REVIEW OF WEB MAPPING TECHNOLOGY

INTRODUCTION

- The creation and use of digital spatial data within archaeology and its associated disciplines has become increasingly prevalent over the past decade
- Traditionally the technology utilised to use spatial data has been expensive desktop based software solutions, but in recent years technological developments have enabled the delivery and exploration of spatial data via the internet.

SPATIAL DATA INFRASTRUCTURES - SDI

EVOLUTION OF GIS

- Traditionally the term GIS has been used to describe the combined use of hardware technology, software, data and people to explore, analyse and visualise spatial data
- The concept of Spatial Data Infrastructures (SDI) was created to define the supporting mechanisms required for WebGIS. The term SDI is used to describe a series of technologies, policies and agreements that facilitate the access to spatial data.
- Sharing information and spatial datasets is, in general terms, the basic goal of any SDI, since it considers that maximizing the access to spatial data is minimizing the production cost of spatial information

TECHNICAL COMPONENTS OF AN SDI

- An SDI is not simply a single feature but a network of interconnected software, technologies, data and policy.
- There are four main components to the core of an SDI which allow spatial data to be: **authored**, **served**, **discovered** and finally **used**.

AUTHOR

- Applications must be present to create and edit spatial data for other users
- The creation of spatial data is still traditionally within the domain of the desktop GIS however, with the increase of speeds and the advent of web feature services (see later) this dominance will probably reduce.
- Within the SDI authoring has another specific role and that is the creation of metadata

SERVE: THE OGC AND THE INTERPOERABILITY OF SPATIAL DATA

- The ability to serve spatial data created lies at the heart of the SDI.
- There is no monopoly on the software we can use to create our spatial data or the resulting formats created.
- The OGC developed a consensus for the establishment of interoperability specifications for spatial data. These OpenGIS® specifications have enabled users around the world to share their spatial data, irrespective of software or platform,
- Standards pertinent to this review include:-

- **WEB MAPPING SERVICE (WMS)** –A simple visual representation of data, e.g. background mapping. e.g. jpeg.
- **WEB FEATURE SERVICE (WFS)** – Objects represented by vector data. together with there associated attributes for selection and querying.
- **WEB COVERAGE SERVICE (WCS)** – Objects represented by raster data sets.
- **GEOGRAPHIC MARKUP LANGUAGE (GML)** – This defines an extension of the XML schema to enable the representation of geographical features.
- **KEYHOLE MARKUP LANGUAGE (KML)** - has become an integral component to Google Earth can include the representation of geometry within its code.
- **WEB CATALOGING SERVICE (CSW)** - supports the ability to publish and search geospatial metadata, services. This enables users to find services created by another organisation.

DISCOVER: METADATA CATALOGUES/PORTALS

- Metadata catalogues or portals enable users to browse and discover spatial data based upon underlying metadata schema
- Supporting such catalogues are many actors at different levels of data creation and administration. They include:-
  - **CATALOGUE CONTRIBUTORS** – Provide metadata entries and associated spatial datasets. In probably would be cultural heritage experts.
  - **CATALOGUE ADMINISTRATORS** – Manage metadata for users. This could be a technical person within a cultural heritage organisation where the spatial data repository lies.
  - **CATALOGUE USER** – The users who browse through the data or pose a specific query to identify a suitable dataset.
- There are different strategies for the implementation of catalogue services, dependent upon the scale and scope of the service:-
  - **CONSORTIUM APPROACH** – An organisation which provides spatial data loads this information into a shared central publically accessible service.
  - **CORPORATE APPROACH** – An organisation which provides spatial data loads this data into a central internal service. is often suited towards large corporate organisation.
  - **WORKGROUP APPROACH** – Each department within an organisation is responsible for the generation and maintenance of their own data and metadata catalogue.
- The selection of appropriate strategy will depend upon several factors, including: size of organisation, technical expertise available, and access rights to information.
- To explore the spatial data referenced through a cataloguing services there are two main styles of interaction that take place:
  - **QUERY** – A user specifies what they are looking for based upon a search criteria, often in the shape of free text.
  - **BROWSE** – User selects paths through categorised information, often related hierarchically to each other.

USE: MAPPING CLIENTS AND APPLICATION

- Web mapping applications enable the visualisation of geospatial information using web accessed software clients.

- Mapping applications can take many different forms including:-
- Dedicated user driven web mapping application
    - These applications are often community driven and created.
    - They require little or no additional software downloads to be carried by the user, therefore they are highly suitable for an audience who has poor technical skills little previous exposure to GIS.
- General user driven web mapping application
    - These mapping applications can be considered as the most similar to desktop GIS.
    - They are usually a component within a larger SDI scheme, offering the mapping interface to visualise data discovered within catalogue
- Basic map tools, plus additional functionality such as search and measurement tools area available
    - Proprietary mapping applications
    - This type of application is one that can be purchased or freely downloaded
    - It offers the user an integrated mapping tool which although doesn't give the full performance of desktop GIS it enables the increased

SOFTWARE

A wide range of software solutions are available at differing costs. In the discussion as to which system to chose, three questions must be considered:

1. Does the software I use require a sustained level of financial support?
2. How many of components of an SDI do I wish to implement?
3. Does the software offer increased functionality that can be adapted and developed for your particular purposes?

CULTURAL LANDSCAPE SDI

- Developing a Cultural Landscape SDI may ensure the protection of heritage by providing accessible information on where things are and why they are important.
- It deals with the heritage information in an integrated mode, which in scientific and management terms is clearly more useful.
- It enhances the social value of the scientific investigation, because the scientific knowledge is openly and easily offered to society, which, in turn benefits the dissemination of heritage, its protection, investigation and management.

SECTION 1: PROJECT INTRODUCTION & METHODOLOGY

BACKGROUND

Over the past 15 years much financial and professional effort has been invested in the collection and analysis of spatial archaeological data by government, research and commercial sectors. Within this digital domain asset, landscape data forms a substantial component and includes: aerial photography; topographic surveys created by LiDAR (Light Detection and Ranging) and digital photogrammetry; and geophysical surveys.

- 27% of archaeological grants awarded by the Heritage Council (HC) have been to research projects whose primary activity is the collection and analysis of spatial data (aerial survey, LiDAR, geophysics). This figure doesn't include the 34% of projects classed as "survey" which also yielded some spatial data.
- Extensive aerial survey and LiDAR surveys carried out by numerous governmental and research bodies including The Discovery Programme, HC, UCD, NUI Galway, DoEHLG, and Meath County Council,.
- In 2007 alone, 264 detection licenses were issued by the DoHELG of which the majority would be used for the primary collection of geophysical data sets.

Once this data is recorded and interpreted, the printed report is often seen as the final deliverable, while the digital archaeological assets created often remain hidden and unused within the source organisations, eliminating any possible knowledge transfer to the wider archaeological community. In the current economic climate the possibility for the loss of archaeological information is great as the digital data collected and held by commercial companies could potentially disappear.

Recently, several reports[1] [2] [3] [4] reviewing the current archaeological research framework within Ireland have highlighted concerns that exist within the archaeological community that require further action. Following the completion of a HC funded landscape project[5] it was noted that a review examining the long term prognosis of the information derived from data projects should be commissioned, with the possibility of creating a centralised geodata server. Specific concerns were also highlighted in an open letter to the Heritage Council[6], the RIA expressed that 'an on-line guide to air photographic collections' should be a practical priority to the Heritage Council.

Major problems to the successful development of the knowledge society in Irish archaeology include:

- Underdeveloped and poorly resourced research infrastructure.
- The unconnected nature of archaeological information and key resources within the archaeological research community
- A lack of accessible and sustainable digital archives for archaeological data, with established standards and metadata
- An inadequate return on the investment in primary data collection, from both development led and grant funded archaeological practice, resulting in the production of hidden archaeological material

The solution for many of the highlighted problems is the creation of an effective complimentary ICT strategy which provides easy access to primary research information whilst providing a sustainable and robust digital archive that adheres to recognised international standards. Developments in

SECTION 4: REVIEW OF WEB MAPPING TECHNOLOGY

INTRODUCTION

The creation and use of digital spatial data within archaeology and its associated disciplines has become increasingly prevalent over the past decade. Data sets ranging from archaeological excavation plans recording stratigraphic relationships to the high resolution LiDAR models detailing the three dimensional nature of an archaeological landscape and its monuments have enabled archaeologists and other interdisciplinary experts to catalogue, analyse and visualise cultural heritage information. This information can then be used to discover trends and explain archaeological theories and concepts. Traditionally the technology utilised to use spatial data has been expensive desktop based software solutions, but in recent years technological developments have enabled the delivery and exploration of spatial data via the internet. This report aims to highlight these technological developments and explore their use in the delivery of spatial data and examine the underlying support factors that are required for their successful implementation. Initially this section was intended to simply look at web mapping application but, as can be seen from the discussion that follows, there are many other facets to be explored that simply how can visualise spatial data.

SPATIAL DATA INFRASTRUCTURES - SDI

EVOLUTION OF GIS

Traditionally the term GIS has been used to describe the combined use of hardware technology, software, data and people to explore, analyse and visualise spatial data[67]. The term often refers to the use of GIS by the individual (desktop GIS), or within a centralised organisation such as government departments (Intranet GIS). The cost of purchasing and maintaining the technology and training users to correctly collect data and utilise the software was often expensive[68] and prohibited the use of GIS by individuals. However, as technological developments of the internet have enabled GIS users to browse and utilise spatial data held by external organisations, the definition of WebGIS was coined to describe this new delivery method. Although the development of WebGIS went hand-in-hand with the development of traditional GIS it was noticed that an overarching definition that included the supporting mechanisms was required, thus the concept of Spatial Data Infrastructures (SDI) was created

The term SDI is used to describe a series of technologies, policies and agreements that facilitate the access to spatial data. According to the GSDI Cookbook,

"The term 'Spatial Data Infrastructure' is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of an access to spatial data. The SDI provides a basis for spatial data discovery, evaluation and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general"[69].

Besides, a SDI is more than a single data set or database, since it "hosts geographic data and attributes, sufficient documentation (metadata), a means to discover, visualize, and evaluate the data (catalogues and Web mapping), and some method to provide access to the geographic data"[70].

