"GPS for Humanity" Applications

Search and Rescue

➢ ***Emergency Beacons***

➢ Airplane and Ship Locaters

➢ OnStar

➢ Tracking Rescue efforts

Global Positioning System (GPS)-enabled Emergency Position Indicating Radio Beacons (EPIRBs)

- Activate EPIRB by flipping a switch
- Beacon then transmits on 406 MHz frequency
- Distress signal detected by COSPAS-SARSAT Satellite Distress Alerting System
- Search and rescue authorities are notified
- *Receive exact GPS coordinates*.

Over 955 People Rescued September 2009
- The ferry was carrying 847 passengers and 117 crew.
- Ferry distress signal allowed rapid rescue efforts

"GPS for Humanity" Applications

Recreational and Automotive

- ➢ Turn by Turn Auto Guidance

- ➢ Waypoint Hiking

- ➢ *GeoCaching*

GeoCaching

- Finding "Treasure" at GPS locations
- Good family recreation
- Worldwide
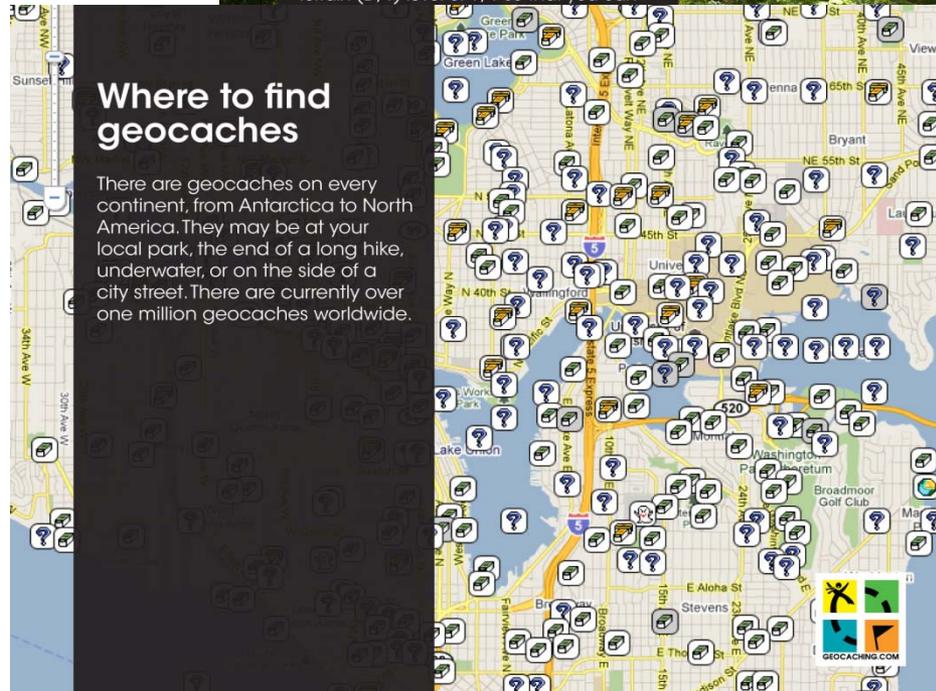- Over 5 Million Participants
- Over 1 Million Geocaches

"GPS for Humanity" Applications

Tracking

➢ ***Vehicle Fleets (Concrete Truck example)***

➢ Children

➢ Animals

➢ Alzheimer's victims

➢ Cargo

➢ Parolees

➢ Criminals

Recent Supreme Court Ruling: GPS "Bugs" require a Warrant (9 to 0!)

Monitoring Concrete Trucks
(about 75,000 in the US!)

Data Center

Command Data

Productivity Increased by:

- Immediate notification of availability for dispatch
- Sensor records of critical events
- Accurate measurement of time on job
- Driver compliance and safety

the key

SHANE W. LINK PHOTOGRAPHY

www.ShaneLink.com

Where is your Child?

Tracking

➤ Vehicle Fleets (Concrete Truck example)
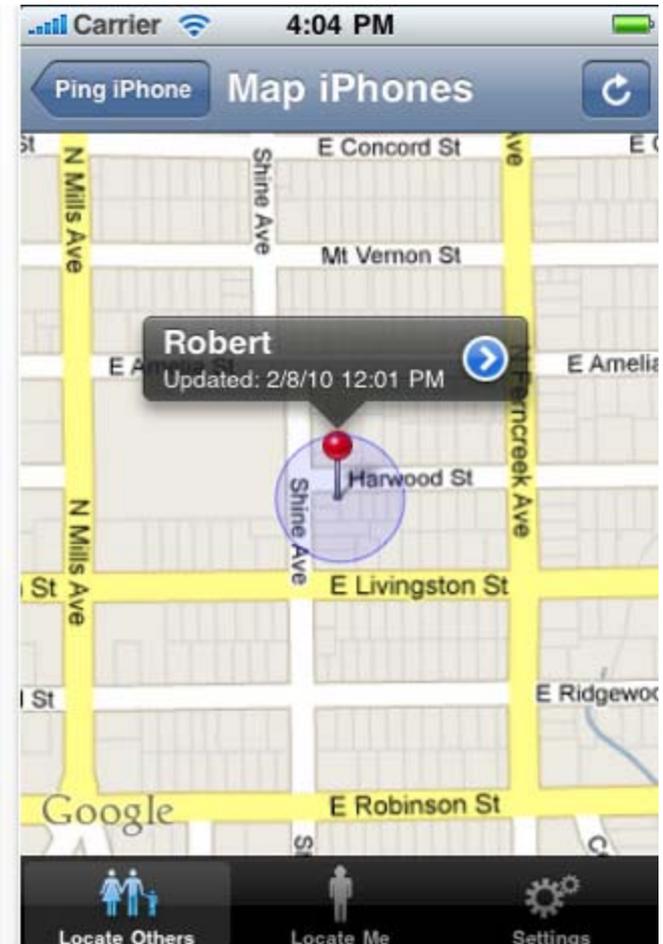
➤ *Children*

