PORTAL-DOORS Infrastructure System for Translational Biomedical Informatics on the Semantic Web and Grid

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Abstract

The PORTAL-DOORS infrastructure system of networked registries and directories has been designed for the semantic web and grid as an extended analogue of the IRIS-DNS system for the original web. Within the PORTAL-DOORS system, BioPORT and ManRay have been developed as prototype registries specific for the problem domains of biomedical computing and nuclear medicine. Potential applications in translational biomedical research are described with examples of study designs involving pharmacogenomics and molecular imaging.

Introduction

The semantic web and grid will enable and accelerate development of novel informatics applications that enhance translational medicine and drug discovery. However, current infrastructure technologies do not yet suffice for effective progress in developing new groundbreaking semantic search and analysis applications. Compelling examples of such breakthrough software applications include automated artificial intelligence analyses of semantic metadata and objects obtained from images within extensive distributed libraries maintained for multi-center clinical drug trials.

Currently, the most important imaging modalities for following functionally active molecular biomarkers include PET-CT and SPECT-CT. Other modalities under development such as PET-MR are also expected to play an important role in the future. Examples of clinical trials that follow imaging biomarkers include those investigating tumor activity in response to anti-cancer drugs, and cognitive function in response to anti-dementia drugs.

Method

To reach these significant long-term goals, biomedical ontologies and semantic search and analysis applications for radiopharmaceuticals, nuclear medicine, and molecular imaging should be developed as envisioned in the ManRay project[1] and interconnected with the genomics and proteomics informatics resources. Moreover, the underlying infrastructure for the semantic web and grid should be built as proposed with the PORTAL-DOORS system[2] (see Figures 1 and 2) in a manner analogous to the existing IRIS-DNS system already established for the original non-semantic web. This previous work[1,2] provides the foundation for ongoing development of XML/RDF schemas and OWL ontologies for the PORTAL-DOORS system with BioPORT and ManRay as prototype registries.

