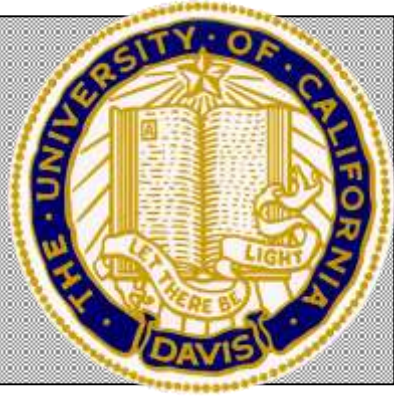
Network Laboratory – Wireless Research Group



HomeMesh: A Low-Cost Indoor Wireless Mesh for Home Networking

Presented By:
Eiman Alotaibi

The Authors are:
T. He, S.-H. G. Chan, and C.-F. Wong

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Outlines

- Introduction.
- HomeMesh System Architecture.
- HomeMesh Channel Assignment Algorithm.
- Access Path determination.
- Evaluation.
- Conclusion.

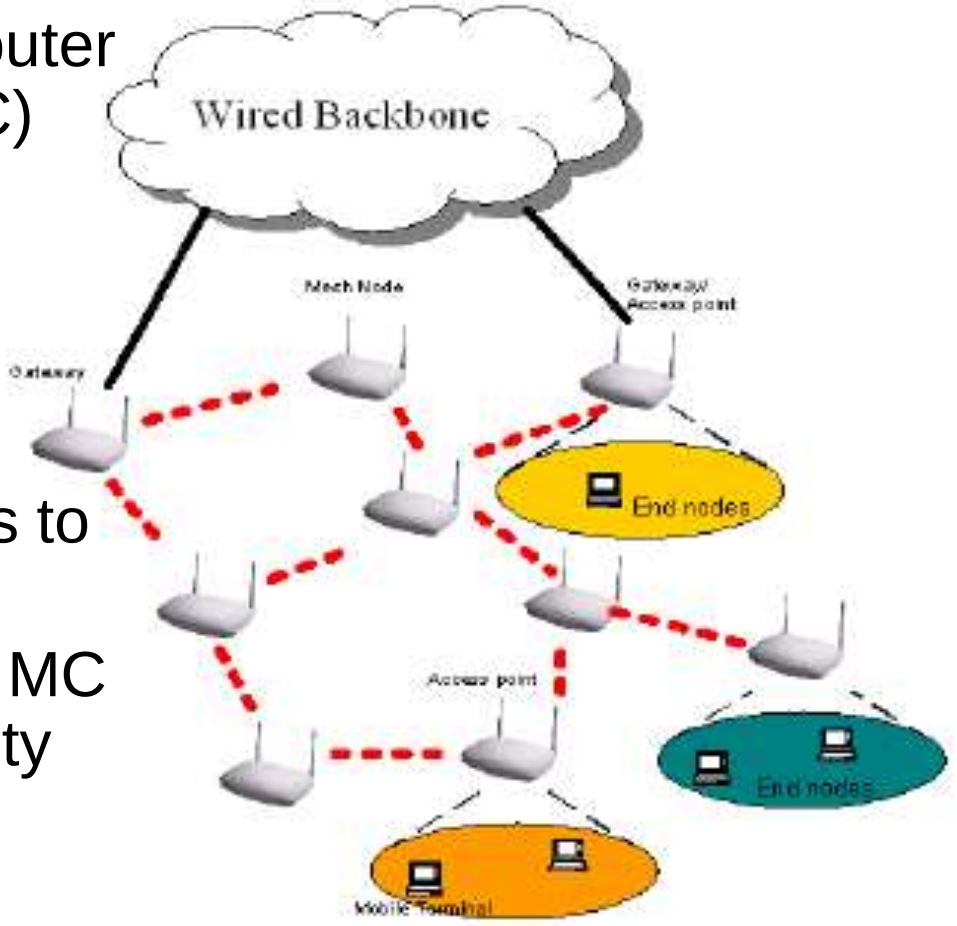
Introduction

- Wi-Fi (Wireless Fidelity) has become popular.
- Users gain wireless access to Internet via Wi-Fi.
- Wi-Fi deployment is limited to areas where wired LAN is available.
- Due to the short transmission range in indoor environment.
- Wireless Mesh Network (WMN) is a practical and efficient solution to extend the wireless coverage.

