



## Remote Rendering and Visualization of Large Textured 3D Models



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## Remote Rendering and Visualization of Large Textured 3D Models



Increasing need to exploit 3D models with a client-server architecture

**But:**

- Weakness of commercial solutions



- Bandwidth of the network

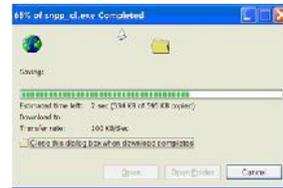


- Protection of *intellectual property rights (IPR)*



Distributing a high-definition 3D model on the Internet means:

- download the model
- powerful hardware
- appropriate navigation software
- compromise solution
- Understand IPR issues



### Related Works

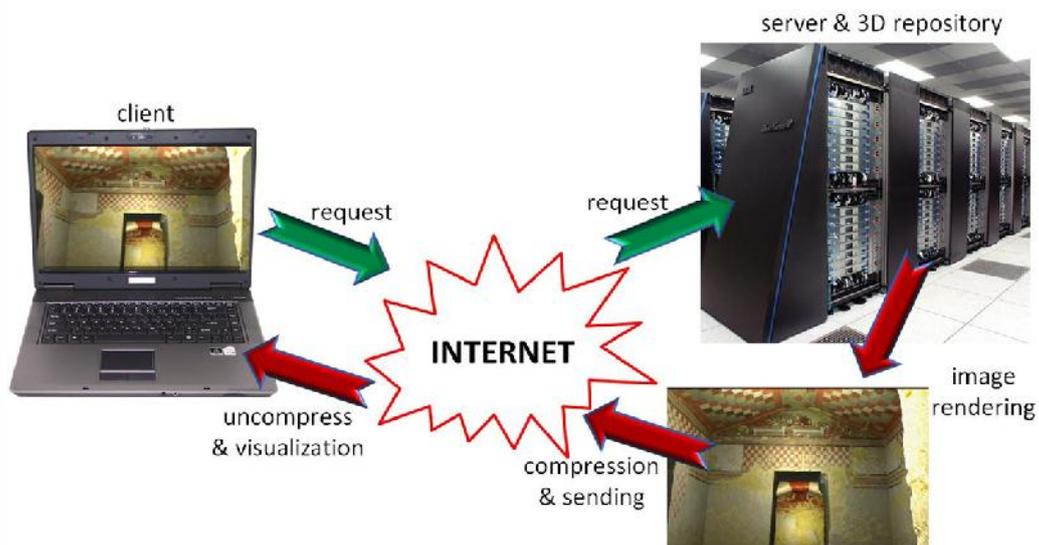
- Image-Based LOD approaches* (e.g. ScanView - Koller et al. 2004, Venus 3D, etc.)
- Point-Based LOD approaches* (e.g. QSplat - Rusinkiewicz et al. 2001)
- Mesh-Based approaches* (e.g. Adaptive Tetrapuzzles - Cignoni et al. 2004)

### Proposed approach and architecture: ARK 3D

- ❑ Hardware and software architecture which allow remote access to a repository of three-dimensional high resolution models
- ❑ Models are uploaded by the users on a servers
- ❑ Users have access via the internet via a registration process
- ❑ Models are loaded (in full resolution) and rendered by the “big” computer/server and displayed as images on the user PC

<https://www.ark3d.enea.it/home.html>

### Proposed approach and architecture: ARK3D



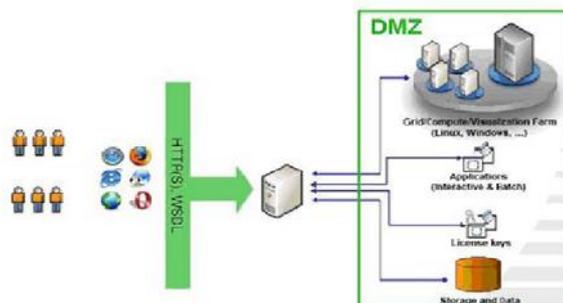
### Proposed approach and architecture: ARK3D

- ❑ This project uses the ICT infrastructure of ENEA-GRID (the graphic cluster built up for CRESCO project)
- ❑ CRESCO HPC infrastructure: cluster divided into sections total peak of **28 TFLOPS**
- ❑ Total **Cores: 3000+**
- ❑ Graphics section consists of **12 workstation** with AMD dual core processors
- ❑ NVidia Quadro FX graphic cards, for a total of 68 cores
- ❑ Into **Top500** Super Computer until beginning 2012



