National Centre for Geocomputation
An tIonad Náisiúnta Geoiríomhaireachta

# THE NATIONAL CENTRE FOR GEOCOMPUTATION

**Stewart Fotheringham**
**http://ncg.nuim.ie**

science foundation ireland
fondúireacht eolaíochta éireann

StratAG
Strategic Research in Advanced Geotechnologies
Taighde Straitéiseach sna hArd-Gheoteicneolaíochtaí

NUI MAYNOOTH
Ollscoil na hÉireann Má Nuad

# Background

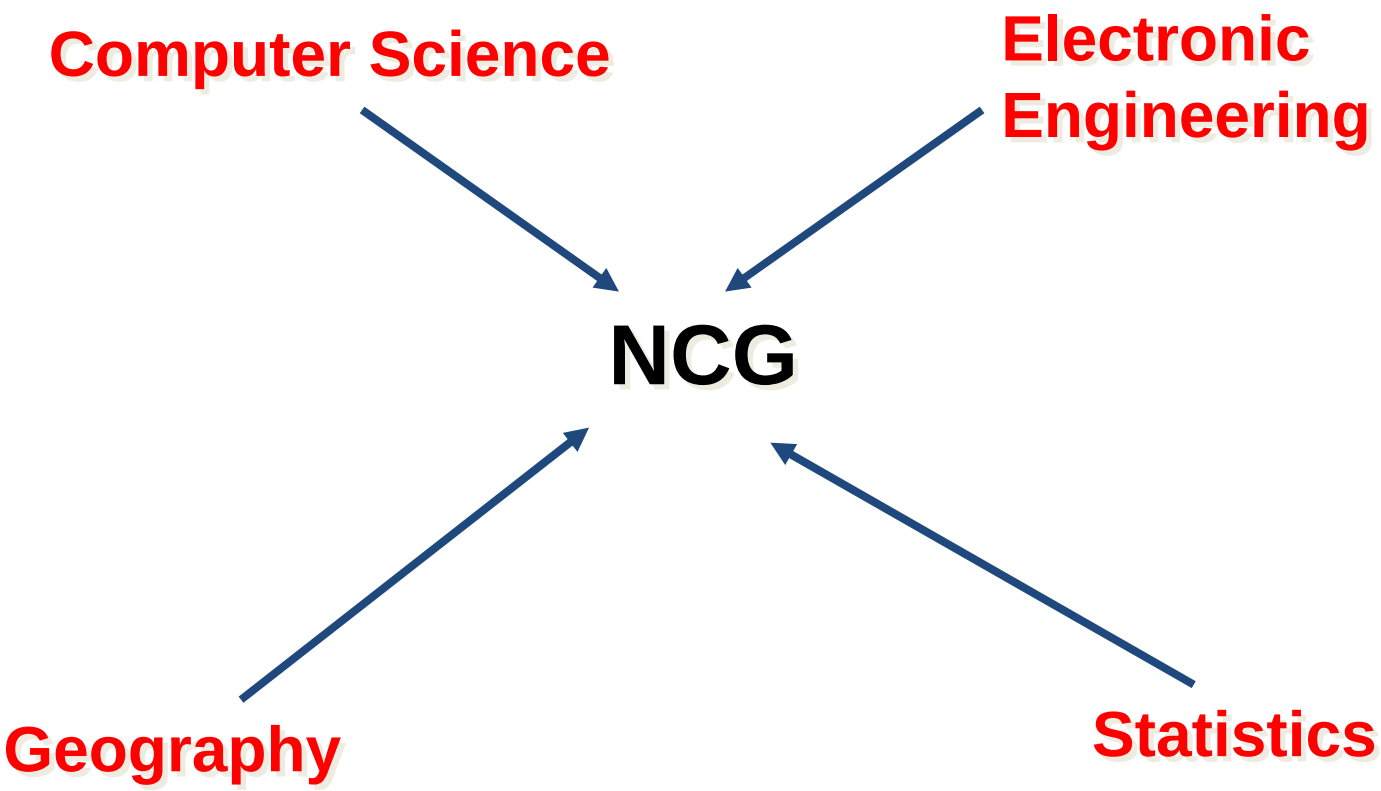
- **Established with award of SFI Research Professorship €2.5 m**
- **Start date – Sept 01, 2004**
- **Grown from 4 to 40 employees**
- **Independent research centre within NUIM**
- **Lead group within StratAG, €8m**

# What do we do?

Geocomputation involves any aspect of the capture, storage, integration, management, retrieval, display, analysis and modelling of **spatial data**

**Spatial data** contain **locational** info as well as **attribute** info. Most data sets are spatial.

# Academic Meeting Ground



# Aims of NCG

- Undertake fundamental research into three main areas: *geocomputational algorithms and modelling; spatial data structures; and applied geocomputational research*
- Position Ireland as key global centre in Geocomputation.
- Help stimulate use of and research into GISc in Ireland
- Attract researchers with international reputations to Ireland
- Undertake research on Irish spatial data issues.

# Examples of Projects

- Spatially encoded digital video
- Development of Geographically Weighted Regression
  - Statistical issues
  - Software development
  - Applications
- Creation of new geography for Ireland – 17,000 polygons for census data (with OSi)
- Sea bed mapping from SB and MBES (with GSi)
- Lead partner in StratAG

StratAG
Strategic Research in Advanced Geotechnologies
Taighde Straitéiseach sna hArd-Gheoteicneolaíochtaí

# Overview

Stewart Fotheringham
*Professor of Geocomputation*
*Director, National Centre for Geocomputation, NUIM*

Research presented in these slides was funded by a Strategic Research Cluster Grant (07/SRC/I1168) by Science Foundation Ireland under the National Development Plan. The authors gratefully acknowledge this support.

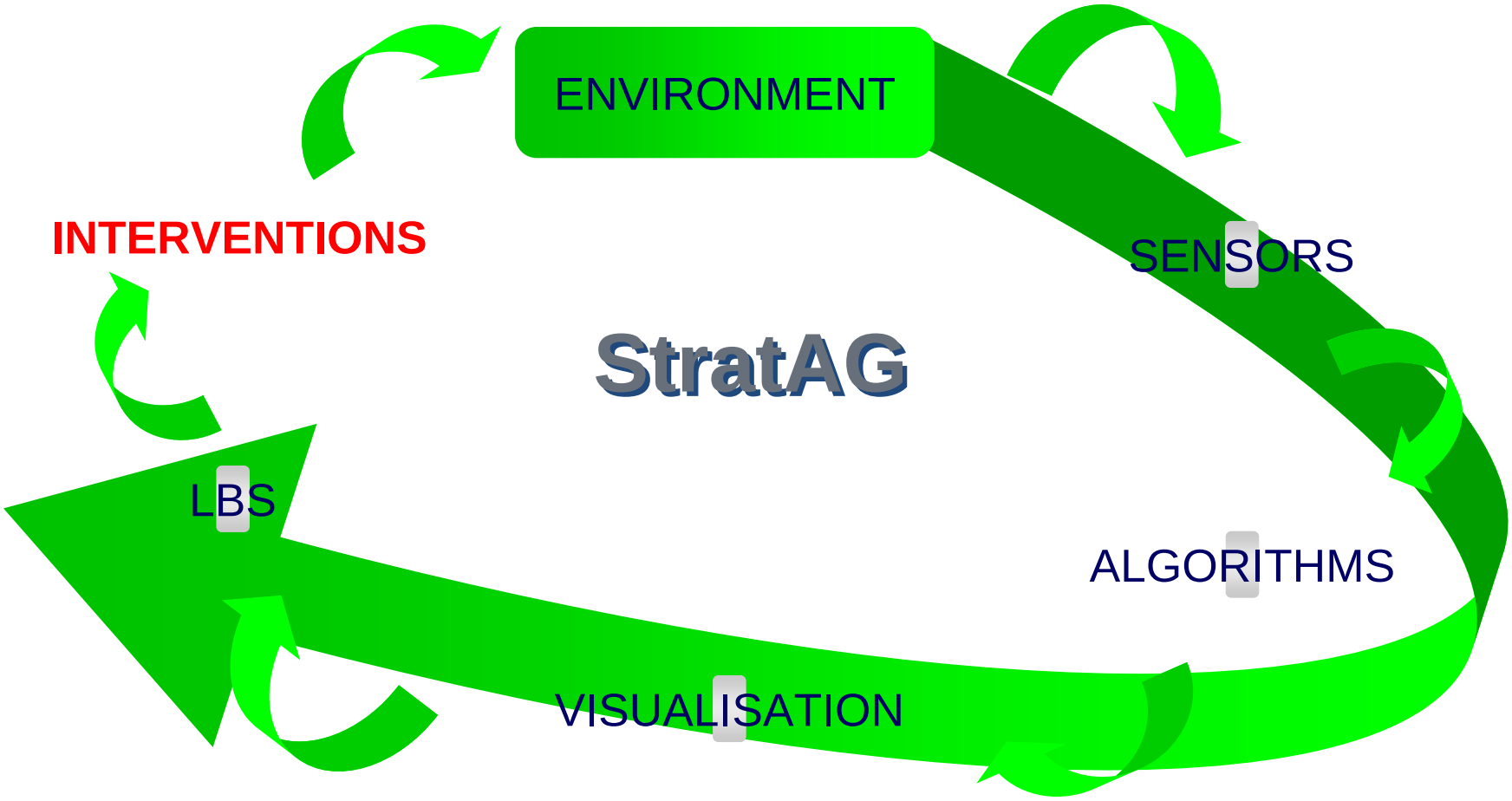
# What are Advanced Geotechnologies?


