Free and Open-source Software

Martin Kellogg

FOSS: reading quiz

Q1: The word “free” in the term “free software” means:

A. “free” as in “free beer” (i.e., zero price)
B. “free” as in “free speech” (i.e., an inalienable right)
C. both A and B
D. something else not mentioned here

Q2: **TRUE** or **FALSE**: The companies that have taken the most commercial value from successful open-source projects like Linux have changed over time

FOSS: reading quiz

Q1: The word “free” in the term “free software” means:

A. “free” as in “free beer” (i.e., zero price)

B. “free” as in “free speech” (i.e., an inalienable right)

C. both A and B

D. something else not mentioned here

Q2: **TRUE** or **FALSE**: The companies that have taken the most commercial value from successful open-source projects like Linux have changed over time

FOSS: reading quiz

Q1: The word “free” in the term “free software” means:

A. “free” as in “free beer” (i.e., zero price)

B. “free” as in “free speech” (i.e., an inalienable right)

C. both A and B

D. something else not mentioned here

Q2: **TRUE** or **FALSE**: The companies that have taken the most commercial value from successful open-source projects like Linux have changed over time

Free and Open-source Software

Today’s agenda:

- History + the “free software” philosophy
- Open-source: licenses and business models

Free and Open-source S

Today's agenda:

- History + the "free software"
- Open-source: licenses and bu

Announcements:

- schedule change: engineer panel will be Monday next week, not this week
- final demo scheduling will start soon (keep an eye out)
- class on 12/10 will be replaced by oral exams
  - if you do well on the oral exam, it'll replace your IP1 grade

Free and Open-source Software

Today's agenda:

- **History + the "free software" philosophy**
- Open-source: licenses and business models

Why does this matter?

Why does this matter?

- Part of being a **software engineer** (vs just a programmer) is understanding the context of your work

Why does this matter?

- Part of being a **software engineer** (vs just a programmer) is understanding the context of your work
- “Free” vs “open-source” vs “closed-source”/”proprietary” is an important **philosophical debate** within the larger software engineering community

Why does this matter?

- Part of being a **software engineer** (vs just a programmer) is understanding the context of your work
- “Free” vs “open-source” vs “closed-source”/”proprietary” is an important **philosophical debate** within the larger software engineering community
- This debate has **consequences** for both how you build and how you use software that, as a software engineer, you should understand

Why does this matter?

- Part of being a **software engineer** (vs just a programmer) is understanding the context of your work
- “Free” vs “open-source” vs “closed-source”/”proprietary” is an important **philosophical debate** within the larger software engineering community
- This debate has **consequences** for both how you build and how you use software that, as a software engineer, you should understand
    - plus, it’s the sort of thing that other, more senior engineers will expect you to have an **informed opinion** about

What is “open-source”?

What is “open-source”?

Definition: ***open source*** refers to any source code that is made freely available for possible modification and redistribution [Wikipedia]

What is “open-source”?

Definition: ***open source*** refers to any source code that is made freely available for possible modification and redistribution [Wikipedia]

- “open source” != “open source software” (we’ll talk about why later)

What is “open-source”?

Definition: ***open source*** refers to any source code that is made freely available for possible modification and redistribution [Wikipedia]

- “open source” != “open source software” (we’ll talk about why later)
- I’ll abbreviate “open source software” as **OSS**

The Case against Open Source

[Variation of popular meme, original source unknown]

The Case against Open Source

- “Open-Source Doomsday”: Once all software is free, we’ll stop making more software and have a market collapse
- Innovation will be stifled by the risk that software will be copied
- Making source code public means easier to attack
- “Anarchistic” licensing prevents companies from profiting from open source software

[Variation of popular meme, original source unknown]

The Case for Open Source

[Screenshot, 2022, opensource.microsoft.com]

The Case for Open Source

- “Many eyes make all bugs shallow”
- End-users can improve and customize software to their needs
- New features can be proposed and developed organically
- Greater productivity when more code is reused (easier with open source)
    - i.e., DRY on an industry-wide scale

[Screenshot, 2022, opensource.microsoft.com]

History: open-source

History: open-source

- in the early days of computing, innovation **focused on hardware**

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway
- what software development did occur happened mostly in **academic labs**, and AT&T's Bell Research Labs

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway
- what software development did occur happened mostly in **academic labs**, and AT&T's Bell Research Labs
- Unix created at Bell Labs using the **new, portable** language "C" (~1970), licenses initially released with source code

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway
- what software development did occur happened mostly in **academic labs**, and AT&T's Bell Research Labs
- Unix created at Bell Labs using the **new, portable** language "C" (~1970), licenses initially released with source code
  - Unix quickly gained a lot of popularity for two reasons:

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway
- what software development did occur happened mostly in **academic labs**, and AT&T's Bell Research Labs
- Unix created at Bell Labs using the **new, portable** language "C" (~1970), licenses initially released with source code
  - Unix quickly gained a lot of popularity for two reasons:
    - portable between hardware (just need a C compiler)

