Overview of the TAM Forecast Database

April 2025

Internet of Things
AI
Hyperconnectivity
HMI
Data Sharing
Edge
RPA
Robotics
3D Printing
PLM
Distributed Ledger
Future Tech

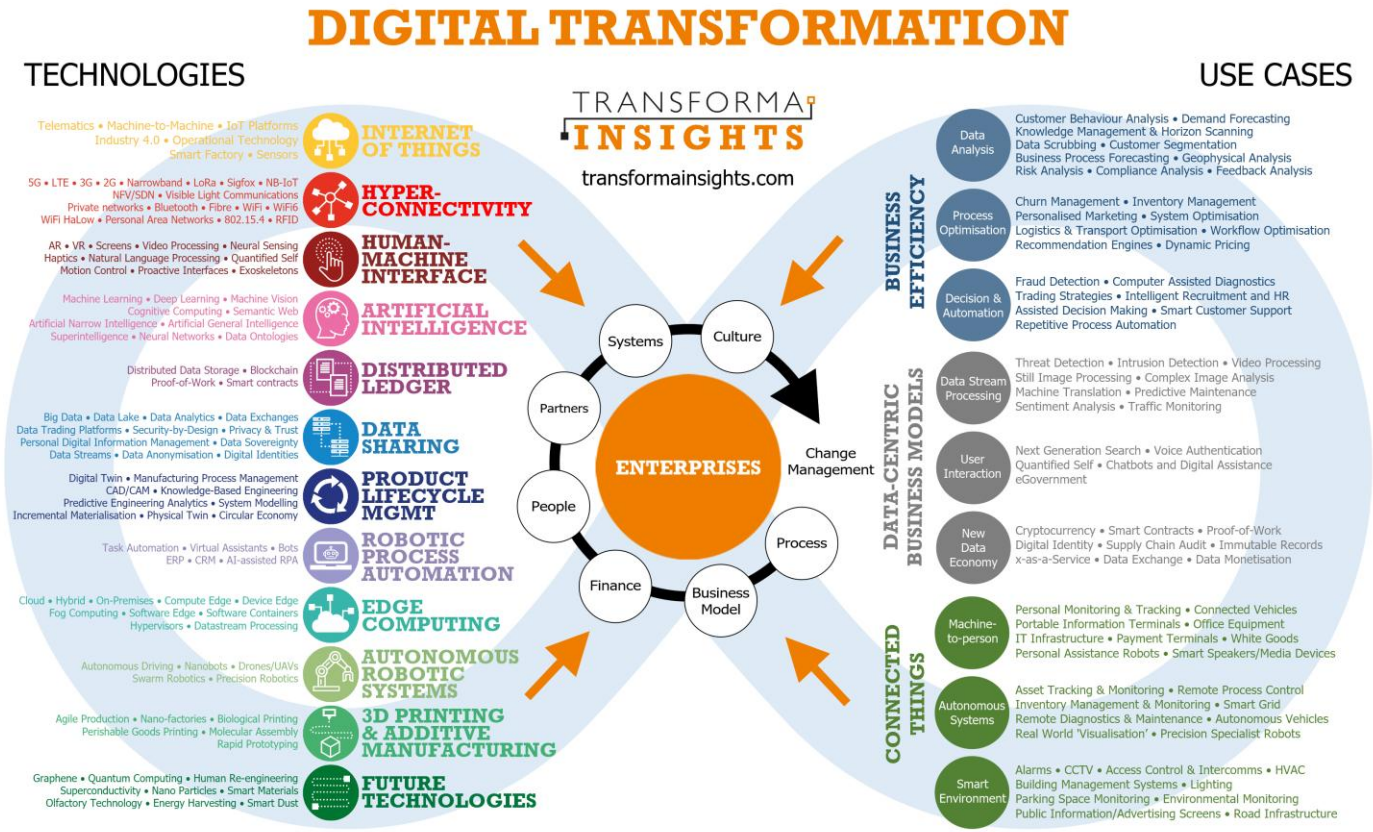
TRANSFORMA INSIGHTS

Introduction

- This document provides details of Transforma Insights' TAM Forecast Database.
- The TAM Forecasts provides our quantitative view of the market opportunity associated with Digital Transformation and all of the associated technologies.
- For information about Transforma Insights more broadly, please see the '*About Transforma Insights*' document which gives an overview of the organisation and all of its products and services.

The Market Map is the basis for all of our forecasts

- Comprehensive market forecasts covering all of the 12 DX technology families, 76 use cases, 20 sectors and 196 countries



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Parameters of published forecasts

Industry Sectors (19)
- Agriculture, Forestry & Fishing
- Mining & Quarrying
- Manufacturing
- Electricity, Gas, Steam & A/C
- Water Supply & Waste Management
- Construction
- Retail & Wholesale
- Transportation & Storage
- Accommodation & Food Service
- Information & Communication
- Finance & Insurance
- Real Estate
- Professional, Scientific & Technical
- Administrative
- Government
- Education
- Health & Social Care
- Arts & Entertainment
- Other Services

DX12 Technologies (12)
- 3D Printing & Additive Manufacturing
- Artificial Intelligence
- Autonomous Robotic Systems
- Data Sharing
- Distributed Ledger
- Edge Computing
- Future Technologies
- Human Machine Interface
- Hyperconnectivity
- Internet of Things
- Product Lifecycle Management
- Robotic Process Automation

Regions (12) +196 countries
- Australasia
- Europe
- Greater China
- India & South Asia
- Japan
- Latin America
- MENA
- North America
- Russia & Central Asia
- South East Asia
- South Korea
- Sub-Saharan Africa

Business Efficiency Use Cases (26)
- **Data Analysis:** Customer Behaviour Analysis; Feedback Analysis; Knowledge Management & Horizon Scanning; Demand Forecasting; Data Scrubbing; Customer Segmentation; Business Process Forecasting; Geophysical Analysis; Risk Analysis; Compliance Analysis
- **Process Optimisation:** Dynamic Pricing; Churn Management; Inventory Management; Personalised Marketing; System Optimisation; Logistics Optimisation; Transportation Optimisation; Workflow Optimisation; Recommendation Engines
- **Decision Support & Automation:** Fraud Detection; Computer Assisted Diagnostics; Trading Strategies; Intelligent Recruitment and HR; Assisted Decision Making; Smart Customer Support; Repetitive Process Automation

Data Centric Business Models Use Cases (23)
- **Data Stream Processing:** Threat Detection; Intrusion Detection; Video Image processing; Still Image Processing; Complex Image Analysis; Machine Translation; Predictive Maintenance; Sentiment Analysis; Traffic Monitoring
- **User Interaction:** Next Generation Search; Voice Authentication; Quantified Self; Chatbots and Digital Assistance; eGovernment
- **New Data Economy:** Cryptocurrency; Smart Contracts; Proof-of-Work; Digital Identity; Supply Chain Audit; Immutable Records; x-as-a-Service; Data Exchange; Data Monetisation

Connected Things Use Cases (27)
- **Machine-to-Person:** Personal Monitoring & Tracking; Smart Speakers & Media Devices; Portable Information Terminals; White Goods; Office Equipment; IT Infrastructure; Payment Terminals; Connected Vehicles; Personal Assistance Robots
- **Autonomous Systems:** Asset Tracking & Monitoring; Inventory Management & Monitoring; Remote Diagnostics & Maintenance; Remote Process Control; Real World 'Visualisation'; Smart Grid; Autonomous Vehicles; Precision Specialist Robots
- **Smart Environment:** Security/Fire Alarms; CCTV; Access Control & Intercoms; HVAC; Building Management Systems; Lighting; Environmental Monitoring; Public Information/Advertising Screens; Parking Space Monitoring; Road Infrastructure Monitoring & Control

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Transforma Insights forecasts overview

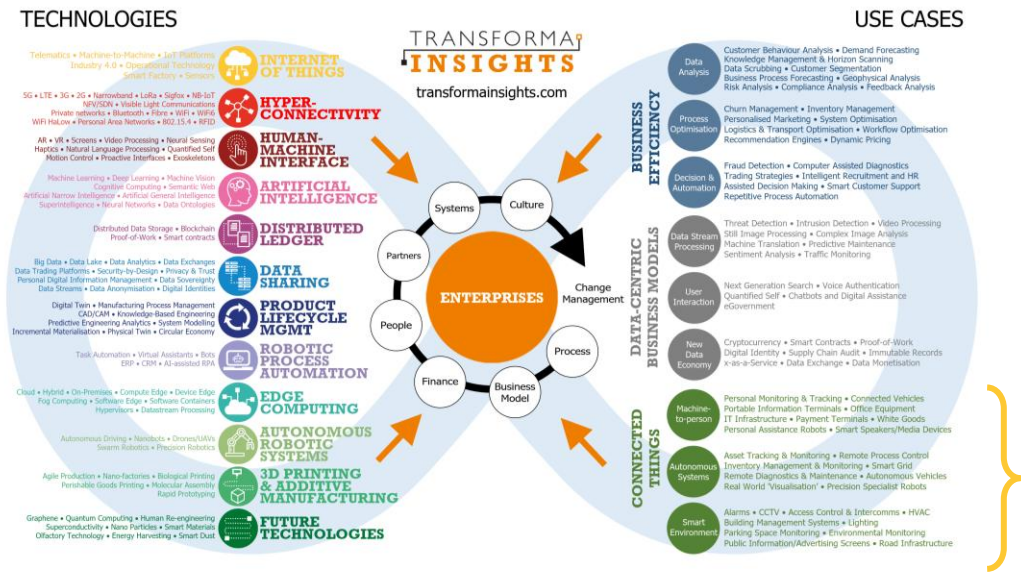
'Connected Things' IoT Forecasts
- End user adoption of IoT devices, by country, sector and use case for instance tracking adoption of smart meters in Poland.
- Metrics include installed base, shipments, user spend and highest connectivity technology.

'Artificial Intelligence' forecasts
- Forecast of AI 'instances' by country and sector
- Based on analysis of 42 use cases such as Natural Language Processing, Predictive Maintenance, Repetitive Process Automation and Risk Analysis

Hyperconnectivity forecasts
- Similar to 'Connected Things' but tracking all technologies used on a device.
- Allows understanding of total number of e.g. 4G equipped payment terminals in South Korea.
- Shipments and installed base.

