PASC24
Zurich Switzerland | 3-5 June 2024

Measuring Software Sustainability

The Secret Sauce for Effective Collaboration and Impactful Research

Will Schroeder, Bill Hoffman, François Mazen

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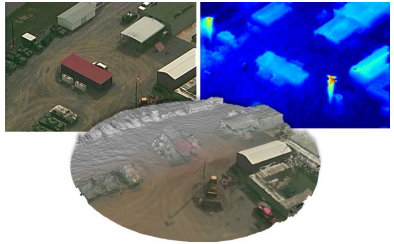
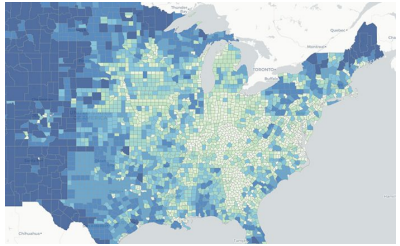
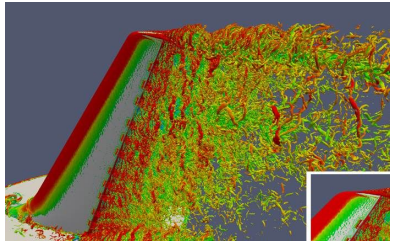
Background

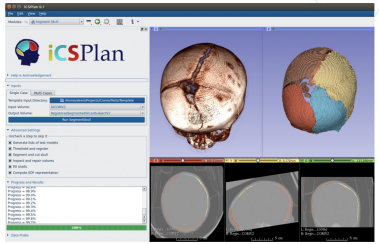
Research Tools / Applications

Based on open source tools
300+ active projects worldwide









Computer Vision

Data and Analytics

Scientific Computing

Medical Computing

Software Solutions

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Secret Sauce: Major Ingredients

- Impact / Value
- Open
- Business model
- Software Process
- Platform Ubiquity
- Community
- Security

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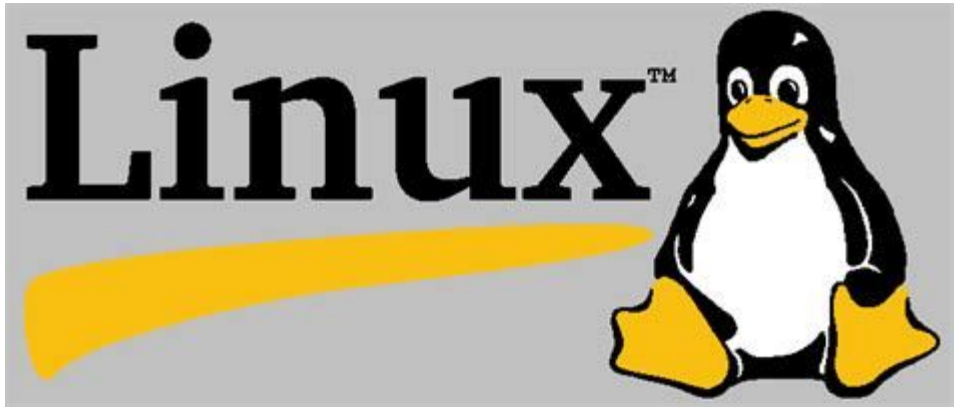
Impact / Value

Improve the lives of others


Linux™

Oh good. You're here too.
IMPORTANT: Open box carefully. DO NOT remove without reading instructions.
Introducing the
EVERYTHING EVERYWHERE ALL AT ONCE
PET ROCK™
OFFICIAL

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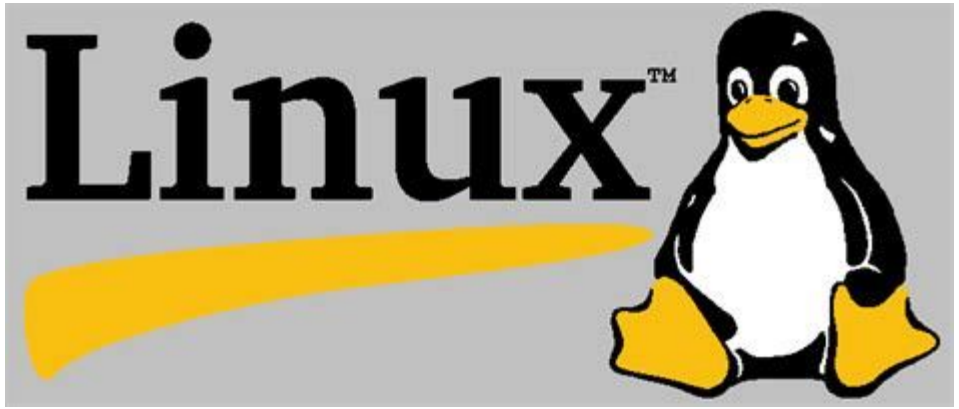

