



RISC-V



Software

Motivation

“The number one motivation is how to move faster

“All of us who build chips and systems for a living spend so much time and energy and money rebuilding the same stuff. If I’m building an ASIC, I have to include a memory interface, and I have to put a control interface on it. They just need so many things that you occupy either engineering time or money, or both. That is the same stuff everybody else is putting on their chips, and whether I have to pay for a piece of silicon that does that job, or whether I can get it for free, the fact that I can just get it

and focus my engineers on my special sauce

is a huge value to anyone doing development.”

Steve Fields, IBM Fellow, Chief Engineer - IBM Power Systems

RISC-V v. Legacy ISAs

Disruptive Technology

Barriers

Complexity

Design freedom

License and Royalty fees
I

Design ecosystem

Software ecosystem

Legacy ISA

1500+ base instructions
Incremental ISA

\$\$\$ - Limited

\$\$\$

Moderate

Extensive

RISC-V ISA

47 base instructions
Modular ISA

Free - Unlimited

Free

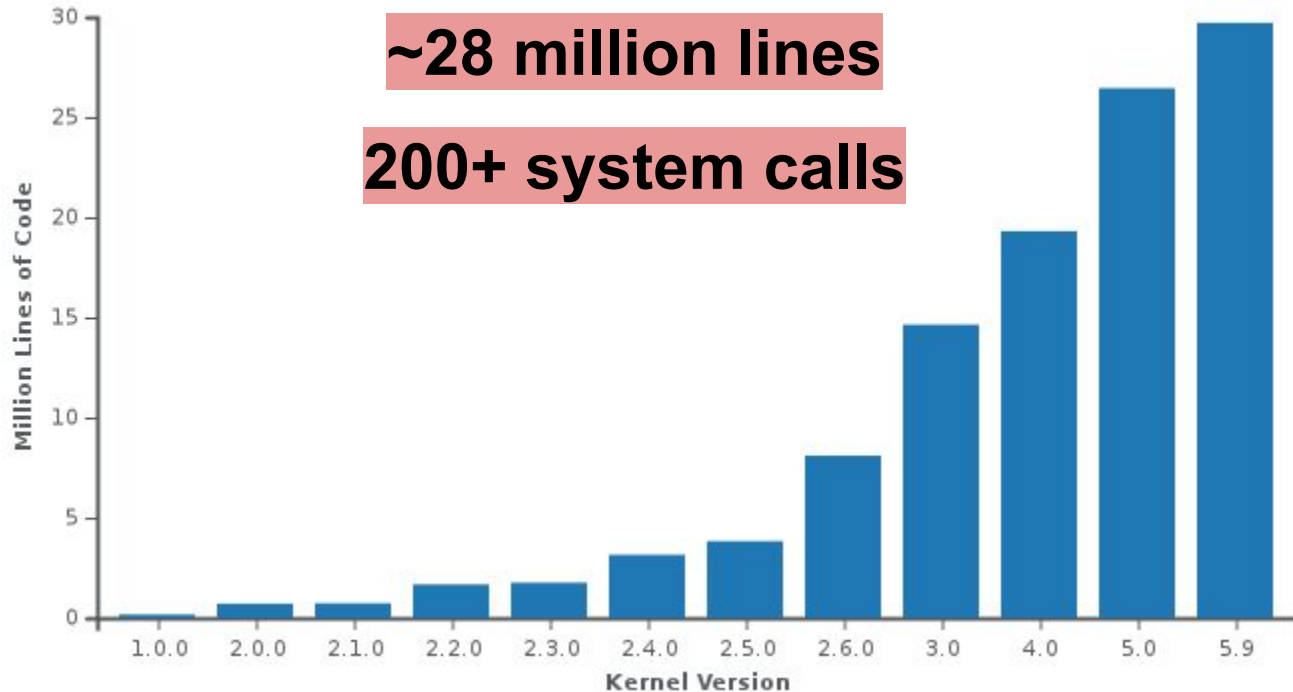
Growing rapidly. Numerous
extensions, open and
proprietary cores

