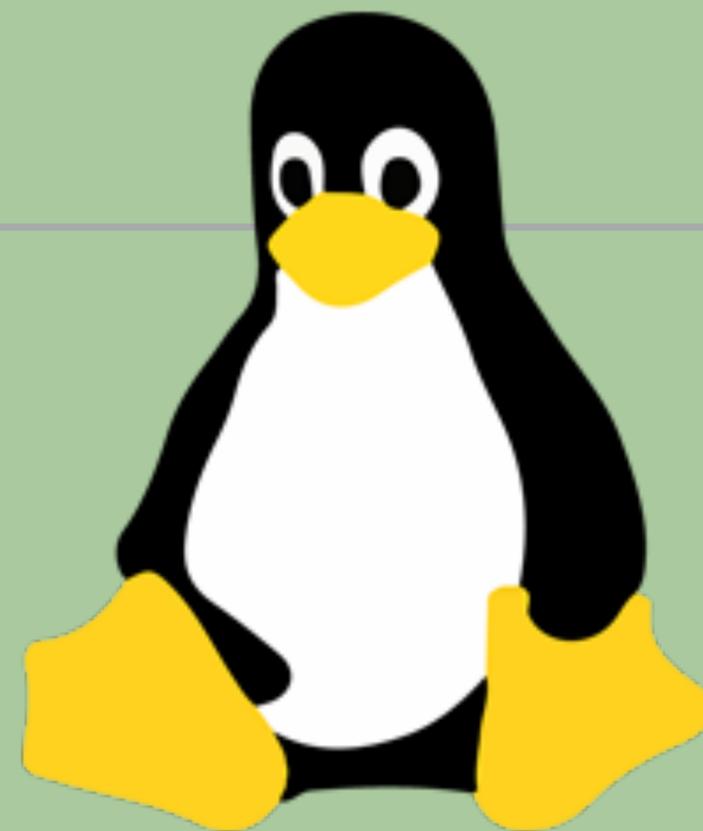
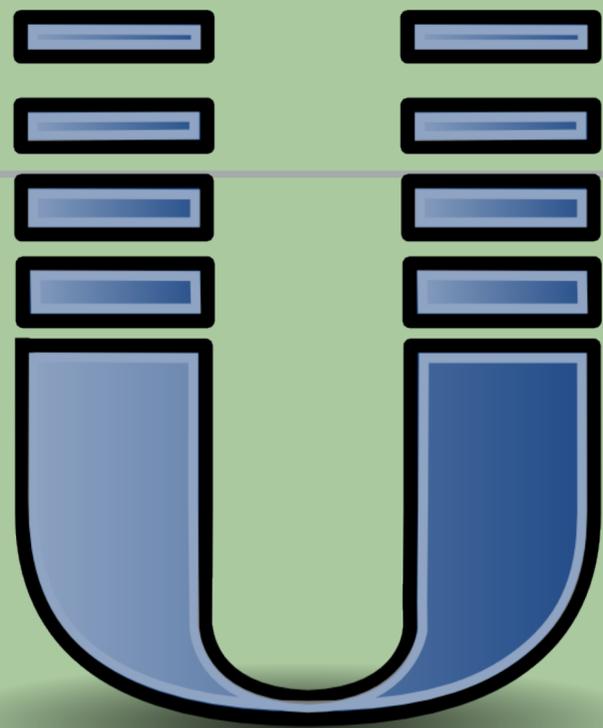


OPERATING SYSTEMS

UNIX, GNU & LINUX



What is an Operating System?

- ▶ The Software platform that supports your computer's basic functions, such as running applications and managing peripherals (mouse, keyboard, etc.)

