

Redneck's and Duct Tape

GIS/GPS Method of Efficient School Bus Routing



Will Davis, GISP

Lake County Schools

Monday, September 19, 2011



Project Background

- 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





Project Background

- 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





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





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
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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*)



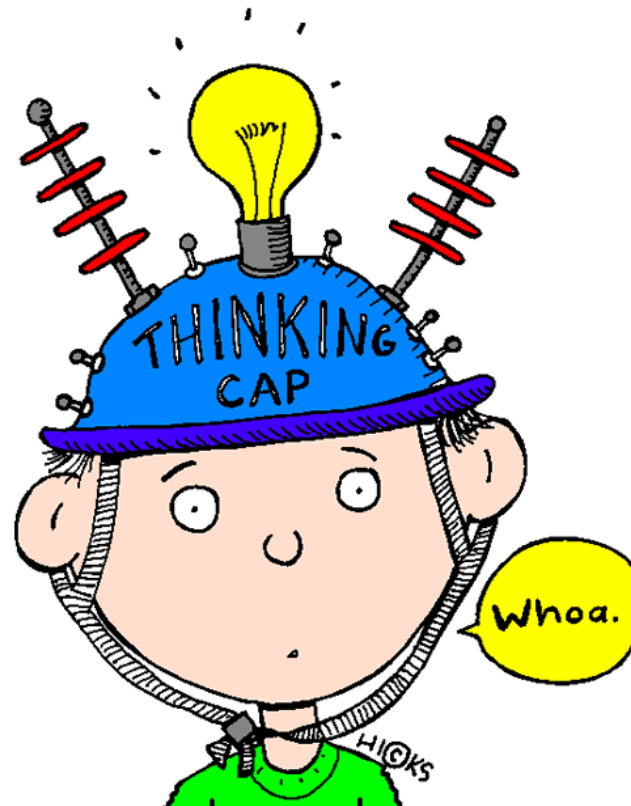


Options Overload





How to Obtain Useful GIS Data





Low-cost Solution

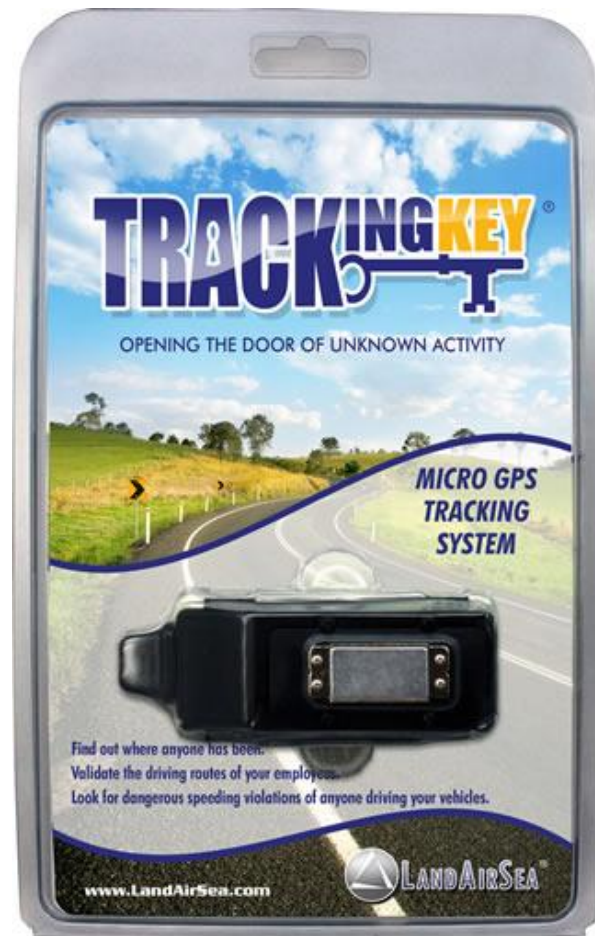
- Ernest P. Worrell GIS Method
 - Affordable GPS Tracking Key
 - Scripts to extract
 - Routes
 - Stops
 - Create GIS Layers
 - Arcs
 - Points





