

Building Custom GIS Applications using Open-Source Toolkits – A Case Study



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Introduction



- **Talk deals with how to get started with a custom development effort**
- **Motivation for creating your own GIS application**
- **Decisions to make along the way**
- **Examples and lessons learned from developing the ORNL Geospatial Viewer (OGV)**

Motivation



- **Several projects needed a simple GIS application for use by non-GIS professionals**
- **Commercial offerings deemed too complicated and/or costly by sponsor**
- **Browser-based offerings had restrictive terms of use and/or copyrighted data**
- **Needed the ability to customize the code for each project**

Requirements



- **Simple to learn (avoid jargon, feature bloat)**
- **Allow custom map making and data capture**
- **Support hardware devices (GPS receiver)**
- **Run on a laptop for mobile operations**
- **Liberal license terms**
- **No per-copy cost**



Challenges



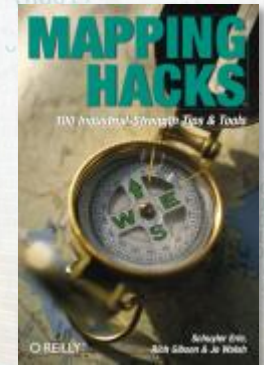
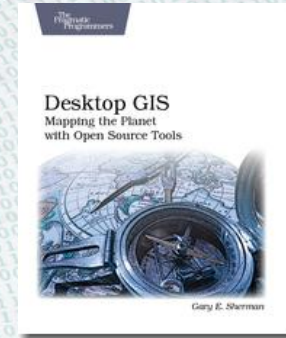
- **Network connection not always available in the field**
- **Laptop must carry the data it needs**
- **User may need to store unstructured or unanticipated data (photos, reports, scanned maps, floor plans, etc.)**
- **Operation on Windows, Mac, and Linux**



Getting Started



- Available applications and toolkits
 - “Desktop GIS” by Gary Sherman
 - <http://desktopgisbook.com>
- Ideas for use cases
 - “Mapping Hacks” by Erle, Gibson, & Walsh
 - <http://www.mappinghacks.com>
- Data sources (region dependent)
- Development help (tool dependent)



Application Elements

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- Graphical user interface (GUI)
- Geospatial database for spatial queries
- Access to web repositories prior to use in the field
- Hardware drivers





- **Python**

- Can be used for OS scripting, procedural programming, or object-oriented programming
- Cross-platform, already installed in many cases
- Minimalist approach to language elements

- **Resources**

- <http://python.org>
- “Learning Python” by Mark Lutz
- “Python in a Nutshell” by Alex Martelli
- <http://oreilly.com/python>





- **wxPython**

- wxWidgets C++ library with Python bindings
- Cross-platform, preserves native OS look and feel
- Active development and user community
- Liberal license for personal and commercial use

- **Resources**

- <http://www.wxpython.org>
- “wxPython in Action” by Rappin & Dunn





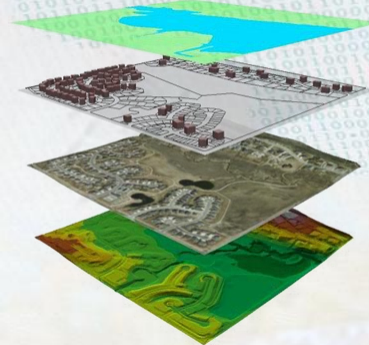
- **PostgreSQL**
 - Cross-platform, supports spatial queries natively
 - Many extensions (PostGIS)
- **Resources**
 - <http://www.postgresql.org>
 - “PostgreSQL” by Douglas & Douglas
- **PsycoPG2**
 - Provides Python DBAPI interface
 - <http://www.initd.org/pub/software/psycopg>



Data Sources



- **On-board laptop**
 - GNIS (<http://geonames.usgs.gov>)
 - National Atlas (<http://www.nationalatlas.gov>)
 - LandScan (<http://www.ornl.gov/sci/landscan>)
 - TIGER (<http://www.census.gov/geo/www/tiger>)
- **Internet access**
 - WMS
 - GeoRSS



