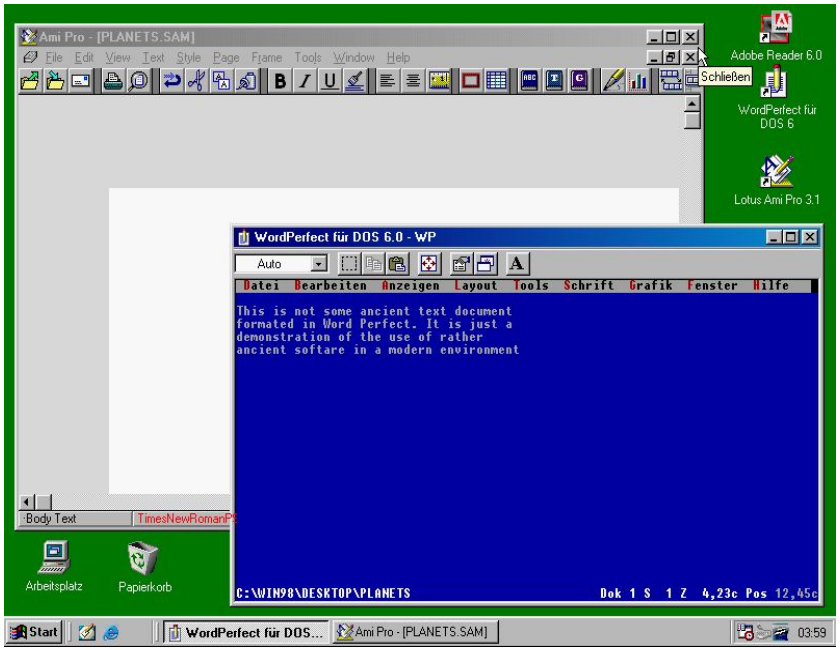
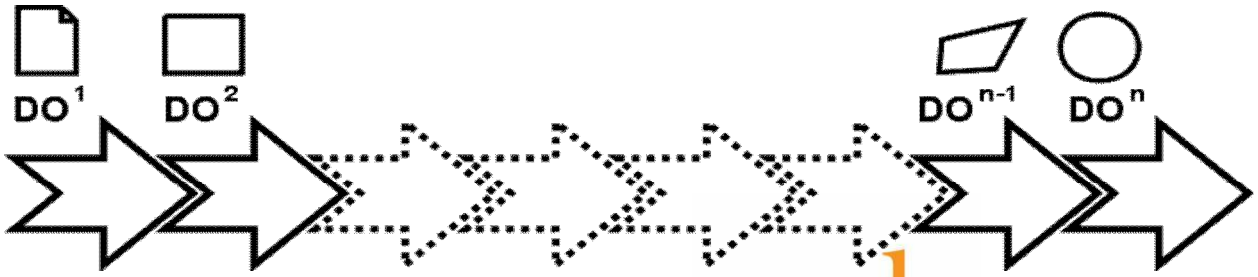
Emulation: Bridging the Past to the Future without Altering the Object

*Dirk von Suchodoletz, Randolph Welte
University of Freiburg – Department of Computer Science

Preservation Challenges

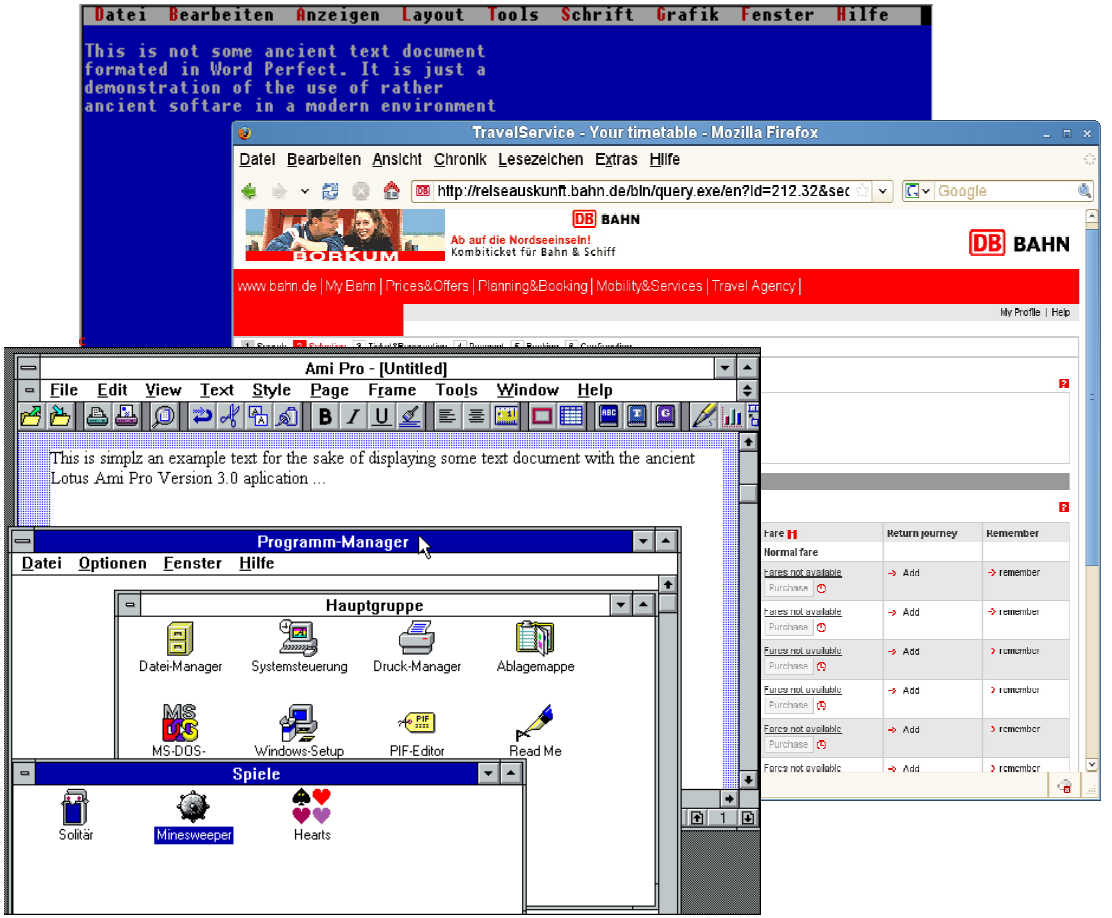
- Digital objects require software / hardware environments to be accessed
- Environments change over the time and obsolete most of digital material
- Mainline strategy: *Migration*
  - Risky to rely on it exclusivly
  - Not suitable for all object types





