Geographical referencing: A practical workshop

A joint Geo-Refer and SASPAC training event
City University London, 9 December 2008
Welcome and introductions

David Martin
Workshop contributors

- David Martin
- Samantha Cockings
- Samuel Leung
- Alan Lewis

URLs

http://www.geog.soton.ac.uk/geo-refer/index.html
http://www.saspac.org
The Geo-Refer Projects

- ESRC Researcher Development Initiative
- 2 Geo-Refer projects
- Focus on training resources in geographical referencing issues
- Particularly aimed at users who are not geographers/geographical information specialists
- Current emphasis on census, local government and health communities
SASPAC

• Small Area Statistics Package

• Owned and managed by the Public Sector and is ‘not for profit’

• Funded purely through user’s annual subscription fees

• Peak membership over 380 organisations (inc. local, central and regional gov’t, health sector, academia, Census Offices, private sector)

• Strong association with the Census (1981-2001) - developed by Census data users for Census data users
Purpose of the workshop

• Conceptual understanding of issues involved in geographical referencing of social, economic and environmental datasets

• Practical skills and methods, including some key datasets – hands-on session with own data or examples provided

• Share questions and experiences with contributors and participants
Schedule of the day

09:30  Arrival and coffee
10:00  Welcome and introductions – David Martin
10:20  Geo-referencing concepts and methods – David Martin and Samantha Cockings
11:30  Break
11:50  Geographical referencing using SASPAC – Alan Lewis
13:00  Lunch
13:45  Briefing for hands-on workshop session
14:00  Hands-on session (participants’ may use own datasets)
16:00  Summary and overview of lessons learned
16:15  Close
Rules of engagement

- This is an informal workshop
- There is no such thing as a silly question!
- Please interrupt
Georeferencing examples

- Link survey results to census data
- Relate local services to indices of deprivation or area classifications
- Aggregate and map local data with national Neighbourhood Statistics
- Identify which service delivery locations fall within different policy areas
Why georeference?

- Massive growth in geographical data
- Adds analytical value
- Fundamentally, geographical referencing leads to either:
  - Data linkage, potentially for aspatial analysis
  - Mapping, and other forms of spatial analysis
Geo-referencing concepts and methods

David Martin, Samantha Cockings
Geographical referencing of social science phenomena: 1

- Characteristics of people or events, recorded at mail addresses
- Geographical location of mail address
Geographical referencing of social science phenomena: 2

- Administration or policy related to defined areas, aggregations of individuals
- Geographical location of area boundaries
Geographical referencing of social science phenomena: 3

- Phenomena that are linear, describing routes or flows
- e.g. bus route, telephone conversation, social network link
Geographical referencing of social science phenomena: 4

- Phenomena or events that have locations but do not fit standard descriptions
  - e.g. road accident, environmental quality
Geographical referencing of social science phenomena: 5

- Complex phenomena not captured by a simple location
- e.g. business locations, catchment populations
Geographical object types

**POINTS**
- E.g.
  - Health data
  - Meteorological data
  - Pollution sources
  - Hospitals
  - Landfill sites

**LINES**
- E.g.
  - Roads
  - Powerlines
  - Railways
  - Rivers

**AREAS**
- E.g.
  - Enumeration Districts
  - Wards
  - Health Authorities
  - Grid squares
  - Water supply zones

+ NETWORKS?

+ SURFACES?
Geographical object types

- **Points:** a single pair of coordinates
- **Lines:** an ordered sequence of coordinates
- **Areas:** closed, ordered sequences of coordinates
- **Networks:** complex line-based structures
- **Surfaces:** mathematically modelled representations of continuously varying phenomena
Direct and indirect georeferencing

- Direct georeferencing: explicit coordinate system
  - Lat/Long, Ordnance Survey grid reference
- Indirect georeferencing: any type of area code or name relating to a known location
  - Postcode, Zip code, County, Census output area/enumeration district/tract; local government district; health authority, etc...
Where do coordinates come from?

