



SWCON201
Opensource & Software
Development Methods and Tools

Selecting Right OS

Department of
Software Convergence

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- Summary
- Reference
- Discussion
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Agenda

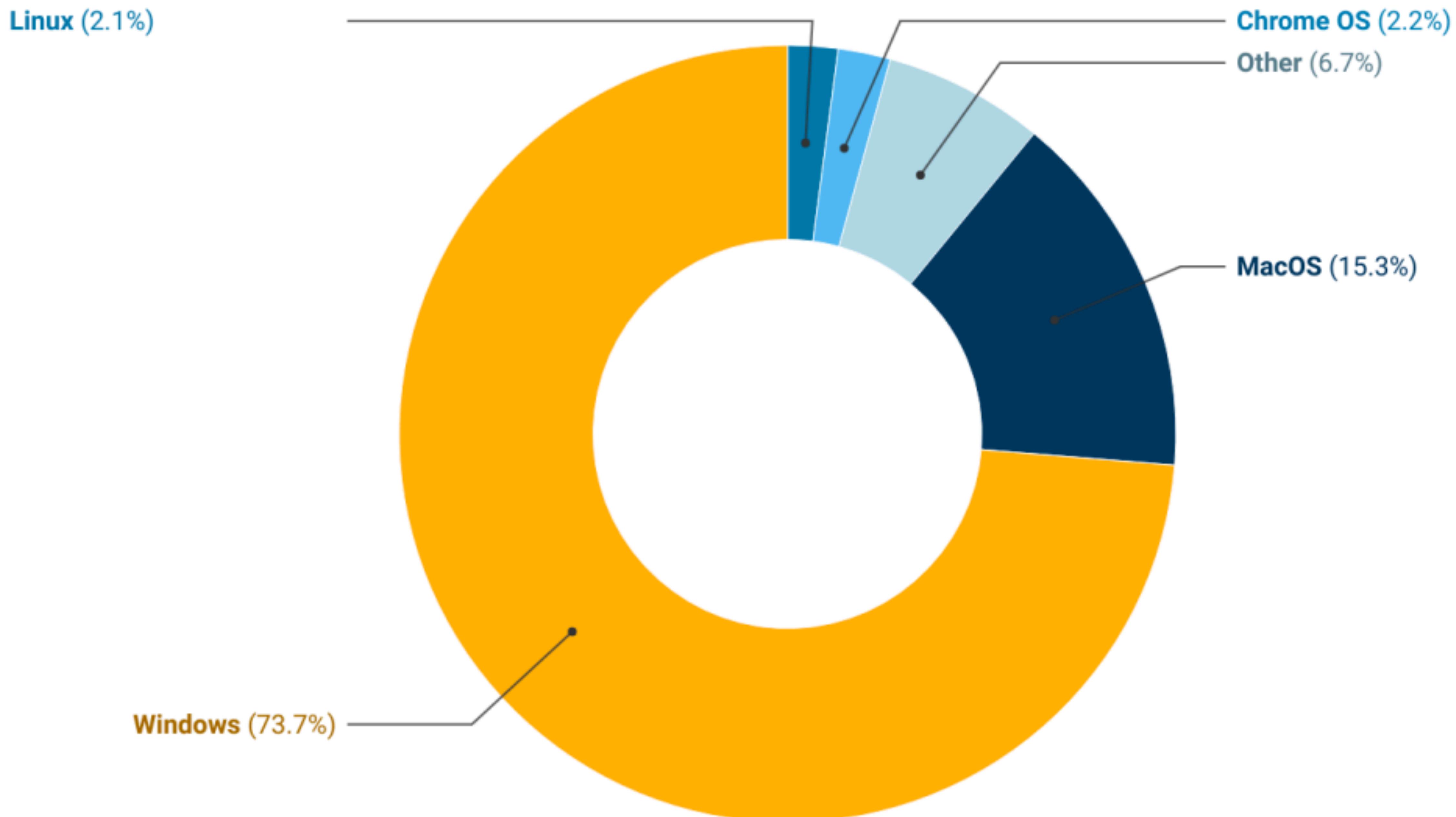
- How many OSs did you use? Why?
- What's your decision point for selecting OS?

Background for selecting OS

- Business
 - ◆ Market share
- Technical requirement
 - ◆ Distributed, Multi & Parallel processing
 - ◆ Realtime processing
 - ◆ Extremely small hardware resource environment
 - ◆ Secure computing
 - ◆ etc

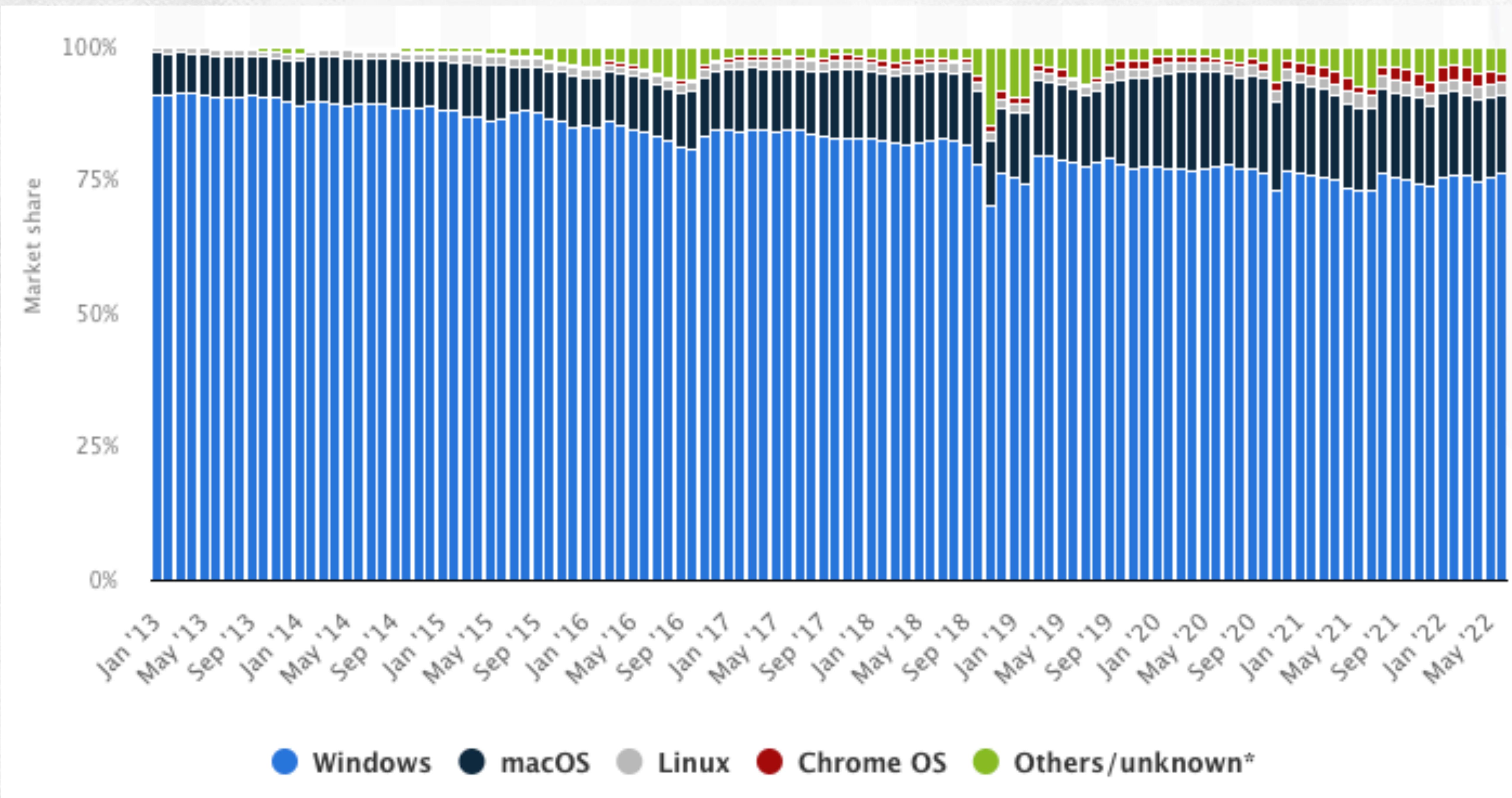
Market Share (PC/Desktop, 2022)

Leading Desktop Operating System Worldwide by Market Share



Source: Enterprise Apps Today

Market Share (PC/Desktop, 2013~2022)

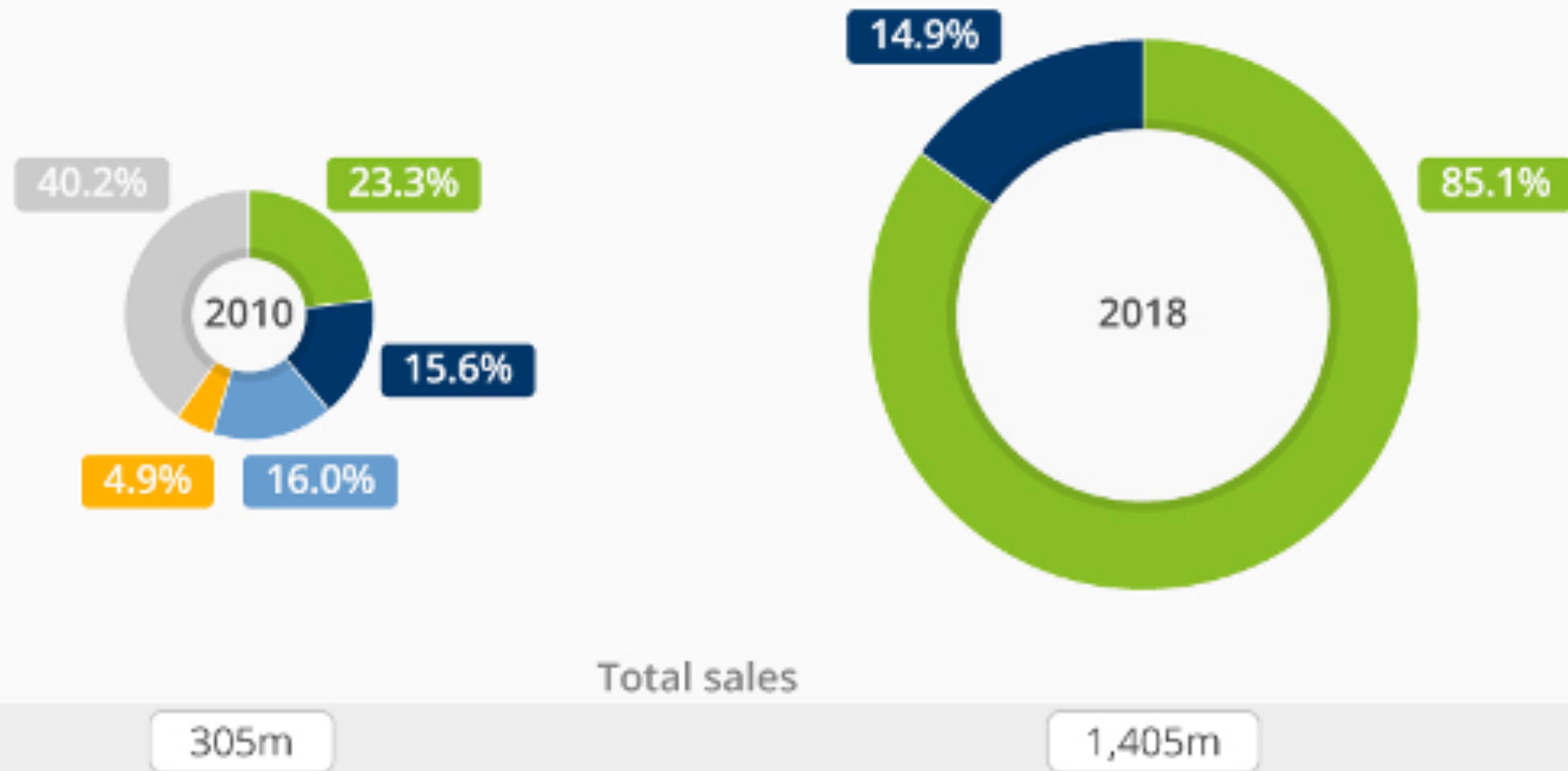


Market Share (Mobile, 2019)

The Smartphone Duopoly

Worldwide smartphone market share by operating system (based on unit shipments)