There's no escaping the importance of value/impact

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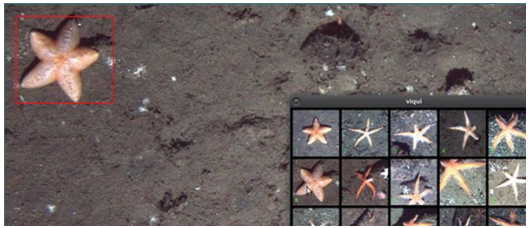
The Effects of Scale

Small:
VIAME
Video and Image Analytics for Marine Environments

100*
downloads/month

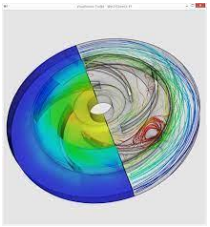
<50K LOC



Medium:
VTK
The Visualization Toolkit

425,000*
downloads/month

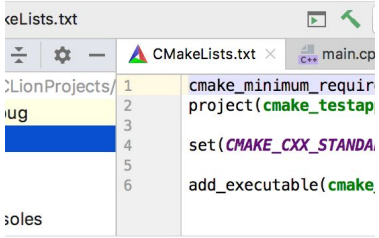
8M LOC**



Large:
CMake
Cross-Platform Make

8,500,000*
downloads /month

1.9M LOC**



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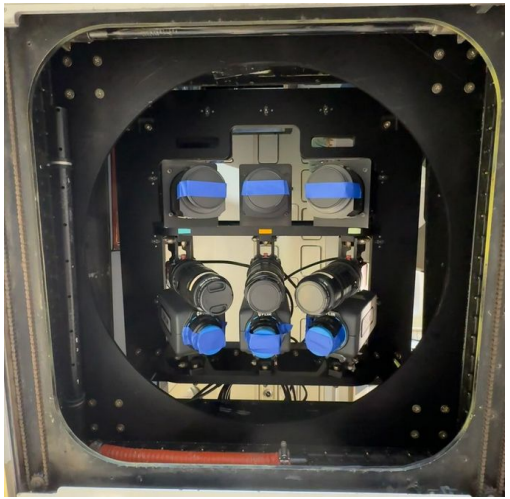
** from Kitware servers*
*** openhub.net*

VIAME - NOAA* Seal population census

(across three Arctic Seas: Bering, Beaufort, and Chukchi)

Adam Romlein (KW) is ready to go on NOAA's King Air



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*** NOAA: U.S National Oceanic and Atmospheric Administration**

Open

Share ideas, support creative innovation, leverage the talents of others

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Measuring the Economic Value of Open Source

Respondents rate these benefits of open source the highest:

- **Cost saving**
- **Faster development speed**
- **Open standards and interoperability**

Almost 2/3 of respondents report that **the benefits of open source exceed the costs.**

Most respondents believe **it costs significantly less money to use OSS** than to provide the software functionality themselves.

The ratio of benefits to costs appears to be rising for nearly half of respondents.

The median respondents report that **the economic value of OSS is 1 to 2 times the cost** of its use.

31% of respondents reported that paying for equivalent software functionality **would incur 4X the cost of OSS.**

