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Brian O'Flaherty  
*University College Cork, Ireland*

Eoin Hayes

Gaye Kiely

Darius Bartlett

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# **The Dynamics of a Spatial Data Infrastructure – A National Case Study**

Brian O'Flaherty, Business Information Systems, University College Cork, Ireland.

Eoin Hayes, Business Information Systems, University College Cork, Ireland

Gaye Kiely, Business Information Systems, University College Cork, Ireland

Darius Bartlett, Geography Department, University College Cork, Ireland

## **Abstract**

It widely cited that 80% of government data is spatial in nature and the accessibility of this data is a critical aspect of E-government. Many countries are developing standardised infrastructures, which will allow sharing and reuse of spatial data. This paper presents the findings of a national level case study of the Spatial Data Infrastructure implementation in Ireland. The study draws on concepts from Corporate Information Infrastructure (CII), most notably the power of the installed base, role of standardisation, multiple actors and top-down versus bottom-up tensions. A significant outcome of this paper is the application of the CII concepts to a national level case study.

**Keywords:** Spatial Data Infrastructure, Deployment, Local Government & Corporate Information Infrastructure

## **1 INTRODUCTION**

E-Government faces many challenges today. In particular, due to the high usage and importance of spatial data in economic and government decision-making, there is a particular need to facilitate creation of spatial data infrastructures (SDI), as a core activity within this broader strategy. To date most SDI activities have taken place at the national to international level, and the potential of implementing SDI at more local scales of government has remained relatively unexplored, even though studies suggest that local government may be responsible for up to a quarter of all national expenditure on geographical information activities (Salgé, 1998). The research described in this paper aims to address this gap. Because of the developing nature of the SDI concept, establishing a comparative framework for this study has proved to be challenging. The definitional components of an SDI provide a static perspective and fail to address the dynamic emerging socio-technical nature of an SDI. This paper draws on the Corporate Information Infrastructure literature (Ciborra 2000) for inspiration in overcoming some of these hurdles. By applying Corporate Information Infrastructure concepts to emerging national SDIs, a case description of the Irish SDI deployment in local government is presented.

## **2 LITERATURE**

### **2.1 e-Government**

Challenges to developing a fully-fledged e-Government include lack of universal access to electronic media, such as the Internet, by the general public (Layne and Lee 2001, Lee-Kelley and James 2003, Li 2003), a barrier that is often called the digital or information divide (Bertot 2003, Theunissen 2001). The European Union (EU) has tried to solve this disparity in access by a process called “e-inclusion” (EU 2001), as have developing countries like South Africa and India, where various initiatives seek to promote access to these technologies via schools, information kiosks etc. (Theunissen 2001).

The need to build a country's telecommunication infrastructure should be seen as an essential prerequisite before any subsequent development of an e-Government framework can take place (Sharma and Gupta, 2003). This may be summarised as an "I before E" strategy that prioritises infrastructure building over anything else (Schware and Deane 2003). While in some cases it may pose a barrier to progress, but it is equally likely to allow developing countries to by-pass early phases in information and communications technology (ICT) adoption, and thus fast-track to more contemporary or future-facing policies without the need to convert existing "legacy" systems first.

## **2.2 Spatial data infrastructures**

There is no economic activity, which completely excludes geographic information (Salgé, 1998) and it has been often quoted that as much as eighty percent of all local government decisions are of a spatial nature (FGDC, 1996). Moving from geographic information itself, to the broader context, Remkes (2000) emphasised the importance of spatial data to Europe's Information Society by stating that "[to] realise the promise of the Information Society to benefit mankind ... requires an information infrastructure, which includes Geospatial Data Infrastructures" (Remkes 2000). Therefore it seems that of the many challenges for e-Government development include development of a spatial data infrastructure capacity, especially at the local government level.

The term Spatial Data Infrastructure (SDI) is now in widespread use around the world, and refers to "the matrix of technologies, policies and institutional arrangements that will facilitate the availability of, and access to, spatial data for all levels of government, the commercial sector, the non-profit sector, academia and citizens in general." (GSDI, 2000; see also Onsrud, 1998).

