Driving Better Mobile Experiences
A Holistic Approach to Hardware & Software

LIAT BEN-ZUR
Sr. Director, Software Strategy & Business Development

@LiatBenZur
Snapdragon System Spans Hardware, Software, Services, and Ecosystem Tools

<table>
<thead>
<tr>
<th>ECOSYSTEM SUPPORT</th>
<th>Developer Hardware</th>
<th>Developer Software Tools</th>
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Growth of Smartphones is Challenging Networks

- Ever growing number of Smartphones driving increased data loads
- Thousands of “chatty” apps running background updates, push, status, etc. driving signaling load

Source: Strategy Analytics, Mar 2011
Growth of Smartphones is Challenging Networks

- Real need for intelligent system selection and effective use of Wi-Fi offload
- Real need to efficiently manage data applications
- Real need to improve performance reduce power consumption

OEMS AND CARRIERS WANT MORE INTELLIGENT PHONES THAT ARE MORE NETWORK AND CONSUMER FRIENDLY
QUALCOMM’S INTELLIGENT CONNECTIVITY ENGINE

PROVIDING REAL SOLUTIONS TO REAL PROBLEMS

WHAT

- Better Wi-Fi Experience
- Reduced Wi-Fi failures
- Longer Battery Life
- Reduced signaling traffic
- Reduced data traffic
- More carrier control of data offloading

HOW

- Real time, dynamic Wi-Fi Throughput & Quality Estimation
- Advanced 3G vs. Wi-Fi System Selection
- Intelligent aggregation of background app data requests (Network Socket Request Manager)
- Carrier Profiles with OMA-DM OTA provisioning
Qualcomm’s Intelligent Connectivity Engine

PROVIDING REAL SOLUTIONS TO REAL PROBLEMS

Intelligent Algorithms that manage all aspects of device connectivity

- Run below the HLOS
- Policy based radio management
- Intelligent network selection
- Tight coupling with other subsystems

CONNECTIVITY ENGINE IS NOT A CONNECTION MANAGER APPLICATION
Snapdragon System Spans Hardware, Software, Services, and Ecosystem Tools

ECOSYSTEM SUPPORT
- Developer Hardware
- Developer Software Tools
- Developer Ecosystem Events and Community
- Carrier-Friendly Services

ADVANCED SOFTWARE TECHNOLOGY
- Entertainment
- Connectivity
- Camera
- Web
- Computer Vision
- Augmented Reality
- AllJoyn™

BROAD SUPPORT FOR HLOS
- Android
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- Windows
- Windows Phone

LEADING HARDWARE
- CPUs
- GPUs
- 3G/4G MODEMS
- MEMORY
- DSPs
- VIDEO/AUDIO
- LOCATION AND SENSORS
- WiFi BT FM
- POWER MGMT
- RF
Accelerating and Enabling a Better Web Experience

- Page Download
- User Snappiness
- Multimedia Streaming
- Power Optimization
- Enhanced Capabilities
Browser Performance Optimizations

![Snapdragon by Qualcomm Logo]

- **21%** Faster Average Page Download1
- **70%** Faster Average on V8 Benchmark1
- **30%** Faster Average Page Reload1
- **46%** Faster Average Download2

Source: Tests performed by Qualcomm Innovation Center, Inc.

1. Tested with 26 sites on both UMTS and Wi-Fi networks on 1.2Ghz Qualcomm MDP8660 between optimized and stock Android 2.3.
2. Tested with 30 sites on Wi-Fi and consistent environment on Android 2.3 using HTC Sensation and production OEM device with Dual-CPU A9.
Browser Performance Optimizations

71FPS
SMOOTH AS GLASS
SCROLL, PAN, ZOOM1

> 30%
FASTER
HTML <CANVAS>
JS GAMEBENCH
SPRITES RENDERED2

7%
AVERAGE POWER IMPROVEMENT
WHEN BROWSING1

Snapdragon 8260: 80-90
Competitor Dual-CPU A9: 60-65

(Higher # is better)

Source: Tests performed by Qualcomm Innovation Center, Inc.