- RECORDING
- PROCESSING
- VIEWING
- DISSEMINATING

**GEOCODED ATTRIBUTES OF OUR ENVIRONMENT**

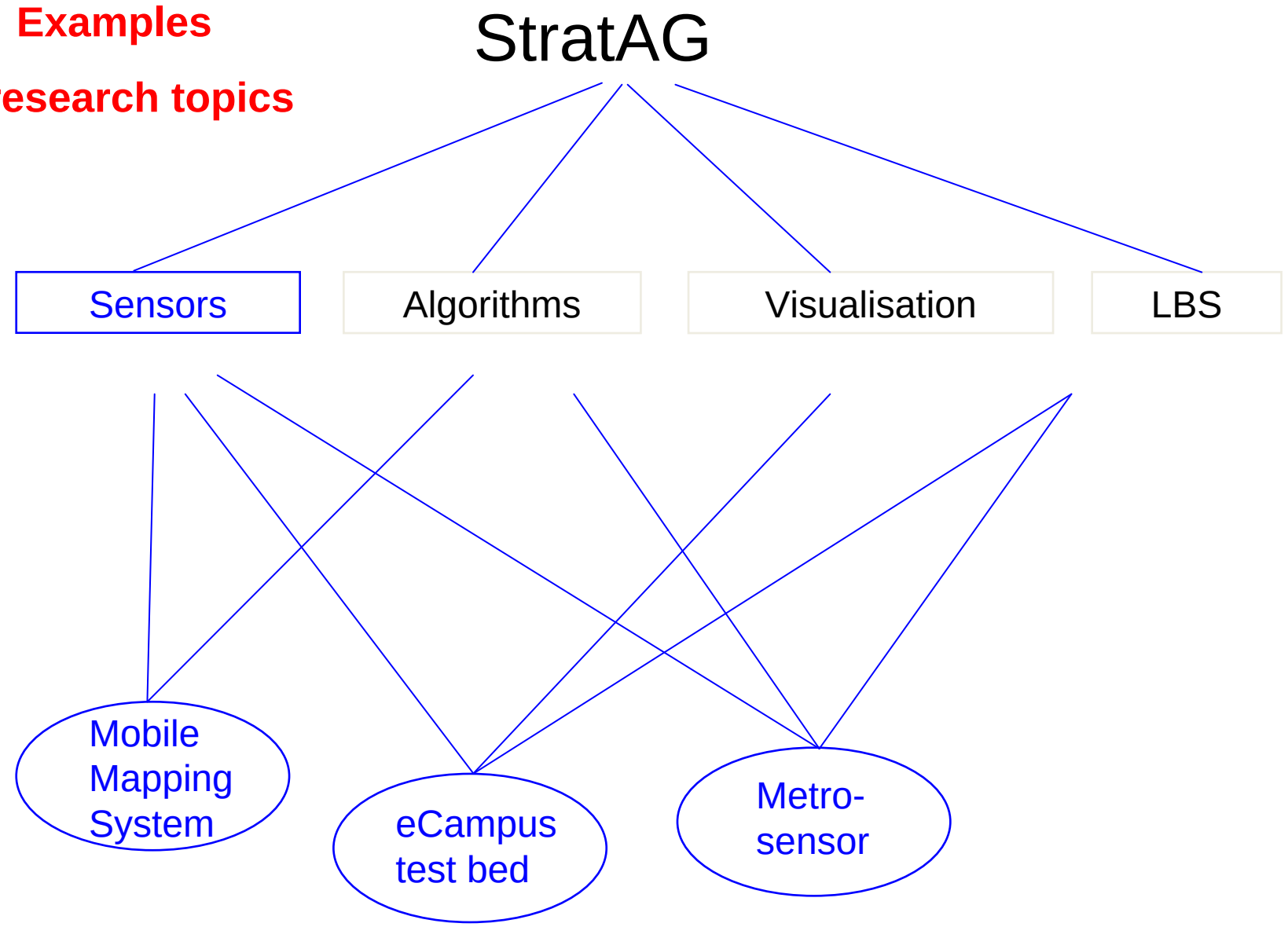
- Knowing where things are
- Knowing where things are in relation to other things
- Making more informed decisions

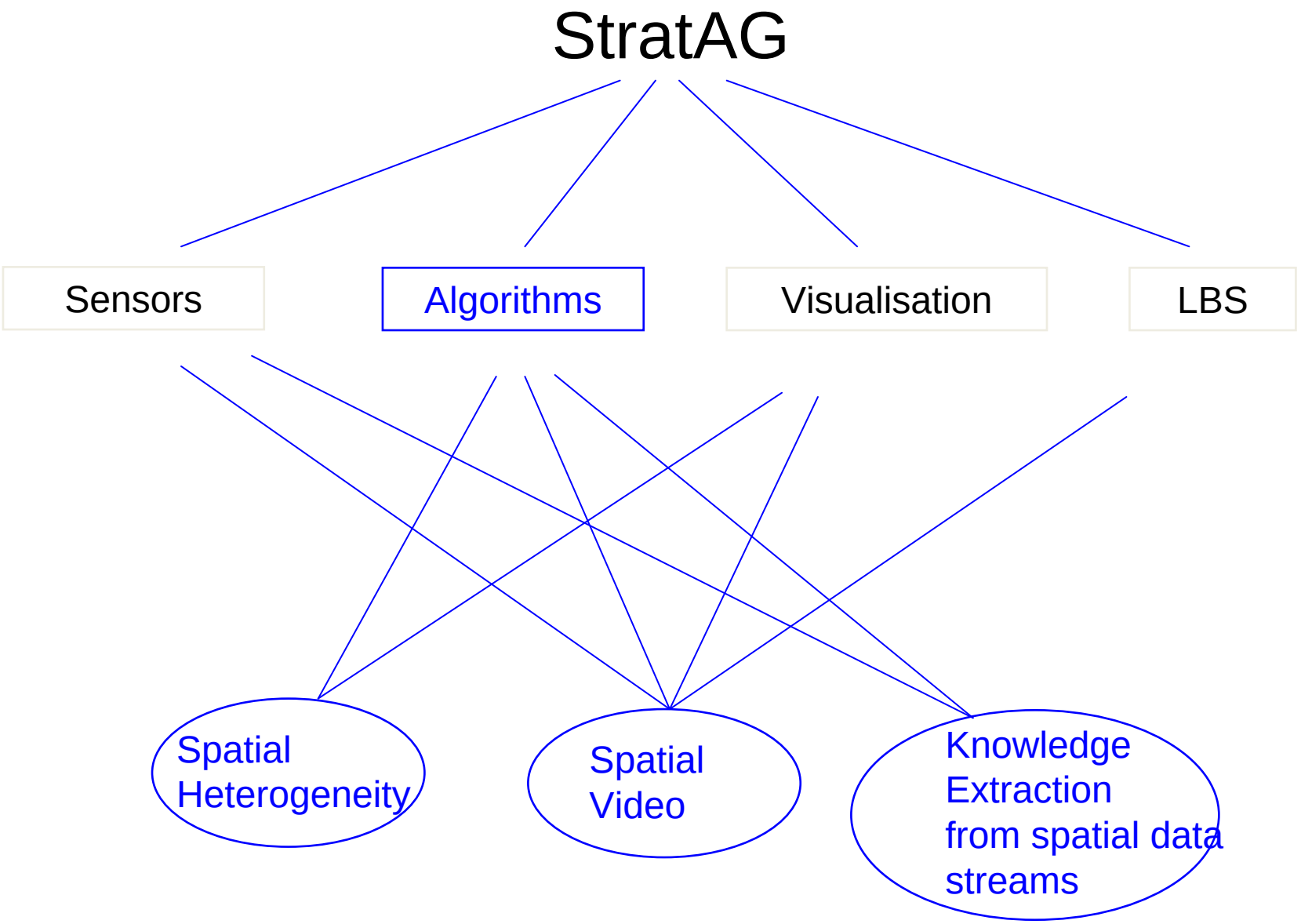
# How is this done?

