Wireless Networking in the Open Source Community

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Overview of Talk

- **History and motivation**
- **Atheros Project (that drove work)**
- **Net80211 Layer (main result)**
- **What worked: "The Good"**
- **What did not work: "The Bad"**
- **Conclusions and Future Work**

Personal History

- **Giving away software for many years**
- **Responsible for 4.2BSD while at UCB**
- **Part of many free software efforts while working at Lucasfilm, Pixar, SGI, VMware**
- **Committer to FreeBSD and NetBSD**
- **Working on networking for 25+ years**
  ⇒ wireless networks for last 5+ years

LinuxForum 2007
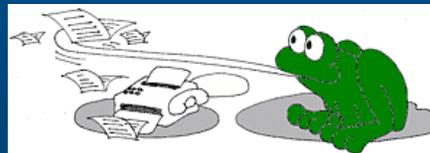
Background

- **Original motivation: point-to-point link between Berkeley and San Francisco**

- **Secondary motivation: community wireless ("mesh networks")**

- **Project started 2001**

Why Atheros?

- **Intersil Prism too limited**
- **Best wireless technology:**
  - **First with 11a (5GHz) parts**
  - **Well-designed MAC architecture**
  - **Superior radio technology**
- **Very supportive of open source and research communities**
- **Personal ties ⇒ good relationship**

Atheros Project: Goals

- **Free driver for open source users and especially researchers**

- **Expose as much hardware functionality as possible: "if you can't do what you want, then ask"**

- **Production quality: supplant Prism as de-facto wireless card**

REGULATORY COMPLIANCE...

Must observe local regulations

Atheros Project: Participation

- **Solicited all groups before starting:**
  - **FreeBSD (Sam Leffler)**
  - **NetBSD (David Young)**
  - **DragonFlyBSD (did not exist)**
  - **OpenSolaris (did not exist)**
  - **OpenBSD ("wait and see")**
  - **Linux …**
- **BSD license to encourage commercial use**
- **Dual-BSD/GPL to enable Linux adoption**

Atheros Project: Linux Story

- **In 2002 it was hard to find wireless developers:**
  - **Lack experience (get bogged down), or**
  - **Lack focus (easily distracted), or**
  - **Unwilling to participate**
  - $\Rightarrow$ ***Less true today***

- **No 802.11 infrastructure made work harder**

IN THE END...

I did the work that became madwifi

Net80211 Layer

- **Device-independent 802.11 support:**
  - **Multi-band: 802.11b, 802.11g, 802.11a**
  - **Station, Adhoc, HostAP, Monitor modes**
  - **Security protocols: WPA, 802.11i**
  - **Multimedia protocols: WME/WMM, QoS**
  - **Scanning and roaming (bg scanning)**
  - **Common management API (ioctls)**

Needed for Atheros devices

Net80211 Layer: Multi-BSS

- Multi-BSS (virtual AP) support
  - Virtualize wireless device
  - Multiple BSS on a single radio:
    - Mutiple access points with different security; e.g. wireless hotspot with open AP and WPA AP
    - Multiple stations; useful for testing
  - Mixed operating mode usage:
    - AP + station = wireless repeater
    - AP + mesh node = mesh AP

Major paradigm shift…

Net80211-based Drivers

- **Support for any 802.11 device:**
  - **From: firmware-based devices such as Prism, Cisco, Intel, Broadcom, Marvell**
  - **To: "Soft MAC" devices such as Atheros, Ralink, Realtek, ZyDAS, ADMTek**
- **PCI, Cardbus, PCMCIA, USB**
- **Drivers "fall back" on the net80211 layer for support: 802.11 protocols, crypto, authentication**

Net80211-based Drivers (cont)

- Uniform/common management interface
- Drivers smaller and easier to write; e.g.