Hardware Support

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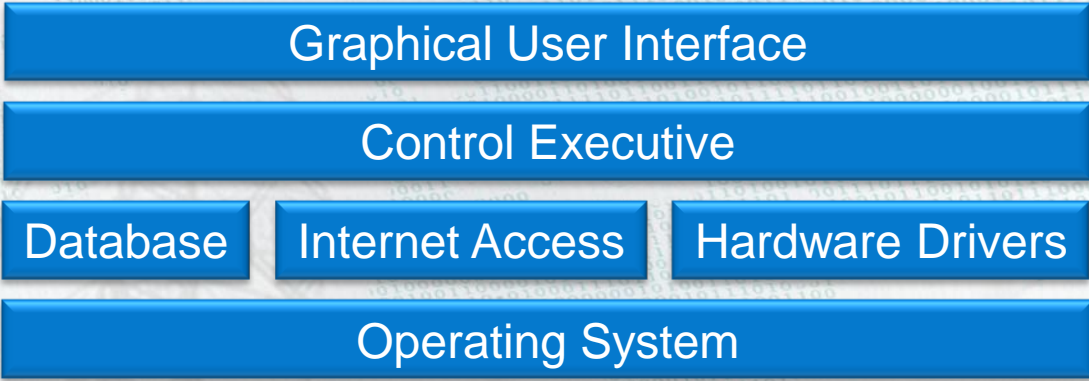


- **GPS receiver**
 - Real-time tracking
 - Downloading waypoints
 - Source of satellite information
 - **PySerial**
 - Cross-platform* Python access to serial port
 - <http://sourceforge.net/projects/pyserial>
- * Windows requires Mark Hammond's Python extensions (<http://www.python.net/crew/mhammond>)



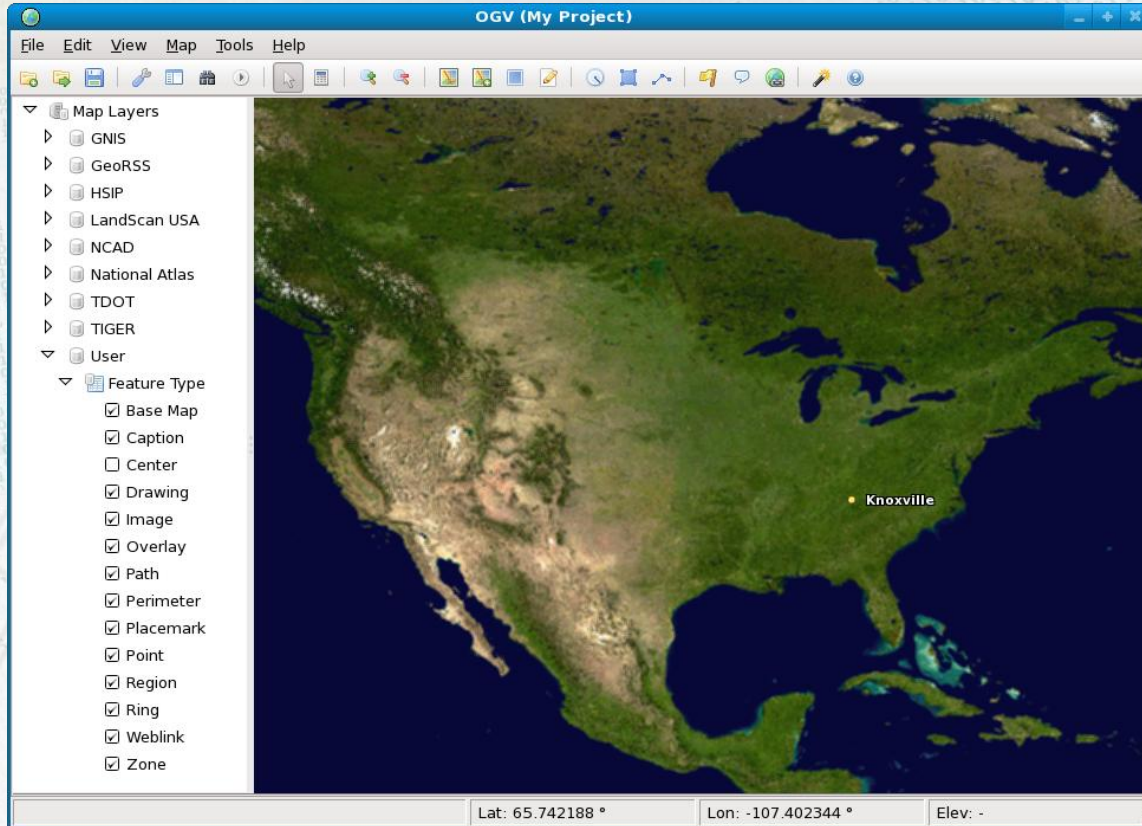
Architecture

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Elements of model-view-controller (MVC) used throughout

