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Contemporary Problems of GIS Interoperability: A Review of GIS Integration with Current Technology

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Abstract

This paper examines GIS interoperability with three current technology trends: Open Source, Smart Devices and Web 2.0. It firsts takes a look at both varying definitions of interoperability as well as different types of interoperability. The author samples a variety of GIS formats with examples of each of the said technologies as a way to measure the current state of GIS interoperability with current technological trends. GIS functions such as viewing, editing and analyzing spatial data are used as a scoring matrix to determine the level of interoperability. The methodology of measure focuses on a technical level of interoperability and reveals that among the three technologies studied, open source technology leads the way in interoperability with GIS. Further research confirms this but also shows that smart devices and Web 2.0 are not only also currently interoperating with GIS but actually a driving force in the development and direction of GIS interoperability.

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Introduction

GIS interoperability with related technologies has been an important issue for as long as GIS has been around. Over the past half century, we have seen an evolution of GIS interoperability from Computer Aided Design (CAD) to enterprise spatially-enabled databases to finally smart phone applications. Interoperability is even more imperative today as the growth and expansion of technology accelerates along with the demands for GIS to keep up with the expectations of user-friendly interfaces, intuitive data-mining, and ubiquitous web-based mapping tools. For example, thousands (if not millions) of dollars are still spent by GIS and CAD systems to coexist and work seamlessly in a single environment. GIS users often need to incorporate engineering drawings to add man-made features to their maps such as roads, sidewalks, parks or utility facilities. Conversely, engineers are often interested in GIS layers such as land cover, land use, soil or elevation when designing a project.

Today, there also exists a need for GIS to integrate with a variety of emerging technologies. This research project seeks to determine the degree to which interoperability between GIS current technological trends has been achieved. In this paper, three such technologies are examined: Open Source technology, Web 2.0, and smart device applications. Open Source technology refers to Software in which the source code is freely available to the public to view and contribute to (dictionary.reference.com). Today, open source software is available for many standard computer programs such as word processors, spreadsheets and slide presentation programs. The advantage with open source programs is that they are not only free, but there is a broad and active community to provide enhancements and support for these products. Many organizations requiring GIS tools that are not able to afford expensive proprietary software have turned to open source alternatives. This paper looks at the degree to which these programs are interoperable with mainstream GIS data. Web 2.0, on the other hand refers to 2nd generation web technology which provides a new set of functionalities pertaining to the ability for the end user to 'interact' with the web. Examples of this include blogs, wikis and social networking (TechTerms.com, 2013). Web 2.0 technologies make it possible for a wider set of a non-GIS audience to not only view, but interact with GIS data. Again, this paper takes a look at the level to which mainstream GIS formats are able to be used by Web 2.0 platforms. Finally, smart devices such as Apple I-PADS, I-Phones and Droid tablets often come with mapping capabilities such as GPS receivers and commercial mapping applications. Organizations needing to bring their GIS data to the field could benefit from these types of technology by finding ways to integrate GIS data with smart devices. Each of these three technologies have opened the way for an unprecedented increase in resources and expansion in knowledge base and are not only being used to interact with GIS data, but in some cases being used as mediums for streamlining GIS interoperability with other types of data systems.

Literature review

Interoperability defined

GIS interoperability can be defined in a number of different ways. Due to the broad nature of the concept of interoperability, it is difficult to find an all-encompassing definition. One such broad definition is offered by Manso-Callejo and Wachowicz, M. as the "ability of a collection of system components to share specified information and operate on that according to a shared operational semantics in order to achieve a specific purpose in a given context" (Manso-Callejo & Wachowicz, 2009). As we will discuss later in this paper, this definition provides a high level framework for interoperability across seven distinct levels of interoperability. A more focused and specific definition is provided by Safe Safe Software, Inc, the proprietor of an industry leading GIS interoperability software known as FME, as "[…] communication by sharing and distribution of data, and the ability to use that data transparently" (www.safe.com, 2013). According to ESRI's GIS dictionary, GIS is defined as "The capability of components or systems to exchange data with other components or systems, or to perform in multiple environments. In GIS, interoperability is required for a GIS user using software from one vendor to study data compiled with GIS software from a different provider." (GISDictionary) In this paper, we will look at GIS interoperability from the definition offered by ESRI.

