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Qualcomm Technologies, Inc.
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Expanding mobile technologies for the Internet of Things

QUALCOMM®
Why Wait™

The evolution of wireless

Redefined Telephony
By mobilizing communications

2002

Mobile surpassed fixed voice

Redefined Computing
By mobilizing the Internet

2010

Mobile surpassed fixed BB

Redefining Everything
By providing the connectivity fabric for everything

Fixed connections per ITU, mobile per GSMA. MBB per GSMA, Jul. '14; Fixed connections: BB per WBIS, Oct. '14

Personalized Retail

Entertainment on-the-go

Smart Digital Homes

Intelligent Energy

Redefining Everything

Reshaping industries

Empowering new experiences

Transforming society

Continuous Healthcare

Transportation Redefined

Sustainable Cities

Accessible Robotics

Connecting everything requires different wireless solutions

To support the wide range of performance, cost, and energy requirements

Personal Area
Bluetooth

Short range communications, such as mobile/PC accessories

Local Area
Wi-Fi 802.11

The center of the connected home/enterprise

Wide Area
Mobile

For applications that demand ubiquitous coverage and high reliability

Bluetooth, Wi-Fi, and LTE all expanding to provide the connectivity fabric for everything

Mobile technologies enable valuable IoT services

Ubiquitous coverage
Established networks serving 7+ Billion connections worldwide[1]

High reliability
Provides redundant network design for high availability, plus managed QoS

Robust security
Features built-in; trusted in government and finance sectors

High performance
Broadband data rates and real-time responsiveness

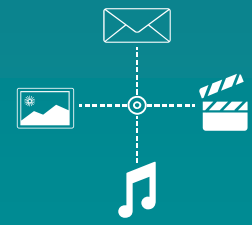
Mature ecosystem
Backed by global standards with seamless interoperability

Sample services

Remote monitoring and management

Real-time control and automation

Secure data services, e.g. financial, medical



Broadband services

1 Source: GSMA Intelligence, Apr. '15;

4G LTE provides a solid foundation for wide area IoT growth

Common global standard

with a vibrant global ecosystem

390+ Networks
in 135+ countries

2,900+ Devices
from 250+ vendors

Network longevity

LTE has become one of the fastest growing wireless technologies providing a solid foundation for many years to come

Network efficiency

Increased spectral efficiency, simplified network infrastructure, and more efficient signaling

Superior performance

LTE and LTE Advanced provides the fastest and best broadband experiences for applicable wide area IoT use cases

Source: GSA (www.gsacom.com) – April 2015 for networks and Feb 2015 for devices

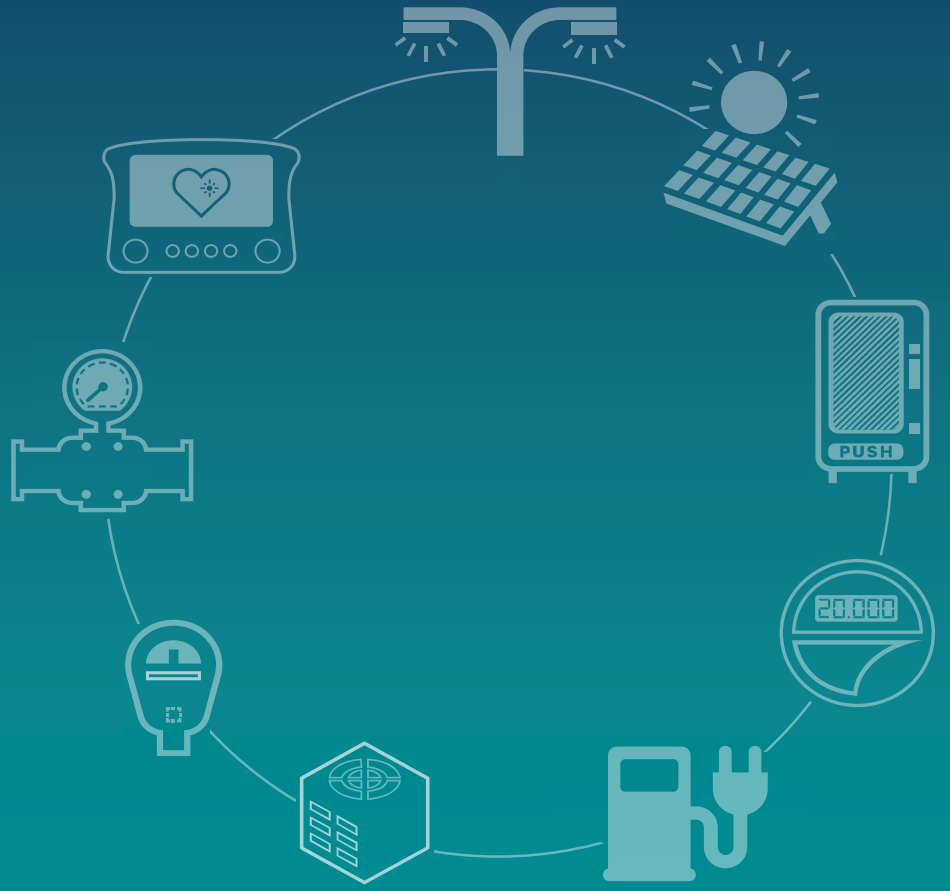
Delivering efficient, low cost wide area IoT communications

