologies in extending connectivity to underserved areas, supporting mobile backhaul, broadcasting and government communications, and complementing terrestrial infrastructure. Discussions also underscored the rapid transformation of the satellite sector, driven by the expansion of LEO constellations, the emergence of D2D and satellite IoT services, and increasing interest in multi-orbit architectures combining GEO and LEO systems to improve network resilience and service availability.

Across all presentations and discussions, members noted that the satellite ecosystem is evolving faster than existing statistical frameworks. New deployment models, partnerships between satellite and mobile operators, and the convergence of terrestrial and non-terrestrial networks are creating important methodological questions regarding definitions, comparability across countries, and the risk of double counting. These developments reinforced the need to review existing indicators and explore a harmonized measurement framework capable of capturing the growing contribution of satellite-based connectivity to national broadband ecosystems.

b. Methodological Challenges Identified

One of the subgroup's central findings was that the rapid evolution of satellite connectivity is challenging traditional ICT statistical frameworks. Historically, satellite services represented a relatively distinct category within telecommunications statistics, with clearly identifiable technologies, operators and service types. Today, however, new architectures, convergence and connectivity models are blurring traditional classifications and creating new measurement challenges.

A first challenge relates to the increasing diversity of satellite technologies. Satellite connectivity now encompasses a range of orbital systems, including Geostationary Orbit (GEO), Medium Earth Orbit (MEO) and Low Earth Orbit (LEO) constellations, each characterized by different technical capabilities, coverage characteristics and market positioning. Members noted that the rapid expansion of LEO services is reshaping the satellite market and raises questions regarding the extent to which future measurement frameworks should capture these distinctions.

The subgroup also observed significant changes in service delivery models. Traditional direct-to-consumer offerings increasingly coexist with wholesale arrangements, partnerships between satellite operators and mobile network operators, and hybrid solutions that combine terrestrial and satellite infrastructure. These developments affect both data availability and reporting responsibilities, raising questions about how services should be classified and which entities should be responsible for reporting data.

Particular attention was given to Direct-to-Device (D2D) services, which emerged as one of the most significant methodological challenges. Presentations from industry representatives highlighted that D2D solutions are becoming increasingly integrated with terrestrial mobile networks, often relying on mobile operator spectrum, infrastructure and subscriber management systems. Consequently, subscriptions may be recorded within mobile services and traffic carried over satellite links may appear as conventional mobile traffic. As network architectures converge, distinguishing between terrestrial and satellite connectivity becomes progressively more difficult, creating risks of both double counting and underreporting if statistical definitions are not carefully designed.

Another area of growing interest is satellite-enabled Internet of Things (IoT) connectivity. The subgroup reviewed examples of emerging deployments supporting sectors such as agriculture, mining, logistics, environmental monitoring and remote telemetry. While these services are expected to play an expanding role in extending connectivity beyond the reach of terrestrial networks, commercial deployment remains at an early stage in many countries and measurement approaches are not yet standardized.

The subgroup further noted considerable differences in national data collection capabilities. Some administrations already collect detailed information on satellite subscriptions, traffic volumes and revenues (see Annex 1 and 2 for information from specific countries), while others are still in the process of developing effective regulatory mechanisms and reporting frameworks to facilitate the

regular collection of information from satellite operators. These differences suggest that any future measurement framework should adopt a flexible and progressive implementation approach, allowing countries to begin with a basic set of indicators and expand reporting as data availability improves.

In light of these findings, members agreed that future indicators should be guided by a number of **overarching principles**. Indicators should support meaningful international comparisons while minimizing reporting burdens on administrations and service providers. They should remain sufficiently simple and flexible to accommodate countries at different stages of market and statistical development, while avoiding unnecessary overlap with existing terrestrial ICT indicators. Members also emphasized the importance of maintaining a technology-neutral approach wherever possible, focusing on services and outcomes rather than specific technological implementations. Such an approach would help ensure that the framework remains relevant as satellite technologies, connectivity models and market structures continue to evolve.

3. Existing Indicators and Identified Gaps

As part of its work, the subgroup reviewed the existing ITU indicator **i271s**, which currently captures satellite broadband subscriptions as a component of fixed broadband indicator (i4213tfbb). Members agreed that the indicator continues to provide valuable information and remains an important baseline measure of satellite connectivity.

The current satellite ecosystem is considerably more complex. The rapid growth of LEO broadband services, the emergence of Direct-to-Device solutions, the development of satellite-enabled IoT applications, and the increasing convergence between terrestrial and non-terrestrial networks are creating new forms of connectivity that are not fully captured by the existing framework. As satellite technologies become more integrated into mainstream telecommunications networks, reliance on a single subscription-based indicator may no longer be sufficient to reflect the diversity and scale of these developments.

