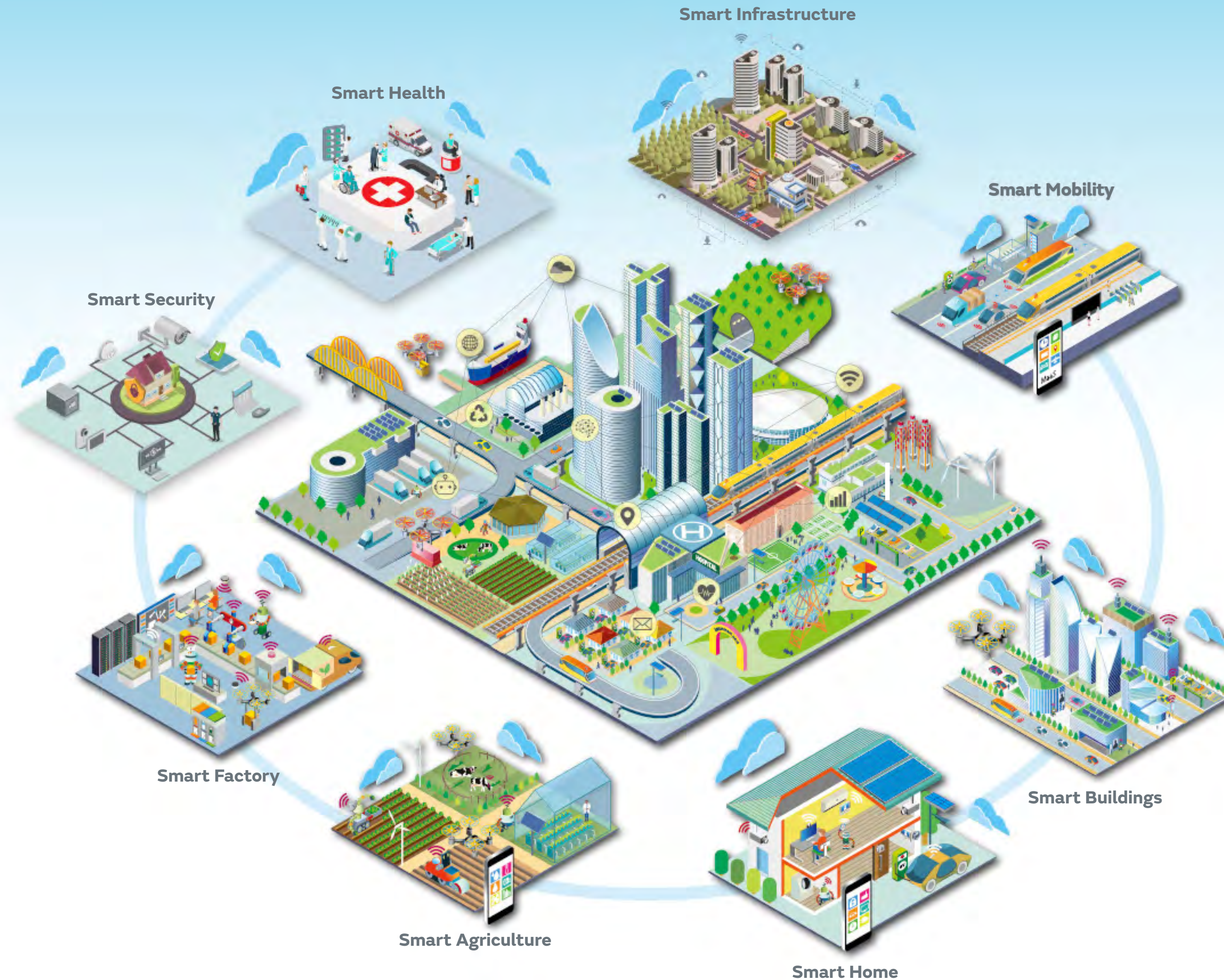# Smart Mobility

Smart Cities

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MaaS

Introduction

**Exploring Emerging
Smart City Opportunities**

▪ Dynamics such as a growing population, an increasing elderly demographic, greater urbanization, plus rising pollution are all putting acute pressures on people's everyday lives. Society must look at what can be done to help enrich modern living conditions and make the world a better place for future generations to inhabit. This can be achieved by utilizing smart technology.

▪ Across the globe, a multitude of smart city projects are now under way. These are enabling air quality issues to be tackled and traffic congestion to be addressed. They are making public transport more efficient, augmenting industrial processes, boosting farming production, enhancing healthcare services and making homes more comfortable and secure.

▪ Through smart city initiatives, municipal governments and utility companies are improving the services that they provide, while also reducing their capital and operational expenditure.