A growing number of initiatives have been launched to develop SDI policies and implementations at scales ranging from the global (GSDI 2000, 2001, 2004), through Regional (e.g. Infrastructure for Spatial Information in Europe Initiative (INSPIRE, 2002)) to national levels (e.g. the Irish Spatial Data Infrastructure, see McCormack, 2003 and Matthews, 2004). However, the need for these multiple levels to be consistently integrated with one another (GSDI 2001), has so far been generally overlooked. This is regrettable, since it has been observed that the establishment of SDIs is most likely to succeed when they engage multiple levels, from the local, through regional and national, to perhaps even the international or global (Craglia et al. 2003).

In recent years, the bulk of SDI development effort has focused on technical issues of hardware and software interoperability, metadata standards, and creation of data warehouses and clearing houses (usually web-enabled). However, SDI development is also a socio-technical task (Rajabifard and Williamson 2003), and data policy and related considerations have increasingly come to the fore as issues requiring to be addressed (van Loenen and Kok, 2004). Concepts drawn from the corporate information infrastructure domain may assist in better understanding these human issues, and the role they may play in the growth of SDI. In this paper, the focus is on outlining this theoretical base, which underpins the case description of the Irish SDI deployment.

## **2.3 Information infrastructures**

Approaches to understanding and defining the concept of information infrastructures include a managerial approach (Weill and Broadbent 1998), an "organic" approach (Star and Ruhleder 1996) and a public policy approach (Gore 1994, Bangemann 1994). Managerial definitions however do not take into account the interdependence of individual elements, or the size and complexity of infrastructures (Hanseth 2004). Star and Ruhleder (1996) take an organic approach, viewing infrastructure as being a more open-ended and unbounded system. They support this view, by pointing out that an infrastructure is built upon an installed base. "It does not grow *de novo*; it wrestles with the 'inertia of the installed base' and inherits strengths and weaknesses from that base" (Star and Ruhleder 1996: 113)

This organic approach was adopted by several authors including Ciborra (2000), Hanseth (2000, 2004), Hanseth & Monteiro (2004) and Rolland (2000), as a basis to further understand the infrastructure concept. Hanseth (2004), for example, defined an information infrastructure to be "a

shared, evolving, open, standardized, and heterogeneous installed base". An infrastructure that is enabling will thus allow for new applications and elements to be added, by providing the necessary architecture and platforms for expansion (Ciborra 2000).

The strategic top-down approach to infrastructure design only succeeds when its main elements can be controlled and planned. However, a bottom-up approach may become advisable as the infrastructure becomes more complex (Ciborra 2000).

Hanseth and Lundberg (1999) stated that classic infrastructures, which provides a general service to the public, should be designed by engineers in a top-down manner; but more complex, "work-oriented" infrastructures need users who have intrinsic knowledge of the needs of the infrastructure itself, and who therefore should have input to the infrastructure design and implementation. Due to the heavy influence of many elements of an infrastructure, including the "installed base" as discussed here, on the shape and workings of the final end product, there is a need to look towards new methods of infrastructure design (Hanseth and Monteiro 2004) to permit this dual top-down and bottom-up approach.

Ciborra (1996) introduced the concept of 'improvisation' to understand the adoption of information technology in an organisation. Emergent change in an organisation can also be seen as several small changes, which in turn leads to a large change that was not originally the intended overall outcome at all (Hanseth and Monteiro 2004). However, the concept of 'drift' implies that the technology has quite an amount of control over human actors (Hanseth and Monteiro 2004). The notion of technology having complete control over its own use is known as technological determinism. It is the opposite of design and engineering and implies the technology is the only actor determining or designing its own use (Hanseth and Monteiro 2004). Cultivation tries to obtain a middle ground of sorts between design and improvisation on one end and drifting and determinism on the other end of the scale (Hanseth and Monteiro 2004).

There is a great need to strike a balance between global universal solutions and local bottom-level needs (Rolland and Monteiro 2000, Star and Ruhleder 1996). Star and Ruhleder argue that the key question with regard to an infrastructure is not what it is but rather when it is.

*"An infrastructure occurs when the tension between the global and the local is resolved"*  
(Star and Ruhleder 1996: 114).

