GPL enforcement and customer benefits: Evidence from OpenWRT

Do Yoon Kim

LibrePlanet 2019

A bit about myself…

- Graduate student studying innovation and digitization
- Not a programmer by training
- Data collection and analysis – observations

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- Principles, strategies, and tactics

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  - Copyleft (GPL) is a strategy to get to these four freedoms, not a principle unto itself
- Tactic: GPL enforcement… but how?

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- Opponents: Legal action is uncecessary
  - Many others…

Diverging opinions

In the ensuing discussion, Bradley Kuhn, President of the SFC wrote, "In the last 10 years brought something that never occurred before with any other copylefted code. Specifically, with Linux, we find both major and minor industry players determined to violate the GPL, on purpose, and refuse to comply, and tell us to our faces: "you think that we have to follow the GPL? OK, then take us to Court. We won't comply otherwise."" Therefore, Kuhn reasons, "In response, we have two options: we can all decide to give up on the GPL, or we can enforce it in Courts."

It's that last part, which drew Torvalds's ire. Greg Kroah-Hartman, a leading Linux developer and maintainer of the Linux stable branch, however, started the heat. Kroah-Hartman wrote:

> I call bullshit on this.
>
> And frankly, I'm tired of hearing it, as it's completely incorrect and trivializes the effort that thousands of people have been doing for 25+ years to preserve the rights that the GPL grants us.
>
> ...
>
> I have NEVER said I oppose "GPL enforcement", I will say that I oppose the way that _you_ approach this task.
>
> And here is why.
>
> I too have had people say to my face, numerous times, "you think that we have to follow the GPL? OK, then take us to Court. We won't comply otherwise." And guess what, no one took anyone to court, and every single time, I ended up with the code. As you well know, when you take legal action against someone, you have to be prepared to lose, and accept the consequences of that loss.
>
> Frankly, I am not prepared to lose, and there is no way in hell that I am willing to accept the consequences of such a loss.

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- Different people, different variables of interest
- Free software advocates are mostly interested in **users' freedom**
- Others seem to be most interested in **"more" code**

The most shining moment for the SFC - hey, it's the lead-in on the wikipedia page - was the GPL compliance enforcement for BusyBox.

And let us not kid ourselves. That may be the shining moment for SFC, but it was *not* a shining moment for BusyBox.

I'm not aware of anybody but the lawyers and crazy people that were happy about how the BusyBox situation ended up. Please pipe up if you actually know differently. All it resulted in was a huge amount of bickering, and both individual and commercial developers and users fleeing in droves. Botht he original maintainer and the maintainer that started the lawsuits ended up publicly saying it was a disaster.

So I think the whole GPL enforcement issue is absolutely something that should be discussed, but it should be discussed with the working title

"Lawyers: poisonous to openness, poisonous to community, poisonous to projects".

RE: PLEASE DO YOUR HOMEWORK FIRST

DATE: 2012-01-31 04:13 PM (UTC)

FROM: LANDLEY.LIVEJOURNAL.COM

Since I'm not the only copyright holder of busybox, I can't STOP the SFLC suing people over it. I added affirmative defenses to the BusyBox license page:

http://busybox.net/license.html

But that didn't stop them from creating a self-funding legal machine where they NEVER found any actual useful code that should have gone upstream, but they still demanded $15k or so in legal fees each time so they could go sue the NEXT company.

My current employer is doing videoconferencing systems based on Android, and has specifically forbid its engineers from shipping any GPL code in userspace, because it's just too legally dangerous. After the SFLC went _back_ after Cisco five years after the first settlement, no amount of "compliance" effort is considered sufficient. The GPL has been _poisoned_ by the actions of the FSF and the SFLC.

http://landley.net/notes-2011.html#16-12-2011

I'm sad this happened, but I'm not going to put on a "Han Shot First!" T-shirt and defend the glorious past. I'm going to distance myself from the crazy and rebuild.

LINK REPLY THREAD FROM START PARENT THREAD HIDE 3 COMMENTS

November 13, 2011

I'm trying to decide whether to relicense Toybox under the OpenBSD 2 clause license, or under Creative Commons Zero. The first is the simplest option, the second would maximally piss off "RMS lite" (I.E. Bruce Fscking Perens) in a "hey, Project Gutenberg predates the FSF by many years you irrelevant waste of oxygen" way. (Yes, I am still bitter.)

Tim Bird poked me a couple days ago wondering if I was interested in working on a competitor to busybox. I reminded him that I spent over a year doing that, and he went "oh".

