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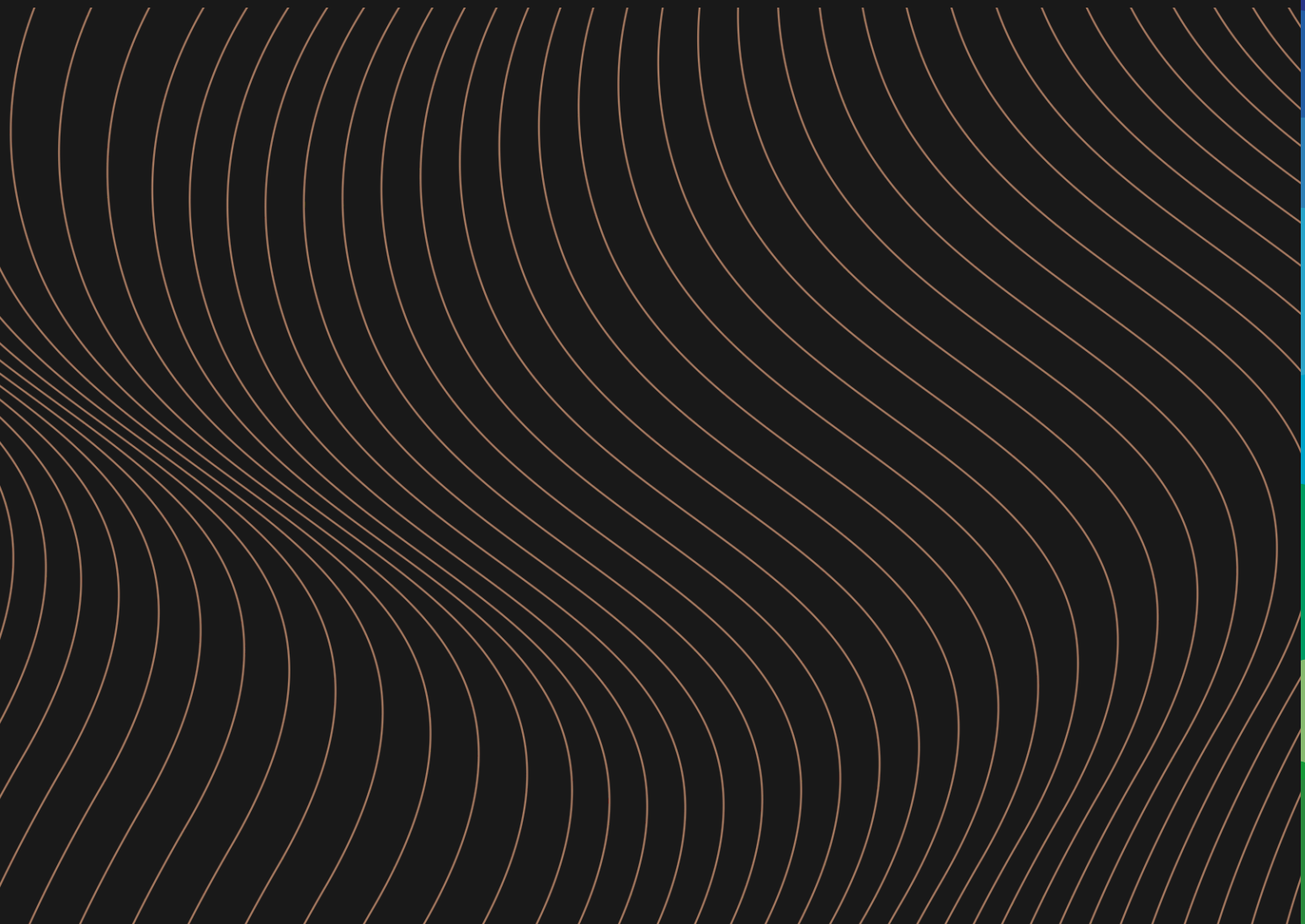
CONNECTED MOBILITY 2.0

THE FUTURE OF VEHICLE CONNECTIVITY



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Connected Mobility 2.0:
The Future of Vehicle Connectivity

This whitepaper provides an overview of the digital transformation in the mobility industry and the value of end-to-end connected vehicle solutions. Aimed at digitalization leaders and senior executives in mobility, it explores technological innovations around vehicle architecture, intelligent tire sensors, and SIM technology.

Connecting mobility assets: why and why now?

Since its inception, the mobility sector has been a driving force behind technological, economic, and social transformation. The industry is currently undergoing a major digital revolution, which is expected to cause an even more significant disruption in the next few years than what occurred in the past century altogether.

Regulations as catalysts for innovation

Regulatory changes actively shape the digitalization of mobility. For instance, consider the legislation surrounding tire pressure monitoring systems (TPMS). These regulations mandate the use of connected sensors in tires to monitor pressure, temperature, and other parameters in real-time. This enhances safety by providing vehicle owners with real-time tire performance data, reducing the risk of accidents. It also promotes efficiency by enabling predictive maintenance, resulting in cost savings for both consumers and businesses.

In accordance with GSR, TPMS became mandatory for newly produced commercial vehicles (trailers/semi-trailers, and buses) in July 2022, and new vehicle registrations will follow in 2024.

This regulation is just one example of how the industry is being pushed toward greater vehicle data. Here are more:

- **Cybersecurity and vehicle compliance:** EU Regulation 2018/858 addresses the approval and market surveillance of motor vehicles and related components in the EU. It aims to establish cybersecurity standards for connected vehicles, protecting vehicle data and systems from breaches and cyber threats. It includes procedures for EU member states to ensure vehicles and components meet safety and environmental standards.

- **Data privacy and telematics ownership:** Different regions have their own laws governing telematics data generated by vehicles. These laws determine who has control over the data, whether it's vehicle owners, manufacturers, or service providers. For example, in the U.S. State of Massachusetts, there is a law saying that vehicle owners have the right to access the telematics data collected about them. China, Japan, and South Korea have also introduced regulations and standards for cybersecurity, autonomous vehicle testing, and V2X (Vehicle-to-Everything) communication technology.

