A Grass-Roots Approach to GIS Development in Bermuda

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Abstract

Since first establishing a GIS committee in 1990, the Bermuda Government has made considerable investment and progress in the deployment of GIS services to Government agencies, private sector and the general public. In contrast to other small countries that typically employ a central land information office, Bermuda has, from the beginning, developed GIS through the coordinated efforts of multiple government agencies. The management principles of this decentralized organizational approach have influenced the development of Bermuda's GIS infrastructure and implementations. GIS managers from jurisdictions in which central control of data and professional territoriality are major problems will find the Bermuda GIS Committee to be a refreshing change. This paper will focus on the grass roots organizational model for GIS in Bermuda and highlight some of its success stories, lessons learned and current intentions towards societal GIS in Bermuda.

Introduction

Enterprise development of GIS resources is a complex process and can occur in many forms. Consider a spectrum ranging between centralized and decentralized organizational models. In one model, a centralized office develops geospatial data, applications and services for the organization. The skills of data collection, database development and software usage are considered highly specialized and clustered within one team. This theoretically achieves economies of scale, but can also place too much control in one department within the organization. In another model, federated nodes of GIS resources and expertise are developed near core functional units in response to the sophistication of the needs of such units. This is more applicable in large organizations where there is a greater scale of geospatial activities in departments within the enterprise. In yet another model, further along this spectrum, GIS resources are dispersed and developed by the business units themselves in a grass roots manner. Unfortunately, this can sometimes lead to splintered initiatives and duplicated efforts. Wherever there is more than one centre of GIS development, the coordination of activities becomes a primary concern.

The experience of the Bermuda Government's Geospatial Information Committee (GIC) has tended toward the decentralized end of this spectrum. For the past fifteen years, user departments have contributed to the gradual development of geospatial data, software and skills. However, the Bermuda GIC has also successfully maintained a high level of coordination between its constituent departments. Decision-making for progressing GIS developments within the Government is conducted in an open and participatory environment, and while this approach has not been without its obstacles, it has over time

produced a cohesive and collaborative group dynamic that allows a superior governance of GIS technology development and reduces risk in technology implementations.

This paper relates the experiences of the GIC in GIS development in this organizational context over the past several years. First, the context of the Bermuda Government's IT environment and a brief history of the GIC are presented. We then describe the grass roots philosophy of Bermuda's GIC, including the gradual achievement of an egalitarian committee, the unique role of the IT Office on the GIC, the rejected concepts of a steering committee and a 'GIS champion', and a guiding principle for extending the reach of the GIC to new members. We then discuss how abiding by this organizational model impacts the GIC's technology implementations in practice. Finally, we conclude with a summary and observations on the benefits of Bermuda's grass roots approach to GIS development.

Background

Bermuda is an island community with an area of 13,000 acres and a population of 62,000 people. The economy is strong and based on international business and tourism. As of 2002, Bermuda's internet penetration rate was 67% for individuals and 93% for businesses. The Government of Bermuda employs approximately 4,000 civil servants. The governance of information technology (IT) within the civil service is currently managed through an interdisciplinary IT Secretariat that makes decisions on policies, funding, an annual IT plan and ongoing review of major projects. The Information Technology Office (ITO) provides services to Government departments in project management, training, and facilitating the development and maintenance of corporate and departmental computer systems. Information technology is well proliferated within the civil service, having over 150 servers and 1,500 workstations deployed.

In 1990, an IT strategy for the Bermuda Government followed a team-based approach to developing IT direction in key business areas and resulted in several cross-department strategic area groups based on the provision of similar services. Examples of strategic areas developed in the strategy included Financial Services, Criminal Justice, Human Services, and Land and Property. The Land and Property Working Group (LPWG) developed Bermuda's GIS initiative. Its mission was:

> "To establish the direction and means which will allow Government to efficiently capture, maintain, analyze, and display all forms of geographically referenced information pertaining to Bermuda for the management and planning of land, property, and other related resources".

