5G- IoT use cases

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    — 9 Cluster: Monitoring and tracking
eMTC/NB-IoT Evolution Towards 5G-IoT

FACT: Better eMTC/NB-IoT Network = Better User Experience for IoT use cases

Network Deployment & Access Rollout

Devices
Evolution Towards Everything

Network Slicing, micro segmentation
Service Oriented Core

2017
2018-2019
2020 - 2025

FACT: Better eMTC/NB-IoT Network = Better User Experience for IoT use cases
Added features on the way..

- Reduced complexity
- Lower power
- Deep coverage
- Higher density

- Single-cell multicast
- Device positioning
- Higher data rates

- TDD support
- Higher spectral efficiency
- Early data transmission
- Wakeup radio

The way to 5G

- eMTC
- NB-IoT
- 2G/3G
- 5G NR IoT

2G/GPRS migration

- 2017
  - 3GPP Release 13
- 2019
  - Release 14
- 2020
  - Release 15
- 2022~2025
  - Release 16+
Innovation is mandate

du announces UAE 5G Innovation Gate (U5GIG) for development of next generation 5G & IoT systems

U5GIG is a practical and innovative initiative in developing 5G standard by 2020 and beyond, inspired by HH vision for UAE Innovation and Dubai Future Accelerators.

UAE-based telecommunications service provider - du, announced the establishment of UAE 5G Innovation Gate (U5GIG). The U5GIG has been envisioned to be a consortium of technical and academic organisations in UAE as well as global telecom vendors to plan and use their expertise to define and develop a global 5G network that will radically change lives across the UAE.

du is taking the lead to build a 5G Innovation Lab to prototype, test and validate early 5G and Internet of Things (IoT) equipment and services. U5GIG will also allow universities and technical organisations across UAE to work together and participate in the development of the 5G ecosystem, and for academia and industry to test applications and technologies in a real-world setting.

Ibrahim Nassry, Chief Human Capital & Administration Officer at du, said: “We are excited to announce this initiative that will allow the UAE to effectively compete with the advanced markets and bring UAE’s voice to the technology development debate. The UAE will be a major industry development leader and we can only do this through collaboration between industry and academia. We plan to work closely with suppliers and SMEs and eventually train future UAE academic and industry leaders. The programme will be open for all UAE universities and industrial organisation that need to be part of the state-of-the-art 5G ecosystem development.”

“The inauguration of U5GIG adds further impetus to the Initiative of His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of UAE and Ruler of Dubai, in establishing the UAE as a global leader in all aspects and as an innovator in technology in the Middle East region,” he added.

U5GIG’s Mission: UAE to participate in developing of the emerging 5G and IoT System of 2020+; inspired by H.H vision for UAE innovation.

A practical contribution to the nation by participating in the development of the next 5G mobile technology and IoT evolution and become technology developer instead of technology adaptors only.

MOHAMMED BIN RASHID AL MAKTOUN LAUNCHES FIRST INNOVATION FUND WORTH AED 2 BILLION

Vice President and Prime Minister and Ruler of Dubai, His Highness Sheikh Mohammed bin Rashid Al Maktoum, today launched the ‘Sheikh Mohammed bin Rashid Al Maktoum Fund to Finance Innovation’, worth AED 2 billion. The fund is designed to provide financing solutions for innovators across various sectors within the UAE, and support them in transforming ideas and suggestions into innovation projects which will contribute to the country’s national innovation strategy and to achieving the UAE Vision 2021.
Use case driven access slicing

data rate requirements with respect to Access

- Cat-1: Using 4G Technology
- Cat-M1: Using 4G Technology
- Cat-NB1: Using NB-IoT Technology
eMTC/NB-IoT Advantages

1. eMTC/NB-IoT eNB Access Designed to Perfection

   NB-IoT network design and coverage roll-out are expanding smoothly to enable more and more use case and respond to the high demand.

