













## 6.1 Interoperability

The main issue to solve in order to achieve semantic annotation simplification is the model interoperability. Nowadays, we have not still a complete ontology allowing modeling representation. Because of this, we have used an open standard like Collada, which is compatible with many visualization and modeling available tools, such as Google Earth or Blender respectively. Collada (COLLABorative Design Activity) [Arnaud, 2006] is an open exchange file format for interactive 3D graphics, currently managed by the Khronos Group consortium. It defines a XML schema and vocabulary for exchanging digital graphics between applications. Originally created by Sony, today is shared between Sony and Khronos Group and it is supported by many game studios, graphic engines and modeling software (e.g. 3D Studio, Maya or Blender). GIRAPIM allows importing and visualization of Collada models (.dae) representing cultural heritage assets with up to high level of detail, especially at interior.

GIRAPIM also support Google Earth (.kmz) file import feature. KMZ is an acronym for KML [Wilson, 2008] compressed that can be easily linked with Collada graphic models. Above this models, users can include semantic tags displayable and navigable in 3D virtual globes and exportable to CityGML. For instance, data can be visualized in Google Earth, or in any web browser thanks to available plug-in. Thus, it simplifies the access and visualization of the semantic information from future Web Services, like in the work of Honda et Al. in [Honda et al., 2006]. Moreover, KMZ files can be easily exported from free version of Google Sketch Up allowing 3D surveying and reconstruction of buildings from satellite images. Semantic annotation process translates 3D geometric model data to 3D semantic model data in CityGML, which is necessary for agent reasoning capabilities. This approach takes advantage of CityGML geographic position of the semantic information in order to support task such as spatial reasoning, problem detection or 3D context-based information provision. With geometrically referenced information we can show context-aware information in 2D maps for mobile devices, allowing intelligent remote content provision. The creation of Web Services to transfer 3D semantic information between many different proposal systems is supported in this framework. GIRAPIM provides data access and management for high level tasks such as case-based reasoning and services in an Ontology and CityGML shared vocabulary.

## 7. CONCLUSIONS AND FUTURE WORK

Urban GIS are emerging as a new way for planning, publishing and managing building information for institutions and citizens. The addition of semantic data to geometric models and geography supports enables application interoperability and creates a common framework to develop a network of Web Services that connect people, things and local administrations. This opens an innovative common space for everyone that needs collaboration in order to create, annotate and manage the information. Our software application GIRAPIM is a prototype that supports these three tasks under the common CityGML framework. Although GIRAPIM allows semi-automatic low resolution building modeling, interventions tasks require a higher level of detail. Hence, these tasks must be performed with professional modeling tools designed for this specific purpose. Moreover, it would be desirable to have a more integrated city model, besides KML export feature, and a complete support and interoperability with focused business processes as in standard Building Information Modeling

through IFC data. Following the same philosophy, we aim to include RDF publication of CityGML building data, in a way fully compatible with Web 3.0, allowing city and building reasoning and detection of risks, needs, etc, in the next future.

## ACKNOWLEDGEMENTS

Comments of referees have been very useful for improving a precedent draft. The authors acknowledge to the MAPA (CICYT) Project for their partial financial support for the development of UvaCad software platform (BIA2004-08392-C02-01). This work is partially supported by the "Proyecto Singular Estrategico PATRAC (Patrimonio Accesible: I+D+i para una cultura sin barreras)", PS-380000-2009-2 of the Spanish Ministry of Science and Innovation which has been co-funded with FEDER grants. The authors acknowledge also to the ADISPA (CICYT) Project with reference BIA2009-14254-C02-01 for their partial financial support

## REFERENCES

- Arnaud, R. and Barnes, M., 2006. COLLADA: sailing the gulf of 3D digital content creation. AK Peters, Ltd.
- Barnes, M., 2006. Collada. In: ACM SIGGRAPH Courses, ACM, p. 8.
- Campbell, D., 2007. Building information modeling: theWeb3D application for AEC. In: Proceedings of the twelfth international conference on 3D web technology, ACM, p. 176.
- Groger, G., Kolbe, T., Czerwinski, A. and Nagel, C., 2008. OpenGIS City Geography Markup Language (CityGML) Encoding Standard. Open Geospatial Consortium.
- Gruber, T. et al., 1993. A translation approach to portable ontology specifications. Knowledge acquisition 5, pp. 199–199.
- Honda, K., Hung, N. and Shimamura, H., 2006. Linking OGC web services to Google Earth. In: SICE-ICASE, 2006. International Joint Conference, pp. 4836–4839.
- Kolbe, T. and Groger, G., 2003. Towards unified 3D city models. In: Challenges in Geospatial Analysis, Integration and Visualization II. Proc. of Joint ISPRS Workshop, Stuttgart.
- Kolbe, T., Groger, G. and Pliimer, L., 2008. CityGML-3D city models and their potential for emergency response. Geospatial Information Technology for Emergency Response p. 257.
- L.M.Fuentes, J.Finat, J., 2006. Using Laser Scanning for 3D urban modeling. Urban and Regional Data Management UDMS 2006 Annual.
- Momjian, B., 2001. PostgreSQL: introduction and concepts. Addison-Wesley.
- Ramsey, P., 2005. PostGIS manual. Refrations Research Inc.
- Wilson, T., 2008. OGC KML, version 2.2.0. Open Geospatial Consortium.