July 2014

Creating a Digital 6th Sense with LTE Direct

QUALCOMM®

LTE Direct is creating a Digital 6th Sense through always-on proximal discovery services

1

Always-on device-to-device discovery of friends, services, offers in one's proximity

Proximal discovery services efficiently integrated with existing LTE Advanced services and networks

2

Required to scale up from today's location-based and proximity beacon solutions

Privacy sensitive and battery efficient discovery of 1000s of devices/services in the proximity of ~500 meters

3

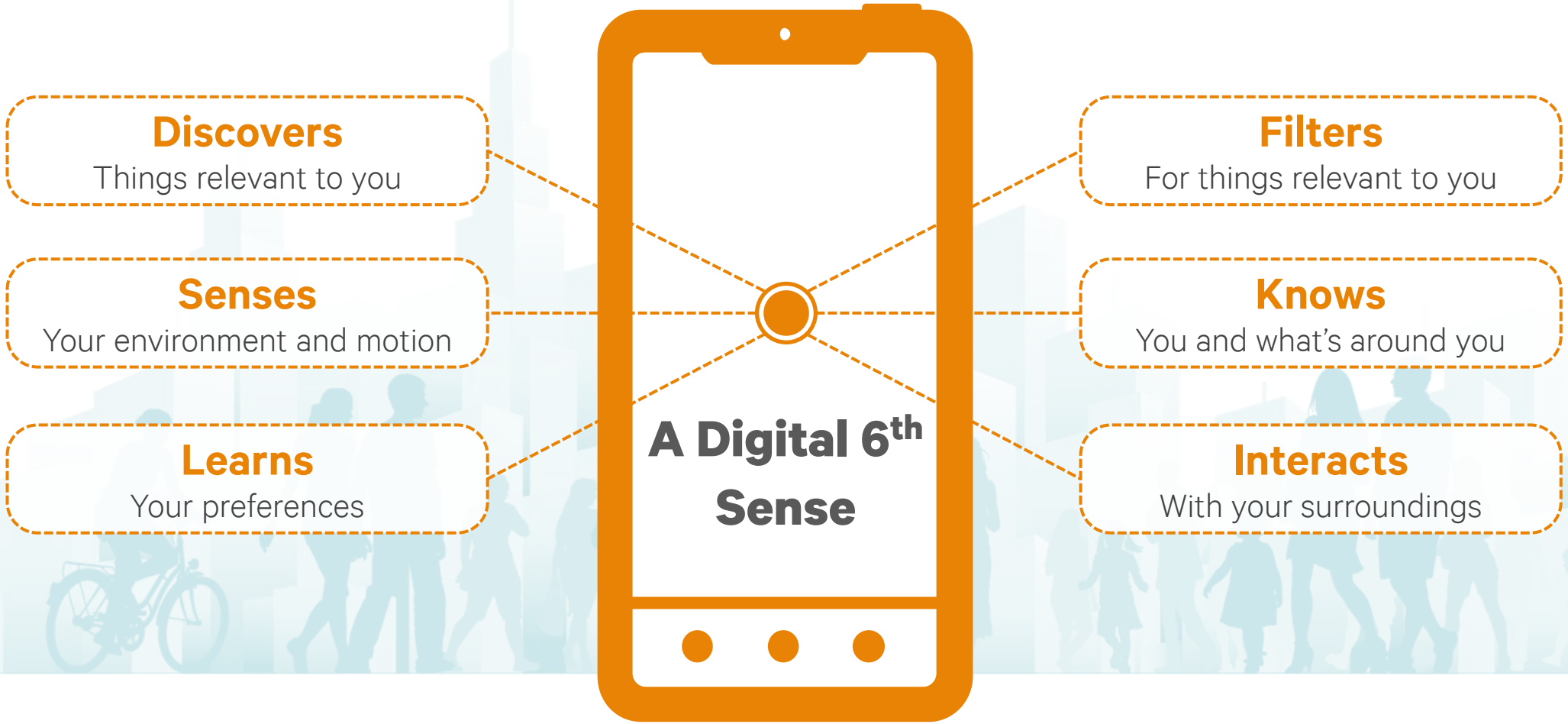
LTE Direct ecosystem implementation underway – defined in 3GPP R12

Operator trials throughout 2014[1]; app developers testing innovative use cases today with LTE Direct Trial SDK[2]

1 Deutsche Telekom trial in Germany announced and enabled by trial devices from Qualcomm Technologies; other trials in planning; 2 LTE Direct Trial SDK by Qualcomm Technologies limited availability through ltedirect.qualcomm.com