Low-cost Solution

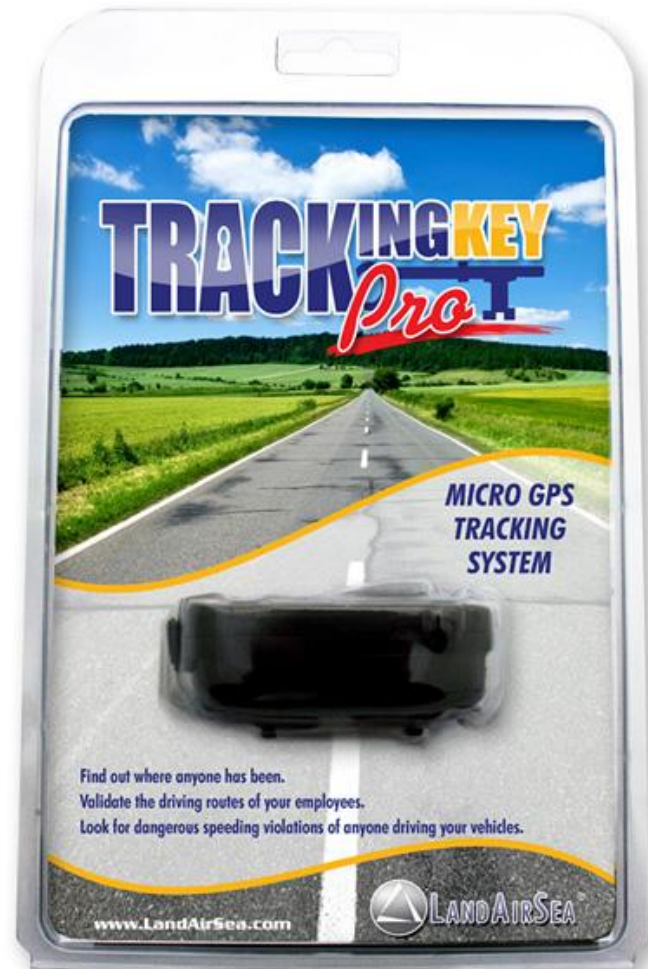
GPS Tracking Key





Newer Solution

Tracking Key Pro





Collecting the Data

Preferred
Bus
Mounting
Option





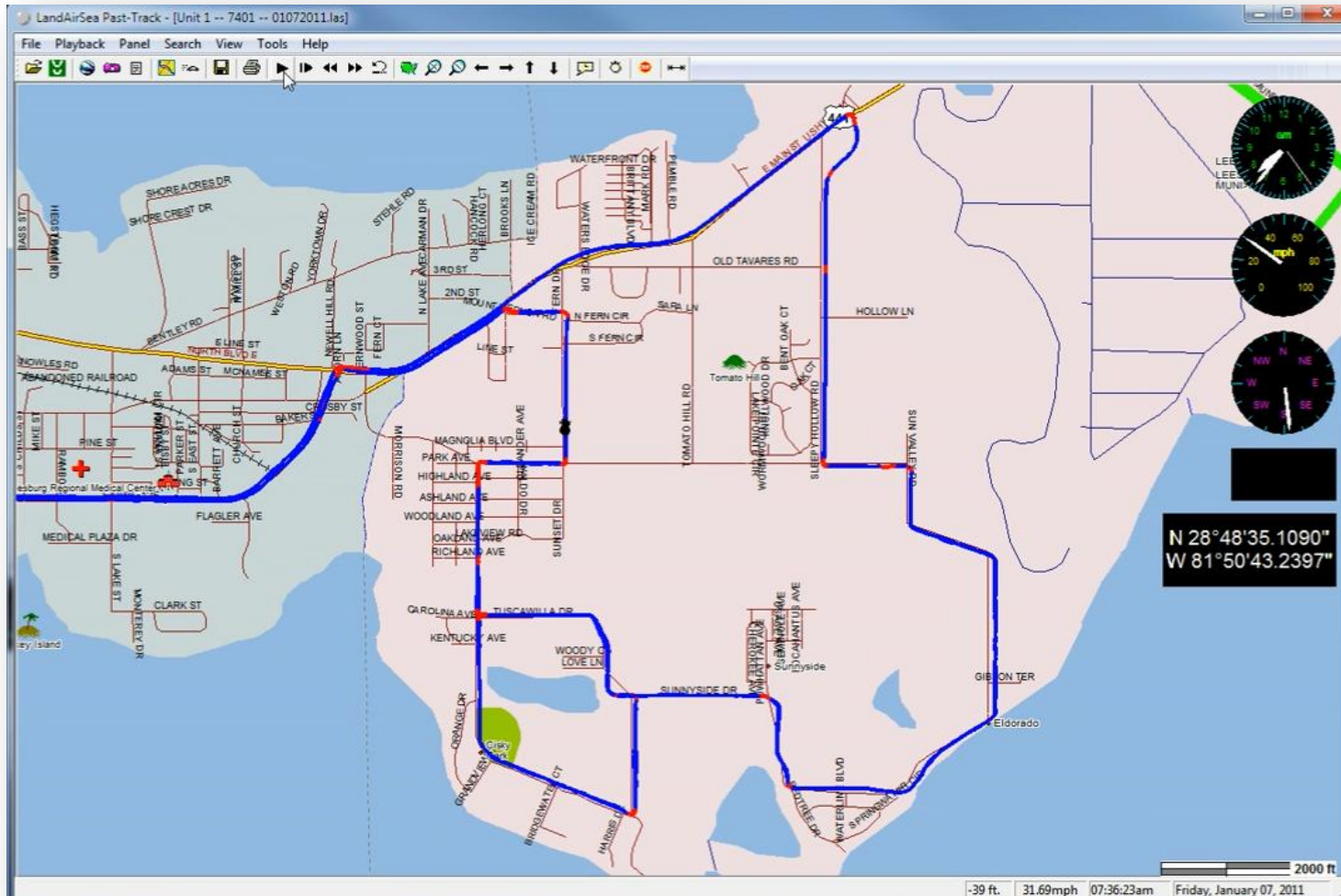
Collecting the Data

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 tracing a path through the land. The interface includes the following elements:

- Search Panel:** Contains a search bar with the text "Fly to e.g., 1600 Pennsylvania Ave, 20006" and buttons for "Fly To", "Find Businesses", and "Directions".
- Places Panel:** Lists various routes from "Route13" to "Route28", each with a checkmark and a location pin icon.
- Layers Panel:** Shows a list of layers including "Primary Database", "Borders and Labels", "Places", "Photos", "Roads", "3D Buildings", "Ocean", "Weather", "Gallery", "Global Awareness", and "More".
- Map Interface:** Includes a search bar, navigation tools (compass, zoom in/out, pan), and a scale bar.
- Status Bar:** Displays "Imagery Date: 1/26/2011", "© 2011 Google", "© 2011 Europa Technologies", and coordinates "28°48'23.41" N 81°50'26.28" W elev 130 ft".