Graphical User Interface (Linux)



Database layers pane can be shown or hidden

Button bar

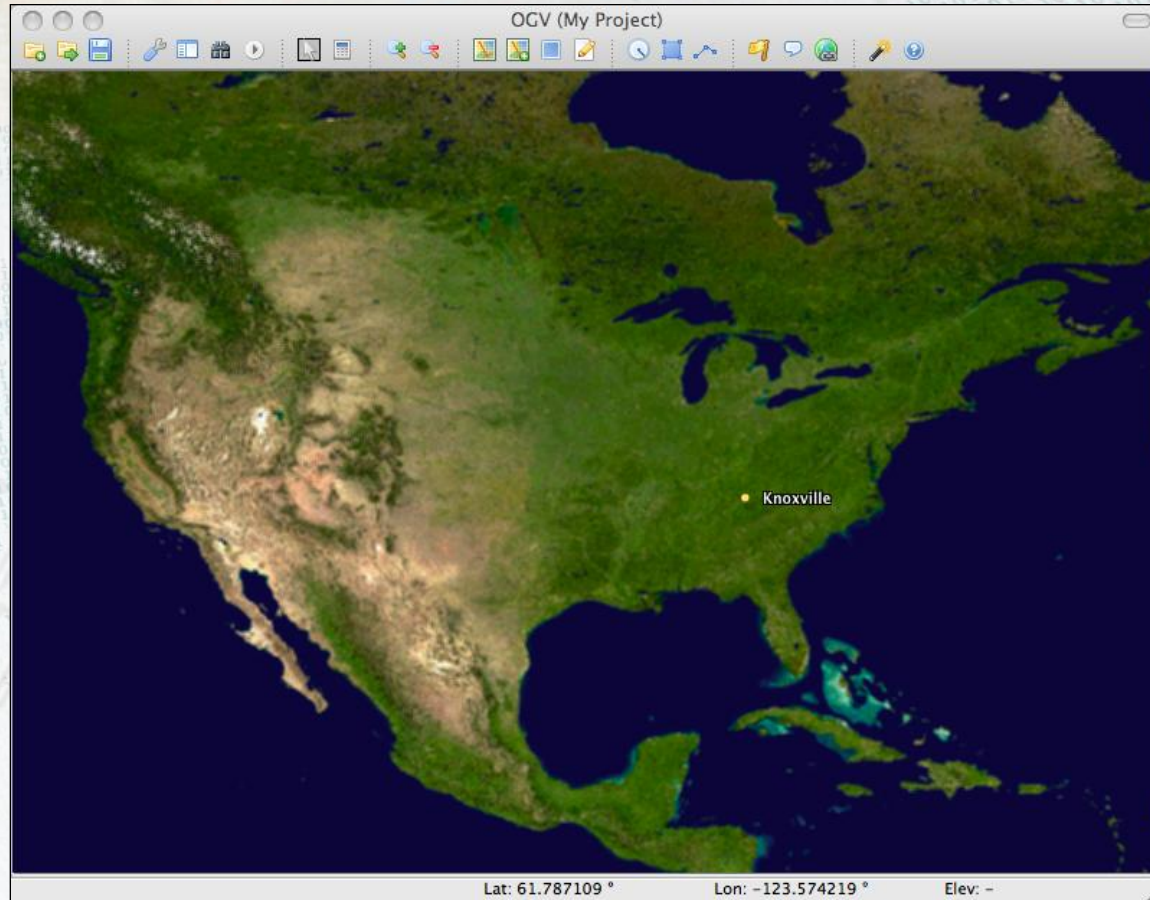
Mouse controls pan (drag) and zoom (wheel)

