

TUTORIAL

Extraction of Geospatial Information from High Spatial Resolution Optical Satellite Sensors

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Use of high resolution satellite imagery for mapping, landscape change detection and map update

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Is high resolution satellite imagery a viable, cost-effective data source for a mapping agency

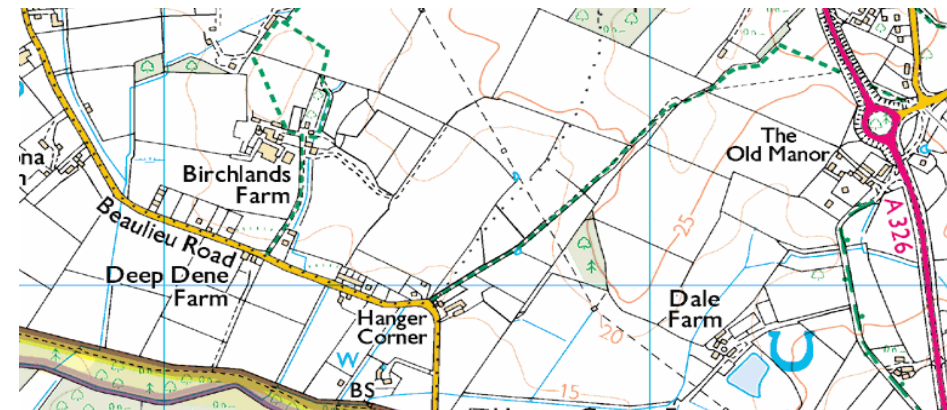


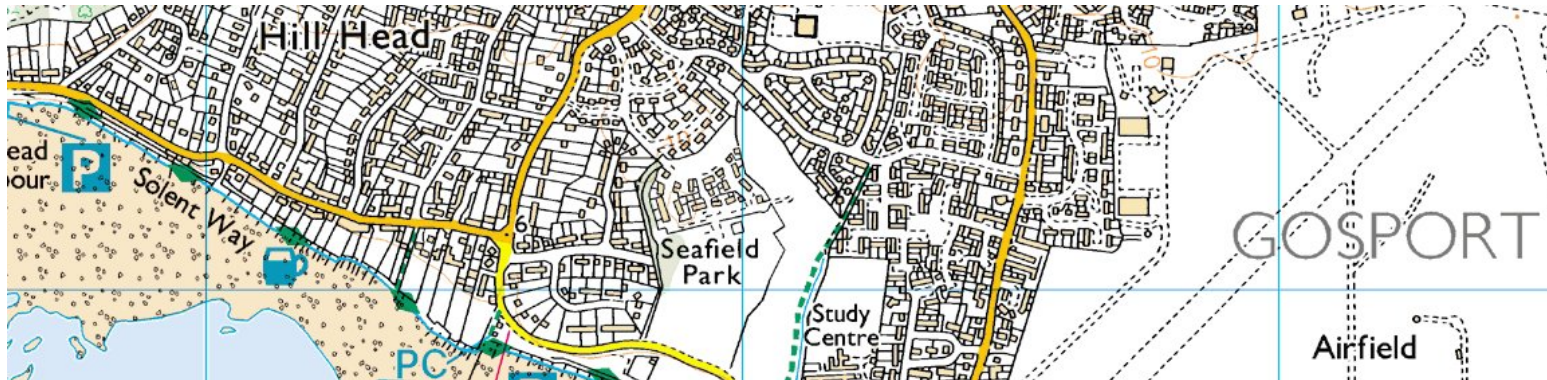
What do I mean by high resolution?

- Anything with a ground sample distance of 1m or less.
- Ordnance Survey have looked at Landsat, SPOT etc. in the past, & concluded that they are not viable for mapping at the current specifications in GB
- This leaves:
 - QuickBird – 61cm
 - Ikonos – 1m
 - OrbView3 – 1m
 - Many “spy satellites” (data not generally available)
 - Several planned missions over the next few years

Different types of mapping possibly suited to HRS data

- Large scale topographic data
 - Scales 1:1 250, 1:2 500, 1:10 000
- Small scale (tourist) mapping
 - Scales 1:50 000 and 1:25 000
- Change intelligence
 - Identifying areas of change
- Land cover mapping, image maps...





