Redneck's and Duct Tape

GIS/GPS Method of Efficient School Bus Routing

Will Davis, GISP

Lake County Schools

Friday, March 2, 2012

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Project Background

294 Buses

Transporting 21,860 Students

Twice Daily

30,670 Miles

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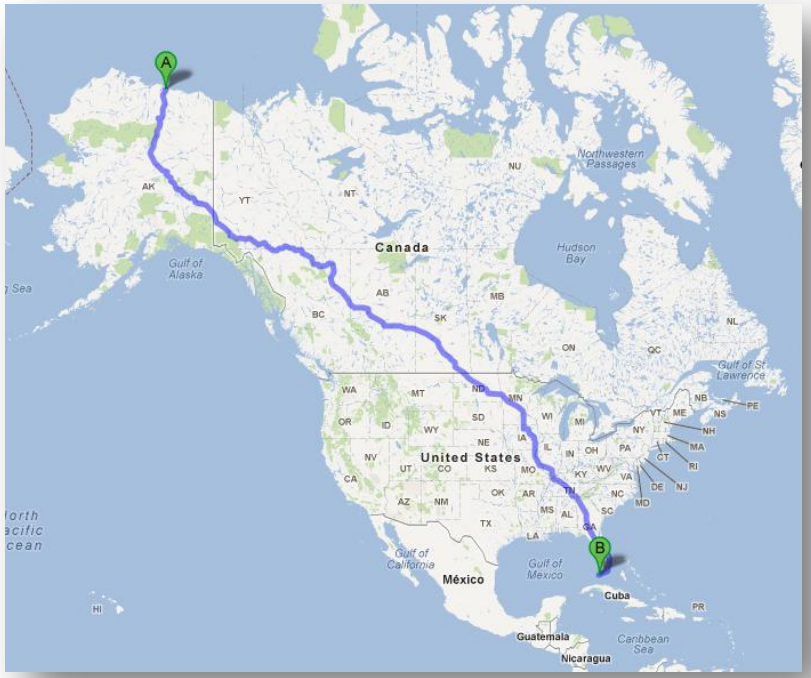
Project Background

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



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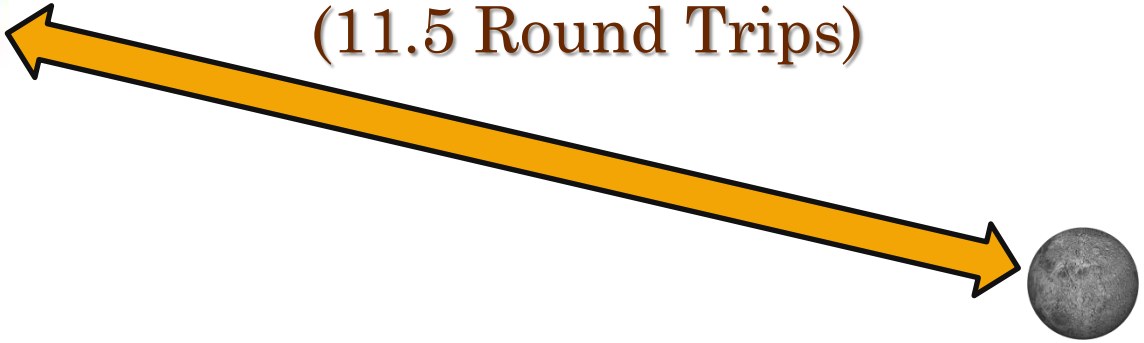
Project Background

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

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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

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Where Do We Start?

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

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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

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How to get there?

