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RADAR

Roaming in a post-Covid world

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Our team of analysts and experts produce regular thought-leading research reports across a range of industry topics.

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Executive summary

In terms of financials, roaming was a remarkably steady line of business prior to 2020. It typically accounts for 5–10% of mobile revenues, and a higher share of profits – even in Europe, where charges for data roaming within the EU were abolished in 2017.

However, revenues were inevitably exposed to the curtailment of international travel as a result of border restrictions and closures once lockdowns came into force in the first half of 2020. For a selection of high tourist footfall countries in Asia, Europe and North America, roaming revenues declined by 20–30% on average in 2020. The transitional period until the world is fully vaccinated is likely to involve a patchwork set of bilateral 'traffic light' systems. Roaming volumes will recover most quickly for those corridors that open first.

Macro-economic conditions aside, technology development plays a key role in how any mobile market moves forward. We address four areas in this analysis:

- **2G/3G decommissioning.** Whether for voice, data or IoT services, at least half of roaming professionals expect an impact from the decommissioning of 2G and 3G networks. The effect on data roaming is likely to be positive, as roamers are moved to more robust 4G networks. Expectations around IoT reflect the reality that 2G/3G devices (which do not consume much data) will need to be accommodated. The voice story is slightly more nuanced, however. The implications of a forced migration to VoLTE are a clear concern – and a bigger one for network operators (85% expect some impact) than MVNOs (64%). This serves as a reminder that different market players will face different pains.

- **VoLTE roaming.** Aspirations of VoLTE-enabled, high-quality voice roaming are not enough to ensure its existence. Significant organisational and technical work is required to bring it to fruition. As VoLTE networks around the world scale, device-side roaming support will garner more attention, and cross-border service continuity will become less of an issue (the potential handover between VoLTE and non-VoLTE calls will be less common). In the here and now, however, it is important to recognise that all the toolkits and technical capabilities are in place to support VoLTE roaming.

- **5G roaming.** In the long term, support for 5G while roaming will become the norm. However, in the near term, operators intent on driving 5G adoption will want to see 5G roaming materialise sooner rather than later. The availability of 5G abroad should serve to make the technology more attractive at home, particularly for users who require (or otherwise got used to) 5G bandwidth. Likewise, operators that are eager to drive traffic to their 5G networks will welcome 5G roamers, especially if they can generate a premium over 4G data users. If 5G has the potential to drive B2B business, 5G roaming should, again, make it a more compelling proposition.

- **Cross-border IoT.** For operators, the attraction of IoT is understandable. A myriad of new IoT devices promises new connectivity revenues, along with an opportunity to develop new systems integration and solution-oriented businesses focused on traditionally under-penetrated enterprise verticals and use cases. At first glance, enterprise views on IoT roaming requirements may seem discouraging; the 34% of enterprises that claim a need for international coverage represent only a fraction of the IoT market. In reality, it is an indicator of an impressive opportunity. GSMA Intelligence forecasts 24 billion IoT devices in 2025. Even if enterprise expectations of their requirements are extremely over-exaggerated, the opportunity is still huge. What's more, not all IoT roamers are actually crossing from one country into the other – many are permanent roamers.

The concurrent trends of network shutdowns, the rise of LTE and early 5G traffic, and use of IoT in B2B scenarios – all buffeted by the pandemic – underline the need to modernise revenue and billing models. Complexity is increasing, and new business models not based purely on traffic or number of devices are driving the industry to look for new ways to be more efficient. The complexity, long lasting negotiations and time-consuming implementation of different roaming services has also led to the emergence of roaming hubs. A hub is essentially a plug-and-play gateway to a multitude of roaming agreements brokered and managed by a central party (usually a large telco) through single sign-up. The advantage of a hub is that it eliminates the need to negotiate and implement multiple agreements and interconnections, reducing time to market.

Continued expansion of M2M/IoT connections and demand for cross-border connectivity make it likely that eSIM will increasingly become an embedded part of roaming services. For consumer and IoT device makers, there will be a gradual/phased shift to eSIM – from a paired model alongside physical cards towards full eSIM. This is likely to proceed faster in IoT, considering the existing momentum in manufactured devices since 2016, with consumer handsets a bit behind. For network operators and MVNOs, it may mean a more competitive retail market because of the seamless switching process.

1

The pandemic's impact and its lasting influences

Direct exposure to lockdown and travel restrictions

To understand the potential changes to international roaming services resulting from the Covid-19 pandemic, it is important first to gauge the nature and extent of the downturn over the last 12 months.

The telecoms sector is traditionally cyclical, in that it moves roughly in line with the broader economy and GDP growth. Based on reporting operators, GSMA Intelligence analysis indicates that the pandemic took 4–8 pp off telecoms revenue growth in 2020. This is slightly below our base case scenario (as a result of second and third waves of infection) but is resilient overall compared to GDP, given the reliance on networks for home working and entertainment. The majority of the negative impact can be ascribed to a combination of four factors: closures of retail stores (and therefore fewer handset upgrades), weakness in the SME and corporate segments, pressure on consumer income, and roaming.

In terms of financials, roaming was a remarkably steady line of business prior to 2020. It typically accounts for 5–10% of mobile revenues, and a higher share of profits – even in Europe, where charges for data roaming within the EU were abolished in 2017.

However, revenues were inevitably exposed to the curtailment of international travel as a result of border restrictions and closures once lockdowns came into force in the first half of 2020. For a selection of high tourist footfall countries in Asia, Europe and North America, roaming revenues declined by 20–30% on average in 2020 (see Figure 1). This is directly related to tourist numbers, which fell 80% on average based on aggregated figures from the UNWTO World Tourism Barometer, having generally grown at 5–10% per year over the last decade (and considerably higher in some countries).

Figure 1

The hit on roaming revenue is a direct consequence of international travel restrictions

Roaming revenue growth (year-on-year)
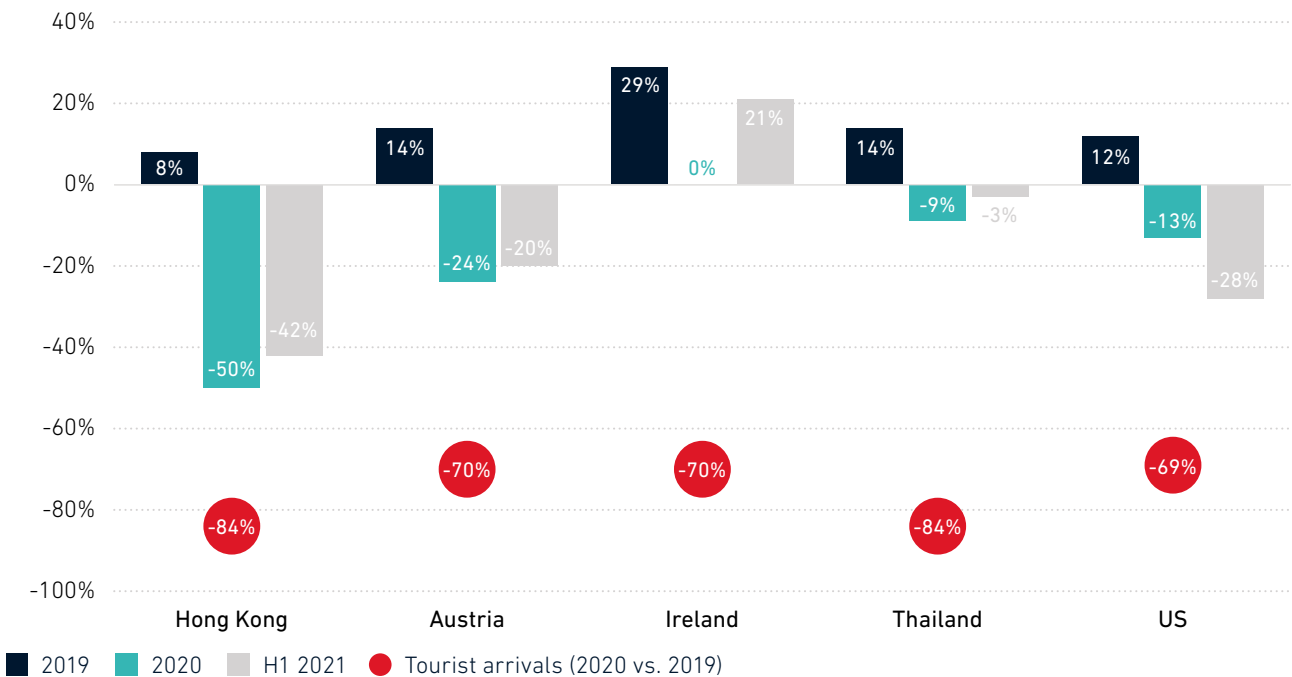
Note: roaming revenue figures are based on reporting operators for a given country, so should be interpreted as a proxy rather than a full market aggregate.
Hong Kong (Hutchison), Austria (A1), Ireland (Eir), Thailand (TrueMove), US (UScellular).

