



# Scaling Emulation And Software Preservation Infrastructure

NYU-MIAP  
Handling Complex Media  
February 12, 2019

Yale



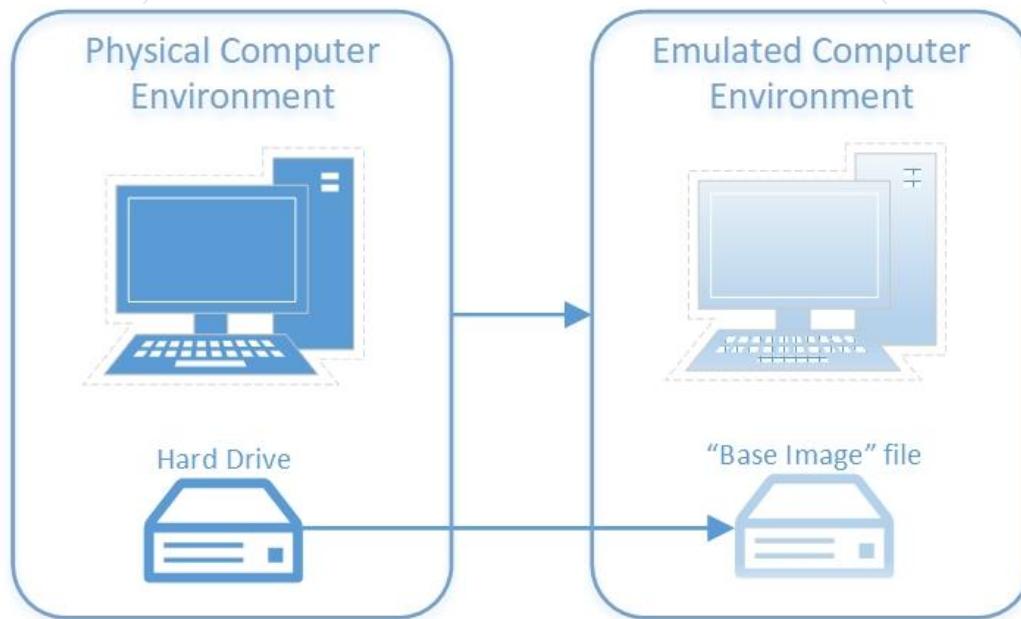
Software  
Preservation  
Network

The logo for EaaS is located in the top-left corner. It consists of the letters "EaaS" in white, with a blue vertical bar extending from the top of the "a" and another small blue dot below the "s". This logo is set against a dark grey circle, which is itself centered within a larger light grey circle.

EaaS

# Emulation





# Environments

Virtual machines

Object Environments

Containers

Search...

**Windows 98 SE - Autoboot to Works Document**

[Run] [Edit description] [Delete] [Add software]





vmware®



WinUAE



MESS



HATARI

Logos taken from project/product websites for: CCS64, MAME, DOSBOX,  
vmware, VirtualBox, MESS, WinUAE, QEMU, Mini vMac, SheepShaver, Hatari

# Does Emulation = Virtualization?

Yes

An emulated computing environment can safely be called a “virtual machine” (opposite of “physical machine”)