1Tested with 26 sites on both UMTS and Wi-Fi networks on 1.2Ghz Qualcomm MDP8660 between optimized and stock Android 2.3.
2Tested with 30 sites on Wi-Fi and consistent environment on Android 2.3 using HTC Sensation and production OEM device with Dual-CPU A9.
Enabling Rich Web App Device APIs

**Location**
- Single location
- Interval location
- Proximity alert

**Sensors**
- Pitch
- Direction
- Speed

**Camera**
- Zoom
- Filter effects
- Image recognition

**Audio**
- Capture
- Pitch
- Rate

**Augmented Reality**
- Image targets
- Frame markers

**Proximity P2P**
- Discovery
- Secure connections
Snapdragon System Span Hardware, Software, Services, and Ecosystem Tools

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- LOCATION AND SENSORS
- WiFi BT FM
- POWER MGMT
- RF
Computer Vision: Fast CV Accelerates These Use-Cases on Mobile Devices

- Augmented Reality
- Gestures
- Face Recognition
- Text Recognition
- Depth Mapping
- Image Stabilization
What is Augmented Reality (AR)?

REAL WORLD VIEW
Live camera view

VIRTUAL CONTENT
Information about points of interest

GPS and Compass-based Augmented Reality Experience
Good for rough location of items outside our field of view

Content placement inaccurate due to compass error
Augmented Reality Use Case Scenario

REAL WORLD VIEW
Live camera view

VIRTUAL CONTENT
Vision-based AR recognizes objects in field of view and aligns graphics tightly to target object

Vision-based Augmented Reality Experience
Enables a more immersive and interactive experience
The core LAN technologies are already ubiquitous and in all our phones (Bluetooth, Wi-Fi)

But… Can your phone find me?

Why Can’t All Smartphones Discover and Connect in this Conference Room?

Can you share the music or pictures currently on your phone with me? Why not?
Peer-to-Peer (P2P) is Complicated

P2P FRICTION DEVELOPERS FACE TODAY

DEVICE DISCOVERY

SERVICE DISCOVERY

PAIRING

PLATFORMS

SECURITY

RADIOS

AD HOC NETWORKING

TRANSIENT DEVICES
What Is AllJoyn?

OPEN SOURCE FRAMEWORK TO ENABLE AD HOC, PROXIMITY-BASED, P2P NETWORKING

AllJoyn unleashes a whole new set of user experiences that span across mobile, tablets, PCs, TVs, and more by abstracting all the complexity of P2P networking from developers.
What AllJoyn is Not…

<table>
<thead>
<tr>
<th>Radio Technology</th>
<th>Hardware Based</th>
<th>OS Dependent</th>
<th>Transport Dependent</th>
<th>Wireless Protocol</th>
</tr>
</thead>
</table>
The AllJoyn P2P Framework

MAKES PROXIMITY P2P EASY

www.Alljoyn.org

Free. Open Source
Apache 2.0

P2P apps made up of 2 parts:
(1) the App, (2) AllJoyn Daemon

Application Layer Discovery. What Services Are Running on Nearby Devices That Are Reachable

Tablets | Mobiles | Televisions | Laptop/PC
Proximal P2P Has Huge Untapped Potential

WWW.ALLJOYN.ORG

Entertainment Experiences

Low Latency, Head-to-Head Multi-Player Gaming

Multiscreen Experiences

Smartphone and Tablet as Companion to Television

Collaborative Experiences

Seamless Discovery, Chat, and Interaction with People Nearby

AllJoyn is an open source project for mobile software being driven out of Qualcomm Innovation Center, Inc (QuIC), a subsidiary of Qualcomm Incorporated that focuses on open source development.
AllJoyn Ushers in New and Exciting User Experiences for Mobile, Tablets, & TVs

Race games add head-2-head competition
Office apps add p2p sync and interact across devices
Social networking apps easily discover who is nearby
Imaging apps seamlessly discover who to send pictures to
Developers easily build phone apps that can work with TV

Great Opportunity to help OEMs & Developers Differentiate with New, Custom Experiences
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Snapdragon Developer Program: Delivering Experiences

PRELOAD APP OPPORTUNITIES FOR OEM CONSUMER CAMPAIGNS

Enable developers to build and optimize differentiated user experiences for Snapdragon enabled devices.

Introduce developers to our OEM and carrier customers for preload and other collaboration opportunities.