Source: GSMA Intelligence, UNWTO World Tourism Barometer (October 2020 edition)

In our recent survey of roaming professionals, which included telecoms operators, MVNOs and other specialists, revenues dropped in line with or worse than expectations for 90% of respondents. Only 5% said they exceeded expectations.

The more nuanced question is how quickly, and to what extent, roaming call and data traffic volumes will recover as countries emerge from the pandemic at uneven speeds. Vaccination rates have reached mass numbers in most Western countries, at 85–95% for at least one dose and 65–80% for the full course. However, comparative rates are far lower in India, Africa and much of Asia because of constraints in terms of supply and affordability. The transitional period until the world is fully vaccinated is likely to involve a patchwork set of bilateral 'traffic light' systems. Roaming volumes will recover most quickly for those corridors that open first (note the US has been an exception among Western countries with its borders largely closed to foreign travellers).

Survey sentiment suggests a majority of operators expect roaming volumes will take two years or more to recover to pre-pandemic levels (see Figure 2), with data volumes more resilient than voice (in part because of heavy use in higher income countries among business travellers).

Industry sentiment indicates roaming will take two to three years to return to normal, with data traffic more resilient

Thinking about the Covid pandemic, roughly how long do you think it will take overall mobile industry roaming traffic volumes to return to pre-Covid levels?

● Mobile voice ● Mobile data

Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)
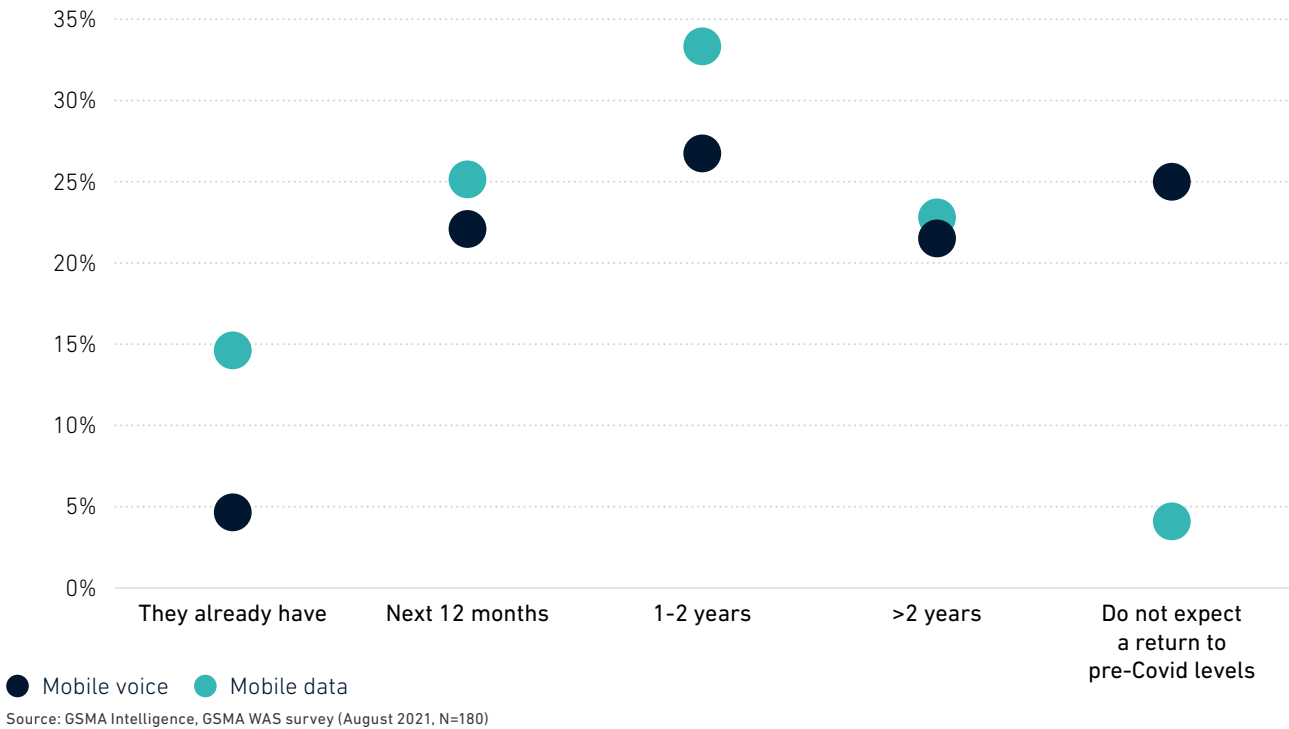
Lasting influences

The pandemic also serves as a checkpoint for assessing the prospects of new addressable markets in the B2B space. The majority of roaming revenues for operators comes from tourism and business travel. IoT and M2M connections have historically represented a much smaller contribution. There is little in the way of reported data for IoT roaming revenues specifically, but we can infer the relative proportioning from the fact that IoT as a whole tends to account for 3–5% of total revenues for operators that report it. This balance in roaming revenues is going to change as tourism and corporate travel lags, while IoT connection installations rise as business investment recovers and projects that were put on hold during the pandemic come back online.

We address the prospects for IoT roaming in more detail in the next section, but it is first useful to gauge industry sentiment on the lasting impacts of the pandemic on emerging verticals. Figure 3 shows

data from our survey in which we asked whether professionals thought a given customer segment for roaming would emerge bigger, smaller or unchanged as a result of the pandemic. For the purposes of this analysis, we have taken the difference between permanently bigger and smaller to give a high-level net sentiment indicator:

- Only one sector – automotive – is expected to emerge from the pandemic permanently larger than before it. Tourism and trucking & haulage are broadly unchanged, though with a lag to their recovery prospects depending on how quickly borders re-open for holiday and commercial trade.

- Aviation and maritime are seen as declining, though with a high degree of uncertainty (20% believe it is too early to say).

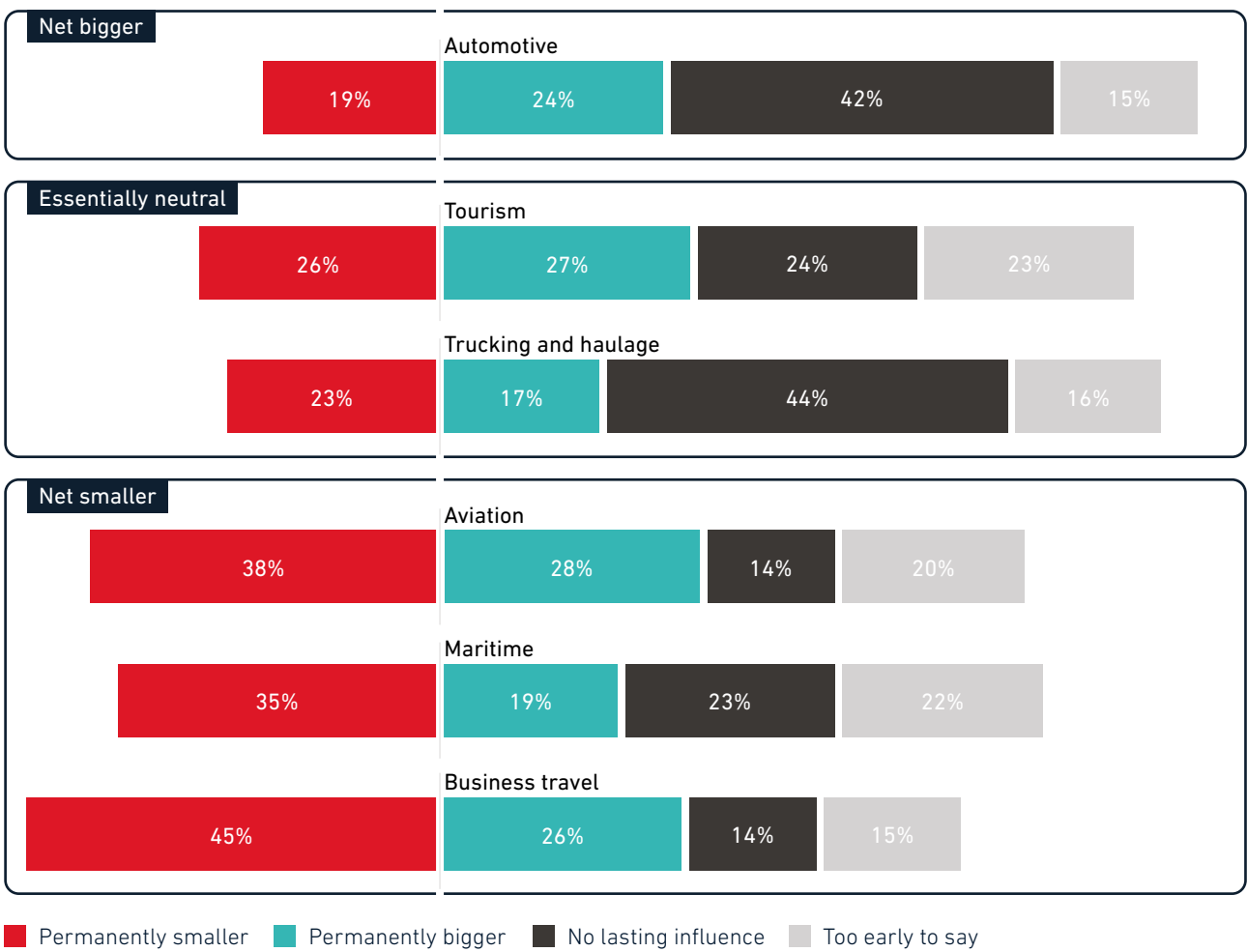- Corporate/business travel sees a strong decline.