Other DX 12 forecasts
- Reports with forecasts for Edge Computing, Product Lifecycle Management (X-aaS), Additive Manufacturing, Distributed Ledger, Human Machine Interface, Robotics, RPA and Data Sharing

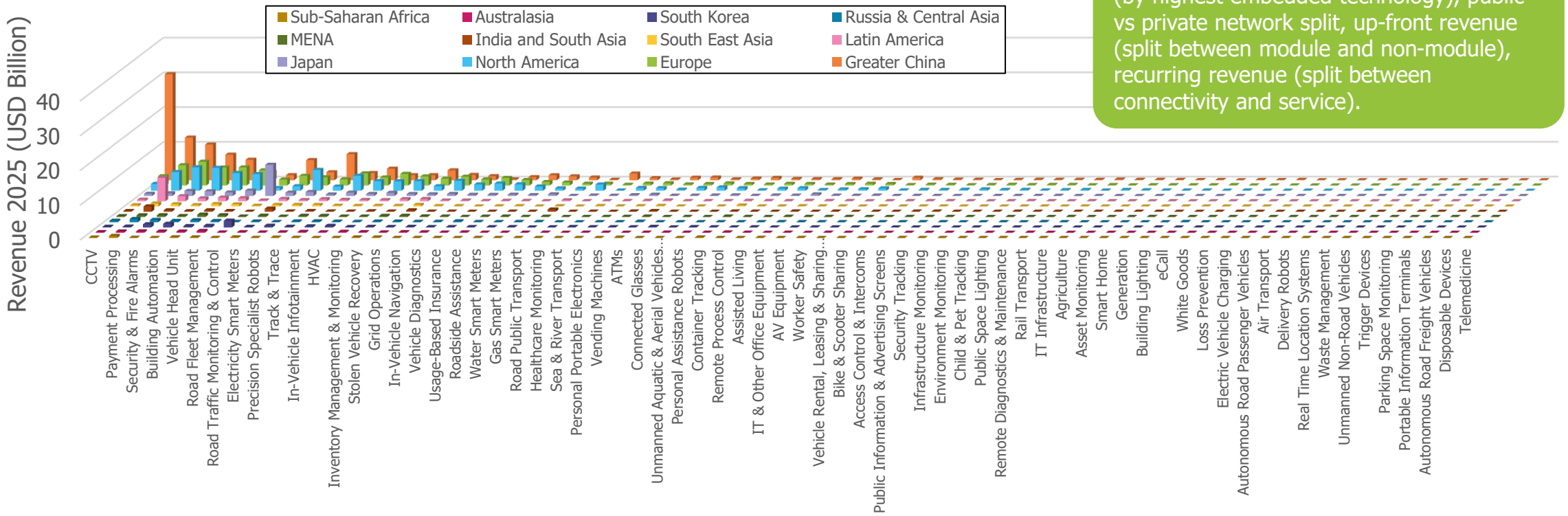
IoT 'Connected Things' Forecasts



- Forecasts of the 'Connected Things' Use Cases, which cover IoT applications.

IoT 'Connected Things' Forecast

Annual IoT spend by Application Group and Geography, 2025
[Source: Transforma Insights, 2021]



The 'Connected Things' forecasts cover 70 Internet of Things application groups, 20 sectors and 196 countries. Metrics include: connected devices, RGUs, technology split (by highest embedded technology), public vs private network split, up-front revenue (split between module and non-module), recurring revenue (split between connectivity and service).

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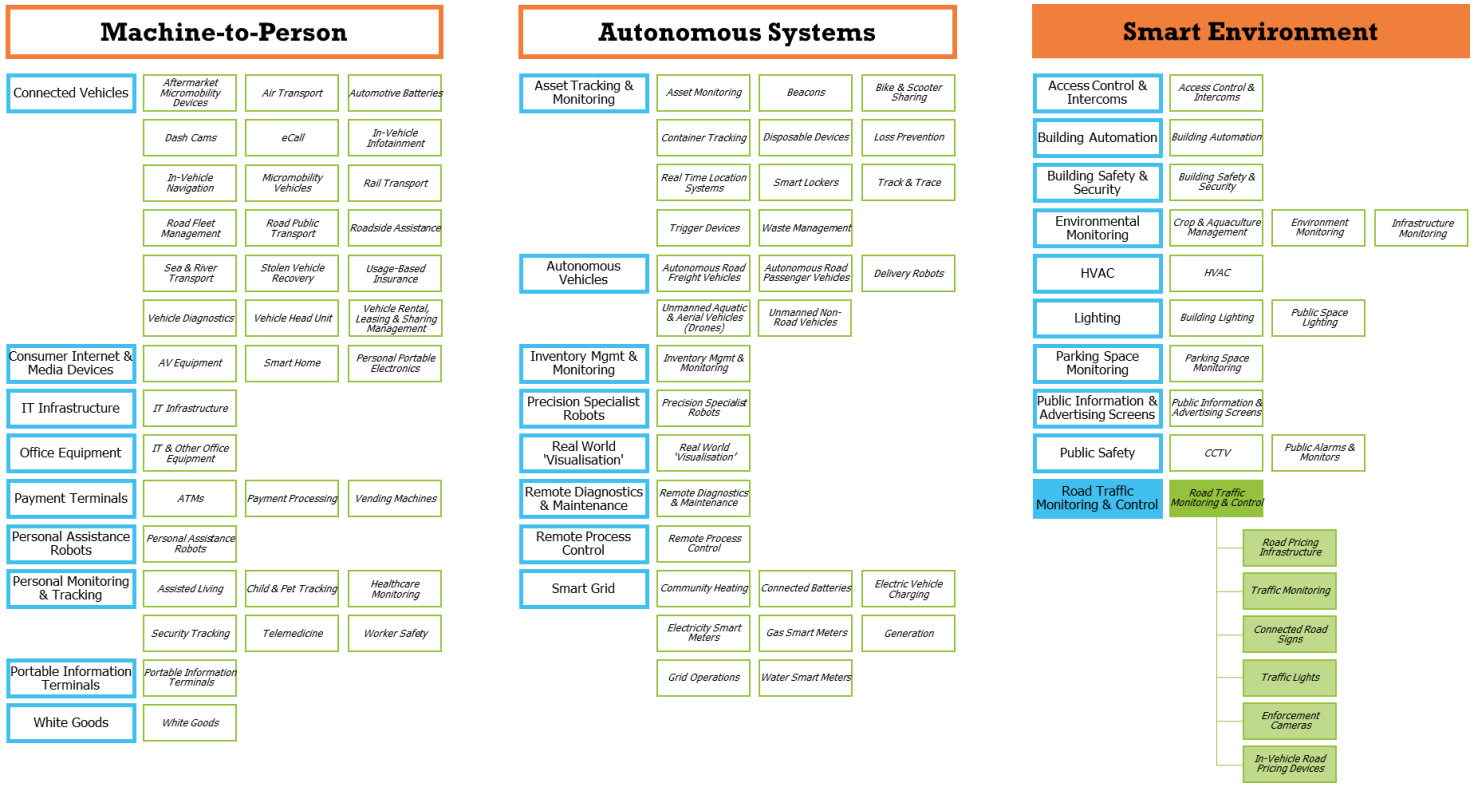
The Connected Things forecasts are built bottom-up

- This image illustrates the three Families, 27 Use Cases, and 78 Application Groups, plus the sub-applications within one of the Application Groups, 'Road Traffic Monitoring & Control'.



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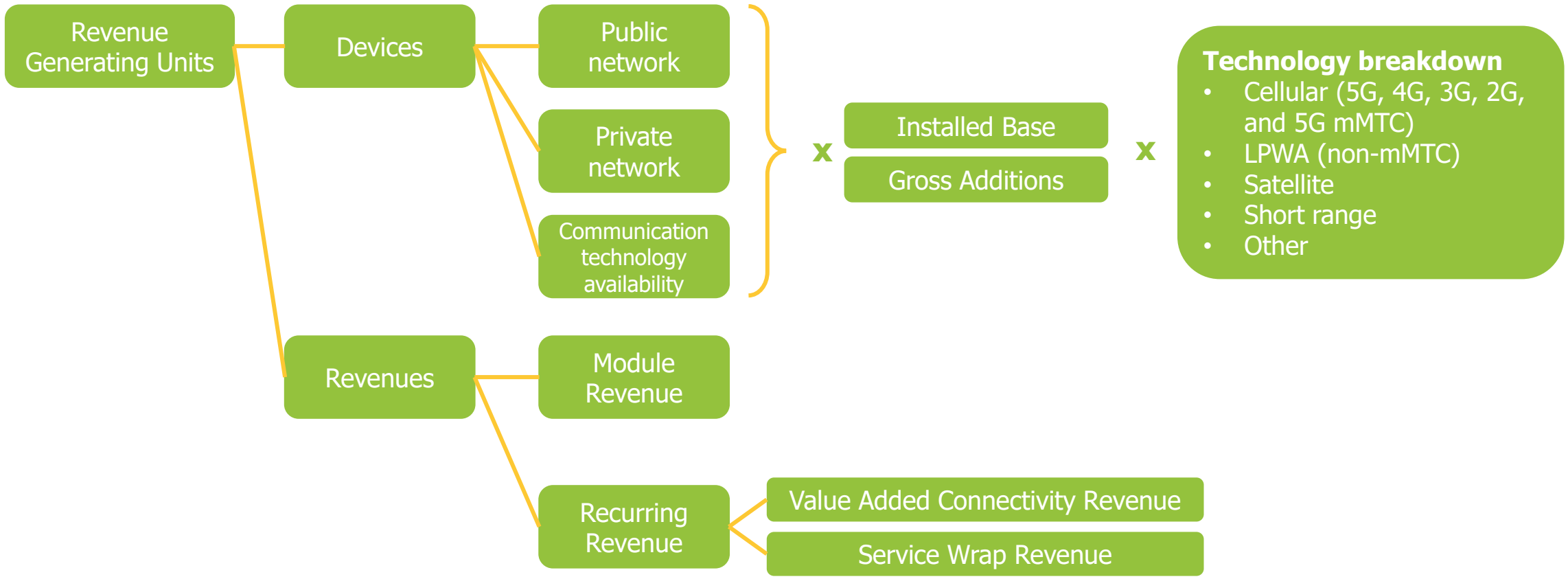
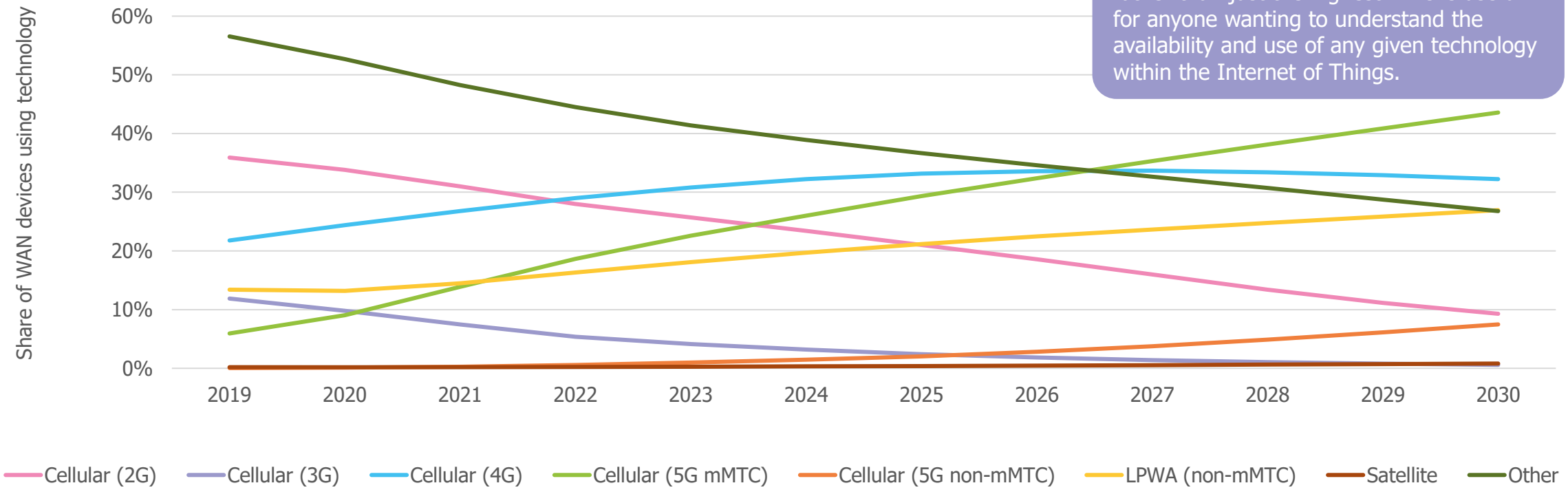
‘Connected Things’ forecast metrics



‘Hyperconnectivity’ forecast launched Jan 2021

The ‘Hyperconnectivity’ forecast is a companion to the Connected Things forecast, covering the same use cases and application groups. The enhancement is that it tracks every embedded technology, rather than just the highest. This is useful for anyone wanting to understand the availability and use of any given technology within the Internet of Things.