- Not all maps are the same...Swiss and British 1:25 000 maps

Some examples of mapping projects

- Street maps of 1,800 sq. km. of the Jakarta metropolitan area using IKONOS 1-meter panchromatic imagery, for use in cable TV network planning
- Mapping of Saudi Arabia (100,000 square km) using IKONOS and QuickBird imagery
- Mapping of large areas of Poland (50,000 square km) using IKONOS
- QuickBird images also used extensively by the press in recent conflicts (the Gulf, Afghanistan, Lebanon)
- Researchers at the CCRS report that QuickBird meets the US 1:2400 to 1:4800 National Map Accuracy standard

Moving to the mainstream?

- For the first few years, Ikonos and QuickBird data was used in:
 - Small projects
 - Research studies
 - Military and intelligence applications
- Once it became more accepted by users:
 - More evidence of larger, national projects
 - More civilian and commercial applications
- Now:
 - All gone quiet...
 - ...or is it now part of the mainstream?

Mapping from QuickBird at Ordnance Survey

- QuickBird imagery of several UK sites (urban and rural)
- Panchromatic and Multispectral
- Some nice images with no clouds (in England!!)
- Orthorectified, typically using large scale map detail as control points and a 10 m-spaced DTM
- Achieved geometric accuracy of 1.7 m to 3.3 m RMSE (we acknowledge that a higher resolution is possible if using GPS control points)
- Geometric accuracy suggests mapping at 1:6000 scale is possible









