Crime, Punishment and the Global Positioning System

Professor David Last

Position, Navigation & Time - 4th Annual Symposium

Stanford University

9 November 2010

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Plot of addresses extracted from TomTom car navigator
## Multiple timed and dated tracks

![Map of multiple timed and dated tracks](image)

<table>
<thead>
<tr>
<th>Trackpoint</th>
<th>Position</th>
<th>Time</th>
<th>Altitude</th>
<th>Leg Length</th>
<th>Leg Time</th>
<th>Leg Speed</th>
<th>Leg Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trackpoint</td>
<td>W2 17.006</td>
<td>28/09/2008 22:05:31</td>
<td>79 m</td>
<td>30 m</td>
<td>0:00:05</td>
<td>22 kph</td>
<td>28° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.994</td>
<td>28/09/2008 22:05:35</td>
<td>78 m</td>
<td>0 m</td>
<td>0:00:02</td>
<td>0 kph</td>
<td>0° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.893</td>
<td>28/09/2008 22:05:41</td>
<td>78 m</td>
<td>111 m</td>
<td>0:00:05</td>
<td>80 kph</td>
<td>92° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.847</td>
<td>28/09/2008 22:05:47</td>
<td>78 m</td>
<td>57 m</td>
<td>0:00:04</td>
<td>51 kph</td>
<td>115° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.714</td>
<td>28/09/2008 22:06:01</td>
<td>78 m</td>
<td>212 m</td>
<td>0:00:14</td>
<td>54 kph</td>
<td>136° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.683</td>
<td>28/09/2008 22:06:10</td>
<td>76 m</td>
<td>128 m</td>
<td>0:00:09</td>
<td>51 kph</td>
<td>135° true</td>
</tr>
<tr>
<td>Trackpoint</td>
<td>W2 16.519</td>
<td>28/09/2008 22:06:17</td>
<td>76 m</td>
<td>57 m</td>
<td>0:00:07</td>
<td>29 kph</td>
<td>164° true</td>
</tr>
</tbody>
</table>

© David Last
<table>
<thead>
<tr>
<th>Location</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>51.66855</td>
<td>-3.90383</td>
</tr>
<tr>
<td>A56 Chester Road, Manchester</td>
<td>53.46023</td>
<td>-2.29038</td>
</tr>
<tr>
<td>Cemetery Road, Sheffield</td>
<td>53.37154</td>
<td>-1.47992</td>
</tr>
<tr>
<td>Coed Y Maes, Bangor (Gwynedd)</td>
<td>53.21327</td>
<td>-4.15964</td>
</tr>
<tr>
<td>Nun's Road, Chester</td>
<td>53.18913</td>
<td>-2.89714</td>
</tr>
<tr>
<td>Unnamed road, Strelley</td>
<td>52.97967</td>
<td>-1.2392</td>
</tr>
<tr>
<td>Unnamed road, Shrewsbury</td>
<td>52.74558</td>
<td>-2.73656</td>
</tr>
<tr>
<td>Granby Avenue, Kitts Green</td>
<td>52.47246</td>
<td>-1.77225</td>
</tr>
<tr>
<td>A38 Bath Road, Broomhall (Worcester)</td>
<td>52.15934</td>
<td>-2.21467</td>
</tr>
<tr>
<td>77 Ty Glas Avenue, Cardiff</td>
<td>51.52687</td>
<td>-3.19156</td>
</tr>
<tr>
<td>Limekiln Close, Stoke Gifford</td>
<td>51.50885</td>
<td>-2.54866</td>
</tr>
</tbody>
</table>

List of addresses extracted from TomTom car navigator

© David Last
Garmin eTrex hand-held GPS

Picture: www.garmin.com

© David Last
Nottinghamshire stops vehicle thieves in their tracks thanks to Masternaut

Leeds, UK, 10 November 2009 - Police forces from South Yorkshire and Nottinghamshire took just 30 minutes to intercept and recover a stolen Nottinghamshire County Council pick-up truck. The vehicle had recently been equipped with a Thatcham Category 5 satellite tracking device from Masternaut Three X.

Using live tracking on the web, Mick Managhan of the Council’s Highway Operations team helped to direct Nottinghamshire Police Force’s helicopter and South Yorkshire patrol vehicles to intercept the stolen vehicle. Within 30 minutes the vehicle was recovered undamaged, saving the Council the cost of replacing it and also stopping further inconvenience caused by the theft.