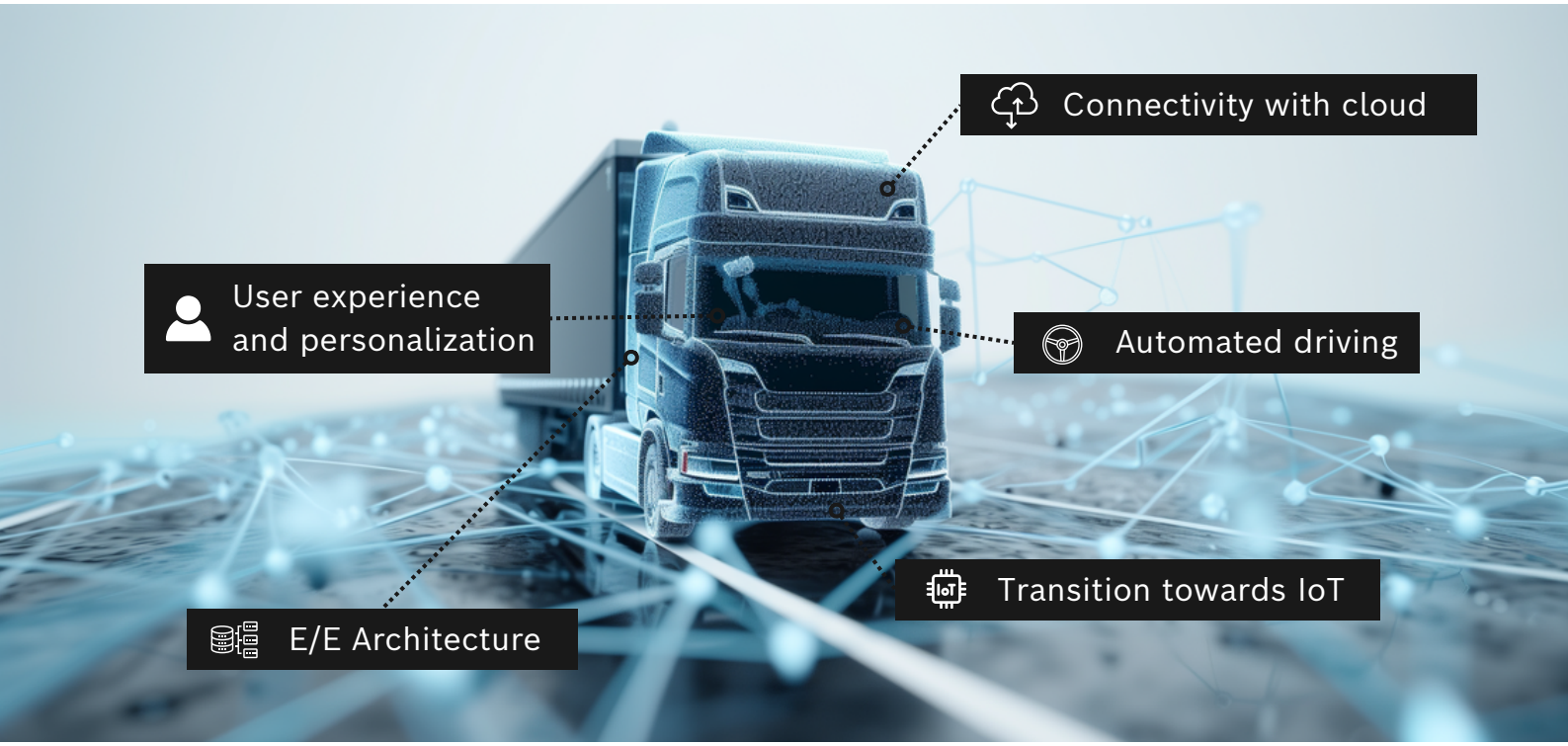
- **Emission Reduction:** In order to combat climate change, many regions have established strict emission reduction targets. For example, the city of Copenhagen is implementing Zero Emission Zones, which means that the use of diesel-powered vehicles without a particulate filter will no longer be legal. Additionally, the EU has agreed on new emission targets for vehicle manufacturers starting in 2025. These legislations necessitate the development of new technologies to manage and estimate emissions.

These regulations span numerous continents and regions, a unified commitment to fostering secure, sustainable, and connected vehicles.

The evolution of the vehicle as an IoT device

Connected mobility holds significant potential for the industry. While self-driving autonomous vehicles receive a lot of attention, there is more to it than just auto-pilot. By connecting additional "dumb" assets within the car, we can create new revenue streams, achieve cost savings, and improve passenger safety and security.

As a result, vehicles are evolving into sophisticated IoT devices, equipped with sensors, GPS, cameras, and onboard computers. These advancements enable real-time data collection and communication, leading to safer and more efficient transportation. They also enable features such as remote diagnostics and over-the-air updates, enhancing safety and efficiency through vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication.