History: open-source

- in the early days of computing, innovation **focused on hardware**
  - no one was worried about keeping their code secret, since it usually would only run on their hardware anyway
- what software development did occur happened mostly in **academic labs**, and AT&T's Bell Research Labs
- Unix created at Bell Labs using the **new, portable** language "C" (~1970), licenses initially released with source code
  - Unix quickly gained a lot of popularity for two reasons:
    - portable between hardware (just need a C compiler)
    - Bell Labs practically gave it away to universities

History: Unix

- 1978: UC Berkeley begins distributing their own derived version of Unix (BSD)

History: Unix

- 1978: UC Berkeley begins distributing their own derived version of Unix (BSD)
- 1983: AT&T broken up by US DoJ, UNIX licensing changed: no more source releases

History: Unix

- 1978: UC Berkeley begins distributing their own derived version of Unix (BSD)
- 1983: AT&T broken up by US DoJ, UNIX licensing changed: no more source releases
- Also 1983: “Starting this Thanksgiving I am going to write a complete Unix-compatible software system called GNU (Gnu’s Not Unix), and give it away free to everyone who can use it”

GNU logo (a gnu wildebeest)

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four “**freedoms**”:

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four “**freedoms**”:
  0. The freedom to run the program as you wish, for any purpose

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four “**freedoms**”:
  0. The freedom to run the program as you wish, for any purpose
  1. The freedom to study how the program works, and change it so it does your computing as you wish

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four “**freedoms**”:
  0. The freedom to run the program as you wish, for any purpose
  1. The freedom to study how the program works, and change it so it does your computing as you wish
  2. The freedom to redistribute copies (of the original) so you can help others

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four "**freedoms**":
  0. The freedom to run the program as you wish, for any purpose
  1. The freedom to study how the program works, and change it so it does your computing as you wish
  2. The freedom to redistribute copies (of the original) so you can help others
  3. The freedom to distribute copies of your modified version to others

The Free Software Philosophy

- UNIX distributed with source code, but with a **restrictive license**
- The Free Software Foundation promoted four "**freedoms**":
  0. The freedom to run the program as you wish, for any purpose
  1. The freedom to study how the program works, and change it so it does your computing as you wish
  2. The freedom to redistribute copies (of the original) so you can help others
  3. The freedom to distribute copies of your modified version to others

"Free as in speech, not as in beer"

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:
  - Are you required to redistribute any modifications (under same license) - “***copyleft***”

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:
  - Are you required to redistribute any modifications (under same license) - "***copyleft***"
  - Can you redistribute executable binaries, or only source?

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:
  - Are you required to redistribute any modifications (under same license) - "***copyleft***"
  - Can you redistribute executable binaries, or only source?
  - Are you allowed to use the software in a restrictive hardware environment? ("***tivoization***")

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:
  - Are you required to redistribute any modifications (under same license) - "***copyleft***"
  - Can you redistribute executable binaries, or only source?
  - Are you allowed to use the software in a restrictive hardware environment? ("***tivoization***")

Difference between GPL v2 and GPL v3: is tivoization banned?

The Free Software Philosophy

- the FSF claims: Free software should be licensed under the GNU Public License (GPL), considering questions like:
  - Are you required to redistribute any modifications (under same license) - "***copyleft***"
  - Can you redistribute executable binaries, or only source?
  - Are you allowed to use the software in a restrictive hardware environment? ("***tivoization***")
- Popular alternative: "Do whatever you want with this software, but don't blame me if it doesn't work" ("***freeware***")

History: GNU/Linux (1991-Today)

- Stallman (FSF founder) set out to build an operating system in 1983, ended up building a **tremendous set of utilities** (“**GNU coreutils**”) that are needed by an OS (compiler, utilities, etc)

History: GNU/Linux

Remember: 1983 = Unix licensing changed because of AT&T breakup

- Stallman (FSF founder) set out to build an operating system in 1983, ended up building a **tremendous set of utilities** (“**GNU coreutils**”) that are needed by an OS (compiler, utilities, etc)

History: GNU/Linux (1991-Today)

- Stallman (FSF founder) set out to build an operating system in 1983, ended up building a **tremendous set of utilities** (“**GNU coreutils**”) that are needed by an OS (compiler, utilities, etc)
- **Linux** is an operating system built around and with the GNU utilities, licensed under GPL

History: GNU/Linux (1991-Today)

- Stallman (FSF founder) set out to build an operating system in 1983, ended up building a **tremendous set of utilities** (“**GNU coreutils**”) that are needed by an OS (compiler, utilities, etc)
- **Linux** is an operating system built around and with the GNU utilities, licensed under GPL
- Rise of the internet, demand for **internet servers** drives demand for cheap/free OS

History: GNU/Linux (1991-Today)