Sharing information and spatial datasets is, in general terms, the basic goal of any SDI, since it considers that maximizing the access to spatial data is minimizing the production cost of spatial information[71]. Each discrete data set is stored only by the organisation that created it; as in the case of national and government bodies, or with an elected archive for smaller independent data creators and served out to be shared by the community as a whole. The benefits for this are numerous and include:

- The financial and technical cost of maintaining the data lies with the creator and provider, not with the user
- Elimination of the duplication of effort in the generation and maintenance of spatial data
- The currency of the data much greater as the user's data is consistent with that of the data creators (unlike downloaded data)

Consequently, SDI is coherent with sustainable development policies and the democratisation of data access. This is especially pertinent for spatial data that has already seen public finances contributing to its generation, which in areas in economic regression, like rural ones, is particularly significant and useful to all agents involved in its management.

TECHNICAL COMPONENTS OF AN SDI

As stated previously an SDI is not simply a single feature but a network of interconnected software, technologies, data and policy. Within the grouping of technology and software a simplified model can be used to describe the individual entities and the interaction and communication of data between them. There are four main components to the core of an SDI which allow spatial data to be: authored, served, discovered and finally used. Figure 4-1 illustrates the main components and functional data flows. Within this report all technical components will be described, however, specific focus will be applied to the discovery and use of spatial data.

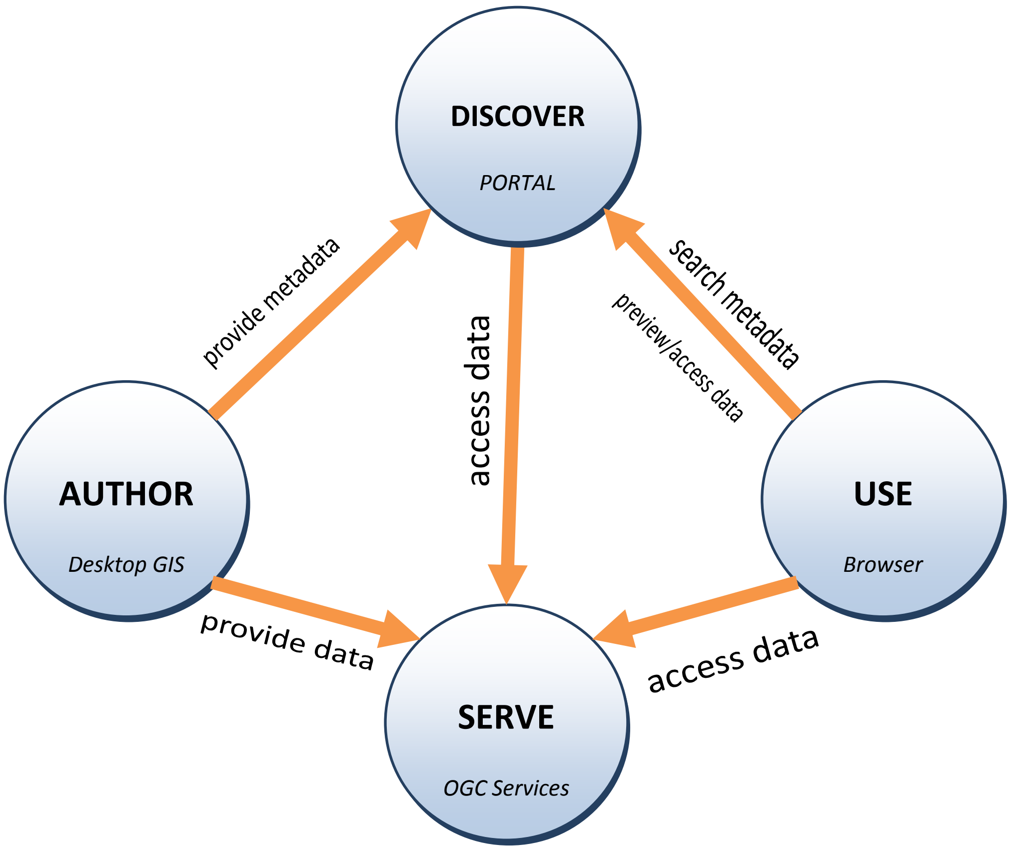


Figure 4-1: Schematic diagram of the components of a SDI based solution for information sharing

AUTHOR

With an SDI, applications must be present to create and edit spatial data for other users down the line to visualise and analyse. The creation of spatial data is still traditionally within the domain of the desktop GIS system as the high resolution digital resources required don't suit the limitations of internet band width. However, with the increase of speeds and the advent of web feature services (see later) this dominance will probably reduce.

Within the SDI authoring has another specific role and that is the creation of metadata that is associated with spatial data. It is here that the cultural heritage expert can have effective input in describing the resources they have created. The creation of this data should be formally included in the process of all data collection and during the time period of data creation to ensure accuracy. A more in-depth discussion of metadata can be found in section 3.

SERVE: THE OGC AND THE INTERPOERABILITY OF SPATIAL DATA

The ability to serve spatial data created within another room, building or country without difficulty lies at the heart of the SDI. Using powerful GIS server technology and associated spatial databases, users can seamlessly integrate spatial data. However, there is no monopoly on the software we can use to create our spatial data or the resulting formats created. The ability for individuals to share spatial data came about due to the efforts of the Open Geospatial Consortium (OGC). The OGC is a non profit organisation founded in 1994, which together with 369 international companies, government agencies and academic developed a consensus for the establishment of interoperability specifications for spatial data. These OpenGIS® specifications have enabled users around the world to share their spatial data, irrespective of software or platform, and have brought about the one of the key enablers of WebGIS and SDIs. In total there are currently 28 standards in operation at present, several of which are pertinent to this review and are detailed below:

WEB MAPPING SERVICE (WMS) – Enables the production of maps from spatial data and distributes them over the internet in the form of a geo-referenced image, e.g. jpeg. These often form the basis for many online mapping sites including Google Maps. This service is suitable for people who wish to get a simple visual representation of data, e.g. background mapping.

WEB FEATURE SERVICE (WFS) – Similar to a WMS, however, mapped objects represented by vectors data: points (a SMR site), lines (a river) and polygons (field boundary) maintain their structure and are available, together with its associated attributes for selection and querying. This service is suitable for queries (e.g. select the monuments which are classified as "Crannog") and gives the user the ability to create, delete and edit spatial feature via the web (i.e. online tool to enable the creation of a uniform country wide HLC dataset)

WEB COVERAGE SERVICE (WCS) – Similar to a WMS, however, mapped objects represented by raster data sets: aerial imagery, digital elevation model (DEM) and other continuous data set (CORINE). User can then interrogate this data for further spatial analysis. This selection of provision would be highly suited to the creation of geophysics, orthoimagry and LiDAR map services to be consumed by the public.

GEOGRAPHIC MARKUP LANGUAGE (GML) – This defines an extension of the XML schema to enable the representation of geographical features. Within GML geometries such as points, lines and polygon can be represented, however it does not support raster coverage data or topology.

KEYHOLE MARKUP LANGUAGE (KML) - Also based upon the XML schema, GML allows for the annotation of maps and images and the creation of navigation paths for users to explore spatial data. It is for this reason that the use of KML has become an integral component to Google Earth and is the adopted standard for the delivery of user content to its globe mapping application. OGC and Google have now agreed to harmonize GML and KML so KML can include the representation of geometry within its code.

Note, all the above specifications also have associated metadata schemes attached for their discovery and use.

WEB CATALOGING SERVICE (CSW) - Unlike the previous specifications, the CSW supports the ability to publish and search geospatial metadata, services and related resources. This enables users to efficiently find services created by another organisation.

DISCOVER: METADATA CATALOGUES/PORTALS

As more organisations and individuals increase the amount of spatial data they create effective ways to organise, describe and access this data becomes progressively more difficult. For efficient decision making access to this resource is paramount. Metadata catalogues/portals enable users to browse and discover spatial data based upon underlying metadata schema and the inherent spatial signature of geographic data. Within a catalogue service, classification systems are employed to group together similarly themed data sets either by geographic location, dominant theme (e.g. elevation data) or data producer (e.g. OSi).

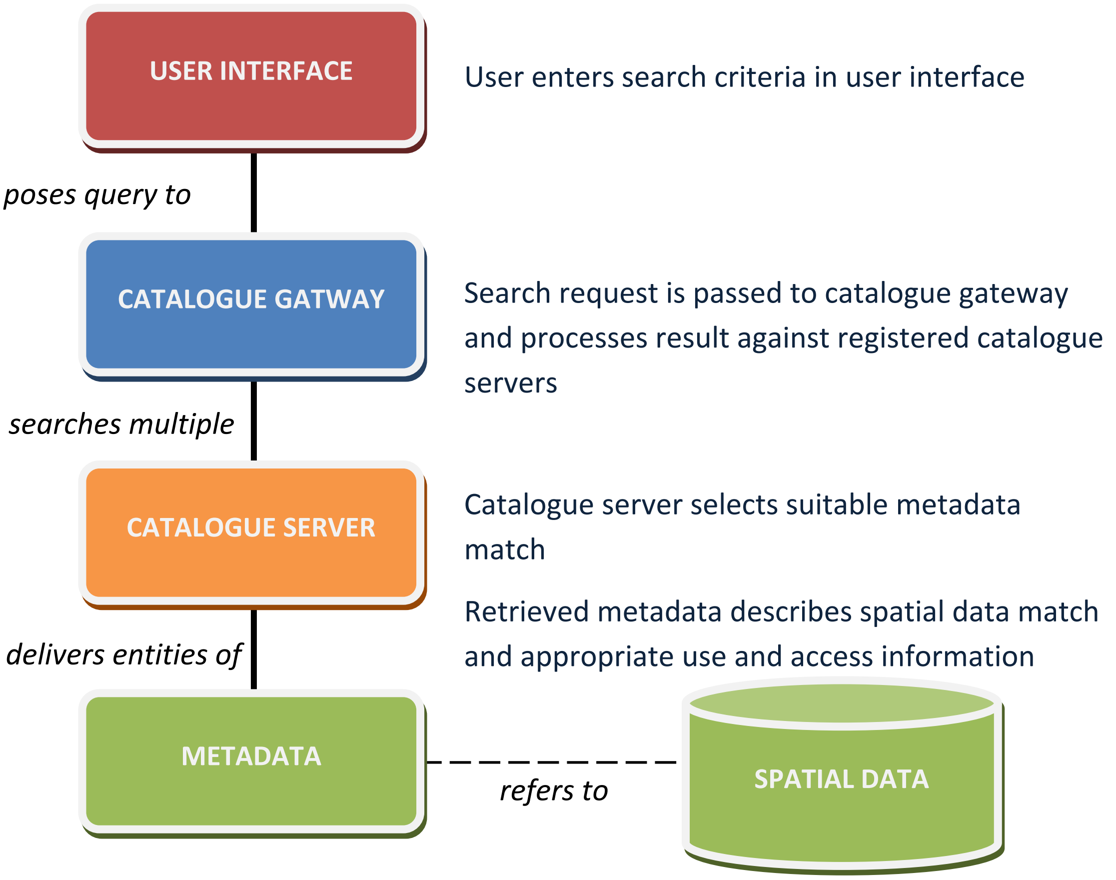


Figure 4- 2: Diagram describing the basic usage of distributed catalogue services and related SDI component[72]

Supporting such catalogues are many actors at different levels of data creation and administration. Outlined below is their description and possible placement within the cultural heritage sector.

