

Past, present and future of Wireless Communities Is rivaling cellular in their future?

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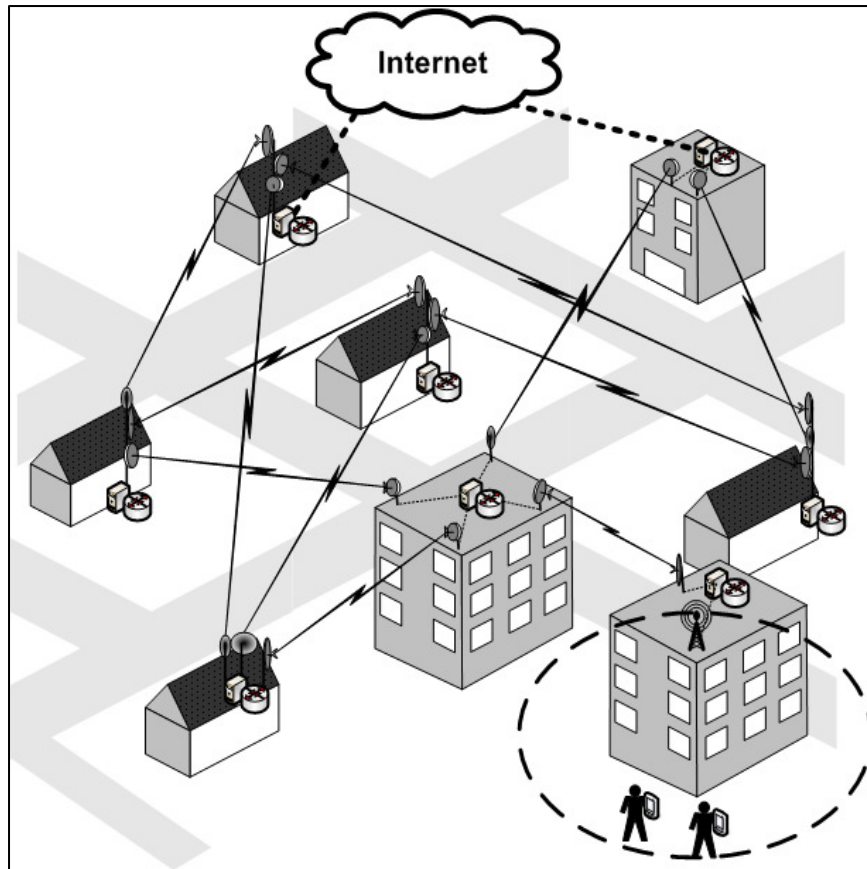
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Wireless Community Networks: Technologies & Architectures

- Technologies
 - ◆ Based on Wi-Fi / IEEE 802.11
 - ◆ Modifications for PtP links
 - ◆ Open hardware and software platforms
 - Hand-made hardware (antennas)
- Architectures
 - ◆ **Mesh** based
 - ◆ **Hotspot** based

