GWT Presents

Ad-hoc Flexible LTE Networks for Public Safety/First Responders

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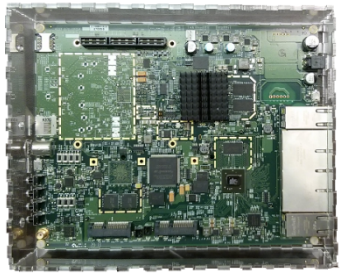
GWT in Brief

- Key Competencies

- Communications protocols
- Software Dev & Testing
- Hardware Design & Development
  - Multi-vendor System on Chip Experience
  - Best Value Solutions
- Work with all major operators

- Products: 32-128 users/sector

Small Cells
Metro Cells
Pico Cells



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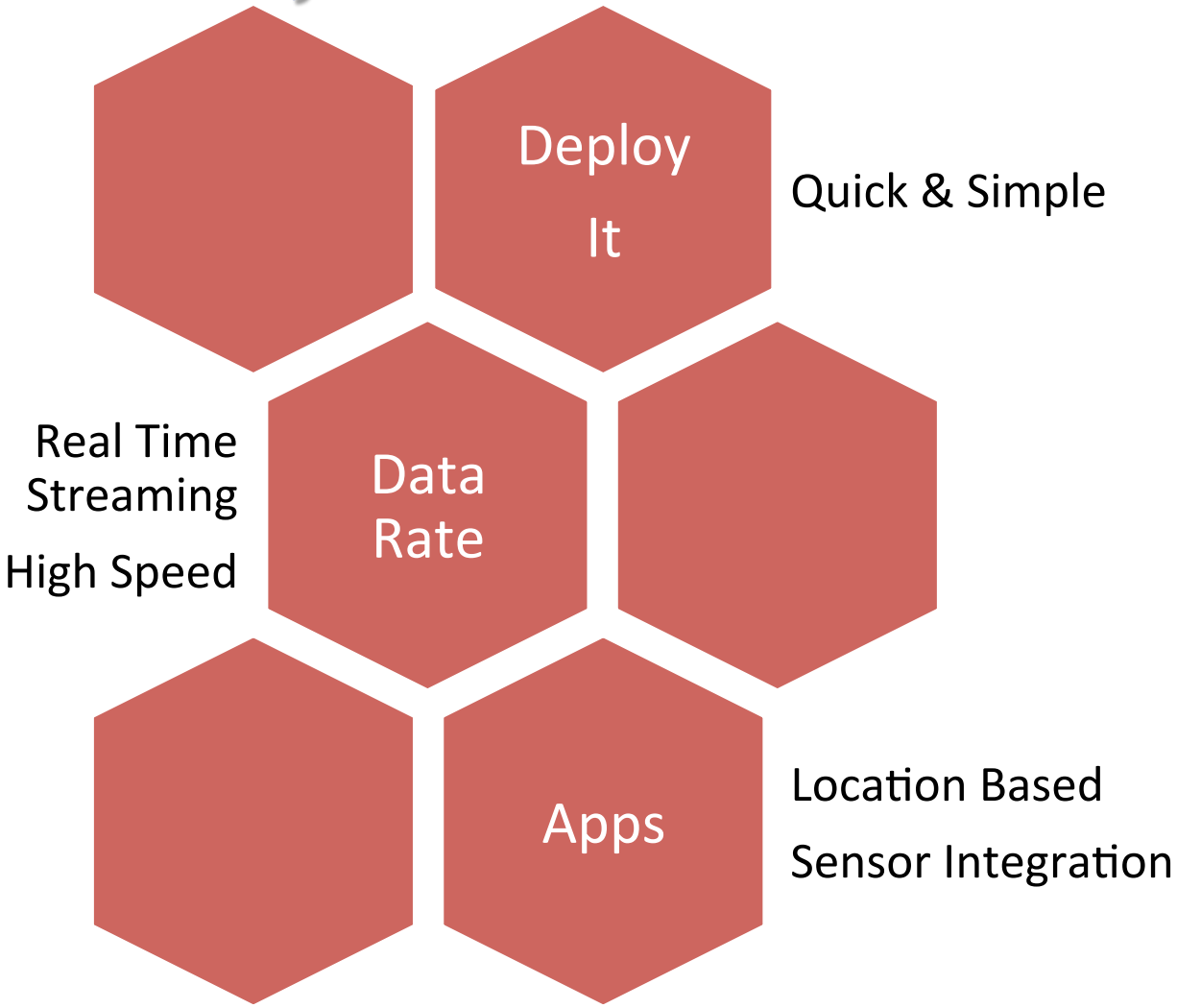
Public Safety/First Responder Objectives for LTE in Band 14



