FREE Live Webinar

Cellular IoT Explained Everything you need to know about 2G, 3G, 4G, 5G, LTE-M and NB-IoT

Please wait until guests have joined the webinar

EMnify

Agenda

- EMnify Introduction
- Background: Mobile Cellular Networks
- Differences in RF Signal Multiplexing
- Coverage
- Power Consumption and Cost
- Key LTE-M and NB-IoT features
- Current State: LTE-M, NB-IoT and 5G
- Q&A



EMnify Snapshot



Cellular Connectivity Anywhere In The World

(2G, 3G, 4G, LTE-M, soon NB-IoT)



movistar T	🔹 🌮 airtel	र •	erizon 🗸 🍯	O 2	vodafone	中国移动通信 CHINA MOBILE	180+	countries
e VimpelCom	Claro- 🗚	Telekom Austria Group	telenor group	Telia wii	ND 8	orange	540+	networks

Our Customers – IoT Solutions



Asset Mmgmt	Manufacturing	Transportation	Environment	
Fleet Mgmt Animal tracking Container tracking Good temperature	Stock inventory Mgmt Predictive Maintenance Safety Monitoring	Vehicle Diagnostics Connected Car Rail monitoring	Air/water quality Noise Radiation Flooding Solar & Air Energy	
Art & Relic Preservation	Machine monitoring			• B2B2B and B2C
Europcar & CargoGuard	BKF. BLACKBIRD		Solarly	Selling Connectivity as
	EXPLOSION POWER SUCCESSION Intelligent Pipeline Monitoring			part of their services

Cellular Connectivity Explained

2G / 3G / 4G / 5G / NB-IoT / LTE-M

Introduction key concepts

What you should consider when deciding for your first or next modem?

NEXT WEBINAR 13.MAY.2020

Top 5 best practices for cellular IoT device security

What is relevant when choosing the radio type?



Background Mobile Cellular Networks



Differences in RF Signal Multiplexing How to distinguish different devices?



Time-based TDMA

Every person gets a specific timeslot to speak every XX µs

Code-based CDMA

Every person uses a different code/language

Frequency-based FDMA

Every person uses a different pitch at a different time

Duplex FDD/TDD

Frequency or Time-based separation of Up and Downlink



Coverage



I want to ship worldwide – does my modem work?

Band	Duplexmode	Frequency	GSM	UMTS	LTE
B1	FDD	2100		449/169 (Row)	26/15 (EU,Asia)
B2	FDD	1900	71/34 (Americas)	64/25 (Americas)	23/12 (Americas)
B3	FDD	1800	341/142 (RoW)		213/94 (EU,Africa,APAC)
B4	FDD	1700		14/6 (Americas)	46/20 (Americas)
B5	FDD	850	57/34 (Americas)	80/42 (Americas/Australia)	15/12 (NA,APAC)
Β7	FDD	2600			123/54 (Americas, EU,APAC)
B8	FDD	900	474/189 (RoW)	105/60 (Europe/APAC)	18/11
B12	FDD	700			13/5
B13	FDD	700			6/5
B17	FDD	700			18/10
B20	FDD	800			98/49 (Europe/Asia)
B25	FDD	1900			5/2
B26	FDD	850			5/1
B28	FDD	700			16/7
B30	FDD	2300			3/1
B40	TDD	2300			16/12
B41	TDD	2500			11/4
B66	FDD	1700			4/2
B71	FDD	600			3/1

GSM

Dual-band

- 850/1900 North America
- 900/1800 RoW

Worldwide: B2,3,5,8

UMTS

Dual Band

- 900/2100 EMEA
- 850/1900 Americas

World-wide (except China/Japan): B1,2,4,5,8

LTE

(27 bands)

Frequency bands and carriers / countries using the band except specific bands used by 1 carrier (Japan, China, Canada): <u>https://www.frequencycheck.com/bands/lte-band-3-1800</u>

Power consumption and Cost



Idle mode: 2G - 15.1mW / 3G: 25.3mW 100 MB download 2G - 10kJ / 3G - 3kJ Sending 50char SMS over 2G - 220mW / 3G - 620mW http://large.stanford.edu/courses/2010/ph240/eason1/docs/ 1569188609.pdf

50% more energy consumption in 4G in Idle mode 100% more energy consumption per Mbyte when sending data over 3G .

http://www.cs.columbia.edu/~lierranli/coms6998-7Spring2014/papers/rrclte_mobisys2012.pdf

Cost comparison cellular modems



More Complexity -> More Processing -> More Power -> Higher Costs

Why is traditional Cellular Connectivity inefficient for IoT? LTE-M and NB-IoT



Designed for Conversational Voice – always listening for paging call.

Periodic Tracking Area Update – let the Core Network know where to page / route the call. Done every 54 minutes.



Key LTE-M and NB-loT features

	CAT-1 (10/5Mbps)	LTE-M	NB-IoT	Network?
PSM Power Save Mode	\checkmark	\checkmark	\checkmark	Partial
eDRX		\checkmark	\checkmark	Partial
Enhanced Coverage		\checkmark	\checkmark	Partial
New Power Class		20db	14/20db	Yes
Control Plane CloT EPS	?	?	\checkmark	Partial







Current State LTE-M and NB-IoT

No Roaming for NB-IoT

Roaming possible for LTE-M

According to GSMA 36 LTE-M 93 NB-IoT BUT networks are missing

Wide range of supported bands – global versions available

LTE-M and NB-IoT deployment in a country can be incomplete – 2G fallback

EMnify – 30+ modules in the network. 15% of the modules using LTE-M (85% 2G – in non-LTE-M countries) EMnify-tested LTE-M networks. LTE-M Roaming agreements with 13 more countries signed – testing outstanding.

Which concepts does 5G bring?



5G State

5G frequency bands will be more complex with differing modules (low/mid/high bands and use case)

First 5G networks are deployed in limited areas



Non-Standalone Mode -> mmWave (26-40Ghz) radio is 5G for IoT only for high but core network is LTE bandwidth use cases Every year (3GPP Release) NB-IoT and LTE-M new NR functionality will be released -> modems, network will merge with 5G core will evolve / adapt First Modules available from 5G for rural areas Quectel, SIMCom, Sierra will utilize low-bands Wireless, Fibocom, ... 3.5Ghz band also used for Private Networks Germany (3.7-3.8Ghz)

73 operators in 41 countries with very limited deployments

US (CBRS 3.5GHz)

Summary

GSM

- Still most used technology for IoT
- Worldwide coverage
- Simple and cheap modem
- Battery usage, indoor coverage good
- GSM being phased out in favor LTE/NR
- No new advances

LTE-M

- World-wide availability limited
- Roaming support make provider selection simpler
- Provides good balance between bandwidth, cost, battery
- Future proof technology

NB-IoT

- World-wide availability limited
- No Roaming
- Best cost, price, battery consumption
- Future proof technology

5G

- Not a viable option today
- Few modems, low coverage, high costs

UMTS

- Widespread deployment worldwide
- Stuck in the middle btw. 2G and LTE-M/NB-IoT
- No specific IoT technology launched as for LTE
- UMTS being phased out in favor of LTE/NR

LTE CAT-1

- Relevant for high bandwidth use cases
- Worldwide coverage in developed countries
- Med/high modem costs
- High battery consumption

Thank you. Q&A

Don't miss our upcoming Webinar:

13.MAY.2020

Top 5 best practices for cellular IoT device security

