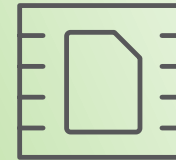# Introduction to: eSIM

Understanding the role of eSIM technology in managing and securing an increasingly connected world

Contents

Glossary of Terms

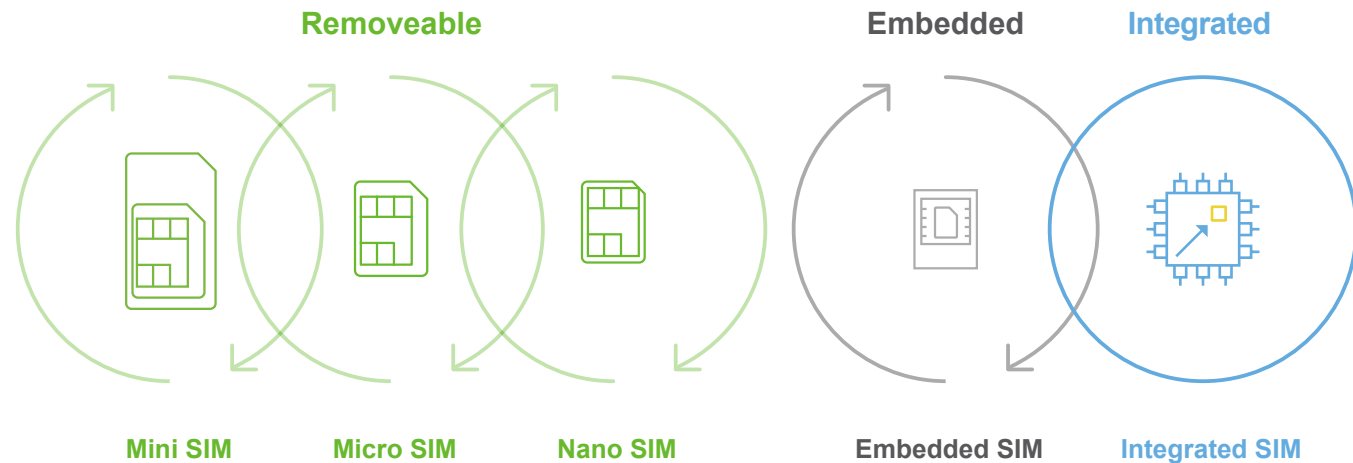| Term	Definition
eSIM	eSIM is the generic term applied to devices and eUICCs that support Remote SIM Provisioning as defined by GSMA.
eUICC	A UICC which enables the remote and/or local management of profiles in a secure way that meets GSMA requirements for Remote SIM Provisioning and are certified in accordance with the GSMA compliance programme. The term originates from "embedded UICC".
Operator	A mobile network operator or mobile virtual network operator; a company providing wireless cellular network services. An operator owns one or more international mobile subscriber identity (IMSI) ranges.
Profile	A combination of data and applications to be provisioned on a UICC or an eUICC for the purpose of providing connectivity to mobile networks.
Remote SIM Provisioning	The process of downloading, installing, enabling, disabling, and deleting a profile on an eSIM in accordance with GSMA Specifications
SIM	A generic term for the application(s) residing on the UICC that identify a subscriber and allow them to securely access a mobile network (e.g. 4G or 5G). The term 'SIM' is sometimes used interchangeably with the term UICC or SIM card.
SIM Card	A SIM that has one of the physical plug-in form factors as defined by ETSI (i.e. plug-in, micro-SIM, nano-SIM)
Tamper Resistant Element (TRE)	A security module consisting of hardware and low-level software providing resistance against software and hardware attacks, capable of securely hosting operating systems together with applications and their confidential and cryptographic data.
UICC	The platform, specified by ETSI, which can be used to run multiple security applications. These applications include the SIM for 2G networks, USIM for 3G, 4G and 5G networks, CSIM for CDMA, and ISIM (not to be confused with integrated SIM) for IP multimedia services. UICC is neither an abbreviation nor an acronym.