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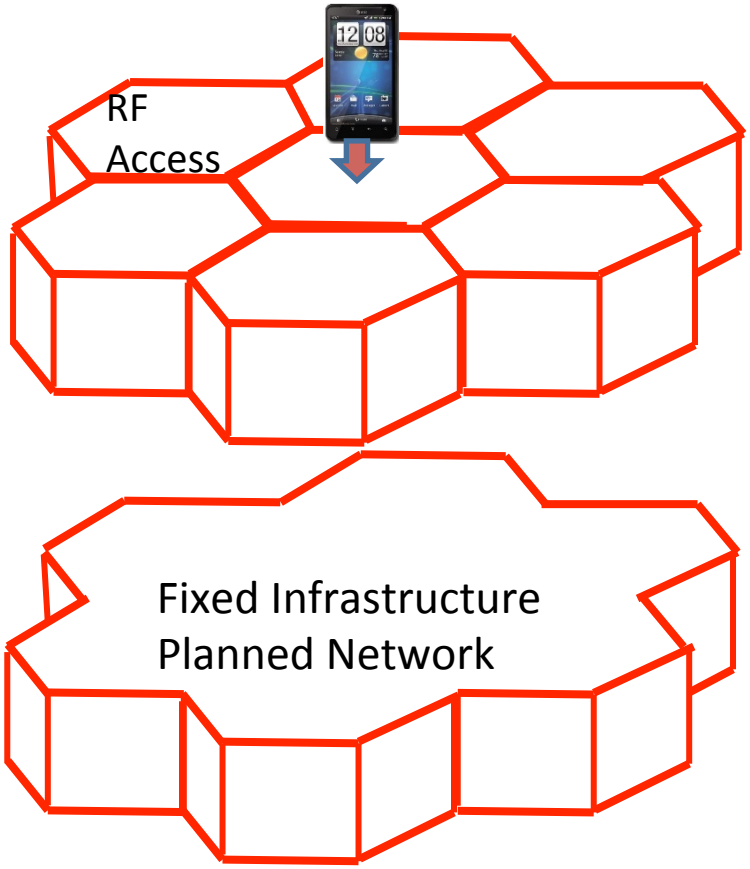
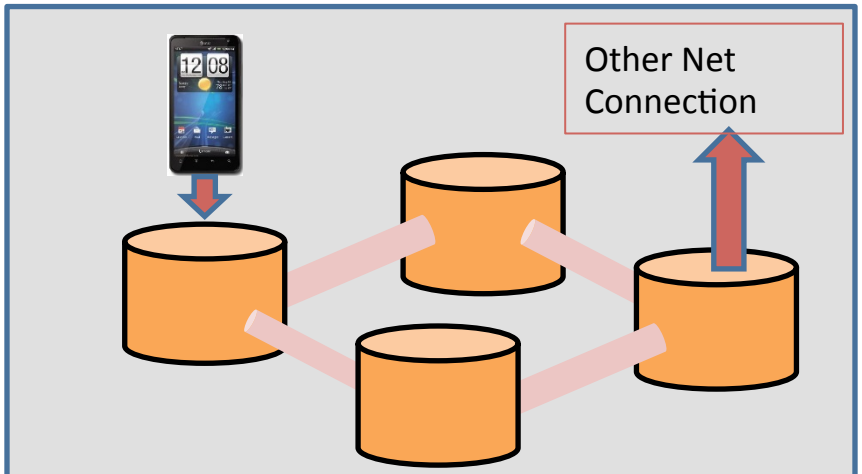
Conventional vs. Public Safety Network