The problem Tim's dealing with is Android's "no GPL in userspace" edict. Google and a bunch of other companies responded to GPLv3 the same way I did (DEATH FIRST). The Jar-Jar Binks of licenses overshadowed the original, the same way the second and third Matrix Movies made the first one less memorable, even before the FSF and SFLC teamed up to go Cisco/Linksys out of the Linux business (Mepis II) in what can only be described as a Tom Cruise jumping on a couch style "career limiting moment". All this had knock-on effects elsewhere (such as spawning LLVM and PCC development projects, to replace gcc).

From a purely pragmatic perspective: I spent over a year doing busybox license enforcement, and a dozen lawsuits later I'm still unaware of a SINGLE LINE OF CODE added to the busybox repository as a result of this, unless you count this:

```
commit eb84a42fdd1d1c2e228dcd691a67b8ad5eeda026
Author: Rob Landley
Date:   Wed Sep 20 21:41:13 2006 +0000

    The Software Freedom Law Center wants us to add a copyright notice to the
    generated binaries, to make copyright enforcement easier.  Our liason with
    them (Bradley Kuhn) suggested the following text:
```

(Broad) research questions

- Has GPL enforcement ever led to “upstreamable code”?
- How does GPL enforcement help users?

In this talk…

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- I will NOT…
  - Give a definite answer as to whether GPL enforcement should/should not involve lawsuits…
  - Answer whether GPL enforcement via lawsuits (as opposed to other forms of enforcement) leads to more code upstream / more users' freedom.

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  - Talk about other ways in which measurement and statistical analyses can help the free software cause

Outline

1. Introduction
2. Theoretical background
3. Background of the Cisco/Linksys GPL violation
4. Data collection
5. Empirical analysis
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  - *Note, IP has many different types
    - Copyright
    - Patent
    - Trademark
    - Trade secrets

Arguments for the protection of Intellectual Property

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from Noun Project

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"It is difficult for a potential buyer to assess the value of an idea before disclosure, but once the idea is known, the buyer has little incentive to pay" (Luo 2013)

Arguments for the protection of Intellectual Property

- Some empirical work
  - Patents enable startup growth (a major source of economic growth) via funding and employment (Farre-Mensa, Hegde, and Ljungqvist 2017)
  - Correlation between patent grants and its scientific importance (Kogan et al 2017)

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- Abuse of patent rights (e.g., patent trolls, patent thickets)
- Discourage follow-on innovation (Williams 2013; Murray and Stern 2007; Galasso and Schankerman 2015;)
- Different types of intellectual property call for different types of protection (RMS 2013; Luo 2014;)

Copyright enforcement and outcomes

- While litigation can help enforce copyright, it may deter existing or future customers away – a “chilling effect” (Galasso and Luo, 2018)

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- Litigation success rates can be improved both directly via increasing monetary threats (Fellner et al. 2013) and also by communicating more clearly the costs associated with the production of copyrighted material (Luo and Mortimer 2017)

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Linksys and the GPL (-2001)

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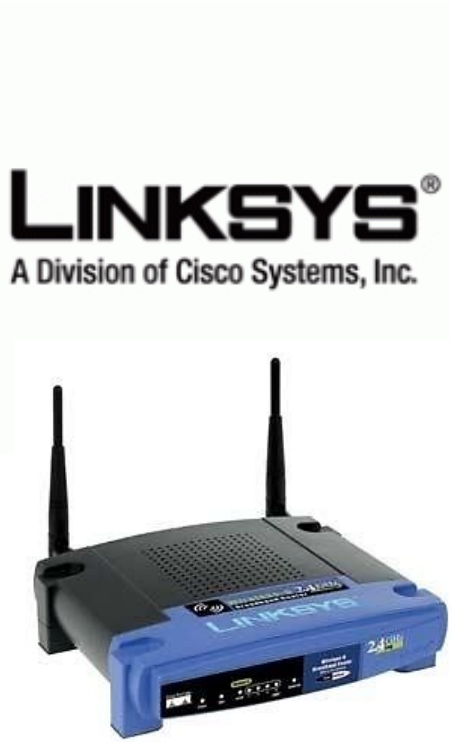

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CyberTAN → LINKSYS®
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- Mar 2003 – Cisco acquires Linksys

Linksys and the GPL (2003)

- Jun 2003 – LKML chain about WRT54g source code

From Andrew Miklas <>
Subject Linksys WRT54G and the GPL
Date Sat, 7 Jun 2003 22:41:23 -0400

share

Hi,

Sorry for the very lengthly posting, but I want to be as precise as possible in describing this problem.

