Data input

Data input

- data input involves digital encoding of both:
  - geographic data (boundaries, point locations), and
  - and attribute data (tables, documents, photos, video)

Data input

- conversion of hardcopy to digital maps is the most time-consuming task in GIS

  - up to 80% of project costs
  - estimated to be a US $10 billion annual market
  - labor intensive, tedious and error-prone
  - database development sometimes becomes an end in itself

Geographic data input

- keyboard entry of coordinates
- digitizing
- scanning and raster to vector conversion
- field work data collection using global positioning systems
- air photos and remote sensing

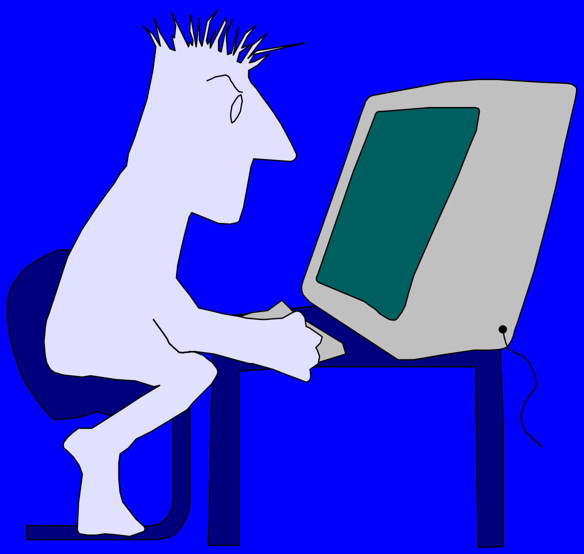
Keyboard entry

- keyboard entry of coordinate data

- e.g., point lat/long coordinates

  - from a gazetteer (a listing of place names and their coordinates)

  - from locations recorded on a map



Latitude/longitude coordinate conversion

- latitude is y-coo, longitude is x-coo!
- common format is

  degrees, minutes, seconds

  113º 15’ 23” W   21º 56’ 07” N

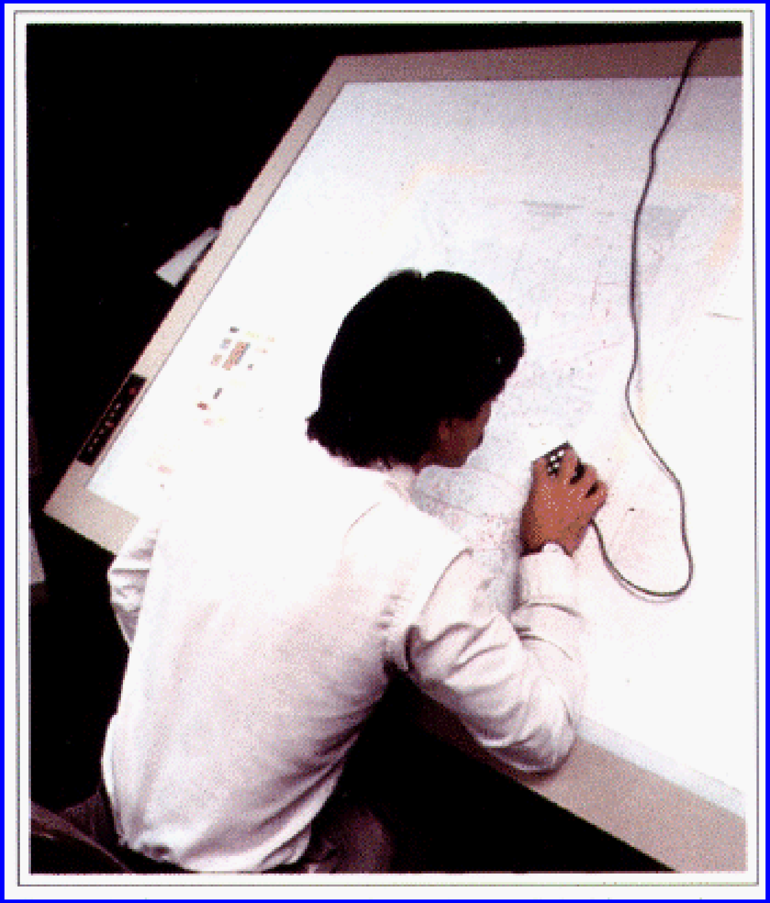
- to represent lat/long in a GIS, we need to convert to decimal degrees

  -113.25639   21.93528

- DD = D + (M + S / 60) / 60

Manual digitizing

- digitizing tables
- 25 x 25cm to
  200 x 150cm
- cost 300$ to 5000$
- most common form of coordinate data input