The interaction between different infrastructural levels is of particular importance in a spatial context since, as previously discussed; an SDI needs to integrate all levels from local to national, regional and even global for it to be most effective and successful (Annoni et al. 2002, Craglia et al. 2003). Within this SDI context, concepts of "scale" and "level" have both vertical (organisational) and horizontal (geographical) significance, and the harmonisation of each of these presents separate but fascinating and interlinking challenges. Effective methodologies for overcoming these hurdles need to be found, and literature such as Star and Ruhleder's (1996) may offer pointers to better understanding the interaction and issues present between different hierarchies of an SDI. This in turn may aid the consistent integration of all SDI levels.

### **3 RESEARCH METHODOLOGY**

This study is qualitative in nature and uses a countrywide case study (Trauth, 2001, Yin, 1994)) of local government in Ireland. Sampling of local authority sites was done purposefully with a strategy known as maximum variation in order to obtain a diverse range of data (Patton, 2000). Semi-structured interviews, elite interviews and document analysis were the various methods used to collect data. Data was collected from 13 interviewees in six local authorities and 3 representatives of the central governments SDI initiative. The role of the interviewees ranged from GIS coordinators, GIS officers, planner and members of the NSDI taskforce. In order for the researcher to analyse the collected data a conceptual model was developed (Hayes et al. 2004) and used as a data reduction technique to break the data down into meaningful parts. Furthermore, qualitative analysis software was used to display the data in various networks.

The analytical framework used for this study is adapted from Ciborra's (2000:4) model for dynamics of infrastructure and explores the issues between local and national levels in light of the emerging Irish SDI development. We believe it could equally be well adapted to the analysis of SDIs elsewhere. The framework emphasises the data-centric push from national level and also examines both national and local levels and tries to identify the main issues emerging as the SDI develops. The framework examines issues between both levels at implementation point, and then possible compromises and tactics necessary to resolve these issues and achieve successful bottom-up alignment of local government with the national SDI. It also examines any feedback from local level that may be necessary for any 'workarounds' in national SDI strategy and policy.

From examining the corporate information infrastructure literature it is obvious that top-down infrastructure design fails as the infrastructure grows, contains more and more elements, and basically becomes much more complex. The literature emphasises the power of the 'installed base' and how this element cannot be ignored. The infrastructure is never built from scratch but is constantly adding to this existing base. There is also a great need to strike a balance between local and global tensions. When these issues between the two interacting levels are resolved perhaps then an infrastructure is in place i.e. 'when the tensions between the local and the global are resolved' (Star and Ruhleder: 114). These concepts of the corporate information infrastructure field can be applied to the Irish SDI (ISDI) context. These concepts were tested, and their utility evaluated in the context of emerging SDIs for local government in Ireland.

## **4 CASE DESCRIPTION**

### **4.1 Irish policy and Government Role in SDI Development**

In 2002, a Government Action Plan called "*New Connections*" was issued in order to develop the concept of e-government in the country through modernisation of the Irish public service, including the establishment of a national spatial data infrastructure. One of the main contributions of the Department of Environment, Heritage and Local Government (DoEHLG) to the NSDI has been the establishment of an Irish SDI (ISDI) Work Group, which provides specialist advice to government on SDI-related issues. The Group comprises of representatives from Ordnance Survey Ireland (OSi), Land Registry, Local Government Computer Services Board (LGCSB), Central Statistics Office (CSO), the Department of the Taoiseach and academics with knowledge in the field.

The Ordnance Survey Ireland (OSi) is Ireland's national mapping agency that supplies most spatial data to many sectors (e.g. government departments, construction, etc.). While the Local Government Computer Services Board (LGCSB) is a public authority that reports to the Department of Environment, Heritage and Local Government, whose primary function is to assist local authorities with all their ICT needs. The LGCSB however can only recommend solutions to local authorities due to their voluntary nature. The National Standards Authority of Ireland (NSAI) is involved in national standardisation and is also involved in regional and global standardisation.

### **4.2 Global Spatial Data Infrastructure**

The Global Spatial Data Infrastructure (GSDI) Association was incorporated in 2002 arising from a GSDI forum that was set up in 1996 to discuss global spatial data issues. The association issued a strategic development plan in January 2004, which outlined various purposes, visions and goals, including supporting the establishment and expansion of local, national and regional spatial data infrastructures that are globally compatible and provision of an organisation to foster international communication and collaborative efforts for advancing spatial data infrastructure innovations.