- The Cellular "Iceberg"



- First Responder Need



- Flexible Network
- Autonomous Network functionality (w/out Core)
- Portable Infrastructure Requirement
- Long range Comms from cell to cell

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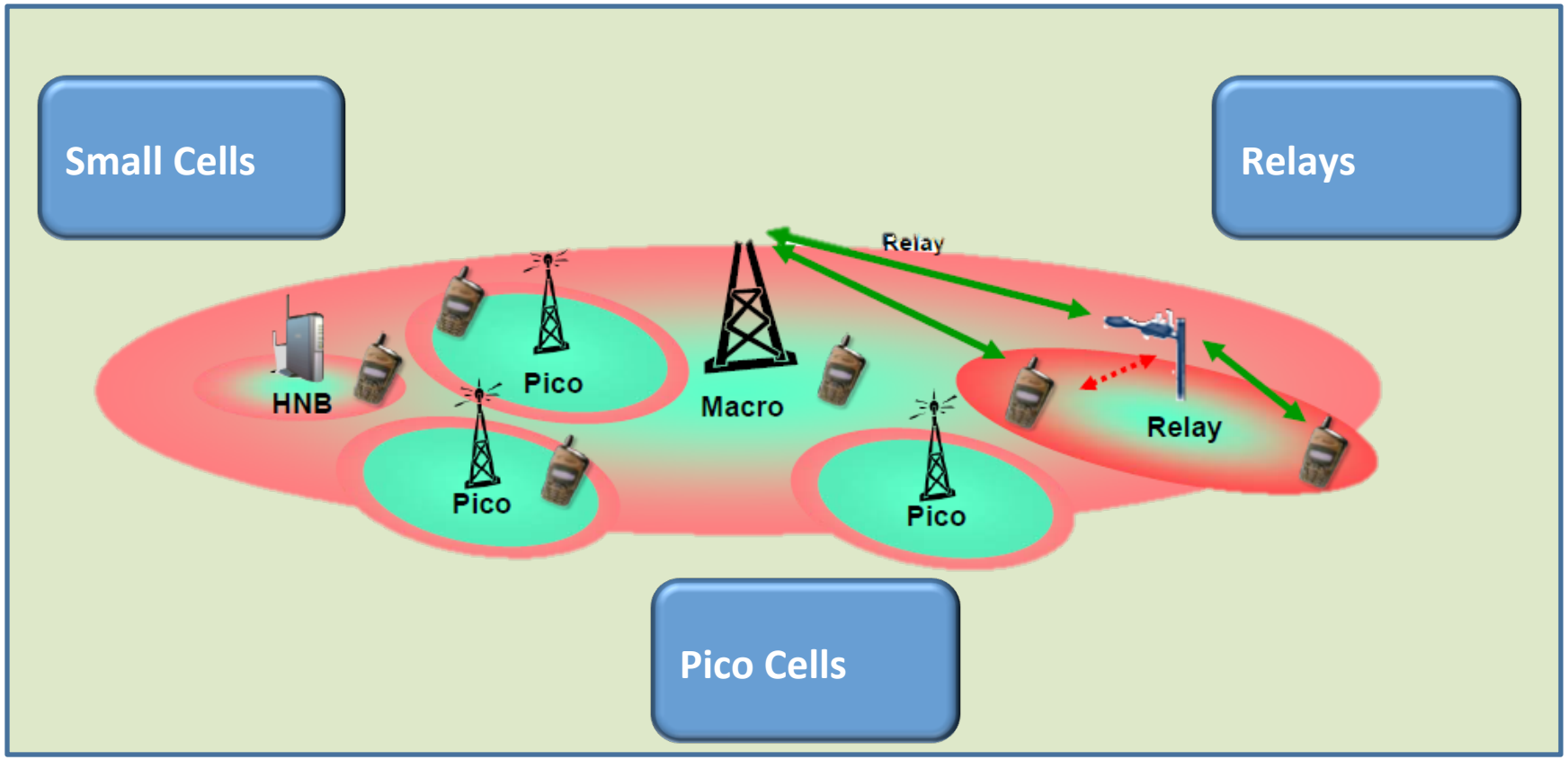
Conventional Network Equipment Deployment Picture