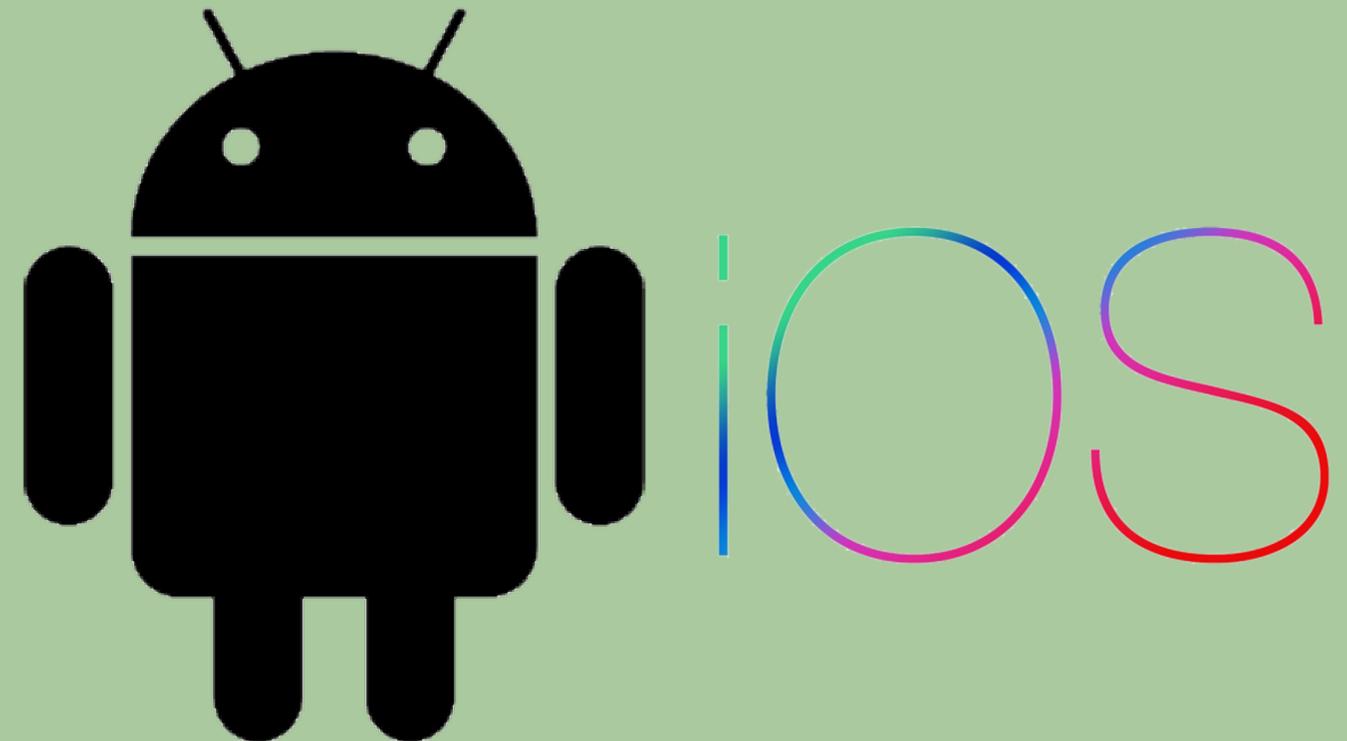
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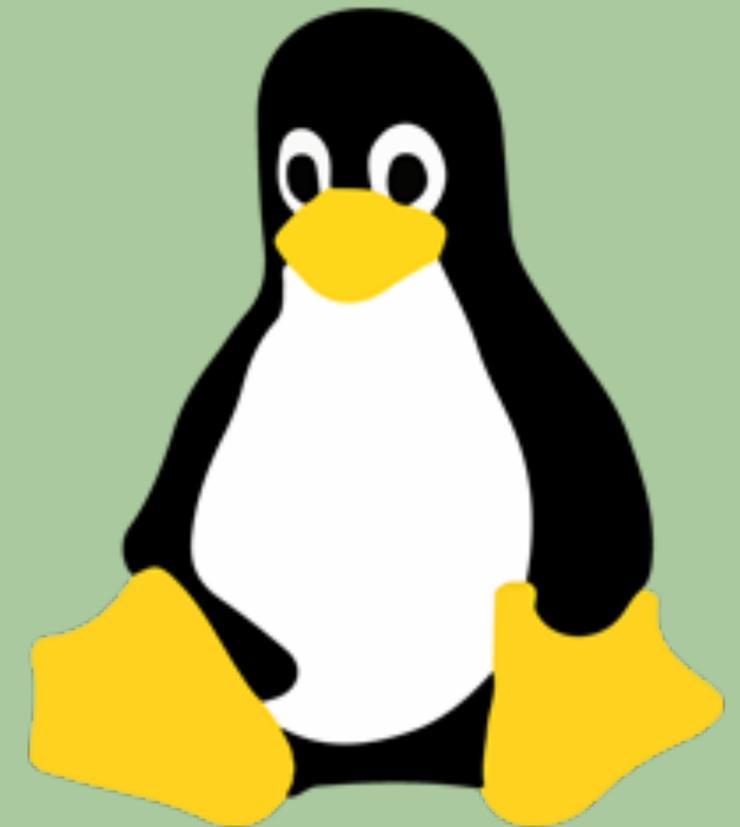
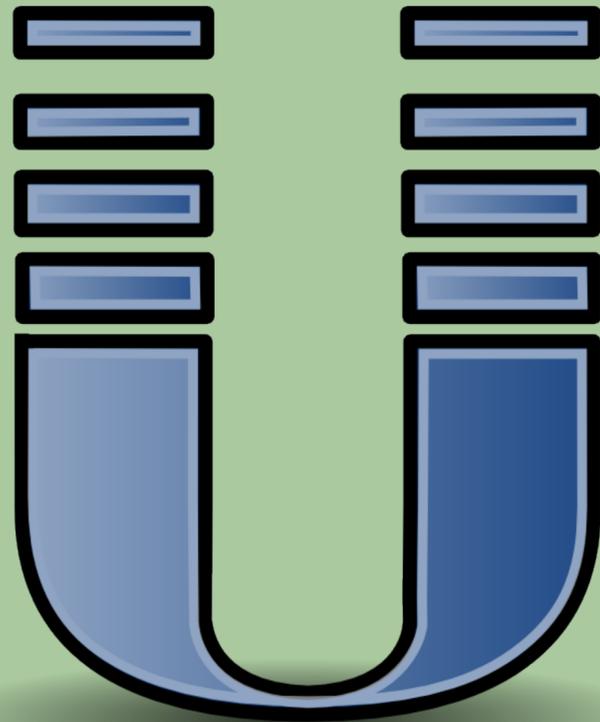
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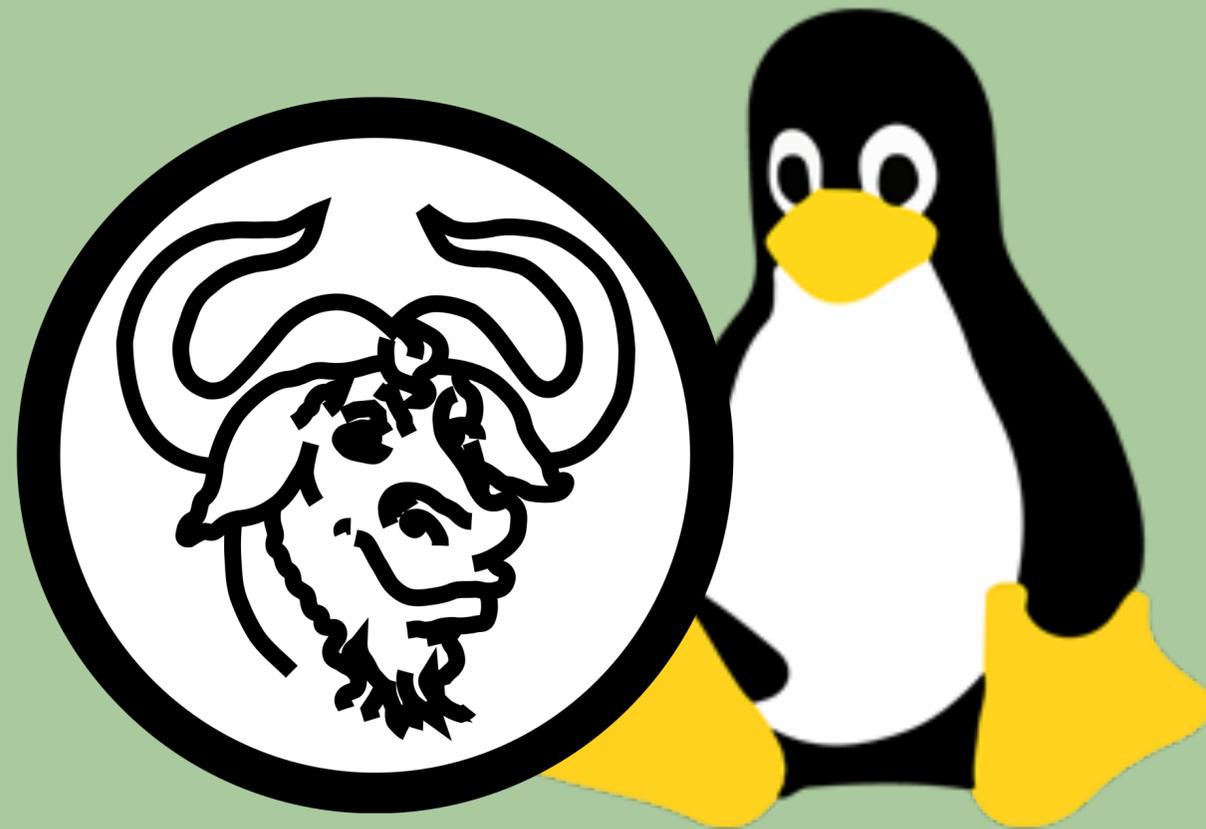
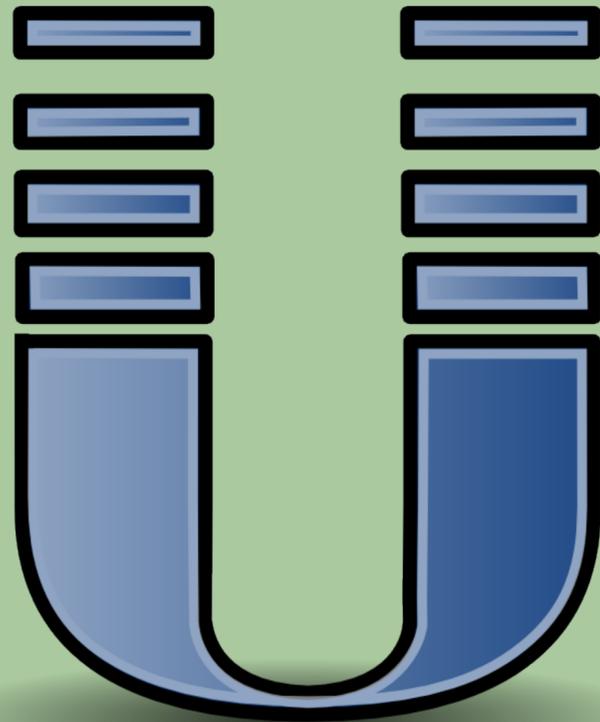
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What is an Operating System?

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UNIX Background & Use

UNIX Background & Use

- ▶ 1970s: UNIX - Supercomputers users like NASA
- ▶ IBM, HP, Dell in the 1980s/1990s to lure people from Windows
- ▶ Mac OSX (UNIX, not Linux)
- ▶ Over 70% of web servers and network servers
- ▶ 98% of supercomputers (molecular dynamics, nuclear test sim.)
- ▶ 89% of mobile operating systems (Android, iOS)

Relevance for Digital Preservation

Relevance for Digital Preservation

SUSTAINABILITY

Relevance for Digital Preservation

SUSTAINABILITY

- ▶ **Longevity, interoperability:** UNIX is a 25 year old standard
- ▶ **Stable platform** for storage, management and, long-term preservation
- ▶ **Control:** Ability to use the operating system via GUI and manipulate it manually via the command-line
- ▶ **Proliferation:** Thousands of "UNIX-like" derivative operating systems (including GNU and Linux)

Relevance for Digital Preservation

SYSTEMS ARCHITECTURE

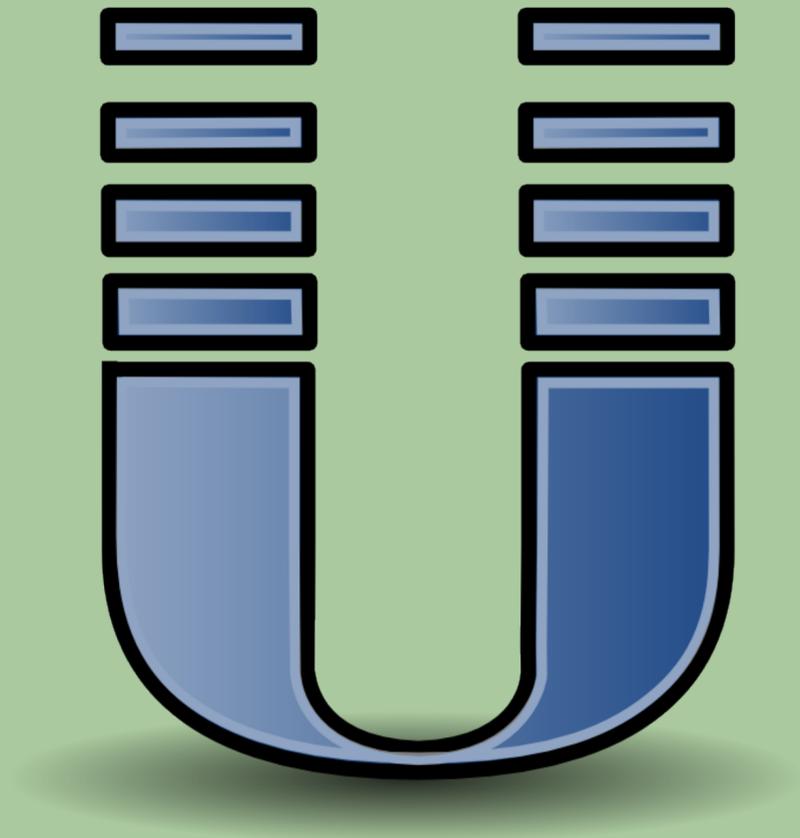
Relevance for Digital Preservation

SYSTEMS ARCHITECTURE

- ▶ Most computers that **store** data are run on a UNIX or GNU/Linux operating system
 - ▶ Network storage: servers in your office
 - ▶ Cloud storage: servers not in your office
- ▶ Many of the **systems** used to manage data run on a UNIX or GNU/Linux operating system (DAMS, etc.)