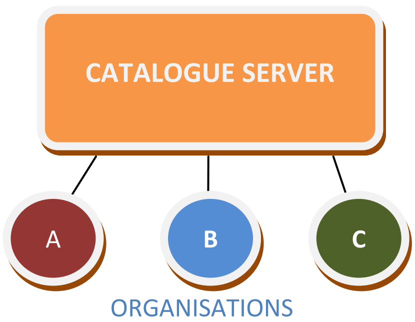
CATALOGUE CONTRIBUTORS – Provide metadata entries and associated spatial datasets. In this case these would be cultural heritage experts.

CATALOGUE ADMINISTRATORS – Manage metadata for users. Can edit and delete user created metadata to enable good quality control, which is integral to successful take up of service. This could possibly be a technical person within a cultural heritage organisation where the spatial data repository lies.

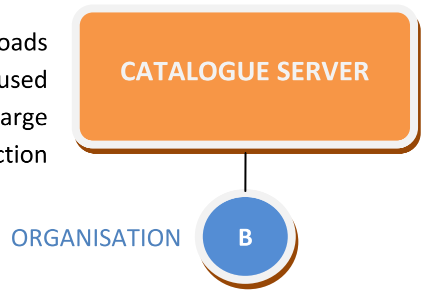
CATALOGUE USER – The public or interested party who browse through the data or pose a specific query to identify a suitable dataset. When considering an appropriate user interface care must be taken to include the wide range in technical skills and interest of the customer. Here our user could be anyone from a member of the general public to a post graduate student.

There are different strategies in the implementation of catalogue services, often dependent upon the scale and scope of the service and each with benefits and disadvantages. Below are their descriptions with associated schematic diagrams

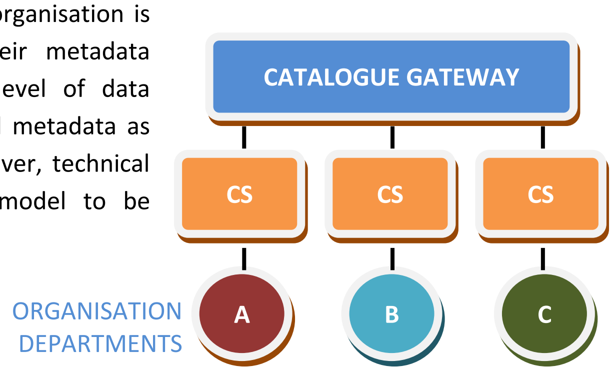
CONSORTIUM APPROACH – An organisation which provides spatial data loads this information into a shared central publically accessible service. A positive aspect to this model are it encourages collaboration between organisations to share each other's data, however, this could be a negative factor if the catalogue contributors fail to formulate any common approach or standards. Another positive factor is the technical overheads of implementing this strategy are weighted with the catalogues host and therefore contributors will not require the full technical structure to add data. Problems do exists with this methodology in that care must be taken that synchronisation of the various organisations data is maintained.



CORPORATE APPROACH – An organisation which provides spatial data loads this data into a central internal service. This solution provides a focused collection of information on a single service and is often suited towards large corporate organisation. This method is useful when some form of restriction needs to be placed on the creation of, and access to metadata.



WORKGROUP APPROACH – Each department within an organisation is responsible for the generation and maintenance of their metadata catalogue. This model has the advantage that a high level of data synchronicity exists between spatial data and its associated metadata as both data sets are organised by the same personnel. However, technical expertise is required within each department for this model to be successful.



The selection of appropriate strategy will depend upon several factors, including: size of organisation, technical expertise available, access rights to information, and level of synchronisation between metadata and spatial data. One important factor in the synchronisation is the long term availability of the spatial resources referenced by the metadata. Unless assurances are given that individuals and individual organisation comprehensively archive their digital spatial data a centralised approach must be advised. In reality a hybrid between a consortium and corporate approach would be the moist suitable. Government organisations and national bodies will control their own central catalogue service but for smaller organisations with poor technical resources the adoption of the consortium model is preferred.

CATALOGUE USER INTERFACE

For the user wishing to explore the spatial data referenced through a cataloguing services there are two main styles of interaction that take place:

1. **QUERY** – A user specifies what they are looking for based upon a search criteria, often in the shape of free text. This method is often preferred by the expert user who knows specifically what they are searching for, however one must accommodate the novice user too. Often two query interfaces are utilised (standard and advanced) to solve this problem. It can often be the case with query interfaces that a small map application is available for the user to delimit the spatial extent of their search. An example of a query could be an archaeologist wishing to know what aerial imagery was available before and after the construction of a road.

2. **BROWSE** – User selects paths through categorised information, often related hierarchically to each other. This method is often used by the novice who is not quite sure what they want but are aware of the theme. An example of this method could be a user is interested in discovering what LiDAR data exists within Ireland. Usually the categories are based upon the underlying thematic nature of the data, e.g. cadastral mapping data, environmental data etc. For larger national catalogue services data may also be grouped by data provider.

Within the scope of cultural heritage data, application of the keyword vocabularies described in section 3 could be used to create a hierarchical catalogue, e.g. the browsing of data based upon the GEMET metadata classification schema. Special interest sections often exist on larger catalogues, and sections highlighting new or data relevant to a current event is displayed.

The results from the queries and browsing selection are often displayed in several styles, again aimed at the range of users that could possibly use the service. These include:

- An HTML based summary document outlining the main descriptive information about the data discovered, allowing the user to instantly gauge whether the service is suitable for use. Other data presented may include data purpose, content keywords, the data provider and a small thumbnail image representation of the data.
- A styled representation of the full xml metadata record to allow the user to examine the full details of the data available
- If a suitable mapping application is available the user is given the opportunity to launch their discovered data set within the browser window
- The ability to get access to additional resources that support the data set, e.g. web site of project, contact details of data creator. Or if function available add to a user defined map

USE: MAPPING CLIENTS AND APPLICATION

Web mapping applications enable the visualisation of geospatial information using web accessed software clients. Expectations both from the general public and from specific users have increased due to the prevalence of the internet in serving geospatial information on the web[73]. Users require sophisticated interactive applications that allow them access to tools.

Mapping applications can take many different forms including:

DEDICATED USER DRIVEN WEB MAPPING APPLICATION

These application are often community driven and created to answer a specific group of questions or visualise a specific collection of spatial data with an under lying theme. These applications are accessed through web browser interfaces such as Microsoft Internet Explorer or Mozilla Firefox and are therefore easy to implement. They require little or no additional software downloads to be carried by the user, therefore they are highly suitable for an audience who has poor technical skills little previous exposure to GIS. A current example that has been recently implemented to great effect is the City of Boston Solar Energy Mapping system [74] which allows public users to access the solar energy potential of their local neighbourhood, using a simple easy understood graphical mapping interface. Although this application is not specifically design for use in cultural heritage, the concept of describing a highly technical issue such as solar potential to the general public has been effectively carried. There are limitations to this approach in that if the application has been overdesigned to the point of limiting the addition of spatial data required by the user.

GENERAL USER DRIVEN WEB MAPPING APPLICATION

These mapping applications can be considered as the most similar to desktop GIS. They are usually a component within a larger SDI scheme, offering the mapping interface to visualise data discovered within catalogue services, often created for somebody with a general non-specific user profile. Basic map tools, plus additional functionality such as search and measurement tools area available for the user to employ on their datasets. The ability to combine, add and alter the visual order of datasets often lend this option to the viewing of dispersed and diverse data sets, often the case for the landscape studies.

Over the past 3 years the emergence of server component architecture has enabled the full complexity of desktop GIS, including its tools and functions to available online through a server online. The sophistication of the tools is limited only by the effort required for their implementation; and where spatial data sets are large, the necessary internet bandwidth for their successful visualisation. Examples of such technology include ESRI's ArcGIS Server (proprietary) and Map Server (open source).

PROPRIETARY MAPPING APPLICATIONS

This type of application is one that can be purchased or freely downloaded from a software company by the user. It offers the user an integrated mapping tool which although doesn't give the full performance of desktop GIS it enables the increased functionality and data manipulation which is required by some users. It can range in complexity from planimetric visualisation (thin clients), to sophisticated 3-dimensional interfaces (thick clients) such as Google Earth.

One of the main benefits for employing this approach is that many of these applications come with global datasets freely available for use within the application. Software such as ESRI 's ArcGIS Explorer allow users to not only use free background mapping aerial imagery but also the opportunity to import data from their own developed collections (e.g. Pinkerton's 1812 global map is available freely for from ESRI's online resource centre [75]).

An additional benefit from some of the better, freely available mapping applications is the large and often helpful user community that supports them. This community can be often the source of numerous individually created data sets, often thematically grouped for viewing ease (e.g. Google Earth Community has a specific group for those creating data sets that have a historical significance), and often show new or innovate uses of the technology to provide mapping solutions e.g. Virtual Alabama[76] , solution for the management of homeland security data uses Google Earth as its mapping interface.

