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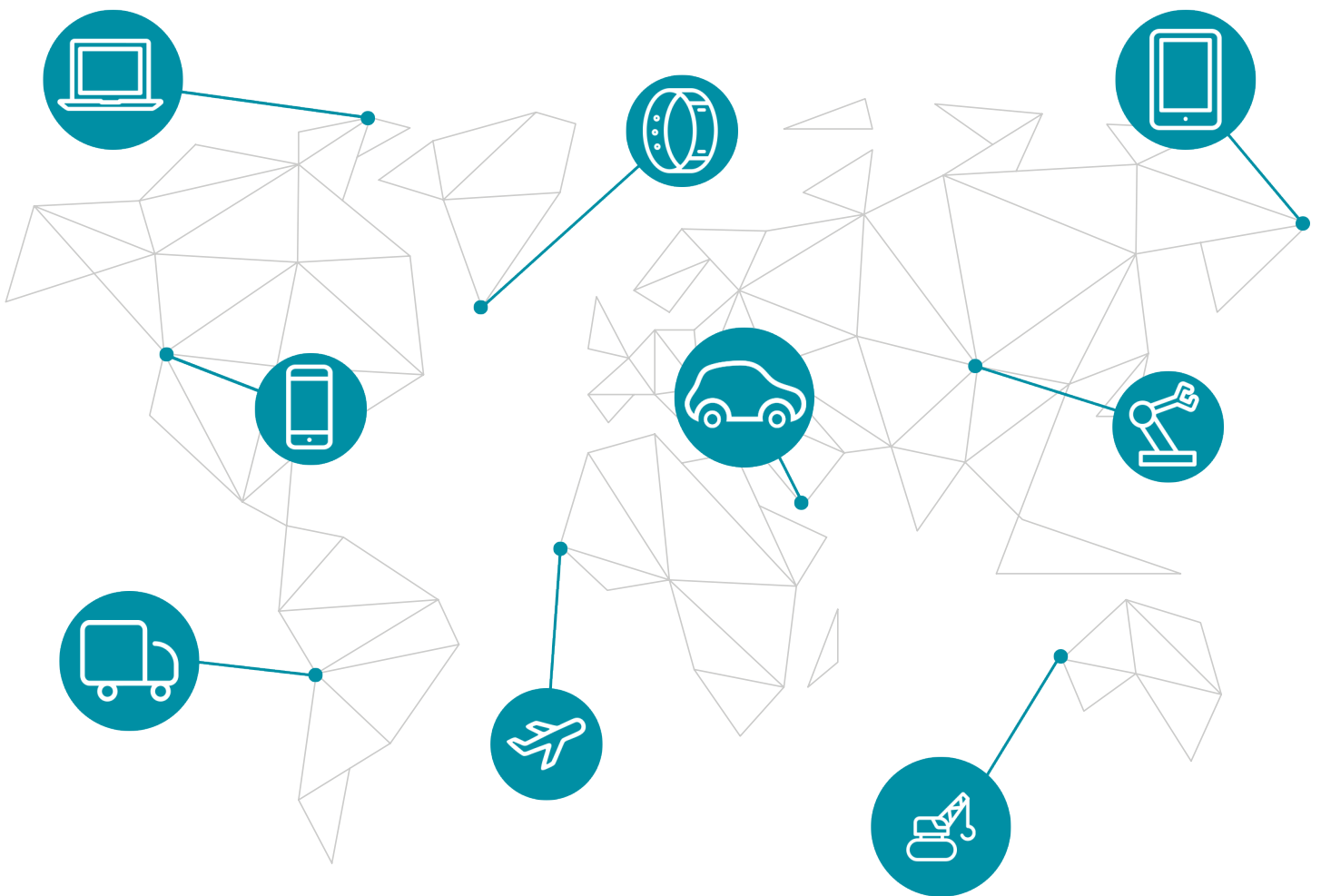**An NTT Company**

CONNECTING VEHICLES: RISKS & SOLUTIONS

Why are car OEMs moving to become telcos?
What are the benefits with an MVNO model?

Who should read this white paper?

This whitepaper is aimed at an audience who already has a basic understanding of the connected vehicle ecosystem.

Executive Summary

For car manufacturers, gaining full control over the connectivity solution embedded in their vehicles is a strategic opportunity. It enables car manufacturers to unleash innovation and maximize the potential of connected services, as well as the income these services will generate.

To best achieve this goal, vehicle manufacturers must adopt a mobile virtual operator approach. To do so, they have the option to either develop it on their own, or to partner with companies who can help them build an optimized and scalable connectivity solution.

The mobile virtual operator approach is the new paradigm: it's the tried and tested approach to successfully deploying connectivity services.

Key Question

Who controls the connectivity?

This is the key issue for the connected vehicle ecosystem. As new mobility models emerge *(intelligent cars, car sharing, autonomous driving, etc.)*, the main differentiation factors on the market will be the connected experience and the service applications provided to customers.

Today, vehicle manufacturers are caught between GAFAM, who provide the digital services, and the mobile operators delivering the connectivity. Players on both sides seek to extract maximum value from the connected car services, leaving the car manufacturers dry. Car manufacturers are left with only one secure option: to become mobile operators themselves, thus avoiding letting other players control the vehicles' connectivity on their behalf.

The MVNO approach is the solution to adopt to avoid the following issues:

- Operator lock-in situations,
- Multiple and complex integrations,
- Lack of flexibility and agility,
- Security issues.