- Surveys for mapping
- Remote sensing
- Digitising paper source documents
- Direct capture using Global Positioning System (GPS) receiver
- **Generally contributing to reference datasets created for re-use**
Accuracy and precision

- **Accurate location**
  - free from locational bias
  - e.g. respondent lives in Southampton

- **Precise location**
  - provides detail (but not necessarily accurate)
  - e.g. respondent lives at 25b Highfield Lane

- **Need to assess and adopt different strategies according to purpose**
Scale and projection

- Map scale
  - Explorer map: 1:25,000
  - Road atlas: typically 1:400,000
- Leads to inclusion/generalization of different features, boundary details, etc.
- Projection systems:
  - Very important when using lat/long datasets,
  - GB National Grid sidesteps the issues...
Locations and attributes

- Locations: points, area boundaries
- Attributes: values, characteristics
Geoprivacy issues

- Detailed location is potentially disclosing
- Postcode is generally considered to be sensitive information
- Explicit subject consent in data collection?
- Subject identification may be possible through linkage and mapping
- All usual rules apply!
What about GIS?

- Massive growth in use of GIS since early 1980s: complex information systems
- GIS growth promoting data standards, growth of geoinformation industry etc.
- GIS provide useful georeferencing tools and lots of other functions not needed here...
- MapShore mapping system within SASPAC
- This is not a GIS course!
Georeferencing methods: linking data
Tabular data linkage example

Research question: What is the relationship between asthma and deprivation?

<table>
<thead>
<tr>
<th></th>
<th>Asthma rates</th>
<th>GP surgeries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dataset 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Deprivation scores</th>
<th>Super Output Areas</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dataset 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tabular data linkage example

Tabular linkage requires lookup(s) between georeferences on two or more datasets

Dataset 1

<table>
<thead>
<tr>
<th>Asthma rates</th>
<th>GP surgeries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postcodes of GP surgeries</td>
<td></td>
</tr>
<tr>
<td>Postcode to Super Output Area LUT</td>
<td></td>
</tr>
</tbody>
</table>

Dataset 2

<table>
<thead>
<tr>
<th>Deprivation scores</th>
<th>Super Output Areas</th>
</tr>
</thead>
</table>

Assumes surgery is appropriate georeference for patient data!
Tabular linkage tools

• Access, SPSS etc. – general purpose database or statistical packages for matching lists with common data items

• SASPAC provides facilities for data aggregation from gazetteer files, e.g. from census OAs to locally-defined neighbourhoods
Data linkage example: input tables

Coded survey responses

Postcode directory

Respondent ID

Gender

Postcode

Postcode

Ward code
Watch the time!

- Extreme care needs to be taken when matching between datasets relating to different dates
- Postcodes, boundaries, area names all subject to change
- All changes on different timescales
- Assume another time = another geography!
Georeferencing methods: mapping data
Mapping

- Map locations of points and/or areas
  - e.g. grid-refs of survey responses
  - e.g. boundaries of Lower Layer Super Output Areas (LSOAs)
- Map attributes of areas
  - e.g. Link survey responses on attitudes to recycling to wards, then map response rates by ward
Mapping grid-referenced points

Grid-refs of car crimes

465474,103429
465490,103409
465517,103409
465507,103374
465703,103334
465791,103271
465869,103294
465577,103238
465825,103146
465673,103129
Linking attribute data to boundary data

Area-based attribute data

```
BEATID, NAME, NOFFS, AUTH
1, westend, 30, Anywhere
2, Southend, 20, Anywhere
3, Eastend, 5, Nowhere
4, Northend, 10, Nowhere
```
Mapping area data: Categorical

Map states of USA shaded by sub-region
Mapping area data: Continuous

Map states of USA shaded by population density
Spatial data linkage

- Where no tabular linkage exists between data
- Can use GIS operations to match points to areas or areas to areas
  - e.g. grid referenced accidents matched to own neighbourhood boundaries
  - e.g. clinic catchment areas to new ward boundaries
Allocation and aggregation

- Allocate
  - e.g. allocate attributes of police beats to car crime locations

- Aggregate
  - e.g. aggregate number of car crimes in each police beat

- Same spatial linkage operation, but different outputs
Modifiable areal unit problem

• Pattern observed in shaded area census maps are artifact of boundaries used
  – Different boundaries would produce different pattern, even with same population
  – Relationships at one level of aggregation need not hold at any other level (ecological fallacy)
Implications for some commonly-used datasets
Census geography: codes and boundaries

