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A Single SIM for Global IoT Deployments

A guide to **eSIM**, **iSIM** and **multi-IMSI technologies**
and how **Remote SIM Provisioning** delivers
the flexibility and scalability for multi-national
IoT deployments.

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Operating any business at scale is always challenging especially when operating in multiple countries with different business, technology and regulatory landscapes. IoT is no different even when using well proven, globally available and interoperable cellular networks.

Cellular IoT has a range of technologies (bearers) designed to support a range of different applications ranging from those requiring long battery life to others with high speed, ultra- low latency requirements. Choosing between those technologies and mapping network availability is an important decision which is sometimes made complex by the national carriers.

While cellular networks are available globally, they are owned and operated by different carriers in each country. These carriers (or MNOs - Mobile Network Operators) are commercial businesses operating in a competitive landscape and are sometimes purely nationally focussed. Business economics, national security and competitive pressure mean that MNO's don't always make it easy or free to deploy devices onto their networks and this creates complexity and cost for OEMs, Solution Providers and large Enterprise who operate internationally if not globally.

IoT device OEMs, Solution Providers and Enterprises would rather:

Deploy globally with a single connectivity provider and not worry about striking deals with local mobile network operators (MNO) in each country

Have consistent network behaviour and experience irrespective of where they deploy their devices

Have control over which network each of their devices use and have the ability to avoid lower quality or more expensive networks.

Operate globally with a single SIM and single device SKU to keep manufacturing, deployment costs and process overheads as low as possible

This is what Conexa delivers. Conexa is a highly flexible and secure planet scale network which was designed for IoT and to provide an enterprise-grade, software defined user experience.

The evolution of the SIM

The primary role of a SIM is to identify the subscriber (or device) and to store credentials (pre-shared keys or PSK) used during the mobile network authentication process.

This remains true today but while the SIM has shrunk in physical size, it plays an increasingly valuable role in helping Enterprises :

> *Optimise international IoT deployments*

> *Reduce the total cost of ownership in IoT*

> *Navigate network quality, commercial and regulatory changes over time*

> *Be the root of trust and secure network identity*

Implementing that software defined solution with eSIM and iSIM can be complex for most Enterprises. Wireless Logic absorb most of the complexity and provide a range of services including hardware recommendations and testing to ensure RSP standards compliance and the sourcing, deployment and management of virtual SIM profiles and IMSI's.

In this guide we will explain the terminology and functionality of the technology and how Enterprises can leverage Conexa to optimise and future-proof their multi-national IoT deployments.

From SIM card to Software Defined

SIM cards have served us well especially roaming SIMs but the need to miniaturise, stay flexible and future-proof and increase security means reprogrammable chip SIMs (eSIM) or integrated SIMs (iSIMs) are increasingly sought after.

Remote SIM Provisioning

The key to success with eSIM and iSIM is the software infrastructure around them. This includes on-SIM software such as SIM operating systems (SIM OS), on-SIM applets and network functions to store, deploy SIM profiles and manage on-SIM applets.

Wireless Logic implements all three GSMA RSP standards - SGP.02, SGP.22, and SGP.32.

A much needed glossary

The terminology around SIMs worked well when used to describe **physical SIM sizes and form factors**. For example…

SIM
Subscriber Identity Module. This contains the credentials for accessing a particular mobile network. These credentials include the IMSI.

FF
Form Factor. This is sometimes used to refer to the size and/or form of the SIM. For example, SIM cards are available in 2FF (mini), 3FF (Micro) and 4FF (nano) form factors.