➤ Animals

➤ Alzheimer's victims

➤ Cargo

➤ Parolees

➤ Criminals

The Expected in 1974: Survey to 1 Meter
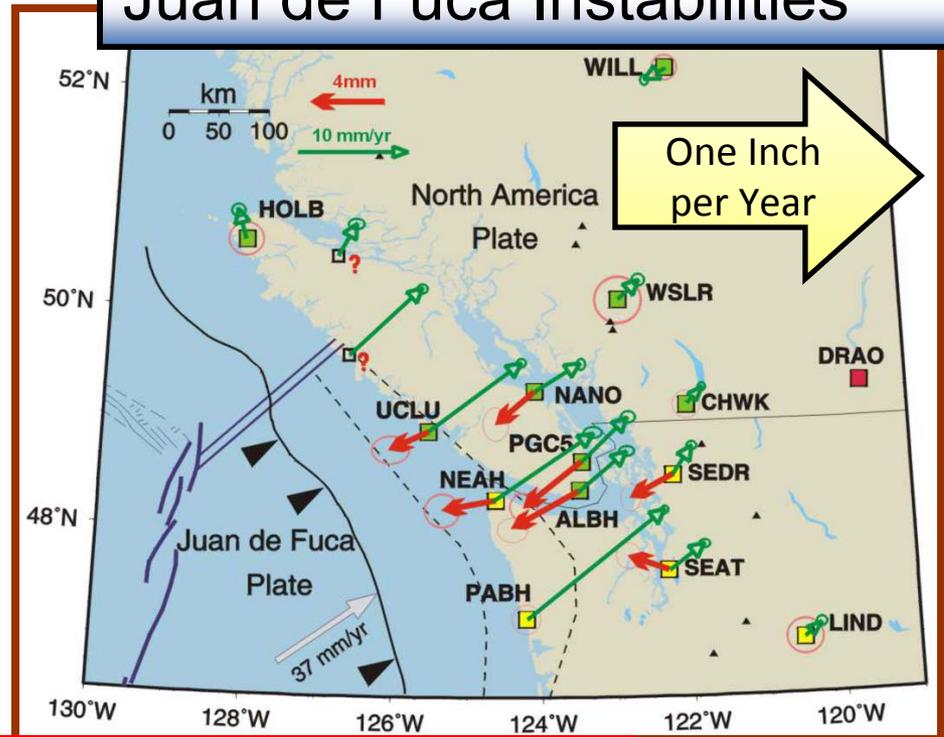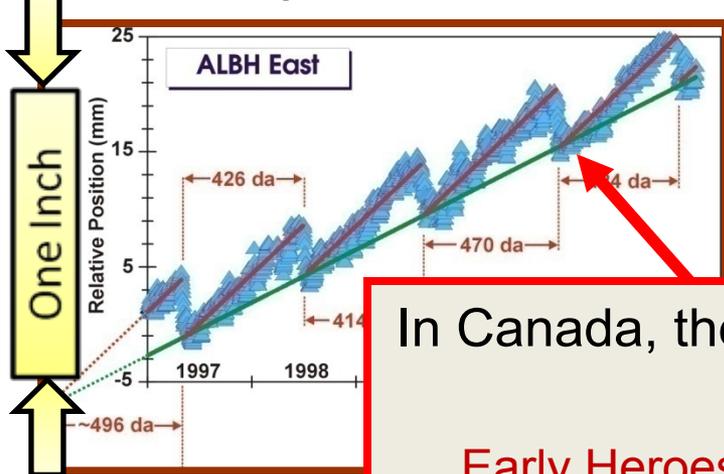# *The Surprise*: Survey to 1 millimeter!

GPS is Vastly Increasing our Understanding of Crustal Motion and Earthquakes

Juan de Fuca Instabilities

One Inch per Year

Slow "earthquakes" are observed

One Inch

In Canada, these events occur about every 16-18 months.

