Wi-5 Prosumer Networking: a full-fledged managed Wi-Fi consumer network

Proposal for a Wi-Fi Prosumer Network with a Radio System Operator, an independent Spectrum Usage Broker and Prosumer Community Control

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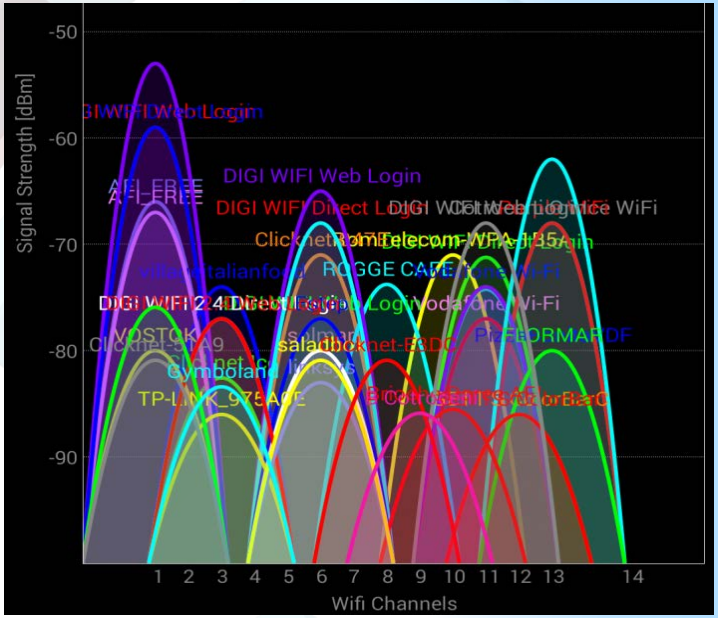
TNO

The Wi-Fi Networking Challenge

Spectrum congestion and performance issues

Technology

Despite many innovations (802.11, 11a, 11b, 11g, 11n, 11ac,…) spectrum congestion is becoming more and more an issue.



Market

- Successful technology: 12 billion devices,
- Increasing bandwidth demands (virtual reality)
- Access networks evolve toward 1 Gbps
- Coverage everywhere:
  - Indoor: private home, offices, airports,…
  - Outdoor: squares, streets, …

Regulatory

- Technology regulated (max transmit power, listen before talk,…)
- Usage on a non-protected basis,
- Users have to accept the risk of interference between different users,
- Spectrum no subject to individual rights.

Tragedy of Commons

Technological solutions fail, managerial arrangement is needed

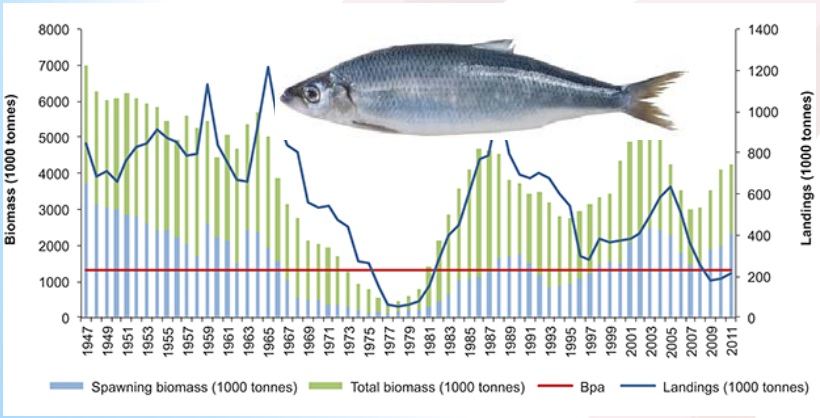
Limited resource with unregulated (free) access, is susceptible congestion and exhaustion of the resource

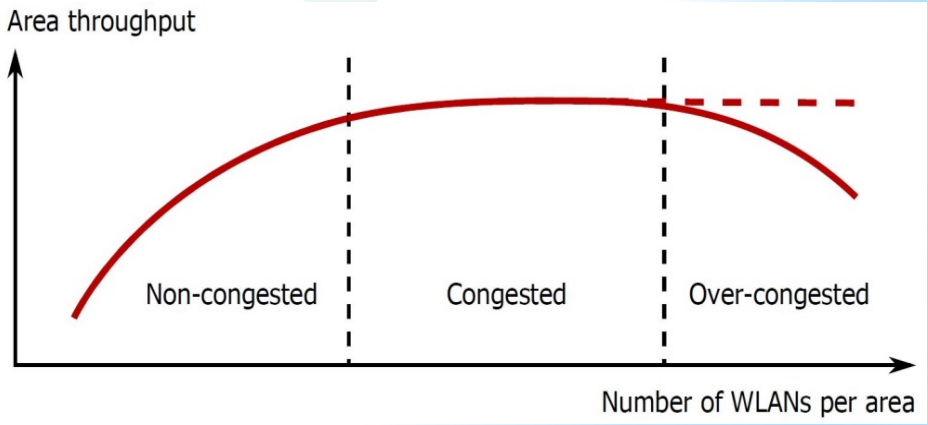
<u>Examples</u>

- Traffic jams (solution: road pricing),
- Overfishing (solution: fishery governance (FAO))
- Wi-Fi