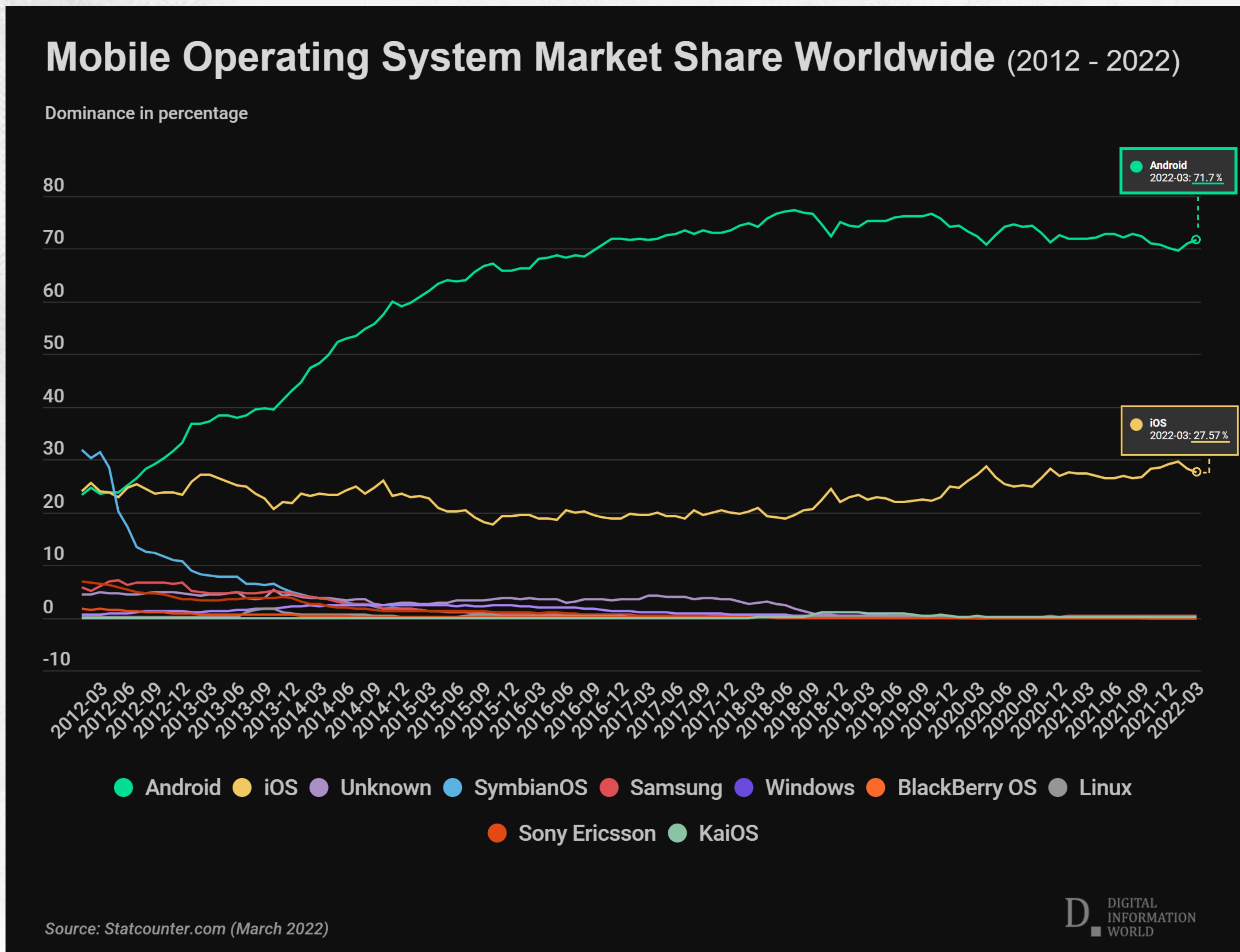
● Android ● iOS ● BlackBerry ● Windows Phone ● Others



@StatistaCharts Source: IDC

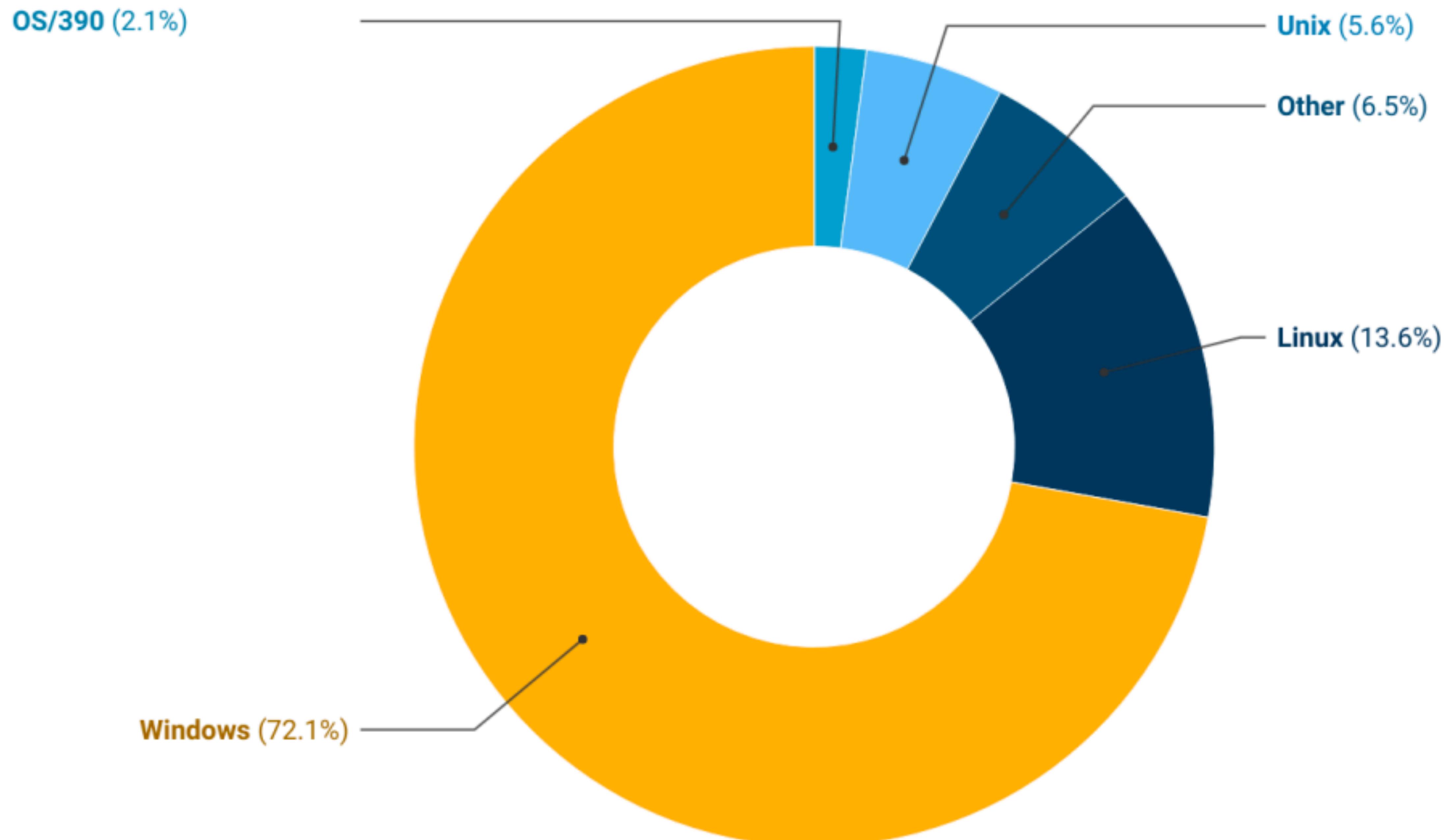
statista

Market Share (Mobile, 2012~2022)



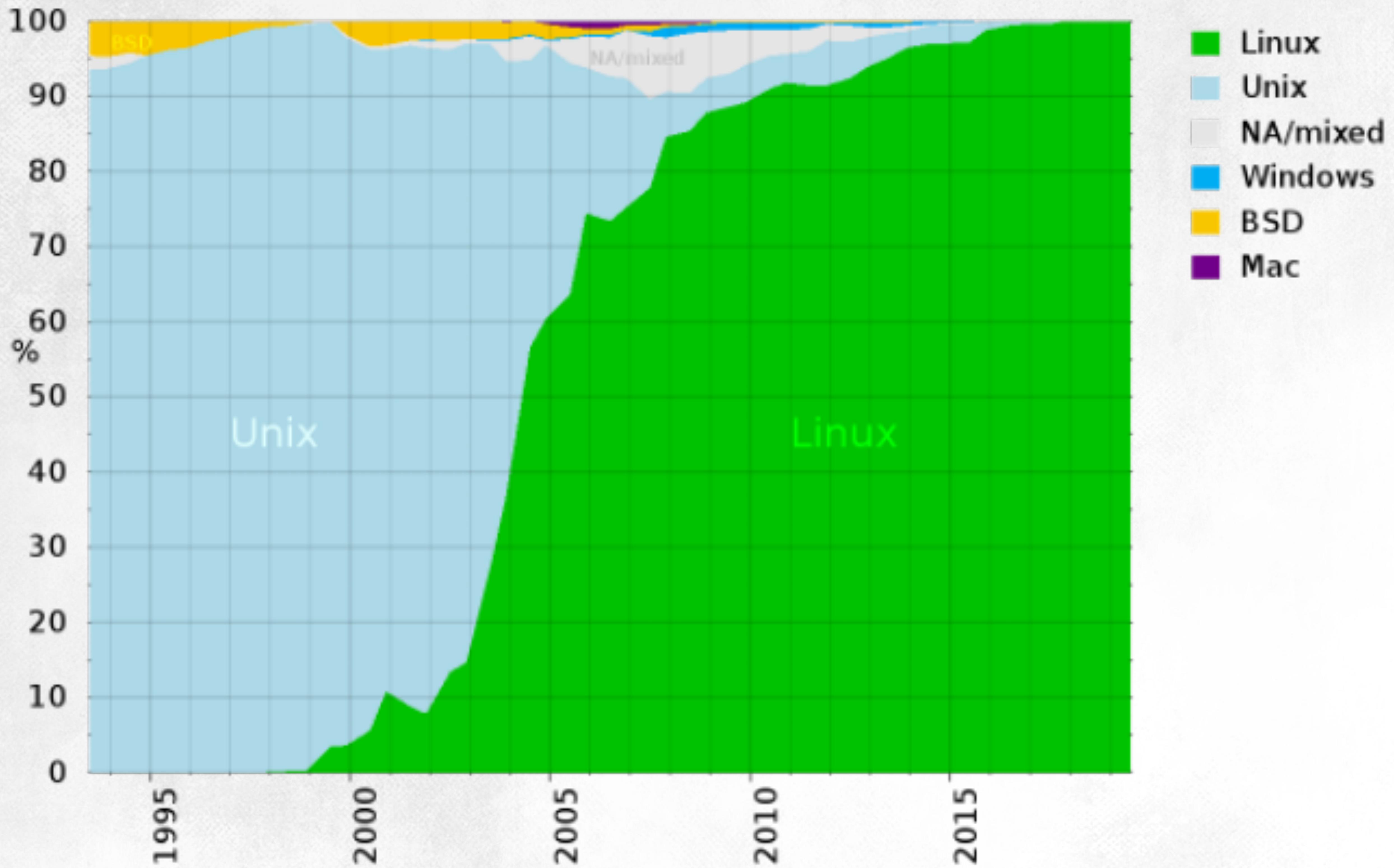
Market Share (Servers, 2022)

Server Market Share Worldwide by Operating System



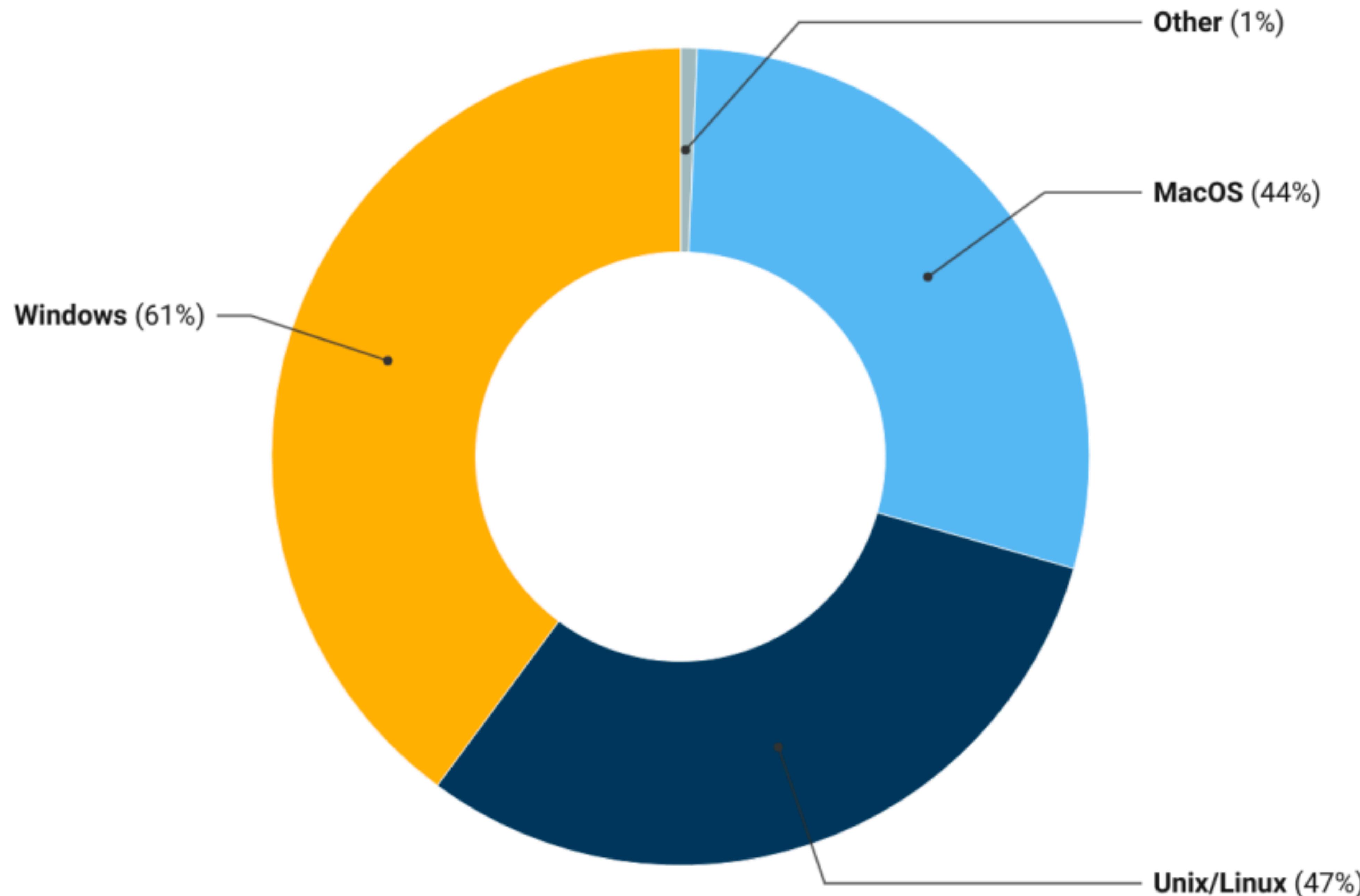
Source: Enterprise Apps Today

Market Share (Supercomputers, 2017)