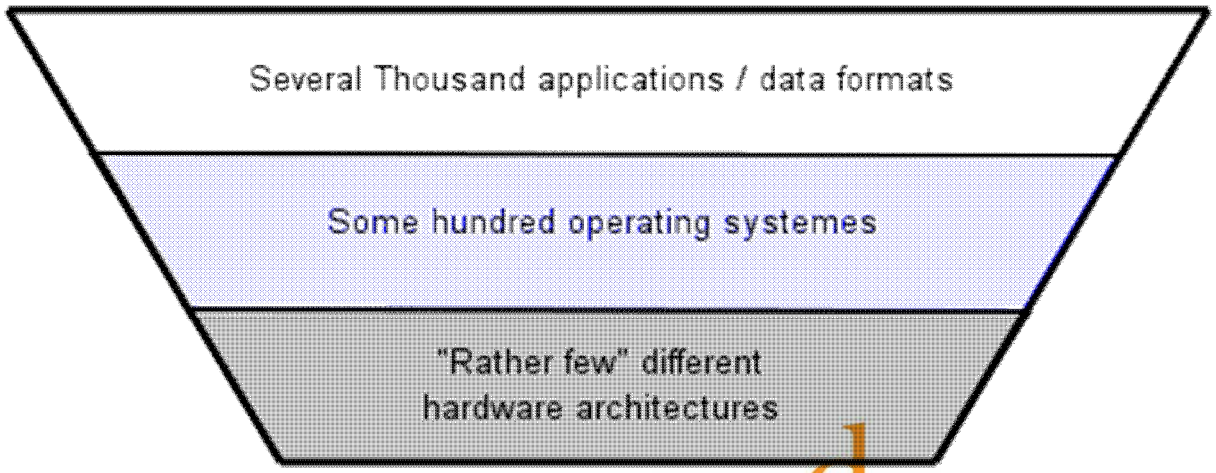
Dynamic Digital Objects

- Dynamic digital objects
  - Applications
  - Operating systems
  - Databases
- Non-linear, user inter-action, multiple views
- No real option:
  - Printing of source, adaption to recent environments; even **if** source code available
  - Video-recording, screenshots of game or application session



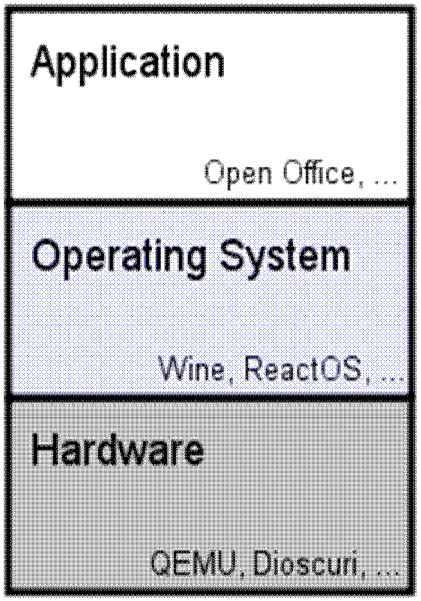
Different Approach

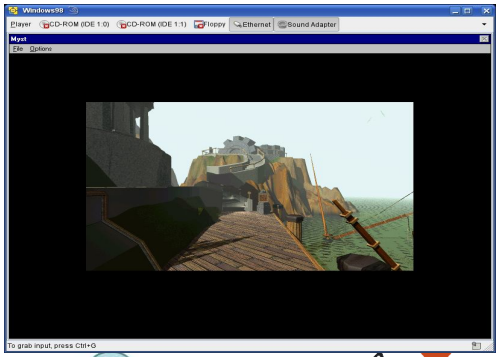
- **Emulation** – no changes on the object, but recreation of original environment
  - Emulators around for quite a while, supplemented by virtualization
  - Can operate on different layers of software/hardware stack
  - Number of objects to cover differs significantly; thus hardware layer seems very attractive to focus on
- Help to bridge widening gap of the computers past to the future



Emulation Layers

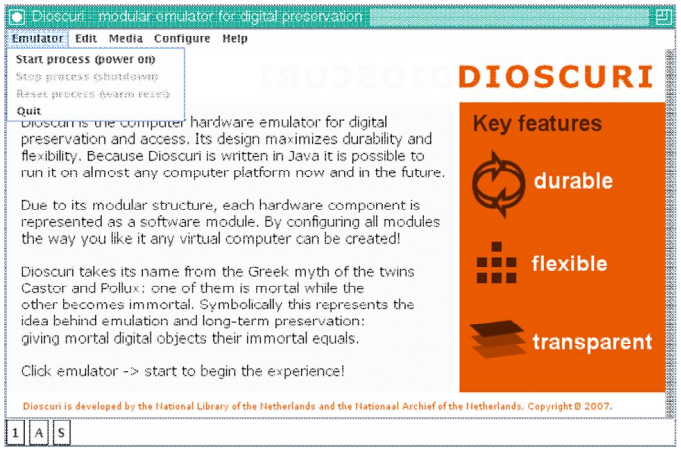
- Different options (text doc, game examples)
  - MS Word document in OpenOffice
  - Running MS Word 97 in Wine on Linux X86
  - Emulation of X86 machine to run complete Windows 98 environment with MS Word installed
- Depends on the type of object
  - Proprietary formats may prevent proper interpretation
  - OS, application APIs often obfuscated (MS)

