GEOLINK: AUTOMATED INTERACTIVE GPS/GIS APPLICATIONS FOR ELECTRIC UTILITIES

Abstract: This applications note summarizes several applications using GeoLink, an automated interactive GPS/GIS field mapping system, to input spatial graphic data and automatically georeferenced attribute data directly into GIS and CAD systems within the electric utility industry. Project applications included are on transmission line route studies in California, the use of GPS and GIS in distribution automation systems for the National Rural Electric Coop Association and outage analysis in Florida. Integration of external digital measurement devices such as laser rangefinders with the GeoLink field mapping systems are also addressed.

SIGNIFICANCE OF GPS/GIS TO ELECTRIC UTILITIES

The large investment electric utilities make in outside plant equipment, and the importance of its continuous safe and reliable operation makes computerized GPS/GIS support of the inventory, inspection, maintenance, dispatch, and repair processes exceptionally valuable.

In electric transmission and electric distribution, outside plant inspection and inventory are continuous tasks which must be applied with a view toward efficiency. Here the GPS location sensor with automated interactive GIS data input capability is exceptionally valuable toward raising that efficiency. Pole and other equipment locations and descriptions can readily be recorded in the field directly in a computer compatible format which can feed CAD system maps, intelligent GIS area and system diagrams, and conventional computerized databases. A person with state-of-the-art GPS/GIS mapping technology (GeoLink) can obtain accurate "real-world" locations and record or verify detailed equipment lists without requiring the support of a conventional survey crew, and without subsequent transcription and keyboarding into the computer.

In emergency repair situations, or in routine maintenance, it is not only essential to dispatch skilled repair personnel to the proper locations, but also to assure that they are adequately informed of the existing plant configuration, and that those who support them by obtaining repair or replacement components are able to easily identify the proper components or equipment needed. Here an accurate outside plant plan and inventory is invaluable. Equally useful are two other aids: in-vehicle display, and computer aided dispatch. If the repair personnel are provided with a computerized GPS/GIS view of the network in the
vehicle, with a cursor always showing their current location on it, mixups as to which line serves which area can be greatly reduced or eliminated, and extra personnel brought in from other service districts can travel the area with confidence and speed approaching that of experienced local linemen. If the dispatcher can see vehicle locations moving in real time on a computerized area and network map, then their ability to coordinate the many field personnel can be enhanced greatly without burdening the voice radio communication system with excessive questions as to who is where doing what.

CURRENT ELECTRIC UTILITY GPS/GIS APPLICATIONS

GPS/GIS technology is already of importance to utility operating companies in the following areas:

• Digital system map creation and maintenance  
  - Expedient field data collection procedures  
  - Field validation of existing CAD and GIS drawings  
  - Aids alignment of data from outside or paper sources  
  - Several levels of measurement accuracy are available  
  - Environmental item mapping for regulatory compliance

• Recording of line and right of way inspections directly from field to computer  
  - Avoids ambiguity as to problem locations  
  - Produces a report map without manual drafting

• In-vehicle navigation aid  
  - Employing local system maps from CAD or GIS  
  - Capable of accepting map sketches as electronic work orders  
  - Assists out-of-district help and contractors

• Dispatch aided by automatic vehicle location  
  - Workers not burdened by location queries  
  - Dispatch nearest available vehicle to the task  
  - Location relates to network map

• Instrumental measurement mapping (pointwise or contour)  
  - Laser range-finder  
  - Depth sounder  
  - Field strength  
  - Infrared remote thermometry

A national demonstration project sponsored jointly by EPRI (the Electric Power Research Institute) and NRECA (the National Rural Electric Coop Association) is currently utilizing GeoLink at the Pierce-Pepin Electric Cooperative in Ellsworth, Wisconsin. In conjunction with installation of SCADA equipment, automation of the network diagram, and real-time linkage of SCADA with the network CAD system, a GPS based mapping system, GeoLink, has been installed in service trucks providing vehicle tracking for dispatch aiding,
and providing the lineman in-vehicle navigation aids. The in-vehicle computer displays position on the same network map as is employed in dispatch and engineering. The dispatch display is connected to the SCADA system so that alarm conditions and vehicle locations are simultaneously visible. In addition, the lineman can use the same equipment to perform system mapping or inventory updates.