Aerial photo – 12cm



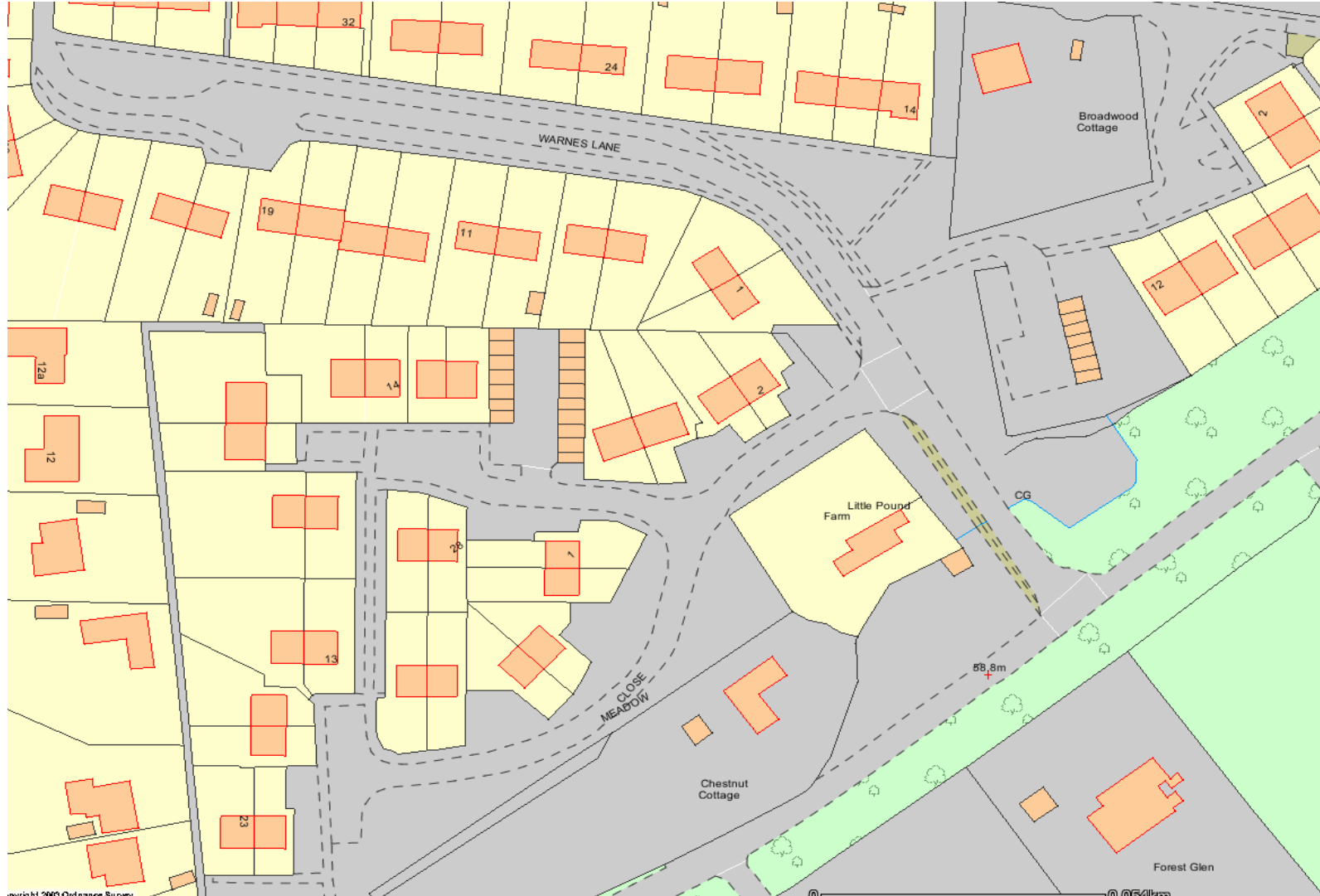
Aerial photo – 25cm



QuickBird – 60cm



Large Scale mapping - example of OS MasterMap



Example of data captured from QB



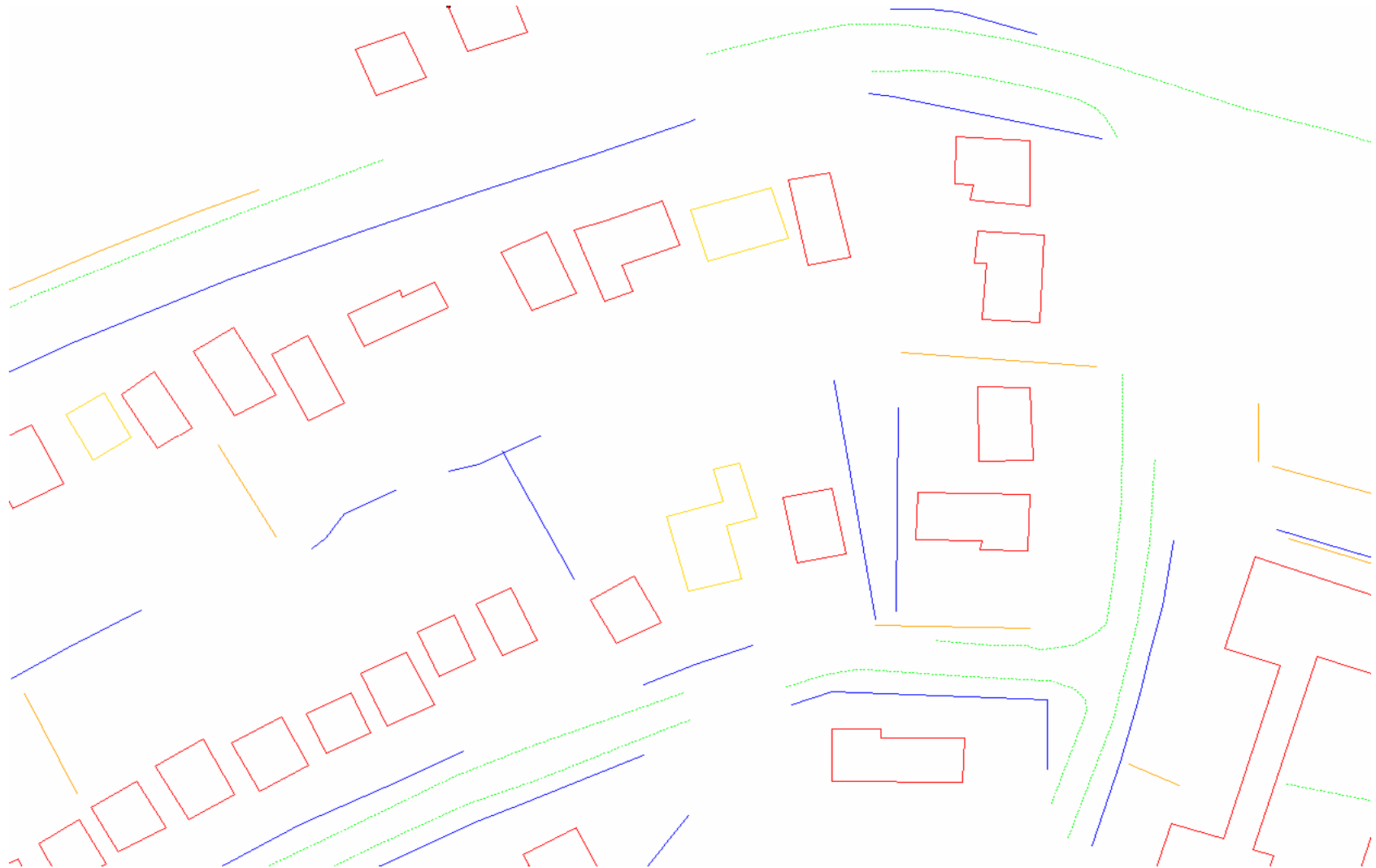
QuickBird plus existing map vectors



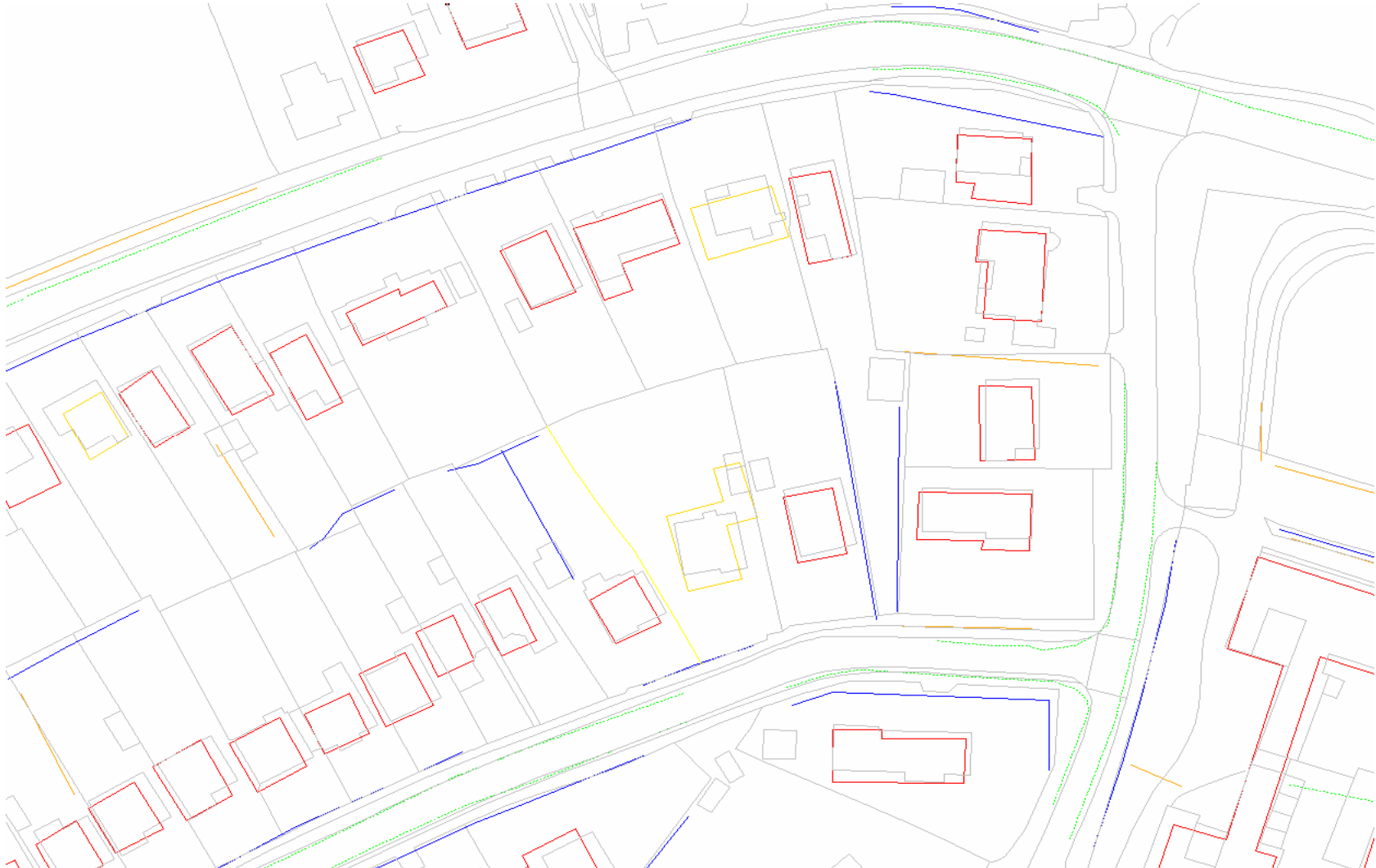
Map data captured from QuickBird



Vectors Captured from QuickBird



Existing vectors and QB captured vectors



Feature geometric accuracy results