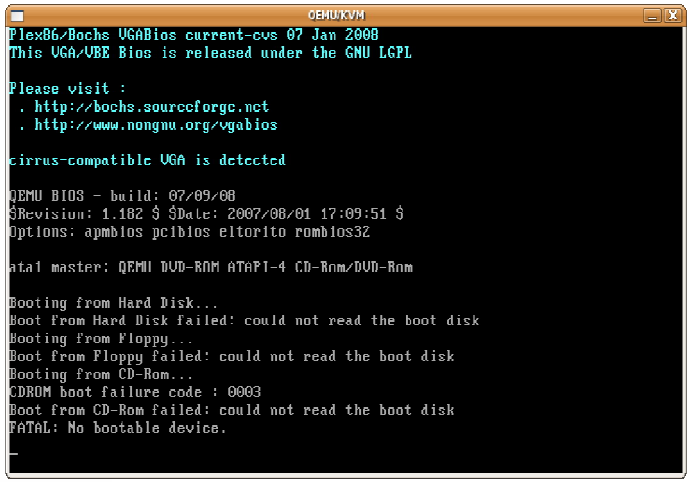




Emulator Examples

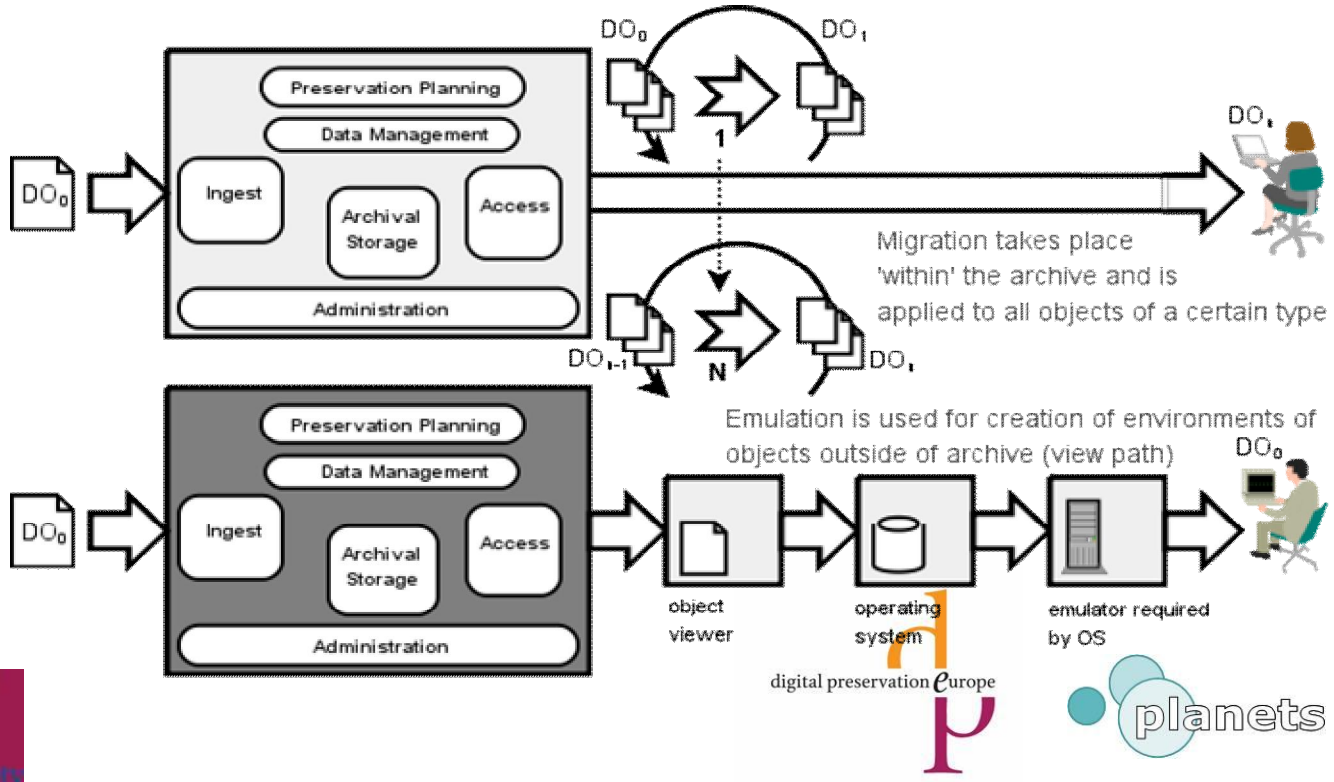
- Dioscuri X86 emulator recreating an 286, 386 PC of the early 1990th
  - Java programming language, modular approach – components like disk, floppy, VGA, CPU, RAM put together to form the machine
  - Running DOS and Windows 3.0
  - Step by step extension to 486++
- QEMU – using popular C programming language multi architecture emulator for X86, PPC, Sparc, ...
  - Large user community
  - Actively developed
- Both Open Source – no vendor dependencies, adaptable





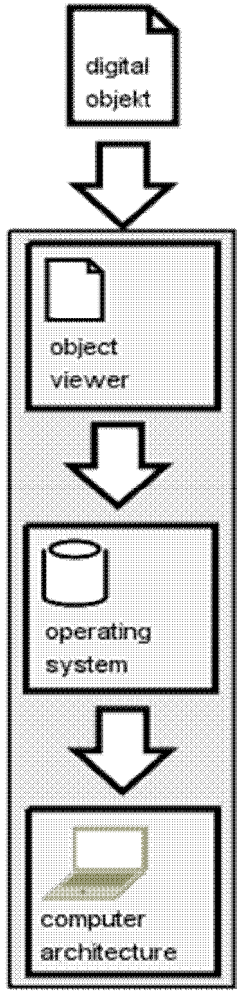
Object Handling on Digest

- Independently of migration or emulation – digital object is to be handled somehow
  - (Re)creation of a certain hardware software environment for access / execution
- Standard workplace environments for migrated objects, but ...