<u>Solution to avoid the Tragedy of Commons:</u>

- Appropriate resource management
- Managerial arrangement to control access to the resource





Mobile Networks

Network management addresses spectrum congestion and efficient use of the resources

Network management is based on three pillars

- **Specification of the customer services**, including price and volume caps to steer traffic demand
  - Bit rate and data bundle
  - Coverage,
  - Availability,
- **Radio Resource Management** to optimize the use of the existing network resources
  - Optimized channel assignment,
  - Handover between access points,
  - Transmit Power Control,
  - …….
- **Capacity Management**

  If traffic demand exceeds the available network capacity, additional base stations are installed

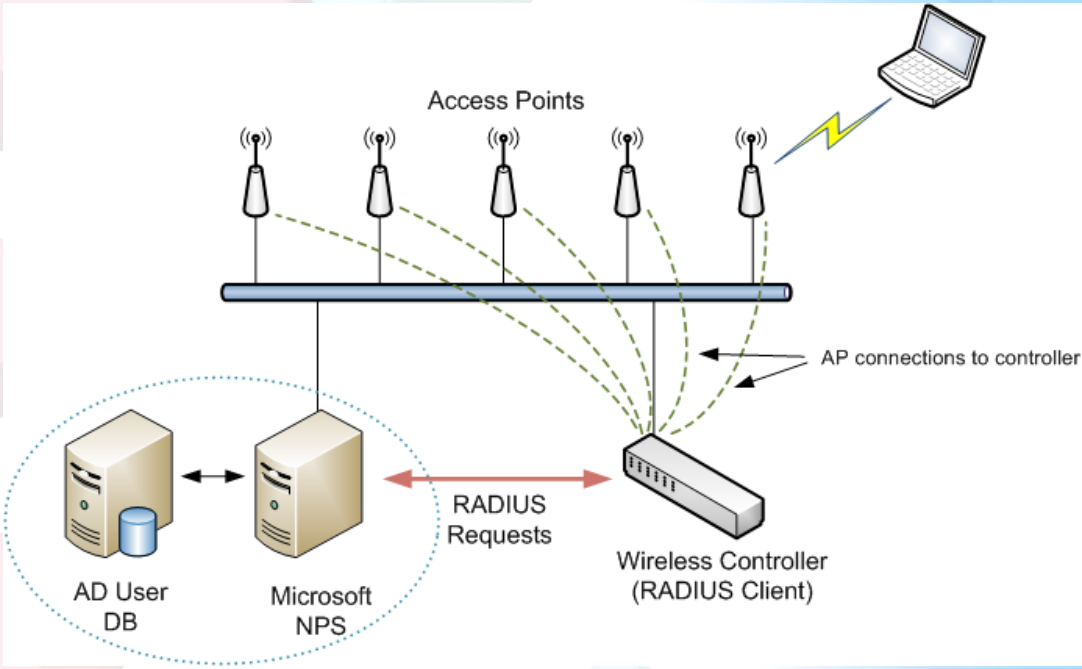
Wi-Fi Enterprise Networks

Offices, factories, schools, etc.

Network management:

- **Specification of network services**
  - Different Virtual Networks (SSIDs) for different user groups
  - Different VLANs for services with priority/QoS
- **Radio Resource Management**
  - Frequency channel assignment,
  - Handover between access points,
  - Transmit Power Control,
  - …….
- **Capacity Management**

  If traffic demand exceeds the available network capacity, additional APs are installed