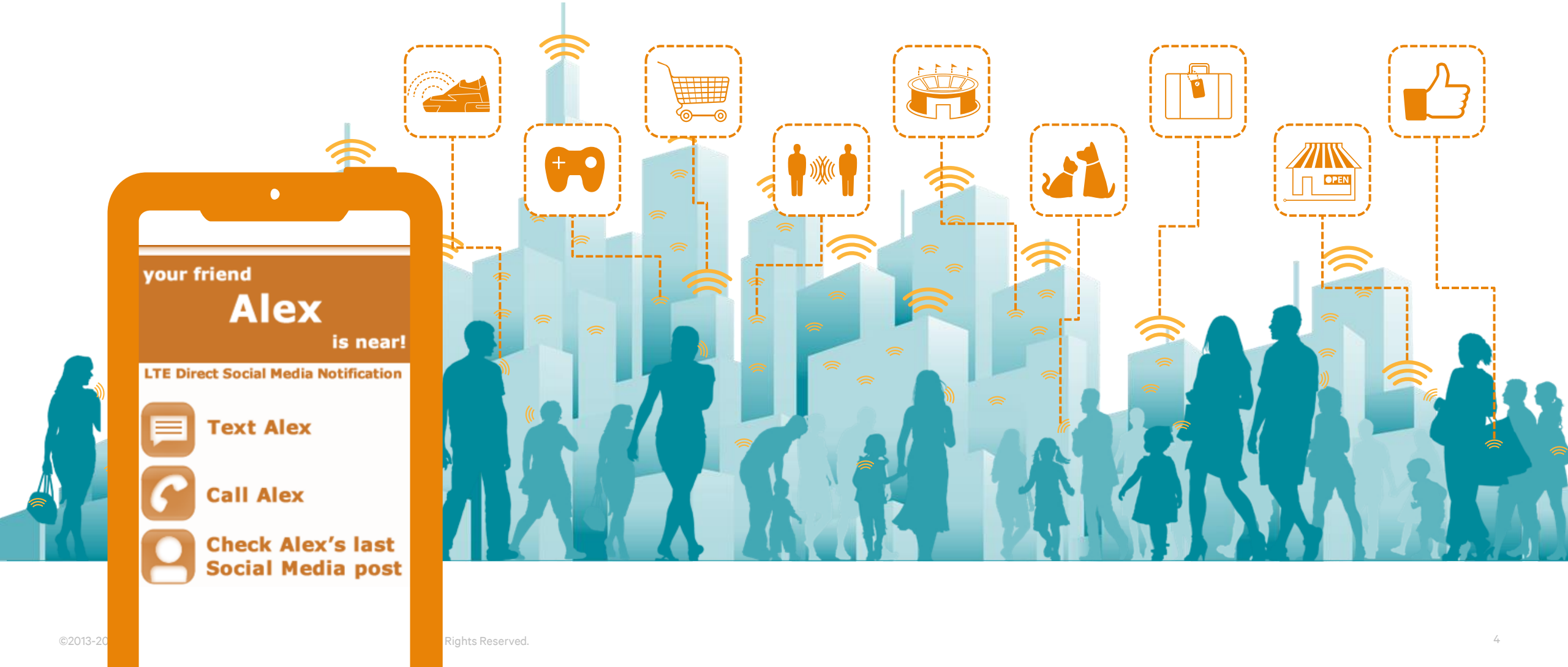
The next generation mobile services in a hyper-connected world

Mobile devices aware of the user and surroundings, connecting our digital and physical worlds



Creating a Digital 6th Sense with always-on proximal discovery

Who's around? What's nearby? Is it relevant to me, now?



The always-on proximal discovery challenge

Scaling proximity services for mass consumer adoption

Privacy

Barriers to technologies that continuously track location

Battery Life

Always-on services require continuous proximal discovery

Scale

Long range and high capacity required to expand use cases

Interoperability

Proprietary platforms lead to mobile app silos

Proximal discovery services are expanding the reach of mobile

Utilizing technologies today that either track user's location or proximity to nearby beacons

Location-based app

Tracking user's location and access cloud to identify relevancy

- \+ Unlimited range
- \+ Large install base
- \- Privacy barrier with location tracking
- \- Battery drain from constant network pings
- \- Proprietary platform

Proximity Beacons (BT-LE[2])

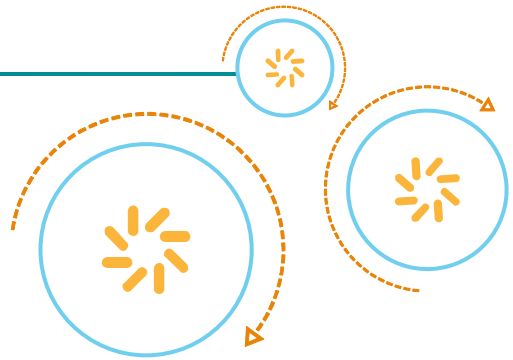
Deliver relevant value by notifying nearby users using an associated app

- \+ Privacy sensitive
- \+ Low power consumption
- \+ Indoor support
- \- Limited range – 10s of meters
- \- Limited capacity that doesn't scale
- \- Proprietary platform

>$7B total M&A activity in proximal discovery services in 2013[1]

1 Source: BIA/Kelsey, May '13; 2 Bluetooth® Smart (Low Energy) feature as part of the Bluetooth Core Specification version 4.0 and higher

LTE Direct is a device-to-device technology required to scale up from today's proximal discovery solutions



