



Cognitive Radio the innovation process

Experience from an SME

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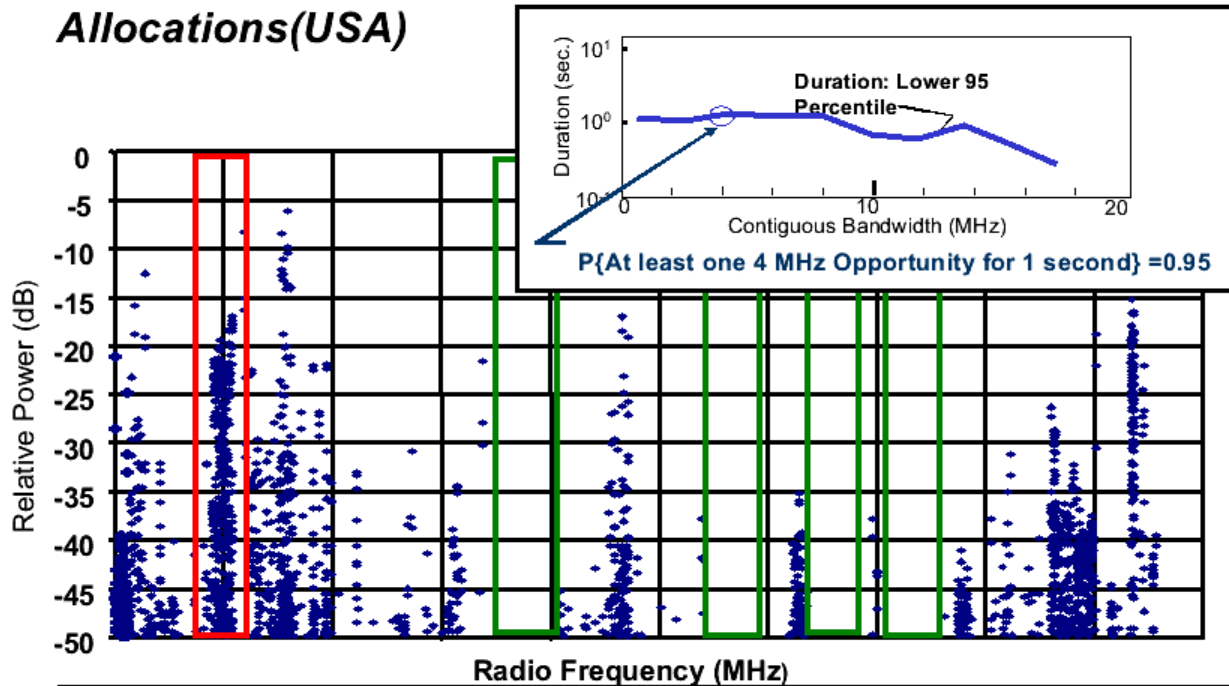


CR Problem definition

- Demand for ‘good’ spectrum increases
 - In particular for Public Safety
- Actual use of spectrum is time and place dependant
- Traditional allocations are static
 - Leave insufficient options for new applications
- Spectrum is a common resource while it is allocated exclusively

