

Redneck's and Duct Tape

GIS/GPS Method of Efficient School Bus Routing



Will Davis, GISP

Lake County Schools

Friday, March 2, 2012



Project Background

294 Buses

Transporting 21,860 Students

Twice Daily

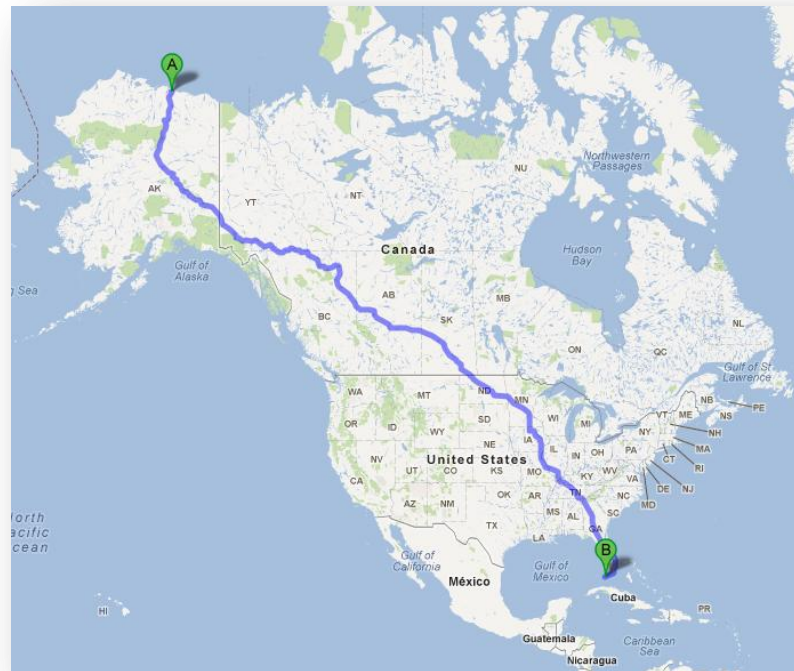
30,670 Miles





Project Background

Key West, FL to Deadhorse, AK -- Distance of 5,482
4 Days 15 Hours -- 30,670 Miles = 2.8 Round Trips
6.2 mpg = 4,950 gallons/day





Project Background



Annual Distance Traveled
5,523,740 Miles
(11.5 Round Trips)





Situation

- Revenue/Budget Shortfall
 - Total Cost = \$16 Million
 - Cost to District = \$7.65 Million
 - State Reimbursement = \$8.35 Million
- Cost Cutting Measures
- State Statute & Board Policy





Key Project Points

- Efficient Routing
 - Travel Time/Distance
 - Depot Stops
- Reduce Ridership
 - State Guidelines
 - Board Policy
- Student Safety
 - Local Govt. Coordination
 - Public Involvement





Project Goals

- Reduce Cost to School District
 - Eliminate routes
 - Eliminate stops (initiate depot stops)
 - Reduce travel time/distance
 - Eliminate or reduce staff hours
 - Cut fuel consumption
 - Cut Maintenance





Where Do We Start?

- Determine tasks & budget
- Data collections efforts
 - Students
 - Routes/Stops
 - Streets (networkable)
 - Cost
- Measuring success





Analysis Constraints

- Determine operating cost
 - Minimize windshield time
 - Driver hours
 - Minimize travel distance
 - Fleet maintenance
 - Reduce fuel cost
- Load balancing of students
- Student travel time constraints
- Bell time constraints
- Stop allocation





How to get there?

- Mapping what we KNOW
 - Geocoded students
 - Determine transportation
 - Routes
 - Stops
 - Networkable GIS layers
 - Walkability (Student)
 - Drivability (Bus)





Locate Bus Routes

Hand Drawn Laminated Paper Maps





Locate Bus Stops

Bus Stop Tabular File from IT Dept.

20090817_bus_route_download-will_davis.xls

	A	B	C	D	E	F
1	BUSKRT	BUSDRNAME	AMPM	STOP	STPTIME	STPNAME
11509	TEL-7626	OPEN	P	00040	03:30	TAVARES RIDGE BLVD: STOP- AFTER TURN
11510	TEL-7626	OPEN	P	00045	03:35	TAVARES MIDDLE SCHOOL
11511	TEL-7627	OPEN	A	00000	07:41	LEAVE TAVARES BUS LOT
11512	TEL-7627	OPEN	A	00005	07:51	DEAD RIVER: MARSH HARBOR
11513	TEL-7627	OPEN	A	00010	07:53	DEAD RIVER: STOP- COVE RD
11514	TEL-7627	OPEN	A	00015	07:57	DEAD RIVER RD:STOP- MAGNOLIA RIDGE
11515	TEL-7627	OPEN	A	00020	08:00	RUBY ST:STOP-FRONT PLAYGROUND
11516	TEL-7627	OPEN	A	00025	08:10	TAVARES ELEMENTARY SCHOOL
11517	TEL-7627	OPEN	P	00000	03:10	LEAVE TAVARES ELEMENTARY
11518	TEL-7627	OPEN	P	00005	03:14	RUBY ST:STOP-FRONT PLAYGROUND
11519	TEL-7627	OPEN	P	00010	03:20	DEAD RIVER: STOP- MARSH HARBOR
11520	TEL-7627	OPEN	P	00015	03:25	COVE RD: STOP- DEAD RIVER
11521	TEL-7627	OPEN	P	00020	03:30	DEAD RIVER:STOP- MAGNOLIA RIDGE
11522	TEL-7627	OPEN	P	00025	03:35	TAVARES MIDDLE SCHOOL
11523	TEL-AFT1	JOANN HAVENS	P	00000	04:45	LEAVE TAVARES BUS LOT
11524	TEL-AFT1	JOANN HAVENS	P	00005	05:00	TAVARES ELEM SCHOOL
11525	TEL-AFT1	JOANN HAVENS	P	00010	05:04	CAROLINE:STOP- ROCKINGHAM
11526	TEL-AFT1	JOANN HAVENS	P	00015	05:15	OLD HWY 441: STOP- LAKE SAUNDERS CIRCLE
11527	TEL-AFT1	JOANN HAVENS	P	00020	05:19	BEXLEY: STOP- BARNSELY

