

On the use of e-Infrastructures for Arts and Cultural Heritage

Roberto Barbera (roberto.barbera@ct.infn.it)

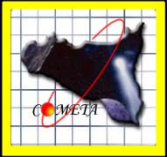
Univ. of Catania & INFN & Consorzio COMETA

ISGC 2011 & OGF 31

Taipei, 23.03.2011



- **Why Grids for Arts Humanities ?**
- **Use Cases:**
 - **Why**
 - **Use Cases: Arts and Humanities**
 - The ASTRA project;
 - Sonification ;



e-Infrastructures at «global» scale

eGee
Enabling Grids
for E-science

>340 sites in 56 countries

~300,000 CPU cores

>250 PB of storage

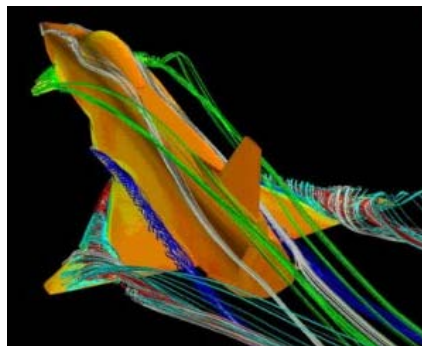
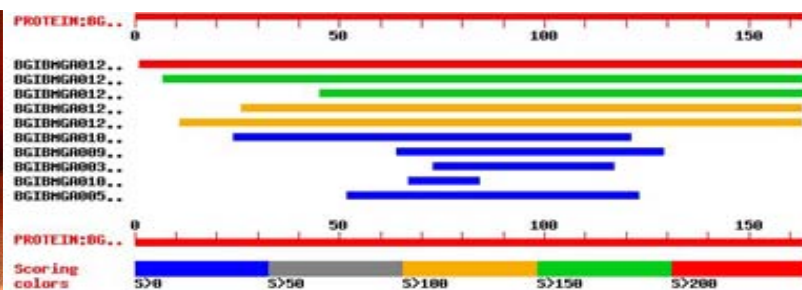
~28 million jobs/month

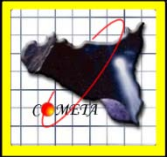
Scheduled = 21539
Running = 25374

21:13:50 UTC



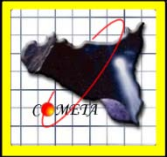
GridPP
UK Computing for Particle Physics





Why Grids also for Arts and Humanities?

- **High performance/throughput computing systems:**
 - Large scale, computationally intensive, problems can be tackled, e.g. “ab initio” sound creation, document/image digital restoration, etc.;
- **High performance storage systems:**
 - Geographically distributed replicas of files
 - Fault-tolerant digital preservation;
- **Simplified authentication systems:**
 - Single sign-on;
- **Fine-grained authorization systems:**
 - Allow to precisely define “who”:
 - Individual user(s), group(s), organization(s), the whole world;
 - And “what”:
 - Read/edit/delete data and metadata;
 - Search, browse;
 - Creation of new repositories;
 - Role assignments, etc.



1st Use Case: ASTRA

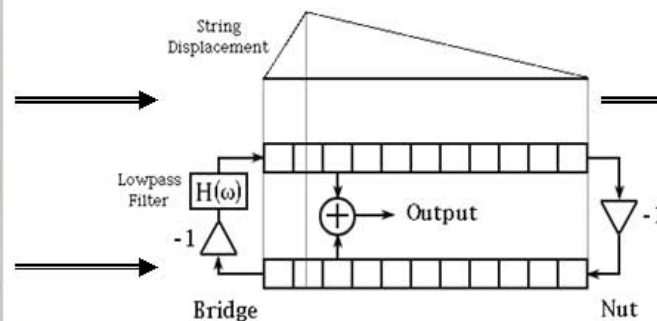
(www.astraproject.org)

- The ASTRA (*Ancient instrument Sound/Timbre Reconstruction Application*) project aims at reconstructing the sound or timbre of ancient instruments using archaeological data as fragments from excavations, written descriptions, pictures, etc.

Archaeological findings



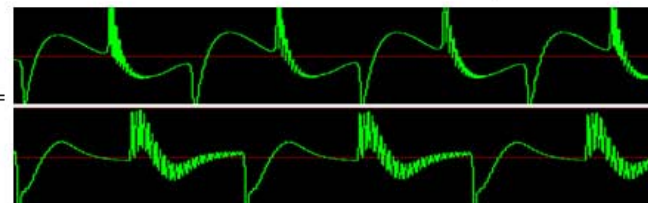
Computing model



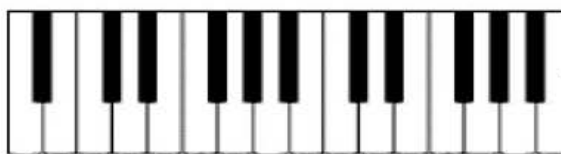
The Grid Network

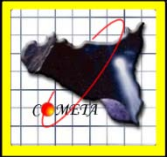


Reconstructed sounds



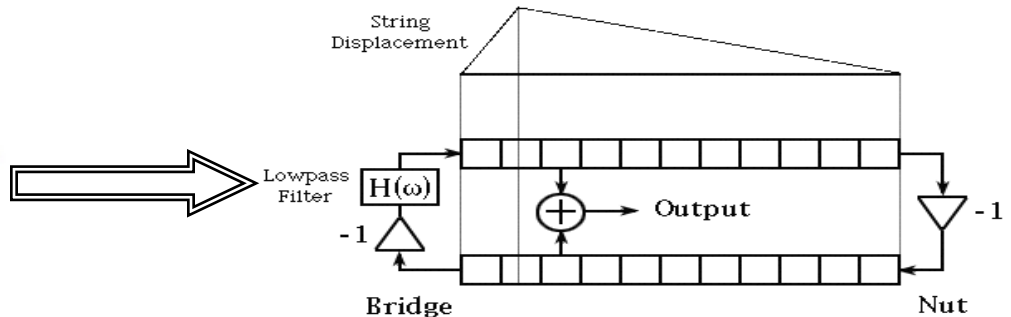
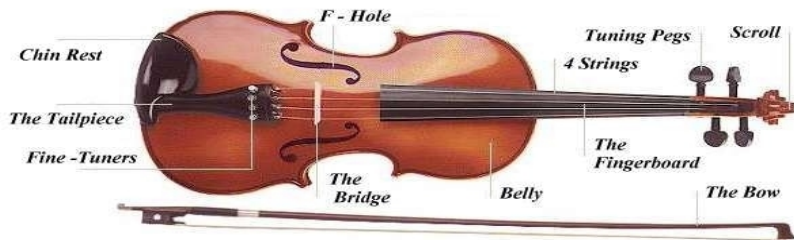
Load the sounds on a piano keyboard and play



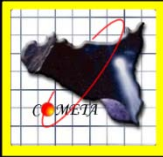


The Physical Modeling Synthesis

- The technique used is the **Physical Modeling Synthesis (PMS)**, a complex digital audio rendering technique which allows to recreate a model of the musical instrument and produce the sound by simulating its behavior as a mechanical system.