### Architecture

- 3D Repository
- Database Queries and Upload System
- Client
- Simple Viewer
- Editing Mode

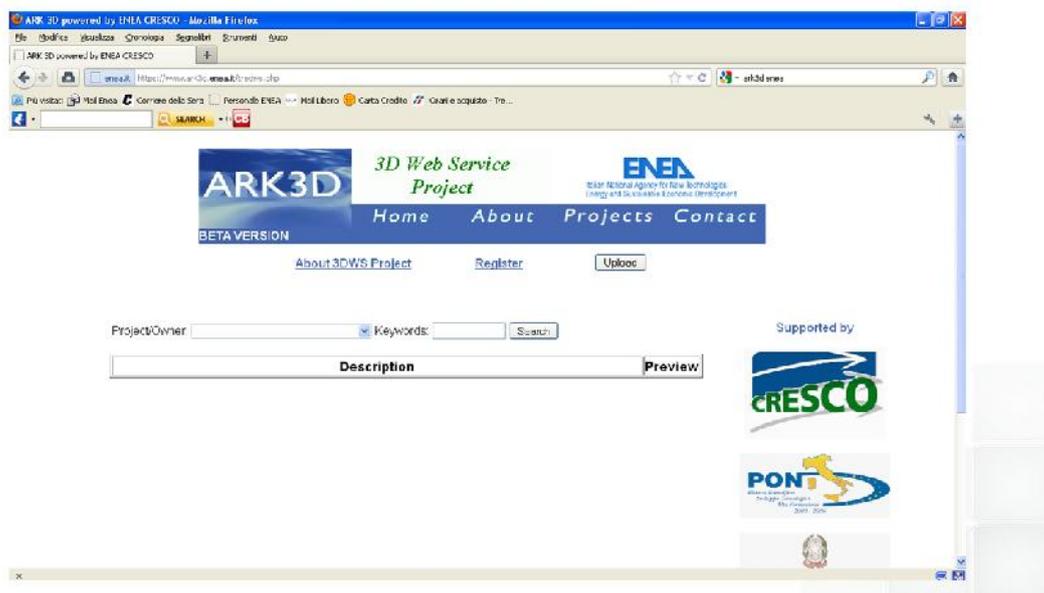


## Repository

- Storage System of Three-Dimensional Models
- Unix/Linux OS
- AFS file System (reference cell enea.it)



## Repository query



The screenshot displays the ARK3D 3D Web Service Project website. The page features a navigation menu with 'Home', 'About', 'Projects', and 'Contact'. Below the navigation, there are buttons for 'About 3DWS Project', 'Register', and 'Upload'. A search section includes a 'Project/Owner' dropdown, a 'Keywords' input field, and a 'Search' button. A 'Preview' button is also visible. The website is supported by CRESCO and PONT, as indicated by the logos at the bottom.

## Repository query

The screenshot shows a web browser window displaying the ARK3D 3D Web Service Project interface. The page features a navigation menu with links for Home, About, Projects, and Contact. Below the menu is a search bar with a dropdown menu for 'Project/Owner' and a 'Search' button. The main content area displays a table of search results with columns for 'Description' and 'Preview'. The table lists four entries, each with a description of a data upload and a corresponding preview image. To the right of the table, there are logos for 'Supported by' including CRESCO and PONT.

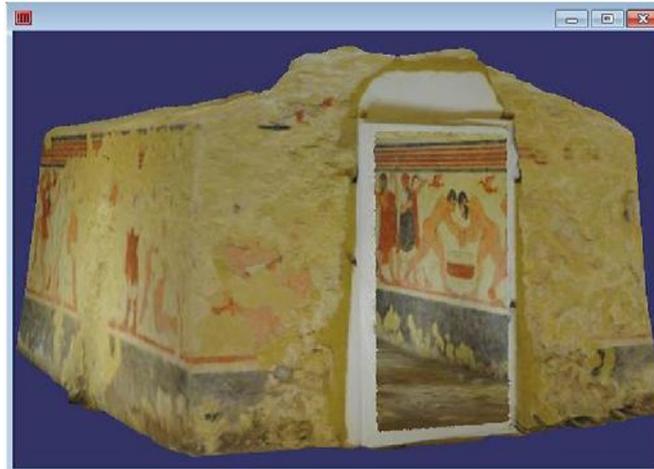
Description	Preview
varcas Augur 11/2/11/11 DATA UPLOAD: 13/01/2012 FBK	
varcas Augur 2/11/11/11 UPLOAD: 16/01/2012 FBK	
varcas Augur 11/11/11/11 DATA UPLOAD: 16/01/2012 FBK	
patocca_n_bil_11/11/11 DATA UPLOAD: 13/04/2012 FBK	