What is an eSIM?
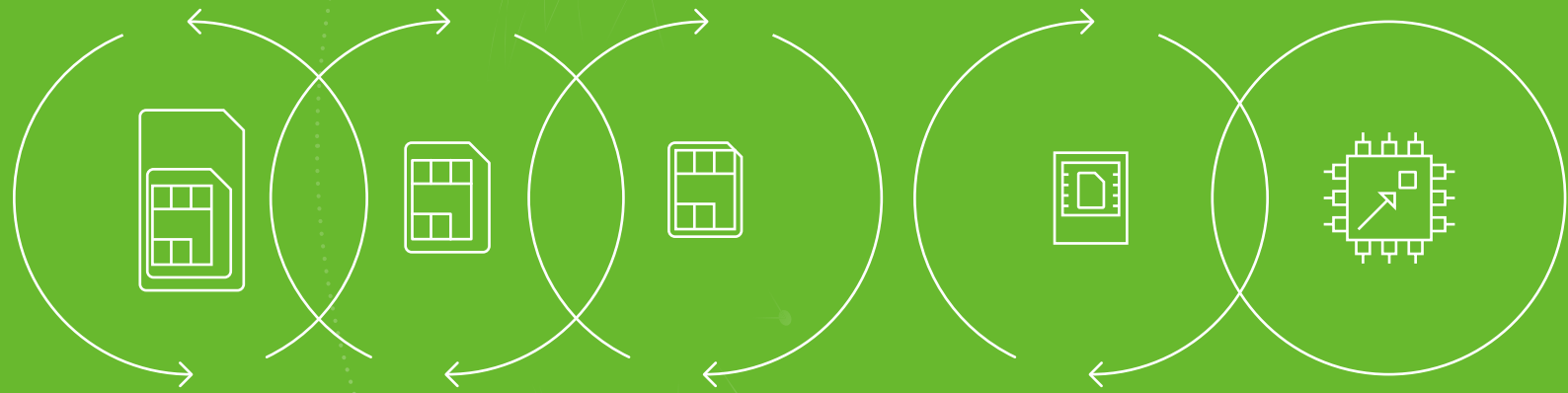
What is an eSIM?

Billions of people around the world are familiar with the SIM card for authenticating their identity and enabling connection to cellular networks. As the global connected ecosystem has expanded, the SIM has emerged as the most widely distributed secure application delivery platform in the world.

The story of the SIM, however, is one of constant evolution. The SIM applications that identify a subscriber and allow secure access to a cellular network are incorporated within connected devices via highly-secure Tamper Resistant Elements (TREs). TREs are available in various different form factors, which have become smaller and more advanced over time as the industry has continued to innovate to meet emerging demands.

Removeable   **Embedded**   **Integrated**

Mini SIM   Micro SIM   Nano SIM   Embedded SIM   Integrated SIM

Did you know?

— *'eSIM' originates from the term 'embedded SIM', and it can be soldered directly into the device to realise various benefits.*

— *However, eSIM also includes removable form factors that can store multiple operator profiles.*

— *The eSIM can also be integrated within a secure enclave on a System-on-Chip (Soc) – known as integrated SIM.*

First introduced in 2010, an eSIM can be seen as a 'digital SIM' that can store multiple operator profiles (the combination of subscriber data and applications that provide secure connectivity to cellular networks) and be remotely managed in accordance with GSMA's Remote SIM Provisioning Specifications.

Remote SIM Provisioning refers to the process of downloading, installing, enabling, disabling, and deleting a profile on an eSIM. Remote SIM Provisioning is enabled by specialised secure servers called eSIM Subscription Manager (SM) platforms.

Over recent years, the industry has invested heavily in establishing a global infrastructure of eSIM SM platforms. This infrastructure allows users to connect to more than one operator and offers the freedom to seamlessly switch mobile operators without changing the SIM card on the device.