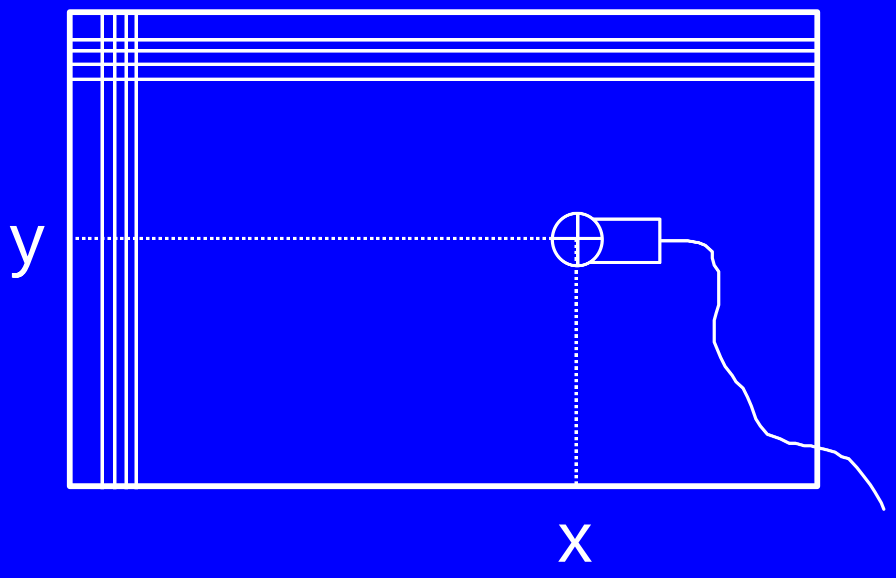


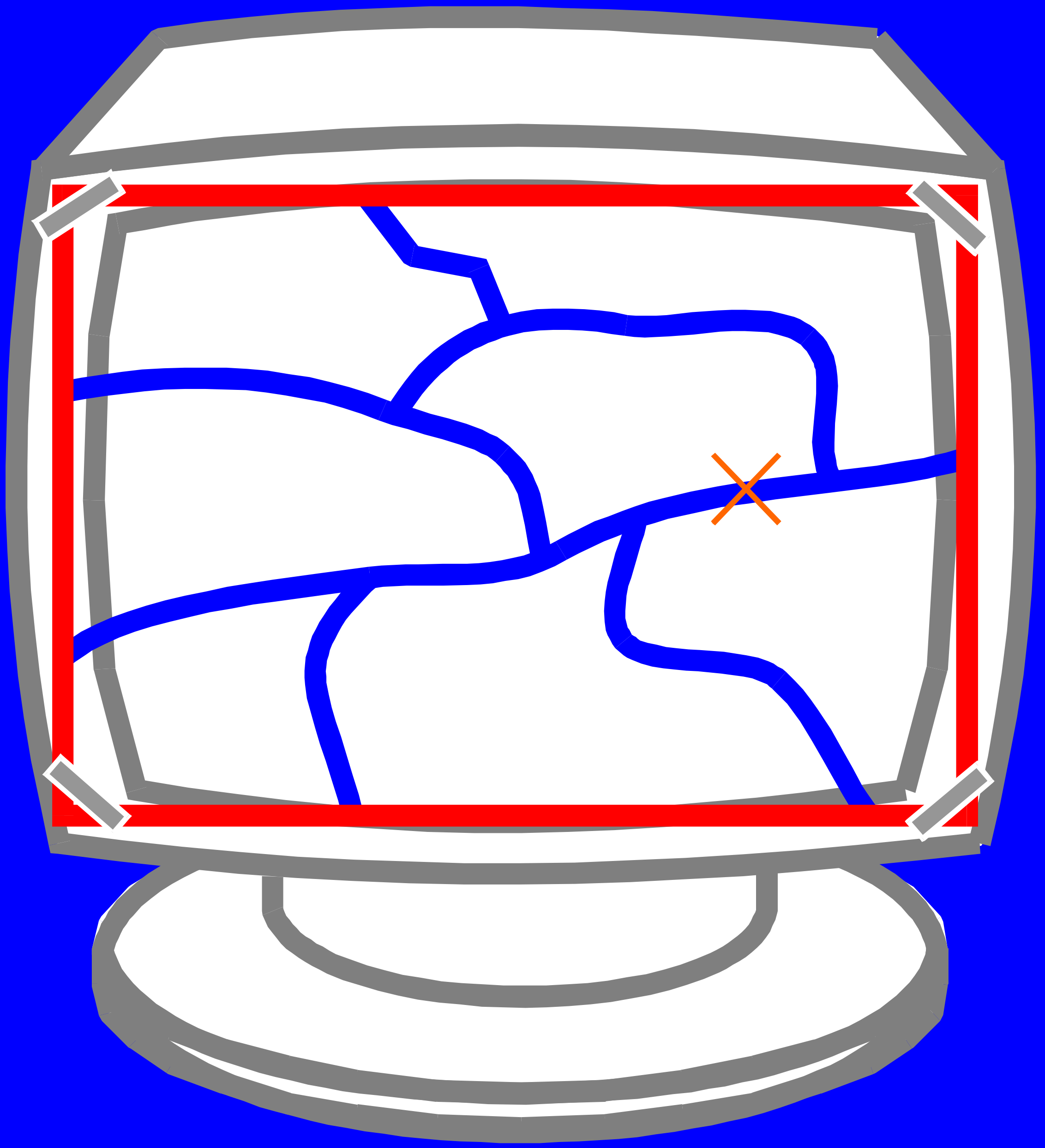
Digitizing steps

- trace features to be digitized with pointing device (cursor)
- point mode: click at positions where direction changes
- stream mode: digitizer automatically records position at regular intervals or when cursor moved a fixed distance

Digitizing table

- grid of wires in the table creates a magnetic field which is detected by the cursor
- x/y coordinates in digitizing units are fed directly into GIS
- high precision in coordinate recording





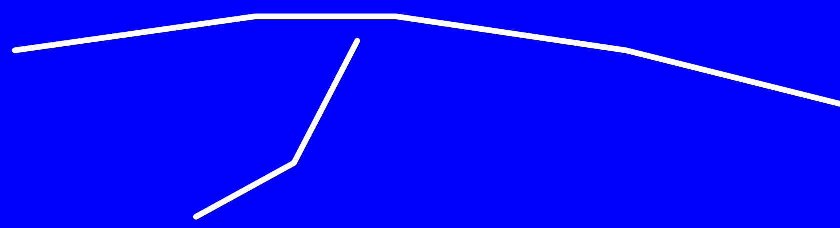
Heads-up digitizing I:

features are traced from a map drawn on a transparent sheet attached to the screen

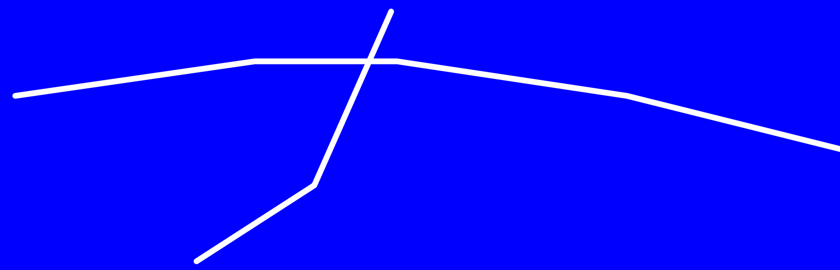
option, if no digitizer is available; but: accuracy very low