Early Heroes: Phil Ward (TI), JPL, Charlie Trimble (TNL)

GPS for Humanity © Bradford W. Parkinson

"GPS for Humanity" Applications
Survey – The first viable GPS market

Survey and Geographic Information Systems

➢ ***Tectonic Plate Motion***

➢ Dam Deformation

➢ Stakeout

➢ Paperless to the Field (with MachineControl)

➢ Geodetic Reference

"GPS for Humanity" Applications

Scientific - *a few of Many*

- Crustal Movement (See survey applications)

- Earth's mass shape and center

- Vertical Atmosphere Profiling

- Ionospheric electron density

- Earth's "wobble" (Chandler Motion)

- ***Migratory Tracking*** (Coupled with tracking)

- ***Disease Tracking***
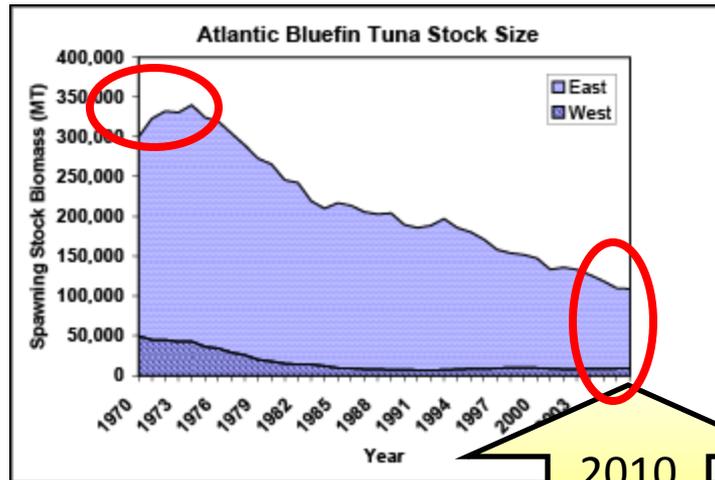
Endangered Atlantic Bluefin Tuna
(Tracking Paths with GPS)

"**Scientists and conservationists disappointed by rejection of proposals to ban trade in eastern Atlantic and Mediterranean Bluefin tuna** (Thunnus thynnus),

--- Despite evidence stocks have fallen below 15% of historic levels." (March 2010 – Nature)

World Record: 1496 Pounds!
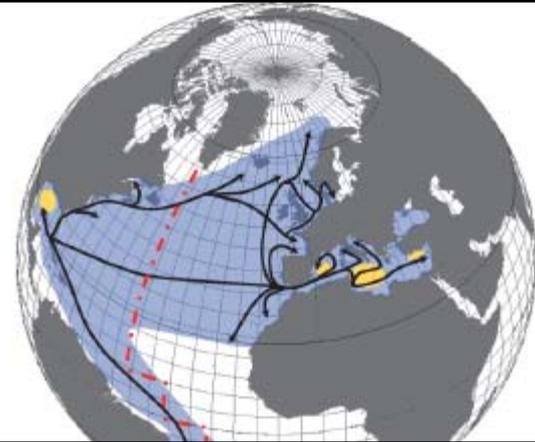
Atlantic Population is comingled – Must be managed as a whole…

Atlantic Bluefin Tuna Stock Size

East
West

Spawning Stock Biomass (MT)

400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0

1970 1973 1976 1979 1982 1985 1988 1991 1994 1997 2000 2003

Year

2010

GPS for Humanity: H.P. Tests Mobile GPS Technology in *Fight Against Malaria*

- The data collected through a smartphone app

    ➢ Stores pictures, video, audio and GPS information

- Goal to help officials and doctors deter a huge malaria outbreak

A nurse in Botswana using the new app on a Palm Pre 2 smartphone to detect and track malaria outbreaks
(HP picture and Product)

Immediate Case

Facility : Kasane Primary Hospital

Date : 2011-03-30 10:28:04

Case ID : 10201KPH0001

Omang :

GPS : -17.87609, 25.161468
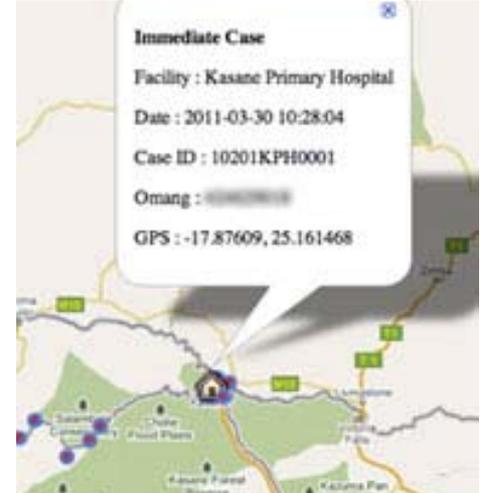
A special app houses database of photos, video, audio, and GPS coordinates

GPS for Humanity © Bradford W. Parkinson

<u>Military</u>

- Precision Weapon Delivery

- Unit and Individual Location

- Precision Air Carrier Landings

- ***<u>Rescue</u>***

Military Rescue using GPS
(8 June 1995)

Capt. Scott O'Grady
        F-16 Pilot, shot down in Bosnia,
Shown in Aviano, Italy after being
        rescued following six days of escape
        and evading in the Bosnian countryside.