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

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Locate Bus Routes

Hand Drawn Laminated Paper Maps

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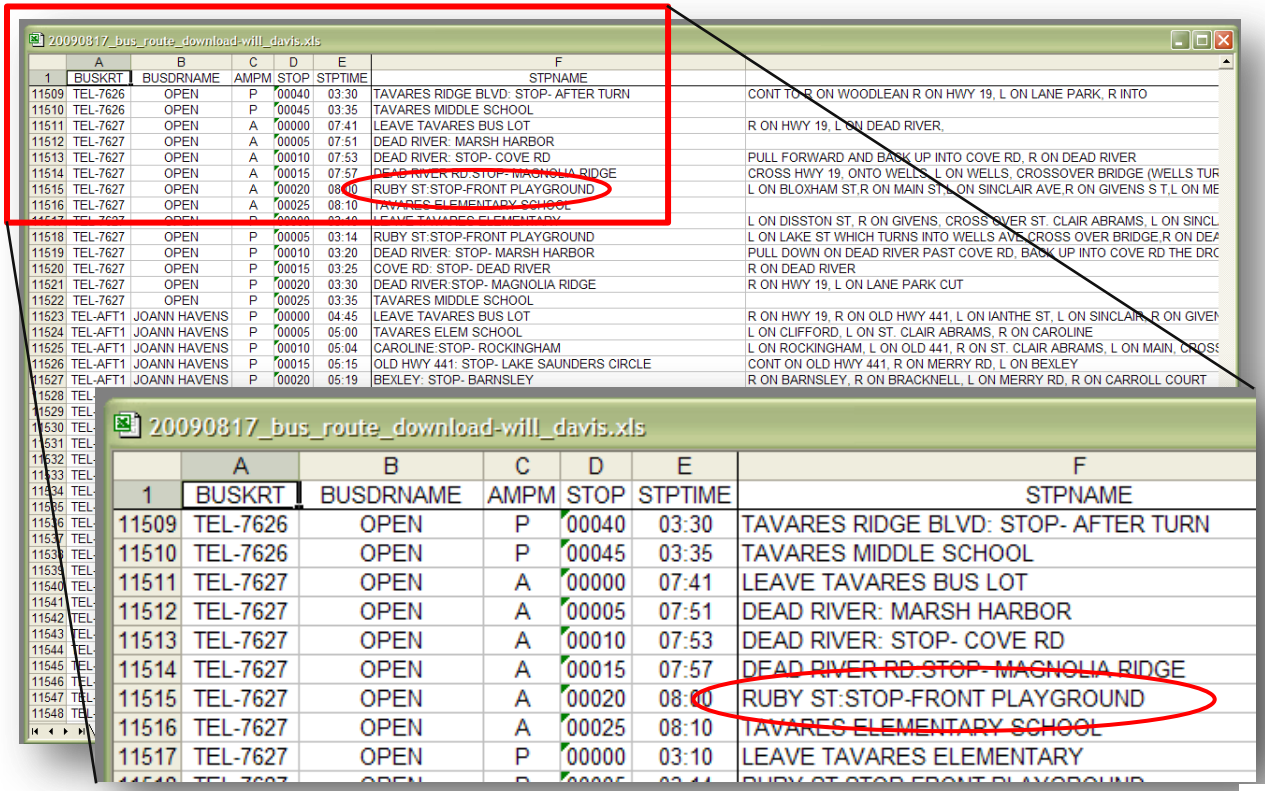
Locate Bus Stops

Bus Stop Tabular File from IT Dept.



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

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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.*)
  - Everday Solutions, Inc. (*GEOREF*)
  - Total Solutions Partners (*BusOnePro*)

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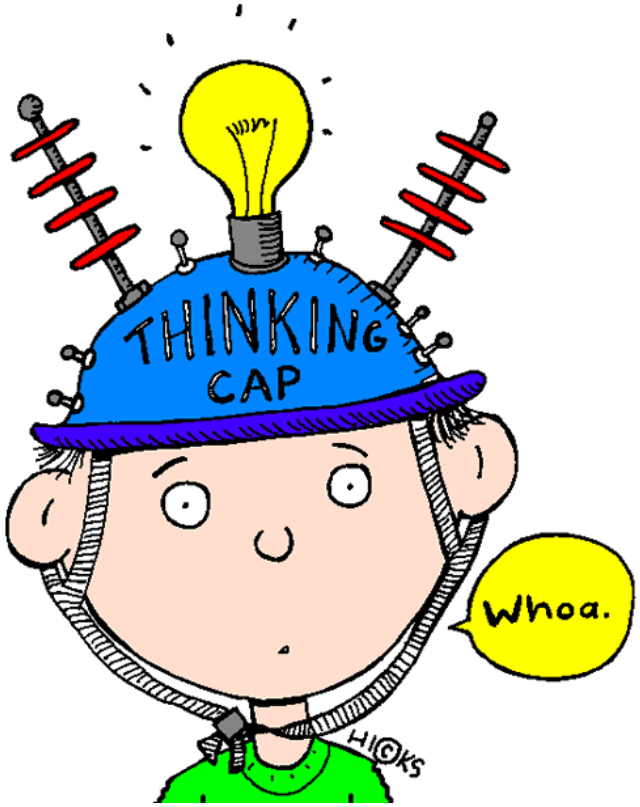
Options Overload