The value of connected mobility

By connecting more assets in the vehicle, we can bring concrete benefits to the ecosystem:

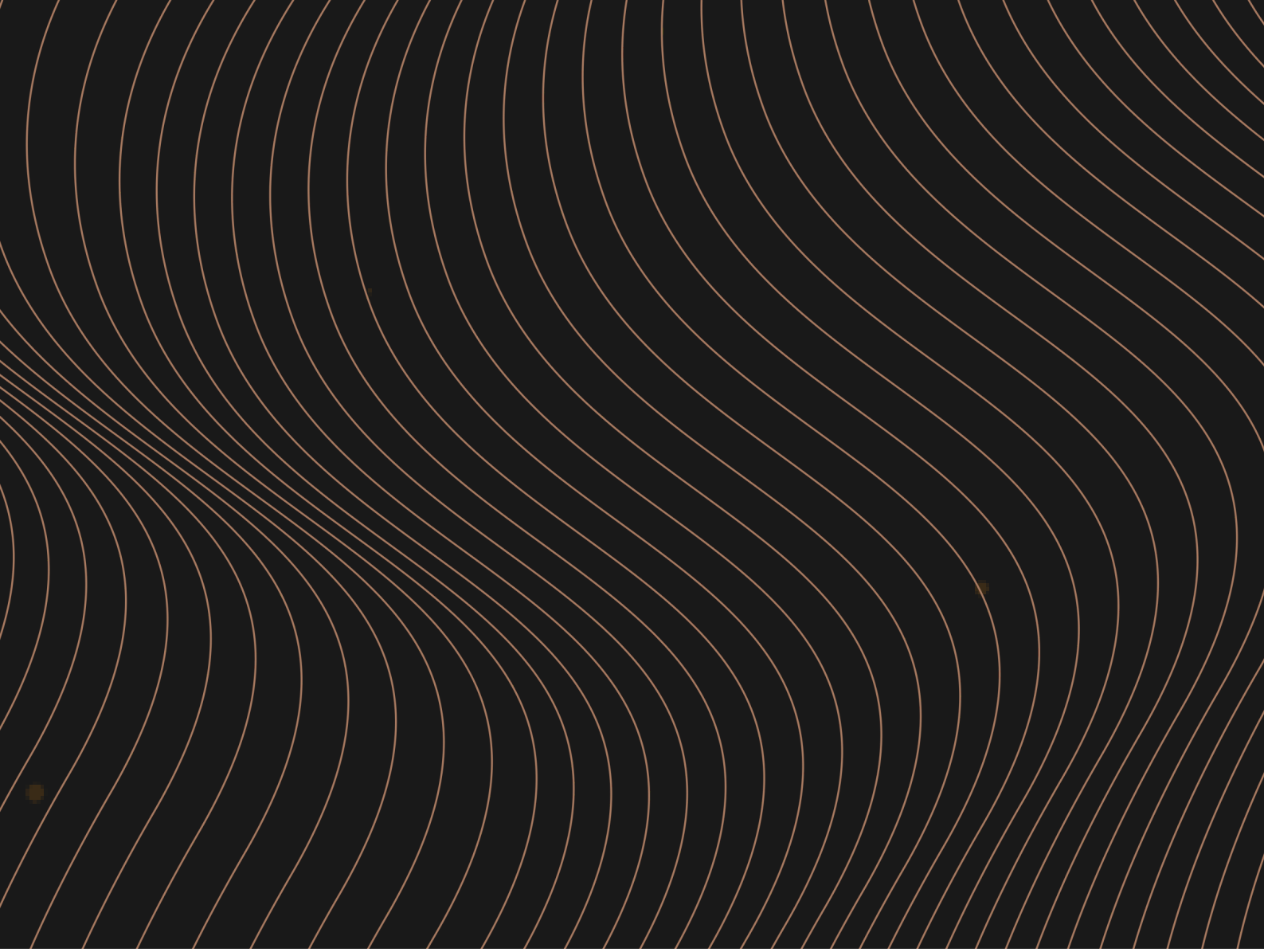
Enhanced Safety: Intelligent monitoring of components like tires, brakes, and cameras helps identify wear and tear early, enabling timely maintenance and preventing accidents. An intelligent sensor system can detect driver fatigue and recommend rest time or even assist with key driver functions like braking or steering.

Reduced Emissions: Connected sensors can optimize vehicle and unit performance for smarter use of fuel. Real-time tire pressure monitoring, for example, helps conserve fuel as a 10% decrease in tire pressure increases fuel consumption by 15%. Additionally, with further connected systems, commercial fleets can optimize routes and find the most fuel-efficient paths.

Real-Time Visibility: Connected vehicle solutions improve data collection and sharing across the ecosystem, helping manufacturers, service providers, consumers, and regulatory bodies make informed decisions. These solutions enable real-time monitoring, remote diagnostics, predictive maintenance, and tracking of assets in the supply chain to ensure they stay on schedule.

New Value Streams: Integration of connected mobility unlocks new opportunities. For example, "tire-as-a-service" offers ongoing monitoring and maintenance based on real-time data. Usage-based insurance models become more precise, customizing premiums to individual driving behavior.

Cost Savings: By investing in advanced connectivity solutions, businesses can streamline OpEx by enabling predictive maintenance, optimizing fuel consumption, and minimizing unplanned downtime.



Fueling mobility with global connectivity

Effective communication is a fundamental requirement for IoT devices, as even the most advanced technology is rendered useless if it cannot connect. This is especially true in the mobility sector, where vehicles frequently cross borders, encountering areas with varying connectivity levels.

At the heart of this connected ecosystem lies cellular communication, a fundamental pillar for smart vehicles. While telematics rely on global cellular networks to transmit crucial data, vehicles also incorporate technologies such as Bluetooth for in-car systems. This section delves into the pivotal role of cellular connectivity in powering the mobility of tomorrow.

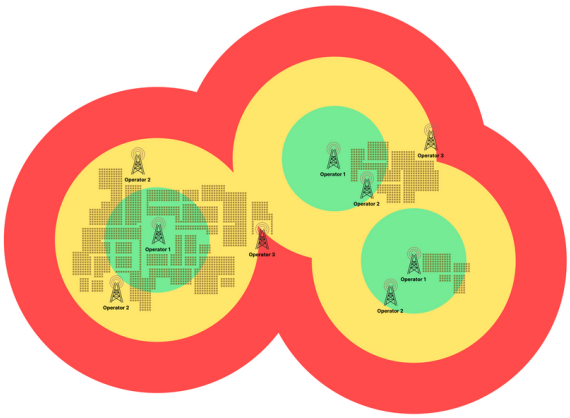
Connectivity roadblocks for mobility

Vehicles are built to move. For connected vehicles, data has to be collected and delivered consistently, without interruptions, for a smooth journey across locations.