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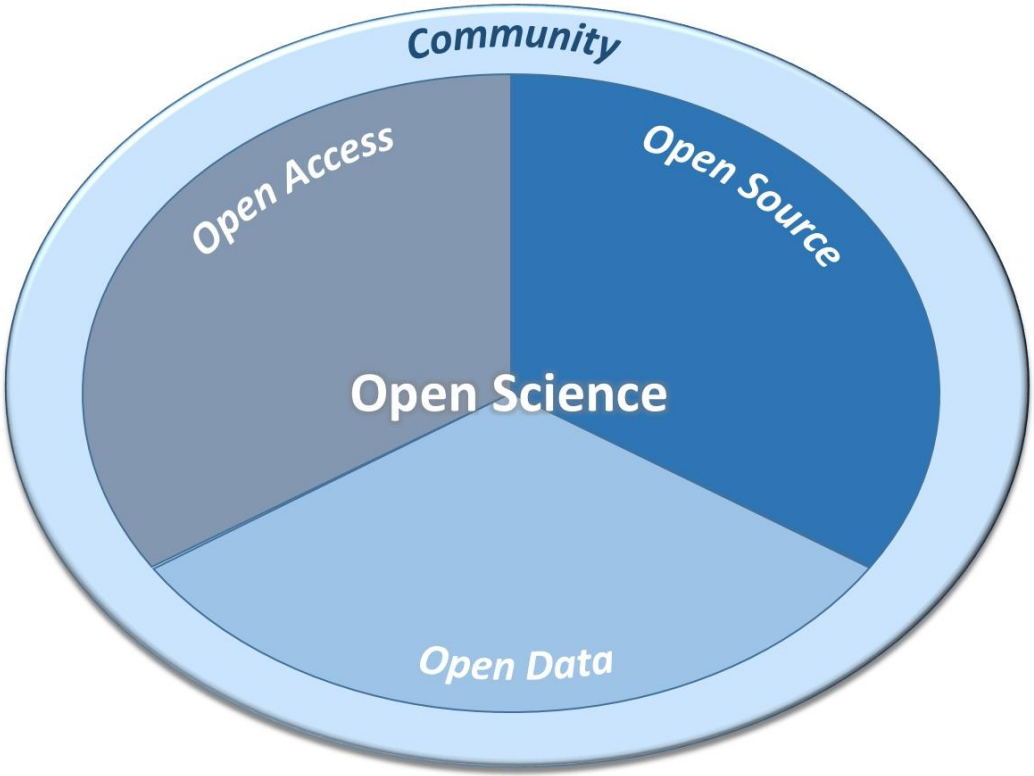
Open Science



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If it’s not reproducible, it’s not Science

Nullius in Verba

“take nobody's word for it”
Royal Society 1660

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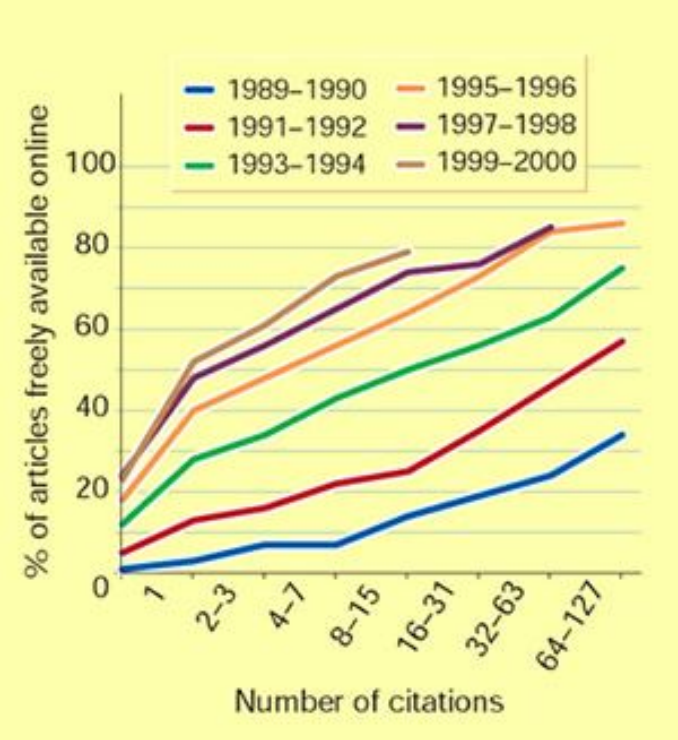
Be Selfish and Share, increase your impact



Steve Lawrence, *Nature*

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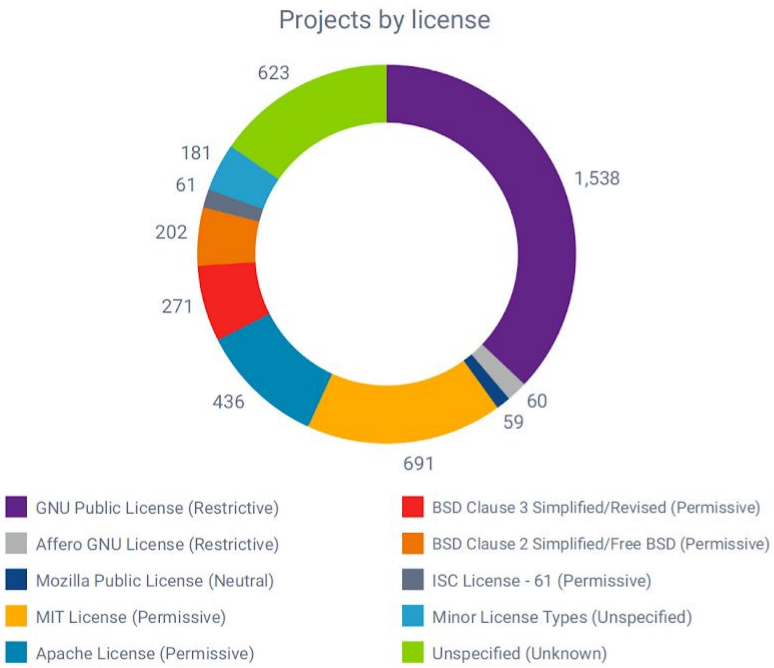
IP & Licensing