How to Obtain Useful GIS Data



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Low-cost Solution

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

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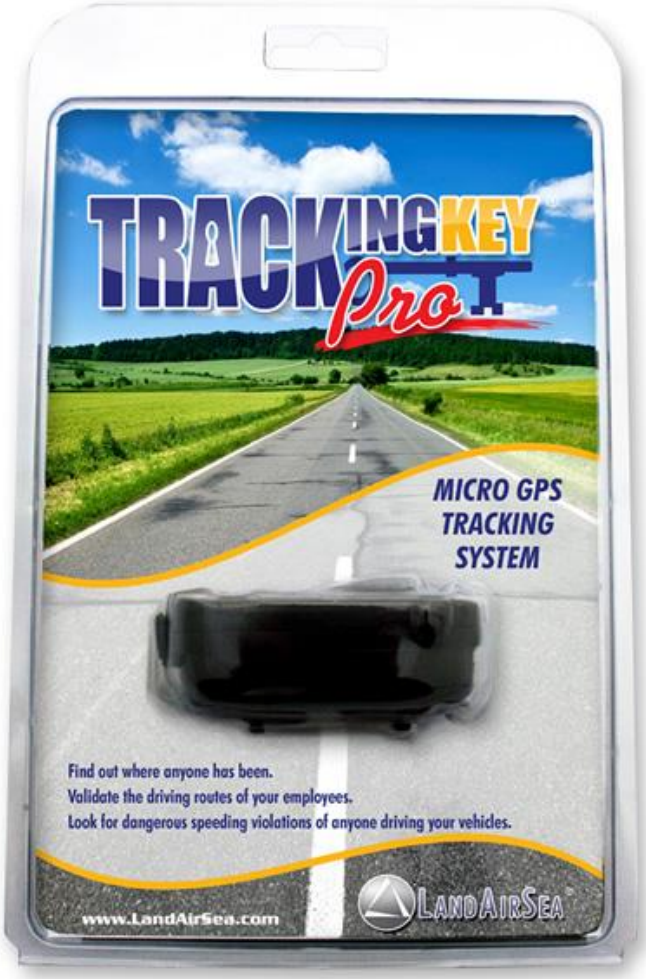
Low-cost Solution