Share of communication technology availability, 2019-2030
[Source: Transforma Insights, 2021]



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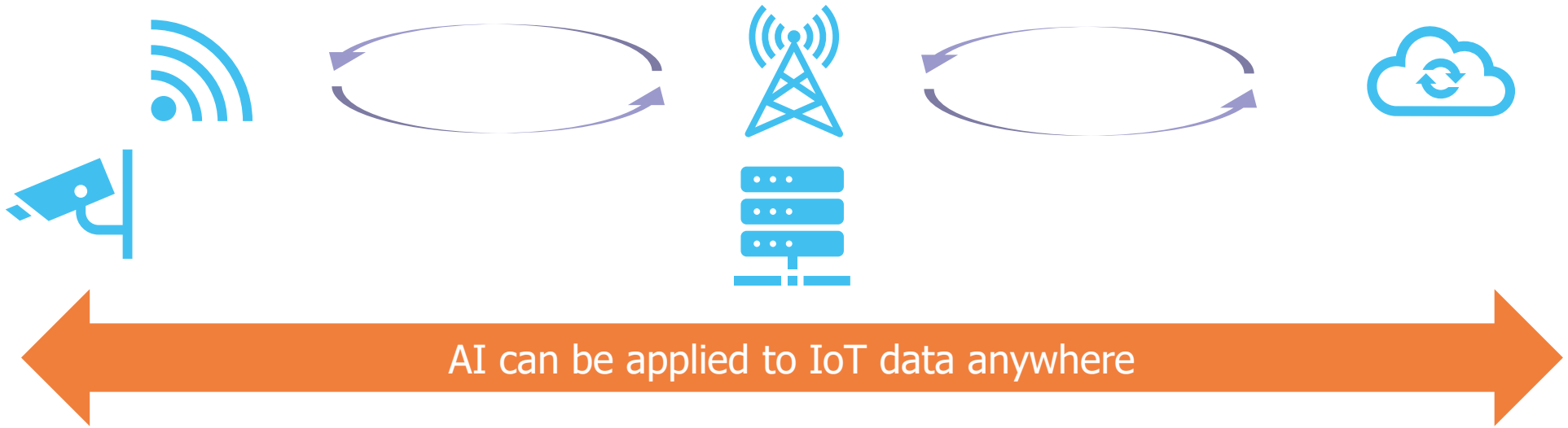
AIoT happens when AI and IoT converge



AIoT

- Improved performance.
- Compliance, privacy, security.
- Reduced operational cost.

AI at the Edge

AI in the cloud

- Compute power.
- Potential scope.
- Version control and evolution.

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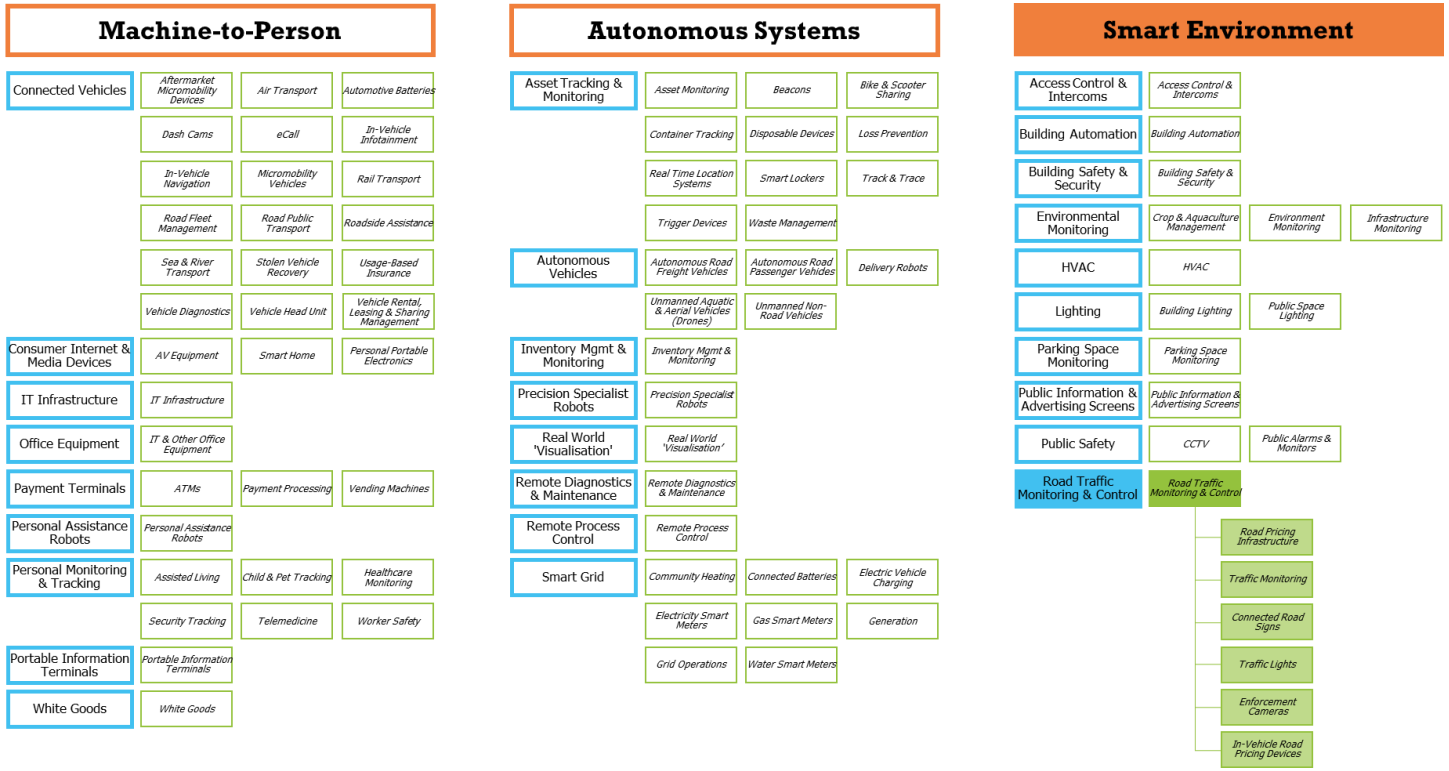
We classify an IoT device as being 'AIoT' when it hosts one or more AI Use Case instances

AI Use Cases
[Source: Transforma Insights, 2024]

Data Analysis	Data-Stream Processing	Decision Support	Process Optimisation	User Interaction
▪ Business Process Forecasting ▪ Compliance Analysis ▪ Customer Behaviour Analysis ▪ Customer Segmentation ▪ Data Scrubbing ▪ Demand Forecasting ▪ Feedback Analysis ▪ Geophysical Analysis ▪ Knowledge Management & Horizon Scanning ▪ Risk Analysis	▪ Activity Recognition ▪ Autonomous Systems ▪ Image Processing & Analysis ▪ Intrusion Detection ▪ Machine Translation ▪ Natural Language Processing ▪ Predictive Maintenance ▪ Sentiment Analysis ▪ Threat Detection ▪ Traffic Monitoring	▪ Bioinformatics ▪ Computer Assisted Diagnostics ▪ Fraud Detection ▪ Intelligent Recruitment and HR ▪ Product Design & Development ▪ Repetitive Process Automation ▪ Smart Customer Support ▪ Trading Strategies	▪ Churn Management ▪ Dynamic Pricing ▪ Inventory Management ▪ Logistics Optimisation ▪ Personalised Marketing ▪ Recommendation Engines ▪ System Optimisation ▪ Transportation Optimisation ▪ Workflow Optimisation	▪ Chatbots and Digital Assistance ▪ eGovernment ▪ Next Generation Search ▪ Quantified Self ▪ Voice Authentication

Connected Things IoT forecasts are built bottom-up

- This image illustrates the three Families, 27 Use Cases, and 78 Application Groups, plus the sub-applications within one of the Application Groups, 'Security & Fire Alarms'.



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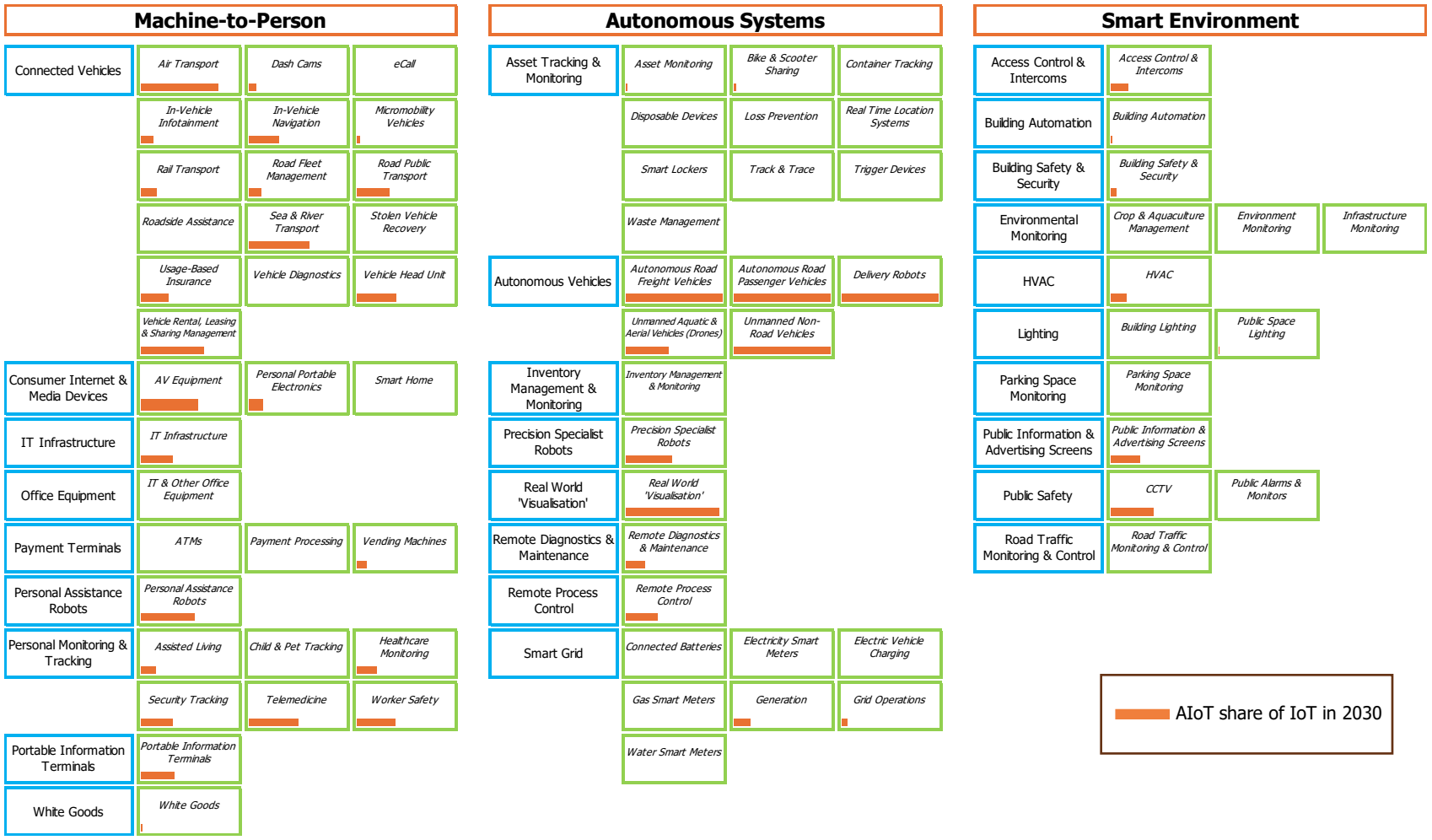
This granularity is maintained for AIoT forecasts