- OSI approved license
- Always controversial!
  - GPL
- Prefer permissive license (Apache, BSD, MIT, CC-BY)
- Incentivizes adoption



2017 Synopsis/Coverity Scan Report

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Business Model

Long term sustenance

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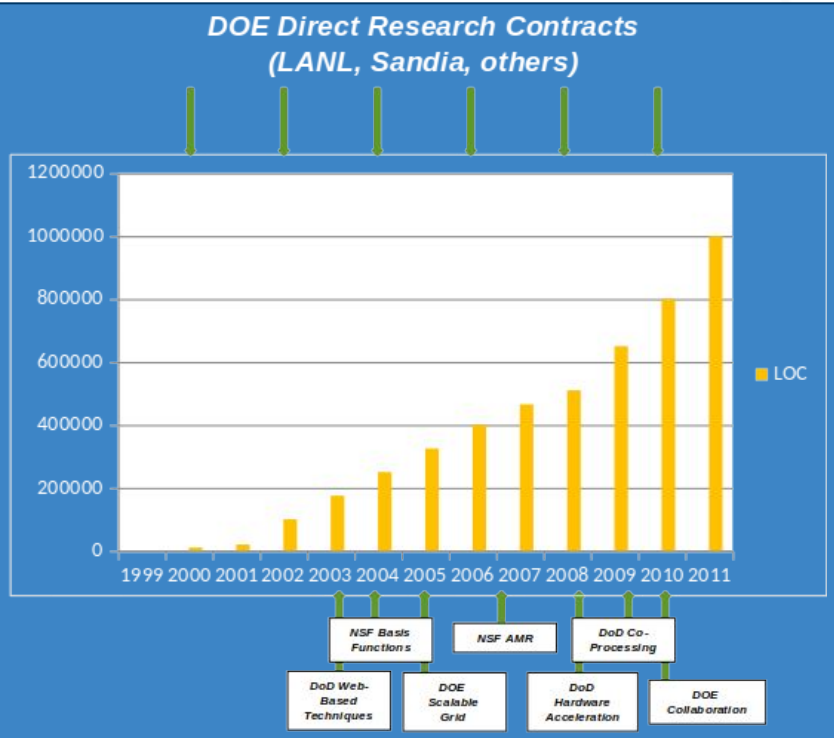
Funding the Development of Open Source Platforms

- Create a Vision
- Harvest support
- Adapt to opportunities
- ParaView example



Kitware / Services

TRAINING

SUPPORT

DEVELOPMENT

GRANT COLLABORATION

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Software Process

Ensure stable, robust, reliable systems

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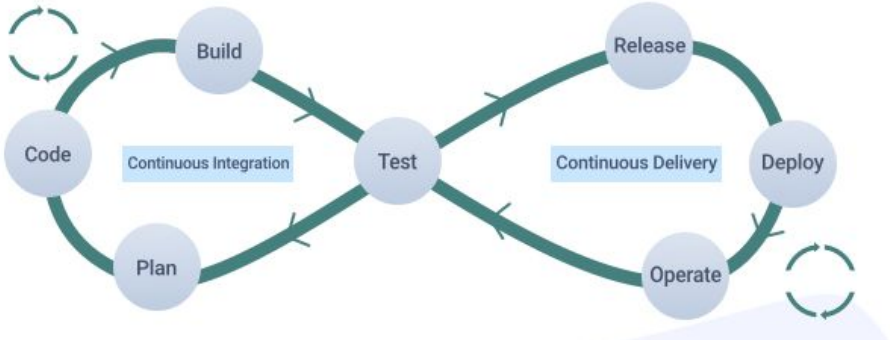
Software Process / CI-CD

- CMake - Cross-platform build generator
- CDash - Continuous Integration
- CPack - Packaging
- CI/CD for Scientific Computing
  - Gitlab/Github
  - C++/Fortran/Python/C#
  - Package management