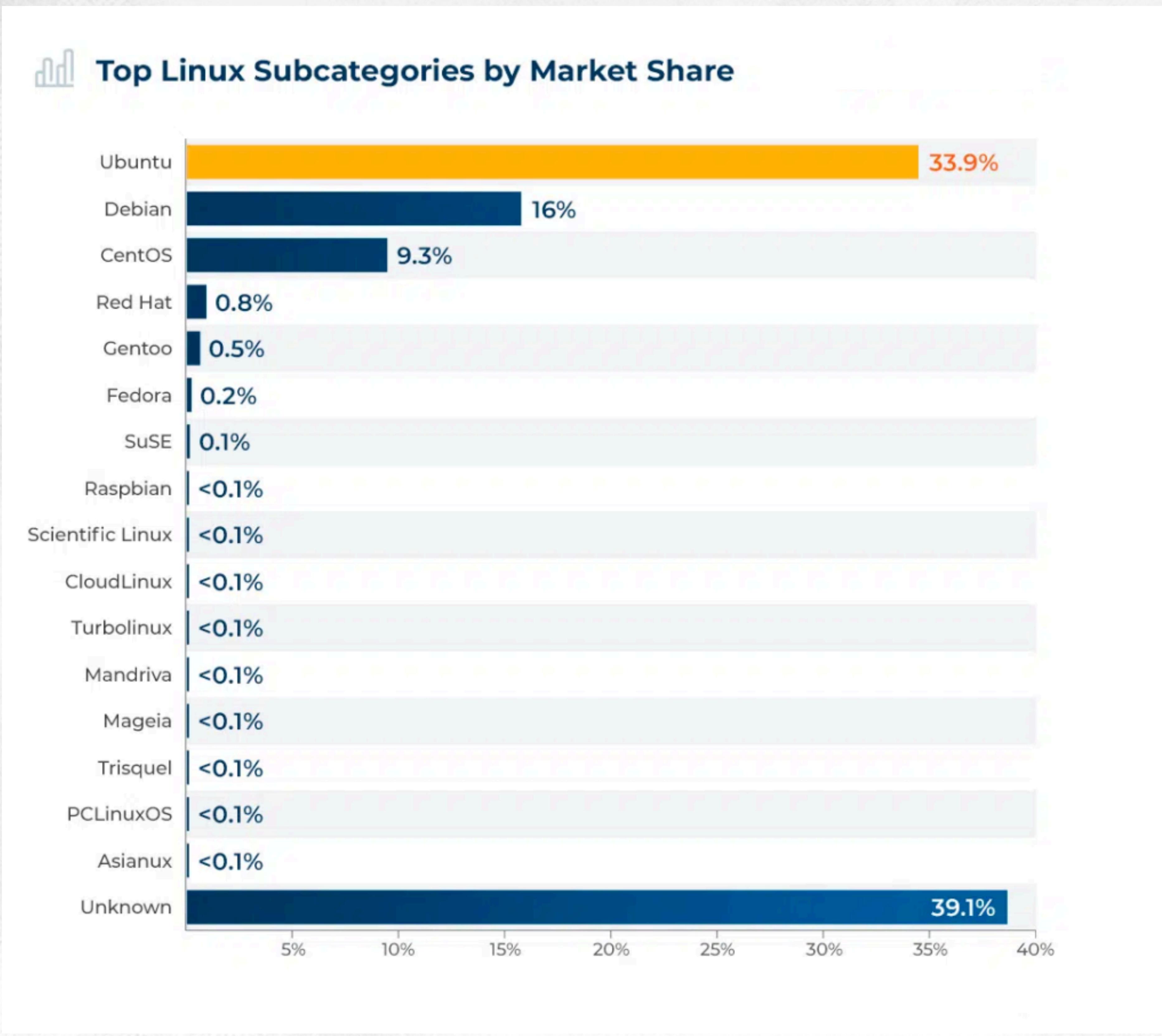
Market Share (Developers, 2022)

Primary operating System Among Professional Developers



Source: enterprise Apps Today

Market Share (Linux Distros, 2022)



Market Share (Linux, 2022)

- Pro developers are enthusiastic about using Linux operating systems and are like **47%**. (Statista)
 - Its capabilities account for **39.2% of websites** whose operating systems are known. (W3Techs)
 - **85% of smartphones** are powered by Linux (Hayden James).
 - Its marketing share is **2.09 %.** is, without doubt, third in Statista's top ten most used desktop operating systems.
 - By 2027, the global Linux market will reach **\$15.64 trillion**. (Fortune Business Insights).
- Linux is the operating system of all the world's fastest supercomputers. (Blackdown)
 - **96.3%** of The top **1,000,000** web servers use Linux. (ZDNet)
- Active Linus distros are still available today(Tecmint).

Market Share (Linux, 2022)

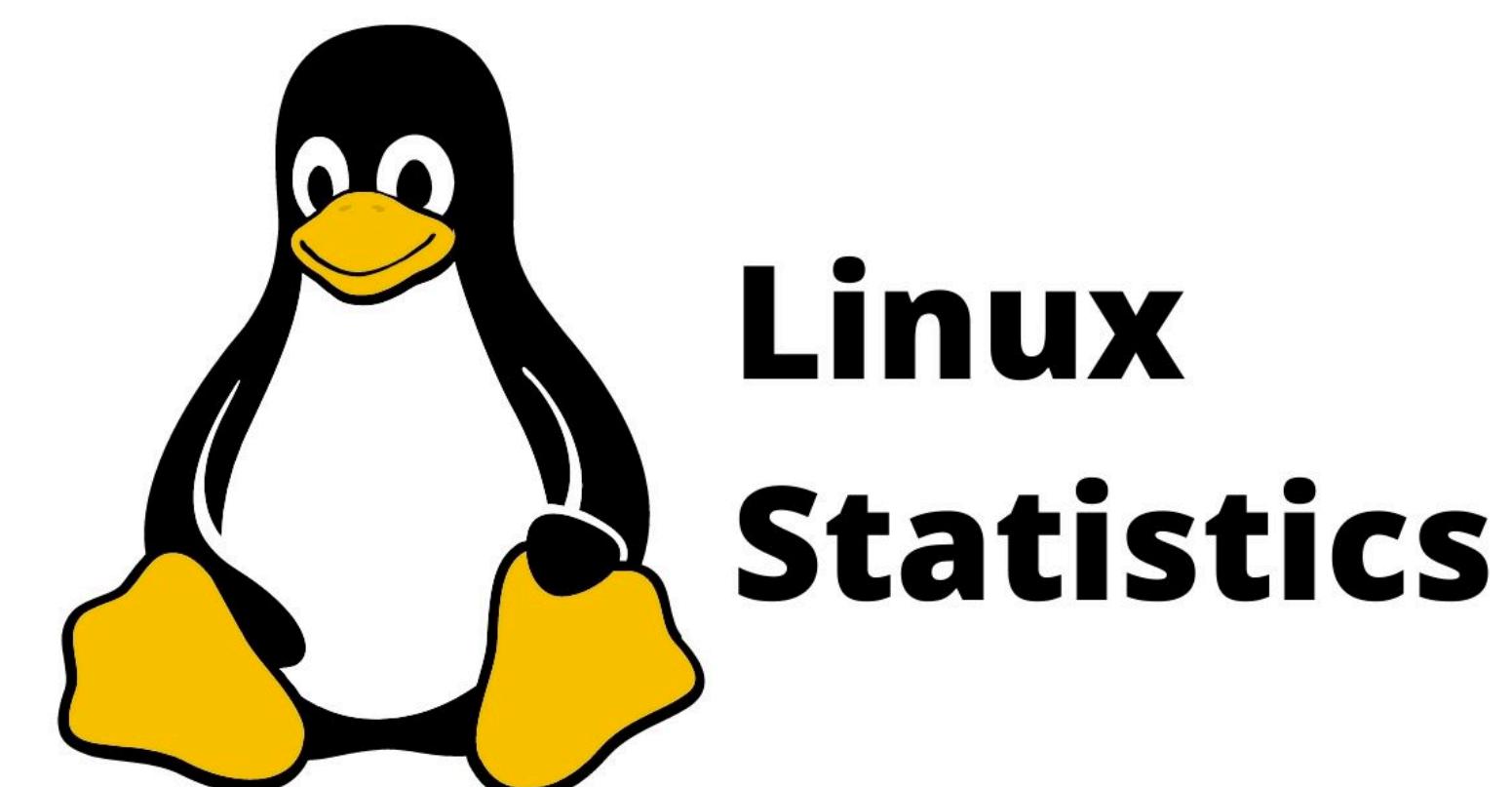
- Women were 9.9% of all Linux kernel Git users.
- Linux boasts more than a 27.8million lines of code.
- SpaceX used Linux-supported Linux systems to successfully complete 65 missions.
- 90+% of Hollywood special effects can be achieved using Linux.

"Linux is used to create amazing special effects. Linux is used in more than 90% of Hollywood visual effects. Linux statistics show that Linux is more popular than other operating systems due to its flexibility, open-source code, and superior performance. (Source: Werts)"

- Steam users are using Linux for 0.44%.
- Intel Technologies and Huawei Technologies rank among the top two contributors to Linux Kernel.
- In 2027, the market of Linux worldwide will exceed \$15.64Billion.
- As of 2017, Linux users are around 90% of cloud infrastructure

Market Share (Linux, 2022)

- Linux is used to power 96.3% of the world's top web servers.
- Today, over 600 Linux distros are active.
- The US has almost two million Ubuntu websites.
- 50% of users saw AI and Machine Learning as the next big area of growth for Ubuntu OS.
- Over 1,000 developers have contributed to the Debian Project.