▪ It must be acknowledged that every smart city implementation is distinct. Each will have different aspects that need to be considered and present its own specific problems to overcome. This means that having access to a broad range of different electronic components will be required in order to develop fully effective solutions.

▪ Murata has already built up a strong reputation in the various application areas that this guide discusses. There are a broad selection of Murata products that can be specified for smart city deployment, with details being given in the following pages.

Smart Infrastructure

Smart Health

Smart Mobility

Smart Security

Smart Factory

Smart Agriculture

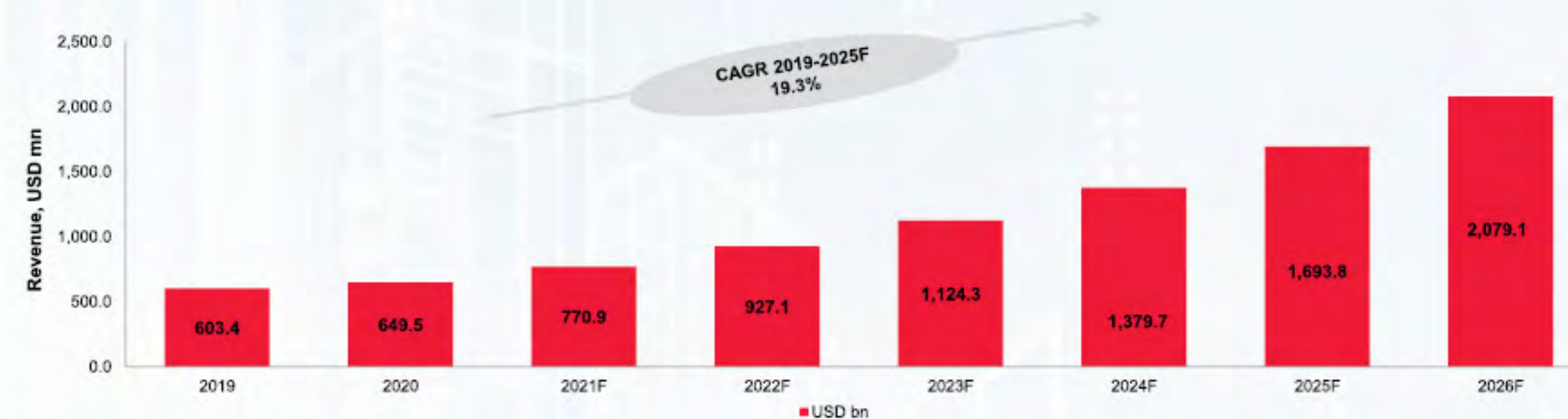Smart Home

Smart Buildings

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Overview

Global Smart Cities Market Expanding Rapidly

▪ Projections from industry analysts Frost & Sullivan estimate that the global smart cities market will experience a compound annual growth rate (CAGR) of approximately 19% over the coming years.

▪ There has already been widespread investment in smart city projects throughout Europe, and further projects are currently being planned. Among the cities where most activity has been seen are Barcelona, London and Amsterdam.

▪ Among the most important features of smart cities are environment monitoring, surveillance, resource management, more efficient farming, manufacturing with higher productivity levels and greater efficiency of healthcare systems. These will help to improve residents' quality of life, as well as enhancing the performance of public services.

FROST & SULLIVAN

CAGR 2019-2025F
19.3%

Smart Cities Market, in USD Billion, Between 2019-2026F

	Revenue, USD mn
2019	603.4
2020	649.5
2021F	770.9
2022F	927.1
2023F	1,124.3
2024F	1,379.7
2025F	1,693.8
2026F	2,079.1