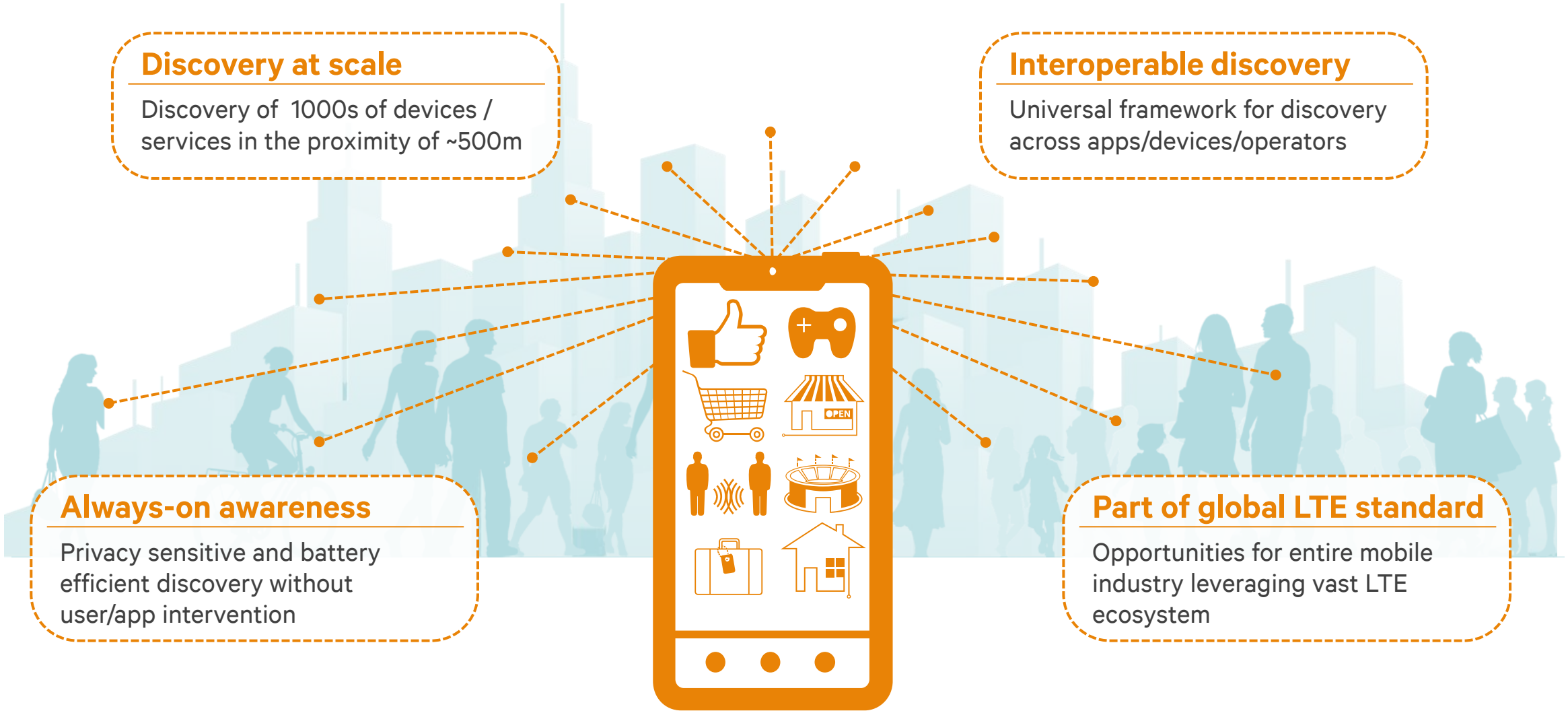
LTE Direct is solving the always-on proximal discovery challenge

Discovery at scale

Discovery of 1000s of devices / services in the proximity of ~500m

Interoperable discovery

Universal framework for discovery across apps/devices/operators



Always-on awareness

Privacy sensitive and battery efficient discovery without user/app intervention

Part of global LTE standard

Opportunities for entire mobile industry leveraging vast LTE ecosystem

Discovery with unparalleled scalability and capacity

LTE Direct enables broader set of use cases than other device-to-device technologies

	BT-LE	LTE Direct
Discovery Density (# of devices covered)	Hundreds	Thousands
Range (m)	~50	~500
Active Duration (ms)[1]	~4000	~75

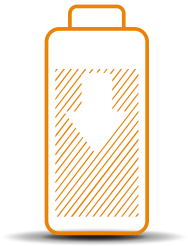
1 Source Qualcomm Technologies simulations; Assumptions: outdoor deployment model (e.g. Farmer's market), Ped A channel model, ITU-1411 pathloss mode, Carrier frequency of 2 GHz for LTE Direct / 2.4 GHz for BT-LE, System bandwidth of 10 MHz FDD for LTE Direct / 2 MHz for BT-LE, LTE Direct protocol implementation of 75 subframes every 18 seconds, BT-LE beacon protocol implementation of advertising for 1.518 ms every 1.20 s with <20% collision / scanning for 256 ms every 1.28 s

Battery efficient and privacy sensitive always-on awareness

LTE Direct provides enhanced user experience over location-based solutions

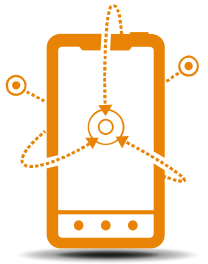
Privacy sensitive

Devices do not need to reveal their identity or allow location tracking, thus minimizing privacy barriers



Battery efficiency

Determining relevancy is done at the device level eliminating battery inefficient network pings



Autonomous

Continuously and passively proximal discovery of relevant value without user or app intervention

LTE Direct provides interoperable discovery

Vastly expanding the reach and value of proximal discovery for mobile app developers

RETAIL SOCIAL TRAVEL MAPS CLASSIFIEDS

Universal framework for discovery across apps, devices, operators

Broader reach

Compared to vertical "Walled Gardens"

Trusted apps

Notification alerts set through your favorite, trusted apps

Better context

User context determined by apps that know the most about you

LTE Direct leverages the global LTE ecosystem

Part of 3GPP Release 12 expected to be complete in 2014

Common global standard

Support for paired (FDD) and unpaired (TDD) spectrum

Vibrant, global ecosystem

>275

Global LTE network launches in >100 countries

>1,500

Global LTE devices from >100 vendors

Source: www.gsacom.com July 17 2013 for networks and July 5, 2013 for devices. Source: GSA, Mar. '14.