I. THE ISSUES WITH A TRADITIONAL 'MULTI-OPERATOR' APPROACH

Typically, vehicle manufacturers try to achieve global coverage by entering into **service agreements** with several large mobile operators for different regions, e.g. Vodafone for Europe, Telefonica for South America, AT&T for North America, China Unicom for Asia, etc. This means that they are fully delegating the management of their cars' connectivity to third parties. This 'multi-operator' approach generates many issues.

Telecom vs. vehicle lifecycles

The average lifetime of a vehicle is about 10 to 15 years. Cellular technology lifecycles are much shorter: a new generation appears every 5 to 10 years. Furthermore, airtime prices *(connectivity costs)*, as well as the quality of service provided by operators, can undergo even faster changes. Thus, an embedded connectivity solution must be able to evolve over a vehicle's lifetime to ensure optimal activity.

2G	2.5G GPRS	3G	3.5G HSDPA	4G	5G

1990   2000   2010   2020

Average vehicle lifetime *(15 years)*
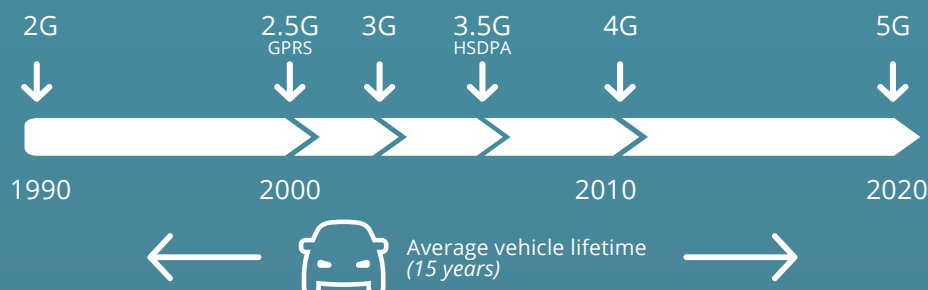
Connected services are booming!

The car ecosystem is increasingly integrating connected services
and applications for all types of uses.

Vehicle-Centric Services

- Firmware update OTA
- Predictive maintenance
- Stolen Vehicle Tracking
- Fleet management
- Remote control & car sharing
- eCall & bCall
- Autonomous driving
- ...

Passenger-Centric Services

- Smart navigation
- Usage Based Insurance
- Smart parking services
- Infotainment (video&music streaming)
- Wi-Fi hotspot (On/Off board)
- Conciergerie services
- In-car purchasing services (highway tolls, parking, gasoline, etc...)
- Personalized in-car advertising
- ...

Vehicle Manufacturers-Centric Services

- Live information for continuous design and manufacturing improvements
- Environmental data for public road services
- Customer data analytics
- ...
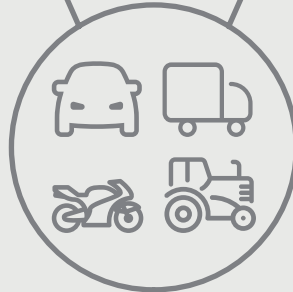
Issue #1: Provider lock-in

Car manufacturers must benefit from high-quality connectivity over time and make sure that they're paying the right price for this connectivity during the entire lifetime of the vehicle. If local network partners alter their quality or rates with time, car manufacturers must always be in a position to ask them to fulfil their commitments. This, of course, is only possible if car manufacturers can easily replace these network partners with a competitor. Unfortunately, this is often where a misconception arises about eSIM capabilities.

Focus on a dangerous misconception:
"I can easily switch operators thanks to a reprogrammable eSIM (supporting the eUICC standard)"
This is a false statement. eUICC was originally designed to facilitate unitary onboarding of vehicles equipped with eSIM upon delivery to their target market. However, it was not designed to efficiently support a massive migration process. Swapping operators with an eSIM is still a painful process:

1. Two additional integrations will have to be conducted: one with the IT system and core network of the new operator, and another one with the SIM vendor's subscription management platform.

2. The new operator profile will need to be uploaded onto the eSIM via a costly over-the-air campaign. Unfortunately, this operation will be impossible for certain vehicles, such as those located in an area with no coverage. Car owners will then have to return to the dealership for a local update, and this will increase the overall cost of the project.

As a result, the *"multiple-operator approach"* places manufacturers in lock-in situations by depriving them of bargaining power with connectivity providers. This has a potentially negative impact on the manufacturers' connected services, in terms of quality of service as well as profitability.

Issue #2: Multiple complex integrations

The first step in setting up the connectivity is to connect the car manufacturer's servers to the mobile operator's platform. It's a project with two levels of complexity:

1. CONNECTIVITY - The implementation of the connectivity itself is complex.
    To cover various regions, it's necessary to interconnect with several large mobile operators: it's a long, painful and costly project every time. Since each operator's platform is based on a different architecture, you can't benefit from economies of scale: each integration is like a brand-new project.

2. SERVICES - On the other hand, the implementation of the services is more difficult in a heterogeneous environment, as services and telecom systems are tightly linked.

Consequently, the traditional *"multi-operator approach"* significantly increases cost and project lead-time before the first connected services can be launched in each additional country.