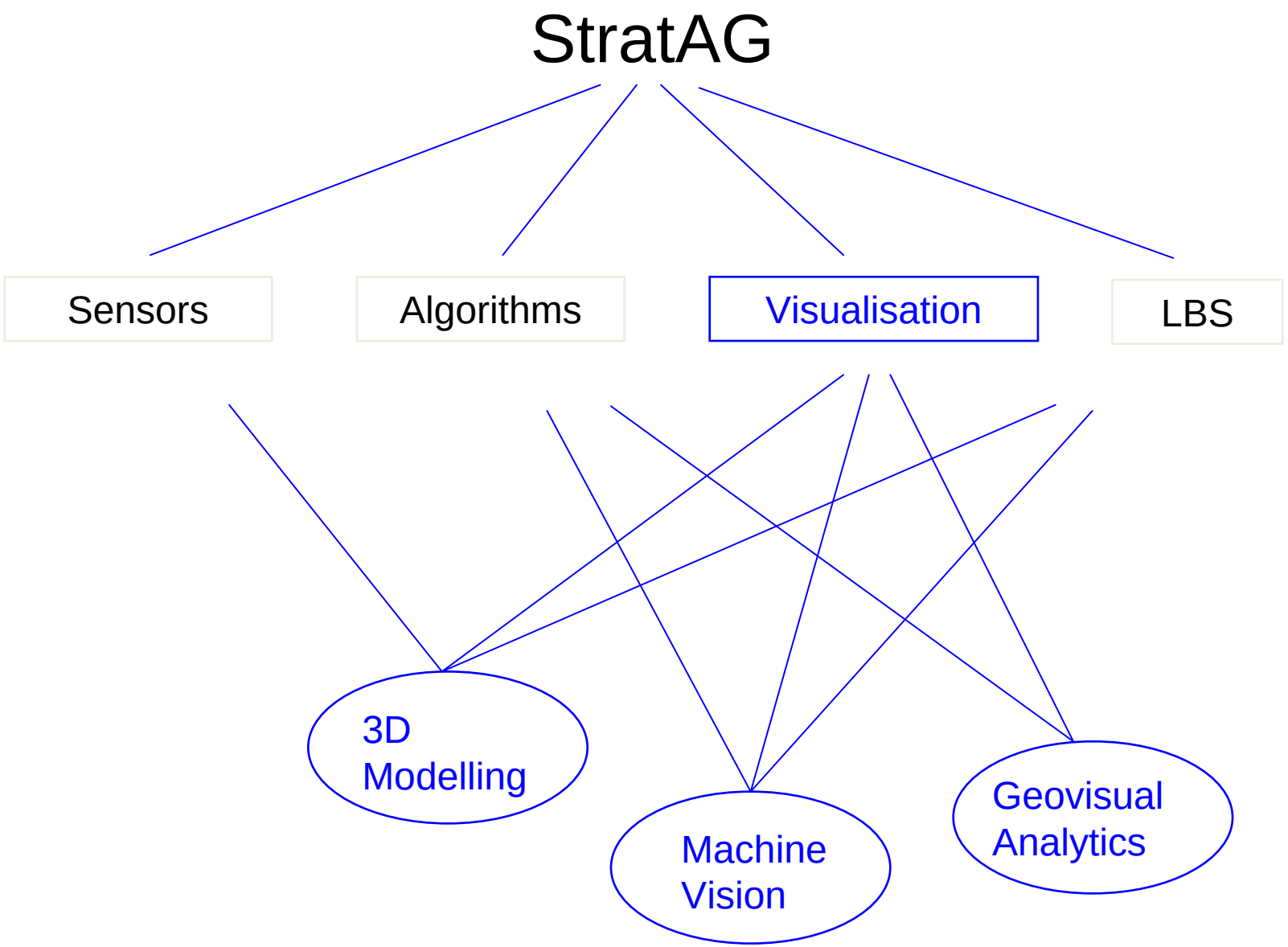


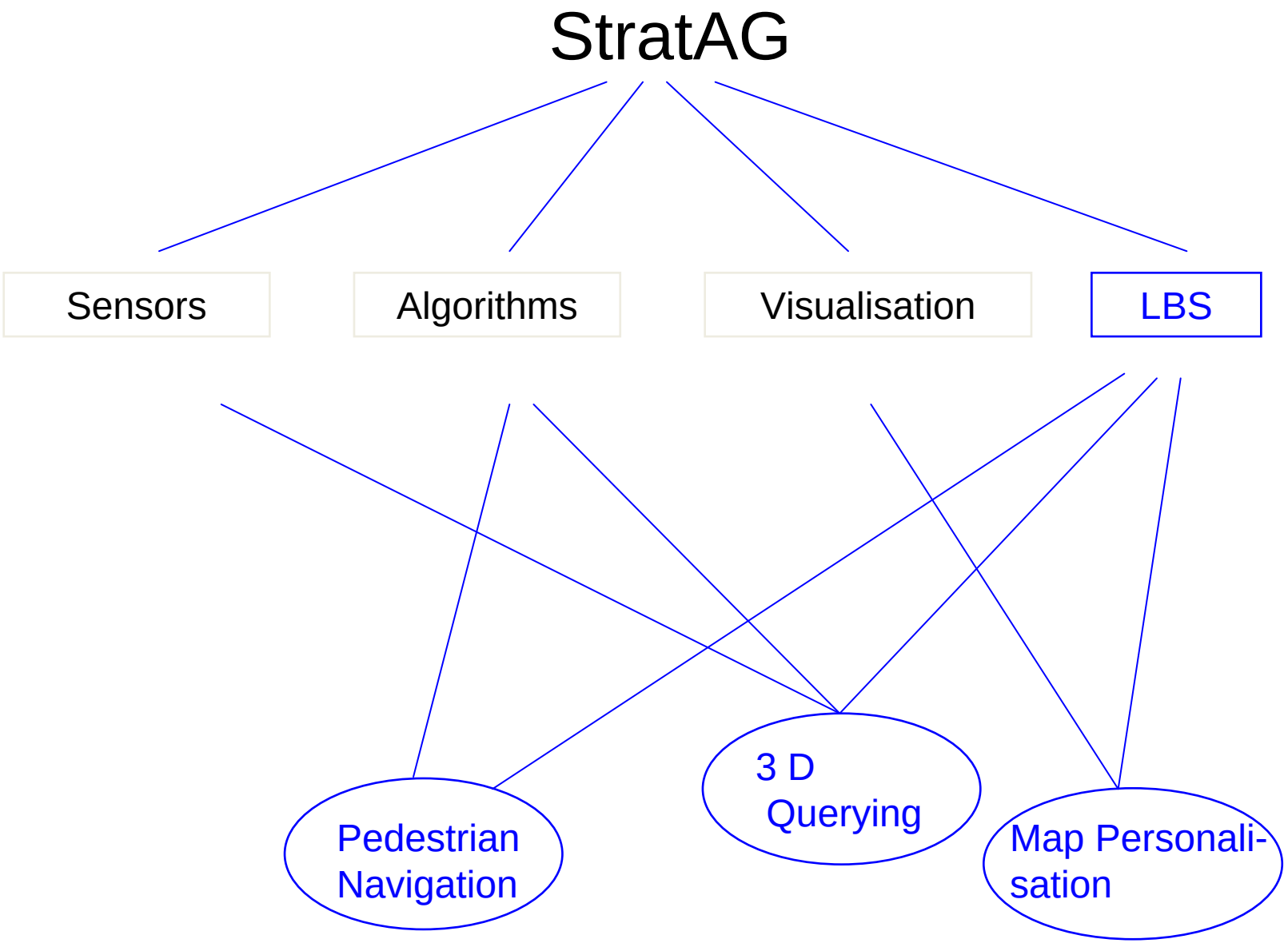
**Examples**

**of research topics**

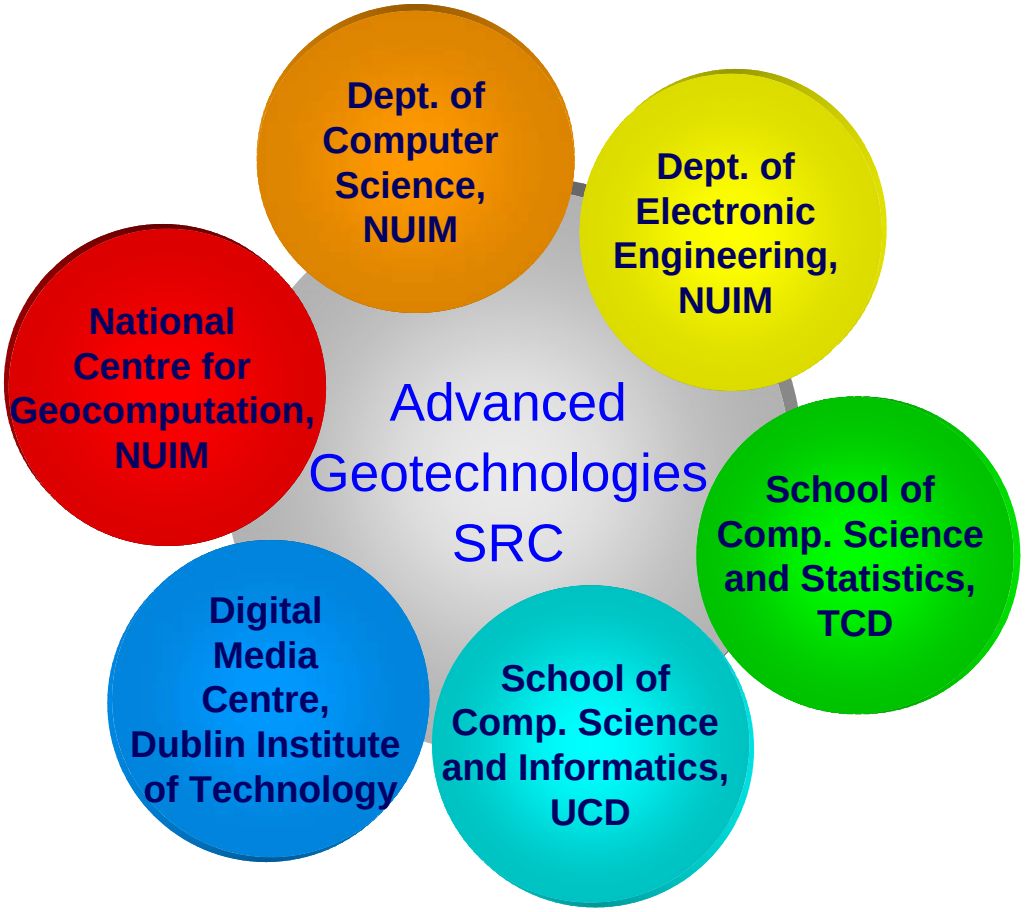



StratAG
Sensors
Algorithms
Visualisation
LBS
Spatial Heterogeneity
Spatial Video
Knowledge Extraction from spatial data streams


StratAG
Sensors
Algorithms
Visualisation
LBS
3D Modelling
Machine Vision
Geovisual Analytics


StratAG
Sensors
Algorithms
Visualisation
LBS
Pedestrian Navigation
3 D Querying
Map Personali-sation

# StratAG is a multi-disciplinary group



With...

## INDUSTRY

- ESRI-Ireland
- eSpatial Solutions
- Pavement Management Systems
- Fugro-BKS

## GOV AGENCIES

- Ordnance Survey Ireland
- Geological Survey of Ireland
- EPA
- NRA
- Marine Institute