Growing rapidly

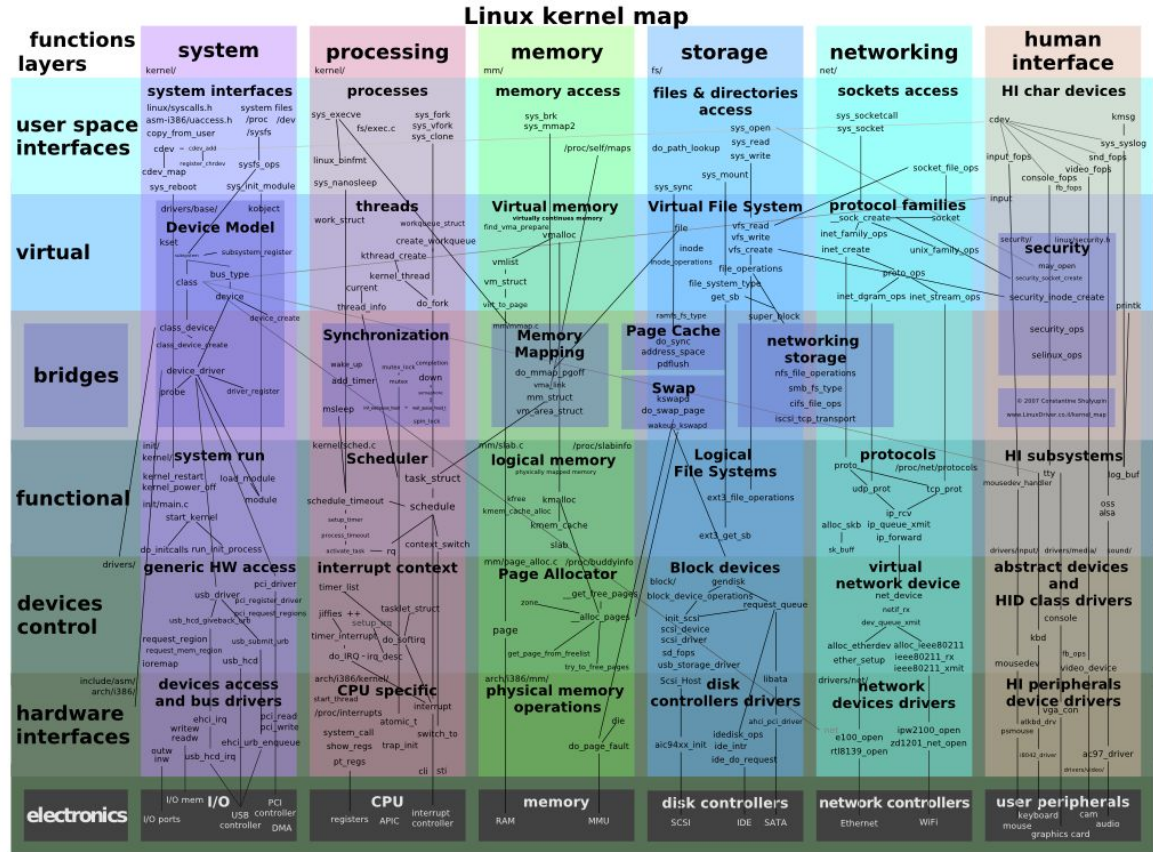


Calista Redmond
CEO RISC-V International

Legacy OS Architecture



Complex



How can software

“... move faster” ?

RISC lessons

“If we review the history of computer families we find that the most common architectural change is the

trend toward ever more complex machines.

... While the trend towards architectural complexity may be one path towards improved computers,

this paper proposes another path

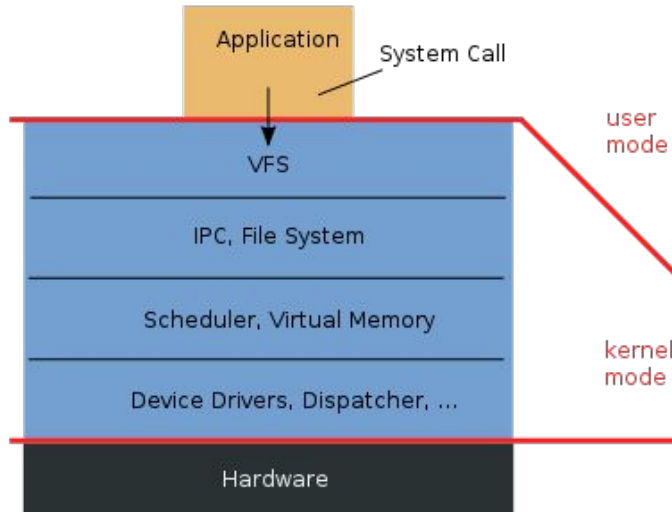
the Reduced Instruction Set Computer.”