Developers Are Creating the Next Generation User Experiences.
We Deliver Enhanced Experiences…

<table>
<thead>
<tr>
<th>Communications</th>
<th>Video and Premium Content (Security)</th>
<th>Audio</th>
<th>Peer-to-Peer</th>
</tr>
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<tbody>
<tr>
<td>Tango</td>
<td>Netflix</td>
<td>WAVES</td>
<td>LoKast</td>
</tr>
<tr>
<td>ooVoo</td>
<td>DIVX</td>
<td>DOLBY</td>
<td>Zombie Lane</td>
</tr>
<tr>
<td>bambuser</td>
<td>SanDisk</td>
<td>SRS</td>
<td>Tower Bloxx</td>
</tr>
<tr>
<td>YagattaTalk</td>
<td>Sling Media</td>
<td></td>
<td>3D Rollercoaster Rush Jurassic</td>
</tr>
<tr>
<td>Skifta</td>
<td>LiveCast</td>
<td></td>
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<td>splashtop</td>
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<td></td>
<td>GAIKAI</td>
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</tbody>
</table>
...And Compelling Games

Snapdragon Game Demos
Optimized and Enhanced Games
for Pre-Install Opportunities

Snapdragon Exclusive Games
for Royalty-Free Pre-Install

gaming.qualcomm.com
# Optimized Apps That Take Advantage of Snapdragon

GREAT FOR PROMOTIONAL CAMPAIGNS TO SELL MORE DEVICES!

- We work with developers to offer leading edge experiences
- Leveraging advanced capabilities in the chip

<table>
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<tr>
<th>Video Optimization</th>
<th>Content Protection</th>
<th>Graphics</th>
<th>Power</th>
</tr>
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<tr>
<td><img src="image1.png" alt="Video Icon" /></td>
<td><img src="image2.png" alt="Content Protection Icon" /></td>
<td><img src="image3.png" alt="Graphics Icon" /></td>
<td><img src="image4.png" alt="Power Icon" /></td>
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<th>Camera</th>
<th>Peer-to-Peer</th>
<th>Multi-Mic and Audio</th>
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<td><img src="image5.png" alt="Facial Processing Icon" /></td>
<td><img src="image6.png" alt="Camera Icon" /></td>
<td><img src="image7.png" alt="Peer-to-Peer Icon" /></td>
<td><img src="image8.png" alt="Multi-Mic and Audio Icon" /></td>
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Thank You

For more information on Qualcomm, visit us at:
www.qualcomm.com
www.qualcomm.com/blog

Follow us on:  
@LiatBenZur
Dedicated Focus for IoE

QCT PRODUCT CATEGORIES

<table>
<thead>
<tr>
<th>Technologies</th>
<th>CPG</th>
<th>CCP</th>
<th>QCA</th>
<th>New IoE Business</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP</td>
<td>Phones</td>
<td>WOS</td>
<td>Atheros</td>
<td>Automotive</td>
</tr>
<tr>
<td></td>
<td>MDM</td>
<td>Computing</td>
<td>WCP</td>
<td>Consumer</td>
</tr>
<tr>
<td>Modem</td>
<td>Gobi</td>
<td>Tablets</td>
<td>GPS</td>
<td>Smart</td>
</tr>
<tr>
<td>Connectivity</td>
<td>CSM</td>
<td></td>
<td>Home</td>
<td>Energy</td>
</tr>
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<td>FSM</td>
<td>Tablets</td>
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<td>Enterprise</td>
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<td></td>
<td>&amp; Industrial</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and more…</td>
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IoE Segments

Consumer Devices
With WWAN Connectivity
- Person, Pet Tracking
- Health, Medical
- eReaders, Frames, Gaming consoles

Smart Energy and Home Automation
With WWAN Connectivity
- Smart Energy, Utilities
- Security, Surveillance
- Automation & Control
- Appliances
- Routers, Gateways

Automotive, Transportation & Logistics
With WWAN Connectivity
- Telematics, Emergency
- Fleet Management
- Insurance, Tracking
- Infotainment Head Unit

Enterprise, Industrial
With WWAN Connectivity
- ATM, Vending
- POS, Digital Signage
- Enterprise Tracking
- Hand Held Terminals
- Retail Kiosks, PoS
- Intelligent Digital Signage
Strong Projected Growth for IoE Segments

Source: Average of ABI Research (Sep 2011) and IMS Research (Jan. 2011) forecasts
Note: Excludes connected CE devices; “Other” includes non-vertical specific gateways

- Telematics
- Energy/Utility
- Security & Tracking
- Retail
- Industrial & Mfg (RMAC)
- Healthcare
- Other

3G & LTE Module Shipments (millions)