One consideration in the adoption of such software technology is the requirement upon the user to install and run the necessary application on their machine. This "thin client" approach passes some amount of the processing to the user's machine and therefore cannot be as dependable as a server side solution.

SOFTWARE

To implement all or some of the components outlined above there is a wide range of software solutions that address the problem in very different ways and at differing costs. In the discussion as to which system to chose, three questions must be considered:

4. Does the software I use require a sustained level of financial support?
5. How many of components of an SDI do I wish to implement?
6. Does the software offer increased functionality that can be adapted and developed for your particular purposes?

The answers to these questions can be dependent on numerous factors that must be assessed at the inception of possible landscape SDI development. An example would be the development of a custom designed mapping application interface, which is part of an overall SDI. The first option considered could be to employ freely available open source software as the basis for the application (e.g. MapServer). However this would come with the limitation of little or no official technical support and increased development cost and long term in-house maintenance (increased employment costs). In comparison adopting a commercial product (e.g. ESRI ArcGIS Server) will often provide a solution which can be easily implemented with technical support for the software developers. However, the long term cost of sustaining this approach would produce higher capital costs for the project. It is also often the case that proprietary software allows for the easy production of a final "polished" product as you are paying a premium for the pre-development that has occurred.

CULTURAL LANDSCAPE SDI

Developing a Cultural Landscape SDI may ensure the protection of heritage facing other agents and activities potentially dangerous to its safeguard, in the sense that it provides enough information to illustrate to other agents where things are and why they are important. Nevertheless, conventional SDIs have been shaped in contexts different from the research and management of Cultural Landscapes. Therefore, the integration of Cultural Landscapes within SDIs demands the discussion of techniques and methods that allow the interoperability of European cultural landscapes data. One important issue here is that the diachronic dimension of cultural landscapes, especially it's historical, archaeological, territorial and social aspects must be taken in account when defining the structure of the SDI, for instance, in the organization of the datasets and in the creation of specific cultural landscape metadata (see Section 3). It is this foundation that emphasizes the difference between having a simple archaeological web mapping service and having a real Cultural Landscape SDI, with all the advantages mentioned before, intrinsic to SDIs. The main advantage of a Cultural Landscape SDI is that the Heritage information is not dealt like a mere sum of points, lines and polygons with historical information attached. Instead it creates a service that deals with the Heritage information in an integrated mode, which in scientific and management terms is clearly more useful. A Cultural Landscape SDI enhances the social value of the scientific investigation, because the scientific knowledge is openly and easily offered to society, which, in turn benefits the dissemination of heritage, its protection, investigation and management.

SUMMARY

It can be shown that the efforts made by the GIS community, with the assistance and guidance of the OGC has made over the past 14 years has brought spatial technology to a point where the sharing of spatial data across the world and disciplines has become seamless and available for all to use. The democratisation of spatial data, and the technology which supports this is available for use now. The ability to use and promote archaeology and cultural heritage data between experts, the public, and decision makers will have profound benefits in the protection of our heritage. The formation of a cultural heritage SDI is the foundation on which the promotion, discourse and decisions about our shared heritage must sit. Effective decision making relies on access to current and reliable information. The ability to use cataloguing services to achieve this and enable even the basic user to find suitable data should not be underestimated. There are caveats and specifications that need to be investigated for the individual user groups. However, it is the will of those groups and the supporting mechanisms to enable the use of this technology which is probably the most difficult thing to attain. Support must be made on several levels:

- The archaeological user community must be willing to share their spatial data and use and apply suitable metadata schemas for their discovery. Without data the system is worthless
- Government, academia and other large institutions should, where possible, constructively support this mechanism fully - both financially and verbally.

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SECTION 5: WEB MAPPING APPLICATION (WMA) - SYSTEM DESIGN SPECIFICATIONS (SDS)

INTRODUCTION

PURPOSE

The purpose of this document is to provide a description of the software system including its functionality and matters related to the overall system and its design. It will act as guidance to the creation of this pilot web mapping application and hopefully aid the creation of any future web mapping applications. The content of the system design specifications (SDS) focuses on three aspects of the SHARE-IT Web Mapping Application. The first focuses on the technical architecture used the setup of the WMA. Secondly the components of the SHARE-IT WMA interface are discussed. Finally the data that will be accessed through the WMA and its associated model are outlined

DEFINITIONS, ACRONYMS AND ABBREVIATIONS

DTM: Digital Terrain Model
DSM: Digital Surface Model
HTTP: Hypertext Transfer Protocol
SDS: System Design Specifications
SOA: Service Orientated Architecture
SOC: Server Object Containers
SOM: Server Object Manager
WMA: Web Mapping Application

CONTRIBUTORS

SOFTWARE CONTRIBUTION

- The Discovery Programme
- Digital Media Centre, DIT
- ESRI Ireland

DATA CONTRIBUTION

- Discovery Programme
- Margaret Gowen & Co. Ltd
- UCD School of Archaeology
- Department of Environment Heritage & Local Government (DoEHLG)

DEVELOPMENT TOOLS

The technologies used to develop this application are

- ESRI ArcGIS Sever 9.3 (Java Platform)
- ESRI ArcGIS Desktop 9.2
- Adobe Dreamweaver CS3

SUPPORTED BROWSERS

The web application will provide support for the following web browsers on the following operating systems:-

Web Browser	Supported Operating Systems
Firefox 2.0	Red Hat Enterprise Linux AS/ES 4.0 Update 2
	SUSE Linux Enterprise Server 10
	Sun Solaris 10 (SPARC)
	Windows 2000 SP4 Server, Advanced Server & Datacenter
	Windows 2003 SP2 Server Standard, Enterprise & Datacenter
	Windows Vista SP1 Ultimate, Enterprise, Business
	Windows XP SP2 Professional Edition
Internet Explorer 6.0	Windows 2000 SP4 Server, Advanced Server & Datacenter
	Windows XP SP2 Professional Edition
Internet Explorer 7.0	Windows 2000 SP4 Server, Advanced Server & Datacenter
	Windows 2003 SP2 Server Standard, Enterprise & Datacenter
	Windows 2008 Server Standard, Enterprise & Datacenter
	Windows Vista SP1 Ultimate, Enterprise, Business
	Windows XP SP2 Professional Edition

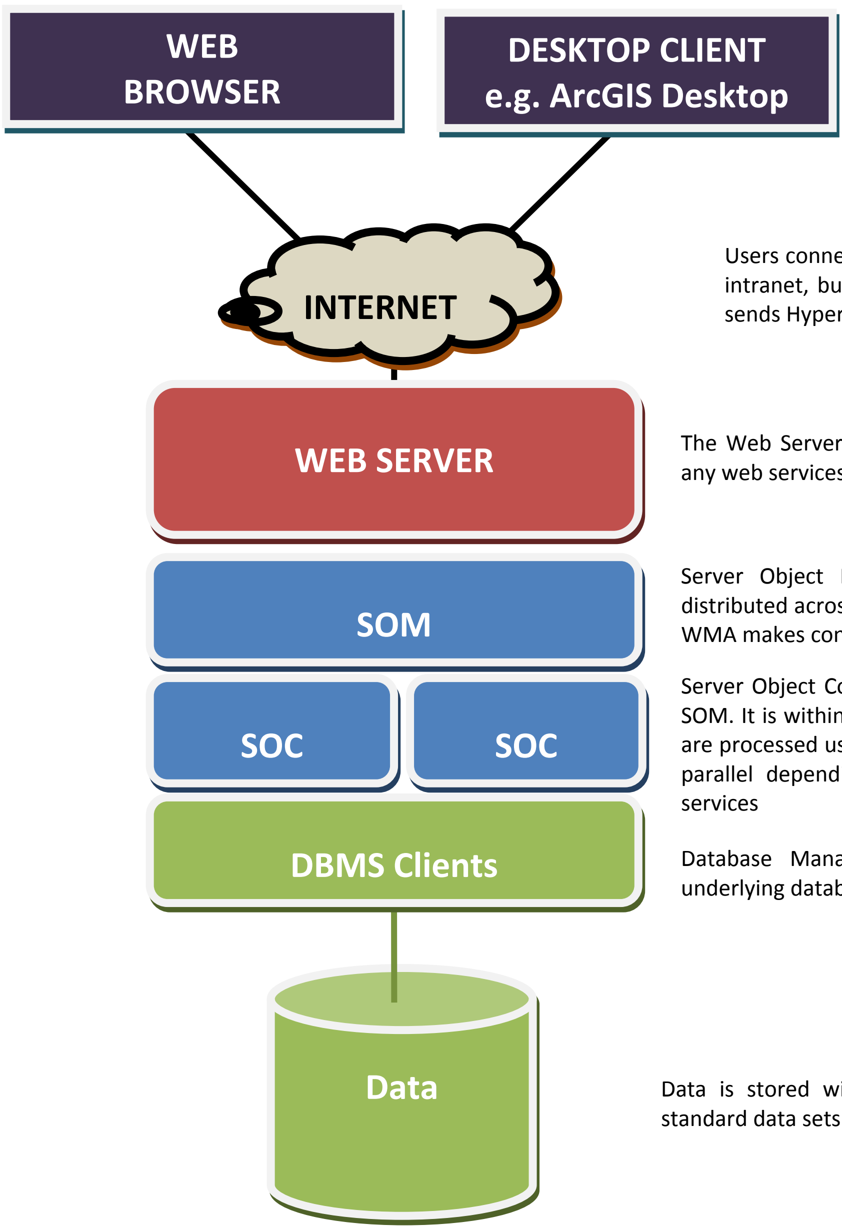
SYSTEM PROCESSES

TECHNICAL ARCHITECTURE

The ESRI ArcGIS Server Software is hosted on a Dell PowerEdge SC1425 Server, with a single Intel Xeon 3.2Ghz Processor and 2Gb of DDR2 ECC memory. The server has the following operating system installed: Operating System: Windows 2003 SP2 (32-bit) Server Enterprise. This server is housed at Dublin Institute of Technology. Connection into the server is be made through an open port via a connected DSL internet link and will be limited to GIS server only traffic for security purposes. The server being used for this demonstrator would sit at the lower end of specifications required to fully implement a SHARE-IT WMA to reduce the incurring of any additional costs in this proof of concept stage. Any future development and construction of a permanent WMA should take into account the optimal server settings for full implementation.