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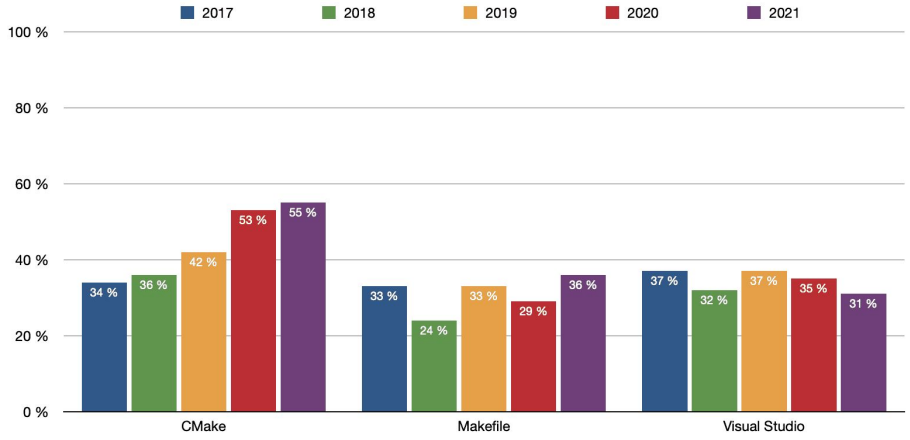
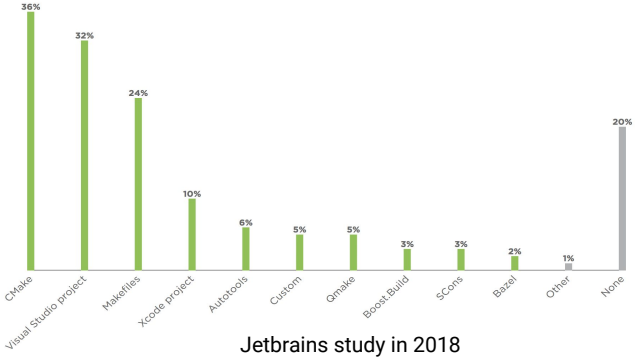
CMake is the most popular C++ build tool at 55%



Jetbrains study 2017-2021

- **Job openings requiring CMake experience, June, 2022:**
  - Indeed.com: 900 jobs at Tesla Motors, DCS Corp, Mindsource, Quanergy, …
  - LinkedIn.com: >600 jobs at Samsung, Johnson Controls, Apple, Uber, Toyota, Microsoft ...

- **Bryce Adelstein Lelbach**, the chair of Standard C++ Library Evolution group, in his talk “What Belongs In The C++ Standard Library?” at C++Now in 2022, stated that **we actually have a standard build system! It’s CMake.**



Jetbrains study in 2018

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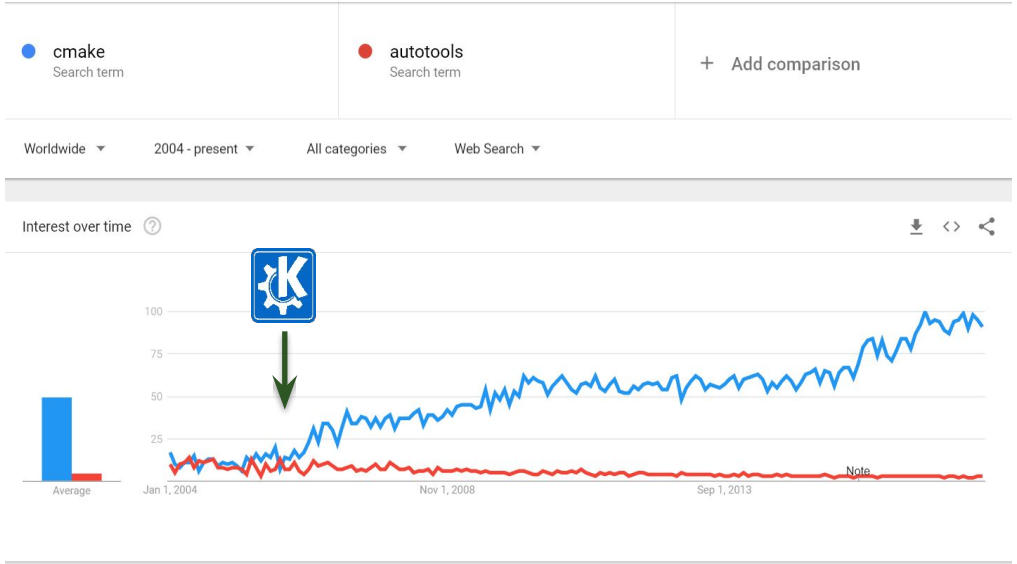
Why CMake? Everyone is using it



CTest/CDash: Search for Relevant Results

Filters Help

Match all of the following rules:

Site	contains	microsoft	- +
Group	is	Nightly Expected	- +
Tests Failed	is greater than	0	- +