Complex integration with a *"traditional, multi-operator"* approach
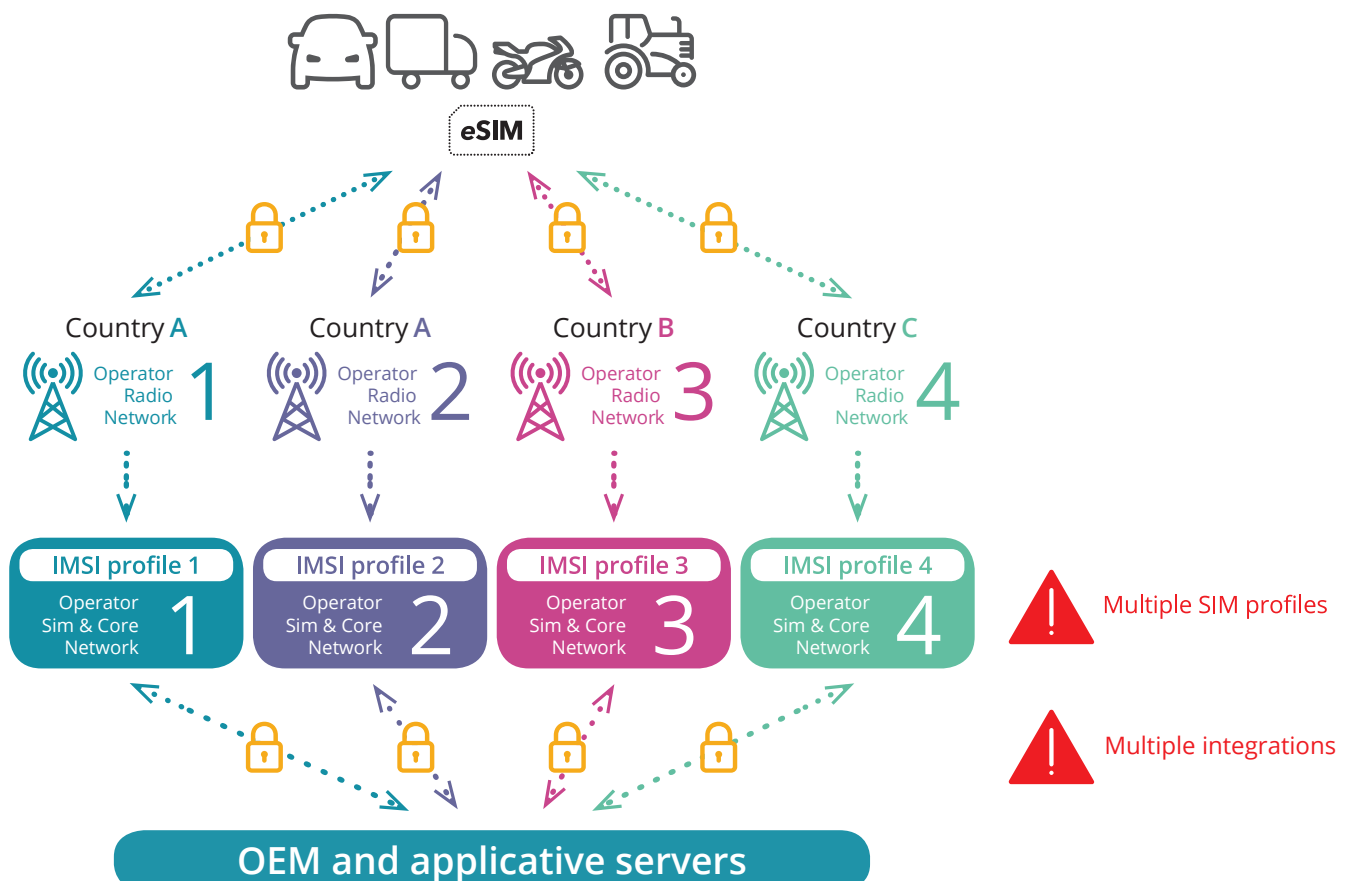
Issue #3: Lack of flexibility and agility

Just as with the smartphone ecosystem, more and more application services will continue to appear for connected vehicles. Unfortunately, the *"traditional, multi-operator"* approach penalizes the launch of new services.

Complex deployment

Every service needs to be developed on each operator's platform, which makes any new service launch both costly and painful.

Poor level of service customization

Major mobile operators lack agility and flexibility with their platforms and technical solutions because they're concentrated on a mass-market approach, and the IoT, for them, remains a side business. They essentially provide off-the-shelf services, leaving little room for personalization and adjustments.

Heterogenous customer experience across the globe

Each mobile operator has its own platform and service environment. The new services deployed will necessarily be different from one region to another. Large operators' absence of flexibility and agility hinders innovation and the launch of new services. This potentially affects the car manufacturers' ability to differentiate in the automotive market.