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Advantages of Small Cells

- Speed, Flexibility and Cost of Deployment
  - Small Cells (16-128 users) w/ SON (i.e. ANR, UE measurements aware)
  - Fills coverage holes and capacity gaps in existing networks
  - Install a Small Cell anywhere where there is a backhaul connection (ethernet cable, satelite, OTA cellular)

- Bring the Network closer to the UEs'
  - Enables cellular architecture for first responder use
  - Resolves range problem

- Footprint
  - Flexibility when it comes to installation (light poles, building tops etc.)
  - Optimized for power consumption
  - Small & lightweight*

- Many areas where there is no existing LTE or cellular infrastructure or where reception is poor or capacity limited (Rural, Urban or In-building areas)

- Any situation where a portable ad-hoc network is required (i.e. disaster relief)

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Small Cell Challenges for Public Safety/ First Responders

- Linking the Cells
  - Coordinating and Comms between the cells w/out a core
  - Potential weak point: if the Small Cell can't reach the core it is useless

- OTA Backhaul
  - In many scenarios, wired infrastructure for backhaul will be unavailable or unreachable
  - Particularly rural areas
  - Incorporate functionality for range and mobility
  - Potential for self interference potential for backhaul

- Inter-cell Interference (Cell Bleeding)
  - Ad-hoc deployment of Small Cells will result in significant interference, particularly at cell edges
  - Magnified if the Small Cells are mobile or portable

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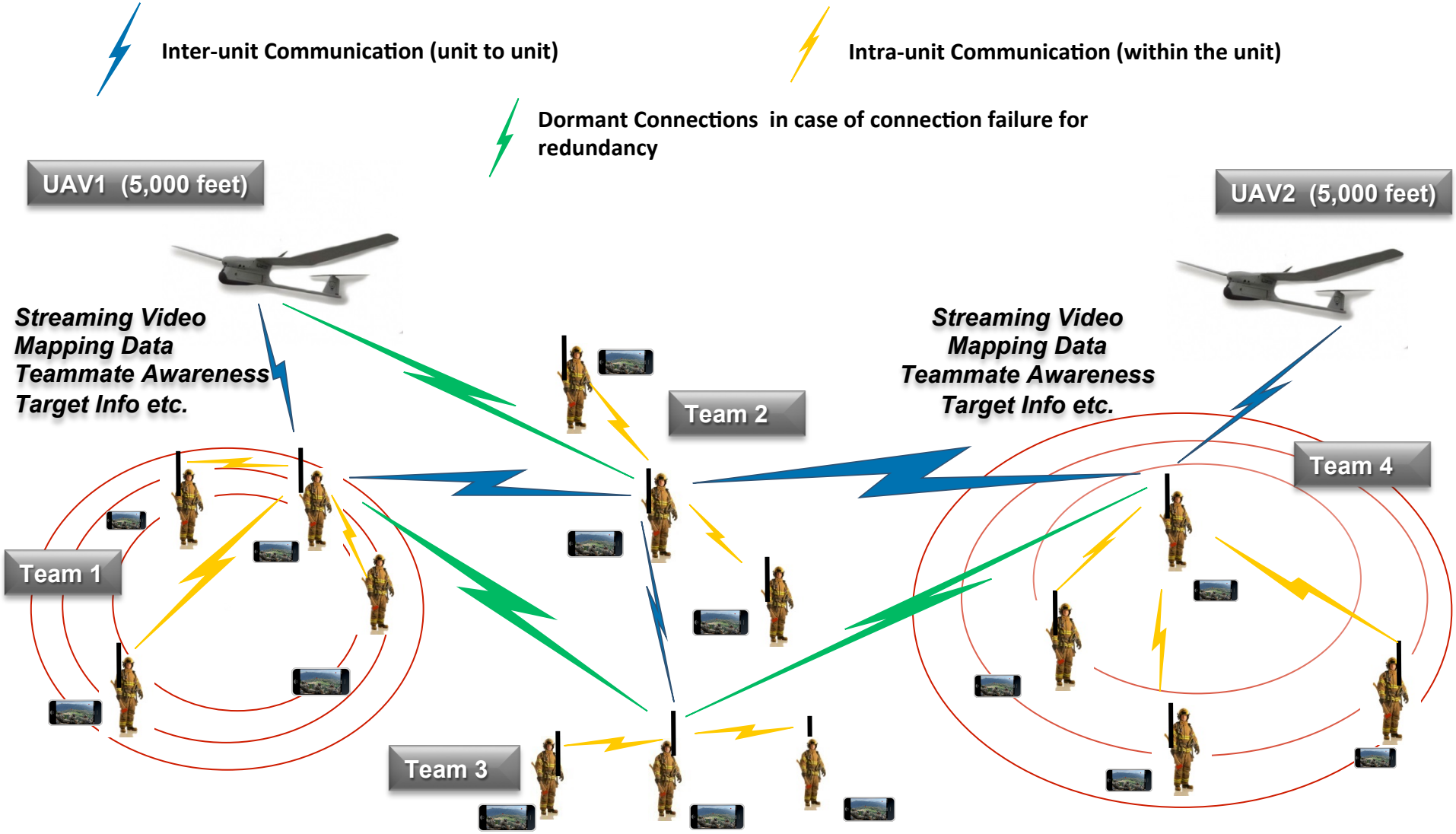
Example Use Case