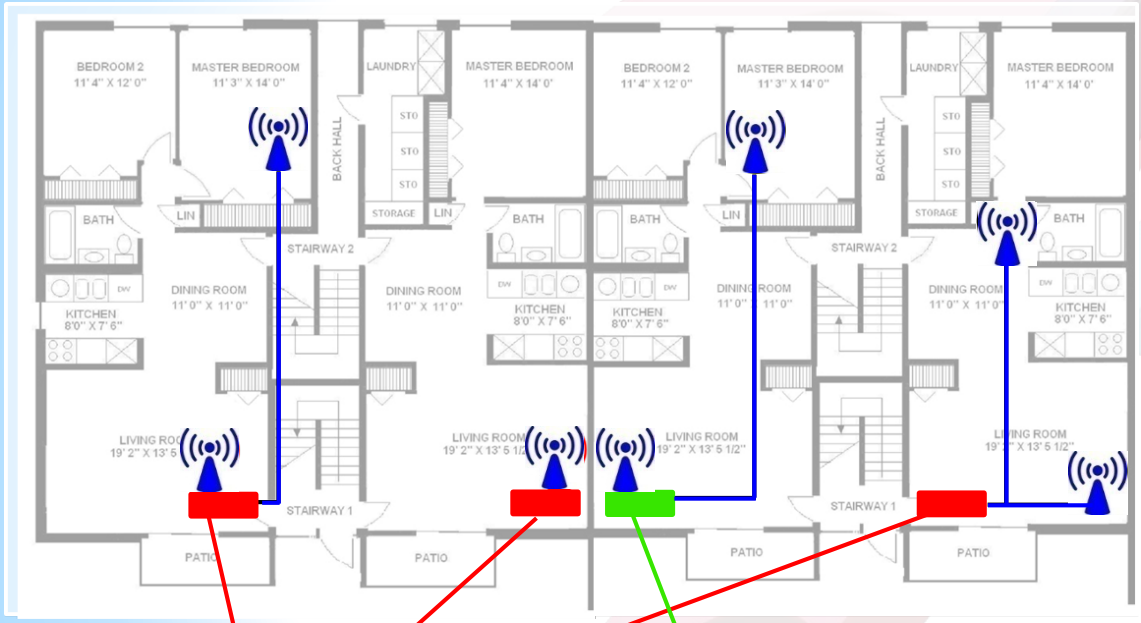


But….

- Limited interference from other APs
- Single domain
- Professionalized management
- (Pricey solution)

Wi-Fi Consumer Networks

Multi-operator & overlapping networks



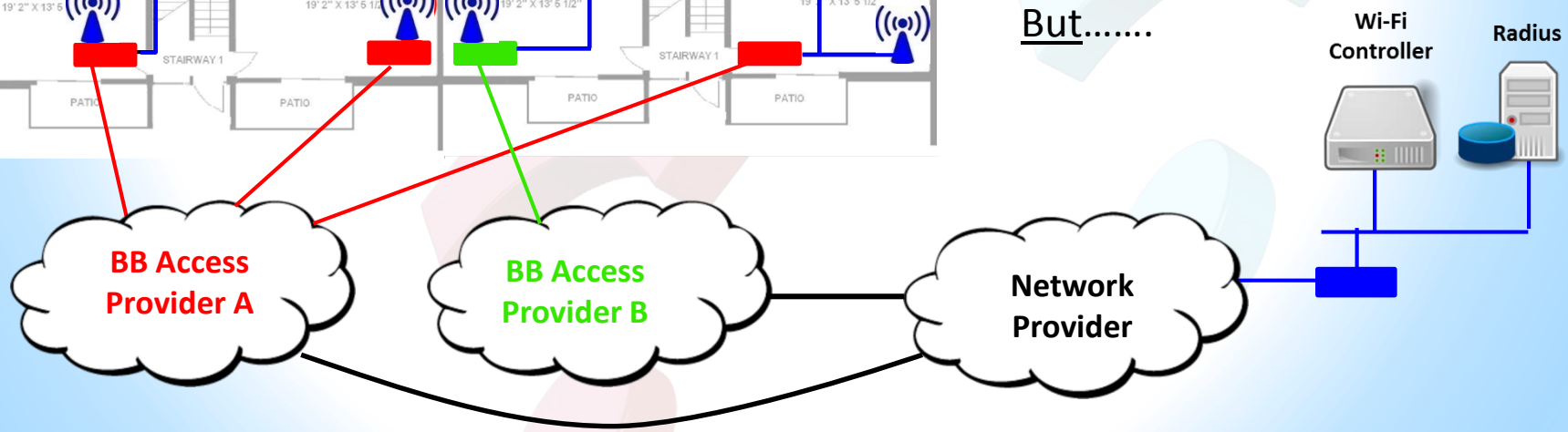
Technical solution:

- Appropriate firmware for APs,
- Wi-Fi Controller
- Database (customer data, service data etc.)

System level solution:

Wi-Fi Prosumer Network

But…….