OPERATING SYSTEMS

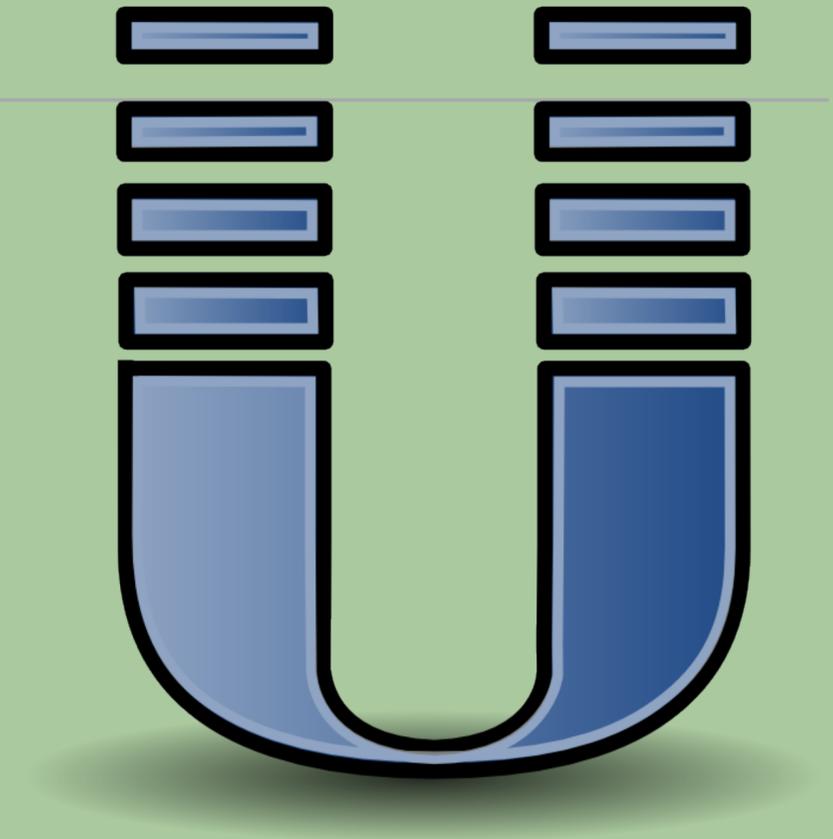
UNIX



OPERATING SYSTEMS

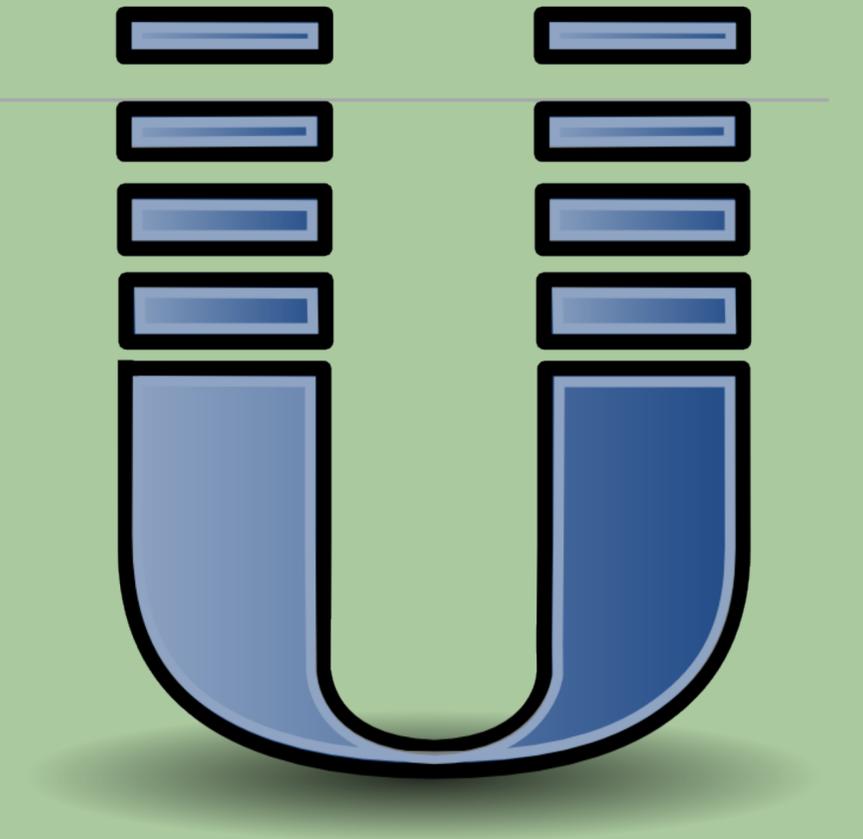
UNIX

What is UNIX?

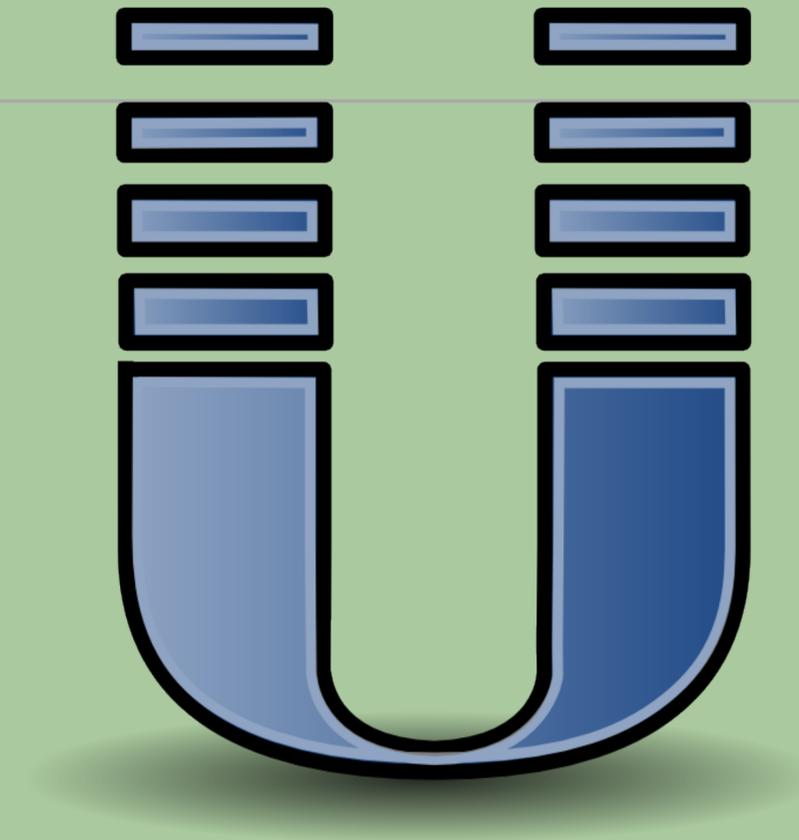


What is UNIX?

- ▶ Family of operating systems created in 1969
- ▶ Uses command line interface (pre GUI)
- ▶ Written in the C programming language

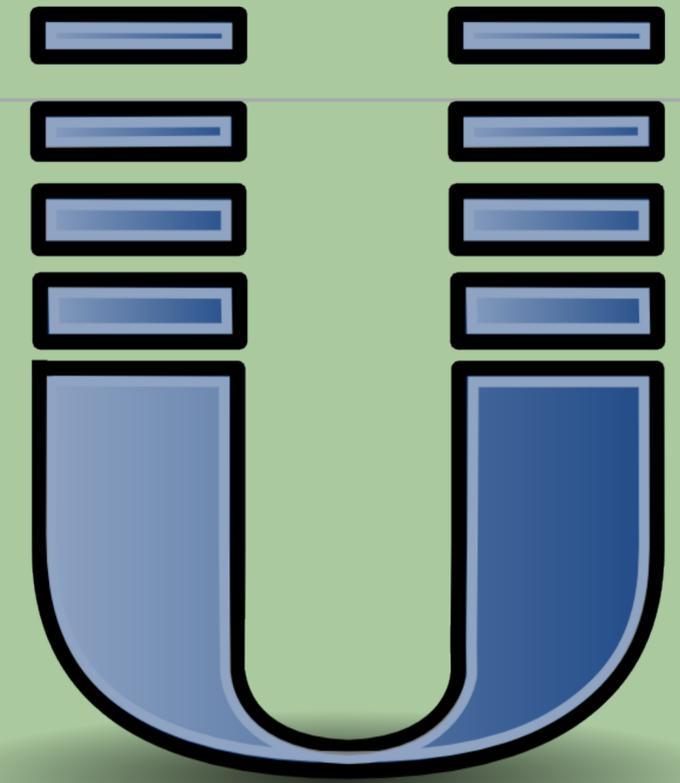


Where did it come from?



Where did it come from?