## Client

The screenshot shows a client interface with a Java applet on the left and a dialog box on the right. The Java applet is represented by a circular icon with a flame and the word 'Java' below it. The dialog box contains the text 'The session is ready to run. Click on the Continue button to start it.' and features a 'Continue' button and a 'Cancel' button. The dialog box also includes logos for 'powered by CRESCO REMOTE 3D RENDERING CLUSTER' and 'powered by ENEA NOMACHINE'.

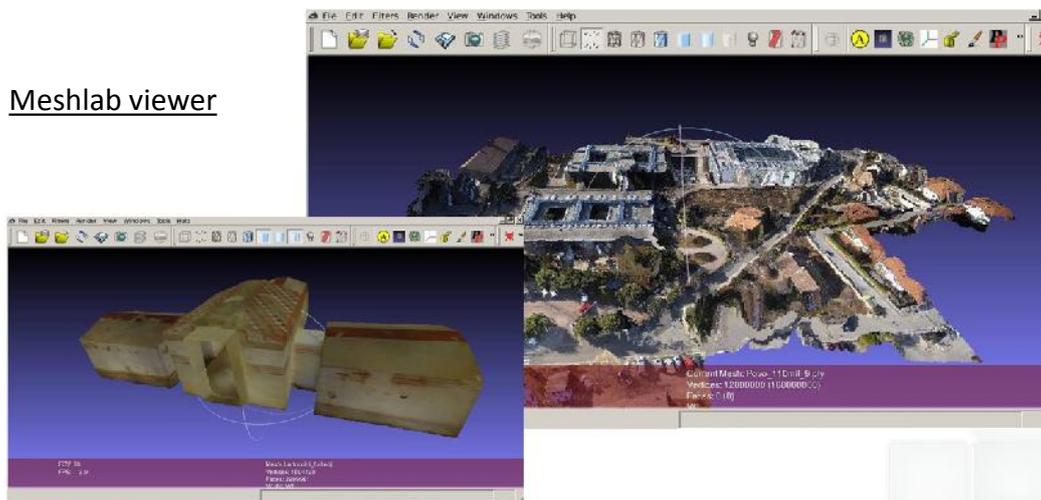
### Visualization mode: Simple Viewer

- Open Scene Graph libraries
- Remote Rendering



### Visualization mode: Editing Mode

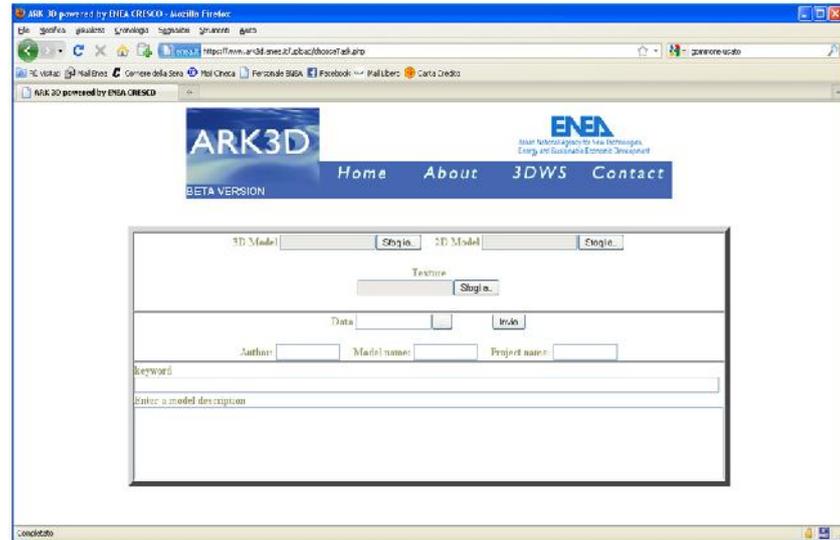
#### Meshlab viewer



The remote display can be basically done through any graphic application using OpenGL technology on a Linux operating system