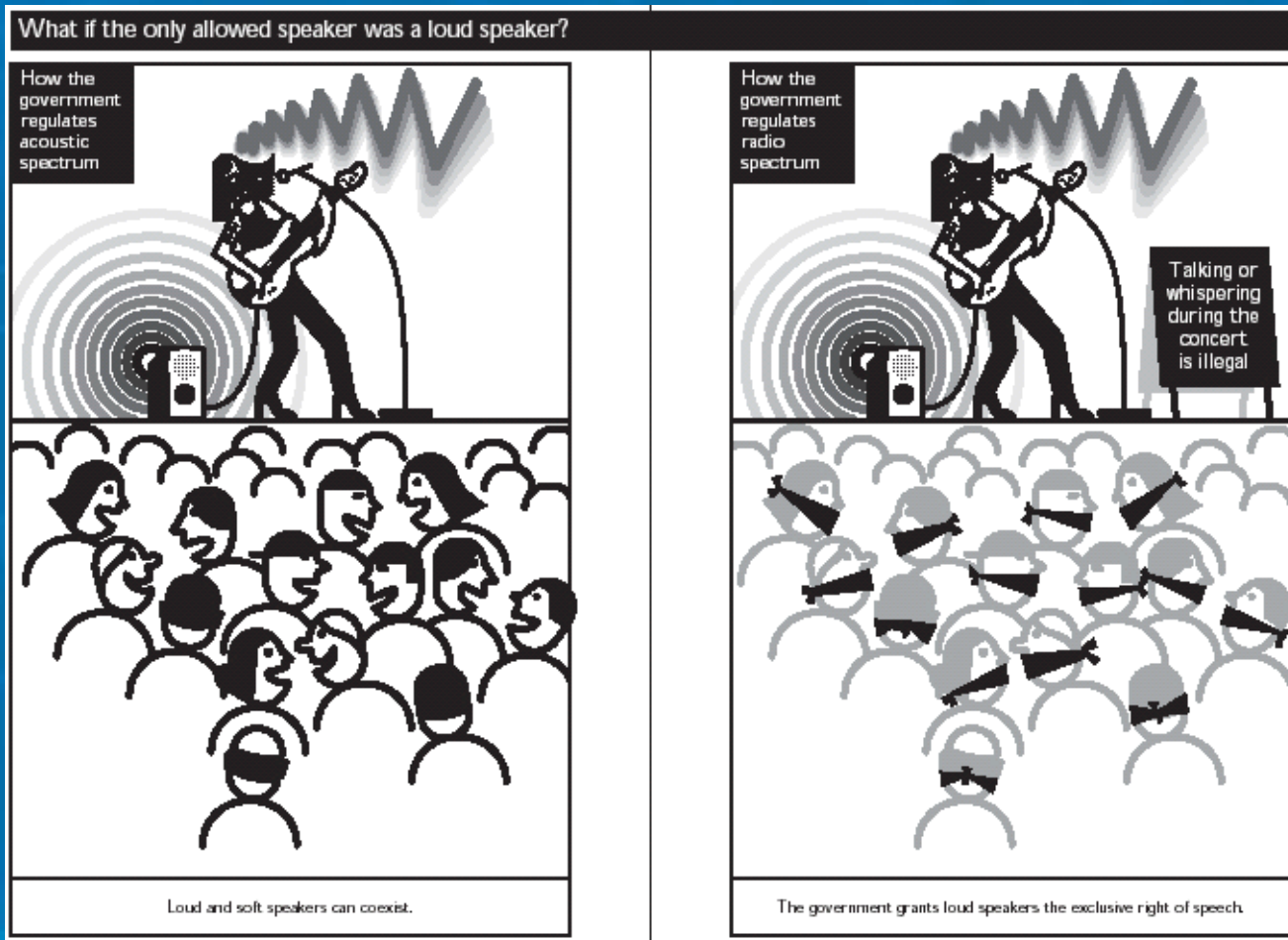
Actual spectrum usage

Observation:
“Local Spectrum is Full of Holes”