- The **PMS** offers great potentialities both to:
 - Musicians searching for the most convincing real-world sound emulations;
 - Musicians searching for unique, never-heard-before sounds by changing the instrument geometry.



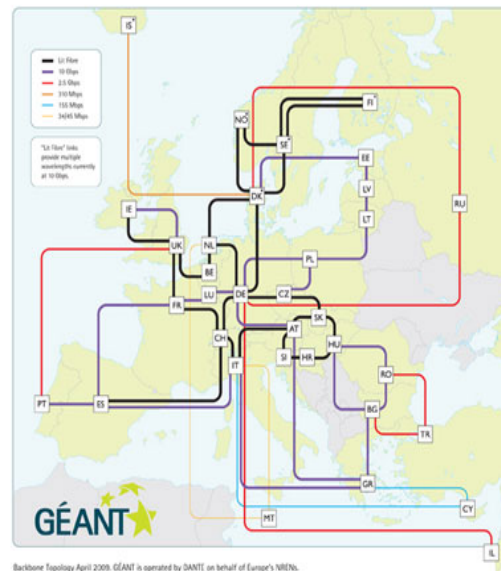
Why does ASTRA need e-Infrastructures ?

- ASTRA project heavily exploits Research Networks and Grid infrastructures:
 - Thanks to the Grid and the network, many simulations can be performed in parallel on different computers at different locations.

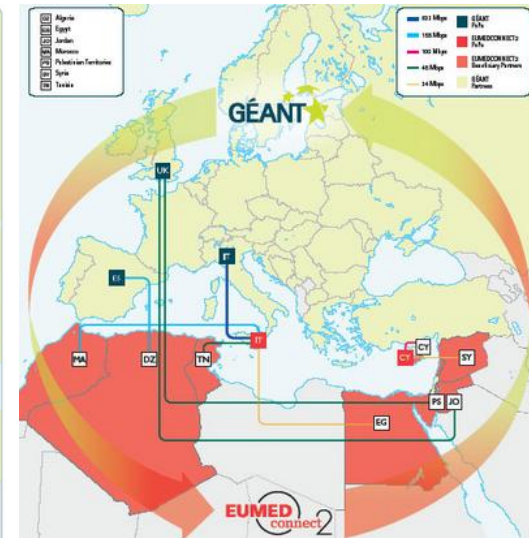
30 s of reconstructed sound need ~ 90 min on a 3.73 Ghz CPU with 2 GB RAM

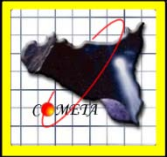
GEANT and EUMEDCONNECT2 provide the needed network infrastructures to speed up the overall computation time.

ASTRA can count on more than 500 CPU cores and the support of more than 20 Grid sites both in the GILDA (part of EGI) and EUMEDGRID infrastructures.



Backbone Topology April 2009. GEANT is operated by DANTE on behalf of Europe's NRENs.





ASTRA main achievements



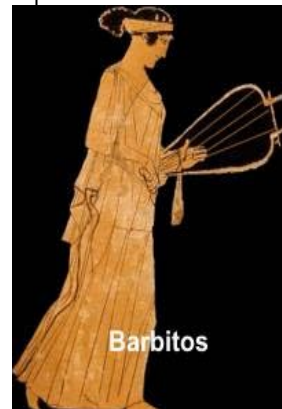
In Dec. 2008, a unique concert was staged using the digitally reconstructed sounds of the **Epigonion** alongside the **Sonora Netwok Ensemble**'s performance of the Czech composer Jan Dismas Zelenka's Psalm "Laetatus sum".

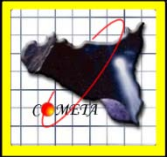
To watch an excerpt of the concert, [click here](#).

In Dec. 2009, the sound of the **Barbitos**, an ancient Greek instrument similar to the double bass, was also reconstructed.

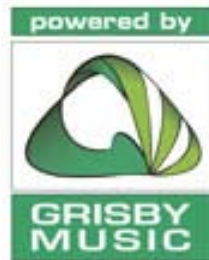
The music was sent **across GEANT and TEIN3 networks** 9,300 km far from the venue in Stockholm to let dancers from the Arts Exchange of Asia dance in **real time** in Kuala Lumpur (Malaysia).

To watch the video, [click here](#).

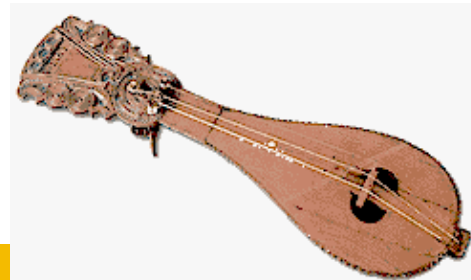


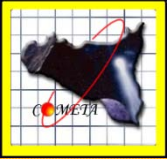


- The Lost Sounds Orchestra is the ASTRA project orchestra:
 - It is a unique ensemble all made of reconstructed ancient instruments coming from the ASTRA research activities;
 - It is the first orchestra in the world composed only by reconstructed instruments;
 - It plays sounds being lost in time due to instruments too complex both to build and play;
- The Lost Sounds Orchestra is currently supported by the following sponsors:



- The ASTRA project is currently finishing modeling other ancient instruments: the *Chitara*, the *Salpinx* and the *Lyra*.





