Advancing the Spatially Enabled Smart Campus

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The term Smart X has been very popular recently, as in Smart City, Smart Bay, and now Smart Campus. All convey a similar meaning, but there are aspects of Smart Campus that give it special significance. In what follows I try to separate the generic from the specific. I also try to emphasize the questions and issues that arise when emphasis is placed on the geospatial: geospatial data, geospatial databases, and geospatial functionality.

We assume first that X fully exploits information technology. At some point in the future, when Smart Campus is fully implemented, mobile devices and sensors will be ubiquitous, and all will be connected through the Internet. Base mapping will be available, sourced perhaps from remote sensing or crowdsourcing, to resolutions and positional accuracies better than 1m. Base mapping will also be three-dimensional, such that 3D representations will be available of both the exterior and interior of all built structures and underground spaces. All individuals and vehicles will be constantly geolocated, through GPS, RFID, or other technologies, such that positions will be accurately known at all times, to better than 1m. X will also fully exploit the potential of the Internet of Things: significant features will exist as URLs, tagged with QR codes, and their attributes will be available for query. These assumptions are of course well beyond current reality, but well within our current vision of a spatially enabled society, and well within the capabilities of current technology.

One of the arguments behind this specialist meeting is that the university campus provides a unique laboratory with many advantages for exploring and evaluating the potential of Smart X. Substantial investments have already been made on most campuses in creating accurate representations of 3D built form, making university campuses among the spaces best equipped with base mapping. Some campuses have also undertaken extensive mapping of environmental features, such as trees and wetlands, in support of ecological restoration. Universities are also home to intelligent and highly motivated students, and GIS programs have long featured campus-based projects. Some universities have surveillance systems that can be used to gather spatio-temporal data on individual movements, and most campus faculty, students, and staff carry smart phones.

I believe it would be both wise and productive to follow a traditional sequence in our discussions. First, we need to identify the use cases of Smart Campus: what questions will people want to ask of Smart Campus? We need to bear in mind that our own abilities as a group to envision such uses are limited: that ultimately it will be the university's students who are best able to think outside the box, and that we should be discussing how to encourage and enable them to do so, rather than prescribing uses on our own. Second, we need to identify the data types that will be needed to serve these uses. This will require the identification of a Smart
Campus ontology, and given our limited ability to imagine a full set of uses it will be important that the ontology be extensible. Third, we need to identify the functionality that will be needed, and delivered perhaps as device-independent apps, many of them created as projects by students.

Within this framework, what do we not yet know how to do, and what other researchable issues arise? The following bullets provide my tentative thoughts in this direction:

- We do not yet know how to represent the interiors of built structures. There are many options, and they depend on use cases. BIM representations exist for many comparatively new buildings, but not older buildings. Applications such as evacuation or infrastructure maintenance have very different ontological requirements. Each ontology has its own issues with respect to data acquisition and maintenance.
- We do not yet know how to capture real-time position within built structures. There are several competing technologies, each with their own advantages and disadvantages in specific use cases.
- Real-time tracking of positions raises concerns about privacy. We will need to know how privacy concerns can be balanced against successful applications in each use case. The campus environment has longstanding traditions of information access, for example to individual grades, that will need to be taken into account.
- Besides practical applications, Smart Campus offers significant potential for social science, in terms both of discoveries made from observations of student behavior, to methods and techniques that can be tested on campus and then applied more generally. The latter include Big Data analytics, since the campus and its rich data can act as a convenient testbed for new tools.
- Many issues of concern to faculty, staff, and students are not confined to the limits of the campus, but also extend to the surrounding territory. Commuting and longer-distance travel, off-campus recreation, and off-campus housing are just some of the activities that may be aided by Smart Campus tools, if the geographic limits of the latter can be extended sufficiently. Similar requirements exist for Smart City. What are the associated requirements for data and functionality?
- We do not yet know how Smart Campus will scale. Will it be necessary to implement spatial divide-and-conquer, in order to achieve satisfactory scalability? Will peer-to-peer applications be feasible, or will all use cases have to be resolved centrally?