WCN Architecture: Mesh-based

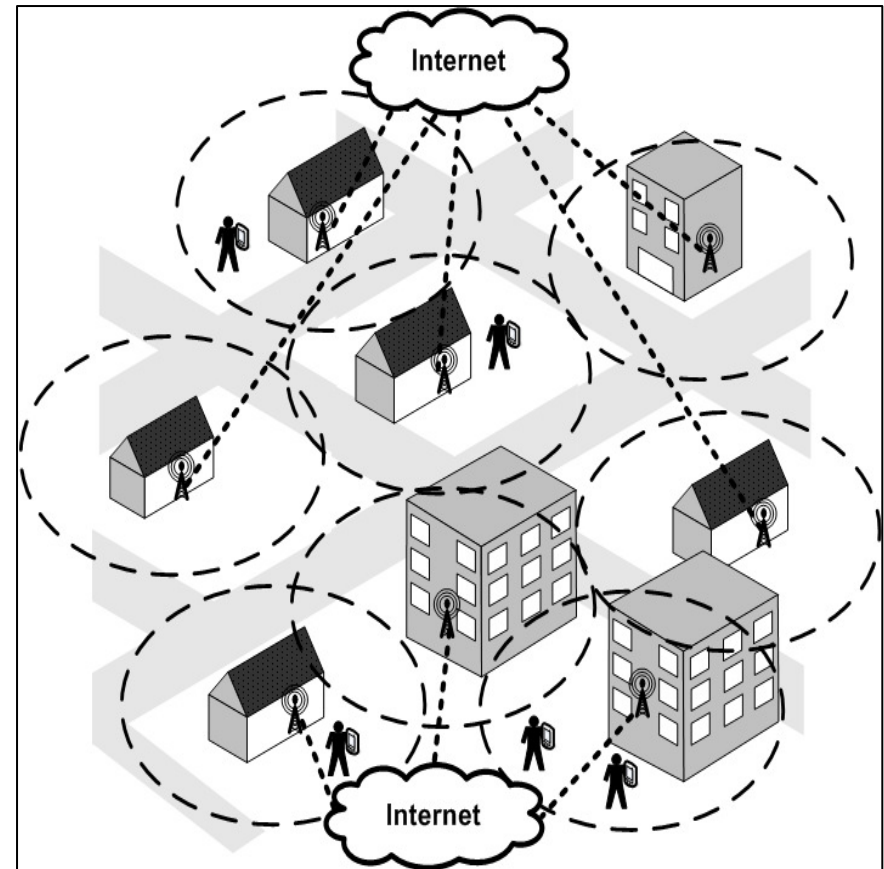


- All-wireless backhaul
- Community owned network
- Access points (optional)
- Internet connection sharing -- WCN-to-Internet gateways (optional)
- Focus on network autonomy

Mesh architecture

WCN Architecture: Hotspot-based

- Community-owned WLAN Access Points
- APs attached to fixed wired broadband lines
- Focus on Internet access



Hotspot architecture

Who runs a WCN?

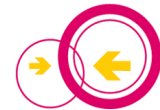
- Volunteers
 - ◆ Free interconnection
 - ◆ Bypassing wired ISPs
 - ◆ Tech-savvy Wi-Fi enthusiasts
- State initiatives
 - ◆ Municipalities offer Wi-Fi access at low/no cost
 - ◆ Athens Wi-Fi, Wireless Philadelphia, The Cloud (London)
- Private companies
 - ◆ Mediation services for the creation of Wireless Communities
 - ◆ FON, NetShare
 - ◆ 'Micro-WISPs' share Wi-Fi for profit, company may get a share

