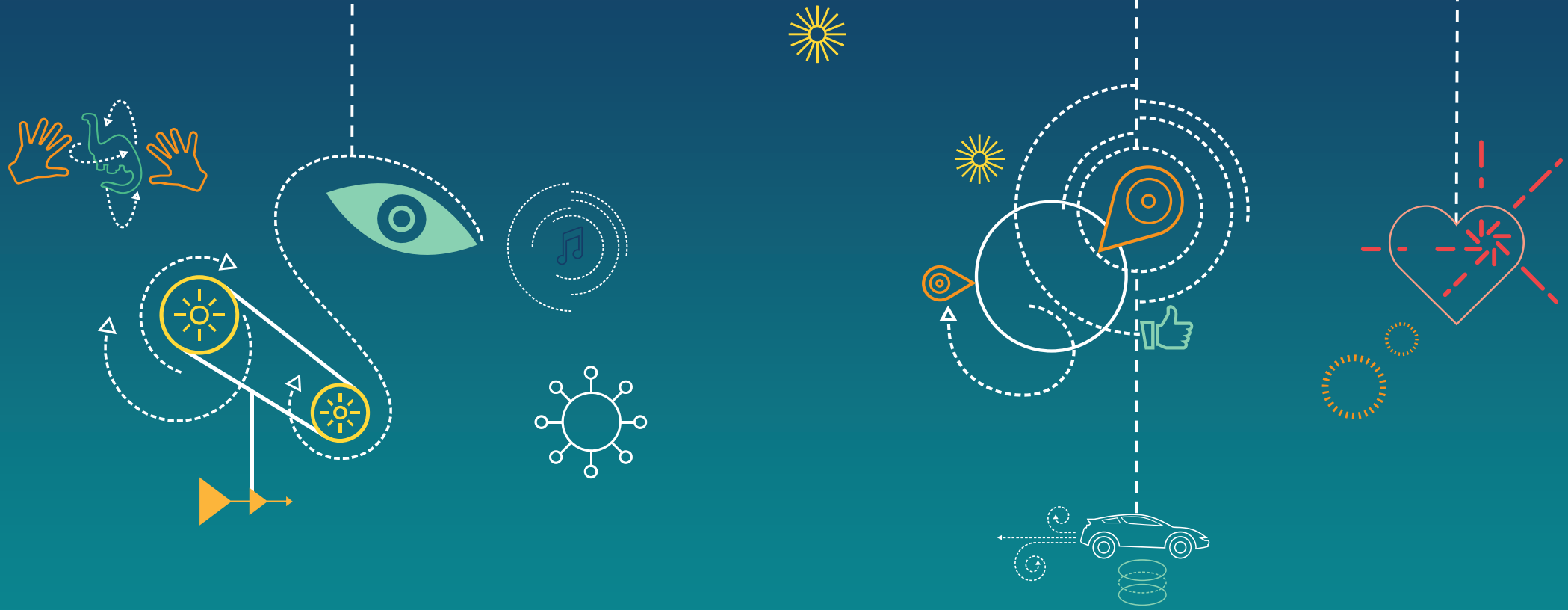


QUALCOMM®

CTIA May 22 2013

Rasmus Hellberg, Sr. Director Technical Marketing

# The 1000x Mobile Data Challenge

QUALCOMM®

# 1000x, Spectrum Innovation & Chipset Evolution

- 1:00pm - 1:30pm **The 1000x mobile data challenge**
  Innovations in small cells, spectrum and higher efficiency
- 1:30pm - 2:00pm **What is next for HSPA+?**
  And related evolutions; WCDMA+ and S-UMTS

Speaker: Rasmus Hellberg,
Sr Director, Technical Marketing

- 2:00pm - 2:30pm **What is next for LTE?**
  LTE Advanced, opportunistic HetNets and LTE Direct
- 2:30pm - 3:00pm **What is next for Wi-Fi?**
  The Wi-Fi evolution, its role in 1000x, connected home and new frontiers

Speaker: Prakash Sangam,
Director, Technical Marketing

- 3:00pm - 3:15pm Break
- 3:15pm - 4:00pm **How do we access more spectrum for 1000x?**
  Cleared, Licensed Spectrum (Voluntary Incentive Auction)/Authorized Shared Access (3.5 GHz)/Unlicensed Spectrum (5 GHz)

Speaker: Dean Brenner,
Sr VP, Government Affairs

- 4:00pm - 4:30pm **Addressing LTE Band Fragmentation**
  RF360 progress, carrier aggregation and more
- 4:30pm - 5:00pm **The 3G/4G multimode roadmap**
  Including LTE Broadcast, VoLTE and voice interworking

Speaker: Sunil Patil,
Director, Product Management

# Mobile data traffic growth—industry preparing for 1000x

preparing for

**1000x**

data traffic growth**

global data traffic growth

**~2x**

from 2010- 2011*


*Global growth, some regions grew more/less. **1000x would be e.g. reached if mobile data traffic doubled ten times, but Qualcomm does not make predictions when 1000x will happen, we work on the solutions to enable 1000x