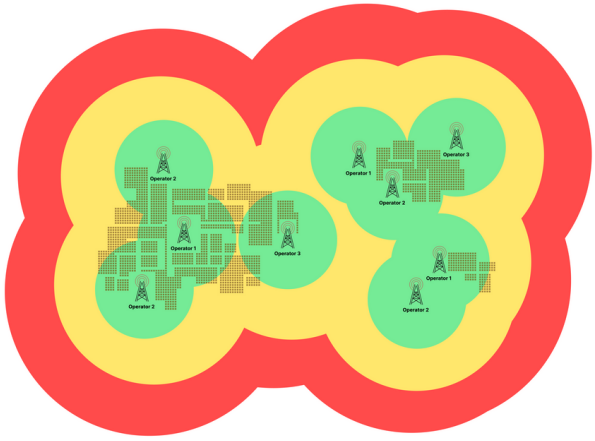
The use of local SIM cards, sourced from regional providers, has become a widespread approach to maintain mobility connectivity wherever the vehicle goes. However, this method frequently introduces limitations on IoT devices because of network steering. Local SIM cards include a PLMN list, which prefers certain networks over others, based on commercial agreements. This is known as a Steered SIM, and they have several impacts on connected mobility devices.

Steered SIMs restrict devices to specific networks and providers even when stronger, more reliable networks from other providers are available. Consequently, there are instances where optimal connectivity is unattainable due to commercial agreements, resulting in areas with unreliable or no connectivity, presenting considerable operational risks. This leads to both an overuse of data from failed attachments, driving up the data costs of connected mobility devices, and sometimes the loss of data transmitted. The images below illustrate the expected coverage you would get with one RAN and steered SIMs, compared to multiple RANs (Radio Access Network).

Coverage with one RAN



Coverage with all RANs (Onomondo)



An alternative solution when crossing borders is to change SIM profiles, either by physically replacing SIM cards or utilizing an eUICC SIM (Embedded Universal Integrated Circuit Card). This solution is rapidly growing in popularity and use, as eUICC enables connected devices to gain the benefit of a wider network availability and with the aim of reducing data costs.

However, one pitfall of this solution is that eUICC SIMs are still subject to SIM steering, so while there are more networks available, the device can waste time and data, selecting the strongest signal available as it steers between networks.

Moreover, in the mobility sector where margins are slim, encountering device or network issues can be costly. Typically, troubleshooting involves submitting a ticket to your network provider, a process that can take 2-3 days to resolve when devices are at home. Troubleshooting is even longer when devices are roaming, as your network operator must then contact their international roaming partners, which can translate to a delay of 10-16 days on average, which could be costly in annual time management costs.

How reliable connectivity drives connected mobility

Onomondo challenges traditional telecom and addresses the connectivity issues faced in international mobility with innovative network technology, embedded at core-level.

Seamless global connectivity

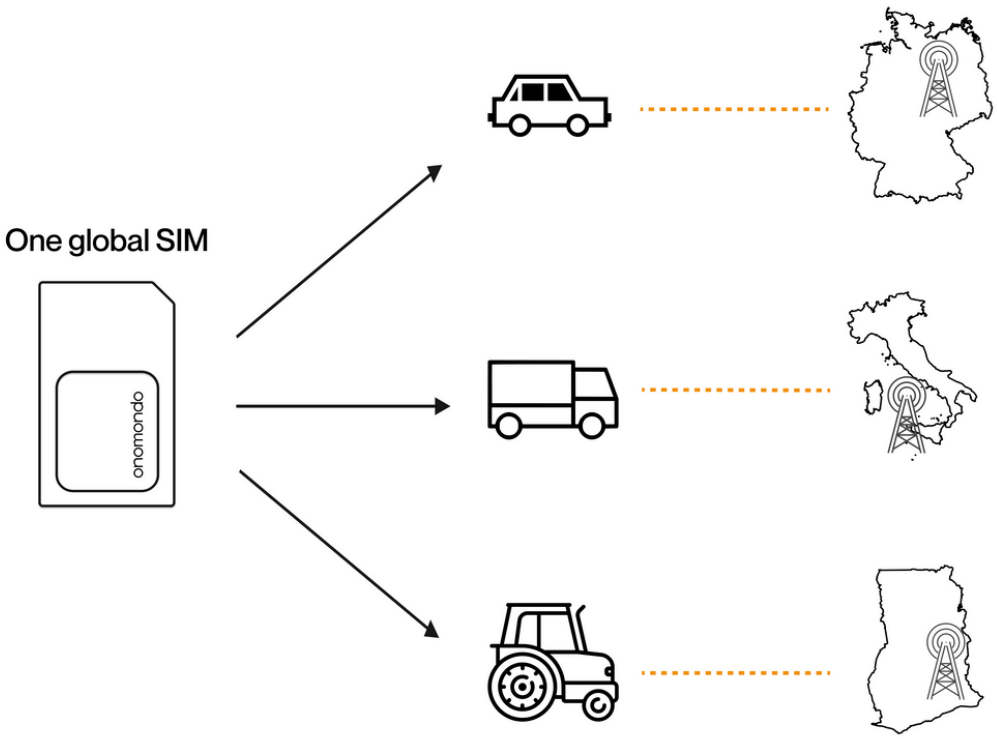
The SIM cards offered by Onomondo are engineered to be network agnostic for maximum flexibility. The SIMs ship pre-activated and automatically connects to the strongest available signal regardless of provider. This non-steered configuration empowers users to select networks that meet their specific needs — whether prioritizing signal quality or data costs. As a result, Onomondo keeps your mobile assets connected even when crossing international borders.