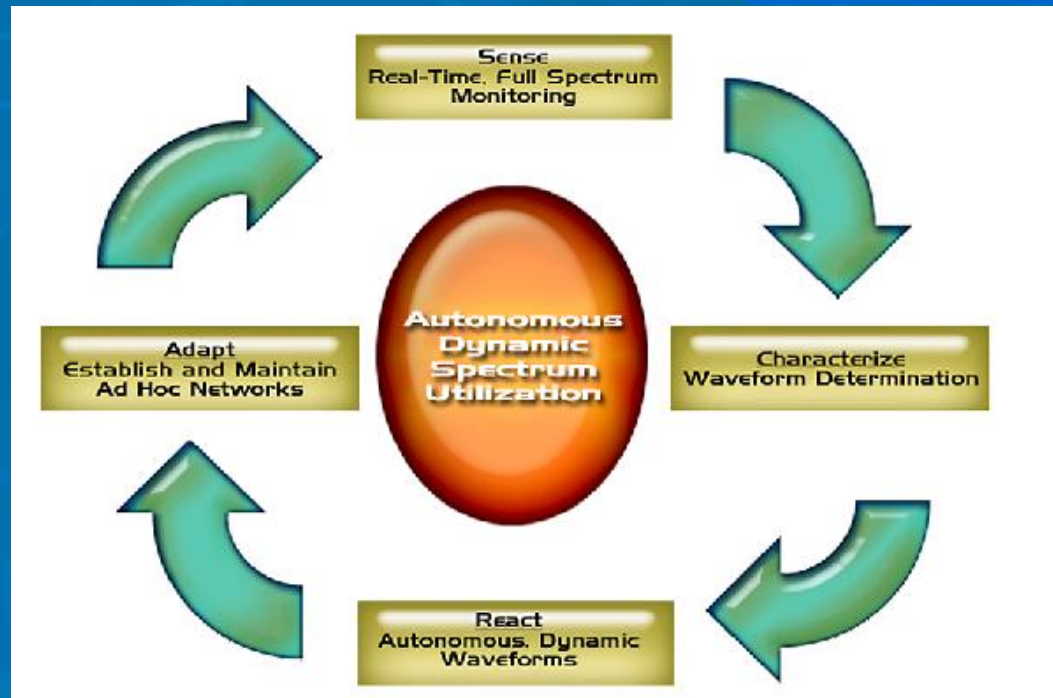
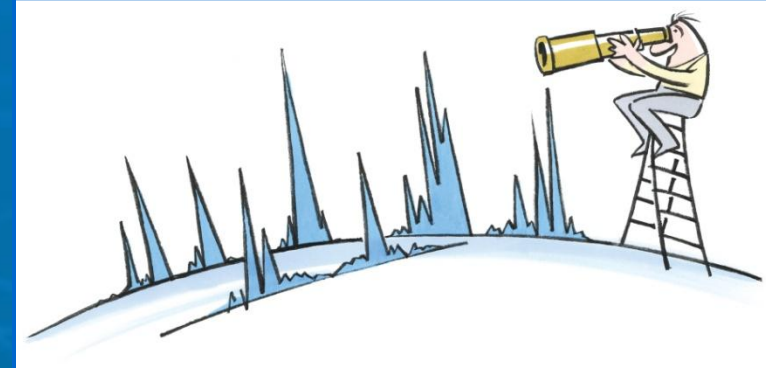
Some frequencies are **continuously used** and others are **never used**

Co-existence is a natural way



What we need: CR

- Autonomous Dynamic Spectrum Utilization



‘Cognitive Radio’ is not new

- › ALOHA: CSMA – Random backoff
- › DECT: Least Channel Interference
 - › Within one technology
- › WiFi
 - › Carrier Sense Multiple Access (CSMA)
 - › Dynamic Frequency Selection (DFS) in 5 GHz
 - › Automatic Channel Selection
 - › Co-existence with Bluetooth, radar, ...

The AAF Project (2003-2008)

- Research project: Adaptive Ad-hoc Freeband communications
- Ambitions
 - Physical resource discovery and selection
 - Frequency, time, place
 - Re-configurable radio system (SDR)
 - Ad-hoc networking
 - Centralized or decentralized control
 - Legal aspects
- WMC, Thales, TU Delft, UTwente

Findings during project

- Full fledged solutions require
 - Legislation in spectral allocation
 - Standardization between industries
 - Technology development
- Scope too big for SME
 - Legislation is a long process with a heavy lobby
 - The technology gap is too big for an SME

