

# Wireless Networking in the Open Source Community

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# Overview of Talk

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- **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 networks for 25+ years  
⇒ wireless networks for last 5+ years

# Background

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- Original motivation: point-to-point link between Berkeley and SF (bandwidth sharing)
- Secondary motivation: community wireless (“mesh networks”)
- Project started 2001

# More Background

- **First came Soekris support:**
  - hardware crypto
  - Fast IPsec
- **Now what about wireless?**
  - Intersil Prism ruled out
  - Enter Atheros

# Why Atheros?

- **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  $\Rightarrow$  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, ask”**
- **Production quality: supplant Prism as de-facto wireless card**

## **REGULATORY COMPLIANCE...**

**Must observe local regulations; especially because of AP support.**

# Atheros Project: Participation

- **Solicited all groups before starting:**
  - FreeBSD (Sam Leffler)
  - NetBSD (David Young)
  - OpenBSD ...
  - Linux ...
  - Open Solaris (did not exist then)
- **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

⇒ *Less true today*
- No 802.11 infrastructure made work harder

IN THE END...

I did the work that became madwifi

# Atheros Project: OpenBSD Story

- “We’ll wait and see...”
- Eventually chose to go their own way

**IN THE END...**

**Minimal support for a few cards**

# Net80211 Layer

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

**Needed for Atheros devices**

# Net80211 Layer: Multi-BSS

- **Multi-BSS (virtual AP) support**
  - **Virtualize wireless device**
  - **Multiple BSS on a single radio:**
    - **Multiple 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**
  - **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 significantly smaller and easier to write;**  
e.g. Intel 2195/2200 driver:
  - lpw2200.c (Linux 2.6.15.6): 11297 lines**
  - lf\_lwi.c (FreeBSD 7.x): 3521 lines (~70% smaller)**

# 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 (cont)

- **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 to contribute

# The Good (cont)

- 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 (cont)

- **Commercial adoption**
  - **Desktop/Laptop users: SuSE, Apple**
  - **Consumer appliances: Sonos, D-Link**
  - **Access points, wireless routers, etc: D-Link, 2Wire, Sony, Colubris Networks, NetGear**
  - **Mesh nodes: Meraki Networks**  
**many others...**

# What did not work: “The Bad”

- **Linux misunderstandings:**
  - “BSD code”
  - “BSD license”

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

# What did not work: “The Ugly”

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- **There have been some painful disagreements: open source zealots don't mix well with real life**

# Conclusions:

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- **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
  - Raw 802.11 packet transmit (madwifi)
  - Station mode UI support (OS X)
  - Analysis and testing support (diagnosing problems is very hard)
  - More vendor buy-in; e.g. Broadcom, Marvell
- **Looming on the horizon is 802.11n**