GPS Tracking Key

Newer Solution

Tracking Key Pro



Real-Time Solution

SilverCloud

Browser Friendly

ShareSpot

Google Maps

3D Viewing

Activity Reports

Alerts

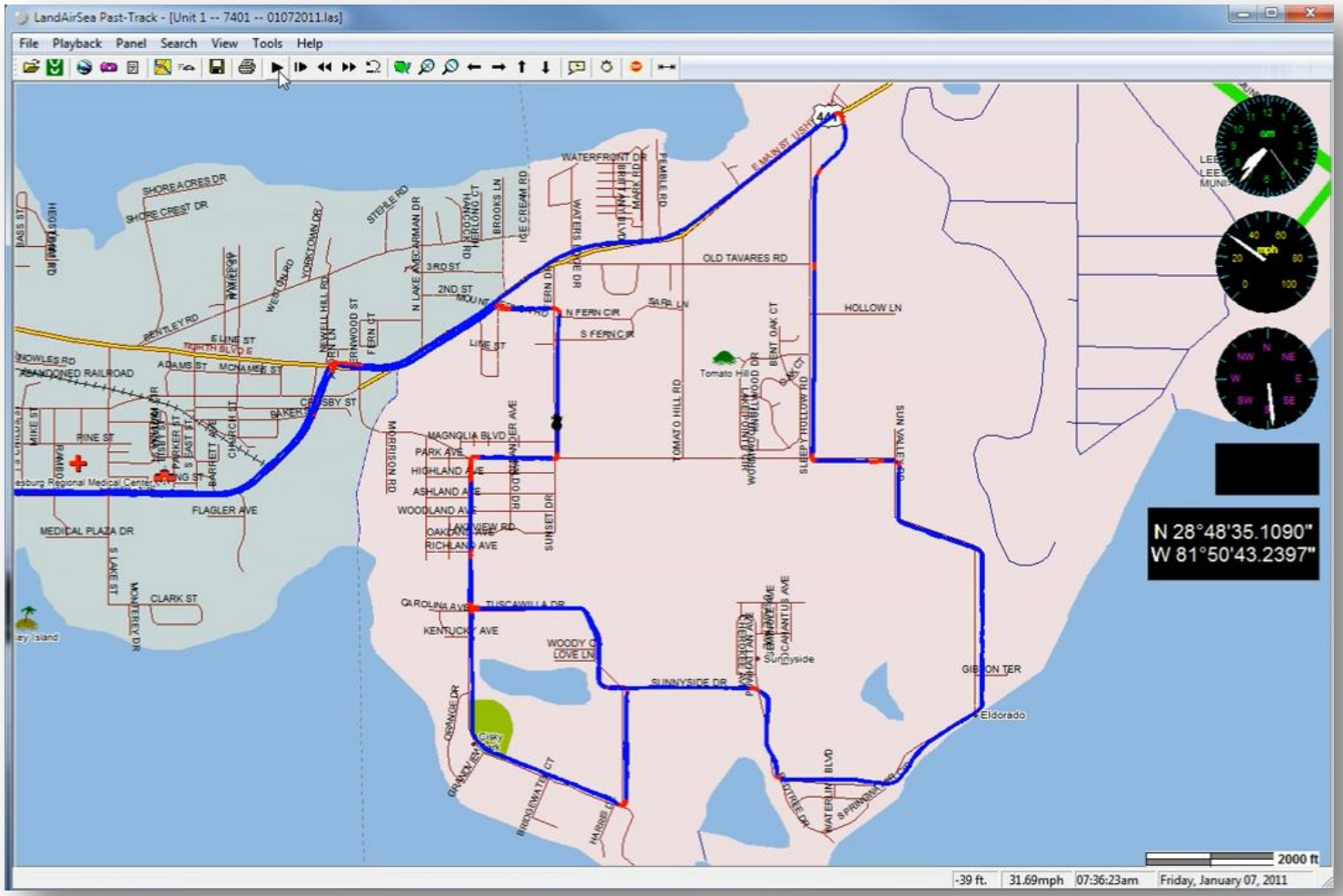
Collecting the Data

Preferred Bus Mounting Option

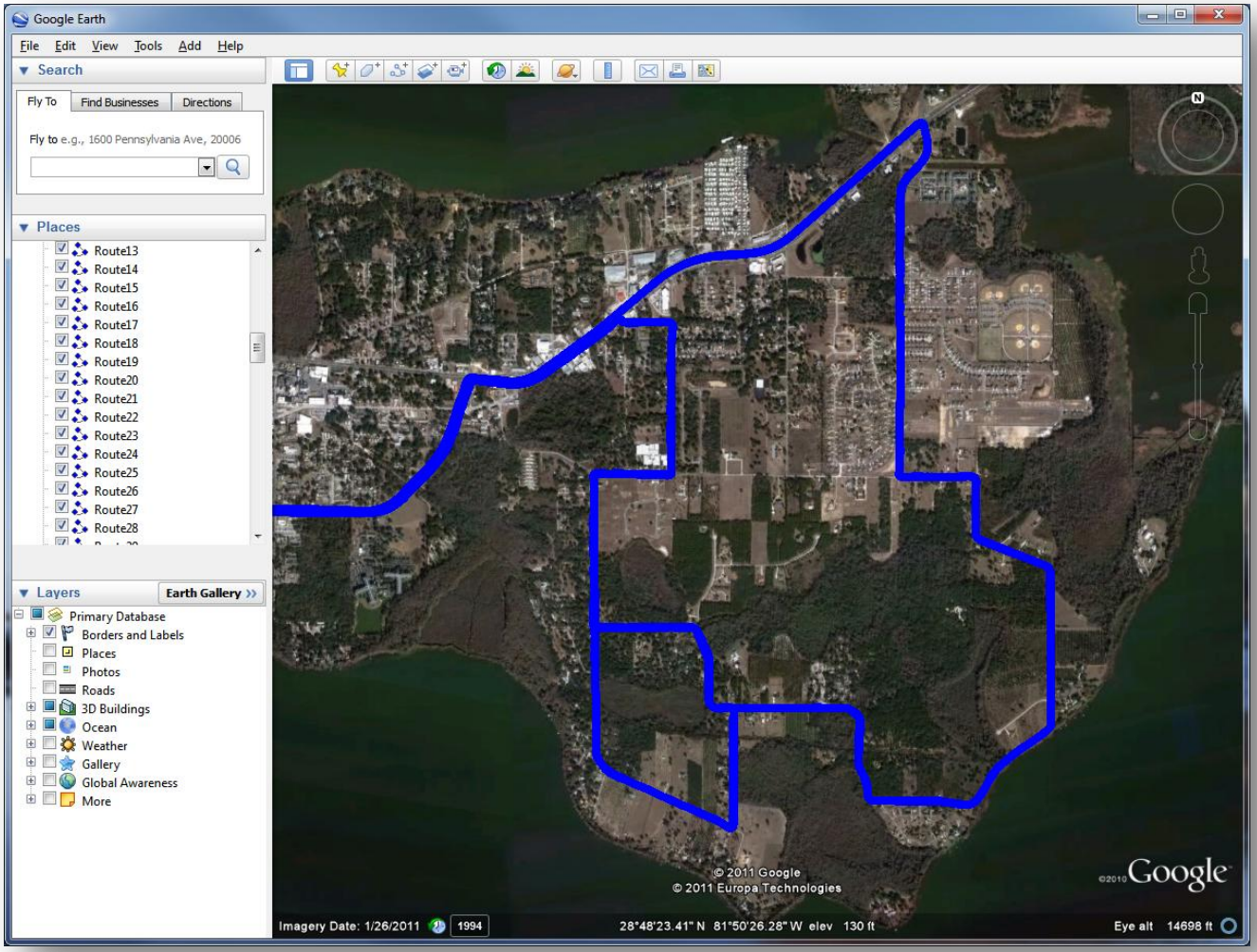
Collecting the Data

Non-preferred Bus Mounting Option