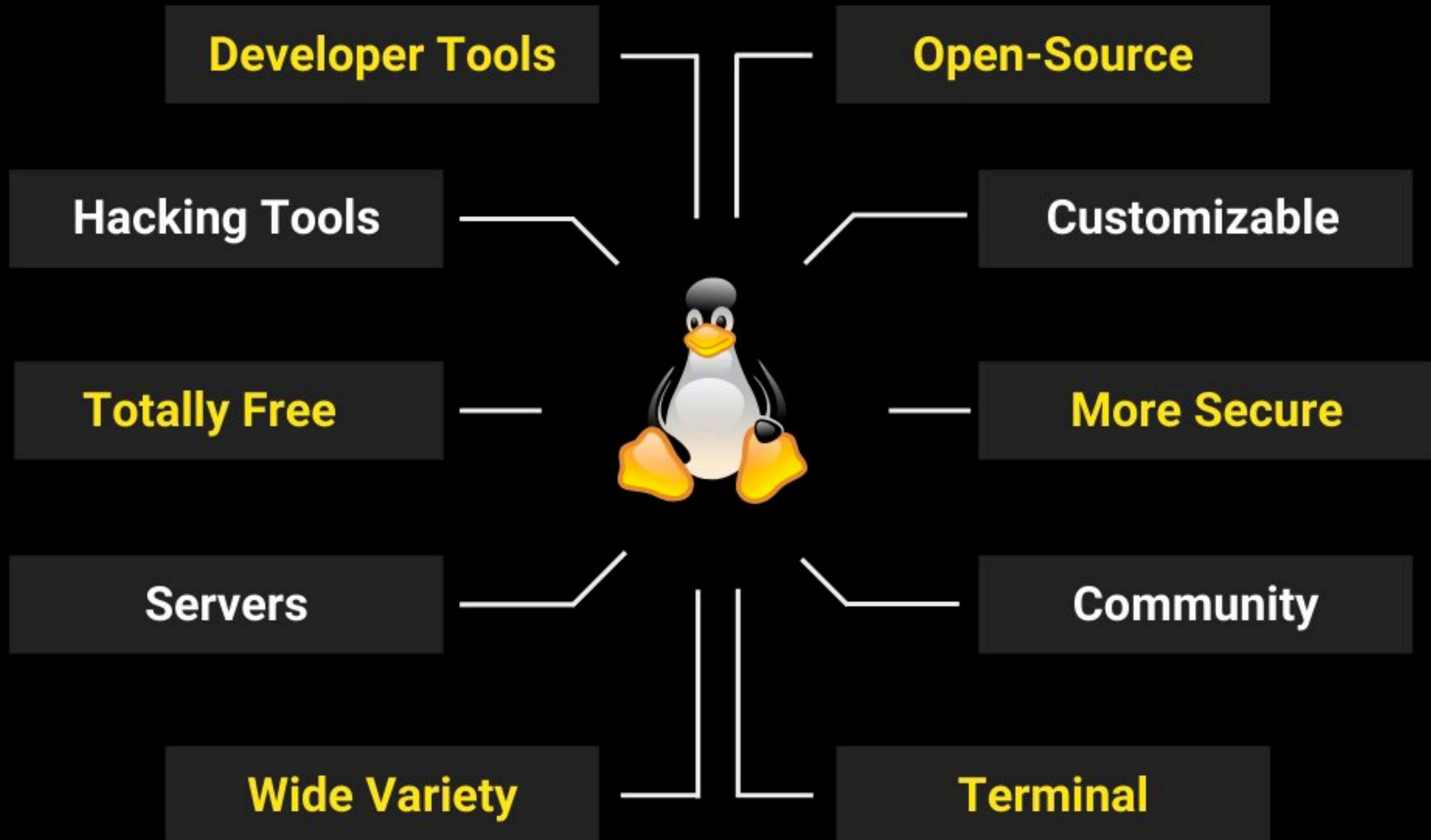


10 REASONS WHY LINUX

- 1st Linux is Open*
- 2nd Linux is Multi-user*
- 3^d Linux is "Free"*
- 4th Linux is Reliable*
- 5th Linux is Backwards-Compatible*
- 6th Linux is Network-friendly*
- 7th Linux is stable*
- 8th Linux is virus free*
- 9th Linux really fast*
- 10th Linux has awesome graphics*



Market Share (Why Linux?)



Linux Foundation

Actively manage your open source project health with LFX Insights. [Learn how.](#)

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Decentralized innovation. Built on trust.

The Linux Foundation provides a neutral, trusted hub for developers and organizations to code, manage, and scale open technology projects and ecosystems.

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850
[open source
projects >](#)

2M+
[developers
trained >](#)

777K
[developers
contributing code >](#)

51M
[lines of code
added weekly >](#)

17K
[contributing
organizations >](#)

70+
[upcoming
events >](#)

2022



KYUNG HEE UNIVERSITY

Reference: <https://www.linuxfoundation.org/> 18

Linux (Open-source Distributed/Multi/Parallel Server OS)

- Linux is a true 32 bit UNIX-like OS developed originally for home PCs, but now it runs on a variety of platforms including PowerPC, Macintosh, Amiga, DEC Alpha, Sun Sparc, ARM, and many others
- The source code for Linux is freely available to everyone
- Linux was created by Linus Torvalds in 1991, and it has been developed with the help of many programmers across the Internet
- Now it has evolved into a very functional, powerful and usable clone of Unix which has at least 10 million users worldwide
- A Linux Distribution has thousands of dollars worth of software for no cost.
- Linux provides a complete development environment

Linux (Open-source Distributed/Multi/Parallel Server OS)

- Linux is a complete operating system:
 - ◆ Stable - the crash of an application is much less likely to bring down the OS under Linux.
 - ◆ Reliable - Linux servers are often up for hundreds of days compared with the regular reboots required with a Windows system.
 - ◆ Extremely powerful

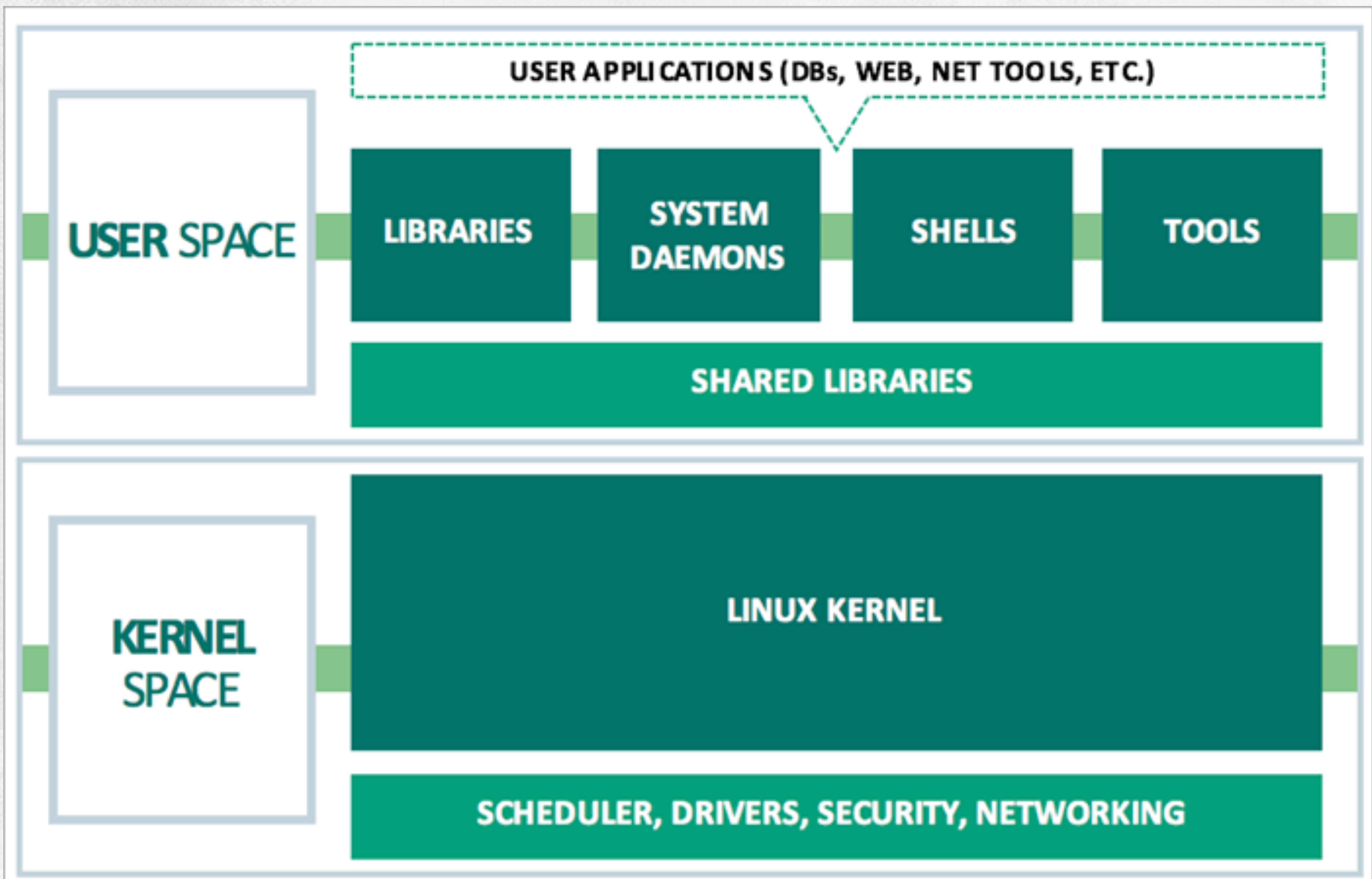
Linux (Open-source Distributed/Multi/Parallel Server OS)

- Excellent networking facilities
- Ideal environment to run servers such as a web server, or an ftp server.
- A wide variety of commercial software is available if not satisfied by the free software
- Easily upgradeable.
- Supports multiple processors.
- True multi-tasking, multi-user OS.
- An excellent window system called X, the equivalent of Windows but much more flexible.
- Full source code is provided and free.

Linux (Open-source Distributed/Multi/Parallel Server OS)

- The Linux system excel in many area, ranging from end user concerns such as stability, speed, ease of use, to serious concerns such as development and networking.
 - Linux kernel
 - Linux networking
 - Linux file system

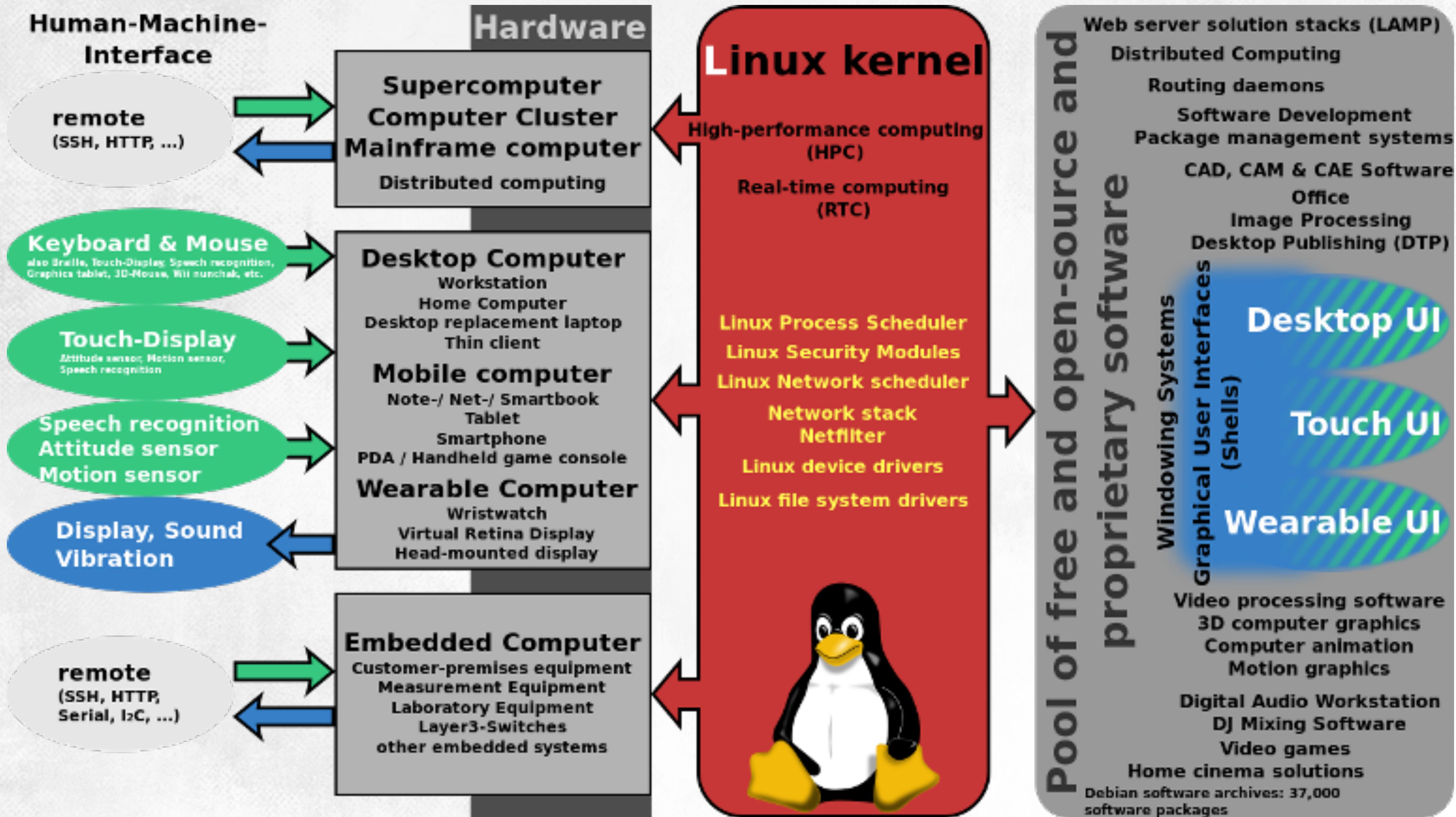
Linux Kernel



Linux Kernel

- The kernel is the central nervous system of Linux, include OS code which runs the whole computer.
- It provides resources to all other programs that you run under Linux, and manages all other programs as they run.
 - The kernel includes the code that performs certain specialized tasks, including TCP/IP networking.
 - The kernel design is modular, so that the actual OS code is very small to be able to load when it needs, and then free the memory afterwards, thus the kernel remains small and fast and highly extensible.