# Partners

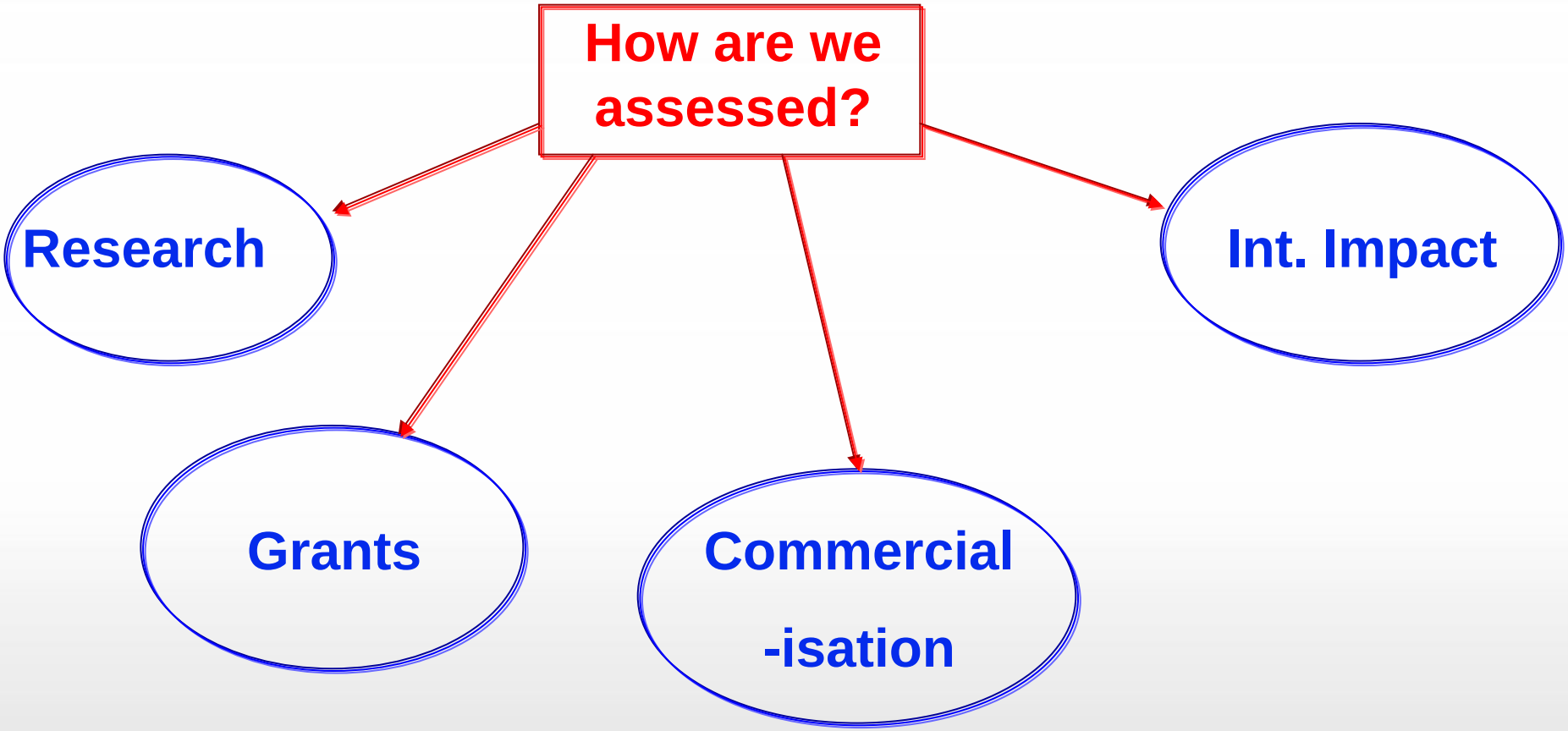
# Brief Background

- Started May 01, 2008 – now 2.5 yrs into potential 5-yr funding programme

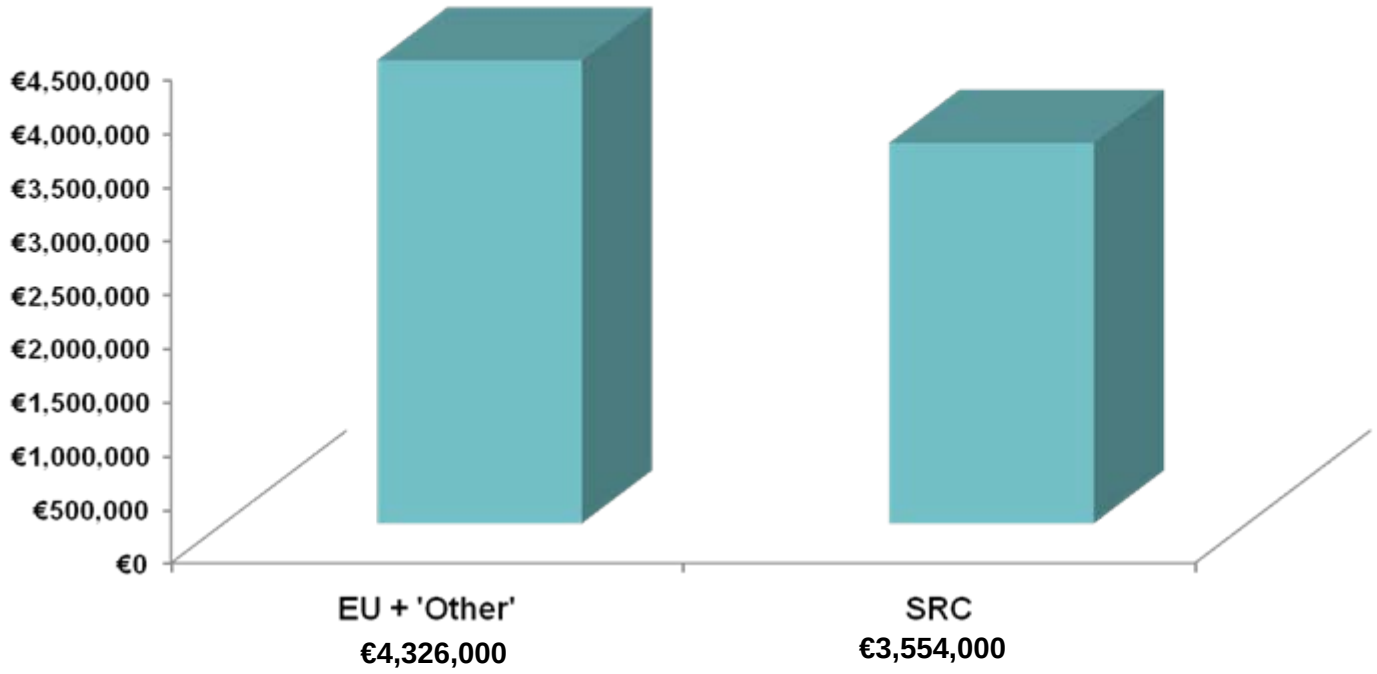
- 47.5 people in 4 universities
  - 12 Co-PIs or FIs
  - 10.5 Postdocs
  - 19 PhD students (11.5 funded through StratAG; 3 IRCSET; 2 Hume Fellowships; 1 Research Council of Canada; 1 Gov. Of China; 0.5 Stokes Fellowship)
  - 6 Admin and Technical Support Staff (3.5 StratAG; 2.5 other)

- Plus 9 partners (4 industry; 5 government agency)

- Have held official launch, 4 research kick-off meetings and two half-time meetings exposing plans to leading academics, science summit, and hosted two international conferences


How are we assessed?
Research
Grants
Commercial -isation
Int. Impact

# EU + ‘Other’ and SRC Grant Income 2008 - 2010



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# Commercialisation