The Open Geospatial Consortium, Inc. (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services. The organisation works with government, private industry, and academia to create open, extensible software application programming interfaces for geographic information systems (GIS).

The ISO's technical committee 211 (ISO/TC 211) is in charge of standardisation in the field of digital geographic information. Other global level organisations such as the OGC and the GSDI Association are in regular liaison with the ISO technical committee. It intends to provide a framework for the development of sector-specific applications using geographic data.

#### **4.3 European Spatial Data Infrastructure**

European Umbrella Organisation for Geographic Information (EUROGI) has two main objectives. These are firstly to facilitate the development of a European Spatial Data Infrastructure. Secondly, it represents European interests in the Global Spatial Data Infrastructure as the organisation is a member of the GSDI association.

INSPIRE (Infrastructure for Spatial Information in Europe), is an initiative launched by the European Commission. It aims to make available relevant, harmonised and quality geographic information for the purpose of formulation, implementation, monitoring and evaluation of community policy-making. The initiative's main purpose is to accelerate the creation of a European spatial information infrastructure. The European Committee for Standardisation (CEN) has a group called technical committee 287 (CEN/TC 287) that is in charge of geographic information standardisation. Furthermore, the committee works closely with ISO/TC 211 to produce a methodology to aid in the transfer of geographic data. The National Standards Authority of Ireland (NSAI) is a member of CEN in order to represent Irish interests in European standardisation issues and agendas.

#### **4.4 Spatial data and technology vendors**

One member of the ISDI Working Group stated that feedback and suggestion was received from private vendors about the ISDI consultation document that was dispersed by the government. It was also discovered through document sources that the vendor ESRI sits on the board of directors of the GSDI actor OGC, and acts as a sponsor to the GSDI association.

#### **4.5 Irish interest group**

IRLOGI is the umbrella organisation for the geographical information industry in Ireland and its membership includes the DoEHLG, LGCSB, the ISDI Working Group, vendors, and academics in the field on its executive committee. One of its main objectives is to encourage the development and adoption of quality and reliability standards for geographic information (GI). IRLOGI is also a member of EUROGI - the European umbrella organisation for geographical information. The organisation contributes to the ISDI its appropriate standards and its executive members are also national government members involved directly with ISDI development.

#### **4.6 The 'installed base'**

Instances of the 'installed base' actor in the model were identified in three main groupings namely personnel, technology and data (all with a spatial or geographic aspect).

The role of GIS Officer existed in all local authorities and was the main role in both developing a GIS and an ISDI infrastructure at each individual local authority. Another role discovered was that of a GIS support officer but this was only evident in more advanced local authorities. The role of a GIS application developer does not formally exist in the installed base. The majority of GIS officers or coordinators have a geography background and therefore have limited systems expertise.

Spatial Data end-users range from personnel in engineering, planning, roads, water, and environment sections. Various technicians and engineers use GIS to utilise spatial data in their daily work tasks. These tasks include map updating and production, and spatial database analysis and utilisation via various application front ends. Furthermore management were also identified as end-users where GIS and spatial data were more widely distributed and available. These end-users view spatial data using a corporate wide GIS intranet application.

#### **4.7 Local Government technology**

Two distinct categories of spatial data technology were discovered. One is national government recommended software through the state body, the Local Government Computer Services Board (LGCSB). Private vendors were ESRI software, Electrical Supply Board Information (ESBI) Computing and Proteus Solutions. Authorities using the LGCSB suite of software had MapInfo as the desktop software and Geomedia, which facilitated organisation-wide access to GIS. One extensively used application was MapRoad, which is a large application containing road accident, network, and management modules.

Spatial data exists mostly in electronic format though there was evidence of non-electronic formats in the form of paper-based maps particularly in planning sections. The main source of local authority spatial data is the Ordnance Survey of Ireland (OSi). Some more proactive or larger authorities also used some private consultants to purchase data also.

#### **4.8 Installed Base**

Relationships between implementation of GIS at local level governments and the installed base are problematic. One main issue is uncustomisable software that is not end-user focused enough. Poor service is also a related issue. Furthermore, hosting of web GIS applications by the LGCSB is considered poor by some local authorities.