The *"traditional, multi-operator approach"* provides
a heterogenous customer experience
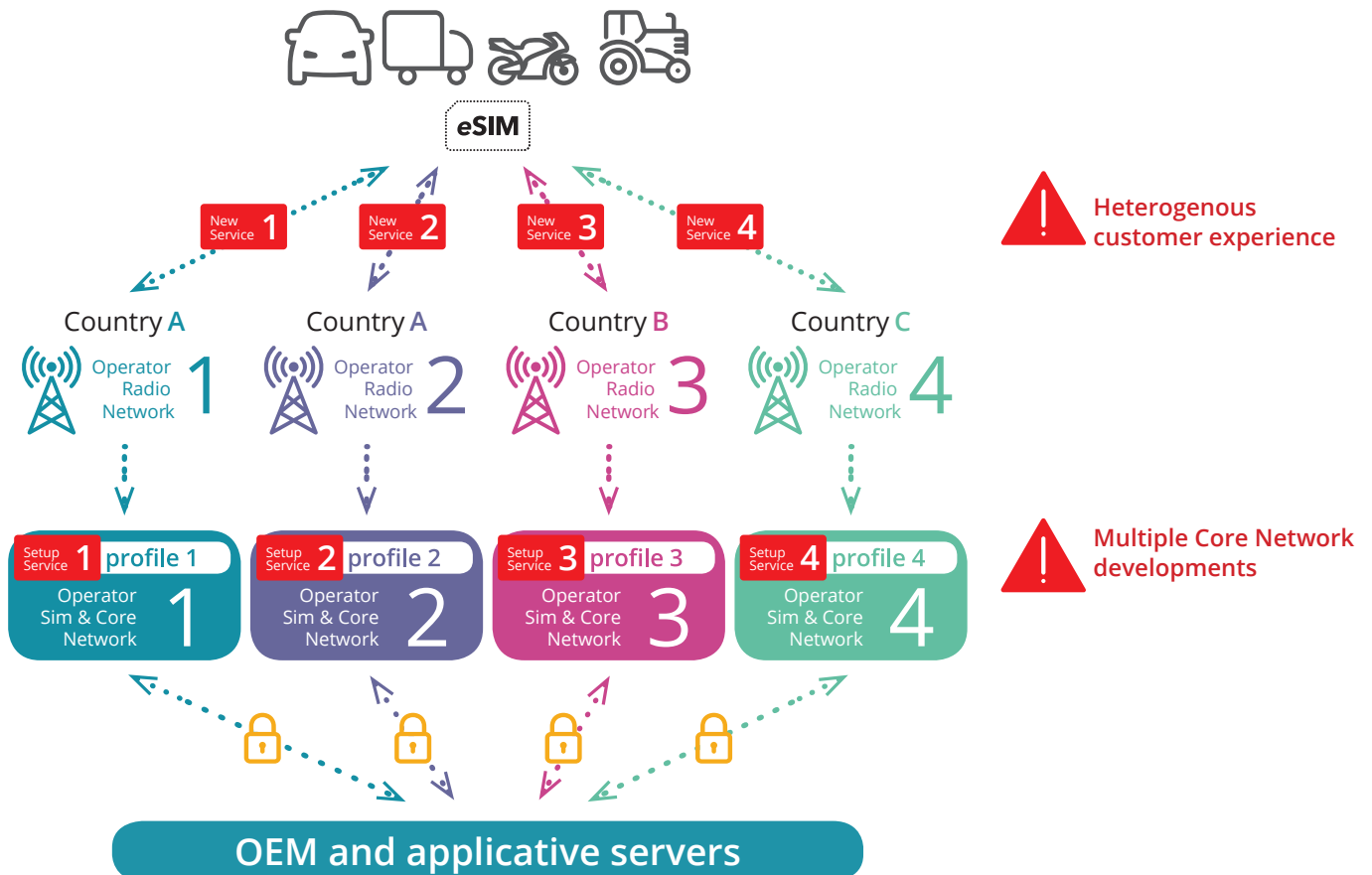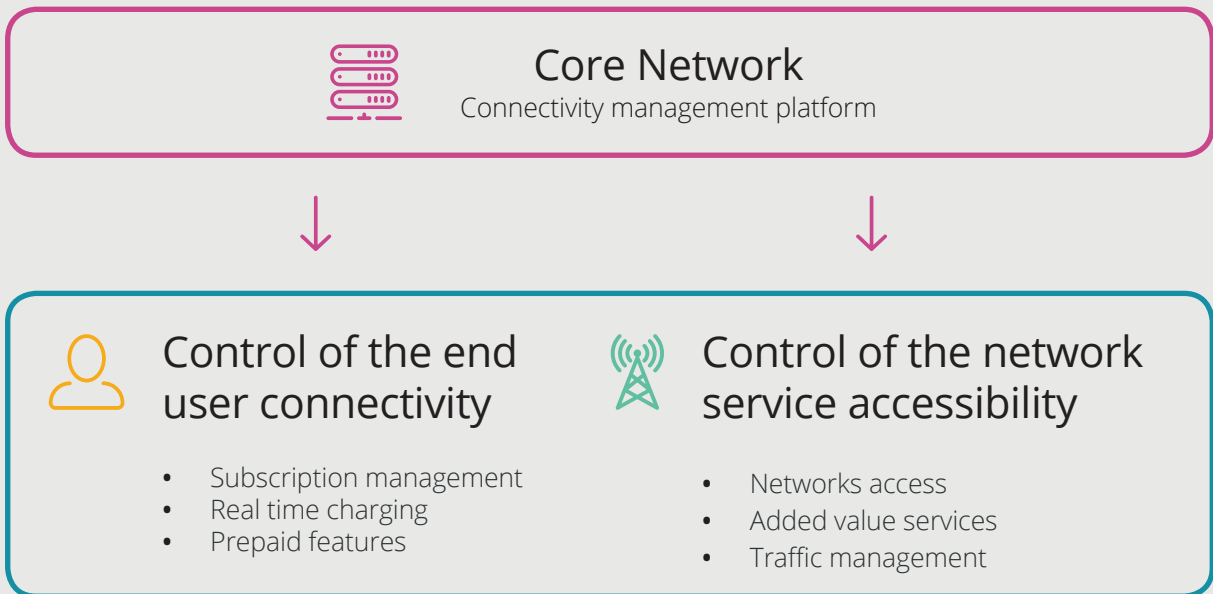
Issue #4: Security

One last and key issue associated with a *"traditional, multi-operator approach"* is the potential inability to secure end-to-end traffic from the core network to the manufacturer's platform.

Every connectivity provider must be able to segregate data traffic into several streams and to manage the level of security assigned to each. A single SIM card can enable very sensitive data transfers such as Over-The-Air Software/Firmware updates, while enabling access to the public internet with lesser degree of security, for services such as Wi-Fi on board.