Data Reinforcement

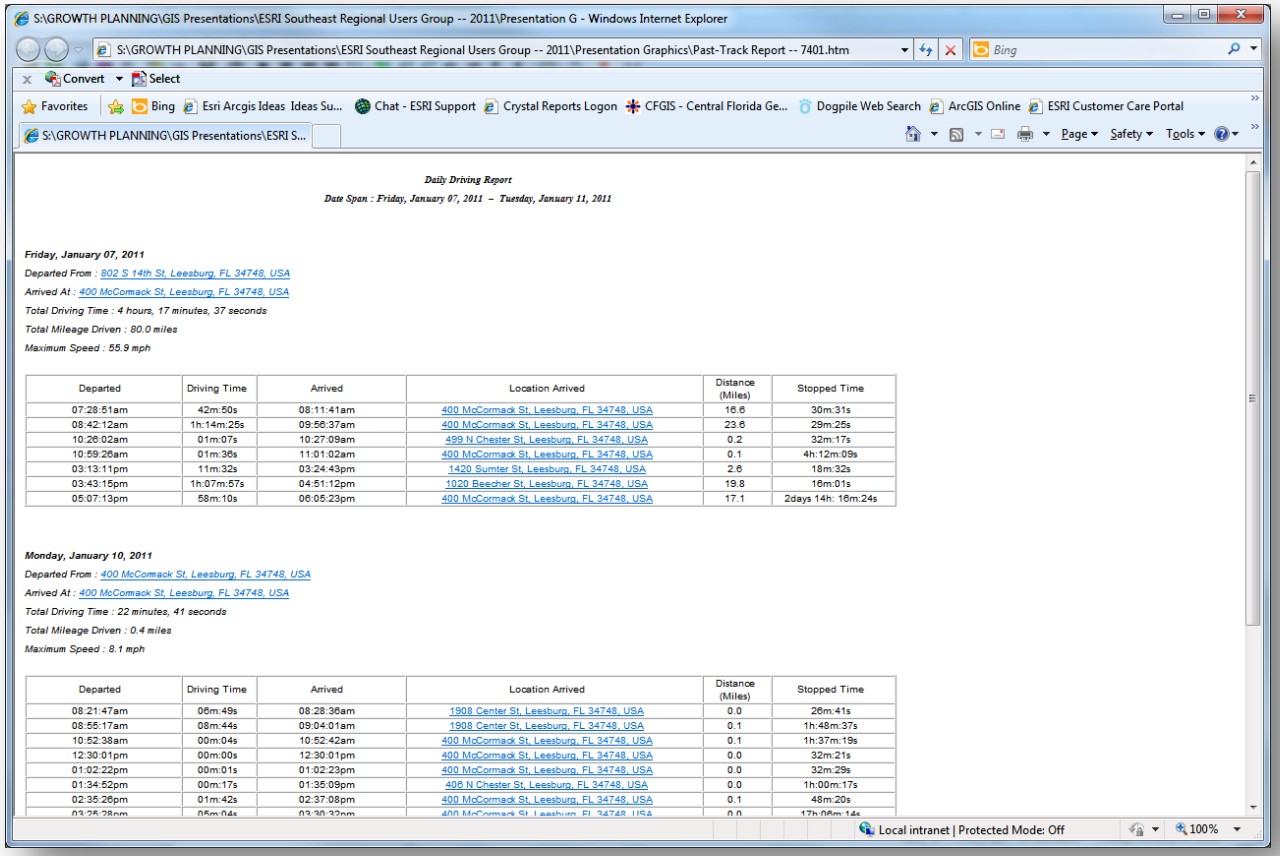


Data Reinforcement



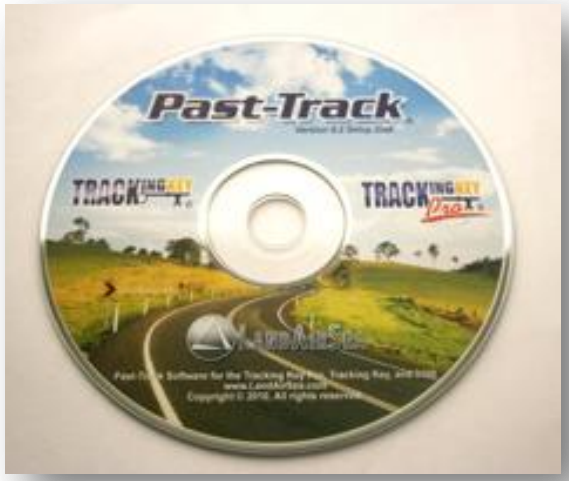
Data Reinforcement

Review Reports in Past Track™



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



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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

