4G-5G & wireless IoT devices
A Technical-Commercial peek

Acal BFi Nordic
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Wireless IoT for digital transformation

- 5G-NR
- 4G-LTE
- LTE LPWA
- cat M1, NB2/NB-IoT
- WiFi, Bluetooth, LoRa
- GNSS, Navigation
- Antennas
- RF Semiconductors
- Thermal imaging
- Sensors
- Device-to-Cloud
- Connectivity (SIMs)
- Device Management
European RF competence centre

- Engineers with extensive R&D and RF experience
- Equipment for RF R&D in-house
- RF application support
- Design review
- Antenna matching
- Reference design

Customer project

Radio
4G LTE cat M1/NB1
GNSS
BLE
RFID

Sensors
IMU, Light, Humidity, Pressure, Temperature

System
uP & Memory
Display
Buzzer
Power & Battery

Single sided PCBA
114 x 60 mm
3GPP Cellular

2G, 3G, 4G, 5G

GSM, GPRS, WCDMA, LTE, LPWA, MTC, NB-IoT, 5G-NR
Count of network operators that have completed, planned or are in progress with 2G and 3G switch-offs.

Source: GSA, July 2022
2G and 3G network switch-offs by region

July 2022 update

Source: GSA, July 2022

2G switch-offs

3G switch-offs

Europe 63%

Asia 21%

North America 5%

Middle East and Africa 5%

Oceania 5%

Latin America and the Caribbean 1%
2G and 3G network switch-offs by year

Source: GSA, July 2022
4G-LTE & 5G-NR

5G is designed to co-exist with 4G

4G will be around for a long time
Operators are upgrading
July 2022 update

- 4G and 5G: 53%
- 4G: 31%
- 5G: 13%
- 3G, 4G and 5G: 3%
Countries without public LTE networks

LTE Not-spots November 2018
LTE Not-spots 2022

Countries without public LTE networks

LTE has >6.6 billion subscribers expected peak at ~7 billion 2022-23

Deployed networks, 760 operators in 210 countries

Investing, 977 operators in 244 countries
5G to reach 1 billion subs 2022

Deployed networks,
221 operators in 87 countries

Investing,
499 operators in 150 countries

245 : EMEA
146 : Americas
108 : APAC
Deployed networks,
• 139 operators in 64 countries
  • 34 : LTE-M & NB-IoT
  • 29 : NB-IoT only
  • 1 : LTE-M only

Investing,
• NB-IoT : 165 operators in 80 countries
• LTE-M : 74 operators in 41 countries
The 5G technology evolution

3GPP timeline

**Rel-15 eMBB focus**
- 5G NR foundation
- Smartphones, FWA, PC
- Expanding to venues, enterprises

**Rel-16 industry expansion**
- eURLLC & TSN for IIoT
- NR in unlicensed
- 5G V2X sidelink multicast
- In-band eMTC/NB-IoT
- Positioning

**Rel-17 continued expansion**
- Lower complexity RedCap
- Higher precision positioning
- Improved IIoT, V2X, IAB, and more...

**Rel-18+ longer-term evolution**
- Next set of 5G releases (i.e., 18, 19, 20, ...)
- Potential projects in discussions
- Rel-18 expected to start in 2022

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1. 3GPP start date indicates approval of study package (study item>work item>specifications), previous release continues beyond start of next release with functional freezes and ASN 1
5G-NR is a unified, more capable air interface

Diverse services

Diverse spectrum

Diverse deployments

10x Decrease in end-to-end latency
10x Experienced throughput
3x Spectrum efficiency
100x Traffic capacity
100x Network efficiency
10x Connection density

Based on ITU vision for IMT-2020 compared to IMT-advanced; URLLC: Ultra Reliable Low Latency Communications; IAB: Integrated Access & Backhaul
5G, Stand Alone (SA) vs. Non-Stand Alone (NSA)

SA

- NR : New Radio (5G)
- 5GCN : 5G Core Network

SA for Low Latency

NSA

- NR : New Radio (5G)
- LTE : Long Term Evolution (4G)
- EPC : Evolved Packet Core (4G)

Dual Connectivity
Distributed Functionality Trend

Central Cloud
- Longer latency
- Big data/aggregated value
- Content/storage/Al/processing

Mobile Edge
- 5G lower latency
- Customized/local value
- Content/storage/Al/processing

5G Device
- Lowest latency
- Compute, vision, sensing
- Al powered use cases
- Low-latency gaming
- Real-time assisted services like voice UI

On-premise control for ultra-low latency
On-device intelligence assisted by cloud
Distributed processing, like boundless XR
New services
Cloud computing, storage, instant access
Real-time assisted services like voice UI
5G private networks
Brings benefits to industry and enterprise