Digitizing errors

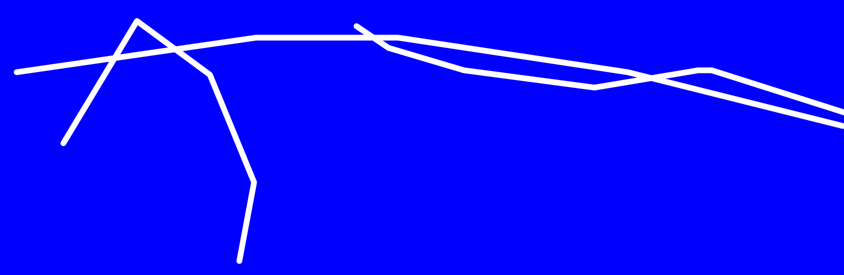
- undershoots



- dangles



- spurious polygons



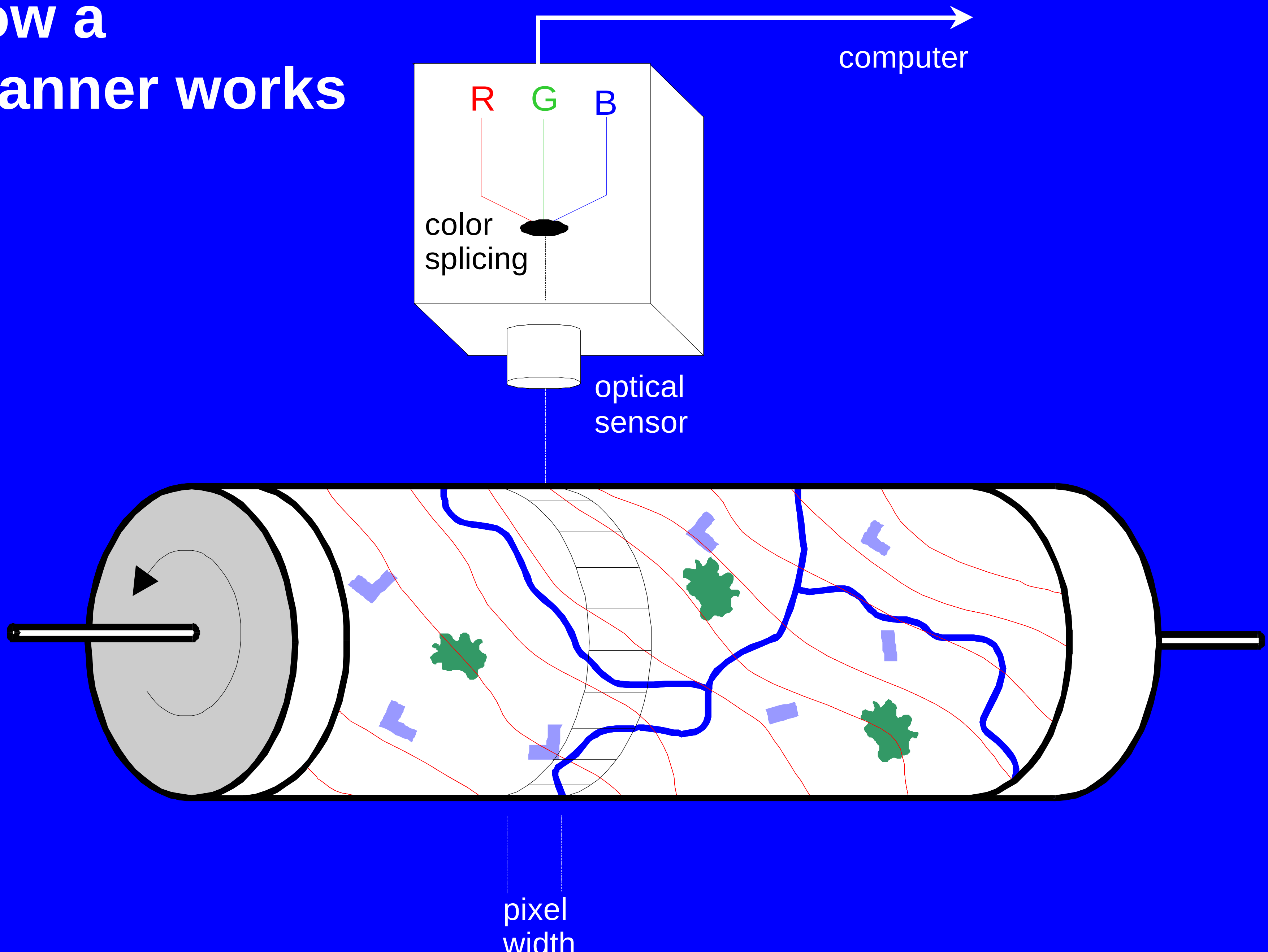
Digitizing errors

- any digitized map requires considerable post-processing
- check for missing features
- connect lines
- remove spurious polygons
- some of these steps can be automated

Scanning

- electronic detector moves across map and records light intensity for regularly shaped pixels
- flat-bed scanner
- drum-scanner (pic.)

How a scanner works



Scanning

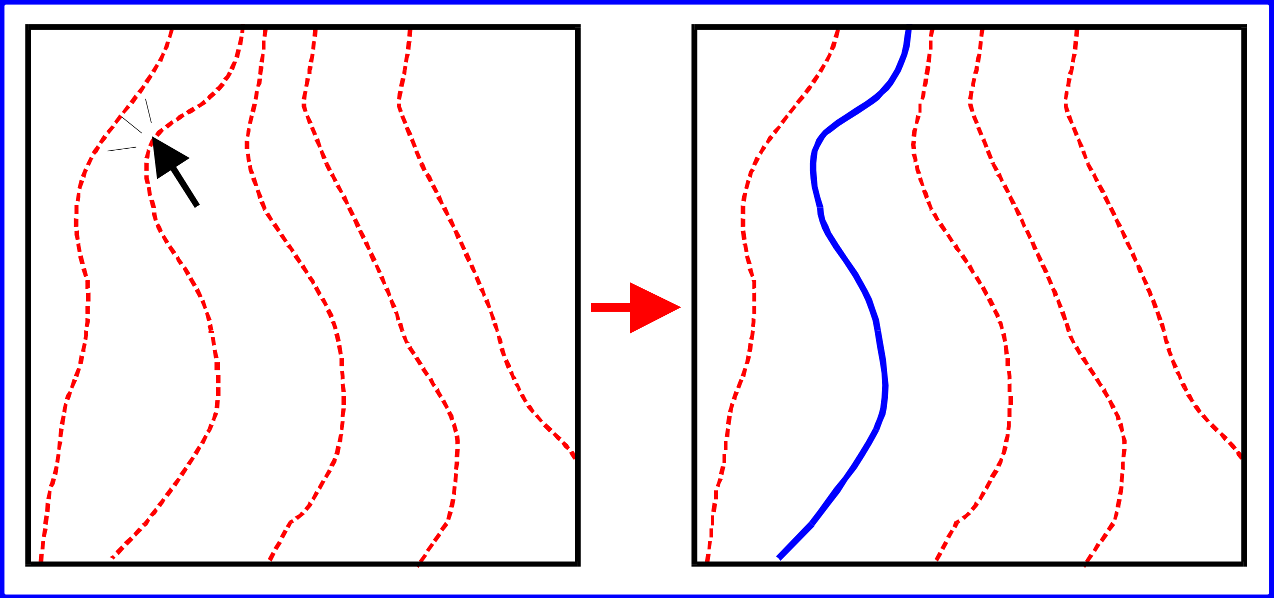
- scanner output is a raster data set

- usually needs to be converted into a vector representation
  - manually (on-screen digitizing)
  - automated (raster-vector conversion)
    - line-tracing - e.g., MapScan