Introduction

- WMN consists of Mesh Router (MR) and Mesh Client (MC) nodes.

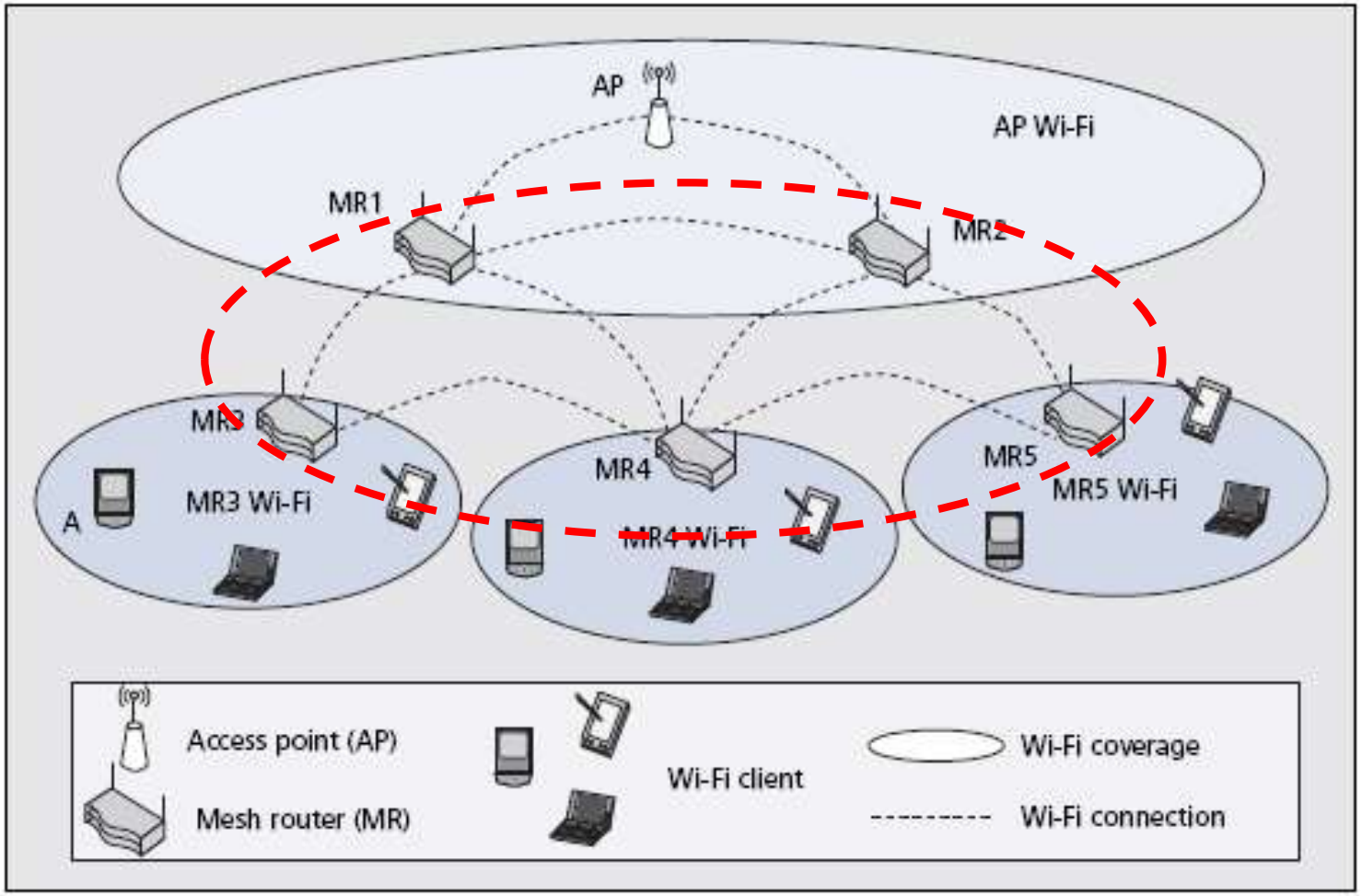
- MR:
  1. is the WMN Backbone.
  2. Provides wireless access to MC.
  3. Maintain connectivity for MC (routing) and WMN (security and load balancing).