In addition to the pandemic, the latter point likely factors in expectations of reduced business travel as part of company targets on carbon emissions. Climate considerations will also impact aviation and shipping. A 5–10 year implication is that roaming prospects in these segments will be influenced by the rate at which clean fuels substitute existing diesel and jet mixtures.

The bigger picture is one in which roaming products for IoT applications offset a portion of the traditional voice and data business permanently lost to the pandemic and lower global travel volumes driven by carbon abatement goals.

Figure 3

Recovery expectations for roaming are most buoyant for automotive

For each of the following roaming customer segments, what do you think will be the lasting impact of the pandemic on their respective market sizes?

Net bigger

Automotive

| 19% | 24% | 42% | 15% |

Essentially neutral

Tourism

| 26% | 27% | 24% | 23% |

Trucking and haulage

| 23% | 17% | 44% | 16% |

Net smaller

Aviation

| 38% | 28% | 14% | 20% |

Maritime

| 35% | 19% | 23% | 22% |

Business travel

| 45% | 26% | 14% | 15% |

■ Permanently smaller   ■ Permanently bigger   ■ No lasting influence   ■ Too early to say

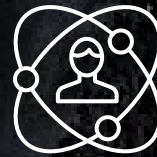Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

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Enhance your Roaming Business by Linking Insights with Action
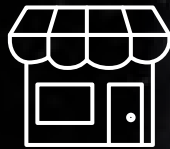
Roaming Management
Increase Revenue

Network Services
Enable the global connectivity

IoT Services
Manage Millions of Devices

International Roaming Network
Ensure Excellent Customer Experience

Know more

2

Tech trends driving market evolution

Macroeconomic conditions aside, technology development plays a key role in how any mobile market moves forward. At its best, it helps operators respond to critical economic and societal trends, while enabling business innovation. At its worst, operators find themselves confounded by tech complexity or unable to respond to the opportunities in front of them. In this context, roaming is no different.

Consider how today's roaming landscape has been shaped by a handful of critical developments. The harmonisation of spectrum assignments across countries has enabled support for voice and data roaming. Multi-band devices, in turn, bring this support to life when combined with the appropriate protocols, band-end infrastructure, billing tools, steering solutions and so on. Customer demand and commercial structures may move the roaming market forward, but key technologies and the pace of their implementation determine how and when.

Four key technology and network trends promise to shape the roaming industry over the near and medium term: 2G and 3G network shutdowns, VoLTE roaming, 5G expansion and cross-border IoT.

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2G/3G decommissioning: don't let the sun set on roaming

In 2020, 4G accounted for 57% of global mobile connections. Looking out to 2025, we expect that number to remain relatively steady at just over 54%. This might seem to suggest that the distribution of connections (and subscribers) across network technology generations over the next five years will be relatively stable. But that is not the case.

While LTE will remain the dominant mobile network technology over the mid-term, 5G will be ramping up – from 3% of connections in 2020, to 24% in 2025. 2G and 3G connections, in turn, will continue their decline. As a result, the pressure to decommission 2G and 3G networks will only increase as operators look to focus on network technologies that better meet end-user demand (broadband data) while re-harvesting precious spectrum to support 4G and 5G. The complexity and costs involved in running multiple networks simultaneously will further support the trend.

The challenges ahead

While it may take years, older technologies will inevitably be replaced by newer ones. In the case of 2G and 3G, shutdowns raise a number of potential issues for roaming:

- **Base layer coverage –** Often deployed in lower-band spectrum, 2G and 3G have provided a coverage layer for voice and data services. Misalignment of coverage at home and abroad could impact the user experience or drive the need to steer roamers to new partners.

- **IoT layer –** IoT devices, in particular, have relied more heavily on 2G networks, reflecting their coverage and bandwidth needs. 2G shutdowns could impact IoT device roaming by forcing new partner relations, restructured commercial offers or IoT device replacements.

- **VoLTE rollouts –** Closing down 2G and 3G networks will necessitate moving voice to VoLTE, impacting the universe of roaming partners (outbound/inbound).

Moving the market forward: what next?

The past six years have seen 43 network shutdowns, with 33 2G and 10 3G. While 2G and 3G have provided robust mobile services for years, their days are clearly numbered in many markets.

The market sees this coming, with a focus on the impact to voice traffic. Whether for voice, data or IoT services, at least half of roaming professionals expect some impact from the decommissioning of 2G and 3G networks. The impact on data roaming is likely to be positive, as roamers are moved to more robust 4G networks. Expectations around IoT reflect the reality that 2G/3G devices (which do not consume much data) will need to be accommodated. The voice story is slightly more nuanced, however. The implications of
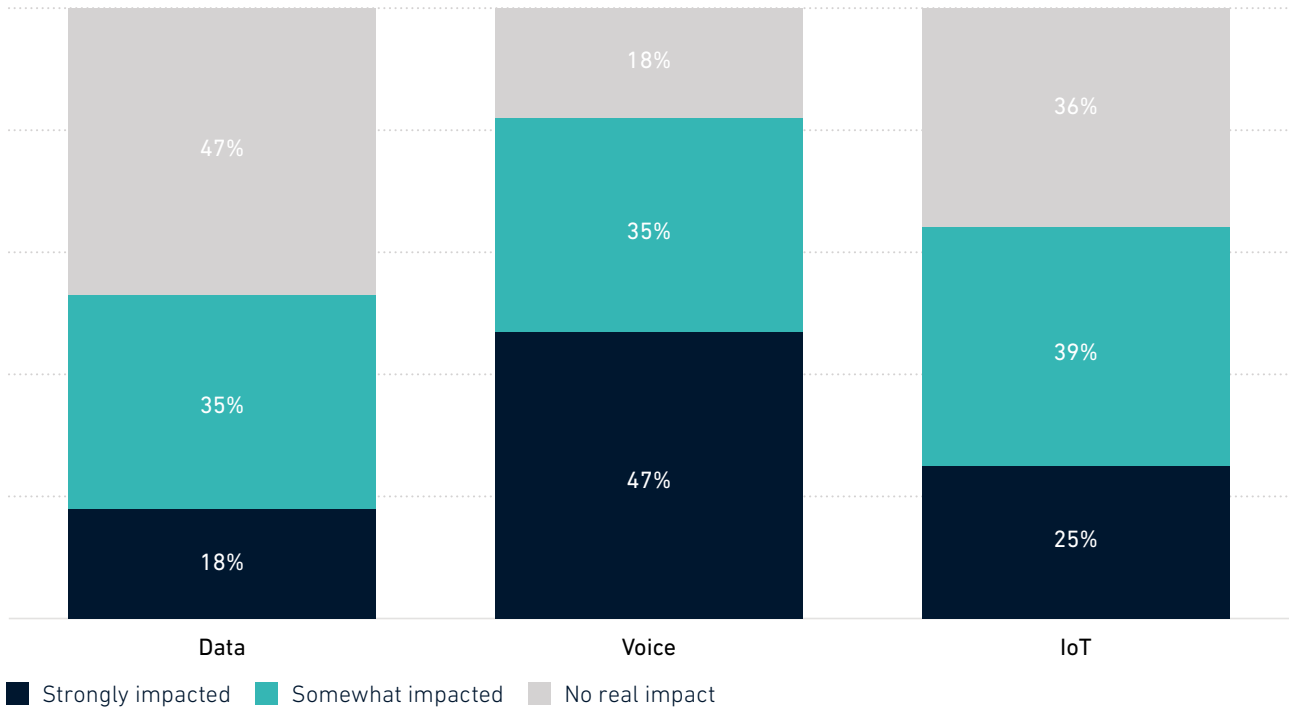
a forced migration to VoLTE are a clear concern – and a bigger one for network operators (85% expect some impact) than MVNOs (64% expect some impact). This serves as a reminder that different market players will face different pains.