Apply Clear Create Hyperlink

Nightly Expected 6 builds

Site	Build Name	Update	Configure		Build		Test			
		Revision	Error	Warn	Error	Warn	Not Run	Fail	Pass	Start Time
gillesk.microsoft	VS2017 x86.rel	602d4c	0	0	0	0	0	4^{+4}_{-4}	471_{-4}	10 hours ago
gillesk.microsoft	VS2015 x64.rel	602d4c	0	0	0	0	0	4^{+3}	476_{-3}	10 hours ago
gillesk.microsoft	VS2012 x86.rel	602d4c	0	0	0	0	0	3^{+3}	412_{-3}	5 hours ago
gillesk.microsoft	VS2012 x64.rel	602d4c	0	0	0	0	0	3^{+3}	412_{-3}	5 hours ago
gillesk.microsoft	VS2017 x64.rel	602d4c	0	0	0	0	0	3^{+3}_{-4}	472_{-3}	10 hours ago
gillesk.microsoft	VS2015 x86.rel	602d4c	0	0	0	0	0	3^{+3}	477_{-3}	10 hours ago

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CTest/CDash: Compare Results Across Systems

Testing summary for kwsys.testConsoleBuf performed between 2018-09-13T01:00:00 and 2018-09-14T01:00:00

98% passed, 2 failed out of 104.

Show Test Failure Trend
Download Table as CSV File

Site	Build Name	Build Stamp	Status	Time (s)	Build Revision
gillesk.microsoft	VS2017 x86.rel	20180913-0100-Nightly	Failed	11.02	602d4c6e06673b9864ad2f8bb3d706d5bd440c1a
trinsic.kitware	vs14-64-ninja	20180913-0100-Nightly	Failed	13.66	602d4c6e06673b9864ad2f8bb3d706d5bd440c1a
aaargh.kitware.com	Linux-EL7-Intel-16.0.0	20180913-0100-Nightly	Passed	0.02	602d4c6e06673b9864ad2f8bb3d706d5bd440c1a
aaargh.kitware.com	Linux-EL7-Intel-16.0.1	20180913-0100-Nightly	Passed	0.02	602d4c6e06673b9864ad2f8bb3d706d5bd440c1a
aaargh.kitware.com	Linux-EL7-Intel-16.0.2	20180913-0100-Nightly	Passed	0.02	602d4c6e06673b9864ad2f8bb3d706d5bd440c1a

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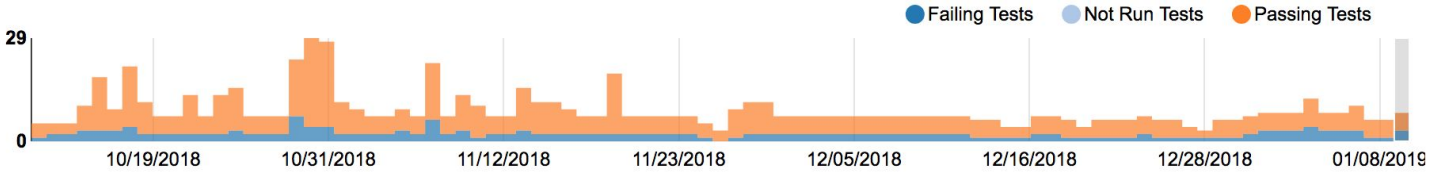
Track Test Health Over Time



Update

Show Filters

28 tests failed during this time period.

Non-Experimental Builds ☐ Include passing tests

Test Name	Failure	Timeout	Total Runs	Time
viewBuildError	100%	0%	2	21s 570ms
upgrade	100%	0%	2	1m 33s 790ms

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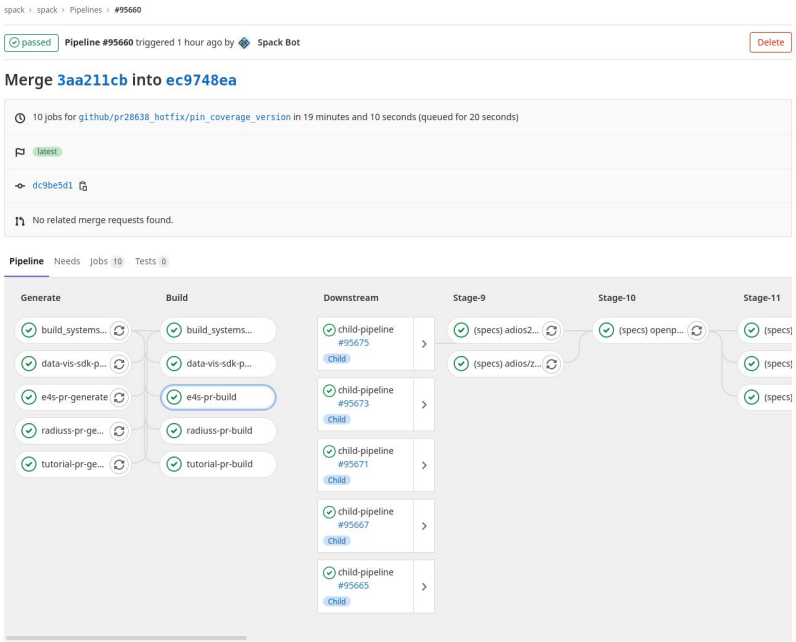
Package Management / Spack