# Richer content, more devices and multiple devices

## Richer content —more video

Average bestseller (Gigabytes)

| | |
|---|---|
| .00091 | Book |
| .0014 | Homepage |
| .14 | Soundtrack |
| 1.8 GB | Game for Android |
| 2.49 GB | Movie (Standard-Definition) |
| 5.93 GB | Movie (High-Definition) |

## More devices

Cumulative smartphone forecast between 2013–2017[1]

~7 Billion

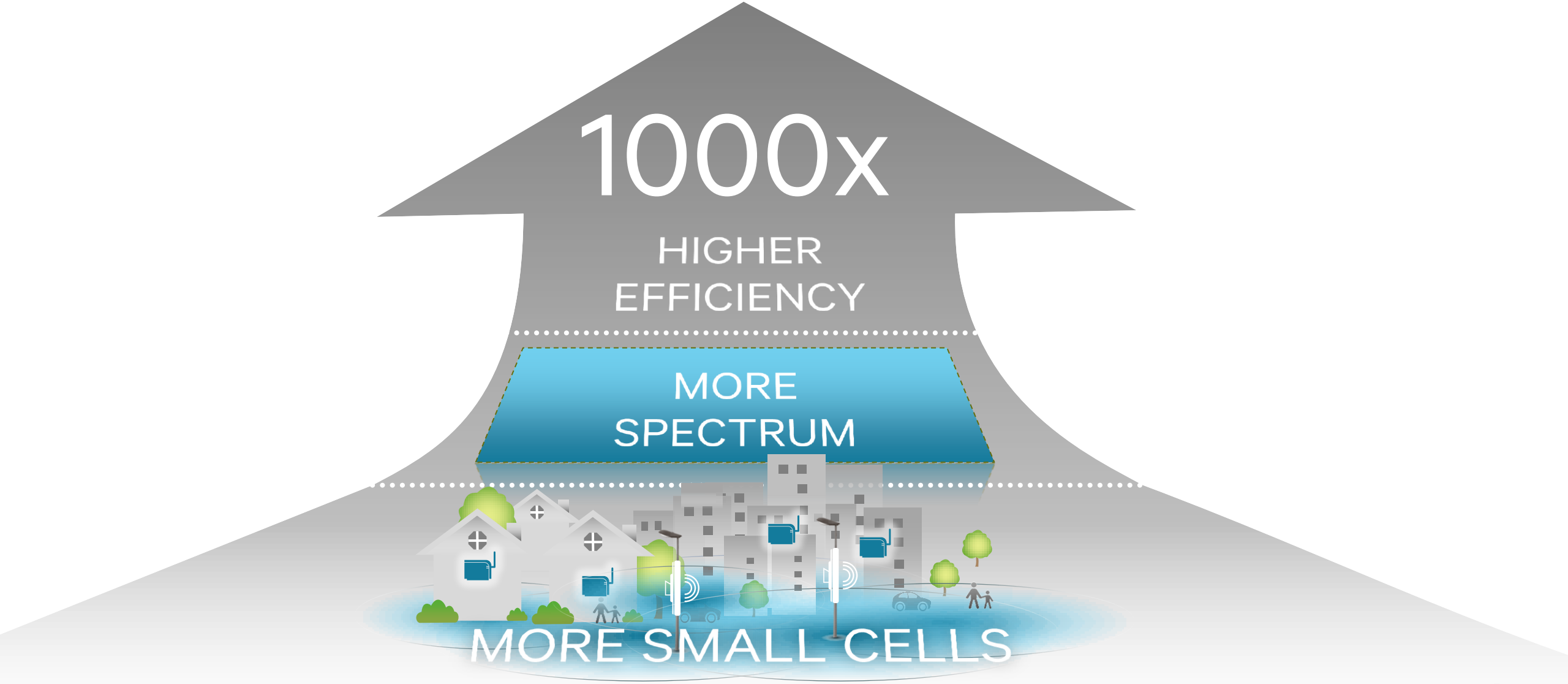
## More devices per user

Revenue will not scale with demand,
so we need new, low cost solutions to address the **1000x** challenge

[1]Source: Gartner, March . '13 .