Intel 2195/2200 driver:
ipw2200.c (Linux 2.6.15.6): 11297 lines
if_lwi.c (FreeBSD 7.x): 3521 lines (~70% smaller)

Intel 3945 driver:
ipw3945.c (version 1.2.0): 16934 lines
origin/base.c (iwlwifi 0.0.9): 12992 lines
lf_wpi.c (FreeBSD 7.x): 2995 lines

Net80211 Layer: Development

- **Original version by Atsushi Onoe (~2001)**
- **Multi-mode device support (2002-2003)**
- **Security protocols (Summer 2004)**
- **Multimedia extensions (Fall 2004)**
- **Multi-BSS support (Spring 2005)**

Work of many people on many platforms

Net80211 Layer: Adoption

- **net80211 + drivers in all BSD systems**
- **Linux users have madwifi and a few other projects use net80211**
- **Commercial applications (see later)**

What worked: "The Good"

- **WPA/802.11i support**
  - **Supplicant and authenticator "out of the box"**
  - **Enables enterprise-use of distributions**
  - **Mostly work of Jouni Malinen**
- **Multi-BSS support**
  - **Raises the bar for others (both commercial and open source--e.g. Linux)**
- **Radiotap**
  - **Finally a common format for tools (ethereal, tcpdump, kismet, etc)**

The Good: Vendor Push

- ## *The Carrot*:
  - net80211 reduces development time so it is less expensive to provide good drivers
  - Atheros cooperation provides an example for other h/w vendors:
    - "Look Atheros did it, you can too"
- ## *The Stick*:
  - Atheros support motivates other h/w vendors:
    - "They'll use Atheros if you do nothing"

  - net80211 work has also motivated s/w vendors

The Good: Research

- **Boon to wireless research and community/mesh networks**
  - **MIT Roofnet: http://pdos.csail.mit.edu/roofnet/doku.php**
  - **UC Berkeley TIER: http://tier.cs.berkeley.edu/**
  - **UC San Diego Jigsaw**
  - **CUWin: http://cuwireless.net/**

  many others…

The Good: Commercial Use

Desktop/Laptop users: Apple

http://blogs.zdnet.com/images/macbook-pro-unboxing-24.jpg

The Good: Commercial Use

Consumer Appliances: Sonos, 2Wire

http://www.sonos.com

http://www.2wire.com

The Good: Commercial Use

Access Points: **Apple, D-Link, Netgear, Proxim, Sony, etc.**

http://gizmodo.com

http://www.netgear.com

http://www.dlink.com

The Good: Commercial Use

Mesh Networks: **Meraki, SkyPilot**

http://meraki.net

http://www.skypilot.com
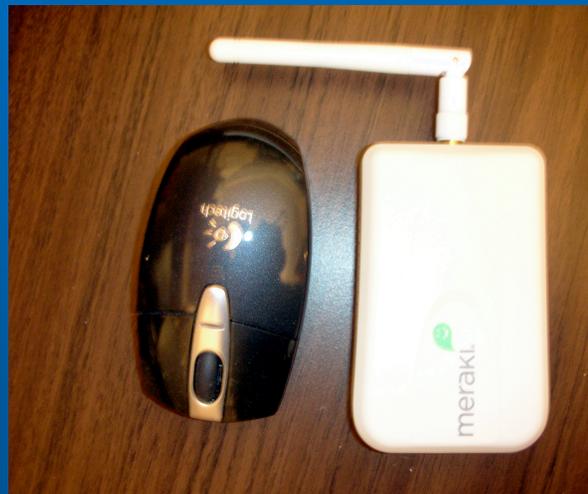
What did not work: "The Bad"

- **Linux misunderstandings:**
  - **"BSD code"**
  - **"BSD license"**

  There aren't enough wireless developers to not work together.

Conclusions:

- **Very large project, much bigger than anticipated**
- **Requires vendor involvement (equipment, compliance testing)**
- **Requires multiple clueful people**

Conclusions: Future Work

- **Current software very stable but there are missing pieces:**
  - **More drivers (varies by system)**
  - **Better transmit rate control**
  - **Station mode UI support (OS X)**
  - **Analysis and testing support (diagnosing problems is very hard)**
  - **More vendor buy-in; e.g. Broadcom, Marvell**
- **802.11n is here!**

http://www.freebsd.org/~sam/LinuxForum2007.pdf