20090817_bus_route_download-will_davis.xls

	A	B	C	D	E	F
1	BUSKRT	BUSDRNAME	AMPM	STOP	STPTIME	STPNAME
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11515	TEL-7627	OPEN	A	00020	08:00	RUBY ST:STOP-FRONT PLAYGROUND
11516	TEL-7627	OPEN	A	00025	08:10	TAVARES ELEMENTARY SCHOOL
11517	TEL-7627	OPEN	P	00000	03:10	LEAVE TAVARES ELEMENTARY



Modeling Methods

- Mapping existing details
 - AVL Tracking Systems
 - GPS “Geofence” detection
 - VRP – Vehicle Routing Problem
 - EMC – Ejection Chain Method
 - TSA – Tabu Search Algorithm
 - Heuristic Method





Vendor Options

- Locating Bus Routes or Stops
 - Transfinder (*Routefinder Pro*)
 - Tyler Technologies (*Versatrans*™)
 - Edulog (*Edulog.nt*)
 - Route Solutions (*StreetSync*™)
 - Trapeze Group (*Trapeze MapNet*)
 - Gecko Microsolutions, Inc. (*T.O.M.*)
 - Everyday Solutions, Inc. (*GEOREF*)
 - Total Solutions Partners (*BusOnePro*)



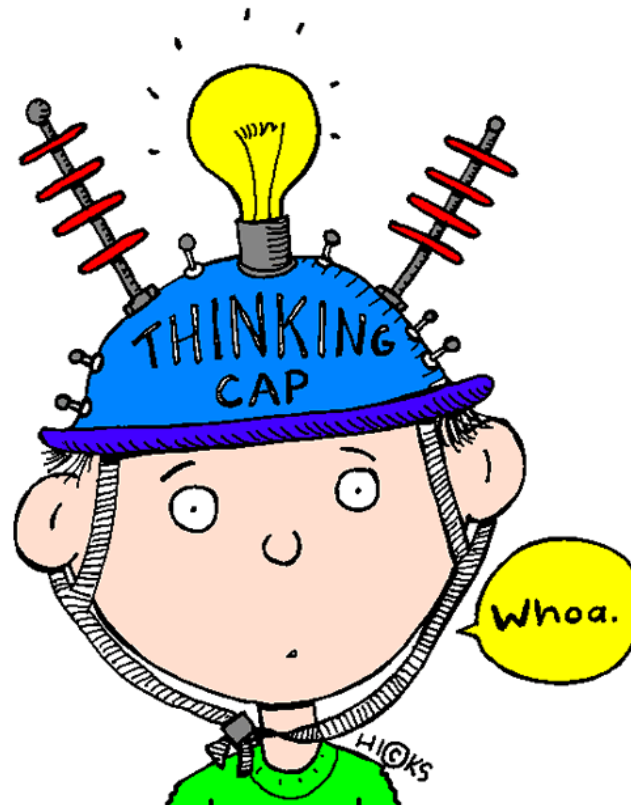


Options Overload





How to Obtain Useful GIS Data





Low-cost Solution

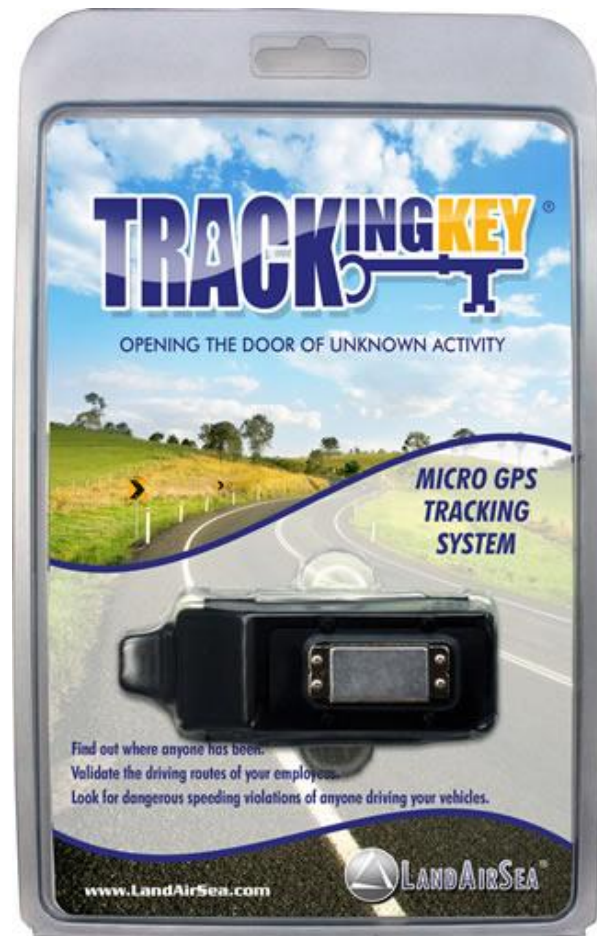
- Ernest P. Worrell GIS Method
 - Affordable GPS Tracking Key
 - Scripts to extract
 - Routes
 - Stops
 - Create GIS Layers
 - Arcs
 - Points