Wi-Fi Consumer Networks

Wi-Fi Network Management SP is needed

Technical: no issues that cannot be solved (Enterprise solution)

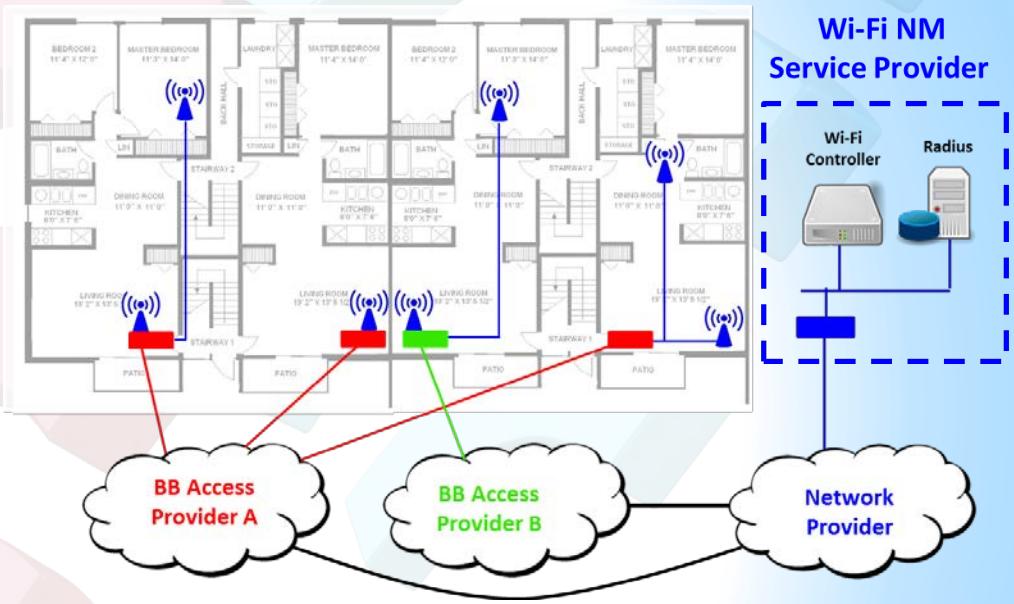
Practical: house owner/tenant is operator, so

- How to specify the services offer?
- Which RRM techniques and which policy rules?
- Who will own and operate the controller and database?
- How to grant neighbours access to your access point
- Interference from neighbours that have not joined the managed network

Economical:

- Avoid free-riding
- Who will invest in capacity and how is this rewarded?

Legal: ????

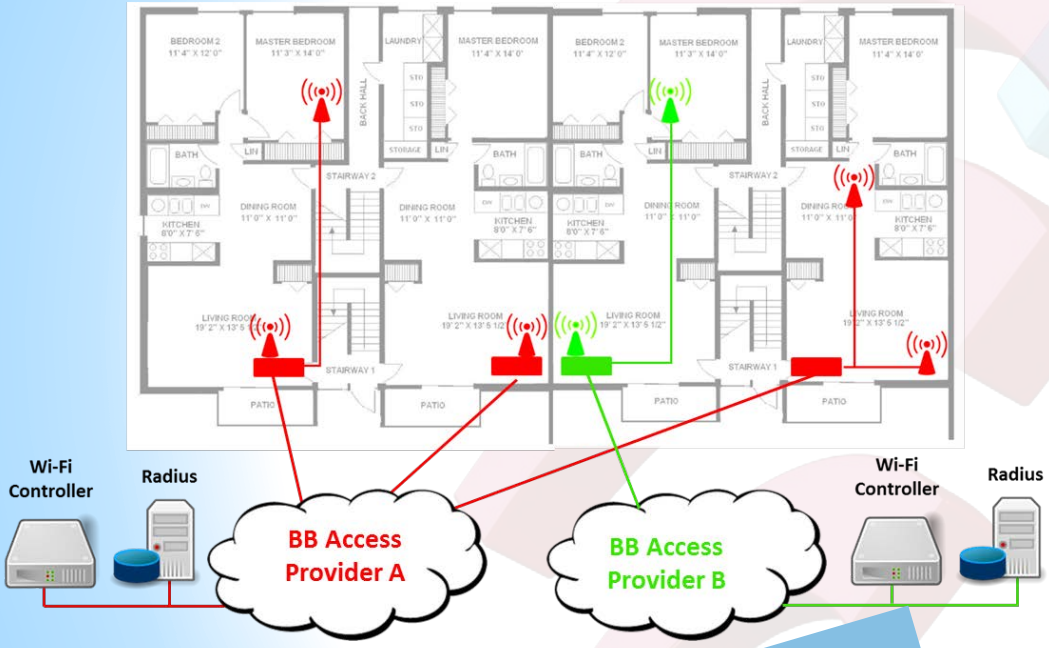


A Wi-Fi NM Service provider is needed:

- Provides the Wi-Fi controller and database
- Defines Wi-Fi network services
- Chooses RRM techniques and defines policy rules
- Administrate the customers and access rights
- Provides customer support (helpdesk, technicians, APs, AP firmware,…)

Wi-Fi Consumer Networks

BB Access Provider potential candidate Wi-Fi NM Service Provider



Wi-Fi Prosumer Network 1.0

Current BB Access Providers already:

- Have the organisation and expertise to deliver consumer market services,
- A customer relation
- Foothold in the home: modem with a Wi-Fi AP

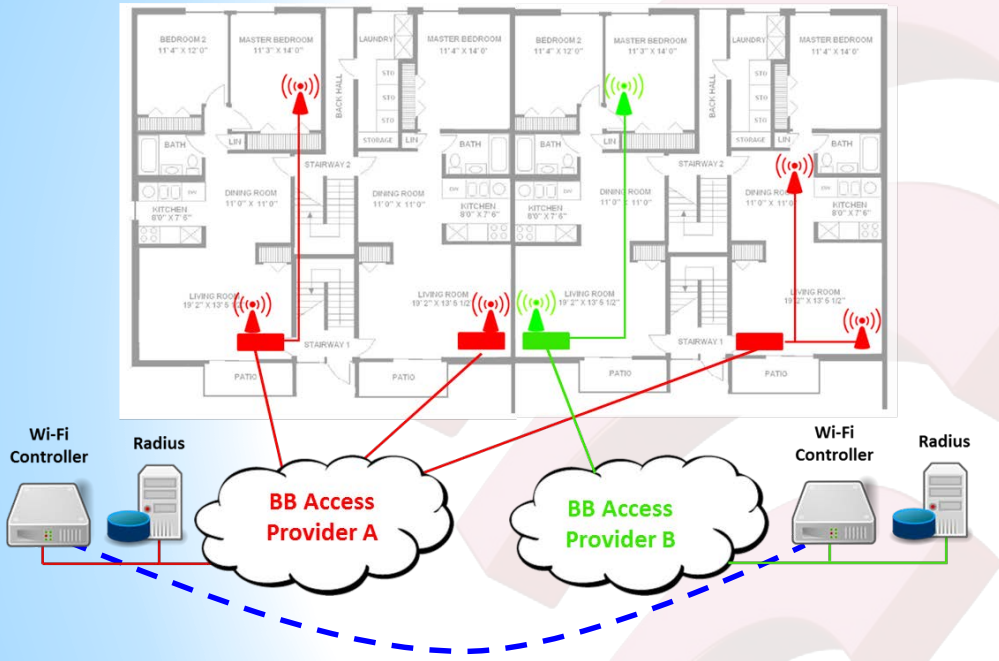
Current BB Access Providers already define the Wi-Fi network services:

- Customer private network (home network, internet access, premium IPTV,…..),
- **Best effort prosumer network** (only Internet access),
- Voluntary service via an opt-out arrangement

Some BB Access Providers already provide 2nd AP

Wi-Fi Consumer Networks

Evolution BB Access Provider as Wi-Fi NM Service Provider



Coordination to optimize Wi-Fi channel plan

Current BB Access Providers could add new RRM mechanisms in the home:

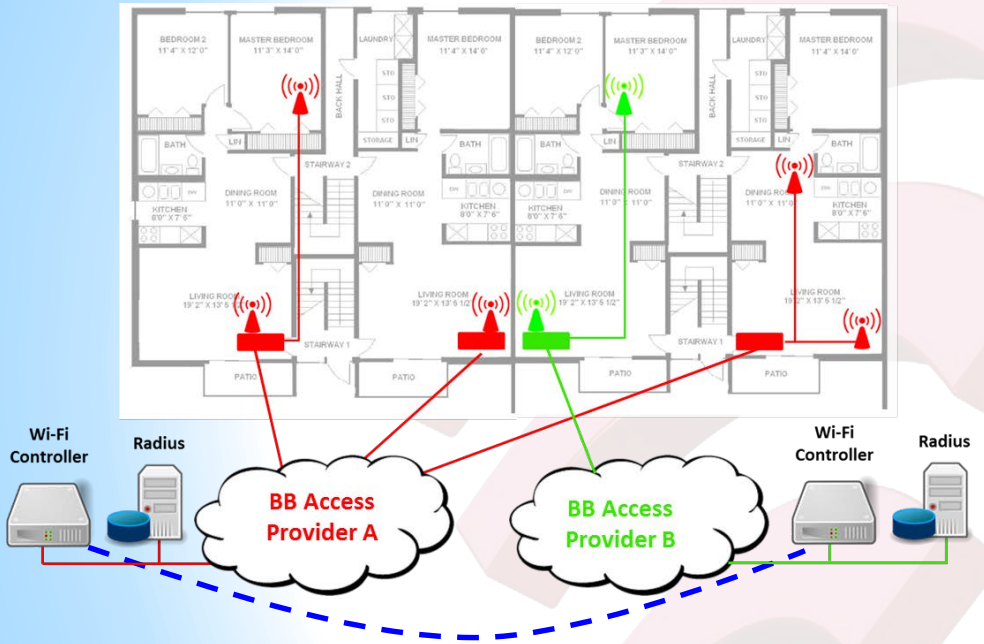
- Optimize the assignment of the STAs to APs (handover),
- Optimization of the channel plan across the APs managed by the BB Access provider