Real-time insights from a single unified core network

By integrating 630+ RANs (Radio Access Networks) globally into a single core network, Onomondo offers a unified network integration that plays a pivotal role in providing seamless cellular connectivity and real-time access to data on any network. With reliable global connectivity, network downtime is minimized and troubleshooting issues can be resolved within minutes instead of days. The centralized architecture also migrates device-based functions to the cloud. Reducing individual device overhead, simplifying provisioning processes and enabling more efficient data transmission across entire fleets.

Simplified profile management

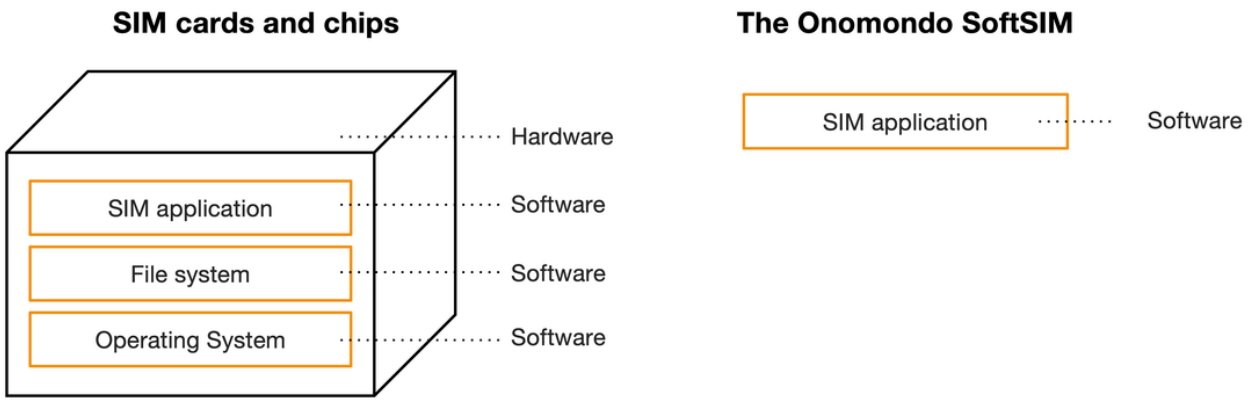
Onomondo offers a single global SIM profile, eliminating the need for separate physical SIM cards in different countries or applications. This streamlines operational efficiency by reducing overhead from managing multiple IMSIs. Additionally, the SIMs use a single SKU and APN, further simplifying logistics and device configuration. All devices equipped with Onomondo SIMs are managed with a single platform and invoiced with a single vendor, minimizing separate contracts and reducing complexity for multinational operations.



One operator profile for global connectivity

SoftSIM technology

Onomondo's software-only SIM — SoftSIM — integrates directly into device modules, removing physical SIM cards entirely. Provisioning is now instantaneous without shipping delays. Waste from plastic SIM components is also eliminated. As a software entity, SoftSIMs incur no idle fees, improving cost predictability for large fleets. Integrated as software, the SoftSIM leverages existing device resources for simplified deployment and management of global connectivity.

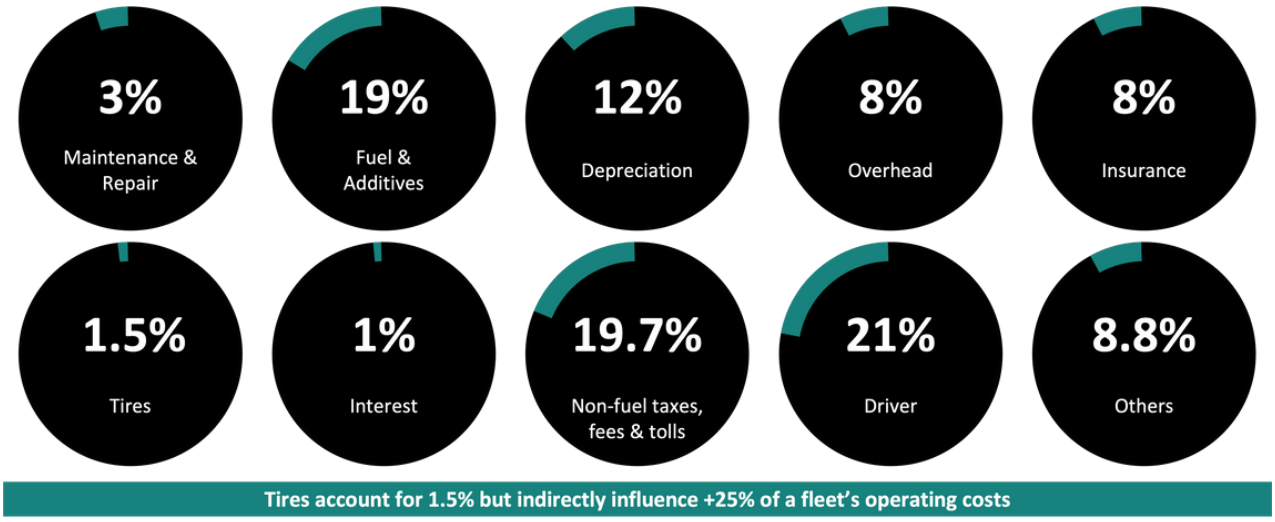


From rubber to real-time data

Pioneering the way for tomorrow's journeys, Intelligent Connected Tires are revolutionizing the transportation landscape. While tires are commonly perceived as “dumb rubber” and a necessary inconvenience, they possess the potential for incremental improvements that can yield remarkable bottom-line enhancements and drive top-line growth.