▪ USD bn

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Rapid Urbanization

Emerging Mega Trends

62.5%

Urban Population
According to Statista, approximately 62.5% of the population will be living in the cities by 2050, as compared to 51% in 2010. Figures compiled by the World Health Organization (WHO) give very similar projections.
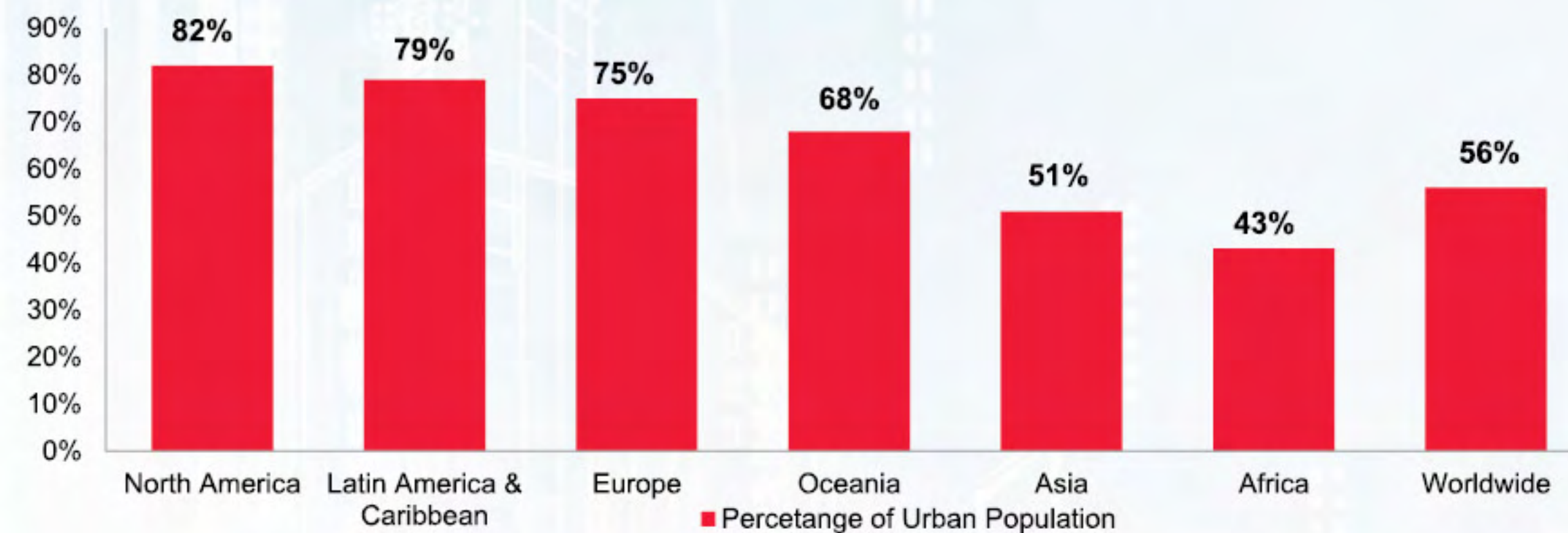
43 megacities

Megacities
A study published by the United Nations (UN) states that, by 2030, the world will have a total of 43 megacities (i.e. ones with more than 10 million inhabitants). Most of these will be situated in developing regions of the world.

▪ Statista states that North America is the most urbanized continent currently, with 82.0% of its population living in cities. Latin America and the Caribbean were also reported as having a high degree of urbanization - as about 79.0% of the population reside in cities.

▪ Europe is ranked third in terms of degree of urbanization. Here 75.0% of the population live in urban areas.

▪ Many countries in Asia and Africa will face challenges in meeting the needs of their rapidly growing urban populations. This will be most noticeable in relation to housing, transportation, energy systems and other infrastructure, as well as for employment and basic services (such as education and healthcare).

Degree of Urbanization by Continent, 2020

Continent	Percentage of Urban Population
North America	82%
Latin America & Caribbean	79%
Europe	75%
Oceania	68%
Asia	51%
Africa	43%
Worldwide	56%

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Internet of Things

Emerging Mega Trends

10.0 bn

IoT Devices Today
In 2021, there were more than 10 billion active IoT devices.

25.4 bn

IoT Devices in the Future
It is expected that the number of IoT devices in operation will surpass 25.4 billion by 2025.
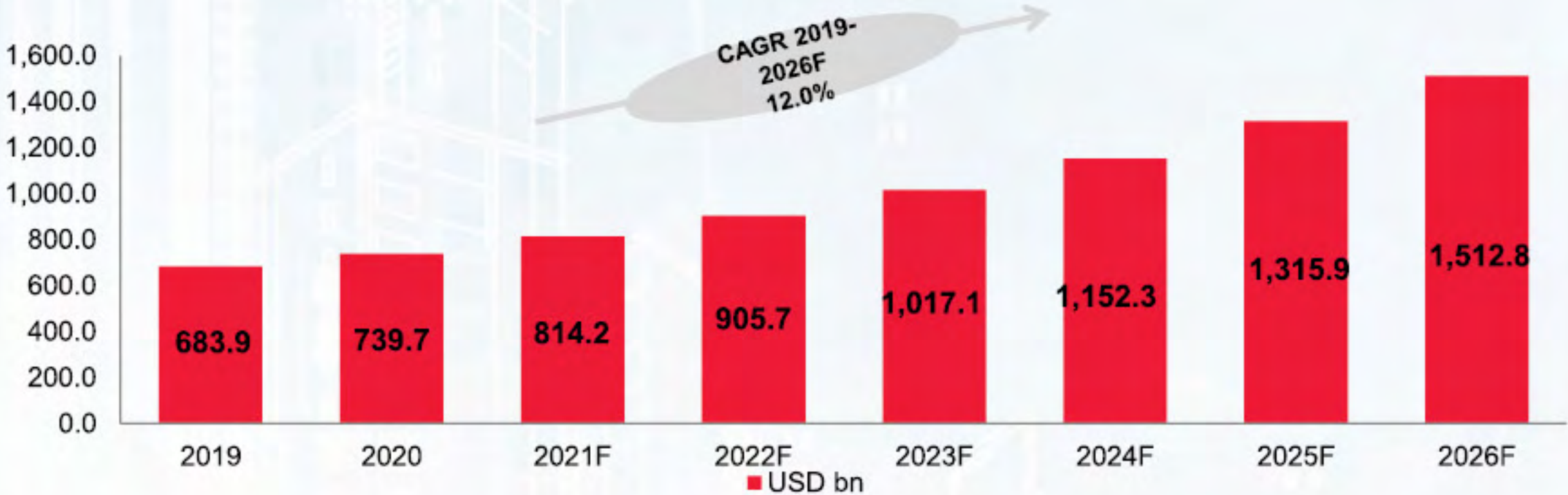
30%