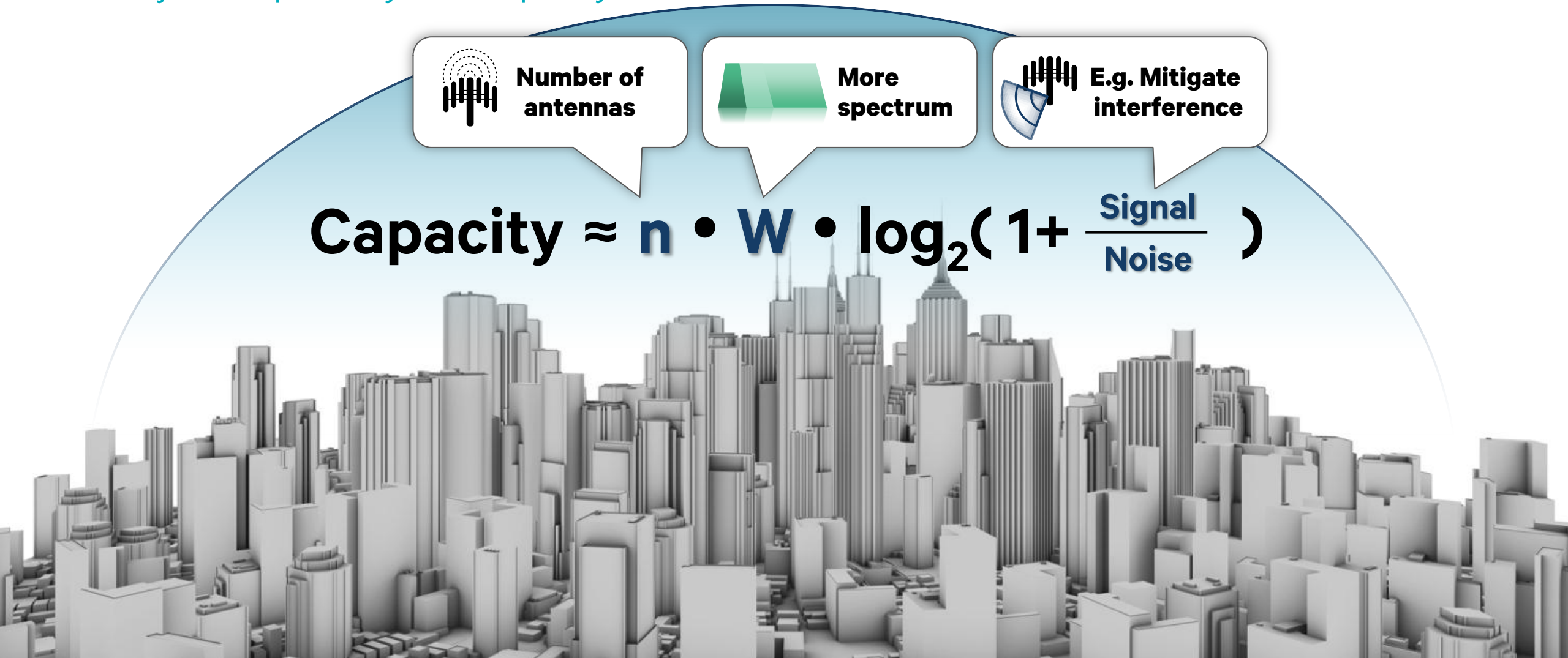
- 1000x Video can be found on YouTube:
  - http://www.youtube.com/playlist?list=PL8AD95E4F585237C1&feature=plcp