2010  2011  2012  2013  2014  2015
## Chipset Mapping to Segmentation

<table>
<thead>
<tr>
<th>4G</th>
<th>3G Multi Mode</th>
<th>3G 1x, DO UMTS</th>
</tr>
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<tbody>
<tr>
<td>CONNECTED CAR</td>
<td>FLEET MANAGEMENT</td>
<td>TELEMATICS</td>
</tr>
<tr>
<td>HOME ENERGY GATEWAY</td>
<td>POINT OF SALE</td>
<td>SECURITY</td>
</tr>
<tr>
<td>DIGITAL SIGNAGE</td>
<td>KIOSK</td>
<td>INSURANCE</td>
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<td></td>
<td>SMART METER</td>
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*Increasing Processing Power operating on many platforms*
Qualcomm Provides Technology Innovation and Leadership to the Value Chain

QUALCOMM DESIGNS, INTEGRATES AND DELIVERS ALL THE PIECES

CHIPSET

POWER MGMT

SOFTWARE/HLOS

RF

SECURITY

GPS

GPU

CPU

DSP

MODEM

CONNECTIVITY

MEMORY

QUALCOMM

DEVICE

CELLULAR MODULE

CARRIER

VERTICAL

QUALCOMM DESIGNS, INTEGRATES AND DELIVERS ALL THE PIECES

CHIPSET

POWER MGMT

SOFTWARE/HLOS

RF

SECURITY

GPS

GPU

CPU

DSP

MODEM

CONNECTIVITY

MEMORY

QUALCOMM

DEVICE

CELLULAR MODULE

CARRIER

VERTICAL
The In-Car Experience is Transforming

- Navigation Services
- Safety and Security
- Application Downloads
- Content Streaming
- Mobile Hotspot
- Rear-Seat Entertainment
Qualcomm Technologies in the Connected Car
New Drivers for Automotive Connectivity

**Infotainment**
- Traffic information for in-car navigation system augmentation
- Internet radio services
- Web access
- Off-board navigation services (e.g. Google maps)

**Telematics**
- Vehicle diagnostics for maintenance
- Roadside assistance and concierge services
- Automatic crash response and stolen vehicle recovery assistance

**PAYD Insurance and Road Use**
- Road pricing, traffic management
- Driver behavior based rates
AUTOMOTIVE TIES INTO SMART ENERGY
How Qualcomm Addresses Smart Energy

- 3G provides superior performance, reliability, security & scale
- QC connectivity solution portfolio addresses a broad range of smart energy applications both inside and outside the home
New Smart Energy Contracts Are Going Cellular

SMART METER
TRANSFORMER
SMART APPLIANCE
CHARGING STATION

Duke Energy

Consumers Energy

EV Project

CPS Energy
Smart Energy in the Home

INTERNET OF EVERYTHING TODAY ENABLES INTELLIGENT CONTROL OF ENERGY USAGE
Qualcomm’s Strong Cellular Ecosystem Helps Engage the Various New IoE Opportunities

- Online searchable database of Qualcomm-enabled M2M modules
- Contains 85+ modules from 13 commercial OEMs
- Includes specs and module vendor contact details
- www.m2msearch.com
Thank You

For more information on Qualcomm, visit us at:
www.qualcomm.com
www.qualcomm.com/blog
Innovating to Drive the Future of Wireless

GLOBAL R&D PRESENCE

INVESTING FOR THE FUTURE

> $17.6B
CUMULATIVE TOTAL R&D INVESTMENTS 2005–2010

THE RIGHT PEOPLE

30% OF ENGINEERS WITH PhDs
40% WITH MASTERS

9 R&D LOCATIONS

Cambridge, UK
Santa Clara, CA
San Diego, CA
Bridgewater, NJ
Vienna, Austria
Nuremberg, Germany
Bangalore, India
Beijing, China
Seoul, S. Korea
Innovation Across Entire Wireless Value Chain

HOLISTIC APPROACH FOR EXCELLENT OVERALL SYSTEM PERFORMANCE
Success of DC-HSPA+

STANDARDS LEADERSHIP
- Major 3GPP contributor
- Recognized expertise

INDUSTRY-FIRST DEMOS
- MWC 2008: dual-carrier
- MWC 2009: dual-carrier 42 Mbps

INDUSTRY-FIRST CHIPSETS
- MDM 8200 HSPA+
  - Launched February 2009
- MDM 8220 DC-HSPA+
  - Launched August 2010

49 COMMERCIAL, 41 COMMITMENTS

Source: www.gsacom.com
Enabling New Mobile Experiences

Connecting Everything
Supporting More Users, at More Places, with More Capacity

Evolve 3G/4G/WiFi
Small Cells/HetNets
Peer to Peer
Intelligent Connectivity

Mobile Computing Everywhere
Leveraging Computing Power and Sensors to Enable New User Experiences

Context Awareness
Computer Vision
Indoor Location
Improving Web Experience
Continuously Improving Wireless Performance

**3G/4G/WiFi**

- **LTE ADVANCED**
  - Realizing the Full Benefits of Hetnets

- **HSPA+ ADVANCED**
  - Maximizing the Performance of HSPA+

- **DO ADVANCED**
  - Increasing Capacity Where and When Needed

- **WIFI**
  - Next-Generation WLAN

- **1X ADVANCED**
  - Up to 4x Voice Capacity to Free Up Resources for Data

- **WCDMA+**
  - Increased Voice Efficiency to Free Up Resources for Data

2.2x
The Next Leap in Performance: Small Cells

How Do We Get More Capacity?