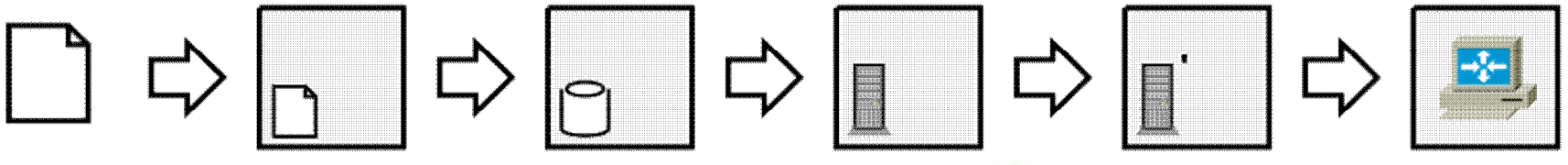
Requirements

- Emulation not working just on its own – additional software is required
- Emulation approach requires recreation of ancient hardware / software environments for access / execution
  - E.g. spreadsheet document requires the proper spreadsheet application for interpretation and displaying
  - Spreadsheet software is dependent on an operation system
  - Operating system was programmed for a very specific or a range of hardware architectures
  - Additional components like fonts might be needed for range of documents, especially for non-latin typesets
- Object transport into viewing / execution environment to be taken care of



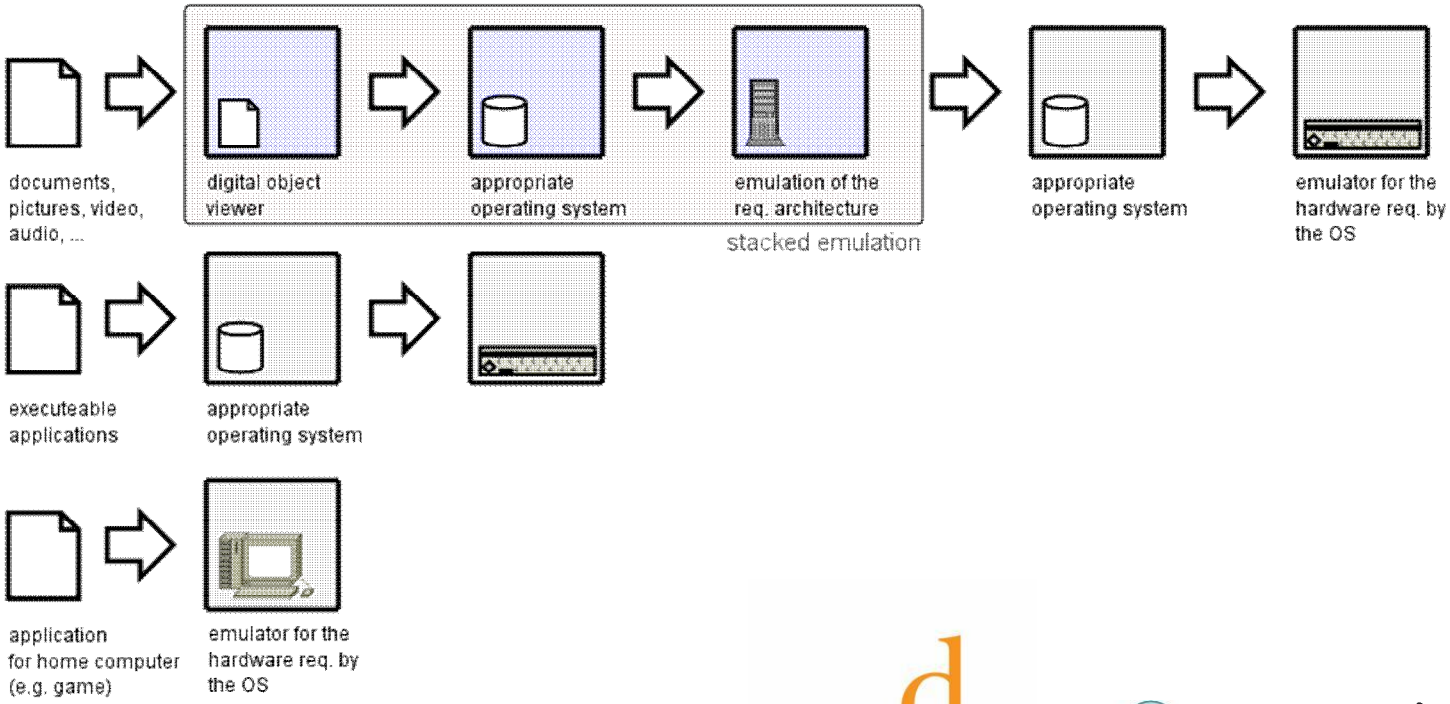
View Path

- View Path – pathway from object to specific environment
- Reference environment – specifically defined software hardware combination for object access, rendering
- Formalization needed – view path as the requirements to be followed to actually access, display the object of interest
- Introduced with Preservation Layer Model (PLM) of IBM/DIAS project
- Concept extended in the ongoing project
  - More flexible layout
  - Introduction of metrics for multiple view path
  - Match to users, organizational needs – significant properties