The installed base uses the Ordnance Survey of Ireland (OSi) for an extensive amount of spatial data. One of the main issues here was that of copyright of spatial data. The local authorities purchase spatial data from the OSi but due to licensing and copyright laws it is very difficult to publish this data on the web. In addition, local authorities are unhappy with the lack of consistency in formatting and quality. The service of the OSi was criticised in the context of the organisation's response to local authority queries or requests.

Resource funding issues was emerging between implementation and the installed base. The need for some sort of extra personnel to monitor the constant updating and standardising of spatial data as well as supplying metadata. They are unable to get this kind of resource from existing technical departments in the organisation. Personnel resources are also a major issue in the lesser-advanced local authorities like South Tipperary and Kerry.

Actors outside the original model relate to the installed base. Firstly, some local authorities contribute to regional initiatives by supplying spatial data to regional agencies. In one instance Tipperary County Council supply the South Eastern River Basin District Authority with county data on the river basin. Secondly, private sector consultant/vendors supply some local authorities with their installed base of spatial data and GIS.

#### **4.9 Angry orphans**

Engineers/technicians were identified as angry orphans who have resisted the Environmental Protection Agency's (EPA) metadata system. According to a manager in Laois County Council, this was due to the technicians not using metadata in their own work and therefore not benefiting from the entry of metadata into the system. This lack of perceived benefit has led to non-compliance (i.e. non-entry of metadata), making it difficult for end-users to receive metadata on datasets. Cork County Council felt that ISDI was more an issue for the vendors and private sector as opposed to the end-user local authority sector. Management resisting infrastructure implementation existed in some local authorities. Management claim that the end benefit they would gain from an ISDI would not outweigh effort and cost necessary for their authority to contribute to the infrastructure

Older generation of planners refused in some instances to use digital maps in their day to day work. They were used to paper based mapping all their lives and hence did not want to change to electronic versions leading to non-contribution to infrastructure implementation, and more specifically GIS.

#### **4.10 Implementation tactics**

The consultation document issued by the ISDI Working Group requested feedback from various sectors including the local government sector. One GIS officer proposed that these informal discussions an forum to discuss ISDI from a local government perspective whereby local authorities could discuss their needs and responsibilities and contribute to the infrastructure.

All local authorities put the reformation of the LGCSB forward. This included the use of more open systems in order to over come the current data lock-in that exists due to the proprietary nature of the installed base of GIS applications. Local authorities that used the LGCSB proposed modularisation. This tactic was proposed in order to overcome the lack of customisation present in existing applications. Finally the reformation tactic included a transformation of actual service as well as the end product. It was suggested that the national level take a supportive role so that different software could be chosen by the local authority as opposed to just having to use one suite of GIS software. This was proposed by local authorities using private vendors for software to let their installed base of non-compliant GIS software utilise the service of national bodies also. One respondent proposed improving the national government hosting service in order to make available GIS web applications on the Internet and intranet.

Internal standardisation of spatial data and work practices surrounding the data was evident in a number of the more advanced local authorities. This tactic was seen as a platform to create a national SDI because by standardising internally the local authority would have a culture appreciative of standards of all types in place before contributing to an ISDI. The tactic of standardisation adoption would overcome the lack of metadata supplied by the technicians and engineers.

Imposition of regulation was suggested by a number of the advanced local authorities as a tactic required for full implementation of the infrastructure. This was seen as necessary to force the less advanced local authorities to contribute. Smaller local authorities such felt that regulation was not the way to go and that perhaps a tangible benefit such as accreditation would encourage participation and ultimately implementation. *“If one local authority started getting accredited then the rest would want to also because you look bad if you are not”* stated a one GIS coordinator. The development of a centralised monitoring body was identified as another possible implementation. This implementation tactic was proposed in order to address the issue of resources required to monitor and check that all spatial data was of a certain standard and in adherence with an ISDI.