He attributes the rescue's success to:
- His faith in God,
- The courage of his Marine and Navy
        rescuers,
- ***and his GPS unit which he referred to
        as his "Guiding Light."***

"GPS for Humanity" Applications
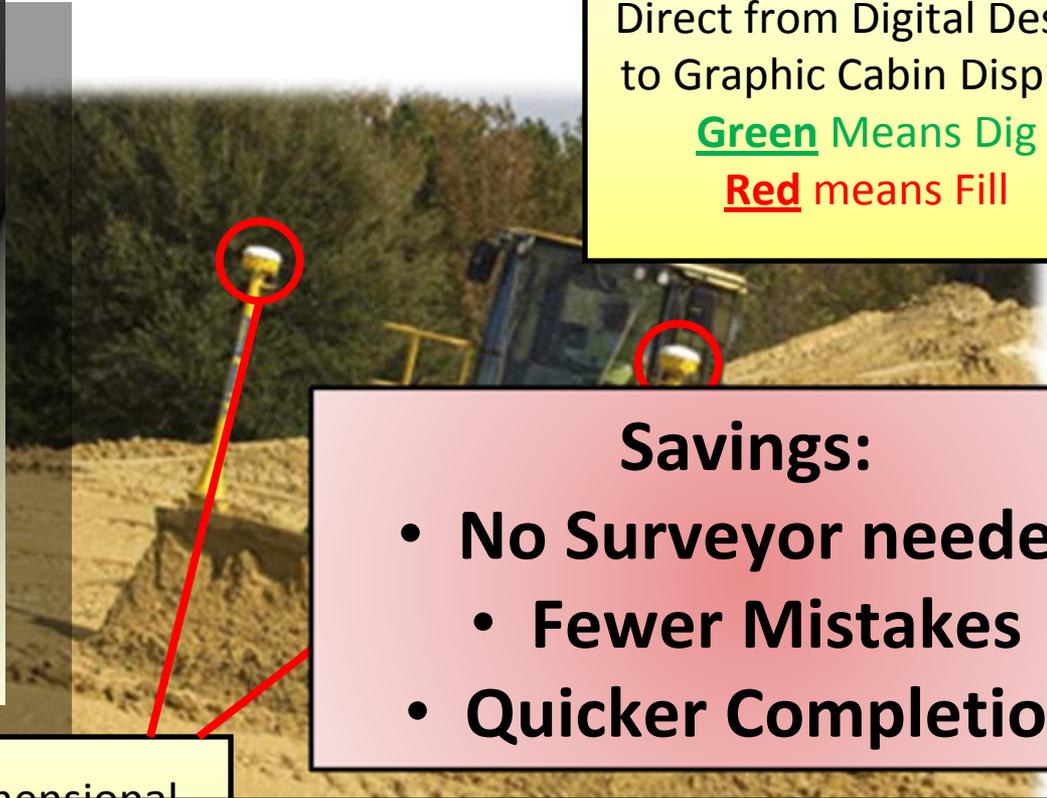
- **Robotics and Machine Control**
  (Also see Ag.)

  ➤ **Bull Dozers**

  ➤ Mining Excavators

  ➤ Mining Trucks

  ➤ Grade Control

  ➤ Snowplows

Direct from Digital Design to Graphic Cabin Display:
Green Means Dig
Red means Fill

Savings:
- **No Surveyor needed**
- **Fewer Mistakes**
- **Quicker Completion**

GPS Measures 3 Dimensional Blade Position Centimeter Accu...

Automatic Blade Control
GCS900 system controls machine hydraulics. Using 3D GPS position, cross-slope and design information, the blade is automatically moved to the exact elevation and cross slope.

Another
Very Important
GPS Application

PhD Thesis Subjects

Pioneering Robotic Applications of GPS At Stanford

Autonomous Model Helicopter
GPS *Position*, *Velocity* and *Attitude*
Bob Cannon and students

The Robotic GPS Sailboat

Professor Gabe Elkaim UCSC

Stanford Robotic Car
Competing in the DARPA Challenge

The Robotic GPS SnoCat
Guttorm Upshaug and Per Enge

Why has GPS become a System for Humanity?
(It is effectively a worldwide utility)

- Signals are free and guaranteed by USG
  - Accuracies down to Millimeters (with differential operation)
  - Availability close to 100% *Worldwide*
  - GPS Receiver Cost is no longer the driver:
    ### *Chips for ~$3*
  - Cost and Advantage in GUIs and Software
- And... *Applications Generally* :
  - Provide or enhance *Safety*
  - Substantially improve *Productivity*
  - Are convenient or *Fun*