For this reason, members concluded that while indicator **i271s** should continue to be maintained, there is a need to explore additional indicators capable of capturing emerging satellite services, improving international comparability, and supporting evidence-based policymaking in an increasingly dynamic connectivity environment.

4. Preliminary Indicator Framework

Throughout its discussions, the subgroup considered a broad range of potential indicators covering different dimensions of satellite connectivity, including subscriptions, traffic, orbit-specific services, active terminals, Direct-to-Device (D2D) connectivity and satellite-enabled IoT services (see Annex for examples). However, members agreed that the initial framework should remain focused on a limited number of indicators that balance policy relevance with reporting feasibility and can realistically be implemented across countries with varying levels of market maturity and data collection capabilities.

A recurring theme throughout the discussions was the importance of avoiding unnecessary complexity in the initial phase. For this reason, the subgroup agreed that the first step should be to prioritize a small set of indicators that can be tested through a pilot exercise and refined over time based on practical experience.

Following extensive discussions on feasibility, data availability and policy relevance, members agreed to prioritize three indicators for pilot testing. These indicators were selected because they capture key developments in the satellite ecosystem while remaining sufficiently focused to allow countries to assess reporting requirements and data collection challenges.

Indicator	Status	Suggestions for definitions and methodological clarifications
Total satellite-based broadband subscriptions	Current sub-indicator for fixed broadband subscriptions (i271s); the aim is to define a breakdown between mobile and fixed satellite connections.	- Clarification: only end-user (human) subscriptions should be included. - IoT/M2M subscriptions will be discussed in further detail. - Possibility to break down by advertised downstream speed classes; - If distinguishing fixed and mobile subscriptions is not possible, i271s definition will need to be revised
Direct-to-Device (D2D) subscriptions/connectivity indicator	Prioritized for pilot testing; definition to be clarified in this report based on countries collecting this indicator.	- Clarification: only end-user (human) subscriptions should be included. - IoT/M2M subscriptions will be discussed in further detail. - Possibility to distinguish between *D2D-enabled or activated* subscriptions and subscriptions with *actual D2D usage*. 'Activated' if by contractual right or, by virtue of the operator's configuration, the subscription is enabled to access a satellite network directly via a user device, without the use of an intermediate mobile earth station; 'actual usage' refers to subscriptions having made at least one communication via a direct D2D link during the reference period.
LEO satellite broadband subscriptions	Prioritized for pilot testing; definition to be clarified in this report based on countries collecting this indicator.	- Clarification: only end-user (human) subscriptions should be included. - IoT/M2M subscriptions will be discussed in further detail - Proposed definition: Number of active satellite broadband subscriptions where the connection to the end user is provided exclusively or predominantly by a constellation of satellites in low Earth orbit. (excludes IoT and M2M and D2D integrated into mobile subscriptions). - LEO subscriptions may be treated as a breakdown of total satellite-broadband subscriptions (based on the logic that it is distinguished by orbital architecture).

During the discussions, members also highlighted the growing importance of satellite-enabled IoT services and their potential relevance for future statistical work. Satellite IoT is increasingly being

used to support applications such as agriculture, logistics, environmental monitoring, remote telemetry and industrial operations. However, participants noted that significant methodological challenges remain regarding how such services should be measured, including the choice of appropriate units of measurement, reporting entities and data sources. Given the diversity of deployment models and the limited experience currently available, the subgroup agreed that further consultation with satellite IoT providers and additional methodological work would be required before a dedicated satellite IoT indicator could be proposed for international data collection.

The proposed indicators should initially be implemented through a pilot data collection exercise. The objective of the pilot is to assess data availability, reporting feasibility, comparability across countries and the overall usefulness of the indicators for monitoring developments in satellite connectivity. Members emphasized that the pilot should also help identify practical collection challenges and information gaps that may require adjustments to indicator definitions or reporting procedures.

As a next step, preliminary definitions will be included for the three prioritized indicators and circulated among subgroup members for review in the current work cycle. The revised framework will be incorporated into the subgroup report and submitted to the EGTI for consideration.

In the 2027 work cycle, a pilot data collection will offer an opportunity for the subgroup to review the definitions and methodology before any final recommendations are made regarding the possible integration of new satellite connectivity indicators into the ITU data collection framework.

5. Conclusions and Recommendations

The work of the subgroup has confirmed that satellite connectivity is undergoing a period of rapid transformation, driven by the expansion of LEO constellations, the emergence of Direct-to-Device (D2D) services, increasingly integrated terrestrial-satellite architectures, and the growing use of satellite technologies to support a wide range of connectivity needs. These developments are expanding the role of satellite services within national broadband ecosystems and, in some contexts, are becoming an increasingly important component of digital inclusion strategies.