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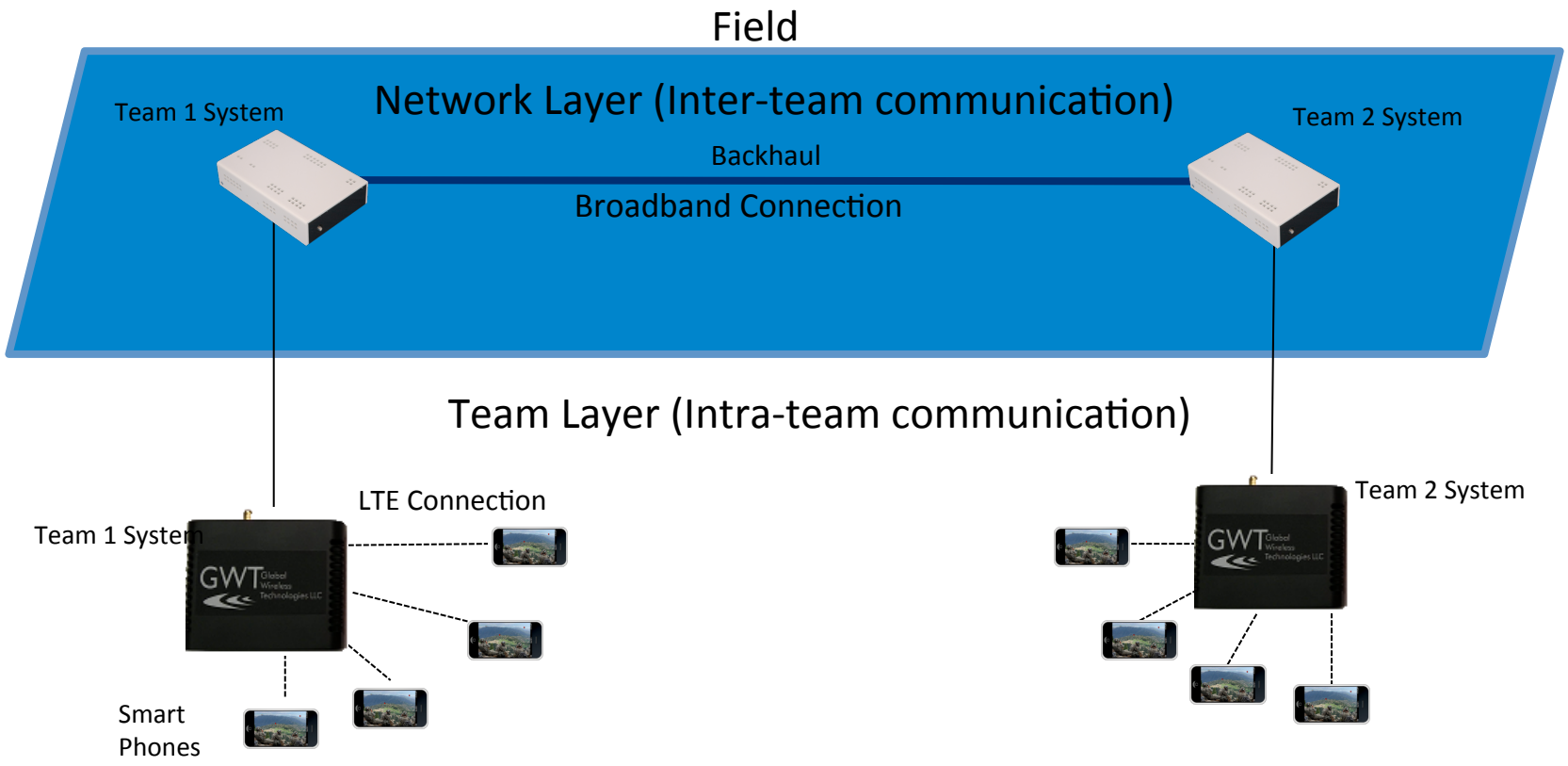
System Architecture