Awhile ago, I mentioned that the Linksys WRT54G wireless access point used several GPL projects in its firmware, but did not seem to have any of the source available, or acknowledge the use of the GPLed software. Four weeks ago, I spoke with an employee at Linksys who confirmed that the system did use Linux, and also mentioned that he would work with his management to ensure that the source was released. Unfortunately, my e-mails to this individual over the past three weeks have gone unanswered. Of course, I also tried contacting Linksys through their common public e-mail accounts (pr@linksys.com, mailroom@linksys.com) to no avail.

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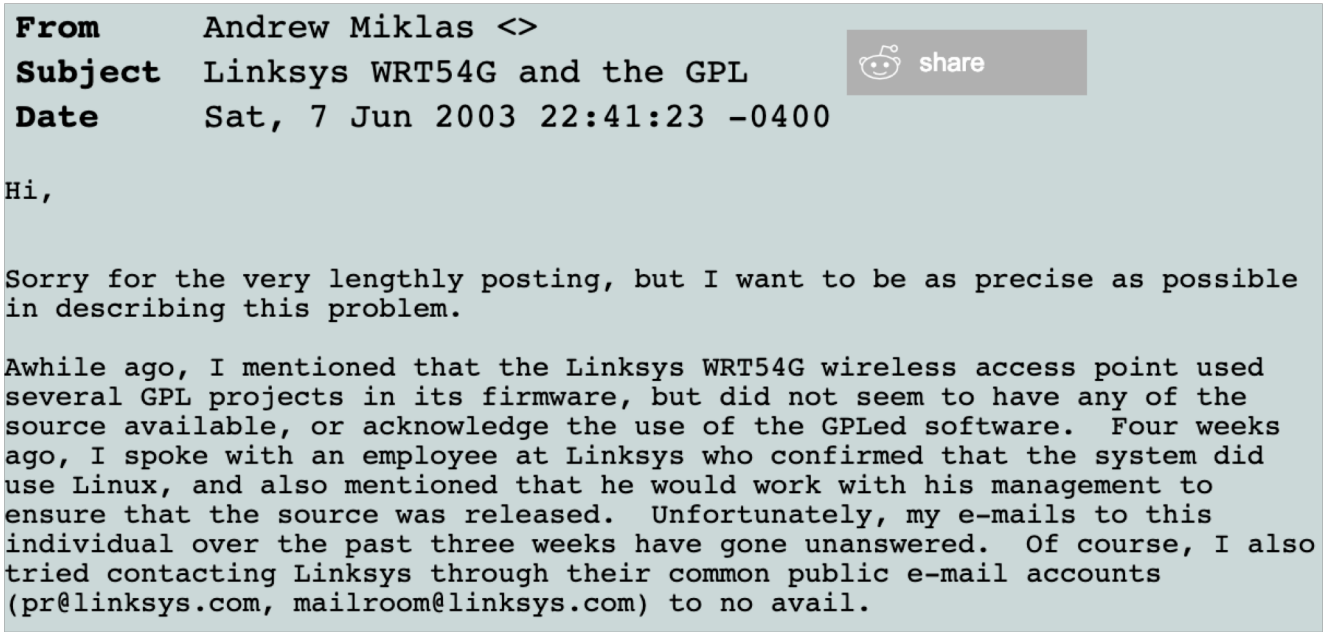

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- Jul 2003 – Linksys releases incomplete source code

Linksys and the GPL (2003)

- Sep 2003 – Another thread urging disclosure of source code

From Andrew Miklas <>
Subject Linksys WRT54G: Part 2
Date Sun, 28 Sep 2003 19:14:24 -0400

Hi,

A few months ago, I wrote to the kernel list describing the relationship between Linksys (now business unit of Cisco Systems), their WRT54G 802.11g wireless home gateway, and Linux. At the time, we had recently discovered that the WRT54G was using a great deal of software made available under the GPL, but was not giving credit to the authors, or providing the source as required by the GPL.

After a bit of public pressure, Linksys posted their "GPL Code Center" [1], where they claim that "the GPL source code contained in this product is available for free download" [2]. Shortly after the code center was made available, a group of developers pointed out to Linksys that their source code, particularly their Linux kernel code, was incomplete.

Linksys and the GPL (2003)

- Sep 2003 – FSF steps in to mediate

Linksys/Cisco GPL Violations

[Posted September 30, 2003 by corbet]

From: David Turner <novalis@fsf.org>
To: linux-kernel@vger.kernel.org
Subject: Linksys/Cisco GPL Violations
Date: 29 Sep 2003 14:22:47 -0400

To Linux Developers Concerned about the Linksys/Cisco GPL Violations:

We are in ongoing negotiating with Linksys/Cisco about this issue. Information from Andrew Miklas and others has been very helpful to us in our negotiations, and we encourage others to share with us any technical information about this or any other GPL violation.