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



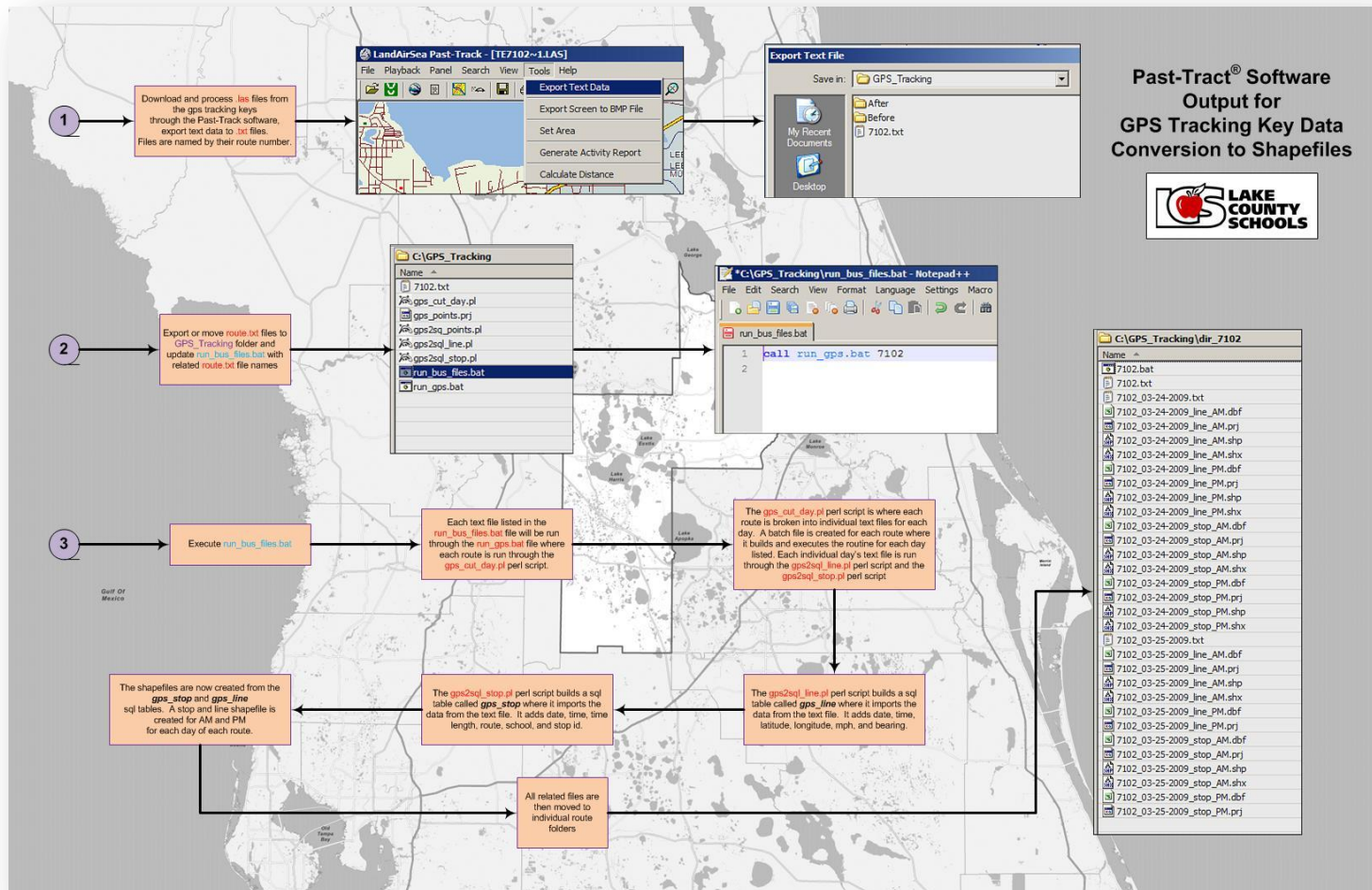


Open Source Options

- 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”