Linux Kernel - Ubiquity



Linux Networking

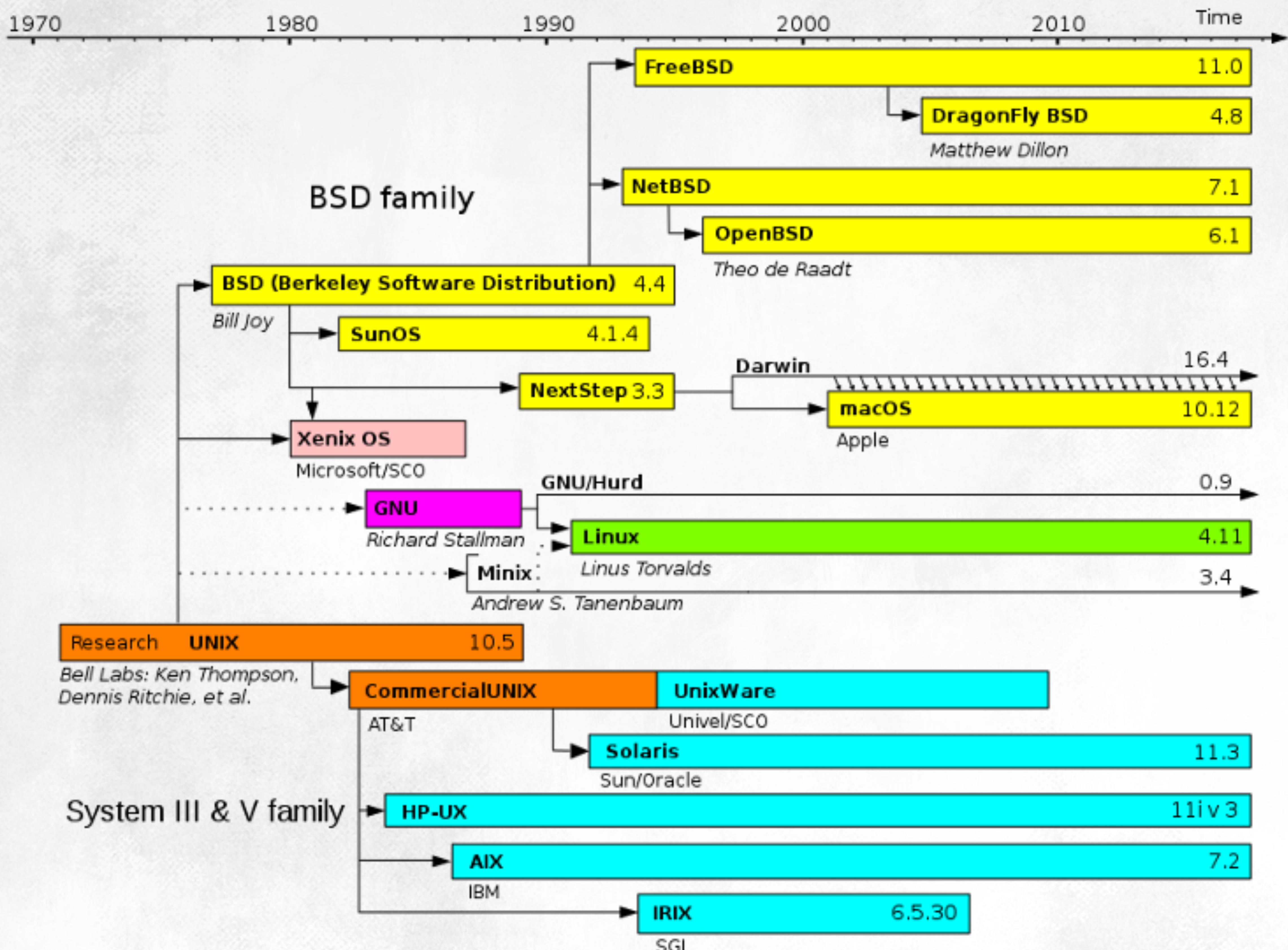
- Networking comes naturally to Linux. In a real sense, Linux is a product of the Internet or World Wide Web (www).
- Linux is made for networking. Probably all networking protocols in use on the Internet are native to Unix and/or Linux. A large part of the Web is running on Linux boxes, e.g. : AOL.

Linux Is Not Unix

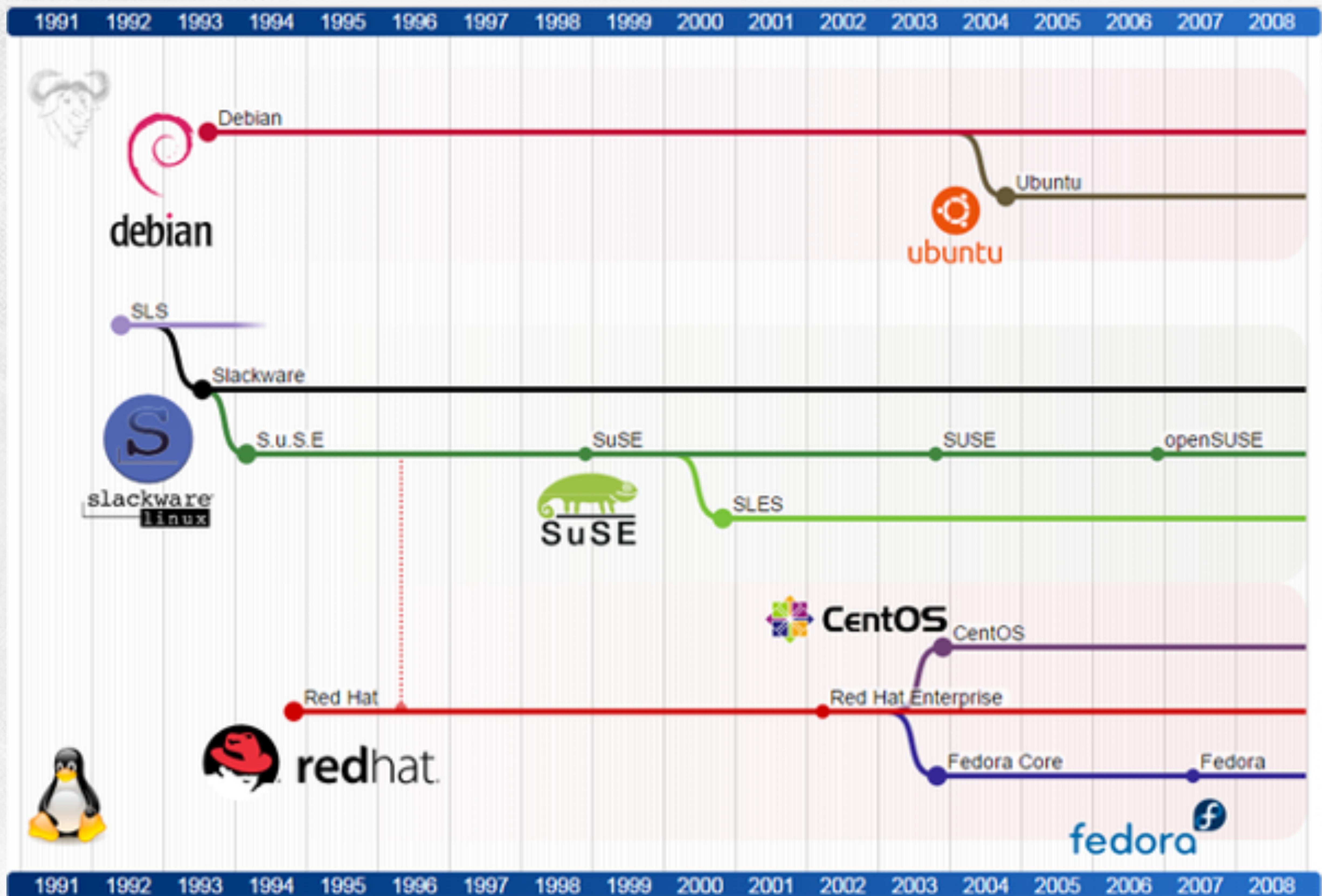
PARAMETERS	LINUX	UNIX
Inception Year	1991	1969
Standard	Open source operating system which is freely available	Operating system can only be used by its copywriters
System type	Just the kernel	Complete Operating system
Target use	Can be used by anyone including home user and developer.	Developed mainly for servers, workstations and mainframes.
Cost	LINUX is freely available and distributed with no associated cost.	UNIX variants come as customized cost.
Security	60-100 viruses listed till date	85-120 viruses listed till date
Interface type	Primarily uses GUI with option of CLI	Primarily uses CLI
Portability	Portable	Not portable
Variants	Ubuntu, RedHat, Solaris, OpenSuse, etc.	AIX, HP-UX, BSD, etc
Source Code	The source code of Linux is available in general public.	The source code not available in general public.

<https://ipwithease.com>

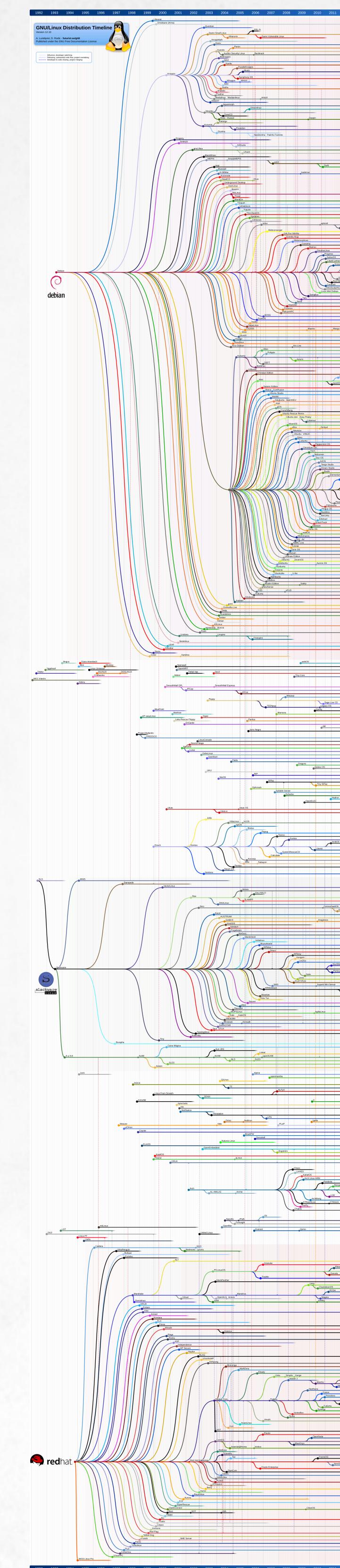
Linux & Unix



Linux Distros

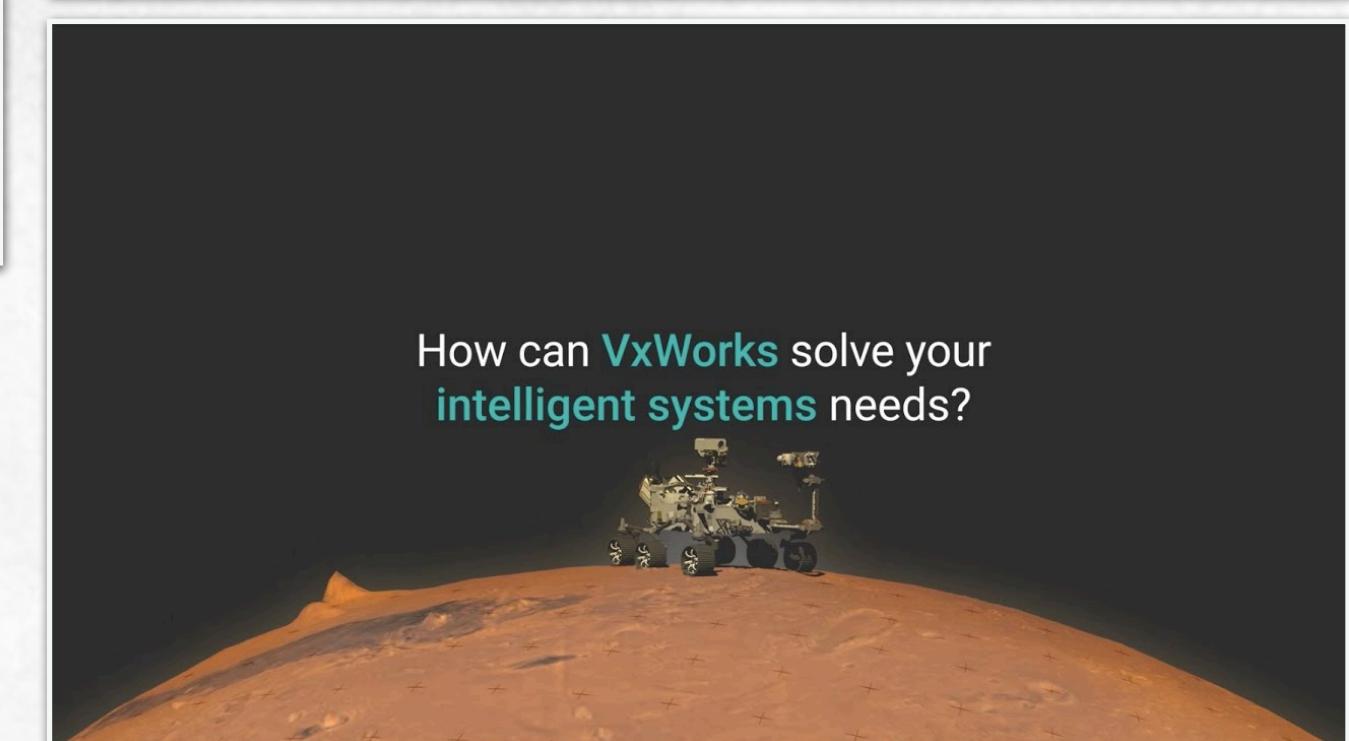


Linux Distros



Reference: <https://futurist.se/gldt/wp-content/uploads/12.10/gldt1210.png> 30

VxWorks (Commercial RTOS)



VXWORKS THE #1 COMMERCIALLY DEPLOYED RTOS

LEADING PROVIDER OF SAFE, SECURE, AND RELIABLE OPERATING SYSTEMS



PROVEN
in hundreds of safety-critical projects across multiple industries and certification standards

LEADING PROVIDER
of embedded hypervisor to support hard real-time OSes with true multi-core capability

BROAD SPECTRUM
of embedded processor support: 32-bit, 64-bit, and multi-core capabilities on ARM, Intel, and Power Architecture

INDUSTRY-LEADING
real-time, deterministic RTOS for safe and secure applications



MARKET LEADERSHIP

25+ years in space missions
35+ years in the industrial market
12+ years in the automotive industry
35+ years in the aerospace and defense market
23% market share among commercial RTOS vendors

600+ SAFETY CERTIFICATION PROGRAMS

20 YEARS' EXPERIENCE IN SAFETY CERTIFICATION SOFTWARE PRODUCTS



MARKET LEADERSHIP DOESN'T JUST HAPPEN. IT'S EARNED.