History and Status of GIS Interoperability

The notion of interoperable GIS has evolved over time. Historically, there was not the same expectation of GIS interoperability as there is today. Due to the high costs associated with GIS technology, GI Systems were rare and interoperability was not a high priority (Han, 2001). But as more industries adopted GI systems, the case for interoperability became more necessary. For example, the ability for GIS to be interoperable with Computer Aided Design (CAD) has been highly sought after for a long time. These are two systems, that both need to be spatially aware but in different contexts (Han, 2001). There is great value in being able to overlay the rich amount of data available in a traditional GIS to engineers who might be interested in topography, land cover, land use and imagery etc. For example, Michael F. Morgan (2009) researched the best methods for integrating CAD and GIS at the University of South Carolina for their facility and space management. He successfully developed a process that took non-georeferenced AutoCAD drawings and brought them into ArcGIS, utilizing automated tools with minimal impact to the current workflow of AutoCAD design. His research and findings serve as an example of both the need for integration as well as a success story for how this can be accomplished.

In addition to GIS interoperability with CAD systems, there has also been a move to integrate GIS with enterprise data systems. A study out of the University of Waterloo discusses the added value that GIS brings to the traditional IT world specifically for Environmental Health and Safety departments of many organizations. It focuses primarily on the natural integration of GIS with relational databases (Environmental Health and Safety Data Integration Using Geographical Information Systems).

The growing need for GIS interoperability has led to organizations such as the Open Geospatial Consortium to provide initiatives for the support and standardization of GIS interoperability. This consortium consists of 480 companies, government agencies and universities working towards open interface standards to support interoperability with a variety of current mainstream technologies. For example, the OGC has worked with the FAA for a solution to automate the dissemination and portrayal of Special Activity Airspace information to the National Airspace System (Open Geospatial Consortium, 2013). This was accomplished using several OGC standards including WFS, FPS and AIXM. The OGC website shows over 50 distinct initiatives like this all dealing with GIS interoperability using open source solutions. The sheer volume of participants in this consortium along with vast array of interoperability initiatives demonstrates the demand for interoperability with current technology in a variety of sectors (Open Geospatial Consortium, 2013).