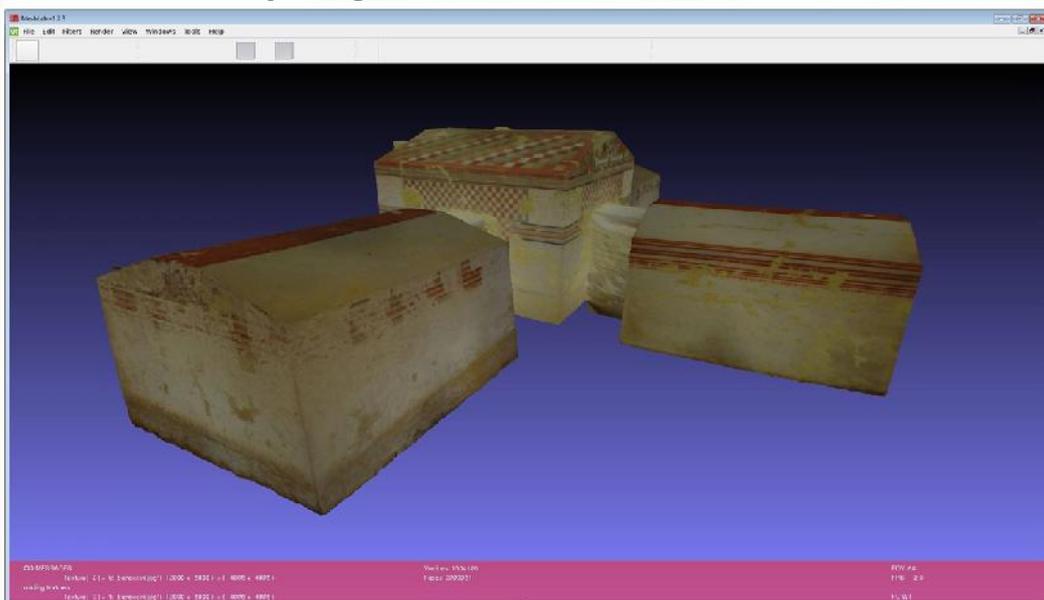
<i>Examples</i>	<i>Tomb 1</i>	<i>UAV cloud</i>	<i>Tomb2</i>	<i>Mountain</i>	<i>Temple</i>
					
Geometry	410K polygons 204K vertices	108 mil. points	3 mil. polygons 1.5 mil vertices	1.5 mil. polygons 470K vertices	40 mil. polygons
RGB Data	2 GB TIF Texture	Colour per point	115 MB JPG Texture	100 MB JPG Texture	-
File Format	OBJ	ASCII PLY	OBJ	OBJ	PLY
File Dimension	43 MB	1.6 GB	345 MB	200 MB	878 MB

**Upload System**



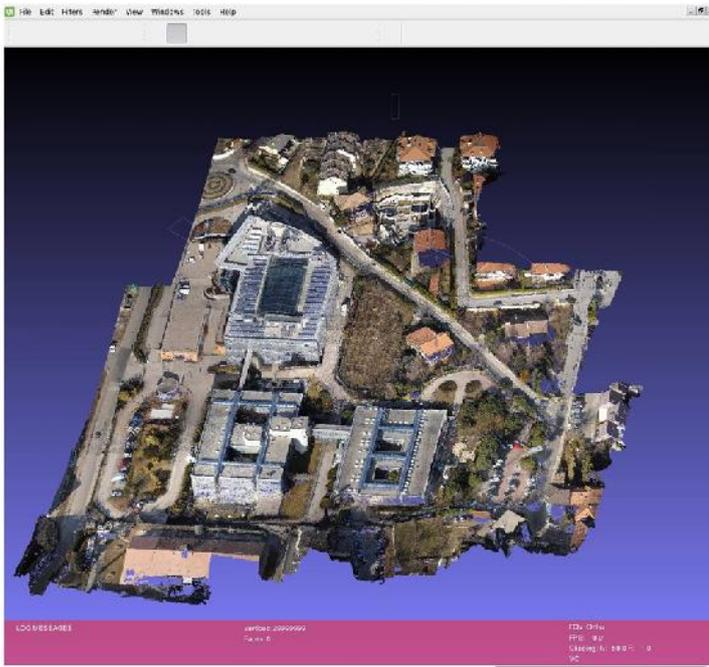
### Security

- AFS file System (reference cell enea.it)
- Access Control List (ACL)
- Keytab (certificate) for specific application