- ▶ Bell Labs - in collaboration with MIT & GE
- ▶ Ken Thompson credited as the creator
- ▶ Project goal: Create a *portable operating system* that allows multiple users to log in to one mainframe simultaneously



Bell Labs

- ▶ Founded in late 1800s by Alexander Graham Bell
- ▶ Purchased by AT&T in 1921
- ▶ Located in Murray Hill, NJ



Bell Labs

INVENTIONS

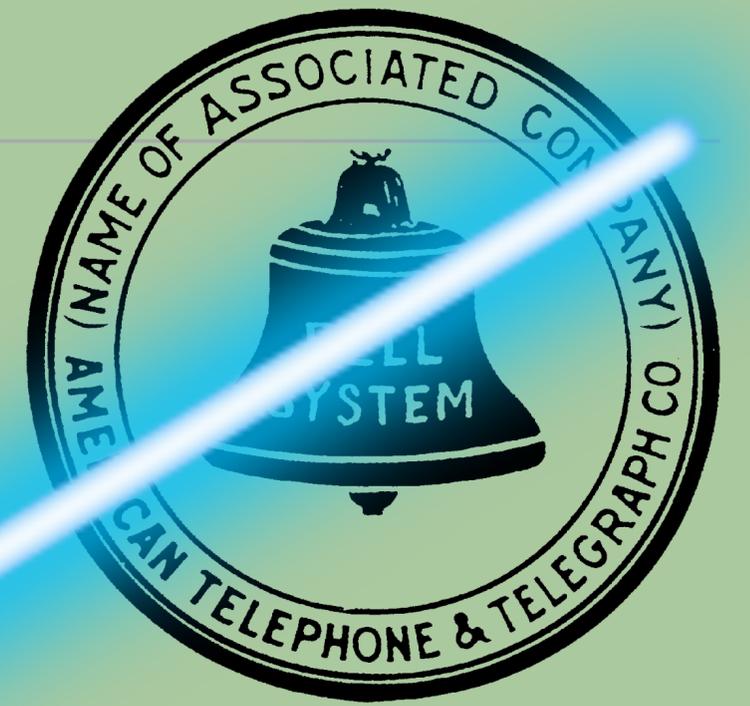
- ▶ 1947: The Transistor
- ▶ 1969: C programming language
- ▶ 1983: C++ programming language



Bell Labs

INVENTIONS

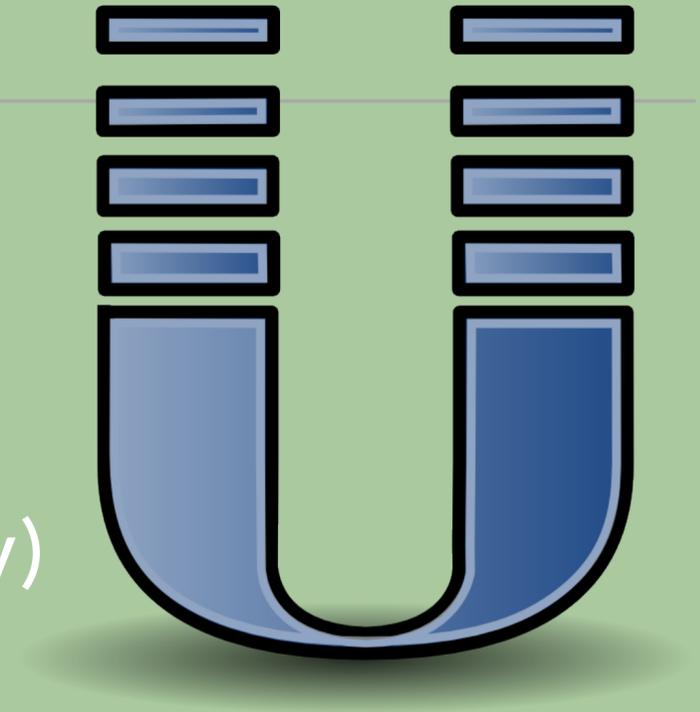
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- ▶ 1969: C programming language
- ▶ 1983: C++ programming language
- ▶ 1960(ish): Lasers



UNIX

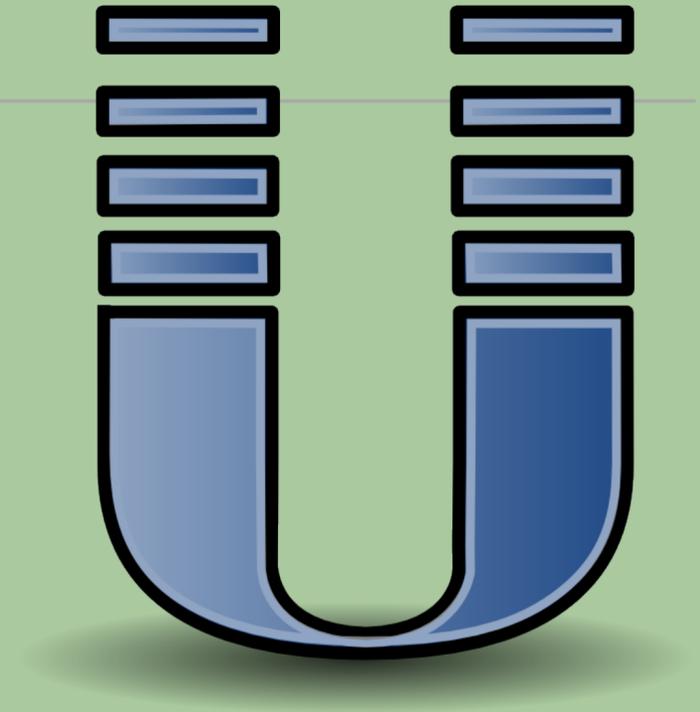
USERS

- ▶ Universities (University of Illinois, Stanford, UC Berkeley)
- ▶ Corporations (Microsoft, IBM and Sun Microsystems)
- ▶ Government (Department of Defense, National Science Foundation)
- ▶ ARPANET



Life Before UNIX

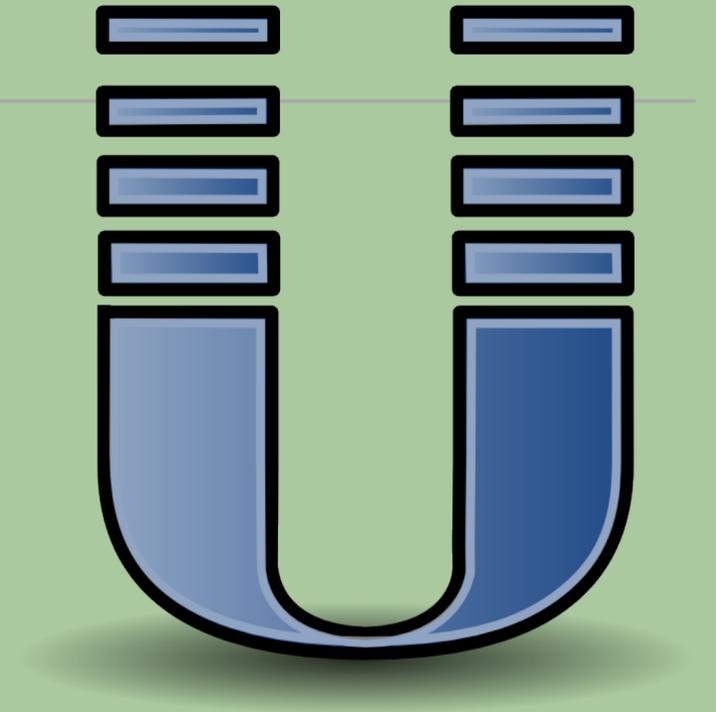
EARLY SOFTWARE



Life Before UNIX

EARLY SOFTWARE

- ▶ Stored programs were limited
- ▶ Computers operated like appliances
- ▶ Software had to specifically be designed for hardware
- ▶ Software could not be moved from mainframe to mainframe



Portable & Interoperable

GOOD FOR PRESERVATION

Portable & Interoperable

GOOD FOR PRESERVATION

- ▶ **Portable**: Intentionally designed to be modular and adaptable
- ▶ **Interoperable**: Hardware and computing platform agnostic
- ▶ **Sharing**: Multiple user logins on a single mainframe
- ▶ **Multipurpose software**: Includes suite of programs that can be used alone or *in combination* (super powerful, more creative computing)

UNIX: Price

HOW MUCH DID IT COST?

UNIX: Price

HOW MUCH DID IT COST?