# Rising to meet the 1000x mobile data challenge

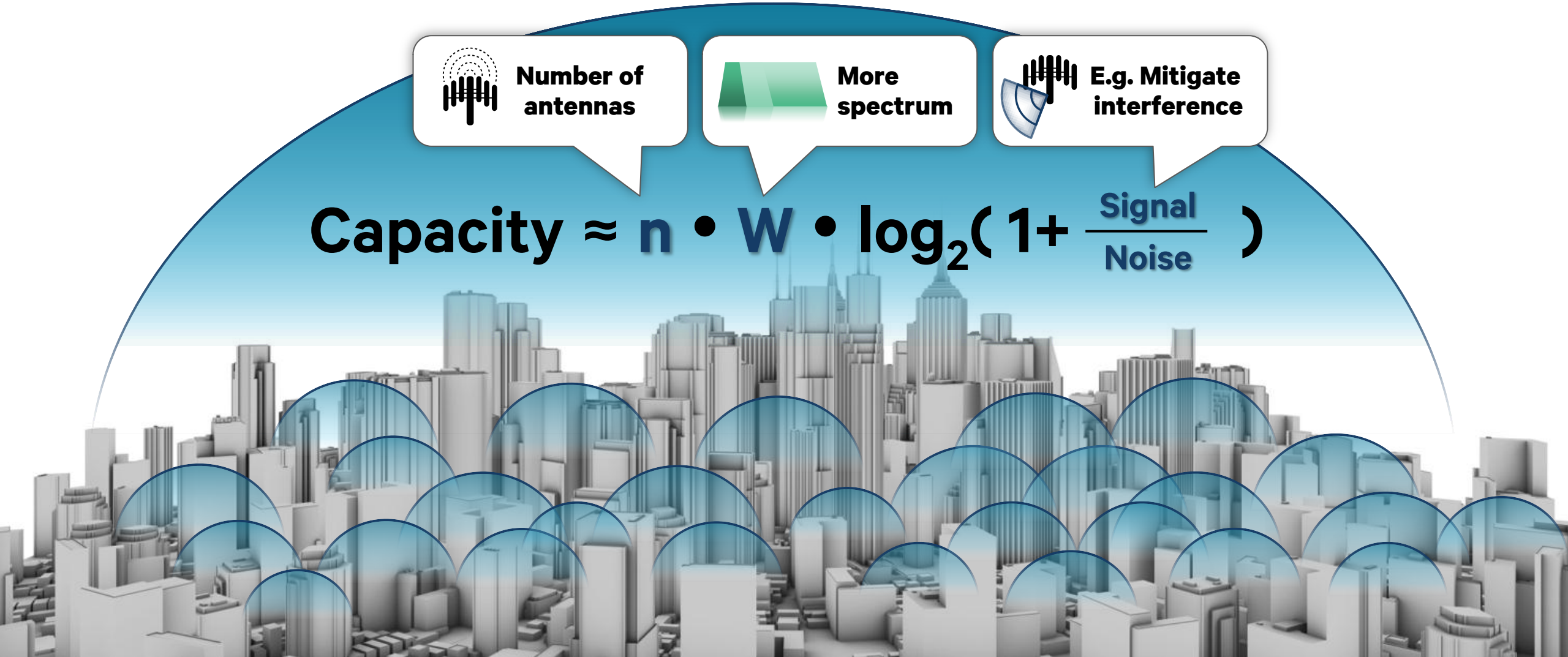


# We can reach the air link limit—Shannon's Law

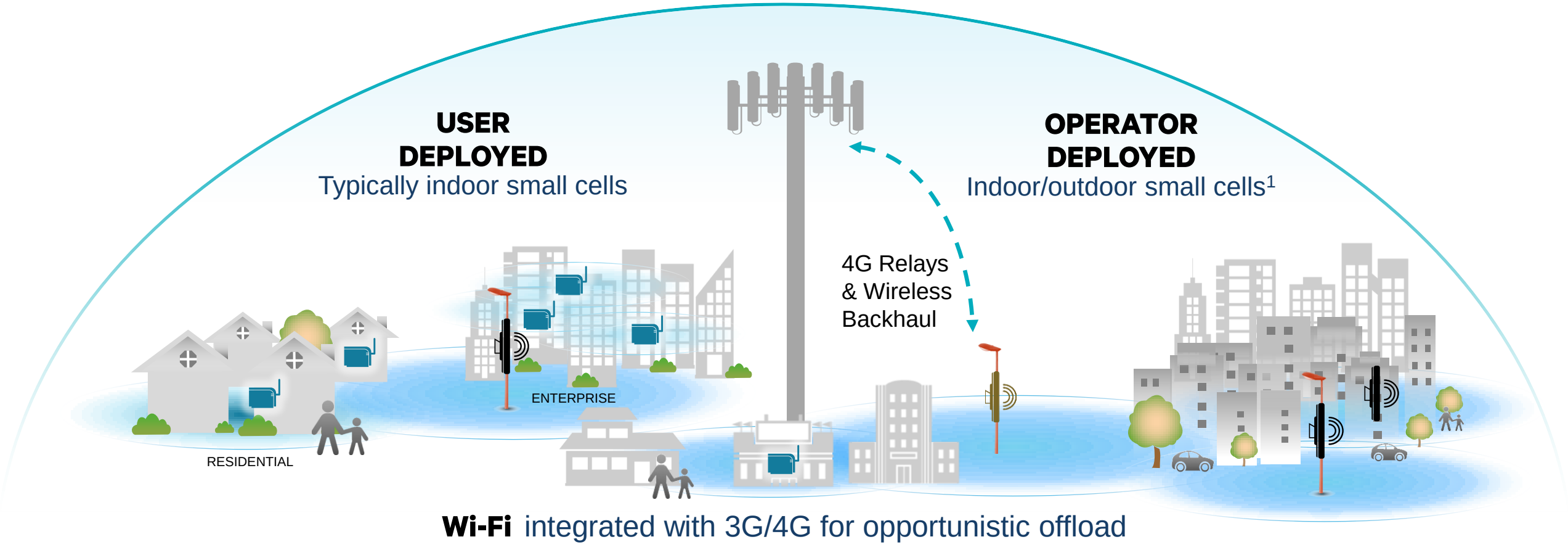
## Still ways to improve system capacity



# The Biggest gain—re-use Shannon's Law everywhere!



# Bringing the network closer to the user is key to 1000x




**Wi-Fi** integrated with 3G/4G for opportunistic offload

## Extreme Densification—3G/4G+Wi-Fi Small Cells Everywhere

[1]Such as relay and Pico/Metro/RRH small cells for hotspots. RRH= Remote Radio Heads, in addition Distributed Antenna Systems are used in HetNets