Cursor lat/lon/elev

Icon set by Mark James – <http://www.famfamfam.com/lab/icons/silk>

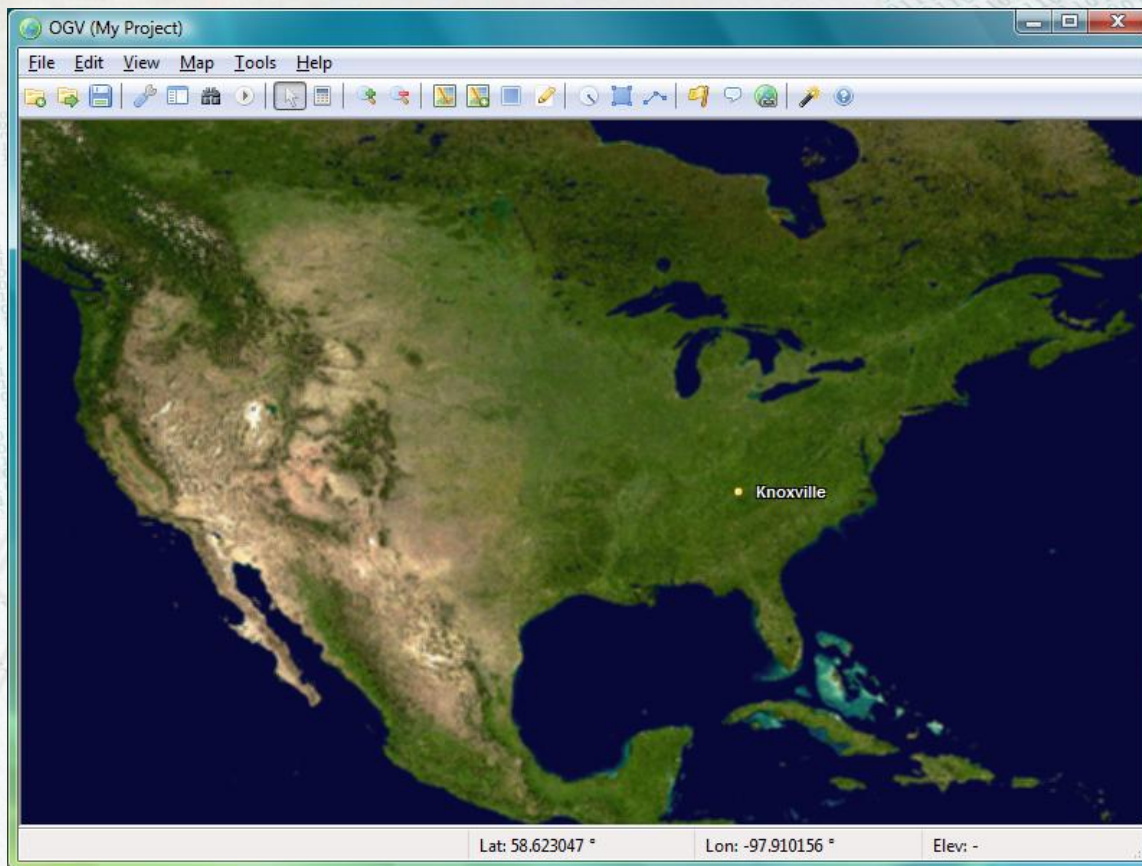
Mac OS GUI

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Windows Vista GUI

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Menu Operations



File	Edit	View	Map	Tools
N ew Project...				Ctrl+N
O pen Project...				Ctrl+O
S ave Project				Ctrl+S
Save Project A s...				
I mport F eature...				
P rint...				Ctrl+P
Q uit				Ctrl+Q

Edit	View	Map	Tools	Help
C ut				Ctrl+X
C opy				Ctrl+C
P aste				Ctrl+V
P aste S pecial				Shift+Ctrl+V
D elete				Delete
S elect A ll				Ctrl+A
G roup				Ctrl+G
U ngroup				Shift+Ctrl+G
D atabase L ogin...				
P roject O ptions...				

View	Map	Tools	Help
R estore V iew			Ctrl+R
Z oom F ull E xtent			Ctrl+E
E xport V iew...			
<input type="checkbox"/> C ompass			
<input type="checkbox"/> G rid			
<input type="checkbox"/> L egend			
<input type="checkbox"/> S cale			
<input checked="" type="checkbox"/> L abels			
<input type="checkbox"/> Show H idden F eatures			
<input type="checkbox"/> R eset L ayers			
V iew A nimation			
<input type="checkbox"/> L oop			
<input type="checkbox"/> G PS T racking			

Map	Tools	Help
G et B ase M ap...		Shift+Ctrl+B
A dd O verlay M ap...		Shift+Ctrl+O
A dd I mage...		Shift+Ctrl+I
A dd D rawing...		Shift+Ctrl+D
D efine Z one		Shift+Ctrl+Z
D efine R egion		Shift+Ctrl+A
D efine P ath		Shift+Ctrl+P
A dd P lacem <u>a</u> rk		Shift+Ctrl+M
A dd C aption		Shift+Ctrl+C
A dd W eb L ink		Shift+Ctrl+W
C lear C ach <u>e</u>		

Help	
H elp	F1
S how T ips	
L aunch W izard...	
W eb H ome	
C heck for U pdates	
S how V ersions	
A bout	

Tools	Help
D isplay C lock	
C onvert G eo-coordinates...	