2nd Use Case: Data Sonification

- **Data sonification is the representation of data sets by sound signals:**
 - It can be considered as the acoustic counterpart of data visualization;
- **Data sonification is currently used in several fields, for different purposes:**
 - science and engineering;
 - education and training;

8

Data

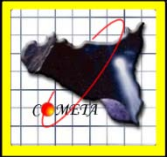
sonification is the representation of data sets by

Data sonification is the acoustic counterpart of data visualization that people use to represent data in
is currently used in several fields, for



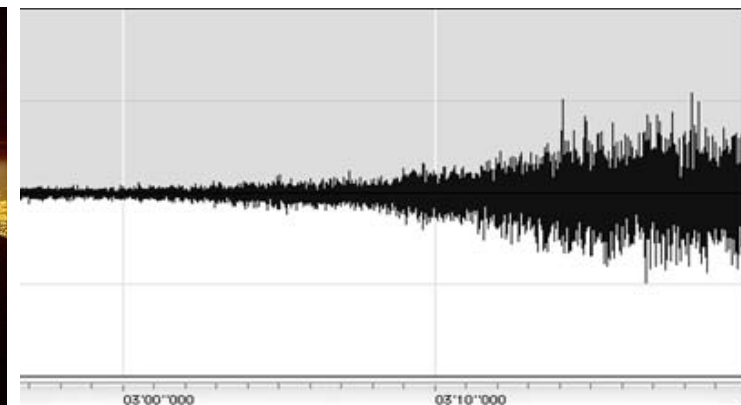
Advantages of Data Sonification

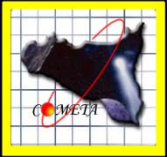
- **Sonic representations are particularly useful when dealing with **complex, high-dimensional** data, or in **data monitoring/pattern recognition** tasks where it is practically impossible to use the visual inspection:**
 - It is quite impossible to distinguish a blinking light flashing 100 times a second from another one flashing 200, 1000, or 10000 times a second;
 - It is much easier to recognize and differentiate periodic signals from 20 Hz to (almost) 20000 Hz;
- **Sound can immediately make clear and recognizable transitions between random states and periodic phenomena.**



From theory to practice: sonification of volcanic seismograms

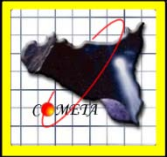
- Currently, no definitive method to predict volcanic eruptions has either been discovered or implemented;
- Data sonification of seismic data aims at:
 - Discovering a sort of “signature tune” of an imminent eruption or earthquake,
 - By the identification of musical patterns that might indicate the preparation of an eruption; it would then be possible to implement civil protection measures, hours or even days before the event.





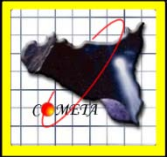
Why does Data Sonification need e-Infrastructures ?

- Converting seismic data into sound waves, through the sonification process, involves substantial computer processing:
 - **1** second long seismic sample generates **120 MB** of data, filling a DVD in **40** seconds (or a CD in just **6** seconds);
- This amount of information, combined with the complexity of the sonification process, requires high bandwidth capacity research networks and advanced Grid infrastructures.



Data Melodisation

- The **melodisation** of a data set allows to convert into aural signals almost any kind of information;
 - Starting from a list of “**m**” elements to be sonified the process provides a list of notes chosen among a set of “**n**” notes;
 - The standard (**Musical Instrument Digital Interface**) **MIDI** code has been adopted to convert data in notes:
 - “C” note corresponds to integer 60;
 - “C#” note corresponds to integer 61;
 - and so on...
 - The lowest acceptable MIDI value is **0** and the highest is **127**;
 - The number of possible notes is then 128: $\mathbb{Z}_m \rightarrow \mathbb{Z}_{128}$

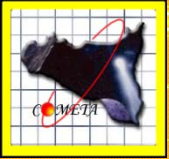


«Melodisation» of Mt. Tungurahua

**Start from an empty score;
Put a seismogram on it...;
Draw the notes in the pentagram;
... and you get the score!**

Have you ever heard a volcano playing a piano ?

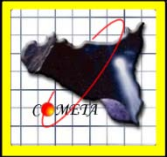




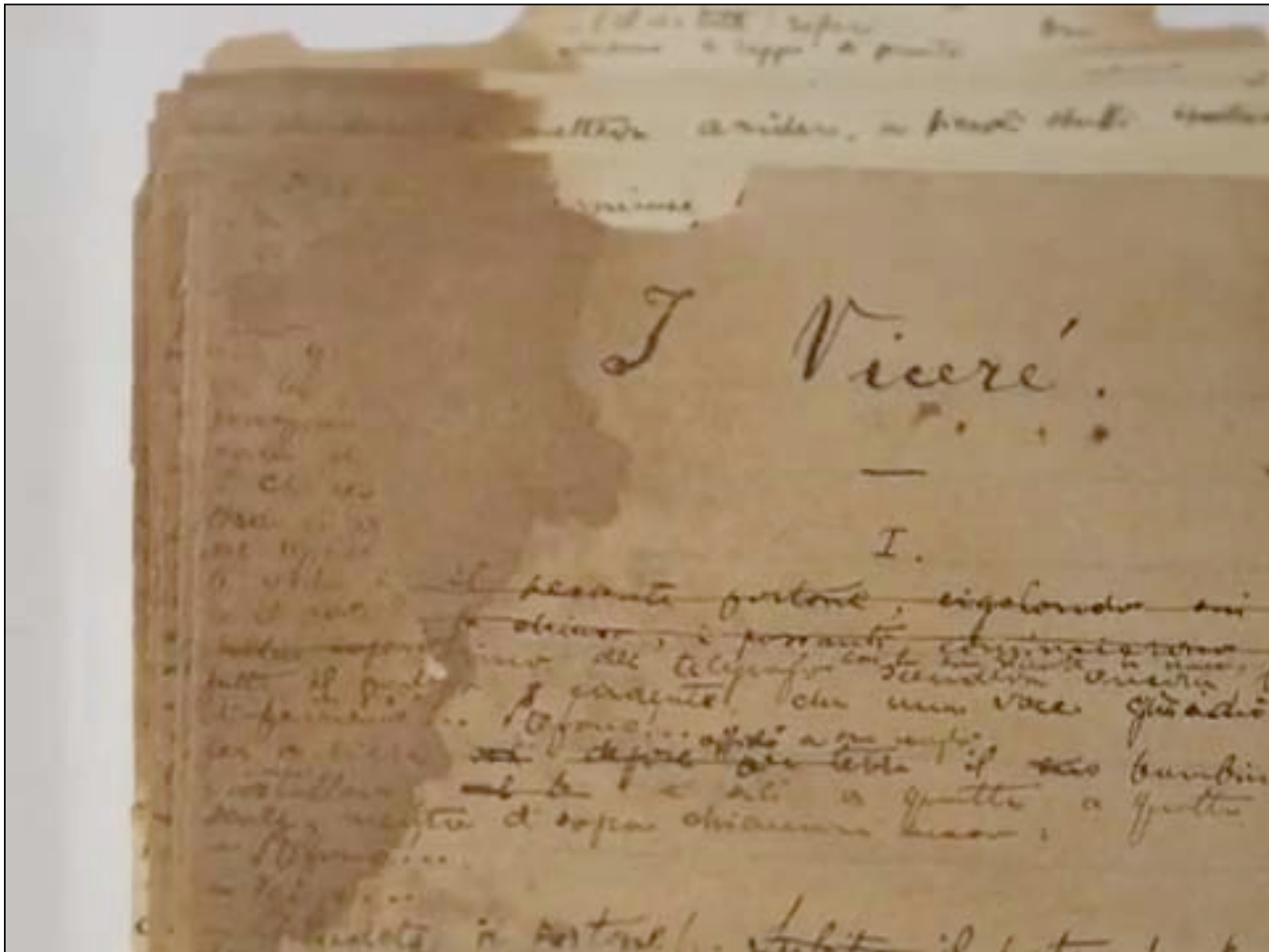
- On the 14th of March 2009 a modern dance company, choreographed by Jason Garcia Ignacio, performed in the US to music generated from seismic data recorded from four different volcanoes belonging to three continents.