In a *"traditional, multi-operator approach"*, the vehicle manufacturer needs to ensure that each mobile operator with which it interconnects has the capability to provide the required level of security for Over-The-Air Software/Firmware updates.

The Core Network's role

The core network is a key component of a mobile operator's infrastructure that manages many services.

Core Network
Connectivity management platform

↓   ↓

Control of the end user connectivity

- Subscription management
- Real time charging
- Prepaid features

Control of the network service accessibility

- Networks access
- Added value services
- Traffic management

II. THE SOLUTION WITH AN MVNO APPROACH FOR CONTROL OVER THE CONNECTIVITY

The solution to the issues mentioned previously measurably improves the car manufacturers' ability to **innovate, differentiate, and maintain good-quality connectivity** during the vehicles' lifetimes. To control the connectivity solution, vehicle manufacturers must adopt an MVNO approach.

WHAT IS AN MVNO?

An MVNO *(Mobile Virtual Network Operator)* does not have a radio infrastructure *(antennas, frequencies, and licenses)*. It rents the Radio Access Network from MNOs to offer its own mobile services to its customers.

It can be a *"Light MVNO"* or a *"Full MVNO"*, depending on the level of ownership and control of the resources *(SIM cards, network code)*, the infrastructure *(core network, other platforms)*, and the interconnection agreements.

Benefit #1: No lock-in situations

As an MVNO controlling its own platform *(or core network)*, a car manufacturer cannot find itself in lock-in situations with mobile operators.

Switch networks easily

If the quality of service or if the prices of a local radio access network are no longer satisfactory, switching operators becomes a simple operation, as is the case for any MVNO. A configuration change at the mobile core network level is then carried out and can be instantly available around the globe. Cost is negligible and there's no need to update SIM cards with complex Over-The-Air campaigns.

Retaining bargaining power

Since a new local radio network can easily be configured, it restores the vehicle manufacturer's bargaining power with its connectivity providers. The core network acts as a marketplace facilitating the negotiation of profitable agreements with the best local networks.

Benefit #2: No setup complexity: Integrate once, deploy globally

The MVNO approach is, by design, the easiest way to launch new car connectivity services: the car manufacturer needs to connect and interact with only **one single core network**, instead of performing multiple integrations with several mobile operators. The single core network allows for a global deployment by relying on a distributed regional architecture to ensure the best possible performance and decrease the likelihood of incidents. The local radio networks are managed from this connectivity management platform to **ensure worldwide coverage** and a **consistent customer experience** across the globe.

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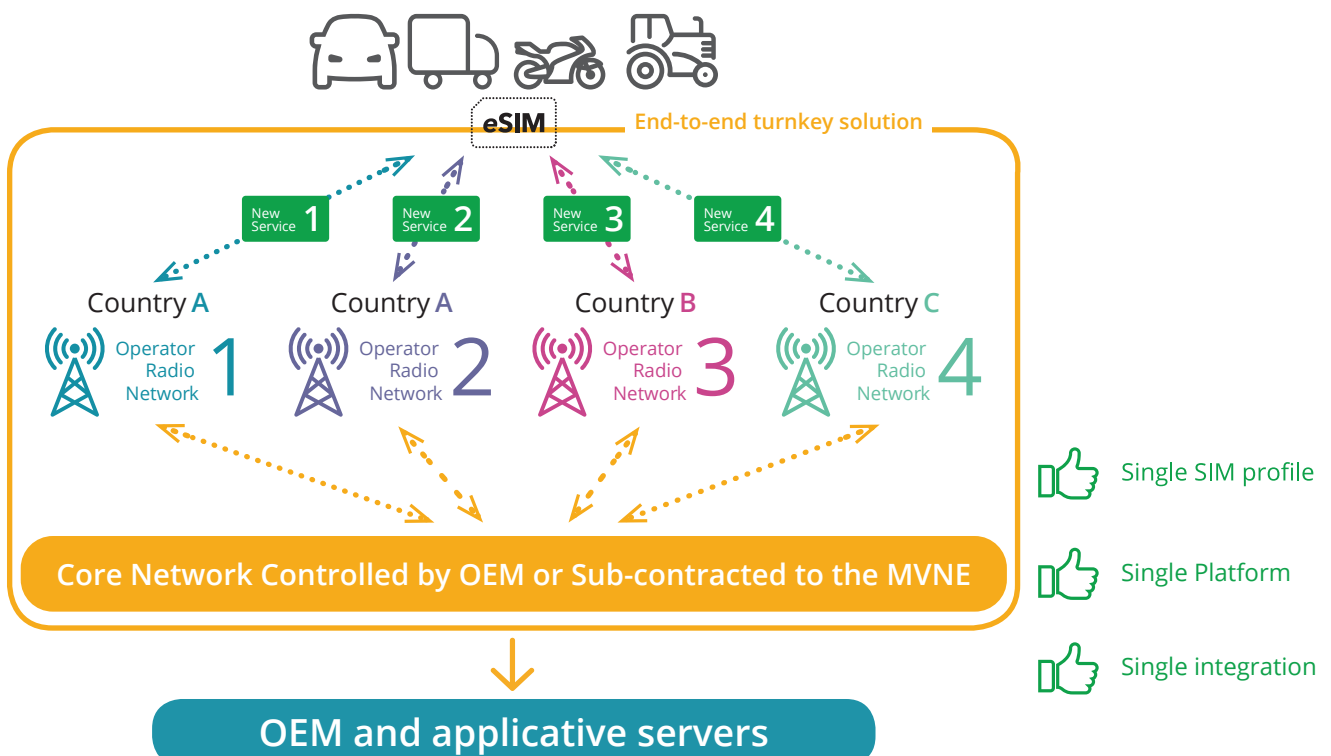
Benefit #3: Freedom to innovate