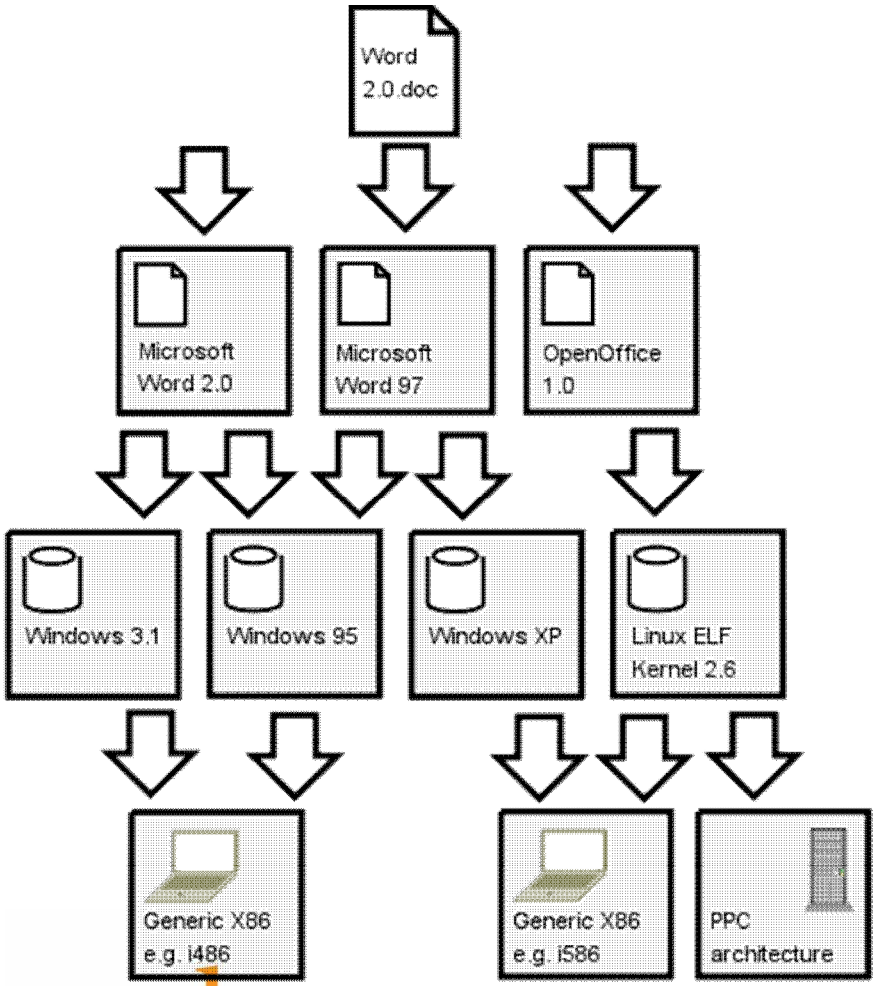
View Path Characteristics

- Variable length; depending on
  - Type of object and platform (image, document, application ...)
  - Emulator preservation strategy – getting longer with emulation stacking



View Path Metrics

- Often more than one view path exists
  - Depending on object more than one renderer available
  - Rendering / execution results may differ (significantly)
  - Less and more simple, expensive view path
- Introduce metrics for decision making in preservation planning processes
- Offer users options to choose depending on their research interest, preferences

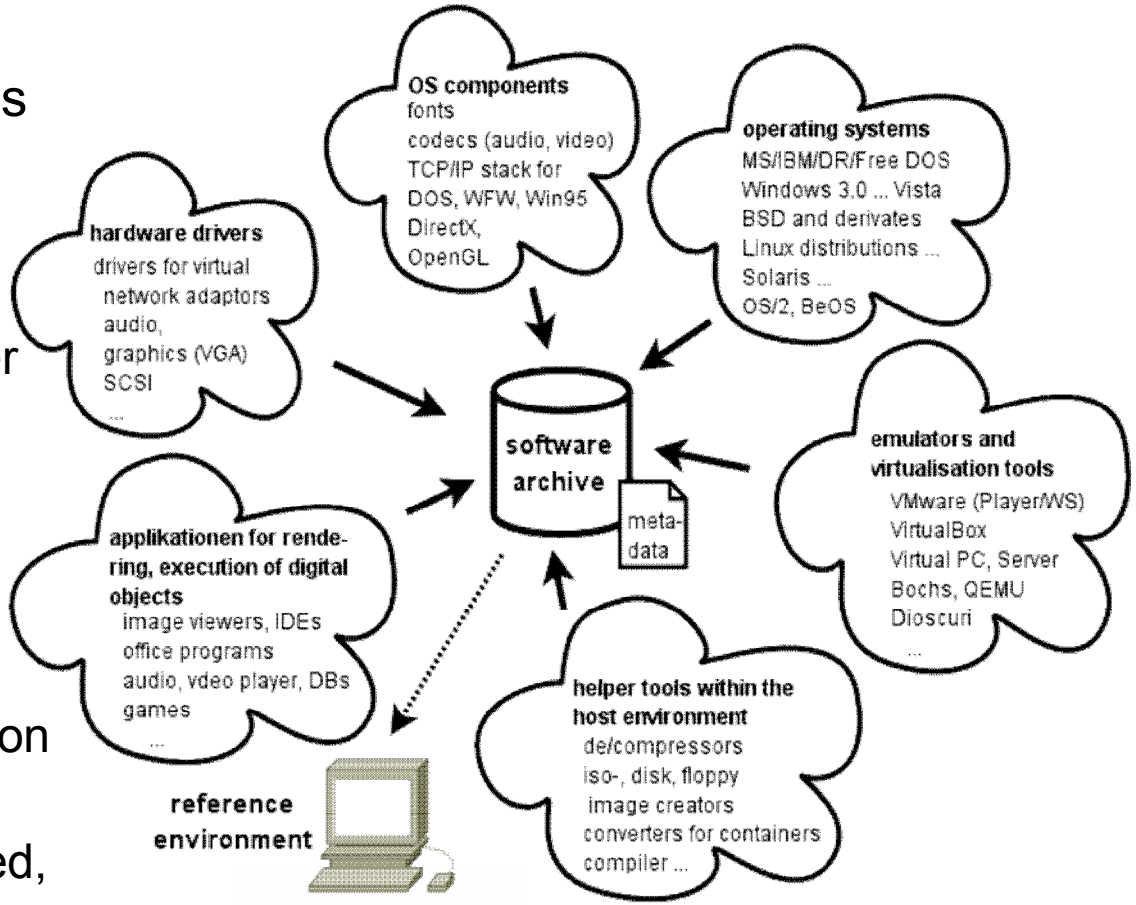


Significant Properties

- View paths not fixed for other dimensions too
- Significant properties highly debated term in digital preservation
  - Determine options how to preserve objects
  - Evaluate and compare preservation strategies and outcomes
- Metrics could be related to significant properties
  - Definitely depended on the designated user communities
  - Archivists, librarians, computer museum curators or retro gamers may not share same vision of significant properties of objects
  - E.g. ask for a definition of the term “authenticity” to get a wide range of good answers
- Use metrics to include users experience, feedback to improve results for similar objects (comparable to recommender systems)