The work of the LPWG was seen as a development opportunity in line with emerging GIS technology. The key drivers of the GIS project were individuals from various departments with a specific interest in the technology and a vision of how it could benefit Bermuda.

Soon after its creation, the LPWG set about initiating pilot projects to prove GIS worthy of future investment. This was comprised primarily of the digitization of sample base maps. By 1994, the group's efforts had amassed hardware, software and a demonstrative sample of geospatial data for one part of the island. At this point, with senior managers convinced of the value of GIS technology, the LPWG entered the next phase of development which was the formal creation of digital map layers for the entire island from existing 1:2500 topographic map sheets. This development was contracted out to an external vendor, but was subject to considerably quality control by the LPWG members, especially Works and Engineering land surveyors. In 1998, the topographic map data

were complete and available for use and the development of applications to use the data promptly followed. Between 1998 and 2003, the departments of Planning, Works and Engineering and Environmental Health each developed and launched central business applications that utilized GIS data. At the same time, skills were developed in off-the-shelf GIS and CAD software and new data layers were being developed by individual departments. Such layers included ortho-photography, addresses, planning zones, vegetation surveys, habitats, and valuation zones among others.

A number of Government departments were originally involved in the LPWG, including Land Valuation, the Registry General, Works and Engineering, Planning, and the Data Processing Unit (later Computer Systems and Services, and now the Information Technology Office). In 1999, the LPWG changed its name to the Geospatial Information Committee (GIC). The LPWG/GIC membership remained steady for several years, but it has more recently reached a tipping point where new member departments have sought involvement, driven by their own business needs.

In the early days of the group, some of the priorities identified were the establishment of a full-time project management resource and the need for private sector involvement in the development of GIS initiatives. While both of these issues subsequently decreased in perceived importance, another recommendation, for a *grass roots and team-based approach to GIS development*, did not. This practice has been consistently pursued to this day, though not without some difficulty. The grass roots, team management approach that the GIC has practiced collectively over the years is, we believe, a key element of the success in GIS development which has been achieved thus far.

In the sections below, we present some key observations and learning experiences on how this management principle has, over the years, affected the dynamics of the group and GIS development in general with regard to project management, ownership, financing, technology implementations and external relationships. We believe these will be pertinent to other small nations or communities that operate in a similar organizational environment and scale, but may be struggling with forces of centralization, territoriality, or uncooperativeness.

A balanced membership

It is sometimes assumed that Government is a single organization and therefore should be able to maintain a coordinated approach to technology. In fact, departments are separated not only by their location in separate ministries but by differing cultures which are driven by differing professional standards and approaches. Departmental cultures create different views of and practices in technology deployment, project management and information management. If the leadership of an inter-government initiative skews towards a single department, that department's culture can drive the direction of a project to the exclusion of the other players and can result in reduced benefits for the organization as a whole.

Over the years, the GIC has developed a practice of balancing roles and responsibilities. This was partly by necessity, as the initiative had always lacked a dedicated GIS resource person. The progress of the group depended upon the collective participation of all its members, since no single department was in a position to act unilaterally on its own. However, at a time when the GIC had limited experience in GIS deployment, the impact of a single member promoting a particular departmental view could be high. The creation of the base topographic map data was a major milestone for Bermuda's GIS development, but also created some challenges to maintaining a grass roots approach.

The Government's Works and Engineering department was primarily responsible for the provision of the base topographic map data (TMD) since hard copy map production has always been part of its legislated mandate. From 1994-1998, the department worked with a vendor to digitize the existing 1:2500 topographic maps and conducted a rigorous quality control exercise on the data delivered. The TMD was obviously a critical component of the GIS data infrastructure upon which the future development of applications depended. While other departments provided input to the exercise this was the only period in the GIC's history in which a single department had a predominating role. This created issues around the design and the control of the resulting datasets.