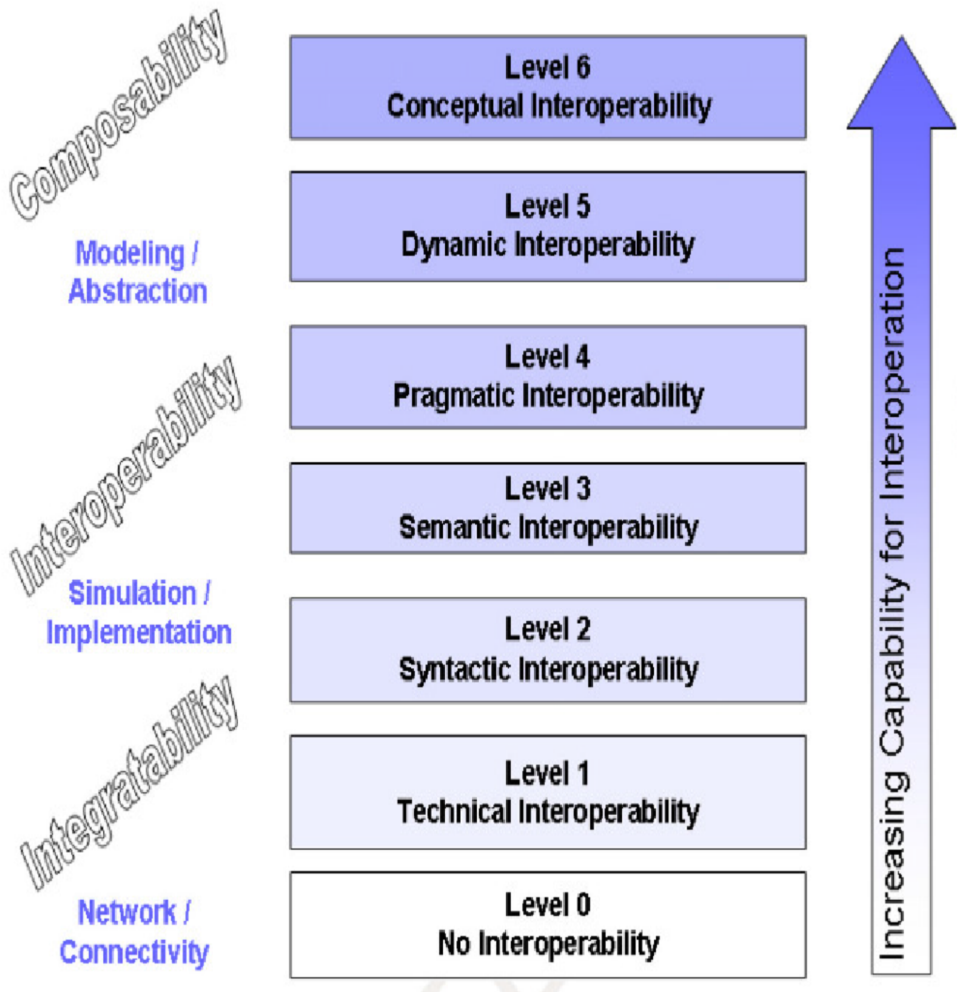
Today, GIS interoperability has evolved to a point where researchers are now proposing models to move GIS interoperability into a semantic interoperability model. Wang Yandong et al. (Wang, Gong, & Wu, 2007) discuss the lack of a complete semantic interoperability between the vast array of GIS and other supporting data systems. They put forward a model based on Ontology Web Language and tested it on data for western cities in China. The result was successful and showed viability of GIS semantic interoperability which holds a promising potential for the future.

Finally, GIS integration with commercial mapping API's such as Bing Maps and Google has led to a greater public interaction with GIS data (Morris, 2006). Commercial mapping has only a small portion the entirety of GIS data (Morris, 2006). A greater public awareness of GIS data has fueled the efforts of GIS interoperability with mainstream technological trends.

Levels and Measures of Interoperability

With the ever growing demand for GIS to be interoperable with a variety of technologies, it is important for us to understand the many facets of interoperability. Many researchers have offered various methods of measuring the level of GIS interoperability. Manso-Callejo et al. (Manso-Callejo & Wachowicz, 2009) describe seven levels of GIS interoperability ranging from Level 0 which indicates no interoperability to Level 6 which indicates conceptual interoperability. Additional levels also include technical, syntactic, semantic, pragmatic, dynamic and finally conceptual (see figure 1 below). It is important to note that these levels of interoperability are not necessarily hierarchal in terms of one level being dependent on another level (Manso-Callejo & Wachowicz, 2009).

Figure 1 **Levels of Interoperability**



(Manso-Callejo & Wachowicz, 2009)

When measuring interoperability, it is important to specify what level of interoperability you are measuring. Technical interoperability focuses on the data formats themselves and the ability for different systems to interact with the data itself. Syntactic interoperability focuses on the need for a common exchange of data models and spatial patterns when integrating data from various data stores. A semantic level of interoperability would focus on more of the meaning of terms across industries and software companies. Pragmatic interoperability deals with interoperability with regards to the intentions of how GIS data is going to be used. Services that provide this type of interoperability must understand and cater to the various uses of that data in order to achieve this level. Dynamic interoperability is achieved when systems are able to account for and take advantage of changes in assumptions and constraints of different systems. Finally, conceptual interoperability takes place when there is a proper alignment of assumptions and constraints between systems. It often appears in the form of something can be documented and understood by a third party. The push for a complete open architecture for integrating various systems is an example of this type of interoperability (Manso-Callejo & Wachowicz, 2009).