Intra-Team Connections

Broadband Connection



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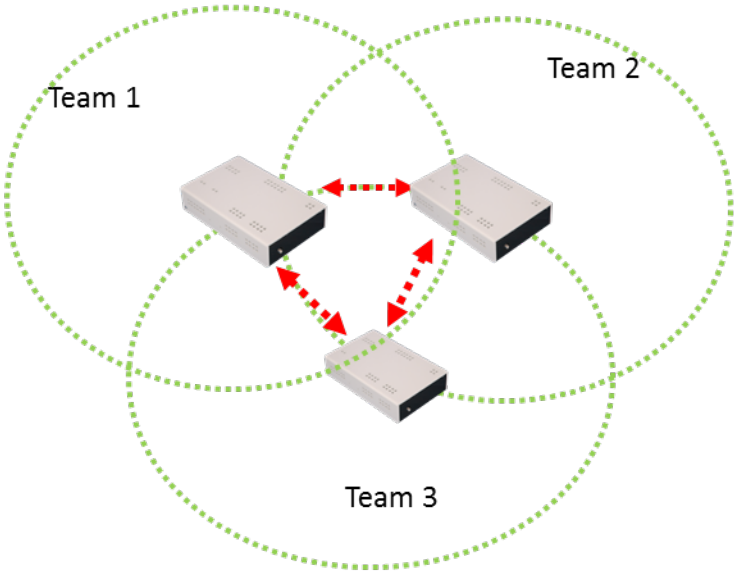
Inter-Cell Communication – Extended

Inter-Cell Communication Requirements

- Meshed
- Enable handover
- Self Interference cancellation
- Longer range than UE
- High throughput capacity to handle data "cascade"

Approach that fulfills requirements:

1. Utilize embedded UE modems to communicate with adjacent Systems via already available existing connection



Embedded UE(s)

- Directional antennae
- Higher power output to increase range
- Able to relay data from Team 1→ Team 2 → Team 3
- **Inherently mobile**
- **Inherently flexible**