Low-cost Solution

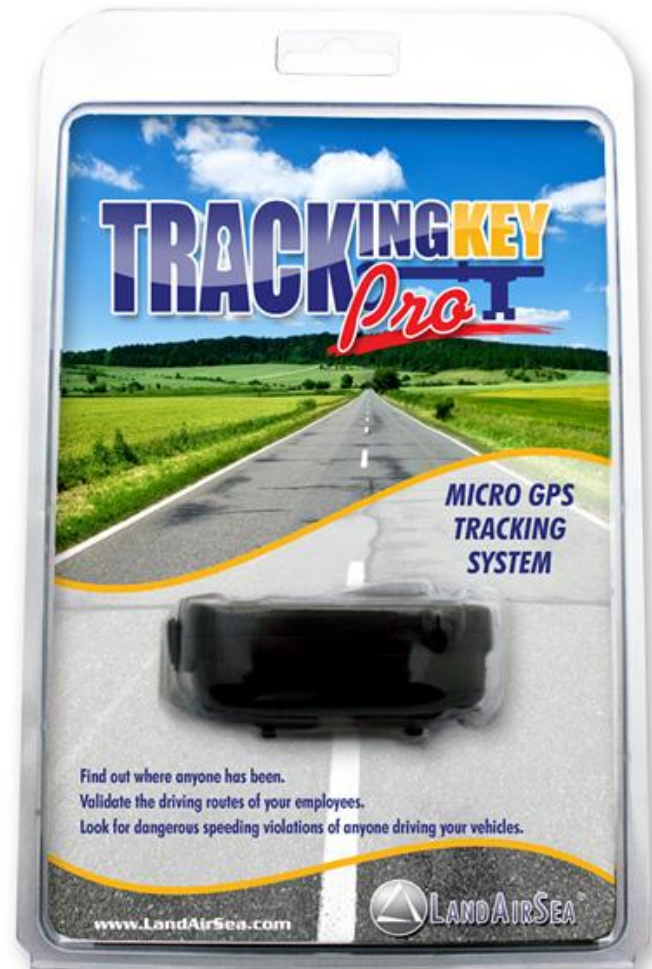
GPS Tracking Key





Newer Solution

Tracking Key Pro





Real-Time Solution

SilverCloud



Browser Friendly



ShareSpot



Google Maps



3D Viewing



Activity Reports



Alerts



Collecting the Data

Preferred
Bus
Mounting
Option





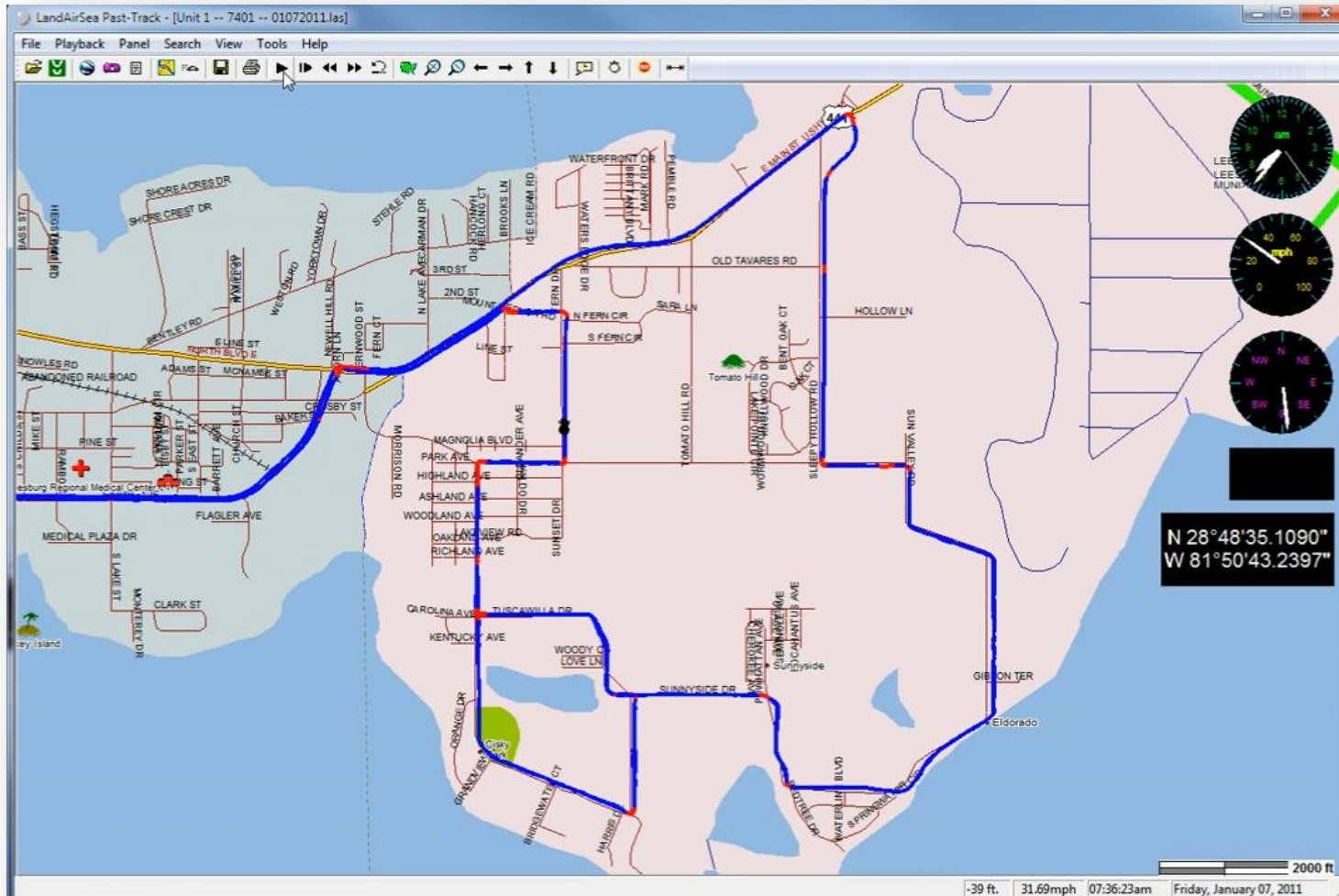
Collecting the Data

Non-preferred
Bus
Mounting
Option





Data Reinforcement





Data Reinforcement

The screenshot displays the Google Earth application window. The main map shows a satellite view of a coastal region with a blue boundary line. The interface includes a search bar at the top left, a 'Places' list on the left side, and a 'Layers' panel at the bottom left. The 'Places' list contains a series of routes from Route13 to Route28. The 'Layers' panel shows various map layers such as 'Primary Database', 'Borders and Labels', 'Places', 'Photos', 'Roads', '3D Buildings', 'Ocean', 'Weather', 'Gallery', 'Global Awareness', and 'More'. The bottom of the window shows the copyright information: '© 2011 Google' and '© 2011 Europa Technologies', along with the imagery date '1/26/2011' and coordinates '28°48'23.41" N 81°50'26.28" W elev 130 ft'. The Google logo is visible in the bottom right corner.



Data Reinforcement

Review Reports in Past Track™

S:\GROWTH PLANNING\GIS Presentations\ESRI Southeast Regional Users Group -- 2011\Presentation G - Windows Internet Explorer