UNIX: Licensing

UNIX: Licensing

- ▶ Proprietary: Owned by AT&T
- ▶ 1956 Antitrust case: AT&T can't exploit software for commercial gain
- ▶ DoJ Mandate: Software must be sold at cost (materials & shipping)

UNIX: Licensing

- ▶ 1973: Bell Labs releases UNIX for educational use as an open system (code visible and editable)
 - ▶ *Everyone* proceeds to use UNIX

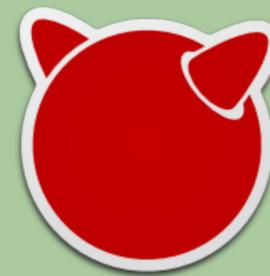
UNIX: Licensing

- ▶ 1979: AT&T attempts to license UNIX for commercial use
 - ▶ Forks by UC Berkeley, Sun Microsystems, Hewlett Packard and Microsoft already in wide use and can legally be redistributed for free
 - ▶ AT&T's UNIX has no commercial value
 - ▶ Forks now in use include **BSD UNIX (Berkeley)** and **GNU**

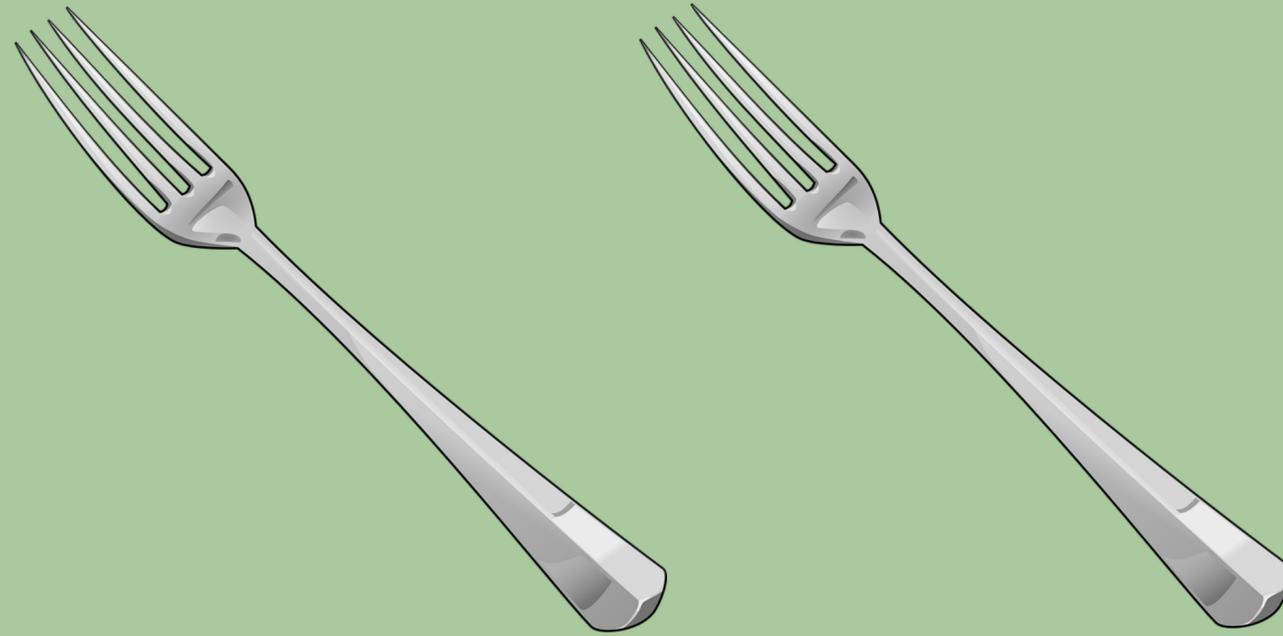


UNIX: Licensing

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UNIX: Licensing



- ▶ Forks now in use include **BSD UNIX (Berkeley)** and **GNU**



UNIX: Licensing



UNIX OPERATING SYSTEMS

- ▶ Forks now in use include **BSD UNIX (Berkeley)** and **GNU**



GNU



GNU

What is GNU?



- ▶ GNU: "GNU is not UNIX"
- ▶ Free and open source UNIX-like **operating system**
- ▶ Contains **no UNIX code**
- ▶ Includes **suite of software tools** and components
 - ▶ Similar to Safari/Edge, Finder/Explorer, etc.

What is GNU?

ORIGINS



- ▶ Launched in September of **1983** (early collaborative model)
- ▶ Initiated by **Richard Stallman** from MIT, founder of the Free Software Foundation
- ▶ Collaborative free software with hundreds of thousands of contributors

What is GNU?

GNU MANIFESTO



1985: Stallman quits his job at MIT and writes "GNU Manifesto" outlining social and technical goals of the project.

I have resigned from the AI Lab to deny MIT any legal excuse to prevent me from giving GNU away.

What is GNU?

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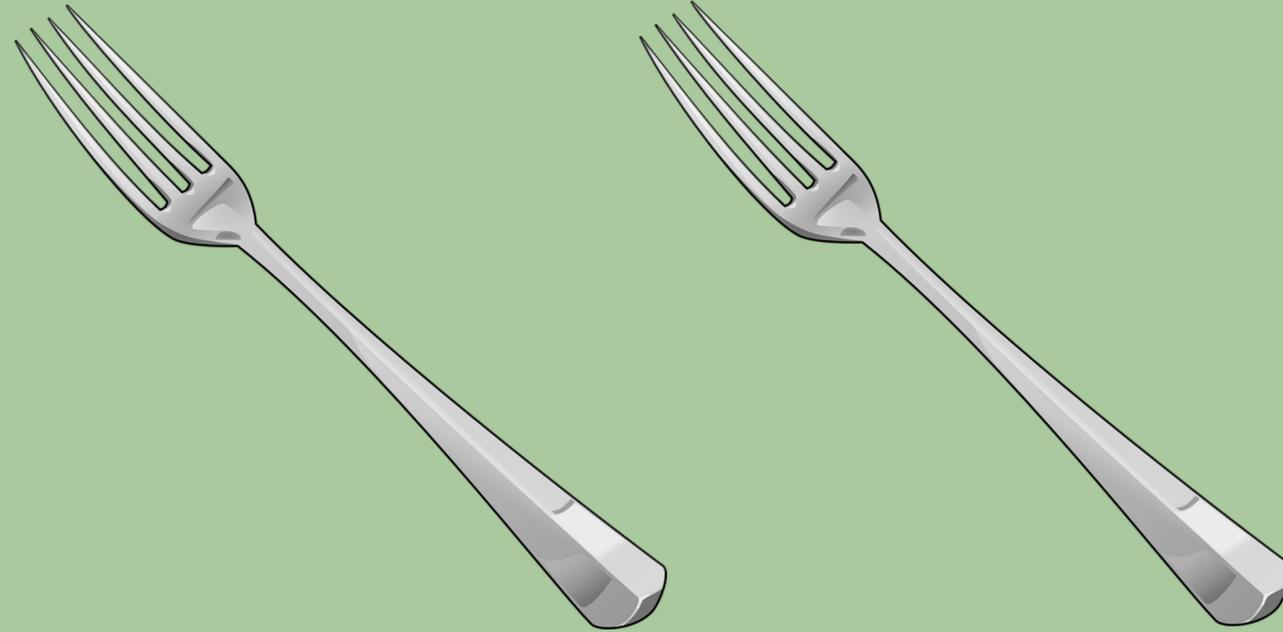
I have resigned from the AI Lab to deny MIT any legal excuse to prevent me from giving GNU away.

Once GNU is written, everyone will be able to obtain good system software free, just like air.

GNU VS. BSD UNIX



GNU VS. BSD UNIX



GNU VS. BSD UNIX



- ▶ Both are UNIX derivatives
- ▶ Both aim to provide a portable operating system to anyone free of charge
- ▶ Code is totally different (BSD uses UNIX code, GNU does not)



GNU VS. BSD UNIX



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- ▶ Both aim to provide a portable operating system to anyone free of charge
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LICENSING

- ▶ GNU uses **GPL license** – "General Public License"
- ▶ BSD uses the **BSD (Berkeley Software Distribution) license**

GNU VS. BSD UNIX

GPL LICENSE MODEL



- ▶ GNU Licensing adds a "**share-alike**" requirement
- ▶ Anyone who adds to the software and writes new code is **required by law** to share it openly and for **free**

GNU VS. BSD UNIX

GPL LICENSE MODEL



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"Free as in speech, not free as in beer."

(a matter of liberty, not price)

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GOOD FOR PRESERVATION

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GNU VS. BSD UNIX

GPL LICENSE MODEL



- ▶ GPL: GNU General Public License
 - ▶ v.1 published in 1989
 - ▶ v.3 published in 2007
- ▶ First "copyleft" license for public use
- ▶ Derivative works must be distributed under the GPL license

GNU VS. BSD UNIX

BSD LICENSE



- ▶ BSD: Berkeley Software Distribution (originally for BSD UNIX)
 - ▶ First published in 1988
- ▶ Considered a "permissive" license
- ▶ No "share-alike" necessary"
- ▶ Retain the option of commercializing at any time

GNU VS. BSD UNIX

BSD LICENSE



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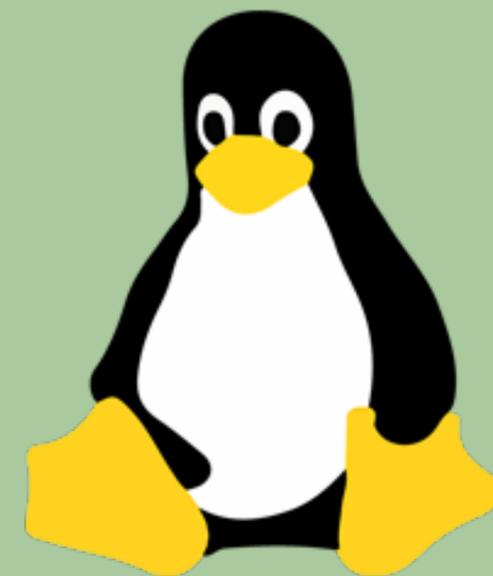
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ALSO PRETTY GOOD FOR PRESERVATION