The building of more collaborative relationships between local authorities was identified as a tactic necessary in order to create an ISDI. This was proposed to overcome the uncollaborative and ‘island-like’ nature of local authorities up until very recently. One City Council believed that the standardisation responsibility should be solved by data providers and software vendors. This local authority used the private sector consultants and vendors frequently for GIS software and spatial data, and therefore standardisation arose as a necessary tactic.

#### **4.11 Compromises**

Compromises were identified in one County Council, as the older generations of planners always use paper maps and don’t see the need or benefit of GIS and electronic spatial data. The council are discussing introducing a planning register which will allow them to maintain a paper copy and an electronic copy. In order to ease older planners into GIS, the idea is to scan the paper-based copies onto a computer, in order to gradually customise them to GIS.

#### **4.12 New actors and relationships**

As discussed earlier, private consultants or private suppliers emerged as a new actor. The main instance of this private GIS software supplier to local authorities is ESRI-Ireland. Other instances of the private supplier/consultant actor include ESBI Computing and Proteus Solutions for GIS software applications and Gamma for spatial data.



Another new local actor discovered was that of a regional government body. A number of County Councils regularly interact with the South East (S-E) Regional Authority by providing them with spatial data on their side of the border in the river basin. This allows the regional authority to develop a river basin management system and strategy.

#### **4.13 Tensions between the local and the global Information Infrastructures**

This section initially focuses on the existence of strategic alignment in the information infrastructure. The section then moves onto the existence of complex standards, processes and technologies that are being pushed from the top-down through this alignment. Tensions existing between the two contextual level of the infrastructure are then documented i.e. tensions between the local authority level and the global context.

#### **4.14 Top-down strategic alignment**

The ‘New Connections’ plan states that a national SDI “is a strategic priority in the context of the overall development of the e-government process”. Furthermore, the action plan states in its progress report that its key focus with regard to an ISDI is to be the “integration of spatial data with all other information management processes across Government, consistent with the principles underpinning integrated delivery of services through the Public Services Broker”. In turn, the ISDI itself has its own objectives and strategies that involve issues of standardisation of spatial data itself with processes and technologies associated with the data.

#### **4.15 More complex standards, processes and IT**

In government documents include a catalogue for spatial data, metadata, georeferencing systems, data transfer using a form of Extensible Markup Language (XML) called Geography Markup Language (GML), software interoperability, semantic interoperability, and data quality standards. They are considered complex due to their relative new and novel nature. All these standards, processes and technologies of spatial data are being pushed by the strategic alignment of the New Connections Action Plan and the ISDI Working Group objective’s and publication on the web.

IT is also being pushed from the top-down in the form of a GIS strategy that is a part of the National Spatial Strategy (NSS). In this strategy, the LGCSB was nominated to manage all new GIS development and implementation in government. Figure 1 below shows instances and relationships between top-down strategic alignment and its push on the development of more complex standards, processes and IT for spatial data use.

Tensions exist in local authorities, who do not have staff to implement the GIS applications as quickly as more advanced local authorities. An integrated ISDI cannot exist, until all local authorities contribute to the infrastructure’s development equally. At end-user level, planners who insist on using paper maps and technicians who create maps using software, without adding metadata provided tensions.

GIS software supplied by the LGCSB is of a proprietary nature, where the local authority pays a licence fee for each installation as well as for upgrades. It also means that the software is not interoperable with other types of software and thus is not an open system. This is causing discontent in local authorities that are using software from sources other than national government bodies. Thus local authorities are reluctant to utilise any new government software due to these restrictions. One GIS officer in such a local authority expressed the need for the national government to move toward open systems.

The quality of service and data provided by both the OSi and private data suppliers is another source of dissatisfaction. The Government’s decentralisation programme is cited as having an affect on the OSi’s performance. Some respondents suggest the OSi monopoly on national spatial data should be stopped, with the introduction of third party data suppliers, like in the UK. The copyright practices, which restricts local authorities from publishing base map data on the web is a significant tension.

There is also tension present between the local authorities and the LGCSB's regional support. One GIS coordinator was dissatisfied with the way that the LGCSB conduct pilots in the east of the country but seem to neglect those in the west. The manger also stated how the national government body may only implement a new GIS application in five counties and then move on, causing a lot of redundant GIS systems. According to one GIS officer, due to the poor web hosting facilities, the county council can only host two small applications, limiting development in the installed base of web applications.