- often requires considerable editing

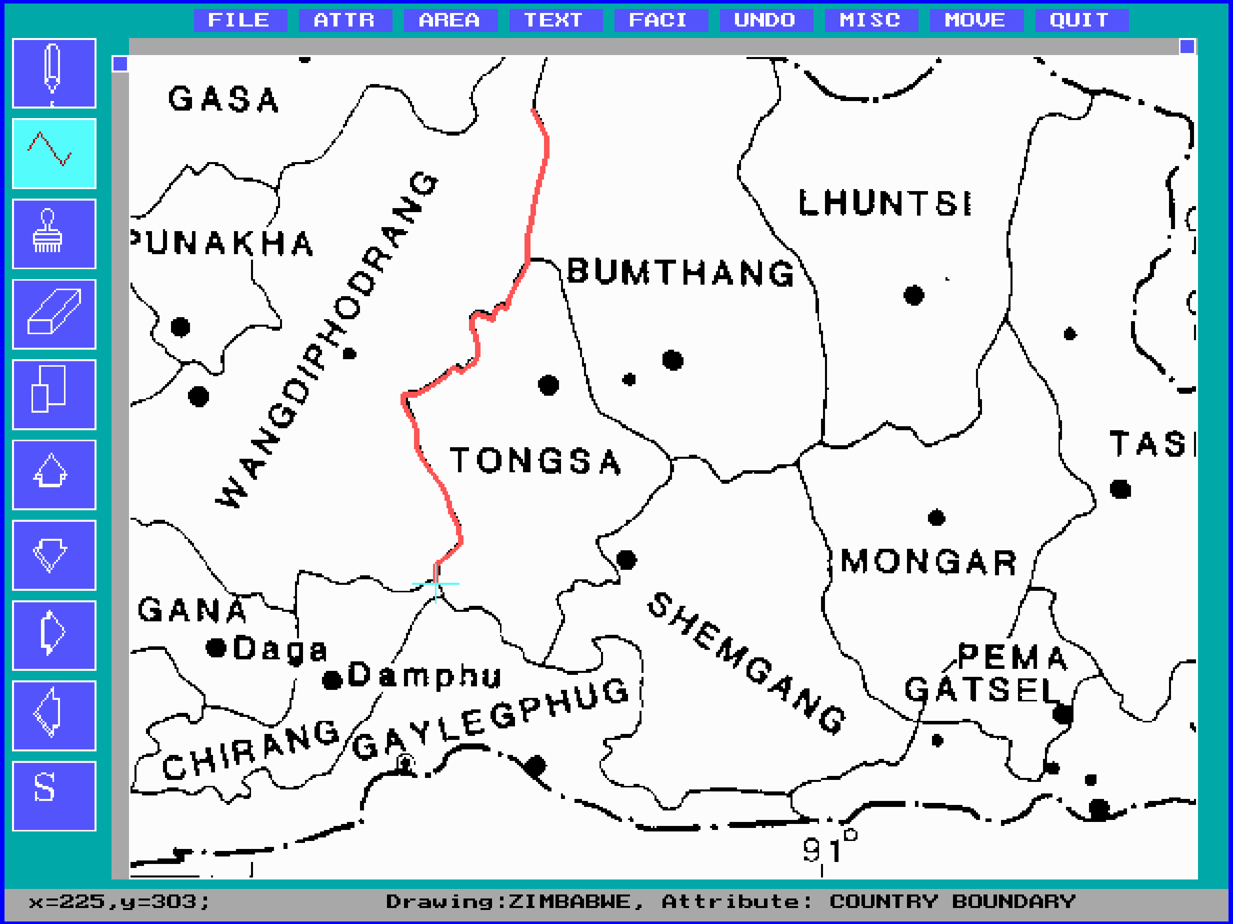
Raster to vector conversion

- **automated vectorization:**
  operator sets "global parameters" and system converts entire map
- **interactive line following:**
  operator points at specific line and system follows and converts the line



Heads-Up Digitizing II:

- Raster-scanned image on computer screen
- Operator follows lines on-screen in vector mode



Scanning

- pre-processing can reduce editing required
- e.g., trace important features manually first (re-drafting)
- scan clearer, simpler map

Scanning

- direct use of scanned images
- e.g., scanned air-photos
- digital topographic maps in raster format

Data input

- for attribute data:

  - spreadsheets

  - nlinks to external database management systems (DBMS)

  tabulation programs (IMPS, Redatam)

Field data collection:
Global Positioning Systems

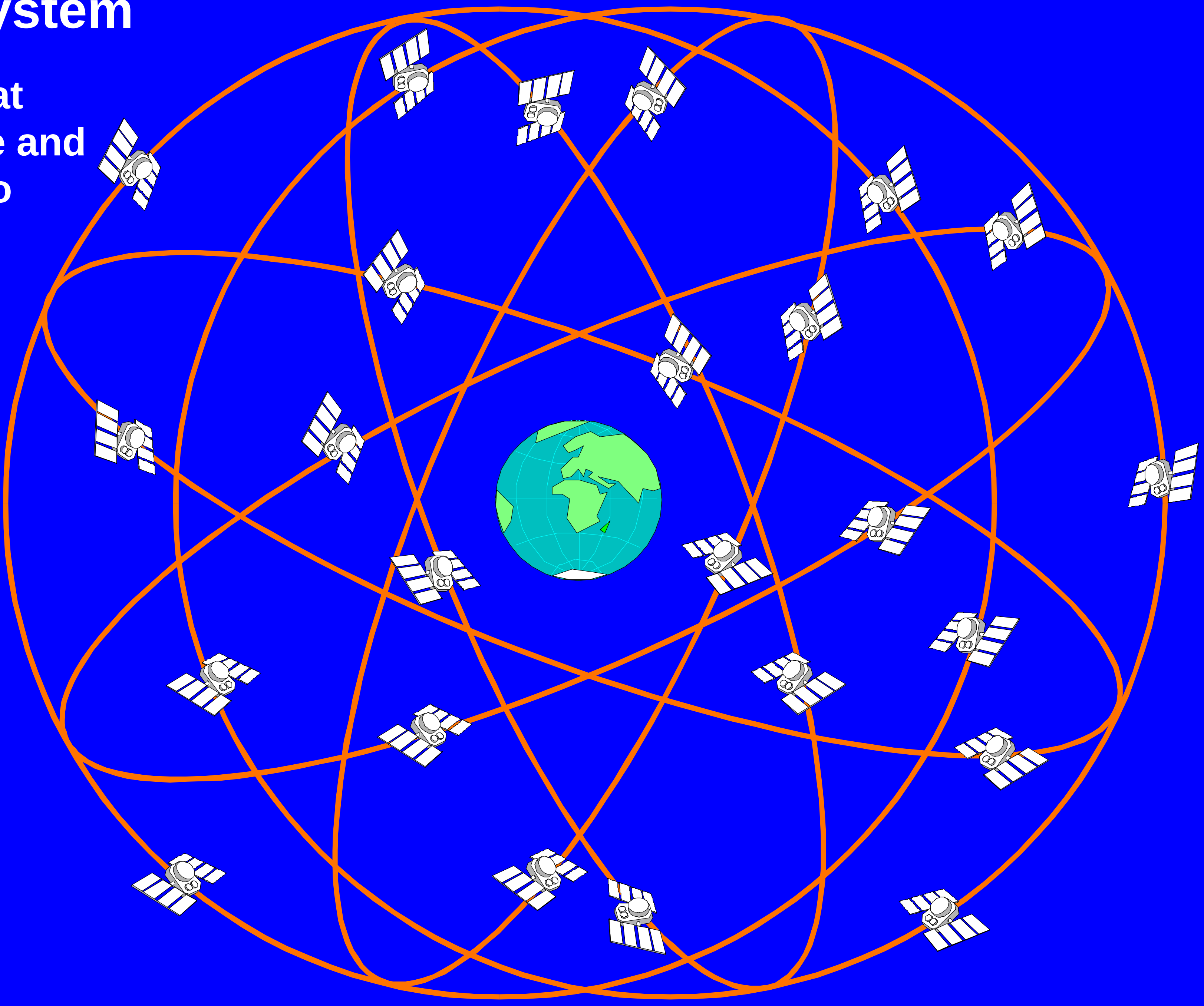
- determine current position based on signals sent by a number of satellites
- accuracy of position can be increased by using a system of control stations (Differential GPS - DGPS)
- *GPS* readings are in digital form - can be read directly into the GIS