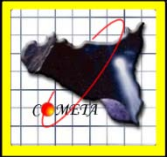


For a short video of the performance click [here](#).



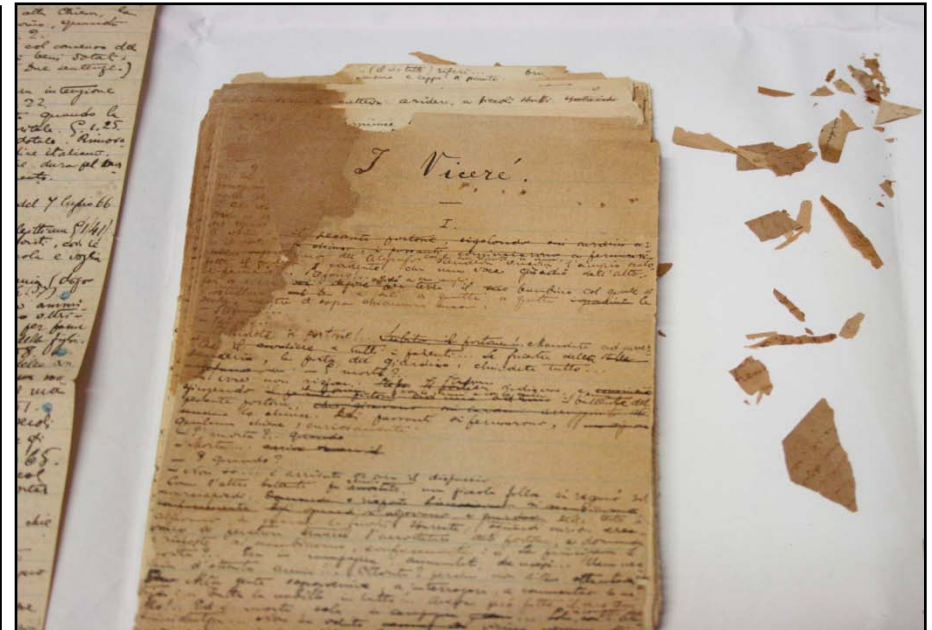
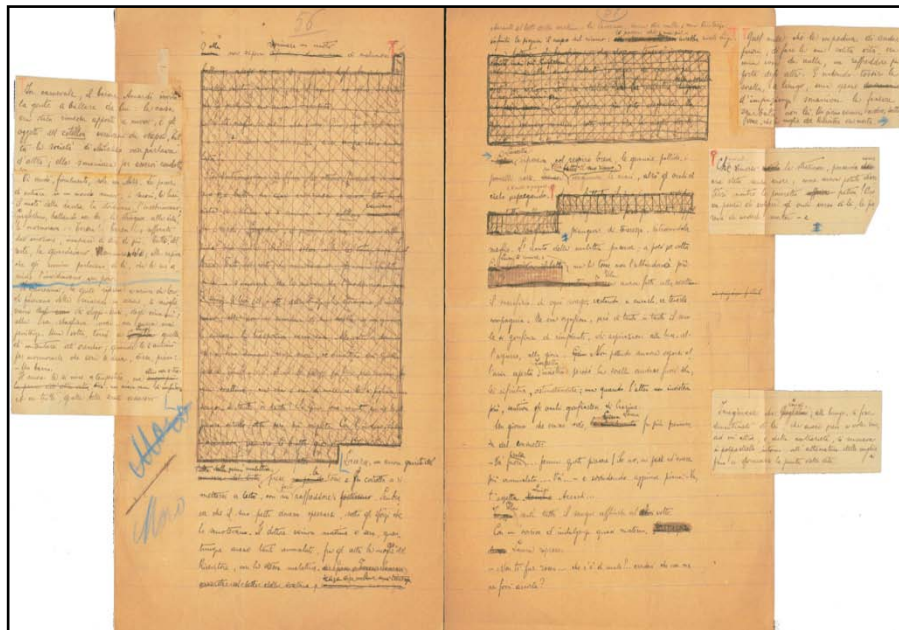
3rd Use Case: Federico De Roberto works

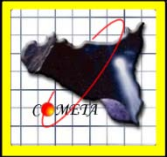




Digitise to preserve

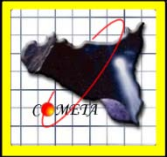
- Some sheets are damaged (mold, crumbed pieces) and need physical restoration;
- Digitisation is mandatory to avoid the loss of this heritage; some works are still unpublished and relevant for the humanistic community.





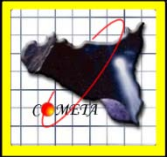
Digitisation phase @ University of Catania





Acquisition stage

- **Digitalization of manuscripts, typescripts, printed works:**
 - TIFF Files, one per page, 600 dpi, about 100 MB for A3
 - High resolution scans for in-depth examination;
 - PDF, one per work, 300 dpi, varying file sizes 40-400MB
 - Overall examination of works;
 - 8000 sheets/scans, 3 Terabyte of disk space;
 - Different physical formats, A3/A4/custom size;
- **Embedded Metadata:**
 - TIFF with embedded metadata to provide scan physical features and information about the content:
 - ImageWidth, ImageHeight, XResolution, FileSize, CreationDate, ModifyDate
 - Description, Keywords, CaptionWriter, Title, Author, Copyright Status, Copyright Notice;
 - Added with Photoshop after the digitisation phase (Adobe XMP format).