- Stallman (FSF founder) set out to build an operating system in 1983, ended up building a **tremendous set of utilities** (“**GNU coreutils**”) that are needed by an OS (compiler, utilities, etc)
- **Linux** is an operating system built around and with the GNU utilities, licensed under GPL
- Rise of the internet, demand for **internet servers** drives demand for cheap/free OS
- Companies began **adopting and supporting** Linux for enterprise customers: e.g., IBM committed over $1B; Red Hat and others

The Cathedral and the Bazaar (1997)

- Eric S Raymond's influential 1997 essay compares two software development methodologies for OSS: "cathedral" or "bazaar"

The Cathedral and the Bazaar (1997)

- Eric S Raymond's influential 1997 essay compares two software development methodologies for OSS: "cathedral" or "bazaar"
- "***cathedral***" model, where **releases** are available for anyone to see, but the development process is restricted to insiders

The Cathedral and the Bazaar (1997)

- Eric S Raymond's influential 1997 essay compares two software development methodologies for OSS: "cathedral" or "bazaar"
- "***cathedral***" model, where **releases** are available for anyone to see, but the development process is restricted to insiders
- However, most of the open source software ecosystem today follows the "***bazaar***" model:
  - Users treated as co-developers
  - Release software early for feedback
  - Modularize + reuse components
  - Democratic organization

The Cathedral and the Bazaar (1997)

- Eric S Raymond's influential 1997 essay compares two software development methodologies for OSS: "cathedral" or "bazaar"
- "***cathedral***" model, where **releases** are available for anyone to see, but the development process is restricted to insiders
- However, most of the open source software ecosystem today follows the "***bazaar***" model:
  - Users treated as co-developers
  - Release software early for feedback
  - Modularize + reuse components
  - Democratic organization

How did the bazaar model become dominant is OSS?

History: Netscape's "Collaborating with the Net"

- **Netscape** was the dominant web browser in the early 90's
  - Business model: free for home and education use, companies paid to use it

History: Netscape's "Collaborating with the Net"

- **Netscape** was the dominant web browser in the early 90's
  - Business model: free for home and education use, companies paid to use it
- Microsoft entered browser market with **Internet Explorer**, bundled with Windows in 1995, soon overtakes Netscape in usage (it's free, with Windows!)
  - also sued by US DoJ for antitrust bundling (!)

History: Netscape's "Collaborating with the Net"

- **Netscape** was the dominant web browser in the early 90's
  - Business model: free for home and education use, companies paid to use it
- Microsoft entered browser market with **Internet Explorer**, bundled with Windows in 1995, soon overtakes Netscape in usage (it's free, with Windows!)
  - also sued by US DoJ for antitrust bundling (!)
- January 1998: Netscape becomes first (?) company to make **source code for proprietary product open** (Mozilla)

History: Free vs Open Source

- Until Netscape/Mozilla, much of open source movement was **concentrated** in the Free Software Foundation and its GPL

History: Free vs Open Source

- Until Netscape/Mozilla, much of open source movement was **concentrated** in the Free Software Foundation and its GPL
- "**Open Source**" coined in 1998 by the Open Source Initiative as a term to capture Netscape's aim for an **open development process**, Eric Raymond's "Bazaar"

History: Free vs Open Source

- Until Netscape/Mozilla, much of open source movement was **concentrated** in the Free Software Foundation and its GPL
- "**Open Source**" coined in 1998 by the Open Source Initiative as a term to capture Netscape's aim for an **open development process**, Eric Raymond's "Bazaar"
    - Publisher Tim O'Reilly organizes a "Freeware Summit" later in 1998, soon rebranded as "Open Source Summit"

History: Free vs Open Source

- Until Netscape/Mozilla, much of open source movement was **concentrated** in the Free Software Foundation and its GPL
- "**Open Source**" coined in 1998 by the Open Source Initiative as a term to capture Netscape's aim for an **open development process**, Eric Raymond's "Bazaar"
  - Publisher Tim O'Reilly organizes a "Freeware Summit" later in 1998, soon rebranded as "Open Source Summit"
  - "Open Source is a development methodology; free software is a social movement" - Richard Stallman, FSF founder

Free and Open-source Software

Today’s agenda:

- History + the “free software” philosophy
- **Open-source: licenses and business models**

What makes an open source project successful?

What makes an open source project successful?

- Open source projects thrive when the **community** surrounding them contributes to push the project forwards

What makes an open source project successful?

- Open source projects thrive when the **community** surrounding them contributes to push the project forwards
- Communities form around **collective ownership** (even if it's only perceived)

What makes an open source project successful?

- Open source projects thrive when the **community** surrounding them contributes to push the project forwards
- Communities form around **collective ownership** (even if it's only perceived)
- Contributors bring **more than code**: also documentation, testing, support, and outreach

What makes an open source project successful?

- Open source projects thrive when the **community** surrounding them contributes to push the project forwards
- Communities form around **collective ownership** (even if it's only perceived)
- Contributors bring **more than code**: also documentation, testing, support, and outreach
- Community/ownership models:
  - Corporate owner, community outreach (MySQL, MongoDB)
  - Foundation owner, corporate sponsors (GNU, Linux)

Is Open Source a Good Business Model?