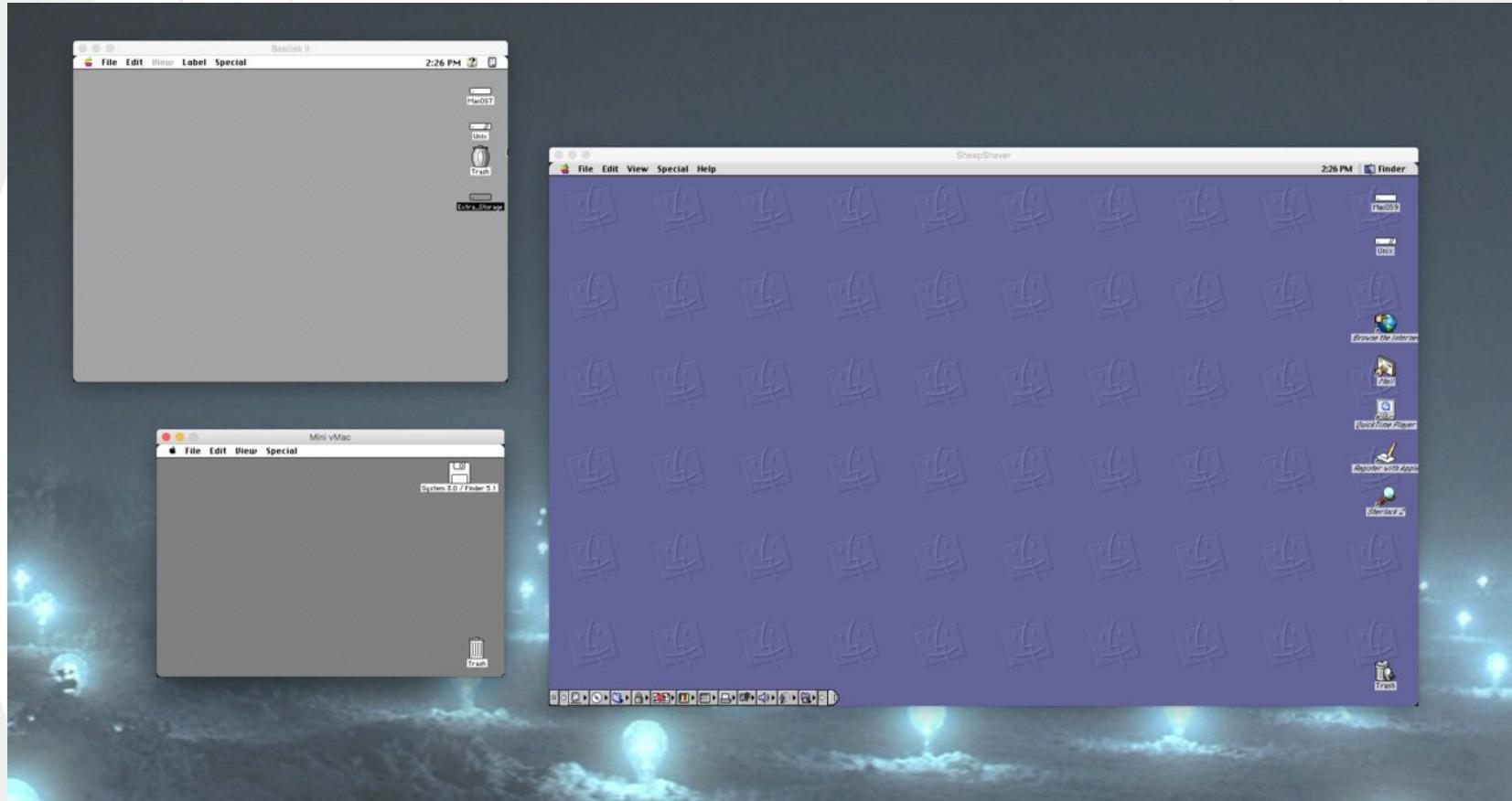
No

Emulated hardware exists entirely in software; virtual machines must host some physical hardware (e.g. a CPU)



It's **Contextual!!**





Clockwise from top: Mac OS 7.5 running in Basilisk II, Mac OS 9.0.2 running in SheepShaver, and Apple System Software 5.0 in Mini vMac

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EaaS

# Emulation-as-a-Service



# EaaS

- In development by bwFLA team at University of Freiburg since 2011
- Dev team has spun out into OpenSLX to provide commercial support



Environments

Object Environments

Software

Create Base Environment

Settings

# Environments

 New environment

Search...

## Apple Mac OS 7.5

[Configure environment] [Edit description] [export] [Delete]

clean

## Apple Mac OS 7.5

[Configure environment] [Edit description] [export] [Delete]

4

## Apple Mac OS 9

[Configure environment] [Edit description] [export] [Delete]

n.a.

## Atari 1040ST (68000 CPU)

[Configure environment] [Edit description] [export] [Delete]

n.a.

1 2 3 4 5 6

Environments

Object Environments

Software

Create Base Environment

Settings

Actions

Screenshot

Restart

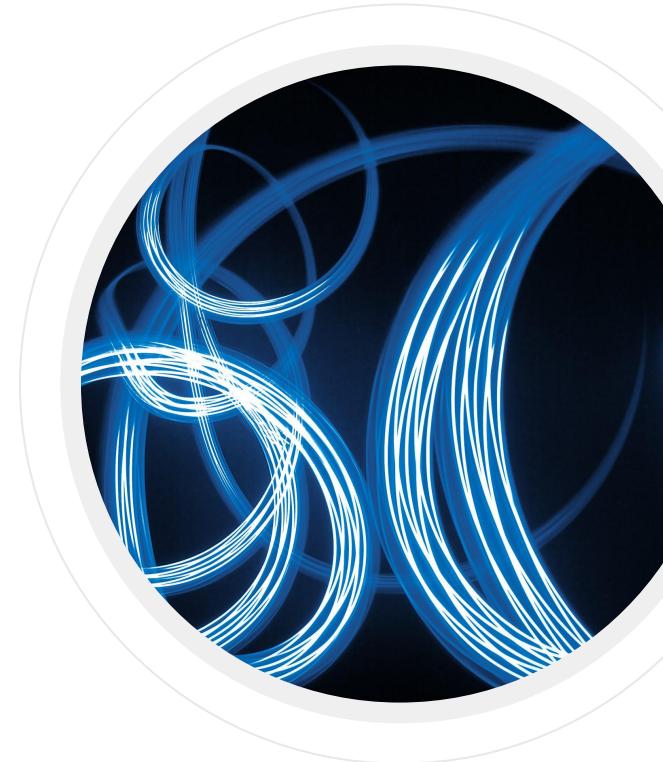
Stop

Save Changes



# Benefits

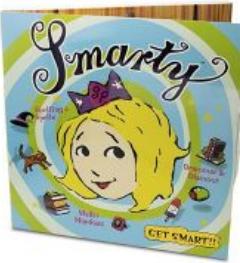
- Supplies right emulator version and preconfigures common settings
- Enables access to emulators over the web via browser interface
- Smooths creation of new emulated computing environments
- Smooths configuration of common OS features in legacy systems