S:\GROWTH PLANNING\GIS Presentations\ESRI Southeast Regional Users Group -- 2011\Presentation Graphics\Past-Track Report -- 7401.htm

Convert Select

Esri Arcgis Ideas Ideas Su... Chat - ESRI Support Crystal Reports Logon CCFGIS - Central Florida Ge... Dogpile Web Search ArcGIS Online ESRI Customer Care Portal

S:\GROWTH PLANNING\GIS Presentations\ESRI S...

Daily Driving Report

Date Spn : Friday, January 07, 2011 - Tuesday, January 11, 2011

Friday, January 07, 2011

Departed From : [802 S 14th St, Leesburg, FL 34748, USA](#)

Arrived At : [400 McCormack St, Leesburg, FL 34748, USA](#)

Total Driving Time : 4 hours, 17 minutes, 37 seconds

Total Mileage Driven : 80.0 miles

Maximum Speed : 55.9 mph

Departed	Driving Time	Arrived	Location Arrived	Distance (Miles)	Stopped Time
07:28:51am	42m:50s	08:11:41am	400 McCormack St, Leesburg, FL 34748, USA	16.6	30m:31s
08:42:12am	1h:14m:25s	09:56:37am	400 McCormack St, Leesburg, FL 34748, USA	23.6	29m:25s
10:26:02am	01m:07s	10:27:09am	499 N Chester St, Leesburg, FL 34748, USA	0.2	32m:17s
10:59:26am	01m:30s	11:01:02am	400 McCormack St, Leesburg, FL 34748, USA	0.1	4h:12m:09s
03:13:11pm	11m:32s	03:24:43pm	1420 Sumter St, Leesburg, FL 34748, USA	2.6	18m:32s
03:43:15pm	1h:07m:57s	04:51:12pm	1020 Beecher St, Leesburg, FL 34748, USA	19.8	16m:01s
05:07:13pm	58m:10s	06:05:23pm	400 McCormack St, Leesburg, FL 34748, USA	17.1	2days 14h: 16m:24s