What is in scope of an SME

- › Option 1: Focus on one element
 - › Full effort on standardization
 - › Dependency on large industry
 - › Long term only
 - › Extreme high cost
- › Option 2: Bring existing elements together
 - › More competition from current solutions
 - › Flexibility
 - › Shorter term
 - › High cost still

What CR can be done now

- Our challenge:
 - “Can we create a smart solution that enhances reliability and bandwidth for mobile communications?”
- Requirements
 - More than the standard radio
 - Within legislation
 - Target users: Public Protection and Disaster Relief

Estimation of capacity

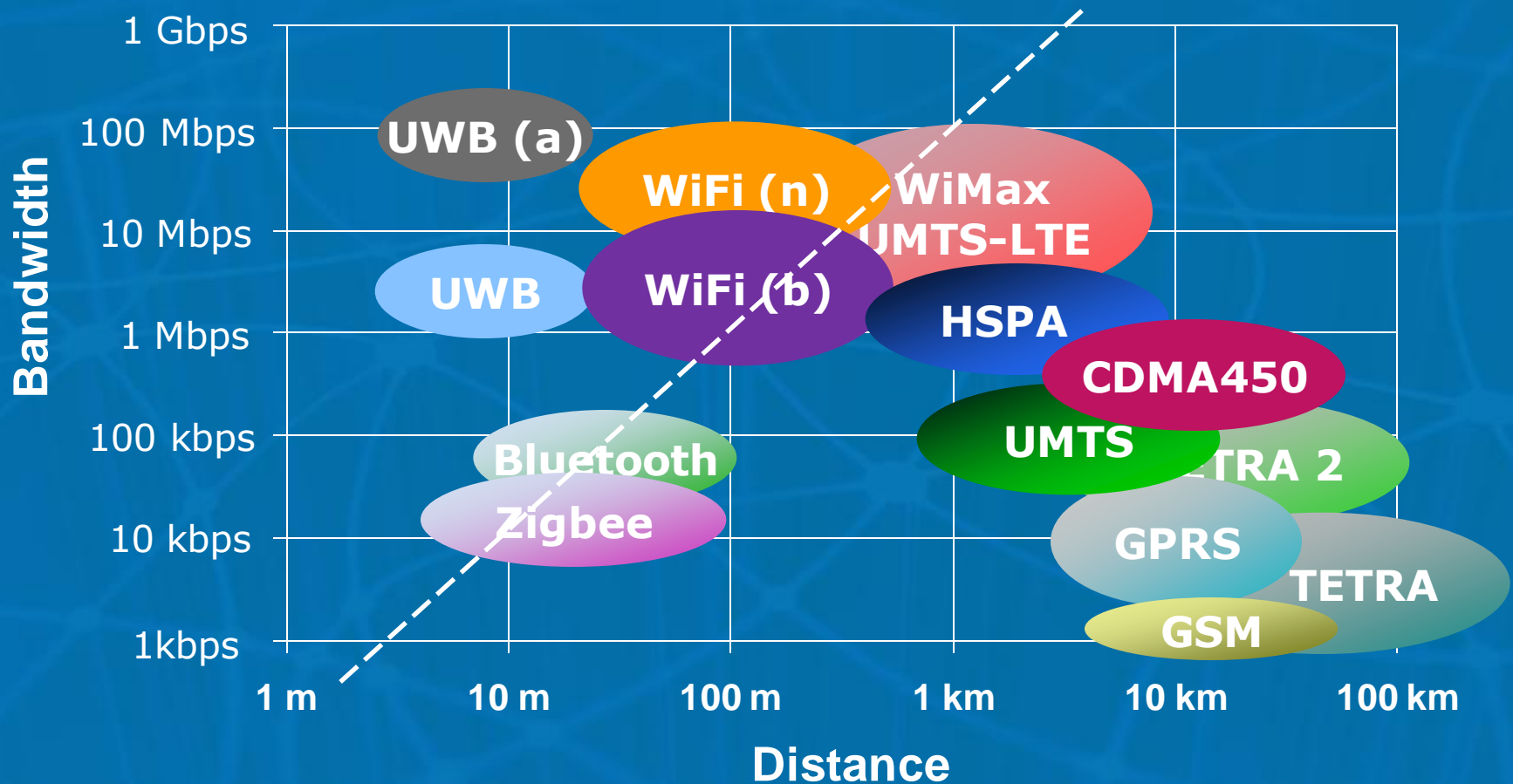
- Train crash scenario
 - Passenger train and freight train with dangerous substances crash near filled stadium
- Deployment
 - Firemen, Paramedics, Police, Experts, Rescue workers
 - First responder vehicles, Ambulances, Command vehicles, Robots, Helicopters