The gLibrary framework

(<http://glibrary.ct.infn.it>)

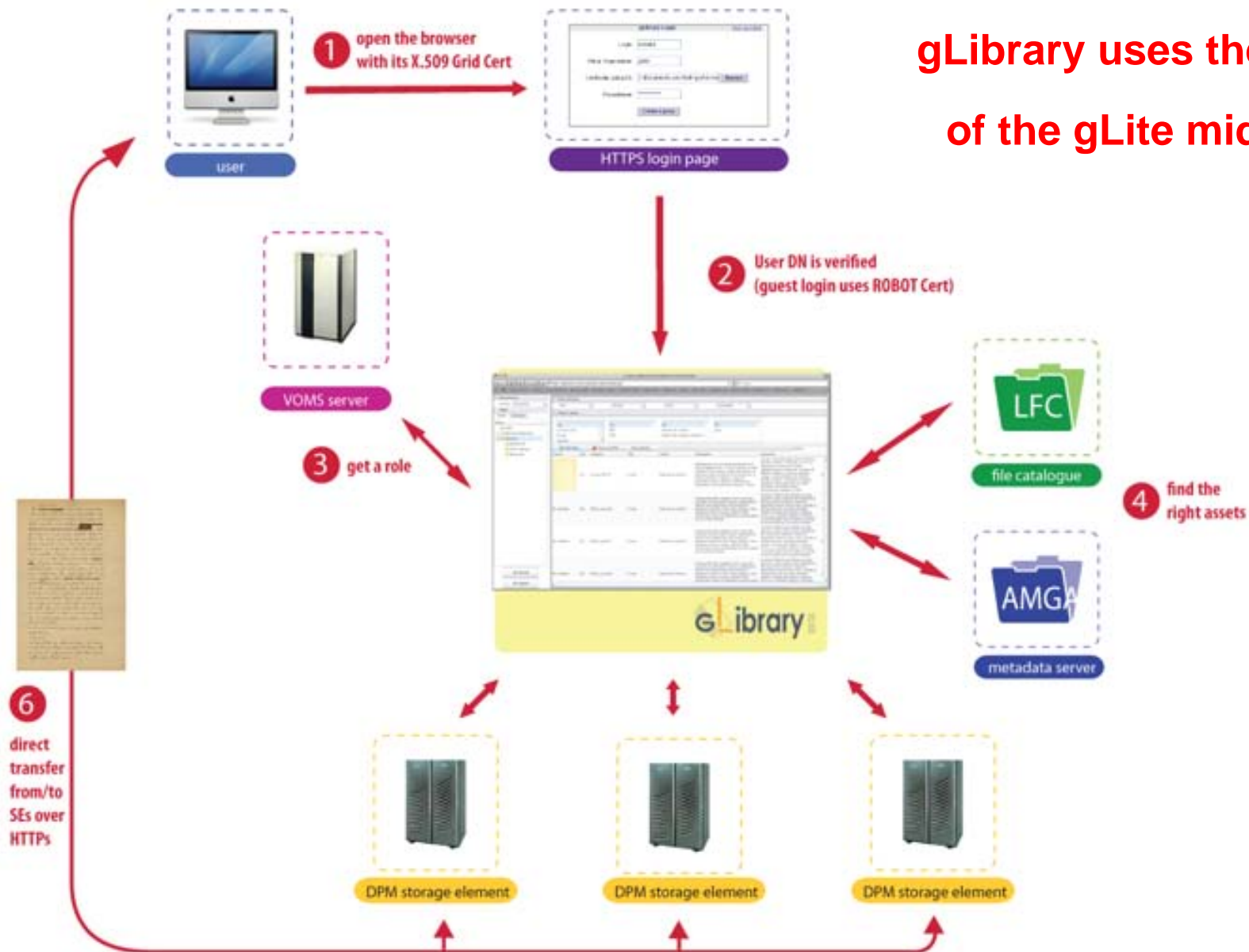
- gLibrary is the INFN/COMETA **platform** that provides a simple yet powerful system to **store, organize, search and retrieve “digital assets”** in repositories built on e-Infrastructures
 - hides the underlying technical details to the users
- What we mean by **“digital asset”**:
 - data + metadata





gLibrary architecture

gLibrary uses the services of the gLite middleware

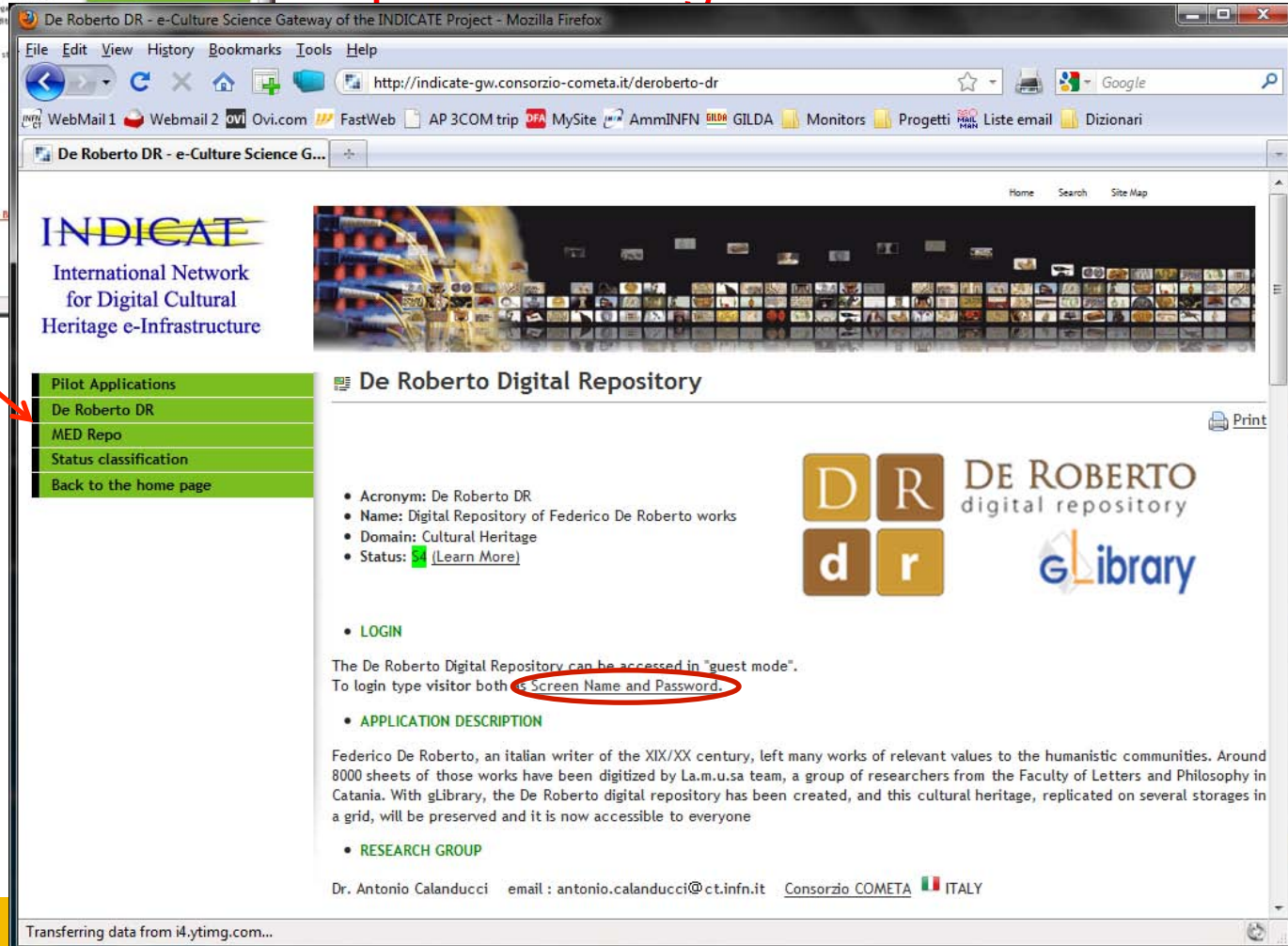
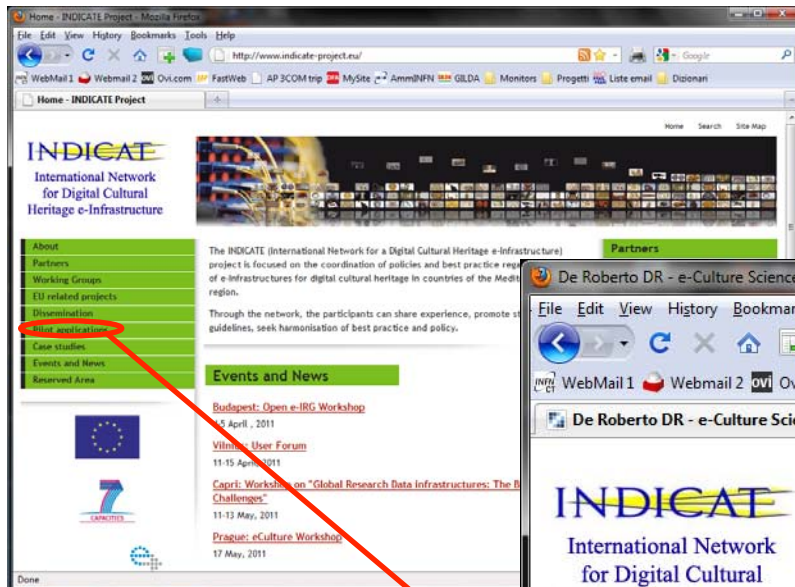