BB Access Providers could cooperate and optimize the channel plan across all APs in an area (apartment building, street, …).

Wi-Fi Prosumer Network 2.0

Wi-Fi Consumer Networks

Full fledged Wi-Fi NM Services proposition



Wi-Fi Prosumer Network 3.0

Access:

- Customer private network (home network, internet access, premium IPTV,.....),
- Best effort network (only Internet access),
- Premium network for neighbours (telephony, video or gaming)

RRM mechanisms:

- Optimize the assignment of the STAs to APs,
- Optimization of the channel plan across all APs in an area
- Dynamic Transmit Power Control,
- Dynamic Channel Assignment,
- ……..
- Advanced algorithms to make optimized use of DTPC, DFS, AP Load Balancing mechanisms

Capacity management: ??????

- How to stimulate (convince) customers to add an AP in case of capacity shortage,
- Free-riding has to be avoided

Wi-Fi Prosumer Network 3.0

Challenge: Capacity Management

Specification of network services offer

- Customer private network
- Best effort prosumer network,
- Premium prosumer network

Radio Resource Management

- Dynamic AP assignment,
- Dynamic channel assignment,
- Dynamic Transmit Power Control,
- ……..
- Advanced RRM optimization algorithms,

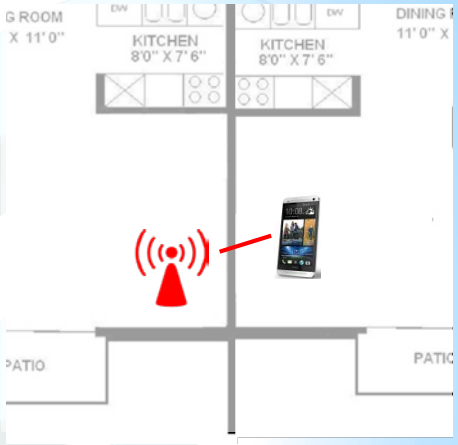
Capacity Management

- How to stimulate (convince) customers to add an AP in case of capacity shortage?
- Free-riding has to be avoided

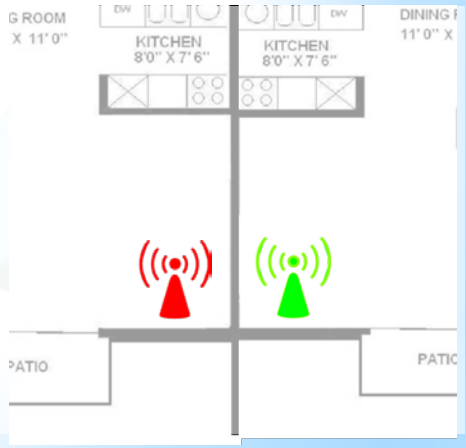
Monetize resources???

- **Wi-Fi Access**
- **Frequency Spectrum**

Wi-Fi Access Sharing



Spectrum Sharing



Wi-Fi Prosumer Network 3.0

Challenge: Market

Specification of network services offer
- Customer private network
- Best effort prosumer network,
- Premium prosumer network

Radio Resource Management
- Dynamic AP assignment,
- Dynamic channel assignment,
- Dynamic Transmit Power Control,
- ……..
- Advanced RRM optimization algorithms,

Capacity Management
- How to stimulate (convince) customers to add an AP in case of capacity shortage?
- Free-riding has to be avoided