We must make best use of all technologies for proximity services

Location-based

User-initiated search (plus navigation)

Enhance relevancy of search results through location tracking with unlimited range

LTE Direct

Always-on device-to-device proximal discovery

Privacy sensitive and battery efficient discovery of 1000s of devices / services in the proximity of ~500m

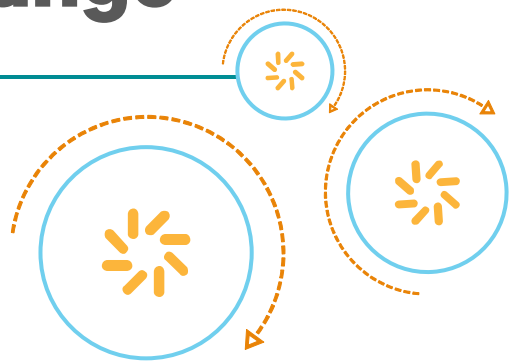
Proximity beacons

Micro-location awareness and geo-fencing

Engage customers in close proximity (~50m) with relevant, timely, and personalized content

LTE Direct provides privacy sensitive and battery efficient discovery at scale and range

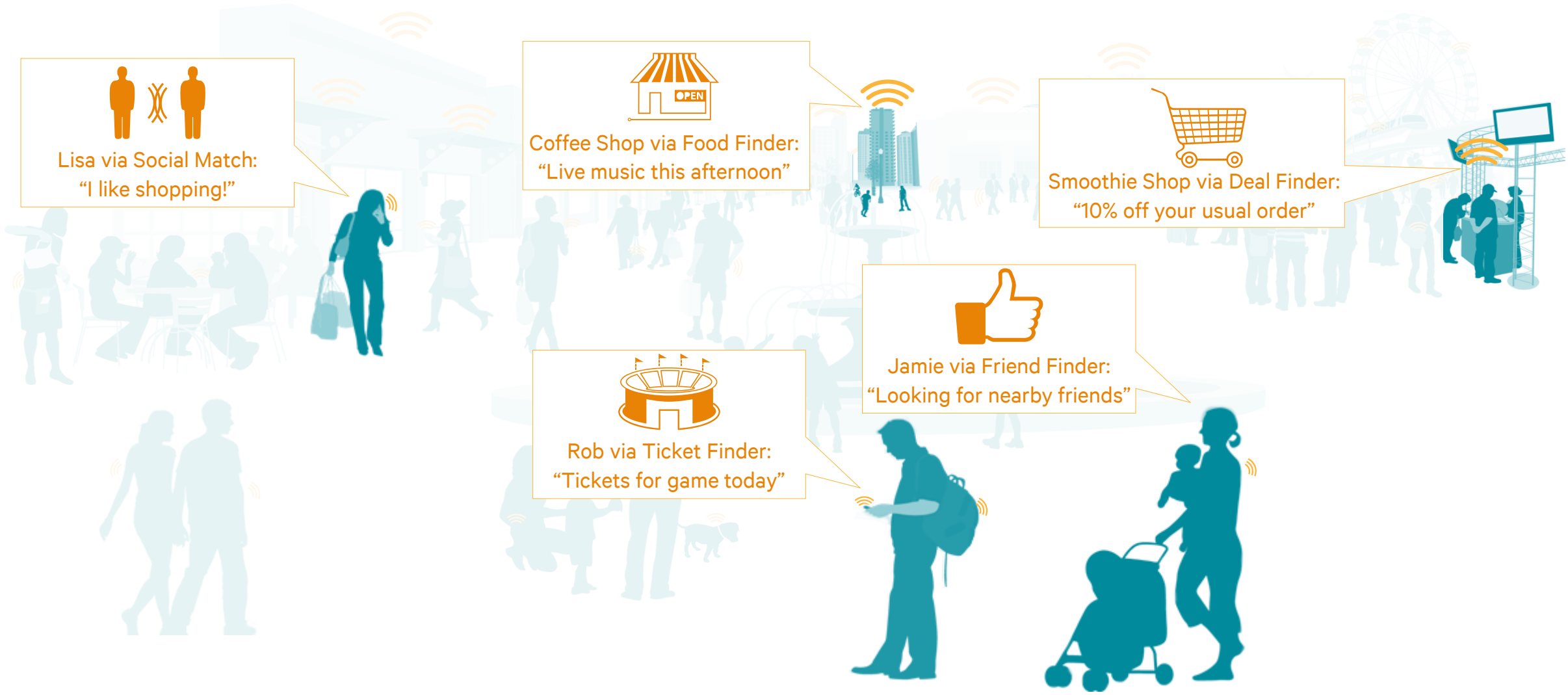
How does it work?



LTE Direct: A day out at the shopping center

LTE Direct is a device-to-device proximal discovery technology

All devices can broadcast needs and services via “expressions”



Services are efficiently mapped to Expressions

Public Expressions

- Application agnostic
- Any proximal device can decode expression
- Good for advertising, local “finder” apps, etc.

Private Expressions

- Application specific
- Only proximal devices with “key” can decode expression
- Good for personal identification

Service

Live Music @ Coffee House

Mobile app leverages centrally managed hierarchical mapping[1]

00110000011101111….

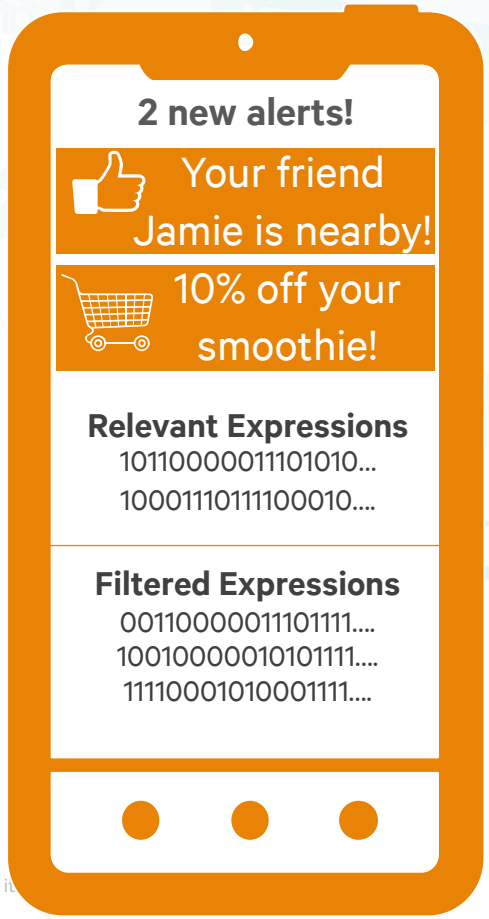
128-bit Expression

1 See appendix slide for more details on how this works. Note: Private Expression mappings based on a one-way hash function with a private key and permissions controlled via specific apps

