

Crime, Punishment and the Global Positioning System

Professor David Last

*Position, Navigation & Time -
4th Annual Symposium*

Stanford University

9 November 2010





TomTom Car Navigator GPS receiver + Computer

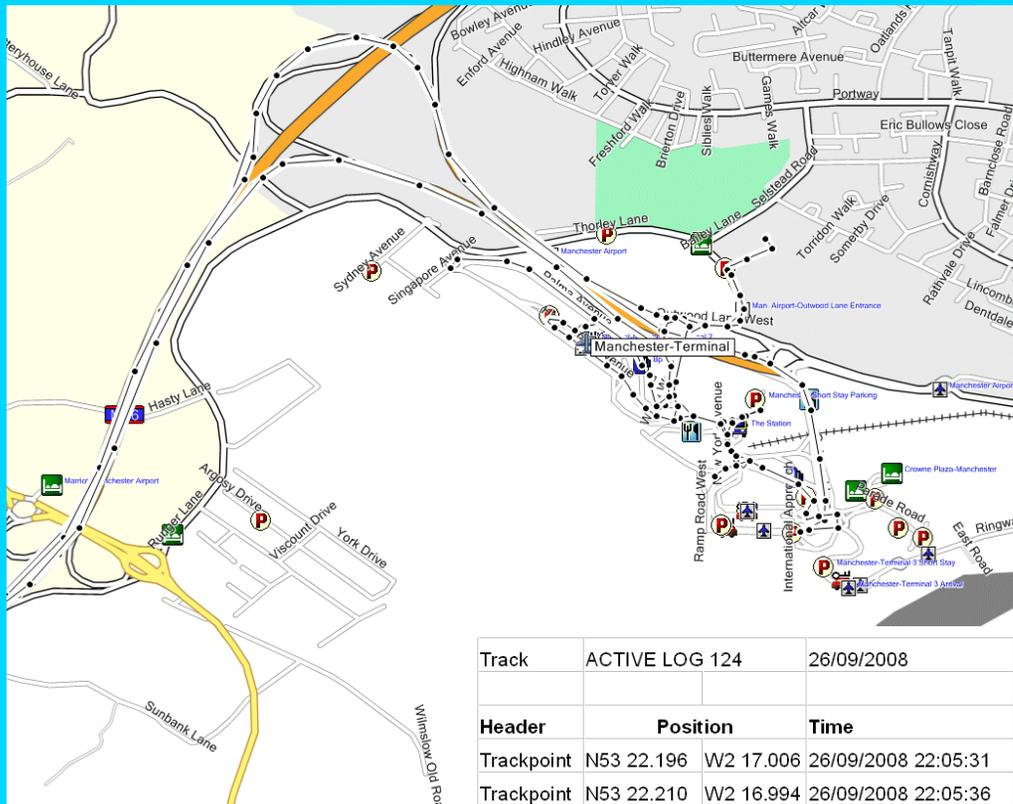
Picture: www.tomtom.com

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



Plot of addresses extracted from TomTom car navigator

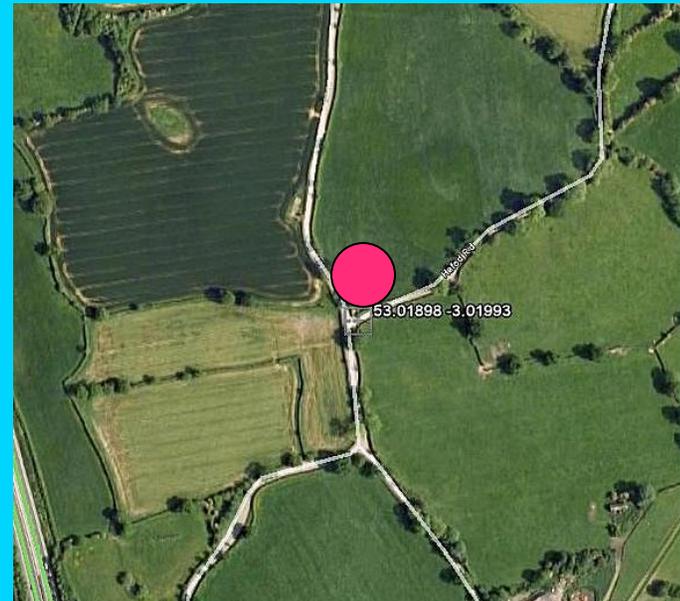
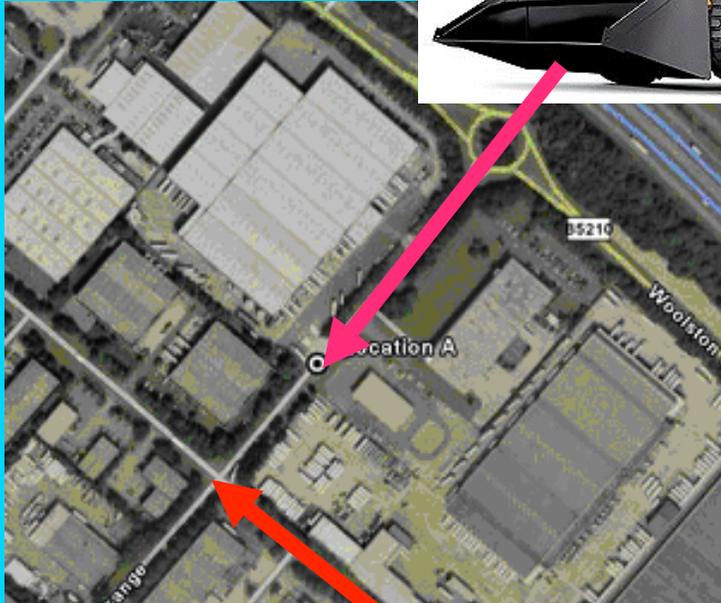
Multiple timed and dated tracks