Monday, January 10, 2011

Departed From : [400 McCormack St, Leesburg, FL 34748, USA](#)

Arrived At : [400 McCormack St, Leesburg, FL 34748, USA](#)

Total Driving Time : 22 minutes, 41 seconds

Total Mileage Driven : 0.4 miles

Maximum Speed : 8.1 mph

Departed	Driving Time	Arrived	Location Arrived	Distance (Miles)	Stopped Time
08:21:47am	06m:49s	08:28:36am	1908 Center St, Leesburg, FL 34748, USA	0.0	26m:41s
08:55:17am	08m:44s	09:04:01am	1908 Center St, Leesburg, FL 34748, USA	0.1	1h:48m:37s
10:52:38am	00m:04s	10:52:42am	400 McCormack St, Leesburg, FL 34748, USA	0.1	1h:37m:19s
12:30:01pm	00m:00s	12:30:01pm	400 McCormack St, Leesburg, FL 34748, USA	0.0	32m:21s
01:02:22pm	00m:01s	01:02:23pm	400 McCormack St, Leesburg, FL 34748, USA	0.0	32m:29s
01:34:52pm	00m:17s	01:36:09pm	406 N Chester St, Leesburg, FL 34748, USA	0.0	1h:00m:17s
02:35:26pm	01m:42s	02:37:08pm	400 McCormack St, Leesburg, FL 34748, USA	0.1	48m:20s
03:28:28pm	05m:04s	03:30:32pm	400 McCormack St, Leesburg, FL 34748, USA	0.0	17h:05m:14s

Local intranet | Protected Mode: Off 100%



Conversion to GIS

- Exporting flat file from Past-Track™
- Run BAT files with scripts for export
 - Arcs representing bus routes
 - Point representing estimate of bus stops