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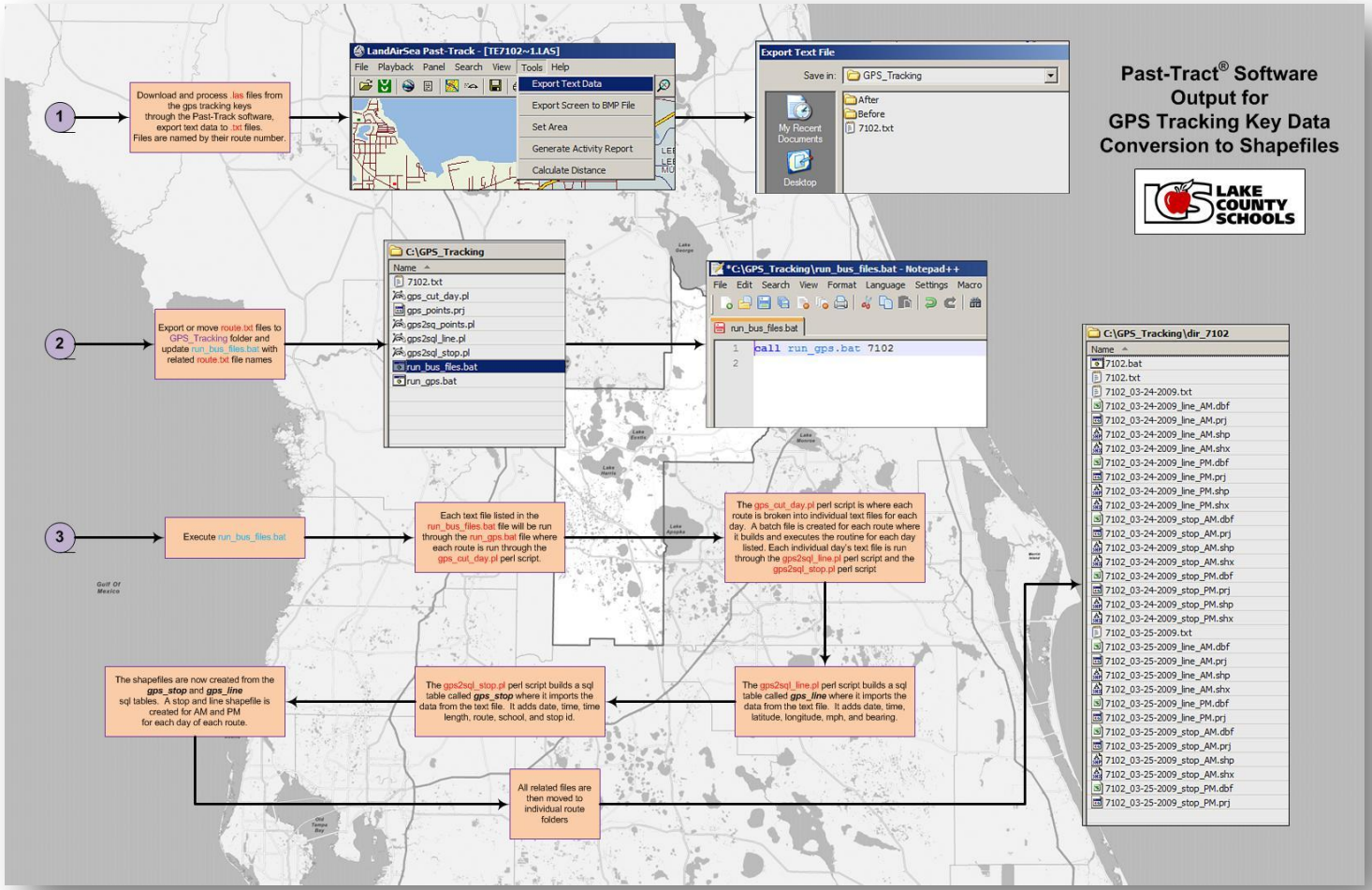
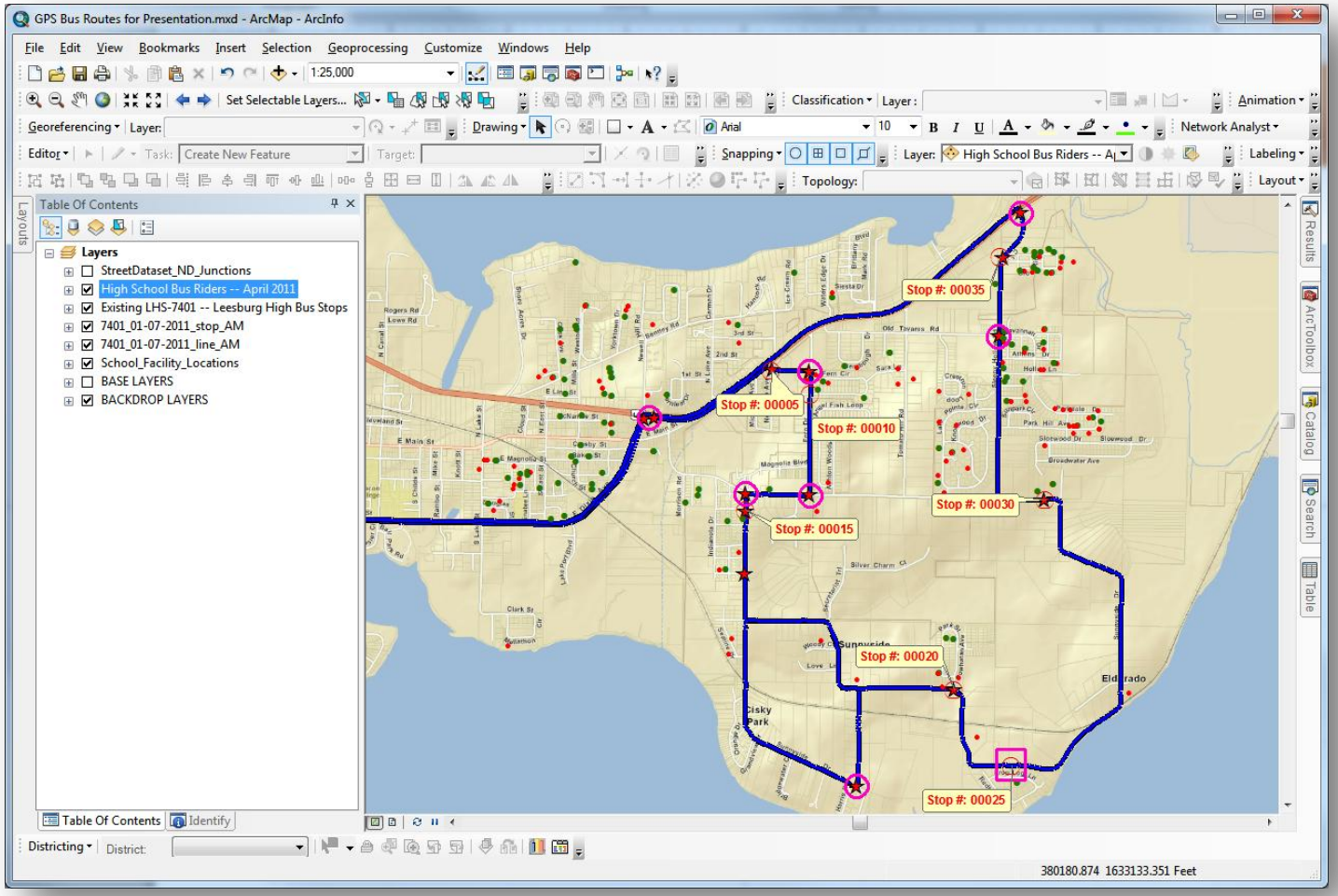
Data Conversion