How intelligent tires showcase connected mobility's potential – from ground to cloud

While tires only constitute a mere 1.5% of the direct operating costs for fleets, their influence extends far beyond that, affecting a significant 25% of all operating costs. This impact encompasses various aspects such as fuel and additives, insurance premiums, maintenance and repair, among others. The challenges and risks associated with tires while operating fleets are diverse, ranging from sudden pressure loss and deformations caused by accidents, to wear and tear and uncertain tire lifetimes. When issues arise with tires, the entire fleet operation is potentially jeopardized. It is crucial to recognize that tires are the sole component of a vehicle "touching the ground", making them a mission-critical asset by design. They not only facilitate the transportation of goods and products, but also have a substantial influence on safety factors like braking distances, efficiency aspects such as fuel consumption, sustainability efforts like prolonging tire lifespan, and overall business performance, including minimizing vehicle downtimes.



Shift happens:
How connected assets enable new business models

We are observing a fundamental shift as traditionally “dumb” assets evolve into intelligent, connected entities, thereby creating new value and enabling innovative business models. Bosch SDS is actively involved in this transformation, developing diverse and advanced solutions for mobility, data sharing, and connected vehicles. The Intelligent Connected Tires solution, seamlessly integrated with cloud-based platforms and smartphone applications, enables the provision of data-based tire-related services. These services encompass monitoring tire and vehicle parameters, as well as offering valuable insights on tire replacement and maintenance.

Intelligent Connected Tires have become a game-changer in the realm of modern mobility. These innovative tires facilitate remote monitoring, diagnostics, predictive maintenance, and enable the creation of digital twins. They surpass traditional tire functionalities by incorporating additional sensors like accelerometers and gyroscopes, resulting in a wealth of tire data. This data-first approach unlocks countless business opportunities throughout the entire tire value chain and extends beyond its boundaries.

Tire Manufacturer

- Product Improvements
- Tire as a Service Model
- Customer Retention
- Warranty Management
- Value-Added Services

Vehicle OEM

- Vehicle Dynamics
- Fuel Consumption
- Safety and Reliability
- Warranty Management
- Customer App

Dealers / Retailers

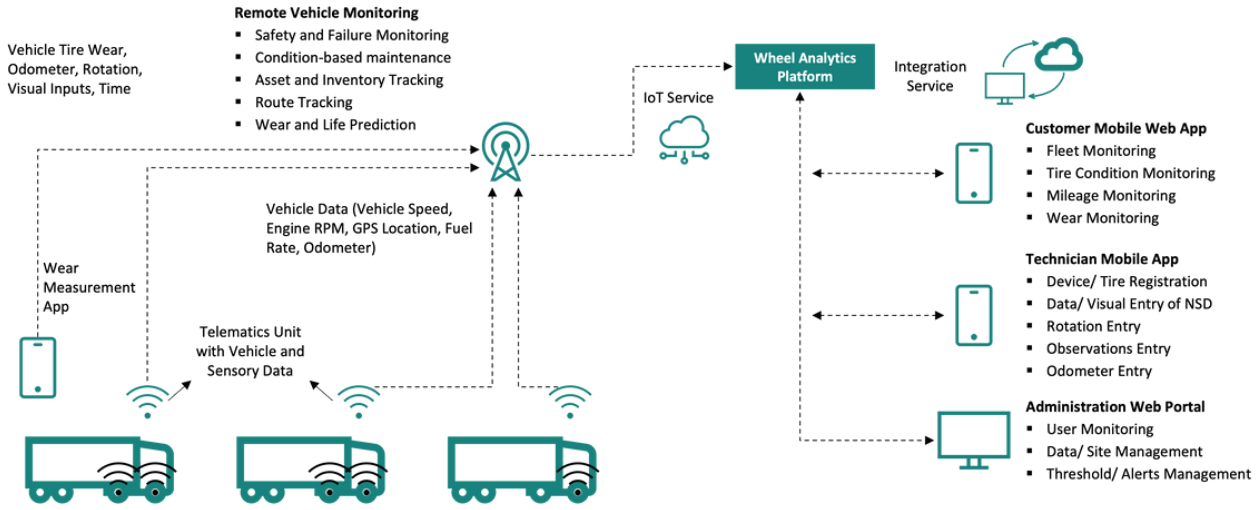
- Customer Connect
- Value-Added Services
- Inventory Management
- Predictive Diagnostics
- Product Traceability

Fleet Owner / Operator

- Diagnostic Information
- Fuel Consumption
- Tire Maintenance
- Safety and Alerts
- Insurance Premiums
- Road Conditions / State

Case Study: The value of tire usage data

To unlock the full potential of tire usage data, Bosch SDS has created an Intelligent Tire Asset Management Platform for an international tire manufacturer, with major footprints in the heavy commercial as well as the off-the-road segment.Today, segmented Tire-as-a-Service models enable new business models and insights into operational data throughout the tire lifecycle offer even more opportunities to explore beyond the surface.



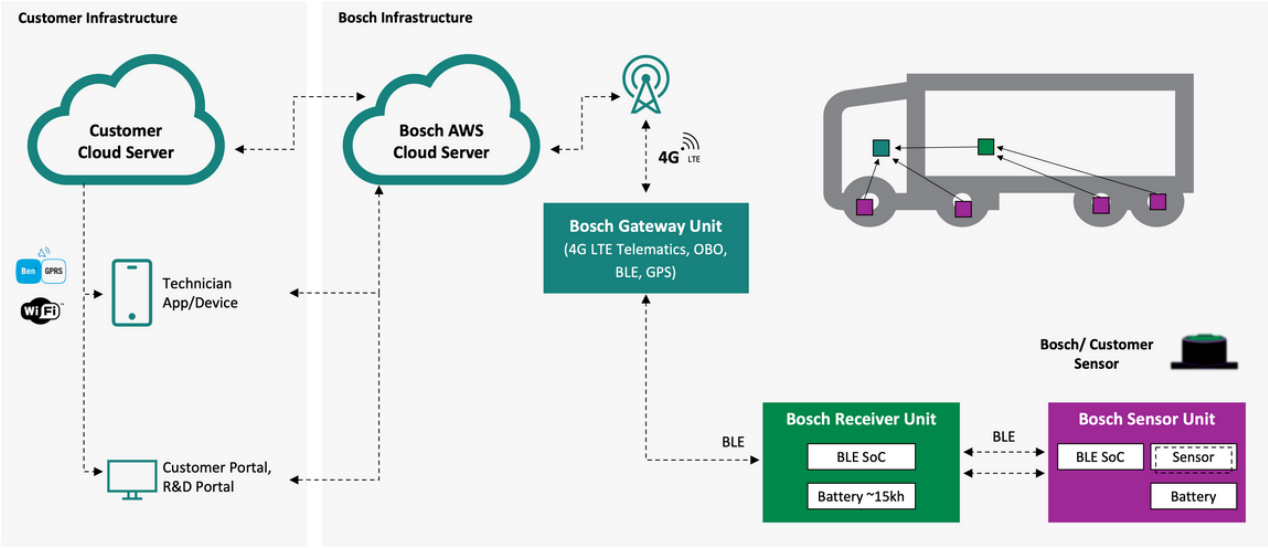
Boosting Operational and Product Efficiency

