



# The Rapid Evolution of Cellular Networks: Femto, Pico and all that

Moderator and Organizer:

**Jeffrey G. Andrews**

Director, Wireless Networking and Comm. Group  
Department of Electrical and Computer Engineering  
The University of Texas at Austin

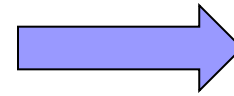
Texas Wireless Summit

Oct. 25, 2011

# The Panel

- Amitava Ghosh
  - Head, Broadband Wireless Innovation, Nokia Siemens, IL
  - Leads NSN's LTE HetNet standardization activities
- Tingfang Ji
  - Senior Staff Engineer, Corporate R&D, Qualcomm, San Diego
  - Leads Qualcomm's LTE HetNet system engineering team
- Phil Kelley
  - Senior VP of Development and Strategy, Crown Castle, Houston
  - Responsible for Crown Castle's vision of future network topology
- David R. Wolter
  - Executive Director of Radio Technology, AT&T Labs, Austin
  - His ground informs AT&T's deployment and standards strategy

# Recent Cellular History



**2000:**  
**Smaller = better,**  
**Voice/SMS**

**2005:**  
**Color screen,**  
**some web support**

**2011:**  
**Paradigm Shift**

- Rocketing data demands
  - Recently, about 2.5x increase per year = 1000x increase in under 8 years
- Revenues decoupled from data demands
  - Need new model for deploying network infrastructure

# Network must grow where data is demanded, not just use brute force.

Networks will have different types of base stations, each with different traits:

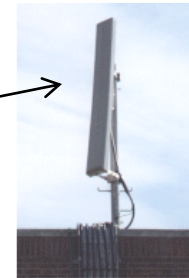
## 1. Tower-mounted traditional base stations.

Expensive (over \$100K, plus high OpEx), 40W EIRP, medium to long-range (1-10 km), fast dedicated backhaul, mainly for guaranteeing universal basic coverage.



## 2. Picocells (Distributed Antennas are roughly similar)

Small, short-range (~100m), 2W EIRP, low-cost (\$15-40K, small OpEx), deployed, maintained and backhauled (perhaps wirelessly) by service provider; typically targeting traffic “hotspots”

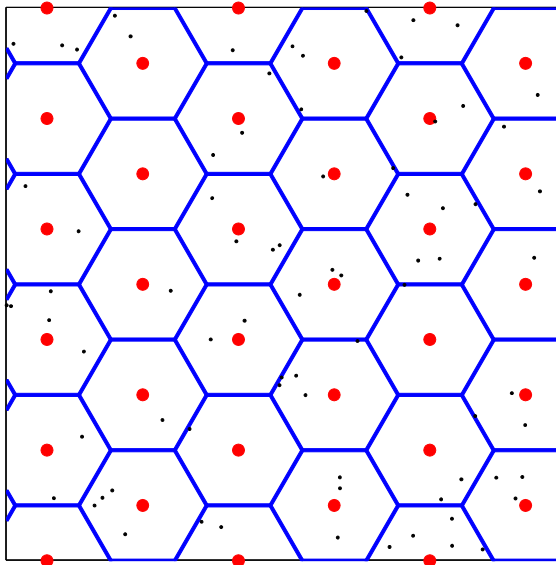


## 3. Femtocells

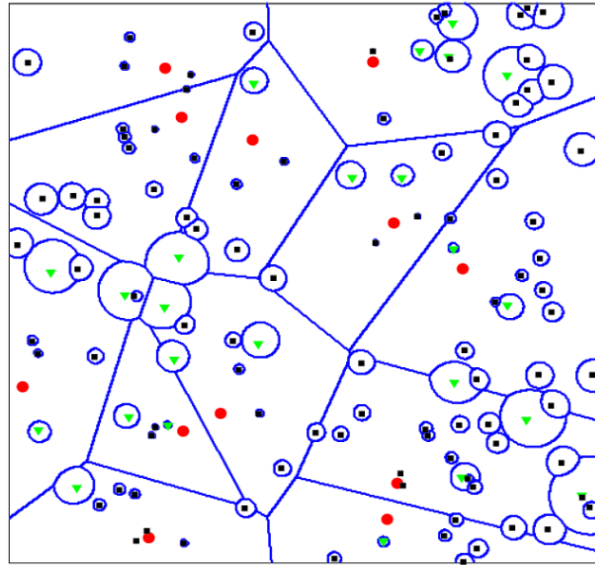
Wi-Fi-esque range, power (200mW), cost (\$100), and backhaul (IP, e.g. DSL). Licensed spectrum, cellular protocols, must inter-operate with cellular network with minimal coordination.



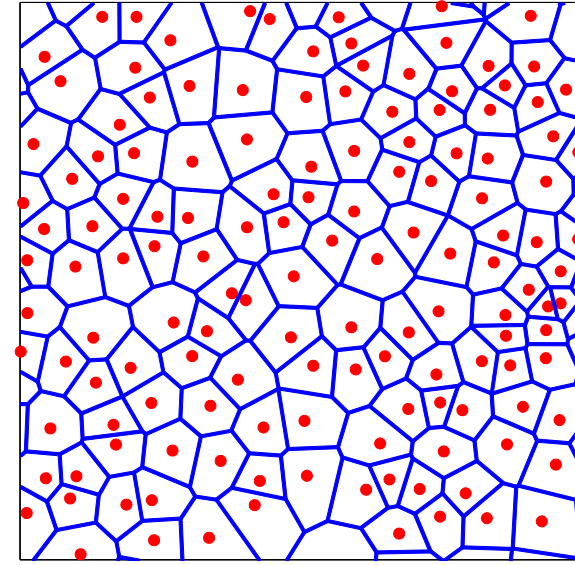
# Resulting Network Architecture and Issues



**Traditional grid model**



**Plausible LTE network  
in 2014**



**Actual 4G macrocells**

- Profound implications on signal quality, interference, network management, mobility/handoff models
- Business opportunities and risks in backhaul, small cell technology, smart deployment strategies, in-band and out-of-band offloading, small cell inter-coordination

**Cellular networks are changing faster than ever before**