IoT Hardware
The most-notable change to the IoT sector will be around the emergence of new software that allows for connection between devices. Hardware still accounts for 30.0% of the total value of IoT technology, although trends suggest its global market value is decreasing.

▪ The global IoT market is expected to reach a value of USD 1,512.8 billion by 2026 (from USD 683.9 billion in 2019). That represents a CAGR of 12.0%.

▪ With the development of new wireless networking technologies, the emergence of advanced data analytics, a reduction in the cost of connected devices and increased cloud platform adoption, the IoT market is expected to keep growing at a considerable rate.

▪ Based on forecasts of over 7.33 billion mobile users by 2023 and more than 1.1 billion connected wearable devices by 2022, show the IoT is destined to become one of the smartest collective and collaborative systems in human history.

▪ Transportation is getting smarter too. Insider Intelligence projects that in the US connected cars will constitute 97.0% of the total number of registered vehicles by 2035.

CAGR 2019-2026F 12.0%

	2019	2020	2021F	2022F	2023F	2024F	2025F	2026F
USD bn	683.9	739.7	814.2	905.7	1,017.1	1,152.3	1,315.9	1,512.8

Global IoT Market, in USD Billion, Between 2019-2026F

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5G

Emerging Mega Trends

35 Gb

Phone Usage
The Ericsson Mobility Report states that the monthly global average data usage per smartphone now exceeds 10GB, and this is forecast to reach 35GB by the end of 2026.

USD 1.0 bn

Horizon Project
Governments are investing in 5G in a bid to make hyper connected public services. For example, China has allotted over USD 30 billion to 5G research and development for the next five years. The European Commission (EC) has earmarked USD 1 billion to 5G as part of its Horizon 2020 project.

350%

5G Coverage
In 2021, 5G coverage grew by a staggering 350.0% to cover 1,336 cities. As a result, 30.0% of the world's countries now have 5G coverage. A year earlier, there were only 378 cities that had 5G.
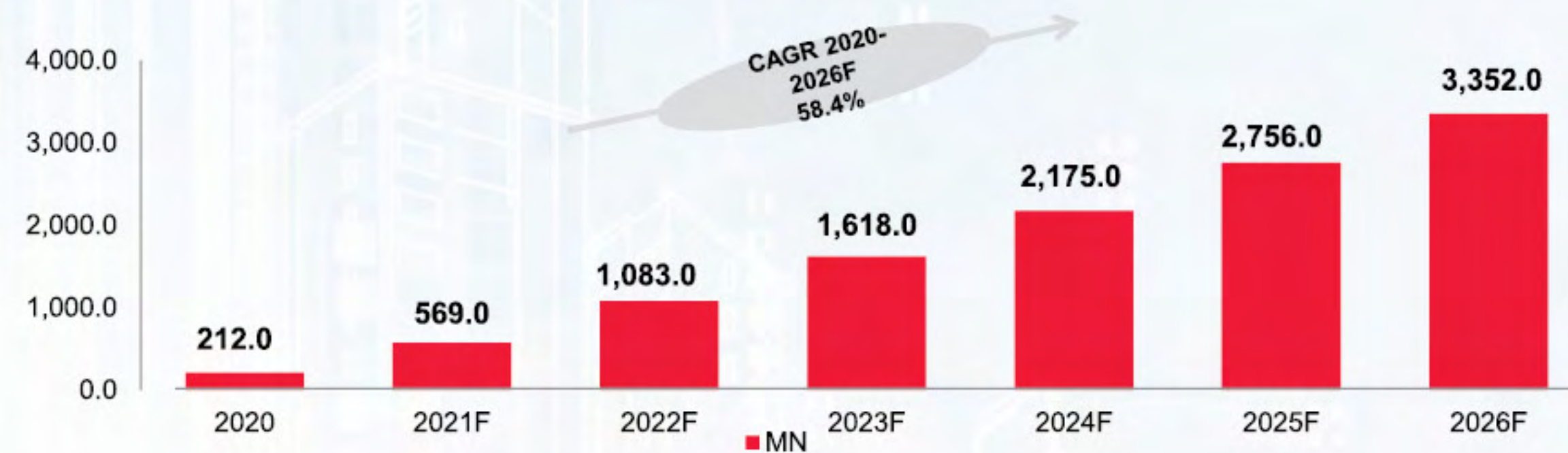
▪ According to estimates from Ericsson's latest edition of its Mobility Report, the number of 5G smartphone subscriptions worldwide passed 500 million in 2021, more than doubling the figure for 2020. In 2022, 5G subscriptions are on target to reach 1.1 billion and this is expected to climb to 3.4 billion during 2026.