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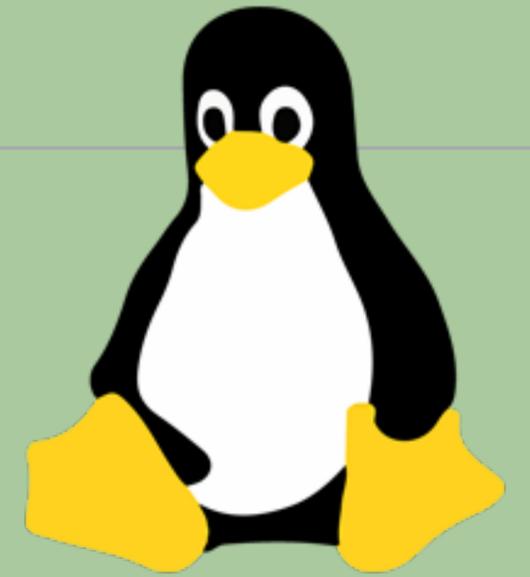
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LINUX



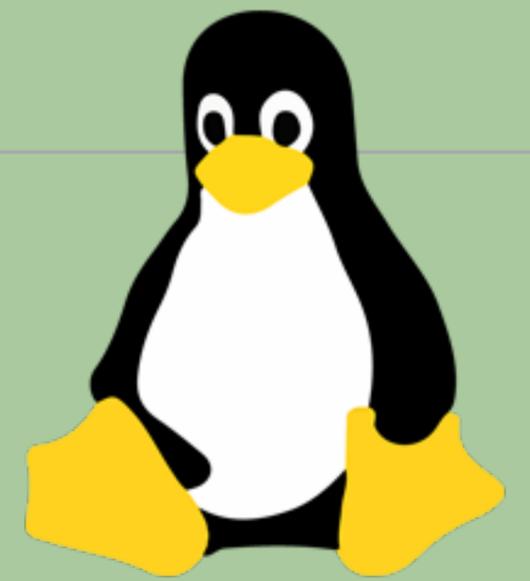
LINUX

What is Linux?



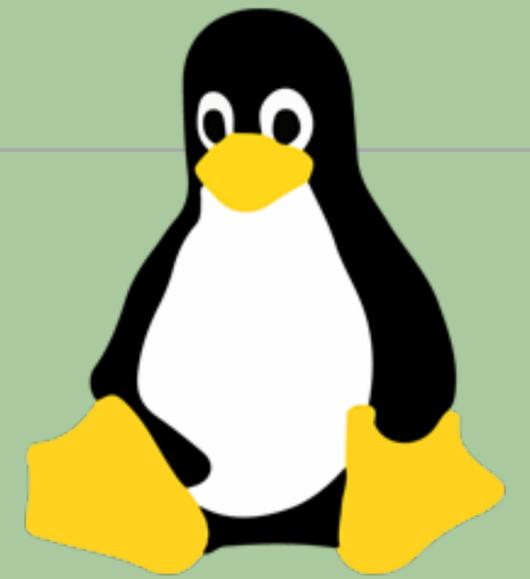
- ▶ Free and open source UNIX-like operating system released in 1991
- ▶ Written by [Linus Torvalds](#), a student at the University of Helsinki
- ▶ Goals: Create an open source, freely available UNIX-like operating system for personal computers

Didn't that already exist?

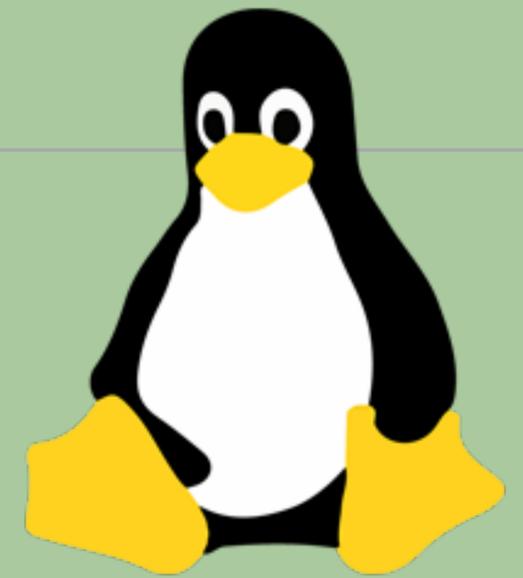


Didn't that already exist?

... almost but not quite.



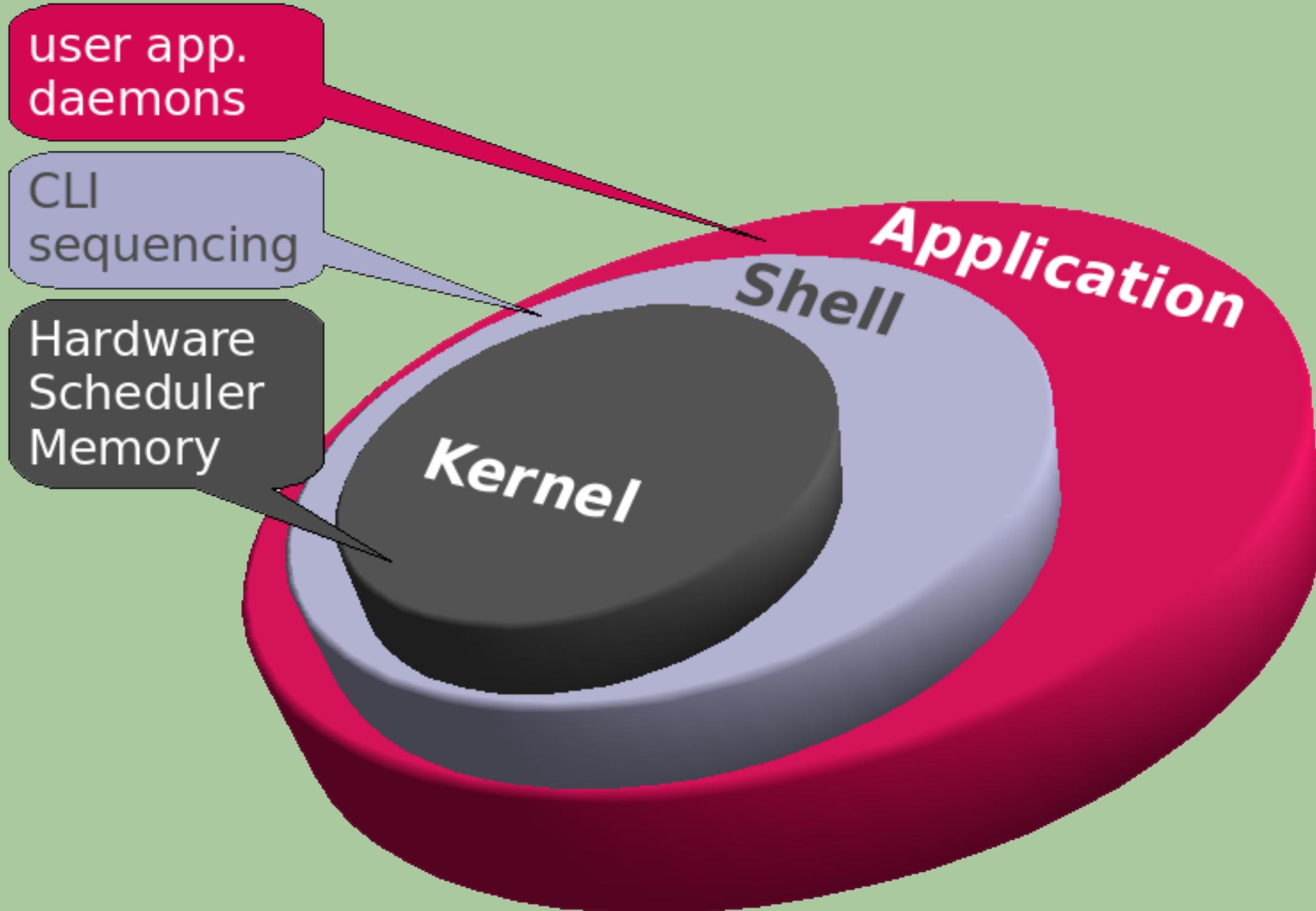
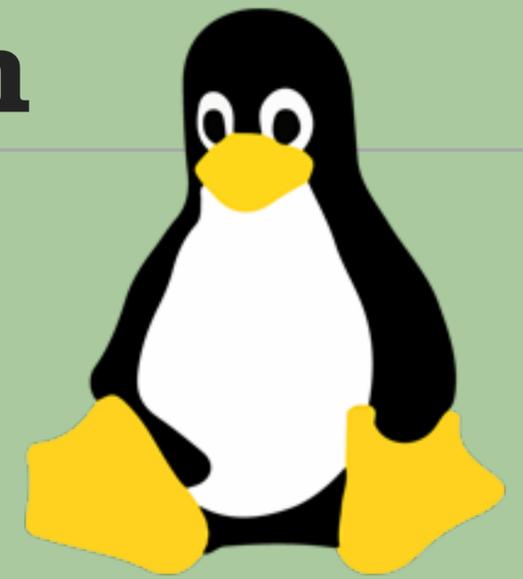
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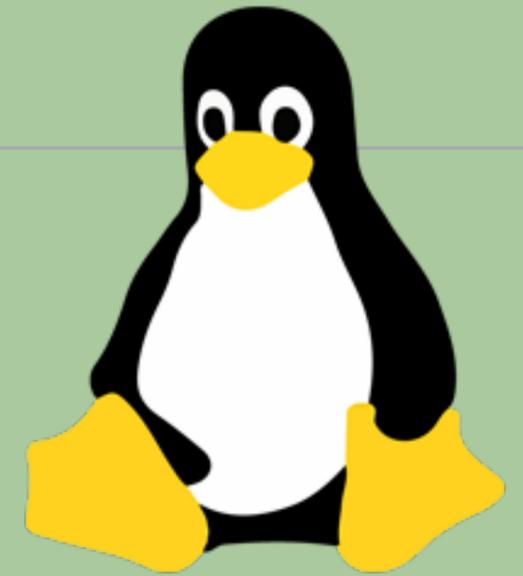
- ▶ GNU's suite of tools and programs were mature by 1991
- ▶ GNU lacked a "**kernel**", or the core component around which the operating system is based
- ▶ Kernel considered to be the **last missing piece of GNU**