OPTIMIZATIONS MAKES THE LEAP EVEN BIGGER—SMART HETNETS

LTE ADVANCED
HSPA+ ADVANCED
DO ADVANCED

SMALL CELLS
Bring Network Closer to User

BETTER TECHNIQUES
Higher Order MIMO, Smart Networks

MORE SPECTRUM
New Bands/Refarming

Radio Link Approaching Theoretical Limit

Note: Other improvements, such as higher order modulation will also help, but 64QAM is already commonly used. Other options are to use the available capacity better and reduce, e.g., power or signaling overhead to get more usable capacity.
UltraSON™ Enables Expanding Role of Small Cells

Initially: Indoor Femto Hot Spots
- Unplanned
- Restricted
- User’s broadband connection

Next: Denser Indoor and Outdoor Deployments
- Open
- Seamless handoff
- Interference coordination
New Femto-based Deployment Model

OPEN-ACCESS INDOOR FEMTOS PROVIDING OUTDOOR COVERAGE

- SIMPLE AND COST-EFFECTIVE
- HIGHER CAPACITY THAN MACRO DEPLOYMENT
- ENABLED BY UltraSON

MACRO NETWORK

FEMTOS ON DEDICATED SPECTRUM
Femto OTA Test Network
Intelligent Connectivity

Connection based on:
- Coverage
- Data speed
- Internet connectivity
- Type of app
- Operator policies
- Per link decision
Enabling New Mobile Experiences

Connecting Everything
Supporting More Users, at More Places, with More Capacity

Mobile Computing Everywhere
Leveraging Computing Power and Sensors to Enable New User Experiences

- Evolve 3G/4G/WiFi
- Small Cells/HetNets
- Peer to Peer
- Intelligent Connectivity
- Context Awareness
- Computer Vision
- Indoor Location
- Improving Web Experience
Context Awareness Enables New User Experiences

Anticipates, Predicts and Alerts

Personalization
Based on User Actions and Preferences

Optimizations
E.g., Battery and Bandwidth

Environment

Location

Actions

Gathers Raw Data

Sensors
(Motion, Location, Networks, Proximity)

Applications Usage
(Email, Phone, Apps, Calendar, Social Networks)

New Applications

Applications
Usage

(Email, Phone, Apps, Calendar, Social Networks)

Context Awareness Enables New User Experiences
Augmented Reality - Market Traction

16,000+
REGISTERED DEVELOPERS FROM 130 COUNTRIES

400+
MODELS OF SMARTPHONES AND TABLETS

150+
APPS AVAILABLE ON ANDROID AND iOS

2011 Future Mobile Entertainment Award for Mobile Augmented Reality
Accurate Indoor Positioning

- High Accuracy (<5m)
  - Leverages existing WLAN AP and infrastructure

- Integrated into Qualcomm Chipsets
  - Highly efficient mobile based solution

- Scalable Across Commercial Venues
  - Airport, train stations, malls, museums, hospitals, sports venues etc.
Web Browser Acceleration

EXPLOITING CONCURRENCY FOR HTML AND JAVASCRIPT

MOBILE COMPUTING INCREASINGLY MULTI-CORE

MULTI-CORE CPU/GPU, DSPs, and Hardware Accelerators

WEB PAGE FORMATTING

LAYOUT

RENDERING

DEVELOPING FOR SNAPDRAGON SOC

- Concurrently use all CPU cores
- Designed to exploit Adreno GPU, Hexagon DSP, and other hardware accelerators

SIGNIFICANTLY FASTER BROWSING EXPERIENCE
Leading the Way in Connectivity and Mobile Computing

- Strong track record of leadership in connectivity and mobile computing
- Broad R&D initiatives to drive innovation in wireless
- Well positioned to bring next generations of user experiences
Thank You

For more information on Qualcomm, visit us at:
www.qualcomm.com/research
www.qualcomm.com/technology