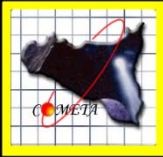


The INDICATE e-Culture Science Gateway (1/3)

<http://www.indicate-project.eu>

<http://indicate-gw.consortio-cometa.it>





The INDICATE e-Culture Science Gateway (2/3)

Browse - e-Culture Science Gateway of the INDICATE Project - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://indicate-gw.consortio-cometa.it/digital-library

WebMail 1 Webmail 2 Ovi Ovi.com FastWeb AP 3COM trip MySite AmmINFN GILDA Monitors Progetti Liste email Dizionari

Browse - e-Culture Science Gateway ...

INDICATE
International
for Digital
Heritage e-In

Pilot Application
De Roberto DR
Browse
MED Repo
Browse
Status classifica
Back to the home

Select the replica to download...

UNIPA
INAF
DMI UNICT

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2011 Cnes/Spot Image
36°59'45.71"N 15°01'22.85"E elev 0 m
Alt 600.18 km

Google
Termini e condizioni d'uso

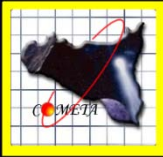
paermo 1919; altre
oto, tipografia rosario
tobre 1932; conservato
biblioteca di storia patria
ia orientale

o della tragedia lirica in
musicata da pierantonio
blicata da officine
igrafiche barravecchia e
palermo 1919; altre
oto, tipografia rosario
tobre 1932; conservato
biblioteca di storia patria
ia orientale

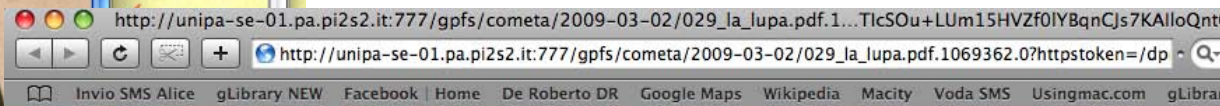
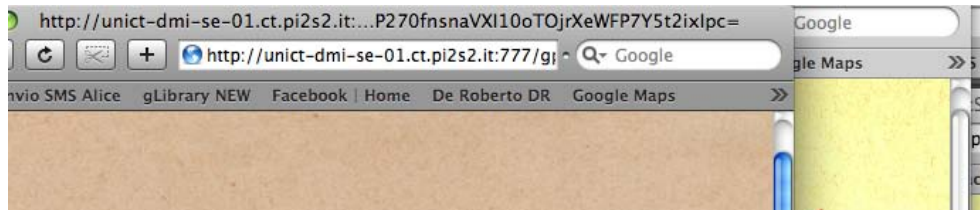
manoscritto della tragedia lirica in
due atti, musicata da pierantonio
tasca, pubblicata da officine
tipo-litografiche barravecchia e
balestrini, palermo 1919; altre

014_la_lupa.tif

Done



The INDICATE e-Culture Science Gateway (3/3)



ATTO PRIMO

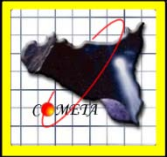
Nell'ala
sull'imbrunire.

A destra la capanna dei mietitori, a sinistra una gran bica ed attrezzi rurali sparsi qua e là. In fondo, l'ampia distesa di messi, già velata dalla sera, e il corso sinuoso di un fiume. S'odono passare in lontananza canzoni straziate, il tintinnio dei campanacci delle mandre abbozzare e di tanto in tanto l'uggiolare dei cani sparsi sulla quale scorrono delle folate di vento, con un fruscio maturo. Negli intervalli di silenzio sembra sorgere e diffondersi delle acque e il trillare dei grilli, incessante. La luna è accesa, sbiancandosi man mano, in un alone afoso.

SCENA I.

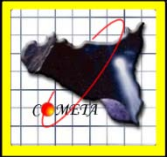
Bruno, Malerba, Neli, Grazia, contadini
dritti sulla paglia e su banchi di erba e cespugli
intorno a Filomena che sta narrando.