Trusted Connectivity Alliance (TCA) has been tracking the development of the eSIM market since its nascent phase. The latest figures collectively reported by TCA members showed that eSIM shipment volumes increased 9% year-on-year to reach 337 million units in 2021. And with TCA forecasting that the total available market for eSIM will see sustained double-digit growth in 2022, this eBook provides a high-level overview of eSIM benefits, key use-cases and the standardisation initiatives that are promoting secure, interoperable eSIM deployments.

eSIM shipment volumes increased
↑**9%**
337 million units
in 2021

What are the benefits of eSIM?

TRUSTED
CONNECTIVITY
ALLIANCE

1

Globally reliable, flexible connectivity

The ability of SIM technology to deliver trusted connectivity and prevent unauthorised access has been proven over decades and on a massive scale, with over 10.5 billion mobile connections and 5.3 billion unique subscribers (Source: GSMA).

Enabled by GSMA's Remote SIM Provisioning specifications, eSIM technology brings additional flexibility to consumer, enterprise, IoT and machine-to-machine (M2M) devices by removing the need to physically change out a SIM card when switching to a different mobile carrier.

This instantly solves the prohibitive costs and logistical challenges associated with deploying and managing devices globally. This delivers the flexibility and scalability required to unlock emerging cellular use-cases spanning the connected ecosystem, anywhere in the world.

2

Advanced, dynamic security

The threat landscape is evolving rapidly, with cybersecurity attacks increasing by 125% in 2021. (Source: Accenture). Within this context, a fundamental benefit of eSIM is that it enables the highest level of security for storing credentials and personal data, both at rest and when in transit.

Advanced security and cryptographic features allow eSIM to pass Common Criteria certification. These features include a securely designed central processing unit and dedicated secure memory to store and process operating systems, sensitive key material, and certificate data. This guards against a wide variety of cybersecurity threats, such as cloning, physical attacks to a single device, and remote attacks from the internet to numerous devices.

It also means the eSIM can be used as a secure hardware Root of Trust (RoT) to establish a secure communication channel for the transportation of data to the cloud backend.

Additionally, eSIM functionality enables remote upgrades to sensitive data, apps and subscriptions according to GSMA and GlobalPlatform specifications so that a device can immediately respond to emerging threats and attacks once it is live in the field.

Mobile operators, device manufacturers, service providers and operating system (OS) developers, as well as many other global industry stakeholders, have embraced eSIM technology because of its unique capabilities:

08

3

End-to-end digitalisation

eSIM technology enables full end-to-end digitalisation, which delivers various advantages. For operators, customer acquisition and onboarding is streamlined, and a direct channel is established to enable the delivery of new value-added services to enhance the overall user experience. Digitalisation also enables operators and device manufacturers to simplify supply chains and production flows, significantly reducing manufacturing, distribution and transportation costs.
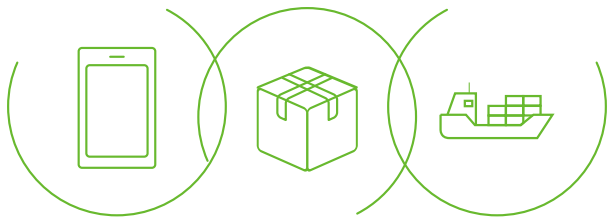
4

Improved sustainability

The telecommunications industry has made significant strides recently to make traditional removable SIM cards more eco-friendly, and eSIM technology promises considerable additional environmental benefits by significantly reducing plastic waste and associated carbon emissions. As eSIMs can be soldered directly to the device, they do not require additional plastic for manufacturing SIM card holders or packaging.

But most importantly, as eSIM can be managed remotely, a new SIM card (and the associated carbon and waste footprint) is not required every time a user switches operators. As adoption builds, network effects mean the environmental benefits will increase exponentially.