Introduction

- WMN existing solutions are mainly industrial-based with complex algorithms and expensive hardware.
- HomeMesh proposes a simple and low-cost WMN solution for indoor home environment.
- HomeMesh achieves Wi-Fi extension by using nonproprietary off the shell technology.

HomeMesh System Architecture



HomeMesh System Architecture

- HMR has a traditional gateway/repeater functions in addition to routing functions.
- HMRs are built on general purpose computer systems and no extra hardware is required.

Strengths

- Wi-Fi coverage extension.
- Low deployment cost.
- Load balancing and fault tolerance.
- Compatible with existing Wi-Fi devices.

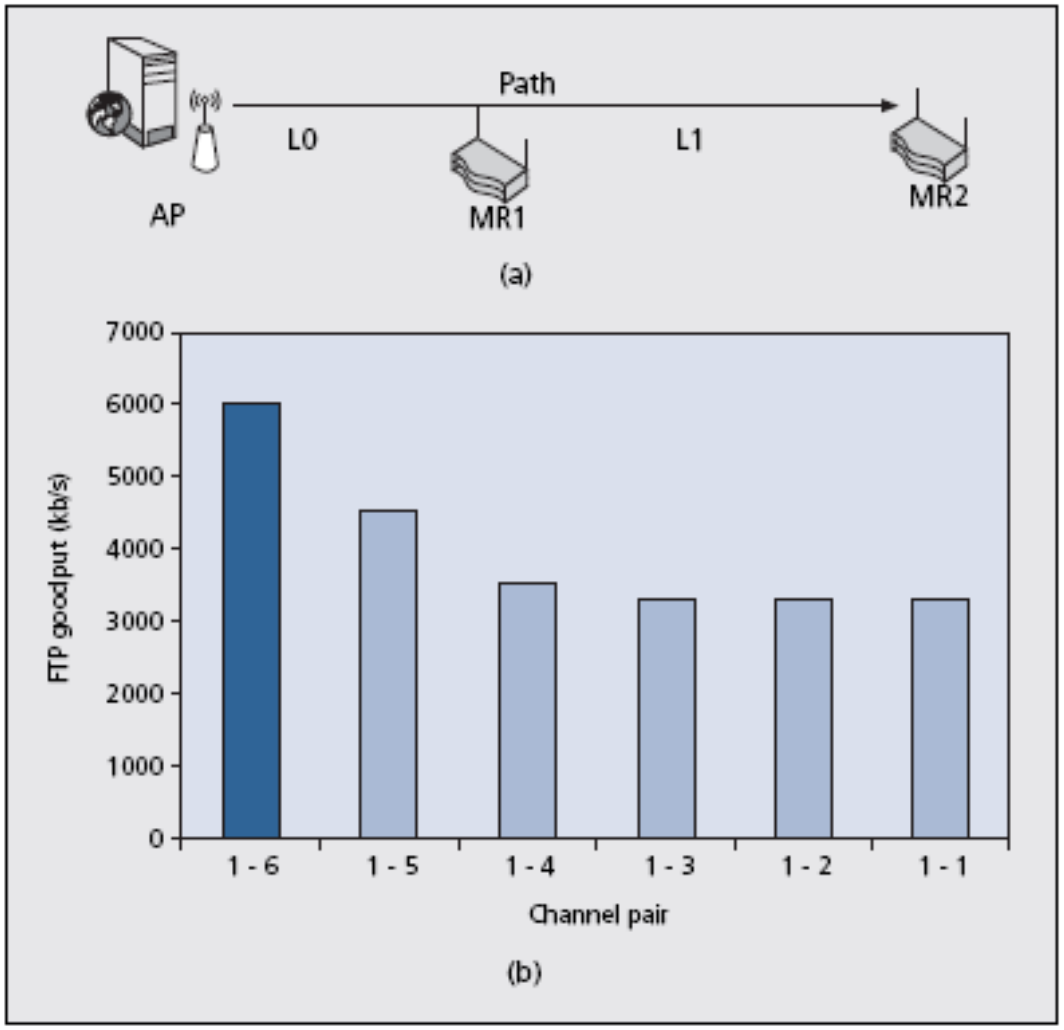
Comparison

	Hyacinth	Meraki	HomeMesh
Hardware requirement	Existing PC/notebook	Need new mesh routers	Existing PC/notebook
Deployment cost	Low	Medium	Low