▪ 5G-led ubiquitous sensor networks will be at the foundation of smart city development. The unique ability of 5G networks to meet differentiated smart city needs will be pivotal in enabling greater collaborative intelligence.

▪ 5G technology can address the needs of smart healthcare. Through this, it will be possible for fair, accessible and inclusive healthcare reform to be promoted.

▪ North America had an 89.3% share in LTE connections in Q4 of 2020. It was followed by Oceania, East and Southeast Asia at 78.4%, Western Europe at 69.73, then Latin America and the Caribbean at 57.59%.

▪ In Europe, the total benefit of a full 5G deployment for open innovation platforms will cost USD 53.2 billion. However, the benefit in doing so will amount to USD 240.0 billion.

	2020	2021F	2022F	2023F	2024F	2025F	2026F
MN	212.0	569.0	1,083.0	1,618.0	2,175.0	2,756.0	3,352.0

CAGR 2020-2026F 58.4%

Global 5G Subscription, in Millions, 2020-2026F

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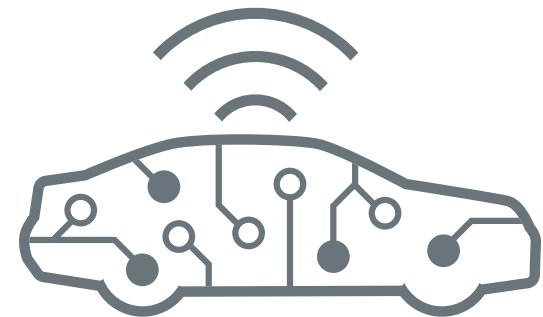
Technological trends

Autonomous Vehicle

These will include drones delivering packages to various locations, service machines doing cleaning and restoration services, plus automated 'personal assistants' helping employees get more done faster and with greater precision.

They will be driven by the improved capabilities from chip vendors (e.g. Qualcomm, Intel, MediaTek, Broadcom, etc.), advanced and more abundant sensors (e.g. visual-based sensors, ultrasonic, touch, smell, LiDAR, etc.), high bandwidth low latency connections (e.g. 5G, Wi-Fi 6), and enhanced AI capabilities/algorithms (e.g. navigation, point-to-point scheduling, visual interpretations, etc.).

Private 5G

5G private networks are isolated either physically or virtually from public networks, using different hardware, virtual machines or network-slices.

Additionally, 5G private networks will further transform the factory floor. The three main components of 5G - enhanced mobile broadband (eMBB), massive IoT and enhanced ultra-reliable low latency communications (eURLLC) - are utilized to connect a diverse set of devices in a factory. The 2020 3GPP Release 16 brought advanced support for 5G non-public networks (NPN), their defining characteristic being a network for private usage and not accessible to public users' navigation, point-to-point scheduling, visual interpretations, etc.)

DSA

Domain-specific architectures (DSAs) will represent the future of artificial intelligence (AI) inference. They will enable adaptable hardware which can be customized, so that workloads may run at the highest possible efficiency. In 2022, AI inferencing will continue to move away from fixed silicon approaches and towards DSAs, helping to eliminate AI productization challenges. With this new ease of programming, FPGAs and adaptable SoCs will continue to become more accessible for hundreds of thousands of software developers and AI scientists - making them the hardware solution of choice for next generation applications.

Cloud Computing

The smart cities that will be so central to our future society will be underpinned by 5G communication, but also reliant on a number of other technologies if they are to function effectively. This is where cloud computing comes in. Approximately 6 billion people are predicted to live in smart cities by 2045 - that will mean significant computing capacity will be necessary. Cloud technology will provide the digital infrastructure for smart cities, functioning as a storage and analysis system for the data used in everything from autonomous vehicles to farming.