2. Modular Core Network

   eMTC/NB-IoT network slice for better control on Quality and allow to ease in scalability in almost all conditions

3. NB-IoT Chipset Support and collaboration

   More and more NB-IoT devices are entering the market. Also industry and Opcos key collaborations are forming.
Examples for IoT use cases evolution with 5G

**Case study**
- Condition-based maintenance
- Hazard and maintenance sensing
- Commercial drone solutions
- Autonomous robotics
- Connected venues
- Enhanced video services

**Current**
- Predictive maintenance
- One pilot – one drone mission planning
- Enhanced in-venue experience

**On the road to 5G**
- Smart, prescriptive maintenance
- Multi-drone flight Autonomous / sensor based flight & actions
- AR enhanced, replay enabled venue experience

**5G experience**
- Visual sensory supported maintenance
- Mass autonomous flight
- Massive multi user experience outside the venues

**Example technologies**
- Multi-standard network
- Cat-M1/NB-IoT
- Cloud based IoT platform
- IoT monetization
- Identity management
- Cloud-optimized network functions
- Virtualized network function orchestration
- Gigabit LTE
- Massive MIMO
- Network slicing
- Dynamic service orchestration
- Predictive analytics
- Data federation
- Security management
- 5G NR
- Virtualized RAN
- Federated network slicing
- Distributed cloud
- Real-time machine learning/AI
- Cross industry monetization
Main IoT targeted Industries

- Automotive
- Media & Entertainment
- Public transport
- Healthcare
- Financial services
- Agriculture
- Retail
- Energy and utilities
- Public safety
- Manufacturing
<table>
<thead>
<tr>
<th>Manufacturing</th>
<th>Automotive</th>
<th>Public transport</th>
<th>Energy &amp; utilities</th>
<th>Public safety</th>
<th>Financial services</th>
<th>Healthcare</th>
<th>Media &amp; entertainment</th>
<th>Retail</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial control and automation</td>
<td>Autonomous driving</td>
<td>Monitoring, communication and analytics systems</td>
<td>Smart grid</td>
<td>Urban and infrastructure security</td>
<td>Lending, payments and investment</td>
<td>Patient applications</td>
<td>Entertainment</td>
<td>Customer experience</td>
<td>Other</td>
</tr>
<tr>
<td>Planning and design systems</td>
<td>Connected services</td>
<td>Passenger information systems</td>
<td>Smart energy management</td>
<td>ID management</td>
<td>Insurance</td>
<td>Hospital applications</td>
<td>Advertising</td>
<td>Operational efficiency</td>
<td>Other</td>
</tr>
<tr>
<td>Field devices</td>
<td>Safety and traffic efficiency services</td>
<td>Smart ticketing systems</td>
<td>Cyber security</td>
<td>Other</td>
<td>Other</td>
<td>Medical data management</td>
<td>Other</td>
<td>Promotion solutions</td>
<td>Other</td>
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# Why use case clusters?

## IoT targeted Industries

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## Benefits of a cluster approach

- Enables shared investments and resource allocation across a larger revenue pool
- Possible to prioritize opportunities depending on investment
- Increase scalability across industries

**From industries to clusters**

**From what to how**
5G-IoT use case clusters

+200 use cases in 10 industries

Go-to-market challenges
- Business and monetization model
- Value chain positioning
- Role in ecosystem
- Partnership development

Deployment challenges
- Technical performance criteria
- Role of 5G
- Device, network, computing and service enablers

Application based cluster methodology

Automotive | Media & Entertainment | Public transport | Healthcare | Financial services
---|---|---|---|---
Agriculture | Retail | Energy and utilities | Public safety | Manufacturing

Enhanced video services | Monitoring and tracking | Real time automation | Smart surveillance | Autonomous robotics
Hazard and maintenance sensing | Augmented reality | Connected vehicle | Remote operations
Emerging IoT & 5G use case cluster Quadrant

- **Operator opportunity 2026**
  - Smart Surveillance
  - Autonomous Robotics
  - Remote operations
  - Enhanced video services
  - Augmented reality
  - Connected vehicle
  - Real-time Automation
  - Hazard and maintenance sensing
  - Monitoring and tracking