# Evolution to low cost ad-hoc small cell deployments

## Extreme densification requires new ways of deploying: neighborhood small cells

AD-HOC USER DEPLOYED
Open access indoor residential

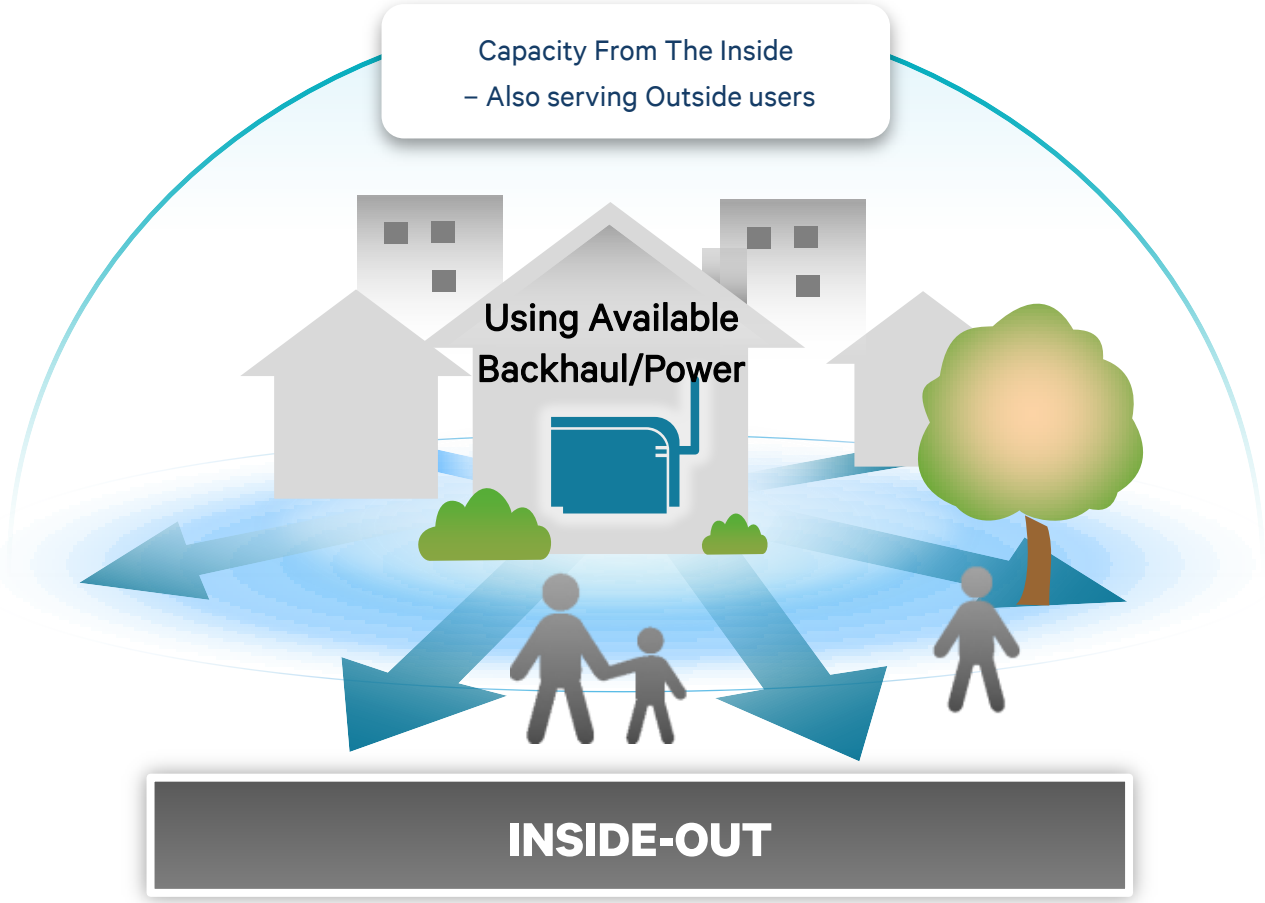
AD-HOC OPERATOR DEPLOYED
Indoor/outdoor, lampposts, walls, malls, anywhere…

AD-HOC PARTNER DEPLOYED
Such as utility provider

- Viral ‘unplanned’, e.g. where backhaul exists—more like Wi-Fi
- Plug & play self organizing
- Licensed spectrum ensures quality of service
- Managed by the operator