Fig 1: Resource metadata registered and published by owners for search by users in the PORTAL-DOORS server networks.
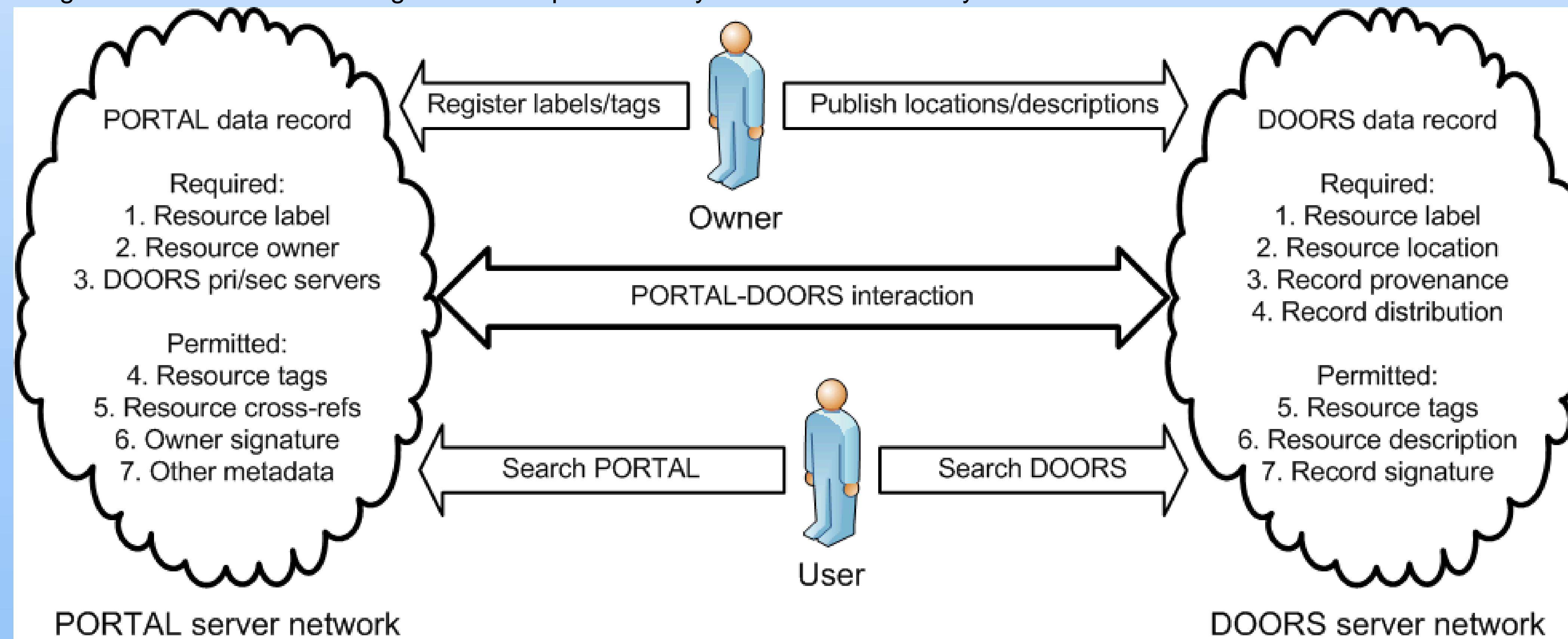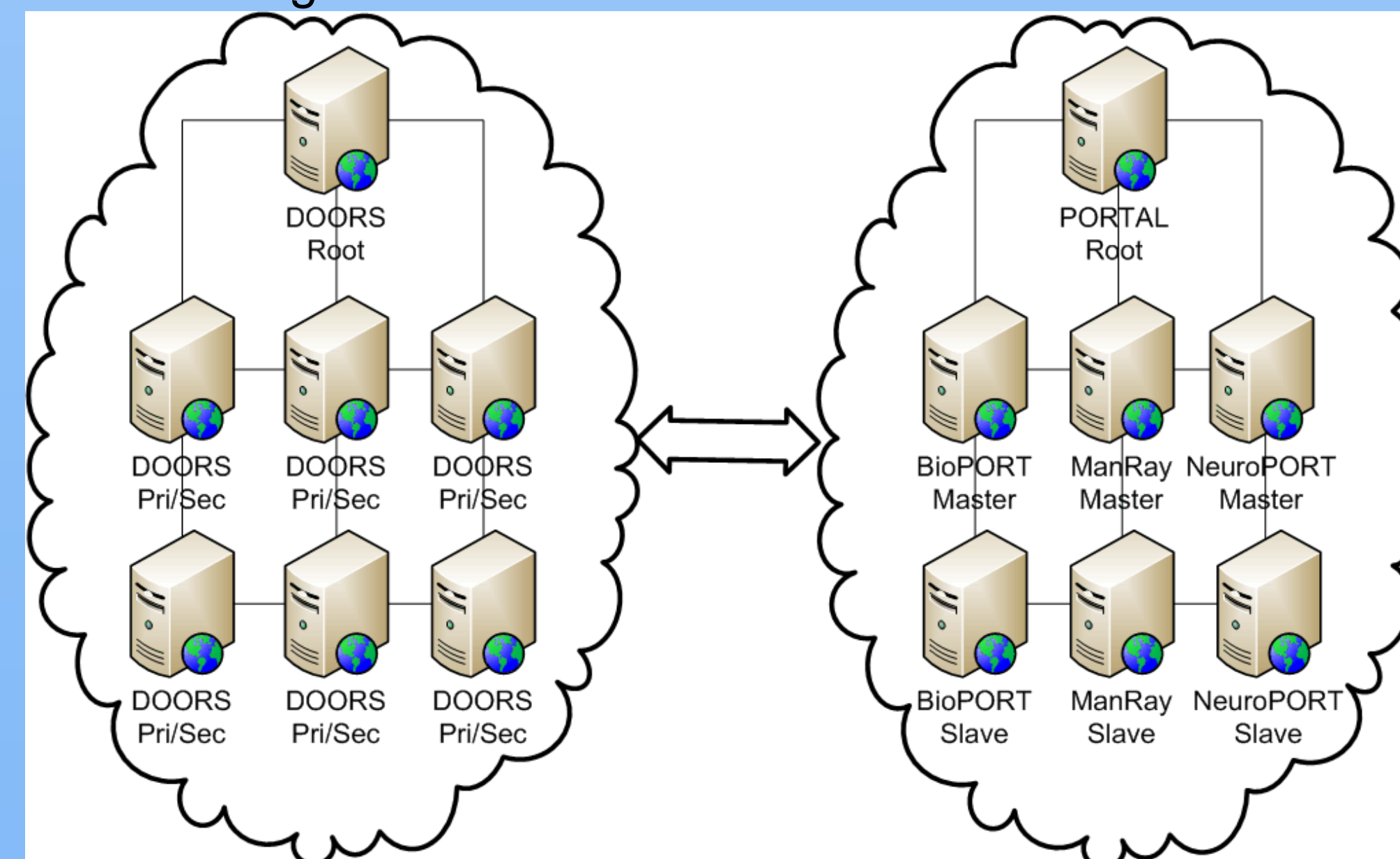