Linux Kernel - Core of Operating System



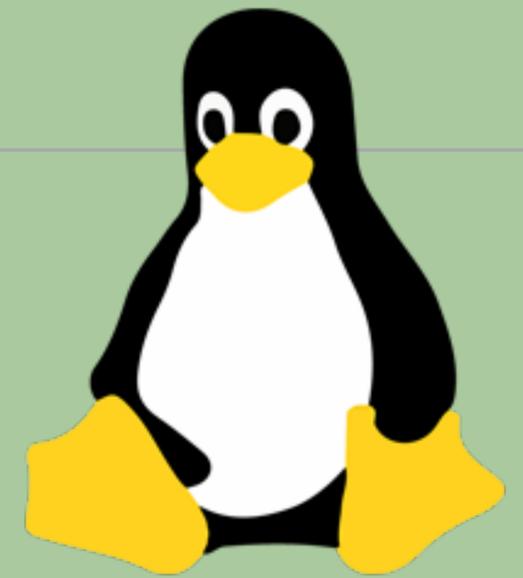
GNU / LINUX

- ▶ 1991: Torvalds creates a kernel for the GNU operating system
- ▶ Names the new kernel "**LINUX**"
- ▶ Introduces a completed GNU/LINUX operating system



GNU / LINUX

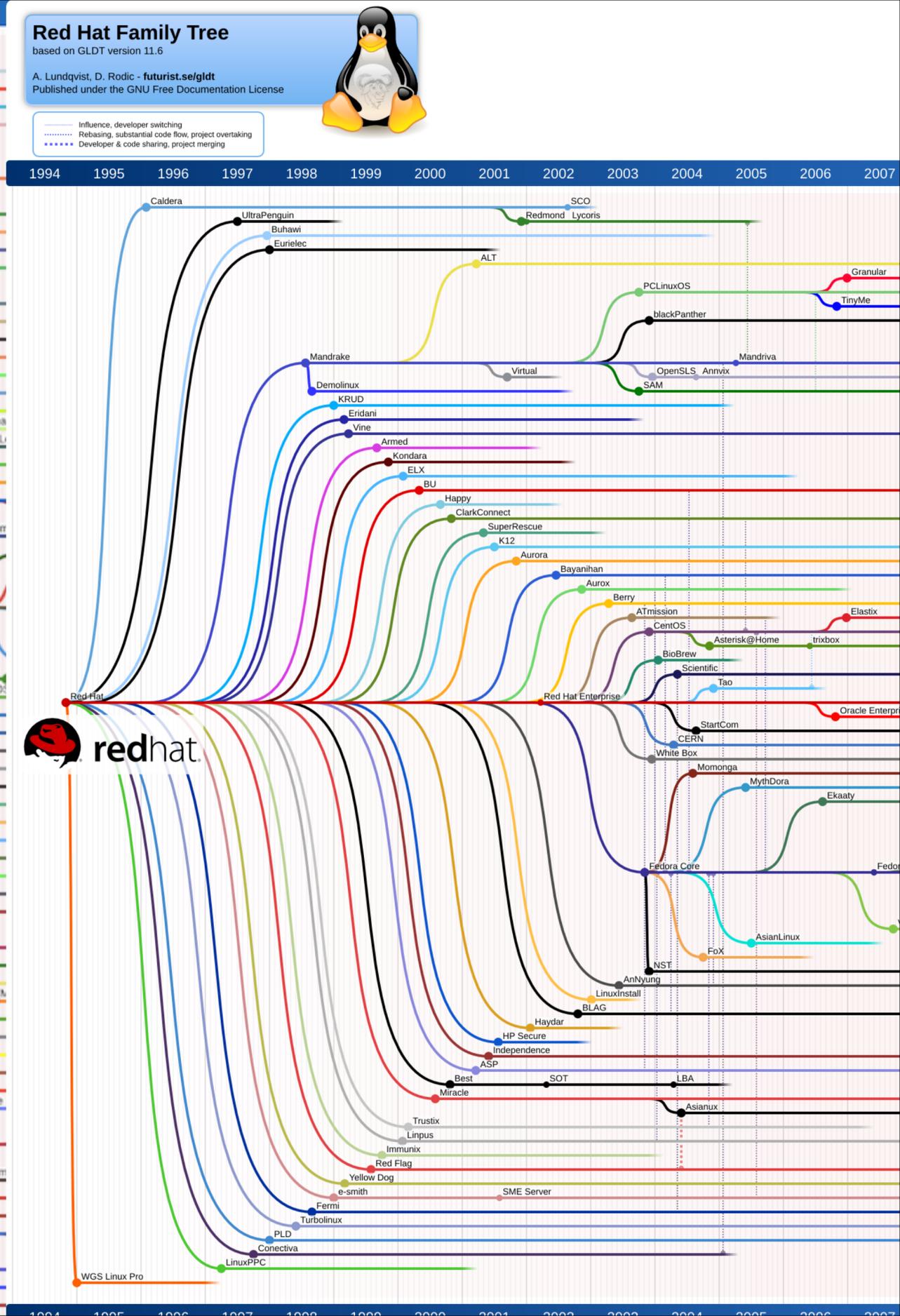
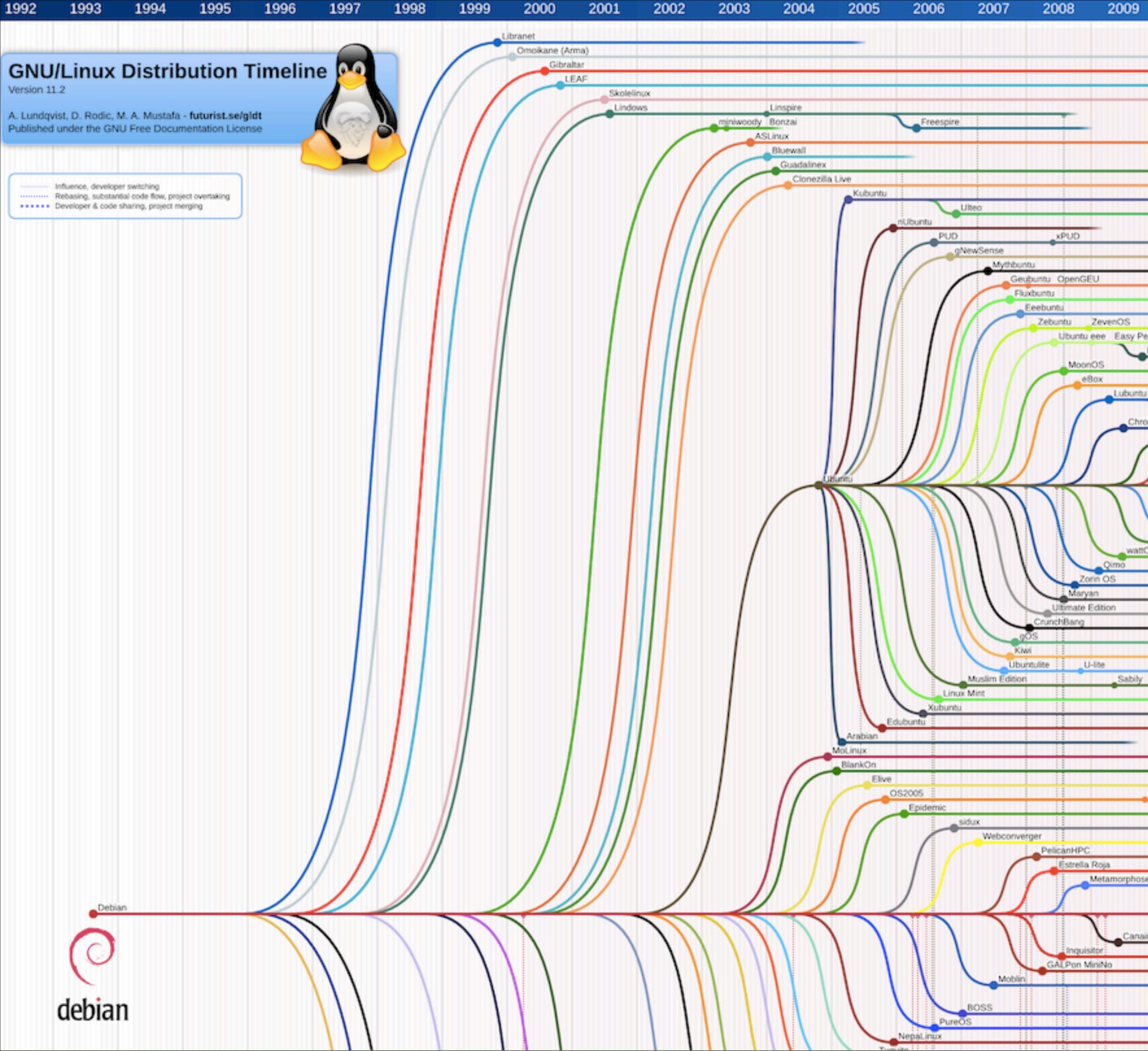
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- ▶ Introduces a completed GNU/LINUX operating system
- ▶ First freely available, UNIX-like OS (**with no UNIX code**)