SOFTWARE & SYSTEM CONFIGURATION

The SHARE-IT Web Mapping Application (WMA) is created based upon a single platform (low capacity requirement for pilot) edition of ArcGIS Server. The ArcGIS Server system is composed of distributed components each playing a specific role in the process of managing, activating, deactivating and load balancing the server resources that are given to a set of services, such as the server object manager (SOM) and server object container (SOC); a Web server; and an administration interface. Each component communicates with the other components to enable the final WMA to operate. Figure 3-1 is a technical illustration, outlining the components of the SHARE-IT WMA and their respective functions.



Users can interact and use WMA through a web browser such as Internet Explorer. If users wish to consume map services this can be done through desktop client software such as ArcGIS Desktop or ESRI ArcExplorer

Users connect to Web applications and Web services over the Internet or intranet, but all the Web application's logic runs in the Web server and sends Hypertext Markup Language (HTML) to the browser client

The Web Server hosts the SHARE-IT Web Mapping Application (WMA) and any web services that exist

Server Object Manager (SOM) manages the set of services that are distributed across one or more SOC machines. It is through the SOM that the WMA makes contact with the ArcGIS Server

Server Object Containers (SOC) hosts the services that are managed by the SOM. It is within the SOC that services such as search services, map services are processed using ESRI Arc Object components. Multiple SOC can be run in parallel depending upon the demand and complexity of the WMA and services

Database Management System Client enables control and access to underlying databases and data structure

Data is stored within several different databases including RDBMS for standard data sets and geo-databases for vector and raster spatial data sets

Figure 3-1 : Illustration outlining the major components of the SHARE-IT technical architecture and their interactions

APPLICATION & DATA SECURITY

Security protection is provided through multiple levels of security controls: physical, administrative and technical, which work together to provide a secure environment to host data and deliver web applications to the public.

USER AUTHENTICATION & AUTHORISATION

Access to the ArcGIS Server to create, edit or delete mapping applications can only be gained using a password authenticated login. This has previously been setup on the host server, within the ArcGIS Server administration and also within the server's operating system (MS Windows Server 2003) where users are created as having administrator privileges.

Access to the SHARE-IT web mapping application, is at present set without any user restrictions or authorisation control. If a fully implemented Archaeological Mapping application was developed in the future user login functions can be easily implemented via the ArcGIS Server software. Control over the ArcGIS Server service orientated architecture (SOA) is also inherited from the Windows Server administrative controls.

HARDWARE SECURITY

To provide sufficient security a reverse proxy Web server within a screened subnet was established within DIT. The reverse proxy will receive incoming HTTP requests through a firewall that restricts traffic to port 80. The proxy server in turn will send a request through another firewall to the ArcGIS Server in a secure internal network. This allows for the ArcServer and all its associated components to gain unrestricted access to each other.

DATA SECURITY

An automated backup copy of all databases, geodatabases and associated mapping data will be made daily to DAT. This process will initiate at 3:00 am each day to reduce the amount of downtime evident in the SHARE-IT WMA. For any future implementation of a WMA and the associated digital archive that underpins it would be prudent to implement a weekly off site remote backup scheme to replicate the data.

APPLICATION INTERFACE

The SHARE-IT web mapping application interface has been developed with several key areas that present data or allow users to gain access to application tools. Users can adjust the width and height of all areas below the tool bars, including map window and layers panel, to their own specifications. The application areas are described below in reference to figure 3-2:

1. MAP APPLICATION WINDOW

This area of the interface provides the user with a visualisation of the spatial data present within the SHARE-IT mapping application. Users can navigate the map window by either using the Compass rose and scale buttons in the top left hand corner of the window , or if the hand icon has been selected from the ArcGIS Server tool bar the user can opt to use the scroll wheel on the mouse to zoom and left mouse click to pan around the map. Also within the map application window is a dynamic scale bar and when the server is actively generating a map or query results a progress bar becomes visible in the lower right corner

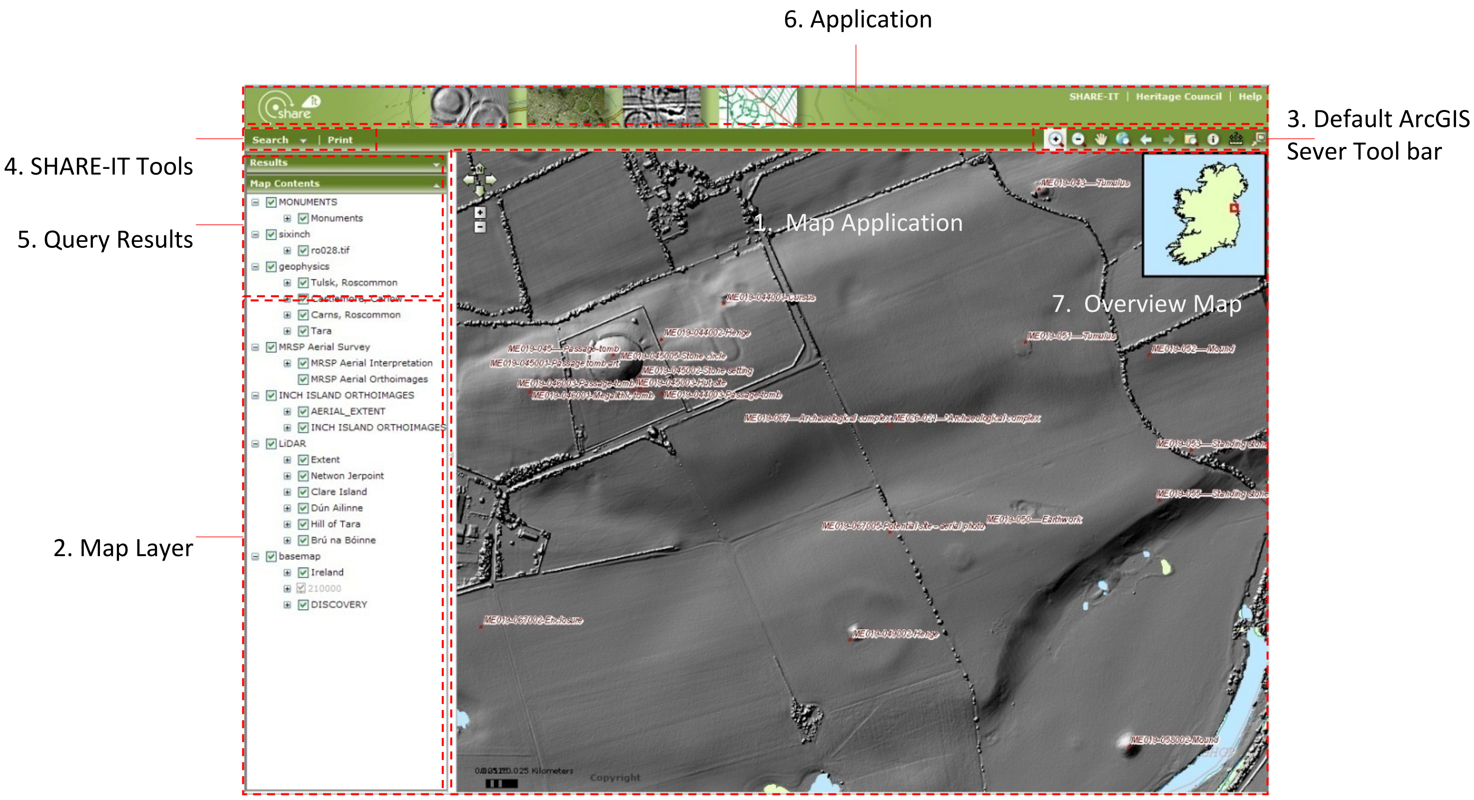


Figure 3-2: SHARE-IT Web Mapping Application Interface

2. MAP LAYER CONTENTS PANEL

Within this section of the application interface the user is presented with the map layers that are available to view within the Map application window (1). Each individual data layer can be expanded to reveal the layers symbology, and the layer may be grouped within a larger thematic data collection which can be expanded or collapsed to reveal the contents. If a scale range has been set for the data (see section on Scale Dependency) it will enabled or faded out depending upon the users current scale in the main map window (1).

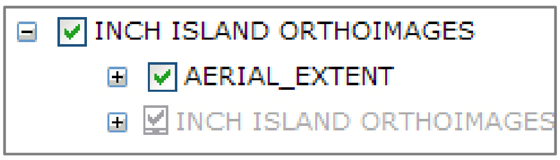


Figure 3-3: 2Example of two data layers within a grouping called “Inch Island Orthoimages” becoming enabled (Aerial Extent) or disabled (Inch Island Orthoimages) depending upon the viewers map scale.

3. DEFAULT ARCGIS SEVER TOOL BAR

This part of the interface area contains the default tools that embedded within the standard ArcGIS Server Mapping Interface and represent the most frequently used tools within a web mapping application. From left to right they are:

- ZOOM IN: Users can click and drag a window to specify where the main map window (1) will zoom to
- ZOOM OUT: Users can click and drag a rectangular window to specify the limit of the map window, the smaller the rectangle, the more the map will zoom out.
- PAN: Users can re-centre and move around the map window by left clicking and dragging the mouse in the desired direction
- FULL EXTENT: On clicking the map window will zoom out to the area of all the data layers.
- PREVIOUS EXTENT: map returns to the area displayed previously.
- NEXT EXTENT: Map displays the next stored map extent, available only if previous extent has been selected beforehand.
- IDENTITY: On selection of this tool users can click on a feature within the map window they wish to identify. An label is displayed informing the user what the feature is, with an expandable box available to observe the other attributes of the map object. If multiple features exist at the chosen location the user is presented with a drop down list to select the feature they wish to inquire about.
- MEASURE: This tool allows the user measure the x, y coordinates of a point, the total and segment length of a polyline digitised by the user, and the perimeter and area of a polygon digitised by the user. For the length and area calculations the user provides a single left mouse click to indicate where each segment of the polyline/polygon should be and a double click to complete the digitisation. At any point during the process or after, the user can change the measurement units by using the drop down list

4. SHARE-IT TOOLS

Several tools will be created for the searching of data within the application interface. These tools will be accessed from the top toolbar area of the application window and are grouped as follows:

SEARCH TOOLS

Initially they will be classified within a single heading "Search" that, when the user moves their pointing device over the title bar it will expand to reveal a larger list of query selection types, including:

1. Townland

   Users will type in the full or partial text of townland name within the entry field. On pressing the "Find" button the search request will query the attribute tables of the OSI townland polygons (Discovery Series Mapping). Once completed, the query will return a list of matched townland names within the Results window. The original search term with the total number of matched records (in brackets) is displayed at the top of the displayed tree. If the mapping window scale is at a suitable level the results of the query will also be displayed as the selected townlands will be highlighted. Additional information for each of the matched townland can be displayed by clicking the "plus" symbol to the left of the townland name extending and displaying the full attribute data set for that entity. Users can right click upon a matched townland and choose to "zoom to", "pan to" or "remove" the townland form the list of results. The number of results displayed at one time is limited to 25. If the query results are more numerous than this the user is given the option to browse through the next 25 records.