While Manso-Callejo et al. (2009) discuss different levels of interoperability; they do not discuss specific methods for testing levels of interoperability between GI Systems. The authors state that further research is needed in order to develop models of testing interoperability.

Furthermore, it is impractical to expect that any test of interoperability would cover all levels mentioned. Instead, they should aim to cover one or two (Manso-Callejo & Wachowicz, 2009). In this project, I propose one such method.

The method described below provides one approach to measuring GIS interoperability on a technical level only. This method focuses on data types and data formats and their compatibility with current technological trends. This does not serve as a comprehensive measure of GIS compatibility; rather it proposes one matrix for measuring GIS interoperability in a technical sense, especially concerning technological trends.

Design and analysis

The purpose of the research described below is to measure the degree of interoperability of GIS with a sample of technologies representing a wide range of current technological trends. In order to measure this, various technologies are sampled spanning three major trends: Smart Devices, Web 2.0, and Open Source. Five different applications are sampled in these areas including GeoREST, a Web 2.0 technology that provides an easy way to distribute GIS data via the Web in a variety of formats; AutoCAD WS, a smartphone application for AutoCAD drawings; ArcGIS Online, ESRI's cloud-based GIS that is compatible with smart devices; ~~-~~GRASS, one of the leading open source GIS platforms; and finally Mapguide, an open source web-based GIS.

For each of these technologies, a series of tests are run which indicate the degree to which they are interoperable with GIS. In order for a technology to be deemed interoperable with GIS, several variables are considered. They must be able to view, query, edit and analyze GIS data. Also, there has to be a minimal number of steps to translate the data into a usable format. There exists today a vast array of GIS formats. This project looks specifically at six of the most common GIS data formats including a sample of both proprietary and open source data types. These formats are among the most widely used and are mentioned in almost every list of commonly recognized GIS data formats. The formats tested include SHP, DWG, KML, JSON, PostGIS and Geodatabases (GDB). Points, lines and polygons for each format are also included to be sure all feature types of GIS data are tested. For each feature type, a score of ‘1’ or ‘0’ is given for each of the said functionalities above. Also, a negative number is given for each number of steps the data must undergo for data translation. For example, if the technology can directly read SHP files with no translation required, no points are deducted. If, on the other hand, the data first requires a conversion to another format before it can be used then 1 point is deducted. In this way, the degree to which interoperability has been achieved based on these sample technologies and traditional GIS data types is measured. In addition to these functionalities, GIS is also tested with raster datasets. A score of ‘1’ or ‘0’ is given if either GeoTIFF or JPEG raster datasets are supported.

Figure 2 Test Matrix

Data Format	View (1,0)	Query (1,0)	Edit (1,0)	Analyze (1,0)	# of Data Transformation Required (-1 for each)	Overall Score
DWG (point)						
DWG (line)						
DWG (polygon)						
SHP (point)						
SHP (line)						
SHP (polygon)						
KML (point)						
KML (polygon)						
GeoJSON (point)						

GeoJSON (line)						
GeoJSON (polygon)						
SQL (point)						
SQL (line)						
SQL (polygon)						
PostGIS (point)						
PostGIS (Line)						
PostGIS (Polygon)						
GeoTiff						
JPEG						
Average						

The data for this project was acquired from the US Census Bureau. Fresno County is the sample data set. Landmarks in Fresno County are used as the points, roads as lines and census block groups as polygons. Safe Software's data translation tool FME is used to translate the data into each of the initial data formats needed for the experiment.

Results

For the purposes of data analysis, the independent variable is represented by the tests of interoperability for each data type. In all there are 100 tests using 20 data types for each technology type. This includes 6 unique vector formats for points, lines and polygons including SHP, DWG, KML, JSON, SQL Spatial and POSTGIS as well as two raster data sets which include GeoTiff and Jpeg.