## 1. Producing 'widgets'

## 2. Working with partners to help product development and joint research

**We have skills that allow our partners to broaden their remit**

## 3. Working on products to stimulate commercial activity in general

## 4. Working to attract other commercial interest

- ✓ **IBM Smart Planet (StratAG on review panel)**
- ✓ **Smart Bay**
- ✓ **Esri Inc (EDC award and partner in Geocrowd)**
- ✓ **Presenting at IDA/SFI showcase of Irish research to Silicon Valley MNEs in November**

# International Connections

## Sabbatical visitors

**EuRSI** – road safety research with ITC (Netherlands); NAST (Austria); IBI (UK); PMS (Ireland)

**Marie Curie ITN (GEOCROWD - collecting and analysing large spatial datasets)**

**ERA Complexity Grant (Cosmic)**

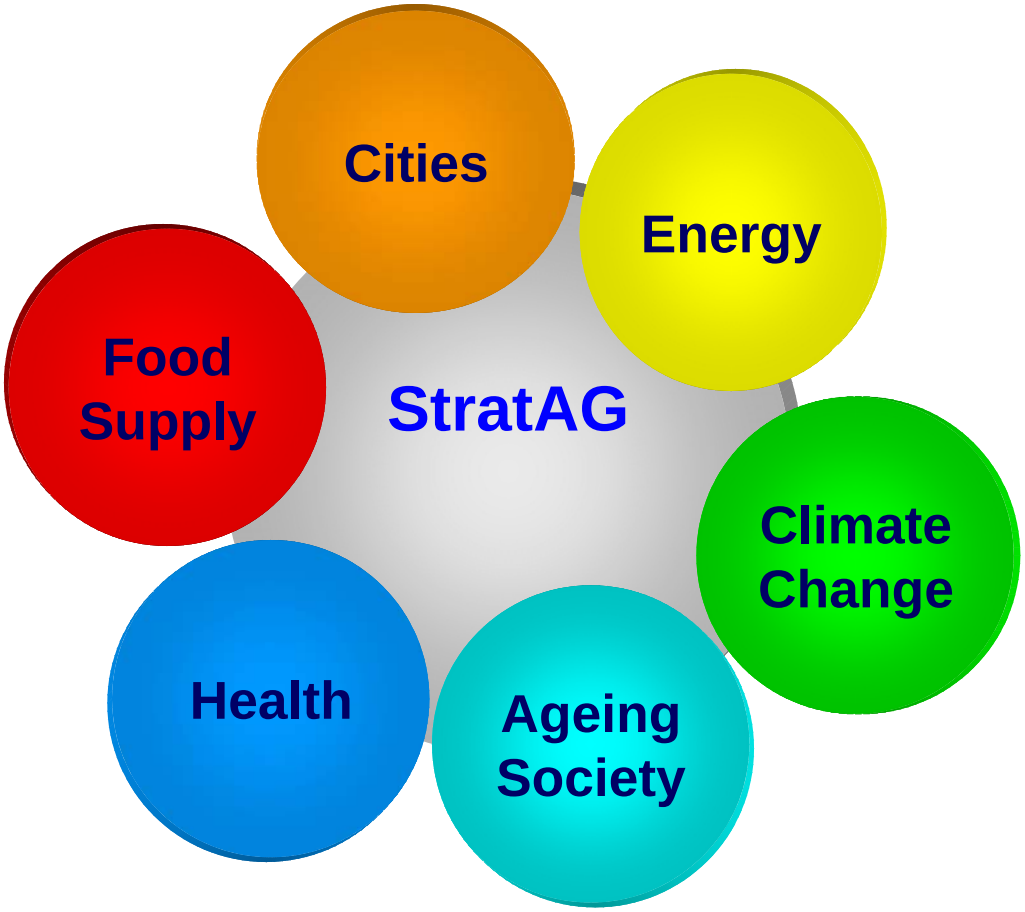
**EU COST Action IC0903 'Knowledge Discovery from Moving Objects (MOVE)**