UICC
Universal Integrated Circuit Card. This is the smart card that houses the SIM, plus other data and credentials needed to access mobile networks.
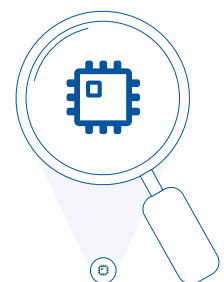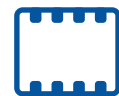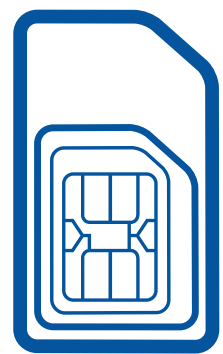
eUICC
Embedded UICC. The word embedded was added to reflect the introduction of a chip format as well as the on-SIM software which made it capable of supporting multiple network profiles and being provisioned remotely. *See next section of glossary.*

Embedded SIM (eSIM)
A chip SIM (MFF2 form factor) which adds physical security and reliability benefits over SIM cards. Since an embedded SIM is soldered onto the internal circuit boards it is difficult to remove and requires remote over-the-air provisioning.

Integrated SIM (iSIM)
iSIM is a new technology that enables the functionality of an eSIM to be integrated into the cellular communications module or another processing element within a device. The approach is more secure, saves space and will enable higher performance and functionality to be integrated into the SIM.

The terms eSIM and eUICC originally had different meanings but over time the market used them interchangeably and in a confusing way.

Wireless Logic uses the term eSIM to mean a reprogrammable (eUICC) SIM. When talking about a physical chip SIM form-factor we say Embedded SIM.

A Single SIM for Global IoT Deployments

A much needed glossary *continued...*

Current and future generations of SIMs are better classified in terms of **software functionality and remote SIM provisioning**. This creates a more useful glossary of terms as it describes the capability more clearly.

SIM OS
A SIM Operating System enables software applications to run on the SIM card. For example an applet which supports over-the-air profile updates on the SIM card.

SIM Applet
SIM applets are small programs which run on the SIM OS inside the SIM. SIM applets provide a way to control the SIM and build features independent from the standard carrier offerings. Both the SIM OS and applets are developed in Java Card which is a subset of the Java programming language.

SIM Profile
A SIM Profile is set of parameters, including an IMSI and authentication key, that allows devices to authenticate against and gain access to a cellular network.

IMSI
International Mobile Subscriber Identity. This is the number that uniquely identifies a 'user' of a mobile network and is allocated and installed on SIMs by MNOs or MVNOs.

Single-IMSI
SIM profiles containing a single IMSI are referred to as single-IMSI profiles or SIMs.

Multi-IMSI
SIM profiles containing multiple IMSIs are referred to as multi-IMSI profiles or SIMs. IMSI selection is performed by a SIM applet and pre-configured on-SIM rules. The rules can be updated over-the-air.

eSIM or iSIM
Both eSIMs (chip or card formats) and iSIMs can be reprogrammed over-the-air. Remote SIM provisioning enables SIM profiles to be added, deleted or switched.

uSIM
uSIM is not a well used term but it is sometimes useful to discriminate between re-programmable (eSIM, iSIM) and non-reprogrammable SIMs (uSIM).

RSP
Remote SIM Provisioning. The entire process of managing, delivering and changing network profiles on an eSIM or iSIM; or managing SIM applets and IMSIs.

OTA
Over The Air. This just means without physical handling and can be used to refer to any kind of wireless transmission.

MNO
Mobile Network Operator. A provider of wireless communications services that has its own network infrastructure.

MVNO
Mobile Virtual Network Operator. A provider of wireless communications services that doesn't have its own radio network infrastructure. Instead it partners with MNOs for radio network access. All references to MNOs in this guide include MVNOs.

Challenges with traditional Roaming SIMs

Using local SIMs from different MNOs is one approach but of course that means significant overhead in contracting, sourcing, installation and life-cycle management. In other words, the total cost of ownership is higher.

Roaming SIMs, including global roaming SIMs were a good solution for a number of years and were the primary solution for global deployments. **Enterprises would select a large carrier in their 'home' country and leverage their international roaming partnerships to get rest of world connectivity.**

This approach has always had some downsides, most notably, the fact that only one network was available in the 'home' country. Those downsides are growing in number however.