• Area hierarchy and codes
  – e.g. 25JPUF0005
  – Output Area (no names) 0005
  – Ward UF
    – LADs (county/district 25JP or unitary authority 00JP)
• Digital boundaries
  – Available all levels from OA upwards
Southampton: 2001 output areas and wards
Census geography: relationships

- Relationship to other geographies
  - OAs mostly built from unit postcodes
  - OAs nest within LSOAs

- Change over time
  - No direct relationship between 2001 and previous censuses
  - Wards (and local authorities) change between censuses
Census geography: future

- ONS and University of Southampton development work underway
- Basic principle of stability, from user consultation
- Some essential splits and mergers to accommodate inter-censal population change
- Very limited redesign due to 2001 census deficiencies
- Aim is for revisions to be nested and geographically constrained
Postcodes: coding structure

- Area hierarchy and codes
  - Unit postcode (NOT areas) BS8 1SS
  - Sector BS8 1
  - District BS8
  - Area BS
- Large/small users/non-geographic codes
Postcodes: spatial referencing

e.g. Ordnance Survey Code-Point

http://www.ordnancesurvey.co.uk/oswebsite/products/codepoint/
Postcodes: relationships

• Relationship to other geographies
  – Controlled directly by Royal Mail
  – No direct relationship to any other geographical units

• Change over time
  – Continuous small-scale change
  – Periodic large-scale reallocation
  – Eventual reuse of discontinued codes
National Statistics Postcode Directory (NSPD): what is it?

- A long list of UK postcodes
- Produced by ONS, Royal Mail and Ordnance Survey
- Multiple additional geographical codes
- Postcode metadata
- Updated quarterly
Morning break!!!
Geographical referencing using SASPAC

Alan Lewis
Overview:

- Introduction to SASPAC
- Software features
- Accessing data (worked example 1)
- Data aggregation/rezoning (worked example 2)
- Mapping data in MapShore (GIS) (worked example 3)
Introduction to SASPAC: 1

- Software to provide link between the complex Census data provided by the Census Offices and the user
- Store, manipulate, export and publish Small Area Statistics (LAs, wards, Output Areas, SOAs, Postcodes)
- Desktop, network, thin-client application
- Owned by IDeA and managed by GLA
- ‘Not for profit’ initiative
Introduction to SASPAC: 2

- Peak at almost 400 organisations following the release of 2001 data
- UK – wide user group, includes: local, central & regional gov., Health sector, Census Offices, Academia, Private sector
- Site licence is £1350+VAT and annual Support fee is £600+VAT
- Developed for the users by the users - SASPAC Advisory Panel (SAP)
Introduction to SASPAC: 3

- Software releases – current v9.00 Nov’08
- Software maintenance/upgrades/enhancements
- Historical and new datasets
- Helpdesk support/advice (web, email, phone)
- Training
Software features: 1

- All 2001 Census datasets
- 2001 Special Workplace and Migration Statistics
- 2001 Specially Commissioned Tables (500 so far!)
- New geographies (SOAs, new wards, PCTs, Parliamentary Cons...etc)
- 1981/1991 Census datasets
- Non-Census (IMD, OAC, local datasets)
Software features: 2

• Customise - create new variables, zones, tables
• Select IF statements (e.g. zones where 0-15>15%)
• GIS selections (polygons, buffers, circles)
• Print tables – export to Excel, HTML
• Print variables – export to delimited, CSV, XML
Software features: 3

- Integrated GIS - MapShore
- Integrated Web Publishing tool
- Google™ Maps integration
- Google™ Earth export
Accessing data: 1

- SASPAC task sequence:
  1. What output do you require?
  2. Select appropriate mode
  3. Define input (system) file
  4. Select required data
  5. Select required area
  6. Export File
     - Spreadsheet
     - CSV text
     - Web page
  7. Print file
  8. Table(s)
  9. Variable(s)
Accessing data: 2

Concepts:

- Windows
- Command files
- System files
- Framework files

### 2001 Census Standard Tables

**Table ST001 AGE BY SEX AND RESIDENT TYPE**

**Table population: All people**

<table>
<thead>
<tr>
<th></th>
<th>ALL PEOPLE</th>
<th>Communal Establishment residents</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Household residents</td>
<td>Total</td>
</tr>
<tr>
<td><strong>0 to 4</strong></td>
<td>2,926,238</td>
<td>2,923,246</td>
<td>2,992</td>
</tr>
<tr>
<td><strong>5 to 9</strong></td>
<td>3,122,529</td>
<td>3,119,999</td>
<td>3,520</td>
</tr>
<tr>
<td><strong>10 to 14</strong></td>
<td>3,229,047</td>
<td>3,199,552</td>
<td>29,492</td>
</tr>
<tr>
<td><strong>15 to 19</strong></td>
<td>3,338,291</td>
<td>3,317,592</td>
<td>5,771</td>
</tr>
<tr>
<td><strong>20 to 24</strong></td>
<td>3,455,450</td>
<td>3,435,698</td>
<td>30,528</td>
</tr>
<tr>
<td><strong>25 to 29</strong></td>
<td>3,573,611</td>
<td>3,555,672</td>
<td>43,202</td>
</tr>
<tr>
<td><strong>30 to 34</strong></td>
<td>3,693,728</td>
<td>3,676,990</td>
<td>3,772</td>
</tr>
<tr>
<td><strong>35 to 39</strong></td>
<td>3,816,842</td>
<td>3,800,316</td>
<td>2,526</td>
</tr>
<tr>
<td><strong>40 to 44</strong></td>
<td>3,942,062</td>
<td>3,926,278</td>
<td>1,784</td>
</tr>
<tr>
<td><strong>45 to 49</strong></td>
<td>4,071,342</td>
<td>4,056,575</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>50 to 54</strong></td>
<td>4,203,670</td>
<td>4,189,804</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>55 to 59</strong></td>
<td>4,339,078</td>
<td>4,325,213</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>60 to 64</strong></td>
<td>4,478,522</td>
<td>4,464,659</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>65 to 69</strong></td>
<td>4,612,018</td>
<td>4,600,154</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>70 to 74</strong></td>
<td>4,748,564</td>
<td>4,734,700</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>75 to 79</strong></td>
<td>4,888,188</td>
<td>4,874,324</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>80 to 84</strong></td>
<td>5,028,884</td>
<td>4,914,916</td>
<td>1,747</td>
</tr>
<tr>
<td><strong>85+</strong></td>
<td>5,171,620</td>
<td>5,057,648</td>
<td>1,747</td>
</tr>
</tbody>
</table>
Accessing data: 3

- Extracting variables:
  1. Select a System file
  2. Select the table set you require
  3. Select the table that contains the topic(s) of interest
  4. Search and select the variable(s) of interest
  5. Select geographic areas of interest from a list or a map
  6. Print the output

There are 18 children aged 0-4 in this area of Spelthorne - 6.14% of the population
Worked example: 1

- Print the 2001 Census Key Statistics table relating to country of birth for all the wards in your own Local Authority. Preview the output in SASPAC, Excel and in Internet Explorer as an HTML file.
Data aggregation/rezoning: 1

- Often required to aggregate zones to build new ones
- e.g. police beats, GP catchments, workplace areas
- Use existing points or boundaries as building blocks
Data aggregation/rezoning: 2

- SASPAC can create new zones in two ways:
  1. Combining explicitly identified existing zones
  2. Reference to a gazetteer file containing allocations of existing zones to new areas

Existing zone (1-10)  New zone (13-18)  Scaling factor (21-24)
Data aggregation/rezonning: 2

- SASPAC can create new zones in two ways:
  
  1. Combining explicitly identified existing zones
  
  2. Reference to a gazetteer file containing allocations of existing zones to new areas
  
- In both cases, a new System file is created
Data aggregation/rezoning: 3

• New zones may be created by:

  1. Adding existing zones together

  2. Subtracting an area from another area of higher geographic level (e.g. ward from a LA)

  3. Use scale factors to allocate proportions of existing areas to new zones
Data aggregation/rezoning: 4

• For example:

Spelthorne (LA)
Stanwell North (ward)
0018 (Output Area)
Police beat 1
Data aggregation/rezoning: 4