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Addressing
the Challenges

What is required and what Murata can offer

▪ At the foundation of any form of smart city deployment will be the ongoing collection of large amounts of data. Through the analysis of this data, the various different services involved can be planned in ways that are the most efficient, environmentally friendly, responsive and cost-effective. Compiling all of this data calls for mass distribution of IoT devices.

▪ With the IoT devices being placed in locations that are difficult to reach, there is little or no opportunity for technicians to return to them once they have been deployed - the logistical costs would simply be too high. It is therefore vital that such hardware is built from high reliability components that will support long-term trouble-free operation. This will mean that the need for replacement or maintenance work can be avoided.

▪ In addition, plug-and-play solutions should ideally be chosen. This will minimize the set-up period and the engineering effort involved in configuration, calibration, etc. Smart city services can then be brought on-line in a much shorter time frame, meaning that citizens will see the benefits sooner.

▪ Murata offers a broad selection of relevant components parts, enabling customers to choose the best fit for their specific application requirements without having to make compromises. These are straightforward to install and deliver prolonged working lifespans.

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Smart Mobility

Bringing us closer to an autonomous future

▪ One of the key elements of future smart cities is certain to be the automation of transportation networks and the removal of human involvement from driving. This will enable safer journeys for citizens, with there no longer being the prospect of accidents occurring. Rather than needing to worry about concentrating on the road, vehicle occupants will be able to simply relax and enjoy the ride.

▪ Industry analysts Statista has predicted that 1 in 10 vehicles will be fully autonomous by 2030. To support this shift away from human control, high accuracy movement predictions will be mandated. This will ensure that optimal distance between vehicles is kept to while they are travelling along highways.

▪ In addition, object detection will be critical - so that any potential danger on the road ahead can be rapidly reacted to (with evasive action being taken if necessary).

▪ Autonomous vehicles will need to communicate with nearby infrastructure and other vehicles. V2X will enable valuable information to be shared, with regard to congestion problems, speed restrictions, accidents, available parking spaces, etc.

▪ Murata's automotive-qualified sensor devices are being featured in many OEMs' smart mobility systems. MEMS-based inertial sensing devices provide accurate data on vehicle positioning and movement. Likewise, ultrasonic sensors are being employed for object detection purposes.

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High accuracy MEMS sensor

3D MEMS technology enables higher performance at lower cost.

Murata offers high performance accelerometers, inclinometers, gyroscopes and combo sensors. Gyroscope components and combined sensors (including gyroscope and accelerometer) are based on our proven 3D MEMS technology and highly integrated electronics.

Industrial gyroscopes offer a performance level that has typically been available only for expensive module products. All products are RoHS compatible and suitable for lead-free reflow soldering.

FEATURES

- **Robust MEMS technology**

- **Field proven reliability & high performance in demanding applications**

- **Good offset stability over temperature and time**

- **High accuracy in demanding applications (eg, high temperature variation, high vibration environment, etc.)**

- **Excellent mechanical shock endurance**

- **Can withstand high impact/dropping**

SCC2000
SCA3300

MURATA BENEFITS & ADVANTAGES:

- **Gyroscope performance:**
  - Bias stability
  - Low noise
  - Accuracy

- **Accelerometer performance:**
  - Low noise
  - Offset stability over temperature
  - Good performance in vibrating environment

ACCELEROMETERS & GYROS

Recommended product	Product description	Benefits	Features
SCA3300	Digital SPI 3 axis accelerometer for inclination measurement	Reliability	
SCC2000	Digital SPI 1 axis gyro & 3 axis accelerometer (X or Z axis)	Combined sensor, Reduced PCB size	Good performance vibrating environment, High offset accuracy over temperature and time, High mechanical shock endurance, Competitive price, Self-diagnostic features
SCC3000	Digital SPI 2 axis gyro and 3 axis accelerometer	Combined sensor, Small size	
SCHA600	Digital SPI 3 axis gyro and 3 axis accelerometer	Excellent bias stability and noise, 6 DoF sensor	