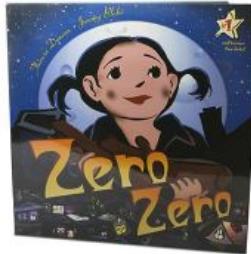
*Chop Suey*  
1995

Play



*Smarty*  
1996

Play



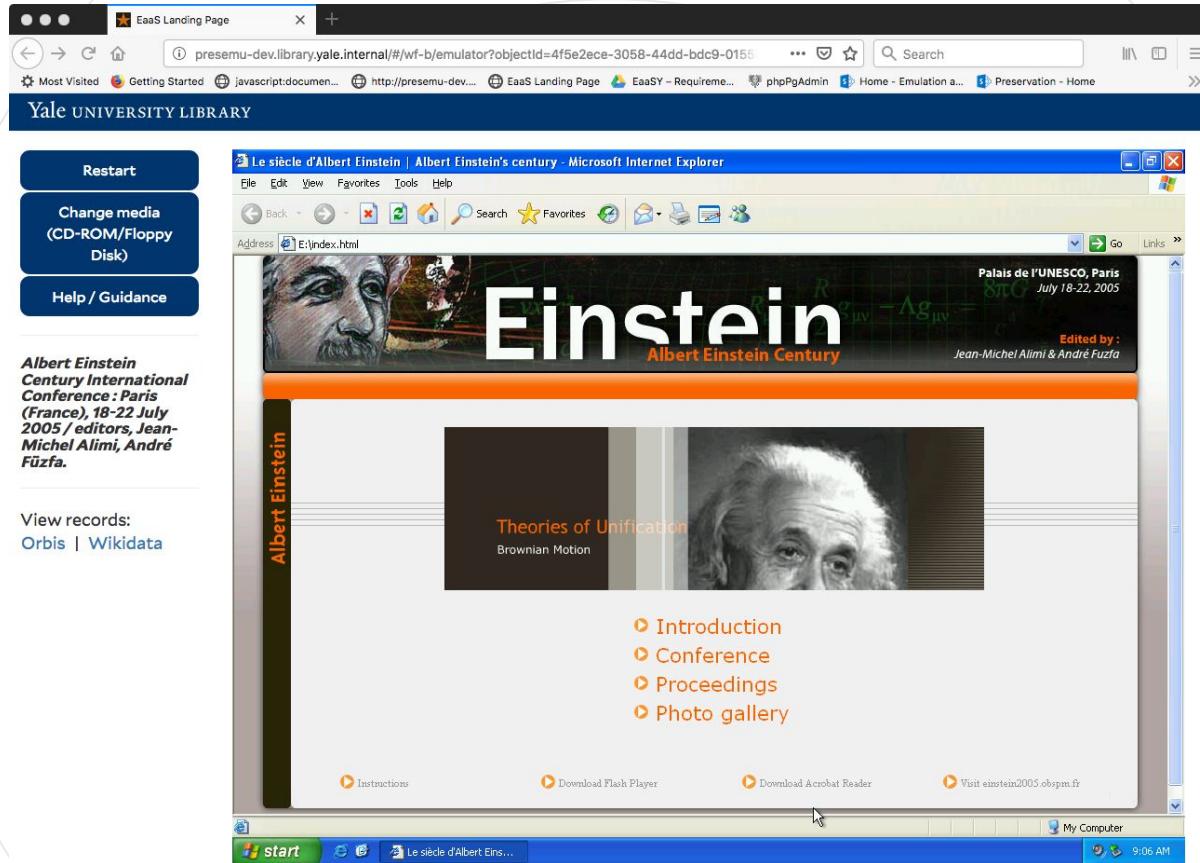
*Zero Zero*  
1997

Play

Run the emulator close to your location:  ▾

► [About Emulation as a Service](#)

**RHIZOME**  
The Theresa Duncan CD-ROMs



The logo consists of the text "EaaS" in white, with the letter "i" having a blue vertical bar extending from its top. This central element is set against a dark grey circle, which is itself centered within a larger, semi-transparent light grey circle.