Police beat 1:

Stanwell North 43UHGD (without 0018)
....and 43UHGB0013
Police beat 1a is a subset of beat 1, and consists of:

Stanwell North 43UHGD (without 0018)

...and ⅓ of 43UHGB0013.
Worked example: 2

- Create a new zone that comprises of all the 2001 output areas that fall within 0.5km of Paddington rail station. Print the total resident population, males and females that fall within this new zone.
GIS – MapShore: 1

- SASPAC’s integrated GIS
- native format is .bdy (import .shp/.MIF)
- 2001 Census Output Area boundaries available from helpdesk
- Other Census boundaries (ward, LAs) also available from Pebblesshore via the helpdesk
GIS – MapShore: 2

- Tools:
  1. Individual polygon selection
  2. Polygons within (partly/completely) a circle
  3. Polygons within (partly/completely) a buffer

- Export polygons back to SASPAC
GIS – MapShore: 3

1. Export a CSV file from SASPAC
2. Select variables
3. ‘Go Mapping’
4. Retrieve .bdy file
5. Retrieve area data
GIS – MapShore: 4

1. Create a CSV file of point data, grid references, photos
2. Retrieve .bdy file
3. Retrieve Point data file (CSV) and define SET file
4. Display points
5. Filter points

Incidents of knife/gun crime
Worked example: 3

- Export and map a CSV file representing the percentage of residents who recorded their ethnic group as Bangladeshi in the 2001 Census for all the wards in the City of Westminster.
More help...

- [www.saspac.org](http://www.saspac.org) (news, examples, training manual, slides, videos...etc)
- Email support: info@saspac.org
- Phone support: 020 7983 4348
- Demos, training at City Hall/on location
Briefing on afternoon practical sessions
Using the Geo-Refer resources

- Complete the user profile form
  - Specify own profile and Geo-Refer will best-match learning materials

- Browse the resources
  - Extensive list of concepts, methods, datasets and examples

- URL - [http://www.geog.soton.ac.uk/geo-refer/workshop5.html](http://www.geog.soton.ac.uk/geo-refer/workshop5.html)
Geo-Refer user profile form

Part 1 - Personal Information

In order to allow us to assign a valid URL to your customised tutorial page, please enter your full email address and a title for the tutorial (using letters, numbers, dot, underscore or space) in the boxes below. The URL of the page will be automatically sent to your email address when the form is completed.

Email Address: ____________________________  Tutorial Page Title: ____________________________

Your discipline

Below is the list of main disciplines and subjects recognised by ESRC. If you are working within the social sciences (whether or not from within the academic sector), please choose the nearest subject(s) to your own project/study. Your answer will help us to search for examples relevant to your interests.

- Area and Development Studies
- Economics
- Education
- Human Geography
- Management and Business Studies
- Psychology
- Social Policy
- Socio-Legal Studies
- Science and Technology Studies
- Arts and Humanities
- Engineering
- Demography
- Economic and Social History
- Environmental Planning
- Linguistics
- Political Science and International Studies
- Social Anthropology
- Social Work
- Sociology
- Statistics, Methods and Computing
- Biological Sciences
- Physical Sciences incl. Astronomy and Particle Physics
Customised set of learning resources

Joe Bloggs
Map points
Postcodes
2006
England
UK Academic
ArcGIS/Access
Health

Concepts
- Points
- Areas
- Postcodes
- Censuses
- Accuracy

Datasets
- 2001 Census: E&W
- NSPD
- IMD2004

Methods
- Map a set of points in ArcGIS
- Joining lists in Access
- Reformat postcodes in Access

Examples
- Transport
- Health
- Planning

A self-contained learning object/activity
A core learning path
Recommended additional learning
Customised online tutorial

Joe Bloggs
Map points
Postcodes
2006
England
UK Academic
ArcGIS/Access
Health
Concepts
Datasets
Methods
Examples
Points
Areas
Postcodes
Censuses
Accuracy
2001 Census: E&W
IMD2004
Joining lists in Access
Reformat postcodes in Access
Transport
Health
Planning