# Evolution to low cost inside-out deployments

## The majority of traffic is indoors[1]—why not also capture the outside?


[1]>70% of mobile data traffic is consumed indoors and steadily increasing

# Ad-hoc deployed small cells are key to 1000x

INSIDE-OUT DEPLOYMENT EXAMPLE

ALSO SERVING OUTSIDE USERS

**1000x**

~ 20 % Household Penetration

+10x Spectrum

**500x**

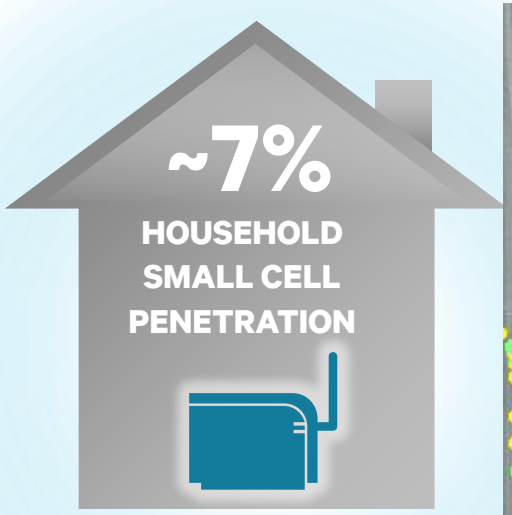
~ 9% Household Penetration

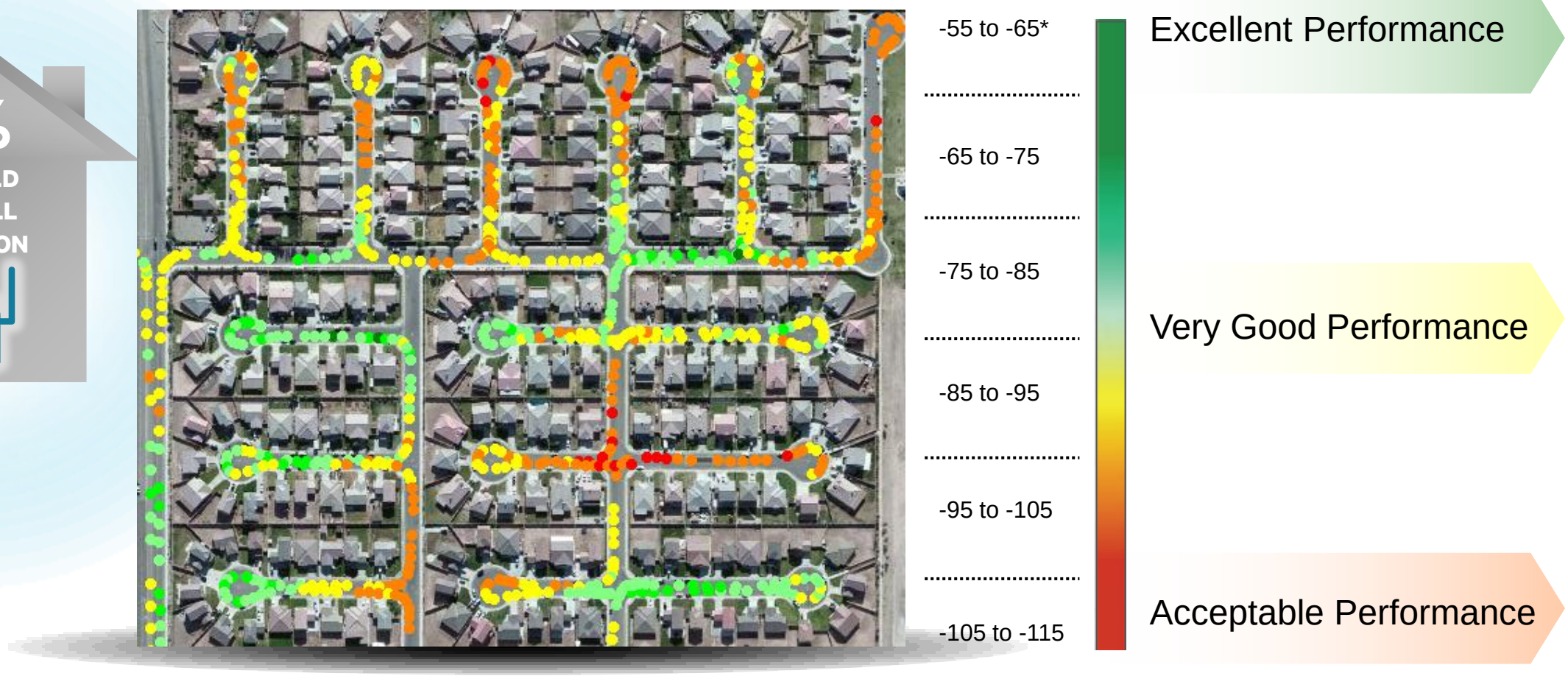
+10x Spectrum

Median throughput gain versus Macro only baseline

Example for LTE FDD, 2x2 MIMO. Assumptions: 70% indoor users, 200 Active users per macrocell, small cells randomly dropped in households in a mix of 2 to 6 story apartments. This example uses small cells on dedicated spectrum, but we envision future neighborhood small cells also sharing the spectrum with macro and other small cells. 20% household penetration equals ~ 144 small cells, and 9% penetration equals ~ 65 small cells.

# Tests show indoor small cells provide outside coverage




Shows actual measured received pilot strength for a small cell deployment: -115dBm results in ~700kbps for Rel-7 5MHz in thermal noise limited case; Points less than -115dBm are not shown on the plots.