Linksys and the GPL (2003-2018)

- Oct 2003 – Linksys releases more source code

LinkSys releases (some) source

[Posted October 10, 2003 by corbet]

In response to pressure from the community, LinkSys has released a new set of sources for the kernel running in its WRT54G wireless router; it can be downloaded from here. There is still some unhappiness, however, with this release: it does not include the wireless driver source. That driver is distributed as a separate loadable module and thus, according to some, does not fall under the requirements of the GPL. Others disagree however, and seem willing to continue pursuing their claims. Stay tuned.

- Jan 2004 – OpenWRT project started
  - 60,000+ commits, 500+ contributors

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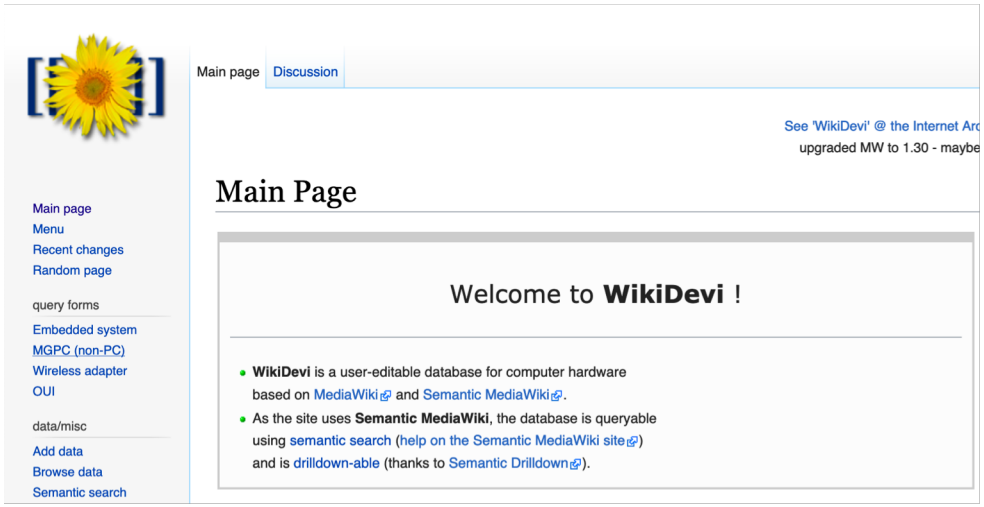

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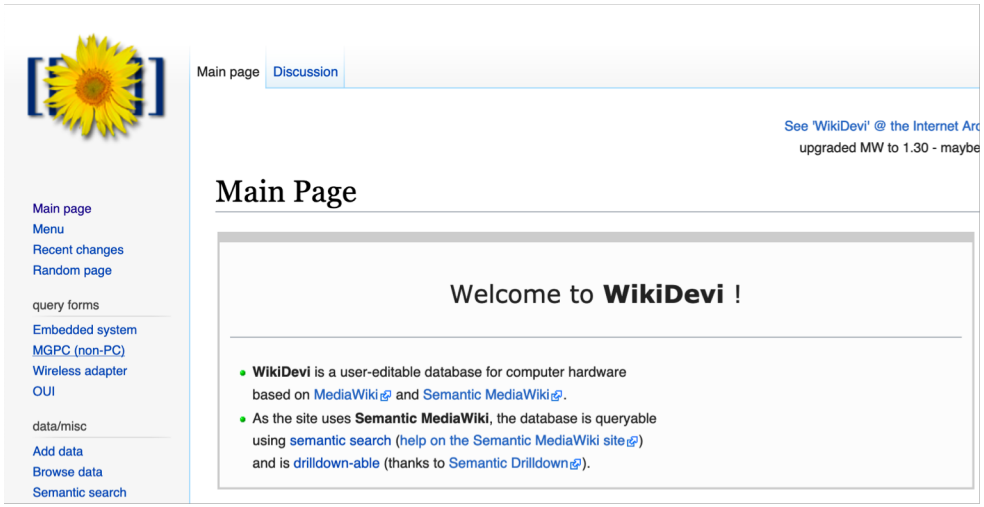