Relevance is passively identified with no user/app intervention

Relevancy is determined at device level

Optional metadata
Additional info available following discovery (e.g., street address)



Sale @ Smoothie Shop
10001110111100010....

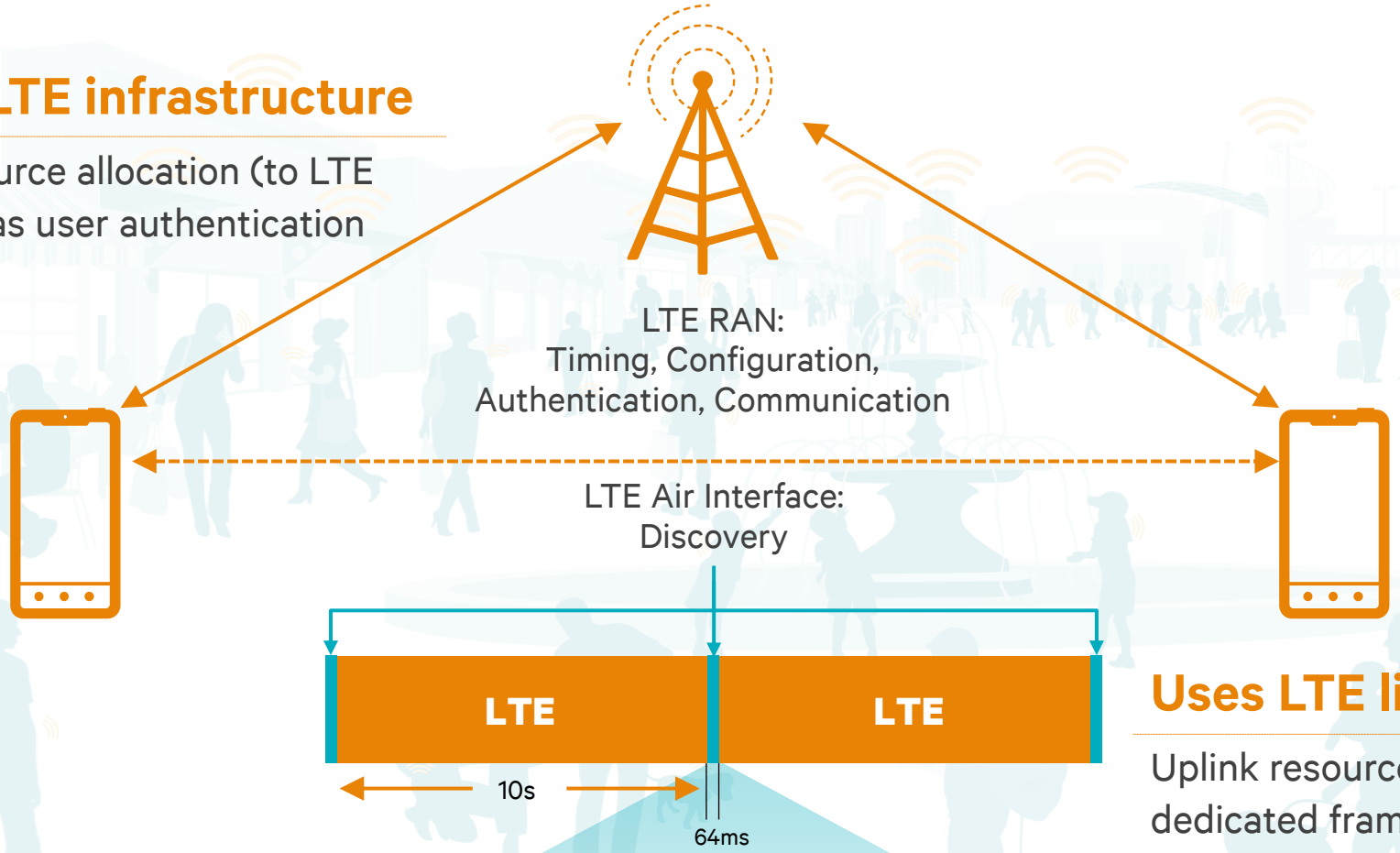
Jamie @ Friend Finder
10110000011101010...