Many GIS project managers will be familiar with two differing perspectives of GIS, one as digital mapping and the other as a spatially enabled database. The former emphasizes the ability to use digital data to reproduce hard copy maps, while the latter values the use of GIS data to visualize other functional data sets in a geospatial form. The former perspective is typically espoused by engineers' approaches to GIS (originating in a background in computer-aided drawing software), while the latter originates in data-oriented departments such as planning, conservation, and statistics.

The 'mapping versus database' discord was actualized in the Bermuda GIC at a time when the engineering department was most influential. The result was the topographic map data was designed and structured primarily from a 'mapping' perspective. As an example a large number of numeric feature codes were instituted to represent every line representation found on the paper maps. This 'mapping' perspective created concern among the other departments as they were developing their own specific application requirements which were more focused around a 'data' driven model. This created some difficulties in using the data but over time the issue resolved itself as departments incorporating the data in their respective systems have influenced how the topographic map data is presented and used. Consequently, the various numeric feature codes are now aggregated into more meaningful thematic layers.

The second issue was around the control and release of the final data product. Works and Engineering as a practice charged out their services to other Government departments, in addition they had invested significant resources in the production and quality control of the Topographic Map Data. It was proposed and agreed by the GIC that private organizations should be charged to use the data, but a conflict arose over internal use by Government departments. Works and Engineering were proposing a nominal charge to departments and a required business case to be accepted before any data was issued. This was to recognize the considerable investment in creating the data, to ensure that it was being used to address viable business related problems, and to minimize the potential data support issues on Works and Engineering. The proposal however caused consternation among the other GIC members, especially as many had contributed to the development of the data product and the ITO had funded the project. Additionally, the lack of active senior level involvement in this grass roots group meant that it was difficult to secure a decision on the issue. This situation was eventually resolved with an executive decision by an ad hoc steering committee (discussed further in a subsequent section).

The predominance of a single department in the GIC during this period caused some disruption to its collaborative environment. Once this 1998 episode was put behind us, the group dynamic returned very quickly to the GIC and geospatial data is now freely exchanged between all GIC member departments. The prevailing perspective from the GIC is that Works and Engineering have a mandate and the surveying expertise to produce geospatial data, but policy surrounding such data is generated through the GIC. The committee members, individually and as a whole, are a more mature group now with

a developed and shared knowledge of GIS and have progressed in the core philosophy of democratizing geospatial data and technology.

The midwife

> "Imagine that you are a midwife; you are assisting at someone else's birth. Do good without show or fuss. Facilitate what is happening rather than what you think ought to be happening. If you must take the lead, lead so that the mother is helped, yet still free and in charge. When the baby is born, the mother will rightly say, 'We did it ourselves!'".
>
> <div align="right">(John Heider's The Tao of Leadership)</div>

In the GIC, we have found good reasons to single out a particular department with special roles: the Information Technology Office (ITO). The ITO is unique on the committee because it is not a user of GIS technology. Its general role is to service the information technology needs of other Government departments. Since the inception of the LPWG, its aim has been, not to control GIS development in Government, but to ensure that it is led by the user departments with the business needs and technical knowledge. The chairmanship of the GIC has remained with ITO since 1999, and we believe this has created a comfortable safety mechanism for the committee which counterbalances any potential power issues. In addition, the ITO carries influence because it has always funded the GIC and been ultimately responsible for its financial management.

While the ITO membership on the GIC serves in varying capacities as a catalyst, facilitator, mediator, and financial controller, the most appropriate analogy in our opinion is that of a midwife. In nursing, midwives adopt a general philosophy of non-intervention, and a sympathetic respect for patients' personal and cultural differences, self-determination, and active participation in their health and well-being. In the context of the GIC membership, the ITO chair intentionally limits his role to facilitating GIS development as directed by the GIC members collectively, and ensuring that no individual department is obstructed from directing their own GIS developments in a manner most suitable to their business needs. This respects the professional differences between Government departments, and results in the use of open technology standards and a motivation-based adoption of GIS technology (discussed in later sections). With its roots in serving the technology needs of all Government departments, the GIC's ITO midwife has a vested interest in ensuring that any interested member can actively participate in the general direction of GIS development.