Is Open Source a Good Business Model?

February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #114, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates

Bill Gates
General Partner, Micro-Soft

The Register

MS' Ballmer: Linux is communism

After a short silence, Motormouth is back, folks...

Graham Lea — Mon 31 Jul 2000 10:10 UTC

MS ANALYSTS Steve Ballmer was the only person to raise the issue of Linux when he wrapped up Microsoft's annual financial analysts meeting in Seattle, although he put Sun and Oracle ahead in terms of being stronger competitors. They of course are 'civilised' competitors - but the Linux crowd, in the world of Prez Steve, are communists.

Redmond top man Satya Nadella: 'Microsoft LOVES Linux'

Open-source 'love' fairly runneth over at cloud event

20 Oct 2014 at 23:45, Neil McAllister

The New York Times

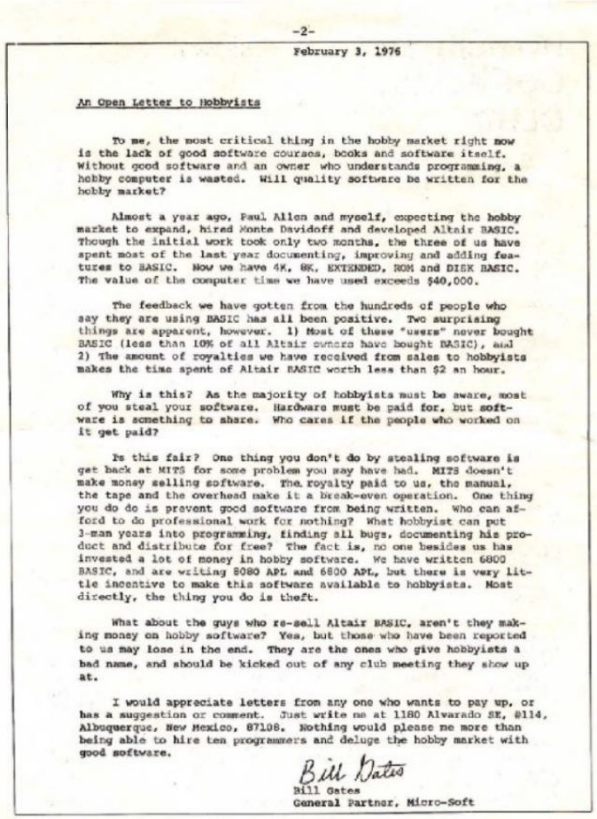
Microsoft Buys GitHub for $7.5 Billion, Moving to Grow in Coding's New Era

Give this article

A GitHub billboard being installed in San Francisco in 2014. Microsoft said on Monday that it would acquire the company for $7.5 billion. David Paul Morris/Bloomberg

By Steve Lohr

Is Open Source a Good Business Model?



-2-

February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

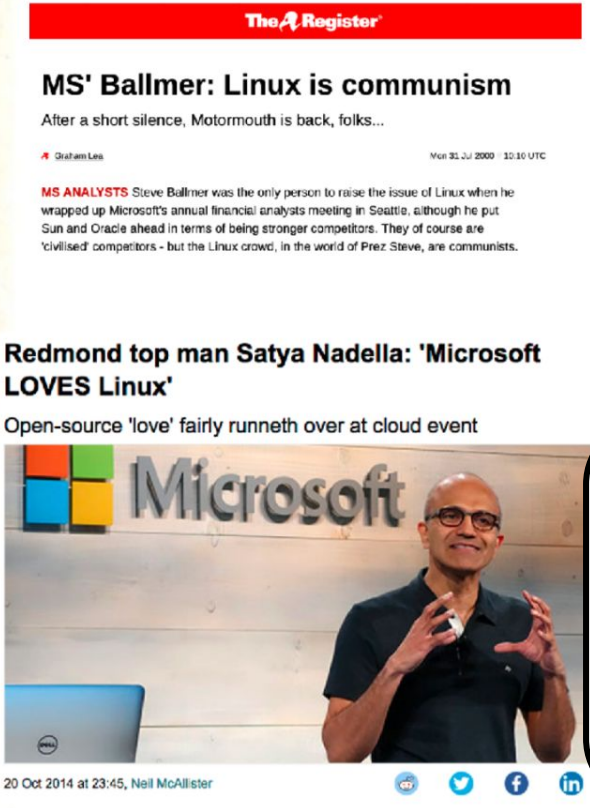
Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #114, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates

Bill Gates
General Partner, Micro-Soft



The Register

MS' Ballmer: Linux is communism

After a short silence, Motormouth is back, folks...