History

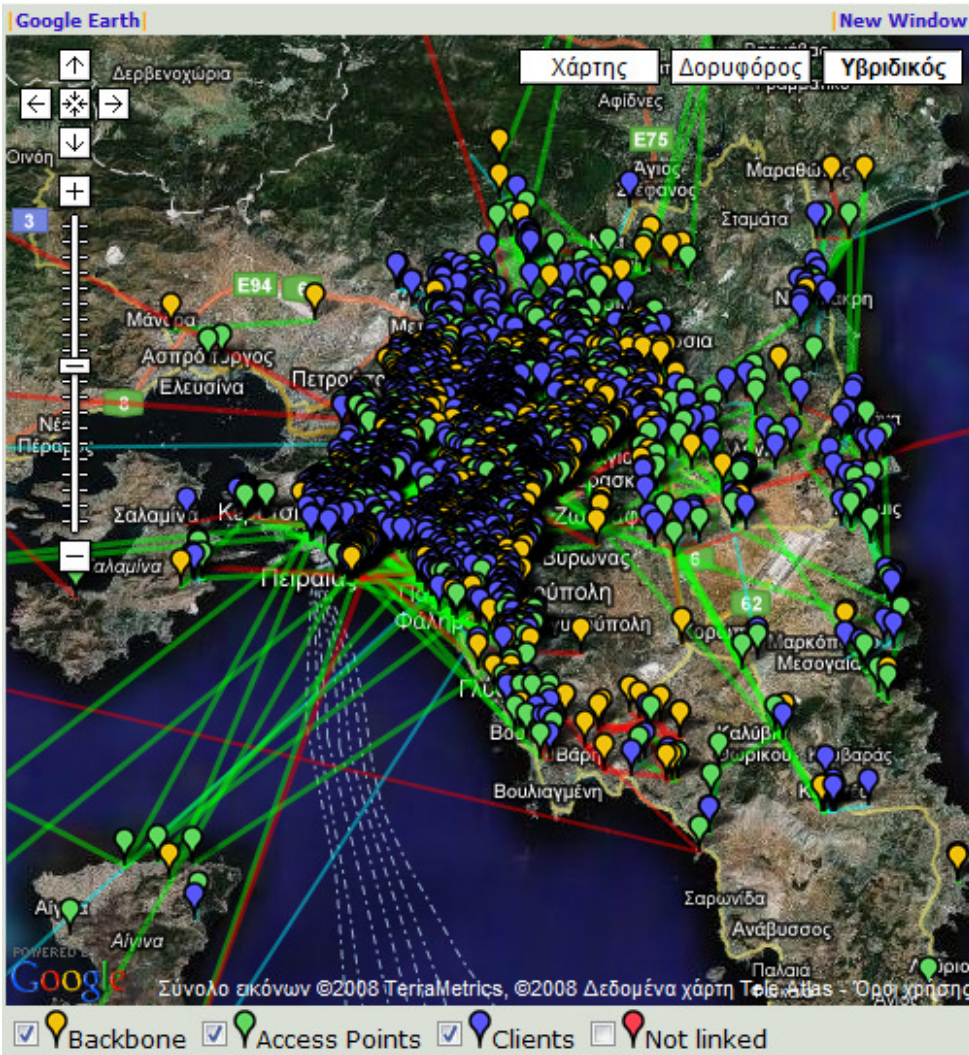
- Birth [late 90s, early 00s]
 - ◆ Fixed broadband: **expensive** and **scarce**
 - ◆ Experiments with Wi-Fi-based long distance links
 - ◆ First WCNs:
 - SeattleWireless (2000)
 - NYCWireless (2001)
 - Athens Wireless Metropolitan Network (2002)
 - ◆ In Greece: community-wide broadband services in the dial-up era!
- Growth factors
 - ◆ Low broadband penetration
 - ◆ Enthusiasm in the academic community
 - Universities deploy/participate in WCNs for experimentation
 - ◆ New Wi-Fi standards: 802.11a
 - Higher throughput, less interference → more interfaces per node
 - Replaced 802.11b at the backhaul

Some numbers...

Seattle Wireless	Seattle, US	75 nodes	Mesh
AWMN	Athens, GR	2331 nodes	Mesh
CUWiN	Urbana, US	48 nodes	Mesh
Berlin's Freifunk	Berlin, DE	316 nodes	Mesh
NYCWireless	NYC, US	149 nodes	Hotspot-based
Wireless Philadelphia	Philadelphia, US	15 miles ²	Hotspot-based
FON	Worldwide	~210 000 registered APs	Hotspot-based



Athens Wireless Metropolitan Network



- among the largest, globally
 - ◆ 2331 active nodes
 - ◆ 2786 links
 - ◆ 791 active services
- **Node #66 @ MMLab**



WCN internals

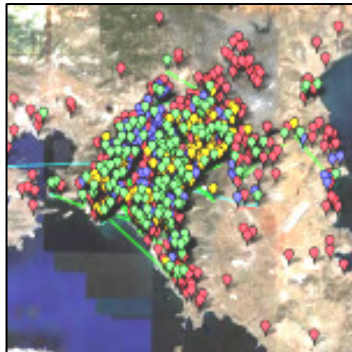
- Incentives for participation
 - ◆ Altruism – “Warm glow” effect
 - ◆ Promise of Wi-Fi access when mobile
- Enforcing contribution and compliance
 - ◆ Implicit or explicit rules in the community
 - ◆ Fear of exclusion
 - ◆ PtP link maintenance: “tit-for-tat”
 - ◆ Exclusion is easy for mesh → isolate a node by tearing down all links to it
- Building reputation
 - ◆ Contributing to collective knowledge/expertise
 - ◆ Contributing to the routing process
 - Usually nodes with many interfaces – “hubs”
 - ◆ Senior community members have better standing