Communication via traditional LTE or Wi-Fi/Wi-Fi Direct

LTE Direct efficiently utilizes LTE spectrum for discovery

Leverages LTE infrastructure

For timing, resource allocation (to LTE Direct), as well as user authentication



Uses LTE licensed spectrum

Uplink resources in LTE FDD system or dedicated frames in LTE TDD system

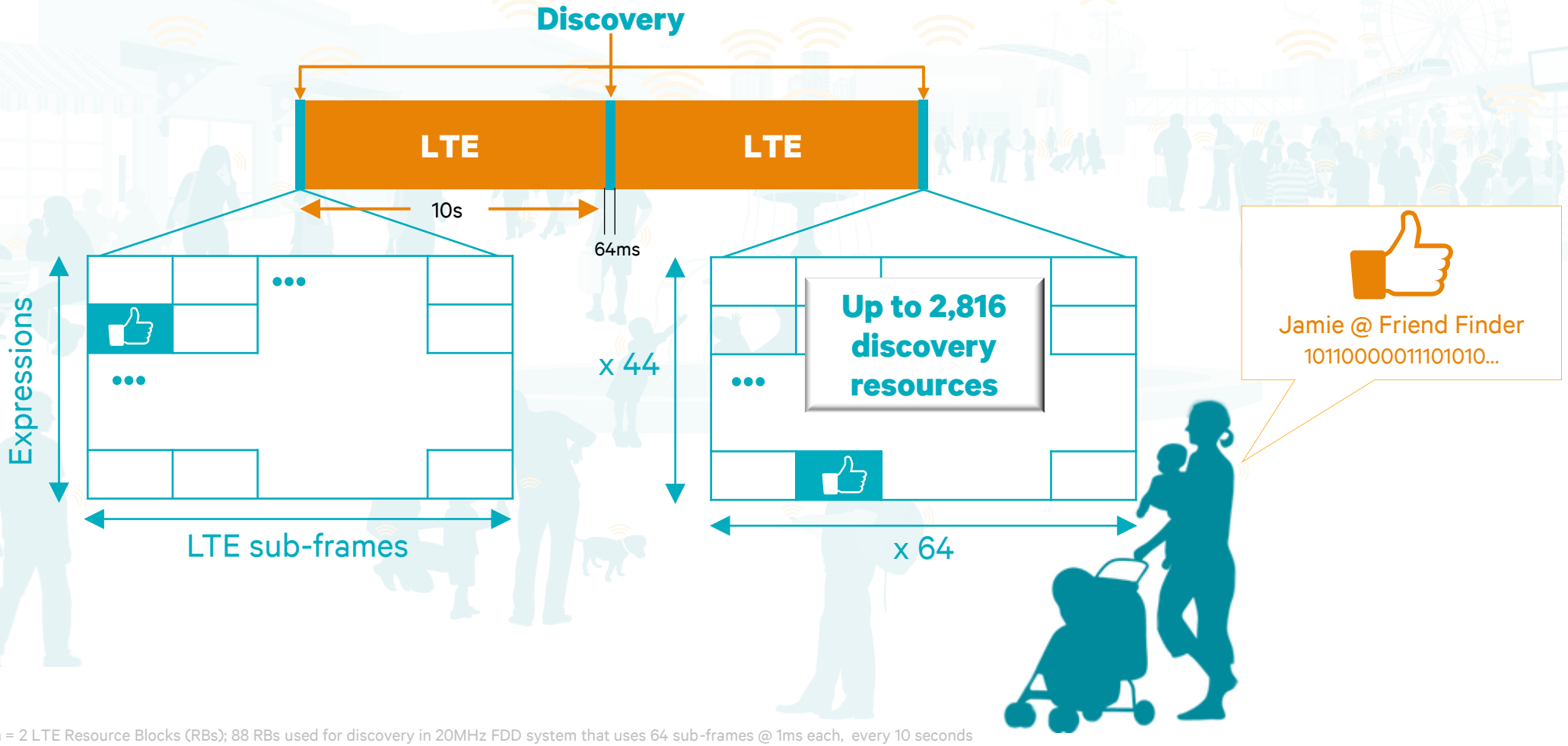
Negligible impact to capacity

Utilizes <1% of uplink resources[1]

1 Source: Qualcomm simulations; Assumes 20MHz system with ~2,000 expressions

LTE Direct resources are managed by mobile operators

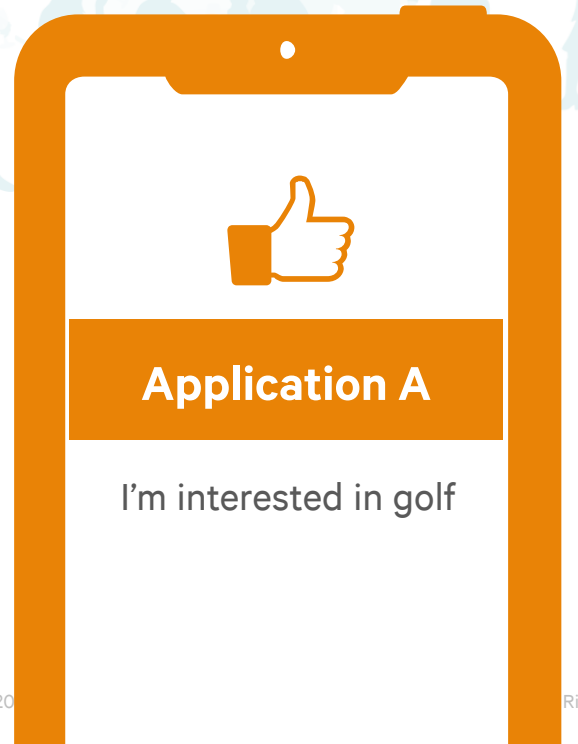
Devices either broadcast or listen within assigned LTE sub-frames



1 Assumptions: 1 Expression = 2 LTE Resource Blocks (RBs); 88 RBs used for discovery in 20MHz FDD system that uses 64 sub-frames @ 1ms each, every 10 seconds