- **Deployment challenges**
  - Easy to deploy
  - Difficult to deploy

- **Go to market challenge**
  - Low
  - High
Industries per cluster for addressable 5G use cases

Service creator opportunity, 2026

Enhanced video services: 47%
Real-time automation: 56%
Monitoring and tracking: 32%
Connected vehicle: 47%

Autonomous robotics: 52%
Hazard and maintenance sensing: 33%
Smart surveillance: 51%
Remote operations: 51%
Augmented reality: 45%

Source: Arthur D Little
**Enhanced video services**
Next generation video telecommunication services that allows for next generation content consumption

**Real-time automation**
Applications that leverages data from sensors in real time to trigger specific actions autonomously

**Monitoring and tracking**
Extensive, and often in real-time, asset tracking combined with next generation navigation capabilities

**Connected vehicle**
Applications to provide moving vehicles with a continuous, nationwide connection

**Autonomous robotics**
Machines that perform tasks and behave autonomously, with limited human intervention

**Hazard and maintenance sensing**
Applications leverage sensors and algorithms to provide alerts for mission critical activities to aid decision making

**Smart surveillance**
Cameras and sensors, a large number of objects are identified and analyzed in real-time

**Remote operations**
Enable remote control, via human intervention, of machinery and/or vehicles from any location

**Augmented reality**
Live view of real-world environment are augmented by visual and audio aids
**Clusters deep dive**

**Connected vehicles—Cluster description**

**Description of cluster**

- **Connected Vehicles** cluster includes applications to provide moving vehicles with a continuous, nationwide connection.
- The cluster should allow operators to enhance their products without investing extensively in new deployment or go-to-market capabilities.

**Example use cases – connected vehicles**

- Connected ambulance
- High-speed internet on trains
- Vehicle to vehicle networking systems
- Emergency vehicle notification system
- Vulnerable Road User (VRU) discovery
- Public safety
- Healthcare
- Public transport
- Automotive

**Realization challenge**

- **Key challenge for connected vehicles cluster** is wide area deployment of high speed mobile broadband.
- **New sales capabilities** to deal with several customers e.g. OEMs, end-customers, public transport companies, etc.

**Deployment challenge**

**Go-to-market challenge**
Clusters deep dive

Connected vehicles—Cluster evolution

5G
Cluster evolution

Connected driving
- Real-time driver statistics
- Personalized insurance services on driving behavior
- Connectivity within the vehicle
- Assisted driving
- Traffic jam warnings

Smart driving
- Vehicle to vehicle communication systems
- Connected ambulance
- High-speed internet access
- Semi-auto pilot driving
- Vulnerable road user (VRU) discovery

Advanced performance
- See-through sensing
- Auto pilot driving
- Advanced infotainment (e.g. 4K streaming)
- Ancillary services such as virtual presence

5G Requirements

Current

On the road to 5G

5G experience

- Battery life
- Latency
- Mobility
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security
Augmented reality – Cluster description

**Description of cluster**
- **Augmented reality cluster** contains all use cases where the live view of real-world environment are augmented.
- AR business models can look similar as that of current smartphone business models - i.e. leveraging operators’ sales channels for both hardware and connectivity sales to the masses.

**Example use cases - augmented reality**
- AR-aiding medical treatment
- AR support for maintenance, construction and repair
- On-site live event experience
- Agriculture on-field AR support
- In-store video & AR-enabled customer care
- Agriculture
- Retail
- Healthcare
- Manufacturing
- Media & enter
- Automotive

**Realization challenge**
- Key deployment challenge for AR is near gigabit wide area coverage and QoS guarantees.
- Operators need to create close partnerships with a wide range of hardware and service providers to be successful.
Augmented reality – Cluster description

**Smartphone driven AR**
- Low demanding AR games (e.g. Pokémon Go)
- In store and at home AR enabled customer care (e.g. Carrefore app)
- AR dashboards in cars
  https://www.youtube.com/watch?v=g-2KmHRqQM