Track	ACTIVE LOG 124	26/09/2008	22:05:31	0:00:46	595 m	47 kph		
Header	Position	Time	Altitude	Leg Length	Leg Time	Leg Speed	Leg Course	
Trackpoint	N53 22.196 W2 17.006	26/09/2008 22:05:31	79 m					
Trackpoint	N53 22.210 W2 16.994	26/09/2008 22:05:36	78 m	30 m	0:00:05	22 kph	28° true	
Trackpoint	N53 22.210 W2 16.994	26/09/2008 22:05:38	78 m	0 m	0:00'02	0 kph	0° true	
Trackpoint	N53 22.207 W2 16.893	26/09/2008 22:05:43	78 m	111 m	0:00:05	80 kph	92° true	
Trackpoint	N53 22.194 W2 16.847	26/09/2008 22:05:47	78 m	57 m	0:00:04	51 kph	115° true	
Trackpoint	N53 22.112 W2 16.714	26/09/2008 22:06:01	78 m	212 m	0:00:14	54 kph	136° true	
Trackpoint	N53 22.063 W2 16.663	26/09/2008 22:06:10	76 m	128 m	0:00'09	51 kph	135° true	
Trackpoint	N53 22.034 W2 16.619	26/09/2008 22:06:17	76 m	57 m	0:00:07	29 kph	164° true	

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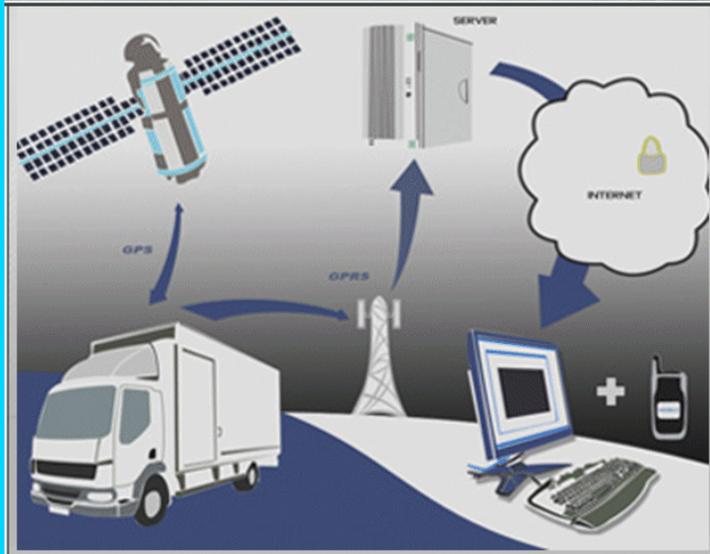
Garmin eTrex hand-held GPS



Picture: www.garmin.com



Sat³ Trailer Tracking



Only one number stands out

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.