Basta coi pianti!
Mara (con passione, piangendo): *Si... poi vedrete quando un'orfanello
al mondo lascerà'!..*
Nanni (furioso): *« Maledetto sia Giuda! E' proprio bella
questa festa ch'io fo! »*
Mara (amaramente): *« Ed io? ed io? »*
Nanni: *« Non e' ver!... Che intendi? »*
Mara (c. s.): *« E negate! negate! »*
Nanni: *« Non e' vero!
Che cosa hai visto, di? »*

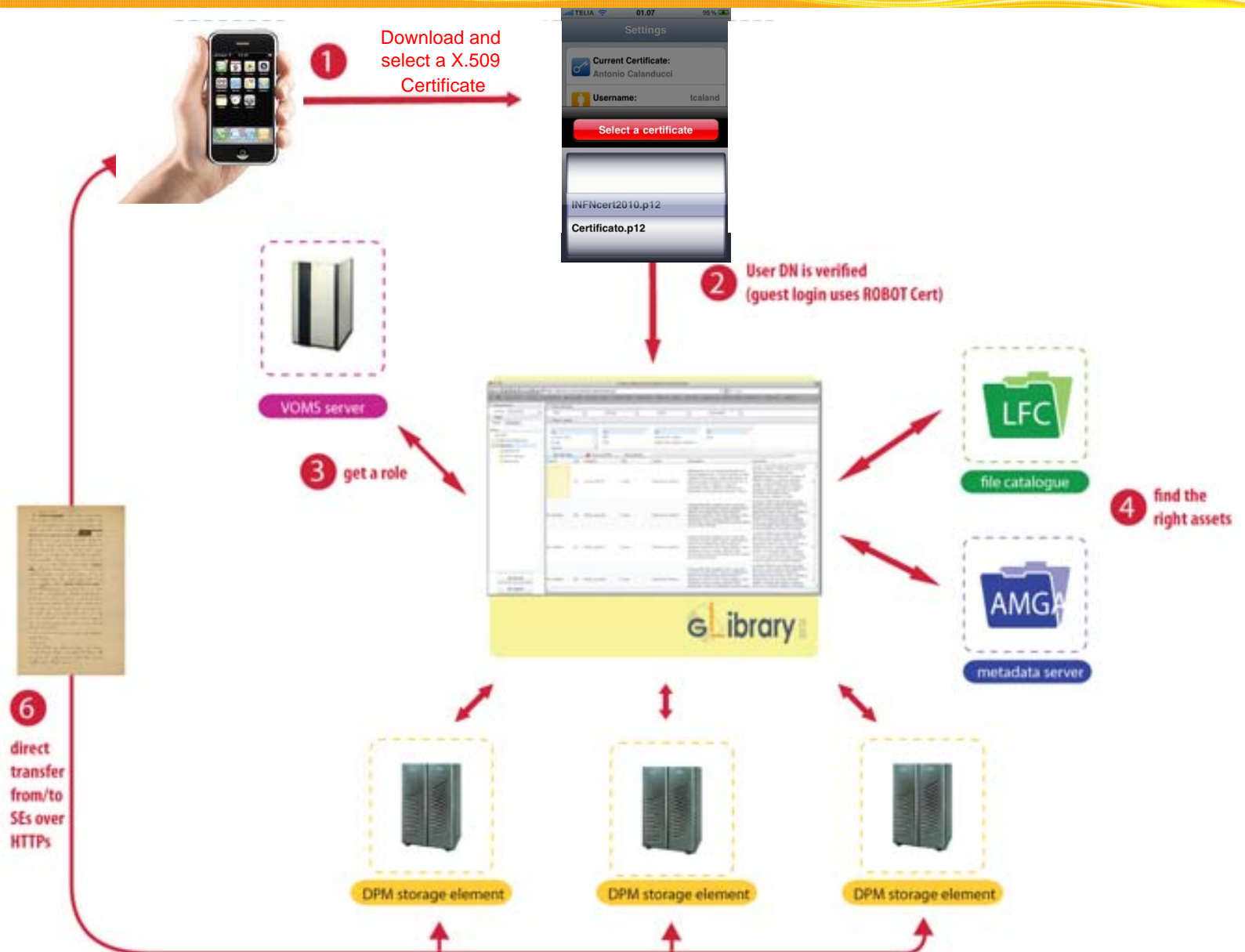


- **Mobile interface to access Grid Digital Libraries:**
 - *iPhone, iPod Touch, iPad;*
- **Advantages:**
 - provides an extremely **intuitive** and **touch-based** user interface to Grid storage elements and metadata, especially for non-expert users;
 - (to do) automatic selection of the closest replica, according to the user physical location retrieved by the integrated GPS;
 - offline access to the assets already downloaded.