Coverage, capacity, and mobility
Outdoor/indoor, high data speeds, seamless handovers, public network fallback

Reliability and precise timing
Industrial grade reliability, latency and synchronization (eURLLC³ and TSN⁴)

Interoperability
Global standard, vast ecosystem, future proof with rich 5G roadmap

1. Also referred to as non-public network (NPN). 2. Quality of service. 3. Enhanced ultra-reliable low-latency communication. 4. Time sensitive network.
Target use cases
- Wearables and high end IoT
- 4G-LTE cat 4 replacement
- Data rate 50-100 Mbps

Cost & capability reductions
- Only 1 antenna
- Lower min BW requirements
- Half duplex FDD

Release 17 feature
Requires new network functionality
Commercial ~2023-2024
4G-LTE modules
Mobile Broadband & Industrial, mPCIe and M.2

- **MC74x1, LTE cat 7/13, Regional**
  - 300 Mbps DL / 150 Mbps UL

- **EM74x1, LTE cat 7/13, Regional**
  - 300 Mbps DL / 150 Mbps UL

- **EM7590, LTE cat 13, Global**
  - 400 Mbps DL / 150 Mbps UL

- **EM7565/7511, LTE cat 12/13, Global**
  - 600 Mbps DL / 150 Mbps UL

- **EM7690, LTE cat 20, Global**
  - 2 Gbps DL / 211 Mbps UL

- **L610-xxx, LTE cat 1, Regional**
  - 10 Mbps DL / 5 Mbps UL

- **NL668-xxx, LTE cat 4, Regional**
  - 150 Mbps DL / 50 Mbps UL

- **FM101-xxx, LTE cat 6, Regional**
  - 300 Mbps DL / 50 Mbps UL

- **EM7590, LTE cat 13, Global**
  - 400 Mbps DL / 150 Mbps UL

- **EM7565/7511, LTE cat 12/13, Global**
  - 600 Mbps DL / 150 Mbps UL

- **EM7690, LTE cat 20, Global**
  - 2 Gbps DL / 211 Mbps UL

- **NL952-xxx, LTE cat 12, Regional**
  - 600 Mbps DL / 150 Mbps UL
<table>
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<th>Module</th>
<th>Category</th>
<th>Regional/GLOBAL</th>
<th>DL (Mbps)</th>
<th>UL (Mbps)</th>
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**Notes:**
- 4G-LTE and LPWA modules
- SMD-LGA, 22 x 23 mm
- SMD-LGA, 22 x 23 mm
- Linux Application Framework, Legato
- SMD-LGA, 32 x 29 mm
- SMD-LGA, 24.2 x 26.2 mm
- SMD-LGA, 22.2 x 20.2 mm
**5G-NR modules**

Mobile Broadband & Industrial, M.2 and SMD-LGA

**EM9190, 5G-NR, 3GPP-R15, Global**
- Sub 6 GHz & mm-wave
- 5,5 Gbps DL / 3 Gbps UL

**EM9191, 5G-NR, 3GPP-R15, Global**
- Sub 6 GHz
- 4,5 Gbps DL / 660 Mbps UL

**EM9291, 5G-NR, 3GPP-R16, Global**
- Sub 6 GHz
- 4,9 Gbps DL / 660 Mbps UL

**EM929x, 5G-NR, 3GPP-R16, Global**
- Sub 6 GHz & mm-wave
- TBA Gbps DL / TBA Gbps UL

**FM160-xxx, 5G-NR, 3GPP-R16, Regional**
- Sub 6 GHz
- 3,5 Gbps DL / 900 Mbps UL

**FM1xx-GL, 5G-NR, 3GPP-R16, Global**
- Sub 6 GHz
- TBA Gbps DL / TBA Mbps UL

**FM160-xxx, 5G-NR, 3GPP-R16, Regional**
- Sub 6 GHz
- 3,5 Gbps DL / 900 Mbps UL

M.2, 30 x 52 mm

SMD-LGA, 41 x 44 mm
4G & 5G routers and gateways
Rugged units for mission critical applications

4G routers
LX60, RV55
FX30 (programmable gateway)

5G routers
XR80, XR90
Wireless IoT for digital transformation

5G-NR
4G-LTE
LTE LPWA
cat M1, NB2/NB-IoT
WiFi, Bluetooth, LoRa
GNSS, Navigation
Antennas
RF Semiconductors
Thermal imaging
Sensors
Device-to-Cloud
Connectivity (SIMs)
Device Management
Thanks for listening

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International presence

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We also have a presence in China, India, Poland, Slovakia, Baltics, South Africa, South Korea, Sri Lanka and USA.

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