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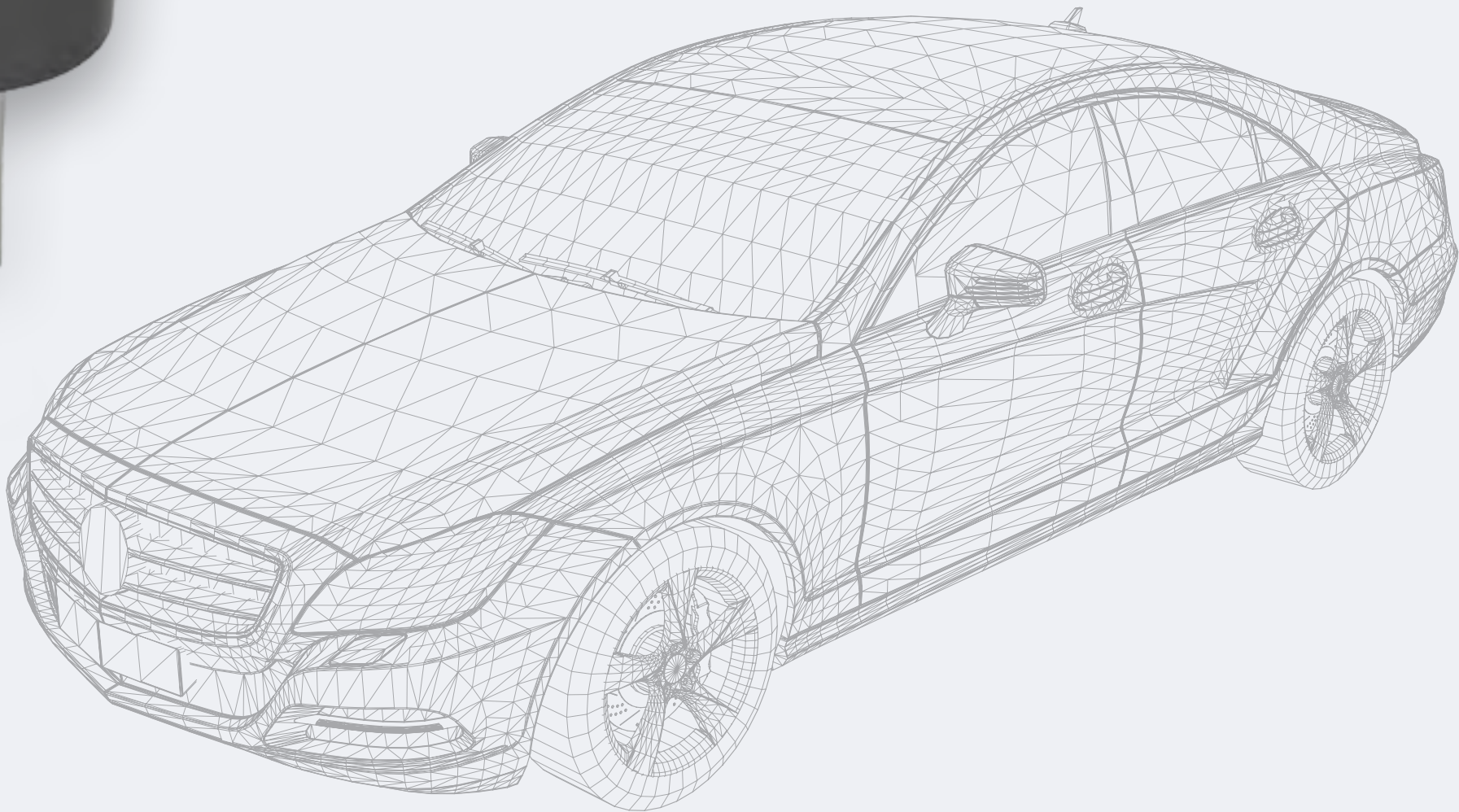INNOVATOR IN ELECTRONICS

Ultrasonic sensor

Low-cost solution for distance detection

Small and lightweight, ideally suited for short-distance range detection and home security.

APPLICATIONS

- **Robotics (consumer use)**
- **Room layout scanning**

MA40S4S
Ø = 9.9mm

Type	Using method	Part number	Driving frequency (kHz)	Diameter (mm)	Capacitance (pF)	Directivity (degree, typ.)	Sound pressure level	Sensitivity	Max. Input voltage
Open type	Transmitter	**MA40S4S**		9.9±0.3	2550±20%		120dB typ. (0db=0.02mPa)	—	20Vp-p Continuous signal
	Receiver	**MA40S4R**	40	9.9±0.3	2550±20%	80	—	-63dB typ. (0db=10V/Pa)	—

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Global Locations

For details please visit www.murata.com

⚠ **Note**

1 Export Control

For customers outside Japan:

No Murata products should be used or sold, through any channels, for use in the design, development, production, utilization, maintenance or operation of, or otherwise contribution to (1) any weapons (Weapons of Mass Destruction [nuclear, chemical or biological weapons or missiles] or conventional weapons) or (2) goods or systems specially designed or intended for military end-use or utilization by military end-users.

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For products which are controlled items subject to the "Foreign Exchange and Foreign Trade Law" of Japan, the export license specified by the law is required for export.

2 Please contact our sales representatives or product engineers before using the products in this catalog for the applications listed below, which require especially high reliability for the prevention of defects which might directly damage a third party's life, body or property, or when one of our products is intended for use in applications other than those specified in this catalog.