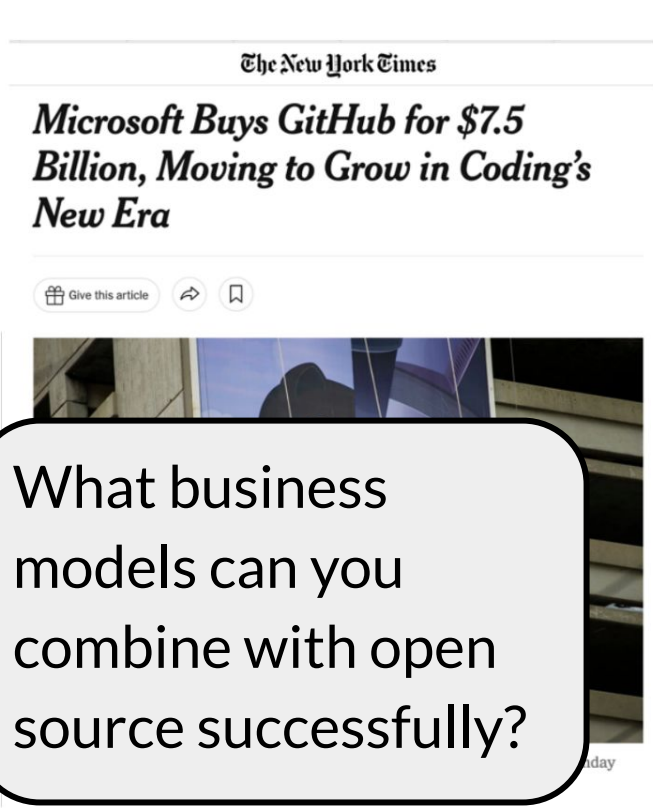
Graham Lea — Mon 31 Jul 2000 10:10 UTC

MS ANALYSTS Steve Ballmer was the only person to raise the issue of Linux when he wrapped up Microsoft's annual financial analysts meeting in Seattle, although he put Sun and Oracle ahead in terms of being stronger competitors. They of course are 'civilised' competitors - but the Linux crowd, in the world of Prez Steve, are communists.

Redmond top man Satya Nadella: 'Microsoft LOVES Linux'

Open-source 'love' fairly runneth over at cloud event

20 Oct 2014 at 23:45, Neil McAllister



The New York Times

Microsoft Buys GitHub for $7.5 Billion, Moving to Grow in Coding's New Era

Give this article

By Steve Lohr

What business models can you combine with open source successfully?

Model: “Open Core”, closed plugins

- “**Open Core**” model: core component of a product is an open source utility; **premium plugins** available for a fee

Model: “Open Core”, closed plugins

- “**Open Core**” model: core component of a product is an open source utility; **premium plugins** available for a fee
- Example: Apache Kafka, a distributed message broker (glue in an event-based system)
  - Product is open source, maintained by Apache foundation, supported by company “Confluent”
  - Confluent provides plugins to connect Kafka to many different systems out-of-the-box

Model: Open Source as a Utility

- The largest, most successful open source projects implement **utility infrastructure**:
  - Operating systems, web servers, logging libraries, languages

Model: Open Source as a Utility

- The largest, most successful open source projects implement **utility infrastructure**:
  - Operating systems, web servers, logging libraries, languages
- **Business model**: build and sell products and services using those utilities, contribute improvements back to the ecosystem

Model: Open Source as a Utility

- The largest, most successful open source projects implement **utility infrastructure**:
  - Operating systems, web servers, logging libraries, languages
- **Business model**: build and sell products and services using those utilities, contribute improvements back to the ecosystem
  - i.e., sell **expertise**

Model: Open Source as a Utility

- The largest, most successful open source projects implement **utility infrastructure**:
  - Operating systems, web servers, logging libraries, languages
- **Business model**: build and sell products and services using those utilities, contribute improvements back to the ecosystem
  - i.e., sell **expertise**
  - many companies provide specialized “distributions” of these open source infrastructure and specialized tools to improve them; support the upstream project

Open source and the law

Open source and the law

- **Copyright** provides creators with protection for creative, intellectual and artistic works - **including software**

Open source and the law

- **Copyright** provides creators with protection for creative, intellectual and artistic works - **including software**
  - Alternative: public domain (nobody has exclusive property rights)

Open source and the law

- **Copyright** provides creators with protection for creative, intellectual and artistic works - **including software**
  - Alternative: public domain (nobody has exclusive property rights)
- Open source software is **generally copyrighted**, with copyright retained by contributors or assigned to a foundation/corporation that maintains the product

Open source and the law

- **Copyright** provides creators with protection for creative, intellectual and artistic works - **including software**
  - Alternative: public domain (nobody has exclusive property rights)
- Open source software is **generally copyrighted**, with copyright retained by contributors or assigned to a foundation/corporation that maintains the product
- Copyright holder can grant a ***license*** for use, placing restrictions on how it can be used (perhaps for a fee)
  - Common open source licenses: MIT, BSD, Apache, GPL

Open source licenses

Two broad classes of open source licenses:

Open source licenses

Two broad classes of open source licenses:

- ***permissive licenses*** (e.g., MIT, Apache, BSD) allow a combination of the licensed code and some other code (i.e., a ***derivative work***) to be released under a **different license** (including proprietary)

Open source licenses

Two broad classes of open source licenses:

- ***permissive licenses*** (e.g., MIT, Apache, BSD) allow a combination of the licensed code and some other code (i.e., a ***derivative work***) to be released under a **different license** (including proprietary)
  - goal: encourage adoption and use of the software

Open source licenses

Two broad classes of open source licenses:

- ***permissive licenses*** (e.g., MIT, Apache, BSD) allow a combination of the licensed code and some other code (i.e., a ***derivative work***) to be released under a **different license** (including proprietary)
  - goal: encourage adoption and use of the software
- ***copyleft licenses*** (e.g., GPL, CC-BY-SA) forces all linked code to be released under the **same license**

Open source licenses

Two broad classes of open source licenses:

- ***permissive licenses*** (e.g., MIT, Apache, BSD) allow a combination of the licensed code and some other code (i.e., a ***derivative work***) to be released under a **different license** (including proprietary)
  - goal: encourage adoption and use of the software
- ***copyleft licenses*** (e.g., GPL, CC-BY-SA) forces all linked code to be released under the **same license**
  - goal: protect the commons, require users to contribute back

Open source licenses

Philosophy: do we force participation, or try to grow/incentivize it in other ways?

Two broad classes of open source licenses:

- ***permissive licenses*** (e.g., MIT, Apache, BSD) allow a combination of the licensed code and some other code (i.e., a ***derivative work***) to be released under a **different license** (including proprietary)
  - goal: encourage adoption and use of the software
- ***copyleft licenses*** (e.g., GPL, CC-BY-SA) forces all linked code to be released under the **same license**
  - goal: protect the commons, require users to contribute back

Model: Dual Licensing

Model: Dual Licensing

- Offer a **free copyleft** (e.g. GPL) license to encourage broad adoption, prevent competitors from improving it without sharing those improvements.

Model: Dual Licensing

- Offer a **free copyleft** (e.g. GPL) license to encourage broad adoption, prevent competitors from improving it without sharing those improvements.
- Offer **custom, more permissive licenses** to third parties who are willing to pay for that (e.g. enterprise)

Model: Dual Licensing

- Offer a **free copyleft** (e.g. GPL) license to encourage broad adoption, prevent competitors from improving it without sharing those improvements.
- Offer **custom, more permissive licenses** to third parties who are willing to pay for that (e.g. enterprise)
- Only possible when there is a **single copyright owner**, who can unilaterally change license

Model: Dual Licensing

- Offer a **free copyleft** (e.g. GPL) license to encourage broad adoption, prevent competitors from improving it without sharing those improvements.
- Offer **custom, more permissive licenses** to third parties who are willing to pay for that (e.g. enterprise)
- Only possible when there is a **single copyright owner**, who can unilaterally change license
- Risk: losing control of the copyleft portion via **forking**

Model: Dual Licensing

- Offer a **free copyleft** (e.g. GPL) license to encourage broad adoption, prevent competitors from improving it without sharing those improvements.
- Offer **custom, more permissive licenses** to third parties who are willing to pay for that (e.g. enterprise)
- Only possible when there is a **single copyright owner**, who can unilaterally change license
- Risk: losing control of the copyleft portion via **forking**
- Examples: MySQL, Qt

When communities move on: forks

- When software is released under a permissive license, the only rights that the creator can realistically retain are trademarks on name/images - code can otherwise be “***forked***”

When communities move on: forks

- When software is released under a permissive license, the only rights that the creator can realistically retain are trademarks on name/images - code can otherwise be "***forked***"
- Example:
  - Sun bought StarOffice in 1999, GPL open-sourced as OpenOffice in 2000 with aim of fighting MS Office

When communities move on: forks

- When software is released under a permissive license, the only rights that the creator can realistically retain are trademarks on name/images - code can otherwise be "***forked***"
- Example:
  - Sun bought StarOffice in 1999, GPL open-sourced as OpenOffice in 2000 with aim of fighting MS Office
  - 2010: Oracle buys Sun, fires many internal developers, frustrating external community

When communities move on: forks

- When software is released under a permissive license, the only rights that the creator can realistically retain are trademarks on name/images - code can otherwise be "***forked***"
- Example:
  - Sun bought StarOffice in 1999, GPL open-sourced as OpenOffice in 2000 with aim of fighting MS Office
  - 2010: Oracle buys Sun, fires many internal developers, frustrating external community
  - 2011: Community forms a foundation, creates fork LibreOffice, OpenOffice dies off (Oracle transfers to Apache)

Model: Hosted OSS As A Service

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, “**fully managed**” installation of the software, as a service

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, “**fully managed**” installation of the software, as a service
- Risk: No competitive advantage vs cloud utility providers (e.g. AWS)