Software Archive

- Each step in view path might add software, tools requirements
  - Applications
  - Operating systems
  - Helper tools like packer
  - Hardware drivers for VGA, audio, network
- Format and tools registries needed
  - PRONOM for file type detection and application selection
  - Open, regularly updated, broad user communities

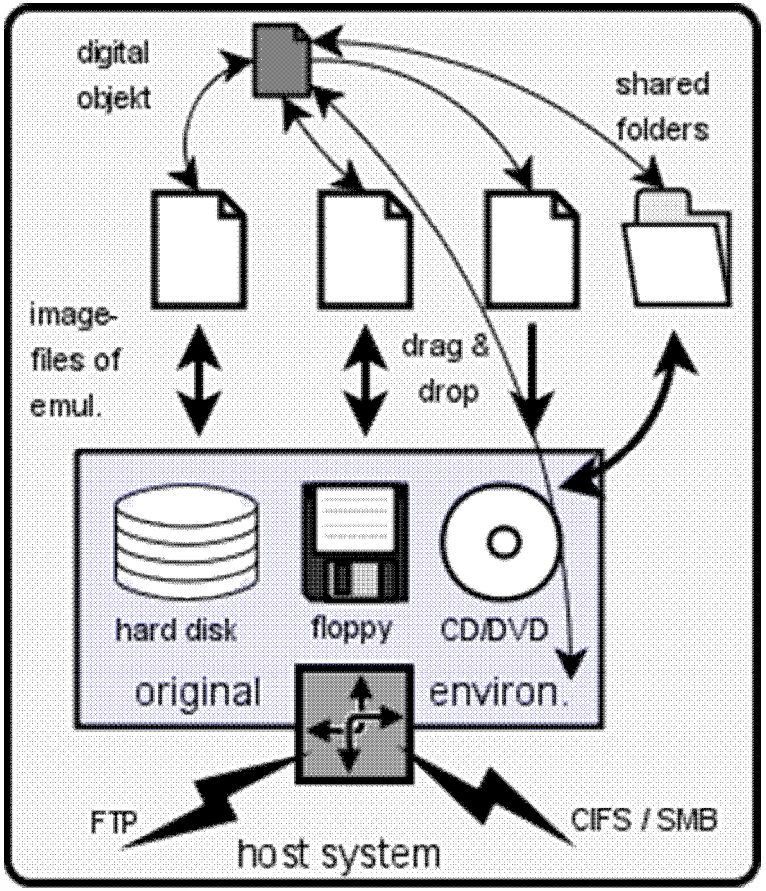


Additional Components

- Additional information and metadata needed in software archive
  - Application handbooks
  - Howtos and trouble shooting guides
  - Application update packages
  - License keys, access codes
- Depending on object
  - Fonts for documents
  - Codecs for video, audio
  - Software extensions like DirectX, OpenGL libraries

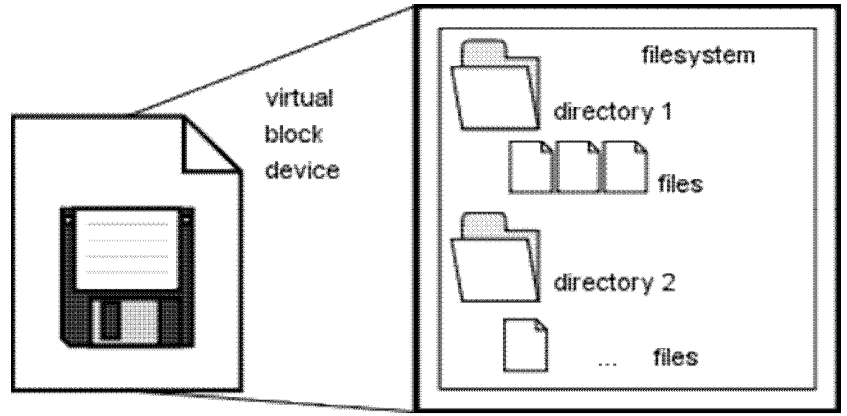
Data Exchange

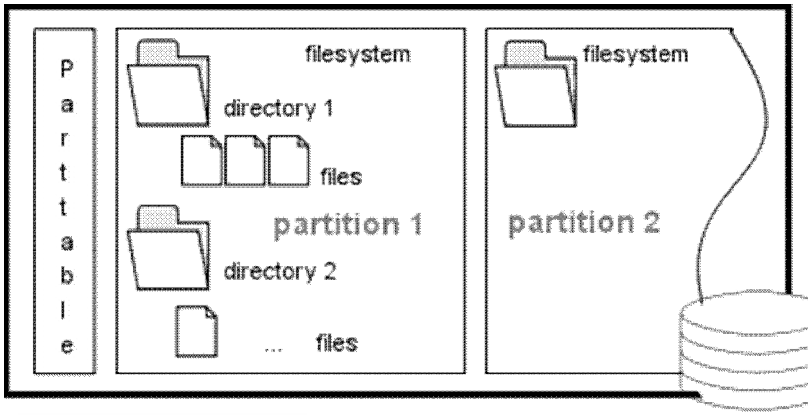
- After object digest out of archive or user data of other sources
  - Transport into emulation environment
  - After or during enviroment setup
- Means of object transport
  - Virtual optical (ISO) or floppy disks as images
  - Disk container files
  - Network connections like FTP, SMB/CIFS
  - “Shared Folders” (as e.g. found in VMware or VirtualBox)
  - Copy&Paste (e.g. text areas in Dioscuri)



Transport Containers

- Data transport requires fromats understood by the target environment, e.g.
  - Floppy disks, ubiquious in for many platforms for a rather long period
  - Images easy to create and store
  - Optical disks: ISO images well understood by many emus
- More complex
  - Container files of the several emulators
  - Creator tools required
  - Adding objects to disk container files before emulators started