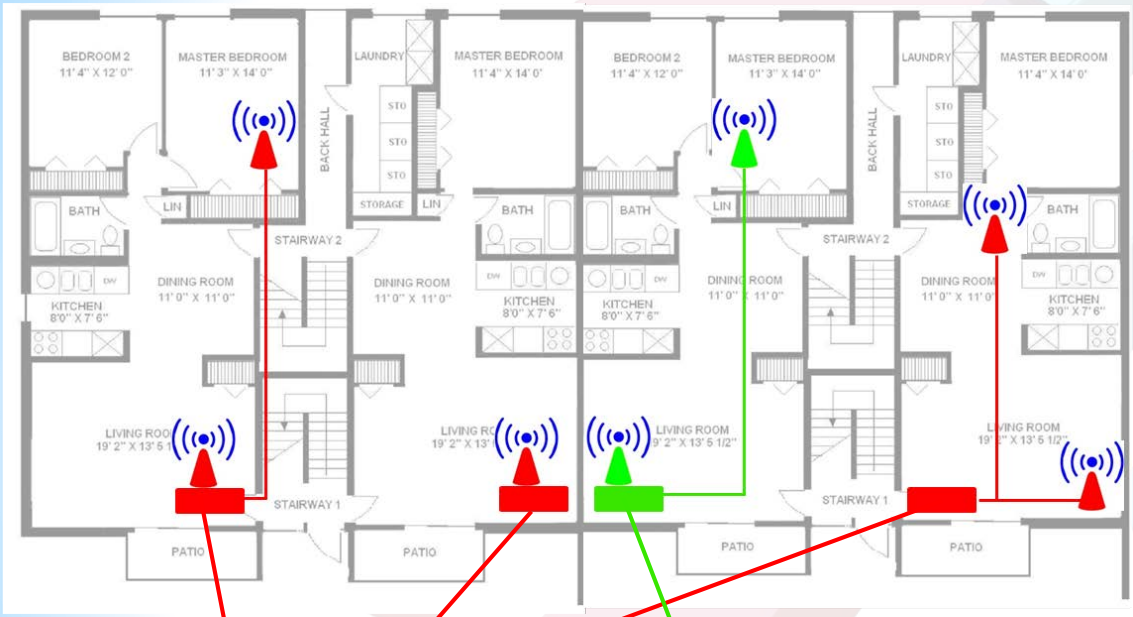
Control should reside with the Community of Prosumers

Regulatory challenges
- **Anti-trust law**
- **Transparency**
- **(BB Access market is very competitive)**