In the past, the tire manufacturer's customer service department would regularly reach out to customers to offer them support and guidance on tire usage, enhancing tire condition, and maximizing cost-effectiveness. This involved physically visiting customers and manually gathering data on tire usage, wear, and other relevant factors. The collected data would then be carefully examined by tire experts, who would subsequently provide customers with valuable advice and recommendations on how to optimize their tire usage and minimize expenses. Although these efforts were crucial for fostering customer loyalty and maintaining strong customer relationships, the process itself was time-consuming and burdensome. By streamlining the data collection and analysis procedures and reducing the need for in-person visits, the operational efficiency of the customer service teams was significantly improved.

The implementation of Bosch's disruptive intelligent tires technology empowers fleet operators to proactively detect and mitigate approximately 95% of tire-related breakdowns. As a result, the overall vehicle uptime experiences a remarkable boost. Through the acquisition of crucial data from the field, an intriguing correlation has been established: a mere 1% decrease in tire pressure translates to a 0.3% decline in fuel economy. Armed with this valuable insight, fleet operators have successfully achieved fuel savings ranging from 2% to 5% by diligently maintaining optimal tire inflation levels.

AI-Driven Data Integration and Visualization

Using Bluetooth Low Energy (BLE), the tire sensor—which includes various sensing elements—transmits data to either the Receiving Unit or Telematics. This data is then seamlessly integrated with vehicle information obtained from the On-Board Diagnostics (OBD) Port. At the edge, the data undergoes initial preprocessing and thanks to Onomondo's integrated core and their AWS Cloud Connector, is then displayed in real-time to the Bosch AWS Server. Here, the tire algorithm is executed with the support of artificial intelligence. Finally, the results are visualized on a dedicated dashboard or forwarded to customer servers through unified interfaces.

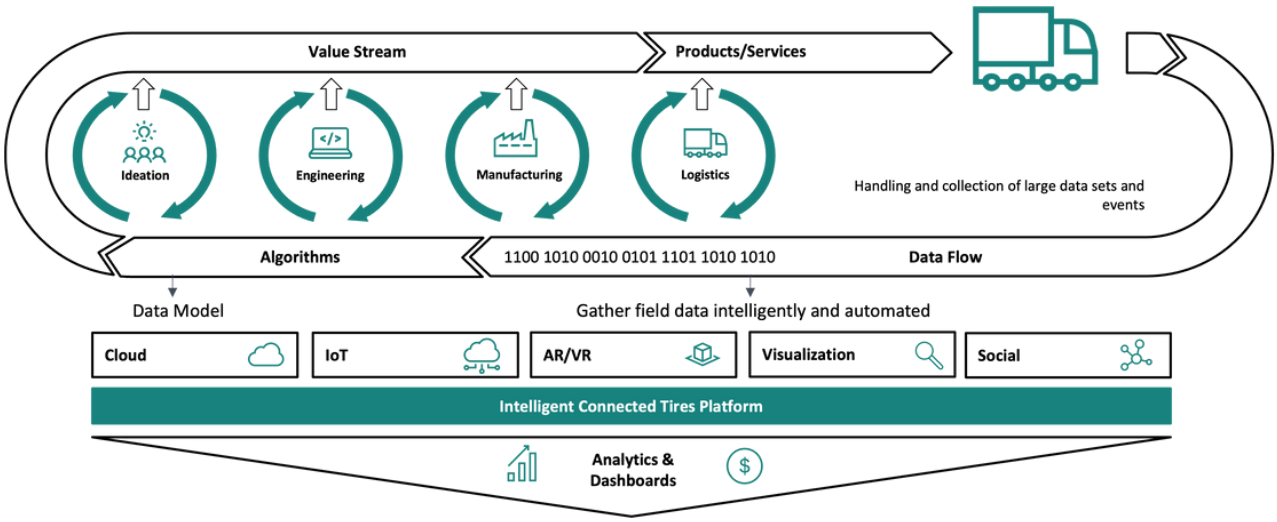


Unlocking New Business Models

By utilizing Bosch's Intelligent Tire Asset Management Platform, the tire manufacturer took a bold step towards a business model transformation. Collecting more data on product performance and usage from the field has unlocked new opportunities. To increase customer retention, tires can now be rented under a Tire-as-a-Service model, where fleet operators pay a monthly subscription based on the actual usage of the tires. In industries with narrow profit margins, such as logistics and transportation, this shift to a usage-based OPEX approach gives fleet operators a significant advantage in optimizing their cost-base.

The tire manufacturer has made significant strides in improving product performance and quality by establishing a continuous feedback loop and seamlessly integrating tire data into their PLM system. This integration empowers them to make data-driven decisions, like metric-based product design as well as real time competitive benchmarking. Furthermore, its customers now have the essential components to revolutionize their businesses as well.