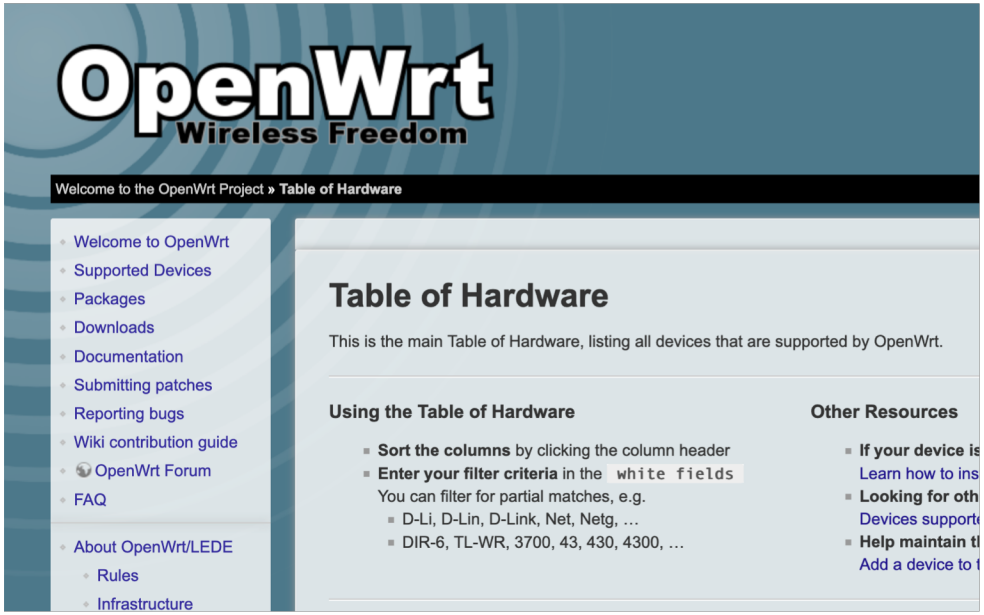

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