Multi-year battery life

Often battery-powered and deployed in field for many years

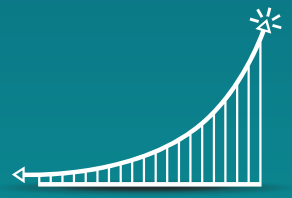
Deeper coverage

May be deployed in challenging locations (e.g., deep inside buildings)



Reduced complexity

Usually do not require the wideband operation of LTE



High node density

Massive number of machines/things per cell

Scaling to connect a wider range of devices/things

Scaling up in performance and mobility

Scaling down in complexity and power

LTE Advanced
>10 Mbps
n x 20 MHz

Today+

LTE Cat-0
Up to 1 Mbps
20 MHz

Release 12

LTE-M (Machine-Type Communications)
10s of kbps up to 1 Mbps
~1 MHz narrowband

Release 13 & beyond

Cellular-IoT (C-IoT)
Up to 10s of kbps
~200 kHz narrowband

Sample use cases

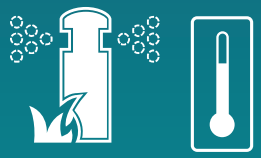

Mobile


Video security


Wearables


Object Tracking


Utility metering


Environment monitoring


Connected car

Energy Management


Connected healthcare


City infrastructure

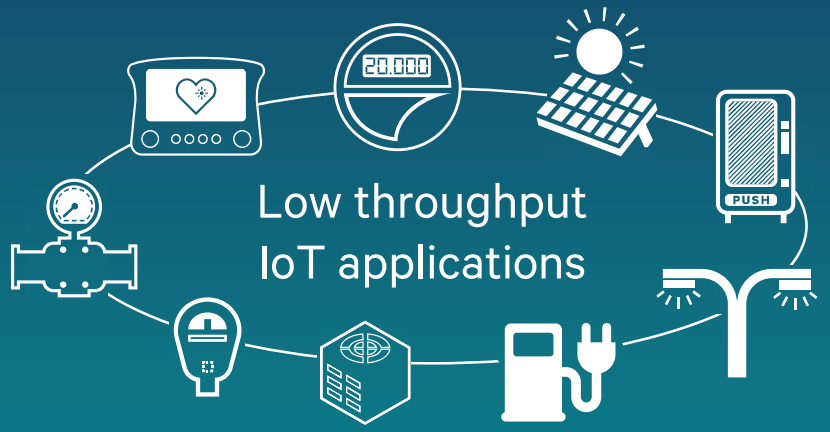

Smart buildings

Significantly widening the range of enterprise and consumer use cases

Delivering new, simpler LTE device categories

Optimized for relatively small, infrequent data transmissions

Mobile Broadband



Low throughput IoT applications

Wideband (20 MHz)	→	Narrowband (~1 MHz)
Fast Data Rate (300+ Mbps[1])	→	Reduced Data Rate (1 Mbps[1])
Diversity Antennas	→	Single receive antenna
FDD or TDD Operation	→	Half Duplex Operation

- Simplifies RF hardware
- Reduces baseband complexity

1 Based on peak data rates per 3GPP standard

Introducing enhanced LTE power modes and efficient signaling

Capable of many years of battery life

Enhanced Power Save Mode (PSM)

More efficiently turn on/off modem; optimized for device-originated or scheduled applications

Extended Discontinuous Reception (DRX)

Longer sleep cycles optimized for delay-tolerant, device-terminated applications

Connectionless Random Access Channel (RACH)

Data transmissions via common channel for more efficient transition between states

