Olive

One-click Execution of Internet-Archived Software

Mahadev Satyanarayanan
School of Computer Science
Carnegie Mellon University

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Computer Scientists and Digital Library Community

Benjamin Gilbert, CMU
Catherine Zhang, IBM
Chris Shillum, Elsevier
Claire Cocco, OCLC
Clifford Lynch, CNI
Doug Freimuth, IBM
Erika Linke, CMU
Giovanni Pacifici, IBM
Glenn Ammons, IBM
Gloriana St Clair, CMU
Jeff Brody, IBM
Joan Smith, Emory
Kevin Guthrie, ITHAKA
M Satyanarayanan (Satya), CMU

Maria Ebling, IBM
Michael Witt, Purdue
Mike Handy, Library of Congress
Mike Lesk, Rutgers
Mladen Vouk, NCSU
Naomi Nelson, Duke
Patrick Drehrer, RENCI
Paul Jones, Ibiblio.org
Peng Ning, NCSU
Steve Griffin, Library of Congress
Tamar Eilam, IBM
Timothy Dilauro, Johns Hopkins
Vasanth Bala (Vas), IBM
Vijay Kumar, MIT

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Archiving Static Content
What About Executable Content?

WordPerfect 1.0 doc
Can you read it today?
100 years from now?

Games

Simulation model
Can you re-run old model with new data?

Application-specific content

Original Wang doc
Can you read it today?
100 years from now?
Execution Fidelity

*Ability to precisely reproduce execution*

- many moving parts
  - hardware, operating system, dynamically linked libraries, configuration parameters, language settings, timezone settings, …
- very difficult to achieve execution fidelity

Problem faced by every software vendor

- large market $\Rightarrow$ configuration flexibility $\Rightarrow$ complexity
- results in *high time to value* for customer

Exactly this problem is faced in archiving executable content

- no help desk for 100-year old software!
- how do we fake the existence of now-obsolete environments?
Computer Museum

For hardware

For software: ???????

30-year functional life
How to test patches?
Solution: Take It With You

*Transform the problem into a scaling problem*

- pack up and carry the entire environment with you (including the OS)
- transitive closure of everything you need

Central idea of a (hardware) *virtual machine (VM)*
VMs Can Relieve Pain

**VM library of pre-tested software combinations**
- use VMs as the basis of software distribution
- outsource configuration pain to third parties
- value to both software vendor and customer

User- and enterprise-specific data outside VM (e.g. dist. file sys.)

**Broader value: archive executable content**
- reproducibility for scientific results
- executable embodiment of archival results (e.g. SIGGRAPH)
- escrow SaaS (software as a service) code as insurance
- ... many others ...

VMs can do for software what VLSI did for hardware
(hide complexity and increase robustness)
But VMs are Huge!

10 GB VM

- @ 100 Mbps → at least 800 seconds (13 minutes) download
- @ 10 Mbps → at least 8000 seconds (over two hours) download

No one will wait that long to look at something briefly!

How do we achieve quick launch?
Video Streaming
VM Streaming Not So Easy

Access to VM image is not linear

Reference pattern depends on many runtime factors

• data dependencies
• human interaction
• spatial and temporal locality (program behavior)

Borrow an old idea from operating systems

• demand paging
• intercept missing VM pieces and fetch over Internet
• prefetching may speed up performance if predictions good
VM-based Cloud Computing Today

- Remote execution (e.g. Grid Computing)
- Managed execution (e.g. Amazon EC2)
- Classic PC model (e.g. laptops)
- Transient PC (e.g. ISR)

- better availability
- better safety

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Transient PC Model

(≌ AFS++)

Cloud

VM changes

Transient PC #1

Suspend

Resume

Suspend

Suspend

Transient PC #2

“Cyber Dishwasher”

Resume

Transient PC #3

Frankfurt Airport
Olive Vision

*Open archive of VM images accessible Internet-wide*

Workshop clarified Olive concepts and value proposition

- clean separation of locations for
  - VM image archiving
  - instance creation
- ability to compose VMs (e.g. for licensing reasons)

Many Olive concepts explored and fleshed out
Librarian viewpoint
• ~10 to 100 year timescale
• no execution capability
• archiving & preservation concerns foremost
• provenance tracking critical
• rigorous licensing scrutiny and enforcement
• heavyweight publication process
• not in mission-critical path

Cloud operator viewpoint
• ~1 to 5 year timescale
• reliability and availability concerns foremost
• usage metering important
• revocation of licenses possible
• lightweight publication process (within cloud and from edge to cloud)

End user viewpoint
• crisp interaction foremost
• availability important
• disconnected operation possible
• “disposable” computing hardware

Global Olive
Few instances 1 to 10 worldwide

Cloud Olive
Numerous instances 10 to 1000 worldwide
One or few per Fortune 500 enterprise

Edge Olive
Myriad instances $10^2$ to $10^6$ per cloud

few to many relationship

one to many relationship

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Olive Demo

(work in progress)