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MAPS, MOBILITY, AND THE SMART GRID

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Location is now a common aspect of ubiquitous computing for consumers; we have become used to navigating, searching, and finding our friends with maps on a variety of mobile devices. Beyond these everyday products, however, there is a class of more demanding mobile applications that are both business-critical and time-critical. The proposed paper employs a specific type of user, the utility field crew, to illustrate the architectural issues that must be addressed in this kind of application.

The need for these systems is rooted in the electrical grid. A complex network spread over a large geographic area, it is inherently spatial in nature. To build and manage that network, the utility has to know the location and connectivity of the wires and devices that make up the system. Geospatial data is a necessary tool; utilities relied on paper maps for decades and were early adapters of GIS technology when it became available in the 1970s.

Utility GIS has matured into a business-critical system for planning and operating the grid. A back-office GIS is not sufficient, however; getting geospatial data to field crews is key for a utility because much of the work has to be done outside. Their job is inherently mobile, moving around the grid to job locations that change rapidly. The work is also highly spatial in nature; crews that are “in” the geography are dealing with problems that are “of” the geography.

A number of technologies - mobile computing, data communications, positioning, geospatial data handling – converge to supply today’s utility crews with the systems that support their work. Another area of technology, however, is starting to change the pose new challenges: the grid itself is transforming, morphing from a static, one-way network to a highly complex system of electrical and information flows.

The proliferation of renewable energy sources (solar, wind) and electric vehicles add complexity to the grid. Smart meters and other monitoring devices will output tremendous volumes of data. While most of the changes will be managed by back office systems, some of the added burden of managing the smart grid will invariably fall on field crews.

Designing systems for these crews will face a number of challenges:

- **Maintaining availability**. The application must be accessible, with at least a minimally useful set of data, under all conditions. The business-critical nature of these applications requires that they work whenever and wherever needed.
- **Keeping data current**. Although most of the spatial data used by utility field crews is relatively static, some can change rapidly, and outdated data can have major safety and operational consequences. In the aftermath of storms, wireless communications networks may be unavailable, making it hard to update important data just when it is needed most.
- **Coping with scale**. The combination of many objects and great detail, replicated over a large area, means data volumes scale rapidly. Data structures that work reasonably well in the current environment may not meet performance expectations with the smart grid.
- **Supporting geocollaboration**. The complexity of the network drives the need to collaborate as multiple crews work together to handle situations like outages.
- **Insuring usability**. The constraints of mobile hardware and the high-pressure nature of the job demand more attention to user interface design.
- **Being both more closed and more open**. Utility GIS is a very closed environment. Security is a real concern. The grid, as it becomes more automated, will be subject to electronic as well as physical attacks. At the same time, future grid operations will require access to outside data sources such as weather feeds and smart devices.

This paper would examine these design issues, illustrating how current geospatial technology – particularly field automation systems - will have to adapt to meet the growing complexity of the smart grid. The paper offers design guidelines for building robust mobile applications.