- Supercomputer package management
- 14 to 64 instance autoscaling cloud-based kubernetes cluster
- 7,300 pipelines a month
- 128,000 jobs a month
- 950+ open source contributors

Lawrence Livermore National Laboratory

EXASCALE COMPUTING PROJECT

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Spack

What's a package manager?

- Spack is a ***package manager***
  - **Does not** a replace Cmake/Autotools
  - Packages built by Spack can have any build system they want
- Spack manages ***dependencies***
  - Drives package-level build systems
  - Ensures consistent builds
- Determining magic configure lines takes time
  - Spack is a cache of recipes

Package Manager

- Manages package installation
- Manages dependency relationships
- May drive package-level build systems

High Level Build System

- Cmake, Autotools
- Handle library abstractions
- Generate Makefiles, etc.

Low Level Build System

- Make, Ninja
- Handles dependencies among *commands* in a single build

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Ubiquity

Run Everywhere

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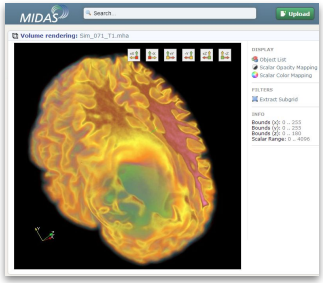
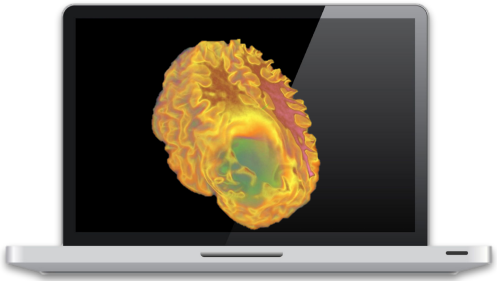
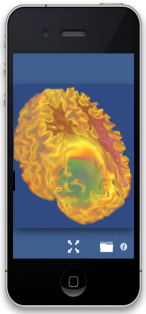
Platform Ubiquity



Web

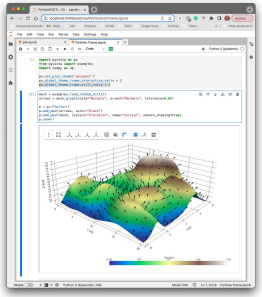


Desktop



Mobile

Cloud /HPC



PyVista, Jupyter, etc

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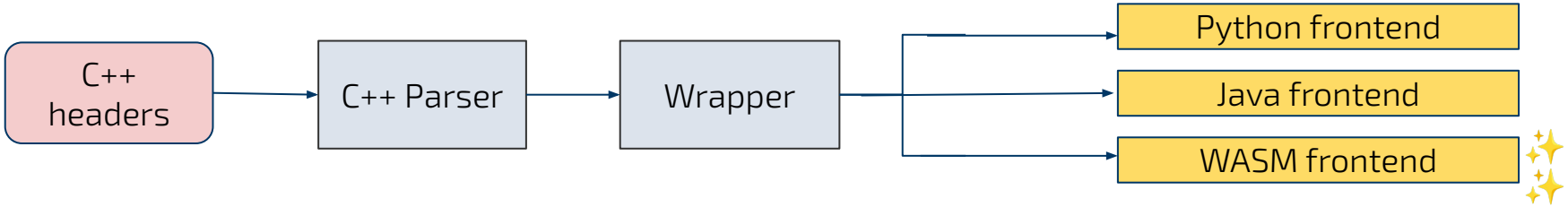
WebAssembly

- A new type of machine code that can run at near-native speed in a sandboxed environment.
- Portable, size- and load-time-efficient binary format.
- Serves as a compilation target which can execute at native speed taking advantage of underlying host capabilities like SIMD.
- Run outside the browser (i.e., desktop) with: WebAssembly System Interface (WASI)