Manufacturers need an agile and flexible connectivity provider that will have the ability to quickly deploy new services and keep the pace with a highly evolving market. The MVNO approach removes the main technical barriers that can hinder innovation and the launch of connected applications: it's the perfect model to support and develop brand differentiation.
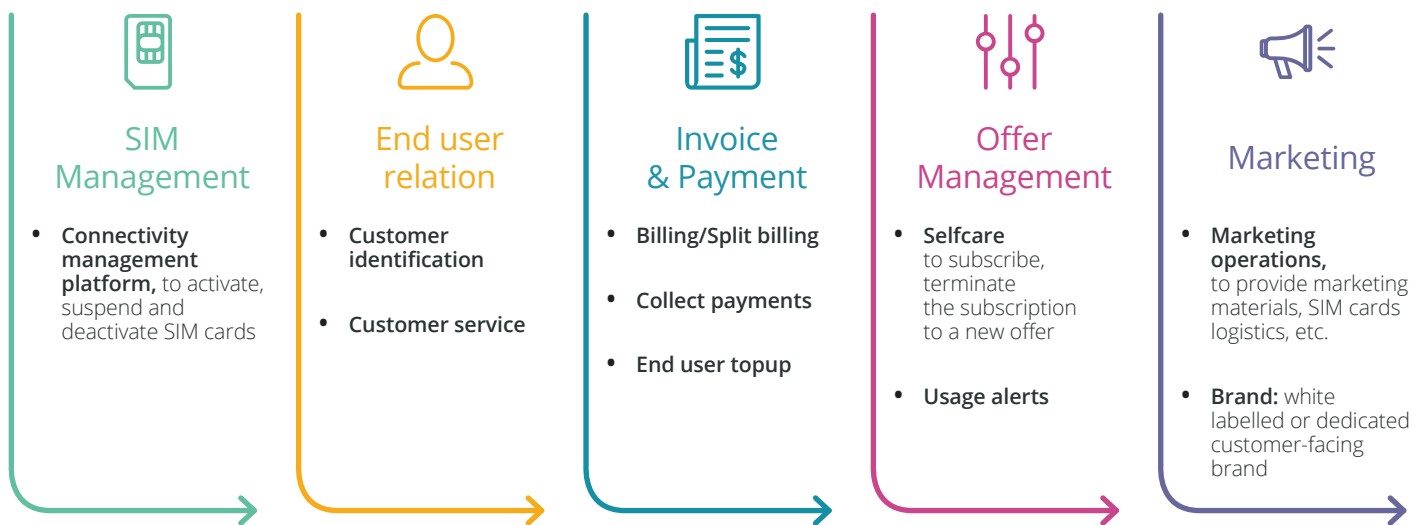
Flexible and agile configuration

An MVNO has full control and independence when it comes to the design of its services, which enables greater agility in deploying advanced and fully-tailored services. Thus, time-to-market is significantly improved.
Applications are developed on a single platform instead of several, which would have been the case with multiple MNOs. The result is that customer experience is consistent across the globe.

Ability to manage the end user

Some services, such as infotainment or on-board Wi-Fi, are directly targeted to the end user.
Car manufacturers will now need to manage the relationship with the end user during the entire vehicle lifecycle, which is a completely new business for them.
Some MVNEs can supply the various components of the customer journey. This is a solution to free manufacturers and let them focus on designing and launching new connected applications.

The main components of the customer journey

SIM Management	End user relation	Invoice & Payment	Offer Management	Marketing
• **Connectivity management platform,** to activate, suspend and deactivate SIM cards	• **Customer identification** • **Customer service**	• **Billing/Split billing** • **Collect payments** • **End user topup**	• **Selfcare** to subscribe, terminate the subscription to a new offer • **Usage alerts**	• **Marketing operations,** to provide marketing materials, SIM cards logistics, etc. • **Brand:** white labelled or dedicated customer-facing brand

Benefit #4: End-to-end, secure connectivity

With an MVNO approach, one SIM card can be programmed to manage multiple data streams.
Even though cellular connectivity is secure by design, some streams such as vehicle firmware updates require advanced protection to isolate the data from the internet. After all, true data security can only be end-to-end.

Only an MVNO with full control of their platform can provide enhanced security features, such as the following:

- **Within the vehicle itself,** the SIM card can be made into a trusted secure element, sending and receiving ciphered and untraceable SMS—to unlock the car, for example. Implementing an IMEI-lock can render the same SIM card inoperative with any other device. Furthermore, the SIM card's advanced features can enable such capabilities
as security authentication of firmware download.

- **At the MVNO-platform level,** data traffic segregation can be operated to split the traffic into various streams and to selectively apply different levels of security to each. This is achieved via a private APN, which operates like a dedicated gateway for registered users *(i.e. the car manufacturer's customers)*.
can be deployed to ensure some data streams are never accessible from the public internet.

III. HOW TO SET UP A CONNECTIVITY SOLUTION

The objective for vehicle manufacturers of becoming an MVNO themselves means moving:

- **From a service agreement**, where mobile operators control the entire connectivity solution,

- **To an access agreement**, where manufacturers own and operate their own platform to easily manage local radio networks.

