Software Heritage

Building the Universal Software Archive

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Software Heritage

Short Bio

Roberto Di Cosmo
Computer Science professor in Paris
now working at INRIA
20 years of Free and Open Source Software

1999 *DemoLinux* – first live GNU/Linux distro

2007 *Free Software Thematic Group*
150 members 40 projects 200Me

2008 *Mancoosi project* `www.mancoosi.org`

2010 *IRILL* `www.irill.org`

2015 *Software Heritage* at INRIA

Software is Pervasive

At the heart of *our society*

- communication, entertainment
- administration, finance
- health, energy, transportation
- education, research, politics
- …

At the heart of *technology*

- house appliances ≈ 10M SLOC
- phones ≈ 20M SLOC, *cars* ≈ 100M SLOC
- Internet of things, …

Software is Knowledge

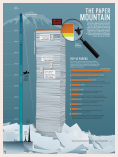
Key mediator for accessing *all* information (c) Banski

Information is a main pillar of our modern societies.

> *Absent an ability to correctly interpret digital information, we are left with […] "rotting bits" […] of no value.*
>
> *Vinton G. Cerf IEEE 2011*

Software is *an essential component* of modern scientific research

> *[…] the vast majority describe experimental methods or sofware that have become essential in their fields.*
>
> Top 100 papers (Nature, October 2014)



Bottomline: Sofware embodies our *Knowledge* and *Cultural Heritage*

It *must* be *collected*, *referenced* and made *accessible*!

Software Heritage

THE GREAT LIBRARY OF SOURCE CODE

Our mission

Collect, preserve and share the *source code* of *all the software* that is publicly available.

Past, present and future

Preserving the past, *enhancing* the present, *preparing* the future.

The source code matters!

"The source code for a work means the preferred form of the work for making modifications to it."

GPL Licence

Hello World

Program (excerpt of binary)

```
4004e6: 55
4004e7: 48 89 e5
4004ea: bf 84 05 40 00
4004ef: b8 00 00 00 00
4004f4: e8 c7 fe ff ff
4004f9: 90
4004fa: 5d
4004fb: c3
```

Program (source code)

```
/* Hello World program */

#include<stdio.h>

void main()
{
    printf("Hello World");
}
```

Software Source Code is *special*

Harold Abelson, Structure and Interpretation of Computer Programs

"Programs must be written for people to read, and only incidentally for machines to execute."

Quake 2 source code (excerpt)

```
float Q_rsqrt( float number )
{
    long i;
    float x2, y;
    const float threehalfs = 1.5F;

    x2 = number * 0.5F;
    y = number;
    i = * ( long * ) &y; // evil floating point bit level hacking
    i = 0x5f3759df - ( i >> 1 ); // what the fuck?
    y = * ( float * ) &i;
    y = y * ( threehalfs - ( x2 * y * y ) ); // 1st iteration
// y = y * ( threehalfs - ( x2 * y * y ) ); // 2nd iteration, this
can be removed

    return y;
}
```

Network queue in Linux (excerpt)

```
/*
 * SFB uses two B[l][n] : L x N arrays of bins (L levels, N bins per level)
 * This implementation uses L = 8 and N = 16
 * This permits us to split one 32bit hash (provided per packet by rxhash or
 * external classifier) into 8 subhashes of 4 bits.
 */
#define SFB_BUCKET_SHIFT 4
#define SFB_NUMBUCKETS  (1 << SFB_BUCKET_SHIFT) /* N bins per Level */
#define SFB_BUCKET_MASK (SFB_NUMBUCKETS - 1)
#define SFB_LEVELS      (32 / SFB_BUCKET_SHIFT) /* L */

/* SFB algo uses a virtual queue, named "bin" */
struct sfb_bucket {
        u16             qlen; /* length of virtual queue */
        u16             p_mark; /* marking probability */
};
```

Len Shustek, Computer History Museum

"Source code provides a view into the mind of the designer."

The reference repository of all Source Code

Fashion victims

- many disparate development platforms
- a myriad places where distribution may happen
- projects tend to migrate from one place to the other over time

One place to bind them…

… in Software Heritage you can find and search *all* the source code

The universal archive of Source Code

like all digital information, Software Source Code is fragile

- inconsiderate and/or malicious code loss (e.g., Code Spaces)
- business-driven code loss (e.g., Gitorious, Google Code)
- for obsolete code: physical media decay (data rot)

If (a repository on) GitHub goes away …

… Software Heritage will have a copy of it!