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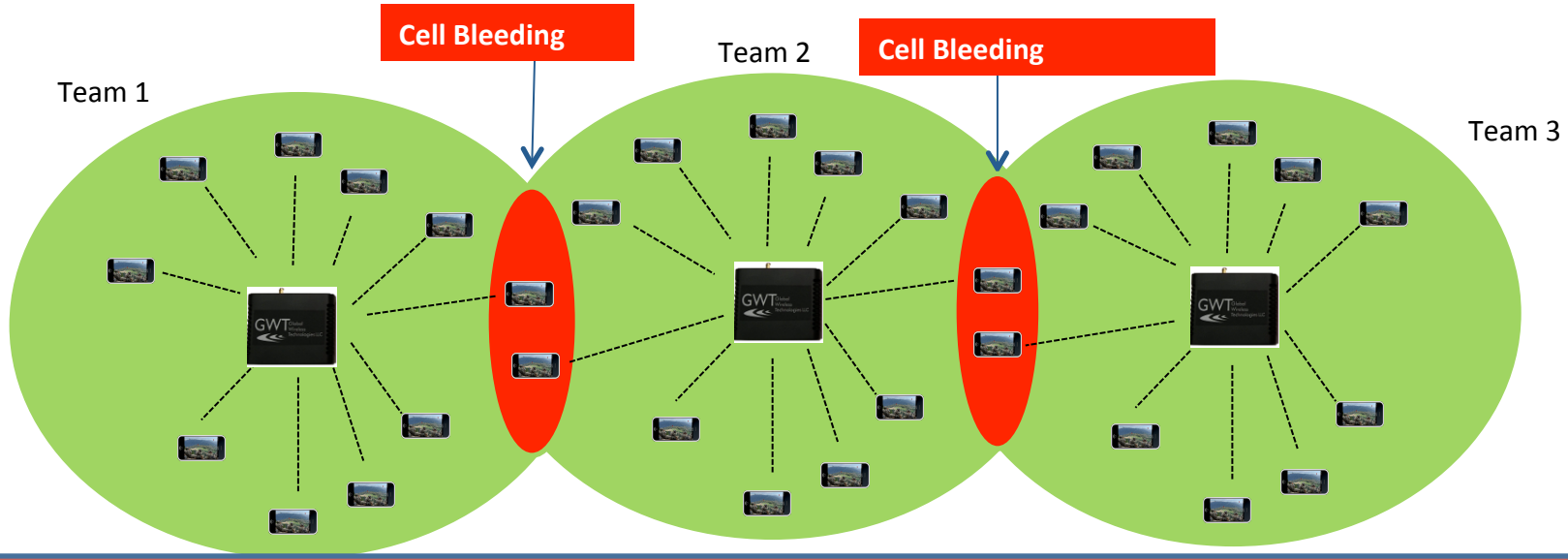
Inter-cell Interference – Dense Operation

Constraints

- Bleeding- Interference can be caused to small cell area by adjacent cells "bleeding" in to adjoining cells.
- Range- The range of each cell is in turn limited by 3 variables
  - Adjacent Cells: Depends on the output power of adjacent cells
  - Power: The amount of power available (man portable vs. vehicle)
  - UEs: The range of the user equipment that the first responder is using. Most consumer UEs have a range of approximately 1.5 mile with no modification