Wrap VTK to Web Assembly



WebGPU - An Render Hardware Interface RHI

- Browser implementers maintain an RHI for their browsers according to W3C WebGPU spec.
- An abstraction layer over several platform-specific graphics APIs. It is usually designed from the ground up to take advantage of DirectX, Metal, OpenGL and Vulkan.
- Allows graphics applications to be forward compatible with constantly evolving graphics vendor APIs.
- Initially designed for web; works fine for desktop (i.e., replacement for OpenGL)

Community

Play nice, enable others,
kindle passion and purpose

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Community Balance

Foundation & Process

- Governance
- Code of conduct
- Style / Coding Specifications
- Architecture / Framework
- API
- Software Process
- Backward compatibility
- Measured feedback processes

Creativity & Purpose

- Purpose / Mission / Impact
- Fun
- Mutual respect / valuing others
- Open to new ideas
- Responsive to change
- Supportive implementation environment
- Meritocracy

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Hackathons

Dialogue from film: Shakespeare in Love
(between Henslowe and Fennyman)

"The natural condition is one of unsurmountable obstacles on the road to imminent disaster.

So what do we do ?

Nothing. Strangely enough, it all turns out well.

How ?

I don't know. ***It's a mystery.***

National Alliance of Medical Image Computing NA-MIC
25th Hackathon
Catanzaro Lido, Italy
In support of: 3D Slicer

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ParaView

Take Part in the ParaView User Day Europe!

Lyon, France - September 26th, 2024

- Inspiring keynotes
- Lightning talks by users
- Kitware one-to-one hands-on sessions
- Demo space
- ParaView dinner (optional)

Join the experience and present!

We understand the value of your expertise, if you want to share with the community, we welcome you to submit a presentation title and summary to present during the event.

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TotalEnergies

More Info: https://www.kitware.eu/paraview-user-day-europe-2024/

Security

Lock the doors, protect our infrastructure

```diff
diff --git a/CMakeLists.txt b/CMakeLists.txt
index 76700591059711e3a4da5b45cf58474dac4e12a7..d2b1af7ab0ab759b6805ced3dff2555e2a4b3f8e 100644 (file)
--- a/CMakeLists.txt
+++ b/CMakeLists.txt
@@ -901,10 +901,29 @@ endif()

 # Sandboxing: Landlock
 if(NOT SANDBOX_FOUND AND ENABLE_SANDBOX MATCHES "^ON$|^landlock$")
-    check_include_file(linux/landlock.h HAVE_LINUX_LANDLOCK_H)
+    # A compile check is done here because some systems have
+    # linux/landlock.h, but do not have the syscalls defined
+    # in order to actually use Linux Landlock.
+    check_c_source_compiles("
+        #include <linux/landlock.h>
+        #include <sys/syscall.h>
+        #include <sys/prctl.h>
+.
+        void my_sandbox(void)
+        {
+            (void)prctl(PR_SET_NO_NEW_PRIVS, 1, 0, 0, 0);
+            (void)SYS_landlock_create_ruleset;
+            (void)SYS_landlock_restrict_self;
+            (void)LANDLOCK_CREATE_RULESET_VERSION;
+            return;
+        }
+
+        int main(void) { return 0; }
+        "
+    HAVE_LINUX_LANDLOCK)

-    if(HAVE_LINUX_LANDLOCK_H)
-        set(SANDBOX_COMPILE_DEFINITION "HAVE_LINUX_LANDLOCK_H")
+    if(HAVE_LINUX_LANDLOCK)
+        set(SANDBOX_COMPILE_DEFINITION "HAVE_LINUX_LANDLOCK")
         set(SANDBOX_FOUND ON)
```

Recent xz Utils backdoor involved hacks to CMake build files. Plus social engineering to infiltrate small community.

System “**blast radius**” - the log of the Common Vulnerability Scoring System (CVSS) score, times the number of repositories depending on a package. *(from Andrew Nesbitt).*

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Recipe for the Secret Sauce: Sustainability Scorecard

Impact	Perceived value Business Model User Base	
Risks	IP & License Bus Rule Security	Dependencies Competition
Community	Culture Software Process	Governance Outreach
Technology	Ubiquity Interoperability	Architecture Latest & Greatest

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Some Other Scorecards

- Linux Foundation's CHAOSS community analytics
- Open Source Security Foundation (OpenSSF) Scorecard
- ORNL Scientific Software Excellence Assessment
- Repo-Review from Scientific Python

Likely Future Ingredients

- **LLMs as a community resource**
  - Answer questions
  - Describe approaches
  - Write code
- **Open source licensing**
  - Supportive of AI training?

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May the Source Be With You

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Delivering Innovation

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