Assessing the Data



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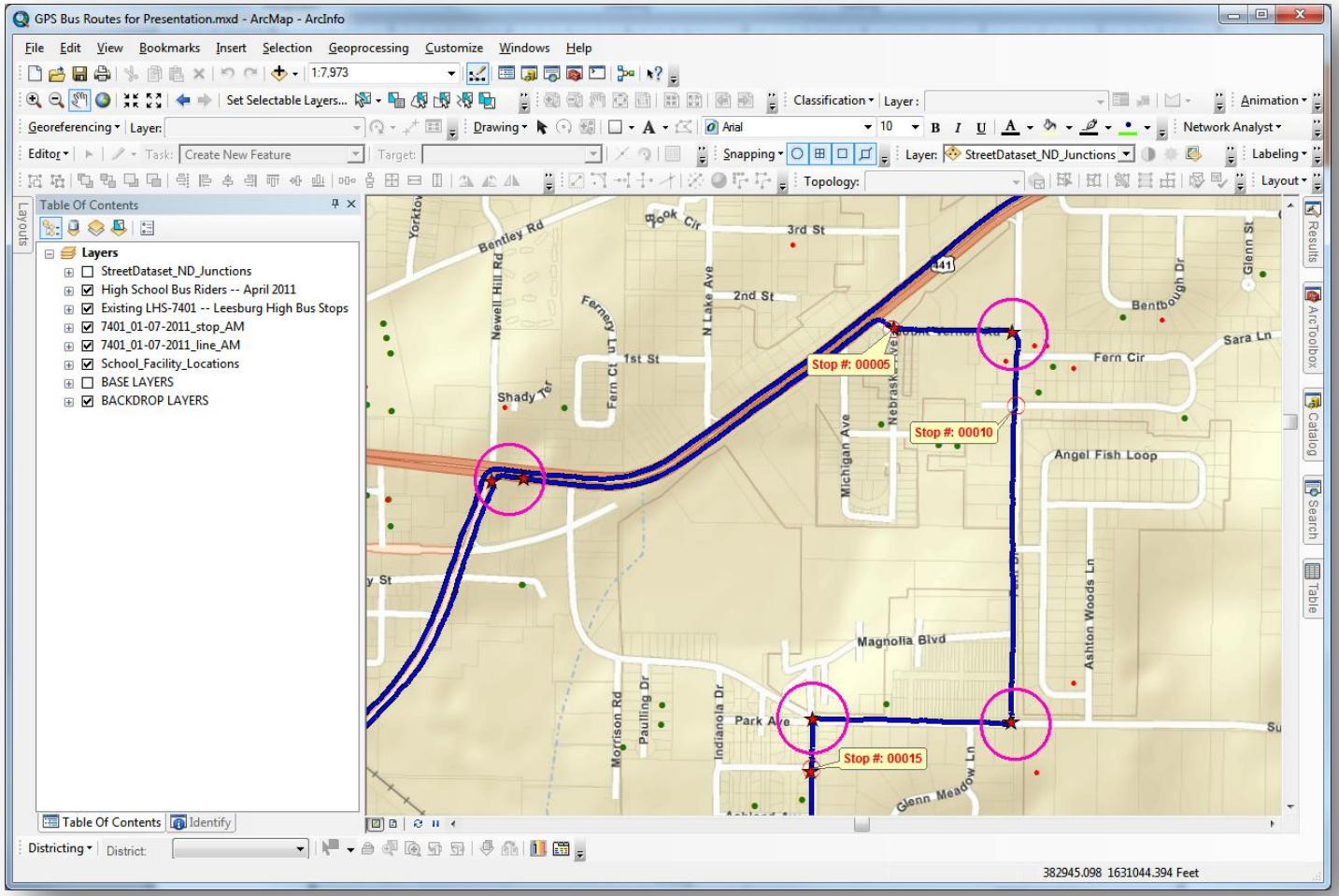