① *Aircraft equipment*
② *Aerospace equipment*
③ *Undersea equipment*
④ *Power plant equipment*
⑤ *Medical equipment*
⑥ *Transportation equipment (vehicles, trains, ships, etc.)*
⑦ *Traffic signal equipment*
⑧ *Disaster prevention / crime prevention equipment*
⑨ *Data-processing equipment*
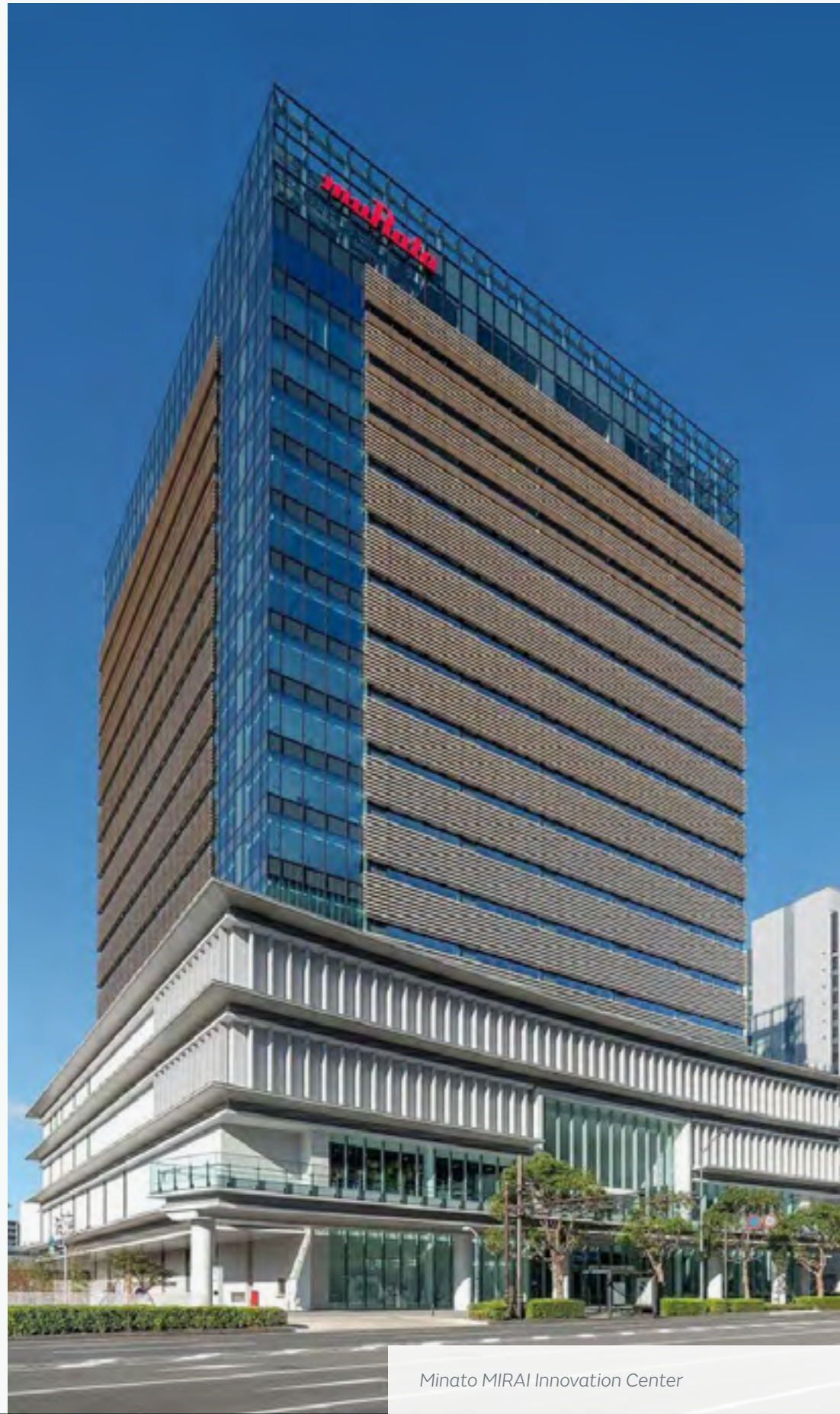⑩ *Application of similar complexity and/or reliability requirements to the applications listed above*

3 Product specifications in this catalog are as of March 2020. They are subject to change or our products in it may be discontinued without advance notice. Please check with our sales representatives or product engineers before ordering. If there are any questions, please contact our sales representatives or product engineers.

4 Please read rating and ⚠CAUTION (for storage, operating, rating, soldering, mounting and handling) in this catalog to prevent smoking and/or burning, etc.

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