Fig 2: PORTAL-DOORS server networks.

Fig 3: XML Schema files maintained at PORTAL-DOORS root servers impose minimal syntactic requirements to which any problem domain specific master registry, such as BioPORT and ManRay, must comply for operation within the metadata server network.
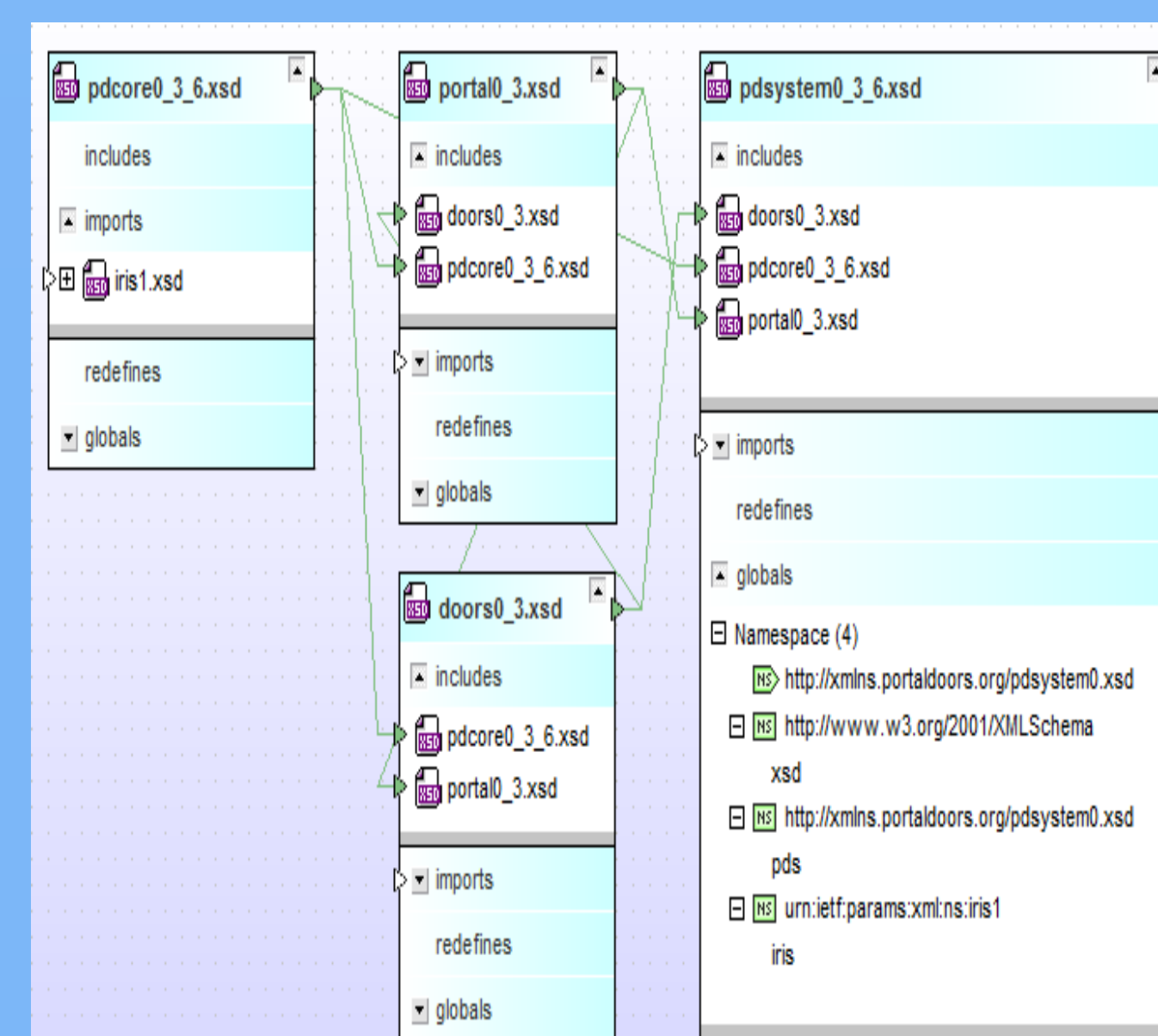