Our detailed IoT forecasts provide us the perfect starting point for an AIoT equivalent. Allowing us to create the most granular AIoT device forecast available.

To do this we evaluate AI demand by:

- Industry sectors
- Geographies
- Use cases and return on investment
- Individual IoT application markets



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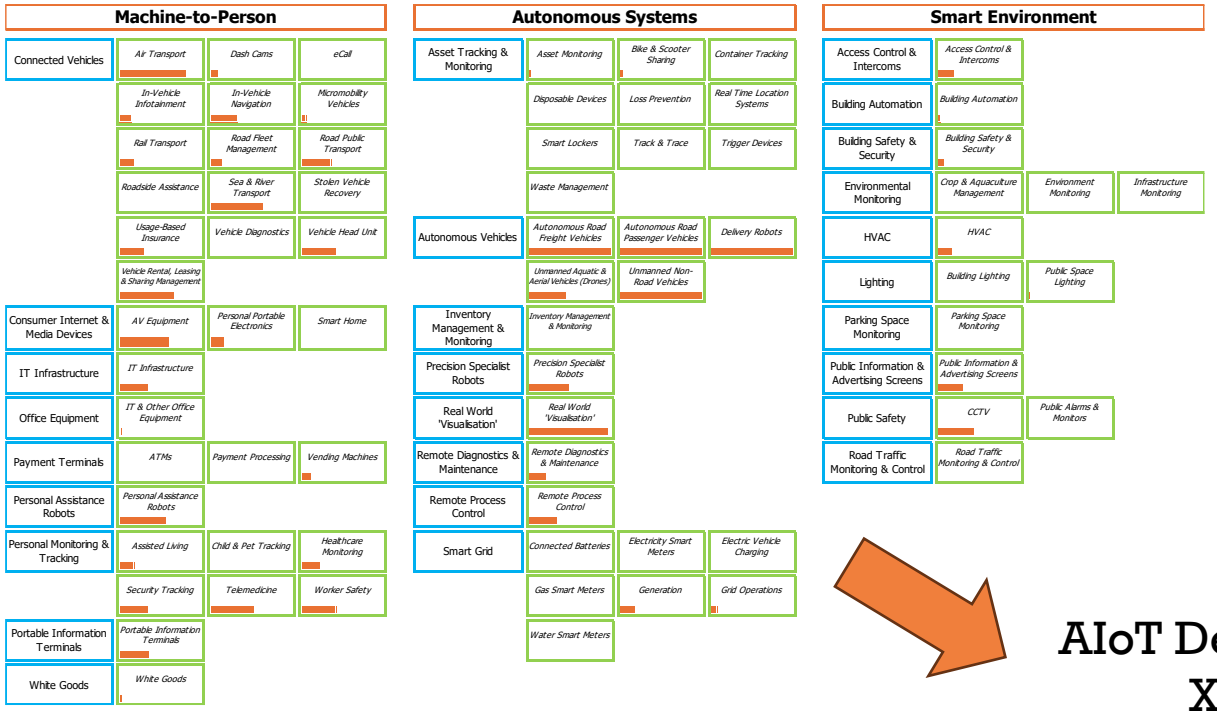
Further analysis identifies the AI Use Cases that feature onboard AIoT devices



AIoT Devices
X
AI Use Cases
=
AIoT Instances per device

AI Use Cases

Data Analysis

Business Process Forecasting
Compliance Analysis
Customer Behaviour Analysis
Customer Segmentation
Data Scrubbing
Demand Forecasting
Feedback Analysis
Geophysical Analysis
Knowledge Management & Horizon Scanning
Risk Analysis

Data-Stream Processing

Activity Recognition
Autonomous Systems
Image Processing & Analysis
Intrusion Detection
Machine Translation
Natural Language Processing
Predictive Maintenance
Sentiment Analysis
Threat Detection
Traffic Monitoring

Process Optimisation

Churn Management
Dynamic Pricing
Inventory Management
Logistics Optimisation
Personalised Marketing
Recommendation Engines
System Optimisation
Transportation Optimisation
Workflow Optimisation

Decision Support

Bioinformatics
Computer Assisted Diagnostics
Fraud Detection
Intelligent Recruitment and HR
Product Design & Development
Repetitive Process Automation
Smart Customer Support
Trading Strategies

User Interaction

Chatbots and Digital Assistance
eGovernment
Next Generation Search
Quantified Self
Voice Authentication

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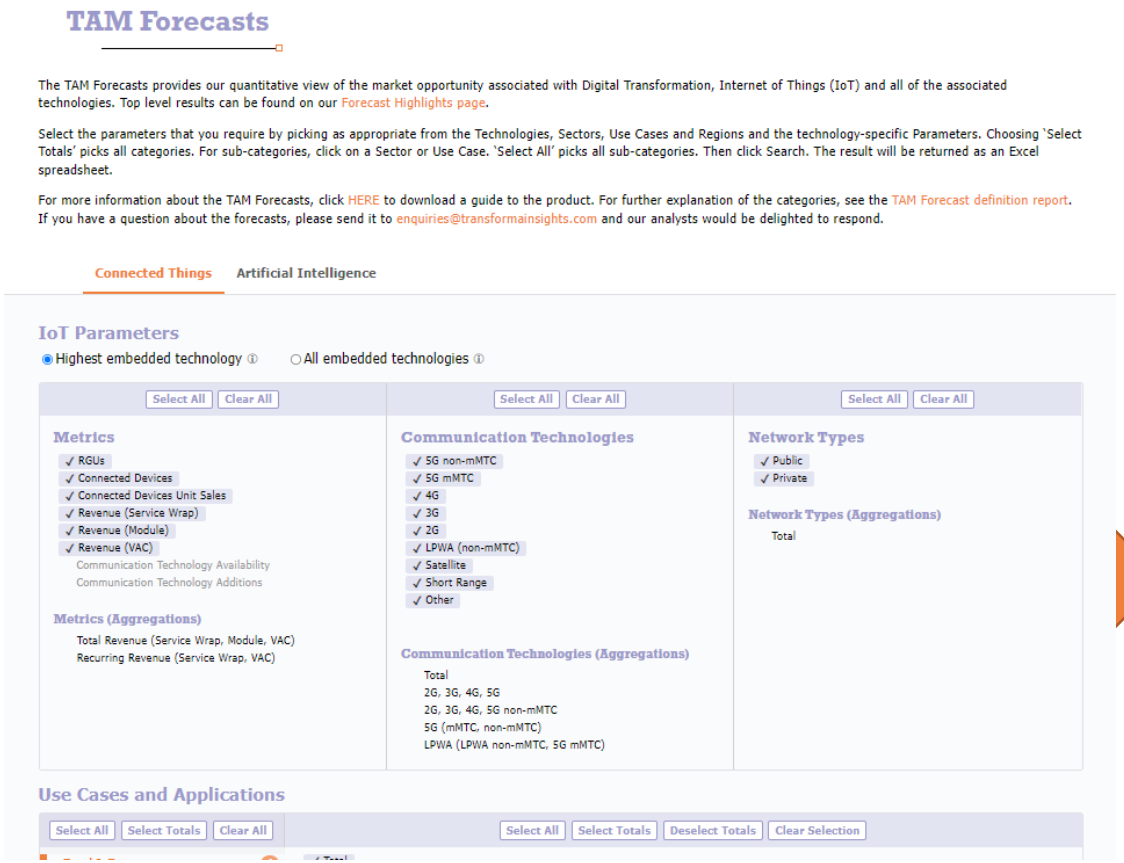
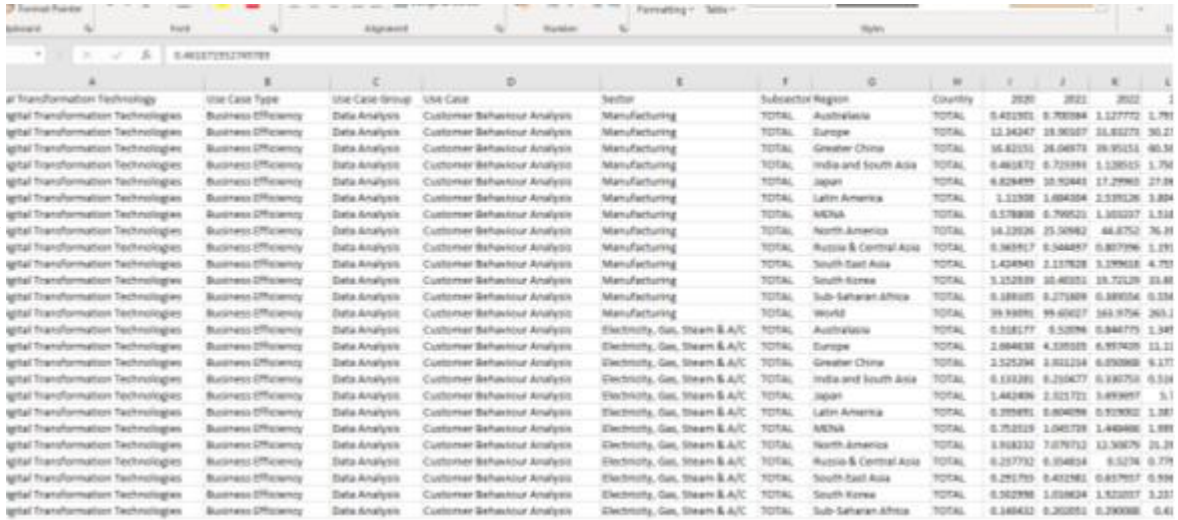


- Online dashboard where you can select technology, vertical, use case and region.
- Outputs to a spreadsheet.