The move to 4G/5G – and, with it, the closure of 2G/3G networks – is inevitable. The good news is that this is a well-understood reality. The roaming industry has been planning for it, and it could be beneficial in supporting more robust data services and driving migration to more efficient IoT technologies. Active planning is needed in terms of supporting new voice services, whether that means implementing new voice infrastructure at home or simply steering roamers correctly.

Figure 4

2G/3G shutdowns

For each of the following telecoms services, to what extent do you think they will be impacted by 2G and 3G network shutdowns over time?

	Data	Voice	IoT
No real impact	47%	18%	36%
Somewhat impacted	35%	35%	39%
Strongly impacted	18%	47%	25%

■ Strongly impacted   ■ Somewhat impacted   ■ No real impact

Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

VoLTE roaming: the decade-long march

VoLTE is the technology that supports voice calls over LTE networks. This is no trivial matter; whereas voice calling on 2G and 3G networks is circuit-switched, LTE is packet-based, requiring a fundamentally new solution for voice – a solution that will also carry over to 5G networks.

Beyond simply providing a way to make voice calls on 4G/5G networks, VoLTE comes with a host of other benefits. The use of new coding schemes allows for higher voice quality, which some would term 'HD voice'. Call set-up times are reduced compared to legacy circuit-switched voice services. Video calling is supported, along with switching between voice and video. The result is an improved customer experience in tandem with the efficiencies of moving traffic from 2G or 3G networks. These benefits all apply in a roaming context. After all, operators want customers to experience the same high-quality voice services abroad as they do at home.

The challenges ahead

Aspirations of VoLTE-enabled, high-quality voice roaming are not enough to ensure its existence. Significant organisational and technical work is required to bring it to fruition.

- **VoLTE rollouts versus shutdowns –** Network shutdowns will necessitate VoLTE rollouts in some markets. In the meantime, VoLTE support is far from ubiquitous, limiting the demand for VoLTE roaming and supply of roaming partners.

- **User experience –** While VoLTE promises an improved user experience, it may be compromised. Service availability (quality) depends greatly on coverage (uplink, in particular), which will vary from network to network. Further, complications around call completion, short-code use, and

emergency and toll-free numbers could hold back interest in driving VoLTE roaming.

- **Revenue leakage –** Where VoLTE traffic is home-routed as data, the higher-margin voice revenue that visited networks are accustomed to could be impacted. At the same time, home networks will now be responsible for termination costs.

- **Device support –** To support VoLTE roaming, devices must support VoLTE and be enabled for VoLTE roaming. However, this level of device support is not always available.

Moving the market forward: what next?

By the end of 2021, GSMA Intelligence forecasts 3.4 billion VoLTE connections (including voice over 5G). By 2025, this will have grown to just under 5.1 billion. While these numbers might seem substantial, it is important to put them in perspective; in 2021, VoLTE will represent 64% of the combined LTE and 5G connections, rising to 73% in 2025. In other words, less than two thirds of today's 4G and 5G connections will be leveraging VoLTE – and even through the mid-term we expect less than three quarters to be on VoLTE. The move to roll out and get users on VoLTE started more than a decade ago and is still work in progress.

This progress puts an upper limit on the potential for LTE roaming. This upper limit is reflected in how the industry expects VoLTE roaming to be supported. Only about 40% of the experts we surveyed expect a majority of operators in the regions they are active in to support VoLTE roaming in the next 12 months.

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Figure 5

VoLTE roaming

In regions where your company is active, when do you think VoLTE roaming will be offered by a majority of operators?
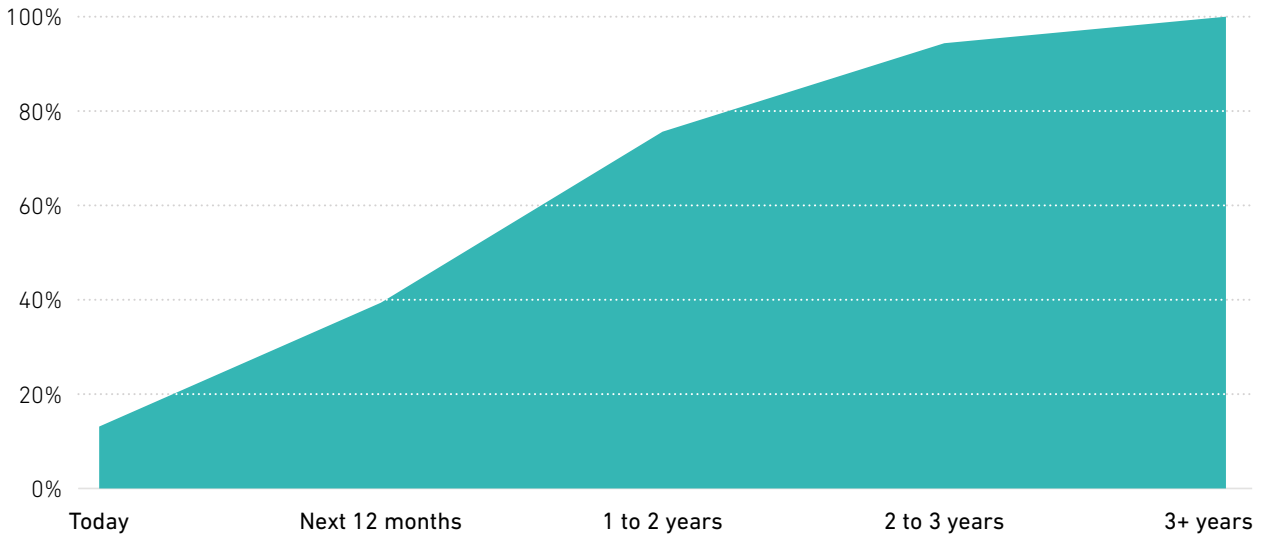
Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

Looking beyond the next 12 months, optimism begins to prevail: within the next two years, market participants expect this figure to exceed 75%. That support will be driven by the implementation of solutions to the challenges noted earlier. LTE coverage (and VoLTE performance) will improve. Analytics solutions and new commercial arrangements will stem revenue leakage concerns. As VoLTE networks around the world scale, device-side roaming support will garner more attention, and cross-border service continuity will become less of an issue (the potential handover between VoLTE and non-VoLTE calls will be less common).

In the here and now, however, it is important to recognise that all the toolkits and technical capabilities are in place to support VoLTE roaming. Standards and specifications exist. Implementation guides are available. Network solutions and guidelines for interworking are plentiful. Moving forward on business planning and VoLTE roaming rollout is key.

5G roaming: when only the best is good enough

5G may account for less than 10% of global mobile connections today, but adoption is scaling quickly, driven by falling device costs (making 5G more accessible), aggressive network builds and strong marketing campaigns. Operators are eager to move consumers to their new 5G networks, and keen to explore ways 5G can help them build new momentum with enterprise digital transformation (IoT) opportunities.