Management at the more advanced local authorities have a problem with seeing the benefit of them contributing to an ISDI. One manager felt that the ISDI was not really a local authority issue but an issue for the suppliers of spatial data and technology. Another County Council believe that the added cost and effort to contribute to the ISDI by providing their own spatial data sets in a standardised format and procedure to the national level is greater than the received benefits.

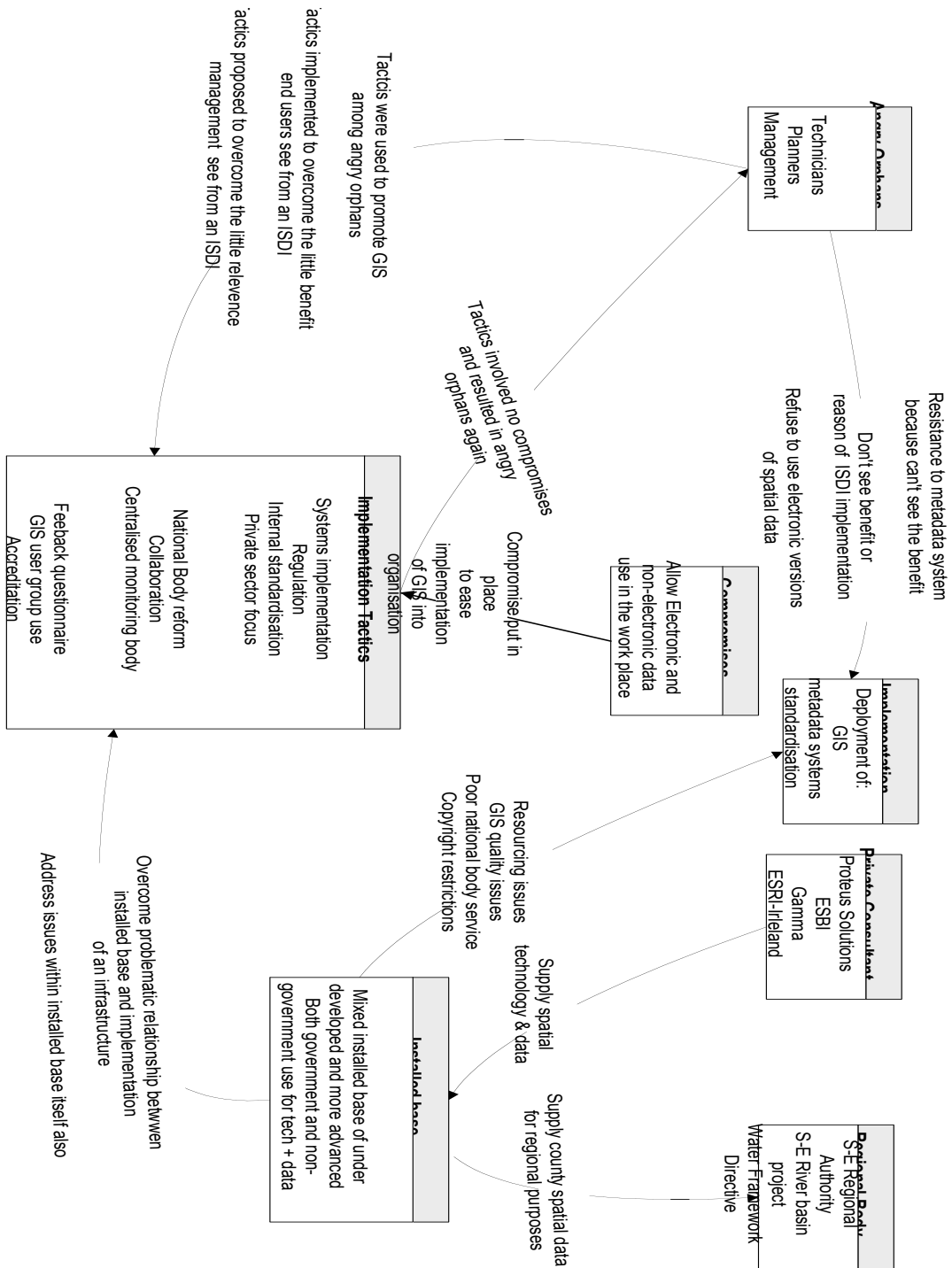


Figure 1 The local information infrastructure

#### 4.16 Tensions between the local authorities and the global context

In less developed local authorities, resources caused tensions, as they do not have the basic technical infrastructure or GIS staff to contribute to an NSDI. However, in the more advanced authorities this was not the case, where the installed base of networks, technical staff and technology is sufficient to contribute effectively to the ISDI. Another proposed human resource issue centres on the need to centrally monitor ISDI compliance.