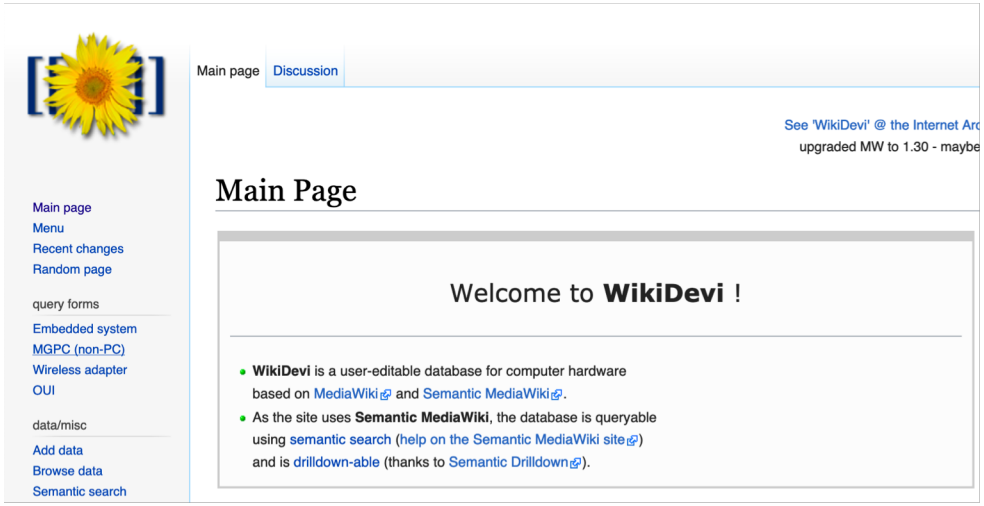
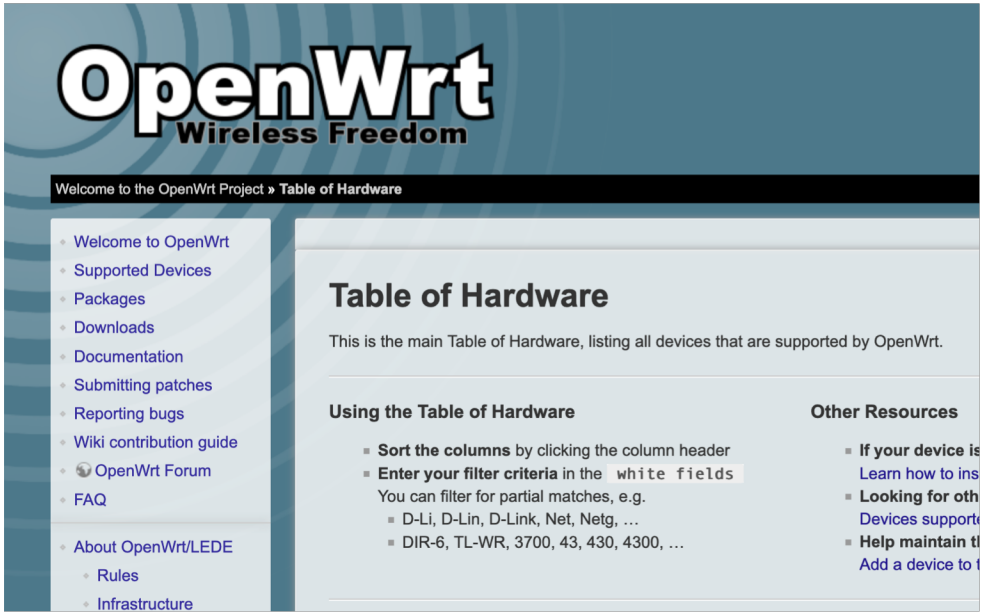
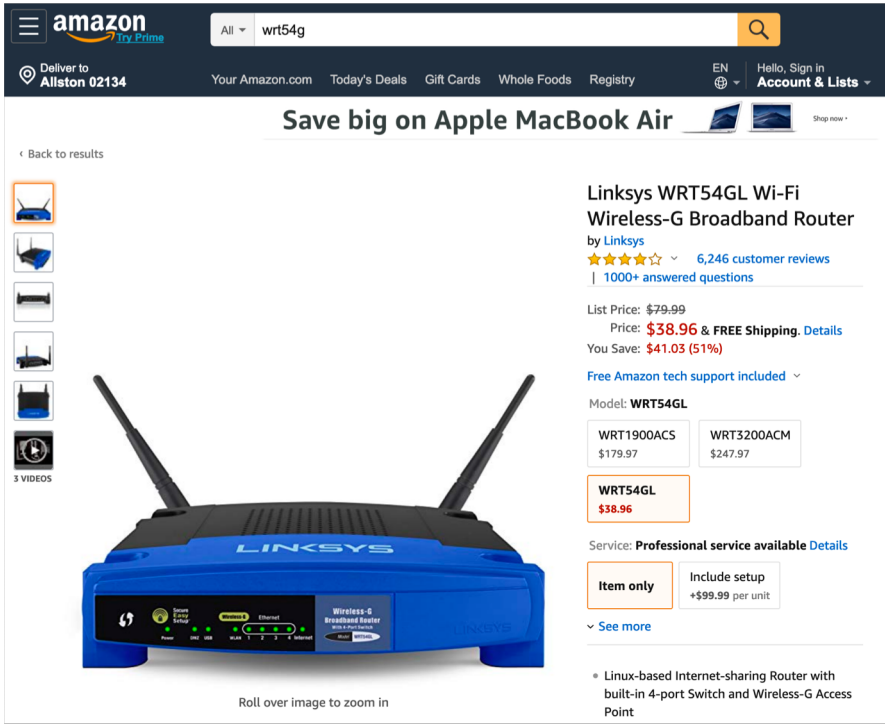