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For more information

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Forecasting Approach

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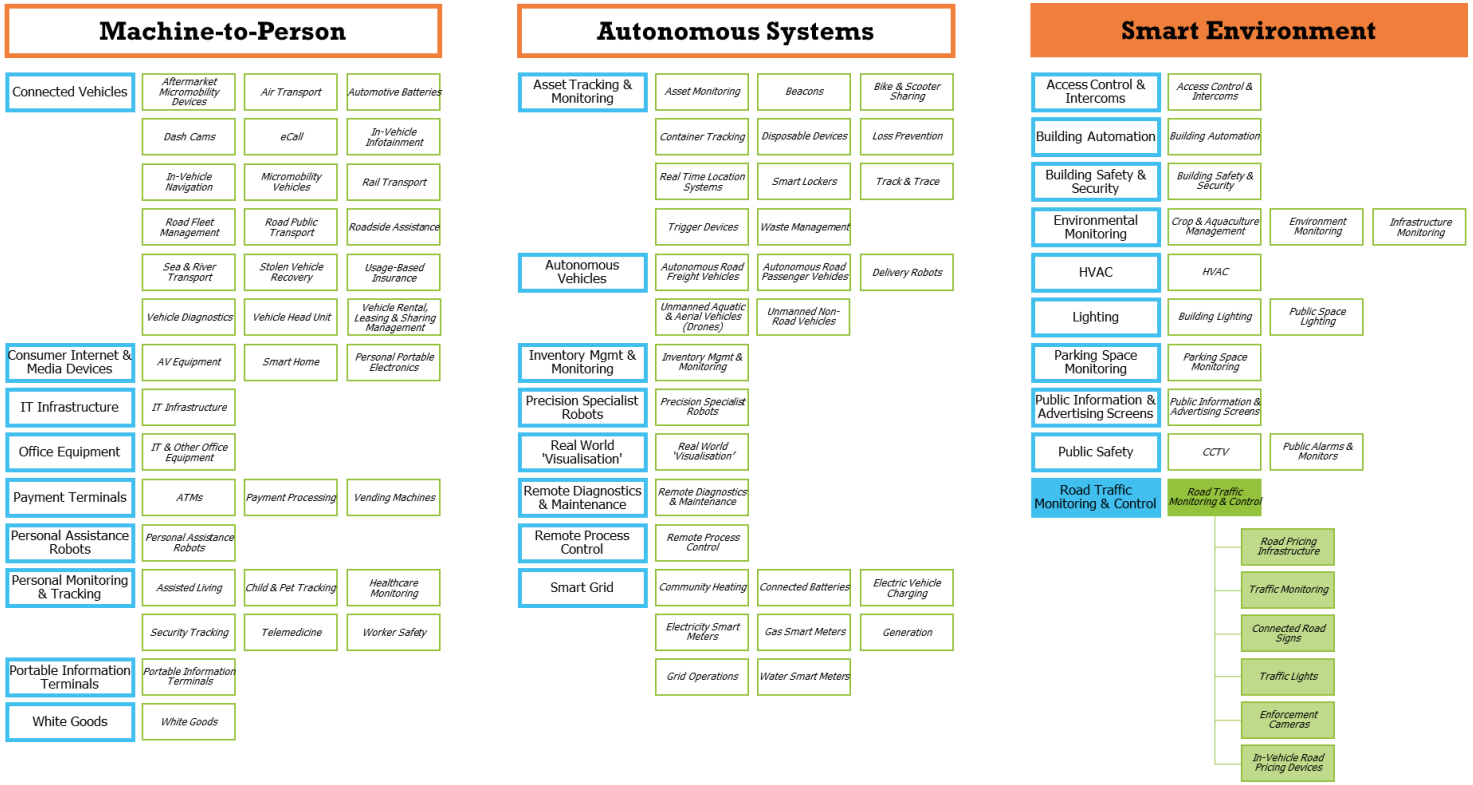
We have developed detailed frameworks to underpin forecasts

Connected Things forecast framework
[Source: Transforma Insights, 2022]



Analytic approach

- The image left illustrates the forecast framework for Connected Things, comprising three Families, 27 Use Cases, and 78 Application Groups, plus the sub-applications within one of the Application Groups, 'Road Traffic Monitoring & Control'.
- The framework aims to include all types of connected (IoT) device, and supports application-by-application bottom-up analysis.
- Application forecasts are assigned to verticals in cases where applications are materially different in a specific vertical. Applications that are generic across multiple industry verticals (e.g. HVAC) are assigned to a 'Cross Vertical' category.

Forecasting process

1. Gather reference information for each forecast application, including numbers of devices deployed by market (where available).
2. Augment available information for each application using key drivers of adoption and forecast market development.
3. Assess connectivity technologies per application, based on application need and technology availability.
4. Generate revenue figures for solution components.
5. Cross check with available global figures and other reference data points.

The following five slides provide additional detail.

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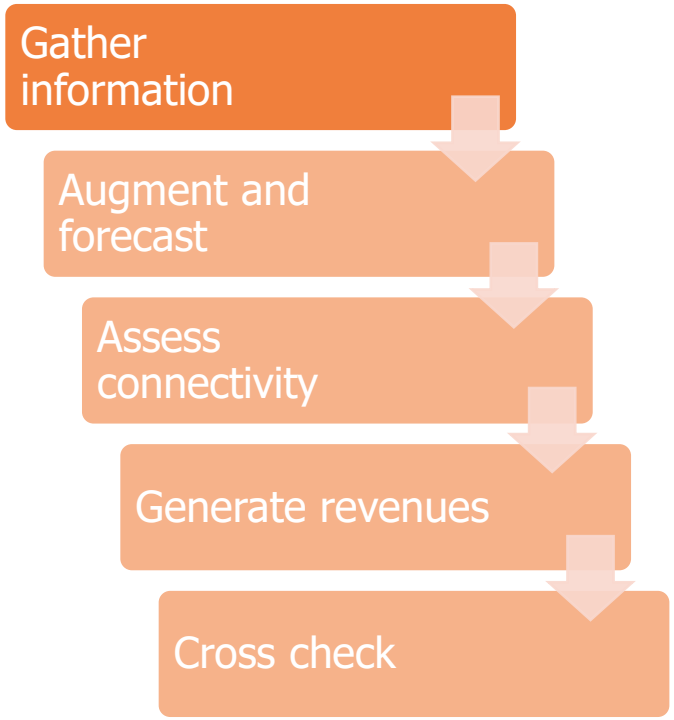
Gathering information is the key first step

Connected Things forecast approach
[Source: Transforma Insights, 2021]

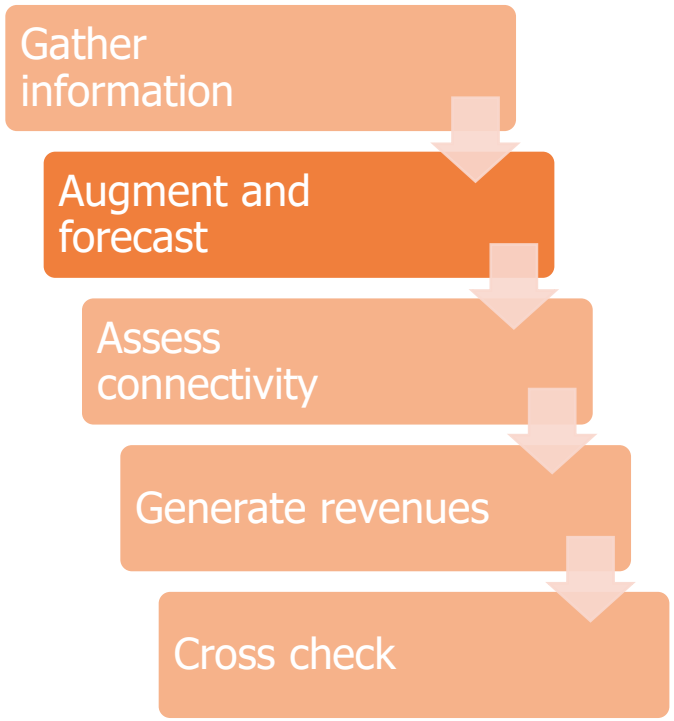


Analytic approach
- Information in the adoption of different forecast applications in different markets can be available from a range of sources.
- Sources include national statistics offices, regulators, industry bodies, manufacturers, and trans-national organisations.
- Available information may be in the form of installed base or shipments. Alternatively, useful information can often be sourced from market research studies.
- We also assess market structure, to ensure that our forecast applications appropriately match any sub-markets that may exist (potentially as a result of market-specific regulations).
- For most applications that we forecast, good, comprehensive, multi-national, consistent sources do not exist so it is generally necessary to 'scrub' source information.

Examples
- **Smart metering:** For many countries, statistics are available on the number of smart meters (electricity, gas, water, etc.) that have been deployed in a market, together with information on national rollout strategies and the expected timeframes for deployment.
- **Connected Vehicles:** OEM strategies for connected vehicles are well-documented, but available information on the numbers of connected vehicles per market is limited.
- **Connected home security systems:** Limited information is available for most markets worldwide, although market surveys of the ownership of such devices have been published.
- **Healthcare remote monitoring:** Limited information is available, other than statistics related to global market size and adoption in a few key countries.
- **Connected irrigation systems:** Some information is available from manufacturers, published market research and datapoints in relevant press releases.

Second, fill in data gaps and forecast

Connected Things forecast approach
[Source: Transforma Insights, 2021]



Analytic approach

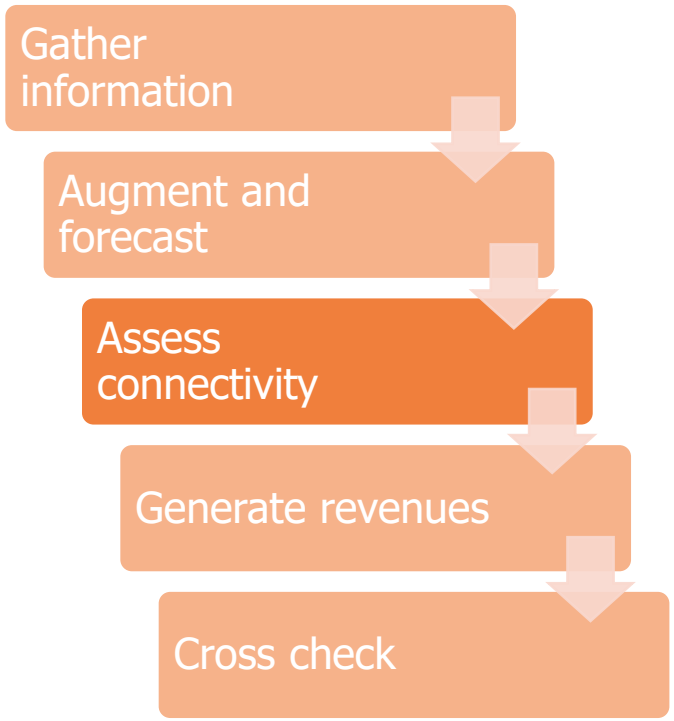
- We review source information per country in relation to drivers for adoption. For example analysing household penetration of smart devices for comparable markets. We investigate the reasons for any notable outliers.
- For many applications that we forecast, adoption information may not be available for specific markets. In these scenarios, we forecast expected adoption levels based on information from comparable markets and adjusted for key underlying demand drivers in specific markets (such as the distribution of GDP/capita within different country markets).
- Having established baseline levels of adoption we forecast future adoption rates based on drivers for adoption in specific markets.
- The distribution of GDP/capita is a key consideration for many consumer applications, since often a certain level of wealth is needed before a consumer will purchase smart 'luxury' (non-essential) goods.
- GDP/ capita is also relevant in the case of many industrial applications, since the business case for adoption of many industrial applications is based on savings of labour costs.
- Overall our forecasts reference 176 sets of baseline 'key driver' information, available for all country markets worldwide and ranging from GVA and employment per industry sector to spend on healthcare and the total number of doctors and hospital beds in a specific market.