It is somewhat ironic that the chair of the GIC does not use GIS data or software, and there is a potential risk of being too far removed from the technological content of the GIC meetings. Inevitably, the ITO member needs to keep abreast of geospatial technology developments in order to effectively keep up with technical discussion of the other GIC members. This knowledge is acquired through discussion with GIC members and vendors and attending conferences. However, the ITO member does bring specific knowledge to the GIC pertaining to IT governance and project management in general. This expertise is applied to the GIS initiatives and ensures their success in the context of other Bermuda Government IT projects. This knowledge is paired with direct contacts with those responsible for Government's IT infrastructure, which can be leveraged to improve the committee's geospatial IT environment.

Senior oversight

Until 1998, the GIC, with its egalitarian approach to GIS development, had progressed well in dealing with mainly technical matters. However, the issue of whether or not to charge internally for geospatial data had led the GIC into a heated policy debate. At loggerheads over this issue, the members decided to re-formulate the existing committee as a technical committee (GITC) and nominate senior level managers for a steering committee (GISC). The mandate of the GITC was to advance and coordinate GIS-related projects, while the GISC would make policy decisions surrounding the technical developments.

The GISC met, deliberated, and came to the conclusion that it was not necessary to charge internally for the data. That was the first and last meeting of the steering committee. The GIC returned to its former grass roots practice of addressing issues through collaboration and consultation among the key players. In the last seven years, there has not been any further suggestion that a steering committee should be reformed.

Following the data charging incident, the GIC members now jointly recognize that most, if not all, issues can be resolved within the committee without the use of a senior level decision. Of course, it is still possible that another contentious and divisive policy issue could trigger the need for external decision-making. However, given the lack of any sustainable agenda for the last steering committee, future policy issues will likely be decided by an ad hoc, rather than institutionalized, appeals body.

In addition to the short-lived steering committee concept, there was one other senior-level entity that had been considered essential for several years. It was often considered that the GIC needed a 'GIS champion' to trumpet the cause of GIS development in Government to senior civil servants, the Cabinet and perhaps the public at large. This person would be cognizant of the business and societal value of geospatial data and technology, senior enough to influence senior level managers elsewhere, and aid in securing further resources for GIS initiatives. This hypothetical person took several forms over the years, from a senior ITO manager, to a Ministry of Finance official, to a GIS Computer Services Officer who would perform the marketing tasks along with technical support. Nevertheless, a compelling need for this person has not arisen. It seems that the GIC, using its grass roots approach, has been able to champion its own goals and gain support through demonstrated successes, persistence, and experiential knowledge.

Thus far, we have discussed the existing egalitarian membership dynamic, the 'midwife' role of the ITO, and the abandoned concepts of a steering body and GIS champion. We now turn to the introduction of new members to the GIC.

New membership – the Prime Directive

We (the authors) often reiterate that the deployment of technology is highly dependent upon the business and management issues of a department. A number of established functions in the Bermuda Government have remained manual and unchanged despite the availability of IT solutions that can create greater efficiencies and increased service levels. However, if a department is not ready and motivated to change their business processes then successful technology deployment is not likely.

This poses a challenge to groups like the GIC that would like to see geospatial technology deployed further in the enterprise setting. The temptation is to create a GIS marketing campaign and attempt to inject the technology in places that the committee deems most appropriate. We have in the past encouraged departments with a potential

need for GIS technology to join in the work of the GIC. However, this has not resulted, in every case, in an ongoing interest or commitment to deploy the technology. A case in point is the 2000 Bermuda Census. In the preparations by the Statistics Department leading up to the census, it seemed obvious to the GIC that the data collected should be geo-referenced in order to facilitate the production of map-based census reports. A member of the census team was asked to join the GIC and report on the ongoing efforts of the census exercise, which they did. However, the Statistics Department never incorporated GIS technology into the census project. As a result, the committee has become cautious about involving others unless there is clear evidence within the department of a driver prepared to manage the project. The successful adoption of GIS technology must be motivated from the site of the implementation.