➤ Roaming agreements on new cellular technologies like LPWAN and 5G less well established

➤ No say in which networks your devices roam onto in different countries

➤ Roaming access fees or roaming restrictions are becoming more common

➤ Many nations, regions, or sectors have Data Sovereignty requirements.

The downsides of traditional carrier solutions can be resolved by using SIMs with built in redundancy, flexibility and can be reprogrammed over-the-air.

This means eSIM, iSIM and multi-IMSI but which is best?

Introducing
eSIM, iSIM & multi-IMSI

In recent years, eSIM and iSIM technology has emerged and resolves many of the challenges described on the previous page.

The difference between eSIM and iSIM is only in form factor (see *glossary*), they both benefit from remote SIM provisioning which is the GSMA standard that allows the network-based loading and activating of SIM profiles. This removes the need to swap physical SIM cards as well as optimizing multi-national deployments, reducing the total cost of ownership and enabling Enterprises to navigate network quality, commercial and regulatory changes over time.

> *Wireless Logic services include sourcing, deployment and management of eSIM and iSIM profiles making it more accessible and easier to adopt than most other connectivity providers.*

eSIM is not perfect however. Although multiple SIM profiles can be stored, only one can be active at any one time and switching or loading a new profile requires a network interaction which may not always be possible in the moment of need. This is where **multi-IMSI SIMs** can help. With multi-IMSI, the SIM comes pre-loaded with a range of IMSIs and the management function required to select or switch IMSIs. This means a multi-IMSI SIM can operate more autonomously from the network.

To get a better picture, it is worth building it up starting with single-IMSI SIM and stepping through to a Conexa solution which combines multi-IMSI and eSIM.

What is an IMSI number?

IMSI stands for *International Mobile Subscriber Identity* and uniquely identifies a cellular user.

The first 6 digits of the IMSI number represent the MCC (Mobile Country Code) and MNC (Mobile Network Code).

The MCC + MNC combination helps any network quickly identify which home network you belong to. The remaining digits in the IMSI uniquely identify the user or device.

A Single SIM for Global IoT Deployments

Introducing **eSIM**, **iSIM** and **multi-IMSI** *continued...*

Single-IMSI SIM

MNOs typically provide single IMSI SIMs with a single subscription profile which

> *Is identified by the IMSI number*

> *Has one set of network keys*

> *Has a fixed set of roaming networks*

This approach is fine for local/national deployments unless quality issues (outages), regulatory (roaming charges or restrictions) or commercial issues arise.

For multi-national deployments, a different SIM SKU would be required in each country or a global roaming SIM could be used but with some significant restrictions.

Multiple single-IMSI (local) SIM SKUs

- Sourcing, manufacturing, deployment overheads
- Multiple MNO network integrations
- Variable network performance and control

Global Roaming single-IMSI SIM

- Lack of resilience on 'home' network
- Network Steering with limited choice
- Higher Latency

Multi-IMSI SIM

A multi-IMSI SIM profile can store multiple IMSIs. An on-SIM management applet will select which IMSI is used based on device location or network conditions. Multi-IMSI provides a fallback option.

The IMSI switching logic is local to the SIM which means the SIM does not need to talk to the connectivity provider's backend to determine which IMSI to use.

This makes it an excellent solution local deployments where flexibility is required to create choice or optimise connectivity over time if quality, regulatory or commercial issues arise.

Likewise for global deployments when devices move between countries, or when OEMs manufacture devices in one location and deploy into multiple markets.

SIM

SIM Profile

IMSI

Network Key

Multi-IMSI Management Applet

Introducing **eSIM**, **iSIM** and **multi-IMSI** *continued...*

eSIM and iSIM (with single or multi-IMSI profiles)

eSIM and iSIM can store multiple SIM profiles and these can be updated over-the-air. These profiles can be single-IMSI or multi-IMSI profiles.