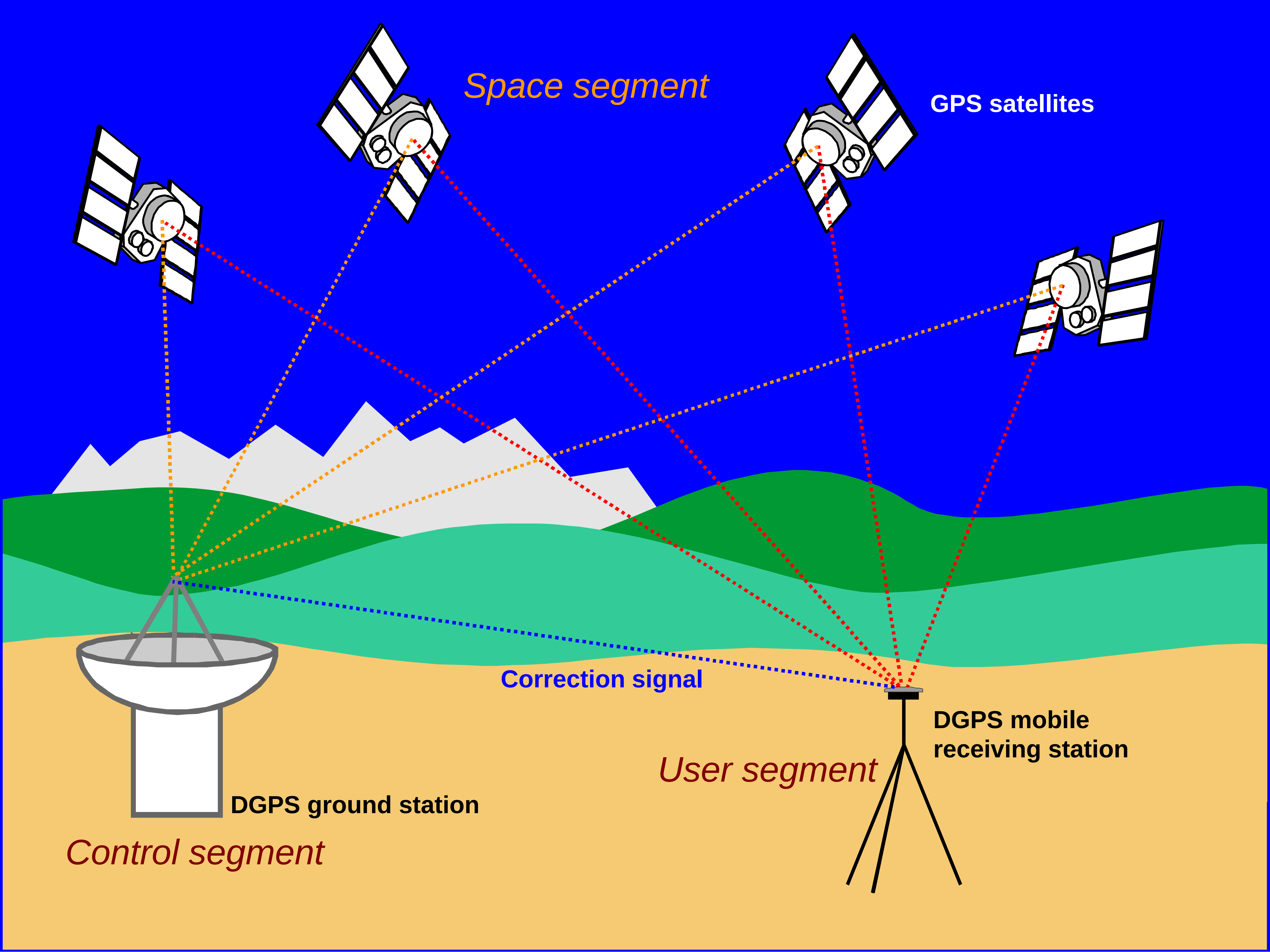
Field data collection: Global Positioning Systems

- Applications:
  - create a village data base
  - produce GIS data sets of public facilities
  - map census enumeration areas
  - locate incidence of disease
  - numerous commercial applications

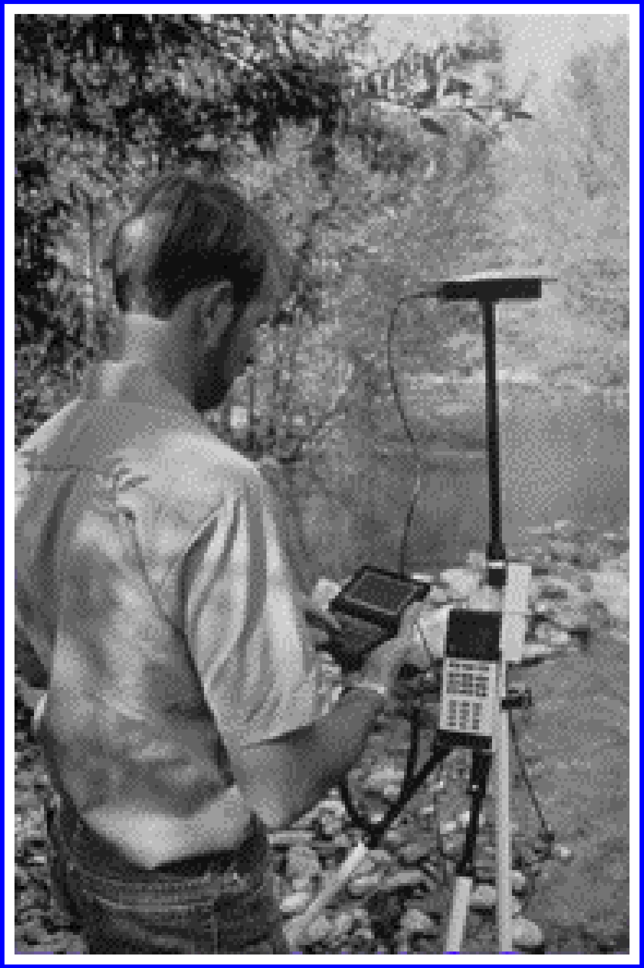
The GPS system

24 satellites that circle the globe and broadcast radio signals





Space segment
GPS satellites
Correction signal
DGPS mobile
receiving station
User segment
DGPS ground station
Control segment



Handheld GPS are now available for about US $150.

GPS - Benefits

- higher accuracy than most traditional field techniques
- automatic georeferencing
- digital data can be brought directly into computer mapping systems

GPS - limitations

- high building densities may cause receiving problems
- 15-100 m accuracy may be insufficient in urban areas
- infrastructure to support Differential GPS is often unavailable and DGPS is expensive
- GPS has highest benefits in rural areas

Remote Sensing

- includes aircraft, spacecraft and satellite based systems
- products can be analog (e.g., photos) or digital images
- remotely sensed images need to be interpreted to yield thematic information (roads, crop lands, etc.)
- increasingly important source of **statistical information**