Incidents such as these have over time established the GIC's "Prime Directive" approach to facilitating technology in the organization.

> "As the right of each sentient species to live in accordance with its normal cultural evolution is considered sacred, no Star Fleet personnel may interfere with the healthy development of alien life and culture. Such interference includes the introduction of superior knowledge, strength, or technology…"
>
> (from Star Fleet's Prime Directive, Star Trek)

Star Fleet's Prime Directive recognizes the potential chaos that can be created through deploying technology in an area that has not recognized the need for change. The GIC adapts this to GIS development in the Bermuda Government. We recognize that there is an inner circle of active GIS-enabled or GIS-interested departments, and an outer circle with potential interest for GIS. Interactions with this outer circle are intentionally limited. GIS is not pushed onto departments that (i) have not acknowledged that they have a business problem; (ii) are not actively seeking technology solutions; and (iii) are not practicably ready to effect changes in their business environment.

There are two implications of this Prime Directive policy for new GIC membership. The first relates to GIS project success rates. Geospatial technology is only adopted by a motivated participant looking to effect change. Usually, potential members have a business problem to solve and they know that they want to build geospatial capabilities within their technology infrastructure, but they need guidance on how to achieve it. By limiting new engagements to individuals who are motivated to participate, we greatly increase the chance of successful technology deployments. In fact, while we have experienced the normal challenges of deploying projects, there is no GIS deployment in the Bermuda Government that we would consider a failure.

The second implication of the Prime Directive pertains to resource management. Each time a new member is introduced to the committee, they not only bring a business problem but also a new resource. The GIC has become an advisory group focusing on the sharing of collective GIS expertise and knowledge, with some resource support provided as is practical. Therefore, each new participant is expected to become conversant in GIS and resolve their own department's problem. To date, this has been successful with the GIC expanding its user core of Planning, Engineering, and Health, to include Archaeology, Conservation, Parks, and Police. In addition, the GIC gains another resource who can participate in shared GIS issues and projects. Consequently, the GIC's demand for project work does not generally outgrow its human resource capacity. It is worth noting also that the ill-fated 'GIS Champion' concept, with a focus

on campaigning on behalf of the GIC, contravenes the current philosophy of the Prime Directive.

Private sector involvement in the GIC, or some broader geospatial forum at a national level, has been an ongoing topic of discussion. Where the committee might expand its reach, we can still lean on the Prime Directive in that only private sector interests that are investing in their own GIS development will be engaged. For example, one of the new active members represents the Bermuda National Trust, a local charitable group. However, extending the GIC to the private sector changes part of the group's dynamic. The openness in communication that the GIC currently enjoys would not necessarily hold in all discussions between Government and the private sector, between competing private sector interests, and between Government and its regulated industries.

There has, until recently, been a lack of a local GIS vendor/developer market. There has been a dependency on overseas companies for GIS development which made regular dialogue difficult. The GIC now includes two local vendors, a GIS consultancy formed by one of the authors and a multimedia company that uses an online mapping product. The GIC now finds itself extending gently beyond the boundaries of the Government into a national arena. It will be a testing ground to see whether the GIC should become a truly national organization, or whether it should remain within Government allowing for an additional broader body to be initiated.

In many countries, a national approach has been initiated from the beginning. In Bermuda, our expansion of GIS has been a gradual but deliberate process developing from an internal view, and expanding in response to emerging problems and our own increasing skills to address larger and more complex issues. This 'managed growth' perspective ensures that the technology has retained its appropriate position relative to the needs and demands of Bermudian society.

Implementation in a grass roots environment

The grass roots organizational philosophy discussed above becomes evident in the geospatial technology implementations of the GIC. Adhering to this philosophy mandates certain requirements on our practices during deployments.