WIND

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VxWorks (Commercial RTOS)

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News Byte

July 25, 2017

Contact Intel PR

Report: Intel Inside New Audi Autonomous Car System

Intel processing power will be part of autonomous driving systems on the 2018 Audi A8, it was unveiled today.

The Silicon Valley Business Journal reported that Audi will use processors from Intel's Programmable Solutions Group (PSG) and from its Wind River subsidiary as part of the self-driving system that will allow for Level 3 autonomous driving, among the most sophisticated technology that will be on the road.

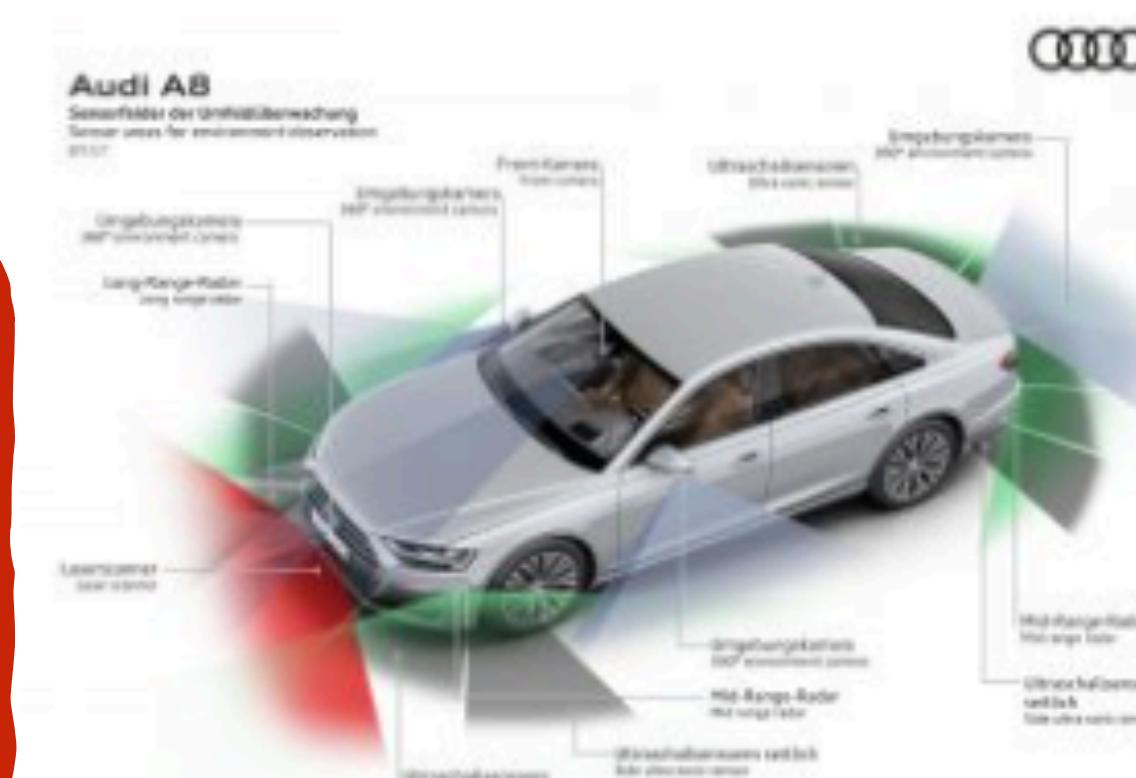
The Business Journal quoted Michael Hendricks, automotive director for PSG:

"If you look across all these different solutions you've got the FPGA (field-programmable gate array) ... and the operating system. So a lot of Intel content (is in) the world's first Level 3 autonomous driving system."

Intel created its Programmable Solutions Group from the former Altera Corp. Intel closed on its [acquisition of Altera](#) in December 2015. PSG is responsible for Intel's field programmable gate array technology. FPGAs allow for great flexibility in the programming of hardware and software, and are often used in the Internet of Things and the data center.

Wind River, an Intel company, supplies the VxWorks operating system for the highly scalable, safety-related electronic control unit. As the underlying software platform, VxWorks maintains and monitors the safety of critical applications.

The Business Journal also reported on Hendricks' comments:



[» Click for full size image](#)

Sensors that provide information to the autonomous driving systems surround the 2018 Audi A8. (Credit: Audi)

Latest News: Automotive



April 12, 2021

[Autonomous Driving / Mobileye](#)



April 12, 2021

[Mobileye and Udely Ink Deal for Autonomous Delivery](#)



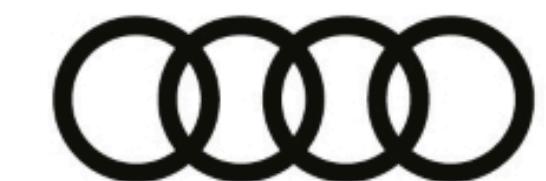
February 25, 2021

[Mobileye, Transdev ATS and Lohr Group To Develop AV Shuttles](#)

[Read More](#)

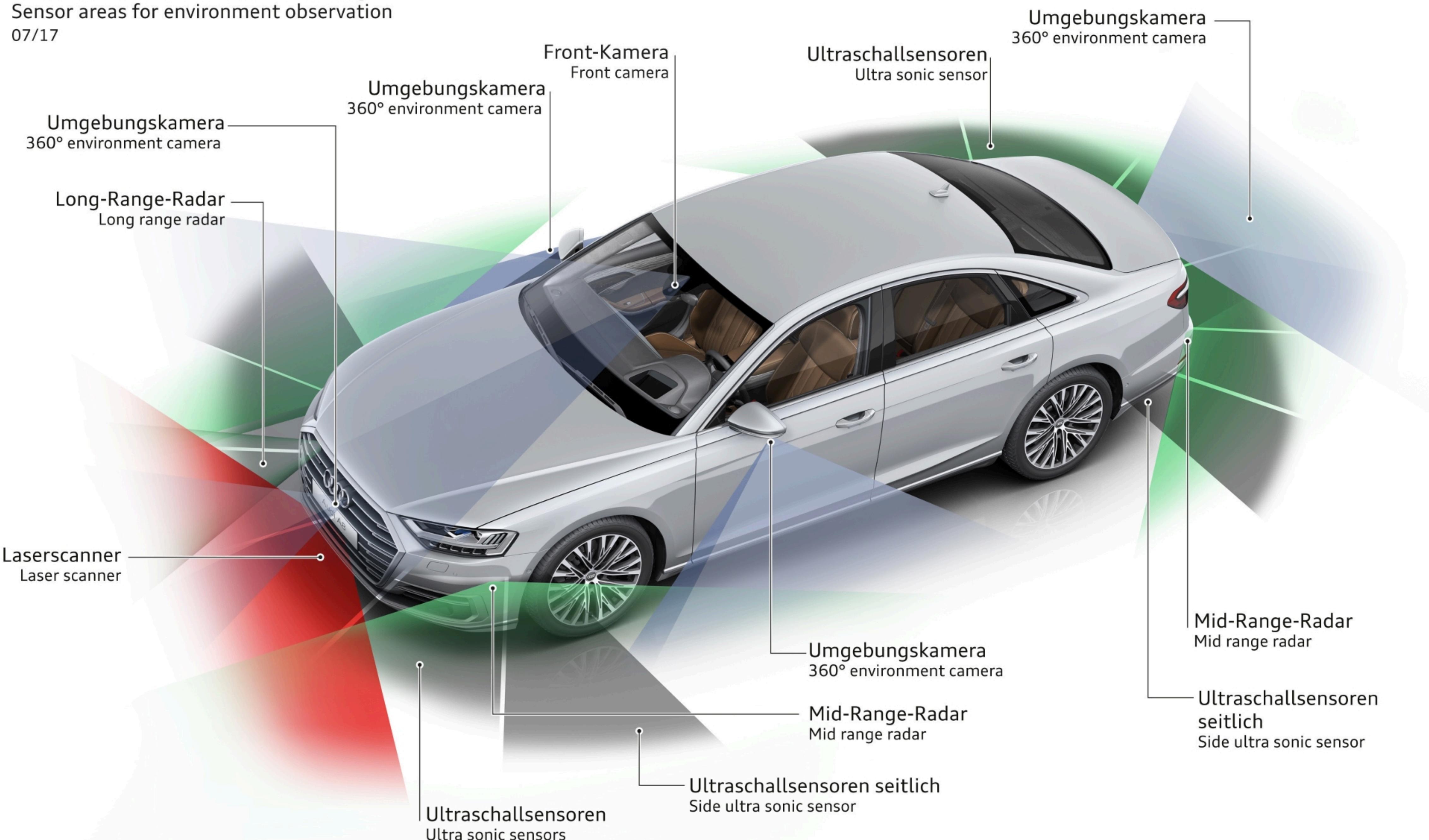


VxWorks (Commercial RTOS)



Audi A8

Sensorfelder der Umfeldüberwachung
Sensor areas for environment observation
07/17



VxWorks (Commercial RTOS)

- VxWorks is a real-time operating system (RTOS) developed as proprietary software by Wind River, an Intel Company of Alameda, California, US.
- First released in 1987, VxWorks is designed for use in embedded systems requiring real-time, deterministic performance and, in many cases, safety and security certification, for industries, such as aerospace and defense, medical devices, industrial equipment, robotics, energy, transportation, network infrastructure, automotive, and consumer electronics.

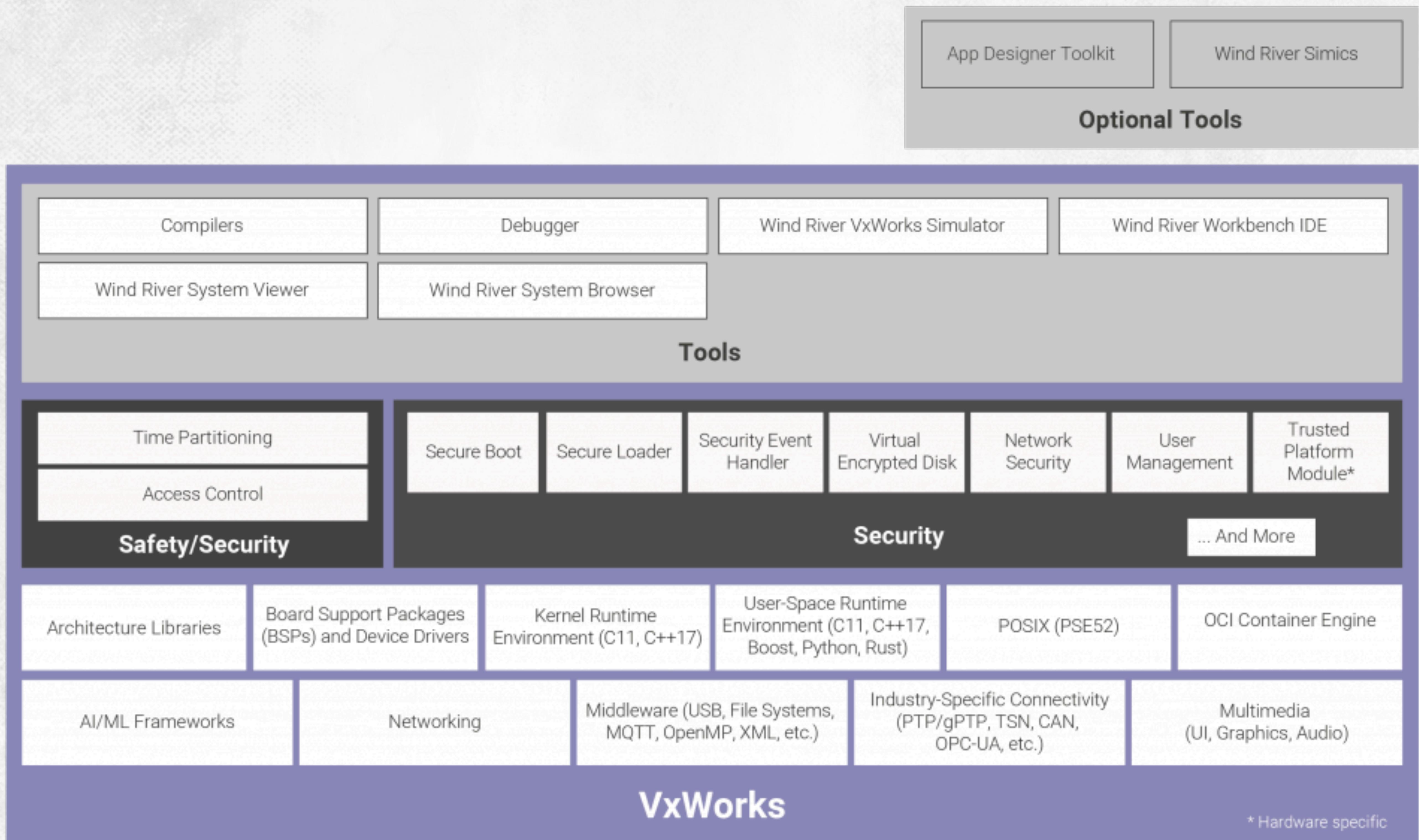
VxWorks (Commercial RTOS)