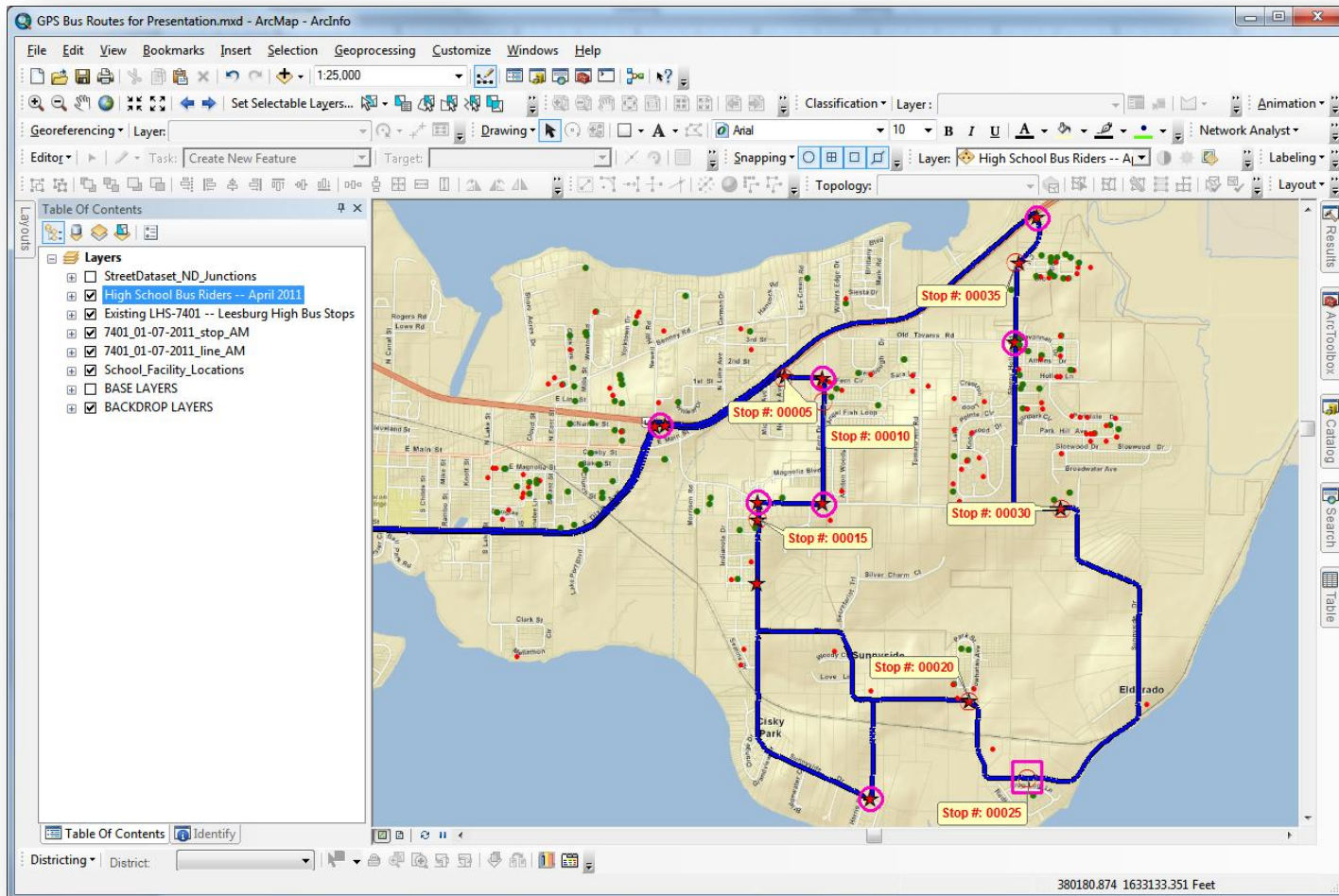


Data Conversion



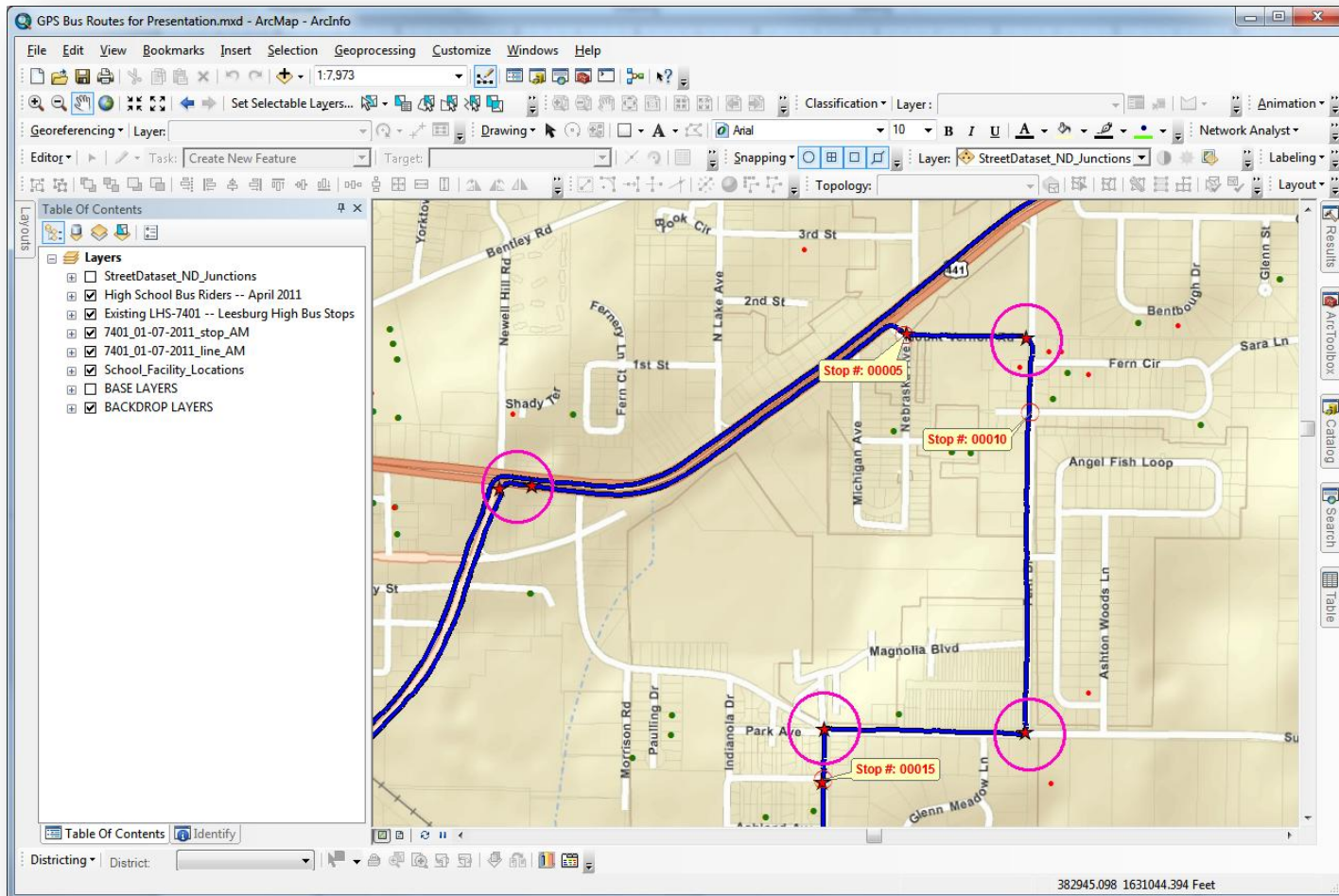


Assessing the Data





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 