Feature Operations



OGV (My Project)

File Edit View Map Tools Help

- Properties
- Folder
- Cut
- Copy
- Delete
- Edit Shape
- Export
- Hide
- Move
- Run Script
- Save
- Send Back
- Blur
- Color
- Label
- Line Weight
- Rotation
- Scale
- Symbol
- Transparency

Properties and folder

Clipboard ops

Actions

Attributes

Knoxville

Elev. -

Properties



The screenshot displays the OGV (My Project) application window with a map of Knoxville, Tennessee. Two 'Placemark Properties: Knoxville' dialog boxes are overlaid on the map. The first dialog box is in the 'General' tab, showing the 'Label' as 'Knoxville' and the 'Position Input' section with radio buttons for 'Degrees', 'DMS', 'UTM', and 'ECEF'. A yellow tooltip is visible over the 'Use' option, stating: 'Position of feature specified in decimal degrees, degrees/minutes/seconds, UTM (meters), ECEF (meters), or UTM-like user grid (meters)'. The second dialog box is in the 'Notes' tab, showing a 'URL' field with 'http://www.ci.knoxville.tn.us/' and a 'Web' button. Below these is a 'Description' field containing metadata: 'id = 1648562', 'Name = Knoxville', 'Category = Populated Place', 'State = TN', 'County = Knox', 'Elev = 276', and 'Map Name = Knoxville'. A yellow tooltip is visible over the description field, stating: 'User-defined text field for general use. Read-only database features often display record contents here.' Both dialog boxes have 'Defaults', 'Restore', and 'Apply' buttons, and the second one also has 'Cancel' and 'OK' buttons.