The approach of the GIC as a GIS enabler, rather than a GIS service provider, influences the geospatial technology architecture of the Bermuda Government in a few different ways. First, because we actively encourage new members to develop their own GIS knowledge and skills, they are empowered to create and manage their own geospatial data. The effect of this on the enterprise is that there are pockets of GIS activity distributed around the Government (although coordinated at the GIC). GIS is encouraged as a pervasive technology that departments can adopt for themselves, not as a mainframe-like monolith that is centrally controlled.

The second implication of the GIC's philosophy for system implementations is that we encourage the use of the most appropriate technology for the task at hand, rather than a single standardized technology that must be adhered to by all departments. This has meant that we sometimes incur greater license fees and purchase solutions that overlap in their functionality, such as ESRI and Autodesk mapping solutions. However, these costs are negligible compared to the benefit of greater flexibility for deploying GIS solutions. While this practice may not be completely cost efficient, it does ensure that users are comfortable with their technology and implementations are more successful. It also ensures that a technology developer with knowledge in a particular business sector is permitted the flexibility to build their solution with a GIS technology familiar to them.

Allowing a diversity of user-appropriate systems at the front-end can create a concern for communication between systems. To address this issue, the GIC (i) provides an open forum for discussion of solutions in the design phase of a project; (ii) provides a central budget to deploy core, shared server infrastructure and (iii) looks to open technology standards at the server level of the enterprise architecture. For example, the GIC chose to implement base topographic map and address data as Oracle Spatial layers to serve the diverse and evolving data needs in the Bermuda Government. The utilization of open technology in this way is the third implication of the grass roots approach for technology deployments.

The final observation regards the Government's relationships with its external application developers. Vendors are involved in a high trust relationship with the GIC member departments, and often act as educational resources. In order for a vendor to participate effectively in this environment, certain criteria are desirable. Vendors must be flexible to approaching a solution in a manner that is appropriate to each department, rather than applying a boilerplate solution. This can become especially challenging when the client is an interdisciplinary group of several departments, such as the GIC. Furthermore, pursuing projects in a decentralized but coordinated manner has resulted in the GIC requiring some vendors to develop a joint solution that integrates their existing systems. Responsive, service-oriented vendors can excel here, and we have been fortunate to have had two recent experiences of this.

Conclusion

In this paper, we have explored several avenues related to grass roots GIS development in Bermuda. We first described the Bermuda Government's Geospatial Information Committee, its history and grass roots philosophy towards advancing GIS technology in the public sector. The importance of equal opportunity for member departments was stressed. We discussed the unique role of the ITO as a 'midwife' on the GIC, and the aborted attempts at oversight bodies/persons. The Prime Directive philosophy was presented in demonstrating how the GIC treats the spread of GIS potential to new Government departments and the private sector. Finally, we illustrated the effects of the grass roots approach on project implementations according to our experiences.

Several benefits of the grass roots approach have been identified. There is equal influence among participants which increases the likelihood of genuine buy-in and collaboration between departments. It also increases the likelihood of information sharing, coordination of data and, consequently, the efficient utilization of resources. We also contend that because of the high level of collaboration, there is a low incidence of project failures. By adopting the Prime Directive, the technology solutions are business-driven, user-appropriate and adequately resourced. In our experience, this approach has encouraged a proliferation of GIS technology through the organization. Perhaps some of our larger projects might have been achieved more quickly had they been centralized in a dedicated GIS/LIS office. However, we believe that they would have incurred a higher risk of failure in terms of user acceptance. The Bermuda Government's gradual but deliberate expansion of GIS has allowed well thought out and adaptive responses to emerging problems. More importantly, such responses are also supported by the GIC members who are more amenable to coordinating their projects with each other.

Bermuda's official motto is "Quo Fata Ferunt" which translated means "to where the fates would lead us". It underlines that fate or chance can be transformed into opportunity. There is an earlier motto for Bermuda which was actually used by the Somers Isles Company set up to develop the island and its economy: "We would have

perished had we not persevered". This quote would be preferred by the GIS committee as it represents the slow but sustained efforts of the GIS initiative in Bermuda to extend the use of this technology to government and the larger society.

Acknowledgments

About the Authors

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