They have two options to do so, either by themselves, or by sub-contracting with an MVNE.

WHAT IS AN MVNE?

An MVNE *(Mobile Virtual Network Enabler)* provides the network infrastructure and related services to third parties to build their own MVNO.
The MVNE does not have a direct relationship with the end users.

Option #1: Become a Full MVNO

The Do-It-Yourself approach is clearly the difficult way to build an MVNO. It's about learning a completely new business, from scratch, alone. Manufacturers will need to successfully carry out a lengthy process before launching
the first operational services, and go through many steps:

- Obtaining their own Mobile Network Code *(MNC)* to operate as a mobile operator
- Building their own infrastructure *(core network, billing system, etc.)* and developing their own features and services
- Negotiating their own roaming agreements with mobile network operators worldwide
- Managing the customer journey and activating/deactivating SIM cards
- Managing the relationship with the end user during the entire vehicle lifecycle

These operations can be costly, complicated, and difficult to implement for a car manufacturer.
There is an easier solution.

Option #2: Partner with an enabler

Vehicle manufacturers don't have to go right away for the Full MVNO model, if they don't feel ready
or mature enough to undertake it.

They can maintain full control and still adopt the MVNO model by sub-contracting with an MVNO enabler.
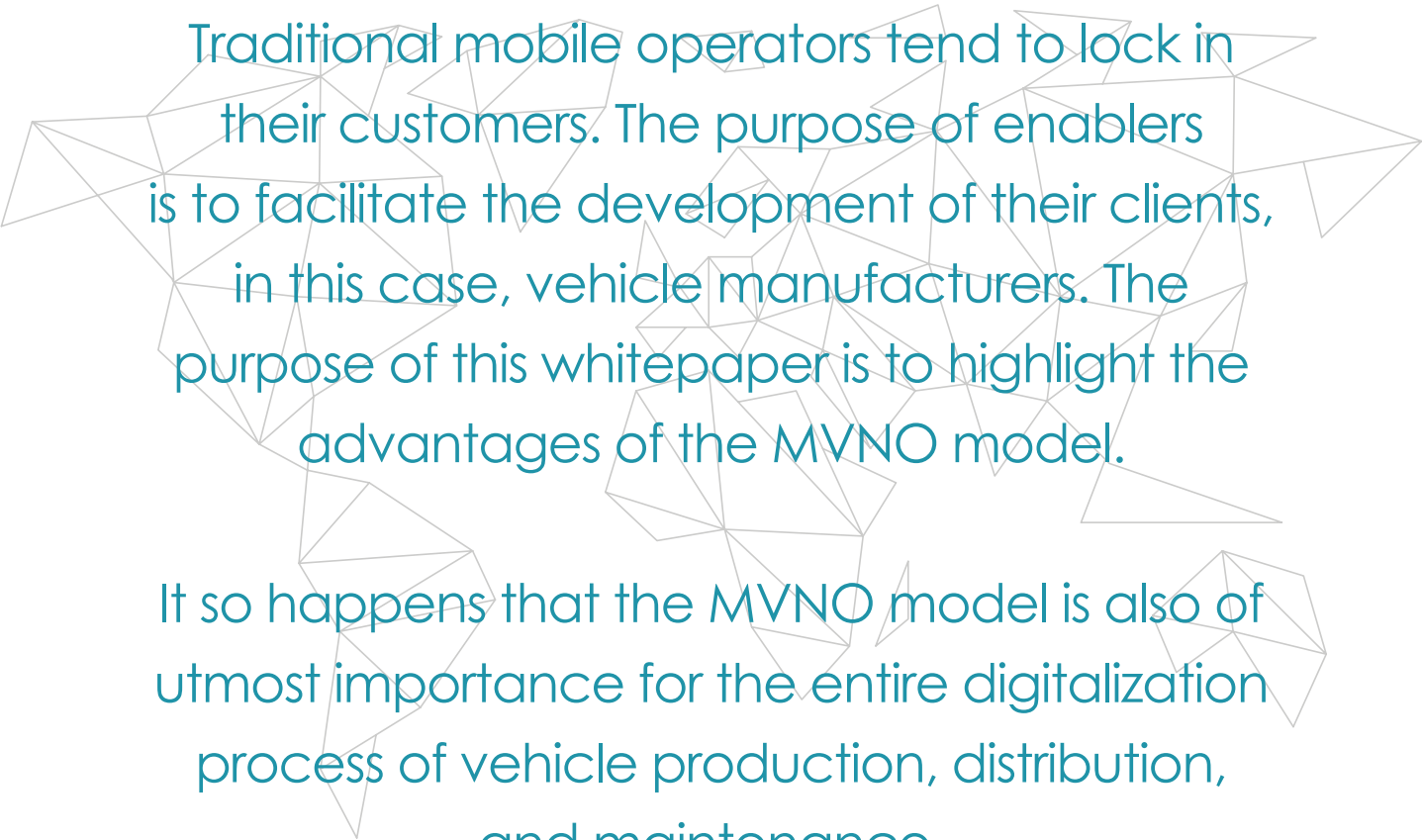
Start with a turnkey solution

With an MVNE's turnkey, one-stop-shop solution, manufacturers can launch their own MVNO in a few months.
If needed, the enabler can handle and operate the mobile operators' key features:

- **Use of the enabler's non-geographic Mobile Network Code (MNC).**
- **Virtualization of the IT and telecom infrastructure.**
  The enabler can use its own core network to develop custom connected services. Manufacturers then
  let the enabler deal with the IT and telecom technical complexity and can focus on vehicle applications.
- **Managing coverage and underlying radio networks with a carrier-agnostic solution.**
  Manufacturers benefit from the enabler's agreements to deploy global coverage.
  They maintain their bargaining power with mobile operators, since switching radio access networks
  is a very simple operation to perform at the core network level.
- **Managing the relationship with the end-user during the entire vehicle lifecycle.**
  The MVNE can handle all or part of the customer journey: subscription, adjusting services, collecting one-time
  or recurring monthly payments, providing customer service, etc.
- **Regulatory compliance.**
  Mobile network legislation varies widely from one country to another. An MVNE has the knowledge
  of the regional legal specificities to build a connectivity solution that is compliant everywhere.