2. Sites & Monument Record (SMR)

   Users will enter the full or partial SMR number for the monument they wish find within the entry field (e.g. "ME019"). The record results from the query will be displayed with the SMR number initially being presented with the user then having the option of extending the information by click the "plus" sign next to the SMR number. Only a limited amount of relevant information from the complete SMR record dataset is displayed, including classification and OSI description. Those records selected from the query will be displayed as push pins on the map interface window. As the user moves their pointer over the SMR query results the push pins in the map interface will dynamically change to indicate which SMR record you are over. As with the townlands query results the user is limited to view 25 record results.

3. Monument

   Users are given the option to search for specific monuments by a combination of monument classification and county. Users will select the monument type from a drop down list of DoEHLG monument classifications and type in the DoEHLG county code in the lower entry field (e.g. ME = Meath). The SMR numbers of those records selected are shown with classification and OSI text information available within collapsible fields (plus sign). Again query results are displayed within the main mapping window and as the user moves their pointer over the returned records the corresponding map marker (red ball) changes to indicate the location of the monument.

All of the search tools have additional functions that can be used to navigate to the query results. Right clicking on query results allows the user to zoom to, pan to or remove the record from the results window. All the above tools can be amended and adjusted, or if required new queries could be created to suit user requirements.

PRINT TOOL

Here the user can print a map of the active map window of the share-it web application. On activation the user will be presented with an interface to customise their final printed map. This includes:

- Map Title: title to display at the top of the print page.
- Map Size: set the size of the map.
- Print table of results for: if query results are displayed, the listed items may be printed from the Results area. Check the boxes for results items to print.

Items such as the north arrow, scale bar and legend are included on the printed page and could be adapted in the future to serve different user groups, i.e. more elaborate maps for the expert users. Two examples from the Brú na Bóinne WHS are shown (Fig 3-4) displaying maps generated using the print button displaying firstly the OSi Discovery series map with highlighted mounds and secondly the associated LiDAR data for the area. Again map templates for print output could be created and adapted to suit different user groups. The inclusion of the printing facility within a final publicly accessible SHARE-IT application must take into account licensing and copyright regulation, including background OSi mapping[77].

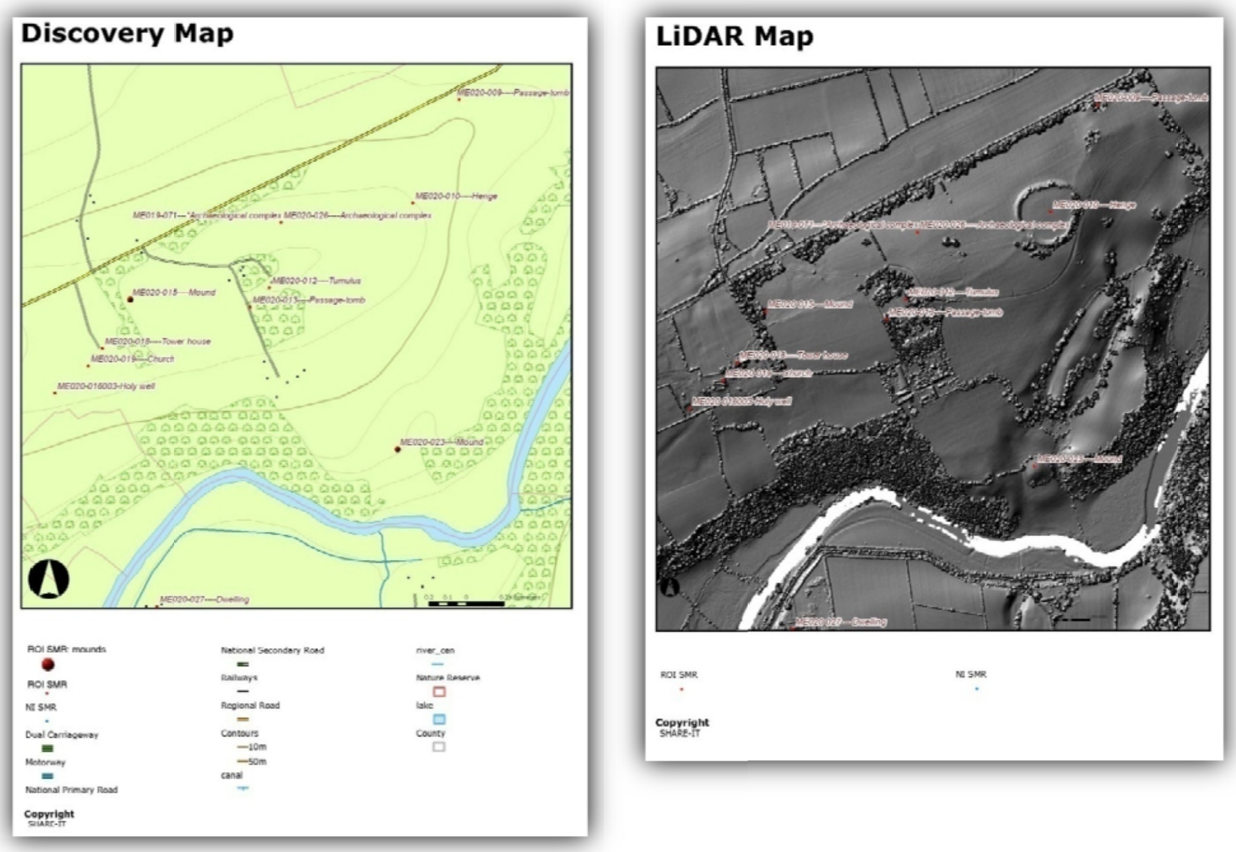


Figure 3-4: Two example print outputs from the SHARE-IT WMA displaying monuments and LiDAR data of a section of the Brú na Bóinne WHS

5. QUERY RESULTS WINDOW

The results panel displays the output from the share-it query tools (4). The panel expands automatically after running a query and the results can be expanded or collapsed as the user wishes.

6. APPLICATION BANNER

The SHARE-IT application banner at the top of the application window allows the site to be branded and consistently styled so users are easily aware of the software they are using, and the theme of the mapping application (i.e. spatial archaeological data). Both banner and colour scheme for the application can be altered accordingly if an additional mapping application was created using the same ArcGIS Server e.g. a web mapping interface to investigate through historic landscape characterisation (HLC) and landscape characterisation (LCA) data created within Ireland.

Additionally to the top right of the application banner three hyperlinks exist allowing the user to open websites for the supporting project and the funding body. The final hyperlink enables the user to access html authored help documentation explaining the major functions of the SHARE-IT web mapping application and the tools available.

7. OVERVIEW MAP

The overview map is available for the user to employ if they wish and displays a dynamically generated extent rectangle based upon the main mapping window location in relation to Ireland. This function can be activated or removed from the display using the button provided in the ArcGIS Server tool bar (3).

DATA

This section of the document outlines the spatial data requirements for the creation of the SHARE-IT WMA, including what data will be used, how this data will be stored and what additional data; such as background mapping, is required.

DATA MIGRATION

For The SHARE-IT project several example datasets where chosen to represent the range of scale and nature of the archaeological landscape record that exist at present. The source of these data sets includes: The Discovery Programme, UCD School of archaeology, Margaret Gowen & Co. Ltd and the DoEHLG – Monuments Service. To acknowledge the recommendations made in Work Package 2 the migration of this data into the SHARE-IT WMS should comply as closely to the OAIS archive model[78].

GEOPHYSICS DATA

Figure 3-5 describes the data migration strategy adopted for geophysics data in accordance with OAIS, to create a DIP suitable for use in the WMA.

