1. Introduction

Future scenario for Geographic Information Systems (GIS) could be plausibly imagined as a potential single infrastructure working together in harmony with a wide variety of geographic-data. This data, often collected independently, is usually heterogeneous in nature. Moreover the data that a given user requests may not be available from a single data source and it is necessary to assimilate data from more than one data source. As can be expected, such information retrieved from multiple sources would not be syntactically, structurally and semantically homogeneous and would be technically unusable. Manual integration usually employed in such cases can be very tedious and error prone, especially at the time of emergencies when such integration is most required. Machine-based integration has been evolved over recent years with the concept of ontology driven GIS (Fonseca et al, 1999) and ontology enabled databases (Sarda, 2003)

Geographic Information Integration is the key to large scale and wide ranging use of geospatial data. Some of the heterogeneities that exist between different information systems can be classified as follows:

i) Data Heterogeneity: It refers to heterogeneity among existing systems in terms of data representation and storage etc. and can be further classified as below (Bishr, 1997).
   a) Syntactic Heterogeneity - in which, the information systems use different storage and representation paradigms.
   b) Schematic Heterogeneity - in which, the same object in the real world is represented using different concepts.
   c) Semantic Heterogeneity - in which a fact can have more than one description or interpretation.

ii) Functional Heterogeneity: This type refers to the heterogeneities among existing systems in terms of service interfaces.

Both types of heterogeneities result from differences in (i) systems and technologies, (ii) systems and standards, and (iii) semantics and domain specific knowledge. Such differences are abundant in most vertical sectors, which produce or use geospatial data. The typical usage of geospatial data includes different vertical and geographic domains. This aggravates the interoperability problems and has been reported by many researchers.

Interoperability itself comes in various stages and many classifications of such stages can be found in literature (Kuhn, 2005). The classification of interoperability in terms of semantic, structural and syntactic issues, in accordance with the heterogeneities discussed above, are important for the approach to resolves such issues. Open standards in geospatial data exchanges such as GML (OGC, 2003a) help to resolve syntactic and structural differences. Many approaches to resolve semantic interoperability exist including that of ontologies and reasoning based on ontological specifications.

This paper presents work on the framework of semantic interoperability developed to deal with heterogeneous geospatial data. It uses geospatial ontologies and mapping mechanisms between them to resolve semantic issues. The paper is arranged as follows: This Section provides a background to the topic of semantic interoperability with an introduction to the specific problems of the Indian NSDI. Section 2 discusses the concept of ontology-enabled