EaaS

# Challenges



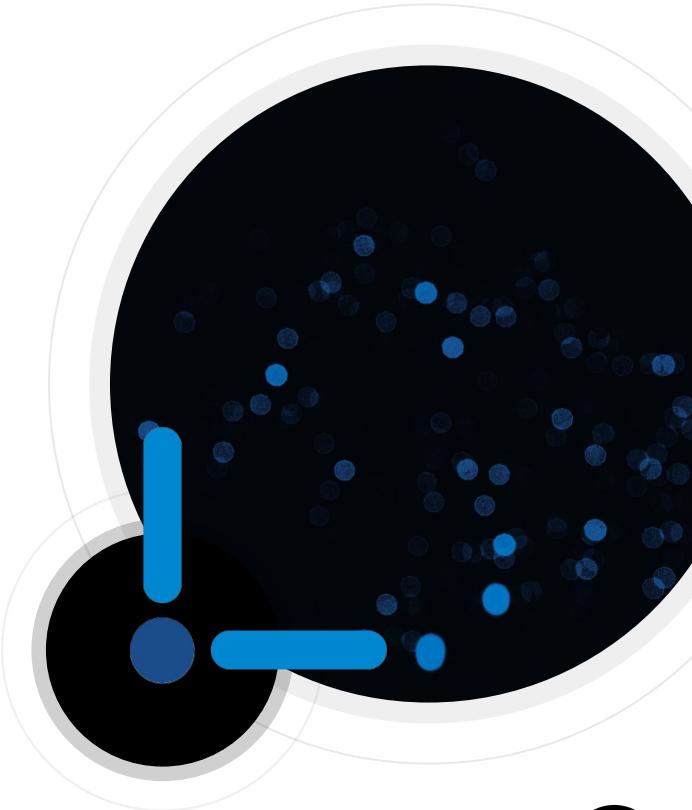
# One

Emulation services do not scale to  
a broad spectrum of users



# Two

Many potential applications to  
install, configure, and access



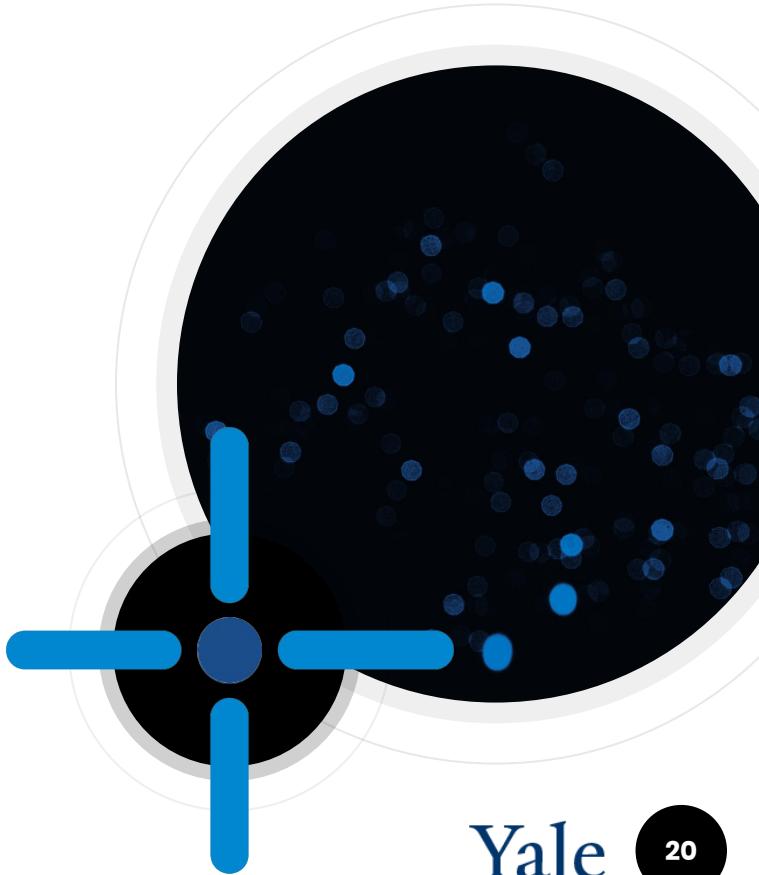
# Three

Descriptive practices for software  
and computing environments are  
inconsistent and/or insufficient



# Four

End-user access services are limited or non-existent



The background features a dark blue circle with three concentric white circles. Inside the innermost circle, there is a cluster of small, semi-transparent blue dots that form the shape of the letters 'EaaS'.

EaaS!

# Scale Up

- Streamline infrastructure for ease of deployment and operation
- Enhance usability of interface and system workflows
- Improve performance and security



# Distributed Management

- Decentralized network of emulation nodes
- Able to share software resources and emulation environments in the network
- Thousands of pre-configured software environments and software resources provided by Yale University Library



# Description

- Defining profile for description of software and computer environments
- Comprehensive, open, machine-readable documentation
- Incorporating services developed by Wikidata for Digital Preservation



# Access

- Emulated CD-ROM environment sharing service
- Virtual Reading Rooms Service
- Scientific Software Portal
- API to automatically render objects in original software via emulation





EaaS

# Demo



An emulated computing environment as initially imported into or created within EaaS.