Less frequent Tracking Area Updates (TAUs) and measurements

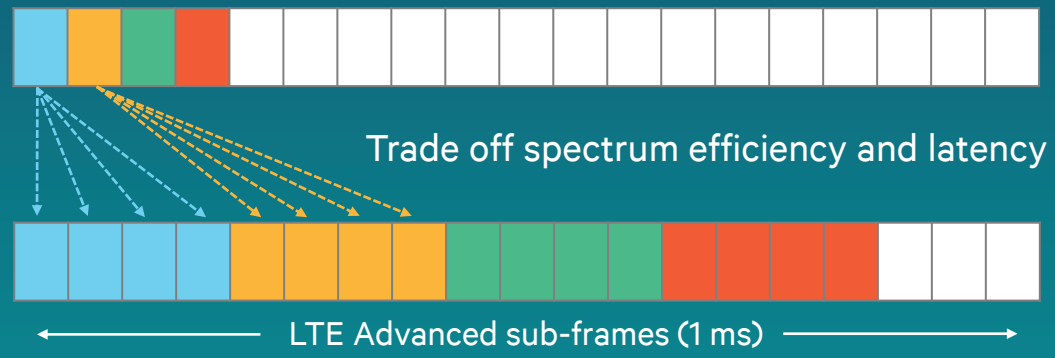
Configurable for low- to zero-mobility applications

Providing enhanced LTE coverage

To reach challenging locations and compensate for device complexity reductions

Redundant Transmissions

Achieve adequate coverage for all necessary channels and messages (Uplink & Downlink) through redundancy



Single Frequency Network (SFN) Multicast

Send redundant broadcast signals from all cells to increase coverage especially at cell edges

More reliable in-building coverage

Better cell-edge performance

Configurable per cell/UE/channel

3GPP is progressively scaling LTE for IoT communications

Coexists with today's services—efficiently integrated with existing spectrum and networks

For more information:
www.qualcomm.com/lte-mtc

RELEASE 11

Overload Control
Such as the ability to restrict access to delay-tolerant devices during overload[1]

RELEASE 12

Power Saving Mode (PSM)
New 'deep sleep' mode for certain use cases

UE Cat-0
Some cost/complexity reductions

RELEASE 13

LTE-M

Significant power savings
Additional enhanced power save modes and efficient signaling

New, simpler Cat-M device
Narrowband[2] operation reduces overall device complexity/cost

Enhanced Coverage
Advanced techniques to reach challenging locations

[1] By utilizing EAB Extended Access Barring; [2] ~1 MHz

3GPP[1] is also defining C-IoT—proposed for Release 13

Leading solution based on DL OFDMA / UL FDMA with 3.75 KHz symbol rates[2]

Envisioned to scale mobile technologies even further

Narrower bandwidth (~200 KHz)	Various potential deployment options including re-farming GSM channels
Higher density	Massive number (10s of thousands) of low data rate 'things' per cell
Longer battery life	Beyond 10 years of battery life for certain use cases
Lower device cost	Comparable to or lower than that of GPRS devices
Extended coverage	Deep indoor coverage, e.g. for sensors located in basements (>164 dB MCL)

Addresses a subset of IoT use cases

Limited data rate	Up to 10s of kbps
Latency insensitive	Seconds of latency
Limited mobility	No handover; cell reselection only

Sample use cases

Remote sensors/actuators

Utility metering

Smart cities/buildings

[1] Feasibility study ongoing in 3GPP GERAN—expected to be complete in August 2015; C-IoT is expected to be standardized in RAN; [2] The basis of a year of study item in 3GPP

Connecting everything requires more than just scaling for IoT

Scaling to connect the Internet of Things

Carrier Aggregation

High performance

Ultra efficient

Cat-0, LTE-M, C-IoT

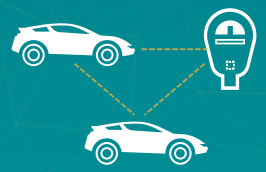
Bringing new ways to connect & interact

Evolving the LTE Direct Platform

Device-to-Device

Multi-hop

Vehicle-to-Vehicle / Infrastructure



Empowering new classes of services

Mission-critical control

LTE ULL

Broadcast

LTE Broadcast

Discovery

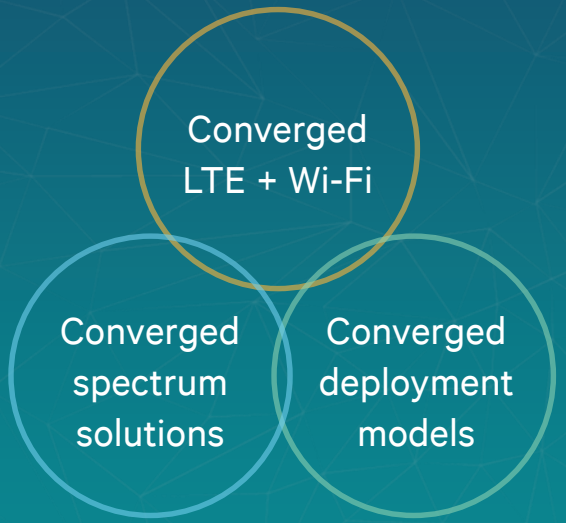
LTE Direct Proximity

Public Safety

LTE Direct MCPTT

Creating a converged connectivity platform

Link aggregation



LTE Unlicensed

Neighborhood small cell

Thank you

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