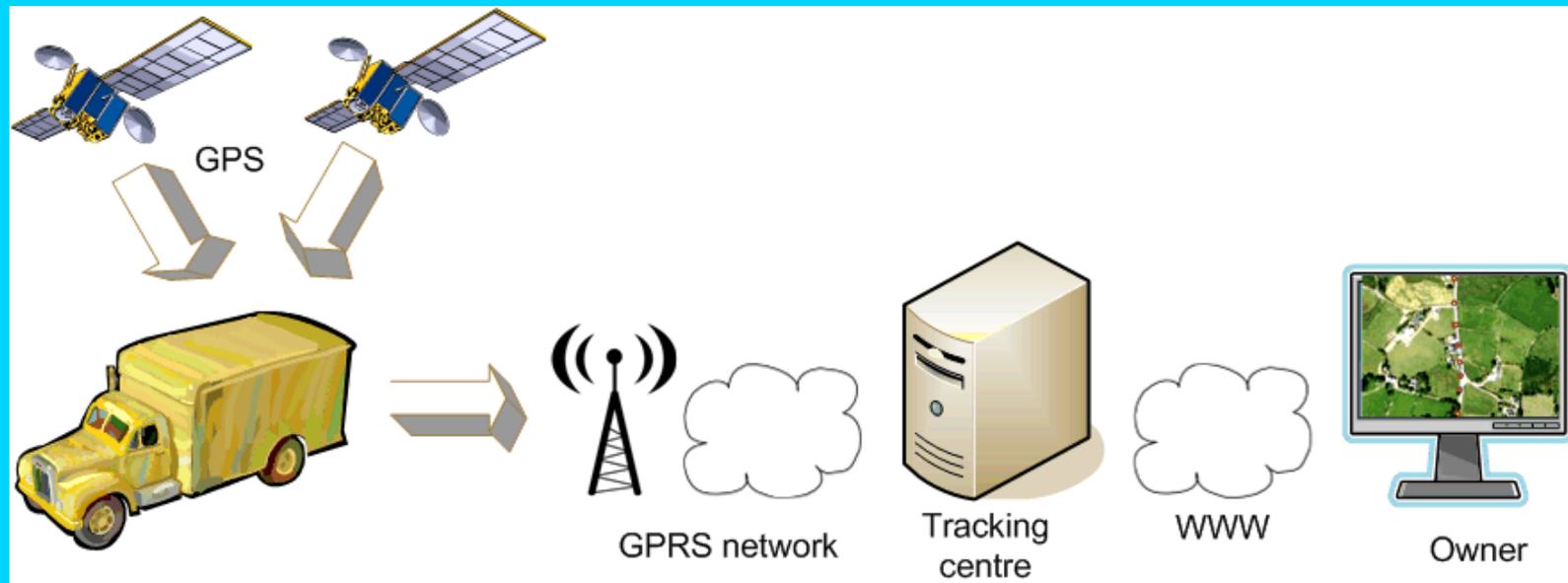
Using live tracking on the web, Mick Monaghan of the Council's Highway Operations team helped to direct Nottinghamshire Police Force's helicopter and South Yorkshire patrol vehicles to intercept the stolen vehicle. Within 30 minutes the vehicle was recovered undamaged, saving the Council the cost of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