The dependent variables are represented by each of the scores as determined by the ability to view, edit, query, and analyze the data as well as the number of translations required to use the data types tested for each of the technologies. (Refer to the codebook in Appendix B for the full dataset.)

In order to determine the average scores for each of the specific applications used, the data is aggregated by each application with an average score for each. Scores range from 0 (not compatible) to a maximum possible of 5 (very compatible). The average score by applications sampled is shown in Table 1 below along with their standard deviations.

Table 1 **Grouped by Applications**

	Applications				
Scores	ACADWS	ArcGIS Online	GeoRest	Grass	Mapguide
Mean Score	0.3	0.06	0.075	2.5	1.75
Standard Deviation	0.73	0.94	0.44	1.43	1.55

Clearly, Grass and Mapguide scored the highest with average scores of 2.5 and 1.75, respectively. Scores for Grass and Mapguide also varied the most with standard deviations of 1.43 and 1.55, respectively. According to this test, Grass and Mapguide have the strongest level of compatibility with other GIS applications.

In addition to aggregating scores by technology type, it is also worth noting the scores based on the technology types. This gives us a comparison on a higher level between the different types of technologies (Web 2.0, Open Source and Smart App). See Table 2 below:

Table 2 **Grouped by Technology Type**

Scores	Technology Type Open Source	Smart Device App	Web 2.0
Mean Score	2.13	.45	.75
Standard Deviation	1.52	.84	.444

Not surprisingly, smart applications rank the lowest on this list. This was evident in the results from Table 1 which show both ACADWS and ArcGIS online (the only two smart applications studied) as the two lowest scorers.

Finally, it is also interesting to see how different software core functions rank on this scoring criteria. Table 3 below summarizes the data by functionality.

Table 3 **Grouped by Function**

Scores	Data Portal	Desktop GIS	Web GIS
Mean Score	0.75	2.5	0.88
Standard Deviation	0.44	1.43	1.27

It is not surprising that the only desktop sample used (GRASS) scored the highest. This is probably due to the fact that desktop products inherently are more functional and versatile. However, both a desktop and web-based GIS were sampled as open source technology to provide a more balanced sample set when comparing technology types above. GeoREST was the only WEB 2.0 technology sampled and since it is more of a data portal as opposed to a true GIS, the scores from these samples were among the lowest affecting the Web 2.0 scores in Table 2.0. What this shows is that functionality plays an important part in the level of compatibility. This may be an indication that the test may be measuring technology function as opposed to compatibility. Further analysis below confirms this.

Table 4 below shows the correlations of scores between each of the groups of data. The data shows a moderate correlation between Compatibility Scores in the Application and Technology Type groups with a correlation coefficient of -.182. The negative relationship would indicate that as the application compatibility scores increase it is expected that the scores for technology type to decrease. However, the 2 tailed significance tests has a value of .070 which is greater than the .01 level needed to be significantly significant. This means there is too high of a probability that the correlation is a coincidence and therefore not conclusive. In other words, there could potentially be a relationship between Compatibility Scores in the Application and Technology Type groups; however the data does not have enough cases to determine this with a high enough confidence level.

The correlation coefficient for the compatibility scores for the applications and functions groups is also a moderate correlation with an r value of -.165. Similar to the correlations above, the findings here are not statistically significant either with a significance value of .1.

The correlation coefficient for the compatibility scores of the technology type and function groups have a statistically significant positive relationship. The r value of .365 indicates a strong relationship which is significant at a .001 level. This means that as the compatibility scores for the technology type increase, so do the scores for the function. A possible explanation for this correlation could be due to the fact that the test of compatibility favors certain functions over another. Since some of the technology types have more samples representing specific functions than other technology types, the groups with functions of higher compatibility affect the scores of that technology type. For example, Table 3 shows the functionality of 'Desktop GIS' having a significantly higher mean than any other function. The only samples of 'Desktop GIS' data are all of an 'Open Source' Technology Type which also has the highest mean of scores among all Technology Types (see Table 2).