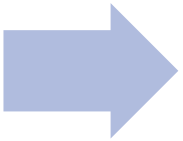


Data Collection

Independent variables

Wikidevi.com+ Custom Firmware Projects

- Hardware characteristics
- Custom firmware compatibility
- Custom firmware compatible date
- Enterprise router



Dependent variables

Amazon.com Reviews

- Review rating
- Review text

Final dataset

- Final dataset of Amazon reviews, product characteristics
  - 1,106 products, 184,013 reviews 151,270 unique reviewers
  - Limit sample to those routers were released before 2007, when reverse engineering was complete

- Method: Staggered difference-in-differences with product and time fixed effects

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- The previous results could come from multiple different reasons:
  - OpenWRT developers support more popular products
  - In particular, companies can “anticipate” OpenWRT development, choose hardware characteristics to accommodate/deter OpenWRT
- We need a “natural experiment” to establish causality!

Reverse engineered wireless drivers (-2007)

Driver family	Driver	Chipsets	Chipset PHY Modes	Integration in mainline	Non-free firmware required[note 1]	License	Development
adm8211	adm8211	ADMtek ADM8211 (IEEE 802.11b MAC/BBP	?	Yes	Yes	GPLv2	With support from Infineon/ADMtek
at76c50x-usb at76c50x-usb	at76c50x-USB	Atmel AT76C503/AT76C505 based USB WLAN adapters	?	Yes	Depends on the model	GPLv2	?
	acx100	Texas Instruments ACX100, ACX111, TNETW1450	?	No	Yes	Dual BSD/MPL	Reverse-engineered
airo	airo	Cisco Systems Aironet 4500/4800 and 340/350	b	Yes	No	Dual GPLv2 and BSD	?
ath	ar5523	Qualcomm Atheros AR5523 based USB dongles	?	Yes	Yes	ISC	Reverse-engineered
	ath5k	Qualcomm Atheros AR2413, AR2414, AR2417, AR2425, AR5210, AR5211, AR5212, AR5213, AR5413, AR5414, AR5423, AR5424	?	Yes (since 2.6.25)	N/A[3]	Dual GPL/BSD	Reverse-engineered
	ath6kl	Qualcomm Atheros AR6003, AR6004 (SDIO), AR6004 (USB)	?	Yes	Yes	ISC	Written by Qualcomm Atheros
	ath9k	Qualcomm Atheros chips with IEEE 802.11n support	a/b/g/n	Yes (since 2.6.27)	N/A[3]	ISC	Written by Qualcomm Atheros
	ath9k_htc	Qualcomm Atheros AR9271, AR7010 (USB-PCIe bridge with AR928x chips)	b/g/n	Yes (since 2.6.35)[4][5]	No[6]	ISC	Written by Qualcomm Atheros
	ath10k	Qualcomm Atheros chips with IEEE 802.11ac support	ac	Yes (since 3.11)[7]	Yes[8]	ISC	Written by Qualcomm Atheros
	carl9170	Qualcomm Atheros AR9170 (802.11n USB)	a/b/g/n	Yes (since 3.0)	No[9]	GPL	Qualcomm Atheros-supported
	wil6210	Wilocity wil6210, 802.11ad 60GHz	?	Yes	Yes	ISC	Written by Qualcomm Atheros
atmel	atmel	Atmel at76c502 at76c504 and at76c506 wireless cards	?	Yes	No	GPLv2+	Reverse-engineered
b43	b43	Some Broadcom 43xx	?	Yes (since 2.6.24)	Experimental OSS firmware[10]	GPL	Reverse-engineered
b43legacy	b43legacy	Broadcom 4301, 4303, and 4306 revisions 1 and 2	?	Yes (since 2.6.24)	Experimental OSS firmware[10]	GPL	Reverse-engineered
brcm80211	brcmfmac	PCIe devices: Broadcom 4356, 43567, 43570, 4358, 4359, 43602, 4365, 4366 SDIO devices: Broadcom 4329, 4330, 4334, 43340, 43341, 43241, 4335, 4339, 43362, 43430, 43455, 4354, 43143 USB devices: Broadcom 43235, 43236, 43238, 43143, 43242, 43566, 43569	a/b/g/n	Yes (since 3.2)	Yes	ISC	Written by Broadcom
	brcmsmac	Broadcom 4313, 43224, 43225	a/b/g/n	Yes (since 3.2)	Yes	ISC	Written by Broadcom
cw1200	cw1200	ST-Ericsson CW1100 & CW1200 WLAN chipsets	?	Yes (since 3.11)[11]	Yes[12]	GPLv2	?
hostap	HostAP	Intersil PRISM-II, PRISM-2.5, PRISM 3	?	Yes	Depends on the model[13]	GPLv2	
ipw2x00	ipw2x00	Intel PRO/Wireless 2100 and 2200 Network Connection 802.11b	?	Yes	Yes[14]	GPL	Written by Intel
iwlegacy	iwlegacy	Intel Wireless WiFi 3945ABG, 4965AGN	?	Yes	Yes	GPL	
iwlwifi	iwlwifi	Intel Wireless WiFi Next Gen AGN - Wireless-N/Advanced-N/Ultimate-N: 6250AGN, 6200AGN, 6300AGN 1000BGN, 5150AGN, 5100AGN, 5300AGN, 5350AGN, 6005, 6030, 6150BGN, 100BGN and 130BGN, 2000	a/b/g/n/ac/ax	Yes	Yes	Dual GPL/BSD	Written by Intel
libertas	libertas	Marvell 88W8686 SDIO Libertas 8388 (USB) 802.11b/g, 8385 (CompactFlash) 802.11b/g, 8385/8686/8688 (SDIO) 802.11b/g, 8686 (SPI) 802.11b/g 88W8388	?	Yes	Yes[15]	GPL	Marvell-supported
libertas_tf	libertastf	Marvell 8388 (USB) WLAN Thinfirm Driver (OLPC)	?	Yes		GPL	cozybit, Marvell-supported

Was the complementary good valuable?