**Industry driven AR**
- AR aiding medical treatment
- AR support in maintenance, construction & repair
- Agriculture on-field AR support
- Classroom AR solutions

**Integrated AR**
- Immersive sports experience for sports fans in stadiums
- Instant virtual telepresence
- Continuous AR integration in daily life through devices such as AR contact lenses

**5G Requirements**
- Availability
- Reliability
- Connectivity density
- Throughput
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**Cluster evolution**
### Clusters deep dive

#### Real-time automation – Cluster evolution

<table>
<thead>
<tr>
<th>Description of cluster</th>
<th>Example use cases – real-time automation</th>
<th>Realization challenge</th>
</tr>
</thead>
</table>
| **Real-time automation** cluster consists of autonomous applications that leverages data from sensors in real time to trigger specific actions autonomously. | — Distributed energy resource management  
— Virtual power plants  
— Bioelectronic medicine  
— Precision medicine  
— Precision pesticide spraying | — Key deployment challenge relate to the low latency required by mission critical applications, the availability, and reliability  
— In order to be successful, operators need to form key partnerships and overcome significant regulatory challenges |
| As the application is autonomous, and is often used in mission critical applications, latency, availability, reliability and security are of key importance for this clusters |  |  |

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**Example use cases** — Energy & Utilities  
— Manufacturing  
— Agriculture  
— Healthcare

**Deployment challenge** Low  
**Go-to-market challenge** High
Clusters deep dive

Real-time automation – Cluster evolution

Local automation
- Automated smart meters to optimize electricity usage
- Smart greenhouses
- Remote sensing for fertilizer optimization and harvesting

Large scale automation
- Precision medicine
- Real-time load balancing
- Distributed energy resource management
- Precision pesticide spraying
- Real-time mobile and high frequency trading

Mission critical automation
- Bioelectronic medicine / neuro-modulation
- Virtual power plants
- Management of edge-of-grid generation (e.g. solar panels in millions of homes)

5G Requirements
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security

Cluster evolution
Hazard and maintenance sensing—Cluster description

**Description of cluster**
- **Hazard and maintenance sensing cluster** consists of use cases that leverage sensors and algorithms to provide alerts for mission critical activities to aid decision making.
- This cluster would require operators to enter or co-create a new ecosystem of partners in order to deliver these services.

**Example use cases—Hazard and maintenance sensing**
- SMACS
- Predictive maintenance of vehicles and equipment
- Grid infrastructure sensors
- Remote patient monitoring
- Power plant fault detection
- Public safety
- Manufacturing
- Healthcare
- Energy & utilities
- Automotive
- Agriculture

**Realization challenge**
- In order to facilitate the mission critical applications, availability and reliability of the network will be key.
- Go-to-market complexity to handle a wide ecosystem as well as complying with current and future regulations.
Clusters deep dive

Hazard and maintenance sensing – Cluster description

**NB-IoT enabled sensing**
- Smart Alarms Monitoring control systems
- Livestock health monitoring
- Detectors of abnormal energy consumption
- Real-time information to farmers on mobile devices

**Wide area NB-IoT**
- Remote patient monitoring
- Grid infrastructure predictive maintenance
- Proactive road maintenance based on weather forecast (e.g. automatic snow clearance)

**Mission critical IoT**
- Real-time detection of hospital infection patterns
- Fully automated manufacturing based on order pipeline
- Power plant fault detection
- Automated road hazard warning

**5G Requirements**
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security

**5G experience**

**Cluster evolution**

**Current**

**On the road to 5G**

**5G**
Enhanced video services – Evolution roadmap

Description of cluster
- Enhanced video services cluster includes all use cases related to next generation video telecommunication services that allows for next generation content consumption.
  - Low latency, high throughput will be key 5G enablers for these use cases.

Example use cases – enhanced video services
- Cloud VR gaming
- Immersive video conferencing
- Massive multi-person video calling
- Cooperative media production
- VR Training simulations
- Public safety
- Manufacturing
- Healthcare
- Media & Entertainment
- Agriculture

Realization challenge
- Key challenge to have access to high quality video content and therefore it is crucial to be able to negotiate with content owners.
- Will require close partnership with medical facilities to enable remote-doctors and virtual surgeries.