5

Enabling device evolution

The eSIM is significantly smaller than the nano-SIM and can be soldered to the device, which enables manufacturers to develop more streamlined, powerful consumer devices with longer battery life. Waterproofing and ruggedisation also supports increasing demand for robust smartphones and wearables. eSIM can also withstand hazardous environments to support emerging industrial use-cases.
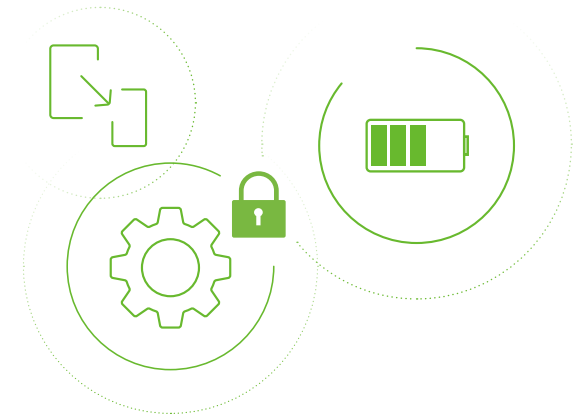
Harnessing the potential of eSIM technology

↑ 54%

Given the benefits, it is not surprising that market monitoring data published by TCA demonstrates that global uptake of eSIM technology is accelerating.

▶▶

According to the data, eSIM profile transactions – which refers to the number of times a mobile operator profile was downloaded – rose by 54% in 2021 as uptake of eSIM functionality increased for a wide variety of use cases across consumer, enterprise, and IoT / M2M verticals.
(Source: TCA)

1

Consumer

TCA's market data showed sustained growth across the consumer eSIM segment in 2021. This comes despite the impact of economic sanctions and broader geopolitical trends on the global market, as well as the delay of new device launches and the reduction of shipped units due to the widely publicised worldwide chip shortage.
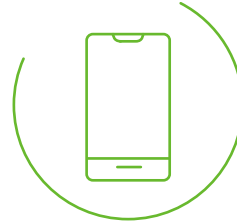
eSIM for: Smartphones

As the number of eSIM-enabled smartphones increases, operators are starting to take an "eSIM-first" approach and fully utilise the functionality of the eSIM. This is enabling operators to simplify customer onboarding and activation, leverage digital distribution channels to communicate personalised offers and rewards, and offer new services such as roaming. This is transforming the customer relationship and providing a competitive point of difference to attract and retain subscribers.

Importantly, this approach is increasing consumer awareness. This has previously posed a challenge, with GSMA reporting in 2021 that only 20% of consumers were aware of eSIM technology. (Source: GSMA) As the marketplace continues to advance, ongoing education and engagement will be integral to driving adoption.

eSIM for: Wearable devices

The market for wearable devices is seeing sustained growth, with shipments reaching record highs in the final quarter of 2021. (Source: IDC)

eSIM has played a key role in this growth, increasing wearable functionality by supporting more advanced designs and removing the need to tether a device to a smartphone, offering unlimited connectivity for standalone voice, text, browsing, music and payments services. For operators, it also allows customers to easily link together different devices and users under a single subscription plan.

Importantly – given that wearable devices collate, store and transmit exceptionally sensitive, high-value user data – the advanced security capabilities of eSIM technology ensure that data stored and transmitted is protected, and that the integrity of device software and firmware is not compromised. This is critical, as 88% of consumers claim trust is a key factor when choosing a wearable device.
(Source: IT World)

2

Enterprise

The impact of the pandemic has increased the complexity of enterprise device management. In 2021, 125 million more laptops and tablets were used as a result of home working. (Source: Gartner) Employees are also increasingly using their own devices for work purposes, known as bring your own device (BYOD). With the trend for remote and hybrid working here to stay (particularly for knowledge economy works where connected device usage is highest), eSIM-enabled smartphones, tablets, laptops and PC models simplify enterprise scale device provisioning, activation and management.

Beyond simplified management, eSIM-enabled devices offer always-on cellular connectivity to deliver secure, reliable network access wherever employees are in the world. This removes the need to connect to public Wi-Fi networks, for example, which has the potential to create significant security risks.

3

M2M and IoT

Market data shows eSIM shipment volumes in 2021 were driven by surging adoption across the automotive sector and various IoT verticals, with TCA members reporting a 38% increase in M2M eSIM shipments.

↑**38%**
increase in M2M
eSIM shipments

▼

eSIM for: Automotive

Regulation such as the European eCall initiative – which mandates all cars are equipped with emergency calling capability – has promoted high eSIM uptake across vehicle manufacturers and saw automotive emerge as the early leading use-case.