Examples

- **Smart metering:** Adoption is available for many markets, and where information is not available estimates are based on published regulator strategies and other information. These same sources inform forecasts.
- **Connected Vehicles:** The profile of new car sales per market by OEM can be combined with the connected car strategies of different OEMs to forecast current and future adoption of connected cars in different markets.
- **Connected home security systems:** Forecasts are based on a range of factors, including GDP/capita distribution and also income inequality (which tends to correlate with crime rates). Significant changes to the structure of the market are also taken into account, in terms of the (rapidly increasing) propensity for security systems to be 'connected'.
- **Healthcare remote monitoring:** Forecasts take into account the incidence of chronic disease (heart disease, respiratory disease, diabetes, etc.) per market, healthcare spending per capita, and the prevalence of obesity.
- **Connected irrigation systems:** Forecasts take into account the amount of agricultural land in any country that is dedicated to crops and also local levels of water stress.

Third, assess connectivity profile per application

Connected Things forecast approach
[Source: Transforma Insights, 2021]



Analytic approach

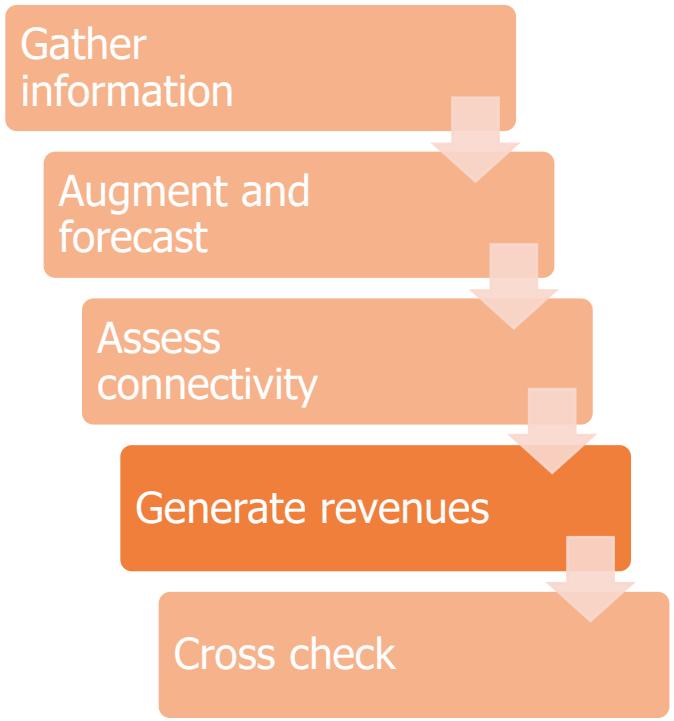
- For each application, we forecast how the devices will be connected including consideration of both wired and wireless technologies (see the Definitions section of this document for the full list of technologies).
- We forecast Revenue Generating Units (RGUs) separately from Devices. A single RGU may comprise multiple Devices (for instance, in the case of a smart home alarm), a single Device (for instance, in the case of a Smart Speaker), or no Devices (for instance in the case of a navigation application hosted on a Vehicle Head Unit). In this way, RGUs represent individual 'sales opportunities' in IoT.
- Connectivity technology forecasts take into account the connectivity needs of any specific application (high or low bandwidth, in-home or wide area connectivity, and so on) and also the potential for any specific technology to be available to support a specific device.
- Key considerations when forecasting connectivity technologies include the timing of roll-out of 5G network technology per market, also the anticipated timing of 2G and 3G network switch-off and the availability of LPWA networks.
- For certain campus and industrial applications we also consider the potential for technology adopters to deploy their own (private) networks to connect devices, and the technology generation profile of any private network connections is adjusted to take into account the dominance of 4G and 5G in this space (as compared to 2G and 3G).
- The forecast 'churn' of installed based for different applications between different connectivity technologies takes into account the anticipated availability of different connectivity technologies for the lifetime of the device, at the time of deployment.

Examples

- **Smart metering:** Smart metering rollout announcements usually include details of the connectivity technology solutions that will be used for that rollout.
- **Connected Vehicles:** Vehicle OEMs tend to be early adopters of new cellular technologies, due to the extended expected lifetime of vehicles on the road and the potential to provide (value added) in-vehicle entertainment and other services. Global supply chains dictate that vehicles that support the latest cellular technologies may be shipped to markets that have not yet rolled out corresponding networks.
- **Connected home security systems:** Many competing forces are at play. Certain solutions with sophisticated functionality will tend to use home Wi-Fi networks, while more robust solutions will more likely use cellular connectivity. Hybrid solutions (e.g. Wi-Fi with cellular fallback, or cellular with LPWA fallback) also exist.
- **Healthcare remote monitoring:** Cellular connectivity can be more appropriate than Wi-Fi particularly if the health remote monitoring device is deployed as part of a 'service', potentially with associated SLAs.
- **Connected irrigation systems:** Such systems likely to be supported by a blend of private network and pubic network wide area wireless connectivity.

Fourth, generate associated revenues

Connected Things forecast approach
[Source: Transforma Insights, 2021]



Analytic approach

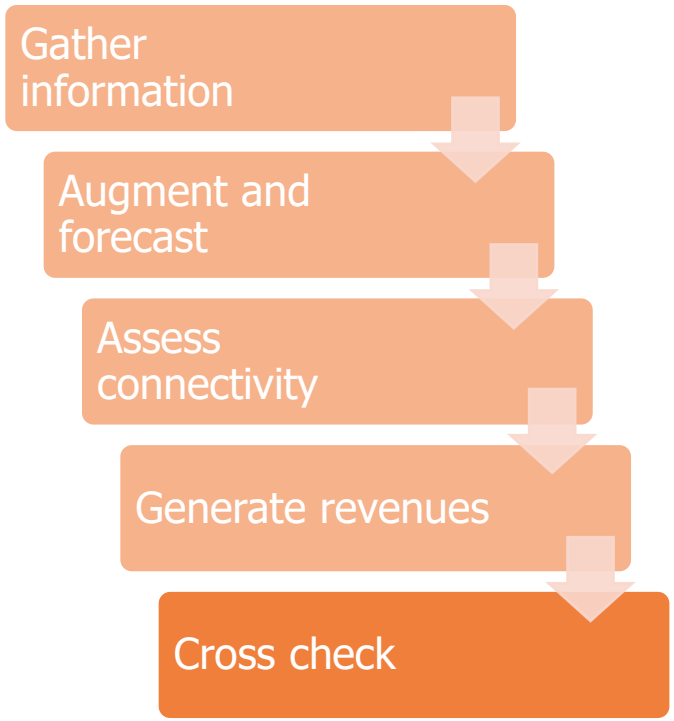
- For each Device we associate a Module revenue representing the cost of a connectivity module of the appropriate technology.
- We also associate a Value Added Connectivity (VAC) figure with each connection. In the case of cellular connectivity this VAC figure represents the revenue that a connectivity provider could be expected to generate from the connection in question, including all aspects of SIM provision and management, connectivity management, carriage of data traffic, reporting, and billing.
- VAC figures per connection are significantly lower where Private network infrastructure is used to support a connection, due to the lack of traffic charges and significantly lower requirements for billing and rating. The costs of implementing and operating private networks are not included in our forecasts.
- For each RGU we associate a 'Service Wrap' figure that represents revenues associated with the core application in question, including IoT enabling platforms and fees associated with the provision of a software application.
- The Service Wrap does not include: systems integration*, business consulting and advisory services; field operations; O&M services; DevOps*; API integration*; system design and architecture*. (*Note: other than where such activities are associated with the development of the core application and where the costs of such services could be expected to be recovered through the fees for an application).

Examples

- **Smart metering:** Service Wrap accounts for the cost associated with generating meter reads and communicating these to a back-end system. It does not include any overall business transformation costs, or costs associated with back-end systems development.
- **Connected Vehicles:** VAC is associated with all RGUs, irrespective of whether the RGU in question is a physical or virtual (hosted software) solution. VAC revenues take into account lower fees for applications that are hosted on a Vehicle Platform, since certain connectivity management (and other) costs will be recovered via the VAC charges for the associated Vehicle Platform.
- **Connected home security systems:** The Service Wrap represents the application revenues associated with the application component of the overall solution, whilst the Module and VAC revenues reflect the connectivity profiles of individual constituent devices. The Service Wrap does not include extensions of the core alarm solution such as access to an Alarm Receiving (call) Centre, or the provision of security guards.
- **Healthcare remote monitoring:** VAC revenues reflect the fees associated with connecting devices, and Service Wrap the core application associated with the connected device (but not extending to include any complex medical functionality).
- **Connected irrigation systems:** Overall VAC revenues will be a blend of public-network and private-network VAC figures, reflecting the extensive use of private network technologies in agricultural contexts.

Lastly, cross check to ensure consistency

Connected Things forecast approach
[Source: Transforma Insights, 2021]



Analytic approach
- Where possible, forecasts are cross-checked with market-level (or regional or global) information.
- For instance, cellular connections in any given market are compared with operator and regulator statistics. However, note that any such comparisons must take into account variances in operator (and regulator) definitions of IoT connections. Differences can include inconsistencies in device types that are classified as IoT, inconsistencies in how 'roaming' connections are counted (either roamed-in or roamed-out), and differences in the definition of an 'active' device.
- Vendor shipment figures can also provide helpful global-level benchmarks, particularly in the case of the NB-IoT (3GPP 5G) technology. In the case of any vendor benchmark figures, account must be taken of the period over which announced connections will be shipped, and delays in the manufacturing and supply chain through to live operations.
- Similarly, total numbers of licence-exempt LPWA connections are compared with available benchmarks.
- For other applications, industry association, regulator, or other benchmarks may be available.