Taken for Granted: Carrying the Torch for GPS
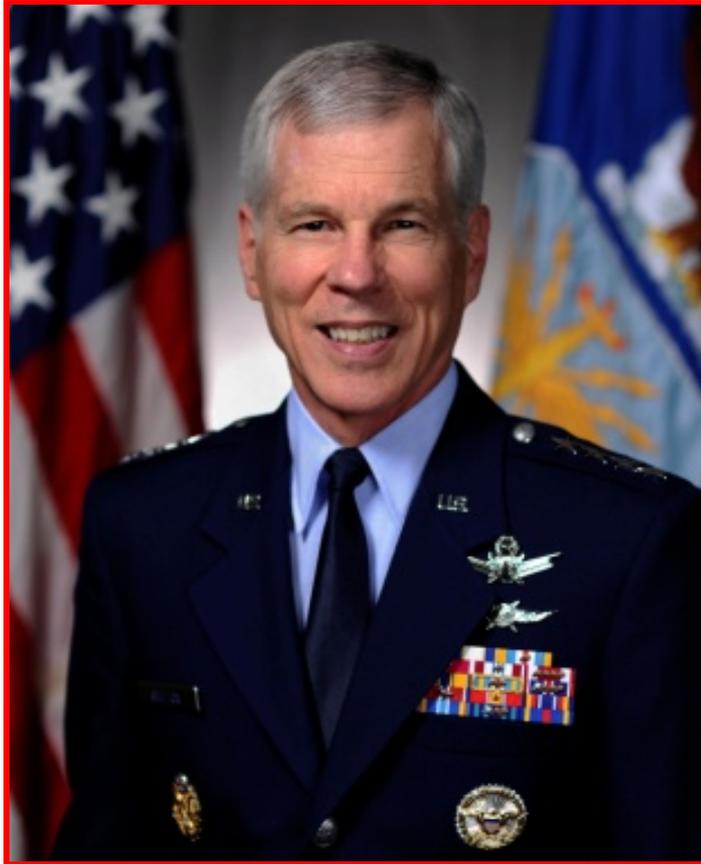
General William Shelton

Commander Air Force Space Command

"Chief Steward of GPS for the World"

Tracking the Chernobyl Radioactivity Paths
(Professor David Last of University of Wales)

What's Next?

GPS for Humanity © Bradford W. Parkinson

PNT to Explode with Opportunities

GLONASS – (Russia)

Galileo
(European)

GP(t)S
(USA)

- Next generation 4 new Civil signals at two new frequencies
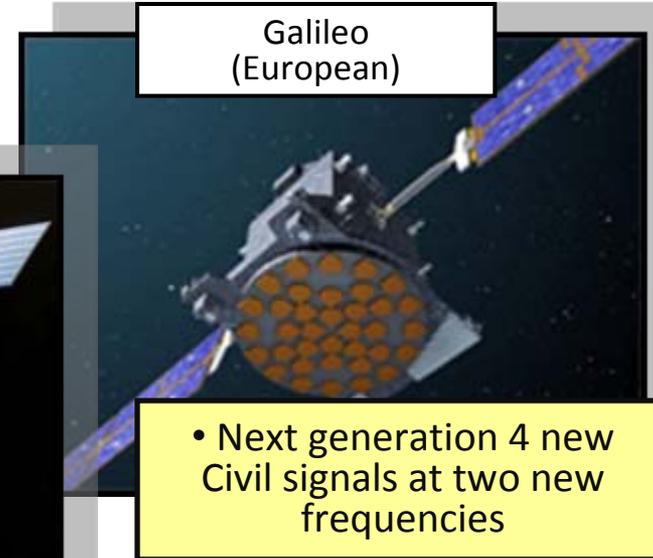
- Next generation 4 new Civil signals at two new frequencies

- 10 New Civil Signals - Included is a new ***International Signal*** called L1C

- It will provide Interchangeability for ***All Navigation Satellite Signals***

- ***And*** there will be over 60 satellites on orbit!

Result: *Even* **Better Accuracy, Availability and Integrity**

A Humanitarian Opportunity

HUMAN DRIVERS
The people behind the wheel are the most dangerous part of driving

IN THE WAKE of Toyota's much publicized recall for unintended acceleration, the idea of conceding control of our cars to software seems about as sane as letting a Roomba vacuum cleaner do brain surgery. And yet the data are unequivocal: according to multiple studies conducted over the pas[...] tors—such as distraction, into[...] ment—are the primary cause [...] Reason suggests that the soon[...] idiotic humans out of the drive[...]

But are sci-fi-style, fully aut[...] David Shinar, head of Ben-Gu[...] man Factors Safety Laborator[...] drivers will probably never be [...] simply change. "We're moving [...] er is the controller of the syste[...]

monitoring the system—sort of like a plane on autopilot," Shinar says. "Even when that system is engaged, the pilot doesn't go back into the first class cabin and take a nap. What we can expect are cars that need less direct controls from the driver; instead, the [...]" which [...] hnolo-[...]e a [...]man [...]se on [...]erless [...]hal-[...] [...]nt [...] Pavlus

US Traffic Fatalities in the ***Last 10 Years***:

387,000

- 213 People Died on our Roads for Every Soldier who died in Afghanistan in the same period

Implementing "**Brilliant Autos**": Auto-guided Automobiles and Freeway Automatic Traffic Control

- **Use all international satellite Position Signals**
  - Vector Kinematic Receivers (10 cm or better)
- **MEMS/IMU**
- **360° Radars**
- **Cooperative Tracking of other vehicles**