Range-based 3D model of the Bartoccini Tomb, 3 mil. polygons and ca 115 MB texture displayed within Meshlab

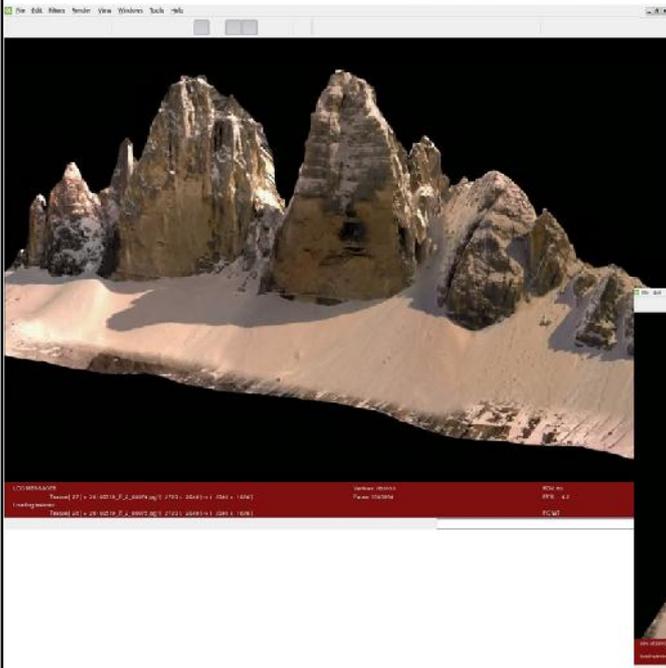
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UAV-derived cloud (POVO, Trento)

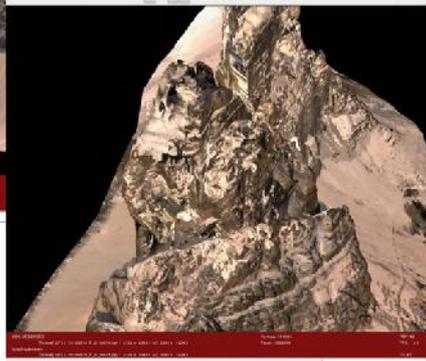
108 mil. points with related RGB colour loaded remotely using Meshlab

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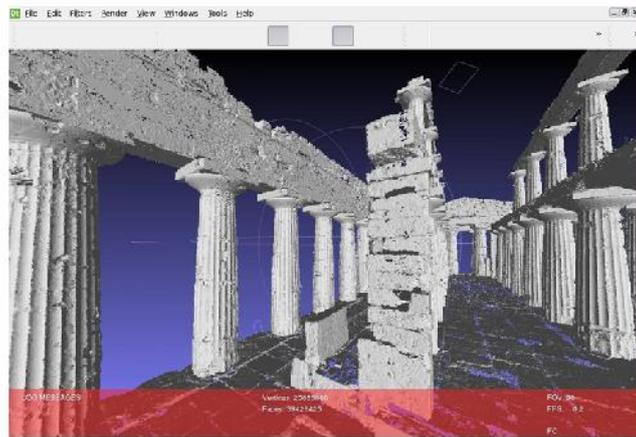
Large landscape 3D model – the Three Picks in Lavaredo, Dolomites

The geometry counts ca 1.5 mil. polygons with texture





A large polygonal model of the Neptune temple in Paestum with ca 40 mil. Polygons



### Conclusions

#### *New method for remote rendering of large 3D models*

- Multi-user
- Frees the user from the need of specific hardware and software resources
- Protects the copyrights related to the 3D applications and data, since the model won't be downloaded locally
- Loading / displaying the full resolution model
- Allows some processing/editing on the remote 3D data
- Exploits the potentialities of an HPC infrastructure on the server-side.

Thank You for your Attention

*Any Questions?*

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