Fig 4: BioPORT class definition and instance example.

Fig 5: ManRay ontology class hierarchy (partial excerpt).
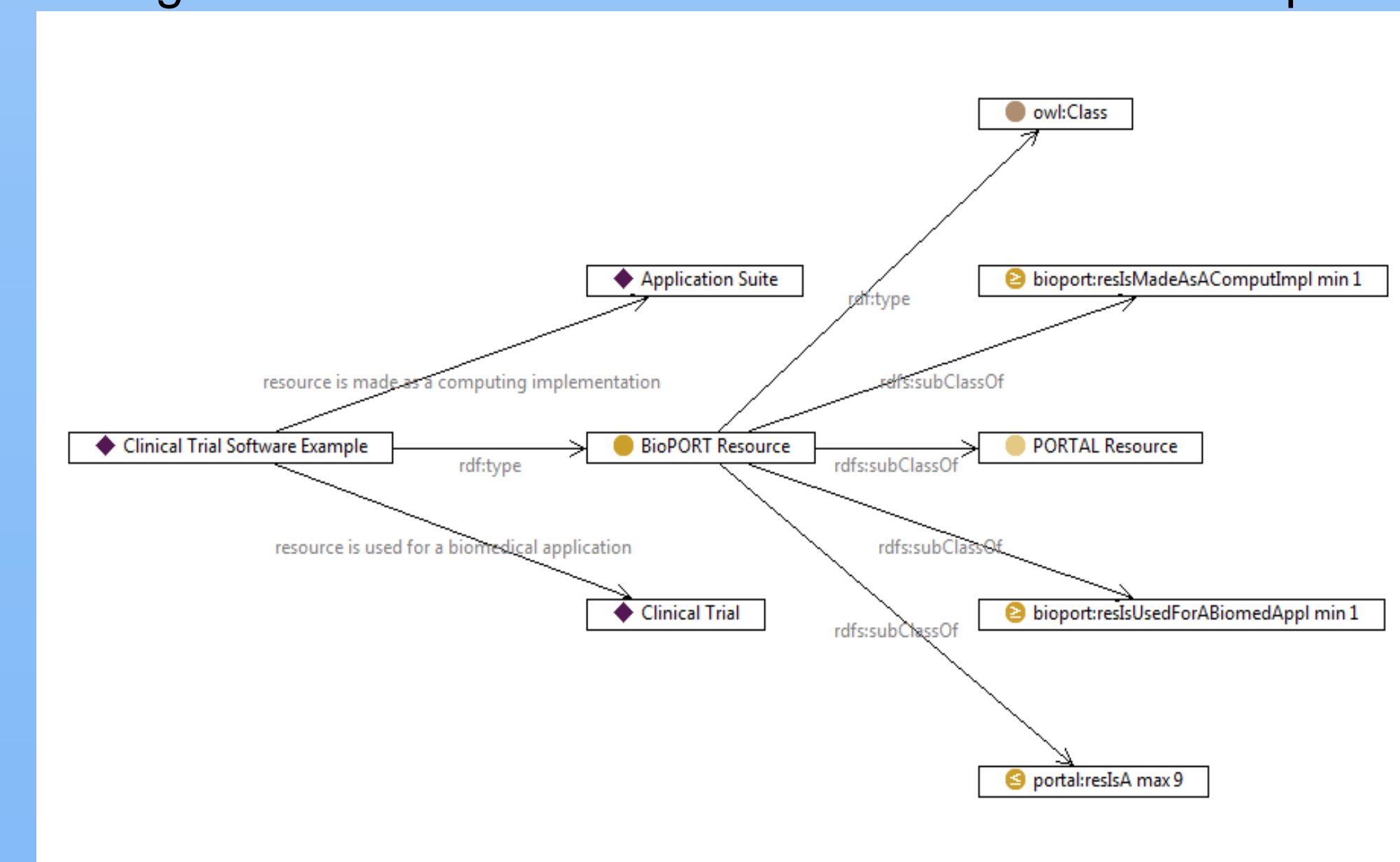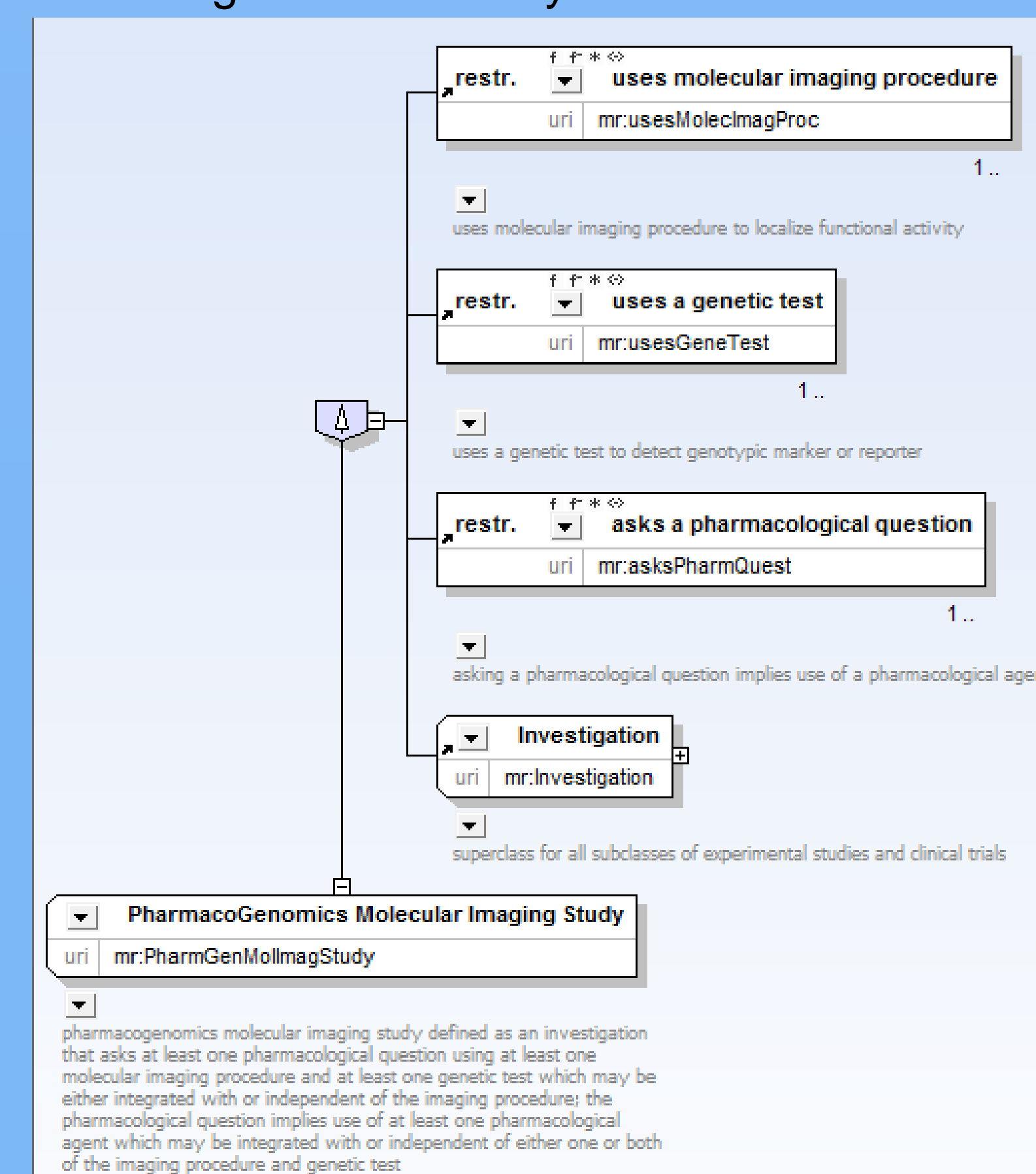