FIGURE 2 Road Departure Crash Warning Sensor Suite
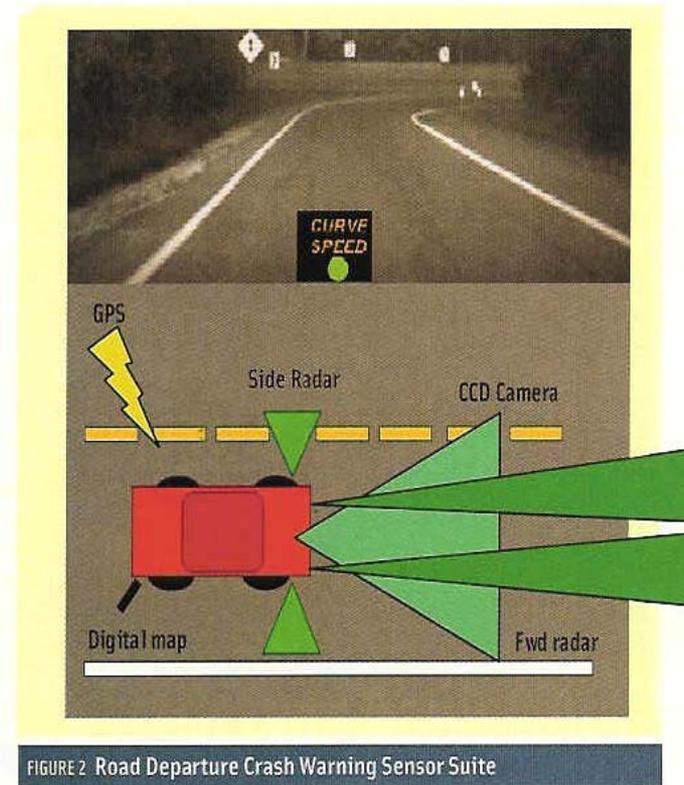
Driverless Cars

(From American Scientist Sept 2001)