In addition, many bilateral working relationships and hosted many short-term visitors ( including kick-off meetings and seminar speakers)

## Some other things worth mentioning...

- Set up MSc in Geocomputation at NUIM – imp for labour force development
- In active discussions with Minister for Science, Technology and Innovation to promote GI Industry and Research in Ireland
- Our technology (Spatial video) supplied to LSU made headlines in NY Times online on its use to record the changing landscape of New Orleans over past 5 years since Hurricane Katrina

# Positioning ourselves re Society's Grand Challenges




Disease patterns, diffusion and etiology

Precision agriculture

Spatial variations in energy use, forecasting demand

Demand for specialised services, provision, facility location

Service provision, Reducing spatial disparities in health

Spatial patterns of insects, disease, crop health

# Two examples of GeoSciences-related research...

- LiDAR – DEMs and coastal flooding
- SBES and MBES seabed classification and mapping

# DEMs and Coastal flood modelling

The impact of data acquisition resolution, vegetation canopy and DEM scale on the accuracy of coastal flood risk modelling.

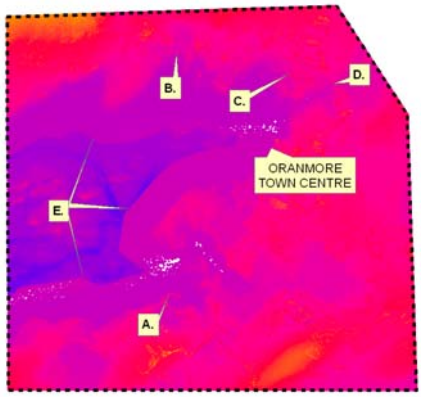
Study (Coveney & Fotheringham, *IN PRESS,* International Journal of Geographic Information Science) assessed the following DEMs:

1. Medium-res. (interpolated) photogrammetric
2. Medium-resolution survey-grade GPS
3. High-resolution survey-grade GPS
4. Very high-resolution Terrestrial LiDAR

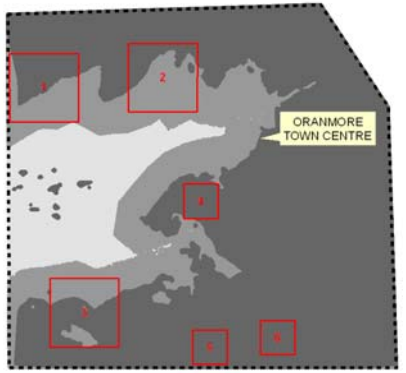
# Topographic / Bathymetric LiDAR integration

Funded INFOMAR research project in 2009 (Coveney, 2009).

Recommendations arising from the project suggested scope for simultaneous acquisition of bathymetric and topographic LiDAR to help minimise the requirement for duplicate surveys (by mapping, coastal defense and offshore mapping agencies.

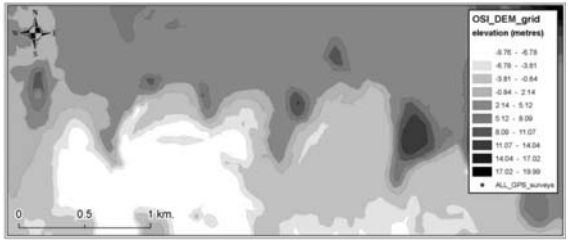



Results (Coveney & Monteys, *IN PRESS,* Journal of Coastal Research).



# Coastal photogrammetric DEM quality testing

Photogrammetric DEM data used widely for environmental process modelling in GIS.




The accuracy limitations of these DEMs are not well described by global error statistics, making it difficult for DEM users to make an informed data selection choice.

Results (Coveney, Fotheringham et al., 2009, *Computers & Geosciences*) used a fusion of Terrestrial LiDAR and dual-frequency GPS to validate elevation error in a coastal photogrammetric DEM.

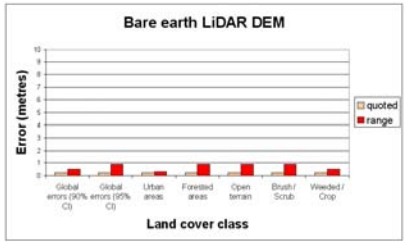
# LiDAR vegetation error (terrestrial & airborne)

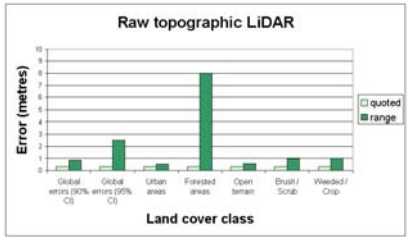
Vegetation cover can be semi-automatically removed from LiDAR data in certain circumstances.

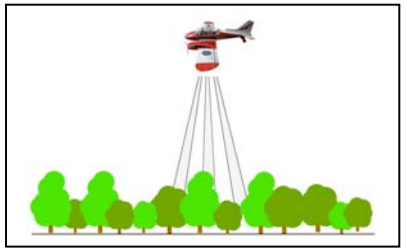
However, it can be difficult to achieve laser illumination of the ground surface in densely vegetated areas.

Project examined relationship between land cover class and elevation error in airborne topographic LiDAR (Coveney, *International Spatial Accuracy symposium 2010*)

Separate study looks at the problem in Terrestrial LiDAR (*research article in second review*).

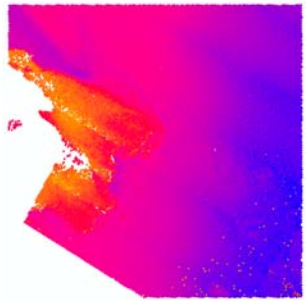


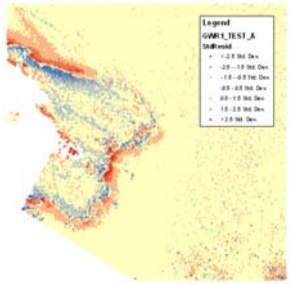
# LiDAR reflectivity clustering for seabed characterisation

Assessment of scope for seabed characterisation from airborne bathymetric LiDAR reflectivity (INFOMAR 2010 project).