Armed raiders hijack lorry

Keith Blackey, 42, of Melksham, Wiltshire, was bundled into the boot of a car and driven to Bristol. The car was then doused in petrol, but the raiders released him before setting it alight.
Vehicle tracking system
Vehicle tracking system

*Checks to establish quality of evidence*
“In high-quality tracking data, a moving vehicle’s fixes lie close to roads and are even biased to the left-hand carriageway.”
Could this fix be 130 metres away?
**How accurate is this GPS, then?**

<table>
<thead>
<tr>
<th>Location</th>
<th>Max. Error</th>
<th>95%-ile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open site, Car roof</td>
<td>3.1m</td>
<td>2.0m</td>
</tr>
<tr>
<td>Open site, Beneath car</td>
<td>5.0m</td>
<td>4.2m</td>
</tr>
<tr>
<td>Urban canyons, Car roof</td>
<td>300m</td>
<td></td>
</tr>
</tbody>
</table>

© David Last
£6m lorry hijackings gang face ten years

Thursday 6th May 2010, 11:30AM BST.

Satellite jamming equipment was used to stop lorries being tracked after they were stolen.
GPS and GSM Jammer

Picture: http://www.tayx.co.uk
• GPS satellite radiates 100W
• From 20,000km range
• Illuminates 38% of Earth
• eg Europe + Africa + Atlantic

Picture: Professor Durk van Willigen
High-powered GPS and Mobile Phone Jammer

Features | GMW08
Desktop professional design. Very large power.
Works on AC/Car power directly for 24 hours 7 days.
Ideal for use in house, truck, vessel etc.
Could block all of the mobile phone networks.
Separated switch for control mobile phone bands and GPS.

Specifications | GMW08
Frequency for Europe: GPS L1 System, CDMA800, GSM900, GSM1800 & UMTS2110 MHz
Frequency for America: or GPS L1 System, GSM850, GSM1900 & W-CDMA2110MHz
Coverage: 20 ~ 40 Meters Radius
Current: 6A
Power: GSM/CDMA/GPS 2W, others 1.5W, total 6.5W
Voltage: DC12 /AC220V
Impedance: 50 Ω
Size: 250x53x355mm (no antenna 250x53x155mm)
Work Temp.: -15 ~ 60 C (~59 ~ 140 F)

Contact us and ask for detail price list.
Download DATA SHEET.

Picture: http://www.gpsjammers.net/gmw08.html
GJ5 is the first GPS jammer blocker to jam all civil GPS L1, L2, L5 bands - GPS blockers - Jammer-Store.mht

GJ5 GPS L1, L2, L5 Jammer + 2.4G Wifi Bluetooth Blocker

No Sales Tax!

Free Shipping

Safe & Secure Shopping

$ 320.00

excl. Shipping Costs

Print product data sheet

Shipping time: 3-4 Days

ADD TO CART


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GPS Spoofing

“… Jon used a desktop computer attached to a GPS satellite simulator to create a fake GPS signal …”

“During later experiments, Jon … spoofed GPS signals at ranges over three quarters of a mile … at Los Alamos.”
LabSat - GPS simulator, recorder and replayer

LabSat GPS Simulator

LabSat by Racelogic is a low cost GPS Simulator which gives you the ability to record and replay real GPS RF data as well as user generated scenarios. If you are selling, testing or developing products incorporating GPS engines, then you’ll find LabSat makes your job easier and more effective.

Scenarios

LabSat is shipped with a number of default scenarios stored on a portable 250Gbyte USB drive. These scenarios include a number of files recorded whilst driving in various different conditions, good reception, heavy tree cover, near tall buildings etc. They also include some high dynamic vehicle tests, and some aircraft scenarios as well. The scenarios can be streamed directly from the USB drive, and it can also be used for recording as well.

Pictures: http://www.labsat.co.uk
• British ship is sunk by Chinese in international waters.

• Clue is fake GPS signal controlled by techno-terrorist.

• Bond discovers GPS device - and wins the girl!
Options to mitigate jamming and spoofing

- Detect and enforce
- Lojack
- Cellular asset recovery
- Dead-reckoning
- Enhanced Loran
Enhanced Loran (eLoran)

• On earth, high-powered
• Different from GPS but a plug-in replacement
• FAA’s GPS complement for aviation + maritime + timing
• Loran-C plus digital technology

Pictures: Mitchell Narins, Federal Aviation Administration; Reelektronika bv

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So ...
where are we headed?

• GPS evidence vital in vehicle crime
• Forensic use of GPS growing rapidly
• Evidence being tested in court
• GPS-based systems now under attack