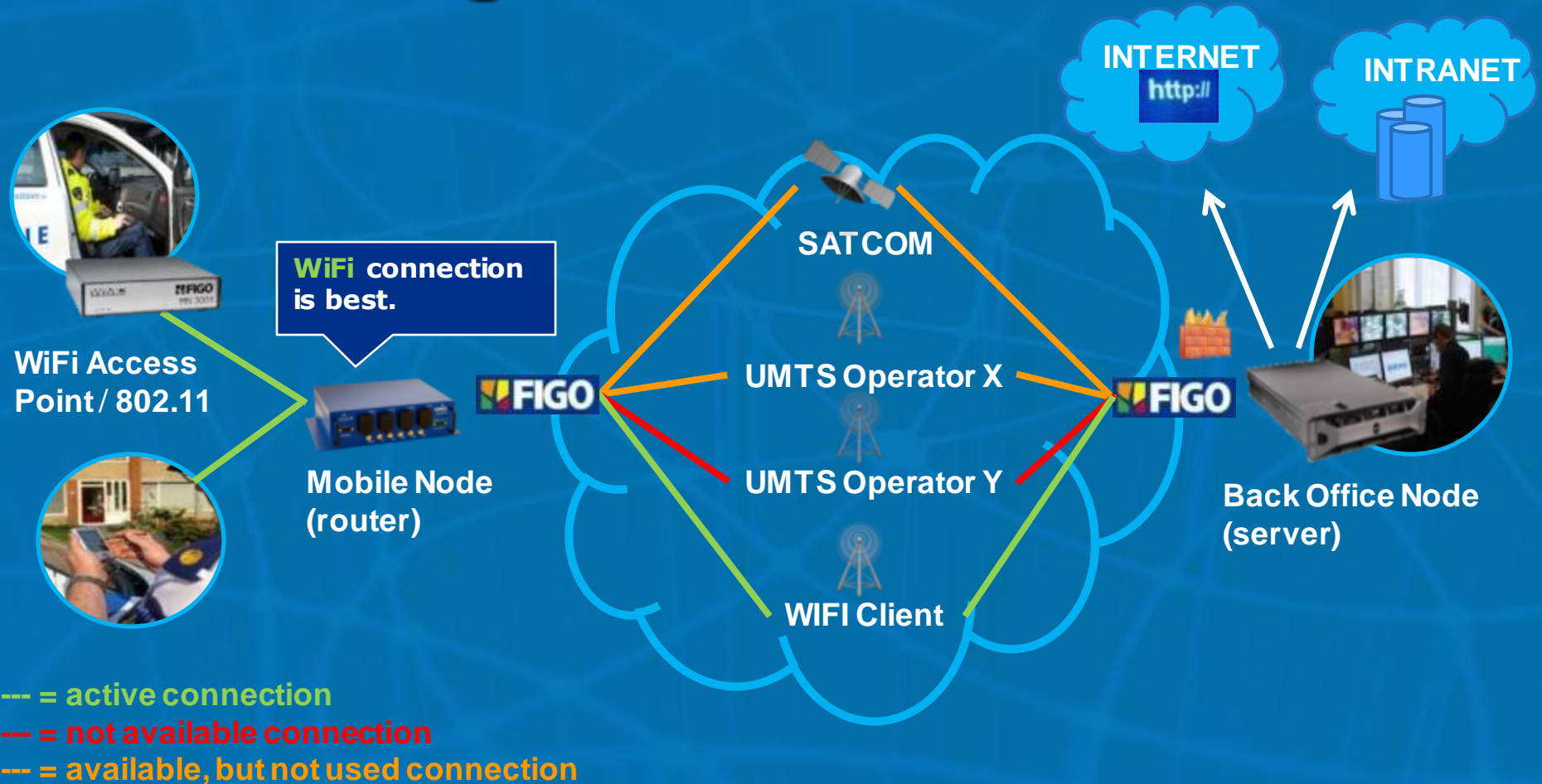
radius: 500 m

The disaster relief team requires an on-scene capacity of 100 Mbps during the operation.