The future of WCNs

- Everyone has broadband...
- ...but not when mobile
- Wi-Fi ships with many handhelds



- 3G costs are higher
- Full (?) Wi-Fi coverage in metro areas



- W(LA)Ns: An alternative to cellular
 - ◆ Faster
 - ◆ < max RF power: 100 - 200 mW
 - ◆ Handovers an issue
 - ...but not a problem for low-mobility video, audio, browsing
- The character of WCNs may change towards mobile network access
- What do we need?
 - ◆ Incentives for participation
 - ◆ Incentives/techniques for Wi-Fi sharing

Can WCNs rival cellular?

- Based on coverage:
 - ◆ Yes, in densely populated urban areas
- Low-cost, best-effort alternative to 2.5G/3G
- Legal issues should be considered
 - ◆ ISP Acceptable Use Policies for Wi-Fi sharing
- Is altruism enough?
 - ◆ Residential WLANs typically closed (secured)
 - ◆ Direct and indirect costs in Wi-Fi sharing
 - ◆ Need incentives

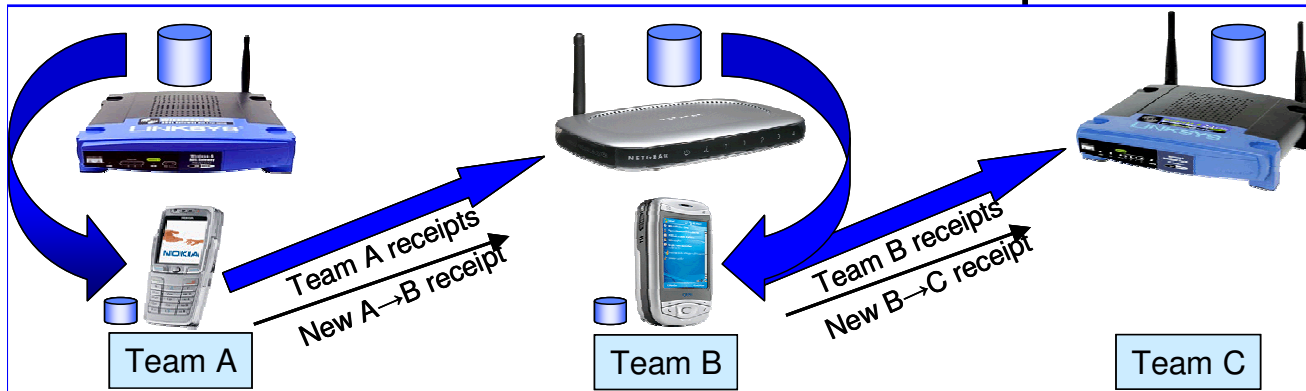
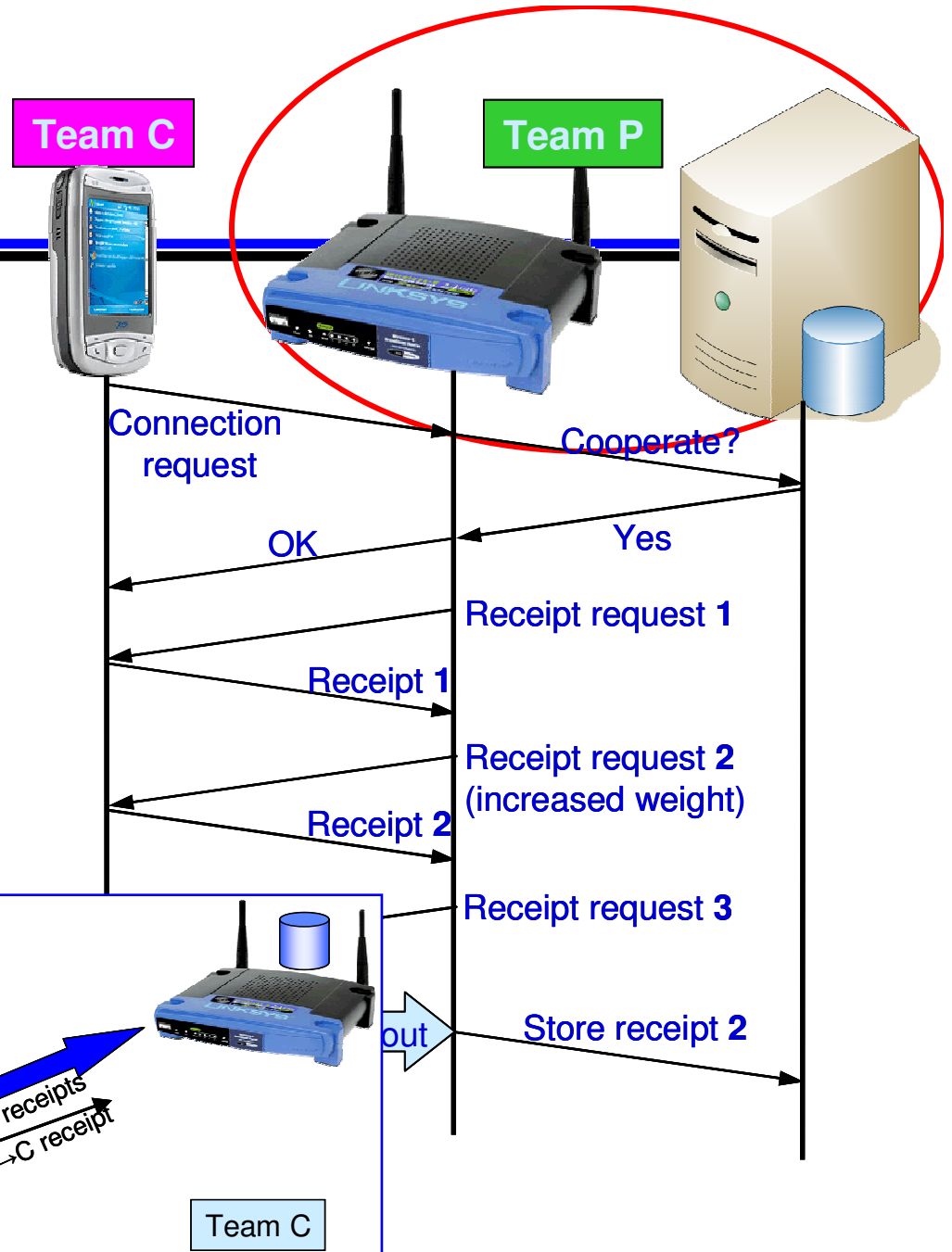
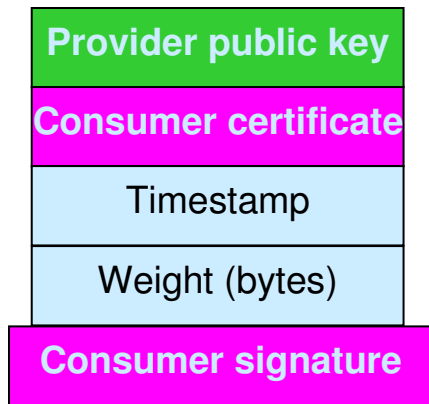
Our approach: sharing Wi-Fi P2P-style

- P2P Wireless Network Confederation (P2PWNC)
 - ◆ A Wi-Fi sharing community
- Rely on **reciprocity**
 - ◆ Users set up their APs for public access
 - ◆ Get access to other peers' APs when mobile
 - ◆ Access opportunities and QoS proportional to their contribution
- No central authorities
 - ◆ Users identified by self-certified public-private key pairs
- Accounting based on the exchange of digital "**receipts**"
 - ◆ Receipt: proof of transaction signed by client
 - ◆ Distributed accounting: each peer stores receipts
- Implementable on common WLAN equipment
 - ◆ Linux-based AP
 - ◆ Smartphones, PDAs

P2PWNC Receipts & Gossiping

P2PWNC receipts

- ◆ Proof of prior contribution





Thanks!

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