Fig 6: PGMI Study class definition.

Results

The PORTAL-DOORS project mandates a hybrid approach accommodating both semantic and non-semantic metadata. Therefore, PORTAL and DOORS root servers must maintain the syntax schemas for interoperable exchange of metadata records. Initial drafts have now been implemented for the *.xsd files (see Figure 3) as well as for the *.owl files necessary for the PORTAL and DOORS root classes used by those registries, such as BioPORT and ManRay, which elect to require semantic metadata for the descriptions of their registered resources. An initial draft of the *.owl file has now been implemented for the BioPORT resource class (see Figure 4), and the previous drafts of the *.owl files for the ManRay ontology have been updated for compliance with the PORTAL-DOORS system and for inclusion of the new classes enabling definition of pharmacogenomics molecular imaging studies (see Figures 5 and 6). All schema and ontology drafts are available from www.portaldoors.org.

Applications

Resource registries enhanced by the semantic power of ontologies transcend the capabilities of traditional database systems. BioPORT demonstrates a simple example where the limited purpose remains publishing the availability of biomedical computing resources. ManRay demonstrates a more complex example with the multiple goals of cataloguing the components, defining the protocols, and interlinking the patient registries that will enable clinical trials with pharmacogenomics molecular imaging studies.

Conclusion

BioPORT and ManRay are two prototype registries within the PORTAL-DOORS infrastructure system for managing online metadata for both online and offline resources serving translational biomedical informatics and other fields of biomedical research. Implemented for the semantic web and grid, this paradigm favors a flexible and modular approach promoting collaborative networks of cross-linking resources and inter-referencing ontologies in a multiplicity of problem oriented domains.

References

1. Taswell C, Franc B, Hawkins R. The ManRay Project: Initial development of a web-enabled ontology for nuclear medicine. J Nucl Med. 2006;47(S1):371P.
2. Taswell C. DOORS to the semantic web and grid with a PORTAL for biomedical computing. IEEE Trans Inf Technol Biomed. 2008; 12(2):191 Special Issue on Bio-Grid (DOI 10.1109/TITB.2008.905861).