- Multitasking kernel with preemptive and round-robin scheduling and fast interrupt response
- Native 64-bit operating system (only one 64-bit architecture supported: x86-64). Data model: LP64.
- User-mode applications ("Real-Time Processes", or RTP) isolated from other user-mode applications as well as the kernel via memory protection mechanisms.
- SMP, AMP and mixed mode multiprocessing support
- Error handling framework
- Bluetooth, USB, CAN protocols, Firewire IEEE 1394, BLE, L2CAP, Continua stack, health device profile

VxWorks (Commercial RTOS)

- Binary, counting, and mutual exclusion semaphores with priority inheritance
- Local and distributed message queues
- Memory protection including real-time processes (RTPs), error detection and reporting, and IPC
- Symbolic debugging

VxWorks (Commercial RTOS) - Kernel



RTL (Real Time Linux collaborative project)

The Real Time Linux collaborative project was established to help coordinate the efforts around mainlining Preempt RT and ensuring that the maintainers have the ability to continue development work, long-term support and future research of RT. In coordination with the broader community, the workgroup aims to encourage broader adoption of RT, improve testing automation and documentation and better prioritize the development roadmap.

[Read more about the RTL collaborative project](#)

The RTL Collaborative Project

The RTL Collaborative Project was first [announced](#) in October 2015.

The Real-Time Linux (RTL) Collaborative Project was founded by industry experts to advance technologies for the robotics, telecom, manufacturing, and medical industries. The RTL Collaborative Project will initially focus on pushing critical code upstream to be reviewed and later merged into the mainline Linux kernel with ongoing support. RTL's Thomas Gleixner, who has been maintaining the RTL branch for more than a decade, will become a Linux Foundation Fellow to dedicate even more time to this project.

Table of Contents

- ❖ Versions of PREEMPT_RT patches
- ❖ Participation
- ❖ Communication
- ❖ Documentation
- ❖ Blog
- ❖ Past Events

Zephyr (OS for Resource Constrained Device)

THE LINUX FOUNDATION PROJECTS



Resources ▾ Community ▾ Learn ▾ Members ▾ Contact

Become a Member



The Zephyr® Project strives to deliver the best-in-class RTOS for connected resource-constrained devices, built to be secure and safe.

[LEARN MORE](#)



- Developed with security in mind
- Includes CNA with PSIRT response team



- Available through the Apache 2.0 open source license
- Free to use in commercial and non-commercial solutions



- Long term support (LTS) with security updates
- Auditable code base developed with a goal of safety certifications



- Supports Bluetooth® Low Energy, Wi-Fi*, 802.15.4
- Supports standards like 6LoWPAN, CoAP, IPv4, IPv6, Ethernet, USB, CAN and Thread

Zephyr (OS for Resource Constrained Device)

- Complete flexibility & freedom of choice
 - Open source & neutral governance
 - Supports multiple hardware architectures
 - Small footprint: scales from small Cortex-M devices to multi-core 64-bit CPUs
- Connect embedded devices securely to any cloud
 - Multiple protocol options including BLE mesh and Thread
 - Supporting industrial, automotive, smart city and smart home
 - Cloud agnostic - Connect with transport layer security to any cloud
- Develop products with safety built in
 - Long-term support
 - In-depth security development lifecycle
 - Functional safety certification coming soon

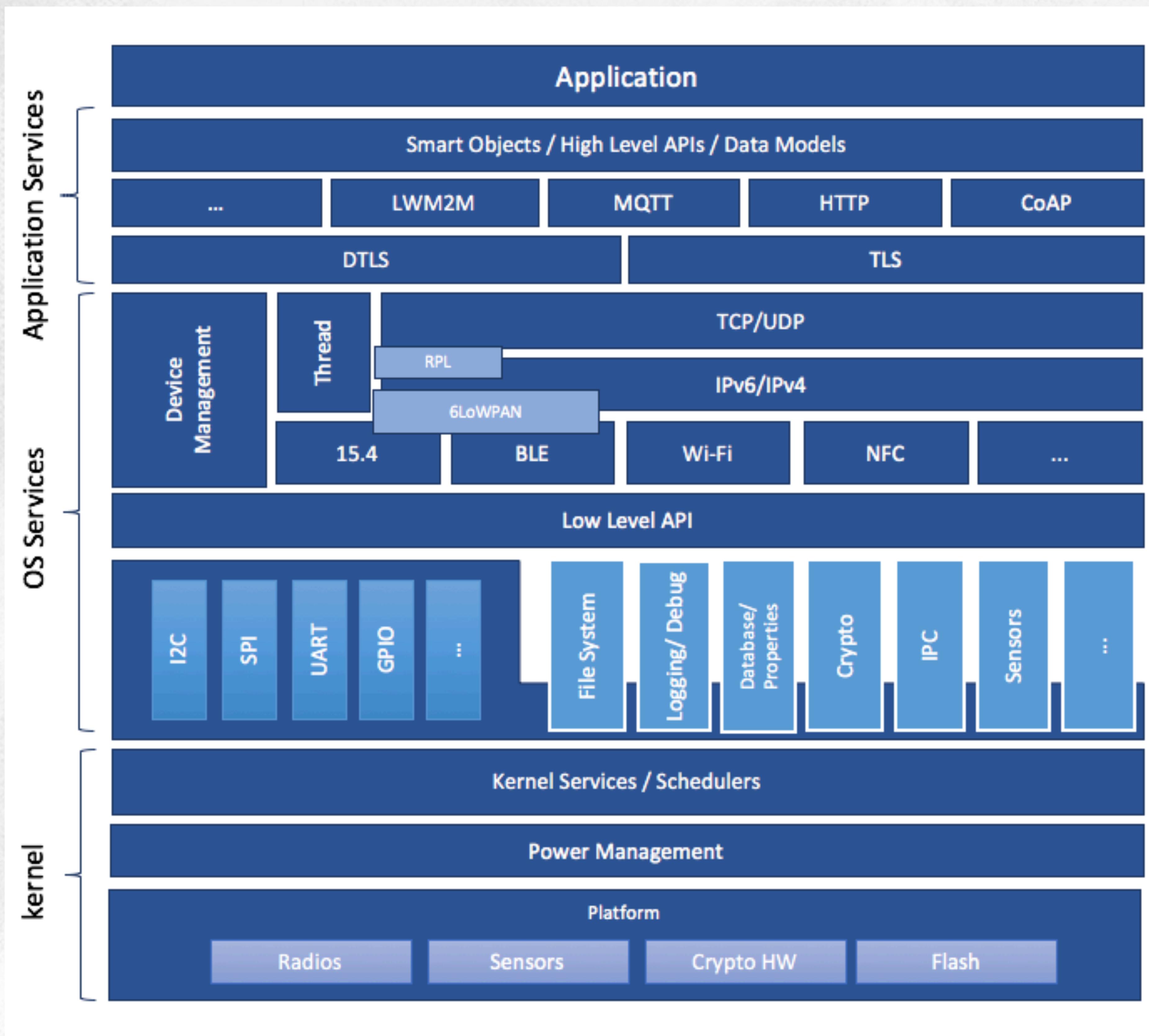
Zephyr (OS for Resource Constrained Device)

- Microcontroller operating system
- Very small memory footprint (will run in 8k)
- Open Source under Apache 2.0 license, hosted by Linux Foundation
- Supports multiple architectures
- Provide an OS that runs best on MCUs for wearable and IoT devices, where the cost of the silicon is minimal
- Highly Configurable, Highly Modular
- Kernel mode only
- Two Modes:
 - Nanokernel: Limited functionality targeting small footprint (below 10k)
 - Microkernel (superset of nanokernel): with additional functionality and features

Zephyr (OS for Resource Constrained Device)

- A high-performance, multi-threaded execution environment with a basic set of kernel features
- Ideal for systems with sparse memory (the kernel itself requires as little as 2 KB!) or only simple multi-threading requirements (such as a set of interrupt handlers and a single background task)
- Examples of zephyr systems include:
 - Embedded sensor hubs
 - Environmental sensors
 - Simple LED wearables
 - Store inventory tags
 - Fitness wearables
 - Smart watches
 - IoT wireless gateways

Zephyr (OS for Resource Constrained Device)





TrustZone

Arm TrustZone Technology

Arm TrustZone technology offers an efficient, system-wide approach to security with hardware-enforced isolation built into the CPU. It provides the perfect starting point for establishing a device root of trust based on Platform Security Architecture (PSA) guidelines.

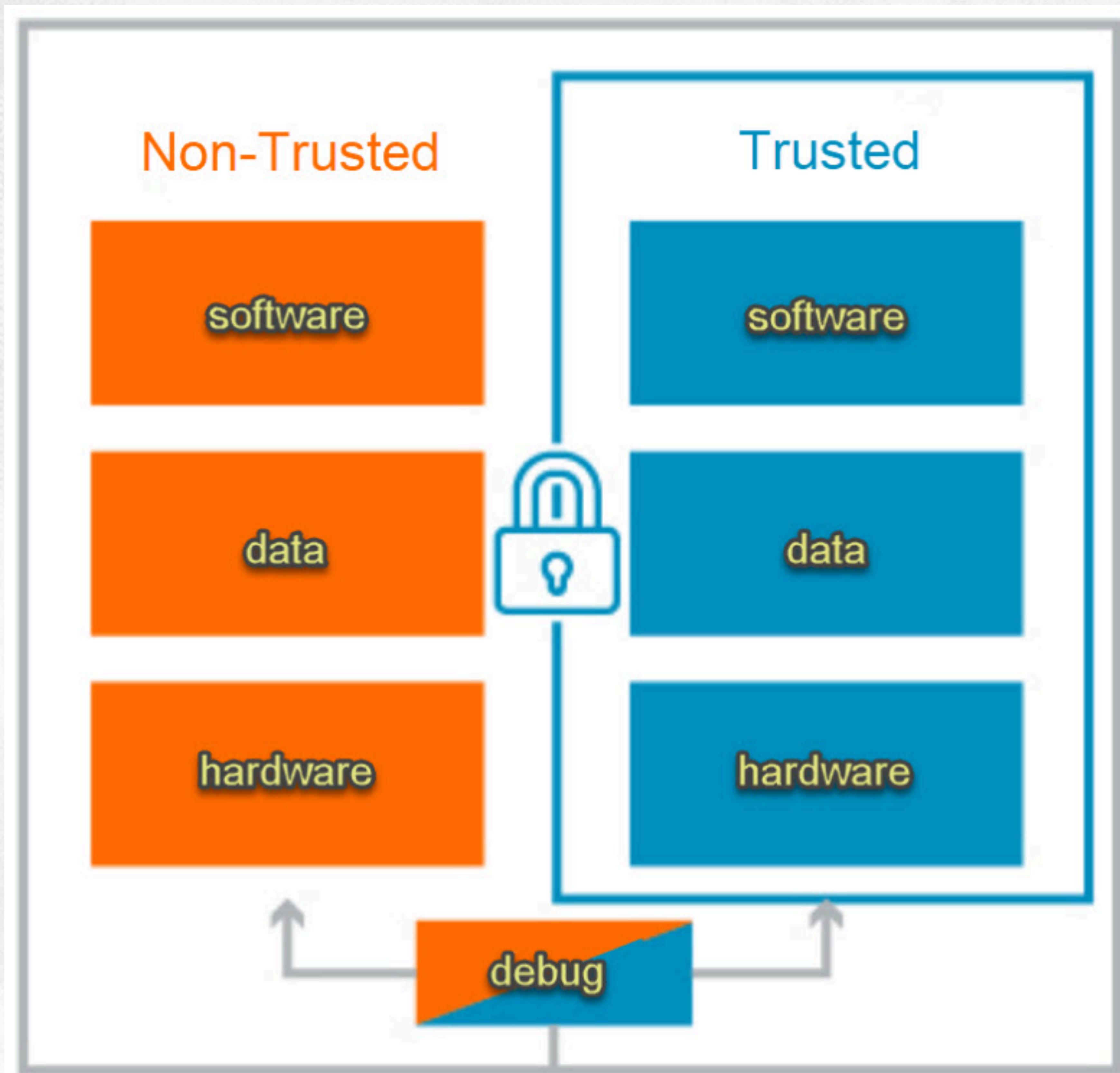
The family of TrustZone technologies can be integrated into any Arm Cortex-A processor or processor based on the Armv7-A and Armv8-A architecture, and Cortex-M processors built on the Armv8-M architecture.