Data Format

GPS Bus Routes for Presentation.mxd - ArcMap - ArcInfo

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

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- 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

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

(0 out of 5231 Selected)

7401_01-07-2011_stop_AM

FID	Shape	DATE_D	TIME_D	TIME_LENTH	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

(0 out of 92 Selected)

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

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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

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Takeaway

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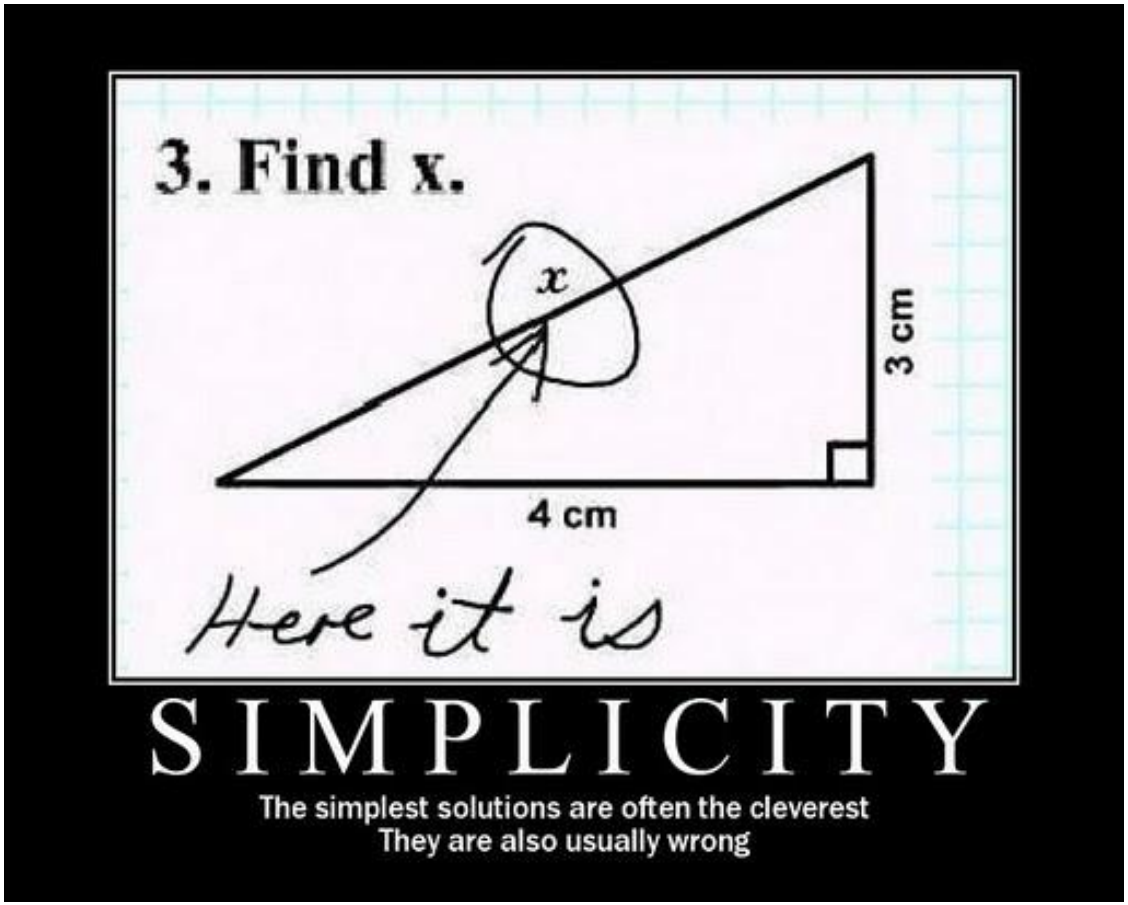
Takeaway


3. Find x.
x
3 cm
4 cm
Here it is
SIMPLICITY
The simplest solutions are often the cleverest
They are also usually wrong

Takeaway

Questions

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General Information

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

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