"ODIN" from Virginia Tech

Right of Way

"Junior" from Stanford
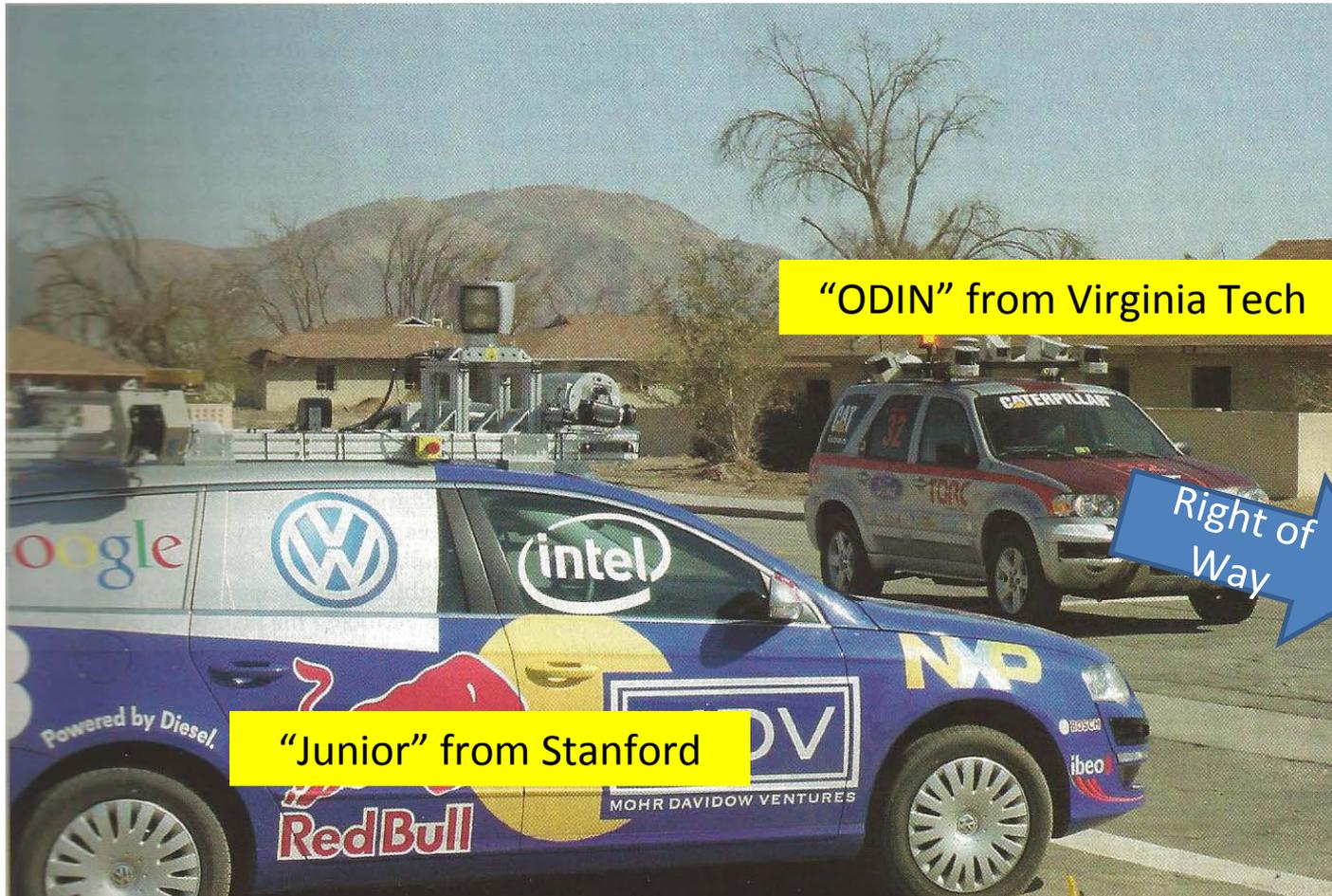
Google Driverless Car
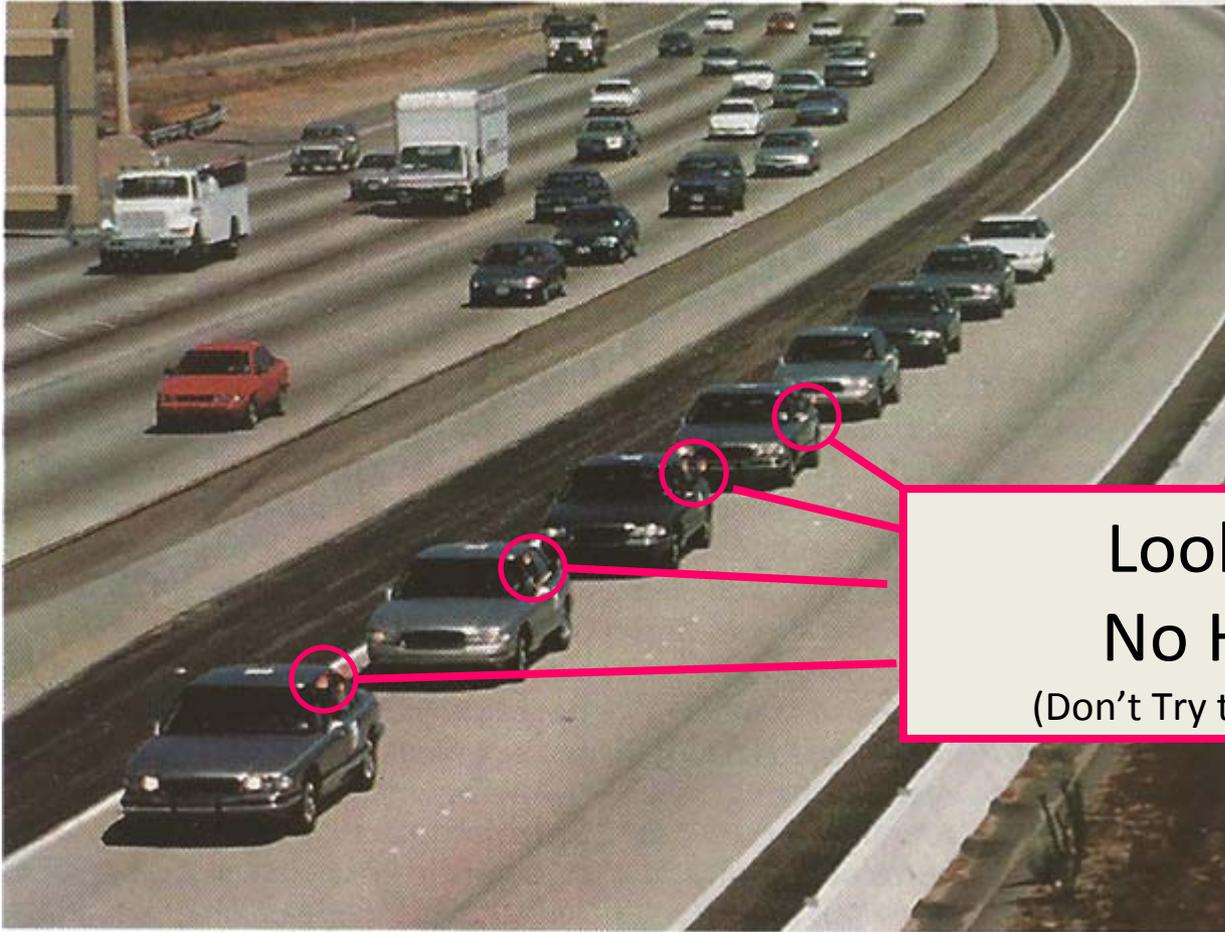
Led by Google engineer Sebastian Thrun, director of the Stanford Artificial Intelligence Laboratory and co-inventor of Google Street View, whose team at Stanford created the robotic vehicle Stanley which won the 2005 DARPA Grand Challenge and its US$2 million prize from the United States Department of Defense

Demonstration: Autopilot Convoy

Look Ma!
No Hands
(Don't Try this at Home!)

Driverless/Automatic Cars

Current auto-features already show trend to **semi-** or <u>fully</u>- driverless cars

Including :

- **Electronic stability control** - capable of detecting a slide or potential roll, and apply specific brakes to regain control.
- **Laser- or radar-based collision warning systems** -automatically apply the brakes to help prevent rear-end crashes.
- **Camera-based, lane-keeping systems** watch the road lines and take over steering to gently regain the proper lane.

The #1 GPtS Worldwide Issue

Spectrum Interference –

(Illegal jamming or Licensed Intrusion)

Is the Illegal Interference Problem Significant?