Examples
- **Smart metering:** Generally good information is available on the number of connections in a market, market saturation levels, and connectivity technologies.
- **Connected Vehicles:** Mobile operator IoT connection figures can generally provide a good benchmark for vehicle connections (once other cellular IoT applications have been allowed for).
- **Connected home security systems:** Can be benchmarked against published primary market research in certain markets.
- **Healthcare remote monitoring:** Can be benchmarked against manufacturer shipments figures, although it is often hard to distil these from published information.
- **Connected irrigation systems:** Limited information available for cross checks, other than potentially relevant statistics contained in relevant industry press releases.

Our approach to forecasting other DX technologies is similar to that described for IoT

DX Technology	Forecasting approach
Hyperconnectivity	• An enhancement of the IoT forecasts to take into account *all* connectivity technologies available in a device (not just the single 'highest' technology, as counted in IoT forecasts)
AI	• Use Case forecasts based on instances of applications deployed by enterprise users • Deployment of AI in support of IoT is overlaid on available IoT forecasts as a percentage penetration of each application.
Edge	• Overlaid on IoT forecasts as a percentage penetration of each application. • Augmented by forecasts of enterprise adoption of gateway and distributed edge ('fog') type devices.
Distributed Ledger	• Based on the expected adoption of distributed ledger-enabled applications by industry vertical, as a share of gross value add (GVA). • Considers the role of an enterprise with respect to distributed ledger information: origination; processing; distribution; deployment; or support.
Robotics	• These are IoT devices. Forecast using the IoT methodology as described.
Additive Manufacturing	• These are IoT devices. Forecast using the IoT methodology as described.
Product Lifecycle Management	• Forecasts include a specific category of emerging PLM: servitisation, or X-aaS. • Overlaid on IoT forecasts as a percentage penetration of each application.
Human Machine Interface	• Devices supporting AR and VR applications in enterprise forecast using the IoT methodology as described.
RPA	• Based on forecasts of total spend on RPA combined with the application of RPA-enabled Use Cases in different industry verticals.
Data Sharing	• Based on forecasts of total spend on Data Sharing combined with the application of data sharing-enabled Use Cases in different industry verticals.

Definitions

Internet of Things
AI
Hyperconnectivity
HMI
Data Sharing
Edge
RPA
Robotics
3D Printing
PLM
Distributed Ledger
Future Tech

TRANSFORMA INSIGHTS

Definitions: IoT 'Connected Things' Parameters

Parameters	Definition	Notes
RGUs	Revenue Generating Units	The number of separate billing instances with which connected devices are associated. In some instances there might be multiple RGUs per device (e.g. multiple connected car services). In others there are multiple devices per RGU (e.g. a building automation system).
Connected Devices	Number of devices connected for the purposes of remote monitoring, control or aggregation of data.	Figure is for year end.
Connected Devices Unit Sales	The number of units sold in a calendar year.	Figure is for number of additions in the year, calculated based on new additions to the installed base plus replacements.
Communication Technology Availability	Total number of devices upon which a communication technology is available.	Figure is for year end. Multi-technology devices will count towards each of the relevant data points. In many cases there will be more instances of Communication Technology Availability than there are Connected Devices.
Communication Technology Additions	Instances of communication technology availability that have been introduced in a calendar year.	Figure is for number of additions in the year, calculated based on new additions to the installed base plus replacements. Multi-technology devices will count towards each of the relevant data points. In many cases there will be more instances of Communication Technology Additions than there are Connected Devices Unit Sales.
Revenue	Annual spend by end customers on IoT hardware, connectivity and services.	A sum of Hardware and Recurring revenue.
Module	Share of hardware accounted for by communications module (or equivalent).	
Revenue - Recurring	Annual spend by end customers on IoT services.	Based on annual spend per active device. Divides between 'Service Wrap' and 'VAC Revenue'
Service Wrap	Share of annual spend accounted for by the end user service associated with the connected device.	For example a fleet management service associated with a connected vehicle.
VAC Revenue	Value-added Connectivity. Share of annual spend accounted for by connectivity.	Covers traffic, connectivity management, connectivity platforms and associated services.
Total	Total number of connected devices.	
2G, 3G, 4G, 5G	All wireless/cellular technologies (2G, 3G, 4G, 5G).	Comprises a sum of the figures for 2G, 3G, 4G and 5G (including both mMTC and non-MMTC).
5G	Fifth Generation mobile networks.	Can be deployed as a public or private network.
5G non-mMTC	Fifth Generation mobile networks excluding mMTC devices.	
5G mMTC	Low Power Wide Area as part of the 3GPP standard, specifically 5G massive Machine Type Communication (mMTC).	A range of technologies with multi-year battery life, low throughput capability and low unit costs. Includes the 3GPP technologies NB-IoT (LTE NB1), LTE M1 and 5G RedCap which have been collectively placed under the umbrella of 5G mMTC).
4G	Fourth Generation mobile networks.	Comprises LTE (3GPP Long Term Evolution) and WiMAX. Can be deployed as a public or private network.
2G, 3G	Second and Third Generation mobile networks.	Includes GSM (GPRS, EDGE), CDMA, W-CDMA and CDMA 1x EVDO and other similar technologies.
2G, 3G, 4G, 5G non-mMTC	All cellular technologies (2G, 3G, 4G, 5G) but excluding mMTC devices.	
LPWA	Low Power Wide Area	A range of technologies with multi-year battery life, low throughput capability and low unit costs. Can be deployed as a public or private network.
5G mMTC	Low Power Wide Area as part of the 3GPP standard, specifically 5G massive Machine Type Communication (mMTC).	A range of technologies with multi-year battery life, low throughput capability and low unit costs. Includes the 3GPP technologies NB-IoT (LTE NB1) and LTE M1 which have been collectively placed under the umbrella of 5G mMTC).
LPWA (non-mMTC)	Low Power Wide Area (excluding 3GPP mMTC devices).	A range of technologies with multi-year battery life, low throughput capability and low unit costs. Includes LoRa and Sigfox.
Satellite	Direct connectivity from a device to a satellite, excluding communication technologies covered elsewhere.	GPS-only devices are not included. NTN (i.e. 3GPP Non-Terrestrial Network) devices are counted as cellular-technology connections and LoRa direct-to-satellite device connections are counted as LPWA (non-mMTC).
Short Range	Any local area network (LAN) including WiFi, Zigbee, Thread, Bluetooth and Ethernet.	Ultimately these devices will connect via a gateway with wide area connectivity.
Other	Any other network by which a device is connected, e.g. Lonworks, Powerline.	
Public Networks	A network owned and run by a network operator to support multiple clients. Includes connections supported via private network slices on public networks.	Predominantly fixed and mobile networks deployed and run by communications service providers.
Private Networks	A network owned and run by, or exclusively for, the owner of the connected devices.	Includes campus area networks, private LTE and 5G networks, many LPWA deployments, and short range/LANs.

Definitions: Geographies

- Our definition of geographies is slightly unusual. It is based predominantly on proximity, but also on two other factors:
  - Uniqueness – How comparable is the economy with those in the region with which it might naturally sit. For instance, European countries are sufficiently similar that we now believe they can be considered as a fairly consistent bloc.
  - Replicability of solutions - the ease of transplanting products and services from one country to another. A successful implementation in a Latin American country, for instance, will be relatively easily replicated in others. The same is true for Europe, North America, MENA and Sub-Saharan Africa. This may not necessarily be the case between, say, Japan and Korea.

Definitions: Geographies

Internet of Things
Hyperconnectivity
Data Sharing
RPA
3D Printing
Distributed Ledger
AI
HMI
Edge
Robotics
PLM
Future Tech

TRANSFORMA INSIGHTS

Definitions: Geographies

Region	Definition	Countries included
Australasia	Australia, New Zealand and Pacific Islands.	Australia, Fiji, Kiribati, Marshall Islands, Micronesia, Nauru, New Zealand, Palau, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu
Europe	All countries west of Russia, including Israel and Turkey.	Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom
Greater China	Solely China and Taiwan.	China, Taiwan
India and South Asia	India plus surrounding countries.	Bangladesh, Bhutan, India, Maldives, Nepal, Sri Lanka
Japan	Solely Japan.	Japan
Latin America	South and Central America and Caribbean.	Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela
MENA	Middle East and North Africa. Countries in West Asia, and Africa north of the Sahara Desert.	Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Syria, Tunisia, United Arab Emirates, Yemen
North America	Solely US and Canada.	Canada, United States of America
Russia & Central Asia	Eurasian countries comprising Russia, Central Asia and other proximate countries.	Afghanistan, Kazakhstan, Kyrgyzstan, Mongolia, North Korea, Russia, Tajikistan, Turkmenistan, Uzbekistan
South East Asia	Asian countries south of China, east of India.	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste, Vietnam
South Korea	Solely South Korea.	South Korea
Sub-Saharan Africa	All countries in Africa south of the Sahara Desert.	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of the, Congo, Republic of the, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

Definitions: Sectors

Sector	Definitions	Sub-sectors
Agriculture, Forestry & Fishing	Industrial Standard Classification (ISIC) code Divisions 01-03. See United Nations 'International Standard Industrial Classification of All Economic Activities' (2008) for more details.	Crop and animal production, hunting and related service activities; Forestry and logging; Fishing and aquaculture
Mining & Quarrying	ISIC code Divisions 05-09.	Extraction of crude petroleum and natural gas; Other mining and quarrying; Mining support service activities
Manufacturing	ISIC code Divisions 10-33.	Manufacture of food products, beverages and tobacco products; Manufacture of textiles, wearing apparel, leather, wood and paper; Manufacture of chemicals and non-metallic mineral products; Manuf. of basic metals and fabricated metal products, except mach. & equip.; Manufacture of electrical equipment and optical products; Manufacture of machinery and equipment n.e.c.; Manufacture of transport equipment; Other manufacturing, repair and installation of machinery and equipment
Electricity, Gas, Steam & A/C	ISIC code Division 35.	Electric power generation, transmission and distribution; Manufacture of gas; distribution of gaseous fuels through mains; Steam and air conditioning supply; Non-Electric/ Gas/ Steam/ Air
Water Supply & Waste Management	ISIC code Divisions 36-39.	Water collection, treatment and supply; Sewerage, waste collection and management services
Construction	ISIC code Divisions 41-43.	Construction of buildings and civil engineering; Specialized construction activities
Retail & Wholesale	ISIC code Divisions 45-47.	Wholesale trade, except of motor vehicles and motorcycles; Retail trade (including wholesale and retail trade and repair of motorcars and motorcycles)
Transportation & Storage	ISIC code Divisions 49-53.	Land transport and transport via pipelines; Water transport; Air transport; Warehousing and support activities for transportation; Postal and courier activities
Accommodation & Food Service	ISIC code Divisions 55 and 56.	Accommodation; Food and beverage service activities
Information & Communication	ISIC code Divisions 58-63.	Publishing, audiovisual and broadcasting activities; Telecommunications; IT and other information services
Finance & Insurance	ISIC code Divisions 64-66.	Financial service activities, except insurance and pension funding; Insurance, reinsurance and pension funding, except compulsory S.S.; Activities auxiliary to financial service and insurance activities
Real Estate	ISIC code Division 68.	Real estate activities
Professional, Scientific & Technical	ISIC code Divisions 69-75.	Legal, accounting, management, architecture, engineering activities; Scientific research and development; Other professional, scientific and technical activities
Administrative	ISIC code Divisions 77-82.	Rental and leasing, employment and travel services; Security, services to buildings and other business support activities
Government	ISIC code Division 84.	Public administration and defence, compulsory social security
Education	ISIC code Division 85.	Education
Health & Social Care	ISIC code Divisions 86-88.	Human health activities; Residential care and social work activities
Arts & Entertainment	ISIC code Divisions 90.93.	Arts, cultural activities, gambling and betting activities; Sports activities and amusement and recreation activities
Other Services	ISIC code Divisions 94-96.	Activities of membership organizations; Repair of computers and personal and household goods; Other personal service activities
Consumer	Connections and spend associated with consumers.	N/A
Cross-vertical	Applications and device types used by enterprises but which are not associated with any specific vertical. For instance, a connected car that is part of a commercial fleet, or an office printer would be include here. They are used by an enterprise, but are not a vertical-specific use case.	N/A