Dynamic tabs based on input coordinate system

User notes and URL



OGV Wizard

Make a weather map

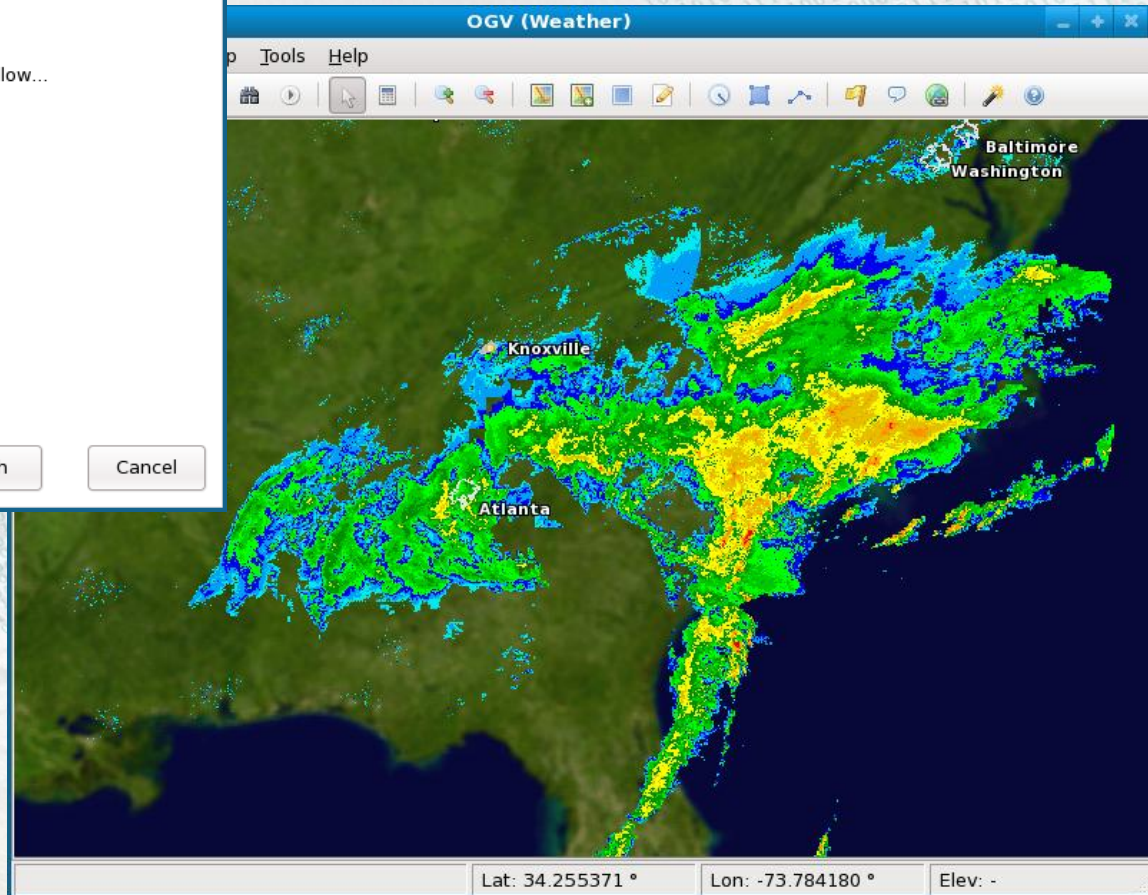
Step 1 of 1

Choose a regional or national map below...

[Regional weather map](#)
[Start regional weather loop](#)

[National weather map](#)
[Start national weather loop](#)