- I estimate the following regression specification:

$$Rating_{rit} = \beta_1 Post_{rit} \times Treated_i + \lambda_t + \phi_i + \epsilon_{rit}$$

- The variables are defined as
  - **Rating**: Amazon review rating for product i
  - **Treated**: Router's device driver was reverse engineered, making it compatible with custom firmware
  - **Post**: Dummy variable for after the product is compatible

Dynamic coefficient plots

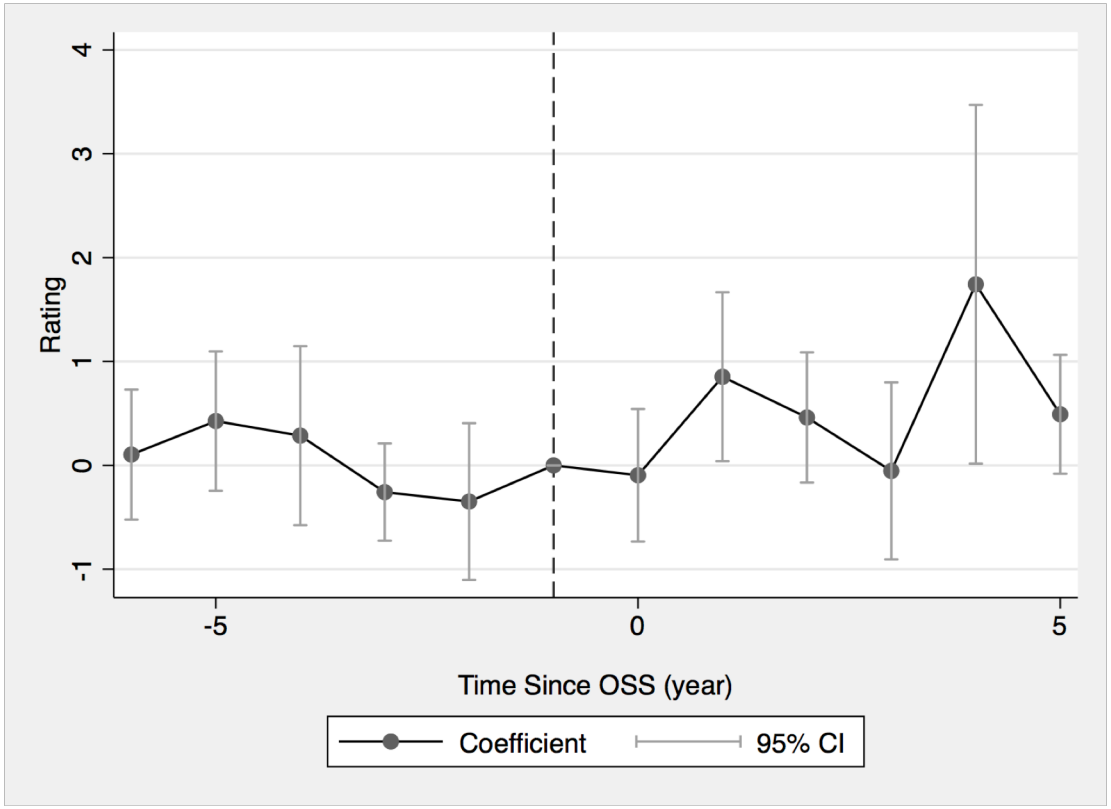

Table 2. *Custom firmware increases user review ratings*

	(1)	(2)	(3)	(4)	(5)
Dep Var:	Rating	Rating	Rating	Rating	Rating
Post x Treated	0.625**	0.624**	0.617**	0.584**	0.575**
	(0.264)	(0.264)	(0.262)	(0.261)	(0.257)
Savviness			0.294**		0.289**
			(0.131)		(0.131)
Review text similarity			-0.554		-0.700*
			(0.403)		(0.407)
Mention cheap				0.080	0.088
				(0.067)	(0.066)
Mention expensive				0.203***	0.215***
				(0.070)	(0.070)
Mention OSS				0.210	0.235
				(0.211)	(0.206)
Product Age	N	Y	Y	Y	Y
Product FE	Y	Y	Y	Y	Y
Month FE	Y	Y	Y	Y	Y
Observations	12759	12759	12759	12757	12757
Adjusted R^2	0.141	0.141	0.142	0.141	0.142

Standard errors clustered at the product-month level

Outline

1. Introduction
2. Theoretical background
3. Background of the Cisco/Linksys GPL violation
4. Data collection
5. Empirical analysis
6. Conclusion

Conclusion

- GPL enforcement can lead to downstream code (think of all the commits!)
- GPL enforcement played a significant role in enhancing customer benefits in the wireless router market
- Compatibility with OpenWRT increases users' satisfaction, as well as product market performance

Final words

- Lots of potential for quantitative analysis, exploring how free software helps users, both upstream and downstream
- Some opportunities
  - Measuring “freedom” – what does that mean?
  - Thinking about the relationships – freedom and innovation, the role of corporations in enabling/hindering users’ freedom
  - “Natural experiments” – sudden increases/decreases in users freedom, and how they affect the community?

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