Building the Software Research Infrastructure

Photo: ALMA(ESO/NAOJ/NRAO), R. Hills

A wealth of software research on crucial issues…

- safety, security; test, verification, proof;
- software engineering, software evolution;
- empirical and big data studies;

If you study the stars, you go to Atacama…

… Software Heritage is the *very large telescope* of source code

Better software for industry and society

A unique reference catalog of all industrial software components

- a single entry point to discover, explore and reuse source code
- eases vulnerability tracking for more secure software
- simplifies traceability for better software integration
- ensures long term preservation of critical software

The people

The core team

- Roberto Di Cosmo
- Stefano Zacchiroli
- Nicolas Dandrimont (Engineer)
- Antoine Dumont (Engineer)
- and *Jordi, Quentin and Guillaume*

Scientific advisors

- Serge Abiteboul (French Science Academy)
- Jean-François Abramatic (former W3C director)
- Gerard Berry (CNRS Gold Medal, French Science Academy)
- Julia Lawall (Coccinelle, Linux Kernel, Outreachy)

The archive

Our sources

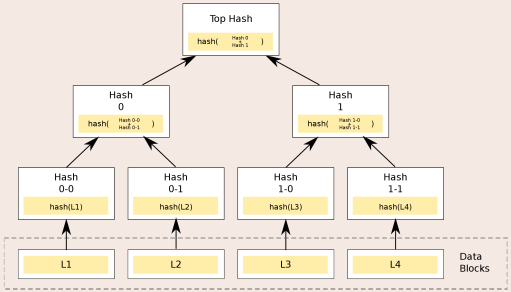
- GitHub — all public repositories as of August 2016
- Debian — daily snapshots of all suites since 2005–2015
- GNU — all releases as of August 2015
- Gitorious — retrieved full mirror from Archive Team
- Google Code — retrieved full mirror from Google

Some numbers

The *richest* source code archive already, … and growing daily!

Merkle trees

Merkle tree (R. C. Merkle, Crypto 1979)



Combination of

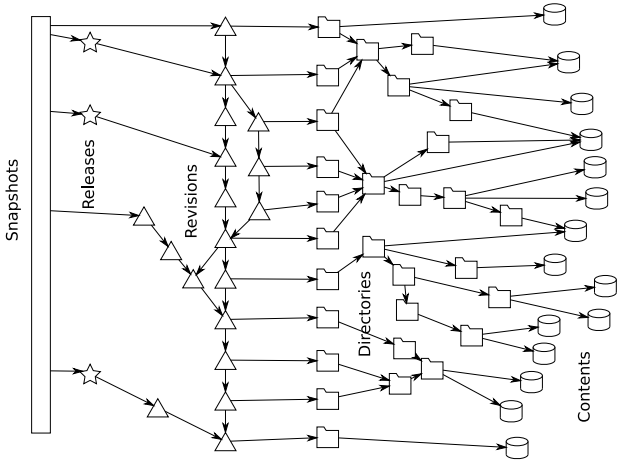
- tree
- hash function

Classical cryptographic construction

- fast, parallel signature of large data structures
- widely used by *Git*, *Bitcoin*, etc.
- natural extension: Merkle *DAG*

The archive in a few pictures

A giant (extended) Merkle DAG



The road ahead

Planned features…

- *lookup* by content hash (done)
- *download*: wget and git clone from Software Heritage
- *provenance information* for all archived code and metadata
- *browsing*: wayback machine for archived code and its history
- *full-text search* on all archived source code files

… and much more than one could possibly imagine

all the world's software development history in a single graph!

that makes a 150TB archive / 5TB database already…

An ambitious, worldwide initiative

Inria as initiator

- founding partner of the W3C,
- creating a non profit, international organisation

Software Heritage benefits society as a whole

- agreement to be signed in the presence of the highest dignitaries
  - preservation of knowledge embedded in software
  - access to the knowledge embedded in software

Support and *first partners*

ACM, Nokia Bell Labs, Creative Commons, DANS, Eclipse, Engineering, FSF, OSI, GitHub, GitLab, IEEE, Informatics Europe, Microsoft, OIN, OW2, SIF, SFC, SFLC, The Document Foundation, The Linux Foundation, …

Conclusion

Software Heritage is

- a revolutionary *reference archive* of *all* software ever written
- a fantastic new tool for *research* and *industry*
- an international, open, nonprofit, *mutualized infrastructure*
- at the service of our society, at the service of mankind!

Now open

`www.softwareheritage.org` - *sponsoring, partnerships*
`wiki.softwareheritage.org` - *working groups, leads*
`forge.softwareheritage.org` - *our own code*

Questions?