Help < Back Finish Cancel

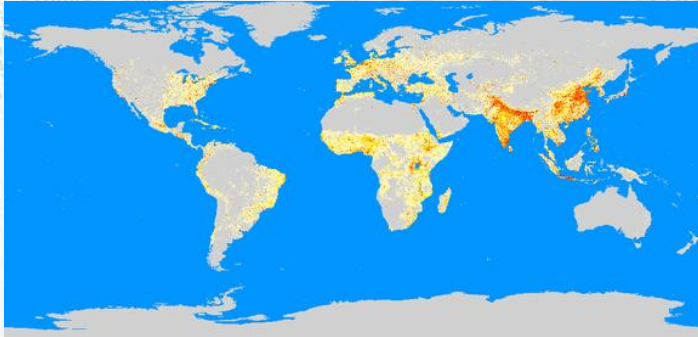


Instruction pages implemented in HTML

Examples



- Emergency response planning
- Satellite tracking
- GeoRSS

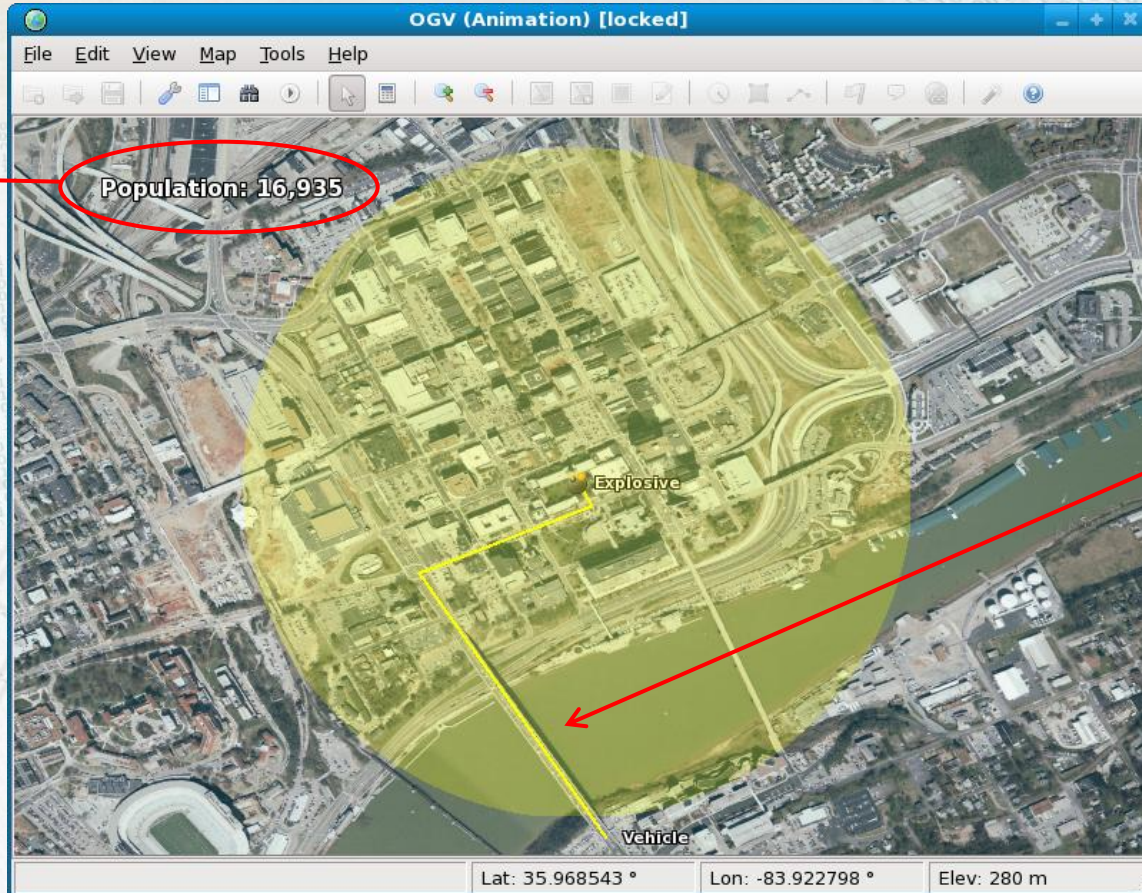


Emergency Response Planning

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Population updated as circle expands

