Structure and Evolution of a Large-Scale Wireless Community Network

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Wireless Nets in Metropolitan Areas…

- “Ubiquitous” Wi-Fi coverage in metropolitan areas
- Infrastructures based on Wi-Fi for public Internet access
- Wireless Community Networks
  * wireless mesh networks
  * organized by radio enthusiasts
  * cover metropolitan areas
  * numerous WCNs around the world
  * Athens Wireless Metropolitan Network
    * one of the largest
Athens Wireless Metropolitan Network

- among the largest, globally
  - 2010 active nodes
  - 2354 links
  - 655 active services

- Node #66 @ MMlab
Investigation

- Our results come from
  - Information stored in WiND database
    - Wireless Node Database
    - available on the Internet
    - stores data about nodes, links, services
  - Measurements that we made from our AWMN node (aueb|mmlab, #66)
    - measurements were repeated on 5 different days and at different times

- We investigate divergences between the two sources
Number of Nodes in AWMN

- Many client nodes connect temporarily and are not always registered in the WiND database
- Backbone nodes are always registered and more stable
- Total number of nodes
  - 2369 according to our measurements
  - 2022 according to WiND
The size of AWMN has always been increasing
Number of newly registered nodes per year

- They started decreasing after 2006
- ADSL price decreased significantly during the same period

Expensive broadband connections were one of the major factors that encouraged the creation of AWMN.
Distances of the Links

- Most links have distance of about 1km
- Shortest link 8m
- Longest link 124km (!)
- Power is within bounds (20dBm)
- Some links extend to neighboring cities
Diameter of the Network

We ran traceroute commands from 5 different spots in Athens

- Diameter based on our traceroute is 9.5

Diameter was calculated according to the links registered in WiND

- Diameter based on WiND is 8.2
- Maybe more accurate, because it takes into account every link
Distribution of Clients (per Backbone Node)

- Many backbone nodes do not support any client nodes
  - Client nodes seen as not contributing much to the network
  - They increase its size and are potential future backbone nodes
Distribution of Links (per Backbone Node)

- The average out degree is 1.58
- Most backbone nodes have 3 links with other peers
- Connectedness and reliability
  - If one node fails, part of the network is not isolated, as there are often other links and alternative paths
Most Popular Services

- We examined whether some of the registered services are indeed provided.
- We noticed that the number of nodes that indeed provide a service is larger than the number registered in WiND.

- Proxy service (when a node shares its fixed broadband connection with the rest of the network) is not always for public use.
Topological Statistics of AWMN—Power Laws Comparison to the Internet during the 90s

- Attempted to model the AWMN topology through 3 power laws
  - Frequency of the Outdegree
  - Rank of the node in decreasing order of Outdegrees
  - Neighborhood size in specific hops
- They help us answer some important questions
  - What does AWMN look like?
  - Are there some topological properties that do not change in time?
  - How will it look like in a year?
- These power laws were identified for the Internet during the 90’s


- A potentially significant similarity(?) between the 2 networks
The frequency, $f_d$, of an outdegree, $d$, is proportional to the outdegree to the power of a constant, $\Theta$:

$$f_d \propto d^\Theta$$
Rank of the nodes in decreasing order of Outdegree

Power-Law 1 (rank exponent) The outdegree, $d_v$, of a node $v$, is proportional to the rank of the node, $r_v$, to the power of a constant, $\mathcal{R}$:

$$d_v \propto r_v^\mathcal{R}$$
Neighborhood Size at a specific Hops-count

Approximation 1 (hop-plot exponent) The total number of pairs of nodes, \( P(h) \), within \( h \) hops, is proportional to the number of hops to the power of a constant, \( \mathcal{H} \):

\[
P(h) \propto h^{\mathcal{H}}, \quad h \ll \delta
\]
Comparison to the Internet

- **Similarities**
  - AWMN resembles the Internet in addressing and routing
  - The services provided are a subset of those on the Internet
  - Free Services (all in AWMN, many on the Internet)
  - We have identified 3 Power Laws
    - that apply to the Internet topology during the 90s and
    - may be argued that they also apply to AMWN

- **Differences**
  - Internet is much larger than AMWN
  - ISP charges--AWMN participation is free
  - no central repository of information about the whole Internet, while there is WiND for AMWN
  - the Internet can be used for profit, while AWMN is always not-for-profit
Thanks!

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