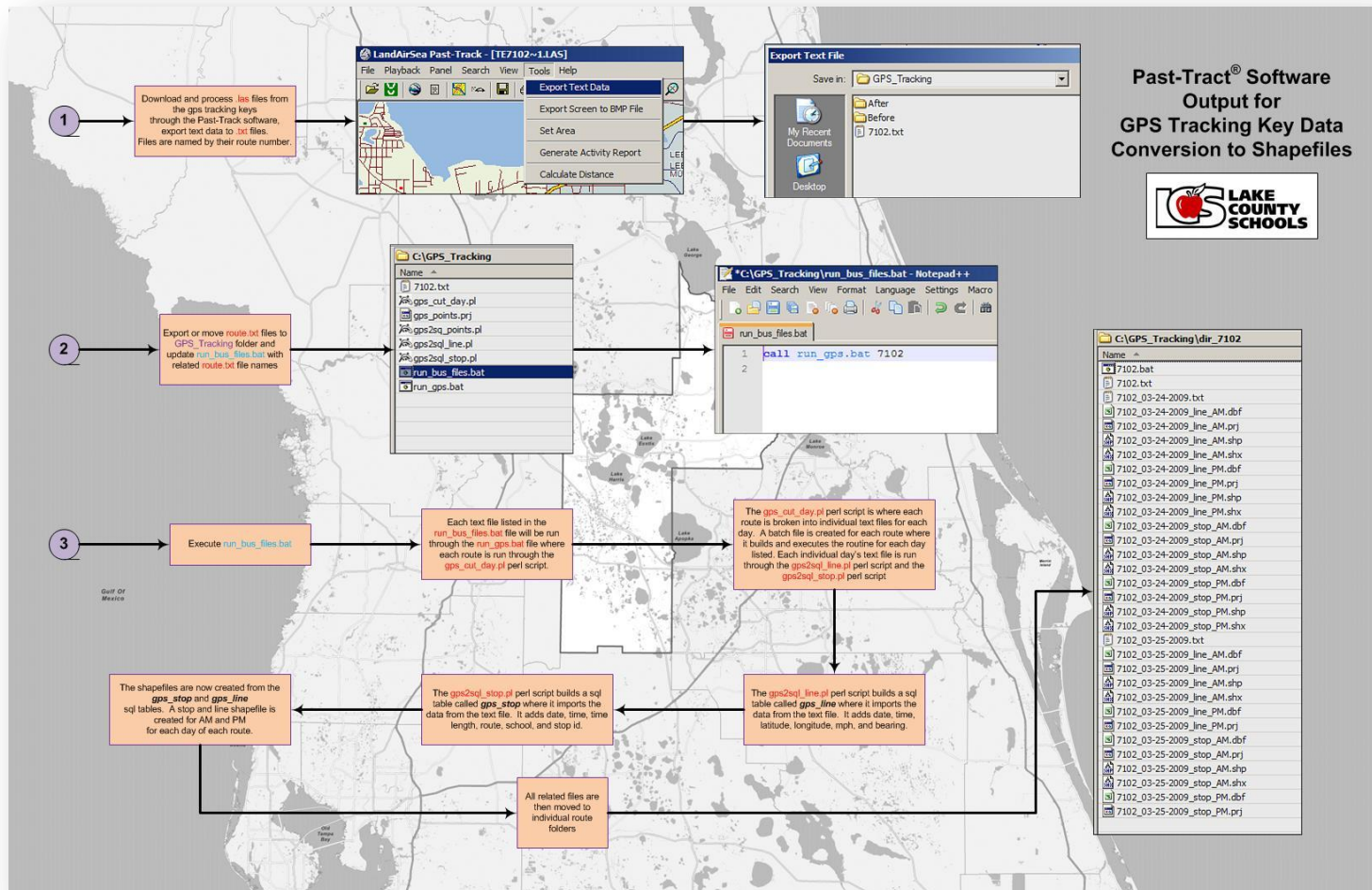


Open Source Options

- Developed scripts for export
 - **ActivePerl**[®] by ActiveState Software, Inc.
 - Multipurpose Program Language
 - Free Community License
 - **PostgreSQL** by PostgreSQL Global Development Group
 - Open source object-relational database system
 - Contains PostGIS geographic object support
 - Spatially enables “PostgreSQL for GIS applications”