MAC layer modification	No	Yes	No
Radio channel	Multiple	Single	Multiple
Channel assignment	Complicated	Simple	Simple
Routing overhead	Relatively High	Relatively low	Relatively low
System management	Centralized	Distributed	Distributed

HomeMesh CA Algorithm

- Each HMR has two radios (wireless interfaces).
- Each HMR operates on two orthogonal channels.
- No channel can be used by two consequence links.
- Simple, efficient and practical CA.
- Wireless connectivity! (not discussed).

HomeMesh CA Algorithm



Access Path Determination

Path selection:

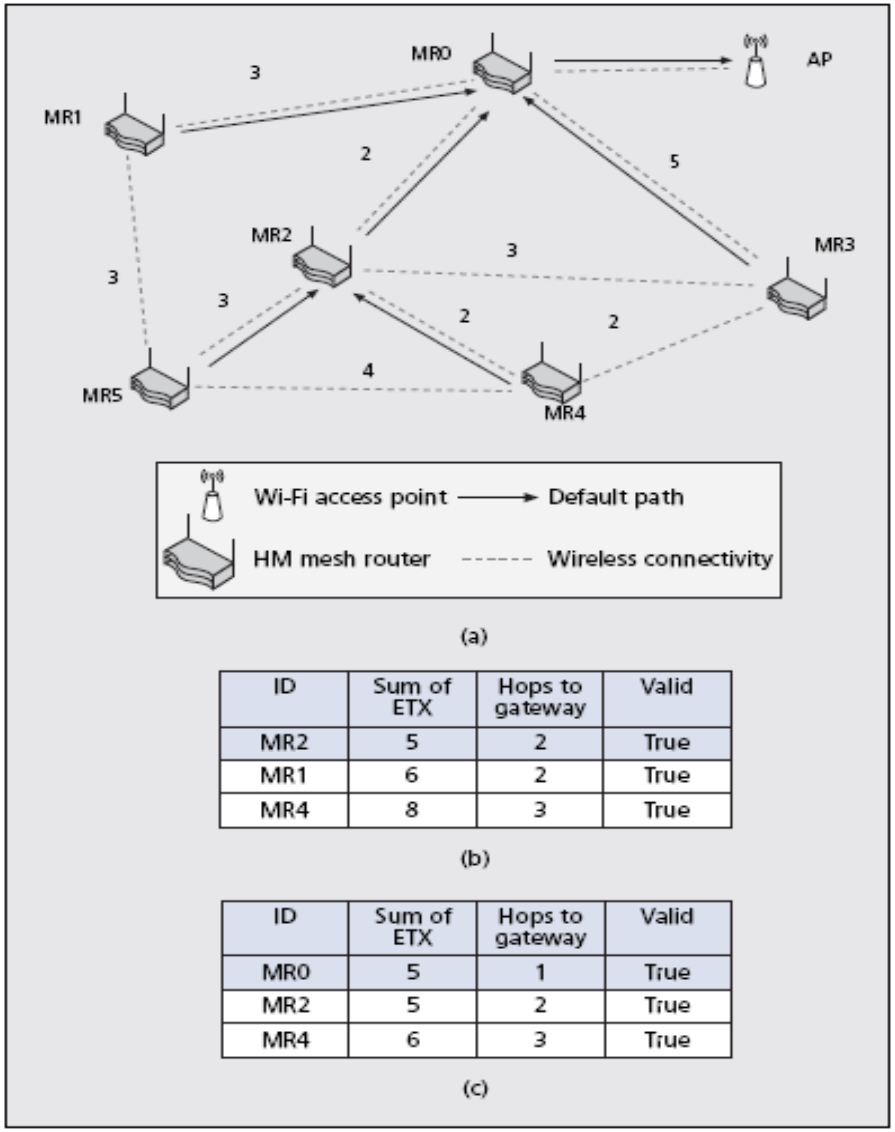
- The access path of each HMR to the Internet is formed dynamically based on ETX hop metric.
- ETX: Expected Transmission Count.
- ETX calculates number of transmissions including retransmissions.
- HomeMesh may use ETT, WCETT, or others.