Table 4 **Correlation**

		Application Compatibility	Technology Type Compatibility	Function Compatibility
Applications Compatibility	Pearson Correlation	1	-0.182	-0.165
	Sig. (2-tailed)		0.070	0.100
	N	100	100	100
Technology Type Compatibility	Pearson Correlation	-0.182	1	0.365**
	Sig. (2-tailed)	0.070		0.000
	N	100	100	100
Function Compatibility	Pearson Correlation	-0.165	.368**	1
	Sig. (2-tailed)	0.100	0.000	
	N	100	100	100

**Correlation is significant at the .01 level (2 tailed).

Discussion

In the three technologies studied to determine interoperability between GIS and current technological trends, open source technology ranks among the most compatible. This is highly due to the fact that desktop GIS's tend to be more functional and lend themselves more easily to open source, and by definition cannot be web 2.0 or smartphone applications. The degree of interoperability scoring difference between open source and the other two categories is quite significant, suggesting from these initial studies that WEB 2.0 and Smart Device applications still need additional development especially in the editing and analyzing capabilities that standard GIS's currently provide. Ultimately, there is definitely interplay between the GIS and the current trends. The fact that at least some categories of technology scored well might also indicate the demand for interoperability and point the way to potential for growth in interoperability in others as well.

Another question that arises from the results of this data is that of the niche of GIS in these trends. Does interoperability necessarily equal the functional ability of a traditional GIS? For example, Table 1.0 shows that all of the interoperability points for WEB 2.0 data portals such as Geo Rest were in the “view” category. This suggests that the ability for these to translate and view almost any data set may better be categorized more as a facilitator of GIS interoperability and perhaps measured differently in future studies. Similarly, uses for smart device apps may be very different than that of desktop applications. Rather than the traditional data crunching a GIS analyst may be used to, these apps may be better suited for surveyors and data collectors and not require the same functionality. The results suggest a very clear trend that the development of these products are moving in different directions of functionality than that of traditional desktop-based GIS’s.

Further research has confirmed that there is a high level of interoperability between GIS and open source technology. However, contrary to my findings above, further research indicates the Web 2.0 and mobile applications have made considerable advances in interoperability with GIS as well.

GIS interoperability with open source technologies appear to be at the most advanced state. Many current articles no longer address the mere basic issues of interoperability, but rather address the needed enhancements for a more perfect interoperability. For example, Jung-Hong Hong et al. discuss the need for visualization of data transformation tools in order to ensure data integrity and proper interpretation of data (Hong & Liao, 2011). There are open source tools available today to merge data from various sources. With these abilities come the important processes of determining if the data is compatible in terms of projections, scale, date collected and other spatial factors. Having the ability to visualize different steps of data merging in order validate it at each stage is an imperative part of the process of data integration (Hong & Liao, 2011). In addition to the advancement of interoperability tools, there is also a push for integrating traditional GIS with an open GIS architecture. Dunfey et al. (2006) propose a model using SVG for web based vector graphics as a foundational element of a completely open GIS. The authors propose that moving to a more open GIS will allow for a greater level of interoperability between different GIS platforms (Dunfey, Gittings, & Batcheller, 2006). This point could be taken further to say that not only does GIS interplay with open source technology, but open source is in fact a driver of GIS interoperability.

Similar to open source technologies, Web 2.0 also plays a key role in driving GIS interoperability. Web services have become a standard way of moving data between systems. The OGC has developed standardized open protocols for distributing mapping data including WMS and WFS. These services provide geospatial data in a common way in the both vector and rasterized formats (Zhao, Foerster, & Yue, 2012).

Smart device applications that support GIS data continue to proliferate. A quick search for 'GIS' at the Apple app store lists 23 different applications that are somehow related to GIS. In many cases, web services actually play a key role in providing the infrastructure needed to support mobile applications (Dasgupta & Ghosh, 2011).