David A. Patterson, David R. Ditzel,

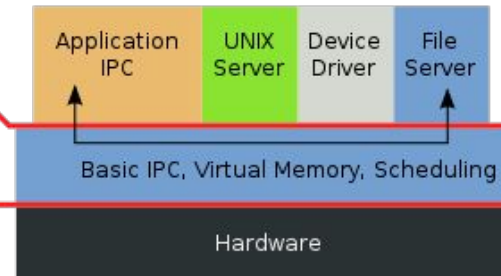
“The case for the reduced instruction set computer”, October 1980

Reduced OSA

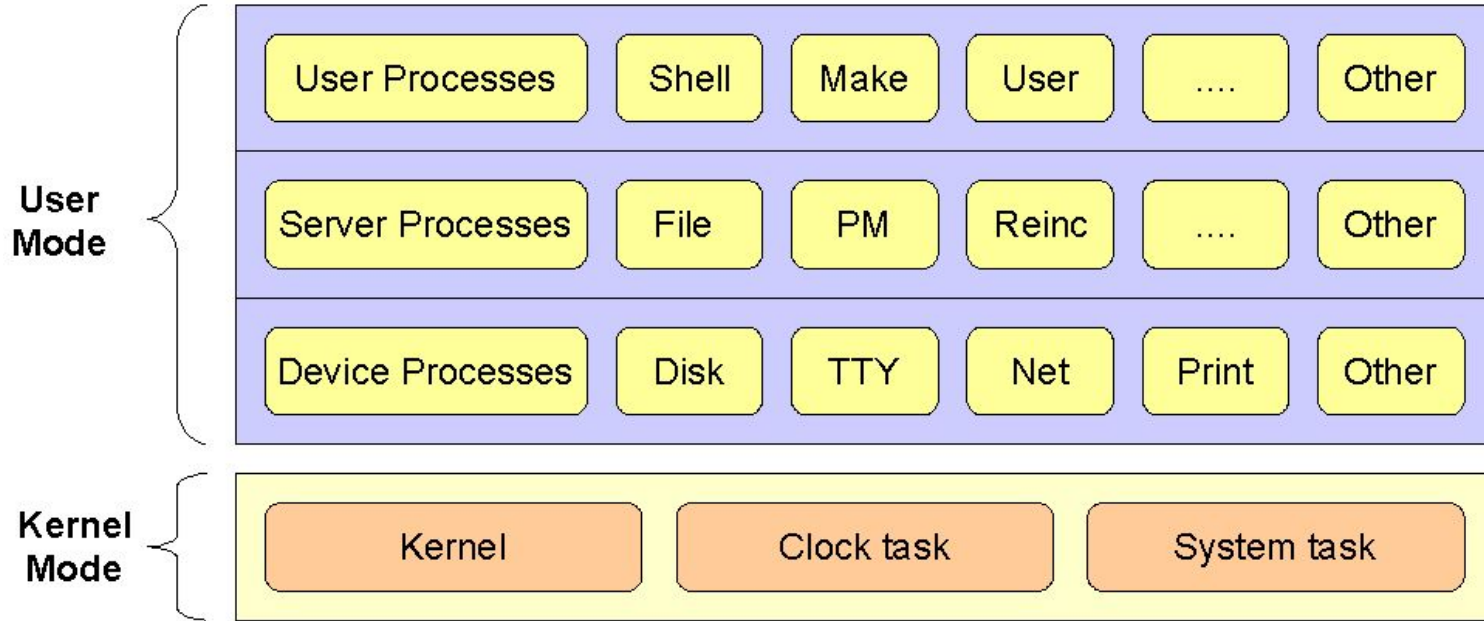
Monolithic Kernel
based Operating System



Microkernel
based Operating System



Flexible OSA



How can software

***“... focus engineers
on the special sauce”?***

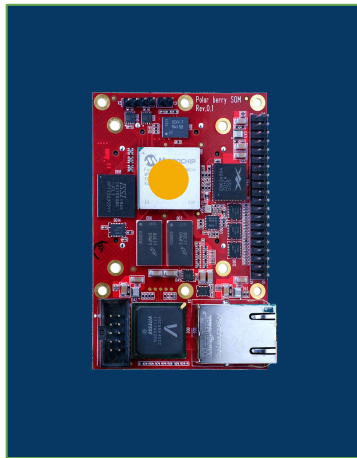
Focus

Where's your special sauce?