Access Path Determination

Mesh Routing Table:

- Exchange messages to update data.
- Broadcast interval can be defined by users.
- HMR maintains a soft-state table contains list of HMRs within its transmission range.
- When two paths have same ETX, hop cout is used.

Access Path Determination



(a)

ID	Sum of ETX	Hops to gateway	Valid
MR2	5	2	True
MR1	6	2	True
MR4	8	3	True

(b)

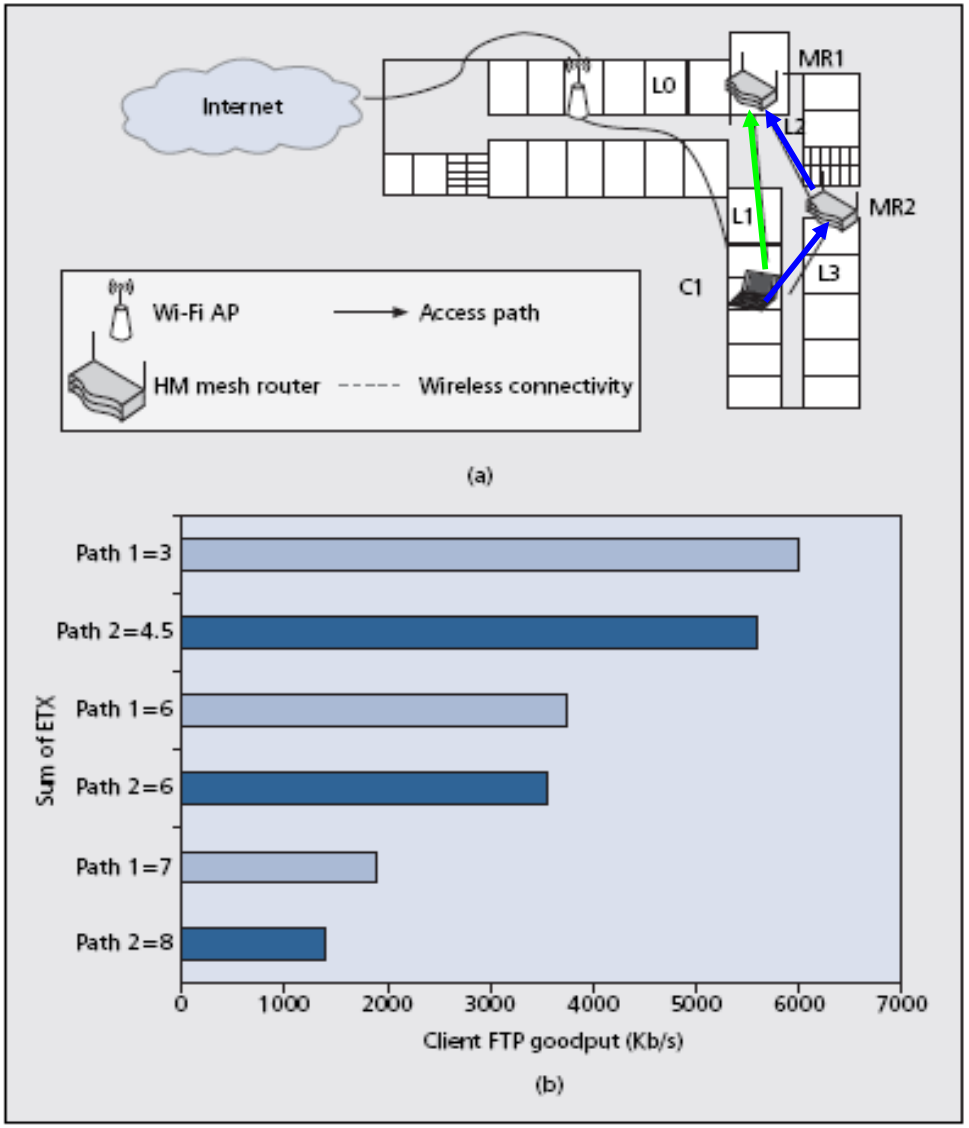
ID	Sum of ETX	Hops to gateway	Valid
MR0	5	1	True
MR2	5	2	True
MR4	6	3	True