In the long term, support for 5G while roaming will become the norm. However, in the near term, operators intent on driving 5G adoption will want to see 5G roaming materialise sooner rather than later. The availability of 5G abroad should serve to make the technology more attractive at home, particularly for users who require (or otherwise got used to) 5G bandwidth. Likewise, operators that are eager to drive traffic to their 5G networks will welcome 5G roamers, especially if they can generate a premium over 4G data users. If 5G has the potential to drive B2B business, 5G roaming should, again, make it a more compelling proposition.
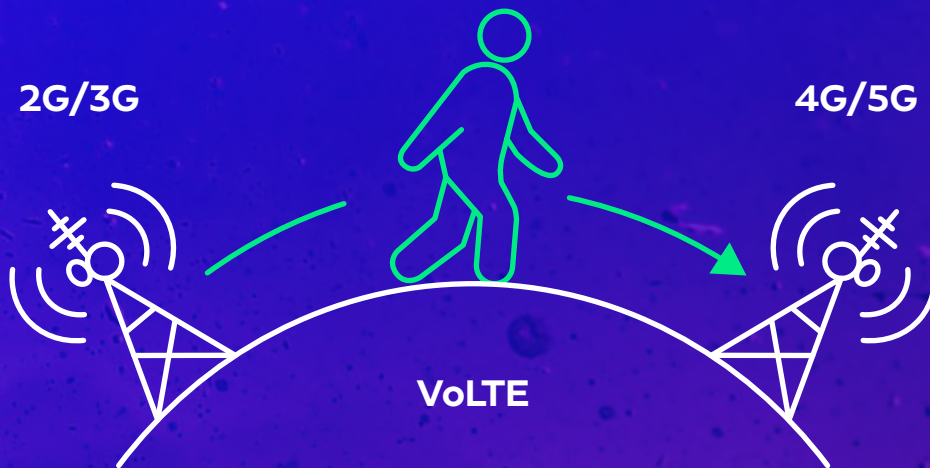
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Take the Hassle Out of VoLTE Roaming Deployment

2G/3G

4G/5G

VoLTE

Steering of Roaming
Sponsored Roaming
Roaming Customer Experience Management
VoLTE Roaming Testing
Roaming Quality Testing

... and be prepared for 5G Rollout

Analytics Platform

Closed-Loop Service Assurance

SEPP

The challenges ahead

5G support for data (and voice) roamers may be inevitable but there is no shortage of dynamics currently holding it back:

- **5G availability –** GSMA Intelligence forecasts just under 640 million 5G connections at the end of 2021. That compares to 4.8 billion LTE connections. A limited base of users makes 5G roaming a lower strategic priority for many operators.

- **Standalone (SA) versus non-standalone (NSA) –** Leveraging 4G core network infrastructure, roaming on 5G NSA networks is technically straightforward to enable. 5G SA, however, involves the deployment of a new core with new functionality, all of which will need to be coordinated for roaming purposes.

- **Slicing and edge computing –** Network slicing and edge computing are key to the 5G value proposition, particularly for IoT devices with demanding performance requirements. Coordination of slicing and edge assets across home and visited networks represents another complexity for roaming.

Moving the market forward: what next?

At the end of Q2 2021, 170 operators in 69 markets had commercially launched 5G, accounting for 450 million 5G connections. By the end of the year, this will rise to nearly 640 million connections (8% adoption globally). By 2025, nearly one in four connections will be on 5G, totalling 2.2 billion.

Figure 6

5G roaming support
In regions where your company is active, when do you think 5G roaming will be offered by a majority of operators?
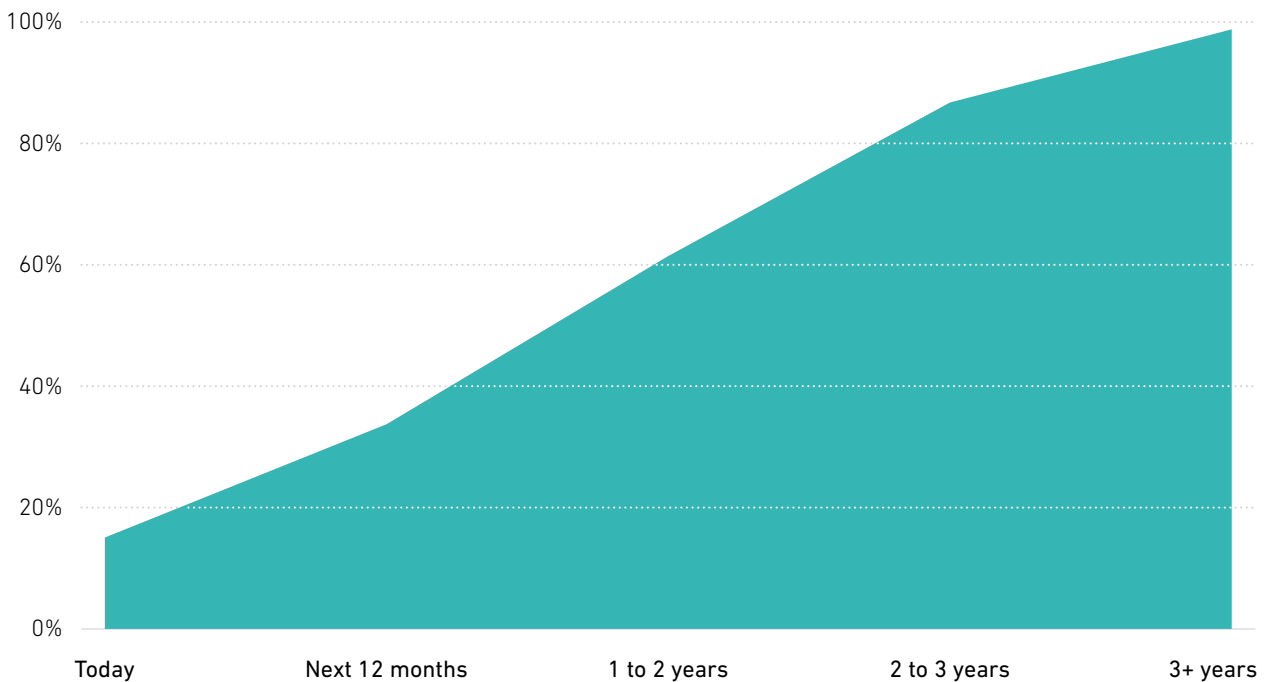
Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

These numbers represent the market of potential 5G roamers. The steady growth of 5G penetration is reflected in the market's expectations for 5G roaming support; almost a third of roaming industry professionals expect a majority of operators across the regions in which they are active to support 5G roaming within the next year. This jumps to more than 60% in two years, and 87% in three years.

The fact that only 25% of global mobile connections will be on 5G by around 2025 (significantly lower in some regions) must be acknowledged as a barrier to 5G roaming progress. Indeed, 29% of roaming professionals feel that the pace of 5G rollout will be one of the top barriers to establishing 5G roaming agreements.

A close second is technical complexity. A focus on this barrier is understandable, but only somewhat. 5G SA will introduce new capabilities (e.g. slicing) and new network architectures (e.g. NG core) for which

the roaming implications – technical, operational, billing – have yet to be ironed out. However, most 5G is currently built on non-standalone architecture, leveraging 4G core assets for which roaming operations are well-established. Meanwhile, it is telling that vendor quality is seen as a 5G roaming barrier by only the smallest minority of market executives. Operators with 5G networks in place, then, should be able to trust in their suppliers to enable NSA-based roaming in the near term, while moving quickly to link SA roaming trials to SA rollouts in order to work out the requirements, gaining a competitive advantage in the process.

Although 5G represents another network technology for operators (home operators) to manage across their roaming partner ecosystem, the potential complexity needs to be weighed against an opportunity for differentiation, with 5G enabling an ability to offer distinct services for specific use cases, thanks to smarter steering.

Figure 7

5G roaming barriers
What do you see as the largest barriers to setting up 5G roaming agreements? (select two)
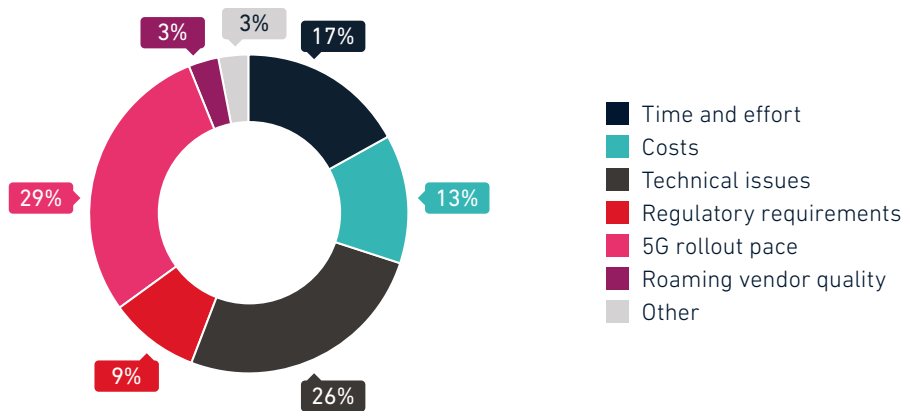
Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

Cross-border IoT: permanent or not, roaming matters

For years, industry watchers have been predicting brisk and scaled IoT uptake. Many of the predictions have proven to be over-optimistic. But the rationale behind them is simple and undeniable: there are significantly more things than people in the world, and connecting those things can bring (monetiseable) value to consumers and enterprises.