While multi-IMSI offers a degree of flexibility and resilience, the ability to update (add, switch, delete) SIM profiles on eSIM and iSIM over-the-air extends these benefits to a higher level albeit, software infrastructure and operator relationships are required to make it work in practice. Wireless Logic services handle all of this complexity on behalf of Enterprise users which won't always be true of other connectivity service providers and MVNOs.

SIM   SIM Profile   IMSI   Network Key   Multi-IMSI Management Applet

Conexa SIM provides the best of both worlds

The Conexa SIM combines **multi-IMSI** and **eSIM**, **iSIM technology** to create an Enterprise grade, software defined user experience for multi-national IoT deployments. It can be deployed on SIM cards, eSIM and iSIM form factors.

Multi-IMSI SIMs expand coverage and resilience

> Multiple pre-loaded IMSIs designed to maximise coverage and create redundancy

> Network selection is automated by the multi-IMSI applet using pre-defined policies

> IMSIs and network selection policies can be updated over-the-air

eSIM and iSIM provide insurance against quality and regulatory constraints

> Switch carrier network if quality or commercial conditions deteriorate

> Switch to local carrier network to comply with local regulations if needed

> Over-the-air eSIM profile updates can be performed manuallly or automated

Selecting the right connectivity solution for multi-national deployments

The table summarises the relative strengths of the different SIM types for multi-national IoT deployments.

The **Conexa SIM** combines multi-IMSI and eSIM technology to create an Enterprise grade, software defined user experience for multi-national IoT deployments. It can be deployed on SIM cards, eSIM and iSIM form factors.

	Local SIMs	Roaming SIM	eSIM	Multi-IMSI	Conexa
Single SKU	✕	✓	✓	✓	✓
Single Management UI, API	✕	✓	◐	✓	✓
Single Connectivity Service Provider	✕	✓	◐	✓	✓
Single Mobile Core Network	✕	◐	◐	✓	✓
Low Latency (Local POPs)	✓	✕	✓	✓	✓
Adapt to Roaming Regulations	✓	◐	✓	◐	✓
Future Proof	✕	✕	✓	◐	✓
Free from Service Provider Lock In	✕	✕	◐	◐	✓
'Local Rates'	✓	✕	✓	✓	✓
Bearer Compatibility	✓	◐	✕	✓	✓
Total Cost of Ownership	✕	✕	◐	✓	✓

Talk to us now or read on

Contact us today for a free consultation on eSIM, iSIM and multi-IMSI or read on for greater insight on the Conexa SIM and how it serves as a single SIM for Global IoT Deployments.

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Conexa SIM - multi-IMSI
How it works

5 *Multi-IMSI Management applet*

1

SIM Profile with multiple IMSIs

2

MNO1

MNOx

3

conexa
the network for **things**

Mobile Core

Remote SIM Provisioning (RSP)

4

Cloud or Enterprise

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1 A multi-IMSI SIM can host multiple IMSIs each with their own list of network roaming options. The on-SIM management applet will decide which IMSI is used.

2 Each time a device (cellular module) completes a network scan, it will provide a set of parameters to the on-SIM management applet for IMSI selection.

3 The management applet selects the appropriate IMSI based on pre-defined business rules and then proceeds to connect to network.

4 Network connections are made via the Conexa core network.

5 The multi-IMSI business rules stored in the on-SIM management applet can be updated OTA after deployment.

Conexa SIM - eSIM
How it works

MNO1

MNOx

conexa
the network for **things**

Mobile Core

*Remote SIM
Provisioning (RSP)*

Enterprise Users

Business Rules

*Automated rules can be
setup in advance of deployment
or implemented later in the
eSIM lifetime*

1 eSIMs and iSIMs can host multiple SIM profiles. The Initial connection is established using the bootstrap (initial) profile credentials.

2 When connected the subscription manager will manage any profile updates according to automated rules setup in advance of deployment or implemented later in the eSIM lifetime.