Approach: Combine Features, Antenna, Cancellation and Spectral Purity Techniques

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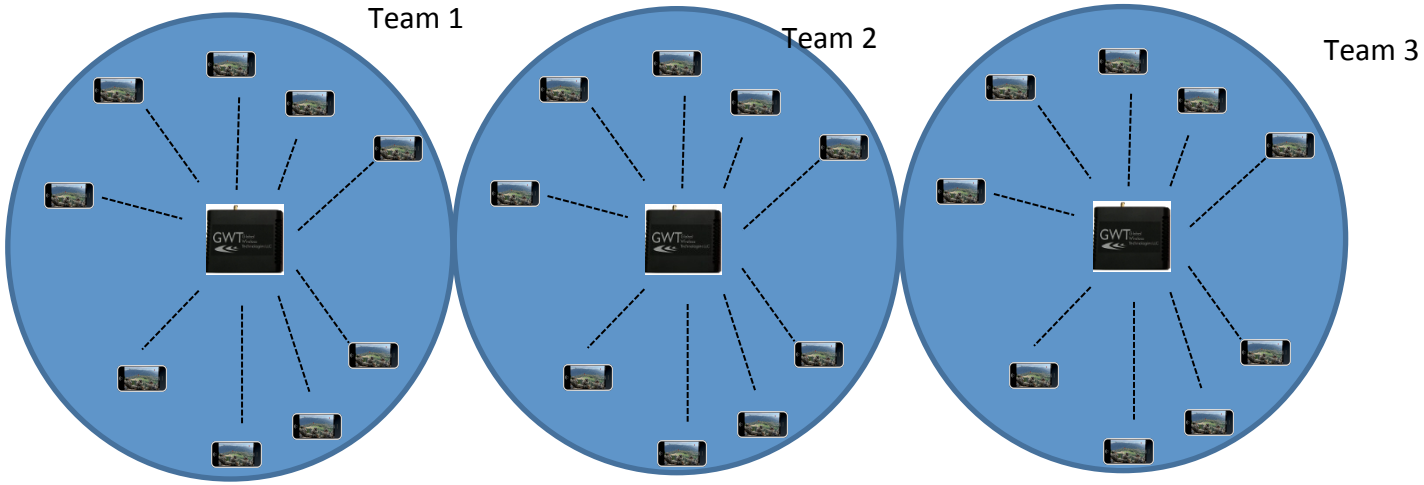
Inter-cell Interference cont'd

Intra-team Communication

- Omni and Sectored antennae depending on power source (man portable, vehicle, or fixed site)
- Dynamic Radio Signal Range determined by Self Organizing Network (SON) algorithms
- SON dynamically tunes cell size according to reference data obtained from surrounding environment (UEs and Base Stations)
  - Neighbor small cell output power
  - UE measurements
  - Alien Registrations etc.
- W/ SON- no cell bleeding, better connection and handover is now possible



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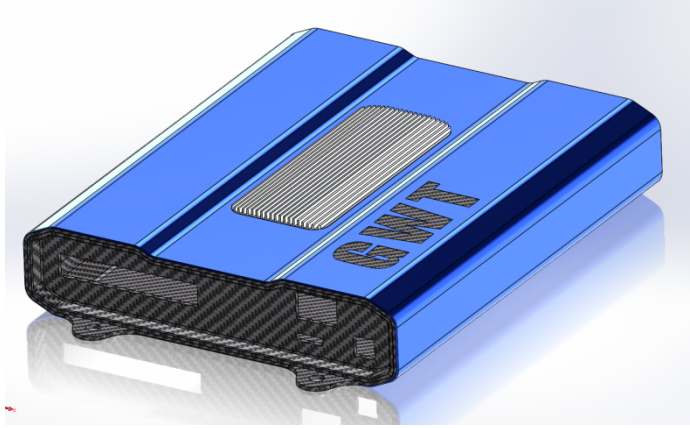
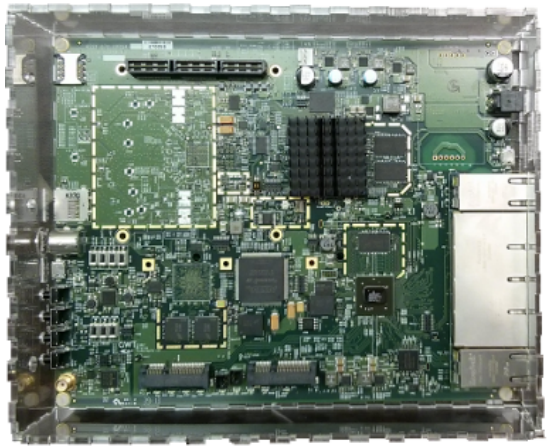
Single Platform for both Team Layer and Network Layer



Common Software
Flexible Deployment
Small SWAP



- Enclosure is customizable
- Carbon Fiber Housing
  - Light weight

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Summary

- Tailored LTE Small Cell solutions are required for Pubic Safety/First Responders
- Difficult to find vendors who have capability or willingness to do so at a reasonable price
- GWT is willing and has the capability to do so

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Thank You

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