Areas of further research

This project merely addresses one aspect of determining the level of interoperability that currently exists between GIS and current technical trends. Further research is needed to explore each of the levels of interoperability, their current status, and relevance to the ever changing state of current technology. In addition, repeatable testing methods need to be developed for each of the layers of interoperability. This paper proposes just one example of such a method. The results showed that though it is possible to measure interoperability in this way, further refinement is necessary in order to ensure a more accurate result. Finally, research on this project has shown that the current technological trends are not only compatible with GIS but in many cases are driving GIS compatibility. Web

2.0 technologies such as web services are used to create service chains that allow migration of data from multiple data formats to another. The OGC has passed initiatives for their open source software pushing for the standardization of interoperability. Commercial mapping applications have led to a greater public awareness of GIS data which creates a demand for GIS integration with mainstream technology. As new and evolving technologies hit the mainstream, it will become increasingly important to research and understand these trends and how they will shape the future of GIS technology.

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Appendix A: Terms and Definitions

Open Source – Software for which the source code is freely available for the public to view and contribute to. The software itself is generally free to use.

Web 2.0 – A label introduced in 2004 that refers to the 2nd generation of web technology which provided a new set of functionalities pertaining to the ability for the end user to 'interact' with the web. Examples include blogs, wikis and social networking (TechTerms.com, 2013).

Smart device applications – any application that can be used on a smart device such as an iPad, iphone or droid tablet.

Data Formats Used

DWG	Autodesk's proprietary drawing format for AutoCAD drawings
GEOTIFF	A specialized TIFF file which stores georeferecing information embedded in the file in order to provide a spatial reference
JPG	A graphic format for hi res images, often used for aerial imagery
GeoJSON	A geospatial data interchange format based on Javascript Object notation (JSON)
KML	(Keyhole Markup Language) An XML based geographic data format used for annotation and visualization initially developed for use with Google Earth.
SHP	A geospatial vector format used in GIS software containing points, lines or polygons and associated attributes
POSTGIS	An open source software program that provides geospatial support for PostgreSQL
SQL Spatial	Microsoft's enterprise database system which supports natively storing spatial data as Geometry or Geography data types.

Appendix B: Code Book

DataType	Tpe	Vw	Qry	Edit	Anl	Trans	Total	TechType	TechCat	Function	Format
dwgline	l	1	0	1	0	0	2	ACADWS	Smart Device Ap	WEBGIS	Vetor
DWGpoing	p	1	0	1	0	0	2	ACADWS	Smart Device Ap	WEBGIS	Vetor
dwgpolygon	pl	1	0	1	0	0	2	ACADWS	Smart Device Ap	WEBGIS	Vetor
geotiff	r	0	NA	NA	NA	0	0	ACADWS	Smart Device Ap	WEBGIS	Raster
jpg	r	0	NA	NA	NA	0	0	ACADWS	Smart Device Ap	WEBGIS	Raster
jsonline	l	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
jsonpoint	p	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
jsonpolygon	pl	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
kmllin	l	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
kmlpoint	p	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
kmlpolygon	pl	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
line	l	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
point	p	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
polygon	pl	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
shpline	l	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
SHPpoint	p	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
shppolygon	pl	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
sqlline	l	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
sqlpoint	p	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
sqlpolygon	pl	0	0	0	0	0	0	ACADWS	Smart Device Ap	WEBGIS	Vetor
dwgline	l	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor

DWGpoing	p	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
dwgpolygon	pl	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
geotiff	r	0	NA	NA	NA	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Raster
jpg	r	0	NA	NA	NA	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Raster
jsonline	l	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
jsonpoint	p	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
jsonpolygon	pl	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
kmllin	l	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
kmlpoint	p	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
kmlpolygon	pl	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
line	l	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
point	p	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
polygon	pl	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
shpline	l	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
SHPpoint	p	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
shppolygon	pl	1	1	0	0	0	2	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
sqlline	l	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
sqlpoint	p	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
sqlpolygon	pl	0	0	0	0	0	0	Arcgisonline	Smart Device Ap	WEBGIS	Vetor
dwgline	l	0	0	0	0	0	0	Georest	Web2.0	data portal	Vetor
DWGpoing	p	0	0	0	0	0	0	Georest	Web2.0	data portal	Vetor
dwgpolygon	pl	0	0	0	0	0	0	Georest	Web2.0	data portal	Vetor
geotiff	r	0	0	0	0	0	0	Georest	Web2.0	data portal	Raster
jpg	r	0	0	0	0	0	0	Georest	Web2.0	data	Raster