LTE Direct provides interoperable discovery across apps

Vastly expanding the field of value for proximal discovery



Application A

Your friend Lisa is nearby and is interested in golf

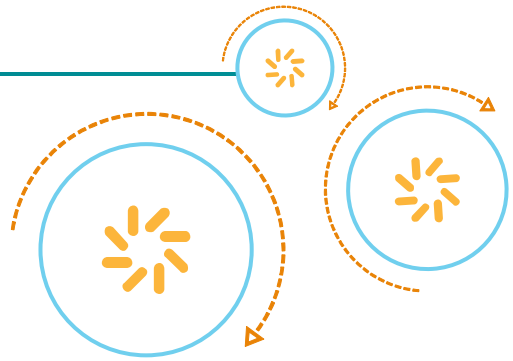
Application B

The Golf Shop has a 20% discount sale on all golf equipment

Application C

Buy one, get one free Golf lesson at The Golf Pro

LTE Direct ecosystem implementation is underway creating opportunities for the entire mobile ecosystem



LTE Direct creates big opportunities for the mobile industry

The next generation of proximity services across an extensive set of use cases

Social networking services

Social Matching

Shared Interests

Shared Experiences

$1.9B Expected revenue in proximity-based social networking applications/services in 2015[1]

Mobile advertising

Retail

Local Services

Classifieds

$5.7B Expected spend in location-targeted mobile advertising in 2015[2]

And many more use cases...

Travel services

Gaming

Loyalty programs

Safety services

Geo-fencing Services

Search services

Source: 1 Smith's Point Analytics, Feb' 13; 2 BIA/Kelsey, May '13

LTE Direct will benefit the entire mobile ecosystem

LTE Direct enables operators to deliver new mobile services

An opportunity to monetize services beyond voice and data with always-on proximal discovery

Operator-owned

Global spectrum holders for LTE Advanced

<1% of uplink resources*

Negligible impact to existing LTE capacity

API Access Fee

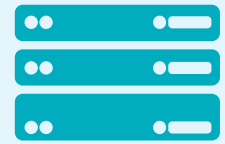
Supply APIs to mobile app developers for easy access to discovery services

Enables discovery across apps/devices

Additional potential value

Commercial advertisers pay for consumer notifications and customer-approved data

Push Advertising



Data Mining

Source: Qualcomm simulations; Assumes 10MHz system with ~2,000 expressions

LTE Direct empowers app providers and OEMs to differentiate

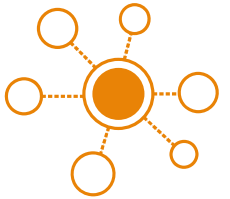
Lead the next generation of mobile proximity services through a differentiated user experience

Discovery at scale

Discovery of 1000s of devices / services in the proximity of ~500m

Always-on awareness

Privacy sensitive and battery efficient discovery without user/app intervention



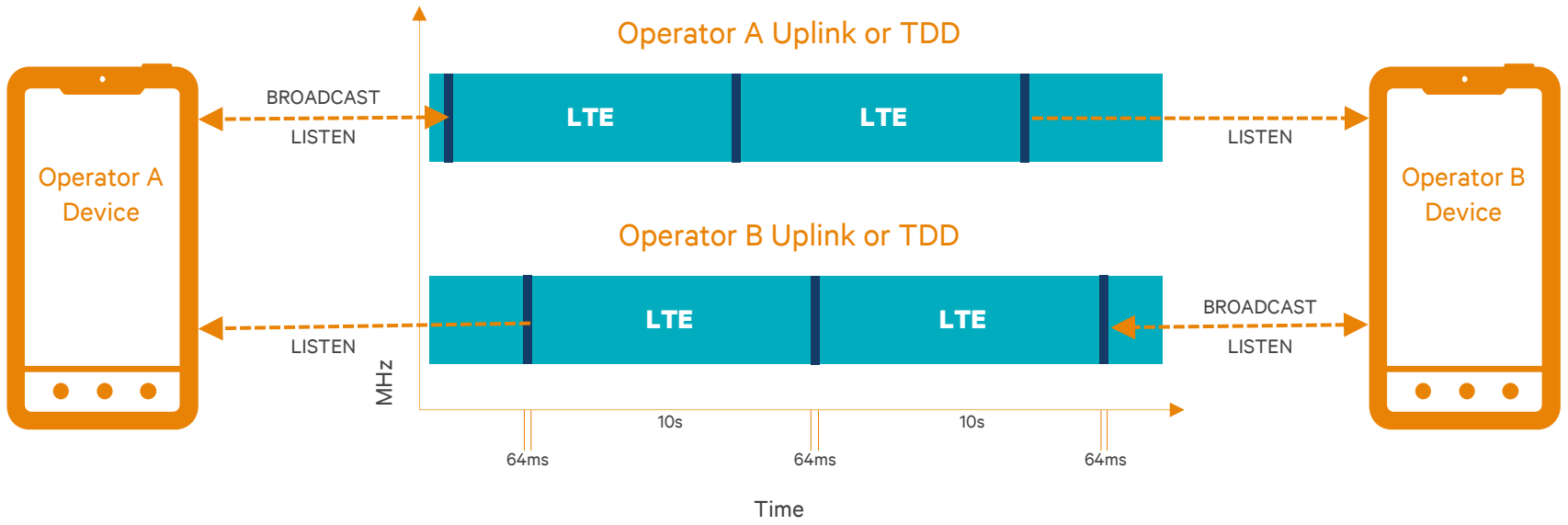
Interoperable discovery

Universal framework for discovery across apps/devices/operators

Solving the always-on proximal discovery challenge

Achieving scale requires discovery between mobile operators

Option 1



Broadcast and listen to expressions on their own spectrum
Listen-only on other operator's spectrum

Option 2

All devices in a country/region broadcast and listen to LTE Direct expressions on the same agreed-upon spectrum band(s)

Both options will require LTE Advanced multiband, multimode devices with global support for the many frequency band combinations of LTE