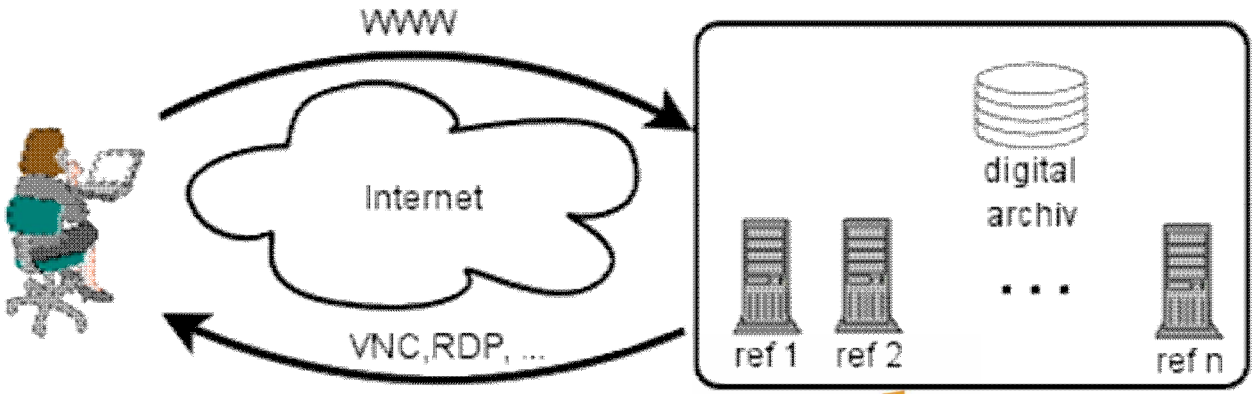




block orientated, non volatile storage (harddisk, floppy,, ...)

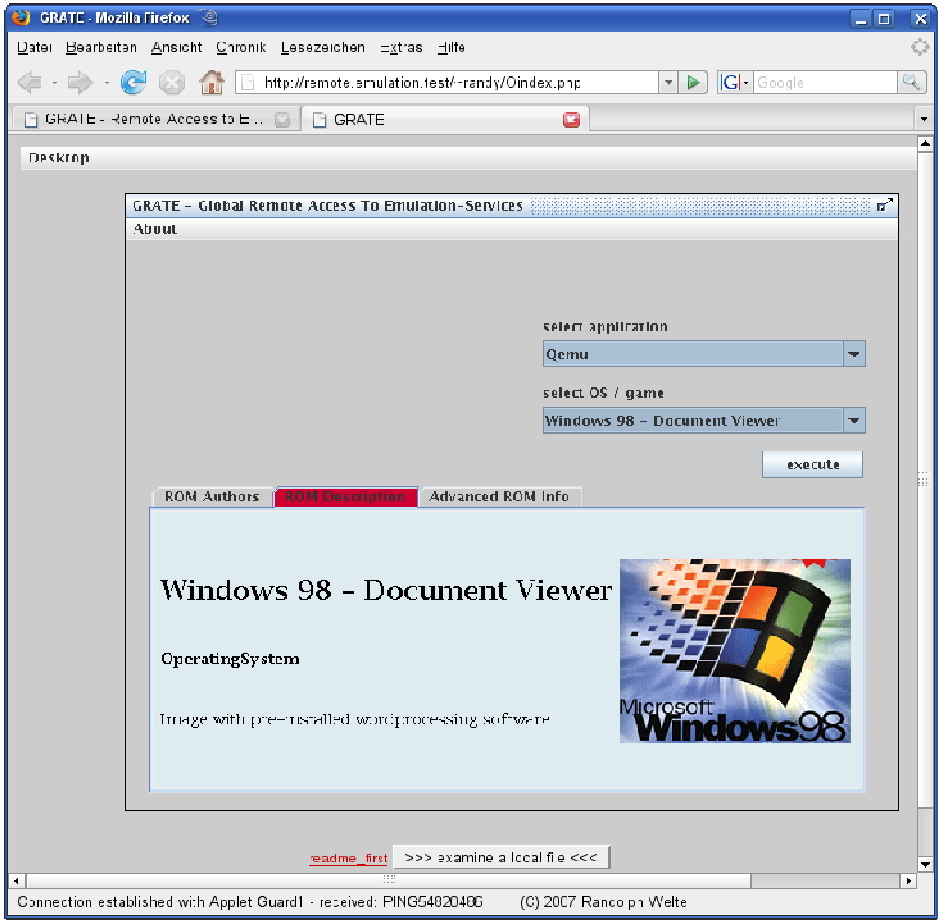
Reference Environment

- Emulation might require quite some steps until object is actually accessible
  - Average archive user is often not trained computer professional
  - Lots of problems to setup emulation environment on average machines
  - Many software components needed are proprietary
- Workstations with defined environment e.g. in library reading rooms
- Offer pre-created environments over the network