For operators, the attraction of IoT is understandable. A myriad of new IoT devices promises new connectivity revenues, along with an opportunity to develop new systems integration and solution-oriented businesses focused on traditionally under-penetrated enterprise verticals and use cases. For select use cases, cross-border connectivity may be a solution requirement. Where it is, operators will want to deliver outbound roaming support and/or benefit from inbound IoT data traffic.

The challenges ahead

IoT device roaming is not just an interesting concept or potential opportunity for operators; IoT devices represent one of the greatest and fastest growing sources of roaming data traffic in many markets. Maintaining this trajectory will mean dealing with a number of market realities and complexities:

- **Roaming requirements –** The future might promise billions upon billions of IoT devices, but it is unclear how many will need to roam outside their home country. Only 34% of enterprises surveyed by GSMA Intelligence cite a need for international coverage for their IoT deployments.

- **2G/3G shutdowns –** 2G and 3G network shutdowns could limit roaming opportunities for existing IoT devices, or force their replacement.

- **Permanent roaming versus alternatives –** Many IoT devices are actually 'permanent roamers' – devices pre-configured with connectivity then shipped into another market. Restrictions against permanent roaming (operator or regulatory) risk these devices being disconnected and/ or device owners looking to localise connectivity via technologies such as eSIM.

- **Architectures and protocols –** Roaming agreements and data architectures are not always optimal for IoT use cases. Lack of support for power saving mode (PSM) or extended discontinuous reception (eDRX) timers, for example, could impact device battery life and IoT economics. Similarly, where data must be backhauled to a home market, latency and reliability impacts could be an issue.
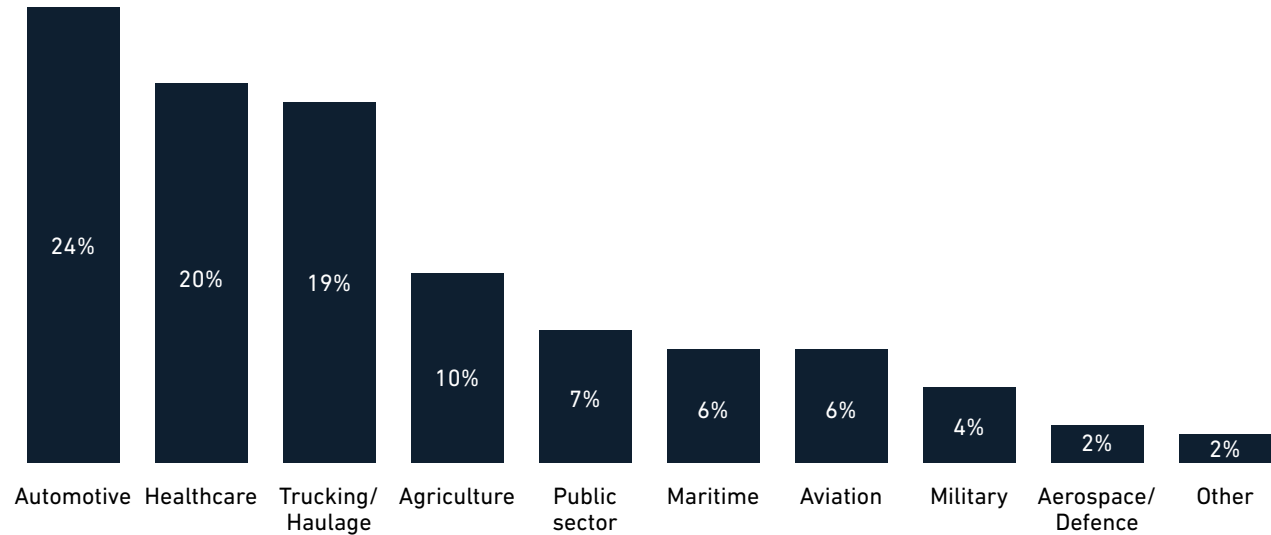
Moving the market forward: what next?

At first glance, enterprise views on IoT roaming requirements may seem discouraging; the 34% of enterprises that claim a need for international coverage represent only a fraction of the IoT market. In reality, it is an indicator of an impressive opportunity. GSMA Intelligence forecasts 24 billion IoT devices in 2025.

Even if enterprise expectations of their requirements are extremely over-exaggerated, the opportunity is still huge. What's more, not all IoT roamers are actually crossing from one country into the other – many are permanent roamers.

IoT roaming opportunities

Which of the following segments do you see as offering the greatest potential for roaming revenues over the next five years? (select three)

Automotive	Healthcare	Trucking/Haulage	Agriculture	Public sector	Maritime	Aviation	Military	Aerospace/Defence	Other
24%	20%	19%	10%	7%	6%	6%	4%	2%	2%

Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

When asked about IoT roaming opportunities, market executives (unsurprisingly) focused on segments where mobility is inherent and cross-border traffic and/or permanent roaming status (due to device manufacture) is probable: automotive and haulage/trucking markets. Healthcare is also seen as a major opportunity – a view likely reinforced by the pandemic as well as an increasing number of B2B and B2B2C business models around consumer wearables that straddle fitness and medical use cases.

The IoT revenue opportunity is about much more than connectivity. By 2025, GSMA Intelligence forecasts that only 5% of IoT revenues will be connectivity related. Applications, platforms, and professional services account for the remainder. From a roaming perspective, this should be good news. Where roaming is built into IoT solutions as a requirement, platform and service support will be critical, adding to the total value and revenue opportunity.

Problems may arise where roaming is not planned for as part of an overall solution. Lack of support for key IoT capabilities could impact device performance; sub-optimal traffic architectures could add costs or latency; and permanent roaming could jeopardise the status of devices. Steering traffic to appropriate partners and localising devices (potentially in tandem with eSIM) offer potential solutions but need to be considered upfront. Likewise, solutions to provide more visibility into 'hidden' devices and permanent roamers can help better monetise IoT.

Quality and security: cross-cutting matters

If we think of network shutdowns, 5G, VoLTE and IoT as the key technology trends impacting the trajectory of roaming markets, two dynamics can be considered horizontal factors affecting them all in some way: security and quality.

While security has always been a priority for mobile operators, its profile has risen in the recent past. Today, 89% of operators claim that end-user security is an extremely or very important consideration in their network transformation strategies, rivalled only by network security. As the market has moved from 2G through 4G, and now 5G, security has become an increasingly integral part of standards. Network shutdowns and 5G roaming should make for more secure services. This is good, particularly where high-value, mission-critical IoT solutions must also be secure.

IoT connectivity requirements reach beyond security, however. Vertical use cases – whether in transport, healthcare or any other segment – will also come with performance requirements. Coverage, speed, latency and uplink versus downlink capacity all matter in engineering an IoT solution. And, while network quality requirements may push deployments to 4G or 5G, the impact of uplink quality (or lack thereof) on VoLTE may have the opposite effect.

Ultimately, the foundational importance of secure and high-quality connectivity means it cannot be taken for granted. Migrating to 5G lends added security capabilities, but operators need solutions in place to monitor and ensure security, while fighting fraud. Meanwhile, quality monitoring will form an important part of ensuring partners are delivering what they promise, and customers are getting what they pay for – potentially informing traffic steering.

Unlock the potential

Generate new revenue streams through simplicity and automation

Built for the future of telecoms, TOMIA's set of wholesale roaming services simplifies business decisions and automates processes – allowing CSPs to navigate new technologies like IoT and 5G, whilst capitalizing on the opportunities that lie ahead.

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Beyond connections

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3

Emerging business models

The concurrent trends of network shutdowns, the rise of LTE and early 5G traffic, and use of IoT in B2B scenarios – all buffeted by the pandemic – underline the need to modernise revenue and billing models. Complexity is increasing, and new business models based not purely on traffic or number of devices are driving the industry to look for new ways to be more efficient.