Feature type	No. of points	Min	Max	Mean	SD	RMSE
House corners	218	0.24	6.57	1.98	1.22	2.32
Fence junctions	28	0.24	3.06	1.37	0.81	1.59

- Comparison between house corners and fence junctions on the map, and the equivalent point on the image.
- Geometric accuracy suitable for mapping at scales of about 1:5000

Feature identification results

Level of requirement:	Quickbird			Air photo		
	High	Medium	Low	High	Medium	Low
No of tests	86	65	63	86	65	63
No. of features present	38	38	25	38	38	25
Number correctly identified	35	26	11	37	32	22
Number not identified	3	12	14	1	6	3
Success rate %	92	68	44	97	84	88

- High: **must** be identifiable at this scale of mapping (e.g. boundary feature)
- Medium: **desirable** to be identifiable at this scale of mapping (e.g. type of boundary – hedge)
- Low: **some interest** at this scale of mapping (e.g. nature of boundary – permanent or temporary)

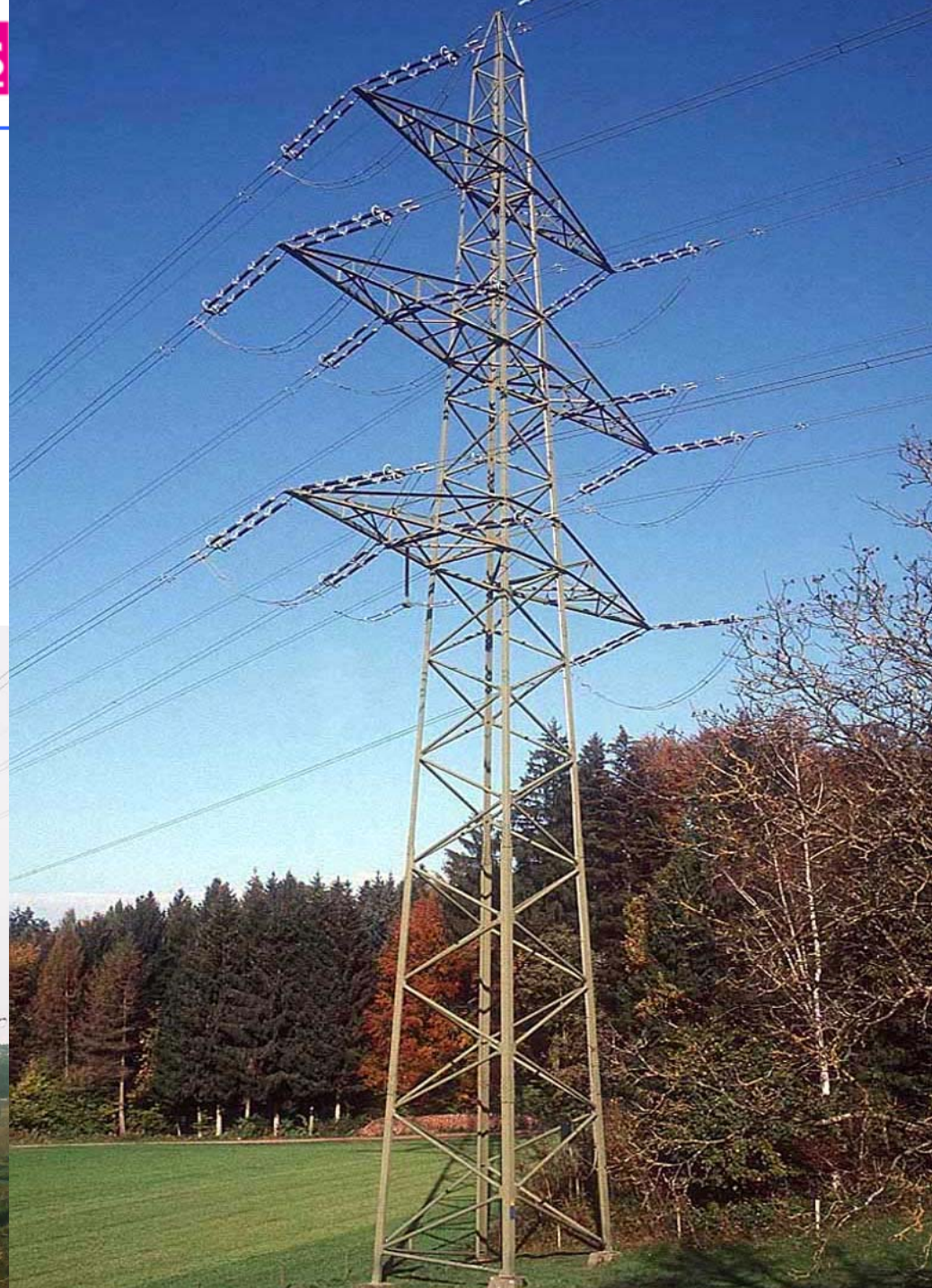
What we can/can't capture using QuickBird imagery