At the same time, the discussions highlighted that existing statistical frameworks do not always adequately reflect these developments. New technologies and service models are creating important methodological challenges related to service classification, data availability and international comparability. These challenges are particularly evident in the case of D2D services, where the convergence of terrestrial and non-terrestrial networks blurs traditional distinctions between mobile and satellite connectivity, and in the case of satellite-enabled IoT services, where measurement approaches remain at an early stage of development.

Against this backdrop, the subgroup agreed that the most appropriate path forward is a gradual and evidence-based approach focused initially on a small number of indicators that can be tested across countries with different levels of market maturity and statistical capacity. To support this objective, the subgroup proposes preliminary definitions of the priority indicators, followed by a pilot data collection exercise through the ITU ICT Data and Analytics Division. The pilot will provide an opportunity to assess data availability, reporting feasibility, methodological challenges and the usefulness of the indicators for monitoring developments in satellite connectivity.

The subgroup further recommends extending its work for another year, continuing the review of candidate indicators, refining definitions and reporting guidance, conducting additional consultations with satellite operators, IoT providers and regulators, and developing methodological recommendations for the treatment of hybrid terrestrial-satellite services. The results of the pilot

exercise will be reviewed during the next EGTI cycle and used to refine the proposed framework before any decision is taken regarding the incorporation of new indicators into the ITU statistical framework.

Ultimately, the subgroup considers that a flexible and technology-neutral framework, supported by ongoing collaboration among regulators, national statistical offices, industry stakeholders and international organizations, will be essential to ensure that ICT statistics remain relevant and capable of capturing the evolving contribution of satellite connectivity to digital development.

ANNEX 1: Summary of ongoing data collection in selected countries

Indicators	Countries
Subscriptions	Botswana, Costa Rica, Ghana, Kenya, Mongolia, New Zealand, Nigeria, Portugal, Zimbabwe
Breakdown by technology/speed	Botswana, Ghana, Mongolia, Portugal
Wholesale connections	New Zealand
Traffic	Costa Rica, Kenya, Mongolia
QoS (performance)	Mongolia, New Zealand, Nigeria
Points of presence, terminals	Ghana, Mongolia, Nigeria
Revenues	Costa Rica, Mongolia, New Zealand, Mongolia, Nigeria
Employment	Mongolia, Nigeria
D2D connectivity	(Kenya: pilot)
Satellite IoT connections	-
Number of licensed operators, types of services provided	Mongolia, Ghana
Spectrum/bandwidth allocated	Ghana, Mongolia

Note: Lists are not comprehensive, the aim is providing examples.

ANNEX 2: Summaries of written contributions

Summary of the contribution from Botswana: The regulatory authority obtains data on subscriptions, broken down by technology, from licensed operators through quarterly questionnaires, in accordance with the Authority's reporting requirements. The data are reviewed and validated by the Authority before publication in official reports. Challenges identified include limited availability of disaggregated data for emerging satellite technologies such as Direct-to-Device (D2D) connectivity and Satellite IoT services, differences in how operators classify satellite services, and that the rapid evolution of satellite broadband services requires continuous updates to statistical definitions and reporting templates. The authority also found good practices that support data collection and validation, including maintaining regular interactions with licensed operators, the periodic review of reporting templates to ensure they capture emerging technologies and evolving market trends, and careful data validation to improve the accuracy and reliability of statistics published.

Summary of the contribution from Costa Rica: Costa Rica, collects data on subscriptions from operators providing internet access via satellite technology (without differentiating between LEO and GEO). Efforts are also underway to segment this subscription data by speed range. Furthermore, the regulator is also requesting aggregated reports of the revenue generated by these subscriptions and the corresponding data traffic. In addition, to encourage operators to report their indicators, the regulator is planning a simplification of the indicator matrix that telecommunications service providers are required to complete periodically. Furthermore, operators with less than 1% market share shall submit information annually, while operators with more than 1% market share will continue to be required to submit quarterly reports (with a monthly breakdown).

Summary of the contribution from Egypt: Egypt appreciates the subgroup’s efforts to advance satellite statistics and the valuable insights gained on data collection challenges. However, Egypt mentioned limited availability of satellite indicator data and their breakdown in many African and developing countries, or many countries are still in the infancy of data collection, therefore Egypt recommends postponing the expansion of satellite indicators and focusing instead on sharing best practices and strengthening data collection capacities.