Roaming hubs: consolidating under one roof

The industry standard for roaming agreements has been individual relationships established bilaterally between two mobile service providers. Our survey indicates that almost 65% or respondents rely heavily on bilateral deals to set up new roaming agreemen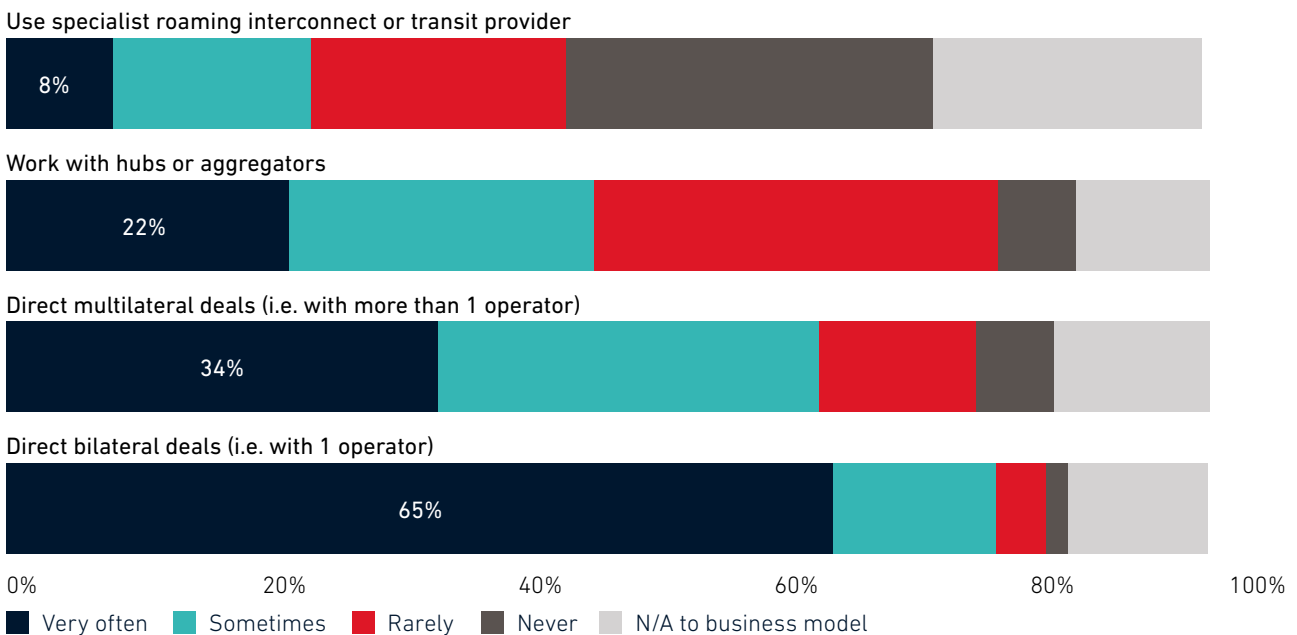ts (see Figure 9). This reflects the fact that most roaming deals were formed in the era of circuit-switched telephony using GSM and 3G in the 1990s and 2000s. These networks required network testing and authentication between host and roaming partners, with a manually driven process for settlement and billing.

Traditional mobile roaming business models used for voice, SMS and data based on traffic are not always suitable for new applications, particularly in IoT settings. Data traffic generated by this type of connectivity can be low and infrequent. Devices such as sensors used for tracking shipments, for example, send very small amounts of data and may stay dormant for several days until moved to a different location. However, they can consume high levels of signalling resources. Charging models based on number of units (typically devices or sensors), flat rates or local break-outs, rather than voice or data traffic, are emerging as an alternative approach. BCE is also gaining traction as a faster and less error-prone method of settlement.

Figure 9

Two thirds of operators still primarily rely on bilateral roaming agreements

Use specialist roaming interconnect or transit provider
8%

Work with hubs or aggregators
22%

Direct multilateral deals (i.e. with more than 1 operator)
34%

Direct bilateral deals (i.e. with 1 operator)
65%

0% 20% 40% 60% 80% 100%

■ Very often ■ Sometimes ■ Rarely ■ Never ■ N/A to business model

Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

The complexity, long lasting negotiations and time-consuming implementation of different roaming services has also led to the emergence of roaming hubs. A hub is essentially a plug-and-play gateway to a multitude of roaming agreements brokered and managed by a central party (usually a large telco) through single sign-up. Multinational operators were first to establish roaming hub services based on their own network coverage and bilateral/multilateral agreements in place with other operators. Some offer regional hubs; others are global. Examples include Vodafone Roaming Services, Telefónica Connectivity Hub, China Mobile iConnect, China Telecom International Roaming, Etisalat's Mobile & Roaming Services and Belgacom's BICS. Global MVNOs serving IoT initiatives such as Syniverse, Eseye, Ritesim, Cubic Telecom, Aeris and Orbcomm are similarly likely to gain momentum over the next five years.

The advantage of a hub is that it eliminates the need to negotiate and implement multiple agreements and interconnections, reducing time to market. At present, specialist vendors typically manage testing required to implement direct agreements, including signalling, IPX services, roaming analytics, troubleshooting, clearing and settlement. The hub concept would consolidate some, or potentially all, of these functions under one roof – a clear efficiency gain considering many operators have or require hundreds of roaming agreements globally. There is also potential to incorporate a blockchain-based mode of processing and settlement as a single version of the truth for operators, vendors and other participants in the roaming value chain.

A simplified approach to roaming

Bilateral roaming agreements   Multilateral roaming agreements
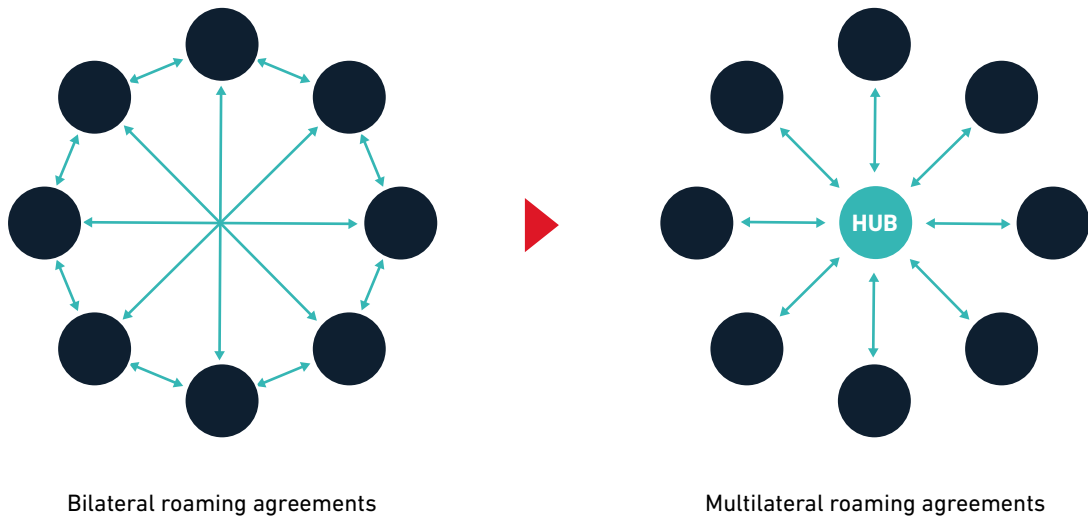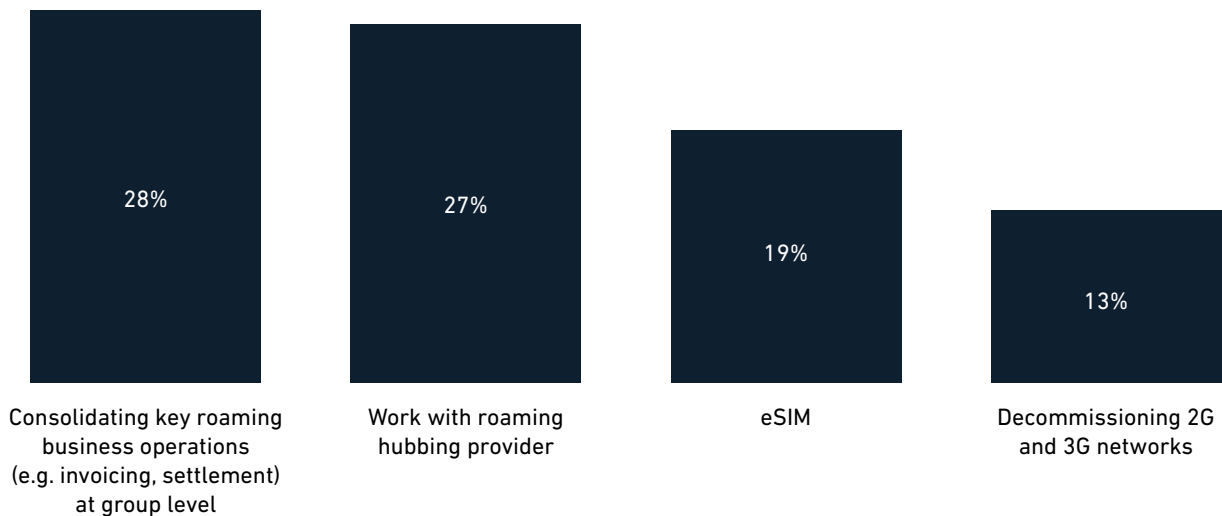
Source: GSMA Intelligence