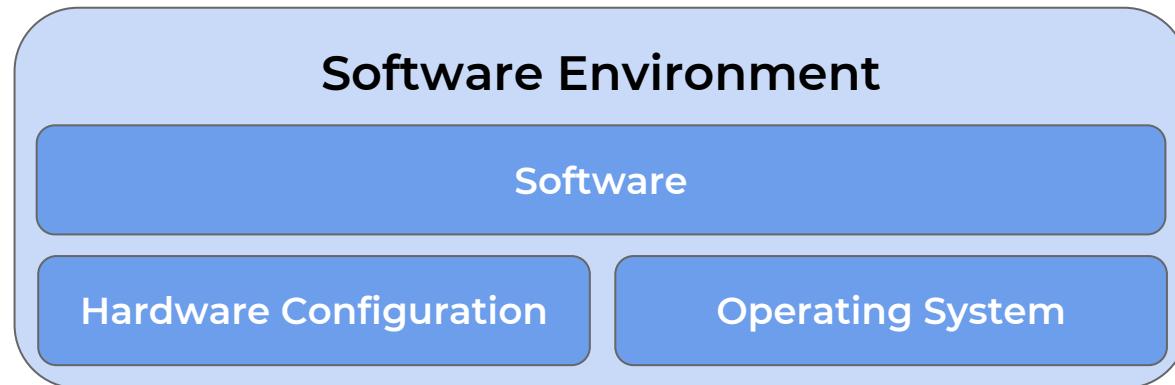
## **Base Environment**

Hardware Configuration

Operating System

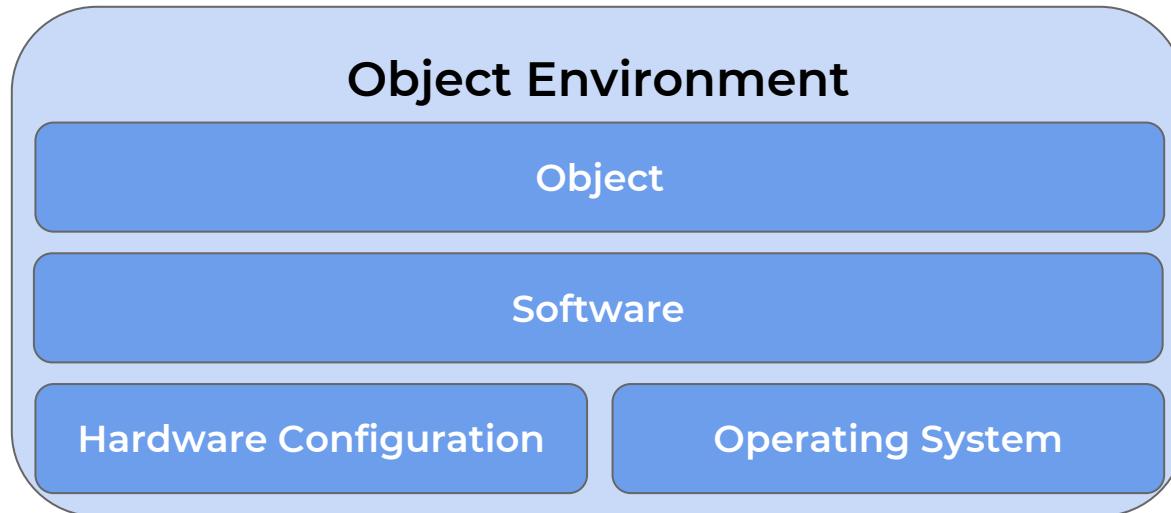
Environment Types

A derivative environment in which Software has been imported, installed, configured and saved into a Base Environment.



Environment Types

A derivative environment in which a digital object (file, set of files, disk image, etc.) has been imported, saved, and/or installed into a Base Environment or Software Environment from the node's available collections (Object Archive).



Environment Types

A circular icon containing the text "EaaS". The letter "i" is stylized with a vertical blue bar extending downwards from its top.

EaaS

# How it Works





"Base"  
Environment  
(e.g. Windows XP)

5 GB  
(Compressed)



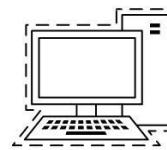
Derivative x1  
(e.g. Windows XP + SPSS 13)  
**150MB**



