LTE (Long Term Evolution) for Public Safety
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Who we are:
Introduction to Nokia Solutions & Networks
Global company with a rich heritage

- Started: 2007
- Telecoms experience in years: 120+
- Countries we operate in: 120
- We acquired Motorola's wireless network: 2011
- Ranking, macro base station vendor competitive assessment: no. 1
- LTE suppliers to launched operator networks: 59
- Employees globally: 50,500
- Our net sales in 2012: €13.4 bn
Market Drivers for evolution from existing systems to LTE
Commercial Drivers for LTE
Continuing the evolution from GSM to LTE

Investment Protection

Re-use of
- Sites and infrastructure
- Backhauling
- Frequency bands

User experience → ARPU

Scalable bandwidth

Low Costs

Cost per Mbyte

Single System to support the world’s communication needs for next decade +
Public Safety Drivers for LTE
Migration from 2G systems to next generation communications

Leverage commercial ecosystem for scale, cost, technology evolution, worldwide interoperability

Over 200
Commercially launched LTE networks in 81 countries

Over 1000
LTE devices from 100+ suppliers

Roaming
Local and global roaming with other networks

Drivers
- Fastest data speeds
- A bigger pipe
- Field-tested across the country
- Global technology standard
- Being adopted as a standard for public safety
- 1st Non-mission critical voice
- Path to Mission Critical Voice

“The TETRA and Critical Communications Association (TCCA) has an objective of driving the development of Mobile Broadband solutions for the users of Mission Critical and Business Critical mobile communications. Having reviewed existing technologies the TCCA believes that LTE holds the greatest prospect for delivering such solutions. As a result the TCCA intends to work with 3GPP to include the functionality necessary within the LTE standard to meet that objective.”
How LTE technology compares to today’s 3.5G networks?

Latency (Roundtrip delay)**

- GSM/EDGE
- HSPA Rel.6
- HSPAevo (Rel.8)
- LTE

- **Server near RAN**

Max. peak data rate

- HSPA R6 (2x2 MIMO/64QAM)
- HSPAevo
- LTE (2x2 MIMO/64QAM)
- LTE (4x4 MIMO/64QAM)

Average cell throughput (macro cell, 2x20 MHt or equivalent)*

- HSPA R6
- HSPAevo (2x2 MIMO/64QAM)
- LTE (2x2 MIMO/64QAM)
- LTE (4x4 MIMO/64QAM)

VoIP capacity*

- HSPA R6
- LTE FDD

* LTE values according to Nokia and Nokia Siemens Network simulations for NGMN performance evaluation report V1.3 (macro cell, full buffer, 500m ISD, pedestrian speed)

** Server near RAN
Why is the LTE experience so good?
It is really fast in speed and low in delay (something needed of PS applications)

Customer experience of network delay

LTE measurements in a commercial network

LTE’s very fast round-trip response time is even better than many DSL connections

Source: Cisco Analysis of Ookla Speedtest Data, 2011
Source: Epitiro Ltd.: LTE 'Real World' Performance Study (TeliaSonera)
What is LTE?
Long Term Evolution
Radio Evolution 101

TDMA “2G”  • Time Division

FDMA “2G”  • Frequency Division

CDMA “3G”  • Code Division

OFDMA “4G”  • Frequency Division
  • Orthogonal subcarriers

User 1  User 2  User 3  User ..
Key features of LTE
State of the art improvements from 3rd Generation systems

- Fast Link Adaptation due to channel behavior
- Short TTI = 1 ms Transmission time interval
- Advanced Scheduling Time & Freq.
- (ARQ) Automatic Repeat Request
- MIMO Channel
- Up to 64QAM Modulation
- DL: OFDMA
- UL: SC-FDMA
- Robust
- High Speed
- Low Latency
- Scalable
LTE Radio principles

Downlink: OFDMA
- Improved spectral efficiency
- Reduced interference
- Very well suited for MIMO

Uplink: SC-FDMA
- Power efficient uplink increasing battery lifetime
- Improved cell edge performance by low peak to average ratio
- Reduced Terminal complexity