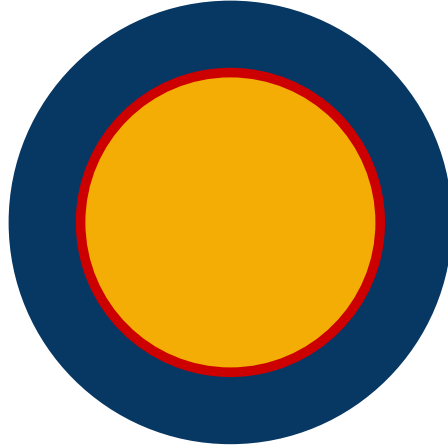
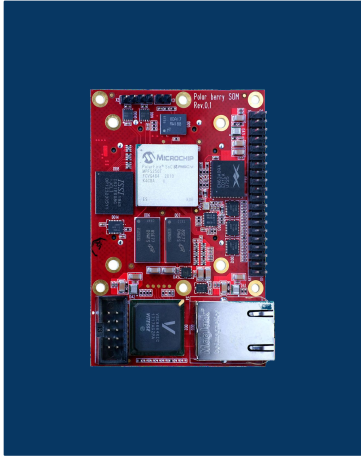
- CPU / SoC / SoM
- PCB & Buses
- Peripherals

Where's your software effort?

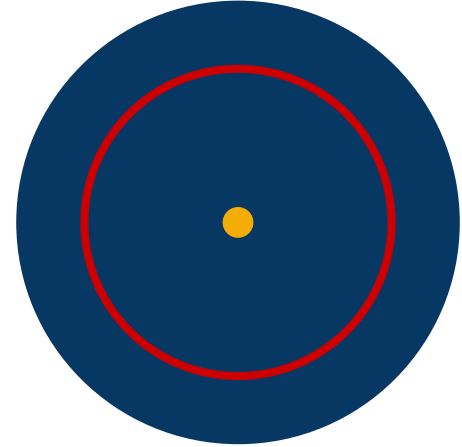
- Kernel
- Custom Drivers
- Applications



Focused OSA



**Monolithic
kernel**



**Micro
kernel**

Engineers

What skills are required?

Which staff are available?

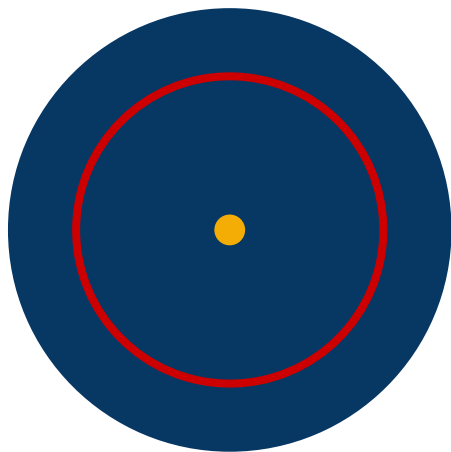


**Kernel space
wizards**



**User space
programmers**

Verifiable OSA



Safe

Small enough to certify

Secure

Tiny attack surface

Reliable

Drivers can not crash kernel

ROSA solution

Reduced Operating System Architecture



RISC-V principles

What's Different About RISC-V?

"RISC Five", 5th Berkeley RISC

- Free and Open
 - Anyone can use
 - More competition
⇒ More innovation
 - Pick ISA first,
pick vendor later
- Simple, Elegant Core
 - Far simpler than
ARM and x86
- Modular
 - Optional vs Required



- Easy to Enhance
 - Room to evolve
- For Cloud & Edge
 - From large to tiny
computers
- Community evolves
 - RISC-V International
owns RISC-V ISA



11



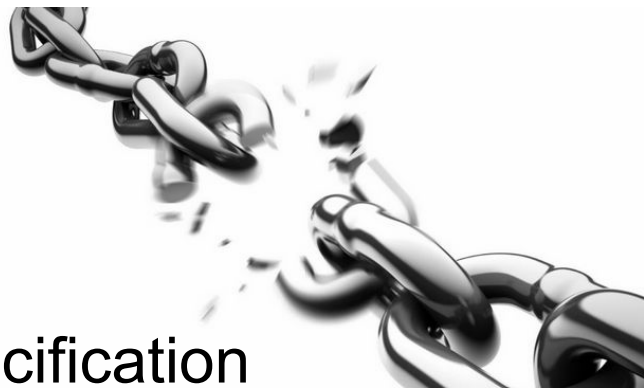
David Patterson

Permissive

Decouple technology from legality

- Apply permissive licenses to the specification and reference implementations *only*
- Allow closed and commercial licenses on any non-reference component or implementation