Summary of the contribution from Kenya: According to information provided by the Communications Authority of Kenya, satellite-based connectivity services in the country include

LEO satellite broadband services, such as Starlink-type offers, emerging Direct-to-Device/Direct-to-Cell connectivity, satellite backhaul for mobile network towers in remote areas, and nascent satellite IoT services. The Authority currently collects LEO satellite broadband subscriptions under the satellite broadband subscription indicator, treats traffic generated by LEO Internet services as domestic Internet traffic reported by Internet service providers, and captures VSAT traffic as utilized international Internet bandwidth through gateway companies; however, data collection has not yet started for Direct-to-Device/Direct-to-Cell services or satellite IoT connections, and no additional related satellite-based connectivity indicators are currently collected. The main methodological conclusions are that LEO Internet services requiring a user kit should be counted similarly to fibre subscriptions, based on active service contracts, while Direct-to-Cell users may also be mobile users, requiring careful identification of the technology generating most traffic to avoid double counting; the Authority also considers that breaking down satellite subscriptions by orbit type may be important, given the potential of LEO services to affect terrestrial mobile markets.

Summary of the contribution from Mongolia: Satellite broadband connectivity in Mongolia is currently provided by Starlink (since 2023) and by ISatcom, the national operator which uses GEO satellite transponder capacity. (This complements longer-standing satellite-based services, such as DTH broadcasting, mobile backhaul, emergency communications and remote sensing applications). The Communications Regulatory Commission (CRC) of Mongolia collects statistical data from satellite communications service providers. Following 2025 revisions to its reporting templates, CRC currently collects information on financial performance (revenue, expenditure, investment), human resources, network infrastructure (earth stations and VSAT terminals, network capacity, customers), subscriptions disaggregated by orbit type, service type, geography, speed and customer category, as well as on traffic (voice and data) and QoS. Although the reporting framework has been substantially enhanced, it is noted that methodologies for compiling network infrastructure, traffic, and QoS indicators are still under development, and transformation from existing reporting practices need further refinement to adequately reflect the characteristics of satellite-based networks, to allow data to be used for international comparison.

Summary of the contribution from New Zealand: New Zealand collects several satellite broadband indicators through different data sources. Through the annual industry questionnaire sent to providers, it collects data on satellite broadband internet subscribers covering both GEO and LEO services, satellite broadband revenue, wholesale satellite broadband connections and revenue; it also requests providers to submit address-level satellite connection and coverage data. As part of the Measuring Broadband New Zealand programme, which uses in-home white boxes operated and verified by an independent third party, the regulator also collects LEO satellite performance indicators such as download speed, upload speed, responsiveness, disconnections, latency and application performance. The performance data, coupled with the address-based data gives the regulator a detailed view of satellite uptake by location and the performance consumers are getting on each plan. Key challenges identified include late responses, data not following requested formats, gaps or errors in provider data, confidentiality constraints where one provider accounts for most connections, and the cost of maintaining the performance monitoring programme.

Summary of the contribution from Nigeria: The regulatory authority of Nigeria collects administrative data on satellite broadband services from licensed operators, including LEO providers such as Starlink, which has recorded strong subscriber growth and become one of the country's leading ISPs. The indicators collected include total and active satellite-based broadband subscriptions, points of presence, Internet usage by speed bands, revenue and staff count, while D2D connectivity is not yet available and satellite IoT connections are not yet collected. Data are compiled mainly from operator-reported subscriber counts and service statistics submitted through established NCC regulatory reporting mechanisms, with potential future sources including licensed satellite broadband operators, ISPs, satellite network operators and mobile operators providing satellite-enabled services. Key challenges include delays in data submission and the need for continued capacity building to ensure common understanding of indicators, standards and

comparability. Good practices include collecting administrative data directly from licensed satellite providers, developing technology-specific reporting templates for satellite broadband, D2D and satellite IoT services, adopting harmonized international definitions and methodologies, strengthening collaboration among regulators, national statistical offices and satellite operators, and periodically reviewing ICT statistical frameworks to reflect emerging non-terrestrial network technologies.

Summary of the contribution from Portugal: In Portugal, ANACOM (NRA) collects data on broadband subscriptions from operators providing internet access via satellite technology (without differentiating between LEO and GEO) and speed range, as well as satellite coverage. The satellite network operator or the retail provider of satellite internet access services must indicate the coverage area of the satellite network/system within the national territory, using a polygonal grid. The maximum download and upload speeds must also be indicated for each of the polygons. Coverage data is available at ANACOM Geo portal.

Summary of the contribution from Zimbabwe: POTRAZ has been collecting subscription statistics from both the traditional GEO VSAT providers and the LEO satellite provider Starlink, following the ITU methodology for indicator i271s. Since the licensing of Starlink in 2024, satellite-based fixed broadband subscriptions have increased rapidly. Direct-to-device connectivity is currently not provided in Zimbabwe, although one operator conducted D2D trials with no provisions as to when it would be offered commercially. There is currently no data collection on satellite-based IoT connections.