Current hub models vary in terms of pricing models. Some large operators run roaming services that can negotiate pricing at a group level on behalf of wholesale customers, while devolving testing to other providers or their local operating companies. Some hubs allow parties to negotiate separate rates or port pre-existing rates from bilateral agreements, effectively supplementing the main agreement with the hub provider. This pricing model can be particularly advantageous for smaller operators

that would otherwise command less negotiating leverage with prospective roaming partners. Whether hub providers move to directly operate end-to-end services themselves is a question, though arguably not the most important. Consolidation and simplicity for operators seeking to sign or extend wholesale roaming is the key; hub providers will likely continue to work with specialist partners for testing and implementation unless there are clear cost or structural reasons not to.

Figure 11

What would most help make roaming simpler?

Consolidating key roaming business operations (e.g. invoicing, settlement) at group level	Work with roaming hubbing provider	eSIM	Decommissioning 2G and 3G networks
28%	27%	19%	13%

Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

eSIM: opportunity and/or threat, it is here to stay

The virtualised nature of eSIM means that switching between connectivity service providers no longer requires the universal physical SIM card to be switched. Like multi-IMSI SIM cards, eSIMs can store multiple operator profiles and be reprogrammed and/or updated over the air with new operating profiles. This has several benefits over physical SIM cards:

- More operator profiles can be pre-loaded. This is possible with physical SIMs too, but eSIM increases the number of networks a customer could connect to automatically depending on signal quality and cost.

- New profiles can be loaded to the eSIM over the air to optimise connectivity and device performance, and reduce costs when new roaming partners are brought on-board.

- Improved connectivity and avoidance of coverage black spots by cycling through the eSIM connectivity options until an available network is found.

- On-board bootstrap profiles initiate and manage reprovisioning should it be necessary for an IoT device without Wi-Fi connectivity.

- Possibility of localising the eSIM card in situations where the deployment country is different from its manufactured origin, such as for connected cars, sensors and other IoT devices.

However, there are perceived risks that centre on customer ownership and price competition. Survey sentiment reflects the delicate balance; more than half of roaming professionals view eSIM as both a competitive opportunity and risk, depending on the situation. By contrast, less than a third see it as an outright opportunity or risk (see Figure 12).

Figure 12

In the context of roaming, do you view eSIM as a competitive opportunity, risk or both?

- Opportunity
- Risk
- Both, it depends on the context
- Neutral
- Don't know
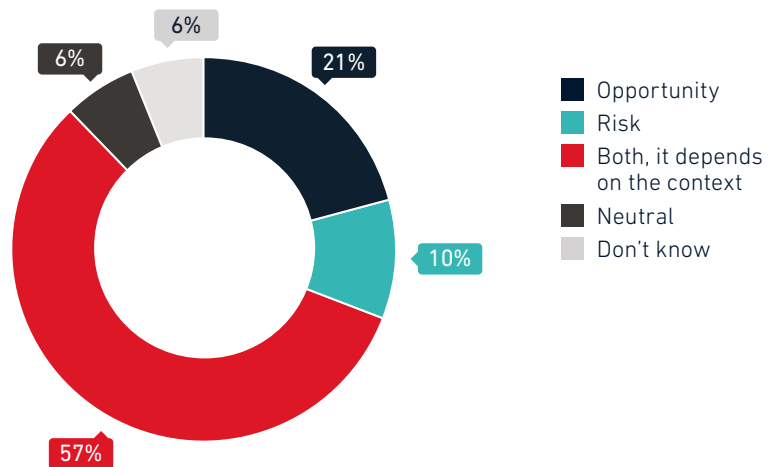
Source: GSMA Intelligence, GSMA WAS survey (August 2021, N=180)

Continued expansion of M2M/IoT connections and demand for cross-border connectivity make it likely that eSIM will increasingly become an embedded part of roaming services. We have summarised a range of use cases in Table 1.

For consumer and IoT device makers, there will be a gradual/phased shift towards eSIM from a paired model alongside physical cards towards full eSIM. This is likely to proceed faster in IoT considering the existing momentum in manufactured devices since 2016, with consumer handsets a bit behind. For operators and MVNOs, it may mean a more competitive retail market because of the seamless switching process. Technical adaptations will also be required to facilitate provisioning and billing, although the software enabling this has proliferated quickly.

Table 1

IoT use cases benefitting from eSIM

Aviation

- eSIM in aviation communication units, eliminating the need to change SIM cards and avoiding coverage gaps through constant connectivity and updating of supported networks.

- Roaming services over the mobile network instead of Wi-Fi to connect smartphones, tablets, laptops and any device fitted with an eSIM while airborne.

Automotive

- Autonomous vehicle roaming connectivity.

- New in-car connected services for media management, navigation and safety, such as fatigue recognition, vehicle diagnostics and mapping.

- Second eSIM provisioning that allows consumers to use their private data plans while in the car, effectively turning it into a personal connected device.

Supply chain

- Roaming connectivity for shipping and logistics services to identify location of goods in real-time.

Object tracking and site monitoring

- Use of low power, wide area networks for object tracking and site monitoring for businesses with multiple facilities in different regions.

Agriculture

- Corporate farming with equipment across different networks and countries. Applications include farming equipment, environmental sensors and connected drones for crop and livestock monitoring.

Healthcare

- Remote medical monitoring with connected devices/wearables to empower patients and reduce hospitalisations.

Source: GSMA Intelligence

Regulatory considerations: solving permanent roaming challenges

An ongoing challenge constraining the proliferation of IoT roaming connectivity for B2B customers arises from regulation that precludes permanent roaming. Roaming agreements between mobile network operators foresee the use of a SIM card in the visiting network for specific time spans, usually up to 90 days and in some cases up to six months. In the case of IoT devices, roaming can be an issue with a SIM card registered in the country of production but sold or used in another country on a permanent basis. The availability of permanent roaming of M2M/IoT devices is an essential part of the business proposition, yet not all countries allow it.

In some cases, restrictions or discouragement comes through local registration requirements or tax obligations. Through these regulations, local authorities try to protect their local market or enforce local legislation, like lawful intercept, which a roaming connection may not comply with. In many countries, restriction comes through the need for data to be hosted locally and not leave the country, especially if data can be traced back to individuals.

Table 2

Countries where permanent roaming is restricted or banned

Country	Permanent roaming status
Australia	Operators' restrictions
Brazil*	Banned by regulator
Canada	Operators' restrictions
China	Prohibited
Egypt	Prohibited
India*	Prohibited
Nigeria	Banned by regulator
Saudi Arabia	Prohibited
Singapore*	Prohibited
Turkey	Banned by regulator
UAE	Prohibited
US	Operators' restrictions

*Requires the installation of local SIMs to all M2M/IoT devices
Source: GSMA Intelligence

One way to avoid permanent roaming restrictions is a multi-IMSI approach, with the SIM card in the device having multiple operator profiles. This also addresses the case where an individual roaming agreement is discontinued, because a SIM with multiple network options in the country in question would roam on one of the alternative networks.

A more recent approach is the use eSIMs with the local MNO profile proactively updated over the air, effectively localising the device. Mobile operators have tried to resolve the issues around permanent roaming by adding clauses to existing bilateral agreements, when allowed. However, such clauses are not always applicable across the board to all agreements. Issues around acceptable detection methods, monitoring and forecasting permanent roaming SIMs vary among the parties. Additionally, tax and financial issues can impact permanent roaming arrangements for operators. Constructive dialogue between industry participants and communication regulators will remain important to avoid costly inefficiencies (and lost trade) given the shift to virtualisation and rise in cross-border commerce post pandemic.

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