Next step: Draft the licensing policies



Simple core

Kernel = CPU + Memory *only*

- All drivers are in user-space
- Core includes essential communication and storage


Next step: Specify the kernel and core components



Modular

Component packaging system



- Automated component distribution
- RISC-V RV *Bit-size, Privileged and Optional* criteria < 
- Licensing, disclosure and authentication criteria

Next step: Specify the component distribution system

Extensible

Standardized extension interfaces

- Optional, non-computational features
- Boot media, FOTA update, Live patch, Virtualization

Next step: Enumerate the possible extension features



Scalable

Standardized scaling extension interfaces

- Microcontroller (MMU-less) operation
- Multi-core and multi-processor synchronization



Next step: Enumerate the scaling extension dimensions

Secure

Standardized security interfaces

- Secure-update extensions
- Secure-boot extensions
- Trusted-execution extension interfaces

Next step: Enumerate the security extension dimensions



Engaging

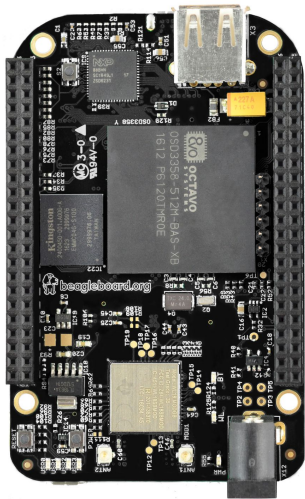
Collaborate with the stakeholders

- Minix3.org and Professor Tanenbaum
- RISC-V.org leadership and working groups
- Engage collaborators to form a foundation

Next step: Engage the founders and foundations



First core reference

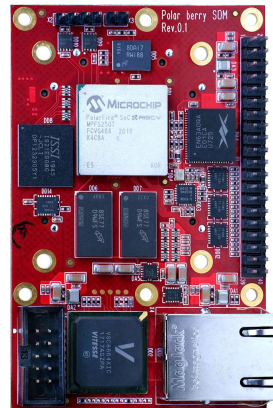


BeagleBone Black
ARM® Cortex-A8

**Port Minix 3
from ARM to RISC-V**

~ 15k lines

~50 sys calls



RISC-V Dev Board
TBD

Authors



40 years

[https://www.linkedin.com/in/](https://www.linkedin.com/in/mike-sharkey-bb940a26/)

mike-sharkey

-bb940a26/

Software

Firmware

Hardware



30 years

[https://www.linkedin.com/in/](https://www.linkedin.com/in/normanyoung)

normanyoung

Request

Strategic Applications

Collaboration

Sponsors





RISC-V

Software

Credits

	https://riscv.org/
	Grant C. https://www.flickr.com/photos/grant_subaru
Steve Fields, IBM	https://semiengineering.com/open-isas-gaining-traction/
RISC-V versus Legacy ISAs	Calista Redmond, CEO RISC-V International https://youtu.be/NWRAppH3ZBU?t=78
Linux kernel 2020	https://www.linuxfoundation.org/resources/publications/2020-kernel-history-report/
Linux kernel code	https://en.wikipedia.org/wiki/Linux_kernel#Development
Linux kernel map	By Conan at English Wikipedia, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=6092674
Linux	Copyright Linux kernel contributors https://github.com/torvalds/linux Trademark owned by Linus Torvalds

Patterson & Ditzel	ACM SIGARCH Computer Architecture News, October 1980 https://dl.acm.org/doi/10.1145/641914.641917
Minix 3 architecture	https://en.wikipedia.org/wiki/MINIX_3#Architecture
Minix	Andrew Tanenbaum and contributors http://www.minix3.org/ https://en.wikipedia.org/wiki/MINIX_3
Polar Berry SoM	Sundance https://www.sundance.com/polarberry-launch/
Lord of the Rings	Tolkien Estate, United Artists
	jencu https://www.flickr.com/photos/jennycu
RISC-V Differences	David Patterson, Vice Chair, RISC-V International https://www.youtube.com/watch?v=JHU1-2MR4QE
	Bill Smith https://www.flickr.com/photos/byzantiumbooks/



Wolfgang W.
<https://www.flickr.com/photos/cuxclipper1/>



Ross Angus
https://www.flickr.com/photos/ross_angus/



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https://www.flickr.com/photos/vintage_illustration/



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<https://www.flickr.com/photos/mbergisch/>

BeagleBone Black

<https://beagleboard.org/black/>



Jolene Thompson
<https://www.flickr.com/photos/za-photos/>