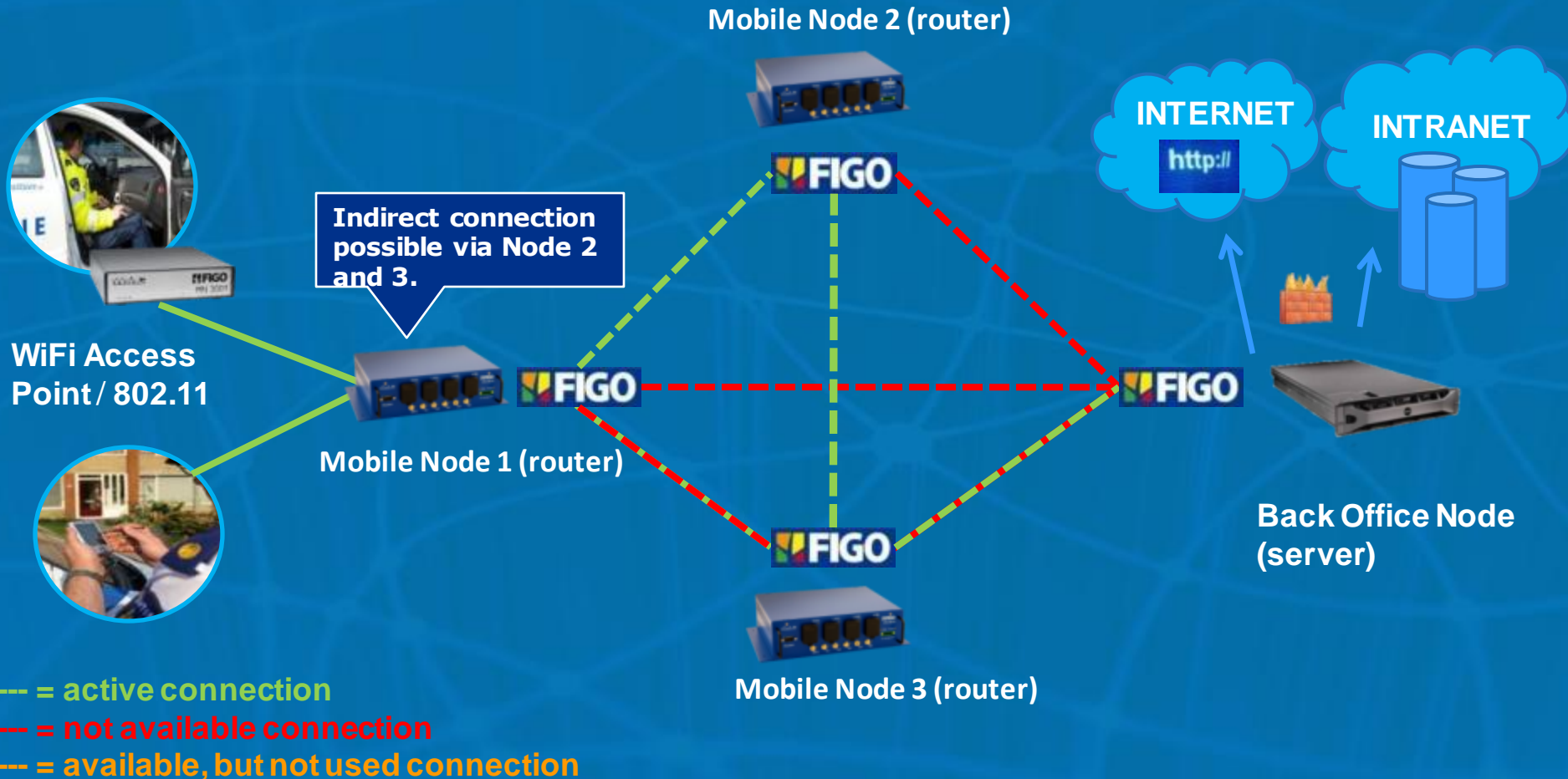
Bandwidth versus Distance



FIGO: Cognitive radio Network



FIGO Ad-hoc mesh network

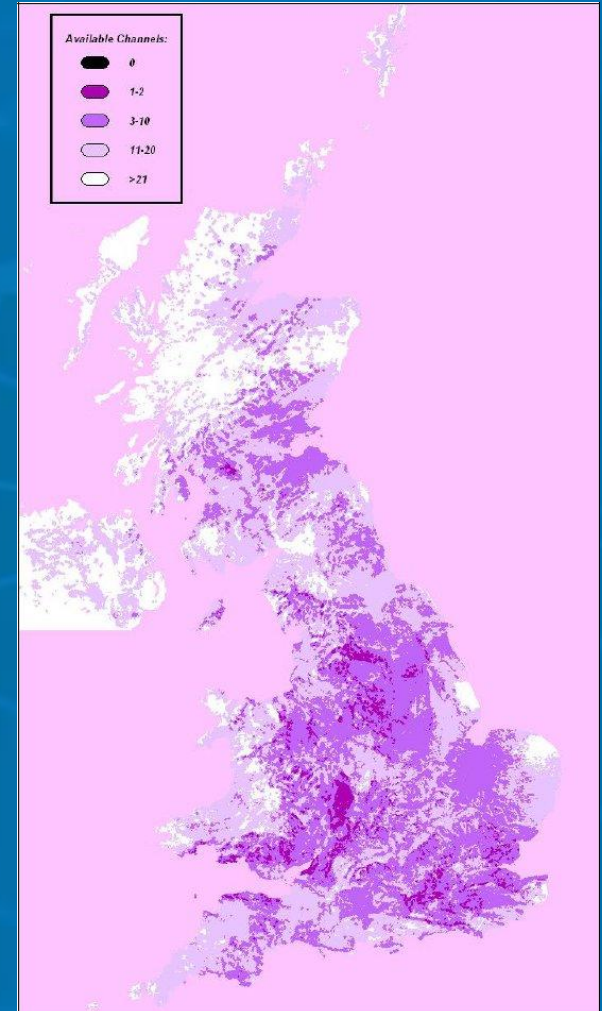


Cognitive radio network: FIGO

- › Multi radio – preLTE
 - › Multiple bands combined
 - › High bandwidth
 - › Selecting best available channels
- › Ad-hoc network
 - › Always Best Connected
 - › Local communication remains local
 - › Interface with applications

Current Development

- TV White Space accepted in US
- CEPT SE43
 - draft ECC Report 159 on “Technical and operational requirements for the operation of cognitive radio systems in the ‘white spaces’ of the frequency band 470-790 MHz”
- Interference avoidance
 - Geo-location database
 - Spectrum sensing
 - Beacon



Position for WMC

- Continue development of our own ‘cognitive radio network’
- Experiments based on existing HW
- Track EU regulation
- Start-up development as soon as regulation becomes clear
 - Go down in the stack to the radio