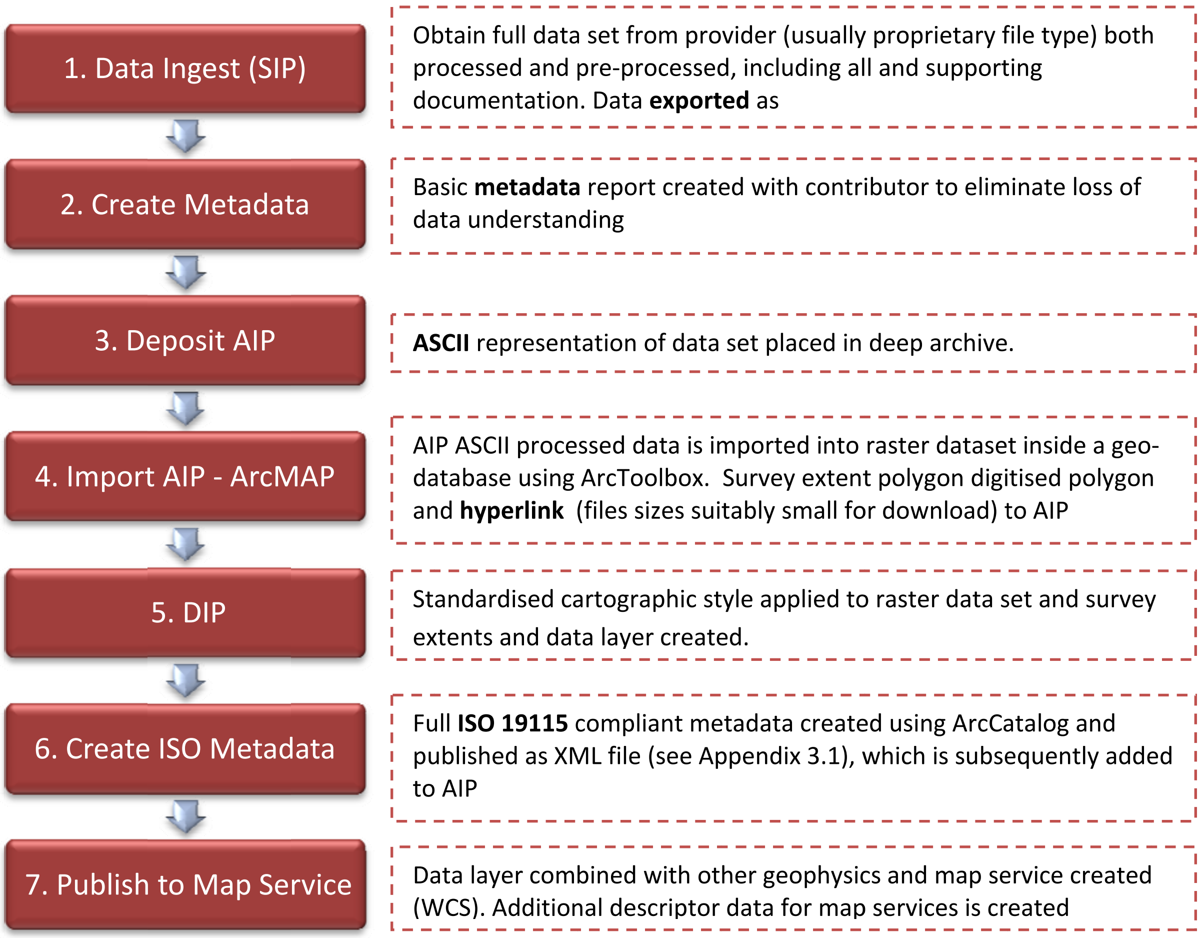


Figure 3-5: Data migration strategy for the archiving of geophysics data

AERIAL ORTHOIMAGERY DATA

Below is a data migration strategy adopted for aerial orthoimagery data in accordance with OAIS, to create a DIP suitable for use in the WMA.

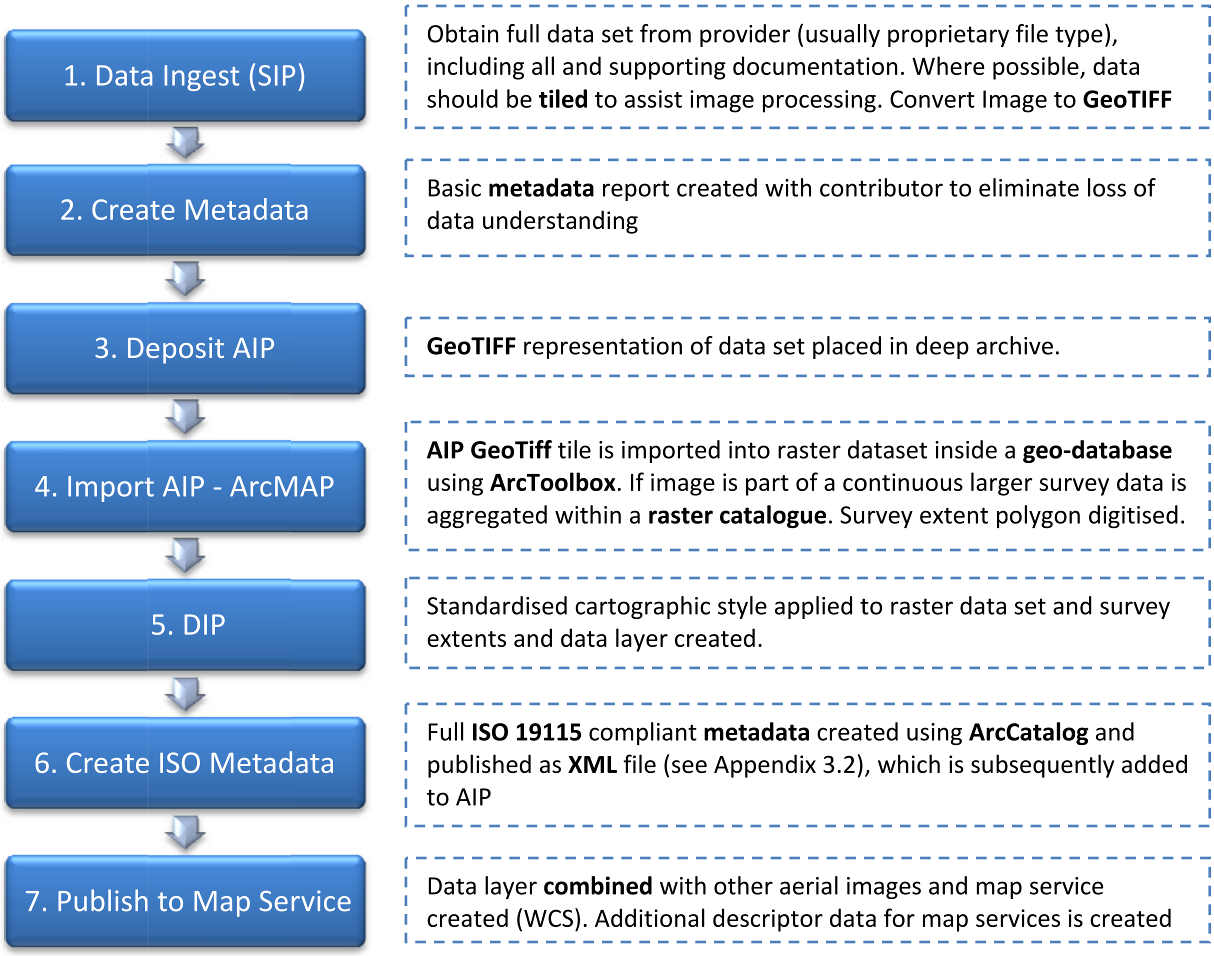


Figure 3-6: Data migration strategy for the archiving of aerial orthoimagery data

LIDAR DATA

Below is a data migration strategy adopted for LiDAR data in accordance with OAIS, to create a DIP suitable for use in the WMA.

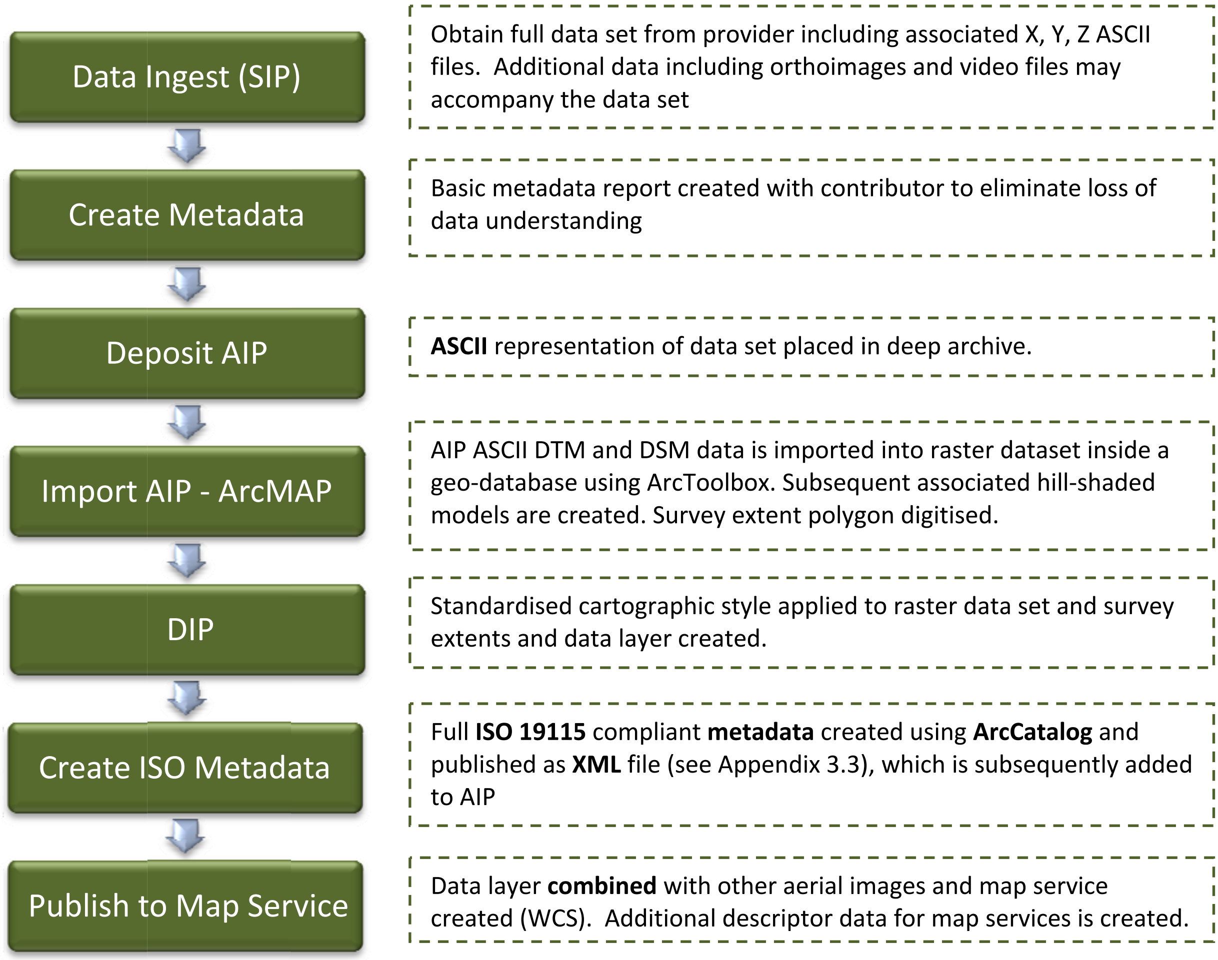


Figure 3-6: Data migration strategy for the archiving of LiDAR data

SERVER TECHNICAL CONSIDERATIONS

When creating a GIS resource for use within the SHARE-IT WMA several specific considerations must be addressed to ensure successful access is achieved

- Data must be stored so all SOC machines, in this case the server, can access it. To ensure this all data will be stored upon the same machine as the ArcGIS Server software as data volume will not be a problem within this pilot project. If a larger WMA is developed in the future and data is stored on a separate server care must be taken to use universal naming convention (UNC) paths to reference data.
- SOC machines should be granted full permissions to access data. This may involve account and domain changes depending upon the location of the spatial data.

