

Chapter XXXIV

Use of Geographic Information Systems in Cyber Warfare and Cyber Counterterrorism

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ABSTRACT

Geographic information systems (GIS) are defined and discussed both in general and specifically with reference to their applications in three distinct modalities. These are, firstly, the application of computer mapping and spatial analysis technologies encompassed by the term GIS in counter terrorism. Secondly, the potential for misuse of GIS technologies in both terrorism in general and more specifically the unique vulnerabilities of these suites of complex programs and the huge and sophisticated datasets that are managed by GIS programs to exploitation and damage by cyber terrorists. Lastly the ways in which these terrorist threats to geo-spatial infrastructure can be detected, avoided and minimized will be discussed.

BACKGROUND

Definition and Structure of GIS: Geographic information systems (GIS) are a rapidly evolving suite of computer programs and related geospatial data sets that provide for the input, storage, manipulation, spatial analysis, query and generation of cartographic and other output related to features existing on the earth. GIS contain data stored in specialized topological data structures with multiple co-registered layers that have coordinate systems and map projections. Features portrayed in each layer including topogra-

phy, infrastructure data such as streets portrayed as lines, jurisdictional boundaries portrayed as polygonal shapes and incident locations portrayed as points all have corresponding descriptive data linked to them in a series of attribute database tables. The topology and coordinate system(s) built into GIS allows the location of features to be precisely determined in real world coordinates and features existing over considerable portions of the curved surface of the earth to be portrayed in the two dimensional space of computer monitors and potentially on printed cartographic output (Burroughs, 1986).

Generic Applications of GIS: GIS was invented in the middle 1960s in Canada to manage large natural resources related data sets (Foresman, 1998). By the 1980s, the typical application areas for GIS had expanded to include such fields as public utility and infrastructure management, land records mapping and management (cadastral applications), business and marketing applications; such as site selection and logistics and in a range of social science and physical science applications (Steinberg & Steinberg 2006). The 1990s saw additional applications develop in such areas as interactive Web-based mapping, vehicle navigation and integration with global positioning systems technology, computer aided design and image processing for remotely sensed data and digital aerial photography (Longley, McGuire, Goodchild, & Rhind, 1999).

GIS Programs and Requirements: GIS programs include the ArcGIS and related software such as ARCVIEW and ArcIMS and the older Arc/Info software from the Environmental Systems Research Institute (ESRI) in Redlands, California (www.ESRI.com), GIS software and related CAD and design tools from Intergraph Corporation in Huntsville, Alabama (www.Intergraph.com) and the less powerful, but less costly, desktop mapping software from MapInfo Corporation in Troy, New York (www.Mapinfo.com). These are also related software for many specific applications such as serving maps interactively over the Internet, interfacing with relational database management systems and various types of modeling and analysis. In some organizations, software from three or more vendors may be employed; thus at the Federal Emergency Management Agency (FEMA), ArcGIS is used to create GIS data, but the simpler MapInfo software is used on laptop computers in the field (URISA, 2003). GIS programs and their associated topologically structured vector and high-resolution raster data sets have substantial system requirements. Specifically, current generations of GIS software run best on machines with at least 1 gigabyte of RAM and featuring high power graphics cards that are a necessary investment. In addition, large high resolution displays, large format

plotters, large format scanners, tape backup devices for low cost, high capacity storage and global positioning systems units capable of displaying GIS data and running “mini” GIS programs such as ARCPAD are a frequent component of GIS installations (GIS, 2005).

APPLICATIONS IN COUNTERTERRORISM

One of the very first GIS applications was a national defense application by the Canadian Navy to map and study attributes of coastal areas, but this mid-1960s application of GIS was actually predated by a decade, by a defense application of computerized maps developed for the RAND Corporation by Dr. Waldo Tobler. This featured the use of computers (without linked databases and therefore not a true GIS) to display radar data from the defense early warning (DEW) line (Monmonier, 1982). Interestingly, with the end of the cold war, defense applications of GIS fell temporarily into decline. An indication of this decline was the consolidation of the mapping functions of the Defense Mapping Agency and the map making functions at the CIA into the National Imagery and Mapping Agency. The attacks on 9/11 had a major impact on this decline, leading to a huge infusion of funds and staff into what has now been dubbed geospatial intelligence and the creation of the National Geospatial-Intelligence Agency (NGA) within the U.S. Defense Department (Greene, 2003). The intention of this agency is to convey often largely paper maps and largely sterile aerial imagery into “advanced” geospatial intelligence; where not merely high resolution images are available in near real-time, but fully descriptive attribute data and current “ground truthed” intelligence is added to enhance the imagery. Increasingly advanced geospatial intelligence is being made available over computer networks and wirelessly to field operations personnel, intelligence analysts, and other widely distributed users.

GIS is featured ever more frequently in both military and law enforcement applications (Leipnik & Albert, 2003). Specifically, with reference to the

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