GNU / LINUX

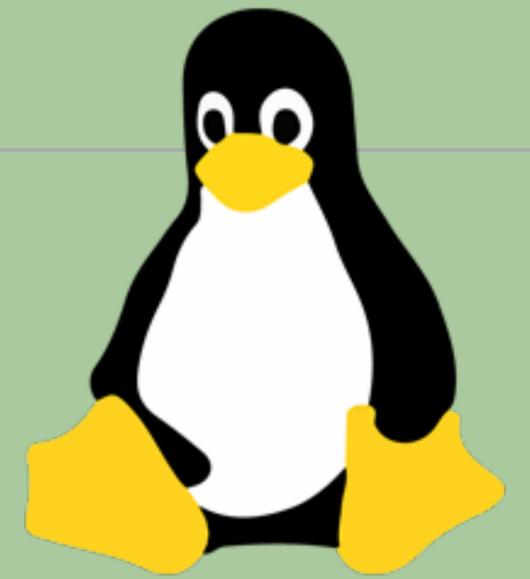


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- ▶ Names the new kernel "**LINUX**"
- ▶ Introduces a completed GNU/LINUX operating system
- ▶ First freely available, UNIX-like OS (**with no UNIX code**)
- ▶ **General Public License** (Free Software Foundation)
 - ▶ Linux proliferates like crazy
 - ▶ Geeks proceed to argue about what to call it (Linux or GNU/Linux)



GNU / LINUX

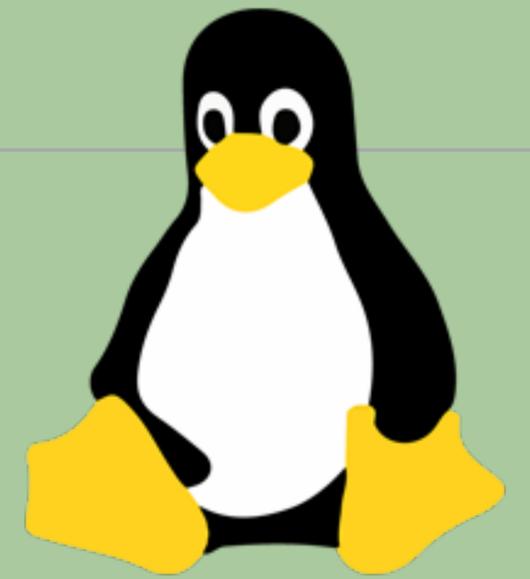
DERIVATIVE OPERATING SYSTEMS



GNU / LINUX

DERIVATIVE OPERATING SYSTEMS

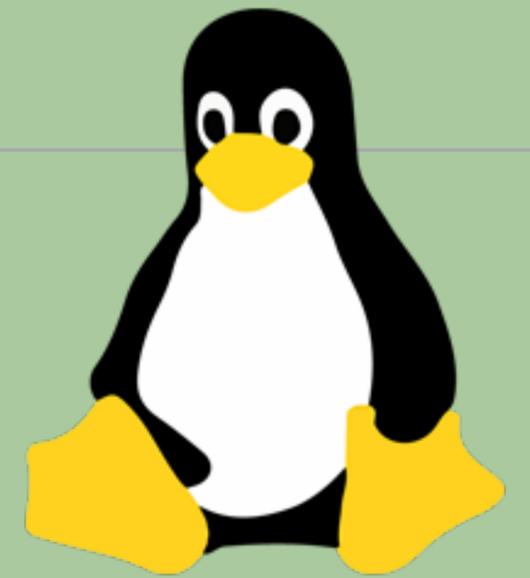
- ▶ Android



GNU / LINUX

DERIVATIVE OPERATING SYSTEMS

- ▶ Android
- ▶ Google Chrome OS



GNU / LINUX

DERIVATIVE OPERATING SYSTEMS

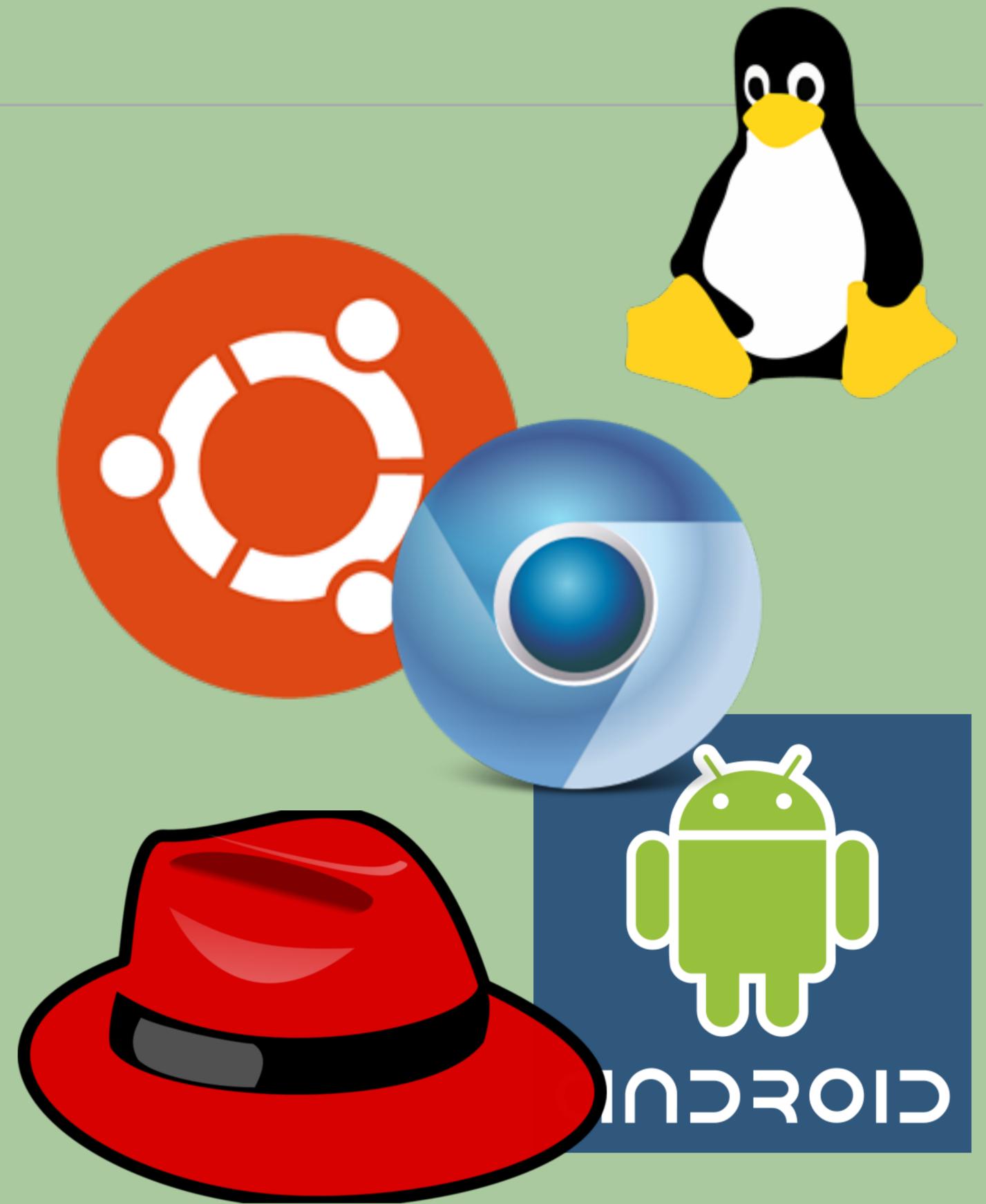
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GNU / LINUX

DERIVATIVE OPERATING SYSTEMS

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GNU / LINUX

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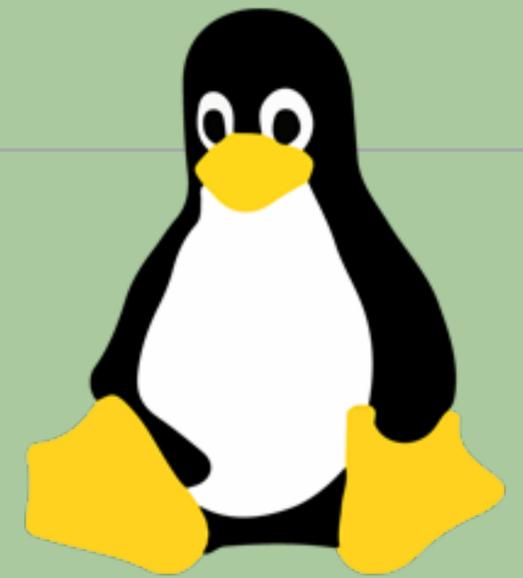
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GNU / LINUX

DERIVATIVE OPERATING SYSTEMS

- ▶ Android
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- ▶ SteamOS



THE

END.