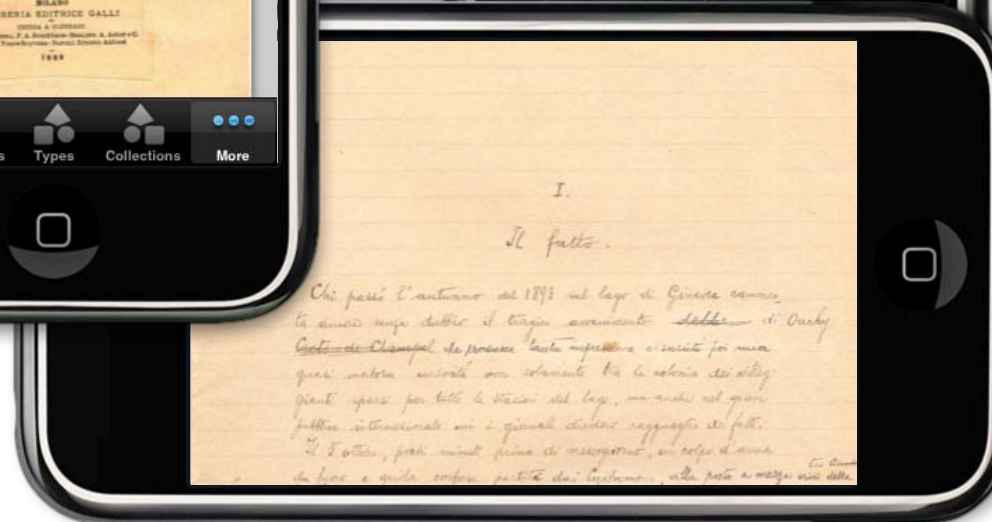
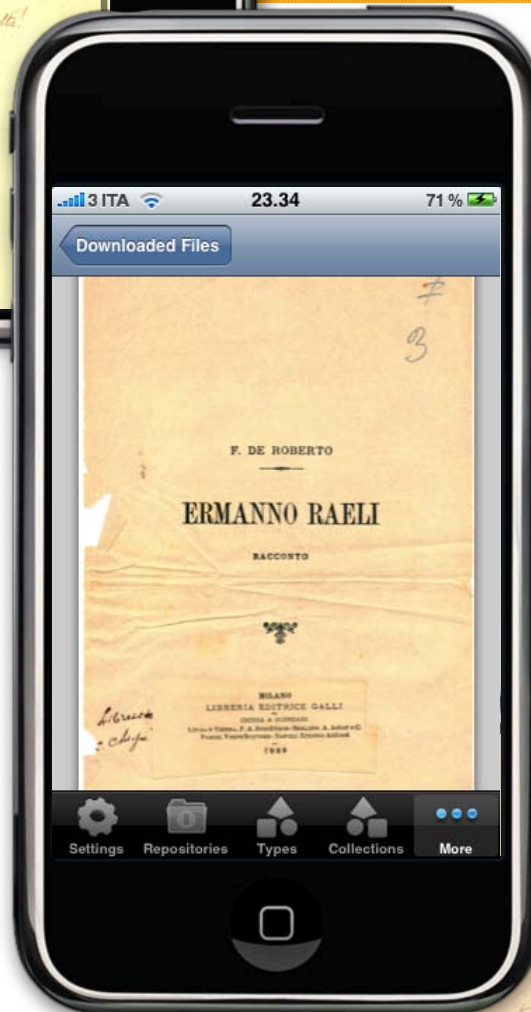
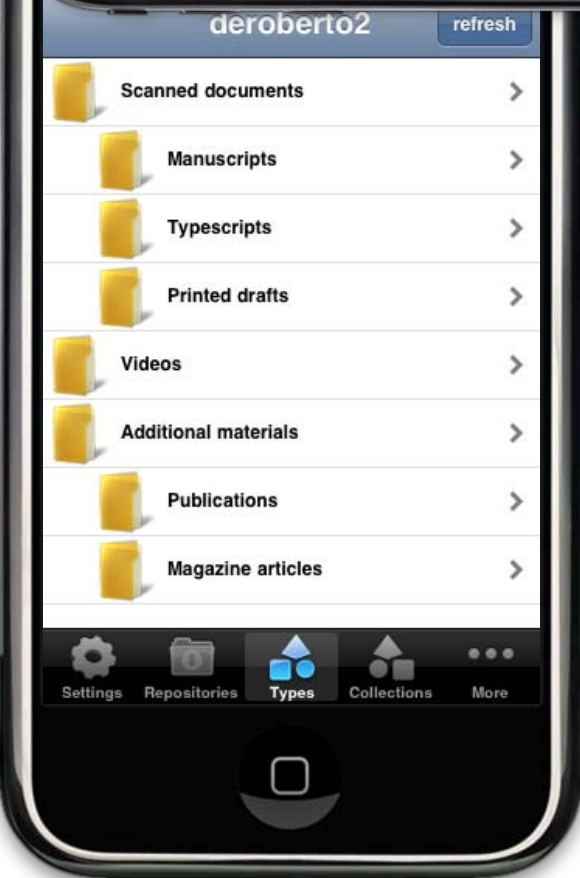
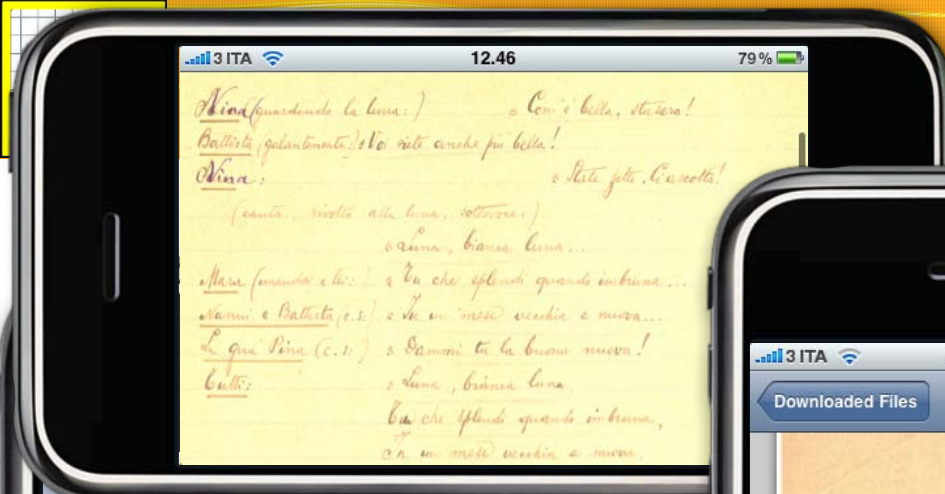
(In collaboration with Dr. C. Pistagna, Univ. of Catania)

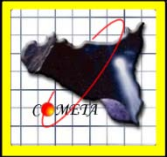


gLibrary mobile architecture



Some s





Summary and Conclusions

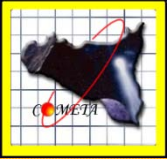
- **e-Infrastructures are key enablers of e-Science carried out by world wide multi-disciplinary collaborations referred to as Virtual Organisations or Virtual Research Communities;**
- **They can be very beneficial platforms for Arts, Digital Cultural Heritage and Humanities in general;**
- **If any of you is interested in the tools/activities described in this presentation, I would be very happy to discuss possible collaboration.**



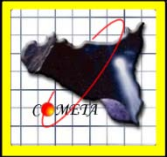
Thank you for your kind attention !

Any questions ?





- The **ASTRA** Project
 - Download examples
- The **Physical Modeling Synthesis**
- The Research Networks:
 - GEANT
 - EUMEDCONNECT2
- The Grid Infrastructures:
 - EUMEDGRID
 - GILDA
- Etna Sonification website
 - Download examples
- **CityDance Ensemble**
- MIDI Toolbox manual



References (2/2)

- **gLibrary contacts:**
 - antonio.calanducci@ct.infn.it, glibrary@ct.infn.it
- **Federico De Roberto repository:**
 - <https://glibrary.ct.infn.it/>
- **Videos:**
 - <http://www.youtube.com/watch?v=VNN3OnpmUUU>
 - <http://www.youtube.com/watch?v=IhFFjHD8IsI>
- **Publications:**
 - A.Calanducci, R.Barbera, J.Sevilla, A. De Filippo, M.Saso, S. Iannizzotto, F. De Mattia, F.Vicinanza. “Data Grids for Conservation of Cultural Inheritance”, 1st International Workshop on Data Grids for e-Science (DaGreS09) at ACM International Conference on Computing Frontiers, May 18-20, 2009 (<http://www.computingfrontiers.org/2009/>)
 - <https://glibrary.ct.infn.it/m/DaGRes-editor.pdf>
 - A. Calanducci, C. Cherubino, L. N. Ciuffo, D. Scardaci, “A Digital Library Management System for the Grid”, Fourth International Workshop on Emerging Technologies for Next-generation GRID (ETNGRID 2007) at 16th IEEE International Workshops on Enabling Technologies: Infrastructures for Collaborative Enterprises (WETICE-2007), GET/INT Paris, France, June 18-20, 2007 (<http://etngrid.diit.unict.it/2007/index.html>).
 - https://glibrary.ct.infn.it/glibrary/downloads/gLibrary_paper_v2.pdf