An inventory project at Denton County Electric Cooperative in Texas has been in operation for about a year, to develop improved automated maps. Over the previous five year period, DCEC personnel digitized existing network drawings from paper, and digitized USGS maps of their entire service area. Where possible, subdivision plats were also digitized and integrated into the area map. This resulted in a far superior system and area map, to which new subdivisions could be added fairly easily. The more expensive pieces of equipment such as transformers were entered into conventional accounting databases on their IBM AS-400 minicomputer, while pole installations and similar records were kept in paper files only. The result was that while the organization possessed excellent records of their system, there was no way of relating records of one type to those of another without extensive manual matching. Here they concluded that by using GeoLink data collection tools they could accomplish several objectives:

- Establish in their GIS actual locations of poles as built
  (previous locations were merely inferred from paper drawings)
- Establish a new pole numbering system with correspondence in the GIS
  (older pole numbering attempts were incomplete and had been abandoned)
- Establish correspondence between electrical equipment and pole locations
  (connect the equipment database with the network GIS database)
- Facilitate insertion of new subdivision plats by obtaining insertion coordinates
  (most plats contain no reference to the GIS coordinate system)

Over the past year, Denton County Electric Cooperative has implemented their GeoLink data collection system, developed their own techniques for integration of the information, installed a local area computer network for intercommunication, and begun acquiring GPS referenced data from the field.

At Florida Power and Light, accurate as-built mapping of facilities was desired as part of their overall information management program. In many cases, poles are not easily accessed due to the swampy ground with which they are surrounded. To speed up the mapping process, FP&L has obtained a customized GeoLink data collection system enhanced with a hand-held laser range finder and digital compass which makes it capable of placing poles on the map if they are visible from somewhere within about 1500 feet. The operator merely has to find a suitable sighting location, start the data system, point the range-finder at the pole and pull the trigger. A specialized module of the GeoLink program measures the operator's location, the rangefinder measures the distance and azimuth to the pole, the data system calculates the actual pole location immediately and records it. The operator then may enhance the entry by adding descriptive information as to the pole structure type, equipment,
usage, etc., which will be stored as feature attributes in the GIS. Since numerous poles can
be sighted from a single observation point, productivity in the field is greatly enhanced.

In military operations, also, electric power distribution is an essential aspect of base
civil engineering, forward operations support, reconnaissance, and so forth. In a pilot project
held at Barksdale Air Force Base, Shreveport, Louisiana, the as-build map of about a mile of
new feeder line was added to the base plan in a matter of a couple of hours, including
attribute blocks describing the poles and construction.

At Pacific Gas and Electric, San Ramon, California, GeoLink systems are being
employed to map vegetative and cultural features in prospective rights of way for
transmission lines under consideration. This type of activity can allow planners to screen
areas with due consideration to environmental concerns without investing heavily in resource
studies prior to selection of the top candidates.

**TRENDS IN GPS/GIS APPLICATIONS FOR UTILITIES**

Many other utilities, including Pacific Gas and Electric (PG&E), Utah Power and
Light, Southwestern Bell, and Bell Atlantic have adopted GeoLink GPS/GIS systems for
applications ranging from automated field inventory by helicopter of power line right of ways,
mapping tree trimming requirements, environmental impact statement data collection, and
automated mapping of cellular telephone signal strength in the field. These and many new
applications, including planning and mapping of corridors for new power lines, mapping
electromagnetic fields around power lines, GPS/GIS based dispatch and monitoring of utility
field crews, and on-going maintenance and inspection of electrical distribution systems are
significant trends the use of GeoLink by major private and public utilities in the United
States.

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