(c)

Evaluation

- MadWi-Fi is used to manipulate the master mode radio.
- Linux for configuration.
- PC → HMR: run HomeMesh script in the user space →initialize the HMR table.
- Wireless card is the only hardware required.

Evaluation



Path-1
Path-2

Conclusion

- Wireless mesh networks can effectively extend Wi-Fi coverage.
- Most of the proposed and implemented solutions are industry-oriented, with high power consumption, and require expensive hardware.
- HomeMesh, a practical and cost-effective implementation of a WMN that extends Wi-Fi coverage in the home environment.
- The router protocol is simple and lightweight, and may be installed on any desktop PC or notebook.
- The HMRs are compatible with the existing Wi-Fi products, and therefore are transparent to APs and mobile clients.
- HMRs dynamically select the access path to the Internet.

Q & A

Thank you.

ETX Routing Metric (MIT03)

- Present High throughput routing metric on Multi-hop wireless networks
- Expected Transmission Count (ETX)
- Useful with long paths and scalable network.
- ETX is Implemented as a metric for DSDV and DSR.
- Single radio Nodes.

ETX Routing Metric (MIT03)

- ETX= the expected number of transmissions, including retransmissions, needed to send a packet across a link.
- Let

  p_f = Probability of packet loss in the **forward** direction.

  p_r = Probability of packet loss in the **reverse** direction

  p = Probability of packet transmission from x to y NOT successful.

  $$\mathbf{p= 1-(1- p_f)(1- p_r)}$$

- Let S(k) = Pr{ the packet will be successfully delivered from *x* to *y* after *k* attempts} = $p^{k-1}(1-p)$

$$ETX = \sum_{k=0}^{\infty} k \times S(k) = \frac{1}{1-p}$$

ETX Routing Metric (MIT03)

- The **path metric** is defined as the sum of the ETX values of each length.

- **Assumptions made for ETX:**

1. Prob. A given packet transmission is independent of its size and it is iid.
2. ETX is bidirectional
3. ETX based on the loss rate but not link BW.

- ETX does well in **homogenous single-radio** case.

- ETX **DOES NOT** perform well in an environment with different rates and multiple radios.