										portal	
jsonline	l	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
jsonpoint	p	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
jsonpolygon	pl	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
kmllin	l	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
kmlpoint	p	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
kmlpolygon	pl	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
line	l	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
point	p	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
polygon	pl	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
shpline	l	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
SHPpoint	p	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
shppolygon	pl	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
sqlline	l	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
sqlpoint	p	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
sqlpolygon	pl	1	0	0	0	0	1	Georest	Web2.0	data portal	Vetor
dwgline	l	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
DWGpoing	p	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
dwgpolygon	pl	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
geotiff	r	1	NA	NA	NA		1	Grass	OpenSource	Desktop GIS	Raster
jpg	r	1	NA	NA	NA		1	Grass	OpenSource	Desktop GIS	Raster
jsonline	l	0	0	0	0		0	Grass	OpenSource	Desktop GIS	Vetor
jsonpoint	p	0	0	0	0	0	0	Grass	OpenSource	Desktop GIS	Vetor
jsonpolygon	pl	0	0	0	0	0	0	Grass	OpenSource	Desktop GIS	Vetor

kmllin	l	1	1	1	1	0	4	Grass	OpenSource	Desktop GIS	Vetor
kmlpoint	p	1	1	1	1	0	4	Grass	OpenSource	Desktop GIS	Vetor
kmlpolygon	pl	1	1	1	1	0	4	Grass	OpenSource	Desktop GIS	Vetor
line	l	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
point	p	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
polygon	pl	1	1	1	1	-1	3	Grass	OpenSource	Desktop GIS	Vetor
shpline	l	1	1	1	1	0	4	Grass	OpenSource	Desktop GIS	Vetor
SHPpoint	p	1	1	1	1	0	4	Grass	OpenSource	Deskop GIS	Vetor
shppolygon	pl	1	1	1	1	0	4	Grass	OpenSource	Desktop GIS	Vetor
sqlline	l	1	1	1	1	-2	2	Grass	OpenSource	Desktop GIS	Vetor
sqlpoint	p	1	1	1	1	-2	2	Grass	OpenSource	Desktop GIS	Vetor
sqlpolygon	pl	1	1	1	1	-2	2	Grass	OpenSource	Desktop GIS	Vetor
dwgline	l	1	0	0	0	0	1	Mapguide	OpenSource	WEBGIS	Vetor
DWGpoing	p	1	0	0	0	0	1	Mapguide	OpenSource	WEBGIS	Vetor
dwgpolygon	pl	1	0	0	0	0	1	Mapguide	OpenSource	WEBGIS	Vetor
geotiff	r	1	NA	NA	NA	0	1	Mapguide	OpenSource	WEBGIS	Raster
jpg	r	1	NA	NA	NA	0	1	Mapguide	OpenSource	WEBGIS	Raster
jsonline	l	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
jsonpoint	p	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
jsonpolygon	pl	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
kmllin	l	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
kmlpoint	p	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
kmlpolygon	pl	0	0	0	0	0	0	Mapguide	OpenSource	WEBGIS	Vetor
line	l	1	1	1	1	0	4	Mapguide	OpenSource	WEBGIS	Vetor
point	p	1	1	1	1	0	4	Mapguide	OpenSource	WEBGIS	Vetor
polygon	pl	1	1	1	1	0	4	Mapguide	OpenSource	WEBGIS	Vetor
shpline	l	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor
SHPpoint	p	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor
shppolygo	pl	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor

n											
sqlline	l	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor
sqlpoint	p	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor
sqlpolygon	pl	1	1	0	1	0	3	Mapguide	OpenSource	WEBGIS	Vetor