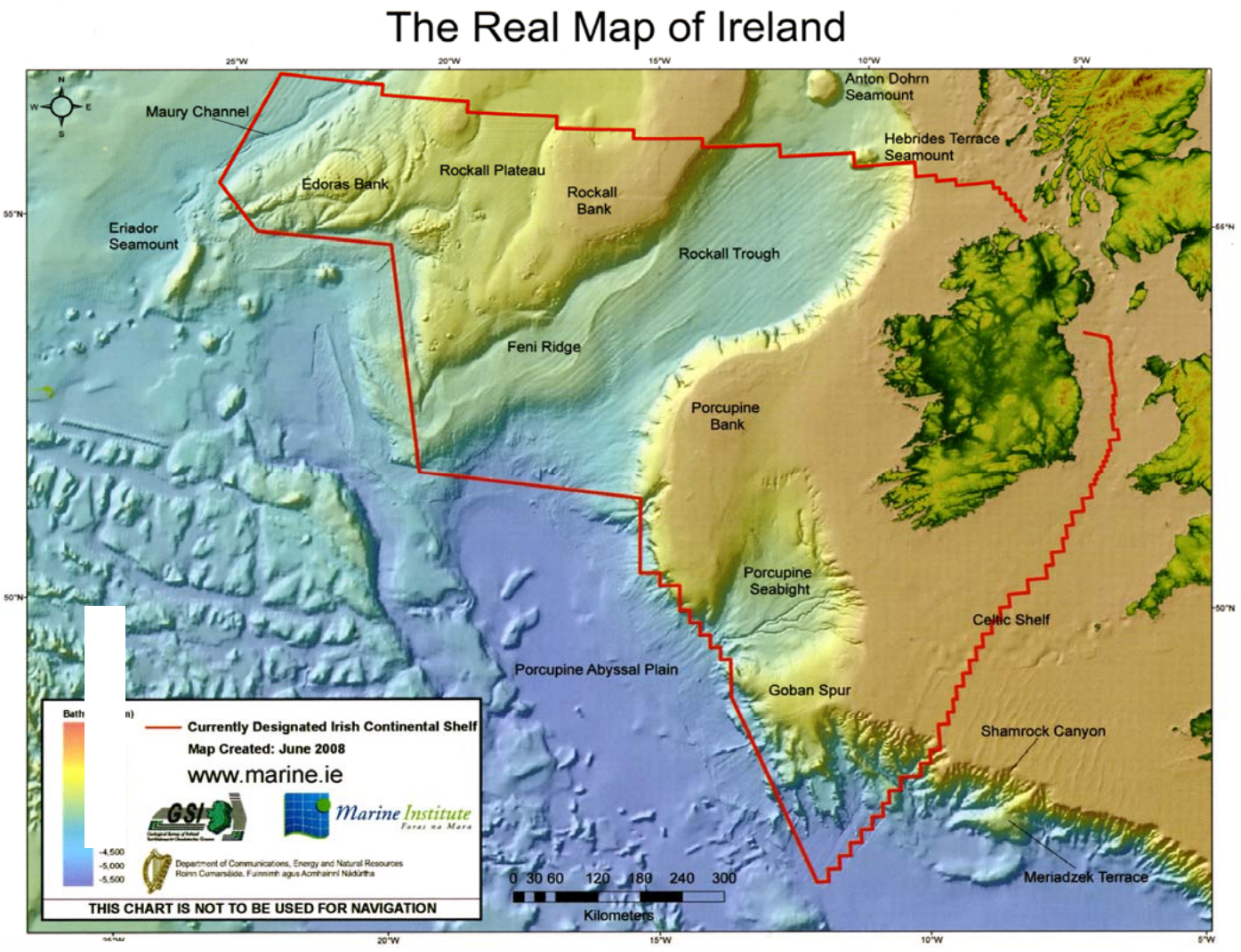
Initial results (OLS, Moran's I & GWR tests) illustrate dependence of LiDAR reflectivity depth, slope and LiDAR scan angle.

The potential for seabed characterisation from LiDAR reflectivity is being assessed in comparison to established sonar-derived seabed characterisation routines



Scope for normalising reflectivity values (based upon on depth, slope and scan angle parameters) being investigated.

# Uncovering Information in Large Marine Acoustic Data Sets




## Research Team


Prof Stewart Fotheringham,
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Dr Urška Demšar,
Dr Paul Harris,
Dr Peter Hung
Kazi Ishtiak Ahmed,
Helen Caughey


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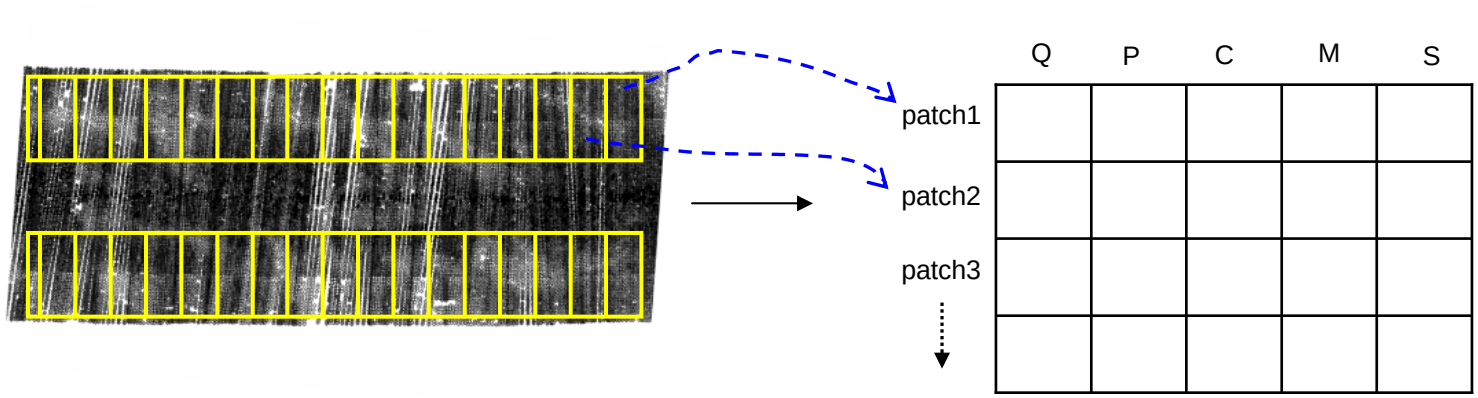
+ GSI / Infomar


Xavier Monteys,
Ronan O'Toole

# MBES Deep water Backscatter clustering

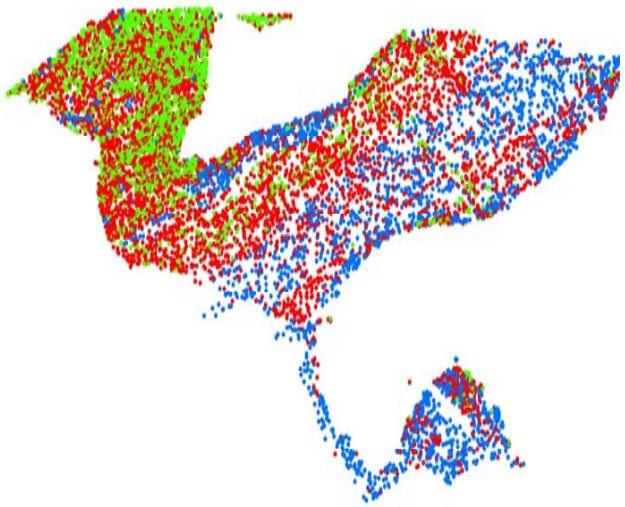

- Deep waters of the Atlantic Ocean designated to ROI
- Depths varies between 200m-5000m
- Consists of 5 statistical descriptors and over 1 million entries



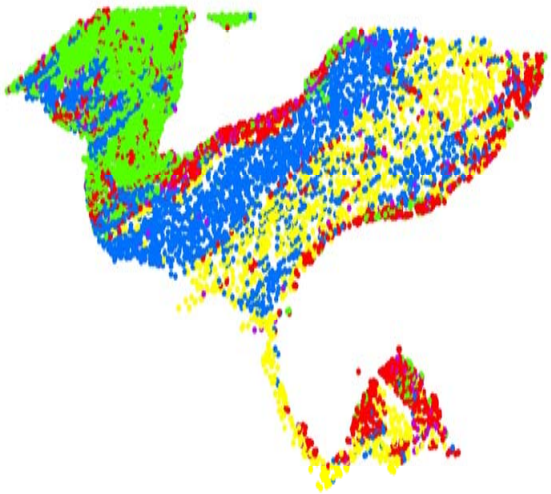

- **Five descriptors Quantile, Pace, Contrast, Mean, and Std.Dev.**
  - Each survey pass (one complete sweep) is divided into rectangular patches
  - Q, P, C, M, S is derived from each of the patches
  - Patch sizes are kept to a size so that grain variation is kept to a minimum
  - Patch size varies with water depth
- **Clustering**
  - A combination of PCA and *k*-means is commonly used for clustering acoustic data
  - we compared to 4 other types of clustering