Derivative x1.1  
(e.g. Windows XP + SPSS 13 + SPSS code)  
**1MB**



Derivative x2  
(e.g. Windows XP + STATA 8.2)  
**250MB**

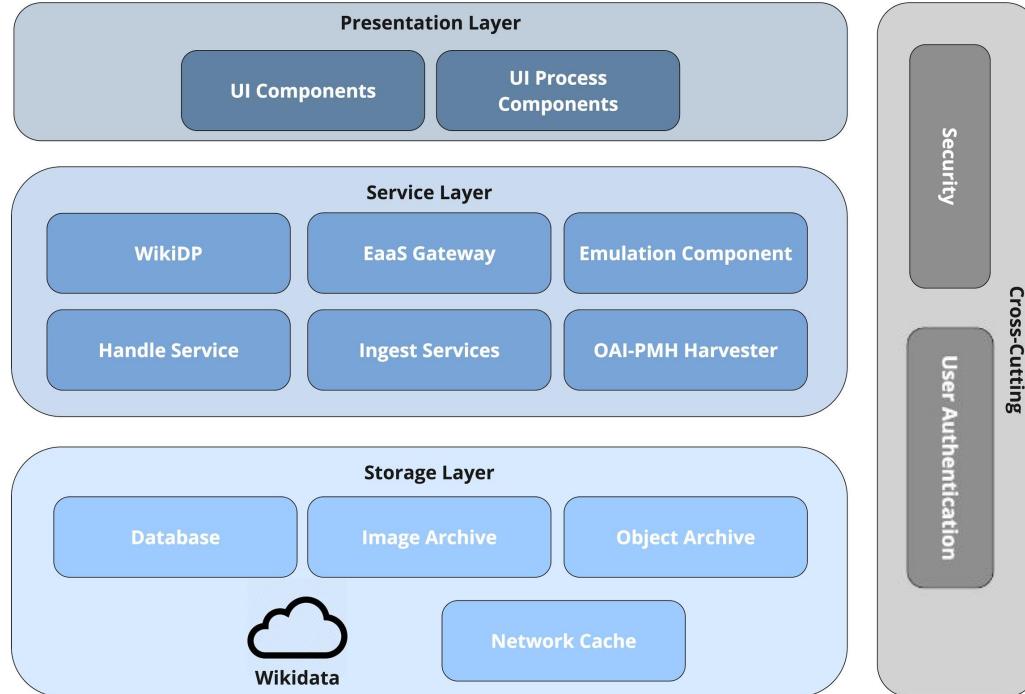


Derivative x3  
(e.g. Windows XP+ STATA 8.2 + STATA  
code)  
**1MB**

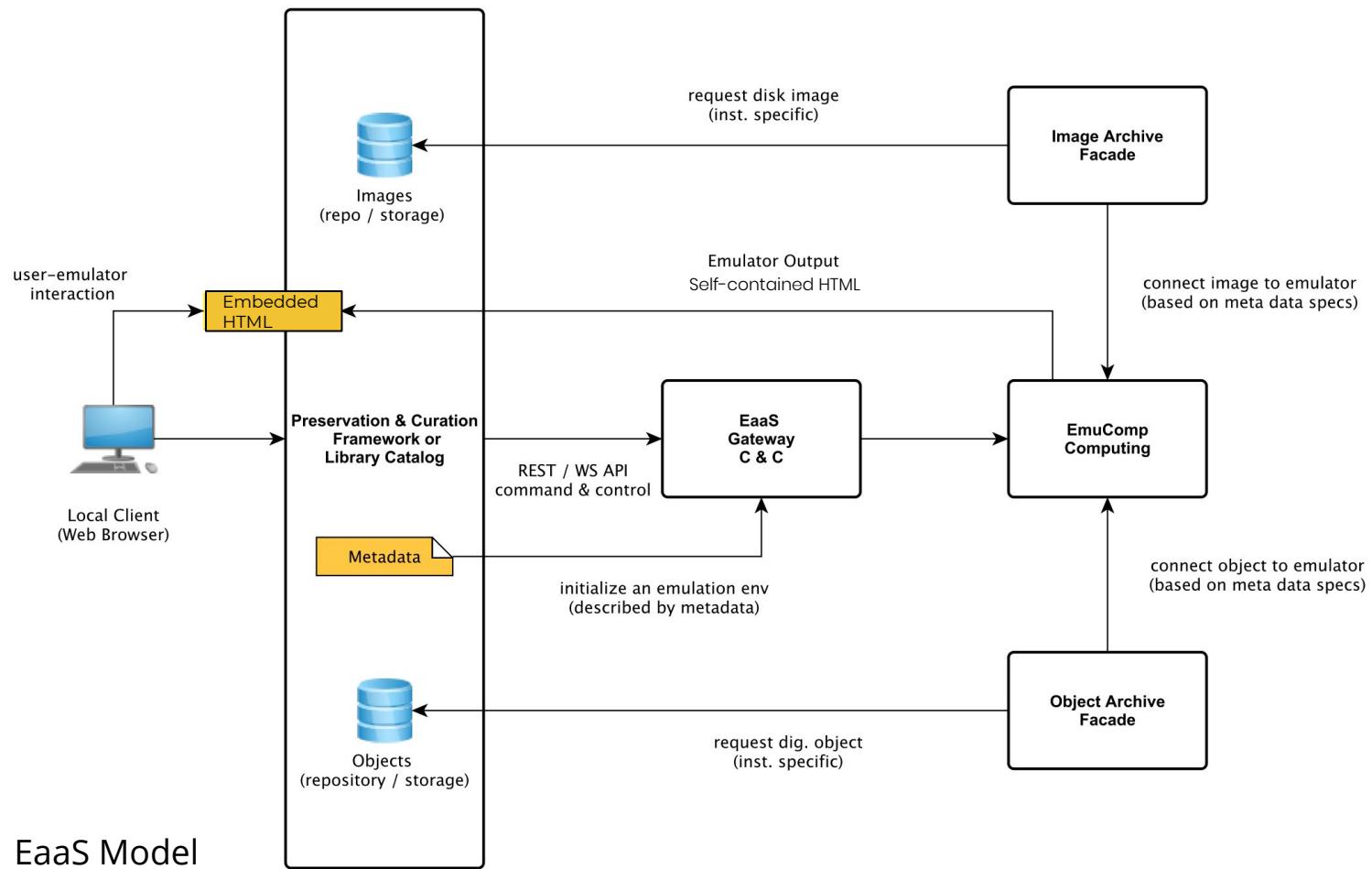


Derivative x3  
(e.g. Windows XP + R 2.0.0)  
**50MB**

## Snapshot - Based Storage

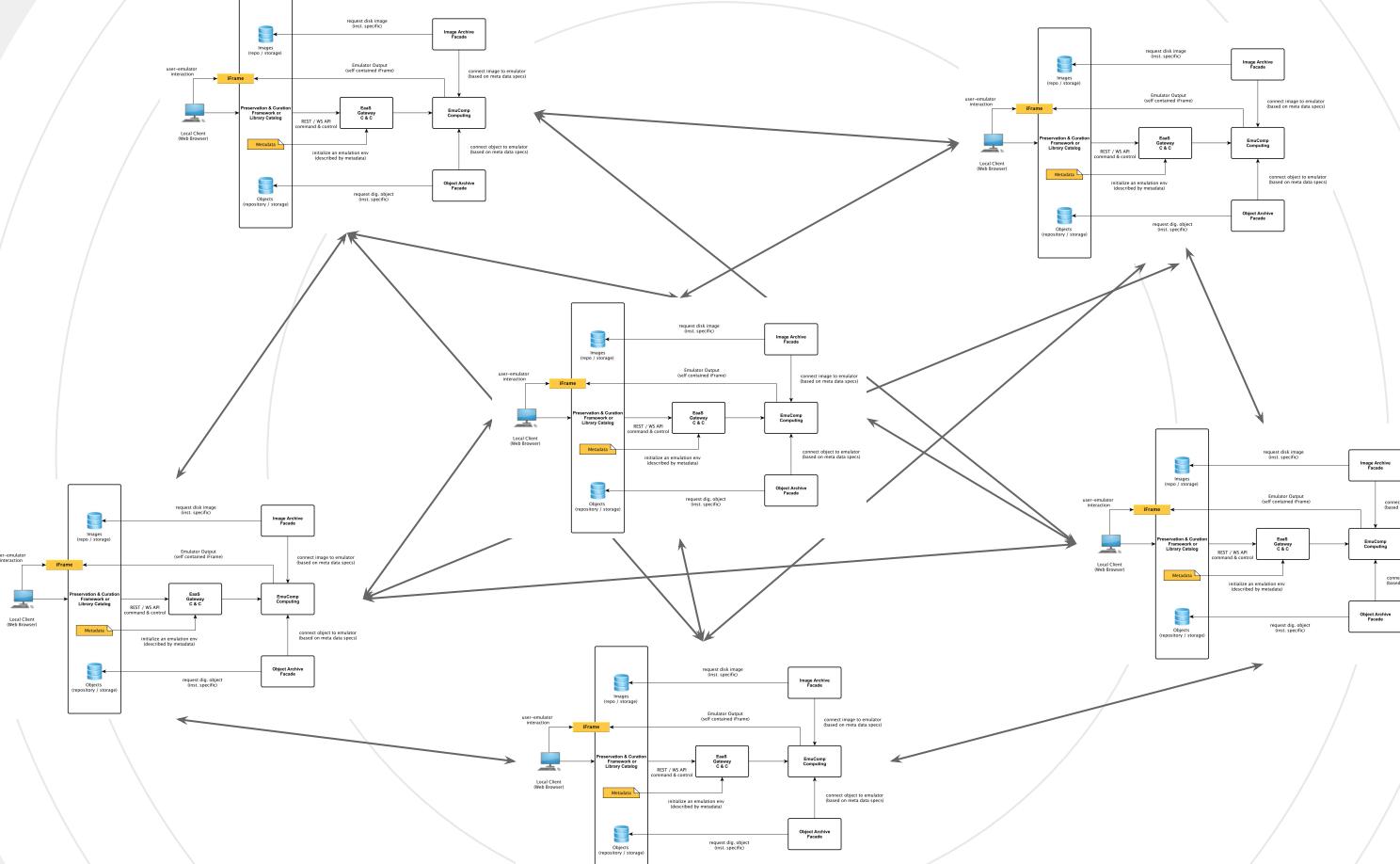


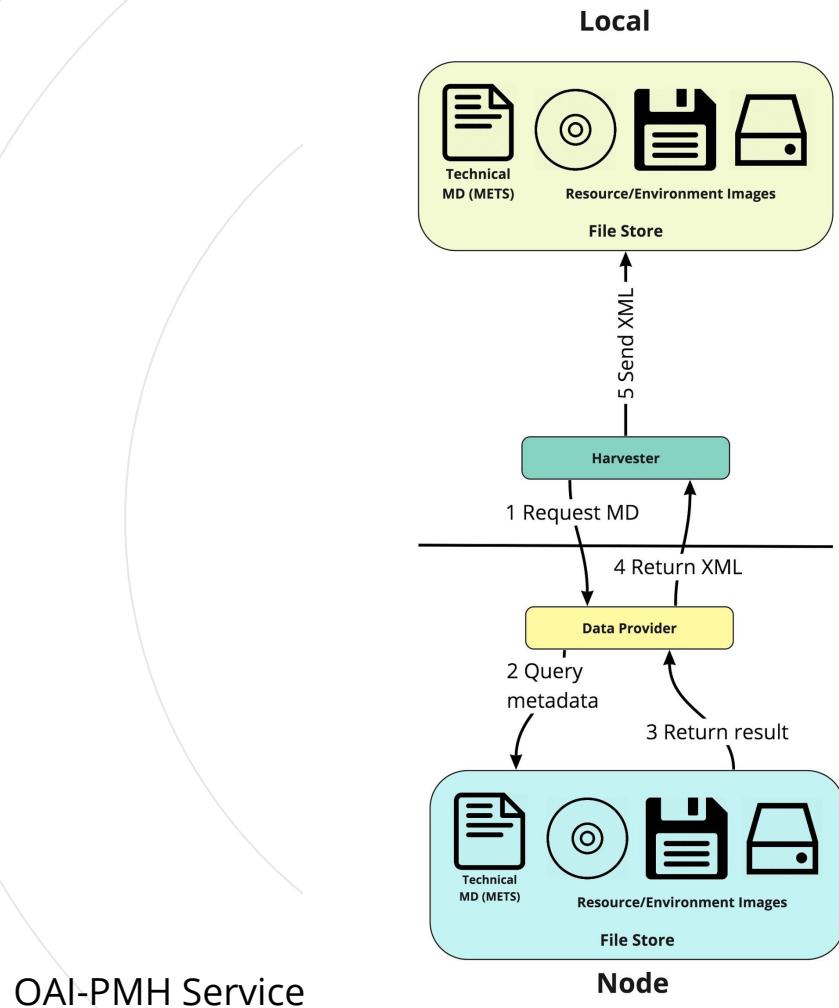
EaaS Architecture



EaaS Model

## EaaSI Model (more or less)





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EaaS

# Our Team

- **Euan Cochrane (YUL)** Principal Investigator
  - **Seth Anderson (YUL)** Program Manager
  - **me (YUL)** Software Preservation Analyst
  - **Klaus Rechert & Oleg Stobbe (OpenSLX)**  
Technical Architecture and Development
  - **Jessica Meyerson (Educopia/SPN)**  
Communications/Outreach