Aerial photography

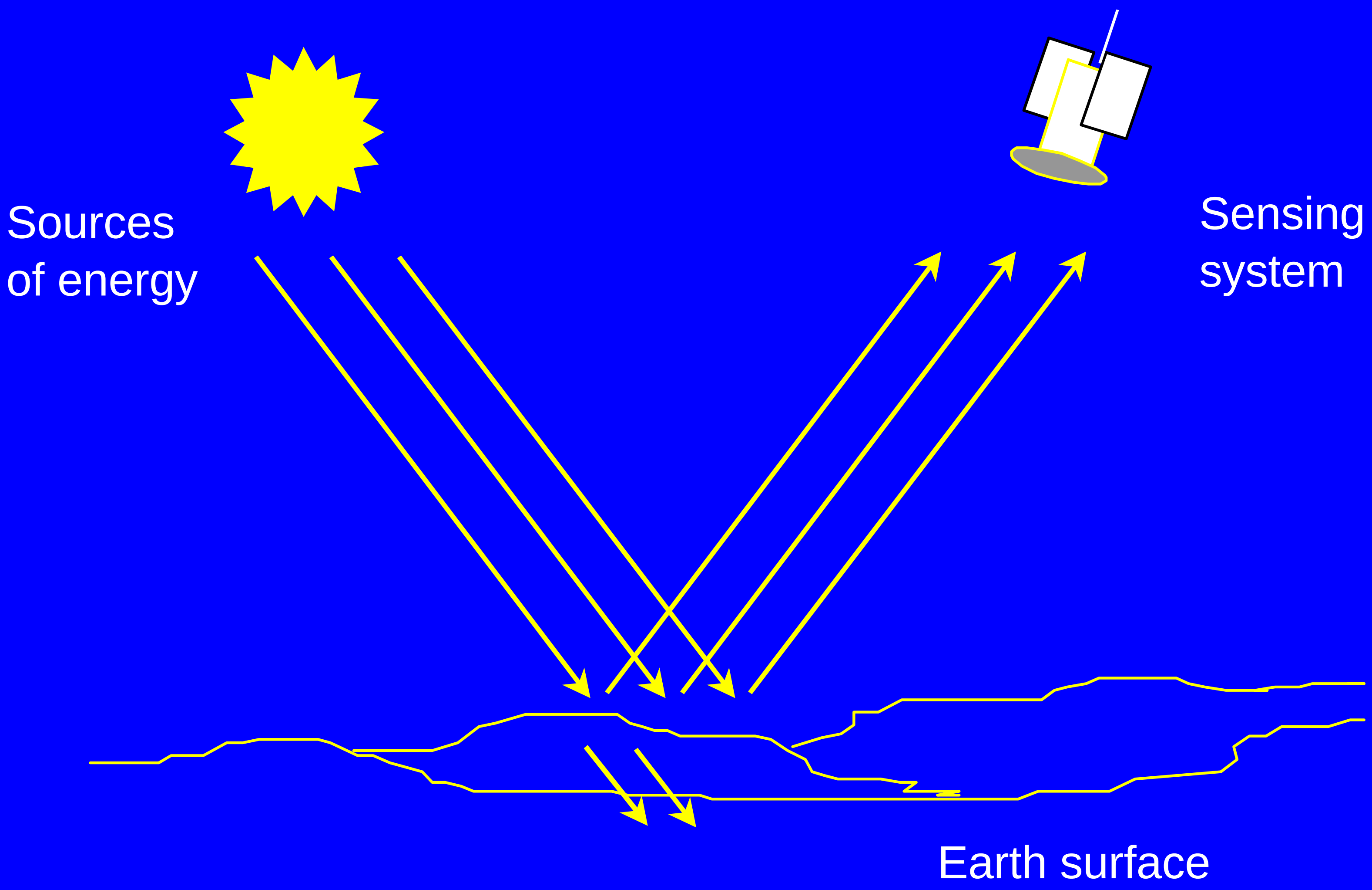
- traditional end product: printed photos
- today: digital image (scanned from photo) in standard graphics format (TIFF, JPEG) that can be integrated in a GIS or desktop mapping package
- future: fully digital process

Aerial photography

- digital orthophotos
  - corrected for camera angle, atmospheric distortions and terrain elevation
  - georeferenced in a standard projection (e.g. UTM)
  - geometric accuracy of a map
  - large detail of a photograph


ArcView GIS Version 3.0a
File
Edit
View
Theme
Analysis
Graphics
Window
Help
Scale 1:
230,377.07
903,859.38
View1
C B map
233d.tif
233c.tif
233b.tif
233a.tif

Remote sensing principle



Satellite based systems

- Landsat , SPOT, etc.
- also: Russian, Indian, Japanese, European, and Canadian
- panchromatic versus multispectral
- Landsat: 7-8 spectral bands
  some in visible spectrum
- new and planned systems have many more (hyper-spectral images)

Satellite remote sensing

- current systems: resolution of 10-60 meters (Spot, Landsat)
- new systems (1998/99): 0.82 m, 1 m
- allow production of orthomaps comparable to those from aerial photography

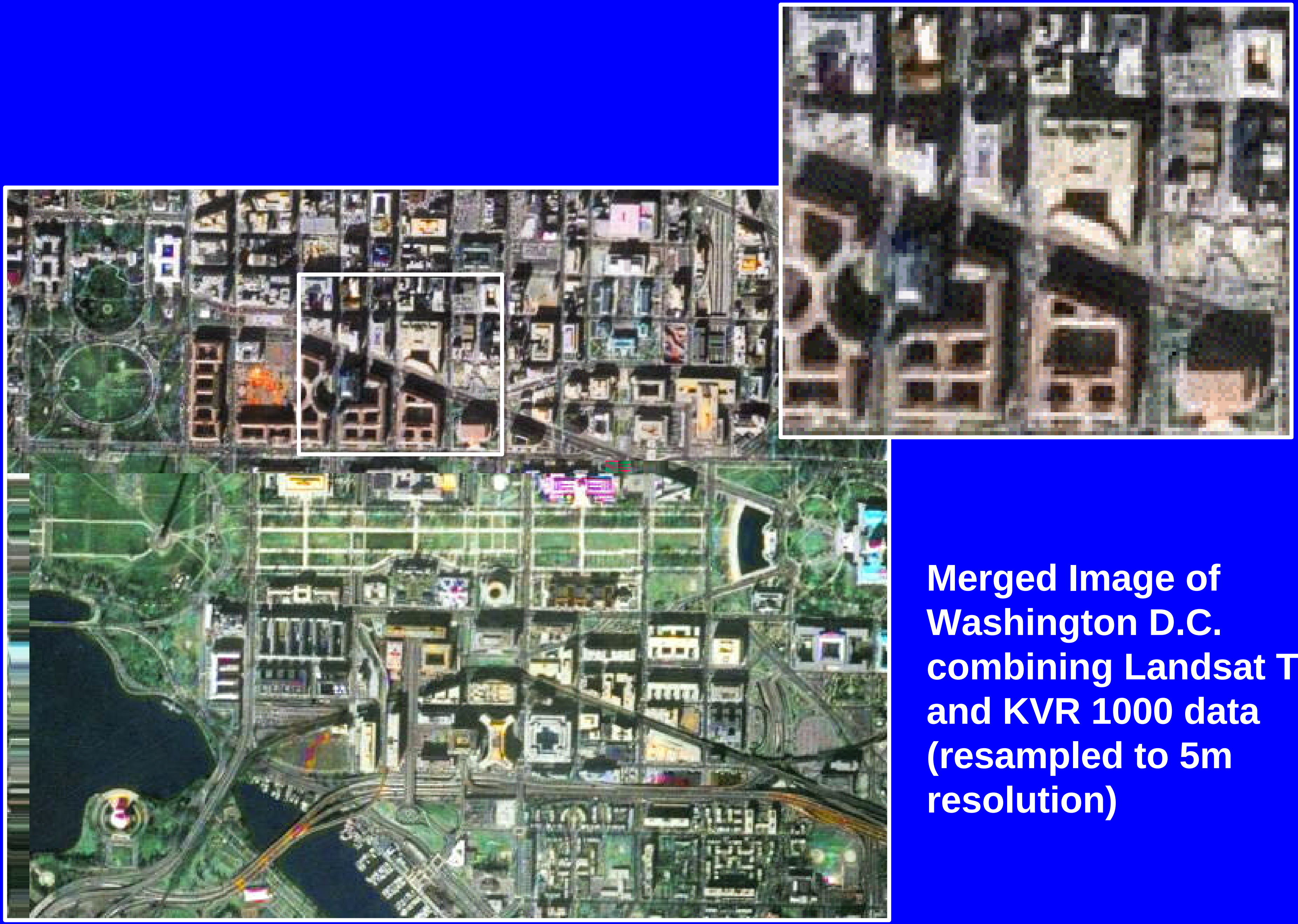
Satellite	Resolution (meters) panchromatic/ multispectral	Channels p / m
EarlyBird	3 / 15	1 / 4
QuickBird	0.82 / 3.28	1 / 4
Ikonos (Carterra 1)	1 / 4	1 / 4
Lewis	5 / 30	1 / 3
Clark	3 / 15	1 / 3
Core Software	1.5 / -	1
OrbView-3	1 / 4	1 / 4
IRS-1C	5.8 / -	1 / 4
IRS-1D	5 / 23	1 / 4
KVR 1000	2 / -	1