- Enabling peak cell data rates of 173 Mbps DL and 58 Mbps in UL *
- Scalable bandwidth: 1.4 / 3 / 5 / 10 /15 / 20 MHz also allows deployment in lower frequency bands (rural coverage, refarming)
- Short latency: 10 – 20 ms **

* At 20 MHz bandwidth, FDD, 2 Tx, 2 Rx, DL MIMO, PHY layer gross bit rate
** roundtrip ping delay (server near RAN)
Our Key Architectural Concept
Flat and Cost effective Mobile Network

- Simplified network architecture with open interfaces
- Decouples network from services and applications (ex Voice, Web, email, etc)
Meeting Public Safety Needs
Public Safety Drivers for LTE
Large new ecosystem created for PS around FirstNet

9/11 attacks in USA create need for national PS network to have interoperable response from multiple agencies

Middle Class Tax Relief & Job Creation Act of 2012 Creates 1st National Public Safety network in USA

700 MHz D Block assigned for PS
7B USD allocated to fund network buildout
PS provided 1,300+ baseline requirements
USA: 2.5 M 1st Responders & 22.6M potential government users

LTE chosen as single technology for FirstNET to leverage commercial ecosystem for devices, network, & applications

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Overall Evolution of PS Communications

- Guaranteed Access
- QoS
- Reliability & Resiliency
- Mission Critical Voice
- Roaming
- Spectrum Efficiency, Capacity, Coverage
- Full Interoperability

US Dept of Homeland Security
3GPP “Third Generation Partnership Project”
Support of Public Safety Requirements

**Rel-8**
- Introduction of LTE
- High Speed Packet Data
- Band 14 PS support
- Voice over LTE (telephony)
- QoS, Basic Pre-emption
- Security (128 bit AES)

**Rel-9**
- Precise Location
- Multimedia Broadcast Svc
- Public Warning System
- E9-1-1 Support
- Cell on Wheels support
- Self Organizing Network

**Rel-10**
- Increased data throughput
- Relay Support (fire truck relay to users)

**Rel-11**
- High Power Devices (1.25W)

**Rel-12+**
- Mission Critical Voice
  - Group Call
  - Proximity Services
  - Priority Handling & Preemption

[http://www.3gpp.org/Public-Safety](http://www.3gpp.org/Public-Safety)
Looking a bit deeper into a important PS feature under development
Group Call Service Enabler requirements

**Parallel Rx**
All users in a given area shall receive the group communication at the same time (perception)

**Support**
Service continuity, Resource efficiency, Roaming

**QoS**
Group handling, QoS assignment (and reassignment) for preemption and prioritization by the EPS

**300 ms**
call setup time

**Relay**
support for out of network coverage UE

**GeoFencing**
Capable to restrict Group communication on geographical area basis

**Multimedia**
Support media such as voice, video or data

**Unlimited groups**
Group members within an area maybe unlimited

**Parallel groups**
UE can connect to multiple groups in parallel
GCSE prioritized features for 3GPP R-12

• Based on input from UK Home Office (SP-130358) and US Dept. of Commerce (SP-130363)
• The following components are critical for Release 12 (SP-130506):

(A), (E) Group Management and associated User Interaction
Includes group creation and group membership control and associated user interaction.

(B) Group Communications
Includes group communications (and setup) in and out of coverage and in roaming scenarios; priority/pre-emption, notifications when group communications start, ability of user to accept/reject/ignore (and for the system to require a user to accept) a group communication, ProSe Group Communication aspects (aside from UE to Network relay).

(F) Service Continuity
When UEs move among different cells providing multipoint service. Considers service continuity when delivery of group communications changes between unicast and multipoint service.

(H) Resource Efficiency
Includes multicast/unicast handling. Without this feature component, UEs and the CN will behave according to configuration (e.g. always use the unicast method or always use the multicast method.)
Summary

• LTE already a widely adopted technology globally
• Public Safety will leverage LTE to gain speed, efficiency, and flexibility from commercial system developments
• Initial systems will have support for data services and basic interoperability
• Government entities are working with 3GPP to add features to allow full migration from legacy systems to LTE for Public Safety
Thank you