PRODUCTION OF MAP DOCUMENTS

Once all data was submitted in compliance with the OAIS archiving methodology, the DIP components of each dataset could be utilised in the construction of suitable web mapping services. As described in section 4 web mapping services are pre-packaged GIS resources that can be consumed and displayed in a wide range of environments. Map services have been grouped into thematic topics. Each primary data type specified in the SHARE-IT aims (i.e. geophysics, LiDAR and orthoimagery) have their own map service. Within each map service different scaled examples of the data exist together with survey extents (e.g. fixed wing LiDAR vs Helicopter LiDAR). Other map services include specific case study areas including Inch Island and North Roscommon (MRSP Aerial). The aim is to produce different services that can complement each other to develop a greater understanding of the landscape and its components. The mapping services can then be consumed to create different WMA depending upon the user needs and interests. All the web services created are summarised in Table 3-1. Each Map service was created in ArcMap GIS Desktop software and suitable cartographic styles applied.

Map Service	Contributors	Description
Geophysics	Discovery Programme, Margaret Gowen & Co. Ltd	Various example from both state funded and commercial archaeology. Some data sets have been stored as images, some as raster datasets
Orthophoto	Discovery Programme, UCD School of Archaeology	Examples of aerial orthoimages created from Heritage Council funding.
LiDAR	Discovery Programme, DoEHLG, Heritage Council, Meath County Council, RIA	Two different scales of LIDAR presented including: fixed wing and a helicopter based collected data. Cartographic presentation provides hill-shade as primary record for interpretation, with user able to turn this layer of it they need to view source DTM. Both bare earth (DTM) and first return models available (DSM).
MRSP Aerial	Discovery Programme,	Selection of orthophotos, and associated interpretation from the MRSP landscape study of North Roscommon.
Base map	OSI	Multi scale background mapping to provide geographical context to archaeological landscape data
Monuments	DoEHLG, DOENI-EHS	Sites and monuments record for Republic of Ireland and Northern Ireland
Overview	OSI Data	Simple outline of Ireland to use as the overview map in the WMA

Table 3-3: Web Map Services Created for SHARE-IT WMA

In addition to the mapping services created for the SHARE-IT WMA, additional mapping services will be created for use within other map browsers or software for all the archaeological data sets. These include:

- Web Mapping Service (WMS) – OGC compliant map service that makes maps available in an open and recognised way across many different platforms.
- Web Coverage Service (WCS) – Map service that can be used within desktop GIS and ESRI ArcExplorer, suitable for raster data, e.g. LiDAR

- Web Feature Service (WFS) - Map service that can be used within desktop GIS and ESRI ArcExplorer , suitable for vector data, e.g. SMR
- Keyhole Markup Language (KML) – XML based map service for use in Google Earth

BASE MAPPING

SELECTION OF BASE MAPPING

How you select your base maps, or background mapping is very important. As this data is present on screen at nearly every point of the user experience considerations must be made to ensure rapid refresh times. Two measures can be implemented; firstly several levels of base mapping data should be used to enable the user to view the maps at different scale levels, and utilise their appropriate map generalisations. Secondly, where possible, background mapping should be in raster format. Unless the user requires access to the underlying attribute data of background mapping i.e. length of a river, or they wish to add or remove background mapping layers to suit their viewing preferences, the use of background mapping constructed for individual vector based layers can cause delays in the map display. When producing maps based upon vector data each individual vector layer has to be sequentially generated to build a single image, compared to raster data where the image is simply displayed. Another factor that promotes the use of a raster background map is the nature of the data you are displaying. As background mapping provides context and is generally not dynamic in nature (i.e. updates to the data happen annually, not daily) the use of a static raster image is suitable.

Within the SHARE-IT project we were unable to avail of access to the OSi web mapping datasets that would have provided ideal background mapping. For continued development beyond the scope of this pilot study, access and use to more suitable OSi data sets will be secured (1:600,000 raster, 1:450,000 raster, and 1:210,000 raster data sets), however these maps may contain to much information for this application and therefore must be tested with a user groups in the future. For the purpose of the demonstrator all background data sets are vector based. OSi Data Utilised:

- 1:50,000 Discovery Series Vector Map Data
- 1:210,000 Vector Map Data

MAP DISPLAY PERFORMANCE

A fundamental consideration in the creation of web mapping application is the display performance of the main mapping window. When selecting which map layers to display one must balance display efficiency with the needs of the user. Can a simple map effectively convey information to the user as a high resolution content rich map? To improve map display performance several data selections and processes can be implemented.

SCALE DEPENDENCY

When creating the map for use within the SHARE-IT web mapping application care can be taken to enable/disable mapping layers depending upon the users viewing scale. By limiting scale levels to the appropriate amount, the display performance is increased as only selected layers are refreshed. An example of this would be to disable the display of any 1:210,000 data layers beyond 1:50,000 as there is a more suitable data set available. Scale dependency is also employed on individual mapping elements to improve the viewing experience by the user. These include:

- SMR monument point data is visible at 1:250,000 with their labels observable at 1:10,000.

- Contours for the 1:50,000 map data set are displayed in two different styles: only 50m contour lines evident at 1:50,000 with all contour lines shown at 1:25,000. This rule is also applied to features which are more suitable for viewing at larger scale e.g. smaller roads and tracks are only displayed at 1:25,000.
- All archaeological data sets including geophysics, aerial imagery and LiDAR data will be represented by survey extents at smaller map scales. The scale at which the actual data becomes visible is variable depending on the geographical extent of the data set and its scale suitability (i.e. a geophysical survey of within a field would only be displayed at a much larger scale in comparison to a 80km² LiDAR survey.

All scale levels are adjustable at a later date to improve user experience.

PRE-CASHING

Pre-caching data is the ability to store scale suitable pre-rendered map display information. This is usually carried out on data that is not required to be dynamic in nature e.g. background mapping. By pre-caching, or "precooking", processing times required to render the map display are reduced to about 33%[79] are reduced. Two options are available when building a map data cache: pre-cache the data within the server before the map data is available, or cache the information locally on the user's machine. The later option is an "on demand" routine and is often suited for web mapping application that has lower user numbers and therefore less demand.

When generating a map cache a pyramid of different scaled rendered maps is created. At the top of the pyramid is the map extent at its lowest resolution (1:2,000,000). Below this in the next pyramid layer, each pixel is represented by 4 pixels and the display resolution increases (1:1,000,000) and the third layer continues by increasing the resolution and doubling the scale (1:500,000). The number of tiled images therefore increases by the power of two each time (see table 3-2). For the SHARE it Project it was estimated that 11 zoom levels would be required by users to explore the data effectively. If spatial data that requires a larger scale was introduced, e.g. excavation data, this would need to be increased to 12 or 13 pyramid levels. The time taken to generate cached layers increases as the number of levels increases and therefore must be tested upon a small area before resources are committed to process the full map extent (see table 3-2)

Map Levels	Number of Tiles	Scale Resolution	Processing Time (hours)
1	1	1:2,000,000	0.001
2	4	1:1,000,000	0.01
3	16	1:500,000	0.05
4	64	1:250,000	0.1
5	256	1:125,000	0.8
6	1024	1:75,000	4
7	4096	1:50,000	10
8	16384	1:25,000	50
9	65536	1:12,500	100
10	262144	1:7,5000	700
11	1048576	1:4,000	3000

Table 3-4: Summary of information for the pre-caching of map levels

For the purpose of the SHARE-IT WMA a small area of background mapping was pre-cached to evaluate the effect on display performance. A slight display improvement was noticed, however, due to the massive overhead in pre-caching the total data set it was decided that a for the purpose of the pilot the effort to carry out this processing would not be suitable.

EXTERNAL DATA

MONUMENT DATA

SMR

Within the SHARE-IT web mapping application the SMR was downloaded from the DoEHLG archaeology.ie web site and is symbolised within the WMA as vector point data. This representation of the data, including the coordinates of each individual point and all the associated attributes of a monument such as classification code are read dynamically from a RDBMS, in this case Microsoft Access. Users are limited to viewing the following attributes for each SMR point object: SMR No, Classification, Sub Classification Description, Inventory Notes, Registered, Excavated, National Monument, although much of the data for the later fields is not present.

NI SMR

Similarly to the ROI SMAR, a copy of the northern Ireland SMR was acquired from the Department of the Environment Northern Ireland - Environment & Heritage Services (DOENI-EHS). This data was placed in the same database as the ROI SMR and represented on the WMA using similar cartographic styles but different colours so users could differentiate between the two data sets. Users are limited to viewing the following attributes for each SMR point object: SMR No., Classification, Period, Townland, Site Name, Edited Notes, Summary, Condition and Threats.

EXTERNAL WEB MAP SERVICES (WMS)

As detailed above the source of both the ROI SMR and NI SMR was to obtain a copy of the database from the suitable source and store and serve monument data from our server. If either the DoEHLG or DOENI-EHS where to make changes or additions to their datasets this would not be reflected within the SHARE-IT data, to do this an update would be required. A more suitable model for the supply would be to implement a web services approach (see Section 4) where each legislative body would store and edit their own database of monuments internally and allow SHARE-IT WMA to access their data using interoperable machine to machine interactions, accessed over the internet. In this way any new updates made by DoEHLG will be automatically represented in the SHARE-IT WMA.

Some web mapping services are currently in operation including the Geological Survey of Ireland (GSI) WMS that provides access to most of the geological data for Ireland. Another web service that has the potential to be implemented is the Placenames Database of Ireland (www.logainm.ie). It should be possible to link OSi townland polygons to the web service to provide supplementary geographic information e.g. Barony and Parish names, and the Irish version of all place names. Enquiries into its use within the SHARE-IT project and archaeology as a whole has been welcomed and efforts are now in place to affect this.

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