Implementation of the LTE Direct ecosystem is underway

Standards	**Standardization** by 3GPP as feature in Release 12 expected to be complete late 2014	
Proof of concept	**Demonstrated** at MWC 2014 with live over-the-air demo enabled by trial devices from Qualcomm Technologies	
Operator trials	**Trial Announced** by Deutsche Telekom in Germany for 2014 enabled by trial devices from Qualcomm Technologies	**Trials Planned** by additional operators in 2014
App developer interest	**Partnerships Announced** with early app partners to create and test use cases leveraging trial SDK by Qualcomm Technologies[1]	Submit creative use case ideas for access to the trial SDK at: ltedirect.qualcomm.com

1 Limited availability starting in May 2014

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Operator trials

App developer interes

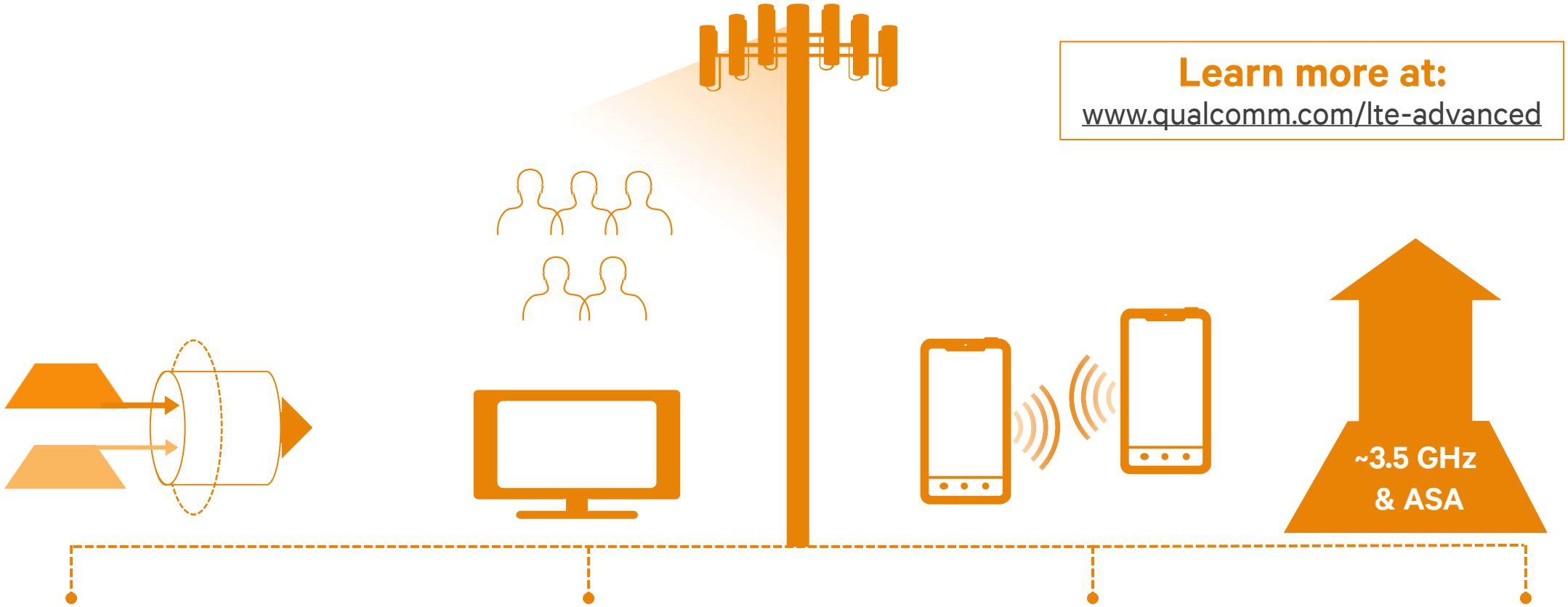
"We are participating in this trial because LTE Direct promises new opportunities in the mobile ecosystem."
– Thomas Kiessling
Chief Product and Innovation Officer at Deutsche Telekom

"We're excited to be bringing to life the frictionless user experiences we all expect of the future, but that have not been possible with today's proximity and geo-location technologies."
– Colin O'Donnell
Founding Partner, Control Group

1 Limited availability starting in May 2014

LTE Advanced is evolving and expanding into new frontiers

LTE Direct is one example enabling new, differentiated mobile apps/services with LTE Advanced



Extending LTE Advanced to unlicensed spectrum

Dynamic LTE broadcast. Being considered for beyond mobile for terrestrial TV

LTE Direct for “always-on”, autonomous device-to-device proximity awareness

Higher spectrum bands new licensing models—authorized shared access

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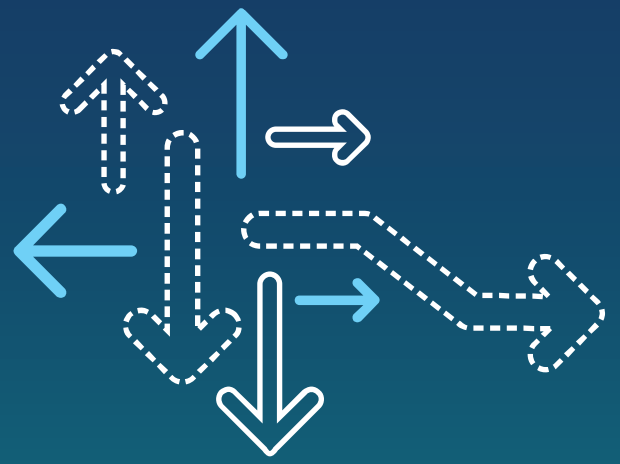
Questions? - Connect with Us



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