Break free when you're ready!

The right MVNE partner is agile and flexible enough to help vehicle manufacturers evolve at their own pace
to take full ownership of the connectivity solution and become full MVNOs. To do so, car manufacturers can take a step-
by-step approach to handle the key features, such as building and managing their own core network, negotiating their
own local radio network agreements, or managing the components of the relationship with the end-user.

To connect their vehicles, car manufacturers need to implement a global, flexible, and cost-effective solution. There are two options to do so: either interconnect directly with local mobile operators or choose the MVNO model.

Traditional mobile operators tend to lock in their customers. The purpose of enablers is to facilitate the development of their clients, in this case, vehicle manufacturers. The purpose of this whitepaper is to highlight the advantages of the MVNO model.

It so happens that the MVNO model is also of utmost importance for the entire digitalization process of vehicle production, distribution, and maintenance.

We will be discussing in a future whitepaper exactly how a managed core network can improve a manufacturer's performance at each step of the digitalization process.
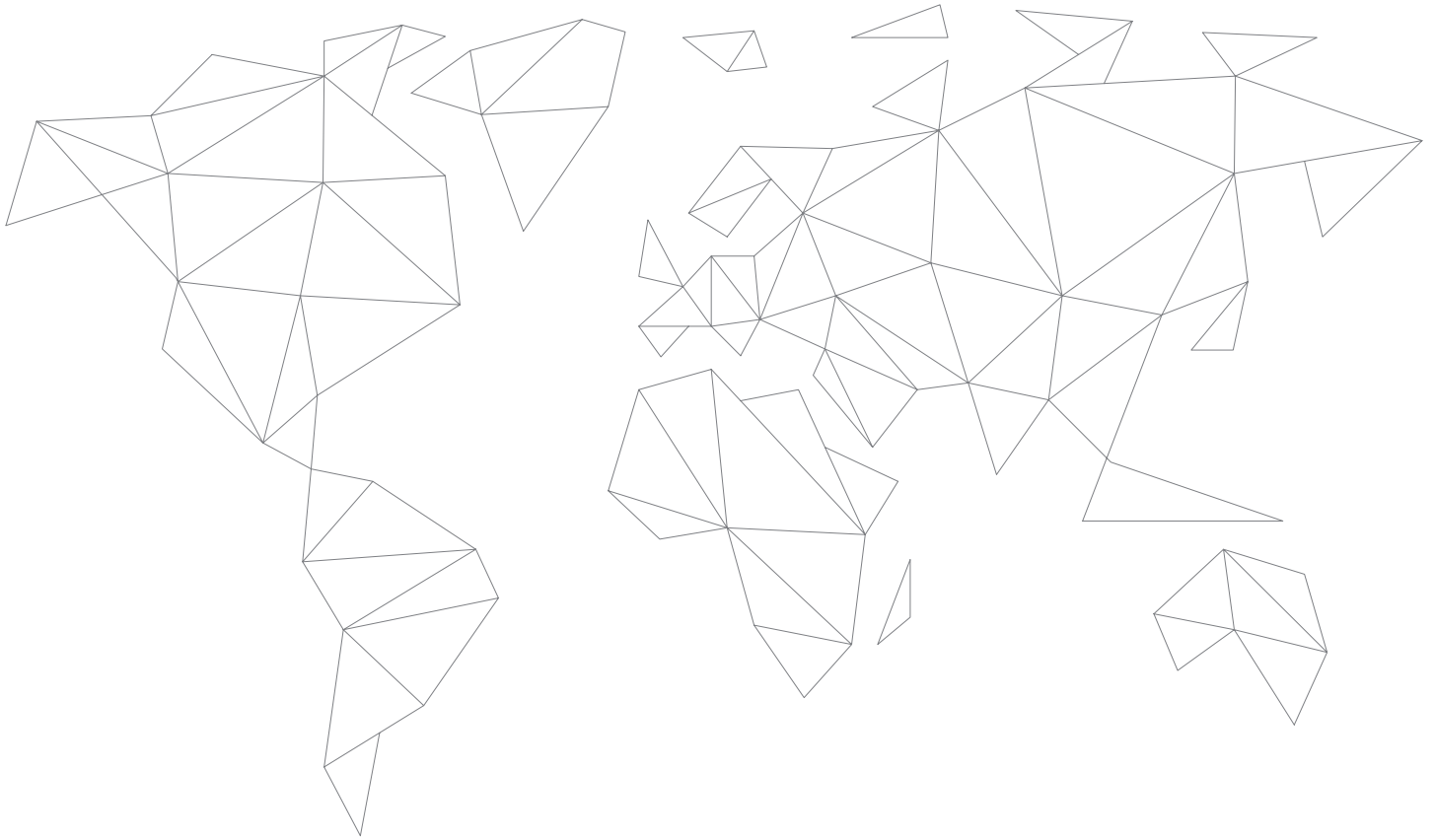
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