Landsat TM image of Hongkong (bands 7,4,3 - 60m resolution) shows vegetation in green, urban areas in purple/ white, water in blue/black

Source: Eosat

Cairo

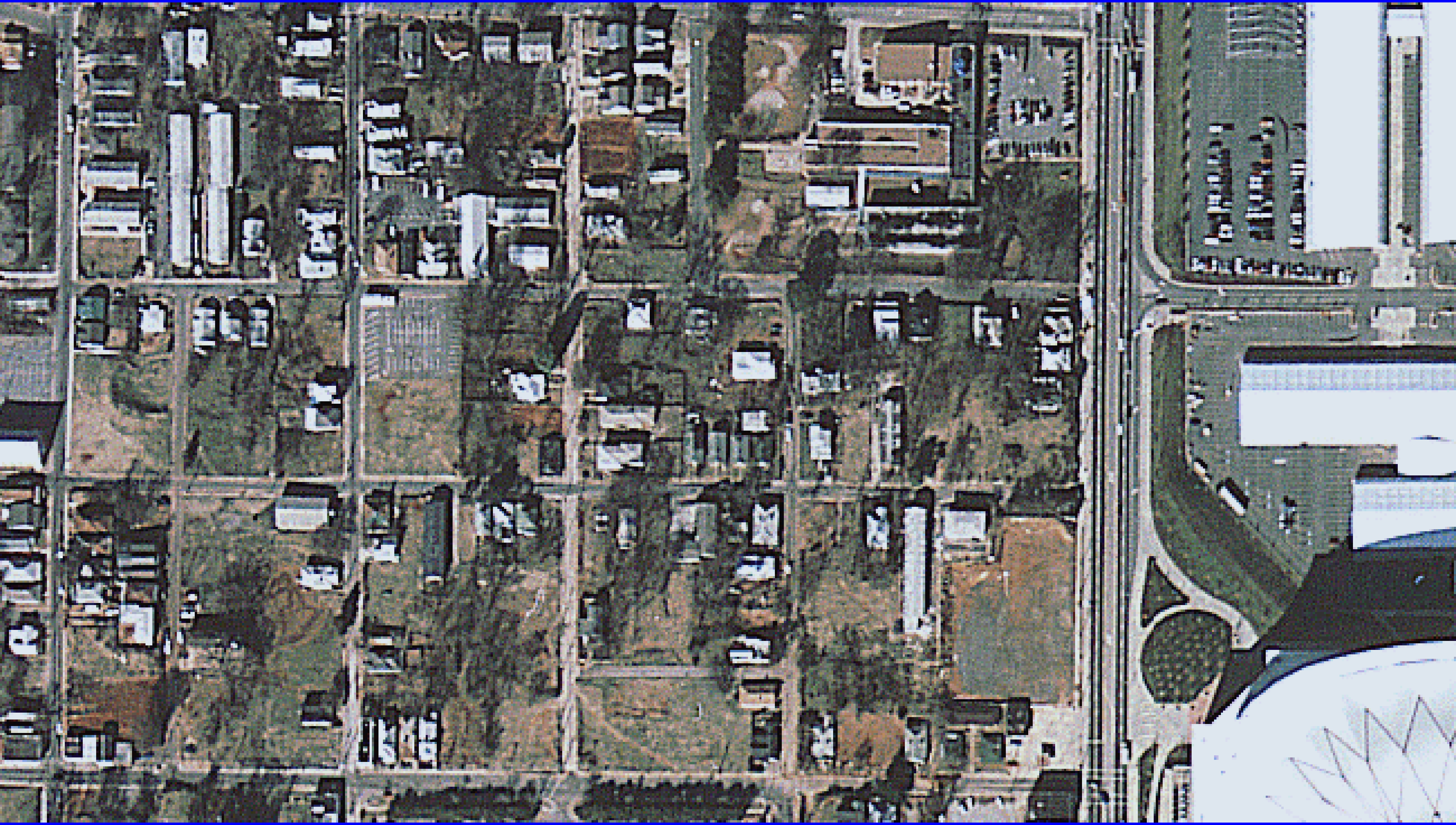
Russian KVR 1000 camera system. SPIN-2 - Aerial Images Inc.



Merged Image of Washington D.C. combining Landsat TM and KVR 1000 data (resampled to 5m resolution)