Beyond emergency calling, eSIM is already being utilised by vehicle manufacturers across the globe to overcome many common security and logistical challenges associated with connected car deployments.

eSIM delivers the advanced security functionality required by connected vehicles. And considering the average lifespan of a car on the road is nearly 12 years, the ability of eSIM technology to address remote software or firmware upgrades and OS patches to mitigate emerging security challenges and threats is crucial.

Also, increasingly advanced in-vehicle services and the rise of self-driving means the ultra-reliable, global connectivity delivered by eSIM is a critical success factor. eSIM also enables a 'build once, ship anywhere' commercial strategy for vehicle manufacturers, which increases efficiencies.

▼

eSIM for: Industrial IoT and Private Networks

5G private networks are increasingly being used as an alternative to public networks or Wi-Fi in settings such as industrial districts and campuses, where ultra-reliable connectivity, high security, superior performance and increased flexibility is paramount.

This is creating an opportunity for operators to dedicate part of the 5G public network to address market demand by leveraging the capabilities of the eSIM to maximise security, privacy and functionality across various industrial use-cases.

▼

eSIM for: Constrained IoT

A rapidly growing array of low-cost sensors are combining to form a vast and rapidly growing IoT ecosystem. These sensors are known as constrained devices, as they have limited bandwidth (network constrained) and / or have no or limited user interface (UI constrained).

These devices, coupled with the transformative impact of big data, are enabling digital transformation across nearly all industry verticals. Sectors such as utilities, healthcare, agriculture, and manufacturing are now harnessing the power of the IoT to drive sustainability by optimising the use of resources (in agriculture, for example) and simplifying complex supply chains.

Accelerating eSIM adoption through standardisation

Industry standards offer significant benefits to technology ecosystems. A key benefit of eSIM technology is that it is supported by an advanced, mature infrastructure that promotes interoperability and security.

Standardisation activity for eSIM has been led by GSMA, the global industry association. Namely, GSMA created the Remote SIM Provisioning Specifications. These are:

• **GSMA eSIM Solution for Consumer Devices** – addresses smartphones and other consumer devices where the end-user activates the profile or switches operator.

• **GSMA eSIM Solution for M2M** – addresses devices where profiles are managed remotely.

GSMA eSIM Security Certifications and Compliance

The Consumer and M2M specifications are supported by GSMA eSIM Security Certification and Compliance Processes. These comprehensive, well-established certification and compliance schemes require that eSIM solutions are subjected to thorough assessment and testing to ensure they are just as secure and interoperable as traditional SIM. This promotes confidence for operators, device manufacturers and service providers.

At a high-level, the Compliance Process comprises of the following components[1]:

[1]*It should be noted that there are separate compliance processes for Consumer and M2M – with separate documentation – to reflect technical differences across the specifications.*

15

eSIM Products

The GSMA eUICC Security Assurance (eSA) scheme was introduced to "expedite the eUICC security certification process, overcome complexities and reduce time to market for eSIM products." (Source: GSMA) It provides a dynamic set of procedures for the security evaluation of eUICC solutions against the Protection Profile defined by GSMA[2]. The scheme is based on the Common Criteria methodology and is aligned with ISO standards. Put simply, this means penetration testing is performed on both the hardware and software to ensure it is secure-by-design and can withstand known threats.

The security certification process also assesses the security of the production site of the eSIM. This is known as the GSMA Security Accreditation Scheme for UICC Production (SAS-UP).

Functional compliance testing also ensures that products will perform as expected and are interoperable. The test plans and certification programmes for this process are managed by GlobalPlatform.

eSIM SM Platforms

This process assesses the security of the operational sites for eSIM SM servers, known as the GSMA Security Accreditation Scheme for Subscription Management (SAS-SM). Functional testing also ensures that Remote SIM Provisioning is performed correctly for reliability and interoperability.

Devices (Consumer Only)

eSIM capable devices must also be assessed to ensure functionality and interoperability.[3] The test plans and certification programmes for this process are managed by the Global Certification Forum (GCF) and PTCRB on behalf of GSMA.