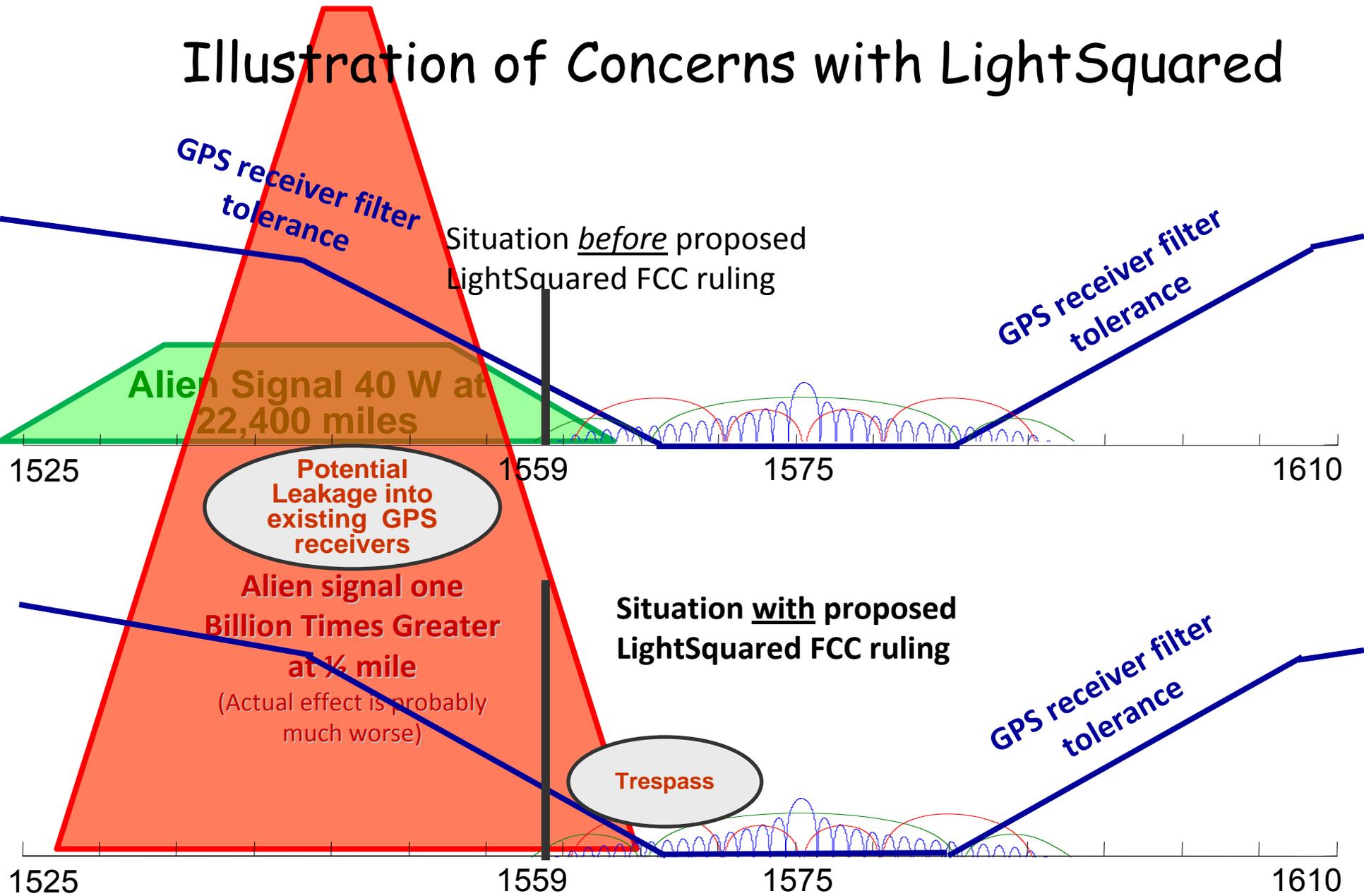*Portable GPS supplier says people who value their privacy need GPS Jammers.*

Handheld GPS Jammer GJ02

Unit Price: $33.00

GPS L1 - 1575.42MHz
Output power: 0.5 Watt

Illustration of Concerns with LightSquared

GPS receiver filter tolerance

Situation _before_ proposed LightSquared FCC ruling

GPS receiver filter tolerance

Alien Signal 40 W at 22,400 miles

1525   1559   1575   1610

Potential Leakage into existing GPS receivers

Alien signal one Billion Times Greater at ¼ mile
(Actual effect is probably much worse)

Situation _with_ proposed LightSquared FCC ruling

GPS receiver filter tolerance

GPS receiver filter tolerance

Trespass

1525   1559   1575   1610

GPS for Humanity © Bradford W. Parkinson

"What was the driving Philosophy behind the GPS Program office in those early, perilous times?"

Lines chiseled in granite –
(Sun Dial in front of the Los Angeles Train Station)

- Vision to See
- Faith to believe
- Courage to Do

- Christine Mabry during the Great Depression

Actually -The Foundation of Many Engineering Achievements

On behalf of <u>all of us</u> who had that
"Faith to Believe",
39 years ago,

<u>Thank You</u>

GPS *<u>Success</u>* is a *<u>tribute</u>* to the whole team of developers, innovators, manufacturers, supporters-

and also… to you, the users.

Questions?

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