Deployment challenge

Go-to-market challenge
Enhanced video services – Evolution roadmap

High quality video
- Telemedicine
- 4K streaming
- Large scale on-demand viewing
- Cloud gaming
- Massive online role-playing gaming

4k/8k on-demand live video
- 4k/8k live on-demand
- Live personal 3D/4k broadcast from mobile services
- Massive multi-person video calling
- Interactive live concerts and sport events

Immersive video consumption
- Immersive at-home sports viewing
- Immersive video conferencing
- Immersive gaming using tactile internet

Cluster evolution

5G Requirements
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security

Current

On the road to 5G

5G experience

Clusters deep dive
Smart surveillance – Evolution roadmap

### Description of cluster

- **Smart surveillance cluster** includes use cases where, via cameras, a large number of objects are identified and analyzed in real-time.
- Smart surveillance in real-time will leverage 5G's high throughput, security, mobility, reliability and availability in order to provide its customer benefit across several industries.

### Example use cases – smart surveillance

- Bird's eye view
- Smart digital billboard marketing
- Real-time localization of firearm usage
- Border and security control
- Real time smart surveillance

### Realization challenge

- Adherence to privacy and data security requirements is different in different markets.
- Distinction between private/public surveillance is a key legal challenge to widespread adoption.
Clusters deep dive

Smart surveillance – Evolution roadmap

- **Connected surveillance**
  - Security monitoring
  - Intrusion detection
  - Traffic prediction analysis and decision support

- **Advanced surveillance**
  - Smart digital billboard marketing
  - Crowd control

- **Automated/intelligent surveillance**
  - Smart video surveillance with automatic face detection, automatic time recording, etc.
  - Real-time person/vehicle video surveillance linked to other systems – like traffic control, taxi dispatch systems, public transportation frequency, etc.

**5G Requirements**
- Battery life
- Latency
- Mobility
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security

**Cluster evolution**

**Current**
- On the road to 5G

**5G experience**
Remote operations – Cluster description

Description of cluster

- Remote operations cluster includes all the use cases where applications enable remote control, via human intervention, of machinery and/or vehicles from any location.

Example use cases – remote operations

- Remote drug administration
- Tele operated driving
- Remote control robotics
- Tele surgery
- Remote control of agricultural machines
- Public safety
- Manufacturing
- Healthcare
- Media & Entertainment
- Agriculture

Realization challenge

- Key deployment challenge include specialized technical expertise to develop solutions for specific industries.
- E.g. Remote operations of heavy machinery in the mining industry.

Deployment challenge

- Low
- High

Go-to-market challenge

- Low
- High

Clusters deep dive
Clusters deep dive

Remote operations – Evolution roadmap

Remote operations assistance
- Wearables that provide employees with instructions (e.g. maintenance manual)
- Partial remote controlling of equipment, processes and operations

Wide spread remote operations
- Remote drug administration
- Remote control of robots
- Remote control of agricultural machines
- Control and management of pipelines from control center

Immersive remote operations
- Remote operations of machinery using VR
- Full remote operations of mining equipment in deep underground mines

5G Requirements
- Battery life
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- Position accuracy
- Security

Current

On the road to 5G

5G experience

Cluster evolution

5G

Wide spread remote operations

Immersive remote operations
Clusters deep dive

Autonomous robotics – Cluster description

Description of cluster

- Autonomous robotics cluster consist of machines that perform tasks and behave autonomously, with limited human intervention.
- With sensors, robots need to observe and analyze their surroundings and act accordingly, often within a well-defined framework.

Example use cases – autonomous robotics

- Rehabilitation robotics
- Real-time closed loop communication between machines (collaborative robots)
- Robotics for assisted living
- Autonomous agricultural machines
- Manufacturing
- Healthcare
- Retail

Realization challenge

- Key deployment challenge include latency, availability, reliability and position accuracy.
- Extreme high regulatory barriers will provide a key challenge for solution providers.