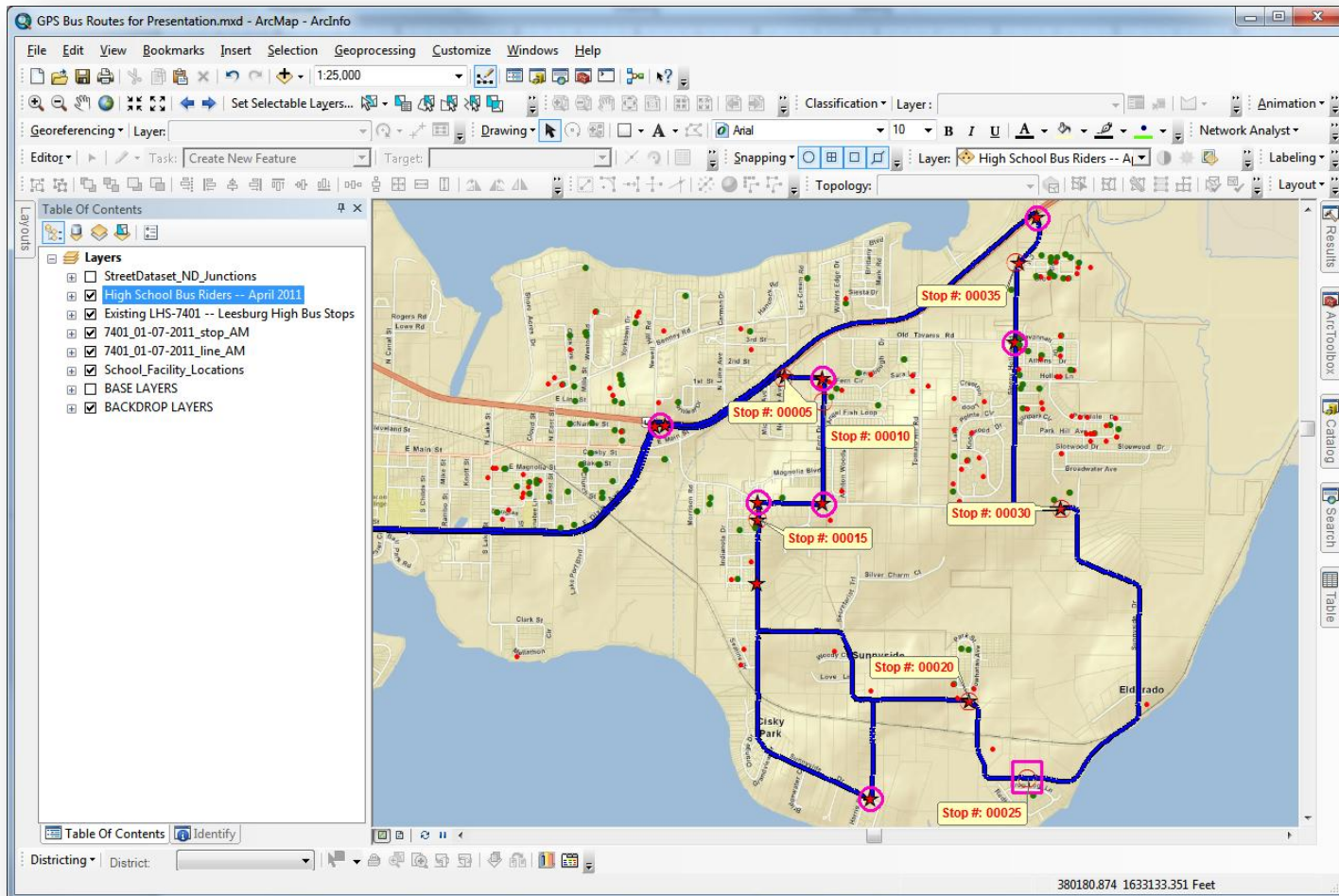


Data Conversion



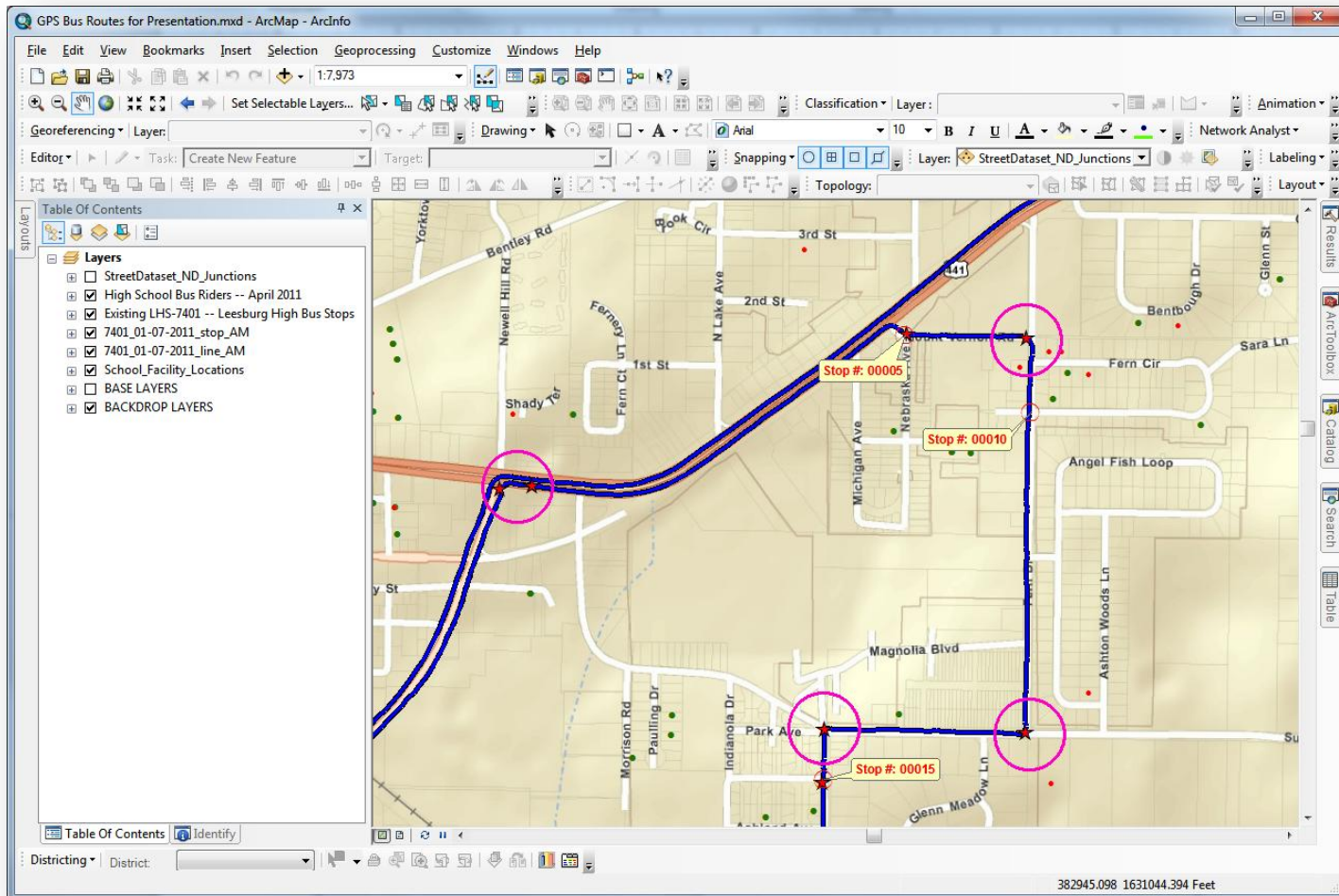


Assessing the Data





Assessing the Data





Data Format

GPS Bus Routes for Presentation.mxd - ArcMap - ArcInfo

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:7.973

Georeferencing Layer: Drawing Snapping Topology: Classification Layer: Animation

Editor Task: Create New Feature Target: Snapping Layer: StreetDataset_ND_Junctions Labeling

Table Of Contents

- Layers
 - StreetDataset_ND_Junctions
 - High School Bus Riders -- April 2011
 - Existing LHS-7401 -- Leesburg High Bus Stops
 - 7401_01-07-2011_stop_AM
 - 7401_01-07-2011_line_AM
 - School_Facility_Locations
 - BASE LAYERS
 - BACKDROP LAYERS