- Neighborhood small cells video can be found on YouTube:
  - http://www.youtube.com/playlist?list=PL8AD95E4F585237C1&feature=plcp

# Ad-hoc deployed small cells opens up new opportunities

## Cost-saving opportunity means that business solutions will emerge

### LOWER COST FOR EXISTING OPERATOR

- User deployed inside-out neighborhood small cells is a key opportunity
- Natural extension for operators also offering fixed broadband
- Opportunity to partner with broadband provider

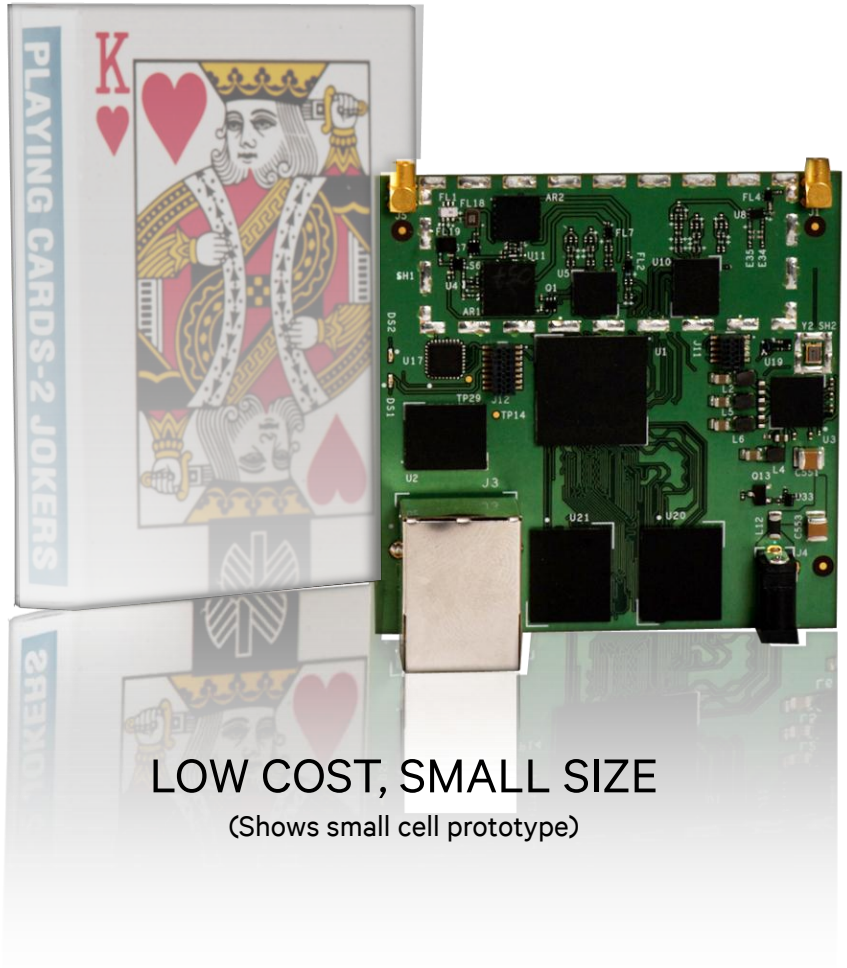
### NEW ENTRANTS

- Fixed broadband provider can add wireless
- New low cost broadband access networks
- Could combine with lower cost ASA spectrum

### NEW BUSINESS MODELS

- Wholesale small cell network
- Paid local access
- Reciprocal access

# Enabling technologies for low-cost, small size small cells




LOW COST, SMALL SIZE

(Shows small cell prototype)


POWER LINE COMMUNICATIONS

(Shows Wi-Fi/PLC prototype)

# Key enablers for small cells everywhere

## BACKHAUL—DRIVES SMALL CELL SOLUTION

**Operator Provided:**
Fixed, Wireless, Relays

**User Provided:**
Enables user installed small cells

## INTERFERENCE MANAGEMENT

So that **capacity scales** with small cells added

Requires **device and network features** for hyper-dense HetNets

## SELF ORGANIZING NETWORKS (UltraSON)

Taking **plug and play** to the next level

Enables all types of **Ad-Hoc deployments**—neighborhood small cells

# 1000x is not just about adding resources

With **HIGHER EFFICIENCY** techniques

- EVOLVE 3G/4G/WI-FI
- MORE EFFICIENT APPS. & SERVICES
- INTELLIGENTLY ACCESS 3G/4G/WI-FI
- INTERFERENCE MANAGEMENT/SON

MORE SPECTRUM


THE WHOLE IS GREATER THAN THE SUM OF THE PARTS

1 + 1 > 2

# Significant gains still possible for certain traffic

## >10x

(HSPA+ Advanced example, compared to HSPA+ R7/R8)


Small Data Bursts

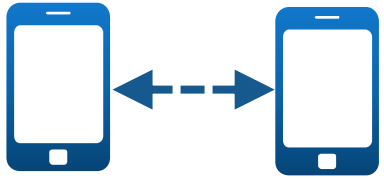
## >10x

(More per 6 multicast users in a network vs. 6 unicast users in dense urban area, but ~3x gain for just two users)