Deployment challenge

Go-to-market challenge
Clusters deep dive

Autonomous robotics – Evolution roadmap

Procedural robotics
- Production line robotics / industrial automation
- A robot with a touch screen as an in-store guide
- Household assisting manual robotics (e.g. vacuum cleaner)
- Automatic lawn mowers

Semi-autonomous robotics
- Robotics for assisted living
- Semi-automated guided vehicles in warehouses
- Automatic shelf management by using smart robots

Autonomous robotics
- Autonomous inventory management robots
- Real-time closed loop communication between machines (collaborative robots)
- Autonomous ‘delivery’ robots
- Complex orchestrating and creating problem solving robotics

5G Requirements
- Battery life
- Latency
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Cluster evolution
## Clusters deep dive

### Monitoring & tracking – Evolution roadmap

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<th>Description of cluster</th>
<th>Example use cases – monitoring &amp; tracking</th>
<th>Realization challenge</th>
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<tbody>
<tr>
<td>Monitoring &amp; tracking cluster involves use cases related to extensive, and often in real-time, asset tracking combined with next generation navigation capabilities</td>
<td><strong>Identification, tracking of goods in the end-to-end value chain</strong>&lt;br&gt;<strong>Connected goods</strong>&lt;br&gt;<strong>Roadside sensors for monitoring of conditions</strong>&lt;br&gt;<strong>Electronic health records sharing</strong>&lt;br&gt;<strong>Tracking patients’ activity at hospitals</strong></td>
<td>While monitoring and tracking already exists, 5G can enable it to offer real operational benefits</td>
</tr>
<tr>
<td>The use cases will be enabled by 5G specifications such as position accuracy, mobility, battery life and security</td>
<td><strong>Manufacturing</strong>&lt;br&gt;<strong>Healthcare</strong>&lt;br&gt;<strong>Retail</strong>&lt;br&gt;<strong>Agriculture</strong>&lt;br&gt;<strong>Public transport</strong>&lt;br&gt;<strong>Energy &amp; Utilities</strong></td>
<td>In order to achieve this, operators would need to work closely with industry specialists to develop end-to-end solutions for targeted industries</td>
</tr>
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<thead>
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<th>Go-to-market challenge</th>
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<tr>
<td>Low</td>
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Clusters deep dive

Monitoring & tracking – Evolution roadmap

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<th>Monitoring</th>
<th>Real-time monitoring</th>
<th>End-to-end lifecycle management</th>
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<tbody>
<tr>
<td>Hospital asset tracking and management</td>
<td>Routing of livestock in real-time</td>
<td>Connected goods, able to communicate with each other</td>
</tr>
<tr>
<td>Connected bus stops</td>
<td>Real-time application for home appliances</td>
<td>Identification, tracking of goods in the end-to-end</td>
</tr>
<tr>
<td>Fleet and freight management</td>
<td>Smart shopping carts for shopping navigation based on</td>
<td>value chain</td>
</tr>
<tr>
<td></td>
<td>digital shopping list</td>
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5G Requirements

- Battery life
- Latency
- Mobility
- Availability
- Reliability
- Connectivity density
- Throughput
- Position accuracy
- Security

Cluster evolution

Current

On the road to 5G

5G experience

Monitoring

- Hospital asset tracking and management
- Connected bus stops
- Fleet and freight management

Real-time monitoring

- Routing of livestock in real-time
- Real-time application for home appliances
- Smart shopping carts for shopping navigation based on digital shopping list

End-to-end lifecycle management

- Connected goods, able to communicate with each other
- Identification, tracking of goods in the end-to-end value chain

5G Requirements

- Battery life
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ADL, Ericsson, Markets and Markets, Machina, Cisco, Gartner, Frost and Sullivan, OVUM, EMC, Analysis Mason, SBD, GSMA, Technavio, Transparency Smart Research, Allied Market Research, FMI, Grandview research, IndustryArc, Theinsightpartners, P&S Market research, PWC, Celent, Mordor Intelligence
Thank You