3 If required, the subscription manager pushes* a new eSIM profile. The eSIM will store this new (operational) profile and when commanded by the Subscription Manager switch to the new profile.

4 The device can now connect to the new network.

5 Profile changes can be re-initiated if network or business conditions change or if user/location context changes. The eSIM could 'fall-back' to the bootstrap profile or adopt another new profile, depending on coverage and policy.

* This is a description of the SGP.02 M2M standard. The Consumer (SGP.22) and new IoT standard (SGP.32) use a pull model and the subscription manager is implemented differently.

A Single SIM for Global IoT Deployments

Life-cycle management
with Conexa SIM

The factory-to-field life-cycle of a Conexa SIM can be fully managed at each stage using the flexibility of multi-IMSI or eSIM profile downloads, switch or fallback options. This includes the ability to resolve commercial or regulatory challenges if they arise during the SIM lifetime.

Factory

End of line testing requires a small amount of local network data at factory site to validate design and hardware functionality.

Solution Test

Device or solution integration and test might be performed in a different location and have specific data requirements and timescales.

conexa

Mobile Core

Remote SIM Provisioning (RSP)

Deploy

Device or solution is shipped to customers or resellers in target geographic markets with the required tariffs.

Coverage and Quality

A multi-IMSI profile provides resilience and expanded coverage options if quality becomes an issue over time.

Commercial

Use multi-IMSI or eSIM to optimise costs. Change IMSI selection rules on SIM or download and switch to new eSIM profile

Regulatory

Some countries/networks have regulatory controls around data sovereignty or block permanent roaming. Download and switch to new eSIM profile.

Redeploy

Devices might be redeployed into a new market or to new owners. Revert to original (bootstrap) profile/IMSI or download and switch to new eSIM profile.

A Single SIM for Global IoT Deployments

Remote SIM Provisioning for eSIM and iSIM – 3 Standards

In July 2023, the GSMA published a new Remote SIM Provisioning standard which means there are three RSP standards in total.

> **SGP.02** is the M2M standard designed for remote devices with no user interface. Profiles are **pushed** from the Service Provider platform direct to the device. This transaction can be manual or initiated by rules-based automation or via API calls.

> **SGP.22** is the Consumer standard designed for devices with a user interface including automotive, smart phones and smart watches. Profiles can be pre-provisioned on devices or **pulled** down and activated via UI or using a QR-code based process.

> **SGP.32** is the IoT standard which converges the M2M and Consumer versions to create a single industry approach for IoT. Like the Consumer standard it is a **pull** model with more intelligence in the SIM or Device. System integrations are simpler and in theory, it allows devices/users to download a profile from any MNO/MVNO.

Wireless Logic implements all three RSP standards and can also deploy single- or multi-IMSI profiles for maximum benefit.

Which approach is right for you will depend on your application, deployment footprint and other business requirements. Wireless Logic will guide you through these thought processes including...

> eSIM or iSIM form-factor?

> Which RSP standard to use and how multi-IMSI can compliment?

> Hardware recommendations – SIM type, Cellular Module and Device capability

> Testing and guidance through certification processes

> Sourcing, deployment and life-cycle management

Why use Wireless Logic
for **Remote SIM Provisioning**...

A Single SIM for Global IoT Deployments
Access to a comprehensive eSIM portfolio built on deep relationships with >50 global MNOs and >150 direct roaming agreements.

Flexible Solutions
We build flexible solutions using advanced multi-IMSI technology and/or M2M, Consumer and IoT Remote SIM Provisioning standards.

Connectivity Management
We provide a single CMP interface (portal/API) to automate management of hybrid SIM fleets.

Remote SIM Provisioning Expertise
Trusted by >20K customers to help design, deploy and manage eSIM based products.

Secure and Resilient
GSMA compliant private infrastructure, transmitting data reliably from device to end-point.

Contact us today...
to talk to an expert or request a starter kit

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