Emulation as a Service (EaaS) – Building Blocks of an Access Cloud Service

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Access through Emulation

• Research on long-term access to a wide range of different digital objects and original environments
  – Research data produced in a wide range of formats, often proprietary
  – Complex environments for analyzing and processing data
  – Preservation of virtual research environments

• Verification of results over long periods
• For reproducible scientific workflows
• Become independent of technological change
Emulation for Object Access

• Requirement: Access a wide range of different DO

• Emulation versatile digital preservation and access strategy
  – Render objects in their original environments
  – Handles any object types if suitable emulator available
  – Don't change the objects!, just migrate the relevant machine layer
Ground- and Related Work

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• But emulation services require complex setups, repetitive tasks and repositories of additional components original environments created from

• KEEP Emulation framework to wrap several emulators and original environments into a single application

• PLANETS Grate-R for remote access to emulation
Motivation for EaaS

• Open challenges in emulation strategy
  – Emulators not suitable for every end user / device
  – Support a wide range of original environments
  – Integration into institutional frameworks

• Instead, use cloud paradigm for Emulation-as-a-Service
  – Go for distributed networked services
  – Share efforts in maintaining software archives of standard components and system images
  – Use economies of scale and long tail
Emulation-as-a-Service

• Centralizes complex setups and tasks in the cloud
  – Using established cloud technology
  – Can scale on demand
  – Standardizes access to services like direct interaction or migration-by-emulation
  – Emulator and framework components deployed in well defined host environments
    • More stability less variance than on end user's devices
Emulation-as-a-Service

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• Specialization
  – Concentration on few platforms in every partner
  – Institutions can share workload and resources

• Allows use of and services for third party
  – Components can be run by different service providers
  – Institutions can offer e.g. access and migration services to outsiders
Content Control

- Often complex requirements regarding objects accessed and their environments
  - License restrictions
  - Object restrictions (privacy, ...)
  - Copy protection (watermarking, ...)
- Remote access offers better control and protection of the objects
  - Objects not leaving institutional perimeters or shared between trusted peers
  - No need to install any proprietary components off-site
Components of EaaS

- Memory Institutions
  - Cloud Service
  - Distribution Software Archive of Standard Components
  - End User Access and Interaction Component (Universal EaaS Viewer)
  - Federated AAA Service
  - Secure Access and Control Layer
  - Hardware Emulators for Original Environments
  - Migration by Emulation Service

- Migrate Objects
- Provide Objects for Rendering
- Cloud Service(s)
Components of EaaS

• **Core service** running the platform emulators, offering *object view/interaction* and *migration services* accessible by different user groups

• Distributed/federated software archive of standard components

• Federated Authentication, Authorization and Accounting services

• End user viewer moderated through secure access and control layer
Access Application

• Allows simplified access/viewer (browser) applications on user side
  – Unified view to a wide range of different original environments/emulators
  – Splits fast technological pace of end user devices from stable service backends
  – Re-use of existing remote access technology like for virtual machines or online gaming
• Suitable abstract remote access protocol
End User Viewer

Remote access to different emulation services including mobile devices

- Adaptation of input: Keyboard mappings, mouse, touch, joystick translations
- Translate device sensors required for mobile devices (GPS, gyroscope, location)
End User Viewer

Adaptation of different output devices for authentic reproduction (for games, digital art, ...)

- *Of output*: Render screen output on different devices in different qualities
- Old PAL/NTSC TV sets differ significantly from (Trinitron) computer displays and from modern LED/LCD devices
End User Access

- Is secured (privacy, confidentiality, IPR, ...) by specific control layer
  - Allows new kind of access controls
  - Watermarking, audio downmix, ... (quality degradation) of IPR material
  - Access restrictions to object aspects
    - Allow certain key input only
    - Restrict mouse access to certain screen regions
    - Allow certain types of DB queries
  - Record object access for later verification
SW Archive of Standard Components

• Software archive of standard components
  – Reproduce original environments from software packages like OS, applications, drivers, …
  – Unique identifier for each package
  – Descriptor for View Path reproduction

• License management should be handled independently
  – Depends on institutional policy and environment (inhouse, external service, …)
  – Could be linked to AAA service
AAA Service

• Distributed networked service needs to be secured and users authenticated
  – Implement IPR, privacy, … restrictions

• Federations of institutions to handle Authentication, Authorization and implement Accounting if required
  – Allows for external, 3rd party services

• Different business models
  – Pay per object, per time
  – Lend in/out software licenses
First Implementation: bwFLA

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• Distributed services for object ingest and output including software archiving
First Implementation: bwFLA

• Access to various hardware platforms and OS including Mac, X86, ...
Remote Access to Mac OS 8.5 (de) PPC
Remote Access to BEOS clone X86

Welcome to the Haiku shell.
BwFLA Framework
Thank you for your Attention!

Questions / Comments?

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