Source: Eosat

1 m resolution Carterra imagery

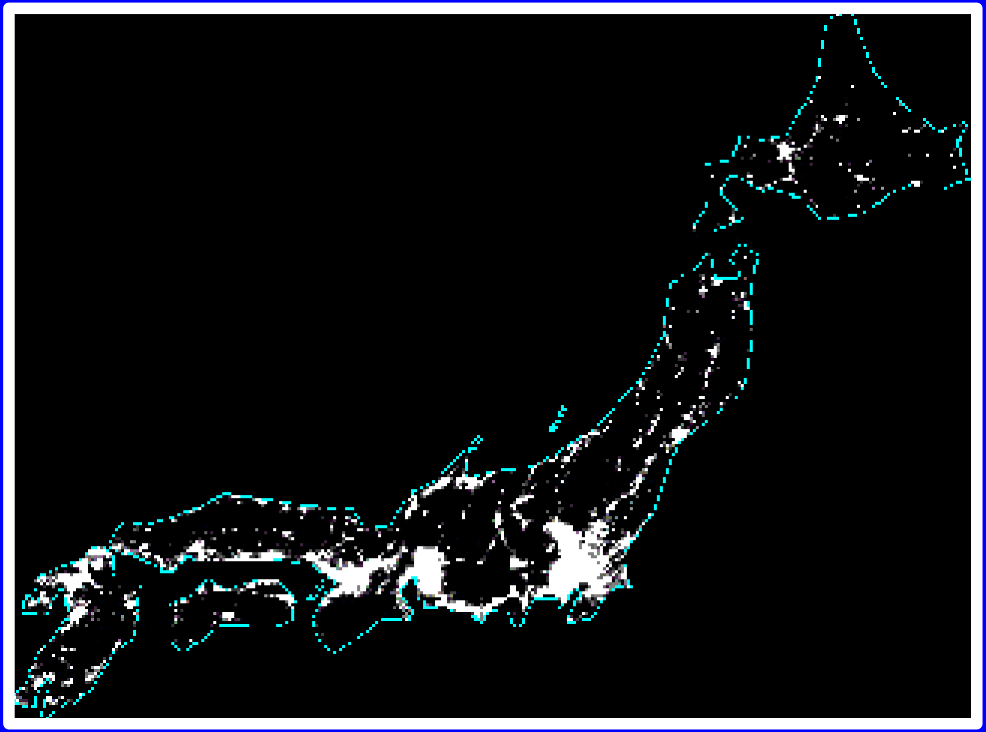


Source: Space Imaging/

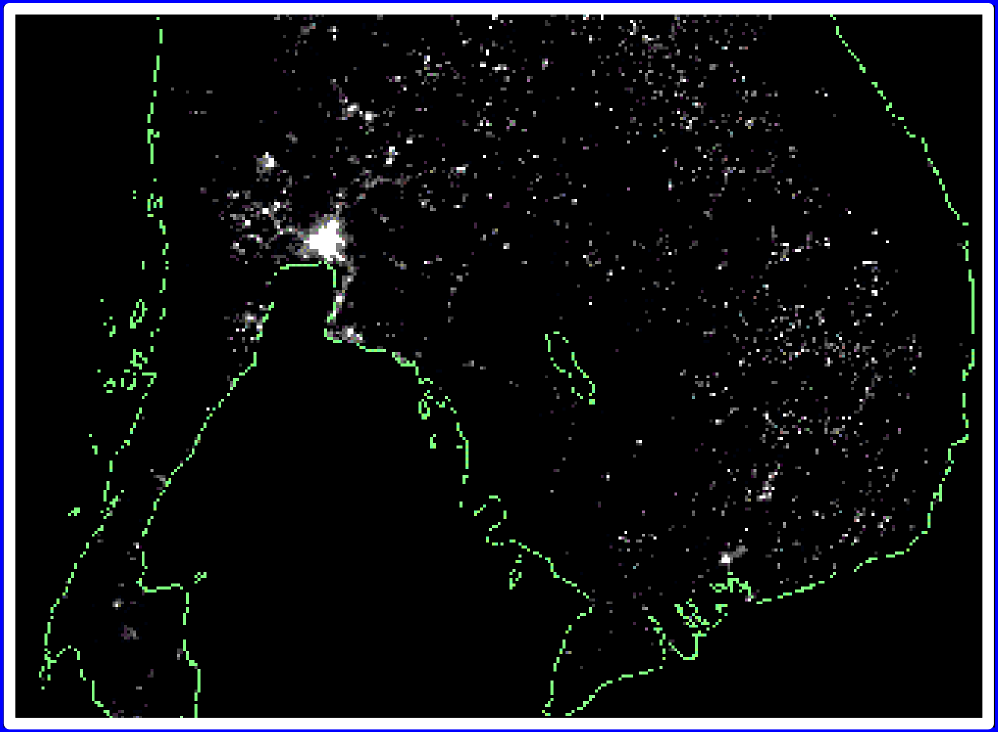
Socioeconomic applications

- delineation of newly urbanized areas (e.g., Quito, Manila)
- mapping of villages for population estimation (e.g., Sudan, W-Africa) with Landsat (rooftop surveys)
- Defense Meteorological Satellite Program's (DMSP) measures nighttime visible light emissions

DMSP data

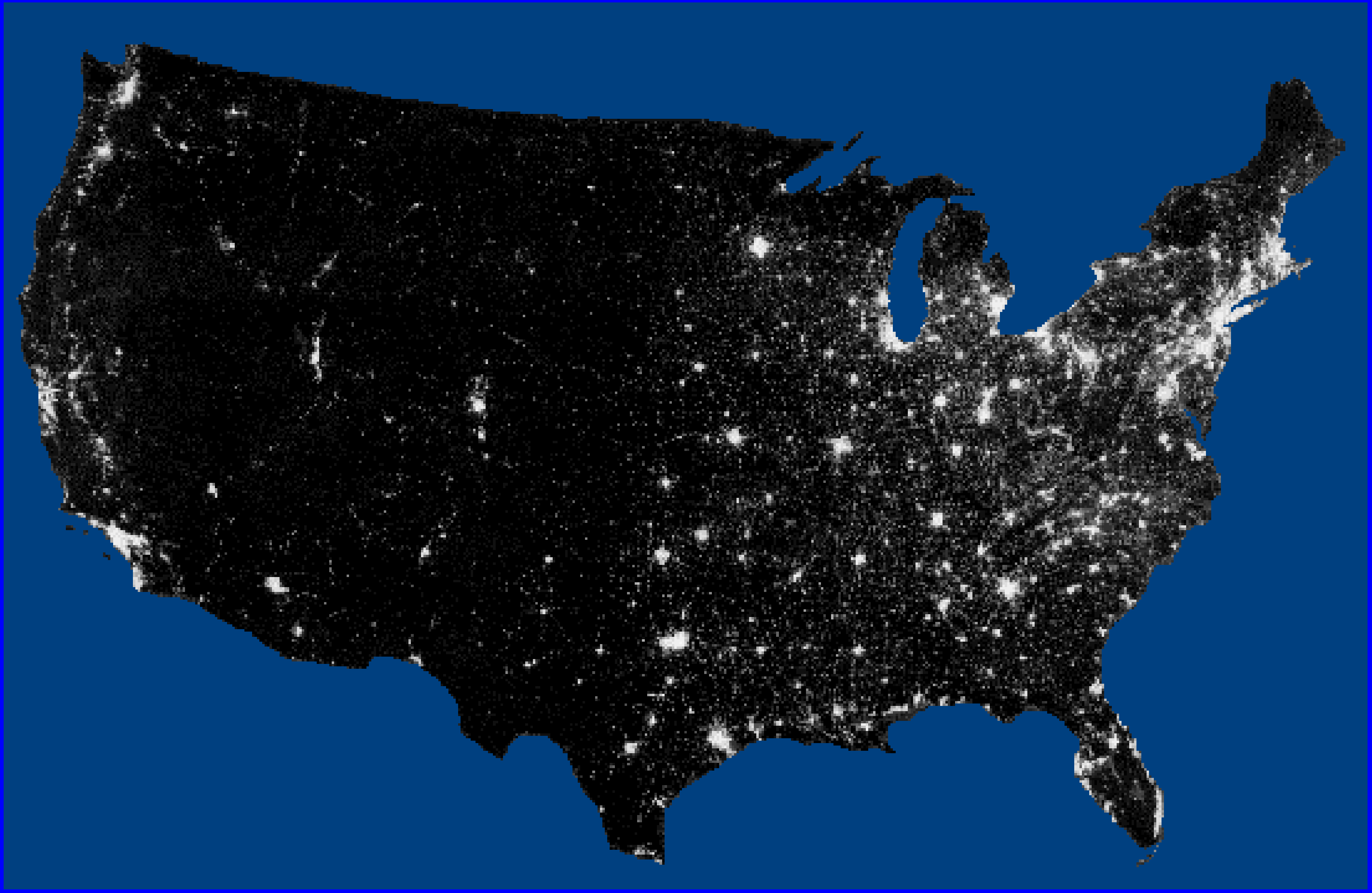


Japan



South-East Asia

Population Distribution 1980
(mapped census data at the block level)



Source: U.S. Bureau of the Census

Census from heaven?

- DMSP data: good for delineating urban/non-urban
- too little variation to link to population densities
- higher resolution data: usually too expensive and not accurate enough for census-type activities
- but: useful source of base maps for EA delineation