Postcodes
Health
Map a set of points in ArcGIS
Points
Areas
Censuses
Accuracy
2001 Census: E&W
IMD2004
Joining lists in Access
Reformat postcodes in Access
Transport
Health
Planning

GEO-REFER Learning Resources Repository
Microsoft Internet Explorer

Customised online geo-referencing Learning Resources
:: Concepts
- Points
- Postcodes
- Accuracy and precision
:: Datasets
- National Statistics Postcode Directory (NSPD)
:: Methods
- Mapping a set of points in ESRI ArcGIS
- Reformating postcodes in Microsoft Access
:: Examples
- Health
- Planning

Additional Resources
Plan learning activities

- Think about what you’ve just heard
- Think about your own requirements
- Browse the Geo-Refer learning resources
- Identify what you’d like to work on (individually or in groups) and let us know
Some ideas

• Link performance table of the primary schools in a London borough to grid references using Microsoft Access

• Download ID2007 data from SASPAC and/or Neighbourhood Statistics service

• Retrieve Census and output area boundaries from SASPAC

• Map schools and deprivation information using MapShore

• Or use own datasets...
Lunch!!!
Round-up and feedback
Workshop evaluation form
Really useful tools/datasets
<table>
<thead>
<tr>
<th>Postcode Directory</th>
<th>Numerous other codes, esp. changing health geographies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postcode</td>
<td>Numerous derived lookup tables</td>
</tr>
<tr>
<td>Ordnance Survey Grid Reference</td>
<td>AKA All Fields Postcode Directory, Central Postcode Directory, Postzon file…</td>
</tr>
<tr>
<td>Dates of introduction and termination (if applicable)</td>
<td>Used in GeoConvert</td>
</tr>
<tr>
<td>Delivery point count</td>
<td>Downloadable from UKBORDERS; registration required</td>
</tr>
<tr>
<td>2001 Census geography codes</td>
<td></td>
</tr>
<tr>
<td>1991 Census geography codes</td>
<td></td>
</tr>
</tbody>
</table>

[http://ukborders.census.ac.uk](http://ukborders.census.ac.uk)
UKBORDERS Digital Boundary Data

Coordinates of area boundaries downloadable in various GIS and mapping formats

Primarily census-derived, covering whole UK

Census, administrative, health and electoral geographies

Includes some historical (pre-1971 boundary sets e.g. 1951 local government

Need to understand which zones are needed

Need suitable software to load the boundaries

Large data volumes and further manipulation often required

No attribute data

Downloadable from UKBORDERS; registration required

http://ukborders.census.ac.uk
Neighbourhood Statistics Services

Wide range of easily downloadable social data
Includes basic 2001 census datasets and administrative data derived from government departments
Searchable by many different georeferences
Some online mapping and analysis
Simple – general audience

Only covers most basic datasets
No lookup tables or boundary data downloadable, just statistics for areas
Data formatting can be frustrating for serious user
Freely accessible from ONS, GROS, NISRA websites; registration increases functionality

http://www.neighbourhood.statistics.gov.uk
Online explanatory material about contemporary UK boundary systems
Includes census, postal, administrative, electoral, health and other geographies
Useful links to other resources
Very clear – written for general audience
Good reference for students!

Does not cover historical datasets: essentially describes the post-2001 census situation
No downloadable data, just explanatory guidance
Freely accessible from ONS website

<table>
<thead>
<tr>
<th>Other useful sites…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royal Mail Postcode Finder and Address Finder</td>
</tr>
<tr>
<td><a href="http://www.royalmail.co.uk">http://www.royalmail.co.uk</a></td>
</tr>
<tr>
<td><a href="http://census.ac.uk/casweb">http://census.ac.uk/casweb</a></td>
</tr>
<tr>
<td>Digimap – Ordnance Survey mapping, inc. historical</td>
</tr>
<tr>
<td><a href="http://www.edina.ac.uk/digimap">www.edina.ac.uk/digimap</a></td>
</tr>
<tr>
<td>Google Earth and Microsoft Live Search Maps</td>
</tr>
<tr>
<td><a href="http://www.earth.google.com">www.earth.google.com</a></td>
</tr>
<tr>
<td><a href="http://www.maps.live.com">www.maps.live.com</a></td>
</tr>
</tbody>
</table>