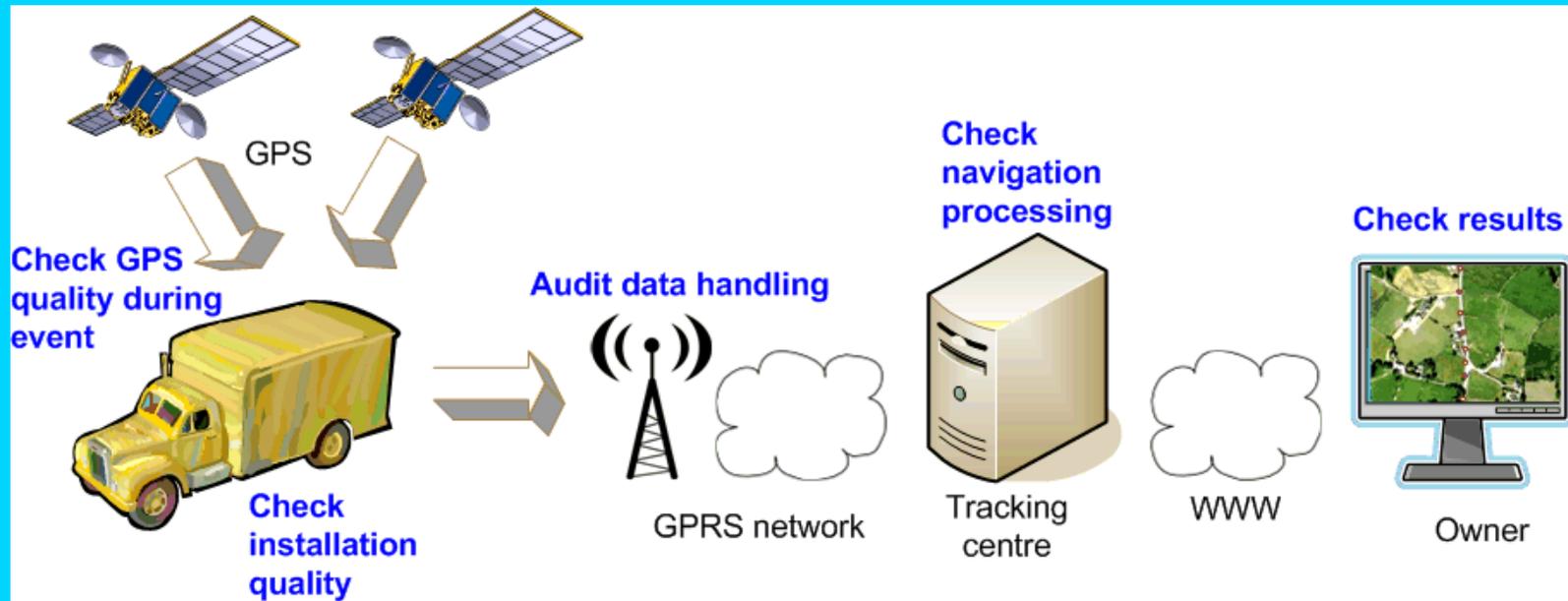
Armed raiders hijack lorry

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.

Pictures: dreamstime.com, findarticles.com, masternaut.co.uk, www.wire3-t.co.uk

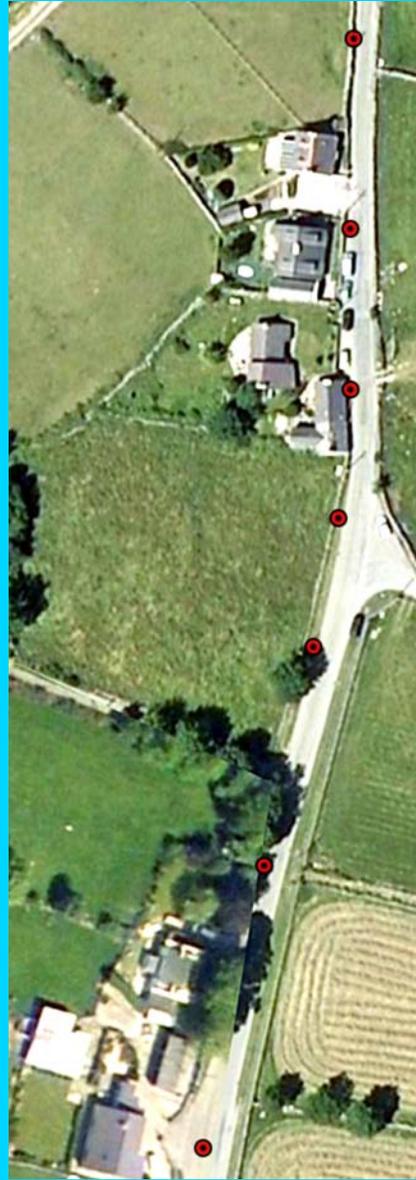


Vehicle tracking system



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.”



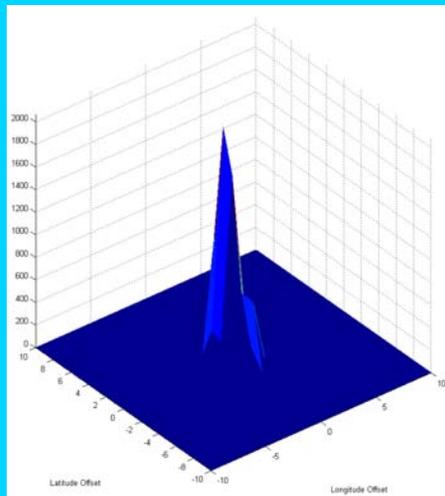
Picture: <http://www.tdl.ltd.uk>

Could this fix be 130 metres away?



How accurate is this GPS, then?