LTE Broadcast

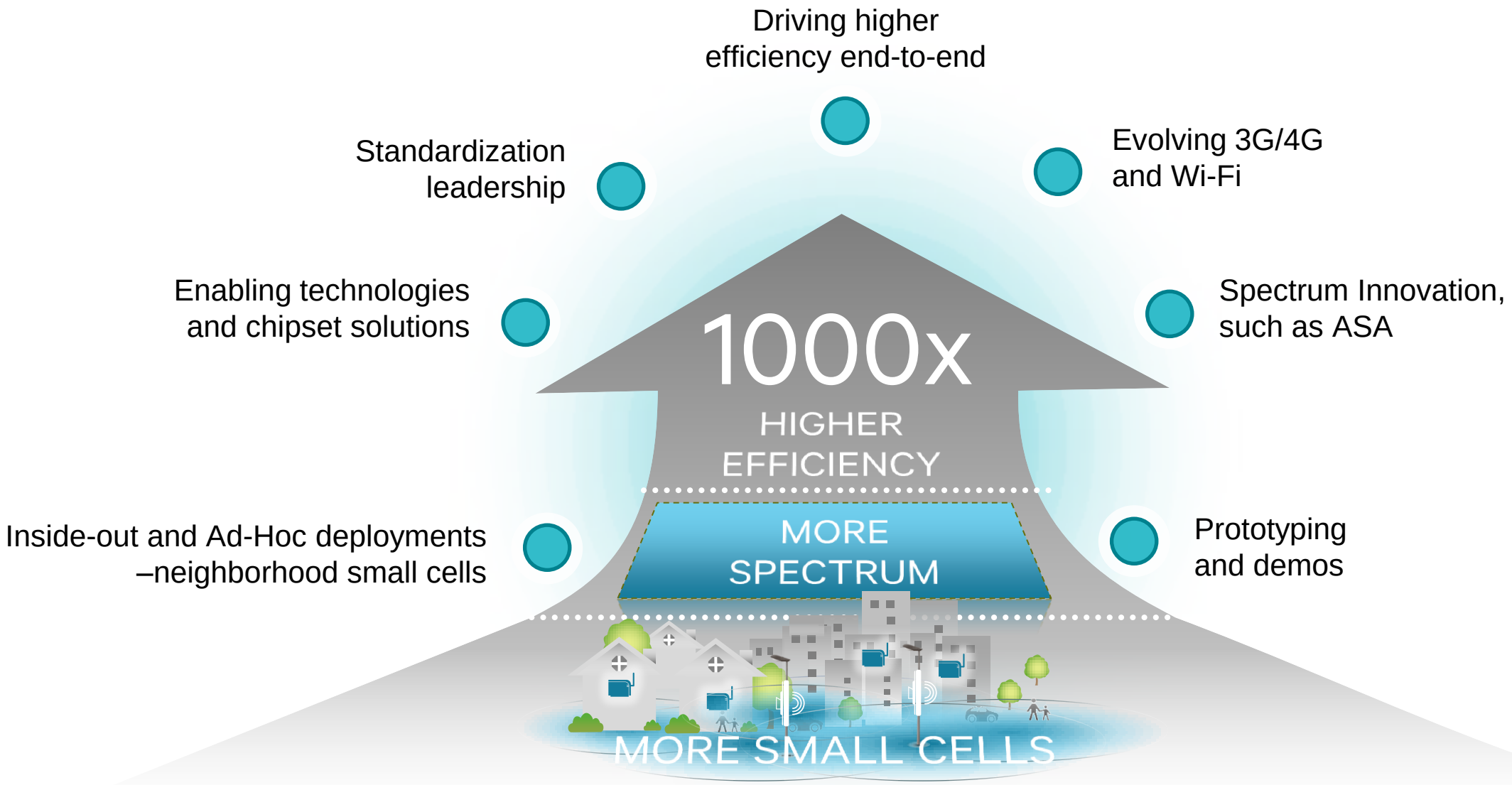
## >10x

(Less resources to discover proximal devices within 20s in a cell with 800 users, vs. regular LTE. Can also discover 16x more devices than Wi-Fi Direct)



Device to Device Discovery and Communication—LTE Direct

# Qualcomm at the forefront to enable 1000x



# Will There Be 1000x Demand?
# It's Just a Matter of Time...

# Driving network evolution

to learn more, go to

**www.qualcomm.com/1000x**


- More details provided at:
  1) 1000x: More Spectrum
  **www.qualcomm.com/spectrum**
  2) 1000x: More Small Cells
  **www.qualcomm.com/HetNets**
  3) 1000x: Higher efficiency
  **www.qualcomm.com/efficiency**

# Thank you

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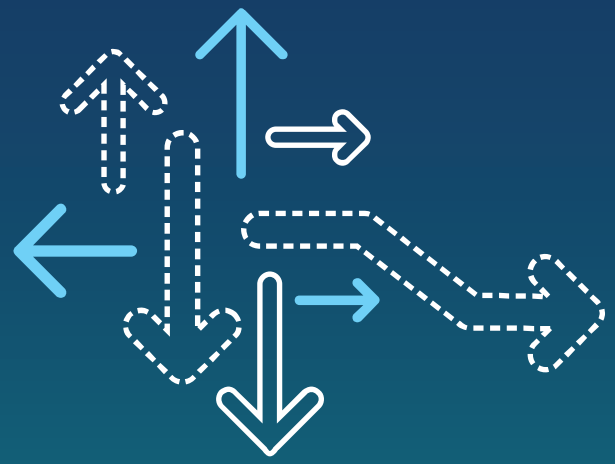
# Questions? - Connect with Us



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