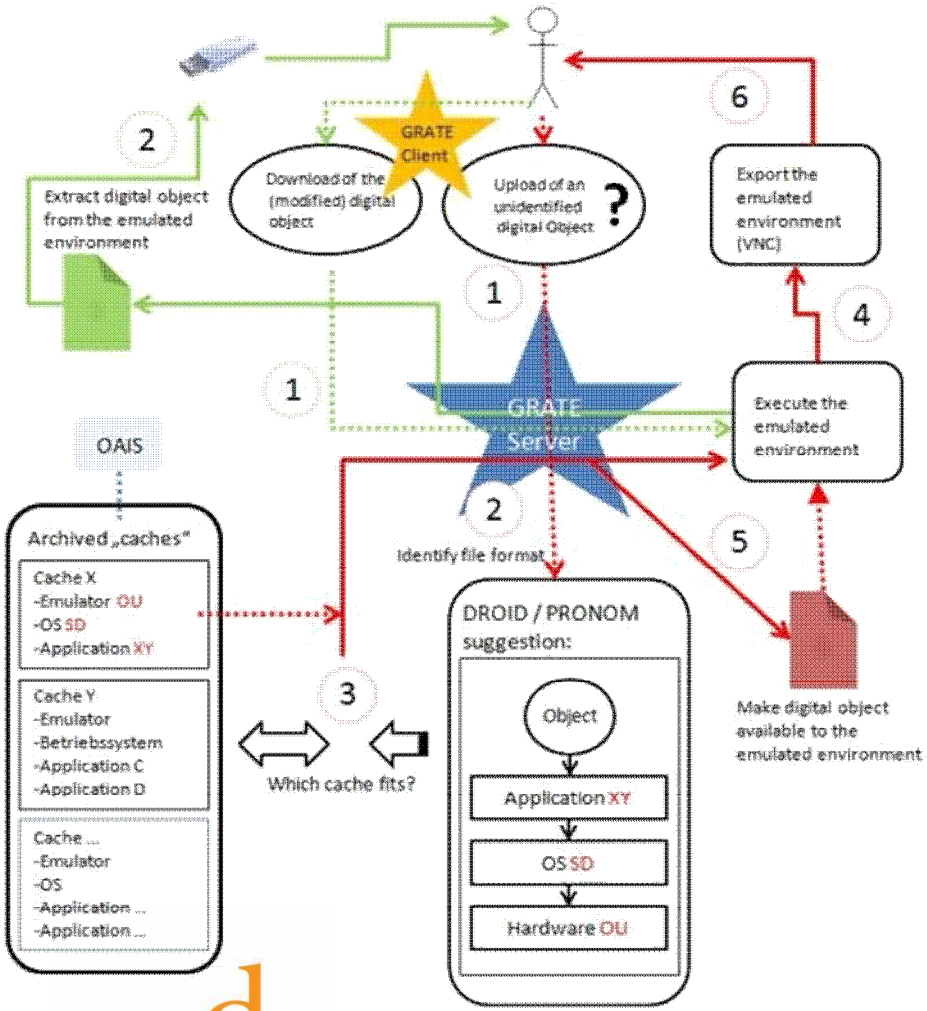
Web Access for Emulation

- Global remote access to emulation (services)
  - Access to different emulation enviroments like Dioscuri, MESS, QEMU, ... for Windows 3.11, Windows 98, C64, Atari, ...
  - Up- and download of objects over the net
  - PRONOM detection of object type and view path suggestion
  - Starting the appropriate emulator and software environment for object access



GRATE

- Client Server application for remote operation
  - Client side: Java application executable in average browsers with JRE 1.5
  - Server side: Standard Linux environment to host the several emulators
  - Open Source
  - Extensible to more emulators, environments
  - Please have a look at our poster explaining the tool a little bit more!

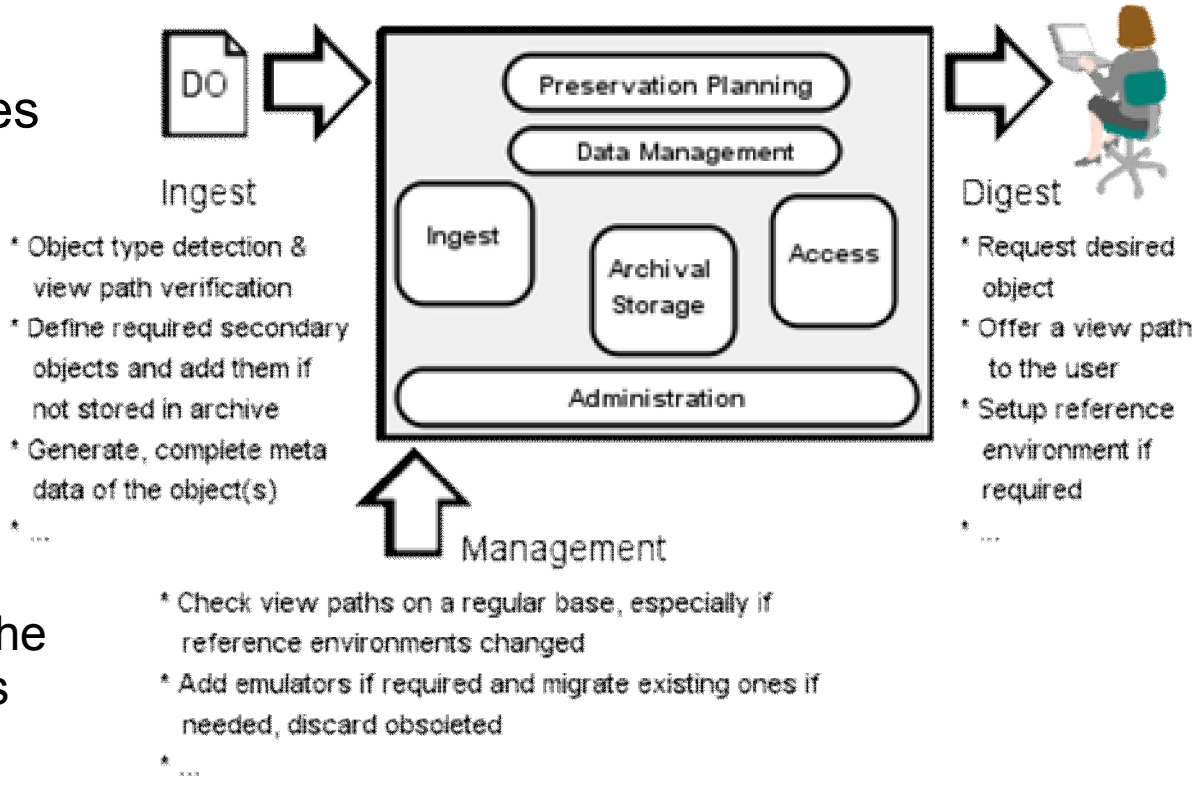


Archive Management

- Additonal archival objects required for view path handling and required software environments
- Storage of view path caches for fast access in GRATE or specifically defined reference workstations
- View path aggregation of often used environments
- With this information – define and use metrics to calculate archive management costs
  - Differentiate view path options
  - Get cost structures to preserve certain object types
  - Evaluate shared, distributed archive approaches to local ones

Emulation in OAIS

- Emulation requires certain archive management activities on
  - Ingest
  - Operation
  - Digest
- Emulation might require OAIS extension
  - Suggestions from the list of archival tasks explained



Thank you! Questions!?

- Randolph Welte
  - rwelte@uni-freiburg.de
- Dirk von Suchodoletz
  - dsuchod@uni-freiburg.de

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