Once a product or service has met the compliance requirements, it is eligible to receive an eSIM Public Key Infrastructure (PKI) Digital Certificate. This demonstrates it can be trusted by ecosystem stakeholders.

[2]A Protection Profile is a minimal, baseline set of requirements targeted at mitigating well defined and described threats.
[3]It should be noted there is no security certification process for devices.

16

Compliance Overview – M2M ▼
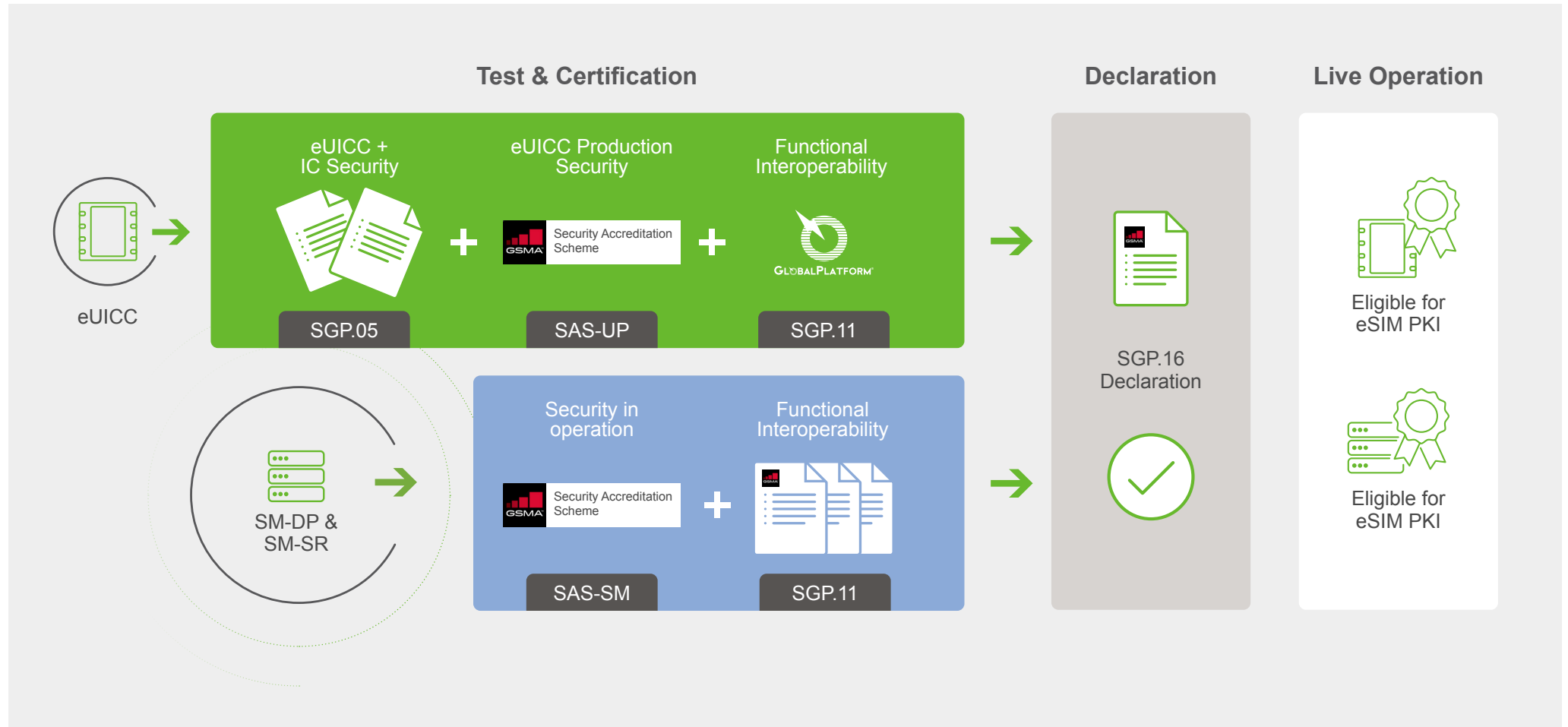
Compliance Overview – Consumer ▼