Table - 7401_01-07-2011_line_AM

FID	Shape	DATE_D	TIME_D	LATITUDE	LONGITUDE	MPH	BEARING	AM_PM	ORDER_CODE
90	Polyline	01-07-2011	14:17:35	28.81644	-81.894786	21.7	183.9	PM	0
91	Polyline	01-07-2011	14:17:36	28.816348	-81.894793	19.3	177	PM	0
92	Polyline	01-07-2011	14:17:37	28.816275	-81.894789	18	183.7	PM	0
93	Polyline	01-07-2011	14:17:38	28.816214	-81.894793	14.9	183.3	PM	0
94	Polyline	01-07-2011	14:17:39	28.816146	-81.894797	14.3	173.6	PM	0
95	Polyline	01-07-2011	14:17:40	28.816101	-81.894791	11.8	183.2	PM	0
96	Polyline	01-07-2011	14:17:41	28.816053	-81.894794	9.9	155.5	PM	0
97	Polyline	01-07-2011	14:17:42	28.816019	-81.894777	6.2	186.2	PM	0
98	Polyline	01-07-2011	14:17:43	28.816007	-81.894778	3.1	133.9	PM	0
99	Polyline	01-07-2011	14:17:48	28.815986	-81.89477	3.1	180	PM	0
100	Polyline	01-07-2011	14:17:49	28.81597	-81.89477	4.3	200.3	PM	0
101	Polyline	01-07-2011	14:17:50	28.815943	-81.894781	5	183.3	PM	0

7 (0 out of 5231 Selected)

7401_01-07-2011_line_AM

Table - 7401_01-07-2011_stop_AM

FID	Shape	DATE_D	TIME_D	TIME_LENGTH	ROUTE	SCHOOL	STOP_ID	AM_PM	ORDER_CODE
51	Point	01-07-2011	16:14:05	8	7401			PM	161405
52	Point	01-07-2011	16:16:49	2	7401			PM	161649
53	Point	01-07-2011	16:18:35	15	7401			PM	161835
54	Point	01-07-2011	16:19:26	14	7401			PM	161926
55	Point	01-07-2011	16:21:13	24	7401			PM	162113
56	Point	01-07-2011	16:23:05	20	7401			PM	162305
57	Point	01-07-2011	16:23:54	2	7401			PM	162354
58	Point	01-07-2011	16:24:31	17	7401			PM	162431
59	Point	01-07-2011	16:26:21	15	7401			PM	162621
60	Point	01-07-2011	16:27:51	5	7401			PM	162751
61	Point	01-07-2011	16:28:19	18	7401			PM	162819
62	Point	01-07-2011	16:31:12	35	7401			PM	163112

1 (0 out of 92 Selected)

7401_01-07-2011_stop_AM

Table Of Contents Identify

381761.543 1628954.139 Feet



Measuring Success

Route 7617

(Treadway Elementary, Tavares Middle & Tavares High School Runs)

Existing Bus Stops = 46 Existing Mileage = 44.4

Proposed Bus Stops = 34 Proposed Mileage = 42.3

Number of Stops Saved = 12 Mileage Saved on Route = 2.1

Calculation of Average Speed for Existing Route

Treadway Elementary = 10.0 miles in 41 minutes or 16.7 mph

Tavares Middle = 11.8 miles in 42 minutes or 16.9 mph

~~Tavares High = 22.6 miles in 55 minutes or 24.6 mph~~

Average = 44.4 miles in 2 hours 18 minutes or 19.3 mph

Travel Time Saved = 2.1 miles/route @ 19.3 mph or 6.5 minutes/route or 13 minutes/day

~~12 stops/route @ 2 minutes/stop = 24 minutes/route or 48 minutes/day~~

Daily time saved = 13 minutes + 48 minutes = 61 minutes/day





The Bottom Line

Daily Savings for Fuel & Maintenance = \$12.76/route

Daily Savings in Personnel = \$15.48/route

Total Daily Savings = \$28.24/route

Total Annual Labor Time Saved = 36,600 hours or 5,228 average work days

Or 29 equivalent employees/year

(average work day is 7 hours/day)

Total Annual Travel Distance Saved = 151,200 miles

Annual Equivalent Daily Routes Eliminated = 1,338

(7.4 routes/day) (based on average of 113 miles/day/route)

Daily Savings = \$28.24/route @ 200 routes = \$5,648/day

Annual Savings = \$5,648/day @ 180 day = \$1,016,640/year





Takeaway



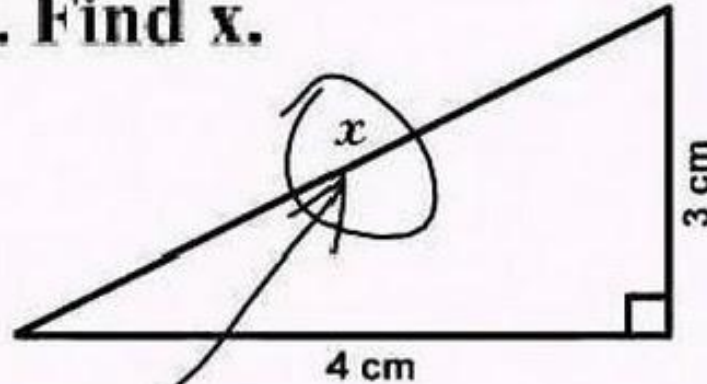
Redneck Repair Kit:
WD 40
Duct tape





Takeaway

3. Find x .



Here it is

SIMPLICITY

The simplest solutions are often the cleverest
They are also usually wrong



Takeaway



SILENCE

Silence is golden. Duct tape is silver.



Questions





General Information

Will Davis -- davisw@lake.k12.fl.us