**Open site
Car roof**



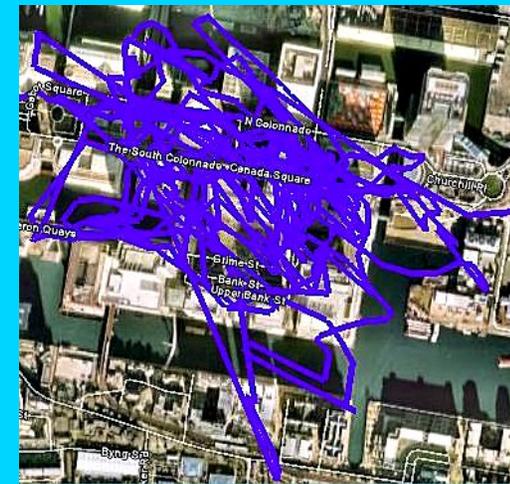
**Max. error: 3.1m
95%-ile: 2.0m**

**Open site
Beneath car**



**Max. error: 5.0m
95%-ile: 4.2m**

**Urban canyons
Car roof**



Max. error: 300m

£6m lorry hijackings gang face ten years

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

nobody gets you closer

Express & Star



Satellite jamming equipment was used to stop lorries being tracked after they were stolen.

GPS and GSM Jammer



Picture: <http://www.tayx.co.uk>

© David Last



- **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

GMW08 || DESKTOP GPS, GSM, GPRS & UMTS JAMMER / BLOCKER / INTERCEPTOR



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

Jammer[®]
The price of silence

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**

Pictures: www.jammer-store.com/gj5-gps-l1-l2-l5-jammer-blocker.html

© David Last

Schneier on Security

A blog covering security and security technology.



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.”

Pictures: www.schneier.com



Simulate, Record, Replay
- GPS RF signals



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LabSat – GPS simulator, recorder and replayer

LabSat GPS Simulator



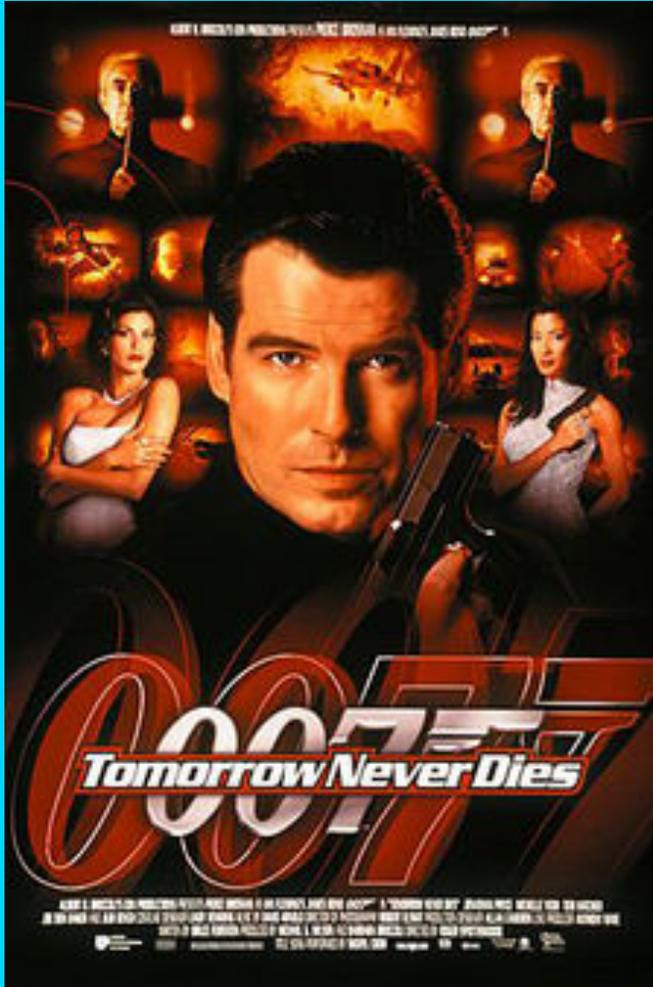
LabSat by Racelogic is a low cost GPS Simulator which gives you the ability to record and replay real GPS RF data as well as user generated scenarios. If you are selling, testing or developing products incorporating GPS engines, then you'll find LabSat makes your job easier and more effective.

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!

Picture: [/www.imdb.com/title/tt0120347](http://www.imdb.com/title/tt0120347), www.naval-technology.com/projects/t23/

Options to mitigate jamming and spoofing

- *Detect and enforce*
- *Lojack*
- *Cellular asset recovery*
- *Dead-reckoning*
- *Enhanced Loran*



Picture: <http://www.tayx.co.uk>

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

**So ...
where are we headed?**

*The Forensics of GPS -
Crime, Jamming & Spoofing*

Professor David Last

NAV10: Position, Location, Timing
30th November 2010
Church House, Westminster



© David Last

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

© David Last