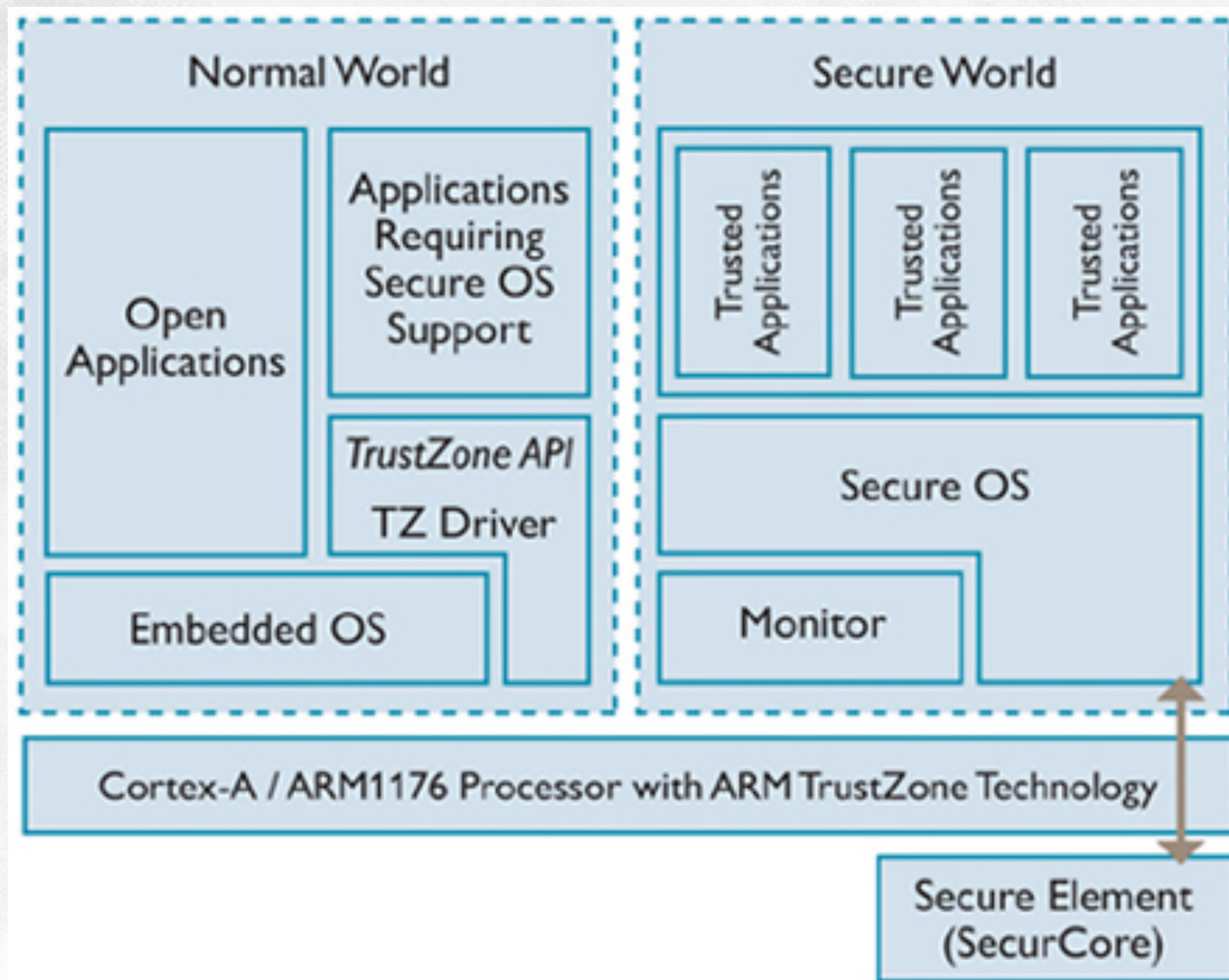
ARM TrustZone (Secure Computing)

- Derived from 'Trusted Computing' concept
- Trusted Computing (TC) is a technology developed and promoted by the Trusted Computing Group.
- The term is taken from the field of trusted systems and has a specialized meaning.
- With Trusted Computing, the computer will consistently behave in expected ways, and those behaviors will be enforced by computer hardware and software.
- Enforcing this behavior is achieved by loading the hardware with a unique encryption key inaccessible to the rest of the system.

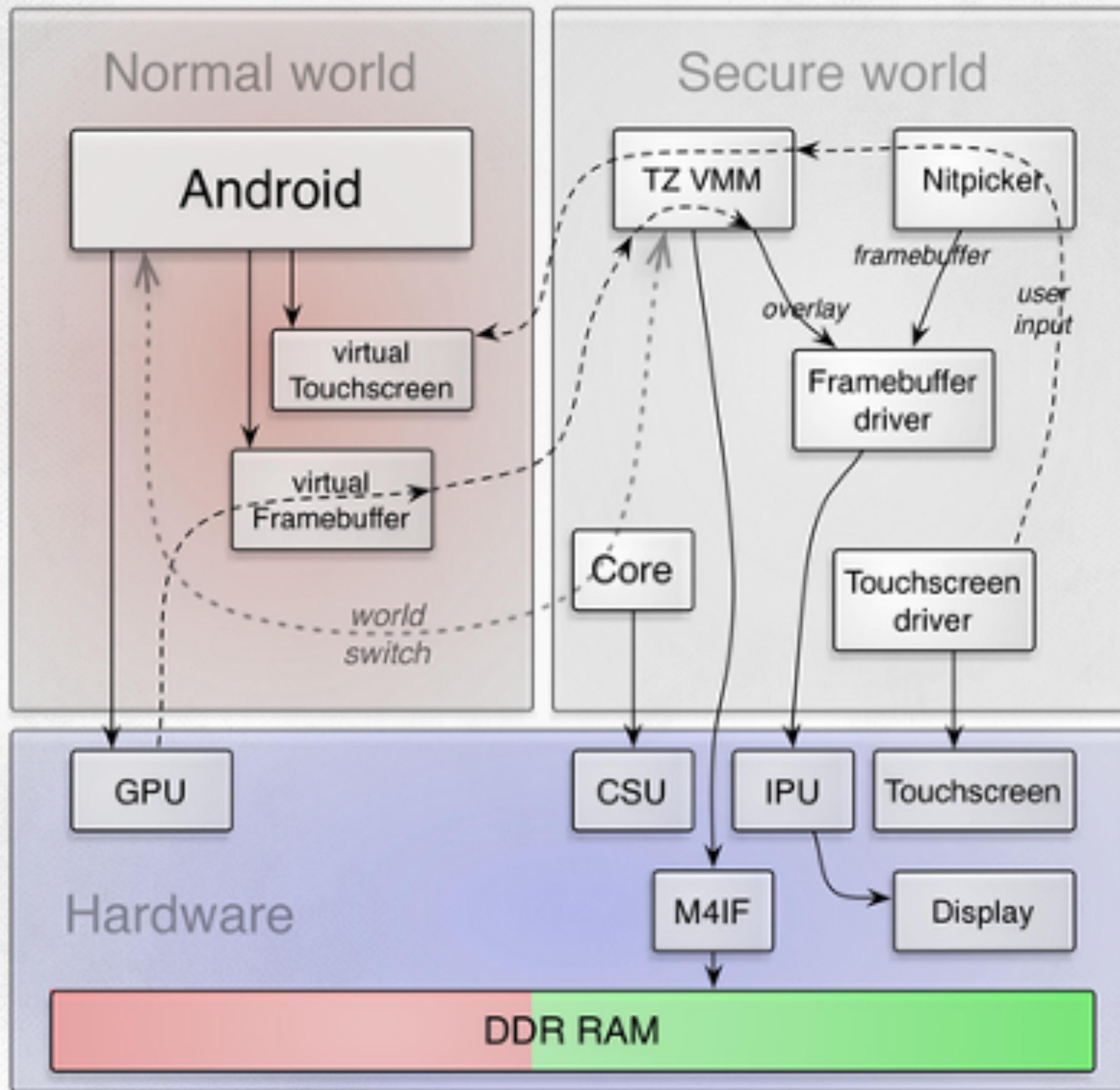
ARM TrustZone (Secure Computing)



ARM TrustZone (Secure Computing)



ARM TrustZone (Secure Computing)



Summary

- Linux may be Ubiquitous
- Special OS may be required for specific areas

Reference



Famous OSs

■ Unix

<https://en.wikipedia.org/wiki/Unix>

■ History of Linux

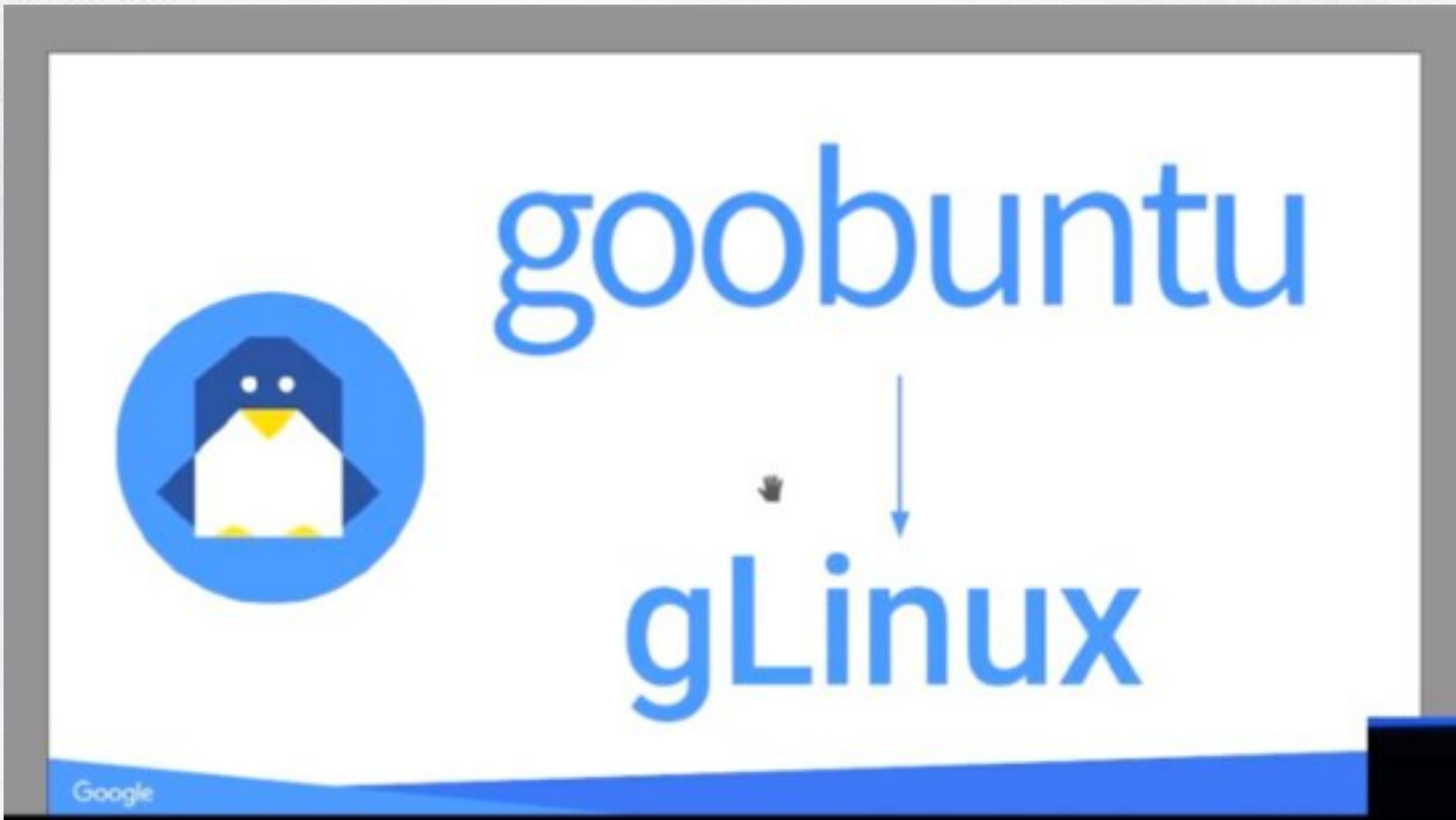
https://en.wikipedia.org/wiki/History_of_Linux

■ NeXTSTEP

<https://en.wikipedia.org/wiki/NeXTSTEP>

Discussion

- Customizable OS
- What's your requirements?



Homework

- Surveys the famous (or interest) OS in your domain such as:

- ◆ ROS for Robots

<http://www.ros.org/>

- ◆ Alpine Linux for Container Technology

<https://alpinelinux.org/>

- ◆ Orbis OS (based on FreeBSD) for PS4

https://en.wikipedia.org/wiki/PlayStation_4_system_software



Thank you