Test & Certification

eUICC

eUICC + IC Security — SGP.25
+
eUICC Production Security — Security Accreditation Scheme (SAS-UP)
+
Functional Interoperability — GLOBALPLATFORM — SGP.23

SM-DP & SM-SR

SM Operational Security — Security Accreditation Scheme (SAS-SM)
+
Functional + Interoperable — SGP.23

Device

Functional + Interoperable — GCF Test Certify Connect — PTCRB — SGP.23

Declaration

SGP.24 Declaration

GSMA ✓

Live Operation

Eligible for eSIM PKI

Eligible for eSIM PKI

Functional + interoperable

18

Conclusion: Advancing eSIM Technology

In an increasingly digital world, eSIM holds the power to cut through complexity and promote simplified global connectivity and advanced security.

The many benefits of eSIM are already being realised, and the continuing evolution of eSIM technology will support new and emerging use cases. As TCA members work collaboratively to facilitate and deploy specifications developed to promote interoperable, secure, and consistent eSIM deployments, eSIM technology will fulfil its transformative potential.

Expanding eSIM benefits to IoT use-cases

As the IoT ecosystem grows to encompass new verticals and use-cases, there are an increasing number of IoT devices deployed that have limited bandwidth and/or have no or limited user interface (UI).

The rapidly growing deployment of network constrained and UI constrained devices across the IoT ecosystem presents significant challenges as they cannot be optimally managed using the existing GSMA Consumer and M2M Specifications.

The industry recognised that enhancing the eSIM infrastructure to meet these specific IoT requirements will be crucial. TCA's IoT Remote SIM Provisioning Working Group is playing a leading role shaping the development of a dedicated GSMA Remote SIM Provisioning Specification for IoT, which is expected to be finalised by the end of 2022.

Promoting eSIM interoperability
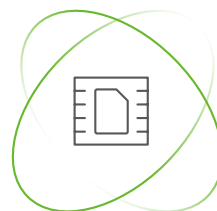
The benefits of eSIM technology can only be realised if operator profiles can be easily loaded and managed.

TCA's eUICC Profile Package: Interoperable Format Technical Specification is used in every eSIM deployed in the field. The specification standardises the format of the profile being downloaded for remote loading of subscriptions onto eSIMs across deployed devices. It also enables operators to load interoperable connectivity profiles in an eSIM, regardless of the SIM vendor.

To ensure continued interoperability as the number of network constrained devices increases, TCA's eSIM Working Group is developing a minimum 'lightweight' profile that makes it possible to provision a profile – even when bandwidth is very limited.

Combining the potential of 5G with eSIM

Looking ahead, the benefits of eSIM technology look set to be amplified by the accelerating rollout of 5G networks.

The 'Recommended 5G SIM' – which includes eSIM – defines the optimum technical capabilities that promote the highest levels of security, privacy, and functionality in 5G networks to maximise operator investments and support emerging 5G use-cases. TCA reported substantial increases in 5G SIM shipments in 2021, building on advances made in 2020, which marked the first year of widespread 5G SIM deployments.

About Trusted Connectivity Alliance

Trusted Connectivity Alliance (TCA) is a global, non-profit industry association working to enable trust in a connected future. The organisation's vision is to drive the sustained growth of a connected society through trusted connectivity which protects assets, end user privacy and networks.

TCA members are leaders within the global Tamper Resistant Element (TRE) ecosystem, and work collectively to define requirements and provide deliverables of a strategic, technical and marketing nature. This enables all stakeholders in our connected society to benefit from the most stringent secure connectivity solutions that leverage TCA members' expertise in tamper proof end-to-end-security.

Trusted Connectivity Alliance is the definitive source for global shipments. Members participate in an annual shipments market monitoring process, which provides an exclusive and statistical view of the global SIM ecosystem based on members' shipment data. A full breakdown of the data collected is available via an annual subscription. For more information, contact info@trustedconnectivityalliance.org.

TCA members:

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