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, “**fully managed**” installation of the software, as a service
- Risk: No competitive advantage vs cloud utility providers (e.g. AWS)
  - AWS could even improve your GPL code and **not share** because it is **not distributing** the program (it operates it as a service)

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, “**fully managed**” installation of the software, as a service
- Risk: No competitive advantage vs cloud utility providers (e.g. AWS)
  - AWS could even improve your GPL code and **not share** because it is **not distributing** the program (it operates it as a service)
- Example: MongoDB Atlas (document-oriented database)

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, “**fully managed**” installation of the software, as a service
- Risk: No competitive advantage vs cloud utility providers (e.g. AWS)
  - AWS could even improve your GPL code and **not share** because it is **not distributing** the program (it operates it as a service)
- Example: MongoDB Atlas (document-oriented database)
  - MongoDB created a **new license** to **require copyleft for service providers** operating MongoDB as a service

Model: Hosted OSS As A Service

- Model: Creators of open source software provide a cloud hosted, "**fully managed**" installation of the software, as a service
- Risk: No competitive advantage vs cloud utility providers (e.g. AWS)
  - AWS could even improve your GPL code and **not share** because it is **not distributing** the program (it operates it as a service)
- Example: MongoDB Atlas (document-oriented database)
  - MongoDB created a **new license** to **require copyleft for service providers** operating MongoDB as a service
  - Amazon created their own fork of the GPL'ed version of MongoDB, ignored code only released under new license

Another example: Java & open-source

- While the Java **specification** is public, there used to be no open source Java runtime **implementation**

Another example: Java & open-source

- While the Java **specification** is public, there used to be no open source Java runtime **implementation**
- Much open source software was/is written in Java, creating “**The Java Trap**” for open source

Another example: Java & open-source

- While the Java **specification** is public, there used to be no open source Java runtime **implementation**
- Much open source software was/is written in Java, creating “**The Java Trap**” for open source
- 1996-2006: GNU, Apache (backed by IBM and Apple), and others attempted to create open source implementations; Sun refused to permit these runtimes to be tested for compatibility, prohibiting them from using the term “Java”

Another example: Java & open-source

- While the Java **specification** is public, there used to be no open source Java runtime **implementation**
- Much open source software was/is written in Java, creating "**The Java Trap**" for open source
- 1996-2006: GNU, Apache (backed by IBM and Apple), and others attempted to create open source implementations; Sun refused to permit these runtimes to be tested for compatibility, prohibiting them from using the term "Java"
- 2007: Sun releases OpenJDK under GPL; third party projects abandoned mostly uncompleted

Another example: Java & ope

Why did Sun release OpenJDK?

- While the Java **specification** is public, t
  source Java runtime **implementation**
- Much open source software was/is written in Java, creating "**The Java Trap**" for open source
- 1996-2006: GNU, Apache (backed by IBM and Apple), and others attempted to create open source implementations; Sun refused to permit these runtimes to be tested for compatibility, prohibiting them from using the term "Java"
- 2007: Sun releases OpenJDK under GPL; third party projects abandoned mostly uncompleted

Another example: Java & ope

Why did Sun release OpenJDK?
They feared **losing control** of Java.

- While the Java **specification** is public, t
  source Java runtime **implementation**
- Much open source software was/is written in Java, creating "**The Java Trap**" for open source
- 1996-2006: GNU, Apache (backed by IBM and Apple), and others attempted to create open source implementations; Sun refused to permit these runtimes to be tested for compatibility, prohibiting them from using the term "Java"
- 2007: Sun releases OpenJDK under GPL; third party projects abandoned mostly uncompleted

Another example: Android

Another example: Android

- Model: “Product” is the **ecosystem** (app store, ads, etc) and the hardware (made by competing manufacturers), not Android itself

Another example: Android

- Model: “Product” is the **ecosystem** (app store, ads, etc) and the hardware (made by competing manufacturers), not Android itself
- Android is **entirely open source**, built on Linux; applications are written in Java/Kotlin, executed using a custom-built runtime

Another example: Android

- Model: “Product” is the **ecosystem** (app store, ads, etc) and the hardware (made by competing manufacturers), not Android itself
- Android is **entirely open source**, built on Linux; applications are written in Java/Kotlin, executed using a custom-built runtime
- To provide implementations of **core Java APIs** (e.g. java.util.X), Android used the open source Apache Harmony implementations

Another example: Android

- Model: “Product” is the **ecosystem** (app store, ads, etc) and the hardware (made by competing manufacturers), not Android itself
- Android is **entirely open source**, built on Linux; applications are written in Java/Kotlin, executed using a custom-built runtime
- To provide implementations of **core Java APIs** (e.g. java.util.X), Android used the open source Apache Harmony implementations
- Oracle v Google: Oracle asserted that Java APIs were their property (copyright) and Google misused that; judge ruled that **APIs specifications cannot be copyrighted**

Risks of using Open Source in Industry

Risks of using Open Source in Industry

- Are licenses **compatible**? A significant concern for licenses with copyleft:

Risks of using Open Source in Industry

- Are licenses **compatible**? A significant concern for licenses with copyleft:
  - Adopting libraries with copyleft clause generally means what you distribute linked against that library **must** also have same copyleft clause (and be open source)

Risks of using Open Source in Industry

- Are licenses **compatible**? A significant concern for licenses with copyleft:
  - Adopting libraries with copyleft clause generally means what you distribute linked against that library **must** also have same copyleft clause (and be open source)
  - Including permissive-licensed software in copyleft-licensed software is generally compatible

Risks of using Open Source in Industry

- Are licenses **compatible**? A significant concern for licenses with copyleft:
  - Adopting libraries with copyleft clause generally means what you distribute linked against that library **must** also have same copyleft clause (and be open source)
  - Including permissive-licensed software in copyleft-licensed software is generally compatible
- Are you certain that the software truly is released under the license that is stated? Did all contributors agree to that license?

Risks of using Open Source

- Are licenses **compatible**? A significa
  copyleft:
  - Adopting libraries with copyleft c at
    you distribute linked against that library **must** also have same copyleft clause (and be open source)
  - Including permissive-licensed software in copyleft-licensed software is generally compatible
- Are you certain that the software truly is released under the license that is stated? Did all contributors agree to that license?

Industry must balance these risks against the **clear benefit** of OSS: reusing existing code

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot **suggest lines of code** as you program or even generate code from scratch

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot **suggest lines of code** as you program or even generate code from scratch
    - Copilot has been observed to output **entire snippets** of code from public GitHub repositories

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot **suggest lines of code** as you program or even generate code from scratch
  - Copilot has been observed to output **entire snippets** of code from public GitHub repositories
- Ongoing **legal battles** over:

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot **suggest lines of code** as you program or even generate code from scratch
  - Copilot has been observed to output **entire snippets** of code from public GitHub repositories
- Ongoing **legal battles** over:
  - Does training a model on public code **violate copyleft** licenses?

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot **suggest lines of code** as you program or even generate code from scratch
  - Copilot has been observed to output **entire snippets** of code from public GitHub repositories
- Ongoing **legal battles** over:
  - Does training a model on public code **violate copyleft** licenses?
  - Who is the **owner** of an LLM's output, especially when it is similar to public code that has an owner?

Licensing and Large Language Models (LLMs)

- Recent development: large language models trained on **all code** in public repositories on GitHub
- Tools like Claude Code or GitHub Copilot can help as you program or even generate code
  - Copilot has been observed to emit code from public GitHub repositories
- Ongoing **legal battles** over:
  - Does training a model on public code **violate copyleft** licenses?
  - Who is the **owner** of an LLM's output, especially when it is similar to public code that has an owner?

Many companies **forbid** their developers from using Copilot or similar tools because of the risks from these legal battles!

Advice: Large Language Models (LLMs) in SE

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and many other disciplines) going forward

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and many other disciplines) going forward
  - many engineers **want** to use them, even if they're not currently permitted to due to legal risks
    - great for generating boilerplate, tests, etc.

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and many other disciplines) going forward
  - many engineers **want** to use them, even if they're not currently permitted to due to legal risks
    - great for generating boilerplate, tests, etc.
- My view: LLMs are like an **untrustworthy but very smart compiler**

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and many other disciplines) going forward
  - many engineers **want** to use them, even if they're not currently permitted to due to legal risks
    - great for generating boilerplate, tests, etc.
- My view: LLMs are like an **untrustworthy but very smart compiler**
  - unlike traditional compiler, do not promise to preserve semantics (and might **hallucinate**)

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and many other disciplines) going forward
  - many engineers **want** to use them, even if they're not currently permitted to due to legal risks
    - great for generating boilerplate, tests, etc.
- My view: LLMs are like an **untrustworthy but very smart compiler**
  - unlike traditional compiler, do not promise to preserve semantics (and might **hallucinate**)
  - but input can be natural language or a specification, rather than another program

Advice: Large Language Models (LLMs) in SE

- Current trends suggest that LLMs are going to be a **major part** of software engineering (and [illegible]ward
  - many engineers **wan**[illegible]rently permitted to due to l[illegible]
    - great for generat[illegible]
- My view: LLMs are like a[illegible]**mpiler**
  - unlike traditional com[illegible] semantics (and might **hallucinate**)
  - but input can be natural language or a specification, rather than another program

Possible future workflow:

1. LLMs generate code
2. deductive verification tools check for correctness
3. SDE reviews final code

Takeaways: free and open-source software

- Free software and open-source software represent different **philosophies** about how code should be shared:
  - Free software: if I share with you, you need to share with me
  - Open source software: I share with you, you do what you want
- Because software is copyrightable, licenses enforce philosophy
  - **copyleft** licenses enforce free software principles
- Many viable open source business models, but all have risks
- **Licensing concerns** are the main reason to avoid open-source code in industry (industry loves permissive licenses)