Definitions: Use Cases

Use Case/Application	Definition & Notes
Machine-to-Person	
Connected Vehicles	Diverse applications including fleet management, usage-based insurance, entertainment, stolen vehicle recovery and navigation provided via aftermarket and factory-fit connectivity. Vast majority focused on road vehicles but also includes air, sea, river and rail vehicles.
Dash Cams	Aftermarket in-vehicle cameras used to record the interior or exterior of the vehicle, often to provide evidence in the event of a road accident.
eCall	Emergency crash notification service, either via regulatory mandate such as the EU eCall directive, or separately provided. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Road Fleet Management	In-vehicle transportation logistics including job allocation, vehicle tracking and vehicle and driver monitoring. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit). Includes heavy vehicles such as tractors, combine harvesters, pile drivers, tunnelling machines and cranes.
In-Vehicle Infotainment	Internet access for device tethering and entertainment services such as music streaming. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
In-Vehicle Navigation	Connected navigation services providing turn-by-turn navigation. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Roadside Assistance	Vehicle breakdown recovery provided in conjunction with a roadside assistance provider. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Stolen Vehicle Recovery	Tracking solution including recovery. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Usage-Based Insurance	Pay-as-you-drive and/or pay-how-you-drive services provided by an insurer. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Vehicle Diagnostics	Monitoring of vehicle operation and health. Can be delivered as a service via a dedicated aftermarket OBD2 device or through the factory-fit connectivity (accessed via the vehicle head unit).
Vehicle Head Unit	Embedded factory-fit on-board unit for providing multiple connected car services.
Vehicle Rental, Leasing & Sharing Management	Application installed in vehicles that are provided on short or long-term lease to third parties, for the purposes of tracking and access control. Can be delivered as a service via a dedicated aftermarket device or through the factory-fit connectivity (accessed via the vehicle head unit).
Road Public Transport	Connections to buses, specifically related to their role as public transport vehicles. Excludes infrastructure such as bus stations
Air Transport	Commercial cargo aircraft. Connected passenger aircraft. Excludes infrastructure such as warehousing or airports.
Sea & River Transport	Connected commercial ships/boats, including fishing boats. Connected passenger ferries and similar. Excludes infrastructure such as ports.
Rail Transport	Connected freight railway locomotives and carriages. Connected passenger railway carriages and locomotives. Excludes infrastructure such as railway stations or tracks.
Consumer Internet & Media Devices	Home and personal electronics devices including audio-visual, cameras and watches.
Personal Portable Electronics	Includes headphones, media players, smart watches and consumer cameras.
Smart Home	Includes webcams, baby alarms, home weather stations and diverse other applications. Excludes home automation.
AV Equipment	Includes TVs, projectors, home video, home audio, AV controls, gaming consoles, smart speakers and other consumer equipment plus consumer AV equipment used by businesses.
IT Infrastructure	Routers, modems and other IT infrastructure.
Office Equipment	Connected commercial and consumer devices including printers, scanners, photocopiers, servers, and other specialist equipment.
IT Equipment	Enterprise and consumer printers, scanners, photocopier and storage.
Other Office Equipment	Enterprise-related devices such as franking machines, fax machines and displays.
Payment Terminals	Handling of payments for goods and services on remote devices, including point-of-sale (POS), NFC terminals, pay-stations, ticket machines and vending machines.
ATMs	Automated Teller Machines. Hole-in-the-wall and free-standing cash points, including currency exchange.
Payment Processing	Card payment terminals, checkout machines and parking payment.
Vending Machines	Machines that dispense hot and cold drinks, prepared and semi-prepared food, cigarettes, electronics goods and sundry other items. Also transport ticket machines.
Personal Assistance Robots	Mobile user interface for diverse services including concierge services, telepresence, search (via Natural Language Processing) and personal monitoring.
Personal Monitoring & Tracking	The use of tracking devices applied to a person (or pet) for the purposes of tracking location and/or health metrics.
Child & Pet Tracking	Tracking devices, mostly for children, cats and dogs but also potentially other houseold pets. Typically including GPS location and mobile connectivity.
Security Tracking	Connected devices carried by security guards, prison guards, soldiers and other military personnel, including 'future soldier' equipment and smart guns. Plus offender tagging.
Assisted Living	Trackers, alarms, and comprehensive assisted living solutions.
Healthcare Monitoring	Coronary heart disease, diabetes and pulmonary disease monitoring. Fitness trackers, scales and other non-clinical personal monitoring.
Worker Safety	Fire, police and emergency medical services and general lone worker safety.
Telemedicine	Mobile and fixed location remote telemedicine using dedicated devices.
Portable Information Terminals	Enterprise device, typically tablet format, for providing mobile staff with information and access to back office systems.
White Goods	Connected commercial and consumer devices including refrigerators, freezers, washers, dryers, cooking equipment, and dishwashers, supporting services including warranty management, service-based pricing, remote maintenance and manufacturer performance tracking.

Definitions: Use Cases

Use Case/Application	Definition & Notes
Autonomous Systems	
Asset Tracking & Monitoring	Simple tracking of remote devices, including location and use.
Asset Monitoring	Monitoring of diverse assets including livestock, commercial fitness equipment, ambulance equipment and gaming machines.
Bike Sharing	Bicycles monitored as part of a public bicycle sharing scheme.
Container Tracking	Chilled and dry freight containers.
Loss Prevention	Security monitoring systems found in retail outlets and similar.
Track & Trace	Connecting an asset for the purpose of location monitoring. Includes theft detection and tool location monitoring. All other location tracking not elsewhere covered.
Waste Management	Connected public bins and similar collection facilities.
Autonomous Vehicles	Commercial and consumer autonomous cars, freight vehicles, aerial vehicles,and specialist equipment such as autonomous mining eq uipment and delivery robots.
Autonomous Road Vehicles	Autonomous versions of road and land vehicles. Includes buses, portside automated vehicles/container lifters and mine vehicles.
Drones	Fixed wing and propellor powered unmanned aerial vehicles (UAVs) for consumer or commercial use.
Retail Delivery Robots	Autonomous road (or pavement) vehicles used for delivery of household goods. Covers two sectors: retail and food delivery.
Inventory Management & Monitoring	Remote monitoring of volumes and inventory, for instance of consumables, warehouse stock, or refuse levels.
Precision Specialist Robot	Autonomous precision machinery focused on a diverse range of specific tasks including surgery, house-building, or organ printing.
Remote Diagnostics & Maintenance	Remote monitoring of equipment to spot faults and predict requirements for maintenance. Particularly focused on factory machinery, healthcare devices and vertical transportation.
Remote Process Control	Remote monitoring of equipment to manage the device in the context of a wider business process and to integrate machine data. Focused on agricultural and industrial processes.
Real World 'Visualisation'	Use of headsets and similar devices to provide augmented or virtual reality support for a field of factory process.
Connected Glasses	Use of headsets and similar devices to provide augmented or virtual reality support for a field of factory process.
Smart Grid	Management of infrastructure related to electricity, gas and water production, distribution and consumption. Includes end points such as smart meters and electric vehicle charging points. In the context of electricity distribution this particularly relates to the management of the relationship between the various elements (i.e. as a Virtual Power Plant).
Connected Batteries	Includes batteries of all sizes and use cases equipped with connectivity, from batteries contained in household devices to grid-scale energy storage.
Generation	Machinery within the power plant and alternative sources.
Grid Operations	Includes transmission towers, distribution networks, pipelines, waste water and remote process control.
Electric Vehicle Charging	Public roadside (or similar) infrastructure for charging electric vehicles. Domestic equivalents are not included here.
Electricity Smart Meters	Any form of connected meter for the purpose of performing automated meter reading (AMR) or the provision of more advanced services.
Gas Smart Meters	Any form of connected meter for the purpose of performing automated meter reading (AMR) or the provision of more advanced services.
Water Smart Meters	Any form of connected meter for the purpose of performing automated meter reading (AMR) or the provision of more advanced services.

Definitions: Use Cases

Use Case/Application	Definition & Notes
Smart Environment	
Access Control & Intercoms	Access control systems, such as control barriers on commercial premises, private homes and public spaces. Includes prisons and border control.
Building Automation	Control system installed in buildings to control electrical and mechanical infrastructure within the building.
Building Safety & Security	Security cameras in addition to security and fire alarm systems, including sensors and management, on commercial premises and private homes.
Environmental Monitoring	Use of sensors to monitor environmental metrics such as temperature, CO2, and noise
Crop & Aquaculture Management	Monitoring of crops and agricutural land for soil condition and local environmental monitoring.
Environment Monitoring	Monitoring of external environment and of pollutants from industrial processes.
Infrastructure Monitoring	Includes road, and rail infrastructure, dams (including hydroelectric and tailing), levees, reservoirs, weirs, and pipelines. During construction projects counts as construction, government at point of handover.
HVAC	Heating, ventilation and air-conditioning systems and their remote and/or automatic control.
Lighting	Remotely managed commercial and residential building lighting systems, and public lighting.
Building Lighting	Lighting within buildings, including large buildings such a stadia and railway stations.
Public Space Lighting	Streetlighting and other public spaces.
Parking Space Monitoring	Remote monitoring of parking spaces to provide users and owners with information on occupancy and availability.
Public Information & Advertising Screens	Remotely updated billboards and public information screens, including public transport.
Public Safety	Monitoring and alert systems in public spaces including CCTV.
CCTV	Connected video cameras used by governments for monitoring of streets and public places.
Public Alarms & Monitoring	Public infrastructure for raising alarms and monitoring, such as for gunshot detection and location identification.
Road Infrastructure Monitoring & Control	Diverse services associated with road infrastructure including road condition monitoring, congestion charging, road tolls, traffic volume monitoring, road signs, traffic lights, enforcement cameras.
Road Traffic Control	Road pricing infrastructure and in-vehicle devices for road tolls and other congestion charging schemes, road signs and traffic lights.
Road Traffic Monitoring	Roadside infrastructure for monitoring traffic volumes and cameras, typically with ANPR, to ensure compliance.