19.8 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

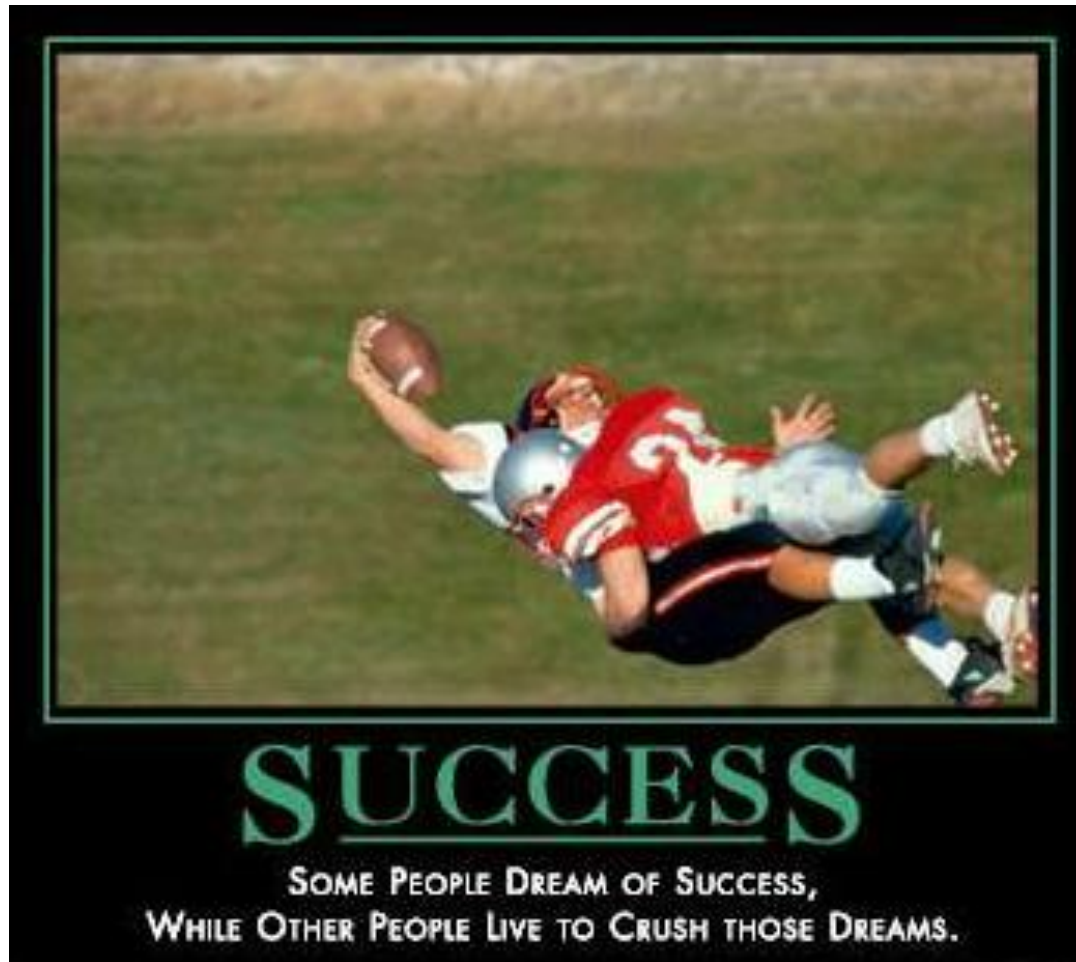


Redneck Repair Kit:
WD 40
Duct tape





Takeaway





Questions