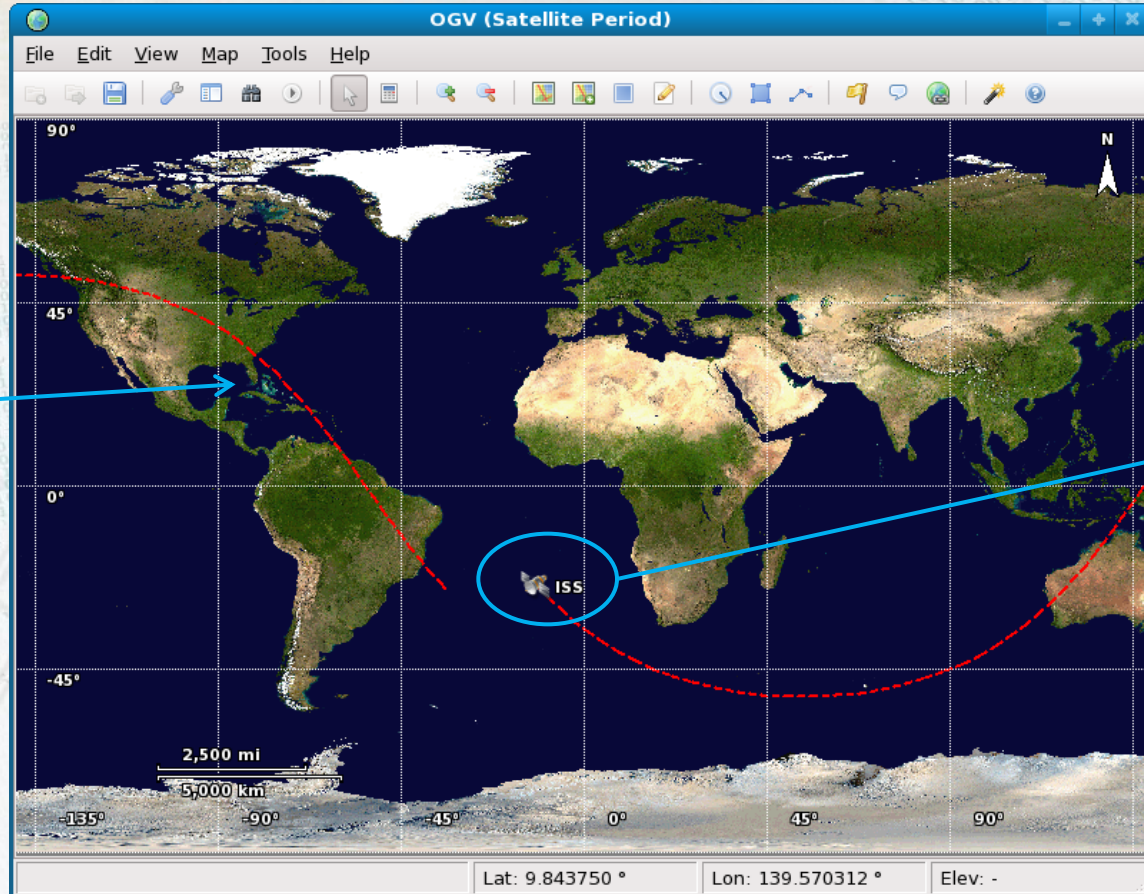


Vehicle moves along path

Animation showing a hazardous release

Satellite Tracking

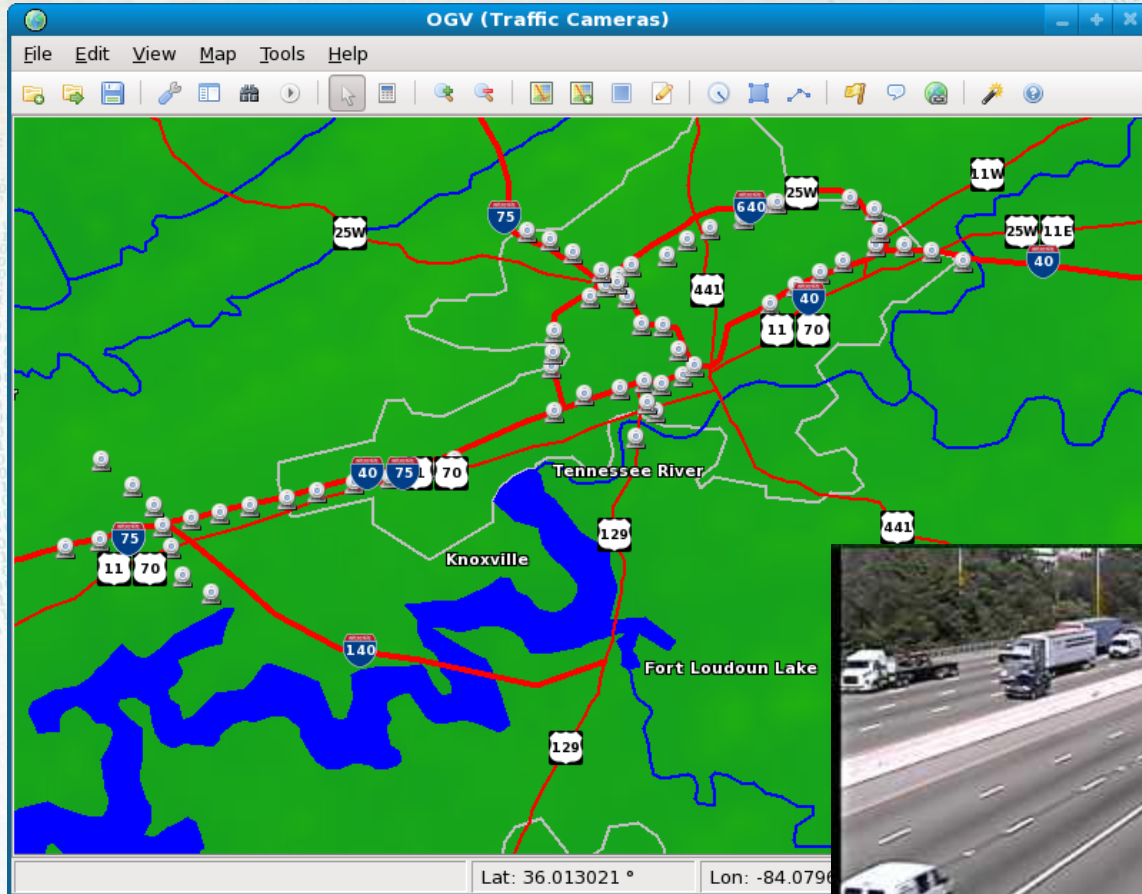
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One period of orbit shown

Current position of satellite

Real-time tracking animation using satellite ephemeris



Webcams pulled as GeoRSS

Double-clicking webcam icon launches browser camera view



False-color DTED generated map with user-selected features

Lessons Learned



- **Make sure you really need a custom solution**
- **Clearly define a minimum set of functions and data types to support at first**
- **Pick a language/toolkit you enjoy using**
- **Allow your code to be organic but constantly refactor into stable bits of functionality**
- **Avoid feature-creep and excessive options**
- **Great vehicle for learning GIS concepts**

Future Efforts

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- **GUI improvements**
- **More simulation capabilities**
- **3D viewing via PyOpenGL**
- **Hardware drivers for other devices**
- **Animation scripting by end-user**