By incorporating tire data into their Fleet Management Systems (FMS), fleet operators can now shift towards predictive maintenance, departing from traditional preventive maintenance, and therefore also introduce innovative products and services to their end-customers.



Towards a connected future: The synergy of Onomondo and Bosch

In the journey towards a smarter, more connected mobility landscape, the strategic partnership between Onomondo and Bosch emerges as a pivotal collaboration. By integrating Onomondo's advanced global connectivity with Bosch's intelligent tire technology and vehicle systems, this partnership delivers an end-to-end solution that redefines vehicle connectivity and management.

Onomondo's network technology ensures seamless data transmission across borders, overcoming traditional connectivity roadblocks that have long hindered the mobility sector. This foundation of reliable, uninterrupted communication is critical for the real-time functionalities that underpin connected mobility, from vehicle diagnostics to predictive maintenance. Onomondo's commitment to "non-steered" SIM technology guarantees that vehicles always connect to the strongest network available, ensuring optimal performance and reducing operational risks.

Bosch stands at the forefront of technological innovation, transforming the “dumb rubber” into intelligent assets capable of communicating vital data. This leap forward in tire technology not only enhances vehicle safety and performance but also paves the way for revolutionary business models like Tire-as-a-Service. Bosch SDS’s expertise in integrating sensors, analytics, and cloud-based platforms brings a new dimension to tire management, offering unprecedented insights into wear, efficiency, and safety.

This collaboration ensures vehicles are not just parts of a network but active participants in a data-driven ecosystem, capable of predictive maintenance and optimized performance.

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Onomondo's mission is based on the belief that connectivity should be as effortless and seamless as turning on a light—it should just work. Since its inception in 2012, Onomondo exists to challenge traditional telecom norms, sparked by frustrations with roaming charges. As the only MVNO with global full-core integration, Onomondo is simplifying the IoT landscape by making hardware more cost-effective and long-lasting, while providing a secure, scalable, and future-proof connectivity platform. Onomondo facilitates global IoT connectivity across 630+ networks in 180+ countries.

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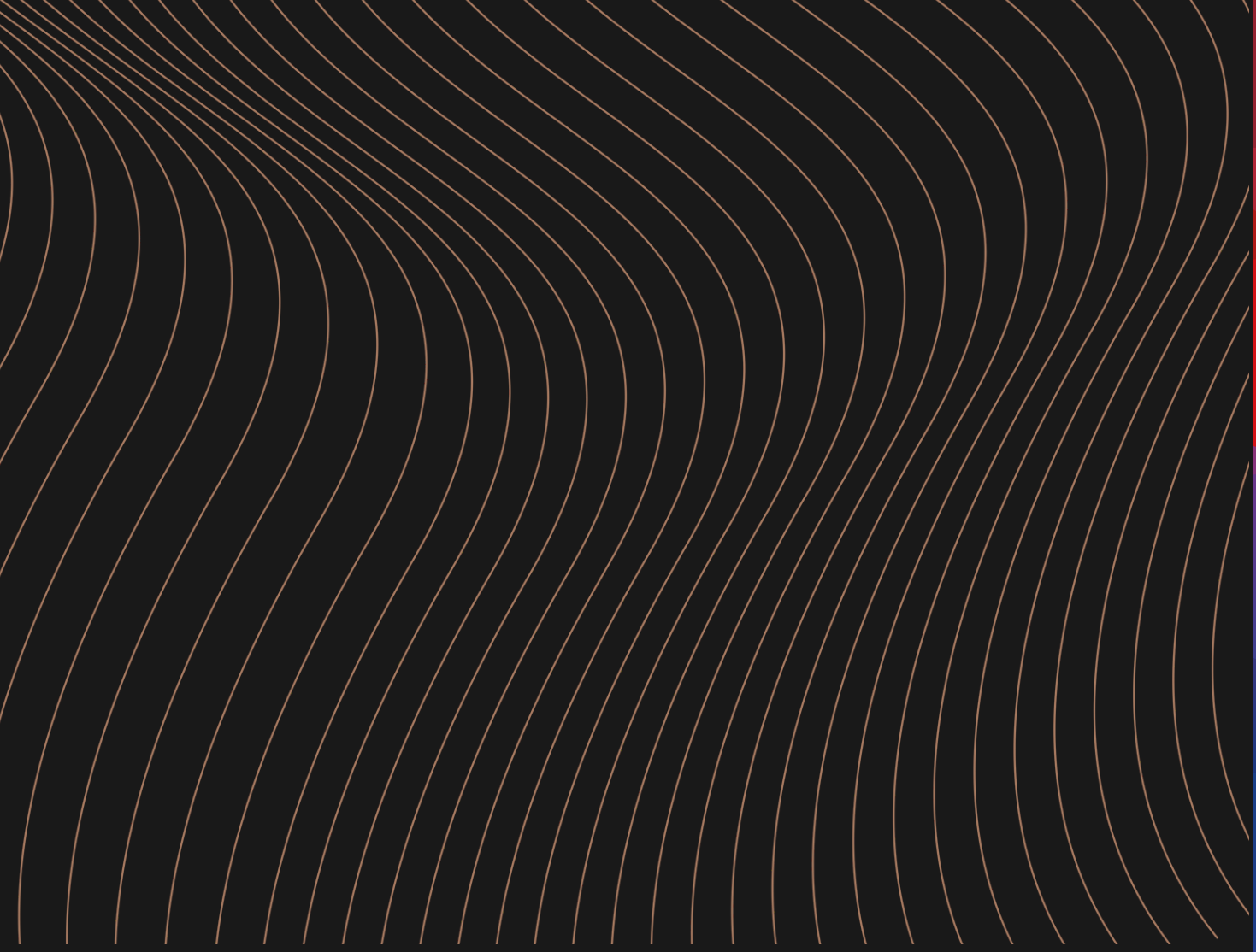

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