# Deep water Backscatter

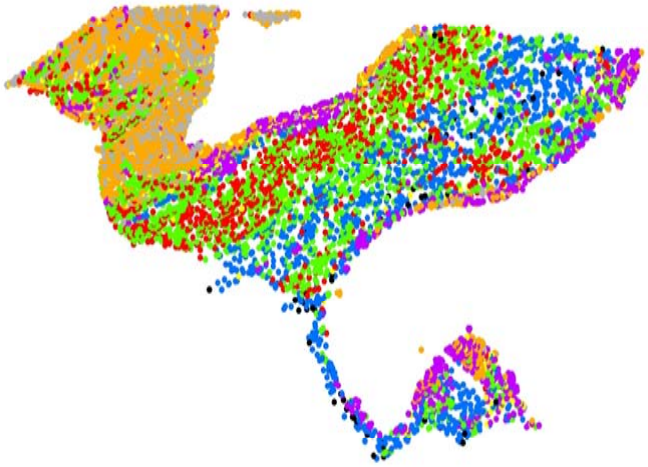
**PCA + *k*-means**



3 Clusters



5 Clusters



8 Clusters

1 5
2 6
3 7
4 8

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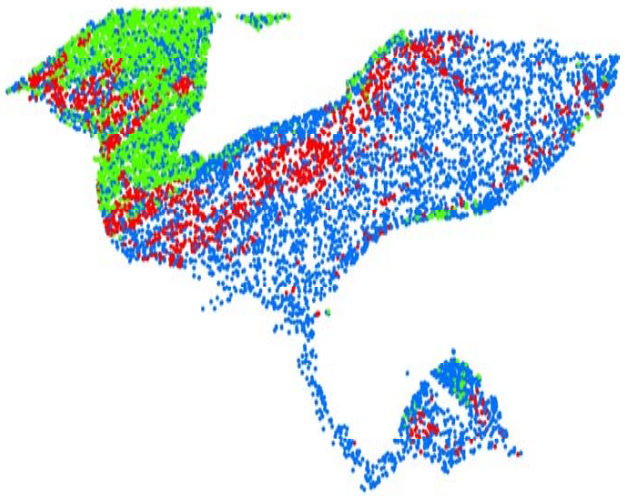
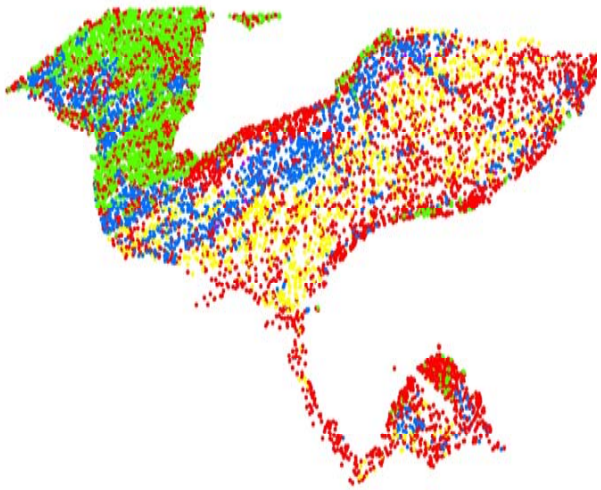
# Deep water Backscatter

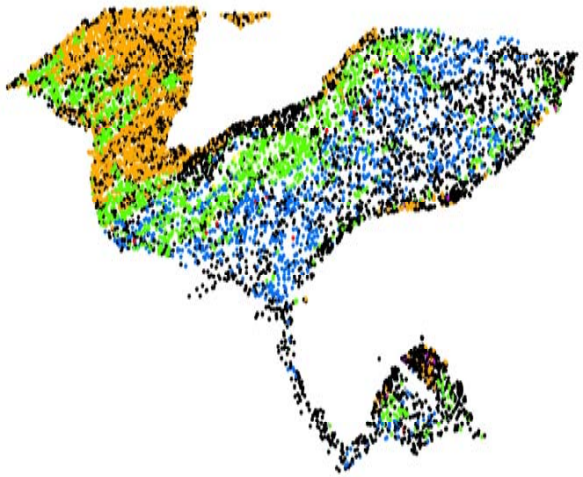
**QT-Local Clustering**



3 Clusters



5 Clusters



8 Clusters

1 5
2 6
3 7
4 8

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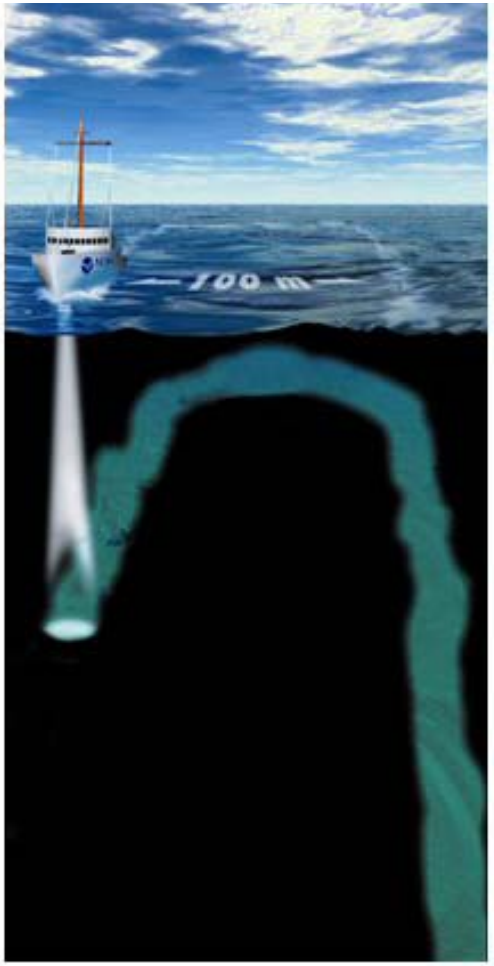
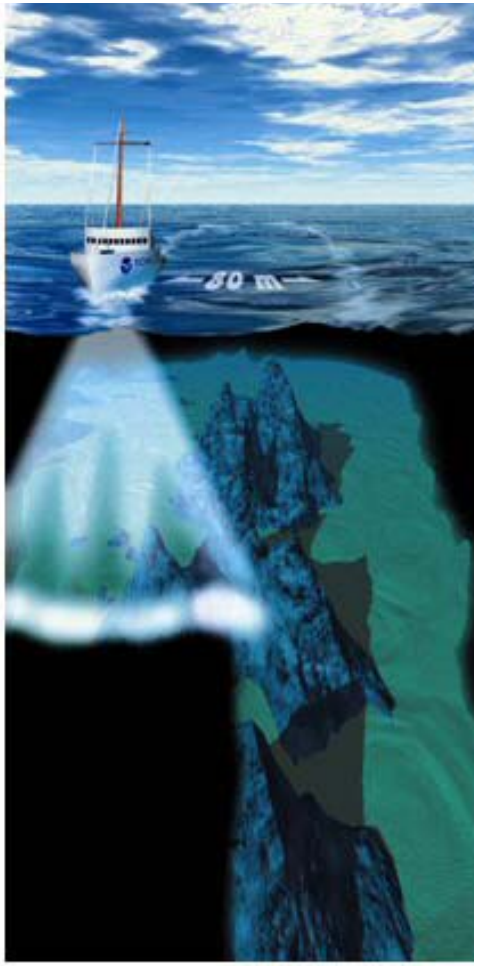
# Background

- Research on seabed clustering usually focus on multi-beam echo sounders (MBES).
- Single-beam SBES traditionally receives less attention.
- While MBES has a much bigger coverage (area), SBES survey (line) has the advantage of adding an extra dimension of sub-seabed information valuable to seabed type determination.
- Applications include seabed mapping, coastal management and marine nature conservation.
- Data colected from Malin Sea 2003




Single Beam Echo Sounder Surveys




Multibeam Full Bottom Coverage

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# End of Presentation

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