- We can successfully identify and capture the following, to meet the Ordnance Survey 1:10 000 scale specification:
 - Roads, railways, airports
- We can **usually** capture:
 - Buildings
 - Lakes, rivers, streams
 - Tracks & paths
- It is **not usually possible** to capture:
 - Fences, walls
 - Narrow tracks & paths
 - Electricity Transmission Lines
 - Field and property boundaries

Other things you cannot collect

- Small geometric objects:
 - juts, recesses on buildings
 - fence posts
 - pylons
- High and low tide lines
- (And, of course, non-topographic attributes such as place names, road classifications, addresses – but these are also fairly difficult to capture from aerial photography!)

Electricity transmission lines





What sort of map could be produced?

- Using only a satellite image, a satisfactory cartographic map could be produced at a scale of 1:6000 or smaller.
- By changing the specification (e.g. not requiring fences, small paths, streams) larger scale maps could be produced.
- Image maps – i.e. georeferenced background images with added attribution – could be produced very easily
- Other information would be needed to populate the attributes (but much of this information may already be available in well-mapped countries)

Change Detection

- Probably the most viable use of satellite imagery for Ordnance Survey
- In both urban and rural areas, QuickBird imagery was successfully used to detect change
- Urban – new housing, industrial buildings, roads
- Rural – fences, tracks, vegetation boundaries
- Main drawback is the cost of the images



Example of
change in
Manchester:
demolition of
industrial
buildings





Other uses

- Capture of transport network information
- Quality auditing (checking currency of maps)
- Image maps (especially from pan-sharpened images)
- Land-cover maps
- Automatic/manual detection/capture of currently-unmapped features (e.g. trees, road markings)

Advantages of satellite imagery over aerial photography

- The satellite is operational 365 days of the year,
- Frequent re-visit times (~every 4 days),
- Imagery is post-processed relatively quickly,
- No Air Traffic Control restrictions apply,
- Large area footprint (e.g. 16.5 x 16.5 km²) cuts down the need for block adjustment and creation of image mosaics,
- The satellite can easily access remote or restricted areas,
- No aircraft, cameras or expensive equipment are required (by the end user).

And the disadvantages...

- The typical off-nadir viewing angle of up to 25° is not acceptable
- The production processes required for high resolution satellite imagery may be different to those of traditional photogrammetric data capture
- The reliability of capture and delivery of imagery can be poor at times
- Image resolution is low compared to most aerial photography
- Cost of the imagery may be too high (when compared with air photos)
- There is a strong possibility of cloud cover

Conclusions

- Current satellite imagery could be used for mapping at 1:6000 scale
- Satellite imagery could be used for several different purposes in a mapping agency, especially change detection
- Satellite imagery is a convenient data source, which is less complex to process than aerial photography
- The true benefit of this imagery in a well-mapped country is yet to be proven, but multiple use of the data could be its major selling point to a mapping agency

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