Monetize resources
- **Wi-Fi Access**
- **Frequency Spectrum**

(Independent) Spectrum Usage Broker

Wi-Fi Prosumer Network 3.0



Wi-Fi Spectrum Usage Broker

Broker Platform

Wi-Fi Controller

Radius

BB Access Provider A

BB Access Provider B

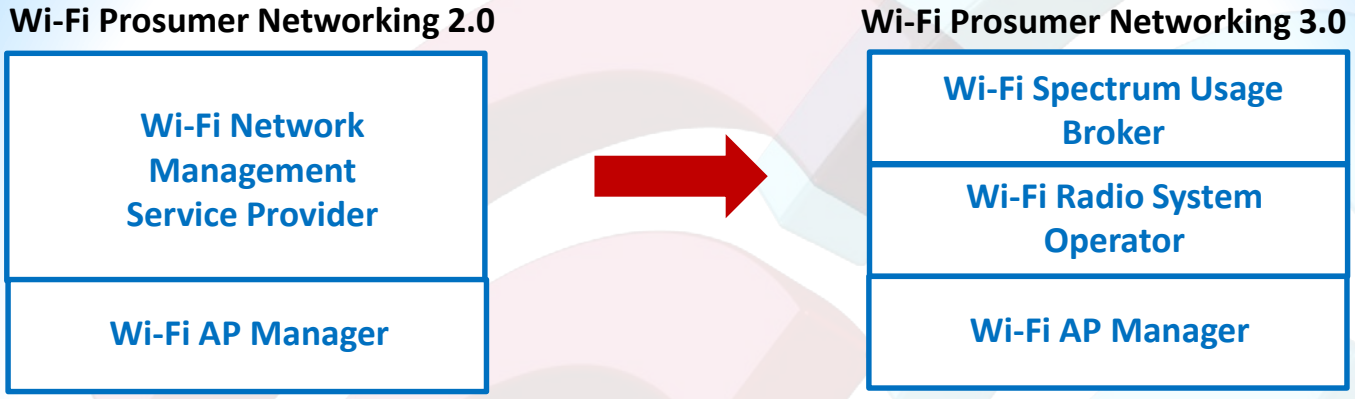
Wi-Fi Controller

Radius

Network Provider

Wi-Fi Prosumer Network 3.0

Regulatory Challenge: new Wi-5 Business Role Model

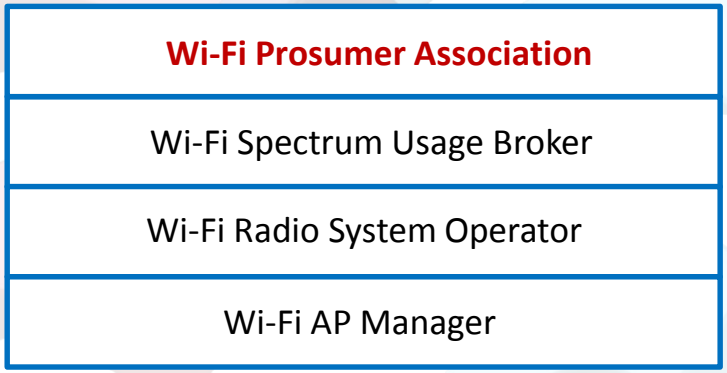


Wi-5 Business Roles

- **Wi-Fi Access Point Manager (Resident)** This role is responsible for *physical* management of the Wi-Fi Access Points and for granting access rights to his/her AP(s)
- **Wi-Fi Access Point Manager & Radio System Operator (BB Provider)** This role is responsible for *i) software* management of the Wi-Fi Access Points, *ii)* development, implementation, and operation of RRM solutions, *iii)* implementation of the Wi-Fi network services and *iv)* operation of the platform needed to execute the Wi-Fi spectrum sharing strategies and resource allocations as devised by the Spectrum Usage Broker.
- **Wi-Fi Spectrum Usage Broker (Independent role)** This broker devices and implements the sensible spectrum and radio resource sharing strategies between Local AP Managers in a cooperative context, including the policy rules to grant access. This may include radio resource pricing models and agreements. This role treats the spectrum as a scarce resource to be fairly shared by the wireless users.

Wi-Fi Prosumer Networking 3.0

Wi-Fi Prosumer Community Control



<u>The W-Fi Prosumer Association develops and specifies (approve):</u>

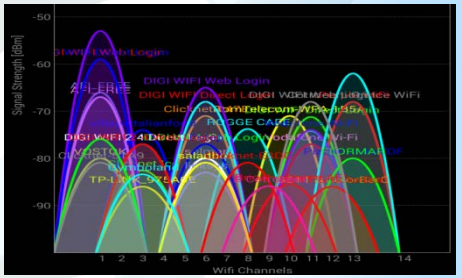
- The Wi-Fi prosumer network services,
- The Radio Resource Management strategies and policy rules,
- Price models for Wi-Fi Access Sharing and Wi-Fi Spectrum Sharing.

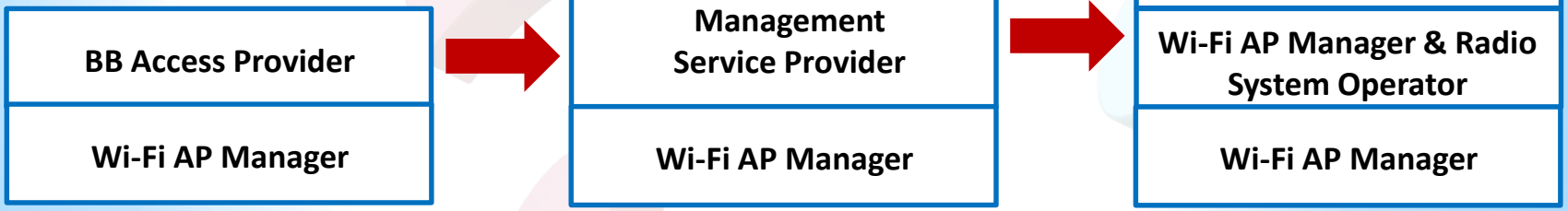
New association or incorporated in:

- **Consumer's association**
- **Association of shopkeepers**
- **Homeowner association**
- **Local Administration (public areas)**

Summary and conclusion

- Wi-Fi spectrum congestion cannot be solved by technological improvements only (Tragedy of the commons)
- Wi-Fi Network Management is needed:
  - Specification of the Wi-Fi network services
  - Radio Resource Management
  - Capacity Management
- We foresee the development of Wi-Fi Prosumer Networking
- Monetization of Wi-Fi resources would be helpful to implement capacity management and create a healthy market
- Evolution of Wi-Fi Prosumer Networking requires evolution of the business model:





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