## 5 CONCLUSIONS AND IMPLICATIONS OF THE STUDY

The nature of an SDI is socio-technical, multi-layered, complex, and dynamic as already discussed. It is an evolving initiative worldwide driven by governments. It is constantly growing and developing and hence is very open. It needs to take into account local government and their spatial resources to develop successfully. Therefore we can say it also building upon the existing ‘installed base’.

From examining the corporate information infrastructure literature it is obvious that top-down infrastructure design fails as the infrastructure grows, contains more and more elements, and basically becomes much more complex. The literature emphasises the power of the ‘installed base’ and how this element cannot be ignored. The infrastructure is never built from scratch but is constantly adding to this existing base. There is also a great need to strike a balance between local and global tensions. When these issues between the two interacting levels are resolved perhaps then an infrastructure is in place i.e. ‘*when the tensions between the local and the global are resolved*’ (Star and Ruhleder: 114)

There is evidently an abundance of tensions present between the local and the global in the e-government information infrastructure. However due to the early stage of ISDI development and implementation there are very few tactics in use at the local level to implement ISDI and even less compromises present. As a result there is limited resolution of tensions, as the national government strategies is at an early stage. Therefore it is evident from the empirical evidence captured in this study that the infrastructure is still emerging. This research’s findings pave way for further research as a further verification of the new information infrastructure model would be very useful and apt in order to obtain another snapshot of the ISDI situation in the future.

The new model derived from actual data collected in the study was verified against the original theoretical model that was developed from the existing base of theory. There are various deviations between the two models. Firstly, within the new model there are various new actors and relationships. A national interest group is a new actor at this level. Furthermore there is many new inter relationships in the new model. Relationships between the GSDI actor and all other actors are complex with multi-relationships in existence. At the local level both regional authorities and private consultants and vendors are new actors in the model. In addition to this, some actors in the original model do not exist in the new model. Actors such as drift, compromises, bottom-up alignment and surprise side affects are not evident in the new model. This is due to the early development of the Information Infrastructure. Further research will almost certainly prove different results. These are more ‘after the fact’ actors and therefore will emerge once the ISDI itself emerges, becomes more visible, and begins to implement.

Though an SDI is often envisaged as a socio-technical infrastructure involving technology and the people and organisations that use it, many SDI initiatives do not fully take these non-technical issues on board at a sufficiently early stage. The national level has a very data-centric focus on SDI implementation – the push seems to be on standardisation of spatial data nationwide. While this is a large and important aspect of SDI development, this needs to be complemented with an outlook on the organisational elements, including those relating to local governments. These existing organisations, which the SDI is building on, need to be considered and prepared for change, otherwise issues may arise during or post-implementation.

Figure 1 is an extension on Ciborra’s (2000:4) model for the dynamics of infrastructure. , and is a proposed analytical framework to explore the issues between local and national levels in light of the emerging Irish SDI development. This analytical framework therefore emphasises the need to explore outside the data-centric box. The framework will examine both national and local levels and try to identify the main issues emerging as the SDI develops. The framework examines issues between both levels at implementation point, and then possible compromises and tactics necessary to resolve these issues and achieve successful bottom-up alignment of local government with the national SDI. It also examines any feedback from local level that may be necessary for any ‘workarounds’ in national SDI strategy and policy.

This study benefits the corporate information infrastructures literature as it proposes to test its concepts and ideas in the public sector and e-Government domain. Furthermore, the study benefits the SDI literature by exploring the need to integrate various levels of an SDI by examining local and national levels in the ISDI context. The authors propose this framework as an analytic and descriptive tool for examining the dynamics of emerging National Spatial Data Infrastructures across countries.

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