  - **Kat Thornton (Data Current/WikiDP)**  
Semantic Architect
- 
- **Justin Aubin, Mac Schmidt, Zoe Sinclair, Idris Sylvester, Eric Timperman, Matt Tu, Kohei Yamaguchi**
  - Software Emulation Configuration Workers



# Our Node Hosts

University of California - San  
Diego

Notre Dame University

University of Virginia

Stanford University

carnegie Mellon University

Yale University

# Affiliated Projects

## **Code of Best Practices for Fair Use in Software Preservation**

Giving individuals and institutions clear guidance on the legality of archiving software.

## **Fostering Communities of Practice: Software Preservation and Emulation in Libraries, Archives and Museums**

Bringing software preservation and access into the mainstream of digital preservation practice.



# A Very Special Thanks to our Funders...





# Thanks!

**You can find me at**

- Twitter: @The\_BFOOL
- Mastodon: @The\_BFOOL@digipres.club
- ethan.gates@yale.edu

**Learn more at**

- [www.softwarepreservationnetwork.org/eaasi](http://www.softwarepreservationnetwork.org/eaasi)
- [github.com/EG-tech/emulation-resources](https://github.com/EG-tech/emulation-resources)

**Yale**



Software  
Preservation  
Network

# Image Credits (non-EaaSI)

- <https://dpconline.org/blog/idpd/designing-a-uvi-for-digital-objects>
- Emulation logos:
  - <http://ccs64.com/>
  - <https://www.mamedev.org/>
  - <https://www.dosbox.com/>
  - <http://www.winuae.net/>
  - <https://www.virtualbox.org/>
  - <https://www.qemu.org/>
  - <https://www.gryphel.com/c/minivmac/index.html>
  - <https://sheepshaver.cebix.net/>
  - <https://hatari.tuxfamily.org/>
- <http://archive.rhizome.org/theresa-duncan-cdroms/>
- <https://blogs.loc.gov/thesignal/2014/08/emulation-as-a-service-eaas-a-t-yale-university-library/>